Czech Development Agency

Nerudova 3, 118 50 Prague 1
tel.: +420 251 108 130, fax: +420 251 108 225
www.czechaid.cz

CONTRACT

REF. NO. 282226/2024-CRA

BETWEEN

CONTRACT OWNER:	**CZECH REPUBLIC – CZECH DEVELOPMENT AGENCY**
Represented by:	Mgr. Zbyněk Wojkowski - head of the Project Realization Department
Registered office:	Nerudova 3, 118 50 Prague 1
Person authorised in contractual matters:	Mr. Josef Darebný
Phone:	
E-mail:	
Company ID no.:	75123924
Bank connection:	Czech National Bank, Na Příkopě 28, Prague 1, Czech Republic
Account number:	0000 – 72929011/0710

(hereafter "Client")

and

SUPPLIER:	**HY Engineering PLC**
Represented by:	Mr. Henok Tsegaye – General Manager
Registered office:	Hawassa, Tabore Sub-city, Hitata kebele, P.O. Box 538, Ethiopia
Tax ID no.:	0057735915
Bank connection:	
Account number:	
SWIFT code:	
Contact person:	Mr. Henok Tsegaye
Phone:	
E-mail:	

(hereafter the „Supplier")

MANDATE CONTRACT

1. SUBJECT OF THE CONTRACT

1.1. The Supplier hereby undertakes to perform the mandate as technical expert. The mandate is specified in Article 2. of this Contract. The Supplier undertakes to perform the mandate duly and carefully according to his abilities.

1.2. Client hereby undertakes to pay the Supplier duly and in time for the performance of the mandate the agreed remuneration in accordance with terms and conditions stated in this Contract.

2. MANDATE

2.1. The Supplier will provide overall verification of the functionality of technical solution for Awaye Keraro site which was part of an identification of public contract "Introduction of a sustainable potable water supply system in the Bura, Dale and Bona Zuriya woredas".

2.2. The Supplier, on behalf of the Client, shall provide detailed verification of functionality of previously conducted construction design of the gravity water supply system in Awaye Keraro (Annex No. 2). The main output of this task shall be detailed design report consisting of:

A. Design Report prepared on the basis of the preliminary study, topographic and baseline surveys, including:
   - summary;
   - baseline assessment (population census - should be provided by Woreda Water Office, existing water sources, location and accessibility, administration);
   - design objectives, methodology and criteria;
   - demand assessment (population growth and projection, water demand analysis for upcoming 20 years etc.);
   - design of the water supply system and its components: water source requirement; reservoir capacity; distribution pipe lines, specification of fittings; location of anchor blocks, valve chambers and water points/taps etc.;
   - implementation plan.

B. Hydraulic Calculation

C. Specification and Bill of Quantity:
   - project summary;
   - supply and installation of pipes and fittings;
   - valve chambers for reservoir and pipe network;

- construction of reservoir, water points (with six faucets, water point for Health Post and school water point with sinks; depends on A)
- specification of pressure break tank, anchor blocks;
- all other components of the water supply system.

D. Cost Breakdown

E. Design Drawings Album:

- general map of the project area;
- general layout of distribution system;
- distribution system profiles;
- reservoir layout with fence (roof plan and section);
- detail pipe connection at the reservoir;
- distribution system fittings detail;
- water point with six faucets and fence (plan, section and schematic pipe connection);
- water point for Health post (plan, section and schematic pipe connection);
- school water point with sinks (plan, section and schematic pipe connection);
- pressure break tank;
- valve chamber;
- anchor block;
- other standard typical drawings (pipe trench, river and road crossing, air release etc.).

F. Letter of acceptance

- Letter of acceptance should be delivered from the respective authorities (namely: Woreda Water Office, Sidama Regional Bureau of Water, Mines and Energy) in regards to the planned design of the project.

2.3. The Supplier should specifically fulfill following tasks (1-12) at Awaye Keraro site:

1) To collect initial yields measurement at Godo 1, Godo 2 and Dassa Dashole between August and October with a minimum time interval 45 days. To verify information from local community about yield fluctuation during the year.

2) To collect water sample from each spring at each measurement and conduct physio chemical laboratory tests (pH, conductivity, TDS, turbidity, total chlorine, total, calcium and magnesium hardness, total, bicarbonate, carbonate and hydroxide alkalinity, dissolved NH_3, NH_4^+, Na^+, K^+, Ca^+, Mg^+, Fe, Cu^{2+}, Mn^{2+}, Cr^{6+}, Cl^-, F^-, Br_2, NO^{2-}, NO^{3-}, SO_4^{2-}, PO_4^{3-}, HCO_3^- and CO_3^{2-}) and measure groundwater temperature on site; total 6 samples

3) To propose a specific way of capturing springs Godo 1, Godo 2 and Dassa Dashole

4) To check all the remaining existing springs in the vicinity (13) and verify information from local community about yield fluctuation during the year.

5) For springs that can be used quantitatively, take water samples for laboratory tests (pH, conductivity, TDS, turbidity, total chlorine, total, calcium and magnesium hardness, total, bicarbonate, carbonate and hydroxide alkalinity, dissolved NH_3, NH_4^+, Na^+, K^+, Ca^+, Mg^+, Fe, Cu^{2+}, Mn^{2+}, Cr^{6+}, Cl^-, F^-, Br_2, NO^{2-}, NO^{3-}, SO_4^{2-}, PO_4^{3-}, HCO_3^- and CO_3^{2-}) and measure groundwater temperature on site (3 samples/analyses in total)

6) To propose a specific way of capturing quantitatively usable springs, determine whether they can potentially be connected to the system or whether it is appropriate/meaningful to capture them for local use only

7) To update and complete the positions of Water Points and update the positions of the reservoirs

8) To carry out geodetic surveying of all individual elements of the system - target the positions of all springs (16), reservoirs and water points

9) To establish current/calculate future requirements for the amount of water in Cham and Bela (people, livestock, ...)

10) To estimate excess balance (what will flow into the 100m³ reservoir in Badalo) of captured springs (Godo 1, Godo 2 and Dassa Dashole) and others, usable for connection to the system in relation to the need in Cham and Bela

11) To verify the state (technical, functionality) of the distribution network in Badalo near the 100m³ reservoir, the current and expected state of water supply (need, sufficiency) in Badalo

12) To verify existence/functioning of WASHCO in Cham, Bele and Badalo

2.4. The Supplier undertakes to perform the mandate exclusively through the employees of the Supplier without using third persons (subcontractors) for any tasks.

3. DURATION

3.1. The period of performance of the Contract is August to November15th 2024 (approximately 3 months).

4. CONTRACT PRICE

4.1. The Client shall reimburse the Supplier for performance of the mandate in the amount of USD 21.275 USD (in words: ten thousand dollars) including VAT (hereafter “contract price”). The contract price is accepted by both parties as non-exceedable. The contract price covers all the costs arising for the Supplier in connection with the performance of the mandate. The Supplier is responsible for the correct determination of the VAT rate.

4.2. The contract price shall be reimburse as a total after delivery of the complete Detail Design verification within the scope ofthe Supplier's mandate specified in Article 2.1 (2.2 respectively):

	Task	Unit	Quantities	Remuneration including VAT
A	Delivery of one Detail Design document (PDF and Word/EXCEL/DWG format) on 5th November consisting of tasks described in 2.1 (A-E) and performed tasks described in 2.2 (1-12)	report	1	8 500 USD
B	Hydraulic Calculation	calculation	1	3 500 USD
C	Specification and Bill of Quantity	BoQ	1	3 800 USD
D	Cost Breakdown	cost breakdown	1	1 200 USD
E	Design Drawings Album	drawings	1	4 200 USD
F	Letter of acceptance	letter	1	75 USD
				21, 275 USD

Above stated remuneration includes VAT and all costs, expenditures, services and additional performances necessary for performance of the mandate.

4.3. The Supplier shall send to the Client request for payment accompanied by invoice issued by the Supplier after fulfillment of all tasks specified in article 2 to this

contract. The request shall always be accompanied by corresponding documents for the respective tasks conducted, which were approved by the Client. The request for payment shall be submitted to the Client and approved by the Client before the payment will be processed.

4.4. In the invoice the Supplier shall state the project name: Awaye Keraro Water Supply Project, invoice number, date of issue, subject of invoicing, name, address, banking connection and signature.

4.5. The maturity period is 21 days from the delivery of the invoice to Client. The date of payment means the day when the payment is subtracted from the Client's account. The invoice must have all the essentials required of such document. Client may return an invoice to the Supplier within the maturity date without making any payment if the invoice contains incorrect data.

4.6. The payments will only be processed in USD.

4.7. Figures in the Supplier's invoices will be in USD.

4.8. The above mentioned amounts will be paid only by bank transfer to the following account opened in the name of the Supplier:

Bank connection: Bank of Abyssinia
Account No.: [redacted]
SWIFT code:

5. OBLIGATIONS OF THE SUPPLIER

5.1. The Supplier undertakes to perform the mandate personally and in accordance with relevant legislation and instructions and wishes of the Client if they aren´t in conflict with the legislation. The Supplier is not allowed to use sub-contractor to perform the mandate.

5.2. The Supplier shall observe any applicable laws in the execution of this Contract, and to hold the Client harmless of any claims from third parties (including State authorities) related to the execution of this Contract.

5.3. The Supplier shall transfer intellectual property right to the Client in accordance with this Contract.

5.4. In case that the Supplier fails to perform the mandate without justified excuse for more than 10 day, the Client has right for contractual penalty in the amount of 1000 USD. The contractual penalty is due by the day when the Client exercises the right for contractual penalty.

5.5. The Supplier is not liable for any delay in the consequence of Client's failure to give assistance under Article 6. hereof.

5.6. The Supplier shall provide free of charge cooperation in case of additional changes and adjustments to the documentation delivered to the Client for the period of six months after the handover.

6. OBLIGATIONS OF THE CLIENT

6.1. Client undertakes to provide to the Supplier full cooperation necessary for the performance of the mandate. Client shall especially:

a) provide all information and material related to the subject matter of this Contract and needed for adequate performance of the mandate by the Supplier;
b) in the case of necessity – delegate the project manager and other Client deputies who will cooperate with the Supplier during the performance of the mandate and are qualified to comment on the situation, issues and requirements related to the execution of this Contract.

7. LICENSES AND INTELLECTUAL PROPERTY, CONFIDENTIALITY

7.1. The Supplier undertakes to protect the Client against all third-party actions for breach of copyright or other intellectual property rights, which might arise out of this Contract.

7.2. The Supplier declares that he is the rightful owner of the intellectual rights to all information supplied by virtue of this Contract, and that he is entitled to sell or transfer those rights in accordance with the terms of this Contract. If intellectual rights are the property of third parties, the Supplier shall request those third parties to confirm to the Client in writing and within four weeks following signature of the Contract, that the Supplier is indeed entitled to sell or dispose of those rights in accordance with the terms of this Contract.

7.3. If the Supplier creates work which is subject to author's rights and this work is related to the performance of the contract by the Supplier, the Supplier hereby grants the license to use the work in accordance with § 12 of the Act. No. 121/2000 Coll.

7.4. All information obtained by the Supplier during performance of this Contract from Client directly or through the project assistant are considered confidential. The Supplier shall not disclose such information to any other person if Client does not state otherwise.

7.5. Client and the Supplier shall exchange all information on any industrial property right that could impede the performance of the Contract.

8. DOCUMENTATION

8.1. Thereafter, the Supplier shall provide free of charge to Client any update of the documentation provided by the Supplier during the term of this Contract.

8.2. The Supplier shall permit Client to reproduce all or a part of the documentation provided, for its internal needs, directly connected with use by its personnel. Client shall ensure that any indication concerning the intellectual property rights appearing on the original copies is reproduced.

9. QUALITY AND STANDARDS

9.1. The Supplier undertakes to perform the Contract to the highest professional standards. The Supplier shall have sole responsibility for complying with any legal obligations incumbent on him, notably those resulting from employment, tax and social legislation.

9.2. The Supplier shall have sole responsibility for taking the necessary steps to obtain any permit or license required for performance of the Contract under the laws and regulations in force at the place where the tasks assigned to him are to be executed.

9.3. The Supplier shall neither represent Client nor behave in any way that would give such an impression. The Supplier shall inform third parties that he does not belong to the Czech public service.

9.4. The Supplier shall have sole responsibility for the tasks assigned to him.

9.5. If the Supplier should fail to perform his obligations under the Contract in accordance with the provisions laid down therein, Client may (without prejudice to its right to terminate the Contract) reduce or recover payments in proportion to the scale of the failure. Client can only exercise this right after the Supplier does not repair such failure within 15 days from notification by Client.

9.6. Client can monitor compliance with the standards.

10. LIABILITY

10.1. Client shall not be liable for damage sustained by the Supplier in performance of the Contract except in the event of willful misconduct or gross negligence on the part of Client.

10.2. The Supplier shall be liable for any loss or damage caused by himself in performance of the Contract. Client shall not be liable for any act or default on the part of the Supplier in performance of the Contract.

10.3. The Supplier shall provide compensation in the event of any action, claim or proceeding brought against Client by a third party as a result of damage caused by the Supplier in performance of the Contract.

10.4. The Supplier shall take out insurance against risks and damage relating to performance of the Contract if required by the relevant applicable legislation. He shall take out supplementary insurance as reasonably required by standard practice in the field. A copy of all the relevant insurance Contracts shall be sent to Client should it so request.

10.5. The Supplier declares:

- that he has not made and will not make any offer of any type whatsoever from which an advantage can be derived under the Contract,
- that he has not granted and will not grant, has not sought and will not seek, has not attempted and will not attempt to obtain, and has notaccepted and will not accept, any advantage, financial or in kind, to or from any party whatsoever, where such advantage constitutes an illegal practice or involves corruption, either directly or indirectly, inasmuch as it is an incentive or reward relating to performance of the Contract.

11. TAXATION

11.1 The Supplier shall have sole responsibility for compliance with the tax laws, which apply to him. Failure to comply shall make the relevant invoices invalid.

12. FORCE MAJEURE

12.1. Force majeure shall mean any unforeseeable and exceptional situation or events beyond the control of the Contracting parties which prevents either of them from performing any of their obligations under the Contract, was not due to error or negligence on their part or on the part of the Supplier and could not have been avoided by the exercise of due diligence. Defects in equipment or material or delays in making it available, labor disputes, strikes or financial problems cannot be invoked as force majeure unless they stem directly from a relevant case of force majeure.

12.2. If either Contracting party is faced with *force majeure*, it shall notify the other party without delay by registered letter with acknowledgment of receipt or equivalent, stating the nature, likely duration and foreseeable effects.

12.3. Neither Contracting party shall be held in breach of its Contractual obligations if it has been prevented from performing them by *force majeure*. Where the Supplier is unable to perform his Contractual obligations owing to *force majeure*, he shall have the right to remuneration only for tasks actuallyexecuted.

12.4. The Contracting parties shall take the necessary measures to reduce damage to a minimum.

13. TERMINATION OF THE CONTRACT

13.1. Client reserves the right to terminate this Contract by written notice and the Supplier undertakes to repay the expenses in the following cases:

- If the Supplier fails to perform the mandate under the terms of this Contract, or
- If the Supplier fails to fulfill any of the terms of this Contract, or
- Where Client seriously suspects the Supplier of fraud, corruption, involvement in a criminal organization or any other illegal activity detrimental to Client' financial interests.

13.2. With the exception of fraud, corruption, involvement in a criminal organization or any other illegal activity detrimental to Client' financial interests, this right can only be exercised by Client after such failure is not repaired by the Supplier within 15 days from notification by Client. In case of exercise of this right of the Supplier, the Contract ends on the day in which the notice was delivered to the Supplier. If the Supplier fails to repair above stated failures within 15 days from notification, the Client has right for contractual penalty in the amount of 1000 USD. The contractual penalty is due by the day when the Client exercises the right for contractual penalty.

13.3. The Client has also right to revoke the mandate without stating reason. In such case the Contract end on the day in which the revocation was delivered to the Supplier and the Client undertakes to pay to the Supplier respective part of the remuneration.

13.4. In case of premature termination of the Contract by the Client by notice because of fraud, corruption or involvement in a criminal organization or withdrawal from the Contract or premature termination of the Contract by the Supplier, the Supplier undertakes to pay to the Client contractual penalty in the amount of 1000 USD. The contractual penalty is due by the day when the Client exercises the right for contractual penalty.

13.5. In case of *force majeure*, notified in accordance with article 13.1., either Contracting party may terminate the Contract, where performance of mandate cannot be ensured in accordance with Article 3. of this Contract.

14. SUSPENSION OF THE CONTRACT

14.1 Without prejudice to Client's right to terminate the Contract, Client may at any time and for any reason suspend execution of the Contract, pending orders or specific Contracts or any part thereof. Suspension shall take effect on the day the Supplier receives notification by registered letter with acknowledgment of receipt or equivalent, or at a later date where the notification so provides. Client may at any time following suspension give notice to the Supplier to resume the mandate suspended. The Supplier shall not be entitled to claim compensation on account of suspension of the Contract, of the orders or specific Contracts, or of part thereof.

15. AMENDMENTS

15.1. Any amendment to this Contract must be in writing, signed by the parties hereto; failing which such amendment shall have no effect and be void.

16. APPLICABLE LAW AND SETTLEMENT OF DISPUTES

16.1. The Contract shall be governed by the national substantive and procedural law of the Czech Republic.

16.2. In the event of a dispute or a suspected or actual violation of the terms and conditions hereof they shall at first try in good faith together to settle the matter between themselves and only after this option turns out unproductive, they shall bring the matter before a court.

16.3. Any dispute between the parties resulting from the interpretation or application of this Contract, which cannot be settled amicably, shall be brought before the courts of the Czech Republic. The District Court of Prague 1 shall be competent court of first instance in the matters of this Contract.

17. PERSONAL DATA PROTECTION

17.1. The Client will hand over to the Supplier personal data necessary for due performance of this Contract (hereafter "Personal Data") and the Supplier will be in the position of data processor within meaning of EU General Data Protection Regulation 2016/679 (hereafter "GDPR"). Personal Data which will be handed to the Supplier are specified in Annex No. 6 to this Contract.

17.2. The Personal Data will be processed by the Supplier only within Contract period.

17.3. The Supplier undertakes to comply with all obligations set out in the personal data protection laws, mainly GDPR or Act No. 110/2019 Coll., Personal Data Processing Act, and keep personal data obtained from the Client confidential.

17.4. The Supplier undertakes to process Personal Data only on documented instructions of the Client and will inform the Client about any requirements for the transfer of Personal Data to a third country or international organization, unless the law provides that such information is not possible for important reasons of public interest.

17.5. The Supplier undertakes to ensure that person entitled to process Personal Data for him will keep Personal Data confidential based on law or contract.

17.6. The Supplier undertakes to keep conditions stated by Client for engagement of other data processor, mainly to choose other data processor with due care and request such guarantees from him, which will secure personal data protection at least in scope corresponding to level of protection of the Supplier and terms of GDPR. Engagement of other data processor is possible only with written consent of the Client.

17.7. The Supplier undertakes to cooperate with the Client in order to fulfil his duties which arise from request of personal data subjects regarding exercise of his rights

and negotiations with supervisory authority.

17.8. The Supplier undertakes that personal data won´t be misused for his gain or gain of third person.

17.9. The Supplier hereby undertakes to take reasonable steps to ensure the reliability of any employee, agent or contractor of any other person who may have access to the Client´s personal data, ensuring in each case that access is strictly limited to those individuals who need to know or access the relevant Client´s personal data, for the necessary purposes of this Contract and to comply with applicable laws as GDPR or Act No. 110/2019 Coll., Personal Data Processing Act. The Supplier undertakes to ensure that all such individuals will be subject to confidentiality undertakings or professional or statutory obligations of confidentiality.

17.10. Taking into account the costs of implementation and the nature, scope, context and purposes of processing as well as the risks and severity for the rights and freedoms of natural persons, the Supplier shall in relation to the Client´s personal data implement appropriate technical and organizational measures to ensure a level of security appropriate to that risk, including, as appropriate, the measures.

17.11. The Supplier undertakes to cooperate with the Client on data protection assessment, security of Personal Data and reporting of personal data security breach.

17.12. The Supplier shall promptly notify the Client about receiving request from a data subject.

17.13. The Supplier shall notify the Client without undue delay and within 48 hours at the latest upon Supplier becoming aware of a Client´s Personal data breach providing Client with sufficient information to allow the Client to meet any obligations to report or inform data subjects or respective state bodies.

17.14. Supplier shall provide reasonable assistance to the Client with any data protection impact assessments, and prior consultations with supervising authorities or other competent data privacy authorities.

17.15. The Supplier will respect Client instructions. If the instruction is in contradiction with GDPR or respective laws, the Supplier shall notify the Client about such contradiction.

17.16. After termination of this Contract the Supplier will dispose of Client Personal Data or hand over all Client Personal Data to the Client, unless it is possible to keep Personal Data in accordance with GDPR.

17.17. If the Supplier gets personal data from personal data subject which he will hand over to the Client, he is obliged to get before processing such personal data written consent with data processing of the personal data subject or his legal representative in case that data subject is a child and this written consent hand over to the Client without undue delay if it isn´t possible to process personal data in accordance with GDPR without consent of personal data subject. The consent must be given on consent form which is Annex No. 7 to this Contract.

18. FINAL PROVISIONS

18.1. The Parties acknowledge that this Contract will be published in the contracts register in accordance with Act No. 340/2015 Coll., on the contracts register, as the Client is a liable party within the meaning of the act, and the Parties agree with the publication hereof. Publication shall be arranged by the Client within 30 days from signature of the Contract by both Parties.

18.2. The Contract becomes valid on the day of its signature and effective upon its publication in the register of contracts. The Client shall inform the Supplier about date of publishing in the contract register within two working days from the date of publishing via email message sent to the email address of the Supplier stated in this Contract.

18.3. This Contract is drawn up in three counterparts from which the Client will receive two counterparts and the Supplier will receive one counterpart.

List of Annexes:
Annex No. 1: Commercial Registration Certificate of the Supplier

Annex No. 2: Detail Design Awaye Keraro

For and on behalf of the Client	For and on behalf of the Supplier
Signed in Prague on	Signed in Hawassa on .....
.....	.....
Mgr. Zbyněk Wojkowski head of the Project Realization Department of Czech Development Agency	Mr. Henok Tsegaye General Manager of the HY Engineering PLC

Sidaamu Dagoomu Qoqqowi Mootimma Daddalunna Dikkote
Latishshi Biiro
ሲዳማ ብሔራዊ ክልላዊ መንግስት ንግድና ገበያ ልማት ቢሮ
Sidama National Regional State Trade and Market Development Bureau

Seri/T/K № 016530

የግብር ከፋይ መለያ ቁጥር/TIN 0057735915
የንግድ ምዝገባ ቁጥር SMD/STMB/2/0000554/2013
Principal Registration No
የቀድሞው የምዝገባ ቁጥር
Previous Registration No
የቀድሞው የምዝገባ ቀን
First Registration Date 12/8/2010
መጀመሪያ የተመዘገበበት ቀን

የንግድ ምዝገባ ምስክር ወረቀት
ስነንግድ ምዝገባና የፈቃድ አዋጅ ቁጥር 980/2008 መሰረት የተሰጠ

Commercial Registration Certificate
Issued under Commercial Registration and Business license proc No. 980/2016

የግለሰቡ/ድርጅቱ ስም
ኤች ዋይ ኢንጂነሪንግ ኃላፊነቱ የተወሰነ የግል ማህበር

1.Owner/ Company Name
H Y ENGINEERING PLC

ዜግነት በኢትዮጵያ የተመዘገበ

2. Nationality Registered in Ethiopia

የሥራ አስኪያጅ ስም አቶ ሔኖክ ፀጋዬ ታደሰ

4. General Manager Name Mr. HENOK TSEGAYE TADESE

የንግድ ድርጅቱ አድራሻ

5. Business Address

ክልል ሲዳማ ዞን/ክፍለ ከተማ ሐዋሳ ከተማ
Region Sidama Zone/Sub City HAWASSA CI

ወረዳ ታቦር ቀበሌ ሂጣታ
Woreda TABOR Kebele HITATA

የቤት ቁጥር አዲስ/New ስልክ ቁጥር 0943986234
House No. አዲስ/New Tel. No 0943986234

ፋክስ ---- ኢ-ሜል ----
Fax ---- E-mail ----

የተፈቀደ ካፒታል በኢት. ብር 200,000.00
6. Capital in ETB 200,000.00

የተሰማራባቸው የንግድ ሥራዎች
በጀርባው ገፅ ይመልከቱ

7. Type of activities engaged
See Back Page

የግብር ከፋይ መለያ ቁጥር 0057735915 የተመዘገበ መሆኑን እናረጋግጣለን ::
has duly been registered under TIN 0057735915

ይህ የምዝገባ የምስክር ወረቀት ዛሬ 2/6/2013 ዓ.ም
This Registration Certification is issued in 2/9/2021

ሲዳማ ተሰጠ ::
on Sidama

Haanna Felleqe Guluma
ሀና ፈለቀ ጉሉማ
Daddalu Borronna Da/Fajjo Oggeette
የንግድ ምዝገባና ፍቃድ ባለሙያ
Trade Registration & Licensing Officer

የኃላፊ ስም
Official's Name

ፊርማ
Signature

ማህተም/Seal

ማስታወሻ፡- 1 ይህ የንግድ ምዝገባ የምስክር ወረቀት በዋስትና ወይም በእዳ ሊያዝ አይችልም።

B.S.S.P.E.

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1 : AGRICULTURE, HUNTING, FORESTRY AND FISHING
8. FINANCIAL INTERMEDIATION, INSURANCE, REAL ESTATE AND BUSINE SERVICES
6 : WHOLESALE AND RETAIL TRADE; REPAIR, HOTELS AND RESTAURANT IMPORT AND EXPORT BUSINESSES
5 : CONSTRUCTION
7: TRANSPORT, STORAGE AND COMMUNICATION ACTIVITIES
9 : COMMUNITY, SOCIAL AND PERSONAL SERVICES
3 : MANUFACTURING

CZECH REPUBLIC—CZECH DEVELOPMENT AGENCY

IMPROVING QUALITY OF LIFE BY ENSURING AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER RESOURCES IN SIDAMA ZONE

DETAIL DESIGN REPORT
OF
AWAYO KERARO KEBELE COMMUNITY WATER SUPPLY AND SANITATION PROJECT
(BONA ZURIA WOREDA, SIDAMA ZONE)

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August 2019

HAWASSA, ETHIOPIA

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ABOUT THE DOCUMENT

This detail study and design of 'Awayo Keraro Kebele' Community Water Supply and Sanitation Project was prepared by HY Engineering consultant team in consultation with 'Sidama' Zones Water, Mines and Energy Department (SZWMED), 'Bona-Zuria Woreda' Water Office and beneficiary communities.

The report was prepared accordance with the contract agreement made with the client, Czech Republic—Czech Development Agency for the program "Improving Quality of Life by Ensuring Availability and Sustainable Management of Water Resources in Sidama Zone".

Program: *"Improving Quality of Life by Ensuring Availability and Sustainable Management of Water Resources in Sidama Zone"*

Project Area: '*Bona Zuria Woreda', 'Sidama' Zone, South Nations Nationalities and People Regional State (SNNPRS), Ethiopia*

Project Name: 'Awayo Keraro' *Community Water Supply and Sanitation Project*
Client: *Czech Republic—Czech Development Agency*

Represented by :(Ing. Pavel Frelich, Director)

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EXECUTIVE SUMMARY

This report presents a detail study and design of 'Awayo Keraro Kebele' Community Water Supply and Sanitation project. The study was conducted by HY Engineering consultancy Plc in consultation with SZWMED and 'Awayo Keraro Kebele' community, as per the contract agreement made with Czech Republic—Czech Development Agency for the program "Improving Quality of Life by Ensuring Availability and Sustainable Management of Water Resources in Sidama Zone". The objective of the project is to improve access to safe, adequate and sustainable water supply service from reliable sources at a reasonable distance from dwelling for the rural communities and public institutions.

The detail study and design report for Construction of New Water Supply Systems in 'Awayo Keraro Kebele'' Community, 'Bona Zuria Woreda' of 'Sidama' Zone has been carried out based on the preliminary designs document prepared by SZWMED. This report comprises and explains the baseline survey methodologies, the detail study and design approaches, hydraulic analysis, bill of quantity, material specification and cost estimation, standard engineering drawings and avoidance of adverse environmental and social impacts during construction and operation of the water distribution system of the proposed project.

The total population to be served from this Water Supply Project for the coming 15 years design period has been forecasted by using the geometric increase model and the population growth rate of 3 %. The total population of the 'Kebele' to be served from this project within the anticipated design period is estimated to be 9,869 people.

The total Water demand (domestic & public water demands) projection has also been made and the per capita water demand of 25 L/C/day within a distance of 0.5 km from the water delivery point for rural piped water supply system is adopted, in accordance with GTP-II minimum service level. The mode and level of services considered for community water supplies are public fountains and for institutions are stand water points. The proposed Water Supply system units are three spring water sources, spring water collecting chambers, 50m^3 capacity standard concrete wet-well, a 100m^3 capacity standard concrete reservoir, valve chambers, manholes, distribution pipe lines, public fountains and anchor blocks. The total estimated cost of the project

is 12,065,568.03ETB (USD 416,054.07, with current exchanging rate of 29 ETB/USD) including 15% VAT. The estimated period for the competition of this project is 180(one hundred eighty) calendar days.

Environmental and Social Impact Assessment (ESIA) was carried out, and the resultant outcome of the assessment has classified the project under environmental and social category C. Further to add the project is related to rural water supply and sanitation, it was found that the displacement of population and their property damage is insignificant. The project will have positive environmental and social impact, which would benefit all member of the community (men, women, boys and girls), improve the health status, reduce women and children work load and provide time to engage in productive activities, provide better quality and sustainable water supply to the area, and create job opportunities. To operate the system efficiently and sustainably, the project will give due consideration for both hard ware and soft ware aspects of the project.

ABBREVIATIONS

ADD	Average daily demand
AJDD	Adjusted Domestic Demand
CSA	Central Statistic Agency
ESIA	Environmental and Social Impact Assessment
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
GTP	Growth and Transformation Plan
ISO	International Standardization Organization
MDD	Maximum Daily Demand
MoWR	Ministry of Water Resources
OWNP	One WaSH National Program
SDGs	Sustainable Development Goals
SNNPRS	South Nations Nationalities and People Regional State
SZWMED	'Sidama' Zones Water, Mines and Energy Department
USD	United States Dollar
UFW	Unaccounted for water
WaSH	Safe drinking water, sanitation, and hygiene
WHO	World Health Organization
L/C/day	Liters per capita per day

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CHAPTER 1
INTRODUCTION

1.1 General

Globally, Safe drinking water, sanitation, and hygiene (WaSH) are fundamental and essential for an improved standard of living of human beings. Access to water supply and sanitation are basic human needs and rights. This right is well recognized in international legal instruments and provides for sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses. The benefits of improved water supply and sanitation are numerous, including prevention of disease, improved basic health care, increased quantity of and access to water, reduction in time and effort required for water collection, promotion of economic activity, strengthening of community organization, and ultimately improved quality of life.

Nonetheless, recent data shows that 4 billion people face severe water stress during at least a month in a year, and 1.8 billion at least six months in a year. Competition for water resource will grow due to increasing population, shifting lifestyles as well as climate change. Potable water supply is a central theme, which can be used to achieve sustainable development goals (SDGs).

In recent years, Government of Ethiopia in collaboration with the international donors has made considerable progress in terms of improving low access coverage of safe water supply, sanitation and hygiene (WaSH), which were made the country to achieve some of the Millennium Development Goals (MDGs) by 2015. Despite the significant acceleration in coverage and a relatively favorable policy environment, it needs further effort to achieve the goals of sustainable development plan and One WaSH National Program (OWNP). Under the One WASH National Program, the Government of Ethiopia aims to increase access to safe water supply to 98 percent for rural areas and 100 percent for urban areas and to provide all Ethiopians with access to basic sanitation.

The baseline survey also indicated that, the existing rural water supply sources of the 'Woreda' couldn't satisfy the water demands of rapidly increasing population and also the daily per capita water consumption is below the standard as prescribed in Growth and Transformation Plan (GTP II Phase) that is 25 L/C/day within a distance of 1 km from the

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water delivery point. There is high waiting time, the access coverage of water supply among 'Kebeles' is varying significantly, and operation and management of the existing community water supply scheme is limited.

The Government of Czech Republic is one of the donors working closely with the Federal Democratic Republic of Ethiopia (FDRE) which has brought out a significant impact in the 'Development Cooperation Programmers' for the period of 2011-2017. It determines Water Supply and Sanitation as one of the priority sectors of the Czech intervention in Ethiopia. They may offer a proven track record of achievements (e.g. building of water sources, including distribution networks, waste water treatment, etc.). According to the Program, the Czech Republic will focus on establishing sources of safe water in smaller towns as well as in rural areas. Czech Development Agency has extended the program due date and allocated a budget for implementing a program in five Communities of 'Sidama' Zone, in 2019. These communities are 'Dale Woreda' ('Yirgalem-Tula', 'Shoye' & 'Degeya' 'Kebeles'), 'Bensa' 'Woreda' ('Hamesho kebele') and 'Bona-zuria Woreda' ('Boreta-weyo' & 'Awayo-keraro' 'kebeles'). Accordingly, this detail study and design has been carried out in accordance with the scope of assignment agreed up on between the client, Czech Development Agency and the consultant for the program "Improving Quality of Life by Ensuring Availability and Sustainable Management of Water Resources in 'Sidama Zone".

The detail study and design is done based on the preliminary (feasibility) study document conducted by 'Sidama' Zone Water, Mine and Energy Department (SZWMED) in the year 2018. The detail study and design work consists of detail investigation on the existing water supply condition, precise measurement of the pipe line route using 'total station' and selection for the economical pipe material & size, detailed structural & architectural design for the system components, construction materials specification, bill of quantity & cost estimation, standard engineering drawing and environmental and social impact assessment (ESIA) as well as sustainable operation and management of the project.

1.2 Location and Accessibility

'Awayo Keraro Kebele' is located in the Southern Ethiopia, particularly in 'Sidama' Zone, 'Bona Zuria Woreda'. The geographic location of the 'Kebele' is shown in figure 1.1. 'Awayo Keraro Kebele' is found at a distance of 520 kilometers from Addis Ababa. Highway from Addis Ababa to 'Bona' town (the 'Woreda' capital) is an asphalt concrete road, with a total length of 370 kilometers. The remaining 60 kilometers from 'Bona' town to 'Awayo Keraro Kebele' is a gravel road. For the supply of construction materials to the site mainly

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those which are transported from Addis Ababa, this path is suitable in all weather conditions.

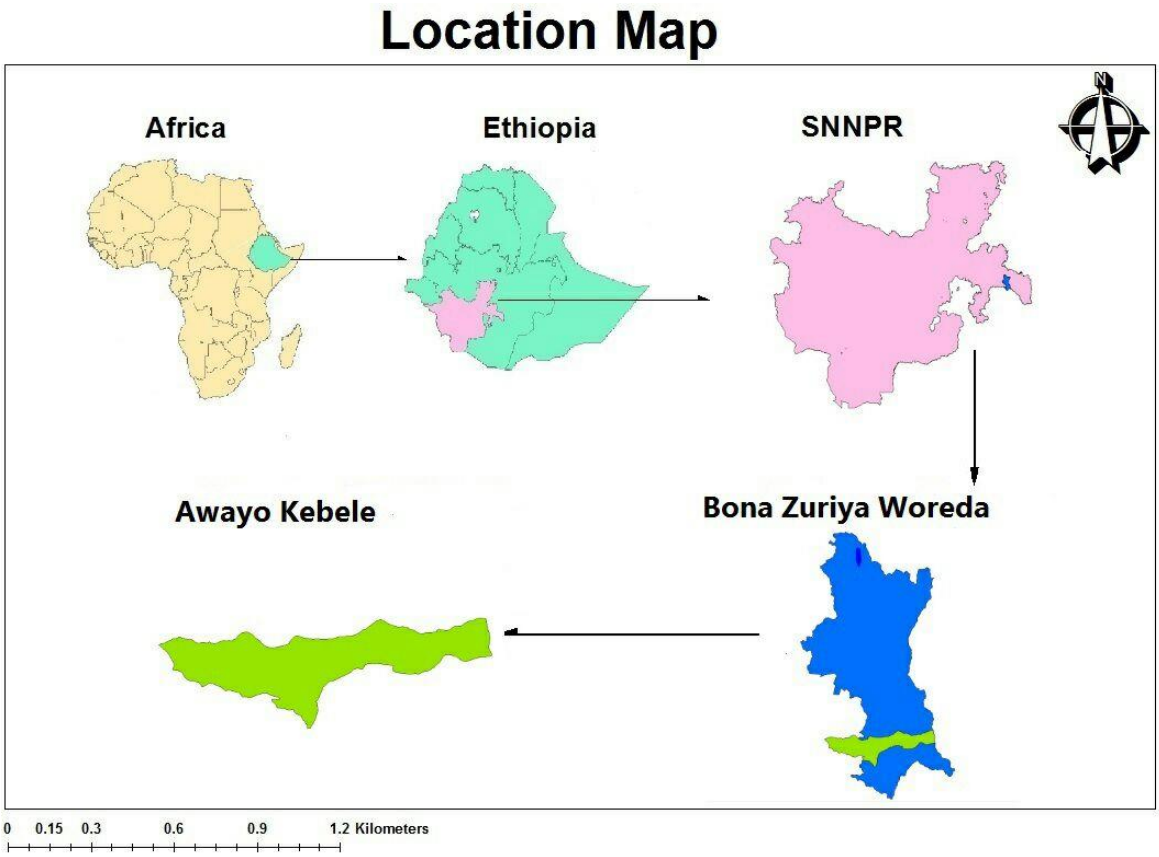

Figure 1.1 Geographical location & accessibility of 'Awayo Keraro'

1.3 Topography, Hydrology and Hydro Geology

The topography of 'Awayo Keraro Kebele' is wide flat. The altitude ranges from 1730 meters to 2270 meters above the mean sea level. The 'Sidama' zone, in general, has three agro-climatic zones, namely cold, semi-arid and arid. 'Awayo Keraro Kebele' in particular is grouped in a climatic condition of semi- arid. There are two main seasons in the 'Kebele', the dry season ("Bega") from March to mid-May and the rainy season ("Keremete") occurring during mid-June to end of the October.

The general geology of 'Sidama' zone is dominantly made up of two types of rocks i.e. Igneous and Metamorphic. Different types of igneous rock comprise more than seventy percent of litho logical unit of the Zone.

1.4 Socio Economic Condition

According to the information from base line survey, the prominent economic activity of the community is agriculture. The major agricultural activities are crop, fruits and vegetable production in the backyard homestead and allied agricultural activity included animal

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husbandry. About 75% of economic activities undertaken by the community are cultivation of Cash crops, mainly coffee & "Chat". Service rendering institutions such as coffee and local beverage shops constitutes about 25% of the economy.

1.4.1 Education Service

As of now, there are two primary schools, Grade (1-8) and Grade (1-6) & 1 secondary school Grade (9-10) in 'Awayo Keraro Kebele', currently. According to the baseline survey data, there are 1,500 students and 20 working staff in the 'Godo' primary school (Grade 1-8). There are 700 students and 15 working staffs for 'Dassa Dashole' primary school from Grade 1-6. In 'Awayo Keraro' Secondary school there are 950 students and 30 working staffs.

1.4.2 Health Condition

One of the assessments conducted during the study period was the health service of the 'Kebele'. Based on the baseline survey data there is a health post with a capacity of giving service for 50 patients per day.

1.4.3 Business Enterprises

Private business and commercial activities in the 'Kebele' is largely dominated by small trading activities; such as coffee shops, local alcohol beverage shops and restaurants. The major economic activity which is found lucrative and support the Kebele's residents are "coffee" & "Chat" trading, petty trading and employed work and daily labor in their order of importance.

1.5 Project target area and Beneficiaries

1.5.1 Project Area

The prime beneficiaries of the proposed water supply project are the population of 'Awayo Keraro Kebele'. The secondary beneficiaries are the neighbor community of Awayo Keraro Kebele'. The proposed project will increase the performance of water supply scheme of the Kebele and indirectly the surrounding 'Kebeles'. The project will provide improved water supply services and it also will solve the current potable water scarcity in the community.

1.5.2 Project Beneficiaries

The residents of 'Awayo Keraro Kebele', as baseline survey, have expressed their willingness to get improved water supply through active participation in the initiatives of the project. In general, the project will benefit residents to have better access to potable water supply. The

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existing water supply problem critically affects women and children who are typically responsible at the household level for collecting water. In order to alleviate the problem, creating accessibility to improved water supply and sanitation facilities is expected to contribute to poverty reduction and gender equality among the beneficiary populations in general and by reducing in house work burden from women through reducing time and energy spent in collecting water in particular. This will furthermore creates an opportunity for women and the household in general in benefiting personal health and engage in productive works.

1.6 **Existing water supply condition**

The results of field survey indicate that there are three unprotected springs in the 'Kebele'. According to the information from the local community the existing water supply condition of the Kebele is only beneficiary for the communities live around the springs. The springs are located more than 5 kms from the 'Awayo Keraro' village. Therefore the community is forced to use surface water such as, ponds and runoff which are exposed to hygienic diseases. This situation led the community vulnerable to water born diseases. It was also observed that the community uses the pond and runoff water mainly for cattle and washing purposes during rainy season which is far from the place of domicile of the community. Thus, the existing water source in the 'Kebele' is not attractive to serve the purpose of the community uniformly. Hence, construction of a new water supply scheme from the spring sources is necessary to solve the existing water supply related problems of the community of 'Awayo Keraro Kebele'.

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CHAPTER 2

OBJECTIVES OF THE PROJECT

2.1 The main objective of the project

The main objective of this project is to offer a sustainable potable water supply for the community of 'Awayo Keraro Kebele ' with a positive impact on community health.

2.2 Specific objectives of the project

The specific objectives of the project are;

1) To design an effective and efficient water supply system from potential water source with permanent structures.
2) To establish a sustainable and environmental friendly water supply scheme.
3) To supply potable water for institutions those are in need of potable water supply such as schools, health centers, etc.
4) To reduce the work burden on women and children by providing water points at a nearby distance.
5) To improve the community health by preventing water borne diseases.

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CHAPTER 3

MATERIALS, METHODOLOGY AND CRITERIA OF DESIGN

3.1 Materials and Software

The materials and engineering tools which were used to study and surveying work are total station; Handle GPS, Topographic Map of Ethiopia; Geological and hydro geological Maps. Engineering software was used for survey data analysis and interpretations are - Auto CAD 2018; Water CAD; Arch GIS and Google Earth.

3.2 Methodology of Study

To carry out the detail design of water supply project of 'Awayo Keraro Kebele', the following general approaches and specific methodologies were applied.

- ✓ Meetings were conducted among the community members to discussing the issues pertaining to existing water supply, sanitation and hygiene frequently. Further, discussions were held among the stakeholders at Zonal and 'Woreda' level.
- ✓ Reconnaissance field visit of the water resource, water supply and demand of the community has been made. .
- ✓ Detail engineering survey work conducted for economic route for collecting water from the springs and distribution network pipelines.
- ✓ Assessment on the current local market price for construction materials conducted in order to estimate the project cost.

3.3 Study Approaches

I. Desk Work

Review of all earlier studies:

- ✓ Useful geological, hydro geological, geotechnical, social-economic and water quality study report relating to study area.
- ✓ Data collection and analysis from secondary data sources
- ✓ Identify data gaps, which need to be investigated during the field study.

Planning of traverse routes for geological fieldwork and identify any potential problems that may need to be dealt with not to impede the project activities.

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II. Fieldwork / Discussions with key stakeholders.

The following stakeholders were identified and discussions were held among them:

- ✓ The 'kebele' administration chairman,
- ✓ Officials from the 'Sidama' Zone water, mines and energy department,
- ✓ Health center officer,
- ✓ School director.

3.4 Units and Standards

The metric system of units is used throughout the detail design report, except where imperial units are acceptable and in common usage (e.g. for galvanized iron pipes and fittings diameters). As far as this design and construction, the relevant Ethiopian National Standard has been used or referred to. If no National Standard exists, then the relevant 'ISO' Standard has been used.

3.5 Design parameters & Criteria

Design criteria issued by the Ministry of Water Resources in 2006, has been used as guidelines in the design of this water supply project and adjustments has been made by the Consultant as appropriate. As per the design criteria, the design period is 15 years and the water supply scheme will be implemented for demands up to 2035.

3.5.1 Design Criteria

The Ethiopian Federal Democratic Republic Government, Ministry of Water, Irrigation and Electricity published the second Edition of the Water Supply Design Manual in the year 2006. This Manual has been extremely useful in meeting the needs of those engaged in the planning and design of water supply systems. Therefore, the detail design for 'Awayo Keraro Kebele' water supply project integrated with this manual.

According to the manual a water supply project should be designed on the basis of the following principles:

- ✓ Capacity to satisfy demand at the projected service levels over the design horizon;
- ✓ Provision of adequate safe and sanitary (potable) water;
- ✓ Wise, effective, efficient and environmental friendly use of the water resource;
- ✓ Safe and sound operation and maintenance of the water facilities;
- ✓ The system and its operations confirm to the Water Act and any regulations &

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guidelines related it; Enhancement of the quality of living standards of the consumers and

- ✓ Appropriate and cost effective technology relevant to the beneficiaries of the system

The Water Supply Design Manual presents the planning and design criteria for the proposed Water Supply projects Feasibility and Detail Design. These criteria are developed for water supply feasibility studies, designs relevant to the National level. The manual states that the user shall modify the parameters taking in to account the particular nature of the area on which the project is to be implemented.

This project is undertaken based on the criteria presented on this design manual as guidelines. The guideline criteria have been reviewed after analysis in the field of socio-economic conditions, water resource situations, operation and maintenance needs and environmental conditions.

3.5.2 Principal Design Criteria

The main criteria adopted for the design of the water supply system are:

- ✓ Design period is 15 years from 2020 to 2035 respectively.
- ✓ Maximum static water pressure in the distribution system is 80 m.
- ✓ Minimum water pressure in the distribution system is 15 m, with some exceptional conditions.
- ✓ Minimum velocity is 0.6 m/sec during peak flow.
- ✓ Maximum velocity is 2 m/sec.
- ✓ The adopted technology is cost effective and appropriate taking into account the maximum use of locally available materials, labor force and skills.
- ✓ Scheme components such as reservoirs and conveyance units are designed as per accepted standards.

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CHAPTER 4

WATER DEMAND ASSESSMENT

4.1 General

In the design of any water supply project, it is necessary to estimate the amount of water required to be supplied throughout the design period. This involves determining the number of people to be served and their per-capita water consumption along with analysis of the factors that may affect the consumption. The total water demand will be calculated by considering the water requirement for public and domestic usage as expected in the community.

4.2 Population Forecasting

4.2.1 Present population

The use of reliable base population figure is very important for optimizing the project cost and sustaining the project service years. Over or under estimation of the population result in a higher investment cost and a lower service run period respectively. Hence, it is very important to initially get realistic base population figures not to come with the above mentioned problems. There are two alternative methods used to determine the current population. One is by projecting the data from the Ethiopian Statistics Agency census report in 2007, and the other is baseline survey from the 'Kebele' administration office. Since the census data is 12 years old, it is not realistic to use the projected figure for the design purpose. Therefore, it is recommended to adopt the population figure from the base line survey. The demographic data from the base line survey is used for government finance allocation, agricultural and health sectors, currently. Hence the population of 'Awayo Keraro Kebele' is 6,150 in 2019.

4.2.2 Population Projection

The water supply system has to be designed not only for the current residential but for the future population growth into consideration. It will inevitably serve during the design period. The rates for domestic water demand calculation will be those available or implied from the above-mentioned CSA publications for the corresponding population.

According to CSA, the rural population has an average of 3% growth rate of population increment. For rural 'Kebele', like 'Awayo Keraro', geometric progression with CSA growth

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rate, i.e. 3%, population forecasting method is selected. The forecasted population of the 'Kebele' for the design period, in the interval of 5 years is listed in table 4.1.

Population forecasting formula for the design period;

$$P1=Po\ (1+K)^{n,}$$

Where:

P1- population at the current period

Po- Population at the previous period

K- Growth rate = 3%

n- Period (years) = 5 Years

Table 4.1 Population projection (2019-2035)

Description	Growth rate per year (%)	Year (Projection period)				
		2019 (Base)	2020	2025	2030	2035
Population projection	3	6,150	6,335	7,343	8,513	9,869

4.2.3 Population characteristics

The majority of population belongs to 'Sidama' ethnicity and speaks 'Sidamu Afoo' which is Cushitic language family.

4.2.4 Household Characteristics

As per CSA, the average number of members in a household in rural areas is estimated to be 5.38.

4.3 Water Demand Analysis

4.3.1 Domestic Water Demand

The demand for water is to serve for different purposes by a household which includes drinking, cooking, washing, cleaning and other related homestead affairs. Nonetheless, the consumption of water varies according to the mode of service delivery, climatic conditions, and socio-economic conditions and so on.

I. Types of Modes of Services

The most common mode of services being prevalent in Ethiopia could be classified into five

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categories as given below.

- ✓ Traditional Source users (TSU)
- ✓ Public Tap users (PTU)
- ✓ Neighborhood Tap users (NTU)
- ✓ Yard Tap users (YTU)
- ✓ House Tap users (HTU)

Table 4.2 The daily domestic demands of different consumptions

Mode of service	Stage 1	Stage 2
House connection (HC)	50 lit/c/day	70 lit/c/day
Yard connection, own (YCO)	25 lit/c/day	30 lit/c/day
Yard connection, shared (YCS)	30 lit/c/day	40 lit/c/day
Public Tap supplies (PT)	20 lit/c/day	25 lit/c/day

Source*: (MoWR, 2006)*

According to the above table water demand in the Public Tap supplies (PT) is 25 Lit/c/day in stage 2. As far as the proposed design is concerned, the appropriate capacity of water supply through Public Tap is 25Lit/c/day in 'Awayo Keraro Kebele' which is also mentioned in GTP-II minimum service level. Therefore, the water demand analysis has been done on the basis of 25 Liter per capita water demand.

II. Projection of service level

There are two different figures regarding the present population of 'Awayo Keraro Kebele'. The baseline survey and the other is population projection based on Central Statistical Agency (CSA) in the 2007. However, after considering two different population figures, the study has adopted population projection from the base line survey data collected from 'Kebele' administration office as a base year population for the study.

The service year for a rural community water supply project is considered 10, 15 or 20 years service year depending of factors such as scope of the project, availability on fund and socio-economical plan. Hence, the design period for 'Awayo Keraro Kebele' water supply project, is 15 years, due to the limited water source. (Source 'SNNPR water resource office design guideline')

III. Per Capita Demand and Projection

The percentage of population to be served by each mode of service will vary with time. Therefore, the present and projected percentage of population served by different demand

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category is estimated by taking the above stated conditions. This projection visualized provision of the traditional source users with public taps.

