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For

Ministry of Agriculture and Water Resources
Republic of Uzbekistan

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Asian Development Bank

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Ministry of Agriculture and Water Resources

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Abbreviations

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
BISA	Basin Irrigation Systems Administration
BVO	River Basin Water Management Organization
CACILM	Central Asian Countries Initiative for Land Management
CDSR	Country Diagnostic Studies Review
CEMP	Construction environmental management plan
CIS	Commonwealth of Independent States
CLUR	Certificate of Land Use Right
COM	Cabinet of Ministers
COS	Country Operational Strategy (ADB)
CRD	Control Revision Department
CSP	Country Strategy and Program
DMS	Detailed Measurement Survey
DPSEC	Department of Pump Stations, Energy, and Communications
DPSO	Department of Pump Station Operations
DWM	Directorate of Water Management
EA	Executing Agency
EIA	Environmental impact assessment
EARP	Environmental Assessment and Review Procedures
EIRR	Economic internal rate of return
EMA	External Monitoring Agent
EMP	Environmental Management Plan
EU TACIS	European Union - Technical Assistance to the Commonwealth of Independent States – CEI
FMA	Financial Management Assessment
FMAQ	Financial Management Assessment Questionnaire
GEF	Global Environment Fund
GDP	gross domestic product
GoU	Government of Uzbekistan
GRC	Grievance and redress committee
HAE	Hydrogeological Ameliorative Expedition
HHS	Households
ICB	International Competitive Bidding
ICWC	Interstate Commission for Water Coordination

I&D	irrigation and drainage
IDB	Islamic Development Bank
IEE	initial environmental assessment
IFAS	International Fund for Saving the Aral Sea
IFI	International Financial Institution
ISA	Irrigation System Administration
I-WISP	Interim Welfare Improvement Strategy Paper
IWMI	International Water Management Institute
LARF	Land Acquisition and Resettlement Framework
LARP	Land acquisition and resettlement plan
LIBOR	London Interbank Offered Rate
M&E	Monitoring and evaluation
MAWR	Ministry of Agriculture and Water Resources
MC	machine canal
MCA	Main canal administration
MoF	Ministry of Finance
NAS	National Accounting Standard
NCB	National competitive bidding
NGO	Non-governmental organization
NPC	Nature Protection Committee
NPV	net present value
O&M	operation and maintenance
OCR	Ordinary capital resources
OPEC	Organization of the Petroleum Exporting Countries
PIU	Project Implementation Unit
PMO	Project Management Office
PNPC	National Nature Protection Committee – Provincial level
POCLA	Permanent <i>Oblast</i> Commission on Land Allocation
PPTA	Project preparatory technical assistance
PSA	Poverty and Social Assessment
PSC	Project Steering Committee
PSEE	Provincial Directorate for State Ecological Expertise
QCBS	Quality and cost-based selection
R&U	Rehabilitation and upgrading
SCADA	supervisory control and data acquisition
SCLRGCS	State Committee on Land Resources, Geodesy, Cartography and State Cadastre
SCNP	State Committee for Nature Protection

SDC	Swiss Agency for Development and Cooperation
SEE	Main Directorate for State Ecological Expertise
SIC	Scientific Information Center of the ICWC
SIEE	Summary Initial Environment Evaluation
SME	Small and medium-size enterprises
TA	Technical assistance
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VAT	Value Added Tax
WB	World Bank
WC	Women Committee of the Republic of Uzbekistan
WIS	Water Sector Investment Strategy
WRMSP	Water Resources Management Sector Project
WUA	Water Users' Association

Units

Ha	Hectare
Km	Kilometer
km ³	cubic kilometer
T	Ton

Glossary

Bonitet	Classification system for land productivity potential
Dekhan	Household plot used for households immediate food requirements and sale of surplus. Given to head of family for the lifelong ownership. Size of <i>dekhan</i> farms: irrigated land 0,35 ha and 0,50 on non-irrigated area
Glavgosecoexpertiza	Main Directorate for State Ecological Expertise, or SEE
Goskompriroda	State Nature Protection Committee
Khokim	Province or District Governor
Khokimiyat	Local government authority
Makhalla	Collection of villages to create a community village
Oblast	Province (Russian version)
Oblvodkhozy	Province administration
O'zuvnazorat	Water inspectorate
Rayon	District (Russian version)
Rayvodkhozy	District administration
Shirkat	Cooperative farm, successor of former kolkhoz
Turman	District, smaller administrative unit of the viloyat
Uzglavgidromet	Chief Hydrometeorological Administration
Viloyat	Province administrative unit of Uzbekistan. Uzbekistan has 12 viloyats and 1 autonomous republic of Karakalpakstan

Currencies equivalents

At the date when report was prepared

Currency unit	Sum (SUM)
	\$ or USD
SUM 1.00 =	\$0.00076
\$1.00 =	SUM1,320.00

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1. The Government of Uzbekistan requested the Asian Development Bank (ADB) for a Technical Assistance to prepare a project to improve water resources management and irrigation. The PPTA for the Water Resources Management Sector Project (WRMSP) includes (i) the preparation of a sector investment project, including the feasibility study of two core subprojects, and (ii) the development of a long-term national strategy for the sector.

2. The present Final Report has been prepared according to the clauses of the contract between ADB and the PPTA Consultant. The report includes: (i) Main Report and its Appendixes; (ii) Supplementary Appendixes; and (iii) stand alone Feasibility Study reports for the two core subprojects Narpay and Besharyk with related Annexes.

I. SECTOR BACKGROUND

A. Agriculture

3. Uzbekistan covers about 450,000 square kilometers (km²). From the total population of 27.04 million¹, about 60% live in rural areas. The climate is arid and continental with annual rainfall limited to 100-200 mm mainly in the winter months. Agriculture uses 28.5 million ha (63% of total area) including 23.4 million ha (52%) of low productive pastures and 4.4 million ha of irrigated land. Irrigation is vital and provided virtually for free by the Government. The main agricultural areas are located in the Amu Darya and the Syr Darya River basins, which supply about 70% of irrigation water (refer to sections I.B and I.C hereafter).

4. Compared with other countries, the irrigated agricultural sector has performed far below its potential. For over a decade, the sector has endured large net transfers resulting mainly from low fixed prices for cotton and wheat which have drained the sector of resources. Despite Government resolutions on deepening reforms, much of the command and control system has been preserved. However, collective farming, due to financial losses and other weaknesses, has largely been abandoned and farm restructuring based on the establishment of private leasehold farms has been progressing quickly. The financial performance of newly established private farms has, so far, only been marginally better than the *shirkats*, due to continued “command and control” procedures, rationing of inputs and monopolized marketing of cotton. The only truly dynamic element of Uzbek agriculture are *dekhan* farms which account for about 65% of the value of agricultural output (40% of crop value and almost 90% of livestock value). Although *dekhan* farms account for only 11% of cropped land, they are vital for the survival of the rural population.

5. Uzbekistan used to be the main producer of cotton and one of the largest suppliers of fresh and processed fruits and vegetables to other parts of the former Soviet Union. Since independence in 1991, the Government’s quest for wheat self-sufficiency has had a significant effect on cropping systems and crop production. Detrimental to soil fertility, over 80% of irrigated land is now planted with cotton (41%) and grains (42%) and are subject to mandatory production targets. Despite the high costs of production, the average yields of cotton and wheat are still low by international standards. Cotton yields have been declining steadily since 1991 and currently average about 2.54 t/ha². In contrast, wheat yields increased from about 2.3 t/ha to about 4.76 t/ha³, but this is still low for irrigated agriculture. Concentration on cotton and wheat has meant that the area planted with other crops (such as potatoes, vegetables and other horticultural crops) has also reduced dramatically. In addition, the area planted with fodder crops declined by

¹ 2007

² Average years 2005 – 2007

³ On irrigated land, average for years 2005 - 2007

two thirds between 1991 and 2004 and now only represents 9% of the cultivated area. Moreover, the cotton/wheat crop rotation is not sustainable and has resulted in a serious loss of soil fertility which has added to environmental degradation.

6. More data, for Uzbekistan as a whole and for the subprojects areas, Narpay and Besharyk, are provided in Supplementary Appendix A to this report.

B. Water resources

1. River basins and international waters

7. The main water resources of Uzbekistan are the surface runoff, formed by the transboundary rivers the Amu Darya and Syr Darya and their tributaries together with the Kashkadarya and Zarafshan rivers. These river basins form the Aral Sea basin:

- The Amu Darya basin in the south (the basin is not on the south alone, when the Amudraya turns to the north/ northwest, it covers all the northwestern area of the country whereas the Syr Darya passes only the Fergana Valley in the west of the country) covering 86.5% of Uzbekistan. About 4.7 km³ / year or 6% of the average of the average total surface water resources of the Amu Darya River basin are generated within Uzbekistan
- The Syr Darya basin in the north (see above comment) covering 13.5% of the territory. About 4.84 km³/year or 13% of the average surface water resources of the Syr Darya River basin are generated within Uzbekistan.

8. Because of important losses in the desert part of their courses, and because of major withdrawal by agriculture, the flow reaching the Aral Sea is limited to a small percentage of the total rivers flow (less than 10% and 5% respectively in driest years).

9. The surface water resources allocated to Uzbekistan are calculated every year, depending on the climatic situation and actual flows. On average the surface runoff coming from upstream countries is around 56 km³, made up of:

- 22.33 km³/year for the Syr Darya River basin at the border between the Kyrgyz Republic and Uzbekistan
- 11.54 km³/year for the Syr Darya River basin at the border between Tajikistan and Uzbekistan
- 22 km³/year for the Amu Darya River basin

2. Management of international waters

10. Already for two decades the Central Asian countries, especially in the lower reaches of the Syr Darya and Amu Darya Rivers, have suffered from a lack of water and its socio-economic consequences. Uzbekistan is the most vulnerable because it possesses the largest irrigated land area (4.3 million ha), a large rural population (more than 16 million people), and the highest density of population. Despite the high demand for water, Uzbekistan has limited possibilities to directly influence the regime and volume of water which flows across its borders, because the country is located in the middle reaches of rivers.

11. During the Soviet time, water management was centralized on the federal level and each republic in the Aral Sea basin received its share of water in accordance with quotas approved by the USSR State Planning Committee. When the republics in the region gained their independence as new nations, it became necessary to set up a mechanism for regional cooperation in the organization of water resource management. Accordingly an interstate agreement was signed in February 1992 establishing a technical Interstate Commission for Water Coordination (ICWC). This was reinforced by

a new agreement on 26 March 1993, with the five states in Central Asia affirming their commitment to cooperate in the management of the basin's water resources. This agreement established regional institutions charged with the comprehensive water management including: Interstate Council on the Aral Sea Problems (ICAS), a high level body charged to recommend actions to the five governments in the name of the basin as a whole; the Executive Committee of ICAS (EC-ICAS), a secretariat for ICAS; the International Fund for the Aral Sea (IFAS), a high level body charged with financing the activities of ICAS. Later on ICAS and IFAS were merged into a newly structured IFAS – International Fund for Saving the Aral Sea.

12. Since the establishment of IFAS the governments of the Central Asian countries have adopted a number of strategic decisions aiming at stabilizing the environmental conditions and improving the management of water and land resources in the Aral Sea basin. The decisions on the use of river water and discharge of water into the river deltas and the Aral Sea adopted at the regional level are binding for the Central Asian countries. BVO Amu Darya and BVO Syr Darya are its executive bodies (refer to Section II.D and Appendix 3).

3. Specific problems of the river basins within project area

a) Zarafshan

13. The long term average runoff of the Zarafshan River which originates in Tajikistan is 5.91 km³ of which only 0.76 km³ is formed in Uzbekistan. The Zarafshan river basin is the region on the right bank of the Amu Darya River with the lowest available water supply.

b) Syr Darya

14. The Toktogul reservoir located in the Kyrgyz Republic provides long-term regulation of the Syr Darya River flow. From 1994, a change in the Toktogul reservoir operational mode caused a sharp reduction in summer irrigation water releases and an increase in winter releases. These changes have led to a reduction in guaranteed water supply during the growing period of 4.5 – 5.0 km³/year, with Uzbekistan's share being 2.5 km³/year including a water deficit in the Fergana valley of up to 1.5 km³/year. According to MAWR data (2005), in Namangan oblast alone there is a summer deficit of 0.9 km³. During a year with average water availability the Naryn River flow during autumn-winter period is more than two times higher than its natural flow and 1.9 times smaller than its natural value during the summer months. This unbalanced water supply has a negative effect on the operation of canals and water structures, forcing them to operate continuously in extreme conditions which lead to their premature deterioration.

c) Water in irrigated agriculture

15. Irrigation accounts for more than 85% out of the total volume of water consumed in Uzbekistan. Considering the importance of agriculture for the national economy and the fact that about 64% of the population lives in rural areas, which are either directly or indirectly depending on it, ensuring an adequate water supply to this sector is extremely important as is the need to adopt water saving technologies in the field of irrigated crop production.

16. Under the current conditions the irrigation of 4.3 million ha of land requires an average of 57 km³ of water annually. Average water withdrawal for irrigation is 14,000 cubic meters per hectare, compared with 9,000 to 10,000 in countries with similar climates⁴. The inefficient use of water is the main factor restricting the development of

⁴ the specific annual water consumption is assumed to be higher in Amu Darya than in the Syr Darya River basin

irrigated agriculture. The main reasons for low efficiency are the significant losses within the deteriorating primary and inter-farm system and the on-farm distribution network, compounded by the fact that farmers do not pay for water and have no financial incentive to improve water use efficiency.

C. The Irrigation and Drainage Sector

1. Situation of the sector

17. Uzbekistan is an arid country and has average rainfall of 264 mm. Because of Uzbekistan's arid climate and the variability in availability of water resources, almost all agriculture has always been dependent on irrigation. Irrigation takes place on 90% of the farmed arable land and is responsible for nearly all agricultural production. It consumes 85% of all water resources and requires about 57 km³ annually; runoff from water resources generated in Uzbekistan is about 11.5 km³ per year with the balance (80%) coming from upstream countries via the Syr Darya and Amu Darya Rivers. Most water is used for irrigation. Accordingly, development and management of irrigation and drainage infrastructure and improved water management are key government priorities.

18. Uzbekistan has 4.3 million ha of irrigated land (2.35 million ha in the Amu Darya River basin and 1.95 million ha in the Syr Darya River basin). During the time of the Soviet Union in the 1960s and 1970s irrigated area expanded to its current area and was mainly devoted for intensive cotton production. The rapid development of intensive irrigated agriculture throughout Central Asia during this period is largely responsible for desiccation of the Aral Sea and the associated environmental, social, and economic disaster. However, the massive investment economically transformed many areas in Uzbekistan and improved the livelihoods of rural communities who are now completely dependent on the flow of irrigation water. Irrigable land is being steadily degraded and it has been estimated that about 20,000 hectares are being abandoned each year due to: (i) failure of irrigation system; (ii) increasing soil salinity

19. To support this vast irrigated area, Uzbekistan has an extensive network of irrigation and drainage infrastructure divided into two types: (i) inter-farm, and (ii) on-farm systems. The inter-farm system comprises the large intake structures for water irrigation supply, and the main and distributary canals that convey water to the farm level outlets as well as the large collector drains that move drainage water from irrigated areas. The on-farm system comprises the smaller field channels and associated structures that distribute the water to farmers' fields as well as the smaller drainage systems that take water from the field and lower the water table to prevent the problems of salinization and waterlogging that occur in many areas. Irrigation in Uzbekistan primarily relies on surface water that is distributed both by gravity and a widespread network of pumps of various sizes. In some areas, such as the Fergana Valley, all these irrigation and drainage facilities are intertwined in a complex and interlinked system. Uzbekistan's irrigation and drainage infrastructure includes (i) 30,000 kilometers (km) of main and inter-farm canals with over 33,000 hydraulic structures; (ii) more than 1,500 pumping facilities, with almost 5,000 pumps that supply irrigation water to over 2 million ha; (iii) 175,000 km of on-farm canals and conveyance structures; (iv) 40,000 km of on-farm horizontal drains and 4,300 vertical drains; (v) 120,000 km of drainage ditches; and (vi) 15,000 km of large drainage collectors.

20. Maintenance of this infrastructure is affected by the lack of funds for infrastructure maintenance resulting in increasing deterioration of canals, drains and pumping stations. It is estimated that 20% of the electricity generated in Uzbekistan and 70% of MAWR's budget are required to cover the costs of pumping irrigation water.

2. Major sector constraints

21. The poor performance of the agriculture sector marked by a decline in cotton production and high production costs is attributed to several key factors:

- Inadequate funding for O&M of I&D infrastructure
- Lack of effective O&M cost recovery mechanisms
- Restrictive crop procurement and pricing policies
- Lack of progress in agri-business privatization
- Government control and interference in private farms
- Lack of agricultural support services for private farming.

D. Institutional aspects

1. Legal basis of the water resources sector

22. The law of the Republic of Uzbekistan on Water and Water Usage was promulgated in May 1983. Salient aspects are as follows:

- Water is a State property
- Off-farm irrigation infrastructure is owned by the Government
- On-farm irrigation works are owned by the shirkats or WUAs

23. The legislation does not appear to provide an adequate legal basis for the regulation of water supply between a WUA and its members.

2. National and Local Water Institutions - Reforms

24. MAWR is the national institution responsible for irrigation and drainage with offices at central, province and district levels.

25. Formerly, the institutional water management system was based on strict administrative boundaries. In view to improve efficiency a two level system of basin irrigation management has been introduced by the Decree of the Cabinet of Ministers of the Republic of Uzbekistan of 21 June 2003 through the establishment of the Basin Administration of Irrigation Systems (BISAs) and WUAs.

26. Ten BISAs (irrigation basin administrations) were created, subdivided into Main Canal Authorities to regulate water resources in main canal systems. While more analysis and details are provided in Appendix 3 it should be noted that:

- Basin Irrigation System Administrations (BISAs) are new organizations and there is a need for strengthening their relationship to work more closely with the WUAs.
- Some of the new organizations are still linked to administrative boundaries. In the Project area it is mainly the case of: the WUA for Narpay District and the three BISAs for Fergana valley which correspond to the three administrative provinces.

Table 1: List of Basin Irrigation System Administrations

No	Basin Administrations (BISAs)	Main Canal and Irrigation System Administrations
1	Naryn-Koradarya Karadarya	3 main canal authorities 5 irrigation system authorities
2	Naryn-Syr Darya	2 main canal authorities 4 irrigation system authorities

3	Syr Darya-Sokh	4 irrigation system authorities
4	Chirchik-Ohangaron	1 main canal authority 3 irrigation system authorities 1 city water resources authority
5	Lower Syr Darya	1 main canal authority 4 irrigation system authorities
6	Zarafshan	1 main canal authority 8 irrigation systems authorities
7	Amu-Kashkadarya	1 main canal authority 4 irrigation system authorities
8	Amu-Bukhara	5 irrigation system authorities
9	Amu-Surkhan	1 main canal authority 3 irrigation system authorities
10	Lower Amu Darya	10 irrigation system authorities 1 delta authority

3. Water Users' Associations

27. The Government has adopted a water user association (WUA) approach under the Cabinet of Ministers Decree No 8 of 5 January 2002. The decree states that I&D infrastructure of the former *shirkat*⁵ becomes the property of the WUA with the inter-farm I&D infrastructure being transferred to the divisions of MAWR.

28. The establishment of WUAs to take responsibility for on-farm water management is a critical component of the institutional reforms and reorganization within the water sector. However, WUAs are not fully established due to the incomplete legal and regulatory framework.

⁵ Collective farms

II. SECTOR ISSUES – MID TERM STRATEGY

29. During the PPTA a draft *Medium Term Sector Strategy and Investment Plan* was prepared for the irrigation, drainage and water resources sector in discussion with the Government. (Appendix 1 to this report). The strategy is derived primarily from the substantial policy work that has already been conducted in Uzbekistan. The strategy focuses on maximizing returns and increasing the productivity of water use. Essential to this strategy is improved water use efficiency to be achieved in part through targeted R&U investment of the inter-farm irrigation system. Many pump schemes are currently operating very inefficiently and have effectively exceeded their design life. The failure of the pumps will result in catastrophic agricultural productivity losses, with subsequent income and social implications, so selective R&U of pump schemes is a vital component of the strategy and investment plan. In addition to infrastructure R&U, the strategy calls for improved water management at both the on-farm and inter-farm levels through strengthened institutions and capacity development. ADB and the Government will continue to discuss and refine the strategy, particularly in view of the additional studies being undertaken by the World Bank and United Nations Development Programme (UNDP).

A. Sectoral Constraints and Issues

1. Reliance on transboundary water resources

30. Since independence Uzbekistan has been a party to bilateral and multilateral agreements and a participant in regional initiatives in the area of joint water and energy resources management. A number of intergovernmental agreements have strengthened dialogue and cooperation amongst the Aral Sea basin countries. In 1992, the Central Asian Republics established the Interstate Commission for Water Coordination (ICWC) to oversee water allocation within the Aral Sea basin. In the current absence of permanent water sharing agreements, allocation is decided annually on an ad hoc basis under the ICWC and managed by the basin water management organizations under the ICWC. (ADB has just launched a new technical assistance operation to re-establish a long term water allocation system among the countries in the region.⁶)

31. However, since the time of the former Soviet Union, Uzbekistan has not had permanent agreement with its neighbors on energy and water allocation. The change in the seasonal water supply because of the changed use of Toktagul reservoir in the Kyrgyz Republic for hydropower generation with higher winter flows in the Syr Darya River and deficit during the peak summer months has affected the water supply regime for Uzbekistan, to the extent that the country now faces water deficits of 5–10% per year compared with the previous regime. Uzbekistan has limited possibilities to directly influence the regime and volume of water flow across its borders, because the country is located in the middle reaches of rivers and many of its irrigation policy decisions are driven by the actions of its neighbors. Water management challenges are also mounting because of the need for higher agricultural production and hydropower generation, and the increased uncertainty due to climate change.

2. Deteriorating I&D infrastructure

32. Irrigation and drainage infrastructure and pump schemes inherited from the Soviet era have deteriorated and are reaching the end of their economic life requiring substantial rehabilitation and capital reinvestment. Some structures are at risk of total failure, which would result in a dramatic decline in agricultural production and farm incomes. According to the UNDP assessment (2007), based on MAWR data (2004-2005), total requirements in rehabilitation of hydraulic infrastructure could be as follows:

⁶ RETA No. 41316, August 2008, Improved Management of Water Resources in Central Asia.

- 32.1% total length of interfarm and main canals (22,300 km) requires rehabilitation, and 23.5% - requires refurbishment;
- More than 42.1% of on farm irrigation network (149,500 km) requires rehabilitation and 17.4% - refurbishment;
- Of 42 water intake control structures, with capacity of 10 to 300 m³/s, 18 require replacement and modernization of hydro mechanical equipment, and 5 control structures requires rehabilitation;
- Most part of pumping stations servicing more than 2.1 M-ha, has already outsourced their service life, although out of 1,130 stations 76 are unique (>100 m³/s), 496 medium (up to 10 m³/s) and 561 small (less than 1 m³/s). As a whole, 80% of large, 50% of medium and 30% of small pumping stations require refurbishment and rehabilitation;
- Of 27 surveyed reservoirs 11 are practically completely silted, and at 5 – sedimentation are now very close to outlet structures.
- About 19,000 km of open on farm drainage requires cleaning, 11,500 km of open and closed drainage requires rehabilitation and refurbishment, and
- Only 50% of closed horizontal drainage is in operational condition.

33. Sustained investment in rehabilitation and upgrading and better O&M will be required to prevent further deterioration and ensure stability in the farming system following R&U.

3. Rural sector dependant on irrigation

34. Over 60% of the population live in rural areas and are vitally dependant on irrigated agriculture for their employment and livelihood. In some cases whole communities are dependent of large pump cascade schemes where water is pumped from the Amu Darya River to high levels, such as the Amu Bukhara, Karshi and Amu Zhang systems that irrigate over 800,000 ha and support several million people. Failure of these pump schemes would have drastic economic and social outcomes and may cause massive social unrest and dislocation. Of the 76 very large pumping stations with capacity greater than 100 m³/s, 60 require immediate rehabilitation.

4. Limited O&M budget and capital reinvestment

35. Although the I&D infrastructure was well built its current condition is poor, primarily due to deferred maintenance and a lack of re-investment. Government investment in agriculture as a whole has declined, from 27% of all investments in 1991 to 8% in 2001. From 1995 to 2002, Government funding for the water network dropped from 3% to under 2% of GDP, a 60% decrease. Expenditure in O&M has slowed by one third. Currently, it is estimated that deferred capital and O&M expenditures amounts to 40% of asset value. Table A6.2 presents the estimates of MAWR on the annual required levels of O&M and repairs (or depreciation) expenditures.

Table 2: Annual Requirements for O&M

Assets	Asset Category	Operations and Maintenance (US\$ m)
Supply canals	Main and inter-farm	111
	On-farm	118
Pump stations	Large and inter-farm	56
	On-farm	61
Collectors and Drainage System	Main and inter-farm	40
	collectors On-farm	73

Other (all off-farm)		91
	Total:	550

Source: Royal Haskoning, WEMP, Regional Report No 2

36. Current annual irrigation investment spending is in the range from US\$30 million to US\$80 million, with priority given to building facilities to mitigate the effects of Kyrgyzstan's operational changes at Toktogul reservoir. Current total annual O&M spending for the water resources sector is about US\$400 million, most for electricity. Rising costs of electricity have severely squeezed the funding for all other kinds of O&M spending and now account to over 70% of expenditure on the water sector.

5. Reliance on pump irrigation

37. Pumped irrigation involves 65% of the irrigated area to some extent and absorbs 70% of MAWR's annual O&M budget. It consumes 20% of Uzbekistan's electricity. The portion of irrigated land served by lifted water varies from 10% in Syr Darya to 100% in Bukhara. Of the 2.4 million ha served by pumped water, 66% has less than 50 m lift, and 12% is between 50 and 100 m. With respect to electricity consumption, it is most important to note that there are 464,000 ha with lifts between 100 and 150 m, and the 24,000 ha with lifts exceeding 150 m. The pump costs to serve these high-lift irrigation projects are very high, and most crop production is uneconomic. The efficiency of pumps is also low due to old and worn out pump equipment (outdated pumps consume 20-25% more electricity than modern equipment), unstable energy supply, unstable water supply, and the low water level in the primary canals. Substantial investment is needed to convert the pumped system into efficient and cost effective operations. The efficiency of smaller pumped extension systems can also be improved through new technology, more demand-responsive operating regimes, and improved irrigation techniques, such as gated pipe and drip irrigation.

6. Poor water management and lack of monitoring use

38. The degraded state of irrigation and drainage infrastructure combined with poor water management practices, result in low water use efficiency and reduced agricultural productivity. The limited use of water-efficient technologies means an additional 10-15% of water supply is required for irrigation. (Average water withdrawal for irrigation is 14,000 m³ per ha, compared with 9,000 to 10,000 m³ per ha in countries with similar climates). Irrigation efficiency nationwide is only about 40%. There is no monitoring on on-farm water use. Farmers are not required to pay for the amount of water used and have no incentive to improve the efficiency with which they use water.

39. The result is wasted water, overloaded drainage systems, environmental degradation including rising groundwater levels, and worsening land mineralization. The high water table and use of drainage water for irrigation increases salinity and requires substantial water for leaching. MAWR estimates that more than 20,000 ha of land goes out of production each year due to salinity caused by poor water management and inadequate drainage. The salinity affects cotton yields, which decline by 20–30% on slightly salinized land, and crop failure is common on highly salinized land. Some degree of salinization and water-logging affects 47% of all irrigated land in Uzbekistan.⁷ Various studies conducted in the rural areas of Uzbekistan show that the percentage of population with low incomes is clearly associated with land degradation (i.e. soil salinity and water-logging).

⁷ ADB is helping to address this situation through ADB. 2006. Technical Assistance for Central Asian Countries Initiative for Land Management Multi-country Partnership Framework Support Project. Manila, that includes Uzbekistan.

7. State order system for cotton and wheat

40. The State effectively mandates the area planted to cotton, wheat, and some other crops, purchases essentially all of the cotton and a portion of the wheat at preset prices below free market prices, and provides many of the inputs for cotton and wheat production. Farmers have neither the right nor the incentive to decide what crops to grow or how to grow them to maximize their farm income.

