SSIGL 24

NATIONAL GUIDELINES

For Small Scale Irrigation Development in Ethiopia

Technical Specifications Preparation

November 2018

Addis Ababa

MINISTRY OF AGRICULTURE

National Guidelines for Small Scale Irrigation Development in Ethiopia

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DISCLAIMER

Ministry of Agriculture through the Consultant and core reviewers from all relevant stakeholders included the information to provide the contemporary approach about the subject matter. The information contained in the guidelines is obtained from sources believed tested and reliable and are augmented based on practical experiences. While it is believed that the guideline is enriched with professional advice, for it to be successful, needs services of competent professionals from all respective disciplines. It is believed, the guidelines presented herein are sound and to the expected standard. However, we hereby disclaim any liability, loss or risk taken by individuals, groups, or organization who does not act on the information contained herein as appropriate to the specific SSI site condition.

FORWARD

Ministry of Agriculture, based on the national strategic directions is striving to meet its commitments in which modernizing agriculture is on top of its highest priorities to sustain the rapid, broad-based and fair economic growth and development of the country. To date, major efforts have been made to remodel several important strategies and national guidelines by its major programs and projects.

While efforts have been made to create access to irrigation water and promoting sustainable irrigation development, several barriers are still hindering the implementation process and the performance of the schemes. The major technical constrains starts from poor planning and identification, study, design, construction, operation, and maintenance. One of the main reasons behind this outstanding challenge, in addition to the capacity limitations, is that SSIPs have been studied and designed using many ad-hoc procedures and technical guidelines developed by various local and international institutions.

Despite having several guidelines and manuals developed by different entities such as MoA (IDD)-1986, ESRDF-1997, MoWIE-2002 and JICA/OIDA-2014, still the irrigation professionals follow their own public sources and expertise to fill some important gaps. A number of disparities, constraints and outstanding issues in the study and design procedures, criteria and assumptions have been causing huge variations in all vital aspects of SSI study, design and implementation from region to region and among professionals within the same region and institutions due mainly to the lack of agreed standard technical guidelines. Hence, the SSI Directorate with AGP financial support, led by Generation consultant (GIRDC) and with active involvement of national and regional stakeholders and international development partners, these new and comprehensive national guidelines have been developed.

The SSID guidelines have been developed by addressing all key features in a comprehensive and participatory manner at all levels. The guidelines are believed to be responsive to the prevalent study and design contentious issues; and efforts have been made to make the guidelines simple, flexible and adaptable to almost all regional contexts including concerned partner institution interests. The outlines of the guidelines cover all aspects of irrigation development including project initiation, planning, organizations, site identification and prioritization, feasibility studies and detail designs, contract administration and management, scheme operation, maintenance and management.

Enforceability, standardization, social and environmental safeguard mechanisms are well mainstreamed in the guidelines, hence they shall be used as a guiding framework for engineers and other experts engaged in all SSI development phases. The views and actual procedures of all relevant diverse government bodies, research and higher learning institutions, private companies and development partners has been immensely and thoroughly considered to ensure that all stakeholders are aligned and can work together towards a common goal. Appropriately, the guidelines will be familiarized to the entire stakeholders working in the irrigation development. Besides, significant number of experts in the corresponding subject matter will be effectively trained nationwide; and the guidelines will be tested practically on actual new and developing projects for due consideration of possible improvement. Hence, hereinafter, all involved stakeholders including government & non-governmental organizations, development partners, enterprises, institutions, consultants and individuals in Ethiopia have to adhere to these comprehensive national guidelines in all cases and at all level whilst if any overlooked components are found, it should be documented and communicated to MOA to bring them up-to-date.

Therefore, I congratulate all parties involved in the success of this effort, and urge partners and stakeholders to show a similar level of engagement in the implementation and stick to the guidelines over the coming years.

H.E. Dr. Kaba Urgessa
State Minister, Ministry of Agriculture

SMALL SCALE IRRIGATION DEVELOPMENT VISION

Transforming agricultural production from its dependence on rain-fed practices by creating reliable irrigation system in which smallholder farmers have access to at least one option of water source to increase production and productivity as well as enhance resilience to climate change and thereby ensure food security, maintain increasing income and sustain economic growth.

ACKNOWLEDGEMENTS

The preparation of SSIGLs required extensive inputs from all stakeholders and development partners. Accordingly many professionals from government and development partners have contributed to the realization of the guidelines. To this end MOA would like to extend sincere acknowledgement to all institutions and individuals who have been involved in the review of these SSIGLs for their comprehensive participation, invaluable inputs and encouragement to the completion of the guidelines. There are just too many collaborators involved to name exhaustively and congratulate individually, as many experts from Federal, regional states and development partners have been involved in one way or another in the preparation of the guidelines. The contribution of all of them who actively involved in the development of these SSIGLs is gratefully acknowledged. The Ministry believes that their contributions will be truly appreciated by the users for many years to come.

The Ministry would like to extend its appreciation and gratitude to the following contributors:

- Agriculture Growth Program (AGP) of the MoA for financing the development and publication of the guidelines.
- The National Agriculture Water Management Platform (NAWMP) for overseeing, guidance and playing key supervisory and quality control roles in the overall preparation process and for the devotion of its members in reviewing and providing invaluable technical inputs to enrich the guidelines.
- Federal Government and Regional States organizations and their staff for their untiring effort in reviewing the guidelines and providing constructive suggestions, recommendations and comments.
- National and international development partners for their unreserved efforts in reviewing the guidelines and providing constructive comments which invaluably improved the quality of the guidelines.
- Small-scale and Micro Irrigation Support Project (SMIS) and its team for making all efforts to have quality GLs developed as envisioned by the Ministry.

The MOA would also like to extend its high gratitude and sincere thanks to AGP's multi development partners including the International Development Association (IDA)/World Bank, the Canada Department of Foreign Affairs, Trade and Development (DFATD), the United States Agency for International Development (USAID), the Netherlands, the European Commission (EC), the Spanish Agency for International Development (AECID), the Global Agriculture and Food Security Program (GAFSP), the Italy International Development Cooperation, the Food and Agriculture Organization (FAO) and the United Nations Development Program (UNDP).

Moreover, the Ministry would like to express its gratitude to Generation Integrated Rural Development Consultant (GIRDC) and its staff whose determined efforts to the development of these SSIGLs have been invaluable. GIRDC and its team drafted and finalized all the contents of the SSIGLs as per stakeholder suggestions, recommendations and concerns. The MoA recognizes the patience, diligence, tireless, extensive and selfless dedication of the GIRDC and its staff who made this assignment possible.

Finally, we owe courtesy to all national and International source materials cited and referred but unintentionally not cited.

Ministry of Agriculture

DEDICATIONS

The National Guidelines for Small Scale Irrigation Development are dedicated to Ethiopian smallholder farmers, agro-pastoralists, pastoralists, to equip them with appropriate irrigation technology as we envision them empowered and transformed.

LIST OF GUIDELINES

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS

AASHTO	American Association State Highway and Transportation Officials
AGP	Agricultural Growth Program
ASTM	American Society for Testing And Materials
BOQ	Bill of Quantities
BS	British Standard
BS EN	British Standard Euro code
EBCS	Ethiopian Building Code Standard
EEPCO	Ethiopian Electric Power Corporation
EN	European Standard
ERA	Ethiopian Road Authority
ETB	Ethiopian Birr
GIRDC	Generation Integrated Rural Development Consultant
GL	Guideline
HCB	Hallow Concrete Block
HDPE	High Density Polyethylene
IS	Indian Standard
IWUA	Irrigation Water Users Association
m2	Square Meter
m3	Cubic Meters
MoANR	Ministry of Agriculture and Natural Resources
PBOQ	Priced Bill of Quantities
PVC	Poly Venile Chloride
SSID	Small Scale Irrigation Development
SSIP	Small Scale Irrigation Project
TOR	Term of Reference
TSCS	Technical Specification Compliance Sheet

PREFACE

While irrigation development is at the top of the government's priority agendas as it is key to boost production and improve food security as well as to provide inputs for industrial development. Accordingly, irrigated land in different scales has been aggressively expanding from time to time. To this end, to enhance quality delivery of small-scale irrigation development planning, implementation and management, it has been decided to develop standard SSI guidelines that must be nationally applied. In September 2017 the Ministry of Agriculture (MoA) had entrusted Generation Integrated Rural Development Consultant (GIRDC) to prepare the National Small-scale Irrigation Development Guidelines (SSIGLs).

Preparation of the SSIGLs for enhancing development of irrigated agriculture is recognized as one of the many core initiatives of the MoA to improve its delivery system and achieve the targets in irrigated agriculture and fulfill its mission for improving agricultural productivity and production. The core objective of developing SSIGLs is to summarize present thinking, knowledge and practices to enable irrigation practitioners to properly plan, implement and manage community managed SSI schemes to develop the full irrigation potential in a sustainable manner.

As the SSIGLs are prepared based on national and international knowledge, experiences and practices, and describe current and recommended practice and set out the national standard guides and procedures for SSI development, they serve as a source of information and provide guidance. Hence, it is believed that the SSIGLs will contribute to ensuring the quality and timely delivery, operation and maintenance of SSI schemes in the country. The SSIGLs attempt to explain and illustrate the important concepts, considerations and procedures in SSI planning, implementation and management; and shall be used as a guiding framework for professionals engaged in SSI development. Illustrative examples from within the country have been added to enable the users understand the contents, methodologies presented in the SSIGLs.

The intended audiences of the SSIGLs are government organizations, NGOs, CSOs and the private sector involved in SSI development. Professionally, the SSIGLs will be beneficial for experienced and junior planners, experts, contractors, consultants, suppliers, investors, operators and managers of SSI schemes. The SSIGLs will also serve as a useful reference for academia and researchers involved and interested in SSI development. The SSIGLs will guide to ensure that; planning, implementation and management of SSI projects is formalized and set procedures and processes to be followed. As the SSIGLs provide information and guides they must be always fully considered and applied by adapting them to the local specific requirements.

In cognizance with the need for quality SSIGLs, the MoA has duly considered quality assurance and control during preparation of the guidelines. Accordingly, the outlines, contents and scope of the SSIGLs were thoroughly discussed, reviewed and modified by NAWMP members (senior professionals from public, national and international stakeholder) with key stakeholders in many consultative meetings and workshops. Moreover, at each milestone of SSIGL preparation, resource persons from all stakeholders reviewed and confirmed that SSIGLs have met the demands and expectations of users.

Moreover, the Ministry has mobilized resource persons from key Federal, National Regional States level stakeholders and international development partners for review, validation and endorsement of the SSIGLs.

Several hundreds of experienced professionals (who are very qualified experts in their respective fields) from government institutions, relevant private sector and international development partners have significantly contributed to the preparation of the SSIGLs. They have been involved in all aspects of the development of SSIGLs throughout the preparation process. The preparation process included a number of consultation meetings and workshops: (i) workshop to review inception report, (ii) workshop on findings of review of existing guidelines/manuals and proposed contents of the SSIGLs, (iii) meetings to review zero draft SSI GLs, (iv) review workshop on draft SSI GLs, (v) small group review meetings on thematic areas, (vi) small group consultation meetings on its final presentation of contents and layout, (vii) consultation mini-workshops in the National States on semi-final versions of the SSIGLs, and (viii) final write-shop for the appraisal and approval of the final versions of SSIGLs.

The deliberations, concerns, suggestions and comments received from professionals have been duly considered and incorporated by the GIRD Consultant in the final SSIGLs.

There are 34 separate guidelines which are categorized into the following five parts concurrent to SSI development phases:

Part-I. Project Initiation, Planning and Organization Guideline which deals with key considerations and procedures on planning and organization of SSI development projects.

Part-II. Site Identification and Prioritization Guideline which treats physical potential identification and prioritization of investment projects. It presents SSI site selection process and prioritization criteria.

Part-III. Feasibility Study and Detail Design Guidelines for SSID dealing with feasibility study and design concepts, approaches, considerations, requirements and procedures in the study and design of SSI systems.

Part-IV. Contract Administration and Construction Management Guidelines for SSI development presents the considerations, requirements, and procedures involved in construction of works, construction supervision and contract administration.

Part-V. SSI Scheme Management, Operation and Maintenance Guidelines which covers SSI Scheme management and operation.

Moreover, Tools for Small Scale Irrigation development are also prepared as part of SSIGLs.

It is strongly believed and expected that; the SSIGLs will be quickly applied by all stakeholders involved in SSI development and others as appropriate following the dissemination and familiarization process of the guidelines in order to ensure efficient, productive and sustainable irrigation development.

The SSIGLs are envisioned to be updated by incorporating new technologies and experiences including research findings. Therefore, any suggestions, concerns, recommendations and comments on the SSIGLs are highly appreciated and welcome for future updates as per the attached format below. Furthermore, despite efforts in making all types of editorial works, there may still errors, which similarly shall be handled in future undated versions.

UPDATING AND REVISIONS OF GUIDELINES

The GLs are intended as an up-to-date or a live document enabling revisions, to be updated periodically to incorporate improvements, when and where necessary; may be due to evolving demands, technological changes and changing policies, and regulatory frameworks. Planning, study and design of SSI development interventions is a dynamic process. Advancements in these aspects are necessary to cope up with the changing environment and advancing techniques. Also, based on observation feedbacks and experiences gained during application and implementation of the guidelines, there might be a need to update the requirements, provisions and procedures, as appropriate. Besides, day-by-day, water is becoming more and more valuable. Hence, for efficient water development, utilization and management will have to be designed, planned and constructed with a new set up of mind to keep pace with the changing needs of the time. It may, therefore, be necessary to take up the work of further revision of these GLs.

This current version of the GLs has particular reference to the prevailing conditions in Ethiopia and reflects the experience gained through activities within the sub-sector during subsequent years. This is the first version of the SSI development GLs. This version shall be used as a starting point for future update, revision and improvement. Future updating and revisions to the GLs are anticipated as part of the process of strengthening the standards for planning, study, design, construction, operation and management SSI development in the country.

Completion of the review and updating of the GLs shall be undertaken in close consultation with the federal and regional irrigation institutions and other stakeholders in the irrigation sub-sector including the contracting and consulting industry.

In summary, significant changes to criteria, procedures or any other relevant issues related to technological changes, new policies or revised laws should be incorporated into the GLs from their date of effectiveness. Other minor changes that will not significantly affect the whole nature of the GLs may be accumulated and made periodically. When changes are made and approved, new page(s) incorporating the revision, together with the revision date, will be issued and inserted into the relevant GL section.

All suggestions to improve the GLs should be made in accordance with the following procedures:

I. Users of the GLs must register on the MOA website: Website: www.moa.gov.et
II. Proposed changes should be outlined on the GLs Change Form and forwarded with a covering letter or email of its need and purpose to the Ministry.
III. Agreed changes will be approved by the Ministry on recommendation from the Small-scale Irrigation Directorate and/or other responsible government body.
IV. The release date of the new version will be notified to all registered users and authorities.

Users are kindly requested to present their concerns, suggestions, recommendations and comments for future updates including any omissions and/or obvious errors by completing the following revisions form and submitting it to the Ministry. The Ministry shall appraise such requests for revision and will determine if an update to the guide is justified and necessary; and when such updates will be published. Revisions may take the form of replacement or additional pages. Upon receipt, revision pages are to be incorporated in the GLs and all superseded pages removed.

Suggested Revisions Request Form (Official Letter or Email)

To: ----------
From: ----------
Date: ----------
Description of suggested updates/changes: Include GL code and title, section title and # (heading/subheading #), and page #.

GL Code and Title	Date	Sections/ Heading/Subheading/ Pages/Table/Figure	Explanation	Comments (proposed change)

Note that be specific and include suggested language if possible and include additional sheets for comments, reference materials, charts or graphics.

GLs Change Action

Suggested Change	Recommended Action	Authorized by	Date

Director for SSI Directorate**: _____Date: _____**

The following table helps to track initial issuance of the guidelines and subsequent Updates/Versions and Revisions (Registration of Amendments/Updates).

Revision Register

Version/Issue/Revision No	Reference/Revised Sections/Pages/topics	Description of revision (Comments)	Authorized by	Date

1 INTRODUCTION

1.1 GENERAL

This Technical Specification Guideline for SSID depicts the material quality and workmanship requirement to be adopted and the overall quality of construction based on the required quality achievement & performance of structures.

1.2 OBJECTIVE

The objective of this guideline is to provide guidance of technical specifications preparation for Construction Works of Small Scale Irrigation Development.

1.3 SCOPE

This guideline covers the basics for technical specification preparation for SSID and standard technical specification applicable for construction of Small Scale Irrigation Development. Based on this guideline, designers shall prepare project specific technical specification during design phase.

1.4 SETTING OF THE GUIDELINE

Technical Specification Preparation Guideline for Small Scale Irrigation Development addressed the issues in detail chapter by chapter. There are eighteen chapters having the following contents:

Chapter one presents introduction of the guideline and deals with the scope and setting out of the guideline. Chapter two deals with technical specifications preparation basics giving guide notes how to prepare a sound technical specification. Chapter three deal with general conditions and specifications that should be included in a given technical specification.

Chapter four and five deal with submittals and contract close out respectively. Chapter six deal with Clearing and Grubbing, whereas, technical specification of excavation as well as earth fill and compaction aderessed in chapter seven and eight respectively.

Technical specification of masonry work, concret work, steel reinforcement for structures, hardcore, gabion structures, and riprap presented through chapter nine to fourteen one after the other. Chapter fifteen deals with technical specification of pump and pump accessories, whereas, chapter sixteen for pipe works. Technical specification for road network & miscellaneous works are presented in chapter seventeen and eighteen respectively.

2 BASICS OF TECHNICAL SPECIFICATIONS PREPARATION

2.1 GENERAL

The information that is needed for construction work is usually conveyed by two basic communication lines. They are Drawings (pictorial) and Specifications (written).

Specifications are devices for organizing the information depicted on the drawings and they are written descriptions of the legal and technical requirements forming the contract documents.

Specification is defined as the designation or statement by which written instructions are given distinguishing and/or limiting and describing the particular trade of work to be executed.

Specifications are written based on the prepared design, drawings, general and scientific trends of workmanship, quality expected, equipment involved and materials to be used for the particular trade of work.

The specifications should clearly specify: -

i. Type and quality of materials, equipments, labor or workmanship
ii. Methods of fabrication, installation and erection
iii. Standards, codes and tests
iv. Allowance, submittals and substitutions
v. Cost included, insurance and bonds
vi. Project records and site facilities

Specifications should be clear, concise, and brief descriptions of what is required to execute the proposed trade of work.

2.2 PURPOSES OF SPECIFICATIONS

The purpose of specifications generally includes but not limited to: -

1. Guide the bidder at the time of tendering to arrive at a reasonable cost for the work,
2. Provide guidance for execution and supervision of works,
3. Guide the contractor for the purchase of materials,
4. Serve as a part of contract document to limit and describe the rights and obligations of each contracting parties,
5. Guide the bidder to identify his capacity to execute the work,
6. Serve as fabrication and installation guide for temporary and permanent works.
7. Guide the contractor for the purchase and/or hiring of equipments.
8. Serve for the owner to know what he/she is entitled to receive,
9. Serve for the manufacturers of construction materials, equipments, tools etc… to grade, classify, and improve qualities of their produces,
10. Indirectly, the specifications are very much related to the legal considerations, insurance considerations, bidding requirements, alternates and options, rights, obligations and remedial measures for the contracting parties.

Note: In the events of conflicts between specification and drawings, the specification governs.

2.3 TYPES OF SPECIFICATIONS

In general, specifications can be broadly classified into four categories as follows: -

2.3.1 Manufacturer's specification

Manufacturers prepare specification of their product for the guidance of their users, which may include property description and installation guidelines.

2.3.2 Guide specification

Specifications prepared by an individual or group of individuals based on manufacturer's specifications, established trends of workmanship, service and laboratory tests and research findings to be used as guidelines for preparation of contract specifications.