IV. Adjusted Domestic Water Demand

The above average domestic demand should further re-fixed by adjustment factors such as climatic and socio- economic conditions.

The water consumption is less in the area where the average temperature is low and high where temperature is very high, in general. 'Awayo Keraro' has an altitude range of from 1700 to 2100 meters above the mean sea level. Accordingly; 'Awayo Keraro Kebele' falls under temperate climatic zone, where the annual temperature is between 15-20 ^{o}C. Hence the climatic factor of 1.0 is considered for water demand adjustment.

Table 4.3 Climatic Factor

Mean annual Temp. (^{o}C)	**Description**	**Altitude**	**Factor**
<10	Cool	> 3300	0.8
10 – 15	Cool Temperate	2300 – 3300	0.9
15 – 20	Temperate	1500 – 2300	1
20 – 25	Warm Temperate	500 – 1500	1.3
25 and above	Hot	<500	1.5

Source*: (MoWR, 2006)*

The results of the socio economic survey shows that the sources of livelihood of the community are cultivation of Cash crops mainly coffee & "Chat", service rendering institutions such as coffee and local beverage shops and etc. In view of the above facts, the town is categorized as Group D (Advanced Rural Towns). Therefore, a socio-economic adjustment factor of 0.9 has been adopted, from table 4.4, as a water demand adjustment factor. After considering changes in population and the mode of service, per-capita- demand and applying the adjustment factors, the domestic demands were calculated and presented in Annexure V.

Table 4.4 Socio- Economic factors

Group	**Description**	**Factor**
A	Towns Enjoying high living standards and with very high potential for development	1.1
B	Towns having a very high potential for development but lower living standards at present	1.05

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C	Towns under normal Ethiopian conditions	1
D	Advanced Rural Towns	0.9

Source*: (MoWR, 2006)*

4.3.2 Non-Domestic Water Demand

Non-domestic water demand can be broadly classified into the following major categories:

I. Institutional Demand

Institutional water demand includes the quantity of water required to be supplied to offices, hospitals, Schools, Universities, etc. This quantity will vary considerably with the nature of the town and the number and type of institutions existing at present. Commercial water demand includes water required for hotels, restaurants, bars, fuel stations, and local drink houses.

Table 4.5 The daily demand of institutions

Item	Consumer Category	Daily demand
1	Day school	5 l/pupil
2	Hospitals & health centers	50 - 75 l/bed

Source*: (MoWR, 2006)*

II. Livestock Water Demand

The demand for livestock watering from the public water supply system shall be assessed in the 'Awayo Keraro kebele' during the baseline survey. Whereas it is not feasible to include livestock demand in the community water supply system for 'Awayo Keraro kebele', Due to the following reasons:

- ✓ Insufficient water source from the springs
- ✓ The availability of surface water sources in the 'Kebele' from which the livestock can consume.

III. Educational Institutions

The number of students attending to schools is normally expected to grow parallel to the total population growth. The number of students in 'Awayo keraro Kebele' primary school is around 1,935 in Primary school and 980 in secondary school. This figure includes the staffs working in the schools. According to the demand analysis result the educational institutions require 11.62% of the total adjusted domestic water supplied to the community. From the total water to educational institutions, 'Godo' Primary school demand 50%, the remainining

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50% will be supplied to 'Dassa Dashole' Primary school and 'Awayo Keraro' secondary school equally.

Table 4.6 Water demand for Educational Institutions

Consumer category	Daily Demand	Number of students & working staff	Demand (l/day)
'Dassa Dashole' Primary school (1-6)	5	715	3,575
'Godo' Primary school (1-8)	5	1,520	7,600
'Awayo Keraro' secondary school (9-10)	5	980	4,900
Average day demand (l/d)			16,075
Average day demand (m^3/day)			16.075
Average day demand (l/s)			0.19
Adjusted Domestic Water Demand (AJDD) in 2019 (m^3/day)			138.38
% of AJDD [(16.075/138.38)*100]			11.62

Source: Baseline survey, 2019

IV. Health Institutions

Based on baseline survey, there is only one health center in the 'Kebele' with a capacity of giving service for 50 patients per day.

Table 4.7 Water demand for Health institutions

Consumer category	Quantity	Daily Demand	No of Beds /visitors	Demand
Health center	1	60	50	3,000
Average demand (l/d)				3,000
Average demand (m^3/day)				3.00
Average demand (l/s)				0.035
Adjusted Domestic Water Demand (AJDD) in 2019 (m^3/day)				138.38
% of AJDD [(3.00/138.38)*100]				2.17

Source: Baseline survey, 2019

Table 4.8 Summary for public & commercial institutional water demand

No.	Institutions & Commercials	Water Demand (% of AJDD)
1	Schools	11.62

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2	Health center	2.17
	Total	**13.79**

4.3.3 Unaccounted-for (or non-revenue) Water

Unaccounted-for water (UFW) is expressed as a percentage of the total water produced for the system. UFW arises from system leakage, water taken by illegal connections, inaccuracies in metering, overflowing of reservoirs, etc. UFW cannot be assessed easily without adequate and reliable metering. However, 15% to 30% of the water produced might be unaccounted for towns. For rural town like 'Awayo Keraro Kebele', a figure of 15% is generally regarded as good and it is uneconomical to try and reduce below this value. Therefore, 15% Total Adjusted Domestic Water Demand (TAD) is adopted for Unaccounted-for (or non-revenue) Water for this project.

4.3.3 Demand Variations

I. Seasonal Peak

The rural communities in Ethiopia are characterized by widely varying climatic conditions and hence the variations in consumption during the year, reflected by a peak seasonal factor, will similarly vary. It is expected that seasonal peak factors will vary between 1.0 and 1.2, representing the relative increase in the average daily demand during the dry and/or hot season months compared with the average annual demand. For convenience, we adopted 1.0 as seasonal peak factors in the analysis of this project.

II. Peak Day Factor

Many communities exhibit a demand cycle that is higher in one day of the week than in others. This situation shall be taken into account by the use of a peak day factor. The proposed maximum day factor usually varies between 1.0 & 1.3 as per the design Criteria (MoWR,2006). According to judicious observance of the habits of consumers and the knowledge of the community and system operators, we adapted the average i.e. 1.15 as a peak day demand factor for 'Awayo Keraro Kebele'.

III. Peak Hour Factor

Water demand varies greatly during the day. The distribution system must be designed to cope with the peak demand, which is taken into account by the use of a peak hour factor. This peak hour factor is expressed as a multiple of the annual average daily demand and applied additionally to the seasonal and peak day factors. The peak hour factor varies inversely with the size of the consumer base. Based on the Ministry of water and energy design criteria

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(MoWR, 2006), for population size less than 20,000 the peak hour demand factor is 2.

Table 4.13 Recommended Peak Hour Factors

Population Range	**Peak hour factor**
< 20,000	2
20,001 to 50,000	1.9
50,001 to 100,000	1.8
> 100,000	1.6

Source: (MoWR, 2006)

4.3.4 **Summary of Water Demand**

The total water demand used for designing the water supply system components is summarized as in Annexure V.

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CHAPTER 5

DESIGN OF WATER SUPPLY SYSTEM

5.1 Introduction

Basically, water supply sources development for particular area start with identifying the problems of the present water supply system of the project area, conduct geological and hydro geological investigations and identification of potential water sources for future use based on the findings of socio-economy and the results of total water demand analysis. The selection of water source for the supply of the area is based on reliable sustainability, quality and feasibility of water source. This design report thus comes out with the best possible water supply system for the 'Awayo Keraro Kebele' community water supply system.

A design period for the proposed scheme is 15 years. The proposed water supply system to be designed for the design period of the project consists of the following scheme components: Spring capping, wet well, transmission system and pipe sizing, reservoir and distribution system, public fountain and etc.

5.2 Water source

5.2.1 Water source location

The water source for 'Awayo Keraro Kebele' water supply scheme is from three water springs. Two springs are located in 'Godo' village and the remaining spring is found in 'Desse Dashole' village. The specific location of the water sources is tabulated in table 5.1.

Table 5.1: Location of Water Spring site

Item No.	Site	GPS Location		
		Easting UTM 37N	Northing UTM 37N	Elevation
1	Godo- 1	465135.7	709935.2	2241
2	Godo -2	465101.7	709917.4	2244
3	Desa Dashole	466434.8	709339.9	2269

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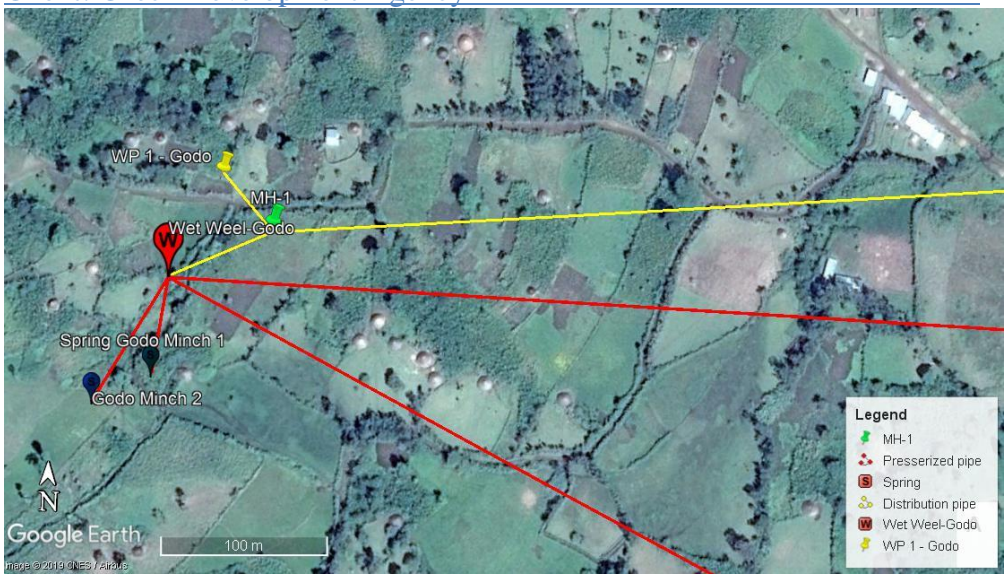

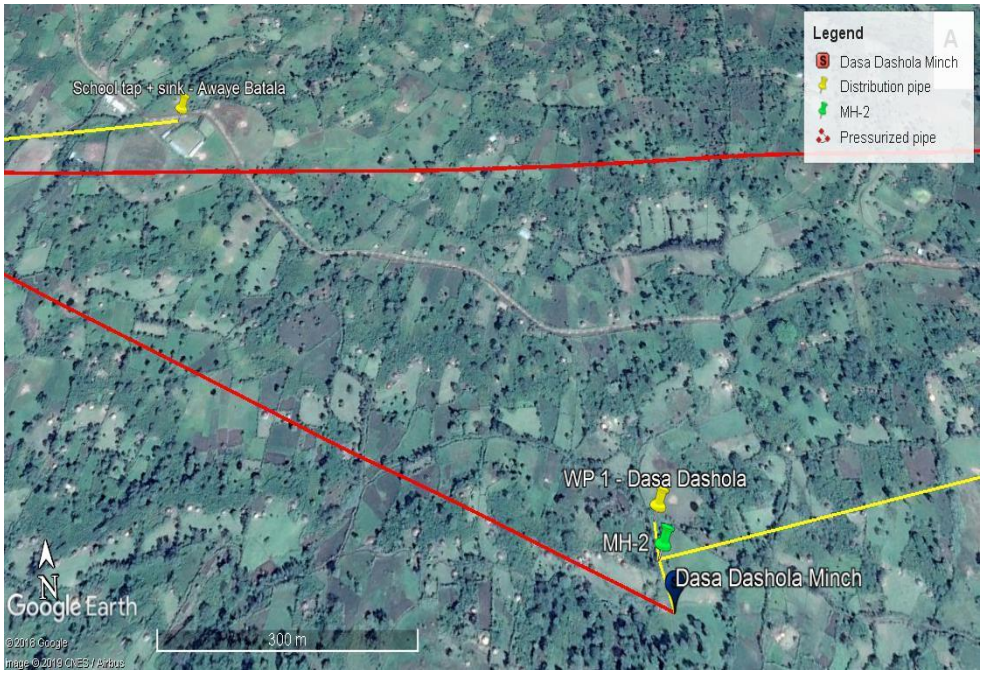

Figure 5.1 Location of the springs' sites

5.2.2 **Water source capacity**

A water source capacity needs to be sized for the total water demand including unaccounted for water (ADD). The water supply source is a spring which is intended to satisfy the maximum daily water demand of the population.

A field measurement on the discharge of the spring is undertaken on 21, June 2019 (the rainy season of the year). A 20 liter plastic can and a stop watch is used as a measuring instruments. The time taken to fill the can is recorded. This process is repeated five times. The average time is used to calculate the discharge of each spring. The discharge can be

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calculated by dividing the volume of the plastic can (20 lit) by the average time. The discharge for each spring is tabulated in table 5.2. According to the Preliminary design made by SZWMED in May 2018 (the dry season of the year) the discharge of the springs is listed in table 5.3.

The seasonal variation on the discharge of the spring can be compute by comparing table 5.2 and table 5.3. The 'Godo' springs doesn't show a significant variation on the discharge by various season of the year, whereas the 'Dase Dashole' spring has a significant change on the discharge during the different season. Therefore, for the design purpose the smaller discharge will be considered. It is not economical to design the diameter of the pipe for the higher discharge of the spring.

The discharge for the springs during the dry season of the year is considered for the design purpose will be:

- Godo-1 will be 0.65 Lit/sec
- Godo-2 will be 0.63 Lit/sec
- Dassa Dashole will be 2.45 Lit/sec

The cumulative discharge of the three springs, i.e. 3.75 lit/sec, is taken as the water source for the community water supply scheme.

Table 5.2: Capacity of the springs during the rainy season of the year

Spring Name	Time (Sec.)						Volume (Lit)	Discharge (Lit/Sec)
	T_1	T_2	T_3	T_4	T_5	$T_{Average}$		
Godo 1	29.8	30.2	28.6	29.4	29.1	29.42	20	0.67981
Godo 2	32.8	30.2	32	31.4	32.1	31.7	20	0.630915
Dassa Dashole	5.6	6.4	6.8	7	6.1	6.38	20	3.134796

Source: Baseline survey

Table 5.3: Capacity of the springs during the dry season of the year

Spring Name	Discharge (Lit/Sec)
Godo 1	0.65

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Godo 2	0.65
Dassa Dashole	2.45

Source: Preliminary design, SZWME, May 2018

According to the demand analysis as shown in table 5.4, the total amount of source required to satisfying the demand of 'Awayo Keraro Kebele' community throughout the design period (for the coming 15 years) will be 3.87 lit/sec. Therefore, the available source, which is 3.75 lit/sec, from the three springs, will satisfy the water demand for the design period. An additional water source, with a capacity of 0.12 Liter per second, is required after 10 years from 2020.

Table 5.4: Water source requirement

Design stage		**Design Period**			
Year	**2019**	**2020**	**2025**	**2030**	**2035**
Maximum daily demand MDD(lit/sec)	2.41	2.48	2.88	3.34	3.87
Water production from the BH source (lit/sec)	3.75	3.75	3.75	3.75	3.75
Required water source (lit/sec) *(BH source – MDD)*	-	-	-	-	0.12

5.2.3 Water Quality

The baseline survey regarding the quality of the spring show the spring has been using for drinking for the long time in the village,. high fluoride contain and high total suspended solids are the major problem regarding the quality of water in SNNPR.The geology and the hydrology of 'Awayo Keraro Kebele' doesn't indicate the continent high fluoride content mineral in the ground water and according to the "Kebele's" health office, there is no any record symptom on the community related with high fluoride containing water. The water the spring capping structure will be constructed in a way to increase the quality of water by reducing the total suspended solids. As shown in drawing number HY-DWG-006, there is graded river gravel filter inside the spring capping structure. The gravel filter is used as a mechanism to reduce the suspended solids in the spring. Moreover, a water quality test will be undertaken during the construction stage and an appropriate measure will be taken to increase the quality of the water as per WHO standard.

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5.3 Reservoir/ Wet Well

Service reservoirs are used to store the treated water with in or near to the demand of distribution areas. As outlined in the Design Criteria, the volume of the reservoirs is sized by comparing the recommended designing methods such as:

(a) Mass curve based on the peak hour demand variations used in the network analysis for each pressure zones plus some allowances (upto10%) for firefighting and emergency volume in case of power break down, repairs or other Operation and management (O&M) activities. This method is mostly used for urban water supply system, where the peak hour demand varies significantly. The house hold connections produce the significant peak hour variation.

(b) The simple-thumb- rules mentioned in the Design Criteria saying 2 to 4hrs storage of the daily average flow or certain percentage of the average daily flow. Finally in each case engineering judgment is used to set the final sizes. This method is preferable for the rural community water supply, where the peak hour demand variation is not significant. This is due to the water pipe network is public tap connection.

Hence, the second option is considered for the design of the reservoir capacity for 'Awayo Keraro Kebele' rural community water supply project. The volume of the service reservoir will be designed using the simple-thumb- rules mentioned in the Design Criteria with the capacity equal with 1/3 of the average daily demand. According to table 5.5, the calculation made for the water demand for the design period, i.e. 15years, 100m^3 capacity circular reinforced concrete service reservoir will be proposed for this project. Refer drawing HY-DWG-009 & HY-DWG-011 for the detail structural and pipe connections. The station/site plan for the reservoir is shown in drawing number HY-DWG-002. The geographic location of the reservoir is UTM 37N 469969.9 North, 709856.7 East & 2025m Elevation above the mean sea level.

Table 5.5: Service reservoir capacity calculation

Description	**Unit**	**Year**				
		2019	2020	2025	2030	2035
Average Day Water Demand(ADD)	m^3/day	181.01	186.44	216.14	250.56	290.47
Reservoir capacity (1/3 of ADD)	m^3	60.34	62.15	72.05	83.52	96.82
Adopted reservoir capacity	m^3	50	50	100	100	100

The volume of the Wet-well is design by taking 3 hours storage from the daily average water

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inflow. The daily average inflow to the wet well from the three springs is 3.75 lit/sec. Therefore, the required volume of wet well can be calculated as follows;

Volume of wet well = 3.75 Lit/sec x 3hrs x 3600 sec/hr / 1,000 Lit/m^3

= 40.5 m^3

Adapted volume of wet well = 50 m^3

The 50m^3 circular reinforced concrete structure wet well is designed to provide sufficient sump to supply of water in a continuous basis volume to the water points at 'Godo' village and to the 100m^3 reservoir located in 'Awayo Keraro' village. Refer drawing HY-DWG-008 & HY-DWG-010 for the detail structural and pipe connections. The station/site plan for the reservoir is shown in drawing number HY-DWG-002. The wet well have a geographical location of 465142.6 North, 709994.6 East & 2236 Elevation above mean sea level.

Both structures (50m^3 & 100m^3 water tanks) have inlet/outlet pipe, drainage pipe, overflow pipes, manhole, ladder & ventilation.

5.4 Water Transmission & distribution Pipe System Design

The purpose of a transmission and distribution pipe system of a water supply scheme is to deliver the right quantity and quality of water conveniently to the demand areas. The delivery system is classified into two: the transmission main and the distribution. Transmission mains convey water from the source, treatment, or storage facilities to the distribution system normally via a storage reservoir. The purpose of this larger diameter pipe is to deliver water to the distribution mains where most of the service connections are. Distribution mains deliver water to individual customer service lines and provide water for fire protection through fire hydrants, if applicable. The distribution mains normally deliver water from a storage reservoir to the consumers.

Among the four basic arrangements of water supply systems, listed in the design manual (MoWR, 2006), to deliver water from the source to the consumer, Type-1 system (Gravity System) is adopted for 'Awayo Keraro Kebele' water supply project. In this type of pipe system, water from the storage to the service reservoir will be delivery by gravitational force. The water will also be distributed from the reservoir to the consumer through gravity. The advantage of Type-1 system, it doesn't required operation cost, where there is no pumping is required in this type of system.

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5.4.1 Design of Gravity distribution Pipe Network

Gravity distribution pipe network in 'Awayo Keraro Kebele' is a distribution system starting from the collection chamber at 'Godo' spring 1 & 2 and 'Dashe Dashole' spring. The water collected from the two springs at 'Godo' will be supplied to the 50m3 wet-well located at 'Godo' village. The spring water collected from 'Dashe Dashole' spring will be supply to the 50m3 wet well at 'Godo' and two public water points in 'Dasa Dashole' village and one school tap in 'Dase Dashole' primary school. The proposed $50m^3$ wet well will distribute water to one public water point in 'Godo' village, one water tap at 'Godo' primary school and to the proposed $100m^3$ reservoir at 'Awayo Keraro' Village. The proposed $100m^3$ reservoir at 'Awayo Keraro' Village will provide water to five proposed public water points & one school tap. The whole pipe network is a gravity system. (Refer drawing number HY-DWG-001 & Water CAD pipe preview in annexure III /HY-WCAD-001-A/)

The distribution network is designed based on the following constraints;

I. Current demand and Future expansion at the node,
II. Economic size of the pipe

I. Current demand and Future expansion at the node

The distribution network is designed based on the peak hour demand for the design period. According to the water demand analysis in chapter 4, the peak hour demand of the community after 15 years will be 7.73 Lit/sec. As a result, the distribution system will be design for 7.73 Lit/sec water demands. The following consideration is taken for the demand of water in the system. Refer Annexure-III, HY-WCAD-001-C, for the demand on each node.

- ✓ Each public water points demands, 0.82 Lit/sec (6.56 lit/sec for 8 water points) ,
- ✓ The school taps demand 1 Lit/sec,(11.62% of 7.73 Lit/sec), refer table 5.6 for the proportion for the three school water taps.
- ✓ The remaining 0.17 lit/sec will be kept in the system for future expansion.

Table 5.6: Proportion for school tap water demand

Name of the school	Proportion from the total demand(1 lit/sec) based on the number of students	Demand (Lit/sec)
'Dassa Dashole' Primary school (1-6)	1/4	0.25
'Godo' Primary school (1-8)	2/4	0.5

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'Awayo Keraro' secondary school (9-10)	1/4	0.25

II. Economic size of the pipe

Distribution systems should be planned with either one large diameter pipe suitable for the final planning horizon or multiple smaller diameter pipes installed at various intermediate-planning horizons. An economic analysis should be carried out to determine the cheapest solution.

The operating pressures in the distribution pipe network for this project ranges from 2.85m to 165.47m, (refer Annexure-III, HY-WCAD-001-C). The pressure above and below the allowable limit is developing at the following nodes, the reason for accepting these points are described below:

- Manhole 1 & Manhole-2 have a pressure of 2.85m and 8.96 m respectively, these nodes are located near the water source. Therefore low pressure near the reservoir is one of the exceptional conditions in the design manual for MoWR, therefore low pressure in these nodes is acceptable.
- The node at WP-1 in 'Godo' village develops a pressure of 5.17meter above the ground, whereas, the height of the water point is below 2meters. Therefore the pressure is acceptable only to deliver water at this point.
- The pressure at the 100m^3 reservoir is 165.47m, i.e. above the design limit. Whereas, at this node there will be a water free fall at the reservoir. Therefore a reservoir will be used as a pressure break tank. Therefore no need for installing a pressures break tank near the reservoir. Note that, the scheme consists of 10m^3 pressure break tank near Manhole-4 and a pressure release valve at Manhole-7 & Manhole-8 to reduce the pressure at the nodes and to result the pressure in the acceptable limit.

Velocity and head loss

Experience shows that a pipe designed to flow at a velocity between 0.6 and 1.5 m/sec, depending on diameter, is usually at optimum condition (head loss versus cost). The water velocities in the distribution pipe system ranges from 0.38 m/s – 1.42 m/s (refer Annexure-III, HY-WCAD-001-D). All pipes develop a velocity in the recommended, range hence ok!, except pipe line label as P-6 (MH1-ABST). The reason for accepting this pipe is described below:

- The method used to increase the velocity of the water in the pipe is by reducing the diameter of the pipe. Therefore for P-6 when the internal diameter is reduced to

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20mm, the Water CAD result shows the velocity in the pipe is 0.98m/s whereas a negative pressure develop at node ABST (-6.05m). It is mandatory to select a pipe with an internal diameter of 26mm, even though the velocity is below the. This will increase the cost of the pipe but there is no other option to optimize the performance of the pipe.

Hydraulic computation

The water CAD software, recognized formula uses in the hydraulic computations, with Hazen-William coefficients, 150 for HDPE pipes.

The physical characteristics (crushing strength, resistance to corrosion, etc) of the pipes should suit the actual service conditions arising in the system with respect to internal and external loads and soil conditions.

The static state pressures in pipelines must be less than the pipe nominal pressure rating. For this, particular project HDPE pipe with PN-16 is adopted, hence the water pressure develop in the pipes is less than the pipe nominal pressure rating.

The hydraulic analysis for the gravity pipe network is shown in Annexure III / HY-WCAD-001-A, B, C & D/.The pipe network preview is shown in Annexure III/ HY-WCAD-001 /. The network preview also shows the location of the reservoir, water points, manhole, & school tap.

Selection of pipe material and types

According to the design manual, the following materials will normally be selected, taking into consideration useful lifetime, leakage levels and maintenance requirements.

For distribution systems:

- ✓ HDPE pipes

The type of pipe material to be selected shall depend on:

- ✓ Characteristics of the soil
- ✓ Chemical nature of the water
- ✓ Cost of the pipe
- ✓ Types of Crossings/fittings

In the preliminary study report for 'Awayo Keraro' Kebele water supply project done by S/Z/W/M/E, (2018) GI- pipes are proposed for the whole distribution pipe system, whereas we propose HDPE pipe material due to the following reasons.

- ✓ The total cost for GI pipes for the whole distribution system is 298% greater than the cost for HDPE pipes. This means, there will be additional 8,488,787.62 Ethiopian Birr or

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303,170.99 US Dollar in the project cost due for using GI- pipes instead of HDPE pipes. For more detail see table 5.8 in comparison with cost estimation for HDPE pipes in the Bill of quantities for pipes & fittings in chapter eight.

- ✓ The advantage of HDPE over GI pipe on Chemical reaction resistance, Corrosion resistance, Venerability for damage, Pressure resistance, Workability/flexibility, Types & number of Crossings/fittings and Availability on the market are listed in table 5.9.

Table 5.7 Cost for the supply & installation of GI-pipes

Supply and Install GI- pipe for the gravity distribution pipe network (Class- B), *Note that, 5% additional length on each pipe item for contingency.*					
Item no	Description	Unit	QTY	Rate	Amount
1	Internal Diameter 100 mm	m	364.35	1,543.67	562,436.16
2	Internal Diameter 75 mm	m	5,158.65	1,223.14	6,309,751.16
3	Internal Diameter 63 mm	m	2,08.95	1,004.72	209,936.24
4	Internal Diameter 50 mm	m	2,427.6	784.64	1,904,792.06
5	Internal Diameter 38 mm	m	5,372.85	684.22	3,676,211.43
6	Internal Diameter 25 mm	m	154.35	454.89	70,212.27
7	Internal Diameter 18.5 mm	m	174.3	297.91	51,925.71
	Total Carried to summary…….ETB				12,785,265.05

Table 5.8 Comparison between GI Vs HDPE Pipes

Item no.	Criteria	GI- Pipe	HDPE Pipe
1	Cost of the pipe (ET. Birr)	12,785,265.05	4,296,477.42
2	Chemical reaction resistance	Low	High
3	Corrosion resistance	Medium	High
4	Venerability for damage	Low	High
5	Pressure resistance	High	Medium
6	Workability/flexibility	Low	High
7	Types & number of Crossings/fittings	Many	Small
8	Availability on the market	Less/ imported	High/manufactured locally

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Therefore, HDPE-(PN16) pipe is proposed as a distribution system for the project. The total length for all types of pipes required for the project is tabulated in pressure pipe inventory; refer Annexure III / HY-WCAD-001-G. Note that an additional 5% on each pipe item is added on the pipe length for contingency purpose. Unlike the GI-pipes, HDPE pipe has a ticker wall. Therefore, for the hydraulic calculation purpose, the inner wall diameter is considered whereas, for specification in the bill of quantity the outer diameter is used. The HDPE pipes are specified by its outer diameter in the local market. Table 5.9 shows the standard HDPE-pipe outer and inner diameters for different pipes.

Table 5.9 Standard for HDPE-pipe outer and inner diameters

PE100 PN16 HDPE Pipes						
Inner Diameter(mm)	**Wall Thickness(mm)**	**OD (mm)**		**Inner Diameter(mm)**	**Wall Thickness(mm)**	**OD**
20.4	2.3	25		61.4	6.8	75
26	3	32		73.6	8.2	90
32.6	3.7	40		90	10	110
40.8	4.6	50		102.2	11.4	125
51.4	5.8	63		114.6	12.7	140

5.3.2 Depth of pipe line in the ground

The criteria governing the depth at which pipes are laid are the protection and safety of the pipeline, easy maintenance and avoidance of excessive earth pressure and live load due to traffic. In these respects, the following criteria should be adopted:

- ✓ The piping shall be laid in an open trench on a 0.8meter thick. Pipes shall be laid either separately or together with another piping.
- ✓ Main pipe laid in rocky conditions may have a minimum cover of.0.6 meter, or could be surface laid if security and anchorage concerns are properly addressed,
- ✓ Where the minimum cover cannot be achieved, a buried pipeline will be encased in an anchor block.

Table 5.10 Normal cover for mains lay in the ground

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Item No.	Pipe material	Depth of cover (cm)
1	HDPE	80

5.3.3 Valves

The provision of valves should be based on the following considerations:

- ✓ Spacing: Isolating valves on mains should be installed at intervals as required, their spacing being dictated by factors such as washout requirements, connections to consumers. The valves installed on each manhole is indicated in drawing numberHY-DWG-005, similarly the valve chamber for 100m^3 reservoir and 50m^3 wet-well is shown in drawing number HY-DWG-0011 & HY-DWG-0010 respectively.
- ✓ Mandatory locations: Isolating valves should be provided at interconnecting pipes, by-pass pipe connections.

5.3.4 Fittings

Pipeline fittings (bends, tees, couplings, flanges, branches, elbows, etc.) should be as follows:

- ✓ Appropriate for the pipeline configuration; normally they will be of Galvanized iron or of HDPE to match the pipeline material installed, the same diameter and the same or higher pressure class of the pipeline in which they are installed.

5.3.5 Water point/Public taps

In this project, the water points, which are required to be designed and provided for the public and school. The public demand 8 water points WP-1 to WP-8, each water points will have 6 water taps. Similarly schools demand three water points with 8 water taps on each water points as shown in the drawing HY-DWG-007. The water point is designed as a standard of masonry structure of 1.45 m high. The public point shall be laid on a stabilized 5.2 x 4.7 m concrete slab, 0.15 m thick. Also, the school point shall be laid on a stabilized 3.6x3m concrete slab, 0.15 m thick. This slab shall be provided with a peripheral intercepting groove 0.20 m wide and 0.05 m deep.

5.3.6 Anchor blocks

It is a supporting structure of pipe network made of stone masonry shown in the figure HY-DWG-005. This project demand four number of anchor block with varying height as per the requirement. It consists of base slab and vertical wall. The typical dimensions of base slab are

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1000x400mm, 250mm thick and the height of the anchor block depends on the alignment of the pipe which depends on the topographic condition. The location of the anchor block will be proposed while the pipe is laid on the ground, in places where it is difficult to bare the pipe under the ground an anchor block will be used to fasten the pipe while it is lay above the ground. As result the number of anchor block might vary.

5.3.7 Manhole

The man hole is made of masonry wall with masonry base slab. There are 8 number of manhole are required for the pipe line network. The structural work of the manhole is same for all the 8 numbers but the water line connection is different which is shown in the drawing HY-DWG-005. The overall typical size of the manhole is 1.2x1.5m. It consists of base slab and vertical walls of thickness 250mm. The base slab is seated with 80mm lean concrete and 150mm well compacted soil.

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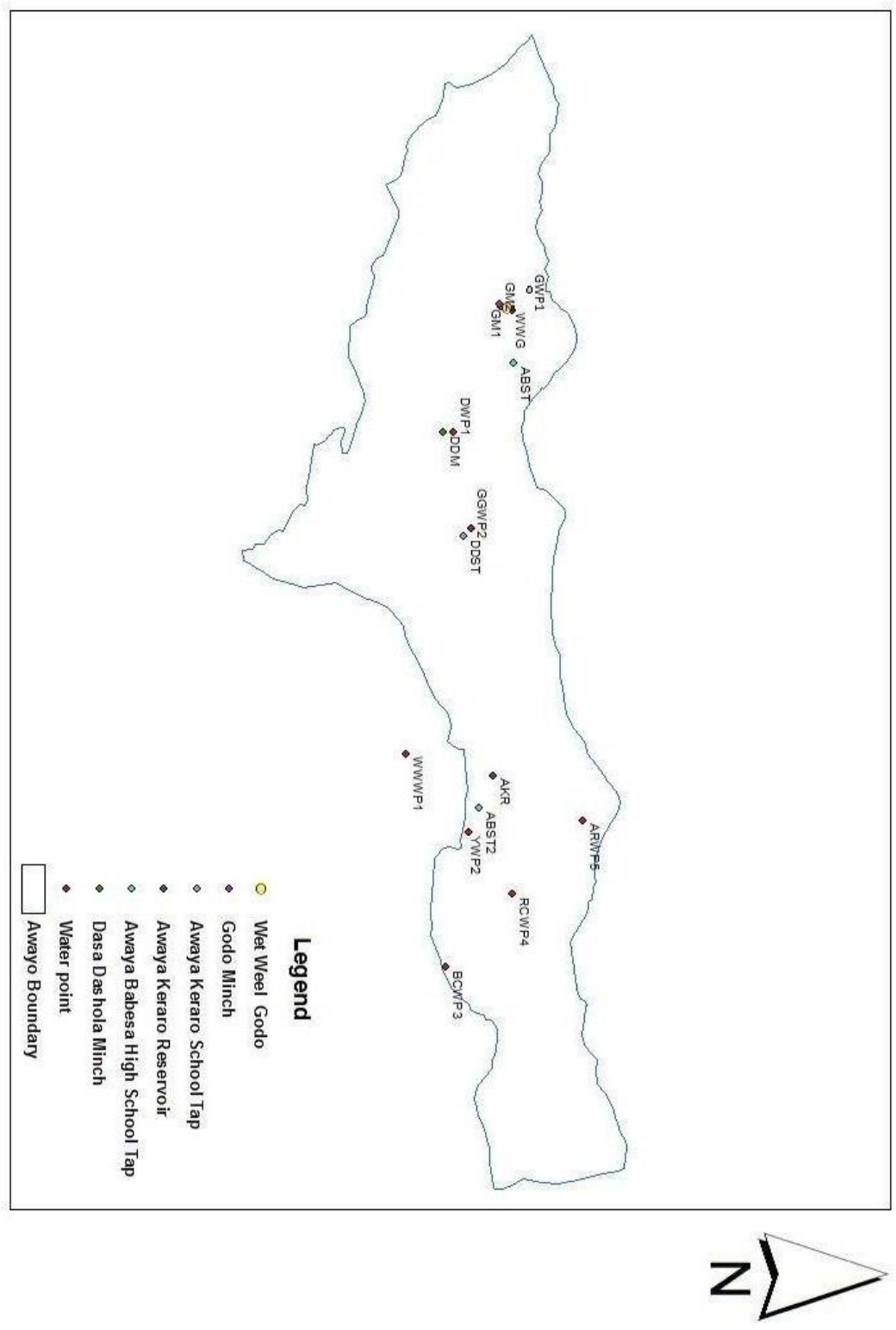

Figure 5.2 Location of water points

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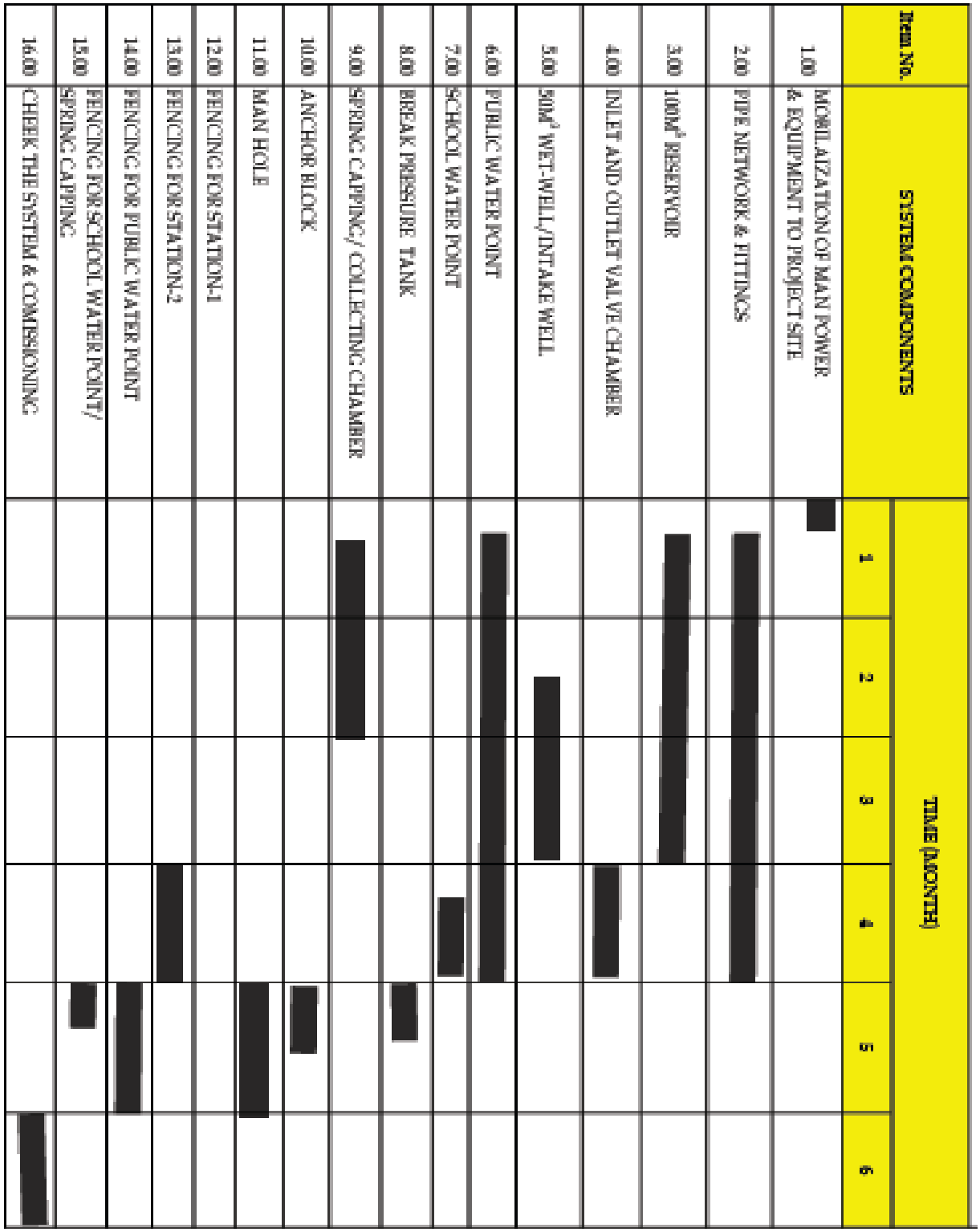
CHAPTER 6

IMPLEMENTATION PLAN/ SCHEDULE/



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CHAPTER 7

BILL OF QUANTITIES

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7.1 COMBINED SUMMARY OF BOQ

	Station/Component	Sub components	No	Unit Cost (ETB)	Total Cost (ETB)
1	Pipe Network and fittings (P&F)	-	1	6,146,076.76	6,146,076.76
	Total cost for P&F……				**6,146,076.76**
2	Station-1	100m^3 Reservoir	1	1,250,487.42	1,250,487.42
		Inlet-outlet chamber	1	68,120.61	68,120.61
		Fencing*	1	122,658.14	122,658.14
	Total cost for Station-1……				**1,441,266.17**
	Station-2	Spring capping	3	160,559.65	481,678.94
		Fencing*	3	43,641.30	130,923.89
3		50m^3 Wet-well	1	513,366.20	513,366.20
		Inlet-outlet chamber	1	68,120.61	68,120.61
		Fencing*	1	81,645.90	81,645.90
	Total cost for Station-2……				**1,275,735.54**
4	Water Point	WP-1toWP-8 (Public)	8	77,332.58	618,660.64
		Fencing*	8	53,341.41	426,731.28
		WP (School Tap)	3	52,106.81	156,320.43
		Fencing*	3	43,641.30	130,923.89
	Total cost for WP……				**1,332,636.24**
5	Man Hole	MH-1 to MH-6	8	6,906.35	**55,250.80**
6	Anchor Block	AB-1 to AB-4	4	1,030.98	**4,123.92**
7	Pressure Break tank	PBT-1	1	132,829.66	**132,829.66**
	TOTAL COST……				**10,387,919.1**
	MISCELLANEOUS (1%)……				**103,879.19**
	TOTAL COST OF THE PROJECT……				***10,491,798.2***
	VAT (15%)……				***1,573,769.74***
	GRAND TOTAL COST OF THE PROJECT……				***12,065,568.0***

* The considered fencing is permanent and made of RC structure with structural steel gate as shown in the drawing which is costlier. If we use wooden fencing, the cost for fencing is approximately 30% off the permanent.

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7.2 SUPPLY AND INSTALLATION OF PIPE NETWORK AND FITTINGS

No	Description	Amount (ETB)
	Summary of Bill of Quantity	
	GRAVITY DISTRBUTION PIPE SYSTEM	
1	Excavation and back fill work.....	1,790,821.76
2	Supply & installation of pipes ……..	4,296,477.42
3	Supply & installation of fittings……	58,777.57
	**Total carried to combined summary ..... **	**6,146,076.76**

GRAVITY DISTRBUTION PIPE SYSTEM

No	Description	Unit	Qty	Rate (ETB)	Amount (ETB)
	1. EXCAVATION & BACK FILL WORK				
1.1	Trench excavation in ordinary soil to a depth 800mm* 600mm width to bared the pipe for 12,861.05 meters length.	m^3	6,173.30	174.48	1,077,106.16
1.2	Trench excavation in weathered rock soil formation to a depth 800mm* 60mm width to bared the pipe for 1,000 meters length.	m^3	480.00	249.62	119,816.24
1.3	Load & cart away all excavated weathered rock soil formation material to an appropriate tip.	m^3	480.00	73.90	35,474.18

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1.4	Back fill with selected material (provide a bedding for the pipe with 300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	6,653.30	83.93	558,425.18
	Total Carried to summary……				1,790,821.76
	2. SUPPLY & INSTALLATION OF PIPES				
2.1	Supply and Install HDPE pipe for the gravity distribution pipe network (Class- PN-16),the cost includes welding the pipe for connection , the quality of the welding shall approved by the consultant with the expense of the contractor. *Note that, 5% additional length on each pipe item for contingency.*				
	Outer Diameter (OD) 110 mm	m	364.35	556.75	202,851.86
	Outer Diameter (OD) 90 mm	m	5,158.65	391.83	2,021,313.83
	Outer Diameter (OD) 75 mm	m	208.95	314.80	65,777.46
	Outer Diameter (OD) 63 mm	m	2,427.60	263.16	638,847.22
	Outer Diameter (OD) 50 mm	m	5,372.85	243.34	1,307,429.32
	Outer Diameter (OD) 32 mm	m	154.35	186.42	28,773.93
	Outer Diameter (OD) 25 mm	m	174.30	180.63	31,483.81
	Total Carried to summary……..				**4,296,477.42**
	3. SUPPLY & INSTALLATION OF FITTINGS				
3.1	Supply & install fittings for the gravity distribution pipe line with (PN-16) Fittings, the cost includes synthetic fiber and paint for joining the pipes with the fitting, the quality of the fitting shall approved by the consultant with the expense of the contractor, the fittings shall be fixed as per the drawing.				
	a) HDPE Coupling with Outer				

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	diameter,				
	Ø 110 mm	pcs	1.00	2,708.79	2,708.79
	Ø 75 mm	pcs	2.00	488.93	977.86
	Ø 63 mm	pcs	6.00	455.33	2,731.98
	Ø 50 mm	pcs	15.00	317.34	4,760.10
	Ø 25 mm	pcs	2.00	77.58	155.16
	b) GI Gate valve with internal diameter,				0.00
	Ø 63 mm	pcs	1.00	2,138.93	2,138.93
	Ø 50 mm	pcs	1.00	1,379.94	1,379.94
	Ø 38 mm	pcs	11.00	818.84	9,007.24
	Ø 18.5 mm	pcs	2.00	250.08	500.16
	c) GI Pressure release valve with internal diameter,				
	Ø 50 mm	pcs	1.00	1,379.94	1,379.94
	Ø 38 mm	pcs	1.00	818.84	818.84
	d) HDPE Tee with Outer diameter,				0.00
	Ø 110 mm	pcs	1.00	2,570.87	2,570.87
	Ø 75 mm (Cross tee)	pcs	1.00	593.33	593.33
	Ø 63 mm	pcs	3.00	455.33	1,365.99
	Ø 50 mm	pcs	2.00	386.34	772.68
	e) HDPE-GI Male Adapter with Outer diameter,				
	Ø 110 mm	pcs	1.00	2,570.87	2,570.87
	Ø 75 mm	pcs	2.00	593.33	1,186.66
	Ø 63 mm	pcs	5.00	455.33	2,276.65
	Ø 50 mm	pcs	12.00	317.34	3,808.08
	Ø 25 mm	pcs	2.00	85.08	170.16

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	f) HDPE Reducer with Outer diameter,				
	Ø 110 mm to Ø 75 mm	pcs	1.00	1,862.93	1,862.93
	Ø 110 mm to Ø 50 mm	pcs	1.00	1,862.93	1,862.93
	Ø 75 mm to Ø .63 mm	pcs	1.00	689.93	689.93
	Ø 75 mm to Ø 50 mm	pcs	1.00	689.94	689.94
	Ø 63 mm to Ø 50 mm	pcs	7.00	689.94	4,829.58
	Ø 50 mm to Ø .25mm	pcs	2.00	308.24	616.48
	g) HDPE Female Adaptor with Outer diameter,				
	Ø 75 mm	pcs	3.00	593.33	1,779.99
	Ø 63 mm	pcs	2.00	455.33	910.66
	Ø 50 mm	pcs	11.00	317.34	3,490.74
	Ø 25 mm	pcs	2.00	85.08	170.16
	Total Carried to summary……..				**58,777.57**

7.3 100 M^3 CAPACITY RC RESERVOIR

Summary of Bill of Quantity

No.	Description	Amount (ETB)
	A. SUB STRUCTURE	
1	Excavation and earth work	32,710.08
2	Concrete works	92,344.12
3	Steel reinforcement	165,460.20
	Total A…….	**290,514.40**
	B. SUPER STRUCTURE	
1	Concrete works	132,479.90
2	Form work	52,081.56
3	Steel reinforcement	529,141.08

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4	Metal works	8,550.61
5	Finishing	135,802.06
6	Pipe and fitting installation	101,917.82
	Total B……	**959,973.03**
	Total A + B……	**1,250,487.42**

A. SUB STRUCTURE

No.	Description	Unit	Qty	Rate (ETB)	Amount (ETB)
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	47.10	37.47	1,764.84
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	44.51	100.51	4,473.65
1.03	Load & cart away all excavated material to an appropriate trip.	m^3	53.93	73.90	3,985.39
1.04	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers (for both the water reservoir and pavement construction)	m^3	19.08	587.90	11,214.49
1.05	250mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	63.59	177.27	11,271.71
	Total Carried to summary……				**32,710.08**
	2. CONCRETE WORK				
2.01	100 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:				
	Under reservoir base slab	m^2	55.65	223.64	12,446.39
2.02	Reinforced concrete quality C-30,360 kg of cement/m3 filled in to form work & vibrated around rod				

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	reinforcement (Formwork and reinforcement measured separately)				
	base slab	m^3	15.30	5,220.45	79,897.74
	Total Carried to summary……..				**92,344.12**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 12 mm deformed bar	kg	1,201.07	82.98	99,664.53
	a) Dia. 10 mm deformed bar	kg	792.91	82.98	65,795.67
	Total Carried to summary……..……...				**165,460.20**
	B. SUPER STRUCTURE				
No.	**Description**	**Unit**	**Qty**	**Rate (ETB)**	**Amount (ETB)**
	1. CONCRETE WORK				
1.01	Reinforced concrete quality C-30,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	a) Reservoir wall	m^3	11.75	5,220.45	61,342.94
	b) Reservoir roof slab	m^3	12.67	5,220.45	66,125.33
	c) Reservoir haunch	m^3	0.96	5,220.45	5,011.63
	Total Carried to summary……..……...				**132,479.90**
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate.				
	a) In the internal wall	m^2	55.95	272.54	15,249.92
	b) To the external wall	m^2	55.95	272.54	15,249.92
	c) In the roof slab	m^2	58.09	272.54	15,830.91

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	d) Haunch	m^2	21.10	272.54	5,750.81
	Total Carried to summary……				**52,081.56**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 8 mm deformed bar	kg	780.09	82.98	64,731.51
	b) Dia. 10 mm deformed bar	kg	1,458.25	82.98	121,005.40
	c) Dia. 14 mm deformed bar	kg	4,138.40	82.98	343,404.16
	Total Carried to summary……				**529,141.08**
	4. METAL WORK				
4.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 1200*1200mm (for reservoir top slab man hole cover)	no	1.00	2,202.25	2,202.25
4.02	Supply, fabricate and mount RT 64-3mm thick for the external and internal ladder according to the structural drawing .Price shall include, 8mm thick base plate with 7mm weld all around with the ladder, 10mm diameter four rock bolt & one coat of antirust and two coats of synthetic enamel painting and all other necessary accessories to complete the work.	no	2.00	3,174.18	6,348.36
	Total Carried to summary……..……..				**8,550.61**

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	5. FINISHING				
5.01	Apply three coats of plastering in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.				
	a) To internal wall & internal slab surfaces	m^2	137.13	206.63	28,335.80
	b)To exposed reservoir top slab	m^2	107.98	206.63	22,312.86
5.02	Apply two coats of plastering to external wall surface in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.	m^2	71.54	188.93	13,515.64
5.03	Apply 3 coat of plastic emulsion painting at external part of the top slab sides. Price shall include pre-cleaning and preparation of the surface.	m^2	5.39	174.46	940.03
5.04	Apply Tyro-line rendering at external part of the vertical wall surface. Price shall include pre-cleaning and preparation of the surface.	m^2	62.74	302.81	18,997.45
5.05	50mm thick smooth finished cement mortar screed (1:3) reservoir floor finish with glass stripping for crack protection c/c 2000mm both ways. Price includes glass. All as per engineers approval.	m^2	46.54	221.55	10,311.52
5.06	C-20 concrete pavement all around the reservoir	m^3	6.6	4,388.14	28,935.40
5.07	Dia. 400mm half concrete pipe ditch around pavement on & including. 100mm thick red ash base and jointed in cement mortar mixes (1:2). Price	ml	40.8	305.08	12,453.37

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	shall include side support stone on the external side of the ditch.				
	Total Carried to summary…….				**135,802.06**
	6.PIPE & FITTING INSTALLATION				
6.01	Supply & install Pipes for the inlet and distribution pipe connections to the reservoir fixtures according to the drawing complete with the necessary connecting pieces such as tees, bends, unions, etc. The unit price shall include all necessary assistance to the installation works such as supports for horizontal and vertical pipes and providing flanged pipes. The installation shall be tested at a pressure of 10 kg/cm^2 at the expense of the contractor.				
	a) Diameter 75 mm for the inlet, over flow, vent & drainage pipe(GI-Class-B)	ml	12	1,560.32	18,723.84
	b) Diameter 75 mm outlet pipe(GI-Class-B Pipe)	ml	6	1,560.32	9,361.92
6.02	Supply & fix flanged Gate Valves of approved quality complete with unions, hand wheels etc.				
	a) Diameter 75 mm	pcs	3	12,212.93	36,638.79
	b) Diameter 100 mm	pcs	1	13,196.87	13,196.87
6.03	Supply & fix Flanged Water Meter of approved quality complete with unions, adapter to HDPE pipe etc.				
	Diameter 100 mm	pcs	1	19,406.87	19,406.87
6.04	Supply & install vent caps of rigid PVC to be connected to the roof terminal of vent pipe.				
	Diameter 80 mm	pcs	2	731.33	1,462.66
6.05	Floor Drain, for the out let pipe, as shown in the drawing, of approved quality complete with all accessories including a removable strainer cap fitted to smell trap, etc.				
	Diameter 100 mm	pcs	1	3,126.87	3,126.87
	Total Carried to summary……				**101,917.82**

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7.4 INLET AND OUTLET VALVE CHAMBER FOR 100M^3 /50M^{3}RESERVIOR

Summary of Bill of Quantity

No.	Description	Amount (ETB)
1	Excavation and earth work……	7,393.38
2	Masonry works……..	27,440.37
3	Concrete works…….	5,849.98
4	Steel reinforcement……...	4,566.51
5	Form work…….	4,566.51
6	Metal works……...	6,856.56
7	Finishing……	11,447.30
	Total carried to combined summary…….	**68,120.61**

No.	Description	Unit	Qty	Rate (ETB)	Amount (ETB)
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	21.04	37.47	788.37
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	14.45	100.54	1,452.80
1.03	Load & cart away all excavated material to an appropriate tip.	m^3	14.45	73.90	1,067.86
1.04	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	3.61	587.90	2,123.79
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with	m^2	13.80	142.07	1,960.57

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	crushed stone .for both foundation & base slab.				
	**Total Carried to summary……..…….....				**7,393.38**
	2. MASONRY WORKS				
2.01	40cm thick Stone masonry wall in cement mortar (1:3)				
	a) outlet valve chamber	m^3	8.89	1,769.89	15,737.86
	b) inlet valve chamber	m^3	6.61	1,769.89	11,702.51
	Total Carried to summary…….				**27,440.37**
	3. CONCRETE WORK				
3.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete: for both foundation & base slab.	m^2	13.80	223.64	3,086.23
3.02	Reinforced concrete quality C-25,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately). Top slab				
	a) outlet valve chamber	m^3	0.81	4,702.56	3,818.48
	b) inlet valve chamber	m^3	0.43	4,702.56	2,031.51
	Total Carried to summary…….Birr				**5,849.98**
	4. STEEL REINFORCEMENT				
4.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	Dia. 8 mm deformed bar	kg	55.03	82.98	**4,566.51**
	5. FORM WORK				
5.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate.				

