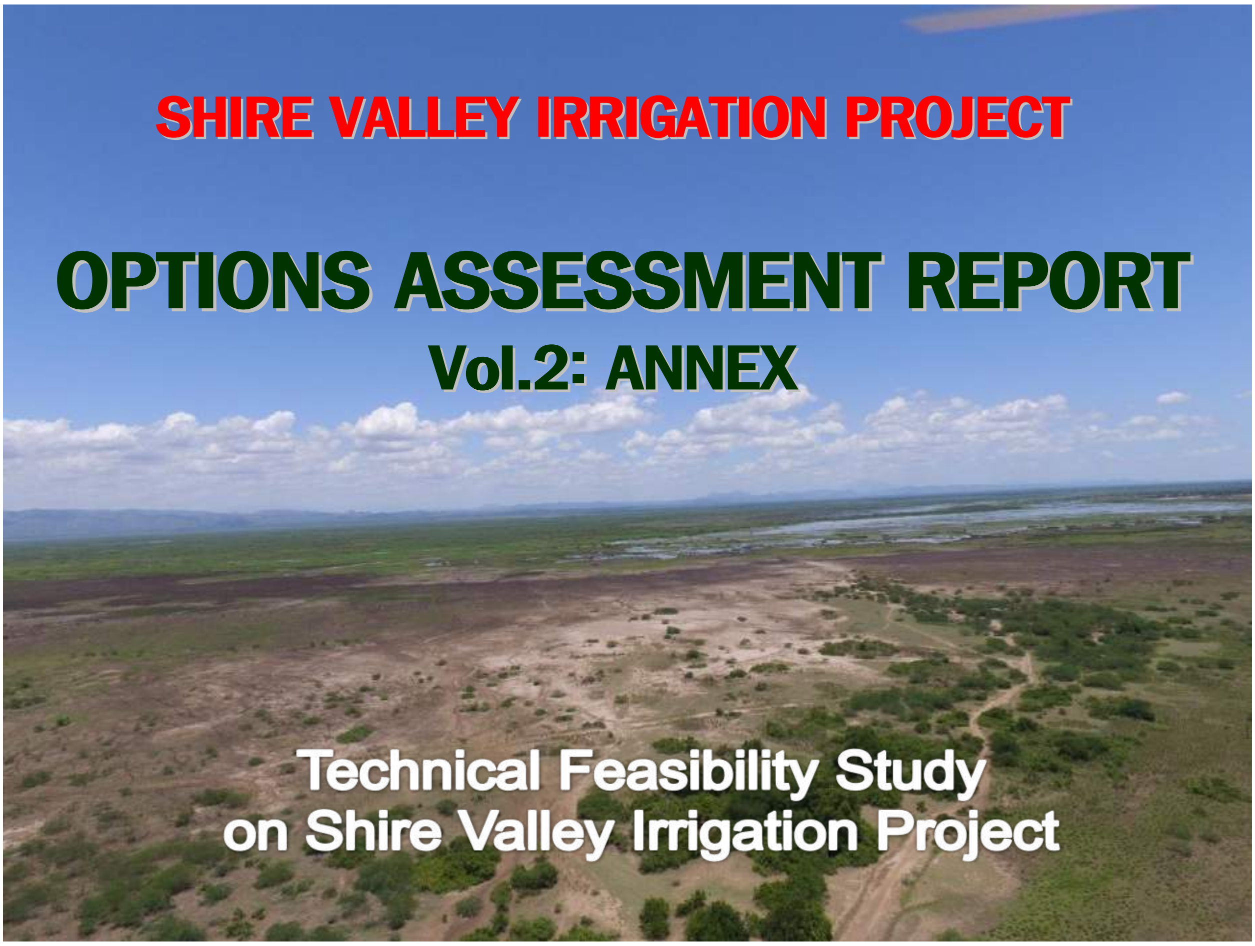
GOVERNMENT OF MALAWI

MINISTRY OF AGRICULTURE, IRRIGATION AND WATER DEVELOPMENT



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KOREA RURAL CORPORATION

in Joint Venture with

DASAN CONSULTANTS CO., LTD.,

GK WORKS CIVIL AND STRUCTURAL ENGINEER

- Annex List -

Annex 1.
Review of References

Annex 1. Review of References

As the Low Shire Valley area has received high attention for a long time as the most probable area of the irrigation development project, the associated data and information is relatively abundant when compared with other regions. However, the contents of the report are different on some subjects according to the change of situation with the lapse of time and the different standpoints between investigators. Therefore it is necessary to review these data and information carefully and assess the suitability of their claims. Such a review should also highlight the key issues agreed upon between the principal bodies (i.e. those that are promoting this project including Malawi government), thereby providing for them to be identified and accurately reflected in the feasibility study. In this chapter, some of these data and information are selected and the main contents related to the technical aspects summarized in reference to how the feasibility study will be carried out. This chapter coves the following aspects:

1) Aide Memoire SVIP of Joint AfDB-WB/FAO Preparation mission (Aug. 2015)
2) Final Main Report of Phase I (CODA and Partners; 2nd Feb.2006)
3) Illovo Sugar Nchalo Shire Valley Irrigation Project: High Level Canal Project Review Report (2010)
4) Study on Water Availability for Irrigation and Hydropower Production on Shire River at Kapichira Falls (Norplan, 2013)
5) Water Resources Investment Strategy, Component 1–Water Resources Assessment (Atkins, 2011)
6) SVIP Final EIA Report (2013)

1.1. Aide Memoire SVIP of Joint AfDB-WB/FAO (Jun. 2015)

The Technical Mission for the Shire Valley Irrigation Project (SVIP) was held from June 8-18 2015 and involved the Government of Malawi (GoM) and the Management of the African Development Bank and the World Bank. The main objectives of the mission were to advance preparation, discuss early consultant outputs, update the timelines for the project and confirm the institutional arrangements for project preparation with the taskforce.

In this mission, the most important political issue in terms of the water allocation of Shire River was finally settled. The letter from the Ministry of Finance clarified the precedence of SVIP over Kapichira III, which in turn enabled the securing of the banks' (ADB and World Bank) support for the project. This means that there is now no objection to moving ahead with financial commitments.

Regarding technical considerations, this memoire indicates several key tasks for the Technical Feasibility Study such as:

- *The Feasibility Study should identify options for minimizing costs by reducing the length and dimensions of canals and pressurized pipelines as much as possible through measures such as selecting the optimum places for river crossings, storage reservoirs and water efficient irrigation.*
- *Any canal built in Phase 1 should have capacity to carry enough water for Phase 2. However, this additional capacity should not be used by farmers in Phase 1 as it would encourage the construction of in-field infrastructure that would have to be changed later.*

- *The Technical Feasibility Study is supposed to design the in-field infrastructure while the possibility is being discussed to provide a bulk water supply to the edge of the field. Selection between these two options will be based on topography, soils, salinization risk, crops, capital and operational costs and the available head.*
- *The Technical Feasibility Study should include topographical and soil surveys to sufficient detail to delineate the areas where irrigation will be possible by different techniques, perhaps with contours showing the pressure at which water will be available.*
- *The Technical Feasibility Study must work closely with ESCOM on the operation of the Kapichira Dam. The annual peak is during the cold season when river flow is at its lowest and irrigation water requirement at its highest.*

1.2. Final Main Report of Phase I (CODA and Partners; Feb.2006)

The study by CODA and Partners in 2008 provides the basic concept of the current SVIP. This report proposes the strategies to tackle this project treating almost all related areas which cover Humanities, Social and Environmental Studies, and Technical Design aspects. Particularly this report should be carefully reviewed for the Technical Feasibility Study of SVIP.

This section summarizes the main technical design aspects of this report which are supposed to be considered for the preliminary designing task.

Phasing of The Project: *Phase I of the project covers 17,320 ha in Chikwawa district, comprising 7,940 ha of new development, 9,200 ha under ILLOVO, and 180 ha under Kasinthula Scheme, and Phase II of the project comprises the southern part of Lower Shire River Valley with a total area of 25,000 ha. This portion of the project runs up to Bangula.*

Water Demand: *The water demand for Phase I is 23 cumecs while the demand for both Phase I and II will be 55 cumecs. The feeder canal and related infrastructure will be developed for the entire water demand of the project. The domestic water demand projected to year 2015 is 0.13 cumecs for the Phase I project area.*

Irrigation Facilities and Structures:

- *General Design Considerations:* *It should be noted that the Shire River is active and has high sediment load especially when in flood. There are associated risks with such river conditions which might affect the project despite allowances for such occurrences have been considered in the design.*
- *Intake Structure: The intake is located just about 70 m upstream of scenic Hamilton Rapids on Shire River. The site is on 150 m contour on the 1:50,000 maps. The structures at the intake comprise a 200 m weir across the Shire River, a diversion channel, intake sill and an intake channel. The intake is designed for a maximum discharge of 55 m^3/sec to cater for the entire project. The elevation of the intake site is 161.28 amsl. Some technical recommendations for design: approach velocity of <0.1 m/s; entrance screens bars 12 mm diameter with 30-50 mm openings with velocity <0.5 m/s and total head loss with 50% blockage less than 150 mm; fine screens required; stop logs provided to enhance flexibility in control of discharges into the feeder canal. (Recently GoM decided to install the intake structure at the reservoir of Kapichira Dam. Therefore TFS doesn't have to consider the*

Hamilton Rapids as the intake point anymore. However the maximum discharge of 55 m^3/sec will be used as a reference value for the design process.)

- *Feeder Canal: The feeder canal is 33 km long with a regular slope. The canal is recommended to be lined in order to reduce water losses, minimize maintenance costs and increase conveyance efficiency. Assumptions for the canal cross-sections: a service road has been provided on both sides of the canal; measures of mitigation for livestock, wild animals, people and environmental impact; counter measures for erosion; siphon crossings to across rivers(two ducts in each siphon with 4.10 m x 3.0 m net openings for both phases of the project); velocity of flow 1.0 m/s for lined canal, and 0.5 m/s for unlined canal.*

- *The Main Canal: The main canal is broken down into four reaches, and each of the reaches regulated by an automatic gate with a constant upstream level control. The fourth reach, with a discharge of 12 cumecs, will serve ILLOVO sugar estate.*

- *Night Storage Ponds (Reservoirs): There are five storage ponds or reservoirs which form the beginning point of each of the five branch canals. Each pond is equipped with an intake which diverts the required flow into the branch and a spillway to discharge surplus flow.*

Design of Field Lay-out: *The field lay-out design and that of the quaternary system is determined by the type of farm to be served. The proposed farm layout designs considered cultural practices, water holding capacity of the soil, peak irrigation requirements and easiness of operation, and the irrigation interval is set at one week.*

Irrigation System: *The main type of irrigation method is controlled flooding irrigation. Water will flow through the ditch opening into well leveled fields. Every farm intake is equipped with a rectangular weir to discharge the water into the tertiary canal when required, and a safety weir is provided at the end of the quaternary canal to absorb excess water.*

Land Clearing and Leveling: *In the first year, land clearing and leveling will be carried out. The cost of land clearing and leveling has been incorporated in the project costs as part of the development of tertiary and quaternary irrigation works.*

Drainage Requirements and Designs

- *Drainage System: The drainage system includes the watersheds of Nthumba and Mwanza rivers which are tributaries of the Shire River. The designed irrigation drainage system will be able to handle rainfall runoff from natural drainage ditches and the surrounding fallow land and surplus water farms. The Gamble-Chow method was used in the analysis with a five-year return period. The structures are designed to be protected against floods of the magnitude of a twenty year return period.*

- *Drainage for Surrounding Areas and Fallow Land: The unit drainage water requirement for the surrounding and fallow land is estimated on average at 3.04 litres per second per ha, or in a worse case scenario 5.11litresper second per hectare, which corresponds to discharge from cyclonic type rains.*

Water Flow at Intake in Phase I: The sizing of the intake structure is based on the peak month of September with a continuous discharge of 23 cumecs. The feeder and main canals are designed to operate for 24 hours. It is expected that management efficiency of the project will have improved during Phase II. The design for this phase has been revised to 1.34 litres *per ha per second to reflect the increase in efficiency. (CODA presented the computed flows for the whole year for the three main crops for Phase I development.)*

Hydrological Data Analysis

- Shire River Flows: At the proposed intake point above Hamilton Rapids, the Shire River has a catchment area of 7,300 km^2. Comparison of long-term flow data indicated a strong correlation of flows at both Liwonde Barrage and Maganga with the flow in lower sections only exceeding that at Liwonde by a mere 40cumecswhich represents possible inputs from tributaries downstream of Liwonde. The bulk of Shire flows at Hamilton falls thus comprises of outflow from Lake Malawi.

- Sediment Load Analysis: ESCOM's sediment survey (1991) showed concentrations of between 50 mg/l and 1,800 mg/l. Because of the deforestation soil erosion could has intensified, so that suspended load as high as 2 g/l during floods can be expected. A settling basin has been incorporated into the intake structure, to desilt the water before abstraction into the feeder canal.

Available Flow for Irrigation and Power Generation

- Shire River Flows: In an average year the Shire River flow is about 300 cumecs. The five-year return period flow was calculated by SFCD at 250 cumecs, while the ten-year return flow is estimated at 220 cumecs. The lowest river flows are experienced in the month of September.

- Power Generation: The discharge requirements for power generation for both phases of the Kapichira Hydro-electric power development were determined as follows: 86 m^3/s for Phase I and 172 m^3/s for Phase II.

- Irrigation Water Requirements: Intake structures and the lead irrigation canal are designed for the maximum gross irrigation requirement of 55 cumecs. The first phase will require 23 cumecs for irrigation, while the balance is required for phase II.

Conflict between Power Generation and Irrigation Development: From the simulation, the monthly flow of the Shire River at Liwonde is generally above 300cummecs with a long-term mean flow of 394.5 cumecs. Assuming that ESCOM demand is held at172 cumecs, this demand can be effectively accommodated without any stress on water resources. The addition of the new water demand for SVIP creates a long-term firm demand of 220 cumecs at Kapichira which is still far below the long-term mean flow of the Shire. Thus, at current rates, water demands for both ESCOM and SVIP can be accommodated without any major impact on the Shire flow. Conflicts between power generation and irrigation will occur in September, when the entire both Phases I and II have been developed. (GoM cleared this issue during the Technical Mission for the Shire Valley Irrigation Project which was held from June 8-18, 2015. In this mission, the letter from the Ministry of Finance clarified the precedence of SVIP over Kapichira III, which enable to secure the banks' support to the project and now that it is obtained there is no objection to moving ahead with financial commitments.)

Irrigation Development: *The irrigation efficiencies comprised of field efficiency, management efficiency and network efficiency, and they are 05, 0.6 and 0.6 respectively without difference among crops. (CODA presented the crop water requirements for the* *whole year for the three main crops.)*

1.3. Illovo Sugar Nchalo Shire Valley Irrigation Project(SVIP) High Level Canal Project Review Report (COYNE et BELLIER 2010)

COYNE et BELLIER reviewed the CODA report, and adjusted some parameters and design references leading to the proposition of a modified water supply system. The aim of this study is seen as follows:

- To examine previous proposals and SVIP bulk water supply infrastructure designs, and comment on the technical justification of these proposals, or propose alternative concepts.
- To apply and compare the very current LUSIP experience to SVIP, with the aim of optimizing designs and reducing development costs.
- To identify the particular potential advantages and technical opportunities that will directly affect the development plans and decision making currently being made at Nchalo by Illovo.

Annual Water Requirement

Required quantity calculation is based for the total area of 40,000 ha. It assumes to grow sugarcane across the area. CROPWAT, FAO program, is used to calculate the required quantity and the following is the key result of calculated:

- *ETo is assessed at an average of 4.83mm/day or 1,764mm/year.*
- *Average annual rainfall is 751mm of which an average of 401mm is effective to the crop.*
- *A basic red sandy loam soil of 750mm rooting depth is assumed.*
- *An 8 crop sugar cane pattern was used with a 12 month growth time.*
- *For a ratoon harvested in mid-April (start of milling), a net crop irrigation water requirement after effective rainfall, is calculated at 1,504mm/year.*
- *With irrigation initiated at 50mm depletion and soils filled to field capacity at each cycle, and using an overall weighted irrigation application efficiency of 69%, the peak infield application rate is calculated at 1.28L/s/ha, which is close to the 1.3L/s/ha peak adopted by Nchalo management.*
- *With a typical 8 ratoon sugar cane crop, and a conveyance and distribution efficiency of 93%, scheme system capacity is a maximum in October and requires a supply rate of 0.73L/s/ha.*
- *This means that the bulk water supply infrastructure should be sized at 0.73L/s/ha, and the infield supply infrastructure should be sized at 1.28L/s/ha. The difference between these two flow rates being taken up by the varying crop water demands of the 8 ratoon crop.*

<u>COMMENTS of TFS:</u>

The goal of the above calculation is to minimize the required quantity. The result shows that yearly largest required quantity happens October with size of 1.28L/s/ha Given that the number is similar to maximum required quantity of 1.3L/s/ha demanded by Nchalo Farm as described in the report, the calculation is believed to be appropriate. To lower the maximum required quantity, it divides the total farming land into 8 sections and sows the seed at different time. It also assumes 98% of water supply and distribution efficiency. Under such conditions, it draws 0.73L/s/ha for maximum required quantity through recalculation.

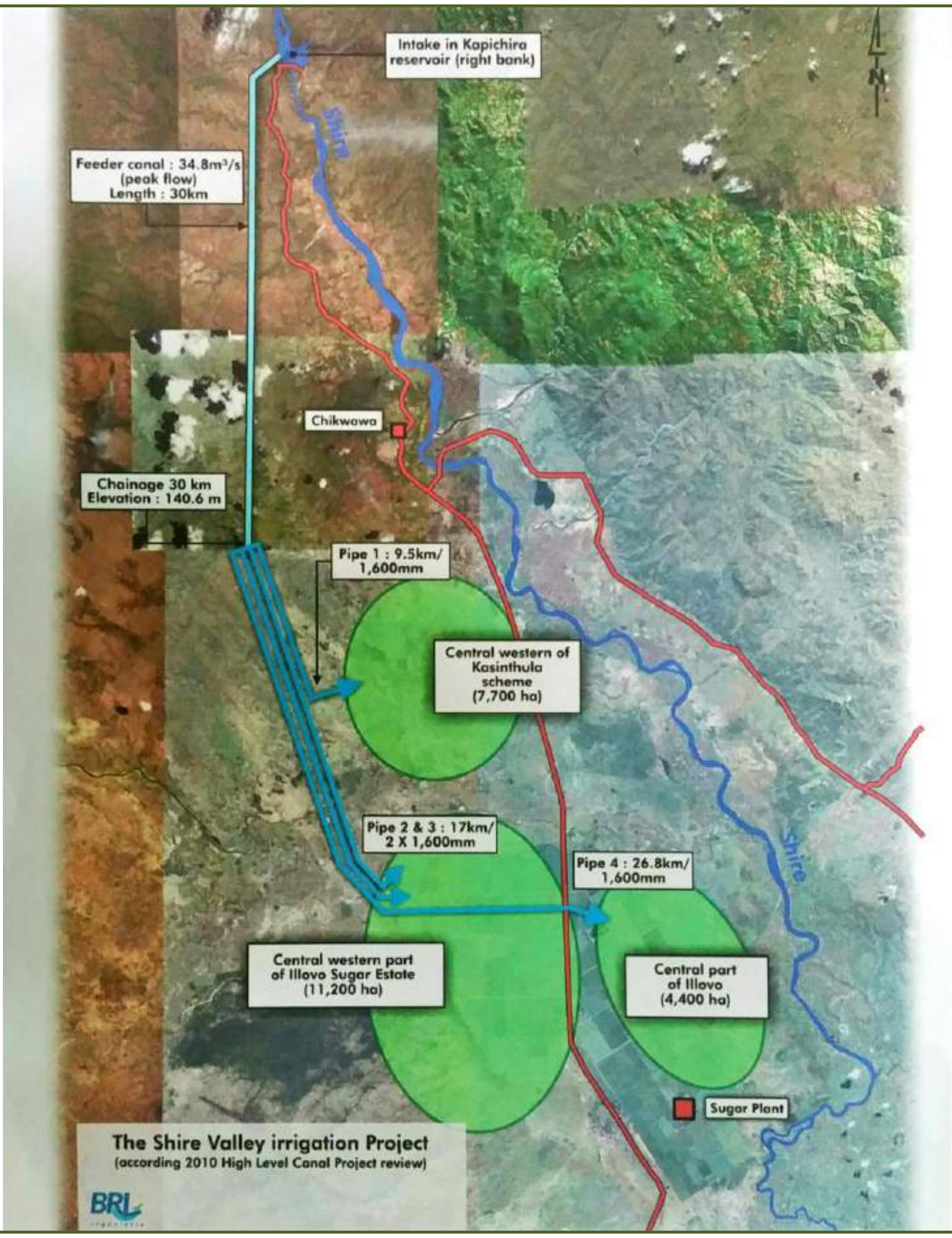
However, required unit quantity of 0.73L/s/ha is unlikely to be practical value for it is comparatively lower than 1-2L/s/ha of required unit quantity for common irrigation system design. It is expected that all the assumptions applied to the calculation coming out with such a low number would be unrealistic in real.

More then anything, it is impossible to plant sugarcane in a total of 40,000ha area. Accordingly, it is not realistic condition to divide the area into 8 and sow the seed at all different time. Considering water supply and distribution efficiency is in general set at 85%, the assumption of 93% is to put the loss too low. All in all, it is concluded that required unit quantity of 0.73L/s/ha is impossible to apply for actual design.

Nchalo and Kasinthula Pressurized Pipe Supply (Phase I)

This report suggests a way to supply water via pipeline to Phase I area. And key description of the concept is as follow:

- *From chainage 30km on the Feeder Canal, a 9.5km long 1600mm diameter class 6 GRP pipe will carry water to the central western area of the proposed Kasinthula block where Illovo could plan their new expansion. There would be around 23m of surplus head left in the pipeline that could be used to develop 7,700ha of pivots.*
- *From the same abstraction location at chainage 30km on the Feeder Canal, a double 17.0km long 1600mm diameter class 6 GRP pipe will carry water to the central western edge of Sucoma Extention. This double pipeline would be able to serve 11,200ha. Again residual head in the pipelines will be 23m sufficient for pivot or furrow irrigation.*
- *Finally a fourth 26.8km long 1600mm diameter class 6 GRP pipe will carry water to the centre of Sucoma Estate. This pipeline would be able to serve 4,400ha. Again residual head in the pipelines will be 23m sufficient for pivot or furrow irrigation.*



[Figure 1.1-1] C&B's Water supply design concept of Phase I (Taken from BRL's report)

Figure 1.1-1 is drawn from BRL report, it is conceptual diagram of water supply pipeline of C&B's Phase I.

COMMENTS of TFS:

Three key concepts suggested above show the result of head calculation for 4 pipelines described in Figure 1.1-1. However, the accuracy of the calculation is in question. Discharging head of pipe supplying water for Kasinthula and Western IIIovo is about 112m. And ground level of the area is widely ranged from 80 to 100m. Only 40% of the area is able to secure the head required for pivot irrigation. Therefore, correction must be made for the parts stating that it is possible to secure 23m of effective head across the area. Meanwhile, Central IIIovo area is expected to have required effective head. In addition, assumption of the area of project site includes some errors. IIIovo Estate included in Phase I is not exceeding 11,200ha. It is understood that error is made to include non existent 4,400 ha of Central IIIovo which does not exist in real.

1.4. Study on Water Availability for Irrigation and Hydropower Production on Shire River at Kapichira Falls(Norplan, 2013)

Although for a long period SVIP has been considered as a very attractive project for Malawi's economy, the GoM has hesitated to embark on this project because of the water conflict issue between hydropower and irrigation. To tackle this problem the GoM commissioned studies to verify water availability in the Shire Valley area. NORPLAN and its association implemented this study with the objectives such as:

- To assess current utilization levels of the Shire River, suggest areas for improvement so that reliable water is available for a number of purposes
- To independently assess the water availability for hydropower and irrigation purposes at Kapichira falls
- To recommend the best possible strategies for accommodating demands for irrigation

The most essential part and their recommendations are summarized in this section.

Required quantity used for this study is estimated from the demand of 2016 and 2022 (2016: 2,532GWh/y; 2022: 2,892GWh/y). For SVIP irrigation demand, it sets 3 cases of $30m^3/s$, $37m^3/s$ and $50m^3/s$ as annual maximum required quantity. Most of analysis has been done based on $37m^3/s$ while analysis result from $30m^3/s$ and $50m^3/s$ are included in appendix without explanation.

It selects three time periods to establish 3 scenarios based on measurement data of Lake Malawi water level, and the followings are the scenarios:

a. Scenario 1 (1990-1919): Extremely dry season

b. Scenario 2 (1934-1953): Mean free water exceeding the required quantity

c. Scenario 3 (1990-2009): Recent days, mean free water exceeding the current average required quantity with dry years occurred in between

It analyzes the water availability for the next 20 years on the assumption that water level pattern for the next 2 decades is recreated by setting the standard level as water level of Lake Malawi at 2013 Jan. 1st.

COMMENTS of TFS:

It is questionable if it is appropriate for the water level of 2013 Jan. 1st to be the standard level. Given that the water level of Lake Malawi is changing day to day, water level at one specific point can be lower or higher than average or even show abnormality. Therefore, it is believed that standard level is more favorable to use average level of recent years or average level of 2013 than level at one specific point.

Analysis case is as follow:

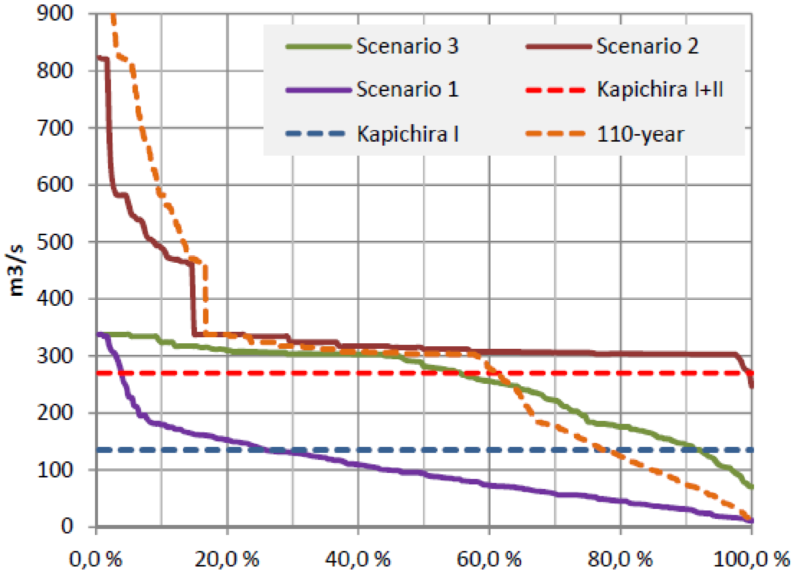
a. Case 1: Escom(I + II)

b. Case 2: Escom(I + II) and SVIP(with Nchalo)

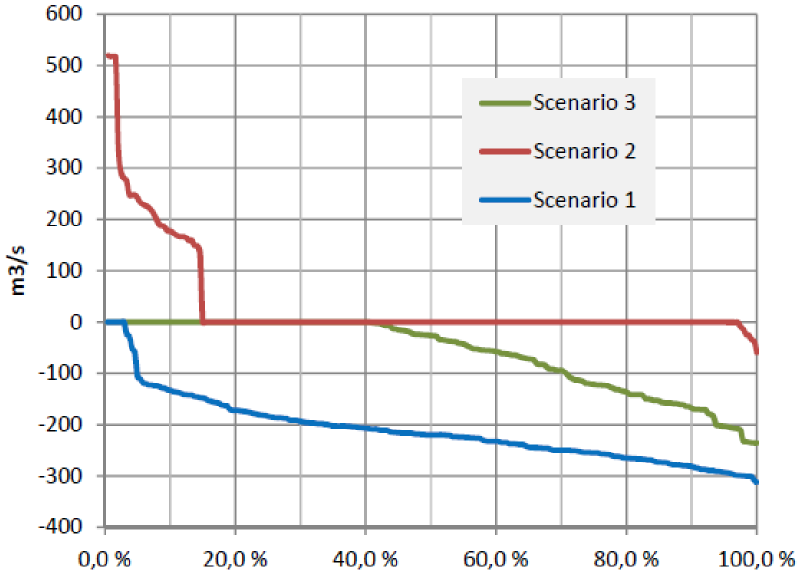
c. Case 3: Escom(I + II) and SVIP(without Nchalo)

The results of generation demand of 2022 (SVIP demand: 37m^3/s) is as follows:

- Scenario 1: meeting the demand for 7 months out of 240 months in total (Exceedance probability is lower than 10%)
- Scenario 2: meeting the demand for 231 months out of 240 months in total (Exceedance probability is lower than 97%)
- Scenario 3: meeting the demand for 97 months out of 240 months in total (Exceedance probability is lower than 48%)

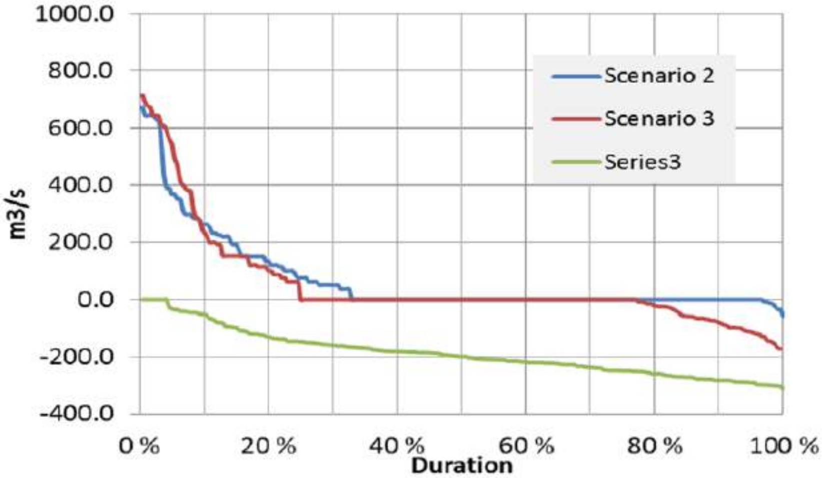


[Figure 1.4-1] Duration Curve Inflow to Kapuchira HPP (Including Abstraction of a Peak SVIP 37m^3/s)



[Figure 1.4-2] Duration Curve Water Balance, 2022

Both Figure 1.4-1 and Figure 1.4-2 show the analysis result of water balance on the assumption that water demand of ESCOM would be maximum (270m^3/s)in 2022 and water demand of SVIP would be 37m^3/s. Figure 1.4-1 displays the exceedance probability against total demand while Figure 1.4-2 does the simulation result of water balance.



[Figure 1.4-3] Case 2C, Duration Curves Water Balance, 2022

Figure 1.4-3 shows the analysis result of the situation where SVIP demand increases to 50m^3/s while everything else keeps the same condition as generation demand (as of 2022) of Figure 1.4-2.

<u>COMMENTS of TFS:</u>

According to Figure 1.4-2 (SVIP demand standing at 37m^3/s), scenario 3 suggests exceedence probability of 77% (Figure 1.4-3). It is illogical because it shows bigger demands would have lower supply probability. It seems two cases are mixed in the course of analysis. If data has mixed during analysis, exceedance probability would become 43% at SVIP demand of 50 m^3/s, not fulfilling the demand of ESCOM neither SVIP.

[Figure 1.4-4] Corrections of Flows New Rating Curve Post 2003 Flood

Norplan arbitrarily modifies some runoff data to use them for analysis. As it determines that huge runoff occurred in 2002 and 2003 lead to cause errors in measurement data, it reassumes the runoff by development new rating curve. Figure 1.4-4 shows the new runoff curve since 2003, it is adjusted downward by about 120 m^3/s than observed runoff curve.

Huge runoff in 2002 and 2003 widened the river course around bight located between Mangochi of Shire river and Lake Malombe, increasing the runoff of Shire river. Runoff data after 2003 is considered as correct without error (refer to Chapter 6. Occurrence of a Long Series of Dry Years and Mitigation Measures of this report for more detail)

1.5. Water Resources Investment Strategy, Component 1 – Water Resources Assessment (Atkins, 2011)

Based on the revised Malawi Growth and Development Strategy(MGDS; 2009), the Malawi government has led Water Resources Management Component of the Second National Water Development Project(NWDP II), and as a part of which, Water Resources Investment Strategy (WRIS) project was also performed.

The emphasis of the WRIS is on the development of multi-purpose investments that aim to meet a range of water needs for productive purposes, i.e. economic development (in agriculture, industrial/commercial, energy etc.), and at the same time help to deliver water supply requirements.

Within this context, the specific objectives of WRIS are:

- To analyze the economic development objectives of the country and how water resources affect the country's achievements in economic growth and poverty reduction;
- To identify key water-related challenges for the country's economic development in the medium and long-term;
- To set-up priorities for the water sector interventions in time and geographically;
- To identify priority water resources sector investments.

Developing the WRIS and fulfilling these objectives comprises two major components:

- Component 1: A National Water Resource Assessment (WRAS)
- Component 2: Development of a National Water Resources Investment Strategy (WRIS)

This report sets out the key findings from Component I, the Water Resources Assessment (WRAS), and provides the foundations for developing the final Investment Strategy in Component II.

Available Water Resources part; Annex II – Surface Water

This is a detailed description of the work done to collect, collate and analyze surface water and rainfall data in order to determine surface water yield. It sets out in detail the methods used for surface water data analysis, rainfall-runoff modeling, EFR determination and, ultimately, surface water yield assessment.

Specific conclusions or issues within WRA 1 (Shire River)

- *Under average dry season conditions, the TOTAL observed flow in the Shire is predicted to be approximately 47,000 Ml/d (545 m^3/s) at the most downstream gauge, and 40,600*

Ml/d (470 m^3/s) at the Walker's Ferry offtake. During drought conditions, the dry season average decreases to 21,000 Ml/d (244 m^3/s) and 16,300 Ml/d (188 m^3/s) at Walker's Ferry. The value is lower at the upstream location due to the greater influence at this point of the low flow regulation from the Kamuzu barrage and the limited hydrological effect of runoff from the intermediate tributaries.

- *It is understood that there are current proposals being considered to increase the installed capacity of the hydropower scheme at Kapichira (pers. comm. World Bank), with resultant required increases in minimum flows in the Shire to this point. Initial estimates suggest that the minimum flow requirements may need to be increased substantially, to approximately 300 m^3/s (approximately 26,000 Ml/d).*
- *Under this scenario, during average dry season conditions, the minimum flow could be increased to this new minimum whilst retaining significant resource availability in the Shire. The difference between the total flow and the new minimum is still over 15,000 Ml/d.*
- *However, during more extreme dry season conditions, the reliability of the hydropower expansion scheme (assuming the continuation of the current operating regime at the Kamuzu barrage at Liwonde) is brought into question. Total average dry season resources in the Shire are predicted to be approximately 56 m^3/s lower (at 244 m^3/s) than the required minimum during a drought period of equal severity to the 1991/92 event, the return period of which has previously been estimated at 1 in 40 years. The key conclusion from this is that either the operation of the barrage at Liwonde needs to be adjusted (if possible) to enable a greater release of water during more extreme drought periods or there will be little or no available water resources in the lower Shire upstream of Kapichira for additional uses should the installed capacity of the system be expanded as currently proposed.*

Summary statistics for the gauging stations are presented in Appendix D. These show average, maximum and minimum flows as well as flow frequency percentiles and flow statistics. These are shown for the standard period 1970–1999.

Station code	Q mean m^3/s	Q min m^3/s	Q max m^3/s	S.D.	C of V	Q10 m^3/s	Q20 m^3/s	Q50 m^3/s	Q75 m^3/s	Q80 m^3/s	Q90 m^3/s	Q95 m^3/s	Specific runoff l/s/km2	Catchment runoff mm/year	Data coverage %
1B1	431.6	134.3	963.0	234.1	0.5	732.5	666.8	419.4	181.8	176.3	164.3	154.0	3.3	104.8	99.2
1P2	532.1	42.9	979.5	230.8	0.4	800.1	744.5	555.5	377.3	325.7	180.4	144.2	4.0	125.3	68.1
1L12	538.8	162.0	1274.6	227.5	0.4	812.0	718.8	532.1	373.1	326.8	216.4	202.9	3.9	123.5	70.6
1G1	576.8	134.9	1818.1	258.4	0.4	860.2	751.7	561.3	390.5	347.0	269.0	205.1	3.9	122.4	92.2
1R3	4.9	0.0	96.2	8.6	1.8	12.3	7.4	1.6	0.6	0.4	0.2	0.0	6.6	215.1	91.7
2B22	1.2	0.0	8.4	1.7	1.4	3.2	1.9	0.5	0.2	0.1	0.0	0.0	4.0	133.0	66.9
2B33	1.2	0.0	9.3	1.7	1.4	3.1	2.1	0.5	0.2	0.1	0.0	0.0	4.6	151.3	66.9
2C3	2.4	0.1	23.0	3.5	1.5	5.8	4.0	0.9	0.3	0.3	0.2	0.2	38.3	1200.8	63.9
3E1	0.4	0.0	6.1	0.7	1.6	1.1	0.6	0.2	0.1	0.1	0.0	0.0	48.2	1519.8	94.2
3E2	2.1	0.0	20.0	3.3	1.6	6.5	3.0	0.7	0.3	0.2	0.1	0.0	16.4	693.1	51.7
3E3	3.9	0.0	33.2	5.3	1.4	10.9	6.1	1.6	0.7	0.6	0.4	0.3	8.5	277.6	58.9
3F3	1.9	0.0	18.3	2.6	1.4	4.7	2.9	0.9	0.4	0.3	0.2	0.1	8.4	325.2	66.7
4B1	33.6	0.0	318.9	48.4	1.4	107.3	67.7	9.5	2.6	1.8	1.0	0.3	4.2	134.2	84.2
4B4	8.2	0.0	99.2	13.6	1.6	27.7	13.3	1.9	0.4	0.3	0.1	0.0	5.8	182.7	93.1
4D4	10.0	0.0	128.5	18.2	1.8	25.4	14.2	2.6	0.8	0.6	0.3	0.1	5.5	178.2	95.6
4B9	14.8	0.0	137.8	21.4	1.4	45.4	31.4	4.1	1.2	0.9	0.4	0.1	5.0	160.5	84.2
5C1	40.3	0.0	320.1	62.0	1.5	129.4	69.1	8.7	2.1	1.5	0.3	0.0	3.8	118.8	79.4
5D1	28.6	0.0	270.2	50.2	1.8	97.9	43.7	5.5	1.1	0.6	0.1	0.0	3.2	100.1	59.7

ATKINS WELLFIELD

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[Figure 1.5-1] Appendix D. Summary Flow Statistics (Atkins, 2012)

This table tells us that 326.8m^3/s is 80% exceedence probability runoff of Shire river at 1L12 point of Chikawa. Such runoff is 320m^3/s bigger than 320m^3/s, which combines the required demand of ESCOM generation of 270m^3/s and SVIP required demand of 50m^3/s com. The result implies that is possible to meet the water supply demand of SVIP with 80% probability.

1.6. SVIP Final EIA Report (2013)

This report presents the environmental and social impact assessment for the SVIP in detail. The major impacts and recommendations are summarized in this section.

Impacts of Construction Projects on the Environment

Site Preparation: *Clearing fields will result in diminishing supply of fuel wood, fodder for livestock, shade for people and domestic animals, fruit trees, trees of medicinal value and source of construction materials. The greatest loss will occur where the canal passes through Lengwe National Park and Majete Game Reserve. It was estimated that clearing an area of about 180 ha would result in loss of trees worth MK 1 million (Dudley et al, 1991).*

Loss of Biodiversity: *Magombo, 1992, surveyed the vegetation of the Majete area around the Kapichira HEP and compared the plant species list with nationwide plant occurrence. No plant species were classified as endemic to the area. However, In terms of the degree of rarity 9 plant species are noted in the Majete area. The construction of the canal will bring about extinction of these species in the project area. To mitigate against this adverse effect the boundaries separating respective crop fields should be utilized for afforestation program. It is also proposed that trees of economic value for timber, fuel wood, ornaments, medicines, poles and fodder be pre-harvested in the canal construction area.*

Impact of Canal Alignment on Fauna: *During construction, earthworks will involve rock blasting and quarrying to achieve the specified 3 m depth. Noise and vibration will be caused by blasting, machine operations and construction vehicles. Blasting activities will have noise impact on the fauna of both the Lengwe National Park and Majete Game Reserve. As the blasting works will take place in uninhabited area and the impact will be minimal.*

Such construction of the feeder canal may obstruct some small animals from going to the river. As for big animals, like elephants, experience has shown that these big animals do not like man-made structures such that the feeder canal structures might be broken time and again. Appropriate protection will need to be made for the entire length of the canal. Allowance has been made to water the animals away from the canal by providing four watering points. The management of Majete Game Reserve will assist in identifying the most appropriate sites to locate these watering points and the specific animal paths where the canal may have to be buried.

Impact on Landscape and Aesthetics: *Special features such as the Hamilton Rapids and Kapichira Falls are of interest to tourists as observed during fieldwork and public disclosure. The SVIP will not affect the scenic beauty of the falls since water abstraction point is at Hamilton Rapids upstream of the Falls. Kapichira HEP will however have a major impact by inundating 180 ha. Only the volume of water will be reduced and this will have a insignificant impact on the Falls. 17 villages will be affected in terms of aesthetics, cemeteries, ancestral land, and prayer/sacrifice sites in the forest. To militate against this* *loss the local people will be counseled and adequately compensated.*

Labour: *Immigrant workers are likely to both negatively and positively impact the socio-cultural set-up. Areas of impact include introduction of new diseases to the local community, susceptibility of the non-immune immigrant workers to local diseases, introduction of incompatible cultural values and attitudes. The immigrant workers will be housed in camps, and for convenience these will probably be near Chikwawa and Boma from where they will be transported to their shifts. The large number of immigrant workers will increase the production of waste which would lead to serious water quality deterioration if released into the existing river systems. In order to militate against this, it is expected that pits and latrines will be constructed by the community.*

Impact of Construction on Soil Erosion and Degradation: *it is estimated that Majete Game Reserve loses some 11-15 mt/ha/year under normal environmental conditions. The canal construction which will take place in the Game Reserve will be carried out during the dry season. Soil loss which will occur will be through earth movement and wind erosion. Immediately the rain sets in, soil loss is also expected, but if canals are well lined and embankments properly stabilized, the loss will be reduced.*

Impact of Construction on Air Quality: *Since the areas around the intake point and the feeder canal are uninhabited, no serious impact on air quality will be caused by operation of construction machines and vehicles. Air quality, however, will be affected by dust generated by the movement of vehicles but the levels will be kept low by periodic sprinkling of water on construction roads.*

<u>Operational Phase Impact</u>

Impact of Water Abstraction at Hamilton on HEP Performance: *These abstraction conflicts will largely be governed by the water flows in Shire River. The amount of water in the river is governed by the barrage at Liwonde, especially during the dry season. Liwonde Barrage is capable of providing a firm flow in Shire River of 170 cumecs in 79 out 80 years. On average the Shire River flow is about 300 cumecs per year. The five year return period has been calculated at 250 cumecs while a ten year return period is estimated at 220 cumecs. The lowest river flows are experienced in the month of September.*

Discharge requirements for power generation for both Phases of the Kapichira Hydro-electric power development are 172 cumecs. Intake structures and the feeder canal are designed for the maximum gross irrigation requirement of 55 cumecs which occurs in September when the entire SVIP Phases I and II have been developed. The first phase will require 23 cumecs for irrigation while the rest are meant for Phase II. Phase I of power development at Kapichira Falls, comprising the first two turbines was commissioned year 2000. It requires 86 cumecs in this phase for HEP generation. It can be concluded that there will be no conflict between irrigation and HEP generation at Kapichira during Phase I of project implementation, even assuming the lowest river flow of 172 cumecs. Phase II of project implementation will experience some conflicts in the driest month of September.

To mitigate against these conflicts it is suggested that the flow regulation at Liwonde should include the irrigation requirements of 23 cumecs and 55 cumecs so that the minimum discharge or power generation and irrigation be revised to 200 cumecs and 230 cumecs to satisfy the water requirement for Phases I and II respectively. The cropping pattern should *also be carried out in such a way that most crops are harvested during the critical month of September. If this type of cropping pattern is strictly adhered to, the conflicts between irrigation and HEP generation will be minimized.*

Impact of Hydrological Changes of Lower Shire River on Agriculture*: Lake elevation determines the outflow and the long term fluctuations are of primary importance in determining the use of the river either for irrigation purposes or for the generation of hydroelectric power. Should low outflows occur in the future, they will have serious consequences on Kapichira HEP operations and agriculture in the valley. However, this scenario has been taken care of by constructing a barrage at Liwonde. Lake outflow has a seasonal component as does river flow originating below the lake. Although flood episodes of local origin are important, a significant proportion of peak average flow is due to higher lake levels during the rainy season.*

This report also noted several miscellaneous effects such as:

- Impact of Reduced Shire River Water Flow on Riverine Vegetation
- Impact of Reduced Shire River Flow on Fisheries
- Impact of the Canal on Wildlife
- Effect of the Canal on Wildlife Movements and Mortality
- Human/Wildlife Conflicts
- Impact of Canal on Fish Migration
- Impact of the Project on Protected Areas
- Project Impact on Tourism
- Impact of Irrigation on Water logging
- Impact of Irrigation on Salinity
- Project Impact on Water Quality
- Impact of the Project on Health
- Impact of Agrochemical Usage
- Impact of Irrigation Project on Agro-Processing

Even though they are not treated here, they will be sufficiently reflected in the study by TFS team.

Annex 2.
Basin Characteristics of the Project Area

Annex 2. Basin Characteristics of the Project Area

No	Basin	Basin Area $A(km^2)$	Channel Length L(km)	Mean Width of Basin A/L(km)	Basin Shape Factor(A/L^{2})
1	Matope River	13.09	7.50	1.74	0.23
2	1_1	0.76	2.86	0.27	0.09
3	1_2	1.81	1.00	1.81	1.82
4	Mwambezi Str.	157.66	33.99	4.64	0.14
5	1_3	0.74	0.68	1.09	1.60
6	1_4	3.65	4.19	0.87	0.21
7	1_5	0.33	0.68	0.48	0.71
8	1_6	1.14	1.78	0.64	0.36
9	Namkati Str.	12.35	7.91	1.56	0.20
10	1_7	0.18	0.48	0.38	0.79
11	1_8	1.11	1.15	0.97	0.84
12	Maskkale Str.	102.83	33.99	3.03	0.09
13	1_9	0.64	1.23	0.52	0.42
14	1_10	1.16	2.45	0.48	0.19
15	1_11	2.18	3.33	0.65	0.20
16	1_12	7.21	5.92	1.22	0.21
17	Manjalende Str.	2.68	2.74	0.98	0.36
18	1_13	0.81	1.52	0.53	0.35
19	1_14	1.94	2.18	0.89	0.41
20	1_15	0.34	1.32	0.25	0.19
21	1_16	0.70	1.36	0.52	0.38
22	1_17	0.53	0.75	0.71	0.94
23	1_18	0.27	0.42	0.63	1.49
24	Manchombe Str.	42.85	18.56	2.31	0.12
25	1_19	0.47	0.78	0.60	0.76
26	Nthumba Str.	69.04	33.26	2.08	0.06
27	1_20	1.26	1.55	0.81	0.52
28	1_21	0.73	1.71	0.43	0.25
29	1_22	0.48	1.29	0.38	0.29
30	1_23	0.32	0.86	0.37	0.43
31	1_24	0.15	0.51	0.30	0.58
32	1_25	0.34	0.52	0.65	1.25
33	Kasinthula Str.	3.87	3.56	1.09	0.31
34	Naphala Str.	3.03	3.43	0.88	0.26
35	Chinggalumba Str.	15.83	1.52	10.42	6.86
36	Nthembe Str.	2.71	2.84	0.96	0.34
37	1_26	0.56	0.95	0.59	0.62
38	Nancholi Str.	2.13	2.44	0.87	0.36

No	Basin	Basin Area A(km^2)	Channel Length L(km)	Mean Width of Basin A/L(km)	Basin Shape Factor(A/L$^{2)}$
39	Mwanza River	1618.39	127.06	12.74	0.10
40	Nadzitimbe Str.	23.64	13.69	1.73	0.13
41	1_27	0.83	1.66	0.50	0.30
42	1_28	1.32	1.50	0.88	0.58
43	1_29	0.33	0.98	0.34	0.34
44	1_30	0.10	0.52	0.20	0.38
45	1_31	0.22	0.69	0.32	0.46
46	1_32	2.29	3.80	0.60	0.16
47	Chombwa Str.	27.92	15.44	1.81	0.12
48	Nkombedzi Wa Fodya River	430.83	47.80	9.01	0.19
49	A_1	3.60	4.09	0.88	0.22
50	A_2	0.32	1.77	0.18	0.10
51	A_3	0.30	0.45	0.67	1.49
52	A_4	0.17	0.53	0.32	0.60
53	A_5	0.69	0.87	0.79	0.91
54	A_6	6.21	4.61	1.35	0.29
55	A_7	4.59	4.05	1.13	0.28
56	A_8	0.71	0.91	0.77	0.85
57	A_9	3.28	4.00	0.82	0.20
58	A_10	0.24	0.81	0.29	0.37
59	Namitalala River	68.04	20.54	3.31	0.16
60	B_1	0.70	1.63	0.43	0.27
61	B_2	6.52	6.56	0.99	0.15
62	B_3	1.08	2.10	0.52	0.25
63	B_4	0.33	0.69	0.48	0.69
64	B_5	7.18	5.27	1.36	0.26
65	B_6	0.88	1.60	0.55	0.34
66	B_7	0.99	2.73	0.36	0.13
67	B_8	2.30	2.37	0.97	0.41
68	B_9	1.36	2.27	0.60	0.26
69	B_10	0.14	0.62	0.22	0.36
70	B_11	0.14	0.58	0.24	0.41
71	B_12	0.17	0.54	0.31	0.57
72	B_13	0.14	0.49	0.28	0.58
73	B_14	0.16	0.39	0.41	1.04
74	B_15	0.18	0.54	0.33	0.61
75	Phwadzi Str.	218.82	33.68	6.50	0.19
76	B_16	2.26	3.04	0.74	0.24
77	B_17	2.89	1.81	1.59	0.88

No	Basin	Basin Area A(km2)	Channel Length L(km)	Mean Width of Basin A/L(km)	Basin Shape Factor(A/L^2)
78	B_18	4.53	6.03	0.75	0.12
79	B_19	0.37	0.72	0.51	0.72
80	B_20	0.78	0.75	1.04	1.40
81	B_21	0.74	1.38	0.54	0.39
82	Chimbwile Str.	5.42	7.05	0.77	0.11
83	B_22	1.83	1.69	1.08	0.64
84	B_23	2.20	2.38	0.92	0.39
85	B_24	6.99	6.97	1.00	0.14
86	B_25	2.45	3.34	0.73	0.22
87	B_26	0.46	1.27	0.36	0.28
88	Namikalango River	142.80	30.58	4.67	0.15
89	C_1	3.44	4.03	0.85	0.21
90	C_2(Zengo Str.)	13.67	10.70	1.28	0.12
91	C_3	0.60	1.12	0.54	0.48
92	C_4	3.38	1.12	3.02	2.70
93	Chimbamira Str.	33.81	15.86	2.13	0.13
94	C_5	0.74	1.12	0.66	0.59
95	Nyakama Str.	76.66	23.69	3.24	0.14
96	C_6	1.30	1.21	1.07	0.89
97	C_7	3.52	3.58	0.98	0.27
98	Ntayanyama Str.	3.45	3.56	0.97	0.27
99	Mikimbo Str.	23.92	11.38	2.10	0.18
100	C_8	0.67	1.12	0.60	0.53
101	C_9	7.28	9.62	0.76	0.08
102	Mbiya Str.	27.30	16.12	1.69	0.11
103	C_10	1.09	1.12	0.97	0.87
104	C_11	10.90	11.56	0.94	0.08
105	Mafolela Str.	31.34	14.28	2.20	0.15
106	Chidyamaga River	3.62	3.86	0.94	0.24
107	Mambala Str.	12.49	11.89	1.05	0.09
108	Kawanda Str.	51.82	20.88	2.48	0.12
109	Mafume River	10.73	10.72	1.00	0.09
110	Lalanje River	72.93	22.56	3.23	0.14
111	D_1	2.35	4.64	0.51	0.11
112	D_2	0.86	2.18	0.40	0.18
113	D_3	5.83	6.34	0.92	0.14
114	D_4	0.86	1.15	0.75	0.65
115	D_5	7.06	6.20	1.14	0.18
116	D_6	1.29	1.61	0.80	0.50

Annex 3.
Flood Runoff Analysis

Annex 3. Flood Runoff Analysis

1. Location and Status of Meteorological Station

Rainfall Station	Location		Start Year	Remark
	Long.	Lat.		
Mwanza	34.5167	-15.6167	1965	
Chikwawa	34.7833	-16.0333	1960	
Nchalo	34.93333	-16.2333	1971	
Ngabu	34.95	-16.5	1960	

2. Maximum Rainfall(mm) in Mwanza Meteorological Station

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1965	22-Feb	76.2	21-Feb	76.2	20-Feb	84.8	19-Feb	98.5
1966	27-Jan	146.1	26-Jan	186.7	13-Dec	212.1	24-Jan	227.3
1967	18-Feb	83.8	13-Jan	134.6	12-Jan	172.4	12-Jan	173.2
1968	17-Feb	83.8	31-Dec	108.0	15-Feb	142.2	14-Feb	152.4
1969	8-Feb	103.1	7-Feb	103.1	22-Dec	113.5	21-Dec	127.0
1970	18-Feb	63.5	7-Dec	82.0	2-Jan	115.1	2-Jan	125.8
1971	1-Jan	63.2	1-Jan	68.5	16-Feb	77.0	15-Feb	77.0
1972	18-Feb	86.1	8-Nov	97.0	8-Nov	105.4	11-Jan	118.6
1973	18-Feb	68.1	12-Feb	95.0	12-Feb	103.6	10-Feb	121.1
1974	17-Feb	80.3	16-Feb	110.8	16-Feb	115.6	14-Feb	141.8
1975	27-Oct	150.9	27-Oct	152.2	26-Oct	152.2	25-Oct	152.2
1976	5-Jan	72.4	5-Jan	86.1	2-Mar	100.8	2-Mar	112.2
1977	20-Jan	98.8	19-Jan	98.8	18-Jan	98.8	18-Mar	120.9
1978	20-Oct	85.6	20-Oct	119.9	19-Oct	119.9	18-Oct	119.9
1979	5-Feb	65.3	6-Mar	82.5	5-Mar	111.2	5-Mar	125.4
1980	10-Apr	48.5	8-Dec	51.8	4-Dec	75.6	6-Dec	90.9
1981	6-Feb	65.9	5-Feb	86.6	5-Feb	89.3	4-Feb	89.3
1982	6-Feb	76.1	6-Feb	123.9	6-Feb	153.3	6-Feb	162.4
1983	6-Feb	87.1	5-Feb	156.9	4-Feb	165.9	3-Feb	197.5
1984	20-Mar	70.0	22-Mar	103.8	20-Mar	136.6	20-Mar	185.9
1985	10-Oct	131.5	10-Oct	147.2	4-Nov	192.6	4-Nov	204.6

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1986	24-Feb	92.7	22-Jan	111.1	22-Jan	152.3	22-Jan	160.2
1987	7-Feb	73.9	7-Feb	116.7	6-Feb	125.5	7-Feb	150.6
1988	7-Mar	103.6	6-Mar	184.2	5-Mar	250.7	5-Mar	279.8
1989	17-Jan	65.1	17-Jan	85.1	16-Jan	90.9	15-Jan	98.9
1990	9-Jan	67.0	9-Jan	101.0	8-Jan	104.7	6-Jan	111.3
1991	21-Nov	66.0	25-Jan	95.5	24-Jan	95.5	23-Jan	95.5
1992	5-Jan	66.0	5-Jan	96.5	5-Jan	114.5	5-Jan	116.5
1993	4-Feb	103.0	24-Jan	155.8	24-Jan	230.9	24-Jan	295.9
1994	11-Dec	159.0	11-Dec	166.0	10-Dec	167.0	9-Dec	167.0
1995	23-Jun	52.0	16-Jan	90.2	21-Jan	108.1	14-Jan	132.3
1996	8-Feb	156.5	7-Feb	184.5	6-Feb	237.0	5-Feb	247.6
1997	14-Mar	143.0	14-Mar	162.5	14-Mar	177.5	13-Mar	180.9
1998	6-Jan	29.4	12-Feb	47.3	13-Feb	71.6	12-Feb	92.7
1999	13-Feb	83.8	9-Apr	100.8	13-Feb	114.6	13-Feb	117.5
2000	30-Nov	120.0	29-Nov	123.5	28-Nov	130.5	27-Nov	151.0
2001	20-Jan	123.0	20-Dec	200.2	20-Dec	202.2	19-Dec	202.2
2002	2-Jan	100.0	1-Jan	140.6	1-Jan	163.5	1-Jan	179.0
2003	3-Mar	49.9	22-Dec	56.4	3-Mar	71.9	3-Mar	84.1
2004	25-Dec	75.7	25-Dec	89.3	25-Dec	99.9	25-Dec	119.7
2005	25-Dec	59.5	14-Jan	90.1	25-Dec	99.2	24-Dec	99.2
2006	1-Jan	126.0	1-Jan	196.2	1-Jan	238.2	1-Jan	262.5
2007	21-Dec	61.2	20-Dec	121.2	19-Dec	170.5	18-Dec	212.7
2008	1-Jan	65.4	1-Jan	84.9	1-Jan	114.9	31-Dec	120.9
2009	20-Jan	71.0	27-Feb	87.1	26-Feb	96.1	25-Feb	137.1
2010	10-Mar	85.0	9-Mar	125.1	9-Mar	135.1	8-Mar	135.1
2011	6-Nov	105.0	6-Mar	109.8	20-Jan	114.4	19-Jan	189.5
2012	26-Nov	124.2	26-Nov	135.4	10-Feb	145.7	8-Feb	185.7
2013	3-Jan	76.0	2-Jan	108.5	1-Jan	146.0	31-Dec	162.4
2014	20-Dec	99.5	19-Dec	101.6	28-Dec	112.7	28-Dec	128.7
2015	24-Nov	65.0	24-Nov	128.0	23-Nov	138.2	22-Nov	141.0
max	11-Dec-94	159.0	20-Dec-01	200.2	5-Mar-88	250.7	24-Jan-93	295.9

3. Maximum Rainfall(mm) in Chikwawa Meteorological Station

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1960	13-Feb	61.5	26-Jan	64	25-Jan	94	25-Jan	95
1961	1-Jan	58.7	31-Dec	81.6	30-Dec	84.9	30-Dec	87.7
1962	28-Jan	172.5	28-Jan	174.5	27-Jan	175.5	25-Jan	183.7
1963	9-Feb	61.5	1-Jan	106.2	1-Jan	107.2	1-Jan	109.2
1964	22-Nov	93.5	21-Nov	110.8	8-Jan	126.5	21-Nov	126.8
1965	20-Jan	62.5	16-Feb	101.9	16-Feb	129.8	16-Feb	173.7
1966	12-Dec	54.9	13-Feb	87.3	12-Feb	93.7	13-Feb	103.3
1967	3-Mar	92.5	14-Mar	140.5	13-Mar	163.4	13-Mar	168.0
1968	31-Dec	91.9	30-Dec	110.7	29-Dec	110.7	28-Dec	125.9
1969	17-Dec	130.6	5-Jan	142.2	5-Jan	165.6	5-Jan	219.7
1970	1-Dec	96.0	1-Dec	101.1	1-Dec	102.4	29-Nov	107.2
1971	21-Nov	126.0	21-Nov	131.8	20-Nov	131.8	23-Jan	140.5
1972	21-Nov	126.0	20-Nov	126.0	19-Nov	128.3	21-Nov	131.8
1973	24-Jan	73.4	23-Jan	100.1	23-Jan	121.2	23-Jan	142.3
1974	4-Jan	47.8	3-Jan	47.8	29-Mar	67.0	29-Mar	72.1
1975	9-Dec	134.1	8-Dec	136.4	7-Dec	136.4	6-Dec	136.4
1976	10-Dec	86.1	10-Dec	86.6	9-Dec	86.6	7-Dec	108.0
1977	27-Dec	67.3	27-Dec	69.3	27-Dec	73.9	27-Dec	92.2
1978	19-Jan	100.8	18-Jan	100.8	18-Dec	125.2	17-Dec	146.0
1979	22-Jan	111.3	22-Jan	139.7	21-Jan	139.7	20-Jan	139.7
1980	6-Mar	110.2	5-Mar	142.7	6-Mar	185.8	5-Mar	218.3
1981	29-Jan	97.2	28-Jan	97.2	27-Jan	97.2	29-Jan	116.0
1982	23-Aug	52.1	8-Jan	82.7	7-Jan	86.7	8-Jan	118.1
1983	3-Dec	48.1	25-Dec	62.0	3-Dec	86.1	2-Dec	86.1
1984	20-Dec	43.1	20-Dec	55.9	19-Dec	66.0	3-Feb	74.8
1985	11-Nov	70.1	11-Nov	74.1	10-Nov	74.1	10-Mar	85.0
1986	23-Oct	80.7	2-Jan	90.4	8-Dec	110.8	8-Dec	122.1
1987	3-Jan	114.0	2-Jan	117.2	1-Jan	120.0	31-Dec	126.0
1988	17-Mar	63.1	26-Jan	69.9	15-Mar	70.1	24-Jan	72.2