2.3.3 Standard specification

Standard specification is specification which is intended to be used as a reference standard in the construction of a project. The guide specification which has been standardized by a recognized authority is considered as standard specification.

2.3.4 Contract (project) specification

The specification prepared for a particular project to accompany the drawings and other contract documents.

"Technical Specification and Methods of Measurement for Construction of Buildings", of March 1991 is the standard specification which has been in use for many years as one of the contract documents in our country. This material has the general requirement part and the specific part.

In the specific part the different trades of works (excavation and earth works, concrete works, etc.) are described in details and the method of measurements are given.

There are the following types of technical specifications:

2.3.4.1 Proprietary specifications

This specifications call for desired materials, producers, systems, and equipments by their trade names and model numbers. For detailed descriptions reference should be made to manufacturer's specifications.

2.3.4.2 Performance specifications

Performance specification: -

- Specifications which define products based on desired end results which are performance oriented;
- Most appropriate when new or unusual products or systems are required or when innovation is necessary; and
- Testing methods and evaluation procedures for defining the required performances must be explicitly specified.

2.3.4.3 Reference Specifications

Specifications which refer to levels of quality established by recognized testing authority or standards set by quality control authorities. These specifications are also used in conjunction with other types of specifications. EBC, ASTM, AASHTO, ES, IS, etc.

Example: - C-25 Concrete.

2.3.4.4 Descriptive specifications

Specifications which describe all components of products, their arrangements and methods of assembly, physical and chemical properties, arrangement and relationship of parts and numerous other details.

The specifier shall take total responsibility for the function and performance of the product.

Example: - “Supply and fix 40mm. thick flush wood door with hard wood frames and both sides covered with best quality 4mm thick ply wood. Price includes approved quality lock, hinges, three coats of varnish paint, door stopper and all necessary accessories to comply ES’’.

2.3.4.5 Cash allowance specifications

Cash Allowance Specifications are specifications meant to direct bidders to set aside a specified amount of money to be applied to the construction work at the direction of the specifier.

Example: - “A lump sum of Ethiopian Birr 100,000.00 for mobilization of construction manpower, materials and machineries.

2.4 SPECIFICATION WRITING

Specification writing embodies certain methods of presenting information and instructions. When specifications are to be written, the following shall be taken into consideration:-

1. Specification writing require: -
   i. Visualization (having clear picture of the system),
   ii. Research (to know the legal impact correctly),
   iii. Clear thinking (understanding things directly without misleading), and
   iv. Organizing (organizing what we know to write the specification).
2. Specification writing require professional ability to read drawings;
3. Specification writing require wide knowledge of the construction materials, various levels of workmanship, different construction equipments and method of construction to be employed;
4. Specifications use simple and clear language such that it can readily be understood;
5. Specifications shall be brief and short as much as possible (avoid long sentences without punctuations);
6. Specifications shall include all items affecting the cost of the work;
7. Specifications shall be fair and do not attempt to throw all risks and responsibilities on one of the parties signing the contract, the employer or the contractor;
8. Specifications shall avoid repetition of information shown on drawings to avoid mistakes and duplications within the specifications and drawings; and

9. Specifications shall not include inapplicable text and do not specify the impossible or anything not intended to be enforced.

The following are useful references in Specification Writing: -

- Codes and ordinances of governments, cities, or municipalities. For example, Ethiopian Building Code of Standards (EBCS);
- Standards prepared by distinct societies and government agents. For example, ACI standards, ASTM standards, BS, ES;
- Standards or model specifications prepared by manufacturers, professional societies, and government bodies. For example, Standard Technical Specification and Method of Measurement for Road Works, 2013. Ethiopian Road Authority;
- Master specifications and previously written specifications; and
- Information or experience acquired by personal observation and contact with trained or experienced people in the construction industry.

2.5 SPECIFICATION LANGUAGE

The specification writer should present his instructions regarding the particular work under consideration in such a manner that: -

- The drawings are more clearly interpreted, not duplicated;
- Rights, obligations, and remedial measures shall be designated without ambiguity or prejudice; and
- Clearly express the extent of works under consideration; therefore, the phraseology used in this regard shall be: -

  a. Judged by its quality not its length,
  b. Should be concise and short and written with commonly used words, and
  c. Punctuations are important but their usage shall be limited to few.

Capitalizing the first letters is mandatory for the following expressions: -

i. Parties to the contract; e.g. Employer/Client/Contractor/Engineer,
ii. Space within the building; e.g. Bed Room, Toilet, Living Room, and
iii. Contract documents; e.g. Bill of Quantity, Working Drawing, Specification.

Minimize pronouns, better to repeat nouns. Minimize the use of symbols. Do not use foot notes, do not underline within a sentence for emphasis.

Words shall be used as follows:-

- shall in place of must; use “shall” for the duties of the contractor or the consultant to represent the word “must”;
- “will” is used for the duties of the employer to represent the word “must”;
- “must” – avoid the use of the word “must” and substitute by the word shall to prevent the inference of different degrees of obligation; and
- Avoid the use of words which have indefinite meanings or limitless and ambiguous in their meanings. For example, any, either, same, similar, etc.

3 GENERAL CONDITIONS AND SPECIFICATIONS

3.1 DESCRIPTION OF THE PROJECT AREA AND LOCATION

The project area and location shall be as specified in the bid document. For the description of project area and location refer *Part I. GL 1: Project Initiation, Planning and Organizations Guideline for SSID and other guidelines* as appropriate of this guideline.

3.2 DESCRIPTION OF WORKS

The principal items of work to be executed under the contract shall be indicated properly. The works vary project to project based on water abstraction system, conveyance system, and application system.

Most commonly the principal items of work to be executed under work Contract in SSID include but are not limited to the following: -

1. Access and Service Road construction along main canals;
2. Road/Canal Crossing, Drainage Culvert construction;
3. Headwork/diversion weir & Pump (incorporating wing walls, intake structure, stilling basin/ apron, and downstream stone Rip-rap) construction;
4. Earthen Canal construction on main and secondary canals;
5. Tertiary canals' and drains' works;
6. On-farm Irrigation structures Division Boxes, Drop structures, Culverts, Cross drain structure i.e. flume, Turn outs and off-takes) ;
7. Flood protection works
8. Installation of gates (that of sluice, intake, division boxes, turn outs and off-takes) construction;
9. On-farm Drainage structures construction;
10. Other works associated with the above including any modifications carried out within the terms of the Contract.

For the detail description of works refer *Part I. GL 1: Project Initiation, Planning and Organizations Guideline for SSID and other guidelines* as appropriate of this guideline.

3.3 SEQUENCE OF WORK

Proposed sequence of work shall be as specified in the contract document. For a given small scale irrigation construction project having water abstraction system of diversion weir, sequence of work to be followed during construction period can be as given below. The smallest Serial No. indicates the first work to be performed then the next higher Serial No. and so on. The proposal sequence of the work may be changed on site owing to the availability of construction material, machinery and weather conditions.

Table 3-1: Construction sequence of diversion weir

Serial No.	Construction Woks Sequence
1	Clearing weir site, then divert the lean flow of the river to the appropriate side of the bank by constructed temporary channel route as approved by the Engineer
2	Excavation of the left side wing wall, scouring sluice route, off-take canal and divide wall foundation. And then construct them the final point.
3	Divert the base flow to the under sluice channel by providing temporary guide channel u/s side of the weir. Then leveling the weir bed level the right side up to the expansion the divide wall left side.
4	Construction of the weir body from the left side up to the expansion joint then construct the rest weir body.
5	Excavate and clearing the primary canal up to the settling basin then constructs the main canal up to the settling basin.
6	Sluice gate and off-take gate installation.

Table 3-2: Construction sequence of irrigation infrastructure

Serial No.	Construction Woks Sequence
I	**Setting out**
1.1	Laying out of canal system and fixing bench marks at a reasonable distance.
1.2	Check the fitness of levels to the given structures and canals.
II	**Canal excavation and main canal masonry lining**
2.1	If the top part is loose strip to 15cm depth
2.2	Sequence of work shall be in series not more than 200 meter distance. This gives the advantage to reduce the haul distance of using excavated material as a back fill/fill. In addition to that enables to rectify any mistakes made during the design and alignment.
2.3	For main canal excavation, trench can be made using labor/machinery and in secondary canals as well whose bed width is 0.4 m. The bottom width of the trench shall be excavated first and the side slopes shaping will be continued.
2.4	Shape of the canals should be made by hand and hand machineries, such as laying out of geo - membrane /clay lining.
2.4	Lining with masonry & selected geo-membrane and clay shall be carried out and this material will be covered with local soils of the area.
III	**Canal filling**
3.1	Compacted fill of canal shall be founded on a stable formation level by removing top soil up to approved level by the engineer.
3.2	Canal in fill should be carried out using machinery and compacted layer not exceeding the specified thickness (25-30cm). Filling and compaction shall be made first and cutting to excavation line will be followed.
3.3	Lining with selected geo-membrane and clay shall be carried out and this material will be covered with local soils of the area.
IV	**Canal and related structures**
4.1	For the structures excavation shall be taken up to the required level and compacting the base and side of the walls shall be carried out as per the engineer instruction.
4.2	Base materials filler material and/or filter materials shall be provided at the base of the foundation with the supervisor/representative engineer approval and order.
4.3	Construction of superstructure shall be carried out in stage as per recommended curing period.
4.4	The space between excavation line and the structure should be compacted and filled with approved selected material after curing end of curing and finishing periods.

3.4 SURVEYING AND SETTING OUT WORKS

The Contractor shall be responsible for the true and proper setting out of the works and for the correctness of the positions, levels, dimensions and alignment of all parts of the works and for the provisions of all necessary instruments, appliances and labor in connection therewith. If at any time during the progress of the works, any error shall appear or arise in the position, levels, dimensions or alignment of any part of the works, the Contractor, on being required to do so by the Engineer, shall at his own expense rectify such error to the satisfaction of the Engineer.

The checking of any setting out or of any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for correctness thereof. The Contractor shall carefully protect and preserve all benchmarks, sight rails, pegs and other things used in setting out the works.

No separate payment will be made for this and the unit rates for the different items entered in the Bill of Quantities are deemed to cover all such expenditure.

For detail of surveying and setting out works refer *GL 4: Topographic and Irrigation Infrastructures Surveying Guideline for SSID prepared as a part of this guideline.*

3.5 CONSTRUCTION METHOD

The techniques used to build small scale irrigation infrastructures may be labour or machinery based on the forms and scales of the work. The commonly adopted methods are as tabulated under.

Table 3-3: Construction method

Serial No.	Type of work	The works to be done using	
		Machinery	Labor
1	Earth Work		
1.1	Clearing	✔	✔
1.2	All earth work, stripping top soil, excavation for foundation of major structure and others excavation	✔	✔
1.3	Canal and small canal structures foundation excavation		✔
1.4	Fill & compaction	✔	✔
2	Form Work		✔
3	Concrete Work		
3.1	Production of crushed aggregates	✔	
3.2	Mixing of concrete	✔	✔
3.3	Placing of concrete		✔
3.4	Compaction of the concrete	✔	✔
3.4	Curing of casted concrete		✔
4	Masonry Work		
4.1	Masonry work		✔
4.2	Cement Mortar mixing		✔
5	Carpentry Work		✔
6	Metal/Steel Works	✔	✔
7	Reinforcement bar Works		✔
8	Finishing Works		✔
9	Electro-Mechanical Works	✔	✔
10	Pipe Works	✔	✔

3.6 MOBILISATION AND DEMOBILISATION

3.6.1 Mobilization

Mobilization is understood to be the full process of furnishing all staff, labour, materials, tools, equipment and incidentals necessary to perform, complete and maintain all works required for moving in to the Site and shall include:

i. Transport of all items of equipment to the sites where they are to be used in the Works and their installations;
ii. Supply of construction materials;
iii. Mobilization of all staff and labour to the Site; and
iv. Erection of all temporary works for Contractor's facilities;

In other words, mobilization shall consist of preparatory work and operations including, but not limited to, those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

The Contractor's Programme shall include full details of her/his intended mobilization procedure. This will ensure completion of the mobilization tasks given in paragraphs (i), (ii) and (iii) above within the agreed specified date from the Start Date.

3.6.2 Demobilization

Demobilization shall consist of cleanup work and operations including, but not limited to, those necessary to the removal of personnel, tools, equipment, and incidentals from the project site. It should be communicated with potential stakeholders.

i. Demobilization of all staff and labour from the Site; and
ii. Dismantling of the work site and removal of all installations, equipment and temporary works so that the Site is left in a neat and tidy condition to the satisfaction of the Project Manager.

Similarly, the Contractor's Programme shall include full details of her/his intended demobilization procedure.

3.6.3 Payment

Payment for mobilization and demobilization will be made at the lump sum price shown in the Priced Bill of Quantities.

Mobilization payment shall be in the proportion of mobilization performance with the approval of the engineer.

The demobilization payment shall be effect with final payment upon completion of the contract and removal of equipment and cleanup of the work areas to the satisfaction of the Engineer.

3.7 CONSTRUCTION CAMP AND CAMPING FACILITIES

The contractor shall make arrangement as necessary for the housing, feeding and welfare of his own employees and/or supervisor staffs by providing, servicing and maintaining a camp on the site or sites approved by the Engineer, by other approved means. The contractor will not be permitted to site such camps with in irrigable area.

The camp should be standard having social infrastructures structures and utilities agreed up on it, such as: -

- Offices for both contractor and supervisor,
- Bed rooms for both contractor's and supervisor's staffs,
- Kitchen,
- Dining room,
- Shower and toilet,
- Potable water supply system if applicable,
- Electrical system from locally available source national/local greed line, solar energy, generator, etc.

Contractually erected structures and/or buildings are the property of the Employer. Camp constructed is a permanent work and will remain to be the property of the community. After completion of the work, the camp and camping facility shall be used by the scheme IWUA.

All hutments and building erected by the contractor on the site at his own expenses, shall, from the time of their erection until the completion of the works is the property of the employer and the contractor shall not be demolished or remove any such buildings without the written permission of the Engineer. But, on the completion of the works they shall become the property of the contractor who shall remove them entirely with all drains and restore the surface of the land to its original condition or other reasonable condition to the satisfaction of the Engineer.

The Contractor shall provide and maintain his own electrical supply. This supply must be adequate to supply the areas set aside for the housing and offices of his own staff and those of the Engineer and his staff.

The Contractor shall provide and maintain all necessary temporary power and lighting and all associated equipment for the duration of the Contract.

Payment for Construction camp and camping facilities will be made based on price shown in the Priced Bill of Quantities forming the contract.

3.8 HOURS AND DAYS OF WORKING

The Contractor shall plan her/his work on the basis of a five-day working week, or permissible by as per local authorities and within the hours of 8:00 am and 6:00 pm. Should the Contractor require additional working hours, or weekend working, he shall submit a request to the supervisor engineer for permission to work extended hours, giving full reasons for the requests. Approval to such requests will not be granted on a regular basis, but only in exceptional circumstances. Notwithstanding the foregoing nothing in this Contract will restrict the Contractor undertaking any tasks at any time where such tasks are essential for the saving of life or property or for the safety of the Works, in which case the Contractor shall immediately advise the supervisor engineer.

3.9 SIGN BOARD

The Contractor shall erect maximum two signboards as shown on the Drawings at the locations as directed by the engineer. No other signboard or notices shall be erected or displayed on the Site, other than those required for purposes of safety, without the written permission of the Project Manager.

Payment for signboard will be made based on price shown in the Priced Bill of Quantities forming the contract.

3.10 FENCING

3.10.1 Temporary fencing

The Contractor shall erect, maintain and remove suitable and approved temporary fencing to enclose such areas of land, (such as Supervisor's/Contractor's offices and yards, construction works being carried out beside buildings, canal, or footpaths and any other place where the Contractor's operations will endanger lives or public property), occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract, to the satisfaction of the Project Manager.

3.10.2 Permanent fencing

The Contractor shall erect, maintain and suitable and approved permanent fencing to enclose permanent structures but not limited to: -

- Pump and pump station,
- Night Storage Reservoir, and
- Along main canal (if required),

Permanent fence can be constructed using 2500mm long(100mm*100mm) precast concrete post spaced every 2000mm center to center of the two consecutive poles with standard barbed wire. Optionally, it can be made from 50mm*50mm*3mm angle iron with standard barbed weir.

Payment shall be made in accordance with the agreed unite rate and the corresponding unit of measurement in the contract.

4 SUBMITTALS

4.1 EMPLOYER'S SUBMITTALS

4.1.1 Contract documents

The Contractor will be provided with full set of the Contract documents for his own use. A complete set of Contract documents supplied by the Project Manager and all further instructions issued by him shall be kept at all times by the Contractor on the Site and available to the Project Manager and his staff.

4.1.2 Design drawings

The Drawings which are included in the bidding documents and which will form part of the Drawings to be used for the construction of the Works show the work to be carried out in accordance with the Contract in sufficient detail for the Contractor to fully plan his activities will be provided through engineer.

The Contractor shall check the Drawings carefully and advise the engineer, in writing, of any ambiguities, discrepancies, errors or omissions and a full instruction will be furnished to the Contractor should any ambiguities, discrepancies, errors or omissions be found. The Contractor shall be required to perform the work in accordance with such further instructions or issued Drawings. Although the Drawings are prepared to scale, work shall be based upon dimensions shown on the Drawings and not on dimensions scaled from the Drawings.

4.1.3 Specification

Specification is one of the contract documents. It will be provided for contractor through engineer to be referred and adopted in the contract period by the contractor and the engineer.

The Contractor shall check the technical specification carefully and advise the engineer, in writing, of any ambiguities, discrepancies, errors or omissions and a full instruction will be furnished to the Contractor should any ambiguities, discrepancies, errors or omissions be found. The Contractor shall be required to perform the work in accordance with such further issued technical specification.

4.2 CONTRACTOR'S SUBMITTALS

4.2.1 Working drawings

The Contractor shall prepare and submit to the Project Manager such working as may be necessary to illustrate his proposed designs and method of working. These working drawings shall: -

- be prepared to appropriate scales and include plans, elevations and sections;
- consist of an electronic copy of the drawing (if available), one print and one copy of design calculations, specification and parts catalogues;
- be signed by a qualified engineer responsible for the design, checked and approved by the Contractor prior to submission;
- Bear the title, Contract No. -------:

The engineer shall signify his approval or request modifications. The Contractor shall modify the designs and drawings, as may be required by the engineer.

The Works shall be constructed in accordance with the approved working Drawings a copy of such Drawings shall be kept on the Site at all times until the completion of the Contract. All Drawings, on which changes are made, shall have the revisions clearly marked and dated.

Construction of any portion of the Works shall not commence until the design and drawings have been approved in writing by the Project Manager and thereafter no change shall be made to any Drawings so approved without the permission of the Project

4.2.2 Shop drawings

The Contractor shall, in close consultation with the Engineer, prepare all the Shop Drawings deemed necessary for the execution of the Works and shall submit the same for approval to the Engineer well in advance to allow specified days in the contract for Engineer's checking and approval. The approval procedure shall be agreed upon with the Engineer. Fabrication and installation shall not proceed until the review is completed.

Where more than one type of shop drawing has been specified for one item, e.g., lay-out details, and dimensional drawings, the shop drawings shall be submitted together, to enable the Engineer to review the drawings as a package.

Shop drawings shall indicate the tag number of instruments and they shall clearly show the features and details applicable to the equipment being supplied. Shop drawings shall be prepared using accepted drafting techniques which will result in drawings of equal or better quality than the contract drawings.

Catalogue pages or drawings applicable to an entire family or range of equipment will not be accepted as shop drawings unless they are clearly marked up to show the pertinent data for the particular materials.

Manufacturer's catalogues, manuals, or price lists will not be accepted as shop drawings, although such material may be used as supplemental information to the shop drawings.

Shop drawings shall be detailed using the metric system. No shop drawings detailed using the imperial system of dimensioning will be accepted.