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	for both inlet & outlet chamber	m^2	15.64	272.54	**4,262.53**
	6. METAL WORK				
6.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint. Each for inlet & outlet chamber				
	750X1750mm	pcs	2.00	3,428.28	**6,856.56**
	7. FINISHING				
7.01	Apply two coats of plastering to internal and external wall surface in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface. For both inlet & out let	m²	55.40	206.63	**11,447.30**

7.5 50M³ CAPACITY RC INTAKE WELL

Summary Of Bill Of Quantities

No.	Description	Unit	Qty	Rate	Amount ETB
	A. SUB STRUCTURE				
1	**Excavation and earth work**				29,460.69
2	**Concrete works**				53,442.70
3	**Steel reinforcement**				31,955.52
	Total A				**114,858.91**
	B. SUPER STRUCTURE				
1	**Concrete works**				69,792.37
2	**Form work**				36,818.89
3	**Steel reinforcement**				104,090.38
4	**Metal works**				8,550.61
5	**Finishing**				71,967.83

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6	**Pipe and fitting installation……...**	107,287.22
	**Total B ……..... **	**398,507.30**
	**Total Carried to combined summary ..... **	**513,366.20**

	A-SUB STRUCTURE				
No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount ETB**
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	31.40	37.47	1,176.56
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	44.51	100.51	4,473.65
1.03	Load & cart away all excavated material to an appropriate trip.	m^3	50.79	73.90	3,753.34
1.04	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers. (for both the water reservoir and pavement construction)	m^3	17.01	587.90	10,003.05
1.05	250mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	56.72	177.27	10,054.09
	Total Carried to summary…….				**29,460.69**
	2. CONCRETE WORK				
2.01	100 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete: Under reservoir base slab	m^2	36.94	223.64	8,261.66
2.02	Reinforced concrete quality C-30,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured				

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	separately)				
	base slab	m^3	8.65	5,220.45	45,181.04
	Total Carried to summary……				**53,442.70**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a)8mm deformed bar	kg	385.10	82.98	31,955.52
	Total Carried to summary……..……				**31,955.52**

	B-SUPER STRUCTURE				
No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount ETB**
	1. CONCRETE WORK				
1.01	Reinforced concrete quality C-30,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	b) In reservoir wall	m^3	7.09	5,220.45	37,000.50
	c) In reservoir roof slab	m^3	5.90	5,220.45	30,783.30
	d) haunch	m^3	0.38	5,220.45	2,008.57
	Total Carried to summary……				**69,792.37**
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate.				
	a) In the internal wall	m^2	35.80	272.54	9,755.84
	b) To the external wall	m^2	38.06	272.54	10,372.00
	c) In the roof slab	m^2	40.14	272.54	10,940.24

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	d) Haunch	m^2	21.10	272.54	5,750.81
	Total Carried to summary……..…				**36,818.89**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) 8 mm deformed bar	kg	1,254.40	82.98	104,090.38
	Total Carried to summary……...				**104,090.38**
	4. METAL WORK				
4.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	METAL DOORS				
	MD= size: 1200*1200mm (for reservoir top slab man hole cover)	no	1.00	2,202.25	2,202.25
4.02	Supply, fabricate and mount RT 64-3mm thick for the external and internal ladder according to the structural drawing .Price shall include, 8mm thick base plate with 7mm weld all around with the ladder, 10mm diameter four rock bolt & one coat of antirust and two coats of synthetic enamel painting and all other necessary accessories to complete the work.	no	2.00	3,174.18	6,348.36
	Total Carried to summary……				**8,550.61**
	5. FINISHING				

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5.01	Apply three coats of plastering in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.				
	a) To internal wall & internal slab surfaces	m²	105.77	206.63	21,856.25
	b)To exposed reservoir top slab	m²	44.12	206.63	9,115.90
5.02	Apply two coats of plastering to external wall surface in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.	m²	43.36	188.93	8,192.76
5.03	Apply 3 coat of plastic emulsion painting at external part of the top slab sides. Price shall include pre-cleaning and preparation of the surface.	m²	3.67	174.46	640.93
5.04	Apply tyro line rendering at external part of the vertical wall surface. Price shall include pre-cleaning and preparation of the surface.	m²	1.13	302.81	342.30
5.05	50mm thick smooth finished cement mortar screed (1:3) reservoir floor finish with glass stripping for crack protection c/c 2000mm both ways. Price include glass. All as per engineers approval.	m²	25.50	221.55	5,650.56
5.06	C-20 concrete pavement all around the reservoir	m^3	3.8	4,388.14	16,589.63
5.07	Diameter 400mm half concrete pipe ditch around pavement on & including . 100mm thick red ashes base and jointed in cement mortar mix (1:2). Price shall include side support stone on the external side of the ditch.	ml	31.4	305.08	9,579.51
	Total Carried to summary……				**71,967.83**
	6.PIPE & FITTING INSTALLATION				

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6.01	Supply & install Pipes for the inlet and distribution pipe connections to the reservoir fixtures according to the drawing complete with the necessary connecting pieces such as tees, bends, unions, etc. The unit price shall include all necessary assistance to the installation works such as supports for horizontal and vertical pipes and providing flanged pipes. The installation shall be tested at a pressure of 10 kg/cm^2 at the expense of the contractor.				
	a) Diameter 50 mm for the inlet, over flow, vent & drainage pipe(GI-Class-B)	m	12	784.64	9,415.68
	b) Diameter 100 mm outlet pipe(GI Pipe)	m	6	1,543.67	9,262.02
6.02	Supply & fix flanged GI Gate Valves of approved quality complete with unions, hand wheels etc.				
	a) Diameter 25 mm	pcs	2	305.84	611.68
	b) Diameter 50 mm	pcs	7	1,379.94	9,659.58
	c) Diameter 75 mm	pcs	2	12,212.93	24,425.86
	d) Diameter 100 mm	pcs	1	13,196.87	13,196.87
6.03	Supply & fix Flanged Water Meter of approved quality complete with unions, adapter to HDPE pipe, reducer, etc.				
	Diameter 100 mm	pcs	1	19,406.87	19,406.87
6.04	Supply & install vent caps of rigid PVC to be connected to the roof terminal of vent pipe.				
	Diameter 80 mm	pcs	2	731.33	1,462.66
6.05	Floor Drain, for the out let pipe, as shown in the drawing, of approved quality complete with all accessories including a				

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	removable strainer cap fitted to smell trap, etc.				
	Diameter 100 mm	pcs	1	3,126.87	3,126.87
6.06	Supply & fix HDPE fittings of approved quality complete with the necessary accessories				
	a) Coupling with Outer Diameter (OD)				
	Ø 90 mm	pcs	2	2,708.79	5,417.58
	Ø 63 mm	pcs	3	455.33	1,365.99
	Ø 32 mm	pcs	2	113.66	227.32
	b) Mal. Adaptor Outer Diameter (OD)				
	Ø 90 mm	pcs	2	2,570.87	5,141.74
	Ø 63 mm	pcs	3	455.33	1,365.99
	Ø 32 mm	pcs	2	113.66	227.32
	c) Fem. Adaptor Outer Diameter (OD)				0.00
	Ø 63 mm	pcs	3	455.33	1,365.99
	Ø 32 mm	pcs	2	113.66	227.32
	d) Reducer Outer Diameter (OD)				
	Ø 63 mm to Ø 32mm	pcs	2	689.94	1,379.88
	Total Carried to summary……				**107,287.22**

7.6 PUPLIC WATER POINT

Summary Of Bill Of Quantities

No.	Description	Amount (ETB)
1	Excavation and earth work……	13,407.98
2	Concrete Works…….	16,560.55
3	Steel reinforcement……	6,495.60
4	Masonry works……..	14,823.54
5	Metal works……	3,548.28
6	Soak away pit…….	457.49

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7	Pipe & fitting installation……..	17,676.57
8	Finishing works……..	4,362.57
	TOTAL CARRIED TO COMBINED SUMMARY…….	**77,332.58**

No.	Description	Unit	Qty	Rate (ETB)	Amount (ETB)
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	48.24	37.47	1,807.55
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	16.98	100.51	1,706.75
1.03	Load & cart away all excavated material to an appropriate tip.	m^3	16.98	73.90	1,254.89
1.04	Back fill with selected material (300 mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	8.49	587.91	4,991.62
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone. For valve chamber	m^2	0.95	142.07	134.26
1.06	300mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone. For water point base	m^2	10.85	323.89	3,512.91
	Total Carried to summary……..				**13,407.98**
	2. CONCRETE WORK				
2.01	80mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:	m^2	10.85	223.64	2,425.60
2.02	Plain concrete quality C-25,360 kg of cement/m3 filled in to form work & vibrated around				
	a) for water point	m^2	2.05	4,702.56	9,629.20
	b) for valve chamber (base slab & walls)	m^2	0.65	4,702.56	3,036.68

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2.03	Reinforced concrete quality C-25,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately). Ring beam	m^3	0.31	4,702.56	1,469.08
	Total Carried to summary……..……				**16,560.55**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	Dia. 6 mm deformed bar	kg	27.73	82.98	2,301.41
	Dia. 10 mm deformed bar	kg	50.54	82.98	4,194.19
	Total Carried to summary……..				**6,495.60**
	4. MASONRY WORKS				
4.01	Stone masonry construction in cement mortar (1:3)	m^3	8.38	1,769.89	**14,823.54**
	5. METAL WORK				
5.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 1550X700mm (for valve chamber man hole cover), including all accessories	pcs	1.00	3,548.28	**3,548.28**
	6. SOAK AWAY PIT				
6.01	Excavate the soil as per drawing and filled with sand	m^3	0.50	907.71	**457.49**
	7.PIPE & FITTING INSTALLATION				
	Supply & install Pipes for the inlet and distribution pipe connections to the water point fixtures according to the drawing complete with the necessary connecting pieces such as tees, bends, unions, etc. The installation shall be tested at a pressure of 10 kg/cm^2 at the expense of the contractor.				
7.01	Plumbing works				

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	GS pipe Ø= 1 1/2"	m	6.00	684.22	4,105.32
	GS pipe Ø= 1"	m	6.00	454.89	2,729.34
	GS pipe Ø= 3/4"	m	3.00	297.91	893.73
7.02	Fitting supply and connection work				
	90 deg elbow Ø=11/2"	pcs	6.00	180.49	1,082.94
	Gate valve Ø=1 1/2"	pcs	1.00	818.44	818.44
	Water meter Ø=1 1/2"	pcs	1.00	2,750.84	2,750.84
	Union Ø=1 1/2"	pcs	1.00	211.64	211.64
	Union Ø=1"	pcs	2.00	140.24	280.48
	Nipples Ø=1 1/2"	pcs	6.00	156.40	938.40
	Nipples Ø=1"	pcs	4.00	105.74	422.96
	Tee Ø=1 1/2"	pcs	1.00	239.24	239.24
	Cross tee Ø=1"	pcs	2.00	305.84	611.68
	Reducer Ø= 11/2" - Ø=1"	pcs	2.00	188.54	377.08
	Reducer Ø= 1" - Ø=3/4"	pcs	6.00	91.38	548.28
	Coupling Ø= 3/4"	pcs	6.00	80.26	481.56
	Faucet Ø=3/4"	pcs	6.00	197.44	1,184.64
	Total Carried to summary……..……..				**17,676.57**
	8. FINISHING WORK				
8.01	Apply three coats of plastering in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.				
	all exposed area	m²	9.13	206.63	1,886.53
8.02	50mm thick smooth finished cement mortar screed (1:3) water jar seat finish. All as per engineers approval.	m²	11.18	221.55	2,476.04
	Total Carried to summary……..				**4,362.57**

7.7 SCHOOL WATER POINT

Summary Of Bill Of Quantities

No.	**Description**	**Amount (ETB)**

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1	Excavation and earth work……....	7,543.96
2	Concrete Works……	13,124.61
3	Masonry works……	5,357.81
4	Metal works……	3,548.28
5	Soak away pit……..	457.49
6	Pipe & fitting installation…….	17,546.10
7	Finishing works……	4,528.56
	TOTAL CARRIED TO COMBINED SUMMARY……	**52,106.81**

No.	Description	Unit	Qty	Rate (ETB)	Amount (ETB)
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	28.00	37.47	1,049.16
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	5.36	100.51	539.23
1.03	Load & cart away all excavated material to an appropriate tip.	m^3	5.36	73.90	396.47
1.04	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	2.68	587.91	1,577.04
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone. For valve chamber	m^2	0.95	142.07	134.26
1.06	300mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone. For water point base	m^2	11.88	323.89	3,847.81
	Total Carried to summary……..				**7,543.96**
	2. CONCRETE WORK				
2.01	80 mm lean concrete quality C-15, with minimum cement content of 150 kg /m3, of concrete:	m^2	11.88	223.64	2,656.84

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2.02	Plain concrete quality C-25,360 kg of cement/m3 filled in to form work & vibrated around				
	a) for water point	m^2	2.50	4,702.56	11,752.64
	b) for valve chamber (base slab & walls)	m^2	0.29	4,702.56	1,371.97
	Total Carried to summary…….……..…….				**13,124.61**
	3. MASONRY WORKS				
3.01	Stone masonry construction in cement mortar (1:3)	m^3	3.03	1,769.89	**5,357.81**
	4. METAL WORK				
4.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 1550X700mm (for valve chamber man hole cover), including all accessories	pcs	1.00	3,548.28	**3,548.28**
	5. SOAK AWAY PIT				
5.01	Excavate the soil as per drawing and filled with sand	m^3	0.50	907.71	**457.49**
	6.PIPE & FITTING INSTALLATION				
	Supply & install Pipes for the inlet and distribution pipe connections to the water point fixtures according to the drawing complete with the necessary connecting pieces such as tees, bends, unions, etc. The installation shall be tested at a pressure of 10 kg/cm^2 at the expense of the contractor.				
6.01	Plumbing works				
	GS pipe Ø= 1"	m	3.00	454.89	1,364.67
	GS pipe Ø= 3/4"	m	3.00	297.91	893.73
6.02	Fitting supply and connection work				
	90 deg elbow Ø=1"	pcs	2.00	180.49	360.98
	Gate valve Ø=1"	pcs	1.00	818.44	818.44
	Water meter Ø=1"	pcs	1.00	2,750.84	2,750.84
	Union Ø=1"	pcs	8.00	211.64	1,693.12
	Nipples Ø=1"	pcs	8.00	156.40	1,251.20

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	Tee Ø=1"	pcs	5.00	239.24	1,196.20
	Cross tee Ø=1"	pcs	2.00	305.84	611.68
	Reducer Ø= 1" - Ø=3/4"	pcs	8.00	91.38	731.04
	Coupling Ø= 3/4"	pcs	8.00	80.26	642.08
	Faucet Ø=3/4"	pcs	8.00	197.44	1,579.52
6.03	waste water pipe				
	GI pipe Ø=1"	m	6.00	454.89	2,729.34
	Elbow GI Ø=1"	pcs	8.00	102.19	817.52
	Tee Ø=1"	pcs	1.00	105.74	105.74
	Total Carried to summary……..……..				**17,546.10**
	7. FINISHING WORK				
7.01	Apply three coats of plastering in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface/ all exposed area/	m²	11.28	206.63	2,330.79
7.02	50mm thick smooth finished cement mortar screed (1:3) water jar seat finish. All as per engineers approval.	m²	9.92	221.55	2,197.78
	Total Carried to summary……..……...				**4,528.56**

7.8 PRESSURE BREAK TANK

Summary Of Bill Of Quantities

No.	Description	Unit	Qty	Rate	Amount ETB
1	**Excavation and earth work.....**				1,760.19
2	**Concrete Works.....**				22,998.74
3	**Steel reinforcement……..**				12,276.31
4	**Masonry works……**				9,769.79

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5	**Metal works……..**	3,548.28
6	**Inlet/outlet Manhole……**	13,812.70
7	**Pipe & fitting installation……**	58,355.42
8	**Finishing works……**	10,308.23
	TOTAL CARRIED TO COMBINED SUMMARY……..	**132,829.66**

No.	Description	Unit	Qty	Rate	Amount ETB
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	16.00	37.47	599.52
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	1.60	100.51	160.82
1.03	Load & cart away all excavated material to an appropriate tip.	m^3	3.36	73.90	248.30
1.04	200mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone . For valve chamber	m^2	5.29	142.07	751.55
	Total Carried to summary……..……..				**1,760.19**
	2. CONCRETE WORK				
2.01	100mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:	m^2	12.00	223.64	**2,683.68**

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2.02	Reinforced concrete quality C-25,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately). Ring beam	m^3	4.32	4,702.56	20,315.06
	Total Carried to summary…….				**22,998.74**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	10 mm deformed bar	kg	147.94	82.98	12,276.31
	Total Carried to summary……..				**12,276.31**
	4. MASONRY WORKS				
4.01	Stone masonry construction in cement mortar (1:3)	m^3	5.52	1,769.89	**9,769.79**
	5. METAL WORK				
5.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 1550X700mm (for Pressure Break Tank man hole cover), including all accessories	pcs	1.00	3,548.28	**3,548.28**
	6. INLET/OUTLET PIPES MANHOLE				

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5.01	Man hole for the inlet and outlet pipes with the internal dimension of 70 X 70 X 100 cm depth. Where Shown On Drawings including a manhole cover metal door hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	Man hole for Pressure Break Tank , including man hole cover	pcs	2.00	6,906.35	**13,812.70**
	6.PIPE & FITTING INSTALLATION				
	Supply & install Pipes for the inlet and distribution pipe connections to the water point fixtures according to the drawing complete with the necessary connecting pieces such as tees, bends, unions, etc. The installation shall be tested at a pressure of 10 kg/cm^2 at the expense of the contractor.				
6.01	Plumbing works				
	GS pipe Ø= 2"	m	6.00	784.64	4,707.84
6.02	Fitting supply and connection work				
	Floating Gate Valve Φ 6''	pcs	1.00	24,926.87	24,926.87
	Gate Valve Φ 2''	pcs	1.00	1,827.84	1,827.84
	Union Φ 6''	pcs	2.00	3,067.43	6,134.86
	Nipples Φ 6''	pcs	1.00	2,515.43	2,515.43
	Tee Φ 2''	pcs	1.00	140.24	140.24

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	Elbow Φ 6''	pcs	4.00	2,681.27	10,725.08
	Coupling Ø= 6"	pcs	1.00	3,564.39	3,564.39
	Adaptor Ø=6"	pcs	1.00	3,812.87	3,812.87
	Total Carried to summary…….				**58,355.42**
	7. FINISHING WORK				
7.01	Apply three coats of plastering in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.				
	all exposed area	m²	32.85	206.63	6,787.80
7.02	50mm thick smooth finished cement mortar screed(1:3) internal surface finish. All as per engineers approval.	m²	15.89	221.55	3,520.43
	Total Carried to summary…….				**10,308.23**

7.9 SPRING CAPPING/ COLLECTING CHAMBER

No.	Description	Unit	Qty	Rate	Amount
	A. SUB STRUCTURE				
1	**Excavation and earth work.....**				12,699.36
2	**Concrete works.....**				3,153.01
3	**Steel reinforcement……**				2,731.45
	Total A				**18,583.82**
	B. SUPER STRUCTURE				
1	**Concrete works.....**				30,193.44
2	**Form work……..**				1,640.15
3	**Steel reinforcement……**				2,731.45
4	**Metal works.....**				2,202.25
5	**Finishing.....**				29,907.05
6	**Pipe and fitting installation……..**				27,301.50

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7	**Water quality test……..**	48,000.00
	Total B …….	**141,975.83**
	TOTAL CARRIED TO COMBINED SUMMARY.....	**160,559.65**

A-SUB STRUCTURE

No.	Description	Unit	Qty	Rate	Amount
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	36.00	37.47	1,348.92
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	8.25	100.51	829.21
1.03	Load & cart away all excavated material to an appropriate trip.	m^3	15.45	73.90	1,141.76
1.04	Back fill with selected material (1000mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	15.13	587.90	8,891.99
1.05	500mm thick graded river filter well rolled,	m^2	2.75	177.27	487.49
	Total Carried to summary…….				**12,699.36**
	2. CONCRETE WORK				
2.01	100 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:				
	Under collection chamber base slab	m^2	6.25	223.64	1,397.75
2.02	Reinforced concrete quality C-20,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	base slab	m^3	0.40	4,388.14	1,755.26
	Total Carried to summary…….				**3,153.01**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				

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	a)10mm deformed bar	kg	32.92	82.98	2,731.45
	Total Carried to summary……				**2,731.45**
B-SUPER STRUCTURE					
No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount**
	1.2. MASONRY WORKS				
1.01	40cm thick Stone masonry wall in cement mortar (1:3)				
	a) Wing wall	m^3	5.65	1,769.89	10,003.42
	b) collection chamber	m^3	11.41	1,769.89	20,190.02
	Total Carried to summary……				**30,193.44**
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate.				
	a) for both bottom and roof slab	m^2	6.02	272.54	1,640.15
	Total Carried to summary……				**1,640.15**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) 10 mm deformed bar	kg	32.92	82.98	2,731.45
	Total Carried to summary……				**2,731.45**
	4. METAL WORK				
4.01	Metal Doors in 38 X 38 X1.5 mm thick LTZ Steel Profile Covered with 1.0 mm Galvanized Ribbed Steel Sheet Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	METAL DOORS				

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	MD= size: 600*600mm (for collection chamber top slab man hole cover)	no	1.00	2,202.25	2,202.25
	Total Carried to summary……				**2,202.25**
	5. FINISHING				
5.01	Apply three coats of plastering in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.				
	a) To exposed surface of wing wall	m²	18.35	206.63	3,791.66
	b)To exposed surface for the collection chamber	m²	55.40	206.63	11,447.30
5.05	50mm thick smooth finished cement mortar screed (1:3) collection chamber internal surface finish with glass stripping for crack protection c/c 2000mm both ways. Price includes glass. All as per engineers approval.	m²	23.50	221.55	5,206.43
5.06	C-20 concrete pavement all around the spring collecting chamber	m^3	1.6	4,388.14	7,021.02
5.07	Diameter 400mm half concrete pipe ditch around pavement on & including. 100mm thick red ash base and jointed in cement mortar mixes (1:2). Price shall include side support stone on the external side of the ditch.	ml	8.0	305.08	2,440.64
	Total Carried to summary……				**29,907.05**
	6.PIPE & FITTING INSTALLATION				
6.01	Supply & install Pipes for the inlet and distribution pipe connections to the reservoir fixtures according to the drawing complete with the necessary connecting pieces such as tees, bends, unions, reducers, adaptors etc. The unit price shall include all necessary assistance to the installation works such as supports for horizontal and vertical pipes and providing				

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	flanged pipes. The installation shall be tested at a pressure of 10 kg/cm^2 at the expense of the contractor.				
	a) Diameter 50 mm for the inlet, over flow, vent & drainage pipe(GI-Class-B)	m	12	1,004.72	12,056.60
	b) Diameter 50 mm outlet pipe(GI Pipe)	m	6	1,827.84	10,967.03
6.02	Supply & fix flanged Gate Valves of approved quality complete with unions, hand wheels etc.				
	a) Diameter 50 mm	pcs	2	2,138.93	4,277.86
	Total Carried to summary……				**27,301.50**
	7.WATER QUALITY TEST				
6.02	Supply & fix flanged Gate Valves of approved quality complete with unions, hand wheels etc.	LS	1	48,000.00	**48,000.00**
	Total Carried to summary……				**48,000.00**

7.10 MAN HOLE

Summary Of Bill Of Quantities

No.	Description	Amount (ETB)
1	Excavation and earth work……	1,334.53
2	Masonry Works……	2,777.78
3	Concrete works……..	1,405.56
4	Steel reinforcement……	769.93
5	Form work……	147.17
6	Finishing works……	471.38
	TOTAL CARRIED TO COMBINED SUMMARY……	**6,906.35**

No.	Description	Unit	Qty	Rate	Amount (ETB)
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	3.78	37.47	141.64

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1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	2.92	100.51	293.09
1.03	Load & cart away all excavated material to an appropriate tip.	m^3	2.92	73.90	215.49
1.04	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	0.73	587.91	428.59
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	1.80	142.07	255.73
	Total Carried to summary……..				**1,334.53**
	2. MASONRY WORKS				
2.01	25cm thick Stone masonry foundation wall in cement mortar (1:3)	m^3	1.83	1,522.07	2,777.78
	3. CONCRETE WORK				
3.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:	m^2	2.50	223.64	559.10
3.02	Reinforced concrete quality C-25,360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately). Prize include transportation, erection, handle bar, etc.				
	top slab	m^3	0.18	4,702.56	846.46
	Total Carried to summary……				**1,405.56**
	4. STEEL REINFORCEMENT				
4.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	Dia. 8 mm deformed bar	kg	9.28	82.98	**769.93**
	5. FORM WORK				

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5.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate.				
	for column 200x200mm	m^2	0.54	272.54	**147.17**
	6. FINISHING				
6.01	Apply two coats of plastering to internal & external wall surface above NGL in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.	m²	2.50	188.93	**471.38**

7.11 ANCHOR BLOCK

Summary Of Bill Of Quantities

No.	Description	Amount (ETB)
1	Excavation and earth work	169.50
2	Masonry Works	441.40
3	Concrete works	89.46
4	Finishing works	330.63
	TOTAL CARRIED TO COMBINED SUMMARY	**1,030.98**

No.	Description	Unit	Qty	Rate (ETB)	Amount (ETB)
	1. EXCAVATION & EARTH WORK				
1.01	Clear and remove top soil to an average depth of 200mm.	m^2	1.12	37.47	41.97
1.02	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	0.22	100.51	22.11
1.03	Load & cart away all excavated material to an appropriate tip.	m^3	0.22	73.90	16.26
1.04	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste &	m^3	0.06	587.91	32.34

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	compact in layers.				
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	0.40	142.07	56.83
	Total Carried to summary…….				**169.50**
	2. MASONRY WORKS				
2.01	25cm thick Stone masonry in cement mortar (1:3)	m^3	0.29	1,522.07	**441.40**
	3. CONCRETE WORK				
3.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:	m^2	0.40	223.64	**89.46**
	4. FINISHING				
4.01	Apply two coats of plastering to exposed wall surface above NGL in cement mortar (1:3). Price shall include pre-cleaning and preparation of the surface.	m²	1.75	188.93	**330.63**

7.12 FENCING FOR STATION-1

Summary Of Bill Of Quantities

No.	Description	Amount (ETB)
A-SUB STRUCTURE		
1	Excavation and earth work……..	9,607.08
2	Concrete works……	15,284.62
3	Form work……	3,548.14
4	Steel reinforcement……..	5,989.50
	Total A……	**28,439.84**
B. SUPER STRUCTURE		
1	Concrete works……	15,833.24
2	Form works……..	20,672.70
3	Steel reinforcement……..	38,199.27
4	Metal works……..	19,513.08
	Total B…….	**94,218.30**

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	TOTAL CARRIED TO COMBINE SUMMARY A + B……..…... 122,658.14				
A-SUB STRUCTURE					
No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount (ETB)**
	1. EXCAVATION & EARTH WORK				
1.01	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	12.74	100.51	1,280.24
1.02	Load & cart away all excavated material to an appropriate tip.	m^3	6.37	73.91	470.71
1.03	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	10.19	587.91	5,990.76
1.04	100mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	9.75	142.07	1,385.18
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	3.38	142.07	480.20
	Total Carried to summary……..……..				**9,607.08**
	2. CONCRETE WORK				
2.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete: fencing post	m^2	13.13	223.64	2,936.39
2.02	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	post & column -footing	m^3	2.81	4,388.14	12,348.23
	Total Carried to summary……..……..				**15,284.62**
	3. FORM WORK				
3.01	Provide, cut and fix in position sawn structural wood or steel formwork	m^2	13.02	272.54	3,548.14

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	whichever is appropriate for post and column				
	4. STEEL REINFORCEMENT				
4.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 6 mm deformed bar	kg	49.78	82.98	4,131.03
	b) Dia. 8 mm deformed bar	kg	22.40	82.98	1,858.46
	Total Carried to summary……				**5,989.50**

B-SUPER STRUCTURE

No.	Description	Unit	Qty	Rate	Amount (ETB)
	1. CONCRETE WORK				
1.01	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)	m^3	3.61	4,388.14	15,833.24
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	75.85	272.54	20,672.70
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 6 mm deformed bar	kg	140.15	82.98	11,629.76
	b) Dia. 8 mm deformed bar	kg	268.24	82.98	22,258.86
	c) Dia. 12 mm deformed bar	kg	51.95	82.98	4,310.65
	Total Carried to				**38,199.27**

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	summary……..……				
	4. METAL WORK				
4.01	Metal Doors in 60 X 60 X3 mm thick LTZ Steel Profile Covered with 1.0mm Galvanized Ribbed Steel Sheet and mesh wire Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 3.2x2.8m	pcs	1.00	8,828.28	8,828.28
4.02	Supply, fabricate and mount 1.5mmthick barbed wire according to the structural drawing .Price shall include, all other necessary accessories to complete the work.	ml	840.00	12.72	10,684.80
	Total Carried to summary……				**19,513.08**

7.13 FENCING FOR STATION-2

Summary Of Bill Of Quantities

No.	Description	Amount (ETB)
A-SUB STRUCTURE		
1	Excavation and earth work……..	5,825.81
2	Concrete works……	10,604.23
3	Form work……..	2,158.19
4	Steel reinforcement……	4,188.79
	Total A……	**22,777.02**
B. SUPER STRUCTURE		
1	Concrete works……	8,780.54
2	Form works……	12,692.73
3	Steel reinforcement……	22,461.73
4	Metal works……	14,933.88
	Total B……	**58,868.88**

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	TOTAL CARRIED TO COMBINE SUMMARY A + B……...				**81,645.90**
A-SUB STRUCTURE					
No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount (ETB)**
	1. EXCAVATION & EARTH WORK				
1.01	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	9.00	100.51	904.33
1.02	Load & cart away all excavated material to an appropriate tip.	m^3	4.50	73.91	332.50
1.03	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	7.20	587.91	4,231.73
1.04	100mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	5.50	142.07	781.39
1.05	150mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	3.38	142.07	480.20
	Total Carried to summary……...				**5,825.81**
	2. CONCRETE WORK				
2.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:				
	fencing post	m^2	8.88	223.64	1,985.92
2.02	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	post & column -footing	m^3	1.96	4,388.14	8,618.31
	Total Carried to summary……...……				**10,604.23**
	3. FORM WORK				

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3.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	7.92	272.54	2,158.19
	4. STEEL REINFORCEMENT				
4.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 6 mm deformed bar	kg	28.08	82.98	2,330.33
	b) Dia. 8 mm deformed bar	kg	22.40	82.98	1,858.46
	Total Carried to summary……..…….				**4,188.79**
B-SUPER STRUCTURE					
No.	**Description**	**Unit**	**Qty**	**Rate (ETB)**	**Amount (ETB)**
	1. CONCRETE WORK				
1.01	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)	m^3	2.00	4,388.14	**8,780.54**
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	46.57	272.54	**12,692.73**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 6 mm deformed bar	kg	62.64	82.98	5,197.64
	b) Dia. 8 mm deformed bar	kg	156.10	82.98	12,953.44
	c) Dia. 12 mm deformed bar	kg	51.95	82.98	4,310.65
	Total Carried to summary……...				**22,461.73**
	4. METAL WORK				
4.01	Metal Doors in 60 X 60 X3 mm thick LTZ Steel Profile Covered with 1.0mm Galvanized Ribbed Steel Sheet and mesh wire Where Shown On Drawings including				

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	hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 3.2x2.8m	pcs	1.00	8,828.28	8,828.28
4.02	Supply, fabricate and mount 1.5mmthick barbed wire according to the structural drawing .Price shall include, all other necessary accessories to complete the work.	ml	480.00	12.72	6,105.60
	Total Carried to summary……...				**14,933.88**

7.14 FENCING FOR PUPLIC WATER POINT

Summary Of Bill Of Quantities

No.	Description	Amount (ETB)
A-SUB STRUCTURE		
1	Excavation and earth work……..	2,843.47
2	Concrete works……	5,231.02
3	Form work……..	2,174.87
4	Steel reinforcement…….	2,712.57
	Total A…….	**10,249.36**
B. SUPER STRUCTURE		
1	Concrete works……..	6,471.96
2	Form works…….	9,631.56
3	Steel reinforcement…….	14,889.05
4	Metal works…….	12,099.48
	Total B……	**43,092.05**
	TOTAL CARRIED TO COMBINE SUMMARY A + B……	**53,341.41**

A-SUB STRUCTURE

No.	Description	Unit	Qty	Rate	Amount (ETB)
	1. EXCAVATION & EARTH WORK				

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1.01	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	4.28	100.51	429.68
1.02	Load & cart away all excavated material to an appropriate tip.	m^3	2.14	73.91	157.98
1.03	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	3.42	587.91	2,010.65
1.04	100mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	4.75	142.07	674.83
	Total Carried to summary……..……				**2,843.47**
	2. CONCRETE WORK				
2.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:				
	fencing post	m^2	4.75	223.64	1,062.29
2.02	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	post & column -footing	m^3	0.95	4,388.14	4,168.73
	Total Carried to summary……..				**5,231.02**
	3. FORM WORK				
3.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	7.98	272.54	**2,174.87**
	4. STEEL REINFORCEMENT				
4.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				

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	a) Dia. 6 mm deformed bar	kg	32.69	82.98	2,712.57
	Total Carried to summary…….……				**2,712.57**
B-SUPER STRUCTURE					
No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount (ETB)**
	1. CONCRETE WORK				
1.01	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)	m^3	1.47	4,388.14	**6,471.96**
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	35.34	272.54	**9,631.56**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) Dia. 6 mm deformed bar	kg	54.10	82.98	4,488.87
	b) Dia. 8 mm deformed bar	kg	125.33	82.98	10,400.17
	Total Carried to summary…….……				**14,889.05**
	4. METAL WORK				
4.01	Metal Doors in 60 X 60 X3 mm thick LTZ Steel Profile Covered with 1.0mm Galvanized Ribbed Steel Sheet and mesh wire Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	MD= size: 1.35x2.8m	pcs	1.00	7,520.28	7,520.28

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4.02	Supply, fabricate and mount 1.5mmthick barbed wire according to the structural drawing .Price shall include, all other necessary accessories to complete the work.	ml	360.00	12.72	4,579.20
	Total Carried to summary……...				**12,099.48**

7.15 FENCING FOR SCHOOL WATER POINT/ SPRING CAPPING

Summary Of Bill Of Quantities

No.	Description	Unit	Qty	Rate	Amount (ETB)
	A-SUB STRUCTURE				
1	**Excavation and earth work.....**				2,244.84
2	**Concrete works.....**				4,129.76
3	**Form work……**				1,717.00
4	**Steel reinforcement……**				2,141.51
	Total A				**8,091.60**
	B. SUPER STRUCTURE				
1	**Concrete works.....**				5,109.44
2	**Form works.....**				7,603.87
3	**Steel reinforcement……**				11,754.5
4	**Metal works……**				11,081.88
	Total B ……..				35,549.70
	TOTAL CARRIED TO COMBINE SUMMARY A + B				**43,641.30**

A-SUB STRUCTURE

No.	Description	Unit	Qty	Rate	Amount (ETB)
	1. EXCAVATION & EARTH WORK				

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1.01	Bulk excavation in ordinary soil to a depth not exceeding 1500mm to remove expansive soil material.	m^3	3.38	100.51	339.22
1.02	Load & cart away all excavated material to an appropriate tip.	m^3	1.69	73.91	124.72
1.03	Back fill with selected material (300mm impervious clay layer well consolidated) from quarry waste & compact in layers.	m^3	2.70	587.91	1,587.36
1.04	100mm thick basaltic stone hardcore well rolled, consolidated and blinded with crushed stone.	m^2	3.75	142.07	532.76
	Total Carried to summary……..				**2,244.84**
	2. CONCRETE WORK				
2.01	80 mm lean concrete quality C-5, with minimum cement content of 150 kg /m3, of concrete:				
	fencing post	m^2	3.75	223.64	838.65
2.02	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)				
	post & column -footing	m^3	0.75	4,388.14	3,291.11
	Total Carried to summary……..				**4,129.76**
	3. FORM WORK				
3.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	6.30	272.54	**1,717.00**

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	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) 6 mm deformed bar	kg	25.81	82.98	2,141.51
	Total Carried to summary……				**2,141.51**
B-SUPER STRUCTURE					
	1. CONCRETE WORK				
1.01	Reinforced concrete quality C-20, 360 kg of cement/m3 filled in to form work & vibrated around rod reinforcement (Formwork and reinforcement measured separately)	m^3	1.16	4,388.14	**5,109.44**
	2. FORM WORK				
2.01	Provide, cut and fix in position sawn structural wood or steel formwork whichever is appropriate for post and column	m^2	27.90	272.54	**7,603.87**
	3. STEEL REINFORCEMENT				
3.01	Mild steel reinforcement according to structural drawings. Price includes cutting, bending, placing in position and tying wire.				
	a) 6 mm deformed bar	kg	42.71	82.98	3,543.85
	b) 8 mm deformed bar	kg	98.95	82.98	8,210.66
	Total Carried to summary……				**11,754.5**
	4. METAL WORK				

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4.01	Metal Doors in 60 X 60 X3 mm thick LTZ Steel Profile Covered with 1.0mm Galvanized Ribbed Steel Sheet and mesh wire Where Shown On Drawings including hardware, approved cylinder lock set , one coat of anti rust Paint and two coat of metal paint.				
	METAL DOORS				
	MD= size: 1.35x2.8m	pcs	1.00	7,520.28	7,520.28
4.02	Supply, fabricate and mount 1.5mmthick barbed wire according to the structural drawing .Price shall include, all other necessary accessories to complete the work.	ml	280.0	12.72	3,561.60
	Total Carried to summary……				**11,081.8**

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CHAPTER 8

CONSTRUCTION DRAWINGS

Item Number	Drawing Number	Drawing Title
8.1	HY-DWG-001	PIPE LINE DISTRIBUTION NETWORK
8.2	HY-DWG-002	STATION SITE PLAN
8.3	HY-DWG-003	FENCING FOR STATION
8.4	HY-DWG-004	BREAK PRESSURE TANK
8.5	HY-DWG-005	MANHOLE AND ANCHOR BLOCK
8.6	HY-DWG-006	SPRING CAPPING
8.7	HY-DWG-007	WATER POINTS
8.8	HY-DWG-008	$50M^3$ WET-WELL
8.9	HY-DWG-009	$100M^3$ RESERVOIR
8.10	HY-DWG-010	VALVE CHAMBER $50M^3$ WET-WELL
8.11	HY-DWG-011	VALVE CHAMBER $100M^3$ RESERVOIR
8.12	HY-DWG-011	FENCING FOR WATER POINTS& SPRING CAPPINGS

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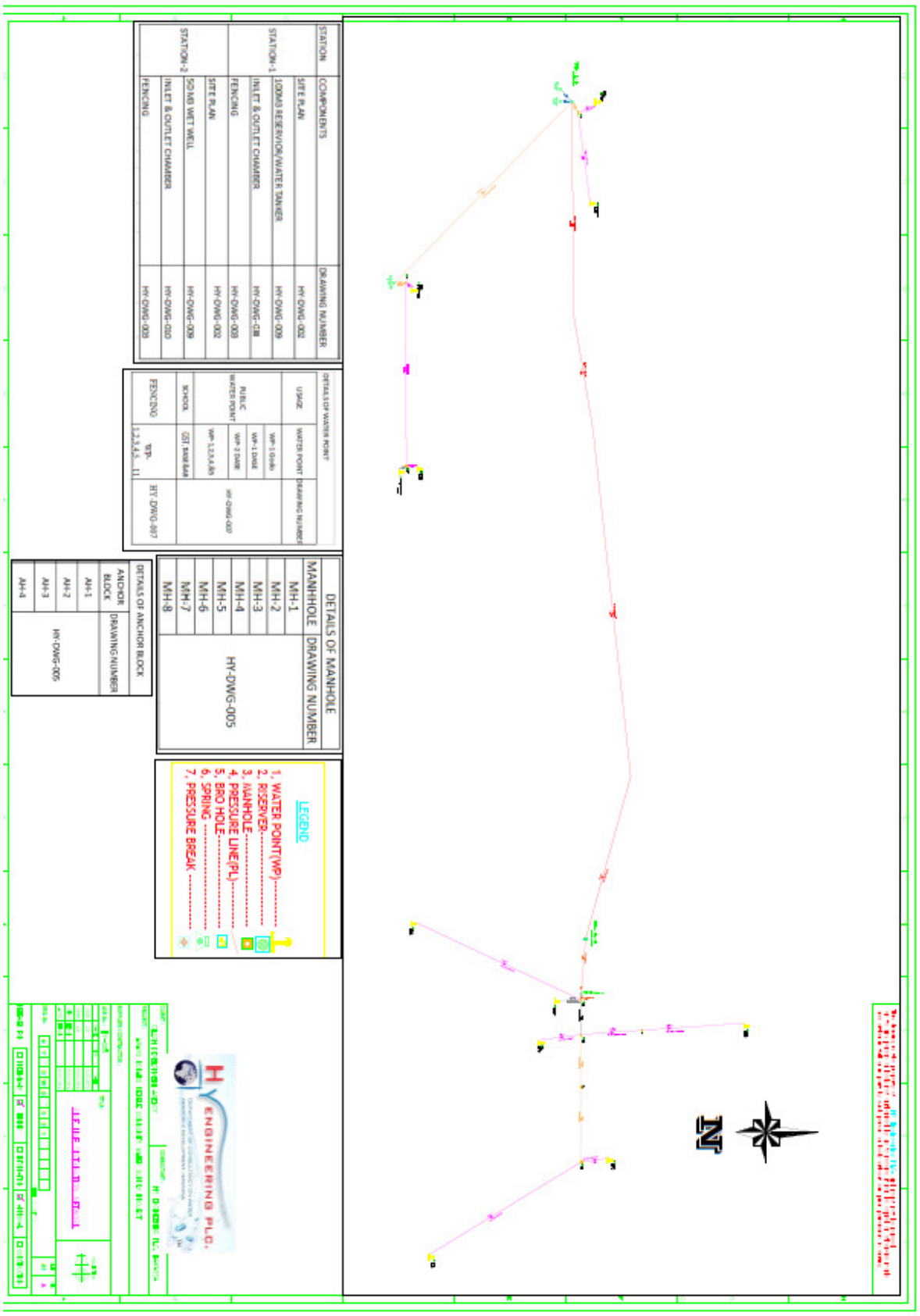
8.1 HY-DWG-001 PIPE LINE DISTRIBUTION NETWORK



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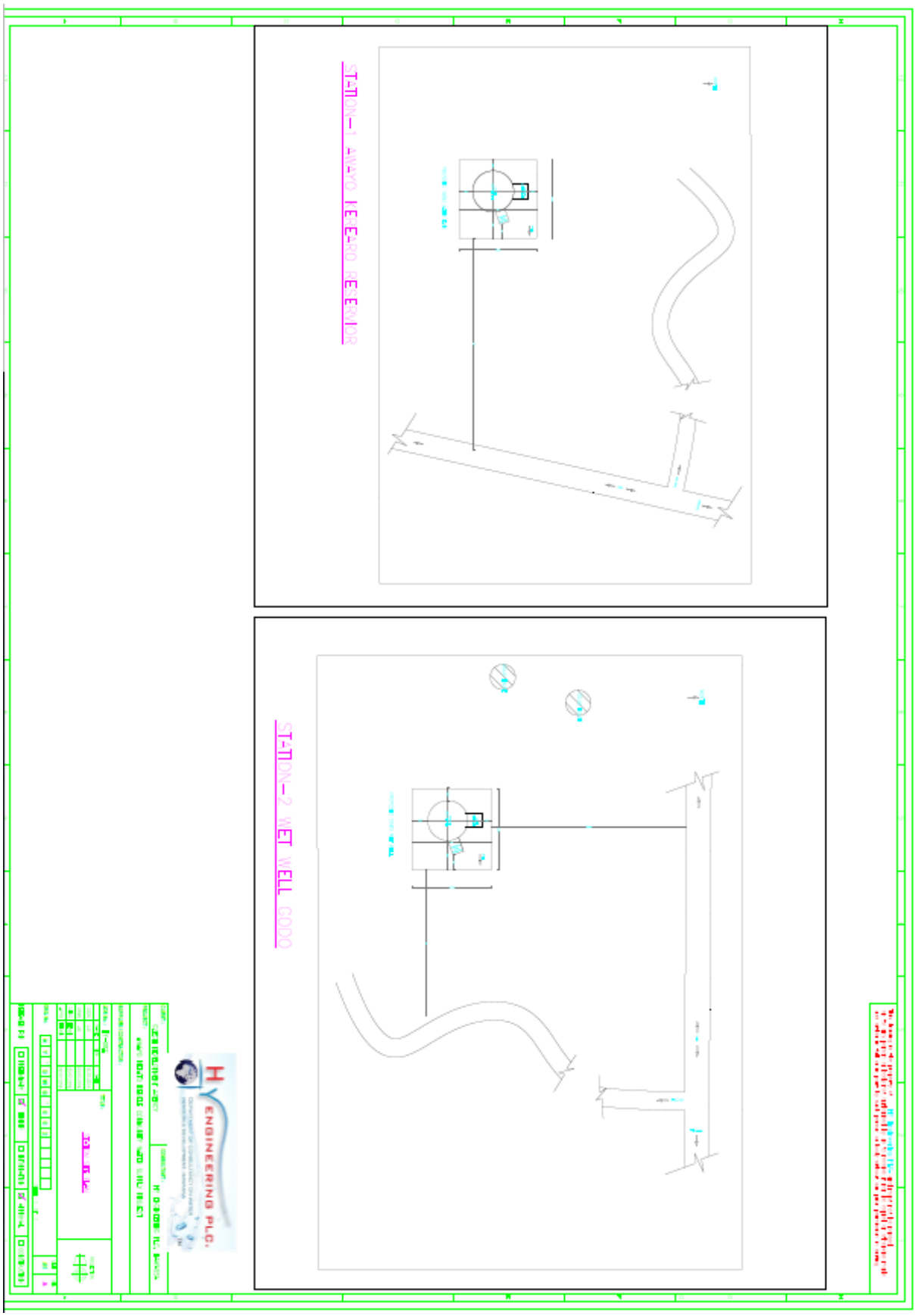
8.2 HY-DWG-002 STATION SITE PLAN