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1989	7-Mar	140.2	6-Mar	235.7	5-Mar	336.5	5-Mar	362.4
1990	8-Jan	104.2	7-Jan	104.2	8-Jan	104.5	7-Jan	104.5
1991	19-Feb	33.3	11-Feb	50.7	11-Feb	67.8	11-Feb	79.9
1992	22-Jan	20.0	17-Dec	31.6	16-Dec	39.6	22-Jan	45.5
1993	13-Jan	78.8	12-Jan	136.6	11-Jan	173.8	10-Jan	220.8
1994	4-Jan	28.6	25-Mar	40.8	24-Mar	51.8	25-Mar	60.5
1995	10-Dec	84.0	10-Dec	127.3	23-Dec	157.4	23-Dec	179.0
1996	7-Feb	87.9	7-Feb	135.4	6-Feb	152.7	7-Feb	163.0
1997	9-Feb	50.5	9-Feb	60.5	6-Apr	64.2	6-Apr	65.5
1998	26-Jan	78.9	29-Dec	107.3	29-Dec	150.2	29-Dec	158.7
1999	3-Jan	55.0	3-Jan	70.3	2-Jan	79.5	3-Jan	99.8
2000	2-Feb	77.0	1-Feb	103.0	31-Jan	114.2	30-Jan	186.7
2001	19-Mar	65.1	19-Mar	83.2	26-Dec	115.2	26-Dec	136.0
2002	20-Jan	102.1	20-Jan	116.2	19-Jan	127.8	19-Jan	134.4
2003	11-Jan	145.7	10-Jan	183.3	10-Jan	184.8	9-Jan	184.8
2004	22-Jan	56.9	21-Jan	60.5	20-Jan	84.8	28-Jan	89.4
2005	29-Dec	72.8	29-Dec	79.1	29-Dec	88.3	29-Dec	91.3
2006	29-Mar	97.0	29-Mar	99.0	28-Mar	99.0	26-Mar	100.3
2007	28-Nov	97.6	2-Jan	146.0	2-Jan	192.2	1-Jan	233.9
2008	10-Jan	44.8	9-Feb	55.5	19-Dec	58.3	24-Jan	65.2
2009	20-Mar	83.5	20-Mar	108.8	18-Mar	147.4	18-Mar	172.7
2010	8-Dec	51.3	7-Dec	101.0	6-Dec	108.5	6-Dec	109.7
2011	9-Mar	73.7	9-Mar	139.7	8-Mar	139.7	7-Mar	139.7
2012	6-Mar	55.8	19-Jan	86.7	19-Jan	118.1	19-Jan	156.0
2013	29-Jan	104.8	28-Jan	144.6	12-Feb	174.9	12-Feb	190.2
2014	30-Dec	89.2	30-Dec	138.8	29-Dec	163.4	29-Dec	165.5
2015	12-Jan	62.8	11-Jan	101.4	11-Jan	123.7	11-Jan	125.3
max	11-Dec-94	172.5	20-Dec-01	235.7	5-Mar-88	336.5	24-Jan-93	362.4

4. Maximum Rainfall(mm) in Nchalo Meteorological Station

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1971	19-Jan	129.0	19-Jan	130.5	2-Jan	149.9	2-Jan	175.3
1972	28-Jan	54.4	28-Jan	60.5	28-Jan	69.6	25-Jan	72.2
1973	13-Jan	85.3	13-Jan	102.6	13-Jan	126.0	10-Jan	158.7
1974	29-Mar	72.4	29-Mar	92.7	29-Mar	98.8	28-Mar	102.4
1975	11-Feb	45.7	17-Dec	54.6	19-Jan	90.9	19-Jan	94.7
1976	25-Dec	63.0	11-Feb	72.6	23-Dec	98.5	25-Dec	107.4
1977	1-Jan	137.7	1-Jan	178.3	31-Dec	208.8	30-Dec	216.7
1978	8-Feb	71.1	7-Feb	78.7	18-Dec	97.8	17-Dec	140.0
1979	27-Nov	51.8	19-Mar	69.8	19-Mar	78.9	25-Feb	96.0
1980	28-Feb	57.1	5-Mar	71.1	5-Mar	74.1	5-Mar	83.5
1981	5-Mar	65.1	5-Mar	68.5	4-Mar	70.9	4-Mar	71.9
1982	8-Dec	71.6	8-Dec	71.8	8-Dec	85.1	7-Jan	90.6
1983	20-Dec	45.3	19-Dec	81.1	18-Dec	123.1	17-Dec	123.1
1984	21-Feb	71.4	3-Feb	105.6	3-Feb	120.2	3-Feb	137.8
1985	10-Nov	66.6	12-Feb	103.0	11-Feb	104.0	5-Jan	111.4
1986	23-Oct	100.4	23-Oct	101.8	22-Oct	101.8	21-Oct	101.8
1987	3-Jan	67.8	2-Jan	73.0	1-Jan	73.8	31-Dec	73.8
1988	7-Feb	94.2	7-Feb	98.8	1-Dec	138.0	30-Nov	155.8
1989	6-Mar	99.4	5-Mar	133.2	4-Mar	150.7	3-Mar	159.5
1990	28-Mar	51.0	28-Mar	53.4	12-Jan	54.3	12-Jan	70.0
1991	15-Nov	40.6	15-Nov	61.6	14-Nov	61.6	13-Nov	61.6
1992	19-Jan	41.6	18-Jan	41.6	13-Dec	42.6	13-Dec	43.6
1993	13-Jan	92.4	12-Jan	162.4	12-Jan	183.6	10-Jan	216.6
1994	29-Jan	54.4	4-Jan	61.1	4-Jan	61.6	2-Jan	67.3
1995	7-Feb	76.2	7-Feb	99.4	6-Feb	110.8	5-Feb	110.8
1996	8-Feb	75.3	8-Feb	109.5	6-Feb	153.1	6-Feb	187.3
1997	18-Feb	51.0	18-Feb	52.0	26-Jan	62.3	25-Jan	64.3
1998	19-Feb	90.3	19-Feb	99.1	19-Feb	123.3	18-Feb	125.6

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
2000	7-Feb	68.5	7-Feb	94.5	7-Feb	105.0	7-Feb	115.5
2001	20-Jan	66.6	20-Jan	128.4	20-Jan	148.4	19-Jan	154.8
2002	2-Jan	88.6	1-Jan	127.2	1-Jan	144.3	1-Jan	166.3
2003	28-Jan	64.4	28-Jan	76.5	28-Jan	80.8	28-Jan	90.2
2004	11-Dec	62.1	10-Dec	66.0	9-Dec	66.0	8-Dec	67.5
2005	29-Dec	90.0	29-Dec	105.6	29-Dec	126.2	29-Dec	154.2
2006	28-Jan	100.0	1-Jan	147.3	1-Jan	204.3	1-Jan	226.3
2007	28-Nov	72.2	27-Nov	72.2	16-Dec	93.0	16-Dec	94.2
2008	4-Jan	65.0	4-Jan	84.9	3-Jan	84.9	4-Jan	114.2
2009	10-Nov	30.0	26-Feb	55.5	25-Feb	76.7	24-Feb	83.5
2010	19-Dec	56.0	9-Mar	73.3	9-Mar	78.9	8-Mar	80.4
2011	18-Mar	100.0	17-Mar	100.0	18-Jan	140.5	18-Jan	180.5
2012	29-Jan	97.0	28-Jan	110.2	28-Jan	117.2	14-Feb	126.0
2013	2-Jan	47.0	2-Jan	57.0	2-Jan	63.5	30-Dec	86.7
2014	30-Dec	39.0	30-Dec	57.9	29-Dec	57.9	28-Dec	57.9
2015	12-Oct	100.0	12-Oct	129.0	23-Nov	170.0	5-Oct	183.4
max	11-Dec-94	137.7	20-Dec-01	178.3	5-Mar-88	208.8	24-Jan-93	226.3

5. Maximum Rainfall(mm) in Ngabu Meteorological Station

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1960	27-Nov	47.5	26-Nov	47.5	30-Dec	60.7	29-Dec	71.6
1961	28-Jan	57.9	18-Feb	68.6	25-Mar	77.3	25-Mar	103.7
1962	7-Dec	68.1	7-Dec	102.1	4-Mar	107.2	7-Dec	124.5
1963	11-Mar	69.1	11-Mar	75.5	11-Mar	92	10-Mar	94.5
1964	10-Mar	72.4	18-Feb	75.4	25-Jan	100.9	24-Jan	100.9
1965	10-Dec	66.0	10-Dec	73.6	9-Dec	73.6	8-Dec	73.6
1966	9-Dec	134.6	8-Dec	134.6	7-Dec	134.6	6-Dec	134.6
1967	20-Jan	80.3	19-Jan	127.3	19-Jan	130.3	18-Jan	130.3
1968	11-Dec	102.9	10-Dec	109.8	9-Dec	128.9	8-Dec	128.9
1969	17-Dec	61.2	17-Dec	65.8	24-Dec	76.7	23-Dec	101.3
1970	1-Dec	99.1	1-Dec	120.7	1-Dec	138.5	1-Dec	153.7
1971	23-Feb	62.5	23-Feb	65.0	21-Feb	66.1	20-Feb	73.2
1972	13-Jan	134.1	13-Jan	148.1	13-Jan	165.9	12-Jan	175.3
1973	2-Feb	86.4	2-Feb	100.1	29-Mar	109.0	29-Mar	110.3
1974	1-Jan	67.3	19-Feb	68.6	19-Feb	75.0	19-Feb	113.4
1975	29-Nov	85.1	29-Nov	85.6	28-Nov	85.6	26-Nov	106.7
1976	24-Dec	63.8	24-Dec	105.2	23-Dec	141.0	23-Dec	162.8
1977	27-Dec	102.9	16-Mar	106.2	15-Mar	119.4	14-Mar	153.9
1978	11-Dec	83.8	10-Dec	89.1	9-Dec	134.8	8-Dec	165.5
1979	27-Nov	45.2	6-Jan	56.6	6-Jan	71.8	5-Mar	86.5
1980	4-Feb	57.5	3-Feb	76.8	4-Dec	97.3	4-Feb	98.1
1981	23-Feb	90.2	10-Jan	98.3	9-Jan	118.3	8-Jan	150.5
1982	28-Jul	74.7	28-Jul	76.5	28-Jul	77.4	27-Jul	77.4
1983	26-Dec	93.3	4-Feb	162.2	3-Feb	226.8	3-Feb	274.0
1984	20-Dec	99.4	20-Dec	107.3	20-Dec	112.7	18-Dec	116.8
1985	11-Feb	54.8	10-Feb	70.2	10-Feb	84.6	2-Jan	89.8
1986	24-Nov	106.1	23-Nov	106.1	22-Nov	106.1	31-Dec	115.3
1987	10-Jan	103.4	10-Jan	103.8	8-Jan	128.5	8-Jan	128.9
1988	22-Jan	63.6	31-Jan	82.6	6-Mar	110.7	5-Mar	141.5

year	1day		2day		3day		Consecutive days	
	generation	rainfall	generation	rainfall	generation	rainfall	generation	rainfall
1989	12-Jan	55.7	14-Jan	59.3	12-Jan	75.0	12-Jan	115.0
1990	23-Mar	75.4	23-Mar	91.4	23-Mar	104.1	6-Mar	125.3
1991	23-Mar	69.2	23-Mar	77.2	22-Mar	79.2	21-Mar	86.3
1992	12-Jan	73.5	12-Jan	101.5	11-Jan	121.5	9-Jan	145.4
1993	6-Nov	88.0	6-Nov	89.0	4-Nov	92.0	4-Nov	93.0
1994	1-Jan	62.2	1-Jan	75.1	1-Jan	113.9	1-Jan	115.5
1995	16-Feb	89.5	16-Feb	102.0	15-Feb	109.3	14-Feb	109.3
1996	3-Apr	63.7	7-Feb	84.0	5-Feb	123.1	5-Feb	165.7
1997	14-Mar	58.2	23-Nov	75.5	28-Nov	75.6	23-Nov	99.3
1998	30-Dec	116.0	29-Dec	116.0	30-Dec	122.3	29-Dec	122.3
1999	12-Mar	165.0	12-Mar	186.0	11-Mar	196.8	11-Mar	200.1
2000	31-Jan	93.0	30-Jan	104.5	30-Jan	112.3	28-Jan	135.8
2001	20-Jan	74.8	26-Dec	128.8	26-Dec	172.0	26-Dec	190.0
2002	7-Mar	57.8	21-Feb	106.0	21-Feb	111.0	1-Jan	133.8
2003	29-Mar	57.6	29-Mar	58.4	28-Jan	60.5	27-Feb	75.3
2004	11-Dec	60.0	10-Dec	63.6	9-Dec	67.1	8-Dec	69.1
2005	29-Dec	89.3	28-Dec	113.6	29-Dec	129.6	29-Dec	165.2
2006	2-Jan	91.2	2-Jan	147.3	1-Jan	183.0	2-Jan	232.3
2007	18-Dec	143.4	18-Dec	143.6	16-Dec	162.0	16-Dec	162.2
2008	7-Dec	66.3	19-Dec	71.2	17-Dec	84.8	17-Dec	107.8
2009	7-Mar	40.1	19-Feb	45.8	5-Mar	64.4	4-Mar	74.2
2010	10-Mar	108.6	9-Mar	110.4	9-Mar	110.8	8-Mar	111.0
2011	16-Dec	71.3	20-Jan	81.8	20-Jan	121.2	19-Jan	145.3
2012	6-Jan	82.1	6-Jan	106.3	6-Jan	128.9	6-Jan	151.6
2013	25-Mar	86.5	24-Mar	86.5	23-Mar	86.5	22-Mar	86.5
2014	31-Dec	25.6	30-Dec	50.8	29-Dec	50.8	28-Dec	50.8
2015	25-Nov	98.4	6-Oct	105.8	31-Oct	133.9	31-Oct	157.7
max	11-Dec-94	165.0	20-Dec-01	186.0	5-Mar-88	226.8	24-Jan-93	274.0

6. 24 hours, 48 hours and 72 hours Consecutive Rainfall Data (mm)

Year	Mwanza				Chikwawa				Nchalo				Ngabu			
	1day	2day	3day	Con	1day	2day	3day	Con	1day	2day	3day	Con	1day	2day	3day	Con
1960					61.5	64	94	95					47.5	47.5	60.7	71.6
1961					58.7	81.6	84.9	87.7					57.9	68.6	77.3	103.7
1962					172.5	174.5	175.5	183.7					68.1	102.1	107.2	124.5
1963					61.5	106.2	107.2	109.2					69.1	75.5	92	94.5
1964					93.5	110.8	126.5	126.8					72.4	75.4	100.9	100.9
1965	76.2	76.2	84.8	98.5	62.5	101.9	129.8	173.7					66.0	73.6	73.6	73.6
1966	146.1	186.7	212.1	227.3	54.9	87.3	93.7	103.3					134.6	134.6	134.6	134.6
1967	83.8	134.6	172.4	173.2	92.5	140.5	163.4	168.0					80.3	127.3	130.3	130.3
1968	83.8	108.0	142.2	152.4	91.9	110.7	110.7	125.9					102.9	109.8	128.9	128.9
1969	103.1	103.1	113.5	127.0	130.6	142.2	165.6	219.7					61.2	65.8	76.7	101.3
1970	63.5	82.0	115.1	125.8	96.0	101.1	102.4	107.2					99.1	120.7	138.5	153.7
1971	63.2	68.5	77.0	77.0	126.0	131.8	131.8	140.5	129.0	130.5	149.9	175.3	62.5	65.0	66.1	73.2
1972	86.1	97.0	105.4	118.6	126.0	126.0	128.3	131.8	54.4	60.5	69.6	72.2	134.1	148.1	165.9	175.3
1973	68.1	95.0	103.6	121.1	73.4	100.1	121.2	142.3	85.3	102.6	126.0	158.7	86.4	100.1	109.0	110.3
1974	80.3	110.8	115.6	141.8	47.8	47.8	67.0	72.1	72.4	92.7	98.8	102.4	67.3	68.6	75.0	113.4
1975	150.9	152.2	152.2	152.2	134.1	136.4	136.4	136.4	45.7	54.6	90.9	94.7	85.1	85.6	85.6	106.7
1976	72.4	86.1	100.8	112.2	86.1	86.6	86.6	108.0	63.0	72.6	98.5	107.4	63.8	105.2	141.0	162.8
1977	98.8	98.8	98.8	120.9	67.3	69.3	73.9	92.2	137.7	178.3	208.8	216.7	102.9	106.2	119.4	153.9
1978	85.6	119.9	119.9	119.9	100.8	100.8	125.2	146.0	71.1	78.7	97.8	140.0	83.8	89.1	134.8	165.5
1979	65.3	82.5	111.2	125.4	111.3	139.7	139.7	139.7	51.8	69.8	78.9	96.0	45.2	56.6	71.8	86.5
1980	48.5	51.8	75.6	90.9	110.2	142.7	185.8	218.3	57.1	71.1	74.1	83.5	57.5	76.8	97.3	98.1
1981	65.9	86.6	89.3	89.3	97.2	97.2	97.2	116.0	65.1	68.5	70.9	71.9	90.2	98.3	118.3	150.5
1982	76.1	123.9	153.3	162.4	52.1	82.7	86.7	118.1	71.6	71.8	85.1	90.6	74.7	76.5	77.4	77.4
1983	87.1	156.9	165.9	197.5	48.1	62.0	86.1	86.1	45.3	81.1	123.1	123.1	93.3	162.2	226.8	274.0
1984	70.0	103.8	136.6	185.9	43.1	55.9	66.0	74.8	71.4	105.6	120.2	137.8	99.4	107.3	112.7	116.8
1985	131.5	147.2	192.6	204.6	70.1	74.1	74.1	85.0	66.6	103.0	104.0	111.4	54.8	70.2	84.6	89.8
1986	92.7	111.1	152.3	160.2	80.7	90.4	110.8	122.1	100.4	101.8	101.8	101.8	106.1	106.1	106.1	115.3
1987	73.9	116.7	125.5	150.6	114.0	117.2	120.0	126.0	67.8	73.0	73.8	73.8	103.4	103.8	128.5	128.9
1988	103.6	184.2	250.7	279.8	63.1	69.9	70.1	72.2	94.2	98.8	138.0	155.8	63.6	82.6	110.7	141.5
1989	65.1	85.1	90.9	98.9	140.2	235.7	336.5	362.4	99.4	133.2	150.7	159.5	55.7	59.3	75.0	115.0
1990	67.0	101.0	104.7	111.3	104.2	104.2	104.5	104.5	51.0	53.4	54.3	70.0	75.4	91.4	104.1	125.3

Year	Mwanza				Chikwawa				Nchalo				Ngabu			
	1day	2day	3day	Con	1day	2day	3day	Con	1day	2day	3day	Con	1day	2day	3day	Con
1991	66.0	95.5	95.5	95.5	33.3	50.7	67.8	79.9	40.6	61.6	61.6	61.6	69.2	77.2	79.2	86.3
1992	66.0	96.5	114.5	116.5	20.0	31.6	39.6	45.5	41.6	41.6	42.6	43.6	73.5	101.5	121.5	145.4
1993	103.0	155.8	230.9	295.9	78.8	136.6	173.8	220.8	92.4	162.4	183.6	216.6	88.0	89.0	92.0	93.0
1994	159.0	166.0	167.0	167.0	28.6	40.8	51.8	60.5	54.4	61.1	61.6	67.3	62.2	75.1	113.9	115.5
1995	52.0	90.2	108.1	132.3	84.0	127.3	157.4	179.0	76.2	99.4	110.8	110.8	89.5	102.0	109.3	109.3
1996	156.5	184.5	237.0	247.6	87.9	135.4	152.7	163.0	75.3	109.5	153.1	187.3	63.7	84.0	123.1	165.7
1997	143.0	162.5	177.5	180.9	50.5	60.5	64.2	65.5	51.0	52.0	62.3	64.3	58.2	75.5	75.6	99.3
1998	29.4	47.3	71.6	92.7	78.9	107.3	150.2	158.7	90.3	99.1	123.3	125.6	116.0	116.0	122.3	122.3
1999	83.8	100.8	114.6	117.5	55.0	70.3	79.5	99.8	54.7	58.5	60.8	65.6	165.0	186.0	196.8	200.1
2000	120.0	123.5	130.5	151.0	77.0	103.0	114.2	186.7	68.5	94.5	105.0	115.5	93.0	104.5	112.3	135.8
2001	123.0	200.2	202.2	202.2	65.1	83.2	115.2	136.0	66.6	128.4	148.4	154.8	74.8	128.8	172.0	190.0
2002	100.0	140.6	163.5	179.0	102.1	116.2	127.8	134.4	88.6	127.2	144.3	166.3	57.8	106.0	111.0	133.8
2003	49.9	56.4	71.9	84.1	145.7	183.3	184.8	184.8	64.4	76.5	80.8	90.2	57.6	58.4	60.5	75.3
2004	75.7	89.3	99.9	119.7	56.9	60.5	84.8	89.4	62.1	66.0	66.0	67.5	60.0	63.6	67.1	69.1
2005	59.5	90.1	99.2	99.2	72.8	79.1	88.3	91.3	90.0	105.6	126.2	154.2	89.3	113.6	129.6	165.2
2006	126.0	196.2	238.2	262.5	97.0	99.0	99.0	100.3	100.0	147.3	204.3	226.3	91.2	147.3	183.0	232.3
2007	61.2	121.2	170.5	212.7	97.6	146.0	192.2	233.9	72.2	72.2	93.0	94.2	143.4	143.6	162.0	162.2
2008	65.4	84.9	114.9	120.9	44.8	55.5	58.3	65.2	65.0	84.9	84.9	114.2	66.3	71.2	84.8	107.8
2009	71.0	87.1	96.1	137.1	83.5	108.8	147.4	172.7	30.0	55.5	76.7	83.5	40.1	45.8	64.4	74.2
2010	85.0	125.1	135.1	135.1	51.3	101.0	108.5	109.7	56.0	73.3	78.9	80.4	108.6	110.4	110.8	111.0
2011	105.0	109.8	114.4	189.5	73.7	139.7	139.7	139.7	100.0	100.0	140.5	180.5	71.3	81.8	121.2	145.3
2012	124.2	135.4	145.7	185.7	55.8	86.7	118.1	156.0	97.0	110.2	117.2	126.0	82.1	106.3	128.9	151.6
2013	76.0	108.5	146.0	162.4	104.8	144.6	174.9	190.2	47.0	57.0	63.5	86.7	86.5	86.5	86.5	86.5
2014	99.5	101.6	112.7	128.7	89.2	138.8	163.4	165.5	39.0	57.9	57.9	57.9	25.6	50.8	50.8	50.8
2014	99.5	101.6	112.7	128.7	89.2	138.8	163.4	165.5	39.0	57.9	57.9	57.9	25.6	50.8	50.8	50.8
2014	99.5	101.6	112.7	128.7	89.2	138.8	163.4	165.5	39.0	57.9	57.9	57.9	25.6	50.8	50.8	50.8

7. Thiessen Factor of Basin

No	Basin	Mwanza	Chikwawa	Nchalo	Ngabu	Remark
1	Matope Riv.	-	100%	-	-	
2	1_1	-	100%	-	-	
3	1_2	-	100%	-	-	
4	Mwambezi Str.	47%	53%	-	-	
5	1_3	-	100%	-	-	
6	1_4	-	100%	-	-	
7	1_5	-	100%	-	-	
8	1_6	-	100%	-	-	
9	Namkati Str.	-	100%	-	-	
10	1_7	-	100%	-	-	
11	1_8	-	100%	-	-	
12	Maskkale Str.	-	100%	-	-	
13	1_9	-	100%	-	-	
14	1_10	-	100%	-	-	
15	1_11	-	100%	-	-	
16	1_12	-	100%	-	-	
17	Manjalende Str.	-	100%	-	-	
18	1_13	-	100%	-	-	
19	1_14	-	100%	-	-	
20	1_15	-	100%	-	-	
21	1_16	-	100%	-	-	
22	1_17	-	100%	-	-	
23	1_18	-	100%	-	-	
24	Manchombe Str.	-	100%	-	-	
25	1_19	-	100%	-	-	
26	Nthumba Str.	-	100%	-	-	
27	1_20	-	100%	-	-	
28	1_21	-	100%	-	-	
29	1_22	-	100%	-	-	
30	1_23	-	100%	-	-	
31	1_24	-	100%	-	-	
32	1_25	-	100%	-	-	

No	Basin	Mwanza	Chikwawa	Nchalo	Ngabu	Remark
33	Kasinthula Str.	-	100%	-	-	
34	Naphala Str.	-	100%	-	-	
35	Chinggalumba Str.	-	100%	-	-	
36	Nthembe Str.	-	100%	-	-	
37	1_26	-	100%	-	-	
38	Nancholi Str.	-	100%	-	-	
39	Mwanza Riv.	61%	39%	-	-	
40	Nadzitimbe Str.	-	100%	-	-	
41	1_27	-	100%	-	-	
42	1_28	-	100%	-	-	
43	1_29	-	100%	-	-	
44	1_30	-	100%	-	-	
45	1_31	-	100%	-	-	
46	1_32	-	100%	-	-	
47	Chombwa Str.	-	100%	-	-	
48	Nkombedzi Riv.	-	95%	5%	-	
49	A_1	-	26%	74%	-	
50	A_2	-	52%	48%	-	
51	A_3	-	100%	-	-	
52	A_4	-	51%	49%	-	
53	A_5	-	-	100%	-	
54	A_6	-	1%	99%	-	
55	A_7	-	-	100%	-	
56	A_8	-	-	100%	-	
57	A_9	-	-	100%	-	
58	A_10	-	-	100%	-	
59	Namitalala Riv.	-	-	100%	-	
60	B_1	-	-	100%	-	
61	B_2	-	-	100%	-	
62	B_3	-	-	100%	-	
63	B_4	-	-	100%	-	
64	B_5	-	-	100%	-	
65	B_6	-	-	100%	-	
66	B_7	-	-	100%	-	

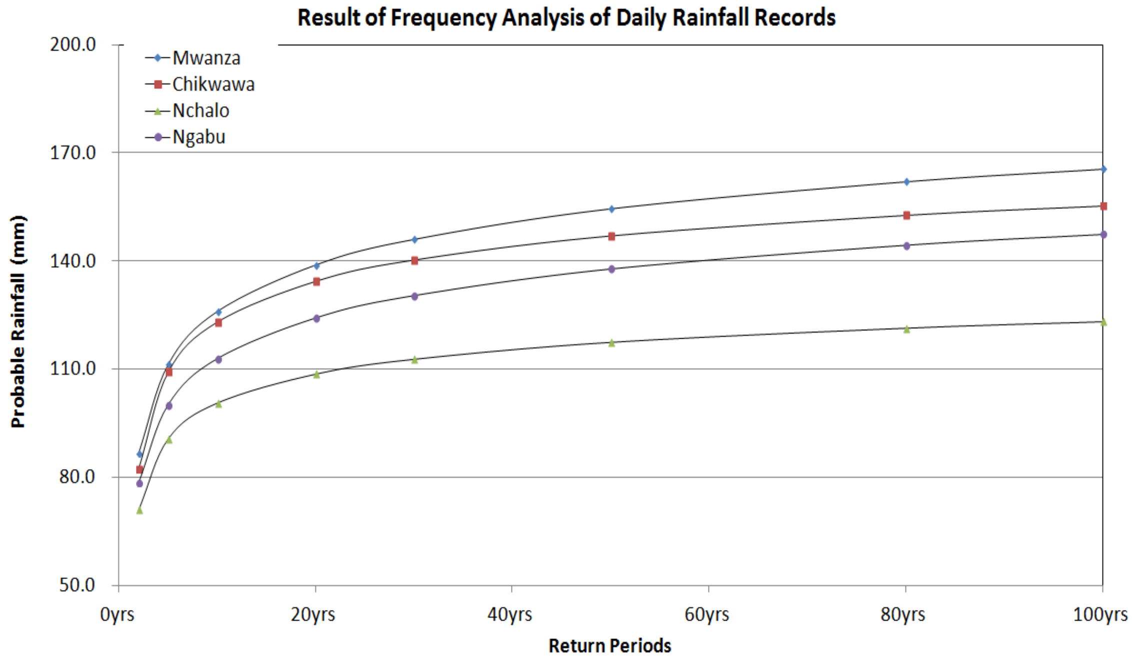
No	Basin	Mwanza	Chikwawa	Nchalo	Ngabu	Remark
67	B_8	-	-	100%	-	
68	B_9	-	-	100%	-	
69	B_10	-	-	100%	-	
70	B_11	-	-	100%	-	
71	B_12	-	-	100%	-	
72	B_13	-	-	100%	-	
73	B_14	-	-	100%	-	
74	B_15	-	-	100%	-	
75	Phwadzi Str.	-	-	100%	-	
76	B_16	-	-	100%	-	
77	B_17	-	-	99%	1%	
78	B_18	-	-	41%	59%	
79	B_19	-	-	100%	-	
80	B_20	-	-	100%	-	
81	B_21	-	-	100%	-	
82	Chimbwile Str.	-	-	16%	84%	
83	B_22	-	-	13%	87%	
84	B_23	-	-	-	100%	
85	B_24	-	-	-	100%	
86	B_25	-	-	-	100%	
87	B_26	-	-	-	100%	
88	Namikalango Riv.	-	-	-	100%	
89	C_1	-	-	-	100%	
90	C_2(Zengo Str.)	-	-	-	100%	
91	C_3	-	-	-	100%	
92	C_4	-	-	-	100%	
93	Chimbamira Str.	-	-	-	100%	
94	C_5	-	-	-	100%	
95	Nyakama Str.	-	-	-	100%	
96	C_6	-	-	-	100%	
97	C_7	-	-	-	100%	
98	Ntayanyama Str.	-	-	-	100%	
99	Mikimbo Str.	-	-	-	100%	
100	C_8	-	-	-	100%	

No	Basin	Mwanza	Chikwawa	Nchalo	Ngabu	Remark
101	C_9	-	-	-	100%	
102	Mbiya Str.	-	-	-	100%	
103	C_10	-	-	-	100%	
104	C_11	-	-	-	100%	
105	Mafolela Str.	-	-	-	100%	
106	Chidyamaga Riv.	-	-	-	100%	
107	Mambala Str.	-	-	-	100%	
108	Kawanda Str.	-	-	-	100%	
109	Mafume Riv.	-	-	-	100%	
110	Lalanje Riv.	-	-	-	100%	
111	D_1	-	-	-	100%	
112	D_2	-	-	-	100%	
113	D_3	-	-	-	100%	
114	D_4	-	-	-	100%	
115	D_5	-	-	-	100%	
116	D_6	-	-	-	100%	

8. Probability Rainfall by Return Period of SVIP Station

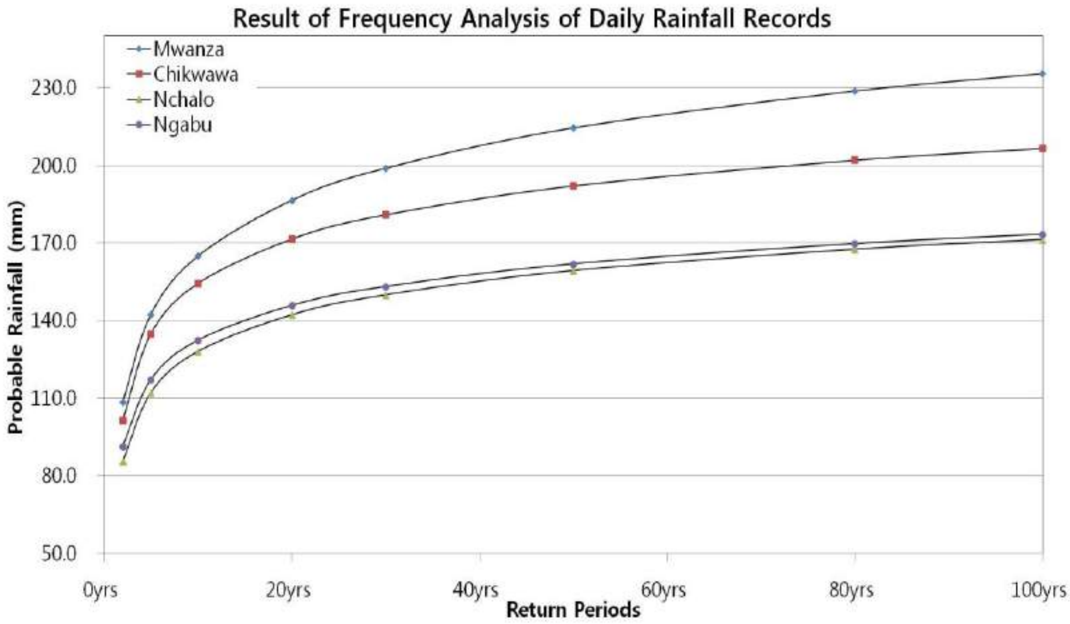
✓ Probability Daily Rainfall - Frequency of SVIP Basin

Rainfall Gauge STA	Quantity by Return Period(mm)							
	2yrs	5yrs	10yrs	20yrs	30yrs	50yrs	80yrs	100yrs
Mwanza	86.6	111.3	126.0	138.9	146.0	154.5	162.0	165.5
Chikwawa	82.3	109.2	123.1	134.4	140.3	147.0	152.7	155.3
Nchalo	71.0	90.7	100.6	108.6	112.7	117.4	121.3	123.1
Ngabu	78.4	100.1	112.9	124.2	130.4	137.8	144.4	147.4



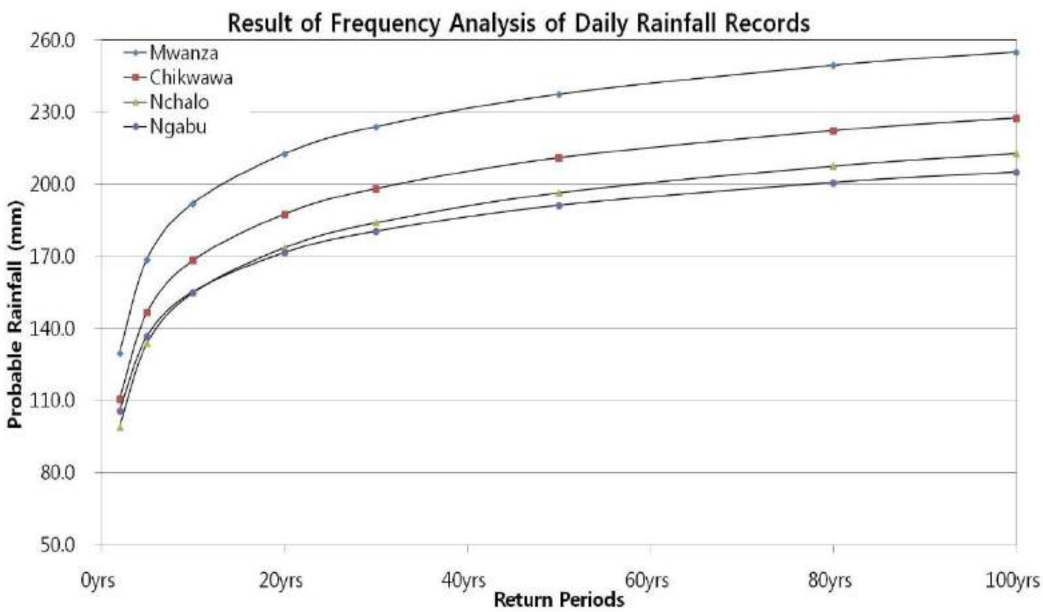
✓ Probability Daily Rainfall - Frequency of SVIP Basin

Rainfall Gauge STA	Quantity by Return Period(mm)							
	2yrs	5yrs	10yrs	20yrs	30yrs	50yrs	80yrs	100yrs
Mwanza	108.5	142.4	164.9	186.5	198.9	214.5	228.7	235.4
Chikwawa	101.4	134.8	154.3	171.5	180.9	192.1	202.0	206.6
Nchalo	85.5	112.1	128.0	142.2	149.9	159.3	167.5	171.3
Ngabu	91.4	117.1	132.3	145.8	153.1	161.9	169.7	173.3



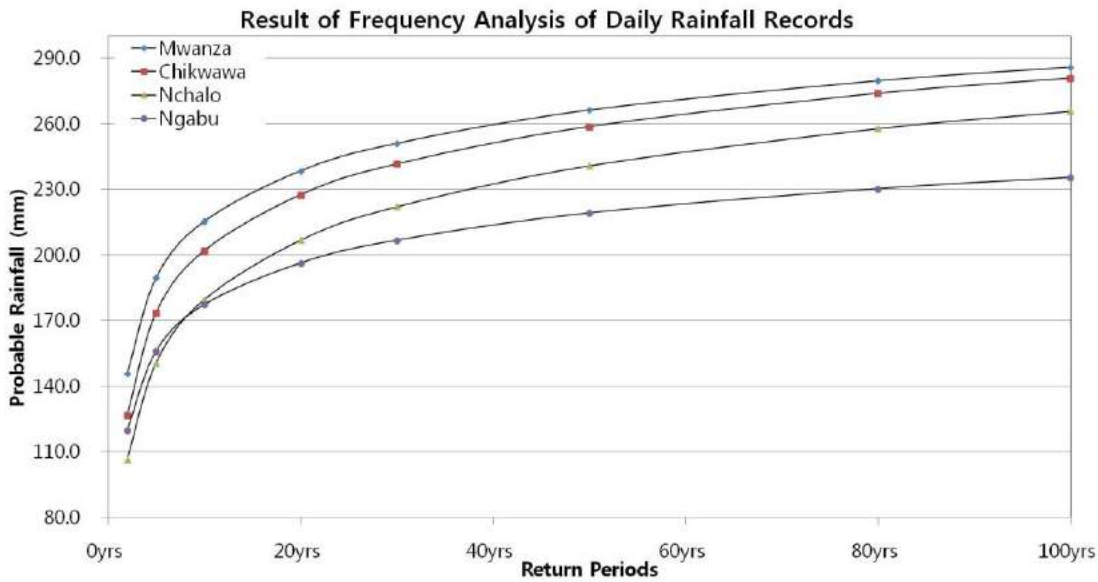
- ✓ Probability Daily Rainfall - Frequency of SVIP Basin

Rainfall Gauge STA	Quantity by Return Period(mm)							
	2yrs	5yrs	10yrs	20yrs	30yrs	50yrs	80yrs	100yrs
Mwanza	129.8	168.8	192.0	212.6	223.9	237.4	249.4	255.0
Chikwawa	110.6	146.7	168.3	187.6	198.2	211.0	222.3	227.6
Nchalo	99.0	133.8	154.8	173.6	184.0	196.5	207.6	212.8
Ngabu	105.7	136.7	155.2	171.5	180.4	191.2	200.7	205.1



✓ Probability Daily Rainfall - Frequency of SVIP Basin

Rainfall Gauge STA	Quantity by Return Period(mm)							
	2yrs	5yrs	10yrs	20yrs	30yrs	50yrs	80yrs	100yrs
Mwanza	145.6	189.4	215.3	238.4	251.0	266.2	279'6	285'8
Chikwawa	126.6	173.4	201.8	227.4	241.5	258.6	273.8	280.8
Nchalo	106.3	150.5	179.5	206.7	222.0	240.8	257.8	265.7
Ngabu	119.8	155.9	177.2	196.2	206.6	219.1	230.2	235.3



9. Flood Runoff Analysis

Section	20year Rainfall (mm)	Catchment Area (km2)	Channel Length (km)	Storage Constant	Time of Concentration		CN	NRCS LagTime (hr)
					min	hr		
Matope Riv.	134.40	13.09	7.50	1.73	113.10	1.89	86.01	1.13
1_1	134.40	0.76	2.86	1.01	32.20	0.54	80.47	0.32
1_2	134.40	1.81	1.00	0.30	25.30	0.42	82.14	0.25
Mwambezi Str.	136.56	157.66	33.99	9.31	460.80	7.68	78.97	4.61
1_3	134.40	0.74	0.68	0.23	19.30	0.32	79.93	0.19
1_4	134.40	3.65	4.19	0.99	62.20	1.04	80.77	0.62
1_5	134.40	0.33	0.68	0.12	9.30	0.16	75.52	0.10
1_6	134.40	1.14	1.78	0.35	25.20	0.42	77.54	0.25
Namkati Str.	134.40	12.35	7.91	1.97	120.80	2.01	81.98	1.21
1_7	134.40	0.18	0.48	0.11	8.80	0.15	81.19	0.09
1_8	134.40	1.11	1.15	0.29	23.80	0.40	80.47	0.24
Maskkale Str.	134.40	102.83	33.99	15.80	460.80	7.68	77.37	4.61
1_9	134.40	0.64	1.23	0.26	19.70	0.33	86.29	0.20
1_10	134.40	1.16	2.45	0.46	28.10	0.47	88.01	0.28
1_11	134.40	2.18	3.33	0.71	43.20	0.72	88.38	0.43
1_12	134.40	7.21	5.92	1.31	81.50	1.36	84.40	0.82
Manjalende Str.	134.40	2.68	2.74	0.48	34.80	0.58	88.88	0.35
1_13	134.40	0.81	1.52	0.32	23.30	0.39	89.04	0.23
1_14	134.40	1.94	2.18	0.40	30.20	0.50	88.91	0.30
1_15	134.40	0.34	1.32	0.24	14.30	0.24	88.87	0.14
1_16	134.40	0.70	1.36	0.26	19.00	0.32	88.85	0.19
1_17	134.40	0.53	0.75	0.17	14.20	0.24	89.05	0.14
1_18	134.40	0.27	0.42	0.14	12.00	0.20	88.97	0.12
Manchombe Str.	134.40	42.85	18.56	7.17	328.50	5.48	84.29	3.29
1_19	134.40	0.47	0.78	0.22	17.40	0.29	89.56	0.17
Nthumba Str.	134.40	69.04	33.26	118.18	502.40	8.37	84.48	5.02
1_20	134.40	1.26	1.55	0.27	20.70	0.35	86.80	0.21
1_21	134.40	0.73	1.71	0.27	18.20	0.30	87.66	0.18
1_22	134.40	0.48	1.29	0.20	14.00	0.23	83.45	0.14
1_23	134.40	0.32	0.86	0.13	9.70	0.16	82.19	0.10

Section	20year Rainfall (mm)	Catchment Area (km2)	Channel Length (km)	Storage Constant	Time of Concentration		CN	NRCS LagTime (hr)
					min	hr		
1_24	134.40	0.15	0.51	0.10	7.70	0.13	88.84	0.08
1_25	134.40	0.34	0.52	0.16	13.60	0.23	80.70	0.14
Kasinthula Str.	134.40	3.87	3.56	0.77	54.60	0.91	75.00	0.55
Naphala Str.	134.40	3.03	3.43	0.69	46.40	0.77	77.01	0.46
Chinggalumba Str.	134.40	15.83	1.52	0.50	43.30	0.72	84.84	0.43
Nthembe Str.	134.40	2.71	2.84	0.73	52.50	0.88	78.34	0.53
1_26	134.40	0.56	0.95	0.21	16.20	0.27	84.98	0.16
Nancholi Str.	134.40	2.13	2.44	0.43	31.60	0.53	83.44	0.32
Mwanza Riv.	137.04	1,618.39	127.06	74.75	2,668.80	44.48	84.34	26.69
Nadzitimbe Str.	134.40	23.64	13.69	1.99	92.30	1.54	88.65	0.92
1_27	134.40	0.83	1.66	0.36	25.10	0.42	79.64	0.25
1_28	134.40	1.32	1.50	0.31	24.50	0.41	86.36	0.25
1_29	134.40	0.33	0.98	0.20	14.40	0.24	88.15	0.14
1_30	134.40	0.10	0.52	0.14	10.10	0.17	76.14	0.10
1_31	134.40	0.22	0.69	0.15	11.20	0.19	80.28	0.11
1_32	134.40	2.29	3.80	1.11	60.80	1.01	84.84	0.61
Chombwa Str.	134.40	27.92	15.44	7.14	308.60	5.14	86.89	3.08
Nkombedzi Wa Fodya Riv.	133.20	430.83	47.80	23.57	1,414.50	23.58	89.00	14.15
A_1	115.20	3.60	4.09	1.11	70.30	1.17	87.54	0.70
A_2	121.92	0.32	1.77	1.20	43.20	0.72	82.54	0.43
A_3	134.40	0.30	0.45	0.17	14.30	0.24	89.05	0.14
A_4	121.68	0.17	0.53	0.14	11.00	0.18	78.70	0.11
A_5	108.72	0.69	0.87	0.32	25.90	0.43	77.66	0.26
A_6	108.96	6.21	4.61	1.25	87.40	1.46	86.11	0.88
A_7	108.72	4.59	4.05	1.15	79.10	1.32	87.75	0.79
A_8	108.72	0.71	0.91	0.25	20.70	0.35	86.93	0.21
A_9	108.72	3.28	4.00	1.20	74.40	1.24	87.25	0.74
A_10	108.72	0.24	0.81	0.27	20.10	0.34	88.77	0.20
Namitalala Riv.	108.72	68.04	20.54	7.41	409.90	6.83	88.74	4.10
B_1	108.72	0.70	1.63	0.40	27.00	0.45	87.95	0.27
B_2	108.72	6.52	6.56	2.05	109.00	1.82	88.89	1.09

Section	20year Rainfall (mm)	Catchment Area (km2)	Channel Length (km)	Storage Constant	Time of Concentration		CN	NRCS LagTime (hr)
					min	hr		
B_3	108.72	1.08	2.10	0.56	37.30	0.62	89.32	0.37
B_4	108.72	0.33	0.69	0.19	15.00	0.25	89.59	0.15
B_5	108.72	7.18	5.27	1.36	91.70	1.53	89.58	0.92
B_6	108.72	0.88	1.60	0.38	27.70	0.46	89.04	0.28
B_7	108.72	0.99	2.73	0.78	37.80	0.63	89.20	0.38
B_8	108.72	2.30	2.37	0.54	40.30	0.67	89.17	0.40
B_9	108.72	1.36	2.27	0.68	46.20	0.77	89.31	0.46
B_10	108.72	0.14	0.62	0.14	10.20	0.17	89.78	0.10
B_11	108.72	0.14	0.58	0.14	10.20	0.17	89.78	0.10
B_12	108.72	0.17	0.54	0.12	9.60	0.16	89.81	0.10
B_13	108.72	0.14	0.49	0.13	9.80	0.16	89.48	0.10
B_14	108.72	0.16	0.39	0.11	9.00	0.15	89.55	0.09
B_15	108.72	0.18	0.54	0.13	9.90	0.17	89.24	0.10
Phwadzi Str.	108.72	218.82	33.68	14.26	864.80	14.41	86.14	8.65
B_16	108.72	2.26	3.04	0.74	49.20	0.82	88.81	0.49
B_17	108.72	2.89	1.81	0.47	38.00	0.63	88.34	0.38
B_18	117.84	4.53	6.03	2.00	91.50	1.53	81.53	0.92
B_19	108.72	0.37	0.72	0.22	17.40	0.29	73.06	0.17
B_20	108.72	0.78	0.75	0.26	21.50	0.36	65.46	0.22
B_21	108.72	0.74	1.38	0.30	22.10	0.37	54.57	0.22
Chimbwile Str.	121.68	5.42	7.05	2.83	112.70	1.88	76.47	1.13
B_22	122.16	1.83	1.69	0.43	34.30	0.57	72.73	0.34
B_23	124.32	2.20	2.38	0.49	36.60	0.61	66.07	0.37
B_24	124.32	6.99	6.97	2.92	149.80	2.50	83.43	1.50
B_25	124.32	2.45	3.34	0.98	62.80	1.05	89.28	0.63
B_26	124.32	0.46	1.27	0.30	20.90	0.35	88.65	0.21
Namikalango Riv.	124.32	142.80	30.58	11.47	614.20	10.24	90.22	6.14
C_1	124.32	3.44	4.03	1.13	71.40	1.19	88.79	0.71
C_2(Zengo Str.)	124.32	13.67	10.70	4.04	177.80	2.96	89.72	1.78
C_3	124.32	0.60	1.12	0.34	26.30	0.44	89.39	0.26
C_4	124.32	3.38	1.12	0.43	37.00	0.62	89.58	0.37
Chimbamira Str.	124.32	33.81	15.86	4.82	235.70	3.93	90.12	2.36

Section	20year Rainfall (mm)	Catchment Area (km2)	Channel Length (km)	Storage Constant	Time of Concentration		CN	NRCS LagTime (hr)
					min	hr		
Chimbamira Str.	124.32	33.81	15.86	4.82	235.70	3.93	90.12	2.36
C_5	124.32	0.74	1.12	0.22	17.00	0.28	89.98	0.17
Nyakama Str.	124.32	76.66	23.69	8.00	395.90	6.60	90.25	3.96
C_6	124.32	1.30	1.21	0.39	31.60	0.53	87.33	0.32
C_7	124.32	3.52	3.58	0.82	56.40	0.94	89.23	0.56
Ntayanyama Str.	124.32	3.45	3.56	0.90	61.70	1.03	89.10	0.62
Mikimbo Str.	124.32	23.92	11.38	2.92	173.50	2.89	88.85	1.73
C_8	124.32	0.67	1.12	0.30	23.20	0.39	88.53	0.23
C_9	124.32	7.28	9.62	6.03	129.90	2.17	88.29	1.30
Mbiya Str.	124.32	27.30	16.12	5.55	211.70	3.53	89.47	2.12
C_10	124.32	1.09	1.12	0.32	26.00	0.43	80.92	0.26
C_11	124.32	10.90	11.56	6.25	148.90	2.48	87.32	1.49
Mafolela Str.	124.32	31.34	14.28	3.59	193.10	3.22	87.80	1.93
Chidyamaga Riv.	124.32	3.62	3.86	1.01	67.00	1.12	89.08	0.67
Mambala Str.	124.32	12.49	11.89	5.55	159.40	2.66	88.15	1.60
Kawanda Str.	124.32	51.82	20.88	6.72	294.30	4.91	85.25	2.95
Mafume Riv.	124.32	10.73	10.72	4.78	152.40	2.54	87.81	1.52
Lalanje Riv.	124.32	72.93	22.56	7.54	386.80	6.45	85.94	3.87
D_1	124.32	2.35	4.64	1.97	78.90	1.32	85.05	0.79
D_2	124.32	0.86	2.18	0.59	35.00	0.58	87.71	0.35
D_3	124.32	5.83	6.34	1.95	101.00	1.68	88.73	1.01
D_4	124.32	0.86	1.15	0.25	19.50	0.33	89.10	0.20
D_5	124.32	7.06	6.20	1.71	101.10	1.69	88.44	1.01
D_6	124.32	1.29	1.61	0.35	26.80	0.45	89.55	0.27

10. Flood Runoff Estimation

Section	Flood Discharge(m^3/s)		
	Clark Method	NRSC Method	Rational Method
Matope River	62.56	94.75	14.71
1_1	4.82	9.67	0.80
1_2	22.85	27.84	1.94
Mwambezi Str.	281.27	492.29	162.24
1_3	9.62	11.97	0.79
1_4	21.88	32.67	3.88
1_5	5.26	6.06	0.34
1_6	1.44	1.87	1.18
Namkati Str.	48.85	76.33	12.77
1_7	3.47	4.19	0.20
1_8	13.61	16.66	1.18
Maskkale Str.	123.95	303.69	103.15
1_9	9.44	12.17	0.70
1_10	13.77	19.16	1.17
1_11	20.13	29.33	2.13
1_12	40.37	61.17	7.03
Manjalende Str.	31.04	40.96	2.63
1_13	11.93	15.56	0.81
1_14	24.81	30.92	1.90
1_15	5.93	7.06	0.33
1_16	10.92	14.21	0.68
1_17	10.38	11.05	0.53
1_18	5.88	6.47	0.27
Manchombe Str.	98.04	174.53	44.61
1_19	8.23	9.73	0.54
Nthumba Str.	20.96	219.25	70.91
1_20	20.74	23.98	1.42
1_21	11.08	14.53	0.83
1_22	7.98	8.69	0.53
1_23	6.16	7.29	0.35
1_24	3.51	4.40	0.17
1_25	5.55	5.68	0.36
Kasinthula Str.	22.31	31.04	3.88
Naphala Str.	20.41	28.36	3.11
Chinggalumba Str.	124.99	159.08	16.81
Nthembe Str.	17.96	25.03	2.81
1_26	9.33	10.42	0.62
Nancholi Str.	22.48	29.42	2.33
Mwanza River	705.10	1745.02	1670.37
Nadzitimbe Str.	121.18	169.75	25.10

Section	Flood Discharge(m^3/s)		
	Clark Method	NRSC Method	Rational Method
1_27	9.03	11.84	0.86
1_28	18.56	22.71	1.45
1_29	6.10	6.74	0.36
1_30	1.57	1.88	0.11
1_31	3.82	4.47	0.23
1_32	14.74	23.04	2.53
Chombwa Str.	66.90	121.83	29.86
Nkombedzi Wa Fodya River	437.91	738.09	455.98
A_1	20.03	29.85	3.33
A_2	1.67	3.23	0.27
A_3	5.99	6.25	0.28
A_4	2.48	2.81	0.14
A_5	7.47	6.30	0.52
A_6	27.51	39.59	5.21
A_7	22.81	32.68	3.98
A_8	8.13	10.27	0.62
A_9	15.81	23.95	2.86
A_10	2.83	3.70	0.19
Namitalala River	141.94	231.07	59.11
B_1	6.83	9.03	0.64
B_2	23.62	39.33	5.63
B_3	9.00	12.56	0.93
B_4	2.77	5.19	0.30
B_5	33.81	48.99	6.60
B_6	9.03	11.41	0.78
B_7	6.92	11.30	0.91
B_8	16.89	25.44	2.09
B_9	11.37	13.60	1.23
B_10	2.45	2.97	0.13
B_11	2.45	2.97	0.13
B_12	3.07	3.61	0.16
B_13	2.50	2.94	0.13
B_14	2.91	3.55	0.15
B_15	3.15	3.76	0.17
Phwadzi Str.	274.70	450.55	191.37
B_16	15.59	21.91	2.10
B_17	25.48	32.27	2.69
B_18	13.12	26.99	4.25
B_19	2.65	3.25	0.30

Section	Flood Discharge(m^3/s)		
	Clark Method	NRSC Method	Rational Method
B_20	3.44	4.14	0.63
B_21	1.02	1.23	0.57
Chimbwile Str.	12.22	25.11	5.05
B_22	11.55	14.84	1.67
B_23	9.65	12.80	2.00
B_24	20.03	35.17	7.02
B_25	16.79	24.49	2.61
B_26	6.27	8.28	0.48
Namikalango River	213.87	363.32	140.59
C_1	21.50	32.06	3.53
C_2(Zengo Str.)	38.15	73.06	14.07
C_3	7.78	9.78	0.61
C_4	37.47	46.67	3.46
Chimbamira Str.	89.93	150.71	32.55
C_5	12.24	14.07	0.61
Nyakama Str.	148.45	254.13	72.96
C_6	14.33	17.86	1.24
C_7	26.95	38.09	3.34
Ntayanyama Str.	24.85	34.55	3.39
Mikimbo Str.	82.82	120.19	23.80
C_8	9.07	11.55	0.67
C_9	15.12	46.09	7.03
Mbiya Str.	67.98	127.27	26.83
C_10	11.48	13.99	1.07
C_11	21.38	61.59	10.67
Mafolela Str.	96.84	147.19	30.07
Chidyamaga River	24.28	35.23	3.67
Mambala Str.	27.22	68.93	12.14
Kawanda Str.	104.82	189.37	47.90
Mafume River	25.75	60.52	10.44
Lalanje River	136.69	230.51	70.08
D_1	9.58	18.53	2.18
D_2	8.03	11.61	0.80
D_3	25.96	43.74	5.55
D_4	12.38	15.81	0.78
D_5	33.45	52.60	6.43
D_6	16.51	20.56	1.34

Annex 4.
Summary of the
Flooding Area Field Survey

Annex 4. Summary of the Flooding Area Field Survey

1. Zone 1-1

Most areas of this zone are located in TA Masseah, and remain are in TA Kasisi and Katunga. According to villager's witnesses, the most widely flood damaged region in Zone 1-1 is near the area of cross point Nthumba River with M1 roads, and both side of Nthumba River, 3.5km upstream from the cross point.

- **South area of MBANDE Village**
  Mbande Village locates between Zone 1-1a and 1-1c. According to the villager's witness, the aspect of flooding was overflowed and rushed from tributary(they called Mwanza River) of Mwanza. According to a villager's witness the most serious flood was occurred in 2015, and the flooding was occurred by overflow of the tributary, and it was continued for 3 months since the rain has come in January. The flooding is happen when there was a heavy rainfall in the upstream regions of rivers. Even though there is a heavy rainfall in the local area while there is no rainfall in the upstream region, the flooding shall not be occurred. Villagers request an installation of a levee and dredging of river to secure the safety from flooding.

Item	Witnesses
Years	2015,
Frequency	-
Duration	About 3 months (W.L repeated up and down)
Causes (Aspects)	Caused by Nthumba River or Shire River Sometimes caused by both rivers.
Flooding Depth	0.4~ 1.0m

- **SESEO village**
  Seseo village locates at the opposite side of Kasinthula Rice Project Area of M1 road. This area is surrounded by M1 road in the east, and by Shire river in the northeast, and by Nthumba river in the south. This village is on the lower than M1 road about by 2.0 m and located at relatively low area than surrounding lands.

Flooding was occurred by the overflow of Nthumba or Shire river, sometime by both rivers. The most seriously damaged by the flooding of 2015. The notable points is that the flooding condition was similar with Matekenya village, that the flooding is depend on upstream rainfall events but not depend on local storm. Villagers also request an installation of a levee and dredging of river to secure the safety from flooding.

Item	Witnesses
Years	2015(February~ MAY), 2014
Frequency	Every 2years
Duration	About 3 months(W.L repeated up and down)
Causes (Aspects)	Caused by Nthumba River or Shire River Sometimes caused by both rivers.
Flooding depth	-


- **BEREU village**

Bereu village locates the southeast end of Zone 1-1a. The Elevation of village is lower than M1 road. There is a tributary of Mwanza river at the south of village. The tributary has a gentle bed slope and has a strong bended section near the village. According to witnesses, they have been damaged every 5 to 7 years, and the most serious damage was by the flood of 2015. The cause of flood was overflowing of the tributary due to the heavy rainfall in the upstream region. Villagers also request an installation of a levee and dredging of river to secure the safety from flooding.

Item	Witnesses
Years	2015(February~ MAY), 2014
Frequency	Every 2years
Duration	About 3 months (W.L repeated up and down)
Causes (Aspects)	Caused by Nthumba River or Shire River Sometimes caused by both rivers.
Water Level	0.8~ 1.0m


- **KALIMA village**

Kalima village locate between Illovo Estate and east side of Shire River and the ground level is much lower than M1 road. A elder of the village told that flooding was occurred in 1997 and 2015. In 2015 the flood was lasted for 3 month, January~ March, and the flooding depth was up to about 1.5m.

Result of inquiry investigation as following.

Item	Witnesses
Years	1997, 2015
Frequency	Unknown
Duration	About 3 months(January~ March)
Causes (Aspects)	Village was submerged as rising as water level of Shire River
Flooding depth	1.5m

2. Zone 1-2

Most of this zone are occupied by Illovo Estate in TA Lundu. The flood damaged areas are around the Estate, most of them are both side of Nkombedzi river. And other damaged area locates between Shire river and the Estate. Many river joined the down-stream section of Nkombedzi river in short distance, where the M8 road is crossing, and it seems not have enough conveyance capacity. The flood damaged villages are Chipakuza-A, Kalezera, Dzilonzo-1 and others.

- **CHIPAKUZA-A Village**

Chipakuza-A Village locate south of Zone 1-2a, between Nkomvedzi River and M8 Road. According to the villager's witnesses, the flooding was occurred by overflow of Nkombedai river, located behind of village. In the terms of flood frequency, villager said the big or small flooding occurs every years, but that of 2015 was the most serious events. The 2015's flood was continued for 4 months from January ~ MAY, and the flooding height was 0.3~ 0.6m. The main cause of flood was the lack of conveyance capacity of the bride on M8 road, blocked the downstream area of this village. Remained flood water was slowly drained through the bridge to downstream of Nkombedzi river. They said the lag time of flooding is about 1 day since a rainfall started. People said that building of levees is essential to prevent flooding damages.

Item	Witnesses
Years	2015, lightly every years
Frequency	Every years
Duration	About 3months (W.L repeated up and down)
Causes (Aspects)	Caused by overflow of Nkombedzi river
Flooding Depth	0.3 ~ 0.6m


- **KALENZERA village**

Kalenzera village locate the northeast Illovo Estate and the west side of Shire river where just after the join with Mwanza river. According to the villager's witness, the flooding was occurred by the overflow of Mwanza and Shire rivers at the same time. In the terms of flood frequency, villager said the flooding is repeated every year, the large scale flooding was occurred in 1996, 1997 and 2015, which was the most serious events. The 2015 flood was lasted for 3 months, February and April, and the flooding height was 0.4~ 0.8m. The main cause of flood was the absence of river bank in Mwanza and Shire rivers.

Villager said that the flood was rarely occurred before development of Illovo Estate because of the area was used a part of flood plain. But after development of Estate the flooding become frequent. On top of that, the bad condition of unimproved river channel and riverbed sediments make the problem worse. Villager said the solution for minimizing the flood hazard is channel rehabilitation of Mwanza river including installation of riverbank, dredging, and so on.

Item	Witnesses
Years	1996, 1997, 2015
Frequency	Every years
Duration	About 4 months (W.L repeated up and down)
Causes (Aspects)	Caused by overflow Mwanza and Shire rivers
Flooding Depth	0.4 ~ 0.8m


DZILONZO 1 Village

Dzilonzo 1 village locates the southeast end of ILLOVO Estate, west side of Shire river. According to the villager's witnesses, the flooding was overflowed from Shire river or from the canal located around Nchalo Estate. In the terms of flood frequency, the flood is had been repeated every year, and the most serious was that occurred in Decemberember 2014. The 2014 flood was continued for 6 months, from Decemberember 2014 to April 2015, and the flooding height was 0.4~ 0.8m. The main cause of flooding was the absent of river bank in Shire river side. Villagers said that it is essential to build river bank of Shire river and drain the canal of Nchalo Estate to minimize the flood hazard.

Item	Witnesses
Years	1997, 2015
Frequency	Every years
Duration	About 5months(W.L repeated up and down)
Causes (Aspects)	Caused by overflow Shire River and drainage canal of Illovo
Flooding Depth	0.2 ~ 1.0m

3. Zone A

This zone locates in the TA Katunga, TA Chapanaga, east area of TA Lundu. The Mwanza River flows through this zone, and bounded by Nkombedzi River on the south. The villages flooded are Thimu Vill.(east), Thanda Marchsh and northeast of Billiati. The other flooded area is the riverside of Mwanza River, where there is no village.