8. WUA limited capacity

41. The Uzbekistan government has strongly embraced WUAs, and devolved state responsibility to them to take over responsibilities for water delivery and management and maintenance of on-farm irrigation and drainage infrastructure. Given the lack of capacity of the WUA and the limited ability of farmers to meet the full cost of maintenance the WUAs are not expected to play a major role in the rehabilitation of I&D infrastructure, except at the most local level. WUAs need assistance in the form of establishing their clear legal basis and implementation structure, training and capacity building and initial operational assets to support them in carrying out their responsibilities.

9. Poorly developed on-farm water management

42. The breakup of the *skirkats* into private farms has resulted in the formation of many small units and land holdings making the distribution and management of irrigation more complicated, whereas the on-farm infrastructure was designed on the basis of the larger former state and collective farms. Consequently on-farm and field distribution is poorly developed leading to poor water control and reduced field efficiency. Farmers pay a nominal fixed charge for water delivery, rather than a charge based on quantity used, and there is no monitoring of water use, reducing their incentive to conserve water. Uncertainty about late and unreliable water supplies causes farmers to apply excess water when it is available as insurance against later shortage, which aggravates the wastage and waterlogging problem.

10. Lack of market depth in goods and service providers

43. The Uzbekistan economy is still in transition and the privatization and liberalization of the agricultural economy is proceeding slowly. The transformation of *shirkats* to private farms was completed in 2007. The agricultural sector is failing to provide rural areas with sufficient income and food security due to the constraints imposed by a combination of factors: inadequate property rights, lack of inputs and mechanization, including access to water technology and agro processing facilities, difficult trading and marketing conditions and low investment into infrastructure. Markets for agricultural inputs and outputs are poorly developed and there is a reliance on quasi-state institutions for the supply of seeds, fertiliser, machinery services and marketing and expertise. Many machinery services are provided by machinery pools set up with equipment disbursed as the *shirkats* were disbanded. Banks are state entities, serving more of a state receipts, disbursements and taxation role, rather than a savings and private enterprise financing role for their customers.

11. Lack of property rights and security of tenure

44. Apart from the *dekhan* plots for which households have more secure and transferable ownership, of land remains the property of the state. Private farm land is allocated through a 50-year lease, but tenure is far from secure as the farmer has to perform to a certain level and meet his crop quota. Poorly performing farmers can easily have their lease revoked and lose their land. Since the reformation and privatization process started in 2000 a process of land aggregation has occurred as many smaller poorly performing farmers have given up their land which has been reallocated to larger

more successful farmers. Private farmers receive no compensation for any capital development on their land reducing their incentive to invest in land improvements.

B. Sector Development Needs

1. World Bank Strategy Report

45. In 2000, MAWR and the World Bank published the *Irrigation and Drainage Sector Strategy and Study*,⁸ which still provides relevant guidance to sector development. According to the strategy, about \$23 billion is required to completely rehabilitate and modernize water resources management, irrigation and drainage infrastructure. The World Bank is currently finalizing an updated study, the *Water Sector Investment Plan: Prioritization of Irrigation Rehabilitation and Management*, which includes criteria and a methodology for prioritizing irrigation infrastructure and a strategy for investment.⁹ In 2007, the UNDP, in cooperation with MAWR, prepared a comprehensive overview of the water sector in Uzbekistan. UNDP has prepared a follow-on proposal for an integrated water resources management strategy for Uzbekistan, initially to be pilot tested in Zarafshan River Basin.

46. The Government's recent Welfare Improvement Strategy (2008–2010) aims to reduce poverty to 20% in 2010 without increasing inequality of income. The strategy relies on irrigated agriculture as an engine for growth and stresses the importance of investment in water resources management, irrigation, and drainage. Restructuring irrigated agriculture for higher productivity is essential to the strategy, which not only requires capital investment rehabilitation in water resources, irrigation, and drainage, but also includes modernization and upgrading of water management systems, expanded use of water efficient technologies, rehabilitation and modernization of pumping systems, and better water resources management at all levels. Other measures in the strategy include (i) development and implementation of a national program for improved measurement of irrigation water, (ii) implementation of appropriate water user fees to encourage the efficient use of water and cash for maintenance, (iii) programs to improve the sustainability of irrigation water supply to water-stressed regions, and (iv) improving the performance of WUAs. According to the Welfare Improvement Strategy, the resources required for land improvement and increasing water supply in irrigated lands for 2007–2011 is \$2 billion, of which \$900 million is expected to be financed by borrowings from development partners. In 2007, the Government established the Amelioration Fund to address its strategic drainage priorities, with a budget of \$65 million equivalent. It has identified about 23,000 km of critical drainage channels for improvement including main collectors, and inter-farm and on-farm systems.

2. Indicative Investment Program for WRMSP

47. The project investment approach endorsed by the Government and ADB is that approximately 75% of the investment is to take place in the Fergana Valley and 25% in the Zarafshan river basin. It is anticipated that this will result in one additional subproject being implemented in the Zarafshan river basin and all additional subprojects (about 3–5) being implemented in the Fergana Valley. The Government has provided an initial list of priority irrigation systems as candidate subprojects to be taken up through the Project. Initial screening of these projects will be undertaken as soon as the PMO is established and implementation consultants fielded. Additional schemes for possible inclusion are being identified by the Government, and it is anticipated that more than an adequate

⁸ World Bank. 2000. *Irrigation and Drainage Sector Strategy and Study*. Washington, DC.

⁹ World Bank. Forthcoming. *Water Sector Investment Plan: Prioritization of Irrigation Rehabilitation and Management*. Washington, DC.

number of irrigation schemes exhibiting a critical need for rehabilitation and upgrading will meet the criteria.

48. The initial list of priority irrigation systems identified by the Government is as follows:

(i)	Rehabilitation of the “Kenimex-1” pumping station	Zarafshan river basin
(ii)	Rehabilitation of the “Kasaba” pumping station	Zarafshan river basin
(iii)	Rehabilitation of the “Galoba-1” pumping station	Fergana Valley
(iv)	Rehabilitation of the “Bulokboshi” pumping station	Fergana Valley
(v)	Rehabilitation of the “Abdusamat-1” pumping station	Fergana Valley

C. Improved Water Management Issues

49. The above sector analysis has highlighted the main issues to be considered in the design of the water resources management sector project. Particular issues relating to planning and design of the rehabilitation of irrigation infrastructure and facilities (pump stations, inter-farm irrigation and drainage facilities) are discussed in this section.

1. Pump stations design capacity and O&M

50. Rehabilitating pump stations to meet irrigation water demand is capital intensive and pump schemes also have high operating costs through their dependency on the electricity supply system which must provide sufficient and reliable supply.

51. For pump schemes O&M costs determine economic viability, rather than the initial capital investment cost of rehabilitation. Therefore pump capacity must be closely matched with water demand through accurately defining the irrigation scheme area and determining peak water demand.

52. Overdesign with excess pump capacity creates excess power requirements, reduces incentive to achieve greater water use efficiency and can create a false sense of security against water shortage and drought.

2. Inter-farm irrigation facilities

53. While modern pumping equipment, including pump motors, has become steadily more energy efficient and requires less maintenance, such improvements are often poorly matched by an irrigation scheme’s water distribution infrastructure.

54. Open canal distribution networks, especially concrete-lined canals can allow higher water distribution efficiencies if the canals are well maintained.

55. Effective in-canal water control structures and off-takes connecting to on-farm networks can improve water use efficiency through allowing control over the volume of water flowing in canals and through off-take structures.

56. Modern hydraulically designed control structures such as duckbill or side weirs are more effective in regulating water levels and canal tail-end structures should be used to monitor water flows and to improve water use efficiency.

57. Inter-farm canals should also be fitted with appropriate flow monitoring structures such as the ISO4360 type measuring weirs.

58. Open canal distribution systems served by pumped irrigation could be transformed into a piped distribution system to reduce water losses and improve water

use efficiency. (Although, the initial capital outlay for establishing a pipe distribution system may be relatively high compared to open canals, in the long term this would be offset by reductions in water demand: through increased conveyance efficiencies; improved timeliness of supply and control of supply volumes, with additional positive benefits of a reduction in seasonal groundwater fluctuations and lower risks of soil salinization).

3. Technical criteria for R&U of irrigation schemes

59. As it will not be possible to simply neglect and eventually abandon uneconomic pump irrigation systems without risking considerable social dislocation and turmoil, pump irrigation systems should be selected for rehabilitation against a set of agreed and clearly defined criteria (technical, financial, environmental) which support intermediate term national and regional development goals. The set of selection criteria were prepared during ADB Fact Finding Mission in August 2008; they were revised again during the second Fact Finding Mission. The last set is presented in the following Section III “*Project location and subprojects selection*”.

60. Adopting such criteria for selecting pump schemes for rehabilitation would contribute to overall improvement of water resources management and in particular contribute to improved performance at scheme level. These improvements would manifest themselves in reduced drainage channel flows and discharge volumes into the primary rivers/drainage network. However, as rehabilitation and improvement of irrigation infrastructure creates a more reliable inter-farm water delivery network the marginal increase in scheme water use efficiency will maybe limited to the range of 5% to 10%, if the improvements are not complemented by further investment in on-farm system infrastructure for better delivery and effective control of water to the agricultural fields.

61. Cost/benefit economic evaluation is an appropriate planning tool to identify schemes critical parameters, such as the maximum hydraulic head for pumped schemes water and the preferred cropping patterns for maximum sustainable returns. Although not all pump irrigation systems in Uzbekistan would qualify for R&U under strict economic criterion as their high lift and O&M costs means their potential productivity is often inadequate to justify the high capital investment in pumping equipment and water distribution networks. A rationalization of high-lift pump schemes is necessary with the eventual retirement of pumps schemes that are clearly uneconomic, and where closure can be done without major social dislocation and cost to the local communities.

4. On-farm system improvement

62. Following dissolution of the Soviet Union in 1991, the I&D infrastructure was temporarily operated by *shirkats* and similar forms of communal land and water users. But now the on-farm infrastructure for delivery of irrigation water and the drainage network has now been transferred to WUAs¹⁰, which are obliged to meet the cost for operating and maintaining them. However the WUAs currently have little to no financial resources: consequently the on-farm irrigation and drainage infrastructure continues to deteriorate, increasingly preventing equitable distribution of water through the inter-farm canal system for crop production. At the same time farmers are increasing the use of drainage water for irrigation by utilizing water pumped from drains and that retained in open channel collector drains.

63. Farmers generally lack the financial resources and equipment for rehabilitation and maintenance of their on-farm irrigation and drainage works. (Moreover private

¹⁰ Page 71, Chapter III, Water – Critical Resource for Uzbekistan’s Future, UNDP Uzbekistan, Tashkent, 2007, reports that WUAs are responsible for about 70,000km canals and 50,000km drainage channels on about 2.8 million ha (2005)

farmers receive no compensation for any capital development on their land reducing their incentive to invest in land improvements). Thus the full potential benefits from investment in R&U of inter-farm irrigation and drainage infrastructure will not be realized, unless there is an associated improvement in the on-farm I&D system. Experience from other countries indicates that farmers are willing to pay for good quality water delivery services which will increase and stabilize their income¹¹. However, without some form of investment support from the Government for WUAs and farmer groups, the on-farm I&D infrastructure is likely to continue to deteriorate with negative impact on land use and soil productivity, crop yields and agricultural production. Therefore, creating opportunities for farmers to increase their income so that they can invest in on-farm I&D and so that WUAs can charge realistic irrigation and drainage service fees is very important.¹²

64. Equitable water distribution is necessary before farmers can practice field irrigation techniques which result in water savings, higher water use efficiencies at field level, and the corresponding reduced groundwater level fluctuation, reduced drainage flows and lower risks of soil salinity. Only if the on-farm irrigation and drainage infrastructure is adequately developed and maintained will it be possible to achieve equitable water distribution to all irrigators within a scheme's service area, leading to improved crop yields and productivity.

65. Practical measures to improve on-farm irrigation and drainage infrastructure to facilitate more timely water deliveries in appropriate volumes include:

- appropriately dimensioned on-farm canals so that their capacity is adequate for their command area (no extra capacity to convey larger than required flows);
- installation of simple, accurately dimensioned, calibrated and operated canal off-take structures on the inter-farm canal system together with installation of an appropriate flow measuring structure – such as the ISO 4360 type weir;
- accurate installation of simple flow dividing and/ or distribution boxes releasing water onto agricultural fields.

66. However, besides rehabilitation and improvement of the I&D infrastructure, proper operation of structures and monitoring of flows in canals and drains by system operators and system users will be required to achieve and maintain high operational standards. Procedures for regular meetings and consultation of farmers, WUAs and ISA representatives to plan, monitor and to address grievances need to be established with the local administration taking the role of decision maker in cases where the parties involved cannot achieve agreement themselves.

67. Eventually the cost of water delivery and marginal analysis of costs and returns to water use needs to be factored into the water distribution and management framework to maximize the returns to water use across the range of locations and schemes in the country.

¹¹ Page 63, Water – Critical Resource for Uzbekistan's Future, UNDP Uzbekistan, Tashkent, 2007

¹² According to ADB assessments (2005), in the current financial conditions it is estimated that the price of cotton and wheat should be increased by 25% - 30% to cover O&M costs of the on-farm I&D network, and by up to 75% to cover O&M costs of all elements of the I&D infrastructure, including pumping costs.

III. PROJECT LOCATION AND SUBPROJECTS SELECTION

A. Project area

68. Following the Government's recommendation, the Project will be located in Fergana Valley with about 75% of the planned investment and for the remaining 25% in the Zarafshan basin (letter dated 30 May 2008 from Ministry of Finance to MAWR). In view of the objective to optimize the improvement of water resources management the ADB proposed that the Project would target only two BISAs: Zarafshan in Samarkand province, and Syr Darya-Sokh in Fergana province. However, the Government has requested that the Project will cover both the Zarafshan BISA and the whole Fergana valley, including its three provinces¹³: Fergana, Andijan and Namangan,

B. Subprojects selection

1. Type of subprojects

69. While the Government puts high priority on rehabilitating irrigation pumping stations WRMSP plans to rehabilitate both gravity-fed and pumped irrigation schemes including related off-farm irrigation and drainage facilities.

2. Criteria

70. Criteria for subproject selection were originally defined during the Inception phase in direct discussions between ADB¹⁴, MAWR, the PPTA Consultant and the UZSUVLOYIHA Design Institute (UDI). The resulting screening process combined an elimination process with a review of primary technical data and parameters collected for each candidate subproject. Following the initial screening of a long list of subprojects, a scoring and ranking scheme was to be applied to develop a shortlist of candidate subprojects for further planning and feasibility study, and implementation with loan funds. The process was deemed adequate to initially identify candidate projects for further studying by the PPTA. While the results were acceptable for identification of core sample subprojects to be studied by the PPTA, the data required to apply the identification and selection criteria proved to be either not available or lacked sufficient accuracy which rendered them largely inapplicable. However, the initial screening process was accepted for identification and selection of core subprojects for which feasibility studies should be prepared during the PPTA.

71. Based on this experience, the ADB Fact Finding mission in August 2008 proposed to refine the criteria for identification and selection of non-core subprojects for potential funding under the forthcoming loan project. Consequently the revised criteria for identification and selection of non-core subprojects are divided into four groups for all irrigation schemes: (i) technical, (ii) agricultural, (iii) environmental and social, (iv) financial and economic, plus an additional set of "specific technical criteria for pump irrigation schemes". An exclusionary approach will be practiced for selection of subprojects to be developed and funded under the Project. The criteria and process are described in Appendix 2 to the present report.

72. Subprojects financed subsequent to the Narpay and Besharyk core subprojects¹⁵ will be screened by the PMO¹⁶ and selected based on agreed technical, economic, social, agricultural and environmental criteria. Subproject screening will: (i) ensure compliance with social and environmental safeguards of ADB and the Government; and;

¹³ the related three BISAs being: Syr Darya-Sokh, Naryn-Karadarya and Naryn-Syr Darya.

¹⁴ Refer to the Aide-Memoire of the Inception mission

¹⁵ Non-core subprojects

¹⁶ Appendix D, Memorandum of Understanding, dated 13 October 2008, Project Preparatory Technical Assistance Review Mission and Second Loan Fact Finding Mission

(ii) identify subprojects which will generate highest returns to investments. Subprojects meeting the screening criteria shall be eligible for preparation of a feasibility study. The PMO will submit its subproject recommendations to the Project Director and ADB for approval before conducting a full feasibility study. Final approval of subprojects for financing will come from both the Government and ADB, and will be based on the results of the feasibility study and compliance with the selection criteria.

3. Preliminary shortlist of candidate subprojects

73. The PPTA Consultant established a short list¹⁷ of candidate subprojects by applying the initially agreed selection criteria to a long list of projects proposed by MAWR and the four concerned BISAs (Zarafshan, Syr Darya-Sokh, Naryn-Syr Darya, and Naryn-Karadarya). The qualitative and quantitative data collated for a multi-criteria review of proposed candidate subprojects identified (i) four out of five subprojects in BISA Zarafshan to be eligible for further study; and (ii) 17 out of 53 subprojects in BISA Syr Darya-Sokh – comprising of 13 gravity operated and 4 pumped irrigation schemes – to be eligible for further studies. The shortlists as presented to MAWR for recommendation of preferred core subprojects are included in Appendix 2 to the report. Out of the eligible subprojects shortlisted the Client proposed two subprojects for further feasibility study:

- the Narpay pump irrigation scheme with its primary Narpay pump station and two secondary pump station plus the Narpay MC (LB) and (RB), and the Turkistan MC in BISA Zarafshan (Narpay rayon), and
- the Besharyk pump irrigation scheme with its canals M-1 and M-2 in BISA Syr Darya-Sokh (Besharyk rayon)

74. Selection of the two core subprojects was confirmed during a meeting of the PPTA Consultant with MAWR on 9 July, 2008.

4. Core subprojects

75. The characteristics of two core subprojects selected and studied at feasibility level under the present PPTA are summarized as follows:

- **Narpay pumped irrigation scheme:** The Narpay subproject is located in Samarkand Province about 300 km southwest of the capital Tashkent and 110 km west of the Samarkand city. It consists of a primary pumping station, installed capacity 12m³/s, plus two smaller secondary pumping stations and about 30 km of inter-farm canals and associated canal infrastructure serving a command area of 8,500 ha. The area is generally free draining and there are generally no groundwater and salinity issues except for some 10ha within the service area. Rehabilitation includes replacement of the pumps and electrical control systems in the primary pumping station including associated repairs of the three rising mains, rehabilitation of three distribution canals plus replacement of canal flow and off-take structures plus provision of ISO4360 type measuring weirs. Provisions are also made for selective rehabilitation of inter-farm collector drainage works.
- **Besharyk pumped irrigation scheme:** The project is located in the western part of Fergana province, on the left bank of the Syr Darya River. The pump station was built in 1978 and is equipped with 10 pump units with an installed capacity of 14.0 m³/s, and 13.5 km long rising mains. There are two primary canals taking off from a stilling basin at the end of the rising mains: a 4.9 km long right branch

¹⁷ For a comprehensive account refer to Appendix 1, Interim Report, BCEOM/ IKS, September 05, 2008



- canal M-1, and a 6.3 km long left branch canal M-2. The total command area which is proposed to be rehabilitated is about 9,850¹⁸ ha and is partly affected by high groundwater levels and soil salinity issues. Rehabilitation includes replacement of pump sets, associated pipe work and electrical control systems, repairs to the five rising mains, rehabilitation of canals plus replacement of canal flow regulating and off-take structures including construction of ISO4360 type measuring weirs, selective remodelling of on-farm canals and re-designation as inter-farm works, and last but not least the rehabilitation of on-farm and inter-farm collector drains.

5. Non-core subprojects

76. The initial shortlist of candidate subprojects is to be subjected to the revised set of criteria for identification and selection (see paragraph 6 above) agreed between MAWR and ADB¹⁹. To avoid selection of non-core subprojects from an unreasonably restricted long list, all of the MAWR and the four BISAs initially identified projects are to be retained for screening. The list of potential non-core subprojects to be screened by the PMO therefore includes:

- priority investment proposals for MAWR as listed in the President's Decree # PP-704, October 9, 2007 but not yet selected for funding;
- four subproject proposals from BISA Zarafshan, Samarkand province, identified as eligible when applying the initial set of criteria for selection;
- 21 gravity operated plus 32 pumped irrigation subprojects from the 3 BISAs of Fergana Valley; with many pumped irrigation subprojects included in the above mentioned list of priority investment proposals for MAWR

77. Though it would be preferable for the non-core subprojects to be selected from amongst the top ranked subprojects of the initial shortlists for Zarafshan and for Fergana valley, the MAWR lately reemphasized that preferred non-core candidate subprojects are those listed under Decree No PP 704, listed as follow:

(a) Zarafshan river basin

- Reconstruction of Narpay and Suvli pump stations and related machine canals systems, Samarkand province
- Reconstruction of Kenimeh 1 pump station, Navoi province
- Reconstruction of Kasaba pump station, Navoi province
- Reconstruction of Uchkara pump station, Navoi province
- Construction of Bulungur reservoir

(b) Syr Darya River basin within Fergana Valley

- Reconstruction of Galaba 1, Namangan province
- Reconstruction of Asaka Adyr pump station, Andijan province
- Reconstruction of Bulokboshi pump station, Namangan province
- Construction of new pump stations to supply water to land within Izbaskan and Pakhtaabad districts, Andijan province
- Reconstruction of Abdusamat 1 pump station, Fergana province
- Reconstruction of Besharyk pump station, Fergana province
- Construction of Kengulsay reservoir, Namangan province

¹⁸ The maximum irrigable area would be 7,800 ha while the area presently irrigated from the pumping plant is only 4,100 ha

¹⁹ See footnote 2 above

C. Revised identification and selection criteria

78. Selection criteria are an essential part of an ADB Sector Project to guide the identification and selection of non-core subprojects to be financed under the Project. The selection criteria and the approval process for non-core subprojects to be financed under the Project are included in the MOU²⁰ of the ADB's second Loan Fact Finding Mission in October 2008, with copy in Table 3 below. As mentioned in paragraph 65 above, it is the PMO which shall review non-core candidate subprojects to be shortlisted using the Government confirmed criteria. The PPTA Consultant in support of the identification and selection process to be practiced has prepared an outline template form for the collection and presentation of information to be collated for each proposed subproject.

Table 3: Final set of subprojects selection criteria

Technical	
1	The subproject must exhibit a current irrigation command area significantly less than that envisaged at design stage or a continuous decline in the size of the irrigated area within the command area.
2	The subproject with sanctioned supplemental inflows to the irrigation distribution system from the drains must be projected to exhibit a neutral or better salt balance following its rehabilitation and upgrading.
3	The subproject must exhibit scope for improved overall irrigation efficiency and increased agricultural productivity
Agricultural	
4	The subproject must have <i>bonitet</i> values (classification system for land productivity potential) for its entire command area with an average value above 50, and none of the sub-areas within the command area will have a value less than 40.
5	The subproject must have a command area that exhibits characteristics conducive to diversification to higher-value crops.
Environmental and Social	
6	The subproject must not have a significant negative impact on or cause irreconcilable conflict with established land or water users
7	The subproject must not have any negative environmental impact for which affordable mitigation treatment cannot be incorporated into the subproject design
8	The subproject must not result in a category A environmental or resettlement category
Financial and Economic	
9	The subproject must have an EIRR of 12% or more.
10	The subproject must have projected incremental increase in farm income exceeding the projected incremental increase in annual production cost such as, but not limited to, agricultural inputs, and irrigation operation and maintenance.
Specific technical Criteria for Pump Irrigation Schemes	
11	The subproject must have adequate water available at the pumping plant to meet the subproject's irrigation water requirements (with the exception of acceptable crop-water deficits) at least 4 out of 5 years
12	The subproject receiving supplemental freshwater inflow from gravity canals will be given preference, provided that the monthly volumes of water transferred and an assessment of the reliability of the supply are available
13	The subproject that requires rehabilitation and upgrading of the pumping plants must have a total installed capacity of 15 cubic meters per second (m ³ /sec) or less
14	The subproject must have its pumping plant discharges (per pumping unit or in total) less than 80% of the design capacity.
15	The subproject must have (static plus dynamic) pumping heads of less than 75 meters

The data template form proposed to record the data for potential subproject relating to the revised set of selection criteria is given in Appendix 2.

²⁰ Refer to footnote 2 above

IV. THE PROJECT

A. Sector Investment Approach

79. The Project will finance investments in the irrigation and drainage sector, especially pumped irrigation systems. The Government has identified a list of priority projects throughout the country. These are reflected in the recent Water Sector Investment Strategy endorsed by the Government. The Government has requested ADB to work in the Fergana Valley and Zarafshan River Basin. Fergana is a strategic priority as it is densely populated and contributes significantly to GDP. The Zarafshan River is a transboundary river from Tajikistan and the irrigation system needs extensive rehabilitation, especially in the case of pumps and canals. It also needs improved water management. Facilities in these two areas are in a poor state of repair and need urgent rehabilitation.

B. Project Impact and Outcomes

80. The impact of the Project is sustained and increased agriculture production and productivity. The Project's outcome is irrigation systems are fully functional and operated efficiently. Two representative core subproject described below were selected and prepared under the PPTA to assess the technical, social, financial, economic, and environmental feasibility of subsequent subprojects and the Project as a whole.

81. The Narpay core subproject is located in Narpay District in the northwest part of Samarkand Province, 110 km west of Samarkand. Its command area is adjacent to Aktash, the district center. The population in the district is 165,000. The area is characterized by a continental climate with an average annual air temperature of about 15° C. In July, the warmest month, average air temperature is between 28 and 29° and in January, the coolest month, air temperatures average between – 2 and +1 ° C. The command area (8,206 ha) is occupied by grey desert soils (sierozems) characterized by low organic content and cultivation with moderate productivity potential. There are some 270 farms in the command averaging some 27 ha in size. Cotton (57%) and wheat (30%) are the principal crops, with small production of fodder vegetables, melons and perennial tree crops (including orchard and vineyard). The pumping plant and irrigation system, receiving water from the Narpay Primary Canal which lies in the Zarafshan basin were established in the early 1970s and underwent subsequent modification since then, including the introduction of secondary lift and additional command. Both the pumping plant and associated inter-farm canal system require major rehabilitation and upgrading.

82. The Besharyk core subproject is a pump irrigation scheme located in Besharyk District of Fergana Province, about 120 km northwest of Fergana city. The project area lies between the Syr Darya River to the north and Besharyk town, the district center. The population in the district is about 175,000. The semi arid area has an average annual air temperature of about 15.2 degrees centigrade. In July, the warmest month, the average temperature is 28.4 degrees with maximum temperatures over 35 degrees. In January, the coolest month, temperatures range from less than one degree to minus 2.6 degrees. The CCA is 8,415 ha and is occupied by typical (34%) and light (36%) sierozem soils characterized by low organic content and moderate production potential²¹. There are over 260 private farms and one thousand dekhan farms in the subproject area. The private farms average about 31.5 ha in size while the dekhan farms average only one tenth in size. Cotton (48%) and wheat (36%) are the principal crops produced with lesser

²¹ Soils occupying the CCA are reported to exhibit moderate (35%) and severe (6%) levels of salinization imposing further limitations on productivity in the absence of effective agricultural drainage.

amounts of maize, vegetables and orchard and perennial fodder crops²². The pumping plant which takes its water directly from the Syr Darya River was established in 1978 and both capacity and the level of reliability have declined significantly over the ensuing years. The pumping plant, the associated inter-farm canal distribution system and the agricultural drainage network serving the command areas all require considerable (R&U) to ensure capturing the benefits associated with the production potential of the area.

C. Project Components and Outputs

83. The Project will finance investments in three areas: (i) rehabilitation and upgrading of irrigation and drainage infrastructure; (ii) improved water resources management; and (iii) project management.

