FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF WATER RESOURCES

ERER DAM & IRRIGATION DEVELOPMENT PROJECT

INCEPTION REPORT **(Final)**

June, 2008

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ACRONYMS

BM	: Bench Mark
DEM	: Digital Elevation Model
DS	: Design Standards
ERA	: Ethiopian Roads Authority
ERTTP	: Ethiopian Rural Travel and Transport Programme
FWUA	: Federation of Water Users Association
GIS	: Geographical Information System
GPS	: Geographical Positioning System
Kin	: Kilo meter
MoWR	: Ministr)' of Water Resources
NE-SW	: North East-South West
NW-SE	: North West-South East
P1M	: Participator}' Irrigation Management
RRTS	: Rural Roads Transport Strategy
RSDP	: Road Sector Development Programme
SPT	: Standard Penetration Test
UTM	: Universal Transverse Mercator
VES	: Vertical Electrical Sounding
VLTTS	: Village Level Travel and Transport Studies
WUA	: Water User Association

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1. Introduction

1.1 Background

The problem of food security has been keenly felt especially in the lowland and some parts of the highlands of Ethiopia, both of which have become increasingly drought prone. The food crises of the 1960s, 1970s, 1980s and at present time have drawn attention of the need for irrigated agriculture. In drought prone areas where the concentration of the human population is relatively high the food demand cannot be adequately supported by rain-fed agriculture alone. Where rainfall is insufficient or unreliable and rain-fed agriculture cannot fully support food production. Thus, irrigation schemes have been considered to be sound investments in such areas. Such investments, it is argued, will help to stabilise agricultural production and promote food security.

The envisaged Erer earth dam and irrigation project is intended to exploit the annual Erer river flow for the purpose of irrigating the right bank of the river. At present, rain-fed agriculture and traditionally irrigated agriculture is being practiced in the area. Despite the huge potential of the area, existing traditional farming practice is not in a harmony with the needs and requirements of developing a productive and sustainable agriculture. The food security situation in the project area has continued to deteriorate for various factors including shortage of rainfall, population growth, deforestation and soil degradation, pest out break and other related factors. Although the initiation of farmer's traditional irrigation practice is appreciated, it is not in a position to provide water for large area of land on sustainable basis and could not bring about effective utilization of available water. Therefore, the development of Erer earth dam and irrigation project is expected to contribute towards availing sustainable water source and bring about efficient utilization of water thereby increasing food supply and income sources to the community in the project area.

1.2 Objectives

The main objective of the Ercr earth dam and irrigation project is to enhance the utilization of surface water resources for irrigation development and thus improve the livelihood of the fanners. Besides, the project is intended to increase agricultural production per unit area, improve the living standard of the local poor farmers and bring about better improvements in socio economic conditions and food security.

1.3 Rationale for Irrigation Development

The provision of more reliable access to irrigation water is expected to increase agricultural productivity. In addition, fanners will be able to change into higher value products, through intensification and diversification of agricultural production, rhus the project aims at supporting comprehensive growth and reduction rural poverty. This project will introduce irrigation in to those areas which are mostly cultivated by subsistence-oriented smallholder farmers who currently depend on unreliable rainfall. The introduction of irrigation will not only reduce risks associated with climate variability, but also help farmers to transform their production systems and capture benefits from linkages with markets.

The Federal Government of Ethiopia and the Regional Governments of Oromia and Harari have initiated a rural development strategy with die main objective of attaining food security at the household level and bring about (he overall socio-economic development of the regions. The core of the development strategy is to utilize the available water resources effectively and efficiently through construction of dams/storagc works and water conveyance systems to increase agricultural production. The project area currently depends on rain-fed agriculture with limited use of traditional irrigation. Highly variable rainfall, frequent floods and droughts, and lack of means io store water in times of availability places the area at risk of drought and chronic food shortages. Thus, the developments of water harvesting, storage and irrigation have become essentials for the area.

The project area has suitable topography and good agronomical potentials and requires introduction of suitable water use technologies for efficient waler use. rhe existence of traditional irrigation practice to supplement rain fed crop production is expected to facilitate adaptation of the intended irrigation system. However, despite the huge potential of the area and existence of some knowledge of irrigation management in the area, the existing practice is not in harmony with the needs and requirements of developing a productive and sustainable agriculture. Thus it is imperative to support and modernize this traditional irrigation practice as well as farmer's commitment and desire for irrigation development, with proper irrigation technology to increase crop production potential of the local community.

1.4 Scope of this Report

The inception report covers the following important aspects:-

- Summarizes the inception level findings of activities as related to the subsequent tasks to be accomplished and there by indicating further elaborations/ adjustments on methodologies and approach to be followed:
- Presents updated work plan and schedule of submission of various technical reports;
- Update work plan indicated by task and assigning personnel by name and schedule of each task shown in chart form. Current developments in terms of required adjustments on the original methodology & approach proposed prior to this inception level;
- Presents project specific evaluation of data availability and needs of additional data collection and organization at project site level and coming up with different strategies of data collection, organization & analysis;

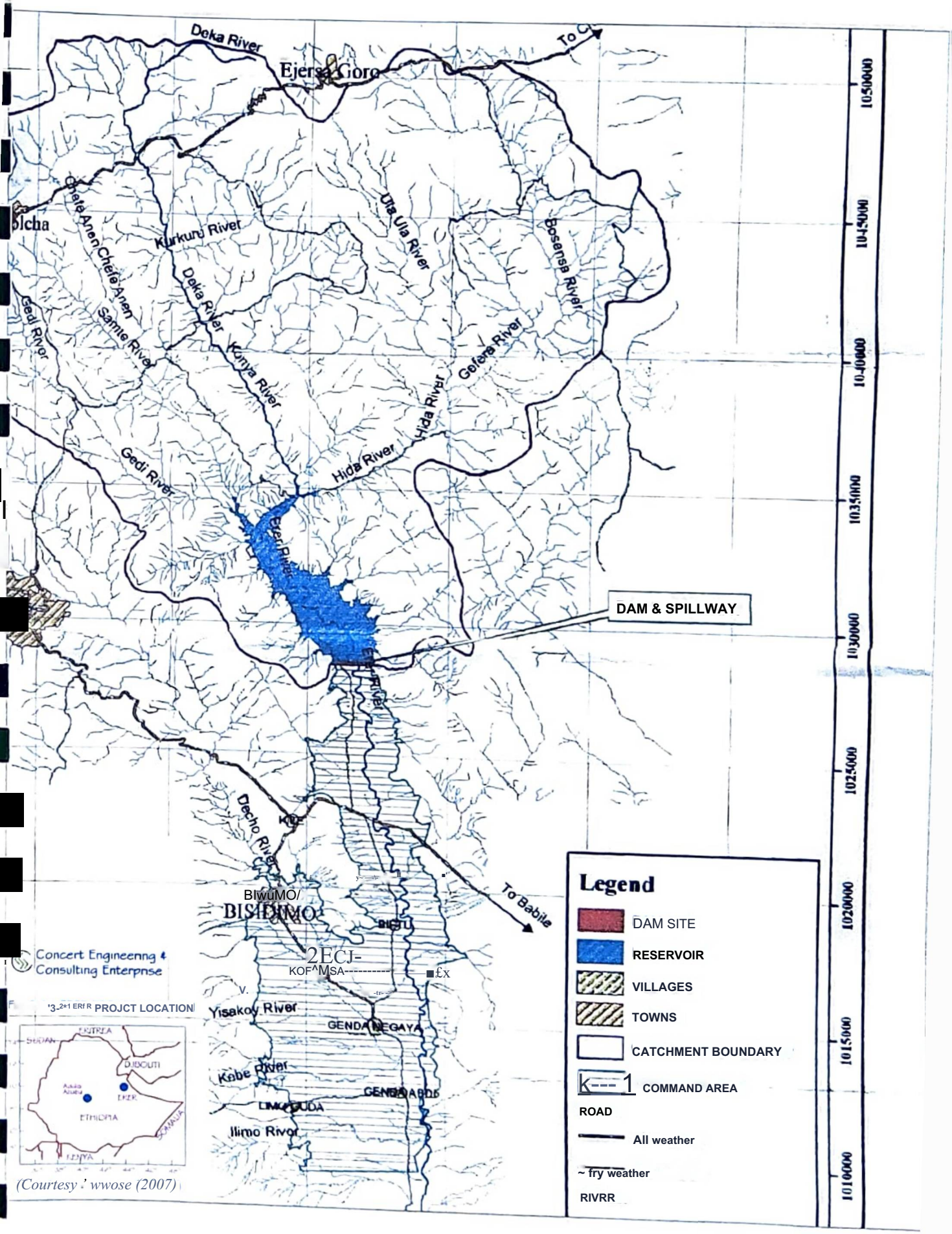
2. Brief profile of the Project area

The following is a selective summary of the profile of Erer earth dam and irrigation project. It focuses on those aspects of the project that are most immediately relevant in the context of the present duty of the consultant.

The Erer project was formulated in the early 1970's in the framework of the Wabe Shebelc River Basin Project. The project envisaged the construction of a 1.4 km long and 36 m high earth dam and 14 kni long main canal originating from the dam and splitting in to two secondary canals of length 7 km and 8 km each besides tertiary canals and drainage network for the development of a total cultivable command area of about 4000 ha situated on the right side of the Erer river.

2.1 Location and Accessibility

Erer Earth Dam and Irrigation Project is located (figure 2.1) within two regional states namely Harari regional state and Oromia regional state. In llarari. the project is situated in Erer and Soft woreda, where as in Oromia region the project is situated in Babile woreda which is in East Hararge zone. The Command area of the project lies between latitude of 9°07'17" and 9°17'40"N and 42°12'24" and 42°16'03·'E longitude and located at 19km from Harar town along Harar/Jijiga road and at about 11 km from Babile town. The proposed irrigable land is accessible by all weather road through out the year. There is a DS 6 standard road leading to the dam site from the region a town of Harar. Alons this road lhe dam site is located at 16.5kilo meters. The dam site is also accessible by dry weather road which branches from lhe Harar -Jijiga main road where lhe junction point is lkm towards Harar town from the bridge.



(Courtesy .' wwose (2007)

2.2 Natural Resource Base

Oromia and Harari Regions in which Erer dam and irrigation project is situated are among the nine regions of Ethiopia and located in eastern parts of the country, lhe project area is generally characterized by erratic and unreliable rainfall resulting in inconsistent agricultural development. Rainfall in the project area follows a bimodal pattern with 2 months of duration for each period followed by a long dry spell. This condition does not permit high yields of the crops grown in the area. The majority of the population is small holder farmers dependent upon agriculture for their livelihoods, where traditional agricultural practices contribute to low production and land degradation.

The proposed dam site has a catchment area of about 419km^2 which can generate required amount of water to insure sustainable irrigation to proposed crops in the command area. The reservoir capacity is expected to accommodate the amount of water which is reasonably enough to irrigate the available irrigable land. The proposed Erer irrigation command area lies in one kebele of Soft and 7 kebeles of Babile wereda. Irrigation development practice by diverting rivers using gravity and pumps has a long history'. Currently spate and pump irrigation using floods and sub-surface flow of the rivers are supplementing the rain fed agriculture.

Topography of irrigable land, traditional practice of the farmers, farmers need for irrigation, availability of flood water from Erer River, availability of suitable dam site, suitability of the farmland for agricultural production, accessibility, and availability of construction materials are among lhe potentials of the area. Check-dams which are small barriers built across the direction of water flow used in the project area for lhe purpose of water harvesting. The water entrapped by the dam, surface and subsurface, is primarily intended for use in irrigation during lhe rainy season and later during lhe dry season, it is also used for livestock and domestic needs.

The irrigation command area starts from some distance down stream of the dam along the right side of the river. The irrigable area is in the order of 4000ha. The topography of the area is not uniform. The catchment area of the dam consists of mountainous terrain and hilly slopes. The mountainous portion is not covered by vegetation except very scattered bushes. The gently slopping and river valley areas are mainly used for agricultural production. The command area is not flat and the slope makes it unsuitable for mechanized farm developments. There are a lot of gullies observed within the command area. Thus, in order to develop 4000ha of irrigable land, land grading and leveling work are required.