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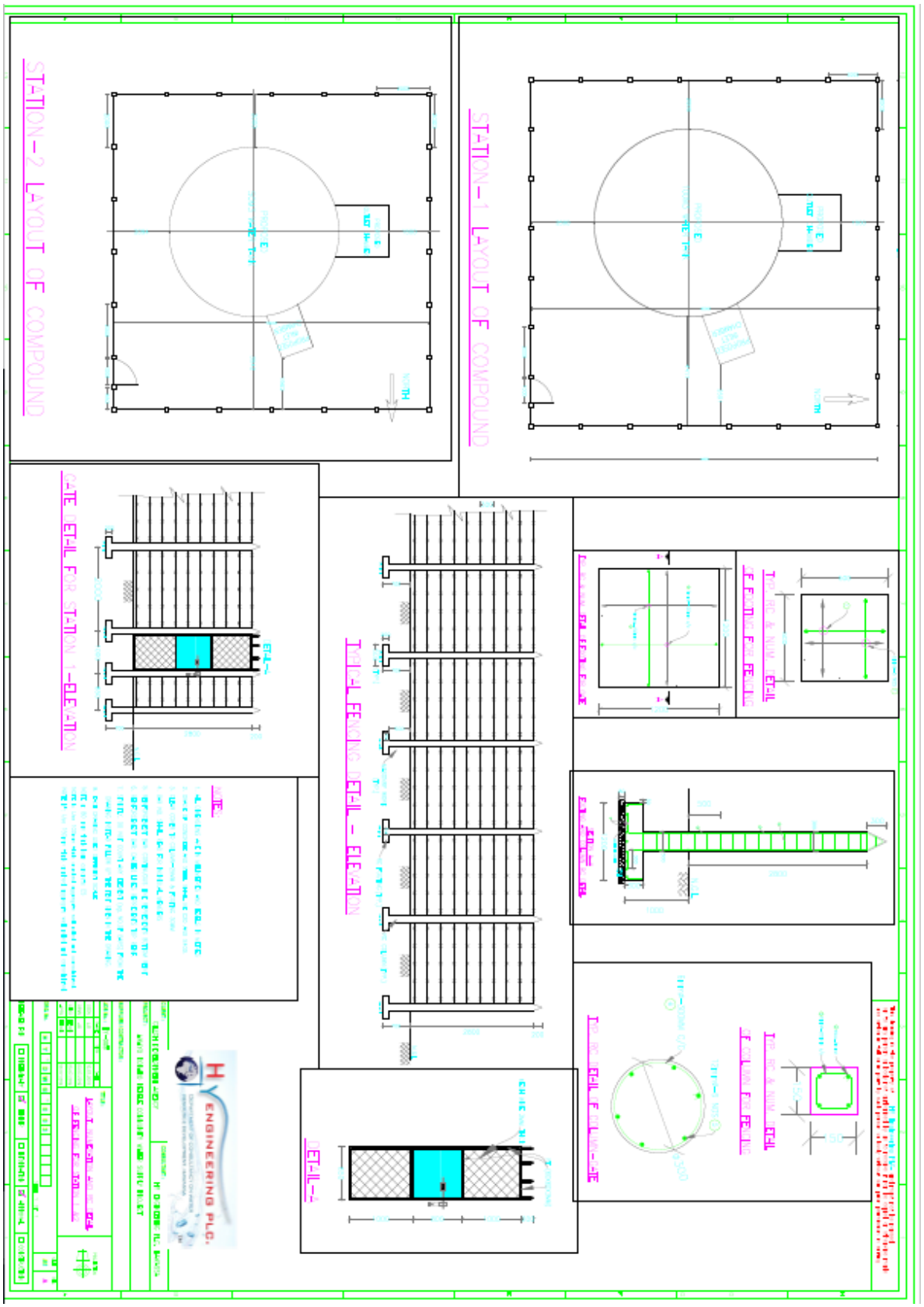
8.3 HY-DWG-003 FENCING FOR STATION



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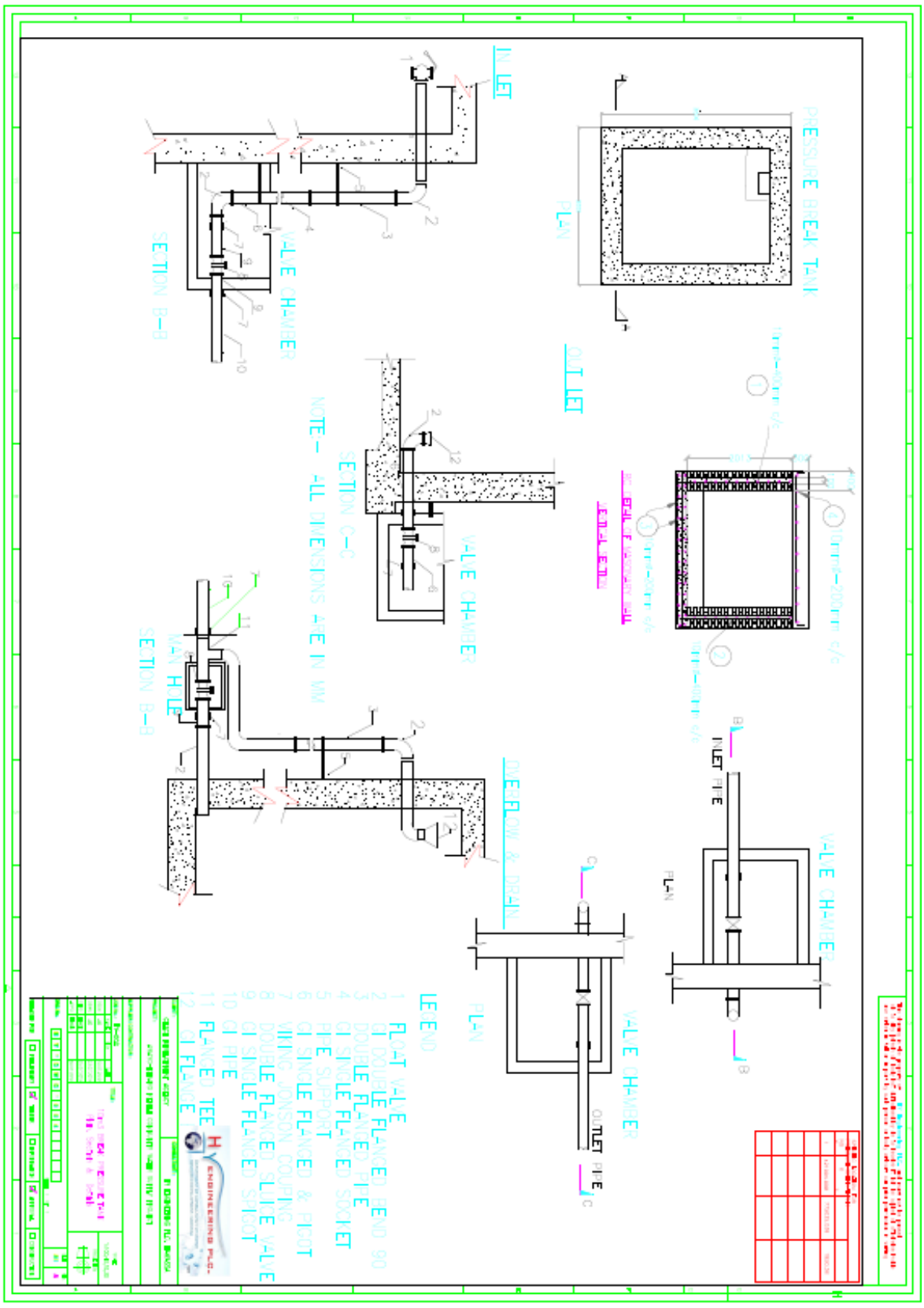
8.4 HY-DWG-004 BREAK PRESSURE TANK



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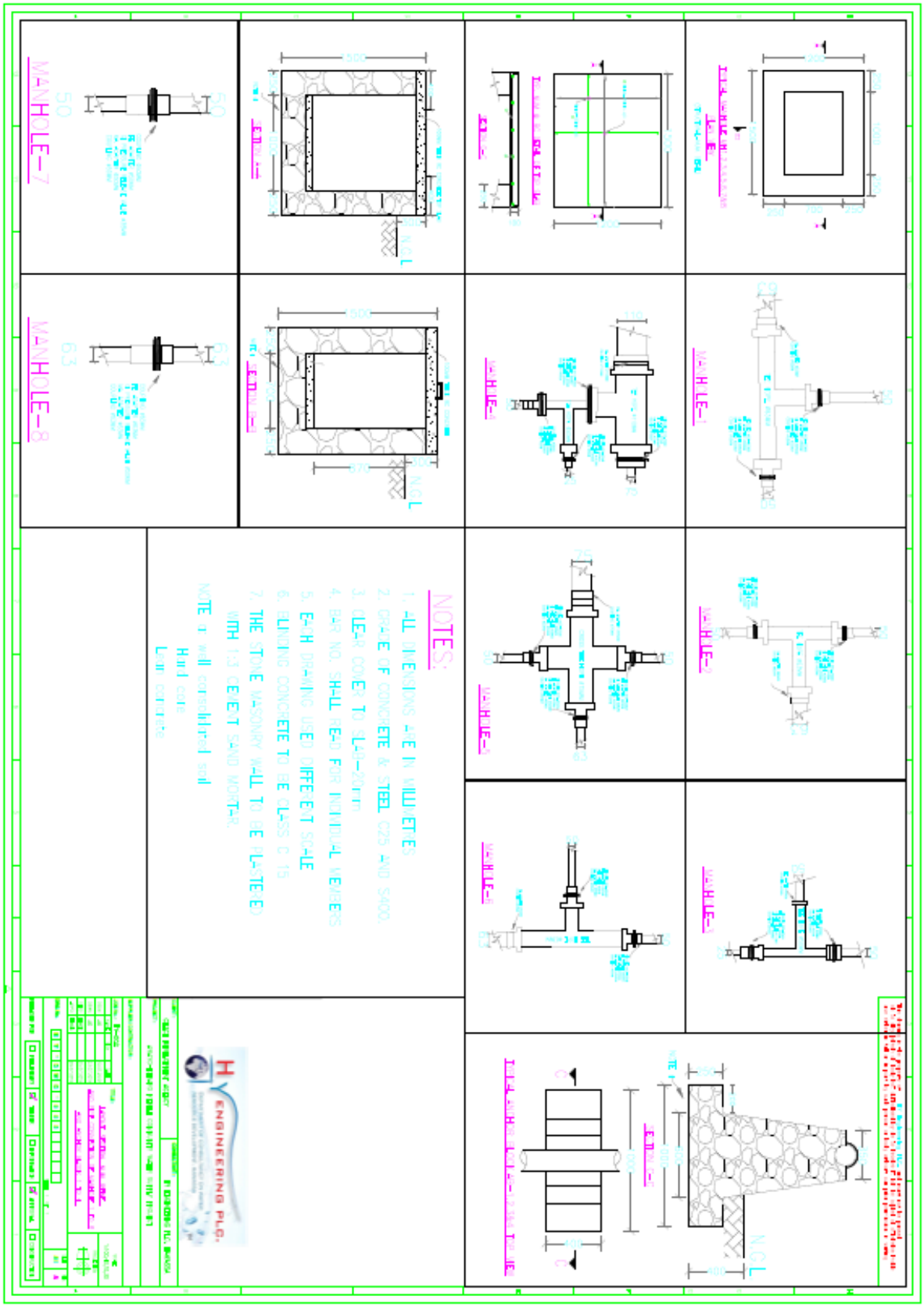
8.5 HY-DWG-005 MANHOLE AND ANCHOR BLOCK



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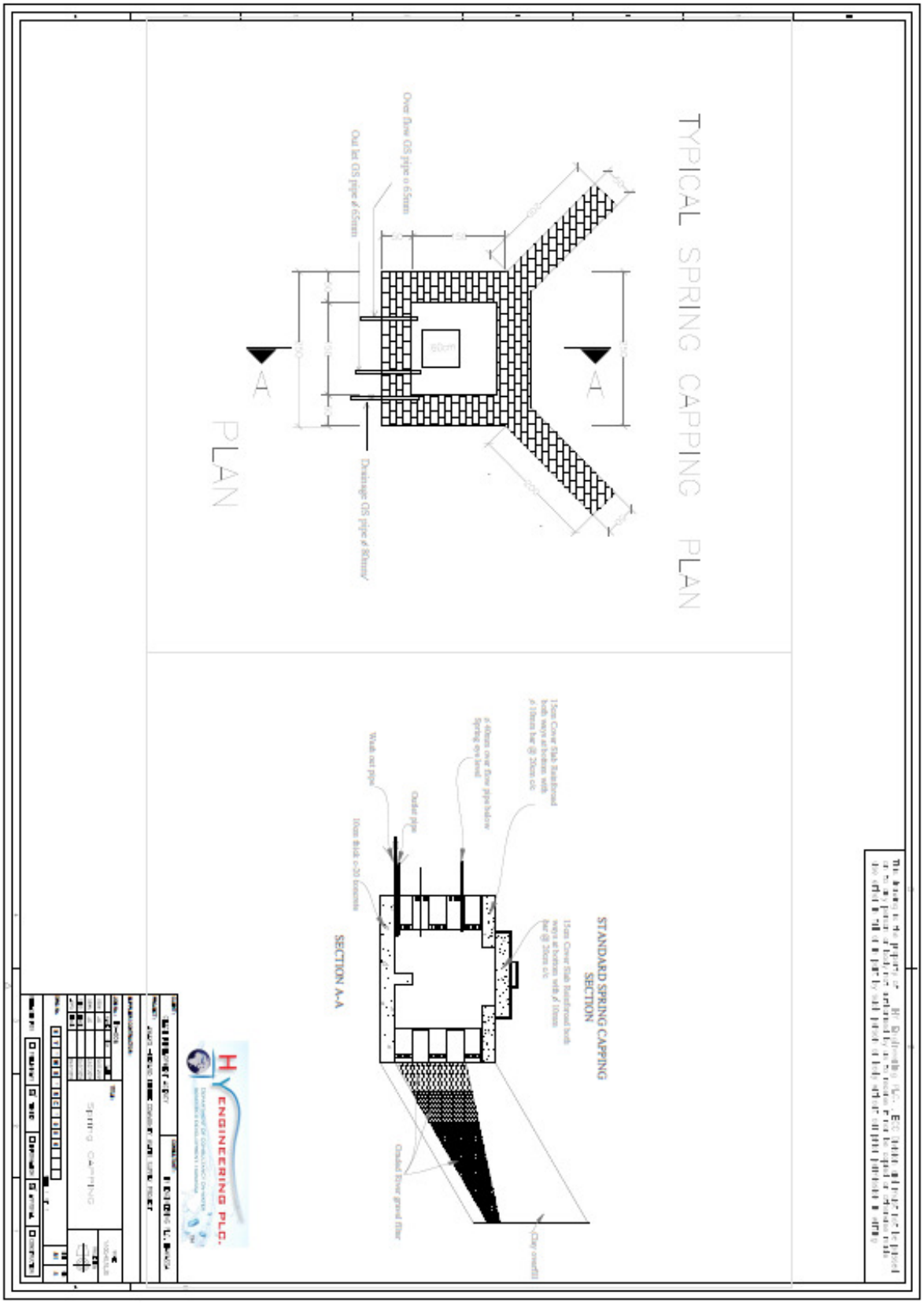
8.6 HY-DWG-006 SPRING CAPPING



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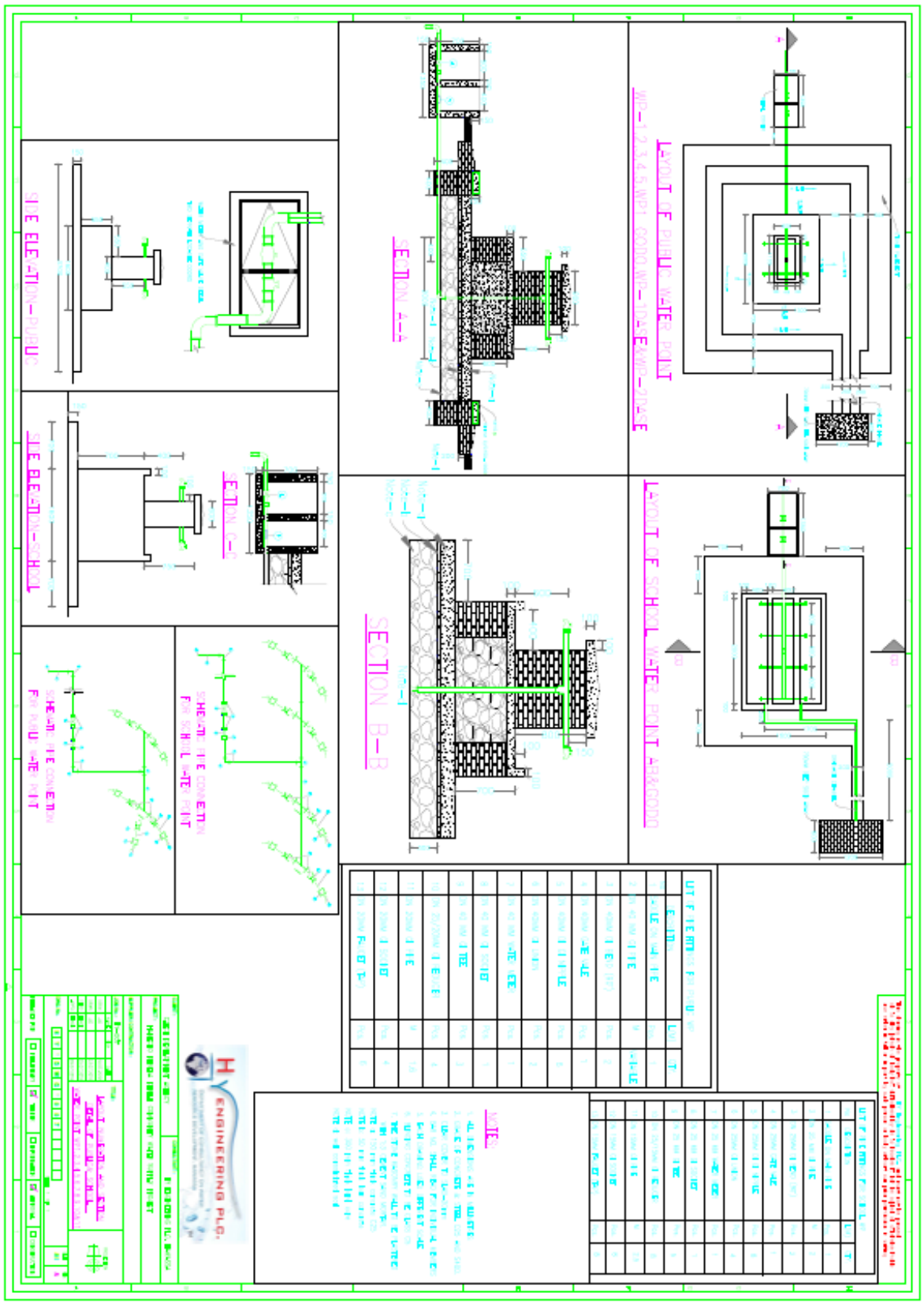
8.7 HY-DWG-007 WATER POINTS



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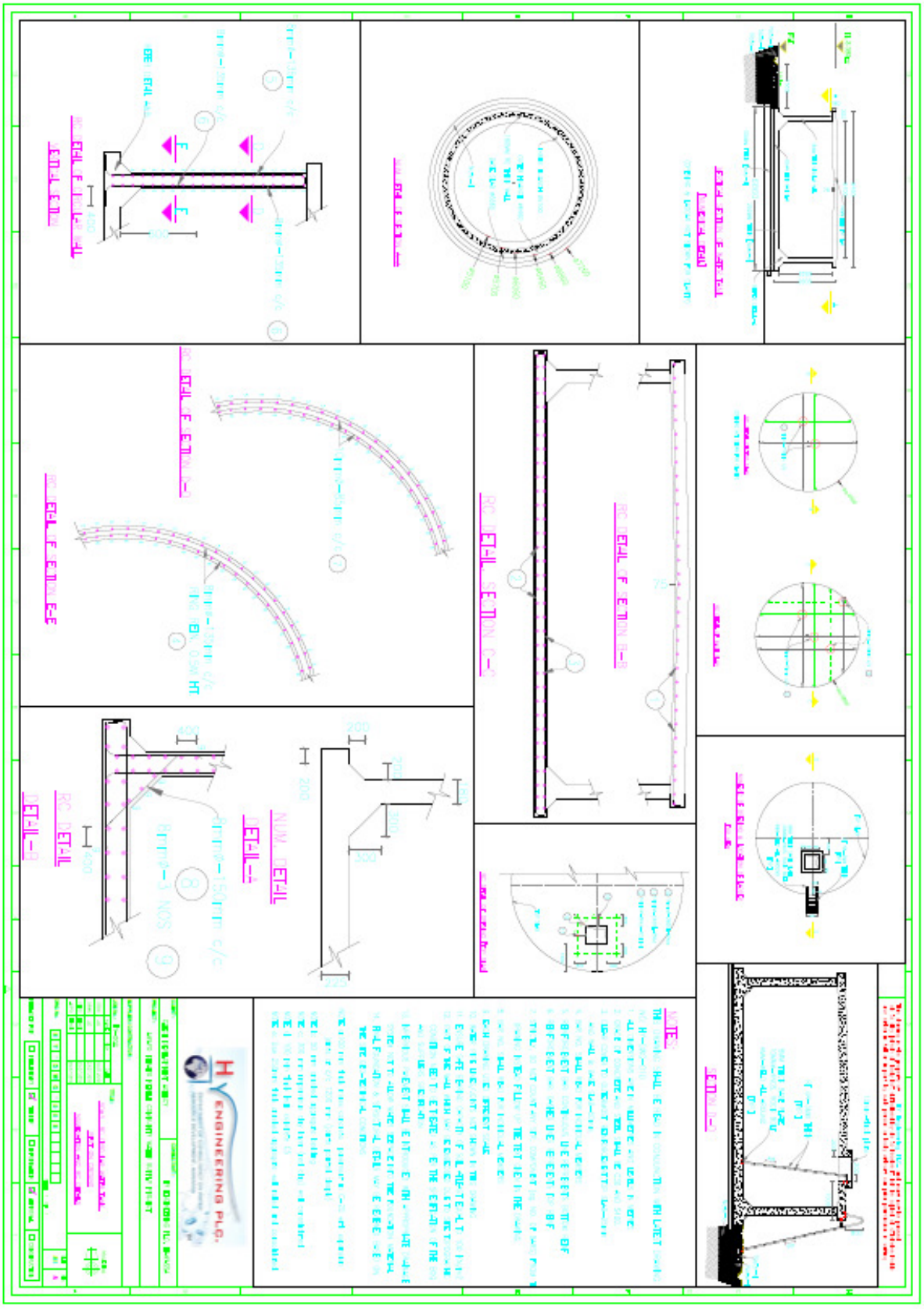
8.8 HY-DWG-008 50M3 WET-WELL



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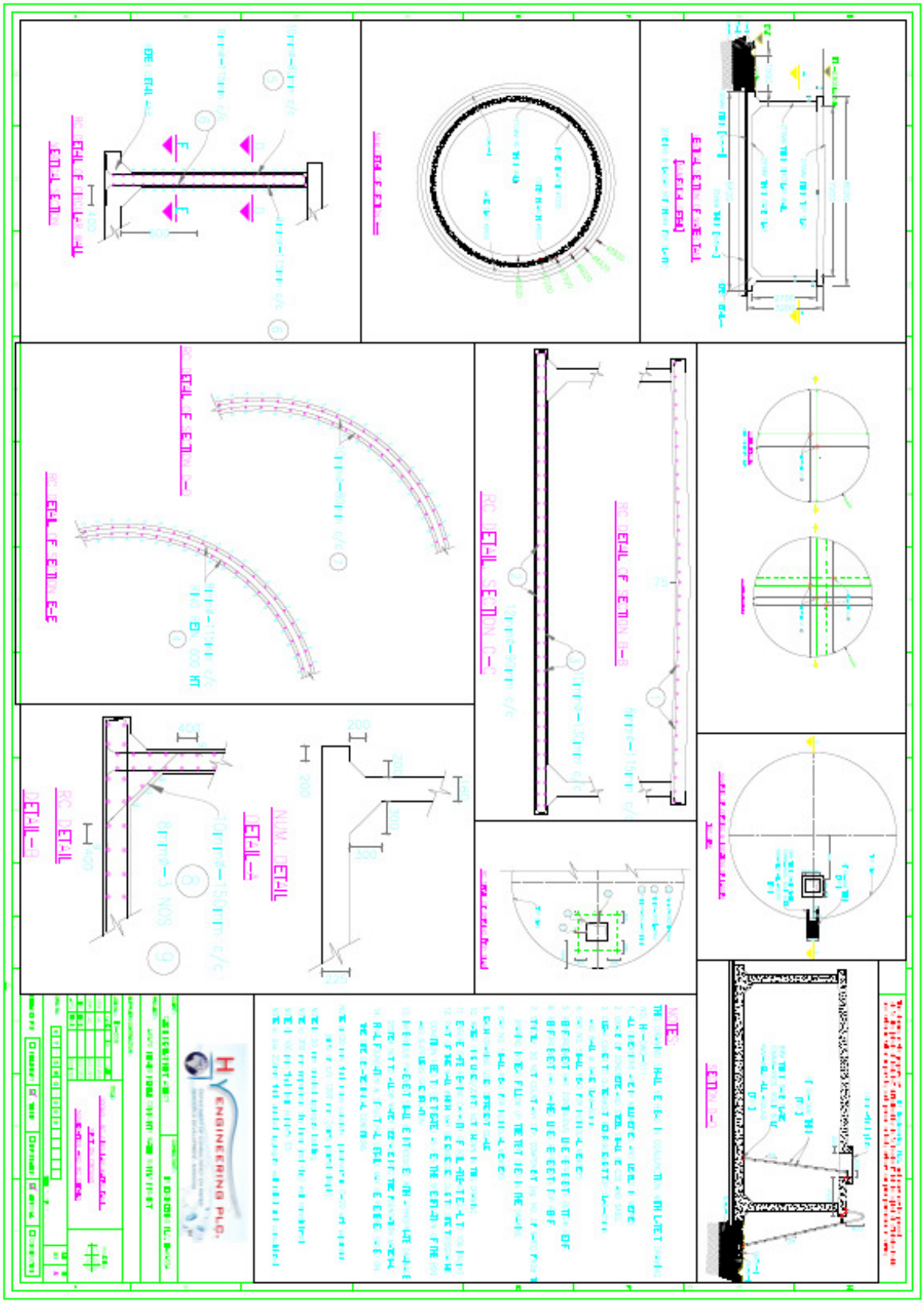
8.9 HY-DWG-009 100M^3 RESERVOIR



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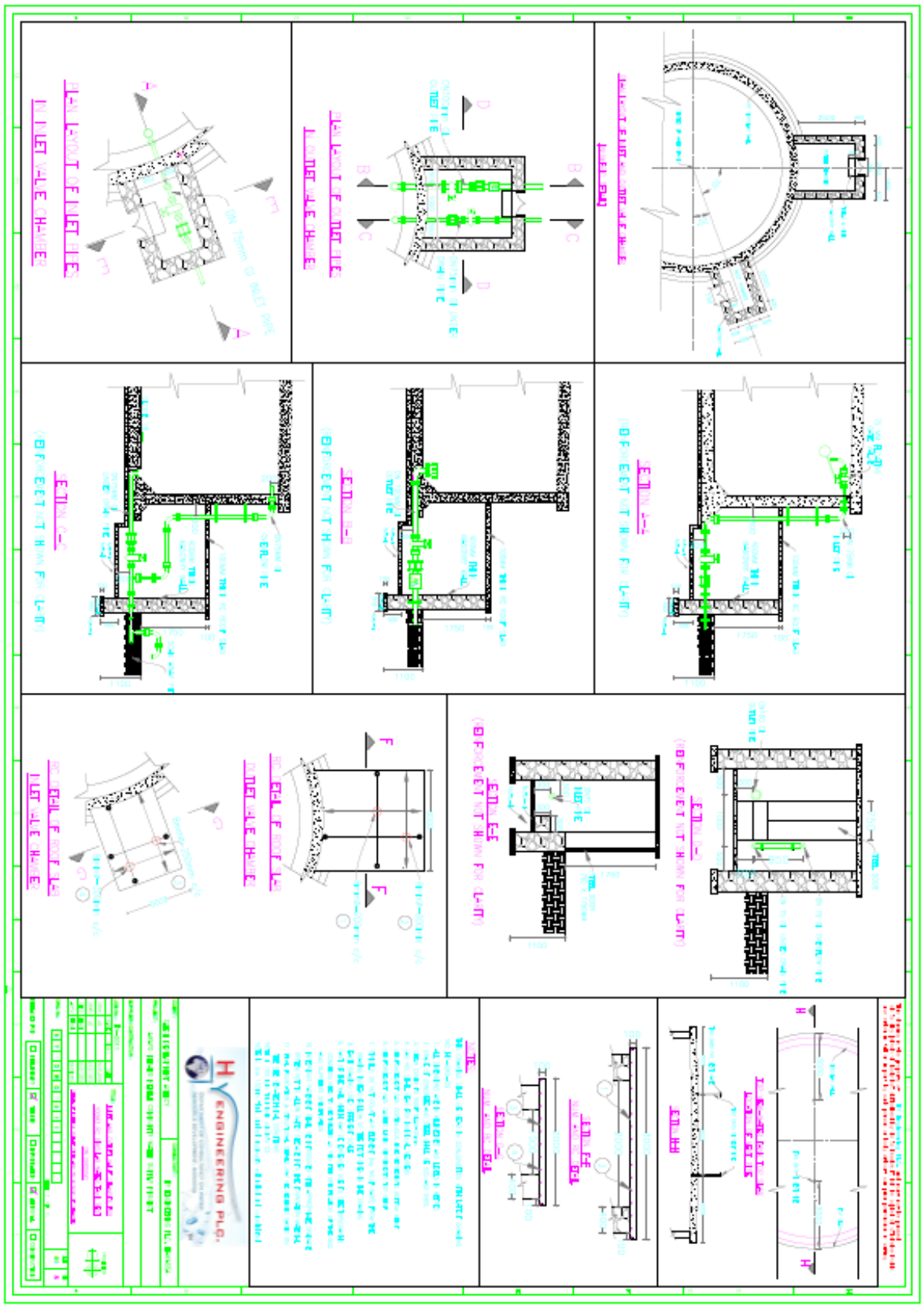
8.10 HY-DWG-011 VALVE CHAMBER 100M^3 RESERVOIR



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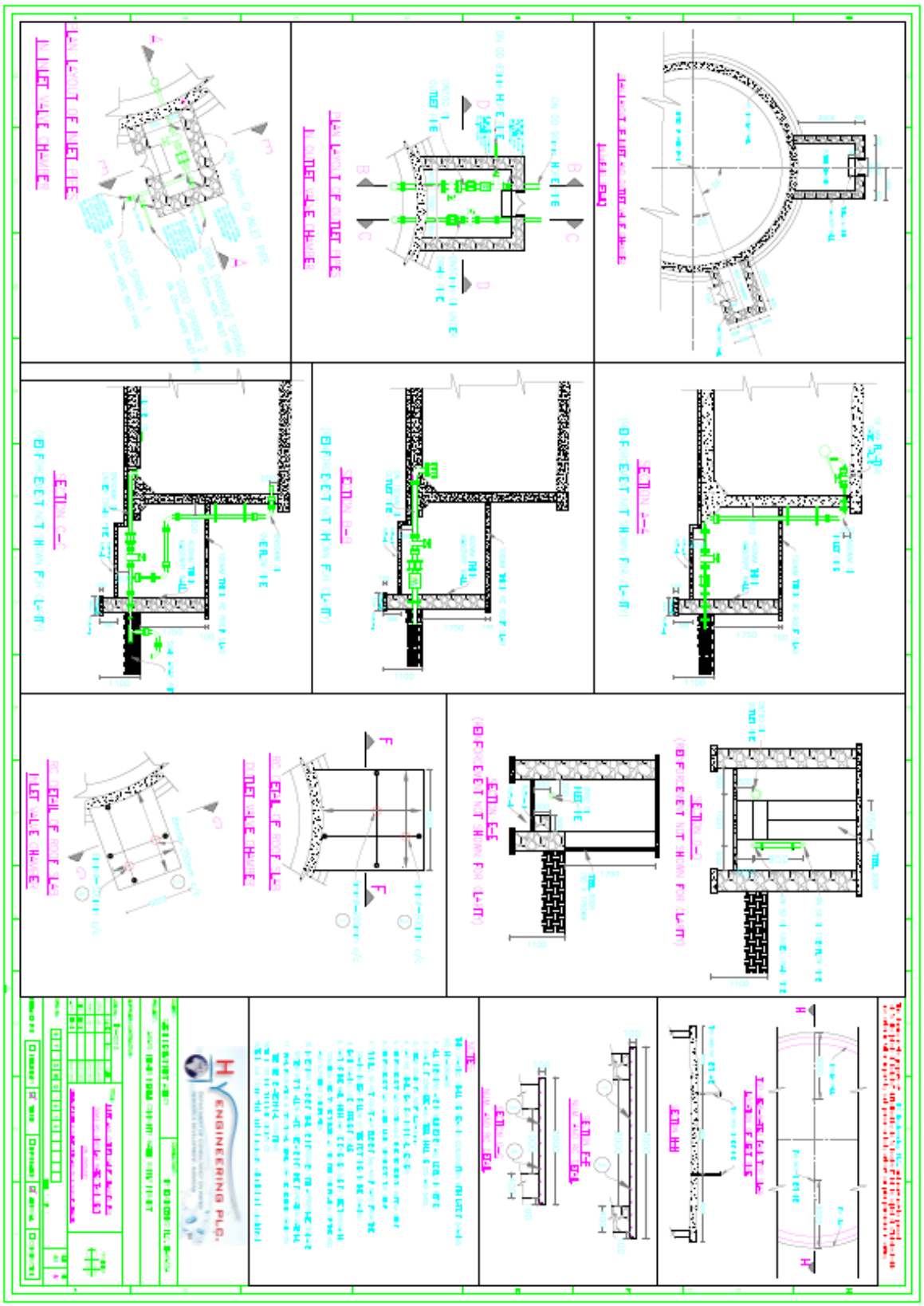
8.11 HY-DWG-010 VALVE CHAMBER 50M3 WET-WELL



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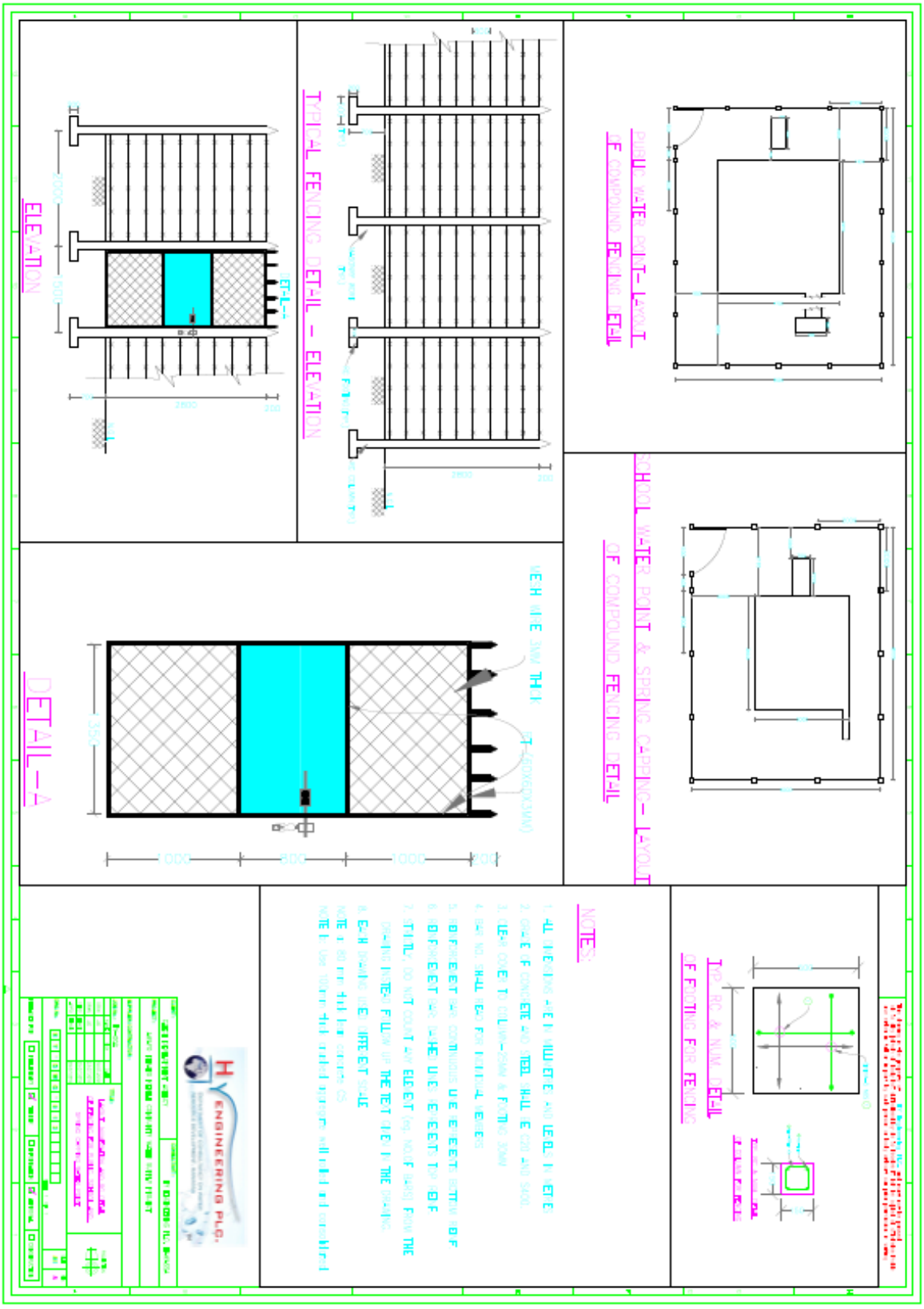
8.12 HY-DWG-012 FENCING FOR WATER POINTS & SPRING CAPPINGS



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CHAPTER 9

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

9.1 General

Environmental impact assessment is a process to improve decision making and to ensure that the project option under consideration are environmentally sound and sustainable.EIA as a system consists the hydrological, biologically, atmospherically, cultural and social conditions. The environmental impact assessment is concerned with identifying, predicting and evaluating the foreseeable environmental effects, alternative and mitigation measures, aiming at eliminating or minimizing the adverse effects and optimizing and maximizing the benefits that is obtained as the results of the project.

There is no as such considerable environmental and social negative impact in this rural water supply and sanitation project. Even the expected impacts are reversible. The project is classified under environmental and social category C (as shown in Annexure VII: Environmental and social screening).

Generally, the major positive impacts of the project are save time and energy in fetching of drinking water and reduces the burden of women and child in fetching of water from remote rivers and unprotected water sources, improve the water supply and sanitation coverage in the project area, improve health, living standard and productivity of the community, Provide better quality and sustainable water supply to the area, and create job opportunities.

9.2 Negative impact and its mitigation measures

- ✓ Due to excavation of the trenches for the pipe laying, reservoir, spring capping for which the natural ground is disturbed, damaged and loss of the original strength of the ground. Themitigation measure could be covering the trench back with soil and compact properly up to the required level of the ground.
- ✓ During the time of construction components of planted trees and vegetables, may get deforested along the pipe line and excavation on stations. The mitigation measure could be to pay compensation and plantation of seedling
- ✓ The springs are used by the people for drinking and irrigation purpose, currently. The construction of this project will affect these people negatively. Providing water

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points near the springs and provide over flow at the spring capping will mitigate these impacts exposed on these people.

9.3 Positive impacts of the projects

This project is expected to generally improve the lifestyle and social status of the beneficiaries. Potential positive impacts of the project can be classified under two categories.

A. Socio-economic impacts

The socio-economic impacts of this project include:

- ✓ Improving environmental quality in the rural community and downstream areas.
- ✓ Developing institutional capacity and creating new employment opportunities.

B. Health related impacts

The health related impacts of this project are:

- ✓ Raising living standards and safeguarding public health.
- ✓ Supplying the population with safe and adequate drinking water will reduce water related diseases.
- ✓ Improve standards of living of rural community.
- ✓ Increased public satisfaction with the rural environment.
- ✓ Improved sanitation and hygiene for residents near river watercourses

Generally, this water supply system provides great advantages to 'Awayo Keraro Kebele' Community for the reasons of adequate supply of clean water that is suitable to healthy and improves standards of living of the community.

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Annexure

Annexure I: Cost Breakdown

Annexure II: Structural design document

Annexure III: Hydraulic analysis/ Water CAD report

Annexure IV: Baseline survey questionnaire

Annexure V: Summary of water Demand

Annexure VI: Environmental and social screening

Annexure VII: Specific Location of System Components

ANNEXURE-I

COST BREAKDOWN

ITEM NO.	CONTENT
1	MATERIAL PRICE
2	BENEFIT FACTOR
3	MAN POWER COST
4	EQUIPMENT RENTAL COST
5	OVERHEAD & PROFIT
6	UNIT COST BREAKDOWN
	➢ GI- PIPES & FITTINGS
	➢ HDPE- PIPES & FITTINGS
	➢ CIVIL STRUCTURE

i. MATERIAL PRICE

Item No	Type of material	Unit	Selling price (ETB)	Selling price with 15% VAT (ETB)	Source
CONCRETE MAKING RAW MATERIALS					
1	Cement	Quintal	495.00	569.25	Building material shop
2	Sand	m^3	530.00	609.50	'Hantate' area sand quarry site
3	Aggregate	m^3	800.00	920.00	'Bensa' area quarry site
4	Stone	m^3	170.00	195.50	' Bensa' area quarry site
5	Crushed stone	m^3	285.00	327.75	"
6	Selected material	m^3	300.00	345.00	"
7	Aggregate 01	m^3	800.00	920.00	'Bensa' area quarry site
8	Aggregate 02	m^3	900.00	1035.00	'Bensa' area quarry site
9	Water	m^3	20.00	23.00	'Bensa' Town
10	Red ash	m3	35.00	40.25	'Bensa' area quarry site
11	Pre-cast concrete pipe dia. 400mm	ml	91.84	105.62	
REINFORCEMENT BAR					
1	Dai 6	kg	60.00	69.00	Building material suppliers (@Bensa Town)
2	Dai 8	kg	60.00	69.00	"
3	Dai 10	kg	60.00	69.00	"
4	Dai 12	kg	60.00	69.00	"
5	Dai 14	kg	60.00	69.00	"
6	Dai 16	kg	60.00	69.00	"
7	Dai 18	kg	60.00	69.00	"
8	Dai 20	kg	60.00	69.00	"

9	Dai 22	kg	60.00	69.00	"
10	Dai 24	kg	60.00	69.00	"
11	Dai 30	kg	60.00	69.00	"
12	Dai 32	kg	60.00	69.00	"
13	Tie wire 1.5mm	kg	80.00	92.00	"
METAL WORK					
1	RHS, SHS & CHS Steel				Metal work shop (@Bensa Town)
	a) 3mm thick	m	600.00	690.00	"
	b) 1.5mm thick	m	350.00	402.50	"
2	Door				"
	size 2.1x0.9 m	LS	2,500.00	2875.00	"
	size 2.1x2 m	LS	4,500.00	5175.00	"
3	Window				"
	size 1.2x1.2 m	LS	1,200.00	1380.00	"
	size 1.2x0.9 m	LS	1,000.00	1150.00	"
4	LP Type Window				"
	size 1.2x1.2 m	LS	700.00	805.00	"
	size 0.4x0.8 m	LS	400.00	460.00	"
5	3m high ladder (RT 64-3mm thick)	LS	1,500.00	1725.00	"
6	Steel plate				"
	a) 3mm thick	m^2	2,300.00	2645.00	"
	b) 1.5mm thick	m^2	1,550.00	1782.50	"
7	Nails				Material Supplier (@Bensa Town)
	a) 3cm & 4cm.	Kg	90.00	103.50	"
	b) 5cm up to 15cm.	Kg	100.00	115.00	"
	c) Doomed nail	Kg	100.00	115.00	"
8	cylinder lock set	PCS	450.00	517.50	"

9	Barbed Wire (80kg or 50m.).	Roll	1,500.00	1725.00	"
10	15cm. Thick H.C.B. wall	PCS	15	17.25	Precast work shop (@BensaTown)
11	20cm. Thick H.C.B. wall	PCS	20.00	23.00	"
12	G-28galvanized iron sheet	m^2	80.00	92.00	Material Supplier (@Bensa Town)
13	Ridge	m	50.00	57.50	"
14	ϕ10mm thick bolt & nut	PCS	35.00	40.25	"
WOOD WORK					
1	Timber for form work	m^2	60.00	69.00	Wood work shop (@Bensa Town
	Dia.=10mm	m	20.00	23.00	"
	Dia.=8mm	m	12.50	14.38	"
2	Eucalyptus Truss wood				"
	Dia. 10 -12 cm	m	25.00	28.75	"
	Dia. 6 -8 cm	m	15.00	17.25	"
3	5cm*7cm Purling	m	50.00	57.50	"
4	Iron Band	Kg	60.00	69.00	"
PAINTING					
1	Anti rust	gal	600	690.00	Building material suppliers (@Bensa Town)
2	Metal paint	gal	800	920.00	"
PIPES(GI)					
1	Galvanized pipe 6"	m	2500.00	2875.00	Building material

					suppliers (@Bensa Town)
2	Galvanized pipe 4"	m	900.00	1035.00	"
3	Galvanized pipe 3"	m	663.33	762.83	"
4	Galvanized pipe 2.5"	m	550.00	632.50	"
5	Galvanized pipe 2"	m	466.67	536.67	"
6	Galvanized pipe 1.5"	m	396.67	456.17	"
7	Galvanized pipe 1"	m	263.33	302.83	"
8	Galvanized pipe 3/4"	m	155.00	178.25	"
GI-FITTINGS					
	Union				"
1	ϕ=6"	pcs	2,100.00	2415.00	"
2	ϕ=4"	pcs	650.00	747.50	"
3	ϕ=3"	pcs	390.00	448.50	"
4	ϕ=2 1/2"	pcs	280.00	322.00	"
5	ϕ=2"	pcs	160.00	184.00	"
6	ϕ=1 1/2"	pcs	110.00	126.50	"
7	ϕ=1"	pcs	60.00	69.00	"
8	ϕ=3/4"	pcs	35.00	40.25	"
9	ϕ=1/2"	pcs	25.00	28.75	"
	Nipples				"
1	ϕ=6"	pcs	1,700.00	1955.00	
2	ϕ=4"	pcs	480.00	552.00	"
3	ϕ=3"	pcs	280.00	322.00	"
4	ϕ=2 1/2"	pcs	190.00	218.50	"
5	ϕ=2"	pcs	95.00	109.25	"
6	ϕ=1 1/2"	pcs	70.00	80.50	"
7	ϕ=1"	pcs	35.00	40.25	"
8	ϕ=3/4"	pcs	25.00	28.75	"
9	ϕ=1/2"	pcs	20.00	23.00	"

	Elbow				
1	ϕ=6"	pcs	1,800.00	2,070.00	"
2	ϕ=4"	pcs	580.00	667.00	"
3	ϕ=3"	pcs	380.00	437.00	"
4	ϕ=2 1/2"	pcs	250.00	287.50	"
5	ϕ=2"	pcs	110.00	126.50	"
6	ϕ=1 1/2"	pcs	90.00	103.50	"
7	ϕ=1"	pcs	35.00	40.25	"
8	ϕ=3/4"	pcs	25.00	28.75	"
9	ϕ=1/2"	pcs	30.00	34.50	"
	Tee				
1	ϕ=6"	pcs	1,980.00	2,277.00	"
2	ϕ=4"	pcs	650.00	747.50	"
3	ϕ=3"	pcs	450.00	517.50	"
4	ϕ=2 1/2"	pcs	380.00	437.00	"
5	ϕ=2 "	pcs	180.00	207.00	"
6	ϕ=2"	pcs	180.00	207.00	"
7	ϕ=1 1/2"	pcs	130.00	149.50	"
8	ϕ=1"	pcs	35.00	40.25	"
9	ϕ=3/4"	pcs	25.00	28.75	"
10	ϕ=1/2"	pcs	25.00	28.75	"
	Cross Tee			0.00	"
1	ϕ=6"	pcs	1,500.00	1,725.00	"
2	ϕ=4"	pcs	1,400.00	1,610.00	"
3	ϕ=3"	pcs	1,200.00	1,380.00	"
4	ϕ=2 1/2"	pcs	800	920.00	"
5	ϕ=2 "	pcs	480.00	552.00	"
6	ϕ=1 1/2"	pcs	250.00	287.50	"
7	ϕ=1"	pcs	180.00	207.00	"
8	ϕ=3/4"	pcs	110.00	126.50	"
9	ϕ=1/2"	pcs	70.00	80.50	"

	Reducer			0.00	
1	ϕ=6"x ϕ=4"	pcs	1,700.00	1,955.00	"
2	ϕ=6"x ϕ=3"	pcs	1,700.00	1,955.00	"
3	ϕ=6"x ϕ=1 1/2"	pcs	1,700.00	1,955.00	"
4	ϕ=4"x ϕ=3"	pcs	480.00	552.00	"
5	ϕ=4"x ϕ=1 1/2"	pcs	480.00	552.00	"
6	ϕ=3"x ϕ=2 1/2"	pcs	380.00	437.00	"
7	ϕ=3"x ϕ= 1 1/2"	pcs	380.00	437.00	"
8	ϕ=21/2"x ϕ=2"	pcs	280.00	322.00	"
9	ϕ=21/2"x ϕ=11/2"	pcs	280.00	322.00	"
10	ϕ=2"x ϕ=11/2"	pcs	95.00	109.25	"
11	ϕ=1"x ϕ=3/4"	pcs	35.00	40.25	"
	Water meter				
1	ϕ=8"(Flanged)	pcs	16,500.00	18,975.00	"
2	ϕ=6"(Flanged)	pcs	16,000.00	18,400.00	"
3	ϕ=4"(Flanged)	pcs	14,000.00	16,100.00	"
4	ϕ=3"(Flanged)	pcs	8,900.00	10,235.00	"
5	ϕ=2 1/2"	pcs	6,000.00	6,900.00	"
6	ϕ=2"	pcs	4,200.00	4,830.00	"
7	ϕ=1 1/2"	pcs	1,950.00	2,242.50	"
8	ϕ=1"	pcs	1,300.00	1,495.00	"
9	ϕ= 3/4"	pcs	980.00	1,127.00	"
	Gate valve				
1	ϕ=8"(Flanged)	pcs	19,000.00	21,850.00	"
2	ϕ=6"(Flanged)	pcs	18,000.00	20,700.00	"
3	ϕ=4"(Flanged)	pcs	9,500.00	10,925.00	"
4	ϕ=3"(Flanged)	pcs	8,800.00	10,120.00	"
5	ϕ=2 1/2"	pcs	1,500.00	1,725.00	"
6	ϕ=2 "	pcs	950.00	1,092.50	"
7	ϕ=1 1/2"	pcs	550.00	632.50	"
8	ϕ=1"	pcs	180.00	207.00	"

9	ϕ= 3/4"	pcs	150.00	172.50	"
10	ϕ= 1/2"	pcs	120.00	138.00	"
	Cheek valve				
1	ϕ=6"	pcs	20,000.00	23,000.00	"
2	ϕ=4"	pcs	15,000.00	17,250.00	"
3	ϕ=3"	pcs	12,000.00	13,800.00	"
4	ϕ=2 1/2"	pcs	3,800.00	4,370.00	"
5	ϕ=2 "	pcs	2,900.00	3,335.00	"
6	ϕ=1 1/2"	pcs	1,880.00	2,162.00	"
7	ϕ=1"	pcs	1,200.00	1,380.00	"
8	ϕ=3/4"	pcs	350.00	402.50	"
9	ϕ=1/2"	pcs	280.00	322.00	"
HDPE- PIPES					
	HDPE PIPES(PN-16)				
1	HDPE pipe 18.5mm	m	25.00	28.75	"
2	HDPE pipe 25mm	m	29.00	33.35	"
3	HDPE pipe 38mm	m	45.00	51.75	"
4	HDPE pipe 50mm	m	53.00	60.95	"
5	HDPE pipe 63mm	m	69.00	79.35	"
6	HDPE pipe 75mm	m	110.00	126.50	"
7	HDPE pipe 100mm	m	220.00	253.00	"
8	HDPE pipe 150mm	m	330.00	379.50	"
9	HDPE pipe 200mm	m	450.00	517.50	"
10	HDPE pipe 250mm	m	650.00	747.50	"
11	HDPE pipe 300MM	m	800.00	920.00	"
	HDPE PIPE (PN-10)				
1	HDPE pipe 18.5mm	m	10.00	11.50	"
2	HDPE pipe 25mm	m	15.00	17.25	"
3	HDPE pipe 38mm	m	35.00	40.25	"

