

**APPENDIX – XIV**  
**TECHNICAL SPECIFICATIONS**  
**OF**  
**SUB-CONTRACT**

**ANNEX - XIV**  
**TECHNICAL SPECIFICATIONS**  
**OF**  
**SUB-CONTRACT**

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# **1 Social Environmental Survey and Soil Survey**

**TECHNICAL SPECIFICATION  
FOR  
SOCIAL ENVIRONMENTAL SURVEY  
AND SOIL SURVEY  
FOR  
THE FEASIBILITY SURVEY ON THE LOWER MUNYATI RIVER BASIN  
AGRICULTURAL DEVELOPMENT PROJECT**

**1. GENERAL**

**1.1 Name of the Work**

Social Environmental Survey and Soil Survey for the Feasibility Study on the Lower Manyati River Basin Agricultural Development Project

**1.2 Survey Area**

The survey area of the Work is broadly divided into the following two (2) areas:

- (1) Submerged area by the construction of Kudu Dam which has been planned by the government of Zimbabwe, and
- (2) Down stream irrigation command area of Kudu Dam reservoir which consists of Communal, Resettlement, Small Scale Commercial, and Large Scale Commercial Areas. Among these Areas, the Work will cover only the Communal and Resettlement Areas (see Attachment-1).

**1.3 Outline of the Work**

In the submerged area, two kinds of social environmental surveys will be carried out by the Contractor, i.e. Villagers' Intention Survey for Involuntary Resettlement and Village Inventory Survey. The former survey will be conducted aiming mainly at clarification of villagers' intention to involuntary resettlement, because their land and houses are located in the proposed submerged area of Kudu Dam according to the dam construction plan. The latter will be carried out with the main object of making an inventory of private and community's properties including land, social infrastructure, economic infrastructure, cultural and historical assets, and so on.

In the down stream irrigation command area, two kinds of social environmental surveys will also be carried out by the Contractor, i.e. household survey and household member survey. The former survey will be conducted aiming mainly at clarification of households' socio-economic conditions. While in the latter survey, daily activities of household members and their intention to the irrigation development will be grasped. Questionnaires will be prepared and used in both surveys for primary data collection from household heads and members. Soil survey will also be carried out in the down stream irrigation command area, in order to evaluate land classification, to check distribution of saline-sodic soil and to clarify soil erosion.

For the execution of these surveys, the Contractor will organize the following four (4) survey teams:

Submerged area

- (1) A team for Villagers' Intention Survey for Involuntary Resettlement,
- (2) A team for Village Inventory Survey,

Down stream irrigation command area in the Communal and Resettlement Areas

- (3) A team for Household Survey and Household Member Survey, and
- (4) A team for Soil Survey.

#### **1.4 Survey Schedule and Survey Personnel**

Survey schedule and survey personnel for the respective surveys are shown in Attachment-2. The survey personnel should be the experts of similar surveys and be familiar with the survey area. The Contractor shall be responsible for employment of enumerators, arrangement of accommodation and transportation required for the field survey. The training of enumerators shall also be carried out by experienced experts of the Contractor in collaboration with the JICA Study Team. Especially for Village Inventory Survey, the survey team should be familiar with the methods of Participatory Assessment such as RRA (Rapid Rural Appraisal), PRA (Participatory Rural Appraisal) etc.

#### **1.5 Materials to be Submitted**

##### **1.5.1 Reports**

All the report shall be prepared in English and shall be submitted to the JICA Study Team. Time schedule and contents of the reports are summarized in the Attachment-3.

##### **1.5.2 Other Materials**

Other materials shall be submitted to the JICA Study Team are summarized in the Attachment-3. As for diskettes of data and tables, if the JICA Study Team make any comments for the database and tables to be prepared by the Contractor, the Contractor shall also re-submit diskettes containing the revised data at the time of submission of Final Report.

## **2. VILLAGERS' INTENTION SURVEY FOR INVOLUNTRAY RESETTLEMENT**

### **2.1 Objectives of the Survey**

The purpose and objective of the villagers' intention survey in the proposed submergence area are as follows :

- 1) to clarify the present socio-economic condition of the affected populations in the proposed submergence area,
- 2) to assess and evaluate the social environmental impacts caused by the Project as quantitatively as possible,
- 3) to grasp and confirm the affected villagers' intention for their resettlement and the project activities, and

- 4) to assess a basic approach of a resettlement plan on the Lower Munyati Basin Agricultural Development Project.

## 2.2 Scope of the Survey

The villager's intention survey is carried out through interviewing the villagers by using questionnaires, which shall be printed by the Contractor using the Attachment-4. The questionnaire is subject to minor change based on the conditions, which will be further confirmed both by the JICA Study Team and Contractor at the initial stage of the survey. The survey works basically comprise (i) preparatory works, (ii) field interview survey and (iii) data analysis.

### 2.2.1 Survey Area

The Survey area covers the proposed submerged area and buffer zone by construction of Kudu dam. According to the proposed plan of Kudu dam, about 7,800 ha will be submerged at full water level.

### 2.2.2 Sampling

#### (1) Number of Samples

It is reported that about 1,000 households are in the proposed submerged area, according to the result of Master plan study conducted in 1995 by JICA. Based on this number of households, about 300 households will be sampled for the interview survey considering 90% probability.

#### (2) Sampling Method

Random sampling method is taken as a sampling method for the interview survey. The Contractor shall, however, consider and decide a detail sampling procedure, which is appropriate for the situation of the Survey area, in consultation with the JICA Study Team.

### 2.2.3 Survey Method and Items

The items to be studied and analyzed through the interview survey are as follows :

Survey items:	Contents
1. Household information :	- household composition, - ages of household members - education levels of household members, - occupation of household members, - tribe of household members - length of stay
2. Household economy :	- income by source (income source), - consumption
3. Farm production :	- cultivated crops (cropping pattern), - cropped area by crops, - yields by crops (production by crops), - farmgate price by crops, - farmland condition (irrigated condition, etc.)
4. Other economic activities :	- other economic activities (fishery, commercial, rural industry), - gross income of the activities, - gross outgo of the activities

5. Livestock raising :	- number and types of livestock raised, - price of the livestock
6. Living environment :	- accessibility and availability of social resources (domestic water, fuel wood, education facilities, sanitation/health facilities), - incidence of diseases (major type, number of affected persons, its causes), - availability foods (cereals, meat, fishes, fruits, etc.)
7. Household property :	- type of house, - ownership of house, - land area of housing yard, - farm land area with cultivation right, - registered person for land utilization right
8. Intention for resettlement :	- degree of understanding for resettlement, - acceptable degree of the resettlement, - preference for resettlement condition, - any other constraints for resettlement

The draft questionnaires, which cover the above items, are presented in Attachment-3. However, the Contractor shall finalize appropriate questionnaires for the villagers' intention survey in consultation with the JICA Study Team.

#### 2.2.4 Data Analysis

Database shall be established based on the data collected in answered questionnaires. Proposed software to be used for the database establishment is "Microsoft FoxPro," "FileMaker Pro.," "Microsoft Access", or similar one. In this analysis, at least N (number), Ave. (average), Min. (minimum), Max. (maximum) and STD (standard deviation) shall be calculated for most of all the items in database. In addition, those shall also be calculated for selected household groups, e.g. farmers and non-farmers, highly educated and non-educated, etc. The results of analysis should be presented in tables to be prepared may be using a software of Excel or similar one.

### 3. VILLAGE INVENTORY SURVEY

#### 3.1 Objectives of the Survey

The purpose and objective of the village inventory survey in the proposed submerged area are as follows :

- 1) to make inventory quantitatively and qualitatively on private and community's properties which would be submerged by the construction of Kudu Dam,
- 2) to make inventory on cultural and historical assets which would be submerged by the construction of Kudu Dam,
- 3) to assess a basic approach of a resettlement plan on the Lower Munyati Basin Agricultural Development Project.

#### 3.2 Scope of the Survey

The village inventory survey is carried out based on inquiry to key informants in each village or Village Development Committees (VIDCOs) in accordance with the concept of Participatory Assessment. Therefore, tools and techniques to be used for gathering and analyzing information would be those of the Participatory Assessment, such as “semi-structured interview”, “mapping”, “transect walking and observing”, etc. In addition to the above items, the direct measurement of infrastructure facilities will also be one of essential works in the inventory survey.

### 3.2.1 Survey Area

The Survey area covers the proposed submerged area and buffer zone by construction of Kudu dam. According to the Mater Plan Study Report, about 7,800 ha will be submerged at full water level and about 1,000 households, which mostly live in Zhombe Communal Land in Kwekwe District, should be removed because of the construction of the Dam.

Unfortunately, information on village numbers and VIDCOs in the submerged area is not available in the Report. Based on the general data, it is estimated that about 25 villages and about 10 VIDCOs exist in the proposed submerged area. According to the Report, the VIDCO is considered as a substantial administrative unit at village level. Thus, the inventory survey will be carried out for ten (10) VIDCOs in the submerged area.

### 3.2.2 Survey Method and Items

#### (1) Survey Items

The items to be studied and analyzed through the inventory survey are as follows :

- 1) Number of village clusters and distribution of these villages clusters
- 2) Number of houses by type in each villages (or cluster)
- 3) Number of households and population in each village (or cluster)
- 4) Conditions of social infrastructure in each village
  - Number of schools and their scales and conditions
  - Road conditions
  - Number of bridges available
  - Number of hospitals / health posts and their scales and conditions
  - Conditions of water supply (No. of wells, No. of households with piped water, etc.)
  - Other social infrastructure, if any
- 5) Land use conditions of each village
  - Size of communal land and its utilization
  - Land areas for housing yard
  - Areas for farming land
- 6) Access to natural resources of each village



- Water resources
  - Food
  - Energy (fuel, diesel, kerosene, firewood, charcoal, electricity, etc.)
  - Forest / grassland utilization
- 7) Location of cultural / historical assets (such as grave, etc.) and its conditions
  - 8) Location of market and its condition
  - 9) Intention to resettlement (key informants and other social structures)

(2) Survey Method

The village inventory survey will be carried out to attain the above objectives in accordance with the following steps.

1) Preparation of the Survey

The Contractor shall prepare and collect the following materials for the survey.

- topographic maps (scale 1: 50,000) which cover the proposed submerged area
- inventory survey sheet
- sticks and seeds for marking
- other required equipment (measure, camera, etc.)

Prior to the field survey, the JICA Study Team will organize a briefing session with the Contractor to discuss the survey objectives, plan of operation, and outputs to be submitted at the end of the work. The survey procedure described in item (2) below will also be discussed by the JICA Study Team with the Contractor.

2) Field survey (Explanation, Mapping, Semi-structured interview, Direct measurement, Transect walking, etc.)

The inventory survey will be executed by the Contractor in accordance with the results of a briefing session. The tentative work steps of the survey are as follows :

- a) When the Contractor visit a VIDCO in the submerged area, The Contractor shall explain the survey objectives and contents to the VIDCO members, and request them to participate in the survey and also to invite other villagers who are in different social condition, such as women, small farmer, young, etc. Then, the Contractor shall organize a small group, which consists of about 10 persons of villages for the following field survey.
- b) The field survey is assumed to be composed by "mapping", "semi-structured interview", and "measurement and transect walking".

"Mapping" is to draw maps up by the group members in consultation with the Contractor. The drawing maps cover VIDCO's territory, which

include the information of the natural resources (forest, grassland, river, etc.), village cluster distribution, location of historical and cultural assets, communal land and private land, and social infrastructure (school, clinic, church, road, bridge, water supply system, electricity, etc.). And the maps will be drawn on the ground by using stick and seeds as a marker of the information. After preparation of the map, the Contractor shall transcribe the information on the ground into topographic maps of 1/50,000 and prepare several maps, such as resource map, village cluster location map, social infrastructure location map, and cultural / historical assets location map.

Thereafter, the Contractor shall make an interview to key informants and other typical villages in VIDCOs in accordance with the concept of "Semi-structured interview". The survey items as described in Section 2.2 will be confirmed and grasped through these interviews.

"Direct measurement and Transect walking" will be carried out by the Contractor in collaboration with villagers. The conditions (scale, size, maintenance conditions, etc.) of the social infrastructure, and historical and cultural assets will be directly confirmed and quantitatively measured as much as possible in the transect walking. The results shall be filled in the inventory survey sheet. If additional information will be identified through the transect walking, it should be inserted into the topographic maps of 1/50,000 and be added into the inventory survey sheet.

### 3.2.3 Data Analysis

As mentioned in the Objectives above, the Contractor shall analyze quantitatively and qualitatively the private and community's properties based on the results of the field survey. The contents of the final report are tentatively considered as follows :

- (i) number of households and population of each VIDCOs
- (ii) private and communal properties (type, size, location)
- (iii) present values of private and communal properties
- (iv) availability of social infrastructure and its operation & management conditions
- (v) estimated importance of social infrastructure for villagers
- (vi) availability of natural resources and their importance for villagers
- (vii) availability of cultural / historical assets and their importance for villagers
- (viii) availability of market and its operation & management conditions
- (ix) intention to resettlement

In addition to the report, the maps and inventory survey sheets shall also be completed as a supporting data.