3. Project Consultancy Service Arrangements

3.1 Mobilization of Experts

The consultancy sendee for the detailed design of the Erer Dam and Irrigation Development Project is being rendered by concert Engineering and consulting enterprise P.L.C in association with Consulting Engineering Services P.L.C. The project staff have been deployed following the contract agreement signed on March 03/200S.

Upon commencement inception level site visits were conducted at the presence of the client project coordinator on March 25 - 26, 2008. Series of consultative and informative discussions were held among project team members on the project objective, task assignment expected out put and schedules of deliverables. Additional field trips have also been made to the project site to get first hand information and to conduct assessment of the existing situation in line with the feasibility study report.

3.1.1 Required Additional Expertise

3.1.2 Resettlement

According to the feasibility study volume 9 , sectoral report 13 (socio-economic study) and volume 10 sectoral report 17 (settlement planning), some of the issues related with the development of the project particularly that of the displacing nature of the reservoir area due to inundation has been identified. However, the reports simply recommend solution to be worked out and as such there is no “road map” in iterms of solving the problem.

As per the field visit made and the assessment conducted this issue due to its multi stake holder (Oromia & Harrari Regions) sharing both the reservoir and command area needs a very well structured study and pre- articulated benefits and responsibilities sharing arrangement among the slake holders residing in the two regional states.

Therefore, apart from preparing a plan of resettlement for the "to be displaced communities'' of the reservoir area, integrating them into the command area by way of allocating irrigable land needs proper assessment of compensation and integration. As this issue is very sensitive tlie exercise would need the involvement ot stake holders woreda and regional concerned institutions of both regions and Ministry' of Water Resources as well. Form the consultant side additional expertise of rural development (social) expert and settlement planner is required.

3.1.3 Farmers Organization

The envisaged irrigation project is medium scale and in accordance with the Ministry of Waler Resources guidelines, such projects have immense technical and administrative task in terms of operation and maintenance of the irrigation system and also the delivery of irrigation extension which includes input supply, marketing, water management, etc.

The feasibility study report volume 11, sectoral report 21 on organizations and management proposes PIM (participatory Irrigation Management) as an out line frame work of institutional arrangement. However, operation of an irrigation scheme for thousands of hectares needs properly articulated mission, objective and task description at pre-commissioning and post commissioning phases. Pre commissioning is much of a duly of technocrats, technicians and established administrative organs. The post commissioning task needs a phase in and phase out arrangement . where by the most formal technical and administrative organs will phase out and the farmers in their full fledged institutional form will phase in. This process and its related functional requirement are not articulated to date.

Therefore unless the beneficiaries are organized in the most desirable way for instance in WUA and Federation of WUA or a belter form of cooperative plat form, it is very difficult if not impossible to realize the whole purpose of developing the project. Thus the assignment of the institutional (WUA) expert is mandatory to proactively plan a

sustainable & comprehensive solution for the effective operation of the irrigated agriculture. Here too, additional input of a cooperative or WUA expertise is required.

3.1.4 Re-locating the Harar-Erer Dodota Road.

As was observed during the field trip and verified by the road infrastructure engineer the Harar- Erer dodota road (which is DS 6 standard road) will be submerged under the water of the reservoir for about 8 Km. This road appears to be an important line linking towns such as Wodiya and Erer dodota to Harrar city, while it also serves as an alternative to the Harar- Babile road. The re-localion of the road is justified from the point of view of its exiting economic use as well as for its utilization to access the dam site. Thus, if the location is to be studied and designed, additional input of hydrological, technical and road infrastructure study is required

3.1.5 Ground Surveying Task

The Erer Project needs sound ground feature control and measurement, considering its scale and importance. However, the feasibility level surveying task has several limitations as outlined under section 4.2.3 of this report thus over hauling the survey work such as establishing sound benchmarks that are tied up with the national system demands, extra input than envisaged in the contract agreement.

3.2. Project Activity Schedule

The project overall activity scheduled (figure 3.1) and the project personnel schedule (figure 3.2) as presented in our proposal shall be adhered to in terms of meeting the completion time table. However, due to problems faced in timely mobilizing the expatriate experts, some changes of experts schedule has become necessary. Thus some re-arrangements are made to comply with the existing project staff allocation.

Figure 3.2 Personnel Schedule

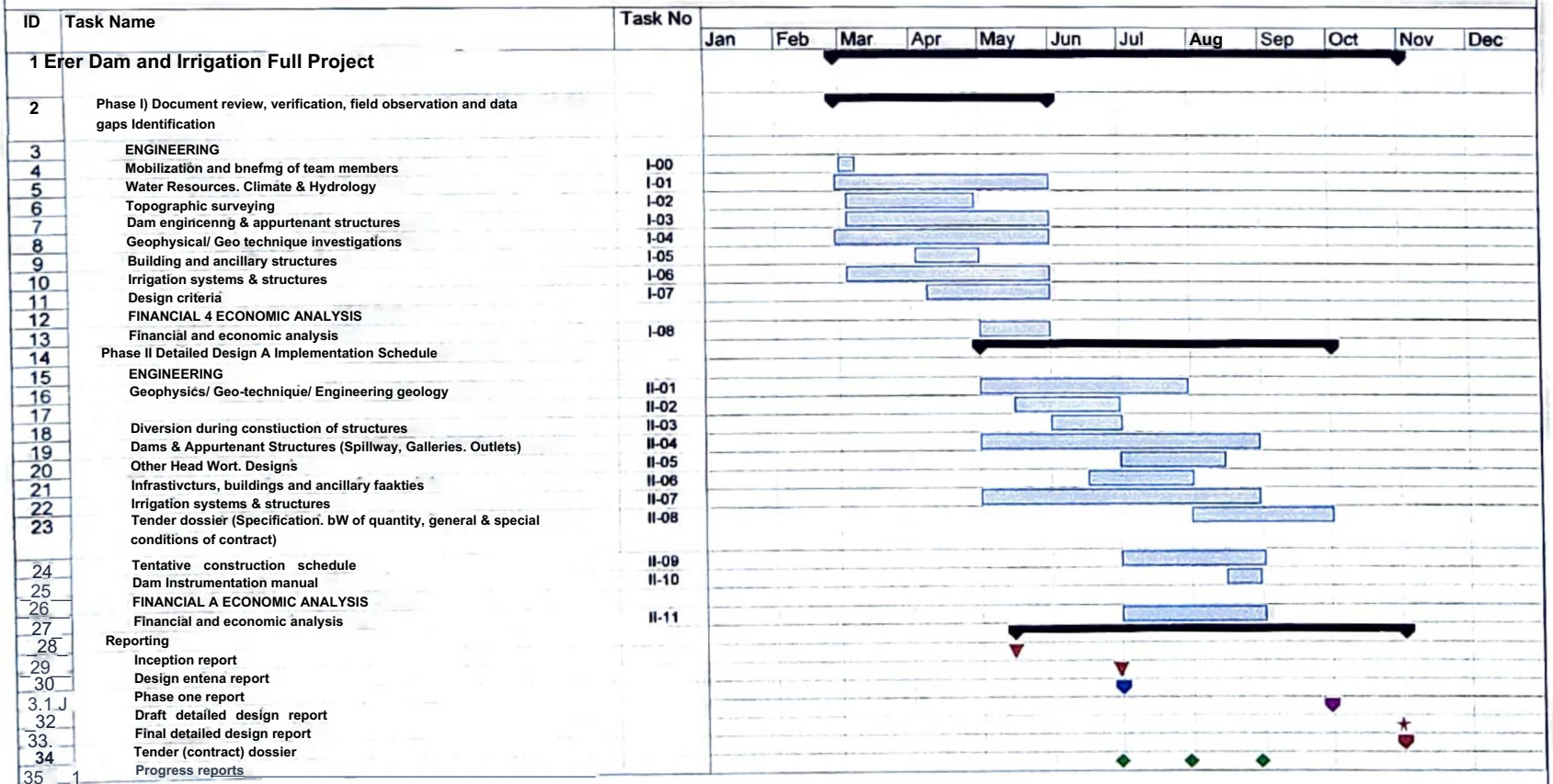
Ever Dam & Irrigation Project Detail Design ***Client- Ministry of Water Resources***

No.	Position [Name]	Position	Field Office Staff-Month		
	Project Team Atividies				
		Professionals			
1	Project Manager/ Dam Engineer	Alemayehu Mengiste	1.5	5.5	7
2	Geophysicsl/ Geotechnical Engineer (I)	Madan Lal Vishwakarma	1	2	3
3	Geophysicsl/ Geotechnical Engineer (II)	Asrat Worku (Dr)	1	2	3
4	GIS Expert	Abdul Azeem *(Dr.)*	0	3	3
5	infrastructural engineer	Mengistu Hailu	0.5	1.5	2
6	Water supply & Sanitation engineer	Assefa Nega	05	0.5	1
7	Electrical engineer	Ketema Tefera	025	0.75	1
8	Irrigation & drainage engineers (i)	Daneal F.Siliassie *(Dr.)*	2	3	5
9	Irrigation & drainage engineers (Ii)	R P S. Yaduwanshi	2	3	5
10	Hydraulic Engineer	Addis H/Michael (Dr)	075	225	3
11	Structural/Civil engineer	Pijusli Kanli Datta	1	3	4
12	Hydrologist	Yilma Seleshi (Dr)	0.75	1.25	2
13	Electromechanical/ Mechanical engineer	Tadewos Alemu	05	1.5	2
14	Economist	Zelalem Temesgen	1	2	3
		Ass. Profess.			
15	Architect/ CAD *Technician*	Amanuel Tesla ye	0.25	2.76	3
16	*Chid Surveyor*	Feki Abdulkadir	3.5	05	4
17	*Surveyor*	To be named	3.5	05	4
18	*Surveyor*	To be named	3.5	0.6	4
19	*Secretary*	Ethiopia W/ Giorgis	0	7	7

Figure 3. I . Activity € Reporting Schedule

Erer Dam and Irrigation Project Detail Design

Client-Ministry of Water Resources



Concert Engineering & Consulting Enterprise, P.L.Co.
and
Consulting Engineering Service (India), P.L.Co.

3.3 Milestones of Report

The contract agreement stipulated the production of seven types of reports including the lender (contract) dossier. All the reports shall be produced and made available as indicated in fieure3.1

4. Inceptions Level Activities and Findings

4.1 Water Resources, Climate & Hydrolog}'

4.1.1 Review of Report and Field Assessment

The feasibility report of Erer dam and irrigation project (volume 3) has been reviewed in this inception level. Subsequently field assessment was conducted to verify the assumptions made in preparing the hydrological study.

a) Stream Flow Analysis

The synthetic monthly flow analysis as presented in the report shows annual average flow of 60.4 million cubic meter, while the 80% dependable flow is 41.3 million cubic meter. It is not possible to check if the standard student test is done during the dependability analysis and this will be verified in the following assessment phase. The figures attained, when checked against the stream flow record al Erer bridge show reasonable correlation, but further assessment shall be done in this respect.

b) Design Flood Determination

The design flood adapted for the design of the spillway structure is the greater of 0.5 PMF or 1000 year return period. Which have the value of 642 cubic meters per second and 582 cubic meters per second respectively. Thus the study has adopted the value of 642. Although this value appears to be consistent with the rain fall pattern, intensity and catchment area of the dam site, further assessments shall be made to verify the adopted design flood magnitude.

c) Reservoir Sedimentation

The task of reservoir sedimentation is rather precarious in the sense that is entirely dependent on empiricisms. However, limited data of suspended sediment in the project area has been used to arrive at sediment transport rate. The sedement rating curve thus developed appears to be useful to stay away form a lot of empiricism. The regional approach employed in generating sediment discharge by using stream flow is acceptable, but with its limitation of depicting only the suspended load with out the bed load. The final total sediment transport load of 1495 cubic meter per km^2 per year appears reasonable when compared to other similar catchments else where in the country. The sediment distribution shall be further assessed.

d) Reservoir Simulation & Routing

The method used in reservoir simulation and routing are with in the acceptable standard procedures. However, the details on the values attained will be worked out.

