Technical Assistance Final Report

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People's Republic of China: Strengthening of Water Resources Management in Guiyang

Prepared for the Water Resources Bureau of Guiyang Municipality

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Asian Development Bank
Final Report Part I

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Prepared by

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Preface

The Strengthening of Water Resources Management for Guiyang which is funded by TA 4912 PRC was undertaken from July 2009 till May 15, 2010. We would thank the Asian Development Bank for participating in this TA as it is a timely TA for China when water shortages have forced most cities, counties and provinces to rethink the whole requirement of integrated water resources management. There are very few options to rising demands in water and supplies are shrinking because of overuse. Demand management is probably the only way to match demand with very limited supplies.

Lesson can be learned from many developed countries that have already gone through this phase of extremely limited water supplies and have to resort to demand management by water saving devices, recycling in industry, water reclamation, reducing water network losses and by other means.

We would like to thank the Guiyang Municipality Water Resources Bureau for the assistance in providing some of the key documents and advice and discussion on the management aspects of water resources for the municipality. We would also like to thanks them for some of the translation services provided intermittently over the course of the TA.

The work undertaken in the TA, apart from the Water Resources Bureau, is also from discussions with the Guiyang Municipality Bureaus such as the Urban Management Bureau, Urban Construction Bureau, and Water Saving Office, Water Supply Company and others.

The Guiyang Water Resources Bureau had completed a major study by its Hydrology Bureau and the findings of the Study are contained in the report Guiyang Integrated Water Resources Planning by the Guiyang Hydrology Bureau in July 2007. The consultants found this report containing a vast amount of detailed information on integrated water resources management and on demand management.

This report was written by Dr. Daniel Gunaratnam with assistance and inputs from Mr. Li Zhi for Chapter 7 and some assistance from Mr. Shen Dajun for some of the institutional arrangements.

This report is Part I which focuses on integrated water resources management and demand management

Part II of the report focuses for the IWRM project components i.e. on the Environmental Management, Water User Organization formation, training, and structure; financial management and institutional arrangements for the Project Management Office; and on the Yudongxia Reservoir Payment for Environmental Services.
Executive Summary

The focus of this Technical Assistance was to focus on developing a plan to undertake Integrated Water Resources Management Plan and to shift the present system water resources supply management to demand management. Chapter one indicates the purpose of the report.

Chapter 2 of the report describes the special features of the water resources system in Guiyang Municipality. This chapter describes the socio economic context of the Guiyang Municipality. The Guiyang Municipality will have an increase of population from 3.8 million to 4.8 million from 2010 to 2030. The urban rural population split will be more marked in 2030 than presently. The urban population is 2.35 million in 2009 and it will increase to 3.85 million in 2030. Rural population will decline from 1.5 million in 2009 to about 1.0 million in 2030.

The economy will grow at an average of 11% from a Gross Regional Product of Y74 billion to Y193 billion (150% increase) in real terms. Urban per capita income will increase from Y19,000 in 2009 to Y38,000 in 2030.

Water resources system will have tremendous challenges to meet the various demands made by the increase in population and the rapid economic growth. The present elasticity of demand for water to economic growth is about +.33, which means for every 1% growth there will be an increase of 0.33% increase in demand for water. For an average growth rate of 11% per year the demand for water will grow at 3.7% per year. This growth of demand for water is unsustainable and it needs to be controlled by demand management.

Although Guiyang Municipality is in a relatively plentiful water resources area it is constrained by the fact there is no groundwater and there are limitations of reservoir storage sites. Because of these limitations of surface and groundwater storage it is only possible to use a maximum of about 33% of the water resources. In addition because of the entire area being in a Karsts area most rainfall penetrates into the ground and form part of the river flow in the downstream parts of the river basin.

The total long term average of water resources of Guiyang is 4.5146 billion cum per year. The available water resources are 1.516 billion cum per year. The maximum sustainable water supply available is 1.306 billion cum per year.

The present use of water in Guiyang Municipality is 1.042 billion cum per year. Guiyang will become a city of about 4.8 million by 2030 which will be the same size as the three international cities (Los Angelis, Singapore and Sydney) as examples for international experience. However Guiyang is using more water (by as much as 30-40%) today than all these three international examples although the per capita incomes of these cities are about 20-30 times higher. It is extremely important to curb Guiyang Municipality’s high demand for a city which ha a much lower income per capita 3-5% of the three international cities and with industrialization which is so low. Several suggested methods of improving the efficiency of the water systems are proposed and discussed fully in chapter 6.
Chapter 3 discusses the international experience in IWRM and demand management. The three cities all suffer from a shortage of water for different reasons. Los Angelis City obtained a mandate after its contacts with Colorado system had expired and needed to undertake IWRM and demand management. The obtained permission by putting it IWRM on the ballot got the California Legislature to allocate money for IWRM. They then developed programs for demand management and all water development was focused on ensuring demand is matched with supply. Essentially they had a water saving program for residences, industry and business and provided rebates for people who adopted water saving devices. Residences had smaller toilet cisterns, shower heads that saved water and irrigation was controlled. In addition they had special programs to eliminate home outdoor irrigation by use of artificial turf. They drastically reduced the network losses to 4%. On the supply side they reclaimed water from wastewater for all non-portable use and enhanced supply by collecting storm water and runoff of the coastal areas and resorted to desalination for all additional water. In undertaking both supply side and demand side management they met all their future needs for water.

Sydney has a similar experience of first damming up all the river basins for water supply so that it had a firm yield of 600 million cum per year. But very quickly in early 2002 Sydney had very long droughts and the yield of the reservoirs became 20-30% less than the earlier yield estimates. They also resorted to firm demand management programs of water saving indoor and outdoor for residences, for business and for industry. In addition they also recycled/reclaimed wastewater and reduced their network losses from 10.7% in 1999 to 7.5% in 2009. For future demand they had three sources: desalination, use of additional groundwater, and extracting water at lower levels in the reservoir. The overall effect is that they managed to meet all their demands from savings of water, reduction of losses and recycled water. Their future plan is to expand more water savings, continue reduce losses and recycling water and if these do not meet the demands it is expected they will develop the desalination plants, groundwater and draw deeply from the reservoirs. The key clearly is that they adopted IWRM principles and used demand management to match demand with supply.

Finally in the case of Singapore the city state had to develop its supply of water from its own Island water resources. On the supply side Singapore developed supplies from rural catchment areas, from urban catchment which will ultimately be stored in deep tunnels, from reclaimed waste water for non-portable use and by developing desalinated water. Whereas Singapore relied 70 of its water coming from Malaysia the Island State now developed 90% of its resources on the Island. Simultaneously they had a very strong demand management program to reduce the water consumption levels through water savings. This resulted in per capita daily consumption declining from 175 liters/capita to 157 liters/capita. They also reduced the network losses to about 5% in 2009 from some 8% a decade ago. Singapore also met their obligation of water by both demand management and supply management.

Overall all the three cities have first, one integrated group institution managing the water resources and thereby integrating the water resources management. Second all three cities kept constrained the demand by demand management essentially by water saving, water recycling, network loss reduction and by educational programs to get the public involved in the demand management program.
Chapter 4 discusses the essential elements of IWRM and the conditions under which demand management can be implemented. There three criteria for IWRM to be successful are: a) economic efficiency, b) equity, and c) environmental and ecological sustainability.

There are three preconditions for IWRM to be successful:

- the enabling environment – the general framework of national policies, legislation and regulations and information for water resources management stakeholders;
- the institutional roles and functions of the various administrative levels and stakeholders; and
- the management instruments, including operational instruments for effective regulation, monitoring and enforcement that enable the decision-makers to make informed choices between alternative actions.

The rest of the chapter focuses on the enabling environment that exists presently in the water law and in the State Council statements which essentially form the enabling environment. The basic institutional arrangements are fragmented and water services are delivered for urban and rural people by different institutions. Because of this there is inefficiency, lack of demand management, absence of pollution control, absence of water saving, lack of coordination of flood control between urban and rural sectors. Some basic preliminary steps are discussed how to undertake monitoring and setup of informal institutions as precursor for IWRM work.

Chapter five lays out the basic institutional reform action program. The first section deals with the functions of the various bureaus in the municipality that deal with water resources. There are eight bureaus that deal with water delivery services. Many of the delivery systems are vertically fragmented and horizontally fragmented. The next discussion the various forms of water affairs bureaus that have been developed in China. The discussion is then on the Action Program phase I and II for institutional program.

First phase Institutional Reform Action Program is preliminary reform that have to be done in the Water Resources Bureau to form Water Management Stations in each River Basin. These will then be the basis for the formation of river basin institutions in the municipality for demand management monitoring and for enforcing the water abstraction levels.

Second Stage Institutional Reform Action Program II is done in three stages. First there is the transfer of the Water Saving Office and River Bank Protection Office into the Water Resources Bureau. Second Stage Reform is to integrate several of the water supply companies in the City districts and Suburban areas so that they are all under one water supply company to get greater efficiency and better integration of services. Also involved in the second phase is the integration of the sewerage treatment companies and drainage office so that all collection and treatment facilities are under one group. The drainage office is still under the municipality and it need to be corporatized and made an independent body which can be integrated with the wastewater treatment companies.
The third stage of the Action Program II is to form the full blown Water affairs Bureau with all the necessary departments in the Urban Management Bureau and the Environmental Protection Bureau and other sections of the Soil Conservation of the Urban Area to be integrated with the Water resources Bureau to form a Water Affairs Bureau. This will then form an Integrated Institutions

Chapter 6 deals with demand management for the new Water Affairs Bureau. The Demand Management Office (DMO) is part of the new Water Affairs Bureau. The prime function of the DMO is to develop a program of demand management programs to ensure demand matches supply. The main program is i) water savings program (for industry, businesses,) which is mainly water quota management through better and more efficient factories on water use; ii) increase recycling levels for all industry; iii) reduce water network losses; iv) increase water savings in apartments with water saving devices; and v) have an educational program to get people involved in water savings.

A demand forecasting model should be developed for preempting any unusual demands that may need new supplies. Demand forecasting model is also needed for actions to be taken to curb new and excessive demands. Finally under this chapter there is a discussion about monitoring needs and basic equipment and communication systems.

Chapter 7 discusses in detailed the rural sector demand management. It has similar demand management tools—water saving program, raise recycling levels for industry, and reduce network losses. In addition it discusses a institutional arrangements for management of demand from county, township and village level.
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Introduction

1 Background

Guiyang Municipality (GM) are on the mountainous ridge of the watershed boundary between the Yangtze River basin to the north, which drains about 95% of the area, and the Pearl River basin to the south.

Administratively Guiyang Municipality is composed of Guiyang city proper plus Guiyang suburb counties, totaling 37 sub-district offices, 15 communities, 30 towns and 49 townships, called “whole municipality” for short. Guiyang urban (downtown) areas include 3 districts, i.e. Nanming, Yunyan and Xiaohe, totaling 30 sub-district offices, 15 communities, 1 town and 2 townships, called “urban areas”. Guiyang suburban areas include 3 districts, i.e. Huaxi, Baiyun and Wudang, totaling 6 subdistrict offices, 11 towns and 19 townships, called “suburban areas. Suburb counties include 3 counties, i.e. Xiuwen, Kaiyang and Xifeng, and Qingzhen City, totaling 1 subdistrict office, 18 towns and 28 townships, called “suburb counties”.

Municipality covers an area of 8034 square km. There are 98 rivers longer than 10 km and over 20 km² of valley area for each, in which 90 rivers are located in the north of the watershed, belonging to Yangtze River valley with the area of 7565 km² (accounting for 94.2%) and 8 rivers in the south of the watershed, belonging to Pearl River valley with the area of 468.9 km² (accounting for 5.8%). For years, the depth of natural runoff averages 400-760 mm with $4515 \times 10^6$ m³ of overall runoff volume (including $1360 \times 10^6$ m³ of surface water transformed from groundwater), of which $4244 \times 10^6$ m³ belong to Yangtze River valley (accounting for 94.0%) and $271 \times 10^6$ m³ to Pearl River valley (accounting for 6.0%).

Water resources are unevenly distributed within one year and between years. At the same time, they have obvious difference in flood year (or water-abundant year) and dry year. From May to August, considerable water resources are in the form of flood, accounting for 70% -80% of the total water volume; while from December to February next year, the volume is less 4.5% of the total in the year. In special dry year, the water resources of the city proper are only about 56% of average for many years.

Annual average precipitation is quite high at 1,096 mm, but large evaporative losses and uneven distribution present particular challenges for capturing and storing water. Total annual renewable freshwater supply is estimated at 8.8 billion m³, almost half of which evaporates due to the poor vegetative cover and rocky terrain of the catchment areas. The remaining water drains into rivers (4.5 billion m³ or 51% of total precipitation) as quick surface flows through numerous short creeks and streams that run deep in valleys, or through fast-flowing deep aquifers (groundwater rivers) through the limestone layers (karst areas). Local surface and underground water resources average 1,300 m³ per capita. This compares poorly with the PRC average of 1,700 m³ per capita. To illustrate these challenges: (i) 74% of rain falls between May and August, and 85% falls between May and September; (ii) only 4.5% falls between December and February; (iii) annual fluctuations with a 100% difference
(i.e. a 1:2 ratio) between a low rainfall year and a high rainfall year; and (iv) northern GM only gets 60% of the amount of rain that falls in the south.

1.1 Project Inputs and Startup

This Technical Assistance was started on July 22, 2009 and the following specialists were involved in the TA for Strengthening for Water Resources in Guiyang Part I:

a) Dr. Daniel Gunaratnam Water Resources/Hydrology and Demand Management and International Specialist
b) Mr. Li Zhi Rural Water, Irrigation and Project Implementation Specialist
c) Dr. Shen Dajun Water Institutional and Demand Management Specialist
d) Professor Jin Leshan Payment for Environmental Services
e) Professor Xie Qingtao Environmental Assessment and Management Specialist
f) Mr. Wujian Water Saving Specialist

1.2 Focus and Impediments of Integrated Water Resources Management (IWRM) in this Study

Focus of Study

There have been several Technical Assistances and Project Preparation Technical Assistance’s (PPTA) 1 given to develop the Integrated Water Resources Management (IWRM) Plans for Guiyang Municipality. The key focus of these activities to be implemented in the IWRM strategic action plan included:

(i) Establish an effective water sector management structure;
(ii) Shift the current supply management to demand management;
(iii) Promote participation in water resources management;
(iv) improve information management and sharing; and
(v) Build the capacity to manage the water in GM. The plan will be implemented in conjunction with the implementation of the Project from 2009 to 2015

However despite the numbers of TA’s a lot of the studies focused on the qualitative aspects and the study’s never produced a definitive plan for IWRM for Guiyang Municipality. This study will develop a definitive plan for IWRM and demand management.

The focus of this TA 4912 Strengthening Water Resources Management Guiyang is to complete the unfinished work in earlier TA to develop a definitive for IWRM and to undertake the specific training activities:

The second workshop was an international and was conducted on November 9-10. The themes of the workshop were i) Integrated Water Resources Management defined ii) Successful cases of IWRM internationally and Chinese experience iii)

1TA 4586 Guiyang Integrated Water Resources Management Project; TA 38594- 01 Guiyang Integrated Water Resources Management Sector Project
IWRM reforms needed for Guiyang and iv) IWRM Project for Guiyang and its Implementation

1.2.2 Impediments To IWRM in Guiyang Municipality

The key impediments to implementation of IWRM in Guiyang can be summarized as follows:

- Institutional fragmentation – particularly but not only horizontal fragmentation between institutions/agencies at the same level of government;
- an absence of participatory structures and consultative processes;
- poor coordination between different agencies and inadequate information flows;
- a lack of comprehensive catchment-based systems analysis in the preparation of the Master Plan; and a continued emphasis on supply-side solutions.

A broad strategy for IWRM-based institutional reforms was outlined as:

- selective institutional reforms to remove specific anomalies and constraints to a more integrated approach;
- clearer definition of the role and responsibility of the WRB as the agency with overarching responsibility for overall water resources management;
- establishing participatory structures, including Water User Associations (WUAs) in rural areas, and involving other non-governmental stakeholders as appropriate;
- improved coordination through joint working groups and standing committees to address specific problems such as:
  - Rural water conservation and agricultural outreach to change cropping patterns,
  - Industrial water saving,
  - promoting urban water saving, and
  - providing comprehensive solutions to water quality issues;
  - greater focus on water management based on catchments rather than on the basis of administrative jurisdictions.

In relation to the Guiyang IWRM Sector Project, potential capacity building needs were identified as relating to:

- the progressive implementation of IWRM principles throughout Guiyang municipality;
- processing the approvals for non-core sub-projects;
- use of participatory approaches including the establishment and development of local WUAs and Water User Groups (WUGs);
- support to farmers for the application of revised cropping patterns to reduce the risk of crop loss and increase crop yields; and
- implementation support to the municipal Project Management Offices (PMO), local PMOs and relevant Implementing Agencies (IAs).
1.3 Demand Management

The PPTA report noted that, despite genuine intentions to introduce IWRM in GM, there remained a strong emphasis on supply-side management. Demand management will need to be strengthened in implementation of the Guiyang IWRM Project. Important aspects of demand management include, but are not limited to, water use efficiency programs and the Chinese concept of a water saving society, public awareness raising, industry efficiency programs, programs that target water losses, and pricing strategies. These are all discussed briefly here, with the exception of pricing strategy for which discussion is deferred until a later section of this chapter on financial sustainability. Demand management takes on particular relevance in an environment where there are shortages of available water. As noted in section 1.4, estimated water availability in GM is 1288 m³ per capita per annum, well below the recognized standard desired of 1760 m³ per capita per annum.

1.3.1 Water Saving Society

A new idea has been formulated and promoted in the PRC in recent years: that of a water saving society. The idea embraces the traditional concepts of water use efficiency and scientific development of water resources and new technology in order to save scarce water. One of the key emphases in the campaign is to improve agricultural water use efficiency. According to MWR sources, most farmland in China is irrigated in the traditional way which is very wasteful. Irrigation efficiency is only around 40%, which is far lower than is being achieved in developed countries. As part of the campaign pilot projects have been initiated in counties within Sichuan and Gansu Provinces, for example, to invest in modern irrigation techniques to achieve higher efficiencies of water use. Industrial water use in China currently achieves only 55% recycling, whereas 85% to 97% can be achieved in developed countries and the water short provinces in China. Waste of water in urban areas is also substantial, and in 2002 pilot projects was launched in three cities suffering water shortages to develop water-saving societies. In Guiyang City, the PPTA report states that 20% to 38% of water is unaccounted for, primarily due to leakage from old infrastructure in poor condition, but also due to billing and revenue collection problems. One of the instruments to be applied in developing water-saving societies is water pricing so that the economic value of water becomes more apparent to consumers. So in broad terms the Chinese campaign to build a water-saving society is a demand management policy being advocated at the national level. Measures to strengthen demand management (as opposed to supply-side management) in GM will therefore support this national imperative.

1.3.2 Water Use Efficiency Programs

Consistent with the campaign to build a water-saving society, the Project should target water use efficiency in agricultural and industrial water use.

1.3.3 Agricultural Water Use Efficiency

In agriculture, the modernization of irrigation infrastructure proposed under the Guiyang IWRM Project will contribute to reduction in loss of water from distribution
networks (channels in poor condition, etc.). Local management by Water Users Association (WUA) has also been shown to contribute to improved efficiency brought about by better maintenance and more conscientious operations of irrigation infrastructure. Training provided to WUAs in water conservation and irrigated agricultural practice will further lead to wiser water use and less wastage. It has been noted that the performance of WUAs in northern China was uneven, but better performance was correlated with greater support provided to WUAs. This TA can therefore contribute to greater water use efficiency in irrigation areas by providing sound training and follow up support to WUAs that are or will be set up for the core sub-projects (e.g. Wudang, Jinlong and Liaojiuzhai sub-projects). These efforts will then serve as a model for the development and support of WUAs for applicable non-core sub-projects, and in that way the initiatives can be sustained with ongoing support from the PMOs. To gain the necessary ongoing support from the PMOs it will be essential during training provided to PMOs to emphasize the important role of the WUA and inculcate the need to provide the WUA with adequate support and training. Training modules should be prepared during the course of this TA for subsequent delivery during the remainder of the IWRM plan “for implementation over a wider area in 3 to 5 years.

1.3.4 Industrial Water Use Efficiency

Improved industrial water use is rather more difficult to achieve, given that the industrial processes consuming water are so many and so varied. However, some generic approaches can achieve water savings.

- One approach is through education and campaigns for raising awareness and the need for water savings, appealing to desires to be good corporate citizens and partners in society. This would be even more effective if water saving measures can be shown to lead to lower operating costs. Saving money while doing good is an irresistible combination for business leaders.
- Subsidies or other incentives may be considered to encourage the introduction of alternative water-saving devices or processes.
- A system could be introduced so that, at the invitation of an enterprise, an official could visit a production site to review current water use practices and advise on measures that could be introduced to save water. Officials delegated these duties would have to well trained for their role.
- Recycling a greater proportion of water used has the potential for reduction in industrial water consumption. Recycling can be encourage by provision of incentives, and supported by voluntary inspection and advisory services as described above. Application of these approaches would assume an office, within an appropriate institution with a mandate for urban water management, dedicated to a campaign to improve industrial water use efficiency and achieve savings in industrial water use.

1.3.5 Urban Water Use Efficiency

Domestic urban water use efficiency can be improved in many ways, some of which are raising public awareness; water pricing. One effective approach is to encourage use of water-efficient appliances such as low-volume flush toilets, efficient clothes
washing machines and low-rate shower heads. Publicity about water-efficient appliances is a useful approach, but a program including incentives is more effective. Water providers can do deals with appliance suppliers for mass purchases at discount prices, on-selling to members of the public with a margin just adequate to cover costs. Toilet flushing is a major component of domestic water use and should be targeted to achieve significant water savings. Direct subsidies have been used in many cities (Shanghai is an example in the PRC) to assist businesses and private households install low volume flush toilets.

1.3.6 Reduction in Distribution Losses

The Master Plan and the PPTA report state that for Guiyang city municipal water supply unaccounted water represents between 20% and 38% of water supplied. Unaccounted water includes water that may be used but not metered or billed – in other words unauthorized water use – but the largest component of unaccounted water by far is undoubtedly due to leakage and spills. These are caused by ageing infrastructure, soil movements, accidents (during construction activity for example), and operational factors (e.g. storage tank spills, excessive mains pressure). The American Water Works Association (AWWA) regards 10% losses as an appropriate target (AWWA, 2007). Assuming that target was applicable to Guiyang City, a reduction of at least 10% to 20% of the water that is currently treated and pumped to the urban distribution network could be achieved without any adverse effect on service delivery to consumers. The costs of treating and pumping that water could be saved. Features of a program to reduce water loss are identification of losses, leak detection and repairs, metering and a maintenance and replacement program (Sykes et al. 1999). Identification of losses refers to system analysis, based on all sources of data available, to identify how much of unaccounted water are losses and where the losses are occurring in the network. Leaks may be visible at the surface or not, but there are methods of leak detection even when they are not visible. Most visible leaks are reported either by the public or by water company employees. An organized program of leak detection and repair will contribute to water loss reduction. There should also be a program for maintenance and progressive replacement of system components (e.g. pipes) with adequate recurrent.
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2.0 Guiyang Municipality Natural Resources Systems

2.1 Background

2.1.0 Purpose

In the context of integrated water resources management (IWRM), the water resources system (WRS) comprises (i) the socioeconomic system—the water-using and water-related human activities (ii) the natural resources system—the natural resources and related infrastructure; and (iii) the delivery of water administrative and institutional system—the system of administration, legislation, and regulation, including the authorities responsible for the management of the WRS and the implementation of laws and regulations.

Socioeconomics of Guiyang and its relation to Water Needs and Development

Present situation of water supply system

The Guiyang Municipality urban water supply infrastructure is old and in poor condition, water pressures are declining, and the supply is rationed in dry periods. Industrial recycling fails to meet the PRC targets of 75% and nonrevenue water is believed to be high, probably over 30% on average. Increased urbanization is generating increased volumes of wastewater and currently only about 10% is treated.

In rural areas of Guiyang Municipality, only 50% of homes have piped water supply. In the absence of public water supply systems, the majority of the rural population relies on local springs and streams, although some have small storage structures near their homes for domestic and livestock use. About 420,000 rural residents face potable water shortages. Most rural water is needed for agricultural purposes (domestic requirements only account for about 10%). However, the steep mountainous terrain makes it very difficult for farmers to obtain river water or groundwater for irrigation, particularly at higher elevations.

About 10% of Guiyang Municipality land area is arable, only 24% of this land has potential access to irrigation, and only 50% of cultivated land is irrigated. Consequently, irrigation coverage is currently only 0.3 mu per capita, lower than the national average of 0.8 mu per capita. It is estimated that production from the 50% of the cultivated area that is irrigated supplies 70% of production. Surface irrigation systems account for 99% of the irrigation area. Up to 40% of these structures have been abandoned, and 28.8 kilometers of canals are damaged. Water conveyance efficiency in larger irrigation schemes is estimated to average 40% and on-farm application efficiency about 90%, implying scheme level efficiencies of no more than 40%. With rehabilitation, conveyance efficiencies of 74% and on-farm application efficiencies of 95% are expected (scheme level 70%). Soil erosion is estimated to affect about 2,600 square kilometers of Guiyang Municipality, and watershed management is urgently needed to conserve soil and protect water sources.
Future trends in Population and economic growth

Population Growth and Urban Rural Split in Population

Guiyang has become the economic hub of the province. Its populations have been growing at 1.7% per year in recent years but projections in future show that it will slow down to 1.35%. The city area is growing at 2.8%-2.54% between 2000 and 2010. Projected growth shows that the center city areas covered by the three districts on Nanming, Yunyan, and Xiaohe are growing much faster than the suburbs which are growing at about 1.27%-1.25% and the projected growth into 2020 is even less of 1.14% and 0.7% (see table 2.0). There is migration of population from the suburbs of 50,000-60,000 people every five years which boosts the population growth. In addition to the migration there is also a move of people from outside the municipality. Most of this growth in population is because of jobs in Guiyang which has become the magnet for economic growth in the region.

Table 2.0 Guiyang Population and Growth 2000-2009 and Projections for 2020-2030

<table>
<thead>
<tr>
<th>Areas of city</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Area</td>
<td>1110.2</td>
<td>1260.1</td>
<td>1428.7</td>
<td>1696.1</td>
<td>1938.8</td>
</tr>
<tr>
<td>Suburbs</td>
<td>749.8</td>
<td>798.6</td>
<td>849.7</td>
<td>951.5</td>
<td>1020.2</td>
</tr>
<tr>
<td>Three Counties &amp;</td>
<td>1433.5</td>
<td>1518.8</td>
<td>1607.6</td>
<td>1786.5</td>
<td>1937.1</td>
</tr>
<tr>
<td>Total</td>
<td>3293.6</td>
<td>3577.5</td>
<td>3886.0</td>
<td>4434.1</td>
<td>4896.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Population Growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Area</td>
</tr>
<tr>
<td>2.80%</td>
</tr>
<tr>
<td>2.56%</td>
</tr>
<tr>
<td>2.54%</td>
</tr>
<tr>
<td>1.73%</td>
</tr>
<tr>
<td>1.35%</td>
</tr>
<tr>
<td>Suburbs</td>
</tr>
<tr>
<td>1.80%</td>
</tr>
<tr>
<td>1.27%</td>
</tr>
<tr>
<td>1.25%</td>
</tr>
<tr>
<td>1.14%</td>
</tr>
<tr>
<td>0.70%</td>
</tr>
<tr>
<td>Three Counties &amp;</td>
</tr>
<tr>
<td>1.20%</td>
</tr>
<tr>
<td>1.16%</td>
</tr>
<tr>
<td>1.14%</td>
</tr>
<tr>
<td>1.06%</td>
</tr>
<tr>
<td>0.81%</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>1.70%</td>
</tr>
<tr>
<td>1.67%</td>
</tr>
<tr>
<td>1.67%</td>
</tr>
<tr>
<td>1.33%</td>
</tr>
<tr>
<td>1.00%</td>
</tr>
</tbody>
</table>

Rural-urban split of the population has also been changing has also been changing. Many of the changes are due to urbanization of the suburbs and also of some of the counties. In addition, agriculture and rural areas are producing less and there is a move to more urban registration. In 2000 the percentage of urban population 47.9% and by 2009 it will be 60.5%. This is an enormous jump in urban population (see Table 2.1) --the forecast for 2030 is that 78% of the population will be urban population.

Table 2.1 Guiyang Urban Rural Population 2000-2009 and forecast 2020 & 2030

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>1577.7</td>
<td>1926.1</td>
<td>2351.4</td>
<td>3178.4</td>
<td>3835.3</td>
</tr>
<tr>
<td>Rural</td>
<td>1715.9</td>
<td>1651.5</td>
<td>1534.6</td>
<td>1255.7</td>
<td>1060.8</td>
</tr>
<tr>
<td>Total</td>
<td>3293.6</td>
<td>3577.5</td>
<td>3886.0</td>
<td>4434.1</td>
<td>4896.1</td>
</tr>
</tbody>
</table>

| % Urban     | 47.9%  | 53.8%  | 60.5%  | 71.7%  | 78.3%  |

<table>
<thead>
<tr>
<th>Population Growth rate of Urban and Rural People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>4.20%</td>
</tr>
<tr>
<td>4.07%</td>
</tr>
<tr>
<td>4.07%</td>
</tr>
<tr>
<td>3.06%</td>
</tr>
<tr>
<td>1.90%</td>
</tr>
<tr>
<td>Rural</td>
</tr>
<tr>
<td>-0.6%</td>
</tr>
<tr>
<td>-0.76%</td>
</tr>
<tr>
<td>-1.46%</td>
</tr>
<tr>
<td>-1.99%</td>
</tr>
<tr>
<td>-1.67%</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>1.7%</td>
</tr>
<tr>
<td>1.67%</td>
</tr>
<tr>
<td>1.67%</td>
</tr>
<tr>
<td>1.33%</td>
</tr>
<tr>
<td>1.00%</td>
</tr>
</tbody>
</table>
This shift in increase of urban population will require enormous urban services in terms of water supply, sewerage, flood protection etc. This require Guiyang City and suburban areas to plan for more water supply and ensure all industrial and domestic wastewater to be collected and treated so as not to exacerbate the water pollution which will cause less clean water to be available.

**Economic Growth**

Economic growth has very significant especially for Guiyang municipality over the last 10 years. GDP of Guiyang Municipality in the last seven years has been growing at the rate of 11% in real terms. The GDP breakdown by sectors is shown below in Table 2.3.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>agriculture</td>
<td>2,445</td>
<td>3,328</td>
<td>4,169</td>
<td>4,181</td>
<td>4,192</td>
<td>5%</td>
</tr>
<tr>
<td>Industry+const</td>
<td>13,469</td>
<td>23,696</td>
<td>32,772</td>
<td>47,071</td>
<td>67,896</td>
<td>9%</td>
</tr>
<tr>
<td>Construction</td>
<td>11,212</td>
<td>20,207</td>
<td>26,517</td>
<td>36,879</td>
<td>51,290</td>
<td>9%</td>
</tr>
<tr>
<td>Services</td>
<td>2,257</td>
<td>3,489</td>
<td>6,255</td>
<td>10,192</td>
<td>16,606</td>
<td>11%</td>
</tr>
<tr>
<td>Total</td>
<td>26,501</td>
<td>49,963</td>
<td>73,413</td>
<td>119,582</td>
<td>194,786</td>
<td>11%</td>
</tr>
<tr>
<td>Per capita</td>
<td>8,046</td>
<td>13,966</td>
<td>18,892</td>
<td>26,969</td>
<td>39,784</td>
<td>9%</td>
</tr>
</tbody>
</table>

Economic Structural Changes are also occurring. Agriculture sector share of the GDP has declined from 9% to 7% from 2000 to 2007 and will continue to decline to 2% by 2030 (see Figure). However the service sector has increased in share from 40% in 2000 to 47% in 2007 and will further increase to 63% by 2030. It is expected the general industrial sector including construction has been declining from 50% to 46% from 2000 to 2007 and will decline further to about 34% by 2030. These forecasts based on present trends and the 2020 and 2030 values do match other cities in China and other developing countries. The question is how these changes affect the water sector? It is clear that service sector will have the largest labor force and probably the largest urban water consumption. The water for agriculture sector will decline and investments in irrigation will ultimately decline. More high value crops (vegetables, fruits and other commercial crops) will require less water than rice. The water use in agriculture will reduce. Industrial water consumption will increase but not as large as the service sector.

**Improvement in the Water Resources System to meet Future Challenges**

24
Future challenges will be first to expand the coverage for water supply for the city to meet all the domestic, industrial and service needs for Guiyang city and its suburbs. The present elasticity of demand for water to economic growth is about +.33, which means for every 1% growth there will be an increase of 0.33% increase in demand for water. For an average growth rate of 11% per year the demand for water will grow at 3.7% per year. This growth of demand for water is unsustainable and it needs to be controlled by demand management.

There should be improvements in efficiency of use of water. In industry there needs to be improvements and enhancements to reduce water use for per ton of product manufactured. This could be accomplished by increased water saving measures and recycling. Water intensity of use should be significantly reduced for all industry to be inline with international industry. Present Water use is about 314 cum per Y10000 of industrial output (see Figure 2.0 and Chapter 6). This intensity could be reduced to about 15% over time to about 44cum per Y10, 000 of net output from the present declining trend.

Figure 2.0 Water Use Intensity in Industry

Third in all the commercial and domestic consumption of water there can be considerable water saving through physical water saving measures and through increasing prices and by reducing network losses. The domestic consumption per capita can be contained by these measures see figure 2.1 below.
2.2 Water Resources of Guiyang

2.2.0 Background

The description of the water resources is to define the total firm water yield available considering the seasonal and annual and spatial the variability. The total amount of water that runoff is generally not available for use by cities and irrigators because of the limited surface water and groundwater storages. Most of the wet season water is not divertible for use or can be stored since reservoirs are not large enough to store it. A demand management system within integrated water resources framework is necessary to keep demand controlled to match the supply. Hence it is essential to have a detailed description of water resources and its availability so that the supply function can be defined.

2.2.1 Outline of River Valley

Guiyang’s rivers belong to Wujiang River system of Yangtze River valley and Hongshuihe River system of Pearl River valley respectively. The north of watershed and the east of Gaopo in Huaxi District belong to Yangtze River valley, with the area of 7565.1 km², accounting for 92.2% of the total; its south part belongs to Pearl River valley, with the area of 268.9 km², accounting for 5.8% of the total. There are 98 rivers longer than 10 km and over 20 km² of river basin area for each in the whole city, in which 90 rivers belong to Yangtze River valley and rivers flow into Wujiang River; and 8 rivers belong to Pearl River valley and empty into Lianjiang River.

There are 98 rivers longer than 10 km and over 20 km² of valley area for each, in which 90 rivers are located in the north of the watershed, belonging to Yangtze River valley with the area of 7565 km² (accounting for 92.2%) and 8 rivers in the south of the watershed, belonging to Pearl River valley with the area of 268.9 km² (accounting for 5.8%). The total areas which the river basin encompasses are 8033.9 km². The main river systems in the Guiyang Municipality are the Wujiang and Qingshui Rivers which straddle the west and east sides of the municipality. The tributaries that feed these rivers are the ones that traverse the municipality and they are composed of the following main sub-basins and in the Ministry of Water Resources Water Zoning...
these are referred to as the Level IV basins. Guiyang Municipality has the following Level IV basin:

**Yangtze River Catchment**

a) Naming River  
b) Maotiao River  
c) Downstream Wujiang  
d) Qingshui River District  
e) Yachi –Gaopitan  
f) Wujiang Upstream  

**Zhuijiang River Catchment (Pearl River)**

g) Liangjiang River  

Map 2.1 shows the water resources Districts. In addition Table 2.1 and Table 2.2 shows the total areas of the catchments and the administrative areas they encompass
2.2.2 Hydrometeorology

2.2.2.1 Temperature

Guiyang belongs to northern subtropical zone with humid and monsoon climate, having the features of altitude, monsoon and humidity. The climate is temperate and humid for whole year, characterized by neither too cold in winter nor too hot in summer. The yearly average temperature is 12.8°-15.3°, the maximum is 15.3° in the urban area and the minimum is 12.8° in Kaiyang County; the coldest climate appears in January with the average temperature of 2.2°-5.1°, the max. 5.1° in the urban area and the min. 2.2° in Kaiyang County. The hottest weather appears in July with the average temperature of 22.3°-22.2°, the minimum 22.2° in Xifeng County and the maximum 22.3° in Kaiyang County. Guiyang’s frost-free period is between 268 and 288 days, of which Xiwen County has the lowest number of such days and Huaxi District has the maximum days. The yearly leading wind direction is north by east, with average wind velocity less 3m/s and the frequency of wind is 23% of the time.
2.2.2.2 *Evapotranspiration Potential*

Guiyang observed water surface evaporation data is available hydrological and meteorological services data. The data is mainly collected in and around the existing Guiyang hydrological stations and the weather stations. An isohyetal map of the evaporation data shows Map 2.3 shows that the evaporation from the pan measurements varies from 700-800 mm. The ground evaporation is similar and has been estimated 550-600 mm and Isopleths are presented in Map 2.2 in the annex Chapter 2.

**Map 2.2 Mean Evaporation Isopleths**

2.2.3 *Rainfall*

There are 35 rainfall stations in the Guiyang Municipality. There is variation in rainfall between the districts but it is not so significant. Annual rainfalls average about 1000-1300 mm. Most of the rains fall between April to September (see Figure 2.2). About 80% fall between this period and the rest of the period has only 20% of the rainfall.
The can be variation from catchment to catchment but the variations are not significant. The areal distribution of annual rainfall is shown in Map 2.3. Rainfall in the southwest of Guiyang Municipality is the highest (1300 mm) and it is the lowest in the North where it is about 1000 mm.

The variations year to year can be significant. There can be variation of rainfall of 1273 mm to 765 mm as shown by the Figure 2.3 below for various probabilities.

**Figure 2.3 Annual Rainfalls For Different Probability**
Map 2.3 Spatial Distribution of rainfall
The coefficient of annual rainfall variation (standard deviation/mean) is about 0.35. The monthly variations in rainfall can be very significant as shown in Figure 2.3 for different years depending on a dry or wet year. A wet year (20% probability) seem to start late in rainfalls reaching 50% higher than the average rainfall for June and also 50-60% higher rainfalls for August and September months. A low rainfall year (95% probability) follows the average monthly rainfalls but the heavy rainfall only last three months (May to July) and all the other months are much lower (see Figure 2.4).

**Figure 2.4 Monthly Rainfall Distributions**

The annual rainfall data shows there can be consecutive periods of low rainfall. Rainfalls well below the mean can occur for a period of 9 years as shown in Figure 2.5 (points in red).

**Figure 2.5 Rainfall from 1956-2000 (Probability in red, green and purple)**

A series of years of low rainfalls creates much lower river flows and unless there is sufficient reservoir storage it would create severe shortages in water supply for cities and for irrigation. The coefficient of variation in annual rainfall is 0.15–0.17.
2.3 River Flows

2.3.1 Catchment areas and administrative areas

The water resources areas and administrative areas are defined below in table.

<table>
<thead>
<tr>
<th>No.</th>
<th>Divided area</th>
<th>Administrative region</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wushang</td>
<td>Qingzhen</td>
<td>281.9</td>
</tr>
<tr>
<td>2</td>
<td>Wuxia</td>
<td>Qingzhen, Xiuwen, Xifeng, Kaiyang</td>
<td>2120.2</td>
</tr>
<tr>
<td>3</td>
<td>Maoshang</td>
<td>Huaxi, Wudang, Baiyun, Qingzhen</td>
<td>506.9</td>
</tr>
<tr>
<td>2</td>
<td>Maoxia</td>
<td>Wudang, Baiyun, Qingzhen, Xiuwen, Xifeng</td>
<td>1315.7</td>
</tr>
<tr>
<td>5</td>
<td>Nanshang</td>
<td>Nanming, Yunyan, Xiohe, Huaxi, Wudang, Baiyun, Qingzhen</td>
<td>953.5</td>
</tr>
<tr>
<td>6</td>
<td>Nanxian</td>
<td>Yunyan, Wudang, Baiyun, Xiuwen, Kaiyang</td>
<td>667.9</td>
</tr>
<tr>
<td>7</td>
<td>Qingshui</td>
<td>Wudang, Xiuwen, Xifeng, Kaiyang, Huaxi</td>
<td>1719.0</td>
</tr>
<tr>
<td>8</td>
<td>Lianjiang</td>
<td>Huaxi</td>
<td>268.9</td>
</tr>
<tr>
<td></td>
<td>Total: 8 water resources areas</td>
<td>6 districts, 1 city and 3 counties, total 10</td>
<td>8032</td>
</tr>
</tbody>
</table>

There are many hydrologic stations in the region and its neighborhood. The data on hand are mainly from Guiyang, Maiweng, Huangmaocun, Xiawan, Longli, Gaowangzhai and Huishui stations. These data were derived from the master plan report and as indicated in the plan was checked for reliability and consistency.

River flow calculations in the Master Plan were performed by means of interpolation and data extension, from the various stations and were then used to calculate the runoff for the various river basins. It will be noticed that the coefficient of variability of river flow is 0.25 to 0.20 and it almost 70-100% more than the coefficient of variability of the rainfall (Figure 2.6). The variability of runoff is due the high level of non-linearity between rainfall and runoff caused by the Karsts type structure of catchments.

Figure 2.6 Coefficient of Variation for Rainfalls and River flow Volumes

Rainfall coefficient of variability \( C_v = 0.15-0.16 \)

River flow variability \( C_v = 0.26-0.2 \)

2.3.2 Volume of Surface Water Resources in Catchment Areas

The hydrologic station were analyzed and based on the specific discharge the natural runoff series for different resources divided area were calculated. As the results of analysis and calculation, the volume of surface water resources is shown for the catchment areas in the table below (see Figure 2.5). The multi-year average volume of surface water in the whole city is \( 45.15 \times 10^8 \) m³ for the Guiyang Municipality.
Table 2.5 Surface Water Volume in All Resources Divisions of Guiyang\textsuperscript{a}

<table>
<thead>
<tr>
<th>Divided area</th>
<th>Catchment area (km\textsuperscript{2})</th>
<th>Multi-year average volume of surface water resources (1 × 10\textsuperscript{8} m\textsuperscript{3})</th>
<th>Volume of surface water resources with different frequency (1 × 10\textsuperscript{8} m\textsuperscript{3})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Cv</td>
<td>Cs/Cv</td>
</tr>
<tr>
<td>Wushang</td>
<td>281.9</td>
<td>2.13</td>
<td>0.29</td>
</tr>
<tr>
<td>Wuxia</td>
<td>2120.2</td>
<td>9.87</td>
<td>0.30</td>
</tr>
<tr>
<td>Maoshang</td>
<td>506.9</td>
<td>3.23</td>
<td>0.29</td>
</tr>
<tr>
<td>Maoxia</td>
<td>1315.7</td>
<td>8.33</td>
<td>0.29</td>
</tr>
<tr>
<td>Nanshang</td>
<td>953.2</td>
<td>5.59</td>
<td>0.25</td>
</tr>
<tr>
<td>Nanxia</td>
<td>667.9</td>
<td>3.78</td>
<td>0.25</td>
</tr>
<tr>
<td>Qingshui</td>
<td>1719.0</td>
<td>9.51</td>
<td>0.25</td>
</tr>
<tr>
<td>Lianjiang</td>
<td>268.9</td>
<td>2.71</td>
<td>0.28</td>
</tr>
<tr>
<td>Total</td>
<td>8032</td>
<td>45.15</td>
<td>0.23</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Taken from Master Plan Report

The IWRM report has divided the catchment areas as shown below in table 2.6 and there are five river basins and several sub-basins. About 42% of the runoff is derived from Qingshui and Yachi-Pigou River Basins, 21% from Nanming River and 26% from Maotiao Rivers. These four river systems provide 89% of the water resources. However the main population is in the Nanming and Maotiao River Basins. The rest of the river basins have very little population. Hence water has to be imported by the Nanming River Basin to satisfy the needs of the urban population in the Nanming Basin.

Table 2.6 Volumes of River Flows from IWRM Report (2007 Guiyang Hydrology Bureau)

<table>
<thead>
<tr>
<th>IWRM Report (100 million cum)</th>
<th>Total by Tributary</th>
<th>Total by River System</th>
<th>% of Water Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qingshi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yuliang River</td>
<td>6.022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qingshui River</td>
<td>3.333</td>
<td>9.377</td>
<td>20.78%</td>
</tr>
<tr>
<td>Wujiiang</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yachi–Pigou</td>
<td>10.063</td>
<td>10.063</td>
<td>22.30%</td>
</tr>
<tr>
<td>Yangchang–Yachi</td>
<td>2.092</td>
<td>2.092</td>
<td>4.64%</td>
</tr>
<tr>
<td>Maotiao</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maotiao Downstr.</td>
<td>8.376</td>
<td>8.376</td>
<td>18.56%</td>
</tr>
<tr>
<td>Hongfeng Lake</td>
<td>1.267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baihua</td>
<td>1.811</td>
<td>3.278</td>
<td>7.26%</td>
</tr>
<tr>
<td>Nanming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longli River Upstr.</td>
<td>0.201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nanming Upstr.</td>
<td>5.351</td>
<td>5.552</td>
<td>12.30%</td>
</tr>
<tr>
<td>nanming Downstr.</td>
<td>3.685</td>
<td>3.685</td>
<td>8.17%</td>
</tr>
<tr>
<td>Meng</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meng River</td>
<td>2.720</td>
<td>2.72</td>
<td>6.03%</td>
</tr>
<tr>
<td>Sum</td>
<td>45.126</td>
<td>45.126</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
2.2.3 Runoff Variation in Wet and Dry River Flow Years

There variation in year to year rainfalls and as a result there is variation in river flows. The water resources from a wet and dry year vary significantly. In both the IWRM and Water Resources Master Plan reports the variation flow have been report. The variation flow by the probability of occurrence is shown below in table 2.7

Table 2.7 Water Resources Annual Water Resources for different Probabilities (100 million cum)

<table>
<thead>
<tr>
<th>Divided area</th>
<th>Catchment area (km²)</th>
<th>Multi-year average volume of Mean value</th>
<th>Cv</th>
<th>Cs/Cv</th>
<th>20%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wujiang Upstr</td>
<td>281.9</td>
<td>2.13</td>
<td>0.29</td>
<td>2</td>
<td>2.62</td>
<td>2.07</td>
<td>1.69</td>
<td>1.39</td>
<td>1.23</td>
</tr>
<tr>
<td>Wujiang Dwnstr</td>
<td>2120.2</td>
<td>9.87</td>
<td>0.3</td>
<td>2</td>
<td>12.2</td>
<td>9.58</td>
<td>7.74</td>
<td>6.32</td>
<td>5.55</td>
</tr>
<tr>
<td>Maotiao upstr</td>
<td>506.9</td>
<td>3.23</td>
<td>0.29</td>
<td>2</td>
<td>3.99</td>
<td>3.15</td>
<td>2.57</td>
<td>2.11</td>
<td>1.86</td>
</tr>
<tr>
<td>Maotiao dwnstr</td>
<td>1315.7</td>
<td>8.33</td>
<td>0.29</td>
<td>2</td>
<td>10.3</td>
<td>8.1</td>
<td>6.6</td>
<td>5.42</td>
<td>4.79</td>
</tr>
<tr>
<td>Nanming upstr</td>
<td>953.4</td>
<td>5.59</td>
<td>0.25</td>
<td>2</td>
<td>6.72</td>
<td>5.47</td>
<td>4.59</td>
<td>3.89</td>
<td>3.51</td>
</tr>
<tr>
<td>Nanxia</td>
<td>667.9</td>
<td>3.78</td>
<td>0.25</td>
<td>2</td>
<td>4.54</td>
<td>3.7</td>
<td>3.11</td>
<td>2.63</td>
<td>2.37</td>
</tr>
<tr>
<td>Qingshui</td>
<td>1719</td>
<td>9.51</td>
<td>0.25</td>
<td>2</td>
<td>11.4</td>
<td>9.31</td>
<td>7.81</td>
<td>6.62</td>
<td>5.96</td>
</tr>
<tr>
<td>Lianjiang</td>
<td>468.9</td>
<td>2.71</td>
<td>0.28</td>
<td>2</td>
<td>3.31</td>
<td>2.64</td>
<td>2.16</td>
<td>1.8</td>
<td>1.59</td>
</tr>
<tr>
<td>Total</td>
<td>8034</td>
<td>45.15</td>
<td>0.23</td>
<td>2</td>
<td>53.57</td>
<td>44.36</td>
<td>37.78</td>
<td>32.46</td>
<td>29.53</td>
</tr>
</tbody>
</table>

It should be noticed that water resources for the 95% probability is only about of 58% to 62% of the long run average value of flows. This means that firm water supplies for cities can be counted on for about 60% of the average flows.

The rainfall data shows similar variation. For a 95% probability rainfall is 59.8% of the long term average (see Figure 2.7).

Figure 2.7 Rainfalls and River Flow in Nanming Catchment in mm

![Rainfall and Runoff for Nanming Catchment](image-url)
2.2.2 Measured Water Resources 2002-2008 (Water Resources Bulletin)

Rainfall

The Water Resources Bulletins give precise recent measurements in rainfalls and runoff and in water consumed. The rainfall does not vary very much from district to district. The rainfall spatial variability is only about 4-10% within the year. But the temporal variability from year to year can vary from 6% to 20%. Overall rainfall variability is relatively small (see table 2.8)

Table 2.8 Rainfall Variability Spatial and Temporal 2002-2007 (mm/yr)

<table>
<thead>
<tr>
<th>Districts/cty</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>Average</th>
<th>Std Dev</th>
<th>Cv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanming</td>
<td>1186.2</td>
<td>920.3</td>
<td>1013</td>
<td>1011.2</td>
<td>990.3</td>
<td>1007</td>
<td>1021.3</td>
<td>88.0</td>
<td>9%</td>
</tr>
<tr>
<td>Yunyang</td>
<td>1085.3</td>
<td>888.9</td>
<td>994.6</td>
<td>1048.9</td>
<td>993.2</td>
<td>964.2</td>
<td>995.9</td>
<td>68.2</td>
<td>7%</td>
</tr>
<tr>
<td>Huaxi</td>
<td>1075.9</td>
<td>961.1</td>
<td>972.2</td>
<td>995.6</td>
<td>971.5</td>
<td>1097.5</td>
<td>1012.3</td>
<td>59.1</td>
<td>6%</td>
</tr>
<tr>
<td>Wudang</td>
<td>1196.5</td>
<td>926.8</td>
<td>1037.1</td>
<td>1033.7</td>
<td>982.3</td>
<td>1033.2</td>
<td>1034.9</td>
<td>90.1</td>
<td>9%</td>
</tr>
<tr>
<td>Bajuyun</td>
<td>1119</td>
<td>832</td>
<td>940.3</td>
<td>1040.8</td>
<td>979.2</td>
<td>1009.8</td>
<td>986.9</td>
<td>97.1</td>
<td>10%</td>
</tr>
<tr>
<td>Xiaohue</td>
<td>1096.4</td>
<td>887.5</td>
<td>972.7</td>
<td>922.3</td>
<td>1043</td>
<td>1156.6</td>
<td>1013.1</td>
<td>104.0</td>
<td>10%</td>
</tr>
<tr>
<td>Qingzhen</td>
<td>1172.6</td>
<td>978.3</td>
<td>1007.4</td>
<td>986.7</td>
<td>952.6</td>
<td>1163.9</td>
<td>1043.6</td>
<td>98.2</td>
<td>9%</td>
</tr>
<tr>
<td>Kaiyang</td>
<td>1243.7</td>
<td>981.6</td>
<td>1071.8</td>
<td>962.3</td>
<td>936.8</td>
<td>1090.5</td>
<td>1047.8</td>
<td>113.8</td>
<td>11%</td>
</tr>
<tr>
<td>Xiuwen</td>
<td>1169.7</td>
<td>805.6</td>
<td>1076.9</td>
<td>817.6</td>
<td>719.3</td>
<td>1109</td>
<td>949.7</td>
<td>190.4</td>
<td>20%</td>
</tr>
<tr>
<td>Xifeng</td>
<td>1185.8</td>
<td>919.4</td>
<td>1047.2</td>
<td>941.5</td>
<td>905</td>
<td>1099.1</td>
<td>1016.3</td>
<td>113.1</td>
<td>11%</td>
</tr>
<tr>
<td>Average</td>
<td>1181.6</td>
<td>933.7</td>
<td>1034.8</td>
<td>961.4</td>
<td>920.3</td>
<td>1097.6</td>
<td>1021.6</td>
<td>103.1</td>
<td>10%</td>
</tr>
<tr>
<td>Std dev mm</td>
<td>55.6</td>
<td>58.5</td>
<td>45.0</td>
<td>69.9</td>
<td>88.1</td>
<td>66.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cv</td>
<td>5%</td>
<td>6%</td>
<td>4%</td>
<td>7%</td>
<td>10%</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2.3 Rainfall Runoff Relationship

The volume of rainfall in Guiyang Municipality and the runoff are very significant for the municipality. The average rainfall is over 1100 mm and the average runoff varies depending on the rainfall from 47-60%. The table below for 2002-2008 gives the rainfall runoff and groundwater relationship. All groundwater runs off after a few months leaving no overlap with the surface water resources. There is essentially no groundwater resource because of the hydro geological Karsts structure makes the subsurface geology to extremely porous. Any waters that seeps into the ground runoffs as surface water (see Table 2.9)

Table 2.9 Rainfall, Runoff, Groundwater and Water Resources Available 2002-2008

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall mm</td>
<td>1181.6</td>
<td>933.7</td>
<td>1034.8</td>
<td>961.4</td>
<td>920.3</td>
<td>1097.6</td>
<td>1231</td>
</tr>
<tr>
<td>Rainfall vol 100 mil</td>
<td>94.91</td>
<td>74.99</td>
<td>83.12</td>
<td>77.22</td>
<td>73.92</td>
<td>88.16</td>
<td>98.87</td>
</tr>
<tr>
<td>Surface water 100 mil</td>
<td>56.82</td>
<td>42.41</td>
<td>43.45</td>
<td>42.893</td>
<td>34.577</td>
<td>46.701</td>
<td>56.2</td>
</tr>
<tr>
<td>Runoff %</td>
<td>60%</td>
<td>57%</td>
<td>52%</td>
<td>56%</td>
<td>47%</td>
<td>53%</td>
<td>57%</td>
</tr>
<tr>
<td>Total WR 100 mil</td>
<td>56.82</td>
<td>42.41</td>
<td>43.45</td>
<td>42.893</td>
<td>34.577</td>
<td>46.701</td>
<td>56.2</td>
</tr>
<tr>
<td>Water Use 100 mil</td>
<td>10.52</td>
<td>9.92</td>
<td>10.95</td>
<td>10.61</td>
<td>10.67</td>
<td>10.63</td>
<td>10.85</td>
</tr>
<tr>
<td>Maximum Yield 100 mil</td>
<td>13.06</td>
<td>13.06</td>
<td>13.06</td>
<td>13.06</td>
<td>13.06</td>
<td>13.06</td>
<td>13.06</td>
</tr>
</tbody>
</table>

Taken from Water Resources Bulletin 2002-2008
The surface water as measured by the runoff can vary from a mean of $45.15 \times 10^8$ cum per year to a low of $34.6 \times 10^8$ cum to a high of up to $56.8 \times 10^8$ cum per year depending on the rainfall (see Table 2.7).

### 2.3 Firm Yield of Water Resources

#### 2.3.1 Seasonal Variability of Water Flows

The monthly values of flows vary a lot from the wet season to the dry season vary considerably. In Maotiao River the monthly water flows vary from over 600 million cum in June/July to under 100 million cum in February.

**Figure 2.8 Monthly Flow Variations in Maotiao River Basin**

For dry year flows (95% probability) the firm yield is about 16% of the long term average flows. Hence it is impossible to extract more water with reservoir storage. Even with reservoir storage the extractable water resources (see Figure 2.9) is only about 30-33%.

**Figure 2.9 Firm Yields for Run-of-River and Reservoir System**
Based on these estimates the Guiyang Hydrology Bureau in the IWRM report has determined that the amount of firm extractable water resources is about 1516.7 million cum per year. The water resources available are 33% of the mean annual flows which is 4515 million cum. The present water use is about 1.08 billion cum. It is expected that future demands will exceed 1.7 billion and about 0.2 billion water will have to be imported from basins outside Guiyang Municipality or derived from wastewater reclamation. The only way for Guiyang Municipality not to import water is to ensure that demand is managed so that it falls within the supply available.

Table 2.10 Firm Yield of Water Resources by County/Districts in Guiyang Municipality

<table>
<thead>
<tr>
<th>Catchment (sq km)</th>
<th>Total average Water Res (Million cum)</th>
<th>Firm Water Res (Million cum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanming</td>
<td>89.1</td>
<td>48.6</td>
</tr>
<tr>
<td>Yunyang</td>
<td>67.5</td>
<td>38.6</td>
</tr>
<tr>
<td>Wudang</td>
<td>962</td>
<td>560.6</td>
</tr>
<tr>
<td>Baiyan</td>
<td>259.6</td>
<td>153.2</td>
</tr>
<tr>
<td>Huaxi</td>
<td>961.4</td>
<td>545.3</td>
</tr>
<tr>
<td>Xiaohu</td>
<td>63.1</td>
<td>34.8</td>
</tr>
<tr>
<td>Qingzhen</td>
<td>1492.4</td>
<td>998.2</td>
</tr>
<tr>
<td>Xifeng</td>
<td>2026.2</td>
<td>1042.7</td>
</tr>
<tr>
<td>Kaiyang</td>
<td>1036.5</td>
<td>483.1</td>
</tr>
<tr>
<td>Xiuwen</td>
<td>1075.7</td>
<td>609.6</td>
</tr>
<tr>
<td>Guiyang Center City</td>
<td>219.7</td>
<td>122.0</td>
</tr>
<tr>
<td>Guiyang Suburbs</td>
<td>2183</td>
<td>1259.1</td>
</tr>
<tr>
<td>3 Counties +Qingzhen</td>
<td>5630.8</td>
<td>3133.6</td>
</tr>
<tr>
<td>Total GM Municipality</td>
<td>8033.5</td>
<td>4514.7</td>
</tr>
</tbody>
</table>

2.3.2 Water Resources and Water Use and Firm Yield

The total water resources as estimated from the river flows have a mean value of 4515 million cum per year. About one fourth of the water is used for domestic,
industry and for agriculture. The Figure 2.10 shows the detailed use by sectors. Most of the water presently is used by industry 53% in 2008

Figure 2.10 Water Use by Sectors in the Economy

The water available for use is about 25% and is far less than that the water resources that is physically in the basin. The main reason for the large percent of unusable water resources is because Guiyang is in a Karsts river basin with an unusual topography and the 80% of rainfall is over 3-4 month period and it is impossible to store it reservoirs and use it in the dry season. In addition the Karsts geology is such that most of the water flows (which is interflow) does not contribute to the groundwater and it runoff in a short period of time. For all these reasons Guiyang Municipality can only use about 25% of its water resources (see Figure 2.11)

Figure 2.11 Water Resources, Use and Availability in Guiyang Area

2.3.3 Spatial Distribution of Water Use
The water resources use is shown as heavily in the south near Guiyang City proper almost 36%. The population density is also highest in that area near Guiyang city it’s the highest.

2.4 Administrative and institutional system for Water Resources Management in Guiyang Municipality.

In recent years, the PRC has recognized the need to improve the comprehensive management of water resources, applying approaches consistent with IWRM methodologies, and to shift the emphasis more toward managing demand, including the use of economic mechanisms. A crucial milestone along this path was reached on 1 October 2002, when the revised Water Law was made effective, and in which added emphasis is given to such issues as water resources planning, protection of water resources, the economical use of water, the resolution of disputes concerning water, and the enforcement of water use regulations—all of which are common water resources management concerns.

As in other provinces and municipalities, Guiyang Municipality level bureaus are subordinate to their relevant central line ministries and agencies. For example, the Guiyang Water Resources Bureau is subordinate to the Ministry of Water Resources, but exercises a coordinating role over water resources management with particular responsibilities for water resource planning, water allocations, water conservation, flood control, and rural water supplies at the local level. At the municipal level, the Urban Construction and Urban Management Bureaus (under the Ministry of Housing and Urban/Rural Construction) are responsible for the management of urban water supply, drainage, and wastewater treatment. The provincial and municipal environmental protection bureaus play important regulatory and enforcement roles in environmental protection and pollution control. The provincial and municipal Development and Reform Commission, operating as the local subordinates of the National Development and Reform Commission, are involved in the approval process of investment projects and in most cases is delegated authority for administering the PRC’s Pricing Law (1997). Other ministries and government offices at the provincial, municipal, and lower levels (notably agriculture, finance, health, civil affairs, land, trade and industry, and forestry) are also involved in water sector issues.

As indicated above, the current management of the Guiyang water sector is not well integrated. There is vertical fragmentation with different responsibilities between provincial, municipal, and district and county levels, and horizontal fragmentation with responsibilities for water sector management split between different functional departments of each level of government (mainly water resources, urban management, and agriculture). Both types of fragmentation lead to problems in water resources management, but generally, horizontal fragmentation presents more difficult problems to deal with. This is because the system of functional supervision within the Government of the PRC allows issues caused by vertical fragmentation to be resolved more easily—although this does not always happen in practice. Problems of horizontal fragmentation have the following major institutional and technical implications: (i) overlap of monitoring functions and lack of data sharing, (ii) inadequate comprehensive water resources planning that includes other sectors, (iii) pollution control planning that is largely unrelated to water resources, and (iv)
lack of integration of function zoning with harmonization of quantity and discharge permitting.

Map 2.4 Water Consumed in Guiyang Municipality
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3.0 International Experience in Integrated Water Resources Management

Several cities in the developed countries where IWRM is part of their operational procedures were selected and the information from many of these cities are clear about the form in which IWRM is used. Three of the strongest cities where IWRM are operational are in Los Angelis in USA, Singapore and Sydney in Australia. Los Angelis has the state of art procedures for application of IWRM procedures. The main features that are applicable are summarized after each description. Guiyang Municipality is very far removed from these three cities because it does not have the institutional structures or the physical infrastructure or the financial resources to develop IWRM to these levels observed in the three cities. However they can aim for some future date to emulate some lessons from these three cities. The main lessons described are as follows:

a) To develop the enabling environment within Guiyang Municipality as these cities have done to pursue IWRM. In Los Angelis they derived their authority and funds by putting IWRM approach to a vote in the ballot. In Sydney this was developed through efficiency campaigns and through subsidies to finance rainwater collectors etc for people to participate in IWRM. In Singapore this was done by information provided by the Public Utility Board as a security issue since water demand had to be reduced and all the waters had to be developed and integrated and IWRM principles used to ensure that demand and supply matched.

b) To develop IWRM it is essential to have one agency manage the water resources and wastewaters generated. Los Angelis has the LA Water Resources Board which manages all water resources and wastewater in the district and surrounding counties. Singapore has the Public Utilities Board which manages all water resources and wastewater treatment and flood control on the Island. The Sydney Catchment Authority and Sydney Water Board are the two authorities responsible for the supply of potable water and wastewater to the Sydney, Illawarra and Blue Mountain areas.

c) To have IWRM it is essential to have water demand management and all investments for future water resources development are directed on supply management and enhancement and demand management via water savings or economic instrument of water price increases etc and education.

d) Demand Management through recycling water especially in industry, water savings through use of more efficient system in residence/business/industry, and regulatory measures such as tariff increases form a central piece of activity to ensure that water is not lost and IWRM approaches can be used to manage demand and through an active program of education of the public for awareness of reduced water use.

e) Demand management combined with water use restriction in times of severe drought can avoid economic losses and distress to people (Sydney City)
3.1 Los Angeles Counties Integrated Water Resources Management

3.1.1 Greater Los Angeles County Region

West Basin is an active participant in the Greater Los Angeles County Integrated Regional Water Management Plan (IRWMP). In 2005 several entities gathered to form a Region to apply funding to the Department of Water Resources and the State Water Resources Control Board.

Figure 3.1.1 Los Angeles Areas Covered

3.1.2 Water Resources Planning

The Planning and Water Resources Planning department is responsible for developing viable plans and initiatives to ensure reliability of the region's water supplies. They play an important role in reducing the region's dependence on imported water by expanding the local water supply portfolio in an economically feasible manner.

3.1.3 The Strategy

“Ensuring L.A.’s Water Supply” was a plan to create sustainable sources of water for the future of Los Angeles. It was an aggressive multi-faceted approach that included:

a) Investments in best technology;
b) A combination of rebates and incentives;
c) The installation water saving devices like of smart sprinklers, efficient washers and urinals; and
d) Long-term measures such as expansion of water recycling and investment in cleaning up the local groundwater supply.

3.1.4 What is integrated planning in California?

Integrated planning was defined as “the effective management of resources through collaboration of efforts of various entities. The integration of multiple water
management strategies via multipurpose projects creates opportunities to meet regional water resource needs, efficiently use fiscal resources, and provide the public with tangible community benefits.”

3.1.5 Integrated Regional Water Management
Regional cooperation will promote a more efficient, comprehensive, and effective approach to water resource management while being responsive within a regional context to the needs of individual communities and districts. In addition, California State funding was more oriented toward regional planning and it was in the Greater Los Angeles County Region's best interests to develop an IRWMP to successfully compete for future funding opportunities. The Greater Los Angeles County Region IRWMP would serve as the master plan to facilitate this type of regional cooperation.