## 4. HOUSEHOLD AND HOUSEHOLD MEMBER SURVEY

### 4.1 Objectives of the Survey

- (1) To clarify the socio-economic conditions/characteristics of households within the irrigation command area through an interview survey to sample households, and to grasp households' intention to irrigation development, and
- (2) To grasp intention of household members for improvement/development of their economy and living standard also through an interview survey to sample household members.

## **4.2 Scope of the Household Survey**

### **4.2.1 Survey Area**

The survey area will be about 81,940 ha of cultivated land in the Communal and Resettlement Areas.

### **4.2.2 Sampling**

#### **(1) Nos. of Sample Households**

The result of Master plan study conducted in 1995 by JICA shows that there are about 23,000 households in the Communal and Resettlement Areas related to the irrigation command area of Kudu Dam. Based on this number of households, about 350 sample households will be sampled for the survey.

#### **(2) Sampling Method**

Random sampling method is proposed to be taken for the household survey. The Contractor shall, however, consider and decide sampling procedure, which is appropriate, the situation of the survey area, in consultation with the JICA Study Team.

### **4.2.3 Survey Method and Items**

The survey shall be conducted through interviews to heads of sample households with the use of the questionnaires, which shall be printed by the Contractor using the Attachment-5. The questionnaire is subject to minor change based on the conditions of villages and villagers that would be further confirmed both by the JICA Study Team and Contractor at the initial stage of the survey. About 5% of sample households shall be re-sampled so as to keep accuracy of the survey. If unreliable filled-out questionnaires were found in re-sampling, the Contractor shall immediately take certain measures including change of enumerator(s) who collect unreliable information.

### **4.2.4 Data Analysis**

Microsoft FoxPro or similar database software shall be used to store and analyze the survey data. The household data would be arranged in terms of location (ward, district, Communal/ Resettlement Areas and total Area), tribe background, main source of household income, income size, size of owned land, etc. The JICA Study Team will inform the Contractor the specific data arrangement methods in the course of the survey.

## **4.3 Scope of the Household Member Survey**

### **4.3.1 Survey Area**

The survey area will be about 81,940 ha of cultivated land in the Communal and Resettlement Areas.

#### 4.3.2 Sampling

##### (1) Nos. of Sample Household Members

The total number of sample household members in the Communal and Resettlement Areas related to the irrigation command area of Kudu Dam will be about 530. However, the total number is subject to minor change.

##### (2) Sampling Method

Sampling of household members shall be done at random among the members of sample households selected in the Household Survey. On an average, 10 household members will be sampled from three sample households. Household members whose ages are less than 15 years old will not be sampled, and whose ages more than 16 years old will be a subject of this survey. The number of samples shall be different from ward to ward depending on the total household size in each ward.

#### 4.3.3 Survey Method and Items

The survey shall be conducted through interviews to sample household members with the use of the questionnaires, which shall be printed by the Contractor using the Attachment-6. The questionnaire is subject to minor change based on the conditions of ward and villagers that will be further confirmed both by the JICA Study Team and Contractor at the initial stage of the survey. About 5% of sample household members shall be re-sampled so as to keep accuracy of the survey. If unreliable filled-out questionnaires were found in re-sampling, the Contractor shall immediately take certain measures including change of enumerator(s) who collect unreliable information.

#### 4.3.4 Data Analysis

Microsoft FoxPro or similar database software shall be used to store and analyze the survey data. The data would be arranged in terms of location (ward, district, Communal/ Resettlement Areas and total Area), gender, age group, etc. The JICA Study Team will inform the Contractor the specific data arrangement methods in the course of the survey.

### 5. SOIL SURVEY

#### 5.1 Objectives of the Survey

To evaluate existing soil and soil classification maps and clarify distributions of saline-sodic soil and soil erosion.

#### 5.2 Scope of the Survey

##### 5.2.1 Survey Area

In the Master plan study of JICA in 1995, a total of 14,700 ha have been selected as the net irrigable area among about 81,940 ha of cultivated land in the Communal and Resettlement Areas. This survey covers in and around the selected irrigable area.

#### 5.2.2 Data Collection and Sampling

- (1) Review of soil survey results previously made by the government of Zimbabwe and by the JICA for Master plan study,
- (2) Select the soil survey locations for 80 sites based on the results of above (1) in consultation with the JICA Study Team,

#### 5.2.3 Survey Method and Items

- (1) At each site, a pit of about 100 cm depth shall be dug, and its profile shall be recorded on a soil profile seat, which will be provided by the JICA Study Team. At the same time, photographs shall be taken for about 10 shots per pit. In addition, topographic conditions and vegetation (or crops) around a pit shall also be recorded,
- (2) In parallel with the above (2), information on saline-sodic soil distributed spottily over the survey area shall be collected from farmers/ extension workers,
- (3) Moreover, information on soil erosion shall be collected also from farmers/ extension workers, then check the type of erosion whether that is gully or surface erosion.

#### 5.2.4 Data Analysis

Microsoft FoxPro or similar database software shall be used to store and analyze the survey data. The data would be arranged in terms of location, type of soil, etc. The JICA Study Team will inform the Contractor the specific data arrangement methods in the course of the survey.

## **2 Aerial Photography, Ground Survey and Digital Ortho Photo Mapping**



**SPECIFICATIONS  
FOR  
AERIAL PHOTOGRAPHY, GROUND SURVEY  
AND DIGITAL ORTHO PHOTO MAPPING  
ON  
THE LOWER MUNYATI RIVER BASIN  
AGRICULTURAL DEVELOPMENT PROJECT  
IN  
THE REPUBLIC OF ZIMBABWE**

**CHAPTER 1 GENERAL**

**Section 1 Background**

In compliance with the Scope of Work for the Feasibility Study on the Lower Munyati River Basin in the Republic of Zimbabwe, which was agreed upon between the Government of the Republic of Zimbabwe and Government of Japan (JICA) on April 15, 1998, JICA has decided to carry out AERIAL PHOTOGRAPHY, GROUND SURVEY and DIGITAL ORTHO PHOTO MAPPING for the Study.

**Section 2 Scope of Work**

Aerial photography, ground survey and digital ortho photo mapping shall be carried out in the Study area in the lower Munyati river basin, Republic of Zimbabwe (see attached Fig. 1-1 and Fig. 1-2).

The work volume is estimated as follows:

(1) Aerial photography

- Covered area at the scale of 1:15,000 : Approx. 1,480 km<sup>2</sup>
- Flight lines : Approx. 27 lines
- Aerial films : Black & White

(2) Ground survey

- Aerial photo signals : Approx. 10 points
- Horizontal control survey (GPS) : Approx. 40 points
- 4<sup>th</sup> order leveling : Approx. 300 km

(3) Digital ortho photo mapping

- Aerial triangulation : Approx. 550 models



- Digital ortho photo mapping : 400 km<sup>2</sup>

### **Section 3 Unit of Measurement**

In accordance with the Japanese Law of Measurement, the metric system shall be used.

### **Section 4 Language and Documentation**

The language and documentation to be used for this Study shall be English.

### **Section 5 Submission of Implementation Plan**

The Contractor shall submit to the Study Team an implementation plan for the use of equipment and materials, the staff members' list and the work schedule before work commencement.

### **Section 6 Work Schedule**

All the work shall be completed by middle of February 1999 as shown in Table 1.

### **Section 7 Reporting**

The Contractor shall submit to the Study Team a weekly progress report at the end of each week, and submit a final report describing the details of aerial photos, the instruments used for ground survey and digital ortho photo mapping, results of accuracy control and other necessary information.

### **Section 8 Standard of Survey and Mapping**

In case there are no provisions for specifications, the standard of survey and mapping work shall be applied as specified in **Specifications of Surveying for the Overseas Development Study** regulated by the JICA, and shall also be adjusted with the Zimbabwean standard of specifications and/or regulations.

## **CHAPTER 2 DETAILED SPECIFICATIONS**

### **Section 1 Aerial Photography**

All the work shall be executed in accordance with this Specifications as well as the instructions and/or requirements of the Supervisor of the Study Team.

The aerial photography operation shall be carried out based on the following items:

#### **1. Aircraft**

The aircraft used for aerial photography shall meet the following requirements:

- 1) Stable when fully loaded while in flight to required height.
- 2) Unobstructed vision in all directions.
- 3) Capable of installing apparatus at a position where exhaust fumes will not affect the aerial photographing work.
- 4) Equipped with an undistorted and calibrated viewfinder window, if necessary.

#### **2. Camera**

The aerial camera shall have a wide angle lens, an exposure format of 23 x 23cm, a 15cm focal length, and meet the following specifications:

- 1) Minimum resolution : 30 lines/mm
- 2) Maximum tangential distortion : 0.015mm
- 3) Maximum radial distortion : 0.01mm
- 4) Flatness of film : less than 0.01mm
- 5) Rotating inter-lens shutter
- 6) Calibration report certified within 4 years with the following items :
  - Camera number and lens number
  - Position of principal point relative to fiducial marks (in 0.01mm)
  - Calibrated focal length (in 0.01mm)
  - Radial distortion
  - Observer 's name and report number
- 7) Type of camera : aerial camera with GPS navigation system  
(e.g. RC-30 or RMK-top or an equivalent)

#### **3. Film**

The aerial negative films shall have the following performance capabilities.

- 1) After processing, the ratio of differential change between longitudinal and lateral dimensions shall not exceed 0.01mm.
- 2) The ratio of differential change shall also be less than 0.001% per 1% of relative humidity.
- 3) The spectral sensitivity shall be panchromatic unless otherwise specified.

#### **4. Flight plan**

The flights shall follow 27 lines in accordance with the flight plan map as shown in Fig. 1-1 and Fig1-2.

#### **5. Flight**

- 1) The flight shall satisfy the following requirements:
  - Overlap : more than 55% and less than 65%
  - Side lap : average 30%
  - Crab : less than 10 degrees
  - Tip & tilt : less than 5 degrees
- 2) The tone of photograph shall allow for details in the shades to be interpreted.
- 3) When a flight line is broken, the broken part shall be covered by an overlap of more than 2 models.
- 4) Photo images should be free of clouds or mist. However, up to 5% may be permissible if covered by photographs of adjacent strips.

#### **6. Re-flights**

Re-flights shall be carried out immediately if the film is rejected, in accordance with the guidance of the Supervisor.

#### **7. Flight record**

The following information shall be written on the flight record:

- 1) Name of contract
- 2) Name of photographing organization
- 3) Film number
- 4) Beginning and finish time of flight
- 5) Date of flight
- 6) Camera number, lens number and magazine number
- 7) Calibrated focal length
- 8) Aperture, filter number and exposure time
- 9) Type of film
- 10) Type of aircraft

11) Flight altitude

(Flight record will be implemented in accordance with the attached form as shown in Table 2.)

### **8. Negative films**

The photo processing of negative films shall be carried out as follows:

- 1) The developer specified by the manufacturer or an equivalent one shall be used.
- 2) Development shall be carried out in such a manner that the negative contains all the highlights and shadow details, and camera recording data is legible.
- 3) The fixer shall be acid-based and fixing shall be carried out thoroughly to remove unused silver halide.
- 4) Washing shall be carried out to remove undesirable residues.
- 5) Distortions shall be avoided during the drying process.
- 6) Photo-images shall not be marred by scratches, fingerprints, smudges, or shrinkage in the photo processing.

### **9. Photo index map**

The photo index map shall be prepared using a map of an appropriate scale, e.g. existing topographic map at the scale of 1:100,000 (1:50,000 topographical map shall be reduced).

### **10. Quality control**

Quality control of the aerial photos shall be implemented in accordance with the attached form as shown in Table 3.

### **11. Final Products to be Delivered**

The Contractor shall deliver the following final products to the Study Team:

- 1) Negative films of aerial photos : 1 set
- 2) Contact prints of aerial photos : 2 sets
- 3) Photo index map : 1 set original and 2 sets of photocopies
- 4) Flight record : 1 set
- 5) Final Reports : 3 sets  
(e.g. to include the calibration report, quality control of aerial photos, weekly progress reports and others.)

## **Section 2 Ground Survey**

All the work shall be executed in accordance with this Specifications as well as the instructions

and/or requirements of the Supervisor of the Study Team.

The work shall be carried out based on the following items:

### 1. Surveying Datum

The following surveying Datum shall be applied:

- 1) Datum of level : National elevation system (Mean sea level)
- 2) Horizontal coordinates : National coordinates system (UTM)
- 3) Ellipsoid : Clarke 1880

### 2. Aerial photo signals

Aerial photo signals shall be established at the horizontal control points or existing triangulation points (approx. 10 points) which were chosen and approved by the Supervisor.