If, after one review by the Engineer, the Contractor fails to submit correct shop drawings, the Owner will be entitled to deduct from any payments due to the Contractor the additional costs to the Owner of the engineering services incurred as a result of the Contractor's failure to submit correct shop drawings.

4.2.3 Samples

Samples, or as otherwise specified, shall be submitted to the Engineer for review of those products and materials for which samples are required. Samples shall be submitted a minimum of thirty days prior to the date for approval required by the Contractor for procurement of the materials.

Samples shall be submitted with complete information concerning manufacturer's data, applicable standards, test results, and location of installation on the project.

Materials for which samples have been approved by the Engineer shall be used only in those areas and locations for which the approval was granted. Materials for which samples have been rejected shall not be delivered to the site, or if delivered, shall be removed promptly.

4.2.4 As-built drawings

On completion of the Works, the Contractor shall submit to the engineer As-built Drawings as specified, including final reduced levels and size and height of the elements of the Works.

The As-built Drawings for the whole Works are to be produced by the Contractor and submitted to the engineer as specified in Contract Document to scales approved by the Engineer. All 'As-built' drawings shall be produced on A1 or A3 paper size using the AutoCAD drawing system. Two paper copies of each drawing shall be submitted for review and approval by the Project Manager.

Following the correction of any errors or omissions identified by the Project Manager the Contractor shall submit the final 'As-built' drawings as: -

a) An electronic copy of each drawing;
b) Three copies of all A1 drawings in bound albums; and
c) Three copies of all A3 drawings (including reduced copies of the A1 drawings) in bound albums.

Final bar-bending schedules shall be submitted with corresponding bar-marks on approved 'As-Built' drawings. Structural steel drawings, supplier's drawings, fabrication and shop drawings, large scale detail drawings including all structural steel connection details not shown nor provided by Project Manager, and any additional drawings, shall be prepared by Contractor and submitted together with detailed design calculations.

A sample of the format of the As-Built drawing which contains title block, text and symbols, metric units, drawing scales etc will be issued to the Contractor by the Project Manager and this shall form the basis of presentations of As-Built drawings.

All costs related to the supply to the engineer of the mentioned number of drawings and calculations shall be deemed to be included in the rates in the bill of quantities any extra copy of the drawings and/or calculations which may be required, shall be supplied against the unit rate as included in the bill of quantities.

4.2.5 Operation and maintenance manuals

The Contractor shall provide operating and maintenance instructions for Plant, including instrumentation, to be supplied and installed under the Contract, it is intended that these instructions will be incorporated in the Operator's Maintenance Manuals for the Works to be compiled by the Engineer and to this end they shall be in loose leaf form on paper of A4 international size.

Operating and maintenance manuals shall generally take the following form and shall contain the following information: -

a. Step-by-step procedures for any operation likely to be carried out during the life of the Plant;

b. Maintenance and troubleshooting information, including charts showing lubrication, checking, testing and replacement procedures to be carried out daily, weekly, monthly and at longer intervals;

c. Where applicable, fault location charts to facilitate tracing the cause of malfunction;

d. Technical details;

e. Description of the installation;

f. Final settings of relays, timers etc.

g. Complete parts list.

The manuals shall have a hard cover bound with the name and title of the installation clearly marked on it. The manual shall be properly indexed and contain dividers with tabs between each section. All data must be organized in a neat and concise manner.

4.2.6 Payment

No additional payment will be made for any submittals. The cost of this work is deemed to be included in the price tendered for the supply and installation of the items for which submittals are required.

4.3 CONSULTANT'S SUBMITTALS

4.3.1 Project completion report

The consultant shall provide a completion report and reference drawings at the end of the contract in accordance with Consultants' terms of reference. This is generally taken to be the end of the Defects Liability period.

It is therefore recommended that the Consultants be required to provide a Project Completion Report at least two weeks before the intended Taking-Over inspection and that the report includes the As-Built drawings, Irrigation infrastructure Inventory and the structures condition surveys.

The Project Completion Report should comprise but not necessarily be limited to the following:

- The rationale for undertaking the project
- A description of the project and its location
- Details of the parties involved in the project
- Details of the Funding Agencies
- Comments on the general implementation of the works
- Comments on problems encountered in the implementation of the works
- Details of solutions to problems encountered
- Comments on the project design
- Details of all design changes with the rationale therefore
- Maintenance requirements and additional work required
- A financial statement

At the time of taking over, the only information which will not be available for the report at this stage will be the final financial details of the project and the information related to the Consultancy contract which can be included in an addendum or revision of the report at the end of the Defects Liability Period.

Therefore, on completion of the Defects Liability Period the Consultant should be required to submit a final consolidated version of the Project Completion report containing all of the above information in its finalized form plus the following:

- All finalized Project Completion Report details
- Details of the Consultant's Staff inputs
- Details of the Consultant's supervision contract
- Problems encountered by the Consultant in supervising the contract
- Comments on the contract
- Financial details of the Consultant's contract.

5 CONTRACT CLOSE OUT

5.1 INSPECTION

The Engineer will give the Contractor due notice of his intention to carry out any inspection of the Works during the Defects Liability Period and the Contractor shall thereupon arrange for a responsible representative to be present at the times, dates and locations named by the Project Manager. This representative shall render all necessary assistance and take note of all matters to which his attention is directed by the Project Manager.

5.2 TESTING

Testing of civil irrigation infrastructures and electro-mechanical equipment's shall be tested by the contractor after successful installation in the presence of client, contractor, contractor and or supplier representatives for the satisfaction of the engineer.

5.3 COMMISSIONING

Upon completion of all work and after completion of all tests the Contractor shall Commission the Works by operating the Plant for a minimum of one week, taking a full record of all operational parameters. The Contractor shall submit his detailed proposal for such commissioning tests to the Project Manager for approval at least 56 Days before the intended start of the commissioning period. The Project Manager shall instruct any modification to the commissioning procedures that he considers necessary for the purpose of demonstrating the functionality of the Works. The Contractor shall provide all consumables during the commissioning period.

5.4 TRAINING

Upon completion of all commissioning of the Works the Contractor shall instruct/and train the Employer or his representative fully in operation, adjustment and maintenance of all Plant. Notice for training days shall be given to the Employer in advance of the training period, along with a detailed training programme, which is expected to take a minimum of two weeks. Trainers shall have relevant vocational qualifications. During the training period the Contractor shall continue to operate the Works subject to the requirements of the training programme. The Contractor shall provide all consumables during the training period.

The Contractor shall be fully responsible for the operation of all Plant until the Employer acknowledges having received all necessary instructions in the operation of the Plant.
Operating and maintenance instructions shall be submitted as drafts for examination and approved by the Project Manager prior to final issue and shall be ready for issue prior to taking over of the Works by the Employer.

Five copies of the operation and maintenance manual shall be supplied by the Contractor to the Project Manager who will retain one copy and deliver the others to the Employer.
Completion will not be certified until the manuals are supplied Manufacturer's advertising literature, and advertising catalogues will not be acceptable for operating and maintenance instructions, but may be included for information.

5.5 FINAL CLEANING

On completion of construction, the Contractor shall remove all temporary structures, rubbish, and waste materials resulting from his operations.

6 CLEARING AND GRUBBING

6.1 SCOPE

It covers the clearing of the site and grubbing necessary for the construction of the permanent and temporary Works; and the removal and disposal of materials resulting from clearing and grubbing. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

6.2 DESCRIPTION OF WORK

(a) Clearing

Where directed by the Engineer, clearing shall consist of the removal of all trees, brush, other vegetation, rubbish, fences and all other undesirable material including the disposal of all material resulting from the clearing and grubbing to a maximum depth of 150mm, except for boulders.

It shall also include the removal and disposal of structures that obtrude, encroach upon or otherwise obstruct the work. This also includes the removal of signposts; the demolition and removal of ditches; and the demolition and removal of any other masonry or concrete structures that obstruct the work.

The moving of a certain amount of soil or gravel material may be unavoidable during the process of clearing. Clearing shall include the removal of all rocks and boulders less than 0.15m^3in size, which are exposed or lying on the surface.

Any trees, structures or artifacts, either identified on the Drawings or noted on Site for care and retention, shall be clearly marked off on the Site in a manner approved by the Engineer to avoid accidental damage during construction operations. Should any such identified trees, structures or artifacts be damaged inadvertently, or otherwise, the Contractor must report the same to the Engineer in writing explaining any known reasons for the damage. Damage deemed to be caused by the negligence of the Contractor shall be repaired at the Contractor's cost.

(b) Grubbing

Where directed by the Engineer, all stumps and roots larger than 75mm in diameter shall be removed to a depth of not less than 500mm below the sub-grade level and a minimum of 300mm below the cleared original ground level. Where the existing ground has to be compacted, all stumps and roots including matted roots shall be removed to a depth of at least 200mm below the cleared surface, except where otherwise specified or directed by the Engineer.

Except at borrow areas, the cavities resulting from the grubbing shall be backfilled with approved material and compacted to a density not less than the density of the surrounding ground.

(c) Ground Surface Level after Clearing and Grubbing

All holes, ruts or other surface deformation remaining after clearing and grubbing should be backfilled and compacted as directed by the Engineer to prevent the ponding of water. The cleared areas may also require grading to improve drainage wherever possible.

(d) Conservation of Topsoil

Where topsoil exists within the limits of the area to be cleared and/or grubbed, the Engineer shall designate areas for removal of the topsoil together with any grass and other suitable vegetation. If not used immediately, the topsoil shall be transported and deposited in stockpiles for later use.

(e) Conservation of Vegetation

Where provided for in the Contract, certain designated plants encountered in the reservoir area buffer zone and borrow areas shall be carefully protected by the Contractor.

6.3 EXECUTION OF FROM CLEARING AND GRUBBING

(a) Areas to be cleared and/or grubbed

The headwork site, reservoir area, canal route as well as certain borrow areas may require to be cleared and/or grubbed. The Engineer shall designate the areas to be cleared and such areas shall not necessarily be limited to those mentioned herein. The Contractor shall note that in order to avoid re-clearing, the clearing and/or grubbing may have to be done immediately before subsequent construction activities.

The Contractor shall control the clearing and/or grubbing activities to ensure that the portion of the headwork site, reservoir area, canal route as well as certain borrow areas reserve that falls outside the limit, or such areas as the Engineer shall designate, shall not be cleared and/or grubbed.

The Contractor shall take the necessary precautions to prevent damage to structures and other private or public property. In addition, the Contractor shall not clear or grub any other areas, or shall not dispose of any material obtained from clearing and/or grubbing without the approval of the Engineer.

No payment shall be made for any areas cleared and grubbed for temporary works at the Contractor's own initiative.

(b) Trees

Individual trees, designated in writing by the Engineer, shall be left standing and undamaged. A penalty equal to the amount specified in the Particular Specifications shall be imposed for every such tree, which is unnecessarily removed or damaged.

(c) Disposal of material

Material obtained from clearing and/or grubbing shall be disposed of, as indicated by the Engineer, in borrow pits or other suitable places and covered with soil or gravel. The burning of combustible material will normally be permitted but may only be carried out with the prior written approval of the Engineer. Care must be taken to observe any regulations related to air pollution.

All tree trunks and branches in excess of 150mm diameter shall be cleaned of secondary branches; sawn into suitable lengths; and stacked at sites indicated by the Engineer. Such timber shall not be used by the Contractor for any purpose and shall remain the property of the Employer unless otherwise agreed with the Engineer.

6.4 MEASUREMENT AND PAYMENT

The tendered rate for the specific measurement and payment item shall include the general requirements. The unit of measurement for clearing and grubbing is the hectare (ha). The quantity shall be taken as the area in hectares (to the nearest 0.1ha) designated by the Engineer and cleared and grubbed in accordance with the contract. The measurement area for clearing and grubbing shall be the plan area of the permanent Works. No deductions shall be made for buildings or structures and existing carriageways shall not be measured.

The tendered rate shall include full compensation for all work necessary for the clearing of the surface; the removal and grubbing of vegetation, bushes, trees, tree stumps and roots, including any blasting; cutting of branches; backfilling and compaction of all holes and cavities; demolition, breaking up and disposal of walls and superficial structures to existing ground level (except as otherwise stated in the Contract); protection from damage of all vegetation and objects designated to remain; and the removal, transporting and disposal of non-reusable material all as specified in the contract.

Clearing and grubbing of borrow areas shall not be measured for payment. No clearing and grubbing shall be measured for payment for work on structures where cutting or excavation is indicated in the Drawings and is prescribed to be spoiled by the Engineer.

The rate shall include disposal of all material and no separate payment will be made for this item.

7 EXCAVATION

7.1 GENERAL

Excavation here is meant the act or process of digging out to the bottom level of structures as well as canal bed levels

7.2 SCOPE

This section consists of excavation, disposal, shaping, or compaction of all material encountered within the limits of the work. Excavation is required to found structure foundation, canal, and ditches; to obtain material for small earth dams; to form the embankments of irrigation canals; to produce a level road formation platform in virgin terrain.

7.3 CLASSIFICATION OF EXCAVATION MATERIALS

For the purpose of payment under the various items, excavated materials are classified as follows:

i. Hard rock (sound rock)

This classification covers the basaltic rock which is black or dark grey in color. This rock is very hard. The normal means of excavation requires the uses of explosives. Where blasting is not permitted the contractor shall use heavy duty rock breaking equipment.

ii. Soft rock

This classification covers primarily basaltic and ignimbrite rock. Its color is light grey. This rock is commonly used for out block masonry. It is rather soft, can easily be hewn, and can be excavated by means of sledge hammers, wedges and miners bars. This grade also includes altered or weathered basaltic rock.

iii. Normal soil

Normal soil shall mean all material except rock, random rock and soft rock as defined above in (i) and (ii).Soil shall include, but not necessarily be limited to, all geologically recent materials overlying rock such as alluvium, black- cotton and talus; volcanic ash tuff, all layers of earth which are cemented so that the soil becomes conglomerate, shall be considered as normal soil.

7.4 EXCAVATION EXTENT

Excess excavation performed by the contractor for any purpose or reason, except that order in writing by the engineer, shall be at the expense of the contractor. All excavation for structures shall be carried to foundation material satisfactory to the engineer regardless of whether the elevation therefore is higher or lower than the elevation shown on the drawings. All necessary precautions shall be taken to preserve the material below and beyond the lines of all excavation in undisturbed conditions. All over excavation required by the engineer to be backfilled shall be back filled by the contractor in the accordance with the instruction of engineer. Materials for use in the work shall be carefully excavated to produce the material in form suitable for the work.

7.5 EXCAVATION TOLERANCES

Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerances are indicated, excavation shall be performed to tolerances established by the engineer as acceptable for the design and type of work involved. In case where the structure or other governing criteria permit, the engineer may relax the tolerances to facilitate construction.

7.6 TYPES OF EXCAVATION

Different types of excavation can be applicable for SSID as discussed below.

A. Excavation for canals, drains and open cuts

Excavation shall comprise and include all excavation for canals, either below or above water or ground water-table, other than structural excavation and borrow excavation for embankment construction, and shall be understood to include disposing of spoil and also hauling up to a distance of 1000m measured in a straight line.

Canal and open cut excavation shall be of two general types in SSID, which shall be designated as follows: -

- Excavation for irrigation canals, and
- Excavation for drains.

Excavation for drains includes excavation for those watercourses, which are designated as drains in the drawings. In order to prevent flooding of the banks of the drain by water entering in upstream sections, the Contractor shall leave temporary dams, until such a time that the drain sections downstream can receive the drainage water.

Excavated soil shall be placed alongside embankments and if excess soil is available, it shall, unless otherwise ordered, be placed in other embankment of canals, levees etc. requiring additional fill as provided in the contract drawings and the bill of quantities.

The Contractor shall follow the Engineer's instruction with regard to the length of drains or amount of bulk excavation, which shall be opened up at one time and follow the sequence of work approved. In general the excavation shall begin from the lower drain in the region proceeding to the upper while complying with periods of completion specified.

The Contractor shall prepare a plan of earthwork operations for each particular part of the works to be constructed at one time detailing the location and programme of excavation in channels and of placing in the embankments.

Excavation for new canals includes all canal excavation that is not designated as excavation for drains.

B. Trench excavation

Trench excavation shall be performed by the use of hand tools and approved mechanical equipment in such a manner as to minimize disturbance of the sides and bottom of the excavation. Trenches for pipes shall be excavated to a sufficient depth to enable the pipe and specified joint, bedding, haunching and surrounding to be accommodated. Unless otherwise stated, the width of the trench shall be equal to the nominal diameter of the pipe plus 400 mm. The Contractor shall fill

any over excavation beneath the pipe or bedding with well rammed selected general excavation material not required for backfilling to spoil tips.

The sides of trenches shall be adequately supported at all times. Alternatively, where the Contractor has elected and the Engineer has approved 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 trimmied so that when the pipiline is laid, no projection of rock comes within 100mm of the outside of the pipe at any point. The over excavatd portion shall be backfilled with approved granular material.

C. Excavation for structures

Excavation for structures shall comprise and include all excavation required in connection with all structural work excluding excavation for the construction of stone pitching, dumped stones and concrete lining.

The work covered by this paragraph of the specifications consists of furnishing all plant, equipment, materials and labour and in performing all excavation in connection with the construction of structures and in strict accordance with this section of the specifications and the applicable drawings.

Pits and trenches for foundation of all structural work, shall be excavated to the levels and dimensions shown on the drawings, or to such other levels as the Engineer may direct. Special care shall be taken not to disturb the bottom of the excavation, and to ensure that the last 15cms are excavated by hand just before the steel, concrete or masonry is placed.
The bottoms of all excavations shall be carefully leveled or shaped as indicated on the drawings, and if necessary stepped or benched horizontally.

Any pockets of soft material, loose rock and fissures in the bottom of the pits and trenches shall be removed and the cavities so formed filled with blinding concrete.

When any excavation has been made and trimmed to the levels and dimensions shown on the drawings or as directed by the Engineer, the Engineer should be informed accordingly so that he may inspect the completed pit or trench. No excavation shall be filled in or covered with concrete unless they have been inspected, and the Contractor has been authorized to proceed with the work. All surplus excavated materials from such excavations not required for refilling should be deposited in embankments or otherwise disposed-of as directed.

All excavation shall be kept dry and all bailing or pumping, timbering, shoring, cross timbering, cofferdams or other special appliances for supporting of sides that may be required, and filling, ramming and disposal of surplus materials necessary in carrying out the excavations for foundation pits and trenches, shall be included in the rate for structural excavation and will not be paid for under separate rates in any other part of the bill.

Excavation to greater depth than indicated shall be brought to grade by placement of blinding concrete and excavation to a greater width than is necessary shall be filled and tightly packed with approved material.

Water shall not be allowed to accumulate in excavations and all excavations shall be kept dry by approved pumps or other means approved by the Engineer, until, in the opinion of the Engineer, any masonry or concrete therein is sufficiently set and the backfilling is completed up to its natural position.

The sides of the pits and trenches shall, when required, be adequately timbered and supported to the satisfaction of the Engineer. Refilling of foundation pits and trenches shall be carried out after the foundation and the structural works within the excavation have been inspected and approved by the Engineer.

Unless otherwise directed by the Engineer, all filling shall consist of approved excavated materials, deposited in layers not exceeding 15cm in depth and rammed and the moisture content shall be adjusted to the approximate optimum moisture content for compaction.

D. Contact excavation for core

Excavation shall be carried out to reasonably sound rock, suitable to receive the impervious core material. Contact length between the impervious core and rock at the main strucure shall be as shown on the drawings.The suitable material excavated will be disposed as directed by the engineer.