4	HDPE pipe 50mm	m	39.00	44.85	"
5	HDPE pipe 63mm	m	49.00	56.35	"
6	HDPE pipe 75mm	m	69.00	79.35	"
7	HDPE pipe 100mm	m	165.00	189.75	"
8	HDPE pipe 150mm	m	220.00	253.00	"
9	HDPE pipe 200mm	m	360.00	414.00	"
10	HDPE pipe 250mm	m	500.00	575.00	"
11	HDPE pipe 300MM	m	690.00	793.50	"
HDPE FITTINGS					
	COUPLING				
1	ϕ=300MM	pcs	4,000.00	4600.00	"
2	ϕ=250MM	pcs	3,500.00	4025.00	"
3	ϕ=200MM	pcs	3,000.00	3450.00	"
4	ϕ=150mm	pcs	2,500.00	2875.00	"
5	ϕ=100mm	pcs	1,880.00	2162.00	"
6	ϕ=75mm	pcs	430.00	494.50	"
7	ϕ=63mm	pcs	280.00	322.00	"
8	ϕ=50mm	pcs	180.00	207.00	"
9	ϕ=38mm	pcs	39.00	44.85	"
10	ϕ=18.5mm	pcs	25.00	28.75	"
	ADAPTOR				
1	ϕ=300MM	pcs	4,200.00	4830.00	"
2	ϕ=250MM	pcs	3,700.00	4255.00	"
3	ϕ=200MM	pcs	3,200.00	3680.00	"
4	ϕ=150mm	pcs	2,700.00	3105.00	"
5	ϕ=100mm	pcs	1,800.00	2070.00	"
6	ϕ=75mm	pcs	380.00	437.00	"
7	ϕ=63mm	pcs	280.00	322.00	"
8	ϕ=50mm	pcs	180.00	207.00	"
9	ϕ=38mm	pcs	39.00	44.85	"

10	ϕ=25mm	pcs	30.00	34.50	"
11	ϕ=18.5mm	pcs	25.00	28.75	"
	ELBOW				
1	ϕ=300MM	pcs	4,000.00	4,600.00	"
2	ϕ=250MM	pcs	3,500.00	4,025.00	"
3	ϕ=200MM	pcs	3,000.00	3,450.00	"
4	ϕ=150mm	pcs	2,500.00	2,875.00	"
5	ϕ=100mm	pcs	1,880.00	2,162.00	"
6	ϕ=75mm	pcs	480.00	552.00	"
7	ϕ=63mm	pcs	310.00	356.50	"
8	ϕ=50mm	pcs	220.00	253.00	"
9	ϕ=38mm	pcs	45.00	51.75	"
10	ϕ=18.5mm	pcs	25.00	28.75	"
	REDUCER				
1	ϕ=300MM-250mm	pcs	3,800.00	4,370.00	"
2	ϕ=250MM-200mm	pcs	3,200.00	3,680.00	"
3	ϕ=200MM- 150mm	pcs	2,900.00	3,335.00	"
4	ϕ=150MM- 100mm	pcs	2,200.00	2,530.00	"
5	ϕ=100MM- 75mm	pcs	1,300.00	1,495.00	"
6	ϕ=75mm-50mm	pcs	450.00	517.50	"
7	ϕ=50mm-38mm	pcs	180.00	207.00	"
8	ϕ=38mm-25mm	pcs	140.00	161.00	"
	TEE			0.00	"
1	ϕ=300MM	pcs	4,000.00	4,600.00	"
2	ϕ=250MM	pcs	3,500.00	4,025.00	"
3	ϕ=200MM	pcs	3,000.00	3,450.00	"
4	ϕ=150mm	pcs	2,500.00	2,875.00	"
5	ϕ=100mm	pcs	1,800.00	2,070.00	"
6	ϕ=75mm	pcs	380.00	437.00	"
7	ϕ=63mm	pcs	280.00	322.00	"
8	ϕ=50mm	pcs	230.00	264.50	"

9	ϕ=38mm	pcs	45.00	51.75	"
10	ϕ=18.5mm	pcs	35.00	40.25	"
	PVC Vent cap				"
1	ϕ=80mm	pcs	120.00	138.00	"
	GI floor Drain				"
1	ϕ=200mm	pcs	850.00	977.50	"
	Faucet				"
1	ϕ=18.5	pcs	120.00	138.00	"
2	ϕ=12.5mm	pcs	180.00	207.00	"
1	**Joint compactor**	kg	8.70	10.00	"
2	**Hemp**	kg	8.70	10.00	"

ii. BENEFIT FACTOR

Description	ETB
Monthly income (Provisional cost)	312.00
Working days per month	26.00
Daily income	12.00
Yearly income	3,744.00
Working days per year	312.00
Project Time in years	1/4

Item	Description	Days/year	Yearly Expense	Assumptions
1	Annual leave	14	117.60	70% of the workers(when it excludes daily laborer)
2	Sick leave	3	12.60	50% of the 70%workers may be sick.
3	Medical Service	62.40	74.88	20% of their salary for 10% of the workers
4	Transport allowance	15.60	187.20	15% of their salary
5	Insurance	31.20	374.40	10% of their salary
6	Mourning Leave	3	25.20	70%of the workers may encounter once in a year
7	Holidays	9	75.60	there is 12 holidays in a year and 70%of them rests on
8	Compensation		300.00	As per Ethiopian Labor law
9	Maternity		5.40	2% of 25% of the workers
10	Rainy Season	13.00	156.00	for 2 Months , retain 50% of the workers
11	Bonus (incentive) per year	13.00	156.00	50% of his salary per year
12	Overtime (shall be allowed by the engineer)	7.80	93.60	1/4 hour per day with double of his salary
	Total		**1578.48**	
	Benefit Factor	**42%**		

iii. MAN POWER COSTS

Item No.	Description Of Labor	Daily Rate (ETB)	Hourly Rate (ETB)	Benefit Factor	Indexed Rate (ETB)
1	Forman	500.00	62.50	142%	88.85
2	Mason II	500.00	62.50	142%	88.75
3	Mason I	250.00	31.25	142%	44.38
4	Carpenter II	500.00	62.50	142%	88.75
5	Carpenter I	250.00	31.25	142%	44.38
6	Plasterer	500.00	62.50	142%	88.75
7	Tiller	500.00	62.50	142%	88.75
8	Chiseler	250.00	31.25	142%	44.38
9	Bar Bender II	250.00	31.25	142%	44.38
10	Bar Bender I	150.00	18.75	142%	26.63
11	Gang Chief	250.00	31.25	142%	44.38
12	Daily Laborer	150.00	18.75	142%	26.63
13	Electrician	500.00	62.50	142%	88.75
14	Plumber	500.00	62.50	142%	88.75
15	Mixer &Vibrator Operator	350.00	43.75	142%	62.13
16	Helper	150.00	18.75	142%	26.63
17	Truck Driver	400.00	50.00	142%	71.00
18	Equipment Operator I	800.00	100.00	142%	142.00
19	Equipment Operator II	850.00	106.25	142%	150.88
20	Equipment Operator III	900.00	112.50	142%	159.75
21	Welder	500.00	62.50	142%	88.75
22	Painter	500.00	62.50	142%	88.75

iv. **EQUIPMENT RENTAL COST**

No	Equipment Type	Rated Capacity	HP	Initial Cost	Life Time		Salvage Value 10%E	Tire			
								Size	Qty	Unit Price	Price (Set)
				(ETB)	(Hour)	Yr	(ETB)			(ETB)	(ETB)
A	B	C	D	E	F	G	H	I	J	K	L
1	**Dump Truck**	7 M3	240	950,000	12,000	6	95,000	11x20, 12x20	10	1924.2	19242
2	**Water Truck**	6000 Lit	150	850,000	12,000	6	85,000	11x20,12x20	6	1924.2	11545
3	**Excavator, wheel Type**	1.0 – 1.5M3	150	4,500,000	12,000	6	450,000	15.5x25	4	4000.0	16000
4	**Concrete Vibrator**	4 Hp	4	90,000	8,000	4	9,000				0
5	**Concrete Mixer, trailer mounted**	250 Lit.	15	150,000	16,000	8	15,000	6.5x16	2	484.41	968.82
6	**Compressor, Trailer Mounted**	250CFM	65	216,945	15,000	7	21,695	6.5x16	2	484.41	968.8
7	**Pick up, single cab, 4x4, Diesel**	1 Ton	85	650,000	11,000	5	65,000	7.5x16	4	605.76	2423
8	**HDPE Welder, Electric**	300 -400 AMP		367,890	8,000	4	36,789				19242

	Depreciation Cost	Interest	Insurance Rate	Repair Cost			Fuel Consumption			Service Cost		Tier Cost	Owning Cost	Operating Cost	Rental Rate
Tire Life	=(E-L-H)/F	=E($(1+0.03)^{F/2}$ ^{000})-1/F		=(E*P/100)*G/F			Factor	(D*T)	Cost =T*F cost			=L/M	(N+O+Q)	(S+V+X+Y)	(Z+Z^1)
Hour	ETB/Hr)	ETB /Hr)	%		% N	ETB /Hr)	Lit/h /Hp	Lit/ Hr	ETB /Hr	% V	ETB /Hr	ETB /Hr	ETB /Hr	ETB /Hr	ETB /Hr
M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	Z^1	A^1
1500	69.6	15	2.2	10	80	55	0.14	33.6	638	20	127.	12	95.4	834	**930.08**
1800	62.7	13	2.2	9.3	80	50	0.14	21.0	399.	20	79.8	6.4	85.8	535	**621.33**
2500	336	72	1.2	27	70	235	0.15	22.5	427	25	106	6.4	435	776	**1212.0**
0	10.1	1.4	0.4	0.1	50	5.0	0.14	0.56	15.6	7	1.1	0.0	11.7	21	**33.56**
2500	8.38	2.5	0.4	0.3	50	4.1	0.14	2.10	39.9	14	5.6	0.3	11.1	50	**61.24**
2500	12.9	3.5	0.4	0.4	50	6.4	0.14	9.10	172	14	24.2	0.3	16.9	203	**220.95**
2100	52.9	10	1.6	5.2	50	26	0.14	11.9	226	16	36.2	1.1	68.5	289	**358.5**
0	41.3	5.7	0.4	0.7	50	20	0.00	0.00	0.00	0	0.0	0.0	47.9	20	**68.59**

v. OVERHEAD & PROFIT

SUMMARY OF INDIRECT SITE COST		
No	**Description**	**Amount**
A	Supervision	681,600.00
B	Administration	398,736.00
C	Plant and tools	429,000.00
D	Office furniture, Equipment and materials	129,720.00
E	Financial	169,950.00
	Total indirect site cost	**1,809,006.00**
	Estimated Project cost	**11,000,000.00**

OVER HEAD & PROFIT		
No	**Project expense description**	**Percentage, %**
1	Percentage of Indirect site cost	**16.45**
2	Profit and Risk margin	**5.00**
	Total over head & profit cost	**21.45 (TAKE 20%)**

INDIRECT SITE COSTS								
A) SUPERVISOR STAF								
No.	**Position**	**Number**	**UF**	**Monthly Salary (ETB)**	**Monthly Indexed Salary**	**Monthly Cost (ETB)**	**Completion Time In Months**	**Total Cost In Project Cost (ETB)**
1	Project Manager	1.00	1.0	30,000.0	1.42	42,600.0	6.00	255,600.0
2	Project Engineer	1.00	1.0	20,000.0	1.42	28,400.0	6.00	170,400.0
3	Office Engineer	4.00	1.0	10,000.00	1.42	14,200.0	6.00	340,800.0
4	General Forman	1.00	1.0	10,000.0	1.42	14,200.0	6.00	85,200.00
5	Surveyor	1.00	0.2	10,000.0	1.42	14,200.0	6.00	85,200.00
							Total carried to summary	**681,600.0**

B) ADMINISTRATION STAF								
1	Administration and Finance	1.00	1.00	8,000.00	1.42	11,360.00	6.00	68,160.00
2	Personnel	1.00	1.00	5,000.00	1.42	7,100.00	6.00	42,600.00
3	Accountant	1.00	1.00	5,000.00	1.42	7,100.00	6.00	42,600.00
4	Casher	1.00	1.00	3,500.00	1.42	4,970.00	6.00	29,820.00
5	Store keeper	2.00	1.00	1,500.00	1.42	2,130.00	6.00	25,560.00
6	Time keeper	3.00	1.00	1,200.00	1.42	1,704.00	6.00	30,672.00
7	Light Vickie driver	3.00	1.00	2500.00	1.42	3550.00	6.00	63,900.00
8	Cleaner	2.00	1.00	800.00	1.42	1,136.00	6.00	13,632.00
9	Guard	8.00	1.00	1,200.00	1.42	1,704.00	6.00	81,792.00
							Total carried to summary	**398,736.00**

C) COMMONLY USED PLANT AND TOOLS							
No	**Type of equipment**	**Number**	**UF**	**Rent per month (ETB)**	**Monthly cost (ETB)**	**Completion time in months**	**Total cost in project cost (ETB)**
1	Light Vickie	1.00	1.00	4,500.00	4,500.00	6.00	27,000.00
2	Pick up	1.00	0.75	30,000.0	22,500.00	6.00	135,000.0
3	Welding Machine	1.00	0.25	15,000.0	3,750.00	6.00	22,500.00
4	Water pump	1.00	0.25	10,000.0	2,500.00	6.00	15,000.00
5	Surveying instrument	1.00	0.25	15,000.0	3,750.00	6.00	22,500.00
6	Water tank	3.00	1.00	10,000.0	10,000.00	6.00	180,000.0
7	Plastic hose(200m)	1.00	1.00	4500.00	4500.00	6.00	27000.00
						Total carried to summary	**429,000.0**

D. OFFICE FURNITURE, EQUIPMENT AND MATERIAL					
No	**Description**	**No**	**Cost Per Month**	**Completion Time In Months**	**Total Cost In Project Cost (ETB)**
1	Computer with printer	1.00	10,000	6.00	60,000.00
2	Table	2.00	800.00	6.00	9,600.00
3	Chair	4.00	600.00	6.00	14,400.00
4	Shelf	1.00	900.00	6.00	5,400.00
6	Safe box	1.00	1,200.00	6.00	7,200.00
7	Adding machine	2.00	50.00	6.00	600.00
8	Filing cabinet	6.00	120.00	6.00	4,320.00
9	Stationery	Ls	1,500.00	6.00	9,000.00
10	Utilities	Ls	2,000.00	6.00	12,000.00
11	Medicine	Ls	1,200.00	6.00	7,200.00
				Total carried to summary	**129,720.00**

E. FINANCIAL COSTS		
No	**Description**	**Amount (ETB)**
1.00	Performance bond (1.4% of 10% project cost) = 0.014 x 0.15 x 11,000,000	46,200.00
2.00	Interest on unpaid sum = (for average delay of certificate= 15days) = 0.03 x 11,000,000 x 1/ 24	13,750.00
3.00	Bid bond guarantee (1% of project cost) = 0.1 x 11,000,000	110,000.00
	Total carried to summary	**169,950.00**

6.1 COST BREAKDOWN ANALYSIS FOR HDPE PIPES & FITTINGS (PN-16)

Project Cost=	100%
Overhead &Profit=	20%
Project cost + Overhead=	120%

			A- Material cost					B- Labor Cost						C- Equipment cost							Dir. cost	Unit Price
No	Description of work	Unit	Type of material	Unit	Qty	Rate	Cost per unit	Labor by trade	No	UF	Indexed Hr Cost	output	cost per unit	Type of Equip.	No	UF	Hourly Rental	output per Hr	Cost per unit	Direct cost A+B+C	Unit price= Dir. Cost + overhead & profit
1	HDPE PIPES OD 25mm (ϕ=3/4")	m	Pipes	m	1.05	28.75	30.19	Forman	1	0.25	88.85	1.50	14.81	Tools welding machine	2	1	3.00	1.50	4.00		
								Plumber	1	1.00	88.75	1.50	59.17		1	1	68.5	10	6.86		
								Daily La.	2	1.00	26.63	1.50	35.50								
							30.19						109.48						10.86	150.5	180.63
2	HDPE PIPES OD 32mm (ϕ=1")	m	Pipes	m	1.05	33.35	35.02	Forman	1	0.25	88.85	1.50	14.81	Tools welding machine	2	1	3.00	1.50	4.00		
								Plumber	1	1.00	88.75	1.50	59.17		1	1	68.5	10	6.86		
								Daily La.	2	1.00	26.63	1.50	35.50								
							35.02						109.48						10.86	155.3	186.42
3	HDPE PIPES OD 50mm (ϕ=1 1/2")	m	Pipes	m	1.05	51.75	54.34	Forman	1	0.25	88.85	1.00	22.21	Tools welding machine	2	1	3.00	1.50	4		
								Plumber	1	1.00	88.75	1.00	88.75		1	1	68.5 89	10	6.86		
								Daily La.	2	1.00	26.63	1.00	26.63								
							54.34						137.59						10.85	202.7	243.34
4	HDPE PIPES OD 63mm	m	Pipes	m	1.05	60.95	64.00	Forman	1	0.25	88.85	1.00	22.21	Tools	2	1	3.00	1.5	4		
								Plumber	1	1.00	88.75	1.00	88.75	welding	1	1	68.5	5	13.72		

	(ϕ= 2")															machine						
								Daily La.	2	1.00	26.63	1.00	26.63							
							64.00						137.59						17.71	219.3	263.16
5	HDPE PIPES OD 75mm (ϕ= 2 1/2")	m	Pipes	m	1.05	79.35	83.32	Forman	1	0.25	88.85	0.85	26.13	Tools	2	1	3.00	1.75	3.43			
								Plumber	1	1.00	88.75	0.85	104.41	welding machine	1	1	68.5	5	13.72			
								Daily La.	2	1.00	26.63	0.85	31.32									
							83.32						161.87						17.15	262.3	314.80
6	HDPE PIPES OD 90mm (ϕ= 3")	m	Pipes	m	1.05	126.50	132.83	Forman	1	0.25	88.85	0.8	27.77	Tools	2	1	3.00	0.75	8.00			
								Plumber	1	1.00	88.75	0.8	110.94	welding machine	1	1	68.5	5	13.72			
								Daily La.	2	1.00	26.63	0.8	33.28									
							132.83						171.98						21.72	326.5	391.83
7	HDPE PIPES OD 110mm (ϕ= 4")	m	Pipes	m	1.05	253.00	265.65	Forman	1	0.25	88.85	0.75	29.62	Tools	2	1	3.00	0.75	8.00			
								Plumber	1	1.00	88.75	0.75	118.33	welding machine	1	1	68.5	2	6.86			
								Daily La.	2	1.00	26.63	0.75	35.50									
							265.65						183.45						14.86	463.9	556.75
8	HDPE PIPES OD 160mm (ϕ= 6")	m	Pipes	m	1.05	379.50	398.48	Forman	1	0.25	88.85	0.55	40.39	Tools	2	1	3.00	0.75	8.00			
								Plumber	1	1.00	88.75	0.55	161.36	welding machine	1	1	68.5	2	6.86			
								Daily La.	2	1.00	26.63	0.55	48.41									
							398.48						250.16						14.86	663.4	796.19
9	HDPE PIPES OD 200mm (ϕ= 8")	m	Pipes	m	1.05	517.50	543.38	Forman	1	0.25	88.85	0.55	40.39	Tools	2	1	3.00	0.75	8.00			
								Plumber	1	1.00	88.75	0.55	161.36	welding machine	1	1	68.5	1	6.86			
								Daily La.	2	1.00	26.63	0.55	48.41									

							543.38						250.16						14.86	808.3	970.07
10	HDPE PIPES OD 250mm (ϕ= 10")	m	Pipes	m	1.05	747.50	784.88	Forman	1	0.25	88.85	0.55	40.39	Tools	2	1	3.00	0.75	8.00		
								Plumber	1	1.00	88.75	0.55	161.36	welding machine	1	1	68.5	1	68.59		
								Daily La.	2	1.00	26.63	0.55	48.41								
							784.88						250.16						76.59	1,111.6	1,333.9
GATE VALVE																					
1	Gate valves Diameter 12.5mm (ϕ= 1")	No.	Valve	No	1	138.00	138.00	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	0.40	4.0	0.20		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66								
							138.01						34.40						0.20	172.6	207.12
2	Gate valves Diameter 18.75mm (ϕ=3/4")	No.	Valve	No	1	172.50	172.50	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	3.00	4.0	1.5		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66								
							172.51						34.40						1.5	208.4	250.08
3	Gate valves Diameter 25mm (ϕ=1")	No.	Valve	No	1	207.00	207.00	Forman	1	0.25	88.85	3.00	7.40	Tools	2	1	3.00	3.0	2.00		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88								
							207.01						45.86						2.00	254.8	305.84
4	Gate valves Diameter 38mm (ϕ= 1 1/2")	No.	Valve	No	1	632.50	632.50	Forman	1	0.25	88.85	3.00	7.40	Tools	4	1	3.00	3.0	4.00		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88								
							632.51						45.86						4.00	682.3	818.84

5	Gate valves Diameter 50mm (ϕ=2")	No.	Valve	No	1	1092.5	1,092.5	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.63	2.50	10.65								
							1,092.5						55.04						2.4	1,149	1,379.9
6	Gate valves Diameter 63mm (ϕ=2 1/2")	No.	Valve	No	1	1725.0	1,725.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65								
							1,725.0						55.04						2.4	1,782.	2,138.9
7	Gate valves Diameter 75mm (ϕ=3")	No.	Valve	No	1	10,120	10,120.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65								
							10,120.						55.04						2.4	10,177	12,212.
8	Gate valves Diameter 100mm (ϕ=4")	No.	Valve	No	1	10,925	10,925.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.0	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							10,925.						68.79						3	10,997.3	13,196.8
9	Gate valves Diameter 150mm (ϕ= 6")	No.	Valve	No	1	20,700	20,700.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.0	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							20,700.						68.79						3	20,772.3	24,926.8
10	Gate valves Diameter 200mm (ϕ= 8")	No.	Valve	No	1	21850.	21,850.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.0	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								

							21,850.						68.79					3	21,922.3	26,306.8
UNION (COUPLING)																				
1	Union Diameter 25mm	No.	Union J. comp.	No	1	28.75	28.75	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	3.00	4.0	1.5	
				Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66							
							28.76						34.40					1.5	64.65	77.58
2	Union Diameter 32mm	No.	Union J. comp.	No	1	44.85	44.85	Forman	1	0.25	88.85	3.00	7.40	Tools	4	1	3.00	3.0	4.0	
				Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							44.86						45.86					4.0	94.72	113.66
3	Union Diameter 50mm	No.	Union J. comp.	No	1	207.00	207.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4	
				Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.63	2.50	10.65							
							207.01						55.04					2.4	264.45	317.34
4	Union Diameter 63mm	No.	Union J. comp.	No	1	322.00	322.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4	
				Kg	0.04	0.03	0.001	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.20	0.004	Daily La.	2	1.00	26.63	2.50	10.65							
							322.01						55.04					2.4	379.44	455.33
5	Union Diameter 75mm	No.	Union J. comp.	No	1	494.50	350.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4	
				Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65							
							350.01						55.04					2.4	407.44	488.93
6	Union Diameter 110mm/ 90mm	No.	Union J. comp.	No	1	2162.0	2,162.00	Forman	1	0.25	88.85	1.5	14.81	Tools	2	1	3.00	2.0	3	
				Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.5	59.17							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	1.5	17.75							
							2,162.						91.73					3	2,257.33	2,708.79

7	Union Diameter 160mm	No.	Union J. comp.	No	1	2875.0	2,875.00	Forman	1	0.25	88.85	1.5	14.81	Tools	2	1	3.00	2.0	3			
			Kg	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.5	59.17									
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	1.5	17.75									
							2,875.						91.73						3	2,970.33	3,564.39	
8	Union Diameter 200mm	No.	Union J. comp.	No	1	3450.0	3,450.	Forman	1	0.25	88.85	1.5	14.81	Tools	2	1	3.00	2.0	3			
			Kg	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.5	59.17									
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	1.5	17.75									
							3,450.60						91.73						3	3,545.33	4,254.39	
9	Union Diameter 250mm	No.	Union J. comp.	No	1	4025.0	4,025.	Forman	1	0.25	88.85	1.5	14.81	Tools	2	1	3.00	2.0	3			
			Kg	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.5	59.17									
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	1.5	17.75									
							4,025.60						91.73						3	4,120.33	4,944.39	
ADAPTER(FEMALE/ MALE)																						
1	Adapter Diameter 18.5mm	No.	Nipple J. comp.	No	1	28.75	28.75	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	3	4	1.5			
			Kg	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66									
							28.76						34.40						1.50	64.65	77.58	
2	Adapter Diameter 25mm	No.	Nipple J .comp.	No	1	34.50	34.50	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	3.00	3.0	2.00			
			Kg	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66									
							34.51						34.40						2.00	70.90	85.08	
3	Adapter Diameter 32mm	No.	Nipple J .comp.	No	1	44.85	44.85	Forman	1	0.25	88.85	3.00	7.40	Tools	4	1	3	3	4			
			Kg	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	3	8.88									
							44.86						45.86						4.00	94.72	113.66	
4	Adapter	No.	Nipple	No	1	207.00	207.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.40			

	Diameter 50mm		J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.63	2.50	10.65							
							207.01						55.04					2.40	264.45	317.34
5	Adapter Diameter 63mm	No.	Nipple J. comp.	No	1	322.00	322.00	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.4	
			Hemp	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50							
				Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65							
							322.01						55.04					2.4	379.44	455.33
6	Adapter Diameter 75mm	No.	Nipple J. comp.	No	1	437.00	437.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3	2.5	2.4	
			Hemp	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
				Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	2.5	10.65							
							437.01						55.04					2.4	494.44	593.33
7	Adapter Diameter 110mm/ 90mm	No.	Nipple J. comp.	No	1	2070.0	2,070.00	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3	2	3	
			Hemp	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2.00	44.38							
				Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2.00	13.31							
							2,070.60						68.79					3.00	2,142.4	2,570.87
8	Adapter Diameter 160mm	No.	Nipple J. comp.	No	1	3105.0	3,105.00	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3.00	2.0	3.00	
			Hemp	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2.00	44.38							
				Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2.00	13.31							
							3,105.60						68.79					3.00	3,177.4	3,812.87
9	Adapter Diameter 200mm	No.	Nipple J. comp.	No	1	3680.0	3,680.00	Forman	1	0.25	88.85	1.00	22.21	Tools	2	1	3	2	3	
			Hemp	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1	88.75							
				Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	1	26.63							
							3,680.60						137.59					3.00	3,821.2	4,585.43
10	Adapter Diameter 250mm	No.	Nipple J. comp.	No	1	4255.0	4,255.00	Forman	1	0.25	88.85	1.00	22.21	Tools	2	1	3.00	2.0	3.00	
			Hemp	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.00	88.75							
				Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	1.00	26.63							
							4,255.60						137.59					3.00	4,396.1	5,275.43

ELBOW

1	Elbow Diameter 18.5mm	No.	Elbow	No	1	28.75	28.75	Forman	1	0.25	88.85	3.00	7.40	Tools	2	1	3.00	3.00	2.0	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							28.76						45.86						2.0	76.62	91.94
2	Elbow Diameter 38mm	No.	Elbow	No	1	51.75	51.75	Forman	1	0.25	88.85	3.00	7.40	Tools	4	1	3.00	3.00	4.0	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							51.76						45.86						4.0	101.6	121.94
3	Elbow Diameter 50mm	No.	Elbow	No	1	253.00	253.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.50	2.4	
			J .comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.63	2.50	10.65							
							253.01						55.04						2.4	310.4	372.54
4	Elbow Diameter 63mm	No.	Elbow	No	1	356.50	356.50	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.50	2.4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65							
							356.						55.04						2.4	413.9	496.73
5	Elbow Diameter 75mm / 80mm PVC vent cape	No.	Elbow	No	1	552.00	552.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.50	2.4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65							
							552.01						55.04						2.4	609.4	731.33
6	Elbow Diameter 100mm	No.	Elbow	No	1	2162.00	2,162	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.00	3	
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31							
							2,162						68.79						3	2,234.3	2,681.27
7	Elbow	No.	Elbow	No	1	2875.00	2,875	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.00	3	

	Diameter 150mm		J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31							
							2,875						68.79					3	2,947.3	3,536.87
8	Elbow Diameter 200mm / 200mm Floor Drainage/	No.	Elbow J. comp.	No	1	3450.00	3,450	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.00	3	
				Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31							
							3,450.						68.79					3	3,522.3	4,226.87
TEE/CROSS TEE																				
1	Tee Diameter 25mm	No.	Tee J. comp.	No	1	40.25	40.25	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	0.40	4.00	0.20	
				Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66							
							40.26						34.40					0.20	74.85	89.82
2	Tee Diameter 32mm	No.	Tee J. comp.	No	1	51.75	51.75	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	3.00	4.00	1.5	
				Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66							
							51.76						34.40					1.5	87.65	105.18
3	Tee Diameter 50mm	No.	Tee J. comp.	No	1	264.50	264.50	Forman	1	0.25	88.8	2.50	8.89	Tools	2	1	3.00	2.5	2.4	
				Kg	0.04	0.07	0.00	Plumber	1	1.00	88.7	2.50	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.6	2.50	10.65							
							264.51						55.04					2.4	321.95	386.34
4	Tee Diameter 63mm	No.	Tee J. comp.	No	1	322.00	322.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.50	2.4	
				Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65							
							322.01						55.04					2.4	379.44	455.33

5	Tee Diameter 75mm	No.	Tee	No	1	437.00	437.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.50	2.4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65								
							437.01						55.04						2.4	494.44	593.33
6	Tee Diameter 110mm/ 90mm	No.	Tee	No	1	2070.00	2,070.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.00	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							2,070.60						68.79						3	2,142.4	2,570.87
7	Tee Diameter 150mm	No.	Tee	No	1	2875.00	2,875.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.00	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							2,875.60						68.79						3	2,947.4	3,536.87
8	Tee Diameter 200mm	No.	Tee	No	1	3450.00	3,450.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.00	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							3,450.60						68.79						3	3,522.4	4,226.87
REDUCER																					
1	Reducer Diameter 32mm-25mm	No.	Reducer	No	1	161.00	161.00	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	3.00	4.0	1.5		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	4.00	6.66								
							161.01						34.40						1.5	196.9	236.28
2	Reducer Diameter 50mm-32mm	No.	Reducer	No	1	207.00	207.00	Forman	1	0.25	88.85	3.00	7.40	Tools	4	1	3.00	3.0	4.00		
			J. comp.	Kg	0.04	0.03	0.001	Plumber	1	1.00	88.75	3.00	29.58								
			Hemp	Kg	0.02	0.20	0.004	Daily La.	2	1.00	26.63	3.00	8.88								
							207.01						45.86						4.00	256.87	308.24

3	Reducer Diameter 63mm-50mm	No.	Reducer	No	1	517.50	517.50	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.003	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.50	0.010	Daily La.	2	1.00	26.63	2.50	10.65								
							517.51						55.04						2.4	574.95	689.94
4	Reducer Diameter 75mm-63mm	No.	Reducer	No	1	517.50	517.50	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.5	2.4		
			J. comp.	Kg	0.04	0.03	0.001	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.20	0.004	Daily La.	2	1.00	26.63	2.50	10.65								
							517.51						55.04						2.4	574.94	689.93
5	Reducer Diameter 110mm/ 90mm-75mm	No.	Reducer	No	1	1495.00	1,495.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3.00	2.50	2.4		
			J. comp.	Kg	0.04	0.03	0.001	Plumber	1	1.00	88.75	2.50	35.50								
			Hemp	Kg	0.02	0.20	0.004	Daily La.	2	1.00	26.63	2.50	10.65								
							1,495.01						55.04						2.4	1,552.4	1,862.93
6	Reducer Diameter 150mm-110mm /90mm	No.	Reducer	No	1	2530.00	2,530.00	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3.00	2.0	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							2,530.60						68.79						3	2,602.4	3,122.87
7	Reducer Diameter 200mm-150mm	No.	Reducer	No	1	3335.00	3,335.00	Forman	1	0.25	88.85	1.5	14.81	Tools	2	1	3.00	2.0	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.5	59.17								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	88.75	1.5	59.17								
							3,335.60						133.14						3	3,471.74	4,166.09
8	Reducer Diameter 250mm-200mm	No.	Reducer	No	1	3680.00	3,680.00	Forman	1	0.25	88.85	1.5	14.81	Tools	2	1	3.00	2.0	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.5	59.17								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	88.75	1.5	59.17								
							3,680.60						133.14						3	3,816.74	4,580.09

Project Cost= 100%

6.2 COST BREAKDOWN ANALYSIS FOR GALVANIZED IRON PIPES & FITTINGS (CLASS- B)

Overhead &Profit= 20%

																			Project cost + Overhead=		120%	
			A- Material cost					B- Labor Cost						C- Equipment cost							Direct cost	Unit Price
No	Description of work	Unit	Type of material	Unit	Qty	Rate	Cost per unit	Labor by trade	No	UF	Indexed Hr Cost	out put	cost per unit	Type of Equip.	No	UF	Hourly Rental	output per Hr	Cost per unit		Direct cost A+ B+C	Unit price with over head
1	Galvanized pipe Diameter 18.75mm (ϕ=3/4")	m	Pipes	m	1.05	178.25	187.16	Forman	1	0.25	88.85	3.00	7.40	Tool	2	1	3.00	1.50	4.00			
			J. comp.	gram	12	0.03	0.36	Plumber	1	1.00	88.75	3.00	29.58									
			Hemp	gram	6	0.20	1.20	Daily La.	2	1.00	26.63	3.00	17.75									
			Access.	No.	0.2	4.00	0.80															
							189.52						54.74						4.00		248.26	297.91
2	Galvanized pipe Diameter 25mm (ϕ=1")	m	Pipes	m	1.05	302.83	317.98	Forman	1	0.25	88.85	3.00	7.40	Tools	2	1	3.00	1.50	4.00			
			J. comp.	gram	12	0.03	0.36	Plumber	1	1.00	88.75	3.00	29.58									
			Hemp	gram	6	0.20	1.20	Daily La.	2	1.00	26.63	3.00	17.75									
			Access.	No.	0.2	4.00	0.80															
							320.34						54.74						4.00		379.07	454.89
3	Galvanized pipe Diameter 38mm (ϕ=1 1/2")	m	Pipes	m	1.05	456.17	478.98	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3.00	1.00	6			
			J. comp.	gram	12	0.05	0.60	Plumber	1	1.00	88.75	2.00	44.38									
			Hemp	gram	6	0.30	1.80	Daily La.	2	1.00	26.63	2.00	26.63									
			Access.	No.	0.2	3.50	0.70															
							482.08						82.11						6		570.18	684.22
4	Galvanized pipe Diameter 50mm (ϕ= 2")	ml	Pipes	m	1.05	536.67	563.50	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3.00	1	6			
			J. comp.	gram	12	0.03	0.36	Plumber	1	1.00	88.75	2.00	44.38									
			Hemp	gram	6	0.20	1.20	Daily La.	2	1.00	26.63	2.00	26.63									
			Access.	No.	0.2	3.50	0.70															
							565.76						82.11						6		653.87	784.64

5	Galvanized pipe Diameter 63mm (ϕ= 2 1/2")	m	Pipes	m	1.05	632.50	664.13	Forman	1	0.25	88.85	1	22.21	Tools	2	1	3.00	0.90	6.67	
			J. comp.	gram	12	0.03	0.36	Plumber	1	1.00	88.75	1	88.75							
			Hemp	gram	6	0.20	1.20	Daily La.	2	1.00	26.63	1	53.25							
			Access.	No.	0.2	3.50	0.70													
							666.39						164.2						6.67	837.26	1,004.72
6	Galvanized pipe Diameter 75mm (ϕ= 3")	m	Pipes	m	1.05	762.83	800.98	Forman	1	0.25	88.85	0.8	27.77	Tools	2	1	3.00	0.75	8.00	
			J. comp.	gram	12	0.07	0.84	Plumber	1	1.00	88.75	0.8	110.94							
			Hemp	gram	6	0.50	3.00	Daily La.	2	1.00	26.63	0.8	66.56							
			Access.	No.	0.2	6.00	1.20													
							806.02						205.2						8.00	1,019.2	1,223.14
7	Galvanized pipe Diameter 100mm (ϕ= 4")	m	Pipes	m	1.05	1035.0	1,086.7	Forman	1	0.25	88.85	0.88	25.24	Tool	2	1	3.00	0.75	8.00	
			J. comp.	gram	12	0.07	0.84	Plumber	1	1.00	88.75	0.88	100.8							
			Hemp	gram	6	0.50	3.00	Daily La.	2	1.00	26.63	0.88	60.51							
			Access.	No.	0.2	6.00	1.20													
							1,091						186.6						8.00	1,286.4	1,543.67
8	Galvanized pipe Diameter150 mm (ϕ= 6")	m	Pipes	m	1.05	1200.0	1,260.0	Forman	1	0.25	88.85	0.55	40.39	Tool	2	1	3.00	0.75	8.00	
			J. comp.	gram	12	0.07	0.84	Plumber	1	1.00	88.75	0.55	161.3							
			Hemp	gram	6	0.50	3.00	Daily La.	2	1.00	26.63	0.55	48.41							
			Access.	No.	0.2	6.00	1.20													
							1,265.						250.1						8.00	1,523.2	1,827.84
	Gate valve																			
1	Gate valves Diameter 12.5mm (ϕ= 1/2")	No.	Valve	No	1	138.00	138.00	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	0.4	4	0.2	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	4	13.31							
							138.01						41.05						0.2	179.26	215.11
2	Gate valves	No.	Valve	No	1	172.50	172.50	Forman	1	0.25	88.85	4.00	5.55	Tool	2	1	3	4	1.5	

	Diameter 18.75mm (ϕ=3/4")		J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4.00	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66							
							172.51						34.40					1.5	208.40	250.08
3	Gate valves Diameter 25mm (ϕ=1")	No.	Valve	No	1	207.00	207.00	Forman	1	0.25	88.85	3.00	7.40	Tool	2	1	3	3	2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							207.01						45.86					2	254.87	305.84
4	Gate valves Diameter 38mm (ϕ= 1 1/2")	No.	Valve	No	1	632.50	632.50	Forman	1	0.25	88.85	3.00	7.40	Tool	4	1	3.00	3	4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							632.51						45.86					4	682.37	818.84
5	Gate valves Diameter 50mm (ϕ=2")	No.	Valve	No	1	1092.50	1,092.50	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.63	2.5	10.65							
							1,092						55.04					2.40	1,149.9	1,379.94
6	Gate valves Diameter 63mm (ϕ=2 1/2") (Flanged)	No.	Valve	No	1	1725.0	1,725.0	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3.00	2.5	2.40		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.5	10.65							
							1,725						55.04					2.40	1,782.4	2,138.93
7	Gate valves Diameter 75mm (ϕ=3") (Flanged)	No.	Valve	No	1	10,120	10,120	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3.00	2.5	2.40		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.5	10.65							
							10,120						55.04					2.40	10,177	12,212.93

8	Gate valves Diameter 100mm (ϕ=4") (Flanged)	No.	Valve	No	1	10,925	10,925	Forman	1	0.25	88.85	2	11.11	Tool	2	1	3.00	2	3.00		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							10,925						68.79						3.00	10,997	13,196.87
9	Gate valves Diameter 150mm (ϕ=6") (Flanged)	No.	Valve	No	1	20,700	20,700	Forman	1	0.25	88.85	2	11.11	Tool	2	1	3.00	2	3.00		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.63	2	13.31								
							20,700						68.79						3.00	20,772.	24,926.87
10	Gate valves Diameter 200mm (ϕ= 8") (Flanged)	No.	Valve	No	1	21,850	21,850	Forman	1	0.25	88.85	2	11.11	Tool	2	1	3	2	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	2	13.31								
							21,850						68.79						3.00	21,922	26,306.87
Union																					
1	Union Diameter 15mm	No.	Valve	No	1.05	28.75	30.19	Forman	1	0.25	88.85	4.00	5.55	Tool	2	1	0.4	4	0.2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66								
							30.19						34.40						0.2	64.79	77.75
2	Union Diameter 20mm	No.	Valve	No	1	40.25	40.25	Forman	1	0.25	88.85	4	5.55	Tool	2	1	3	4	1.50		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	4	6.66								
							40.26						34.40						1.5	76.15	91.38
3	Union Diameter 25mm	No.	Valve	No	1	69.00	69.00	Forman	1	0.25	88.85	3	7.40	Tool	2	1	3	3	2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58								

			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							69.01						45.86					2	116.87	140.24
4	Union Diameter 38mm	No.	Valve	No	1	126.50	126.50	Forman	1	0.25	88.85	3	7.40	Tool	4	1	3	3	4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	3	8.88							
							126.51						45.86					4	176.37	211.64
5	Union Diameter 50mm	No.	Valve	No	1	184.00	184.00	Forman	1	0.25	88.85	2.50	8.89	Tool	2	1	3	2.5	2.4	
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.625	2.5	10.65							
							184.01						55.04					2.4	241.45	289.74
6	Union Diameter 63mm	No.	Valve	No	1	322.00	322.00	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.40	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	2.5	10.65							
							322.01						55.04					2.4	379.44	455.33
7	Union Diameter 75mm	No.	Valve	No	1	448.50	350.00	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65							
							350.01						55.04					2.4	407.44	488.93
8	Union Diameter 100mm	No.	Valve	No	1	747.50	747.50	Forman	1	0.25	88.85	1	22.21	Tool	2	1	3	2	3	
			J .comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1.00	88.75							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	1	26.63							
							748.10						137.5					3	888.69	1,066.43
9	Union	No.	Valve	No	1	2415.0	2,415.0	Forman	1	0.25	88.85	1.00	22.21	Tool	2	1	3	2	3	

	Diameter 150mm		J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1	88.75							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	1	26.63							
							2,415						137.5					3	2,556.1	3,067.43
Nipples																				
1	Nipples Diameter 15mm	No.	nipple	No	1	23.00	23.00	Forman	1	0.25	88.85	4.00	5.55	Tool	2	1	0.4	4	0.2	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66							
							23.01						34.40					0.2	57.60	69.12
2	Nipples Diameter 20mm	No.	Nipple	No	1	28.75	28.75	Forman	1	0.25	88.85	4	5.55	Tool	2	1	3	4	1.50	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66							
							28.76						34.40					1.5	64.65	77.58
3	Nipples Diameter 25mm	No.	Nipple	No	1	40.25	40.25	Forman	1	0.25	88.85	3	7.40	Tool	2	1	3	3	2	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88							
							40.26						45.86					2	88.12	105.74
4	Nipples Diameter 38mm	No.	Nipple	No	1	80.50	80.50	Forman	1	0.25	88.85	3	7.40	Tool	4	1	3	3	4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	3	8.88							
							80.51						45.86					4	130.37	156.44
5	Nipples Diameter 50mm	No.	Nipple	No	1	109.25	109.25	Forman	1	0.25	88.85	2.50	8.89	Tool	2	1	3	2.5	2.4	
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.62	2.5	10.65							
							109.26						55.04					2.4	166.70	200.04
6	Nipples	No.	Nipple	No	1	218.50	218.50	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.40	

	Diameter 63mm		J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	2.5	10.65							
							218.51						55.04					2.4	275.94	331.13
7	Nipples Diameter 75mm	No.	Nipple	No	1	322.00	322.00	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	2.5	10.65							
							322.01						55.04					2.4	379.44	455.33
8	Nipples Diameter 100mm	No.	Nipple	No	1	552.00	552.00	Forman	1	0.25	88.85	2.00	11.11	Tool	2	1	3	2	3		
			J .comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	2	13.31							
							552.60						68.79					3	624.39	749.27
9	Nipples Diameter 150mm	No.	Nipple	No	1	1955.0	1,955.0	Forman	1	0.25	88.85	1	22.21	Tool	2	1	3	2	3.00		
			J .comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1	88.75							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	1	26.63							
							1,955						137.5					3	2,096.1	2,515.43
Elbow																				
1	Elbow Diameter 15mm	No.	Elbow	No	1	34.50	34.50	Forman	1	0.25	88.85	4.00	5.55	Tool	2	1	0.4	4	0.2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	17.75	4	4.44							
							34.51						32.18					0.2	66.88	80.26
2	Elbow Diameter 20mm	No.	Elbow	No	1	28.75	28.75	Forman	1	0.25	88.85	4	5.55	Tool	2	1	3	4	1.50		
			J .comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	17.75	4	4.44							
							28.76						32.18					1.5	62.43	74.92
3	Elbow Diameter 25mm	No.	Elbow	No	1	40.25	40.25	Forman	1	0.25	88.85	3	7.40	Tool	2	1	3	3	2		
			J .comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58							

			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	17.75	3.00	5.92							
							40.26						42.90					2	85.16	102.19
4	Elbow Diameter 38mm	No.	Elbow	No	1	103.50	103.50	Forman	1	0.25	88.85	3	7.40	Tool	4	1	3	3	4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	17.75	3	5.92							
							103.51						42.90					4	150.41	180.49
5	Elbow Diameter 50mm	No.	Elbow	No	1	126.50	126.50	Forman	1	0.25	88.85	2.50	8.89	Tool	2	1	3	2.5	2.4	
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	17.75	2.5	7.10							
							126.51						51.49					2.4	180.40	216.48
6	Elbow Diameter 63mm	No.	Elbow	No	1	287.50	287.50	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.40	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	17.75	2.5	7.10							
							287.51						51.49					2.4	341.39	409.67
7	Elbow Diameter 75mm	No.	Elbow	No	1	437.00	437.00	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.4	
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50							
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	17.75	2.50	7.10							
							437.01						51.49					2.4	490.89	589.07
8	Elbow Diameter 100mm	No.	Elbow	No	1	667.00	667.00	Forman	1	0.25	88.85	2.00	11.11	Tool	2	1	3	2	3	
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38							
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	17.75	2	8.88							
							667.60						64.36					3	734.96	881.95
9	Elbow	No.	Elbow	No	1	2070.00	2,070.00	Forman	1	0.25	88.85	2	11.11	Tool	2	1	3	2	3.00	

	Diameter 150mm		J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	17.75	2	8.88								
							2,070						64.36						3	2,137.9	2,565.55
Tee																					
1	Tee Diameter 15mm	No.	Tee	No	1	28.75	28.75	Forman	1	0.25	88.85	4.00	5.55	Tool	2	1	0.4	4	0.2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	4	6.66								
							28.76						34.40						0.2	63.35	76.02
2	Tee Diameter 20mm	No.	Tee	No	1	28.75	28.75	Forman	1	0.25	88.85	4	5.55	Tool	2	1	3	4	1.50		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	4	6.66								
							28.76						34.40						1.5	64.65	77.58
3	Tee Diameter 25mm	No.	Tee	No	1	40.25	40.25	Forman	1	0.25	88.85	3	7.40	Tool	2	1	3	3	2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88								
							40.26						45.86						2	88.12	105.74
4	Tee Diameter 38mm	No.	Tee	No	1	149.50	149.50	Forman	1	0.25	88.85	3	7.40	Tool	4	1	3	3	4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	3	8.88								
							149.51						45.86						4	199.37	239.24
5	Tee Diameter 50mm	No.	Tee	No	1	207.00	207.00	Forman	1	0.25	88.85	2.50	8.89	Tool	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.62	2.5	10.65								
							207.01						55.04						2.4	264.45	317.34
6	Tee Diameter 63mm	No.	Tee	No	1	437.00	437.00	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.40		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								

			Hemp	Kg	0.02	0.20	437.00	Daily La.	2	1.00	26.62	2.5	10.65					2.40		
							874.00						55.04					4.8	933.84	1,120.60
7	Tee Diameter 75mm	No.	Tee	No	1	517.50	517.50	Forman	1	0.25	88.85	2.5	8.89	Tool	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65								
							517.51						55.04					2.4	574.94	689.93
8	Tee Diameter 100mm	No.	Tee	No	1	747.50	747.50	Forman	1	0.25	88.85	2.00	11.11	Tool	2	1	3	2	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.625	2	13.31								
							748.10						68.79					3	819.89	983.87
9	Tee Diameter 150mm	No.	Tee	No	1	2277.0	2,277.0	Forman	1	0.25	88.85	2	11.11	Tool	2	1	3	2	3.00		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	2	13.31								
							2,277						68.79					3	2,349.3	2,819.27
Cross Tee																				
1	Cross Tee Diameter 15mm	No.	Tee	No	1	80.50	80.50	Forman	1	0.25	88.85	4.00	5.55	Tool	2	1	0.4	4	0.2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66								
							80.51						34.40					0.2	115.10	138.12
2	Cross Tee Diameter 20mm	No.	Tee	No	1	126.50	126.50	Forman	1	0.25	88.85	4	5.55	Tool	2	1	3	4	1.50		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66								
							126.51						34.40					1.5	162.40	194.88
3	Cross Tee Diameter 25mm	No.	Tee	No	1	207.00	207.00	Forman	1	0.25	88.85	3	7.40	Tools	2	1	3	3	2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58								

			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88								
							207.01						45.86						2	254.87	305.84
4	Cross Tee Diameter 38mm	No.	Tee	No	1	287.50	287.50	Forman	1	0.25	88.85	3	7.40	Tools	4	1	3	3	4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	3	8.88								
							287.51						45.86						4	337.37	404.84
5	Cross Tee Diameter 50mm	No.	Tee	No	1	552.00	552.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.625	2.5	10.65								
							552.01						55.04						2.4	609.45	731.34
6	Cross Tee Diameter 63mm	No.	Tee	No	1	920.00	920.00	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.40		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	2.5	10.65								
							920.01						55.04						2.4	977.44	1,172.93
7	Cross Tee Diameter 75mm	No.	Tee	No	1	1380.0	1,380.0	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.4		
			J .comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65								
							1,380						55.04						2.4	1,437.4	1,724.93
8	Cross Tee Diameter 100mm	No.	Tee	No	1	1610.0	1,610.0	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3	2	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.625	2	13.31								
							1,610						68.79						3	1,682.3	2,018.87
9	Cross Tee Diameter 150mm	No.	Tee	No	1	1725.0	1,725.0	Forman	1	0.25	88.85	2	11.11	Tools	2	1	3	2	3.00		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	2	13.31								