Dimension and materials of aerial photo signal shall be as follows:

- 1) Dimension of marker: 0.9 m x 0.25 m (3 wings)
- 2) Materials of marker: Wooden board painted by white color, or piled rocks

### 3. Horizontal control survey

The horizontal control survey shall be performed to establish the photo control points necessary for aerial triangulation and digital ortho photo mapping.

The horizontal control survey shall be carried out by GPS surveying for horizontal positioning. The locations of horizontal control points are shown in Fig.1-1, and the details will be instructed by the Supervisor.

Installation method of control points shall be applied in accordance with the attached Fig. 2.

Observation method, computation results and accuracy for GPS surveying shall be as follows:

#### 1) Observation

- Observation method: Deferential static method
- Type of GPS receiver: Dual or single frequencies type
- Capacity of GPS receiver:  $\pm(10\text{mm}+2\text{ppm} \times D)$  (D = distance of baseline)
- Number of GPS receivers: 4 receivers or more
- Number of sessions: Approx. 25 sessions in the case of 4 receivers
- Observation time: 2 hours
- Interval of data acquisition: Less than 30 seconds
- Number of GPS satellites: More than 4 satellites
- Existing triangulation points (known points) to be connected: Approx. 6 points
- Horizontal control points to be pricked: 30 points

#### 2) Computation results

The computation results to be finalized shall consist of the latitude/longitude, the XY

coordinates of UTM and the ellipsoidal height of the new horizontal control points, based on the analysis of the respective baselines and the polygonal (traverse) network adjustment.

3) Accuracy of the horizontal control points

- Standard deviation of the horizontal position : less than 0.5m
- Standard deviation of the vertical position: less than 0.3m

**4. 4<sup>th</sup> order leveling**

The 4<sup>th</sup> order leveling shall be carried out using auto levels along the planned leveling routes.

The locations of the leveling routes, and installation method of temporarily bench marks shall be instructed by the Supervisor, using the aerial photos or topographic map at a scale of 1:50,000. (see attached Fig. 2).

Known points shall be chosen among the existing bench marks. The existing bench marks and horizontal control points along the planned and finalized leveling routes shall be connected in elevation.

The observation method and accuracy of the 4<sup>th</sup> order leveling shall be as follows:

1) Observation method

- Single running route: Route from a known point to an other known point, or loop route
- Double running route: Route from a known point to a horizontal control point or a triangulation point
- Interval of measurement: Less than approx. 80m
- Unit of measurement: mm
- Interval between pricking vertical points: Approx. 0.5 km intervals

- 2) Tolerable error of observation:  $20 \text{ mm} \sqrt{S}$  (S: length of leveling routes )  
(S = km unit)

**5. Final products to be delivered**

The Contractor shall deliver the following final products to the Study Team:

- |  |        |
|--|--------|
| 1) Field survey data:  | 1 set  |
| 2) Computation data:   | 1 set  |
| 3) Table of coordinates and elevation:                       | 1 set  |
| 4) Network map of GPS observations:                          | 1 set  |
| 5) Route map of 4 <sup>th</sup> order leveling:              | 1 set  |
| 6) Aerial photos pricked horizontal/vertical control points: | 1set   |
| 7) Final reports and point descriptions:                     | 3 sets |

### **Section 3 Digital Ortho Photo Mapping**

All the digital ortho photo mapping shall be executed in accordance with this Specifications as well as the instructions and/or requirements of the Supervisor of the Study Team. This Section 3 is specified including the aerial triangulation necessary for ortho photo mapping.

#### **1. Aerial triangulation**

Aerial triangulation determines the coordinates and elevations of pass points and tie points necessary for digital ortho photo mapping in the objective area. Aerial triangulation shall be carried out by block adjustment using the analytical method such as the independent model method or bundle method.

The main specifications of method and accuracy of aerial triangulation shall be as follows:

- (1) Measurement of photo coordinates
  - Coordinates measurement of control points, pass points, tie points and fiducial marks shall be carried out twice by a precise comparator or analytical plotter.
  - When the difference is less than 0.02 mm, the mean shall be adopted.
- (2) Inner orientation
  - Diapositive shrinking effects shall be considered in each photograph.
  - The error of distance between fiducial marks shall be less than 0.03 mm.
  - Distortion of aerial camera is required to be corrected.
- (3) Relative Orientation
  - All of the points in a model shall be used for relative orientation.
  - Effects of atmospheric refraction shall be considered.
  - Residual error of relative orientation shall be less than 0.03 mm on the diapositive.
  - Discrepancies of model coordinates at a common point between successive models shall be less than 0.05% of flight height for the planimetry and the height.
- (4) Transformation from model coordinates to geodetic coordinates
  - Independent model method or bundle method shall be adopted for block adjustment.
  - Effect of earth curvature shall be corrected.
  - Discrepancies of coordinates at common point between adjacent models shall be less than 0.08% of flight height for the planimetry and the height.
  - Residuals at control points used for block adjustment shall be less than 0.08% of the flight height.
  - Residuals at tie points between adjustment blocks shall be less than 0.06% of the flight height for planimetry and height.

## 2. Digital ortho photo mapping

Ortho photo map shall be prepared using the method of digital photogrammetric system which has the digital elevation model (DEM) obtained from photo image data and stereo matching.

The main specifications of method and accuracy of digital ortho photo mapping shall be as follows:

- 1) Mapping scale: 1:15,000
- 2) Mapping area: 400 km<sup>2</sup>
- 3) Contour intervals:
  - Main contour 5 m
  - Supplementary contour 2.5 m (in flat area)
  - Index contour 25 m
- 4) Density of mesh data: Approx. 100 m × 100 m
- 4) Resolution of scanning: More than 28 microns (900 dpi)
- 5) Resolution of digital ortho photo data: 900 dpi
- 6) Data format: TIFF
- 7) Plotter: Laser plotter or equivalents
- 8) Sheet size of hard copies: A-1 size
- 9) Neat line: 50 cm × 70 cm
- 10) Annotation: To indicate the geographical names, horizontal/vertical control points, spot heights and other information instructed by the Supervisor.

## 3. Final products to be delivered

The Contractor shall deliver the following final products to the Study Team:

- 1) Computation data of aerial triangulation: 1 set  
(including pricked positive films and annotated contact prints)
- 2) Soft copies of digital ortho photo map: 1 set (CD-ROM)
- 3) Hard copies of digital ortho photo map: 1 set
- 4) Final report: 3 sets



**Table 1 Work Schedule (tentative)**

Work Items	1998			1999		
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
<b>Preparatory Work and Contract</b>	■					
<b>Aerial photography</b>	■	■				
<b>Ground Survey</b>						
- Aerial photo signals and installation of horizontal control points	■					
- Horizontal control survey (GPS)		■	■			
- 4 <sup>th</sup> order leveling		■				
<b>Digital ortho Photo Mapping</b>						
- Aerial triangulation			■			
- Digital ortho photo mapping				■	■	
<b>Final products to be delivered</b>						▲

### **3 Laboratory Analysis of Water Quality**



**TECHNICAL SPECIFICATIONS  
FOR  
LABORATORY ANALYSIS OF WATER QUALITY  
FOR  
THE FEASIBILITY STUDY ON THE LOWER MUNYATI RIVER  
AGRICULTURAL DEVELOPEMENT PROJECT**

**1. Description of the Works**

The Works are laboratory analysis for water of rivers and wells in and around the study area of the Lower Munyati River Agricultural Development Project in order to assess their water quality for use of irrigation and drinking water. The Works of the laboratory analysis of water will be carried out for thirty (30) water samples to clarify the physico-chemical features of water quality in the area.

**2. Scope of the Works**

The Contractor shall carry out the Works as specified below :

- (1) The Contractor shall carry out laboratory water quality analysis of 30 water samples. The items of analysis of water, method of water analyses and quantities of the Works are described in sections 3 and 4 below.
- (2) The Contractor shall submit the JICA Study Team three(3) hard copies of the reports including all the results of laboratory analysis and a computer diskette according to the formats and specifications given by the JICA Study Team.

**3. Quantity of the Works**

The items to be analyzed in the water quality analysis and quantities are indicated below.

<u>Items for laboratory analysis</u>	<u>Quantity of analysis</u> (Samples)
1) Color	30
2) Turbidity	30
3) Water Temperature	30
4) Suspended Solid (SS)	30
5) Electric Conductivity (EC)	30
6) Total Dissolved Solid (TDS)	30
7) Dissolved Oxygen (DO)	30
8) Concentration (pH)	30
9) Sodium (Na)	30
10) Fluorine (F)	30
11) Nitrogen (N)	30
12) Phosphoric Acid (P)	30

13) Magnesium (Mg)	30
14) Calcium (Ca)	30
15) Potassium (K)	30
16) Mercury (Hg)	30
17) Lead (Pb)	30
18) Chromium (Cr)	30
19) Cadmium (Cd)	30
20) Copper (Cu)	30
21) Biological Oxygen Demand (BOD)	30
22) Chemical Oxygen Demand (COD)	30
23) COLIFORM (Plate count)	30

The quantities shown in Table-1 " Bill of Quantities " may be changed without changing the unit prices quoted by the Contractor and within the contracted amount originally agreed between the JICA Study Team and the Contractor.

#### **4. Methods of Laboratory Analysis**

The methods of water analysis to be used for each of the test shall be made in accordance with the standard methods adopted by the Government of Zimbabwe for assessment of the quality of water for both purposes, irrigation and drinking water. Prior to the commencement of laboratory analysis, the Contractor shall submit the schedule and procedure, including the specific method to be applied for the respective analysis for approval from the JICA Study Team.

#### **5. Supervision of the Works**

The JICA Study Team has the right to supervise all of the works and to approve the plan of operation, work methods and progress of the Works. The JICA Study Team also has the right to confirm and accept the result of the Works.

#### **6. Time Schedule**

All the works shall be completed by the 5th of March 1999. The Contractor shall submit the detailed plan and schedule to the JICA Study Team and the works shall be commenced soon after the approval thereof by the JICA Study Team.

Table - 1

THE BILL OF QUANTITIES

Item	Q'ty	Unit Cost (US\$)	Amount (US\$)
Color	30	3.00	90.00
Turbidity	30	8.00	240.00
Temperature	30	3.00	90.00
SS	30	8.00	240.00
EC	30	4.00	120.00
TDS	30	4.00	120.00
DO	30	6.00	180.00
pH	30	3.00	90.00
Na	30	8.00	240.00
F	30	8.00	240.00
N	30	8.00	240.00
P	30	8.00	240.00
Mg	30	8.00	240.00
Ca	30	8.00	240.00
K	30	8.00	240.00
Hg	30	11.00	330.00
Pb	30	10.00	300.00
Cr	30	8.00	240.00
Cd	30	10.00	300.00
Cu	30	8.00	240.00
BOD	30	10.50	315.00
COD	30	10.50	315.00
COLIFORM	30	6.00	180.00
Total		169.00	5,070.00

## **4 Construction Material Investigation**

TECHNICAL SPECIFICATIONS  
FOR  
CONSTRUCTION MATERIAL INVESTIGATION  
FOR  
THE FEASIBILITY STUDY ON THE LOWER MUNYATI RIVER  
BASIN AGRICULTURAL DEVELOPMENT PROJECT

**1. Description of the Works**

The Works are construction material investigation of Kudu Dam for the Lower Munyati River Agricultural Development Project in order to assess physico-mechanical properties of dam construction materials. The Works consist of pitting and laboratory testing of soil, sand/gravel and rocks in borrow areas.

**2. Scope of the Works**

The Contractor shall carry out the Works as specified below:

- (1) The Contractor shall carry out pitting at ten (10) spots of 5 m deep in clay borrow areas and five (5) spots of 1 m deep in a sand/gravel borrow areas as described in sub-clause 4.2. The items, methods, and quantities of the laboratory testing are described in sub-clause 4.3.
- (2) The Contractor shall submit the Engineer three (3) hard copies of the reports including all the results of the Works and photographs of test pits and samples.

**3. Quantity of the Works**

The items and quantities of the Works are indicated in Table 1 "Bill of Quantities." The quantities shown in Table 1 may be changed without changing the unit prices originally agreed between the JICA Study Team and the Contractor.

**4. Period of the Works**

All the Works shall be completed by 10th of March 1999.

**5. Methods of the Works**

**5.1. General**

The methods of the Works to be used for each of the test shall be made in accordance with the standard methods adopted by the Government of Zimbabwe for assessment of the material properties for dam embankment. Prior to the commencement of investigation, the Contractor shall submit the schedule and procedure, including the specific method to be applied for the respective testing, for approval of the Engineer.



## 5.2. Test Pitting

Excavation of test pits at the minimum horizontal-section of 1.0 × 1.0 m shall be performed at the spots directed by the Engineer. When test pit excavation is obstructed due to the hard rocks or seepage water, it shall be terminated upon approval of the Engineer.