1. Rehabilitation of Irrigation Infrastructure

84. Project investments will focus on pumping facilities, gravity head-works, inter-farm distribution canals and drainage. This will increase the reliability of irrigation supplies, improve water distribution and reduce soil degradation. The R&U of pumping facilities and replacement of unusable pumps and motors with more efficient equipment will result in energy savings. In addition subprojects located in Fergana will require R&U of the drainage systems to reduce soil salinity.

85. Indicative types of R&U include (i) pumping stations comprising replacement and/or repair of intake works, including bulkhead gates and trash racks; replacement of pumps and motors; upgrading electrical control works; replacement of problematic and/or unreliable reaches of the rising mains; replacement of control valves; provision of appropriate surge protection systems; and repair or replacement of auxiliary works such as floor drains, overhead cranes, and ventilation systems; (ii) improving either major or minor surface water intakes for both pump and gravity systems to provide greater capture efficiencies and improved control; (iii) improving control structures and gauging stations on inter-farm canals consistent with enhanced water management targets; (iv) upgrading and/or replacing gated outlets to on-farm canal outlets from the inter-farm canal and providing a means for measuring the discharge at each outlet point; (v) providing necessary rationalization of both alignment and grade of the inter-farm canals; (vi) providing adequate cross drainage treatment for the inter-farm canals; (vii) providing auxiliary facilities associated with the inter-farm canals such as vehicle and pedestrian bridges and canal access for non-irrigation purposes; and (viii) agricultural drainage facilities, especially in subproject areas affected by high water table and/or levels of soil salinity

2. Improved Water Resources Management

86. The Project will support improved irrigation, drainage, and water resources management from the river basin to the on-farm level. The Project will also support a basin and irrigation and drainage management institutional optimization and coordination study to prepare a plan and capacity development program to improve water use efficiency and productivity for inter-farm irrigation and drainage in the Fergana Valley. The study will (i) analyze existing institutional and organization structures of BISAs, ISA, MCA, Department of Pump Station Operations (DPSO), WUAs, local government, and other relevant stakeholders; (ii) analyze their existing management rules, regulations, procedures, and systems to identify bottlenecks and inefficiencies for irrigation, drainage, and water management; (iii) analyze coordination between water management

²² In addition to the irrigation supplies the pumping plant and elements of the distribution system supply water to over 450 ha of fish ponds located to the north of the irrigation area serviced by the M2 Canal and adjacent to the river.

stakeholders; (iv) develop options and a plan to improve (a) the institutional and organization structures, (b) management and operational procedures and systems,²³ and (c) coordination between stakeholders; and (v) develop and implement a capacity development program to support the recommendations.

87. At the on-farm level, the Project will strengthen WUAs and improve on-farm water management through a training program based on the successful experience of the SDC program implemented by IWMI and ICWC SIC²⁴. WUA officials and staff will be trained and provided materials in (i) O&M and repairs, (ii) water distribution and management, (iii) basic irrigation system design, (iv) crop and irrigation scheduling, (v) system monitoring and evaluation (M&E), (vi) management and collection of irrigation service fees, (vii) financial management and auditing, and (viii) dispute resolution mechanisms. WUAs will review the designs for the inter-farm R&U in their subproject area, and measurement capacity within the on-farm distribution system will be improved for better water management.

88. The Project will work with BISA, ISA, MCA, DPSO, and WUA staff to develop water management and O&M plans for each subproject. WUAs, in cooperation with BISA, ISA, and DPSO, will develop specific management plans to optimize on-farm water delivery for efficiency and productivity that will be supported through improved coordination and more efficient inter-farm distribution and pump operation. To support creation and implementation of the management and O&M plans, training will be provided to relevant staff in subproject areas.

3. Project Management

89. The Project will provide implementation support to the project management office (PMO), which will be established in Tashkent. This will be supported by two project implementation units (PIUs) - one in Fergana city and one in Samarkand city. The PMO will deal with technical issues, procurement, accounting, M&E, water resources management, and safeguards. The PMO and PIUs will have national staff supported by national and international specialists. Comprehensive results-based monitoring will be a critical function of the PMO.

D. Special Features

90. The Project represents a shift from previous assistance to Uzbekistan in that its focus is on the R&U of pumps and inter-farm canals and structures and associated water management. The R&U of irrigation infrastructure will introduce more efficient pumps to improve both water use and energy efficiency. The Project explicitly recognizes Uzbekistan's need to improve water use efficiency and productivity, and uses a comprehensive approach to implement improved water management measures at the (i) overall basin level with BISAs; (ii) inter-farm level through improved water management and operations of the canal commands and pumps of the subprojects; and (iii) on-farm level through the training of WUAs to manage the on-farm systems more effectively. It will strengthen integration of operations between inter- and on-farm systems.

²³ This will include use of improved computing, communications and networks, management information systems, and other advanced technical options.

²⁴ The Swiss Agency for Development and Cooperation (SDC) has the most experience in supporting programs that provide training for WUAs and has on-going programs for WUA training and water management in Fergana Valley. This program has been implemented through a joint venture of the International Water Management Institute (IWMI) and the ICW SIC

E. Project Cost and Financing

1. Assumptions

91. Costs for the six-year project were prepared using COSTAB and are based on prices prevailing in Uzbekistan in mid 2008 expressed on a calendar year basis. Costs are grouped into three main components: Rehabilitation of Irrigation; Support for Improved Water Management; and Project Management and M&E. Detailed cost tables were prepared for each of the sub-components (Narpay subproject, Besharyk subproject, Non-core subprojects, Capacity development for water management and WUAs; Project management and M&E; and Project Management - PMO and PIU support) and are presented along with the summary tables generated by COSTAB. Costs are expressed in Uzbekistan Sum and USDollars. Constant Purchasing Parity (CPP) exchange rates have been used in the analysis in order to minimize the impact of local inflation and instability of the Uzbekistan sum during the six-year project implementation period using an exchange rate of Sum 1,320 = US\$1.00 in mid 2008. The costs include an allowance for taxes and duties that currently prevail (mostly 20% VAT), and no allowance has been made for exemptions from taxes and duties that may apply to the project, except that pumps, pipe and equipment required for pump station rehabilitation are assumed to be imported duty free with a nominal tax of 2%.

2. Physical and Price Contingency

92. An allowance of 10% for physical contingencies has been applied to most cost items concerned with the rehabilitation of irrigation, consulting services (international and national) and operating costs, except for training costs, lumpsum items and provisional sums which have a zero allowance. The price inflation factors used are those indicated by the ADB as of mid 2008: for local costs they are 10.5% and 10.9% cost escalation per year for 2009 and 2010, then 9% per year for the remaining four years of the project; while for foreign costs an escalation factor of 0.7%, 1.4%, 0.4% per year for 2010 to 2011 and 0.5 per year for the last three years has been used.

3. Project Costs

93. Total project costs are estimated at US\$146.3 m (equivalent to SUM257.5 billion) over the six-year project implementation period. The Project base costs are US\$128.5 m, made up of \$101.4 m of investment costs (79%) and \$27.1 m for recurrent costs (21%), with physical and price contingencies contributing UD\$7.38 m (6% of base costs). Interest charges during implementation and commitment charges total \$10.4 m and are to be funded by the Government. The rehabilitation of irrigation component makes up 72% of total Project base costs, Support for improved water resources management and WUAs 1 %, project management and M&E 5%, and recurrent costs funded by the Government for the operation and maintenance cost of the rehabilitated schemes during the life of the Project are 21%. Summaries of the costs by component and expenditure categories are shown in the tables presented that follow. Detailed cost estimates are provided in Appendix 4.

Table 4: Summary of project Costs by Component

Component	(Soum '000)			(US\$ '000)			% Foreign Exchange	% Total Base Costs
	Local	Foreign	Total	Local	Foreign	Total		
A. Rehabilitation of Irrigation								
1. Narpay Pump Irrigation Scheme	2,873,939.8	12,091,736.6	14,965,676.4	2,177.23	9,160.41	11,337.63	81	9
2. Besharyk Pump Irrigation Scheme	8,269,763.2	19,765,171.1	28,034,934.3	6,264.97	14,973.61	21,238.59	71	17
3. Other Non-Core Subprojects	24,616,644.4	54,538,356.8	79,155,001.2	18,648.97	41,316.94	59,965.91	69	47
4. Environment & Resettlement	190,740.0	86,460.0	277,200.0	144.50	65.50	210.00	31	-
Subtotal	35,951,087.3	86,481,724.6	122,432,811.9	27,235.67	65,516.46	92,752.13	71	72.0
B. Support for Improved Water Resources Management								
1. Water Resources Management	184,800.0	79,200.0	264,000.0	140.00	60.00	200.00	30	-
2. Support for WUAs	1,495,560.0	642,840.0	2,138,400.0	1,133.00	487.00	1,620.00	30	1
Subtotal	1,680,360.0	722,040.0	2,402,400.0	1,273.00	547.00	1,820.00	30	1.0
C. Project Management and M&E								
1. Supervision	3,011,355.6	5,045,792.4	8,057,148.0	2,281.33	3,822.57	6,103.90	63	5
2. Procurement	68,112.0	-	68,112.0	51.60	-	51.60	-	-
3. Results Based Management (M&E)	225,456.0	689,040.0	914,496.0	170.80	522.00	692.80	75	1
Subtotal	3,304,923.6	5,734,832.4	9,039,756.0	2,503.73	4,344.57	6,848.30	63	5.0
D. Recurrent Operating Costs								
1. Narpay Subproject	9,141,940.0	-	9,141,940.0	6,925.71	-	6,925.71	-	5
2. Besharyk Subproject	7,642,800.0	-	7,642,800.0	5,790.00	-	5,790.00	-	5
3. Non-core Subprojects	19,008,000.0	-	19,008,000.0	14,400.00	-	14,400.00	-	11
Subtotal	35,792,740.0	-	35,792,740.0	27,115.71	-	27,115.71	-	21.0
Total BASELINE COSTS	76,729,110.9	92,938,597.0	169,667,707.9	58,128.11	70,408.03	128,536.14	55	100
Physical Contingencies	1,430,672.7	3,734,556.0	5,165,228.7	1,083.84	2,829.21	3,913.05	72	3
Price Contingencies	33,452,575.2	32,084,628.0	65,537,203.2	1,701.86	1,766.16	3,468.02	51	3
Total PROJECT COSTS	111,612,358.7	128,757,781.0	240,370,139.7	60,913.82	75,003.40	135,917.22	55	106
Interest During Implementation	16,358,353.2	-	16,358,353.2	9,987.93	-	9,987.93	-	8.00
Commitment Charges	765,761.6	-	765,761.6	425.65	-	425.65	-	-
Total Costs to be Financed	128,736,473.6	128,757,781.0	257,494,254.6	71,327.39	75,003.40	146,330.79	51	114

Table 5: Summary of project Costs by Expenditure Category

Expenditure category	(US\$ '000)			% Foreign Exchange	% Total Base Costs
	Local	Foreign	Total		
I. Investment Costs					
A. Civil Works					
Structures and Gates	1,262.73	1,426.73	2,689.46	53	2
Canal Rehabilitation	1,691.91	1,691.91	3,383.83	50	3
Non-core Subprojects	17,150.97	40,018.94	57,169.91	70	44
Environment & Resettlement	144.50	65.50	210.00	31	-
Drainage	695.35	695.35	1,390.70	50	1
Non-core Drainage	1,250.00	1,250.00	2,500.00	50	2
Subtotal	22,195.46	45,148.43	67,343.89	67	52
B. Equipment					
Pumps, motors and machinery	1,127.97	10,091.75	11,219.72	90	9
Piping, valves & flow meters	3,427.39	7,712.63	11,140.01	69	9
Electrical equipment	284.85	2,563.65	2,848.50	90	2
Vehicles	77.25	247.75	325.00	76	-
Office equipment and furniture	21.78	33.33	55.10	60	-
Subtotal	4,939.23	20,649.10	25,588.34	81	20
C. Training, Capacity Development & Studies					
Training MAWR & BISA	156.25	68.75	225.00	31	-
Training WUAs	1,133.00	487.00	1,620.00	30	1
Surveys and Studies	500.00	300.00	800.00	38	1
Subtotal	1,789.25	855.75	2,645.00	32	2
D. Consulting Services					
International Consultants	308.00	2,772.00	3,080.00	90	2
National Consultants	588.00	-	588.00	-	-
Consultant support costs	318.74	773.67	1,092.40	71	1
Financial Audit	45.00	45.00	90.00	50	-
Subtotal	1,259.74	3,590.67	4,850.40	74	4
E. Project Management & Monitoring					
PMO/PIU Staff	642.00	-	642.00	-	-
PMO/PIU Operating costs	186.72	164.08	350.80	47	-
Subtotal	828.72	164.08	992.80	17	1
Total Investment Costs	31,012.40	70,408.03	101,420.43	69	79
II. Recurrent Costs					
A. O&M Costs /a					
Pumping costs	24,710.71	-	24,710.71	-	19
O&M pump stations	1,199.24	-	1,199.24	-	1
O&M Inter-farm system	1,105.76	-	1,105.76	-	1
Resettlement	100.00	-	100.00	-	-
Total Recurrent Costs	27,115.71	-	27,115.71	-	21
	58,128.11	70,408.03	128,536.14	55	100
Physical Contingencies	1,083.84	2,829.21	3,913.05	72	3
Price Contingencies	1,701.86	1,766.16	3,468.02	51	3
	60,913.82	75,003.40	135,917.22	55	106
Interest During Implementation	9,987.93	-	9,987.93	-	8
Commitment Charges	425.65	-	425.65	-	-
	71,327.39	75,003.40	146,330.79	51	114

a Operation and Maintenance of rehabilitated schemes.

Table 6: Summary of project Component Costs by Financier

Component	(US\$ '000)										
	ADF		OCR		Government		Total		For. Exch.	Local (Excl. Taxes)	Duties & Taxes
	Amount	%	Amount	%	Amount	%	Amount	%			
A. Rehabilitation of Irrigation											
1. Narpay Pump Irrigation Scheme	10.71	0.1	11,901.37	93.8	773.19	6.1	12,685.27	8.7	10,250.78	1,661.30	773.19
2. Besharyk Pump Irrigation Scheme	1,258.55	5.3	19,931.25	83.9	2,559.49	10.8	23,749.30	16.2	16,742.13	4,447.67	2,559.49
3. Other Non-Core Subprojects	5,103.19	8.3	53,167.38	86.1	3,479.76	5.6	61,750.33	42.2	42,546.05	15,724.52	3,479.76
4. Environment & Resettlement	189.38	80.0	-	-	47.34	20.0	236.72	0.2	73.84	115.54	47.34
Subtotal	6,561.83	6.7	85,000.00	86.4	6,859.79	7.0	98,421.62	67.3	69,612.80	21,949.03	6,859.79
B. Support for Improved Water Resources Management											
1. Water Resources Management	164.30	80.0	-	-	41.07	20.0	205.37	0.1	61.61	102.69	41.07
2. Support for WUAs	1,324.36	80.0	-	-	331.09	20.0	1,655.45	1.1	497.66	826.70	331.09
Subtotal	1,488.66	80.0	-	-	372.16	20.0	1,860.82	1.3	559.27	929.39	372.16
C. Project Management and M&E											
1. Supervision	6,154.11	90.8	-	-	623.47	9.2	6,777.57	4.6	4,248.33	1,905.77	623.47
2. Procurement	46.18	80.0	-	-	11.54	20.0	57.72	-	-	46.18	11.54
3. Results Based Management (M&E)	749.23	96.7	-	-	25.37	3.3	774.59	0.5	582.99	166.24	25.37
Subtotal	6,949.51	91.3	-	-	660.38	8.7	7,609.89	5.2	4,831.33	2,118.19	660.38
D. Recurrent Operating Costs											
1. Narpay Subproject	-	-	-	-	7,136.63	100.0	7,136.63	4.9	-	7,136.63	-
2. Besharyk Subproject	-	-	-	-	5,966.33	100.0	5,966.33	4.1	-	5,966.33	-
3. Non-core Subprojects	-	-	-	-	14,921.92	100.0	14,921.92	10.2	-	14,921.92	-
Subtotal	-	-	-	-	28,024.89	100.0	28,024.89	19.2	-	28,024.89	-
	15,000.00	11.0	85,000.00	62.5	35,917.22	26.4	135,917.22	92.9	75,003.40	53,021.49	7,892.33
Interest During Implementation	-	-	-	-	9,987.93	100.0	9,987.93	6.8	-	-	-
Commitment Charges	-	-	-	-	425.65	100.0	425.65	0.3	-	-	-
TOTAL	15,000.00	10.3	85,000.00	58.1	46,330.79	31.7	146,330.79	100.0	75,003.40	53,021.49	7,892.33

4. Financing Plan

94. The ADB would finance US\$100 million through a blended loan consisting of US\$15 million from the Asian Development Fund (ADF) and US\$85 million from ADB's ordinary capital resources (OCR). The loans will finance 68.4 percent of project costs. The Government would contribute US\$46.3 m (31.7%) made up of recurrent operating costs of \$28.02 m and including funding all taxes and duty associated with the expenditure, and the cost of interest during construction (IDC). The OCR loan will have a 26-year term, including a grace period of 6 years, an interest rate determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility, and a commitment charge of 0.15% per annum. The ADF loan will have a 32-year term, including a grace period of 8 years, an interest rate of 1% yearly during the grace period and 1.5% yearly after that. The financing plan is summarized in Table 6.

95. The OCR loan will finance 58.1% of the total project cost, including civil works and physical irrigation rehabilitation of pump stations and inter-farm canals. The ADF loan will finance 10.3% of the total project cost and will meet the cost of consulting services and associated consulting support costs, training and project management, consulting services and associated consulting support costs, training, and project management, with some contribution to civil works. The Government will provide counterpart finance 31.7% of the project cost in duties and taxes, interest during construction, inter-farm and on-farm drainage rehabilitation, any land acquisition and resettlement compensation costs.²⁵ In addition the Government will fund the operation and maintenance costs of the rehabilitated schemes for the duration of the Project with an estimated cost of \$28.02 million, made up mostly of pumping costs.

F. Overall Project Economic Analysis

1. Introduction

96. Financial and economic analyses were prepared as part of the feasibility studies for the two core subprojects Narpay and Besharyk (presented in section V) and an economic analysis also prepared for the overall sector project. The purpose of the financial analysis is to show the Project's impact on the participating farmers and to indicate whether there are sufficient benefits and incremental income for them to participate fully in the project, and the extent that they could contribute to the operational cost of maintaining the irrigation system. The economic analysis is conducted from the perspective of the whole economy to indicate if the projected investments are justified and a satisfactory use of resources from a National viewpoint. The main economic benefit of the project is the avoidance of a reduction in the area irrigated by the subprojects, either through failure of pump station, irrigation and drainage infrastructure or water logging and mineralization, and the resultant loss of agricultural production. The "with project" situation also assumes saving in energy through the installation of more efficient electric motors and pumps and increased water efficiency through better water management. A modest increase in yield and cropping intensity is also applied. Detailed supporting tables related to the financial and economic analyses of the Project are provided in the Appendix 6.

2. Key Assumptions in the Financial and Economic Analysis

a) Prices

97. The feasibility study used prices prevailing in mid 2008. For traded commodities (cotton, wheat, maize and fertiliser) economic prices were prepared based on border parity using the World Bank's commodity price forecasts of May 2008. Prices of non-

²⁵ ADB is investigating possible co-financing possibilities with SDC on WUA development.

traded goods and services, including fodder, vegetables, fruit and agricultural inputs are in mid 2008 prices based of prevailing prices in the subproject areas collected during the PPTA. Farm machinery costs were based on average current rates for machinery service providers. The current prices were considered as being similar to the economic price and no adjustment was made in the economic analysis. Agricultural labour is given a shadow value of 0.85 in recognition of the high rates of unemployment and underemployment in Uzbekistan. The current rates for land tax (based on the bonitet score) and WUA fees are included in the crop budgets, although the land tax is excluded from the economic analysis as it is a transfer payment. No charge is included for water as currently it is provided free by government and farmers are not required to contribute to water costs, except for a very low nominal charge.²⁶ Maintenance of on-farm irrigation infrastructure is the responsibility of the WUA, and is covered by the WUA charge, which is assumed to increase by four times in the future to SUM28,000 per ha per year. Maintenance of the inter-farm irrigation and drainage system and facilities rehabilitated by the Project is assumed to cost SUM100,000 per ha in the future. The economic cost of electricity is assumed to be US\$ 5 cents per kWh (SUM66 per kWh c.f. the current financial rate of SUM52.5 /kWh). For the derivation of the economic costs of capital investment in rehabilitation works and O&M a standard conversion factor of 0.85 was applied in order to reflect the removal of taxes and duties and inefficiencies in the economy. An exchange rate of US\$ 1.0 = SUM1,320 has been used.²⁷ The economic and financial analyses are undertaken in constant 2008 prices assuming a project life of 30 years and assuming an opportunity cost of capital of 12 %.

98. A summary of the main prices used for the analysis is included in Table 7.

b) Traded goods

99. The prices of the main traded goods cotton, wheat and fertiliser have been estimated at border parity based on the World Bank commodity price forecasts. Details of the derivation of border parity prices are included in Appendix 6.

100. **Cotton.** Cotton prices are currently at a 10 year historical high in current prices with prices in the first four months of 2008 over 30% higher than the 2007 average, although they have weakened slightly in recent months. The price recovery, which has been weaker than for food commodities, is largely in response to a 15% reduction in US plantings as land is diverted to grain production to meet biofuel demand. The main factors affecting global cotton production is the emergence of India and China as the world's largest producers with India's output doubling from 2002 to 2006 while China's output increased by 60%. Apart from the USA all other major producers are expected to increase cotton production in 2008/09. Uzbekistan is expected to maintain its position as the world's sixth largest producer.

101. The World Bank price commodity predictions of May 2008 show cotton prices in real or constant prices to a 2000 base year to be at a high of US\$1.32 per kg for 2008 having increased from US\$1.20 in 2007, but to decline to the long run price of US\$1.01 per kg by 2020. (Although the present price boom is still below average prices for the 1980s and 1990s in constant prices). For the economic analysis an average of the forecast prices for the years 2010, 2015 and 2020 has been used which equates to a price of US\$1.12 per kg. This is more realistic of the long run average price and discounts the effect of the current abnormally high price from the economic analysis. The

²⁶ Some WUA charge an amount of 23 Tiyn per M3 for water, which for a typical consumption of 20 kilo m3 per ha is equivalent to SUM4,600 per ha, or \$3.49. This may be included in the WUA fee.

²⁷ For estimating project costs Constant Purchasing Parity (CPP) was applied to determine exchange rates during the six year period.

current financial price of cotton SUM430 per kg for seed cotton is close to the long run economic price of Sum 448 per kg.

102. **Wheat.** International wheat stocks are around the lowest level relative to consumption since the 1960s which through a combination of factors (drought, increased demand on crop land to produce biofuel feedstock reducing the wheat area) has contributed to a more than doubling of wheat prices by early 2008 since 2007. The wheat price is regarded as now having peaked and in current prices is expected to reduce to around \$306 per ton in 2010, as a response to increased supply and the end of the drought in Australia. The World Bank commodity price projections predicted a price of \$306 per ton in 2008 (in constant 2000 prices), and to progressively decline to \$179.9 per ton by 2020, which is constant price terms is still above the historical prices during the 1980s and 1990s. For the economic analysis the average of the forecast price for 2010, 2015 and 2020 of \$205.43 per ton has been used, adjusted to a 2008 base, which barring unexpected price swings is expected to be a realistic forecast of the long run price, and largely excludes the effect of the current exceptionally high prices. Nevertheless the current financial wheat price of SUM211 per kg is still only about two-thirds of the long run economic price of SUM331 per kg that has been used for the economic analysis.

103. **Fertiliser.** Uzbekistan imports the main phosphate and potassium fertiliser requirements but is a net exporter of the urea, which is a by-product of the oil and gas industry. The current financial prices of fertiliser in Uzbekistan do vary and do not relate closely to the estimated economic prices based on border parity. Some like urea are close to the economic price while other fertilizers show quite wide divergence from the economic price, with some such as KCL being more expensive in financial prices; while others such as DAP (AmoPhos) are cheaper.

c) Non-traded goods

104. Non traded goods which includes locally produced vegetables and fruits, maize fodder and forage are valued at their representative domestic prices. Their prices are relatively similar in the two areas where the subprojects are located, Narpay and Besharyk.

d) Labour

105. Uzbekistan has a relatively high rate of unemployment and underemployment, especially in the rural areas, which contributes to the high numbers of the workforce who are working overseas as migrant labour in Russia and Kazakhstan. Although there used to be set wage rates for agricultural workers on the former state and collective farms, the situation has changed and agricultural labour employed on private farms now receives varying rates depending on the agreement between the employer and employee. For the economic and financial analysis an overall rate of SUM2,100 has been used.

e) Other inputs

106. Uzbekistan has moderate taxes. Since 2007 the top income tax rate is 25% and the top corporate tax rate is 10%. Other taxes include a value added tax (VAT) of 20% and a property tax. In recent years the overall tax as a percentage of GDP was 21.8%.

Table 7: Summary of Financial and Economic prices

	Unit	Financial	Economic					Average Yr2010-2020
		2008	2008	2009	2010	2015	2020	
		Sm						
Outputs								
Seed Cotton	kg	430	538	512	490	426	426	448
Cotton stalks	kg	10	10	10	10	10	10	10
Wheat	kg	211	477	427	376	323	294	331
Wheat straw	kg	35	35	35	35	35	35	35
Rice	kg	200	484	416	368	324	282	325
Maize grain	kg	200	317	302	285	273	224	261
Maize silage	kg	45	45	45	45	45	45	45
Maize stover	kg	35	35	35	35	35	35	35
Vegetables (tomato, onion, carrot)	kg	170	170	170	170	170	170	170
Lucerne	kg	80	80	80	80	80	80	80
Tomatoes	kg	170	170	170	170	170	170	170
Melons	kg	210	210	210	210	210	210	210
Potato	kg	350	350	350	350	350	350	350
Fruit	kg	250	250	250	250	250	250	250
Grapes	kg	280	280	280	280	280	280	280
Inputs								
Seeds/planting material :	25%							
Cotton	kg	820	820	820	820	820	820	820
Wheat	kg	350	596	534	470	403	367	413
Rice	kg	820	605	520	460	405	353	406
Maize grain	kg	450	450	450	450	450	450	450
Pulses	kg	375	375	375	375	375	375	375
Oilseeds	kg	313	313	313	313	313	313	313
Vegetables (tomato, onion, carrot)	kg	2,150	2,150	2,150	2,150	2,150	2,150	2,150
Lucerne	kg	950	950	950	950	950	950	950
Tomatoes	kg	213	213	213	213	213	213	213
Melon	kg	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Potato	kg	900	900	900	900	900	900	900
Fertilizers (per kg fertiliser)								
- Urea (34% N)	kg	270	486	385	328	255	199	261
- Ammonia Nitrate (33% N)	kg	248	348	276	235	183	143	187
- Triple Super Phosphate (TSP) 47%P)	kg	300	1,096	766	604	479	410	498
- KCL, MOP (60% K)	kg	606	640	584	489	417	361	422
- Single superphosphate(16% P)	kg	118	373	261	205	163	140	169
- DAP AmoFos (21% N, 46% P)	kg	488	1,291	766	629	504	434	522
- Farm Yard Manure	kg	20	20	20	20	20	20	20
Agrochemicals								
- Fungicides	kg/l	10,000	10,000	10,000	10,000	10,000	10,000	10,000
- Pesticides	kg/l	25,000	25,000	25,000	25,000	25,000	25,000	25,000
- Herbicides	kg/l	25,000	25,000	25,000	25,000	25,000	25,000	25,000
- Biological control	ha	9,500	9,500	9,500	9,500	9,500	9,500	9,500
- Defoliant	ha	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Mechanization:								
- Ploughing	ha	32,500	32,500	32,500	32,500	32,500	32,500	32,500
- Chisel Ploughing	ha	10,600	10,600	10,600	10,600	10,600	10,600	10,600
- Land levelling	ha	9,400	9,400	9,400	9,400	9,400	9,400	9,400
- Harrowing	ha	3,900	3,900	3,900	3,900	3,900	3,900	3,900
- Planting/sowing	ha	19,300	19,300	19,300	19,300	19,300	19,300	19,300
- Making furrows/ridges	ha	8,500	8,500	8,500	8,500	8,500	8,500	8,500
- Inter-row cultivation	ha	9,100	9,100	9,100	9,100	9,100	9,100	9,100
- Harvesting (combine)	ha	62,000	62,000	62,000	62,000	62,000	62,000	62,000
- Harvesting (maize silage/fodder)	tn	1,900	1,900	1,900	1,900	1,900	1,900	1,900
- Applying defoliant	ha	7,400	7,400	7,400	7,400	7,400	7,400	7,400
- Chopping cotton stalks	ha	6,500	6,500	6,500	6,500	6,500	6,500	6,500
- Transport	kg	5	5	5	5	5	5	5
- Transport (road)	tn/km	600	600	600	600	600	600	600
Other inputs								
- Bags & Packaging (cotton)	kg	12	12	12	12	12	12	12
- Tools & Equipment	ha	20,000	20,000	20,000	20,000	20,000	20,000	20,000
- Irrigation cost	ha	3	3	3	3	3	3	3
- Cotton harvesting (manual)	kg	100	85	85	85	85	85	85
Labour								
- male	workday	2,100	1,785	1,785	1,785	1,785	1,785	1,785
- female	workday	2,100	1,785	1,785	1,785	1,785	1,785	1,785
Taxes and fees								
- Agricultural land tax	ha	55,000	-	-	-	-	-	-
- Water User Charges	ha	7,000	7,000	7,000	7,000	7,000	7,000	7,000
Fuel and Electricity costs								
Electricity Econ px US\$0.05kWh)	kWh	53	66	66	66	66	66	66
Diesel	lt	825	980	955	894	713	713	773

3. Project Benefits

107. The project benefits will emanate from the three main interventions of the project: first, the rehabilitation of pump stations to properly serve their command areas; second, rehabilitation and upgrading of the inter-farm irrigation system and associated rehabilitation of drainage; and lastly the impact of improved water management from the support to the BISAs and WUAs. The Project does not include support for the physical development of the on-farm irrigation and drainage system, except that provision is made for rehabilitation of the inter-farm and on-farm drainage through sediment removal. However the benefit from the support to the BISAs and WUAs provided by the project will have a direct impact on water management, irrigation efficiency and farm productivity. Enhanced on-farm water management is expected to result from the rehabilitation of irrigation infrastructure as well as better irrigation scheduling and in-field water control

a) The Without Project situation

108. In the without project situation it is assumed that the existing pump stations and their irrigation and drainage systems will continue to deteriorate with a resultant decline in the volume of water delivered to the command area especially during the peak period of demand from June to September. (The two core subprojects are both pump irrigation schemes, and the majority of the other subprojects are likely to be pump schemes). Many of the pump schemes date from the 1970s with pump and motors well past their design life, failing and in need of replacement, which combined with deteriorated irrigation and drainage infrastructure means that irrigation effectiveness is in decline. MAWR staff consider that the remaining life of the pumps for the Narpay and Besharyk schemes is no more than five years.