E. Dental excavation

Zones of unsatisfactory material below the foundation levels shown on the drawing which will require excavation, may be encountered. All such matrial, regardless of character, shall be removed and disposed of as directed by the Engineer. Dental excavation shall consist of the removal of earth such as talus or alluvium or unsound rock such as soft, friable or highly weatherd rock below the foundation or other base excavation lines indicated on the drawings or directed by the Engineer for structures and for impervious earth-rock contact, and from locations such as joints, fissures, pockets and between rock beds, where the use of power excavation equipment is not practicable. Dental excavation shall not include removal of materials by pressure wahing and shall not include excavation which is classified by the Engineer and paid for under aother Contract item. Excavated areas covered in this clause shall be cleaned as as directed by the Engineer.

F. Excavation in borrow areas

In sections where the material required for the construction of the embankment is insufficient or unsuitable, material shall be obtained from borrow areas as determined by the Engineer.

Where approved borrow material has markedly dissimilar characteristics, the source shall be worked as directed by the Engineer.

The borrow pits and borrow areas shall have a depth of not more than 1.0 m below the ground surface, and shall be finished and trimmed as the natural ground feature of the area. Finishing and trimming of borrow pits and borrow areas shall take place after the canal excavation and embankments are completed and the side slopes have been trimmed, and any excess material has been disposed. Special care shall be taken in the excavation of the borrow pits in view of their special significance for the drainage of surface water, so that the bottom shall have a regular and uninterrupted gradient as directed by the Engineer.

No payment for overhaul shall be admissible if the average distance measured in a straight line between the borrow area and the embankment area where the relevant material is placed

amounts to less than 1000m except for areas found suitable for such purposes as discussed and agreed with the Project Manager.

7.7 DISPOSAL OF EXCAVATED MATERIAL

All excavated material, so far as it is suitable, shall be available to meet the requirements for fill or backfill or embankment fill. Any surplus material, whether or not temporarily allowed to be placed within a stream area, shall be finally disposed of in such a manner as not to obstruct any stream nor otherwise impair the efficiency or appearance of the Works, nor is it to endanger the partly finished structure.

The Contractor shall transport and dispose of all excavated material not required for the Works. The locations proposed by the Contractor for disposing or storing excavated materials, whether temporarily or permanently, shall be subject to the approval of the Project Manager.

Excavated material shall be deposited in such places and in such a manner as not to cause damage to any highway, services, property or agricultural land either within or outside the Site, and so as to cause no impediment to the drainage of the Site or surrounding area.

7.8 MEASUREMENT AND PAYMENT

The measurement and payment for excavation shall be according to the type of excavated materials and the depth of excavations as specified in the Priced Bill of Quantities forming the contract. The item rate for payment of excavation shall include the disposition of material in the specified manner.

8 EARTH FILL AND COMPACTION

This work shall consist of embankment fill and back fill around structures constructed in conformity with the lines, grades, dimensions, and design shown on the Drawings; and in accordance with this Specification.

8.1 EMBANKMENT FILL AND COMPACTION

8.1.1 Material for embankment fill

Fill materials shall be obtained from required excavations, from the borrow areas and from rock quarries as indicated on the drawings and as specified in this section. All materials shall conform to the requirements of the specifications, and their disposition in the embankments shall be as shown on the drawings unless otherwise directed by the Engineer.

8.1.2 Execution of embankment fill and compaction

Embankment and levees shall be constructed to the lines and grades shown on the drawings or as directed by the Engineer.

Material for construction of embankments shall be obtained from canal or drain excavation or from borrow areas as directed by the Engineer.

Only material, which, in the opinion of the Engineer, is suitable for embankment construction shall be used. Material, which has previously been compacted and thereafter excavated, shall not be used for the construction of embankments.

The Engineer will designate which material shall be used for each section of embankment, and the Contractor shall carry out the works accordingly.

Embankments shall be constructed of fill material of generally silty or clay soils placed in successive layers over the full width of the cross-section and in such lengths as are suited to the sprinkling, mixing and compaction methods employed.

Extra material shall be placed beyond the lines of the side slopes as indicated on the drawings to ensure that the specified compaction is obtained throughout the final cross-section. Each layer shall be spread to uniform depth by bulldozer, grader or other approved methods.

Prior to compaction, the depth of any one layer, including underlying scarified material, shall not exceed more than 15 cm for pneumatic rolling. Clods of lumps shall be thoroughly broken up by dicing, harrowing or other approved methods. The material shall be at the approximate optimum moisture content for compaction when rolling begins.

Should the material be too dry, the required amount of water shall be applied uniformly, and thoroughly mixed in the soil by blending, dicing and harrowing until uniform and satisfactory moisture content is obtained throughout the total depth of the layer. Should the material be too wet, it shall be aerated by blending, dicing, and harrowing until the moisture content is satisfactory.

- Each loose layer shall be thoroughly compacted by means of sheep-foot rollers and/or pneumatic rollers and/or other types of compactors as approved by the Engineer.
- If backfill around structures cannot be placed and compacted by means of mechanical equipment such as, pneumatic rollers or other types of compactors or if, the Engineer so directs, the filling around the structures above the ground level shall be deposited in layers not exceeding 15cm in depth and compacted.
- Rolling shall begin at the edge of the fill and progress toward the centreline with overlapping on successive trips by at least one half the width of the roller unit. The entire area being compacted shall be subject to a sufficient number of complete coverage, as above, to produce uniform compaction and a dry density of at least 95 % of Proctor maximum dry density at optimum moisture content.
- Unless otherwise specified, the minimum acceptable density is 95 % of Proctor maximum density for silty and clayey soils and 70 % relative density for the minus 75mm (3 inch) fraction of pervious sand and gravel soils. For soils which are border-lined between the silty and clayey soils controlled by the proctor test and pervious sand and gravel soils controlled by the relative density test.
- Each compacted layer must be approved by the Engineer prior to placing of the next loose layer. Where required by the Engineer, the surface of a compacted layer shall be loosened by dicing or harrowing before applying the next loose layer in order that the new material may bond satisfactorily.
- After completion of the compaction of the embankment extra material placed beyond the side slopes, as indicated on the drawings or as directed, shall be re-excavated and removed from the embankment and deposited in borrow pits or in spoil deposits to such lines and grades as directed by the Engineer.
- The final layer shall be finished smoothly to the required grades and cross-sections by blending and pneumatic rolling or by flat wheel (power) rolling. Slopes of embankments shall be trimmed accurately.

8.2 BACKFILL AND COMPACTION

8.2.1 Material for backfill

The local material can be used for compacted backfill, except where granular material is specified as backfill. All materials used for compacted backfill of structures shall be approved by the Engineer. The compacted backfill at the structures shall be completed as shown on the drawing and as required by the Engineer. Backfill will not be placed at any of the structures until the Engineer has inspected this part or parts and given his final acceptance.

8.2.2 Execution of backfill and compaction

Materials, which are designated for compacted backfill after dumping at required places, which previously have been dried from water, shall be spread by hand or using light mechanical equipment after approved by the Engineer.

The material shall be spread at approximately horizontal layers with thickness not more than 15 cm before compaction.

The material after dumping and during spreading shall be either dampened or dried in order to obtain the required optimum moisture content.

Compaction of backfill shall be made using hand or mechanical tampers of approved type until a density, of equal or higher degree is obtained as the fills compacted by heavy equipment. Parts of

excavation works placed within 1.2m of the face of structures shall be compacted by tractors or other heavy equipment on the condition that the approval by the Engineer is obtained.

The protecting surface layer of sand-gravel mix of thickness 15 cm shall be made, around the structures and in other places if required by the Engineer. The Sand-gravel mix used for granular backfill or protecting surface layer should be thoroughly placed and compacted. No additional payment shall be made in regard to these works.

8.3 MEASUREMENT AND PAYMENT FOR EARTH FILL AND COMPACTION

Filling shall be measured as equal to the void to be filled. Any thickness stated shall be deemed to be after compaction. Filling to excavations shall be measured in cubic meter. Payment will be made at the contract unit prices per cubic meters.

9 MASONRY WORK

9.1 SCOPE

This work shall consist of stonework constructed with interlocking elements; generally mortared, but can be constructed without mortar.

9.2 STONE MASONRY WALLS

Stone masonry walls shall be plain with dry joints or constructed with stones set in cement mortar as indicated on the Drawings or as instructed by the Engineer. The minimum mass of stone shall be 10kg. The minimum dimension of stone shall be 75mm.

(a) Dry stone masonry walls

A foundation trench shall be excavated down to rock, or to material of adequate bearing capacity at a minimum depth of 300mm below ground level. All large stones shall be laid with the longest dimension in the horizontal plane. Stones shall be individually placed to break joints, to provide a minimum of voids, and shall be firmly bedded against adjoining stones. The spaces between the larger stones shall be filled with spall securely rammed into place. The larger stones shall not bear on the spall used to fill the voids. The top and ends of the wall shall be neatly finished with selected coping stones laid with their largest dimension in the horizontal plane.

The finished surface of the wall shall present an even, tight and neat appearance with no stones varying by more than 50mm from the specified surface grade or line. All stones shall be carefully set with a bond stone provided at the rate of not less than one (1) to every square meter of exposed face. Bond stones shall measure not less than 150mm by 150mm on the exposed face and not less than 450mm in length; or the full thickness of the wall if the latter is less than 450mm. **Dry Stone Masonry Walls commonly used in spring protection especially at the spring eye side to allow free flow of spring water.**

(b) Cement mortared stone masonry walls

The walling shall be constructed as specified in (a), with the exception that the stones shall be wetted and set in 3:1 sand/cement mortar. All large stones shall be laid with the longest dimension in the horizontal plane. Exposed stones on the wall faces shall be cleaned of mortar by washing or wire brushing. The mortar shall be flush-pointed to the approval of the Engineer. Weep holes shall be provided as ordered and shall be cleaned of mortar and any other debris or obstruction that may have entered during construction. The walling shall be protected from the elements and kept moist for a minimum period of four (4) days after completion.

9.3 MATERIAL REQUIREMENTS FOR STONE MASONRY STRUCTURES

(a) Stone

The stone shall be sound and durable, quarried, or recycled dismantled masonry, and shall be subject to the Engineer's approval.

The stone shall preferably be native to the vicinity of the work and shall be of a kind that previous use has proven to be satisfactory for the specified purpose. The stones shall be properly protected at all times.

(i) Sizes and shapes

Each stone shall be free from depressions and projections that might weaken it or prevent it from being properly bedded, and shall be of such shape as will meet both architecturally and structurally the requirements specified.

When dimensions for stones are shown on the Drawings, they shall be of the size shown. When no dimensions are shown on the Drawings, the stones shall be furnished in the sizes and face areas necessary to produce the general characteristics and appearance as indicated on the Drawings.

(ii) Dressing

The stone shall be dressed to remove any thin or weak portions.

(b) Quarry operations

Quarry operations and delivery of stone to the point of use shall be organized so as to insure keeping deliveries well ahead of masonry operations.

A sufficiently large stock of stone of the kinds being used in the work shall be kept on the site at all times, to permit adequate selection of stone by the masons.

(c) Mortar

Mortar shall consist of three parts by volume of fine aggregate or sand to one part by volume of cement complying with the requirements.

9.4 SUBMITTALS

The following construction materials for masonry works shall be submitted by the contractor prior to commencement of works, but not limited to: -

- Portland cement: -Brand and Manufacturer’s name.
- Sand: -Location of sand quarry, and test data from certified laboratory.

9.5 CONSTRUCTION REQUIREMENTS

(a) Excavation and backfill

Excavation and backfill shall conform to the requirements specified in the contract.

(b) False work

Arch centering shall be constructed in accordance with construction drawings submitted by the Contractor as required by the Conditions of Contact.

Suitable wedges shall be provided for raising or lowering the forms to exact elevation and for taking up any settlement occurring during loading. Centering shall be lowered gradually and symmetrically so as to avoid over-stresses in the arch.

When directed, centering shall rest upon approved jocks in order to take up and correct any slight settlement, which may occur after the placing of masonry has begun.

In general, centering shall be struck and the arch made self-supporting before the railing or coping is placed. For filled spandrel arches such portions of the spandrel walls shall be left for construction subsequent to the striking of centers as may be necessary to avoid jamming of the expansion joints.

When, in the opinion of the Engineer, additional false work and bracing are necessary to hold the stones in proper position, the Contractor shall construct such false work and bracing in a manner satisfactory to the Engineer. Failure of the Engineer to order their construction shall not release the Contractor from his obligation to build a satisfactory structure.

(c) Selection and placing

When the masonry is to be placed on a prepared foundation bed, the bed shall be firm and normal to, or in steps normal to, the face of the wall, and shall have been approved by the Engineer before any stone is placed. All loose, fractured or otherwise unsuitable material shall be removed prior to the construction of masonry. The masonry structure shall be adequately keyed on sloping surfaces.

When it is to be placed on foundation masonry, the bearing surface of this masonry shall be cleaned thoroughly and wetted immediately before the mortar bed is spread.

All masonry shall be constructed by experienced workmen.

Face stones shall be set in random bond so as to produce the effect shown on the plans and to correspond with the sample section approved by the Engineer.

Care shall be taken to prevent the bunching of small stones or stones of the same size. When weathered or colored stones; or stones of varying texture are being used, care shall be exercised to distribute the various kinds of stones uniformly throughout the exposed faces of the work.

Large stones shall be used for the bottom courses and large, selected, stones shall be used in the corners. In general, the stones shall decrease in size from the bottom to the top of work.

All stones shall be cleaned thoroughly and wetted immediately before being set; and the bed which is to receive them shall be clean and moistened before the mortar is spread. They shall be laid with their longest faces horizontal in full beds of mortar; and the joints shall be flushed with mortar.

(d) Pointing

The pointing or finishing of joints shall be as shown on the Drawings or as otherwise indicated by the Engineer.

When raked joints are called for, all mortar in exposed face joints and beds shall be raked out squarely to the depth noted on the Drawings. Stone faces in the joints shall be cleaned free of mortar.

When weather joints are called for, the beds shall be weather struck. The joints shall be slightly raked to conform to the bed weather joint and in no case shall the mortar be flush with the faces of the stones.

The mortar in joints on top surfaces shall be crowned slightly at the centre of the masonry to provide drainage.

This sub-clause also applies to re-pointing in extension work or in the repair of the existing masonry work. Cracks in the masonry of the existing bridges and culverts shall be repaired as follows:

- Deteriorated and loose mortar particles, dirt and other undesirable materials shall be raked free and loose stones shall be chopped out.
- The joints shall be cleaned by wire brushing, sandblasting, or by other acceptable means, to the full depth of deteriorated mortar but in no case less than 75 mm.
- Voids and cavities which are encountered shall be cleaned.
- The surface texture of the exposed faces shall not be damaged.
- The joints shall be dampened and filled completely with cement mortar, packed solidly into the joints and voids.
- The masonry shall be kept damp during the repointing operations.
- The masonry joints shall be finished to match the existing mortar joints and the stone work left clean and free of mortar droppings.

(e) Plastering of masonry walls

Where shown on the Drawings or called for by the Engineer, the Contractor shall plaster the surface with cement mortar, consisting of one part cement to three parts of sand by volume to a minimum thickness of 12 mm of plaster unless otherwise instructed by the Engineer.

(f) Weep holes

All walls and abutments shall be provided with weep holes.

Unless otherwise shown on the Drawings or directed by the Engineer, the weep holes shall be placed at the lowest points where free outlets can be obtained and shall be spaced not more than three (3) meters centre to centre (c/c).

Weep holes can be square, rectangular or circular in opening.

Alternatively, 100 mm diameter PVC circular pipe of appropriate length can be used. In this case, the provision of 3m spacing c/c is replaced by 1.5m c/c spacing which shall be both horizontally and vertically.

(g) Cleaning Exposed Faces

Immediately after being laid, and while the mortar is fresh, all face stone shall be thoroughly cleaned of mortar stains and shall be kept clean until the work is completed.

If ordered by the Engineer, the surface of the masonry shall be cleaned using wire brushes and an approved acid before final acceptance.

9.6 MEASUREMENT AND PAYMENT

Stone masonry shall be measured in cubic meter. Payment will be made at the contract unit prices per cubic meters complete in place and accepted.

The quantity of Plastering of Stone Masonry Walls to be paid shall be the square meter of wall completed in place and accepted.

10 CONCRETEWORK

10.1 GENERAL

Concrete in this context is referred to a mixture of cement, sand, aggregate, and water in specific proportions that hardens to a strong stony consistency over varying lengths of time. These ingredients when filled in a form arranged in the desired shape form a stable structure. Thus, appropriate proportions of such ingredients shall be kept as to the standard referred here so as to obtain the required strength.

10.2 SCOPE

This covers the production, transporting, placing, testing, and curing of different classes of concrete used in the Works where plain/mass, reinforced, or Cyclopean concrete as specified.

10.3 TYPES OF CONCRETE

10.3.1 Plain concrete

Plain concrete is concrete without reinforcementbars or wire.Plain concrete does not easily withstand tensile and shear stresses caused by wind, earthquakes, vibrations, and other forces. Therefore it is unsuitable in most structural applications.

10.3.2 Reinforced concrete

It is concrete in which steel is embedded in such a manner that the two materials act together in resisting forces. That means, in reinforced concrete, the tensile strength of steel and the compressive strength of concrete work together allow the member to sustain these stresses over considerable spans.

10.3.3 Cyclopean concrete

Cyclopean concrete is concrete prepared as a result of usage of large stones as aggregate in normal concrete (commonly 60% plain concrete and 40% large stones) for the objective of producing relatively large amount of concrete for given cement content. The dosage of plain concrete varies in accordance with the type of work.

The plain concrete to be used in this job shall have a minimum resistance of 180 kg/cm^{2}on the 28th day the materials should be saturated before creating the mixture. Stony materials will comply with the ASTM standard and dosage will be according to concrete design.

The large size of stones is termed as plums. The size of stones may be variable size between 100mm up to 300 mm. But, stone size ≤ 1/3 X (Least dimension of concrete mass).

There has restriction with volume of plums; this is Plums volume ≤ (20 ~30) % of volume of finished concrete. The plums should be dispersed rationally throughout the concrete mass.

The construction procedure for cyclopean concrete is: -

- A normal concrete layer (usually 15 centimeter depth) is placed on desired surface and then plums are spread manually on top thoroughly. The spaces between the stones will not be less than 5 centimeters in any of the rows and from structure edges. Another layer of concrete is placed above spread plums.

- Each layer of concrete is placed in such way that each plum has at least 100 mm concrete around it until the desired height is reached. Problem may arise with entrapped air beneath stones. Care has to be taken to avoid air void to work entire section of cyclopean concrete as one unit.
- No adhering coating on plums is allowed as discontinuities in bond between plums and surrounding concrete may produce cracking and concrete becomes permeable.

Note: -To obtain good, strong, long-lasting and cheap concrete, the following items should be closely monitored: -

- Material Quality,
- Dosage of components, and
- Management, placing and concrete setting.

10.4 CONCRETE STANDARDS

Table 10-1: Summary of Concrete Standards and their Characteristics

Class	Maximum Size of Aggregate, mm	Compressive Strength at 28 days (MPa)	Maximum Water Cement Ratio	Minimum Cément Content (kg/cm)	Slump (mm)
C-5	20	5	-	-	76+25
C-10	20	10	-	-	75+25
C-20	40*	20	-	250	75+25
C-25	40*	25	0.5	300	75+25
C-30	40*	30	0.5	300	75+25

** Maximum aggregate size is 20mm for element less than 200mm thick.*

10.5 MATERIALS

10.5.1 Cement

Cement shall be furnished package as approved by the Engineer. It shall be Portland cement and shall conform to British standard. The cement shall be tested as tested as storage site in accordance with the ASTM requirements. No cement shall be used until notice has been given by the engineer that test results are satisfactory, but if unsatisfactory it shall be removed from the site of work. Cement which has been in storage at project site longer that (4) four months shall not be used until retest proves it shall be satisfactory.

During transportation of cement shall be completely protected from exposure moisture. Cement which has been adversely affected by moisture as determined by the Engineer shall be rejected. Cement shall be stored in dry weather tight and properly ventilated structure.