4.1.2 Methodology to be Adapted

A. Climatic data shall be collected and updated to fill data gap. Nearby stations such Harar, Haramaya, Dire Dawa, and Jijiga (at the average distance of 60 km) can be used for estimating the mean climatic variables needed in irrigation system design. The value of estimated mean monthly rainfall, temperature, wind speed, sunshine hours and relative humidity over the irrigation area will be updated.

4.1.3 Studies to be conducted

B. The feasibility level study that has been conducted by Water Works Design and Supervision Enterprise (WWDSE) for Erer irrigation project and any other relevant document will be thoroughly reviewed and the gaps and shortcomings shall be clearly identified.

- All other data considered necessary and simulation of hydrologic data shall be assessed.
- Data shall be collected to fill data gap and updated long-term flow generation will be cnducted to determine annual and month)}' flow at the dam site.

The methodology and approach applied in the analysis ot annual & low flow will be reviewed whether the analysis was conducted in the absence of data or presence of adequate data representing the project area.

- The data set shall be subjected to frequency analysis and the result should be used in fixing the dependable flow for the scheme.
- After fixing the dependable flow, deficit (shortfall cases) will be identified by sequent algorithm method for reservoirs or by conventional operation rule.
- The dependability of flow shall be generally in the range of 75-80%, taking into account the international experience, which is adequate for project functionality and cost effectiveness.
- The feasibility study shall be reviewed in light of these situations and 0.5 PMF or 10.000 years return period Good will be considered for the detail design of the spillways.
- The flood estimation (flow analysis, flood magnitude and flood hydrograph for design of the dam) shall be carried out by standard procedures by conducting frequency analysis and fixing the design flood with specified return period that really shall confirm to international standards.
- Cross-drainage design flood shall be determined conducting frequency analysis and fixing the design flood with specified return period.
- Ī he sediment yield of the catchment and the nature of bed load coming along the river/stream will be examined and described so as to mitigate any adverse effect on the dam capacity.
- Assessment of the upstream and downstream effect of the water will be carried out.

4.2 Topographic Sun eying

Topographical survey activities will be taken up primarily to fill the gaps in the survey conducted during feasibility study stage, so as to generate the topographical maps as per the required standards proposed in the agreement for the detail design of the project.

The required scale of topographical maps to be generated during this detail design phase of study would be at 1: 1.000 with lm contours in steep slope areas and 0.5m contours in gentle slope and plain areas of the locations inclusive of dam. appurtenant structures, irrigation canal system associated structures as well as for the project infrastructure like roads, colonies etc.

4.2.1 Review of Reports and Field Assessments

A. Review of Feasibility Report

During the feasibility study the following surveys were conducted and drawing plans/maps were prepared for different components of the project -

a. Topographic survey of Dam site

For the dam site and the areas of appurtenant structures topographic plans/maps at 1:4,000 and 1:2,000 scales with appropriate contour interval are developed alter undertaking survey. Apart from the topographic maps for the dam site area valley cross sections along dam axis and line parallel to the dam axis at 25m interval up to 250m distance on both upstream and downstream of dam axis are made. Longitudinal profile along the planned center line of the spillway is also generated.

b. Topographic survey of Reservoir area

Topographic maps/plans of the reservoir area are available on scales of 1:10,000 and 1:20,000 with contour interval of lm. Survey in an area of 725 ha has been carried out upstream of proposed dam axis.

c. Topographic survey of command area

Detailed topographic survey based command area maps are available al 1:10,000 and 1: 5,000 scale with contour at 2m and 1 m intervals respectively.

1: 2,000 scale topographic map with contour interval of 0.5m is also available for a sample block used to undertake detail planning of the distribution system.

d. Control Points / Benchmarks

A total of 53 permanent benchmarks have been established during feasibility stage, spread all over the project area. The UTM coordinates and elevations in meter units of these benchmarks are made available in the feasibility report.

Out of the total 53 benchmarks listed in the topography section of Main Feasibility report, 22 benchmarks have duplicate names with two benchmark (BM-2) having duplicate coordinates and elevations where as two have same coordinate but different elevation (BM-28B).

e. Drawings

The softcopy of the drawing for the topography survey developed during feasibility study has been studied, the same was found to have following deficiencies.

i. The drawing is not geo referenced according to the UTM coordinate system, instead has a grid overlaid on the same which is very coarse.

ii. I he drawing lacks the original points (levels) captured during the survey.

iii. The drawing has contours which do not carry' any elevation value.

iv. Drawing does not have impoilant alignments like dam axis, certain canals, command area boundary etc.

B. Field Assessment of Survey done for Feasibility study

Following are the observations comprehended during the field visit.

- Dam site has not been marked on the ground.
- The benchmark which represents the Dam axis on right bank, BM-I6B was not traceable, instead BM-16 was found on the rock.
- The benchmark which represent the left dam axis. BM-3, label marked on rock by paint was totally wom-out.
- All the benchmarks which ever found on the ground either has an offset of about 240 to 250m as compared to the coordinate mentioned in the report with GPS coordinate or do not exist in the listed benchmarks of the feasibility report.
- The benchmarks are cither not concreted at all (just painted on rocks) or cemented with two to 4 inch masonry which have been removed by the villagers.
- The command area benchmarks were not traceable on the ground.
- The benchmark located on the confluence of Decho river with Erer river does not exist in the list of benchmarks mentioned in the feasibility report.

4.2.2 Methodology to be adopted

The survey methodology will be focused to deliver the required survey out puts as per the prescribed standards for the detail design. However all <. Torts will be done to use the survey conducted during the feasibility study of the project.

Selective dcnsification of the survey levels with the total station will be the primary approach to be adopted for the survey during this phase of detail design.

A. Surveys to be undertaken

Following densification surveys will be undertaken during detail design phase of the study.

a. Dam site survey

The dam site area will be densified by the total station survey by taking the most appropriate reference benchmarks established during the survey for feasibility study. The addition of survey points will be done in the survey gaps which arc apparent during feasibility study level survey.

In the regions of changing topography close levels are to be used so that topography is correctly reflected on the ground.

b. Command Area survey

Survey will be carried out for the densification of the command area survey which has been undertaken during feasibility study. Densification for the command area survey will be carried out only for the cultivable command area.

The benchmarks will be carried and transferred from the dam site to the command area and will be re established for undertaking command area survey.

c. Canal strip survey

After identifying the canal alignments a strip survey for a corridor of 50m meters will be carried out along the canal alignments.

d. Structures survey

A dense survey will be cairicd lor the areas of the structures locations.

c. Roads

For the corridors of the new road alignments a strip survey will be conducted.

f. Colonics

An area survey with dense levels will be done for the locations of the colonies to be developed for the construction and maintenance of the project.

B. Software to be used

Appropriate software such as AutoCAD CivilSd and ArcGIS will be used for the development of DEM and finally development of contours and the required GIS layers for the project.

Drawings will be developed in 1: 1000 scales for the dam site, command areas/ canal corridors and other required areas of development.

4.2.3 Outstanding Issues in Topographic Survey

The outstanding issues related to the topographic survey carried out and drawings generated during feasibility study are as follows.

a. There are gross discrepancies in the benchmarks of the feasibility study. Some of them are listed below.

- The benchmarks do not match with the UTM coordinates on the ground. There is a general shift of about 240 to 250 m in the south-west direction.
- The benchmarks are not concreted on ground. Most of the benchmarks are displaced, removed and paint wearied off.
- There are duplication of Benchmark names and coordinates.
- (Out of the total 53 benchmarks listed in the topography section of Main Feasibility report, 22 benchmarks have duplicate names with two benchmark (BM-2) having duplicate coordinates and elevations where as two have same coordinate but different elevation (BM-28B).

b. As the benchmarks almost arc non-existent, new concreted benchmarks with reasonable dimensions and steal pin have to be established both in the dam site and the command area.

c. Tying the feasibility study benchmark with new benchmarks has to be done. Also all the benchmarks have to be brought to real world U1 M coordinate system

d. Drawing generated during feasibility study has many problems such as, absence of geo-referencing and non standard drawing standards which need to be rectified.

4.3 Dam Engineering

4.3.1 Review of Report and Field assessment

The feasibility report of the project (volume 6 sectoral report 6 and 7) have been reviewed along with the drawing album. Based on the information contained in the report inception level field assessment was conducted. The dam site and its axis have been physically examined using some of the existing bench marks (some are not in place) and it was possible to verify the location of core drilling sites around the axis.

The inception level field assessment and thorough review of the dam design feasibility report revealed that in general the dam site selected and the axis as well as the selected dam type and construction material for core, chimney filter, shell rock toe appears to be acceptable. However, the use of grouting (both consolidating and curtain as proposed by the feasibility study is being closely examined. The un reported but apparently conducted tests of permeability (lugeon tests) and core drilling results shall be very closely examined by the geotcchnicqucs and dam engineer of the consultants.

The provided width of camber and crest i.e 5.0m and 9.0m respectively appear to be small when considering the important use and expected maintenance activities. Although these sizes have no effect on the stability analysis, increment will yield benefit in case of operation and maintenance. The use of cut off in most leaky foundations is very useful

provided the economics of doing it permits. Thus in subsequent studies this will be investigated and analyzed for its proper utilization.

The geological profile attached in the report was prepared while some of the core drilling and lugion tests were underway. Thus, the final results of these tests need to be incorporated for a better assessment and further planning of foundation investigation. Apparently the foundation of the dam has three distinctive features al left and right abutment with glaring contrast on the formation at the river channel which has quite considerable alluvium thickness (35m). The feasibility report did not ascertain this depth or the nature of the alluvium from point of view of stability.

The proposed measure of blanketing the river alluvium, for controlling leakage is expected to be quite extensive, probably to the extent of the fetch length, 'rhe stability analysis conducted indicated the use of standard and acceptable stability criteria; however, it is not clear if the section considered for stability analysis takes into account the alluvium formation of the river bed under steady state and sudden drawdown conditions. The dam instrumentations proposed are acceptable, however, in light of the location and the size of the dam it is worth to have an instrument to measure strong motion record. The record of strong motion will facilitate the establishment of net work of data centers for long term dam safety evaluation in addition to the operation and maintenance activity of the Ministry of Water Resources.

The report did not point out the need for test fills of shell material and impervious core. This is highly recommended to be done at the start of construction. Conducting test fills on shell and core material will assist to rationally determine lift thickness, number of passes, placement water content, checking segregation and also the proper selection of compaction effort.

4.3.2 Methodology to be adopted

Sufficient emphasis shall be given to carefully organize and asses all investigation data such as laboratory results, geophysical investigation result and core drilling assessment results.

Based on the site conditions and reviewed previous studies, a suitable type of dam and associated structures shall be proposed to store the sufficient emphases shall be give required water and convey it to the main canal by gravity.

- Optimization of dam height to achieve minimum cost of dam and its operation and maintenance will be carried out.
- Layout, profiles and cross-sections of dam and its appurtenant structures shall be started to prepare at appropriate scales.
- Storage requirement and reservoir operation required for irrigation and other purpose (if any) will be investigated with due consideration of floods, siltation and future expansion of irrigation in the region (reservoir planning and quantification of spillway).

4.3.3 Studies to be conducted

The studies and design to be conducted are out lined in the consultant's proposal and these will be guided by the design criteria which are under preparation. The focus of design will be;

- Dam crest elevation/ dam height /determination
- Design of embankment protection structures.
- Selection of basic dam sections.
- Filter type and design
- Settlement analysis.
- Seepage analysis.

- Uplift pressure analysis
- Forecasting of embankment material deformations
- Stability analysis

The foundation of the dam shall be studied and the precise construction and size of the dam different zones shall be established and firmed up. in particular:

Proper size of filter, drain, transitions, etc will be elaborated on the basis of proper standards and state of the an practice. This design shall result from proper stability analysis, deformation and settlement analysis, seepage and erosion analysis, etc

The design report shall give full details of material parameters, design assumptions, analytical techniques and loading conditions which shall be prepared, covering all aspects of the design.