3.1.6 People Vote for IWRM
In November 2002 the voters of California enacted the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 ("Proposition 50"), adding provisions to the California Water Code. Chapter 8 of Proposition 50, under the Water Code section, authorizes the Legislature to appropriate $500 million for Integrated Regional Water Management (IRWM) projects. The intent of the IRWM program is to encourage integrated regional strategies for the management of water resources, and to provide funding, through competitive grants, for projects that protect communities from drought, improve water reliability, protect and improve water quality, and improve local water security by reducing dependence on imported water. The California Department of Water Resources and the State Water Resources Control Board in November 2004 issued Integrated Regional Water Management Grant Program Guidelines (Guidelines) to establish the process and criteria that these agencies will use jointly to solicit applications, evaluate proposals, and award grants under the IRWM Grant Program.

3.2 Sub Regional Steering Committees
3.1.1 Formation of Steering Committee
Each of the five sub-regions of the Region IWRM planning area will be guided by a Steering Committee consisting of representatives of agencies or organizations involved in local water management. To the extent feasible, the formation and composition of each Steering Committee will be consistent with the following Guidelines:

1. Agencies and organizations will have responsibility for at least one of the following Water Management Elements: groundwater, surface water, storm water management/water quality, sanitation, and habitat/open space/recreational access.
2. Steering Committees should strive to include at least one representative organization for each of the Water Management Elements.
3. The appointing authority for each agency or organization will designate a member(s) and alternate to represent it on the Steering Committee.
4. The member and alternate designated by each agency or organization should be an executive level representative. Each member will serve at the pleasure of the appointing agency or organization.
3.2.2 Historical Water Use

Water use in the City of Los Angeles peaked in 1986, at just over 864 million cum year. What followed was five years of severe drought, widespread water shortages, and the implementation of mandatory conversation measures. Due to conservation, a boost in rainfall in 1992 and 1993, and tough economic times, water use dropped by more than 17 percent in the following years.

Since the early 1980s, the City has invested millions of dollars in conservation measures, particularly the installation of low-flow toilets and shower heads. These efforts have resulted in L.A.’s water demand to be maintained to about the same as it was 25 years ago, despite a population increase of 1 million people.

The demand from 1970 to 2000 is shown on the figure below. It will be noticed that demand increased from about 700 mcm/yr to 845 mcm/year in 1986-1989. This was 0.8% increase per year. Strong demand management programs introduced reduced demand significantly in 1991 to 1999 see Figure 3.2.2

Figure 3.2.2 Water Demand and Impact of Conservation

3.2.3 Water Supply Current Sources

The City of Los Angeles historically receives water from five major sources: the Eastern Sierra Nevada watershed (via the Los Angeles Aqueduct); the Colorado River (via the Colorado River Aqueduct) and the Sacramento-San Joaquin Delta (via the State Water Project / California Aqueduct), which are purchased from the Metropolitan Water District of Southern California (MWD); local groundwater; and recycled water for industrial and irrigation purposes. In addition, the City’s successful conservation programs have reduced demand, preserved the water supply and offset the need for new resources.
3.2.4 Water Demand and Water Supply

Demand Supply balance is shown in figure 3.2.4 below. The balance in demand and supply can only be achieved by recycling and reclaiming from conservation. Use of Recycled water and water conservation (reclaimed water) after 2010 will have to be part of the water balance to meet the requirements.

Figure 3.2.4 Demand and Supply for Los Angeles

3.2.5 Water Conservation for demand Management

Water conservation is to change the behavior and attitudes about water consumption and taking immediate action to develop alternative water supplies. The City made a commitment to every resident of Los Angeles to meet all new demand through a combination of conservation and recycling. This would be done through key short-term and long-term strategies to secure the water future, including:

Short-Term Conservation Strategies
   a)  Enforcing prohibited uses of water
   b)  Expanding the prohibited uses of water
   c)  Extending outreach efforts
   d)  Encouraging regional conservation measures

Long-Term Conservation and Recycling Measures
a) Increasing water conservation through reduction of outdoor water use and use more efficient technology  
b) Maximizing water recycling  
c) Enhancing storm-water capture  
d) Accelerating clean-up of the groundwater basin  
e) Expanding groundwater storage

The residential toilet replacement programs were completed in 2006, requiring ultra-low-flush toilets and low-flow showerheads in all residential properties prior to resale. The low-flush toilet program alone saved 14 billion gallons or 53 million cum meters or 6 percent of the demand of water each year. LADWP then focused more on technology to reduce outdoor water use.

From a long-term perspective, significant opportunities existed in reducing on water that is wasted outdoors, including the installation of smart sprinkler systems and drought tolerant landscaping. Additional conservation was pursued to encourage planting with California native drought tolerant plants and expansion of gray water reuse systems. Storm water capture and reuse could result in water savings including rainwater collectors or cisterns through 2030.

3.3 Singapore Water Management

3.3.1 Background

Singapore is a city state with an area of about 700 km

2. It currently consumes about 1.36 billion liters of water per day. It is a water-scarce country and thus imports its entitlement of water from the neighboring Johor state of Malaysia, under long-term agreements signed in 1961 and 1962, when Singapore was still a self-governing British colony. Under these agreements, Singapore can transfer water from Johor for a price of less than 1 cent per 1,000 gallons until the years 2011 and 2061 respectively. The water from Johor is imported through three large pipelines across the 2-km causeway that separates the two countries.

The two countries have been negotiating the possible extension of the water agreement. The results thus far have not been encouraging since the two countries are still far apart in terms of their national requirements.

Because of this continuing stalemate, Singapore has developed a new plan for increasing water security and self-sufficiency during the post 2011-period, with increasingly more efficient water management, including formulation and implementation of new water-related policies, heavy investments in desalination and extensive reuse of wastewater, and catchment management and other similar actions.

3.3.2 Overall Approach

A main reason as to why Singapore has been very successful in managing its water and wastewater is because of its concurrent emphasis on supply and demand management, wastewater and storm water management, institutional effectiveness and creating an enabling environment, which includes a strong political will,
effective legal and regulatory frameworks and an experienced and motivated workforce. Water management institution in a country can only be as efficient as its management of other development sectors. The current implicit global assumption that water management institutions can be improved unilaterally when other development sectors remain somewhat inefficient is simply not a viable proposition.

### 3.3.3 Supply Management

Singapore is one of the very few countries that look at its supply sources in its totality as shown in Figure 3.4.1. In addition to importation of water from Johor, it has made a determined attempt to protect its water sources (both in terms of quantity and quality on a long-term basis). In addition it has expanded its available sources by desalination and reuse of wastewater and storm water, and use technological developments to increase water availability, improves water quality management and steadily lower production and management costs. The Public Utilities Board (PUB) has an in-house Centre for Advanced Water Technology, with about 50 expert staff members who provide it with necessary research and development support.

![Figure 3.4.1 Total Supply Sources in Singapore](Source: PUB Website)

Over the years, catchment management has received increasing emphasis. Protected catchment areas are well demarcated and gazetted and no pollution-causing activities are allowed in such protected areas. In land-scarce Singapore, protected catchment it is reported that classification covers less than 5% of the area.

**Desalination** is important component for augmenting and diversifying available national water sources. In late 2005, the Tuas Desalination Plant was opened at a cost of US$119 million. Designed and constructed by a local water company, Hyflux, it is
the first design, build, own and operated desalination plant in the nation. The process used is reverse osmosis. The cost of the desalinated water during its first year of operation is S$0.78/m³.

**Reclaimed Water** The supply is also being increased through collection, treatment and reuse of wastewater. With a 100% sewer connection, all wastewater is collected and treated. Singapore is probably one of the very few countries where the water utility is reclaiming wastewater after secondary treatment by means of advanced dual-membrane and ultraviolet technologies. This treated water is then mainly supplied to industrial and commercial customers who can better use NEWater’s (word used in Singapore for reclaimed water) ultra-pure quality. There are now three plants producing NEWater. PUB has recently awarded another PPP project to construct the country’s largest NEWater factory at Ulu Pandan. The first year tender price for NEWater was S$0.30/m³, which is significantly less than the cost of desalinated water. The overall acceptance of this recycled ultra-pure water has been quite high.

### 3.3. 4 Demand Management

#### 3.3.4.1 Water Demand

In 1972 the demand for water was about 100 MGD (million gallons per day) and about 70% of the supply was coming from Malaysia and about 30%. The population was about 2.2 million. In 2002 about 30 years later the demand had risen to 300 MGD and the population was well over 3 million people. A significant part of the water was coming from Malaysia. But in 2010 the population will be over 4 million and the demand is expected to about 400 MGD and it is expected that Singapore will cap its demand to around this figure by several water saving and demand management techniques. By 2010 Singapore will have four sources of water:

a) Local water resources through rainfall in the catchments and through storm water collection  
b) Imported water but enormously reduced  
c) Reclaimed water from reclamation of wastewaters  
d) Desalinated water

Water security is of high priority and therefore Singapore went radically to obtain all the sources of water under its control and reduced its dependence on imported water. The figure below shows the changes in sources of water. Despite it almost 4 fold increase in water demand, the PUB has managed to obtain water sources from its own urban and rural catchments; reclaimed water and desalted water to meet all the needs. The City has a very strong demand management program to keep demand under 400 MGD. Population in that period increased from 2.2 million in 1972 to 4.78 million in 2008.
3.3.4.2 Water Conservation

PUB’s water conservation strategy in curbing water demand growth takes a multi-prong approach through pricing, mandatory water conservation requirements and promoting and encouraging ownership and voluntarism through 3P partnership in water conservation.

3.3.4.3 Mandatory Requirements in Water Saving Devices

Legislative measures have been put in place to deter water wastage. Punitive measures for noncompliance include fines and/or court prosecution. The legislative measures are constantly being reviewed to keep abreast of the latest development in the area of water conservation. Since 1983, installation of water saving devices such as constant flow regulators and self-closing delayed action taps was made mandatory in all non-domestic premises and common amenities areas of all private high-rise residential apartments and condominiums.

Figure 3.4.2 Water Source Development in 1970-2009/2010

Since 1992, low capacity flushing cisterns (LCFCs) that use not more than 4.5 liters of water per flush were installed in all new public housing units. The installation of LCFCs, in place of the conventional 9-litres cistern for all new and ongoing building projects, including all residential premises, hotels, commercial buildings and industrial establishments, was made mandatory in 1997. To prevent excessive flow rate at the water fittings, PUB limits the maximum allowable flow rates at water fittings. A review was conducted in 2003 and the maximum allowable flow rates at water fittings were reduced by between 25 – 33% to prevent water wastage. PUB has also extended the requirement on limiting the maximum allowable flow rates at water fittings to all domestic premises.
PUB conducts spot checks on completed residential developments to ensure compliance of the mandatory requirements.

### 3.3.4.4 Ownership through 3P initiatives

#### Public Education and Publicity Program

Singapore has an on-going public education and publicity program to educate the public in the management of water resources, emphasizing on the importance of water conservation. The main objective of the program is to effect behavioral change in the way water is being used so that saving water becomes an ingrained habit. The various activities are targeted at both the domestic and non-domestic sectors. Some of the major activities carried out were:

- **Save Water Campaigns and Sustained Publicity Programs**

  Month-long National Save Water Campaigns were held on a need basis, especially during the drier months, to remind the public of the limited and precious water resources and to use water wisely so as to avoid water rationing. It is also important to reinforce the save water message in between campaigns so as to sustain public commitment to the water conservation effort. In this respect, sustained publicity programs are carried out. Some of these activities are:

  - i) Dissemination of water conservation messages through the media;
  - ii) Distribution of publicity materials such as save water leaflets, posters and stickers;
  - iii) Set up of save water exhibitions at constituencies, hospitals, community centers, etc; and
  - iv) Post save water tips and information on water saving devices on PUB website.

- **3P Partnership Involvement**

  Community participation in water conservation is also part of the publicity and educational program. The program engages the institutions, large customers and grassroots organizations. They have responded well by organizing activities such as distribution of save water leaflets, signing of the Save Water Pledge, organizing essay and art competitions and save water exhibitions. We have also maintained close liaison and consultation with government agencies and the various industries such as the Singapore Hotel Association, Singapore Plumbing Society and Singapore Sanitary Wares Importers & Exporters Association to promote the sharing of water conservation know-how among its members through exhibitions, conferences and seminars.

- **Water Efficient Homes Program**

  In 2003, PUB initiated a new water conservation program, Water Efficient Homes, to help residents conserve water and save on their water bills. Together with its 3P partnership approach involving residents and grassroots leaders and volunteers, residents are encouraged to run water efficient homes by installing water saving devices and adopt good water saving habits. In this outreach program, do-it-yourself (DIY) water saving kits is distributed to the residents free-of charge for self installation. Mobile exhibitions were also set up to brief and demonstrate to residents the effectiveness of the water saving devices and its installation procedure.
Water Efficient Buildings Program

On the non-domestic front, commercial/industrial customers are encouraged to run water efficient buildings by reviewing and reducing their water consumption and repairing leaking fittings promptly. They are also encouraged to recycle/reuse used water where feasible. Circulars were sent to large non-domestic customers urging them to reduce the flow rate at the wash basin taps in all their staff and public toilets within the premises to 2 liters/min and urinal flush volume to 0.5 liters/flush. They were also advised to conduct checks on water fittings in their premises to ensure the flow rates are not excessive and to adopt water efficient flow rates for the various water fittings.

Water Audit

As part of the Public Utility Board’s efforts to promote water conservation, regular water auditing is carried out by PUB officers for large customers (consumption more than 5000 m³/month). The visits are part of a market-oriented program to obtain industries’ feedback on water supply and to work with customers on the implementation of water conservation measures within their premises.

3.4.5 Demand Reductions

Demand reductions due to all the significant demand reduction measures taken by the government are shown in the figure below. Per capita use of water decreased from 176 L/cap to 157 L/cap during 1994 to 2007. It must be clear that Singapore has invested a lot in different water saving activities plus price changes plus metering system and reduced unaccounted for water by leakage studies.

Figure 3.4.3 Decrease in Per Capita Consumption

![Per Capita Consumption of water](image)

- **Achieved:**
  - Per capita domestic consumption fell to 158 litres per day in 2006.
- **New target:**
  - To further lower to **155 litres per day by 2012**
- **Policies and programmes to achieve target**:
  - Water Efficient Labeling Scheme
  - Mandatory installation of dual-flush low-capacity flushing cisterns
  - 10-Litre Challenge
  - Water Volunteers Group

Source: Taken from Singapore Public Utility Board Papers 2008
3.4.6 Price Increases and Tariff

Concurrent to the diversification and expansion of water sources, PUB has put in place a well thought out and comprehensive demand management policy. It is useful to review the progress of water tariffs for water during the 1997-2000 periods (Figure 3.4.4). These tariffs are the old tariffs but they are used as an example to demonstrate the effect of tariffs on water consumption.

Before July 1, 1997, the first 20 $m^3$ of domestic consumption for each household was charged at S$0.56/m$^3$. The next block of 20 to 40 $m^3$ was charged at S$0.80/m^3$. For consumption of more than 40 $m^3$/month and non-domestic consumption, it was S$1.17/m^3$.

Effective July 1, 2000, domestic consumption of up to 40 $m^3$/month and non-domestic uses were charged at a uniform rate of S$1.17/m^3$. For domestic consumption of more than 40 $m^3$/month, the tariff became S$1.40/m^3$, which is higher than non-domestic consumption. The earlier cheaper block rate for the first 20 $m^3$ of domestic consumption was eliminated. The increase in tariff dramatically reduced the water use per household from 22 cum/month to 19 cum/month.

Table 3.4.4 Impact of tariff on Monthly Household Consumption

<table>
<thead>
<tr>
<th>Item</th>
<th>1995</th>
<th>2000</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average monthly consumption, $m^3$</td>
<td>21.7</td>
<td>20.5</td>
<td>19.3</td>
</tr>
<tr>
<td>Average monthly bill, inclusive of all taxes</td>
<td>S$14.50</td>
<td>S$31.00</td>
<td>S$29.40</td>
</tr>
</tbody>
</table>

Source: Singapore Exemplary Case of Urban Water Management in by Cecilia Tortarjada 2006

3.4.7 Unaccounted for Water (Non Revenue Water)

The source of water is further expanded by reducing unaccounted for water (UFW) or non revenue water, which is defined as actual water loss due to leaks, and apparent water loss arising from water which is not billed or stolen. Unlike other South and South-east Asian countries, Singapore simply does not have any illegal connections to its water supply systems. As shown in Figure 3.4.5, in 1990, unaccounted for water (UFW) was 9.5% of the total water production. Even at this level, it would still be considered to be one of the best examples in the world at the present time. However, PUB has managed to lower the UFW consistently to around 5% in recent years. The most recent figure UFW in 2005 was 4.7%, 2006 4.5% and in 2007 it was 4.4%. This is a level which few countries’s can match at present. In comparison, in England and Wales, the only region in the world which has privatized its water more than a decade ago, the best any of its private sector companies have managed to achieve is more than twice the level of Singapore. Similarly, UFW in most Asian urban centers now range between 40 and 50%\(^2\). This figure is derived from World Bank IBNET database which has some 944 utilities.

Figure 3.4.5 Unaccounted for Water in Singapore 1990-2004

Source: Taken from PUB Papers 2006
3.5 Sydney Metropolitan Water Resources management

3.5.1 Background
The Sydney Catchment Authority and Sydney Water Board are the two authorities responsible for the supply of potable water to the Sydney, Illawarra and Blue Mountain areas (see Figure 3.5.1). The Catchment Authority provides bulk water to Sydney Water, which then retails it to approximately 1.3 million accounts and a population of 4.15 million. In the Sydney Water service area, the residential sector is the biggest user of water, comprising 61 per cent of total demand.

Figure 3.5.1 Catchment Areas for Water Supply for Metropolitan Area of Sydney

Source: Taken from Sydney Catchment Authority Website
3.5.2 The Sydney Water Supply Institutional Framework

The Sydney Catchment Authority and Sydney Water is the two authorities responsible for the supply of potable water to the Sydney, Illawarra and Blue Mountain areas. The State Government established the Sydney Catchment Authority in response to the Sydney Water Inquiry, which investigated a water contamination incident in 1998. The Inquiry recommended that the proposed ‘Catchment Commission’ be independent of Sydney Water and control the relevant infrastructure including dams, reservoirs and associated land. With the passage of the Sydney Water Catchment Management Act 1998, the Authority became operational on 3 July 1999. The role of the Authority, as outlined in the Act, is to:

(a) Manage and protect the catchment areas and catchment infrastructure works;
(b) Be a supplier of bulk water, and
(c) Regulate certain activities within or affecting the outer catchment area as well as the Inner catchment area.

The Authority’s main functions are to:
- manage and protect the catchment areas, and the dams, storages and pipelines;
- supply bulk water to Sydney Water, other water supply authorities and direct customers;
- protect and enhance water quality;
- carry out research on catchments generally and on the health of its own catchments in particular; and
- help educate the community about water management and catchment protection.

The water supply system is under Sydney Water, and comprises six main components, and how they work and are connected to supply water is shown in Figure one. Bulk water is supplied from the Authority’s system of 18 major dams and two diversion weirs, through a network of pipes and canals to 11 water filtration plants. The six components are:

- The Prospect Reservoir System;
- The Upper Nepean Dams and Upper Canal System;
- The Woronora Dam System;
- The Warragamba Dam and Warragamba Pipeline System;
- The Shoalhaven System; and
- The Blue Mountains System.

The detailed connection between the Catchment Authority and Sydney Water is shown in Figure 3.5.3

The network of 11 major reservoirs supplying Sydney, Illawarra, the Blue Mountains and the Southern Highlands has a large storage capacity as shown below in Table 3.5.1. The reservoir capacity in total is large for the population and gives a storage area of 620 cum per capita.
### Table 3.5.1 Reservoir Storage Capacities

<table>
<thead>
<tr>
<th>Storage</th>
<th>Full operating storage (MCM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cataract</td>
<td>94.30</td>
</tr>
<tr>
<td>Cordeaux</td>
<td>93.64</td>
</tr>
<tr>
<td>Avon</td>
<td>146.70</td>
</tr>
<tr>
<td>Nepean</td>
<td>69.81</td>
</tr>
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<tr>
<td>Prospect</td>
<td>33.30</td>
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<tr>
<td>Wingecarribee</td>
<td>24.10</td>
</tr>
<tr>
<td>Fitzroy Falls</td>
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<tr>
<td>Tallowa</td>
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<tr>
<td>Blue Mountains</td>
<td>2.79</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>2,608.7</strong></td>
</tr>
</tbody>
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#### 3.5.3 Sydney Water Resources and Safe Yield and Demand Management.

In 1997 Master plan the safe yield of Sydney’s drinking water storages was estimated as 600MCM/year. The yield is defined as the amount of water that can be withdrawn from a reservoir on a continuous basis with a small risk of reducing the reservoir storage to zero. Demand has fluctuated around 600MCM/year since 1980, despite population increasing by around 700,000 during from 1980 to 1997. Sydney’s water consumption has been above the safe yield for the last three years and for six of the last ten years.

Demand management targets for water conservation purposes were first included in Sydney Water’s 1995 Operating License. Despite this, the plan did not allow for much spending on recycling, water saving and demand management. It also did not consider the least cost options of future development. The first review and revision of strategy was conducted in 2003. The revised strategy contained five broad goals:

- a) clean and safe drinking water
- b) sustainable water supplies into the future
- c) wise resource use
- d) clean beaches, ocean, rivers and harbors
- e) smart growth pattern which is takes into account water use
Figure 3.5.2 Sydney Water System Schematic
Based on the 2003 review it was quite clear that the future growth in water supply depended on demand management but this was not considered seriously although the only pathway to meet demand for the future was to manage future demands.

From 2002/03 onwards with the drought the reservoir capacity started to decline and by 2006 the reservoir capacity became 43.9% of the maximum storage. The 600
MCM firm yield was not feasible and significant effort was needed for demand management.

**Figure 1 Reservoir Capacity Drought Decline 2002-2006**

### 3.5.3.1 Review 2004 of 25 Year Water Plan and 2006 Metropolitan Water Plan

In 2004, State Government released its 25-year Water Plan, Meeting the challenges - *Securing Sydney's Water Future*. The plan contained a broad range of initiatives, covering infrastructure projects, recycling, demand management and protection of the environment.

The NSW Government commissioned a review of the 2004 plan in 2005. A Progress Report was released in 2006, followed by the release of the *2006 Metropolitan Water Plan*. As a result of the review of the initial Metropolitan Water Plan, the Government:

- decided that it would not proceed to construct a desalination plant at this stage, but will be fully ready to construct a plant at short notice if dam levels drop to critical levels in future
- would continue to do the preparatory work necessary to ensure that it is able to proceed with construction of the desalination plant in the event that severe drought conditions return and dam levels fall to critical levels
- would undertake preparatory work to enable it to tap into newly identified groundwater resources in the event that the current drought worsens, or to help meet drought needs in the future
- would pursue regulatory reform to support small scale recycling, among other new initiatives to encourage reuse of water.

The Government's latest approach to water management was heavily focused on recycling and the intention to introduce greater competition and private sector involvement in the metropolitan water industry.

The 2006 Metropolitan Water Plan is the NSW Government’s plan to ensure a sustainable and secure water supply for greater Sydney. The NSW Government was
currently updating the plan for the longer term, with the new plan to be released in 2010 and 2015

The four major parts of the plan - dams, recycling, desalination and water efficiency - together with the plan’s adaptive approach, prepare greater Sydney for drought, variable rainfall, potential impacts of climate change, and a growing population. The plan secures our water for life --for people and the environment. The following actions needed to be taken:

a) **Dams.** Additional water from the dam storage, one of the largest per capita storages in the world, can be obtained by installing new pumps to reach deep water in major dams.

b) **Recycling** Large recycling schemes underway and planned will increase water recycling so that it provides 12% of greater Sydney’s water needs by 2015 – that’s 70 MCM of water every year.

c) **Desalination** The desalination plant would provide up to 15% of our water needs. The plant is now online and its power needs will be fully offset by renewable energy.

d) **Water efficiency** The water needs will be reduced by 24% by 2015 through water efficiency initiatives across all sectors, including households, government, business and farms; as well as by building water efficient homes and by fixing and reducing leaks and through continued community education on wise water use.

e) **Protecting the environment** was also an extremely important aspect of the Metropolitan Water Plan. Healthy rivers and catchments were essential for recreational use, for business and for tourism. The focus was on environmental flows and the NSW Government had also established an Office of the Hawkesbury-Nepean to improve the health of the Hawkesbury-Nepean River System.

The plan also includes reforms to create a competitive and dynamic water industry, by encouraging the participation of the private sector in the water industry. Should Sydney experience another drought, the plan includes a number of drought response measures such as accessing groundwater reserves and implementing water restrictions, which are being reviewed as part of the updated plan.

### 3.5.4 Sustainable Supplies and Forcing Demand to Meet Supply Available

Sydney Water was drawing, prior to 2003, 630 MCM/year from the Hawkesbury-Nepean and Shoalhaven River systems and discharged more than 450 MCM of wastewater into rivers and oceans. The safe yield was thought to be 600 MCM/year but this does not account for supply of an environmental flow. Sydney Water's business as usual projections suggest 650 MCM/year in 2031 but this assumed water conservation (demand management) targets are met, if demand management failed, projections were over 730 MCM/year. These estimates were clearly not tenable.
3.5.5 Demand Management

Both the demand management and recycling programs were token efforts, compared to the magnitude of change needed. Quantitative targets for reducing demand for water and recycling sewage effluent were the key elements of the New Direction for Sydney Water and were written into the Operating License. The Water Chief Executive Officers Taskforce had the objective to develop and recommend a Sustainable Water Strategy for Sydney. Recommendations of the Strategy include:

- Mandate minimum water efficiency performance standards for appliances;
- Mandate appliance rating and labeling;
- Mandate minimum levels of water efficiency in new residential developments;
- Implement permanent low level outdoor water use conditions;
- Obtain a 15% reduction in Government agencies’ water use;
- Review water pricing and tariff structures to send stronger conservation price signals to consumers and business;
- Implement mandatory planning controls requiring water fit for purpose approaches in new developments (e.g. Rainwater tanks or recycled water where available);
- Increase business water reuse and recycling;
- Develop incentives for farmers to improve agricultural irrigation efficiency;
- Supply recycled water to irrigators along the Hawkesbury Nepean River to replace current river extraction;
- Introduction of a market based adjustment mechanism

Demand management benefits were clearly demonstrated during have saved 33.9 million cum of treated water which is valued at $44 million in terms of cost of production (treatment) and revenues foregone due to water lost.

3.5.6 Demand Management and Conservation Approaches

Sydney Water has several demand management programs currently in place, covering residential; business; water recycling and water leakage. These are discussed below.

3.5.6.1 Residential

- **Residential indoor retrofit programs:** - the ‘Every Drop Counts’ retrofit program began in January 2000 and offers householders the opportunity to have a plumber visit their house to install water efficient devices. The program has: reduced water use by 4,376 ML/year; reduced household utility bills by $30 - $100 per year; and water savings have been shown to be sustained four years after retrofit;

- **Outdoor water conservation program** – ‘Go slow on the H2O’, this program has been delivered in spring each year since 2000, and is an educational program to promote water efficient gardening and other outdoor water use practices. Discount vouchers for water efficient products and promotional material was distributed to one million households with gardens throughout the Sydney Water operating area;
• **Rainwater tank rebate program** – research has shown that rain captured on roofs in rainwater tanks can reduce the demand on reticulated water supplies by between 30 and 50 percent, depending on the end uses of the stored water, tank size, roof catchment area and rainfall patterns. The rebate program aimed to: assess whether a rebate incentive can stimulate an increase in tank installations; and to encourage tank purchasers to install larger size tanks and to connect them to either their toilets or washing machines.

• **Water efficient washing machine rebate program** – provided a $100 rebate in early stages to newly purchase of water-efficient washing machines. The aim of the program was to stimulate a permanent increase in consumer take-up of water efficient washing machines.

• **Public housing retrofit program** – prior to the introduction of user pays tariff pricing in the early 1990s, public housing water consumption was consistent with average residential consumption. Since this time, public housing consumption has remained constant, while average private house consumption has reduced in response to the price signals. Currently the Department of Housing pays the full cost of public housing tenant’s water accounts. Sydney Water and the Department of Housing are developing an agreement to retrofit Department of Housing properties over the next six years.

• **Residential landscape assessment program** – this program, still being developed, aims to provide a garden tune-up and advisory service that targets Sydney’s highest outdoor water consumers.

As a result of these measures residential consumption decreased 450 LCD in 1991 to 325 LCD in 2007 (see Figure 3.5.6.1).

**Figure 3.5.6.1 Water Consumption 1991-2007**

![Figure 3.5.6.1 Water Consumption 1991-2007](Taken from 2009 Sydney Water Annual Report)
3.5.6.2 Business Water use

The ‘Every Drop Counts’ Business program targets customers in the manufacturing, commercial, hospitality, education and government sectors. The program targets potential participants from the highest water using business sectors and individual high water users within these sectors. The program consists of the following elements: co-operative partnerships; identification of technical projects; employee awareness; and corporate citizenship. Nearly 35% of the total business sector in 2003 formally joined the ‘Every Drop Counts’ Business program but this has embraced all the business community. In 2009 the business community saved some 22 MCM/yr through these programs. This was shown in a 15% reduction in water use in existing business.

3.5.6.3 Water Recycling

In 1999 Sydney Water developed a Water Recycling Strategy, and based on this work, gazetted a Water Recycling Projection for 2000 – 2005 in May 2000. The projection indicated that the volume of water recycled from the sewerage system would increase by between 4 and 67 ML/day in the future. A review of the strategy in 2006 noted that unless required as part of a sewerage treatment plant upgrade, water recycling schemes have been considered a viable public investment if full cost recovery could be achieved through a commercial agreement with recycled water customers. However, the fact that recycled water must often be priced to compete with potable water has limited the scale of the recycled water market that Sydney Water could viably service, and restricted the potential contribution of recycled water as a sustainable water source. A Recycled Water Program was developed, which indicated what recycled products will be provided to which markets and the schedule for delivering to those markets over the next ten years. Since 2001, recycled water use has increased from 10 ML/day to 25 ML/day (see Figure 3.5.6.3).

Figure 3.5.6.3 Recycled water program

![Sydney Recycling of Water in Industry and Business](image-url)

Figures Derived from 2009 Sydney Water Annual Report
3.5.6.4 Non Revenue Water Reduction Program

Sydney Water notes that water leakage prior to 1999 within reticulated system varied from 4% of demand in very well maintained systems, to 50% of demand averaging about 20%, which occurs primarily in third world countries. Since 1999 Sydney Water has reduced non revenue water loss rate of 10.7% of demand to 7.5% over 11 year from 1999 to 2009.

Figure 3.5.6.4 Non Revenue Water (mainly leakage) 1999-2009

Managing leaks from the water pipes (a main feature of non revenue water) that carry water to households, businesses and councils across Sydney, Illawarra and the Blue Mountains, was one of the ways used to secure Sydney's water supply.

Sydney Water's active leak detection and repair program is the largest and most comprehensive program in Australia to reduce leakage from its system. On behalf of the NSW Government, Sydney Water has:

- inspected and repaired all of the water pipes – a length about the same distance as travelling once around Australia
- committed to re-inspecting and repairing all water mains every year at an annual cost of $100 million
- Improved response times by having crews available 24 hours a day, seven days a week.

**Excessive water pressure** can lead to water main breaks and cause leaks in Sydney Water's system. Water pressure management aims to adjust water pressure levels in the supply system to achieve more consistent pressure levels which will reduce the number of water main breaks, improve the reliability of the water supply system and conserve water.

Most properties receive an average water pressure of around 50 metes head. Some properties receive significantly higher water pressures – up to 100 meters’ head. Sydney Water has a water pressure management program to target those areas where pressure levels are well above average and there is a history of water main breaks.
The Water Pressure Management program is an important part of Sydney Water's leak prevention program and the NSW Government's Metropolitan Water Plan. The program has the following benefits:

- met water conservation targets by reducing demand and leaks
- Improve reliability and continuity of supply as a result of reduced main breaks.
- Reduce pressure fluctuations to achieve more consistent pressures across the water supply system.
- Extend the life of Sydney Water’s water mains and assets.

Sydney Water has an Operating License condition, ensuring that there is a minimum pressure of 15 meters’ head at the connection point to your property. The loss reduction in water according all the leakage reduction programs is shown below in Figure 3.5.6-1. In 1999 the loss of water was 64 MCM per year and in 2009 it was down to 36 MCM per year. The program is now saving about 28 MCM per year in Sydney.

Figure 3.5.6.4-1 Leakage Loss from 2001-2009

![Sydney: Water Lost due to Leakage 1999-2009](Taken from Sydney Water 2009 Annual Report)

3.5.6.5 Water Pricing

Water pricing comprised a mixture of components including: property based charges; pre-paid water allowances; fixed charges and usage charges. The Government Pricing Tribunal conducted an inquiry into the pricing of water. Key recommendations that have been implemented since that inquiry include:

- Two-part tariffs, incorporating a fixed component and a component that varies with Usage;
- Cost reflective pricing – linking prices paid by customers to the cost of service delivery;
- The removal of cross-subsidies between different customer classes and types of services;
• Removal of property value based charges in favor of user based charges for all services; and
• Removal of all pre-paid water allowances.

3.6 Overall performance

3.6.1 Demand Management
Since the turn of the twenty first century demand management has been emphasized very strongly by the Sydney Water Board. It was quite clear that the amount of water available from the reservoirs would be limited to 600 MGD and alternative sources of water had to be obtained. Initially demand management was only given lip service but with the onset of the drought in 2001/2002 it became quite clear that demand management was the only way to solve the additional water problem. The 600 MCM firm yield was clearly not available from the reservoir and the shortfall had to be made in water saving, recycling and other forms of demand management.

3.6.2. Residential demand Management
Residential water demand management was achieved through leakage reduction, residential indoor water saving through changes to water cisterns, shower heads, etc, grey water recycling, outdoor water saving, regulatory measures through water tariff increases and in businesses through water saving programs in the business such as Every Drop Counts. Figure 3.6.2 shows that demand was reduced by the various programs from almost zero savings of water in 1999 to 83 MCM per year water saving in 2009.

The main reasons of water savings were: 34% in leakage reduction, 27% in business programs, 16% in indoor appliance changes, 13% in recycling, 6% in tariff increases and 4% in outdoor residence programs. Leakage reduction brings the largest savings in demand reduction.

3.6.2. Overall demand Management
Total water use reduction due to demand management programs is shown in Figure 3.6.2-1. Water use was reduced by the various demand management programs by
107 MCM per year. Demand management was taken more seriously when water restrictions were imposed by the onset of the 2002-2006 drought. The drought caused the Sydney Water Board to impose severe restrictions on water use and there were also several incentives to save water. The Sydney Water Board invested in measures to save water using water saving techniques. This resulted in water use 98% of the water reservoir in 2000 to 81% in 2009. The water savings increased from 2% in 2000 to 18% in 2009 (see Figure 3.6.2-2). Most of the water saving were 26% from leakage reduction, 23% from industrial recycling, 21% businesses who adopted *Every Drop Counts program*, 15% from residential programs for use of smaller toilet cisterns, water saving shower heads etc, 10% from recycling grey water in residences and 5% from tariff increases.

**Figure 3.6.2-1 Demand Management Effect on reducing Total Water Use**

![Demand Management Impact on Reducing Total Demand](chart1)

**Figure 3.6.2-2 Decline in share of Reservoir water use with demand management**

![Sydney Water Sources 2000](chart2)

![Sydney Water Sources 2009](chart3)

It was always believed that the system of reservoirs in the Sydney Catchment Authority could provide 600 MCM/yr as firm yield for the city. With the onset of the drought in 2002 the firm yield decreased and the reservoir storage dropped for all the major reservoirs below the 55% needed for the firm yield. The water available from the reservoirs, 526MCM in 2005, 528MCM in 2006, 510MCM in 2007, 482 MCM in 2008 and started to recover in 2009 to 495 MCM. The Sydney Water Board imposed very severe restrictions between 2003 and 2007 and the alternate sources of water came from demand management. It had to be developed by users to avoid the inconvenience of extreme shortage of water. With demand management the alternative water sources like recycled water, water saved in homes and business, etc. increased the apparent supply to Sydney to 602 MCM in 2009, 579 MCM in 2008, 583 MCM 2007, etc and this made it closer to the apparent needed supplies and it reduced the pain of shortages. What Sydney Water Board demonstrated is that it is possible to live with extreme shortages in supply by demand management that

![Figure 3.6.4 Sydney Water Supply 2000-2009](image)

3.7 Sydney’s Water Supply for 2015, 2020 including drought management

After the worst drought which drew down the reservoir storage below the 55% needed for firm supply the Government felt the capacity of the system to deal with periods of low rainfall needed the community to do its share through saving water and observing restrictions. While in the past Sydney has relied solely on water from dams, there was a need to diversify the source of water supplies. Increasingly, water
sourced from rainfall collected in dams will be supplemented by recycled water for industry, agriculture, the environment and for dual reticulation to new homes.

With limited and highly variable rainfall in the catchments, the community can no longer rely on water from the dams. To increase the water supply, Sydney Water is:

- Increasing the amount of water recycled. Water recycling will provide up to 12% of greater Sydney's water needs by 2015
- building a desalination plant to provide up to 15% of Sydney's water supply this summer
- helping the community and business to use water wisely - water efficiency initiatives will save up to 145 billion liters a year by 2015. That's about 24% of the water supply.

The 2015 plan for water was therefore to be supplied from the reservoirs 574 MCM (could be varied); 140 MCM from water saving and efficiency improvements; 70 MCM from recycling and 77 MCM from additional water see Figure 3.7.

The experience from the worst drought for Sydney has demonstrated that demand management with the cooperation of the public, industry and business can solve the problems of water shortages and reduce the economic disruptions due to the drought.
Chapter 4 Integrated Water Resources Management and Demand Management
Chapter 4 Integrated Water Resources Management and Demand Management

4.1 Background

4.2 Key Issues in IWRM

4.3 Important Criteria and Requirements to make IWRM function

4.3.1 Criteria for IWRM to be successful

4.3.2 Important Pre-Conditions for IWRM Success

4.4 IWRM Implementation

4.4.1 Background

4.4.2 Enabling Environment

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4.6 Guiyang’s Water Resources Bureau Move towards Integrated Water Resources Management

4.6.1 Towards Basin Management Step 1

4.6.2 Monitoring of Water Abstraction Step 2

4.6.3 Monitoring Station Predicting Short Term Demand and other things

4.6.4 Need For Demand Management

4.7 Summary Guiyang Municipality Needs
Chapter 4 Integrated Water Resources Management and Demand Management

4.1 Background

The Global Water Partnership defines “IWRM is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”.

The concept of Integrated Water Resources Management – in contrast to “traditional”, fragmented water resources management – at its most fundamental level is as concerned with the management of water demand as with its supply. Thus, integration can be considered fewer than two basic categories:

- the natural system, with its critical importance for water resource availability and quality, and
- the human system, which fundamentally determines the resource use, waste production and pollution of the resource, and which must also set the development priorities.

Integration has to occur both within the natural system with its variability of natural resources (in this being water) taking into account variability in time and space. Managing the natural water resources system to provide supplies to meet externally determined needs will be required. IWRM approaches should assist in recognizing that their behavior also affects water demands. Clearly, consumers can only “demand” the product supplied, but water can be supplied with very different properties, for instance in terms of quality and availability in low flow or peak demand periods. There are several areas of integration that are needed i.e.

g) Land and Water management
h) Surface and Groundwater management
i) Integration of water quantity and quality management
j) Ensuring that all sectors and section of the river basins are getting water at the time and quantity and quality needed

4.2 Key Issues in IWRM

The key issues that need to be considered for IRWM are:

a) **Influencing economic sector decisions** The decisions of economic sector actors (from large state-owned companies to individual farmers or households) will in most countries have significant impact on water demands, water-related risks and the availability and quality of the water resource. These decisions
will not be water sensitive unless clear and consistent information is available on the full costs of their actions; importantly, incentives to take account of the external costs of their decisions have to be given.

b) **Integration of all stakeholders in the planning and decision process.** The involvement of the concerned stakeholders in the management and planning of water resources is universally recognized as a key element in obtaining a balanced and sustainable utilization of water. But in many cases stakeholders represent conflicting interests and their objectives concerning water resources management may substantially differ. To deal with such situations the IWRM should develop operational tools for conflict management and resolution as well as for the evaluation of trade-offs between different objectives, plans and actions. An important issue here is the need to identify and designate water resources management functions according to their lowest appropriate level of implementation; at each implementation level the relevant stakeholders need to be identified and mobilized.

c) **Integrating water and wastewater management** Without coordinated management wastewater the flows often simply reduce effective supplies by impairing water quality and increasing future costs of water supply. Incentives for reuse can be provided to individual users but to be effective reuse opportunities have to be designed into the City systems and incentive for reuse need to be provided.

d) **Need for cross sectoral Integration** The cross-sectoral integration between water use sub-sectors, and the role of IWRM is an imperative and is illustrated by the figure 4.1

a. Need for Cross Integration between Water Use Sectors
4.3 Important Criteria and Requirements to make IWRM function

**Criteria for IWRM to be successful**

In pursuing IWRM there is a need to recognize some criteria that take account of social, economic and natural conditions:

- **Economic efficiency in water use**: Because of the increasing scarcity of water and financial resources, the finite and vulnerable nature of water as a resource, and the increasing demands upon it, water must be used with maximum possible efficiency

- **Equity**: The basic right for all people to have access to water of adequate quantity and quality for the sustenance of human wellbeing must be universally recognized

- **Environmental and ecological sustainability**: The present use of the resource should be managed in a way that does not undermine the life-support system thereby compromising use by future generations of the same resource.

**Important Pre-Conditions for IWRM Success**

The IWRM framework and approach recognize that complementary elements of an effective water resources management system must be developed and strengthened concurrently. These complementary elements include:

- **the enabling environment** – the general framework of national policies, legislation and regulations and information for water resources management stakeholders;

- **the institutional roles** and functions of the various administrative levels and stakeholders; and

- **the management instruments**, including operational instruments for effective regulation, monitoring and enforcement that enable the decision-makers to make informed choices between alternative actions. These choices need to be based on agreed policies, available resources, environmental impacts and the social and economic consequences.

4.4 IWRM Implementation

4.4.1 Background

Rapidly increasing urban population has seriously stretched the existing water supply capacity, resulting in reduced water pressure and water rationing, and shortage of irrigation water in dry periods, particularly the spring planting season. More than twenty new industries are planning to move to Guiyang Municipality by 2010; Based on the projected population growth from 3.6 million in 2004 to 3.9 million in 2010, GM forecasts its annual water demand will be 1.46 and 1.77 billion m³ in 2010 and 2020, respectively. Consequently, without the development of new resources the annual water shortage will be 420 and 642 million m³ in 2010 and 2020, respectively.

In the surrounding rural area, shortage of water – for potable use and irrigation - is
also seen as a critical constraint to improving rural resident incomes and living standards, and alleviating persisting poverty. Due to the steep mountainous terrain topography, surface and ground water is not readily available to many farmers, particularly those who are located sparsely and cultivate crops in hilly, upper catchment areas. This situation is worse in Xifeng County where lower than average precipitation of 1,000 mm has been recorded. Arable land comprises only about 10% of GM area, and less than half of this area is irrigated. Seasonal and annual variation in water availability is high, over 70% of the rainfall is concentrated from May to August and drought condition occurs between February and April. Consequently, farmers have difficulties growing their crops during this critical period, and are limited in their ability to diversify their crops year-round. Due to water constraints for household use and irrigation, subsistence farmers are trapped in poverty and susceptible to a worsening situation as the demand from potable and industrial water users increases.

The majority of the rural population in smaller villages is not connected to a public water supply system, and must depend on local springs and streams. Some villagers have small storage structures close to their houses, for domestic, livestock and agricultural use. Currently, around 430,000 rural residents, or 28% of GM’s rural population, lack satisfactory provision for their water needs. By far the largest portion of the rural water needs is for agricultural purposes (domestic requirements account for only around 10%). Yet, irrigation facilities are old and the efficiency of irrigation infrastructure is low with a high percentage of water losses. The area of land irrigated in an effective manner is reported to be only around 24-30% of the total cropland. Attempts to cultivate higher and/or steep slopes in mountainous areas have led to increasing soil erosion.

In parallel with augmentation of water supply, measures for improved water management need to be encouraged. Farming techniques to conserve water and to preserve soil need to be widely disseminated and practiced by farmers. GM industries in general are encouraged to reuse their process water. Urban water saving measures should further gain proper understanding from consumers regarding the importance of economic water resources management under water scarcity. There have been pilot programs to conserve water (development of a “Water Saving Society”) and control soil erosion from farming on sloping fields. These attempts – including improved on-farm water management – must be further promoted and expanded. Many of the rural water infrastructure facilities are in a dilapidated and worn out state, and in need of rehabilitation, suggesting that proper and sustainable institutional arrangements for operation and maintenance need to be developed and implemented.

4.4.2 Enabling Environment

In recent years the Peoples’ Republic of China (PRC) has recognized the need to improve the comprehensive management of water resources, applying approaches consistent with IWRM methodologies, and to shift the emphasis more towards managing demand, including the use of economic mechanisms.

**Water Law**
A crucial milestone along this path was reached on October 1, 2002 when the revised Water Law was made effective, and in which added emphasis is given to such issues
as water resources planning, protection of water resources, the economical use of water, the resolution of disputes concerning water and the enforcement of water use regulations, all of which are common water resources management concerns. The Water Law constitutes an enabling environment for integrated water resources management, including:

- management,
- utilization,
- conservation and protection of water resources, and
- development of water resources

The Water Law covers both surface water and groundwater sources, and both quantity and quality of water. It states that the policy of the Government of China is to move from supply driven management towards increased management of demands. To implement the policies of the Water law is a priority task of the Ministry of Water Resources (MWR). The MWR is putting particular emphasis on strengthening integrated water resources management (IWRM) through more efficient allocation of water, implementing water resources demand management with regulatory and economic instruments, and strengthening water resources protection. Specific MWR priorities are water allocation (including drought planning), permitting, economic measures and water savings for regulation of demand, and strengthening water resources protection by putting into effect all the related systems and comprehensively implementing the regulatory functions.

**State Council Circulars and Regulations**

More recently the State Council has two circulars/regulations which directly advocate the reform of the water sector to use IWRM approach. These regulation have a much more direct enabling environment to reform the water management using the IWRM approach. Two circulars/regulations of the State Council state:

- Water issues (shortages, pollution, floods etc) have become a basin wide systemic issue which has worsened continuously
- With the current management there is no way to deal with water transjurisdiction and intersectoral issues. Need to adopt a comprehensive approach: institutional, policy, technology and management measures
- IWRM is an ideal approach to implement balanced development at the river basin or ecosystem level
- Water Affairs Bureau can be an IWRM unifying model has to be established in cities where water supply, wastewater collection and treatment and all other water issues can be resolved
- this new approach is needed in the 11th Fiver Year Plan

**Yangtze Forum**

A further indication of changing emphasis in PRC government policy was declared at the Yangtze Forum held in Wuhan in April 2004, when a clear and strong message was given on the need for an integrated approach to river basin and water management. The requirement for cross-agency coordination was strongly emphasized, with a focus on the need to strengthen communications and exchange of
information. An updating of master plans to emphasize the balance between protection, development and the environment was called for at the Yangtze Forum, and non-structural measures such as research, monitoring and information systems should be given higher priority so that decisions can be scientifically based. Policy and financial support from central to local governments needs to be strengthened. Complexities of cross-agency management demand a more strategic approach, and greater public involvement is needed to increase the effectiveness of regulatory mechanisms.

The MWR has prepared a draft national guidance on integrated water resources planning, and this is being piloted by a number of Provincial Water Resources Departments including in Liaoning and Gansu Provinces.

The importance of integrated water management has been acknowledged by the Guiyang Municipal Government (GMG), and there is a strong motivation to establish IWRM practices in line with best national practice, international experience and developments, and the ADB water policy.

4.4 Present institutional Issues

4.4.1 Background

The present institutional arrangements for water resources management in Guiyang are extremely fragmented:

a) Management of rural water which covers: irrigation, water saving in irrigation, flood control, rural water supply, river maintenance, etc are handled by the county and Guiyang Water Resources Bureaus

b) Urban water supply, flood control, river bank management, water supply for urban resident, drainage and wastewater collection and treatment etc are managed by the Urban Construction Bureau of the city or the county. Water supply is actually managed by a water supply enterprise

c) Water Pollution control is managed by the County or City Environmental Protection Bureau

The implementation of water projects whether they are for rural or urban are financed and sourced by each Bureau or Department submitting their plans to the municipal government. Although all Bureau’s or Departments are given an opportunities to comment on each others projects there is an unwritten agreement not to oppose each others project unless it seriously affects each other Department or Bureau’s work. Hence projects get constructed and only achieve sub-optimal returns for their projects because they are not reviewed to the extent as required.

Water Shortage Issue.

The problem comes mainly in management of the water resources. In a drought situation the urban and rural domestic water supply should have priority over all other uses. However under drought conditions the allocation of water to the different sectors varies as to how much water the Bureau or Department has jurisdiction of the
water within its boundary. Hence the County/City Departments/Bureau’s allocate the water according to all their needs. They will allocate to all their users at the expense of a neighboring County which has no drinking water. Droughts cover whole areas and have no respect to jurisdiction boundaries. **Hence water gets allocated to the least important sectors in a county with more water than another county has serious drinking water shortages. This is extremely sub-optimal and causes extreme distress to basic needs of people. In addition water shortages are rampant.** The water shortage in Guiyang in March 2007 affected 800,000 people. Water shortage is now in almost every province and in a majority of the counties in China because of lack of integrated management and lack of control of demand. Guiyang Municipality has 4.4 billion cum meter of water but only 1.4 billion cum can be used because of the high flows in the wet season which are not divertible and most of it lost.

**Lack of Demand Management**

There at present no demand management in Guiyang municipality at all. Water consumption has been increasing at 29% of income increases. Income increases have been about 10% to 12%. At present the per capita water use in Guiyang City in 2007 is over 172 liters/capita and by 2010 will be 180 l/capita. This water use is higher than Beijing, Shanghai, United Kingdom (161 l/capita), France (161 l/capita), Singapore (147 l/capita), Germany (144 l/capita), and Portugal (87 l/capita). Most of these countries have incomes close to $34,000 to $40,000 per capita. The water use which reflects the demand is uncontrolled and will gobble up all the available resources. There has been no attempt to manage demand through increases of tariffs or by aggressive water savings techniques.

**Lack of efficiency**

The water loss in the pipe-net work and the unaccounted water amounted to 34% of the supply. There is no transparency of the water loss figures. Every account and every report indicates the loss of 20% as the figures everybody should be told. The water loss by a latest Japanese consultant report was that it was 38% in 2001 and has decreased to 34% in 2006. A 34% loss means that out of the 144 million cum of domestic water supplied close to 49 million cum is lost and most of these losses are paid for by the consumer since water companies will only take responsibility for the main losses in the truck main which is about 2-7%. A detailed study of the main sources of unaccounted water and leakage is needed. Based on the study there is an immediate need to systematically replace all old pipes. New sources of water supplies should only be developed after the leakage and unaccounted water is reduced to about 10-14%. In most developed and middle income countries the leakage losses vary from 7-14%. In the USA it is between 7-12% with most cities having 7% unaccounted water, with the exception of Los Angelis City which has unaccounted for water including leakage of 4%. In Singapore it is about 4.7% and in Sydney it is 7.5%.

Water saving implementation should be aggressively implemented for both urban and rural water usage. Incentives should be provided in terms of subsidies to improve efficiency in residences and for business. Industry should recycle all water that can be recycled.
Flood Design/Management Issue.

Urban areas Urban Construction Bureau take care of the river banks and design and management of these banks, and have to take care of them. For rural areas if it is a river crossing/going through many counties the Guiyang Municipality has to be responsible for the design and management. Otherwise the County Water Resources Bureau is responsible for design and construction and management of the protection works. The inconsistency between the protection works of the urban and rural structures and levels creates more floods in some regions. There is a need for one agency to be in charge of flood control in both rural and urban areas to ensure uniformity of flood control works

Soil Conservation and Sediment Control.

The soil conservation in the rural areas is undertaken by the County Water Resources Bureau and by Bureau of Agriculture but in urban areas it is controlled by the Urban Construction Bureau. There is no uniformity of soil conservation between the two groups and therefore there is a lot of sediment that flows through the river and it silt up structures and river bed levels are raising and there is a need for uniformity in approaches in sediment control.

Absence of Water Pollution Control

The Water Resources Bulletin 2008 indicates that of the 93.7 km of major rivers out of 393.7 are polluted to Class V levels. About. 36.7 km are Class IV and these with the amount above Class V water form 33% of river lengths with very poor quality. The other 67% of river water are Class II or III waters where there is a low density of population. The City Environmental Protection Bureau has little or no control of industrial waste being discharged into the river. The river quality of Nanming River deteriorates after passing Guiyang from Class III to Class V and over (see Figure below). The deterioration is due first to the lack of separate sewers for sanitary waste and for storm water and therefore in the very rainy days (120 days per year) the storm water and the wastewater overflow into the river and pollute the river waters. Second industrial waste even if it treated to standards has extremely high pollution loads. Hence the Nanming River has very poor quality of water just before the center city area and proceeds to all the way down until it meets the Yuejiang River. In fact the entire main reservoirs like Baihua and Hongfeng which supply Guiyang’s drinking water are polluted to level IV quality. The Nanming water below Guiyang is of such poor quality that it is essentially untreatable by conventional methods and therefore unusable by most people. Generally from estimates made from other cities it could create a loss of use of water and a damage to the economy of about 2% per year. If this polluted water is to be used as portable water it will need to be treated first through a sewerage treatment plant with advanced waste treatment and subsequently by water treatment plant with micro-filtration and granulated activated carbon for removal of organics and VOC’s and for odor removal before it can be used for potable water. The cost of such treatment is about Y3-4/cum³. It is extremely shortsighted on behalf of the EPB and industries of the city to let the water quality to

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3 Bayannaoer Water Reclamation and Pollution Control Project –World Bank 2010
There has to be a lot of investments in sewer interception and distribution systems and also treatment plants to separate sanitary sewers from storm drains. Industries have to pre-treat their waste so that there are virtually no heavy metal, synthetic organics or ammoniated organics or ammonia and then let their waste go into the municipal sewers. Industries that are located far from the municipal sewers have to treat the waste to very high standards before it can be discharged into open bodies of water. Presently the Drainage Department of the Urban Management Bureau manages the urban drainage. The urban drainage acts like a combined sewer for storm water and sanitary waste. Water Supply is managed by the water enterprise. The reservoir where the water enterprise gets its water is managed by a Reservoir Management Company. The EPB is responsible for pollution control to ensure that river waters are protected. Water Resources Bureau of Guiyang is responsible for design and construction of all dams and water control structures. Five different agencies with different tasks control water supply, wastewater collection, pollution control, manage reservoirs etc. There is fragmentation in institutions for managing water. As a result there are water shortages in the city and county areas, water quality deterioration of the rivers and other issues. One water agency is required to ensure all the works are constructed and operated and managed so that all people get their water in the quality and quantity as needed.

4.6 Guiyang’s Water Resources Bureau Move towards Integrated Water Resources Management

4.6.1 Towards Basin Management Step 1

The Guiyang Water Resources has been trying to develop a basin committee to meet for the Nanming Basin. They were trying to get the big users of water, government groups along the river, and others including the public. The main idea of the Basin Committee is to not only work with big users to rational their water withdrawals but
to also see how pollution discharges can be controlled to improve the water quality in the river. It was suggested to the Water Resources Bureau the US River Basin Agencies were very loose Compact (committee) arrangements however they can work if they do meet and make decisions. The US River Basin Compacts in Potomac Basin was between the States of Virginia, Maryland, Washington DC and Pennsylvania and they only met when there were shortages of water in the Lower Potomac River. In the Delaware Compact three States Delaware, Pennsylvania, and Maryland met regularly to sorted groundwater withdrawals, pollution control and some cases surface water withdrawals. The Nanming Committee can be like a river basin compact which can meet several times year to sort out problems of pollution and withdrawal rates from the river,

The plan was to migrate from Nanming Basin to also setup a committee in Maotiao River Basin. The Basin Committee will help resolve many of the excessive abstraction issues and the pollution problems.

4.6. 2 Monitoring of Water Abstraction Step 2

The Water Resources Bureau has now moved over the last several years from only doing administrative work to water measurement work. They have established a Water Monitoring Station attached to the Water Resources Management Department for measuring the water abstractions from the river managing the municipal water resources and maintaining ecological environment and implementing water abstraction permit for water sources.

They are using some 40 stations in addition to obtain this data and compiling it so as to regulate demand and to control water quality. The monitoring station is also looking into water saving effects.

4.6.3 Monitoring Station Predicting Short Term Demand and other things

The monitoring station is also looking into short demand assessing water quality, water supply and demand analysis and forecasting, assessing water resources availability.

It is also undertaking to compile water resources plans and the exploitation volume of groundwater.

In addition it measures the total waste loading analysis, the total control of sewage discharge, and environmental assessment.

These measurements are the first steps to implement a single agency to undertake the task of managing the water
4.6.3 Recommended Institutional Change

There needs to be one institution/department/bureau that is responsible for all water resources matters. The details are discussed in the next chapter. The State Council Regulations also reinforce this statement:

- no way to deal with water Tran jurisdiction and intersectoral issues with the current management-
- IWRM is an ideal model to implement balanced development at the river basin or ecosystem level
- All matter dealing with planning, design and operation in rural and urban areas fall under one institution. In the case of Guiyang the functions that need to be under one Water Affairs Bureau are i) the Urban Management Bureau of water supply management and development, and sewerage development management, river bank protection, soil conservation activities in urban areas; ii) Urban Construction Bureau in Water Supply development and water saving activities and groundwater management; iii) Water Resources Bureau of Planning and Design for the entire municipality; irrigation and rural water design and management; soil conservation activities; and groundwater in rural areas; iv) Soil conservation activities under the Agriculture Bureau; v) Price regulation in the Price Bureau; and vi) Water pollution control under the EPB

Need for Demand Management

With the institutional change there needs to be a change in mode of operation under IWRM. Most systems are designed so that supply always attempts to meet demand. A demand management system will ensure that demand meets supply. In order to develop a demand management system which essentially regulates demand through water saving, conservation methods and price regulation to ensure demand is always less than supply. Where demand tends to exceed supply despite water saving and price regulation it may be necessary to adopt to recycling or reclamation of water.

4.7 Summary Guiyang Municipality Needs

The Guiyang Steps to IWRM is as follows:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Establish for each river basin Water Management Stations so that River Basin Management Approach can be adopted</td>
</tr>
<tr>
<td>b.</td>
<td>Develop a water abstraction monitoring system for each basin</td>
</tr>
<tr>
<td>c.</td>
<td>Develop a water quality monitoring system</td>
</tr>
<tr>
<td>d.</td>
<td>Water Management Stations should develop short term demand forecasts</td>
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<tr>
<td><strong>e.</strong></td>
<td>Integrate all water function bureaus into one Water Affairs Bureau</td>
</tr>
<tr>
<td><strong>f.</strong></td>
<td>Under the Water Affairs Bureau there will be a department responsible for demand management: undertake demand forecasts; introduce water savings for all sectors and provide for incentives for water saving facilities for domestic and industrial sectors; and prepare with Price Bureau necessary price increases to impact on water use reductions</td>
</tr>
<tr>
<td><strong>g.</strong></td>
<td>Limit the pollution load into the river from different sections of the river</td>
</tr>
<tr>
<td><strong>h.</strong></td>
<td>Prepare emergency operations measures for drought conditions: prepare priority of water use; prepare allocation of water under emergency conditions according to priority needs</td>
</tr>
</tbody>
</table>
5.0 Guiyang Municipality Institutional Reform for Integrated Water Resources Management

5.1 General

5.1.1 Background on the Water Resources Sector

5.1.2 Present Water Resources Management

5.1.3 Present Urban Management Bureau

5.1.4 Environmental Pollution Control Bureau

5.2 Integrated Water Resources Management (IWRM)

5.2.1 IWRM - impediments to its successful implementation

5.3 Background of Basic Reform Approach

5.3.1 Background

5.3.2 Qingzhen model of Water Affairs Bureau

5.3.3 Xifeng County IWRM Reform

5.3.4 IWRM Reform Performed in Chinese Cities

5.4 Guiyang Pre-reform reform Activities (Stage I Action Program)

5.4.1 Establishment of River Basin Management Stations

5.5 Reforms in the Water Sector and Stages (action Program II)

5.5.1 Selection of Appropriate Water Affairs Bureau Reform

5.5.2 Guiyang City Water Affairs Staged Reform

5.5.2.1 First Stage Water Resources Bureau Reform

5.5.2.2 Second Stage Reform Urban Water and Wastewater Reform

5.5.2.3 Third Stage Reform to Form a Water Affairs Bureau—next 5 years

5.8 Summarizing the reform Activities for IWRM and Demand Management Development

ANNEX 5 Annex Table 5-I Functions of Water Affairs Bureau’s in China
5.0 Guiyang Municipality Institutional Reform for Integrated Water Resources Management

5.1 General

The organisational structure of each of the Guiyang Districts and Counties are broadly similar and largely replicate the structure of the municipality, but with a degree of rationalisation to reflect the smaller scale of these fourth tier governments.

The three urban districts of Nanming, Yunyan, and Xiaohe form the central urban area of Guiyang. Included in these three districts are three new Sub-Districts Sanqiao, Jinyang, and Longdongpao. These Districts are served by the Guiyang Municipal Tap Water Company and do not have their own water supply companies. The other Districts and Counties have their own water supply companies that serve the urban areas.

There is one other notable exception to the normal arrangements at the District/County level. In Xifeng County the local Water Resources Bureau and not the local Urban Construction Bureau is responsible for urban tap water supplies.

In turn the suburban Districts and Counties have administrative jurisdiction of Township Governments. These are the lowest level of formal government, but in turn the townships control a number of villages each run by an elected village committee under the leadership of an elected village head.

5.1.1 Background on the Water Resources Sector

As the economic hub of the province, GM has a rapidly increasing population and industrial development, and hence increasing demand for water. Servicing this population and related municipal and industrial water demands is putting a severe strain on the existing water supply facilities. Urbanization in GM means increased water demand for household, commercial, and industrial use. Water quality in local rivers and water sources is also a growing concern.

Guiyang Municipality presently has many institutions dealing with water. A diagram showing all the key institutions are shown in Annex 5 Annex table 5.2. There are approximately 40 Municipality Bureau’s of which about 8 Bureau’s deal with water resources planning, management and supervision. The jurisdictions are overlapping and functions for rural is different from urban water resources. These bureaus are:

a) Municipal Water Resources Bureau
b) Urban Management Bureau

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4 This report is a essentially a summary with additional recommendations of Dr. Dajun Shen’s report Institutional Reform of the Water Sector in Guiyang Municipality for the under Asian development TA 4912-PRC for the Advisory Technical Assistance for Strengthening Water Resources Management in Guiyang Municipality
The Water Resources Bureau deals mainly with rural water resources and overall water resources planning including flood control, construction of major water projects for the municipality. The urban bureau’s deal with services of water at the urban area level i.e. water supply for the city, sewerage and drainage at city level, soil conservation, flood defense at city level etc. The Price Bureau and Municipal Development Reform Commission are involved in regulating prices for water and also review and approve the future project for both urban and rural government.

5.1.2 Present Water Resources Management

The Guiyang Municipality Water Resources Management is moving away from the administrative management (purely government function) that they had for the last 30 years and its being slowly shifted to a water management station which is more of an operational function. The administrative tasks are as given below in text Box 1

**Text Box 1 Administrative Functions**

<table>
<thead>
<tr>
<th>Main Administrative Tasks of Water Resources Bureau -</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Drafting water resources development strategies and middle- and long-term plans, r.</td>
</tr>
<tr>
<td>● Responsible for the integrated management of water resources (including surface water and groundwater), organizing to draft long-term water supply and demand plans, water resources allocation plans and monitoring and flood control; organizing to implement water abstraction permit system</td>
</tr>
<tr>
<td>● Developing water saving policies</td>
</tr>
<tr>
<td>● Organizing water function zoning and control over discharge to water bodies including drinking water supply sources, monitoring water quantity and quality in rivers, lakes and reservoirs;</td>
</tr>
<tr>
<td>● Administrative law enforcement; arbitrating and coordinating water disputes</td>
</tr>
<tr>
<td>● Drafting economic regulation measures in water sector for investments</td>
</tr>
<tr>
<td>● In charge of the assessment for water resources project proposals, feasibility reports, preliminary designs, budget reviews. Guiding the implementation and monitoring of standards in the water sector.</td>
</tr>
<tr>
<td>● Management and protection of water facilities, water bodies and shoreline, the urban rivers; hydropower dam safety monitoring.</td>
</tr>
<tr>
<td>● Guiding rural water resources activities, especially for drinking water works.</td>
</tr>
<tr>
<td>● In charge of the municipal water and soil conservation, and monitoring, supervision and prevention, law enforcement for erosion.</td>
</tr>
<tr>
<td>● In charge of water-related foreign affairs, scientific and technological works; guiding staff building in water sector.</td>
</tr>
<tr>
<td>● Undertaking the daily work of municipal flood control and drought relief headquarter</td>
</tr>
</tbody>
</table>

The management functions are done by the Water Management Stations, Reservoir Management Stations, and Soil Conservation Management Station. A Management Station will provide management services and is able to collect fees. The Water Resources Department If the Water Resources Bureau wanted to shift to IWRM mode it will have to establish Water Management Station and work through the stations to undertake the tasks.
The present Water Resources Bureau has the following divisional departments

- The financial division
- The construction division
- The management division
- The water resources division (water saving office)
- The planning and programming division
- Guiyang Municipal People's Government Flood Control and Drought Relief Office
- The water and soil conservation division (Office of Municipal Water and Soil Conservation Committee)
- The policies and legislative division

In addition the Water Resources Bureau has several monitoring and management stations

- Guiyang Water Resources Management Station
- Guiyang Water and Soil Conservation Monitoring Station
- Guiyang Huaxi Reservoir Management Office
- Guiyang Xiao guan Reservoir Management Office
- Guiyang Yudonghe Reservoir Management Office

5.1.3 Present Urban Management Bureau

The Urban Management Bureau (UMB) has a similar issue to separate its administrative or government functions from its management functions. The UBC is a little ahead than the Water Resource Bureau because it has divested its main management functions to the Water Enterprise for water supply and Sewerage Treatment to a Treatment Plant Company. In many cases it has even allowed the private sector to take over the function.
Urban Management Bureau has the three divisions

- The Public Utility Division
- The Urban Utility Management Office
- Water Saving Office

Text Box 3 Urban Management Bureau Tasks

- According to national, provincial policies and legislations about urban water supply and drainage, water saving, researching and drafting the municipal implementation methods and organizing to implementation and supervising.
- Responsible for urban water supply and drainage sectoral management, urban water saving management work, drafting and implementing relevant development plans.
- According to “Guiyang Urban River Course Temporary Management Methods” and related regulations, responsible for construction, maintenance, management of urban river facilities.
- According to “Guiyang Urban Water Saving Management Regulation”, responsible for the management of groundwater development and protection in urban plan zone, and urban water use plan, water saving works.
- Responsible for urban water supply sectoral management, as the urban water supply administrative department.
- The Public Utility Division is responsible for drafting and supervising the implementation of the sectoral policies, reform measures, reform plans; guiding and managing urban water supply, wastewater treatment; responsible for the management of groundwater development and protection in urban plan zone, and urban water use plans, water saving works.
5.1.4 Environmental Pollution Control Bureau

The Environmental Protection Bureau has the same functions as in most parts of China. The EPB implements the pollution control laws and enforces them (see Text Box 4 for all functions). The EPB will have monitoring stations and supervision teams to ensure the national laws and local laws of pollution control are implemented.