10.5.2 Aggregates

Aggregates shall be generally consists of natural sand and coarse aggregates consists of natural gravel, or crushed gravel or combination thereof. The Contractor shall bring concrete aggregate from approved location which is natural deposits or shall produce crushed aggregate from approved location. The aggregates will be sampled as delivered to the mixer to determine compliance with specification provision.

The shape of particles fine aggregate and in coarse aggregate shall be generally spherical or cubical. The quantity of flat and elongated particles in the coarse aggregate, as defined and determined by standard tests approved by the Engineer shall not exceed 25 %.

Aggregates shall be stored at the site of work in such a manner as to prevent inclusion of foreign materials in concrete. Sufficient aggregate shall be maintained at site at all times to permit continues placement and completion of any lift of concrete started.

All fine and coarse aggregates shall be remaining in free draining basin at site for at least 6hours before placing.

Aggregates as delivered to the mixers shall consist of clean and uncoated particles.Aggregates shall not contain deleterious amounts of organic materials such as grass, timber or similar materials as shown in Table below.

Table 10-2: Maximum amount of deleterious substances

Item	Maximum Percentage by Mass	
	Fine Aggregate	Coarse Aggregate
Material passing 0.075 mm sieve	2.0	1.0
Lightweight material	2.0	2.0
Organic matter	0	0
Clay lumps	1.0	0.5
Other deleterious substances	2.0	1.0

(i) Fine Aggregate for Portland Cement Concrete.

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand conforming to AASHTO M-6 Class B including the reactive aggregate supplementary requirement, except as amended or supplemented by the following: -

- Material passing a 0.075 mm sieve shall not exceed 3.0% when tested in accordance with AASHTO T-11.
- The Sand Equivalent Value in accordance with AASHTO T-176 shall not be more than 75.
- Lightweight fine aggregate shall conform to AASHTO M-195.

The fine aggregate grading shall comply with Table below.

Table 10-3: Grading of fine aggregate

Sieve size (mm)	Percentage of total mass passing sieve
10	100
4.76	95-100
2.38	68 - 86
1.19	47 - 65
0.59	27 - 42
0.30	9 - 20
0.15	0 - 7
0.075	0 - 2.5 (4.0)*

*Note: subject to approval by the Engineer.

In addition to the grading limits the fine aggregate as delivered to the mixer, shall have a fineness modulus of not less than 2.3 or more than 3.10.

(ii) Coarse Aggregate for Portland Cement Concrete.

Coarse aggregate shall conform to AASHTO M-80 Class A, except as amended or supplemented by the following: -

- The Los Angeles Abrasion value shall not exceed 40% when determined in accordance with the requirements of AASHTO T-96.
- The adherent coating value shall not exceed 1.0% when determined in accordance with the requirements of FLH T-512.
- For bridge decks or surface courses, aggregates known to polish, or carbonate aggregates containing less than 25% by mass of insoluble residue as determined by ASTM D 3042, shall not be used.
- Lightweight coarse aggregate shall conform to AASHTO M-195.

The coarse aggregate grading shall comply with Table below.

Table 10-4: Nominal size and grading of coarse aggregate

Nominal Size (mm)	Percentage of total mass passing sieve						
	Sieve size (mm)						
	31.25	25	19	12.5	10	4.75	0.075
25	90 - 100		0 – 20		0 - 2		0 - 0.5
20		100	80 – 100		10 - 40	0 - 4	0 - 0.5
10			100	90- 100	40 -70	0 -15	0 - 0.5

10.5.3 Water

Water shall be clean and free from detrimental concentration of acids, alkalis, urine, salts, sugar, and other organic or chemical substances.

If the water used is not obtained from a public drinking water main the Engineer may require the Contractor to have the suitability of the water proved by tests carried out by an approved laboratory.

Such tests shall comply with the requirements of AASHTO T-26 and in particular:

- The total percentage of solids by weight shall not exceed 2.25%.

For reinforced concrete construction the requirements are:

- Chloride (as Cl2) (ASTM D 512)400 ppm max.
- Sulphates (as SO3) (ASTM D 516)500 ppm max.
- Alkali Carbonates and Bicabonates750 ppm max
- Total dissolved solid (ASTM D 1888)2000 ppm max.
- pH7 to 9

Concrete made with water not meeting the requirements specified herein may be rejected for inclusion in the Works.

10.5.4 Admixtures

Admixtures other than as specified below shall not be added except with written authorization from the Engineer:

- Water-reducing admixture shall conform to BS5075: Part I.
- Retarding admixtures shall conform to BS 5075: Part I.

All admixtures shall be non- chloride.

10.6 STORAGE OF MATERIALS

(a) Cement

Cement, which is stored on site, shall be kept under cover, that provides adequate protection against moisture and other factors which may promote deterioration.

When the cement is supplied in bags, they shall be closely and neatly stacked to a height not exceeding twelve (12) bags and arranged so that they can be used in the order in which they were delivered to the Site.

Storage of cement in bulk in silos or similar containers shall be permitted provided that the cement drawn for use is measured by mass and not by volume.

Cement shall not be kept in storage for longer than six (6) weeks without the Engineer's permission and different brands and/or types of the same brand shall be stored separately. Any cement in storage which in the opinion of the Engineer is no longer satisfactory for whatever reason shall be rejected and disposed of as directed by the Engineer.

The Contractor shall provide the Engineer with copies of all bills of loading for each consignment of cement within three (3) days of its delivery to site and advise the Engineer of, but not limited to, the following:

- The source of the cement;
- The tonnage, type and date on which the consignment is received;
- The location where the cement is being stored.

The Contractor shall maintain a stock book inventory of all cement on site indicating the date of arrival; storage location; distribution to and use at the various sites within the project; and the tonnage of each type of cement available in storage.

The following shall also apply:

- Only cement from a source and of a type approved by the Engineer shall be used;
- The delivery of all consignments at the site or to storage shall be logged with information as indicated previously to the Engineer;
- The test certificate from the supplier/manufacturer shall be submitted to the Engineer. However, this will not relieve the Contractor from testing the material as instructed by the Engineer;
- The Engineer shall be entitled to reject any lot or thereof on account of improper storage or the initiation of setting of the cement in any bag prior to its use.

(b) Aggregates

Aggregates of different nominal sizes shall be stored separately and in such a way that segregation is avoided. Intermixing of different materials and contamination by foreign matter shall be avoided.

Aggregates exposed to a marine environment shall be covered to protect them from salt contamination. Where concrete is batched on site, the aggregates shall be stored in bins with a 3.0m wide concrete apron slab constructed around the outer edge of the aggregated stockpile area to prevent contamination during the process of tippling and hoisting the aggregate. The

aggregates shall be tipped on the concrete apron slab. The storage bin shall have a concrete floor of 150mm thickness.

(c) Storage capacity

The storage capacity provided and the amount of material stored (whether cement, aggregates, or water) shall be sufficient to ensure that no interruptions to the progress of the work are occasioned by lack of materials.

Special storage facility shall be provided for storing cement to ensure that cement does not get exposed to moisture.

(d) Deteriorated material

Material that has deteriorated, or that has been contaminated or otherwise damaged, shall not be used in concrete. Such materials shall be removed from the site without delay.

10.7 PLACING AND COMPACTION OF CONCRETE

(a) Placing

- Before placing of concrete the structural excavation and backfill; design and construction of false-work and forms; construction of reinforcing steel; structural steel; bearing devices; jointing material; and miscellaneous items shall be performed to the satisfaction of the Engineer according to the relevant sections of these specifications.
- Concrete shall not be placed until the forms; all materials to be embedded; and, for spread footings, the adequacy of the foundation material; have been inspected and approved by the Engineer.
- Concrete shall be transported and placed in a manner that will prevent segregation or loss of constituent materials and contamination.
- Concrete shall not be placed in any part of the works until the Engineer's approval has been given. If concreting is not started within 24 hours of approval being given, approval shall again be obtained from the Engineer.
- Concreting operations shall only be carried out during daylight hours unless proper lighting arrangements have been made and lights are in working order by noon. Workmen shall not be allowed to work double shifts and the Contractor shall provide a fresh team for nightshifts.
- The placing and compaction of concrete shall at all times be under the direct supervision of an experienced concrete supervisor.
- Once concreting has begun it shall be carried out in a continuous process between construction or expansion joints.
- The delivery rate; placing sequence; and methods shall be such that fresh concrete is always placed and consolidated against previously placed concrete before initial set has occurred in the previously placed concrete.
- Concrete shall be placed within 15 minutes from completion of mixing and within one (1) hour from the start of mixing.
- All excavations and other contact surfaces of an absorbent nature such as timber formwork shall be damp but no free water shall be permitted to remain on these surfaces. The formwork shall be cleaned internally.
- The method of placement used shall not cause displacement of reinforcing steel or other embedded materials.
- Re-tempering the concrete by adding water to the mix shall not be permitted.
- Temporary form-spreader devices may be left in place until concrete placement precludes their need, after which they shall be removed.

- During and after placement of concrete, care shall be taken not to damage the concrete or break the bond with reinforcement.
- Once the concrete is set, care shall be taken not to disturb the forms or reinforcing bars that project from the concrete until it is of sufficient strength to resist damage.
- Normally concrete shall only be placed in the dry.
- Placing concrete under water shall be allowed only in exceptional circumstances where in the opinion of the Engineer it is not feasible to dewater before placing.
- No concrete shall be placed in flowing water.
- Underwater placement of concrete is permitted only for seal concrete and drilled shafts. If other than seal concrete is used, the minimum cement content shall be increased by 10%.
- The concrete mix used for underwater placing shall be specifically designed and approved for this purpose to ensure good flowability, plasticity, and cohesion. Increased sand and cement contents over normal mixes will usually be required.
- Equipment used for placing of concrete shall have sufficient capacity that is designed and operated to prevent mix segregation and mortar loss. Equipment that causes vibrations that could damage the freshly placed concrete shall not be used.
- Concrete shall be placed as near as possible to its final position. Concrete shall not be placed in horizontal layers greater than 450mm thick.

(b) Compaction

Concrete shall be fully compacted by approved means during and immediately after placing. It shall be thoroughly worked against the formwork around the reinforcement tendons, ducts, and embedded fittings and into corners to form a solid mass free from voids.

The concrete shall be free from honeycombing and planes of weakness and successive layers of the same lift shall be thoroughly bonded together. In no case shall the depth of a lift exceed 600mm.

When placing operation would involve dropping the concrete more than 1.5 m, the concrete shall be dropped through a tremie or chute as required.

Unless otherwise agreed by the Engineer concrete shall be compacted by means of vibrators. Internal vibrators shall be capable of producing not less than 10000 cycles/minute and external vibrators not less than 3000 cycles/minute. Sufficient stand-by vibrators shall be held available in case of breakdown.

Vibrators shall be applied by experienced labour and over vibration resulting in segregation, surface water and leakage shall be avoided. Contact with reinforcement and formwork shall, as far as practicable be avoided when using internal vibrators. Concrete shall not be subjected to disturbance by vibration within 4 to 24 hours after compaction.

Whenever vibration is applied externally, the design of the formwork and positioning of the vibrator shall be such as to ensure efficient compaction and avoidance of surface blemishes all subject to prior approval of the Engineer.

Special attention shall be given to the compaction of concrete in the anchorage zones and behind the anchor plates and in all places where high concentrations of reinforcing steel or cables occur. In such cases where the placing and compaction of concrete is difficult a mix containing small size aggregate may be used but only with the approval of the Engineer and after a mix containing such

aggregate has been designed and tested. Sufficient number of vibrators shall be provided to consolidate each batch as it is placed.

External form vibrators shall be used only when the forms have been designed for external vibration and when internal vibration is not possible.

The concrete shall be vibrated at the point of deposit and at uniformly spaced points not farther apart than 1.5 times the radius over which the vibration is visibly effective.

Vibrators shall not be used to move concrete and shall be inserted vertically and withdrawn slowly from the concrete.

The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete, but not to cause segregation and at any one point long enough to cause localized areas of grout to form.

Reinforcement bars shall not be vibrated in order to vibrate the concrete.

10.8 CONSTRUCTION JOINTS

(a) General

Concreting shall be carried out continuously up to the construction joint shown on the Drawings or as approved. Where concreting has to be interrupted due to an emergency (such as breakdown of the mixing plant or the occurrence of unsuitable weather), a construction joint shall be formed at the place of stoppage in the manner which will least impair the durability, appearance, and proper functioning of the concrete.

Unless otherwise shown on the Drawings the exact position of horizontal construction joints shall be marked on the formwork by means of grout checks in order to obtain truly horizontal joints.

(b) Preparation of surfaces

When the concrete has set and while it is still “green”, the surface film and all loose material on the construction joint shall be removed by means of a water jet assisted by light brushing to expose the aggregate, but without disturbing the aggregates and leaving a sound, irregular surface. Where this is not possible the surface film should be removed after the concrete has hardened by mechanical means appropriate to the degree of hardness to the concrete so as to expose the aggregate and leave a sound, irregular surface. The roughened surface shall be washed with clean water to remove all laitance, dirt, and loose particles.

(c) Placing fresh concrete at construction joints

When fresh concrete is placed the same day as the construction joint was formed the fresh concrete shall be cast directly against the face of the construction joint.

When concreting recommences a day or more after the forming of the construction joint the following procedure shall be followed: -

- The construction joint shall be kept continuously wet for a period of at least two (2) hours before concreting starts but shortly before re-concreting, further application of water shall cease so that the surface is just damp when further concreting has to commence.

- Any dirt, excess water, and loose particles shall be removed prior to starting re-concreting.
- For horizontal construction joint surfaces a freshly mixed slurry consisting of sand, cement and water mixed in the same proportions as used in the concrete shall be applied approximately10 mm thick in the construction joint surface immediately ahead of concreting. The slurry must still be in a plastic state when applied.
- For vertical construction joint faces, a thin coat of a freshly mixed paste of neat cement and water, using as little water as is practical, shall be applied to the construction joint immediately ahead of concreting.
- Epoxy resins specially designed for bonding old concrete to new shall be used at construction joints where so directed by the Engineer. The preparation of the construction joint surface and the application of the epoxy resin shall be strictly in accordance with the manufacturer's recommendations and the Engineer's instructions. The actual brand and type of resin used shall be subject to the Engineer's approval.

(d) Bonding

Unless otherwise shown on the plans, horizontal joints may be made without keys; and vertical joints shall be constructed with shear keys. Surfaces of fresh concrete at horizontal joints construction joints shall be rough floated sufficient to thoroughly consolidate the surface and intentionally left in a roughened condition.

Shear keys shall consist of formed depression in the surface covering approximately one -third of the contact surface. The forms for key shall be beveled so that removal will not damage the concrete.

All construction joints shall be cleaned of surface laitance, curing compound and other foreign materials before fresh concrete is placed against the surface of the joint.

(e) Bonding and doweling to existing structures

When new concrete is shown on the plans to be bonded to existing concrete structures, the existing concrete shall be cleaned and flushed. When the plans show reinforcing dowels grouted into holes drilled in the existing concrete at such construction joints, the holes shall be drilled by methods that will not shatter or damage the concrete adjacent to the holes. The diameters of the drilled holes shall be6 mm larger than the nominal diameter of the dowels unless shown otherwise on the Drawings. The grout shall be neat cement paste of Portland cement and water. The water content shall be not more than 15 liters per 50 kg of cement. Sufficient grout shall be placed in the holes so that no voids remain after the dowels are inserted. Grout shall be cured for a period of at least three (3) days or until the dowels are encased in concrete.

10.9 EXPANSION AND CONTRACTION JOINTS

(a) Open joints

- Open joints shall be formed with a wooden strip, metal plate, or other approved material.
- Joint forming material shall be removed without chipping or breaking the corners of the concrete.
- Reinforcement shall not be extended across an open joint.

(b) Filled joints

- Pre-moulded expansion joint filler shall be cut to the shape and size of the surface being jointed.
- The joint filler shall be secured on one surface of the joint using galvanized nails or other acceptable means and spliced according to the manufacturer's recommendations.
- After form removal, all concrete or mortar that has sealed across the joint shall be removed and neatly cut.

(c) Steel joints

- Plates, angles, or other structural shapes shall be fabricated accurately to conform to the concrete surface.
- Joint opening shall be set to conform to the ambient temperature at the time of concrete placement.
- The joints shall be securely fastened to keep them in the correct position.

(d) Water stops

Water stops shall be of copper, plastic or rubber water stops according to AASHTO requirements.

(e) Compression joint seals

- One-piece compression joint seals shall be used for transverse joints and the longest practicable length for longitudinal joints.
- Joints shall be cleaned and dried; and spalls and irregularities shall be removed.
- A lubricant/adhesive shall be applied as a covering film to both sides of the seal immediately before installation.
- The seal shall be compressed and placed in the joint as recommended by the manufacturer and the seal shall be in full contact with the joint walls throughout its length.
- All seals that are twisted, curled, nicked or improperly formed shall be removed and discarded. All joint seals that elongate more than 5% of their original length when compressed shall be removed and reinstalled. All excess lubricant adhesive shall be removed before it dries.

10.10 CURING AND PROTECTION OF CONCRETE

All concrete shall be cured for a period of not less than 7 consecutive days. The curing methods shall be approved by the Engineer. Unhardened concrete shall be protected from rain and flowing water. Concrete shall be moist-cured by maintaining all surfaces continuously (not periodically) wet for the duration of the entire curing period. Water for curing shall be clean and free from any elements, which will cause staining, or discoloration of the concrete. Where forms of wood lagging are used and left in place during curing, the lagging shall be kept wet at all times. Horizontal construction joints and finished horizontal surface cured with sand shall be covered with minimum uniform thickness of 5cmof sand, which shall be kept continuously saturated during entire curing period.

10.11 MEASUREMENT AND PAYMENT

The unit of measurement for in situ cast concrete shall be the cubic meter of concrete in place. Quantities shall be calculated from the dimensions shown on the Drawings or as authorized. No deduction in volume measured for payment shall be made for the volume of any reinforcing steel, inserts and pipes or conduits up to 150 mm in diameter embedded in the concrete.

The tendered rate shall include full compensation for procuring and furnishing all the materials; storing the materials; providing all plant; mixing, transporting, placing and compacting the concrete; forming the inserts; construction joints (except mandatory construction joints) and contraction joints; curing and protecting the concrete; repairing defective surfaces; and finishing the concrete surfaces as specified.

Payment shall distinguish between the different classes of concrete.

11 STEEL REINFORCEMENT FOR STRUCTURES

11.1 SCOPE

This section covers the furnishing and placing of steel reinforcement in concrete structures.

11.2 MATERIALS REQUIREMENT

(a) Steel reinforcement

- Deformed and plain carbon steel reinforcing bars shall conform to the requirements of AASHTO M-31 and ASTM A615.
- Low alloy steel, deformed and plain billet steel bars, for concrete reinforcement shall be Grade 60 to ASTM A 706. The nominal area of the bar, as given in Table 1 of AASHTO M-31 or ASTM A 706, shall be used for computation.
- Steel fabric reinforcement shall comply with AASHTO M-225, M-221 or M-54 as appropriate.
- Hard drawn mild steel wire reinforcement shall comply with AASHTO M-55, welded steel wire fabric for concrete reinforcement.
- Deformed steel wire for concrete reinforcement shall comply with AASHTO M-225 and cold drawn steel wire for concrete reinforcement shall comply with AASHTO M-32.

(b) Mass of reinforcing bars

- The mass of Reinforcing Bars is shown in the Table 8302/1.The Contractor shall provide the manufacturer's chart for the exact calculations.

Table 11-1: Mass of reinforcing bars (as recommended by the South African reinforced concrete association)

Bar Diameter (mm)	Mass (kg/m)
8	0.395
10	0.617
12	0.888
16	1.58
20	2.47
25	3.85
32	6.31
40	9.86

(c) Mechanical couplers

Mechanical couplers shall be used only if pre-approved or detailed in the contract documents or authorised in writing by the Engineer. Such mechanical splices shall develop in tension or compression, as required, at least 125% of the specified yield strength of the bar being spliced.