- **TIMBU Village**

Timbu Village locates the south of Mwanza River within very sinuous course. According to the villager's witnesses, the flooding was occurred by overflow of Mwanza River. In the terms of flood frequency, villagers said the flooding occurred in 1997, 2007, 2015, and the 2015 flood was the most serious events. During the 2015 flood, the flooding height was 0.6~ 1.4m. The main cause of flooding is the lack of conveyance capacity due to the sediment deposit in Mwanza River.

Item	Witnesses
Years	1997, 2007, 2015
Frequency	Every 8~10 years
Duration	About 1 months(W.L repeated up and down)
Causes (Aspects)	Caused by overflow Mwanza River
Flooding Depth	0.6 ~ 1.4 m


- **BILLIATI Village**

Billiati Village located at the east of Zone A-b, and Mwanza River flows toward to the east and passes the north of this village. On the other hand Nkombedzi Wa Frdya River flows toward the same direction at the south of this village. According to the villager's witnesses, the flooding was occurred by the overflow of Mwanza River or from Nkombedzi Wa Fodya River, but sometimes overflow of both river, in case of the 2015 Flood. In the terms of flood frequency, villager said the flood came 1997, 2015, and 2015 flood was the most serious. It said that 2015 flood lasted for 4 month, from December 2014 to March 2015, the flooding height was 0.4~ 1.3m.

Item	Witnesses
Years	1997, 2007, 2015
Frequency	Every 8~10 years
Duration	About 1 months(W.L repeated up and down)
Causes (Aspects)	Caused by overflow Mwanza River
Flooding Depth	0.4 ~ 1.3 m

4. Zone B

This zone locates in the TA Nchalo, TA Ngabu. in Chikwawa District. The is bounded by D139 road and Nkombedzi Wa Fodya River in the south. The villages near of Nkombedzi River and along the East of Shire River damaged by flooding. Major flooded areas are Nyamphota Vill., Zilonzo 2 Vill., Lunkhwe Vill., and Mphoza Dambo. The Alumenda Estate area was not damaged by 2015 flood.

- **NYAMPHOTA Village**

Nyamphota Village locates at the north end of Zone B-a and the south side of Nkombedzi River. According to the villager's witnesses, the flooding occurs usually from the northwest to southeast between Nkomgedzi Wa Fodya River. They said that the 2015 flood begun in January and lasted for 5 months until April 2015 and the flooding height was 0.3~ 1.0m. And the flooding status continued until the water infiltrated into ground and naturally dried out. The notable points is that the flooding occurred 3~ 4days after rain begun.

Item	Witnesses
Years	2015
Frequency	Every years(didn't damaged exclude 2015)
Duration	About 5 months(W.L repeated up and down)
Causes (Aspects)	By overflow Nkombedzi River
Flooding Depth	0.3 ~ 1.0 m

ZILONZO 2 Village

Zilonzo 2 Village locates in the north Zone B-a and southwest of Nkombedzi River. According to the villager's witnesses, the flood rushed from Namitalala River, the tributary of Nkombedzi Wa Fodya River, the north of this village. The flood had been damaged at 1997, 2007, 2015 and the most serious was 2015 flood. They said that the 2015 flood begun at December 2014 and continued for 6 months until April 2015 and the flooding height was 0.2~0.6m. And the flooding status continued until the water infiltrate into ground and naturally dried out. The time lag from the rain begun to flooding was about 2 days, they witnessed the flood caused by upstream flood discharge and river bed sediments. So the villager insisted the river dredging is essential to prevent flood disaster.

Item	Witnesses
Years	2015
Frequency	Every years(didn't damaged exclude 2015)
Duration	About 5 months(W.L repeated up and down)
Causes (Aspects)	By overflow Nkombedzi River
Flooding Depth	0.2 ~ 0.6 m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LUNKWE Village

Lunkwe Village locates around the cross point of M8 road and Phwadzi River. According to the villager's witnesses, the flood begun at the bridge, where concrete conduits are located. Because of the lack of conveyance capacity and debris the flood was overflowed and the bridge had been lost. The flood had been damaged in 1997, 2007, 2015 and the most serious was 2015 flood. They said that the 2015 flood continued for 2 weeks in January and the flooding height was 0.2 ~ 0.6m.

Item	Witnesses
Years	1997, 2007, 2015
Frequency	Every 8 ~ 10 years
Duration	About 2 weeks(W.L repeated up and down)
Causes (Aspects)	Overflow of Phwadzi River
Flooding Depth	0.2 ~ 0.6 m

5. Zone C

Most area of this zone locats in TA Ngabu in Chikawa. This area is bounded by Namikalango River in the North, and bounded by the Ngabu township and M8 road in the west. The flood damaged areas are located along the East side of Shire River. Major flooded areas are Machilika Vill., Kadyamba Vill. and others.

- **MACHILIKA Village**

Machilika Village locate belong to TA Ngabu. and nearby Shire River. According to the villager's witnesses, the flooding usually occurs from the water spreading from Shire river, occurred in 2010, 2015. They said that the 2015 flood begun at January continued for 4 months until April, the highest water level was occurred at March, and the flooding height was 0.2m. And the flooding status continued until the water soak into ground and dried out.

Item	Witnesses
Years	2010, 2015
Frequency	5 years
Duration	About 5 months(W.L repeated up and down)
Causes (Aspects)	Overflow of Shire River
Flooding Depth	0.2m

- **KADYAMBA Village**

Kadyamba Village belongs to TA Ngabu. and sited nearby Shire River in the east end of Zone C-a. According to the villager's witnesses, the flooding usually occurs from the water spread of Shire River and rising up rapidly. The flooding was occurred in 1997, 2015. They said that the 2015 flood begun at January continued for 3 months until March, the highest water level was occurred at March, and the flooding height was 0.2m. And the flooding status continued until the water soak into ground and dried out.

Item	Witnesses
Years	1997, 2015
Frequency	Unknown
Duration	About 3 months(W.L repeated up and down)
Causes (Aspects)	Overflow of Shire River
Flooding Depth	0.4~1.0m

6. Zone D

Most area of this zone locates in TA Ngabu in Chikawa. The Lalanje River and Namikalango River set the boundaries in the north and the Ngabu township and M8 road in the west. The flood damaged areas are located along the east side of Shire River. Major flooded area Mbenje 2, Kadyamba Vill. and others.

- **Mbenje 2 Village**

Mbenje 2 Village belongs to TA Ngabu. and located nearby Shire River. According to the villager's witnesses, the flooding was occurred from the overflow rushed from Lalanje river because of the bottleneck situation at the Junction of Shire river and Ruo river. In the terms of flood frequency, there were not many flood disaster, the flooded year were 1997, 2015. The 2015 flood was continued for 3 months, from December 2014 to February 2015, and the flooding height was 0.4~ 0.6m. When it was normal status of Shire River and Ruo River the flood in Lalanje River didn't occur even if there was heavy rain in Lalanje River basin. Villager said it is essential to channel improvements for Ruo River to minimize or prevent the flood hazard.

Item	Witnesses
Years	1997, 2015
Frequency	8 years
Duration	About 3 months(W.L repeated up and down)
Causes (Aspects)	Overflow of Lalanje River
Flooding Depth	0.4 ~ 0.6m

- **CHISAMUBA Village**

Chisamuba Village locates belong to TA Ngabu., near Shire River. According to the villager's witnesses, the flooding was occurred from the overflow of Shire River due to the bottleneck situation at the Junction of Shire river and Ruo River. In the terms of flood frequency was the same with previously Mbenje2 Vill., 1997, 2015. The period of 2015 flood was different from that of Mbenje2, and it was continued for 3 months, from December 2014 to February 2015, and the flooding height was very high up to 2.3m. Villager said, it is essential to channel improve the junction of Shire River and Ruo River to minimize or prevent the flood hazard.

Item	Witnesses
Years	1997, 2015
Frequency	8 years
Duration	About 3 months(W.L repeated up and down)
Causes (Aspects)	Overflow of Shire River
Flooding Depth	0.2 ~ 2.3m

Annex 5.
Checklist for Focus Group Discussions

Annex 5. Checklist for Focus Group Discussions

SHIRE VALLEY IRRIGATION PROJECT

Checklist

a) Preferred crops and varieties for rainfed and irrigated farming
b) Climate change and crop production
c) Crop Production constraints and how these can be addressed
d) Cropping technologies for adaptation to climate change
e) Cost of production for all the main crops
f) SWOT analysis of the area

SHIRE VALLEY IRRIGATION PROJECT

CHECKLIST FOR FOCUS GROUP DISCUSSIONS (FGDs)

FGDs to be conducted in the EPAs within the project sites. FGDs to include men and women

Name of district :____________________________________
Name of EPA :____________________________________
Name of village :____________________________________
TA :
Number of people in FGD: women= men=.............................
Date on interview :

Checklist for Focus Group Discussions

I. Crops and cropping systems

a) What are the crops and varieties grown under rainfed and irrigation?
b) For each crop mentioned above, what are the cropping systems?
c) When are these crops planted in rainfed and under irrigation?
d) What are the reasons for growing these crops?
e) For the main crops, describe what you do to improve soil fertility?
f) Estimated crop yields for the main crops. (assume if the crop is planted on 1acre plot or ask the farmers to indicate the plot area they are familiar with)
g) What are the top three preferred crops for rainfed and irrigation farming? [ask for men and women]
h) Are there other crops or varieties that you would like to grow but currently not grown?
    i. If yes, which crops or varieties?
    ii. Why are you interested in growing these crops or varieties?
    iii. Why not growing these crops or varieties at the moment?
i) Have you ever used minimum tillage on your farm? If so, on which crops?
j) For the main crops grown in this area under both rainfed and irrigation, what are the main constraints to increased crop yield?

II. IRRIGATION

a) Farmer experiences with irrigation farming?
b) Preferred crops for irrigation farming
c) What irrigation systems are used? Which ones are preferred by men and women?
d) Capacity building needs in irrigation farming.
e) What are the challenges faced with irrigation farming and what can be done to address the problems?

III. Crop –livestock integrated farming systems

- What livestock found in the area
- Reasons for keeping livestock
- Challenges/problems faced and how do they deal with the challenges
- Potential for crop-livestock integration in farming systems?

IV. Costs of crop production

a) For the main crops grown in this area: assume farmer planted on 1 acre, estimate the costs of production from land preparation to harvesting

- e.g. *clearing land, tilling land, ploughing (especially for rice), ridging, seed cost, planting, weeding, bunking, fertilizer cost, fertilizer application, pest management, harvesting, storage chemicals*

Activity	**Crop 1**		**Crop 2**	
	No. of days or quantity/ha	**Cost (MWK)/ha**	**No. of days or quantity/ha**	**Cost (MWK)/ha**
Land preparation – clearing land				
Tilling/ploughing				
Ridging			-	-
Seed cost				
Planting				
Transplanting	-	-		
Weeding				
Bunking			-	-
Fertiliser cost				
Fertilizer application				
Herbicides				
Pesticides				
Harvesting				
Total man days				

Annex 6.
Use of Other Water Resources

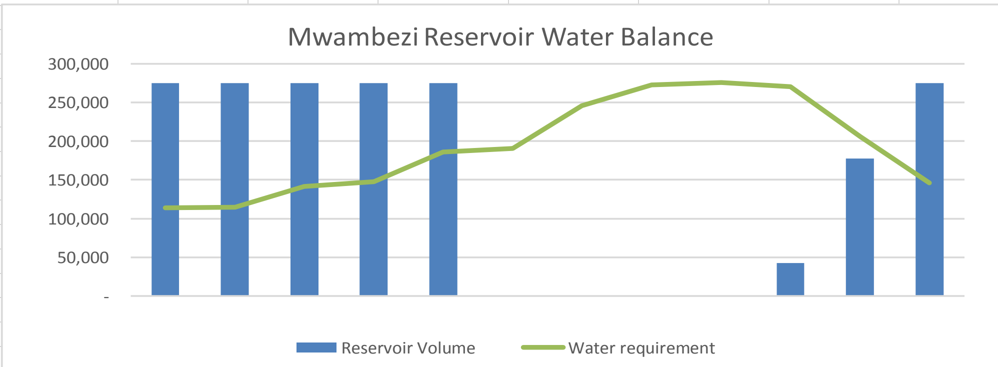
Annex 6. Use of Other Water Resources

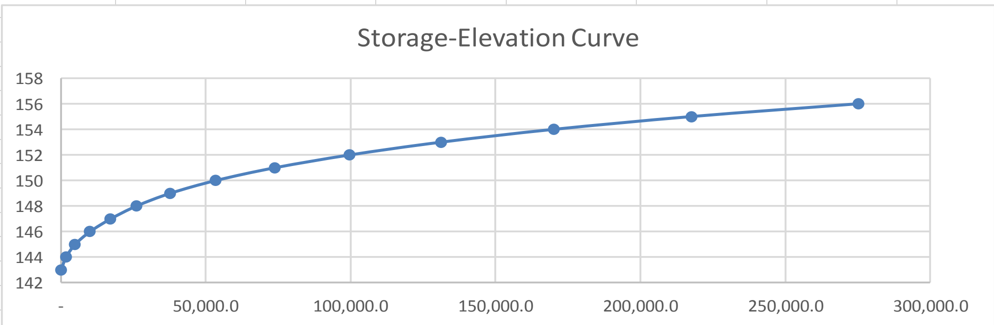
1. Calculation of Mwambezi Reservoir Water Balance

Mwambezi Reservoir Water Balance

	Catchment Area(㎢)		156.3		*Capacity(㎥)*		275,106
Division	Runoff			Dam			Remark
	Rainfall (mm)	(%)	㎥	Surface Area(㎡)	Evaporation (mm/day)	Water Loss(㎥)	
JAN	190.2	2.462%	731,932	63,287	5.80	7,965	
FEB	137.8	2.224%	478,967		5.50	6,822	
MAR	95.3	2.462%	366,735		5.50	7,553	
APR	91.3	2.383%	340,009		5.00	6,645	
MAY	13.5	2.462%	51,951		4.20	5,767	
JUN	13.3	0.000%	2		3.70	4,917	
JUL	17.8	0.000%	2		3.90	5,355	
AUG	6.9	0.000%	-		5.10	7,003	
SEP	7.1	0.000%	-		6.70	8,904	
OCT	13.9	2.462%	53,490		8.00	10,986	
NOV	50.6	2.383%	188,438		8.20	10,898	
DEC	124.3	2.462%	478,334		6.40	8,789	

Division	Reservoir Volume		Water requirement				Discharge
	Inflow	Storage (㎥)	Daily Demand ㎥/day/ha		Irrigation Area(ha)	㎥	㎥
JAN	723,967	275,106	40.9	31	90	114,111	334,750
FEB	472,145	275,106	45.6	28		114,912	82,127
MAR	359,182	275,106	50.7	31		141,453	-
APR	333,364	275,106	54.8	30		147,960	-
MAY	46,184	275,106	66.7	31		186,093	-
JUN	-	-	70.5	30		190,350	-
JUL	-	-	88	31		245,520	-
AUG	-	-	97.7	31		272,583	-
SEP	-	-	102.1	30		275,670	-
OCT	42,504	42,504	96.8	31		270,072	-
NOV	177,540	177,540	76.2	30		205,740	-
DEC	469,545	275,106	52.4	31		146,196	48,243



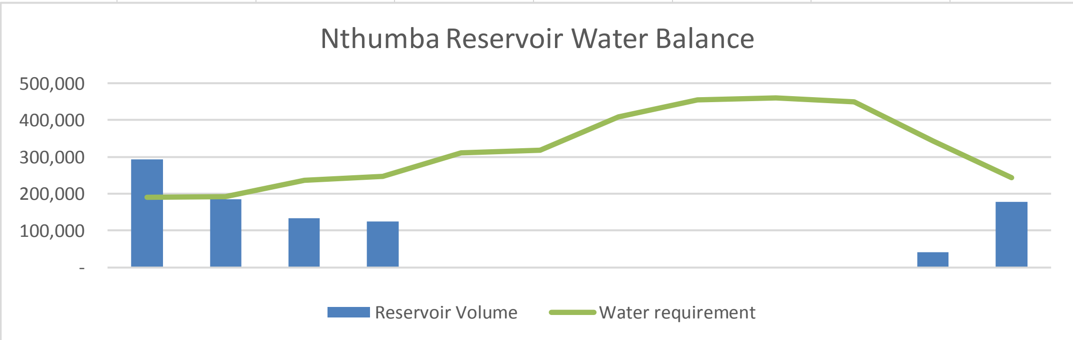


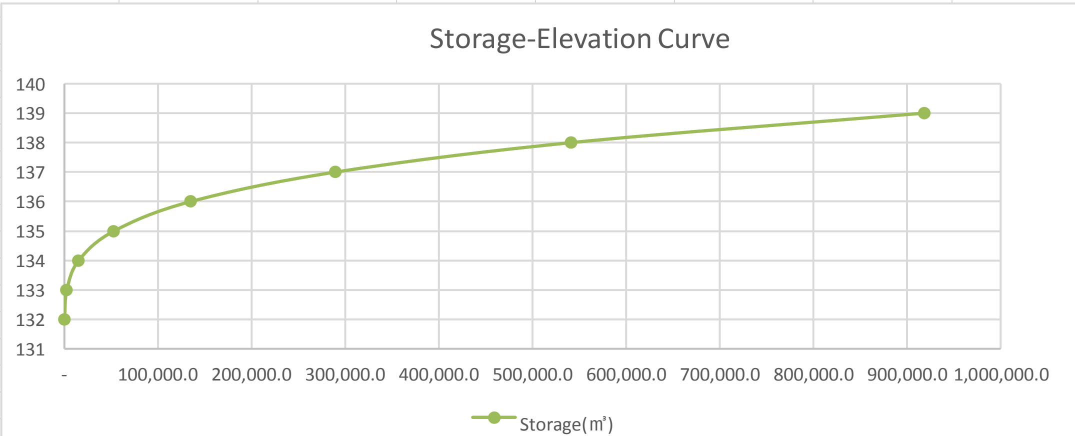
2. Calculation of Nthumba Reservoir Water Balance

Nthumba Reservoir Water Balance

	Catchment Area(㎢)		69.4		*Capacity(㎥)*		918,328
	Runoff			Dam			
Division	Rainfall			Surface	Evaporation	Water	Remark
	(mm)	(%)	㎥	Area(㎡)	(mm/day)	Loss(㎥)	
JAN	190.2	2.462%	324,991	253,200	5.80	31,867	
FEB	137.8	2.224%	212,670		5.50	27,294	
MAR	95.3	2.462%	162,837		5.50	30,219	
APR	91.3	2.383%	150,970		5.00	26,586	
MAY	13.5	2.462%	23,067		4.20	23,076	
JUN	13.3	0.000%	-		3.70	19,673	
JUL	17.8	0.000%	1		3.90	21,428	
AUG	6.9	0.000%	-		5.10	28,021	
SEP	7.1	0.000%	-		6.70	35,625	
OCT	13.9	2.462%	23,750		8.00	43,955	
NOV	50.6	2.383%	83,670		8.20	43,601	
DEC	124.3	2.462%	212,389		6.40	35,164	

	Reservoir Volume			Water requirement			Discharge
Division	Inflow	Storage	Daily Demand		Irrigation		
		(㎥)	㎥/day/ha		Area(ha)	㎥	㎥
JAN	293,124	293,124	40.9	31	150	190,185	-
FEB	185,376	185,376	45.6	28		191,520	-
MAR	132,618	132,618	50.7	31		235,755	-
APR	124,384	124,384	54.8	30		246,600	-
MAY	-	-	66.7	31		310,155	-
JUN	-	-	70.5	30		317,250	-
JUL	-	-	88	31		409,200	-
AUG	-	-	97.7	31		454,305	-
SEP	-	-	102.1	30		459,450	-
OCT	-	-	96.8	31		450,120	-
NOV	40,069	40,069	76.2	30		342,900	-
DEC	177,225	177,225	52.4	31		243,660	-



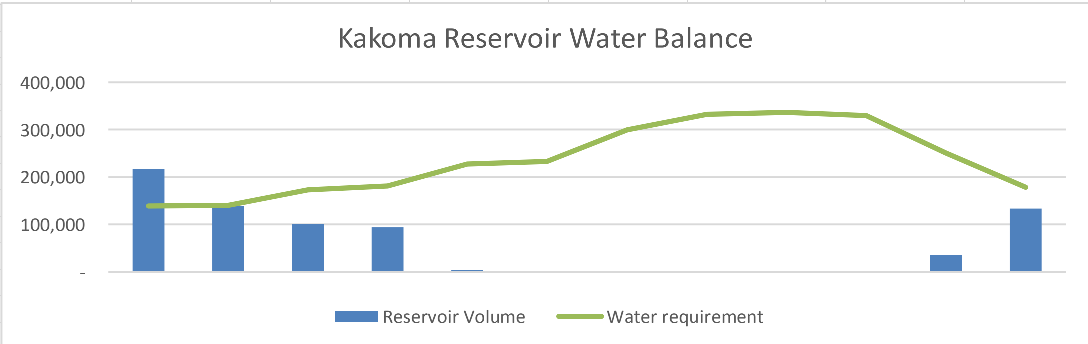


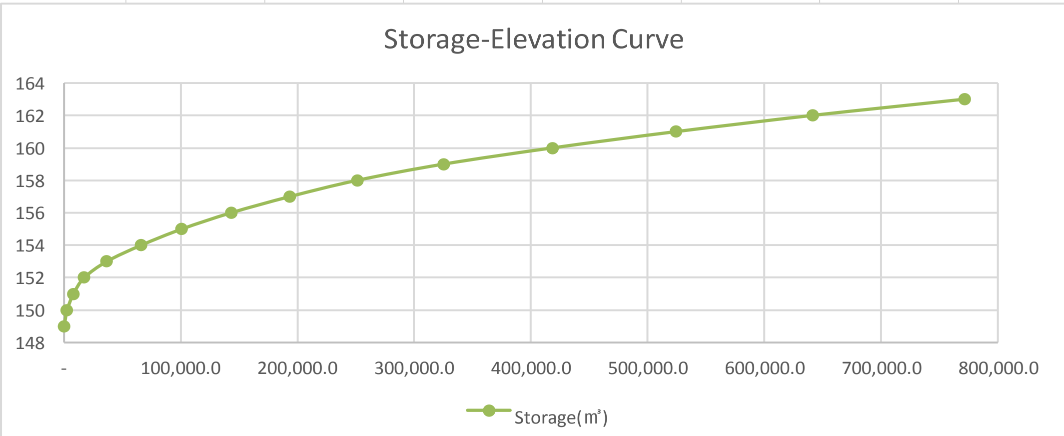
3. Calculation of Kakoma Reservoir Water Balance

Kakoma Reservoir Water Balance

	Catchment Area(㎢)		50.2		*Capacity(㎥)*		771,597
	Runoff			Dam			
Division	Rainfall			Surface	Evaporation	Water	Remark
	(mm)	(%)	㎥	Area(㎡)	(mm/day)	Loss(㎥)	
JAN	190.2	2.462%	235,080	142,500	5.80	17,935	
FEB	137.8	2.224%	153,833		5.50	15,361	
MAR	95.3	2.462%	117,787		5.50	17,007	
APR	91.3	2.383%	109,203		5.00	14,962	
MAY	13.5	2.462%	16,685		4.20	12,987	
JUN	13.3	0.000%	-		3.70	11,072	
JUL	17.8	0.000%	-		3.90	12,059	
AUG	6.9	0.000%	-		5.10	15,770	
SEP	7.1	0.000%	-		6.70	20,049	
OCT	13.9	2.462%	17,179		8.00	24,738	
NOV	50.6	2.383%	60,522		8.20	24,538	
DEC	124.3	2.462%	153,630		6.40	19,790	

	Reservoir Volume		Water requirement				Discharge
Division	Inflow	Storage	Daily Demand		Irrigation		
		(㎥)	㎥/day/ha		Area(ha)	㎥	㎥
JAN	217,145	217,145	40.9	31	110	139,469	-
FEB	138,472	138,472	45.6	28		140,448	-
MAR	100,780	100,780	50.7	31		172,887	-
APR	94,241	94,241	54.8	30		180,840	-
MAY	3,698	3,698	66.7	31		227,447	-
JUN	-	-	70.5	30		232,650	-
JUL	-	-	88	31		300,080	-
AUG	-	-	97.7	31		333,157	-
SEP	-	-	102.1	30		336,930	-
OCT	-	-	96.8	31		330,088	-
NOV	35,984	35,984	76.2	30		251,460	-
DEC	133,840	133,840	52.4	31		178,684	-



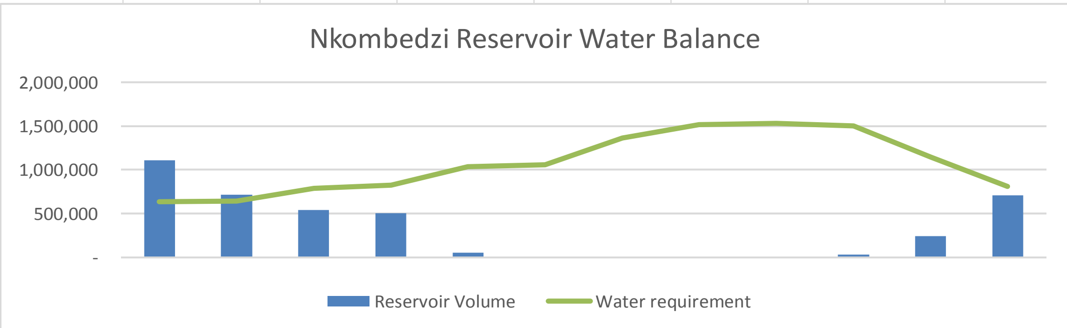


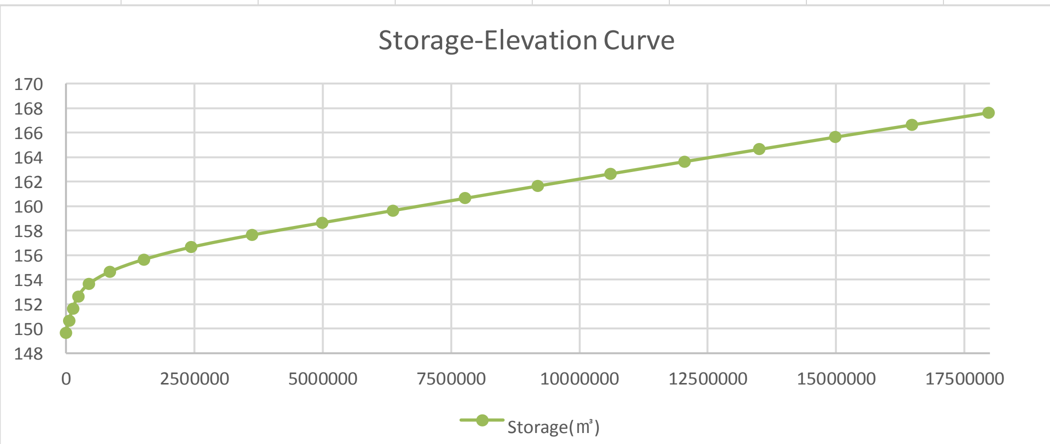
4. Calculation of Nkombedzi Reservoir Water Balance

Nkombedzi Reservoir Water Balance

	Catchment Area(㎢)		244.1		*Capacity(㎥)*		17,978,247
	Runoff			Dam			
Division	Rainfall			Surface	Evaporation	Water	Remark
	(mm)	(%)	㎥	Area(㎡)	(mm/day)	Loss(㎥)	
JAN	190.2	2.462%	1,143,088	294,300	5.80	37,040	
FEB	137.8	2.224%	748,022		5.50	31,725	
MAR	95.3	2.462%	572,746		5.50	35,124	
APR	91.3	2.383%	531,006		5.00	30,901	
MAY	13.5	2.462%	81,134		4.20	26,822	
JUN	13.3	0.000%	3		3.70	22,867	
JUL	17.8	0.000%	4		3.90	24,906	
AUG	6.9	0.000%	-		5.10	32,570	
SEP	7.1	0.000%	-		6.70	41,408	
OCT	13.9	2.462%	83,537		8.00	51,090	
NOV	50.6	2.383%	294,292		8.20	50,678	
DEC	124.3	2.462%	747,033		6.40	40,872	

	Reservoir Volume		Water requirement				Discharge
Division	Inflow	Storage	Daily Demand		Irrigation		
		(㎥)	㎥/day/ha		Area(ha)	㎥	㎥
JAN	1,106,048	1,106,048	40.9	31	500	633,950	-
FEB	716,297	716,297	45.6	28		638,400	-
MAR	537,622	537,622	50.7	31		785,850	-
APR	500,105	500,105	54.8	30		822,000	-
MAY	54,312	54,312	66.7	31		1,033,850	-
JUN	-	-	70.5	30		1,057,500	-
JUL	-	-	88	31		1,364,000	-
AUG	-	-	97.7	31		1,514,350	-
SEP	-	-	102.1	30		1,531,500	-
OCT	32,447	32,447	96.8	31		1,500,400	-
NOV	243,614	243,614	76.2	30		1,143,000	-
DEC	706,161	706,161	52.4	31		812,200	-



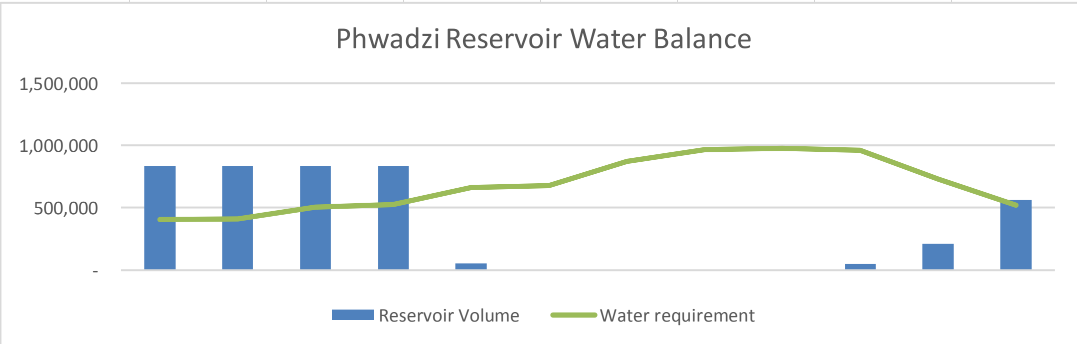


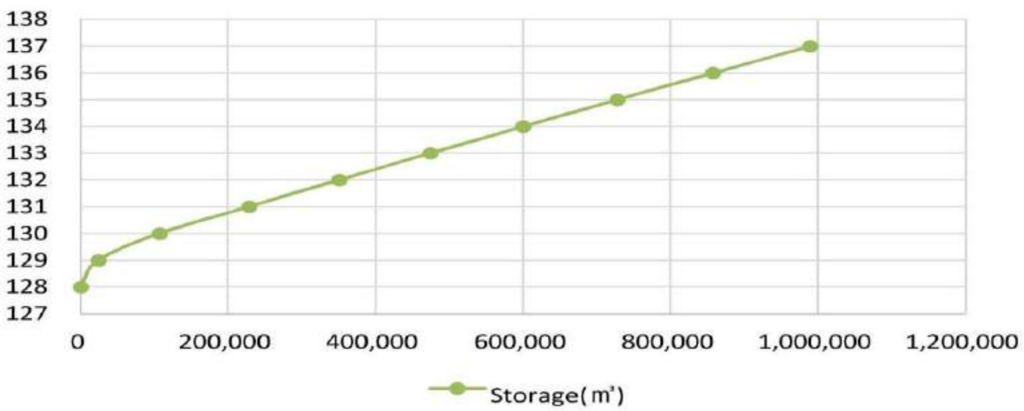
5. Calculation of Phwadzi Reservoir Water Balance

Phwadzi Reservoir Water Balance

	Catchment Area(㎢)		188.4		*Capacity(㎥)*		835,300
Division	Runoff			Dam			Remark
	Rainfall (mm)	(%)	㎥	Surface Area(㎡)	Evaporation (mm/day)	Water Loss(㎥)	
JAN	190.2	2.462%	882,252	94,200	5.80	11,856	
FEB	137.8	2.224%	577,335		5.50	10,154	
MAR	95.3	2.462%	442,053		5.50	11,242	
APR	91.3	2.383%	409,838		5.00	9,891	
MAY	13.5	2.462%	62,620		4.20	8,585	
JUN	13.3	0.000%	2		3.70	7,319	
JUL	17.8	0.000%	3		3.90	7,972	
AUG	6.9	0.000%	-		5.10	10,425	
SEP	7.1	0.000%	-		6.70	13,253	
OCT	13.9	2.462%	64,475		8.00	16,353	
NOV	50.6	2.383%	227,139		8.20	16,221	
DEC	124.3	2.462%	576,571		6.40	13,082	

Division	Reservoir Volume		Water requirement				Discharge
	Inflow	Storage (㎥)	Daily Demand ㎥/day/ha		Irrigation Area(ha)	㎥	㎥
JAN	870,396	835,300	40.9	31	320	405,728	-
FEB	567,181	835,300	45.6	28		408,576	-
MAR	430,811	835,300	50.7	31		502,944	-
APR	399,947	835,300	54.8	30		526,080	-
MAY	54,035	54,035	66.7	31		661,664	-
JUN	-	-	70.5	30		676,800	-
JUL	-	-	88	31		872,960	-
AUG	-	-	97.7	31		969,184	-
SEP	-	-	102.1	30		980,160	-
OCT	48,122	48,122	96.8	31		960,256	-
NOV	210,918	210,918	76.2	30		731,520	-
DEC	563,489	563,489	52.4	31		519,808	-





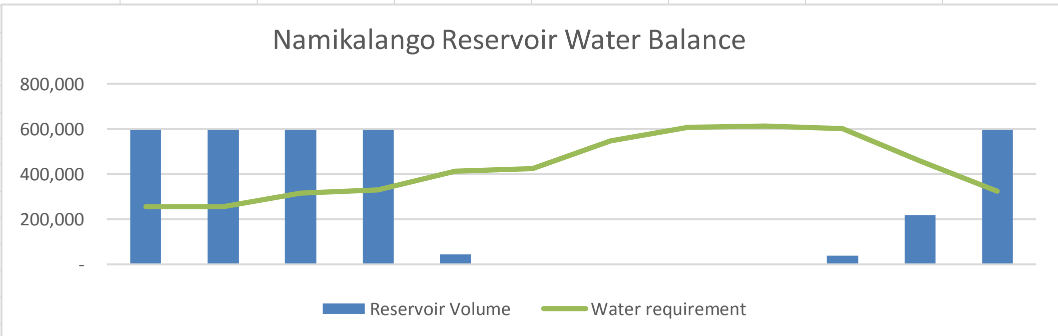
6. Calculation of Namikalango Reservoir Water Balance

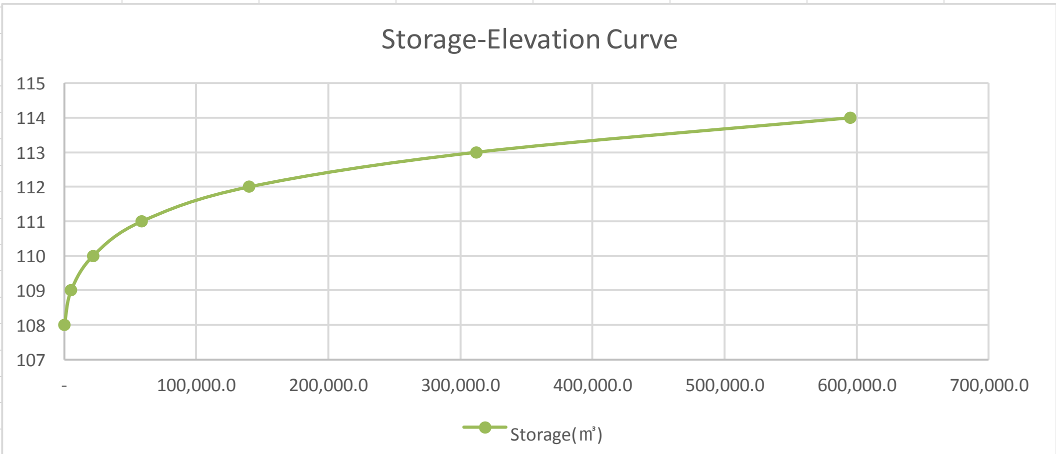
Namikalango Reservoir Water Balance

Catchment Area(㎢) 142.6 | *Capacity(㎥)* 595,407

Division	Runoff Rainfall (mm)	Runoff (%)	Runoff ㎥	Dam Surface Area(㎡)	Dam Evaporation (mm/day)	Water Loss(㎥)	Remark
JAN	190.2	2.462%	667,777	59,200	5.80	7,450	
FEB	137.8	2.224%	436,985		5.50	6,381	
MAR	95.3	2.462%	334,590		5.50	7,065	
APR	91.3	2.383%	310,206		5.00	6,216	
MAY	13.5	2.462%	47,397		4.20	5,395	
JUN	13.3	0.000%	1		3.70	4,599	
JUL	17.8	0.000%	2		3.90	5,010	
AUG	6.9	0.000%	-		5.10	6,551	
SEP	7.1	0.000%	-		6.70	8,329	
OCT	13.9	2.462%	48,801		8.00	10,277	
NOV	50.6	2.383%	227,139		8.20	10,194	
DEC	124.3	2.462%	436,407		6.40	8,221	

Division	Reservoir Volume Inflow	Reservoir Volume Storage (㎥)	Water requirement Daily Demand ㎥/day/ha		Irrigation Area(ha)	㎥	Discharge ㎥
JAN	660,327	595,407	40.9	31	200	253,580	-
FEB	430,604	595,407	45.6	28		255,360	-
MAR	327,525	595,407	50.7	31		314,340	-
APR	303,990	595,407	54.8	30		328,800	-
MAY	42,002	42,002	66.7	31		413,540	-
JUN	-	-	70.5	30		423,000	-
JUL	-	-	88	31		545,600	-
AUG	-	-	97.7	31		605,740	-
SEP	-	-	102.1	30		612,600	-
OCT	38,524	38,524	96.8	31		600,160	-
NOV	216,945	216,945	76.2	30		457,200	-
DEC	428,186	595,407	52.4	31		324,880	-



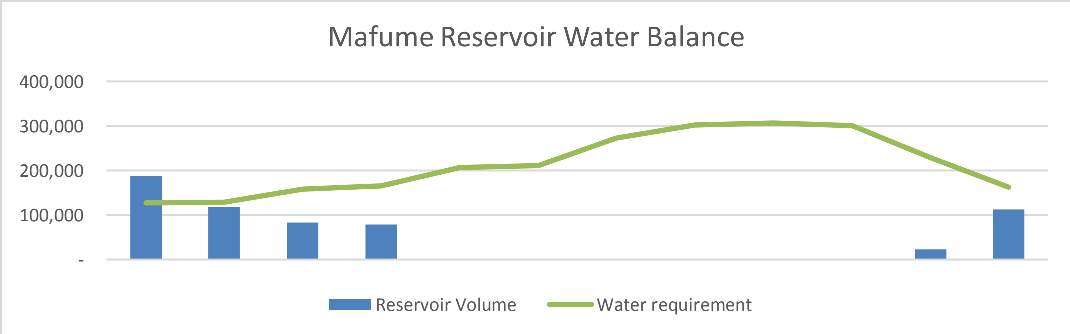


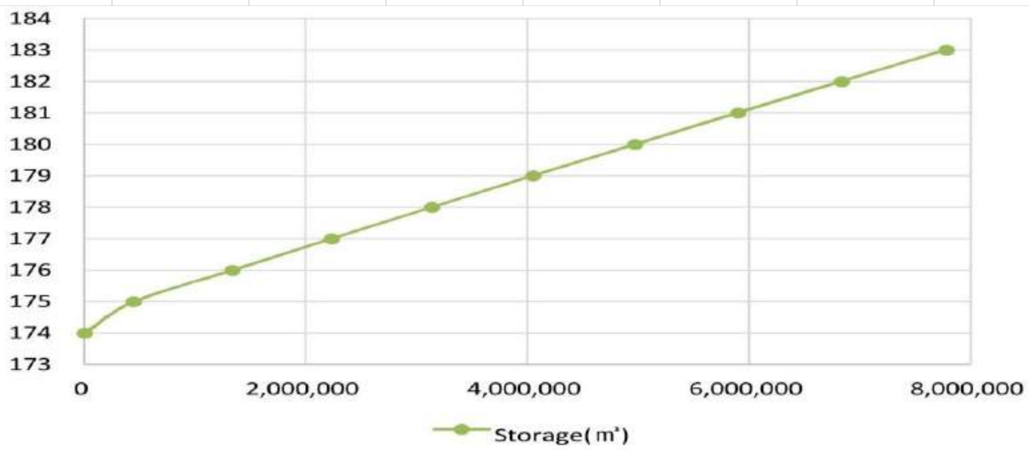
7. Calculation of Mafume Reservoir Water Balance

Mafume Reservoir Water Balance

	Catchment Area(㎢)		44.8		*Capacity(㎥)*		2,308,582
	Runoff			Dam			
Division	Rainfall			Surface	Evaporation	Water	Remark
	(mm)	(%)	㎥	Area(㎡)	(mm/day)	Loss(㎥)	
JAN	190.2	2.462%	209,792	184,300	5.80	23,195	
FEB	137.8	2.224%	137,285		5.50	19,867	
MAR	95.3	2.462%	105,116		5.50	21,996	
APR	91.3	2.383%	97,456		5.00	19,351	
MAY	13.5	2.462%	14,890		4.20	16,797	
JUN	13.3	0.000%	-		3.70	14,320	
JUL	17.8	0.000%	-		3.90	15,597	
AUG	6.9	0.000%	-		5.10	20,396	
SEP	7.1	0.000%	-		6.70	25,931	
OCT	13.9	2.462%	15,331		8.00	31,994	
NOV	50.6	2.383%	54,011		8.20	31,736	
DEC	124.3	2.462%	137,104		6.40	25,595	

	Reservoir Volume			Water requirement			Discharge
Division	Inflow	Storage	Daily Demand		Irrigation		
		(㎥)	㎥/day/ha		Area(ha)	㎥	㎥
JAN	186,597	186,597	40.9	31	100	126,790	-
FEB	117,418	117,418	45.6	28		127,680	-
MAR	83,120	83,120	50.7	31		157,170	-
APR	78,105	78,105	54.8	30		164,400	-
MAY	-	-	66.7	31		206,770	-
JUN	-	-	70.5	30		211,500	-
JUL	-	-	88	31		272,800	-
AUG	-	-	97.7	31		302,870	-
SEP	-	-	102.1	30		306,300	-
OCT	-	-	96.8	31		300,080	-
NOV	22,275	22,275	76.2	30		228,600	-
DEC	111,509	111,509	52.4	31		162,440	-



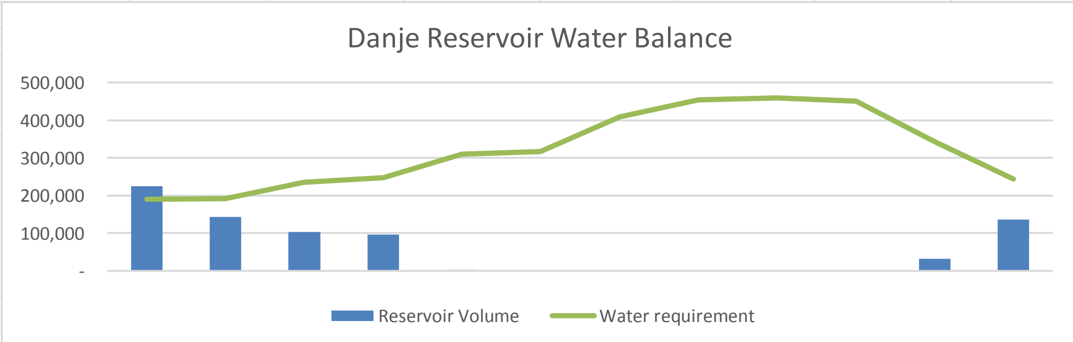


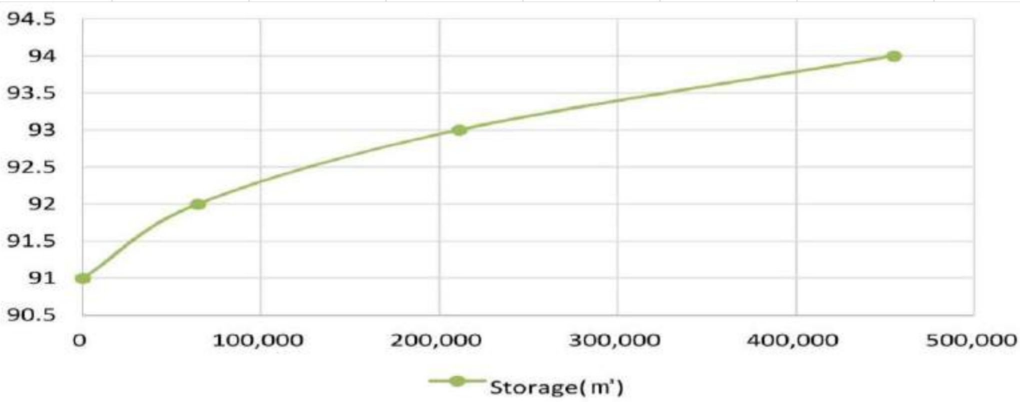
8. Calculation of Danje Reservoir Water Balance

Danje Reservoir Water Balance

	Catchment Area(㎢)		53		*Capacity(㎥)*		454,566
Division	Runoff			Dam			Remark
	Rainfall (mm)	(%)	㎥	Surface Area(㎡)	Evaporation (mm/day)	Water Loss(㎥)	
JAN	190.2	2.462%	248,192	184,300	5.80	23,195	
FEB	137.8	2.224%	162,413		5.50	19,867	
MAR	95.3	2.462%	124,356		5.50	21,996	
APR	91.3	2.383%	115,294		5.00	19,351	
MAY	13.5	2.462%	17,616		4.20	16,797	
JUN	13.3	0.000%	-		3.70	14,320	
JUL	17.8	0.000%	1		3.90	15,597	
AUG	6.9	0.000%	-		5.10	20,396	
SEP	7.1	0.000%	-		6.70	25,931	
OCT	13.9	2.462%	18,138		8.00	31,994	
NOV	50.6	2.383%	63,898		8.20	31,736	
DEC	124.3	2.462%	162,199		6.40	25,595	

Division	Reservoir Volume		Water requirement				Discharge
	Inflow	Storage (㎥)	Daily Demand ㎥/day/ha		Irrigation Area(ha)	㎥	㎥
JAN	224,997	224,997	40.9	31	150	190,185	-
FEB	142,546	142,546	45.6	28		191,520	-
MAR	102,360	102,360	50.7	31		235,755	-
APR	95,943	95,943	54.8	30		246,600	-
MAY	819	819	66.7	31		310,155	-
JUN	-	-	70.5	30		317,250	-
JUL	-	-	88	31		409,200	-
AUG	-	-	97.7	31		454,305	-
SEP	-	-	102.1	30		459,450	-
OCT	-	-	96.8	31		450,120	-
NOV	32,162	32,162	76.2	30		342,900	-
DEC	136,604	136,604	52.4	31		243,660	-



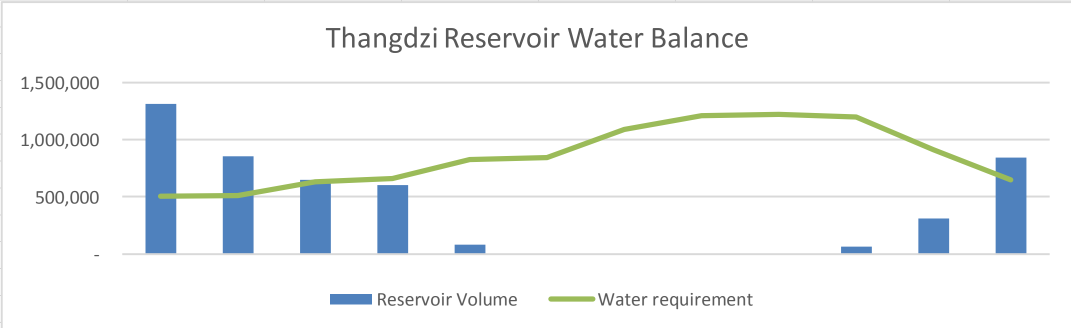


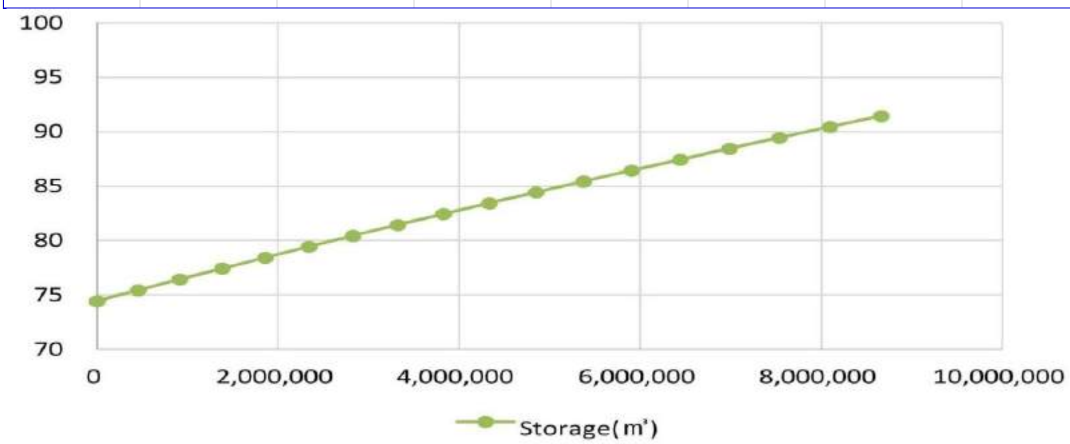
9. Calculation of Danje Reservoir Water Balance

Thangdzi Reservoir Water Balance

	Catchment Area(㎢)		285		Capacity(㎥)		8,658,287
	Runoff			Dam			
Division	Rainfall			Surface	Evaporation	Water	Remark
	(mm)	(%)	㎥	Area(㎡)	(mm/day)	Loss(㎥)	
JAN	190.2	2.462%	1,334,617	184,300	5.80	23,195	
FEB	137.8	2.224%	873,357		5.50	19,867	
MAR	95.3	2.462%	668,712		5.50	21,996	
APR	91.3	2.383%	619,978		5.00	19,351	
MAY	13.5	2.462%	94,728		4.20	16,797	
JUN	13.3	0.000%	3		3.70	14,320	
JUL	17.8	0.000%	5		3.90	15,597	
AUG	6.9	0.000%	-		5.10	20,396	
SEP	7.1	0.000%	-		6.70	25,931	
OCT	13.9	2.462%	97,535		8.00	31,994	
NOV	50.6	2.383%	343,602		8.20	31,736	
DEC	124.3	2.462%	872,202		6.40	25,595	

	Reservoir Volume		Water requirement				Discharge
Division	Inflow	Storage	Daily Demand		Irrigation		
		(㎥)	㎥/day/ha		Area(ha)	㎥	㎥
JAN	1,311,422	1,311,422	40.9	31	400	507,160	-
FEB	853,490	853,490	45.6	28		510,720	-
MAR	646,716	646,716	50.7	31		628,680	-
APR	600,627	600,627	54.8	30		657,600	-
MAY	77,931	77,931	66.7	31		827,080	-
JUN	-	-	70.5	30		846,000	-
JUL	-	-	88	31		1,091,200	-
AUG	-	-	97.7	31		1,211,480	-
SEP	-	-	102.1	30		1,225,200	-
OCT	65,541	65,541	96.8	31		1,200,320	-
NOV	311,866	311,866	76.2	30		914,400	-
DEC	846,607	846,607	52.4	31		649,760	-





Annex 7.
Calculation of FAO CROPWAT

Annex 7. Calculation of FAO CROPWAT

1. Climate and Rainfall Data Sets

Climate information to calculate the reference evapo-transpiration ETo is coming from Nchalo estate station and covers a 44 years' period from 1971 to 2014. Nchalo estate station data were the most reliable and easy to collect close to the study area. FAO stations were more distant and more to the south in Makanga and Ngabu. Moreover Kasinthula out growers are also using climate data coming from Nachalo estate. However no humidity data are available at Nchalo. These data have been obtained from FAO database CLIMWAT for Makanga (as in the Coyne et Bellier study).

ETo represents the rate of evapo-transpiration of an extended surface of an 80 to 150mm tall green grass cover, actively growing, completely shading ground and not short of water. The ETo calculation is based on sunshine hours, wind run, water vapour pressure deficit and net radiant energy and uses the Penman-Monteith method with the following values for Angstrom's coefficients: a=0.25 and b=0.5. The calculation of ETo has been done using FAO CROPWAT 8.0.

Figure : Climatic Data and ET_o Calculation

Monthly ETo Penman-Monteith - C:₩ProgramData₩CROPWAT₩data₩climate₩SVIP1009.PEM

Country MALAWI Station Nchalo

Altitude 73 m. Latitude 16.25 캎 Longitude 34.89 캪

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	23.2	33.4	76	122	6.9	21.3	4.93
February	22.9	33.1	80	119	7.3	21.6	4.82
March	22.4	32.9	77	134	7.7	21.0	4.74
April	20.6	31.6	70	152	8.0	19.3	4.45
May	17.5	30.0	62	133	8.0	17.1	3.85
June	15.2	28.1	59	129	7.5	15.4	3.35
July	14.9	27.8	55	147	7.4	15.8	3.57
August	16.0	30.1	47	172	8.7	19.3	4.70
September	18.8	33.2	41	211	9.0	22.1	6.23
October	21.2	34.9	43	241	9.2	24.0	7.20
November	22.7	35.6	49	221	9.1	24.6	7.11
December	23.2	34.3	66	158	7.4	22.1	5.58
Average	**19.9**	**32.1**	**60**	**162**	**8.0**	**20.3**	**5.04**

Average monthly rainfall data have been collected from Nchalo station. Effective rainfall is calculated using FAO CROPWAT 8.0 and is based on the FAO empirical formula (FAO/AGLW formula) to estimate dependable rainfall, the combined effect of dependable rainfall (80% probability of exceedance) and estimated losses due to Runoff and Deep Percolation.

For programming of irrigation water supply and management, rainfall data of normal, wet and dry years are used. An estimate of the respective rainfall data can be obtained by computing and plotting probabilities from the rainfall records. The different steps involved are:

i) Tabulate yearly rainfall totals for a given period.

ii) Arrange data in descending order of magnitude.

iii) Tabulate plotting position according to:

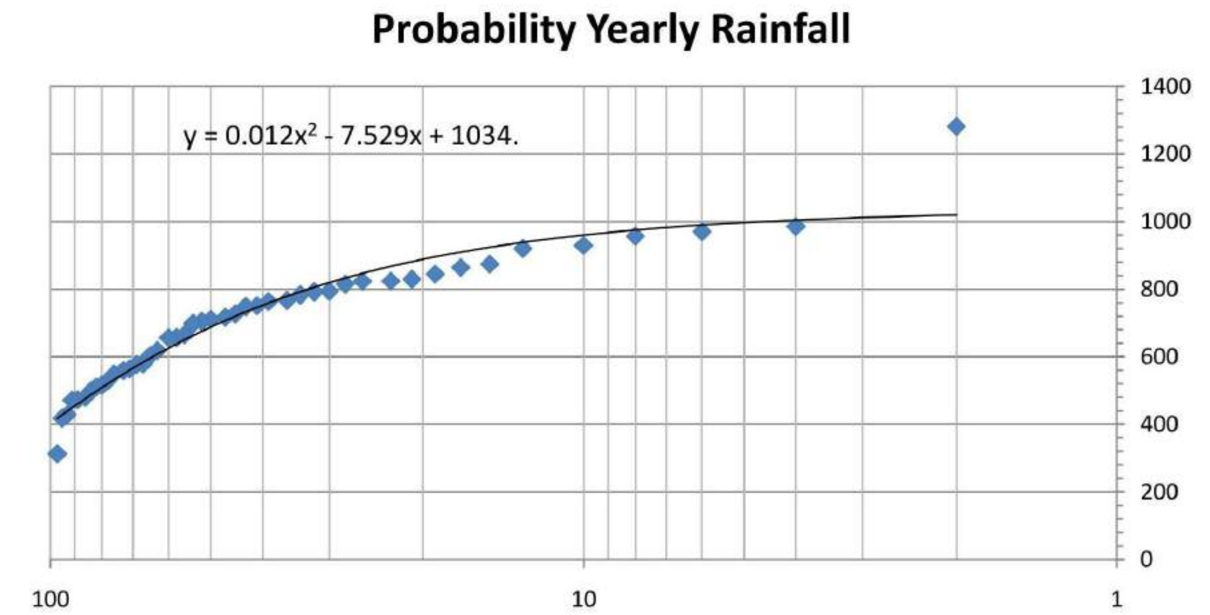
$$Fa = 100 * m / (N + 1)$$

where: N = number of records, m = rank number, Fa = plotting position

Table :Processing Rainfall records

Rank No	1	2	3	4	5	6	7	8	9
Rain(mm)	1281.9	985.9	970.9	957.3	929.7	920.5	874.1	864.4	844.7
Fa(%)	2	4	6	8	10	13	15	17	19
Rank No	10	11	12	13	14	15	16	17	18
Rain(mm)	829.6	824.5	823.6	815.2	794.3	792	783.1	767.2	764.1
Fa(%)	21	23	26	28	30	32	34	36	39
Rank No	19	20	21	22	23	24	25	26	27
Rain(mm)	751.6	748.3	726.7	716.9	711.4	704.9	698.4	665.9	657.8
Fa(%)	41	43	45	47	50	52	54	56	58
Rank No	28	29	30	31	32	33	34	35	36
Rain(mm)	656.6	619.3	604.1	579.1	577.2	564.8	559.2	550	529.9
Fa(%)	60	63	65	67	69	71	73	76	78
Rank No	37	38	39	40	41	42	43	44	45
Rain(mm)	516.3	511.3	499	480.6	473.1	472.4	429.4	418.8	313
Fa(%)	80	82	84	86	89	91	93	95	97

iv) Plot values on log-normal scale and obtain the logarithmic regression equation, as shown in the following figure.



v) Calculate year values at 20, 50 and 80% probability: - P80 = 510.00 mm
- P50 = 688.67 mm

- P20 = 889.15 mm

vi) Determine monthly values for the dry year according to the following relationship:

$$P_{i_{dry}} = P_{i_{av}} * \frac{P_{dry}}{P_{av}}$$

where: Pi av = average monthly rainfall for month i , Pi dry = monthly rainfall dry year for month i
Pav = average yearly rainfall , Pdry = yearly rainfall at 80% probability of exceedance

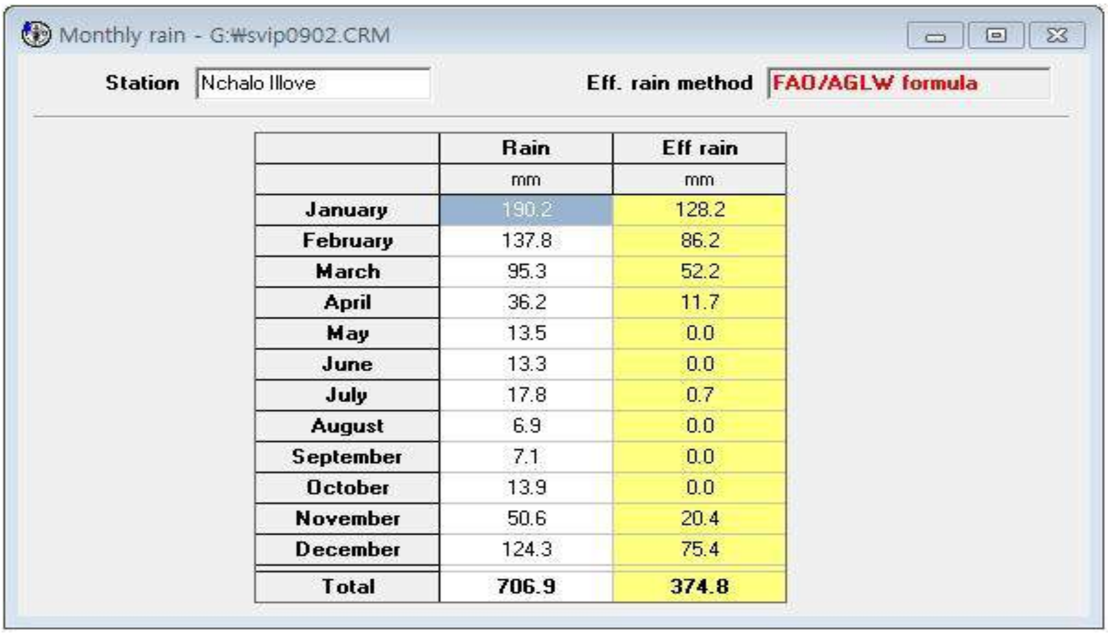
Similarly values for normal and wet years can be determined. Results are given in the following table.

Table : Processing Rainfall records

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average	190.2	137.8	95.3	36.2	13.5	13.3	17.8	6.9	7.1	13.9	50.7	124.3	706.8
Dry	137.2	99.4	68.8	26.1	9.7	9.6	12.8	5.0	5.1	10.0	36.6	89.7	510.1
Wet	239.3	173.4	119.9	45.5	17.0	16.7	22.4	8.7	8.9	17.5	63.8	156.4	889.4

Note that the effective rainfall estimation from FAO empirical calculation may be more optimistic than calculation done directly from the 80% dependable rainfall.

Figure : Rainfall and Effective Rainfall Data


Monthly rain - G:₩svip0902.CRM

Station: Nchalo Illove   Eff. rain method: FAO/AGLW formula

	Rain	Eff rain
	mm	mm
January	190.2	128.2
February	137.8	86.2
March	95.3	52.2
April	36.2	11.7
May	13.5	0.0
June	13.3	0.0
July	17.8	0.7
August	6.9	0.0
September	7.1	0.0
October	13.9	0.0
November	50.6	20.4
December	124.3	75.4
Total	706.9	374.8

2. Crop Pattern

Based on field survey results, five main crops, namely: sugarcane, maize, beans, cotton and tropical fruits were selected in calculating crop water requirements. Currently, sugarcane takes up 36% of the total project area. About 44% of the area is designated for sugarcane, considering the future expansion of Presscane and plantation development.