Text Box 4 Functions Pollution Control Bureau

- Implementing national policies, laws and regulations
- Supervising and implementing national and provincial environmental protection standards;
- Drafting municipal middle- and long-term environmental protection plans
- Responsible for environmental protection works for air, water body and soil;
- Supervising and managing natural ecological and environmental protection
- Guiding and coordinating municipal and cross-boundary key environmental problems;
- Drafting and organizing to implement environmental protection management systems;
- Organizing environmental science and technology researches;
- Responsible for the municipal environmental monitoring;
- Guiding the municipal environmental education;
- Environmental Supervising Team, entrusted by the environmental protection bureau, is responsible for supervising the implementation of environmental protection policies and legislations.
- The Guiyang Environmental Monitoring Center, is responsible for the municipal environmental monitoring plans

5.2 Integrated Water Resources Management (IWRM)

Under the 2002 Water Law the responsibilities of the River Commissions and local Water Bureau in respect of integrated water resources planning have been strengthened. The newly prepared Guiyang Integrated Water Resources Master Plan in 2006 is an attempt to put that new responsibility into practical effect.

Guiyang Municipal Government has indicated a clear commitment to IWRM and to move to make the concept a practical reality over a period of time. However, the degree of fragmentation and the complexity of water sector management issues mean this is not an initiative that can be dealt with by a “short term fix”. The ensuing sections of this chapter illustrate the extent and complexity of the problem.

5.2.1 IWRM - impediments to its successful implementation

The current management of the water sector is highly fragmented as illustrated clearly in the earlier current situation paper. There is vertical fragmentation with different responsibilities between Provincial, Municipal and District/County levels
and there is horizontal fragmentation with responsibilities for water sector management split between different functional departments (mainly Water Resources, Urban Management and Agriculture).

Both types of fragmentation can lead to problems in water resources management, but generally horizontal fragmentation presents the more difficult problems to deal with. This is because the system of functional supervision within PRC government allows (in theory at least) issues caused by vertical fragmentation to be resolved more easily – although this does not always happen in practise.

**Figure 5.1 Vertical Fragmentation by the delivery services and Horizontal Fragmentation for Areas of Service**

*Vertical fragmentation* is shown by water services delivery for irrigation, flood control, rural water supply and agriculture being provided by Water Resources Bureau with some services provided by Agriculture and Forestry Bureau’s for soil conservation. Water Supply, sewerage, drainage and water treatment services are delivered for urban areas by the Urban Management Bureau and Two Lakes and one Reservoir and pollution control is essentially carried out by the Municipal EPB. Hence vertical fragmentation occurs by different section of government delivering different services for water. There two major groups supplying water to the system by two agencies with urban water supply. The Environmental Protection Agency controls the water quality essentially in the urban areas with some points reaching rural areas. However it functions is not control by the Water Resources Bureau or the Urban Management Bureau. Hence quality of water and quantity of water are controlled by two agencies.

*Horizontal fragmentation* occurs when the water delivery systems deliver to different areas of the municipality i.e. water resources management for urban areas are a different government agency from that of rural water resources agencies. Since the river basin water flows are continuous through the river basin the extraction of water in one area affects the availability of water to other areas. Even flood defence
and flood control, soil conservation all need to be controlled by one same agency. Horizontal fragmentation further exists to county governments which are described in Chapter seven.

There needs to be an integration of the vertically disaggregated government delivery services into one agency at the municipality level. This one agency can then deliver the water services to both urban and rural areas and give the same level of services.

It is found that the governmental organization structure related to water resources management in Guiyang, is very scattered and inefficient compared to other places in China. It is almost like a copy of the central governmental structure before 1998. This arrangement will impact the integrated water resources management and increase the transaction costs of governmental operation and management cost for water resources. The problems existing in the current system are as follows.

- **Urban and rural water management and investment are separated.** This reflected in the functions of Water Resources Bureau, Urban Management Bureau, Construction Bureau and Planning Bureau, in terms of water resources planning, development, allocation, use, protection and water saving and conservation. These water systems designs are inconsistent between urban and rural areas, and these results in poor management of urban water supply and the ability to control urban river pollution.

- **Ground and surface water management are separated.** This is reflected in the functions of Water Resources Bureaus, Urban Management Bureau and Planning Bureau, in terms of groundwater management in urban area. Due to the complex interaction between groundwater and surface water in Karst area in Guiyang, it is necessary to have an overall management of surface and ground water.

- **Quantity and quality of water are separately managed.** This reflected in the role of Water Resources Bureau and Environmental Protection Bureau, in terms of water resources protection and water pollution control, data sharing etc.

- **Separation of management in water resources in different parts of a river basin.** This reflects in functions of the Management Bureau for Two Lakes and One Reservoir and Water Resources Bureau, Environmental Protection Bureau etc. Two Lakes (Hongfeng and Baihua) and One Reservoir (Aha) area is regarded as special region managed by a special agency. The Two Lakes should be managed as part of Maotiao River Basin and Aha should be managed by Nanming River Basin.

- **Lack of coordination in urban and rural water resources management.** The coordination of rural and urban water resources is critical to proper and efficient management of water resources. In Guiyang, it is found that in planned water use and water abstraction permit management the permit is issued by different authorities for different areas even within the municipalities. This makes it difficult for management of water resources.
5.3 Background of Basic Reform Approach

5.3.1 Background

After 2000 water sector institutional reform has been happening all over China. These reforms cover almost all of the water resources management institutions at the province, prefecture, city, and county levels. Among these reforms, integrated urban and rural water affairs management is an important part of this reform. The major reform has been to integrate water resources management for rural and urban water use and also to incorporate water quality management. The integrated institutions have been called Water Affairs Bureaus which are part of the province, prefecture, city and county levels. At the end of 2008, there had been 1532 administrative regions who have set up Water Affairs Bureau’s (WAB) and who have implemented integrated urban and rural water management accounting for 62.9% of total administrative regions above county level.

The WAB model subsumed the role of Water Resources Bureau, Urban Construction Bureau and Urban Management Bureau and worked and coordinated water resources management functions. The main roles of the WAB were:

a) Implement all water related policies and legislation  
b) Planning and design of all water resources for urban and rural parts of the region  
c) Conduct Integrated management of all water resources (surface and groundwater), This integrated management plans will be drafted for short, medium and long term  
d) Be responsible for municipal water supply , and wastewater collection and treatment and be responsible for all fee collection through the water supply company  
e) Be responsible for the management of the municipal and rural river course, reservoir, lakes, monitoring of water quality and control of waste discharge into the river. In addition be responsible for water protection structures along the river banks, lakes etc  
f) Be responsible for drought and flood control, relief work and undertake the municipal flood and drought relief headquarters  
g) Be responsible for soil conservation and rural water resources, irrigation development and coordinating its work  
h) Arbitrating water disputes between different groups in the municipality  
i) Drafting policies for water pricing/tariffs, taxation and fees

This model of Water affairs Bureau has been adopted by many Cities e.g. Beijing, Shenzhen, Shanghai, Tianjin, Shijiazhuang, Harbin, Changchun, Chengdu, etc Even Qingzheng City within Guiyang Municipality has already adopted this radical reform pattern and formed a Water affairs Bureau. In addition Xifeng County has adopted this integrates water resources management role under the County Water Resources Bureau.
5.3.2 Qingzhen model of Water Affairs Bureau

Qingzhen City has moved all the responsibilities of Water Resources Bureau into the Water Affairs Bureau, with the flood protection and water-saving functions. The Water Affairs Bureau will be responsible for urban water supply, the maintenance and management of recycling water-use equipment and the proposals of water tariff, water saving activity and manage industrial water use. The water resources stations will be under the Water Affairs Bureau, with the name changed into water affairs station.

Detailed Responsibilities of the Water Affairs Bureau in Qingzhen

a) Implement laws and regulations related to water resources and draw up the short and long term water use plans and implement them;
b) Overall management of water resources i.e. undertake planning for: water supply, drought demand management, flood protection, water-saving, water use permits, water tariff and recycling and water reclamation;
c) Implement the water-saving and conservation projects;
d) Monitor the water quality and quantity of rivers, give advice on limiting pollution, and report of pollution discharges to the environmental bureau.
e) Be responsible for urban water supply, waste water treatment and recycling using water. Propose and plan the water and wastewater tariff for submission to the price. Manage water pipe maintenance.
f) Monitor environment protection of all water resources.
g) Implement and supervise and enforce the water law. Resolve conflicts related to water.
h) Draw up capital planning of water investment projects and be responsible for the construction of water projects after approval by Government; monitor and manage construction.
i) Responsible for rural water supply and irrigation.
j) Responsible for water and soil conservation.
k) Responsible for flood protection tasks; manage, coordinate and guide flood fighting work.

5.3.3 Xifeng County IWRM Reform

Xifeng which also a county in the Guiyang Municipality has also integrated the water resources management in the county for urban and rural water resources management. Although Water Resources Bureau has taken over a lot of the functions of the Urban Construction and Utilities Bureau it has not changes the name of the bureau as a Water Affairs Bureau. At present the Xifeng Water Resources Bureau has taken over all the functions of water supply, water saving and flood control in Xifeng County. It is essentially acting as a Water Affairs Bureau. The only function yet to be undertaken to date is the waste water management. It is in the process of taking over the Xifeng waste water treatment plant and sewer and drainage management in the townships.

5.3.4 IWRM Reform Performed in Chinese Cities
The IWRM reform has been done in over 1500 administrative regions above the county level in China. Much of the reforms that have been done have culminated in the formation of a Water Affairs Bureau’s (WAB). Some of the most successful Water Affairs Bureau is in the major cities and a review of several of these was done and a list of key functions of these WAB are given below in Text Box 5.3 and Annex 5-II.

Text Box 5.3 Main functions of a Water Affairs Bureau

<table>
<thead>
<tr>
<th>Draw strategy and planning</th>
<th>Manage water resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use permit</td>
<td>Monitor water quality</td>
</tr>
<tr>
<td>Monitor water saving</td>
<td>Organize construction project of water</td>
</tr>
<tr>
<td>Water and soil conservation</td>
<td>Manage water funds</td>
</tr>
<tr>
<td>Organize flood and drought control jobs</td>
<td></td>
</tr>
<tr>
<td>Draw and implement water laws</td>
<td></td>
</tr>
<tr>
<td>Rural water issue</td>
<td>Fishing</td>
</tr>
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<td>Hydropower</td>
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<td>Sea and Island Management</td>
<td>Protect sea environment</td>
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5.4 Guiyang Pre-reform reform Activities (Stage I Action Program)

5.4.1 Establishment of River Basin Management Stations

Before Guiyang undertake major reform it needs to reform some of its activities so that it can take place it needs to setup the River Basin Committees which will be translated River Basin Management stations in Nanming and Maotiao Basin within the next 2 years and Yuliang Basin shortly thereafter. The Management stations will perform the following as given in the text box

Text Box 4 River Basin (RB) Management Station Functions

a) Responsible for managing the municipal water resources within the basin and maintain ecological environment; commissioned by the administrative authorities, undertaking to compile water resources plans, assessing water quality, water supply and demand analysis and forecasting, assessing water resources availability, the exploitation volume of groundwater, implementing water abstraction permit for water sources, water balance test, water use quota development, water-saving technology and product identification, the total waste loading analysis, the total control of sewage discharge, environmental assessment for water infrastructures, water resources management information services.
b) The RB management Office will essentially be the integrating force within the basin and it will create the IWRM needs
c) The River Basin Management Office would set up a section to undertake short, medium and long term demand forecast based in actual conditions. The demand management team would look into water saving techniques for all sectors. Based on the water saving and incentives for its various clients it should shift supply based operations to demand based operation.

5.5 Reforms in the Water Sector and Stages (action Program II)

5.5.1 Selection of Appropriate Water Affairs Bureau Reform

There are about 1500 water affairs bureau’s in China. The structure of each one varies, although the core activities of each of them are similar. A study of water affairs bureau’s shows that many of them have evolved to have similar institutions with identical IWRM functions. Annex 5 shows an analysis of several city water affairs bureau and the common activities which are core activities are similar.

Reform for Guiyang is not an option that can be avoided because it is a covenanted requirement under IWRM loan i.e.

“GMG will ensure that the principles of IWRM under the Guiyang Integrated Water Resources Master Plan and developed under TA 4912-PRC are carried out under the Project. In particular, GMG will ensure that the IWRM Strategic Action Plan agreed between GMG and ADB (Supplementary Appendix S) is implemented in a timely manner. Key activities to be implemented will include: (a) establishment of an effective water sector management structure, (b) shift from the current supply management to demand management, (c) greater public participation in water resources management, (d) improvement in information management and sharing among relevant agencies, and (e) capacity building in water management in GM.”

5.5.2 Guiyang City Water Affairs Staged Reform

Guiyang City water reform will be a staged reform process since the City will need to have more consultation will all the various agencies and bureaus involved. The reform to form an integrated Water Affairs Bureau in Guiyang may require three the stages. The stages are as follows:

a) First Stage reform is to move some offices in Urban Management Offices to the Water Resources Bureau and merge the functions with the present water resources functions. These offices to be moved are the Water Saving Office and the River Course Management Office in Urban Management Bureau.

b) Second Stage Reform which runs parallel to the first stage reform is to reform the water and sewerage services within Urban Management Bureau. There is
a need to amalgamate the water companies within the city areas so that there is only one company that represents are water supply services. In addition it is necessary to unify the wastewater collection and treatment facilities. The wastewater collection and treatment must be unified and corporatized so that there one company that deals with all wastewater in the city. At present the wastewater company’s are a disaggregated bunch of treatment plants who are corporate entities with no control on the collection system.

c) Third Stage of Reform will be the final stage when all the individual institutions are ready for formation of a Water Affairs Bureau. In this phase a new Bureau is form taking the entire Water Resources Bureau and adding to it the Utilities Management portion of Water and Sewerage Services in the Water Resources Bureau with the already moved Water saving Office and River Course Management Office (in Stage I) to form one Water Affairs Bureau. This Bureau will have all the function to deliver water and sewerage, and flood control and groundwater management services.

5.5.2.1 First Stage Water Resources Bureau Reform

In the first stage reform the following steps should be taken immediately to merge some of the urban water management functions with the Water Resources Bureau. These functions involve the Water Saving Office and the Urban River bank Management Office under the Urban Utilities Management Bureau. The reform involves the shift of these two departments into the Water Resources Bureau in Guiyang i.e.

a) The Water Saving Office under Urban Utilities Management Bureau will be merged with the Water Resources Bureau. The new office will be under Water Resources Bureau to conduct municipal water saving works and water use management works. Rural Water Saving will continue with the Water Resources Bureau

b) The River Course Management Office in the Urban Management Bureau should be merged into the Water Resources Bureau. The office shall split the functions as a governmental organization in terms of policy formulation, policy implementation and service providing company. The reformed is as an implementation agency under Water Resources Bureau, and to separate policy formulation function to Water Resource Bureau, and to allocate service providing to a company or set up a new company.

Under this merge the Water Resources Bureau’s functions expands as follows:

- The management of groundwater development and protection in urban planned area currently under Urban Utilities Management Bureau will be shifted to Water Resources Bureau.
• The urban water use management currently under Urban Utilities Management Bureau will be shifted to Water Resources Bureau.
• The urban water saving management currently under Urban Construction Bureau will be shifted to Water Resources Bureau. Water Saving Office and Water Resources Management Station will be merged into one under Water Resources Bureau.
• The urban river course management currently under Urban Construction Bureau will be shifted to Water Resources Bureau.

5.5.2.2 Second Stage Reform Urban Water and Wastewater Reform

The Urban Water Supply and Wastewater Sector have to be reformed within the Urban Management Bureau so as to be amalgamated later as part of a Water Affairs Bureau

a) Urban Water supply reform

• Merging six downtown districts companies into one.
At present, there are four water treatment plants providing water in six downtown districts. These are Guiyang Water Supply General Company, Huaxi District Water Supply Company, Wudang District Water Supply Company and Baiyun Water Supply Company. These water company’s should be integrated to form one Guiyang Water Supply Company (see figure 5.2).

• Extending water supply to urban and suburb areas.
With the integrated development of urban and rural areas, some rural areas are being planned to be supplied with tap water. In Guiyang, it is necessary to extend urban water supply to the suburb and rural areas along the city

• Replacing self-built water supply system by urban public water supply
Due to insufficient groundwater sources, poor water quality and simple treatment process, together with the environmental issues it is to replace self-built water supply systems throughout the peri-urban areas.
b). Urban wastewater treatment sector reform

- **Strengthening regulatory capacity of the waste water and drainage offices**
  It is necessary to train the regulatory staff of the Urban Utility Management Bureau responsible for wastewater and urban drainage to have the enough ability to conduct regulatory functions. These training shall include cost control and auditing, effectiveness assessment, wastewater treatment operation, asset management. At the same time, it is necessary to recruit competent professionals.

- **Improving network management and operation**
  At present, the network is managed and operated by the Urban Utility Management Office, with the full governmental financial supports. It is necessary to reform the Office, to improve its ability to conduct maintenance and repair activities. Furthermore, it is necessary to improve its financial operation, to make it a fully self-financing agency with collection of revenue from its services for wastewater collection and treatment to be included as part of the water tariff.

- **Separation of storm water network and wastewater sanitary collection network**
  At present the drainage canals/storm water drains are used also as sewers and carry both rainwater and sewerage. It is necessary to construct separate sanitary sewers from drainage canals. Separation of storm water from sanitary waste will reduce the wastewater entering the river in times of storms when all the storm water mixed with the wastewater flow into the river through storm water overflow. This separation of
the drains from sanitary sewers will significantly reduce the pollution in Nanming River.

- **Integrate the operations of the collection system with the sewage treatment plants**

This integration will have to have the formation of enterprise which will be responsible for the treatment plant and the sewer collection system. The Guiyang Municipality will have to be responsible for the initial financing of sewer networks since separate sewers will incur significant cost and the individual departments cannot finance them.

**5.5.2.3 Third Stage Reform to Form a Water Affairs Bureau—next 5 years**

This reform has to be adopted for the design of the formation of a Water Affairs Bureau (5 years time), and would require the following changes:

a) All functions currently at Water Resources Bureau will be integrated into Water Affair Bureau;

b) The management of groundwater development and protection in urban planned area currently under Urban Management Bureau will be shifted to Water Affair Bureau.

c) The urban water use management currently under Urban Management Bureau will be shifted to Water Affair Bureau.

d) The urban water saving management currently under Urban Management Bureau will be shifted to Water Affair Bureau. Water Saving Office and Water Resources Management Station will be merged into one under Water Affair Bureau.

e) The sectoral management of urban water supply and wastewater treatment will be shifted to Water Affair Bureau.

f) The urban river course management function currently conducted by Urban Management Bureau will be shifted to Water Affair Bureau and Environmental Protection Bureau accordingly.

g) The urban water infrastructure planning and construction function currently conducted by Construction Bureau will be shifted to Water Affair Bureau.

h) The Water Affair Bureau is responsible for water resources protection, and Environmental Protection Bureau is responsible for water environmental quality and water pollution control. The coordination mechanism shall be developed among two bureaus to promote communication and consultation.
The reform process is shown in figure 5.3 for the Water Resources and Municipal Management Bureaus. Water related Divisions from each of these bureaus are inserted into WAB.

**Figure 5.3 Reform Process of merging Divisions from various Municipal bureaus**

The WAB will be a new bureau under the municipality as is being done in all other administrative areas in China.
5.8 Summarizing the reform Activities for IWRM and Demand Management Development

Summarizing all the major activities and timing for reform of the water sector to undertake IWRM activities is shown in Figure 5.4. The overall time for reform is 5 years. The first and second stage of reform activities will take at least 3 years. The third stage will take another two years.

Figure 5.4 Scheduling of Reform Activities

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<th>No</th>
<th>Activity</th>
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<td>b) Move river Course Manage Off</td>
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<td>b) Extend Water Supply to suburbs</td>
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<td>c) Replace Self Supply with Pipe Water</td>
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<td>d) Reform of drainage and Sewerage</td>
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ANNEX 5
## Annex Table 5-I Functions of Water Affairs Bureau’s in China

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Annex 5-2 Institutions dealing with Water Resources Supply and Management
(Blue/green boxes refer to direct involvement and green involvement in policy decisions) etc

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Chapter 6 Demand Management in Reformed Water Affairs Bureau in Guiyang Municipality

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Chapter 6 Demand Management in Reformed Water Affairs Bureau in Guiyang Municipality

6.1 General

6.1.1 Supply and Demand Driven Systems

Current approaches towards water resources management tend to be “supply driven”; meaning that whenever there is a shortage, the solution usually involves the capital investment in new water supply projects. A shift from the traditional supply orientated approach towards one of water conservation and demand management is essential for the sustainability of water resources and the environment, as well as economic efficiency and social development. Demand management approach differs from supply-oriented approach by placing more emphasis on social and economic uses of the water. When used with current water supply management approaches, water demand management offers the prospect of greatly improved water management in comparison to its present status.

6.1.2. Master Plan and PPTA Findings

In terms of comprehensive water management, the Master Plan has addressed the overall water balance, options for affecting demand and supply within the boundary of the GM as follows:

- Examining both supply of and demand for water;
- Recognizing that supply problems are not due to absolute shortage but rather the timing and location of water and water use efficiency;
- Recognizing the need for environmental ecological water flows;
- Identifying the benefits of water saving;
- Emphasizing pollution prevention through wastewater treatment and water resource protection;
- Giving priority to water for drinking while recognizing the need to ensure reliable allocation of water for other needs;
- Identifying the prominent role of irrigation and proposing measures to improve efficiency of water use in agriculture while improving farm incomes; and
- Identifying the need to increase industrial water use efficiency.

In addition, Guiyang Municipality’s efforts on integrated water resources management to date include the following:

- Establish the Project Leading Group as a basis for intersectional coordination;
- Water Saving Society Program;
- Water Abstraction licensing System

6.1.3 Integrated Water Resources Management (IWRM) Study by Guiyang Hydrology Bureau (in Chinese only)

This study completed in July 2007 has the most far reaching conclusions than all earlier studies performed. Even the Water Resources Master Plan Study Completed in 2006 for ADB by the Guizhou Hydrology Bureau does not do the projections for water demand and supply as has been done in the IWRM study. The IWRM Study
goes further in use of water saving to reduce demand into the future 2015-2020 and 2030 and determines if supply side expansions are needed. The only issues that were not discussed in the IWRM report are the need to look into water price changes and their impact on water demand.

It should however be noted that all the international examples of IWRM –Los Angelis City, Sydney City Water Board, and Singapore City State all have demand management requirements to ensure that demand is always managed not to exceed supply. Singapore, Sydney and Los Angelis vary from about little over 4 million people to about 4.8-5 million people. Guiyang is only 3.7+ million people and will become a city of about 4.8 million by 2030. However Guiyang is using more water (by as much as 30-40%) today than all these three international examples although the per capita incomes of these cities are about 20-30 times higher. It is extremely important to determine why the Guiyang Municipality has such high demand despite its low income and low level of commerce and industrial output.

6.2 Approach to Water demand Management

6.2.1 General Aspects of Control of Demand

International experience shows there are three aspects demand control that needs to be implemented so demand of water can be managed. In the three international examples (see Chapter 3) control of demand is by:

a) Water Saving Techniques
b) Regulatory methods such as water prices, incentives to use of water savings
c) Overall management of the water systems so that there is efficient distribution of water and reduction of loses in the network.

In most of the more advance East Coast Provinces of China where demand management is being planed it expected that water savings will provide for 33% of the demand reduction, regulatory methods especially price control will provide 33% of the reduction and overall management of the water distribution network, etc will provide for the other 33% of the demand reduction. However in more mature systems like those cities like Sydney discussed under the international experience it will be noticed the measures used in reducing demand is:

a) Water saving total 60% composed of:
   -Residential Housing Water Saving 20%
   -Industrial Recycling and Water Saving 13%
   -Business Water Saving 27%

b) Network Management and Leakage reduction 34%
c) Regulatory Methods including tariff increases 6%

The total demand reduction was 107 MCM (18%) in 2009 out of a planned demand of 602 MCM. The demand management actually reduced the total demand for water. 60% of the demand reduction came from water savings, 34% from reduced leakage in network and reduction in non revenue water and 6% in regulatory methods such as tariff increases. The demand management took 11 years to implement and the
extreme and long drought helped the Sydney Water Board to reduce demand (see Figure 6.2.1).

**Figure 6.2.1 Demand Management and Reduction in Water Consumed**

<table>
<thead>
<tr>
<th>% of total Demand</th>
<th>1999</th>
<th>2001</th>
<th>2003</th>
<th>2005</th>
<th>2007</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water consumed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Revenue water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demand Management Reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.3 Guiyang’s Approach to Demand Management

#### 6.3.1 General Approach to Demand Management

It is important for Guiyang to start early on demand management although at present there seems to be adequate water for most years except when there are droughts and there is a shortage of water for the rural areas for drinking. The three approaches that need to be taken are:

a) Introduce water savings to all sectors of the economy: residential, business and commerce; construction; industry, irrigation and power sectors;

b) Manage the water resources especially the delivery systems so that losses are minimized

c) Undertake regulatory reforms to manage water resources better through institutional reform and price reform to reduce water use

#### 6.3.2 Water Savings

Water saving and conservation play a great role in keeping demand down as much as possible. Water savings have to be done systematically for each sector on a long term basis to achieve results in demand management. There are structural measures and non-structural measures that need to be introduced to achieve to reduction in demand. In addition education and information dissemination and incentives must be provided.

#### 6.3.2.1 Industry and Power Plant Water Saving as Part of Demand Management
There are three aspects of industrial water saving that have been recommended in the IWRM Report 2007 by Guiyang Water Resources Bureau:

a) Water Intensity Reduction (improve efficiency of process)

b) Increase Water Recycling

c) Reduce Loss in the local water distribution system for industry

Water Intensity use (or often referred as water quota) can be significantly reduced in industry. Most industry in the East Coast are using less than 50 m$^3$/Y10^4. However Guiyang is using over 150 cum/Y10^4 or three times the China average. It has been proposed in the IWRM report that by 2030 the intensity should be about 33 cum/Y10^4 (see figure 6.3.2.1 and Table 6.3.2.1). Water intensity reduction will require changing some of the industrial processes. Incentives should be provided by the Municipality for industry to obtain lower interest loans to industry to undertake such changes.

**Figure 6.3.2.1 Intensity of Water Use in Industry**

![Guzhang Intensity of Water Use in Industry](image)

Similarly recycling of water should be improved from 65% to 87% (see figure 6.3.2.2). Distribution system loss for industry should also be reduced from 22% to about 10% between 2010 and 2030. Recycling should be the responsibility of industry and should be undertaken by them. The proposed Water Affairs Bureau should undertake 3-year water audits of all firms and encourage them to increase water recycling and should work with the Municipal Finance Bureau to provide tax incentives for industry who achieve higher recycling levels.
Figure 6.3.2.2 Recycling of Water Use in Industry

![Graph showing recycling rate in industry over time]

Note Figures derived from Guiyang IWRM Report 2007

Table 6.3.2.1 Demand Management Measures to be undertaken by Power and Industrial sectors

<table>
<thead>
<tr>
<th>Year</th>
<th>Power m$^3$/Y$10^4$</th>
<th>Recycling</th>
<th>Intensity m$^3$/Y$10^4$</th>
<th>Recyling</th>
<th>Distribution losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>8303</td>
<td>91%</td>
<td>227</td>
<td>63%</td>
<td>22%</td>
</tr>
<tr>
<td>2010</td>
<td>7130</td>
<td>91%</td>
<td>156</td>
<td>75%</td>
<td>19%</td>
</tr>
<tr>
<td>2020</td>
<td>5258</td>
<td>95%</td>
<td>69</td>
<td>85%</td>
<td>18%</td>
</tr>
<tr>
<td>2030</td>
<td>3877</td>
<td>97%</td>
<td>33</td>
<td>88%</td>
<td>10%</td>
</tr>
</tbody>
</table>

If all the demand management measures are undertaken then the saving in water will rise to 16% of the demand or 139 million cum per year out of 877 million cum per year.

Figure 6.3.2.3 Water Savings through Demand Management

![Graph showing water savings through demand management]

Note Figures derived from Guiyang IWRM Report 2007

The 2005 water savings in industry have been accomplished. The short term measures are the reduction of network losses and distribution losses and the long term measures are the water intensity reduction measures which will require changes to the industrial processes.
6.3.2.2 Business/Commerce and Construction Industry Water Saving as Part of Demand Management

Water savings can be performed for commercial enterprises, businesses, government enterprises and construction industry. The water can be reduced by using water saving appliances in the enterprises and in construction industry. For businesses an audit has to be done to switch to water saving devices that can be used. The IWRM Report indicated that water intensity can be reduced (see Table 6.3.2.2 and Figure 6.3.2.2) from 33 cum/Y10^4 to 8 cum/Y10^4. Overall water saving from introducing water saving devices in business and in construction and reducing network losses can be as much as 63.8 MCM/yr. The water saved can go up as high as 39% per year. The 2005 savings have been established and Guiyang City needs to continue with the program by performing audits of businesses and construction industry every two years and provide incentives (low interest loans) to procure water saving devices.

Table 6.3.2.2. Water Savings for Businesses and Construction Industry 10^4cum/yr

<table>
<thead>
<tr>
<th>Year</th>
<th>Businesses m^3/Y10^4</th>
<th>Constr. Industry m^3/Y10^4</th>
<th>Losses in Distribution</th>
<th>Demand 10^4cum</th>
<th>Saving 10^4cum</th>
<th>% Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>33</td>
<td>25</td>
<td>18%</td>
<td>7051</td>
<td>2685</td>
<td>38%</td>
</tr>
<tr>
<td>2010</td>
<td>27</td>
<td>19</td>
<td>16%</td>
<td>9965</td>
<td>3943</td>
<td>40%</td>
</tr>
<tr>
<td>2020</td>
<td>17</td>
<td>12</td>
<td>12%</td>
<td>14813</td>
<td>4980</td>
<td>34%</td>
</tr>
<tr>
<td>2030</td>
<td>8</td>
<td>6</td>
<td>8%</td>
<td>16439</td>
<td>6380</td>
<td>39%</td>
</tr>
</tbody>
</table>

Figure 6.3.2 Water Savings in Businesses, & Construction Industry by Demand Management (IWRM Report 2007)

There are other areas of water savings that can be undertaken for irrigation and urban water residential in house. Irrigation water savings would require

6.3.2.3 Water savings in Irrigation

Water savings in irrigated agriculture comes as a result of changing the irrigation system so that less water is used per hectare. In the case of vegetables there can be low pressure drip irrigation and the returns are very large and the water use is almost 10% of flood irrigation. In the case of paddy the canals can be lined to ensure that less water is lost in the canals. Water duties at the on farm level can be considerably
reduced in open canal irrigation by making the farm canals much shorter and field areas smaller plots. Besides the on farm water duty reductions there is a requirement to reduce main canal system losses. This is done by lining the canals or by drip irrigation where pipe losses are almost non existent. In addition operational efficiency of water delivery should be timely so that farmers can use water when delivered. Irrigation system efficiency can be raised from 60% to 75% (see Table 6.3.2.3).

Table 6.3.2.3 Water savings in Irrigation as part of Demand Management

<table>
<thead>
<tr>
<th>Year</th>
<th>Water duties (m³/mu)</th>
<th>System efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paddy</td>
<td>other</td>
</tr>
<tr>
<td>2005</td>
<td>566</td>
<td>291</td>
</tr>
<tr>
<td>2010</td>
<td>550</td>
<td>290</td>
</tr>
<tr>
<td>2020</td>
<td>523</td>
<td>287</td>
</tr>
<tr>
<td>2030</td>
<td>499</td>
<td>283</td>
</tr>
</tbody>
</table>

The savings in water through these methods would be considerable through these methods. Savings of 35% can be obtained by 2030 if these approaches are followed. The 2005 water savings have been already accomplished (see figure 6.3.2.3).

Figure 6.3.2.3 Water savings in Irrigation

6.4.0 Regulatory Methods of Demand Management --Water Price Impact on Guiyang Demand

Regulatory methods refer to areas of water tariff reform to manage demand of The water price and income impact are very significant and need to be considered for all demand calculations. The forecast for demand for the municipality for domestic water is 286 million as forecasted by the Guiyang Hydrology Bureau. However a 5%
price increase in water will completely cause the demand to level off as shown in Table 6.2.

<table>
<thead>
<tr>
<th>Water Price Increases</th>
<th>Design Institute Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>2005</td>
<td>7816.3</td>
</tr>
<tr>
<td>2010</td>
<td>10646.2</td>
</tr>
<tr>
<td>2015</td>
<td>14451.1</td>
</tr>
<tr>
<td>2020</td>
<td>21587.7</td>
</tr>
<tr>
<td>2030</td>
<td>28698.1</td>
</tr>
</tbody>
</table>

Figure 6.4 shows the same table plotted graphically for Yunyan District. An 8% increase of water tariff will level off the demand completely.

Regulatory method is a powerful way to introduce demand management. In city’s like Sydney the regulatory methods do not show up significant because they have already priced water very early in the history of the city and therefore only water savings shows up more significantly.
**6.5 Demand Management through Reduction of Non Revenue Water**

**6.5.1 General Discussion on NRW**
One of the best areas to demonstrate reductions in water demand can be best observed in urban water supply. Non revenue water is one area where better management practice can significantly reduce demand. Non Revenue Water (NRW) can cause a lot of money to be lost. The World Bank in its 2006 *Report the Challenge of Reducing Non Revenue Water* has indicated that the cost of NRW in developing countries is estimated to cost as much as $46 billion/yr to Governments because of water lost that cannot be charged and also because of the cost of treatment of the waters lost. NRW could be caused not only due to leakage but due to several other factors most of which are management issues in water companies. Figure 6.5 shows a schematic representation of the sources of non-revenue water.

Figure 6.5 Sources of Non Revenue Water

<table>
<thead>
<tr>
<th>System Input Volume (corrected for known errors)</th>
<th>Authorized Consumption</th>
<th>Billed Authorized</th>
<th>Billed Metered Consumption (including water exported)</th>
<th>Billed Unmetered Consumption</th>
<th>Non-Revenue Water (NRW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Losses</td>
<td>Unbilled Authorized Consumption</td>
<td>Unbilled Metered Consumption</td>
<td>Unbilled Unmetered Consumption</td>
<td>Unauthorized Consumption</td>
<td>Customer Metering Inaccuracies</td>
</tr>
<tr>
<td></td>
<td>Apparent Losses</td>
<td>Data Handling Errors</td>
<td>Leakage on Transmission and Distribution Mains</td>
<td>Leakage and Overflows at Utility’s Storage Tanks</td>
<td>Leakage on Service Connections up to point of Customer metering</td>
</tr>
<tr>
<td></td>
<td>Real Losses</td>
<td>Non-Revenue Water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The NRW is composed of:

a) Unbilled meter and unmetered consumption  
b) Unauthorized Consumption  
c) Metering inaccuracies  
d) Data handling errors  
e) Actual leakage losses

All factors a) to d) are management issues that need to be handled by the Water Company. The NRW in Guiyang is supposed to be about 33% in 2009 and has been as high as 45% in 2000 as reflected in the IWRM report. The Developing World picture of NRW is given in the 2006 report of World Bank indicates that modal
value of NRW is about 30-40% for developing countries and Guiyang falls in this category.

Figure 6.5.1 Non Revenue Water Percentage by Percentage of Developing Countries

![Non Revenue Water and Percentage of Developing Countries](image)

6.5.1.2 Approach to reduce NRW in Guiyang

**General**
The 2000 and 2005 NRW in Guiyang was 30 MCM/yr and 39 MCM/yr respectively. The cost of lost water due to water not being billed and cost of treatment of the water lost is Y89 million and Y114 million for 2000 and 2005, the NRW is said to be purely leakage. Several reports show Guiyang NRW more than leakage including unbilled sources and others as listed above. Guiyang NRW must be significantly being reduced from 36% to below 10% by 2030. The steps must be taken by management of the water company to reduce NRW are as follows:

a) Unbilled meter and unmetered consumption must be identified
b) Unauthorized Consumption identified
c) Metering inaccuracies should measured on pilot basis
d) Data handling errors should be determined by review of data by independent audits

The following action should be taken
o NRW due to factors a) and b) cannot be rectified except by the management of the water company.
o Metering errors can only be rectified by testing of meters and by replacement of trunk line and branch line meters every 5-7 years and household and business meters be changed every 10-12 years
o For meters which measure large flows, “Magflow” or Magnetic Flow meters should be used as these are more accurate than propeller driven meters.
o Data handling errors can be rectified by ensuring meter readers do not go on the same area for each round of meter reading each month. In addition remote monitoring electronic meters can be used for several units together
Leakage reduction

An active leak detection and repair program to reduce leakage from the system. The Guiyang Water Company should set up the following a team for:

- inspect and repair all of the water pipes which are leaking
- commit to re-inspecting and repairing all water mains every year
- Improved response times by having crews available 24 hours a day, seven days a week.

Excessive water pressure can lead to water main breaks and cause leaks in Guiyang Water's system. Water pressure management to adjust water pressure levels in the supply system to achieve more consistent pressure levels will reduce the number of water main breaks, improve the reliability of the water supply system and conserve water. Guiyang Water Company should set up pressure zone areas (as Sydney has set up Figure 6.5.2) to control pressure in pipes to reduce leakage.

Figure 6.5.2 Sydney Pressure Zone Area to Control Leakage

The steps needed are to invest in leakage detection and to repair the most serious leaking pipes. In addition all management actions should be taken to reduce non-structural NRW due to accounting or unbilled customers. Metering errors should be checked and reduced by replacing meter periodically.
6.6 Control of Water Demand to Match Supply for Guiyang

6.6.1 Ensuring Demand Matches Supply

Demand management is not an option that can be treated light lightly even for Guiyang municipality where water resources are relatively not constrained today. The demand forecast from the IWRM Report by Guiyang Water Resources Bureau shows that in 2030 unconstrained demand without water saving is projected to go up to 19.11x10^8 cum per year (see figure 6.6.1) which is approximately about twice that of the present demand of 10.45 x10^8 cum.

![Figure 6.6.1 Unconstrained Demand Forecast 2010-2030](image)

The sustainable water supply available for Guiyang Municipality is 13.065x10^8 cum per year. This means that some 6.045 x10^8 of water will have to be imported from trans-basin diversion from neighboring river basins and/or water reclaimed to meet the demand in 2030. Water reclamation and importation will actually have to start from 2020 to meet demand. The diversion or reclamation of water will require a significant amount of funds.

If water demand management program is aggressively followed through water savings in all sectors, recycling, network and loss reduction as shown in the early sections of this chapter and as recommended by the IWRM report 2007, demand can be constrained to 15.2 x10^8 but will still be above the sustainable levels of water.
resources available (see figure 6.5.2). It is still about $2.135 \times 10^8$ cum/year more than the sustainable levels of water supply available.

It will be necessary to resort to price/tariff increases to reduce it a further $2.0 \times 10^8$ cum/year (see figure 6.6.2)

**Figure 6.6.2 Demand and Supply for Guiyang 2005-2030 with and w/o Demand Management**

[Graph showing water use projection with and without demand management]

### 6.5.2 Summary of Demand Management

In Guiyang Municipality had adopted some from of demand water as far back as 2005. The only factor that has not been introduced is price reform. The consultant worked out the effects of tariffs to see how much demand will be further reduced by introducing price reform into the demand. However the management of demand through water saving, recycling has to aggressively follow to reduce demand to systematically as recommended in the IWRM Report 2007. Figure 6.6.3 shows the demand reduction that need to be obtained to get the desired overall demand reduction to meet supply.
Demand growth rate will be reduced from 1.9% to 1.5% by the planned demand management. Figure 6.6.4 shows the percentage of 2020 and 2030 demand reduction share. Major reduction share is in industry, irrigation and businesses.
6.6 Methodology of Demand Forecasting

Several methodologies have been developed for forecasting:
- Trend Analysis
- Per Capita Flow Factors
- Sectoral Disaggregation
  - Fixed Flow Factor Approach
  - **End Use Models**
  - Econometric Modeling
  - Variable Flow Factor Approach

The analysis of demand must reflect demand in the short, medium and long term. If there are deviations in the demand there should be a re-estimation of the demand to make sure that there is tracking of the values.

Econometric modeling is the technique of choice given adequate resources (time, expertise, and data) and general agreement on the proper model specification. Take advantage of the econometric analysis done by others using a Variable Flow Factor approach.

Demand elasticity’s are a key to determine the variable factors like income and price of water and how they affect the growth in demand. For example in the USA some of the elasticity’s are as shown below.

**Figure 6.6.1 Elasticity Range of demand on price of water and income of people**

![Elasticity Range Graph](image)

Note: taken from Seattle Water Department 2007

For Guiyang the value is -0.29 for price elasticity of demand and 0.34 for income elasticity of demand for domestic demand. Industrial demand is also sensitive to prices of water and the price elasticity to industrial demand can be as much as -0.4.
A variable flow model will require the following parameters to be determined:
- Current water demand flow factors by sector for Seattle and each wholesale customer.
- Impacts of variables such as price, income and conservation on water flow factors for each sector over time.
- Forecasts of households and employment

The inputs needed for the forecast are as follows:
- For Base Year Water Flow Factors:
  - Current consumption
  - Current households and employment
- Other Inputs Affecting Future Flow Factors:
  - Future income growth (forecast)
  - Income elasticity of demand (literature review)
  - Future growth in water prices (forecast)
  - Price elasticity of demand (statistical studies of data and review)
  - Future conservation savings
  - Conservation “overlap function”

6.6.1 Detailed methodology
A typical flow chart for a demand model that is used by the City of Seattle is shown below:

**Figure 6.2 Flow Chart of Demand Models (taken from Seattle City)**
Using the demand model the demand is derived and using risk analysis either by Monte Carlo simulation a demand is derived into the future which will not only forecast the range of values that the demand can range looking into the future. A typical demand is derived is shown in figure 6.3 below.

**Figure 6.6.3 Water Demand Forecast for Seattle City**
6.6.2 Results for Guiyang

The demand curve is not just a point in the future but a range of values it can take based on the probability of certainty. It is necessary to observe that the mean firm yield for water is above the demand because of water prices effects and water savings. It should be noticed that forecast is such that supplies will be able to meet demand to beyond 2060 and to 70% and 90% probability for 2060 and 2048 respectively (see table 6.6.3)

<table>
<thead>
<tr>
<th>Table 6.6.3 Supply Probability to meet demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Supplies Sufficient to Meet Demand Until</td>
</tr>
<tr>
<td>Official Forecast</td>
</tr>
<tr>
<td>70% Probability</td>
</tr>
<tr>
<td>90% Probability</td>
</tr>
</tbody>
</table>
6.7 **Institutional Arrangements for Demand Management**

In the reformed Water Affairs Bureau a new department or division called an IWRM division demand management office will have to be setup. This department will have a Demand Management General Office. The IWRM DM Office will have the Water Saving Section, Statistics Section for Water Use, Monitoring and Enforcement section and an Demand Management Audit Section (DMO). The DMO will be responsible for demand forecast and to ensure that operation of the water systems for urban and rural sectors will be such that all demand for water will be managed and kept below the supply available.

![Diagram of Integrated Water Resources Department and Demand Management Office]

The Demand Management Office will be responsible for all demand forecasts –both short term 3 year and medium term 8 years and long term 12-20 years. The water statistics office will collect all water use data and collate the data for the forecasters. They will also be responsible for ensuring the demand forecasts are adhered to.

The Water Statistics Office will be responsible for all water use statistics. They will collect on a monthly basis the Urban Water use by districts, industrial water use by industry, rural water use from irrigators etc. They will collate the data and alert the water demand office if there are any new developments.

The water Saving Office besides their usual work on monitoring water savings, they will be responsible for placing proposals for key water sectors where water savings have considerable potential in water savings. They will look at all sectors and based on the proposed water saving study they will determine for domestic, industrial and other sectors where water saving potential is significant.

The Water Abstraction and Enforcement Office will be responsible for monitoring the main abstractors of water and enforcing the requirement sign for in their water permits. They will maintain a monitoring system on an real-time basis.
The Water Audits Office will review all large water consumers to ensure that they follow the water quota as required. This office will be responsible for issuing permits for water abstraction.

### 6.8 Water Monitoring System

In order to enforce abstraction are in line with demands allowable it is necessary to have a water monitoring system. The most recent water monitoring systems operate on a data platform with cell-phone communications system as shown in Figure 6.8.1. The importance of this system is that many staff (City area, water company, Suburban area staff, County staff etc) can obtain the data and be aware of the water situation. In addition over extraction can be policed better by regional staff. It is also a very reliable and inexpensive system.

**Figure 6.8.1 Water Monitoring System**

The water monitoring system will pick up data of flows at key points where there are major abstractions to monitor the water usage and to ensure that the demands are being maintained. A 60-70 gauge monitoring systems would be used over the Nanming and Maotiao Rivers. The monitoring system will send all the information via the internet to servers in the Demand Management Office and others who would require the data. The system can also be interrogated by user directly by his cell phone. The total cost of a monitoring system would be about $500000-600,000 which can be implemented very quickly.
Chapter 7. Rural Water Resources Development and Demand and Management
Chapter 7. Rural Water Resources Development and Demand and Management

7.1. Background

7.1.1 Present Social-economic situation in Guiyang Development

7.2 Water demand for Rural Sector

7.2.1 Water Demand for the Rural Areas

7.2.2 Agriculture and Water Needs

7.2.2.1 Irrigation

7.2.2.2 Issues with Irrigation

7.3 Price Impact on Rural Water

7.4 Farm Budgets and Economic Returns to Water

7.4.1 Farm Budgets

7.4.2 Economic Value of Water in Irrigation

7.5 Rural Water Resources Organization and Demand Management

7.5.0 County Water Resources Management

7.5.1 Township Water Resources Management

7.5.2 Functions of Township Water Resources Management Stations (TWRMS)

7.5.3 Issues with Township Water Resources Management (TWRMS)

7.5.4 Reform of TWRMS to Manage Rural Water Resources

7.5.5 Village Level Water Reform

7.5.6 Water Resources Demand Management at County/Township and Village Level

7.5.6.1 County Level Demand Management Scheme

7.5.6.2 Demand Management at County Level
Chapter 7. Rural Water Resources Development and Demand and Management

7.1. Background

7.1.1 Present Social-economic situation in Guiyang Development

**Rural Population** The present rural population in Guiyang is 1.5 million out of a total population of 3.89 million which accounts for 39% of the total population. Rural population has declined in population from 1.72 million in 2000 by about 210,000 people. The decline in population has been happening since 2000 and economic planners in Guiyang expect it will continue till 2030 until rural population declines to about 1.1 million. Most of the population has been declining because of the lack of opportunities to have a better life (see Table 7.1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Urban</th>
<th>Rural</th>
<th>% Rural</th>
<th>Floating Pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3293.6</td>
<td>1577.7</td>
<td>1715.9</td>
<td>52%</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>3577.5</td>
<td>1926.1</td>
<td>1651.5</td>
<td>46%</td>
<td>68.4</td>
</tr>
<tr>
<td>2010</td>
<td>3886.0</td>
<td>2351.4</td>
<td>1534.6</td>
<td>39%</td>
<td>118</td>
</tr>
<tr>
<td>2020</td>
<td>4434.1</td>
<td>3178.4</td>
<td>1255.7</td>
<td>28%</td>
<td>351</td>
</tr>
<tr>
<td>2030</td>
<td>4896.1</td>
<td>3835.3</td>
<td>1060.8</td>
<td>22%</td>
<td>620</td>
</tr>
</tbody>
</table>

**Rural Income** Rural GDP share is forecasted to decline from 9% share of total GDP to 2% by 2030\(^5\). The agriculture GDP will increase two fold from Y2.4 billion to Y4.19 billion by 2030. On the other hand rural population declines from 1.72 million to 1.06 million over 30years. The agricultural rural GDP per capita share to total rural GDP of is expected to decrease from 61% in 2000 to 29% by 2030 (see table 7.2). The agriculture per capita income share decline and the rapid growth of non agricultural sources reflects that non-agriculture sources of income in the rural sector will play a greater role (71% in 2030) than agricultural sector (29%). This is observed in almost in every county, township and village in China since early 1990’s\(^6\).

---

5 Guiyang Statistics Year Book 2008
6 China Rural Statistics (for Income Structure) and China Statistics Year Books (1993-2008)
### Table 7.2 Share of Rural Income from Agricultural Sector

<table>
<thead>
<tr>
<th>Rural GDP/per cap</th>
<th>Unit</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>agriculture GDP</td>
<td>10000's</td>
<td>244485</td>
<td>332772</td>
<td>416916</td>
<td>418053</td>
<td>419193</td>
</tr>
<tr>
<td>Rural Population</td>
<td>000's</td>
<td>1716</td>
<td>1651</td>
<td>1535</td>
<td>1256</td>
<td>1061</td>
</tr>
<tr>
<td>Per capita Agric GDP</td>
<td>Yuan</td>
<td>1425</td>
<td>2015</td>
<td>2717</td>
<td>3329</td>
<td>3952</td>
</tr>
<tr>
<td>Rural Per cap GDP</td>
<td>Yuan</td>
<td>2347</td>
<td>3321</td>
<td>5128</td>
<td>9224</td>
<td>13653</td>
</tr>
<tr>
<td>% of Rural per cap</td>
<td></td>
<td>61%</td>
<td>61%</td>
<td>53%</td>
<td>36%</td>
<td>29%</td>
</tr>
</tbody>
</table>

#### 7.2 Water demand for Rural Sector

##### 7.2.1 Water Demand for the Rural Areas

Water demand for rural areas is from irrigation, afforestation, aquaculture (fisheries), livestock, and rural domestic and from environmental and ecological needs. The overall summary of rural demand is shown in table 7.3.

Table 7.3 Rural Demands for Water by the Economic Sectors, 2010, 2020, and 2030 (Xiuwen, Xifeng and Kaiyang)

<table>
<thead>
<tr>
<th>Rural Demand</th>
<th>Probability</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>50%</td>
<td>315,452</td>
<td>332,796</td>
<td>345,099</td>
<td>68.5%</td>
</tr>
<tr>
<td></td>
<td>75%</td>
<td>358,295</td>
<td>382,021</td>
<td>396,318</td>
<td></td>
</tr>
<tr>
<td></td>
<td>85%</td>
<td>358,295</td>
<td>382,021</td>
<td>396,318</td>
<td></td>
</tr>
<tr>
<td>Afforest.</td>
<td>50%</td>
<td>5,053</td>
<td>11,715</td>
<td>18,060</td>
<td>3.1%</td>
</tr>
<tr>
<td></td>
<td>75%</td>
<td>3,758</td>
<td>3,832</td>
<td>3,910</td>
<td>0.7%</td>
</tr>
<tr>
<td>Fishery</td>
<td>50%</td>
<td>21,415</td>
<td>32,549</td>
<td>49,831</td>
<td>8.6%</td>
</tr>
<tr>
<td>Livestock</td>
<td>50%</td>
<td>44,809</td>
<td>44,917</td>
<td>46,463</td>
<td>8.0%</td>
</tr>
<tr>
<td>Rural Domestic</td>
<td>50%</td>
<td>33,141</td>
<td>48,607</td>
<td>64,151</td>
<td>11.1%</td>
</tr>
</tbody>
</table>

\*Taken IWRM Report Guiyang Hydrological Bureau 2007*

Over 68% of the water demand (median case) is for irrigation. Domestic demand for rural people is 8%, livestock needs are 8.6% and other needs for forestry and aquaculture are about 4%. Ecological and environmental needs are about 11%. Detailed estimate for each of these sectors is shown in the Annex 7.1. The 2030 demand by counties and districts is shown in Figure 7.1. The rural demand is particularly high in four counties or districts: Qinzheng, Kaiyang, Xiuwen, Xifeng and Wudang. All these counties have large rural areas although they fall under the municipality. Xiaohe which is part of the three City Center Districts has very little rural areas and has virtually no rural demand. The maximum to minimum demand do not vary very much and is relatively stable.
Overall demand goes up from 466 MCM/yr in 2000 to 578 MCM/yr in 2030 which is only 24% over 30 years (0.7% per year). This reflects that the economic growth in the rural sector is very low. In addition the population actually declines and the demand for water from the agricultural sector is virtually stagnant (0.2% per year).

7.2.2 Agriculture and Water Needs

7.2.2.1 Irrigation

The cultivated area in Guiyang is 1,465,700 mu, with each farm family having 0.81 mu. There are 4,256 irrigation schemes, in which, the total capacity of water storage is $183.97 \times 10^6$ m$^3$, and the discharge of diversion works is 14.1 m$^3$/s, and the pumped irrigation schemes have pumping capacity of 12420 kW.

The designed irrigation area, effective irrigation area, guaranteed irrigation area and actual irrigation area are 833,600 mu, 703,500 mu, 557,600 mu and 543,000 mu respectively. Of the guaranteed irrigation area 462,000 mu paddy, 81,000 mu is for other irrigated crops (corn and vegetables). Each farmer is given 0.31 mu/per capita of guaranteed irrigation area.

The distribution of irrigation area is shown in table 7.3. The largest irrigated areas are in Qingzhen, Xiwen, Xifeng and Huaxi. These counties and districts also have the largest rural population.

7.2.2.2 Issues with Irrigation

Irrigation facilities are old and the efficiency of irrigation infrastructure is low causing water loss and soil erosion. The effectively irrigated land is reported to be only around 30% to 50% of the total cropland. The systems as designed are not suited to supporting an agricultural transformation that is taking place in rural areas around the city. Farming techniques to conserve water and to preserve soil need to be widely disseminated and practiced by farmers. There have been pilot programs to conserve water and control soil erosion in farms on sloping fields. These attempts, including improved on-farm water management, must be further
promoted and replicated. Many of the rural water infrastructure facilities are in a dilapidated and worn out condition, and in need of rehabilitation, suggesting that a proper and sustainable operation and maintenance (O&M) mechanism needs to be developed and implemented.

Clearly there needs to be an irrigation development and management component of the Project that integrates the management of water resources at river sub-basin level with modernizing irrigation development and management that is attuned to agricultural transformation and farmer needs as well as empowerment of the farmers through establishment of water user associations (WUAs). To summarize the issues the main problems in irrigation is the following:

a) Lack of Water in dry season
b) Poor Yield
c) Lack of good soil depth
d) Lack of agriculture and Irrigation extension services
e) Village based Institutional Arrangements and issues
f) Need for institutional reform

### Table 7.4 Irrigation Area in Guiyang

<table>
<thead>
<tr>
<th>No.</th>
<th>Area</th>
<th>No.</th>
<th>Reservoir Capacity for Irr. 10,000 m³</th>
<th>Irrigation Area(mu)</th>
<th>Irrigation water Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Design</td>
<td>Effective</td>
</tr>
<tr>
<td>1</td>
<td>Yunyan</td>
<td>24</td>
<td>12843</td>
<td>797731</td>
<td>672389</td>
</tr>
<tr>
<td>2</td>
<td>Nanming</td>
<td>35</td>
<td>12843</td>
<td>3458</td>
<td>3439</td>
</tr>
<tr>
<td>3</td>
<td>Xiaohe</td>
<td>10</td>
<td>31</td>
<td>3670</td>
<td>3650</td>
</tr>
<tr>
<td>4</td>
<td>Baiyuan</td>
<td>178</td>
<td>337</td>
<td>3130</td>
<td>3100</td>
</tr>
<tr>
<td>5</td>
<td>Huaxi</td>
<td>598</td>
<td>4066</td>
<td>32325</td>
<td>34260</td>
</tr>
<tr>
<td>6</td>
<td>Wudang</td>
<td>936</td>
<td>561</td>
<td>142496</td>
<td>117068</td>
</tr>
<tr>
<td>7</td>
<td>Qingzheng</td>
<td>474</td>
<td>1127</td>
<td>128120</td>
<td>104587</td>
</tr>
<tr>
<td>8</td>
<td>Xiuwen</td>
<td>605</td>
<td>1936</td>
<td>118445</td>
<td>110630</td>
</tr>
<tr>
<td>9</td>
<td>Xifeng</td>
<td>659</td>
<td>2132</td>
<td>122867</td>
<td>99686</td>
</tr>
<tr>
<td>10</td>
<td>Kaiyang</td>
<td>749</td>
<td>2608</td>
<td>135346</td>
<td>108788</td>
</tr>
</tbody>
</table>

Taken from Guiyang Water Resources Master Plan prepared for ADB 2006

Irrigation needs are based on the cropping pattern, cropped areas and water duties used for irrigation and efficiency of distribution systems. The consultant reviewed several earlier reports by Guiyang Water Resources Bureau and the most accurate report and up-to-date report was prepared by the Guiyang Hydrology Bureau called *Integrated Water Resources Planning Report July 7 2007*. In addition to estimating a base case scenario for demand the possible water savings was also estimated and a high low and medium estimate of demand was made for 2010, 2020, and 2030 and is shown in table Annex 7 table A7.2 and also for total for the Guiyang Municipality it is shown in Table 7.5. The present demand for agriculture is about 358 MCM/year for the median case (see table 7.4). However the use of water for agriculture is only is 268 MCM/year (Table
7.4) because of the poor irrigation facilities with huge losses and poor operational management. The need for formation of Water User Organization Village by Village or in group of villages is very important and urgently needed to improve the operational efficiencies in irrigation.

Table 7.5 Irrigation demand 2010 to 2030 for Guiyang Municipality (10^4 cum/year)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Irrigation Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10000 cum</td>
</tr>
<tr>
<td></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>85%</td>
</tr>
<tr>
<td>2010</td>
<td>31545</td>
</tr>
<tr>
<td>2020</td>
<td>33280</td>
</tr>
<tr>
<td>2030</td>
<td>34510</td>
</tr>
<tr>
<td></td>
<td>Increase 2010 to 2030</td>
</tr>
<tr>
<td></td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>11%</td>
</tr>
</tbody>
</table>

Most of the increase in demand for water is due to the vegetable cropped area increasing by 60% and the corn crop area doubling in 2010 to 2030. This increase in areas is in the right direction since Guiyang City demand for vegetables and corn increase significantly. Rice area is kept virtually constant although consultant analysis indicates that economic value of water for rice is very low and it is not very economic in this area. Vegetables and corn would give a much higher returns.

**Livestock and Afforestation.** The demand for water for livestock goes up from 21 to 49 MCM per year. This is almost a doubling of the water needs as meat, eggs and other animal products increase dramatically to feed the urban population. Small animal population doubles and large animal population increases by 60%.

**Afforestation** demand goes up from 5 MCM/yr to 18 MCM/yr due increased afforestation –planting of seedlings in critically eroded areas to protect the soil and to increase the cover forestry over these areas.

**Aquaculture** demand only increases very slightly because of the lack of land for ponds.

Detailed table for the demand are shown in table Annex 7 Table A7.4

**Rural Domestic Water** Rural domestic water will only increase from 44 MCM/yr to 46 MCM/yr. This is a very small increase mainly because population in the rural area decreases by 0.7 million. There however an increase in quota for rural water which counteracts to increase the demand slightly. The TA consultant’s evaluation is that that the quota used by Guiyang Water Resources Bureau in IWRM Report 2007 for domestic water consumption per capita for rural people is too high (see table 7.6 below). Domestic demand cannot rise as quickly as indicated by the Bureau Figures. The revised domestic consumption will decrease demand by 14 MCM/yr to 33 MCM/yr from 47 MCM/yr in 2030 as estimated by the Hydrology Bureau.
### Table 7.6 Domestic Demand Per Capita Consumption Comparison by Hydrology Bureau and by TA Consultants

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrology Bureau</td>
<td>48.0</td>
<td>62.0</td>
<td>80.0</td>
<td>98.0</td>
<td>120.0</td>
</tr>
<tr>
<td>Estimated by TA Con</td>
<td>48.0</td>
<td>53.5</td>
<td>63.4</td>
<td>76.9</td>
<td>87.2</td>
</tr>
</tbody>
</table>

### 7.3 Price Impact on Rural Water

Throughout China price impacts for rural water was applied only to rural domestic water. Impacts on irrigation water were not applied because of poverty considerations. The rural poor are completely depended on subsistence living on agriculture and small irrigated areas. The other reason for not applying price impacts for irrigation water is because of poor irrigation scheme management. Water is not supplied on time and in the quantity required by farmers. Even in very difficult areas such as Inner Mongolia and Xinjiang where the value of irrigation water value is about Y1-2.5/cu m the price mechanism is not applied because of poor irrigation management. In discussion with the Price Bureau in about 15 different provinces it has been found, that price mechanism is not applied or if applied it is at a level very low levels, because the effect of prices on irrigation water are inconsequential.

The price of water for domestic use however can be applied and it does have significant impact on water use in the rural areas. Figure 7.6 shows that the price impact on rural domestic water is significant. The starting point of the price impact is year 2010. Price elasticity on water demand of -0.29 was worked out by Black & Veatch Consultants for the preparation report (PPTA) for the Guiyang Integrated Water Resources Management Project for ADB. **Price increase will apply from the present price of water of Y1-2/cum for domestic water. An 8% price increase per year will decrease demand in 2030 by 50%; a 5% increase in price will decrease demand by 25% per year; and a 3% increase in price will decrease the demand by 17%. The Guiyang Municipality should seriously take note of the price influence as very strong way of reducing domestic demand.**
The consultant demand figures finally worked out show these decreases in demand will totally eliminate the need for additional construction for more water sources in 2020 to 2030 except for cases where dry season water flows decreases are such that there needs to be construction for storages as reflected in the ADB GIWRM Project 2009.

### 7.4 Farm Budgets and Economic Returns to Water

#### 7.4.1 Farm Budgets

Economic farm budgets were constructed for some 360 rural household in 10 villages in 3 counties (Huaxi, Wudang, Xifeng) chosen as typical examples of farm budget impact with irrigation projects. Average farm family has a per capita holding of 0.81mu/capita and the family has about 3.5 mu each. The surveys reveal that the cropping pattern and water use pattern are as follows as shown (see table 7.7).

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area Cropped (mu)</th>
<th>Cropping Index</th>
<th>Water use (average cum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>1</td>
<td>Once</td>
<td>400</td>
</tr>
<tr>
<td>Vegetable</td>
<td>0.5</td>
<td>Three or four times</td>
<td>300</td>
</tr>
<tr>
<td>Corn</td>
<td>2</td>
<td>Once</td>
<td>400</td>
</tr>
<tr>
<td>Fruit</td>
<td>1</td>
<td>once</td>
<td>260</td>
</tr>
<tr>
<td>Total</td>
<td>4.5</td>
<td>Twice average</td>
<td>1360</td>
</tr>
</tbody>
</table>

Although these figures in table 7.7 represent an average household for illustration purposes the TA consultant has individual farm family figures for 360 household in ten villages. The economic net returns from the 360 households are given below as an average for each village surveyed.
**Income Impact.** The net income impact varies from village to village depending on the soil fertility and soil depth, the efficiency of irrigation, slope of land, the ability for the soil to hold water since a lot of land is very rocky. The average village impact varies from 15% to 57% increase in household agricultural income per year (see table 7.8). Those families with little income impact by irrigation have very poor soil conditions and poor land levels. The agricultural income only accounts for 53% of their total income in 2010 (see table 7.2). Hence income impact overall will be about 7.5% to 28% of their total household incomes. These returns to irrigation are low and economically infeasible for.