All the walls and the bottom of each test pit shall be colour photographed to show the materials conditions, and the photographs shall be submitted to the Engineer together with the negatives. Careful observation shall be done on the materials on the walls and bottoms, and the observation results shall be shown on logs in the form as approved by the Engineer.

The Contractor shall have full responsibility for the safety of the work. The walls of the pits shall be protected, if necessary, with cribbing at the Contractor's expense. All the test pits shall be re-filled with excavated materials at the direction of the Engineer after sampling and inspection.

In the clay borrow area, ten (10) test pits shall be dug and two (2) disturbed samples will be taken from each pit. Each sample shall be representative of the materials in the pit or the layer, and be enough quantity for testing in accordance with the direction of the Engineer. In addition to above-mentioned disturbed sample, small portion of disturbed sample of approximately 500 mg in weight shall be taken simultaneously from the same portion of the disturbed sample. The small sample should be kept in airtight polyethylene bags, and sent to the laboratory as soon as possible for testing of moisture content.

In the sand/gravel borrow area, five (5) test pits shall be dug and two (2) disturbed samples shall be taken from each pit in the same manner as mentioned above.

Each sample shall be preserved, immediately after being taken, in a bag attached with a label showing the name of the scheme, the pit number, the sample number, the depth of the sample, and the date when taken.

The Contractor shall transport all the samples to a laboratory.

## 5.3. Laboratory Testing

All the test methods and record forms shall be in accord with the Zimbabwean Standard, the following standards, or equivalents to be approved by the Engineer. The items and quantities of the testing are summarised below.

### 5.3.1. Earth material

- |   |            |
|---|------------|
| 1) Particle size analysis by sieve & hydrometer [ASTM D422] | 20 samples |
| 2) Liquid limit, plastic limit, plastic index [ASTM D431]   | 20 samples |
| 3) Specific gravity of soil [ASTM D854]                     | 20 samples |
| 4) Water content of soil [ASTM D4959]                       | 20 samples |
| 5) Proctor compaction test [ASTM D698]                      | 20 samples |
| 6) Triaxial compression, CU [ASTM D4767]                    | 10 samples |
| 7) Permeability test [USBR E-13, refer to Earth Manual]     | 10 samples |
| 8) Dispersive characteristics [ASTM D4221]                  | 10 samples |

### 5.3.2. Sand and gravel

9) Sieve analysis of aggregates [ASTM C136]	10 samples
10) Specific gravity and water absorption (fine) [ASTM C127]	10 samples
11) - do - (Coarse) [ASTM C128]	10 samples
12) Proctor compaction test [ASTM D698]	10 samples
13) Permeability test [USBR E-13, refer to Earth Manual]	10 samples

### 5.3.3. Rock

14) Sample preparation (Coring+cutting)	3 samples
Three (3) pieces of block samples will be provided by the Engineer.	
15) Sample preparation (Cutting)	9 samples
Nine (9) pieces of drilling core samples will be provided by the Engineer.	
16) Specific gravity and water absorption (Coarse) [ASTM C128]	12 samples
17) Abrasion test by Los Angeles machine [ASTM C131]	12 samples
18) Soundness test by sodium sulfate [ASTM C88]	12 samples
19) Alkali-silica reactivity test [ASTM C289]	12 samples
20) Unconfined compressive strength test [ASTM D2939]	12 samples

## 6. Supervision of the Works

The Engineer has the right to supervise all of the works and to approve the plan of operation, work methods and progress of the Works. The Engineer also has the right to confirm and accept the result of the Works.

## 7. Others

### 7.1. Preservation of Existing Vegetation

The Contractor shall preserve and protect all existing vegetation such as trees, vegetables, shrubs, and grasses on or adjacent to the site which do not unreasonable interfere with the execution of the works, as may be determined by the Engineer. The Contractor shall be responsible for all unauthorised cutting or damaging of trees, vegetables, shrubs, and grasses including damage due to careless operation of equipment, stock piling of materials, or tracking of farm areas by equipment.

### 7.2. Cleaning-up

The Contractor shall keep the site free from accumulation of waste materials or rubbish at all time, and remove any rubbish from the site prior to completion of the Works. Upon completion of the Works, the Contractor shall leave the site in a clean, neat and workmanlike condition satisfactory to the Engineer.

## 8. Measurement and Payment

### 8.1. Test pitting

Measurement and payment for Item 1, Mobilisation and Preparation shall be

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made in lump sum. The price tendered for Item 1 shall include all costs of manpower, equipment, materials, and all other things for mobilisation, pit to pit transportation, preparation such as tripod setting-up, and demobilisation.

Measurement and payment for Item 2, Test Pitting shall be made on the basis of linear metre of test pit excavated from the ground surface by manpower or excavator. Unit price tendered for Item 2 shall include all cost of manpower, equipment, materials and all other things for pitting, re-filling, recording, reporting, and all other works concerned in accordance with the Specification and/or the Engineer's direction.

Measurement and payment for Item 3, Sampling and Transporting shall be made in lump sum. The price tendered for Item 3 shall include all cost of manpower, equipment, materials, and all other things for sampling, sealing/packing, transporting the samples to the laboratory, and all other works concerned in accordance with the Specification and/or the Engineer's direction. No separate payment is made for the sampling of small portions for the test of water content.

## **8.2. Laboratory testing**

Measurement and payment for Item 4, Laboratory Testing shall be made on the basis of the number of tests performed in accordance with the Specifications and/or directions of the Engineer.

Unit prices tendered for laboratory testing shall include cost of all manpower, materials, and all other things for testing, data arranging, report preparing, and all other works concerned in accordance with the Specifications and/or the Engineer's direction.

Table 1 BILL OF QUANTITIES

Item	Unit	Q'ty	Unit Price (US\$)	Amount (US\$)
1 Mobilisation and Preparation	LS	-	620.00	620.00
2 Test Pitting	m	55	35.00	1,925.00
3 Sampling and Transporting	LS	-	500.00	500.00
4 Laboratory Testing				
a) Earth material				
1) Particle size analysis by sieve & hydrometer	nr.	20	17.25	345.00
2) Liquid limit, plastic limit, plastic index	nr.	20	6.70	134.00
3) Specific gravity of soil	nr.	20	5.75	115.00
4) Water content of soil	nr.	20	2.76	55.20
5) Proctor compaction test	nr.	20	12.88	257.60
6) Triaxial compression, CU	nr.	10	111.55	1,115.50
7) Permeability test	nr.	10	16.10	161.00
8) Dispersive characteristics	nr.	10	7.25	72.50
b) Sand and gravel				
9) Sieve analysis of aggregates	nr.	10	6.70	67.00
10) Specific gravity and water absorption (fine)	nr.	10	6.90	69.00
11) Specific gravity and water absorption (Coarse)	nr.	10	6.90	69.00
12) Proctor compaction test	nr.	10	12.88	128.80
13) Permeability test	nr.	10	23.00	230.00
c) Rock				
14) Sample preparation (Coring+cutting)	nr.	3	82.80	248.40
15) Sample preparation (Cutting)	nr.	9	2.50	22.50
16) Specific gravity and water absorption (Coarse)	nr.	12	6.90	82.80
17) Abrasion test by Los Angeles machine	nr.	12	23.00	276.00
18) Soundness test by sodium sulfate	nr.	12	11.50	138.00
19) Alkali-silica reactivity test	nr.	12	11.50	138.00
20) Unconfined compressive strength test	nr.	12	28.75	345.00
<b>Total</b>				<b>7,115.30</b>

## **5 Route Survey along the Proposed Channel**

**SPECIFICATIONS  
FOR  
ROUTE SURVEY ALONG THE PROPOSED CHANNEL  
ON  
THE LOWER MUNYATI RIVER BASIN  
AGRICULTURAL DEVELOPMENT PROJECT  
IN  
THE REPUBLIC OF ZIMBABWE**

**CHAPTER 1 GENERAL**

**Section 1 Background**

In compliance with the Scope of Work for the Feasibility Study on the Lower Munyati River Basin in the Republic of Zimbabwe, which was agreed upon between the Government of the Republic of Zimbabwe and Government of Japan (JICA) on April 15, 1998, JICA has decided to carry out **ROUTE SURVEY** along the proposed channel for the Study.

This route survey shall be carried out under the supervision of the JICA Study Team's Experts (hereinafter called the Supervisor).

**Section 2 Scope of Work**

Route survey along the proposed channel shall be carried out in the Study area in the lower Munyati river basin, Republic of Zimbabwe (see attached Figure. 1).

The work volume is estimated as follows:

- (1) Primary control survey
  - Control points : Approx. **18 points**
- (2) Secondary control survey
  - Profile posts : Approx. **1,367 points**  
(include the critical point posts and IP posts)
- (3) Direct leveling (4th order leveling)
  - Length of leveling routes : Approx. **45 km**
- (4) Longitudinal profile survey (4th order leveling)
  - Length of longitudinal profiles : Approx. **182.3 km**
  - Interval of survey points : Approx. **200 m intervals (Approx. 1,385 points)**
- (5) Cross-section survey
  - Number of cross-sections : Approx. **912 sections (each 200 m intervals)**
  - Width of cross-sections : Approx. **50 m**

### **Section 3 Unit of Measurement**

In accordance with the Japanese Law of Measurement, the metric system shall be used.

### **Section 4 Language and Documentation**

The language and documentation to be used for this Study shall be English.

### **Section 5 Submission of Implementation Plan**

The Contractor shall submit to the JICA Study Team an implementation plan for the use of equipment, materials, survey software, the staff member's list and the work schedule before work commencement.

### **Section 6 Work Schedule**

All the work shall be completed by the middle of May 2000 as shown in Figure 2.

### **Section 7 Reporting**

The Contractor shall submit to the JICA Study Team a weekly progress report at the end of each week. The Contractor shall also submit a final report describing the process of survey method a s work flow, the instruments used for ground survey, results of accuracy control, coordinates/elevation list of control points/profile posts and other necessary information.

### **Section 8 Standard of Survey and Mapping**

In case the no provide in this specifications, the standard of survey and mapping work shall be applied "Specifications of Surveying for the Overseas Development Study" regulated by the JICA, and shall also be adjusted them with the Zimbabwean standard of specifications and/or regulations.

## **CHAPTER 2 DETAILED SPECIFICATIONS**

### **Section 1 Execution of the Route Survey**

All the work shall be executed in accordance with this Specifications as well as the instructions and/or requirements of the Supervisor of the JICA Study Team.

The work shall be carried out based on the following technical items:

#### **1. Surveying standard**

The following surveying standard shall be applied:

- 1) Datum of level : National elevation system (Mean sea level)
- 2) Horizontal coordinates : National coordinates system (UTM)
- 3) Ellipsoid : Clark 1880

#### **2. Primary control survey**

Primary control survey shall be carried out in order to measure the precise positions (coordinates) of the control points installed along the proposed channel routes to be instructed by the Supervisor, as well as the control points for topographic mapping. These horizontal positioning shall be linked to existing control points which has been installed on the Ground Survey in Phase I Study or national triangulation points.

The observation shall be done using the GPS receivers in accordance with the session planning prepared by the Contractor.

As a rule, the main specifications of measurement and computation will be applied the following items.

- 1) Control points to be installed : Concrete marker with nail (see attached Figure 3)
- 2) Capacity of GPS receiver :  $\pm(10\text{mm}+2\text{ppm}\times D)$  (D = distance of baseline)
- 3) Observation method : **Static method**
- 4) Observation time : More than 60 minutes
- 5) Interval of data acquisition : Less than 30 second
- 6) GPS satellites to be received : More than 4 satellites
- 7) Latitude/longitude standard declination by three-dimensional network adjustment : Less than 15 cm
- 8) Ellipsoidal height standard declination by three-dimensional network adjustment : Less than 30 cm

The computation results to be finalized will consist of the latitude/longitude, the XY coordinates of UTM and the ellipsoidal height of the primary control points, based on the



analysis of the respective base lines and the three-dimensional network adjustment.

The computation results will be compiled in final results tables, and the control points will be presented in control point description sheets.

### 3. Secondary control survey

Secondary control survey shall be carried out in order to measure the precise positions (coordinates) of the supplementary control points installed along the proposed channel routes to be instructed by the Supervisor, as well as the control points for topographic mapping.

Supplementary control points consist of profile posts to be installed at intervals of approximately 200m along the proposed channel routes selected on the 1:5,000-scale planning map, as well as critical point posts and IP posts.

These horizontal positioning shall be linked to the said primary control points or existing control points which has been installed on the Ground Survey in Phase I Study.

The observation shall be done using the GPS receivers or Total Station System( hereinafter called the "TS").

As a rule, the main specifications of the observation will be applied the following items.