							1,725						68.79					3	1,797.3	2,156.87
Reducer																				
1	Reducer Diameter 20mm-15mm	No.	Tee	No	1	40.25	40.25	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	0.4	4	0.2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66								
							40.26						34.40					0.2	74.85	89.82
2	Reducer Diameter 25mm-20mm	No.	Tee	No	1	40.25	40.25	Forman	1	0.25	88.85	4	5.55	Tools	2	1	3	4	1.50		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66								
							40.26						34.40					1.5	76.15	91.38
3	Reducer Diameter 38mm-25mm	No.	Tee	No	1	109.25	109.25	Forman	1	0.25	88.85	3	7.40	Tools	2	1	3	3	2		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88								
							109.26						45.86					2	157.12	188.54
4	Reducer Diameter 50mm-38mm	No.	Tee	No	1	109.25	109.25	Forman	1	0.25	88.85	3	7.40	Tools	4	1	3	3	4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	3	8.88								
							109.26						45.86					4	159.12	190.94
5	Reducer Diameter 63mm-50mm	No.	Tee	No	1	322.00	322.00	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.625	2.5	10.65								
							322.01						55.04					2.4	379.45	455.34
6	Reducer Diameter 75mm-63mm	No.	Tee	No	1	437.00	437.00	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.40		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								

			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	2.5	10.65									
							437.01						55.04							2.4	494.44	593.33
7	Reducer Diameter 10mm-75mm	No.	Tee	No	1	552.00	552.00	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.4			
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65									
							552.01						55.04							2.4	609.44	731.33
8	Reducer Diameter 150mm-100mm	No.	Tee	No	1	1955.0	1,955.0	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3	2	3			
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38									
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	2	13.31									
							1,955						68.79							3	2,027.3	2,432.87
Water meter																						
1	Water Meter Diameter 15mm	No.	Tee	No	1	1127.0	1,127.0	Forman	1	0.25	88.85	4.00	5.55	Tools	2	1	0.4	4	0.2			
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	4	6.66									
							1,127						34.40							0.2	1,161.6	1,393.92
2	Water Meter Diameter 20mm	No.	Tee	No	1	1495.0	1,495.0	Forman	1	0.25	88.85	4	5.55	Tools	2	1	3	4	1.50			
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	4	22.19									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.625	4	6.66									
							1,495						34.40							1.5	1,530.9	1,837.08
3	Water Meter Diameter 25mm	No.	Tee	No	1	1495.0	1,495.0	Forman	1	0.25	88.85	3	7.40	Tools	2	1	3	3	2			
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3	29.58									
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	3.00	8.88									
							1,495						45.86							2	1,542.8	1,851.44
4	Water Meter	No.	Tee	No	1	2242.5	2,242.5	Forman	1	0.25	88.85	3	7.40	Tools	4	1	3	3	4			
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	3.00	29.58									

	Diameter 38mm		Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	3	8.88								
							2,242						45.86						4	2,292.3	2,750.84
5	Water Meter Diameter 50mm	No.	Tee	No	1	4830.0	4,830.0	Forman	1	0.25	88.85	2.50	8.89	Tools	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.07	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.50	0.01	Daily La.	2	1.00	26.62	2.5	10.65								
							4,830						55.04						2.4	4,887.4	5,864.94
6	Water Meter Diameter 63mm	No.	Tee	No	1	6900.0	6,900.0	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.40		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.62	2.5	10.65								
							6,900						55.04						2.4	6,957.4	8,348.93
7	Water Meter Diameter 75mm	No.	Tee	No	1	10235	10,235	Forman	1	0.25	88.85	2.5	8.89	Tools	2	1	3	2.5	2.4		
			J. comp.	Kg	0.04	0.03	0.00	Plumber	1	1.00	88.75	2.5	35.50								
			Hemp	Kg	0.02	0.20	0.00	Daily La.	2	1.00	26.63	2.50	10.65								
							10,235						55.04						2.4	10,292	12,350.93
8	Water Meter Diameter 100mm	No.	Tee	No	1	16100	16,100	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3	2	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	2	13.31								
							16,100						68.79						3	16,172	19,406.87
9	Water Meter Diameter 150mm	No.	Tee	No	1	18400	18,400	Forman	1	0.25	88.85	2.00	11.11	Tools	2	1	3	2	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	2	44.38								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.625	2	13.31								
							18,400						68.79						3	18,472	22,166.87
10	Water Meter	No.	Tee	No	1	18975	18,975	Forman	1	0.25	88.85	1	22.21	Tools	2	1	3	2	3.00		

	Diameter 200mm		J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	1	88.75								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	1	26.63								
							18,975						137.5						3	19,116	22,939.43
1	Bronze Faucet Diameter 18.5mm	No.	Faucet	No	1	138.00	138.00	Forman	1	0.25	88.85	6.00	3.70	Tools	2	1	3	2	3		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	6	14.79								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	6	4.44								
							138.60						22.93						3	164.53	197.44
2	Bronze Faucet Diameter 25mm	No.	Faucet	No	1	207.00	207.00	Forman	1	0.25	88.85	6	3.70	Tools	2	1	3	2	3.00		
			J. comp.	Kg	0.04	10.00	0.40	Plumber	1	1.00	88.75	6	14.79								
			Hemp	Kg	0.02	10.00	0.20	Daily La.	2	1.00	26.62	6	4.44								
							207.60						22.93						3	233.53	280.24

6.3 COST BREAKDOWN ANALYSIS FOR CIVIL STRUCTURES

			A- Material cost					B- Labor Cost						C- Equipment cost						Direct cost	Unit Price
No	Description of work	Unit	material	Unit	Qty	Rate	Cost per unit	Labor by trade	No	UF	Indexed Hr Cost	out put	cost per unit	Type of Equip.	No	UF	Hourly Rental	out put per Hr	Cost per unit	Direct cost A+ B+C	Unit price with over head
EXCAVATION & EARTH WORK																					
1	**Site clearing to an average dept of 20cm**	m^2						G. leader	1	0.10	44.38	2	2.22	Tools	2	1	0.16	2	0.16		
								D. labor	2	1.00	26.63	2	26.63								
								Forman	1	0.05	88.85	2	2.22								
													31.07						0.16	31.23	**37.47**
2	**Bulk excavation to a depth not exceeding 1500mm**	m3						G. leader	1	0.10	44.38	0.75	5.92	Tools	2	1	0.16	0.35	0.914		
								D. labor	2	1.00	26.63	0.75	71.00								
								Forman	1	0.05	88.85	0.75	5.92								
													82.84						0.9143	83.75	**100.51**
3	**Trench excavation on Rock formation to a depth not exceeding 1500mm**	m3						G leader	1	0.10	44.38	0.3	14.79	Tools	2	1	0.16	0.35	0.914		
								D. labor	2	1.00	26.63	0.3	177.50								
								Forman	1	0.05	88.85	0.3	14.81								
													207.10						0.914	208.01	**249.62**
4	**Trench excavation on ordinary soil up to 150 cm depth**	m^3						G. leader	1	0.10	44.38	0.43	10.32	Tools	2	1	0.16	0.35	0.91		
								D. labor	2	1.00	26.63	0.43	123.84								
								Forman	1	0.05	88.85	0.43	10.33								
													144.49						0.91	145.40	**174.48**
5	**Back filling of trench up to 150 cm depth**	m^3						G. leader	1	0.10	44.38	0.9	4.93	Tools	2	1	0.16	0.35	0.91		
								D. labor	2	1.00	26.63	0.9	59.17								

								Forman	1	0.05	88.85	0.9	4.94							
													69.03					0.91	69.94	**83.93**
6	**Fill around found.**							G. leader	1	0.10	44.38	0.7	6.34	Tools	4	1	0.16	0.3	2.13		
	from site.	m^3						D. labor	4	1.00	26.63	0.7	152.14								
								Forman	1	0.05	88.85	0.7	6.35								
													164.83					2.13	166.96	**200.35**
7	**Ditto but brought from**		Selec.mat	m^3	1.2	345.00	414.00	G .leader	1	0.10	44.38	0.83	5.35	Tools	4	1	0.16	0.6	1.07		
	quarry waste	m^3						D. labor	2	1.00	26.63	0.83	64.16								
								Forman	1	0.05	88.85	0.83	5.35								
							414.00						74.86					1.07	489.92	**587.91**
8	**Cart away**	m^3																		
								truck Driver	3	1.00	71.00	50	4.26	D. truck	3	1	930	50	55.81		
								D. laborer	2	1.00	26.63	50	1.07	Tools	4	1	0.16	50	0.01		
								Forman	1	0.25	88.85	50	0.44								
													5.77					55.82	61.59	**73.90**
9	**100mm thick hard**	m^2	stone	m^2	0.1	195.50	19.55	mason-1	1	1.00	44.38	1.5	29.58	Tools	3	1	0.16	1.5	0.32		
	core							D. labor	3	1.00	26.63	1.5	53.25								
								Forman	1	0.10	88.75	1.5	5.92								
							19.55						88.75					0.32	108.62	**130.34**
10	**150mm thick hard**	m^2	stone	m^2	0.15	195.50	29.33	mason-1	1	1.00	44.38	1.5	29.58	Tools	3	1	0.16	1.5	0.32		
	core							D. labor	3	1.00	26.63	1.5	53.25								
								Forman	1	0.10	88.75	1.5	5.92								
							29.33						88.75					0.32	118.40	**142.07**
11	**250mm thick hard**	m^2	stone	m^2	0.3	195.50	58.65	mason-1	1	1.00	44.38	1.5	29.58	Tools	3	1	0.16	1.5	0.32		
	core							D. labor	3	1.00	26.63	1.5	53.25								
								Forman	1	0.10	88.85	1.5	5.92								
							58.65						88.76					0.32	147.73	**177.27**

12	**300mm/270 mm thick hard core**	m^2	stone	m^2	0.35	195.50	68.43	mason-1	1	1.00	26.63	1.5	17.75	Tools	3	1	0.16	1.5	0.32		
								D. labor	3	1.00	88.75	1.5	177.50							
								Forman	1	0.10	88.75	1.5	5.92							
							68.43						201.17						0.32	269.91	**323.89**
13	**Soak away pit /Sand fill**	m^3	sand	m^3	1.05	609.50	639.98	G. leader	1	0.10	44.38	1	4.44	Tools	4	1	0.16	0.6	1.07		
								D. labor	4	1.00	26.63	1	106.50							
								Forman	1	0.05	88.85	1	4.44							
							639.98						115.3						1.07	756.43	**907.71**
CONCRETE WORK																					
1	**C.5 lean concrete with 100mm / 80mm thickness**	m^2	cement	qnt	0.075	569.25	42.69	Forman	1	0.05	88.85	1.63	2.73	Tools	15	1	0.16	1.63	1.472		
			sand	m3	0.024	609.50	14.63	Mason II	1	0.05	88.75	1.63	2.72	Mixer	1	1	61.24	1.63	37.57		
			Aggregate	m3	0.0475	920.00	43.70	G. leader	1	0.05	44.38	1.63	1.36	Vibrator	1	1	33.56	1.63	20.58		
			Water= % cement	5%			2.13	D. labor	15	0.05	26.63	1.63	12.25								
			Water= % sand	1%			0.15	Mixer operator	1	0.05	62.13	1.63	1.91								
								Vibrator operator	1	0.05	62.13	1.26	2.47								
							103.30						23.43						59.63	186.36	**223.64**
2	**C-15 concrete**	m^3	cement	qnt	2.80	569.25	1,593.90	Forman	1	0.20	88.85	1.26	14.10	Tools	18.0	1.0	0.16	1.26	2.29		
			Sand	m3	0.50	609.50	304.75	Mason	1	1.00	88.75	1.26	70.44	Mixer	1.0	1.0	61.24	1.26	48.60		
			aggregate	m^3	0.75	920.00	690.00	G. leader	1	1.00	44.38	1.26	35.22	Vibrator	1.0	1.0	33.56	1.26	26.63		
			Water= % cement	5%			79.70	D. labor	18	1.00	26.63	1.26	380.36								
			Water= % sand	1%			3.05	Mixer opr	1	1.00	62.13	1.26	49.31								
								Vibrator operator	1	1.00	62.13	1.26	49.31								
							2,671.39						598.73						77.52	3,347.64	**4,017.17**
3	**C-20 concrete**	m^3	cement	qnt	3.20	569.25	1,821.60	Forman	1	0.20	88.85	1.26	14.10	Tools	15	1	0.16	1.26	1.90		
			Sand	m3	0.50	609.50	304.75	Mason	1	1.00	88.75	1.26	70.44	Mixer	1	1	61.24	1.26	48.60		
			aggregate	m^3	0.75	920.00	690.00	G. leader	1	1.00	44.38	1.26	35.22	Vibrator operator	1	1	33.56	1.26	26.63		

			Water= % cement	5%			91.08	D. labor	18	1.00	26.63	1.26	380.36							
			Water= % sand	1%			3.05	Mixer operator	1	1.00	62.13	1.26	49.31							
								Vibrator operator	1	1.00	62.13	1.26	49.31							
								Bar bend-II	1	1.00	44.38	1.26	35.22							
								carp-II	1	1.00	44.38	1.26	35.22							
							2,910.48						669.16					77.14	3,656.78	**4,388.14**
4	**C-25 concrete**	m^3	Cement	qnt	3.60	569.25	2,049.30	Forman	1	0.20	88.85	1.26	14.10	Tools	20	1	0.16	1.26	2.54		
			Sand	m3	0.52	609.50	316.94	Mason-1	1	1.00	88.75	1.26	70.44	Mixer	1	1	61.24	1.26	48.60		
			Aggregate	m3	0.78	920.00	717.60	G. leader	1	1.00	44.38	1.26	35.22	Vibrator	1	1	33.56	1.26	26.63		
			Water= % cement	5%			102.47	D. labor	18	1.00	26.63	1.26	380.36							
			Water= % sand	1%			3.17	Mixer operator	1	1.00	62.13	1.26	49.31							
								vibrator Operator	1	1.00	62.13	1.26	49.31							
								Bar bender	1	1.00	44.38	1.26	35.22							
								Carp.1	1	0.50	44.38	1.26	17.61							
							3,189.47						651.55					77.78	3,918.80	**4,702.56**
5	**C-30 concrete**	m^3	Cement	qnt	4.00	569.25	2,277.00	Forman	1	0.20	88.85	1.26	14.10	Tools	15	1	0.16	1.26	1.905		
			Sand	m3	0.46	609.50	280.37	Mason-1	1	1.00	88.75	1.26	70.44	Mixer	1	1	61.24	1.26	19.841		
			Aggregate	m3	0.90	920.00	828.00	G. leader	1	1.00	44.38	1.26	35.22	Vibrator Operator	1	1	33.56	1.26	9.524		
			Water= % cement	5%			113.85	D. labor	25	1.00	26.63	1.26	528.27							
			Water= % sand	1%			2.80	Mixer Operator	1	1.00	62.13	1.26	49.31							
								Vibrator Operator	1	1.00	62.13	1.26	49.31							
								Bar bender	1	1.00	44.38	1.26	35.22							
								Carp.1	1	1.00	44.38	1.26	35.22							
							3,502.02						817.08					31.27	4,350.37	**5,220.45**
6	**Form work**	m^2	Timber	m^2	1.1	69.00	75.90	Forman	1	0.20	88.85	0.8	22.21	Tools	2	1	0.16	0.9	0.533		

			Eucalyptus pole dia.=10mm	m	1.00	20.00	20.00	carp-2	1	0.20	88.75	0.8	22.19							
			Nail (5cm up to 15cm.)	kg	0.07	115.00	8.63	carp-1	1	0.20	44.38	0.8	11.09							
								D-labor	2	1.00	26.63	0.8	66.56							
							104.53						122.06					0.533	227.11	**272.54**
7	**Steel reinforcement**	Kg	Steel rein.	Kg	1.05	60.00	63.00	Bar bend II	1	1.00	44.38	40	1.11	Tools	2	###	0.16	30	0.01	
			Tie wire 1.5mm	Kg	0.03	92.00	2.76	Bar bend I	1	1.00	26.63	40	0.67	cut.mac	1	###	6.25	30	0.05	
								D .labor	2	1.00	26.63	40	1.33							
								Forman	1	0.10	88.85	40	0.22							
							65.76						3.33					0.06	69.15	**82.98**
8	**Cement mortar production (1:3)**	m^3	cement	qnt	4.2	569.25	2,390.85	Masion-1	1	1.00	44.38	0.9	49.31	Tools	10	1	0.16	0.9	1.78	
			sand	m3	1.08	609.50	658.26	D. Labor	10	1.00	26.63	0.9	295.83	Mixer	1	1	56.45	0.9	62.72	
			W/Cement	5%			119.54	Mixer operator	1	1.00	62.13	0.9	69.03							
			W/Sand	1%			6.58	Forman	1	0.20	88.85	0.9	19.74							
							3,175.24						433.91					64.50	3,673.65	**4,408.38**
9	**Pre-cast concrete pipe Dia.= 400mm**	m2	pipe	ml	1.10	105.62	116.18	Forman	1	0.10	88.85	1.50	5.92	Tools	2	1	0.16	1.00	0.32	
			Red ash	m3	0.01	40.25	0.40	Mason-2	1	1.00	88.75	1.50	59.17							
			Mortar	m3	0.01	3673.65	36.74	D. labor	2	1.00	26.63	1.50	35.50							
							153.32						100.59					0.32	254.23	305.08
MASIONERY WORK																				
1	**50 cm thick stone masonry foundation wall.**	m^3	stone	m^3	1.30	195.50	254.15	Forman	1	0.2	88.85	0.40	44.43	Tools	4	1	0.16	1.00	2.56	
			Mortar	m^3	0.24	3673.65	881.68	Mason-2	1	1	88.75	0.40	221.88							
			wa.mot	5%			44.08	D. labor	4	1	26.63	0.40	266.25							
							1,179.91						532.55					2.56	1,715.02	**2,058.02**

2	**40 cm thick stone masonry foundation Wall.**	m^3	stone	m^3	0.98	195.50	191.59	Forman	1	0.2	88.75	0.60	29.58	Tools	4	1	0.16	1.00	2.56		
			Mortar	m^3	0.24	3673.65	881.68	Mason-2	1	1	88.75	0.60	147.92								
			wa.mot	5%			44.08	D. labor	4	1	26.63	0.60	177.50								
							1,117.35						355.00						2.56	1,474.91	**1,769.89**
3	**25 cm thick stone masonry foundation wall.**	m^3	stone	m^3	0.65	195.50	127.08	Forman	1	0.2	88.75	1.00	17.75	Tools	4	1	0.16	1.00	2.56		
			Mortar	m^3	0.24	3673.65	881.68	Mason-2	1	1	88.75	1.00	88.75								
			wa.mot	5%			44.08	D. labor	4	1	26.63	1.00	106.50								
							1,052.83						213.00						2.56	1,268.39	**1,522.07**
4	**20cm. Thick H.C.B. wall**	m^2	H.C.B.	No.	13.00	23.00	299.00	Forman	1	0.10	88.85	1.25	7.11	Tools	2	1	0.16	1.25	0.26		
			Mortar	m^3	0.027	4,408.38	119.03	Mason II	1	1.00	88.75	1.25	71.00								
			Waste	5%			5.95	D. laborer	2	1.00	26.63	1.25	42.60								
							423.98						120.71						0.26	544.94	**653.93**
5	**15cm. Thick H.C.B. wall**	m^2	H.C.B.	No.	13.00	17.25	224.25	Forman	1	0.10	88.85	1.25	7.11	Tools	2	1	0.16	1.25	0.26		
			Mortar	m^3	0.0203	4,408.38	89.49	Mason II	1	1.00	88.75	1.25	71.00								
			Waste	5%			4.47	D. laborer	2	1.00	26.63	1.25	42.60								
							318.21						120.71						0.26	439.18	**527.01**
FINISHING WORK																					
1	**Cement sand mortar floor finishing (1:3)**	m^2	Cement	Qnt	0.21	320.00	67.20	Masion-1	1	0.05	44.38	1	2.22	Tools	10	1	0.16	1.00	1.60		
			Sand	m^3	0.054	430.00	23.22	D .Labor	10	0.05	26.63	1	13.31	Mixer	1	1	56.45	1.00	56.45		
			W/Cement	2%			1.34	Mixer operator	1	0.05	62.13	1	3.11								
								Forman	1	0.05	88.85	1	4.44								
			Wa.san	1%			0.23														
							92.00						23.08						58.05	173.13	**207.75**

2	**Pointing in cement sand (1:3) to masonry wall**	m^2	mortar	m^3	0.019	173.13	3.29	Forman	1	0.10	88.85	2.00	4.44	Tools	2.00	1	0.16	2	0.16		
								Plasterer	1	1.00	88.75	2.00	44.38								
								D. Labor	2	1.00	26.63	2.00	26.63								
							3.29						75.44						0.16	78.89	**94.67**
3	**Three Coates plastering in cement mortar (1:3)**		Mortar	m^3	0.022	173.13	3.81	Forman	1	0.10	88.85	0.9	9.87	Tools	2	1	0.16	0.9	0.36		
			W/ Mortar	10%			0.38	Plasterer	1	1.00	88.75	0.9	98.61								
								D. labor	2	1.00	26.63	0.9	59.17								
							4.19						167.65						0.36	172.20	**206.63**
4	**Two coats plastering**	m^2	Mortar	m^3	0.02	173.13	3.12	Forman	1	0.10	88.85	0.98	9.07	Tools	2	1	0.16	0.98	0.33		
			W/Mortar	10%			0.03	plasterer-	1	1.00	88.75	0.98	90.56								
								D. labor	2	1.00	26.63	0.98	54.34								
							3.15						153.96						0.33	157.44	**188.93**
5	**Tyro line rendered Coat**	m^2	Mortar	m^3	0.010	4408.3	44.08	Forman	1	0.20	88.85	0.77	23.08	Tools	2	1	0.16	0.98	0.33		
			W/ Mortar	10%			0.44	plasterer-	1	1.00	88.75	0.77	115.26								
								D. labor	2	1.00	26.63	0.77	69.16								
							44.52						207.49						0.33	252.34	**302.81**
6	**Cement mortal/ screed**		Cement	Qnt	0.17	569.25	96.77	Masion-1	1	0.05	44.38	1	2.22	Tools	10	1	0.16	1.00	1.60		
		m^2	W/Cement	2%			1.94	D. Labor	10	0.05	26.63	1	13.31	Mixer	1	1	61.24	1.00	61.24		
								Mix. operator	1	0.05	62.13	1	3.11								
								Forman	1	0.05	88.85	1	4.44								
							98.71						23.08						62.84	184.63	**221.55**
7	**compound fence with barbed wire**		C-20 concrete	m3	0.01	3656.78	36.57	Forman	1	0.05	88.85	1	4.44	Tools	10	1	0.16	1.00	1.60		
		m^2	Re-Bar	kg	0.264	69.00	18.22	D. Labor	10	0.05	26.63	1	13.31								
			barbed wire	m	2	30.00	60.00	Masion-1	1	0.05	44.38	1	2.22								
							114.7						19.97						1.60	136.36	**163.63**

8	**Pre-cast concrete**	m2	C-20 Conc.	m^2	1.00	73.14	73.14	Forman	1	0.10	88.85	1.5	5.92	Tools	2	1	0.16	1.00	0.32		
	Pavement		Red ash	m^3	0.1	40.25	4.03	Mason-2	1	1.00	88.75	1.5	59.17								
			Mortar	m^3	0.015	3673.65	55.10	D. labor	2	1.00	26.63	1.5	35.50								
							132.2						100.59						0.32	233.18	**279.81**
9	**Pre-cast concrete Dia. 400mm**	m2	pipe	m^2	1.10	105.62	116.18	Forman	1	0.10	88.85	1.50	5.92	Tools	2	1	0.16	1.00	0.32		
	pipe		Red ash	m^3	0.01	40.25	0.40	Mason-2	1	1.00	88.75	1.50	59.17								
			Mortar	m^3	0.01	3673.65	36.74	D. labor	2	1.00	26.63	1.50	35.50								
							153.32						100.59						0.32	254.23	**305.08**
11	**Three Coates plastic emulsion paint**	m2	paint	Gal	0.10	920.00	92.00	Forman	1	0.20	88.85	3.00	5.92	Tools	2	1	0.16	2.50	0.13		
								D. laborer	2	1.00	26.63	3.00	17.75								
								painter	1	1.00	88.75	3.00	29.58								
							92.00						53.26						0.13	145.38	**174.46**
12	**Roof cover in G-28 galvanized Corrugated iron sheet**	m^2	G-28 GIS	m^2	1.10	92.00	101.20	carpl-2	1	1.00	88.75	2.50	35.50	Tools	3	1	0.16	2.50	0.19		
			Nail	Kg	0.15	115.00	17.25	carp-1	1	1.00	44.38	2.50	17.75								
			Ridge cap	ml	0.15	57.50	8.63	D-Labor	2	1.00	26.63	2.50	21.30								
								Car form	1	0.20	88.85	2.50	7.11								
							127.0						81.66						0.19	208.93	**250.71**
13	**G28 galvanized sheet metal copping**		metal	ml	1.05	107.00	112.3	carp-1	1	1.00	44.38	0.8	55.47	Tools	3	1	0.16	4.0	0.12		
		ml	antirust	gallon	0.012	690.00	8.28	painter	1	1.00	88.75	0.8	110.94								
			Synthetic	gallon	0.036	920.00	33.12	D. laborer	2	1.00	26.63	0.8	33.28								
							153.7						199.69						0.12	353.55	**424.27**

CAREPENTERY & JOINER

1	**Dia.= 10 -12 cm**	ml	Eucalyptus Truss wood	ml	1.15	28.75	33.06	carp-2	1	1.00	88.75	20	4.44	Tools	3	1	0.16	8	0.06		
	Eucalyptus Truss wood		Nail	Kg	0.15	115.00	17.25	carp-1	1	1.00	44.38	20	2.22								
			Iron Band	Kg	0.10	69.00	6.90	D- Labor	2	1.00	26.63	20	2.66								
								Forman	1	0.20	88.85	20	0.89								
							57.21						10.21						0.06	67.48	**80.98**
2	**Dia.= 8-10 cm**	ml	Eucalyptus Truss wood	ml	1.15	14.38	16.53	carpl-2	1	1.00	88.75	20	4.44	Tools	3	1	0.16	8	0.06		
	Eucalyptus Truss wood		Nail	Kg	0.15	115.00	17.25	carp-1	1	1.00	44.38	20	2.22								
			Band	Kg	0.10	69.00	6.90	D- Labor	2	1.00	26.63	20	2.66								
								Forman	1	0.20	88.85	20	0.89								
							40.68						10.21						0.06	50.95	**61.14**
3	**5x7 CM Purling 'Zigba' tree wood**	ml	purling	ml	1.10	57.50	63.25	carpl-2	1	1.00	88.75	5	17.75	Tools	2	1	0.16	5	0.06		
			Nail	Kg	0.10	115.00	11.50	carp-1	1	1.00	44.38	5	8.88								
								D- Labor	2	1.00	26.63	5	10.65								
								Forman	1	0.10	88.85	5	1.78								
							74.75						39.05						0.06	113.87	**136.64**

METAL AND STEEL WORK

1	**Metal Door**	set	Door set	set	1.00	6500.00	6,500.00	Carpenter .I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64		
	- size 3.2x 2.8 m		Lock	pcs	0.50	517.50	258.75	Carpenter .II	1	1.00	88.75	0.75	118.33								
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79								
								Plasterer	1	0.25	88.75	0.75	29.58								
								Forman	1	0.63	88.85	0.75	74.63								
								D. Labor	2	1.00	26.63	0.75	71.00								
							6,988.75						367.5						0.64	7356.9	**8,828.2**

2	**Metal Door /Type W1/ Type D1 - size 2.1x0.9 m**	set	Door set	set	1.00	2875.0	2,875.00	Carpenter .I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64		
			Lock	pcs	0.50	517.50	258.75	Carpenter II	1	1.00	88.75	0.75	118.3								
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79								
								Plasterer	1	0.25	88.75	0.75	29.58								
								Forman	1	0.63	88.85	0.75	74.63								
								D. Labor	2	1.00	26.63	0.75	71.00								
							3,363.75						367.5						0.64	3731.9	**4,478.2**
3	**Metal Door /Type W1/ Type D1 - size 2.8x0.8 m**	set	Door set	set	1.00	2950.0	2,950.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64		
			Lock	pcs	0.50	517.50	258.75	Carpenter II	1	1.00	88.75	0.75	118.33								
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79								
								Plasterer	1	0.25	88.75	0.75	29.58								
								Forman	1	0.63	88.85	0.75	74.63								
								D. Labor	2	1.00	26.63	0.75	71.00								
							3,438.75						367.5						0.64	3806.9	**4,568.28**
4	**Metal Door /Type W2/ Type D1 - size 2.1mx2 m**	set	Door set	set	1.00	5175.00	5,175.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64		
			Lock	pcs	0.50	517.50	258.75	Carpenter II	1	1.00	88.75	0.75	118.33								
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79								
								Plasterer	1	0.25	88.75	0.75	29.58								
								Forman	1	0.63	88.85	0.75	74.63								
								D. Labor	2	1.00	26.63	0.75	71.00								
							5,663.75						367.5						0.64	6031.9	**7,238.28**
5	**Metal Door /Type W3/ size 1.35mx 2.8 m**	set	Door set	set	1.00	5410.0	5,410.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64		
			Lock	pcs	0.50	517.50	258.75	Carpenter II	1	1.00	88.75	0.75	118.3								
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79								
								Plasterer	1	0.25	88.75	0.75	29.58								
								Forman	1	0.63	88.85	0.75	74.63								
								D. Labor	2	1.00	26.63	0.75	71.00								
							5,898.75						367.5						0.64	6266.9	**7,520.28**

6	**Metal Door /Type W3/ Type D1 - size 1.75mx0.75 m**	set	Door set	set	1.00	2300.0	2,300.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
			Lock	pcs	0.50	517.50	258.75	Carpenter II	1	1.00	88.75	0.75	118.3							
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.63	88.85	0.75	74.63							
								D. Labor	2	1.00	26.63	0.75	71.00							
							2,788.75						367.5						0.64	3156.9	**3,788.28**
7	**Metal Door /Type W3/ Type D1 - size 1.55mx0.7 m**	set	Door set	set	1.00	2100.0	2,100.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
			Lock	pcs	0.50	517.50	258.75	Carpenter II	1	1.00	88.75	0.75	118.3 3							
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.63	88.85	0.75	74.63							
								D. Labor	2	1.00	26.63	0.75	71.00							
							2,588.75						367.5						0.64	2956.9	**3,548.28**
8	**Window /Type W1/ size 1.2mx0.9m**		Window	set	1.00	1150.0	1,150.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
			Syntactic	m^2	0.10	920.00	92.00	Carpenter II	1	1.00	88.75	0.75	118.3 3							
								Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.20	88.85	0.75	23.69							
								D. Labor	2	1.00	26.63	0.75	71.00							
							1,242.00						316.5						0.64	1559.2	**1,871.05**
9	**Window /Type W2/ size 1.2mx1.2m**		Window	set	1.00	1380.0	1,380.00	Carpenter .I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
			Syntactic	m^2	0.15	920.00	138.00	Carpenter II	1	1.00	88.75	0.75	118.3							
								Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.20	88.85	0.75	23.69							
								D. Labor	2	1.00	26.63	0.75	71.00							
							1,518.00						316.5						0.64	1835.2	**2,202.25**

10	**Window/Type LP1/ size 0.4mx0.8m**		Window	set	1.00	460.00	460.00	Carpenter I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
			Syntactic	m^2	0.10	920.00	92.00	Carpenter II	1	1.00	88.75	0.75	118.33							
								Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.20	88.85	0.75	23.69							
								D. Labor	2	1.00	26.63	0.75	71.00							
							552.00						316.5					0.64	869.21	**1,043.05**
11	**Window/Type LP2/ size 1.2mx1.2m**		Window	set	1.00	805.00	805.00	Carpenter .I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
			Syntactic	m^2	0.15	920.00	138.00	Carpenter .II	1	1.00	88.75	0.75	118.3							
								Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.20	88.85	0.75	23.69							
								D. Labor	2	1.00	26.63	0.75	71.00							
							943.00						316.5					0.64	1260.2	**1,512.25**
12	**Ladder**	set	Ladder	set	1.00	1725.00	1,725.00	Carpenter .I	1	1.00	44.38	0.75	59.17	Tools	3	1	0.16	0.75	0.64	
	Length 3m		ϕ10mm bolt	pcs	8.00	40.25	322.00	Carpenter II	1	1.00	88.75	0.75	118.3							
			Syntactic	m^2	0.25	920.00	230.00	Chiseler	1	0.25	44.38	0.75	14.79							
								Plasterer	1	0.25	88.75	0.75	29.58							
								Forman	1	0.63	88.85	0.75	74.63							
								D. Labor	2	1.00	26.63	0.75	71.00							
							2,277.00						367.5					0.64	2645.1	**3,174.18**
13	**compound fence with barbed wire**	ml	barbed wire	ml	1.05	2.3	2.42	Forman	1	0.10	88.75	20.00	0.44	Tools	3	1	0.16	0.75	0.64	
								Mason-2	1	1.00	88.75	20.00	4.44							
								D. labor	2	1.00	26.63	20.00	2.66							
							2.42						7.54					0.64	10.60	**12.72**

ANNEXURE-II

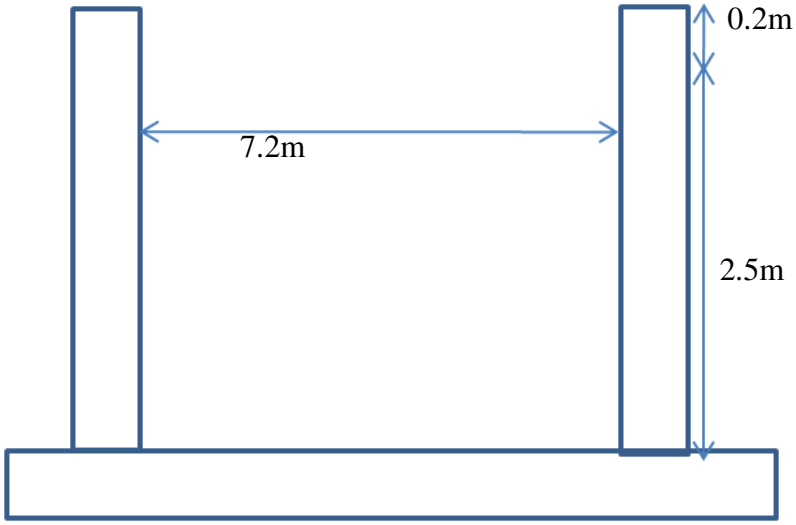
STRUCTURAL DESIGN DOCUMENT

100M^3 RC CIRCULAR WATER TANK REST ON GROUND DESIGN DOCUMENT

1 PRELIMINARY DATA

1.1 Dimensions of the tank

Capacity of the tank	C	=	100	m^3
Height of the water tank	H"	=	2.5	m
Clear board	h"	=	0.2	m
Total height of the water tank	H	=	2.7	m
Internal diameter of the tank	D_{req}	=	$\sqrt{\{100/[2.5x(3.14/4)]\}}$	
		=	7.14	m
Provided diameter of tank	D_{pro}	=	7.2	m
Provided volume of tank	C_{pro}	=	101.7	m^3
		>	100	m^3
			Hence ok!	



1.2 Material Property

Grade of Concrete		=	**C30**	
Grade of Steel		=	**S400**	
Cylin.Com. strength of concrete	f_{ck}	=	24	N/mm^2
Ten. Strength of steel	f_{yk}	=	400	N/mm^2
Design strength of concrete	f_{cd}	=	$0.85 \times f_{ck}/\gamma_c$	
		=	0.85 x 24 / 1.5	

= 13.6 N/mm^2

Design strength of steel reinforcement. f_{yd} = f_{yk} / γ_s

= 400 / 1.15

= 347.8 N/mm^2

1.3 Load Combination

Ultimate limit state

Partial safety factor for dead load = 1.35

Partial safety factor for Water pressure = 1.2

Load Combination = 1.35DL+1.2WP

Serviceability limit state

Partial safety factor for dead load = 1.0

Partial safety factor for Water pressure = 1.0

Load Combination = 1DL+1WP

1.4 Base Pressure

Unit weight of water = 10 kN/m^3

Height of water including free board = 2.7 m

Water pressure at base = 27 kN/m^2

1.5 Safe bearing capacity of soil

Considered safe bearing capacity of soil = 100 kN/m^2

Allowable deflection = 0.01 m

Modulus of sub grade reaction = 100/0.01

= 10000 kN/m^2/m

2 STRUCTURAL ANALYSIS OF CIRCULAR WALL

2.1 MANUEL METHOD

Height of the water tank	H	=	2.7	m
Internal diameter	D	=	7.2	m
Wall thickness	t	=	210	mm
Parameter	h^2/Dt	=	2.7^2/[7.2x(210/1000)]	
		=	4.83	
Base pressure	qh	=	27	kN/m^2

2.1.1 Maximum shear force at base

	Coefficient	=	0.217	
Maximum shear force at SLS		=	0.21691 x 27 x 2.7	
		=	15.82	kN
Maximum shear force at ULS [γ_F=1.2]		=	1.2x15.82	
		=	18.98	kN

2.1.2 Maximum Bending moment at base

	Coefficient	=	0.023	
Maximum bending moment at SLS		=	0.022982 x 27 x 2.7^2	
		=	4.53	kN-m
Maximum bending moment at ULS [γ_F=1.2]		=	1.2x4.53	
		=	5.436	kN-m

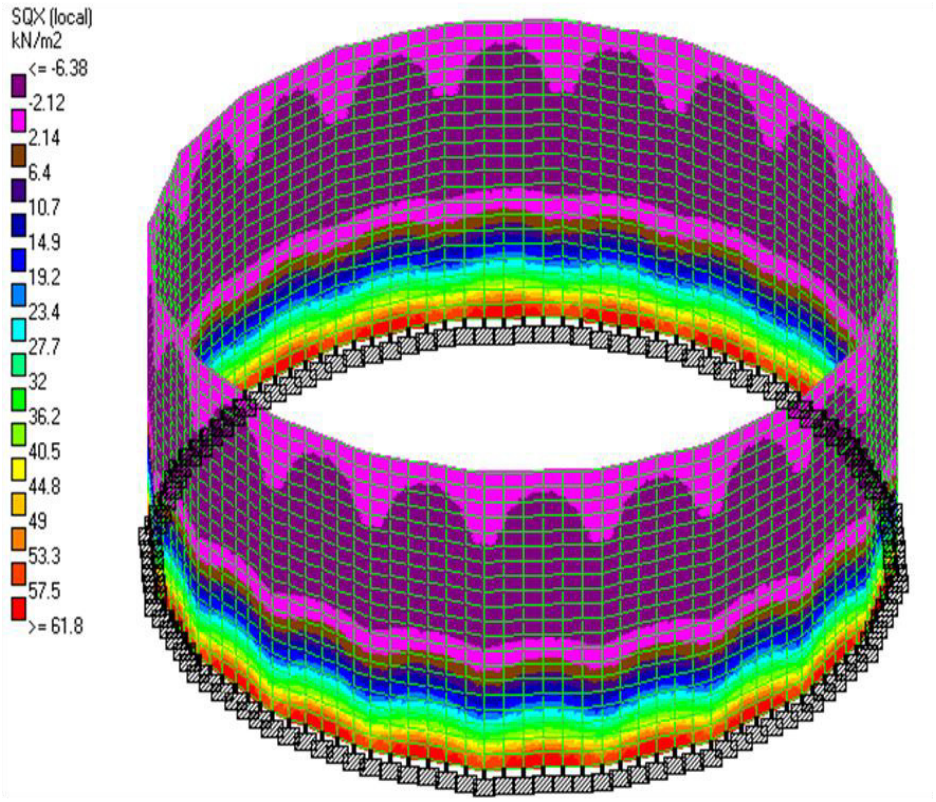
2.1.3 Maximum Ring tension at middle

	Coefficient	=	0.469	
Maximum ring tension at SLS		=	0.46884 x 27 x 3.6	
		=	45.58	kN
Maximum ring tension at ULS [γ_F=1.2]		=	1.2x45.58	
		=	54.7	kN

2.2 FINITE ELEMENT METHOD

2.2 A CIRCULAR WALL

2.2.1 Maximum shear force at base



Maximum shear force at SLS = 61.8 kN/m^2

Maximum shear force at SLS = 12.98 kN

Maximum shear force at ULS [Υ_F=1.2] = 1.2x12.978

= 15.57 kN

3A DESIGN OF CIRCULAR WALL FOR CRACK

3.1 Preliminary data

Grade of Concrete = **C30**

Grade of Steel = **S400**

Cylin.Com. strength of concrete f_{ck} = 24 N/mm^2

Tensile Strength of steel	f_{yk}	=	400	N/mm^2
Design strength of concrete	f_{cd}	=	0.85 x f_{ck}/γ_c	
		=	0.85 x 24 / 1.5	
		=	13.6	N/mm^2
Design strength of steel rein.	f_{yd}	=	f_{yk} / γ_s	
		=	400 / 1.15	
		=	347.8	N/mm^2
Consider 1m Width of wall	b	=	1000	mm
Overall thickness of wall provided	h_{pro}	=	210	mm
Assume clear cover	c	=	40	mm
Effective thickness of wall provided	d_{pro}	=	166	mm
Height of the tank	H	=	2.7	m
Hydraulic head	h_o	=	2.7	m
For flexure				
Diameter of bar for bending	ϕ	=	8	mm
Provided spacing of bar	S	=	115	mm
For Pure tension				
Diameter of bar for pure tension	ϕ	=	10	mm
Provided spacing of bar	S	=	80	mm

3.2 **CRACK WIDTH CALCULATION FOR LOADING STAGE - FLEXURE & RING TENSION**

MATERIAL PROPERTY

Secant modulus of elasticity of concrete

	E_{cm}	=	$22[0.8+0.1f_{ck}]^{0.3}$	
			22x[0.8+(0.1x24)]^0.3	
		=	31.19	Gpa
Assume creep coefficient	ϕ	=	1.5	
Long term	E_c	=	E_{cm} / (1+ϕ)	

			31.19/(1+1.5)	
		=	12.48	GPa
Modulus of elasticity of steel	Es	=	200	GPa
	α_e	=	Es/Ec	
		=	200/12.476	
		=	16.03	

3.2.A CRACK WIDTH CALCULATION FOR LOADING STAGE - FLEXURE ONLY

3.2.1 MINIMUM STEEL FOR LOADING-FLEXURE

	$A_{s,min}$	=	$K_c K f_{ct,eff} A_{ct}/f_{yk}$	
	K	=	1.00	for h
	K	=	0.65	for h
Interpolate the value of k.	K	=	1	
	A_{ct}	=	b x h	
		=	2E+05	mm^2
For flexure	Kc	=	0.5	
	$f_{ct,eff}$	=	f_{ctm}	
		=	$0.3fck^{0.67}$	
		=	2.53	Mpa
	$A_{s,min}$	=	664.1	mm^2
Min. area of steel required for two face	$A_{s,req,2}$	=	664.1	mm2
Min. area of steel required for one face	$A_{s,req,1}$	=	332.1	mm2
Required spacing of bar	S_{req}	=	151.3	mm
Area of steel provided for one face	$A_{s,pro}$	=	436.9	mm2
	$A_{s,pro}$	>	$A_{s,req,1}$	

Hence provided steel is sufficient to resist crack due to bending

3.2.2 MAXIMUM CRACK SPACING & ACTUAL CRACK WIDTH

3.2.2.1 Calculation of concrete & steel stresses

Maximum ring tension occour at mid height at SLS

T = 300 kN/m

Stresses in tension reinforcement by assuming cracked section

All the tension is resisted by steel

Stres in the tension steel σ_s = T/A_s

= 300x10^3/(2x981.25)

Stres in the concrete σ_s = 152.9 MPa

hc,eff = min[2.5(h-d); 0.5h]

= 105 mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete $A_{c,eff}$ = $h_{c,eff}$ b

= 1E+05 mm^2

Effective reinforcement ratio $\rho_{p,eff}$ = $A_S/A_{c,eff}$

= 0.01

$f_{ct,eff}$ = f_{ctm}

= $0.3fck^{0.67}$

= 2.523 Mpa

For long term loading Kt = 0.4

3.2.2.2Calculation of mean strain in reinforcement - mean strain in concrete

[EN-1992-1-1: 7.3.4]

$\varepsilon sm-\varepsilon cm$ = $[\sigma s-Kt\ (fct,eff/\rho p,eff)(1+\alpha e\ \rho p,eff)]/Es > 0.6\sigma s/Es$

= 0.000179 < 0.000458599

$\varepsilon sm-\varepsilon cm$ = 0.0004586

3.2.2.3 Calculation of maximum crack spacing

[EN-1992-1-1: 7.11]

Maximum crack spacing,	Sr,max	=	k3c+k1k2k4ϕ/ρp,eff
For high bond bars	k1	=	0.8
For pure tension	k2	=	1
	k3	=	3.4
	k4	=	0.425
	Sr,max	=	(3.4x40)+(0.8x1x0.425x10/0.01)
		=	476mm

3.2.2.4 Calculation of actual crack width

[EN-1992-1-1: 7.8]

Wk,act	=	Sr,max x (εsm-εcm)
	=	476x0.0004586
	=	0.2182936mm

3.2.2.5 Calculation of permissible crack width

[EN-1992-3-7.3.1]

Tightness class	=	Choose tightness class 1

Permissible crack width

Wk,per	=	0.22mm
	>	Wk,act

This is an acceptable crack width, Satisfied

CONCLUSION: Minimum requirements as per code - each face & each direction

For flexure

Actual crack width	=	0.049232mm
Diameter of bar	=	8mm
Spacing of bar	=	115mm

For pure tension

Actual crack width	=	0.2182936mm

Diameter of bar = 10mm

Spacing of bar = 80mm

3B DESIGN OF CIRCULAR WALL FOR LOADING

3.1 DESIGNS FOR VERTICAL BENDING AT FIXED BASE

3.1.1 Calculation of reinforcement to resist bending causing tension

Moment at base at serviceability limit state

M = 4 kNm/m

Maximum bending moment causing tension on inner face at base at ULS [ϒf=1.2]:

M = 4.8 kNm/m

k = M/bd2fck <0.167

= 0.00726

Calculation of lever arm Z/d = 0.5[1+√(1-3k/η)]

= 0.5 x [1+√(1-(3x0.00726/1))]

= 0.995

Total reinforcement required to resist cantilever bending

As = M/[0.87fykz]

= 4.8x10^6/(0.87x400x0.995x166)

= 83.50852726 mm2

Area of steel for bending As,req = 83.50852726 mm2

Spacing of bars for bending Sreq = 601.615208 mm

Minimum spacing of bar for crack control = 115 mm

Required spacing of bar = 115 mm

Provided spacing of bar = 120 mm

Hence safe !

Provided area of steel As,pro = 418.67 mm2

3.1.2 Check the effective thickness of wall to resist bending causing compression

Required effective thickness of slab to resist bending

dreq = √(M/0.196bfck

= √[4.8x10^6/(0.196x1000x24)]

= 31.94382825 mm

< dpro

Hence provided wall thickness is sufficient to resist compression due to bending !

3.2 DESIGN FOR SHEAR AT BASE

3.2.1 Check the adequacy of the thickness to resist shear

Maximum shear force at base at SLS

V = 12.978 kN

Maximum shear force at base at ULS [ϒf=1.2]:

VED = 15.5736 kN

Lever arm, approximately z = 0.98d

= 162.68 mm

$\upsilon 1$ = 0.6(1-fck/250)

= 0.5424

For non-pre-stressed structures

αcw = 1

Conservatively assume cotΘ=1

Crushing strength of the concrete diagonal strut

[EN-1992-1-1: (6.9)]

VRD,max = 0.9d αcwbυ1fcd/(cotΘ+tanΘ)

= 551.035008 kN

> VED

Hence the provided thickness is sufficient to resist compression due to shear!

3.2.2 Check whether shear reinforcement can be avoided

[EN-1992-1-1: 6.2.2 (1)]

CRd,c = 0.18/ɣc

= 0.18/1.5

= 0.12

k = 1+√(200/d) ≤2.0

= 1+√(200/166)

= 2.0976426 > 2

= 2

100ρl = 100 Asl/bd ≤2

= 100x418.67/(1000x166) ≤ 2

= 0.252210843 ≤ 2

= 0.26

V min = 0.035K1.5√fck [EN-1992-1-1: 6.3N]

= 0.035x2^1.5x√(24)

= 0.484974226

The shear capacity of the concrete without any shear reinforcement [EN-1992-1-1: 6.2a]

VRd,c = CRd,cK[100ρl fck]1/3bd ≥ Vmin bd

= 0.12x2x(0.26x24)^(0.34)x1000x166/1000

= 73.35 kN < 80.50572154 kN

= 73.35 kN

VRd,c > VRE

Hence the provided depth is sufficient to resist tension due to shear without shear reinforcement

3.3 DESIGN FOR RING TENSION AT MIDDLE

Direct tension at ULS = 42.4116 kN

Total direct tension at ULS [Ɣf=1.2]

T = 1.2 x 42.4116

= 50.89392kN

Total reinforcement required to resist direct tension

As = T/0.87x fy

= 50.89392x1000/(0.87x400)

= 146.2468966mm3/m

Area of steel for direct tension As, required, 2 = 146.2468966mm2

For one face As, required, 1= 73.12344828 mm2

Spacing of bar for direct tension S = 1073.527054 mm

Minimum spacing of bar for crack control S min. = 80 mm

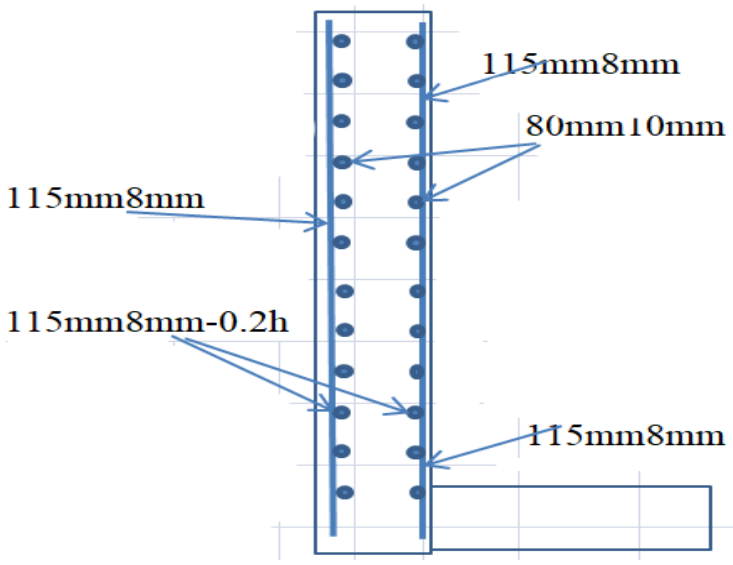
Required spacing of bar S req. = 80 mm

Provided spacing of bar S pro. = 80 mm

> S req.

Hence satisfied!