The design report shall present the design criteria and assumptions used in the design, the methodology adopted, the codes and standards followed, the computer software used, the input data and the results of the computations. The design compulation shall be accompanied by graphs, diagrams and figures where appropriate.

4.4 Dam's Appurtenant Structures

4.4.1 Review of Report & Field Assessment

The Land and Water Resources Study of the Wabi Shebele Basin identified the present study area as being one of the potential areas for irrigation development. Recently, the Ministry of Water Resources completed the Erer dam and irrigation project feasibility study (September 2007) and consequently the current Consultancy Services is for preparation of detail design and lender documents for the project.

The dam appurtenance structures constitute the Erer dam spillway and irrigation outlet works. Our studies of both structures have incorporated an extensive review of relevant

material in 12 volumes (including an album of drawings) on previous studies. The reports provide valuable background information on the dam appurtenance structures. However, level of detail required on account of the objectives of the present study to comply with the Consultant's Technical Proposal would call for more data and information to complete the study to an acceptable standard. Yet existing MoWR (2007) data may help to reduce the level of additional investigation required for completion of the designs.

Provision of spilling arrangement is an essential part of embankment dam planning and layout since dam overtopping can not be allowed. According to the Feasibility' Study (September 2007), the selected spillway structure comprises 29.99m wide approach channel leading water to a 30 m wide straight-ogee crest control section and 335.8m long inclined chute terminating into a 43 m long stilling basin. After the dissipation of energy in the stilling basin, the flow's over the spillway will be conveyed back to the river through an outfall channel joining the Humec stream, a left bank tributary of the Erer River. There is limited information on the size of the spillway chute, i.e. no data on chute bed width, depth and freeboard. The spillway has been located on the left bank of the river for different reasons, namely;

a. The foundation situation are more favorable
b. The required length of spilhvay chute is shorter
c. The spillway works are not intersected by the proposed irrigation outlet works

It should however be noted that the Feasibility Study proposed curtain grouting below' the foundation of the spilhvay along the dam axis in order to reduce permeability to 5 lugeons.

The irrigation outlet is located at the foundation level on the right abutment of the dam to feed the gravity irrigation canal network also located entirely on the right bank of the Erer River. The outlet conduit is a l.l m diameter vertical pipe connected to a lm by Im horizontal reinforced concrete square conduit, the transition from circular to square section being a 90° bend. The conduit is provided with 60 cm high reinforced concrete cut-off collars spaced @ 5m c/c and joints with seals laid over 15cm thick lean concrete.

The outlet has been designed for a discharge of 3.05m^3/sec. It is not mentioned whether the hydraulic dimensioning of the conduit takes into account any future expansion of the irrigable area. In addition to releasing the impounded water as and when needed for irrigation and maintenance of the environment, the outlet work shall be used to:-

- Pass a part of the design flood to the downstream, as a supplement to the spillway in case of emergency
- Empty the reservoir up to its sill level to permit inspection, to make needed repairs or to maintain the upstream face of the dam or the spillway, and
- Control rise of the reservoir during initial filling

In general, the level of design detail accorded during the feasibility study to the dam spillway is less compared to the irrigation outlet works.

Field Assessment:

Following preparatory review of reports and drawings the study team visited the project site from March 25/ 2008 to March 26/ 2008 and again from 4/05/2008 to 10/05/2008. This has been supplemented by a ground reconnaissance of the Erer dam site, appurtenant structure locations, the irrigable area and the Erer dam catchment area. The approach was essentially to consider the entire project area section by section. The outline conclusions of the site visit findings relevant to the appurtenance structures, namely the spillway and irrigation outlet works, follow:-

- The severity of soil erosion in the Erer River catchment has been observed. In the context of the development of water resources for irrigation, the principal effects are rapid sedimentation in the reservoir and the introduction of high silt loads into the irrigation area.

- The field assessment also indicated that given that there is no catchment erosion curbing activities insight in the project area, protection measures in the Erer dam catchment area will be unlikely to effectively mitigate the level of sedimentation in the reservoir for years to come.

- For this reason, the overview concluded that it could be unrealistic to plan the irrigation outlet works on the expectation that the erosion situation could be contained or improved in the short term. Therefore sufficient dead storage capacity ought to be provided during the detail design in consultation with the project Hydrologist.

- On the other hand, there clearly exists a significant potential for improvement of the erosion situation both by engineering practices such as terracing, bunding and, more importantly, by biological control methods such as minimum tillage and alternative cropping patterns. Although the latter methods are being widely advocated in our country, such methods have yet to be tested for their appropriateness in the local context. However, contour ploughing is being practiced by local farmers in the area.

- In a gravity irrigation project, the importance of accurate topographic maps at appropriate scale need not be overstated. Observed discrepancy between plot of topographic survey coordinates taken at the location of Bench Marks during the Feasibility Study of the project and actual readings taken during the field assessment using a hand head GPS was very significant. Hence there is an urgent need to reconcile and correct the anomalies once and for all in order for the map to be representative of the project ground features.

4.4.2 Methodology' to be Adopted

The methodology and approach is the same as section 4.3.2. The subsequent studies will focus on evaluation of items described under section 4.4.3 in relation to the irrigation outlet and the dam spillway respectively.

4.4.3 Studies to be conducted

a) Irrigation outlet Works

Downstream water needs so far identified are for irrigation and environmental releases. The farm water needs and full supply level of the primary canal will be determined by the project Irrigation Group depending on the area to be irrigated, the consumptive use of water (duty), types of crops to be grown, cropping pattern, etc. Equally the magnitude of riparian water demand shall be quantified and considered.

The discharge capacity of the outlet w'orks will be determined from reservoir operation studies. The most critical period usually occurs when the reservoir storage is low but the irrigation water demands are at their peak. The discharge capacity of the irrigation outlet will be decided considering the available reservoir storage during that period.

The overall size of the outlet works is determined by its hydraulic head and the required discharge capacity. For a given Q. if H is increased, the cross sectional area of the conduit can be reduced. In other words, the conduit size can be reduced if the minimum pool level, at which the outlet is located, is kept low'. For a given head H and discharge Q. the conduit size can also be reduced by decreasing the various losses and hence the composite coefficient of all losses.

For the detail design, the total head losses encountered in the outlet works shall be calculated. These losses include those caused by trash racks, conduit entrance, conduit friction, gates and valves, transitions and bends. The net effective head responsible for flow' shall then be determined. Moreovci the outlet works system will be checked io determine reservoir evacuation requirements.

Besides the outlet works design shall take lull account of

- any expected foundation movements and appropriate provisions to counter its impact on the structure

- adequate measures that need to be adopted to prevent piping
- hydraulic efficiency and structural safely
- flow control upstream versus downstream, manual versus motor driven operation

Spillway

Subsequent studies will focus on ensuring that the design fulfills the essential requirements of a good spillway, i.c.

- It must have adequate discharging capacity
- Il must be hydraulically and structurally safe
- The material of the spillway must be erosion resistant
- The spillway must be so located that the spillway discharge does not erode or undermine the downstream toe of the dam
- It should be provided with some device for dissipation of excess energy
- The spillway discharge should not exceed the safe discharge capacity of the downstream river channel to avoid over bank flooding

4.5 Geophysical and Geotechnical Investigations

4.5.1 Review of Report and Field Assessment

In preparing this inception level report, the pertinent volume of the Feasibility Report - Volume 4, Sectoral Report 2: Geological and Geotechnical Study - has been consulted and the project site visited.

The report consulted covers the following major works conducted during the feasibility study:

- Review of the pre-feasibility study;
- Regional and local geology;
- Seismic Appraisal;
- Geotechnical and geophysical investigations; and
- Evaluation of the project features.

The *pre-feasibility geological and geotechnical studies* are summarized in the report as follows:

- Both die reservoir and the dam site areas arc covered by Precambrian basement rocks consisting of biotite gneisses, amphibole-biotite gneisses, and migmatites. These rocks outcrop on the surfaces of the abutment hills, whereas the flood plain is mainly covered by varying proportions of alluvial, residual, terrace and colluvial deposits with varying grain sizes.
- The only geophysical studies reported is VES profiling, which indicated that the surfacial deposits extend to depths of 9 to 38 meters on the right bank and 12 to 22 meters on the left bank.
- Two boreholes were sunk on the right bank of Erer. One of them was terminated at a depth of 7 meters, while the second continued to a depth of 30 meters. The logging of the single borehole indicates that the surface soil cover extends to a depth of 22 meters followed by the bed rock.

It should be mentioned that *the geological study* report of the feasibility' stage is well organized and quite informative. It starts with the description of the regional geological setting and proceeds with the geology of the site. Both the reservoir area and the dam site are studied in detail including the proposed spillway site and the main canal alignment. The study includes separate reports of the structural geology and the geomorphology of the site. A geologic map of the area with pertinent sections is provided. The information provided in the report confinns the findings of the pre-feasibility study with significant amount of additional details.

The structural geology revealed the presence of a 3 km wide ductile shear zone/band with a NE-SW orientation and dipping sub-vertically towards northwest. The southwestern margin of this shear zone is reported to intersect the right abutment and is found responsible for the formation of the detached blocks of gncissic rocks hanging on the lop of the right abutment. Due to the estimated intensive shearing, the depth of weathering at this location is expected to be deeper than elsewhere along the dam axis. Unfortunately, no borehole was sunk on the abutments to confirm this anticipation. In addition to the shear zone, a fault/fracture system trending NW-SE has been identified.

The study of *the geomorphology'* of the project site notes that, due to the nature of the rocks forming the hills and the presence of the intensive shearing zone, the steep-sloped valleys are easily erodible and are sources of the large sediment carried by the Erer River and its tributaries. This is evidenced by the rather murky appearance of the water of the rivers during rains. The report clearly states that traces of old and recent landslides are not observed in the project site, though it, on the other hand, cautions the likelihood of sediment cliffs that are commonly seen along the banks of the stream and gullies may easily collapse during impounding of water behind the dam.

On the basis of the results of the above-described geological studies, three alternative sites were selected for the dam. These sites are located fairly close to each other. Option I was found to posses the best ''geo-topographical" features and would result in a dam of around 1.4 km crest length. Both abutments are also found by and large in good stability condition with some instability of rock blocks expected at the right abutment into which the dam would be plugged. The rock slopes on the left abutment is also believed to provide a natural chute to the spillway with good foundation conditions. In contrast to the rather clear geological and geotechnical conditions around the abutments, there exists an uncertainly with regard to the foundation condition under the larger portion of the river plain. This is mainly because of the overburden that covers the bedrock.

The geotechnical investigation reported in the Feasibility Report consists of geophysical surveys and exploratory drillings accompanied by field and laboratory tests. They were initially planned in such a manner that they would fill the gap of information regarding the geological and geotechnical conditions of the wide plain area on both sides of the river. This initial plan was, however, not lully implemented due to foice majeure.

The geophysical survey was limited to vertical electrical sounding (VES) along five profiling lines. One of these lines coincides with the dam axis of Option 1 (where exploratory drilling and field tests were also conducted), two are parallel to the dam axis, and two are perpendicular to the dam axis and located closer to the respective abutments

than to the river banks. The initially planned VES profiling perpendicular to the dam axis on either side of the river and closer to the banks could not be conducted, according to the report, because of flooding of the area by seasonal surface water that turned the plains marshy. The VES profiling plan was thus conducted according to a modified plan.

Though contours of apparent resistivity are annexed to the report, no interpretation thereof is provided. It is planned to further consult the relevant documents and the participating professionals in order to make essential interpretations of the data provided. Il is also believed that the work would be more complete if profiling closer and parallel to the river banks are made during the earlier stages of the detailed design.

Ten *exploratory drilling works* were originally planned around the dam axis. Six of these were envisaged along the dam axis (Option I), one borehole on each side of the dam axis and two boreholes on the anticipated spillway. However, two of the boreholes on the dam axis and located nearer to the stream could not be sunk due reportedly to the same problem of flooding cited above in connection with the VES profiling. For this reason, the information regarding the foundation condition under the dam and the nature and thickness of the overburden remains still wanting. Furthermore the borehole drilling planned upstream of the dam axis and the one planned around the spillway exist were not conducted for reasons not stated in the report.