109. A reduced water supply will lead to a reduced area planted and declining agricultural productivity on the remaining irrigated, with reduced yields and less intensive cropping. As irrigation supply becomes more unreliable, because of more frequent pump breakdown farmers will lose confidence in the irrigation system and reduce their investment in agriculture accordingly – lower use of fertilizer and less attention to good crop husbandry, and eventually abandon their land.

110. The mix of pump schemes and gravity schemes in the Project is not known at this stage, but it is likely to have a majority of pump schemes. The situation with a deteriorating gravity irrigation system is not as dramatic as a pump scheme. The change in the trans-boundary water supply regime following the use of water resources stored in the Toktagul reservoir in Kyrgyzstan for winter power generation has fundamentally shifted Uzbekistan's irrigation supply regime during the summer months leading to water shortages in downstream areas at crucial times. The "without project" situation for gravity schemes is a decline in productivity through the failing irrigation delivery infrastructure, and lack of water for crucial irrigation. Inadequate water management may also lead to problems of water logging and mineralization resulting from poor water delivery management and in-field practices. The benefits of rehabilitation of the irrigation and drainage infrastructure and support for improved water management and WUA capacity building will also apply, but the without project situation is not expected to be as serious as for a pump scheme facing failure and resultant loss of the command area.

b) Future With project situation

111. For pump irrigation schemes the impact of the Project will be to restore the pumps to a capacity to fully satisfy water demand in the command area and to improve energy efficiency (around 20%). Some savings in the operation and maintenance costs of the pumps and motors will also occur, in the initial years at least, as the new equipment will not require the same level of repair and maintenance as is the case now.

However adequate levels of O&M must be provided to ensure that the equipment is kept fully functional throughout its design life and to avoid the situation of deferred maintenance. Agricultural productivity would be restored to the full level for the command, combined with an increase in yields and a modest increase in cropping intensity because of the gains in water use efficiency brought about by the associated support to water management and the WUAs. Rehabilitation of the irrigation infrastructure will reduce water losses and allow better water management. For gravity irrigation schemes the gains will be from more effective irrigation and drainage infrastructure and the associated support to water management and WUAs, as is the case with the pump schemes.

c) Crop Yields and Gross Margins

112. Crop budgets for the range of crops found in the Narpay and Besharyk subprojects were prepared including cotton, wheat, maize silage/fodder, vegetables, annual forage and fruit trees representing the current situation and with the inclusion of melons and potato for the “future with” project situation. The gross margins for *dekhan* farms are considerably higher than for private farms reflecting the higher productivity and the use of family labor at no financial cost, compared to mechanical cultivation and hired labor for private farms. Vegetables, melon and potato show the highest return while the gross margin for wheat is currently significantly more than that for cotton. Summaries of the yields and gross margins for the two subprojects are presented in Section V.

d) Project Areas and Beneficiaries

113. **Project area.** For the two subprojects Narpay’s net command area (i.e. land that could be irrigated) for Narpay scheme is stated as 8,605 ha, while the Besharyk pump scheme has a potential service area for the pump station of 7,820 ha.²⁸ Based on the scale of these two core subprojects, the other non-core subprojects are likely to cover an area of around 40,000 ha, making a total command area of around 60,000 ha to be rehabilitated by the sector Project.

114. **Beneficiaries.** There are two categories of farms – private and *dekhan*. Narpay has 223 private farms and Besharyk 192, with an overall holding size of around 30 ha. The area of *dekhan* farms is estimated to be 270 ha at Narpay and 450 ha owned by 6,645 households with an average holding of 0.11 ha. The Besharyk command area is relatively densely settled with 7,500 households, many of whom are dependent on the agricultural sector for their livelihood, compared with 2,970 households in Narpay. In addition to the number of farmers it is estimated that a further 2,800 agricultural workers (roughly one worker for every three ha of irrigated land), are attached to the land in permanent employment. A large number of people are also employed as seasonal workers, especially to harvest cotton. Based on this distribution the total number of beneficiaries for the overall project is assessed to be of the order of 2,500 private farms, 30,000 *dekhan* farms, and 25,000 other agricultural households closely involved in providing farm labour and services to the private farms. Farmers are organized into Water User Associations (WUA) responsible for water scheduling and the maintenance on on-farm irrigation facilities and WUAs will be the main means of building farmers’ capacity.

e) Cropping patterns and Production

115. The predominant crop is cotton which is grown on around 50% of the area followed by wheat at around 30%. Maize, lucerne, vegetables and fruit are produced from the remaining area to give a current average cropping intensity of around 100% for

²⁸ Besharyk’s service area is determined by the capacity of the pumps and the rising main according to the cropping pattern and water demand. Not all this area is currently irrigated from the pump station.

the irrigated land. Private farmers are compelled to produce a quota of cotton and wheat under the State order system, while *dekhan* farmers are free to choose what they grow. No cotton is grown on the *dekhan* farms. Summaries of the present land use in the command area for the Narpay and Besharyk subprojects based on an average of the last three years data 2005-2007 is presented in section V and Table 23 and Table 34..

- Future With cropping pattern

116. In the “future with” Project situation the cropping pattern for Narpay and Besharyk is not expected to change markedly except for a small increase in the area of lucerne, in recognition of its benefit as a restorative crop in the cotton-wheat rotation, and increased production of high value crops – vegetables, potatoes and melons. The average cropping intensity is expected to increase to around 115% with an increase in the second crop of maize fodder grown after the winter wheat is harvested. This situation is expected to apply to all subprojects included in the Project.

4. Financial Analysis

117. The purpose of the financial analysis is to show the project’s impact on a particular entity, be it the participating farmers, the pumping station or the irrigation scheme. When the analysis is done from the point of view of the participating farmers then the financial returns can be used to indicate whether there are sufficient benefits and incremental income for them to participate fully in the project, and the extent that they could contribute to the operational cost of maintaining the irrigation system. In the case of the two subprojects that have been analyzed to feasibility study level the financial analysis is not so meaningful. The pump station operation cannot be considered as a separate entity as they do not receive any revenue from the operation of the pumping station as there are no charges levied for the delivery of water. Therefore as the entity has no revenue it does not have a cash flow from which it can measure its financial performance against.

118. Similarly the participating farmers are not required to contribute any equity of labour to the rehabilitation, nor are they required to contribute to the cost of delivering water, except for a low nominal amount that is included in their WUA fee and land tax. Therefore the financial and farm budget analysis of the Narpay and Besharyk schemes is also not as meaningful than for more usual irrigation development as the collapse of the pump station will lead to a reduction of the irrigated area to around a third of the command area, resulting in a drastic reduction in farm income per farm, and inevitably the financial ruin of many farmers. As the farmers are not currently required to make any contribution to the Project, either as equity or voluntary labour, as a result of the rehabilitation they will receive the all the benefits with no costs. All farms are expected to show an increase in net farm income after rehabilitation, and the absolute level of the increased income can be used to indicate the capacity they have to pay for water and other O&M costs after rehabilitation.

119. An analysis of the impact of the project on a typical private farm of 30 ha is included in the feasibility studies for Narpay and Besharyk subprojects. Currently is estimated that an average farm of 30 ha in Narpay generates an annual net income of around SUM 7 million (\$5,400), or around \$180 per ha. In the “without project” situation this would deteriorate to a net return of only \$54 per ha across the command area. In the “with project” situation the average farm would generate a net income of SUM 10.8 million (\$8,200) a 50% increase from the current situation. The incremental income per ha per year as a result of the project i.e. average returns per ha between the “future without” and “future with” project situation is estimated as SUM 300,000 per ha (\$225) which for the average sized farm of 30 ha represents an increase of SUM8.9 million, or \$6,750 per farm, a 127% increase in net farm income. This shows that the prevention in

the loss of the irrigated area through rehabilitating the pump station is the major source of the benefits. Farmers will have sufficient benefits and incentive to participate in the Project, and the additional returns would allow them to contribute to water costs if the government continues with its policy to introduce a charge for recovering the cost of delivering irrigation water.

5. Economic Analysis

a) Project Costs

Capital costs. The total overall Project cost are estimated to be \$146.3 million, made up of \$119.2 million of investment costs and \$27.1 million of recurrent costs (representing the Governments contribution to the O&M of the rehabilitated schemes during the Project following the completion of their rehabilitation). The project investment costs were converted to economic value by applied the conversion factor of 0.85.

For the two subprojects for which a detailed feasibility study has been prepared, the total base rehabilitation costs of the Narpay scheme are estimated at \$11.43 million to which has been added 16% for physical contingency and design and supervision making a total cost of \$13.26 million, or \$1,560 per ha of irrigated command area. The rehabilitation of the Narpay pump station involving the replacement of 8 pumps and motors is the most significant cost contributing 69% to the costs. Rehabilitation of the irrigation infrastructure is estimated to cost only \$1.5 million or 10% of total costs - \$177 per ha. The rehabilitation costs for the Besharyk subproject are significantly higher with a total base cost of \$21.14 million (\$24.52 million with contingencies and D&S) resulting in an average cost of \$3,136 per for the service area of 7,820 ha. Replacement of the pumps, repair of the rising main and widening the intake channel contributes 57% while of the remaining; the construction of the off-takes from the rising main and a piped delivery system contributes 20%. Rehabilitation of the existing irrigation infrastructure is estimated to cost \$1.05 million, 11.6%. The rehabilitation costs include the installation of additional offtakes from the rising main and a piped distribution to serve the lower portion of the irrigated area, an area that is poorly served by the present distribution system. An allowance for desilting inter-farm and on-farm drains is also included amounting to \$1.29 million which costs an estimated \$165 per ha.

O&M Costs. Future operation and maintenance costs of the rehabilitated schemes are based on a percentage of the cost of the physical works. For Narpay subproject these are estimated to total SUM 470 million per year (\$356,000), mostly for the maintenance of the pumps. However the application of the full O&M cost is delayed for five years after completion of the project because the new pumps are expected to require little maintenance in their initial years of operation and there is provision in the cost estimates for a supply of spare parts sufficient for the first five years of operation. The total cost of electricity per year is estimated to be \$2 million per year based on an economic cost of electricity of \$0.05 per kWh, (decreasing to \$1.89 million per year as improved water use efficiency reduces the volume of water pumped). Electricity costs are assumed to be 20% less for the same volume of water as in the current situation because of the more efficient motors and pumps to be installed.

For Besharyk, future operation and maintenance costs are based on a percentage of the cost of the physical works and are estimated to total SUM 681 million per year (\$516,000), mostly for the maintenance of the pumps. However the application of the full O&M cost is delayed for five years after completion of the project because the new pumps are expected to require little maintenance in their initial years of operation and there is provision in the cost estimates for a supply of spare parts sufficient for the first five years of operation. The O&M costs were converted to economic costs using the SCF of 0.85. The total cost of electricity per year is estimated to be SUM 1,901 million (\$1.44 million) per year based on an economic cost of electricity of \$0.05 per kWh. For the

Besharyk subproject electricity costs are assumed to be 8.75% less for the same volume of water as in the current situation. Although the new pumps and motors are assumed to be 20% more energy efficient, the new pumping configuration will involve an increased in the dynamic head resulting in an overall efficiency gain of 8.75%. In addition to the rehabilitation of the pumps the project will install a new dedicated pump to provide water for the 500 ha of fish ponds in the area adjacent to the pump station. Currently the fishponds are supplied by the existing pumps, which operate at a much higher head, so the new pump will operate with a saving of 65% of energy for the same volume of water. This saving in economic costs of electricity has also been included.²⁹

b) Project Benefits

120. The crop budgets were adjusted for economic prices of inputs and outputs and taxes and transfer expenditure such as land tax excluded, then combined with the cropping pattern to show the cash flow of net benefits.

121. The main Project benefit is the prevention of the reduction in the irrigated areas which would happen in the absence of the rehabilitation and benefits of a modest increase in crop yield, efficiency gain of 20% in the operation of the pumps and an a gain of 10% in the efficiency in the use of water, which results in a lower volume having to be pumped to satisfy crop water requirements. The most important benefits are those generated by the Project through the prevention of the reduction in irrigation through pump failure, and to a lesser extent the saving in electricity consumption through more efficient pumps and the improvement in water use efficiency through support for water management and training WUAs. For the Narpay subproject the volume of water saved through improved water use efficiency is assumed to become available for irrigation elsewhere at an average economic return of SUM300,000 per ha (\$226), while for Besharyk the additional water is assumed to allow an expansion of the irrigated area surrounding the scheme.

c) Core Subprojects Economic Analysis

- Narpay Subproject

122. The Narpay Project is found to be economically viable; the economic internal rate of return (EIRR) is 15.4%. At a 12% discount rate the net present value (NPV) is SUM3,040 million (\$2.3 million) and the benefit cost ratio is 1.14. The most important benefits are those generated by the Project through the prevention of the reduction in irrigation through pump failure, and to a lesser extent the saving in electricity consumption through more efficient pumps and the improvement in water use efficiency through support for water management and training WUAs.

- Besharyk Subproject

123. The Besharyk Project is found to be economically viable; the economic internal rate of return (EIRR) is 13.3%. At a 12% discount rate the net present value (NPV) is SUM1,993 million (\$1.51 million) and the benefit cost ratio is 1.06. The most important benefits are those generated by the Project through the prevention of the reduction in irrigation through pump failure, the increase in irrigable area and to a lesser extent the saving in electricity consumption through more efficient pumps and the improvement in water use efficiency through support for water management and training WUAs.

²⁹ Apart from the reduced energy costs for pumping no economic benefit from the fish pond has been included in the analysis as it is assumed that the fish ponds would remain in production in the without project situation.

124. The estimates of the benefits made possible by the Project are considered to be conservative, because the economic evaluation does not consider that the pump stations will stop operating completely in the “future without” project situation but are assumed to continue to operate at one third of current capacity. Even with this situation, there is likely to be major social dislocation in the project area because of the reduction in the irrigated area and loss of employment in agriculture, which would require some families to relocate to other areas. These costs have not been quantified and the actual benefit from the Project could substantially exceed those quantified for the analysis. A summary of the cash flows for the economic analysis is presented in Table 38

d) Combined Project Economic Analysis

125. An indicative economic analysis for the overall Project has been prepared using the Narpay and Besharyk subprojects as an indication of the likely costs and benefits for the three components: rehabilitation of irrigation; support for water resources management; project management and monitoring. A summary of the project cash flows is shown in Table 9.

126. **Assumptions.** The main assumptions for the economic analysis are:

- Costs in mid 2008 constant prices with implementation over 6 years from 2009 and a project life of 30 years.
- Total capital investment costs of \$107.892 million converted to economic values through COSTAB to \$93.96 million (conversion factor of 0.88)
- Total rehabilitation area of 61,425 ha made of Narpay 8,605 ha, Besharyk 7,820 and other non-core subprojects 45,000 ha.
- Schemes assumed to deteriorate in the without project situation to 30% of the current command areas over eight years producing a net annual agricultural benefits per ha of \$390 and \$586 for Narpay and Besharyk subprojects respectively, and \$275 per ha for the non-core subprojects. (The non-core subprojects assumed to include the rehabilitation of some gravity schemes which will have a lower level of benefits per ha).
- A general benefit from the support to provincial level water resources management of \$1 million per year (\$5 per ha for 200,000 ha)
- Incremental pumping costs of \$136 and \$174 per ha per year for Narpay and Besharyk and \$100 per ha for the non-core subprojects (representing the difference in net pumping costs between the future without and future with project situation, after allowing for a 20% increase in energy efficiency from the new motors and pumps)
- Incremental pump station repairs and maintenance costs of \$30 per ha for Narpay and Besharyk and \$22.5 per ha per year for the non-core subprojects.
- Incremental O&M costs for inter-farm irrigation and drainage infrastructure of \$50 per ha per year.
- Incremental on-farm O&M costs of \$15 per ha per year.
- Incremental project management cost for the BISA's in Zarafshan and Fergana of \$50,000 per year and for WUA support of \$25,000 per year following completion of project implementation.

127. **Economic results.** The EIRR is 15.6% which indicates that the overall Project is economically viable as it exceeds the opportunity cost of capital of 12%. A summary of the cash flows for the economic analysis is presented in Table 9.

128. **Sensitivity analysis.** The results of a sensitivity analysis show that the Project is robust to a 20% increase in capital costs and O&M costs and is most sensitive to the level of benefits. A combination of a 20% increase in costs and a 20% reduction in the net benefits reduces the EIRR to 6.1% as shown by the sensitivity analysis in the table below.

Table 8: Sensitivity Analysis and Switching Values Overall Project

Test Case	Test Variation (+/- %)	NPV Sum million	EIRR	Sensitivity Indicator	Base case Value of Parameter	Switching Value (+/-%)*	Switching Value
Base (reference case)		19,554	15.6%				
Increases in Costs							
Initial Capital Cost	20%	2,773	12.4%	4.29	\$93,793	23.0%	\$115,365.26
O&M Costs	20%	13,772	14.6%	1.48		65.0%	
Pumping costs	20%	10,895	14.1%	2.21	5 cts/kWh	45.0%	7.25 cts /kWh
Decreases in Benefits							
Decrease in net benefits	-20%	-15,655	8.7%	9.00	\$330.70	-11.0%	\$294.33
Initial Cost (+) and All Benefits (-)	-20%	-32,435	6.1%	13.29			
Initial Cost (-) and All Benefits (+)	20%	71,542	25.9%	13.29			

* A switching value of "-100%" indicates that the parameter has no practical switching value, when all other benefits are held constant.

e) Benefit Distribution and Poverty Analysis

129. The most recent information on the overall incidence of poverty in Uzbekistan is from the World Bank Living Standards report 200730 which based on 2003 data assessed the head count poverty rate as being 27.2 nationally and 29.8 for rural areas. The poverty rate for the economic regions where the Project is located is 31.8 for the Fergana valley and 28.3 for the Northern Region. The results of the household survey of the two subproject areas conducted as part of the PPTA studies indicated a poverty rate of 30.5% for Narpay (based on a consumption of 2100 Kcal per person per day as the poverty line) and 19.5% in Besharyk.

130. The population in the Project area has a high dependency on agriculture for employment and sustenance, with a little alternative employment, which means that there would be a sharp increase in poverty if agriculture production were to decline through failure of the pump schemes. For most poor households production from *dekhan* farms and households and livestock is important for subsistence, which would be seriously affected if water supplies were to be limited. Poor households would benefit from the increased agricultural productivity resulting from rehabilitation, and the attention given to improved water management. For the Narpay subproject it is estimated that the Project would generate an additional 142,000 person days (600 person years) of employment as a result of the project (mostly for harvesting activities) and avoid in the "without project" loss of a similar number of person days. Using the Narpay labor involvement of an additional 16 person days per ha as a yardstick for the whole project, the overall Project is estimated to generate over 2,500 additional person years of employment after the rehabilitation. Most of the additional employment is expected to accrue to rural agriculture workers and poor households. Therefore the poverty impact is likely to be pro poor.

³⁰ World Bank Republic of Uzbekistan Living Standards Assessment Update. August 2007

G. Economic Returns to Water

131. Over 65% of the irrigated land in Uzbekistan relies on pumping to some extent which creates a big demand for electricity to power the pumps, to the extent that 71.5% of the budget for O&M of the irrigation infrastructure is used for pumping. The economic cost of water is a major input cost for agriculture, particularly where water delivery involves high lifts and when it is used to irrigate cotton which has a relatively high water demand, compared to wheat for example. As an exercise to compare the marginal costs and returns to the water as a factor in crop production, data from the Narpay subproject has been analyzed to indicate the comparative economic return to water.

6. Crop Gross Margins

132. The crop gross margins that were prepared for Narpay to represent the future with project situation in economic prices for the economic feasibility study can also indicate the return to water by dividing the gross margin per ha by the volume of water required to produce the crop taking into account the field efficiency of water use. (For this purpose a field efficiency of 45% was used). Water demand varies considerable between the crops with cotton, lucerne and vegetables having the highest demand and winter wheat the lowest. The water demand per ha used are those that were calculated to determine water demand during the feasibility study, using the FAO CROPWAT software program. The values at an assumed field efficiency of 45% are noted in the table below. Based on the projected cropping pattern in the future with project situation with an overall cropping intensity of 115% the weighted average water demand per ha per year is estimated to be 19,750 m³.

Table 10: Crop Water Demand for Narpay Subproject

Crop	Demand (m ³ /000/yr)	Cropping pattern % of command area
Cotton	24.8	49.8
Wheat	6.6	27.8
Maize silage	8.9	16.4
Vegetables	18.6	4.2
Lucerne	25.0	10.9
Melons	15.0	0.6
Fruit trees	10.0	5.4
Average	19.75	115.1%

133. A summary of the crop budgets for Narpay showing water demand per ha and the return to water use expressed as a value per m³/000 are shown in Table 11 below. The return to water in economic prices varies from SUM158,220 to SUM13,976 (\$119.86 to \$10.59) per m³/000. Wheat has the highest return at \$119.86 per m³/000 and cotton the lowest at \$10.59. Other crops show a range in between. The average return to water for all seven crops is \$49.0 per m³/000. Adjusting the average for the assumed future cropping pattern for Narpay as noted in the table above gives a weighted average return to water of \$48.72 per m³/000.

Table 11: Summary of Crop Budgets showing Economic Returns to Water

Soum per ha							
Crop	Cotton	Wheat	Maize fodder	Lucerne	Vegetables	Melon	Fruit
Yield (kg per ha)	2,650	4,500	12,250	12,000	16,800	15,750	4,589
Gross Income	1,186,379	1,614,242	551,250	960,000	2,856,000	3,307,500	1,147,125
Inputs							
Seeds, Fertiliser & chemicals	356,404	394,062	107,121	119,867	892,450	1,085,193	334,497
Mechanization	390,570	135,180	145,425	127,600	371,200	352,300	82,593
Labor	64,796	28,560	49,980	12,495	406,266	227,141	110,465
Other	28,000	28,007	28,000	28,025	28,000	28,012	28,008
Total costs	839,769	585,809	330,526	287,987	1,697,916	1,692,647	555,562
Gross margin per ha	346,610	1,028,433	220,724	672,013	1,158,084	1,614,853	591,563
Water demand m ³ 000/ha	24.8	6.5	8.9	25.0	18.6	15.0	10.0
Return per M ³ 000 Soum	13,976	158,220	24,800	26,881	62,263	107,657	59,156
US\$							
1320 per ha							
Crop	Cotton	Wheat	Maize fodder	Lucerne	Vegetables	Melon	Fruit
Gross Income	898.77	1,222.91	417.61	727.27	2,163.64	2,505.68	869.03
Inputs							
Seeds, Fertilizer & chemicals	270.00	298.53	81.15	90.81	676.10	822.12	253.41
Mechanization	295.89	102.41	110.17	96.67	281.21	266.89	62.57
Labor	49.09	21.64	37.86	9.47	307.78	172.08	83.69
Other	21.21	21.22	21.21	21.23	21.21	21.22	21.22
Total costs	636.19	443.79	250.40	218.17	1,286.30	1,282.31	420.88
Gross margin	262.58	779.12	167.22	509.10	877.34	1,223.37	448.15
Water demand m ³ 000/ha	24.80	6.50	8.90	25.00	18.60	15.00	10.00
Return per M ³ 000 \$	10.59	119.86	18.79	20.36	47.17	81.56	44.82

Water demand calculated for Narpay at 45% overall scheme efficiency.

7. Pumping Costs

134. The cost of pumping irrigation water depends on two main factors: the head or lift that the water has to be pumped against, and the cost of the energy in driving the pumps (in Uzbekistan predominantly electricity). The energy costs in kW per m³/s for an electrical pumpset are calculated by the formula:

$$\text{kW} = \frac{\text{C} \times \text{Q}(\text{m}^3/\text{s}) \times \text{H}(\text{m})}{\text{pump efficiency}}$$

where C= 9.807 H = head
 Pump efficiency = 80.75% pumpset
 95% Motor
 85% Pump

135. The pump efficiency is a combination of the efficiency of the electrical motor and the pump itself; typically for new pumpsets this is 95% and 85% respectively to give an overall efficiency of 80.75%. The dynamic head is the total of the static head or elevation that the water has to be pumped, and the extra head caused by the resistance in the pipe.

136. The table below shows the energy requirement in kW per m³/s for a range of pumping heads from 1m to 100m and the corresponding cost per m³/000. The cost of electricity used is the long run economic generation cost of US\$ 5 cents per kWh, equivalent to SUM66 /kWh, which is 26% more than the current financial cost of electricity to MAWR for pumping of SUM52.5 per kWh.

Table 12: Energy Needs and Pumping Costs according to Head

Pump head (m)	Energy per m ³ /s for pumping heads		cost/kWh/1000m ³	
	kW	kWh/m ³ /s	SUM	US\$
1	12.14	0.00	223	0.17
2	24.29	0.01	445	0.34
5	60.72	0.02	1,113	0.84
10	121.45	0.03	2,227	1.69
15	182.17	0.05	3,340	2.53
20	242.90	0.07	4,453	3.37
25	303.62	0.08	5,566	4.22
30	364.35	0.10	6,680	5.06
40	485.80	0.13	8,906	6.75
50	607.24	0.17	11,133	8.43
55	667.97	0.19	12,246	9.28
60	728.69	0.20	13,359	10.12
65	789.42	0.22	14,473	10.96
69.35	842.25	0.23396	15,441	11.70
70	850.14	0.24	15,586	11.81
75	910.87	0.25	16,699	12.65
80	971.59	0.27	17,813	13.49
90	1,093.04	0.30	20,039	15.18
100	1,214.49	0.34	22,266	16.87

137. The dynamic head calculated for the Narpay pump station after rehabilitation is 69.35 m which is a combination of the static head and the pumping resistance from the combination of the volume pumped and pipe configuration. This gives an energy need of 0.23396 kWh/m³/s. Therefore at a price of \$ 5cents per kWh, from the table the energy cost per m³/000 for delivering water to the stilling basin at the end of the rising main is

SUM15,441 or \$11.70 per m³000. The Narpay scheme also involves a second level of pumping from the Chorvador and Turkistan pumping stations to deliver water to land above the Narpay (RB) inter-farm canal. The lift for the Chorvador pump station is another 60m which adds a further cost of \$10.12 per m³000 for the power required.