Provided area of steel	As, pro. =	981.25	
Minimum steel			
Minimum area of steel for each face & each direction =	0.2%Ac		
	=	420	mm2
Vertical bar above 0.2h from base -inner face			
Diameter of bar	=	8	mm
Required spacing	=	119.6190476	mm
Provided spacing of bar	=	115	mm
Vertical bar - outer face			
Diameter of bar	=	8	mm
Required spacing	=	119.6190476	
Provided spacing of bar	=	115	mm
Horizontal bar up to 0.2h from base			
Diameter of bar	=	8	mm
Required spacing	=	119.6190476	
Provided spacing of bar	=	115	mm



4 DESIGN OF TOP SLAB

4.1 Preliminary data

Grade of Concrete		=	C30	
Grade of Steel		=	S400	
Cylin.Com. strength of concrete	fck	=	24	N/mm2
Tensile Strength of steel	fyk	=	400	N/mm2
Design strength of concrete	fcd	=	0.85 x fck/ɣc	
		=	0.85 x 24 / 1.5	
		=	13.6	N/mm2
Design strength of steel rein.	fyd	=	fyk / ɣs	
		=	400 / 1.15	
		=	347.826087	N/mm2
Consider 1m Width of slab	b	=	1000	mm
Overall thickness of slab provided	h pro	=	225	mm
Assume clear cover	c	=	25	mm
Effective thickness of slab provided	d pro	=	195	mm

4.2 DESIGN FOR BENDING

BOTTOM REINFORCEMENT [EN-1992-1-1: 9.2.1.1]

Diameter of bar for bending	ϕ	=	10	mm
Design bending moment at ULS				
	M	=	20.7	kNm/m
	k	=	M/bd2fck <0.167	
		=	0.023	
Calculation of lever arm	Z/d	=	0.5[1+√(1-3k/η)]	
		=	0.5 x [1+√(1-(3x0.023/1))]	
		=	0.983	
Reinforcement required resisting bending				
	As	=	M/[0.87fykz]	
		=	20.7x10^6/(0.87x400x0.983x195)	

Area of steel for bending As = 310.32 mm2

Minimum area of steel As, min. ≥ 0.26 fctm / fyk b d ≥ 0.0013 b d

fct, eff. = fctm [EN-1992-1-1: (9.1N)]

= 0.3fck0.67

= 2.522683616 MPa

As, min. = 319.7501484 > 253.5 mm2

Area of steel for required A req. = 319.7501484 mm2

Spacing of bars required S req. = 245.5041863 mm

Maximum spacing of bar S max. = 3h ≤ 400mm [EN-1992-1-1: 9.3.1.1(3)]

= 400 mm

Provided spacing of bar = 150 mm

Hence safe**!**

Provided area of steel As, pro. = 523.34 mm2

Check the effective thickness of wall to resist bending causing compression

Required effective thickness of slab to resist bending

D req. = √(M/kbfck

= √[20.7x10^6/(0.023x1000x24)]

= 193.6491673 mm

< D pro.

Hence provided wall thickness is sufficient to resist compression due to bending!

4.3 **DESIGNS FOR SHEAR**

Check the adequacy of the thickness to resist shear

Design shear force at base

VED = 15.525 kN

Lever arm, approximately z = 0.98d

= 191.1 mm

υ1 = 0.6(1-fck/250)

= 0.5424

For non-pre-stressed structures

αcw = 1

Conservatively assume cotΘ=1

Crushing strength of the concrete diagonal strut *[EN-1992-1-1: (6.9)]*

VRD, max. = 0.9d αcwbᵛ1fcd/(cotΘ+tanΘ)

= 647.30016kN

> VED

Hence the provided thickness is sufficient to resist compression due to shear

Check whether shear reinforcement can be avoided *[EN-1992-1-1: 6.2.2 (1)]*

CRd, c = 0.18/γc= 0.18/1.5

= 0.12

k = 1+√(200/d) ≤2.0

= 1+√(200/195)

= 2.012739367 > 2

= 2

100ρl = 100 Asl/bd ≤2

= 100x523.34/(1000x195) ≤ 2

= 0.268379487 ≤ 2

= 0.27

V min. = 0.035K1.5√fck [EN-1992-1-1: 6.3N]

= 0.035x2^1.5x√(24)

= 0.484974226

The shear capacity of the concrete without any shear reinforcement *[EN-1992-1-1: 6.2a]*

VRd,c = CRd,cK[100ρl fck]1/3bd ≥ V min. bd

= 0.12x2x(0.27x24)^(0.34)x1000x195/1000

= 87.26 kN < 94.56997409 kN

= 87.26 kN

VRd,c > VRE

Hence the provided depth is sufficient to resist tension due to shear without shear reinforcement

4.4 CHECK FOR DEFLECTION *[EN-1992-1-1: (7.16a)]*

Limiting span to depth ratio

L/d = K [11+1.5√fckρo/ρ+3.2√fck(ρo/ρ-1)3/2]

For simply supported slab K= 1 [EN-1992-1-1: 7.4N]

The reference reinforcement ratio ρo = 0.1√fck

= 0.489897949

Required tension reinforcement ratio at mid span

ρ = 0.160

Basic L/d, limit = 79.92

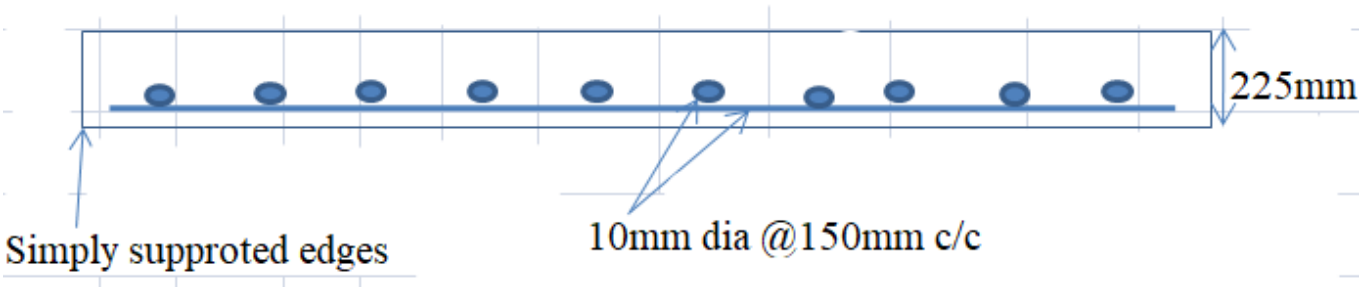
Modified L/d, limit = 79.92x523.34/310.32

= 134.7812993

Actual span to depth ratio L/d, actual = 36.92307692

< L/d, limit

Hence the provided depth is sufficient to resist deflection



5 DESIGN OF TOP SLAB

5.1 Preliminary data

Grade of Concrete		=	C30	
Grade of Steel		=	S400	
Cylin.Com. strength of concrete	fck	=	24	N/mm2
Tensile Strength of steel	fyk	=	400	N/mm2
Design strength of concrete	fcd	=	0.85 x fck/γc	
		=	0.85 x 24 / 1.5	
		=	13.6	N/mm2
Design strength of steel rein.	fyd	=	fyk / γs	
		=	400 / 1.15	
		=	347.826087	N/mm2
Consider 1m Width of slab	b	=	1000	mm
Overall thickness of slab provided	h pro	=	275	mm
Assume clear cover	c	=	40	mm
Effective thickness of slab provided	d pro	=	229	mm
Height of the tank	H	=	2.7	m
Hydraulic head	ho	=	2.7	m

Bottom reinforcement

Diameter of bar upward bending	ϕ	=	12	mm
Provided spacing of bar	S	=	90	mm

Top reinforcement

Diameter of bar for downward bending	ϕ	=	10	mm
provided spacing of bar	S	=	130	mm

5.2 CRACK WIDTH CALCULATION FOR LOADING STAGE - FLEXURE

[EN-1992-1-1: 7.3.4]

MATERIAL PROPERTY

Secant modulus of elasticity of concrete

$$Ecm = 22[0.8+0.1fck]$$

= 0.322x [0.8+ (0.1x24)]^0.3

= 31.19 Gpa

Assume creep coefficient ϕ = 1.5

Long term Ec = Ecm / (1+ϕ)

= 31.19/(1+1.5)

= 12.476 GPa

Modulus of elasticity of steel Es = 200 GPa

αe = Es/Ec

= 200/12.476

= 16.0307791

5.2.1 MINIMUM STEEL FOR LOADING-FLEXURE

As,min = KcKfct,effAct/fyk

K = 1 for h ≤ 300 mm

K = 0.65 for h ≥ 800 mm

Interpolate the value of k. K = 1

Act = b x h

= 275000 mm2

For flexure Kc = 0.5

fct, eff. = fctm

= 0.3fck0.67

= 2.53 Mpa

As, min = 869.6875 mm2

Bottom reinforcement

Min. area of steel required As, req= 869.6875 mm2

Required spacing of bar S req = 129.9777219 mm

Area of steel provided for one face As, pro= 1256 mm2

As, pro> As, req

Hence provided steel is sufficient to resist crack due to bending

Top reinforcement

Min. area of steel required	As, required	=	869.6875	mm2
Required spacing of bar	S required	=	90.26230686	mm
Area of steel provided for one face	As, pro.	=	603.8461538	mm2
	As, pro.	<	As, required	

5.2.2 MAXIMUM CRACK SPACING & ACTUAL CRACK WIDTH

Bottom reinforcement [Support moment]

Calculation of concrete & steel stresses

Depth of neutral axis

1/2 b X2	=	αeAs (d-X)	
X	=	77.99	mm
Lever arm Z	=	d-(X/3)	
	=	229-(77.99/3)	
	=	203.01	mm

Support Moment at serviceability limit state

M	=	53.5	kNm/m

Stress in the tension steel

σs	=	M/Asz	
	=	53.5x10^6/1256x203.01	
	=	209.8199173	MPa
Stress in the concrete σc	=	2M/bxz	
	=	2 x 53.5 x 10^6 / 1000 x 77.99 X 203.01	
	=	6.758143764	MPa

Effective depth of concrete surrounding the reinforcement

hc, eff	=	min.[2.5(h-d); (h-x); 0.5h]	
	=	115	mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete	Ac, eff	=	hc,eff b
		=	115000 mm^2
Effective reinforcement ratio	ρp,eff	=	AS/Ac,eff

= 0.02

fct,eff = fctm

= 0.3fck0.67

= 2.522683616 Mpa

For long term loading Kt = 0.4

Calculation of mean strain in reinforcement - mean strain in concrete *[EN-1992-1-1: 7.9]*

εsm-εcm = [σs-Kt (fct,eff/ρp,eff)(1+αe ρp,eff)]/Es >0.6σs/Es

= 0.00071595 > 0.00062946

εsm-εcm = 0.000716

Calculation of maximum crack spacing *[EN-1992-1-1: 7.11]*

Sr, max. = k3c+k1k2k4ϕ/ρp,eff

For high bond bars k1 = 0.8

For bending k2 = 0.5

k3 = 3.4

k4 = 0.425

Sr, max. = (3.4x40) + (0.8x0.5x0.425x12/0.02)

= 238 mm

Calculation of actual crack width *[EN-1992-1-1: 7.8]*

Wk, act = Sr, max. * (εsm-εcm)

= 238x0.000716

= 0.170408 mm

Calculation of permissible crack width

Tightness class = Choose tightness class 1

Wk, per = 0.2 for ho/h ≤ 5

Wk, per = 0.05 for ho/h ≥ 35

h/ho = 1

Using interpolation Permissible crack width

Wk,per= 0.22 mm

> Wk,act

This is an acceptable crack width, Satisfied!

Top reinforcement [Field moment]

Calculation of concrete & steel stresses

Depth of neutral axis

	1/2 b X2	=	αeAs (d-X)
	X	=	57.61 mm
Lever arm	Z	=	d-(X/3)
		=	229-(57.61/3)
		=	209.8 mm

Field Moment at serviceability limit state

	M	=	35.3 kNm/m
Stress in the tension steel σs		=	M/Asz
		=	35.3x10^6/603.846153846154x209.8
		=	278.6396507 MPa
Stress in the concrete σc		=	2M/bxz
		=	2 x 35.3 x 10^6 / 1000 x 57.61 X 209.8
		=	5.84119012 MPa

Effective depth of concrete surrounding the reinforcement

	hc,eff	=	min[2.5(h-d); (h-x); 0.5h]
		=	115 mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete	Ac,eff	=	hc,eff b
		=	115000 mm2
Effective reinforcement ratio	ρp,eff	=	AS/Ac,eff
		=	0.01
	fct,eff	=	fctm
		=	0.3fck0.67
		=	2.522683616 Mpa
For long term loading	Kt	=	0.4

Calculation of mean strain in reinforcement - mean strain in concrete *[EN-1992-1-1: 7.9]*

εsm-εcm	=	[σs-Kt (fct,eff/ρp,eff)(1+αe ρp,eff)]/Es >0.6σs/Es		
	=	0.00080778	<	0.000835919
εsm-εcm	=	0.000836		

Calculation of maximum crack spacing *[EN-1992-1-1: 7.11]*

$S_{r,max} = k_3c + k_1k_2k_4\phi/\rho_{p,eff}$

For high bond bars $k_1 = 0.8$

For bending $k_2 = 0.5$

$k_3 = 3.4$

$k_4 = 0.425$

$S_{r,max} = (3.4x) + (0.8x0.5x0.425x203.01/0.01)$

$= 170$ mm

Calculation of actual crack width *[EN-1992-1-1: 7.8]*

$W_{k,act} = S_{r,max} \times (\varepsilon_{sm} - \varepsilon_{cm})$

$= 170x0.000836$

$= 0.14212$ mm

Calculation of permissible crack width

Tightness class = Choose tightness class 1

$W_{k,per} = 0.2$ for $h_o/h \leq 5$

$W_{k,per} = 0.05$ for $h_o/h \geq 35$

$h/h_o = 1$

Using interpolation Permissible crack width

$W_{k,per} = 0.22$ mm

$> W_{k,act}$

This is an acceptable crack width, Satisfied!

5.3 DESIGN FOR BENDING

BOTTOM REINFORCEMENT [SUPPORT MOMENT] *[EN-1992-1-1: 9.2.1.1]*

Diameter of bar for bending		ϕ	=	12	mm
Design bending moment at ULS		M	=	66.2	kNm/m
		k	=	M/bd2fck <0.167	
			=	0.053	
Calculation of lever arm		Z/d	=	0.5[1+√(1-3k/η)]	
			=	0.5 x [1+√(1-(3x0.053/1))]	
			=	0.959	
Reinforcement required to resist bending					
		As	=	M/[0.87fykz]	
			=	66.2x10^6/(0.87x400x0.959x229)	
Area of steel for bending		As	=	866.22 mm2	
Minimum area of steel		As,min	≥	0.26 fctm / fyk b d ≥ 0.0013 b d	
	fct,eff	=	fctm	[EN-1992-1-1: (9.1N)]	
		=	0.3fck0.67		
		=	2.522683616	MPa	
	As,min	=	375.5014563	> 297.7	mm2
Area of steel for required	Areq	=	866.22 mm2		
Spacing of bars required	Sreq	=	130.4980259	mm	
Maximum spacing of bar	max	=	3h ≤ 400mm	[EN-1992-1-1: 9.3.1.1(3)]	
		=	400	mm	
Provided spacing of bar		=	90	mm	
		Hence safe!			
Provided area of steel	As,pro	=	1256	mm2	

TOP REINFORCEMENT [FIELD MOMENT] [*EN-1992-1-1: 9.2.1.1]*

Diameter of bar for bending	ϕ	=	10	mm
Design bending moment at ULS	M	=	44	kNm/m
	k	=	M/bd2fck <0.167	
		=	0.035	
Calculation of lever arm	Z/d	=	0.5[1+√(1-3k/η)]	
		=	0.5 x [1+√(1-(3x0.035/1))]	
		=	0.974	
Reinforcement required to resist bending				
	As	=	M/[0.87fykz]	
		=	44x10^6/(0.87x400x0.974x229)	
Area of steel for bending	As	=	566.87 mm2	
Minimum area of steel	As, min	≥	0.26 fctm / fyk b d ≥ 0.0013 b d	
	fct,eff	=	fctm	[EN-1992-1-1: (9.1N)]
		=	0.3fck0.67	
		=	2.522683616	MPa
	As,min	=	375.5014563 > 357.5	mm2
Area of steel for required	Areq	=	566.87 mm2	
Spacing of bars required	Sreq	=	138.479722	mm
Maximum spacing of bar	Smax	=	3h ≤ 400mm	[EN-1992-1-1: 9.3.1.1(3)]
		=	400 mm	
Provided spacing of bar		=	130 mm	
	Hence safe!			
Provided area of steel	As,pro	=	603.85 mm2	

EFFECTIVE DEPTH TO RESIST BENDING

Required effective thickness of slab to resist bending

$$d_{req} = \sqrt{(M/kbfck}$$
$$= \sqrt{[66.2x10^6/(0.167x1000x24)]}$$
$$= 128.5183491 \text{ mm}$$
$$< d_{pro}$$

Hence provided wall thickness is sufficient to resist compression due to bending

5.4 DESIGNS FOR SHEAR AT BASE

Check the adequacy of the thickness to resist shear

Design shear force at base

$V_{ED} = 69.575$ kN

Lever arm, approximately $z = 0.98d$

$= 224.42$ mm

$\nu_1 = 0.6(1-fck/250)$

$= 0.5424$

For non-pre-stressed structures

$\alpha_{cw} = 1$

Conservatively assume $\cot\Theta=1$

Crushing strength of the concrete diagonal strut [EN-1992-1-1: (6.9)]

$$V_{RD,max} = 0.9d\ \alpha_{cw} b \nu_1 f_{cd}/(\cot\Theta+\tan\Theta)$$
$$= 760.162752 \text{ kN}$$
$$> V_{ED}$$

Hence the provided thickness is sufficient to resist compression due to shear!

Check whether shear reinforcement can be avoided *[EN-1992-1-1: 6.2.2 (1)]*

$$C_{Rd,c} = 0.18/\gamma_c$$
$$= 0.18/1.5$$
$$= 0.12$$
$$k = 1+\sqrt{(200/d)} \leq 2.0$$

= 1+√(200/229)

= 1.934538627 < 2

= 1.94

100ρl = 100 Asl/bd ≤2

= 100x1256/(1000x229) ≤ 2

= 0.548471616 ≤ 2

= 0.55

V min. = 0.035K1.5√fck [EN-1992-1-1: 6.3N]

= 0.035x1.94^1.5x√(24)

= 0.463314892

The shear capacity of the concrete without any shear reinforcement [EN-1992-1-1: 6.2a]

VRd,c = CRd,cK[100ρl fck]1/3bd ≥ Vmin bd

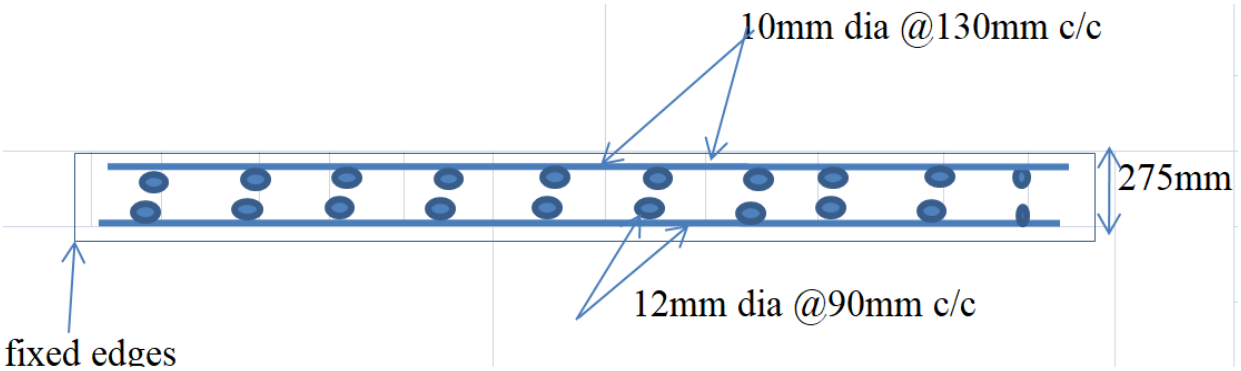
= 0.12x1.94x(0.55x24)^(0.34)x1000x229/1000

= 126 kN > 106.0991104 kN

= 106.0991104 kN

VRd,c > VRE

Hence the provided depth is sufficient to resist tension due to shear without shear reinforcement



6 CHECK FOR BASE PRESSURE

Consider 1m Width of slab	b	=	1000	m
Overall thickness of wall provided	hpro	=	0.21	m
Inner diameter of tank	Di	=	7.14	m
Outer diameter of tank	Do	=	7.56	mm
Total height of the tank	H	=	2.7	m
Thickness of top slab	ht	=	0.225	m
Diameter of top slab	Dt	=	7.56	
Thickness of bottom slab	hb	=	0.275	m
Diameter of bottom slab	Db	=	8.16	

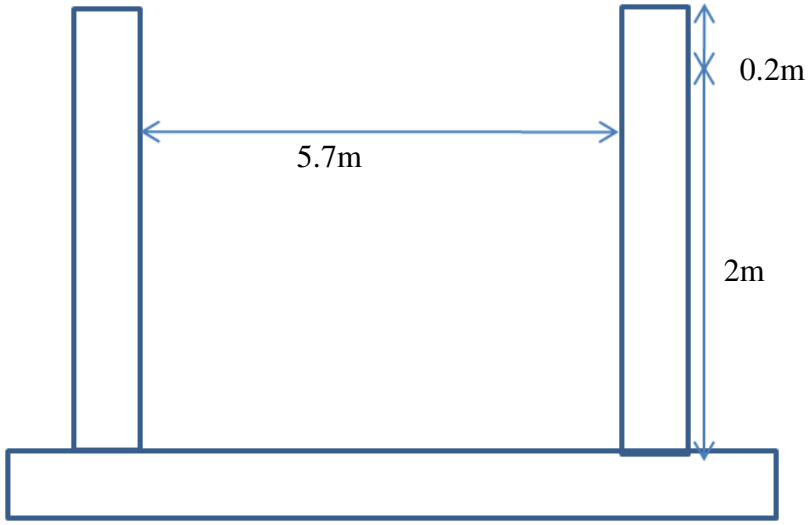
50M^3 RC CIRCULAR WATER TANK REST ON GROUND
DESIGN DOCUMENT

1 PRELIMINARY DATA

1.1 Dimensions of the tank

Capacity of the tank	C	=	50	m^3
Height of the water tank	H"	=	2	m
Clear board	h"	=	0.2	m
Total height of the water tank	H	=	2.2	m
Internal diameter of the tank	D_{req}	=	√{50/[2x(3.14/4)]}	
		=	5.65	m
Provided diameter of tank	D_{pro}	=	5.7	m
Provided volume of tank	C_{pro}	=	51.01	m^3
		>	100	m^3

Hence **ok!**



1.2 Material Property

Grade of Concrete		=	**C30**	
Grade of Steel		=	**S400**	
Cylin.Com. strength of concrete	f_{ck}	=	24	N/mm^2
Ten. Strength of steel	f_{yk}	=	400	N/mm^2
Design strength of concrete	f_{cd}	=	0.85 x f_{ck}/γ_c	

		=	0.85 x 24 / 1.5	
		=	13.6	N/mm^2
Design strength of steel rein.	f_{yd}	=	f_{yk} / γ_s	
		=	400 / 1.15	
		=	347.8	N/mm^2

1.3 **Load Combination** *[EN 1991-4-B3]*

Ultimate limit state *[EN 1991-4-A2]*

Partial safety factor for dead load	=	1.35	
Partial safety factor for Water pressure	=	1.2	
Load Combination	=	1.35DL+1.2WP	

Serviceability limit state

Partial safety factor for dead load	=	1.0	
Partial safety factor for Water pressure	=	1.0	
Load Combination	=	1DL+1WP	

1.4 **Base Pressure**

Unit weight of water	=	10	kN/m^3
Height of water including free board	=	2.2	m
Water pressure at base	=	22	kN/m^2

1.5 **Safe bearing capacity of soil**

Considered safe bearing capacity of soil	=	100	kN/m^2
Allowable deflection	=	0.01	m
Modulus of sub grade reaction	=	100/0.01	
	=	10000	$kN/m^2/m$

2 STRUCTURAL ANALYSIS OF CIRCULAR WALL

2.1 MANUEL METHOD

Height of the water tank	H	=	2.2	m
Internal diameter	D	=	5.7	m
Wall thickness	t	=	180	m
Parameter	h^2/Dt	=	2.2^2/[5.7x(180/1000)]	
		=	4.72	
Base pressure	qh	=	22	kN/m^2

2.1.1 Maximum shear force at base

	Coefficient	=	0.219	
Maximum shear force at SLS		=	0.21944 x 22 x 2.2	
		=	10.63	kN
Maximum shear force at ULS [γ_F=1.2]		=	1.2x10.63	
		=	12.76	kN

2.1.2 Maximum Bending moment at base

	Coefficient	=	0.023	
Maximum bending moment at SLS		=	0.023488 x 22 x 2.2^2	
		=	2.51	kN-m
Maximum bending moment at ULS [γ_F=1.2]		=	1.2x2.51	
		=	3.012	kN-m

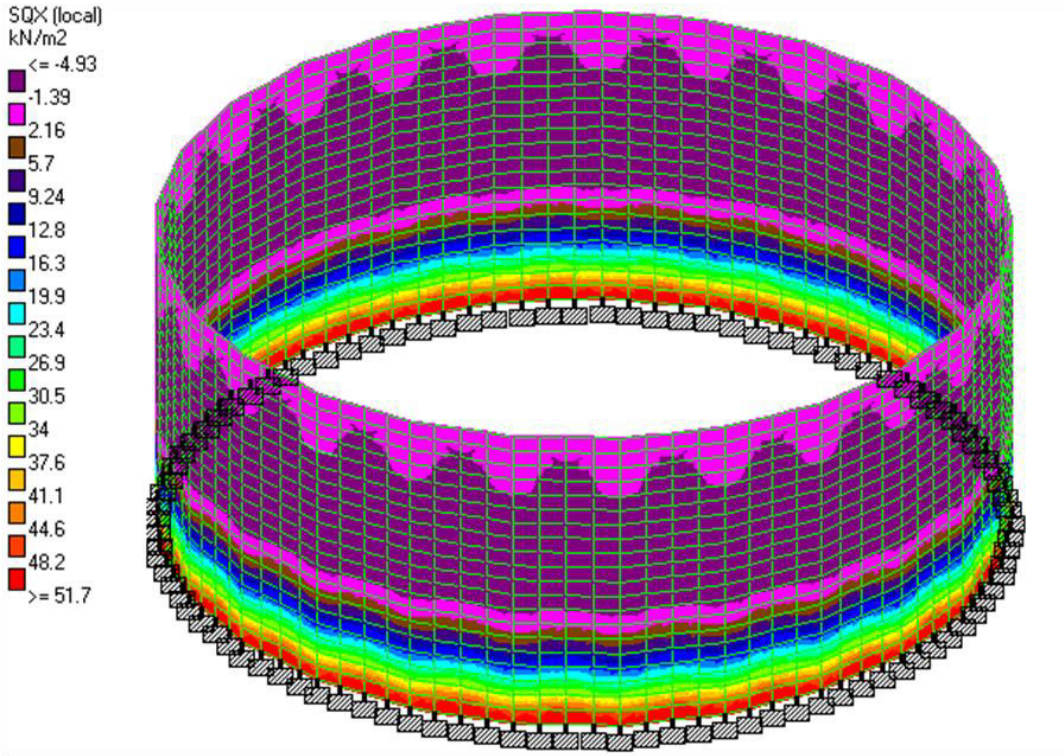
2.1.3 Maximum Ring tension at middle

	Coefficient	=	0.464	
Maximum ring tension at SLS		=	0.46356 x 22 x 2.85	
		=	29.07	kN
Maximum ring tension at ULS [γ_F=1.2]		=	1.2x29.07	
		=	34.88	kN

2.2 FINITE ELEMENT METHOD

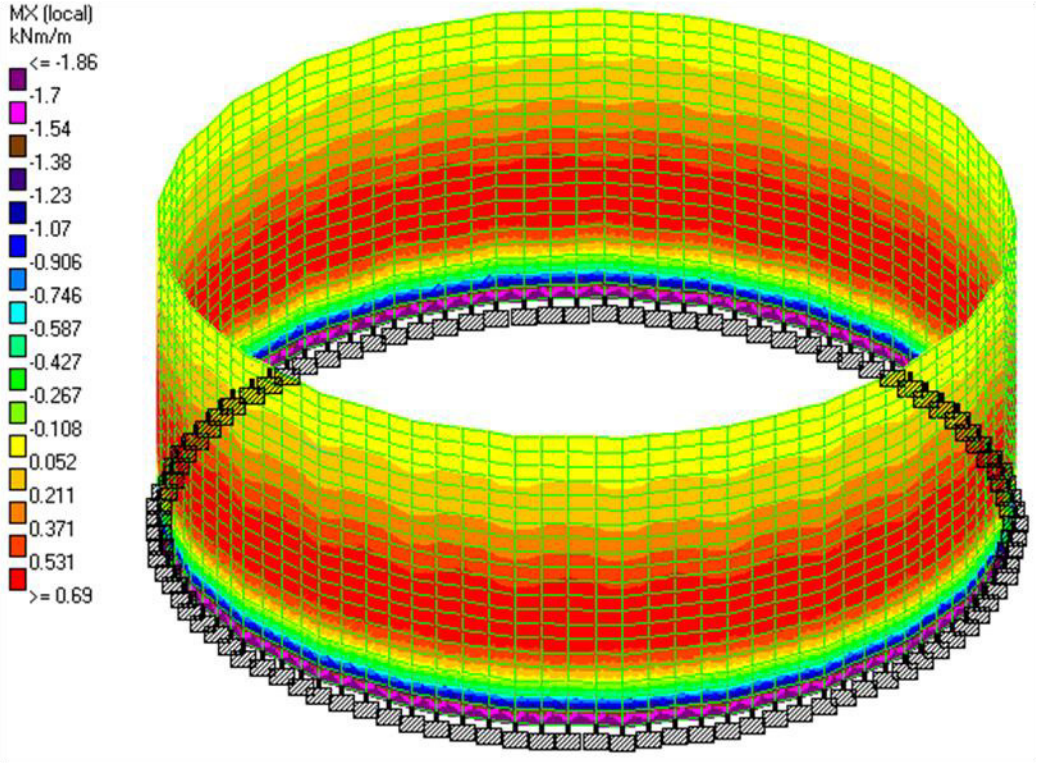
2.2 A CIRCULAR WALL

2.2.1 Maximum shear force at base



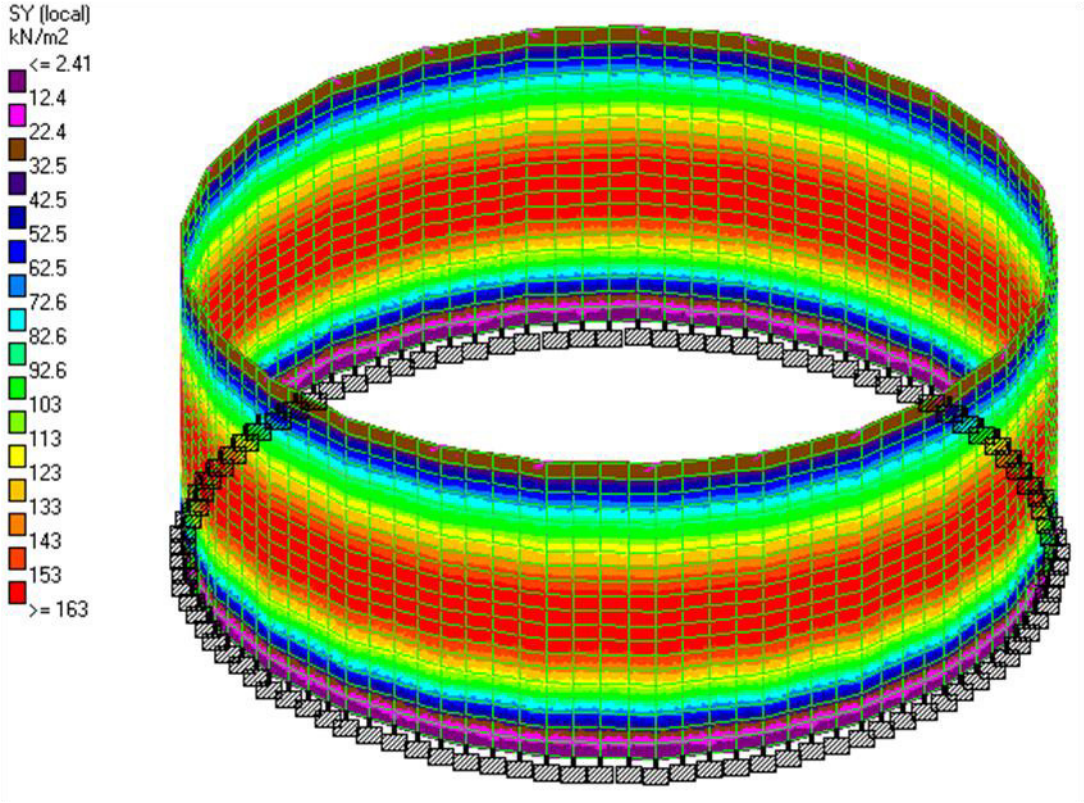
Maximum shear force at SLS	=	51.7	kN/m^2
Maximum shear force at SLS	=	9.306	kN
Maximum shear force at ULS [γ_F=1.2]	=	1.2x9.306	
	=	11.17	kN

2.2.2 **Maximum Bending moment at base**



Maximum bending moment at SLS	=	1.86	kNm
Maximum bending moment at ULS [γ_F=1.2]	=	1.2x1.86	
	=	2.232	kN

2.2.3 Maximum Ring tension at middle



Maximum ring tension at SLS	=	163	kN/m^2
Maximum ring tension at SLS	=	29.34	kN
Maximum ring tension at ULS [γ_F=1.2]	=	1.2x29.34	
	=	35.21	kN

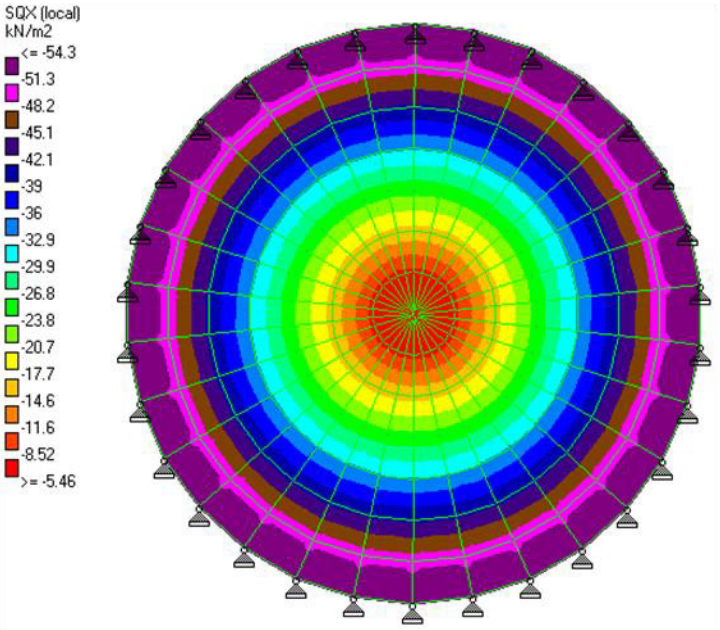
Comparing the analysis results obtained from manual and finite element method, the result from Manuel method considered for structural design.

2.2 B TOP SLAB

Load combination = 1.35DL+1.5LL

Live load considered = 1 kN/m^2

2.2.1 Maximum shear force

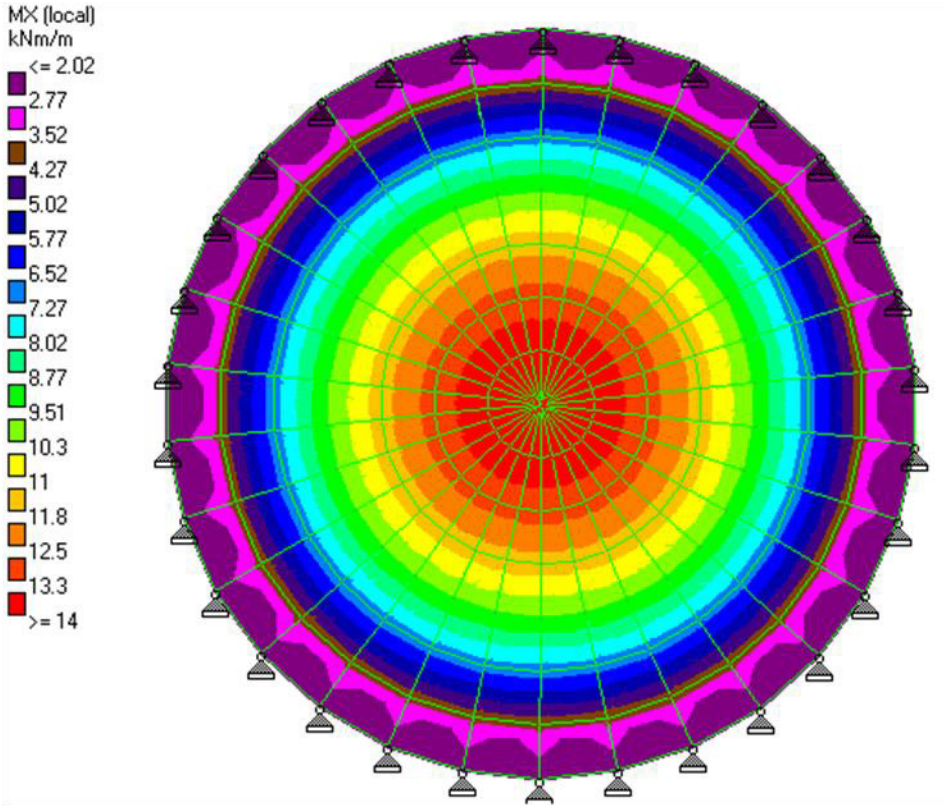


Maximum shear force at SLS = 54.3 kN/m^2

Thickness of top slab = 180 mm

Maximum shear force at ULS = 9.774 kN

2.2.2 Maximum Bending moment

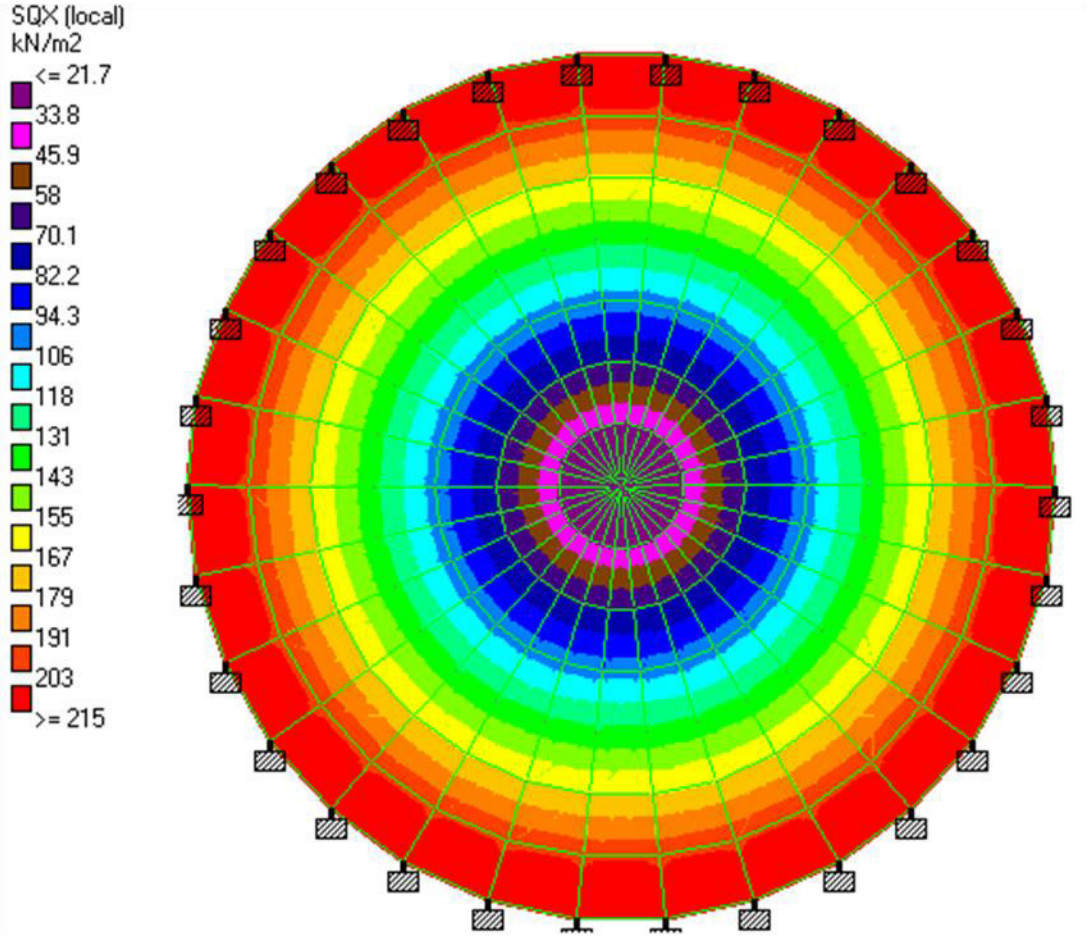


About both X & Y axis

Maximum bending moment at ULS = 14 kN

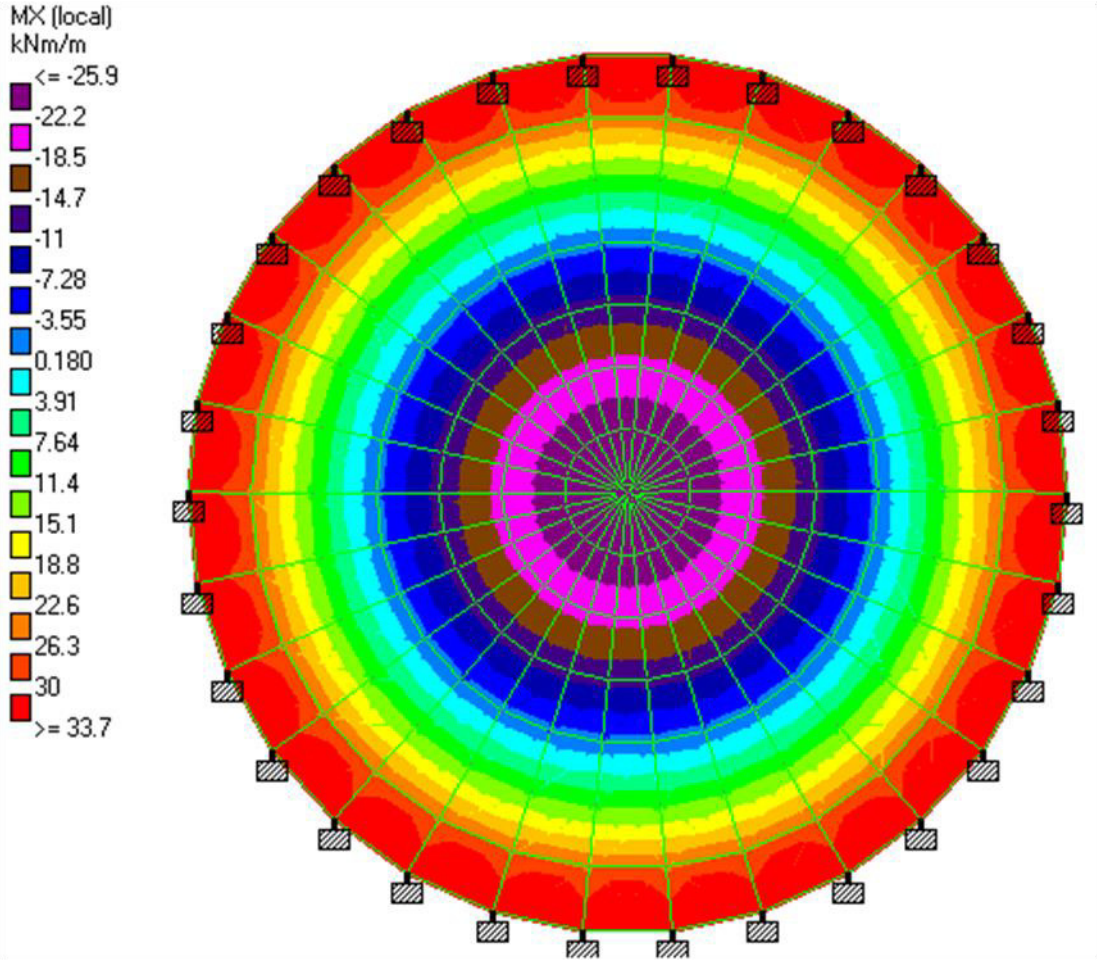
2.2 C **BASE SLAB**

2.2.1 Maximum shear force



Maximum shear force at ULS	=	215	kN/m^2
Thickness of top slab	=	225	mm
Maximum shear force at ULS	=	48.38	kN

2.2.2 Maximum moment



About both X & Y axis

Design support moment at ULS	=	33.7	kNm
Design span moment at ULS	=	26	kNm
Design support moment at SLS	=	27	kNm
Design span moment at SLS	=	21	kNm

3A DESIGN OF CIRCULAR WALL FOR CRACK

3.1 Preliminary data

Grade of Concrete		=	**C30**	
Grade of Steel		=	**S400**	
Cylin.Com. strength of concrete	f_{ck}	=	24	N/mm^2
Ten. Strength of steel	f_{yk}	=	400	N/mm^2
Design strength of concrete	f_{cd}	=	$0.85 \times f_{ck}/\gamma_c$	
		=	0.85 x 24 / 1.5	
		=	13.6	N/mm^2
Design strength of steel rein.	f_{yd}	=	f_{yk} / γ_s	
		=	400 / 1.15	
		=	347.8	N/mm^2
Consider 1m Width of wall	b	=	1000	mm
Overall thickness of wall provided	h_{pro}	=	180	mm
Assume clear cover	c	=	40	mm
Effective thickness of wall provided	d_{pro}	=	136	mm
Height of the tank	H	=	2.2	m
Hydraulic head	h_o	=	2.2	m
For flexure				
Diameter of bar for bending	ϕ	=	8	mm
Provided spacing of bar	S	=	135	mm
For Pure tension				
Diameter of bar for pure tension	ϕ	=	10	mm
Provided spacing of bar	S	=	85	mm

3.2 CRACK WIDTH CALCULATION FOR LOADING STAGE - FLEXURE & RING TENSION MATERIAL PROPERTY

Secant modulus of elasticity of concrete

$E_{cm} = 22[0.8+0.1f_{ck}]^{0.3}$

22x[0.8+(0.1x24)]^0.3

$= 31.19$ Gpa

Assume creep coefficient $\phi = 1.5$

Long term $E_c = E_{cm} / (1+\phi)$

31.19/(1+1.5)

$= 12.48$ GPa

Modulus of elasticity of steel $Es = 200$ GPa

$\alpha_e = Es/Ec$

$= 200/12.476$

3.2.A CRACK WIDTH CALCULATION FOR LOADING STAGE - FLEXURE ONLY

[EN-1992-1-1: 7.3.4]

3.2.1 MINIMUM STEEL FOR LOADING-FLEXURE

As,min = KcKfct,effAct/fyk

K = 1.00 for h ≤ 300 mm

K = 0.65 for h ≥ 800 mm

Interpolate the value of k. K = 1

Act = b x h

= 180000 mm2

For flexure Kc = 0.5

fct,eff = fctm

= 0.3fck0.67

= 2.53 Mpa

As, min = 569.25 mm2

Min. area of steel required for two faces as, req, 2 = 569.25 mm2

Min. area of steel required for one face As,req,1 = 284.625 mm2

Required spacing of bar S req. = 176.5129556 mm

Area of steel provided for one face As, pro = 372.15 mm2

As, pro > As, req, 1

Hence provided steel is sufficient to resist crack due to bending

3.2.2 MAXIMUM CRACK SPACING & ACTUAL CRACK WIDTH

3.2.2.1 Calculation of concrete & steel stresses

Depth of neutral axis

$1/2\ b\ X2 = \alpha e As\ (d-X)$

$X = 34.76$ mm

Lever arm $Z = d-(X/3)$

$= 136-(34.76/3)$

$= 124.42$ mm

Moment at base at serviceability limit state

$M = 1.86$ kNm/m

Stress in the tension steel $\sigma s = M/Asz$

$= 1.86x10^6/372.15x124.42$

$= 40.17026751$ MPa

Stress in the concrete $\sigma c = 2M/bz$

$= 2 \times 1.86 \times 10^6 / 1000 \times 34.76 \times 124.42$

$= 0.860147587$ MPa

Effective depth of concrete surrounding the reinforcement

$hc,eff = \min[2.5(h-d); (h-x); 0.5h]$

= 55.58 mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete Ac, eff. = hc, eff. b

= 55580 mm2

Effective reinforcement ratio ρp,eff = AS/Ac,eff

= 0.01

fct,eff = fctm

= 0.3fck0.67

= 2.522683616 Mpa

For long term loading Kt = 0.4

3.2.2.2 Calculation of mean strain in reinforcement - mean strain in concrete

[EN-1992-1-1: 7.9]

εsm-εcm = [σs-Kt (fct,eff/ρp,eff)(1+αe ρp,eff)]/Es >0.6σs/Es

= -0.00038 < 0.00012

εsm-εcm = 0.00012

3.2.2.3 Calculation of maximum crack spacing

[EN-1992-1-1: 7.11]

Sr,max = k3c+k1k2k4ϕ/ρp,eff

For high bond bars k1 = 0.8

For bending k2 = 0.5

k3 = 3.4

k4 = 0.425

Sr,max = (3.4x40)+(0.8x0.5x0.425x8/0.01)

= 272 mm

3.2.2.4 Calculation of actual crack width

[EN-1992-1-1: 7.8]

Wk,act = Sr,max x (εsm-εcm)

= 272x0.000121

= 0.032912 mm

3.2.2.5 Calculation of permissible crack width

Tightness class = Choose tightness class 1

Wk,per= 0.2 for ho/h ≤ 5

Wk,per= 0.05 for ho/h ≥ 35

h/ho = 1

Using interpolation Permissible crack width

Wk,per= 0.2 mm

> Wk,act

This is an acceptable crack width, **Satisfied**

3.2 B CRACK WIDTH CALCULATION FOR LOADING STAGE - RING TENSION ONLY

3.2.1 MINIMUM STEEL FOR LOADING-DIRECT TENSION

[EN-1992-1-1: 7.1]

As, min = KcKfct,effAct/fyk

K = 1 for h ≤ 300 mm

K = 0.65 for h ≥ 800 mm

Interpolate the value of k. K = 1

Act = b x h

= 180000 mm2

For pure tension Kc = 1

fct,eff = fctm

= 0.3fck0.67

= 2.522683616 Mpa

As, min= 1135.207627 mm2

Min. area of steel required for two face As,req,2= 1135.207627 mm2

Min. area of steel required for one face	As,req,1=	567.6038137	mm2	
Required spacing of bar	S req.	=	138.3006916	mm
Min. area of steel provided for one face	As,pro	=	923.5294118	mm2
	As,pro	>	As,req,1	

Hence provided steel is sufficient to resist crack due to direct tension

3.2.2 MAXIMUM CRACK SPACING & ACTUAL CRACK WIDTH

3.2.2.1 Calculation of concrete & steel stresses

Maximum ring tension occur at mid height at SLS

T = 300 kN/m

Stresses in tension reinforcement by assuming cracked section

All the tension is resisted by steel

Stress in the tension steel	σs	=	T/As
		=	300x10^3/(2x923.529411764706)
Stress in the concrete	σs	=	162.4203822 MPa
	hc,eff	=	min[2.5(h-d); 0.5h]
		=	90 mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete	Ac,eff	=	hc,eff b
		=	90000 mm2
Effective reinforcement ratio	ρp,eff	=	AS/Ac,eff
		=	0.02
	fct,eff	=	fctm
		=	0.3fck0.67

= 2.522683616 Mpa

For long term loading Kt = 0.4

3.2.2.2 Calculation of mean strain in reinforcement - mean strain in concrete

[EN-1992-1-1: 7.3.4]

$\varepsilon sm-\varepsilon cm = [\sigma s-Kt\ (fct,eff/\rho p,eff)(1+\alpha e\ \rho p,eff)]/Es > 0.6\sigma s/Es$

$= 0.000479 < 0.000487261$

$\varepsilon sm-\varepsilon cm = 0.00048727$

3.2.2.3 Calculation of maximum crack spacing

Maximum crack spacing, Sr, max $= k3c+k1k2k4\phi/\rho p,eff$ [EN-1992-1-1: 7.11]

For high bond bars k1 = 0.8

For pure tension k2 = 1

k3 = 3.4

k4 = 0.425

Sr,max = (3.4x40)+(0.8x1x0.425x10/0.02)

= 306 mm

3.2.2.4 Calculation of actual crack width

[EN-1992-1-1: 7.8]

Wk,ac t = Sr,max x (εsm-εcm)

= 306x0.00048727

= 0.14910462 mm

3.2.2.5 Calculation of permissible crack width [EN-1992-3-7.3.1]

Tightness class = Choose tightness class 1

Permissible crack width

Wk, per = 0.2 mm

> Wk, act

This is an acceptable crack width, Satisfied

CONCLUSION: Minimum requirements as per code - each face & each direction

For flexure

Actual crack width	=	0.032912	mm
Diameter of bar	=	8	mm
Spacing of bar	=	135	mm

For pure tension

Actual crack width	=	0.14910462	mm
Diameter of bar	=	10	mm
Spacing of bar	=	85	mm

3B DESIGN OF CIRCULAR WALL FOR LOADING

3.1 DESIGN FOR VERTICAL BENDING AT FIXED BASE

3.1.1 Calculation of reinforcement to resist bending causing tension

Moment at base at serviceability limit state

M = 1.86 kNm/m

Maximum bending moment causing tension on inner face at base at ULS [ϒf=1.2]:

M = 2.232 kNm/m

k = M/bd2fck < 0.167

= 0.00503

Calculation of lever arm Z/d = 0.5[1+√(1-3k/ŋ)]

= 0.5 x [1+√(1-(3x0.00503/1))]

= 0.997

Total reinforcement required to resist cantilever bending

As = M/[0.87fykz]

= 2.232x10^6/(0.87x400x0.997x136)

= 47.30214986 mm2

Area of steel for bending As,req = 47.30214986 mm2

Spacing of bars for bending	Sreq	=	1062.108174	mm
Minimum spacing of bar for crack control		=	135	mm
Required spacing of bar		=	135	mm
Provided spacing of bar		=	135	mm

Hence safe

Provided area of steel As,pro = 372.15 mm2

3.1.2 Check the effective thickness of wall to resist bending causing compression

Required effective thickness of slab to resist bending

dreq = √(M/0.196bfck

= √[2.232x10^6/(0.196x1000x24)]

= 21.78278669 mm

< dpro

Hence provided wall thickness is sufficient to resist compression due to bending

3.2 DESIGNS FOR SHEAR AT BASE

3.2.1 Check the adequacy of the thickness to resist shear

Maximum shear force at base at SLS

V = 9.306 kN

Maximum shear force at base at ULS [ϒf=1.2]:

VED = 11.1672 kN

Lever arm, approximately z = 0.98d

= 133.28 mm

υ_1 = 0.6(1-fck/250)

= 0.5424

For non-pre-stressed structures

αcw = 1

Conservatively assume cotΘ=1

Crushing strength of the concrete diagonal strut

[EN-1992-1-1: (6.9)]

$V_{RD,max} = 0.9d\ \alpha_{cw} b_w 1 f_{cd}/(\cot\Theta+\tan\Theta)$

$= 451.450368$ kN

$>$ VED

Hence the provided thickness is sufficient to resist compression due to shear

3.2.2 Check whether shear reinforcement can be avoided

[EN-1992-1-1: 6.2.2 (1)]

$C_{Rd,c} = 0.18/\gamma_c = 0.18/1.5$

$= 0.12$

$k = 1+\sqrt{(200/d)} \leq 2.0$

$= 1+\sqrt{(200/136)}$

$= 2.212678125 > 2$

$= 2$

$100\rho_l = 100\ A_{sl}/bd \leq 2$

$= 100x372.15/(1000x136) \leq 2$

$= 0.273639706 \leq 2$

$= 0.28$

$V_{min} = 0.035K^{1.5}\sqrt{f_{ck}}$ [EN-1992-1-1: 6.3N]

$= 0.035x2^{1.5}x\sqrt{(24)}$

$= 0.484974226$

The shear capacity of the concrete without any shear reinforcement

[EN-1992-1-1: 6.2a]

$V_{Rd,c} = C_{Rd,c}K[100\rho_l f_{ck}]^{1/3}bd \geq V_{min}\ bd$

$= 0.12x2x\ (0.28x24)^{(0.34)}x1000x136/1000$

$= 61.6$ kN $<$ 65.95649475 kN

$= 61.6$ kN

$V_{Rd,c} >$ VRE

Hence the provided depth is sufficient to resist tension due to shear without shear reinforcement

3.3 DESIGN FOR RING TENSION AT MIDDLE

Direct tension at ULS = 35.208 kN

Total direct tension at ULS [Yf=1.2]

T = 1.2 x 35.208

= 42.2496 kN

Total reinforcement required to resist direct tension

As = T/0.87x fy

= 42.2496x1000/(0.87x400)

= 121.4068966 mm3/m

Area of steel for direct tension

As,req,2 = 121.4068966 mm2

For one face As,req,1 = 60.70344828 mm2

Spacing of bar for direct tension S = 1293.172006 mm

Minimum spacing of bar for crack control S min = 85 mm

Required spacing of bar S req. = 85 mm

Provided spacing of bar S pro. = 85 mm

> S req.