<table>
<thead>
<tr>
<th>Village Name</th>
<th>Income from Irrigation Y/yr</th>
<th>without</th>
<th>With</th>
<th>Increase Income</th>
<th>% Increase</th>
<th>value of water/cu m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daqiao</td>
<td></td>
<td>2831</td>
<td>3935</td>
<td>1104</td>
<td>39%</td>
<td>0.81</td>
</tr>
<tr>
<td>Dawan</td>
<td></td>
<td>1557</td>
<td>2445</td>
<td>889</td>
<td>57%</td>
<td>0.65</td>
</tr>
<tr>
<td>Wangjiaping</td>
<td></td>
<td>2414</td>
<td>2845</td>
<td>431</td>
<td>18%</td>
<td>0.32</td>
</tr>
<tr>
<td>Xicun</td>
<td></td>
<td>2607</td>
<td>3301</td>
<td>695</td>
<td>27%</td>
<td>0.51</td>
</tr>
<tr>
<td>Jianxi</td>
<td></td>
<td>4327</td>
<td>4973</td>
<td>646</td>
<td>15%</td>
<td>0.47</td>
</tr>
<tr>
<td>Zulin</td>
<td></td>
<td>2316</td>
<td>2844</td>
<td>529</td>
<td>23%</td>
<td>0.39</td>
</tr>
<tr>
<td>Sanjiang</td>
<td></td>
<td>1770</td>
<td>2213</td>
<td>443</td>
<td>25%</td>
<td>0.33</td>
</tr>
<tr>
<td>Shuitian</td>
<td></td>
<td>2489</td>
<td>2923</td>
<td>434</td>
<td>17%</td>
<td>0.32</td>
</tr>
<tr>
<td>Gaichen</td>
<td></td>
<td>2167</td>
<td>3233</td>
<td>1065</td>
<td>49%</td>
<td>0.78</td>
</tr>
<tr>
<td>Songbai</td>
<td></td>
<td>1906</td>
<td>2490</td>
<td>584</td>
<td>31%</td>
<td>0.43</td>
</tr>
</tbody>
</table>

The income impact for each household is shown for high, median and low income villages in Figure 7.7. It should be noticed that high income earners could obtained an income increase of as much as Y10,000 per HH and low income households got only below Y500 per households. The disparity is huge –about 20:1 increases for high income compared to low income households.
Figure 7.7 Farmer Income Impact on each Village household (Low, Median and high Income)

**High Income Villages**

**Middle Income Villages**

**Low Income Villagers**
7.4.2 Economic Value of Water in Irrigation

The economic value of water was estimated for the 10 villages and is presented in Table 7.7. The economic value of water vary from 0.32 to 0.81 per cum. The individual village value of irrigation water is shown below in Figure 7.8.

The costs have to be averaged for several villages since each irrigation scheme serves several villages. Costs of irrigation average about 1000/mu. The cost of water for each farm is about 3500 and the amount of water delivered is 1350 cum. The cost of water at a discount rate 12% is 0.47/cum. Hence all projects with economic values of water of 0.47/cum would have rate of economic returns of 12% or more. Five out of the ten villages (50%) have projects which are economically viable and others are not viable. Care should be taken to ensure that projects chosen are economically viable and sustainable.

A more detailed analysis of each village shows 58% of families can generate incremental income that have an economic value of water greater than the cost of water. Table 7.9 shows the percent of farm families with income greater or less than the cost of water.
Table 7.9 Families with economic values of water greater or less than the cost of water

<table>
<thead>
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<th>% Families with economic value of water above cost of water</th>
<th>% Families with economic value of water below cost of water</th>
</tr>
</thead>
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<td>31.0%</td>
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<td>44.0%</td>
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<td>Shuitian</td>
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<td>48.4%</td>
</tr>
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<td>Wangjiaping</td>
<td>45.0%</td>
<td>55.0%</td>
</tr>
<tr>
<td>Songbai</td>
<td>44.8%</td>
<td>55.2%</td>
</tr>
<tr>
<td>Xincun</td>
<td>41.0%</td>
<td>59.0%</td>
</tr>
<tr>
<td>Sanjiang</td>
<td>38.7%</td>
<td>61.3%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>58.2%</strong></td>
<td><strong>41.8%</strong></td>
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</table>

7.5 Rural Water Resources Organization and Demand Management

7.5.0 County Water Resources Management

Rural water resources management involves management at county level demands, and that at township and village level water needs. A

7.5.1 Township Water Resources Management

Rural water resources management has to be performed by the Township Water Resources Management Stations (TWRMS). These township water resources management stations are technically under township governments or under their own township water resources bureaus. They receive technical guidance from the County Water Resource Bureau’s if these exist separately in the County’s or from County Bureau’s that have combined function which include agriculture and water resources. Xifeng County for example has a county water resources bureau.

At present 2009, there are 51 township water resources management stations, of which 3 are under administration of water resources bureaus and 48 are under the administration of township governments. The total staff positions defined are 236, and with 192 on positions. The details of the county and districts are as following:

- Each town has setup township water resources management station, under the administration of township governments in Xiuwen, Xifeng, Kaiyang and Qingzheng.
- Three regional water resources management stations are set up under the administration of Water Resources Bureau in Huaxi District.
- Township water resources management stations were set up with agricultural development centers in Baiyun District and Wudang District after 2000.
- No township water resources management station was set up in Yunyan District, Xiaohe District and Gaoxin District; because of they are purely urban areas and have no real rural areas.
7.5.2 Functions of Township Water Resources Management Stations (TWRMS)

**Functions.** The official functions of the station include rural water supply, irrigation, flood control and drought relief, water and soil conservation, small project design, guiding and coordinating rural drinking water supply, water administrative enforcement. The station manages i) small II reservoirs; ii) small ponds and iii) pump stations.

The station is responsible to be the main counterpart with the village, responsible for issues in the village including family planning program etc. Each year, about 7-month work time is work unrelated to water resources work.

**Staffing.** Typical staffing in a (TWRMS) is about four to five staff that does all the tasks of rural water supply, irrigation, flood control and drought relief etc. The staff may also do other work apart from the water resources work for the township government.

**Budgets.** The TWRMS is funded by the township government.

**Organization of the TWRMS.** Organization is best reflected in the Kaiyang County. Kaiyang County presently has 16 TWRMS. These are directly under the county government and they communicate with the villages. They get some technical direction on water matters from the County Water Resources Bureau.

7.5.3 Issues with Township Water Resources Management (TWRMS)

The main issues with the TWRMS are as follows:

a) Lack of organization of staff into specific work arrangements

b) Staff are not qualified

c) No focus of TWRMS on water issues

d) Lack of funding to undertake water resources relates tasks

e) Village water institutions are not established to communicate with TWRMS.

7.5.4 Reform of TWRMS to Manage Rural Water Resources

The main reform for TWRMS is to ensure that these institutions are established for all townships or groups of townships to ensure that rural water resources start to be managed. The TWRMS will be part of the County Water Resources Bureau. It would be subordinate to the County Water Resources Bureau and be responsible for the following main administrative functions:

i) rural water supply for villages,

ii) small scale irrigation planning and construction,

iii) flood control and drought relief work ,

iv) water and soil conservation,
v) small project design,

vi) guiding and coordinating rural drinking water supply,

vii) water resources administrative enforcement of the water law

For water resources management functions TWRMS will be responsible

viii) Responsible for the maintenance and protection of small water infrastructures in jurisdiction, and promoting of agricultural irrigation water saving technology.

ix) Responsible for the daily management of flood control and drought relief, water resources management, water saving, water pollution and protection etc. water resources management activities in jurisdiction.

x) Supporting county water administrative department to conduct sectoral management for water supply (including rural water supply) and drainage and rural water demand management through short term demand forecast and supply management.

7.5.5 Village Level Water Reform

At the village level there in Guiyang Municipality there is very little formal organization for managing water. The recommended organization at village level is the Water User Association (WUA). The WUA as is seen in other parts of China will manage the village level water for irrigation and for drinking water. They will have to communicate with Township Water Management Station who in turn communicates with the County Water Resources Bureau. There are six key principles of WUA summarized from most of the WUAs’ setup. The six key WUA principles can be presented as follow:

• The WUA must be certificated by local civil administration;
• The WUA must be non-profit organization with legal person;
• The WUA is farmers’ own irrigation organization (farmers elect, manage, make decision, etc.);
• It is organized on the basis of hydraulic boundaries (Figure 7.9);
• It adopt volumetric water charges based on water measurement; and
• It has right and capacity to collect water charges and submit them to water supplier, for both sustainable use of water resources and its own self-managing/financing costs.
In Guiyang project area, WUA have found some issues:

1) For WUA to be certificated by Guiyang civil administration, the certification fee is Y20,000 for each WUA, which is not affordable to the WUA;

2) Most counties in the project area are poverty counties, where economies are rated as less developed, and agriculture is subsistence oriented, and irrigation system are small systems, and control only 100-150ha area.

If the area of irrigation system and its individual hydraulic unit is over 200ha and the Guiyang government supports the certification fee, the WUA will be established or else a group of WUAs from the water user group (WUG) will be established to receive support from the Guiyang Government:

- WUG is managed by the farmers themselves, which will organizes and gives responsibility for local irrigation distribution networks. The WUG will produce quite good results in water delivery and well system maintenance, and show the high potential for farmer group management at the distribution network level. The WUG will be farmer group that is permanent organization,, and the group leader is elected by farmers themselves so as to be responsible to farmers themselves. What is significant by the groups in the tendency of farmer’s participation in local irrigation management and the management is thus being handed over to an organization, which sees as their own.
• The WUG need not be certificated by local civil administration; and is not non-profit organization with legal person; the WUG is farmers’ own irrigation organization (farmers elect, manage, make decision, etc.), organized on the basis of hydraulic boundaries, adopt volumetric water charges based on water measurement; and has right and capacity to collect water charges and submit them to water supplier, for both sustainable use of water resources and its own self-managing/financing costs.

The potential impact of WUG of farmer perspective has positive and negative impact: positive impacts are sense of ownership, increased transparency of processes, great accessibility to system personal, improved maintenance, improved irrigation service, reduced conflicts among users, and increased agricultural productivity; negative impacts are higher cost, more time and effort required to manage, less disaster assistance, no assured rehabilitation assistance, and less secure water right.

WUG formation is discussed in Part II Report. WUG need to be established in every village so that demand management of water resources can take place at the county level.

7.5.6 Water Resources Demand Management at County/Township and Village Level

7.5.6.1 County Level Demand Management Scheme

The three counties and one city –Xiuwen, Xifeng and Kaiyang, Qingzhen and one city and each of them are reasonably independent from the municipality on government funding and also on the water resources management. It is important for each of these counties’s to develop their own demand management scheme. The demand management scheme will require the same type of demand reductions as was described for the Guiyang City Districts and Suburbs i.e. reduce the water quota for industry, businesses, and construction industry; improve efficiency of irrigation at farm level and improve the system efficiency of systems; reduce network losses of urban and township water supply systems.

County Industrial Water Use Demand Management.

It has been recommended by Guiyang Water resources Bureau IWRM Report in 2007, that the county industrial quota’s for water use be significantly reduced and to manage demands. The present quotas for the county are almost five times that of the city quotas and they need to be reduced over time (see Figure 7.10)
Figure 7.10 Industry Quotas for County and Township proposed by the IWRM Report 2007

Recycling rates should also be increased, as it was for the city industry, from 65% of the water to 85% over the 20 year period. Similar incentives in terms of tax breaks should be provided for industries to improve their quota reductions and higher recycling rates.

Business and Construction Demand Management Via Quotas

Business and Construction Quotas for water use should also be reduced as indicated in Figure 7.11. These substantial reductions will bring demand under control.

Figure 7.11 Water Quota Reductions at County and Township Level Business and Construction Industry

Irrigation Efficiency

Irrigation efficiency and irrigation water quota reductions have been discussed in chapter 6 and similar arrangements for efficiency improvements have to be done for the counties.
Overall Demand Management Reductions at County Level

Overall demand changes will be about 11.5% in 2020 and 12.5% in 2030 for water quota lowering, irrigation efficiency improvements; increasing recycling and reducing network loss (see Figure 7.12)

Figure 7.12 Rural demand and Proposed Demand Management Reductions

7.5.6.2 Demand Management at County Level

A demand management office at the county should be created to undertake demand management of the county. Their main responsibility will be to manage demand of water at county, township and village. They will also have to ensure that drinking water supply will have the highest priority and all other sources demand for water are managed so that demand always is matches supply.

A Demand Management Office (DMO) will be created as part of the County Water Resources Bureau. The DMO will undertake the function as mentioned in chapter 5 for the City DMO. It structure will be similar.

At the township level it will coordinate with the Township Water Resources Management Station (TWRMS) and these TWRMS will have a branch office that will be responsible for township level demand management.

At the Village Level the demand management will be undertaken by the WUA/WUG for irrigation, drinking water and all other users. The WUA/WUG will coordinate via the village and be responsible for demand management. This group will coordinate with the TWRMS who will in turn coordinate with the County DMO.

A organization structure for demand management is shown in Figure 7.13. Figure 7.14 shows the boundaries and groupings of the Water Users and Water User Group.
Figure 7.13 Proposed Demand Management Organization at County/Township and Village Levels

Figure 7.14 Formation of Water User Association to manage demand
## Annex 7

### Table A7.1 Total Rural Water demand by County and District 2010, 2020, 2030

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## Table A7.2 Irrigation Water Demand 2010, 2020, 2030 by District & County

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<th>Vegetable</th>
<th>Total Actual Area (10,000 mu)</th>
<th>Total Irrigation Demand 1000 cum</th>
<th>% Irrigated</th>
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## Table A7.3 Ecology and Environmental Needs 2010, 2020, 2030 by District & County

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Chapter 8. Recommendations and Conclusions
Chapter 8. Recommendations and Conclusions

8.1 General
Guiyang Municipality has been developing very rapidly at the rate of over 11% in GRP for the region from 2000 to 2009. The planned growth rate for the next

Although the water resources of Guiyang is 4.5 billion cum/year and the rainfall averages 1050 mm per year the total water use is presently only about 1.04 billion cum per year. The use can vary slightly +/- 10% depending on the rainfall. The total amount of water that runoff is generally not available for use by cities and irrigators because of the limited surface water and groundwater storages. Groundwater essentially does not exist because most groundwater flows out as part of the surface water with 3-4 months of the end of the rainy season. This mainly due the Karst formation does not allow for groundwater to be stored.

Presently there are four main issues in Guiyang Municipality

a) Water Resources is plentiful in an average year is limited in times of drought; the karts geology makes it difficult to build structures for large water storages
b) Projections for demand are based on economic projections which essentially follow the present patterns of growth. The economic projects
c) Water demand as computed by the Guiyang Water Resources Bureau in the future clearly shows that there will be shortages by 2020-2030
d) Water resources services providers are fragmented vertically by the services provided for urban or rural areas and horizontally by regions of water provided. There is a need for water resources institutions to be integrated for IWRM to take place
e) Demand management is not practiced and essentially there is a run away demand and supply management will not meet all the demand
f) Real time water resources needs to be expanded to cover all abstractions of water besides monitoring of a few reservoirs

8.2 Recommendations

The following are the main recommendations:

a. The first and main recommendation is to integrate water resources management at the Municipality Level. It is essential to integrate the water services institutions into one agency. Integration of water resources management is to i) Influencing economic sector decisions based on water resources availability and constraints; ii) Integration of all stakeholders in the planning and decision process in water services; iii) Integrating water and wastewater management; and iv) Need for cross sectoral integration. The formation of a Water Affairs Bureau would start to bring about integration of water services in Guiyang Municipality. The Water Affairs Bureau will integrate
planning, design and operation of all water services in the municipality. The formation of Water Affairs Bureau has to be done in three stages:

i. First Stage reform is to move some offices in Urban Management Offices to the Water Resources Bureau and merge the functions with the present water resources functions. These offices to be moved are the Water Saving Office and the River Course Management Office in Urban Management Bureau.

ii. Second Stage Reform which runs parallel to the first stage reform is to reform the water and sewerage services within Urban Management Bureau. There is a need to amalgamate the water companies within the city areas so that there is only one company that represents are water supply services. In addition it is necessary to unify the wastewater collection and treatment facilities. The wastewater collection and treatment must be unified and corporatized so that there one company that deals with all wastewater in the city. At present the wastewater company’s are a disaggregated bunch of treatment plants who are corporate entities with no control on the collection system.

iii. Third Stage of Reform will be the final stage when all the individual institutions are ready for formation of a Water Affairs Bureau. In this phase a new Bureau is form taking the entire Water Resources Bureau and adding to it the Utilities Management portion of Water and Sewerage Services in the Water Resources Bureau with the already moved Water saving Office and River Course Management Office (in Stage I) to form one Water Affairs Bureau. This Bureau will have all the function to deliver water and sewerage, and flood control and groundwater management services.

iv. Details of the reform stages can be found in chapter 5. The entire reform process should be done in 5 years.

b. Second recommendation is the formation of a Demand Management Department/Office within the Water Affairs Bureau for managing demand so that demand meets the supply. The functions of this office is as follows:

   i. demand forecasts –long, medium and short term forecasts
   ii. Water use statistics and collect and monthly water use statistics.
   iii. water saving and monitoring water savings, and proposals for key water savings have considerable potential
   iv. water abstraction and enforcement.
   v. water audits to review all large water consumers to ensure that they follow the water quota as required and be responsible for issuing permits for water abstraction

This office will manage demand and ensure that they shift away from supply management to demand management.
c. The third recommendation is **put in place a real time monitoring of water resources and abstraction of water of all major consumers.** The present system is very limited as it mainly monitors reservoirs and floods.

d. A **demand management office at the county should be created** to undertake water demand management at the county level. Their main responsibility will be to manage demand of water at county, township and village. They will also have to ensure that drinking water supply will have the highest priority and all other sources demand for water are managed so that demand always is matches supply. A **Demand Management Office (DMO)** will be created as part of the **County Water Resources Bureau.** The DMO will undertake the function as mentioned in chapter 5 for the City DMO. It structure will be similar. **At the township level** it will coordinate with the Township Water Resources Management Station (TWRMS) and these TWRMS will have a branch office that will be responsible for township level demand management. **At the Village Level** the demand management will be undertaken by the WUA/WUG for irrigation, drinking water and all other users. The WUA/WUG will coordinate via the village and be responsible for demand management. This group will coordinate with the TWRMS who will in turn coordinate with the County DMO.

e. Water User Association should be formed under water user groups to improve water use efficiency at village level. Training should be undertaken for all villages to undertake the necessary WUA formation.
Asian Development Bank
TA 4912 PRC Guiyang Integrated Water Resources
Management Project
PART II of TA REPORT
(Implementation Support for IWRM Project)

Environmental Assessment Summary by Prof. Xie Qingtao

Yudongxia Reservoir Payment for Environmental Services
Report by Prof Jin Leshan

Rural Water Resources Reform and Water User Association
Formation Professor Li Zhi & Dr. D Gunaratnam (Specialized Inputs)

Report Edited/Produced by Dr. Daniel Gunaratnam
PREFACE

There are three reports prepared for the Part II Report of the TA. These were prepared as part of the project support documents for implementation of the Guiyang Integrated Water Resources Project. The individual reports have been prepared by Professors Xie Qingtao (Environmental Impact Assessment), Jin Leshan (Yudongxia Reservoir Payment for Environmental Services), and Li Zhi (Rural Water Resources Reform and Water User Association Formation). The report was edited and compiled by Dr. Daniel Gunaratnam with specialized inputs especially for the rural water reform.

The Part II-1 first document describes the preparation of the Environmental Impact Assessment. It is a summary of all the activities that have taken place till end of the first quarter this year. The consultant’s specific tasks relate to environmental screening for the Non-Core Reservoir Projects. There is a description of the review of all the Environmental Impact Reports prepared by the Guiyang Project Management Office. There were several reviews of the Environmental Forms (EIF), the Environmental Impact Reports (EIA) and the Initial Environmental Examination (IEE) of several Sub-Projects. Reviews were also done for the first batch of Environmental Impact Forms for sub-projects for Irrigation rehabilitation, Initial Environmental Examination for sub-projects for Soil Conservation and for Small Water Storage Project.

A summary in English is prepared for Summary Environmental Impact Assessment, Summary Initial Environmental Examination, and Summary Environmental Impact Reports.

The description is also given of the environmental supervision mechanism. These consist of the environmental supervision rules (ESR), the terms of reference for the Environmental Supervision Engineer (ESE), and the engagement of the ESE. There is also a description of the contract clauses that need to be included in Sub-Project Construction Contracts and Service Agreements of Construction Engineers. In addition the report describes the establishment of Environmental Supervision Mechanism.

Finally the report describes the External Environmental Monitoring, Environmental Training and Environmental requirements in project operational manual.

There are several annexes which give detailed outline of Environmental Screening Forms, Suggested TOC EIA, Suggested TOC of Initial Environmental Examination Comments on EIA on Liangchahe and Limu Reservoir, etc as shown below.

Annex 1 Environmental Screening Forms
Annex 2 Several key issues to be observed in reservoir environmental assessment
Part II-2 of the report describes the Yudongxia Reservoir Payment for Environmental Services. This document in its first part describes the PES background and case studies and lessons learned. Second section of the report deals with the objectives of the PES for the Yudongxia Reservoir and what it proposes to achieve. In section 3 deals with the methodology in detail for the PES activity for this project.

Section four of the report details out the various costs of mitigation measures for pollution sources in the Longli Catchment which is the upstream catchment. The essential mitigation measures are: for household wastewater mitigated by bio-gas treatment plants; conversion of sloped land farming to forest; soil erosion prevention by terraced farming; and point source pollution from pig farms and industry by pollution treatment. The total cost of mitigation is about Y2.0 million for capital costs and the operating costs are Y1.68 million for the first 5-8 years and there after is drops to Y0.85 million

Section five deals with the downstream people who are required to pay to the upstream people who have incurred a cost for their mitigation measures to keep the water clean for the downstream people. In order to assess their willingness-to-pay a survey was done to evaluate the watershed service valuation for the downstream.

Section six details the linking of the upstream costs to the downstream people willingness to pay. Over 67% are willing to pay for the cost of environmental services. These cost will be charges as a surcharge on the water tariff of Y0.37 cum. The net revenue collected from this surcharge is about Y 8.67 million which far exceeds the mitigation measures.

Section seven details the institutional setting; Section eight details the monitoring needs and arrangements; section nine market elements.

Part II-3 of the report deals with rural water reform and Water User Association (WUA) formation. Section one details the need to form WUA at the village level for
water demand management, drought management and for integrated water resources management.

In section I of this report there is the background of how the Ministry of Water Resources adopted the WUA as the best and most effective form of organization at the village level.

Section one also describes the functions of the WUA essentially integrates the water resources management for all water use in the village. In addition the function of the WUA is that it becomes the village water institution to undertake demand management and drought management.

Section two describes the guidelines to form WUA or Water User Groups in Guiyang Municipality. There are eight detailed steps for the formation of WUA/WUG for Guiyang.

Section three details the consultation with the Guiyang Municipality for the formation of WUA. Section four describes the training program for agricultural extension workers. Section five of this report deals with targeted training modules for WUA on agricultural practices. Section six of this report details the Wudang training module for WUA formation as an example of WUA formation.

Finally section seven of the report describes the formation of the Shuitian WUA formation and the institutional linkages with the township management institution.
Part II – ENVIRONMENTAL Assessment Summary

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Part II –I ENVIRONMENTAL Assessment Summary

Xie Qingtao
6 April. 2010

ABBREVIATIONS

ADB Asia Development Bank
CC Construction Contractor
CSE Construction Supervision Engineer
EA Environmental Assessment
EARP Environmental Assessment and Review Procedures
EEM External Environmental Monitor
EIA Environmental Impact Assessment
EIF Environmental Impact Form
EIR Environmental Impacts Report
EMP Environmental Management Plan
EMO Environmental Management Office
EMRPC Environmental Management Regulation for Project Construction
EPB Environmental Protection Bureau
EPM Environmental Protection Measure
ERD Environment & Resettlement Division
ESE Environmental Supervision Engineer
GIWRMP Guiyang Integrated Water Resources Management Project
GWDI Guiyang Water Design Institute
IEE Initial Environmental Examination
MEP Ministry of Environmental Protection
PMO Project Management Office
PRC People’s Republic of China
Rules Environmental Management Rules for GIWRMP Construction
SEAF Summary Environmental Assessment Framework
SEIA Summary Environmental Impact Assessment
SEIR Summary Environmental Impact Report
SERMD Social-Environment-Resettlement Management Division
SIEE Summary Initial Environmental Examination
TOR Terms of Reference
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1. OBJECTIVES AND TASKS

1.1 Objectives

This report summarizes the major work done by the Environmental Safeguard Specialist (the Consultant) in the period from August 25, 2009 to February 28, 2010, the contract period.

The major task of the Consultant is to assist the Guiyang PMO in GIWRMP preparation and implementation on environmental issues including preparation of environmental documents and establishment of environmental implementation (management) systems. Main specific duties described in the TOR for the Consultant are listed as follows:

(i) Conducet environmental screening of reservoir subprojects;
(ii) Review EIRs prepared by the local certified agency for all noncore subprojects involving the construction of reservoirs;
(iii) With the support from local design institute, prepare SEIA and/or SIEE and/or SEIR in English for each noncore subproject;
(iv) Introduce the environmental supervision engineering mechanism to supervise the contractors' environmental performance (including the engagement, training, and procedures, etc.);
(v) Develop and implement an environmental monitoring program and reporting procedures to ensure appropriate mitigation measures are undertaken during the project construction and operational phases of the project facilities.
(vi) Provide training in environmental monitoring in accordance with ADB requirements and follow up advice and support to local IAs.
(vii) Facilitate the PMO’s communications with ADB’s environmental safeguard specialist.
(viii) Produce the environmental section for the operational manual for the reservoir subprojects' implementation;
(ix) Contribute to the related section in the TA’s draft final report.
2.0 SUMMARY of Consultant’s activities and achievements

2.1 Major Activities

Following major working activities were carried out by the consultant:

i) Worked in Guiyang: visited and worked in Guiyang in the periods:
   a. from August 29, to October 1, 2009;
   b. from November.2 to December 4, 2009;
   c. from December 28, 2009 to February 8, 2010;
   d. from February 22 to February 28.

ii) Workshop: participated the International Workshop in Guiyang on Integrated Water Resources Management from November 9 to November 11 and presented a presentation on “Environmental Management in GIWRMP implementation”;

iii) Meetings and Technical discussions: over 5 formal meetings/trainings with Guiyang PMO and local PMOs and over 7 formal technical discussions with EIA teams and local experts;

iv) Technical discussions with ADB officials: including discussions during the Workshop, in Zhengzhou, and through emails;

v) Site visits: 3 days site visits separately to Huaxi District, Wudang District, and Xiuwen County. Sites visited include 3 dam sites, 2 soil conservation sites, 2 small water storage sites, and 2 irrigation rehabilitation sites.

2.2 Achievements and outputs

Major achievements and outputs of the consultant include:

i) Environmental screening reports for noncore reservoir subprojects;

ii) Guidelines and comments on preparation of EA documents for noncore subprojects;

iii) Preparation of Environmental Management Rules for GIWRMP construction;

iv) Preparation and establishment of environmental supervision system;

v) Preparation of TOR for establishment of external monitoring system;

vi) PPT presentation on environmental management in the international workshop (Guiyang Nov.2009) and other training/meeting activities;

vii) Basic environmental training to Guiyang PMO and local PMOs;

viii) Draft environmental section in the Operational Manual for reservoir subprojects.
2.3 Tasks to be done

As mentioned above, the major task of the Consultant is to assist the Guiyang PMO in GIWRMP preparation and implementation on environmental issues including preparation of environmental documents and establishment of environmental implementation systems, which depends on the effective operation of the Guiyang PMO. Due to the difficulties of the Guiyang PMO in its establishment and operation, some of the tasks of the consultant remain to be done:

Preparation of English SEIA and/or SIEE and/or SEIR for each noncore subproject-
Due to the delay of preparation of updated Chinese EA documents, delay in establishment and operation of a dam safety panel, and delay of preparation of corresponding resettlement action plans, the English SEIA and/or SIEE and/or SEIR for noncore subprojects remain to be done later;

i) Environmental training for Environmental Supervision Engineers would be carried out when the Engineers are employed;

3. Description of work done for specific tasks

3.1 Environmental Screening for Noncore Reservoir Subprojects

Subprojects

3.1.1 Background
Following PRC regulations, a general Environmental Impacts Report (EIR) for the overall project was prepared in August 2008, which had been approved by the Ministry of Environmental Protection (MEP) on 20 January 2009.

For ADB’s environmental assessment purposes, the Project has been classified as Category A. The Project will be implemented under a sector loan modality, and six core subprojects have been prepared to ADB standards. Three EIAs for 3 core reservoir subprojects and three IEEs for the other 3 core subprojects were completed. These have been summarized into one SEIA and one SIEE, reviewed by ADB environmental specialists, and posted on the ADB website.

During the ADB appraisal mission to Guiyang in Feb.16-March 1, 2009, a “Principles-based approach to environmental categorization of dams/reservoirs” was prepared and included in the “Memorandum of Understanding (ADB appraisal mission with Guiyang Government, March 2009)”, Attachment 23, for environmental categorization of the planned 43 noncore reservoir subprojects included in the overall project.
According to the proposed screening approach, “environmental assessments will be prepared for non-core subprojects involving construction of reservoirs for rural water supply and irrigation. Each environmental assessment will be conducted in a stepwise manner. The first step will be to categorize each sub-project into either Category A or B as determined by an environmental screening. The screening is oriented towards describing sub-projects in terms of their ability to comply with environmental principles” and “the screening will be conducted in a participatory manner. A panel, comprising experts from PMO, EPB, and Land Resources Bureau (LRB) and stakeholders from local government, farmer's union, women's union and local academies, would be responsible for screening of the dam sub-projects”. A Screening Form was also developed accordingly for use by the screening panels.

3.1.2 Modifications of Screening Form
The consultant checked the Screening Form and found that modifications were needed to make the screening more practical and easier to be carried out. Following modifications were proposed:

i) Two local stakeholders, the Forest Bureau and the Archaeological Bureau, are added in the Panel for the screening because in Chinese government system, the local Forest Bureau is responsible for identification and protection of “ecological systems, natural habitats, wetlands, flora and fauna,” and etc. and the local Archaeological Bureau is responsible for identification and protection of “archaeological sites and monument”.

ii) The “b) Notified or planned protected archaeological site or monument as per national Guidelines on Sensitive Area” included in the original Question 1 is separated from the Question 1 and listed as Question 2; In this way, the expert from local Forest Bureau would answer the Question 1 and sigh directly following his/her answers and the expert from local Archaeological Bureau would answer Question 2 and sigh directly following his/her answers;

iii) The original Question 2, 3, and 4 were combined into Question 3 because all the 3 questions could be answered by expert from local Water Resources Bureau and the expert could sigh directly following his/her answers;

iv) The original Question 5 becomes Question 4 and the expert from local EPB is to answer the question and sigh after his/her answers;

v) One new question on land use is added, Question 5: Will the subproject have significant impacts on local land use? The expert from local Land Resources Bureau would answer the question and sigh after his/her answers;

vi) The subproject categorization would be recommended jointly by local EPB and local PMO based on above screening answers and explanations to be filled in the screening forms. The representatives from local EPB and local PMO would sigh on their recommendations, instead of by representatives from local Land Resources Bureau and local Water
Resources Bureau. It’s not very adequate for local Land Resources Bureau and local Water Resources Bureau to sigh on recommendations for subproject environmental categorization because it’s not their business and it’s beyond their capabilities.

vii) Some basic subproject information is added on the screening form including subproject location, design indexes (dam height, reservoir capacity, land requisition, resettlement, etc.) and objectives, etc..

Annex 1 shows the modified screening form and the original screening form.

3.1.3 Environmental Screening of Non-core Reservoir Subprojects

Following the procedures of the “Principles-based approach to environmental categorization of dams/reservoirs” and with the modified screening forms, environmental screening was carried out by local PMOs, directed and assisted by Guiyang PMO and the consultant, in September 2009. Three screening reports were submitted to ADB and the final report had been confirmed by ADB on December 18, 2009.

During the screening it was known that the originally planned 43 noncore reservoir subprojects now have been reduced to 39 because 4 of them have started construction with domestic fund and therefore they are not subprojects of the project anymore.

Among the 39 noncore reservoir subprojects, 5 were classifies as Category A and 34 as Category B. The reasons for classification of each Category A subproject include two or more of the following features:

i) near provincial protected areas;
ii) with major objective of industry water supply;
iii) relatively higher dam height and bigger reservoir capacity;
iv) with pollution sources in upstream areas; and
v) with relatively more land requisition and relatively more people to be resettled.

Following flowchart shows the process of the environmental screening for noncore reservoir subprojects.
Flowchart of Environmental Screening for Reservoir Subprojects

- Review of background documents and proposal of modification on environmental screening form for reservoir subprojects
- Discuss with Guiyang PMO on the modifications and get agreement from the PMO
- Report to ADB and get confirmation from ADB about the modifications
- Meeting with Guiyang PMO and local PMOs on ADB requirements and procedures of environmental screening for noncore reservoir subprojects
- Environmental screening by local screening panels organized by local PMOs
- Review and confirmation of environmental screening results by Guiyang PMO and local PMOs
- Environmental screening report to ADB by Guiyang PMO
- Review and comments on environmental screening report by ADB
- Updating of the screening report and report to ADB the updated screening report by Guiyang PMO
- Confirmation of the environmental screening report by ADB
  18 December 2009
Following table shows the list of screening results for noncore reservoir subprojects.

<table>
<thead>
<tr>
<th>No</th>
<th>Component/ Project Name</th>
<th>District/ County</th>
<th>Capacity (Mm³)</th>
<th>Dam Height (m)</th>
<th>IL (^a) (Mu)</th>
<th>PR (^b)</th>
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</table>

Data source: Feasibility Study, Guizhou Provincial Design Institute, April 2009

\(^a\) IL–inundated land; \(^b\) PR–persons to be relocated
3.2 Review of EIRs prepared by local EIA teams

3.2.1 Background and Progress
As mentioned above, a general Environmental Impacts Report (EIR) for the overall project was prepared in August 2008, which had been approved by the Ministry of Environmental Protection (MEP) on 20 January 2009.

According to PRC regulations, if an overall EIA for a project comprising several or many subprojects is approved by authorized government agency, the approval covers all the subprojects the overall project comprises. It means that it is no longer necessary for government agencies to review and approve environmental assessment documents for individual subprojects.

Anyway, initial Chinese environmental assessment had been carried out for most of the subprojects, except the soil conservation subprojects (no assessment report is needed according to Chinese EIA classification), and an environmental impacts report (EIR) or an environmental impacts form (EIF) had been prepared for each of the subprojects, including core subprojects and noncore subprojects.

Following the PRC Government environmental categorization criteria, the Yudongxia reservoir, one of the 6 core subprojects, a medium sized reservoir with future water storage capacity of 18.6 million m$^3$ is classified as Category A and all other subprojects involving construction of smaller reservoirs and irrigation system rehabilitation, regardless of their contents and locations have been classified as Category B. So EIFs were prepared for all the noncore reservoir subprojects and noncore irrigation rehabilitation subprojects following Chinese requirements for B-level environmental assessments. And no assessment reports are needed for soil conservation subprojects and for small water storage subprojects.

3.2.2 First Round Review of Chinese EIFs for Noncore Reservoir Subprojects
The consultant reviewed several EIFs for noncore reservoir subprojects and concluded that significant revisions are needed in accordance with the requirements of the Summary Environmental Assessment Framework (SEAF) included in the “Memorandum of Understanding (ADB appraisal mission with Guiyang Government, March 2009), Attachment 11”.

An environmental assessment meeting (training) was held in Guiyang by Guiyang PMO on 22 Sept. 2009. A total of 23 persons participated the meeting and most of them were representatives of all the EIA teams who were involved in preparing the EIFs.

On the meeting, the consultant firstly explained the major differences between Chinese EA reports and ADB EA reports. As for the environmental assessment for noncore reservoir subprojects, several key points were indicated by the consultant to
be observed in follow up EIR or EIF revisions (See Annex 2). Meanwhile, comments on the major gaps in the EIF for the Limu reservoir subproject were made available by the consultant to the EIA team for the Limu reservoir subproject as well as for the representatives of all other EIA teams for their reference (See Annex 3).

Based on the “Recommended Format for EIA Reports, ADB 2003 Environmental Assessment Guidelines, a detailed Table of Contents of an EIA report for a Category A subproject was prepared and made available by the consultant to all the EIA teams for them to follow in preparing revised EIA reports (See Annex 4). Similarly, a detailed Table of Contents of an IEE report for a Category B subproject was prepared and made available to all the EIA teams for them to follow in preparing revised IEE reports (See Annex 5).

3.2.3 Second Round Review of Chinese EIA Report for Non-core Subprojects

1) Review of Draft EIA for Liangchahe Reservoir Subproject

A draft EIA report was prepared by the Guizhou Provincial Design Institute for the Liangchahe Reservoir, one of the screened 5 Category A subprojects, following the format and table of contents proposed by the consultant in Sept. 2009. The draft EIA report was presented to the consultant on Nov. 19, 2009.

The consultant reviewed the draft EIA and found that significant gaps still existed, mainly including:

- i) assessment on impacts of industry wastewater discharge on receiving water;
- ii) analysis of downstream ecology water demand;
- iii) identification of environmental study area;
- iv) assessment of impacts on downstream water users; and
- v) environmental management plan.

A special meeting was held on Nov. 27, 2009 by the Guiyang PMO with participants of representatives from all EIA teams. Detailed comments on further revisions of the report were discussed and made available to the EIA team for the Liangchahe reservoir subproject and other EIA teams for other noncore subprojects (See Annex 6). A technical meeting was held in the Provincial Design Institute on December 2, 2009 to further discuss revisions of the draft EIA report for Liangchahe Reservoir subproject.

The EIA report after revision was intended to be a sample for other reservoir EIAs or IEEs. Unfortunately, the revised Liangchahe reservoir EIA was not made available by Feb. 28, 2010 though continuous efforts were made by the consultant to push forward.

2) Review of Draft EIA for Limu Reservoir Subproject

A draft EIA report was prepared by the Kunming Design Institute for the Limu Reservoir, one of the screened 5 Category A subprojects, following the format and
The consultant reviewed the report and regarded the report “unacceptable”. The comments on the EIA report for the subproject, provided by the consultant in September 2009, were ignored with major environmental impacts ignored. Additional comments were made available by the consultant to Guiyang PMO and the Kunming EIA team. Finally, the Guiyang PMO decided to dismiss the team and employ a better team, the Guiyang Water Design Institute (GWDI), who prepared the overall EIA for the GIWRMP, to take over. A draft Chinese version EIA report for the Limu Reservoir subproject is planned to be prepared by the GWDI by end of April, 2010.

3.2.4 Review of EIFs for noncore irrigation rehabilitation subprojects
The consultant reviewed two Chinese EIFs (Environmental Impacts Forms) prepared by local EIA teams for two irrigation rehabilitation subprojects and concluded that significant revisions (adjustments) are needed to meet ADB’s requirements on preparation of EA documents for such subprojects.

In order to make the revisions more effective and in good quality, the consultant suggested that one consolidated IEE be prepared by one qualified EIA team (to be employed by Guiyang PMO) for all the irrigation rehabilitation subprojects, instead of preparation of different IEEs for different subprojects by different EIA teams to be employed by county/district PMOs.

The Guiyang PMO and county/district PMOs agreed with the suggestion and the GWDI is suggested to prepare the consolidated IEE. A special meeting was held by the Guiyang PMO with the GWDI on Feb. 2, 2010. Following arrangements were reached:

1. The GWDI is to prepare the consolidated IEE for all the irrigation subprojects included in GIWRMP;
2. The Table of Contents for IEE prepared by the consultant (Annex 5) is to be followed in preparation of the consolidated IEE; and
3. Following environmental issues are to be mainly assessed: a. land use, b. irrigation water quality and quantity, c. impacts of irrigation retain water (run-off from farmland) on receiving water, d. impacts on groundwater, e. impacts on downstream water use, f. impacts during subproject construction, and g. dam safety (conclusions from dam safety panel).

A draft Chinese version IEE for irrigation rehabilitation subprojects is expected to be completed on 15 June 2010.
3.2.5 Preparation of IEEs for noncore soil conservation subprojects

No environmental assessment documents are needed for soil conservation subprojects according to current Chinese EA regulations and requirements. Therefore, no Chinese EIFs were prepared for soil conservation subprojects. But the SEAF requires that IEEs be prepared for all the soil conservation subprojects. The consultant suggested that one consolidated IEE be prepared by one qualified EIA team (to be employed by Guiyang PMO) for all the soil conservation subprojects. The Guiyang PMO and county/district PMOs agreed with the suggestion and the Guiyang Water Design Institute (GWDI) is suggested to prepare the consolidated IEE. At the special meeting held by the Guiyang PMO with the GWDI on Feb. 2, 2010, following arrangements were reached:

i) The GWDI is to prepare the consolidated IEE for all the soil conservation subprojects included in GIWRMP;

ii) The Table of Contents for IEE prepared by the consultant (Annex 5) is to be followed in preparation of the consolidated IEE; and

iii) Following environmental issues are to be mainly addressed: a. land use, b. impacts on reservoir water quality (especially use of chemical fertilizers and pesticides), c. prevention of species invasion, d. impacts of hill closures, e. impacts during subproject construction, and f. impacts on protected scenery (if any).

A draft Chinese version IEE for soil conservation subprojects is expected to be prepared by end of May 2010.

3.2.6 Preparation of an Environmental Report for small water storage subprojects

The GWDI is to prepare an Environmental Report for all the noncore small water storage subprojects included in GIWRMP. Comments on preparation of the report were provided by the consultant to the GWDI, which would be followed in preparation of the environmental report for all the small water storage subprojects.

A draft Chinese version Summary Environmental Report for the small storage subprojects is expected to be prepared by the end of May 2010.

3.2.7 Preparation of the EA plan for first batch subprojects

In the period of 23 February to 8 March 2010, major reasons of the delay in preparation of qualified Chinese version EIA/IEE reports were identified and a series correction measures were taken by the Guiyang PMO with assistance of the consultant. The first batch of noncore subprojects was selected and a specific plan has been prepared for the preparation of the EA documents for all and each of the first batch noncore subprojects. See Annex 13: Environmental Assessment Plan for First Batch noncore Subprojects The EA documents preparation for the first batch noncore
subprojects including preparation of draft English summaries is planned to be finished in July 2010.

3.3 English Summary of SEIA, SIEE and/or SEIRs

As mentioned above, due to the difficulties of the Guiyang PMO in its establishment and operation, and due to the delay of preparation of updated Chinese EA documents, delay in establishment and operation of a dam safety panel, and the delay of preparation of corresponding resettlement action plans, the English SEIA and/or SIEE and/or SEIR for noncore subprojects remain to be done later;

3.4 Establishment of Environmental supervision mechanism

3.4.1 Preparation of “Environmental Management Rules”

The SEAF indicates that “PMO and ADB have agreed that an Environmental Management Regulation for Project Construction (EMRPC) will provide the legal basis for the overall environmental management of the Project. The EMRPC will be developed by the SERMD of PMO. It will address the common environmental management and mitigation requirements and issues of all subprojects, which will include, but not be limited to a summary of: (i) the mitigation measures presented in the EIA/EIR, (ii) the project EMP, (iii) the applicable PRC environmental regulation and standards presented in the EMP, and (iv) the requirements for incorporation of environmental considerations into subproject construction tendering documents and contracts”.

According to above requirements, a draft “Environmental Management Rules for GIWRMP construction (Rules)” was prepared by the consultant in November 2009, which was reviewed and discussed during a special meeting held by Guiyang PMO on Dec 3, 2009. Comments on revision of the Rules were provided by representatives from Guiyang EPB, Guiyang Water Design Institute, Guizhou provincial Design Institute, and Guiyang Environmental Research Institute, as well as from Guiyang PMO. The draft Rules was updated in January 2010, which was finalized at a special
meeting held by Guiyang PMO and local PMOs on Jan. 29, 2010. The final Rules is to be made into effect by Guiyang PMO soon. **Annex 7** is an English version of the main text of the Rules.

As a key component of the environmental supervision mechanism to be established, the major objectives of the Rules include i) summarize and embody all the environmental protection measures (EPMs), identified in project EIAs, to be implemented by construction contractors; ii) clarify responsibilities of and relationships among all parties involved in project construction, including construction contractors, environmental supervision engineers (ESE), construction Engineer, as well as the PMO; and iii) clarify environmental enforcement procedures and liabilities in case of breach of the Rules.

The Rules would form basis for contractor’s implementation of EPMs, for ESE’s supervision, for Engineer’s cooperation, and for PMO’s environmental management.

3.4.2 Preparation of TOR for ESE
A draft TOR for Environmental Supervision Engineer (ESE) was prepared in Nov. 2009 by the consultant, which is to be applied when the ESE is selected and engaged. See **Annex 8**.

3.4.3 Engagement of ESE
The GWDI has been recommended to form a team to take the responsibilities of the ESE. The consultant discussed with representatives of the GWDI on objectives, tasks, procedures, and performance requirements of the ESE. The GWDI agreed to make a technical proposal to Guiyang PMO. The ESE is to be engaged by the Guiyang PMO after review and confirmation of the proposal. The ESE is to start working when construction of subprojects begins.

3.4.4 Preparation of clauses in subproject construction contracts
In order to make construction contractors to follow the Rules, clauses to be included in subproject construction contracts were prepared by the consultant, see **Annex 9**. The clauses are to be included in construction contracts for each subproject.

3.4.5 Preparation of clauses in Service Agreements of construction engineers
In order to make construction Engineers to follow the Rules, draft clauses to be included in Service Agreements of construction Engineers were prepared by the consultant, see **Annex 10**. The clauses are to be included in Service Agreements to be signed by Guiyang PMO and local PMOs with construction supervision Engineers.

3.4.6 Establishment of Environmental Supervision Mechanism
With the Rules to be included in project construction contracts and ESE to be engaged to work in subproject construction sites, and with the clauses mentioned above be included in corresponding contracts or agreements, an environmental supervision
mechanism is to be established in GIWRMP implementation. Follow-up environmental training program will be conducted by Guiyang PMO for ESE, PMO staff, construction Engineer, as well as for construction contractors to make the mechanism function smoothly and effectively.

3.5 External environmental monitoring

For external environmental monitoring purposes, an External Environmental Monitor (EEM) is to be employed. Based on current situations in China, the consultant suggested that a team comprising three qualified environmental experts be engaged by the PMO and the team will be responsible for the external environmental monitoring. A TOR for the EEM was prepared by the Consultant, which will guide the selection and engagement of the EEM by Guiyang PMO. See Annex 11.

Main tasks of the EEM include: i) evaluation of the implementation of the EMPs for subprojects; ii) assessment of effects of the mitigation measures; and iii) identification of gaps and making recommendations on needed correction actions.

The EEM will visit the project areas semi-annually during project implementation, about 10 days for each visit. The visit is to be organized and supported by the Guiyang PMO. Activities of the EEM include: i) review of documents/reports related to project EMPs implementation; ii) field visits to project areas/project affected areas/construction sites; iii) discussions with pertinent agencies or parties; iv) preparation of monitoring reports; and v) other activities regarded necessary by the team.

The EEM will prepare an external monitoring report before completion of each monitoring visit. The external monitoring report will be submitted to ADB and the PMO after each visit.

3.6 Environmental training

Environmental training on environmental management, environmental assessment, as well as on environmental monitoring has been provided by the consultant to Guiyang PMO, local PMOs, IAs (implementation agencies), and EIA teams through following activities:

i) International Workshop
In the International Workshop in Guiyang on Integrated Water Resources Management, November 9 - 11, 2009, the consultant presented a presentation on “Environmental Management in GIWRMP implementation”. Main topics of the presentation include:
a. concept and reasons of project-environmental management in China;
b. environmental management during project construction;
c. environmental supervision mechanism;
d. case study and examples.

Participants of the workshop included Guiyang governmental agencies including EPBs, Guiyang PMO, local PMOs, project IAs, and representatives of technical agencies and universities;

ii) Meetings
Over 5 formal meetings/trainings with Guiyang PMO and local PMOs were held by Guiyang PMO, in which trainings were provided by the consultant on environmental screening, environmental assessment, environmental supervision, and environmental management.

iii) Technical discussions
Over 6 formal technical discussions with EIA teams and local experts were held by the Guiyang PMO, in which training was provided by the consultant on guidelines on preparation of EA documents, comments on draft Chinese version EIR reports, and detailed guidance on preparation of Chinese EIAs and IEEs in accordance with ADB environmental policies and EA guidelines;

iv) Personal guidance/supervision
Personal guidance/supervision has been given by the consultant to the personnel assigned to take care of environmental issues in the Guiyang PMO. Four guys in the Guiyang PMO have been assigned the same job successively in the period of August 2009 to January 2010. Same guidance was given to the guys successively.

3.7 Environmental requirements in project operational manual

A draft Environmental Management section was prepared by the consultant in Feb. 2010, which is to be included as one section in the Operational Manual for the reservoir subprojects. See Annex 12. Major contents of the Environmental Management section include:

a. institutional arrangements fro environmental management during reservoir subproject operation;
b. major environmental tasks to be carried out, including water quality protection, guarantee of downstream ecology flow, investigation of subproject impacts, public consultation, environmental monitoring, and environmental training;
c. requirements on environmental reporting.

The draft Environmental Management section is to be updated with Guiyang PMO and to be included in the Operational Manual for reservoir subprojects to be prepared.
Annexes

Annex 1 Environmental Screening Forms
Annex 2 Several key issues to be observed in reservoir environmental assessment
Annex 3 Comments on Limu Reservoir EIA
Annex 4 Suggested Table of Contents of an EIA report
Annex 5 Suggested Table of Contents of an IEE report
Annex 6 Comments on Liangchahe Reservoir EIA
Annex 7 Environmental management Rules for GIWRMP construction
Annex 8 TOR for Environmental Supervision Engineer
Annex 9 Proposed Clauses in construction contracts
Annex 10 Proposed Clauses in Service Agreements
Annex 11 TOR for External Environmental Monitor
Annex 12 Environmental requirements in project Operational Manual
Annex 1(1) Environmental Impact Modified Screening Form

Subproject Name:___________________________________
Subproject Location:___________________________________

Subproject Design Indexes:
Dam height: _____m; Capacity: _______m³; Objectives___________;
Land requisition: ____ha; People to be resettled_____

Date:__________________________________

Question 1(ecology): Will the subproject directly or indirectly affect one or more of the
following: a) Notified or planned ecosystem as per national Guidelines on Sensitive Area; b)
Sensitive or critical area as per ADB environmental safeguard policies, natural forests, wetland
area, swamps etc; c) Significant habitats of species protected by national legislation (e.g., by
national Red Book) by IUCN Red Book or international environmental conventions, e.g.,
Convention on Migratory Species; and/or d) flora and fauna protected by national legislation.

Explanation (this may include design information, calculations, expert
opinion, and comments from local EPB, local WRB, and/or
stakeholders)

Yes/No/Unknown

Signed

Local Forest Bureau

Question 2 (culture relics): Will the subproject directly or indirectly affect Notified
or planned protected archaeological site or monument as per national Guidelines on
Sensitive Area;

Explanation

Yes/No/Unknown

Signed

Local Archaeological Bureau

Question 3 (water use): a) Will downstream environmental flows drop below
minimum requirements of downstream users during the dry season? b) Will the
subproject directly or indirectly affect existing drinking water resources of local communities? and c) Will the subproject adversely affect local uses of groundwater?

Explanation (this may include design information, calculations, expert opinion, and comments from EPB, WRB, and/or stakeholders)

Signed

Local Water Resources Bureau

**Question 4 (pollution control):** Will pollution such as industry and domestic wastewater be discharged into the proposed reservoir? If yes, does it exceed national emission standards?

Explanation (this may include design information, calculations, expert opinion, and comments from EPB, WRB, and/or stakeholders)

Signed

Local EPB

**Question 5 (land use):** Will the subproject significantly affect the use of local land resources?

Explanation (this may include design information, calculations, expert opinion, and comments from EPB, WRB, and/or stakeholders)

Signed

Local Land Resources Bureau

**Question 6:** This is space for an additional screening question/concern raised by the local EPB to account for any specific environmental concerns of the subproject that are not covered other screening questions.

Explanation (this may include design information, calculations, expert opinion, and comments from EPB, WRB, and/or stakeholders)
stakeholders)

Signed

__________________________

Proposed Environmental Categorization

[ ] A    [ ] B

Signed

__________________________    ______________________

Local EPB               Local

PMO
Annex 1 (2) Original Screening Form

Subproject Name

___________________________________

Date

___________________________________

**Question 1:** Will the subproject directly or indirectly affect one or more of the following: a) Notified or planned ecosystem as per national Guidelines on Sensitive Area; b) Notified or planned protected archaeological site or monument as per national Guidelines on Sensitive Area; c) Sensitive or critical area as per ADB environmental safeguard policies, natural forests, wetland area, swamps etc; d) Significant habitats of species protected by national legislation (e.g., by national Red Book) by IUCN Red Book or international environmental conventions, e.g., Convention on Migratory Species; and/or e) flora and fauna protected by national legislation.

Explanation (this may include design information, calculations, expert opinion, and comments from local EPB, local WRB, and/or stakeholders)

Yes/No/Unknown

**Question 2:** Will downstream environmental flows drop below minimum requirements of downstream users during the dry season?

Explanation (this may include design information, calculations, expert opinion, and comments from EPB, WRB, and/or stakeholders)

Yes/No/Unknown

**Question 3:** Will the subproject directly or indirectly affect existing drinking water resources of local communities?

Explanation (this may include design information, calculations, expert opinion, and comments from EPB, WRB, and/or stakeholders)

Yes/No/Unknown

**Question 4:** Will the subproject adversely affect local uses of groundwater?
Question 5: Will pollution such as industry and domestic wastewater be discharged into the proposed reservoir? If yes, does it exceed national emission standards?

Yes/No/Unknown

Question 6: This is space for an additional screening question/concern raised by the local EPB to account for any specific environmental concerns of the subproject that are not covered other screening questions.

Yes/No/Unknown

Proposed Environmental Categorization

|   | A | B |

Signed

LMB                Local EPB
Local WRB
Annex 2 Several Issues to be Observed in Reservoir EA

Xie/21 Sept. 2009 Guiyang

1. Project integrality

EA should cover not only reservoir/dam but also water supply facilities and water supply areas.

2. Indirect impacts

Indirect impacts should be assessed carefully, such as:
- **Industry water supply** - industry wastewater-pollutants-impacts on receiving water
- **Irrigation water** - runoff-pollutants-impacts on receiving water
- **Domestic water supply** - domestic wastewater-pollutants-impacts on receiving water

3. Impacts on downstream water users

Current water flow distribution - current downstream users - impacts of reservoir water storage on downstream water users.

4. Downstream ecology water release

Attention needs to be paid on the following:

1) **Necessity:**
   To be determined through analysis of current river flow and current downstream ecology situations

2) **Minimum flow**
   It’s not always adequate to determine the minimum water flow by 10% of the annual average flow. The current minimum flow needs to be considered.

5. Impacts on groundwater of reservoir surroundings

Analysis may be supplemented through investigations on groundwater situations of nearby similar existing reservoirs.

6. Resettlement

Following 3 aspects need to be assessed in resettlement EA

1) Social-economic program;

2) Environmental rational;

3) Necessary environmental facilities: safe water supply, drainage, sanitary toilets, solid waste management, health care and etc..

7. Other affected villagers

Are there any villagers who are affected but not included in resettlement program?
For example, those villagers who are in the area out of the reservoir red-lines but they are affected due to loss of public infrastructures and due to reservoir impounding.
1) transport, communication, infrastructures;

2) impacts of mosquito increase and rat escaping from reservoir inundation areas on public health of the villagers

8. **Cumulative impacts**

Cumulative environmental impacts of reservoirs on a river, in a basin.
Annex 3 Comments on Limu Reservoir EIR
Xie-22 Sept.2009

1. More data is needed on the nature, components, and distribution of the project affected landscape/sight seeing areas and nearby sight seeing spots, to be illustrated with maps.
   i ) Impacts of reservoir on Gaopo landscape and on nearest sight seeing spot?
   ii ) Impacts of irrigation canals on Gaopo and Qiantao landscapes ?
   iii ) Impacts of water supply pipelines on the ancient Qingyan Town?

2. The dam is in the Gaopo Landscape area, how to make (design) the dam/reservoir be “harmony” with the nature/environment?

3. At the peak period, a total of 180 construction workers would be in the dam construction area, how to prevent damages to the landscapes?

4. The EIR mentioned that all the earth needed for dam construction is to be bought from outside. How much earth is needed? Where does the earth come from? Environmental impacts of the earth excavation?

5. Further evaluation on the amount of the ecology water release flow is needed. 10% of the annual average flow(0.518 m³/s), 0.0518 m³/s? what is the current minimum flow?

6. Where does the water flow to before reservoir construction? Who are the major downstream water users? Impacts of the reservoir on downstream water users?

7. A formal confirmation letter from authorized government agency is needed to confirm that there are no state, local protected ecology areas in project areas.

8. A formal confirmation letter from authorized government agency is needed to confirm that there is no significant adverse impacts of the Limu reservoir subproject on the landscapes in the subproject area and that the agency has approved the subproject.
### Annex 4 Suggested EIA Table of Contents

Xie-Sept. 21, 2009

1. **Introduction**
   1.1 Purpose and Background
   1.2 Review of Project Preparation
   1.3 Legal Basis of EA
   1.4 EA Responsibilities and Inputs
   1.5 Contents of the Report
   1.6 Other Statements

2. **Project Description**
   2.1 Project Location
   2.2 Objectives and Benefits
   2.3 Project Components
   2.4 Land Requisition and Resettlement
   2.5 Implementation Design
   2.6 Schedule and Cost Estimates
   2.7 Summary

3. **Environmental Settings**
   3.1 Environmental Study Area
   3.2 Physical Resources
   3.3 Ecological Resources
   3.4 Economic Development Resources
   3.5 Social and Cultural Resources
   3.6 Summary

4. **Alternatives**

5. **Impacts Assessment and Mitigation Measures**
   5.1 Positive Impacts
   5.2 Adverse impacts
      1) Impacts during Project Construction
      2) Impacts during Project Operation
   5.3 Mitigation Measures
   5.4 Risk Analysis and Prevention Measures
   5.5 Summary
6. Economic Assessment

6.1 Major Economic Indexes
6.2 Environmental benefits
6.3 Environmental Losses
6.4 Environmental Cost/benefit Assessment

7. Environmental Management Plan

7.1 Introduction
7.2 Major Potential Impacts
7.3 Mitigation Measures
7.4 Summary of Environmental Monitoring Program

7.5 Institutional Arrangements
7.6 Environmental Construction Management
7.7 Technical Assistance and Training
7.8 Environmental Report and Supervision
   1. Report
   2. Supervision
7.9 Cost Estimates and Funding

8. Public Consultation and Information Disclosure

8.1 Public Consultation
8.2 Information Disclosure
8.3 Follow-up Program
8.4 Summary

9. Conclusions

9.1 Objectives and Benefits
9.2 Adverse Impacts prediction and Assessment of Mitigation Measures
9.3 Risk Analysis and Conclusions
Annex 5 Suggested IEE Table of Contents

Xie Sept.21, 2009

1 . Introduction

1.1 Purpose and Background
1.2 Contents of the Report
1.3 EA Responsibilities and Inputs
1.4 Other Statements

2 . Project Description

2.1 Location
2.2 Objectives and Benefits
2.3 Components
2.4 Land Requisition and Resettlement
2.5 Implementation Design
2.6 Schedule and Cost Estimates

3 . Environmental Settings

3.1 Environmental Study Area
3.2 Physical Resources
3.3 Ecological Resources
3.4 Economic Development Resources
3.5 Social and Cultural Resources
3.6 Summary

4 . Impacts Assessment and Mitigation Measures

5.1 Positive Impacts
5.2 Adverse impacts
   1 ) Impacts during Project Construction
   2 ) Impacts during Project Operation
5.3 Mitigation Measures

5 . Environmental Management Plan

5.1 Major Potential Impacts and Mitigation Measures
5.2 Summary of Environmental Monitoring Program
5.3 Institutional Arrangements
5.4 Environmental Report and Supervision
5.5 Cost Estimates and Funding

6 . Public Consultation and Information Disclosure

28
6.1 Public Consultation
6.2 Information Disclosure
6.3 Follow-up Program
6.4 Summary

7. **Findings and Conclusions**

7.1 Findings
7.2 Conclusions
Annex 6 Comments on Liangchahe Reservoir EIA report

Xie/Nov.27,2009/Guiyang

A. General
A.1 The Table of contents of the report has been adjusted in accordance with the TOC recommended by the consultant in Sept. 2009.
A.2 Big gaps exist. The issues raised by the consultant in Sept. 2009 were not tackled. Therefore significant revisions are needed.

B. Detailed Comments on Chapters/Sections
Chapter 1 Introduction
1.1 Purposes and Background
1 ) What is the purpose of the report? Should be described at very beginning.

2 ) The background here is to explain why we have this project and the relationship of the subproject with the overall project (GIWRMP).

3 ) Why we have this report?

1.2 Review of project preparations
The purpose of the section is to let reviewers to know the procedures of project preparation, to answer why this report is prepared till now. Describe domestic EA procedures and ADB EA procedures on the project.

1.3 Basis of the report
Four parts are suggested to be described.
1 Chinese laws, regulations, standards;
2 ADB policies, guidelines;
3 ADB documents on the project;
4 Comments of ADB mission members and consultants.

1.4 Tasks and Responsibilities
Were all the environmental assessments and mitigation measures (Chapter 5) done by one guy? Tasks assignments need to be clarified.

1.5 Components of the report
This section is to describe structure of the report, major contents of each chapter to let reviewer have a general understanding of the report. Not just put the TOC in a table.

1.6 Others
Move first paragraph here to Section 1.3 Basis.

Chapter 2 Project Description
2.1 Location
1 ) A special map is needed to illustrate the subproject location in Guiyang and location of Guiyang in China.
2) The names of places mentioned in report should be able to be found in maps. Otherwise, don’t mention them.

### 2.2 Objectives and Benefits

What are the subproject benefits? Increase of water supply is not a final benefit. The subproject is to supply water to an industry base. What is the benefit when the water is available to the base?

### 2.3 Project components

The section is to let reviewers know what is to be done. Please be aware that the reviewer is an EA reviewer not an Engineering reviewer and what are the major concerns of an EA reviewer.

1) The content is too simple, missing most important environmental information.

2) Major indexes such as dam height, storage capacity, regulating capability should be described.

3) The Map 4 needs to be updated.

(1) Only use the core part of the map or use a schematic map. The current map has too much unnecessary information.

(2) The project index table may be listed separately.

### 2.4 Land Requisition and Resettlement

1) Other land 70.23 mu, what are they?

2) How many people to be relocated? 7 (page 9) or 42 (page 29)?

### 2.5 Construction Design

1) Where are the “T2sh1”, “T1m2”, and “T1m1”? Every word in the report should be understandable to reviewers!

2) Project schedule may be presented in a simpler way.

3) Cost estimates may be simplified with a summary table.

### Chapter 3 Description of the Environment

#### 3.1 Project area

1) Project area should be clearly identified:

(1) Project affected areas: reservoir area, affected reservoir surrounding areas, dam area, water supply pipeline area, water supply area, and affected downstream area.

(2) Areas affecting project: watershed area, reservoir surrounding area.

2) Illustration maps are needed.
3) The “environment” should be the environment in the project area.

4) It should be made clear whether there are any protected areas, wet lands, important natural habitats, and protected fauna and flora.

5) Page 19, what are the biology in the river course?

6) What are the economic development resources? Please follow the outline of Sept.2009, GDP? Industries? Incomes (rural, urban)?

7) Nationalities? especially any minorities?

**Chapter 4 Alternatives**

Note that the alternatives should be evaluated mainly from environmental point of view.

1) The impacts of “do nothing” were not clearly analyzed. What’s the consequence of the “do nothing” alternative? what are the environmental impacts of the selected alternative? The descriptions of Section 4.1.2 are neither environmental impacts nor project benefits.

2) Other water supply alternatives: Are there any other water sources? How about ground water sources?

3) Different dam sites: a schematic map and a table is suggested to show the dam locations and the environmental impacts.

4) Whether different dam heights were considered?

**Chapter 5 Environmental Impacts Assessment**

**5.1 Positive Impacts**

The positive impacts described were not compelling:

1) Consuming materials is not positive impact;

2) Is the labor value created by construction workers, CNY 1.9045 million, a positive environmental impact?

3) To meet enterprise’s water demand is not definitely a positive environmental impact. Sometimes it may cause environmental disasters.

4) Other positive impacts listed were not compelling too.

**5.2 Adverse Impacts**

**5.2.1 Construction Period**

Following impacts were missed or need to be clarified:

1) Public health
   
   (1) construction workers with heavy tasks and poor living conditions may easily get sick;
   
   (2) The route between the dam site and the county seat will form flow of personnel and goods, which is a favorite condition for breakout of infective diseases.

2) river closure impacts: downstream water users, downstream ecology;

3) soil erosion

**5.2.2 Impacts in operation period**

Big gaps existed. Much more to be done.
1) impacts of industry water supply – downstream water quality
2) impacts on ecology impacts of inundation, impacts on downstream ecology due to change of river flow
3) impacts on current downstream water users
4) impacts on groundwater in reservoir surroundings
5) public health: impacts due increase of rat and mosquito density in reservoir surroundings
6) land use impacts due to land inundation especially the impacts on land use in the villages with land inundation
7) accumulate impacts/consistence with river basin planning
8) dam safety

Chapter 6 Economic Analysis

6.1 Economic indexes
A table is suggested to list major economic indexes.

6.2 Environmental benefits
1) direct benefits: increase of water supply should not be regarded as environmental benefits;
2) indirect benefits: need more rationale
   (1) how would the project solve grain safety problem ?
   (2) how much groundwater exploitation would be reduced ?
   (3) how would the reduction of groundwater exploitation reduce sickness disasters ?
   (4) how would the project favor steady progress in soil conservation after implantation ?
   (5) how would the project greatly improve agricultural infrastructures in project area ?

6.3 Environmental loss
1) the environmental resources compensation fees need to be listed item by item;
2) Only CNY 400,000 for all the environmental protection measures ? need to be re-estimated;
6.3 analysis and evaluations
How was the environmental benefit of the project, CNY117.8 million, estimated ?