The exploratory drillings were thus conducted according to a modified plan consisting of five boreholes along the dam axis and a borehole around the center of the anticipated alignment of the spillway. The drilling work was accompanied by field tests including standard penetration test (SPT) and field permeability tests. The latter comprised single packer tests in rocks and falling head permeability tests in granular deposits. The borehole logs show that there exists at least a ten meters thick overburden of transported soil overlying the weathered bed rock of varying degree on the left side of the river. The weathering in the upper part of the bed rock is so intensive that in some of the boreholes the rock disintegrated to a state of sand deposit. The deepest drilling was conducted (30 and 33 m) in two boreholes close to the stream on the side of the right bank. The borehole logs accompanied by photographs of the core samples show that the overburden in these

boreholes extend to a depth of up to 19 meters followed by fully to highly fractured gneissic bed rock. This confirms the anticipation in the geological report.

It is not clear whether the reported SPT blow counts have been adjusted, though a mention is made in the report about adjustment for overburden pressure only. Except for one test point in BED-05 at a depth of around 5 meters, where the N-value is only 12, the blow counts recorded at all test points suggest a dense granular formation overlying the bedrock. Therefore, shear strength may not be a big problem in such formations.

The majority of the permeability tests conducted is falling-head permeability test. Inconsistency in the values of the permeability coefficients is observed as reported in the compulation sheets and the respective borehole logs. Besides this, the falling-head permeability test results may not be representative of the behavior of the material just below the stripping depth. Furthermore, only three packer tests were undertaken, of which two are incomplete. Considering the importance of seepage in this specific project, it is believed that further attempts will be made in the early stage of the detailed design to obtain as reliable and as much information as possible for a sound design of the dam.

Consolidation test results are included in the feasibility report that are reportedly obtained from testing of "disturbed" samples. The reported values of compression index (c_c) are very small. If indeed the tests are conducted on disturbed samples, what purpose would be served by the results is not clear. Assuming that the samples are remolded ones (compacted), once again the results would be of little use as one deals here with natural foundation material, and thus not with the man-made dam sections.

Though the project site is not known lor high seismicity tisk, the Seismic Appraisal in the Feasibility Report lacks clarity in providing sufficient information pertinent to seismic analysis and design of the dam and its appurtenant structures. The following statement in the concluding paragraph can be cited as an example of inconclusive and unclear information: "... the Erer Project falls in Predicted Acceleration 0 - 10% g with a predicted maximum intensity of VII to IX as per the Seismic Zoning Map of the

Country." Thus, the seismic appraisal of the site needs considerable revisiting in the detailed design stage.

The inception level visit to the site confirmed most of the findings of the surface geology study. In addition, it appears that measured coordinates of drilled boreholes do not generally coincide with those recorded in the feasibility documents.

4.5.2 Methodology to be Adopted

From the preceding discussion, it is apparent that there exists information scarcity regarding the nature of the material along the dam axis, especially close to the river. This is evidenced by the omission of VES profiling lines and boreholes that were initially planned for execution. It is thus envisaged that additional boreholes be sunk in this area to a deeper depth. This will be accompanied by permeability tests in both the bedrock and the overburden.

4.5.3 Studies to be Conducted

The following studies need to be made in the early stages of the detailed design work:

- Core drilling on either side of the river banks accompanied by properly planned field sounding as well as permeability tests;
- Conducting VES profiling at least along two lines across the dam axis. The profile lines are best located closer to the river than were previous profiling lines.
- Opening test pits and trenches starting from the river banks outwards and conduct appropriate field permeability tests;
- Extracting samples lrom the boreholes and the test pits for selected index property, strength and permeability tests;
- A borehole at the top of the right abutment to see if permeability and stability could be potential hazard to the dam.

4.6 Road Infrastructure

4.6.1 Review of Reports

4.6.1.1 Feasibility Report on the Road Infrastructure

The major source in reviewing the project for the assessment of road infrastructure is the feasibility study conducted on the overall project viability. On this report the road network is synchronized with the irrigation system following the primary, secondary and tertiary canals laid for the scheme. Roads identified to serve the irrigation scheme are summarized as follows;

- Primary' canal length induced 14.11 km
- Secondary canals have two separate directions resulted Sl-P 6.8 Km and S2-P 9.53 Km
- Tertiary canals are commenced from each of the above higher canals and also stated in the report that there arc seven such canals. These are as follow;
    - o Two from primary canal
    - o Three from S1 -P canal
    - o Two from S2-P canal

Quaternary canals are provided in the scheme for the irrigation but the provision of accesses for the canals are not identified which need further identification to include in the network. These quaternary canals are very important to the farmer where the roads maintenance could also be handled by themselves.

The length of the road provided for the tertiary canals are not determined which is important to makeup the final chainage that have to be laid to determine the total length.

On the specific report the design criteria for each of the road under different categories is not defined except the width of the formation and pavement for the primary and secondary canals. These elements are defined on the typical cross-sections of the primary and secondary canals where the width of formation and pavement arc determined.

Design of drainage structures, other than the Dccho Tributary that crosses the two secondary canals, are not well elaborated that need further identification, design and costing have to be done during the detail design phase. One important case is regarding the provision of canal crossing at the Harar — Babile Road. The report recommends that the trapezoidal section of the primary canal will be changed to rectangular with transition sections at the upper and lower stream of the bridge.

During the inception level site visit it was possible to note that as part of the Hara-Jijiga road upgrading project, new bridge is under construction for crossing the Erer River. The Project Coordination Office of the Ministry of Water Resources could take this opportunity to line the construction of the projects canal crossing structure with the ongoing road project so as to save cost and to create disruption of the traffic.

4.6.1.2. Woreda Integrated Development Plan Study

As part of the efforts made in developing the Road Sector Development Prognun (RSDP), the Government formulated the Ethiopian Rural Travel and Transport Program (ERTTP) based on the principles of the Rural Roads and Transport Strategy (RRTS). ERTTP is intended to address the deficiencies in rural infrastructure and transport services, and to reduce the hindrances that they impose on rural development. RRTS and ERTTP were developed, with the participations of all stakeholders, and the assistance provided by the World Bank and the SSATP- Rural Travel and Transport Program.

The goals of the ERTTP are broad and development-oriented. They are instruments for enhancing development and creating a better future for the expansion and improvement of (i) rural road and transport sendees, (ii) social and domestic facilities and (iii) income generating opportunities so as to help reduce rural transport burden and poverty. An important input to the development of the ER'ITP approach were the results of the Village Level Travel and Transport Studies (VLTTS) carried out in 1999, which clearly demonstrated the need to take a broad holistic approach to the understanding of access and mobility issues, and their interconnection with basic livelihood issues, and to seek

solutions in a broader rural development framework. Thus, the basic analytical frame of the ERTTP is the household.

In line with the foregoing, the road infrastructure study of the project should have made use of these very relevant and important country wide programme based interventions. However, under the present study and design proper linkage and synergy with these on going programme shall be made.

As the ERTTP has been initiated to tackle the rural travel and transport problem, it calls the close co-ordination and co-operation with the Sectoral Development Organizations. NGOs, Donors and the Private Investors under the cunent project design, specific objectives of the ERTTP, (i) to contribute to the national socio-economic development efforts by reducing the transport burden of rural households; (ii) to improve die access of vulnerable, food insecure communities to goods and sendees, and (iii) to enhance agricultural input & output marketing and rural development, shall be emphasized.

ERTTP, the plans would also establish the mechanisms for monitoring and evaluating such multi sectoral intenentions within the Wereda.

The project under the study will properly tap the concept and implementation arrengments of the WIDP where the community involvement in die participation on the provision of accesses in the beneficiary Woredas would be utmost important. This concept under the development of the irrigation project will address the road infrastructure to connect important socio-economic and service centers and also to serve the operation and maintenance of the irrigation scheme.

4.6.1.3 Ethiopian Roads Authority Design Documents

In considering the provision of access at all levels, it would be very important to review and meet the requirements of road design criteria under the Ethiopian Roads Authority (ERA). The Standard and Specification 2000 of ERA will be the base for the road design, specification and specification of the construction of all components of the road infrastructure. This however may be altered for lower standard design cases where the beneficiary themselves may undertake the construction works.

In the case of higher road standards the design criteria of ERA would be adhered to although this has not been considered during the feasibility study of the irrigation project. The ERA standard considers all pavements, drainage and other facilities of road section. Design of the different road services, specification of works, workmanship and equipment would be the part of the bidding documents for the construction of the irrigation road network.

This in turn will initiate the consideration of the in and out - puts of farm and other social and economical requirement of the scheme in particular and the beneficiary population at large.

4.6.1.4 Issue of Consideration regarding farm Road

The design of the primary canal crossing structure at the road from Harar to Babile is considered in the feasibility study. The design criteria and preliminary design of the bridge is mentioned to be available on sectoral report but this report is not available for review during this inception phase.

The aqueducts of two secondary canals to be constructed over the Decho Tributary are also mentioned to be available on the same report for the hydraulic and structures design. However, the sectoral report is not available for revision.

4.6.2 Methodology to be adopted

4.6.2.1 Road Network Design

The basic network of the road infrastructure would generally follow the irrigation scheme. Further to the irrigation scheme social and economical centers in the Weredas under the influence area would be considered in order to meet the requirements of WIDP concept. This in turn will assess resettlement of people in the reservoir area, under the farm and other facilities to be considered during the appraisal of the project implementation like operation and maintenance of dam and irrigation systems.

The different functional roads serving different purposes will have its own standard that will consider the volume of traffic expected during tlic operation of the farm. The network will be connected to either the major road or near by town for further connectivity with other outlet. The naming of each of the road segment will be adopted for further communication during the preparation of design, bills of quantities, construction and maintenance phases.

Hierarchy of road network could be categorized according to their major functions. All roads would be provided with adequate side drains from runoff water and disposed at the nearest natural channels. The amount of water discharge in each drain during the occurrence of high storm would be calculated in order to make sure of their capacity.

4.6.2.2 Road Design Criteria

The Ethiopian Road Standard and Specification 2000 will be adopted for the different classes of road to be provided in the irrigation scheme. One major point is that the entire road network under consideration will have specific geometric design to fulfill the major function it serves.

Both the physical characteristics and turning capabilities of vehicles are controls in geometric design. Vehicle characteristics and dimensions affecting design include power to weight ratio, minimum turning radius and travel path during a turn, and vehicle height and width. The road elements affected include the selection of maximum gradient lane width, horizontal curve widening, and junction design. The present vehicle fleet in Ethiopia includes a high number of four-wheel drive utility vehicles and overloaded trucks and for this particular project farm tractors and accessories could be common for the use of the roads.

In general the following flow chan (figure 4.1) below will define the class of road to be considered during the design of each road.