8. Crop Gross Margins after Water Cost

138. Adding the pumping costs for Narpay pump station to the crop gross margins reduces the net return per ha as shown in the table below.

Table 13: Crop Gross Margin including Pumping Costs

Crop	Gross Margin (\$ per ha)	Water cost (\$ per ha)	Net Margin after Water Cost (\$ per ha)
Cotton	262.58	290.11	- 27.52
Wheat	779.12	76.04	703.08
Maize fodder	167.22	104.11	63.10
Lucerne	509.10	292.45	216.65
Vegetables	877.34	217.58	659.76
Melon	1,223.37	175.47	1,047.91
Fruit	448.15	116.98	331.17

139. The gross margin for cotton is negative after allowing for the pumping cost, while the other crops still show a positive return. Cotton as a relatively lower gross margin and has a high water demand (more than four times winter wheat). Pumping to the second level through the Chorvador and Turkistan adds a further cost of \$10.12 per m³000, which in the case of cotton adds an additional \$250 per ha in the energy cost.

9. Other Pumping Costs

140. The energy cost of pumping is just one of the cost elements of pump irrigation, there are also additional costs of the operation and maintenance of the pump sets, pump-house, valves, electrical system and the rising main; the depreciation of the capital investment over the life of the investment, and the cost of the capital that is used, or interest charges on the loan, as is the case of the Narpay pump station where the rehabilitation costs are funded through an ADB loan.

a) Operation and maintenance

141. The annual O&M costs of the rehabilitated Narpay pump station and rising main are assessed as \$212,000 per year (in economic prices). This is based on applying a percentage of the investment costs of rehabilitation and is assumed to be sufficient to maintain the facilities in working order for the duration of the 30 year economic life. The total annual volume of water pumped by Narpay is estimated to be 150,000 million m³. The annual O&M costs are therefore \$1.41 per m³000 per year, or on average \$24.43 per ha for the command area of 8,605 ha. For cotton, which has the highest water demand and makes up the majority of the cropped area, the O&M cost is an additional \$35.00 per ha.

b) Depreciation

142. The total investment cost involved with the rehabilitation of the Narpay pump station and its rising main is estimated to total \$9.446 million in (economic prices), which over a 30 year economic life has an annual depreciation cost of \$315,000. This is equivalent to \$37 per ha or \$2.10 per m³000 per year for the total volume of water pumped. For cotton this would add another \$52 per ha per year.

c) Cost of capital

143. Rehabilitation of the Narpay scheme is to be funded through an ADB OCR loan with interest payments based on the 5-year LIBOR rate and repayment over 26 years. At an interest rate of 4.5% per year, interest on the loan of \$9.5 million would amount to an average of \$427,500 per year, or around \$50 per ha per year, or \$2.85 per m³/000 of irrigation water per year.

10. Conclusion

144. In total the average cost of delivering water through the Narpay pump station after allowing for the above cost elements (electricity, O&M, depreciation, and cost of capital) is in the order of \$2.71 million per year, of which the cost of power accounts for \$1.755 million or 65%. The average cost per m³/000 for a total volume pumped per year of 150 million m³ is \$18.1 per m³/000. For the cotton crop this means that the opportunity cost of supplying water to meet its demand of 24.8 m³/000 per ha is almost \$450 per ha per year, when the estimated economic net return is \$263 per ha, and which implies a loss of \$185 per ha. It does not make economic sense to grow cotton in the Narpay scheme where every hectare involves a considerable loss per hectare, which for the cost of electricity alone is \$27.00.

145. This simple analysis of the costs of pump irrigation shows the need to take into account the real cost of delivering water through pump schemes in selecting the cropping pattern. An analysis of the marginal cost of delivering water and the marginal returns to different crops and water demand needs to be applied in making decisions about the rational use and distribution of water. The high relative of pump scheme irrigation water compared with gravity schemes highlights the need to achieve greater water use efficiency in the distribution of water through the inter-farm system and use on farm. Using cotton as an example a 10% saving in water use would save pumping costs of \$29 per ha and allow the gross margin to achieve a positive return.

H. Financial Management Assessment

1. Introduction

146. A Financial management Assessment (FMA) was prepared for MAWR, the proposed Executing Agency (EA) for the Project during the PPTA. The purpose of the FMA is to assess the financial management capacity of the EA and to highlight any short-comings that would need to be addressed to ensure effective financial management of the project implementation. The FMA is based on ADB's *Guidelines for the Financial Governance and Management of Projects Financed by the Bank (2002)*. The assessment included a review of the MAWR's systems for financial and management accounting, reporting, auditing and internal controls. In addition a review of disbursement and cash flow management arrangements. FMAs were prepared for MAWR during the preparation of two other ADB funded project in 2005 and 2006/7 – Land Improvement Project UZB-4343, and Farm and Agribusiness Development Project which conclude that MAWR satisfies ADB's minimum financial management requirements for EAs. MAWR is currently managing four PMOs and PIUs for the implementation of projects for irrigation rehabilitation and support to the agricultural sector and is experienced in the implementation of ADB-funded projects. The FMA review for WRMSP is based on the previous FMAs prepared for these projects. ADB's standard financial management assessment questionnaire (FMAQ), the instrument used for FMA assessment, was updated based on consultation and interviews with MAWR senior financial officers, PMO staff in Tashkent, follow up consultations and supporting documents.

2. Summary Findings of the FMA

147. It is concluded that MAWR currently satisfies ADB's minimum financial management requirements for EAs. The MAWR has a satisfactory financial management capability to: (i) record required financial transactions and balances; (ii) provide regular and reliable financial statements and monitoring reports; (iii) safeguard financial assets; and (iv) submit the required financial documents to auditors with arrangements acceptable to ADB. A summary of the FMA is given in the table below. The full FMA and the completed FMAQ questionnaire is included in Appendix 7.

Table 14: Summary of the FMA for MAWR

Particulars	Rating	Conclusions
A. Implementing Agency	Moderate	MAWR is a government ministry that is accountable to the Cabinet of Ministers (COM) of the Republic of Uzbekistan. MAWR has experience in managing and implementing large scale projects financed by ADB, World Bank, and other international funding institutes.
B. Funds Flow Arrangements	Satisfactory	MAWR has knowledge of and working experience in ADB funds flow arrangements. Preliminary funds flow and lending arrangements have been identified in consultation with MAWR and Ministry of Finance representatives. Prior to loan negotiations it is essential to ensure the availability of counterpart funds for year 2009, which were not included in state investment program for year 2009.
C. Staffing	Moderate	MAWR is moderately staffed with experienced financial specialists. Since the project staff will be newly recruited, it is recommended to organize training and workshops on ADB financial management procedures. It is expected that on-the-job training provided by the staff of other PMO/PIU of ongoing projects, being implemented under MAWR, will also be beneficial.
D. Accounting Policies and Procedures	Satisfactory	The MAWR accounting policy is based on the Uzbekistan National Accounting Standards, which are progressively being modernized in accordance with International Accounting Standards. For WRMSP PMO/PIU separate accounting policy, subject to annual updates, and a financial management manual will be established in accordance with requirements of ADB and MOF of Uzbekistan.
E. Internal Audit	N.A.	There is no internal audit unit within the structure of the MAWR.
F. External Audit	N.A.	MAWR has not been audited by external auditor but annual procedural audits are conducted by MOF. Operating PMOs under the Ministry are audited by independent external auditors on an annual basis. Audit of the project accounts will be done in accordance with the International Standards on Auditing (ISA), which complies with the requirements of ADB, and this shall be stipulated in the loan agreement.
G. Reporting and Monitoring	Satisfactory	MAWR and PMO reports comply with the reporting requirements of the MOF, the Ministry of Economy (MOE), and the State Taxation Committee. Acceptable reporting requirements for the proposed PMO and PIUs shall be stipulated in the Loan Agreement between ADB and Government of Uzbekistan.
H. Information Systems	Moderate	MAWR's financial system utilizes the <i>1S Buhgalteriya</i> accounting software supplemented with the use of excel spreadsheets and manual methods. Management and operational units of projects, being implemented under MAWR, use similar accounting software for internal and project operations, as well as financial reporting.

I. Project Disclosure and Public Consultations

148. In compliance with ADB's Public Communications and Disclosure Policy (March 2005), the joint Project Disclosure and Public Consultations were conducted on the following dates for the two core subprojects, with representatives from the EA: (i) September 19, 2008 for Narpay Subproject; and (ii) September 26, 2008 for Besharyk Subproject. Prior to the two joint occasions, invitations were announced in the local media. The public were informed on the impacts of the Project in terms of environment, social and resettlement. Both consultations have been successful where the stakeholders, represented by different associations, have fully supported the Project and nobody had raised any objection against its implementation. The Minutes of Consultations are attached to their respective Due Diligence Report shown in Supplementary Appendixes E.1 and E.2 of this Report.

V. CORE SUBPROJECTS FEASIBILITY STUDIES

149. This section presents the feasibility studies for the two core subprojects – Narpay and Besharyk that were prepared during the PPTA. Supporting material is included in the appendixes and supplementary appendixes.

A. Narpay Core Subproject

1. Description of the Subproject

a) Present situation

150. The Narpay pump irrigation scheme is located some 300 km southwest of Tashkent and about 120 km from Samarkand town in Narpay rayon. The original scheme was conceived in the late 1960s. A first part was implemented in 1973 comprising the Narpay pump station with three rising mains, a header canal conveying water to the left and right branches of the Narpay Machine Canal (NMC). Between 1983 and 1990 the scheme underwent various modifications including a major command area expansion in 1990, giving it its present configuration.

151. The scheme is located adjacent to the town of Aktash, on slightly undulating land generally sloping towards the Karadarya bifurcation. The schemes infrastructure comprises the following components:

- Primary Narpay pump station on Narpay Primary Canal, secondary pump stations Chorvador and Turkistan on Narpay MC (RB), see Table 15 below;
- the Narpay MC header canal, concrete lined, with a length of 0.347 km;
- the Narpay MC left branch (LB), concrete lined, length 6.04 km, command area 1,552 ha;
- Narpay MC right branch (RB), concrete lined, length 15.49 km and command area 7,054 ha.
- Turkestan MC, a concrete lined canal with a length of 9.3 km, and including 11 cross drainage structures.

Table 15: Narpay scheme - Primary features of BISA operated pump stations

No	Item description	Unit	Narpay Primary Canal	Narpay Machine Canal (RB)	
1	2	3	4	5	6
1	Name of pump station		Narpay	Chorvador	Turkestan
2	Location on canal	Km	32.700	4.800	12.250
3	Commissioned	Year	1973	1990	1998
4	Pump station building	M	102.0 x 12.0	72.0 x 6.0	16.0 x 6.0
5	Pump station – machine pit	M	84.0 x 12.0	54.0 x 6.0	12.0 x 6.0
6	Pump station – electric section	M	18.0 x 12.0	18.0 x 6.0	4.0 x 6.0
7	pump model installed and nominal capacity		24 NDS @ 1.5m ³ /s	20 NDS @ 0.8m ³ /s	300D90 @ 0.3m ³ /s
8	Units operational - June 2008	Nos	6	3	2
9	capacity of electric motors	kVA	12,800	2,400	
10	Pumping head (static)	M	52.5	55.0	52.0

No	Item description	Unit	Narpay Primary Canal		Narpay Machine Canal (RB)	
			4	5	6	
11	Rising mains – number, length and diameter		3x2,500m/ Ø1,4m	1x2,100m/ Ø1,2m 1x1,420m/ Ø1,0m	1x2,600m/ Ø0.7m	
15	service areas	Ha	8,605	1,699	200	

Source: ISA Narpay-Navoi, Aktash, August 2008

152. Four other pump stations abstract water from Narpay MC (RB) but are operated by water users to provide supplementary supplies to part of the command area. These are:

Table 16: Narpay scheme - Water Users operated pump stations

No	Item	Unit	Pump Station Name			
			Nurobod	Oktosh meva	Charkar	Ittifok
1	Station on Narpay MC (RB)	Km	1.600	13.700	15.100	15.400
2	Commissioned	year	1985	2004	1992	1991
3	Irrigation area	Ha	45	210	30	250

Source: ISA Narpay-Navoi, Aktash, August 2008

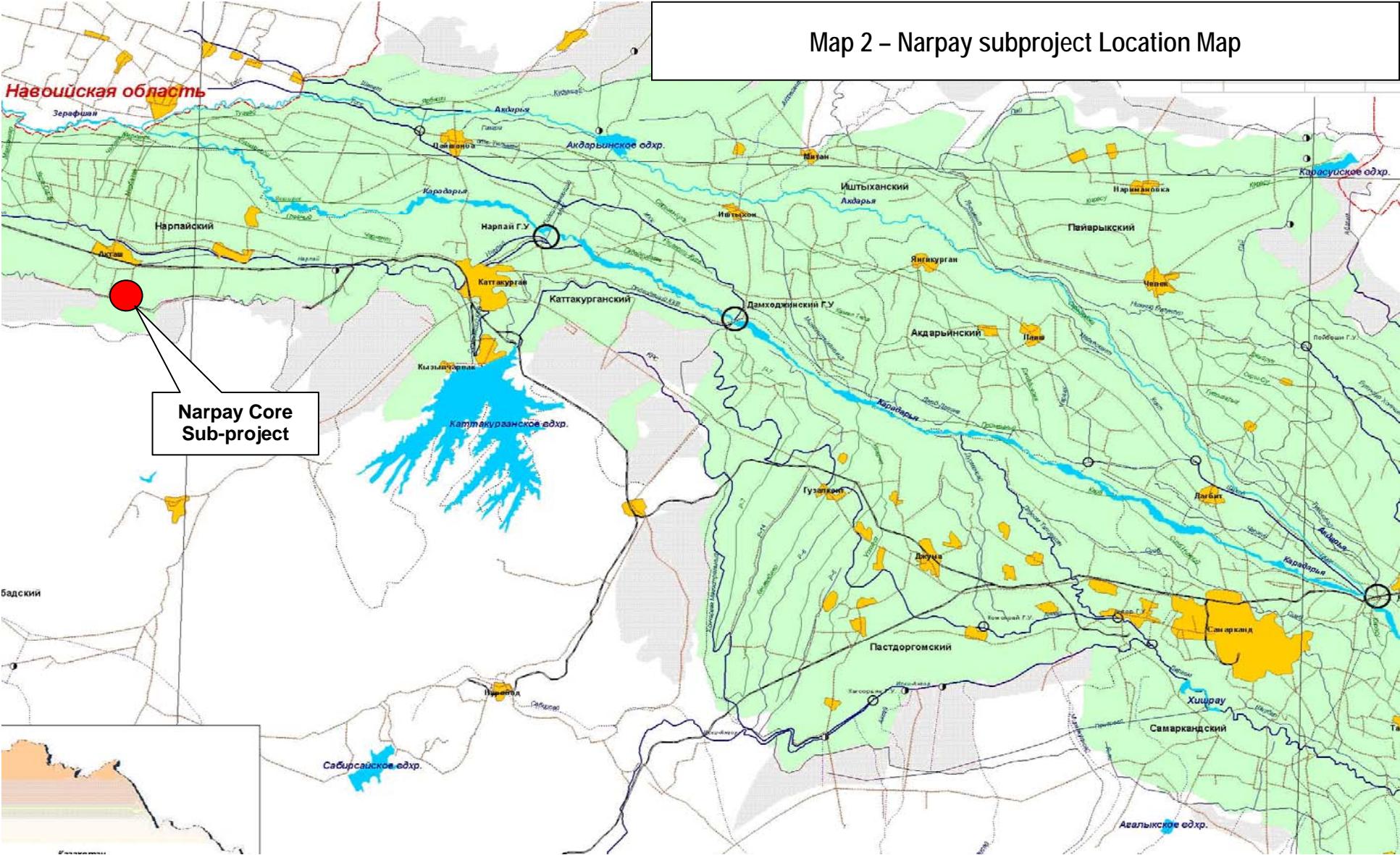
153. Scheme associated primary and collector drains amount to some 100 km but suffer from neglect and deferred maintenance, and need to be cleaned and reshaped to function appropriately. Of the total drainage length, some 26 km or roughly 25% are within the perimeter of the Narpay scheme area. The actual length of individual drainage channels within the command area varies from 11 to 92% of its total length.

154. Flood protection banks exist on the uphill sides of the Narpay MC (LB) and (RB), preventing surface water flowing down the slope into the canals. In places this bank is massive, 3 to 4 m high. These flood banks divert the surface water to the natural drainage lines where there are culverts under the canal. Rainfall above a certain amount will create surface runoff from the downslope side of the flood bank which will enter the canal carrying sediment with it.

b) Assessment

155. The scheme infrastructure including the mechanical equipment for lifting and conveying of water has been in operation for more than 30 years. While the pumping equipment is generally beyond its economic lifetime and has deteriorated to the extent that adequate supplies can no longer be assured, the canal works are in reasonable structural shape considering its more than 30 years of usage. However, limited funding for and irregular execution of maintenance resulted in general deterioration of scheme infrastructure to the extent that canal water flow cannot be effectively controlled, resulting in low water use efficiencies and scheme performances. Pump stations do no longer work according to their design capacities and it is common to find only few pumps in a set of several actually capable of supplying water. Spare parts are hard to come by while the machinery and motors need constant repair, causing unexpected and prolonged machine downtime, rendering water supplies erratic and difficult to predict.

156. The design of the canals on the Narpay scheme does not allow for a change in the basic method of irrigation water management; the capacity of the canals reduces in a downstream direction and the lack of cross-regulators means that it is not possible to adopt a rotational delivery to the offtakes, allowing water to be managed more efficiently on-farm. Instead the canal must be operated with continuous flow to maintain constant



Map 2 – Narpay subproject Location Map

water levels in the canals and, in so far as possible, constant flows through the offtakes. It is therefore envisaged that, after rehabilitation, pump stations and canals will be operated in the same manner as at present. Any improved efficiency of irrigation water use will arise because of:

- Matching the water supplied to the water requirements of the crops.
- Controlling the flow in the canals and offtakes to the required values.
- Ensuring that water is not lost from the end of the canals.

- Narpay primary pump station

157. Details of the pump station building are given in Table 15 above. The building is generally in poor condition with a leaking roof, crumbling brick walls, missing windows and broken access doors, and suffers from high groundwater levels and ingress of this groundwater through the subterranean parts of the building structure.

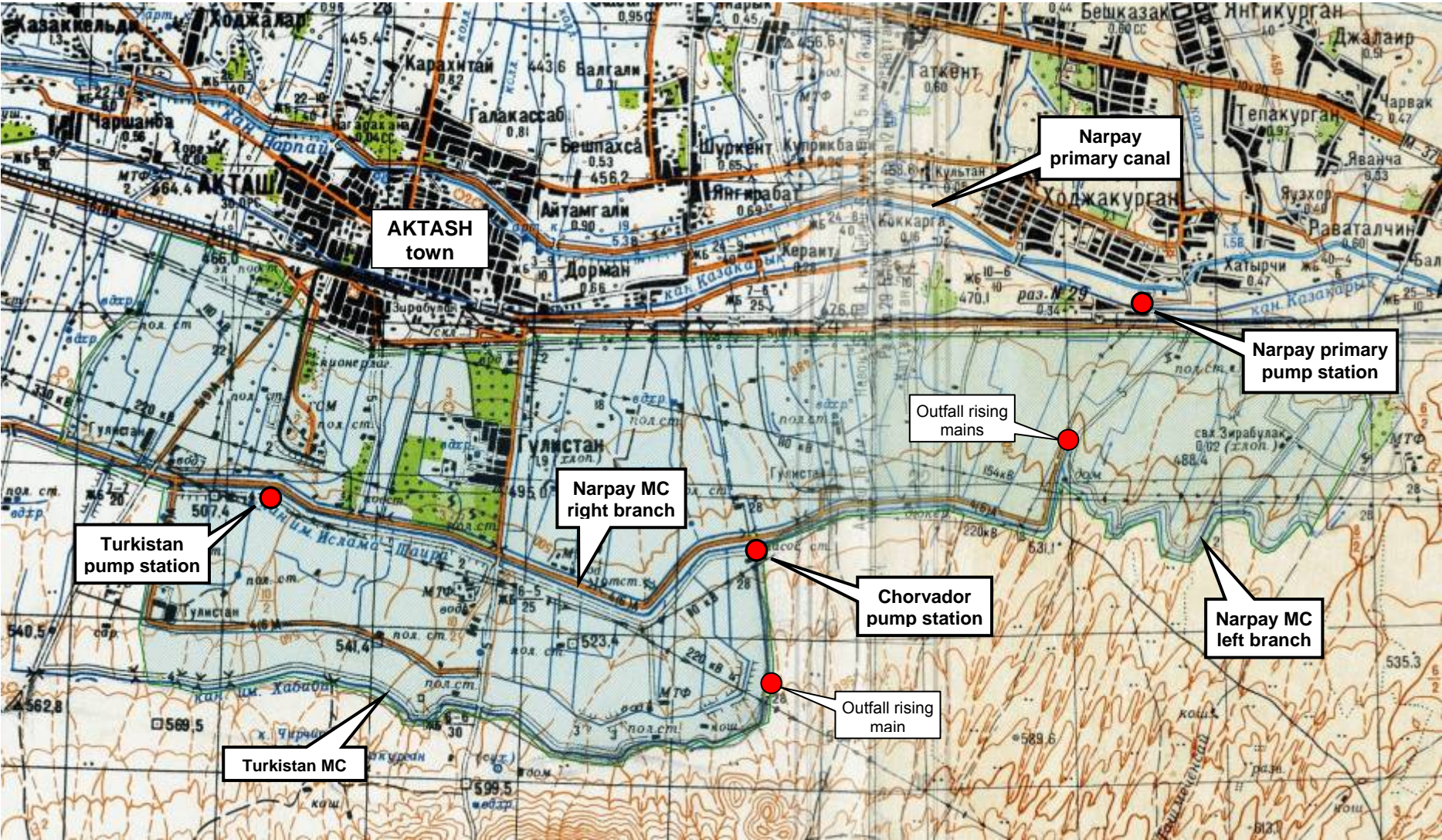
158. The installed pumps and motors have outlived their economic lives and undergone several major overhauls and repairs. Presently six out of the eight pump units are in working condition. The equipment installed comprises of double suction, axial split case, horizontal centrifugal type pumps driven by electrical motors. The pumps have a nominal capacity of 1.5m³/s at 80m head, and the electrical motors are 6,000 volt, 1600 kVA, engines with 750 rpm fixed speed. The pumps and engines are degraded and require complete replacement including electrical installations to drive and control motor and pump operations, such as cabling and earthing, electrical switchgear and control panels and associated instrumentation. The pumps are installed in a dry pit below minimum water level in the Narpay primary canal, resulting in a positive static suction head for the pumps. Installed gate valves are leaking and the original valve actuation mechanisms of motorized valves no longer work.

159. The present lack of equipment to protect pumping equipment from the effects of hydraulic surges caused by sudden stoppages of pumps due to power failure is limited to intermediate non-return valves in the rising mains. A new surge protection system comprising surge vessel(s), compressors, air piping, control panel etc. is required. Air vessels may be installed outside the pump house and connected to the common delivery header. Instrumentation on pump sets is presently limited to a few installed pressure gauges. To improve operational safety of the new pumping equipment, installation of a comprehensive instrumentation set, including pressure gauges on individual pump suction and discharge piping, a common header, pressure switches, pressure transmitters, and flow meters on rising mains are required.

160. Replacement of existing pump sets will require installation of new machine foundations and recasting of the dry pit floor slab. This will facilitate reestablishment of proper internal drainage to effectively evacuate spillage of water. The present drainage pumps operate inadequately and require complete replacement after floor rehabilitation.

161. The existing three rising mains are weakened in the high pressure stretch above the pump house. Replacement of all pipes for about 400m measured from the pump station building will be required. While replacing pipes, the rising mains will be realigned near the pump house and connected to a common pump discharge header. A motor operated butterfly valve and a non return valve will be installed on each of the rising mains near the header. In addition existing but malfunctioning air valves require replacement.

Map 3 : Narpay core sub-project



- Secondary pump stations

162. **Chorvador pump station.** This is an L-shaped building and details are given in Table 15 above. The building has provisions for nine machine foundations, six of which have been constructed. Presently there are three working pump units plus one additional motor installed. There are nine suction pipes leading from the canal to the pump house. Unnecessary and obsolete suction pipes should be removed to avoid unnecessary obstacles to canal flow. The internal drainage condition of the pump house building is unsatisfactory and requires addressing.

163. The three working pump sets are in good condition except for one electric motor which will need to be replaced. The pump sets comprise of double suction, axially split case, horizontal centrifugal type pumps, nominal capacity 0.8 m³/s at 52 m head, and electric motors (6kV, 800kVA) with 1,000rpm fixed speed. An additional pump set of identical specification will be required to meet actual peak water requirements. Existing electric motor driven butterfly valves of three pumps delivering water to the Turkestan canal are in poor operating condition and will be replaced by new valves of the same size. To avoid malfunctioning and to ensure more timely priming and start-up of pumps the existing vacuum pumps require replacement with two new sets of vacuum pumps, capacity about 60 m³/hr (1 duty + 1 standby).

164. Flow meters are presently non-existing and require to be installed on the two rising mains to facilitate accurate measuring of supplies allowing for timely and reliable system water management.

165. **Turkistan pump station.** Its building is 16m long and 6m wide and in reasonable condition (for details see Table 15 above). The pump sets were installed in 1998 and one of the two pumps is in reasonably good working condition. This pump station mostly serves as an “on-farm pump station,” hence no repairs or modifications are considered under this project. No flow measuring device presently exists and it is recommended to install one on the rising main to facilitate accurate measuring of supplies allowing for more timely and reliable water management.

- Canals and structures

166. Besides the Narpay header canal there are the left and right branches of the Narpay Machine Canal, and the Turkistan MC. Both the construction length of Narpay MC (RB) and Turkistan MC differ substantially from design documents available, resulting in somewhat ambiguous canal command areas. The individual canal command areas are given in Table 17 below.

Table 17: Narpay irrigation scheme - Canal command (irrigation) areas

No	Description	Information made available ¹⁾ Ha	estimated command areas Ha	command and service areas		
				Canals Ha	primary pumping Ha	secondary pumping Ha
1	Turkestan MC		1,377	1,377		1,377
2	Narpay MC - left branch		1,552	1,552	1,552	
3	Narpay MC - right branch		7,054	7,054	7,054	
4	Narpay MC - head canal	8,605	8,605	8,605	8,605	

source: ADB TA 7061-UZB, August 2008

167. Canal head reach sections were generally constructed with cross sections as given in available design documents but the length of Narpay MC (RB) had been shortened by about 6.6 km and that of Turkistan MC by some 2.3 km. However, no

engineering surveys were undertaken or available to verify canal design properties such as canal bed slopes and elevations, canal side slopes and bed width or lining depth. A detailed walk-through assessment of all canal works was undertaken to determine the status of works and the repair or improvement requirements.

168. The heads of the Narpay MC and the Turkestan MC where rising mains discharge into canals are in good condition. However, the anchor block for the rising mains discharging to Narpay MC requires strengthening. No work on any discharge basin located at the head of each canal is envisaged. The condition of the concrete lining is generally good in so far as it could be observed with the canals in operation; however certain panels of the lining showed serious deterioration. Canals are generally constructed of 150 mm thick unreinforced concrete except for the smallest canals where the lining is 135 mm thick. Such lining thicknesses are about double the thickness recommended outside the CIS. Construction joints are placed at 5m intervals. Most joints are no longer sealed and vegetation with roots in the joints is evident above the water level. This vegetation will increase the roughness of the canal when flowing under “forced flow” conditions and should be removed.