When requested by the Engineer, up to two field couplers out of each 100, or portion thereof, placed in the work and chosen at random by the Engineer, shall be removed by the Contractor and tested by the Engineer for compliance to the required 125% of the specified yield strength of the bars being spliced

(d) Supply and storage of materials

Steel reinforcement shall only be used from a source with prior approval of the Engineer. Steel reinforcement shall be stacked off the ground and, in aggressive environments, protection shall be provided in the form of sheds or tarpaulins. All reinforcement shall be rust free and the Engineer shall be entitled to reject on inspection any reinforcement showing signs of rusting.

Different grades of reinforcement shall be stored in separate locations and shall be clearly identified and logged. Steel delivered directly to site shall also be logged accordingly by the Contractor.

Details of each consignment showing source of supply; manufacturer's certificate of test strength; constituents (% carbon etc); and date of rolling shall be submitted to the Engineer. However, this will not relieve the Contractor of any responsibility for testing the material as instructed by the Engineer.

11.3 CONSTRUCTION REQUIREMENTS

(a) Equipment

The equipment used for the cutting, cropping and bending of the reinforcement shall be capable of producing prefabricated or in-situ assemblies complying with the requirements of this Division.

(b) Bending of reinforcement

- Reinforcement shall be cut and bent to the dimensions shown on the Drawings and in accordance with ACI 315.
- All reinforcement shall be bent at temperatures in the range of 5ºC to 100ºC unless otherwise approved by the Engineer.
- The Contractor shall submit a Bar Bending Schedule at least thirty (30) days prior to the placement of the reinforcement, for the Engineer's approval. All costs for the preparation of the schedule shall be incidental to the work.
- No flame cutting of steel bars shall be permitted except with the approval of the Engineer.
- Except as otherwise approved, all bars shall be bent cold and bending shall be done slowly, a steady, even pressure being used without jerk or impact.
- If approved, hot bending of bars of at least 32 mm diameter will be permitted, provided that the bars do not depend for their strength on cold working.
- When hot bending is approved, the bars shall be heated slowly to a cherry red heat (not above 840ºC) and after bending shall be allowed to cool slowly in air. Quenching with water shall not be permitted.
- Reinforcing bars that have already been bent shall not be re-bent at the location of the original bend without the permission of the Engineer.

(c) Surface conditions

Immediately before the concrete is placed around the reinforcement, the reinforcement shall be clean, free from mud, oil, grease, paint, loose rust, loose mill scale or any other substance that can have an adverse chemical effect on the steel or concrete, or reduce the bond.

(d) Placing and fixing

Reinforcement shall be secured against displacement during the placement and compaction of the concrete.

Reinforcement shall be positioned as shown on the Drawings and accurately secured in these positions within the specified tolerance by tying with wire or by the use of suitable clips or, where permitted by the Engineer, by tack welding. The wire adjacent to permanently exposed faces and the internal faces of hollow box superstructures shall be 1.2 mm diameter stainless steel. Elsewhere 1.6 mm diameter soft annealed wire may be used.

Cover and spacer blocks required to support the reinforcement shall be as small as possible consistent with their use and be of approved design and material. Projecting ends of ties or clips shall not encroach into the concrete cover.

Where protruding bars are exposed to the elements for an indefinite period the bars shall be adequately protected against corrosion and damage and shall be properly cleaned before being permanently encased in concrete.

In members that are formed with sliding formwork, spacer "ladders" for the placing and fixing of the wall reinforcement shall be used at spacing indicated on the Drawings or as directed by the Engineer. The ladders shall consist of two 3.7 m long bars with lateral ties of 4 mm diameter welded to them in the form of a ladder. The ties shall be spaced at multiples of horizontal bar spacing in the wall, and be used to secure the horizontal reinforcement. The laps in the horizontal reinforcement shall be staggered to ensure that no part of two laps in any four consecutive layers lie in the same vertical plane.

(e) Cover

The term "cover" in this context shall mean the minimum clear thickness of concrete between the surface of the reinforcement and face of the concrete.

The cover to any bar in an outer layer of reinforcement shall not be less than the minimum cover shown on the Drawings and shall not exceed the minimum by more than 4% of the overall dimension of the member, measured in the same direction, or by more than 20 mm, whichever is the lesser. Where no cover is indicated, the minimum cover provided shall not be less than the appropriate values shown in Table below.

The cover shall be increased by the expected depth of any surface treatment (eg when concrete is bush-hammered or when rebates are provided).

Additional cover as directed by the Engineer shall be provided if porous aggregates are used.

Concrete spacer blocks shall be made with 5 mm maximum size aggregate and shall be of the same strength and material source as the surrounding concrete. Tying wire complying with the requirements of this clause shall be cast into the block for the purpose of tying it to the reinforcement. The blocks shall be formed in specially manufactured moulds and the concrete compacted in a table vibrator all to the approval of the Engineer.

Cover blocks or spacers required for ensuring that the specified cover is obtained shall be of a material, shape, and design acceptable to the Engineer.

The Contractor shall provide adequate support to reinforcement by way of stools/chairs. The stools/chairs shall be suitably robust, and fixed securely so that they cannot swivel or move. The stools/chairs shall have sufficient strength to perform the required functions, taking into account

amongst others temporary loads such as the weight of workmen and wet concrete, and forces caused by vibrators and other methods of compacting the concrete.

Table 11-2: Minimum concrete cover over reinforcement

Water/Cement Ratio		≤0.40	0.4 to 0.5	≥0.50
Situation		**Cover (mm)**	**Cover (mm)**	**Cover (mm)**
Direct exposure to salt water		80	100	120
Cast against earth (i.e. Bottom of footings)		60	75	90
Exterior other than above		40	50	60
Interior other than above (i.e. hollow structures)	Up to ø35 Bar	32	40	48
	ø45 and ø55Bars	40	50	60
Bottom of cast-in place slabs	Up to ø35 Bar	35	35	42
	ø45 and ø55Bars	40	50	60
Precast soffit form panels		20	20	24
Precast Reinforced Piles	Non-corrosive environments	32	40	48
	Corrosive environments	60	75	90
Precast Pre-stressed Piles		40	50	60
Cast-in-place Piles	Non-corrosive environments	40	50	60
	Corrosive environments	60	75	90
	General Protected	60	75	90
	Shells	40	50	60
	Auger cast, tremie concrete or slurry construction	60	75	90

(f) Laps and joints

Laps, joints, splices and mechanical couplings shall be made only by the methods specified and at the positions shown on the Drawings, refer to ACI 318 or as agreed to by the Engineer.

11.4 MEASUREMENT AND PAYMENT

The unit of measurement for steel bars shall be the kilogram (kg) of reinforcement in place in accordance with the Drawings or as authorised by the Engineer.

The tendered rate shall include full compensation for the supply, delivery, cutting, bending, placing and fixing of the steel reinforcement; including all tying wire, clips, separators, stools/chairs and other steel used for positioning reinforcement; extra reinforcement at laps; and all wastage.

12 HARD CORE

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

Hardcore stone shall be place over soil to form foundation of the main structure. It is usually 20cm to 25cm thick.

Stone for hard coring shall be obtained from an approved source. It shall be clean, hard, durable, sound and free from impurities or decomposed rock. Stones shall be set in position with their natural beds as near as possible to the horizontal. The commonly depth of hard coring is 20cm. Measurement of hard core is in m^2.

Bottom concrete work (if any) can be executed mix proportion for plain concrete of material as recommended and stated in the specification. The commonly depth of bottom concrete work is 10cm. Measurement of bottom concrete work is in m^3.

13 GABIONSTRUCTURES

13.1 SCOPE

This section covers the construction of gabion structures.

13.2 MATERIALS REQUIREMENT AND METHOD OF CONSTRUCTION

Construction materials for gabion walls and mattresses used in aprons for retaining walls, lining of channels, revetments, and other anti-erosion structures in accordance with the Drawings or as ordered by the Engineer are as discussed here under but not limited to:

Rock: stones or rock for filling gabions shall be clean, hard, sound, durable and un-weathered boulders or rock fragments. It can be obtained from sources located by the Contractor and approved by the Engineer.

No rock particles shall exceed the maximum size given in table below and at least 85% of the rocks shall have a size equal to or above minimum size given in the table.

Table 13-1: Rock size

Depth of cage (mm)	Minimum (mm)	Maximum (mm)
0.2	75* or 95**	125
0.3	100	200
0.5	100	250
1.0	100	300

*Using 60 x 80 mm mesh
**Using 80 x 100 mm mesh
Source: ERA Standard Technical Specifications and Method of Measurement for Roadwork, 2013

Wire: All wire used in the fabrication of the gabions and in the wire operations during construction shall be to ASTM A 910, Grade # 1010 or 1015, having a tensile strength of not less than 350 MPa. Cold drawn steel wire fabric shall meet the requirements of AASHTO M-55.

Galvanizing: All wire used in the fabrication of gabions shall be galvanized in accordance with the provisions of ASTM A 641 with Class 3 coating or aluminized with a coating weight as per ASTM A 809 for Class A heavy galvanized mild steel wire. The minimum mass of the zinc- coating shall be according to the figures shown in Table below.

Table 13-2: Coating of wire

Nominal diameter of coated wire (mm)	Mass of coating (g/m^2 surface area)
3.7-4.0	290
3.0-3.6	275
2.2-2.9	260
below 2.2	245

Source: ERA Standard Technical Specifications and Method of Measurement for Roadwork, 2013

The adhesion of the zinc coating to the wire shall be such that when the wire is wrapped six turns round a mandrel of four times the diameter of the wire, it shall not flake or crack to such an extent that any zinc can be removed by rubbing with bare fingers.

Wire Mesh and Clip Fasteners: Wire mesh shall be hexagonal-woven mesh wherein the joints are formed by twisting each pair of wires through three half turns. The tightness of the twisted joints shall be such that a force of not less than 1.7 kN is required when pulling on one wire in order to separate it from the other wire provided each wire is prevented from turning; and the applied forces and the wire are all kept in the same plane. The diameter of the wire and the size of mesh used shall be as shown in Table below.

Table 13-3: Mesh size

Depth of gabion (m)	Mesh size (mm)	Wire diameter (mm)
0.5 and over	80x100	2.5
	100x120	2.7
0.2 -0.3	80x100	2.2
	60x80	2.0

Source: ERA Standard Technical Specifications and Method of Measurement for Roadwork, 2013.

The shorter dimensions of the mesh shall be taken from centre to centre of the twisted joints, and the larger dimensions shall be between the inside ends of twisted joints.

Alternatively; wire used in the body of the mesh shall not be thinner than 11-gauge for galvanized baskets and 12-gauge for PVC coated baskets. Selvage wire shall not be less than 10 gauges, and lacing and tie wire shall not be thinner than 13-gauge.Clip fasteners shall be galvanized and/or PVC coated as required and may be of any type that provides positive lock when installed. They shall be stronger than the mesh to which they are attached.
Galvanizing on the steel clips shall be in accordance with ASTM A 641 with a Class 3 coating, and aluminizing shall be in accordance with ASTM A 809.

Gabions using PVC coated wire: When gabions using PVC coated wire is specified, the wire used for the gabion mesh, and for wiring the gabions during construction shall be galvanized wire as specified in Clause 9102(b) onto which is extruded a polyvinylchloride (PVC) coating. The average thickness of the PVC coating shall be as specified, either 0.30 mm for use in mildly corrosive conditions or 0.55 mm for use in marine and other severely corrosive or abrasive conditions. The minimum thickness of the coatings shall be 0.25 mm and 0.4 mm respectively, and the coatings shall be capable of resisting the deleterious effects of natural weather and salt-water exposure. The PVC coated gabions shall be of a proven brand and the brand shall be subject to the Engineer's approval.

Geotextile filter fabric: Where indicated on the Drawings or ordered by the Engineer, one layer of approved geotextile material shall be placed on the prepared surface prior to the placing of gabions. The material shall be placed as directed in vertical strips with a minimum overlap of 300 mm, and shall be properly fastened to prevent any movement or slipping during the placing of gabions.

13.3 MEASUREMENT AND PAYMENT

The unit of measurement for gabion structure shall be the cubic meter (m^3) of completed work in accordance with the Drawings or as authorised by the Engineer.

14 RIPRAP

14.1 GENERAL

Riprap shall consist of a course(s) of large rock placed on bank slopes and toes; river and streambeds; and other localities where protection of this type may be required.

14.2 MATERIALS

Stone for riprap shall be hard field or quarry stone not susceptible to disintegration or excessive weathering on exposure to the atmosphere or water. It shall be free from soft material such as sand, clay, shale or organic material and shall not contain an excessive amount of elongated or flakey stone.

The required size of stone shall be determined by the "critical mass" specified. At least 50% by mass of the material comprising the riprap shall consist of stones having a mass heavier than the critical mass and not more than 10% by mass of the material shall consist of stone having a mass of less than 10% of the critical mass or more than 5 times the critical mass. The grading requirements for riprap are shown in Table 1.

Table 14-1: Gradation requirements for riprap

Class	Mean Diameter (D50)	Critical Mass (Kg)	Rock By Mass (%)	Mass (Kg)	Approximate Cubic Dimension (mm)
1	125	5	20	10 – 15	150 – 200
			30	5 – 10	125 – 150
			40	0.5 – 5	50 – 125
			10	0 – 0.5	0 – 50
2	175	10	20	25 – 50	200 – 250
			30	10 – 25	150 – 200
			40	1 – 10	75 – 150
			10	0 – 1	0 – 75
3	300	50	20	100 – 150	350 – 400
			30	50 – 100	250 – 350
			40	5 – 50	125 – 250
			10	0 – 5	0 – 125
4	400	100	20	250 – 350	450 – 500
			30	100 – 250	350 – 450
			40	10 – 100	150 – 350
			10	0 – 10	0 – 150
5	500	350	20	700 – 1000	650 – 700
			30	350 – 700	500 – 650
			40	25 – 350	200 – 500
			10	0 – 25	0 – 200
6	600	500	20	850 – 1600	700 – 850
			30	500 – 850	550 – 700
			40	50 – 500	250 – 550
			10	0 – 50	0 – 250

Two types of riprap are specified:

- Packed riprap: where the rocks are individually packed;
- Dumped riprap: where the stone is dumped and then spread by machines.

The surface of the areas to receive riprap shall be neatly trimmed to line and level and all loose material compacted. The perimeters of riprap shall be protected by the construction of either rock-filled trenches, walls, or other structures as may be required .Perimeter trenches shall normally be backfilled with rock of the same size and quality as used in the construction of the riprap it adjoins. Any cavities shall be filled with smaller material and the whole backfill shall be well consolidated.

(a) Filter BED

The filter bed shall consist of a layer(s) of permeable material placed on the prepared surface to the required thickness and finished to an even surface and thickness after placing each layer. Compaction of previous material will not be required. Care shall be taken neither to mix various grades of filter materials nor to disturb material already placed when constructing subsequent layers or riprap.

When the use of synthetic fiber filter fabric is required the material shall be placed on the prepared surface, or on the filter backing as may be required. The overlap between adjacent sheets shall be 150mm unless otherwise specified. Care shall be taken not to damage the filter fabric when placing subsequent layers; nor to expose the filter fabric when placing subsequent layers; nor to expose the filter fabric to the sun for periods of more than a day before covering.

(b) Packed riprap

Packed riprap shall be constructed from rocks individually placed to break joints and firmly bedded on the prepared surface. The spaces between larger stones shall be filled with spall and smaller stones securely rammed into place. On inclined surfaces the rock shall be laid in long horizontal lengths starting from the bottom and not in strips up the slope. The completed riprap shall present an even, tight surface. Local surface irregularities of the riprap shall not exceed 150mm.

(c) Dumped riprap

Dumped riprap shall be constructed by dumping the stone on the prepared surfaces, spreading it with a bulldozer, or other suitable earthmoving equipment, and trimming to the required lines and levels. The material shall be placed in a manner that shall prevent segregation of the small and larger stones. The final layer shall be tight with a minimum of voids.

14.3 MEASUREMENT AND PAYMENT

The unit of measurement shall be the cubic meter of riprap in place including rock in trench backfill.

The rates tendered shall include full compensation for the preparation of surfaces, including excavations,(but excluding excavations for trenches and bulk excavations), and for the furnishing, transporting, handling, and placing of riprap.

Collectively the rates shall also include full compensation for all other incidentals necessary for completing the work as specified.

15 PUMP AND PUMP ACESSARIES

15.1 PUMP UNITS

The term “pumping unit” used hereinafter is deemed to mean a complete pump with all relevant equipment complying with the General and Particular technical specification that includes electric motor, connecting shafting, bearings, couplings, impellers, seals, accessories, base plate, appurtenances and all associated equipment. All external electrical connections shall be part of the unit and all required electrical equipment for the pumping units shall be furnished and installed by the Contractor.

15.1.1 Manufacturer`s eligibility & qualifications

The supplier shall note that standards for workmanship, material and equipment, and references to brand names or catalogue numbers designated by the clients Technical specifications are intended to be descriptive only and not restrictive. The supplier may substitute alternative standards, brand names and/or catalogue numbers in its offer, provided that it demonstrates to the client’s satisfaction that the substitutions are substantially equivalent or superior to those designated in the Technical Specifications.

All pumping units shall be of approved design by standard organization make and product of manufacturers who have manufactured and built equipment of similar type, size and capacity for at least ten years, and who have sufficient time proven and test data to cover the design of the equipment specified.

Upon request, the Contractor shall submit a list of references of the proposed manufacturer’s pumping equipment, including at least installations of design, capacity and service similar to the equipment proposed to be furnished, which installations shall have been in successful operation.

All pumping units shall be designed and built for twenty-four (24) hours per day continuous service at any and all points within the specified range of operation, without over-heating, cavitation, excessive vibration or strain, and requiring only the degree of maintenance generally accepted as normal for the specific type of pump required.

The Supplier shall submit full details of the proposed Manufacturer’s ability to promptly fill replacement orders as well as about his authorized representatives in Ethiopia for supplying spare parts and for maintenance of pumping equipment.

The pump Manufacturer must possess or have readily available access to suitable testing facilities adequate for performing the shop test required and here in after specified. The Contractor shall submit a description of the proposed manufacturer’s testing facilities, including hydraulic, mechanical, electrical and periodical calibration provisions for all instruments. The documentary evidence of the goods and services conformity to the bidding documents shall be in the form of original manufacturer’s brochure, literature, drawings and data to be furnished.

Failure to successfully comply with the preceding requirements will constitute grounds for disqualification of the Pump Manufacturer and Contractor as well

Poor performance of similar pumping equipment now in operation under the specified conditions of service rating will constitute grounds for disqualification of the Pump Manufacturer unless such poor performance has been corrected.

All information specially required by the above terms shall be submitted by the Contractor with his Bid. Any additional information that may be required shall be submitted by the Contractor within fourteen (14) calendar days of the issue of a written request thereof, unless otherwise specified.

15.1.2 Specific information to be submitted for Approval

(i) Characteristic curves:-

For each pump type and model (or pumping unit where overall efficiency is specified) the following curves shall be provided for the acceptable flow range.

(a) Total Head (in meter) Vs Discharge (l/s, m^3/horl/min)

(b) Pump Efficiency (in %) Vs Discharge (l/s)

(c) Power Vs Discharge (l/s)

(d) N.P.S.H. (meter) Vs Discharge (l/s)

For the pump specified, the Supplier shall first submit for approval their characteristic curves. These shall be plotted on at least A4 graph paper. The curves shall regard the pump as a whole (not per stage).

(ii) Drawings

The following drawings shall be submitted by the Contractor:

(a) Detailed workshop drawings necessary for final design of the structure, connected piping and valves, pump drip and venting pipes, electrical connections, protective and auxiliary equipment.