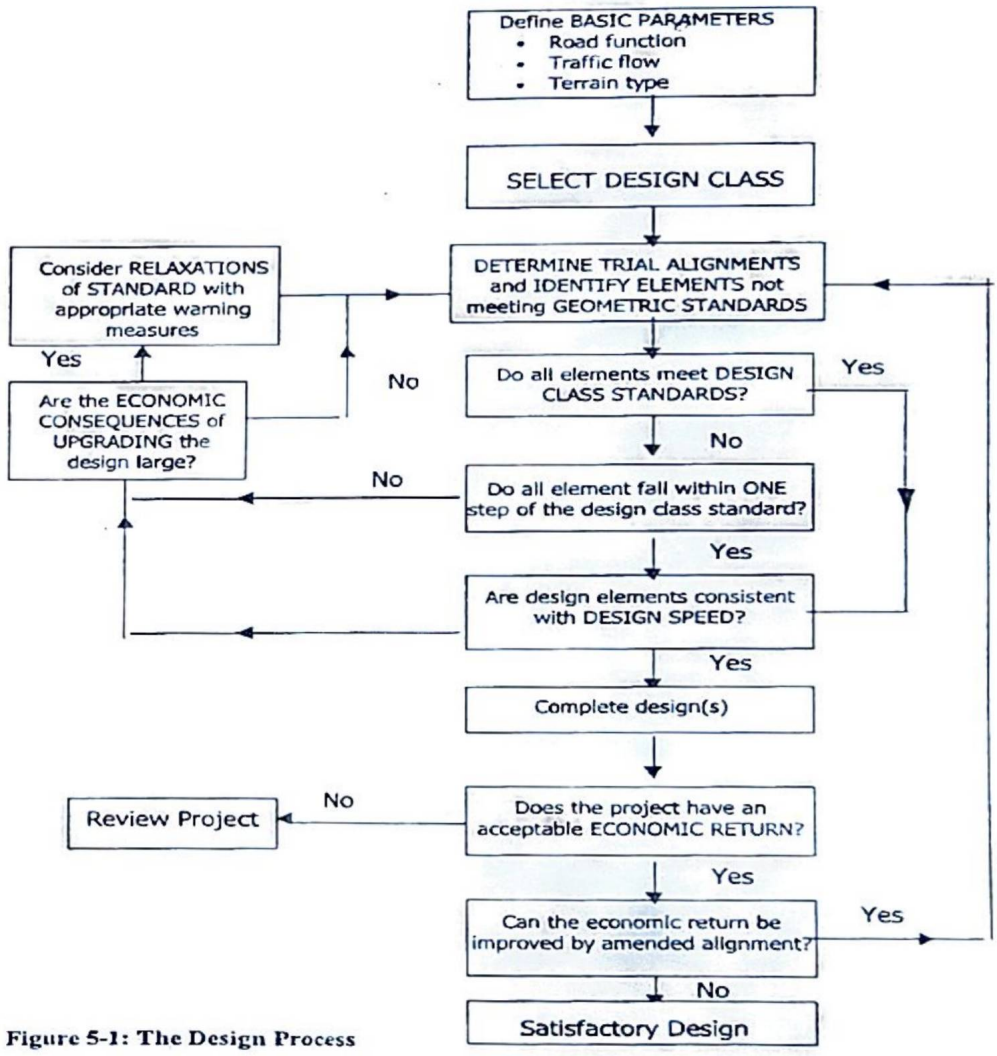


Figure 5-1: The Design Process

Figure: V. *1 the Design Process*

A further factor influencing the development of road design standards, and in particular the design speed, is the volume and composition of traffic. The design of a road should be based in part on factual traffic volumes. Traffic indicates the need for improvement and directly affects features of design such as widths, alignments, and gradients. Traffic data

for a road or section of road, including traffic trends, is generally available in terms of annual average daily traffic (AADT).

Using road functional classification selection and design traffic flow, a design class, or standard, is selected. The functional hierarchy is such that traffic aggregates as it moves from feeder to main collector to link then trunk roads. However the actual flows will vary from region to region and it is important that the designation of a road by functional type should not give rise to over-design for the traffic levels actually encountered.

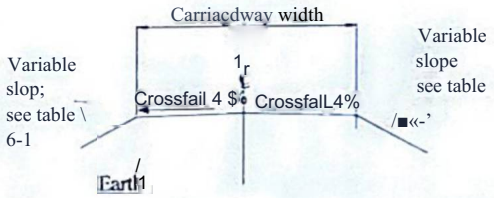
The geometric standards for low volume roads, for the case of the project, have less importance and it depends on if it is passable at all times.

In such circumstances when traffic load is non-frequent, it is appropriate to adopt inexpensive standards that enable the further development of a system of such feeder roads at minimal cost. This policy encourages overall national economic development.

Hence considering the project at hand, the basic elements of the design of low volume roads follows hierarchal orders. This comprised from in-farm roads to main canal then to major center to outlet classes of road. The following classes of roads at the preliminary level arc selected for the different category of functions. These are shown consecutively with the typical sections of each class with their function (figure 4.2 & figure 4.3).

Road section for the tertiary canals as well as for in-farm roads will be, DS-10 standard which is the lowest standard under the specification (figure 4.2). The singled lane width of the road would be 3.3 meters where in most cases farm tractors and carts may use the road section frequently. In case of two directions are occupied one against the other a passing lane would be provided within a sight distance or at every 400 to 500 meters alternatively. The width of the lane could be widened at village section where there would be a need for parking lanes as well as pedestrian walk way.
The surface could also be paved using natural gravel if there is necessity. Otherwise if there is no need of using during the rainy season the surface may be natural soil surface. This road could also be constructed using labor-based road construction technique by the beneficiaries as practiced in the community road construction methods

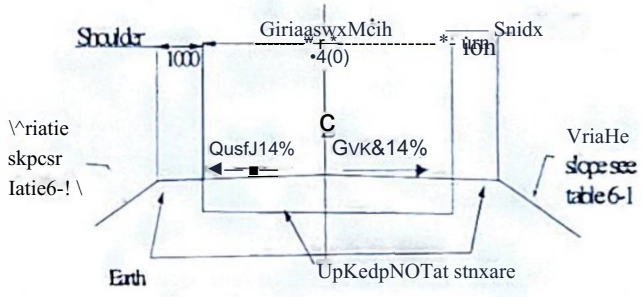
The next hierarchy of road network (DS-7) /Figure 4.3)\vould be road provided for the primary and secondary canals and other social and economical centers under the scheme. All roads of the DS-10 standard will be connected to these roads. This road level will be used to do intensive canal maintenance, in addition to the operation of the irrigation system and transportation of farm in and out puts before and after ever}[7] farming and harvest periods.



Nonna! section of design standard DS 10

Figure 4.2: Design Standard JO Normal (DS 10)

The higher level of the road network under the Erer irrigation project is the connection of the above roads to the higher standard roads or to the nearest town where the Ethiopian road network existsd. This level of the road network will be designed to the DS-6 (figure 4.4) standard. This standard connects all the lower roads of the scheme to the outside world.



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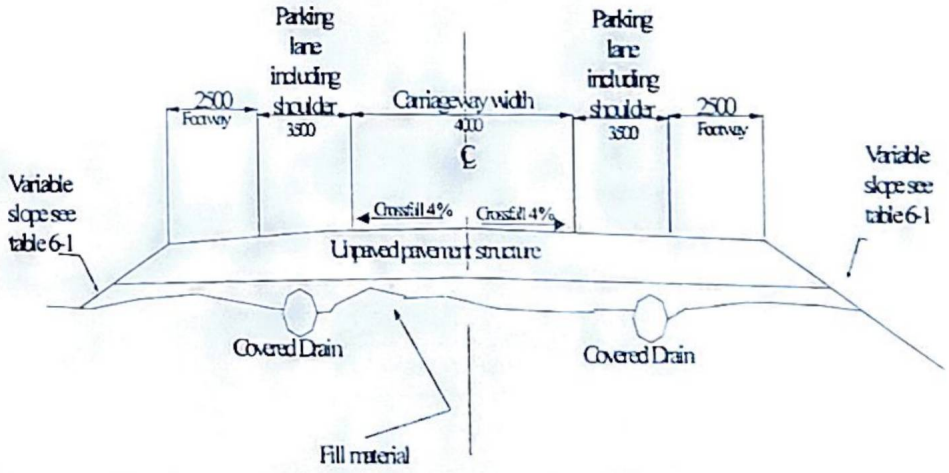
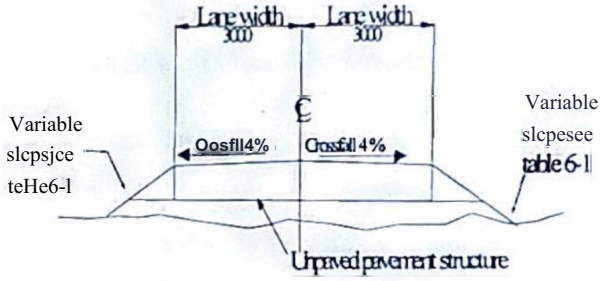


Town section of design standard DS7

Figure 4.3: Design Standard Normal and town section DS7

Detail design of the road would be carried out once the standards are approved by the client on the selection of the road standards for the different levels of road functions.



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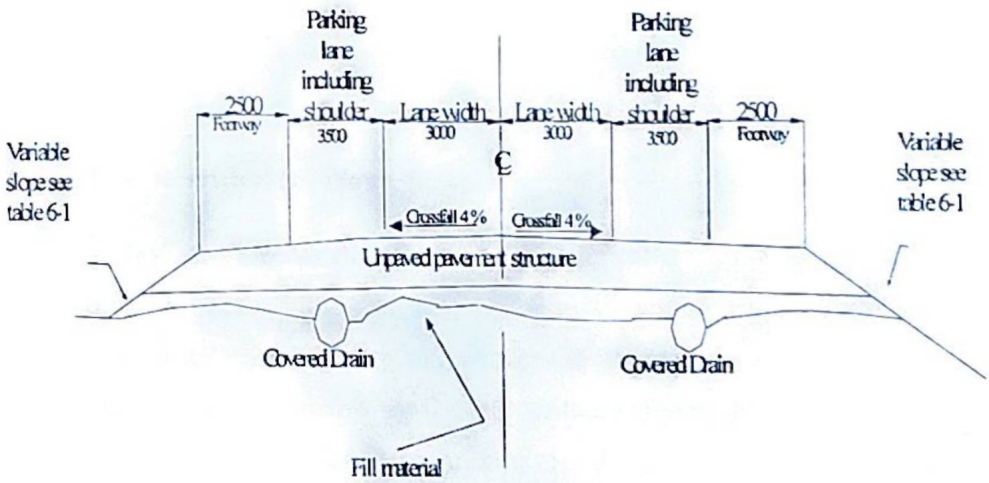

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Figure 4.4 Design standards for DS 6

4.6.3 Studies to be conducted

4.6.3.1 Design, Preparation of Bills of Quantities, Specification

All the different standards of road components including the drainage and facilities would be carried out as per the requirements of the ERA specifications. The detail of the network and the final alignment of the entire road alignment would be finalized once the scheme of the irrigation is placed. Additional routes under the project scheme where the requirements for social and economical centers of importance would be connected. The road standard criteria defined as the above would be adhered for each of the network as per the road functional classification.

The draft network and design including the specifications and bills of quantities would be presented for the approval of the client for further adjustment if there needs such provision. All the final work would be incorporated with the major dam and irrigation scheme of the command area of the development for contract provision.

4.6.3.2 Road for Resettlement Plan

On the feasibility study conducted for the development of the Erer River dam and irrigation indicated that the impact of the proposed dam and reservoir would affect four Kebeles. The proposed resettlement plan however did not identify where the resettlement place to be under taken. Depending on the new settlement plan; the requirement of road infrastructure will be designed in order to minimize the negative social impacts due to the new development.

Based on the identified settlement area within the previously surveyed location, additional design of road and facilities would be initialed as approved by the client. The detail part of additional cost incurred due to the work could be forwarded once approval is made.

4.6.33 Road Realignment in/ncar the Reservoir area

The road linking Harar town with Errer Dodota would be under the reservoir. Relocation of this road is necessary' and needs further study. The study includes surveying work and design of the road alignment at different routes in order to keep the community' undisturbed by the project.

Tins will need to conduct selection of corridor, route alignment for surveying and the design of the road under the project. The detail part on the requirements for the additional work would be proposed if approved by the client.

4.7 Building Infrastructure and Sendee Centers

4.7.1 General Back Ground

The dam and irrigation area is approximately 20km south-east of Harrar town; the project site could be approached from Harrar taking two different directions with two roads. One of them is the main Harrar-jijiga road, is an all-weathered road. This road is currently under restoration.

The orientation of the water-collecting area, the dam and the command areas run a north to south direction where as there are hills and mountains sandwiching the above mentioned areas on the eastern and western side.

To run the dam and the irrigation areas efficiently after they are built a proper infrastructure and buildings to manage them should be constructed.

The location of building infrastructure and service centers considered necessary for the smooth operation of the dam and irrigation project more of less depends on the easy access to the basic infrastructural needs which mainly are electric power, telephone connection, availability of waler and access to circulation (roads).

Definitions of building infrastructure and service centers could be formulated after comprehensive study of the basic organizational structure of typical dam and irrigation projects.