169. The canal lining will be repaired in where it has deteriorated; otherwise it will be left as it is apart from carrying out of deferred maintenance such as removing sediment from the canal bed and vegetation from the joints in the concrete lining. As there are no particular indications suggesting that the Narpay MC (RB) and (LB) or the Turkestan MC to loose canal water due to excessive seepage flows, no particular provisions will be included in the works and cost estimates allowing for the rebuilding of lining joints as a separate component. There is however a reach of about 300m length on the Narpay MC (LB) which has been left without concrete lining in the past. This reach requires to be concreted.

170. All three inter-farm canals appear to have been constructed with varying freeboard in selected reaches. To reduce the incidence of canal overtopping rising of canal lining is envisaged for selected reaches totally 13.8 km or about 40% of total canal length. Lining will be raised by 20 cm on average. The top of canal embankments have degraded, particularly where used as inspection and service roads, often leaving the upper edge of the canal side lining panels unsupported. While erosion of embankments is not evenly spread throughout the scheme area, rebuilding of roadside embankments will be necessary to support lining increases and to prevent concrete panel deterioration. Rebuilding embankment tops will require scarifying operations before placement of additional earth material, proper mixing of scarified with newly brought in fill material.

171. There are four regulators along the Narpay MC (RB) but none along the (LB) canal or the Turkistan MC. The regulators are simple concrete structures each with a single steel gate. In some cases the concrete superstructure has deteriorated, requiring replacement. Most of the installed gates are broken or inoperable and need to be replaced. To improve operation of gates, it is recommended to install electric drives on all four regulator structures. Though the type of regulator installed is intrinsically less good at providing a constant upstream water level than an overflow structure such as a duckbill or side weir, the latter will not be used to replace dilapidated works.

172. Downstream of Chorvador pump station there is no regulator. At present the water level at the Chorvador intake is maintained by lumps of concrete placed in the canal. This is unsatisfactory and a proper regulator – preferably of the fixed crest weir type – should be constructed at this location to maintain submergence of pump intakes.

173. No canal has been constructed with a tail end structure to control outflow of water from the scheme. This is unsatisfactory and renders proper scheme water management

obsolete. The project will install new fixed crest weir structures at the end of each canal to ensure appropriate depth of flow in canals and to reduce unwarranted escape of water from the canal system.

174. A total of 34 canal offtake structures exist to convey water from the inter-farm canals to the on-farm canal works. Of the 34 structures some 14 are located along Narpay MC (RB), 8 along the Narpay MC (LB), and the remaining 12 on the Turkistan MC. All 12 structures along the Turkistan MC require replacement as they were poorly constructed initially. Additional six offtake structures are recommended to be constructed to ensure complete coverage of the Turkistan MC command area. The other 22 offtakes require repairs which include replacing structure headwalls at both ends of the pipe conduits, delivery and installation of new gate frames, gates and lifting devices, together with construction of the downstream outfall basins.

175. At present the only point where there is a gauging structure is at the head of the Narpay Left canal. This structure is in poor condition and will be replaced by the project. To improve scheme water management it is proposed to install new gauging weirs downstream of the three drops at cross-regulators on the Narpay (RB), because these are the only points along the canals where there is sufficient head available to install a gauge. Gauging weirs will also be installed downstream of the tail-end structures.

176. Flow measurement in the canals will be by a gauging weir to International Standard ISO 4360³¹. These triangular profile gauging weirs have a number of advantages:

- Easy to construct accurately
- Can pass fine sediment
- Low head loss across the weir

177. A similar ISO 4360 gauging weir will be provided at each offtake to ensure that the gate is set accurately to deliver the flow required at that offtake; the provision of the gauging weirs on the canals will give a check that the water is being managed correctly.

- Drainage

178. The scheme associated primary and collector drains amount to some 100 km which suffer from neglect and deferred maintenance, and need to be cleaned and reshaped to function appropriately. No Water User Association operated on-farm drainage channels are reported to exist within the scheme area. Of the total inter-farm drainage length, some 26 km or roughly 25% are within the perimeter of the Narpay scheme area. The actual length of individual drainage channels within the command area varies from 11 to 92% of its total length. Drainage channels have been reported to be marginally operational, only, and to suffer from deferred sediment removal and reshaping. Reportedly this has not contributed to widespread rises in groundwater levels or even waterlogged areas. The reason may be that the soils are generally free draining while being of rather fine texture in the top soil with a higher sand fraction in the soils below. With the exception of a 10 ha area within the command area, no groundwater or waterlogging issues have been reported. However, information available suggests that a 20% loss of cross section area due to sedimentation and channel side slope deterioration has occurred throughout the lengths of drainage channels located within and outside the subproject area.

³¹ International Standard ISO 4360, Liquid flow measurement in open channels by weirs and flumes - Triangular profile weirs, Second edition – 1984 -12-15

2. Project Sub-components

a) Narpay primary pump station

179. Rehabilitation of Narpay pumping station aims at providing assured water supplies for irrigation of 8,600 ha with a peak flow requirement of 11.6m³/s. The works to be undertaken can be summarized into four primary sub-items:

- inlet channel to the pumping station;
- pump station building repairs and modifications;
- equipment and machinery for pumping; and
- repairs to rising mains.

180. **Inlet channel to the pump station:** improvements aim at facilitating proper operation of the intake structure while preventing the inflow of debris and other unwarranted materials to the pump intake pipes. Works include installation of bulk head gates including operating devices, replacement of the trash rack and related civil works.

181. **Pump station building repairs and modifications:** involves the removal and replacement of eight pump set foundations for the installation of new pumping equipment and including the laying of new pump pit concrete flooring to proper slope and required internal drainage channels. Construction work includes new concrete pipe supports and thrust blocks inside and outside the pump house building, installation of new valve / flow meter chambers within the pumping station area. If determined necessary, additional or extended switch gear room needs to be constructed. The installation of new compressors and other hydro-pneumatic vessels for surge protection necessitates the casting of appropriate foundations. Other, general refurbishment of the pump house building includes replacement of doors, windows, platforms, plastering of walls and wall painting, etc.

182. **Equipment and machinery for pumping:** replacement and installation of eight new pump sets each with 1.66m³/s capacity and comprising of horizontal split case double suction, single stage, centrifugal pumps including cast iron body, stainless steel (CF8M) impellers and casing wear rings, with mechanical seals, common base plate and all accessories. Plus installation of eight squirrel cage induction motors (6kV, 3-phase, 50Hz, 750rpm) with closed circuit water cooling system for above mentioned pumps. Installation of the pump sets includes all replacement of all suction and discharge piping with valves and additional dismantling joints. Installation of pump sets includes replacement of all electrical system components comprising of 6.0kV and auxiliary L.V. switch gear panels, auxiliary transformer, lighting distribution boards, control panels (control desk), H.V. and L.V. cabling, pump house lighting, grounding (earthing) etc.

183. **Header and rising mains:** Delivery and installation of a common discharge header including all isolation butterfly and non-return valves, surge protection equipment and a 200kVA, 0.4kV diesel generator set.

184. Provision of electro magnetic flow meters for the three rising mains and other instruments such as pressure gauges, pressure switches, pressure transmitter etc.

185. **Rising mains:** Replace the first 450m of each rising main plus realignment of pipes within the pump station area and connection to the common discharge header and including all necessary excavation and back filling, proofing of pipes against corrosion and lightning. Replace existing air valves with isolation valves on three rising mains of Narpay pumping station. Provision of electro magnetic flow meters for the three rising mains and other instruments such as pressure gauges, pressure switches, pressure transmitter etc.

186. Inspection and testing of three rising mains before completion of the rising mains rehabilitation work.

b) Secondary pumping stations – Chorvador and Turkistan

187. Rehabilitation of secondary pumping stations will be limited to the provision of selected materials and equipment to assure continuous operation of the facilities and to improve measuring and monitoring of water deliveries. Equipment and machinery for pumping at Chorvador pump station involves replacement of one 6.0 kV, 800 kVA electrical motor for one of the three existing pumps plus delivery and installation of one additional pump set with 0.8m³/s capacity, including 800 kVA, 6.0 kV electric motor with required suction and discharge piping, and valves. Replacement of electrical motor operated butterfly valves in the discharge pipes connected to the DN 1200 mm diameter rising main feeding the Turkistan Canal. Provision and installation of two new vacuum pumps complete with air / water piping and valves, plus two submersible drain pumps with independent discharge piping and valves to replace existing equipment. Provision and installation of electromagnetic flow meters, pressure gauges and pressure switches with isolation valves and replacement of air valves with isolation valves for both the rising mains.

188. For Turkistan pumping station the project will only provide a new water metering device for measuring cumulative out flow through the pumping station.

c) Canal rehabilitation

189. Canal rehabilitation aims at ensuring continued operation of the canal system with high conveyance efficiency and least losses of water, thus contributing to assured delivery of water to the on-farm canal network. The work included in rehabilitation of canal cross sections may be grouped as follows:

- canal lining repairs;
- increasing canal lining;
- earthworks on canal banks and inspection roads, and
- removal of sediment.

- Canal lining repairs

190. Lining repairs will be undertaken where it has deteriorated. Implementation of works involves the removal of dilapidated works, all preparatory tasks such as slope and base preparation for in-situ casting of concrete, any formwork and incidental joint filler. The work item includes the making good of lining cracks which should be properly opened up to a width of about 5 cm to allow for proper filling with a suitable concrete mix and to achieve bonding between different materials. Canal lining repair work is spread over the total length of all canals and includes a 300m long reach on Narpay MC (LB) not presently provided with concrete lining. A total of some 565m³ concrete lining work will have to be executed under the project to repair defective concrete lining panels. Summary details of lining repair volumes for each canal are given in Table 18 below.

Table 18: Canals - Summary of work volumes

No	Works	Narpay MC (RB)		Narpay MC (LB)		Turkistan MC		Sum	
		Length	Qty	length	qty	qty	length	length	qty
		M	m ³	m	m ³	m ³	m	m ³	m ³
1	Repair of concrete lining	15,837	259	6,400	297	9,300	9	31,537	565
2	Increase concrete lining	4,347	261	2,837	170	6,600	317	13,784	748
3	Embankment work	4,347	11,737	2,837	8470	6,600	17,820	13,784	38,027

No	Works	Narpay MC (RB)		Narpay MC (LB)		Turkistan MC		Sum	
		Length	Qty	length	qty	qty	length	length	qty
		M	m ³	m	m ³	m ³	m	m ³	m ³
4	Inspection road	15,837	12,670	6,400	5120	9,300	7,440	31,537	25,230
5	Sediment removal	15,837	3,489	6,400	745	9,300	2,675	31,537	6,909

source: ADB TA 7061-UZB, August 2008

d) Increasing canal lining

191. All three inter-farm canals appear to have been constructed in reaches with varying freeboards. To reduce the risk of canal overtopping and to safely accommodate peak flow requirements the rising of canal lining is envisaged for some 13.7 km selected reaches or about 40% of total inter-farm canal length on Narpay scheme. Lining will be increased by 20 cm on average totalling nearly 750 m³ of additional concrete lining, nearly 50% of which needs to be executed on Turkistan MC. In this context attention is also drawn to the reach upstream of the new cross regulator at the Chorvador pump station where it will be necessary to raise the canal lining for a distance of some 1,100 m; as far as the next cross regulator upstream, i.e. at chainage 3.7 km. Summary details of works by canal are given in Table 18 above.

- Earthworks on canal banks

192. Canal reaches with increased lining height require building up of canal bank tops. This is necessary to ensure proper support of increased concrete lining works. In such reaches embankments need to be increased by some 20 cm on average. Building up of bank tops will require scarifying operations before placement of additional earth material. Essential in this context is proper mixing of scarified material with that newly brought in to fill the missing part. Selective material should be used, omitting any dispersive material such as gypsum or clays. Tight control of moisture for compaction of material is essential for achieving well compacted layers. The total volume of earthworks has been estimated to equal some 38,000m³ with nearly 50% of the volume to be executed along Turkistan MC. Earthwork at Turkestan MC allows for reshaping selected reaches of the hill side bank top to direct surface water runoff towards canal cross drainage structures or canal overshoots. Summary details of work to be executed by inter-farm canal are given in Table 18 above.

- Inspection roads on canal banks

193. Canal side inspection roads facilitate scheme operation and maintenance, access to water monitoring installations and the on-farm infrastructure. They are essential for delivering agricultural inputs to fields and speedy removal of harvested products from the area. Road surfaces located on canal banks have not only degraded, they simply do not exist anymore or may not have been provided for initially. Rehabilitation of roads comprises preparatory scarifying of existing earthwork, hauling in of material from sites not more than 2.0 km away from work sites, proper mixing of scarified with newly brought-in material prior to compaction and well controlled water applications to achieve good quality compaction. The road surface layer is assumed to have a 4.0m width (shoulder not less than 0.5m wide on either side of the road), and a 20 cm working depth for addition of material. The total volume of work amounts to some 25,200m³ for all canals. Of this amount some 12,670m³ of material are required to rebuild the inspection road of Narpay MC (RB). Details about work volumes by canal are given in Table 18 above.

- Sediment removal

194. Sediment deposits in canals are the result of deferred maintenance but must be removed from canal cross sections to facilitate the execution of other works. There are no serious sedimentation problems affecting the operation of pumps or canals, primarily as sediment is generally of the colloidal fraction. The total volume of sediment to be removed has been assessed as 6,909m³. Of this amount some 3,489m³ are to be removed from the Narpay MC (RB), another 745m³ from the Narpay MC (LB) and the remaining 2,675m³ from the Turkestan MC.

e) Canal structures

195. Work grouped under canal structures includes rehabilitation of existing works, repairs to some and the installation of new works. The works may therefore be summarized as including but not limited to:

- selective works in conjunction with the regulator at the Narpay Primary Canal associated with the Narpay pump station,
- the rehabilitation of existing regulators along the Narpay MC (RB), improvement of canal tail ends,
- rehabilitation, improvement and new construction of canal offtakes; and
- the addition of measuring structures along the three inter-farm canals and below each offtake to the on-farm canal network. Table 19 below shows summary work volumes.

Table 19: Structures - Summary of work volumes

No	Works	Unit	Narpay MC (RB)	Narpay MC (LB)	Turkestan MC	Total volume
1	2	3	4	5	6	7
	RC concrete	m ³	1,168	303	715	2,186
	Gates and Lifts	Units	22	10	14	46
	Electric drives	Units	9	0	0	9
	Earthwork	m ³	11,824	2,770	8,625	23,219
	Asphalt	m ³	39	0	0	39
	RC concrete/ asbestos pipes	M	8	72	254	334
	Stainless steel sheets	m ²	17	2	2	21

Source: ADB TA 7061-UZB, August 2008

196.

197. Cross regulator on Narpay primary canal (km 32.591): The works comprises the installation of a new gate at the right side of the structure, including any preparatory tasks, delivery and installation of gate, frame and all fixtures required. All gates will be provided with electric drives to facilitate timely and more accurate gate setting. In addition, rehabilitation of a 30m long section of concrete lining below the cross regulator structure on the left side of the Narpay Primary Canal has been included.

198. Off take structure – Narpay MC (LB): The existing head regulator for the Narpay MC (LB) will be removed and reconstructed to its original design specification. This includes a new gate, frame and drive but no electrification. Provisions include for miscellaneous works and structure transition to the regular canal cross section.

199. Cross regulators on Narpay MC (RB): The four existing cross regulators, located at chainage 1.400 km, 3.700 km, 9.070 km; and 12.310 km, will be rehabilitated to their original design specification. This involves demolition and removal of degraded concrete works, including foundation work, casting of wing walls and deck. Provisions include delivery and installation of new gate frames, gates, motorized lifting devices and all

miscellaneous items and incidental works. An additional cross regulator will be constructed immediately downstream of Chorvador pump station, at about km 4.800. It is proposed that this should be a simple side weir structure.

200. Escapes: An escape will be constructed immediately upstream of the new regulator at Chorvador pump station such that it can discharge into a nearby existing drainage channel. This will prevent overtopping of canal banks in the event of a power failure to the Chorvador pump station or mismanagement of the flow in the canal. The escape should have its crest 200 mm below the top of the raised canal lining and the crest should be 25 m long.

201. Offtake structures to on-farm canals: All of the existing 34 canal offtake structures will be repaired or rehabilitated and 6 new offtakes are proposed to be constructed along the head reach of Turkestan MC. Rehabilitation may be summarized as follows:

- Five offtake structures on Narpay MC (RB) require only minor repairs while nine need substantial rehabilitation. Rehabilitation includes replacement of headwalls at both ends of the pipe conduits, delivery and installation of new gates, frames, gates and lifting devices, and construction of downstream outfall basins.
- The offtake structure to the right of the canal at Chainage 15.490 km will require substantial remodelling as it is to be moved to upstream of the tail end side weir on Narpay MC (RB). All work volumes for remodelling of the offtake have been included.
- Similarly the offtakes located on Narpay MC (LB), all of which will have their headwalls on both sides of the pipe conduit replaced, new gates and lifting devices installed and downstream outfall basins constructed.
- The existing offtakes on Turkestan canal will be completely replaced with new ones together with the construction of six additional offtakes to facilitate development of some 140 ha for irrigated agricultural production.

202. Measuring structures (hydro posts): It is proposed to install new gauging weirs of the International Standard ISO 4360³² type downstream of the three cross-regulators on the Narpay Right canal and downstream of the three tail-end structures. A similar ISO 4360 gauging weir will be provided at each of the 40 offtake structures to ensure that the gate is set accurately to deliver the flow required at that offtake; the provision of the gauging weirs on the canals will give a check that the water is being managed correctly.

203. Tail end structures: Tail end structures will be provided at the end of the three canals to maintain the water level upstream of the final offtake gate. The flow that passes over weir will be measured by a gauging weir. These tail end structures will be in the form of simple side weirs.

204. Cross drainage structures: There are eleven locations along the Turkestan MC where cross drainage structures convey surface runoff from the lower slopes of the nearby hills safely across the canal. The locations of cross drainage structures 1.242 km, 2.823 km, 3.351 km, 4.138 km, 5.834 km, 6.111 km, 6.349 km, 6.673 km, 8.735 km, 9.227 km, and 7.454 km along the Turkestan MC. They comprise of two double and nine cross drainage structures with single pipe barrels.

- Four of the eleven cross drainage structures require complete reconstruction, involving excavation and removal of the existing works including opening up of the irrigation canal crossing above.

³² International Standard ISO 4360, Liquid flow measurement in open channels by weirs and flumes - Triangular profile weirs, Second edition - 1984-12-15

- The other seven cross drainage structures will need to have their headwalls and sidewalls rebuild as well as pipe end sections replaced.
- For all cross drainage structures adequate attention must be paid to rebuilding of structure transitions.

205. Road bridge – Canal crossing at Chorvador pump station: To provide easy and efficient access to the pump station, it is proposed to construct a motorable road crossing immediately adjacent to the Chorvador pump station building. This road bridge will have dimensions adequate to permit vehicles with a gross weight of no more than 6 metric tons to cross over the canal.

206. Overshoots: At a number of locations along the Turkestan MC, surface water enters the canal. A total of five overshoots have been identified though only two locations have at present be unambiguously ascertained, i.e. at chainage 2.484 km and 8.328 km on Turkestan MC. The other three overshoots require more detailed site investigations. Overshoots will be constructed to carry surface runoff safely to the down-slope side of the canal.

f) Drainage

207. Primary, collector and inter-farm drainage channels crossing the Narpay scheme command area were not inspected but have been reported to be marginally operational, only, and to suffer from deferred sediment removal and reshaping. Reportedly this has not contributed to widespread rises in groundwater levels or even waterlogged areas, probably because the soils are generally free draining. With the exception of a 10 ha area within the command area, no groundwater or waterlogging issues have been reported. Hence, based on a 20% loss of cross section area due to sedimentation and channel side slope deterioration, a bed width of 1.0m and a collector channel depth of 3.0m to 5.0m, the volume of sediment within a collector drain amounts to between 3,300m³/km and 8,500m³/km drainage channel. The total sediment volume to be removed from such drainage channels has been estimated to equal about 161,400m³. However, it is the middle or lower reaches for most of the drainage channels which pass through the command area. Further channel sedimentation downstream of the subproject area is likely to occur increasing the risk of seasonally rising groundwater levels. The problems associated with increasingly dysfunctional drainage channels have been recognized. The Ministry of Finance, under instruction from the Office of the Cabinet Ministers has established the “Amelioration Fund,” primarily to fund land improvement and drainage channel rehabilitation works. While the Project will rehabilitate drainage channel reaches within the subproject area, this activity needs to be closely coordinated with the Government’s “Amelioration Fund” to ensure that downstream drainage channel reaches will be attended to in time and prior to implementation of subproject drainage desilting activities.

3. Narpay Cost Estimates

208. The cost of the Narpay Subproject total \$13.264 million (SUM17,509 million) to be implemented over three years 2009 – 2011. A breakdown of the costs is shown below.

209. The cost of rehabilitation of the pump station contributes 69% to the total costs with the pumps and motors making up 39%. The repair of the Narpay rising main costs \$1.66 million, or 15% of base costs. The rehabilitation of the irrigation canals and infrastructure costs \$1.198 million or 11% of base costs. Total costs including contingencies (10% physical and 6% for design and supervision) represent an average cost of \$1,541 per ha of the 8,605 ha command area.

Table 20: Summary of Narpay Subproject Costs

Item	\$ million	% of Total
Narpay Pump Station		
Pumps and Motors	4.420	39
Valves & piping	1.784	16
Other works	0.343	3
Electrical system & Instrumentation	1.096	10
Civil Work	0.281	2
Subtotal	7.923	69
Charvador Pump Station	0.551	5
Narpay Rising Mains Repair	1.661	15
Narpay Machine Canal (right branch)	0.639	6
Narpay Machine Canal (left branch)	0.193	2
H. Turkiston Machine Canal	0.366	3
Drainage rehabilitation	0.97	1
Total Base Costs	11.435	100
Contingencies (10% physical and 6% design & supervision)	1.83	16
Grand Total	13.264	116

4. Implementation Arrangements

210. Following loan approval it is assumed that a minimum six months will be required to identify and engage a suitably qualified Consultant for detailed design and supervision. A minimum of further 5-6 months will be required to complete the design work and to finalize tender and contract documents for the rehabilitation work. Rehabilitation works to be undertaken can be divided into the following packages:

- One ICB contract for pumps, motors, pipes, electrical and ancillaries

211. One ICB contract will concern the rehabilitation of pumping station including supply and installation of pumps and motors, all associated and miscellaneous mechanical and electrical equipment plus necessary civil works for installation of pump sets and refurbishment of the pump station building. The package further includes the rehabilitation of the intake structure and the three rising mains. The contract package could be a turnkey contract for the supply, installation, testing and commissioning of a complete pumping system and including provisions for training of local personnel, supervision of operation and maintenance of works for a period of one year from the date of commissioning and handing over.

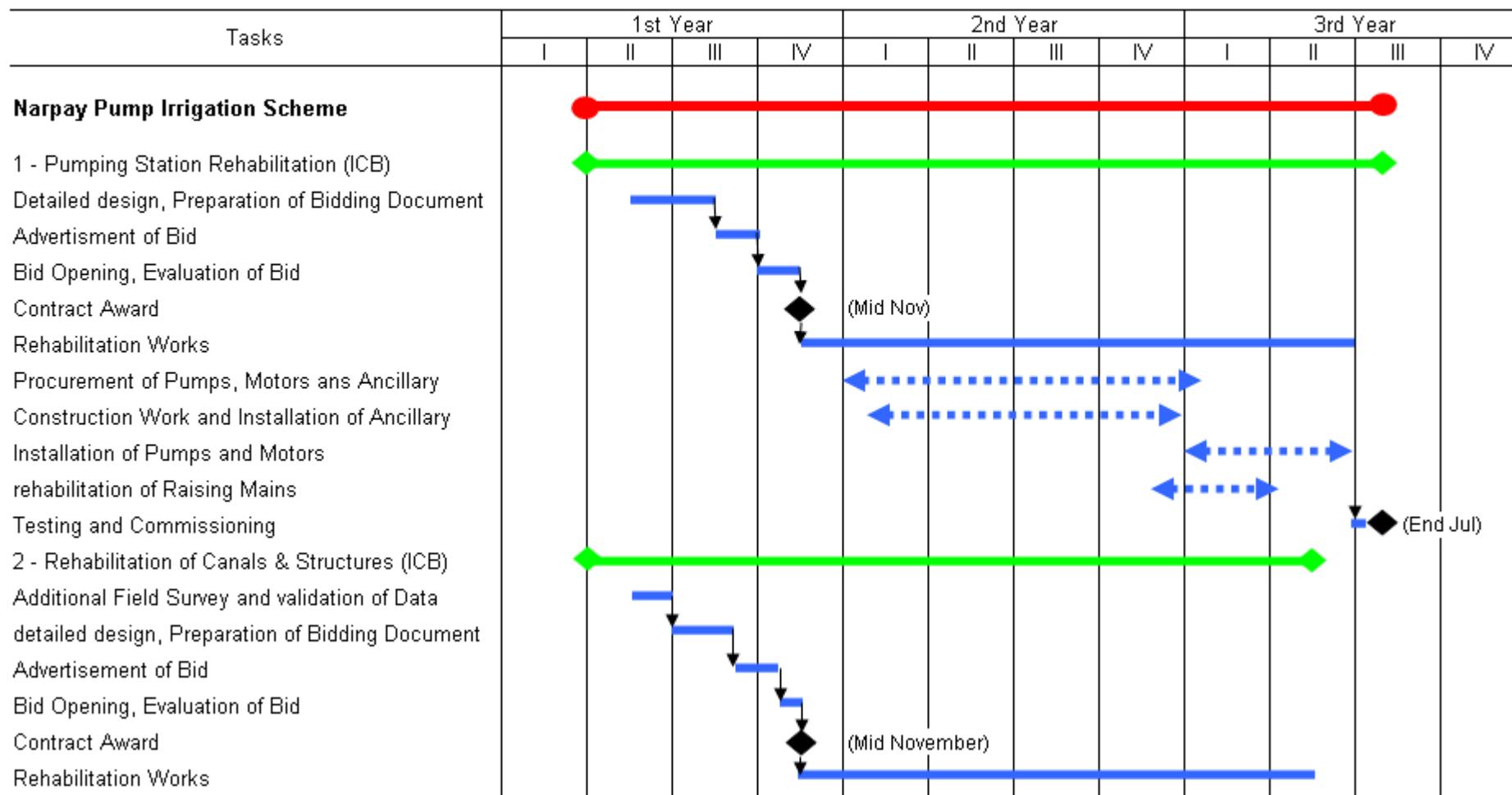
212. A minimum working period of 18 months extending up to 24 months will be required to complete the rehabilitation work of pumping stations. With pumps, electrical motors and valves having a delivery time of 8 to 12 months, actual rehabilitation work may likely be started by the end of 2009 or at the beginning of 2010. Completion of contract may therefore be earliest by mid-2011.

- One to three ICB contracts for rehabilitation of canals and structures

213. ICB(s) will relate to the rehabilitation of canals and structures. Implementation of civil works contracts requires closure of the canal network. Issue of more than one contract for implementation of rehabilitation works will be advantageous as it would permit completion of works during two canal closure periods. Hence civil works contracts may require a period of 15 to 18 months, thus allowing for two canal closure periods within the contract time. Thus work could possibly be started by the end of 2009 and completed by spring 2011.