- 1) Control points to be installed : Wooden peg (see attached Figure 3)
- 2) GPS observation method : **Kinematics method**
- 3) GPS observation time : More than 1 minutes
- 4) Interval of data acquisition by GPS : Less than 5 second
- 5) GPS satellites to be received : More than 5 satellites
- 6) Limit of the double angle difference by TS : 60 "
- 7) Limit of the observed difference by TS : 40 "
- 8) Limit of the discrepancy of distance measurement by TS: 20 mm

The computation results to be finalized will consist of the latitude/longitude, the XY coordinates of UTM and the ellipsoidal height of the secondary control points/profile posts.

These computation results will be compiled in final results tables.

### 4. Direct leveling

Direct leveling shall be carried out in order to check and link the elevation of control points/profile posts along the proposed channel routes. These leveling routes will be instructed by the Supervisor.

As a rule, the main specifications of measurement and computation shall be applied the following items.

- 1) Measuring method
  - Single running route : Route to link from a reference point to an other reference point, or loop route

- 2) Interval of turning points : Less than approx. 80 m
- 3) Reading unit : 1 mm unit
- 4) Limit of closing error :  $20 \text{ mm}\sqrt{S}$  (S: length of leveling route)

### 5. Longitudinal profile survey

Longitudinal profile survey shall be carried out in order to measure the elevation of control points, profile posts, critical point posts and IP posts, and ground height to instruct by the Supervisor. These heights shall be linked to existing control points which has been installed on the Ground Survey in Phase I Study. The measurement shall be done direct leveling method using the Auto Levels. As a rule, the specifications of measurement, computation and drawing shall be applied the following items.

#### 1) Measuring method

- Single running route : Route to link from a reference point to an other reference point, or loop route
- Double running route : Route from a reference point to a unknown point

- 2) Interval of turning points : Less than approx. 80 m
- 3) Reading unit : 1 mm unit
- 4) Limit of closing error :  $20 \text{ mm}\sqrt{S}$  (S: length of leveling route)
- 5) Standard scale of drawing
  - Horizontal : 1:1,000
  - Vertical : 1:100
- 6) Dimension of drawing sheet : A-1 size ( polyester base)

### 6. Cross-section survey

The measurement of cross-sections for the proposed channel shall be done at an interval lines of approx. 200 m which were installed cross-section posts along the channel routes.

The measurement shall be done using the Auto Level or TS. As a rule, the specifications of measurement, computation and drawing shall be applied the following items.

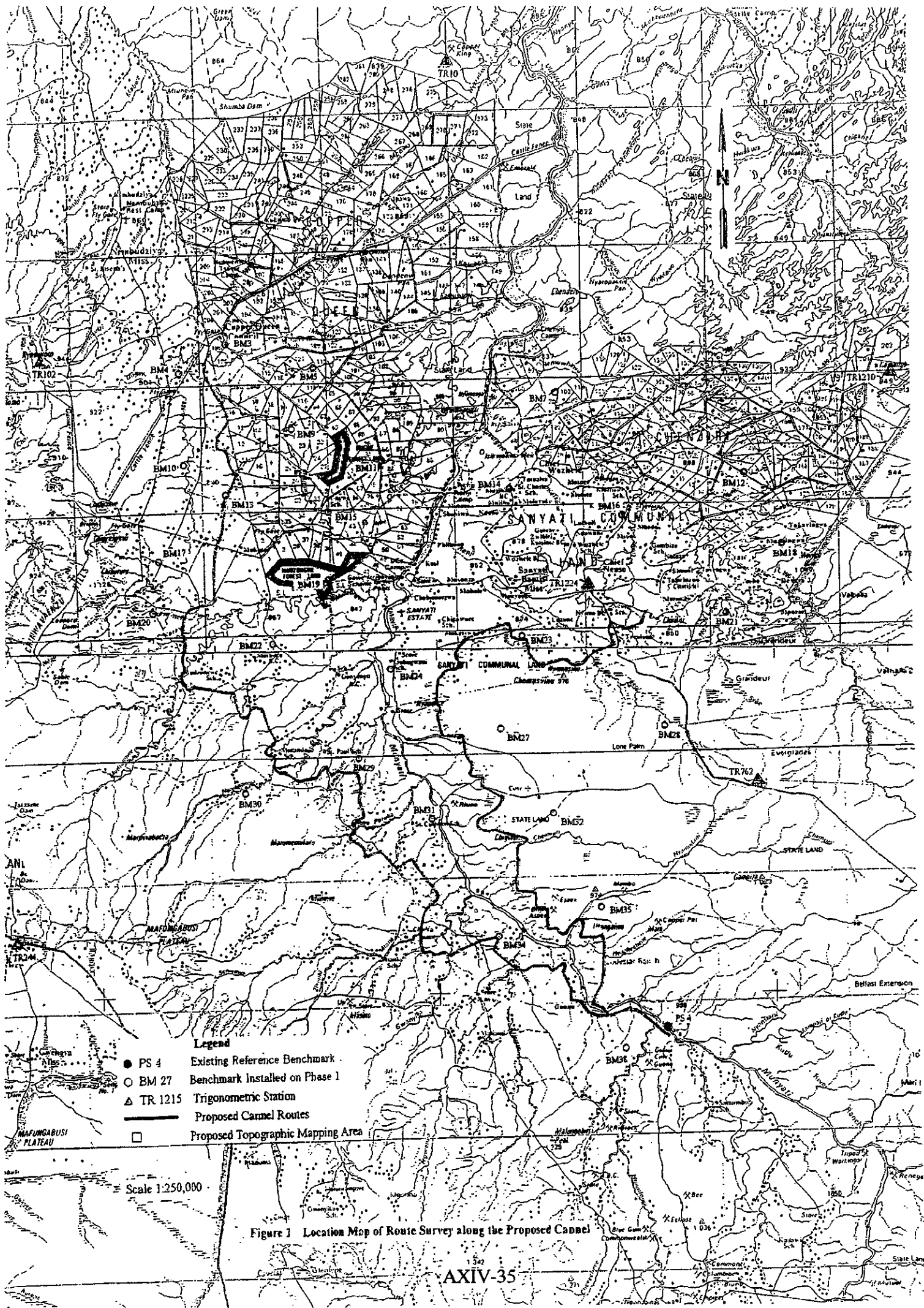
- 1) Measuring width : 50 m (25 m from profile post to both side)
- 2) Interval of measuring point : Approx. 5 m and topographical change points
- 3) Reading unit : 1 cm unit
- 4) Accuracy of measuring points
  - Distance : 1:500
  - Height :  $2\text{cm} + 5\text{mm}\sqrt{S}$  (S: meter unit)
- 5) Standard scale of drawing
  - Horizontal : 1:100
  - Vertical : 1:100

6) Dimension of drawing sheet : A-1 size ( polyester base)

## **Section 2 Final Products to be Delivered**

The Contractor shall deliver the following final products to the JICA Study Team.

- 1) Field survey data: 1 set
- 2) Computation data: 1 set
- 3) Location map of route survey: 1 set  
(to use the 1:5,000 topographic maps prepared by the JICA Study Team)
- 4) Longitudinal profile sheets: 2 sets (original 1 set, duplicate 1 set)
- 5) Cross-section sheets: 2 sets (original 1 set, duplicate 1 set)
- 6) Final report: 3 sets



Work Items	1999		2000				
	Dec.	Jan.	Feb.	Mar.	Apr.	May	
Preparatory Work & Contract		█					
Primary Control Survey		█					
Secondary Control Survey			█	█			
Direct Leveling			█				
Longitudinal Profile Survey		█			█		
Cross-section Survey						█	
Reporting						█	
Final Products to be Delivered							▲

Figure.2 Work Schedule (tentative)

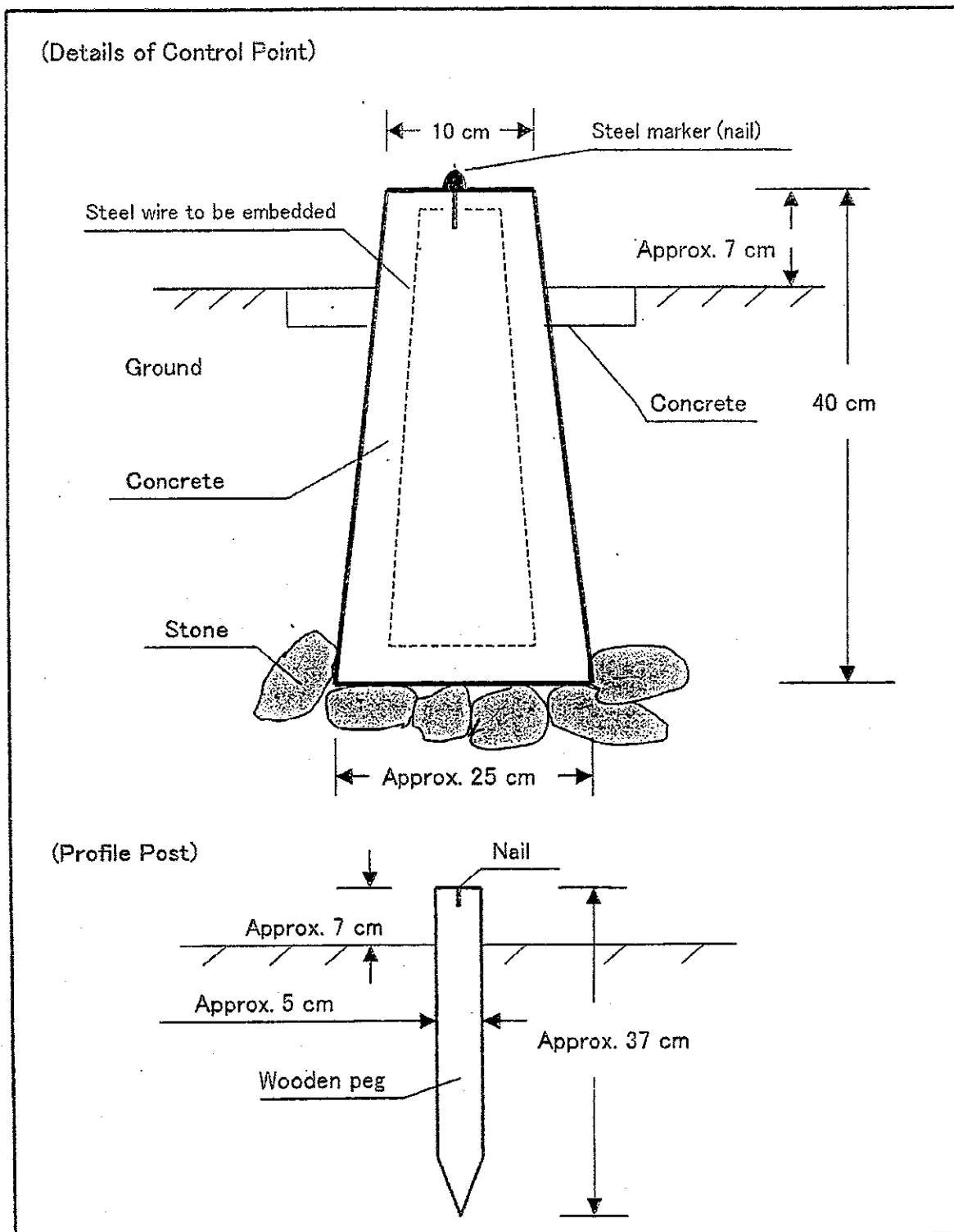


Figure. 3 Details of Control Point and Profile Post

**6 A Survey on the Incorporation of  
Social Dimension  
into the Nyarupakuwe Pilot Project**

## **1 Introduction**

The Lower Munyati River Basin Agricultural Development Project is one of the large scale irrigation projects in Zimbabwe targeting to provide large amount of irrigation water for a large number of small holders. This project is expected to play a pioneering role in the future of agricultural development projects for small holders in the country.

In order to assist in the preparation of a feasibility study for the Nyarupakwe Pilot Project, profiles of social dimensions will have to be prepared for the Nyarupakwe Pilot Project Area of the Lower Munyati River Basin Agricultural Development Project. Prepared profiles will be used for:

- 1) formulating the agricultural facility development and training facilities related to farming practices;
- 2) formulating the institutional development and training facilities in order to maintain overall irrigation system; and
- 3) formulating the infrastructure development related to overall agricultural development plan of which it is a significant part of the Nyarupakwe Pilot Project.

## **2 Outline of Nyarupakwe Pilot Project**

Outline of Nyarupakwe Pilot Project is to:

- 1) conduct Feasibility Study on the Nyarupakwe Pilot Project Area, approximately 100 ha, in order to formulate agricultural development plan for the Communal Areas and Resettlement Areas (see Figure 1);
- 2) carry out a survey on the socio-economic structure of the Nyarupakwe Pilot Project Area based on the active participation of the local population to the Nyarupakwe Pilot Project for which it is a part of the Nyarupakwe Pilot Project to provide a model survey method and output that they should become applicable measures to other areas within the framework of the Lower Munyati River Basin Agricultural Development Project; and
- 3) carry out, in the course of the Study, technology transfer to counterpart personnel of the Government of Zimbabwe.

## **3 Definitions**

The following shall be applied for the wording and/or phrasing stated in this Terms of Reference.