During the site visit from May 5th to May 8th, regardless of the fact that some bench marks from earlier surveying have been dislocated by the local farmers, the total project site has been identified with out any problems.

4.7.2 Review of Feasibility Report

Hie feasibility study report doesn't cover comprehensively and in detail about the building infrastructure and the service centers to be built on the project area, for this reason much of the work in formulating the program and design input starts as of the first inception and site visit. Furthermore consultation with the client would unquestionably help in developing a basic frame work in acquiring a proper project program.

4.7.3 Project Site Assessment and Analysis

As it is already mentioned on the general background, the two major sites which are the dam area and the irrigation area are placed in north and south direction respectively. The two major areas are being analyzed accordingly- (fig 4.5)

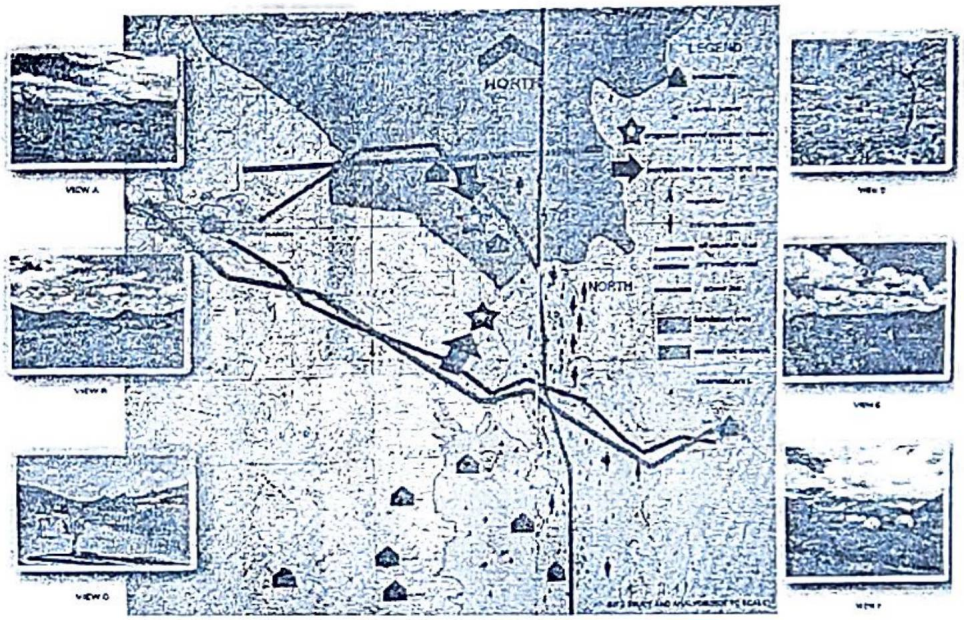
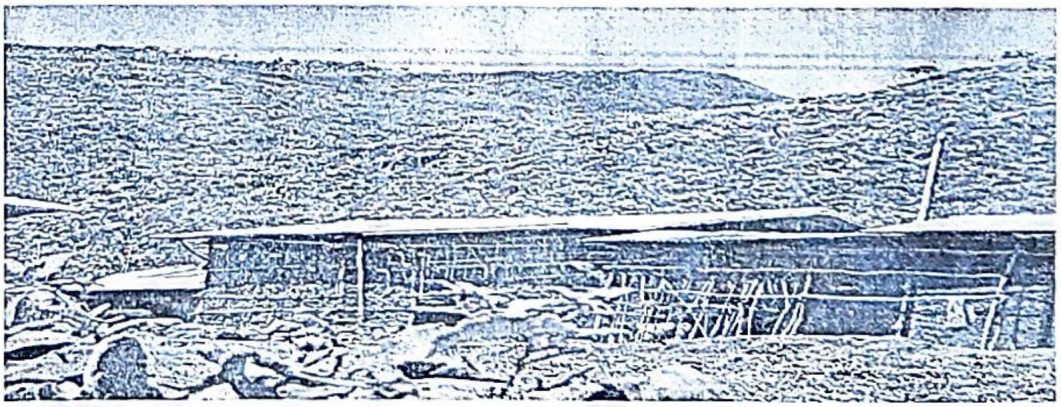


Fig4.5 Site Study and Analysis

A) Infrastructure

Electric power

The electric power available in the area is limited to relatively to the extreme north and south directions. The northern nearest power available is located around a small settlement called Marco. Whereas, the southern power availability is mainly limited to the area of the main Harrar-Jijiga road.



Picture showing the small settlement macro with its elementary power provision.

Telephone

Wired telephone line is only limited to major towns around the area, moreover the availability of mobile network is very random throughout the site. Nevertheless there are a numerous wireless telephones being used all over the site.

Water

- In the feasibility study it has been mentioned that some water holes have been drilled witnessing the availability of a significant amount of water underneath.
- The exact locations of the drill areas taken shall still to be consulted with feasibility documents and local farmers.

Road

The accessibility of roads and streets is a major factor in the allocation of buildings and infrastructures.

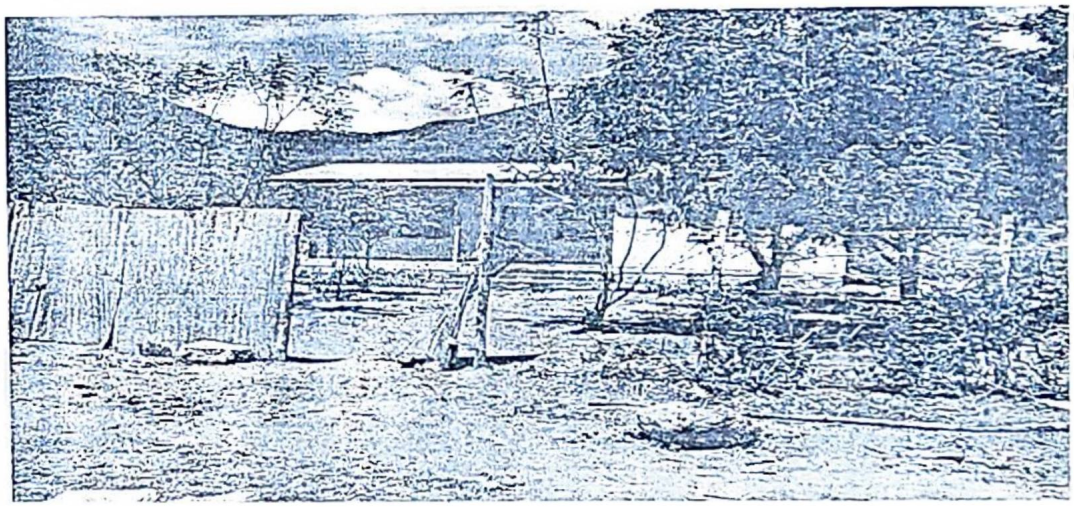
Currently there exists two main roads passing through the site, these are

The Harrar-jijiga road which at this lime is been renovated, and a dry weathered road which runs parallel to Errer River.

Picture showing the dry-weathered road which mainly runs north to south direction of the project site

B. Building materials

There is abundance of clay soil in the vicinity of the project site, as a matter of fact some settlements around the area are using this soil type, as walling material after it is being sun dried. Other Available building materials are wood, hollow block and sun dried blocks.



Picture showing a moderate house in Roka settlement without electricity

4.7.4 Studies to be carried out

The basic studies to be conducted hence are -

- First and for most definition of the basic program which are the fundamental needs of both the dam and irrigation areas, this shall include detail space provision for the functions needed, building materials etc-
- Allocation of the above formulated spaces on suitable areas with available infrastructure with minimum cost, adaptability as well as ease for maintenance.
- Propose a resettlement plan for the people who arc going to be displaced.

4.7.5 Methodology

At the project site buildings are required to serve as residential, laboratories, office and administration buildings. The design shall be made, in such a way to fit the project area climatic and cultural conditions.

Considering that the buildings to be designed, initially will serve as a camp for construction supervision team, the construction of the houses should be completed as early as possible before the start of main structures construction period. In this regard to facilitate quick constniction possibilities of pre-cast/prefabricated elements shall be considered.

During this level of study various layouts of different design type using different materials and location of these buildings will be prepared for the clients (MoWR) approval.

Dam Operation Center

The dam area shall comprise spaces provisions for technical staff offices, maintenance areas, stores, generator, transformer and pump houses, and other ancillary[1] functions. (Fig 4.5)

The availability of a road, electric power, telephone and water is mandatory' to the dam operation center.

Irrigation Operation Center

For smooth operation of the irrigation area there shall be buildings which shall house nursery sheds, tractor sheds, administration offices, stores, pump houses and the like (Fig 4.5). Il should be noted that such functions should be manipulated by local farmers and maintenance of the above buildings should not be difficult.

It is very essential having a road for smoother transportation of goods in and out oi the area. However the availability of other infrastructures is secondary compared to electric power.

4.8 Irrigation System and Structure

One of the prominent features of agriculture in the Erer river valley is the traditional irrigation systems. A single village, or several adjacent ones, would construct administer, and repair the irrigation system which diverted water from Erer river and sent it through the canal systems into their fields. The temporary diversion dams which raise the water level to facilitate the flow into the canal system are temporary structures constructed of wooden poles and bundles of brushwood. When the river is in flood stage, the diversion structures are usually destroyed and are required to be reconstructed yearly. Thus, during our field visit we did not get a chance to see any of these temporary structures. Tasks to be carried out but not limited to the following specific tasks:

- Design canal crossing (for cattle and machinery') at selected location.
- Design proper drainage system (irrigation waler surplus and rainfall runoff).
- Detailed irrigation scheduling.
- Delineation of irrigable land,
- Location of Canal structures al selected sites

4.8.1 Review of Report and Field Assessment

The study team focused on the elements of quality of feasibility report which encompasses relevance, accuracy, timeliness, accessibility, interpretability, and coherence. Assessing these elements of quality required a review of its concepts, organization, sampling, data collection, data processing, etc. In doing so the team has addressed issues of concern and its uses for analysis and client's decision making. The team has endeavored to identify specific improvements, in collection, compilation, interpretation, of data in the present case and requirement of state-of-the-art methods to

be used in the future, and in making it accessible to potential users. In general the quality of survey data presented in the feasibility report is not found to the mark. The study with based on the erroneous survey data are thus subjected to change. A special effort is required to review/update the survey data at this stage. TTiis is the element the study group was least able to assess with confidence, because knowledge is inadequate about the true values of many data items that feasibility report estimates. Obtaining better information about the accuracy of survey based information from the survey is a central reason for our call which is sounded throughout this inception report.

The study team visited the project site from March 25/ 2008 to March 26/ 2008 and again from 4/05/2008 to 10/05/2008. During this time physical assessment of the project area was done and local authorities of the project area were contacted. The inception report is prepared based on the project team members' preliminary field assessment, site visits and review of previous studies. The Client's acceptance is required on issues raised in this report. The main purpose of this review and field assessment is to review the conclusions reached at feasibility study and set out an approach and work plan for completion of detailed design of the project. The report also incorporate deployment schedule of personnel involved, time frame for detailed design and reporting schedule of various activities.

Topographic maps of scale 1: 50,000 are collected for review and analysis. During the field visit of dam site, reservoir site and potential irrigable land were inspected. In overall assessments the project looks feasible. T he alignment of canals, drains and location of associated structures are subjected to change on the bases of detailed surveys and investigation which are being subjected to review after detailed site surveys and investigations. However no major changes on the alignment and location of irrigation and drainage structure are anticipated.

4.8.2 Methodology to be adopted

Based on the feasibility study of the present project the consultant will conduct the following sub activities:

- The feasibility level study made by the WWDSE for the proposed project in the assignment and any other site specific and master plan studies relevant to the proposed project area will be critically reviewed.
- The irrigation design shall ensure reliability, equity and flexibility of water delivery to farmers. It will aim at reducing conflicts among water users and will lead to lower operation and maintenance costs.
- Updating (if it exist) and computation of the actual Evapo-transpiration, crop water requirement, irrigation demand/ duty using the existing and recent agronomic, climatologic and soil data using more appropriate methodologies.
- Identify and update the specification of main canal, canal-lining requirements using the inputs from engineering geology studies and mitigate in the design process.
- Critically review design and specification of pumping stations (if included), and other principal irrigation works required to supply all suitable lands including cost estimates.