Chapter 7 EMP

7.2 Summary of environmental protection measures
Update according to newly updated environmental issues;

7.3 Summary of environmental monitoring
Update according to newly updated environmental issues;

Sections 7.4 – 7.9
Update with the “Huanggang project EMP” provided as reference;

Chapter 8 Public consultation and information disclosure
1) a supplementary investigation is suggested because it has been more than two years since last investigation;
2) An additional public consultation and information disclosure needs to be conducted when the draft final EIA report is prepared; The draft final EIA report needs to be disclosed in local libraries, government websites; a consultation meeting needs to be held on the draft EIA report with stakeholders;
3) keep records of above consultation and disclosures;

**Chapter 9 Conclusions**

Update according to revisions mentioned above;
Annex 7 Environmental Management Rules

February 2010

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Abbreviations
CC Construction Contractor
CR Chlorine Residual
CSE Construction Supervision Engineer
EIA Environmental Impact Assessment
ERD Environment & Resettlement Division
EPB Environmental Protection Bureau
EPM Environmental Protection Measure
ESE Environmental Supervision Engineer
GIWRMP Guiyang Integrated Water Resources Management Project
PMO Guiyang Project Management Office
Chapter 1

1.1 General

Clause 1.1 The Environmental Management Rules (Rules) for Construction of the Guiyang Integrated Water Resources Management Project (GIWRMP) has been prepared by the Guiyang Project Management Office (PMO).

Clause 1.2 The preparation of the Rules is based on following documents:

1. Loan Agreement between PRC and ADB for GIWRMP;
2. Pertinent national and Guizhou provincial laws, regulations, standards applicable to GIWRMP;
3. The approval document of the Ministry of Environmental Protection on the project;
4. Memorandum of ADB appraisal mission with Guiyang municipality government (March 2009);
5. Environmental Management Plans for subprojects of the GIWRMP.

Clause 1.3 The main purpose of the Rules is to ensure implementation of the environmental protection measures required in above mentioned documents in the period of GIWRMP construction.

Clause 1.4 The Rules is applicable only to GIWRMP construction areas (including construction sites and affected areas) and camp areas.

Chapter 2 Environmental Management and Supervision

Clause 2.1 The Environment and Resettlement Division (ERD) of Guiyang PMO shall, on behalf of the PMO, be fully responsible for GIWRMP environmental management. The environmental personnel in county/district PMOs, directed by Guiyang PMO, is responsible for environmental management in subprojects in the county/district.

Clause 2.2 Environmental supervision is a complement and extension of engineering supervision. The Environmental Supervision Engineer (ESE) is entrusted by the PMO to environmentally supervise the construction activities of all construction contractors (CCs) involved in GIWRMP construction during the period of construction.

Clause 2.3 For those non-significant environmental problems existing in construction areas or camping areas, the ESE may orally ask responsible CC to resolve and the CC shall resolve its problems following ESE’s instructions.

Clause 2.4 For those significant environmental problems existing in construction areas or camping areas, the ESE shall prepare and sign an “Environmental Notice” to, through site Construction Supervision Engineer (CSE), pertinent CC and require the CC to solve the problem within a specified time limit. The CC shall take all measures possible to solve the problem within the time limit in accordance with ESE’s requirements and afterwards report the results to the ESE.
Clause 2.5. In case that the CC refuses to solve the problem or the problem is not solved after the specified date, the ESE, after consultation with the ERD and CSE, shall, through the CSE, sign and issue an “Environmental Action Notice” to the CC. And the ERD or other qualified institutions assigned by the ERD shall enter, 14 days (7 days in special cases) after the notice issuing, the site and take actions to solve the problems. All the cost increase and damages to the PMO due to the actions shall be borne by the CC and shall be deducted from the next monthly payment to the CC.

Clause 2.6. All written notices or communications between the ESE and CC shall be via the site CSE.

Clause 2.7. The CSE shall follow the requirements of the Rules and cooperate actively with ESE’s work:

1. Timely notify CCs of ESE’s personnel, their responsibilities and their power of environmental supervision at site;
2. Timely notify ESE of any existing environmental problems found;
3. At no conditions and with no delay, sign of receiving and issuing or transfer any notices and correspondences between the ESE and CCs. The ESE will bear the consequences due to the notices and correspondences.

Clause 2.8. The CSE shall support the PMO in its claiming on CCs following Clause 2.5. The PMO will take full responsibilities of the claim.

Clause 2.9. All CCs shall strengthen environmental education and awareness for their employees such that they will consciously follow environmental protection laws, regulations, standards, contract provisions as well as the Rules. Any violation of the said documents will be punished in accordance with pertinent stipulations.

Clause 2.10. All CCs shall, according to the nature of the project and their construction activities, establish environmental management systems and assign special environmental staff to be responsible, under guidance of the ESE, for environmental management.

Clause 2.11. All CCs shall establish their internal environmental management systems, assign environmental personnel to carry out, with guidance of the ESE, environmental protection tasks in their responsible areas including areas of their sub-contractors.

Clause 2.12. All CCs shall conduct their own environmental monitoring on issues or parameters as required by the Rules or by the ESE and provide the ESE with a monthly report on their environmental protection activities and monitoring results of each month. The contents and formats of the monthly report shall be consistent with the requirements of the ESE and shall be satisfactory to ESE. The ESE may require CCs to modify or update the contents and formats of their monthly reports.
Clause 2.13 All CCs must ensure that all pollution control measures proceed simultaneously with their construction and operating activities.

Clause 2.14 All CCs shall establish public awareness plates at appropriate positions to inform public about their construction activities, timing, contact ways etc.. CCs shall actively take measures to properly settle, including holding liabilities, any environmental disputes with residents or entities due to their construction or daily activities.

Clause 2.15 Regular or special environmental monitoring may be conducted by agencies or institutes entrusted by the ERD in the construction areas and camping areas. The monitoring shall be arranged by the site CSE and informed in advance to pertinent CCs. All pertinent CCs shall make efforts to cooperate those monitoring activities.

Clause 2.16 The environmental management of GIWRMP shall be supervised by environment agencies of local governments. The ESE and all CCs shall actively cooperate with environmental supervisions and inspections of the agencies.

Chapter 3 Water Pollution Control

Clause 3.1 All CCs shall incorporate environmental protection and effective water resources utilization into their work plans including implementation of wastewater treatment measures.

Clause 3.2 All CCs and other organizations with wastewater discharge shall comply the wastewater discharge standards listed in Attachment 1. Any wastewater discharge shall not affect the functions of the water body receiving the wastewater.

Clause 3.3 All CC’s shall take measures to reduce wastewater discharges, including domestic and production wastewater. For those wastewater necessary to be discharged following measures shall be taken:
(a) Since the wastewater stemming from foundation excavation, quarry operation, and aggregate processing contains plentiful suspended substance, CCs shall provide, according to the design requirements, purification facilities such as sumps, detention dikes or settlement pools etc. to ensure that SS in the discharged wastewater satisfies the standard;
(b) All equipment washing wastewater shall be collected and treated separately. Direct discharge without treatment is prohibited.
(c) All domestic wastewater shall be firstly fermented and disinfected through septic tanks and then centrally treated or transmitted through special pipelines to harmless water body; and
(d) Wastewater from medical care clinics and hospitals shall be treated as stipulated in the “Integrated Wastewater Discharge Standard” (GB8979-1996).

Clause 3.4 Monitoring shall be exercised and reported by all CCs on the wastewater they discharged. In case of any discharge of wastewater exceeding the standard or that the discharge of
wastewater has virtually affected the function of the receiving water, the CC discharging the wastewater shall take necessary correction actions.

Clause 3.5 Surface water shall be prevented from pollution as follows:
(a) Any oil, acid liquid, alkaline liquid, or any other toxic liquid shall not be allowed to be discharged into any water body; Any container ever used to hold oil or any other toxic pollutant shall not be washed in the water body; Any production spoil material, domestic rubbish, and any other wastes shall not be discharged or poured into water body; Any liquid and solid waste with a radiation intensity exceeding the standard shall not be discharged into the water body.
(b) Fuel-tank farms and chemical storehouses shall be provided with protection measures, as required by the design and contract documents, to avoid soil and water pollution.

Clause 3.6 Groundwater shall be prevented from pollution as follows:
(a) No seepage pit or well or crack shall be used to discharge wastewater;
(b) Any chemical material to be applied to the cut-off works shall not be allowed to cause groundwater pollution; and

Chapter 4 Air Pollution Control

Clause 4.1 The environmental air quality in residential area and those construction areas without construction operations shall be in compliance with the standards listed in Attachment 1.

Clause 4.2 Any waste gas and dust arising from construction and production operations shall be in compliance with the standards specified in the “Integrated Emission Standards for Air Pollutants” (GB 16297-1996) as listed in Attachment 2.

Clause 4.3 Construction machinery waste gas discharge shall follow requirements:
(a) The smoke from any diesel machinery and equipment shall be in compliance with the limit of FSN4.0 for smoke emission from “Fixed-Model Diesel Engines” as stated in the “Standards for Smoke Emission from Diesel Engine of Vehicles at Full Load” (GB14761.7-93) and with the limit as stated in the “Standard for Smoke Emission from Diesel Vehicles at Free Acceleration” (GB14761.6-93).
(b) The concentration of pollutants from any gasoline machinery and equipment shall be in compliance with the following standards:
   (b.1) The concentration of pollutants from a light vehicle shall be in compliance with the limit as stated in the “Standards for Exhaust Pollutant Emission from Light Vehicles” (GWPBI-1999);
   (b.2) The concentration of pollutants from a gasoline engine of a vehicle shall be in consistency with the limit as listed in the “Standards for Pollutant Emission from Gasoline Engine of a Vehicle” (GB14761.5-93).
Clause 4.4  Aggregate processing and batching plant operations shall be provided with dedusting measures to meet corresponding environmental and labor protection requirements, and to avoid possible environmental pollution and worker health damage.

Clause 4.5  Before blasting operations, CCs shall submit blasting plan to ESE for approval. Blasting and work-face watering shall be linked to minimize environmental pollution and worker health damage due to fume and toxic gas.

Clause 4.6  To avoid blown dust or person injury due to fallen material being hauled, vehicles hauling cement, lime and rubbish among others shall be closed and covered. When construction is carried out in city (town) area or residential area, to avoid air pollution due to secondary blown dust on roads, all construction roads at the Site shall be watered and the quantity and frequency of the watering shall meet ESE’s requirements and be fully recorded.

Clause 4.7  Any material susceptible to contributing toxic/harmful smoke or objectionable smell shall not be burned at the Site. Wherever it does be necessary to burn such material, advance agreement shall be obtained from local environmental government agencies and control measures shall be taken with supervision by the ESE.

Chapter 5  Noise and Electromagnetic Radiation Pollution Control

Clause 5.1  Noise Control

1) The noise in camping areas and construction areas without construction operations shall be in compliance with the standards listed in Attachment 1.

2) The noise on both sides of highways shall be in compliance with the standard for Category D in the GB3096-93, i.e. $L_{Aeq}$ not more than 70 dB(A) during day hours and not more than 55 dB(A) during night hours.

3) Frequent and occasional abrupt noise shall be in consistency with clause 5 of GB3096-93.

4) Noise at construction sites shall meet the requirements of “Noise Limit for Construction Sites” (GB 12523-90). Any construction equipment expected to have a noise level above the standard shall not be allowed into the Site.

5) Traffic noise shall be in compliance with the standards as stated in the “Noise Standards for Vehicles” (GB1495-79).

6) At work areas exposed to high level noise, the standards for workers protection stipulated in the “Sanitary (Noise) Standards for Industrial Enterprises” (GB12348-90), shall be followed, i.e. noise level is preferably not more than 90 dB(A) and is not allowed to be more than 115 dB(A) when ear plugs are not provided; and preferably not more than 112 dB(A) and not allowed to be more than 120 dB(A) when earplugs are provided.

Clause 5.2  To prevent noise nuisance, following regulations shall be followed in camping areas and construction areas without construction operations:

(a) No agency or individual shall be allowed to use any tweeters;
(b) Any vehicle entering into the camping areas or residential areas shall not be allowed to press high-voice or strange-voice horns;
(c) Necessary public address or use of sound equipment shall be properly arranged so as not to affect normal public work, study, and rest.
(d) Noise disturbance arising from electric saw and drill operations shall be prevented.

Clause 5.3 Contractors working in the vicinity of urban areas, camps and residential areas shall properly arrange their work time to mitigate or avoid noise and shock disturbance. Construction in the period of 12:00 to 14:00 and of 22:00 pm to 7:00 am is not allowed. In special cases that construction in such period has to be carried out, permit has to be obtained from pertinent government agencies and corresponding measures have to be taken as required.

Clause 5.4 All CCs shall try their best to use low noise equipment. For high noise equipment noise isolation room or sound barrier shall be established.

Clause 5.5 The ESE may ask CCs to carry out noise monitoring in sensitive locations within their sponsored areas.

Clause 5.6 Electromagnetic radiation pollution control shall be carried out in accordance with pertinent national regulations.

Chapter 6
Spoil Materials and Solid Waste Treatment

Clause 6.1 Any spoil material and solid waste due to construction operations shall be moved to designated disposal sites, as required by project design and contract documents in accordance with the “Law of Solid Waste Pollution Prevention and Control” rather than willfully piled at unauthorized locations. Any area for holding such spoil materials and solid wastes (including other materials fields) shall be provided with engineering protection measures, as specified in project design documents, to avoid possible landslide and soil erosion.

Clause 6.2 All CCs shall furnish temporary facilities to store their rubbish. The rubbish shall be regularly cleared and moved to designated sites and buried in accordance with pertinent requirements.

Clause 6.3 Any solid waste containing lead, chromium, arsenic, mercury, cyanogen, sulphur, copper and pathogens among other harmful and toxic things shall not be allowed to willfully discharge or directly bury into ground. The treatment of such waste shall be reported to ESE and PMO. Permission shall be obtained through PMO from local government agencies and treatment shall be carried out under supervision of ESE.

Chapter 7
Public Health

Clause 7.1 Anti-epidemic Programs
(a) All CC’s employees shall go to qualified health authorities, accepted by the EMO, for physical examinations before they set foot on the Site. Those who do not pass the examinations shall not be allowed to the Site.

(b) All CCs shall have physical examinations for their employees at least once a year and establish corresponding individual health files. Food staff shall obtain post certificates in accordance with requirements stipulated in the “Law of Food Sanitation” and take their posts with certificates.

(a) The epidemic situation shall be carefully watched by all CCs. Any evidence that an epidemic may be happening shall be immediately reported to local anti-epidemic agency and adequate emergency control measures shall be taken. At the same time, the ESE shall be informed of the epidemic situation.

Clause 7.2 Rat Killing
All living and working areas and facilities shall be disinfected and cleaned on a regular basis. Rat density investigation shall be carried out by CCs according to ESE requirements. The density shall be controlled under 3% (rat trace method), otherwise forceful rat killing measures shall be taken to prevent plague, hemorrhagic fever, and leptospirosis from occurring. The poison used to kill rats shall be confirmed by ESE which shall neither cause any risk to human health nor pose any secondary environmental pollution.

Clause 7.3 Insect-borne Diseases Control
All CCs shall take measures to kill mosquitoes and flies to control malaria, encephalitis, and food pollution diseases. Concentrated mosquito killing and fly killing shall be conducted three times annually (in July, August, September). The poison used to kill mosquitoes and flies shall neither cause any risk to human health nor pose any secondary environmental pollution.

Clause 7.4 Water-borne Diseases Control

(a) Drinking water shall meet the requirements of the “Sanitary Supervision and Management for Drinking Water” and the “Sanitary Standards for Drinking Water” (GB5479-2005).

(b) To protect drinking water source, distinct sanitary protection zone shall be identified. In case of a surface drinking water source, discharge of production and domestic wastewater and stockpile of rubbish shall not be allowed 1,000 m upstream and 100 m downstream of the water-taking place. If the drinking water is from groundwater, the well collar shall be 30-50 cm above the surrounding ground, and well platform and cover shall be provided to prevent water pollution due to invasion of precipitated water.

(c) Concentrated drinking water supply system shall be purified and disinfected with chlorine as required in relevant sanitary standards. CCs shall keep daily records of chlorine consumption, chlorine residue at pipeline terminals (water taps) and operation of the chlorine application system and shall submit a monthly report to the ESE. Any new equipment and pipelines or
newly repaired pipelines shall be carefully cleaned, disinfected, inspected and certified before put into use.

(d) Chlorine residual and total coliform bacteria shall be monitored once a month for drinking water quality at representative water taps selected. Also, a full-scale analysis of drinking water shall be carried out once a year. Any problem shall be promptly dealt with as instructed by the ESE.

Clause 7.5 Excreta Management

In construction areas with highly concentrated construction workers, the treatment of excreta and garbage shall follow the standards in Table 1 (Sanitary Standards for High Temperature Compost) of the “Harmless Treatment Standards for Excreta and Garbage” (GB7959-87). Water flush toilets and high efficient septic tanks shall be set up by all CCs in places where they are required. Dry toilets free from fly, maggot and foul, and free from environment pollution are allowed where people are scattered. However, harmless treatment shall be made to the night soils.

Chapter 8
Wild Life and Rare Species Protection

Clause 8.1 All CCs shall pay due attention to protection of wild life in their construction activities and reduce as much as possible damage to eco-environment.

Clause 8.2 Ground clearing during project construction shall be with the designed area.

Clause 8.3 All CCs shall enhance public awareness of wild life protection, strengthen the cognition of wild life and eco-environmental protection. Hunting and deforesting is prohibited. Any hunting and deforesting actions shall be promptly stopped and reported to the ESE and relevant agencies for proper treatment. Protection actions shall be immediately taken if a rare species or habitat is discovered or suspicious. Then it shall be reported to pertinent agencies and the ESE for proper treatment.

Clause 8.4 Fishing is prohibited in any river in construction areas.

Chapter 9
Land Use, Water Conservation and Greening

Clause 9.1 All CCs shall save on land use as required in the Project design and Contract Documents. Wherever any land is temporarily used for material stockpilling, transportation and building purposes beyond the design and Contract Documents, the CC shall apply to the PMO who will be responsible for application of land use to local land administrative agencies. Such land shall not be used unless an approval is obtained.

Clause 9.2 Topsoil shall be properly reserved to restore or re-plough the land used by temporary Works upon their completion.

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Clause 9.3 All CCs shall take measures, in construction activities, to prevent erosion and to avoid damage to vegetation and other environmental resources in close compliance with the Project design and contract documents. To this end, it is required that:

(1) Land leveling shall be ensured in borrow area to prevent soil erosion when soil and aggregate borrowing and processing operations are carried out;

(2) Engineering or biological measures shall be taken, in light of the local topography and geology, to prevent landslide, bankcaving or erosion during construction of dike, culvert, and road. No soil, sand or rock should be borrowed from any place subject to landslide or bankcaving.

(3) Any river, gully, canal in construction areas shall not be blocked by CC’s construction disposals to prevent serious erosion.

(4) CCs shall clear their construction sites and do land leveling as required by project plan and design documents when project is completed.

Chapter 10
Cultural Relics

Clause 10.1 All CCs shall enhance public awareness of cultural relics protection and promote their employees’ self-consciousness of cultural relics protection and their abilities of preliminarily identifying relics.

Clause 10.2 Being property of the Government, any underground or surface cultural relics shall not be grabbed by any organization or individual.

Clause 10.3 Whenever any cultural relics (or considered to be cultural relics) are discovered in construction activities, the work shall be immediately suspended for proper measures to be taken to prevent removal of or damage to such. Also, the ESE and cultural relics departments shall be promptly informed and their instructions to cultural relics salvation shall be followed.

Clause 10.4 CCs shall report to ESE of their finding and treatment of cultural relics (if the CCs are required to be involved in treatment activities).

Clause 10.5 The suspended works shall be restarted only when permission is obtained from pertinent government agency.

Chapter 11
Scenery Area Protection
Clause 11.1 The Scenery area mentioned in the Rules refers to the area which is approved to be protected scenery area by State Council or by provincial government. The range of the area is the area designated.

Clause 11.2 While carrying out construction activities in or near scenery area, CCs shall take measures to protect the area according to the requirements of the “Scenery Area Regulations, State Council, 2006” and the “Guizhou Scenery Area Protection Stipulations, Qianfa 31, 1995” and the Rules.

Clause 11.3 Before entering construction sites, permission shall be obtained by CCs from pertinent government agency. Before commencing, CCs shall submit their construction plan to ESE for approval and training on scenery protection shall be conducted to CC’s construction workers.

Clause 11.4 CCs shall control land occupation according to project design. Construction or excavation over designated area is prohibited.

Clause 11.5 All construction workers shall work and live in designated areas. No hunting, trees cutting, or fruit collecting, which are not necessary project construction activities, are prohibited.

Clause 11.6 No spoil disposal sites, borrow areas, oil storage, and explosive storage are allowed in scenery areas.

Clause 11.7 No wastewater is allowed to be discharged in scenery areas. Production wastewater or domestic wastewater shall be reused after treatment.

Clause 11.8 CCs shall control their waste gas, dust, road dust, and noise in accordance with ESE’s requirements.

Clause 11.9 Disposal of construction spoils and domestic solid wastes in scenery areas is prohibited. Construction spoils and domestic solid wastes shall be properly collected and timely moved to designated places for treatment.

Chapter 12 Utilization of the Rules

Clause 12.1 The Rules shall be put into effect from 1 February 2010.

Clause 12.2 All the laws, regulations, standards cited in the Rules are the current national or local ones. If any new national or local laws, regulations, and standard are issued, this Rules shall be promptly updated.

Clause 12.3 Guiyang PMO reserves the right to interpret the Rules.
**Annex 8 Terms of Reference for Environmental Supervision**

**Engineer**

Xie Qingtao

(February 2010)

**Background**

1. The ADB is providing a loan in an amount of US$ 150 million to the People’s Republic of China for a Guiyang Integrated Water Resources Management Project (GIWRMP). The project will finance Guiyang Municipality Government in utilizing scarce water resources by improving conservation, management, and development of water resources in Guiyang municipality.

2. There are five key infrastructure development activities to be financed with the ADB loan:

   (i) **Urban Water Supply** comprising the establishment of one medium-sized reservoir and two small reservoirs, including the construction of dams, water conveyance tunnels, transmission pipelines, four water treatment plants, and the extension of the municipal water distribution networks.

   (ii) **Rural Water Supply and Irrigation** comprising the construction of up to 43 small reservoirs, including about 3 for county water supply, 20 for water supply and irrigation at the township level, and 20 for human and livestock water supply and small irrigation systems. Many of these include investments in water conveyance systems, small township water treatment facilities, and irrigation systems.

   (iii) **Irrigation System Rehabilitation** comprising rehabilitation and upgrading of up to nine irrigation systems covering a total area of 195,447 mu (13,030 hectares [ha]), including installation or repair of intake structures, canals, and aqueducts.

   (iv) **Soil and Water Conservation** comprising farmland restructuring, conversion of sloping farmland to terraces and tree or grass planting, and fruit tree planting, to protect the upper catchments of the water sources (about 800 square kilometers [km²]) from soil and water losses.

   (v) **Small Water Storage Structures** comprising the provision of up to 105,100 small water storage tanks in rural areas to catch spring water for human consumption, and rainwater for irrigation and livestock consumption.

4. For ADB’s environmental assessment purposes, the Project has been classified as Category A. The Project will be implemented under a sector loan modality, and six core subprojects have been prepared to ADB standards. Three EIAs for core reservoir subprojects and three initial environmental examinations (IEEs) for the other core subprojects were completed.

4. A Summary Environmental Assessment Framework (SEAF) has been prepared to ensure that, for all activities financed by the project, all efforts are made to avoid and minimize environmental and social impacts; and where they cannot be avoided, these impacts are identified and necessary...
mitigation measures are developed and implemented following relevant Chinese laws and regulations and ADB policies.

**Environmental Supervision Engineer (ESE)**

5. In order to ensure EMP implementation, the SEAF requires that “the PMO will adopt the environmental supervision engineer (ESE) mechanism to supervise the Contractors’ environmental performance”.

6. Major task of the ESE is to supervise on spot the environmental performances of construction contractors to ensure actual implementation of the mitigation measures, identified in project EIAs and included in project EMPs to be implemented by construction contractors during project construction. Activities of the ESE include:

   i) supervision on construction sites of contractor’s environmental performance;

   ii) preparation of supervision log files;

   iii) preparation of “environmental notices” to contractors;

   iv) preparation of “environmental action notices” to contractors;

   v) preparation of “monthly environmental supervision reports”, “semianual environmental supervision reports”, and “special supervision reports” to Guiyang PMO;

   (vi) coordination with project engineering supervision Engineer on project environmental issues; and

   vii) other activities necessary for environmental supervision or required by Guiyang EMO.

**Qualification Requirements for the ESE**

7. The ESE is to be organized by an institute/entity with engineering supervision certificate. The ESE is to be consisted by following professionals:

   i) project / environmental management, chief engineer;

   ii) environmental assessment;

   iii) pollution control;

   iv) public health;

   v) ecology protection.

**Selection of the ESE**

8. The ESE will be selected and engaged by Guiyang PMO
Environmental Protection

1. Compliance with the “Environmental Management Rules for GIWRMP construction”
In order to effectively protect environment in project construction, an “Environmental Management Rules for GIWRMP construction (Rules)” has been prepared by Guiyang PMO. The Rules has been formally made into effect on February 2010 and has been distributed to all bidders. The Rules has been attached in the construction contract as Attachment ?.

The contractor consent that the contractor will follow the requirements in the Rules during construction of said subprojects, accept the supervision of the ESE, and implement all the environmental management and environmental protection measures.

2. Payment
The cost to implement the Rules by the contractor has been included in the unit prices of subproject components. No additional payment is to be requested by the contractor.
Annex 10 Clauses to be Included in Service Agreements

by Xie Qingtao
Nov. 2009

Environmental Protection

1. Compliance with the “Environmental Management Rules for GIWRMP construction”
In order to effectively protect environment in project construction, an “Environmental Management Rules for GIWRMP construction (Rules)” has been prepared by Guiyang PMO. The Rules has been formally made into effect on February 2010.

The construction Engineer consent that the Engineer will follow the requirements in the Rules during construction of said subprojects, cooperate with the ESE, and support the measures taken by the PMO in implementing the Rules.

2. Payment
The cost to implement the Rules by the Engineer has been included in the Service Agreement signed by the Engineer with the PMO. No additional payment is to be requested by the Engineer.
Annex 11 Terms of Reference for External Environmental Monitor

Xie Qingtao
(10 Feb. 2010)

Background:
1. The ADB is providing a loan in an amount of US$ 150 million to the People’s Republic of China for a Guiyang Integrated Water Resources Management Project (GIWRMP). The project will finance Guiyang Municipality Government in utilizing scarce water resources by improving conservation, management, and development of water resources in Guiyang municipality.

2. There are five key infrastructure development activities to be financed with the ADB loan:

   (vi) **Urban Water Supply** comprising the establishment of one medium-sized reservoir and two small reservoirs, including the construction of dams, water conveyance tunnels, transmission pipelines, four water treatment plants, and the extension of the municipal water distribution networks.

   (vii) **Rural Water Supply and Irrigation** comprising the construction of up to 43 small reservoirs, including about 3 for county water supply, 20 for water supply and irrigation at the township level, and 20 for human and livestock water supply and small irrigation systems. Many of these include investments in water conveyance systems, small township water treatment facilities, and irrigation systems.

   (viii) **Irrigation System Rehabilitation** comprising rehabilitation and upgrading of up to nine irrigation systems covering a total area of 195,447 mu (13,030 hectares [ha]), including installation or repair of intake structures, canals, and aqueducts.

   (ix) **Soil and Water Conservation** comprising farmland restructuring, conversion of sloping farmland to terraces and tree or grass planting, and fruit tree planting, to protect the upper catchments of the water sources (about 800 square kilometers [km²]) from soil and water losses.

   (x) **Small Water Storage Structures** comprising the provision of up to 105,100 small water storage tanks in rural areas to catch spring water for human consumption, and rainwater for irrigation and livestock consumption.

2. For ADB’s environmental assessment purposes, the Project has been classified as Category A. The Project will be implemented under a sector loan modality, and six core subprojects have been prepared to ADB standards. Three EIAs for core reservoir subprojects and three initial environmental examinations (IEEs) for the other core subprojects were completed.

4. A **Summary Environmental Assessment Framework (SEAF)** has been prepared to ensure that, for all activities financed by the project, all efforts are made to avoid and minimize environmental and social impacts; and where they cannot be avoided, these impacts are identified and necessary
mitigation measures are developed and implemented following relevant Chinese laws and regulations and ADB policies.

**External Environmental Monitor (EEM)**

5. In order to ensure EMP implementation, The SEAF requires that “the PMO will, with Government counterpart financing, employ a third-party or external environmental monitor to regularly monitor the key environmental parameters in the affected areas”.

6. It was proposed that a team comprising 3 qualified environmental experts is to be engaged by the PMO by end of March 2010. The team will be responsible for the external environmental monitoring.

7. Main tasks of the EEM include: i) evaluation of the implementation of the EMPs for subprojects; ii) assessment of effects of the mitigation measures; and iii) identification of gaps and making recommendations on needed correction actions.

8. The EEM will visit the project areas semi-annually during project implementation, about 10 days for each visit. The visit is to be organized and supported by the Guiyang PMO. Activities of the EEM include: i) review of documents/reports related to project EMPs implementation; ii) field visits to project areas/project affected areas/construction sites; iii) discussions with pertinent agencies or parties; iv) preparation of monitoring reports; and v) other activities regarded necessary by the team.

**Qualification Requirements for the Environmental Experts:**

9. Following qualifications for the environmental experts are required:
   - i) Technical certificate: senior engineer or higher;
   - ii) Environmental management/assessment experience: 8 years or more;
   - iii) Environmental experience with ADB/World Bank projects: 3 years or more.

**Selection of the Environmental Experts**

10. The environmental experts will be selected and engaged by Guiyang PMO following Chinese procedures and requirements. The EEM is to be financed by Guiyang PMO with Government counterpart financing.

**Deliverables**

11. The EEM will prepare an external monitoring report before completion of each monitoring visit. The external monitoring report will be submitted to ADB and the PMO after each visit.

(Xie/Feb., 2010)

Environmental Management
When construction of a reservoir subproject is completed the reservoir is to be put into operation. Accordingly, environmental management in reservoir operation period is to be started.

1. Institutional Arrangements
After completion of a reservoir subproject, the responsibilities of reservoir subproject management will be shafted from PMO to reservoir management agency. Accordingly, the responsibilities of environmental management for the reservoir subproject will be shafted from PMO to reservoir management agency.

An environmental management office (group, EMO) is to be established in the reservoir management agency to be responsible for environmental management in the operation period of the reservoir. The staff of the EMO shall be formed mostly by the personnel currently in the PMO.

Environmental personnel is to be assigned in each reservoir management division (station) to be responsible, with guidance from the EMO, for environmental management during operation period of the reservoir.

2. Major Tasks
Major tasks on environmental management during reservoir operation period include:
1) Water quality protection
In addition to water quality monitoring, investigation on water pollution sources in watershed areas, prevention and control of new pollution sources, and promotion of control of current water pollution sources shall be carried out. Meanwhile, emergency response system on reservoir pollution accidents is to be established by the EMO with pertinent agencies to protect reservoir water quality. The investigation of water pollution sources is to be conducted twice a year.

2) Guarantee of Downstream ecology flow
A minimum downstream ecology flow is required, in project EIA, to be released from each of some reservoirs to protect downstream ecosystems. During reservoir operation period, the EMO and environmental personnel will be responsible for supervision and investigation of the release of the ecology flow to ensure actual and adequate release of the flow. The supervision and investigation is to be organized by the EMO. In case of that the ecology flow is not ensured or the released ecology flow is too low to meet demand of downstream ecosystems, the EMO shall cooperate with pertinent agencies to ensure release of ecology flow or to adjust (increase) flow to meet demand of downstream ecosystems.

3) Investigation of actual environmental impacts
When a reservoir is impounded and put into operation the actual impacts of the reservoir on surrounding environment shall appear. The EMO shall organize investigation of the impacts including impacts on groundwater, downstream ecology, downstream water environment, and downstream water users. The investigation is to be conducted twice a year. If any significant problem is found through investigation the EMO shall report to reservoir management agencies and correction measures need to be taken.

4) Public consultation and information disclosure

During reservoir operation period, regular public consultation and information disclosure needs to be carried out with affected groups and stakeholders. The affected groups include groups affected due to reservoir inundation, reservoir construction, and change of river flow. Such groups include resettled people, host villagers, villagers or residents in reservoir surrounding areas, and original downstream water users before reservoir construction. Public consultation forms include interview, questionnaire, and hearing meetings. Information disclosure includes disclosure of those investigation results and correction measures to be taken etc..

5) Environmental monitoring

Environmental monitoring shall be carried out during reservoir operation period. The monitoring items, parameters, and frequencies are determined according to the EMPs for reservoirs. Follow table shows summary of environmental monitoring program for reservoir operation period.

<table>
<thead>
<tr>
<th>Item</th>
<th>Location</th>
<th>Parameters</th>
<th>Frequency</th>
<th>Implementer</th>
</tr>
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<tr>
<td>Water Quality</td>
<td>Reservoir, dam front</td>
<td>Surface water parameters</td>
<td>3 times/year</td>
<td>Reservoir Division</td>
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<tr>
<td>Groundwater level</td>
<td>Reservoir surroundings</td>
<td>Water level</td>
<td>twice/year</td>
<td>Reservoir Division</td>
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<td>Downstream Ecology</td>
<td>Downstream</td>
<td>River ecology, bank vegetation</td>
<td>once/year</td>
<td>Monitoring Institute</td>
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<tr>
<td>Quality of receiving water</td>
<td>Upstream, inlet, and 100m downstream</td>
<td>Surface water parameters</td>
<td>twice/year</td>
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</tr>
<tr>
<td>Rat density</td>
<td>Villages in reservoir surroundings</td>
<td>Rat density</td>
<td>1-2times/year</td>
<td>Monitoring Institute</td>
</tr>
<tr>
<td>Reservoir stability</td>
<td>Reservoir bank</td>
<td>Bank Stability</td>
<td>once/year</td>
<td>Reservoir Division</td>
</tr>
<tr>
<td>Soil erosion</td>
<td>Watershed, borrow area, spoil disposal sites</td>
<td>Soil loss</td>
<td>once/year</td>
<td>Reservoir Division</td>
</tr>
</tbody>
</table>

6) Environmental training
The EMO is responsible for environmental training for the environmental personnel of each reservoir on tasks, procedures, an report preparation etc..

3. Reporting

An environmental management report is to be prepared annually by the environmental personnel in each reservoir and the report is to be submitted to the EMO. The report shall cover environmental tasks fulfilled, environmental investigation results, summary of environmental monitoring results, and work done on public consultations.

An environmental management report is to be prepared annually by the EMO and the report is to be submitted to Guiyang EPB. The report shall cover environmental tasks fulfilled, environmental investigation results, summary of environmental monitoring results, and work done on public consultations, as well as summary of individual environmental report prepared by environmental personnel of each reservoir.
## Annex 13 Draft EA Plan for First Batch Noncore Subprojects/Guiyang PMO

<table>
<thead>
<tr>
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<td>A</td>
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<td>Kaiyang</td>
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<td>PWDI</td>
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<td>End Date</td>
<td></td>
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<tr>
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<td>Xifeng</td>
<td></td>
<td>29 March</td>
<td>5 April</td>
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<td>28 June</td>
<td></td>
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</tbody>
</table>

**Note:** GWDI=Guiyang Water Design Institute; PWDI=Provincial Water Design Institute; PESI=Provincial Environmental Science Institute
PART II-2 Yudongxia Reservoir Payment for Environmental Services Report
1. YUDONGXIA RESERVOIR PAYMENT FOR ENVIRONMENTAL SERVICES

II. Introduction

1.1 Yudongxia Reservoir Project

1.2 Payment for environmental services: some cases

1.3 Payment for environmental services: lessons learned from the past

1.4 Alternatives to PES scheme

2. Objective

3. Methodology

4. Cost estimation in the upstream Longli catchment

4.1 Boundary of the catchment of Yudongxia Reservoir in Longli County

4.2 Economic activities and environmental quality in the catchment

4.3 mitigation costs

4.3.1 Installation of household based biogas system to treat animal manure

4.3.2 Conversion of sloping farming land (≥25°) into forestland

4.3.3 Soil erosion prevention in other areas (terraced farming land etc.)

4.3.4 Point source pollution abatement

4.4 Development Benefit Foregone Because Of The Catchment Protection

4.5 Comparison among Mitigation Measures

5. Watershed service valuation in the downstream Guiyang

5.0 Methodology

5.1 CVM methodology

5.1.1 Sampling

5.1.2 Study design principle

5.1.3 Commodity Definition

5.1.4 Payment vehicle

5.1.5 Elicitation method

5.1.6 Bid distribution

5.1.7 Questionnaire

5.1.8 Survey method

5.1.9 Enumerator training

5.1.10 Supervising implementation of field survey

5.2 Descriptive statistics from the CVM survey

6. Linking upstream with downstream for stable and clean water supply

A. 6.1 Comparison of upstream costs and downstream WTP

7.0 Institutional settings

8.0 Monitoring and modelling

9.0 market elements in the PES scheme
1.1 Yudongxia Reservoir Project

Yudongxia Reservoir will be located at the Toupu village along the Yudong River. The Yudong River is originated from the Chaxiangpo village of Longli county, and runs 19.38 km long before reaching the Yudongxia Reservoir. The catchment area of the Yudongxia Reservoir is 118 km², among which 91 km² is in Longli county.

Yudongxia Reservoir is a key project of Guiyang city to be one of its drinking water sources. The following government plans has urged to construct Yudongxia Reservoir:
- Guiyang Municipality 11th Five Year Plan for Economy and Social Development;
- Wudang District 11th Five Year Plan for Economy and Social Development;
- Guizhou Provincial Plan for Reservoir Construction;
- Water Sector 11th Five Year Plan of Guizhou Province.

The research of the design institute showed that in the water supply areas of the Yudongxia Reservoir, the expected water demand will outrun the existing water supply by an increasing margin. Table 1 shows the increasing water demand in the service areas of the Yudongxia Reservoir. The water supply capacity of the Yudongxia Reservoir is 100,000 tons/day. From 2015 and on, the service area will be short of water by 5.61 million m³/a in 2015, 11.55 million m³/a in 2020, and 16.02 million m³/a in 2030 even if the Yudongxia Reservoir is built (project EIA report, 2008).

<table>
<thead>
<tr>
<th>Year</th>
<th>Net integrated water demand 10,000 m³/a</th>
<th>Net industrial water demand 10,000 m³/a</th>
<th>Net environmental water demand 10,000 m³/a</th>
<th>Annual water demand 10,000 m³/a</th>
<th>Daily highest water demand 10,000 m³/d</th>
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<tr>
<td>2005</td>
<td>540</td>
<td>1193</td>
<td>31</td>
<td>1764</td>
<td>5.56</td>
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<tr>
<td></td>
<td>692</td>
<td>1530</td>
<td>40</td>
<td>2262</td>
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<tr>
<td>2010</td>
<td>899</td>
<td>2431</td>
<td>70</td>
<td>3400</td>
<td>10.71</td>
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<tr>
<td></td>
<td>1058</td>
<td>2860</td>
<td>82</td>
<td>4000</td>
<td>12.60</td>
</tr>
<tr>
<td>2015</td>
<td>1186</td>
<td>3222</td>
<td>96</td>
<td>4504</td>
<td>14.19</td>
</tr>
<tr>
<td></td>
<td>1363</td>
<td>3704</td>
<td>110</td>
<td>5177</td>
<td>16.31</td>
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<tr>
<td>2020</td>
<td>1401</td>
<td>3844</td>
<td>116</td>
<td>5361</td>
<td>16.89</td>
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<tr>
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<td>4985</td>
<td>140</td>
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</tbody>
</table>

Source: project EIA report, 2008

The Yudongxia Reservoir is very important for Guiyang city. To be a source of drinking water, Yudongxia Reservoir should be kept with high quality of water, which is what the downstream Guiyang wants to make sure. For the upstream Longli county, it will incur some costs to prevent the catchment from being polluted and/or degraded. Longli county is out of the administrative boundary of the Guiyang city. A deal between the upstream and downstream might be a solution to meet both needs.
1.2 Payment for environmental services: some cases

Payment for environmental services (PES) is emerging to be a potential economic and environmental policy instrument in China and abroad to address the upstream/downstream relations especially regarding the water quality. In PES, the downstream pays for environmental services provided by the upstream because the downstream benefits from the efforts of upstream to prevent the watershed from degradation. So it applies the “beneficiary pays principle” in PES rather than the “polluter pays principle”, which is usually applied in point-source pollution control.

Catskill watershed of the US is well known for its PES scheme, in which the downstream New York City takes Catskill Watershed River for its drinking water source but the upstream communities discharge pollutions from a lot of cattle farms. New York City pays for upstream community environmental management and pollution control and the amount paid is only a fraction of the amount that the New York city would otherwise have to pay to clean the water with treatment plants if there was no upstream environmental management program (Rosa et al., 2002).

PES is not new in Guiyang. It has been carried out in the Hongfeng Lake watershed. Hongfeng Lake is in the southwest of Guiyang city and one of the drinking water sources for Guiyang. But a large part of the catchment of the Lake is located in the Pingba County, out of Guiyang city. Guiyang wants to assure the water quality from the catchment, and Pingba incurs costs to keep it clean. A deal has been reached in which downstream Guiyang pays CNY1.5 million/year to Pingba with an incremental amount of Y100,000/year (PMO, 2009).

PES has also been tried in other parts of China. Jin River and Luoyang River basins eco-compensation scheme is one example in Fujian Province. Quanzhou Municipality Government set up an eco-compensation account for the river basin. During 2005-2009, CNY20 million would be collected each year for the account. The fund is used by the upstream governments to invest in the environmental protection projects such as subsidy to building-up of wastewater treatment plants. The downstream governments contribute to the account according to their respective quota of water withdrawal from the Jin River and Luoyang River basins. With this proportion, the downstream governments contribute the following amounts of money each year for the account: Licheng, CNY1.13 million; Fengze, CNY1.13 million; Luojiang, CNY0.26 million; Quangang, CNY0.98 million;
Jinjiang, CNY6.49 million; Shishi, CNY1.8 million; Nanan, CNY1.28 million; Huian, CNY1.93 million; and the remaining CNY5 million comes from the Quanzhou Municipality Government.

Another example is the eco-compensation scheme for the Min River Basin of Fujian Province. The Fujian Provincial Government set up an account and collects CNY100 million each year to invest in the upstream for environmental protection. The downstream Fuzhou Municipality contributes CNY30 million each year. The payment is conditional on the water quality, quantity, and pollutants of cross-section. If the water quality is up to the standard with the frequency of 80% or more, the payment will be given to the upstream 100%, with other indicators in mind. If the water quality is up to the standard with the frequency of 60%-80%, the 60%-80% of payment will be given to the upstream. If the water quality is up to the standard with the frequency below 60%, there will be no payment to the upstream.

South-North Water Diversion Project has a component of eco-compensation. The central government and three provincial governments will invest in 2112 projects worth of CNY19.4 in the 3 upstream provinces of Hubei, Henan, and Shaanxi. The projects include small watershed management, wastewater treatment plant, clean-production of point-source industries, eco-agriculture, wetland rehabilitation, monitoring capacity building, etc. In 2008, the Ministry of Finance appropriated CNY1.46 billion of additional public transfer from the national treasure to the 3 upstream provinces of Hubei, Henan, and Shaanxi to support the provincial and local governments in environmental protection.
Beijing and its upstream Hebei province have eco-compensation mechanism for protecting Beijing’s drinking water source. During 2005-2009, Beijing Municipal Government appropriated CNY20 million each year to Zhangjiakou and Chengde which are in the upstream of Beijing’s drinking water sources for them to do water resources protection programs. One of the programs is to pay CNY550/mu to upstream farmers for them to convert from rice-growing to maize-growing, which is less water intensive and less polluting. There are also investments from the national government in upstream afforestation, watershed management, and wastewater treatment plants etc. The eco-compensation mechanism is very comprehensive, involving the central government, Hebei Provincial Government, Beijing Municipal Government, Zhangjiakou Municipal Government of Hebei province, and Chengde Municipal Government of Hebei province.

1.3 Payment for environmental services: lessons learned from the past

PES around the world has been in different forms such as public payment schemes, open trading, and self-organized private deals. The following ten components seem to be essential for any PES scheme to succeed:

- identified ecosystem services;
- enabling legal, regulatory and administrative context;
- supporting institutions including public/private entities;
- engaged local communities and stakeholders;
- flow of market information;
- technical assistance to sellers, buyer and other market actors, which includes training, education and advising;
- financing for all needed components including management costs, transaction costs etc.;
- support services for market actors such as brokering, legal advice, measurement and valuation of ecosystem services, third party certification, accounting, etc.;
- standards and guidelines for ecosystem services payments or markets;
- awareness of ecosystem service values, payment and markets among policy-makers as well as potential sellers and buyers (Scherr, S. et al., 2006)

In China, PES takes various forms and is specific to geographic and institutional conditions. One kind of PES form is based on public transfer through government
systems, such as the Sloping Land Conversion Program (SLCP) in China and Fujian cases. Another kind of form is the negotiated deal between specific parties such as upstream and downstream of Dongjiang and Yiwu cities in Zhejiang Province. Various forms of PES are encouraged to explore in China and there has not been an official policy on PES in China up to date.

Eco-compensation, the PES-like scheme in China takes place in every scale, from the multi-billion national programs to provincial levels, and local levels. Compensation and penalty are often integrated in the eco-compensation mechanism, which implies that it accommodates both polluter pays principle, and beneficiary pays principle. In large and national eco-compensation programs, the relation between the compensation and the environmental services is weak. But in the emerging watershed eco-compensation designs, the compensation is more and more conditional on the environmental services provided and it is monitored more carefully in the mechanism.

1.4 Alternatives to PES scheme

PES is one of instruments to seek for an assured water supply. Alternatives to the PES scheme should be considered and weighed before it is adopted to make sure it’s cost effective.

One obvious alternative is additional treatment, i.e. to invest more to make sure the water is treated up to the standard. No matter how polluted the water is in the upstream, the treatment plant will treat the water to the drinking water standard. The advantage of this engineering alternative is that it has assured results. But it may incur high costs, including both investment costs and operating costs. The Catskill case of PES in New York shows that this kind of engineering solutions cost 8 times more than the PES scheme. In this Yudongxia case, it need rigorous economic analysis of the treatment plant to see how costly it would be to treat the polluted water if nothing is done in the upstream to prevent pollution. At this stage, we assume that the costs of this kind of deep treatment are too high to consider this alternative given the marginal treatment costs are increasing significantly as shown by empirical studies (Rosa et.al., 2002).

There might be alternatives to the Yudongxia Reservoir itself. One potential way to substitute the water supply by the Yudongxia project is demand management. If the water consumption is elastic to the water tariff, it is possible to meet the water demand by adjusting the water tariff. In this regard, a lot of work has to be done to see how elastic Guiyang households water consumption is to the water tariff. Available information shows that household water consumption is not elastic to water tariff (Daniel Gunnad, 2009?). In this case study, we assume that demand side management is not a realistic alternative to the PES scheme in Guiyang.
2. Objective

This study is to explore the rationale for a possible PES mechanism for the Yudongxia Reservoir, and facilitate the PES agreement between the upstream and downstream in technical aspects.

3. Methodology

The methodology consists of:

- Estimating the mitigation costs and benefits foregone of the upstream Longli catchment with field survey;
- Estimating the willingness to pay by the downstream Guiyang with contingent valuation survey of water end users;
- Having Upstream-downstream consultation meetings;
- Interview water supply company people and figure out water supply alternatives;
- Interview line agencies to discuss the fund collection and transfer mechanism;

4. Cost estimation in the upstream Longli catchment

4.1 Boundary of the catchment of Yudongxia Reservoir in Longli County

Longli County catchment area is 91 km² based on the statistical summarization of individual village data provided by the Longli county. This data has not been verified by the project design institute. See Table 2 for the basic facts of the catchment in Longli.
There are 14 administrative villages in 3 townships in the catchment. The catchment area of the Yudongxia Reservoir is largely in Xingshi Township, as shown on Table 2. The other two townships are Gujiao and Napang. There are 12,388 people in 3,009 households live in the catchment. Among the 91 km2 of catchment areas, about 73 km2 or 80% are in Xingshi Township. In fact, there is only one village in Xingshi Township, Xiaoqing village, which is out of the catchment.
<table>
<thead>
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<th>township</th>
<th>Administrative village</th>
<th>Number of natural villages</th>
<th>households</th>
<th>Population (persons)</th>
<th>Land area (km²)</th>
<th>in which farming land area(mu)</th>
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<td></td>
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<td>499</td>
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<tr>
<td>3</td>
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<td>3.583</td>
<td>603.25</td>
<td>603.92</td>
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<tr>
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<td>356</td>
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<td>2.611</td>
<td>547</td>
<td>850</td>
</tr>
<tr>
<td>5</td>
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<td>Liangshui</td>
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<td>241</td>
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<td>6.466</td>
<td>604</td>
<td>574</td>
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<tr>
<td>6</td>
<td></td>
<td>Jiuzhai</td>
<td>7</td>
<td>161</td>
<td>646</td>
<td>8.185</td>
<td>457</td>
<td>440</td>
</tr>
<tr>
<td>7</td>
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<td>Dingshui</td>
<td>7</td>
<td>251</td>
<td>970</td>
<td>4.916</td>
<td>676</td>
<td>629</td>
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<tr>
<td>8</td>
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<td>Yuanbao</td>
<td>9</td>
<td>403</td>
<td>1714</td>
<td>13.012</td>
<td>663</td>
<td>827</td>
</tr>
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<td>9</td>
<td></td>
<td>Jichang</td>
<td>11</td>
<td>427</td>
<td>1885</td>
<td>14.122</td>
<td>837</td>
<td>1462</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Sanbao</td>
<td>1</td>
<td>45</td>
<td>115</td>
<td>1.187</td>
<td>63</td>
<td>106</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Yangchangsi</td>
<td>4</td>
<td>159</td>
<td>697</td>
<td>6.523</td>
<td>303</td>
<td>534</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Subtotal for Xingshi township</strong></td>
<td><strong>84</strong></td>
<td><strong>2823</strong></td>
<td><strong>11619</strong></td>
<td><strong>72.6922</strong></td>
<td><strong>5891.25</strong></td>
<td><strong>6797.92</strong></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Gujiao</td>
<td>Chaxiang</td>
<td>5</td>
<td>157</td>
<td>16.8165</td>
<td>163</td>
<td>495</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td>Gaojian</td>
<td>1</td>
<td>22</td>
<td>1.2</td>
<td>42</td>
<td>81</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Napang</td>
<td>Mafeng</td>
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<td>7</td>
<td>0.6</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total for Longli county</strong></td>
<td><strong>91</strong></td>
<td><strong>3009</strong></td>
<td><strong>12388</strong></td>
<td><strong>91.30835</strong></td>
<td><strong>6096.25</strong></td>
<td><strong>7409.92</strong></td>
</tr>
</tbody>
</table>

Source: Longli county Resettlement Office, 2009
<table>
<thead>
<tr>
<th>Year</th>
<th>Value added (million CNY)</th>
<th>Growth rate (%)</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>agriculture</td>
<td>industry</td>
<td>tertiary</td>
</tr>
<tr>
<td>2008</td>
<td>3509</td>
<td>650</td>
<td>760</td>
</tr>
<tr>
<td>2007</td>
<td>3267</td>
<td>607</td>
<td>692</td>
</tr>
<tr>
<td>2006</td>
<td>3051</td>
<td>571</td>
<td>575</td>
</tr>
<tr>
<td>2005</td>
<td>2856</td>
<td>517</td>
<td>500</td>
</tr>
<tr>
<td>2004</td>
<td>2741</td>
<td>434</td>
<td>478</td>
</tr>
<tr>
<td>2003</td>
<td>2569</td>
<td>366</td>
<td>433</td>
</tr>
<tr>
<td>2002</td>
<td>2292</td>
<td>294</td>
<td>399</td>
</tr>
<tr>
<td>2001</td>
<td>2505</td>
<td>248</td>
<td>345</td>
</tr>
<tr>
<td>2000</td>
<td>2437</td>
<td>213</td>
<td>303</td>
</tr>
</tbody>
</table>

Source: Longli county Resettlement Office, 2009
4.2 Economic activities and environmental quality in the catchment

Agriculture is the main industry in the catchment although there are a few factories and tertiary industry. Table 3 shows the economic volume and structure in the catchment. More than 70% of the economy is in agriculture. Agricultural sector is still growing at about 7% annually though industry and tertiary sectors are also growing. Table 4 shows the dominant industry and farmers’ net income. Agriculture, especially animal raising, vegetable and fruit trees are becoming more and more important for farmers to make their living. And Table 5 shows industrial activities and point source pollution. Longli Xingwang Slaughter House Co. Ltd., one of the main polluters in the catchment, discharges wastewater by 29164 m3/a with some kind of treatment.

At present, there are no environmental monitoring activities in the Yudong River watershed. But the water quality monitoring for the project environmental impact assessment (EIA) indicates a good water quality of class II in the Yudong River (Project EIA report, 2008).

### Table 4 Dominant Industry and farmer’s income level in Xingshi township

<table>
<thead>
<tr>
<th>Year</th>
<th>Dominant industry</th>
<th>Rural household net income (CNY/capita)</th>
<th>Growth rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Animal raising, vegetable, fruit trees</td>
<td>3311</td>
<td>17.41</td>
</tr>
<tr>
<td>2007</td>
<td>Animal raising, vegetable, fruit trees</td>
<td>2820</td>
<td>5.62</td>
</tr>
<tr>
<td>2006</td>
<td>Animal raising, vegetable, fruit trees</td>
<td>2670</td>
<td>5.95</td>
</tr>
<tr>
<td>2005</td>
<td>Animal raising, vegetable, fruit trees</td>
<td>2520</td>
<td>6.33</td>
</tr>
<tr>
<td>2004</td>
<td>Animal raising, vegetable</td>
<td>2370</td>
<td>4.41</td>
</tr>
<tr>
<td>2003</td>
<td>vegetable</td>
<td>2270</td>
<td>4.61</td>
</tr>
<tr>
<td>2002</td>
<td>vegetable</td>
<td>2170</td>
<td>4.83</td>
</tr>
<tr>
<td>2001</td>
<td>vegetable</td>
<td>2070</td>
<td>5.08</td>
</tr>
<tr>
<td>2000</td>
<td>vegetable</td>
<td>1970</td>
<td>-1.57</td>
</tr>
</tbody>
</table>

Source: Longli county Resettlement Office, 2009
Table 5 Sources of Industrial pollution in the catchment areas

<table>
<thead>
<tr>
<th>Factories/firms</th>
<th>Located at (village)</th>
<th>pollutants</th>
<th>Discharge</th>
<th>Mitigation costs</th>
<th>Up to discharge standard ( % )</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qingdao Xingbang Electronics Corporation, Longli Branch</td>
<td>Xingshi</td>
<td>Wastewater, exhaust emission</td>
<td>Exhaust: 494 million m3/a SO2: 11.52t/a NOx: 1.411t/a SP: 1.766t/a</td>
<td>Capital costs: CNY150,000 Operating costs: CNY30,000/a</td>
<td>No monitoring</td>
<td>Wastewater is recycled. Data are from pollution source survey.</td>
</tr>
<tr>
<td>Longli Hongxin Foam Co. Ltd.</td>
<td>Xingshi</td>
<td>Wastewater, exhaust emission</td>
<td>Exhaust: 2093 million m3/a SO2: 8.01t/a SP: 2.475t/a NOx: 0.72 t/a</td>
<td>Capital costs: CNY200,000</td>
<td>0</td>
<td>Wastewater is recycled. Production day: 250 days/year; 18 hours a day. Chimney is 16 m high, half of the standard height</td>
</tr>
<tr>
<td>Longli Penglong Building Materials Co. Ltd.</td>
<td>Jinhua</td>
<td>Exhaust, solid waste</td>
<td>Exhaust: 930 million m3/a SO2: 18t/a; NOx: 3.7t/a; SP: 6.8t/a</td>
<td>Capital costs: CNY400,000</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Longli Xingwang Slaughter House Co. Ltd.</td>
<td>Yangchangsi</td>
<td>Wastewater, manure wastes</td>
<td>Wastewater: 29164m3/a COD: 28.476t/a NH3-N: 1.98t/a Total P: 0.204t/a</td>
<td>Capital costs: CNY300,000; Operating costs: CNY13,000/a</td>
<td>No monitoring</td>
<td></td>
</tr>
<tr>
<td>Guizhou Tiancheng Animal Husbandry Co. Ltd.</td>
<td>Yuanbao</td>
<td>Manure</td>
<td>Wastewater: 36.5t/a Manure: 365t/a</td>
<td>0</td>
<td>No monitoring</td>
<td>Based on agricultural source pollution survey</td>
</tr>
<tr>
<td>Company</td>
<td>Location</td>
<td>Waste Type</td>
<td>Wastewater</td>
<td>Capital Costs</td>
<td>Estimated on</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------</td>
<td>------------</td>
<td>------------</td>
<td>---------------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Guizhou Longgang Eco-resources</td>
<td>Jichang</td>
<td>Wastewater</td>
<td>Wastewater: 2430m3/a COD: 18.2t/a NH3-N: 0.19t/a</td>
<td>Capital costs: CNY250,000 in construction</td>
<td>Estimated on: 100 workers; 175 liter/day/worker; 90g of COD/worker; 7g of NH3-N/worker</td>
<td></td>
</tr>
<tr>
<td>Longli Xingshi Bean Processing Factory</td>
<td>Xingshi</td>
<td>wastewater</td>
<td>Wastewater: 2430m3/a COD: 18.2t/a NH3-N: 0.19t/a</td>
<td>No monitoring</td>
<td>Estimated on: Production of 300 kg/day</td>
<td></td>
</tr>
<tr>
<td>Xingshi Sanbao Brickyard</td>
<td>Sanbao</td>
<td>Exhaust, solid wastes</td>
<td>Exhaust: 512 million m3/a SO2: 1.5t/a; NOx: 0.69t/a SP: 1t/a</td>
<td>No monitoring</td>
<td>Estimated on: Production of 1 million bricks/a</td>
<td></td>
</tr>
<tr>
<td>Xingshi Yuanbao Coal Processing Factory</td>
<td>Yuanbao</td>
<td>Wastewater</td>
<td>Wastewater: 24000m3/a COD: 3.9t/a Petroleum: 0.16t/a Solid wastes: 2400t/a</td>
<td>Capital costs: CNY250,000 in construction</td>
<td>Estimated on: Production of 30000 t/a</td>
<td></td>
</tr>
<tr>
<td>Jinlonggu Tourism Company</td>
<td>Dayan</td>
<td>wastewater</td>
<td>Wastewater: 6388m3/a COD: 3.385t/a NH3-N: 0.26t/a</td>
<td>No monitoring</td>
<td>Estimated on: 100 workers; 175 liter/day/worker; 90g of COD/worker; 7g of NH3-N/worker</td>
<td></td>
</tr>
<tr>
<td>Guizhou Dazhong</td>
<td>Xingshi</td>
<td>wastewater</td>
<td>Wastewater: 274663</td>
<td>No monitoring</td>
<td>Estimated on:</td>
<td></td>
</tr>
<tr>
<td>Company</td>
<td>Location</td>
<td>Pollution Type</td>
<td>Wastewater (t/a)</td>
<td>Manure (t/a)</td>
<td>Monitoring Status</td>
<td>Source and Note</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------</td>
<td>----------------</td>
<td>------------------</td>
<td>--------------</td>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Real Estate Co. Ltd.</td>
<td></td>
<td></td>
<td>m3/a</td>
<td>COD: 141.26t/a NH3-N: 10.99t/a</td>
<td>4300 employees</td>
<td></td>
</tr>
<tr>
<td>Xingshi Laowangshan Animal Raising Farm</td>
<td>Yuanbao</td>
<td>Wastewater, manure</td>
<td>Wastewater: 16.425t/a Manure: 164.25t/a</td>
<td>0</td>
<td>No monitoring</td>
<td>Based on agricultural pollution source survey</td>
</tr>
</tbody>
</table>

*Source: Longli county Resettlement Office, 2009, Note: SP-- Suspended particulate; COD—chemical oxygen demand*
4.3 Mitigation costs

Mitigation costs will be incurred in the upstream Longli catchment area to get the river water clean enough. Although the present river water quality is good, the agricultural sector in the catchment is still growing at about 7% annually with animal raising and vegetable growing as its main subsectors. Animal raising is an important polluting source if not treated properly. And the industrial sector is also growing at about 7% annually with point source pollutions. There is also farming at the sloping land which causes soil erosion leading to siltation of river. Without mitigation of these potential pollution sources, the Yudong River will be polluted in the near future.

At least the following mitigation costs are involved:
- Installation of household based biogas system to treat animal manure
- Conversion of sloping farming land (≥25°) into forestland
- Soil erosion prevention in other areas (terraced farming land etc.)
- Point source pollution abatement

4.3.1 Installation of household based biogas system to treat animal manure

Animal raising is one of the main income sources of farmers in the catchment. Almost every household raises animals to different scales. Pig and poultry are the two most popular animals for domestic raising although cattle and sheep are also raised.

The Longli statistics shows that 7,822 heads of pig, 31,258 heads of poultry, 3,571 heads of cattle, and 2,642 heads of sheep are kept in stock each year. See table 6 for details. The manure of poultry, cattle and sheep is easy to collect and most of them are used as fertilizers. Pig manure is difficult to collect and it’s often a source of pollution if not treated properly.

Biogas system fed by pig manure is a good system in treating the manure and providing energy for cooking at households. At present, 316 households among the total 3009 households have been installed with biogas system. Some households are not eligible for installation of biogas system for various reasons. For example, in some households, adult farmers go to towns and cities for job and only children and old people are left behind, in which circumstances no one takes care of the pigs and biogas system.

But there still are a lot of households that are eligible to install biogas system. One of the main reasons why they have not installed biogas tanks is the costs. In the Longli catchment, a household based biogas system costs about CNY2000-3000/biogas system. The 316 households which have installed biogas system get government subsidy of about CNY1000 for each biogas system. Even though it’s subsidized, some households can still not afford it. The remaining costs of CNY1000-2000 might amount to his/her annual net income.
Table 6 Animal raising in the catchment of Longli, 2009

<table>
<thead>
<tr>
<th>#</th>
<th>Village</th>
<th>Number of stock in a year</th>
<th>Number of Medium-large Scale Animal farms</th>
<th>scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pig</td>
<td>Cattle</td>
<td>Sheep</td>
</tr>
<tr>
<td>1</td>
<td>Dayan</td>
<td>486</td>
<td>182</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Daba</td>
<td>402</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Xingshi</td>
<td>588</td>
<td>362</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Jinhua</td>
<td>885</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Liangshui</td>
<td>756</td>
<td>403</td>
<td>58</td>
</tr>
<tr>
<td>6</td>
<td>Jiuzhai</td>
<td>589</td>
<td>291</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>Dingshui</td>
<td>886</td>
<td>304</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Yuanbao</td>
<td>986</td>
<td>410</td>
<td>2564</td>
</tr>
<tr>
<td>9</td>
<td>Jichang</td>
<td>856</td>
<td>594</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Sanbao</td>
<td>605</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Yangchangsi</td>
<td>398</td>
<td>155</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subtotal for Xingshi township</td>
<td>7437</td>
<td>3571</td>
<td>2642</td>
</tr>
<tr>
<td>12</td>
<td>Chaxiang</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Gaojian</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total for the catchment in Longli</td>
<td>7822</td>
<td>3571</td>
<td>2642</td>
</tr>
</tbody>
</table>

There are at least 761 households in the catchment that are eligible for biogas system based on field survey and Xingshi township statistics. They have not been installed with biogas system because there are no further government programs and subsidies.

About CNY1500 of subsidy is needed for installing one household based biogas system according to former government biogas programs. To further install 761 household based biogas system, it will need CNY 1.1415 million of subsidies to households. There is a medium scale pig farm in the Dingshui village with a yearly stock of 85 pigs. It will need a big biogas tank to treat the manure. Such a biogas system would cost CNY 100,000 by
rough estimate. Household-based biogas system plus one big biogas tank system for pig farm would amount to CNY 1.2415 million of subsidies needed.

Table 7 Household based biogas system: status and further needs

<table>
<thead>
<tr>
<th>#</th>
<th>Village</th>
<th>Number of household based biogas system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Already built</td>
</tr>
<tr>
<td>1</td>
<td>Dayan</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Daba</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>Xingshi</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Jinhua</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Liangshui</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Jiuzhai</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Dingshui</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>Yuanbao</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>Jichang</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>Sanbao</td>
<td>12</td>
</tr>
<tr>
<td>11</td>
<td>Yangchangsi</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Subtotal for Xingshi township</td>
<td>216</td>
</tr>
<tr>
<td>12</td>
<td>Chaxiang</td>
<td>60</td>
</tr>
<tr>
<td>13</td>
<td>Gaojian</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Total for the catchment in Longli</td>
<td>316</td>
</tr>
</tbody>
</table>

4.3.2 Conversion of sloping farming land (≥25°) into forestland

The catchment is a hilly area dotted with farming plot. Sloping farming land is prone to soil erosion. In the past years, 10361.12 mu of sloping farming land (≥25°) in the catchment has been converted to forestland with the government funded Sloping Land Conversion Program (SLCP), which contributes to the reduction of soil erosion in the catchment. There are still 7550.5 mu of sloping farming land (≥25°) which should be converted but have not been converted to forestland in the catchment. The government stopped the SLCP in 2007. No existing sloping farming land (≥25°) will be converted to forestland under SLCP.
To prevent the soil erosion in the sloping farming land (≥25°), it’s helpful to convert all the 7550.5 mu of existing sloping farming land (≥25°) into forestland in the catchment. The compensation rate is CNY210/mu for the first 5-8 years and CNY105/mu for the remaining 5-8 years according to the SLCP policy. This will cost CNY1.5856 million/year for the first 5-8 years, and CNY 0.7928 million/year for the remaining 5-8 years. Five-year applies to economic trees and 8-year applies to ecological trees. This compensation rate has been highly welcome by the households in the past years, which indicated that the rate could cover the opportunity costs of this conversion. And in this hilly area, agriculture can hardly be expanded.