“Employer” shall mean JICA Study Team.

“Contractor” or “Survey Team” shall mean the firm/organization that undertakes the works stated in this Terms of Reference.

“Pilot Project Area” shall mean the area selected for Nyarupakwe Pilot Project approximately 100 ha.

“Survey” shall mean the field works and any other works mentioned, stated or implied within



this Terms of Reference herein.

“Social Analysis” shall mean to obtain data and information, conduct study in the area in and around the Nyarupakwe Pilot Project or any other areas designated by the Employer, and analyze and compile relevant data for the Nyarupakwe Pilot Project.

#### **4 Objectives of Survey**

Objectives of Survey shall be:

- 1) to clarify the needs and demands of the local population within the Pilot Project Area;
- 2) to assess anticipated positive and negative effects and obligations committed by the beneficiaries of the Nyarupakwe Pilot Project;
- 3) to develop sense of participation among the local population in and around the Pilot Project Area and that it leads to the consensus of the local population toward the Nyarupakwe Pilot Project through public hearing, dialogues and other activities of the Survey; and
- 4) to support and realize measures necessary to incorporate social dimensions into the Nyarupakwe Pilot Project and thereby the measures, which help to ensure a high quality of final project design of the Lower Munyati River Basin Agricultural Development Project.

#### **5 Scope of Survey**

##### **5.1 Social Analysis**

###### **(1) Identification of Overall Population of the Pilot Project Area**

To identify and incorporate social dimensions into the Pilot Project Area, the following social analysis has to be carried out in and around the Pilot Project Area:

- Identify the overall population which will be served by the Nyarupakwe Pilot Project;
- Identify subgroups within the population whose needs, demands and absorptive capacities may differ from one area to the other and that they may demand different project designs and implementation arrangements; and
- Prepare a socio-economic profile for each subgroup of population in a way which identifies differences in the needs, demands and absorptive capacity of each subgroup.

###### **(2) Needs of Subgroups**

The following is a part of social analysis in terms of identifying the needs of subgroups of local population.

- Evaluate the priority of the needs of subgroups of local population in relation to the Nyarupakwe Pilot Project such as irrigation, drainage, flood control, farm production, processing, off-farm income and various social services; and
- Assess differences among important subgroups in respect of the priority of needs related to the Nyarupakwe Pilot Project.

### **(3) Demand of Subgroups**

The following is a part of social analysis in terms of identifying the demands of subgroups of local population:

- Describe and examine historical activities for agricultural and rural development made by the local population including to request assistance from the government;
- Describe and examine the satisfaction/dissatisfaction of the local population and the response made by the government to these requests;
- Assess the willingness and ability of subgroups of local population to participate for newly developed agricultural and rural development schemes; and
- For this purpose, describe and examine efforts that local population may have to undertake operation and maintenance activities.

### **(4) Absorption Capacity**

The following is a part of social analysis in terms of identifying the capacity absorption of new concept and technology in agricultural development that the local population may encounter:

- Examine the experience of the local population in the process of introducing to new cropping patterns and management of agricultural facilities. Determine whether it is reasonable to assume that the local population will be willing to and able to make required such technical adjustment;
- Identify and assess conflicts among local population, if any, between those located in and around the Pilot Project Area, new residents and old residents, land owners and tenant farmers, large holders and small holders, those who grow plantation crops and those who grow staple crops, and any other potential conflicts that may arise within the framework of agricultural activities;
- Assess local customs and belief which may influence the organization of farmer organization anticipated to organize. Assess also local value system that might be of a help for institutional development related to the Nyarupakwe Pilot Project, and that it contributes to manage the newly established system, to enforce group discipline and to resolve internal conflicts; and
- Assess the need to deploy community organizers to facilitate and mobilize any community organizations if any such organizations exists, which could effectively participate in the preparation of detailed designs, supervision of the construction and operation and maintenance of the Nyarupakwe Pilot Project.

### **(5) Gender Issue**

The following is a part of social analysis in terms of identifying the issues on gender within the subgroups of local population:

- Describe the differing roles of males and females (both adults and children) in differences in the allocation of time to household and productive activities. Assess the importance of these differences in the likelihood that certain practices will be adopted and retained in the deployment of the services that may be provided through the Nyarupakwe Pilot Project;

- Assess the relative access of men and women to resources which relate to the acquisition and use of agricultural facilities that might be provided through the Nyarupakwe Pilot Project. Identify potential constraints between men and women in obtaining access to services and facilities that may be provided through the Nyarupakwe Pilot Project; and
- Determine whether major decisions regarding farming activities are made by males, females or are made jointly. Assess the implications of this information concerning the audience for imparting messages regarding recommendations to adopt new practices or technology.

#### **(6) Adverse Effect**

The following is a part of social analysis in terms of identifying the adverse effects as a result of implementation of the Nyarupakwe Pilot Project that might affect subgroups of local population.

- Identify subgroups which may be disadvantaged by the Nyarupakwe Pilot Project. For example, through relocation, loss of rights to use land, loss of income, loss of cultural properties such as ancestral land;
- Prepare socio-economic profiles for each vulnerable subgroup and describe quantitatively the impact of the Nyarupakwe Pilot Project on the affected subgroup(s); and
- Identify, assess and discuss options for avoiding, mitigating or compensating subgroups which may be adversely affected.

#### **5.2 Participatory Development Process**

Participatory development process is one of the key factors of Survey. The following is particularly important to incorporate into the Nyarupakwe Pilot Project. It is therefore the Survey Team should prepare recommendations on the following issues in order to support designing process of the Nyarupakwe Pilot Project:

- Based on the result of social analysis, to incorporate the result for which implementation of the Nyarupakwe Pilot Project is fully accepted by the local population. Method of incorporation should be based on a number of public hearing held on site, analysis made after the field data are obtained, and feed-back of the result of analysis over time during the survey period or any other method as per stated in the Section 5.5 of this Terms of Reference;
- Incorporate provisions obtained as a result of social analysis and its feed-back data into the Nyarupakwe Pilot Project and prepare specifications of the control structure that may fit into the scope of the Nyarupakwe Pilot Project;
- Incorporate provisions obtained as a result of the social analysis and its feed-back data into the Nyarupakwe Pilot Project so as to be able to supervise the construction works of physical facilities and to verify the expenditures which may incur during the construction period;
- Formulate means to commissioning and acceptance process involving newly established farmer organization, the existing government agency and a neutral third party as an observer;
- Incorporate provisions for members of newly established farmer organization to acquire training and experience in managing the agriculture facilities, which will be carried out prior to the turn over of the system to farmer organization; and

- Assess the capabilities of existing farming system and its water user association outside of the Pilot Project Area and identify any other organizations related to agricultural development if any in terms of providing the basis for explanation to operate and maintain such facilities and organizations as potential capacity in managing the operation and maintenance of the Nyarupakwe Pilot Project. Where necessary, organize a trip or two to such area and hold an informal discussion as a learning process to recognize function of the existing facilities and the system of organization, and maintenance and operation.

### **5.3 Implementation Mechanisms**

Legislative mechanisms should be closely examined in order to implement participatory process of the Nyarupakwe Pilot Project as follows:

- Assess the adequacy of existing laws and regulations which provide the legal underpinnings needed for the newly established farmer organizations to perform the functions described in the Section 5.2 on participatory development process. If considered inadequate, make suggestions in terms of improving legislative mechanisms;
- Assess the administrative procedures of the government agencies in terms of the effectiveness of these procedures for achieving participation of the farmer organizations. If the procedure would require revision or strengthening, Survey Team should suggest means to revise or strengthening administrative structure of the government agencies. Assess the organizational structure of the agency needed to support the implementation of these procedures;
- Assess the number of government staff assigned to implement the participatory process of the Nyarupakwe Pilot Project as described above, and the experiences and motivation of these staff. If the number of these staff is inadequate in relation to the numbers which is required, determine whether these functions would be conducted by staff who are employed by the agency or whether these functions would be undertaken by NGOs; and
- Determine if there is a need for assistance from NGOs to augment the provision of service by the government agencies toward the Nyarupakwe Pilot Project.

### **5.4 Benefit Monitoring and Evaluation**

Benefit monitoring and evaluation are important tool of successful implementation of the participatory process. The Survey Team should therefore prepare recommendations on the following aspects to:

- Identify a few indicators of the achievement of the Nyarupakwe Pilot Project output, purposes, and goals for each project component;
- Assess the ability of the government agencies' monitoring and evaluation on the operation and maintenance of agricultural facilities. If considered inadequate, assess what improvements should be made;
- Assess the ability of the farmer organizations' internal capability for monitoring and evaluation on the operation and maintenance of agricultural facilities. As necessary, specify procedures and measures for the monitoring and evaluation to be carried out by the farmer organizations.

## 5.5 Method of Survey

### (1) Preparatory Works

The following is required to prepare prior to conduct field survey:

- Arrange visitations to the Nyarapakwe Pilot Project Area for identification of the villages to be involved in the Project together with courtesy call for explaining the purpose of survey to the relevant government agencies;
- Preparation of inaugural meeting in a manner that it will play a leading role to hold a series of public hearings during the survey period within the Nyarapakwe Pilot Project Area.
- Based on the data to be provided by JICA Study Team, the Survey Team should prepare definite survey plan in terms of field works and arrangement of a series of public hearings;
- Preparation of questionnaire intended to use during the field survey; and
- Logistics and its arrangement for field works.

### (2) Baseline Survey and Social Analysis

Based on the contents stated in the Section 5.1 of this Terms of Reference, Survey Team should carry out base line survey after the inaugural meeting.

### (3) Inaugural Meeting Public Hearings

#### a. Inaugural Meeting

After the preparatory works, Survey Team should organize inaugural meeting inviting those who are concerned with the Nyarapakwe Pilot Project.

#### b. Public Hearings

Upon completion of the analysis of social analysis data, Survey Team should carry out public hearings presenting the result of analysis. Contents of discussions should be duly recorded and reproduced as periodical activity report to submit to JICA Study Team.

Public hearing should be held at least every 3 calendar weeks or every 2 calendar weeks at best during the survey period. It is therefore important Survey Team shall arrange, schedule and fix to maintain such fixed schedule of public hearings, which are to be held for the purpose of feed-back information obtained during the field works.

### (4) Feed-back Process of Public Hearing

As per schedule of survey, feed-back analysis should be carried out based on the contents of public hearing held prior to the feed-back analysis in order to achieve highly acceptable

incorporation of the social dimensions of Pilot Project Area.

## **(5) Recording of Daily Activities**

Survey Team should be responsible to maintain detailed record of daily activities and public hearings including inaugural and conclusive meetings without summarizing words of speakers. The same principle should be applied to the hearing data obtained from the field works for social analysis. They shall be properly recorded using tape recorders or any other electronics devices and duly reproduced as readable print-out for distribution among the members of JICA Study Team.

## **6 Reporting**

### **6.1 Inception Report**

Survey Team should prepare Inception Report (3 copies) as is stated in the Section 5.5 (1).

### **6.2 Periodical Activity Report**

Survey Team should prepare Periodical Activity Report (3 copies) throughout the contract period as is stated in the Section 5.5. (3) b.

### **6.3 Final Report**

In order to provide measures as a model of survey applicable to further project areas within the framework of the Lower Munyati River Basin Agricultural Development Project in terms of social analysis and its role to influence overall project design of each project area and that the participatory development process is achieved. It is therefore important that Survey Team should arrange the report in a manner that it is comprehensible as framework of a survey for incorporation of social dimensions into the Project and be possible to use it as future reference. Survey Team should prepare and submit 5 copies of Final Report to JICA Study Team.

The report produced by Survey Team shall contain:

- Introduction;
- Employed method of survey;
- Outline of the contents of survey, describing the result of social analysis;
- Compiled data obtained during the field survey;
- Schedule of public hearings and the result of analysis tabled for each public hearing;
- Process of analysis in terms of prioritization of the needs and demands of the local population;
- Evaluation of the absorption capacity, gender issue, and adverse effect;
- Conclusions; and
- Attachment such as photographs, maps, tables, figures and data obtained from the field works.

## **7 Schedule of Survey**

Survey Team and its overall schedule of survey shall be as per Figure 2.