In addition to the methodology, presented above however, the following issue shall be given due emphasis. Subsequent to this inception report functional detailed design of the dam and appurtenant structures together with the irrigation infrastructure will be prepared. Plans sections and structural details shall be prepared to the required levels. However, as staled earlier the methodology to be followed and the detailed design of the main canal would be subject to review after detailed site surveys and investigations.

4.8.3 Additional Data to be acquired

The studies to be conducted shall be as outlined in the consultant proposal, however the following aspects shall be given due attention. On having analyzed the topographical

drawing made available by the client the following deficiencies have been observed. These need to be sorted out:

- Drawing docs not has geo-referencing in UTM
- Drawing does not have original surveyed points (levels).
- Drawing is without complete legend (such as scale and description of drawing features).
- Drawings does not have proposed alignments of the project, like the Dam site, spill way, main canal etc.

We also call attention to the need for better channels of communication between federal, local irrigation/agriculture office and beneficiaries/farmers. These initiatives may require an infusion of funding and enhancement of staff expertise in irrigation management skills.

Other activities to be carried out, but not limited to, are the following;

- Conducting topographic surveys of the project area,
- Preparing the lay out of irrigation and drainage system; locating the necessary structures, distribution system, infrastructures and existing main features,
- Design of irrigation canals and canals structure w'ilh appropriate scale ,
- Design of drainage canals and canals structure wdth appropriate scale,
- Design of Infrastructures and protection structures with in the farm including access roads,

A manual that would guide on the requirements, methods & procedures for management, operation and maintenance of the project shall be prepared.

4.9. Preparation of Detailed Design Criteria and 1 endcr Dossier

4.9.1 Review of Report & Field Assessment

a) Design Criteria

The design criterion needs the full apprehension and understanding of the project by all project staff. To this effect sufficient brain storming & technical discussion were held and the task is being handled properly. All project team members have made use of the field assessment to lay the basis for the engineering and other studies, rhe feasibility studies reports indicated the use of Indian standards in the engineering studies while national & Regional policy and strategy and legislative documents have been utilized for the non-engineering studies.

b) Tender dossier

The feasibility reports prepared in 14 volumes do not have tender documents as it was before detailed design phase. However, these reports shall lay the ground work for the ongoing detailed design phase on which the tender document (dossier) shall be based upon.

4.9.2 Methodology to be adopted

The Tender Document will be prepared subsequent to the completion of the detailed design. It will consist oi instructions to bidders, general conditions of contract, specific conditions of contract, working drawings, detailed bills of quantities, technical specifications of all the design works and structures, confidential cost estimate, lists of equipment for construction, estimated construction schedule, written with clarity and completeness of detail to avoid ambiguity of interpretation during implementation. The preparation will be consistent with the practice of the Ministry of Infrastructure and relevant international standards, such as F1DIC.

4.9.3 Studies to be conducted

The subsequent studies to be done in the course of preparing the design criteria and tender dossier shall be in complete harmony to working local and international standards..

4.10 Financial and Economic Analysis

4.10.1 Review of Reports and Data

This inception level financial and economic feasibility analysis study is prepared based on the review of previous study reports as well as preliminary field level information.

The Erer irrigation project feasibility study was undertaken in year 2007 and relevant document of the study have been reviewed.

Findings

The irrigation project is located in two regional slate (Harari and Oromia). The previous study indicates to develop irrigated land area of 4000 hectare.

4.10.1.1 Economic Features of the project Area

The economic features of both woreda are largely crop production and live stock also contributes a great role in household livelihood and income source. Generally, mixed agriculture rain fed. irrigated crops and live stock rearing economic basis of the people.

However, the rain fed crop production and productivity is influenced by erratic rain fall and other factors to meet livelihood source and food security of the community. Previous study indicates 91 % of the communities are food in-secured and food aid dependent (Erer irrigation project feasibility study, Volume 9).

The project area also uses traditional irrigation and produces fruits and vegetables including Mango. Avocado. Papaya, sugar cane and other vegetable product. However, like rain fed production, irrigated crop production at the project area is also characterized by production and productivity constraints due to technical and other non technical problems.

4.10.1.2. Description of the project

The intended irrigation project envisages development of Erer earth dam irrigation projects with the anticipation of increased production and efficient water management.

The previous feasibility study has indicated and planned development of 4000 ha considering the over all agronomic and other irrigated agricultural production system.

The current over all study aims detail design of the project and this report refers to the scope of task indicated in the financial economic analysis of the technical proposal.

4.10.1.3 Financial and Economic Study Results

The previous financial and economic analysis study report has tried to assess the financial and economic impacts of the projects.

The analysis used crop budget of proposed crops and also considered with and with out situation of the project and determined viability of the project. The analysis and evaluation used price constant price estimated at farm gate price of year 2007. The tools of evaluation and analysis includes net resent value (NPV), Internal Rae of return (1RR). Cost-benefit ratio (C/B) and sensitivity test. The financial analysis net present value at 10.5% discount rate indicates 71,264 thousands and 1RR is about 13.35 % showing viability of the project. The economic net present value indicates 64,137 thousands and IRR has shown 13.35 %. The result of the financial and economic viability indicators as well as the sensitivity test has shown remarkable feasible viability indicators for

implementing the project. The final results of the analysis has shown and come up with viability indicators as shown below.

Indicator	Financial	Economic
NPV	71,263,817	64,137,435
IRR	13.35%	13.35%
B/C	1.99	1.99

The financial and economic viability analysis was based on the following proposed crops.

- Maize
- Sorghum
- Rice
- Groundnuts
- Hair coat beans
- Vegetables
- Sugar cane
- Orchids (Fruits)
- Sweet potato
- Tomato
- Potato

Project Cost

The total capital investment cost estimated by the cost engineer and indicated in the feasibility study was birr 286,983 thousand. The Operation and maintenance cost was estimated to be 5,740 birr/ha.

The study has concluded technical, financial and economic viability of the project and recommended the projects for implementation based on the prevailing investment cost, output price and objective conditions of the time.

The current study aims to up dates this study with current cost and benefits by taking the inflation rate on food crops and undertake detail investigation on viability of the project.

4.10.2 Methodology' to be adopted

The analysis and evaluation follows the conventional project analysis where benefits and costs are first estimated on a common basis, market prices for the financial analysis and "shadow prices" for the economic. The analysis identifies and values the costs and benefits that arise with project and with out project situation. Opportunity' cost and the discount rate taken at current inflation rate.

4.10.2.1 Project Analysis/ Evaluation Approach

Estimation of project costs: Cost components include manpower, extension costs, additional fertilizers or seeds, diversions and other civil works, water conveyance, annual operating and maintenance expenditures and any other costs identified for the specific project. The costs are allocated to the year of expenditure and expressed at constant prices.

Estimation of project benefits: The principal project benefit is the value of increased production through improved yields although there are also oilier direct or indirect benefits other than yield , for example, Additional benefit from fish harvesting and other benefits are considered to the year they are incurred and expressed at constant prices.

Calculation of net benefits: The net benefit stream is the difference between the project benefit stream and the project cost stream.

Financial analysis: In financial analysis, typical crop and farm budgets are prepared and evaluated to assess the incremental returns to the fanners participating in the projects.

In the economic analysis, project costs and benefits are compared using discounted measures of project worth. Discounting is the technique by which one can convert a stream of benefits of costs to its net present value to account for the time value of money.

Viability indicators: The following major viability indictors will be used for evaluation and decision making;

Net Present Value: The most common of project worth is the net present value. It is the present worth of the incremental net benefit stream and the net present worth must be positive, if the project meant for implementation.

Internal Rate of Return: The internal rate of return is the discount rate which makes the net present value of the incremental net benefit stream equal to zero. Projects will be accepted if the calculated internal rate of return exceeds the cut-off rate or opportunity cost of capital.

Benefit-Cost Ratio: The benefit-ratio is the ratio of the present worth of the benefit stream to the present worth of the cost stream. If the benefit- cost ratio exceeds one, the project should be accepted for implementation.

Sensitivity test: Sensitivity test will be undertaken for major variable based on the assumption and prediction on the viability of the project with some major factors change.

4.10.2.2 Key Evaluation Parameters

The evaluation is based on a number of key assumptions. The principal criteria and parameters are discussed below.

Discount Rate

The basic discount rate of opportunity cost of capital will take in to consideration the Ethiopian public investment guideline as well as the inflation rate.

Price

All costs benefits are expressed in constant prices (i.c.. excluding general escalation) at June 2007 price levels. This will also be the base date for all present value calculations. In general, local market prices will form the basis for both financial and economic prices.

Planning Horizon

The costs and benefits are evaluated over a period of 20 years. This period is expected to be long enough to fully include all benefits from the expected economic life of the irrigation facilities.

Sensitivity Cases

Sensitivity case will be developed on the basis of foreseeable fluctuations in operating costs, high and low flow rates and modifications in the anticipated prices (revenue); and fixed costs.

Economic analysis can include a simplified shadow pricing technique employing a Standard Conversion Eactor to conduct the analysis at "border prices".

4.10.2.3 Financial and Economic Input and Output Prices

The financial prices of farm inputs and outputs are based on the observed prices in the local markets during the marketing surveys. The financial prices are adjusted where necessary to reflect the opportunity cost to society and in doing so determines the economic prices.

Farm Inputs

All fertilizers are imported to Ethiopia and made available to small farmers are not taxed. The financial and economic prices of fertilizer are based on the current market price. In the project area the market price for both DAP and Urea, the most economy used fertilizer, is at prevailing market price of undertaking the study.

Machinery and Equipment

The landed cost tractors, machinery and equipment, pipes (convey, main system and distributor lines) arc taxed if they are purchased from import -export trade agent or others.

Final viability indicators: The cost and benefits stream will be indicated in detail based on the revised detail design, prevailing constant price with break down of each component and final viability indicators will be analyzed and presented for decision making about the future plan of the project.

4.10.3 Studies to be conducted

The subsequent studies will remain as presented in the consultant's proposal. However, sufficient attention will be made to the change and alterations that would occur as a result of the review of the feasibility study and the detail design study.

5.0 Out Standing Issues

5.1 Dam Catchments area Treatment

The Erer dam & irrigation project is expected to harness its water source from the catchments area above the dam axis. According to the feasibility study report volume 10, sectoral report 18 and as per the field assessment the catchments area of the dam which is expected to generate runoff, is severely degraded with an estimated annual sediment transport rate of 0.62 million cubic-mater. This rate is an estimate which is bound to be much higher unless well organized catchments rehabilitation work is started right now.

As catchments rehabilitation takes effect through time, its implementation requires lead time of minimum 3-5 years hence if not late the time for the catchments rehabilitation task should be now, with out further delay.

Delaying this activity will not only shorten the service life of the dam but also will cause unprecedented social upheaval that will be caused by the disruption of the regular operation of the dam and its ancillary facilities.

5.2 Beneficiary Orientation

The feasibility report volume 10, sectoral report 18 presents the wishes and desires of the population leaving in the reservoir area as "not accepting displacement". During the consultants' field assessment, this view has been clearly demonstrated by the inhabitants. Therefore with out wasting time it is very critical to establish a working arrangement between the Ministry of Water Resources, Oromia National Regional State & Harari Regional State, so as tn reach the direct stakeholdnrs in a very careful and proper wav. Possible arrangement could be a ''Steering committee" for the project which would be consisting of the mentioned partners of the project by making the inhabitants at the center.

The consultants feel that a lot of public awareness & public consultation has to be intensively conducted in order to implement the project. The timing is very important, which is a little late at the moment.

5.3 Re- Location of the Harra -Ercr Dodota Road

The Harar-Erer dodota road shall be submerged by the impounding water of the reservoir. This road has important economic and social uses on top of its possible use to access the dam and appurtenant structures. Thus decision is required on the re-location and the associated engineering design work regarding this road.