Sugarcane requires 12 months to mature and be ready for harvest; as such, the 44% area designated for sugarcane cannot be shared with other crops. With the completion of SVIP, it is envisaged that some of the crops that were only grown during the rainy season could also be grown during dry season under irrigation. Thus, SVIP will enable farmers to do double-cropping.

Table : Areas of Crops for the Water Requirement Estimation

<table>
<tr><th rowspan="2">Total</th><th colspan="3">Sugarcane</th><th colspan="3">Cotton, Maize, Bean, Tropical Fruits</th></tr>
<tr><th>Total</th><th>Existing</th><th>New</th><th>Total</th><th>Existing</th><th>New</th></tr>
<tr><td>43,370 ha</td><td>19,083 ha</td><td>15,757 ha</td><td>3,326 ha</td><td>24,287 ha</td><td></td><td>24,287 ha</td></tr>
<tr><td>100%</td><td colspan="3">44%</td><td colspan="3">56%</td></tr>
</table>

Figure : Cropping Pattern

<table>
<tr><td>Division</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td></td></tr>
<tr><td>Pattern Ⅰ</td><td colspan="12">Surgacane(44%)</td><td></td></tr>
<tr><td rowspan="3">Pattern Ⅱ</td><td colspan="6">Cotton(30%)</td><td colspan="6">Dry Bean(20%)</td><td></td></tr>
<tr><td></td><td colspan="5">Soya Beans(20%)</td><td colspan="5">Maize(30%)</td><td></td><td></td></tr>
<tr><td colspan="12">Tropical Fruits(6%)</td><td></td></tr>
</table>

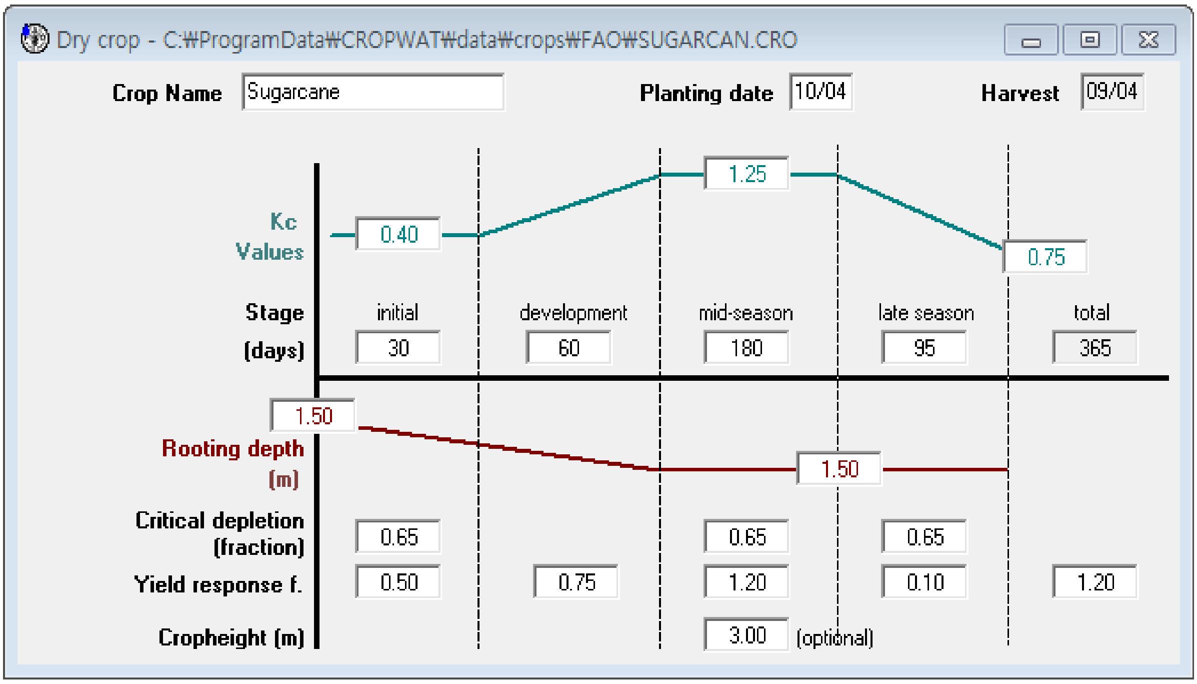
3. Crop Coefficient

Water demand is calculated depending of the crop evapo-transpiration ETc that is determined by multiplying ETo by a crop coefficient Kc. Kc varies predominately with the specific crop characteristics and crop stage.

The Kc for each crop has been defined by referencing to FAO guidelines (FAO – Guidelines for computing crop water requirements – paper 56 / chapter 6 and FAO website – Water Development and Management Unit – Crop information) and Nchalo climate data.

A. Sugarcane Varies

Kc for sugarcane varies in average from 0.40 (initial stage) to 1.25 (mid-season stage) and 0.75 (end stage). No irrigation is applied during the last month dry-off prior harvesting. Sugarcane is considered with a 12 months growth time and 9 crop sugarcane pattern (9 ratoon from mid-April to mid-December).

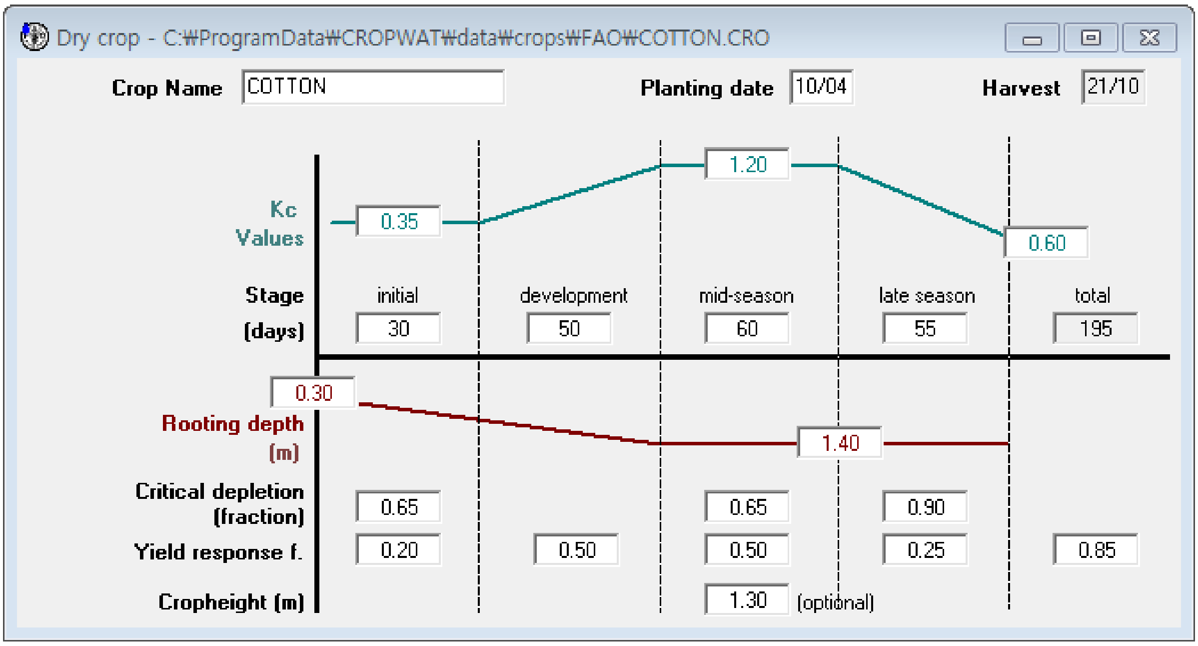


Calculation from FAO - 1998 - Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage paper 56 /

Month	Kc mid - Mid-season	Kc mid - Planting date	Kc end	Kc ini
January	1.09	1.15	0.59	0.42
February	1.09	1.18	0.59	0.42
March	1.10	1.19	0.60	0.42
April	1.12	1.19	0.62	0.42
May	1.12	1.19	0.62	0.50
June	1.12	1.17	0.62	0.50
July	1.14	1.15	0.64	0.50
August	1.18	1.13	0.68	0.42
September	1.23	1.11	0.73	0.35
October	1.26	1.11	0.76	0.35
November	1.22	1.11	0.72	0.35
December	1.14	1.13	0.64	0.42
Average	**1.15**	**1.15**	**0.65**	**0.42**

B. Cotton Varies

Kc for cotton varies from 0.35 (initial stage) to 1.20 (mid-season stage) and 0.60 (end stage). Cotton is considered with a 6.5 months growth stage. It is to notice that this growth time could be reduced.

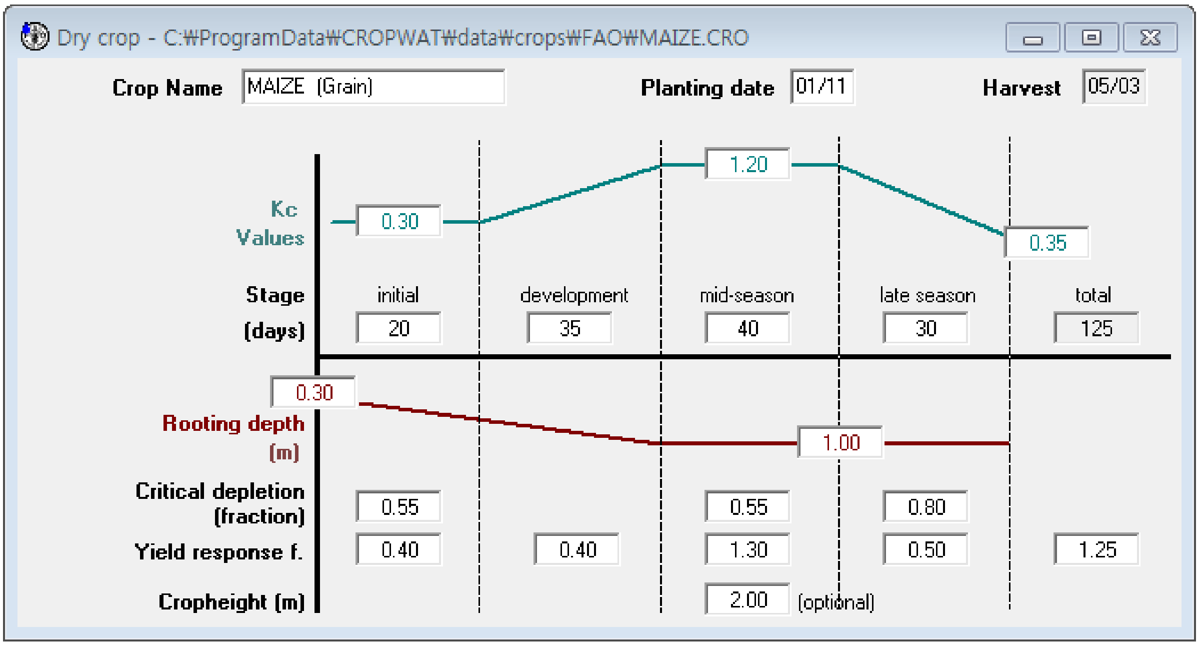


Calculation from FAO - 1998 - Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage paper 56 /

Month	Kc mid - Mid-season	Kc mid - Planting date	Kc end	Kc ini
January	1.05	1.06	0.58	0.42
February	1.05	1.07	0.57	0.42
March	1.06	1.07	0.58	0.42
April	1.07	1.08	0.60	0.42
May	1.07	1.10	0.60	0.50
June	1.08	1.14	0.60	0.50
July	1.09	1.17	0.61	0.50
August	1.12	1.16	0.65	0.42
September	1.16	1.12	0.69	0.35
October	1.18	1.07	0.71	0.35
November	1.15	1.05	0.67	0.35
December	1.09	1.05	0.61	0.42
Average	**1.10**	**1.10**	**0.62**	**0.42**

C. Maize Varies

Kc for maize varies from 0.30 (initial stage) to 1.20 (mid-season stage) and 0.35 (end stage). Maize is considered with a 4.2 months growth stage. It is to notice that this growth time could be reduced.

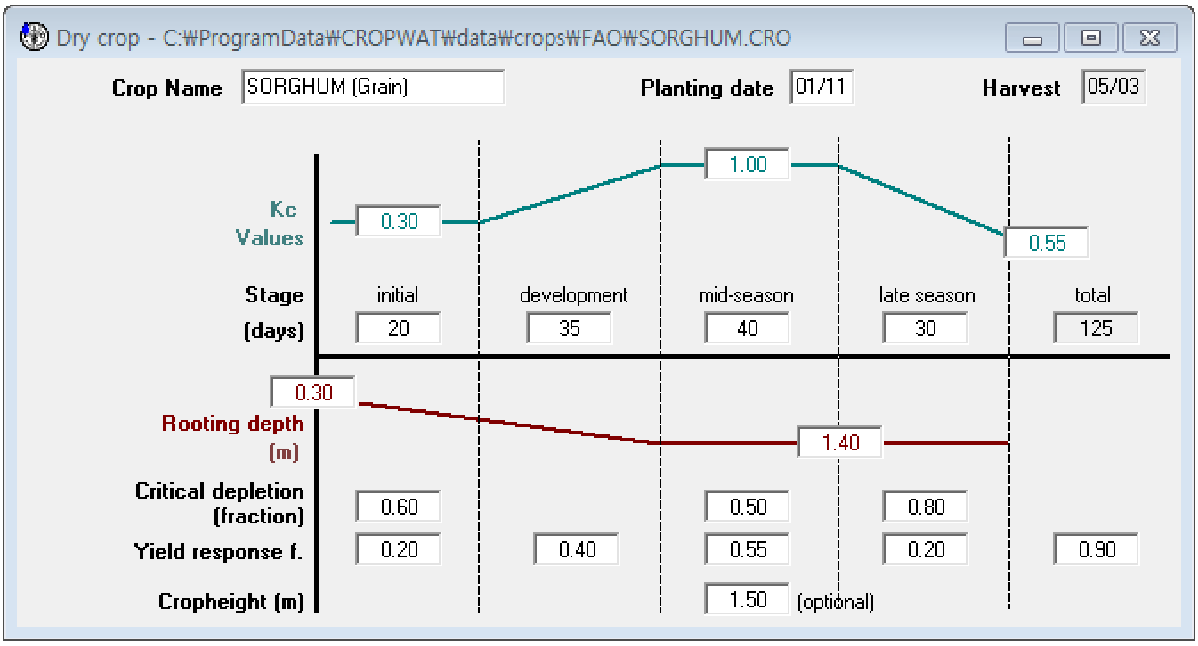


Calculation from FAO - 1998 - Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage paper 56 /

Month	Kc mid - Mid-season	Kc mid - Planting date	Kc end	Kc ini
January	1.06	1.07	0.91	0.42
February	1.06	1.08	0.91	0.42
March	1.07	1.09	0.92	0.42
April	1.08	1.09	0.93	0.42
May	1.08	1.12	0.93	0.50
June	1.09	1.16	0.94	0.50
July	1.10	1.20	0.95	0.50
August	1.14	1.19	0.99	0.42
September	1.18	1.14	1.03	0.35
October	1.21	1.08	1.06	0.35
November	1.17	1.06	1.02	0.35
December	1.10	1.06	0.95	0.42
Average	**1.11**	**1.11**	**0.96**	**0.42**

D. Sorghum Varies

Kc for sorghum varies from 0.30 (initial stage) to 1.00 (mid-season stage) and 0.55 (end stage). Sorghum is considered with a 4.2 months growth stage.

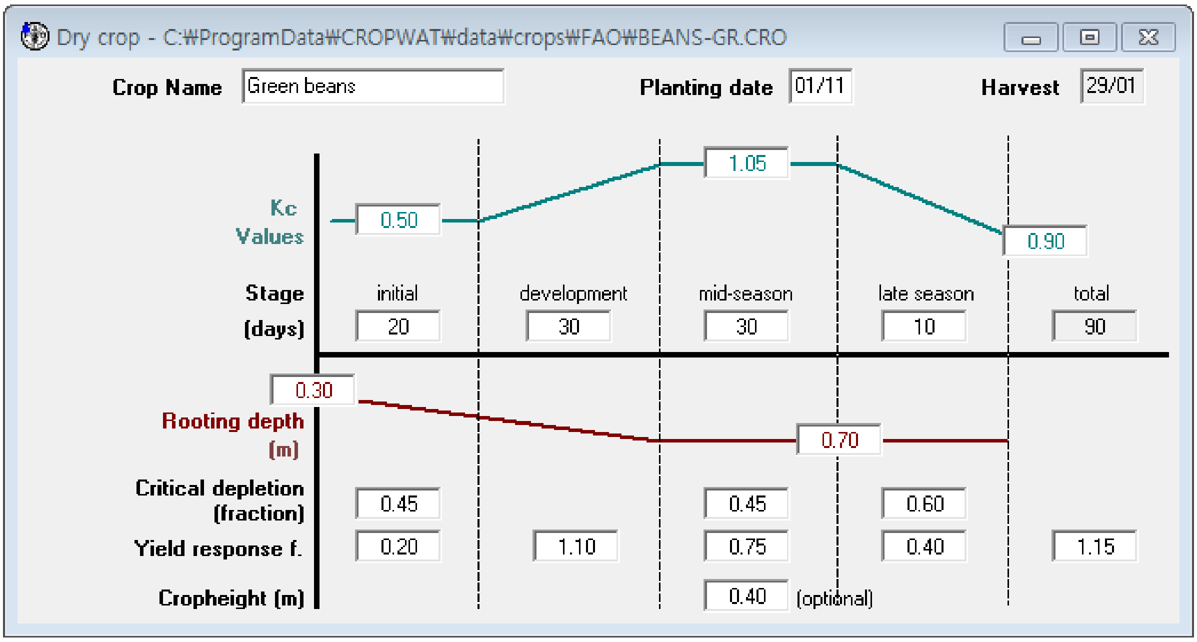


Calculation from FAO - 1998 - Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage paper 56 /

Month	Kc mid - Mid-season	Kc mid - Planting date	Kc end	Kc ini
January	0.97	0.98	0.42	0.42
February	0.97	0.99	0.42	0.42
March	0.98	0.99	0.43	0.42
April	0.99	1.00	0.44	0.42
May	0.99	1.03	0.44	0.50
June	1.00	1.06	0.45	0.50
July	1.01	1.10	0.46	0.50
August	1.04	1.09	0.49	0.42
September	1.09	1.04	0.54	0.35
October	1.11	0.99	0.56	0.35
November	1.07	0.97	0.52	0.35
December	1.01	0.97	0.46	0.42
Average	**1.02**	**1.02**	**0.47**	**0.42**

E. Beans Varies

Kc for beans varies from 0.50 (initial stage) to 1.05 (mid-season stage) and 0.90 (end stage). Beans are considered with a 3 months growth stage

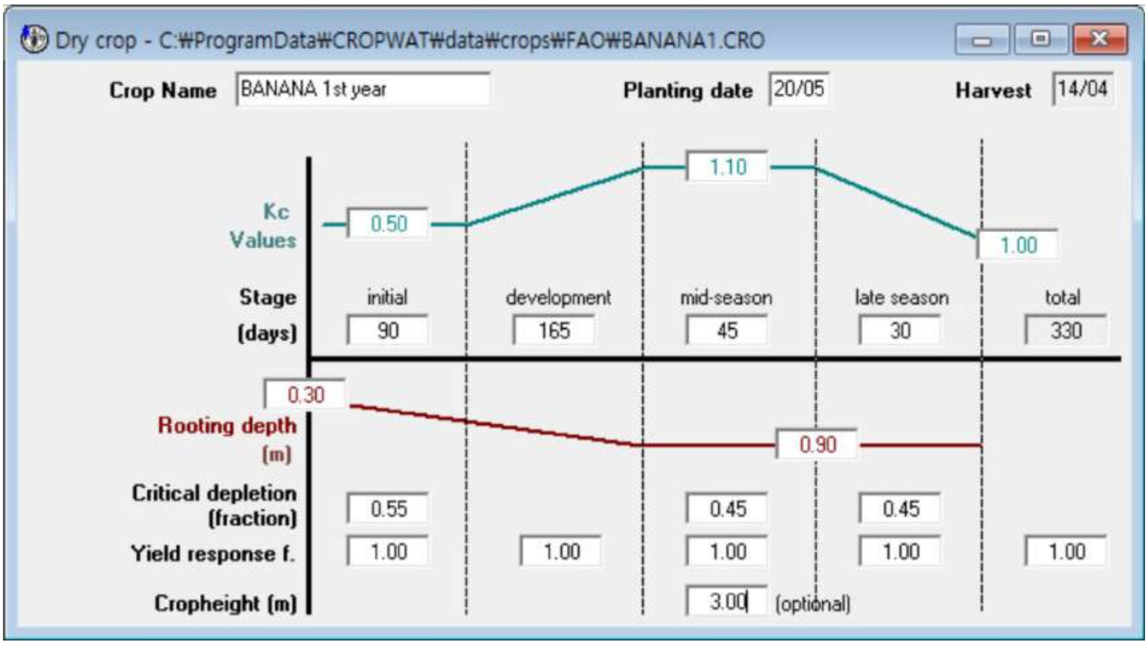


Calculation from FAO - 1998 - Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage paper 56 /

Month	Kc mid - Mid-season	Kc mid - Planting date	Kc end	Kc ini
January	1.06	1.07	0.27	0.42
February	1.06	1.07	0.26	0.42
March	1.06	1.07	0.27	0.42
April	1.07	1.08	0.28	0.42
May	1.07	1.10	0.28	0.50
June	1.08	1.12	0.28	0.50
July	1.08	1.15	0.29	0.50
August	1.11	1.14	0.31	0.42
September	1.14	1.11	0.34	0.35
October	1.15	1.07	0.35	0.35
November	1.13	1.06	0.33	0.35
December	1.09	1.06	0.29	0.42
Average	**1.09**	**1.09**	**0.30**	**0.42**

F. Topical fruit Varies

Kc for banana varies from 0.50 (initial stage) to 1.10 (mid-season stage) and 1.00 (end stage). Banana is considered with a 12 months growth stage.



Calculation from FAO - 1998 - Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage paper 56 /

Month	Kc mid - Mid-season	Kc mid - Planting date	Kc end	Kc ini
January	1.01	1.02	0.92	0.42
February	1.01	1.02	0.91	0.42
March	1.01	1.02	0.92	0.42
April	1.02	1.03	0.93	0.42
May	1.02	1.05	0.93	0.50
June	1.03	1.07	0.93	0.50
July	1.03	1.10	0.94	0.50
August	1.06	1.09	0.96	0.42
September	1.09	1.06	0.99	0.35
October	1.10	1.02	1.00	0.35
November	1.08	1.01	0.98	0.35
December	1.04	1.01	0.94	0.42
Average	1.04	1.04	0.95	0.42

Annex 8.
Water Requirement Analysis

Annex 8. Water Requirement Analysis

NO	Division	unit	1972	~	2014
①	Mean Temp	°c			
②	Humidity	%			
③	Wind	km/day			
④	Mean Rainfall	mm			
⑤	Crop Coefficint Kc=				
⑥	ETo	mm/day			
⑦	Mean ET : ⑥ X JAN manth days	mm			
⑧	Consumptive use : ⑦*⑤	mm			
⑨	Land Preparation	mm			
⑩	Percolation Losses	mm			
⑪	Nurser Requirement	mm			
1)	Total Water Demand : ⑧+⑨+⑩+⑪	mm			
2)	Effective Rain	mm			
3)	Net Irrig. Requirement : 1)+2)	mm			
4)	Application Efficiency Ea				
5)	Distribution Efficency Ed				
6)	Fild Irrig. Requirement : 3)/4)*5)	mm			
7)	Conveyance Efficiency Ec				
8)	Gross Irrigation Req. : 6) / 7)	mm			
9)	Gross Daily Irrigation Req.	mm/day			
10)	Month Demand	㎥/m/ha			
11)	Daily Demand	㎥/day/ha			

- Water Demand : Jan.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.1	27.3	27.9	27.1	27.3	27.6	28.9	28.4	28.2	29.3	28
②	74	82	69	74	80	76	69	82	80	75	62
③	103	93.3	141.6	33.2	174.5	121	113	126.5	171.6	109.8	64.8
④	416.1	157.2	294.1	152.7	109.5	66.0	275.1	79.2	103.4	64.8	135.5
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	3.4	3.45	4.07	3.29	4.12	4.16	3.72	3.53	4.18	4.23	3.64
⑦	105.4	107	126.2	102	127.7	129	115.3	109.4	129.6	131.1	112.8
⑧	90.64	91.98	108.5	87.71	109.8	110.9	99.18	94.11	111.4	112.8	97.04
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	90.64	91.98	108.5	87.71	109.8	110.9	99.18	94.11	111.4	112.8	97.04
2)	308.9	101.8	211.3	98.2	63.6	29.6	196.1	39.4	58.7	28.9	84.4
3)	0	0	0	0	46.24	81.31	0	54.71	52.74	83.87	12.64
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	0	0	80.03	140.7	0	94.69	91.28	145.2	21.88
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	0	0	0	88.92	156.4	0	105.2	101.4	161.3	24.31
9)	0	0	0	0	2.868	5.044	0	3.394	3.272	5.203	0.784
10)	0	0	0	0	889.2	1564	0	1052	1014	1613	243.1
11)	0	0	0	0	28.68	50.44	0	33.94	32.72	52.03	7.842

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.6	28.1	27.4	27.7	27.4	27.7	28.9	28.2	28.2	28.8	29.8
②	84	60	49	77	87	73	64	57	79	70	52
③	96.6	167.7	159.7	125.8	134.2	137	132.1	157.1	116.6	150.2	176.6
④	154.6	59.7	31.2	215.5	226.8	174.8	133.9	185.9	165.3	77.6	48.4
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	3.39	4.99	4.97	3.5	3.2	3.92	4.34	4.51	3.47	4.2	5.32
⑦	105.1	154.7	154.1	108.5	99.2	121.5	134.5	139.8	107.6	130.2	164.9
⑧	90.38	133	132.5	93.31	85.31	104.5	115.7	120.2	92.51	112	141.8
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	90.38	133	132.5	93.31	85.31	104.5	115.7	120.2	92.51	112	141.8
2)	99.7	25.8	8.7	148.4	157.4	115.8	83.1	124.7	108.2	38.1	19
3)	0	107.2	123.8	0	0	0	32.6	0	0	73.87	122.8
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	185.6	214.3	0	0	0	56.43	0	0	127.9	212.6
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	206.2	238.1	0	0	0	62.7	0	0	142.1	236.2
9)	0	6.652	7.68	0	0	0	2.023	0	0	4.582	7.62
10)	0	2062	2381	0	0	0	627	0	0	1421	2362
11)	0	66.52	76.8	0	0	0	20.23	0	0	45.82	76.2

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	27.6	28.6	28.1	28.7	28.3	28.8	27.9	29	27.7	28.6	28.4
②	81	66	78	80	84	87	88	74	84	82	84
③	134.1	176.5	139.1	129.9	117.9	128.3	113.9	169.1	126.8	159.5	127.7
④	418.3	193.6	161	187.4	124.9	154.2	299.6	108.4	164.9	202.6	316.2
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	3.48	4.45	4.55	4.94	4.53	4.19	3.83	5.16	4.41	5.37	4.68
⑦	107.9	138	141.1	153.1	140.4	129.9	118.7	160	136.7	166.5	145.1
⑧	92.78	118.6	121.3	131.7	120.8	111.7	102.1	137.6	117.6	143.2	124.8
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	92.78	118.6	121.3	131.7	120.8	111.7	102.1	137.6	117.6	143.2	124.8
2)	310.6	130.9	104.8	125.9	75.9	99.4	215.7	62.7	107.9	138.1	229
3)	0	0	16.5	5.8	44.87	12.31	0	74.87	9.671	5.064	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	28.56	10.04	77.66	21.3	0	116.6	15.06	7.888	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	0	31.74	11.15	86.28	23.66	0	129.6	16.74	8.765	0
9)	0	0	1.024	0.36	2.783	0.763	0	4.18	0.54	0.283	0
10)	0	0	317.4	111.5	862.8	236.6	0	1296	167.4	87.65	0
11)	0	0	10.24	3.598	27.83	7.633	0	41.8	5.399	2.827	0

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	29.6	28.8	29.2	27.4	28.2	28.5	29.9	28.2	27.2	27.7	28.2	26.4
②	77	87	86	89	87	85	52	84	77	82	84	78
③	149.9	126.3	103.6	99.3	89.2	78.8	146.6	81.7	69.7	74.7	74.1	58.8
④	169.5	85.2	212.8	571.5	218.6	115.9	50.8	116	353.2	272.3	159.5	576
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	5.08	4.82	4.93	3.8	4.63	4.55	6.19	4.39	4.24	4.17	4.61	3.8
⑦	157.5	149.4	152.8	117.8	143.5	141.1	191.9	136.1	131.4	129.3	142.9	117.8
⑧	135.4	128.5	131.4	101.3	123.4	121.3	165	117	113	111.2	122.9	101.3
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	135.4	128.5	131.4	101.3	123.4	121.3	165	117	113	111.2	122.9	101.3
2)	111.6	44.2	146.2	433.2	150.9	68.7	20.5	68.8	258.6	193.8	103.6	436.8
3)	23.83	84.3	0	0	0	52.6	144.5	48.24	0	0	19.3	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	37.12	131.3	0	0	0	81.94	225.1	75.14	0	0	33.41	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	41.25	145.9	0	0	0	91.04	250.1	83.48	0	0	37.12	0
9)	1.331	4.706	0	0	0	2.937	8.069	2.693	0	0	1.197	0
10)	412.5	1459	0	0	0	910.4	2501	834.8	0	0	371.2	0
11)	13.31	47.06	0	0	0	29.37	80.69	26.93	0	0	11.97	0

- Water Demand : Feb.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.1	27.3	27.9	27.1	27.3	27.6	28.9	28.4	28.2	29.3	28.0
②	75	73	71	83	81	70	82	80	81	71	83
③	141	122.6	129.4	3.4	116.4	110.5	155.2	125.2	167.5	87.1	68.4
④	20.8	109.5	25.7	157.2	176.8	164.3	25.7	153.4	120.4	98	167.5
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	4.43	4.03	4.71	3.08	4.01	4.13	4.37	4.25	4.38	4.23	3.68
⑦	124	112.8	131.9	86.24	112.3	115.6	122.4	119	122.6	118.4	103
⑧	106.7	97.04	113.4	74.17	96.56	99.45	105.2	102.3	105.5	101.9	88.61
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	106.7	97.04	113.4	74.17	96.56	99.45	105.2	102.3	105.5	101.9	88.61
2)	2.5	63.6	5.4	101.8	117.4	107.4	5.4	98.7	72.3	54.4	110
3)	104.2	33.44	108	0	0	0	99.83	3.64	33.17	47.46	0
4)	0.6	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	180.3	57.88	186.9	0	0	0	172.8	6.3	57.41	82.14	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	200.3	64.31	207.7	0	0	0	192	7	63.79	91.26	0
9)	7.155	2.297	7.418	0	0	0	6.856	0.25	2.278	3.259	0
10)	2003	643.1	2077	0	0	0	1920	70	637.9	912.6	0
11)	71.55	22.97	74.18	0	0	0	68.56	2.5	22.78	32.59	0

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.6	28.1	27.4	27.2	27.6	28.9	27.5	26.8	28.4	28.8	29.6
②	86	76	80	85	81	68	83	88	83	78	42
③	107.1	136.6	128.9	122.2	131.1	168.8	140.7	77.5	127.8	117.2	187.4
④	196.9	120.6	261.2	194.6	179	38	253.4	226	45.3	93.1	8.6
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	3.61	4.25	3.83	3.61	3.98	5.1	3.71	3.39	4.05	4.02	6.29
⑦	101.1	119	107.2	101.1	111.4	142.8	103.9	94.92	113.4	112.6	176.1
⑧	86.93	102.3	92.23	86.93	95.84	122.8	89.34	81.63	97.52	96.8	151.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	86.93	102.3	92.23	86.93	95.84	122.8	89.34	81.63	97.52	96.8	151.5
2)	133.5	72.5	185	131.7	119.2	12.8	178.7	156.8	17.2	50.5	0
3)	0	29.84	0	0	0	110	0	0	80.32	46.3	151.5
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	51.64	0	0	0	190.4	0	0	139	80.13	262.1
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	57.38	0	0	0	211.5	0	0	154.5	89.04	291.3
9)	0	2.049	0	0	0	7.555	0	0	5.517	3.18	10.4
10)	0	573.8	0	0	0	2115	0	0	1545	890.4	2913
11)	0	20.49	0	0	0	75.55	0	0	55.17	31.8	104

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	28.4	27.4	28.6	28.1	26.4	28.4	27.7	28.5	27.4	27.8	28.8
②	81	61	70	87	91	87	89	86	91	82	86
③	142.2	156.8	160	139.9	120.2	137.4	107.2	105.9	99.6	134.4	128.1
④	37.3	44.7	100.8	214.2	347.7	113.4	265.8	208.8	280.2	169	135.2
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	4.15	4.86	5.73	4.45	3.41	4.82	3.61	4.66	3.52	5.03	4.9
⑦	116.2	136.1	160.4	124.6	95.48	135	101.1	130.5	98.56	140.8	137.2
⑧	99.93	117	138	107.2	82.11	116.1	86.93	112.2	84.76	121.1	118
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	99.93	117	138	107.2	82.11	116.1	86.93	112.2	84.76	121.1	118
2)	12.4	16.8	56.6	147.4	254.2	66.7	188.6	143	200.2	111.2	84.2
3)	87.53	100.2	81.38	0	0	49.37	0	0	0	9.922	33.79
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	151.5	173.5	140.8	0	0	85.44	0	0	0	17.17	58.48
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	168.3	192.7	156.5	0	0	94.93	0	0	0	19.08	64.98
9)	6.012	6.884	5.589	0	0	3.39	0	0	0	0.681	2.321
10)	1683	1927	1565	0	0	949.3	0	0	0	190.8	649.8
11)	60.12	68.84	55.89	0	0	33.9	0	0	0	6.815	23.21

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	28.2	28.9	29.2	28.5	27.8	28.2	28.6	27.6	28.6	27	27.3	27.2
②	85	84	87	86	83	86	76	79	82	84	88	79
③	120.7	142.3	111.8	96	114.1	121.4	108.8	141.9	93.7	79.7	67.8	37.9
④	102.9	61.9	93.3	119.9	40.7	72.6	148.7	55.8	94.9	219.4	147.4	292.1
⑤	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
⑥	4.57	5.29	5.23	4.81	5.17	4.91	4.51	5.22	5.11	4.45	4.08	4.46
⑦	128	148.1	146.4	134.7	144.8	137.5	126.3	146.2	143.1	124.6	114.2	124.9
⑧	110	127.4	125.9	115.8	124.5	118.2	108.6	125.7	123	107.2	98.25	107.4
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	110	127.4	125.9	115.8	124.5	118.2	108.6	125.7	123	107.2	98.25	107.4
2)	58.3	27.1	50.6	71.9	14.4	34.1	95	23.5	51.9	151.5	93.9	209.7
3)	51.75	100.3	75.34	43.92	110.1	84.13	13.6	102.2	71.15	0	4.346	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	89.56	173.6	130.4	76.02	190.5	145.6	23.54	176.9	123.1	0	7.522	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	99.51	192.8	144.9	84.47	211.7	161.8	26.15	196.5	136.8	0	8.358	0
9)	3.554	6.887	5.174	3.017	7.561	5.778	0.934	7.019	4.886	0	0.299	0
10)	995.1	1928	1449	844.7	2117	1618	261.5	1965	1368	0	83.58	0
11)	35.54	68.87	51.74	30.17	75.61	57.78	9.341	70.19	48.86	0	2.985	0

- Water Demand : Mar.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.1	27.3	27.8	26.9	26.5	27.2	27.3	27.6	27.1	27.1	27.1
②	73	82	79	78	76	62	82	80	78	65	62
③	138.9	116.5	131.5	5.3	155.9	140.7	136.8	128.3	142.7	109.7	76.5
④	49.8	18.5	67.1	247.4	32.8	105.4	177.0	184.9	230.6	118.4	111.9
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	4.81	4.62	4.85	3.68	4.78	4.61	4.19	4.2	4.13	4.71	4.36
⑦	149.1	143.2	150.4	114.1	148.2	142.9	129.9	130.2	128	146	135.2
⑧	119.3	114.6	120.3	91.26	118.5	114.3	103.9	104.2	102.4	116.8	108.1
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	119.3	114.6	120.3	91.26	118.5	114.3	103.9	104.2	102.4	116.8	108.1
2)	19.9	1.1	30.3	173.9	9.7	60.3	117.6	123.9	160.5	70.7	65.5
3)	99.39	113.5	89.98	0	108.8	54.03	0	0	0	46.11	42.63
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	172	196.4	155.7	0	188.4	93.51	0	0	0	79.8	73.78
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	191.1	218.2	173	0	209.3	103.9	0	0	0	88.67	81.97
9)	6.165	7.039	5.582	0	6.752	3.351	0	0	0	2.86	2.644
10)	1911	2182	1730	0	2093	1039	0	0	0	886.7	819.7
11)	61.65	70.39	55.82	0	67.52	33.51	0	0	0	28.6	26.44

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.4	27.8	27	27.6	27.1	28.9	27.8	26.8	27.6	27.9	29.3
②	79	65	78	83	70	51	85	86	55	85	52
③	129.3	124.9	159.8	133	137	168.5	137.1	136.9	160	160.7	172.1
④	57.1	80.4	109.5	119.8	79.6	21.0	111.2	219.4	53.4	93.1	45.2
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	4.75	5.2	4.38	4.09	4.64	6.01	4.12	3.91	5.66	4.4	5.91
⑦	147.3	161.2	135.8	126.8	143.8	186.3	127.7	121.2	175.5	136.4	183.2
⑧	117.8	129	108.6	101.4	115.1	149	102.2	96.97	140.4	109.1	146.6
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	117.8	129	108.6	101.4	115.1	149	102.2	96.97	140.4	109.1	146.6
2)	24.3	40.3	63.6	71.8	39.7	2.6	65	151.5	22	50.5	17.1
3)	93.5	88.66	45.02	29.63	75.37	146.4	37.18	0	118.4	58.62	129.5
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	161.8	153.4	77.92	51.28	130.4	253.5	64.34	0	204.9	101.5	224.1
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	179.8	170.5	86.58	56.98	144.9	281.6	71.49	0	227.6	112.7	249
9)	5.8	5.5	2.793	1.838	4.676	9.085	2.306	0	7.343	3.636	8.031
10)	1798	1705	865.8	569.8	1449	2816	714.9	0	2276	1127	2490
11)	58	55	27.93	18.38	46.76	90.85	23.06	0	73.43	36.36	80.31

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	27.7	27	28.7	26.6	28.3	29	27.7	28.1	27.8	28.1	28.4
②	71	60	56	87	87	85	88	87	89	71	87
③	163	155.3	219.3	136.8	173.4	171.1	175.4	111.9	138.1	151.5	134.4
④	35.0	69.0	26.3	146.3	42.6	23.9	129.6	149.7	135.9	69.1	104.4
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	5.04	5.17	6.59	3.99	4.69	5	4.38	4.57	4.19	5.09	4.42
⑦	156.2	160.3	204.3	123.7	145.4	155	135.8	141.7	129.9	157.8	137
⑧	125	128.2	163.4	98.95	116.3	124	108.6	113.3	103.9	126.2	109.6
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	125	128.2	163.4	98.95	116.3	124	108.6	113.3	103.9	126.2	109.6
2)	11	31.4	5.8	93	15.6	4.3	79.7	95.8	84.7	31.5	59.5
3)	114	96.82	157.6	5.952	100.7	119.7	28.92	17.54	19.21	94.73	50.12
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	197.3	167.6	272.8	10.3	174.3	207.2	50.06	30.35	33.25	164	86.74
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	219.2	186.2	303.1	11.45	193.7	230.2	55.62	33.72	36.94	182.2	96.37
9)	7.071	6.006	9.778	0.369	6.247	7.425	1.794	1.088	1.192	5.876	3.109
10)	2192	1862	3031	114.5	1937	2302	556.2	337.2	369.4	1822	963.7
11)	70.71	60.06	97.78	3.692	62.47	74.25	17.94	10.88	11.92	58.76	31.09

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	28.4	28.5	28	27.9	26.6	27.1	28.1	28.2	28	27.2	27.8	27
②	87	76	90	85	84	85	84	78	69	77	85	78
③	130.1	140	122.9	110.4	118.8	125	135.1	140.9	112	139.5	92.5	28.9
④	69.3	10.2	258.0	136.0	58.0	88.4	58.6	88.9	131.2	63.0	171.3	216.8
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	4.41	5.32	3.95	4.59	4.52	4.49	4.49	4.77	4.93	5.05	4.8	4.06
⑦	136.7	164.9	122.5	142.3	140.1	139.2	139.2	147.9	152.8	156.6	148.8	125.9
⑧	109.4	131.9	97.96	113.8	112.1	111.4	111.4	118.3	122.3	125.2	119	100.7
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	109.4	131.9	97.96	113.8	112.1	111.4	111.4	118.3	122.3	125.2	119	100.7
2)	31.6	0	182.4	84.8	24.8	46.7	25.2	47.1	81	0	5.2	42.8
3)	77.77	131.9	0	29.03	87.3	64.65	86.15	71.2	41.26	125.2	113.8	57.89
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	134.6	228.3	0	50.25	151.1	111.9	149.1	123.2	71.42	216.8	197	100.2
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	149.5	253.7	0	55.83	167.9	124.3	165.7	136.9	79.35	240.8	218.9	111.3
9)	4.824	8.184	0	1.801	5.415	4.011	5.344	4.416	2.56	7.769	7.062	3.591
10)	1495	2537	0	558.3	1679	1243	1657	1369	793.5	2408	2189	1113
11)	48.24	81.84	0	18.01	54.15	40.11	53.44	44.16	25.6	77.69	70.62	35.91

- Water Demand : Apr.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	26.5	26.5	25	24.6	25.7	25.3	25.8	26	25.7	26.3	24.8
②	71	73	72	77	77	69	77	75	80	69	49
③	147.9	135	134.3	110.3	108.1	107.1	172.7	127.2	150.8	98.7	83.1
④	3.6	51.6	41.4	62.0	15.0	48.5	5.6	67.6	21.3	30.0	77.8
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	5.41	4.96	4.49	4.3	4.66	4.19	5	4.42	4.86	4.89	4.6
⑦	162.3	148.8	134.7	129	139.8	125.7	150	132.6	145.8	146.7	138
⑧	120.1	110.1	99.68	95.46	103.5	93.02	111	98.12	107.9	108.6	102.1
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	120.1	110.1	99.68	95.46	103.5	93.02	111	98.12	107.9	108.6	102.1
2)	0	21	14.8	27.2	0	19.1	0	30.6	2.8	8	38.2
3)	120.1	89.11	84.88	68.26	103.5	73.92	111	67.52	105.1	100.6	63.92
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	207.9	154.2	146.9	118.1	179	127.9	192.1	116.9	181.9	174	110.6
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	231	171.4	163.2	131.3	198.9	142.1	213.5	129.8	202.1	193.4	122.9
9)	7.699	5.712	5.441	4.375	6.631	4.738	7.115	4.328	6.736	6.446	4.097
10)	2310	1714	1632	1313	1989	1421	2135	1298	2021	1934	1229
11)	76.99	57.12	54.41	43.75	66.31	47.38	71.15	43.28	67.36	64.46	40.97

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	25.6	27.6	25	25.1	26.2	26.3	27.7	26	27.4	25.3	27.5
②	61	48	58	76	61	45	77	84	47	74	46
③	136.2	166.6	166	141.7	139.9	181.9	416.3	80.9	157.6	148.6	190.9
④	35.2	0.0	12.6	63.0	61.8	210.7	31.8	53.7	12.8	55.1	1.0
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	5.12	6.06	5.28	4.5	4.83	6.13	5.9	4.37	6.04	4.72	6.52
⑦	153.6	181.8	158.4	135	144.9	183.9	177	131.1	181.2	141.6	195.6
⑧	113.7	134.5	117.2	99.9	107.2	136.1	131	97.01	134.1	104.8	144.7
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	113.7	134.5	117.2	99.9	107.2	136.1	131	97.01	134.1	104.8	144.7
2)	11.1	0	0	27.8	27.1	144.6	9.1	22.2	0	23.1	0
3)	102.6	134.5	117.2	72.1	80.13	0	121.9	74.81	134.1	81.68	144.7
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	177.5	232.8	202.9	124.8	138.7	0	210.9	129.5	232.1	141.4	250.5
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	197.2	258.7	225.4	138.6	154.1	0	234.4	143.9	257.9	157.1	278.3
9)	6.574	8.624	7.514	4.622	5.136	0	7.813	4.796	8.595	5.236	9.278
10)	1972	2587	2254	1386	1541	0	2344	1439	2579	1571	2783
11)	65.74	86.24	75.14	46.22	51.36	0	78.13	47.96	85.95	52.36	92.78

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	28	26.4	26.7	25.4	25.6	26.8	25.9	26.5	26.3	26.1	26
②	52	63	49	82	84	73	85	87	85	58	83
③	171.6	211.3	183.5	195.6	228.2	180.6	148.9	168.3	152.2	160.8	151.2
④	5.6	1.8	17.1	25.7	65.3	16.2	61.8	18.3	35.7	46.8	16.2
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	6.13	5.86	5.54	4.08	3.92	4.82	3.47	4.07	4.25	5.01	4.39
⑦	183.9	175.8	166.2	122.4	117.6	144.6	104.1	122.1	127.5	150.3	131.7
⑧	136.1	130.1	123	90.58	87.02	107	77.03	90.35	94.35	111.2	97.46
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	136.1	130.1	123	90.58	87.02	107	77.03	90.35	94.35	111.2	97.46
2)	0	0	0.3	5.4	29.2	0	27.1	1	11.4	18.1	0
3)	136.1	130.1	122.7	85.18	57.82	107	49.93	89.35	82.95	93.12	97.46
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	235.5	225.2	212.3	147.4	100.1	185.2	86.42	154.6	143.6	161.2	168.7
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	261.7	250.2	235.9	163.8	111.2	205.8	96.02	171.8	159.5	179.1	187.4
9)	8.723	8.339	7.864	5.46	3.707	6.859	3.201	5.728	5.317	5.969	6.247
10)	2617	2502	2359	1638	1112	2058	960.2	1718	1595	1791	1874
11)	87.23	83.39	78.64	54.6	37.07	68.59	32.01	57.28	53.17	59.69	62.47

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	26.6	27.5	26.5	27.1	24.9	25	27.6	26.7	24.4	25.1	25.3	25.6
②	87	54	86	83	66	81	84	74	60	56	81	76
③	147.4	160.2	145	132	157.6	132.3	123.4	137.4	116.5	132.5	118	72.5
④	26.7	2.3	12.1	18.5	0.0	58.8	33.4	26.3	45.8	76.8	48.9	5.7
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	3.74	5.3	4.03	4.23	4.56	3.82	3.8	4.32	4.13	4.51	3.81	3.82
⑦	112.2	159	120.9	126.9	136.8	114.6	114	129.6	123.9	135.3	114.3	114.6
⑧	83.03	117.7	89.47	93.91	101.2	84.8	84.36	95.9	91.69	100.1	84.58	84.8
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	83.03	117.7	89.47	93.91	101.2	84.8	84.36	95.9	91.69	100.1	84.58	84.8
2)	6	0	0	1.1	0	25.3	10	5.8	17.5	37.4	19.3	0
3)	77.03	117.7	89.47	92.81	101.2	59.5	74.36	90.1	74.19	62.72	65.28	84.8
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	133.3	203.6	154.8	160.6	175.2	103	128.7	155.9	128.4	108.6	113	146.8
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	148.1	226.3	172	178.5	194.7	114.4	143	173.3	142.7	120.6	125.5	163.1
9)	4.938	7.542	5.735	5.949	6.489	3.814	4.766	5.776	4.755	4.02	4.185	5.436
10)	1481	2263	1720	1785	1947	1144	1430	1733	1427	1206	1255	1631
11)	49.38	75.42	57.35	59.49	64.89	38.14	47.66	57.76	47.55	40.2	41.85	54.36

- Water Demand : May.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	22.4	24.2	22.6	22.7	23.5	22.1	24.2	23	23.1	23.2	21.8
②	70	67	65	77	69	70	74	71	74	63	51
③	125.6	109.6	114.7	47.6	71.8	88.4	135.4	119.8	138.9	90.2	65.2
④	63.8	1.5	2.5	16.5	12.2	34.8	2.0	50.3	9.4	12.0	23.8
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	4.77	4.86	4.79	3.64	4.63	3.99	5.08	4.62	4.64	4.76	4.2
⑦	147.9	150.7	148.5	112.8	143.5	123.7	157.5	143.2	143.8	147.6	130.2
⑧	90.2	91.9	90.58	68.83	87.55	75.45	96.06	87.36	87.74	90.01	79.42
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	90.2	91.9	90.58	68.83	87.55	75.45	96.06	87.36	87.74	90.01	79.42
2)	28.3	0	0	0	0	10.9	0	20.2	0	0	4.3
3)	61.9	91.9	90.58	68.83	87.55	64.55	96.06	67.16	87.74	90.01	75.12
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	107.1	159.1	156.8	119.1	151.5	111.7	166.3	116.2	151.9	155.8	130
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	119	176.7	174.2	132.4	168.4	124.1	184.7	129.2	168.7	173.1	144.5
9)	3.84	5.701	5.619	4.27	5.431	4.004	5.959	4.166	5.443	5.584	4.66
10)	1190	1767	1742	1324	1684	1241	1847	1292	1687	1731	1445
11)	38.4	57.01	56.19	42.7	54.31	40.04	59.59	41.66	54.43	55.84	46.6

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	22.3	25.7	24.8	22.7	23.7	24.6	23.9	23.6	24.9	23.7	25.4
②	57	47	50	58	45	43	61	70	56	53	45
③	124.1	86.7	144.9	140.5	132.9	178.8	273	98.5	141.4	154.3	160
④	13.1	10.2	7.0	10.4	4.3	4.0	60.6	7.8	28.7	3.8	5.0
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	4.65	5.01	5.32	4.85	5.36	6	5.47	4.49	4.99	5.27	5.96
⑦	144.2	155.3	164.9	150.4	166.2	186	169.6	139.2	154.7	163.4	184.8
⑧	87.93	94.74	100.6	91.71	101.4	113.5	103.4	84.91	94.36	99.66	112.7
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	87.93	94.74	100.6	91.71	101.4	113.5	103.4	84.91	94.36	99.66	112.7
2)	0	0	0	0	0	0	26.4	0	7.2	0	0
3)	87.93	94.74	100.6	91.71	101.4	113.5	77.04	84.91	87.16	99.66	112.7
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	152.2	164	174.1	158.7	175.4	196.4	133.3	146.9	150.8	172.5	195.1
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	169.1	182.2	193.5	176.4	194.9	218.2	148.1	163.3	167.6	191.6	216.7
9)	5.455	5.877	6.241	5.689	6.287	7.038	4.779	5.267	5.407	6.182	6.991
10)	1691	1822	1935	1764	1949	2182	1481	1633	1676	1916	2167
11)	54.55	58.77	62.41	56.89	62.87	70.38	47.79	52.67	54.07	61.82	69.91

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	25.1	23.8	25	24.5	22.4	24.1	23.7	23.4	24.2	23.7	23.9
②	44	47	55	69	72	52	75	83	81	48	68
③	124.6	185.5	190	162.4	138.2	127.7	136.8	148.2	160.5	139.9	152.3
④	0.8	0.0	13.9	12.2	5.3	0.8	0.7	8.6	10.2	7.9	11.8
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	5.7	6.01	4.56	3.65	3.49	4.23	3.52	3.21	3.59	4.37	3.97
⑦	176.7	186.3	141.4	113.2	108.2	131.1	109.1	99.51	111.3	135.5	123.1
⑧	107.8	113.6	86.23	69.02	66	79.99	66.56	60.7	67.89	82.64	75.07
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	107.8	113.6	86.23	69.02	66	79.99	66.56	60.7	67.89	82.64	75.07
2)	0	0	0	0	0	0	0	0	0	0	0
3)	107.8	113.6	86.23	69.02	66	79.99	66.56	60.7	67.89	82.64	75.07
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	186.5	196.7	149.2	119.5	114.2	138.4	115.2	105.1	117.5	143	129.9
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	207.3	218.5	165.8	132.7	126.9	153.8	128	116.7	130.5	158.9	144.4
9)	6.686	7.05	5.349	4.282	4.094	4.962	4.129	3.765	4.211	5.126	4.657
10)	2073	2185	1658	1327	1269	1538	1280	1167	1305	1589	1444
11)	66.86	70.5	53.49	42.82	40.94	49.62	41.29	37.65	42.11	51.26	46.57

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	23.3	24.4	23.8	24.3	24.3	24.5	24.6	24.4	23.3	22.7	23.4	0
②	83	51	77	73	54	70	66	54	48	45	66	73
③	119.8	211.2	119.1	138.7	135	115.8	114.9	120.8	139.2	123.2	100.7	0
④	21.1	0.0	0.8	4.2	0.0	33.0	21.8	2.5	10.8	12.2	29.5	0.0
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	3.17	4.97	3.37	3.63	4.12	3.59	3.08	3.94	4.18	3.9	3.43	3.4
⑦	98.27	154.1	104.5	112.5	127.7	111.3	95.48	122.1	129.6	120.9	106.3	105.4
⑧	59.94	93.98	63.73	68.64	77.91	67.89	58.24	74.51	79.04	73.75	64.86	64.29
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	59.94	93.98	63.73	68.64	77.91	67.89	58.24	74.51	79.04	73.75	64.86	64.29
2)	2.7	0	0	0	0	9.8	3.1	0	0	0	7.7	0
3)	57.24	93.98	63.73	68.64	77.91	58.09	55.14	74.51	79.04	73.75	57.16	64.29
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	99.07	162.7	110.3	118.8	134.8	100.5	95.44	128.9	136.8	127.6	98.93	111.3
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	110.1	180.7	122.5	132	149.8	111.7	106	143.3	152	141.8	109.9	123.6
9)	3.551	5.83	3.953	4.258	4.833	3.603	3.421	4.622	4.903	4.575	3.546	3.988
10)	1101	1807	1225	1320	1498	1117	1060	1433	1520	1418	1099	1236
11)	35.51	58.3	39.53	42.58	48.33	36.03	34.21	46.22	49.03	45.75	35.46	39.88

- Water Demand : Jun.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	20.8	19.7	20.8	20.6	21.3	20.7	20.9	20.5	21.1	20.4	20.2
②	71	79	70	67	72	70	74	66	72	66	48
③	141.6	92.7	129.5	32	91.4	105.5	128.9	125.5	143.1	88.8	77.8
④	6.3	21.6	20.3	25.1	16.0	12.7	8.1	22.1	20.6	10.0	5.6
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	4.21	4.13	4.16	3.99	4.12	3.93	4.48	4.16	4.13	3.98	4.28
⑦	126.3	123.9	124.8	119.7	123.6	117.9	134.4	124.8	123.9	119.4	128.4
⑧	97.25	95.4	96.1	92.17	95.17	90.78	103.5	96.1	95.4	91.94	98.87
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	97.25	95.4	96.1	92.17	95.17	90.78	103.5	96.1	95.4	91.94	98.87
2)	0	0	2.2	5.1	0	0	0	3.3	2.4	0	0
3)	97.25	95.4	93.9	87.07	95.17	90.78	103.5	92.8	93	91.94	98.87
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	168.3	165.1	162.5	150.7	164.7	157.1	179.1	160.6	161	159.1	171.1
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	187	183.5	180.6	167.4	183	174.6	199	178.4	178.8	176.8	190.1
9)	6.234	6.115	6.019	5.581	6.101	5.819	6.634	5.948	5.962	5.893	6.337
10)	1870	1835	1806	1674	1830	1746	1990	1784	1788	1768	1901
11)	62.34	61.15	60.19	55.81	61.01	58.19	66.34	59.48	59.62	58.93	63.37

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	21.5	23.2	21.8	20.5	20.6	20.5	21.9	21.4	23.4	21.1	22.4
②	50	48	53	51	48	48	49	60	52	51	52
③	125.4	99.7	152.7	143.6	140.1	155.9	151.5	87.7	123	127.4	143.8
④	6.0	2.8	9.0	5.2	18.7	35.6	19.7	24.9	24.2	10.0	10.2
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	4.8	4.83	4.7	4.82	4.78	4.95	5.12	4.24	4.94	4.71	4.99
⑦	144	144.9	141	144.6	143.4	148.5	153.6	127.2	148.2	141.3	149.7
⑧	110.9	111.6	108.6	111.3	110.4	114.3	118.3	97.94	114.1	108.8	115.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	110.9	111.6	108.6	111.3	110.4	114.3	118.3	97.94	114.1	108.8	115.3
2)	0	0	0	0	1.2	11.4	1.8	4.9	4.5	0	0
3)	110.9	111.6	108.6	111.3	109.2	102.9	116.5	93.04	109.6	108.8	115.3
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	191.9	193.1	187.9	192.7	189	178.2	201.6	161	189.7	188.3	199.5
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	213.2	214.6	208.8	214.1	210	198	224	178.9	210.8	209.2	221.7
9)	7.107	7.152	6.959	7.137	7.001	6.599	7.466	5.964	7.026	6.974	7.389
10)	2132	2146	2088	2141	2100	1980	2240	1789	2108	2092	2217
11)	71.07	71.52	69.59	71.37	70.01	65.99	74.66	59.64	70.26	69.74	73.89

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	22	22.4	21.4	21.8	23.2	22.2	21.7	23.3	21.8	22.3	22.2
②	53	50	53	59	59	51	66	79	67	55	65
③	139.7	172.6	154.6	145.1	119.3	230.8	134.6	195.4	159.9	142.7	132.8
④	45.3	12.1	10.2	27.8	0.0	0.8	8.0	12.1	3.5	14.3	8.1
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	4.83	5.12	3.73	3.53	3.55	4.58	3.18	3.25	3.53	3.45	3.14
⑦	144.9	153.6	111.9	105.9	106.5	137.4	95.4	97.5	105.9	103.5	94.2
⑧	111.6	118.3	86.16	81.54	82.01	105.8	73.46	75.08	81.54	79.7	72.53
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	111.6	118.3	86.16	81.54	82.01	105.8	73.46	75.08	81.54	79.7	72.53
2)	17.2	0	0	6.7	0	0	0	0	0	0	0
3)	94.37	118.3	86.16	74.84	82.01	105.8	73.46	75.08	81.54	79.7	72.53
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	163.3	204.7	149.1	129.5	141.9	183.1	127.1	129.9	141.1	137.9	125.5
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	181.5	227.4	165.7	143.9	157.7	203.4	141.3	144.4	156.8	153.3	139.5
9)	6.049	7.581	5.523	4.797	5.257	6.782	4.709	4.812	5.227	5.108	4.649
10)	1815	2274	1657	1439	1577	2034	1413	1444	1568	1533	1395
11)	60.49	75.81	55.23	47.97	52.57	67.82	47.09	48.12	52.27	51.08	46.49

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	21.6	23.6	22.1	22.7	21.6	22.2	21.9	22.5	21.9	21.1	21.6	0
②	71	52	69	61	51	55	60	46	50	49	56	72
③	120.1	157.6	133.6	126.7	133.8	120.6	126.3	113.9	132.2	80.1	86.9	0
④	27.4	0.0	7.3	8.1	1.6	1.6	3.8	0.0	14.4	36.3	5.8	0.0
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	2.87	3.99	3.12	3.38	3.57	3.47	3.39	3.66	3.58	2.81	2.95	2.78
⑦	86.1	119.7	93.6	101.4	107.1	104.1	101.7	109.8	107.4	84.3	88.5	83.4
⑧	66.3	92.17	72.07	78.08	82.47	80.16	78.31	84.55	82.7	64.91	68.15	64.22
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	66.3	92.17	72.07	78.08	82.47	80.16	78.31	84.55	82.7	64.91	68.15	64.22
2)	6.4	0	0	7.2	0	0	0	0	0	11.8	0	0
3)	59.9	92.17	72.07	70.88	82.47	80.16	78.31	84.55	82.7	53.11	68.15	64.22
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	103.7	159.5	124.7	122.7	142.7	138.7	135.5	146.3	143.1	91.92	117.9	111.1
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	115.2	177.2	138.6	136.3	158.6	154.1	150.6	162.6	159	102.1	131	123.5
9)	3.839	5.908	4.62	4.543	5.286	5.138	5.02	5.419	5.301	3.404	4.368	4.116
10)	1152	1772	1386	1363	1586	1541	1506	1626	1590	1021	1310	1235
11)	38.39	59.08	46.2	45.43	52.86	51.38	50.2	54.19	53.01	34.04	43.68	41.16

- Water Demand : Jul.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	20.5	20.8	20.4	20.7	20.9	19.8	21.1	19.2	21.2	20.5	20
②	66	69	66	67	63	66	67	63	61	55	50
③	127.5	135.4	133.5	21.9	89.7	113.8	169.8	127.5	149.6	123.6	247.3
④	10.4	7.6	30.0	28.7	1.0	8.1	8.6	15.0	43.9	14.0	32.2
⑤	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
⑥	4.32	4.27	4.37	3.44	4.31	4.36	4.34	4.11	4.4	4.3	5.33
⑦	133.9	132.4	135.5	106.6	133.6	135.2	134.5	127.4	136.4	133.3	165.2
⑧	128.6	127.1	130.1	102.4	128.3	129.8	129.2	122.3	130.9	128	158.6
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	128.6	127.1	130.1	102.4	128.3	129.8	129.2	122.3	130.9	128	158.6
2)	0	0	8	7.2	0	0	0	0	16.3	0	9.3
3)	128.6	127.1	122.1	95.17	128.3	129.8	129.2	122.3	114.6	128	149.3
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	222.5	219.9	211.2	164.7	222	224.6	223.5	211.7	198.4	221.5	258.4
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	247.2	244.4	234.7	183	246.7	249.5	248.4	235.2	220.5	246.1	287.1
9)	7.975	7.883	7.571	5.904	7.957	8.049	8.012	7.587	7.112	7.938	9.263
10)	2472	2444	2347	1830	2467	2495	2484	2352	2205	2461	2871
11)	79.75	78.83	75.71	59.04	79.57	80.49	80.12	75.87	71.12	79.38	92.63