(b) Drawings of pump foundations, motor supports, bearing supports and foundation frames (if recommended) presenting location, size and full details of foundation bolts. Weights and forces on foundations shall be clearly shown on such drawings, so that the structural design may be checked. Such forces shall be the maximum possible under any conditions.

(c) Dimensioned assembly outline drawings of the complete pump, drive and all associated equipment, presenting plan, elevation and any other views or sections required, including scaled cross-section of the assembled pump, showing full details and materials.

15.1.3 Submersible borehole pumps

The pump and the motor shall be delivered as a single pumping unit completely assembled. Submersible borehole pumps shall be of radial or mixed flow type, multi-stage units depending on the specification suspended from surface plates by vertical discharge Riser pipes and driven by submersible, water filled electric motors. The speed of these pump motors shall be no more than 2,900rpm at 50Hz

The materials and the pump construction will be suitable for the groundwater quality characterized mainly by:

- sand content up to 50 g/m3
- low pH, minimum 5
- high CO2 content up to 100 g/1

The pump body shall be stainless steel for submersible pumps. The body shall be capable of withstanding a hydraulic pressure, equal at least tones and a half (1.5) times the closed valve head.

Bearings shall be positively retained within the pump body to prevent the possibility of the bearing rotating; a press fit alone shall not be acceptable.

The pump shall be fitted with a suction case of a material suitable for the liquid being pumped and shall be provided with long bearings to stabilize the shaft and motor shaft and to avoid radial thrust on the motor bearing. A screen shall be incorporated having a minimum open area of four (4) times the eye of the impeller.

The submersible motor shall be of the water filled, enclosed type suitable for continuous duty. Motor performance shall be in accordance with the relevant section of IEC60034.

An expansion chamber or diaphragm shall be provided to relieve thermal expansion of the internal motor fluid due to temperature, and shall provide motor internal and external pressure balance under all conditions of temperature and pressure.

The bearings shall be water lubricated. The motor thrust bearing shall be capable of carrying the thrust load corresponding to maximum head, operating with rotation in either direction.

The pump cable (in a length equal to pump installation depth +30 or 25m depend on the pump house distance from boreholes) will be also a part of the delivery.

The borehole pump column (rising pipe) including discharge elbow shall be supplied and installed together with the pump. It shall comprise a number of sections at the option of the Suppliers that the total length may be adjusted by plus or minus 2m.

The well Head-plate shall be of a design which will ensure a water tight capping of the well and shall be rigid and strong enough to support the en tire weight of the suspended parts when filled with water. The plate shall provide suitable openings for all cables, well vent and water level indicator/transmitter. There shall be provision to allow a manual to be used to confirm the water level within the well.

The head-plate shall be fitted directly on to the upper portion of the inner casing by means of a bolted flange.

The discharge connection (elbow) shall be flanged, at a diameter similar to the rising pipe, and with a pressure rating consistent with the maximum surface pressure that can be delivered by the pump.

The discharge elbow shall be equipped with a discharge pressure gauge.

15.1.4 Surface centrifugal pumps

The pumps shall be provided with suction baskets or strainers, in order to prevent the ingress of impurities from the suction sump. In addition, negative suction head pumps shall be provided with foot valve. The strainer shall be constructed entirely of stainless steel and shall have an inlet area equal to at least four (4) times the impeller inlet area.

The pump and the motor shall be mounted on a common rigid, reinforced steel base plate, and directly coupled by means of a flexible spacer type coupling. The coupling and any other exposed rotating parts shall be protected by appropriate guards. Priming funnels (if needed) shall be fitted on each pump for priming. The pump design will include a hydraulic balance system. The pump sealing shall be by means of a packed gland.

Lubrication arrangements shall be so designed that there shall be no contamination of the pumped fluid.

The pumps and associated pipe work shall be, wherever possible, arranged so that air can be completely expelled during priming. Where this is not possible, facilities shall be provided for the removal of trapped air. Adequate facilities shall be provided for drainage of the pumps for inspection purposes.

15.1.5 Accessories and instrumentation

(i) Air relief valves

Each pump shall be provided with air relief valve on the discharge pipe (if not otherwise specified). The air relief valve shall be of the “aero-kinetic” double orifice type, allowing the air to flow out and into the pipeline.

The air relief valves shall be mounted using isolating valves. The diameter of the air relief valve and its isolation valve shall be sufficient to exhaust air during pump start-up and all other normal operating conditions.

The air relief valve and its isolating valve shall be rated to at least one and a half (1.5) times the shut- off pressure of the pumps.

(ii) Manometers (pressure gauges)

Pressure gauges shall be installed on both inlet and outlet pipes of any surface pump (new or overhauled) and on the discharge of any borehole pump (new or overhauled). The manometers shall be of Bourdon elastic tube type, directly activated by the flowing water (unsheathed).

The manometers shall be of “outdoor” protection class. They shall be mounted using ascrewed½"3- way cock in order to ensure its drainage and isolation.

The manometers shall be of heavy duty type, anti-vibration, with at least a 100mm dial. The pressure range shall be approximately 133% of the shut-off pressure of the pump.

(iii) Flow Meters (water meters)

The flow meters shall be of “propeller” or “turbine” type, provided with totaliser, calibrated in metric units. The indicator-totaliser shall be mounted in an easy readable position. The nominal pressure rating of the flow meter shall take into account the shut-off pressure of the pump.

(iv) Valves and non-return valves

The valves shall be flanged. The non-return valves shall be flanged, swing type, without lever arm. They shall be of cast steel, cast iron or bronze made. All the components shall be suitably protected against corrosion. The rating shall take into consideration the shut-off pressure of the pump.

(v) Pressure switch

Pressure switches shall have over range protection upto1.5 times the maximum anticipated line pressure.

Internal parts shall be of stainless steel, bronze or other corrosion resistant material.

All pressure switches shall be supplied complete with isolating valves and calibration points to enable calibration or removal without loss of fluid.

Pressure and differential pressure switches shall have contacts with separate ‘cut in’ and‘ cut out’ pressure values.

The nominal pressure values at which pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value(s) shall be clearly indicated by means of a scale and pointer.

15.1.6 Tests

(i) Factory tests

Each pumping unit shall be tested individually on the Manufacturer’s premises in full accordance with BSENISO9906 Grade2.

The pumps shall be tested complete, with all the bearings and directly driven auxiliaries, or, where this is impracticable, the Contractor shall state the allowances to be made for losses incurred by these items and shall demonstrate the accuracy of these allowances. The test of each pump shall be carried out with its own motor.

Such tests shall show that the pump has the general characteristics of head, efficiency, power, NPSH, and such other properties as they appear on the approved curves submitted. Such tests shall also establish that the pump is free from overheating, cavitations, and that vibration is within the specified tolerance over the specified range.

The pump shall be tested over the full working range, from closed valve condition to maximum discharge point. Readings shall be taken at a minimum of five points, including one point within ±2 percent of the design duty point.

Head/flow rate curve, pump efficiency/flow rate curve, power/flow rate curve and NPSH/flow rate curve shall be drawn for each pump. For the production of these curves, the values of motor efficiencies obtained during the motor tests may be used. The curves produced shall be used to demonstrate that the pump shall be capable to meet the full range of operating conditions on site.

Pump casing shall be subject to a pressure test one and a half (1.5) times the maximum pressure with the delivery valve closed. The positive suction head shall be taken into account in deciding this pressure.

A relevant certificate shall be produced for each test, showing the readings obtained performance calculations, the final results and full details of all instruments used, including serial number and details of the calibration certificates.

(ii) Site tests after installation

Site test shall be carried out. The tests will be witnessed by Contracting Authority's, Supervisor's and Contractor's representatives.

15.2 ELECTRICITY SUPPLY

The Contractor shall arrange for EEPCO (Inspectorate Division) to undertake any testing and inspection necessary for the electricity supplies to be connected when required. On completion of the tests and inspections, and not less than two (2) weeks prior to the power supply being required, the Contractor shall submit to the Supervisor a copy of his Electrical Installation Completion Certificate and of the EEPCO test certificates.

15.3 STANDBY GENERATING SETS

All equipment shall be supplied and delivered, designed, construction assembled and equipped in accordance with the operating conditions specified.

15.3.1 General

The diesel generating sets shall consist of diesel engines and alternators mounted together on common base plates. It shall be rated for continuous duty of twenty four (24) hours per day, for operation under the climatic conditions and altitude as specified, and shall be rated at speed of 1,500rpm.

The generating set shall be capable to deliver continuously 110% of its rated output for one hour in every twelve (12) hours, without any part impaired.

15.3.2 Engine

Engine shall be industrial and designed for standby power rating 4 strokes, direct injection; natural aspiration, water cooling with mechanical radiator and pusher air fan or air cooled; electric starting with batteries and battery charger, oil filter, air filter, fuel filter, injection pump with mechanical rpm governor, aspiration by means of feeding pump, alarm senders for low oil pressure and high engine temperature.

15.3.3 Cooling system (water cooled or air cooled)

(i) Water cooled

The engine shall be complete with a tropical capacity radiator for cooling the machine in tropical ambient temperature, with an engine driven blower type heavy-duty cooling fan. The cooling system shall be of the forced circulation type with engine mounted gear type coolant pump.

The closed circulating system shall include a direct acting thermostatic valve for automatically controlling the engine temperature and for by passing the radiator for quick warm up. A block heater shall be provided to keep the coolant/water mix at adequate temperature for easier starting of the stand by diesel generator. The cooling system shall be of sufficient capacity to permit continuous full load operation of the engine without boiling of the coolant at atmospheric air temperatureofupto50^{0}C.

The radiator cooling air shall be exhausted to the atmosphere via a louvered opening and a bellows connection to the radiator. A further louvered opening shall be providing to supply cooling and charge air.

(ii) Air cooled

If air cooled the air blower capacity and the cooling fin arrangement shall be sufficient to permit continuous full load operation of the engine without overheating the engine at atmospheric air temperature of 50^{0}C. The velocity of cooling air should be sufficiently high to prevent formation of dust deposits which could impair the cooling efficiency. The fins shall have adequate area for prompt and efficient cooling.

15.3.4 Lubrication system

The lubrication system shall be powered by a mechanically driven gear type positive displacement pump of sufficient capacity to operate at the specified ambient air temperature and altitude.

The system shall be equipped with suitable oil pump, dual centrifugal and replaceable full flow-filters and suitably arranged oil passages in the cylinder block.

Full details regarding the type, capacity, pump and filters of the lubrication system shall be submitted with the bid.

15.3.5 Fuel system

The fuel system shall ensure a continuous and clean supply of fuel. The engine shall be capable of operating with fuels complying with clause A, B1 and B2 of BS2869. The fuel system shall have primary fuel/water separator and filters of the fine wire mesh type.

A day tank complete with level indicator having capacity to provide minimum 12 hours running at full load shall be provided with an automatic fuel transfer pump and emergency hand pump to fill daily service tank from main storage tank. Fuel lines shall be black iron pipe, steel or copper to avoid fuel contamination. The fuel system shall be located on the generator or bed plate and fully within any acoustic or weather enclosure.

The system shall incorporate easily accessible, interchangeable and readily removable injectors and filters of adequate capacity.

The main storage fuel tank shall be fitted with a level indicator and filling, vent and drain connections. It shall be installed with a sloping base with the drain at the lowest point to allow the draining of accumulated water. The main tank shall also be fitted with an inspection hatch and shall be located so as not to be affected by heat from the engine, exhaust pipe, or muffler.

Completespecificationdatarelatingtothedieselenginefuelsystemshallbesubmittedby Contractor.

15.3.6 Power rating

The power ratings are in accordance with the provisions of standard compatible (with BS, DIN or ISO). The power rating of the engine is the active power expressed in KW available at the terminals of the generating set at nominal voltage and frequency and under stationary applications of ambient temperature ambient pressure and relative humidity.

Certified engine data showing, at least, net power, (continuous, intermittent and maximum) torque performance curves, specific fuel consumption curve at specified site altitude above sea level shall be submitted with the bid.

Cyclic irregularity of the engine/alternator combination shall not exceed that specified in BSISO3046.

15.3.7 Electrical system

The engine shall be provided with a complete electrical charging, starting, electrical switch, preheating switch and at least two keys.

The generator or alternator shall be the manufacturer's standard production model and shall be adequate to provide service under normal operating conditions.

The generator shall be rated to ensure that it is possible to start any likely motor combination under maximum load conditions. This requirement must be strictly observed and the successful starting warranted.

The alternators shall be effectively cooled by open forced air ventilation. The ventilation openings shall be screened against ingress of small insects and rodents.

Alternator bearings shall preferably be of the cartridge type, preventing contamination by dirt or moisture when the alternator is dismantled. The bearings shall be grease lubricated. Easily accessible nipples for re-greasing shall be provided.

All control panels shall be complete with a mains powered battery charger and battery. In the case of an electric starting generator the battery shall be the starting battery and shall be rated accordingly.

The Control panel shall be a single integrated unit, mounted on the generator bed plate and shall include provision for all generator services and power switching including such items as the fuel transfer pump.

15.3.8 Exhaust systems for diesel engines

For permanent installations system shall be suspended from the walls and roof by suitable brackets
andangletieswhichshallincludemountingstopreventthetransmissionofvibrationandnoisetothe building.

The system shall be adequately lagged and fixed within the building. Where the roof is of combustible material and the walls of the building are of incombustible material, the exhaust shall be routed to atmosphere through the wall rather than the roof. Where both the walls and roof are of combustible material, special care shall be taken to protect the building from the exhaust piping and the hot gases discharged from it.

The exhaust system outlet section shall be horizontal and where possible it shall point in the direction of the prevailing wind.

The exhaust system shall be adequately guarded and/or lagged to prevent accident al contact with hop parts.

15.3.9 Enclosure

Unless otherwise specified the generator shall be supplied with an acoustic and weather proof enclosure to suit the climatic conditions at the site.

15.3.10 Technical documentation

A manual shall be handed over prior to commissioning of the works .It will include a description, installation and operation instructions, maintenance instructions with trouble-shooting (faultfinding) details, drawings with identification numbers of parts, and parts identification list.

The manual shall cover the entire works provided or refurbished under the contract.

16 PIPE WORK

16.1 GENERAL

All pipe materials and fittings used shall conform, as a minimum, to the specifications contained in this section. Should the contractor desire to use other materials not listed in these specifications, written permission must be obtained from the Owner's Engineer. Specific types of pipe shall be specified in the Schedule of Bid Items and/or the Special Provisions.

All material shall be free from defects impairing strength and durability and be of the best commercial quality for the purposes specified. It shall have structural properties sufficient to safely sustain or withstand strains and stresses to which it is normally subjected and be true to detail.

Pipes, fittings and valves shall be of the diameter and class of material as specified or shown on the Drawings and their joints shall be completely watertight. All pipes, valves and pipe fittings shall conform to the relevant standards. The Contractor shall if required forward to the Engineer certificates showing that the materials have been tested and comply with the requirements of this Specification and the relevant Standard.

Where the Contractor wishes to use a type of pipe not manufactured in the minimum internal diameter indicated in the Contract, he may substitute the next larger diameter manufactured subject to full compliance with the design requirements, clearance and cover.

The Contractor shall not use pipes and fittings supplied by more than one manufacturer, for each material specified, without approval in writing by the Engineer. The manufacture of pipes, pipe fittings and accessories shall be open to inspection by the Engineer at the manufacturer's works. Pipes shall be ordered in the maximum lengths available to minimize the number of joints. The Contractor shall be responsible for the supply of all materials in sufficient quantities and shall ascertain the required quantities immediately prior to placing any order, especially for imported goods.

16.2 MATERIALS OF PIPES

16.2.1 Steel pipes and fittings

Steel pipes shall be of the diameter and thickness as shown on the Drawings and shall comply with BS3601.Steel pipes and fittings shall be coated both internally and externally with at least two (2) layers of bitumen to BS3416 type 1, Class A. Unless otherwise specified steel pipes shall be jointed by double flange joints or approved equivalent joints, and joints to fittings, structures, etc. shall be flanged with PN16 flanges complying to BS4504.

Pipes for cutting shall be clearly identifiable. They shall be supplied rounded throughout their length, and shall be used only as directed.

The Flanged Steel Pipe shall conform to the ASA Specification B16.I, Class 125 and Gaskets shall be one-sixteenth inch thick ring gaskets of red sheet rubber.

16.2.2 Unplasticized PVC (UPVC) pipes and fittings

Unplasticized PVC pipes and fittings for main distribution line shall comply with the relevant provisions of EN 1452-1 and EN 1452-2 or equivalent. The pipe shall be legibly marked with the following information: manufacturer's name or trade mark, Number of the system standard (EN 1452), material (PVC-U), Nominal outside diameter (dn x wall thickness en), Nominal pressure PN, Manufacturer's information, and Number of the extrusion line. The marking shall conform to ENV 1452-6.

Unless otherwise specified joints for U-PVC pipes and fittings shall be flexible spigot and socket joints in accordance to EN 1452-3:1999.

16.2.3 HDPE pipes and fittings

The High Density Polyethylene (HDPE) Pipe shall be made from base polymer and shall conform to the requirements as specified in MS 1058 Part 1:2002.

16.3 HANDLING OF PIPES

The Contractor shall be responsible for the safe handling of all pipes, valves and pipe fittings. When loading, unloading, or otherwise handling, the greatest care shall be taken to avoid shocks likely to cause cracking, chipping or any other damage to pipes, valves or fittings or to their coatings.

All pipes and fittings too heavy to be carried by hand shall be loaded and off-loaded only by means of a crane or any other approved lifting and handling device, with slings or hooks suitably padded. In this case recesses shall be dug beneath the invert to permit the slings or ropes to be properly withdrawn.

Particular care shall be taken to ensure that sheeting and lining are intact before jointing pipes and fittings. No pipes shall be rolled into place for lowering.

Before any piping is lowered into the trench, it shall be cleaned and examined for cracks, flaws etc. whilst hanging in the sling, and to see that no earth or foreign matter is within the pipe barrel or coupling. No protective cap, or disc or other appliance shall be removed permanently until the pipe or fitting that it protects is about to be jointed.

Suitable measures shall be taken to prevent flotation or other movement before the works is complete.

16.4 INSTALLATION OF PIPELINES

16.4.1 Trench excavation

The excavation of trenches for pipelines shall at any one time be limited to lengths previously approved by the Engineer in writing. Except with the written approval of the Engineer, work on each approved length shall be completed to the satisfaction of the Engineer before work on any new length is commenced. Before commencing, the alignment of the pipeline shall be pegged out and approved.

Trenches for pipelines and cables, unless specified otherwise, shall be restricted, up to a level 300mm above the crown of the pipe

The Contractor shall provide and maintain an adequate support system for upholding the ground actually encountered and the safety of adjacent structures, buildings, or utilities shall not be affected.

16.4.2 Foundation and bedding

Unless specified otherwise, pipelines shall be laid in trenches excavated in the ground. Unless unsuitable soil is encountered, trenches shall be excavated to the specified depth below the barrel of the pipe.

Granular bedding of sand for pipes shall be placed by spreading and compacting granular bedding material over the complete width of the pipe trench. Where pipes are jointed, bell holes of ample dimensions shall be formed in the bedding to ensure that each pipe is uniformly supported throughout the length of its barrel and to enable the joint to be made and inspected during testing. After pipe laying additional material shall be placed and compacted by hand rammer in 150mm layers equally on each side of the pipe as side support for the pipe.

Where pipes are laid on granular beds in ground with high groundwater level, puddled clay shall be constructed at 25m intervals at the midpoint of an individual pipe. The puddled clay shall be 0.5m long and shall be recessed 300mm into the sides and base of the trench, and shall extend by a minimum of 150mm above the top level of the granular material.

16.4.3 Installation

Installation of pipelines includes the supply, laying and jointing of pipes and fittings, construction of beddings and foundations, manholes and other structures in the line, testing, and backfilling of trenches, surface restoration and commissioning.