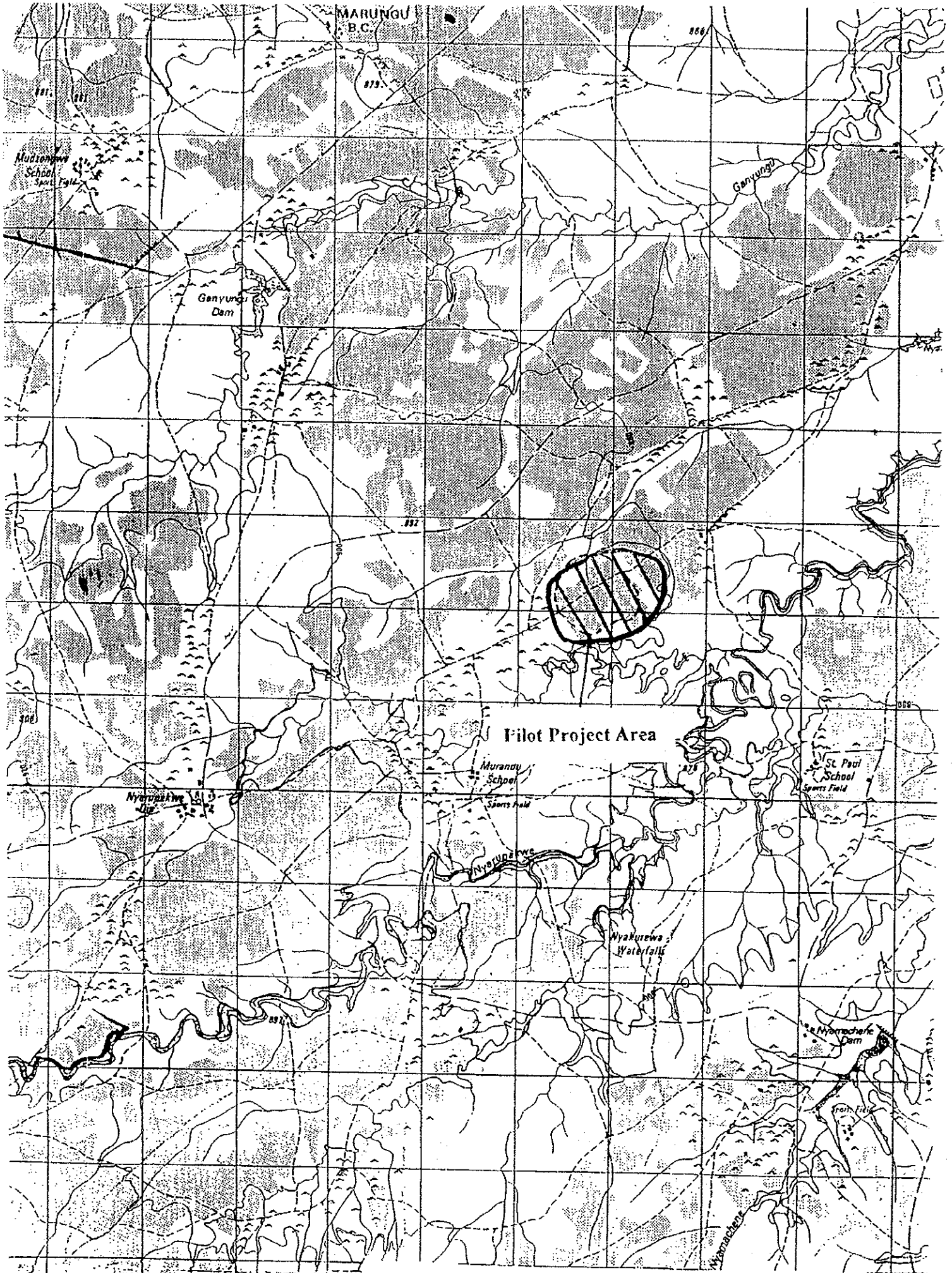
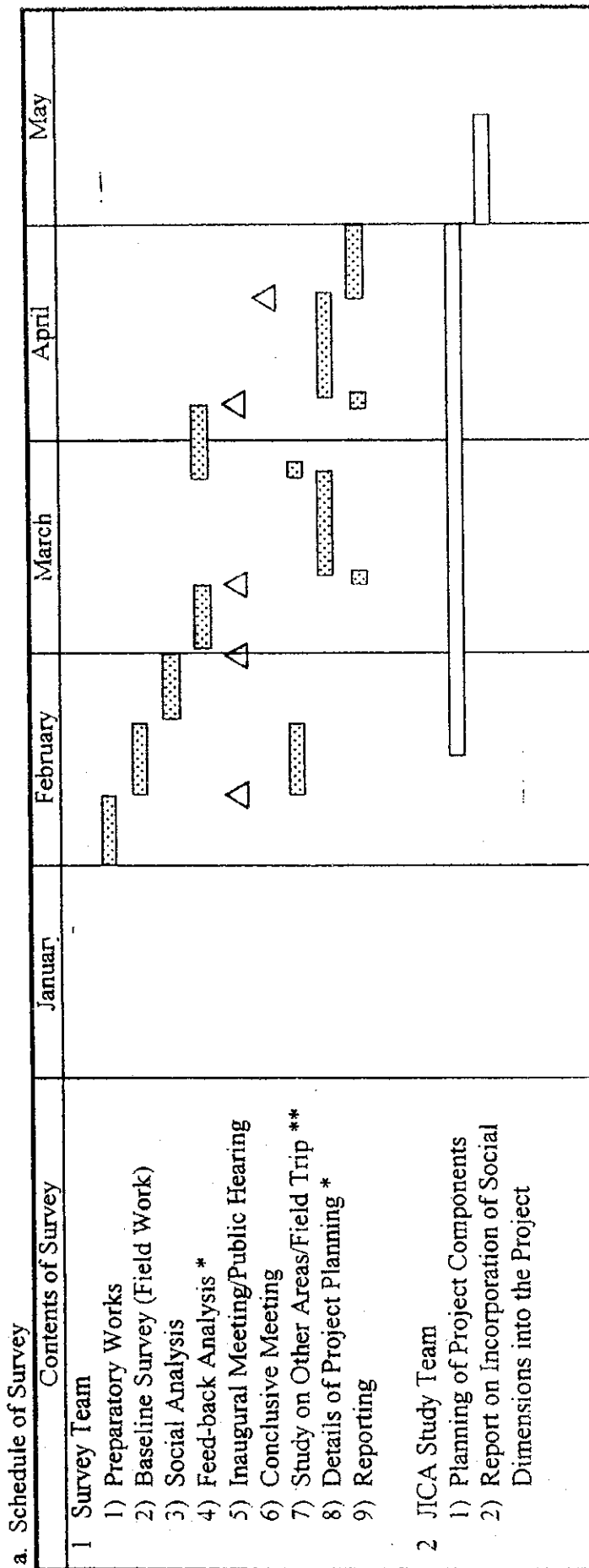


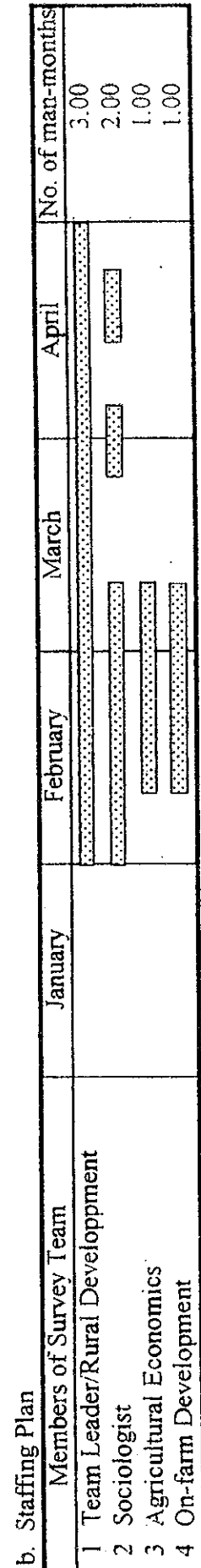
Figure 1 Project Area Scale 1:50,000

**Figure 2 Schedule of Survey for Incorporation on Social Dimention**



Note: \* - Joint Discussion of Survey Team and JICA Study Team

\*\* - Main members of the Pilot Project Area will be taken to other successful area of agricultural development scheme.





**7 Geological Core-boring and  
Soil Mechanical Investigation of  
Nyarupakuwe Dam**

## **1. SCOPE OF WORK**

### **1.1 Mobilization and Demobilization**

The Contractor shall perform the following works.

- 1) to establish the detailed working plan including a list of personnel and working schedule
- 2) mobilization and site preparation including to get footpath, if necessary
- 3) geological core-boring as specified in paragraph 1.2
- 4) soil mechanical investigation as specified in paragraph 1.3
- 5) demobilization and site clearing

### **1.2 Geological Core-Boring**

#### **1.2.1 General**

The geological core-boring for geological investigation by means of the core-drilling, including the permeability test, standard penetration test and laboratory test shall be performed so as to obtain the data of sub-surface geotechnical conditions of the Nyarupakwe dam site.

Scheduled quantity and location of the Works are summarized on the attached list of Work Quantity (refer to Table 1). The quantity of the Works and the locations of drilling holes may be subjected to minor changes depending on new findings in the course of the Work.

The geological investigation shall be carried out by the Contractor under supervision of the Supervisor approved by the Employer. The Works shall be conducted in accordance with this detailed specifications given in Chapter 2, Technical Specifications.

#### **1.2.2 Core-Drilling**

Core drilling including soil sampling and description of bore-hole drill logs shall be made maximum 20 m from the ground surface for obtaining the detailed geological information of rock beds, soil and gravel deposits. Diameter of the bore hole shall not be less than 64 mm. Every effort should be made to achieve the core recovery of 100%. The estimated work quantity of core-drilling is shown in Table 1.

#### **1.2.3 Permeability Test**

Permeability test in rock beds shall be carried out by water pressure method for 2 times for each borehole through rock beds, in order to evaluate the seepage conditions of the foundation rocks. The estimated work quantity of permeability test is shown in Table 1.

#### **1.2.4 Standard Penetration Test (S.P.T.)**

Standard Penetration Test (S.P.T.), in accordance with the USBR specification (Earth Manual), shall be carried out at every 1.0 meter of depth in the bore hole test sections which are penetrable in unconsolidated deposits in order to assess the bearing capacity of the earth deposits layers. The estimated work quantity of standard penetration test is shown in Table 1.

#### **1.2.5 Laboratory Test**

Laboratory test on the soil samples, which will be taken from unconsolidated soil deposits for each bore hole shall be made at the Contractor's desired laboratory. The samples shall at least be taken 3 nos. from each hole. The test items are i) Specific Gravity, ii) Natural Moisture Contents and iii) Particle Size Analysis. The estimated work quantity of the laboratory test is shown in Table 1.

### **1.3 Soil Mechanical Investigation**

#### **1.3.1 General**

The soil mechanical investigation by means of test pit digging, including the soil sampling, soil profile description and the laboratory work on soil mechanical analysis shall be performed so as to obtain the data and detailed information on earth materials which will be used for construction of the Nyarupakwe dam.

Scheduled quantity and location of the Works are summarized on the attached list of Work Quantity (refer to Table 1). Quantity and conditions of the Works may be subjected to minor changes depending on new findings in the course of the Work.


The soil mechanical investigation shall be carried out by the Contractor under supervision of the Supervisor approved by the Employer. The Works shall be conducted in accordance with this detailed specifications given in Chapter 2, Technical Specifications.

#### **1.3.2 Soil Samplings**

Soil sampling shall be carried out not less than 1 meter of depth in the sub-surface soil. The estimated work quantity of soil samples is as shown in Table 1.

#### **1.3.3 Soil Mechanical Analysis**

Soil mechanical analysis shall be made for each soil sample. The test items are i) Particle Size Analysis, ii) Soil Density Test, iii) Plastic and Liquid Limit Analysis, and iv) Compaction Test. The estimated work quantity of the laboratory test is as shown in Table 1.



## 2. TECHNICAL SPECIFICATIONS

### 2.1 Core-Drilling

#### 2.1.1 Equipment for the Works

All drilling and testing equipment used herewith shall be of a type, capacity and mechanical condition suitable for doing the Works as determined by the Supervisor. The power and equipment and the layout and transportation thereof shall meet all applicable requirements of local and government regulations and codes both safety and otherwise. The Contractor shall submit to the Supervisor for approval an equipment list and operation plan including water supply and transportation route prior to the commencement of the Work.

- (1) Drilling machine shall be of hydraulic driven rotary type, with drilling capacity of not less than 30 m of vertical depth with 64 mm of hole diameter through hard rocks. Machine shall be prepared to complete the works on schedule.
- (2) Core barrel shall be of double tube type with outer diameter of not less than 64 mm. Use of single tube core barrel may be allowed in case drilling without water circulation is made for better core recovery in unconsolidated deposits.
- (3) Drill bit shall be diamond bit for rocks. Metal bit can be used for drilling unconsolidated deposits. The bit shall be selected deliberately to meet the geological conditions to attain for the best core recovery and efficiency. Diameter of the drill bit shall be not less than 64 mm.
- (4) Water pump for water pressure test shall be of reciprocating piston type with a pumping capacity of not less than 150 liters per minute under pressure of not less than 15 kg/cm<sup>2</sup>.
- (5) Water pressure gauge shall have more than 15 kg/cm<sup>2</sup> of range and not more than 0.2 kg/cm<sup>2</sup> of minimum reading, and shall be well calibrated before it is brought to use in the site.
- (6) Packer shall be of mechanically expanded rubber type or pneumatically expanded sleeve type, and shall have an appropriate diameter to fit the bore holes.
- (7) Equipment for the standard penetration test shall be those as specified by USBR in Earth Manual or equivalent approved by the Supervisor.