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	20.7	22.9	22.4	20.9	20.7	20.8	21.7	21.2	21.7	21.6	21.9
②	56	48	45	45	44	41	47	50	44	50	50
③	123	88.4	187.6	155.7	168.1	180.8	167.9	87.1	162.2	143.1	186.5
④	30.5	41.4	0.0	4.6	2.0	0.0	16.8	43.7	5.0	15.8	15.8
⑤	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
⑥	4.33	4.51	5.31	4.99	4.97	5.54	5.09	4.42	5.25	4.77	5.22
⑦	134.2	139.8	164.6	154.7	154.1	171.7	157.8	137	162.8	147.9	161.8
⑧	128.9	134.2	158	148.5	147.9	164.9	151.5	131.5	156.2	142	155.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	128.9	134.2	158	148.5	147.9	164.9	151.5	131.5	156.2	142	155.3
2)	8.3	14.8	0	0	0	0	0.1	16.2	0	0	0
3)	120.6	119.4	158	148.5	147.9	164.9	151.4	115.3	156.2	142	155.3
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	208.7	206.7	273.5	257	256	285.3	262	199.6	270.4	245.7	268.9
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	231.8	229.6	303.9	285.6	284.4	317	291.1	221.8	300.4	273	298.7
9)	7.479	7.408	9.803	9.212	9.175	10.23	9.39	7.155	9.692	8.806	9.637
10)	2318	2296	3039	2856	2844	3170	2911	2218	3004	2730	2987
11)	74.79	74.08	98.03	92.12	91.75	102.3	93.9	71.55	96.92	88.06	96.37

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	22.6	22.3	22.5	20.4	21.1	22	21.7	21.7	21.6	23.2	21.2
②	52	50	48	54	62	50	60	70	60	45	60
③	167.7	217.7	187	151.3	173.6	185.5	176.3	153.4	168.5	132.7	183.4
④	4.6	5.6	7.1	36.5	50.5	6.7	25.5	17.5	28.7	14.7	31.9
⑤	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
⑥	5.01	5.31	4.29	5.03	3.36	4.21	3.46	3.2	3.65	3.99	3.67
⑦	155.3	164.6	133	155.9	104.2	130.5	107.3	99.2	113.2	123.7	113.8
⑧	149.1	158	127.7	149.7	99.99	125.3	103	95.23	108.6	118.7	109.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	149.1	158	127.7	149.7	99.99	125.3	103	95.23	108.6	118.7	109.2
2)	0	0	0	11.9	20.3	0	0	0	0	0	0
3)	149.1	158	127.7	137.8	79.69	125.3	103	95.23	108.6	118.7	109.2
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	258	273.5	221	238.5	137.9	216.8	178.2	164.8	188	205.5	189
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	286.7	303.9	245.5	265	153.3	240.9	198	183.1	208.9	228.3	210
9)	9.249	9.803	7.92	8.548	4.944	7.772	6.387	5.907	6.738	7.366	6.775
10)	2867	3039	2455	2650	1533	2409	1980	1831	2089	2283	2100
11)	92.49	98.03	79.2	85.48	49.44	77.72	63.87	59.07	67.38	73.66	67.75

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	21.3	22.3	22.3	21.5	21.9	21.1	22.3	20.4	20.8	20.4	21.6	0
②	60	53	59	58	48	58	60	50	44	51	51	70
③	113.9	161.4	146	136.1	151.3	137.4	160.4	123	127.6	110.9	111.3	0
④	32.7	21.3	0.0	28.6	4.7	10.7	30.3	14.4	0.0	12.0	25.2	0.0
⑤	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
⑥	3.12	3.86	3.55	3.34	3.83	3.33	4.36	3.36	3.58	3.38	3.27	0
⑦	96.72	119.7	110.1	103.5	118.7	103.2	135.2	104.2	111	104.8	101.4	0
⑧	92.85	114.9	105.6	99.4	114	99.1	129.8	99.99	106.5	100.6	97.32	0
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	92.85	114.9	105.6	99.4	114	99.1	129.8	99.99	106.5	100.6	97.32	0
2)	6.4	0	0	7.2	0	0	0	0	0	0	5.1	0
3)	86.45	114.9	105.6	92.2	114	99.1	129.8	99.99	106.5	100.6	92.22	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	149.6	198.8	182.8	159.6	197.3	171.5	224.6	173.1	184.4	174.1	159.6	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	166.2	220.9	203.2	177.3	219.2	190.6	249.5	192.3	204.9	193.4	177.3	0
9)	5.363	7.126	6.554	5.719	7.07	6.147	8.049	6.203	6.609	6.24	5.72	0
10)	1662	2209	2032	1773	2192	1906	2495	1923	2049	1934	1773	0
11)	53.63	71.26	65.54	57.19	70.7	61.47	80.49	62.03	66.09	62.4	57.2	0

- Water Demand : Aug.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	22.5	21.8	22.1	23.1	22.3	21	22.6	23.5	23.1	21.9	22.6
②	59	59	60	56	58	59	59	58	54	54	39
③	146.4	154.1	160.2	2.6	133.2	137.3	188.4	138.6	174.7	130.5	123.7
④	0.0	15.0	8.1	4.6	4.6	0.0	5.6	0.0	0.5	10.0	0.0
⑤	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
⑥	5.26	4.95	5.03	3.95	4.69	4.77	4.98	5.25	5.42	4.77	5.21
⑦	163.1	153.5	155.9	122.5	145.4	147.9	154.4	162.8	168	147.9	161.5
⑧	138.6	130.4	132.5	104.1	123.6	125.7	131.2	138.3	142.8	125.7	137.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	138.6	130.4	132.5	104.1	123.6	125.7	131.2	138.3	142.8	125.7	137.3
2)	0	0	0	0	0	0	0	0	0	0	0
3)	138.6	130.4	132.5	104.1	123.6	125.7	131.2	138.3	142.8	125.7	137.3
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	239.9	225.7	229.4	180.1	213.9	217.5	227.1	239.4	247.2	217.5	237.6
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	266.5	250.8	254.9	200.2	237.6	241.7	252.3	266	274.6	241.7	264
9)	8.598	8.091	8.222	6.456	7.666	7.797	8.14	8.581	8.859	7.797	8.516
10)	2665	2508	2549	2002	2376	2417	2523	2660	2746	2417	2640
11)	85.98	80.91	82.22	64.56	76.66	77.97	81.4	85.81	88.59	77.97	85.16

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	22.4	22.4	22.4	22.9	22.5	24.1	22.7	23.5	22.8	22.7	22.4
②	41	46	40	43	31	42	42	41	44	42	44
③	172.3	101.8	201	231.2	158.2	255.4	225.9	113.9	189.6	177.9	185.2
④	6.2	0.0	4.4	9.0	0.0	53.0	13.8	1.0	7.2	7.2	16.1
⑤	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
⑥	5.58	4.59	5.96	5.87	5.91	6.43	6	5.11	5.68	5.63	5.39
⑦	173	142.3	184.8	182	183.2	199.3	186	158.4	176.1	174.5	167.1
⑧	147	120.9	157	154.7	155.7	169.4	158.1	134.6	149.7	148.4	142
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	147	120.9	157	154.7	155.7	169.4	158.1	134.6	149.7	148.4	142
2)	0	0	0	0	0	21.8	0	0	0	0	0
3)	147	120.9	157	154.7	155.7	147.6	158.1	134.6	149.7	148.4	142
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	254.5	209.3	271.8	267.7	269.5	255.5	273.6	233	259	256.8	245.8
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	282.7	232.6	302	297.4	299.5	283.9	304	258.9	287.8	285.3	273.1
9)	9.121	7.503	9.742	9.595	9.66	9.158	9.807	8.353	9.284	9.203	8.81
10)	2827	2326	3020	2974	2995	2839	3040	2589	2878	2853	2731
11)	91.21	75.03	97.42	95.95	96.6	91.58	98.07	83.53	92.84	92.03	88.1

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	23.1	23.5	25.5	23	23.3	23.4	23.3	23.1	23.6	25	22.6
②	44	45	43	42	42	50	51	57	48	45	45
③	195.3	258.3	254.5	183	205.4	220.1	197.9	231.8	136.3	194	182.4
④	11.9	3.0	0.0	4.2	2.4	12.3	0.0	5.5	36.7	2.2	0.2
⑤	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
⑥	5.66	6.15	5.92	8.32	5.31	4.93	4.73	4.77	4.53	5.17	4.84
⑦	175.5	190.7	183.5	257.9	164.6	152.8	146.6	147.9	140.4	160.3	150
⑧	149.1	162.1	156	219.2	139.9	129.9	124.6	125.7	119.4	136.2	127.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	149.1	162.1	156	219.2	139.9	129.9	124.6	125.7	119.4	136.2	127.5
2)	0	0	0	0	0	0	0	0	12	0	0
3)	149.1	162.1	156	219.2	139.9	129.9	124.6	125.7	107.4	136.2	127.5
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	258.1	280.5	270	379.4	242.2	224.8	215.7	217.5	185.8	235.8	220.7
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	286.8	311.6	300	421.6	269.1	249.8	239.7	241.7	206.5	262	245.2
9)	9.252	10.05	9.677	13.6	8.679	8.058	7.731	7.797	6.66	8.451	7.911
10)	2868	3116	3000	4216	2691	2498	2397	2417	2065	2620	2452
11)	92.52	100.5	96.77	136	86.79	80.58	77.31	77.97	66.6	84.51	79.11

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	23.9	25.1	24.2	23.4	23.5	23.1	22.1	21.7	23.7	22.6	23.4	0
②	45	36	44	44	42	44	49	45	40	37	43	62
③	181.2	166.4	172.5	173.7	153.2	180.4	174.7	152.9	163.6	127.4	151	0
④	12.8	0.0	0.0	2.5	0.5	2.4	27.0	6.9	0.0	5.7	0.0	0.0
⑤	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
⑥	4.94	5.28	4.87	4.84	4.66	4.85	6.34	4.33	4.85	4.31	4.61	0
⑦	153.1	163.7	151	150	144.5	150.4	196.5	134.2	150.4	133.6	142.9	0
⑧	130.2	139.1	128.3	127.5	122.8	127.8	167.1	114.1	127.8	113.6	121.5	0
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	130.2	139.1	128.3	127.5	122.8	127.8	167.1	114.1	127.8	113.6	121.5	0
2)	0	0	0	0	0	0	6.2	0	0	0	0	0
3)	130.2	139.1	128.3	127.5	122.8	127.8	160.9	114.1	127.8	113.6	121.5	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	225.3	240.8	222.1	220.7	212.5	221.2	278.4	197.5	221.2	196.6	210.2	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	250.3	267.5	246.8	245.2	236.1	245.8	309.3	219.4	245.8	218.4	233.6	0
9)	8.075	8.63	7.96	7.911	7.617	7.928	9.978	7.078	7.928	7.045	7.535	0
10)	2503	2675	2468	2452	2361	2458	3093	2194	2458	2184	2336	0
11)	80.75	86.3	79.6	79.11	76.17	79.28	99.78	70.78	79.28	70.45	75.35	0

- Water Demand : Sep.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	24.9	25.8	25.9	24.5	25.2	25.4	26.3	25.8	26.1	26.2	24.9
②	54	52	54	54	60	54	54	50	53	53	35
③	197.1	176.8	173.3	5.9	170.2	200.4	232.2	184.5	187.7	136.7	137.1
④	0.0	2.0	0.0	4.3	0.0	1.8	20.3	0.0	2.0	4.0	11.0
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	5.82	5.81	5.75	3.87	5.47	5.69	6.13	5.78	5.79	5.36	5.5
⑦	174.6	174.3	172.5	116.1	164.1	170.7	183.9	173.4	173.7	160.8	165
⑧	134.4	134.2	132.8	89.4	126.4	131.4	141.6	133.5	133.7	123.8	127.1
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	134.4	134.2	132.8	89.4	126.4	131.4	141.6	133.5	133.7	123.8	127.1
2)	5.82	5.81	5.75	3.87	5.47	5.69	6.13	5.78	5.79	5.36	5.5
3)	128.6	128.4	127.1	85.53	120.9	125.7	135.5	127.7	128	118.5	121.6
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	222.6	222.2	219.9	148	209.2	217.6	234.5	221.1	221.5	205	210.4
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	247.3	246.9	244.4	164.5	232.5	241.8	260.5	245.6	246.1	227.8	233.7
9)	8.245	8.231	8.146	5.482	7.749	8.061	8.684	8.188	8.202	7.593	7.791
10)	2473	2469	2444	1645	2325	2418	2605	2456	2461	2278	2337
11)	82.45	82.31	81.46	54.82	77.49	80.61	86.84	81.88	82.02	75.93	77.91

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	24.1	26.3	26.1	26.5	25	26.9	25.8	25.2	24.7	26	26.5
②	40	29	32	34	35	35	37	36	39	31	32
③	211.6	118.7	248.7	239.8	246.8	292.6	283.1	187.3	203.2	182.3	234.3
④	15.4	0.0	0.0	0.0	2.1	55.1	6.2	10.4	8.6	4.8	0.0
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	6.1	5.58	7.17	6.87	6.73	7.67	7.36	6.13	5.99	6.3	7.12
⑦	183	167.4	215.1	206.1	201.9	230.1	220.8	183.9	179.7	189	213.6
⑧	140.9	128.9	165.6	158.7	155.5	177.2	170	141.6	138.4	145.5	164.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	140.9	128.9	165.6	158.7	155.5	177.2	170	141.6	138.4	145.5	164.5
2)	6.1	5.58	7.17	6.87	6.73	7.67	7.36	6.13	5.99	6.3	7.12
3)	134.8	123.3	158.5	151.8	148.7	169.5	162.7	135.5	132.4	139.2	157.4
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	233.3	213.4	274.2	262.8	257.4	293.4	281.5	234.5	229.1	241	272.3
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	259.2	237.1	304.7	292	286	326	312.8	260.5	254.6	267.7	302.6
9)	8.641	7.905	10.16	9.732	9.534	10.87	10.43	8.684	8.486	8.925	10.09
10)	2592	2371	3047	2920	2860	3260	3128	2605	2546	2677	3026
11)	86.41	79.05	101.6	97.32	95.34	108.7	104.3	86.84	84.86	89.25	100.9

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	26.4	26.7	27	26.8	26.1	26.7	25.5	27	25.9	27	26.4
②	36	37	34	36	53	36	42	39	38	40	40
③	250.2	281.5	274.5	362.8	248.6	269.9	226.2	222.5	196.1	261.4	228.4
④	0.0	5.7	0.0	22.0	7.7	0.5	15.5	0.0	20.0	3.4	2.3
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	6.91	7.43	7.34	8.12	5.8	7.2	6.23	6.7	6.21	6.96	6.55
⑦	207.3	222.9	220.2	243.6	174	216	186.9	201	186.3	208.8	196.5
⑧	159.6	171.6	169.6	187.6	134	166.3	143.9	154.8	143.5	160.8	151.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	159.6	171.6	169.6	187.6	134	166.3	143.9	154.8	143.5	160.8	151.3
2)	6.91	7.43	7.34	8.32	5.8	7.2	6.23	6.7	6.21	6.96	6.55
3)	152.7	164.2	162.2	179.3	128.2	159.1	137.7	148.1	137.2	153.8	144.8
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	264.3	284.2	280.7	310.2	221.8	275.4	238.3	256.3	237.5	266.2	250.5
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	293.7	315.8	311.9	344.7	246.5	306	264.8	284.7	263.9	295.8	278.4
9)	9.789	10.53	10.4	11.49	8.216	10.2	8.825	9.491	8.797	9.86	9.279
10)	2937	3158	3119	3447	2465	3060	2648	2847	2639	2958	2784
11)	97.89	105.3	104	114.9	82.16	102	88.25	94.91	87.97	98.6	92.79

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	26.2	26.8	25.5	26.6	26.3	26.8	25.4	25.7	26.9	26.5	25.3	0
②	41	37	43	38	35	36	37	35	35	32	38	54
③	224.6	206.4	227.6	219.1	181.5	217.1	221.9	202.6	183.3	156.6	162.5	0
④	9.9	21.0	0.0	2.5	7.0	0.0	1.2	7.5	0.0	34.5	1.8	0.0
⑤	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
⑥	6.34	6.38	6.2	6.52	6.02	6.45	6.9	6.22	6.14	5.66	5.68	0
⑦	190.2	191.4	186	195.6	180.6	193.5	207	186.6	184.2	169.8	170.4	0
⑧	146.5	147.4	143.2	150.6	139.1	149	159.4	143.7	141.8	130.7	131.2	0
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	146.5	147.4	143.2	150.6	139.1	149	159.4	143.7	141.8	130.7	131.2	0
2)	6.34	6.38	6.2	6.52	6.02	6.45	6.34	6.22	6.14	5.66	5.68	0
3)	140.1	141	137	144.1	133	142.5	153.1	137.5	135.7	125.1	125.5	0
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	242.5	244	237.1	249.4	230.3	246.7	264.9	237.9	234.8	194.8	195.5	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	269.4	271.1	263.5	277.1	255.8	274.1	294.3	264.3	260.9	216.5	217.3	0
9)	8.981	9.038	8.783	9.236	8.528	9.137	9.811	8.811	8.698	7.216	7.242	0
10)	2694	2711	2635	2771	2558	2741	2943	2643	2609	2165	2173	0
11)	89.81	90.38	87.83	92.36	85.28	91.37	98.11	88.11	86.98	72.16	72.42	0

- Water Demand : Oct.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.3	27.8	28.5	27.3	26.1	27.3	28.9	28.5	28.8	27.1	25.7
②	53	49	52	62	58	53	49	51	59	50	39
③	221.9	242.2	232.2	221.1	126.4	198.3	267.5	181.4	218.6	153.2	246.0
④	0.0	0.8	3.6	11.2	63.5	47.8	0.0	8.9	1.3	21.0	13.4
⑤	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
⑥	6.17	6.46	6.3	5.75	4.88	5.65	6.94	5.81	5.96	5.23	6.25
⑦	191.3	200.3	195.3	178.3	151.3	175.2	215.1	180.1	184.8	162.1	193.8
⑧	101.4	106.1	103.5	94.47	80.18	92.83	114	95.46	97.92	85.93	102.7
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	101.4	106.1	103.5	94.47	80.18	92.83	114	95.46	97.92	85.93	102.7
2)	6.17	6.46	6.3	5.75	4.88	5.65	6.94	5.81	5.96	5.23	6.25
3)	95.2	99.68	97.21	88.72	75.3	87.18	107.1	89.65	91.96	80.7	96.44
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	164.8	172.5	168.2	153.6	130.3	150.9	185.3	155.2	159.2	139.7	166.9
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	183.1	191.7	186.9	170.6	144.8	167.6	205.9	172.4	176.8	155.2	185.4
9)	5.906	6.183	6.03	5.504	4.671	5.408	6.643	5.561	5.705	5.006	5.982
10)	1831	1917	1869	1706	1448	1676	2059	1724	1768	1552	1854
11)	59.06	61.83	60.3	55.04	46.71	54.08	66.43	55.61	57.05	50.06	59.82

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	26.2	27	28.4	28	27.2	26.8	27.6	27.1	28.3	27.5	29.5
②	46	37	32	35	47	39	44	37	32	35	31
③	203.1	147.4	264.0	246.8	263.6	318.8	243.8	236.2	231.5	249.5	242.9
④	44.8	0.8	0.0	45.3	107.4	30.0	31.9	12.2	0.0	1.2	0.0
⑤	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
⑥	5.62	5.52	7.45	6.9	6.25	7.38	6.29	6.57	7.02	7.02	7.5
⑦	174.2	171.1	231	213.9	193.8	228.8	195	203.7	217.6	217.6	232.5
⑧	92.34	90.69	122.4	113.4	102.7	121.3	103.3	107.9	115.3	115.3	123.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	92.34	90.69	122.4	113.4	102.7	121.3	103.3	107.9	115.3	115.3	123.2
2)	5.62	5.52	7.45	6.9	6.25	7.38	6.29	6.57	7.02	7.02	7.5
3)	86.72	85.17	115	106.5	96.44	113.9	97.05	101.4	108.3	108.3	115.7
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	150.1	147.4	199	184.3	166.9	197.1	168	175.5	187.5	187.5	200.3
7)	0.9`	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	166.8	163.8	221.1	204.7	185.4	219	186.6	194.9	208.3	208.3	222.5
9)	5.379	5.284	7.131	6.604	5.982	7.064	6.021	6.289	6.719	6.719	7.179
10)	1668	1638	2211	2047	1854	2190	1866	1949	2083	2083	2225
11)	53.79	52.84	71.31	66.04	59.82	70.64	60.21	62.89	67.19	67.19	71.79

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	29.2	27	31.1	28.7	27.5	29.4	26.6	28.3	28.4	29.1	28.6
②	42	45	29	33	55	43	43	40	37	47	46
③	312.9	331.5	221.7	259.7	296.4	293.9	305.6	296.9	274.5	282.8	242.9
④	3.8	18.2	0.0	5.5	14.0	0.3	10.1	4.3	0.9	6.5	0.0
⑤	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
⑥	7.57	6.9	8.29	8.24	6.77	8.01	7.4	8.01	8.07	7.7	7.35
⑦	234.7	213.9	257	255.4	209.9	248.3	229.4	248.3	250.2	238.7	227.9
⑧	124.4	113.4	136.2	135.4	111.2	131.6	121.6	131.6	132.6	126.5	120.8
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	124.4	113.4	136.2	135.4	111.2	131.6	121.6	131.6	132.6	126.5	120.8
2)	7.57	6.9	8.29	8.12	6.77	8.01	7.4	8.01	8.07	7.7	7.35
3)	116.8	106.5	127.9	127.3	104.5	123.6	114.2	123.6	124.5	118.8	113.4
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	202.2	184.3	221.4	220.3	180.8	213.9	197.6	213.9	215.5	205.6	196.3
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	224.6	204.7	246	244.7	200.9	237.7	219.6	237.7	239.5	228.5	218.1
9)	7.246	6.604	7.935	7.894	6.48	7.667	7.083	7.667	7.724	7.37	7.035
10)	2246	2047	2460	2447	2009	2377	2196	2377	2395	2285	2181
11)	72.46	66.04	79.35	78.94	64.8	76.67	70.83	76.67	77.24	73.7	70.35

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	28.3	29.3	29.3	28.1	29	28	29	28	29.1	26.5	26.9	0
②	56	41	41	39	38	40	39	43	38	47	37	51
③	252.5	252.0	249.7	236.2	257.6	256.6	206.4	182.8	226.9	202.0	209.9	0.0
④	15.9	0.0	0.0	7.0	0.3	1.7	0.0	69.1	0.0	57.0	39.7	42.0
⑤	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
⑥	6.58	7.78	7.54	7.4	7.85	7.3	7.1	6.37	7.43	6.61	6.82	0
⑦	204	241.2	233.7	229.4	243.4	226.3	220.1	197.5	230.3	204.9	211.4	0
⑧	108.1	127.8	123.9	121.6	129	119.9	116.7	104.7	122.1	108.6	112.1	0
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	108.1	127.8	123.9	121.6	129	119.9	116.7	104.7	122.1	108.6	112.1	0
2)	6.58	7.78	7.54	7.4	7.85	7.3	6.9	6.37	7.43	6.61	6.82	0
3)	101.5	120	116.3	114.2	121.1	112.6	109.8	98.29	114.6	102	105.2	0
4)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	175.7	207.8	201.4	197.6	209.6	194.9	189.9	170.1	198.4	176.5	182.1	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	195.2	230.8	223.7	219.6	232.9	216.6	211.1	189	220.5	196.1	202.4	0
9)	6.298	7.447	7.217	7.083	7.514	6.987	6.808	6.097	7.112	6.327	6.528	0
10)	1952	2308	2237	2196	2329	2166	2111	1890	2205	1961	2024	0
11)	62.98	74.47	72.17	70.83	75.14	69.87	68.08	60.97	71.12	63.27	65.28	0

- Water Demand : Nov.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.9	27.5	27.9	29.3	28.1	30	28.8	28.8	29	30.3	29.8
②	55	58	48	52	61	55	55	59	62	47	41
③	202.9	227.3	191.2	192.4	165.9	153	202.4	213.9	231.5	129.8	215.2
④	54.4	22.4	138.7	44.2	50.8	1.3	64.5	13.5	65.3	4.3	34.4
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	5.24	5.43	5.37	5.58	4.96	5.36	5.33	5.57	5.56	5.18	6.23
⑦	157.2	162.9	161.1	167.4	148.8	160.8	159.9	167.1	166.8	155.4	186.9
⑧	95.89	99.37	98.27	102.1	90.77	98.09	97.54	101.9	101.7	94.79	114
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	95.89	99.37	98.27	102.1	90.77	98.09	97.54	101.9	101.7	94.79	114
2)	22.6	3.4	87	16.5	20.5	0	28.7	0	29.2	0	10.6
3)	73.29	95.97	11.27	85.61	70.27	98.09	68.84	101.9	72.55	94.79	103.4
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	126.8	166.1	19.51	148.2	121.6	169.8	119.1	176.4	125.6	164.1	179
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	140.9	184.5	21.67	164.6	135.1	188.6	132.4	196	139.5	182.3	198.9
9)	4.698	6.152	0.722	5.488	4.504	6.287	4.413	6.534	4.65	6.076	6.629
10)	1409	1845	216.7	1646	1351	1886	1324	1960	1395	1823	1989
11)	46.98	61.52	7.225	54.88	45.04	62.87	44.13	65.34	46.5	60.76	66.29

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.4	30.3	28.3	27.8	27.9	29.9	26.7	28.9	28.4	28.4	30.3
②	45	36	49	46	50	38	45	37	45	50	47
③	295.6	160.2	251.4	221.8	233.6	303.5	242.4	229.3	258.2	237.5	250.6
④	16.9	20.8	51.8	90.6	68.3	27.4	83.4	96.4	42.5	102.8	32.9
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	6.55	5.82	5.8	6.93	5.38	7.44	7.46	7.16	6.12	7.4	7.04
⑦	196.5	174.6	174	207.9	161.4	223.2	223.8	214.8	183.6	222	211.2
⑧	119.9	106.5	106.1	126.8	98.45	136.2	136.5	131	112	135.4	128.8
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	119.9	106.5	106.1	126.8	98.45	136.2	136.5	131	112	135.4	128.8
2)	0.1	2.5	21.1	48.5	31	6.4	42.7	53.1	15.5	58.2	9.7
3)	119.8	104	85.04	78.32	67.45	129.8	93.82	77.93	96.5	77.22	119.1
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	207.3	180	147.2	135.5	116.7	224.6	162.4	134.9	167	133.6	206.2
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	230.3	200	163.5	150.6	129.7	249.5	180.4	149.9	185.6	148.5	229.1
9)	7.677	6.667	5.451	5.02	4.324	8.317	6.014	4.995	6.185	4.95	7.636
10)	2303	2000	1635	1506	1297	2495	1804	1499	1856	1485	2291
11)	76.77	66.67	54.51	50.2	43.24	83.17	60.14	49.95	61.85	49.5	76.36

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	28.9	29.7	30.3	31.2	30	30.3	29.3	28.6	31	28.4	30.1
②	51	37	48	43	48	58	50	69	56	48	58
③	286.3	240.3	276.4	248.5	217.7	247.1	213.6	167	240	266.6	244.7
④	73.5	46.2	34.5	72.4	50.7	72.2	39.7	164.0	14.1	9.2	12.5
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	6.5	7.73	6.78	7.1	6.83	7.81	6.93	5.38	7.44	7.46	7.16
⑦	195	231.9	203.4	213	204.9	234.3	207.9	161.4	223.2	223.8	214.8
⑧	119	141.5	124.1	129.9	125	142.9	126.8	98.45	136.2	136.5	131
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	119	141.5	124.1	129.9	125	142.9	126.8	98.45	136.2	136.5	131
2)	34.8	17.7	10.7	33.9	20.4	33.8	13.8	107.2	0	0	0
3)	84.15	123.8	113.4	96.03	104.6	109.1	113	0	136.2	136.5	131
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	145.6	214.2	196.2	166.2	181	188.9	195.6	0	235.6	236.3	226.8
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	161.8	238	218	184.7	201.1	209.8	217.3	0	261.8	262.5	252
9)	5.394	7.933	7.267	6.156	6.704	6.995	7.245	0	8.727	8.751	8.399
10)	1618	2380	2180	1847	2011	2098	2173	0	2618	2625	2520
11)	53.94	79.33	72.67	61.56	67.04	69.95	72.45	0	87.27	87.51	83.99

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	29.4	30.9	29.3	29.6	30.3	28.9	30.1	29	28.9	29.5	27	0
②	63	50	46	58	42	49	45	47	41	46	41	59
③	174.1	211.6	211.8	191.1	237.3	201	193.8	198.9	239.8	204.6	193.2	0
④	41.9	64.3	66.8	145.2	14.1	65.6	31.5	45.4	7.3	26.3	3.6	0.0
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	6.12	7.4	7.04	6.5	7.73	6.78	7.1	6.83	7.81	7.49	6.53	0
⑦	183.6	222	211.2	195	231.9	203.4	213	204.9	234.3	224.7	195.9	0
⑧	112	135.4	128.8	119	141.5	124.1	129.9	125	142.9	137.1	119.5	0
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	112	135.4	128.8	119	141.5	124.1	129.9	125	142.9	137.1	119.5	0
2)	15.1	28.6	30.1	92.2	0	29.4	8.9	17.2	0	5.8	0	0
3)	96.9	106.8	98.73	26.75	141.5	94.67	121	107.8	142.9	131.3	119.5	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	167.7	184.9	170.9	46.3	244.8	163.9	209.5	186.6	247.4	227.2	206.8	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	186.3	205.4	189.9	51.44	272	182.1	232.7	207.3	274.8	252.4	229.8	0
9)	6.211	6.847	6.329	1.715	9.068	6.069	7.758	6.909	9.161	8.414	7.66	0
10)	1863	2054	1899	514.4	2720	1821	2327	2073	2748	2524	2298	0
11)	62.11	68.47	63.29	17.15	90.68	60.69	77.58	69.09	91.61	84.14	76.6	0

- Water Demand : Dec.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	28	29.8	27.8	28.7	28	28.4	28.5	27.5	27.9	28.5	28
②	69	68	72	64	65	69	77	90	67	63	56
③	144.9	152	158	159.5	102.5	100.3	128	160.9	183.3	103.3	172.2
④	138.9	72.9	151.6	75.7	121.9	257.6	231.1	269.5	47.2	178.3	91.8
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	3.95	4.62	3.81	4.09	3.82	3.52	3.66	3.02	4.26	3.73	4.63
⑦	122.5	143.2	118.1	126.8	118.4	109.1	113.5	93.62	132.1	115.6	143.5
⑧	84.49	98.82	81.5	87.49	81.71	75.29	78.29	64.6	91.12	79.78	99.04
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	84.49	98.82	81.5	87.49	81.71	75.29	78.29	64.6	91.12	79.78	99.04
2)	87.1	34.3	97.3	36.6	73.5	182.1	160.9	191.6	18.3	118.6	49.4
3)	0	64.52	0	50.89	8.21	0	0	0	72.82	0	49.64
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	111.7	0	88.07	14.21	0	0	0	126	0	85.9
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	124.1	0	97.85	15.79	0	0	0	140	0	95.45
9)	0	4.002	0	3.157	0.509	0	0	0	4.517	0	3.079
10)	0	1241	0	978.5	157.9	0	0	0	1400	0	954.5
11)	0	40.02	0	31.57	5.093	0	0	0	45.17	0	30.79

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	28.3	28.4	28.3	27.8	28.1	29.8	27.6	27.9	29.7	28.5	29.7
②	46	60	67	73	64	51	60	58	50	46	65
③	166.5	110.5	186.7	143.7	174.4	170.9	222.6	161	218.7	218.7	137.9
④	174.9	222.5	171.1	171.7	42.0	117.6	208.2	104.5	25.8	8.6	129.8
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	5.07	3.99	3.98	3.4	4.32	4.94	4.79	4.25	5.71	5.6	4.1
⑦	157.2	123.7	123.4	105.4	133.9	153.1	148.5	131.8	177	173.6	127.1
⑧	108.4	85.35	85.13	72.73	92.4	105.7	102.5	90.91	122.1	119.8	87.7
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	108.4	85.35	85.13	72.73	92.4	105.7	102.5	90.91	122.1	119.8	87.7
2)	115.9	154	112.9	112.9	15.2	70.1	142.6	59.6	5.5	0	79.8
3)	0	0	0	0	77.2	35.57	0	31.31	116.6	119.8	7.899
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	0	0	133.6	61.56	0	54.18	201.9	207.3	13.67
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	0	0	0	148.5	68.39	0	60.2	224.3	230.3	15.19
9)	0	0	0	0	4.789	2.206	0	1.942	7.235	7.43	0.49
10)	0	0	0	0	1485	683.9	0	602	2243	2303	151.9
11)	0	0	0	0	47.89	22.06	0	19.42	72.35	74.3	4.9

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	30	29.4	28	28.4	28.7	28.8	29.8	27.9	29.9	29.1	30.4
②	48	53	78	66	79	77	58	75	74	58	72
③	248.3	189.7	193.3	156.9	193	160.2	215.8	155.4	150.1	199.4	175.9
④	75.3	29.5	206.3	119.9	104.1	218.0	64.2	97.1	113.9	33.4	17.8
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	6.18	5.21	4.93	5.46	4.99	5.09	6.82	5.02	5.38	6.44	6.17
⑦	191.6	161.5	152.8	169.3	154.7	157.8	211.4	155.6	166.8	199.6	191.3
⑧	132.2	111.4	105.5	116.8	106.7	108.9	145.9	107.4	115.1	137.8	132
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	132.2	111.4	105.5	116.8	106.7	108.9	145.9	107.4	115.1	137.8	132
2)	36.2	7.7	141	71.9	59.3	150.4	28.5	53.7	67.1	10	0.7
3)	95.99	103.7	0	44.89	47.44	0	117.4	53.68	47.98	127.8	131.3
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	166.1	179.5	0	77.69	82.1	0	203.1	92.9	83.04	221.1	227.2
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	184.6	199.5	0	86.32	91.22	0	225.7	103.2	92.26	245.7	252.4
9)	5.954	6.435	0	2.785	2.943	0	7.281	3.33	2.976	7.925	8.143
10)	1846	1995	0	863.2	912.2	0	2257	1032	922.6	2457	2524
11)	59.54	64.35	0	27.85	29.43	0	72.81	33.3	29.76	79.25	81.43

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
①	28.5	28.9	29.9	28.1	29.1	29.6	28.3	29.2	28.2	28.5	28.4	0
②	81	79	65	79	76	66	77	52	62	62	60	71
③	107.2	129.2	136.9	95.7	121.3	141.7	125.8	155.2	150.5	169	120	0
④	186.8	263.7	75.6	237.9	153.5	60.6	109.2	39.6	40.8	108.9	99.3	0.0
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	4.45	4.85	5.81	4.53	4.84	5.82	4.72	6.4	5.63	5.87	5.25	0
⑦	138	150.4	180.1	140.4	150	180.4	146.3	198.4	174.5	182	162.8	0
⑧	95.19	103.7	124.3	96.9	103.5	124.5	101	136.9	120.4	125.6	112.3	0
⑨	0	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0	0
1)	95.19	103.7	124.3	96.9	103.5	124.5	101	136.9	120.4	125.6	112.3	0
2)	125.4	187	36.5	166.3	98.8	26.4	63.4	13.8	14.5	63.1	55.4	0
3)	0	0	87.78	0	4.728	98.09	37.56	123.1	105.9	62.46	56.9	0
4)	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642	0.642
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	151.9	0	8.182	169.8	65.01	213	183.3	108.1	98.47	0
7)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
8)	0	0	168.8	0	9.091	188.6	72.23	236.7	203.7	120.1	109.4	0
9)	0	0	5.445	0	0.293	6.085	2.33	7.636	6.571	3.874	3.529	0
10)	0	0	1688	0	90.91	1886	722.3	2367	2037	1201	1094	0
11)	0	0	54.45	0	2.933	60.85	23.3	76.36	65.71	38.74	35.29	0

Annex 9.
Applied Meteorological Data

Annex 9. Applied Meteorological Data

- **Rainfall(1971~2014)**
- **Max Temperature (1971~2015)**
- **Min Temperature (1971~2014)**
- **Sunhours (1971~2014)**
- **Avg Daily Wind Run (1971~2014)**
- **Humidity (1971~2014)**

Rainfall(1971~2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1971	416.1	20.8	49.8	3.6	63.8	6.3	10.4	0.0	0.0	0.0	54.4	138.9	764.1
1972	157.2	109.5	18.5	51.6	1.5	21.6	7.6	15.0	2.0	0.8	22.4	72.9	480.6
1973	294.1	25.7	67.1	41.4	2.5	20.3	30.0	8.1	0.0	3.6	138.7	151.6	783.1
1974	152.7	157.2	247.4	62.0	16.5	25.1	28.7	4.6	4.3	11.2	44.2	75.7	829.6
1975	109.5	176.8	32.8	15.0	12.2	16.0	1.0	4.6	0.0	63.5	50.8	121.9	604.1
1976	66.0	164.3	105.4	48.5	34.8	12.7	8.1	0.0	1.8	47.8	1.3	257.6	748.3
1977	275.1	25.7	177.0	5.6	2.0	8.1	8.6	5.6	20.3	0.0	64.5	231.1	823.6
1978	79.2	153.4	184.9	67.6	50.3	22.1	15.0	0.0	0.0	8.9	13.5	269.5	864.4
1979	103.4	120.4	230.6	21.3	9.4	20.6	43.9	0.5	2.0	1.3	65.3	47.2	665.9
1980	64.8	98.0	118.4	30.0	12.0	10.0	14.0	10.0	4.0	21.0	4.3	178.3	564.8
1981	135.5	167.5	111.9	77.8	23.8	5.6	32.2	0.0	11.0	13.4	34.4	91.8	704.9
1982	154.6	196.9	57.1	35.2	13.1	6.0	30.5	6.2	15.4	44.8	16.9	174.9	751.6
1983	59.7	120.6	80.4	0.0	10.2	2.8	41.4	0.0	0.0	0.8	20.8	222.5	559.2
1984	31.2	261.2	109.5	12.6	7.0	9.0	0.0	4.4	0.0	0.0	51.8	171.1	657.8
1985	215.5	194.6	119.8	63.0	10.4	5.2	4.6	9.0	0.0	45.3	90.6	171.7	929.7
1986	226.8	179.0	79.6	61.8	4.3	18.7	2.0	0.0	2.1	107.4	68.3	42.0	792.0
1987	174.8	38.0	21.0	210.7	4.0	35.6	0.0	53.0	55.1	30.0	27.4	117.6	767.2
1988	133.9	253.4	111.2	31.8	60.6	19.7	16.8	13.8	6.2	31.9	83.4	208.2	970.9
1989	185.9	226.0	219.4	53.7	7.8	24.9	43.7	1.0	10.4	12.2	96.4	104.5	985.9
1990	165.3	45.3	53.4	12.8	28.7	24.2	5.0	7.2	8.6	0.0	42.5	25.8	418.8
1991	77.6	93.1	93.1	55.1	3.8	10.0	15.8	7.2	4.8	1.2	102.8	8.6	473.1
1992	48.4	8.6	45.2	1.0	5.0	10.2	15.8	16.1	0.0	0.0	32.9	129.8	313.0
1993	418.3	37.3	35.0	5.6	0.8	45.3	4.6	11.9	0.0	3.8	73.5	75.3	711.4
1994	193.6	44.7	69.0	1.8	0.0	12.1	5.6	3.0	5.7	18.2	46.2	29.5	429.4
1995	161.0	100.8	26.3	17.1	13.9	10.2	7.1	0.0	0.0	0.0	34.5	206.3	577.2
1996	187.4	214.2	146.3	25.7	12.2	27.8	36.5	4.2	22.0	5.5	72.4	119.9	874.1
1997	124.9	347.7	42.6	65.3	5.3	0.0	50.5	2.4	7.7	14.0	50.7	104.1	815.2
1998	154.2	113.4	23.9	16.2	0.8	0.8	6.7	12.3	0.5	0.3	72.2	218.0	619.3
1999	299.6	265.8	129.6	61.8	0.7	8.0	25.5	0.0	15.5	10.1	39.7	64.2	920.5
2000	108.4	208.8	149.7	18.3	8.6	12.1	17.5	5.5	0.0	4.3	164.0	97.1	794.3
2001	164.9	280.2	135.9	35.7	10.2	3.5	28.7	36.7	20.0	0.9	14.1	113.9	844.7
2002	202.6	169.0	69.1	46.8	7.9	14.3	14.7	2.2	3.4	6.5	9.2	33.4	579.1
2003	316.2	135.2	104.4	16.2	11.8	8.1	31.9	0.2	2.3	0.0	12.5	17.8	656.6
2004	169.5	102.9	69.3	26.7	21.1	27.4	32.7	12.8	9.9	15.9	41.9	186.8	716.9
2005	85.2	61.9	10.2	2.3	0.0	0.0	21.3	0.0	21.0	0.0	64.3	263.7	529.9
2006	212.8	93.3	258.0	12.1	0.8	7.3	0.0	0.0	0.0	0.0	66.8	75.6	726.7
2007	571.5	119.9	136.0	18.5	4.2	8.1	28.6	2.5	2.5	7.0	145.2	237.9	1,281.9
2008	218.6	40.7	58.0	0.0	0.0	1.6	4.7	0.5	7.0	0.3	14.1	153.5	499.0
2009	115.9	72.6	88.4	58.8	33.0	1.6	10.7	2.4	0.0	1.7	65.6	60.6	511.3
2010	50.8	148.7	58.6	33.4	21.8	3.8	30.3	27.0	1.2	0.0	31.5	109.2	516.3
2011	116.0	55.8	88.9	26.3	2.5	0.0	14.4	6.9	7.5	69.1	45.4	39.6	472.4
2012	353.2	94.9	131.2	45.8	10.8	14.4	0.0	0.0	0.0	0.0	7.3	40.8	698.4
2013	272.3	219.4	16.3	76.8	12.2	36.3	12.0	5.7	34.5	3.8	26.3	108.9	824.5
2014	159.5	147.4	25.3	48.9	29.5	5.8	25.2	0.0	1.8	3.7	3.6	99.3	550.0
LTM	**190.2**	**137.8**	**95.3**	**36.2**	**13.5**	**13.3**	**17.8**	**6.9**	**7.1**	**13.9**	**50.7**	**124.3**	**706.8**
MAX	**576.0**	**347.7**	**258**	**210.7**	**63.8**	**45.3**	**50.5**	**53.0**	**55.1**	**107.4**	**164.0**	**269.5**	

Max Temperature (1971~2015)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1971	31.8	32.4	32.7	32.5	28.6	26.7	27.5	30.7	32.3	34.8	34.2	33.8	31.5
1972	33.2	32.4	32.8	32.0	30.1	27.2	27.2	29.6	33.7	34.9	34.7	36.4	32.0
1973	33.0	33.2	33.5	29.7	29.7	26.8	27.3	29.7	34.4	36.0	34.3	33.4	31.8
1974	33.3	31.9	31.9	29.7	27.9	27.4	26.6	30.6	32.5	35.1	36.4	32.6	31.3
1975	33.8	32.8	31.6	31.0	30.2	27.0	27.6	28.8	32.4	33.4	35.0	33.6	31.4
1976	34.0	32.8	31.9	29.9	27.6	26.8	27.3	28.4	32.4	34.5	37.0	34.2	31.4
1977	33.0	34.4	32.1	31.8	31.3	28.6	27.4	29.4	33.3	36.1	35.3	33.9	32.2
1978	33.5	33.7	32.1	30.7	29.3	26.4	25.6	31.5	33.0	35.7	35.4	32.2	31.6
1979	33.6	33.5	31.8	31.4	29.2	27.2	27.1	30.1	33.5	36.0	35.3	33.4	31.8
1980	34.1	35.1	32.0	31.8	30.2	26.6	26.2	28.9	33.8	33.1	37.1	33.4	31.9
1981	34.3	32.6	31.9	29.8	27.4	26.8	26.7	29.7	32.0	31.9	36.4	33.4	31.1
1982	32.8	32.1	32.6	30.9	28.2	27.7	27.2	29.1	30.8	32.6	34.3	34.5	31.1
1983	35.0	33.1	33.6	32.8	31.7	29.1	29.2	28.1	33.1	33.5	36.8	33.7	32.5
1984	34.1	32.1	32.0	30.6	30.7	27.4	28.4	29.4	33.0	35.4	33.7	33.2	31.7
1985	32.1	31.7	32.3	30.1	28.7	27.1	27.5	29.3	32.8	34.4	33.5	32.6	31.0
1986	32.2	32.8	32.7	31.3	29.9	27.0	27.4	30.7	31.8	33.3	34.0	33.6	31.4
1987	32.6	34.6	35.1	32.4	31.3	27.2	28.2	30.5	33.9	33.4	36.6	36.0	32.7
1988	34.3	32.1	32.5	33.4	29.2	28.6	28.4	29.6	33.1	33.9	33.2	33.1	31.8
1989	33.4	31.3	31.5	30.8	29.3	27.7	28.1	30.7	32.1	33.8	34.9	33.5	31.4
1990	33.0	33.8	34.0	33.2	30.4	30.1	28.7	29.6	31.6	35.8	35.4	36.2	32.7
1991	34.0	33.9	32.9	30.4	30.1	28.0	28.1	29.7	33.7	34.6	34.5	34.5	32.0
1992	36.0	36.1	35.2	33.3	32.2	28.9	28.5	29.1	34.3	37.1	37.3	35.6	33.6
1993	32.2	33.5	33.2	34.0	32.5	28.5	28.9	30.0	33.3	35.6	35.0	36.5	32.8
1994	33.8	32.7	32.8	32.6	31.1	29.0	28.2	30.1	33.9	32.9	36.5	35.5	32.4
1995	33.0	34.0	34.7	33.2	30.6	28.1	29.1	31.9	34.0	39.0	36.9	33.1	33.1
1996	34.0	32.7	31.1	30.8	29.8	28.0	27.2	30.5	34.5	36.1	38.3	33.6	32.2
1997	33.1	30.2	33.5	30.8	29.1	31.1	26.5	30.6	32.5	33.8	36.6	33.8	31.8
1998	33.3	33.4	34.3	32.7	31.7	29.4	28.9	29.7	33.8	36.4	36.3	34.1	32.8
1999	32.2	31.9	32.3	30.7	29.9	27.9	27.1	29.8	32.6	32.9	35.8	35.9	31.6
2000	34.3	33.7	33.1	31.9	29.4	29.3	27.6	29.3	34.6	35.0	34.1	32.8	32.1
2001	32.1	31.9	32.4	31.7	30.1	28.4	28.3	31.4	33.3	35.3	37.7	35.3	32.3
2002	33.6	32.6	33.1	31.8	30.5	28.3	30.8	31.7	33.7	35.7	34.6	34.9	32.6
2003	33.1	33.6	33.1	31.5	29.9	27.4	26.7	30.0	33.6	35.6	36.5	36.3	32.3
2004	34.9	33.1	33.4	31.3	28.7	27.3	27.5	31.0	33.2	34.7	35.0	32.8	31.9
2005	33.5	34.5	34.3	33.8	30.8	30.1	28.1	32.7	33.9	36.5	38.2	34.1	33.4
2006	34.3	34.4	32.2	31.8	30.3	28.0	28.6	31.0	32.2	35.8	35.3	35.4	32.4
2007	31.3	33.5	33.1	32.1	30.4	28.8	27.6	30.6	33.7	35.0	35.4	32.8	32.0
2008	32.7	33.3	31.8	31.4	31.1	28.5	28.5	30.6	33.7	36.2	37.1	34.4	32.4
2009	33.4	33.5	32.1	30.5	30.4	29.5	27.0	30.3	34.0	34.5	35.6	35.6	32.2
2010	35.9	33.5	33.4	32.9	30.7	27.7	27.7	28.7	33.0	36.6	37.0	33.8	32.6
2011	33.5	33.0	33.5	32.6	31.4	30.0	27.5	28.9	33.1	34.8	35.2	35.5	32.4
2012	32.5	34.4	33.9	30.0	30.2	28.8	28.7	31.1	34.3	36.6	35.9	34.0	32.5
2013	32.2	32.2	33.0	31.4	29.6	28.7	27.3	31.0	34.4	33.0	36.9	34.9	32.1
2014	33.9	32.4	33.9	31.4	30.4	28.8	28.8	30.9	33.1	34.4	30.8	34.7	32.0
LTM	**33.4**	**33.1**	**32.9**	**31.6**	**30.0**	**28.1**	**27.8**	**30.1**	**33.2**	**34.9**	**35.6**	**34.2**	**32.1**
MAX	**36.0**	**36.1**	**35.2**	**34.0**	**32.5**	**31.1**	**30.8**	**32.7**	**34.6**	**39.0**	**38.3**	**36.5**	**33.6**
MIN	**31.3**	**30.2**	**31.1**	**29.7**	**27.4**	**26.4**	**25.6**	**28.1**	**30.8**	**31.9**	**30.8**	**32.2**	**31.0**

Min Temperature (1971~2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1971	22.7	21.8	21.5	20.5	16.2	14.9	13.6	14.4	17.5	19.8	21.6	22.3	18.9
1972	22.5	22.2	21.8	21.0	18.3	12.3	14.4	14.0	17.9	20.7	20.4	23.2	19.1
1973	22.9	22.6	22.1	20.3	15.5	14.9	13.6	14.6	17.5	21.1	21.6	22.2	19.1
1974	21.8	22.4	22.0	19.5	17.5	13.8	14.8	15.6	16.6	19.6	22.3	24.9	19.2
1975	22.4	21.9	21.5	20.5	16.9	15.6	14.2	15.8	18.1	18.8	21.2	22.4	19.1
1976	22.5	22.4	22.5	20.8	16.6	14.7	12.4	13.6	18.4	20.2	23.1	22.7	19.2
1977	23.2	23.5	22.5	19.9	17.2	13.2	14.9	15.8	19.3	21.8	22.3	23.1	19.7
1978	23.5	23.2	23.1	21.3	16.7	14.6	12.8	15.5	18.6	21.3	22.3	22.8	19.6
1979	22.3	22.9	22.4	20.1	17.0	15.1	15.3	16.2	18.8	21.7	22.8	22.5	19.8
1980	22.6	23.6	22.3	20.9	16.3	14.3	14.8	15.0	18.7	21.1	23.5	23.6	19.7
1981	23.3	23.4	22.4	19.9	16.2	13.7	13.4	15.5	17.9	19.5	23.3	22.6	19.3
1982	23.3	23.1	22.2	20.4	16.4	15.3	14.3	15.7	17.5	19.9	20.5	22.2	19.2
1983	23.4	23.2	22.0	22.4	19.7	17.3	16.6	16.7	19.5	20.5	23.8	23.1	20.7
1984	23.2	22.8	22.1	19.4	18.9	16.2	16.5	15.5	19.3	21.4	22.9	23.5	20.1
1985	23.4	22.8	22.9	20.2	16.8	14.0	14.4	16.5	20.3	21.6	22.1	23.1	19.8
1986	22.7	22.4	21.6	21.2	17.6	14.2	14.1	14.3	18.2	21.2	21.8	22.6	19.3
1987	22.8	23.2	22.8	20.2	18.0	13.8	13.4	17.7	20.0	20.2	23.2	23.6	19.9
1988	23.5	23.0	23.1	22.1	18.6	15.2	15.0	15.8	18.5	21.4	20.2	22.2	19.9
1989	23.0	22.3	22.1	21.2	18.0	15.1	14.4	16.3	18.4	20.4	22.9	22.4	19.7
1990	23.4	23.0	21.3	21.6	19.4	16.7	14.7	16.1	17.9	20.8	21.5	23.3	20.0
1991	23.7	23.7	22.9	20.2	17.4	14.2	15.1	15.8	18.3	20.4	22.3	22.6	19.7
1992	23.6	23.2	23.5	21.7	18.6	15.9	15.4	15.8	18.8	21.9	23.4	23.9	20.5
1993	23.0	23.4	22.2	22.0	17.8	15.5	16.4	16.3	19.5	22.9	22.8	23.5	20.4
1994	23.4	22.2	21.2	20.3	16.5	15.9	16.4	17.0	19.5	21.1	23.0	23.3	20.0
1995	23.2	23.3	22.7	20.3	19.4	14.7	15.9	19.1	20.0	23.3	23.8	23.0	20.7
1996	23.4	23.6	22.2	20.1	19.3	15.7	13.6	15.5	19.1	21.3	24.1	23.2	20.1
1997	23.5	22.6	23.1	20.4	15.7	15.3	15.8	16.1	19.8	21.3	23.5	23.6	20.1
1998	24.4	23.4	23.7	20.9	16.5	15.0	15.2	17.2	19.7	22.4	24.4	23.5	20.5
1999	23.7	23.5	23.1	21.2	17.5	15.5	16.3	16.8	18.4	20.4	22.8	23.7	20.2
2000	23.8	23.3	23.1	21.2	17.5	17.3	15.9	17.0	19.4	21.6	23.1	23.1	20.5
2001	23.4	23.0	23.3	21.0	18.4	15.3	14.9	15.9	18.6	21.5	24.4	24.6	20.4
2002	23.7	23.0	23.1	20.5	17.0	16.3	15.6	18.4	20.4	22.6	22.2	23.4	20.5
2003	23.7	24.0	23.7	20.5	17.9	17.0	15.7	15.3	19.2	21.6	23.7	24.5	20.6
2004	24.3	23.4	23.5	21.9	18.0	16.0	15.1	16.9	19.2	22.0	23.9	24.3	20.7
2005	24.2	23.4	22.8	21.2	18.1	17.1	16.5	17.5	19.8	22.2	23.6	23.8	20.9
2006	24.2	24.0	23.8	21.3	17.3	16.2	16.0	17.4	18.9	22.8	23.3	24.4	20.8
2007	23.6	23.6	22.8	22.2	18.2	16.7	15.4	16.2	19.5	21.2	23.8	23.4	20.6
2008	23.8	22.3	21.4	18.5	17.5	14.7	15.3	16.4	18.9	21.8	23.5	23.9	19.8
2009	23.6	23.0	22.1	19.5	18.7	15.0	15.3	16.0	19.7	21.6	22.3	23.7	20.0
2010	24.0	23.7	22.9	22.3	18.5	16.1	17.0	15.5	17.9	21.4	23.2	22.9	20.5
2011	23.0	22.2	22.9	20.8	17.5	15.1	13.4	14.5	18.3	21.2	22.9	22.9	19.6
2012	22.0	22.9	22.1	18.9	16.5	15.0	13.0	16.4	19.6	21.7	21.9	22.5	19.4
2013	23.2	21.8	21.4	18.8	15.9	13.6	13.6	14.3	18.6	20.1	22.1	22.1	18.8
2014	22.6	22.2	21.8	19.2	16.4	14.4	14.5	15.9	17.6	19.5	23.3	22.1	19.1
LTM	**23.2**	**22.9**	**22.4**	**20.6**	**17.5**	**15.2**	**14.9**	**16.0**	**18.8**	**21.2**	**22.7**	**23.2**	**19.9**
MAX	**24.4**	**24.0**	**23.8**	**22.4**	**19.7**	**17.3**	**17.0**	**19.1**	**20.4**	**23.3**	**24.4**	**24.9**	**20.9**
MIN	**21.2**	**21.5**	**20.6**	**18.5**	**15.5**	**12.3**	**12.4**	**13.6**	**16.6**	**18.8**	**20.2**	**22.1**	**18.8**

Sunhours (1971~2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1971	6.1	8.8	8.4	9.5	9.0	7.5	7.9	10.1	10.0	10.5	8.7	7.2	8.6
1972	6.6	6.9	8.6	8.3	8.5	8.5	7.9	8.9	9.7	9.9	9.3	9.3	8.5
1973	7.7	9.5	8.7	6.9	8.6	7.3	8.1	9.2	9.5	9.3	8.5	6.7	8.3
1974	7.1	5.2	6.2	7.1	5.7	8.5	6.6	9.3	9.2	10.0	9.3	6.7	7.6
1975	8.4	7.5	8.7	8.2	8.8	7.8	8.5	8.3	9.9	9.6	9.7	7.9	8.6
1976	9.0	7.2	6.2	5.7	6.4	6.6	8.6	9.3	9.1	9.0	10.3	6.1	7.8
1977	6.7	8.0	6.6	8.6	9.4	8.6	7.0	7.8	9.4	10.3	8.3	7.0	8.1
1978	6.6	7.9	6.5	6.6	8.1	7.0	7.6	9.9	9.1	9.4	9.9	5.8	7.9
1979	9.0	8.2	6.0	8.7	8.3	6.9	7.1	9.4	9.2	9.6	9.8	7.4	8.3
1980	9.7	7.4	7.9	8.4	8.6	7.0	7.2	8.6	9.2	9.2	9.9	6.8	8.3
1981	7.3	6.6	7.2	7.2	7.4	8.1	7.5	9.4	9.0	8.6	9.5	8.1	8.0
1982	6.6	6.4	8.7	8.1	7.4	8.3	7.0	9.0	9.2	8.3	9.2	9.4	8.1
1983	9.5	7.5	9.3	9	8.3	8.4	7.6	8.1	9.9	9.7	10.5	7.8	8.8
1984	8.5	6.5	6.8	8.1	7.8	6.8	7.1	9.3	9.7	9.6	7.9	5.7	7.8
1985	6.2	6.4	6.3	7.2	7.7	8.2	7.9	7.8	8.7	8.8	7.9	5.2	7.4
1986	5.9	7.2	7.3	6.5	8.4	7.6	7.0	9.9	8.8	8.1	9.3	7.5	7.8
1987	7.6	9.4	9.0	8.5	8.3	7.7	9.1	8.6	9.2	9.6	9.9	7.3	8.7
1988	8.2	6.2	6.7	8.8	6.9	8.2	7.4	8.4	9.8	7.9	9.1	8.1	8.0
1989	7.4	6.0	6.3	7.6	7.8	7.5	8.3	8.9	9.1	9.1	8.3	6.6	7.7
1990	6.1	7.3	9.1	9.1	7.0	7.8	7.9	8.7	8.3	9.6	8.7	9.1	8.2
1991	7.7	6.7	7.3	7.8	8.0	7.7	7.4	8.8	8.8	9.8	8.6	8.8	8.1
1992	9.0	10.0	8.3	9.5	8.9	7.8	7.6	7.7	9.6	10.2	9.4	6.7	8.7
1993	6.4	7.5	8.4	9.1	9.3	7.6	7.3	8.0	8.6	9.4	8.7	9.3	8.3
1994	7.4	8.4	8.1	9.1	9.3	7.1	6.9	7.8	9.2	8.1	9.6	8.8	8.3
1995	5.7	9.0	10.0	8.7	7.9	8.1	8.4	8.8	9.0	10.4	9.0	6.3	8.4
1996	7.0	6.4	6.2	7.9	6.5	7.8	7.9	9.4	9.7	10.0	9.9	7.1	8.0
1997	6.1	3.9	8.1	6.8	7.8	8.1	6.1	9.4	7.5	8.4	8.5	6.4	7.3
1998	5.1	7.7	8.6	9.0	8.9	8.4	8.2	8.0	9.3	9.3	7.7	6.8	8.1
1999	4.2	4.0	7.4	5.5	7.6	7.1	6.0	8.0	8.6	8.7	8.9	8.9	7.1
2000	6.6	7.0	7.9	8.0	7.0	7.4	6.8	8.6	9.6	9.4	7.1	7.0	7.7
2001	5.9	3.9	6.8	8.9	8.3	8.7	7.5	9.3	9.3	10.4	9.7	7.0	8.0
2002	8.6	8.3	8.1	8.9	9.3	6.6	8.7	8.4	9.2	9.6	9.3	8.5	8.6
2003	6.6	7.8	7.1	9.4	9.1	6.6	7.8	8.9	9.4	10.0	9.6	9.0	8.4
2004	6.6	6.7	7.1	6.7	7.3	6.3	6.9	8.6	8.7	8.5	8.7	5.8	7.3
2005	7.3	8.7	9.3	8.8	9.0	8.1	8.1	9.4	8.7	9.9	9.3	6.4	8.6
2006	7.4	8.7	5.9	7.9	7.2	7.1	7.5	8.3	9.0	9.2	8.7	8.2	7.9
2007	4.6	7.7	7.9	8.4	7.6	7.6	6.6	8.7	9.1	9.6	8.9	6.0	7.7
2008	6.9	8.8	8.0	8.4	8.2	7.6	7.4	8.5	8.5	9.6	8.8	6.1	8.1
2009	6.4	7.9	7.7	7.3	7.9	7.5	6.9	8.6	8.1	8.3	8.6	8.2	7.8
2010	8.1	5.7	7.2	6.3	7.0	5.5	5.6	7.2	8.6	7.9	8.7	6.1	7.0
2011	5.8	8.7	7.6	7.7	7.5	8.1	6.4	8.0	8.7	8.2	8.7	8.8	7.9
2012	5.6	8.4	7.7	7.1	8.3	7.2	6.7	8.6	8.5	8.8	9.8	7.5	7.9
2013	5.3	6.9	8.2	8.0	7.5	5.1	7.4	8.1	7.7	8.7	9.8	7.6	7.5
2014	6.6	5.7	8.6	6.9	7.2	6.4	6.3	8.2	8.7	8.2	8.8	6.7	7.4
LTM	**6.9**	**7.3**	**7.7**	**8.0**	**8.0**	**7.5**	**7.4**	**8.7**	**9.0**	**9.2**	**9.1**	**7.4**	**8.0**
MAX	**9.7**	**10.0**	**10.0**	**9.5**	**9.4**	**8.7**	**9.1**	**10.1**	**10.0**	**10.5**	**10.5**	**9.4**	**8.8**
MIN	**4.2**	**3.9**	**5.9**	**5.5**	**5.7**	**5.1**	**5.6**	**7.2**	**7.5**	**7.9**	**7.1**	**5.2**	**6.8**