Table 8 Sloping farming land (≥25°) in the catchment in Longli unit: mu

<table>
<thead>
<tr>
<th>#</th>
<th>Village</th>
<th>Sloping farming land (≥25°) that have been converted to forestland</th>
<th>Existing area of sloping farming land (≥25°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dayan</td>
<td>238.67</td>
<td>528.8</td>
</tr>
<tr>
<td>2</td>
<td>Daba</td>
<td>253.73</td>
<td>354.6</td>
</tr>
<tr>
<td>3</td>
<td>Xingshi</td>
<td>315.57</td>
<td>450</td>
</tr>
<tr>
<td>4</td>
<td>Jinhua</td>
<td>513.15</td>
<td>104.1</td>
</tr>
<tr>
<td>5</td>
<td>Liangshui</td>
<td>149.76</td>
<td>542.7</td>
</tr>
<tr>
<td>6</td>
<td>Jiuzhai</td>
<td>621.99</td>
<td>599.9</td>
</tr>
<tr>
<td>7</td>
<td>Dingshui</td>
<td>621.85</td>
<td>492.9</td>
</tr>
<tr>
<td>8</td>
<td>Yuanbao</td>
<td>1494.75</td>
<td>1773.5</td>
</tr>
<tr>
<td>9</td>
<td>Jichang</td>
<td>1357.07</td>
<td>1243.6</td>
</tr>
<tr>
<td>10</td>
<td>Sanbao</td>
<td>1564.1</td>
<td>585.4</td>
</tr>
<tr>
<td>11</td>
<td>Yangchangsi</td>
<td>400.48</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Subtotal for Xingshi township</td>
<td>7531.12</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Chaxiang</td>
<td>2500</td>
<td>800</td>
</tr>
<tr>
<td>13</td>
<td>Gaojian</td>
<td>330</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total for the catchment in Longli</td>
<td>10361.12</td>
<td>7550.5</td>
</tr>
</tbody>
</table>

Note: 1 ha = 15 mu

4.3.3 Soil erosion prevention in other areas (terraced farming land etc.)

Besides the sloping farming land (≥25°), there are 1645.5 mu of other land which is prone to soil erosion. Most of the land is the terraced farming land, river valley, and
roadside. Treatment is needed to conserve the water and soil in these pieces of land, such as small dams, ponds, grass or tree planting.

The average costs of preventing soil erosion in Guizhou are estimated to be CNY455/mu based on statistics of the Ministry of Water Resources (Jin, 2009). Then it will cost CNY748,703 to treat the 1645.5 mu of land erosion.

<table>
<thead>
<tr>
<th>#</th>
<th>Village</th>
<th>Soil erosion areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dayan</td>
<td>168.9</td>
</tr>
<tr>
<td>2</td>
<td>Daba</td>
<td>152.6</td>
</tr>
<tr>
<td>3</td>
<td>Xingshi</td>
<td>154.6</td>
</tr>
<tr>
<td>4</td>
<td>Jinhua</td>
<td>136.9</td>
</tr>
<tr>
<td>5</td>
<td>Liangshui</td>
<td>134.5</td>
</tr>
<tr>
<td>6</td>
<td>Jiuzhai</td>
<td>116.8</td>
</tr>
<tr>
<td>7</td>
<td>Dingshui</td>
<td>108.3</td>
</tr>
<tr>
<td>8</td>
<td>Yuanbao</td>
<td>174.3</td>
</tr>
<tr>
<td>9</td>
<td>Jichang</td>
<td>268.7</td>
</tr>
<tr>
<td>10</td>
<td>Sanbao</td>
<td>101.5</td>
</tr>
<tr>
<td>11</td>
<td>Yangchangsi</td>
<td>128.4</td>
</tr>
<tr>
<td></td>
<td>Subtotal for Xingshi township</td>
<td>1645.5</td>
</tr>
<tr>
<td>12</td>
<td>Chaxiang</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Gaojian</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total for the catchment in Longli</td>
<td>1645.5</td>
</tr>
</tbody>
</table>

Note: 1 ha = 15 mu

4.3.4 Point source pollution abatement
There are 12 point source polluters in the catchment in Longli as shown on table 5. Most of them are small scale industry with minor pollution. But 3 polluters are noteworthy since they discharge wastewater with a considerable amount. See table 10.

Facilities are needed to treat the point source wastewater. Longli Xingwang Slaughter House Co. Ltd. has installed wastewater treatment facilities with capital costs of CNY300,000. Xingshi Yuanbao Coal Processing Factory is installing wastewater treatment facility with capital costs of CNY250,000. Guizhou Dazhong Real Estate Co. Ltd. has not installed any wastewater treatment facilities.
It’s not clear if the polluters have to be resettled outside the drinking water source areas. Associated with the enterprises is employment for local people and tax revenues for local government. One option might be that the existing enterprises are can continue to produce without any expansion in the future. In this case, wastewater treatment facilities are needed to install and operate. It is estimated that an operating costs for the 3 main polluters would be CNY 100,000 each year.

Table 10 Three major polluters discharging wastewater in the catchment in Longli

<table>
<thead>
<tr>
<th>Factories/firms</th>
<th>Located at (village)</th>
<th>Discharge</th>
<th>Mitigation costs</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longli Xingwang Slaughter House Co. Ltd.</td>
<td>Yangchangsi</td>
<td>Wastewater: 29,164 m3/a COD: 28.476t/a NH3-N: 1.98t/a Total P: 0.204t/a</td>
<td>Capital costs: CNY300,000; Operating costs: CNY13,000/a</td>
<td></td>
</tr>
<tr>
<td>Xingshi Yuanbao Coal Processing Factory</td>
<td>Yuanbao</td>
<td>Wastewater: 24,000 m3/a COD: 3.9t/a Petroleum: 0.16t/a Solid wastes: 2400t/a</td>
<td>Capital costs: CNY250,000 in construction</td>
<td>Estimated on: Production of 30000 t/a</td>
</tr>
<tr>
<td>Guizhou Dazhong Real Estate Co. Ltd.</td>
<td>Xingshi</td>
<td>Wastewater: 274,663 m3/a COD: 141.26t/a NH3-N: 10.99t/a</td>
<td>0</td>
<td>Estimated on: 4300 employees</td>
</tr>
</tbody>
</table>

4.4 Development Benefit Foregone Because Of the Catchment Protection

Some economic activities will be restricted when the catchment is designated as the drinking water source areas, such as:
- Large scale livestock farm
- Mining
- Logging
- Tourism
- Bottled water production
- Expansion of polluting enterprises

At present stage, the development benefits foregone are difficult to estimate. It’s scenario-dependent, and policy-dependent. Any results from the estimation might be volatile. A possible way to estimate it might be to predict it based on historic trends.
To sum up the upstream costs, there will be CNY 1.99 million of capital costs and CNY 892,800-CNY 1.68 million of annual costs will be incurred by the upstream Longli catchment areas for preserving the drinking water source areas.

Table 11 Summary: Costs incurred by the upstream Longli catchment areas to preserve the drinking water source areas

<table>
<thead>
<tr>
<th>Activities</th>
<th>Capital costs (CNY)</th>
<th>Annual costs (CNY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation of household based biogas system to treat animal manure</td>
<td>1,241,500</td>
<td>1,585,600 for the first 5-8 years; 792,800 for the remaining 5-8 years</td>
</tr>
<tr>
<td>Conversion of sloping farming land (≥25°) into forestland</td>
<td>748,703</td>
<td>100,000</td>
</tr>
<tr>
<td>Soil erosion prevention in other areas (terraced farming land etc.)</td>
<td>1,990,203</td>
<td>1,685,600 for the first 5-8 years; 892,800 for the next 5-8 years</td>
</tr>
</tbody>
</table>

4.5 Comparison among Mitigation Measures

Four mitigation measures are identified and their costs are estimated. Some measures are more costly than others. If we assume that the environmental gains of the 4 mitigation measures are identical, we could rank the 4 mitigation measures by their cost-effectiveness. Point source pollution abatement should be adopted first, followed by soil erosion prevention, installation of household based biogas system, and finally conversion of sloping farming land into forestland.

It does not necessarily hold that identical environmental effects would be gained from each of the 4 mitigation measures. Some measures might be more effective than others in terms of environmental improvement. In this case the costs of each environmental costs acquired with the mitigation measures should be estimated. This estimation has implications in approving applications of PES fund for a specific mitigation measure.

Although point source pollution abatement has a low cost and high certainty of environmental effects, the field study came up with such a judgment that the non-point source pollution, especially pollution from the animal raising composes the biggest risk to the environment. This suggests that installation of household based biogas system is vital for environmental improvement in the upstream of Longli.
5. Watershed service valuation in the downstream Guiyang

5.0 Methodology
Contingent valuation method (CVM) is used to estimate the downstream Guiyang’s willingness to pay (WTP) for the upstream watershed services. The CVM field survey will follow the ADB (2007) guide Good Practices for Estimating Reliable Willingness-to-Pay Values in the Water Supply and Sanitation Sector.

5.1 CVM methodology
5.1.1 Sampling
The total population in the service area is 1.3923 million people in the districts of Wudang, Yunyan, and Nanming (Guiyang Statistical Bureau, 2009). Given the household family size is 2.95 persons/family; there are 471,966 households in the service area (Guiyang Statistical Bureau, 2009). The districts of Huaxi, Baiyun, and Xiaohe are out of study area since their water sources will not be from the Yudongxia Reservoir.

There are 291 neighborhoods in the study area (Guiyang Statistical Bureau, 2008), among which 30 are missing in the name list. We take all the remaining 261 neighborhoods as our sample frame. The list of the 261 neighborhoods is in Appendix 1.

Random sampling was adopted as our sampling strategy. Rich and poor groups of households are too difficult to identify in such large dispersed group of people. So, a simple random sampling was used. The sampling method adopted was:

- In a neighborhood, select the 1st building, select the 1st unit, and select the 1st floor household
- Next in the 5th building in the neighborhood, select the 2nd unit and the 2nd floor household
- Next in the 10th building in the neighborhood, select the 3rd unit and the 3rd floor household
- Sample using the same by the rule
- Maximum samples in a neighborhood are 30 households
- If there are less than 5 buildings in the neighborhood, then go to the next neighborhood after one sample is taken

If there is no one that can be interviewed in the proposed building then go to the next building and do the same, and repeat until a household is interviewed.

Sample size: the following aspects are considered in deciding the sample size:
- The basic questionnaire is determining the willingness to pay, asking respondents to vote on a benefits obtained with a value in terms their willingness to pay and the price they would pay
- 6 bids will be used;
- simple random sampling strategy;
- 5 independent variables explaining WTP: perception of water quality, income, education, age, gender
- To assure 30 samples in each cell;
The survey will be limited by the time and budget available.

The sample size results in 900 households after considering the above factors. The number of returned questionnaires valid is 853. Some of the questions may have valid responses less than 853.

5.1.2 Study design principle

ADB (2007) recommends what National Oceanic and Atmospheric Administration (NOAA) Panel suggested in designing a CV study as the following practices, which will be followed in this study:
(i) Interview in person rather than over the telephone.
(ii) Question about a future hypothetical occurrence rather than a historical event.
(iii) Use a referendum format (as opposed to open-ended questions) in which the respondent “votes” on a benefit with a known price.
(iv) The interviewer should begin with a scenario accurately describing the benefits of a contingent market commodity.
(v) The survey should remind that payment for the new commodity may reduce consumption of other goods.
(vi) The survey should remind that substitutes exist for the hypothetical commodity in question.
(vii) There should be follow-up questions to make sure the respondent understands the choices made.

5.1.3 Commodity Definition
The Guiyang households were asked how much they would be willing to pay for prevention of Yudong River from pollution down to grade III of GB3838-2002 or below from the present grade II. The present quality of water in the Yudong River will be indicated to the respondents while their subjective perception of the Yudong River water quality will be also investigated. The difference of the foreseen scenario (deterioration of water quality in the Yudong River) from the present status (grade II) will be specified to the respondents. It will be explained that the fund raised will be used by the upstream with a PES mechanism.

5.1.4 Payment vehicle
The respondents are supposed to pay in the form of increments to the current water bill. It’s familiar to households. But its disadvantage is that it is bundled to water bill. People
may not have free choice. Costa Rica experiences show that most people choose to pay if they are given the choice on water bill (Stafine, 2006). To simplify the study, a surcharge on water bill as the payment vehicle without additional design of the water bill.

5.1.5 Elicitation method

To follow the ADB (2007) guide, a close-ended question (referendum question) will be asked though in this case WTP of respondents has to be estimated with econometric models. The elicitation question is:

*Are you willing to pay for avoidance of deterioration of water quality in the Yudong River in the form of a sur-charge (of this amount) on the water bill, keeping in mind your total disposal budget and other competing consumption items. [show the water quality class II and class III and blow]*

This question is preceded by a number of other questions on description of the hypothetic commodity, how to use the fund raised, and household water consumption.

5.1.6 Bid distribution

A specific amount of surcharge to the water bill will be asked to each household, but different households may be asked different amounts of surcharge to run econometric modeling. A range of bids will be presented to different households.

There are 6 bids, which are 0.05, 0.1, 0.3, 0.5, 0.7, and 1.2 (CNY/m3) respectively.

In deciding the range of bids, the following aspects are counted.
- CNY0.05/m3 is an amount which will be accepted by almost all the interviewees in the preparatory field survey;
- CNY1.0/m3 is a little less than the present water tariff (excluding wastewater treatment fees of CNY0.85/m3), and an increase of CNY1.0/m3 would mean an 80% increase in water tariff, which is rather high;
- Budget constrain restricts more bids to test.

5.1.7 Questionnaire

The questionnaire has 5 sections.
- Introduction of background and purpose of the survey;
- Questions on demographic, socioeconomic profile of the household, and socioeconomic profile of the respondents interviewed;
- Questions on current water supply and consumption behaviors;
- WTP elicitation questions;
- Debriefing questions.

Questionnaire is in appendix 2.

5.1.8 Survey method
Face to face in-person interview is used in this survey. 13 enumerators are hired to carry out the field survey with 2 field coordinators.

5.1.9 Enumerator training

The objective of this training is to have enumerators i) understand the purpose of the survey; ii) familiar with survey instrument such as the intricate details in each section; iii) acquire and share survey techniques; and refine the questionnaire itself.

The following contents are included in the training:
- discuss the purpose of the survey;
- explain the CV method;
- go through the questions one by one in the questionnaire;
- emphasize the WTP elicitation question and how to ask it;
- explain how the survey data will be used in the final analysis;
- role-play in which some of enumerators act as interviewees;
- explain the rules for enumerators to follow, which is in appendix 3.

5.1.10 Supervising implementation of field survey

Supervision of the field survey is to
- ensuring that the intended samples are interviewed;
- detailed review of every completed questionnaire before leaving the site;
- assessing the quality of interview;
- random checking of interview;
- implementation of incentive/disincentive scheme based on performance of enumerators.

The 13 enumerators are divided into 2 groups, each of which has a coordinator. The coordinator him/her-self does the interview as well but his/her responsibility includes onsite supervision. We have also arranged the “re-interview” of the selected samples (about 10% of the total sample), to check if they were interviewed by our enumerators according to survey rules. The results of re-interview are in appendix 4.

A database is set up with the SPSS template.

5.2 Descriptive statistics from the CVM survey

More questions than elicitation one are asked in the CVM survey to provide background information to better understand households’ WTP. These questions are:
- subjective perception of tap water quality of his/her home;
- subjective perception of water quality of the Yudong River;
- monthly tap water consumption of his/her household;
- monthly tap water fee of his/her household;
- family size of his/her household;
- reasons for not willing to pay for the hypothetic commodity;
- reasons for willing to pay for the hypothetic commodity;
- monthly household income;
- house area;
- age, gender, and education of respondents

Most households (77%) report a good or very good tap water quality although there is about 23% of respondents regards their tap water as not good.

### Table 12 Perception of tap water quality at home

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>32</td>
<td>3.1</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>good</td>
<td>626</td>
<td>60.3</td>
<td>73.5</td>
<td>77.2</td>
</tr>
<tr>
<td>Not good</td>
<td>194</td>
<td>18.7</td>
<td>22.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>852</td>
<td>82.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>System</td>
<td>187</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1039</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 13 Perception of Yudong River water quality

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very good</td>
<td>102</td>
<td>9.8</td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>good</td>
<td>317</td>
<td>30.5</td>
<td>37.2</td>
<td>49.2</td>
</tr>
<tr>
<td>Not good</td>
<td>55</td>
<td>5.3</td>
<td>6.5</td>
<td>55.6</td>
</tr>
<tr>
<td>Very bad</td>
<td>6</td>
<td>.6</td>
<td>.7</td>
<td>56.3</td>
</tr>
<tr>
<td>Don’t know</td>
<td>370</td>
<td>35.6</td>
<td>43.4</td>
<td>99.8</td>
</tr>
<tr>
<td>Don’t care</td>
<td>2</td>
<td>.2</td>
<td>.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>852</td>
<td>82.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>System</td>
<td>187</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1039</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A considerable number of respondents (43%) have no idea of Yudong River’s water quality, and almost all the respondents who have an idea regard the water quality as good or very good.

### Table 14 Household water consumption

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-7 tons</td>
<td>364</td>
<td>35.0</td>
<td>43.8</td>
<td>43.8</td>
</tr>
<tr>
<td>8-18 tons</td>
<td>388</td>
<td>37.3</td>
<td>46.7</td>
<td>90.5</td>
</tr>
<tr>
<td>19-25 tons</td>
<td>65</td>
<td>6.3</td>
<td>7.8</td>
<td>98.3</td>
</tr>
<tr>
<td>25 tons or more</td>
<td>14</td>
<td>1.3</td>
<td>1.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>831</td>
<td>80.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>System</td>
<td>208</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1039</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
More than 90% of households consume water no more than 18 m³ a month. And almost half of households (44%) consume less than 7 m³ of water a month. Similarly, 90% of households have a monthly water bill of CNY40 or less. About 37% of households have a monthly water bill of CNY15 or less.

<table>
<thead>
<tr>
<th>CNY</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>318</td>
<td>37.3</td>
<td>37.3</td>
<td>37.3</td>
</tr>
<tr>
<td>15-40</td>
<td>450</td>
<td>52.8</td>
<td>52.8</td>
<td>90.0</td>
</tr>
<tr>
<td>40-60</td>
<td>59</td>
<td>6.9</td>
<td>6.9</td>
<td>97.0</td>
</tr>
<tr>
<td>60</td>
<td>26</td>
<td>3.0</td>
<td>3.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 15 Household water bill

There are 5 persons or less in most households (94%). About 37% of households have 3 family members in a household.

<table>
<thead>
<tr>
<th>Person/household</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>1</td>
<td>31</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>203</td>
<td>23.8</td>
<td>27.4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>317</td>
<td>37.2</td>
<td>64.6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>166</td>
<td>19.5</td>
<td>84.1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>87</td>
<td>10.2</td>
<td>94.3</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>19</td>
<td>2.2</td>
<td>96.5</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>14</td>
<td>1.6</td>
<td>98.1</td>
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<td></td>
<td>8</td>
<td>10</td>
<td>1.2</td>
<td>99.3</td>
</tr>
<tr>
<td></td>
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<td>5</td>
<td>.6</td>
<td>99.9</td>
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<tr>
<td></td>
<td>10</td>
<td>1</td>
<td>.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16 Household population

Most households (63%) are willing to pay for avoidance of water pollution in Yudong River although there are a considerable number of households (37%) who are not willing to pay any.

Those who are not willing to pay any are not willing for various reasons. About 66% of those who are not willing to pay any think the present water tariff has already been high.

<table>
<thead>
<tr>
<th>Valid</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not willing</td>
<td>318</td>
<td>30.6</td>
<td>37.3</td>
<td>37.3</td>
</tr>
<tr>
<td>willing</td>
<td>535</td>
<td>51.5</td>
<td>62.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>82.1</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>186</td>
<td>17.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1039</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
About 31% of those think that pollution control is government’s business. And 11% of that doubt if the fund raised would be used for pollution control in the upstream. Other reasons include that it’s up stream’s people’s responsibility, it’s water supply company’s business, and it’s not our business, etc.

**Table 18 Survey of Unwillingness to pay for the environmental services**

<table>
<thead>
<tr>
<th>Nos</th>
<th>100</th>
<th>29</th>
<th>211</th>
<th>35</th>
<th>24</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>31.4</td>
<td>9.1</td>
<td>66.4</td>
<td>11.0</td>
<td>7.5</td>
<td>12.6</td>
</tr>
</tbody>
</table>

*Note: 318 respondents or 37% are not willing to pay any*

Most households (80%) have an income of less than CNY4000 per month according to the statistics of the responses. Respondents tend to underestimate their income and some of them are reluctant to reveal their income range. So, if we take the upper side income of a range as the household income, the average household income would be CNY3796/household/month.

**Table 19 Household income distribution**

<table>
<thead>
<tr>
<th>CNY</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 or less</td>
<td>89</td>
<td>8.6</td>
<td>10.5</td>
<td>10.5</td>
</tr>
<tr>
<td>1000-2000</td>
<td>278</td>
<td>26.8</td>
<td>32.7</td>
<td>43.2</td>
</tr>
<tr>
<td>2000-4000</td>
<td>309</td>
<td>29.7</td>
<td>36.4</td>
<td>79.6</td>
</tr>
<tr>
<td>4000-6000</td>
<td>95</td>
<td>9.1</td>
<td>11.2</td>
<td>90.8</td>
</tr>
<tr>
<td>6000-8000</td>
<td>38</td>
<td>3.7</td>
<td>4.5</td>
<td>95.3</td>
</tr>
<tr>
<td>8000-10000</td>
<td>23</td>
<td>2.2</td>
<td>2.7</td>
<td>98.0</td>
</tr>
<tr>
<td>10000-12000</td>
<td>12</td>
<td>1.2</td>
<td>1.4</td>
<td>99.4</td>
</tr>
<tr>
<td>14000-16000</td>
<td>3</td>
<td>.3</td>
<td>.4</td>
<td>99.8</td>
</tr>
<tr>
<td>16000-18000</td>
<td>2</td>
<td>.2</td>
<td>.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>849</td>
<td>81.7</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>System</td>
<td>190</td>
<td>18.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1039</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

About half respondents (47%) got an education up to junior high school, and the other half respondents got an education from senior high school to university. It’s relatively diverse in distribution.

**Table 20 Respondent’s education distribution**

<table>
<thead>
<tr>
<th>Valid</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>illiteracy</td>
<td>49</td>
<td>4.7</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Primary school</td>
<td>100</td>
<td>9.6</td>
<td>11.8</td>
<td>17.5</td>
</tr>
</tbody>
</table>
A little more than half the respondents (56%) are women. As a household survey, it seems that more women than men are at home during the interview period (9:00am to 18:00pm).

Table 21 Respondent’s gender distribution

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>473</td>
<td>45.5</td>
<td>55.5</td>
<td>55.5</td>
</tr>
<tr>
<td>Male</td>
<td>380</td>
<td>36.6</td>
<td>44.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>853</td>
<td>82.1</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5.3 WTP Determination

The determination of WTP is not as obvious for a close-ended CV questionnaire as for an open-ended CV questionnaire. A PROBIT model will be used to determine the mean WTP for avoidance of water deterioration in the Yudong River. And factors influencing WTP will be explored.

Table 22 shows that among the 535 sample who are willing to pay some amount for clean water. The “YES” vote (probability) is corresponding to respective prices. About 95% of respondents are willing to pay CNY0.05/m3 of surcharge on their water bill for the commodity, while 34% are willing to pay CNY1.0/m3 for it. This relationship could be illustrated in Figure 1.

Table 22 Cell counts and Residuals

<table>
<thead>
<tr>
<th>Value of Water Agreed</th>
<th>No. of Households responding to the Value</th>
<th>YES vote to this bid (observed responses)</th>
<th>Expected Responses</th>
<th>Residual</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.050</td>
<td>88</td>
<td>83</td>
<td>83.943</td>
<td>-.943</td>
<td>.95389</td>
</tr>
<tr>
<td>0.100</td>
<td>96</td>
<td>93</td>
<td>90.458</td>
<td>2.542</td>
<td>.94227</td>
</tr>
<tr>
<td>0.300</td>
<td>93</td>
<td>84</td>
<td>81.085</td>
<td>2.915</td>
<td>.87188</td>
</tr>
</tbody>
</table>
Table 23 shows the estimates corresponding to each probability and its confidence interval with 95% confidence. With the formula 5-1,

$$WTP = \frac{\sum estimate \times Pi}{\sum Pi}$$  \hspace{1cm} (5-1)$$

Mean WTP could be estimated with Table 23. The mean WTP is CNY0.37/m3, and this surcharge is acceptable to 80%–85% respondents of the sample.

**Table 23  Estimates with a distribution of probability**

<table>
<thead>
<tr>
<th>Probability</th>
<th>Estimate</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>estimate*probability</th>
<th>Mean Value in Y/cum</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>1.884</td>
<td>1.481</td>
<td>2.830</td>
<td>0.018844</td>
<td></td>
</tr>
<tr>
<td>0.02</td>
<td>1.759</td>
<td>1.391</td>
<td>2.619</td>
<td>0.035187</td>
<td></td>
</tr>
</tbody>
</table>

90
With a mean WTP of CNY0.37/m³, we could estimate that annual WTP by Guiyang households for avoidance of water deterioration of the Yudong River is CNY8.47 million/year, given the expected water supply volume of 100,000 m³/day and the rate of being willing to pay of 62.7%.

5.4 Factors affecting WTP
About 63% of households are willing to pay for avoidance of water pollution and siltation, while 37% are not willing to pay any for the watershed services. With Goodman and Kruskal tau analysis shown on Table 24, we could find the following factors are the significant factors that determine why some households are willing to pay while others are not:

- perception of tap water quality at home;
- perception of Yudong River water quality;
- household income;
- house area

Table 24 Determinants of WTP or not with Goodman and Kruskal tau coefficient

| Q1 perception of tap water quality | .009 | .006 | .021* |
| Q2 perception of Yudong River water quality | .016 | .008 | .021* |
| Q3 household water consumption | .001 | .002 | .923* |
| Q5 household family size | .017 | .008 | .104* |
| Q11 household income | .050 | .014 | .000* |
| Q12 house area | .010 | .008 | .009* |
| Q13 age | .003 | .004 | .150* |
| Q14 education | .001 | .002 | .993* |
| Q15 gender | .000 | .000 | .925* |

a. Not assuming the null hypothesis
b. Based on chi-square approximation bold- significant factors

5.5 Welfare implications

Households expressed their willingness to pay, with price surcharge, for the sustained and high quality water supply. The increase in water tariff will have welfare implications for the whole population in the service areas.

Water as a necessity is theoretically inelastic and the analysis of the household questionnaire data also supports the judgment. See table 25. Base on this analysis, 10% increase in Guiyang household income will result in only 0.81% increase in water expenditure, which is inelastic.
Table 25 regression statistics

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>.594</td>
<td>.111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log household size</td>
<td>.759</td>
<td>.048</td>
<td>.474</td>
<td>15.678</td>
</tr>
<tr>
<td>Log household income</td>
<td>.085</td>
<td>.032</td>
<td>.081</td>
<td>2.678</td>
</tr>
</tbody>
</table>

a. Dependent Variable: household water expenditure

( household water expenditure)=0.594+0.759log (household size)+0.085log (household income)

Table 26 Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.491a</td>
<td>.241</td>
<td>.240</td>
<td>.24905</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), log (household income), log (household size)

To minimize the welfare side effect of pricing, a progressive tariff is proposed rather than the present uniform pricing.
- the first 7 m3/household/month will be charged at the present tariff, i.e. CNY2.2/m3
- 8-18 m3/household/month will be charged with a higher tariff of CNY2.9/m3
- 19m3 and more will be charged with the highest tariff of CNY3.9/m3

About 43.8% of households consume 7 m3 or less per month (Table 14). This amount of water could be regarded as the basic need for everyday life. And these households will not be affected by price increase.

Those households who are in the Life Minimum Guarantee (LMG) system will be subsidized for their water consumption as before.

6. Linking upstream with downstream for stable and clean water supply

6.1 Comparison of upstream costs and downstream WTP
Yudongxia Reservoir is to be the drinking water source for Guiyang city. The downstream Guiyang needs stable and clean water supply and value the environmental services at about CNY8.47 million/year estimated by CVM household survey. The upstream incurred some costs to prevent water pollution and soil erosion in the catchment. The estimated costs are CNY 1.99 million of capital costs and CNY892,800-CNY 1.68 million of annual costs except the development benefits foregone because of designating the catchment as the drinking water source area. This significant difference between upstream costs and downstream WTP could justify a PES scheme between upstream and downstream.

To compare the downstream WTP and upstream costs, the following factors have to be accounted:
- Transaction costs: in this case, the water quality monitoring costs might be high, for example, a real-time online water quality monitoring station might costs CNY2 million/each. Other transaction costs with fund transfer should also be accounted.
- Cooperation surplus: If there is no cooperation surplus or the surplus is small, the possibility of downstream and upstream reaching a PES agreement will be small.

6.2 Facilitation of consultation meetings between upstream and downstream

Field estimation of mitigation costs and value of watershed services will be presented to the upstream and downstream stakeholders. Consultation meetings will be held to find some kind of consensus on the PES scheme.

7.0 INSTITUTIONAL settings

In the upstream there are 3009 households which are to provide the watershed services. In the downstream there are 471,966 households which are potential beneficiaries of the services. It is impossible to link the services providers and beneficiaries in so large a scale without an institutional setting.

The institutional settings should consist of the components of i) service providers’ organization; ii) beneficiaries’ organization; iii) PES fund management. In Cost Rica, USA, and many other countries, NGO plays an important role in organizing the service providers and/or beneficiaries, and brokering the PES deal. In China the NGOs are less developed while governments at all levels predominates these things and others. It’s most likely that the local government of Longli County or the Xingshi Township takes the lead to organize the service providers in the upstream. For the downstream beneficiaries, it’s most likely that the Guiyang Municipal Government initiates the price increase of water supply and the beneficiaries respond it to some degrees. Given the high mobilization capacity of the local governments, it’s almost for sure that enough households will be mobilized to join the PES scheme if it’s a fair deal.
There has been an agreement between the upstream government (Qiandongnan Municipal Government on behalf of Longli County) and the downstream government (Guiyang Municipal Government) that there should be a PES scheme between Longli and Guiyang. The terms of the deal needs to be detailed. The institutional framework, compensation rate and timing, responsibilities and obligations, and organization settings have to be set in the forthcoming detailed agreement.

### 8.0 MONITORING and modelling

Monitoring is a critical part of the PES scheme and will incur considerable costs. There are various sources of pollution in the upstream, for example point sources, rural domestic, animal raising, farming etc. It is almost impossible to monitor all of the sources, especially the non-point rural pollutants. Alternatively, the quality of river water running into the Yudongxia Reservoir (tail of the Reservoir) should be monitored and the monitoring information should be transmitted simultaneously to both upstream and downstream authorities.

Modeling of relationships between each discharge and river water quality will help a lot to rank the various mitigation measures and set the pollution threshold. This implies a lot of scientific investment. Rule of thumb applies before those scientific information is revealed.

### 9.0 market elements in the PES scheme

International experiences show that market based PES scheme might be more sustainable. There might be some aspects in this PES scheme in which market can fit.

There might be cash flow problems with this PES scheme since to mitigate the pollution a considerable number of initial investment costs will incur while the benefits and WTP flow in the coming years. To solve the mismatch of cash inflow and outflow, a loan to invest into the biogas installation and other environmental protection works might be apply. The fund collected from the beneficiaries each year will be used to pay the loan.

The cap-and-trade possibility needs to be explored in the upstream catchment with 20 point source polluters at present. The total discharge will be capped in the catchment and the discharge quota is allocated among the polluters with bidding or grandfathering procedure. The quota saved by one polluter could be sold to another or new comers. And any polluter who want to expand and need more quota has to buy from other polluters.

A reverse-tenders mechanism or other competitive approach might be useful in allocating PES fund since mitigation costs are significantly different from one mitigation measure to another. The less costly measures will be first funded with this mechanism, which is an efficient use of the PES fund resources.
References


Hello, We are university students, my name is________. I come here just for an investigation related to tap-water. As you know, the drinking water in your district comes from surrounding surface water and groundwater. Yudongxia Reservoir project is one of the major projects that provide drinking water to your district. Yudong River is originated from Longli County, run through Longli and Guiyang. The water quality of Yudong River will affect the drinking water source of your district. The Yudongxia Reservoir will guarantee a stable water supply to your district and at the same time, the upstream communities have contributed a lot to control the water pollution such as building of household based biogas systems. Your district as the downstream is the beneficiaries, especially the water user, directly benefit from the upstream pollution control. Therefore, the purpose of this survey is to know you as the tap water user whether you are willing to pay for pollution control of the Yudong River.

Your answer is no right or wrong. Hope you express your true thoughts. The Investigation would probably take up your several minutes, we will send you a small gift to gratitude your work [Investigator: send a small gift].

Q1 what do you think of the tap water quality of your home Investigator read out the three option and let the interviewee choose one
1. very good
2. good
3. not good, sometimes have problems

Q2 what do you think of the water quality of Yudong river Investigator read out the six option and let the interviewee choose one
1. Very good    2. Good    3. Not very good    4. bad
5. I don’t know    6. I don’t care    7. other- list out

Q3 how much water did your family use every month in average according to water meter _________m$^3$

Q4 how much did your family pay for water every month in average _______ Yuan

Q5 How many people is there in your household sharing one water meter

Q6 Are you willing to pay a little higher on your water bill to raise funds in order to help the upstream for pollution control and avoid water pollution in Yudong river. [show picture water quality class II and class III] This fund will be transferred to the upstream with a PES scheme.
1. Yes  go to Q8      2. no

Q7 what is the reason that you are not willing to pay  Investigator  please let the interviewee say and classify his answer to the list below according to the content he said  Multiple Choice
1. Pollution control is a matter that government should do
2. Treating water is a matter that the water supply company should do
3. The current water charges have been high enough
4. Are you sure the money we paid could be used for the upstream water pollution control
5. Water pollution control is the matter that the upstream should do themselves
6. Other   list
Go to Q11

Q8 following Q6  are you willing to pay a surcharge of ____yuan/m3 over your current water bill but it will increase your monthly spending, its share of your expenditures, and its competing use.
1. Yes  go to Q9      2. No  go to Q10
    note the current water fee  2.2yuan/m3

Q9 can you explain why you are willing pay the increase fee   Investigator let the interviewee say
Investigators Records

Q10 can you explain why you are not willing   Investigator  let the interviewee say
Investigators Records

Q11 Cold you tell us the relatively stable average monthly income of your family (including all family members)  Income includes wages, pensions, rental income and allowances. only disposable income, does not contain hidden subsidies, non-disposable income
1. below 1,000yuan   2. 1,000-2,000yuan   3. 2,000-4,000yuan   4. 4,000-6,000yuan
5. 6,000-8,000yuan   6. 8,000-10,000yuan   7. 10,000-12,000yuan   8. 12,000-14,000yuan
9. 14,000-16,000yuan  10. 16,000-18,000yuan  11. 18,000-20,000yuan  12. 20,000-22,000yuan
13. 22,000-24,000yuan  14. over 24,000yuan
Q12 your house construction area _________m²

Q13 your age

Q14 what is your level of education:
1. Illiterate; 2. Primary school; 3. Junior high school; 4. Senior high school; 5. College; 6. University; 7. graduate school

Q15 Gender of Respondant  Investigator write directly
1. Man     2. Women

Investigator  In order to make sure investigate quality, investigation may be a return visit to you, can you tell us:
Respondent name
Address  Guiyang city___district___road_number___sub-district___building___room
Telephone number:

Thanks for your support and cooperation, wish you a happy life

Investigator field diary The survey found, problems, improvement suggestions, impressions, etc.
<table>
<thead>
<tr>
<th>#</th>
<th>Rule</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read every question exactly as written in the questionnaire.</td>
<td>Research on the art of asking questions shows that the precise wording of questions may significantly affect a respondent’s answers. If each enumerator develops her own way of asking questions, one can never be sure that the same question is being asked. Ensure that each respondent is answering the same question. Reading the question exactly also makes the interview shorter.</td>
</tr>
<tr>
<td></td>
<td>- Do not improvise.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Read the question slowly enough so that the respondent can understand.</td>
<td>An enumerator has seen each question hundreds of times before. It is natural for the enumerator to want to go quickly over a question that he knows so well, but it is the first time for the respondent. The enumerator thus needs to speak slowly.</td>
</tr>
<tr>
<td>3</td>
<td>Wait for the respondent to answer.</td>
<td>Some enumerators will read the question once, then look up and repeat the question, and sometimes even start a lengthy explanation, before letting the respondent answer. Ask once very clearly, and let the respondent think.</td>
</tr>
<tr>
<td>4</td>
<td>If the respondent cannot answer, repeat the question.</td>
<td>The respondent may not have been paying attention the first time. If, after the second reading the respondent still cannot answer, go to the next question.</td>
</tr>
<tr>
<td>5</td>
<td>Remain absolutely neutral about the respondent’s answers.</td>
<td>Never express surprise, approval, disapproval, judgment, or doubt about a response. Do not let your facial expression change. Just record the answer. For example, if a respondent says that they would be willing to pay a very large amount for a good or service, the enumerator should not say, “wow!” If a respondent gives an answer that is factually wrong, the enumerator should not reveal that he knows the answer is incorrect.</td>
</tr>
<tr>
<td>6</td>
<td>Do not act embarrassed about a respondent’s answers to sensitive questions.</td>
<td>This will increase the embarrassment of the respondent, not reduce it. Be very matter of fact.</td>
</tr>
<tr>
<td>7</td>
<td>Never suggest an answer unless the instructions say to read the answers to the respondent.</td>
<td>For example, if the respondent is having difficulty estimating what he will pay for a good or service, do not prompt him with suggestions like...“would you pay more than CNYxx? Less than zz?”</td>
</tr>
<tr>
<td>8</td>
<td>Do not repeat the respondent’s answers.</td>
<td>This is repetitive and wastes time.</td>
</tr>
<tr>
<td>9</td>
<td>Conduct the interview in private.</td>
<td>This means that the interview should not be within earshot of other people in the household. If someone does not want to leave, the enumerator should offer to interview him or her separately. If they still would not leave, then the enumerator should explain to the respondent that he will have to return later.</td>
</tr>
<tr>
<td>10</td>
<td>Do not give advice to respondents on personal matters.</td>
<td>Enumerators should refer respondents to the appropriate authorities for answers to questions that may arise that are outside the scope of the interview.</td>
</tr>
<tr>
<td>11</td>
<td>Answer directly any questions the respondent may have about the purpose of the survey.</td>
<td>Respondents are entitled to know the purpose of the survey and how they have been selected to be interviewed. The enumerator should not be reluctant.</td>
</tr>
</tbody>
</table>
to take time to provide clear, detailed answers to such questions.

It is very off-putting to the respondent if the enumerator is inattentive. Moreover, the respondent may be offering an answer that is in fact different than it first appears to be. In such cases the enumerator needs to be listening carefully to hear what is actually being said.

Source: ADB, 2007
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PART II - 3 Rural Water Reform Water User Associations Development and Training

1.1 Introduction

1.1.0 Need for Rural Reform at Village

There are some 199 villages in Guiyang with a rural population of about 1.53 million. 37% of the townships are considered poor counties. The rural demand is 444 MCM/yr of which about 44 million is domestic and local business demand, irrigation is 353.0 MCM/yr is irrigation. Because the irrigation structures and the water resources management systems are not in place the present irrigation system uses only 285 MCM/yr. Most the rural people rely on river water and rainwater collectors, ponds and springs for their water supply. Groundwater does not exist. The water supply is derived from the irrigation system and water supply for domestic and other purposes could be from piped systems also from river water. However a large number of people rely of carrying the water from rivers. If there is a drought for 3-4 months as we have had in 2010 then a large number of people will not have water for irrigation or for drinking. In the drought March 2010 18.1 million people especially in the rural areas did not get their domestic water supply. In the Guiyang Municipality about 600,000 people did not receive their domestic water supply. In addition most small scale irrigation dried up.

Institutionally the irrigation water and domestic water and all other water supplies are run by farmers who essentially run the irrigation using informal village institutions. There is no demand prediction, no management of demand, and no conservation programs unless there is a project. The farmers are therefore seriously affected when there is a drought.

The need to organize a Water User Association (WUA) is extremely important to bring about the management of irrigation water, drinking water, and industrial water and all other use of water at the village level. The WUA will have to communicate with all the upper levels of water use i.e, the township water management station and county water resources bureau’s

1.1.1 China Irrigation Management Reform at the Village Level

In China, farmers’ participation in irrigation management (PIM) though water users association (WUA) has changed poorly managed situation of local systems to a much more dynamic system. Ministry of Water Resources has recommended the formation of WUA for the institutional reform in irrigation management at village level. The other approaches to farmer participation in this program include the auctioning the management to a third party, management contacting to a third party, and renting of some small irrigation schemes and facilities, like ponds, wells etc., to very progressive individual farmers. But the MWR has concluded that formation of WUA and have farmers control over these public goods collectively better than using third party management contracting or by control by very progressive individual farmers.
The participatory methods of WUA formation to enhance efficiency and effectiveness of local irrigation system, are the best reform in water sector at the village level. MWR has been promoting the disseminating the extension of WUA formation throughout the country. As a result, there are now roughly are 12,000 WUAs in total spreading over most provinces in China.

During the preparation of the World Bank supported Yangtze Basin Water Resources Project in Hubei and Hunan provinces in the early 1993, it was found that there are in fact some experimental cases managed by the farmers themselves for years in which farm “water users group” were organized and given responsibility for local irrigation distribution networks. These experiments had produced quite good results in water delivery and lateral canal maintenance, and showed the high potential for farmer group management at the distribution network level. Their main weaknesses were that the farmer groups were not permanent organizations and had to be re-established each year, and the group leaders were appointed by local officials rather than being elected so as to be responsible to farmers themselves. Nevertheless, what was significant by the groups is the tendency of farmer’s participation in local irrigation management was being handed over to an organization, which farmers saw as their own. With elections of the group leaders such groups could become formal Water User Associations (WUAs), which were farmer-managed, and permanent legal persons.

During the preparation of the World Bank supported Water Conversation Project in Beijing, Qingdao, Shenyang municipalities and Hebei province in 2001, a new paradigm was needed in order to keep the WUA’s reform effective and sustainable. There were six key WUA principles can be presented as follow:

- The WUA must be certificated by local civil administration;
- The WUA must be non-profit organization with legal person;
- The WUA is farmers’ own irrigation organization (farmers elect, manage, make decision, etc.);
- It is organized on the basis of hydraulic boundaries;
- It adopts volumetric water charges based on water measurement; and
- It has right and capacity to collect water charges and submit them to water supplier, for both sustainable use of water resources and its own self-managing/financing costs.

The type and nature of the WUAs are directly related to the structure of the economy as well as the type of irrigation found in the countries. In Mexico, Japan, Taiwan, Turkey, Argentina and Colombia, the WUAs are large (2,000-50,000ha) and are organized more along the lines of commercial entities, reflecting the more commercial nature of the irrigation sector. Agriculture is developed on a cash basis and many of the staff is hired professionals paid in cash from the irrigation service fund. Given their large size, the WUAs can afford to purchase and maintain their own transport and maintain equipment. The type and nature of WUAs are very dependent on the structure of the broader economy as well as the type of irrigation and the tradition of management prevailing in
the country. Where economies are more developed and diversified and irrigation systems are large, WUAs have tended to evolve successfully.

In contrast, WUAs in the Philippines are very small (100-300 ha) and are often organized based on the village structure. Most of the labor is voluntary labor provided by the users, and very few, if any, of the irrigation staff are hired professional. Given the small size of the WUAs there are diseconomies of scale and hence the organization cannot afford to own specialized maintenance equipment. The WUAs tend to be small and more problematic in terms of management.

1.1.2 Guiyang Water User Association Formation Requirements

In Guiyang project area there are some issues also for WUA formation:

1) WUA must be certificated by Guiyang civil administration, but **the certification fee is ¥20,000 is collected for each WUA**. The WUA cannot afford to pay this fee. In the project cost estimate for the IWRM the fee for WUA certification was not included. If Guiyang government can waive the fee for WUA certification, the WUA would be certificated, or else it is impossible for the beneficiary farmers to pay the fee;

2) Most of the counties in the project area are listed as poverty counties, where their economies are less developed; agriculture is subsistence farming, and irrigation systems are small canal systems, which control only 100-150 ha area, and **the WUA tends to be small and more and they cannot afford and charges to the Guiyang Government**

In the project area, if the area of irrigation system and its individual hydraulic unit is over 200 ha, the Guiyang government will support the certification fee, and will clear the way for the WUA to be established. If the areas are less a group of WUA will have to form a water user group (WUG) which then have a area greater than 200 ha.

WUG is managed by the farmers themselves, which organizes and gives responsibility for local irrigation distribution networks. The WUG will have efficient water delivery and well system maintenance, and have a high potential for farmer group management at the distribution network level. The **WUG will be a permanent organization**, and the group leader is elected by farmers themselves so as to be responsible to farmers themselves. What is significant is farmers participate in local irrigation management and the farmers own the management.

The WUG do not need be certificated by local civil administration and it does not have to be non-profit organization with legal person. The WUG is the farmers’ own irrigation organization (farmers elect, manage, make decision, etc.), organized on the basis of hydraulic boundaries, adopt volumetric water charges based on water measurement; and
have the right and capacity to collect water charges and submit them to water supplier, and for their own self-managing/financing costs.

The farmers can develop the guideline to support WUA development in Guiyang, including rural drinking water supply projects and irrigation projects.

The potential impact of WUG of farmer has positive and negative impacts:

- Positive impacts are sense of ownership, increased transparency of processes, great accessibility to system personal, improved maintenance, improved irrigation service, reduced conflicts among users, and increased agricultural productivity;

- Negative impacts are higher cost, more time and effort required to manage, less disaster assistance, no assured rehabilitation assistance, and less secure water right.

1.1.3 WUG Setting Up Issues

a) Transparency

Transparency is very essential in financial accounting than any other organizational issues. With WUG collecting and managing funds, and with accounting done on the basis of the unit management by WUG, users can get a better understanding of how their money is being collected and used. However, strict supervision and auditing of water fee collection and expenditures by an independent accountant is still necessary to counter the possibility of money being diverted for unauthorized purposes.

b) Water Fees Increase

Usually one of the immediate effects of WUG is an increase in water fee at the irrigation district level. However to make a valid comparison, fee rates must be in real terms before being compared with previous year fees. Irrigation service costs are generally considered appropriate if they constitute 5% to 8% of production costs, and these fees should be adequate to operate a WUG. In the case of small holding sizes with lower value crops agriculture, the incomes of farm households is very low and therefore the irrigation service fee can create hardships to these farmers. The WUG with efficient financial management and better service once the association is formed can change the farmers negative feelings on water fee.

c) Subsidies

Subsidies are also normally available in the case of emergencies situations. In drought conditions due to the lack of water, WUG will not have water to deliver to farmers; consequently, and collection of fees drops nearly to zero. For many of the WUG the government had to step in with subsidy programs to avoid a collapse of WUG. A few WUGs that were only partially affected by the drought tackled the program by hastily imposing a compensation fee on their farmers to implement a water reuse program.
d) Productivity Factor

Underlying difficulties in generating sufficient irrigation service fund revenue to sustain system operations, in many cases, are the low productivity of irrigation agriculture in system command areas. Low productivity can results from a large number of factors, but is often associated with small farm size, production of low value crops such grains, inappropriate agricultural policies, a poor natural resource base, and inadequate agricultural support services. In such cases, a solution to the WUG’s financial problems may be possible only if the underlying problems in the agricultural sector are addressed. If these problems cannot be solved, then the options are for the government (a) to have other agencies provide technical assistance to increase production, or (b) provide the WUG with special subsidies. As a last resort, the government may have to consider taking back the responsibility of system management and financing. However, as irrigation service fees typically constitute only 3 to 10 percent of total production costs, reducing them will generally not solve underlying programs of high agricultural production cost and productivity.

e) Rehabilitation

Rehabilitation has to be tackled in a consistent policy. In the absence of a clear and consistent policy on rehabilitation, maintenance is often deferred. There is a valid argument for developing a cost sharing formula where the government pays a share and the users pay the remaining share. If possible, the WUGs should have a sinking fund for accumulating funds to cover their share of future rehabilitation costs. When this fund is insufficient, it is important to have an outside source of credit for emergency repairs. Other needed supporting services including assistance with maintenance assessment practices and technical design and construction services.

WUA Functions

1.1.4 Village Water User Association Functions

Overall Functions

The water user organization at village level will be responsible for managing the following water uses:

a) Irrigation water
b) Village drinking water
c) Village water for business, and industry
d) Fisheries (aquaculture) forestry  
e) Livestock water  
f) Water for off stream environmental purposes for cleaning the village center, dust control ext.

**Organization Relationship to Upper Levels**

Although the WUA or WUG will be responsible to the village administration they will need to communicate with the Township Water Management Station for guidance of water use and water conservation, demand management. Figure 1.1 shows the organizational communicational lines.

**Figure 1.1 Water User Organizations and the Relationship to Township and County Water Resources Organization**

**Demand Management**

Rural water demand management is discussed in Chapter 7 of Part I Report. It should be noted that almost two thirds of water demand for the rural sector is for irrigation (68%) (See Figure 1.2)
Demand management in rural areas is mainly by managing irrigation quota and also the efficiency of the tertiary canal network. The best way of managing irrigation quota is to reduce losses at the on-farm level by reducing the length of travel of water in the canals before getting into the fields; and reducing the main system efficiency by adopting lined system of canals, piped systems or drip irrigation for vegetable farming. In addition with the water users a system of operating rules should be developed so that the operational losses are minimized. The IWRM 2007 Report by Guiyang Hydrological Bureau indicates that field efficiencies and main system efficiencies can be significantly improved and water quota’s can be reduced. Figure 1.3 shows the efficiency improvements (via Lining canals, pipe, drip for vegetables etc) for field increasing from 75% to 95% and main system efficiencies being improved from 55% to 70%. The net saving will be 78 MCM/year in 2010, 98 MCM/year in 2020 and 120 MCM/year in 2030. This would save about 9% of the demand requirements in 2020. These are long term demand management methods that can be adopted by the WUA for demand management.

**Drought management by WUA**

Drought is fairly frequent event at village level in Guiyang. In the last drought in 2010 about 600,000 rural people needed drinking water in Guiyang and a total of 18 million people were affected in Guizhou Province. The Municipal Flood and Drought
Management Group can assist in many ways but the Villages using the WUA can also help to mitigate the drought before municipal or province or state drought assistance arrives. Each WUA and WUG must have a drought task force. Their main function is the following as defined in the Text Box 1. The detailed steps are identified in Text Box 1.0.

**Text Box 1. Drought Mitigation Tasks by WUA/WUG Task Force**

<table>
<thead>
<tr>
<th>a)</th>
<th>define the type of drought: a hydrologic drought or an agricultural drought (no rainfall and therefore no soil moisture) or a socioeconomic drought</th>
</tr>
</thead>
<tbody>
<tr>
<td>b)</td>
<td>Plan for drought each year before the dry season. Identify the priority/critical users of water:</td>
</tr>
<tr>
<td></td>
<td>i. domestic supply</td>
</tr>
<tr>
<td></td>
<td>ii. animal water supply</td>
</tr>
<tr>
<td></td>
<td>iii. aquaculture needs/ fruit trees etc</td>
</tr>
<tr>
<td></td>
<td>- Determine the home storage of water; assemble in the village center the supplies for emergency food and for animal food supply; repair all mobile pumps and pipes that will be used in time of drought to pump water out of streams etc</td>
</tr>
<tr>
<td>c)</td>
<td>Undertake mitigation measures in event of drought</td>
</tr>
<tr>
<td></td>
<td>i. Stockpiled pumps, pipes, water filters, and other equipment</td>
</tr>
<tr>
<td></td>
<td>ii. Established water hauling programs for domestic and livestock purposes</td>
</tr>
<tr>
<td></td>
<td>iii. List livestock watering locations</td>
</tr>
<tr>
<td></td>
<td>iv. Established hay/foi/der hotline</td>
</tr>
<tr>
<td></td>
<td>v. Fund water system improvements, new systems, and new wells</td>
</tr>
<tr>
<td></td>
<td>vi. Fund drought recovery programs</td>
</tr>
<tr>
<td></td>
<td>vii. Lowered well intakes on reservoirs for rural water supplies</td>
</tr>
<tr>
<td></td>
<td>viii. Created drought property tax credit program for farmers</td>
</tr>
</tbody>
</table>

In order to undertake these activities there needs each WUA must have a representative in the WUG. The drought activities must be performed by the Drought Management Task Force which part of the WUG leadership.

**Figure 1.3 Irrigation Field and Main System Efficiencies by Water Saving Investments**
1.2 The guideline to support WUA development in Guiyang

The guideline and training handbook for WUA development in Guiyang has compiled. The guideline and training handbook for WUA development are in Part III of this report. The steps are as follows as shown in ensuing steps

1.2.1 Establishment of WUA/WUG

The WUA establishment needs the steps as outlined in Text Box 1.0

**Text Box 1.0  WUA Establishment**

1. To establish the leading group and the office
2. To launch promotion campaign
3. To divide WUA/WUG and establish WUA/WUG preparation group→ define hydraulic boundary
4. To Collect basic information;
5. To prepare WUA charter;
6. To arrange location and facility for WUA activity;
7. To divide water using groups, elect water users representatives (water users group leader), and nominate WUA executive committee candidates.
8. To organizing water users congress and establish WUA;
9. To register;
10. To implement preliminary repair and maintenance of irrigation works;
11. To develop rules and regulations;
12. Checking and acceptance
1.2.2 WUA/WUG Promotion Scheme

The second most important item is to launch a WUA/WUG promotion scheme. As WUA establishment is based on the farmer’s willingness, it is important to have a dissemination targeting the farmers. This is a critical link in WUA preparation and establishment. The objective of the dissemination is to enable the farmers fully aware that WUA is a new irrigation management organization and the benefit to them. Only based on this, would the farmers be willing to apply for joining WUA. The dissemination mainly includes the following aspects as shown in Text Box 1.1

**Text Box 1.1 WUA Promotion Scheme**

1. Concept, nature and function of WUA;
2. Function and impact of WUA establishment;
3. Organizational structure of WUA and its internal relationship;
4. Responsibility, operation and management mechanism of WUA;
5. Right and obligation of WUA members;
6. Procedure for the farmers to join WUA, the procedure and method for WUA establishment;
7. Advantage and feasibility to establish WUA

1.2.3 Dividing WUA and Establishing WUA Preparation Group

The next step is to divide the WUA group and establishing WUA preparation group and the steps are shown in text box 1.2

**Text Box 1.2 WUA group Preparation**
• The leading group investigates the hydraulic distribution in the irrigation district, designates hydraulic boundary and proposes a preliminary program for WUA dividing according to the principle of designating WUA based on hydraulic boundary;
• To call the meeting of irrigation administration and the township government staff, to discuss about the preliminary program of dividing WUA and the name list of WUA preparation group;
• To call the meeting of farmers representatives, to broadly consult the farmers of different types on the WUA dividing program and WUA preparation group composition;
• The leading group summarizes different views and designates the geographic range of dividing WUA;
• To establish WUA preparation group, consisting: Township government staff and Village leaders, staff of irrigation district administration, staff of water supply unit and representatives of farmers. Among them, the representatives of farmers should be no less than half of the total number of the group members.
• The leading group and the local government in the WUA located area approve formal establishment of WUA preparation group.

1.2.4 Collecting Basic Information about WUA

WUA preparation group should obtain basic information about the area where WUA is planned to establish according to the designated geographic range. Basic information should include the following aspects as given in text box 1.3

**Text Box 1.3 Collection of Basic Information**

1. Number of households, population and labor within the WUA range;
2. The area of land and farmland, crop distribution and cropping area in the WUA range.
3. The present situation of irrigation (drainage) works within the WUA range and propose a feasible preliminary repair and maintenance plan;
4. Rural economic and social situation within the WUA range;
5. Present situation of water management, water using, water measuring and water tariff collection.

2. Collecting the WUA application forms from farmers. The form mainly includes the information of name, population in the household, agricultural labor, irrigation area and view to join WUA.

1.2.5 Dividing of Water users Group, Electing Water users’ Representatives, etc

The preparation group should divide several water users groups within the WUA range according to the hydraulic boundary in the WUA boundary (see Text Box 1.4)

**Text Box 1.4 Electing End User Representatives**
1. The preparation group negotiates with the township government staff and village leaders, consult broadly on farmers’ views, nominates water users candidates of the group based on groups (women should occupy a certain proportion in the nominated candidates), and then calls conference of all water users group members to elect water users representatives.

2. The preparation group should broadly consult the water users representatives and the public views, to nominate the candidates for WUA executive committee members (women should occupy a certain proportion in the nominated candidates). The number of nominated candidates should be more than the executive member number. The candidates should meet the following requirement:
   (1) Having high awareness to serve the farmers;
   (2) Having education higher than middle school graduation;
   (3) Being responsible and having a certain level of working capacity;
   (4) Having a certain practical experience in irrigation management and agricultural production;
   (5) Having good public reputation.

1.2.6 Development of WUA Charter
The next step is for WUA preparation group to prepare the WUA charter (draft) for discussion at the water users’ congress.

1.2.7 Organizing Water Users Congress

The leading group organizes or assists WUA to call water users congress. The task of water user’s congress is given in Text Box 1.5

Text Box 1.5 Adoption of WUA Report and Charter

1. To adopt the work report of WUA preparation group;
2. To adopt WUA charter;
3. In the election of WUA executive committee members, the method of secret ballots and balanced election should be used;
4. In general, the executive committee has 1 chairman, 1-2 vice chairmen, and 2-3 members (engineer, financial staff and administrative staff), or the posts can also be held by vice chairmen.;
5 To discuss preliminary repair and maintenance plan for irrigation works.

1.2.8 Registration of WUA
The steps are given in text Box 1.6

**Text Box 1.6 Registration of WUA**

<table>
<thead>
<tr>
<th>Time</th>
<th>Training Content</th>
<th>Trainees</th>
</tr>
</thead>
<tbody>
<tr>
<td>April, 2010</td>
<td>Integrated water resources management</td>
<td>PMO or local irrigation management specialist</td>
</tr>
</tbody>
</table>

1. WUA executive committee or the leading group are responsible for submitting application to local county level civil affairs department according to the registration requirement and procedure. The application contains the name, location, legal representative, profession scope, activity range and professional administration unit of WUA.

2. WUA executive committee prepares documents required for application, according to the unified form for applying WUA, the content of the charter and other requirements of civil affairs department. The documents required include:
   (1) WUA Charter;
   (2) Name list of WUA executive committee and CV of WUA chairman;
   (3) Application for legal person of social organizations;
   (4) Registration for legal person of social organizations;
   (5) Certificate documents for WUA asset;
   (6) Certificate documents for right of using and managing irrigation (drainage) works.

### 1.3 Consultation with Guiyang PMOs to Establish WUAs within Guiyang Project Area

During July, 2009, Wudang District, Huaxi District, and Xifeng County have been visited. To determine practical ways to:

a. Assist local governments establish and support WUAs in irrigation areas.

b. Train agricultural extension workers to provide training and support to irrigators.

c. Deliver the assistance identified in above items – this may be by a training course or by other means such as working collaborative side by side with local government officers preparing to introduce WUAs.

### 1.4 Training Proposals to Build Capacity of Agricultural Extension Workers

The most important of these is probably the re-establishment of a well funded agricultural extension service that can support on-farm efforts to improve crop and land management methods. This important measure is consistent with IWRM.
### 1.5 Targeted Training Module for WUAs on Agricultural Practices

It is important for WUAs to train. As training of WUAs, the training courses or by other means such as working collaboratively side by side with local government officers introduce WUAs.

During the implementation of Guiyang Integrated Water Resources Management Project, the train WUAs models for the different groups, such PMO for GM, and PMOs from selected countries and districts, are below:

- **Study Tour:** A group of oversea study tour is planning. Spain, Cambodia and India are the advantage of irrigation management. PMO and Counties staffs in irrigation management are selected. At least two groups of domestic WUAs study tour have been proposed. Tieshan, Hubei Province and Aksa, Xinjiang may be selected.
- **On-farm course:** the staffs and specialist of the irrigation management will introduce the WUA to the farmers on farm. On other hand, the farmers will discuss their experiences each other.
- **Workshop:** in the midterm of the project, the workshop will be held for the improvement irrigation management.

### 1.6 The WUA Training Module to the Wudang WUA

Wudang District has recently taken steps to establish a Water User Association (WUA) for the Wudang irrigation core sub-project. It is proposed that this WUA be established as a legal entity. It is intended it take the form of a committee legal person - that is the committee is the legal entity, and the chair of the committee is the designated “legal person” (with legal and financial responsibility broadly equivalent to the legal person of a Chinese enterprise. It should be noted that village committees in China operate under this arrangement, so it is a well proven legal model. The WUA would be under the

<table>
<thead>
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<th>Date</th>
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<tbody>
<tr>
<td>June, 2010</td>
<td>Operation and management of irrigation system</td>
<td>Local irrigation specialist</td>
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<tr>
<td>May, 2011</td>
<td>Operation and management of WUA</td>
<td>Local WUA consultant</td>
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<tr>
<td>June, 2011</td>
<td>Agriculture management in irrigation system - irrigation schedule</td>
<td>Local water institution</td>
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<td>Oct. 2011</td>
<td>Balance fertilize under irrigation condition</td>
<td>Local agriculture specialist</td>
</tr>
<tr>
<td>2012-2013</td>
<td>Technique for agriculture, forestry cultivation and management, pest management, and green vegetable technology</td>
<td>Agriculture specialist</td>
</tr>
</tbody>
</table>
supervision of Township government, just as village committees are. But the certification fee of the civil administration is Y20,000 for each WUA.

The other model of water user group will be promoted. The WUG not be formal legal entities. These local WUGs would be represented on the water user association and be responsible for coordinating activities at the local level, including operations, organizing maintenance, collecting water use fees (and passing these to the WUA) etc. The WUA would contract with the local water station for the irrigation supplies.

This model has been selected by the PMO because it fits well with existing local institutional arrangements and thus can be implemented relatively easily. The model is somewhat different from the model initially presented by the PPTA team which envisaged the WUA being a lower level organization operating at village level, with a formal status and also having grass roots WUGs. The PPTA team envisaged a WUA federation being formed at township level to contract with the local water station, giving a three tier arrangement rather than a two tier arrangement favored by the PMO. However, the two models are sufficiently close and with broad commonality of objectives, and it is therefore proposed that support be given to the PMO approach, as it commands local ownership.

Initially the PMO was proposing that only one WUA be established immediately and used as a pilot, with the implementation of other core and non-core subprojects being implemented in a more traditional PRC manner. The PPTA team has expressed some concern that this approach would risk a repeat of past mistakes and in principle we favor setting up WUAs for each irrigation and reservoir subproject. The PMO accept our point, but in the discussion raised the issue of how a large number of WUAs can be adequately supported in the early phases of project implementation.

Consideration has also been given to whether establishment of a WUA should be part of the implementation arrangements for the soil conservation sub-projects. The conclusion reached was that as these sub-projects involve broader livelihood issues then the relevant village committee should assume ownership and responsibility for the sustainability of these, under the supervision of the relevant township.

1.7 Case: Shuitian Water Users Association

1.7.1 Description of Shuitian Township Water Users Association
Shuitian Water Users Association (STWUA) is located in the Shuitian town irrigation system of Wudang district in Guiyang municipality, in which there is a irrigation scheme with total length of 44130 meters and annual irrigating water capacity of 1.6—2.6 million cube meter in one small (A) size reservoir (Qiankanqing Reservoir) irrigation area, one small (B) size reservoir (Bashanqiu Reservoir) irrigation area and a diversion Works (Sanjiang Diversion Works). The total irrigated area is up to 6980 mu involving 6 administrate villages and 65 natural villages, in which water users are 1987 households and 8204 people.
1.7.2 Shuitian Township Farmer Income Analysis

In 2006, 10 villages and 360 household in the project area were surveyed by Guiyang Agriculture Statistical & Survey Team. In Shuitian Township, one village and 10 household were surveyed. The result of Shuitain Township is below in Table 1.2.

Table 1.2 Net Agricultural Income Present (2005) and future with irrigation
The average farmer income of Shuitian Township will increase from 5185 Yuan to 6089 Yuan with the project. The crop pattern will be huge adjusted with the project. The rate of grain and cash crop will change from 2:1 to 1:1.2.

In the figure 1.4, the value of irrigation in the all project area is over 0.30 Yuan per m³, including the value of irrigation in Shuitain 0.32 Yuan per m³.
1.7.3 The Water Management Station and WUA Financial Sustainability Analysis

Three WUAs (Jinlong, Wudang and liujiuzhai) and their water management stations have been analysed in financial sustainability. The result table is below. If the water tariff for each WUA according the current irrigation water price, any WUA in financial sector could not afford to pay their cost. Liaojiuzhai WUA will loss about 59 thousand Yuan, Wudang 62 thousand Yuan and Jinlong 517 thousandsYuan. Each WUA will loss Their finance is not sustable. With the reducement of WUA area, the more loss..