Figure 1: Narpay irrigation scheme - Implementation Schedule

Narpay Pump Irrigation Scheme Implementation Schedule



5. Financial and Economic Analysis

a) Project area and beneficiaries

214. The Narpay pump irrigation scheme's net command area (irrigable) is assessed as being 8,605 ha made up of 8,335 ha of private farms and 270 ha of *dekhan* farms.³³ The number of Water User Association (WUA) members registered for the scheme area is recorded as 223 (June 2008) who own 6,760 ha with an irrigated area of 6,176 ha. The number of *dekhan* farms is estimated to be 1,350 based on an average holding size of 0.20 ha. The socio-economic household survey conducted as part of the feasibility study recorded the population of the Narpay subproject areas as 13,700 in 2,970 households (average family size 4.61), all classified as being rural. Farmers are organized into WUA responsible for water scheduling and the maintenance on on-farm irrigation facilities and WUA will be the main means of building farmers' capacity.

b) Key assumptions in the financial and economic analysis - prices

215. The feasibility study used prices prevailing in mid 2008. For traded commodities (cotton, wheat, and fertiliser) economic prices were prepared based on border parity using the World Bank's commodity price forecasts of May 2008. Prices of non-traded goods and services are in mid 2008 prices based on prevailing prices in the Narpay subproject area collected during the feasibility studies. Farm machinery costs were based on average current rates for services provided by machinery service providers with a 25% increase to allow for recent price increases. These prices were considered as being similar to the economic price and no adjustment was made in the economic analysis. On the other hand agricultural labour is given a shadow value of 0.85 in recognition of the high rates of unemployment and underemployment in the province. The current rates for land tax (based on the *bonitet* score) and WUA fees are included in the crop budgets, although the land tax is excluded from the economic analysis as it is a transfer payment. No charge is included for water as currently farmers are not required to contribute to water costs, except for a very low nominal charge.³⁴ Maintenance of on-farm irrigation infrastructure is the responsibility of the WUA, and is covered by the WUA charge. This charge is assumed to increase four times to Sum28,000 per ha.

216. The economic cost of electricity is assumed to be \$ 5 cents per kWh (SUM66) which is comparable with the current financial price of SUM52.5 /kWh in Uzbekistan³⁵. For the derivation of the economic costs of investment in rehabilitation works, a standard conversion factor of 0.85 was applied in order to reflect the removal of taxes and duties and inefficiencies in the economy. An exchange rate of \$ 1.0 = SUM 1320 has been used. The economic and financial analyses are undertaken in constant 2008 prices assuming a project life of 30 years and assuming an opportunity cost of capital of 12%.

c) Project benefits

217. The project benefits will emanate from the three main interventions of the project: first, the rehabilitation of the Narpay and Chorvador pump stations to properly serve their command areas (including the Narpay rising main); second, rehabilitation and upgrading of the inter-farm irrigation system; and lastly the impact of improved water management from the support to the Zarafshan BISA and WUAs serving the Narpay subproject area. The benefit from the support to the BISA and WUAs will have a direct impact on water management, irrigation efficiency and farm productivity. Enhanced on-farm water

³³ The actual precise area will need to be confirmed during detailed design.

³⁴ Some WUA charge an amount of 23 Tiyn per m³ for water, which for a typical consumption of 20 kilo m³ per ha is equivalent to SUM4,600 per ha, or \$3.49. This may be included in the WUA fee.

³⁵ UK Energy Research Centre. Review of Electricity Unit Cost Estimates. May 2007. This study estimated the levelised costs of gas electricity generation to be £3 pence per kWh, equivalent to \$ 5 cents/kWh.

management is expected to result from the rehabilitation of irrigation infrastructure as well as better irrigation scheduling and in-field water control

- The Without Project situation

218. In the without project situation it is assumed that the Narpay pump station, its rising main and the irrigation system will continue to deteriorate with a resultant decline in the volume of water delivered to the command area especially during the peak period of demand from June to September. The Narpay pump station was constructed in the 1970s, its pumps and motors are well past their design life, and despite MAWR efforts in maintaining the pumps they are failing and need replacement. MAWR staff consider that the remaining life of the pumps for Narpay, despite their efforts is no more than five years.

219. A reduced water supply will lead to a reduced area planted and declining agricultural productivity on the remaining irrigated area, with reduced yields and less intensive cropping. As irrigation supply becomes more unreliable, because of more frequent pump breakdown farmers will lose confidence in the irrigation system and reduce their investment in agriculture accordingly – lower use of fertiliser and less attention to good practices, and eventually abandon their land.

- Future With Project situation

220. The “future with” project situation for Narpay is that the pump station will be restored to a capacity to fully satisfy water demand in the command area with improved energy efficiency. Some savings in the operation and maintenance costs of the pumps and motors will also occur, in the initial years at least, as the new equipment will not require the same level of repairs and maintenance as is the case now. However adequate levels of O&M must be provided to ensure that the equipment is kept up to standard and able to function throughout its design life and deferred maintenance does not occur. Agricultural productivity would be restored to the full level for the command, combined with a modest increase in yields and an increase in cropping intensity because of the gains in water use efficiency brought about by the associated support to water management and the WUAs. Rehabilitation of the irrigation infrastructure will reduce water losses and allow better water management.

221. A summary of the main assumptions concerning the “future without” and “future with” Project situations for the financial and economic analysis of the Narpay pump scheme subproject is presented as follows.

- Future Without Situation

- The six pumps currently in operation progressively decline to only two pumps delivering 30% of the current volume of water by 2016 (year 8) and to maintain at that level for the duration of the project, to ensure continuity of water supply for the domestic needs of people living in the command area.
- The irrigated area to decline from a current intensity for a command areas of 8,605 ha of 95% to 30% after 8 years, or an irrigated area of 2,600 ha
- A reduction in crops yields of 10% over a period of eight years. Cotton to decline from 2.5 to 2.25 ton/ha and wheat to decline from 4.19 to 3.771 ton/ha
- The Charvador and Turkistan pump stations stop operating in year 2012 as a result of reduced water supply from the Narpay PS and the command area above the Narpay Machine Canal right branch is abandoned.

- Expenditure on operation and maintenance for Narpay PS to reduce by 50% in 2016, reflecting the fewer pumps in operation. Electricity consumption to reduce in line with the reduced volume of water pumped.

- Future With situation

- Narpay and Charvador pump stations rehabilitated with a capacity to service the command area of 8,605 ha.
- New pumps and motors have a 20% improvement in energy efficiency.
- Net command irrigable area to remain at 8,605 ha
- Crop yields increase by 6% for cotton and 7% for wheat from current levels
- Cropping intensity increases to 115%, with inclusion of more profitable crops – vegetables and potatoes. Cotton and wheat continue to be the dominant crops in the cropping pattern.
- Benefits to accrue over three years from the completion of rehabilitation.
- Water use efficiency to increase by 10% over a period of 10 years after rehabilitation of the scheme and the associated support to the BISA and WUA training. The volume of water saved would be used elsewhere in Zarafshan at an average net economic return to water of \$226 per ha.

d) Financial analysis

- Crop yields and gross margins

222. Crop budgets for the range of crops found in the Narpay scheme were prepared including cotton, wheat, maize silage/fodder, vegetables, annual forage and fruit trees representing the current situation and with the inclusion of melons and potato for the “future with” project situation. They are in 2008 financial prices. A summary of the yields and gross margins for Narpay subproject is presented in Table 21 below.

Table 21: Narpay Subproject - Summary of Crop Budgets

Source: Consultants estimates based on Dept. Agriculture data

Crop	Yields kg per ha			Gross margin Sum'000 per ha		
	Present	Future w/o	Future with	Present	Future w/o	Future with
Cotton	2,500	2,250	2,650	134.4	101.8	142.8
Wheat	4,190	3,771	4,500	366.8	300.1	402.6
Maize silage	9,780	8,802	12,250	79.3	54.7	141.2
Lucerne fodder	8,000	7,200	12,000	314.1	273.4	612.8
Vegetables	16,000	14,400	16,800	1,013.2	810.3	1,012.9
Melon	15,000	13,500	15,750	1,420.2	1,245.8	1,506.4
Potato	17,000	15,300	17,850	5,950.0	4,096.4	2,037.5
Orchards	4,370	3,933	4,589	495.9	409.0	514.2

Crop	Yields kg per ha			Gross margin US\$ per ha		
	Present	Future w/o	Future with	Present	Future w/o	Future with
Cotton	2,500	2,250	2,650	101.79	77.11	108.18
Wheat	4,190	3,771	4,500	277.85	227.34	304.97
Maize silage	9,780	8,802	12,250			

				60.04	41.43	106.94
Lucerne fodder	8,000	7,200	12,000	237.99	207.09	464.27
Vegetables	16,000	14,400	16,800	767.59	613.89	767.38
Melon	15,000	13,500	15,750	1,075.92	943.78	1,141.23
Potato	17,000	15,300	17,850	4,507.58	3,103.33	1,543.59
Orchards	4,370	3,933	4,589	375.71	309.83	389.56

Source: Consultants estimates based on Dept. Agriculture data

223. Vegetables, melon and potato show the highest return while the gross margin for wheat is more than double that for cotton.

- Command area and number farmers

224. The net command area (i.e. land that could be irrigated) for Narpay scheme is stated as 8,605 ha by the Department of Agriculture, although in recent years it is evident from other records that the full command has not been irrigated. There are two categories of farms in Narpay scheme: 8,335 ha of private farms with an average holding size of 30 ha leased from the State and 270 ha of *dekhan* farms.³⁶ Most (60%) of *dekhan* farms are located next to the owner's household and mainly used for production of fruits and vegetables while 40% are situated some distance from the village in the scheme area and more commonly used for producing forage. In addition to the private and *dekhan* farmers it is estimated that a further 2,500 agricultural workers are attached to the land in permanent employment. A large number of people are also employed as seasonal workers, especially to harvest cotton.

225. Analysis of the 223 farms recorded as belonging to WUA in June 2008 shows a considerable variation in the size of land holding from less than 5 ha to 265 ha. Farms of less than 10 ha make up 23.5% of farms while those more than 50 ha make up 17% of the farms and 42% of the area. There is not much variation in cropping pattern with farm size as all farms are required to grow around 50% cotton in accordance with their lease agreement with government.

Table 22: Narpay Subproject - Summary of Farm Size Distribution

Farm size	No farms	% of farms	Area	% of area
Less than 10 ha	52	23.3%	268	4.0%
10 - 20 ha	38	17.0%	534	7.9%
20-30 ha	37	16.6%	920	13.6%
More than 30 ha	96	43.1%	5,038	74.5%
Total	223	100.0%	6,761	100.0%

- Cropping patterns and production

226. The predominant crop is cotton which is grown on 50% of the area with winter wheat the next most important crop with 26%. A summary of the present land use in the command area based on an average of the three years data 2005-2007 provided by the District Agriculture and Aquaculture Department is presented in Table 23 below. Currently the cropping intensity is 95% with over 500 ha of land in the scheme area not cropped. Total annual production is estimated as 11,000 ton of cotton, 9,500 ton of wheat and around 10,000 ton of other products - vegetables, fodder etc. It is interesting

³⁶ The last of the Shirkat cooperative farms in Narpay scheme was converted to private farms in 2007.

that *dekhan* farms that make up only 3.14% of the command area contribute 6.85% to total output, which is a reflection of the higher yields and greater productivity from *dekhan* farms. No cotton is grown on the *dekhan* farms.

Table 23: Narpay Subproject - Summary of Land Use 2005 - 2007

Crop	Area			Percentage of Total			Total Scheme
	Private farms	Dehkan farms	Total ha	Private farms	Dehkan farms	Total ha	
<u>Annual crops:</u>							
Wheat	2,241	25	2,266	98.9%	1.1%	29.9%	28%
Cotton	4,317	-	4,317	100.0%	0.0%	57.0%	54%
Vegetables	181	9	190	95.1%	4.9%	2.5%	2%
Maize silage & fodder	229	27	256	89.5%	10.5%	3.4%	3%
Other annual fodder	389	70	459	84.7%	15.3%	6.1%	6%
Perennial fodder/hay	76	11	87	87.4%	12.6%	1.1%	1%
Total annual crops	7,433	142	7,576	98.1%	1.9%	100.0%	94%
<u>Tree crops:</u>							
Orchards (fruits)	171	44	215	79.6%	20.4%	46.2%	3%
Vineyards	131	34	164	79.5%	20.5%	35.2%	2%
Mulberry	87	-	87	100.0%	0.0%	18.6%	1%
Total tree crops	389	78	466	83.3%	16.7%	100.0%	6%
Total	7,822	220	8,042	97.3%	3%	100.0%	100%
<u>Second cropped area</u>							
Maize (fodder/silage)	161	0	161	2%	0	2%	
Total Cropped area	7,983	220	8,203	97%	3%	102%	102%

Source: District Agriculture and Aquaculture Department

Table 24: Narpay Subproject - Summary of Crop Production 2005 - 2007

Crop	Yield (ton/ha)			Total production (ton)			% of Total
	Private farms	Dehkan farms	Overall Ave.	Private farms	Dehkan farms	Total	
<u>Annual crops:</u>							
Wheat	4.17	5.60	4.19	9,348	140	9,488	28%
Cotton	2.53	-	2.53	10,922	-	10,922	32%
Vegetables	15.59	26.57	16.13	2,822	248	3,070	9%
Maize silage & fodder	8.62	19.60	9.78	1,974	529	2,503	7%
Other annual fodder	8.59	10.70	8.91	3,342	749	4,091	12%
Perennial fodder/hay	6.53	9.55	7.31	496	140	636	2%
Total				28,904	1,806	30,710	91%
<u>Tree crops:</u>							
Orchards (fruits)	3.70	6.95	4.37	634	306	940	3%
Vineyards	3.34	5.73	3.83	437	193	630	2%
Mulberry			-	0	0	0	0%
Total				1,071	499	1,570	5%
Total	-	-	-	29,975	2,305	32,280	96%
<u>Second cropped area</u>							
Maize (fodder/silage)	8.62	19.60	8.62	1,388	-	1,388	4%
Grand Total				31,363	2,305	33,668	100%

Source: District Agriculture and Aquaculture Department

227. In the “future with” Project situation the average cropping intensity is expected to increase to 115% with the introduction of vegetables and potato to the cropping pattern and an increase in the second crop of maize fodder grown after the wheat is harvested. Cotton will remain as 50% of the irrigated area assuming that the government’s mandatory requirement for farmers to grow cotton continues. The following Table 25 summarizes the “future with” project situation.

Table 25: Narpay Subproject - Future With Project Cropping Pattern

Crop	Area		Total ha	Percentage of Total		
	Private farms	Dehkan farms		Private farms	Dehkan farms	Total NCA
Annual crops:						
Wheat	2,384	25	2,409	28.6%	9.3%	28.00%
Cotton	4,303	-	4,303	51.6%	0.0%	50.01%
Vegetables	248	10	258	3.0%	3.7%	3.00%
Melons	86	-	86	1.0%	0.0%	1.00%
Maize silage & fodder	211	47	258	2.5%	17.4%	3.00%
Other annual fodder	256	90	346	3.1%	33.3%	4.02%
Perennial fodder/hay	411	17	428	4.9%	6.3%	4.97%
Total annual crops	7,899	189	8,088	94.8%	70.0%	93.99%
Perennial crops:						
Orchards (fruits)	208	45	253	2.5%	16.7%	2.94%
Vineyards	128	36	164	1.5%	13.3%	1.91%
Mulberry	100	-	100	1.2%	0.0%	1.16%
Total perennial crops	436	81	517	5.2%	30.0%	6.01%
Total cropped	8,335	270	8,605	100.0%	100.0%	100.0%
Not Cropped	-	-	-	0.0%	0.0%	0.0%
Total Net Command Area	8,335	270	8,605	100.0%	100.0%	100.0%
Second cropped area						
Vegetables	258	-	258	2.8%	0.0%	2.6%
Potato	172	-	172	1.9%	0.0%	1.7%
Maize (fodder/silage)	861	0	861	9.4%	0.0%	8.7%
Sub-total	1,291	-	1,291	14.0%	0.0%	13.0%
Total Cropped area	9,196	270	9,896	110%	100%	115%

Source: District Agriculture and Aquaculture Department and Consultants estimates.

- Farm budget analysis

228. An analysis of a typical farm budget for an average farm of 30 ha has been done to indicate the impact of the Project on net farm income. The farm model is based on the information on cropping pattern, yields, and inputs used in preparing the gross margins. Farms in the Narpay command area do not have much variation in their cropping patterns as the private farms are required by Government to grow a certain proportion cotton and wheat on their land and do not have any choice. *Dekhan* farms do have freedom of choice but as they only make up 3% of the command area, a separate farm model as not been shown for Narpay. The objective of the financial analysis of a typical farm is to show the effect of the project on the farm households’ net income and returns to labour as an indication of financial viability and to indicate the incentive farmers have to participate in the Project. For the farm budget analysis of the Narpay scheme the financial analysis is not as meaningful than for more usual irrigation development as the collapse of the pump station will lead to a reduction of the irrigated area to around a third of the command area, resulting in a drastic reduction in farm income per farm, and inevitably the financial ruin of many farmers. Moreover the farmers are not currently required to make any contribution to the Project, either as equity or voluntary labour, as a result of the rehabilitation they will receive the benefits with no costs. Currently farmers are not required to contribute to the pumping costs of water or to repay any of the investment costs except through the WUA fee.

229. Currently is estimated that an average farm of 30 ha generates an annual net income of around SUM 7 million (\$5,400), or around \$180 per ha. In the “without project” situation this would deteriorate to a net return of only \$54 per ha across the command area. In the “with project” situation the average farm would generate a net income of SUM 10.8 million (\$8,200) a 50% increase from the current situation. The incremental income per ha per year as a result of the project i.e. average returns per ha between the “future without” and “future with” project situation is estimated as SUM 300,000 per ha (\$225) which for the average sized farm of 30 ha represents an increase of SUM 8.9 million, or \$6,750 per farm, a 127% increase in net farm income. Not all the current number of farms would still be operating in the without project situation so this does exaggerate the average farm situation. The change in income per ha between the “present situation” and the “future with” project situation reduces to SUM 122,000 (\$92.70), which is still a significant 54% increase in net farm income over the current situation. This shows that the prevention in the loss of the irrigated area through rehabilitating the pump station is the major source of the benefits. Farmers will have sufficient benefits and incentive to participate in the Project, and the additional returns would allow them to contribute to water costs if the government continues with its policy to introduce a charge for recovering the cost of delivering irrigation water.

e) Economic analysis

- Project costs

230. The total rehabilitation cost of the Narpay subproject is estimated at \$11.434 million to which has been added 16% for physical contingency and design and supervision making a total cost of \$13.26 million, or \$1,560 per ha of command area. The rehabilitation of the Narpay pump station involving the replacement of eight pumps and motors is the most significant cost contributing 69% to the costs. Rehabilitation of the irrigation infrastructure is estimated to cost only \$1.5 million including contingency and design and supervision or 10% of total costs, - \$177 per ha. The project costs were converted to economic value by applied the conversion factor of 0.85.

231. Future operation and maintenance costs of the rehabilitated scheme are based on a percentage of the cost of the physical works and are estimated to total SUM 470 million per year (\$356,000), mostly for the maintenance of the pumps. However the application of the full O&M cost is delayed for five years after completion of the project because the new pumps are expected to require little maintenance in their initial years of operation and there is provision in the cost estimates for a supply of spare parts sufficient for the first five years of operation. The total cost of electricity per year is estimated to be \$2 million per year based on an economic cost of electricity of \$0.05 per kWh, (decreasing to \$1.89 million per year as improved water use efficiency reduces the volume of water pumped). Electricity costs are assumed to be 20% less for the same volume of water as in the current situation because of the more efficient motors and pumps to be installed. The crop budgets were adjusted for economic prices of inputs and outputs and taxes and transfer expenditure such as land tax excluded, then combined with the cropping pattern to show the cash flow of net benefits.

- Project benefits

232. The main Project benefit is the prevention of the reduction in the irrigated areas which would happen in the absence of the rehabilitation and benefits of a modest increase in crop yields of 5 - 7%, an efficiency gain of 20% in the operation of the pumps and an a gain of 10% in the efficiency in the use of water, which results in a lower volume having to be pumped to satisfy crop water requirements.

- Results of the economic analysis

233. The Narpay Project is found to be economically viable; the economic internal rate of return (EIRR) is 15.4%. At a 12% discount rate the net present value (NPV) is SUM3,040 million (\$2.3 million) and the benefit cost ratio is 1.14. The most important benefits are those generated by the Project through the prevention of the reduction in irrigation through pump failure, and to a lesser extent the saving in electricity consumption through more efficient pumps and the improvement in water use efficiency through support for water management and training WUAs.

234. The estimates of the benefits made possible by the Project are considered to be conservative, because the economic evaluation not does consider that the Narpay pump station will stop operating completely in the “future without” project situation but is assumed to continue to operate at one third of its current capacity. Even with this situation, there is likely to be major social dislocation in the project area because of the reduction in the irrigated area and loss of employment in agriculture, which would require some families to relocate to other areas. These costs have not been quantified and the actual benefit from the Project could substantially exceed those quantified for the analysis. A summary of the cash flows for the economic analysis is presented in Table 27.

- Sensitivity analysis

235. The EIRR calculation was subjected to sensitivity analysis to test the effects of negative changes in the key parameters that determine the benefits and costs of the Narpay subproject. The sensitivity analysis found that the Narpay subproject remains economically viable in the face of a 20% increase in costs but the EIRR would fall below 12% with a 20% decrease in net benefits. The switching value for increased rehabilitation costs was determined to be 21.5%, and the switching value for decreased benefits was determined to be 12.5%. The analysis is not sensitive to the economic price of electricity with a switching value of 37% indicating that the price of electricity could increase from \$5 cents to almost \$7 cents per kWh. Similarly a reduction in the irrigated area to zero in the without project situation after 10 years and conversely a 20% increase in the net irrigated area in the future without situation did not affect the EIRR significantly.

Table 26: Narpay Subproject - Sensitivity Analysis and Switching Values

Test Case	Test Variation (+/- %)	NPV Sum'000	EIRR	Sensitivity Indicator	Basecase Value of Parameter	Switching Value (+/-%)*	Switching Value
Base (reference case)		3,040,404	15.4%				
Increases in Costs							
Initial Capital Cost	20%	754,470	12.7%	3.76	\$13.08 m	21.5%	\$15.90 m
O&M Costs	20%	1,061,296	13.2%	3.25		31.0%	
Economic cost of Electricity	20%	1,284,178	13.5%	2.89	5 cents/kWh	37.0%	6.9cents /kWh
Decreases in Benefits							
Decrease in net benefits	-20%	-1,832,718	9.8%	8.01		-12.5%	
Increase in net command Future without	20%	2,272,689	14.6%	1.26			-
Total scheme failure by 10 years		3,783,349	16.0%		30% capacity	-100.0%	-
Price wheat & cotton	-20%	-2,814,635	8.5%	9.63		-9.0%	

* A switching value of "-100%" indicates that the parameter has no practical switching value, when all other benefits are held

constant.

236. Overall, the economic analysis is most sensitive to a reduction in the economic price of wheat and cotton as indicated by the Sensitivity Indicator (SI) of 9.63. The switching values in the above table show the percentage increase in a cost variable or decline in a benefit variable required for the NPV to become zero, which is the same as the EIRR reducing to the cut-off level of 12%.

Table 27: Narpay Subproject – Economic Analysis Summary Cash Flows

Constant 2008 SUM million							
Year	Economic Costs			Net Economic Benefits		Total Benefits	Net Benefits
	Capital Cost	Incremental O&M	Total Incremental Project Costs	Net Ag benefits	Economic value of saved water		
1 2009	1,488.27	-	1,488.27	-	-	-	1,488.27
2 2010	8,483.12	-	8,483.12	-	-	-	8,483.12
3 2011	4,911.28	156.61	5,067.89	1,643.13	-	1,643.13	3,424.76
4 2012	-	871.28	871.28	2,560.79	68.99	2,629.78	1,758.50
5 2013	-	1,424.83	1,424.83	3,293.44	82.78	3,376.22	1,951.39
6 2014	-	1,745.40	1,745.40	3,954.60	110.38	4,064.98	2,319.58
7 2015	-	1,966.51	1,966.51	4,337.39	137.97	4,475.36	2,508.85
8 2016	-	2,019.35	2,019.35	4,502.46	206.96	4,709.41	2,690.06
9 2017	-	2,156.44	2,156.44	4,529.36	275.94	4,805.31	2,648.86
10 2018	-	2,156.44	2,156.44	4,529.36	275.94	4,805.31	2,648.86
11 2019	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
12 2020	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
13 2021	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
14 2022	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
15 2023	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
16 2024	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
17 2025	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
18 2026	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
19 2027	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
20 2028	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
21 2029	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
22 2030	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
23 2031	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
24 2032	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
25 2033	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
26 2034	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
27 2035	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
28 2036	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
29 2037	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
30 2038	-	2,176.21	2,176.21	4,529.36	275.94	4,805.31	2,629.10
NPVs:	11,587	10,769	22,356	24,434	1,145	25,579	3,223
% NPVs:	52%	48%	100%	96%	4%	100%	
EIRR:							15.43%
EOCC =	12%						

- Benefit distribution and poverty analysis

237. The most recent information on the overall incidence of poverty in Uzbekistan is from the World Bank Living Standards report 2007³⁷, which based on 2003 data assessed the head count poverty rate as being 27.2 nationally and 29.8 for rural areas. The poverty rate for the Northern economic region where the Narpay subproject is located was 28.3. The results of the household survey of the Narpay subproject area conducted as part of the PPTA studies indicated a poverty rate of 30.5 (based on a consumption of 2100 Kcal per person per day as the poverty line).

238. The population in the Narpay subproject area as confirmed by the socio-economic survey has a high dependency on agriculture for employment and sustenance, with little opportunity for alternative employment. This means that there would be a sharp increase in poverty if the pumps were to fail and rehabilitation did not happen. For most poor household's production from *dekhan* farms and household plots and domestic livestock (cattle, sheep and poultry) is important for their subsistence and for generating some extra income, which would be seriously affected if water supplies were to be limited. Poor households are expected to benefit from the increased agricultural productivity resulting from rehabilitation, and the attention given to improved water management, particularly from the extra employment generated from increased production. For the Narpay subproject it is estimated that the rehabilitation of the scheme would generate an additional 142,000 person days (600 person years) per year of employment after full development and avoid in the "without project" loss of a similar number of person days. This is equivalent to an additional 16.5 person days per ha per year. Most of the additional employment is expected to accrue to rural agriculture workers and poor households. Therefore the poverty impact is likely to be pro poor.

6. Narpay Environmental Assessment

239. An IEE and SIEE were prepared for the Narpay subproject. The Narpay subproject is located within an arid area in which the environment has been extensively altered by the development of the irrigation system in 1978. The soils of the area are favourable to irrigation and there will be few concerns with regard to application of irrigation water providing water application is properly managed and drainage is maintained.

240. There were few alternatives with regard to the subproject and these have been addressed by the technical design in the selection and optimization of the pumping stations. The environmental assessment prepared an EMP that identified issues during pre-construction, construction and operation. The main design issues concern the need for the provision of staff facilities and addressing health and safety issues in the redesign of the buildings, provision of oil and water separators in the pump house, development of a worker safety plan for the pump station operators, improvement of on farm drainage which also requires the evaluation of lowering a culvert under the Samarkand-Tashkent railway line that is impeding drainage. Improved maintenance and safety training conditions are to be included in the procurement requirements, while the EMP conditions are to be incorporated in the bid and contract document. Contractors will be evaluated on their abilities to address the environmental compliance requirements of the EMP. Construction issues identified in the EMP include the need to undertake additional public awareness prior to construction commencing to advise farmers of the work schedule and how this will affect water supplies, induction of the contractor to site with regard to complying with the EMP, removal of trees along the canals, loss of livelihood caused by interrupted water flows, removal and disposal of excavated materials, opening of borrow areas, storage and handling of materials brought to site, noise and dust, solid and liquid

³⁷ World Bank Republic of Uzbekistan Living Standards Assessment Update. August 2007

waste management and rehabilitation and closing of sites. During operation the main issues identified in the EMP are: application of the training programs provided with the supply of the equipment for the sustainable maintenance and safe operation of the equipment.

241. Both informal and formal public consultation has been held and comments received from the formal consultation have been incorporated in the EMP. The EMP will be implemented by PMO with the Safeguards Officer being assisted by a nationally recruited Environmental Specialist and an internationally recruited Environmental Specialist who will assist in establishing the environmental management program. The cost of the EMP is included within the overall budget for the eight subprojects within the sector project of \$374,900. The subproject will not increase the amount of water extracted from the main supply canal nor will it increase the irrigated area that was originally designed for the subproject. The EMP has been able to address all of the impacts and it is concluded that an EIA is not required.