All equipment, including the above, shall be put to use only upon the Supervisor's approval. The Contractor shall replace any equipment which are not appropriately functioning to meet the purpose of the Works as judged by the Supervisor, even if the equipment had once been approved.

#### 2.1.2 Core-Drilling

Core-drilling shall be performed by the use of hydraulic driven rotary drilling machine, at the sites, in the directions and up to the depths as specified and/or as directed



by the Supervisor.

The Work shall aim at 100% core recovery as much as possible. the Supervisor shall hold the right to require re-drilling entire bore holes in case that the core recovery in each 10 meters section of that hole is less than 70% without reasons acceptable to the Supervisor.

The recovered samples shall be placed in order in core boxes and shall be submitted to the Supervisor. Each core box shall have five grooves, each of which shall have dimension to contain core samples for one meter section. Accordingly, each core box shall contain core samples for five meters section. The core boxes shall be marked with bore hole numbers and figures to indicate the depths where the core samples are taken. The core samples shall be placed in order in the same length of the grooves of core box as the length drilled to take those core samples. The parts of no core recovery shall be left vacant in the grooves.

Water level in bore holes shall be measured and recorded every morning before commencement of the day's drilling work. This measurement shall be continued for each bore hole during the period when the hole is being drilled.

In case outstanding losses of drilling water or spring-up of groundwater are encountered, its depth shall be recorded accurately and reported to the Supervisor as early as possible. For the spring water, its quantity shall be recorded together with the height of the top of casing pipe if any, where the spring discharge is measured. Also the back pressure of the spring shall be measured by attaching water pressure gauge at the closed casing pipe or in terms of water head in stand pipe joined at the top of the hole.

Daily reports of drilling, written in the form as ordered by the Supervisor shall be submitted daily to the Supervisor in the site. The forms for daily reports shall be prepared by Contractor.

The exact position and ground elevation of each bore hole shall be surveyed by using a suitable survey equipment of Contractor.

### **2.1.3 Water Pressure Test**

#### **(1) Water Pressure Test in Rock Beds**

Water pressure tests in rock beds shall be performed in the sections of boreholes which are drilled through weathered or fresh rocks, by 5 m stage in descending order, by use of packer.

When a bore hole has been drilled by 5 m into rock bed, the hole shall be washed by flushing water through drill rod which is inserted to the bottom until the returning water becomes clean. Then, a packer shall be installed at the top of the 5 m section and water shall be pumped into the section through an injection pipe. Under a certain water pressure that is kept constant by controlling return diversion flow at the

neck of the hole the injected water quantity shall be observed for ten minutes to obtain injection rate in terms of liters every minutes. The ten minutes observation shall not be started until the injection rate becomes nearly constant. During the ten minutes observation the injected water quantity shall be observed and recorded every minute. The observations in the same procedure shall be made, in each stage of 5 m section, for fifteen different pressures, that is 0.2 kg/cm<sup>2</sup>, 0.5 kg/cm<sup>2</sup>, 1.0 kg/cm<sup>2</sup>, 2.0 kg/cm<sup>2</sup>, 4.0 kg/cm<sup>2</sup>, 6.0 kg/cm<sup>2</sup>, 8.0 kg/cm<sup>2</sup>, 10.0 kg/cm<sup>2</sup>, 8.0 kg/cm<sup>2</sup>, 6.0 kg/cm<sup>2</sup>, 4.0 kg/cm<sup>2</sup>, 2.0 kg/cm<sup>2</sup>, 1.0 kg/cm<sup>2</sup>, 0.5 kg/cm<sup>2</sup>, 0.2 kg/cm<sup>2</sup>, in order.

Water level in the bore hole and relative height of the pressure gauge from the neck of the hole shall be recorded in each test.

After the above observation is completed, the hole shall be drilled by another 5 m, for which the test in the same procedure shall be repeated. In the same manner, the bore holes shall be drilled and water-pressure-tested up to the planned depths.

In case that the pressure cannot rise up to 10 kg/cm<sup>2</sup> under 150 liters per minute of injection rate because of much leakage from the test section, the test shall be made only for the attainable pressures. If insufficient rise of water pressure be due to deficiency of the equipment, such as low capacity of pump or leakage from hose and pipe, the deficiency should be rectified immediately.

Water to be injected for the test shall be sufficiently clean.

The test record shall be prepared in the form approved by the Supervisor and submitted to the Supervisor in the site within two days after the test. The results presented shall include coefficients of permeability and Lugeon unit as calculated by the following formulae:

Coefficient of permeability

$$k = \frac{q \times 10^3}{2\pi LH \times 60} \cdot \ln \frac{L}{r} \quad \text{when} \quad L > 10r$$

$$k = \frac{q \times 10^3}{2\pi LH \times 60} \cdot \sinh^{-1} \frac{L}{2r} \quad \text{when} \quad 10r > L > r$$

Lugeon unit

$$Lu = \frac{q}{LH} \times 10^6$$

where,

- K : Coefficient of permeability (cm/sec.)
- Lu : Lugeon unit
- q : Injection rate (litter/min.)
- L : Length of test section (cm)
- r : Radius of hole (cm)
- H : Water pressure in head (cm)
- H = A + B + C - H<sub>f</sub>

A = Pumping head (cm)

B = Static water head from middle part of test section up to the hole.

If groundwater level is higher than the middle part of test section,  
this is the head from water level to the top of hole (cm)

C = Height of water pressure gauge from the top of hole (cm)

H<sub>f</sub> = Friction loss of energy injection pipe (cm)

See Clause (2)

## (2) Measurement of Friction Loss of Energy

When large quantity of water is injected through the injection pipe, the energy of flow will be lost due to friction with the side of the pipe, and the water pressure observed by a pressure gauge at the neck of hole will not represent the actual pressure built in the test section at the bottom of the hole. Correction will be necessitated on the results of the water pressure tests. To obtain the decreased head (H<sub>f</sub>) due to the friction loss, the following test shall be made once for a sort of injection pipe which is utilized for the water pressure test in the site.

The injection pipes shall be connected to form a line of about 40 m in length. One end of the line shall be left open and the other end shall be attached with a water pressure gauge and connected to a hose from a pump. A water flow meter shall be attached between the pressure gauge and the pump, and a diversion valve shall be attached between the water flow meter and the pump to control the pressure. The line of injection pipes shall be laid horizontally on the ground.

At first, water shall be pumped through the line in full capacity with the diversion valve closed. Water flow rate and pressure at the pressure gauge shall be recorded. Then, water flow shall be decreased and pressure lowered by opening the diversion valve and the flow rate and the pressure shall be recorded. In the same manner, by opening the diversion valve in various extents, five pairs of flow rate (liter/min.) vs pressure (kg/cm<sup>2</sup>) shall be recorded and plotted on a graph. Measurement of flow rate for each pair shall be made for five minutes.

The similar observation shall be made for 30 m, 20 m and 10 m in approximate lengths of the line of injection pipes.

The flow rate/pressure graph obtained as the result will give decreased head (H<sub>f</sub>) for certain injection rate and certain length of injection pipe line.

### 2.1.4 Standard Penetration Test (S.P.T.)

Standard penetration tests shall be performed at the rate of one meter depth in the sections of bore holes which are drilled through unconsolidated deposits and zone of rock beds decomposed into the condition of residual soils as specified and/or as directed by the Supervisor in the site.

The standard penetration tests shall be made in accordance with the specifications of

USBR presented in the Earth Manual or equivalent standard approved by the Supervisor. Prior to S.P.T., soil sampling for laboratory shall be performed at the rate of three samples per bore-hole of which the depth will be directed by the Supervisor.

The results of the tests shall be recorded in daily reports of drilling in number of blow for each 10cm of penetration of the 30cm long test drive.

### 2.1.5 Laboratory Test

The samples taken from bore holes should be examined by the following laboratory tests. The laboratory tests shall be carried out in accordance with the following test standards or other equivalent ones approved by the Supervisor.

- |                              |   |             |
|------------------------------|---|-------------|
| 1) Specific Gravity          | : | ASTM D 854  |
| 1) Natural Moisture Contents | : | ASTM D 4959 |
| 2) Particle Size Analysis    | : | ASTM D 422  |

### 2.2 Soil Mechanical Investigation and Analysis

This specification covers the performance of the Soil Mechanical Investigation and the Laboratory Tests on the soil samples (to be embankment materials) in connection with the entire Contract. The Works include but not limited to the following items:

- 1) Preparation of Exploratory pits  
Exploratory pits shall be 1m x1m square and 3 m deep at minimum. Soil profile description shall be prepared in terms of boundary of layer, color, soil texture, consistency.  
Photograph shall be taken at least one shot per pit after completion of digging.
- 2) Soil Sampling  
Three soil samples shall be taken from each exploratory pit. Each sample shall be representative of materials in the pits or the layer, and be enough quantity for testing in accordance with the direction of the at the Supervisor.
- 3) Laboratory Test  
The laboratory test shall be carried out in accordance with the following test standards or other equivalent ones approved by the Supervisor,
  - (1) Particle size analysis : ASTM D 422
  - (2) Soil density test : ASTM D 1556
  - (3) Liquid limit test : ASTM D 431
  - (4) Plastic limit test : ASTM D 431
  - (5) Compaction test : ASTM D 698





### **3. REPORT**

#### **3.1 Report**

The Contractor shall submit the technical report with the photographs and the earth and rock samples stipulated in the Technical Specifications to the Supervisor at termination of the Works. The technical report shall consist of one set of original papers, drawings and negatives of photo, three (3) copies of the report with drawings and the printed photographs with certain-cum-proper explanation.

The forms and data sheets used in the technical report shall be approved by the Supervisor prior to finalization of the report.

#### **3.2 Copyright of the Report**

The copyright of the report including drawings and the photographs shall belong to the Employer.

The cost for preparation of the technical report shall be included in the unit prices of respective items in the Bill of Quantities, so that no separate payment shall be made.

#### **3.3 Language**

The report and all the attachment shall be written in English.

#### **3.4 Particular Contents of the Report**

The report on geological core-boring shall be submitted to the Employer.

The report shall present continuous record of bore holes with at least 1/100 scale in vertical length, and shall contain the following information :

- (1) Bore hole number and location
- (2) Elevation at the neck of the hole
- (3) Inclination and depth of the hole
- (4) Model name of drilling machine
- (5) Dates of drilling
- (6) Total core recovery
- (7) Geological descriptions of the bore hole or the recovered core, including classification of rocks and deposits, extent of weathering, spacing cracks, condition of cracks (open or close, stained or fresh), color of rocks, solidity of rocks (soft, moderately hard or hard, massive or flaky or fractured), etc.
- (8) Core recovery length, core recovery ratio and R.Q.D. for every one meter section or for every raising of core barrel




- (9) Results of standard penetration tests
- (10) Water level in the hole
- (11) Color photograph of the core samples

As for the soil mechanical investigation and laboratory test on the soil samples, Contractor shall prepare an investigation report in English. The investigation report shall consist of the detailed soil profiles, photo, etc. in each site and the results of soil mechanical tests as well as particular remarks.

A handwritten signature in black ink, appearing to be 'L. Lee', located in the bottom right corner of the page.

Table 1 WORK QUANTITY

- I. Geological Core-Boring and Mechanical Test on Unconsolidated Deposits
1. Location and Core-Drilling Length  
at Nyarupakwe dam site : 5 holes, each 20 m in depth, total 100 m length
  2. Permeability Test
    - (1) Pitch : every 5 m at drilling hole
    - (2) Quantity : at Nyarupakwe dam site  
assuming 2 nos./hole, total 10 nos.
  3. Standard Penetration Test
    - (1) Pitch : every 1 m for unconsolidated deposits portion  
for each hole.
    - (2) Quantity : assuming at 10 nos./hole, total 50 nos.
  3. Laboratory Test (for unconsolidated deposits)
    - (1) Item : (a) Specific gravity  
(b) Natural moisture contents  
(c) Particle size analysis
    - (2) Quantity : 3 samples/hole, total 15 samples for above each  
item
- II. Soil Mechanical Investigation and Laboratory Tests
1. Soil Sampling
    - (1) Test Pitting, Soil Profile : 5 pits ( Test pit : 1 m x 1 m x 3 m )  
Description and Sampling
    - (2) Sampling and Quantity : 3 samples from sub-soil layer(s) at each pit,  
total 15 samples  
(Note; Locations of the pits will be instructed by the Employer before contract  
agreement.)
  2. Laboratory Test (for unconsolidated deposits)
    - (1) Item : (a) Particle size analysis  
(b) Soil density test  
(c) Plastic and liquid limit analysis  
(d) Compaction test
    - (2) Quantity : 3 samples/profile, total 15 samples for above  
each item









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