If the water tariff would be increased to the planning water tariff under the value of water, the only Wudang WUA will have little profit. The WUA controls the area at leat 200ha. If the irrigation management will be executed by their water management station, each station will lose even though the water tariff would be increased to the planning water tariff.
## Financial Analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Water Station</th>
<th>WUA</th>
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<td>61110000</td>
<td>Y 7030000</td>
<td>8557600</td>
</tr>
<tr>
<td>PROJECT INVESTMENT PER YEAR</td>
<td>TOTAL</td>
<td>120 120</td>
<td>194.7 194.7</td>
<td>431.2 431.2</td>
<td></td>
</tr>
<tr>
<td>IRRIGATION AREA SERVED (ha)</td>
<td>Dryland</td>
<td>120 120</td>
<td>194.7 194.7</td>
<td>431.2 431.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partial</td>
<td>120 120</td>
<td>194.7 194.7</td>
<td>431.2 431.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full</td>
<td>120 120</td>
<td>194.7 194.7</td>
<td>431.2 431.2</td>
<td></td>
</tr>
</tbody>
</table>

### I. WATER CHARGE REVENUE

1.1 Water production
- Volume of water used at field level
  - m³: 394568
  - 318200
  - 471300
  - 471300
  - 1840000
  - 1840000

1.2 Water charge rate
- yuan/m³
  - Current rate: 0.10
  - Planned rate: 0.25
  - Full cost recovery rate: 0.85
  - O&M cost recovery rate: 0.37

1.3 Collection rate / %
- 95%

1.4 Revenue collected
- yuan
- 30229
- 75573
- 256947
- 111847

### II. OPERATING EXPENSES

2.1 Salary & benefits
- yuan
- 22400
- 2240
- 27267
- 5453
- 126000
- 0

2.2 Repair
- yuan
- 39050
- 3905
- 47535
- 9507
- 0
- 0

2.3 Maintenance
- yuan
- 39050
- 3905
- 47535
- 9507
- 340000
- 0

2.4 Power
- yuan
- 5600
- 560
- 6817
- 1363
- 0

2.5 Fuel/k
- yuan
- 0
- 0
- 0
- 340000
- 0

2.6 Labor
- yuan
- 39000
- 3900
- 47475
- 9495
- 0

2.7 Labor provided by farmers
- yuan
- 0

Subtotal II:
- yuan
- 145100
- 14510
- 176630
- 35326
- 806000
- 115520

### III. FEES AND CHARGES

3.1 Irr. district management and water delivery fee
- yuan
- 75573
- 0
- 89547
- 0

3.2 Water Resources Fee
- yuan
- 0
- 0
- 0
- 0

3.3 Insurance
- yuan
- 0

3.4 Interest
- yuan
- 0

Subtotal III:
- yuan
- 0
- 75573
- 0
- 89547
- 0
- 611800

### IV. Depreciation
- yuan
- 175750
- 213940
- 0
- 1527750
- 0

### V. TOTAL COST
- yuan
- 320850
- 90883
- 390570
- 124873
- 2333750
- 727320

### VI. SURPLUS/DEFICIT (I-V)

(63904) 15719 (220431) 9448 (1494710) 6840

Surplus/Deficit
- with current water charge
  - yuan
  - -290621
  - -327887
  - -62190
  - -2123990
  - -517560

- with planned water charge
  - yuan
  - -245278
  - -301023
  - 9448
  - -1721950
  - 6840

- with at-cost water charge
  - yuan
  - -63904
  - -220431
  - 1494710

### VII. FINANCING CAPITAL
- Government subsidy
- yuan
- 245278
- 301023
- 1721950

### 1.7.4 The Wudang WUA Institution Structure and Frame
The Wudang irrigation scheme covers an area of 440ha, most of which is controlled by the Qiangkangqing reservoir. If the WUA covers an area less than 200 ha, its financial capacity will be high risk. The registration certification fee for WUA in Guiyang is 20,000 Yuan. It is hard for local government and farmers. So, Wudang WUA will establish a Qiankanqing WUA, including Bashanqiu and Sanjiang water user groups.

Qiankanqing WUA is the legal unit. It will contract the water supply agreement in the beginning of the year with Qiankanqing, Bashanqiu reservoirs. In the meantime, each group will plan and manage the irrigation schedule, and communicate with these reservoirs.

The Shuitian Township water management station will support the Qiankanqing water user association in technology service and engineering management.

The Shuitian Township government will subsidize and support in finance to the Qiankanqing water user association. It will help the Qiankanqing WUA to find the location of its office.

The Wudang district water resources bureau will guide the Qiankanqing water user association in irrigation management. It controls the two reservoirs: Qiankanqing and Bashanqiu (see Figure 1.5).

**Figure 1.5 Wudang District Water Resources Bureau & Township WR Management Stn**
There are 4 executive committee members voted by farmers themselves, whom a chairman and a deputy chairman will come from Qiankanqing, others will come from Sanjiang and Bashanqiu. WUA is a non-government society organization to let water users to participate into the irrigation management.

The roles of WUA are:

- organizing water users to management and maintenance the irrigation system to control the flood and draught;
- Allocating and Distributing water for members of WUA;
- Instructing members to saving water and scientific irrigation;
- Measuring and charging water fees and finance management;
- Marketing development and managing producing to make WUA sustainable operation;
- Coordinating with township government agencies such as water resources station, agriculture service office and village committee and so on.

The WUA is established as a juridical association by farmers (water users) to managing irrigation system with legal and financial responsibility. On the basis of government’s management Rules on different levels, the ownership and management right of facilities in the irrigation system (except Qiankanqing Reservoir) are transferred to the WUA. Pursuant to relevant Laws and Rules of People’s Republic of China, the WUA will
cooperate with the government to develop, improve and manage the irrigation system in the irrigation scheme to preserve and enhance its asset value. The office of WUA is located in the irrigation area.

The WUA is comprised of two branches: water users groups (WUGs) on the basis of hydrology boundary considering the administration and natural villages (see Annex I).

All beneficiaries in the irrigation area are members of the WUA. Water user’s representatives in each WUG are selected from the members; at least there is one representative from each natural village. If the area is large there should be one or two representatives. 4 members voted from representative’s setup an executive committee (executive agency), in which there is a chairman and a vice-chairman. Chairman will be the legal person of WUA.
Annex 1  WUG/WUA Organization

six villages of Shuitian Town in northern Wudang District.
1. irrigation canal improvements for 6,980 mu (465 ha) 465
2. potential beneficial population of 8,512 8512
CNY 53.5 million 5350
Figure 1.6  Tertiary Canal System
Preface

There five separate studies for which reports have been produced. Most of these studies were prepared at the request of ADB some of which were under the terms -of-reference of Professor Li Zhi. Dr. Gunaratnam had only some advisory inputs to most of these reports.

There were five reports prepared:

a) Financial Management Report
b) Supporting Documentation for reimbursement from ADB
c) Project Performance Monitoring
d) Training Water User Organization
e) Project Procurement
f) Project Costs and Financing

There was considerable work put into a lot of these reports by Mr. Li Zhi and compilation was by Dr. Gunaratnam and since most of this documentation was in Chinese it took several months to compile them. The Project Procurement and Project Costs and Financing were written for the PMO and are in Chinese and not translated
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<td>2. City, county ADB projects supporting documentation required for Reimbursement</td>
<td>23</td>
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<tr>
<td>3. Project Performance Monitoring System</td>
<td>31</td>
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<tr>
<td>4. Training Manual for Water User Organization</td>
<td>45</td>
</tr>
<tr>
<td>5. Project Procurement (Chinese)</td>
<td>95</td>
</tr>
</tbody>
</table>
Guiyang Integrated Water Resources Development and Conservation Project

Financial Management Manual

Summary

Based on the China law of Accountant and the financial management handbook of Asian Development Bank, the financial management handbook is compiled only for Guiyang Integrated Water Resources Management Project following the Project Loan Agreement and RRP. In the handbook, these sectors will be described following below:

First, financial management organization and its staff positions have been defined. The financial management of the Guiyang Integrated Water Resources Management Project is divided into two levels, such as city level and county level. At least 3 professional staffs will be required for city level, two particular staffs for county level.

All staffs shall be satisfied with the base condition in the handbook required. While any financial staff will transfer her position, the processing following the handbook required will be conducted.

Second, the project costs will be disbursed following the Asian Development Bank's Disbursement Handbook and using Guiyang project. Guiyang municipal government has promised to supply the count part on time and enough. ADB will disburse the quality costs by the disbursement rate in the Project Loan Agreement. Second, the project costs will be disbursed following the Asian Development Bank's Disbursement Handbook and using Guiyang project. Guiyang municipal government has promised to supply the counter-part on time and and in numbers of staff. ADB will disburse the allocated costs by the disbursement rate in the Project Loan Agreement.
Third, the project asset management has been defined in the handbook. These assets following the procurement processing shall be transferred following the ruler in the handbook. The supervision for the project asset will be held in the each end of year. Third, the project asset management has been defined in the handbook. These assets following the procurement processing shall be transferred following the ruler in the handbook. The supervision for the project asset will be held in the each end of year.

Fifth, the ADB disbursement procedure has been defined in detailed for the project following the ADB Disburesment Handbook 2007. How to use SOE for civil works, goods and service will be cleared in the Project Loan Agreement. Force Account will be disbursed following annex 7 and ADB required. Fifth, the ADB disbursement procedure has been defined in detailed for the project following the ADB Disburesment Handbook 2007. How to use SOE for civil works, goods and service will be cleared in the Project Loan Agreement. Force Account will be disbursed following annex 7 and ADB required.

Sixth, the balance sheet, project schedule and special account table will be described in detailed in the Annex 9-11. The tables shall be compiled on time for ADB. Sixth, the balance sheet, project schedule and special account table will be described in detailed in the Annex 9-11. The tables shall be compiled on time for ADB.

1. The purpose of this project is the manual in Guiyang City, the first implementation of integrated water resources management project. City and County's of the project the following project management personnel are the first implementation of the Asian Development Bank loan project, therefore, the preparation of the manual has the following three purposes:

   - Unification and standardization of the project financial management procedures and method of operation;
   - Finance for the project, training of personnel and to provide training materials;
   - Financial officer for the project to provide necessary procedures for financial Management.

2. The scope of this manual applies to this project at all levels of Project Management Office (hereinafter referred to as "Project Office") and the management of the project accounts of institutions.

4. **Guiyang City.** The project **financial management institutions** of Guiyang City Project Office should set up a separate finance department, staffed with qualified personnel, responsible for engaging in the project financial management.

5. **PMO is responsible for** financial management of departments and should set up a responsible person for financial management of the daily management. Head of Financial Management should have the following basic qualifications and experience:

   - In Charge of a unit or units is an important aspect of work not less than three years;
   - Domestic or international organizations experience in the financial management of loan projects not less than two years;
   - Understand the state and infrastructure-related laws, regulations, policies and operational practices;
   - Familiar with the Asian Development Bank loan project management knowledge;
   - Physically able to adapt to the requirements of their jobs.

6. **Guiyang City. The management of** the financial department should be equipped with competent staff in the financial management of the project. Key financial management staff should have the following experience and qualifications:

   - Certificate in Accounting;
   - Domestic or international organizations experience in the financial management of loan projects not less than two years;
   - Understand the state and infrastructure-related laws, regulations, policies and operational practices;
   - Familiar with the Asian Development Bank loan project management knowledge;
   - Physically able to adapt to the requirements of their jobs.

7. **PMO of Guiyang City.** The **financial management of the main office in** Guiyang City, is mainly responsible for the following project financial management-related work:

   - Management of project funds;
   - Supervision, inspection program run by the county the use of funds and financial management;
   - Project Office responsible for reviewing the annual withdrawals for reimbursement plan;
   - County Project Office is responsible for review of the Asian Development Bank loans accounted for withdrawal;
   - Asian Development Bank loan processing withdrawals reimbursement procedures;
   - Project summary of the city's annual withdrawals for reimbursement plan;
• Accounting and Reporting;
• For the County Project Office to provide guidance and training of financial personnel.

8. **County PMO project financial management** at the county level should be set to do full-time financial officers responsible for the project’s financial management.

1. Financial management of county-level project management office personnel should have the following qualifications and experience:

   • Certificate in Accounting;
   • Not less than two years engaged in accounting work;
   • Understand the state and infrastructure-related laws, regulations, policies and operational practices;
   • Understanding of the Asian Development Bank loan project management knowledge;
   • Physically able to adapt to the requirements of their jobs.

2. **County-level project management office of the principal financial** County Project Office responsible for the following and financial management-related work:

   • Management and supervision of the county the use of project funds;
   • The annual preparation of the county funds the project plan and withdrawals are accounted for using the program;
   • Asian Development Bank loans handled withdrawals reimbursement procedures;
   • Accounting and Reporting.

9. **Mobilization of financial staff** to do various projects to keep the stability of the financial staff to ensure continuity of financial management. If it proves necessary exchange of financial officers, according to the following procedure:

   • Developed by the Ministry of Finance, "Basic Accounting Standards" Chapter III of the transfer to complete the task.; no hand-over procedure before the former financial officers shall not transfer;
   • Former financial officer of the replacements should be completed the necessary training, including:
     o Internal control procedures;
     o How to apply for the Asian Development Bank’s ATM reimbursement procedures;
     o How to perform Project Accounting and Reporting.

10. **Control** at all levels of the PMO Monetary Fund should be established under the Ministry of Finance "Accounting Internal Control Standards - Monetary Funds (Trial)" (see Annex 1) strengthen the control of monetary funds.
11. PMO at all levels of engineering controls should be established under the Ministry of Finance, "Accounting Internal Control Standards - Projects (For Trial Implementation)" (see Annex II) to strengthen the control on the project and payment.

12. Procurement Control Office at different levels should be established under the Ministry of Finance, "Accounting Internal Control Standards - Procurement and Payment (Trial)" (see Annex III) to strengthen the project procurement and payment controls.

13. The project costs incurred by the Asian Development Bank loan and domestic counterpart funds co-payment. But only "Loan Agreement" and "project agreement" in order to use the provisions of the qualified costs of the Asian Development Bank loans to pay. Capital flows and loan arrangements see Annex 14.

14. The project, the Asian Development Bank loan to pay for qualified expenses with the following criteria in the cost of the project costs are eligible, may apply for the payment of the Asian Development Bank:
   - To achieve the project goals for costs incurred;
   - "Loan Agreement" and "Project Agreement" costs incurred after the signing;
   - "Loan Agreement" to pay the prescribed fee category;
   - Loans account for costs incurred prior to the closure;
   - Asian Development Bank has agreed to use the procurement procedures to procure goods, works and consulting services that occur goods, works and services expenditures;
   - Asian Development Bank, the territory of Member States, the costs, including the territory of the Member States of goods produced, from the territory of the Member States to provide the services and so on.

15. ADB loans in the 2007 version of the manual payment, add the following costs are eligible costs of the following can be used to pay the Asian Development Bank:
   - Land acquisition and right of way compensation payments;
   - Taxes and tariffs;
   - Local transportation, freight and insurance;
   - Late fees;
   - Recurrent expenditure;
   - Food costs;
   - Severance pay;
   - Co-financing of the construction period interest;
   - Social & resettlement;
   - Bank charges;
   - Second-hand goods;
   - Rent.

16. Asian Development Bank loans to pay the proportion of the project: ADB loan to pay the cost categories in the proportion determined by the project loan agreement.
### The allocation of loan funds and summary

**(Guiyang Integrated Water Resources Management sector projects)**

<table>
<thead>
<tr>
<th>类别</th>
<th>Category</th>
<th>序号</th>
<th>Serial number</th>
<th>亚行贷款根据 ADB loans under the</th>
<th>allocation of ADB loans</th>
<th>从贷款帐户提款比例 The proportion of withdrawals from the Loan Account</th>
</tr>
</thead>
<tbody>
<tr>
<td>土建工程</td>
<td>Civil Engineering</td>
<td>1</td>
<td>1</td>
<td>123,800,000</td>
<td>该总支出要求的 51.9% The requirements of 51.9% of total expenditure</td>
<td></td>
</tr>
<tr>
<td>设备和材料</td>
<td>Equipment and materials</td>
<td>2</td>
<td>2</td>
<td>22,500,000</td>
<td>该总支出要求的 86.4% The requirements of 86.4% of total expenditure</td>
<td></td>
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<tr>
<td>咨询服务 - 执行 Consulting Services - Implementation</td>
<td>3</td>
<td>3</td>
<td>2,500,000</td>
<td>该总支出要求的 100% * The total expenditure required for 100% *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>培训和能力建设 Training and capacity building</td>
<td>4</td>
<td>4</td>
<td>1,100,000</td>
<td>该总支出要求的 60% The 60% of the total expenditure required</td>
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</tr>
<tr>
<td>合计</td>
<td>Total</td>
<td></td>
<td></td>
<td>150,000,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** "Loan Agreement - Annex 3"

17. Domestic counterpart funds to pay for this project, according to the management regulations.

18. The project procurement arrangements, procurement of property by the beneficiaries themselves, self-care use by the beneficiary; purchase the property by the project office, the procedures shall be promptly delivered, delivery, use the appropriate beneficiaries in order to realize the benefit.

19. The PMO is responsible for purchasing the property should be delivered the following procedures of property procedures:

- The PMO should keep a record of property purchase. Registration include: property name, manufacturer name, the main technical specifications, product serial number, purchase price, purchase time (reference format see Annex IV).
• PMO prepared according to the object property to accept delivery of property inventory, in duplicate.
• PMO for delivery of property lists (including copies of invoices) and recipients of property and property exchange.
• Recipient of the property and the property inspection and property delivered after the list of check, signed and sealed.
• Delivery of property, one for each user and recipient of delivery of property lists, and billing accordingly.

21. **PMO should urge the beneficiaries of the project to strengthen the protection of property** on the project to ensure the safety of the property to ensure the project benefits of play. End of each year, the project should the project do site inspections of the property.

22. **The Asian Development Bank project withdrawals** signatory designated by the provincial Department of Finance, withdrawal procedures by the Asian Development Bank, the "2007 loans to pay Manual" regulations. Asian Development Bank loans to private accounts by the provincial Department of Finance requirements by the Asian Development Bank, set up, manage and use. City, county withdrawal signatory designated by the local financial sector.

23. **Asian Development Bank loans to domestic withdrawal program** uses the Asian Development Bank Loan Project Office should first submit an application at the same level financial department confirmed, submission to higher level project management office, handle the relevant formalities.

24. **Reimbursement to the City by the project owner ADB Project Office → City →.** Provincial Finance Department of Finance withdrawals are accounted for. City, ADB Project Office, Municipal Finance Bureau to the designated persons responsible for organizing and processing withdrawals ADB loan reimbursement work.

25. **Reimbursement by the project** unit's withdrawal of financial departments, financial departments should set up specifically responsible for organizing and processing withdrawals ADB loan reimbursement. Specific procedures work as follows:

• County Project Office for an application the time to process, after confirmation by the County Financial Bureau should not exceed 5 working days. City Project Office and the Municipal Finance Bureau for examination and confirmation, the City Project Office and the Municipal Finance Bureau to confirm their own time should not exceed 5 working days. For Municipal Financial Bureau drew the provincial financial department to pay. Provincial Project Office shall be completed within 5 working days review.

• City Project Office of an application, pay the municipal finance bureau directly. Then submitted to the provincial financial department to make payments. Provincial Department of Finance shall be paid within 5 working days to complete the work.
24. **Asian Development Bank loan documents required** for all domestic ATM withdrawal applications shall be submitted for authorization of withdrawal for reimbursement on behalf of the three signatory signed original of the application withdrawal, a summary table, or the cost report and related documents. Withdrawal application shall indicate the detailed payment instructions—Withdrawal Form, summary table and the form of cost reports submitted in Chinese/English.

25. Provincial Department of Finance in the examination and approval of withdrawal applications, will show withdrawal for the City Project Office, and indicate the amount of its financial opinion and the actual approval. Cities and counties can do the same deal with city and county Finance Office of the withdrawal application project.

26. **Withdrawal of applications for domestic fund use.** Department of Finance of Guizhou Province in the first paragraph reimbursement issues before the withdrawals authorized signatory should be authentic sample (see annex V) in duplicate reported to ADB. Withdrawal submitted to the ADB should be responsible for managing the signatory of the provincial financial department dedicated account relevant personnel.

According to the different purpose of withdrawal, the Withdrawal Form is divided into three forms (see annex V):

- **Withdrawal Form (a)** is suitable for the repayment of advance payments have been using its own funds.
- **Withdrawal Form (b)**, for applications that require the money paid directly to the supplier, contractor or beneficiary, or request to open letters of credit payments to suppliers.
- **Withdrawal Form (c)**, applicable to overseas study and training delegations of the withdrawal.

In addition, if an international competitive bidding, you can use loan to pay or commitment to pay: by letter of credit under the ADB’s special commitment to the commercial banks. Individual special account credit is less than 25% allocation, apply for payment under letters of credit. Letters of credit amount is greater than or equal to the individual special account allocation of 25% apply to ADB’s commitment to pay special section.

27. **Cost reporting limits for goods, works and consulting services withdrawal**

For project loans, for the amount of each contract value less than 200,000 U.S. dollars, shopping using three bid prices can be used. Contract limits will be stipulated in the loan agreement. Limit of this project is ¥20 million.

In addition to withdrawal application, the

1. **Individual contract limits**, the amount of the above statements in the cost of withdrawal of goods shall be submitted to a summary table (see annex VI), and shall be accompanied by two contract copies, invoices and proof of shipment and
a copy of the certificate of origin. If applying for letters of credit and the only copy of the contract to provide to open letters of credit applications; such as the Asian Development Bank to apply for a special commitment required to submit two copies of the contracts and three copies of letters of credit.

2. Individual contract limits the amount of the above statements in the cost of civil engineering drawing, should submit a summary table (see annex VI), and shall be accompanied by two contracts, invoices and copies of statements works.

3. Individual contract limits the amount of the above statements in the cost of consulting services to withdrawal shall be submitted in a summary table (see annex VI), and shall be accompanied by two copies of contracts and invoices.

28. Study abroad, training costs of withdrawal, in addition to withdrawal application, we must also submit an overseas mission orders, cost estimates table to go abroad to study or training programs, the other invited electricity, the Ministry of Finance a copy of approved overseas mission program.

29. Individual contract limits below the threshold amount of the cost of goods, engineering, consulting and domestic training and study tours and other types of withdrawals, there only need to have a report cost incurred in these items. As files remain in the project management office to prepare for post review, there is no need to submit the relevant documents to the Asian Development Bank.

30. Community participation in procurement withdrawal (FA self-engineering), in addition to withdrawal application, we must also submit a report of community involvement in procurement costs (see Annex VII). There is no need to submit the relevant documents to the Asian Development Bank, as files remain in the project management office for post review by the ADB.

31. Accounting Method This requires the implementation of the Ministry of Finance of the “World Bank Loan Project Accounting Method” (Financial World [2000]13) (see Annex VIII).

32. PMO at all levels should establish an independent, comprehensive project accounting system, set up a separate bank account, for the accounting of all funds for the project.

33. Basic accounting unit The county project office accounting unit will account all the costs incurred and keep the original documents which should be brought together to the county PMO and the county PMO will keep the accounting files.

34. Common accounting courses under the project “World Bank Loan Project Accounting Procedures” provisions, combined with the actual situation of this project, annex VIII (one of) lists for the main subjects of this project. “World Bank Loan Project Accounting Measures,” in other subjects, the project financial staff can do the actual situation.

35. The project of accounts use under “World Bank Loan Project Accounting Measures” requirement and the actual situation of this project, listed in Annex VIII used in this project for use of accounting subjects.
36. **Accounting** Offices at the different levels of financial personnel should be established under the Ministry of Finance, "Basic Accounting Standards" in Chapter III of the request, inspect the original documents, fill in accounting documents, account books, registration, and preparation of financial statements.

37. PMO staff at all levels should be file financial documents in accordance with the original accounting documents or other documents as listed below:

1. Storage units from the original certificate copy the original document. Copy before the financial staff should be established under the Ministry of Finance, "Basic Accounting Standards" requirements of the original documents for review. Only the review be carried out correct copy of the original certificate.
2. Copy of the original certificate should indicate the accounting units of the original documents stored number, for later examination.
3. Copy of the original documents should include at least the original amount of funds used class of certificates.
4. Copies of original documents such as the writing is not clear when the original certificate in accordance with the signed copy in the space marked, but not be described in the original handwriting Department.

38. PMO financial officer, after obtaining copies of original documents should develop according to the Ministry of Finance, "World Bank Loan Project Accounting Method", fill in the accounting documents and registered account books:

1. Copying the original documents should be on a regular basis. Fill in the registration certificate and the accounting books on the sources of funds to be used. 不得将大于资金占用数的资金来源数记入货币资金。 Shall not occupy more than the number of sources of funds credited to the number of currency funds.
2. Require number of copies of the original certificate, and you can prepare the list of original documents, without having to copy each original document. Original documents list should include the following: title of certificate; the date of the certificate; the name of the unit certificate or fill in the name; quantity, unit price and the amount of money.

39. PMO at all levels of the financial statements prepared financial statements include:

1. Balance sheet (see Annex IX);
2. Project schedule (see Annex 10);
3. Provincial Department of Finance special account statements be prepared (see Annex 11).

40. PMO of the financial statements, that under "World Bank project accounting methods" requirement and the actual situation of the project by the project management office.

41. Financial statements submitted to the PMO should be submitted half-yearly to the Asian Development Bank once.

42. Submit on August 15 and 15 March the following year, therefore, at all levels of the financial statements submitted to the PMO the time determined as follows:
41. Project financing and management  Project funding sources: First, the ADB loan, the second is the matching funds. Domestic counterpart funding include: local funds, domestic commercial bank loans and capital and other beneficiaries of their labor and properly folded.

(1) Project ADB loan should be shown separately accounted for separately. ADB loans should be "loan agreement" to pay the relevant provisions.

(2) The Provincial Department of Finance should be provide the loan agreement, the designated bank of the U.S. dollar in the foreign exchange special account for funds deposited in pre-financing of ADB loans.

(3) Guiyang Municipal Finance Bureau, should set up the appropriate project-specific (RMB) for the ADB loan and domestic counterpart funds in the account. After the commencement of the loan agreement, the project unit costs incurred, should follow the ADB procedures and the proportion of withdrawals for reimbursement.

42. The use of ADB loan: The project loan agreement provides that:
1. Section 3.01 (a), the borrower should follow terms and conditions satisfactory to ADB to use its funds.
2. Unless otherwise agreed by ADB to provide loan funds to municipalities conditions shall include: (i) interest rates and commitment fees with the same loan terms; (ii), including a grace period of repayment, including
loan terms with the same period; (iii) municipal government to pay the loans of foreign exchange and interest rate change risks.

3. The Borrower shall promote municipal government will loan for the loan and project agreements under the project expenditure.

Section, paragraph 3.02 Use of the loan procurement of goods, works, consulting services and other expenditures, as well as in goods, works and consulting services and other expenditure items, the different types of loan categories in the amount of allocation in accordance with Appendix 3 of this loan agreement provisions of the appendix and at any time revised in consultation by the borrower and the ADB.

Section, paragraph 3.03 Unless otherwise agreed by the ADB, the loans with funds to pay for all goods, works and consulting services shall be in accordance with the provisions of Appendix 4 of the loan agreement, procurement. The failure to agree with the borrower and ADB procurement procedures, or ADB the contract terms and conditions not satisfied, ADB may declare misprocurement and refuse to provide funding for the contract.

Section, paragraph 3.04 Unless otherwise agreed by ADB, the Borrower shall be responsible for all funds paid by the loan of the goods, works and consulting services only for the implementation of this project.

Section 3.05, paragraph Rule under the loan provisions of paragraph 9.02, the loan account for the withdrawal of the related accounts by June 30, 2016, or by the borrower and the ADB agreed to another date at any time.

43. ADB’s loan of the use of special terms

Section 4.01 (a), the Borrower shall cause Guiyang municipal government to follow sound administrative, financial, engineering, environment, and the needs of water resource management, due diligence, the effective implementation of this project. And (b) in the process of project implementation and operation of the facility, the Borrower shall perform or instruct the performance of this loan agreement and project agreement in Appendix 5 in the Appendix all the obligations stipulated.

Section 4.02 In addition to this loan, the borrower should be based on actual needs and ADB accepted the terms and conditions, timely implementation of the project to the city to provide the necessary funding, facilities, services, land and other resources.

Section 4.03, paragraph The Borrower shall ensure that project implementation and project facilities, operations departments and agencies can work in accordance with sound management systems and procedures and to maintain coordination.
Section 4.04, paragraph Borrower shall take all necessary measures to ensure Guiyang municipal government follows the provisions of the project in accordance with agreement obligations. Borrowers should not take or allow any action that might impede the measures to meet these obligations.

44. Management of loan repayment reserve

1. In order to reduce the risk of the project debt, to ensure that the project unit debt service payment in strict accordance with the agreement, according to who is who shall pay to use the principles of municipal finance bureau should be prepared to a certain amount of money as a loan repayment reserve.

2. Repayment reserve mainly from three

   1) The local financial sector budget arrangements;

   2) The exchange rate risk;

   3) Other income, including special accounts deposits.

Repayment reserve management by the finance department should take into account the exchange losses and debt repayment. Strict implementation of building wealth outside the [2001] 55 document "Forward Provincial Department of Finance <Guizhou Province on the issuance of the international financial organizations and foreign government loan repayment reserve management practices to raise notice> notice" on the repayment provisions of the use of reserves.

3. Repayment reserve the municipal finance bureau at the state-owned commercial banks to set up accounts management, separate account, earmarked, and accept the audit department audits. Any unit or individual shall not misappropriated.

4. Repayment reserve to cover (or advance) due debts, ensuring timely and sufficient in the case of debt, can avoid the use of modern financial instruments, exchange rate risk. Value can be used to purchase government bonds, and loan projects for international financial organizations, temporary liquidity withdrawals are accounted for.

45. Management of resettlement funds For the reservoir construction project of resettlers, see Annex 11, "Resettlement Administration of special funds."

46. Project audit "project agreement" provides in the following:

   1. Section 2.09, paragraph (A) Guiyang municipal government should: (i) maintain a separate account for this project; (ii) a basis consistent with the principles of auditing standards by independent auditors to audit, their qualifications, experience and fiduciary matters are approved ADB annual audited accounts and related financial statements (balance sheet, income and expenditure shows and related instructions); And (iii) in such accounts and related financial statements promptly after preparation, but in any event not
later than the end of the relevant financial year, six (6) months, submit to the ADB. The audited accounts and financial statements and a certified copy of the audit report (including the auditor's opinion on the use of loan proceeds, compliance with loan agreements, and impress account the special requirements / expenses statement), all had to use English and Chinese language. Guiyang Municipal Government shall submit to ADB Asian Development Bank at any time reasonable requested on these accounts and financial statements for further information. The audit report, submit after 6 months, will give a formal warning; and reimbursement are overdue more than 12 months because of failure to submit audited accounts suspended.

2. Should be ADB's request, Guiyang City are required to provide the conditions and opportunities for ADB, in accordance with the above paragraph 2.09 (a) the requirements of paragraph, at any time with the Guiyang municipal government together with the designated auditor to discuss the Guiyang municipal government's financial statements and financial situation and shall authorize and require any representative of such auditors to participate in the requirements by ADB of any such discussions, unless otherwise agreed in Guiyang City. Such discussions can only be authorized in Guiyang City in the conduct of officials.

3. Paragraph 2.10 Guiyang municipal government should provide the conditions for the ADB on behalf of and opportunities for the projects, financed by the loan proceeds for goods and works and any associated records and documents to be checked.

4. Specific method for audit of the project can refer to Annex 12.
Annex 1

Internal Accounting Control Standards – Monetary Funds (Draft)

Accounting [2001] 41

Release Date: June 22, 2001

Chapter I General Provisions

The first in order to strengthen internal control and management, to ensure the safety of funds, management should be according to "The People’s Republic of China Accounting Law" and "Internal Accounting Control Standards – Basic Standards" and other laws and regulations.

The second referred to the standard unit of funds refers to cash accounts, bank deposits and other funds.

Article III Financial Management norms applicable to State organs, social organizations, companies, enterprises, institutions and other economic organizations (hereinafter referred to as units) will be followed.

Article IV The system of internal controls provisions of the funds shall be according to relevant State Council departments and relevant state laws and regulations.

All units should have a the system of internal control in accordance with relevant laws and regulations and the norms, combined with the funds department or, the establishment of units for the operational characteristics and requirements of the Money Management control systems and their implementation.

Article V of the unit to which the funds belong are to establish and improve internal controls for ensuring that funds are disbursed for the proposed purposes with transparency.

Chapter 2 status and authority to authorize the division of labor

Article VI The Unit shall establish for fund management, responsible personal, the relevant departments and positions clearly the responsibility and authority to ensure that funds go through the operations making sure there is no conflict of interest for the control and supervision of funds.

Cashier function be separated from auditing, accounting, file keeping and income, expenses, costs, claims and liability accounts registration.
Article VII Financial Management Unit should have qualified personnel, and with job rotation according the conflict of interest requirements.

Article VIII Financial Management Unit will adopt accounting procedures according to international procedures acceptable to ADB, ensuring the fund authorization

第九条
审批人应当根据货币资金授权批准制度的规定，在授权范围内进行审批，不得超越审批权限。Article approval shall authorize the approval system for currency funding requirements for approval within authorized limits, not beyond the approval limits.

经办人应当在职责范围内，按照审批人的批准意见办理货币资金业务。Managers should be in the areas of responsibility, in accordance with the advice of approval were approved by the monetary funds business. 对于审批人超越授权范围审批的货币资金业务，经办人员有权拒绝办理，并及时向审批人的上级授权部门报告。Goes beyond the scope of examination and approval authority to approve the monetary fund business, handling staff have the right to refuse to handle, and timely approval of the person's superior authority to department.

第十条 单位应当按照规定的程序办理货币资金支付业务。Article unit shall handle money according to the procedures provided funds to pay business.

(A) Advance payment submissions should indicate the use of funds, amount, budget together with effective economic contract or relevant documents.

(B) Approval for the payment under the contract will be done according to the contract.

(C) Certificate of Payment shall be reviewed for the currency, application for review of disbursement of funds, review applications for approval of funds to pay the currency of reference, powers, procedures are correct, procedures and related documents are available, the amount of calculation is accurate, payment, payment of the appropriateness of such units. After review and correct, by the personnel for the cashier to pay procedures.

(D) Handling payments. Payments should be based on review and corrected application, follow the required procedures, and payment made will be registered for the withdrawal made of cash and bank withdrawals.

Article XI Funds to pay for important services, should be approved and to establish accountability system, to prevent corruption, and to prevent misappropriation of funds.

Article XII It is strictly prohibited without the authorized personnel for the disbursement of funds to non project works.

Chapter III Management of cash and bank deposits
Article XIII quota units shall strengthen the cash inventory management, cash over stock limit should be timely bank deposits.

Article XIV units must be based on “cash management” Provisional Regulations for the provisions of the actual situation of the unit to determine the scope of this unit cash costs. Cash expenditure does not belong to the scope of business shall be settled by bank transfer.

Article XV of cash received shall be promptly deposited in banks, shall not be used directly to pay the unit’s own expenses. Due to special circumstances any proposed expenditure, should be reported in advance by the Bank for examination and approval. Use of funds must have authorized approval process and unauthorized use or lending funds is strictly prohibited.

Article XVI of the monetary unit of capital inflows must be made promptly recorded, and may not sub-accounts receivable are not recorded strictly prohibited.

Article XVII, “Payment and Settlement” and other relevant national regulations, to strengthen the management of bank accounts, in strict accordance with the provisions of open accounts; make deposits, withdrawals and settlement.

Units should be regularly inspected, clean up a bank account open and use, identify problems and timely treatment. Units shall strengthen the balance sheet of banks fill in the certificate, transfer and custody and other aspects of the management and control.

Article XVIII The Unit is not allowed to issue no notes or long-term funding guaranteed checks, to obtain bank credit; cash in banks and others funds; allowed unreasonably refused payment, bank other funds; allowed to open and use bank accounts.

Article XIX The unit shall designate a person regularly check bank accounts, at least once a month, and the preparation of bank balance sheet to the carrying amount of bank deposits adjusted in line with the bank statements. If, the reasons should be identified and timely treatment.

Article XX The unit should carry out regular and regular cash inventory, to ensure that the cash book balance in line with the actual funds in hand. Discrepancies in book balances will be reported in a timely manner to identify causes to the problem.

Chapter notes and the management of the seal

Article XXI Financial Management unit should be strengthened on the management of funds, specifically the purchase of items, consumables, transfer of funds or cancellation and dedicated registers recorded against lost or stolen items.

Article XXII Units shall strengthen the management of bank seal. Seal is kept by a financial personal or a duly authorized officer.
City, county ADB projects supporting documentation required for Reimbursement

1. Withdrawal Form

City, county PMO materials reported withdrawal reimbursement is required by the Office of the preparation of the sub-project application and the reimbursement schedule (including the summary table and the SOE form), bank statements. ATM reimbursement directory summary, sealed at the same level of Finance audit report, stamped, reported after the withdrawal signatory City Project Office (and the second accounting of the material generated a floppy disk). Withdrawal Form as follows:

District (County) ADB Loan withdrawal application for integrated water resources management project

GY**01 Application No: GY ** 01

District (County) ADB Loan Project Office of Integrated Water Resources Management

In ***** date on

II. Second, civil works

A. National Competitive Bidding (NCB), to pay the proportion of 51.9%, by:

1, a single contract value is greater than or equal to one million U.S. dollars project, reimbursement accompanying drawing as follows:

(1) the views of ADB's no objection letter in English

(2) contract

(3) The schedule of project expenditures
(4) the engineering construction enterprises issuing invoices

(5) acceptance certificate signed by supervision engineer

2. A single contract is greater than the amount equal to 200 thousand U.S. dollars is less than 100 million project, drawing the attached reimbursement as follows:

(1) the views of ADB’s no objection letter in English (the first two years of the first NCB civil works)

(2) City Project Office approved

(3) Contract

(4) The schedule of project expenditures

(5) the engineering construction enterprises issuing invoices

(6) acceptance certificate signed by supervision engineer

(B) Minor Works (SW), a single contract value of less than ¥20 million, to pay ratio of 51.9%, ATM reimbursement attached as follows:

1. the views of ADB’s no objection letter in English (the first two years of the first NCB civil works)

2. district project office referrals

3. City Project Office approvals (counties in each of the first SW Engineering)

4. the contract

5. project expenditure schedule

6. the engineering contractor invoices issued

7. supervising engineer signed acceptance certificate.

(C) self-management projects (FA), a single contract value of less than 10 million, paid 51.9% more than listed. Reimbursement accompanying drawing as follows:
1. district project office referrals

2. City Project Office approval (districts and counties in each of the first FA works)

3. district office of the engineering labor and properly project the situation of confirmation

4. the construction agreement

5. labor and properly Summary

6. project expenditure schedule

7. acceptance report acceptance of a single cut

8. NCB civil works in the labor and properly folded part of the invoice information

Summary of confirmation and labor and properly the following format:

<table>
<thead>
<tr>
<th>District (County) Project Office on the **project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor and properly confirmation of the situation</td>
</tr>
</tbody>
</table>

ADB loans for integrated water resources management project **
District (County) in the project area *** The total area of hectares, equivalent to ** mu.

District (County) Project Office ** works on labor and properly review the list of conditions and the labor that they reported to vote

Labour is the case, no misrepresentation, omission, will enter the labor list clear, complete, and the total number of women in Chang *** Meet the requirements of ADB.

Original documents (or copies) from the project as save.

District (County) ADB Loan Project Office of Water Saving Irrigation

In **** date on
Town vote in work situations

Total employment Hours (equivalent to 个) A)

Man Hours (equivalent to nos), A), Workers% of total investment

Women Hours (equivalent to nos), A), Workers% of total investment

District Project Office seal

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**Project Expenditure Schedule**

<table>
<thead>
<tr>
<th>费用名称</th>
<th>单位</th>
<th>工程量</th>
<th>单价</th>
<th>金额（元）</th>
<th>资金来源</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fees Name</td>
<td>Unit</td>
<td>Quantity</td>
<td>Unit price</td>
<td>Amount (yuan)</td>
<td>Sources of funding</td>
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</table>

合计
Total

施工单位：（盖章）Construction Unit: (Seal)

领导签字：Signature of:

日 Japan 期：Duration: 年 Years 月 Month 日 Japan

填表人：Table by:
### Project Expenditure Schedule

<table>
<thead>
<tr>
<th>Serial number</th>
<th>Name</th>
<th>Sex</th>
<th>Attendance numbers (hours)</th>
<th>Name</th>
<th>Sex</th>
<th>Attendance numbers (hours)</th>
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</tbody>
</table>

本页合计出工__小时，其中：男工__小时，女工__小时。Page __ hours total labor, of which: male __ hours __ hours of women workers.

注：此表各级项目办保留，报账时不留附。Note: This table reservation at all levels of project management office, reimbursement is not required attached.
C. Procurement of Goods

(A) International Competitive Bidding (ICB), 单 ranking, A single contract value is greater than or equal to Million dollars

Paid according to the ratio of CIF 86.4%

The loan reimbursement attached as follows:

1. ADB no objection letter in English
2. Contract
3. Invoice
4. Acceptance of goods alone

(B) National Competitive Bidding (NCB), a single contract value is greater than or equal to 100,000 U.S. dollars but less than one million U.S. dollars

The ratio of domestic price to pay 86.4%, reimbursement attached as follows:

ADB no objection letter in English (the first two years of the first NCB)

5. Contract
6. Invoice
7. Acceptance of goods alone

Domestic Inquiry (NS) procurement, a single contract value is less than 100 thousand U.S. dollars The ratio of domestic price to pay 86.4%

1. City Project Office procurement, drawing the attached quotation is as follows:

1. ADB no objection letter in English (the first two years of the first NS)
2. City Project Office notice
3. Contract
4. Invoice
5. Acceptance of goods alone
2. District Project Office procurement, reimbursement accompanying drawing as follows:

1. District Project Office referrals
2. City Project Office approval (NS counties in each of the first project)
3. Inquiry records
4. List of purchased goods
5. Invoice payment
6. Acceptance certificate acceptance of goods

4. Procurement

4. Single-source consulting services contract, is greater than or equal to 10 million in a single consulting contract, and greater than or equal to 5 million in personal consulting contract, before the trial by the ADB.

5. About 100 thousand U.S. dollars a single consulting contract and less than 5 million individual consulting contract, the project office before the trial.

All payments are 100% the proportion of the loan reimbursement the following should be attached:

1. ADB no objection letter;
2. District Project Office of referrals;
3. City Project Office approval;
4. Text of the contract;
5. Invoice (copy).

(B) Foreign and Training (OST), drawing the attached material as follows:

1. the cost for overseas study
2. foreign study program approved training group;
3. The city government's overseas confirmed cases;

4. Foreign invitations;

5. Study abroad, training programs (to specify country-specific travel city name, make use of inter-city transportation applications);

6. Training report

(C) Domestic and Training (DST) attached material as follows:

1. The following should be sent for approval:

   (1) The District Project Office investigation referrals

   (2) The Office of the inspection of approved projects

   (3) tours

   (4) inspection fee invoices

   (5) Investigation Report

   (6) Investigation of the municipal project management office should be held in the relevant notice

2. training

   (1) The District Project Office training referrals

   (2) City Project Office approval for training

   (3) Training programs

   (4) Training of relevant invoices

   (5) Training Summary

   (6) Training Registration

   (7) Training organized by the municipal project management office should notify the relevant
Guiyang Integrated Water Resources Management Project

Project Performance Management System (v1)
First, the project performance monitoring

The early implementation of the project, in consultation with the implementing agencies with the assistance of consultants, will develop comprehensive project performance monitoring and evaluation processes, systems project activities to generate the input and output data; and measure the impact of socio-economic projects, Health and Environment indicators. Project Office will improve the project performance management system framework to determine the availability of objective, determine the arrangements for monitoring and recording. After the start of the project no later than 6 months should be established to project performance monitoring systems and procedures.

Main project performance and monitoring indicators, including the progress of the project, the results of capacity development, water resources management performance and related services, the social impact of the project, water user satisfaction, quality and price, and monitoring of projects and the related economic and health data.

According to the project performance management system framework, by implementing agencies required time interval, the baseline and progress data, including environmental management plan (EMP) of the semi-annual reports provided to the PMO. In consultation with experts, with the system data, the PMO will be responsible for analysis and synthesis, through its management information. Project performance management system designed with sufficient flexibility to allow the project design, schedule, project activities and development impact of remedial action. The project office will carry out monitoring and evaluation of project activities on a quarterly basis to the actual implementation of ADB projects and financial reports to ensure that the requirements in accordance with ADB's impact on the monitoring and reporting. The social and environmental security of the key issues and progress, should be included in the project brief to the quarterly progress reports; resettlement and environmental changes in the external air quality monitoring and evaluation will be based on half year report.

Project management arrangements should be further improved to take account of project activities involving non-governmental organizations (NGOs) lessons learned, particularly in the assessment of its institutional capacity and with government agencies and community interaction experience. Non-governmental organizations to do the work will be project monitoring and evaluation experts closely monitored. If the non-governmental organizations will participate in the work of the resettlement community, the impact of their participation will also be recorded in the resettlement process monitoring. Consultation with non-governmental organizations in the contract, shall provide to ADB for its community mobilization work on reporting requirements. Project implementation consultant inputs will also be closely monitored and linked to specific outputs.

Second, the benefits of the project and stakeholders
This project will provide a wide range of water efficiency, its effectiveness will affect about 1.6 million of Guiyang City residents, or about 45% of the total population of residents. Completion of the project, the expected benefits include:

(I) an annual increase of about 40 million cubic meters of water supply;

(ii) rural water supply increased by about 94.8 million cubic meters per year;

(iii) Improve the existing irrigation area of about 10,773 hectares, an increase irrigated area of about 18,815 hectares;

(iv) to increase irrigation coverage of 0.3 mu per capita - 0.5 acres;

(V) the risk in the erosion of the land area of 800 square kilometers of soil and water conservation treatment;

And (iv) to provide 105,100 small cellar in rural areas to intercept and store human and animal consumption and irrigation with spring water and rainwater. It is estimated that about 24 million rural beneficiaries will take advantage of safe drinking water, about 59,200 farmers benefited from improved irrigation services.

**Third, water demand management**

**Institutional reform for integrated water resources management for the ongoing technical assistance, institutional environment can effectively help the implementation of this project.** Through technical assistance to emphasize three main measures:

(i) strengthen the government agencies responsible for water resources management coordination and effectiveness;

(ii) To promote community participation in water resources management approach;

(iii) A shift to demand management, consistent with current national construction, "saving society" activities.

**To policy, institutional, and technical assistance at the same time the implementation of integrated water resources management-based reforms, combined with the institutions** under the project intervention will bring the following improvements:

(i) By increasing stakeholder participation in the subproject design,
(ii) The sustainability of the operation and maintenance,

(iii) Water conflict resolution,

(iv) Inter-agency and Cross-Sectoral collaboration,

(v) Monitor water-saving activities.

Guiyang Municipal Government will ensure that, according to Guiyang Integrated Water Resources Master Plan as well as technical assistance TA4912-PRC Development of integrated water resources management principles, to the implementation of this project. In particular, the Guiyang municipal government of Guiyang Municipal Government and ADB to ensure that consultations between the plan of action for integrated water resources management strategies can be implemented in time. The main activities to be implemented will include:

(A) Establish an effective management of water sector institutions-establish a Water Affairs Bureau,

(B) Move from the current supply management to demand management –establish a Demand Management Department in the Water Affairs Bureau,

(C) Greater public participation in water resource management,

(D) Improved information management and information sharing between relevant agencies

(E) Water management capacity-building in Guiyang.

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Fourth, the financial sustainability of the project

Construction of water for the Water Industry Co., Ltd. of Guizhou (GZWRC), Guiyang Water Supply Corporation (WSC), Wudang District Water Supply Company, Xiwen county water company, Jinlong reservoir subproject, Liao Jiuzhai reservoir irrigation rehabilitation subprojects and subprojects prepared by Wudang financial projections are based on ADB's guidelines 28. The financial statements of these sub-projects that, in addition to reservoirs and Liu Jinlong reservoir subproject Jiuzhaigou, other income will be sufficient to cover operating and maintenance costs and debt service rate, and in any case can provide a reasonable rate of return. According to financial projections, these entities generally acceptable
a) Minimum debt service coverage 1:4,
b) maximum debt-equity ratio of: 70:30

Therefore, in addition to Liu Jinlong Jiuzhai and outside all subprojects are considered to be financially viable and sustainable. Liao Jiuzhai reservoir subproject will require a bit of its ongoing financial subsidy to make it financially sustainable. Jinlong reservoir for the sub, if the financial viability, will encounter some short-term cash flow difficulties, need financial assistance, so that sustainable development. To solve this problem, Guizhou provincial government has provided a written commitment to provide short-term financial benefits and improve the medium-term price.

5. The adjustment of agricultural

The project will provide an opportunity for farmers, by increasing the area of irrigated land to increase agricultural income, so that they can from the low-yielding crops and subsistence agriculture to high value crops. The project will also provide reliable through the water supply to farmers.

6. Willingness to pay for water

According to urban and rural water supply users, and increase crop production income of the family's willingness to pay (WTP) assessments show that beneficiaries are willing to accept the proposed water charge increases. Willingness to pay for water is estimated that about 1.4 Yuan / m3. Water for poor families registered before relief in the notes and in all cases the calculation of the cost share, in the "With this project", the water charges account for less than 5% of household expenditure.
7. Project Design and Monitoring Framework
(see tables next page)
<table>
<thead>
<tr>
<th>Design Summary</th>
<th>Performance indicators and targets</th>
<th>Monitoring mechanisms</th>
<th>Assumptions and risks</th>
</tr>
</thead>
</table>
| Affect         | • Guiyang City, the overall socio-economic development of sustainable | • Total value of agricultural production from 3.8 billion yuan in 2006 to 6.1 billion yuan in 2020 | • Municipal Government Statistics | - Government continues to promote sustainable development  
- Farmers have adequate financing and marketing of rural infrastructure |
|                | • Guiyang City, the rural poverty rate of 28.7% in 2004, a decrease of 20.0% a 2020 | • Guiyang City, the rural poverty rate of 28.7% in 2004, a decrease of 20.0% a 2020 | - Climate change, drought and excessive  
- People from rural to urban migration beyond the forecast |
|                | • Guiyang's urban poverty rate of 4.3% in 2004, a decrease of 3.0% in 2020 | • Guiyang's urban poverty rate of 4.3% in 2004, a decrease of 3.0% in 2020 | - Climate change, drought and excessive  
- People from rural to urban migration beyond the forecast |
| Result         | • Guiyang city water supply and water demand in a sustainable manner to maintain a balance | • Total available water resources from 900 million m$^3$ per year to 1.4 billion per year by 2015 m$^3$ | • Water Resources Bureau (WRB) Statistics  
- Guiyang Municipal Government Statistics  
- Environmental Protection Bureau (EPB) monitoring data | • The Government encourages participatory management of water resources  
• The introduction of effective incentive mechanism for inter-agency coordination  
• Financing is considered other activities under the overall planning |
|                | • 94% of 2015 surface water quality compliance | • 94% of 2015 surface water quality compliance | • The Government encourages participatory management of water resources  
• The introduction of effective incentive mechanism for inter-agency coordination  
• Financing is considered other activities under the overall planning |
|                | • 94% of 2015 surface water quality compliance | • 94% of 2015 surface water quality compliance | - Climate change, drought and excessive  
- People from rural to urban migration beyond the forecast |
<table>
<thead>
<tr>
<th>Output</th>
<th>Hypothesis</th>
<th>Risk</th>
</tr>
</thead>
</table>
| 1. Water quality improvement | • Water Conservancy Bureau of Statistics  
• Environmental management plan, resettlement plan and ethnic minority development plans of internal and external monitoring and evaluation report  
• Jie Shuiban data  
• Water company data  
• Project Progress Report | • To obtain public support, to help build and maintain rural water supply infrastructure  
• Who wastewater, whoever paid for the pollution control measures  
• Full implementation of the environmental management plan, resettlement plan and ethnic minority development plan | • Unexpected ground / construction conditions |
| 2. Increased domestic water, industrial water and irrigation water supply | • Project area farmers to drink water (at the national drinking water standard) increased from 71.5% to 90.0% (population 238,650 beneficiaries)  
• The total reservoir storage capacity from 184 million to 366 million m\(^3\)  
• Land irrigated area to 914,800 acres from 557,600 acres  
• Irrigation efficiency from 45-50% to 65-70%.  
• Non-revenue water from 30% to 20% reduction  
• To 2013, all irrigation areas were established Water Users Association (WUA) and work, in which the proportion of women in leadership | |
| 3. Improve the efficiency of water use | | |
| 4. In the system and the technical capacity to manage | | |

As the project activities did not report negative cumulative environmental impact  
EPA monitoring data  
Resistance to tariff reform
<table>
<thead>
<tr>
<th>Major activities:</th>
<th>Financial Commitments (Unit: millions of dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The establishment of project management and monitoring system, strengthening of institutional management and capacity development efforts (to the project outputs 1, 2, 3, 4)</td>
<td>ADB sector loans: 150.0</td>
</tr>
<tr>
<td>a. In accordance with the phased establishment of sub-projects and equipment to do the municipal and local projects.</td>
<td>Guiyang city: 258.0</td>
</tr>
<tr>
<td>b. the establishment of water user associations (where possible).</td>
<td>Guiyang City Commercial Bank: 20.0</td>
</tr>
<tr>
<td>c. training of city, county, district governments at all levels of key personnel, in accordance with PRC laws and ADB’s security measures (according to subproject phasing), planning, design, implementation and monitoring of structural and non-structural water integrated management.</td>
<td>Beneficiary: 11.2</td>
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<tr>
<td>d.</td>
<td>by the municipal and local supervision and monitoring of projects to do the implementation of subprojects.</td>
</tr>
<tr>
<td>e.</td>
<td>Project performance management system in accordance with the principles of work planning, and on the success of the project implementation, monitoring and evaluation, strengthening municipal project management capacity (technical, financial, management and implementation aspects) (through the implementation of the project from beginning to end).</td>
</tr>
<tr>
<td>f.</td>
<td>management of the water industry to establish an integrated information management system.</td>
</tr>
<tr>
<td>g.</td>
<td>to establish municipal hydrological monitoring center.</td>
</tr>
</tbody>
</table>

Events - 2009 has been established for all non-core subprojects of the project office, the beginning of the loan consultation report provides capacity development activities.

2. For urban water supply to build a medium-sized and two small reservoirs (up to the project outputs in Section 2).

3. For rural water supply and construction of 43 small irrigation reservoirs (up to the project outputs in Section 2).

4. Construction and reconstruction of nine irrigation system (to the project outputs in the 2, 3, 4).

5. Soil and Water Conservation up to 800km² (to achieve the project outputs in the first 1, 2).

6. The construction of 105,100 small cellar (to the project outputs in Section 2).

Activity in 2-6 above requirements in accordance with the project implementation plan (see Appendix 11) for the event include:
a. preparing a feasibility study for each selected subproject reports.

b. In accordance with the laws and regulations and ADB's environmental security policy to prepare for each non-core subproject environmental impact report / environmental impact assessment report and environmental management plan.

c. preparation of the necessary social An Baowen documents (resettlement plan and / or ethnic minority development plan).

d. prepare the detailed engineering of each selected subproject design.

e. Acquisition of land required for civil works, temporary or permanent rehousing the affected people, according to the laws and regulations and ADB policy on resettlement and ethnic minority protection, for relocation compensation and to take social and economic compensation measures.

f. construction of water infrastructure.

g. Monitoring and evaluation of environmental management plans, resettlement plans and ethnic minority development plan implementation.
<table>
<thead>
<tr>
<th>Number</th>
<th>Project</th>
<th>Baseline &amp; increase</th>
<th>Monitoring mechanisms and data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.</td>
<td>General development measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>GDP and GDP per capita growth</td>
<td>2007 was 19,564 yuan, an increase of 2,539 over 2006 yuan</td>
<td>Guiyang Municipal Government Statistics</td>
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<td>1.2</td>
<td>The disposable income</td>
<td>2007: 13,786 yuan (city) And 4,140 (rural)</td>
<td>Guiyang Municipal Government Statistics</td>
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<tr>
<td>1.3</td>
<td>The number of urban poor and the percentage of</td>
<td>2008: 83,404; 4.56%</td>
<td>Guiyang Municipal Government Statistics</td>
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<tr>
<td>1.4</td>
<td>The number of rural poor and the percentage of</td>
<td>2008: 70,414; 3.88%</td>
<td>Guiyang Municipal Government Statistics</td>
</tr>
<tr>
<td>1.5</td>
<td>The incidence of water-borne diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>The total incidence of</td>
<td>(i) 3,254/100,000 (I) 3,254 /100,000</td>
<td>Guiyang City Bureau of Health Statistics</td>
</tr>
<tr>
<td>ii.</td>
<td>Mortality rate</td>
<td>(ii) 1/100,000 (II) 1 / 100,000</td>
<td></td>
</tr>
<tr>
<td>2.2.</td>
<td>Water resources management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>In 2007 the total amount of water resources</td>
<td>4.67 billion m$^3$</td>
<td>Water Conservancy Bureau of Statistics</td>
</tr>
<tr>
<td>2.2</td>
<td>City water treatment capacity</td>
<td>1.2 million m$^3$ / d (Note c)</td>
<td>Water company data</td>
</tr>
<tr>
<td>2.3</td>
<td>Water from the water company percentage of the population</td>
<td>97% (Note b)</td>
<td>Water company data</td>
</tr>
<tr>
<td>2.4</td>
<td>The average daily production of urban water</td>
<td>500,000 m$^3$ / d (Note c)</td>
<td>Water company data</td>
</tr>
<tr>
<td>2.5</td>
<td>Average daily sales volume of</td>
<td>500,000 m$^3$ / d (Note e)</td>
<td>Water company data</td>
</tr>
<tr>
<td>2.6</td>
<td>The percentage of non-tax revenue water</td>
<td>&gt; 30% (Note d)</td>
<td>Water company data</td>
</tr>
<tr>
<td>2.7</td>
<td>Urban per capita daily water consumption</td>
<td>213 l/c/d (Note b) 213 l/c/d (note b)</td>
<td>Water company data</td>
</tr>
<tr>
<td>2.8</td>
<td>Water consumption per unit of industrial output</td>
<td>62 m$^3$ / CNY10,000 Yield (Note b)</td>
<td>Jieshui Ban Statistics</td>
</tr>
<tr>
<td>2.9</td>
<td>Industrial water reuse</td>
<td>70% (Note b)</td>
<td>Jieshui Ban Statistics</td>
</tr>
<tr>
<td>2.10</td>
<td>The percentage of urban wastewater treatment</td>
<td>15% (Note b)</td>
<td>Wastewater treatment company data</td>
</tr>
<tr>
<td>2.11</td>
<td>Meet the quality requirements of surface water percentage</td>
<td>90% (Note b)</td>
<td>EPA monitoring data</td>
</tr>
<tr>
<td>2.12</td>
<td>The percentage of irrigated land</td>
<td>53.6% (Note b)</td>
<td>Water Conservancy Bureau of Statistics</td>
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<tr>
<td>2.13</td>
<td>Safe and reliable water supply is not the number of rural residents</td>
<td>300,000 without a reliable water supply (Note (^b))</td>
<td>Water Conservancy Bureau of Statistics</td>
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<tr>
<td>2.14</td>
<td>Irrigation efficiency</td>
<td>Estimated to be 50% (Note (^d))</td>
<td>Water Conservancy Bureau of Statistics</td>
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</table>

### 3.3. Project implementation and capacity building

<p>| | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>In accordance with the ADB loan agreement</td>
<td>n/a n/a</td>
<td>ADB review mission</td>
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<tr>
<td>2</td>
<td>The percentage of completed sub-projects on time</td>
<td>n/a n/a</td>
<td>Record of implementing agencies</td>
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<tr>
<td>3</td>
<td>Subproject costs and budget</td>
<td>n/a n/a</td>
<td>Record of implementing agencies</td>
</tr>
<tr>
<td>4</td>
<td>Economic costs of accidents reported</td>
<td>n/a n/a</td>
<td>Record of implementing agencies</td>
</tr>
<tr>
<td>5</td>
<td>By land acquisition and resettlement activities affect people’s satisfaction, (%) (sex)</td>
<td>n/a n/a</td>
<td>Survey of affected people</td>
</tr>
<tr>
<td>6</td>
<td>In accordance with the Resettlement Action Plan</td>
<td>n/a n/a</td>
<td>Independent monitoring reports</td>
</tr>
<tr>
<td>7</td>
<td>In accordance with the Environmental Management Plan</td>
<td>n/a n/a</td>
<td>Independent monitoring reports</td>
</tr>
<tr>
<td>8</td>
<td>In accordance with the development of events</td>
<td>n/a n/a</td>
<td>Monitoring the agreed plan</td>
</tr>
<tr>
<td>9</td>
<td>By gender action plan</td>
<td>n/a n/a</td>
<td>Monitoring the agreed plan</td>
</tr>
<tr>
<td>10</td>
<td>Urban water services cost recovery, (%)</td>
<td>n/a n/a</td>
<td>Bureau of Water Resources data</td>
</tr>
<tr>
<td>11</td>
<td>Operation of irrigation facilities, cost recovery, (%)</td>
<td>n/a n/a</td>
<td>Water Conservancy Bureau statistical data</td>
</tr>
</tbody>
</table>

### 4.4. Social impact of measures

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Consumer sustainability of water supply services</td>
<td>To be determined</td>
<td>Export statistics from the municipal government</td>
</tr>
<tr>
<td>2</td>
<td>The rates of water supply companies</td>
<td>To be determined</td>
<td>Water company data</td>
</tr>
<tr>
<td>3</td>
<td>The project to create long-term work on gender equality</td>
<td>To be determined</td>
<td>IA records</td>
</tr>
</tbody>
</table>

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\(\%\) = Percentage, ADB = Asian Development Bank, APs = affected people, CNY = yuan, EPB = Environmental Protection Agency, GDP = gross domestic product, GMG = Guiyang City, IA = implementing agency, l/c/d = 1/person/day, LAR = land acquisition and resettlement, \(m^3/d\) = cubic meters per day, \(m^3/y\) = cubic meters per year, n/a = not available, pa = per year, tba = to be determined, WRB = Water Conservancy Bureau,WSC = water supply company.
Note: a Statistics from the Guiyang municipal government official in 2004 baseline; b master plan project proposals from the 2004 baseline; c water company data; d project preparatory technical assistance, estimates.
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1. Basic Information

1.1 HOW TO IDENTIFY “PROBLEMS” IN RURAL DEVELOPMENT

To determine whether people face problem or not, We determine to what extreme people can meet their basic needs. In trying to find problems, be sure it is the real problem, otherwise the goal will be set to solve the symptomatic problems than the causative problems. It is not useless to solve the symptomatic problems because the real problem are still alive.

Example of the problems are:

- Low income
- Low productivity
- Lack of water for cultivation
- Non-adoption of improved methods of cultivation
- Poor health
- Poor sanitation etc.

How to determine priority among the problems:

The following are some criteria that we can use in Rural Development activities:

1. What proportion of the whole country is affected by it?
2. What proportion of the target group (E.G. Poverty or some other disadvantage group) is affected by it?
3. How does it effect the sanitation of basic needs?
4. How important is it in the view of the people?
5. How feasible is it to solve the problems at the local level in the short run? (If the solution of the problems requires high level policy make decision that would take much time, It is not a problems we can do much about at local level).

1.4 Problems with Irrigation in Guiyang

1.4.1 Water Resource Shortage

The increasing growth of Guiyang City as well as increasing connections to the piped water supply system is creating a rapidly increasing demand for water. In the rural area surrounding Guiyang City and within the Municipal boundary the shortage of water, for both potable and irrigation supplies, is also seen as a critical constraint to improving rural resident incomes and living standards, and alleviating the persisting poverty.

1.4.2 Poor Yield

Due to steep mountainous terrain, both river and ground water is not available to many farmers, particularly those who cultivate crops in hilly, upper catchment areas. Arable land is only about 10% of GM area, and less than half of it is irrigated. Seasonal and annual variation in water availability is extreme, resulting in difficulties to grow crops during critical spring season, and to diversify crops year-round. Subsistence farmers are trapped in poverty and susceptible to a worsening of the situation, as the demand from potable and industrial water users increases. Irrigation facilities are old and the efficiency of irrigation infrastructure is low causing water loss and soil erosion. The effectively irrigated land is reported to be only around 25-30% of the total cropland. The systems as designed are not suited to supporting an agricultural transformation that is taking place in rural areas around the city.

1.4.3 Lack of agriculture and Irrigation extension services

Farming techniques to conserve water and to preserve soil need to be widely disseminated and practiced by farmers. There have been pilot programs to conserve water and control soil erosion in farms on sloping fields. These attempts, including improved on-farm water management, must be further promoted and replicated. Many of the rural water infrastructure facilities are in a dilapidated and worn out condition, and in need of rehabilitation, suggesting that a proper and sustainable operation and maintenance (O&M) mechanism needs to be developed and implemented.