Hence satisfied

Provided area of steel As, pro= 923.5294118

Minimum steel

Minimum area of steel for each face & each direction

= 0.2%Ac

= 360 mm2

Vertical bar above 0.2h from base -inner face

Diameter of bar = 8 mm

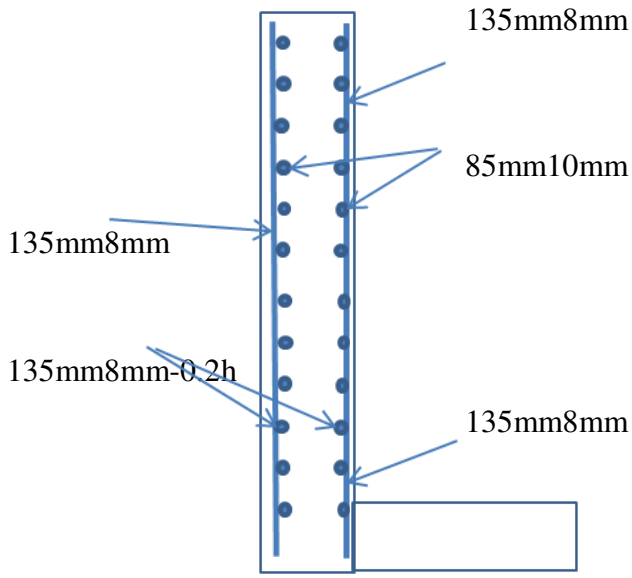
Required spacing	=	139.5555556	mm
Provided spacing of bar	=	135	mm

Vertical bar - outer face

Diameter of bar	=	8	mm
Required spacing	=	139.5555556	
Provided spacing of bar	=	135	mm

Horizontal bar up to 0.2h from base

Diameter of bar	=	8	mm
Required spacing	=	139.5555556	
Provided spacing of bar	=	135	mm



4 DESIGN OF TOP SLAB

4.1 Preliminary data

Grade of Concrete		=	C30	
Grade of Steel		=	S400	
Cylin.Com. strength of concrete, fck		=	24	N/mm2
Tensile Strength of steel	fyk	=	400	N/mm2
Design strength of concrete	fcd	=	0.85 x fck/ɣc	
		=	0.85 x 24 / 1.5	
		=	13.6	N/mm2
Design strength of steel rein.	fyd	=	fyk / ɣs	
		=	400 / 1.15	
		=	347.826087	N/mm2

Consider 1m Width of slab	b	=	1000	mm
Overall thickness of slab provided	h pro.	=	180	mm
Assume clear cover	c	=	25	mm
Effective thickness of slab provided	d pro.	=	151	mm

4.2 DESIGN FOR BENDING

BOTTOM REINFORCEMENT [EN-1992-1-1: 9.2.1.1]

Diameter of bar for bending	ϕ	=	8	mm
Design bending moment at ULS				
	M	=	14	kNm/m
	k	=	M/bd2fck <0.167	
		=	0.026	
Calculation of lever arm	Z/d	=	0.5[1+√(1-3k/ɳ)]	
		=	0.5 x [1+√(1-(3x0.026/1))]	

= 0.981

Reinforcement required resisting bending

As = M/[0.87fykz]

= 14x10^6/(0.87x400x0.981x151)

Area of steel for bending As = 271.59 mm2

Minimum area of steel As, min ≥ 0.26 fctm / fyk b d ≥ 0.0013 b d

fct,eff = fctm [EN-1992-1-1: (9.1N)]

= 0.3fck0.67

= 2.522683616 MPa

As,min = 247.6013969 > 196.3 mm2

Area of steel for required Areq = 271.59 mm2

Spacing of bars required Sreq = 184.9847196 mm

Maximum spacing of bar

Smax = 3h ≤ 400mm [EN-1992-1-1: 9.3.1.1(3)]

= 400 mm

Provided spacing of bar = 150 mm

Hence safe

Provided area of steel As, pro = 334.94 mm2

Check the effective thickness of wall to resist bending causing compression

Required effective thickness of slab to resist bending

dreq = √(M/kbfck

= √[14x10^6/(0.026x1000x24)]

= 149.7861724 mm

< d pro.

Hence provided wall thickness is sufficient to resist compression due to bending

4.3 DESIGN FOR SHEAR

Check the adequacy of the thickness to resist shear

Design shear force at base

VED = 9.774 kN

Lever arm, approximately z = 0.98d

= 147.98 mm

$\upsilon 1$ = 0.6(1-fck/250)

= 0.5424

For non-pre-stressed structures

αcw = 1

Conservatively assume cotΘ=1

Crushing strength of the concrete diagonal strut

[EN-1992-1-1: (6.9)]

VRD, max = 0.9d αcw$b\upsilon 1$fcd/(cotΘ+tanΘ)

= 501.242688 kN

> VED

Hence the provided thickness is sufficient to resist compression due to shear

Check whether shear reinforcement can be avoided

[EN-1992-1-1: 6.2.2 (1)]

CRd,c = 0.18/γc= 0.18/1.5

= 0.12

k = 1+√(200/d) ≤2.0

= 1+√(200/151)

= 2.150870675 > 2

= 2

100ρl = 100 Asl/bd ≤2

= 100x334.94/(1000x151) ≤ 2

= 0.22181457 ≤ 2

= 0.23

Vmin = 0.035K1.5√fck [EN-1992-1-1: 6.3N]

= 0.035x2^1.5x√(24)

= 0.484974226

The shear capacity of the concrete without any shear reinforcement

[EN-1992-1-1: 6.2a]

VRd,c = CRd,cK[100ρl fck]1/3bd ≥ Vmin bd

= 0.12x2x(0.23x24)^(0.34)x1000x151/1000

= 64.05 kN < 73.23110814 kN

= 64.05 kN

VRd,c > VRE

Hence the provided depth is sufficient to resist tension due to shear without shear reinforcement

4.4 CHECK FOR DEFLECTION

[EN-1992-1-1: (7.16a)]

Limiting span to depth ratio L/d = K[11+1.5√fckρo/ρ+3.2√fck(ρo/ρ-1)3/2]

For simply supported slab K = 1 [EN-1992-1-1: 7.4N]

The reference reinforcement ratio ρo = 0.1√fck

= 0.489897949

Required tension reinforcement ratio at mid span

ρ = 0.180

Basic L/d, limit = 66.42

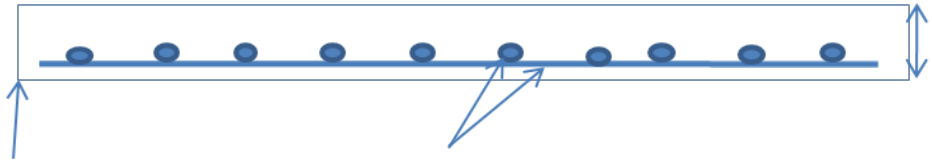
Modified L/d, limit = 66.42x334.94/271.59

= 81.91286424

Actual span to depth ratio L/d, actual = 37.74834437

< L/d,limit

Hence the provided depth is sufficient to resist deflection



5 DESIGN OF TOP SLAB

5.1 Preliminary data

Grade of Concrete		=	C30	
Grade of Steel		=	S400	
Cylin.Com. strength of concrete	fck	=	24	N/mm2
Tensile Strength of steel	fyk	=	400	N/mm2
Design strength of concrete	fcd	=	0.85 x fck/ɣc	
		=	0.85 x 24 / 1.5	
		=	13.6	N/mm2
Design strength of steel rein.	fyd	=	fyk / ɣs	
		=	400 / 1.15	
		=	347.826087	N/mm2
Consider 1m Width of slab	b	=	1000	mm
Overall thickness of slab provided	h pro.	=	225	mm
Assume clear cover	c	=	40	mm
Effective thickness of slab provided	d pro.	=	181	mm
Height of the tank	H	=	2.2	m
Hydraulic head	ho	=	2.2	m
Bottom reinforcement				
Diameter of bar upward bending		=	8	mm
Provided spacing of bar	S	=	70	mm

Top reinforcement

Diameter of bar for downward bending ϕ = 8 mm

Provided spacing of bar S = 140 mm

5.2 CRACK WIDTH CALCULATION FOR LOADING STAGE - FLEXURE

[EN-1992-1-1: 7.3.4]

MATERIAL PROPERTY

Secant modulus of elasticity of concrete,

Ecm = 22[0.8+0.1fck]0.3

= 22x[0.8+(0.1x24)]^0.3

= 31.19 Gpa

Assume creep coefficient ϕ = 1.5

Long term Ec = Ecm / (1+ϕ)

= 31.19/(1+1.5)

= 12.476 GPa

Modulus of elasticity of steel , Es = 200 GPa

αe = Es/Ec

= 200/12.476

= 16.0307791

5.2.1 MINIMUM STEEL FOR LOADING-FLEXURE

As,min. = KcKfct,effAct/fyk

K = 1 for h ≤ 300 mm

K = 0.65 for h ≥ 800 mm

Interpolate the value of k. K = 1

Act = b x h

= 225000 mm2

For flexure Kc = 0.5

fct,eff = fctm

= 0.3fck0.67

		=	2.53	Mpa
	As, min.	=	711.5625	mm2

Bottom reinforcement

Min. area of steel required	As, req.	=	711.5625	mm2
Required spacing of bar	S req.	=	70.60518226	mm
Area of steel provided for one face	As, pro.	=	717.72	mm2
	As, pro	>	As, req.	

Hence provided steel is sufficient to resist crack due to bending

Top reinforcement

Min. area of steel required	As, req.	=	711.5625	mm2
Required spacing of bar	S req.	=	70.60518226	mm
Area of steel provided for one face	As, pro	=	358.8571429	mm2
	As, pro	<	As, req.	

5.2.2 MAXIMUM CRACK SPACING & ACTUAL CRACK WIDTH

Bottom reinforcement [Support moment]

Calculation of concrete & steel stresses

Depth of neutral axis

$$1/2\ b\ X2 = \alpha e As\ (d-X)$$

	X	=	54.05	mm
Lever arm	Z	=	d-(X/3)	
		=	181-(54.05/3)	
		=	162.99	mm

Support Moment at serviceability limit state

	M	=	27	kNm/m
Stress in the tension steel	σs	=	M/Asz	
		=	27x10^6/717.72x162.99	
		=	230.8063515	MPa
Stress in the concrete	σc	=	2M/bxz	
		=	2 x 27 x 10^6 / 1000 x 54.05 X 162.9	
		=	6.129670106	MPa

Effective depth of concrete surrounding the reinforcement

	hc,eff	=	min[2.5(h-d); (h-x); 0.5h]
		=	110 mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete	Ac,eff	=	hc,eff b			
		=	110000			mm2
Effective reinforcement ratio	ρp,eff	=	AS/Ac,eff			
		=	0.01			
			fct,eff	=	fctm	
				=	0.3fck0.67	
				=	2.522683616	Mpa

For long term loading	Kt	=	0.4

Calculation of mean strain in reinforcement - mean strain in concrete

[EN-1992-1-1: 7.9]

εsm-εcm	=	[σs-Kt (fct,eff/ρp,eff)(1+αe ρp,eff)]/Es >0.6σs/Es

= 0.000568614 < 0.000692419

εsm-εcm = 0.000693

Calculation of maximum crack spacing

[EN-1992-1-1: 7.11]

Sr, max = k3c+k1k2k4ϕ/ρp,eff

For high bond bars k1 = 0.8

For bending k2 = 0.5

k3 = 3.4

k4 = 0.425

Sr, max = (3.4x40)+(0.8x0.5x0.425x8/0.01)

= 272 mm

Calculation of actual crack width

[EN-1992-1-1: 7.8]

Wk,act = Sr,max x (εsm-εcm)

= 272x0.000693

= 0.188496 mm

Calculation of permissible crack width

Tightness class = Choose tightness class 1

Wk,per = 0.2 for ho/h ≤ 5

Wk,per = 0.05 for ho/h ≥ 35

h/ho = 1

Using interpolation Permissible crack width

Wk,per. = 0.2 mm

> Wk,act

This is an acceptable crack width, Satisfied

Top reinforcement [Field moment]

Calculation of concrete & steel stresses

Depth of neutral axis

$1/2\ b\ X^2 = \alpha e As\ (d-X)$

	X	=	40.25	mm
Lever arm	Z	=	d-(X/3)	
		=	181-(40.25/3)	
		=	167.59	mm

Field Moment at serviceability limit state

	M	=	21	kNm/m
Stress in the tension steel	σs	=	M/Asz	
		=	21x10^6/358.857142857143x167.59	
		=	349.1801914	MPa
Stress in the concrete	σc	=	2M/bxz	
		=	2 x 21 x 10^6 / 1000 x 40.25 X 167.59	
		=	6.226375445	MPa

Effective depth of concrete surrounding the reinforcement

	hc, eff.	=	min[2.5(h-d); (h-x); 0.5h]
		=	110 mm

Effective area of concrete surrounding the reinforcement

Effective tension area of concrete	Ac,eff	=	hc,eff b	
		=	110000	mm2

Effective reinforcement ratio	ρp,eff	=	AS/Ac,eff	
		=	0.01	
	fct,eff	=	fctm	
		=	0.3fck0.67	
		=	2.522683616	Mpa
For long term loading	Kt	=	0.4	

Calculation of mean strain in reinforcement - mean strain in concrete

[EN-1992-1-1: 7.9]

εsm-εcm	=	[σs-Kt (fct,eff/ρp,eff)(1+αe ρp,eff)]/Es >0.6σs/Es			
	=	0.001160483	>	0.001047541	
εsm-εcm	=	0.001161			

Calculation of maximum crack spacing

[EN-1992-1-1: 7.11]

$S_{r,max} = k_3c + k_1k_2k_4\phi/\rho_{p,eff}$

For high bond bars $k_1 = 0.8$

For bending $k_2 = 0.5$

$k_3 = 3.4$

$k_4 = 0.425$

``$S_{r,max} = (3.4x)+(0.8x0.5x0.425x162.99/0.01)$

$= 136$ mm

Calculation of actual crack width

[EN-1992-1-1: 7.8]

$W_{k,act.} = S_{r,max} \times (\varepsilon_{sm}-\varepsilon_{cm})$

$= 136x0.001161$

$= 0.157896$ mm

Calculation of permissible crack width

Tightness class = Choose tightness class 1

$W_{k,per.} = 0.2$ for ho/h ≤ 5

$W_{k,per.} = 0.05$ for ho/h ≥ 35

h/ho = 1

Using interpolation Permissible crack width

$W_{k,per.} = 0.2$ mm

$> W_{k,act}$

This is an acceptable crack width, Satisfied

5.3 DESIGN FOR BENDING

BOTTOM REINFORCEMENT [SUPPORT MOMENT]

[EN-1992-1-1: 9.2.1.1]

Diameter of bar for bending $\phi = 8$ mm

Design bending moment at ULS $M = 33.7$ kNm/m

	k	=	M/bd2fck <0.167	
		=	0.043	
Calculation of lever arm	Z/d	=	0.5[1+√(1-3k/η)]	
		=	0.5 x [1+√(1-(3x0.043/1))]	
		=	0.967	
Reinforcement required resisting bending				
	As	=	M/[0.87fykz]	
		=	33.7x10^6/(0.87x400x0.967x181)	
Area of steel for bending	As	=	553.29 mm2	
Minimum area of steel	As,min	≥	0.26 fctm / fyk b d ≥ 0.0013 b d	

fct,eff	=	fctm		[EN-1992-1-1: (9.1N)]	
	=	0.3fck0.67			
	=	2.522683616	MPa		
As,min	=	296.7937275	>	235.3	mm2

Area of steel for required	Areq	=	553.29 mm2	
Spacing of bars required	Sreq	=	90.80229175	mm
Maximum spacing of bar	Smax	=	3h ≤ 400mm	[EN-1992-1-1: 9.3.1.1(3)]
		=	400 mm	
Provided spacing of bar		=	70 mm	
	Hence safe			
Provided area of steel	As,pro	=	717.72 mm2	

TOP REINFORCEMENT [FIELD MOMENT] [EN-1992-1-1: 9.2.1.1]

Diameter of bar for bending	ϕ	=	8	mm
Design bending moment at ULS	M	=	26	kNm/m
	k	=	M/bd2fck <0.167	
		=	0.034	
Calculation of lever arm	Z/d	=	0.5[1+√(1-3k/η)]	
		=	0.5 x [1+√(1-(3x0.034/1))]	

			=	0.974	

Reinforcement required resisting bending

		As	=	M/[0.87fykz]	
			=	26x10^6/(0.87x400x0.974x181)	
Area of steel for bending		As	=	423.8	mm2
Minimum area of steel	As,min		≥	0.26 fctm / fyk b d ≥ 0.0013 b d	
	fct,eff	=	fctm		[EN-1992-1-1: (9.1N)]
		=	0.3fck0.67		
		=	2.522683616	MPa	
As,min	=	296.7937275	>	292.5	mm2
Area of steel for required	Areq	=	423.8	mm2	
Spacing of bars required	Sreq	=	118.5464842	mm	
Maximum spacing of bar	Smax	=	3h ≤ 400mm		[EN-1992-1-1: 9.3.1.1(3)]
		=	400	mm	
Provided spacing of bar		=	140	mm	
		Hence safe			
Provided area of steel	As,pro	=	358.86	mm2	

EFFECTIVE DEPTH TO RESIST BENDING

Required effective thickness of slab to resist bending

dreq	=	√(M/kbfck
	=	√[33.7x10^6/(0.167x1000x24)]
	=	91.69614841 mm
	<	dpro

Hence provided wall thickness is sufficient to resist compression due to bending

5.4 DESIGN FOR SHEAR AT BASE

Check the adequacy of the thickness to resist shear

Design shear force at base

VED = 48.375 kN

Lever arm, approximately z = 0.98d

= 177.38 mm

$\upsilon 1$ = 0.6(1-fck/250)

= 0.5424

For non-pre-stressed structures

αcw = 1

Conservatively assume cotΘ=1

Crushing strength of the concrete diagonal strut [EN-1992-1-1: (6.9)]

VRD,max = 0.9d αcwbυ1fcd/(cotΘ+tanΘ)

= 600.827328 kN

> VED

Hence the provided thickness is sufficient to resist compression due to shear

Check whether shear reinforcement can be avoided [EN-1992-1-1: 6.2.2 (1)]

CRd,c = 0.18/γc= 0.18/1.5

= 0.12

k = 1+√(200/d) ≤2.0

= 1+√(200/181)

= 2.051176662 > 2

= 2

100ρl = 100 Asl/bd ≤2

= 100x717.72/(1000x181) ≤ 2

= 0.396530387 ≤ 2

= 0.4

Vmin = 0.035K1.5√fck [EN-1992-1-1: 6.3N]

= 0.035x2^1.5x√(24)

= 0.484974226

The shear capacity of the concrete without any shear reinforcement

[EN-1992-1-1: 6.2a]

VRd,c = CRd,cK[100ρl fck]1/3bd ≥ Vmin bd

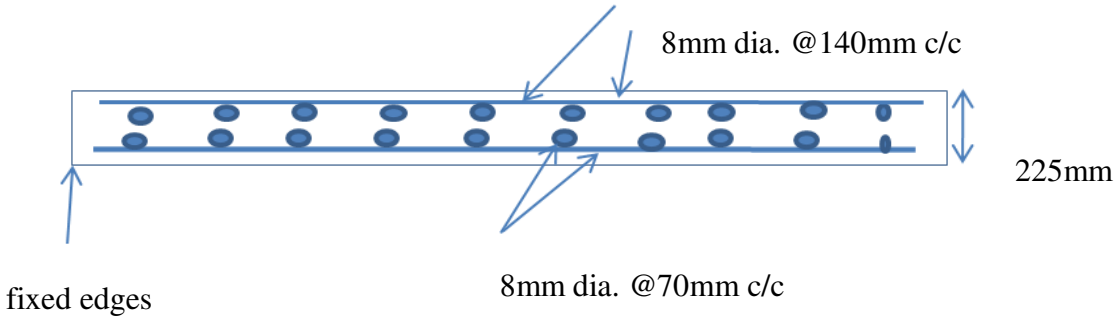
= 0.12x2x(0.4x24)^(0.34)x1000x181/1000

= 92.33 kN > 87.78033493 kN

= 87.78033493 kN

VRd,c > VRE

Hence the provided depth is sufficient to resist tension due to shear without shear reinforcement



6 CHECK FOR BASE PRESSURE

Consider 1m Width of slab	b	=	1000	mm
Overall thickness of wall provided	hpro	=	0.18	m
Inner diameter of tank	Di	=	5.65	m
Outer diameter of tank	Do	=	6.01	mm
Total height of the tank	H	=	2.7	m
Thickness of top slab	ht	=	0.18	m
Diameter of top slab	Dt	=	6.01	
Thickness of bottom slab	hb	=	0.225	m
Diameter of bottom slab	Db		6.61	

Dead load

Self weight of top slab		=	127.5942533	kN

Self weight of bottom slab	=	192.9279291	kN	
Self weight of circular wall	=	222.42033	kN	
Total dead load	=	542.9425123	kN	
Water load				
Total weight of water	=	676.5973875	kN	
Live load	=	28.3542785	kN	
Total load				
Total load due to DL,WP & LL	P	=	1247.894178	
Base Pressure				
Area of base	A	=	34.2982985	m2
Base pressure due to the total load		=	P/A	
	σ	=	36.38355933	kN/m2
Allowable Safe bearing capacity of soil at site				
	σSBC	=	100	kN/m2
		>	36.38355933	kN/m2

Hence safe

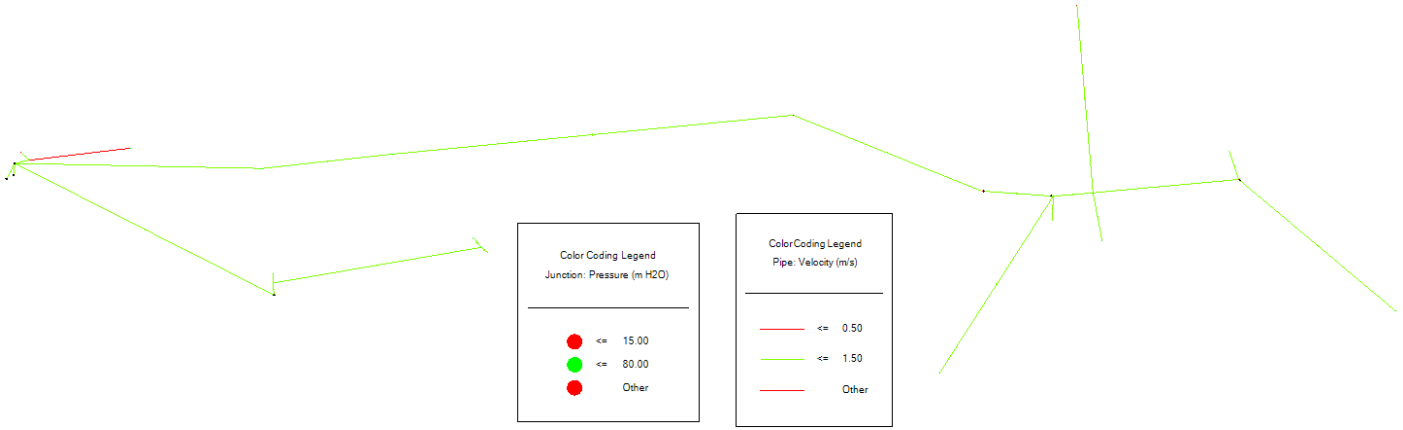
ANNEXURE-III

HYDRAULIC ANALYSIS/ WATER CAD REPORT

No.	CONTENT	DESCRIPTION
	I. GRAVITY DISTRIBUTION PIPE NETWORK	
1	HY-WCAD-001-A	PIPE NETWORK PREVIEW
2	HY-WCAD-001-B	SCENARIO SUMMARY REPORT
3	HY-WCAD-001-C	JUNCTION TABLE
4	HY-WCAD-001-D	PIPE TABLE
5	HY-WCAD-001-E	PRV TABLE
6	HY-WCAD-001-F	TANK TABLE
7	HY-WCAD-001-G	PIPES INVENTORY

1 HY-WCAD-001-A PIPE NETWORK PREVIEW

Scenario: Base



2. HY-WCAD-001-B SCENARIO SUMMARY REPORT

Scenario Summary Report
Scenario: Base

Scenario Summary	
ID	1
Label	Base
Notes	
Active Topology	Base Active Topology
Physical	Base Physical
Demand	Base Demand
Initial Settings	Base Initial Settings
Operational	Base Operational
Age	Base Age
Constituent	Base Constituent
Trace	Base Trace
Fire Flow	Base Fire Flow
Energy Cost	Base Energy Cost
Transient	Base Transient
Pressure Dependent Demand	Base Pressure Dependent Demand
Failure History	Base Failure History
SCADA	Base SCADA
User Data Extensions	Base User Data Extensions
Steady State/EPS Solver Calculation Options	Base Calculation Options
Transient Solver Calculation Options	Base Calculation Options

Hydraulic Summary			
Time Analysis Type	Steady State	Use simple controls during steady state?	True
Friction Method	Hazen-Williams	Is EPS Snapshot?	False
Accuracy	0.001	Start Time	12:00:00 AM
Trials	40	Calculation Type	Hydraulics Only

3 HY-WCAD-001-C JUNCTION TABLE

FlexTable: Junction Table

Label	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H20)
100M3 RESEVIOR	3.50	2,190.80	165.47
ABST	0.50	2,233.57	18.54
AKST	0.25	1,947.84	29.78
ARWP5	0.82	1,867.87	32.80
BCWP3	0.82	1,848.68	65.55
DDST	0.25	2,247.08	34.01
DWP1	0.82	2,267.47	15.44
GGWP2	0.82	2,247.94	42.86
GWP1	0.82	2,235.18	5.17
J-2	0.00	2,225.02	74.87
J-4	0.00	2,200.27	72.13
J-5	0.00	2,218.92	38.84
MH-1	0.00	2,235.85	2.85
MH-2	0.00	2,267.97	8.96
MH-3	0.00	2,248.65	37.57
MH-4	0.17	1,952.31	42.23
MH-5	0.00	1,948.34	49.24
MH-6	0.00	1,860.09	41.00
RCWP4	0.82	1,858.41	39.33
WWWP1	0.82	1,940.61	45.52
YWP2	0.82	1,945.61	42.53

4. HY-WCAD-001-D PIPE TABLE

FlexTable: Pipe Table

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Velocity (m/s)	Flow (L/s)
P-1	87	Godo Spring 1	WET WEEL	26.0	HDPE	150.0	1.42	0.75
P-2	60	Godo Spring 2	WET WEEL	26.0	HDPE	150.0	1.32	0.70
P-3	1,449	Dasa Dashole Spring	WET WEEL	51.4	HDPE	150.0	1.05	2.19
P-4	74	WET WEEL	MH-1	51.4	HDPE	150.0	0.64	1.32
P-5	60	MH-1	GWP1	40.8	HDPE	150.0	0.63	0.82
P-6	508	MH-1	ABST	40.8	HDPE	150.0	0.38	0.50
P-7	60	Dasa Dashole Spring	MH-2	51.4	HDPE	150.0	0.91	1.89
P-8	45	MH-2	DWP1	40.8	HDPE	150.0	0.63	0.82
P-9	1,053	MH-2	MH-3	40.8	HDPE	150.0	0.82	1.07
P-10	63	MH-3	GGWP2	40.8	HDPE	150.0	0.63	0.82
P-11	43	MH-3	DDST	20.4	HDPE	150.0	0.76	0.25
P-13	655	J-2	J-5	73.6	HDPE	150.0	0.82	3.50
P-14	2,003	J-5	J-4	73.6	HDPE	150.0	0.82	3.50
P-17	123	MH-4	AKST	20.4	HDPE	150.0	0.76	0.25
P-18	1,043	MH-4	WWWP1	40.8	HDPE	150.0	0.63	0.82
P-19	199	MH-4	MH-5	61.4	HDPE	150.0	1.11	3.28
P-20	243	MH-5	YWP2	40.8	HDPE	150.0	0.63	0.82
P-23	150	MH-6	RCWP4	40.8	HDPE	150.0	0.63	0.82
P-36	334	100M 3 RESERVOIR	10M3 PBT	90.0	HDPE	150.0	0.71	4.52
P-37	13	10M3 PBT	MH-4	90.0	HDPE	150.0	0.71	4.52
P-42	1,233	WET WEEL	J-2	73.6	HDPE	150.0	0.82	3.50
P-48	1,017	J-4	100M3 RESEVIOR	73.6	HDPE	150.0	0.82	3.50
P-79	1,017	MH-6	BCWP3	40.8	HDPE	150.0	0.63	0.82
P-80	300	MH-5	PRV-1	51.4	HDPE	150.0	0.79	1.64
P-81	429	PRV-1	MH-6	51.4	HDPE	150.0	0.79	1.64
P-82	350	MH-5	PRV-2	40.8	HDPE	150.0	0.63	0.82
P-83	586	PRV-2	ARWP5	40.8	HDPE	150.0	0.63	0.82

5. HY-WCAD-001-E PRV TABLE

FlexTable: PRV Table

ID	Label	Elevation (m)	Diameter (Valve) (mm)	Flow (L/s)	Hydraulic Grade (From) (m)	Hydraulic Grade (To) (m)	Headloss (m)
105	10M3 PBT	1,952.39	90.0	4.52	2,023.62	1,952.39	71.24
180	MH-8 PRV-1	1,865.72	51.4	1.64	1,944.40	1,865.72	78.67
183	MH-7 PRV-2	1,874.44	40.8	0.82	1,944.42	1,874.44	69.98

6. HY-WCAD-001-F TANK TABLE

FlexTable: Tank Table

ID	Label	Elevation (Base) (m)	Elevation (Minimum) (m)	Elevation (Initial) (m)	Elevation (Maximum) (m)	Flow (Out net) (L/s)	Hydraulic Grade (m)
81	100M 3 RESERVOIR	2,025.00	2,025.30	2,025.50	2,028.50	6.52	2,025.50
82	50M3 WET WEEL	2,236.00	2,236.30	2,236.50	2,238.50	3.18	2,236.50

7. HY-WCAD-001-G PIPES INVENTORY

Pressure Pipes Inventory

Diameter (mm)	Length (HDPE) (m)	Length (All Materials) (m)	Volume (m³)
20.4	166	166	0.05
26.0	147	147	0.08
40.8	5,118	5,118	6.69
51.4	2,311	2,311	4.80
61.4	199	199	0.59
73.6	4,908	4,908	20.88
90.0	348	348	2.21
All Diameters	13,197	13,197	35.30

ANNEXURE IV

BASELINE SURVEY QUESTIONNAIRE

I. Baseline data

1. What is the existing main source of water?
   - Borehole №…… Discharge……
   - Hand pump №…… Discharge…….
   - Well №…… Discharge…….
   - Other №…… Discharge…….
2. Connection profile
   - House connection (HC)
   - Yard connection (YCO)
   - Yard connection (YCS)
   - Public tap connection (PTC)
3. How many religious institutions are there?
   - Orthodox churches, №…… No of members ……
   - Protestant churches, № …… No of members ……
   - Mosques, № …… No of members…….
4. Non-residential demands
   - Hotels, restaurants & bars № …….. № of users/day……..
   - Offices № …… № of users/day……..
   - Factory № …… № of employees…….
5. What is the number of livestock?
   - Cattle's №……
   - Sheep's & goat's №r……..
6. Types of cash cops?
7. Schools?
   - Primary schools, №……..№ students & staff ……
   - Secondary schools №……№ of students & staff ……
8. How many health centers?
   - Health post, № of beds…….
   - Clinic № of beds…….
   - Hospital № of beds…….

9. Types ethnic groups in the community?
    - Sidama
    - Oromia
    - Amhara
    - Wolayita
    - Gurage
    - Gamo
    - Tigiria
    - Other
10. Distance from "Hawassa"(the regional capital)
    - Asphalt road ……..……km
    - Gravel road ……..…km
    - Mud road …..…….……km
11. Population
    - Total ……
    - Male ……..
    - Female ……..

II. Current Demand assessment

1. Are you satisfied with the current water supply situation?

2. How much water, from the main source above, does your family use per day in average in Dry Season and Rain Season, respectively?

3. What is your perception on water quality of the main source?

4. How far is the main water source from your house?

5. How often does your family fetch water from the main source?

6. Is the quantity of water adequate for daily consumption?

7. Is water available throughout the year?

ANNEXURE V

SUMMARY OF WATER DEMAND

Description	Unit	Base Population	Construction Period	Deign Period		
Year		**2019**	**2020**	**2025**	**2030**	**2035**
Population Growth Rate		3%	3%	3%	3%	3%
Per Capita Demand	l/c/d	25.00	25.00	25.00	25.00	25.00
Projected/Forecasted population	No.	6,150	6,335	7,343	8,513	9,869
Domestic water demand(DWD)	**m^3/d**	**153.75**	**158.36**	**183.59**	**212.83**	**246.72**
	l/s	**1.78**	**1.83**	**2.12**	**2.46**	**2.86**
Socio -Economic Factor		0.90	0.90	0.90	0.90	0.90
Climatic Factor		1.00	1.00	1.00	1.00	1.00
Adjusted Domestic Water Demand (AJDD) *[DWD*(a)*(b)]*	**m^3/d**	**138.38**	**142.53**	**165.23**	**191.54**	**222.05**
	l/s	**1.60**	**1.65**	**1.91**	**2.22**	**2.57**
Institutional Water Demand; Health centers & schools. (**13.75 % of AJDD**)	m^3/d	19.03	19.60	22.72	26.34	30.53
Livestock water Demand (**0% of AJDD**)	m^3/d	0.00	0.00	0.00	0.00	0.00
Total Adjusted Water Demand (TAD) *[(AJDD) + (c) + (d)]*	**m^3/d**	**157.40**	**162.12**	**187.95**	**217.88**	**252.58**
	l/s	**1.82**	**1.88**	**2.18**	**2.52**	**2.92**
Percent of non -Revenue -Water **(15-25% of TAD)**	%	15%	15%	15%	15%	15%
Non -Revenue -Water	m^3/d	23.61	24.32	28.19	32.68	37.89
(**15% of TAD**)	l/s	0.27	0.28	0.33	0.38	0.44
Average Day Water Demand(ADD) *[TAD +(e)]*	**m^3/d**	**181.01**	**186.44**	**216.14**	**250.56**	**290.47**
	l/s	**2.10**	**2.16**	**2.50**	**2.90**	**3.36**
Maximum day Factor (1.2*ADD)		1.15	1.15	1.15	1.15	1.15
Maximum daily demand	**m^3/d**	**208.16**	**214.41**	**248.56**	**288.15**	**334.04**

(MDD) *[Maximum day Factor *ADD]*	**l/s**	**2.41**	**2.48**	**2.88**	**3.34**	**3.87**
Peak Hour Factor		2	2	2	2	2
Peak Hour demand (PHD)	**m^3/d**	**416.33**	**428.82**	**497.12**	**576.29**	**668.08**
*[Peak Hour Factor *MDD]*	**l/s**	**4.82**	**4.96**	**5.75**	**6.67**	**7.73**
Water production from existing Source(Wet-Well)	l/s	3.75	3.75	3.75	3.75	3.75
New Plan Water source	l/s					0.12
Reservoir Capacity *(1/3 of ADD)*	m^3	60.34	62.15	72.05	83.52	96.82
Adopted Reservoir capacity(m^3)	**m^3**	**50**	**50**	**100**	**100**	**100**

ANNEXURE VI

ENVIRONMENTAL AND SOCIAL SCREENING

Name of the project: 'Awayo Keraro Kebele' Community Water Supply and Sanitation Project

Program: "Improving Quality of Life by Ensuring Availability and Sustainable Management of Water Resources in 'Sidama' Zone"

Project Area: 'Bona Zuria Woreda', 'Sidama' Zone, South Nations Nationalities and People Regional State (SNNPRS), Ethiopia

Client: Czech Republic—Czech Development Agency

Consultant: HY Engineering consultancy Plc

Approving authority: 'Sidama' Zones Water, Mines and Energy Department (SZWMED)

Part A: Brief Description of the project

The project is located in SNNPRS, 'Sidama Zone', 'Dale Woreda', 'Awayo Keraro Kebele' at about 390 kilometers (Km) far from 'Hawassa' (the regional capital). The detail study and design of new water supply and sanitation project is aimed to alleviate the prevailing critical potable water supply shortage and improve the living conditions of inhabitants by constructing water supply system through identification of the safe water source, cost effective and affordable water source design, as well as establishing and providing capacity building for user community. The project will consists of borehole drilling and construction (constructed), pipe laying works, construction of reservoir, valve chambers, manhole and water point to ensure better water supply coverage. The proposed water supply scheme will cover for demand up to the year 2039.

The proposed scheme will consists of:

- 3 spring capping structures
- Construction 100m^3 RCC concrete reservoirs & 50m^3 RCC concrete wet well
- Laying different diameter distribution networks
- Construction of eight water points & three school tap
- Construction two valve chamber in reservoir, six manhole in pipe networks

Part B: Brief Description of the Environmental situation and identification of the environmental and social Impacts

Environmental sensitive area or threatened species

Are there any environmentally sensitive area or threatened species (specify below) that could adversely affected by the program?

I. Intact natural forest: Yes _____No_√____

II. Forest: Yes _____No_√____

III. Surface water courses, natural springs: Yes _____No_√____

IV. Wetlands (lakes, rivers, swamp, seasonally inundated areas):Yes _____No_√____

V. How far the nearest wetland (lakes, rivers, seasonally inundated areas)?

O.5Km from Borehole drilling and construction site

VI. Area of the high biodiversity: Yes _____No_√____

VII. Habitat of endangered/threatened, or rare species for which protection is required under Ethiopian national law/local law and/or international agreements: Yes _____No_√____

VIII. Others (describe): Yes_____ No_√____

Rivers and Lake Ecology

Is there possibility that, due to construction and operation of the program, the rivers and lakes ecology will be adversely affected? Attention should be paid to water quality and quantity; the nature, productivity and use of aquatic habitats, and variations of these over time.

Yes _____No_√____

Comments: *There is no any ecology and rivers affected by the implementation of sub-program*

Site Hydrogeology (According to available information)

Type of aquifer: (Continuous, fracture)

Depth of aquifer: relatively found at optimum depth

Seasonal fluctuations: *there exists slight seasonal fluctuation of water levels*

Known quality problems: *None*

Surface water

What is the water course in the surrounding of the site? *Surface water*

Nature (River, Stream, spring, Lake): *Stream Water*

Give an assessment of potential water course sensitive to water point construction and operation: *There is no sensitive water course due to the construction and operation of the project*

Drainage conditions on site

Description of present Drainage conditions on site (site topography, infiltration capacity of soil): *The site is located on sloppy topography, hence the project area is well drained and has a medium infiltration capacity as result there is no observed drainage problem*.

Risks of Water retention (Site in low point): *There is no risk of water retention.*

Feasibility of simple drainage improvement to eliminate water retention problems: *not needed*.

Water use and water users

Describe water use in the vicinity of the site: *the surface water in the project locality is used for*

cloth washing, bathing and animal watering only.

Is there potential for conflict between users, if so how should be this conflict be solved? *No potential for conflict anticipated in water use within the community.*

Protected area

Does the sub-program area (or component of sub-program) occur within /adjacent to any protected areas designated by government (National park, National reserve, World heritages site)? Yes _____No_√____

If the program is outside of, but close to any protected area, is it likely to adversely affect the ecology within the protected area'(e.g., interference with the mitigation routes of mammals or birds). Yes _____No_√____

Contamination and pollution Hazards

Is there a possibility sub program that the sub program will be at risk of contamination and pollution hazards (from latrines, dump sites, industrial discharges, drilling oils etc)?

Yes _____No_√____

Landscape / aesthetics

Is there possibility that the program will adversely affect the aesthetic attractiveness of the local land escape? Yes _____No_√____

Historical, Archaeological or cultural heritage site

Could sub program alter any historical, archeological, cultural heritage tradition (sacred, ritual areas) site, cemetery, graves, or required excavation? Yes _____No_√____

Resettlement and/or land Acquisition

Will involuntary resettlement and acquisition, relocation of property, or loss, denial or restriction of access to land and other economic resources be caused by program implementation?

Yes _____No_√____

Loss of Crops, Fruit Trees and Households infrastructures

Will the program result in the permanent or temporary loss of crops, fruits trees and household infrastructure (such as granaries, outside toilets and kitchens, livestock shed etc)?

Yes _____No_√____

Block of access and routes or disrupt normal operations in the general area

Will the program or block access, routes etc (for people, livestock and wild life) or traffic routing and flows? Yes _____No_√____

Degradation and/ or depletion of resource during construction and operation

Will the program involve use of considerable amount of natural resource (Construction material, water spillage, land, energy from biomass etc.) Or may lead to their depletion or degradation at point of source? Yes _____No_√____

Will the quarries have to be rehabilitated? No need of acquiring a quarry site and no rehabilitation is needed.

Solid or liquid Wastes

Will the program generate solid or liquid wastes? (Including human excreta/sewages, hospital waste,) Yes _____No_√____

If "yes,""does the sub-program include a plan for their adequate collection and disposal?

Yes _____No_____

Public Health

Will the sub program contributes to increase in malaria due to increase in water supply?

Yes _____No_√____

Comments: The program has positive contribution for the improvement of the community health and well-being due to safe and adequate water supply provision. Also, there is no anticipated adverse effect because of program implementation.

Part C: Social Safeguards Screening Format

S/N	Social safeguards screening information	Yes	No
1	Will the sub project reduce other people access to their economic resource, like land, pasture water, public services or other resources that they depend on?		✓
2	Will the project result in resettlement of or individuals or families or require the acquisition of land (public or private temporarily or permanently) for its development?		✓
3	Will the project result in the temporary or permanent loss of crops, fruits trees and Households infrastructure (such as granaries, outside toilets and kitchens, etc)?		✓
4	Will the project require excavation near any historical, Archeological or cultural heritage site?		✓
5	Might the project adversely affect vulnerable people (e.g elderly poor pensioners, physically challenged, Women, particularly Head of Households		✓

	or widows etc) living in the area?		
For all issues indicated by "Yes "the applicants is expected to explain how she or he intended to mitigate them. Implementation of the mitigation measures will require using the RPF			

Public Consultation

Has public Consultation and participation been sought? Yes_√____ No_____

Sub Program categorization (Tick application box)

A. Category A: This sub program has been categorized as A (schedule 1) due to one or more major adverse impacts and therefore cannot be funded under the WaSH II program. It will be either re designed and re-summated to the environmental screening process after re – design, or abandoned.

B. Category B: This sub program has been categorized as B (schedule 2) due to potential environmental issue identified which can be mitigated as follows:

B1. Category B1 No farther Environmental Assessment work required; application of mitigation measures as outlined in the ESMF

B2. Category B1 Farther Environmental Assessment work required: Preparation of separate ESIA to get better understanding of the potential environment and social issues that have been identified in the screening processes and develop a specific Environmental and Social management plan.

✓ C. Category C: No significant Environmental issues identified, no specific mitigation required; sub-program implementation can proceed. Environmental Guidelines for construction contractors shall be appended to construction contract and applied.

ANNEXURE VIII

SPECIFIC LOCATION OF SYSTEM COMPONENTS

'Total Station' survey report				
	Specific Location (UTM 37N)			
Station No.	**Easting (m)**	**Northing (m)**	**Elevation (m)**	**Label**
1	709983	465118	2233	BM1
2	709971.4	465143.3	2231.034	BM2
3	465135.7	709935.2	2241	GM1
4	465101.7	709917.4	2244	GM2
5	465142.6	709994.6	2236	WWG
6	710006.6	465214.4	2229.475	JC
7	465171.8	710052	2230	GWP1
8	465719	710070.5	2215	ABST
9	466434.8	709339.9	2269	DDM
10	466430	709444.6	2252	DWP1
11	467499.8	709549.9	2213	AKST
12	46524.39	710025	2231	MH-1
13	466428.6	709399.5	2259	MH-2
14	467466.3	709577.1	2211	MH-3
15	470316.7	709831.2	1910	MH-4
16	470514.7	709848.4	1899	MH-5
17	471240.7	709915	1819	MH-6
18	469969.9	709856.7	2025	AK 100m^3 Reservoir
19	467425.6	709625.2	2205	GGWP2
20	469751.9	708954.2	1895	WWWP1
21	470311.2	709708.4	1918	ABST2
22	470560.7	709609.5	1903	YWP2
23	472023.7	709259.8	1783	BCWP3
24	471194.3	710057.5	1819	RCWP4