Avg Daily Wind Run (1971~2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1971	103.0	141.0	138.9	147.9	125.6	141.6	127.5	146.4	197.1	221.9	202.9	144.9	153.2
1972	93.3	122.6	116.5	135.0	109.6	92.7	135.4	154.1	176.8	242.2	227.3	152.0	146.5
1973	141.6	129.4	131.5	134.3	114.7	129.5	133.5	160.2	173.3	232.2	191.2	158.0	152.5
1974	33.2	3.4	5.3	110.3	47.6	32.0	21.9	2.6	5.9	221.1	192.4	159.5	69.6
1975	174.5	116.4	155.9	108.1	71.8	91.4	89.7	133.2	170.2	126.4	165.9	102.5	125.5
1976	121.0	110.5	140.7	107.1	88.4	105.5	113.8	137.3	200.4	198.3	153.0	100.3	131.4
1977	113.0	155.2	136.8	172.7	135.4	128.9	169.8	188.4	232.2	267.5	202.4	128.0	169.2
1978	126.5	125.2	128.3	127.2	119.8	125.5	127.5	138.6	184.5	181.4	213.9	160.9	146.6
1979	171.6	167.5	142.7	150.8	138.9	143.1	149.6	174.7	187.7	218.6	231.5	183.3	171.7
1980	109.8	87.1	109.7	98.7	90.2	88.8	123.6	130.5	136.7	153.2	129.8	103.3	113.5
1981	64.8	68.4	76.5	83.1	65.2	77.8	247.3	123.7	137.1	246.0	215.2	172.2	131.4
1982	96.6	107.1	129.3	136.2	124.1	125.4	123.0	172.3	211.6	203.1	295.6	166.5	157.6
1983	167.7	136.6	124.9	166.6	86.7	99.7	88.4	101.8	118.7	147.4	160.2	110.5	125.8
1984	159.7	128.9	159.8	166.0	144.9	152.7	187.6	201.0	248.7	264.0	251.4	186.7	187.6
1985	125.8	122.2	133.0	141.7	140.5	143.6	155.7	231.2	239.8	246.8	221.8	143.7	170.5
1986	134.2	131.1	137.0	139.9	132.9	140.1	168.1	158.2	246.8	263.6	233.6	174.4	171.7
1987	137.0	168.8	168.5	181.9	178.8	155.9	180.8	255.4	292.6	318.8	303.5	170.9	209.4
1988	132.1	140.7	137.1	416.3	273.0	151.5	167.9	225.9	283.1	243.8	242.4	222.6	219.7
1989	157.1	77.5	136.9	80.9	98.5	87.7	87.1	113.9	187.3	236.2	229.3	161.0	137.8
1990	116.6	127.8	160.0	157.6	141.4	123.0	162.2	189.6	203.2	231.5	258.2	218.7	174.2
1991	150.2	117.2	160.7	148.6	154.3	127.4	143.1	177.9	182.3	249.5	237.5	218.7	172.3
1992	176.6	187.4	172.1	190.9	160.0	143.8	186.5	185.2	234.3	242.9	250.6	137.9	189.0
1993	134.1	142.2	163.0	171.6	124.6	139.7	167.7	195.3	250.2	312.9	286.3	248.3	194.7
1994	176.5	156.8	155.3	211.3	185.5	172.6	217.7	258.3	281.5	331.5	240.3	189.7	214.8
1995	139.1	160.0	219.3	183.5	190.0	154.6	187.0	254.5	274.5	221.7	276.4	193.3	204.5
1996	129.9	139.9	136.8	195.6	162.4	145.1	151.3	183.0	362.8	259.7	248.5	156.9	189.3
1997	117.9	120.2	173.4	228.2	138.2	119.3	173.6	205.4	248.6	296.4	217.7	193.0	186.0
1998	128.3	137.4	171.1	180.6	127.7	230.8	185.5	220.1	269.9	293.9	247.1	160.2	196.1
1999	113.9	107.2	175.4	148.9	136.8	134.6	176.3	197.9	226.2	305.6	213.6	215.8	179.4
2000	169.1	105.9	111.9	168.3	148.2	195.4	153.4	231.8	222.5	296.9	167.0	155.4	177.2
2001	126.8	99.6	138.1	152.2	160.5	159.9	168.5	136.3	196.1	274.5	240.0	150.1	166.9
2002	159.5	134.4	151.5	160.8	139.9	142.7	132.7	194.0	261.4	282.8	266.6	199.4	185.5
2003	127.7	128.1	134.4	151.2	152.3	132.8	183.4	182.4	228.4	242.9	244.7	175.9	173.7
2004	149.9	120.7	130.1	147.4	119.8	120.1	113.9	181.2	224.6	252.5	174.1	107.2	153.5
2005	126.3	142.3	140.0	160.2	211.2	157.6	161.4	166.4	206.4	252.0	211.6	129.2	172.1
2006	103.6	111.8	122.9	145.0	119.1	133.6	146.0	172.5	227.6	249.7	211.8	136.9	156.7
2007	99.3	96.0	110.4	132.0	138.7	126.7	136.1	173.7	219.1	236.2	191.1	95.7	146.3
2008	89.2	114.1	118.8	157.6	135.0	133.8	151.3	153.2	181.5	257.6	237.3	121.3	154.2
2009	78.8	121.4	125.0	132.3	115.8	120.6	137.4	180.4	217.1	256.6	201.0	141.7	152.3
2010	146.6	108.8	135.1	123.4	114.9	126.3	160.4	174.7	221.9	206.4	193.8	125.8	153.2
2011	81.7	141.9	140.9	137.4	120.8	113.9	123.0	152.9	202.6	182.8	198.9	155.2	146.0
2012	69.7	93.7	112.0	116.5	139.2	132.2	127.6	163.6	183.3	226.9	239.8	150.5	146.3
2013	74.7	79.7	139.5	132.5	123.2	80.1	110.9	127.4	156.6	202.0	204.6	169.0	133.4
2014	74.1	67.8	92.5	118.0	100.7	86.9	111.3	151.0	162.5	209.9	193.2	120.0	124.0
LTM	**121.8**	**118.7**	**134.0**	**151.8**	**132.9**	**128.8**	**147.0**	**171.8**	**210.8**	**241.1**	**220.8**	**158.3**	**162.1**
MAX	**176.6**	**187.4**	**219.3**	**416.3**	**273**	**230.8**	**247.3**	**258.3**	**362.8**	**331.5**	**303.5**	**248.3**	**219.7**
MIN	**33.2**	**3.4**	**5.3**	**72.5**	**47.6**	**32.0**	**21.9**	**2.6**	**5.9**	**126.4**	**129.8**	**95.7**	**69.6**

Humidity(1971~2014)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1971	74	75	73	71	70	71	66	59	54	53	55	69	66
1972	82	73	82	73	67	79	69	59	52	49	58	68	68
1973	69	71	79	72	65	70	66	60	54	52	48	72	65
1974	74	83	78	77	77	67	67	56	54	62	52	64	68
1975	80	81	76	77	69	72	63	58	60	58	61	65	68
1976	76	70	62	69	70	70	66	59	54	53	55	69	64
1977	69	82	82	77	74	74	67	59	54	49	55	77	68
1978	82	80	80	75	71	66	63	58	50	51	59	90	69
1979	80	81	78	80	74	72	61	54	53	59	62	67	68
1980	75	71	65	69	63	66	55	54	53	50	47	63	61
1981	62	83	62	49	51	48	50	39	35	39	41	56	51
1982	84	86	79	61	57	50	56	41	40	46	45	46	58
1983	60	76	65	48	47	48	48	46	29	37	36	60	50
1984	49	80	78	58	50	53	45	40	32	32	49	67	53
1985	77	85	83	76	58	51	45	43	34	35	46	73	59
1986	87	81	70	61	45	48	44	31	35	47	50	64	55
1987	73	68	51	45	43	48	41	42	35	39	38	51	48
1988	64	83	85	77	61	49	47	42	37	44	45	60	58
1989	57	88	86	84	70	60	50	41	36	37	37	58	59
1990	79	83	55	47	56	52	44	44	39	32	45	50	52
1991	70	78	85	74	53	51	50	42	31	35	50	46	55
1992	52	42	52	46	45	52	50	44	32	31	47	65	47
1993	81	81	71	52	44	53	52	44	36	42	51	48	55
1994	66	61	60	63	47	50	50	45	37	45	37	53	51
1995	78	70	56	49	55	53	48	43	34	29	48	78	53
1996	80	87	87	82	69	59	54	42	36	33	43	66	62
1997	84	91	87	84	72	59	62	42	53	55	48	79	68
1998	87	87	85	73	52	51	50	50	36	43	58	77	62
1999	88	89	88	85	75	66	60	51	42	43	50	58	66
2000	74	86	87	87	83	79	70	57	39	40	69	75	71
2001	84	91	89	85	81	67	60	48	38	37	56	74	68
2002	82	82	71	58	48	55	45	45	40	47	48	58	57
2003	84	86	87	83	68	65	60	45	40	46	58	72	66
2004	77	85	87	87	83	71	60	45	41	56	63	81	70
2005	87	84	76	54	51	52	53	36	37	41	50	79	58
2006	86	87	90	86	77	69	59	44	43	41	46	65	66
2007	89	86	85	83	73	61	58	44	38	39	58	79	66
2008	87	83	84	66	54	51	48	42	35	38	42	76	59
2009	85	86	85	81	70	55	58	44	36	40	49	66	63
2010	52	76	84	84	66	60	60	49	37	39	45	77	61
2011	84	79	78	74	54	46	50	45	35	43	47	52	57
2012	77	82	69	60	48	50	44	40	35	38	41	62	54
2013	82	84	77	56	45	49	51	37	32	47	46	62	56
2014	84	88	85	81	66	56	51	43	38	37	41	60	61
LTM	76.2	80.2	76.7	69.9	61.7	59	54.9	46.6	40.7	43.4	49.4	65.8	60.4
MAX	89	91	90	87	83	79	70	60	60	62	69	90	70.5
MIN	49	42	51	45	43	46	41	31	29	29	36	46	46.5

Annex 10.
Total Project Cost
(With Illovo)

Annex 10. Total Project Cost (With Illovo)

1. Intake and Sandtrap

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
1	Total : Intake Q=50.2				4,000,000
1.1.1	Embankment	6,300	㎥	3.50	22,018
1.1.2	Sheetpile(400*150*13)	450	EA	49.50	22,275
1.1.3	Porterage and Manufacture	45%		22,275	10,023
1.1.4	Cofferdam section	40%		44,293	17,717
1.2.1	Excavation	25,675	㎥	0.84	21,489
1.2.2	Backfill	20,540	㎥	0.90	18,527
1.2.3	Con'C	4,182	㎥	151.10	632,824
1.2.4	Plate form	1,742	㎡	13.89	24,192
1.2.5	Reinforcing steel	280.20	Ton	1,377	385,835
1.2.6	Sand foundation	6,535	㎥	30.77	201,705
1.2.7	GATE(3.0*4.0)	12	EA	4,600	55,200
1.2.8	Winch	12	EA	3,157	37,884
1.2.9	Spindle	96	m	310	29,760
1.2.10	Porterage and Manufacture	45%		122,844	55,279
1.3.1	Administrative buildings & other	1	EA	2,672,731	2,672,731

2. Feeder Canal(Q=50.2㎥/s Lined Canal)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
2	Total : Feeder Canal	46,800	m		33,100,000
2.1.1	Cutting(earth)	890,329	㎥	2.21	1,966,736
2.1.2	Cutting(rock)	345,000	㎥	4.10	1,414,845
2.1.3	Embankment	1,186,649	㎥	3.50	4,147,338
2.1.4	Lined sod	342,551	㎡	0.74	254,515
2.1.5	Lining(t=0.10)	106,293	㎥	143.37	15,239,227
2.1.6	Reinforcing steel	2,112	Ton	1,377	2,908,224
2.2.1	Excavation	20,118	㎥	0.84	16,838
2.2.2	Backfill	16,094	㎥	0.90	14,517
2.2.3	Con'C(Plain)	2,350	㎥	143.37	336,879
2.2.4	Con'C(Reinforced)	14,384	㎥	151.10	2,173,399
2.2.5	Plate form	43,967	㎡	13.89	610,608
2.2.6	Reinforcing steel	2,470	Ton	1,377	3,400,987
2.2.7	Concrete pipe	3,132	m	172.31	539,665
2.2.8	Sand foundation	1,933	㎥	30.77	59,482
2.2.9	GATE(2.5*2.8)	2	EA	950	1,900
2.2.10	GATE(1.2*2.4)	5	EA	420	2,100
2.2.11	Spindle	28	m	210	5,880
2.2.12	Winch	7	EA	411	2,877
2.2.13	Porterage and Manufacture	30%		12,757	3,827
2.2.14	Others				156

3. Illovo Canal (Q=11.8㎥/s Lined Canal)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
3	Total : Illovo Canal	11,500	m		5,900,000
3.1.1	Cutting(earth)	82,110	㎥	2.21	181,380
3.1.2	Embankment	94,185	㎥	3.50	329,176
3.1.3	Lined sod	42,340	㎡	0.74	31,443
3.1.4	Lining(t=0.10)	12,650	㎥	143.37	1,813,630
3.1.5	Reinforcing steel	515	Ton	1,377	709,155
3.2.1	Excavation	6,185	㎥	0.84	5,176
3.2.2	Backfill	4,948	㎥	0.90	4,463
3.2.3	Con'C(Plain)	565	㎥	143.37	81,004
3.2.4	Con'C(Reinforced)	3,623	㎥	151.10	547,435
3.2.5	Plate form	93,782	㎡	13.89	1,302,444
3.2.6	Reinforcing steel	587	Ton	1,377	808,299
3.2.7	Concrete pipe	357	m	172.31	61,513
3.2.8	Sand foundation	597	㎥	30.77	18,369
3.2.9	GATE(1.2*2.4)	2	EA	420	840
3.2.10	Spindle	8	m	210	1,680
3.2.11	Winch	2	EA	411	822
3.2.12	Porterage and Manufacture	30%		3,342	1,002
3.2.13	Others				2,169

4. Bangula Canal (Q=29.9㎥/s Lined Canal)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
4	Total : Bangula Canal	L=94,300	m		51,200,000
4.1	Bangula Canal A	L=14,780	m		7,800,000
4.1.1	Cutting(earth)	263,864	㎥	2.21	582,875
4.1.2	Embankment	258.375	㎥	3.50	903,020
4.1.3	Lined sod	68,275	㎡	0.74	50,728
4.1.4	Lining(t=0.10)	25,703	㎥	143.37	3,685,039
4.1.5	Reinforcing steel	293	Ton	1,377	403,461
4.2.1	Excavation	10,103	㎥	0.84	8,456
4.2.2	Backfill	8,082	㎥	0.90	7,290
4.2.3	Con’C(Plain)	809	㎥	143.37	115,986
4.2.4	Con’C(Reinforced)	4,601	㎥	151.10	695,211
4.2.5	Plate form	14,098	㎡	13.89	195,793
4.2.6	Reinforcing steel	749	Ton	1,377	1,031,373
4.2.7	Concrete pipe	570	m	172.31	98,214
4.2.8	Sand foundation	387	㎥	30.77	11,907
4.2.9	GATE(1.2*2.4)	3	EA	420	1,260
4.2.10	Spindle	12	m	210	2,520
4.2.11	Winch	3	EA	411	1,233
4.2.12	Porterage and Manufacture	30%		5,013	1,503
4.2.13	Others				4,131
4.3	Zone A Canal	L=3,640	m		11,600,000
4.3.1	Excavation	258,440	㎥	0.84	216,314
4.3.2	Backfill	167,440	㎥	0.90	151,030
4.3.3	Con’C(Reinforced)	38,169	㎥	151.10	5,767,335
4.3.4	Con’C(Plain)	4,331	㎥	143.37	620,935
4.3.5	Reinforcing steel	2,143	Ton	1,377	2,950,911
4.3.6	Plate form	97,290	㎡	13.89	1,351,163
4.3.7	Sand foundation	17,180	㎥	31	528,611
4.3.8	Others				13,701
4.4	Bangula Canal(Phase Ⅱ)	75,900	m		31,800,000
4.4.1	Cutting(earth)	993,635	㎥	2.21	2,194,939

4.4.2	Embankment	972,966	㎥	3.50	3,400,516
4.4.3	Lined sod	257,105	㎡	0.74	191,029
4.4.4	Lining(t=0.10)	96,792	㎥	143.37	13,873,069
4.4.5	Reinforcing steel	1,104	Ton	1,377	1,520,208
4.5.1	Excavation	49,939	㎥	0.84	41,798
4.5.2	Backfill	39,951	㎥	0.90	36,035
4.5.3	Con'C(Plain)	3,948	㎥	143,37	566,024
4.5.4	Con'C(Reinforced)	22,266	㎥	151.10	3,364,392
4.5.5	Plate form	67,747	㎡	13.89	940,870
4.5.6	Reinforcing steel	3,700	Ton	1,377	5,094,900
4.5.7	Concrete pipe	2,895	m	172.31	498.828
4.5.8	Sand foundation	1,670	㎥	30.77	51,384
4.5.9	GATE(1.2*2.4)	9	EA	420	3,780
4.5.10	Spindle	36	m	210	7,560
4.5.11	Winch	9	EA	411	3,669
4.5.12	Porterage and Manufacture	30%		15,039	4,511
4.5.13	Others				2,458

5. Branch Canal

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
5	Total : Branch Canal		m		12,800,000
5.1	Branch Canal Phase Ⅰ		m		5,800,000
5.1.1	Cutting(earth)	195,956	㎥	2.21	432,866
5.1.2	Embankment	186,461	㎥	3.50	651,681
5.1.3	Lined sod	76,544	㎡	0.74	56,872
5.1.4	Lining(t=0.10)	18,623	㎥	143.37	2,669,979
5.1.5	Reinforcing steel	552	Ton	1,377	760,104
5.2.1	Excavation	2,016	㎥	0.84	1,687
5.2.2	Backfill	-	㎥	0.90	
5.2.3	Con'C(Plain)	300	㎥	143.37	43,011
5.2.4	Con'C(Reinforced)	2,923	㎥	151.10	441,665
5.2.5	Plate form	10,435	㎡	13.89	144,921
5.2.6	Reinforcing steel	185	Ton	1,377	254,745
5.2.7	Concrete pipe	1,680	m	172.31	289,475
5.2.8	Sand foundation	-	㎥	30.77	-
5.2.9	GATE(1.2*2.4)	24	EA	420	10,080
5.2.10	Spindle	96	m	210	20,160
5.2.11	Winch	24	EA	411	9,864
5.2.12	Porterage and Manufacture	30%		40,104	12,031
5.2.13	Others				859
5.3	Branch Canal Phase Ⅱ		m		7,000,000
5.3.1	Cutting(earth)	269,332	㎥	2.21	594,954
5.3.2	Embankment	231,284	㎥	3.50	808,337
5.3.3	Lined sod	94,485	㎡	0.74	70,202
5.3.4	Lining(t=0.10)	21,925	㎥	143.37	3,143,387
5.3.5	Reinforcing steel	650	Ton	1,377	895,050
5.4.1	Excavation	2,352	㎥	0.84	1,968
5.4.2	Backfill	-	㎥	0.90	-
5.4.3	Con'C(Plain)	362	㎥	143.37	51,899
5.4.3	Con'C(Reinforced)	3,545	㎥	151.10	535,649
5.4.4	Plate form	12,425	㎡	13.89	172,558

5.4.5	Reinforcing steel	218	Ton	1,377	300,186
5.4.6	Concrete pipe	2,170	m	172.31	373,906
5.4.7	Sand foundation	-	㎥	30.77	
5.4.8	GATE(1.2*2.4)	22	EA	420	9,240
5.4.9	Spindle	88	m	210	18,480
5.4.10	Winch	22	EA	411	9,042
5.4.11	Porterage and Manufacture	30%		36,762	11,028
5.4.12	Others				4,114

6. Land Consolidation

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
	Total : Land Consolidation		ha		317,520,000
6	Land Consolidation Phase Ⅰ		ha		119,520,000
6.1	Canal				22,950,000
6.1.1	Zone Ⅰ-1	6,670	ha	1,465	9,780,000
6.1.2	Zone Ⅰ-2 L1	16,300	m	179.55	2,930,000
6.1.3	Zone Ⅰ-2 M1	17,800	m	166.73	2,970,000
6.1.4	Zone A	4,959	ha	1,465	7,270,000
6.2	Leveling				77,250,000
6.2.1	Zone Ⅰ-1	6,670	ha	6,642	44,310,000
6.2.2	Zone Ⅰ-2	-	ha	6,642	-
6.2.3	Zone A	4,959	ha	6,642	32,940,000
6.3	Others(Road & Drainage)				19,320,000
6.3.1	Zone Ⅰ-1	6,670	ha	1,660	11,080,000
6.3.2	Zone Ⅰ-2	-	ha	1,660	-
6.3.3	Zone A	4,959	ha	1,660	8,240,000
7	Land Consolidation Phase Ⅱ		ha		197,990,000
7.1	Canal				30,380,000
7.1.1	Zone B	6,179	ha	1,465	9,060,000
7.1.2	Zone B - Alumenda	7,100	m	111.55	790,000
7.1.3	Zone C	10,749	m	1,465	15,750,000
7.1.4	Zone D	3,257	ha	1,465	4,780,000
7.2	Leveling				134,090,000
7.2.1	Zone B	6,179	ha	6,642	41,050,000
7.2.2	Zone C	10,749	ha	6,642	71,400,000
7.2.3	Zone D	3,257	ha	6,642	21,640,000
7.3	Others(Road & Drainage)				33,520,000
7.3.1	Zone B	6,179	ha	1,660	10,260,000
7.3.2	Zone C	10,749	ha	1,660	17,875,000
7.3.3	Zone D	3,257	ha	1,660	5,410,000

Annex 11.
Total Project Cost
(Without Illovo)

Annex 11. Total project Cost (Without Illovo)

1. Intake and Sandtrap(Q=35.1㎥/s)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
1	Total : Intake Q=35.1				3,380,000
1.1.1	Embankment	6,300	㎥	3.50	22,018
1.1.2	Sheetpile(400*150*13)	450	EA	49.50	22,275
1.1.3	Porterage and Manufacture	45%		22,275	10,023
1.1.4	Cofferdam section	40%		44,293	17,717
1.2.1	Excavation	19,635	㎥	0.84	16,435
1.2.2	Backfill	15,708	㎥	0.90	14,169
1.2.3	Con'C	2,892	㎥	151.10	436,943
1.2.4	Plate form	1,694	㎡	13.89	23,526
1.2.5	Reinforcing steel	201.45	Ton	1,377	277,396
1.2.6	Sand foundation	4,390	㎥	30.77	135,083
1.2.7	GATE(3.0*4.0)	9	EA	4,600	41,400
1.2.8	Winch	9	EA	3,157	28,413
1.2.9	Spindle	72	m	310	29,760
1.2.10	Porterage and Manufacture	45%		122,844	44,807
1.3.1	Administrative buildings & other	1	EA	2,272,731	2,260,035

2. Feeder Canal(Q=35.1㎥/s Lined Canal)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
2	Total : Feeder Canal	46,800	m		29,900,000
2.1.1	Cutting(earth)	861,960	㎥	2.21	1,904,069
2.1.2	Cutting(rock)	302,800	㎥	4.10	1,241,782
2.1.3	Embankment	1,004284	㎥	3.50	3,509,972
2.1.4	Lined sod	293,333	㎡	0.74	217,946
2.1.5	Lining(t=0.10)	92,857	㎥	143.37	13,312,908
2.1.6	Reinforcing steel	1,847	Ton	1,377	2,543,319
2.2.1	Excavation	20,118	㎥	0.84	16,838
2.2.2	Backfill	16,094	㎥	0.90	14,517
2.2.3	Con'C(Plain)	2,350	㎥	143.37	336,879
2.2.4	Con'C(Reinforced)	14,384	㎥	151.10	2,173,399
2.2.5	Plate form	43,967	㎡	13.89	610,608
2.2.6	Reinforcing steel	2,470	Ton	1,377	3,400,987
2.2.7	Concrete pipe	3,132	m	172.31	539,665
2.2.8	Sand foundation	1,933	㎥	30.77	59,482
2.2.9	GATE(2.5*2.8)	2	EA	950	1,900
2.2.10	GATE(1.2*2.4)	5	EA	420	2,100
2.2.11	Spindle	28	m	210	5,880
2.2.12	Winch	7	EA	411	2,877
2.2.13	Porterage and Manufacture	30%		12,757	3,827
2.2.14	Others				1,048

Annex 12.
Feeder Canal Cost
(Lining Canal)

Annex 12. Feeder Canal Cost (Lining Canal)

1. Feeder Canal(Q=50.1㎥/s Earth Canal)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
1	Total : Feeder Canal	46,800	m		26,100,000
1.1.1	Cutting(earth)	1,715,442	㎥	2.21	3,789,411
1.1.2	Cutting(rock)	985,000	㎥	4.10	4,039,485
1.1.3	Embankment	2,558,604	㎥	3.50	8,942,320
1.1.4	Lined sod	591,911	㎡	0.74	439,789
1.2.1	Excavation	21,023	㎥	0.84	17,956
1.2.2	Backfill	16,818	㎥	0.90	15,170
1.2.3	Con'C(Plain)	3,101	㎥	143.37	444,567
1.2.4	Con'C(Reinforced)	18,885	㎥	151.10	2,853,542
1.2.5	Plate form	59,548	㎡	13.89	827,006
1.2.6	Reinforcing steel	2,687	Ton	1,377	3,699,649
1.2.7	Concrete pipe	5,220	m	172.31	899,442
1.2.8	Sand foundation	3,544	㎥	30.77	109,051
1.2.9	GATE(2.5*2.8)	2	EA	950	1,900
1.2.10	GATE(1.2*2.4)	5	EA	420	2,100
1.2.11	Spindle	28	m	210	5,880
1.2.12	Winch	7	EA	411	2,877
1.2.13	Porterage and Manufacture	30%		12,757	3,827
1.2.14	Others				6,338

Annex 13.
Illovo Canal Cost

Annex 13. Illovo Canal Cost

1. Concrete Canal (Q=11.8㎥/s)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
1	Total : Feeder Canal	11,500	m		16,700,000
1.1.1	Cutting(earth)	97,980	㎥	2.21	216,437
1.1.2	Embankment	104,535	㎥	3.50	365,349
1.1.3	Lined sod	47,150	㎡	0.74	35,032
1.1.4	Con'C(Reinforced)	37,364	㎥	151.10	5,645,700
1.1.5	Con'C(Plain)	11,253	㎥	143.37	1,613,342
1.1.6	Reinforcing steel	3,349	Ton	1,377	4,611,573
1.1.7	Plate form	92,313	㎡	13.89	1,282,042
1.1.8	Backfill	84,401	㎥	0.90	76,129
1.1.9	Sand foundation	16,000	㎥	30.77	492,304
1.2.1	Excavation	1,097	㎥	0.84	918
1.2.2	Backfill	878	㎥	0.90	791
1.2.3	Con'C(Plain)	10,024	㎥	143.37	1,437,140
1.2.4	Con'C(Reinforced)	1,653	㎥	151.10	249,768
1.2.5	Plate form	5,859	㎡	13.89	81,369
1.2.6	Reinforcing steel	393	Ton	1,377	541,161
1.2.7	Concrete pipe	216	m	172.31	37,218
1.2.8	Sand foundation	293	㎥	30.77	9,015
1.2.9	GATE(1.2*2.4)	1	EA	420	420
1.2.10	Spindle	4	m	210	840
1.2.11	Winch	1	EA	411	411
1.2.12	Porterage and Manufacture	30%		1,671	501
1.2.13	Others				2,540

2. Pipe Canal (Q=11.8㎥/s)

Item	Description	Quantity	Unit	Unit Cost(USD)	Cost(USD)
2	Total : Feeder Canal	9,600	m		34,600,000
2.1.1	Cutting(earth)	460,800	㎥	2.21	1,017907
2.1.2	Embankment	14,400	㎥	3.50	50,328
2.1.3	Lined sod	20,160	㎡	0.74	14,978
2.1.4	Backfill	184,320	㎥	0.90	166,256
2.1.5	Sand foundation	26,400	㎥	30.77	812,301
2.1.6	D=1900mm	19,200	m	1,485	28,512.000
2.1.7	Porterage and Manufacture	13	%	28,512,000	3,585,098
2.2.1	Excavation	709	㎥	0.84	593
2.2.2	Backfill	567	㎥	0.90	511
2.2.3	Con'C(Plain)	124	㎥	143.37	17,777
2.2.4	Con'C(Reinforced)	986	㎥	151.10	148,924
2.2.5	Plate form	3,154	㎡	13.89	43,801
2.2.6	Reinforcing steel	51	Ton	1,377	69,979
2.2.5	Concrete pipe	887	m	172.31	152,836
2.2.6	Others				6,711

Annex 14.
Cost Estimation of SVIP

Annex 14. Cost Estimation of SVIP

BREAKDOWN OF UNIT PRICE

Item No : SVIP-1
Work Item : Cutting
Unit Price : USD 2.209 Equivalent : MK 1,435 / m³

Unit : 1 m³

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Porterage(10%) Semiskilled Labour 0.1man		
cost : 1.538 X 0.1 X 10% = 0.015		
· Porterage(10%)) Cultivator 1ton		
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96		
L=50m, V1=57, V2=83, T=11		
cm=(L/V1+L/V2) + T = 1.22min		
Q=60*q*F*E/cm = 76.09 m³/hr		
cost : 2.000 / 76.09 X 10% = 0.002		
1) Sub Total of 1	0.017	0.017
2. Equipment		
· Cutting(90%)) Bulldozer 19ton		
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.55, e=0.96		
L=20m, V1=40, V2=70, T=0.25		
cm=(L/V1+L/V2) + T = 1.18 min		
Q=60*q*F*E/cm = 81.17 m³/hr		
cost : 87 / 81.17 X 90% = 0.964		
· Porterage(90%) Bulldozer 19ton		
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96		
L=30m, V1=55, V2=70, T=0.25		
cm=(L/V1+L/V2) + T = 1.22 min		
Q=60*q*F*E/cm = 76.14 m³/hr		
cost : 87 / 76.14 X 90% = 1.028		
1) Sub Total of 2	1.992	1.992
2. Direct Cost	2.009	2.009
3.Over head and profit	0.200	0.200
(10 % of Direct Cost)		
TOTAL	2.209	2.209

BREAKDOWN OF UNIT PRICE

Item No : SVIP-2

Work Item : Cutting(Rock)

Unit Price : USD 4.101 Equivalent : MK 2,665 / m³

Unit : 1 m³

Description									Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Equipment										
· Hydraulic Ripper 20ton			Bulldozer 19ton							
F=1.00/1.00=1.0, E=0.60, An=0.30										
L=20m										
cm=(0.05*L) +0.25 =			1.25	min						
Q=60*An* L *F*E/cm =			120.80	m³/hr			173			
cost :	89	/	120.8	X	100%	=	0.736			
· Bulldozer 19ton			Lodder							
q=3.2*0.96=3.07, F=1.00/1.30=0.77, E=0.35										
L=20m, V1=40, V2=46, T=0.25										
cm=(L/V1+L/V2) + T =			1.18	min						
Q=60*q*F*E/cm =			29.07	m³/hr			42.1			
cost :	87	/	29.07	X	100%	=	2.993			
1) Sub Total of 2									3.729	3.729
2. Direct Cost									3.729	3.729
3.Over head and profit									0.372	0.372
(10 % of Direct Cost)										
TOTAL									4.101	4.101

BREAKDOWN OF UNIT PRICE

Item No : SVIP-3

Work Item : Embankment

Unit Price : USD 3.495 Equivalent : MK 2,271 / m³

Unit : 1 m³

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Porterage(10%) Semiskilled Labour 0.1man		
cost : 1.538 X 0.1 X 10% = 0.015		
· Porterage(10%)) Cultivator 1ton		
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96		
L=50m, V1=57, V2=83, T=11		
cm=(L/V1+L/V2) + T = 1.22min		
Q=60*q*F*E/cm = 76.09 m³/hr		
cost : 2.000 / 76.09 X 10% = 0.002		
1) Sub Total of 1	1.045	1.045
2. Equipment		
· Cutting(90%)) Bulldozer 19ton		
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.55, e=0.96		
L=20m, V1=40, V2=70, T=0.25		
cm=(L/V1+L/V2) + T = 1.03 min		
Q=60*q*F*E/cm = 70.86 m³/hr		
cost : 87 / 70.86 X 90% = 1.105		
· Porterage(90%) Bulldozer 19ton		
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96		
L=30m, V1=55, V2=70, T=0.25		
cm=(L/V1+L/V2) + T = 1.22 min		
Q=60*q*F*E/cm = 76.14 m³/hr		
cost : 87 / 76.14 X 90% = 1.028		
1) Sub Total of 2	2.133	2.133
2. Direct Cost	3.178	3.178
3.Over head and profit	0.317	0.317
(10 % of Direct Cost)		
TOTAL	3.495	3.495

BREAKDOWN OF UNIT PRICE

Item No : SVIP-4

Work Item : Lined sod

Unit Price : US$ 0.743 Equivalent : MK 482 / m³

Unit : 1 m³

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Canal cutting		
Unskilled labourer 0.02 man		
cost : 2 X 0.02 X 100% = 0.030		
Unskilled labourer 0.01 man		
cost : 5 X 0.01 X 100% = 0.046		
1) Sub Total of 1	0.076	0.076
2. Equipment		
· Canal cutting Excavated(Crawler) 0.7㎥		
q=0.7,k=0.9, F=1.00/1.25=0.8, E=0.7		
cm = 13 min		
Q=3600*q*k*F*E/cm = 2.28 m³/hr		
cost : 0.60 = 0.600		
1) Sub Total of 2	0.600	0.600
2. Direct Cost	0.676	0.676
3.Over head and profit (10 % of Direct Cost)	0.067	0.067
TOTAL	0.743	0.743

BREAKDOWN OF UNIT PRICE

Item No : SVIP-5

Work Item : Con'c(Plain)

Unit Price : US$ 143.37 Equivalent : MK 93,190 / m²

Unit : 1 m³

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Concrete placing mixer — Concrete worker 0.94man		
cost : 4.615 X 0.94 = 4.338		
· Concrete placing mixer — Unskilled labourer 0.24man		
cost : 1.538 X 0.24 = 0.369		
1) Sub Total of 1	4.707	4.707
2. Material		
· Concrete 40-13		
cost : 114.53 X 105% = 120		
1) Sub Total of 2	120	120
3. Equipment		
· Concrete Mix — Mixer 0.10㎥		
q=0.10, E=0.8		
Q=60*q*E/4 = 1.20 m³/hr		
cost : 5.000 / 1.2 X 105% = 4.375		
· Concrete Compaction — Vibrator 4.0㎥/hr		
cost : 4.000 / 4.0 = 1.000		
1) Sub Total of 3	5.375	5.375
2. Direct Cost	130.337	130.337
3.Over head and profit (10 % of Direct Cost)	13.033	13.033
TOTAL	143.370	143.370

BREAKDOWN OF UNIT PRICE

Item No : SVIP-6

Work Item : Con'c(Reinforced)

Unit Price : US$ 151.10 Equivalent : MK 98,215 /m³

Unit : 1 m³

Description								Local Currency Component: Unit Price (USD)	Local Currency Component: Amount (USD)
1. Labour									
· Concrete placing mixer			Concrete worker 0.94 man						
cost :	4.615	X	0.94	=	4.338				
· Concrete placing mixer			Unskilled labourer 0.24 man						
cost :	1.538	X	0.24	=	0.369				
1) Sub Total of 1								4.707	4.707
2. Material									
· Concrete			40-21						
cost :	121.22	X	105%	=	127				
1) Sub Total of 2								127	127
3. Equipment									
· Concrete Mix			Mixer 0.10㎥						
q=0.10, E=0.8									
Q=60*q*E/4 =			1.20	m³/hr					
cost :	5.000	/	1.2	X	105%	=	4.375		
· Concrete Compaction			Vibrator 4.0㎥/hr						
cost :	4.000	/	4.0	=	1.000				
1) Sub Total of 3								5.375	5.375
2. Direct Cost								137	137
3.Over head and profit								13.736	13.736
(10 % of Direct Cost)									
TOTAL								151.100	151.100

BREAKDOWN OF UNIT PRICE

Item No : SVIP-7

Work Item : Reinforcing steel

Unit Price : US$ 1,377.00 Equivalent : MK 895,050 / TON

Unit : 1 TON

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Manufacture and Erection		
Steel worker 2,76 man		
(Manufacture 1.07man / Erection 1.69man)		
cost : 4 X 2.76 X 0.971 = 10		
Unskilled labourer 1.04 man		
(Manufacture 0.35man / Erection 0.69man)		
cost : 2 X 1.04 X 0.971 = 1		
· Hire of Machines 가공비의 2%		
cost : 10 + 1 X 2% = -		
1) Sub Total of 1	11	11
2. Material		
· Binding Wire(0.9mm) 5.0kg		
cost : 2 X 5.0 = 11		
· Prime Cost of Reinforcing Steel 1ton		
cost : 1,231 X 1.0 = 1,230		
1) Sub Total of 2	1,241	1,241
2. Direct Cost	1,252	1,252
3.Over head and profit	125.000	125.000
(10 % of Direct Cost)		
TOTAL	1,377.00	1,377.00

BREAKDOWN OF UNIT PRICE

Item No : SVIP-8

Work Item : Excavation

Unit Price : US$ 0.837 Equivalent : MK 544 / m³

Unit : 1 m³

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Canal cutting		
Unskilled labourer 0.16 man		
cost : 1.538 X 0.16 X 10% = 0.024		
1) Sub Total of 1	0.024	0.024
2. Equipment		
· Canal cutting Excavated(Crawler) 0.7㎥		
q=0.7,k=0.9, F=1.00/1.25=0.8, E=0.7		
cm = 20min		
Q=3600*q*k*F*E/cm = 63.5 m³/hr		
cost : 52.000 / 63.5 X 90% = 0.737		
1) Sub Total of 2	0.737	0.737
2. Direct Cost	0.761	0.761
3.Over head and profit	0.076	0.076
(10 % of Direct Cost)		
TOTAL	0.837	0.837

BREAKDOWN OF UNIT PRICE

Item No : SVIP-9

Work Item : Backfill

Unit Price : US$ 0.902 Equivalent : MK 586 / m³

Unit : 1 m³

Description	Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour		
· Backfill Unskilled labourer 0.1man		
cost : 1.538 X 0.1 X 10% = 0.015		
· Compact Tamping Compactor 1.5ton		
Q=1000*V*W*D*E*F/N= 9 m³/hr		
cost : 2.000 / 9.0 X 10% = 0.022		
1) Sub Total of 1	0.037	0.037
2. Equipment		
· Backfill Excavated(Crawler) 1.0m³		
q=1.0,k=1.1, F=0.90/1.25=0.7, E=0.75 cm = 21 min		
Q=3600*q*k*F*E/cm = 101.82 m³/hr		
cost : 63.000 / 101.82 X 90% = 0.556		
· Compact Tamping Compactor 1.5ton		
Q=1000*V*W*D*E*F/N= 9.00 m³/hr		
cost : 2.000 / 9.00 X 90% = 0.200		
· Grading Unskilled labourer 0.02man		
cost : 1.538 X 0.02 X 90% = 0.027		
1) Sub Total of 2	0.783	0.783
2. Direct Cost	0.820	0.820
3.Over head and profit (10 % of Direct Cost)	0.082	0.082
TOTAL	0.902	0.902

BREAKDOWN OF UNIT PRICE

Item No : SVIP-10

Work Item : Plate form

Unit Price : US$ 13.89 Equivalent : MK 9,027 / ㎡

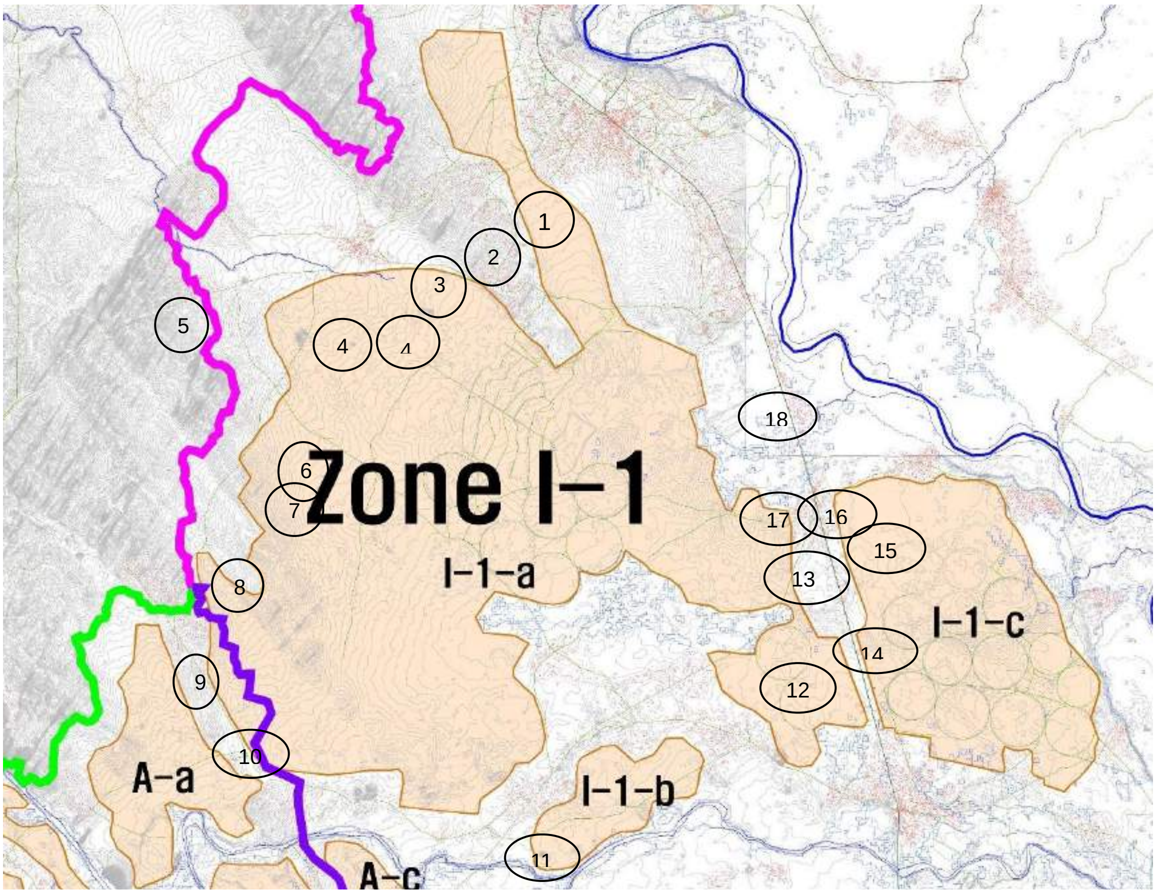
Unit : 1 ㎡

Description						Local Currency Component Unit Price (USD)	Local Currency Component Amount (USD)
1. Labour							
· Plate form				Wood worker 0.22 man			
cost :	3.076	X	0.22	=	0.676		
· Plate form				Unskilled labourer 0.12 man			
cost :	1.538	X	0.12	=	0.184		
1) Sub Total of 1						0.860	0.860
2. Material							
· Plate form			0.7931㎡				
cost :	12.307	X	0.7931	=	9.760		
· Rectangular timber			0.02926㎥				
cost :	-	X	0.02926	=	-		
· Steel wire			0.29kg				
cost :	2.307	X	0.29	=	0.669		
· Nail			0.2kg				
cost :	2.307	X	0.20	=	0.461		
· Separrating material			0.19ℓ				
cost :	4.615	X	0.19	=	0.876		
1) Sub Total of 2						11.766	11.766
2. Direct Cost						12.626	12.626
3.Over head and profit (10 % of Direct Cost)						1.262	1.262
TOTAL						13.888	13.888

Annex 15. Field Survey

Annex 15. Field Survey

[1. Zone Ⅰ-1]



Ⅰ-1(1) Location:

Coordination	691115, 8225091
The end of the village that goes to 1.2km along the S136 road from the M1 junction	
	
 	
Paved road width = 15m, road height = 2m, Drainage culvert (1,000mm x 6)	

Ⅰ-1(2) Location:

Coordination	689098, 8224169
Intersection of Branch I2(S136 Road), 0.8km of the feeder canal direction	
 	
  	
Paved road width=15m, height=0.5m, crossing of the Branch Ⅰ2	

Ⅰ-1(3) Location

Coordination	688849, 8224085
The point of going to 4.3km along the S136 road from the M1 junction	
 	
  	
Road width = 15m, road height = 2m, Drainage culvert (1,000mm x 2), starting point of drainage canal	

Ⅰ-1(4) Location :

Coordination	687771, 8223239
The crossing point between S136 road and Nthumba River	





Bridge 1(L=4m, H=2.5m) and Bridge 2(L=10m, H=2.5m) of Nthumba River

Ⅰ-1(4-1) Location :

Coordination	685723, 8222817
Branching in left direction of road through the Nthumba River along the S136 road	





Feeder canal point of the unpaved road next Living Hope Church

Ⅰ-1(5) Location ：

Coordination	686248, 8219849

Crossing point with Nthumba River that goes to 1.2km along the S136 road





Feeder canal crossing point of the unpaved road next Living Hope Church

Ⅰ-1(6)~(7)Location ：

Coordination	686248, 8219849

4.0~4.3km from the crossing point of S136 Road and Nthumba River





Feeder canal crossing point of unpaved road, height of road left and right is same

I -1(8) Location ：

Coordination	685435, 8218194
6.0km from the crossing point of S136 Road and Nthumba River	





Crossing point of Branch I5 and Feeder canal crossing point of unpaved road

I -1(9) Location ：

Coordination	685186, 8217509
The end of village is 7.2km from the crossing point of S136 Road and Nthumba River	





Crossing point of Feeder canal and unpaved road

Ⅰ-1(10) Location ：

Coordination	685656, 8216034

8.4km from the crossing point of S136 Road and Nthumba River





Passing point of Illovo canal along the left road form the Feeder canal

Ⅰ-1(11) Location ：

Coordination	690950, 8213490

next the village that is 0.4km along the way form D140 Road junction





Crossing point of the unpaved road and Branch canal

I -1(11-1) Location ：

Coordination	

Pivot irrigation site of right side, 3.0km next the junction of M1 road along the D140 Road

Whole view of command area

I -1(12) Location ：

Coordination	695638， 8217436

2.4km next the junction of M1 road along the D140 Road

Ending point of drainage canal in irrigation area

Ⅰ-1(13) Location ：

Coordination	
0.4~0.5km next the junction between M8 Road and M1 Road along the D140 Road	
  	

Ⅰ-1(14) Location ：

Coordination	696574, 8217754
1.5km next the junction of M1 Road along the D140 Road	
  	
Crossing point of Branch canal and M1 Road	

Ⅰ-1(15) Location ：

Coordination	696181, 8219298
Junction of D 143 Road from M1 Road	
  	

Ⅰ-1(15-1) Location ：

Coordination	695638， 8217436
Nearby Shire River of 2.4km along the from M1 Road to the junction of D143 Road	
	
 	
Whole view of flooding area of Shire River, and hearing of opinion	

Ⅰ-1(16) Location ：

Coordination	696055， 8219718
0.7km toward Chikwawa District from junction between D140 Road and M1 Road	
	
 	
Drainage condition for connection of drainage canal in irrigation area	

I -1(18) Location ：

Coordination	695291, 8222100

2.7km toward Chikwawa District from junction between D140 Road and M1 Road





Second-level pumping station from Shire River, and existing drainage condition for the connection of drainage canal

I -1(18-1) Location ：

Coordination	

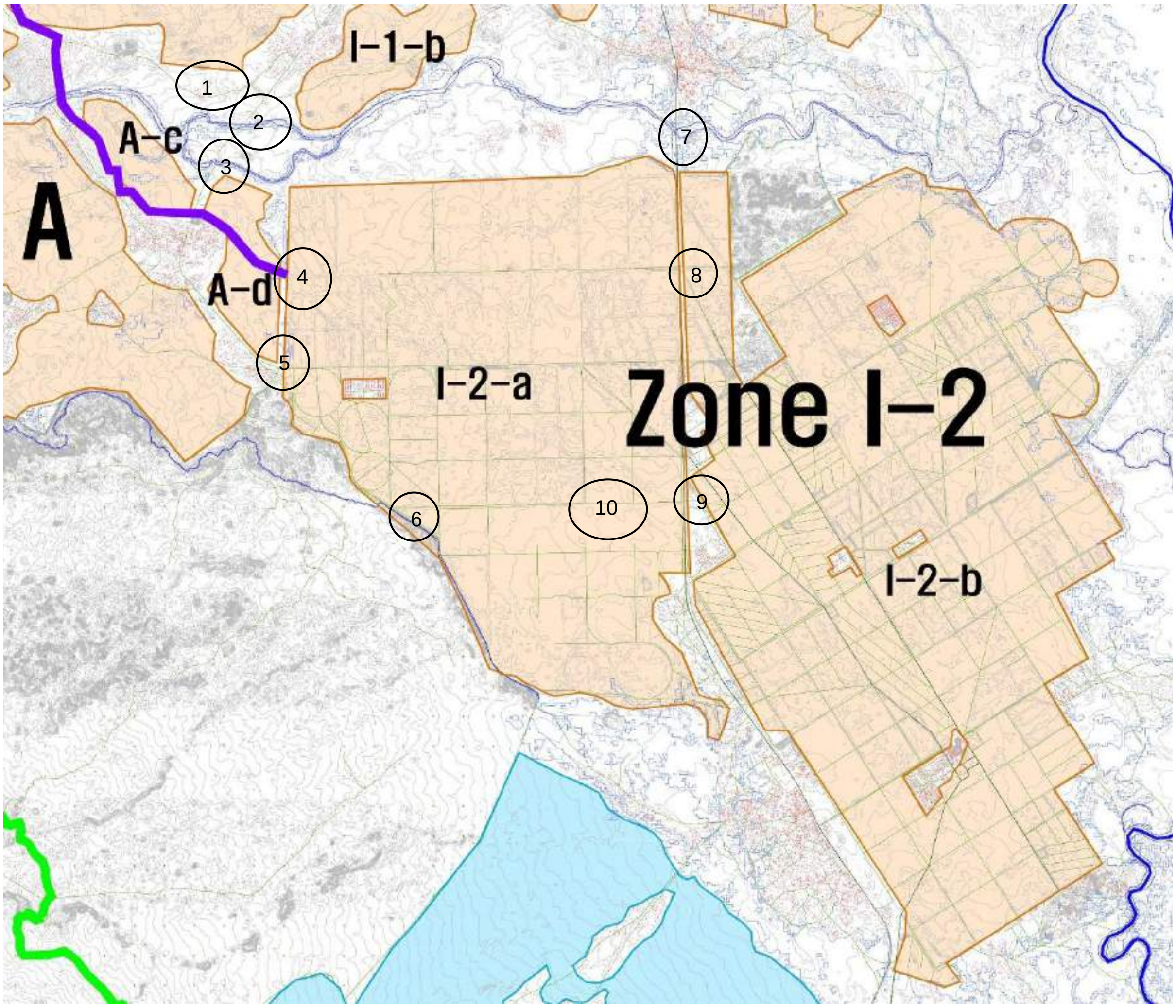
2.7km toward Chikwawa District from junction between D140 Road and M8 Road





First-level pumping station from the Shire River, and sand trap

[2. Zone Ⅰ-2]



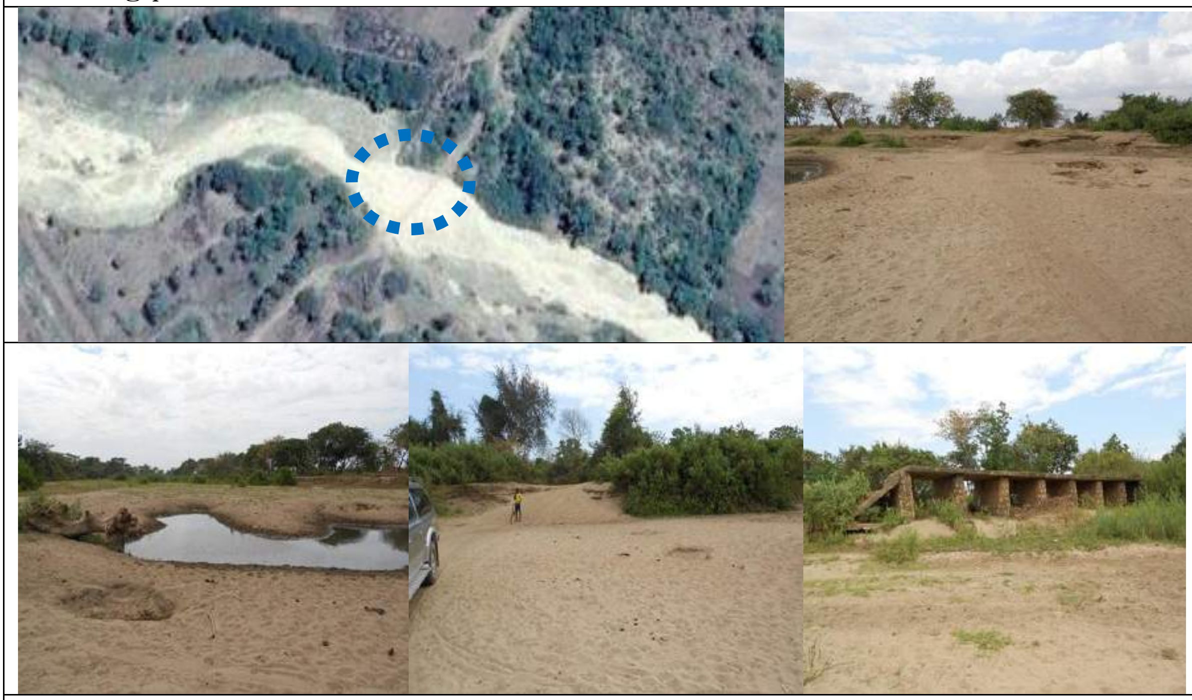
Ⅰ-2(1) Location :

Coordination	688972, 8213769
The end of village 1.4km along the junction from the D140 Road	
	
 	
Crossing point between Illovo canal and road	

Ⅰ-2(2) Location ：

Coordination	690538, 8212962
Crossing point between D140 Road and Mwanza River	
	
View of the Mwanza River	

Ⅰ-2(3) Location ：

Coordination	690420, 8212750
Crossing point between D140 Road and Mwanza River	
	
Mwanza River width 70~90m, crossing point between Illovo canal and road	

I -2(2-1) Location :

Coordination	

Crossing point between D140 Road and Mwanza River

View of the Mwanza River

I -2(4) Location :

Coordination	691143, 8210243

Boundary of Illovo Estate

Ending point of Illovo canal of Zone I-2

Status of existing water supply facilities at the ending point of Illovo canal of Zone I-2

I -2(5) Location :

Coordination	690420, 8212750
Crossing point between D140 Road and Mwanza River	

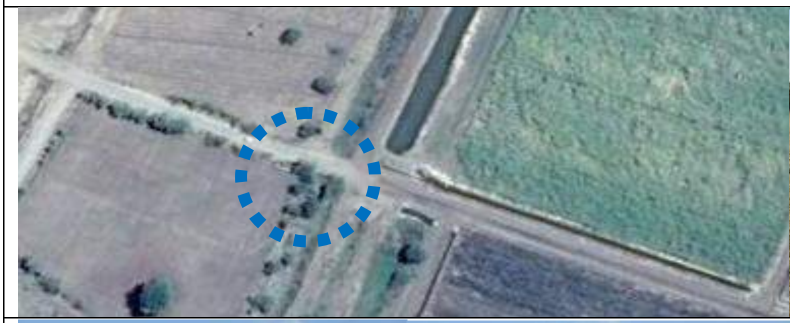




Mwanza river width 70~90m, crossing point of Illovo canal and road

I -2(5) Location :

Coordination	691196, 8208702
Boundary of Illovo Estate	





Irrigation structures in Zone I-2 of Illovo Estate

Ⅰ-2(6) Location :

Coordination	693664, 8205867
Boundary of Illovo Estate and nearby Nkombedzi Wa Fodya River	





Pivot irrigation facilities in Zone I-2 of Illovo Estate

Ⅰ-2(7) Location :

Coordination	697638, 8212678
Mwanza River	




Mwanza River width 90~130m

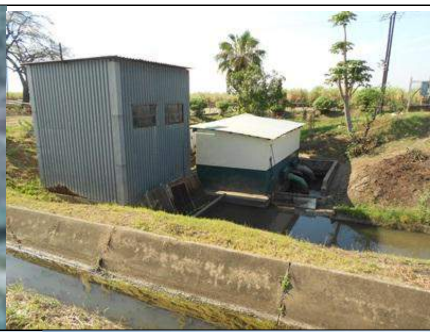
I-2(8) Location :

Coordination	697673, 8210365
Mwanza River→Illovo Estate canal L=2.40km	
	
Irrigation structures in Zone I-2 of Illovo Estate	

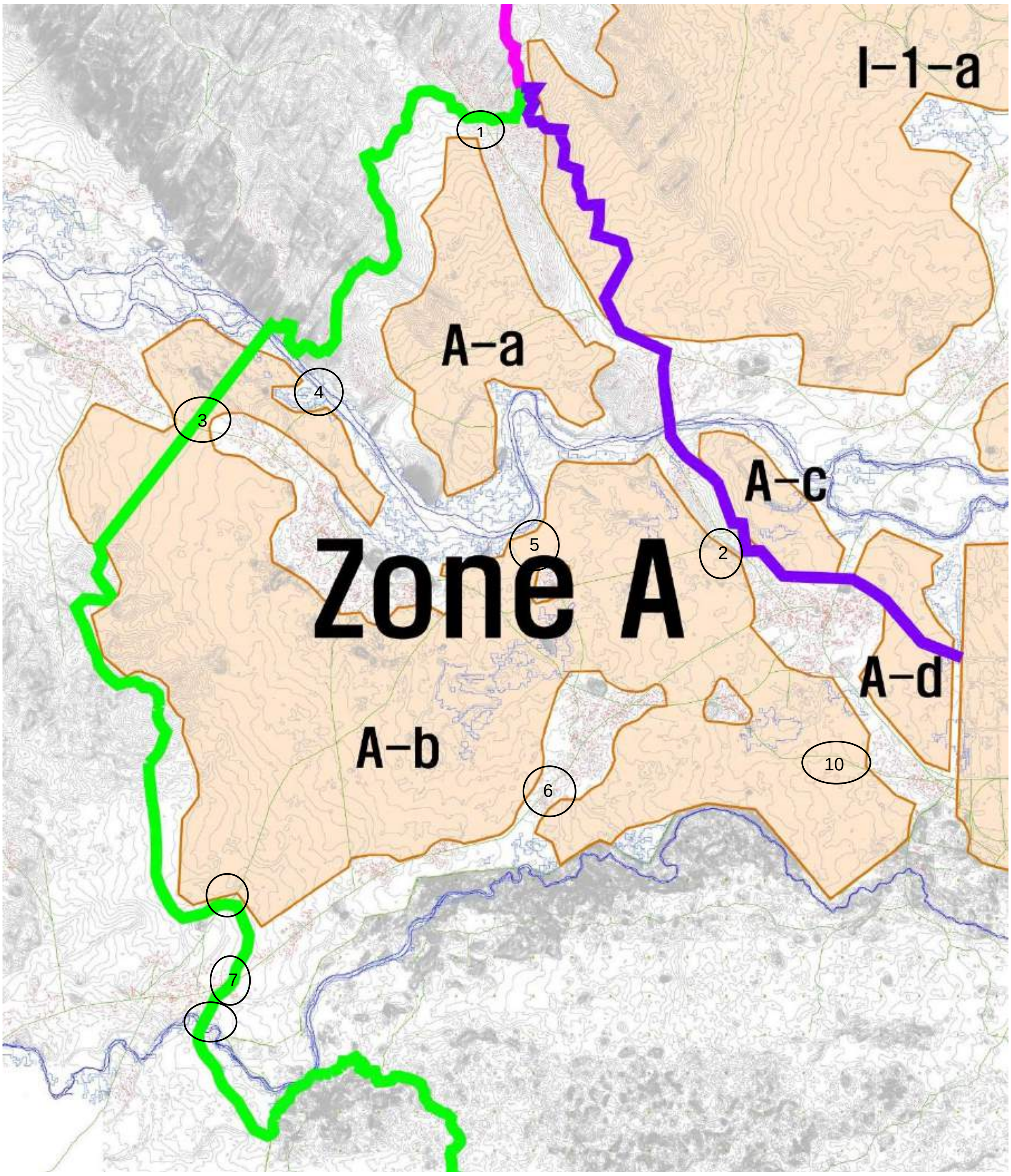
I-2(9) Location :

Coordination	697725, 8206447
Point along the M1 Road 6.2km from Nchalo	
	
Irrigation structures in Zone I-2 of Illovo Estate	

I -2(10) Location ：

Coordination	694877, 8206412
Point along the M1 Road 6.2km	
	
  	
Pumping station and irrigation facilities in Zone I-2 of Illovo Estate	

[3. Zone A]



A1 Location ：

Coordination	689398, 8210837
1.3km north-west from the crossing point of Zone I-1 and Road No.9	

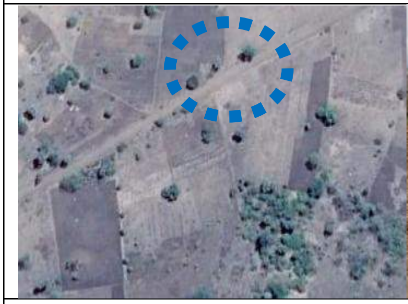
Branch A1 of the junction from the Bangula canal

A2 Location ：

Coordination	687416, 8211586
Point along the T423 Road 0.4km from D140 Road and along the right Road 1.7km	

Point between ending point of drainage canal in the irrigation area and Road

A2-1 Location :

Coordination	
Point along the T423 Road 0.4km from D140 Road and along the right Road 2.6km	
  	
Crossing point between drainage canal and Road	

A2-2 Location :

Coordination	
Point along the T423 Road 0.4km from D140 Road and along the right Road 4.2km	
	
 	
 	