1.4.4 Need for institutional reform
Clearly there needs to be an irrigation development and management component of the Project that integrates the management of water resources at river sub-basin level with modernizing irrigation development and management that is attuned to agricultural transformation and farmer needs as well as empowerment of the farmers through establishment of water user associations (WUAs). The objective of the irrigation component of the preparation is therefore to raise farming families out of poverty by increasing farm incomes by culturing higher value crops with greater water management efficiency. This will be achieved by evaluating the needs:

- The farmers and, through establishing WUAs, preparing them for participatory management of an irrigation system developed to service a developing and complex agricultural situation;
- The Agricultural department for field research, development and farmer training to support appropriate agricultural transformation;
- Local Government to support WUA establishment and joint management of irrigation and water supply facilities;
- The technical institutes carrying out canal system design to ensure it matches the farmers’ needs and expectations; and
- The WRB to ensure water availability and to carry out coordination between the various development partners and stakeholders.
2. Concept of WUAs

Farmer Water Users Association means it shall be formed legally by beneficiary farmers within command area of irrigation (drainage) districts on a voluntary basis, as non-profit making farmer water using cooperative organization with a nature of social group. Farmer Water Users Association is an integrated institutional system engaged in water management and water use comprising an Association, some Water Users Groups (WUGs) under this Association and some Water Users under one Water Users Group. The highest authoritative body of a WUA is Member Representative Assembly. WUA Executive Committee is an executive body of Member Representative Assembly.

Basic features of a WUA are as follows:

- WUA shall be based on hydraulic boundaries. Its responsible person shall be a member of this WUA and elected by members or member representatives democratically.

- WUA shall be registered with Civil Affairs Agencies above county level, and be an independent legal person.

- WUA shall have its Charter and relative regulations on internal management, featuring democracy, self-discipline, self-management, self-operation and protection of self rights and benefits legally.

- WUA shall enter into a water supply contract with Water Supplier. WUA shall have water measurement facilities or equipment, calculate water supplied make payment based on the volumes of water used, collect water charges directly and pay Water Supplier.

- WUA shall be responsible for taking care of irrigation work facilities of this Association and guarantee maintenance and appreciation of asset value of water works.
3. Comparison between WUAs and Village-base Grass Root Water Management Organizations

WUA is different from previous village-base grass root water management organization. Major differences consist of: previous village-base grass root water management organization has certain administrative implication, while farmer Water Users Association has no administrative implication but carries out a self-management. It is defined that previous village-base grass root water management organization is set up based on administrative regions, its inconsistency with hydraulic boundaries leads to conflicts over water use frequently within different administrative regions and inconvenience for organization of engineering maintenance, while farmer Water Users Association is set up based on hydraulic boundaries, there are no such contradictions and problems; secondly, members of previous village-base grass root water management organization are assigned by town government or village committee, or taken by the staff members of town water management station or village committee members, who could not be on behalf of the benefits of water users sometimes and were interfered by the factors of other aspects, while management staff members of WUA are elected by WUA democratically, on behalf of water users own benefits, without interference of other factors. In conclusion, WUA is farmers own irrigation water cooperative organization fully.

WUA establishment involves many aspects, including policy, laws and regulations, management systems, government institutions, relevant social organizations, rural grassroots organizations, as well as irrigation facilities and operational management skills which guarantee the operation. The quality of WUA establishment directly links with whether the operation of WUA will achieve the designed function and it directly links with the personal interest of the farmers. Therefore, the preparation of WUA establishment requires high attention, careful organizing and solid work.
4 Objective and Basic Requirement of WUA Establishment

2.4.1 Objective of WUA Establishment

The objective is to establish WUA which is popular among water users, healthy and complete in rules and regulations; with an independent legal status, self-disciplined democracy, independent management and finance, and qualified staff who are passionate to serve the water users.

2.4.2 Basic Requirement for WUA Establishment

- **To Combine Organizational Construction with Ideological Construction**

  WUA establishment is not only a change on organizational structure, but also is an ideological transfer process, from traditionally relying mainly on the government and functional institutions to relying on the water users’ own organization, which is independently managed by themselves. WUA has enhanced master awareness among the farmer water users, enabling them participating actively in the irrigation management. Therefore, in the whole process of WUA establishment, this basic concept should be repeatedly inseminated to the WUA preparation staff and the mass of water users, enabling it to be known to each household and each person.

- **To Insist on Principle of willingness, Open and Democracy**

  Whether water users should join WUA, we must stick to the principle of willingness. The whole process of WUA preparation and establishment must be open, to enable every participant to know what WUA to be established is, how to prepare the establishment, as well as the right and obligations of WUA and water users. The procedure of WUA establishment must be democratic, i.e. The charter and regulations of WUA should be discussed and developed by the mass of water users; the WUA staff should be elected by the mass of water users. Only by doing this, we can enable water users to treat WUA as their own organization and representative, to enable to feel really that they are the master of WUA through participating in this proceeding, resulting in actively participating in the work and activity of WUA.

- **Combining Rehabilitation of Irrigation Works with Management System Reform**

  The present civil work facility in the vast irrigation district, especially the on-farm irrigation works at township and village levels has the serious
problem of incomplete facility, being old and lack of maintenance and repair. Therefore, in the preparation and establishment of WUA, the leading group and the preparation group of WUA should organize the mass of water users to rehabilitate and repair in existing capacity the civil work facilities within the WUA range. The local government and relevant departments should also increase the input on the on-farm irrigation works, to create condition for normal operation of WUA.

- To Strictly Follow Procedure of WUA Establishment

In order to reach the objective of WUA establishment, we must regulate the procedure for preparation and establishment of WUA.
5. Guiyang Irrigation Groups

Perceptions of current irrigation management are presented in the following sections based on visits to core subproject areas. At present the areas currently supplied are much lower than full scheme areas due to poor water management. Flows are neither measured nor controlled in any systematic way and canal divisions do not have control gates or means of proportional division that would facilitate equitable flow division. Farmers complain of poor management of the main canal systems and that they are provided with insufficient water in terms of quantity and timing. This is partially due to poor condition and maintenance of the canal systems. Irrigation liability rate of about 75% are given to several core schemes indicating that some 25% of the schemes are now not served at all. The low area of reliable supply is also a function of the high demand requirements in April and May for rice land preparation and the poor water management around each scheme area.

Water management in distribution areas is poor due to many open and illegal off takes from the main canal and lack of procedures to better conserve water. At diversion structures there are no facilities except stones and mud for controlling flows or proportionally dividing them.

There are many factors influencing the condition of the canal systems. Main and secondary canals are frequently severed and blocked by other developments, such as housing areas, factories and roads and sediment due to proximity to poorly cultivated fields and roadside and village drainage systems discharging into them. Water is lost for a variety of reasons which include:

- Many off takes on the main canals that are simply gaps in the canal walls;
- Leakages in the canals due to poor construction;
- Leakages along steep side slopes where spills have previously occurred or farmers removed canal support banks or dry walls to increase their terrace widths;
- Reaches of canals blocked by sediment of garbage and overflow;
- No control or measurement structures at key diversions to equitably divide flows in relation to areas (assuming soil permeability's are similar between areas);
- Illegal off takes where farmers have breached canal walls;
- Wasteful practices in on-farm water management where farmers take too much water and let considerable quantities flow to waste;
- Poor pudding of soils to farm a hard, impermeable day layer below the rice field so that deep percolation losses are much greater than achievable values of 1 to 3mm/day; and
- Little community identification with the scheme and under funding for O&M to be carried out by the District WRB.

Irrigation efficiencies have been stated as 50% whilst in fact an efficient rice irrigation system would be about 65%. In practice the efficiency is probably far lower.
6. Procedure for Preparation and Establishment of WUA

The procedure for WUA preparation and establishment is shown in the following figure 1:

(1) To establish the leading group and the office

(2) To launch promotion campaign

(3) To divide WUA and establish WUA preparation Group -> define hydraulic boundary

(4) To collect basic information
(5) To prepare WUA charter
(6) To arrange location and facility for WUA activity
(7) To divide water using groups, elect water user representatives (water user group leader), and nominate WUA executive committee candidate

(8) To organize water user congress and establish

(9) To register
(10) To implement preliminary repair and maintenance of irrigation works
(11) To develop rules and regulations

(12) Review and acceptance

Figure 1 the procedure for WUA Establishment
6.1 Setting up Leading Group and Office

1. To establish WUA work leading group composed of deputy county (city or district) chief responsible for agriculture in the irrigation districts and leaders from CAD, water resource bureau, civil affairs bureau, irrigation administration bureau and relevant township government.

2. The leading group is fully responsible for guiding WUA establishment from beginning to the end. It is responsible for supervision of the project construction fund, preparing plan for WUA construction and relevant documents, especially responsible for organizing and coordinating.

3. Organizing the farmer representative meeting, to consult farmers from different districts and different types about WUA dividing program and WUA preparation group composition.

6.2 Launching promotion Campaign

As WUA establishment is based on the farmers' willingness, it is important to have a dissemination targeting the farmers. This is a critical link in WUA preparation and establishment. The objective of the dissemination is to enable the farmers fully aware that WUA is a new irrigation management organization and the benefit to them. Only based on this, would the farmers be willing to apply for joining WUA. The dissemination mainly includes the following components:

- Concept, nature and function of WUA;
- Function and impact of WUA establishment;
- Organizational structure of WUA and its internal relationship;
- Responsibility, operation and management mechanism of WUA;
- Right and obligation of WUA members;
- Procedure for the farmers to join WUA, the procedure and method for WUA establishment;
- Advantage and feasibility to establish WUA.

6.3 Dividing WUA and Establishing WUA Preparation Group

1. The leading group investigates the hydraulic distribution in the irrigation district, designates hydraulic boundary and proposes a preliminary program for WUA dividing according to the principle of designating WUA based on hydraulic boundary;

2. To call the meeting of irrigation administration and the township government staff, to discuss about the preliminary program of dividing WUA and the name list of WUA preparation group;
3. To call the meeting of farmers representatives, to broadly consult the farmers of different types on the WUA dividing program and WUA preparation group composition;
4. The leading group summarizes different views and designates the geographic range of dividing WUA;
5. To establish WUA preparation group, consisting: Township government staff and Village leaders, staff of irrigation district administration, staff of water supply unit and representatives of farmers. Among them, the representatives of farmers should be no less than half of the total number of the group members.
6. The leading group and the local government in the WUA located area approve formal establishment of WUA preparation group.

6.4 Collecting Basic Information about WUA

1. WUA preparation group should obtain basic information about the area where WUA is planned to establish according to the designated geographic range. Basic information should include following aspects;
   - Number of households, population and labor within the WUA range;
   - The area of land and farmland, crop distribution and cropping area in the WUA range.
   - The present situation of irrigation (drainage) works within the WUA range and propose a feasible preliminary repair and maintenance plan;
   - Rural economic and social situation within the WUA range;
   - Present situation of water management, water using, and water measuring and water tariff collection.

2. The form mainly includes the information of name, population in the household, agricultural labor, irrigation area and view to join WUA.

6.5 Dividing of Water users Group, Electing Water users’ Representatives, Nominating Executive Members of WUA

1. The preparation group should divide several water users groups within the WUA range according to the hydraulic boundary in the WUA boundary.
2. The preparation group negotiates with the township government staff and village leaders, consult broadly on farmers’ views, nominates water users candidates of the group based on groups (women should occupy a certain proportion in the nominated candidates), and then calls conference of all water users group members to elect water users representatives.
3. The preparation group should broadly consult the water user’s representatives and the public views, to nominate the candidates for WUA executive committee members (women should occupy a certain proportion in the nominated candidates). The number of nominated candidates should be more than the executive member number. The candidates should meet the following requirement:
• Having high awareness to serve the farmers;
• Having education higher than middle school graduation;
• Being responsible and having a certain level of working capacity;
• Having a certain practical experience in irrigation management and agricultural production;
• Having good public reputation.

6.6 Development of WUA Charter

WUA preparation group should prepare the WUA charter (draft) for discussion at the water user’s congress.

6.7 Arranging Location and Facility for WUA Activity

The preparation group should prepare and make available the location and the necessary facility for WUA activity and obtain the ownership or using right of the asset according to the plan of WUA preparation and establishment, and the principle of being “cost-effective”.

6.8 Organizing Water Users Congress

The leading group organizes or assists WUA to call water users congress. The task of water user’s congress is:
1. To adopt the work report of WUA preparation group;
2. To adopt WUA charter;
3. In the election of WUA executive committee members, the method of secret ballots and balanced election should be used;
4. In general, the executive committee has 1 chairman, 1-2 vice chairmen, and 2-3 members (engineer, financial staff and administrative staff), or the posts can also be held by vice chairmen.
5. To discuss preliminary repair and maintenance plan for irrigation works.

6.9 Registration

1. WUA executive committee or the leading groups are responsible for submitting application to local county level civil affairs department according to the registration requirement and procedure. The application contains the name, location, legal representative, profession scope, activity range and professional administration unit of WUA.
2. WUA executive committee prepares documents required for application, according to the unified form for applying WUA, the content of the charter and other requirements of civil affairs department. The documents required include:

- WUA Charter;
- Name list of WUA executive committee and CV of WUA chairman;
- Application for legal person of social organizations;
- Registration for legal person of social organizations;
- Certificate documents for WUA asset;
- Certificate documents for right of using and managing irrigation (drainage) works.

6.10 Training for WUA Executive Members and Water Users Representatives

The leading group should organize training for WUA executive members and water user’s representatives, to improve their management skill. The training courses include: how to develop WUA charter and regulations, how to conduct operation and maintenance of civil works, how to calculate water cost.

6.11 Establishing operating systems

Under the guidance of the leading group, WUA chairman is responsible for organizing executive members and some water user’s representatives to develop rules and regulations which are written into documents. These rules and regulations include:

- Responsibilities of the executive committee members;
- WUA operation manual and establishment of irrigation area filing cards for water users
- WUA financial management system
- Irrigation works management system
- Irrigation management system;
- Reward and Punishment system.

6.12 Implementing Preliminary Maintenance of Civil Works

1. WUA executive committee should prepare preliminary civil work maintenance plan according to the maintenance program and based on existing capacity in human resource, physical resource and financial resource.

2. WUA civil work staff is responsible for organizing in stages the implementation of the plan. During the implementation, WUA accepts supervision from water user’s representatives, to guarantee the normal operation of WUA work.

6.13 Checking and Acceptance
1. When all the preparation and establishment is completed and all the documents for checking and acceptance are prepared, WUA executive committee can deliver an application to the leading group for checking and acceptance. The checking and acceptance report contains: the procedure of WUA establishment and its result, the basic situation and organizational structure of WUA, the irrigation and drainage within the WUA range, WUA charter and regulations, the operation plan and preparation of checking and acceptance;

2. To prepare documents for checking and acceptance. The documents include the following:
   - Certificate of Social Organization Legal Person, issued by the Ministry of Civil Affairs;
   - Charter and Regulations of WUA;
   - WUA operation manual;
   - Training record and information about WUA executive members and water users representatives;
   - Layout plan of irrigation works within the WUA boundary and the related information about the irrigation facilities;
   - Filing card of WUA water users
   - The Written record and information about the procedure of WUA preparation and establishment.

3. The leading group is responsible for organizing a WUA checking and acceptance group, which is composed of: representative of the leading group, representative of water supply unit, representative of local township government, village leader and water user’s representative etc...

4. The checking and acceptance group should conduct the evaluation according to the WUA completion standard (detail is shown in Chapter 4) and to make decision of pass, suspension or rejection.

5. The WUA which have passed the checking and acceptance are issued with qualification certificate. The WUA suspended in the checking and acceptance is required to conduct rectification within a limited time before the rechecking and acceptance is conducted. The WUA rejected in the checking and acceptance should carry out the WUA preparation and acceptance again and apply for checking and acceptance once more.
7. Water User Association in Guiyang

In rural areas responsibilities for irrigation are fragmented between the local Water Resources Bureau (reservoirs and primary, secondary distribution) and the local Agricultural Bureau (cropping pattern and agriculture assistant). Poor distribution and inefficient use of water results from the horizontal fragmentation. The effective management of irrigation systems has been shown to follow the transfer of responsibility of irrigation system assets and management to water users, as long as it is supported by appropriate capacity building and regulatory provisions. Chinese and international experience in establishing and operating water user associations (WUA) or water user groups (WUG) will be used to guide an assessment of the current management of irrigation schemes. An initial assessment will include recommendations for further development of WUA or WUG roles and responsibilities during project implementation.

7.1 Development and Role of Water User Associations

GMG and Wudang District have recently taken steps to establish a Water User Association (WUA) for the Wudang irrigation core sub-project. It is proposed that this WUA be established as a legal entity. It is intended it take the form of a committee legal person - that is the committee is the legal entity, and the chair of the committee is the designated “legal person” (with legal and financial responsibility broadly equivalent to the legal person of a Chinese enterprise. It should be noted that village committees in China operate under this arrangement, so it is a well proven legal model. The WUA would be under the supervision of Township government, just as village committees are. It is further proposed that at grass roots level informal Water User Groups be established, but these would not be formal legal entities. These local water user groups would have representation on the water user association and be responsible for coordinating activities at the local level, including operations, organizing maintenance, collecting water use fees (and passing these to the WUA) etc. The WUA would contract with the local water station for the irrigation supplies.

This model has been selected by the PMO because it fits well with existing local institutional arrangements and thus can be implemented relatively easily. The model is somewhat different from the model initially presented by the PPTA team which envisaged the WUA being a lower level organization operating at village level, with a formal status and also having grass roots WUGs. However, the two models are sufficiently close and with broad commonality of objectives, and it is therefore proposed that support be given to the PMO approach, given the fact it commands local ownership.

Initially the PMO was proposing that only one WUA be established immediately and used as a pilot, with the implementation of other core and non-core subprojects being implemented in a more traditional PRC manner. The PPTA team has expressed some concern that this approach would risk a repeat of past mistakes and in principle we favor setting up WUAs for each irrigation and reservoir subproject. The PMO accept our point,
but in the discussion raised the issue of how a large number of WUAs can be adequately supported in the early phases of project implementation. Consideration has also been given to whether establishment of a WUA should be part of the implementation arrangements for the soil conservation sub-projects. The conclusion reached was that as these sub-projects involve broader livelihood issues then the relevant village committee should assume ownership and responsibility for the sustainability of these, under the supervision of the relevant township.

7.2 The Role and Responsibilities of a WUA

The Figure below shows the structure of Water User Associations at the secondary canal or village level, composed of Water User Groups at the tertiary or quaternary level, and which may be joined into a larger federation at one or more higher levels depending on the size and layout of the irrigation system. The WUA would be established as legal bodies, with authority to manage water and irrigation infrastructure and collect money for their own activities and for payment of irrigation and water resources fees. WUA/WUG relationships with the units operating reservoirs would be formally structured through water service agreements laying out the rights and responsibilities of both parties. The WUA/WUG will prepare an annual operation and maintenance plan for its activities. In the case of multi-purpose reservoirs, the unit managing the reservoir will prepare a reservoir O&M plan, based on consultation with a panel of stakeholder representatives, and in accordance with sub-basin and overall municipal water allocation plans.

For the purpose of the Project a single tier WUA has been set up for the Wudang District subproject. Water User Groups at the village level are also being formed.

7.3 Development Action Required

WUAs will only operate effectively if they are viewed by water users as meaningful institutions that can help in solving local water related issues. The WUA must become to be viewed as a partner and client of the local water station and not a rival or threat to it. The WUA is a partner of the water station in its role of promoting effective and efficient use of water. A WUA is a client of the water station in its purchase of water on behalf of its members – the water users.

Establishment of empowered and effective WUAs requires:

- training
- finance (at least for an initial period until the WUA is fully established)
- capacity building support in how to manage and operate the WUA

Training needs to be given to WUA members, water users, water station employees and local township government officials. Training needs to include:

- WUA roles and responsibilities
- organising appointments to the WUA
• the WUA charter and rules of operation
• ways to improve water projects
• simple water engineering
• water conservation
• opportunities and benefits of alternative cropping
• book-keeping and financial management

Specific development actions in the context of the Project are:

• WUAs to be established for each irrigation subproject as a condition of loan approval.
• relevant County/Township government to give assurance of WUA financial support over a minimum period of 3 years (extent to be discussed and agreed)
• The PMO’s implementation consultants to prepare a WUA training pack and provide initial training to WUAs as these are established,
• The PMO’s implementation consultants to give advice and support in the development of WUAs during the period of project implementation
• An annual meeting of WUA representatives to be held in Guiyang to discuss and share experience in the development and operation of WUAs. This meeting will be organised by GPMO supported by their consultants and will also introduce potentially relevant experience and development form elsewhere in China and overseas.
8. Financial Management

8.1. Budgeting

Organization needs to know how to plan money have and how much they need. Organization commonly prepares two kinds of budget: Annual budget and Project Budgets. An annual budget for an organization include all expenses and income of the whole organization in one year and all organization projects and all administrative expenses, such as rent, electricity and office space.

8.2. Preparing a Budget

There two parts to a budget: Expenses and Income

8.2.1 Expenses

All money paid out by organization in support of the organization work and itemizes all expenses and then places them in the appropriate categories. Common expense categories include:

- **Personnel**
  - Any cost related to staffs (full time and part time)

- **Administration**
  - Necessary for the office to operate efficiently
  - Rent, electricity, security, office supplies, photocopying

- **Equipment**
  - Any equipment purchased, rented
  - Computers, copiers, telephones, furniture, fax machine

- **Traveling and Training**
  - Any cost related to professional development of the staff
  - Conference fee, and educational fees
- Traveling and food

Programs

- All cost related to temporary or one-time projects
- Included expenditure for goods that need to run the projects

In-kind donation

- Computer, furniture, office space
- Items should be given cash value if possible

8.2.2 Income

All the money that comes into the office, either earned, donated, to support organization activities; Earned income (money earned by your organization) and Government (money granted by the national agencies)

8.2.3 Cashbook

- Date
- Invoice Number
- Total income
- Total expense
- Record all invoice into ledger or cash book
- Total remaining budget
- Record all invoice refer to income and expense
- All document keeping by Treasure

8.2.4 Water fee record

- First date of water use
- Pay date
- Budget paid
- Total budget
- Balance

8.2.5 Prepare list of water fee who have date expired

- Name of farmers
- First date of water use
- Pay date
Note:
+ If expired 3 month could be free
+ If expired 3-6 month could be charge 25 % on the total budget (Penalty)
+ If expired more than 6 month could be charge 50 % on the total budget (Penalty)

Guiyang Integrated Water Resources Management Project

Water User Association                   Code No……
Irrigation Scheme:...................
District:..........................
Commune:............................
Province:............................
Group No……
Sub group No.

WATER FEE INVOICE
Water User Association Of................

Received from.........................Sex.........Amount of rice.................Kg or in cash...............Yuan for water user ......................to support the irrigation scheme after rehabilitation to be sustainable.

Date / month / Year

WUA Chief    Treasure    Provider

EXPENDITURE FORM
Water User Association Of..................

Payer by..................Sex........Fore..................Total ..................Yuan (write
down in world) expense on ..........................................................

Date / month / Year

WUA Chief Treasure Provider

Guiyang Integrated Water Resources Management Project

Water User Association
Irrigation Scheme:..............
District:.........................
Commune:......................
Province:......................

CHECKING FORM (EXPENSE)

Water User Association Of.............

- Total budget received from MOWRAM:...........................................
- Budget income for the end:..............................................................

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Guiyang Integrated Water Resources Management Project

Water User Association
Irrigation Scheme:………………
District:……………………
Commune:……………………
Province:…………………..

CHECKING FORM (INCOME)

Water User Association Of………………

- Budget income: …………………………………………………………………
- Budget income received from MOWRAM: ………………………………………
- Budget income for the end:…………………………………………………………

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Guiyang Integrated Water Resources Management Projects

Date. ........../.........../2010

List of income per month.............2010

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Chief of WUA

Accountant
Guiyang Integrated Water Resources Management Projects

*******

Date. ………/…………/2010

List for expense per month……………..2010

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WUA Chief

Accountant

Guiyang Integrated Water Resources Management Projects

*****

Date. ……/……./2010

List for audit per year............

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Chief of WUA

Accountant

Income Invoice

WATER USRE ASSOCIATION

Village:………………………… Fund:……………………
Date:…………………………

Income From

Name:…………………………
Purpose:……………………………………………………………………………………………………………………………………
Amount budget:………………………………………………………………………………………………………………………………
(Write down in world):……………………………………………………………………………………………………………………

WUA Chief    Treasure    Provider

Income List

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Income
Community Member Out
Total Income

Checking By: D/Y
Closing Check, Date: D/M/Y
WUA Chief

Date: D/M/Y
Treasure

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## Budget List/Cashier

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**See and Approval**
Date: D/M/Y

**Closing Check**
Date: D/M/Y
Amount of Budget: 

WUA Chief

Treasurer

## Record List

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<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Invoice No.</th>
<th>Description</th>
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<th>Water Fee Collection</th>
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**Total**

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Follow up list whom have date expire

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## 8.3 Types of budget

### 8.3.1 Detailed Budget

It would be helpful to prepare for the year of the project and make sure the cost is associated with the project implementation. Direct Project Costs includes costs that directly associated with specific project activity and sorts your budget into budget categories:
8.3.2. The budget Summary

There are two basic components of budget format

1. Personnel cost
   - Salaries and wage
   - Fringe benefits
   - Consultant and Contract Services

2. Non-personnel cost
   - Space Cost
   - Rental, Lease or Purchase of equipment
   - Consumable Supplies
   - Travel & Per Diem
   - Staff development
   - Telephone
   - Other Costs

8.4 Budget explanation

It is the most important section in your proposal in terms of getting money to operate your organization and activities. Fund will look at this section very critically in terms of deciding what they will fund. In this section, you must discuss:

1. All the major categories of the proposed budget, explaining the need and its reasonableness of the expenses.
2. Costing should reflect the input listed in the previous sections.
3. Be as specific as possible (i.e. salaries itemized by month, recurrent cost for fuel, paper, medication, training supplies etc.). Separate personnel from non-personnel costs.
4. Be sure to adequately anticipate administrative expenses such as: phones, faxes, utilities, rent, etc.
5. If other funds are needed for project, explain how you will get additional money.
Here are some of the major questions that must be answered by your organization when preparing your budget:

- What are the major budget categories costs, transport etc. included?
- How will you spend the grant money?
- Are all personnel, equipment, training costs, transport etc. included?
- Is there sufficient budget to cover actual administrative costs?
- If the project is for more than one year duration, is funding broken down by year?
- Are the costs of the proposal reasonable?
- How much can the organization contribute to the project (funds, staff material etc)
- Identify programs and potential sources of funding. Funders will fund organization that will be survived in the long term. How will you get additional projects funds, if necessary?
- How will the project be funded after the grant?
- Attached copies of the organization budget and project budget.

### 8.5 Financial Account System

#### Planning

- Prepare planning budget
- Prepare work plan activity and financial management

#### Bookkeeping

- Collect the information relate income and expense
- Compiling and Keeping its
- Record all income and expense

#### Summary

- Summary all income and expense based on each activities
- Checking with total budget before expense
- Record all income and expense based on the total budget
**Evaluation**

- Focus on income and expense report and determine the problem and select which activity is the first priority
- Firstly looking to what activity is successful or unsuccessful and then follows up it.
- If found which activity is successful, the project could be start.

**Annual planning for O & M**

**Yearly Expenditure of WUA**

<table>
<thead>
<tr>
<th>No.</th>
<th>FWUC Committee</th>
<th>Expense / month</th>
<th>Expense/ Year</th>
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<tbody>
<tr>
<td>1.</td>
<td>Support for WUA Committee</td>
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<td>Leader of Committee</td>
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<td>Sub committee</td>
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| 2.  | Other resource person       |                |               |
|     | Accountant                  |                |               |
|     | Administration              |                |               |
3. Other expenses

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<td>Fuel</td>
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<td>Communication</td>
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<td>Advertising to WUA member</td>
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<td>Others</td>
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Activity planning sheet

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<td>Objective</td>
<td>Expected Results</td>
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<th>Steps/Task</th>
<th>Who</th>
<th>Calendar (weeks)</th>
<th>Resources needed</th>
<th>Problem or assumptions</th>
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9. Monitoring & Evaluation of WUAs

9.1 Introduction of Monitoring and Evaluation

9.1.1 Concepts of Monitoring and Evaluation

Monitoring and Evaluation are key parts of modern project management. Being inseparable counterparts, Monitoring and Evaluation shall be made an integrity a subsystem of project management in general. Monitoring is focused on collections of data comparatively, while evaluation is focused on analysis and identification based on
the data thereof. Monitoring is a constant process; evaluation is phased, for instance, interim evaluation, as-build evaluation and post-project evaluation, etc.

One type of reform exploration and one kind of project development, WUA is a new thing in China. Monitoring and evaluation should be arranged for the establishment and operation of farmer WUAs in a manner of project management since the development of farmer WUAs has been implemented and extended in terms of a project in China as yet. Monitoring and evaluation for farmer WUAs are supposed to conduct dynamic follow-up investigations, statistics and measurement with regard to the establishment, operation, impacts, functioning of farmer WUAs and so on through the set up of a Monitoring & Evaluation System by means of certain approaches and technical methodologies so as to acquire exactly information of various aspects with respect to farmer WUAs, carrying out scientific analysis and impersonal evaluation in terms of establishment, operation, impacts and benefits, etc.

9.1.2 Main Body and Executive Institution of Monitoring & Evaluation

Monitoring & Evaluation are different from the evaluation by a farmer WUA itself. Self-evaluation is one of jobs inside farmer WUAs, but Monitoring & Evaluation should be got through from the outside. Monitoring & Evaluation are different from supervision & management, the latter is aimed to carry out supervisions and inspections addressed to project implementation, the former is aimed to provide investigation, analysis and evaluation to a project technically and financially. Hence, Main body of self-evaluation is farmer WUAs, main body of supervision & management is project responsible line unit, while main body of Monitoring & Evaluation should consist of project responsible line unit and social third-party evaluation institution, project implementation unit and farmers WUAs should give a good cooperation in the process of Monitoring & Evaluation.

9.2 Key Points of Evaluation on Farmer WUAs

9.2.1 Evaluation on Establishment and Operation of Farmer WUAs

Evaluation on the establishment and operation of a farmer WUA should be consistent with following 5 major principles (or requirements on key objectives) as well as 20 specific criteria.

1. Major Principles for Evaluation on Farmer WUAs

   Farmer WUA is the farmers own organization—farmers election, self-management and democratic decision-making.
   Farmer WUA is based on hydraulic boundaries.
Farmer WUA collects water charges by volumes of water used.
Farmer WUA collects water charges to improve the sustainable use of water resources and to provide fund to self-management and self-financing. Farmer WUA is entitled to collect water charges and pay water charges to water supplier.
Farmer WUA has an adequate water supply and distribution system.

2. Specific Criteria for Evaluation on Farmer WUAs

Specific criteria addressed to a high quality and sustainable WUA as follows have been concluded based on the experiences in establishment and operation of WUAs so far. Despite not all farmer WUAs could meet whole specific criteria hereof, they should least meet the most of those criteria and must stick to aforesaid major principles fundamentally. The sustainability of long-term development of individual farmers WUA is subject to how far its quality could meet the criteria below. Specific criteria for evaluation on farmer WUAs are as follows:

Farmer WUA is established with a charter and relative regulations, operates independently from government function.
Each WUA must be registered with the Civil Affairs Bureau and be a legal person.
The WUA jurisdiction is based on the command area of a canal.
Each WUA should have water measuring devices and facilities.
The water supplied to a WUA should be measured at the WUA intake head gate(s).
The WUA pays water charges directly to the water supplier based on the volume of water which is measured at the intake head gate(s) (volumetric water charges).
The WUA should be legally entitled to collect water charges from its members, to pay the water charges directly to the water supply company/water supply management unit.
The WUA should be authorized a right to the access to customary labors for the purpose of maintenance of irrigation and drainage facilities.
Local government has assigned to WUAs the responsibilities for operation and maintenance of branch or lateral canals as well as on-farm water works, including the hand over of asset of works and use right to WUAs.
Farmer WUA and water users participate in the planning, layout and construction of local irrigation facilities and on-farm water works.
WUA responsible person, local leaders and farmers have got adequate training and guidance with regard to general and financial management in the process of establishment and operation of a WUA. These training and guidance should be repeated if necessary.
Farmer WUA has its own office building and office facilities.
The run of farmer WUA should be independent and self-managed separated from village and county.
Responsible persons of a farmer WUA should be elected by WUA members.
and should be the farmers within the jurisdiction of the WUA. The ballots need to be archived for inspection.

The charter and regulations of a farmer WUA should be agreed to with WUA members and be posted on the office wall.

Farmer WUA should be of self-financing and financially independent. The water charges collected by a WUA should cover the expenditures accrued with operation and maintenance of water facilities within the jurisdiction of the WUA as well as the cost of water procurement.

Farmer WUA received the training on financial management, having a breakdown and clear account books.

Farmer WUA entered into a water supply contract with the water supplier, measures the amount of water supplied and pays water charges volumetrically.

In the area where water supply companies exist, there should be WUA representatives in the board of company, accounting to 40-50% of the total board members.

All farmers have heard farmer WUA before and keep an active attitude to it.

9.3 Evaluation on Impacts and Effects of Farmer WUA

The evaluations on impacts and effects of farmer WUA should be carried out by a social third-parties institution, addressing to the monitoring and evaluation on the farmers within project areas based on a follow-up monitoring to the farmers within project areas. The main work is to make a household survey (spot check).

The process of a household survey (spot check) is as follows:

1. Professional persons shall put forward a design of indicators (tables) for survey and a design of survey plan;
2. To arrange the spots according to certain approaches;
3. Professional persons shall carry out household interviews and fill in questionnaires and recheck the date;
4. To set up a database for household survey and do data processing;
5. To give an analysis to the outcomes from survey and make necessary additional surveys;

The household survey (spot check) should least cover basic status of households, household land holding, household labors and jobs, cropping structure, input and return of cropping production, production and business of culture, business of non-farming industry, migrant labors, changes in incomes and livelihood of households, changes in irrigation condition and irrigation cost, financing for and investment in constructions of water works, understanding and attitudes of households (individual farmer) to farmer WUA, and so on. Specific contents and questionnaires (including quantity and indicators questionnaire and willingness questionnaire) shall be designed specifically with
consideration to the types of various areas, economical and social conditions, features of farmer WUAs and agricultural production.

10. WUA Rules

10.1 Charter of WUA

Chapter I General Provisions

Article 1 This organization is named XXX WUA.

Article 2 Nature of the WUA: The WUA is a public social organization, set up by the whole water users for the management over the water supply in agriculture. It is a non-profitable mutual-aiding organization for water using.

Article 3 Objective of the WUA: Based on water users, service is provided as efficiently as possible for the water supply in agriculture, to enhance stable and high yield in agricultural production and high effectiveness in water conservation.

Article 4 The WUA shall strictly abide by the Constitution, national laws, regulations and policies. It shall be supervised and advised technically by the agencies of Finance, Comprehensive Agricultural Development, Water Resource and Civil Affairs etc., in order to guarantee the work done effectively.

Article 5 Location of the WUA: __________________________

Chapter II Scope of Business

Article 6 the scope of business of the WUA is as follows:

(1) Taking full responsibility for the operation, maintenance of the irrigation works and water supply allotment within the command area of the WUA;

(2) Taking responsibility for collecting water tariff from the water users.

(3) Acting for water users to Pay electricity tariff to electric power supply unit and other tariffs to the relevant agencies;

(4) Providing the water users with technical and consulting service concerning water resource and irrigation.

Chapter III Membership
Article 7 The WUA is established based on the hydraulic boundary of canal system (branch canal and lateral canal). The water users within this boundary are the members of the WUA.

Article 8 Anyone who apply for membership of the WUA must meet the following conditions:
(1) Being water users within the boundary of this canal system;
(2) Willing to join the WUA;
(3) Accepting the Charter of the WUA.

Article 9 Procedure to apply for Membership
(1) Individual Water user (individually) shall submit application;
(2) The application shall be reviewed and approved by the executive committee or the preparation committee of the WUA;
(3) The certificate shall be issued to the members from the WUA’s executive committee.

Article 10 the members shall have the following rights:
(1) The right to use the water;
(2) The right to elect, be elected for being a representative of the members;
(3) The right to make suggestions and requirement to the WUA;

Article 11 the members shall fulfill the following obligations:
(1) Paying water tariff based on the water consumed;
(2) Executing the resolutions of the WUA and observe all the rules and regulations of the WUA;
(3) Maintaining and protecting the irrigation works, preventing any destructive action to the irrigation works;
(4) Saving water

Article 12 when any WUA member withdraws the membership, a written application shall be made to the executive committee and the membership certificate shall be returned. The farmer withdrawn from WUA shall no longer have the right and obligation of the WUA;

Article 13 when any WUA member found serious violation of the charter is dismissed from the WUA, the right and obligation shall terminate.

Chapter IV Organizational Structure and Selection and Dismiss of Responsible Persons

Article 14 the highest authority in the WUA shall be the WUA congress, the function and power of which shall be as follows:
(1) To elect and dismiss the executive committee members;
(2) To review and adopt the work plan, water use plan and the management rules and regulations of the executive committee;
(3) To review the annual financial budget and financial statement;
(4) To review and adopt or revise the charter of the WUA;
(5) To divide water user groups in the WUA;
(6) Responsible for developing operation rules of the water user groups.

Article 15 The WUA congress is held once or twice each year. It can also be held in temporary when a request is made to the executive committee by more than two thirds of the formal WUA members. The congress shall be attended by more than three forth of formal representatives and the resolution of the congress shall be voted by the formal WUA members present at the congress. The resolution shall come into effect only when approved by over half of the voters.

Article 16 The WUA congress is termed 5 years. When WUA congress has to shift ahead of normal term or postponed due to special circumstances, an application shall be made to the business authority and the civil affairs department for approval. However, the time to postpone the term shift shall not exceed one year.

Article 17 The executive committee shall be the executive body of the WUA congress and shall lead the WUA in carrying out the routine activities, responsible to the WUA.

Article 18 The Responsibilities of the Executive Committee:
(1) To implement the WUA congress resolutions and report to WUA;
(2) To prepare and organize the WUA congress;
(3) To hire the WUA staff;
(4) To prepare management rules, including the water use management rule, the irrigation works management rule, and the financial management rule;
(5) To prepare the annual water use plan, water works maintenance and repair plan, financial income and expense plan, and other work plans, which are submitted to the meeting of the WUA congress for review and approval before the implementation.
(6) Fully responsible for the irrigation management within the WUA command range and responsible for value protection of the asset.
(7) Responsible for coordinating the external relationship for the WUA;
(8) Responsible for settling and addressing the water affair dispute on irrigation;
(9) To make decision on other major issues.

Article 19 the executive committee adopts chairman responsibility system and the chairman is the legal representative of the WUA (being not legal representative for the other organizations). There are total of ____ members in the executive committee, with the posts of one chairman and ____ vice chairmen. The chairman is responsible for directing overall work, while the vice-chairmen have the shared responsibilities.

Article 20 the executive committee members must meet the following requirements:
(1) Having good political qualification and adhere to the Communist
Party’s guideline and policy;
(2) Having junior or senior middle school or higher level diplomas, with certain social experience and capabilities in organizing and leading, and having basic knowledge and skills in agricultural irrigation;
(3) Enthusiastic at irrigation work in providing service to the water users, being dedicated, justice and equitable; having a high prestige among the farmers;
(4) Healthy and able to be engaged in normal work constantly;
(5) Having full capacity dealing with civil affairs.

Article 21 The Executive Committee members shall be elected by the WUA congress by secret ballots and differential voting in a democratic manner. The positions in the WUA for irrigation management and financial management shall be held by the current vice chairmen or can be appointed by the chairman.

Article 22 The executive committee members shall work for 5 years in each term and can be re-elected to work in the committee successively in more than one term. The age of the executive committee candidates generally is not exceeding _____. The resignation of the executive committee staff shall be applied in advance and approved by the WUA congress. Before the approval, the responsibility shall continue to be exercised.

Chapter V Principles of Assets Management and Use

Article 23 The funding of the WUA comes from the following sources:
(1) Water tariff paid by the members; the management cost of the WUA is covered by the collected water tariff based on the set quota;
(2) Financial support from the government;
(3) Other legal incomes.

Article 24 The WUA shall collect water tariff in accordance with the national policy and stipulations and the “Water Tariff Collection Measures” of the WUA.

Article 25 The management of the WUA’s assets shall be complied with the financial management regulations of the state and supervised by the WUA congress and the authority in the asset supervision and administration.

Article 26 The canal system and its auxiliary civil works are the fixed assets used by the WUA and shall be managed and maintained according to the relevant national laws and regulations, as well as the “Infrastructure Management Regulations” formulated by the WUA.

Article 27 The WUA shall establish the “financial management system” and appoint qualified financial staff to ensure the accounting information real, accurate, and complete.

Article 28 The WUA shall receive a financial auditing by the business authority or the social organization registration agency before the term shift or the change of legal representatives.
Article 29 The WUA assets shall not be occupied, allocated privately or diverted in use by any units and individuals.

Chapter VI Procedure for Charter Revision

Article 30 Revision of the WUA charter shall be proposed by the executive committee and submitted for review and approval by the WUA congress.

Article 31 The revised Charter shall come into effect after it is reviewed and approved by the business authority and the social organization registration authority.

Chapter VII Termination Procedure and Assets Disposal after Termination

Article 32 When the termination is proposed by more than half of the WUA members or there is a need to cancel the WUA due to splitting or merging, the dissolve shall be proposed by the executive committee.

Article 33 The dissolve proposal made by the executive committee shall be adopted by voting at the WUA congress before it is submitted to the business authority for review and approval.

Article 34 Before the termination of the WUA, a liquidation organization must be established under the guidance of the business authority and the relevant agencies, to clear up credits and debts and deal with relevant unfinished issues. During the liquidation, the WUA shall not carry out any other activities beyond the liquidation. After the liquidation, the WUA shall hand over the assets to the asset management and supervision agency by going through the formalities of assets and file transfer.

Article 35 The WUA shall terminate once the registration has been canceled in the social organization registration agency.

Article 36 The remaining property after the WUA termination shall be disposed under the supervision of the business authority and the social organization registration agency, according to the relevant national regulations and the request of the WUA members.

Chapter VIII Supplementary Provisions

Article 37 The Charter hereof was adopted by voting at the WUA congress on the date of _____.

Article 38 The Executive Committee of the WUA shall be responsible for the interpretation of the Charter.
Article 39 The Charter hereof shall come into effect upon the date of verification and permission by the social organization registration administration authority.

10.2 Financial Management Rules

Article 1 The Association shall abide by the laws and the financial management regulations of the People’s Republic of China in terms of its financial management activities, fulfill its financial obligations earnestly, reflect the actual financial status, and are subject to the inspection and supervision from the competent line authorities.

Article 2 The Association shall establish a profit-loss balanced cost accounting system following the principle of virtuous operation.

Article 3 The Association shall be staffed with qualified financial personnel (accountant and cashier) and maintain them stable. In case of any alternation of financial personnel, audit shall be performed and financial matters shall be handed over and taken over beforehand.

Article 4 Cash payment credence must be signed by, in addition to the operator, the financial principal (held by an executive member concurrently) or his authorized person. The expenditure shall be under strict control, and the overhead cost be tightened.

Article 5 Income from water charge and other incomes shall be entered an item in the account in time, and the copy for accounting of the financial receipt for shall be used as the credence to do so.

Article 6 The Association shall check and make an inventory of the fixed assets upon the request of the competent financial authorities. The net income or loss due to the gain, loss and damage of the fixed assets shall be put on as non-business income or business income.

Article 7 The special government allocation to the Association must be listed separately and spent for the designated purpose within the scope of project budget stipulated by the State or the relevant higher-level authorities.

Article 8 The Association shall prepare and submit financial reports at the time and in line with the requirements as stipulated by the superior competent authority.

Article 9 The Association shall establish financial archives for the annual financial reports, all kinds of account credence, account books and relevant data and maintain them appropriately.

10.3 Irrigation Management Rules

With a view to using water on a planned basis, saving water, and increasing agricultural irrigation benefits and reliability of water supply, the present Irrigation Management
Rules are formulated in accordance with the provisions of WSO (WSC) and the Charter of the Association.

Article 1 Essentially, the irrigation management is to, based on the annual and staged water supply plans, supply water in proper time, deliver water safely, utilize water resources in a rational way, balance the supply and demand, distribute water scientifically, and bring into full play the irrigation benefits.

Article 2 An executive committee responsibility system for dispatching and management shall be adopted for the irrigation management, following such principles as application for water use, planned water supply, rational distribution, and measurement by stage.

Article 3 WUGs shall gather the annual water use application forms filled by the water users in every ________ (month) and submit them to the Association. The Association shall determine the annual water supply plan through consulting with the WSO (WSC), submit it to the WSO (WSC), and sign the water supply contract with the WSO (WSC).

Article 4 WUGs shall report the cropping water demand to the Association prior to each turn of irrigation, and transact the water use plan for that turn of irrigation, stating time of supply and flow and total amount of water to be used.

Article 5 Irrigation dispatching regulations shall be followed strictly. An application shall be submitted 72 hours prior to each turn of irrigation, and any increment of deduction of water amount intended to be used shall be reported ___ hours beforehand.

Article 6 The principle of supplying water upon payment and delivering water after making out an invoice shall be implemented. It is forbidden to deliver water to seek personal favor or for connection, to keep back or transfer water volume, and to deduct water volume without permission to seek private gain through power.

Article 7 With regard to the confirmation of measured amount of water supplied (used), both parties, the water supplier and the water user, must be present, make records and sign.

Article 8 Dispatch water scientifically and allot water rationally. Comply with the principle of “delivering water to the upper region first and then to the lower region, upper region considering the demand of the lower region, and the part being subordinate to the whole”, put an end to flood irrigation, and do a good job in water storage, water conservation, and water saving.

Article 9 Conduct the flood control and public security of the canals with great efforts. During the water delivery and irrigation period, WUGs must assign person(s) to inspect dike, watch out water, and check on section by section. Administrative zoning responsibility system shall be enforced in respect of emergency handling and breach plugging.

Article 10 Calculate and collect water charges in earnest. The settlement of water amount by the Association shall be in agreement with that by the WUGs and the water
users. The water price regulations shall be followed strictly, and water rates shall not be increased without authorization. Water charges shall be spent only for designated purpose and be prevented from being misappropriated or withheld.

Article 11 Observe irrigation disciplines, maintain irrigation order, and obey unified dispatching. It is forbidden to steal water, rob water, damage the structures, close canal to deliver water without permission, and grow crops on the dike crest or on the slope of the canal.

Article 12 strictly manages the water by law. The Association shall, depending on the seriousness of the case, impose sanctions on the water users who violate regulations in the light of the Charter of the Association and the relevant provisions. Serious cases shall be reported to the government authorities, and the cases violating the Criminal Law shall be handed over to the judicial authorities.

**10.4 Water Works Management Rules**

Article 1 The Association has the power of management and the utilization rights on the canals and structures beyond the main canal within the command area of the Association.

Article 2 During the irrigation, both the water user representatives and the executive members shall inspect the dike and protect the water supply. WUG must organize the water users to enhance the inspection and maintenance of the canal section it is responsible for so as to ensure the safe water delivery through canal.

Article 3 The Association shall carry out an overall canal inspection prior to irrigation and shall timely organize people to repair the canals and structures that may influence water delivery.

Article 4 After the completion of each water delivery, the water user representative (water controller) shall inspect the canals within the command area of the WUG, timely organize the water users to repair in case of any damage to or failure of the canals, and report to the Executive Committee of the Association to arrange the repair in case of serious safety problems.

Article 5 Hierarchical-responsibility system is enforced for the water works management of the Association. The branch and its associated structures shall be managed by the Association on a unified basis, while the lateral, its inferior canals, and associated structures are managed by WUG.

Article 6 The Association shall be responsible for preparing scheme for the maintenance, repair, construction of supporting structures, and renovation of the branch and its associated structures and submit the scheme to the Water User
Representative Assembly for approval. The fund needed shall be shared by the WUGs according to the beneficiary area.

Article 7 The WUG shall be responsible for preparing scheme for the maintenance, repair, construction of supporting structures, and renovation of the bilateral, its inferior canals, and associated structures and implementing the scheme upon the approval of the WUG Member Assembly. The fund needed shall be shared by the water users of the WUG according to the beneficiary area.

Article 8 The plan and design of new irrigation facilities of the Association shall be organized by the Executive Committee and be subject to the review and approval of the Water User Representative Assembly. The fund and labor needed shall be shared by the beneficiaries of the new facilities according to the irrigation area.

Article 9 The fund for routine maintenance of the water works can be put on the water supply cost of the Association, be pre-collected based on the mean expenses thereon over the past years, and be cleared according to the actual routine maintenance expenses at the year-end account settlement.

Article 10 Complying with the polices in force, a means of “one matter one discussion” shall be adopted to deal with the overhaul and renovation of the water works and the construction of new facilities and supporting facilities of the Association. The required funds thereon shall be determined and raised after being discussed and studied within the Water User Representative Assembly.

Article 11 Canal forestation shall be under hierarchical management. The water user representatives and the Executive Committee shall organize the people to do it and manage it.

Article 12 All members of the Association shall fulfill their obligation of the maintenance of the irrigation facilities. Any member may not refuse to do so.

10.5 Management Rules of Collection and Use of Water Charges for Farmer Water Users WUA (WUA)

**General Provisions**

Article 1 The Rule shall be formulated according to the Document No.____ of _______ Province (City, District) as well as the Charter of the WUA.

Article 2 The Rule shall be adapted to all Water Users Groups and Water Users in the WUA. Water Users shall be under an obligation to pay water charges on time of their own accords.

**Criteria for Water Charges Collection**

220
Article 3 Normal collection of water charges. Unit price of water charges shall be made verified and agreed by Member Representative Assembly.

Article 4 Collection of water charges for irrigation water beyond the plan. Any water amount used exceeding planned water delivery shall be charged for irrigation water charges beyond the plan according to excess water charges regulated by the government (The WUA may not be permitted to set a water price for water delivery beyond the plan without permission if there is no such regulation by local government).

Water Charges Collection Measures

Article 5 Collection of water charges for the WUA is in a way of prepayment before irrigation rotation and settlement after irrigation rotations of whole year.

Article 6 Water Users Group shall collect the prepayment of water charge from water users and submit to the WUA in a timely manner following specified procedure according to planned water amount and water price standard within provided time before the start of irrigation rotations.

Article 7 Water Users Group shall settle with each water user the irrigation cost of whole year and bill to each water user formally in receipts or invoices based on actual water amount used and water price standard according to the provisions of the WUA after the end of irrigation rotations of whole year in this Water Users Group.

Article 8 Water Users Group with a collection rate of water charges lower than the specified and water user who defaults/owes water charges always or refuses to pay water charges shall be given a disposal in terms of imposition of fine for delaying payment, delay of water supply provisionally, suspension of water supply etc. depending on seriousness of the case according to the Regulations on Reward and Punishment of the WUA.

Management Measures of Water Charges Payment and Use

Article 9 Water charges collected by the WUA shall be given an account in accordance with Regulations on Financial Management and kept properly. No embezzlement may be permitted.

Article 10 Water Charges Payment. Water charges collected except the part set aside for overhead of the WUA shall be submitted to the Water Supplier (Company) by installments or once for the settlement of water cost as specified in the contract at a price verified and approved by government agency toward Water Supplier
Article 11 Fund for operation and maintenance considered in water supply cost of the WUA is collected together with water charges. It is held and used by the WUA. The scope of expenditures must be approved by Member Representative Assembly.

Article 12 Scope of use of water charges set aside by the WUA as specified:

(1) Salaries, subsidies and expenses for business trips of WUA staff members;
(2) Administration fee, business production and building repairs cost;
(3) Expenses for engineering operation & maintenance, including: small engineering repairs, engineering maintenance, canal cleaning, maintenance and repairing and lubricating and scrubbing with small equipment, without consideration to overhaul and rehabilitation with the system.
(4) The WUA’s expenditure for water charges shall be public to members periodically to ensure transparent accounts and democratic monitoring.
10.6 Regulations on Reward and Punishment

Article 1 If irrigation works within jurisdiction of the WUA is destroyed intentionally, Executive Committee shall release such a disposal depending on seriousness of the case as remedies within provided period, compensation to loss, fine, reduction in water supply, suspension of water supply and so on.

Article 2 If regulation gates on or protection slope along the canal above branch level are destroyed intentionally, the violator shall make remedies within 10 days.

Article 3 If water delivery gates are destroyed intentionally, the violator shall make remedies within 3 days otherwise a fine ranging from 500 Yuan RMB to 2000 Yuan RMB could be given. The WUA will charge the fine and take responsibilities for organization of remedies.

Article 4 Any breaching canal, detaining water on canal shall be punished by stealing water with a fine ranging from 100 Yuan RMB to 500 Yuan RMB each case, furthermore, supplemental water charges shall be paid based on actual volumes used.

Article 5 any conflicts or fights over water using within the command area of Water Users Group (WUG) shall be handled by WUG head in WUA with water user representatives, between WUGs shall be handled by the WUA. Occurrence of fight and scolding shall be reported to county (town) government for disposal. Occurrence of loss in economy or injuries to person or death shall be delivered to justice departments for disposal.

Article 6 No delaying and owing payment by members may be permitted. 1% of monthly water charges as a fine for delaying payment shall be imposed on defaulter. Water charges delayed or owed shall be settled within provided period. There is no water supply by the WUA until the settlement of all water charges.

Article 7 Financing allocation approved by the WUA for the purposes of launching new or maintaining irrigation works shall be paid by each beneficiary member fully. The one who refuses to do so will be limited even suspended to access to water supply.

Article 8 Conflicts on water between this WUA and other organizations shall be tackled by competent line agency coordinately.

Article 9 the meetings of Water Users (Member) Representative Assembly shall be called at the end of year, in which WUGs and water users with outstanding performances of irrigation works management and water charges collection will be honored and rewarded.

Article 10 The member who has an outstanding performance of taking good care of water works, making payment of water charges in time, financing for launching system will be honored and rewarded by the WUA at any moment.
10.7 Responsibilities of Chairman and Vice Chairman of Executive Committee

1. Responsibilities of Chairman

Article 1 The Chairman of the Executive Committee shall be the legal representative of the WUA. Between the meetings of Member Representative Assembly, the Chairman shall exercise the functions and powers in accordance with the Charter and resolutions approved by Member Representative Assembly and take responsibilities for taking care of the overall activities.

Article 2 To give dissemination to members regarding state policies concerned, provisions of Water Supplier (Company) and regulations and rules of the WUA. Conduct the alteration to the articles in Charter, regulations and rules concerned in accordance with the resolutions approved by Member Representative Assembly.

Article 3 to rise to Water Supplier (Company) on behalf of the WUA rational suggestions advanced by water users, strive for an appropriate solution.

Article 4 to be responsible for taking care of the overall use and management of the WUA’s fund. Strictly review and approve various expenditures. No pecans and violation may be permitted.

Article 5 to call meetings of Member Representative Assembly and report to the Assembly on its work. To put forward new work plans and guideline according to new situation and implement resolutions approved by the Assembly.

Article 6 to report to meetings of Member Representative Assembly on its work by the end of year.

Article 7 to make preparations for and call meetings of Executive Committee members and arrange routine activities.

Article 8 Support and supervise the work of Vice Chairman.

2. Responsibilities of Vice Chairman

Article 1 to be responsible for taking care of irrigation management in accordance with the Charter approved by Member Representative Assembly.

Article 2 to set up a water supply plan throughout a year or for each irrigation rotation in negotiation with Water User Group on time.

Article 3 to submit to Water Supplier (Company) the water supply plan throughout a year or for each irrigation rotation in time.

Article 4 to arrange irrigation order and time for each irrigation rotation and coordinate well in and record irrigation turns among WUGs during irrigation period.

Article 5 to be responsible for timing irrigation of canal sections, measuring flow and calculating volumes of water on time and making records well.
Article 6 to be responsible for organization of replacement, rehabilitation, maintenance and taking care of system facilities.

Article 7 to report to Chairman or Member Representative Assembly on irrigation and management work.

Article 8 to do a good job of routine work of the WUA according to job divisions.
Project Procurement (v1)
(第1稿)

2010年1月
一、土建和货物采购

亚行资助的土建工程、设备、材料、货物和服务的采购，将依据亚行的《采购准则》的规定（2007年，不时修订的版本）进行。对于价值相当于100万美元或以上的设备和材料重大合同的授予，应通过亚行的国际竞争性招标（ICB）程序进行。价值不到100万美元的设备和材料合同的授予，应依据中华人民共和国招标投标法（1999年），通过国内竞争性招标（NCB）程序进行；也要依据于与亚行协商后所做的修改。估计相当于1000万美元费用的土建工程合同，将采用国际竞争性招标程序进行，而费用相当于不到1000万美元的土建工程合同，则采用国内竞争性招标（NCB）程序进行。允许价值相当于不到10万美元的货物和合同的购买、以及价值相当于不到20万美元的土建工程合同的购买。一些涉及小型水坝、灌溉系统修复、水土保持以及小水窖的子项目，以及价值相当于不到10万美元的小型土建工程合同，只要可行，就将在包工工程基础上或通过社区参与进行，以确保可持续发展和实现项目的社会目标。外国承包商可采用国内竞争性招标（NCB）程序参与合同竞标。这些程序、规范以及合同应当促进这类活动的参与，只要它对以下是有用的：

(i) 涉及地方社区和/或非政府组织；
(ii) 使用更多的当地知识和材料；
(iii) 使用劳动密集型以及其他适当的技术。

亚行的《反腐败政策》（1998年，按当修订的版本）有关章节将包括在所有的采购文件和合同中。

二、咨询服务

在项目实施的头4年的中，本项目将支持24人-月的国际咨询服务和171人-月的国内咨询服务，以支持项目实施与能力建设，项目办、地方项目实施办以及项目实施机构。咨询专家将加强其项目实施能力，以确保：

(i) 子项目的实施机构能够起到有效的项目管理单位的作用；
(ii) 亚行资助的非核心子项目，能得到及时评估并在商定的资格标准基础上得以批准；
(iii) 水资源需求管理活动的实施，将促进所有类别的用户更有效地利用水资源；
(iv) 社会、移民安置和环境影响得到监测及缓解。项目实施机构能力的开发，将通过本项目和技术援助TA 4912实施的咨询投入、项目设施的管理和操作培训、在中国境内的培训以及由中国政府提供的资金资助的详细设计与工程实施管理进行。这类能力的开发，对中国并不陌生；因此国内咨询专家具有提供成本效率支持的知识。不过，总的能力开发计划既庞大又多样化，国际咨询专家就计划的内容对其提供全面的指导。将依据亚行的《咨询专家使用指南》（2007年，按当修订的版本）、聘用一家国际咨询公司、使用质量和成本（80:20）为基础的选择方法、以充分的技术建议进行国际和国内咨询服务。由中国政府提供的配资金资助的详细设计与工程实施监理，将由地方政府负责和具体实施。
三、合同的提前签订与有追溯效力的融资

贵阳市政府已要求提前签订合同，并采用追溯贷款，以促使土建工程的早日启动以及为本项目实施招聘咨询专家。已向中国政府建议，追溯贷款只能用到贷款协议签署前不早于12个月的、亚行贷款额适用于支出费用20%的。评估团评估期间，确定将需要相当于约352万美元的追溯贷款，用于涉及到的下列项目：

(i) 用于渔洞峡水库/大堤建设的土建工程，
(ii) 用于小水窖的土建工程（118万美元），
(iii) 灌溉系统修复子项目和农村供水子项目的土建工程（68万美元），
(iv) 水土保持子项目的土建工程（28万美元），
(v) 能力建设和培训（40万美元）。

提前行动的所有合同，都将依据《亚行的采购准则和咨询专家使用准则》的规定。还向中国政府建议，为本项目提前签订合同和有追溯效力的融资的批准不向亚行承诺为本项目融资。

四、反腐败政策

亚行的《反腐败政策》（1998年，按目前最新修订的版本）已向中国政府和贵阳市政府解释并讨论过。与其好的管理方法，问责制和透明度的承诺一致，亚行有权直接或通过其代理人，对有关本项目的任何涉嫌腐败、欺诈、串通或施加压力的做法进行调查。为了支持这些努力，亚行的《反腐败政策》已列入贷款规章和项目的招标文件的有关规定中。特别是，由亚行资助的与项目有关的所有合同中，应包括具体规定亚行有权审核和检查执行机构和所有承包商、供应商、咨询专家和其他服务提供者涉及本项目的所有记录和帐户。
五、采购计划

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对于子项目中涉及（1）小水窖，（2）水土保持，（3）灌溉系统配改，（4）小型水库的100,000美元或以下的小型土建工程，可以采用包工方法或通过公众参与的采购。当这种小型工程分散在边远地区，且有资质的建设公司不太愿意以合理的价格投标时，建议采用包工的方式。公众参与对于小型子项目来说是一种较为理想的方式，能够保证可持续性和农民的所有权并达到项目的社会效益，因为公众参与方式能够（a）唤起当地社团组织的参与意识，（b）采用劳动密集型技术及其它合适的技术。

应当首先考虑公众参与的方法，只有当公众参与的方法行不通时，才可最后考虑包工的方法，特别是当工程位于边远地区，没有对工程感兴趣的当地承包人，也没有非政府组织或社团组织参与时。施工设备的效率，以及执行机构和实施机构是否能够以合理的价格承担工程和达到要求的质量，都必须令亚行满意才行。
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货物和服务的采购

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咨询服务的补充

基于质量和成本的选择 (QCBS) 前审

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六、

1999年8月30日中华人民共和国主席发布第21号令, 公布了中华人民共和国招投标借款人法,按照亚行的指南要求, 需要做以下一些解释和说明:

I. 所有招标都应在借款人所在国家的国家新闻机构、官方报纸或自由出入的网站上进行公示。这种公示应当给可能的投标人以足够的时间, 以进行资格预审和准备及提交招标文件。无论在何种情况下, 至少要给30天的准备期。准备期应从 (a) 公示之日起计算, 或 (b) 从得到文件时开始计算, 以上两种情况以较后的时间为准。应当规定公示以及资格预审和提交招标文件的最后审限。

II. 对投标人的资格要求, 以及对每个投标人资格的评定方法, 应当在招标文件中予以详细规定, 如果在投标前要进行资格预审, 也应在资格预审文件中加以规定。

III. 如果在投标前要进行资格预审, 则只有符合资格预审文件中资格标准的投标人才有资格投标, 对资格预审的投标人的数量没有限制。

IV. 要求所有投标人要有足够的保证, 在承包人违约的情况下, 能够保护借款人和项目执行机构。投标文件中应规定这种保证的要求形式和数量。

V. 允许投标人采用邮件或手递的方式投标。
VI. 所有投标应公开进行；应给所有投标人能在开标时到场的机会（无论亲自到场还是通过其代表），但并不要求投标人在开标时必须到场。

VII. 所有评标的标准都应在招标文件中披露，并以货币的形式量化，或以通过或未通过招标要求的形式来表示。

VIII. 不得只根据投标人的标价低于标准合同估价，或借款人/项目执行机构确定的平均要价，而拒绝其投标。

IX. 每个合同应发包给对最低评估价作出反应的投标人，即该投标人符合有关能力和资源的适当标准，其投标被确定为（a）对投标文件作出充分的反应；（b）提出最低的评估成本。作为决标的条件，不要求中标人负责投标文件中没有规定的工作，但也不得修改原来标的的内容。

X. 每个亚行资助的合同都应规定，供应商和承包人应按亚行所要求的那样，允许亚行检查其有关合同履行方面的账目和记录，并由亚行指派的审计师审计这些账目和记录。

XI. 允许借款人所在国的国有企业投标，只要其（a）在法律上和经济上有自治权；（b）按贸易法运作；（c）不是借款人/项目执行机构的从属机构。

XII. 不允许只是因为投标数量少于3个的重新投标。
Project Financing Plan (v1)

2010 1
Project Cost Estimated and Financing Plan (v1)
目录

一、项目投资概算 242
二、项目投资概算的基本假定 242
三、项目融资计划 245
四、拨付与转贷条件 245
一、项目投资概算

本项目投资成本估计相当于439.2百万美元（相当于29.42亿人民币），其中含3180万美元的税费（相当于2.13亿元）。按子项目构成的项目总投资概算（表1，表2，表3）内。

表1：项目投资计划

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二、项目投资概算的基本假定

1. 包括税费3180万美元；

2. 采用2009年的价格。基本费用包括环保措施费用；
3. 实物不可预见费是以所有费用的5%。价格不可预见费是依据亚行规定的国内和国外价格调整因子，按年份和支出类型进行计算。

4. 实施期间的利息，是以未来5年伦敦银行同业拆借利率、加上亚行贷款6年的0.2%的利差以及本地银行贷款3年的5.97%进行计算。

5. 由于四舍五入，合计数字可能略有差异。

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三、项目融资计划

中国政府已向亚行申请一笔普通资金来源的1.5亿美元贷款，以资助本项目。这笔贷款期限为25年，包括6年的宽限期；其利率依据亚行的伦敦银行同业拆借利率（LIBOR）为基础的贷款利率，每年承诺费为0.15%，并按照草拟的贷款协议和项目协议中提出的这类其它条件。中国政府已向亚行提供：（i）其作出根据亚行的伦敦同业拆借利率的条款和条件基础上的贷款服务向亚行决定借款的理由；以及（ii）保证这些选择都是其自己的独立决定，而不是靠任何通信联系或来自亚行的任何咨询作出的决定。

费用的余额将由贵阳市政府、国内借款和受益人提供劳务出资。贵阳市政府将为土地征拨与移民安置费用以及亚行贷款的财务费用出资。贵阳市商业银行将提供一笔15年期、其中包括3年宽限期、相当于2000万美元的贷款融资，利率依据中华人民共和国的当前利率确定。还要由贵阳市政府安排一个机构提供为商业银行贷款的财务费用。中国政府会将亚行贷款的收益转贷给贵州省政府（GPG）；贵州省政

四、拨付与转贷条件

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资料来源：亚行估计
中央政府将亚行贷款的收益转贷给贵州省政府；贵州省政府将以亚行贷款的相同条件转贷给贵阳市政府。子项目的贷款资金将由贵阳市财政局支付给地方一级的财政局。贵阳市政府将承担利率和汇率风险，并负责贷款的偿还（见图1）。

使用期限 直到2016年3月31日

估计项目完成日期 2015年9月30日