Installation of pipelines shall in principle follow the recommendations of EN 1452-6 or BS 8010 Code of Practice for Pipelines.

All plant, operation and haulage required from source of supply or store to bring the pipes, valves, and other items to their place of stripping and laying, including any unloading into temporary storage areas and any subsequent reloading for haulage to the place of laying shall be included in the supply of pipes and fittings.

16.4.4 Jointing and cutting

All joints shall be flexible joints and comply with the relevant provisions of the appropriate British Standard and shall be made to the manufacturer's recommendations and the Specifications hereafter.

Flanged joints shall be properly aligned before any bolts are tightened. Gaskets for flanged joints shall be of the inside-bolt-circle type. Jointing compounds shall not be used when making flanged joints except that to facilitate the making of vertical joints. Gaskets may be secured temporarily to one flange face by a minimum quantity of clear rubber solution. Bolt threads shall be threaded with

graphite paste and the nuts shall be tightened evenly in diametrically opposed pairs. Nuts shall be secured against loosening by vibration.

Rubber joint rings for water mains and drainage purposes shall be Types 1 and 2 respectively, complying with the relevant provisions of BS 2494 and shall be obtained from the pipe manufacturer. Joint lubricants for sliding joints and used for jointing water mains shall not impart to water taste, color, or any effect known to be injurious to health, and shall be resistant to bacterial growth and leaching.

16.4.5 Curves and bends

The pipes shall be laid in straight lines where possible. Curves of long radius shall be obtained by deflection at the joints. The deflection of the joints for this purpose shall not be more than 50% of the maximum deflection as specified by the pipe manufacturer for the relevant type of joint. Where a required change of direction cannot be obtained by deflection of the joints, prefabricated bends shall be used.

Concrete thrust blocks shall be provided where ordered by the Engineer, indicated on the Drawings and at reducers, tee junctions, caps, etc. and curves or bends deflecting 11¼ degrees or more. The type and size of thrust blocks shall be in accordance with the Drawings or as approved by the Engineer. Concrete for thrust blocks shall be placed carefully against undisturbed earth or rock and shall in no case give less than 150mm of cover to the pipe. When casting thrust blocks, no couplings or joints shall be covered, and where timber shuttering has been used such timber shall be removed before backfilling.

16.4.6 Protection

After excavation of the trench, placing and compacting the bedding, laying the pipe and concreting the thrust blocks the pipe must be surrounded by fill or concrete.

The Contractor shall not cover up any pipe except U-PVC pipe until it has been inspected, tested and approved. U-PVC may be covered to a depth of 150mm to reduce thermal movement if immediate inspection and testing is not practicable.

Unless otherwise specified the pipe surround for concrete and U-PVC pipes shall be covered with clay or concrete tiles of at least 40mm thickness and compression strength of 5N/mm².

The trench above the so finished pipe surround shall be filled with fill and shall be compacted flush with ground level.

Where indicated on the Drawings, ordered by the Engineer and where pipes are surfacing or having less than the required ground cover of 750mm and crossing roads serving vehicular traffic, pipes shall be surrounded by concrete bedding of grade C-25.

Pipes to be surrounded by concrete shall be supported by precast concrete setting blocks not less than 150mm deep covered with two layers of compressible packing of bitumen damp proof sheeting complying with BS743. Concrete shall be placed on one side of the pipe and carefully worked under the pipe without displacing the pipe. Then concrete shall be placed on both sides

and on top of the pipe in one operation. The concrete cover shall at least be 150mm to the barrel of the pipe.

Unless specified otherwise concrete shall not be reinforced and shall be interrupted over the full section at intervals not exceeding 8.0 meters by compressible filler. The interruptions shall coincide with the pipe joints.

16.4.7 Measurement and payment

The unit of measurement for pipe and fitting works shall be the meter (m) in place in accordance with the Drawings or as authorised by the Engineer.

The tendered rate shall include full compensation for the supply, installation, testing and commissioning.

17 ROAD NETWORKS

17.1 ACCESS ROADS

This will be expected to be cleared and grubbed by participation of communities of the project site. Access road having 4m width 20cm root clearing, 25cm base selected material, and 5cm red ash or 10cm compacted gravel surfacing will be constructed along the main canal to access the headwork site and canal structures. These roads will be provided with Drainage Trench (ditch) Excavation of same length but on the upstream of roads to prevent the roads and canals from flood erosion. The same to road construction, trench excavation and drainage culverts will also be done by the contractor/s as indicated on the drawing.

17.2 FARM ROADS

This work shall include the excavation of all types of earth material, backfilling, compaction, forming embankments and slopes, etc., as is necessary for the completion of the Works. Thus the nominated contractor/s will be supposed to construct all weather roads of which is 4m width 20cm depth root clearing, spread & compaction of 25cm base selected material, and 5cm red ash or 10cm compacted gravel surfacing along secondary and/or tertiary canals to allow vehicles for transportation of inputs and products and O&M purposes.

17.3 EXISTING PUBLIC ROADS

The Contractor shall ascertain for himself the practicability of using the existing public roads as shown on the Drawings for access to the site.

The highways, roads and bridges have widely varying load limits, and the Contractor shall be responsible for determining the load limits existing at the time and ensuring that his equipment does not exceed such limits. Before moving any heavy construction traffic onto highways, roads and bridges, the Contractor shall make suitable arrangements with the appropriate authorities and obtain their approval for the passage of such traffic. Where the authorities require and specify any special protection or strengthening to highways, roads or bridges, the Contractor shall submit to the Project Manager his proposals for such work, after their approval by the authority concerned.

The Contractor shall be responsible for inspecting the existing tracks and shall make his own assessment of the work necessary to bring them to the required standard for constructional traffic.

The Contractor shall take all reasonable precautions to ensure the safety of members of the public using the access roads. The Contractor shall maintain access to properties adjacent to the tracks at all times throughout the duration of the Contract.

The Contractor shall not drive tracked Equipment on any bituminous sealed road surface. Only rubber tyre vehicles, conforming to applicable load restrictions, will be permitted to use bituminous sealed roads.

17.4 PAYMENT

Payment for access and farm road will be made using the rate and unit of measurement shown in the Priced Bill of Quantities forming the contract.

18 MISCELLANEOUS

18.1 SCOPE

This section covers furnishing and installing of structural drains, gates, steel pipe for intake structure, valves, and other miscellaneous works connected with the structures.

18.2 STRUCTURE DRAINS

18.2.1 General

Under drainage and weep holes shall be provided for the main structure and canals along the side walls of the chute as shown on the drawing. It shall also be provided under other canals and structures as found necessary.

18.2.2 Materials

Pipes: Concrete pipes of the internal diameter sizes as specified on the drawings shall be used, each piece shall be 30cms. Long with straight and shall be laid dry, pieces of pipe shall be laid keeping 3 to 4mm space between the ends.

Material around the pipes: The material around the pipes shall consist of gravel clean and well graded; D85 of material must be equal to or greater than twice the size of the opening between the pips, as approved by the Engineer.

18.2.3 Installation

Trenching: Widths and depths of the trenches of drains shall be as indicated on the drawings and where not indicated shall be of minimum width necessary for trenching shall be performed by barring and wedging or any other approved method which will not damage the rock in the foundations.

Pipe installation: Each pipe shall be carefully inspected before it is aid any defective or damaged pipe shall be rejected. The laying of pipe shall precede upgrade beginning at the lower end of the pipe line. Under no circumstances the pipe shall be laid in water and pipes shall not be laid when the trench conditions are unsuitable for such work. Full responsibility for de-watering of trenches during construction shall be borne by the Contractor. Pipes shall be laid to the lines and grades as shown on the drawings. When pipe laying is inter interrupted the Contractor shall seal the ends of the pipe line to prevent the entry of foreign matter. No back-fill shall be placed over or around the pipe until the installation is approved by the Engineer.

Back filling: Before pipes are laid, graded gravel material as specified above shall be placed to the depth as shown on the drawings or as directed by the Engineer. Care shall be taken to ensure thorough compassion of the fill under the pipe. Material shall be placed along the side of the pipe in layers not exceeding 10cm in the depth and shall be compacted by hand tamping.

18.2.4 Steel work

Unless otherwise approved, steel and other metal work shall comply with British Standard Specifications.

The measurement will be the calculated weights of the sections used based on the nominal weights quoted by the manufacturers and no allowance will be made for rolling margins. No adjustments will be made to the quantities to allow for bolts, washers, nuts, and bolt holes, lifting holes, lifting lugs, weld metal and protective coatings.
The rates for structural steel work are to include for supply, fabrication where necessary, transporting, handling, site working, welding, cutting and drilling, bolts, nuts, washers, plates, packing and the like and all erection costs.

The rates are also to include for cleaning, all preparation and painting or galvanizing, where specified, and where no separate items have been provided. The cost of all labors and materials expended in making joints between adjacent members is to be covered by the rates.

18.3 TRASH RACK /SCREEN/

General: The Contractor shall furnish, assemble and install trash racks or screens including arrangements required for satisfactory installation.

Material specifications: All material used shall be of highest grade, free from defects and imperfections, all material shall be of recent manufacture and unused and of classification and grade designated on the drawings.

Workmanship:

a) General
Workmanship and finish shall be first class and equal to the best practice in modern fabrication and machine shops. Before laying out, cutting or fabricating the work in any way, the material shall be thoroughly straightened by methods that will not result in damage, except that sharp kinks or bends in members to be straightened will be cause for rejection. Finished members shall be free from kinks, bends. or winds. Shearing shall be accurately done, and all portions of the work neatly finished. Bends, except for minor details, shall be made by approved dies or bending rolls. Where heating is required, precautions shall be taken to avoid overheating the metal and it shall be allowed to cool in such a manner as not to destroy the original properties of the metal. Holes for drainage shall be provided in such horizontal or inclined members as may be subject to retention of entrapped water.

a) Dimensional tolerances for structural works

i) Structural work fabricated under this Contract and delivered to the work site in sub-assemblies will have been fabricated to and shall be assembled in accordance with the dimensional tolerance herein specified.

ii) Unless otherwise specifically authorized the major dimensions of any structure fabricated of structural steel shall be within 3mm of the dimensions shown on the drawing. Dimensions shall be measured by means of an approved calibrated steel tape of the same temperature as the structure at the time of measurement. Unfairness of plate work shall be held to a practicable minimum.

c) Welding

i) All welding and work related thereto shall comply with the requirements of the American Welding Society or the ASME Code applicable to the equipment being welded. All welds shall be continuous unless otherwise approved by the Engineer and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum.

ii) Members to be joined by welding shall be cut accurately size. The edges of the members shall be sheared, flame cut or machined to suit the type of welding. The cut surfaces shall expose sound metal free from defects. The surfaces of plates to be welded shall be free from rust, grease and other foreign matter for a distance of at least 2cm back from edge of the weld.

iii) All welding shall be performed by the electric are method. After being deposited, welds shall be cleaned of slag and shall show uniform sections, smoothness of weld metal, feather edges without overlap and free from porosity and clinkers. All pinholes, cracks and other defects shall be repaired by chipping or grinding the defects to sound metal and re-welding.

iv) Arc welding equipment shall be of a type approved by the Engineer that will produce proper voltage, amperages and polarity for all uses and positions for which the electrodes are suitable. Electrode shall conform to ASTM Designation A-2333 or similar.

d) Inspecting and testing during manufacture

The Engineer shall be entitled at all times during manufacture to inspect, examine and test on the place of manufacture the materials and the workmanship of all equipment to be supplied under the Contract. Such examination or testing if made shall not release the Contractor from any obligation under the Contract.

Installation:

a) General

The Contractor shall assemble and stall the trash rack in accordance with the details shown on the drawings or as directed by the Engineer.

b) Erection Equipment and Supplies

The Contractor shall furnish all equipment including but not limited to, lifting and erecting devices and welding machines and supplies necessary for the erection of the gate and trash rack. The Contractor shall furnish temporary supports, blocking bracing, jacks, anchor bolts and all similar items necessary for the support of equipment. The Contractor shall lubricate all parts requiring lubrication before operating any equipment.

Painting: All metal surfaces except those to be embedded in concrete shall be painted in accordance with the provisions of this clause or as directed by the Engineer. All painting and surface preparation work shall be carried out at the site. Surfaces to be painted that will be inaccessible after installation. All oil, grease, dirt and rust preventive compound shall be removed from the surface by the use of a suitable solvent and clean wiping material. Following the solvent cleaning, surfaces to be painted shall be cleaned of all rust, mill scale, dirt and other foreign substances. Immediately after cleaning, the surfaces shall be given the first coat of priming paint. Surfaces of metal items which are not submerged in water shall be given one coat of priming paint and two coats of Aluminum finish paint. Structural steel and miscellaneous metal works that will be

submerged in water shall be given two coats of Red Lead priming paint and two coats of phonetic resin aluminum finish paint.

So separate payment will be made for any of the painting of metal work performed under these specifications and all costs therefore shall be included in the rate or amount tendered for the item to which the painting is appurtenant.

18.4 STEEL PIPES AND VALVES

Steel pipes: Steel pipes and fittings shall be in accordance with BS 778 and shall be protected internally and externally against corrosion by hot applied bitumen coatings to BS4147. All pipe sections, which pass through walls of water retaining structures, shall incorporate integral paddle flanges for building in and shall be left un-coated externally over the length encased in the concrete. All internal coatings shall be of non-toxic material.

Valve-general: All valves shall be manufactured by specialist manufacturers and shall be of long-proven design in regard to spindle, gland, seating, operating gear an electric motor actuator. In so far as they are applicable, the requirements of BS 5163, BS 5133 and BS 5515 shall be observed as appropriate.
The working pressure rating of valves shall be suitable for 120 % of the maximum pressure that can be developed by the pump in the pipe work system plus the maximum pressure at the pump inlet.

Except as otherwise specified or approved, valves shall be of double-flange cast iron construction and shall be designed and tested to the declared Standard Specification. Non-ferrous materials shall be used for valves and cocks of 50-mm normal bore and below. Such valves may be flanged or internally threaded for screwed tube. Gland packing shall be entirely suitable for use in tropical conditions.

Each valve shall have cast-in lettering showing maker, year of manufacture, nominal bore, rated working pressure and the Standard with which the valve conforms and, where appropriate, an arrow to indicate the direction of flow. In addition each sluice and butterfly valve shall be provided with a complete set of operating gear as set out below.

Valve operation: Each valve shall be fitted with a hand-wheel and head-stock and shall be suitable for operation by one man against the maximum working head. Valves shall be geared if necessary to permit this and shall be closed by clockwise operation of the hand-wheel. Hand-wheel shall be readily removable.

Where gearing is required for operation, the gear shall be machine cut and shall be fully enclose with external greasing points. The position of valve hand-wheels and operating gear shall be carefully arranged so as to afford easy operation from the adjacent floor or plat form level.

Valves having extended operating shafts shall be provided with all necessary lubricated support brackets for the shafts extensions.

Sluice valve: Sluice valves of 50 mm to 600 mm shall comply with BS 5163. Sluice valves over 600 mm size shall be of an equivalent standard to those specified in BS 5163 and shall be of

approved design and manufacture. Each valve shall have cast or stamped on the outside of its body, the manufacturer's name, its size and its pressure rating.

Each valve shall be fitted with a hand-wheel. Manually operated valves shall be suitable for operation by one man against the maximum working head. Valves shall be geared if necessary to permit this and shall be closed by clockwise operation of hand-wheel. Hand-wheels shall be readily removable. Geared actuators shall be of the enclosed type and easily lubricated in a cast iron housing. Gland packing shall be entirely suitable for use in tropical country.

Butterfly /wing/ valves: Butterfly valves shall comply with BS 5155 and shall be of the drop tight closure, short or wafer type body with flanged ends of the appropriate char, stainless steel spindles. The valves shall have cast or ductile iron body and disc, and removable neoprene or nitrile rubber sealing faces against stainless steel seats. Means of slinging shall be provided for sizes of 300 mm dia. and larger.

Each electric motor and actuator shall be fitted with a hand-wheel, so arranged that the valve will close by clockwise operations of the hand-wheel. Valves shall be geared for one-man operation and shall be fitted with indicators. Hand-wheels shall be readily removable.

Check valves: All check valves complying with BS 5153 shall be of slanting disc type designed to close rapidly without shock for the first 90% and gently for the remaining 10%. The valve covers shall be of ample size to allow clear access to the valve seats when the valve is fully open. Each check valve shall have the direction of flow, nominal pressure rating and size cast or stamped onto the body.

Stop-log: The Contractor shall furnish stop-logs to close the diversion inlet after the construction of the main Structure is completed. The stop-log shall be made of reinforced concrete capable of withstanding reservoir water and other structures. The fabrication shall be approved by Engineer.

Water stops: Water stops shall be of the material and form shown on the drawings. No water stop material shall be brought on site until the Contractor has submitted full details of the materials he proposes to use; including samples and these has to be approved by the Engineer. All samples shall be of adequate length for testing.

Water stops shall be made of materials of which are resistant to chlorides, sulphates or other deleterious substances which may be present in the environment of the permanent works.

Rubber water stops may be of natural or synthetic rubber and shall have an elongation at breaking stress of at least 500 per cent at 25^0 C and shall be capable of accommodating a transverse movement of at least 50-mm.

Polyvinyl chloride (PVC) water stops shall be extruded from an unfilled plasticized PVC polymer or copolymer, which does not contain any, reclaimed or scrap PVC. PVC water stops shall have an elongation at breaking stress of at least 225 per cent at 25^0 C and shall be capable of accommodating a transverse movement of at least 10 mm.

Low modulus water stops shall be of rubber or PVC as described above but shall have an elongation at breaking of at least 200 per cent at 25^0 C under a tensile stress of 6 N/mm^2 and shall be capable of accommodating a transverse movement of at least 50 mm.
Water stops shall be supplied in lengths as long as possible consistent with ease of handling and construction requirements.

In rubber or plastic materials, joints other than butt joints shall be supplied ready-made by the manufacturer. Butt joints shall be made on site in accordance with the manufacturer's instructions and with equipment supplied for the purpose by the manufacturer.

Water stops materials shall be stored carefully on site to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic water stops shall be stored in cool well-ventilated places away from direct sunlight.

Rubber and plastic water stops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete on the other side, shall be protected from the sun.

Water stops shall be firmly fixed in the form work so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease, oil, etc. before placing concrete.

Concrete shall be placed carefully round water stops so as to avoid distortion or displacement and shall be fully compacted. Where water stops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the water stop.

Form work round water stops shall be carefully removed to avoid damage. If water stops suffer any damage which cannot be properly repaired in situ the Engineer may require a section of concrete to be removed and the water stop replaced.

18.5 PAYMENT

Payment for each work will be made at the unit prices, or otherwise, as shown in the Bill of Quantities.

REFERENCE MATERIALS

- GUIDELINE, Manuals & Standard Design of Small & Medium Scale Irrigation Projects in Ethiopia. Part III-B. Design Standards on Technical Specifications. The FDRE Ministry of Water Resources. July, 2002.
- Standard Methods of Measurement for Building Works (Final Draft). The FDRE Ministry of Urban Development, Housing and Construction. June, 2014.
- Standard Technical Specification and Method of Measurement for Road Works. The FDRE Ethiopian Road Authority. Addis Ababa, 2013.
- Technical Specifications for Building Works (Final Draft). The FDRE Ministry of Urban Development, Housing and Construction. June, 2014.

Special References

The following Standards, Code, Technical Specification documents can be referred while preparing sound and matured project specific technical specification. It is available in soft copy with MOANR. The reader also advised to use the recent version.

- AASHTO
- ASTM
- BS
- EBCS
- EURO CODES
- INDIAN STANDARD PRECAST CONCRETE CODES
- IS REINFORCEMENT CODE
- The Technical Specification and Method of Measurement by ERA, 2013
- The Technical Specification and Method of Measurement by BaTCoDA, March 1991
- MOC project Management office; Construction Project Management guidelines

SSIGL 24

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