Farmland condition of Zone A	

A3 Location ：

Coordination	681383, 8213198

Point along the T423 Road 0.4km from D140 Road and along the right Road 9.4km





Site between siphon of Bangula canal and Road

A4 Location ：

Coordination	682898, 8213608

0.4km along the T423 Road from D140 Road Mbewe village, and 8.4km along the Road from the right junction, and Mwanza River of right side of village





Mwanza River width 103m, and total width 122m

A5 Location :

Coordination	684335, 8211271
Point along the T423 Road 0.4km from D140 Road and along the right Road 1.7km	
 	
  	
Crossing point between drainage canal and road	

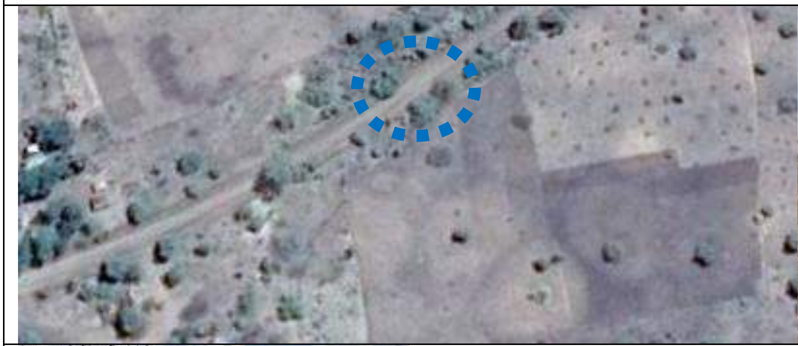
A6 Location :

Coordination	686061, 8208876
Junction of Mbewe village along the D140 Road 3.3km	
 	
  	
Crossing site of Branch A5 ending point from junction of Bangula canal	

A7 Location :

Coordination	681840, 8206161

Ndakwera village starting point of the T423 Road



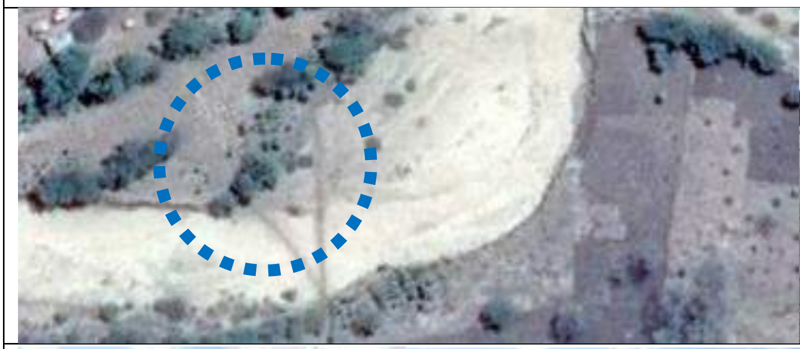


Crossing point between Bangula canal and Road before the Ndakwera village

A8 Location :

Coordination	680471, 8205119

Nkombedzi Wa Fodya River



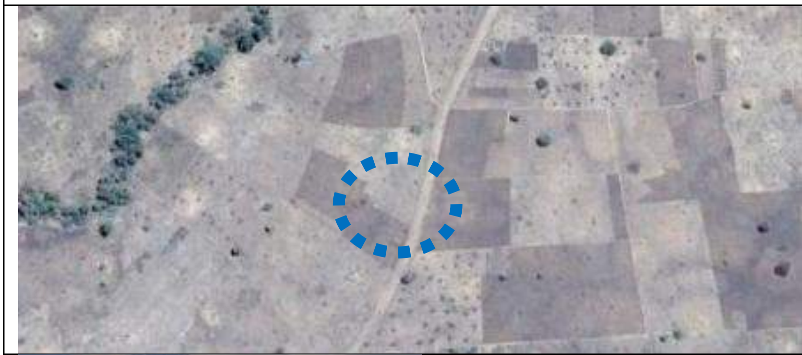


Upper Nkombedzi Wa Fodya River width 40m

A9 Location :

Coordination	681407, 8206878

1.7km point from the junction of T423 Road Ndakwera village





Crossing point between Bangula canal before the Branch A5 and Road,

A10 Location :

Coordination	

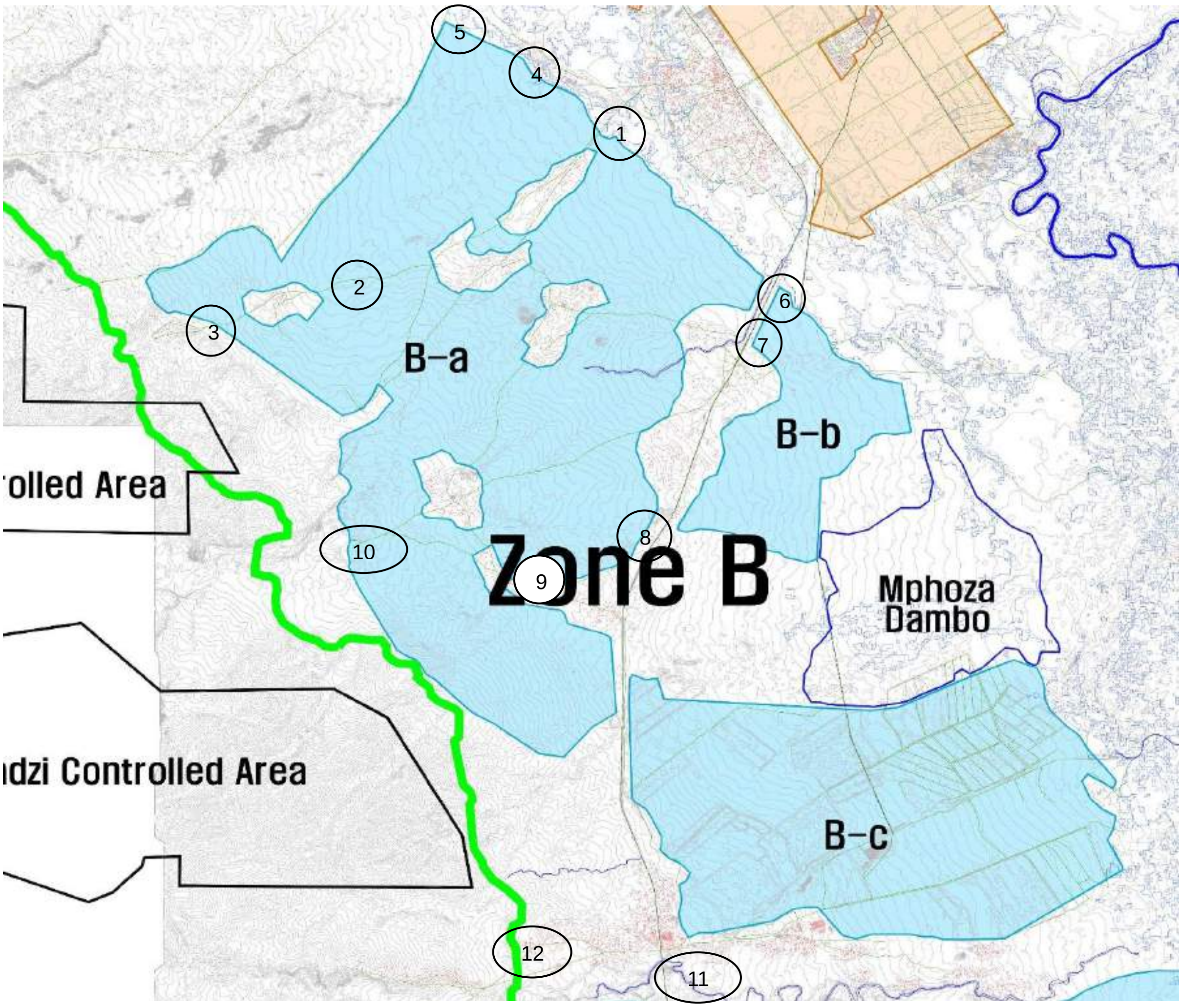
2.1km along the right junction of 2.8km along D140 Road from Mbewe village



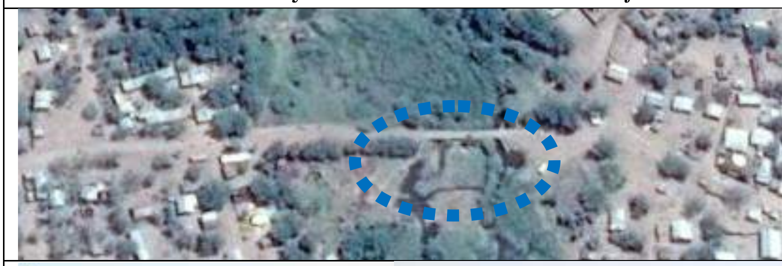
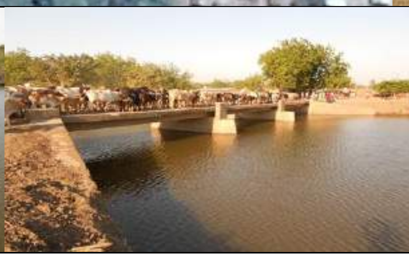


Farmland condition of Zone A

[4. Zone B]



B1 Location :

Coordination	697970, 8200667
Nkombedzi Wa Fodya River of 1.3km from junction of M1 Road and Road(Nchalo)	
	
 	
Nkombedzi Wa Fodya River status of Zone B boundary	

B1-1 Location :

Coordination	698693, 8201154
Nkombedzi Wa Fodya River of 1.3km from junction of M1 Road and Road(Nchalo)	

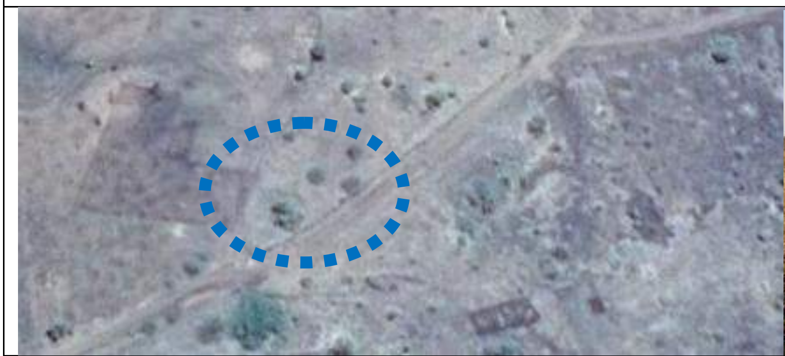




Tributary of Nkombedzi Wa Fodya River in Zone B

B2 Location :

Coordination	693166, 8197569
8.1km along the Road from the junction of M1, M8 Road, and next Nsanjama village	





Crossing point between starting point of drainage canal in Zone B and Road

B3 Location :

Coordination	691016, 8196778

Mwanza River bridge of D140 ROAD, 9.3km along the junction of Road

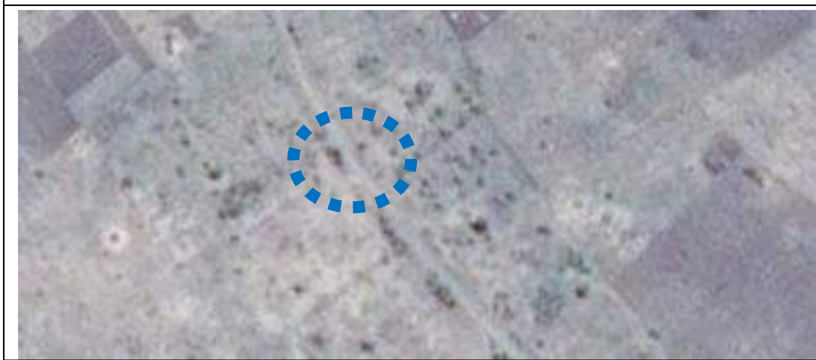



Crossing point between starting point of drainage canal in Zone B and Road

B4 Location :

Coordination	695942, 8202330

1.3km along the Junction form M1 Road, and 2.9km along the left Road






Crossing point between ending point of drainage canal in Zone B and Road

B5 Location :

Coordination	
Nkombedzi Wa Fodya River between Znoe I-2 and Zone B	
 	
  	
Condition of Nkombedzi Wa Fodya River between Znoe I-2 and Zone B	

B6 Location :

Coordination	
Crossing between Nkombedzi Wa Fodya River and M1 ROAD	
 	
  	
Condition of crossing point between Nkombedzi Wa Fodya River and M1 ROAD	

B7 Location :

Coordination	700168, 8196559
Crossing point between Nkombedzi Wa Fodya River and M8 Road, and right side of Lunkhwe village	





Tributary of Nkombedzi Wa Fodya River in connection with drainage canal of Zone B

B8 Location :

Coordination	69810, 81933207
5.4km from the bridge of M1 Road of Nkombedzi Wa Fodya River	





Crossing point between the ending point of Branch B2 and M1 Road

B9 Location :

Coordination	696046, 8192186
2.2km form the junction of M1 Road Pzjva villag	
	
	
Crossing point between Branch B2 from the junction of Bangula canal and Road	

B10 Location :

Coordination	693602, 8192893	
Right junction in front of M1 Road Paiva village, and 6.1km along the road next Ntowa village		
		
		
Grazing area having the wire fence in Zone B		

B11 Location :

Coordination	698700, 8185524

The end of M1 ROAD Gome village, and Namikalango River





Crossing point of bridge at the Namikalango River of M1 Road Gome village

B12 Location :

Coordination	

2.6km along the right side junction of M1 Raod(Gome village)





Crossing point between Branch B3 from junction of Bangula canal and D140 Road

B11-1 Location :

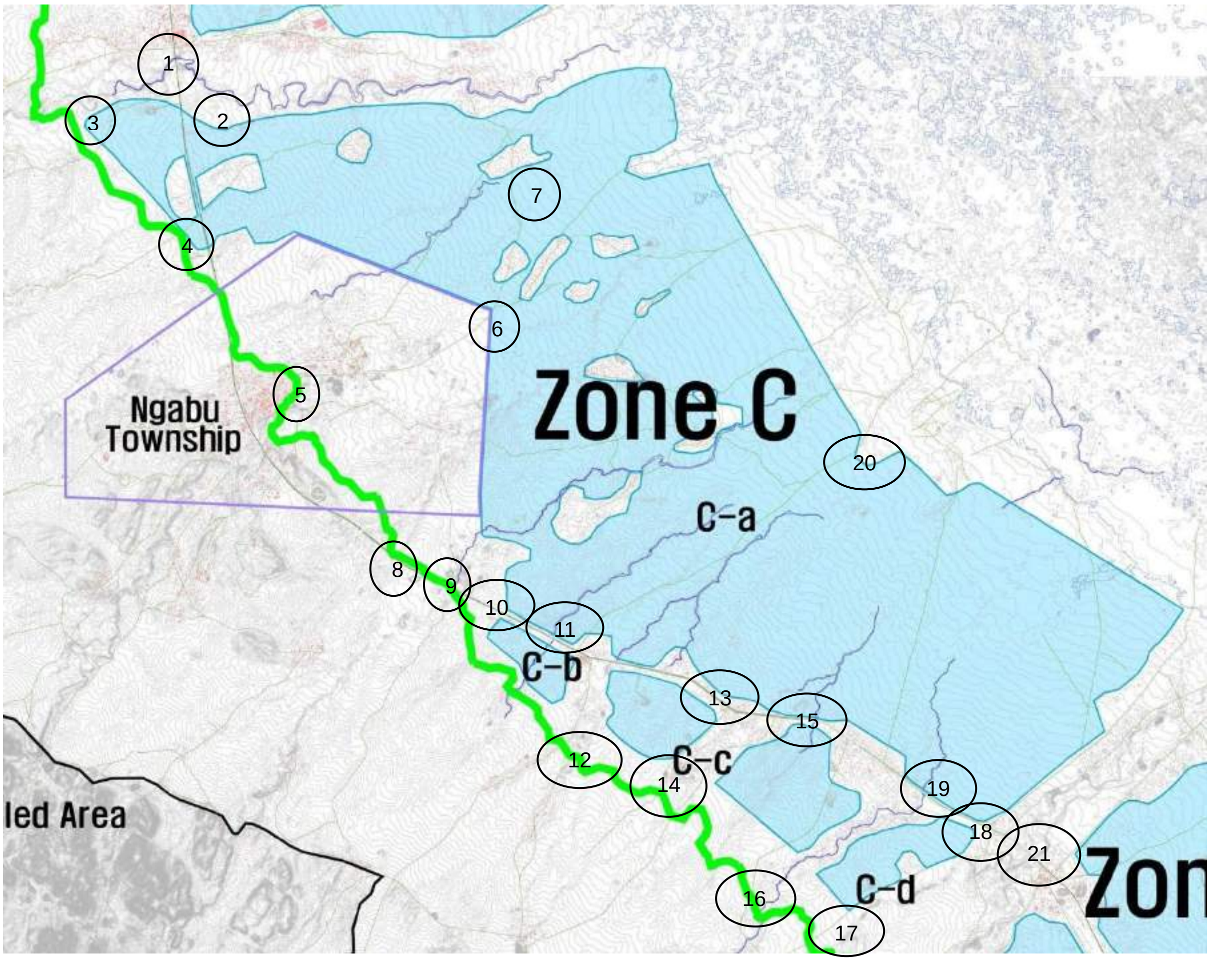
Coordination	699330, 8185700

Alumenda 0.4km from the crossway between M1 Road and D140 Road

Status of the Branch B2 from junction of Bangula canal, Alumenda of connection

Irrigation facilities in the Alumenda (Zone B-c)

[5. Zone C]



C1 location :

Coordination	698763, 8185289
Namikalango River bridge of M1 Road	

Namikalango River bridge of M1 Road Gome village

C2 Location :

Coordination	698837, 8184399
0.8km from the M1 Namikalango River bridge	





Crossing point of Branch C1 form the Bangula canal and M1 Road

C3 Location :

Coordination	696681, 8183372
2.9km from the M1 Namikalango River bridge, and right junction 0.6km	

C4 Location :

Coordination	697776, 8181421
2.9km from M1 Namikalango River, and 0.6km along the right junction 0.6km	




Crossing point between Bangula canal and Road

C5-1 Location :

Coordination	699695, 8179847
Starting point of M1 Road Ngabu village	





Crossing point between Bangula canal in Ngabu village and M1 road

C5-2 Location :

Coordination	700754, 8179539
Junction of Road of 1.4km from the M1 Road	





Crossing point between Bangula canal in Ngabu village and Road

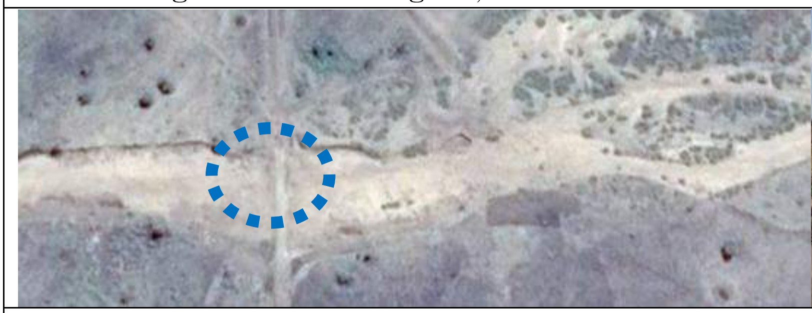
C5-3 Location :

Coordination	700309, 8178751
0.7km from the junction of M1 Road Ngabu village	
	
Pass point of Bangula canal in Ngabu village	

C6 Location :

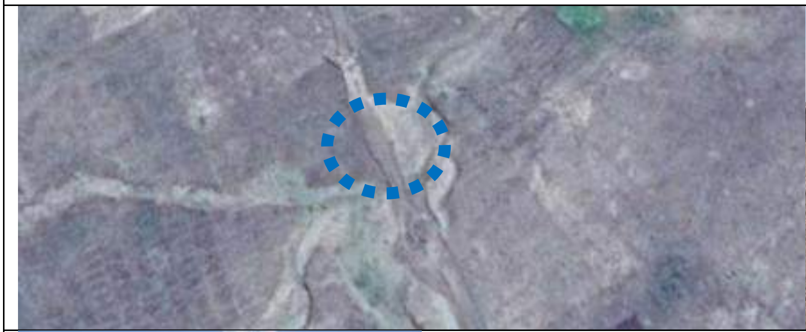
Coordination	704554, 8180702	
Left turn of M1 Road Ngabu, junction of 3.5km along the left Road		
		
		
Boundary of Zone C, starting point of drainage canal		

C7 Location :

Coordination	704999, 8183475
5.4km along the M1 Road Ngabu, before the Bwamba village	
	
Starting point of drainage canal in Zone C	

C7-1 Location :

Coordination	
4.6km along the M1 Road Ngabu, before the Bwamba village	



Drainage culvert (600mm x 5, 600mm x 3) in Zone C

C8 Location :

Coordination	701775, 8176870
3.1km along the M1 Road from the M1 Road Ngabu village	

Crossing point Between Bangula canal of Dolo region and M1 Road

C9 Location :

Coordination	702502, 8176354
4.6km along the M1 Road from the M1 Ngabu	
	
Crossing point of Branch C2 of Bangula Canal	

C10 Location :

Coordination	702760, 8176175	
Crossroad of M1 Ngabu village, 5.2km along the M1 Road		
		
		
Point of drainage canal in Zone C, and cross-section of M1 Road		

C11 Location :

Coordination	703837, 8175535
Crossroad of M1 Ngabu village, 7.3km along the M1 Road	

Point of drainage canal in Zone C, and cross-section of M1 Road

C12 Location :

Coordination	705753, 8172581
Right turn of M1 road Nsangwe, 1.9km along the left Road	

Village pass point after the Branch C3 of Bangula canal

C13 Location :

Coordination	708669, 8173539

Crossroad of M1 Ngabu, 10.8km along the M1 road before Ngombe village



Crossing point between Branch C4 of Bangula canal and M1 Road

C14 Location :

Coordination	707551, 8171669

Right turn in M1 Road No13, and 2.2km along the Road



Crossing point of between Branch C4 of Bangula canal and Road

C15 Location :

Coordination	710529, 8173099
Crossroad of M1 Ngabu, 12.7km along the M1 Road	





Ending point of drainage canal on Zone C, and cross-section of M1 Road

C16 Location :

Coordination	709196, 8169511
0.7km from M1 NO15, 3.8km along the right Road	





Crossing point between Bangula canal and Road

C16 -1 Location :

Coordination	707783, 8171135

0.7km of M1 NO15, and 2.8km along the right Road, and right to 0.8km





Starting point of drainage canal of Zone C

C17 Location :

Coordination	714532, 8170581





Crossing point between Branch C5 of Bangula canal and Road

C18 Location :

Coordination	713493, 8171213
1.3km along the M1 Road from the Mafume River	


Crossing point between Branch C5 of Bangula canal and M1 Road

C19 Location :

Coordination	712534, 8171741
2.4kmalong the M1 Road from the Mafume River	





M1 Road ceoss-section of the drainage canal inflowing in Zone C

C20 Location :

Coordination	711704, 8178892
3.1km along the M8 from Mafume bridge, and 5.6km along the right Road	

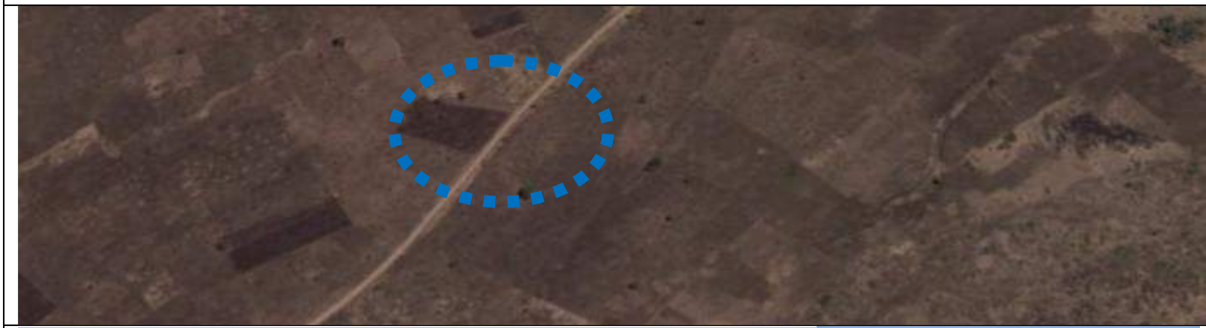




Ending point of Zone C a neighboring Shire River

C21 Location :

Coordination	712902, 8178905
3.1km along the M8 from Mafume bridge, and 5.6km along the right Road	



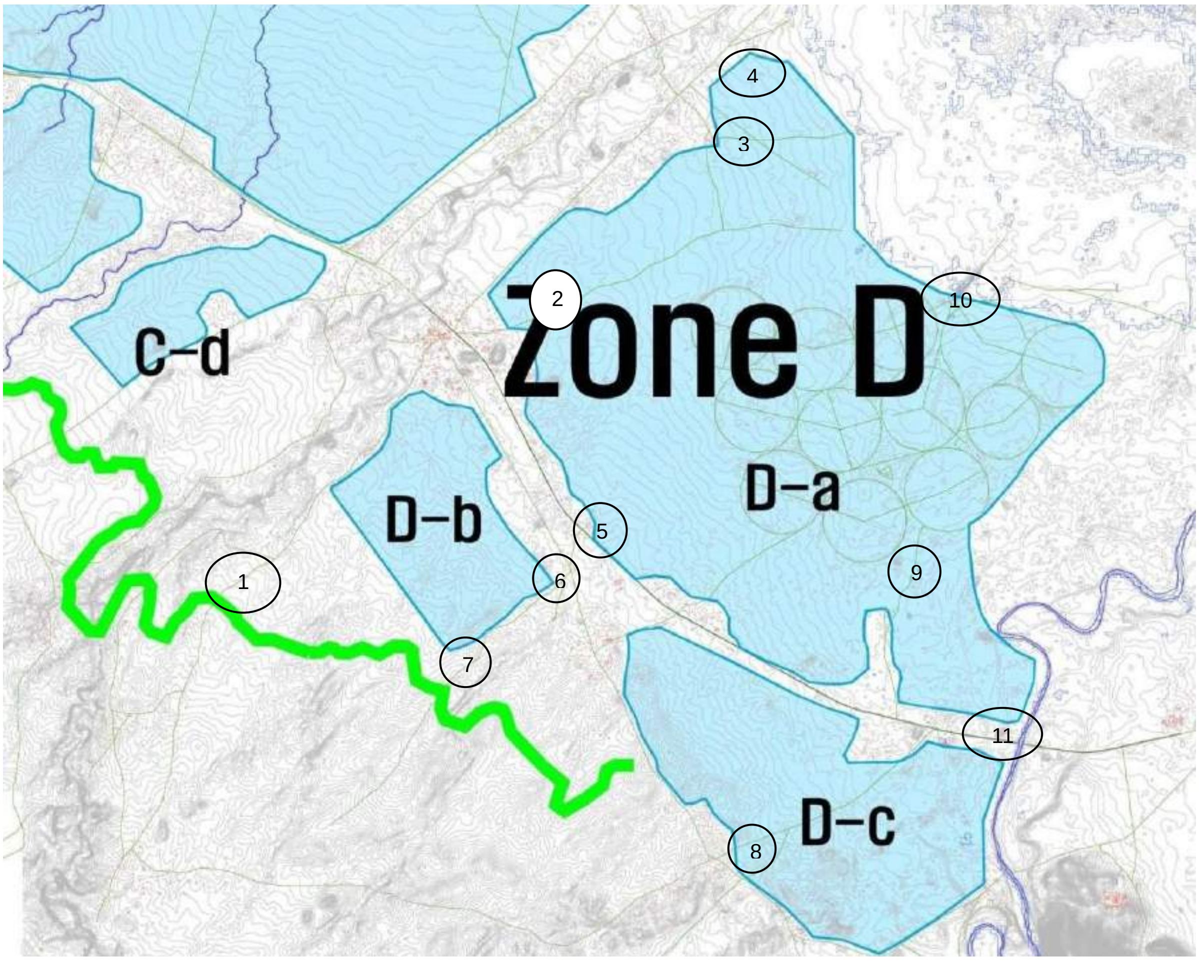
Farmland condition in Zone C

C22 Location :

Coordination	714536, 8170581
Crossing between D142 Road and M1 Road, and Mafume River along the M1 Road	

Mafume River bridge of M1 Road

[6. Zone D]



D1 Location :

Coordination	712676, 8167564
The Location that neighboring the three-way intersection point goes to 3.7km along the right junction road from Sorgin village neighboring the M1 Mafume River river.	
 	
	
Current state of the road pass section point at the Bangula Canal	

D1-1 Location :

Coordination	
The Location that 3.7km along the right junction road from the Sorgin village neighboring the M1 Mafume River river bridge.	
  	
Current state of the farmland of the Zone D	

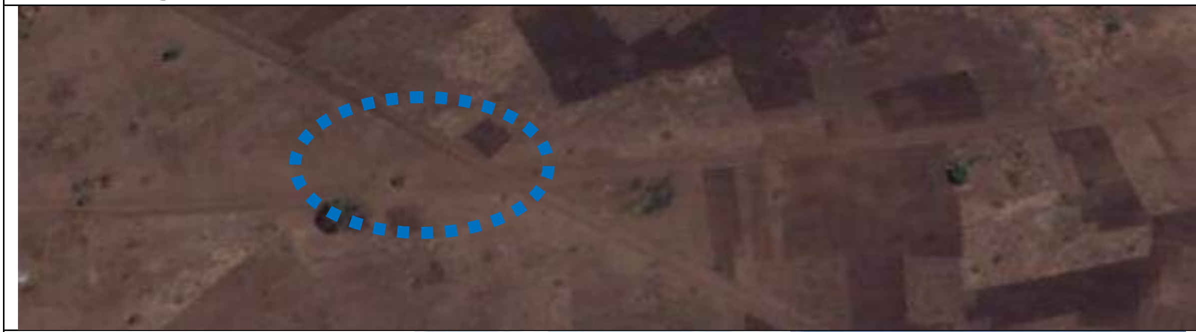
D2 Location :

Coordination	715638, 8170293
The Location that 1.1km along the left junction road from the Sorgin village neighboring the M1 Mafume River river Bridge.	
	
  	
Location and current state of starting point of the drainage canal of the Zone D	

D3 Location :

Coordination	718377, 8172422

The Location that 5.1km along the left junction road from the M1 Mafume River river Bridge



Location and current state of end of the drainage canal of the Zone D

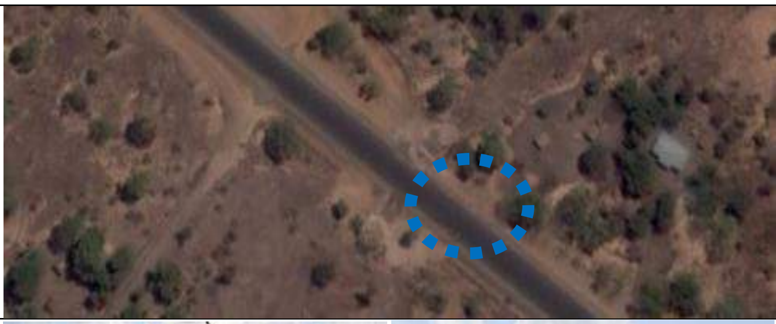
D4 Location :

Coordination	718061, 8173478

The Location that 5.1km along the left junction road from the M1 Mafume River river Bridge

Current state of the area neighboring the Shire River except the Zone D

D5 Location :

Coordination	716383, 8167957
The Location that 3.4km along the road from the M1 Mafume River river Bridge.	
 	
  	
Current state of the road pass section point at the end of the Branch D1 of the Bangula Canal	

D6 Location :

Coordination	716362, 8167448
The Location that goes to 0.4km from right junction point that goes to 3.4km along the road from the M1 Mafume River river Bridge.	
 	
  	
Current state of the road pass section point at the end of the Branch D1 of the Bangula Canal	

D7 Location :

Coordination	715241, 8166582
The Location that goes to 2.3km from right junction point that goes to 3.4km along the road from the M1 Mafume River river Bridge.	
	
Condition of oad pass section point at the center of Bangula Canal and Branch D1	

D7-1 Location :

Coordination	
M1 Mafume River bridge, 3.4km along M8 Road, 2.5km along right junction of Road	
	
Condition of borrow pit is located in starting point of Bangula Canal and Branch D1	

D8 Location :

Coordination	718263, 8164367
The Location that goes to 2.6km along the road from No.6	
	
Condition of road pass section point at the center of Bangula Canal and Branch D2	

D8-1 Location :

Coordination	717929, 8164204
The Location that goes to 2.6km along the road from No.6	

Current state of the Zone D

D9 Location :

Coordination	720045, 8167163
1.5km along the right junction of Ngabu village direction from M1 Road Thangadzi bridge, and drainage calan of 1.4km along the Road	

Current state of the Zone D

D10 Location :

Coordination	720274, 8170960
Location of influent channel at the pivot irrigation area at Zone D	
	
Current state of the influent channel at the pivot irrigation area at Zone D	

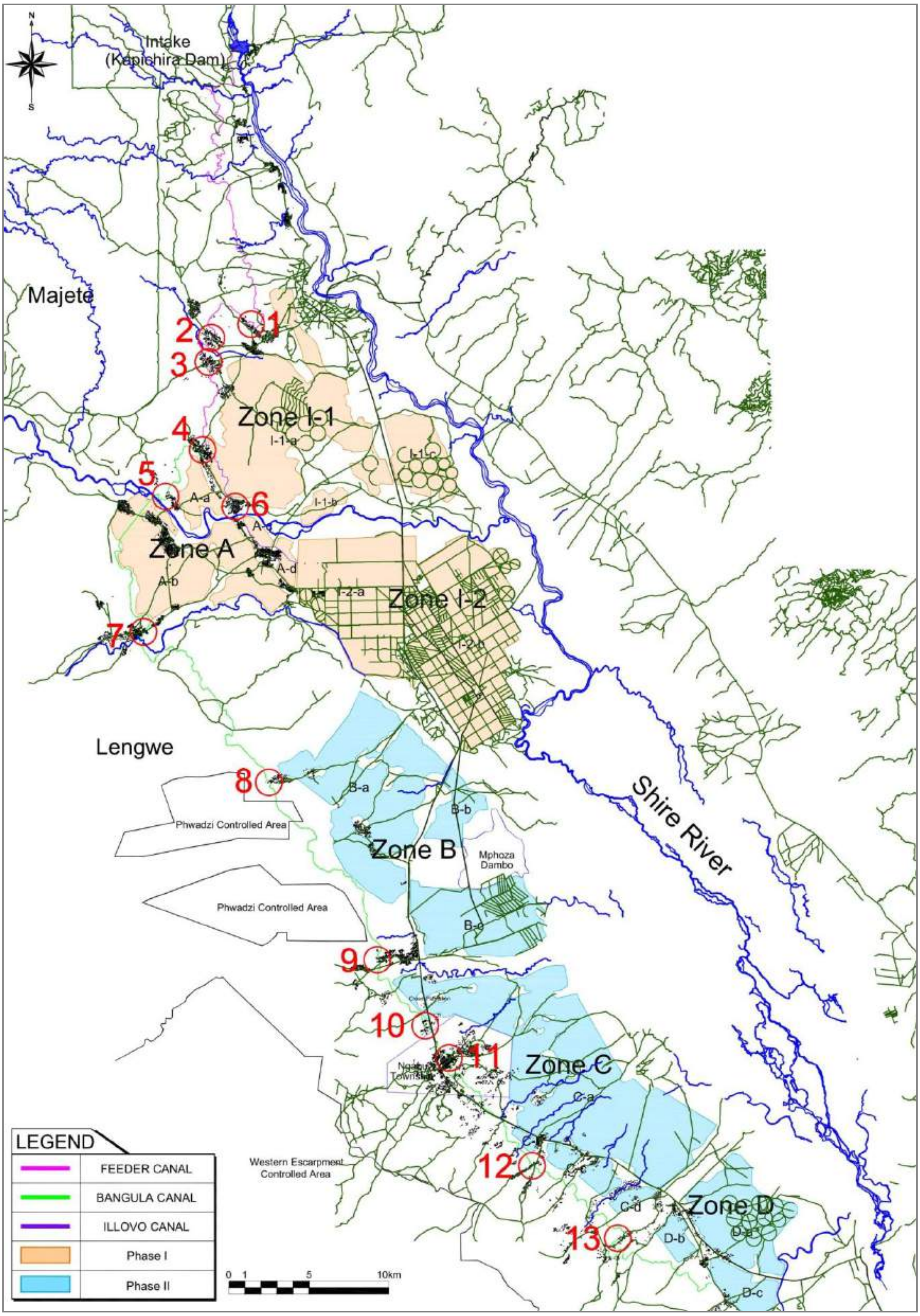
D11 Location :

Coordination	
The Thangadzi Bridge at M1 ROAD	
	
	
Current state of the Thangadzi Bridge at M1 ROAD	

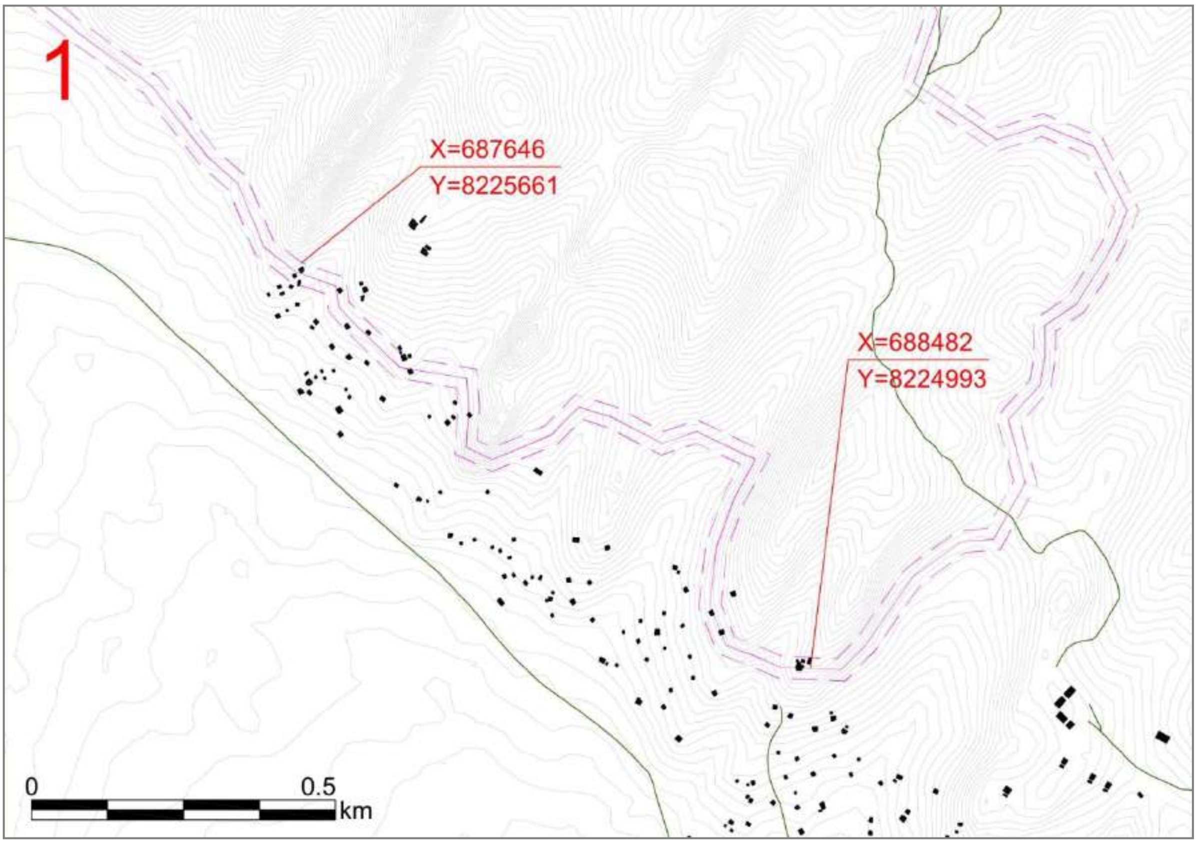
Annex 16.
Canal Routes
into the Village Section

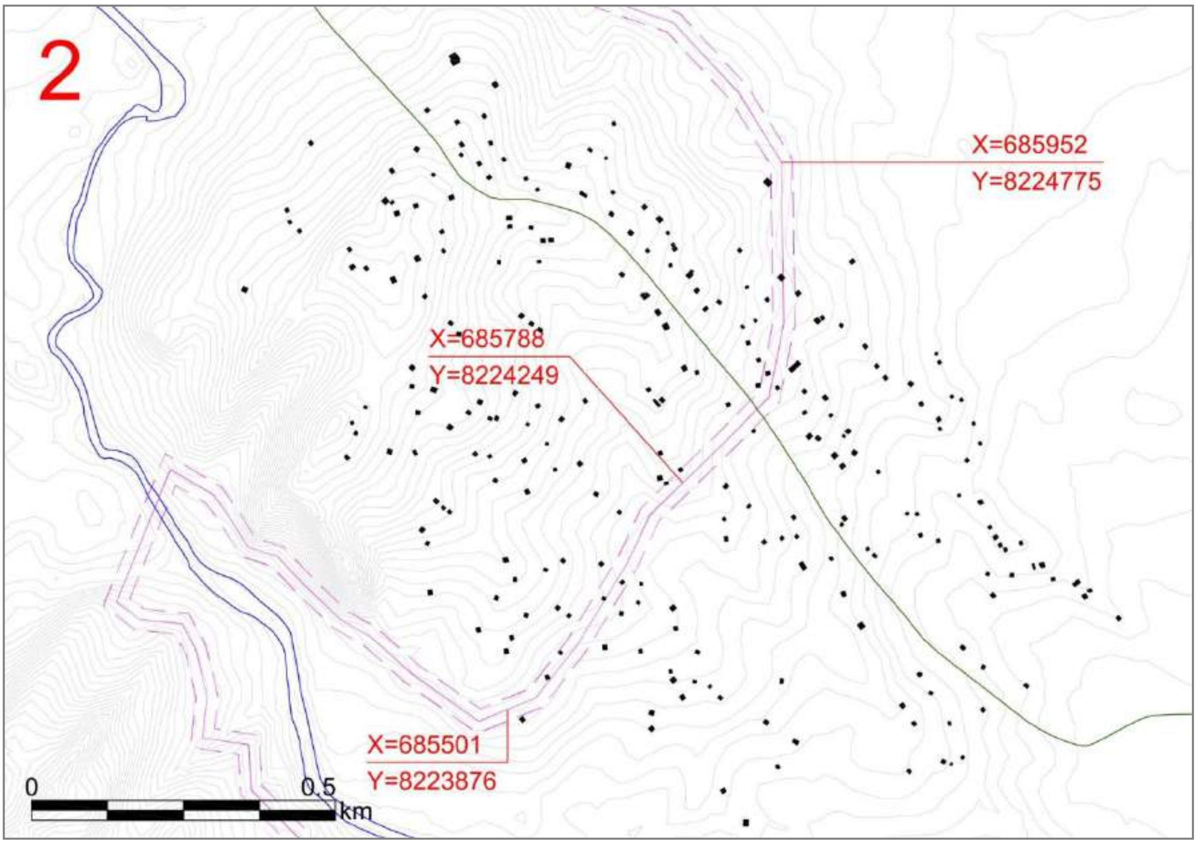
Annex 16. Canal Routes into the Village Section

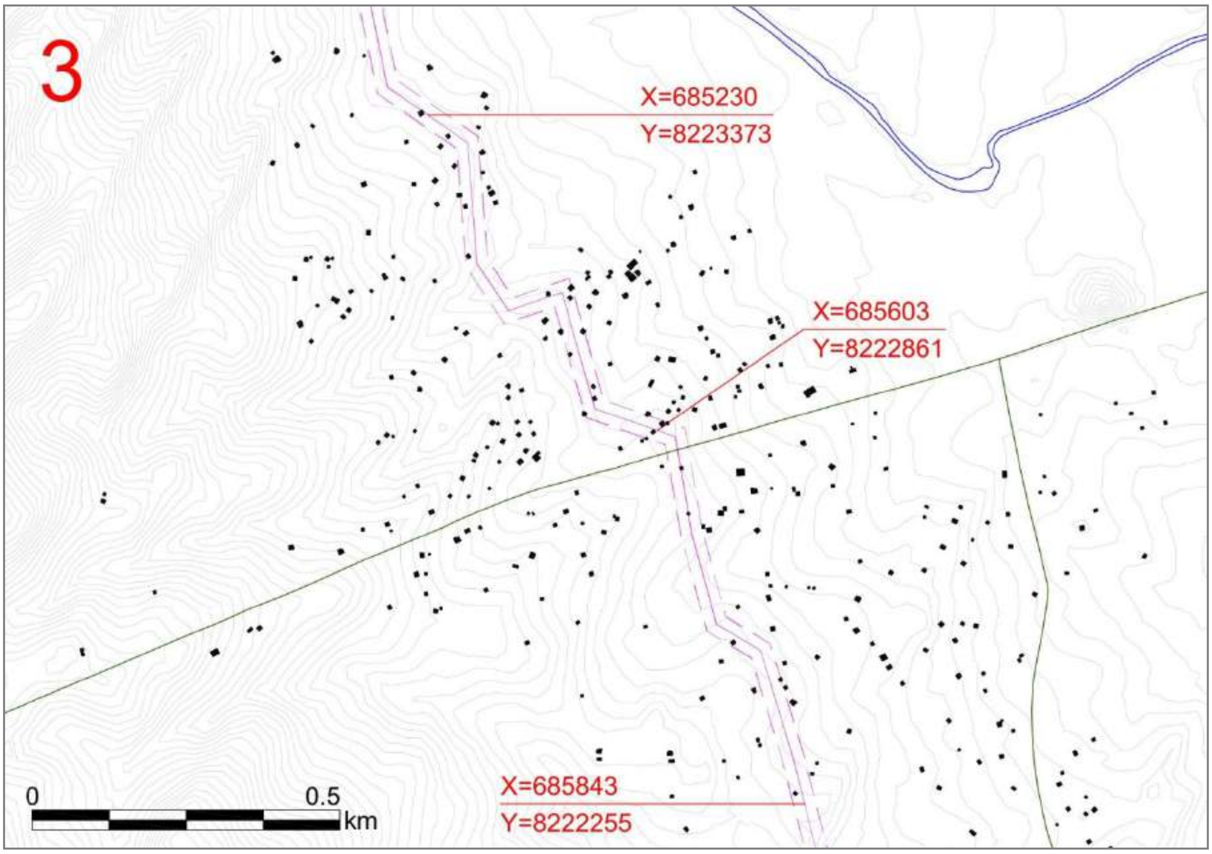
1. Location Map of Canal Route into the Village



2. Detailed Canal Planning nearby the Village



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X=685603
Y=8222861
X=685843
Y=8222255
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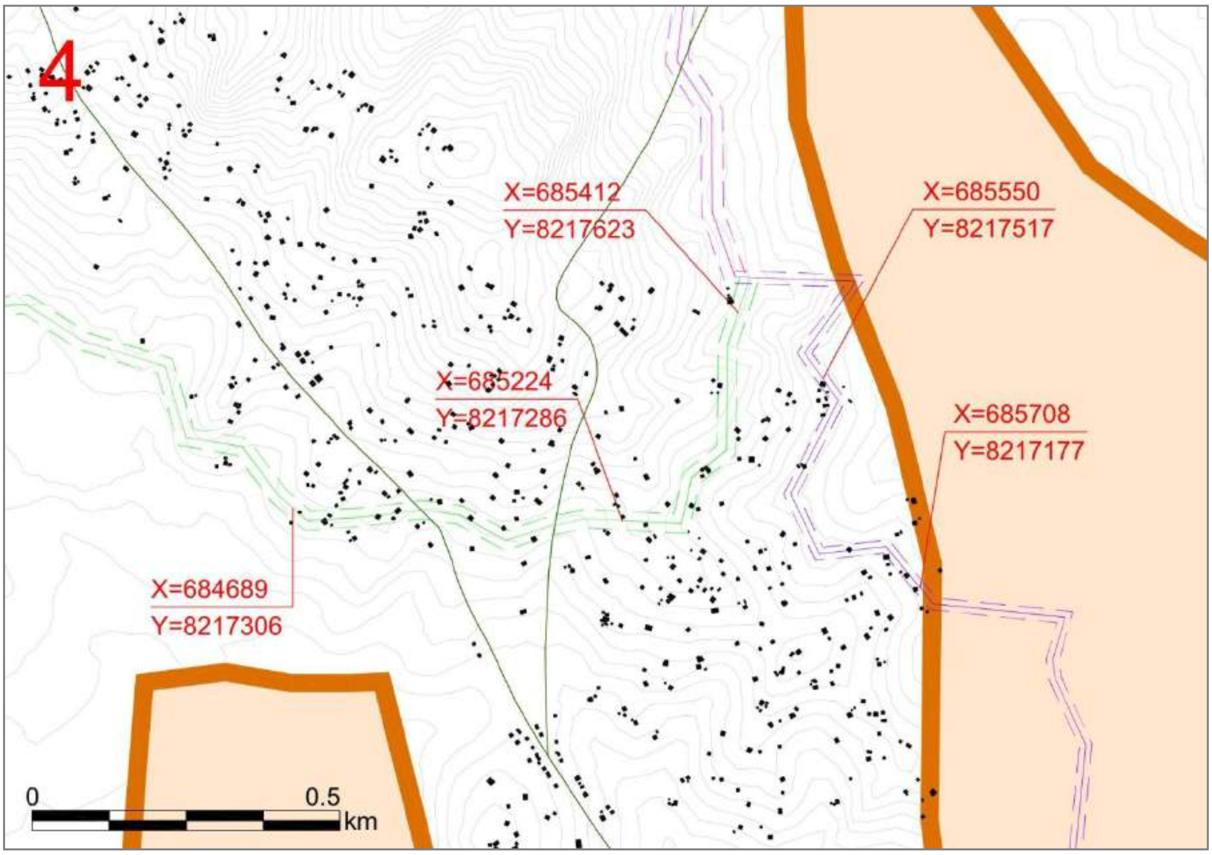
0.5
km


4
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X=685550
Y=8217517
X=685224
Y=8217286
X=685708
Y=8217177
X=684689
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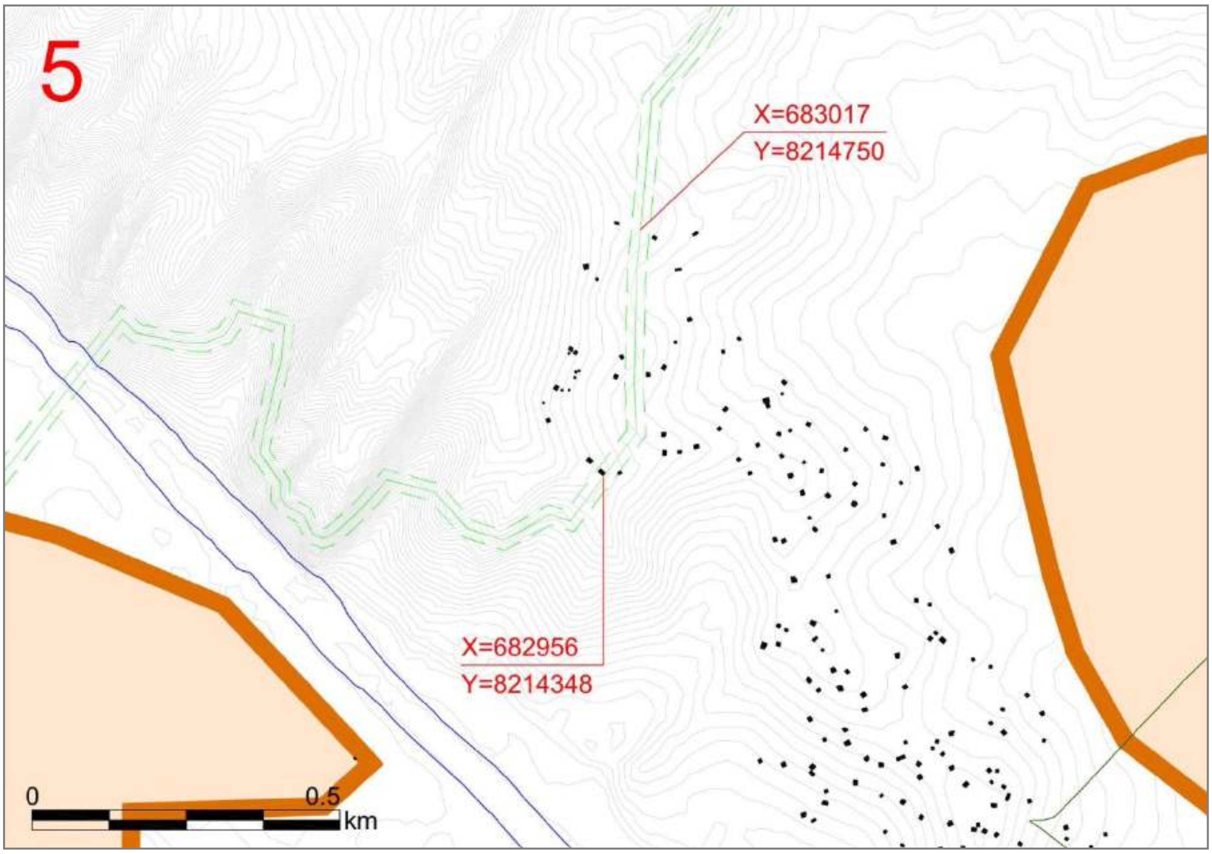
km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X=682956
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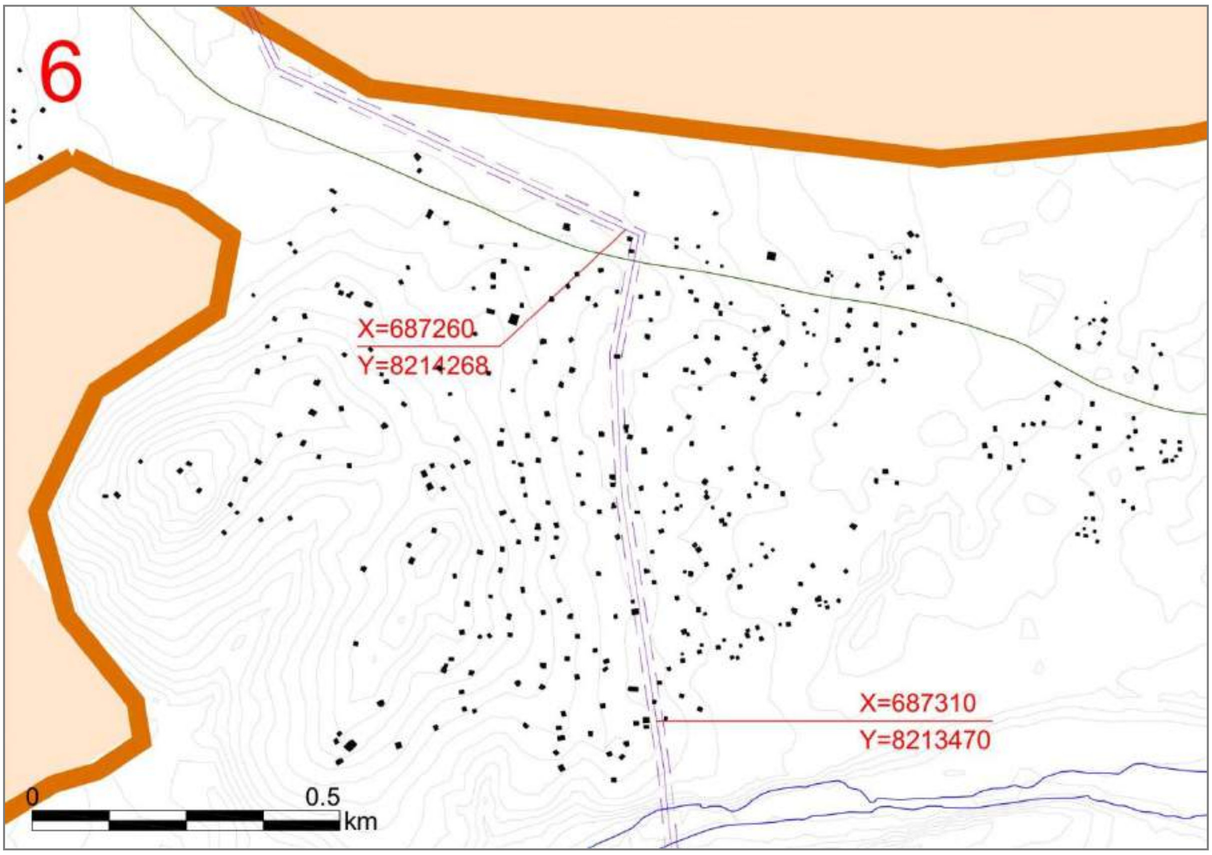
km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X=687310
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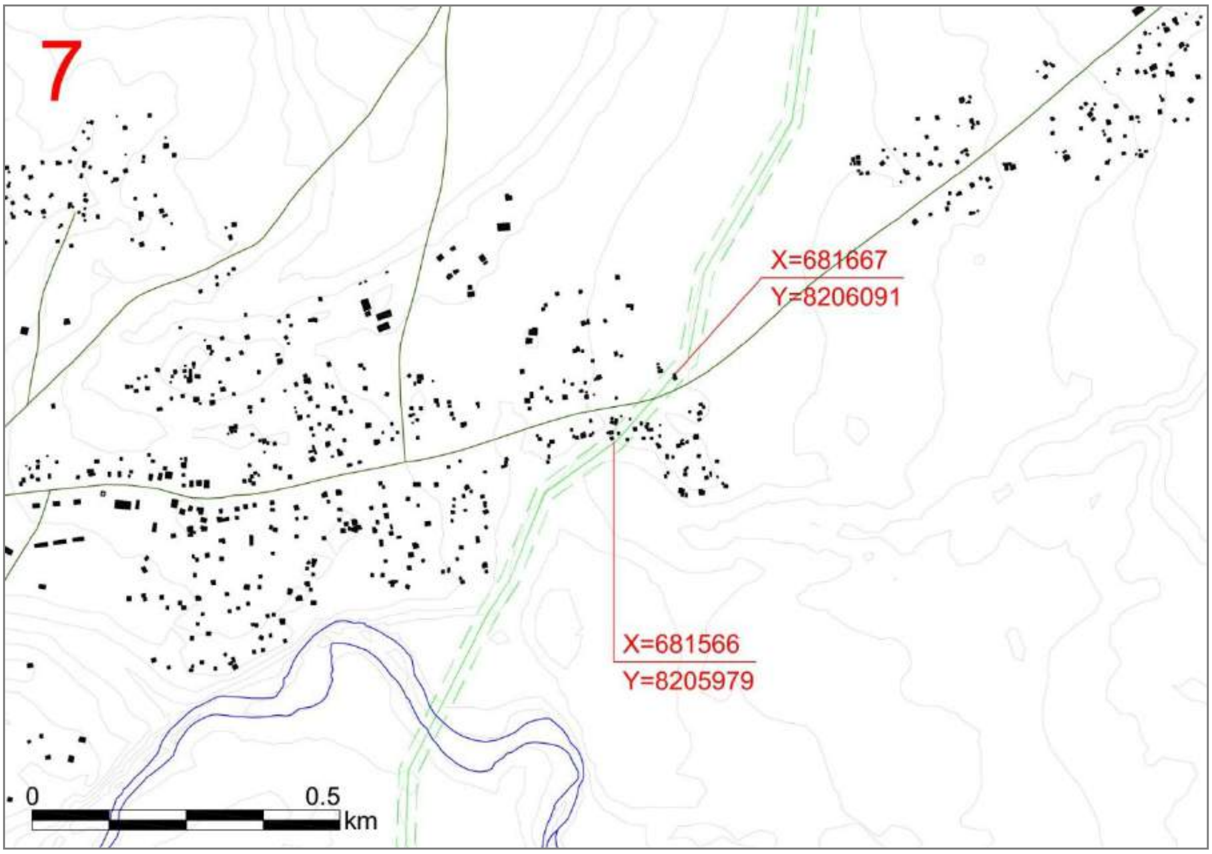
km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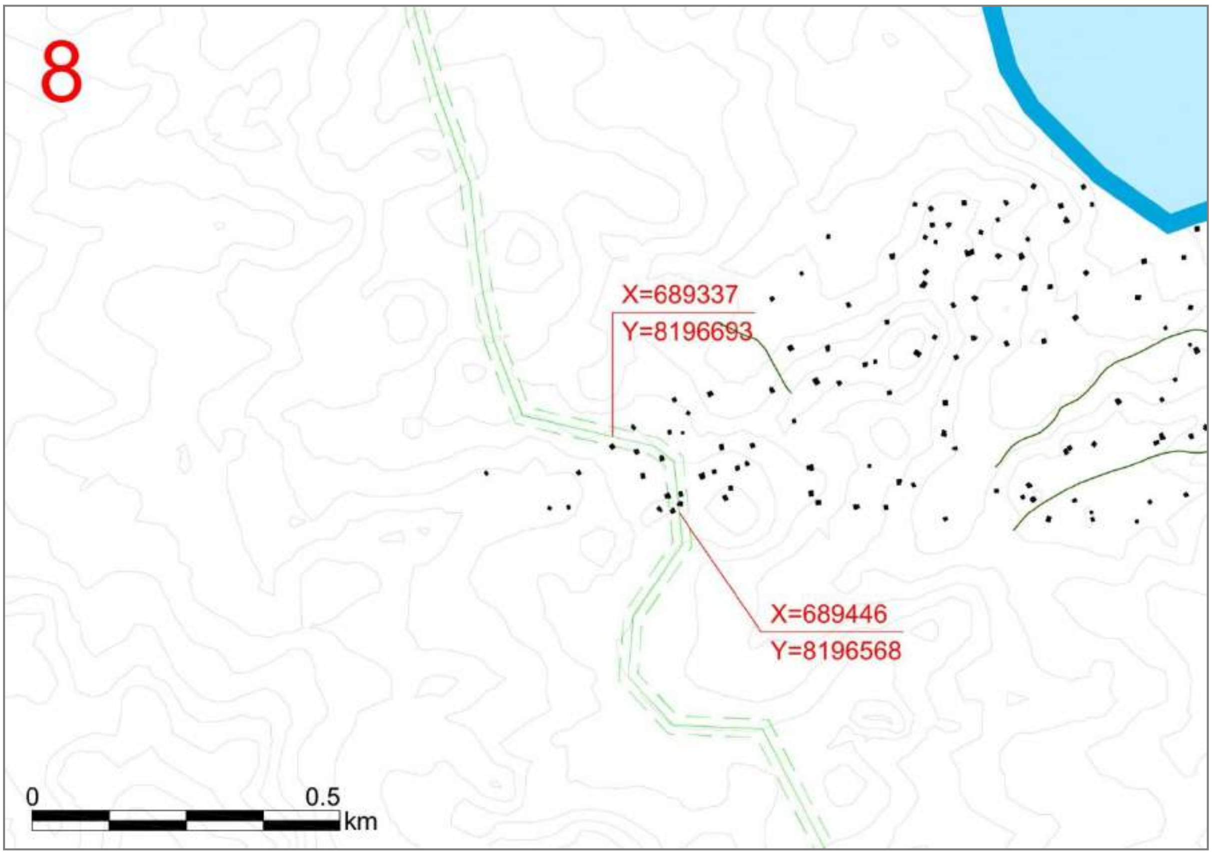
km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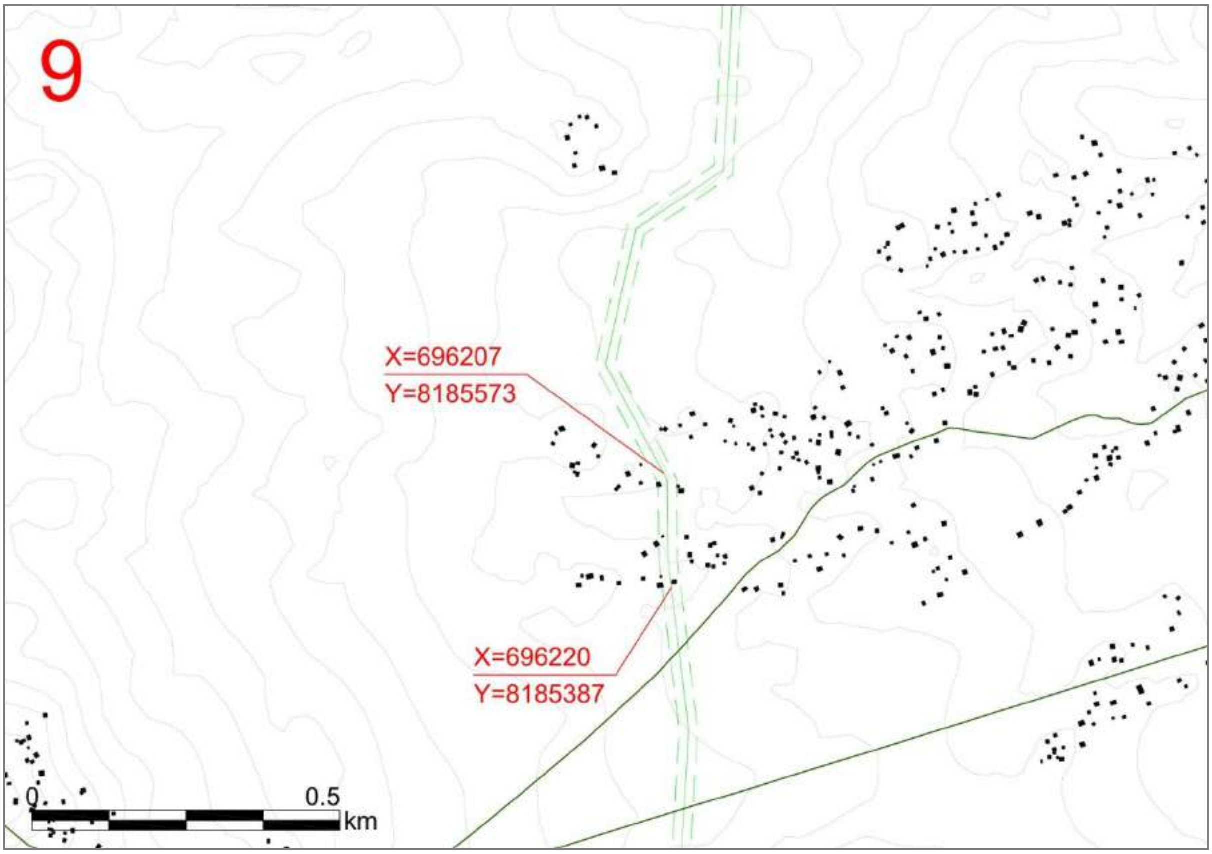
km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Y=8185573
X=696220
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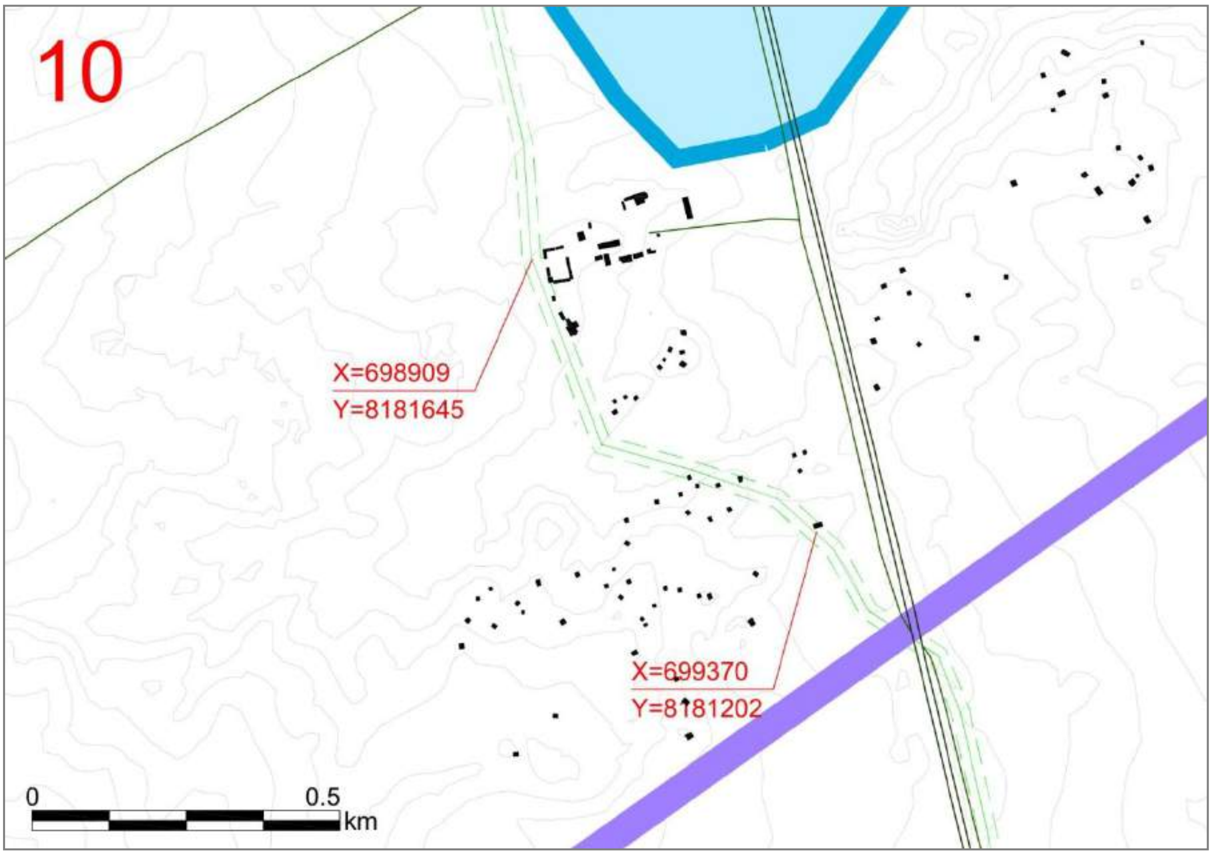
km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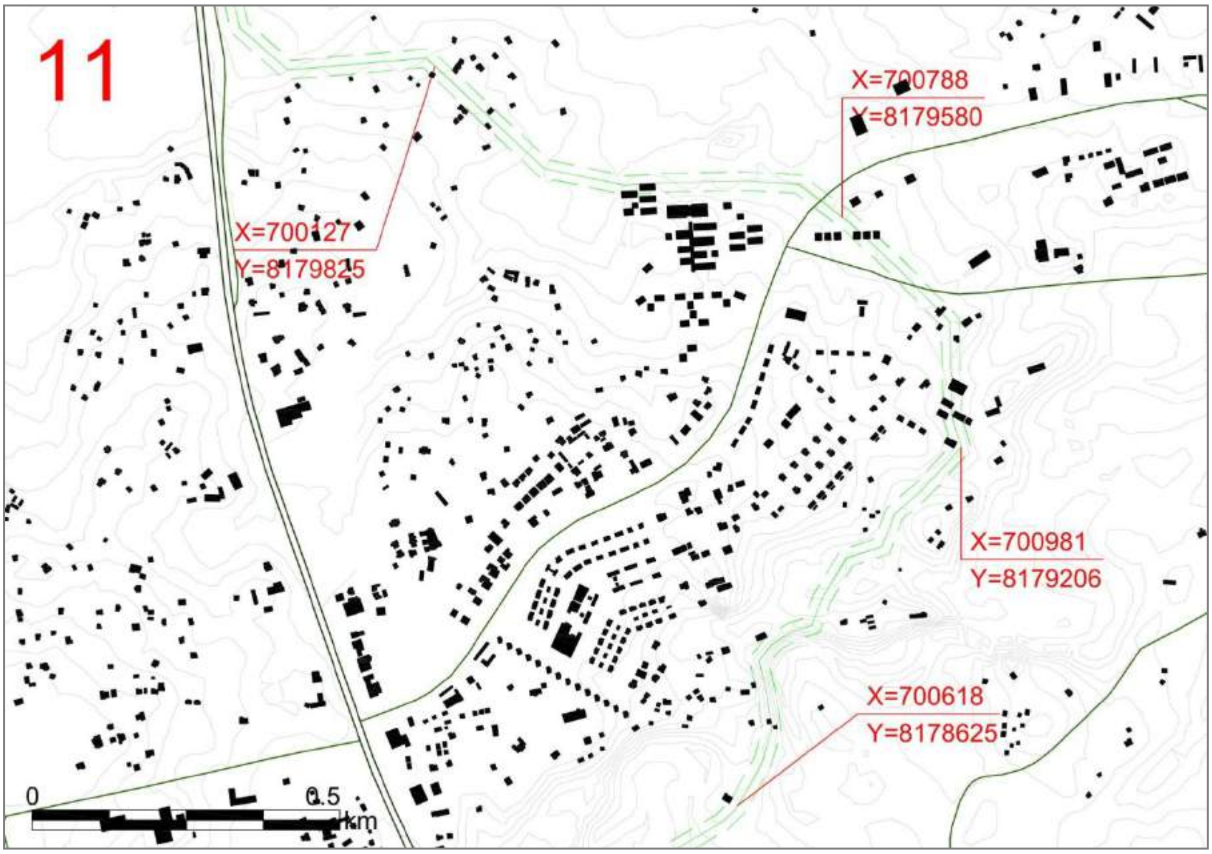
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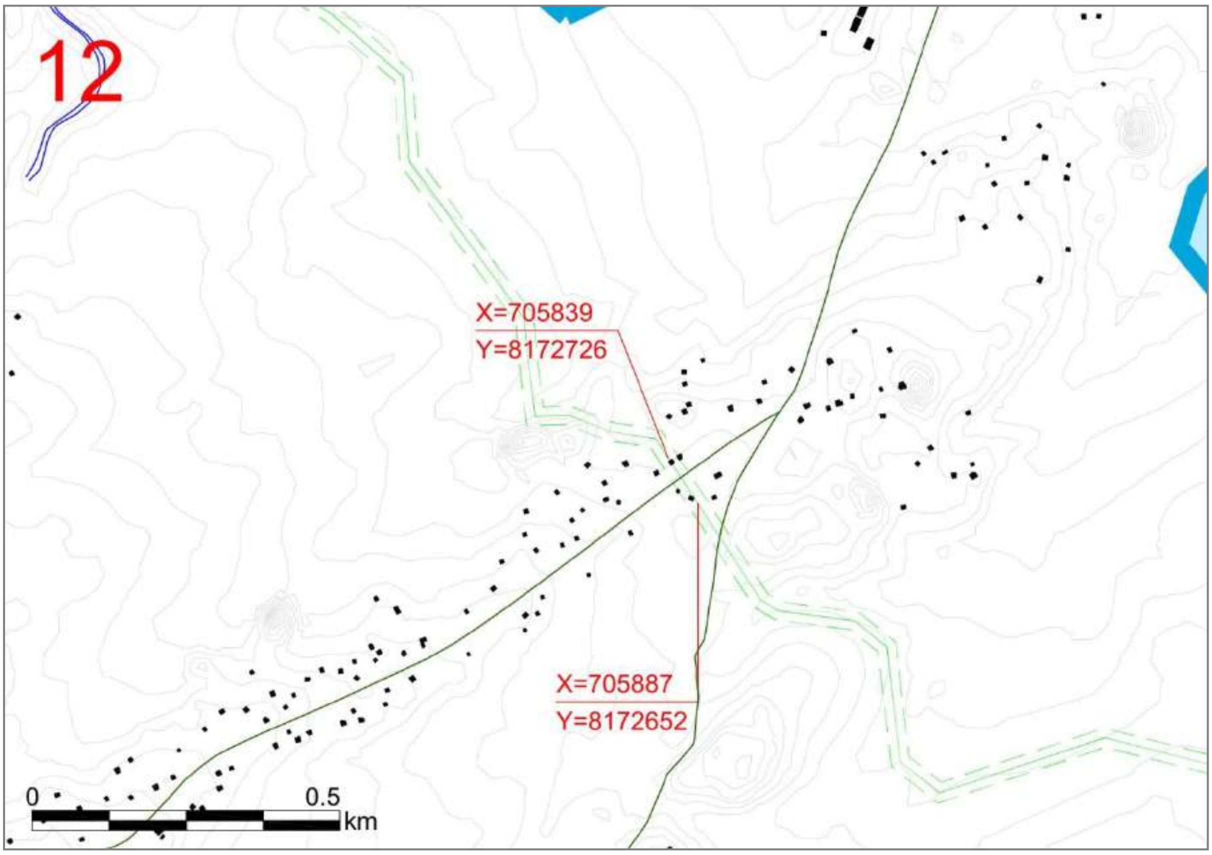
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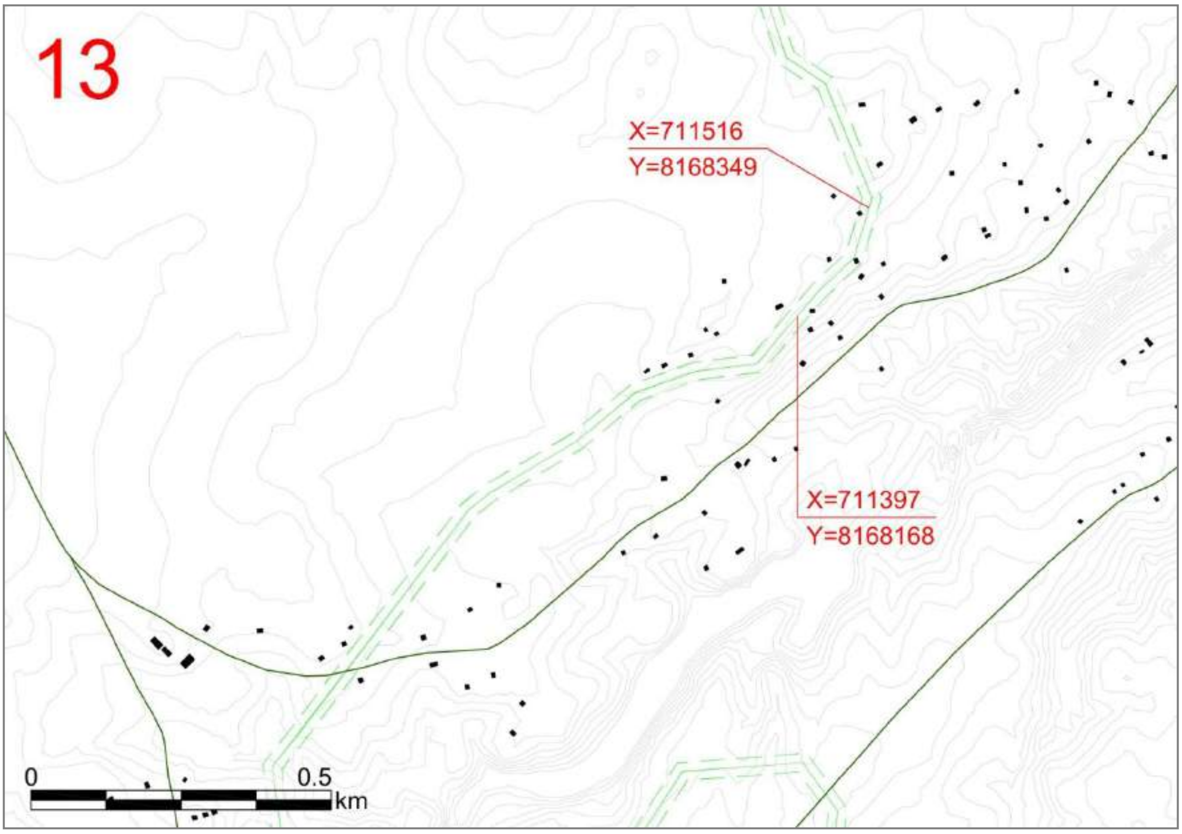
km



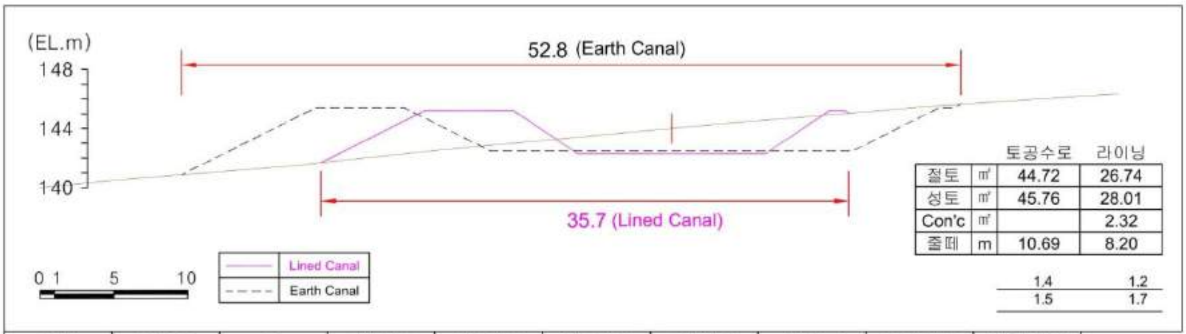
3. Coordination and Length of Canal nearby the Village

No	Start		End		Length (m)	Canal Width (m)	Remark
	X(East)	Y(South)	X(East)	Y(South)			
1	688482	8224993	687646	8225661	1,482	35.7	Feeder
2	685952	8224775	685501	8223876	588	35.7	Feeder
3	685230	8223373	685843	8222255	1,449	35.7	Feeder
4	685412	8217623	684689	8217306	1,030	30.0	Bangula
	685550	8217517	685708	8217177	517	19.9	Illovo
5	683017	8214750	682956	8214348	420	30.0	Bangula
6	687260	8214268	687310	8213470	819	19.9	Illovo
7	681667	8206091	681566	8205979	152	30.0	Bangula
8	689337	8196693	689446	8196568	194	30.0	Bangula
9	696207	8185573	696220	8185387	188	30.0	Bangula
10	698909	8181645	699370	8181202	704	30.0	Bangula
11	700127	8179825	700618	8178625	1,947	30.0	Bangula
12	705839	8172726	705887	8172652	88	30.0	Bangula
13	711516	8168349	711397	8168168	222	30.0	Bangula

Annex 17.
Main Canal Optimization

Annex 17. Main Canal Optimization

1. Feeder Canal Section Optimization



구분	기준Q	Q	수심(h)	저폭(b)	상폭(B)	전체폭	여유고	종단경사	사면경사
Earth	50.20	50.236	2.1	24.6	33.0	52.8	0.8	1/5,000	1:2.0
Lined		50.396	2.1	12.7	19.0	35.7	0.8	1/5,000	1:1.5

Feeder Canal(Lining thickness t=10cm), Q=50.202m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=2.1, Bed Width b=12.7, Upper Width B=19.0
Hydrology Optimization: Water Depth H=3.8, Bed Width b=2.3, Upper Width B=13.7

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.34	1.32	38.18	1.5	23.2	27.7	1.33	28.61
50.23	1.36	36.96	1.6	20.7	25.5	1.40	26.47
50.46	1.40	36.13	1.7	18.7	23.8	1.45	24.83
50.48	1.43	35.28	1.8	16.9	22.3	1.51	23.39
50.39	1.46	34.49	1.9	15.3	21.0	1.56	22.15
50.32	1.49	33.80	2.0	13.9	19.9	1.60	21.11
50.40	1.51	33.29	2.1	12.7	19.0	1.64	20.27
50.36	1.54	32.78	2.2	11.6	18.2	1.68	19.53
50.28	1.56	32.32	2.3	10.6	17.5	1.71	18.89
50.67	1.58	32.16	2.4	9.8	17.0	1.74	18.45
50.25	1.59	31.63	2.5	8.9	16.4	1.77	17.91
50.46	1.60	31.46	2.6	8.2	16.0	1.79	17.57
50.37	1.62	31.19	2.7	7.5	15.6	1.81	17.23
50.56	1.63	31.08	2.8	6.9	15.3	1.83	17.00
50.51	1.64	30.89	2.9	6.3	15.0	1.84	16.76
50.83	1.65	30.90	3.0	5.8	14.8	1.86	16.62
50.32	1.65	30.54	3.1	5.2	14.5	1.86	16.38
50.24	1.65	30.40	3.2	4.7	14.3	1.87	16.24
50.66	1.66	30.53	3.3	4.3	14.2	1.88	16.20
50.22	1.66	30.26	3.4	3.8	14.0	1.88	16.06
50.34	1.66	30.28	3.5	3.4	13.9	1.89	16.02
50.33	1.66	30.24	3.6	3.0	13.8	1.89	15.98
50.99	1.67	30.53	3.7	2.7	13.8	1.90	16.04
50.73	1.67	30.40	3.8	2.3	13.7	1.90	16.00

Feeder Canal(Lining thickness t=10cm), Q=50.202m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,100
Cross Section of Optimization: Water Depth H=2.1, Bed Width b=12.8, Upper Width B=19.1
Hydrology Optimization: Water Depth H=3.8, Bed Width b=2.3, Upper Width B=13.7

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.26	1.31	38.48	1.5	23.4	27.9	1.34	28.81
50.44	1.35	37.44	1.6	21	25.8	1.40	26.77
50.48	1.38	36.47	1.7	18.9	24.0	1.46	25.03
50.26	1.42	35.46	1.8	17.0	22.4	1.51	23.49
50.20	1.45	34.68	1.9	15.4	21.1	1.56	22.25
50.49	1.48	34.20	2.0	14.1	20.1	1.60	21.31
50.26	1.50	33.50	2.1	12.8	19.1	1.64	20.37
50.25	1.52	33.00	2.2	11.7	18.3	1.68	19.63
50.61	1.54	32.78	2.3	10.8	17.7	1.72	19.09
50.61	1.56	32.40	2.4	9.9	17.1	1.75	18.55
49.76	1.57	31.63	2.5	8.9	16.4	1.77	17.91
50.46	1.59	31.72	2.6	8.3	16.1	1.79	17.67
50.40	1.60	31.46	2.7	7.6	15.7	1.81	17.33
50.62	1.61	31.36	2.8	7.0	15.4	1.83	17.10
50.60	1.62	31.18	2.9	6.4	15.1	1.85	16.86
50.33	1.63	30.90	3.0	5.8	14.8	1.86	16.62
50.47	1.64	30.85	3.1	5.3	14.6	1.87	16.48
50.41	1.64	30.72	3.2	4.8	14.4	1.88	16.34
50.86	1.65	30.86	3.3	4.4	14.3	1.89	16.30
50.45	1.65	30.60	3.4	3.9	14.1	1.89	16.16
50.60	1.65	30.63	3.5	3.5	14.0	1.90	16.12
50.62	1.65	30.60	3.6	3.1	13.9	1.90	16.08
50.49	1.65	30.53	3.7	2.7	13.8	1.90	16.04
50.23	1.65	30.40	3.8	2.3	13.7	1.90	16.00

Feeder Canal(Earth Canal), Q=50.202m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=2.1, Bed Width b=24.6, Upper Width B=33.0
Hydrology Optimization: Water Depth H=4.5, Bed Width b=2.4, Upper Width B=20.4

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.23	0.71	71.25	1.5	44.5	50.5	1.39	51.21
50.21	0.73	68.80	1.6	39.8	46.2	1.47	46.96
50.31	0.75	66.81	1.7	35.9	42.7	1.54	43.50
50.34	0.77	64.98	1.8	32.5	39.7	1.60	40.55
50.28	0.79	63.27	1.9	29.5	37.1	1.67	38.00
50.27	0.81	61.80	2.0	26.9	34.9	1.72	35.84
50.24	0.83	60.48	2.1	24.6	33.0	1.78	33.99
50.29	0.85	59.40	2.2	22.6	31.4	1.83	32.44
50.33	0.86	58.42	2.3	20.8	30.0	1.88	31.09
50.41	0.88	57.60	2.4	19.2	28.8	1.92	29.93
50.36	0.89	56.75	2.5	17.7	27.7	1.97	28.88
50.22	0.90	55.90	2.6	16.3	26.7	2.00	27.93
50.31	0.91	55.35	2.7	15.1	25.9	2.04	27.17
50.41	0.92	54.88	2.8	14.0	25.2	2.07	26.52
50.25	0.93	54.23	2.9	12.9	24.5	2.10	25.87

50.48	0.93	54.00	3.0	12.0	24.0	2.12	25.42
50.51	0.94	53.63	3.1	11.1	23.5	2.15	24.96
50.32	0.95	53.12	3.2	10.2	23.0	2.17	24.51
50.69	0.95	53.13	3.3	9.5	22.7	2.19	24.26
50.50	0.96	52.70	3.4	8.7	22.3	2.20	23.91
50.53	0.96	52.50	3.5	8.0	22.0	2.22	23.65
50.41	0.97	52.20	3.6	7.3	21.7	2.23	23.40
50.59	0.97	52.17	3.7	6.7	21.5	2.24	23.25
50.63	0.97	52.06	3.8	6.1	21.3	2.25	23.09
50.55	0.97	51.87	3.9	5.5	21.1	2.26	22.94
50.33	0.98	51.60	4.0	4.9	20.9	2.26	22.79
50.51	0.98	51.66	4.1	4.4	20.8	2.27	22.74
50.59	0.98	51.66	4.2	3.9	20.7	2.28	22.68
50.57	0.98	51.60	4.3	3.4	20.6	2.28	22.63
50.45	0.98	51.48	4.4	2.9	20.5	2.28	22.58
50.23	0.98	51.30	4.5	2.4	20.4	2.28	22.52

Feeder Canal(Earth Canal), Q=50.202m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,100
Cross Section of Optimization: Water Depth H=2.1, Bed Width b=24.9, Upper Width B=33.3
Hydrology Optimization: Water Depth H=4.6, Bed Width b=2.1, Upper Width B=20.4

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.29	0.70	72.00	1.5	45.0	51	1.39	51.71
50.32	0.72	69.60	1.6	40.3	46.7	1.47	47.46
50.22	0.75	67.32	1.7	36.2	43.0	1.54	43.80
50.28	0.77	65.52	1.8	32.8	40.0	1.60	40.85
50.27	0.79	63.84	1.9	29.8	37.4	1.67	38.30
50.30	0.81	62.40	2.0	27.2	35.2	1.73	36.14
50.31	0.82	61.11	2.1	24.9	33.3	1.78	34.29
50.21	0.84	59.84	2.2	22.8	31.6	1.83	32.64
50.27	0.85	58.88	2.3	21.0	30.2	1.88	31.29
50.38	0.87	58.08	2.4	19.4	29.0	1.93	30.13
50.37	0.88	57.25	2.5	17.9	27.9	1.97	29.08
50.26	0.89	56.42	2.6	16.5	26.9	2.01	28.13
50.38	0.90	55.89	2.7	15.3	26.1	2.04	27.37
50.21	0.91	55.16	2.8	14.1	25.3	2.07	26.62
50.38	0.92	54.81	2.9	13.1	24.7	2.10	26.07
50.32	0.93	54.30	3.0	12.1	24.1	2.13	25.52
50.36	0.93	53.94	3.1	11.2	23.6	2.15	25.06
50.56	0.94	53.76	3.2	10.4	23.2	2.18	24.71
50.57	0.95	53.46	3.3	9.6	22.8	2.19	24.36
50.40	0.95	53.04	3.4	8.8	22.4	2.21	24.01
50.45	0.95	52.85	3.5	8.1	22.1	2.23	23.75
50.35	0.96	52.56	3.6	7.4	21.8	2.24	23.50
50.54	0.96	52.54	3.7	6.8	21.6	2.25	23.35
50.60	0.96	52.44	3.8	6.2	21.4	2.26	23.19
50.53	0.97	52.26	3.9	5.6	21.2	2.27	23.04
50.33	0.97	52.00	4.0	5.0	21.0	2.27	22.89
50.53	0.97	52.07	4.1	4.5	20.9	2.28	22.84
50.62	0.97	52.08	4.2	4.0	20.8	2.29	22.78
50.62	0.97	52.03	4.3	3.5	20.7	2.29	22.73
50.52	0.97	51.92	4.4	3.0	20.6	2.29	22.68
50.32	0.97	51.75	4.5	2.5	20.5	2.29	22.62
50.25	0.97	51.70	4.6	2.1	20.4	2.29	22.67

Feeder Canal(Concrete Canal), Q=50.202m^3/s, Freeboard =0.50m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=2.1, Bed Width b=19.4, Upper Width B=19.4
Hydrology Optimization: Water Depth H=4.1, Bed Width b=8.1, Upper Width B=8.1

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.46	1.24	40.74	2.1	19.4	19.4	1.73	23.60
50.32	1.28	39.33	2.3	17.1	17.1	1.81	21.70
50.42	1.33	37.96	2.6	14.6	14.6	1.92	19.80
50.37	1.35	37.24	2.8	13.3	13.3	1.97	18.90
50.69	1.37	36.90	3.0	12.3	12.3	2.02	18.30
50.62	1.39	36.30	3.3	11.0	11.0	2.06	17.60
50.70	1.41	36.00	3.6	10.0	10.0	2.09	17.20
50.43	1.41	35.72	3.8	9.4	9.4	2.10	17.00
50.35	1.41	35.60	4.0	8.9	8.9	2.11	16.90
50.51	1.42	35.67	4.1	8.7	8.7	2.11	16.90
50.59	1.42	35.70	4.2	8.5	8.5	2.11	16.90
50.56	1.42	35.69	4.3	8.3	8.3	2.11	16.90

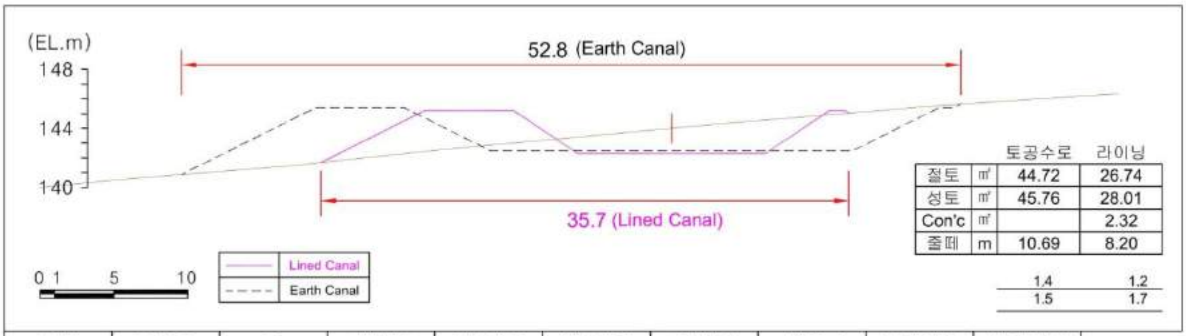
Feeder Canal(Concrete Canal), Q=50.202m^3/s, Freeboard =0.50m, Gradient I = 1 : 5,100
Cross Section of Optimization: Water Depth H=2.1, Bed Width b=18.0, Upper Width B=18.0
Hydrology Optimization: Water Depth H=4.1, Bed Width b=8.2, Upper Width B=8.2

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.32	1.33	37.80	2.1	18.0	18.0	1.70	22.20
50.21	1.37	36.57	2.3	15.9	15.9	1.78	20.50
50.30	1.42	35.36	2.6	13.6	13.6	1.88	18.80
50.22	1.45	34.72	2.8	12.4	12.4	1.93	18.00
50.64	1.47	34.50	3.0	11.5	11.5	1.97	17.50
50.56	1.49	33.99	3.3	10.3	10.3	2.01	16.90
50.79	1.50	33.84	3.6	9.4	9.4	2.04	16.60
50.94	1.51	33.82	3.8	8.9	8.9	2.05	16.50
50.60	1.51	33.60	4.0	8.4	8.4	2.05	16.40
50.65	1.51	33.62	4.1	8.2	8.2	2.05	16.40
50.60	1.51	33.60	4.2	8.0	8.0	2.05	16.40

Feeder Canal(Concrete Canal), Q=50.202m^3/s, Freeboard =0.50m, Gradient I = 1 : 5,000
Cross Section of Optimization : Water Depth H=2.1, Bed Width b=17.9, Upper Width B=17.9
Hydrology Optimization : Water Depth H=4.1, Bed Width b=8.1, Upper Width B=8.1

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
50.50	1.34	37.59	2.1	17.9	17.9	1.70	22.10
50.35	1.39	36.34	2.3	15.8	15.8	1.78	20.40
50.35	1.43	35.10	2.6	13.5	13.5	1.88	18.70
50.23	1.46	34.44	2.8	12.3	12.3	1.92	17.90
50.59	1.48	34.20	3.0	11.4	11.4	1.97	17.40
50.44	1.50	33.66	3.3	10.2	10.2	2.00	16.80
50.59	1.51	33.48	3.6	9.3	9.3	2.03	16.50
50.70	1.52	33.44	3.8	8.8	8.8	2.04	16.40
50.30	1.51	33.20	4.0	8.3	8.3	2.04	16.30
50.32	1.52	33.21	4.1	8.1	8.1	2.04	16.30
50.24	1.51	33.18	4.2	7.9	7.9	2.04	16.30

2. Bangula Canal Section Optimization



구분	기준Q	Q	수심(h)	저폭(b)	상폭(B)	전체폭	여유고	종단경사	사면경사
Earth	50.20	50.236	2.1	24.6	33.0	52.8	0.8	1/5,000	1:2.0
Lined		50.396	2.1	12.7	19.0	35.7	0.8	1/5,000	1:1.5

Bangula Canal(Lining thickness t=10cm), Q=29.89m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=1.8, Bed Width b=9.7, Upper Width B=15.1
Hydrology Optimization: Water Depth H=3.1, Bed Width b=2.0, Upper Width B=11.3

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
30.02	1.26	23.78	1.5	13.6	18.1	1.25	19.01
30.04	1.29	23.20	1.6	12.1	16.9	1.30	17.87
30.02	1.32	22.70	1.7	10.8	15.9	1.34	16.93
30.08	1.35	22.32	1.8	9.7	15.1	1.38	16.19
30.04	1.37	21.95	1.9	8.7	14.4	1.41	15.55
29.95	1.39	21.60	2.0	7.8	13.8	1.44	15.01
30.23	1.40	21.53	2.1	7.1	13.4	1.47	14.67
29.89	1.42	21.12	2.2	6.3	12.9	1.48	14.23
30.05	1.43	21.05	2.3	5.7	12.6	1.50	13.99
30.00	1.44	20.88	2.4	5.1	12.3	1.52	13.75
30.20	1.45	20.88	2.5	4.6	12.1	1.53	13.61
30.22	1.45	20.80	2.6	4.1	11.9	1.54	13.47
30.08	1.46	20.66	2.7	3.6	11.7	1.55	13.33
30.30	1.46	20.72	2.8	3.2	11.6	1.56	13.30
30.39	1.47	20.74	2.9	2.8	11.5	1.56	13.26
30.37	1.47	20.70	3.0	2.4	11.4	1.57	13.22
30.22	1.47	20.62	3.1	2	11.3	1.56	13.18
29.95	1.46	20.48	3.2	1.6	11.2	1.56	13.14

Bangula Canal(Lining thickness t=10cm), Q=29.89m^3/s, Freeboard =0.80m, Gradient I = 1 : 4,000
Cross Section of Optimization: Water Depth H=1.8, Bed Width b=8.6, Upper Width B=14.0
Hydrology Optimization: Water Depth H=3.0, Bed Width b=1.8, Upper Width B=10.8

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
30.04	1.40	21.53	1.5	12.1	16.6	1.23	17.51
29.94	1.43	20.96	1.6	10.7	15.5	1.27	16.47

30.12	1.46	20.66	1.7	9.6	14.7	1.31	15.73
30.19	1.48	20.34	1.8	8.6	14.0	1.35	15.09
30.18	1.51	20.05	1.9	7.7	13.4	1.38	14.55
30.18	1.52	19.80	2.0	6.9	12.9	1.40	14.11
30.25	1.54	19.64	2.1	6.2	12.5	1.43	13.77
30.04	1.55	19.36	2.2	5.5	12.1	1.44	13.43
30.00	1.56	19.21	2.3	4.9	11.8	1.46	13.19
30.20	1.57	19.20	2.4	4.4	11.6	1.47	13.05
30.22	1.58	19.13	2.5	3.9	11.4	1.48	12.91
30.06	1.58	18.98	2.6	3.4	11.2	1.49	12.77
30.27	1.59	19.04	2.7	3.0	11.1	1.49	12.73
30.34	1.59	19.04	2.8	2.6	11.0	1.50	12.70
30.28	1.59	19.00	2.9	2.2	10.9	1.50	12.66
30.10	1.59	18.90	3.0	1.8	10.8	1.50	12.62
30.04	1.40	21.53	1.5	12.1	16.6	1.56	13.18
29.94	1.43	20.96	1.6	10.7	15.5	1.56	13.14

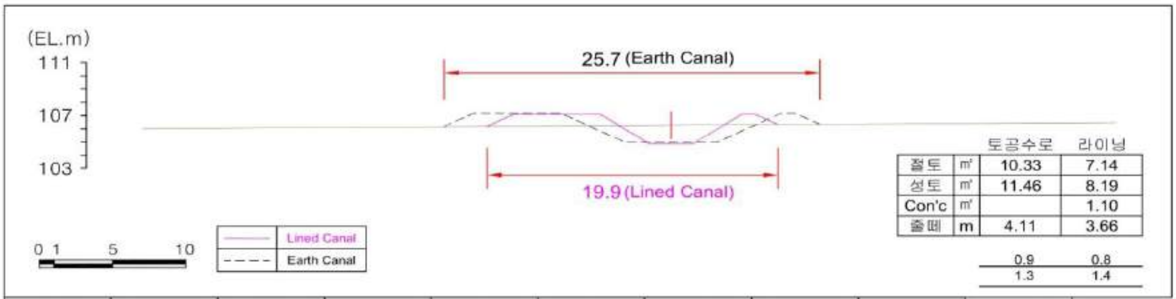
Bangula Canal(Earth Canal), Q=29.89m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=1.8, Bed Width b=18.8, Upper Width B=26.0
Hydrology Optimization: Water Depth H=3.7, Bed Width b=2.0, Upper Width B=16.8

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
29.98	0.68	43.80	1.5	26.2	32.2	1.33	32.91
29.90	0.71	42.40	1.6	23.3	29.7	1.39	30.46
29.93	0.72	41.31	1.7	20.9	27.7	1.45	28.50
29.91	0.74	40.32	1.8	18.8	26.0	1.50	26.85
29.94	0.76	39.52	1.9	17	24.6	1.55	25.50
29.95	0.77	38.80	2	15.4	23.4	1.59	24.34
29.99	0.78	38.22	2.1	14	22.4	1.63	23.39
29.94	0.80	37.62	2.2	12.7	21.5	1.67	22.54
30.05	0.81	37.26	2.3	11.6	20.8	1.70	21.89
29.93	0.82	36.72	2.4	10.5	20.1	1.73	21.23
30.06	0.82	36.50	2.5	9.6	19.6	1.76	20.78
30.00	0.83	36.14	2.6	8.7	19.1	1.78	20.33
30.03	0.84	35.91	2.7	7.9	18.7	1.80	19.97
29.90	0.84	35.56	2.8	7.1	18.3	1.81	19.62
29.91	0.85	35.38	2.9	6.4	18	1.83	19.37
30.09	0.85	35.40	3	5.8	17.8	1.84	19.22
30.17	0.85	35.34	3.1	5.2	17.6	1.85	19.06
30.13	0.86	35.20	3.2	4.6	17.4	1.86	18.91
29.98	0.86	34.98	3.3	4	17.2	1.86	18.76
30.09	0.86	35.02	3.4	3.5	17.1	1.87	18.71
30.12	0.86	35.00	3.5	3	17	1.88	18.65
30.06	0.86	34.92	3.6	2.5	16.9	1.88	18.60
29.92	0.86	34.78	3.7	2	16.8	1.88	18.55
30.13	0.86	34.96	3.8	1.6	16.8	1.88	18.59
81.04	1.07	75.66	3.9	11.6	27.2	2.61	29.04
29.98	0.68	43.80	1.5	26.2	32.2	1.33	32.91

Bangula Canal(Earth Canal), Q=29.89m³/s, Freeboard =0.80m, Gradient I = 1 : 4,000
Cross Section of Optimization: Water Depth H=1.8, Bed Width b=16.7, Upper Width B=23.9
Hydrology Optimization: Water Depth H=3.6, Bed Width b=1.7, Upper Width B=16.1

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
30.04	1.40	21.53	1.5	12.1	16.6	1.31	30.01
29.94	1.43	20.96	1.6	10.7	15.5	1.37	27.96
30.12	1.46	20.66	1.7	9.6	14.7	1.43	26.20
30.19	1.48	20.34	1.8	8.6	14.0	1.48	24.75
30.18	1.51	20.05	1.9	7.7	13.4	1.52	23.60
30.18	1.52	19.80	2.0	6.9	12.9	1.56	22.54
30.25	1.54	19.64	2.1	6.2	12.5	1.60	21.69
30.04	1.55	19.36	2.2	5.5	12.1	1.63	21.04
30.00	1.56	19.21	2.3	4.9	11.8	1.66	20.39
30.20	1.57	19.20	2.4	4.4	11.6	1.69	19.93
30.22	1.58	19.13	2.5	3.9	11.4	1.71	19.48
30.06	1.58	18.98	2.6	3.4	11.2	1.73	19.13
30.27	1.59	19.04	2.7	3.0	11.1	1.74	18.77
30.34	1.59	19.04	2.8	2.6	11.0	1.76	18.62
30.28	1.59	19.00	2.9	2.2	10.9	1.77	18.37
30.10	1.59	18.90	3.0	1.8	10.8	1.78	18.22
30.04	1.40	21.53	1.5	12.1	16.6	1.78	18.06
29.94	1.43	20.96	1.6	10.7	15.5	1.79	18.01
30.12	1.46	20.66	1.7	9.6	14.7	1.80	17.96
30.19	1.48	20.34	1.8	8.6	14.0	1.80	17.91
30.18	1.51	20.05	1.9	7.7	13.4	1.80	17.85
30.18	1.52	19.80	2.0	6.9	12.9	1.80	17.80
30.25	1.54	19.64	2.1	6.2	12.5	1.80	17.85
30.04	1.55	19.36	2.2	5.5	12.1	1.31	30.01
30.00	1.56	19.21	2.3	4.9	11.8	1.37	27.96
30.20	1.57	19.20	2.4	4.4	11.6	1.43	26.20

3. Illovo Canal Section Optimization



구분	기준Q	Q	수심(h)	저폭(b)	상폭(B)	전체폭	여유고	종단경사	사면경사
Earth	11.81	11.907	1.6	6.2	12.6	25.7	0.6	1/3,000	1:2.0
Lined		12.002	1.6	3.0	7.8	19.9	0.6	1/3,000	1:1.5

Illovo Canal(Lining thickness t=10cm), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=4.2, Upper Width B=9.0
Hydrology Optimization: Water Depth H=2.2, Bed Width b=1.4, Upper Width B=8.0

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.97	1.08	11.12	1.3	6.6	10.5	0.98	11.29
12.01	1.10	10.92	1.4	5.7	9.9	1.02	10.75
11.98	1.12	10.73	1.5	4.9	9.4	1.04	10.31
11.94	1.13	10.56	1.6	4.2	9.0	1.06	9.97
11.93	1.14	10.46	1.7	3.6	8.7	1.07	9.73
12.02	1.15	10.44	1.8	3.1	8.5	1.09	9.59
11.97	1.16	10.36	1.9	2.6	8.3	1.10	9.45
12.09	1.16	10.40	2.0	2.2	8.2	1.11	9.41
12.12	1.17	10.40	2.1	1.8	8.1	1.11	9.37
12.04	1.16	10.34	2.2	1.4	8.0	1.11	9.33
11.87	1.16	10.24	2.3	1.0	7.9	1.10	9.29

Illovo Canal(Lining thickness t=10cm), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 4,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=3.6, Upper Width B=8.4
Hydrology Optimization: Water Depth H=2.1, Bed Width b=1.4, Upper Width B=7.7

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.93	1.18	10.08	1.3	5.8	9.7	0.96	10.49
12.00	1.21	9.94	1.4	5.0	9.2	0.99	10.05
11.82	1.22	9.68	1.5	4.2	8.7	1.01	9.61
11.87	1.24	9.60	1.6	3.6	8.4	1.02	9.37
12.00	1.25	9.61	1.7	3.1	8.2	1.04	9.23
11.98	1.26	9.54	1.8	2.6	8	1.05	9.09
11.82	1.26	9.41	1.9	2.1	7.8	1.05	8.95
11.85	1.26	9.40	2.0	1.7	7.7	1.05	8.91
12.12	1.27	9.56	2.1	1.4	7.7	1.07	8.97
11.95	1.26	9.46	2.2	1.0	7.6	1.06	8.93

Illovo Canal(Lining thickness t=10cm), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 3,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=3.0, Upper Width B=7.8
Hydrology Optimization: Water Depth H=2.0, Bed Width b=1.3, Upper Width B=7.3

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.91	1.34	8.91	1.3	4.9	8.8	0.93	9.59
12.00	1.36	8.82	1.4	4.2	8.4	0.95	9.25
11.85	1.37	8.63	1.5	3.5	8	0.97	8.91
12.01	1.39	8.64	1.6	3.0	7.8	0.99	8.77
12.02	1.40	8.59	1.7	2.5	7.6	0.99	8.63
11.85	1.40	8.46	1.8	2.0	7.4	1.00	8.49
11.88	1.40	8.46	1.9	1.6	7.3	1.00	8.45
12.16	1.41	8.60	2.0	1.3	7.3	1.01	8.51
11.98	1.41	8.51	2.1	0.9	7.2	1.00	8.47

Illovo Canal(Earth Canal), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=8.4, Upper Width B=14.8
Hydrology Optimization: Water Depth H=2.7, Bed Width b=1.1, Upper Width B=11.9

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.97	0.59	20.15	1.3	12.9	18.1	1.08	18.71
11.98	0.61	19.60	1.4	11.2	16.8	1.12	17.46
11.90	0.62	19.05	1.5	9.7	15.7	1.16	16.41
11.81	0.64	18.56	1.6	8.4	14.8	1.19	15.56
11.88	0.65	18.36	1.7	7.4	14.2	1.22	15.00
11.93	0.66	18.18	1.8	6.5	13.7	1.25	14.55
11.83	0.66	17.86	1.9	5.6	13.2	1.27	14.10
11.91	0.67	17.80	2.0	4.9	12.9	1.29	13.84
11.87	0.67	17.64	2.1	4.2	12.6	1.30	13.59
11.92	0.68	17.60	2.2	3.6	12.4	1.31	13.44
11.87	0.68	17.48	2.3	3	12.2	1.32	13.29
11.95	0.68	17.52	2.4	2.5	12.1	1.32	13.23
11.96	0.68	17.50	2.5	2.0	12.0	1.33	13.18
11.90	0.68	17.42	2.6	1.5	11.9	1.33	13.13
12.02	0.68	17.55	2.7	1.1	11.9	1.33	13.17
11.83	0.68	17.36	2.8	0.6	11.8	1.32	13.12

Illovo Canal(Earth Canal), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 4,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=7.4, Upper Width B=13.8
Hydrology Optimization: Water Depth H=2.6, Bed Width b=1.0, Upper Width B=11.4

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.95	0.66	18.20	1.3	11.4	16.6	1.06	17.21
11.98	0.67	17.78	1.4	9.9	15.5	1.10	16.16
11.87	0.69	17.25	1.5	8.5	14.5	1.13	15.21

11.88	0.70	16.96	1.6	7.4	13.8	1.17	14.56
11.83	0.71	16.66	1.7	6.4	13.2	1.19	14.00
11.91	0.72	16.56	1.8	5.6	12.8	1.21	13.65
11.86	0.73	16.34	1.9	4.8	12.4	1.23	13.30
11.84	0.73	16.20	2.0	4.1	12.1	1.24	13.04
11.89	0.74	16.17	2.1	3.5	11.9	1.25	12.89
11.85	0.74	16.06	2.2	2.9	11.7	1.26	12.74
11.94	0.74	16.10	2.3	2.4	11.6	1.27	12.69
11.94	0.74	16.08	2.4	1.9	11.5	1.27	12.63
11.88	0.74	16.00	2.5	1.4	11.4	1.27	12.58
12.00	0.74	16.12	2.6	1.0	11.4	1.28	12.63
12.07	0.74	16.20	2.7	0.6	11.4	1.28	12.67

Illovo Canal(Earth Canal), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 3,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=6.2, Upper Width B=12.6
Hydrology Optimization: Water Depth H=2.4, Bed Width b=1.2, Upper Width B=10.8

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.92	0.75	15.99	1.3	9.7	14.9	1.03	15.51
11.85	0.76	15.54	1.4	8.3	13.9	1.07	14.56
11.91	0.78	15.30	1.5	7.2	13.2	1.10	13.91
11.89	0.79	15.04	1.6	6.2	12.6	1.13	13.36
11.83	0.80	14.79	1.7	5.3	12.1	1.15	12.90
11.95	0.81	14.76	1.8	4.6	11.8	1.17	12.65
11.93	0.82	14.63	1.9	3.9	11.5	1.18	12.40
11.99	0.82	14.60	2.0	3.3	11.3	1.19	12.24
11.94	0.82	14.49	2.1	2.7	11.1	1.20	12.09
11.31	0.82	13.86	2.2	1.9	10.7	1.18	11.74
12.01	0.83	14.49	2.3	1.7	10.9	1.21	11.99
11.92	0.83	14.40	2.4	1.2	10.8	1.21	11.93
12.03	0.83	14.50	2.5	0.8	10.8	1.21	11.98

Illovo Canal(Concrete Canal), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 5,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=7.3, Upper Width B=7.3
Hydrology Optimization: Water Depth H=2.4, Bed Width b=4.7, Upper Width B=4.7

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.95	0.96	12.48	1.3	9.6	9.6	1.02	12.20
11.93	0.98	12.18	1.4	8.7	8.7	1.06	11.50
11.81	1.00	11.85	1.5	7.9	7.9	1.09	10.90
11.82	1.01	11.68	1.6	7.3	7.3	1.11	10.50
11.85	1.02	11.56	1.7	6.8	6.8	1.13	10.20
11.94	1.04	11.52	1.8	6.4	6.4	1.15	10.00
11.89	1.04	11.40	1.9	6.0	6.0	1.16	9.80
11.97	1.05	11.40	2.0	5.7	5.7	1.18	9.70
11.95	1.05	11.34	2.1	5.4	5.4	1.18	9.60
11.82	1.05	11.22	2.2	5.1	5.1	1.18	9.50
11.91	1.06	11.27	2.3	4.9	4.9	1.19	9.50

11.92	1.06	11.28	2.4	4.7	4.7	1.19	9.50
11.87	1.06	11.25	2.5	4.5	4.5	1.18	9.50
11.75	1.05	11.18	2.6	4.3	4.3	1.18	9.50

Illovo Canal(Concrete Canal), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 4,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=6.7, Upper Width B=6.7
Hydrology Optimization: Water Depth H=2.3, Bed Width b=4.5, Upper Width B=4.5

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.93	1.05	11.31	1.3	8.7	8.7	1.00	11.30
11.92	1.08	11.06	1.4	7.9	7.9	1.03	10.70
11.83	1.10	10.80	1.5	7.2	7.2	1.06	10.20
11.92	1.11	10.72	1.6	6.7	6.7	1.08	9.90
11.82	1.12	10.54	1.7	6.2	6.2	1.10	9.60
12.06	1.14	10.62	1.8	5.9	5.9	1.12	9.50
11.91	1.14	10.45	1.9	5.5	5.5	1.12	9.30
11.90	1.14	10.40	2.0	5.2	5.2	1.13	9.20
12.09	1.15	10.50	2.1	5.0	5.0	1.14	9.20
11.87	1.15	10.34	2.2	4.7	4.7	1.14	9.10
11.89	1.15	10.35	2.3	4.5	4.5	1.14	9.10
11.83	1.15	10.32	2.4	4.3	4.3	1.13	9.10

Illovo Canal(Concrete Canal), Q=11.81m^3/s, Freeboard =0.80m, Gradient I = 1 : 3,000
Cross Section of Optimization: Water Depth H=1.6, Bed Width b=6.0, Upper Width B=6.0
Hydrology Optimization: Water Depth H=2.2, Bed Width b=4.3, Upper Width B=4.3

Calculated Flow	Flow Velocity	Area	Water Depth	Bed Width	Upper Width	Hydraulic Radius	Perimeter
Q	V	A	H	b	B	R	P
11.95	1.19	10.01	1.3	7.7	7.7	0.97	10.30
11.93	1.22	9.80	1.4	7.0	7.0	1.00	9.80
11.85	1.23	9.60	1.5	6.4	6.4	1.02	9.40
12.02	1.25	9.60	1.6	6.0	6.0	1.04	9.20
12.03	1.26	9.52	1.7	5.6	5.6	1.06	9.00
11.87	1.27	9.36	1.8	5.2	5.2	1.06	8.80
11.86	1.27	9.31	1.9	4.9	4.9	1.07	8.70
12.05	1.28	9.40	2.0	4.7	4.7	1.08	8.70
12.15	1.29	9.45	2.1	4.5	4.5	1.09	8.70
12.18	1.29	9.46	2.2	4.3	4.3	1.09	8.70
12.11	1.28	9.43	2.3	4.1	4.1	1.08	8.70
11.96	1.28	9.36	2.4	3.9	3.9	1.08	8.70

Annex 18.
Calculation of Width for Intake Gate

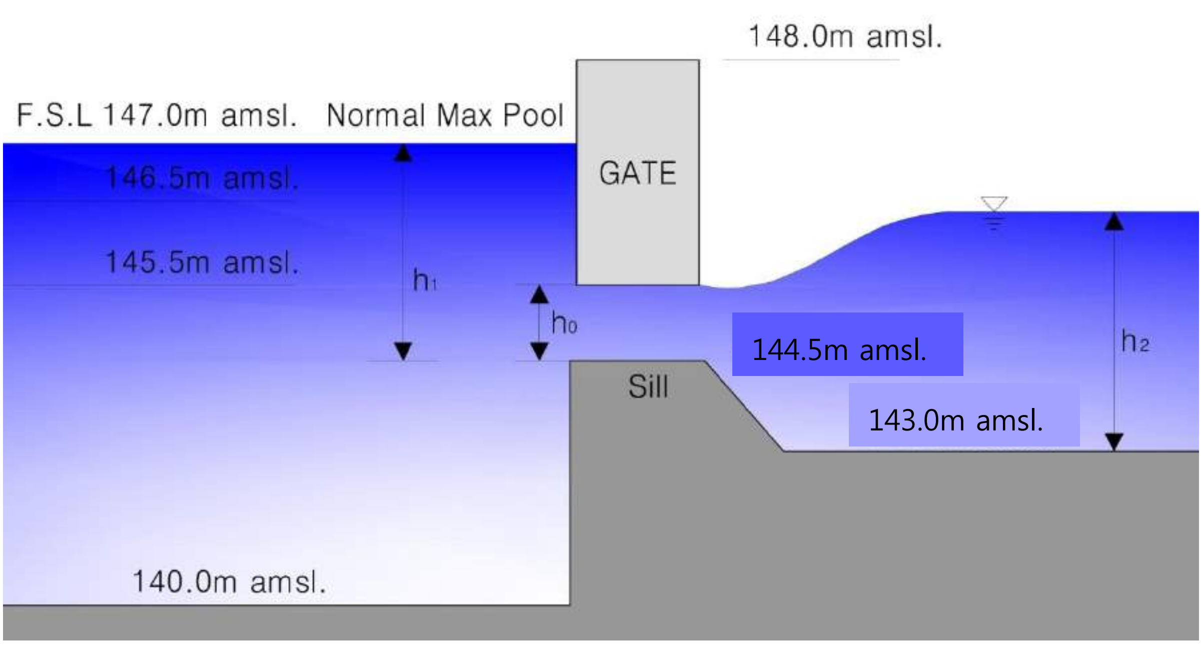
Annex 18. Calculation of Width for Intake Gate

Use the Orifice formula:

Q(m^3/s)=C * B * h0 * (2g(h1-h0/2))^1/2

where, C = Coefficient of discharge

B= Width of Intake Gate(m)



* Result: When the sill elevation is 145.0m a.m.s.l.,

Q=50.2 m^3/s the Width of Intake Gate B= 36.0m

Q=35.1 m^3/s the Width of Intake Gate B= 25.0m

Q(m^3/s)	C	h0(m)	2g(m/s^2)	h1(m)	h0/2	(2g(h1-h0/2))^1/2	B(m)
50.2	0.65	0.50	19.6	0.70	0.25	4.41	36.0
43.5	0.65	0.50	19.6	0.70	0.25	4.41	31.0
35.1	0.65	0.50	19.6	0.70	0.25	4.41	25.0
30.5	**0.65**	**0.50**	**19.6**	**0.70**	**0.25**	**4.41**	**22.0**

Annex 19.
Gross Margins of
Agriculture Production of Chikwawa Region

Annex 19. Gross Margins of Agriculture Production of Chikwawa Region

CROP	YIELD	PRICE	V/COSTS
SWEET POTATOES	6,500	70	130,500
	5,000	70	70,500
	9,000	65	163,500
	8,000	65	70,500
	7,500	80	72,500
EPA TOTALS	**36,000**	**350**	**507,500**
DISTRICT AVERAGE	**7,200**	**70**	**101,500**
MILLET	500	70	45,100
	900	75	28,700
	650	70	76,350
	600	70	25,800
EPA TOTALS	**2,650**	**285**	**175,950**
DISTRICT AVERAGE	**663**	**71**	**43,988**
SORGHUM	900	75	40,050
	2,500	60	77,750
	1,500	80	102,000
	1,600	70	54,750
	630	75	21,450
	750	80	44,750
EPA TOTALS	**7,880**	**440**	**340,750**
DISTRICT AVERAGE	**1,313**	**73**	**68,150**
BEANS IRRIGATED	600	500	188,600
	500	500	138,950
	800	450	143,750
	900	500	188,110
	800	500	140,200
	700	450	146,200
EPA TOTALS	**4,300**	**2,900**	**945,810**
DISTRICT AVERAGE	**717**	**483**	**157,635**
TOMATOES	10,000	80	180,000
	18,000	70	262,400
	16,000	80	265,900
	21,000	80	261,600

	15,000	80	255,650
	13,000	90	273,200
EPA TOTALS	93,000	480	1,498,750
DISTRICT AVERAGE	15,500	80	249,792
CASSAVA	10,000	70	115,900
	3,800	80	47,000
	12,000	70	71,250
	3,200	80	49,500
	3,500	75	58,800
EPA TOTALS	32,500	375	342,450
DISTRICT AVERAGE	6,500	75	68,490
G/NUTS	900	500	83,750
	700	500	79,750
	700	450	101,900
	800	500	81,250
	700	500	91,800
EPA TOTALS	**3,800**	**2,450**	**438,450**
DISTRICT AVERAGE	**760**	**490**	**87,690**
MAIZE RAINFED	2,000	90	286,800
	900	90	233,200
	1,700	90	242,450
	2,800	90	232,600
	1,900	90	246,600
	2,000	80	227,500
EPA TOTALS	**11,300**	**530**	**1,469,150**
DISTRICT AVERAGE	**1,883**	**88**	**244,858**
MAIZE IRRIGATED	1,300	90	235,800
	2,100	90	200,900
	1,500	80	238,500
	1,700	90	212,750
EPA TOTALS	6,600	350	887,950
DISTRICT AVERAGE	1,650	88	221,988
RICE IRRIGATED	2,200	160	231,000
EPA TOTALS	2,200	150	213,000

DISTRICT AVERAGE	2,200	150	213,000
RICE RAINFED	600	150	208,800
	1,800	140	198,500
	900	150	150,200
	1,500	150	167,000
	1,500	140	163,000
EPA TOTALS	6,300	730	887,500
DISTRICT AVERAGE	1,575	183	221,875
COTTON	800	210	228,400
	1,000	190	224,100
	1,200	215	231,050
	1,100	230	227,250
	1,000	220	219,000
	900	240	217,200
EPA TOTALS	6,000	1,305	1,347,000
DISTRICT AVERAGE	**1,000**	**218**	**224,500**
COW PEAS	600	300	82,300
EPA TOTALS	**600**	**300**	**82,300**
DISTRICT AVERAGE	**600**	**300**	**82,300**
P/PEAS	900	450	141,660
	700	450	92,250
EPA TOTALS	1,600	900	233,910
DISTRICT AVERAGE	800	450	116,955

Annex 20. Flood Map

Annex 20. Flood Map