7. Resettlement Issues

242. The Land Acquisition and Resettlement Framework (LARF) has been prepared according to ADB guidelines (Appendix 8). The Subproject falls under Involuntary Resettlement Category C in which Land Acquisition and Resettlement Plan (LARP) is not required. While the subproject R&U may have impact on land, the subproject will not require permanent land acquisition that shall displace any person or affect any crops, properties or structure. Such impacts on land are expected, but only temporary, due to the excavation of three rising mains made of low alloyed steel, buried 1.0 m deep on soil. Subject to excavations are the first 450 m at the lower portion of high pressure three rising mains, each with length of 2.5 km. The excavation and R&U shall be undertaken in three months time which shall be scheduled from December to February to avoid disruption on water distribution and planting activities in the farms. The affected lands will be restored to their original condition. But in case of delay, the EA will have to pay compensation to farmers, equivalent to the value of crops grown on that portion of affected lands; this is provided for in the Subproject's Due Diligence Report (Supplementary Appendix E.1).

B. FEASIBILITY STUDY OF BESH ARYK CORE SUBPROJECT

1. Description of the Subproject

a) Present situation

243. The Besharyk subproject area is bounded by the Syr Darya River forming the border with Tajikistan to the north and Besharyk town to the south. The subproject is located in the western part of Fergana Valley, some 30 km east of Kairakkum reservoir in Tajikistan, and about the same distance west of Kokand city. The distance to Fergana city, the oblast administrative centre, is about 120 km east by road from Besharyk town. Besharyk pump station and related canal works became operational in 1978.

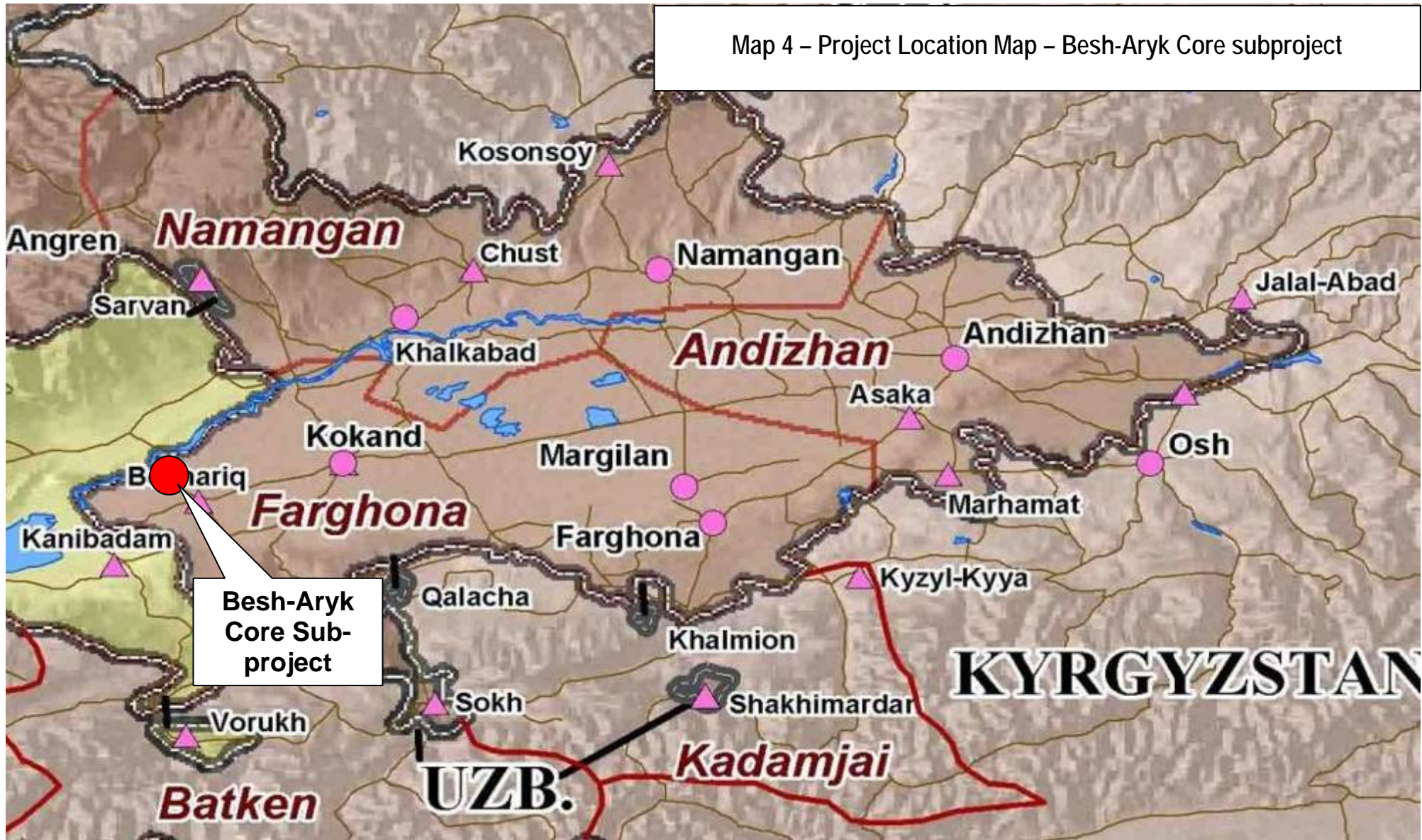
244. The Besharyk subproject area covers land located above the Syr Darya flood plain. The passport³⁸ for the pump station and other available subproject documents indicate the subproject's infrastructure to comprise of:

- an intake canal (length 750 m, flow depth maximum 3.5 m, bed width 6.0 m) between Syr Darya River (station³⁹ (ПК) 2,058 km) and Besharyk pump station with its forebay and trash rack;
- Besharyk pump station building (89m x 13m) with 10 pump sets, fed by an electrical substation (110/ 35/ 6kV) with two transformers (each 10MW capacity), and a common header structure with five rising mains;
- a set of four rising mains, diameter 1,420 mm and 1,220 mm, each 13.25 km long, delivering water to a stilling basin at an elevation of 34 m above the pump station site, plus one dedicated rising main of diameter 1,420 mm and 4.5 km long delivering water for irrigation and to a fish pond area;
- a stilling basin (width between 21 m and 18 m) with headwork structures for inter-farm canals M-1 and M-2, plus two other gated headwork structures to canals serving the pump station service area;
- inter-farm canals (M-1 and M-2): M1 with a length of 4.9 km supplying water to 12 off-take structures and M2 6.3 km supplying 15 off-take structures;
- 338 km of open channel collector drains evacuating runoff from about 80% of the service area, and 265 km of an on-farm drainage network;
- some 25 to 30 vertical drainage wells (VDW) within the subproject area to monitor and partially control groundwater levels.

245. Despite bordering the Syr Darya River the subproject area is unlikely to ever be inundated by river flood flows. However, areas immediately adjacent to the river suffer from partially impeded drainage as is indicated by the high groundwater table surrounding the Besharyk pump station building.

³⁸ A standard document commonly issued and containing technical data and specifications to identify an installation or asset

³⁹ River stationing is reported to start where the Syr Darya River discharges into the Aral Sea (km 0.000) and to proceed to its origin, the confluence of Naryn River with Karadarya River. Such river stationing is most unusual and has not been observed anywhere else.



Map 5: Besh-Aryk Core Sub-project

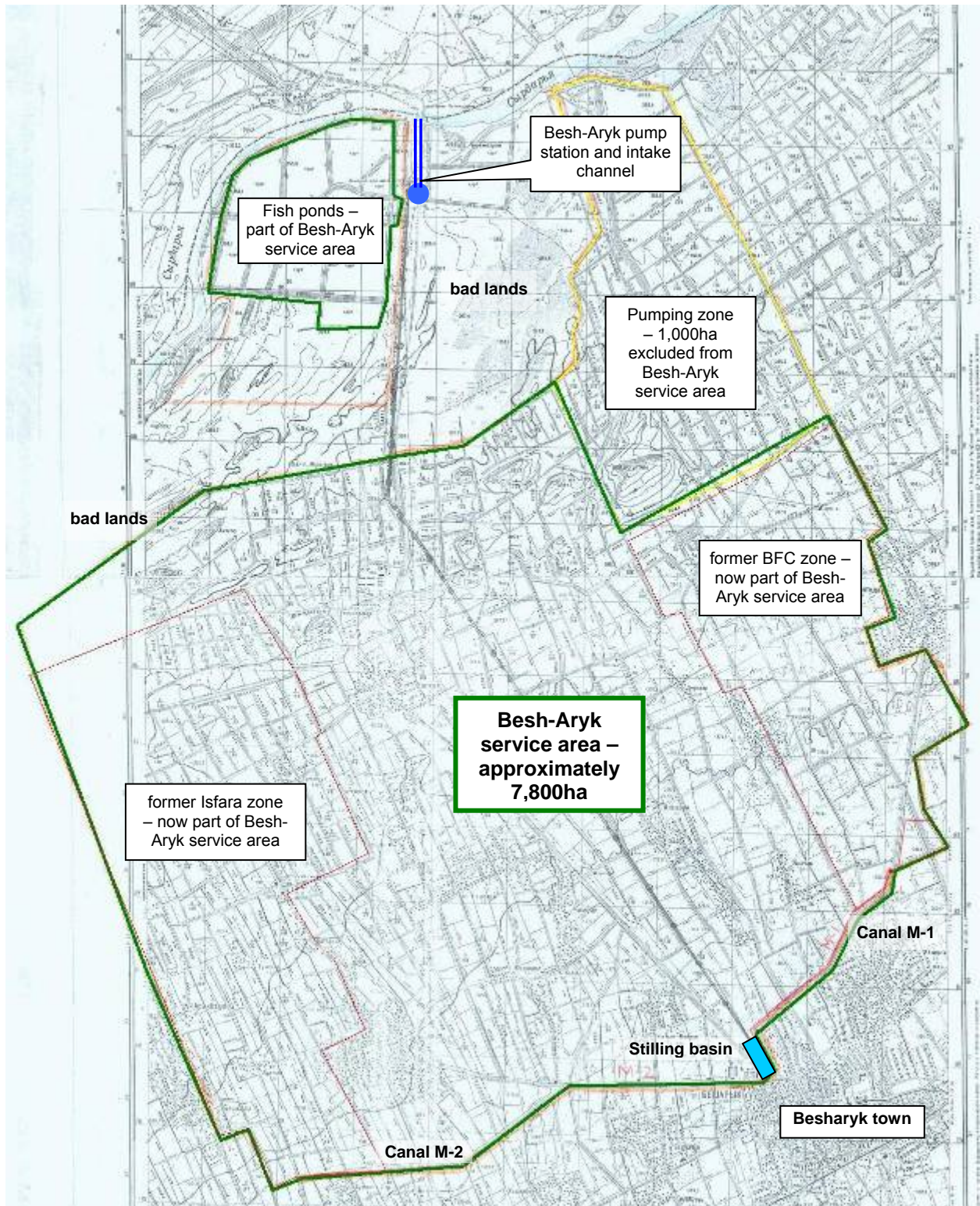


Table 28: Besharyk subproject - WUAs within the pump station service area

No	WUA Name	WUA area		Primary crop		WUA members		In Besharyk service area		
		Total		Cotton	Wheat	Total	Private Farms	WUA area		Private farms
		ha		Ha	ha	ha	nos	%	ha	nos
1	2	3		4	5	6	7	8	9	10
1	Besharyk Uttiz Ombor	3,313		1,288	738	140	115	90	2,982	73
2	T. Eshkuziev	3,137		1,416	1,110	158	145	47	1,470	32
3	Dekhkonov Ganizhon Dekhonovich	1,988		902	680	170	151	95	1,888	117
4	Igitali Meliev Melievich	1,793		898	724	130	115	80	1,434	32
5	Yakkatut Pakhtakor Faiz	4,436		1,910	1,252	295	265	15	668	13
6	Household plots	390		Plus encroachment on irrigated lands					390	
	Total	15,057		6,414	4,504	893	791		8,832	267

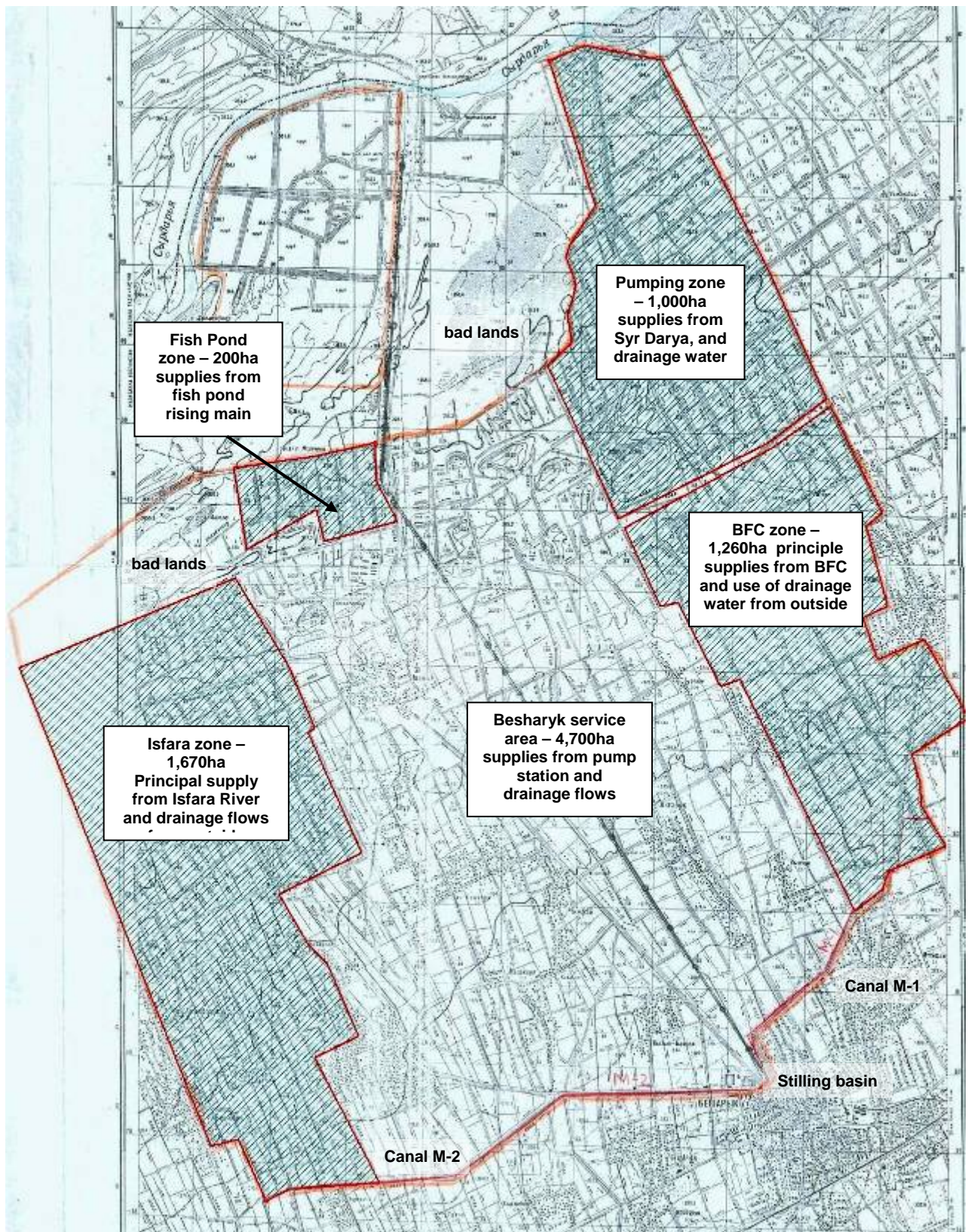
b) Assessment

246. The subproject infrastructure including the mechanical equipment for lifting and conveying of water has been in operation for 30 years since 1978. Available documentation indicates that the original scheme design had the capacity to meet the water requirements of a 5,000 ha to 6,000 ha area. However, a post-rehabilitation service area of 9,850 ha had been initially proposed but conflicts with the proposed boundaries of the Besharyk subproject scheme. The geographic area within the selected service boundaries suggests 8,832 ha maximum irrigable area including 396 ha *dekhan* farms and household plots within residential areas. Besharyk subproject service boundaries have been defined with the objective to incorporate areas formerly receiving water for irrigation primarily from the BFC and the Isfara River plus an area of about 1,000 ha presently supplied with water for irrigation directly from Syr Darya River by a cascade of small pump stations. The principle zones and their approximated areas are given in Figure 2 below.

247. While Besharyk pump station was installed with a nominal peak supply capacity of 14.0m³/s, the hydraulic configuration water lifting installations and rising mains permitted maximum deliveries of 7.0m³/s, only. Because of this overall scheme configuration – long rising mains, relatively short inter-farm canals serving lengthy on-farm canals (up to 10-12 km) – scheme water distribution remained unequal and inefficient, thus being the primary cause for a number of pressure pipe outlets installed along the rising mains. Unwittingly these installations improved the hydraulic performance of the pumping installations (more energy efficient) and increased the capacity to deliver water for irrigation to farmers.

248. Today, the pumping equipment is generally beyond its economic lifetime though has been kept operational by rigorous repairs and frequent reconditioning of worn parts. Pump station operation staff assesses pump sets as delivering no more than 0.9-1.0m³/s instead of the nominal 1.4m³/s capacity. Reportedly the pump station has never been allowed to operate more than 5 pump sets at a time, hence maximum supply capacity will have been 4.5-5.0 m³/s at best, sufficient to irrigate the 4,100 ha indicated by BISA Syr Darya-Sokh.

Figure 2: Besharyk - Zones of principal water supply for irrigation

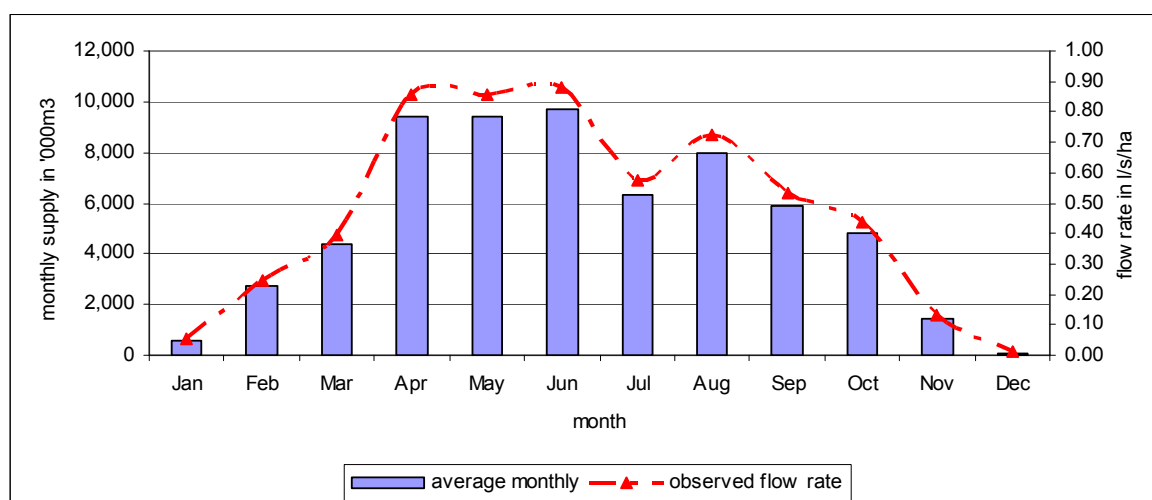


249. With reference to Figure 2 above, the “pumping zone,” BFC zone and Isfara zone earlier received supplies for irrigation from sources other than the Besharyk pump station. Except for the “pumping zone” receiving supplies from a separate pumping station on the Syr Darya River, supplies from BFC and Isfara River have nearly dried up or become extremely unreliable during the annual cropping season. Whereas the 1,000 ha of the “pumping zone” will be excluded from the Besharyk pump station service area, land within the BFC or Isfara zones shall become part of the subprojects service area, thus reducing the 8,832 ha proposed to 7,832 ha. However, no supplementary supplies to this service area are expected from either the BFC or the Isfara River during the annual cropping season. Though the Navkat (sometimes Naukat) canal links the BFC with the canal M-2 of the Besharyk scheme, the average inflow rate to the command area of canal M-2 is almost negligible as it remains below 0.3m³/s throughout the annual year. A more detailed account is provided in Section II.D, Supplementary Appendix C.1.

250. Pumped water supply volumes for the period 2000-2007 show that the average annual supplies equal 62.0 Mm³ but ranges from a 47.6 Mm³ in 2007 to as high as 74.8 Mm³ in 2001. Whilst this indicates irrigation supplies to range from 11,600 m³/ha to 18,200 m³/ha per annum for a 4,100 ha service area, it is the peak crop water requirement period which causes considerable uncertainties. With reference to Figure 3 below, the July supply volumes badly reconcile with actual crop water requirements when the primary cotton crop reaches its flowering stage. Eight years monitoring errors are unlikely to be the cause of consistently low supply volumes in July and it is therefore of high importance to establish the cause of low supplies during the months.

251. While sedimentation of the intake channel or possibly breakdown of pump sets may contribute to reduced supplies in July, this is unlikely to always occur in the month when water demand is highest. The stage discharge relationship needs to be ascertained to confirm river flow at pump canal intake with the difficulty that there is no nearby gauging station. River flow measurements are only available for Kal-Syr Darya gauging station (1998 to 2007) some 115 km upstream of Besharyk pump station which is insufficient to identify with accuracy the probable low flow water surface elevation.

Figure 3: Besharyk pump station – monthly supplies volumes and flow rates, period 2000 - 2007



252. The rising mains are buried in the ground, cannot be easily inspected but neither have been any substantial repairs been reported and hence are considered safe to use for another 20-year period provided use of rehabilitated pumping equipment does not exert excessive pressures. As mentioned above, a total of 8 pressure off-takes have been installed on rising mains between stations (ПК) 3.095 km and 8.090 km, and before

the rising mains discharge into the stilling basin at station (ПК) 13.25 km. At the stilling basin canals M-1 and M-2 take off, with canal M-1 having an initial design capacity of 5.5m³/s. Canal M-2 head reach has been identified as having cross section dimensions identical those of canal M-1. Other canal design parameters such as canal bed slope and roughness coefficients are assumed to be identical, too. Only topographic surveys can provide the necessary details to confirm these assumptions.

- River intake channel and risk

253. The river intake channel conveys water from the Syr Darya River to the suction pipes of Besharyk pump station and has a length of 750m, and a bed width of 6.0m. Minimum depth of flow is given as 1.5m and maximum as 3.2m. The channel regularly silts up and this limits its capacity to convey an adequate volume of water to the pump station, possibly restricting operation of pump sets at times when sediment reduces the channel capacity. Assuming a Manning's roughness coefficient of 0.23, the design intake channel conveyance capacity at 1.5m depth of flow equals 5.8m³/s at a velocity of 0.46m/s, while at 3.2m depth of flow some 23.5m³/s at velocity 0.68m/s would be conveyed to the intake pipes of the pump station. A recent topographic survey⁴⁰ of the intake channel indicates a bed slope of 0.0023 which, assuming all other parameters to remain equal, gives a conveyance capacity of almost 25m³/s, albeit at a velocity of not less than 2.0m/s. At such velocity much sediment would be carried into the channel with most of it deposited at the end of the forebay. There is no regular observation of water turbidity for the site of the intake channel. Reportedly, turbidity levels at the confluence of the Naryn and Karadarya rivers equal 1.1 kg/m³ for the first and 1.6 kg/m³ for the latter before 1992. Whereas particle size distribution of suspended sediment in Syr Darya River at the former Chilmakhram gauging station suggests that 80% are smaller than diameter 0.05 mm during spring season flow (probably the months of February to May), dropping to about 45% during the remaining months of the year. The largest particles observed are in the range of 0.5 mm to 0.8 mm. A single Syr Darya River water sample obtained and analyzed by the TA's environmental specialist monitors 0.926g/l sediment⁴¹ in July 2008.

254. To ensure adequate inflow to the pump station the present intake channel requires widening and deepening. This would to avoid early season channel sedimentation restricting water abstraction from the Syr Darya River and inflow to the pump station. Actual configuration of the intake channel must be based on a detailed review of a stage discharge curve at the intake channel site or a nearby location and detailed topographic survey of the intake channel site left side bank area and the intake location on the Syr Darya River. Uninterrupted river runoff volumes and flow depth readings are available for Kal-Syr Darya gauging station, 115 km upstream of the Besharyk pump station. Other records are limited to historical data for Chilmakhram gauging station (1970, 1977, 1980, and 1987) located about one kilometre upstream of Besharyk pump station but out of operation since 1992. While long term river discharge records are commonly used to define the probabilities of river discharge, this commonly assumes that no general changes have taken place in the river discharge regime. But this is precisely what happened concerning the discharge pattern of the Syr Darya River which primarily conveys flows from the Naryn and Karadarya tributaries. Both rivers pass through reservoirs, initially erected and operated to provide water for irrigation during the annual cropping period (principally April to October). However, the operation mode of the Toktagul reservoir on the Naryn River in Kyrgyzstan has been changed from one releasing flows for irrigated agriculture to one generating hydro-electric power primarily during the colder winter period (non-vegetation period). The Naryn River generates

⁴⁰ BISA Syr Darya-Sokh arranged for a topographic survey of the intake channel between Syr Darya River and entry to the suction pipes on 29 September 2008.

⁴¹ Refer to paragraph 32, page 13, IEE for Besharyk core subproject, October 15, 2008

about 45%⁴² of the inflow to the Syr Darya River. This has led to drastic changes in Syr Darya River discharge during the summer period causing a summer shortfall of up to 1.5 km³ in the Fergana Valley. The shift in reservoir operation for hydropower generation started in the early 1990s and has now become the principle operation modus. Unfortunately only stage discharge data is limited to 1987 records for the Chilmakhrum gauging station about one km upstream of the intake channel location and a ten year time series record for the Kal-Syr Darya gauging station 115 km upstream of the pump station has become available during the preparation of the Besharyk subproject preparation, completely inadequate to identify the depth of river flow so that the minimum inflow volume to the Besharyk pump station can be identified with reasonable probability ratings. Thus a risk exists that the 1.5m minimum depth of flow assumed for design of the pump station in the mid-1970s may no longer be applicable for planning rehabilitation of the Besharyk pump station. Only further data collection and river flow monitoring would provide the necessary.

- Besharyk pump station

255. The pump station building is generally in poor condition with the roof leaking, crumbling brick walls, missing windows and broken access doors. The area surrounding the pump station building suffers from high groundwater levels and ingress of this groundwater through the subterranean parts of the building structure. The installed pump sets have outlived their economic lives and undergone several major overhauls and repairs. Presently 6 out of 10 pump sets are in working condition. The equipment installed comprises of double suction, axial split case, centrifugal type pumps driven by electrical motors with 1.39m³/s nominal capacity at 55m head, and 6,000 volt, 1000kVA electrical motors with 750 rpm fixed speed. Pumps and engines installed require complete replacement including all mechanical accessories, electrical installations and associated instrumentation. The pump sets are installed in a dry pit below minimum water level in the intake channel, giving rise to a positive static suction head for the pumps. Gate valves leak and originally motorized valve actuation mechanisms no longer work. Full details of all pumping equipment and pump station building related issues are given in Supplementary Appendix C.2, Final Report.

256. A new surge protection system is required. Air vessels may be installed outside the pump house and connected to the common delivery header. To improve operational safety of new pumping equipment, a comprehensive instrumentation set (pressure gauges each on pump suction and discharge piping), pressure switches and transmitters, and flow meters are required to be installed on rising mains. Present internal drainage works no longer operate adequately and requires replacement after floor rehabilitation. New machine foundations for replaced pump sets and a new dry pit floor slab will be cast and this facilitates installation of internal drainage for effective evacuation of spillage from the building.

257. External drainage of the area surrounding the pump station building is impeded resulting in high groundwater levels adjacent to the pump station building and hydrostatic pressure on the walls of the machine pit. Groundwater mineralization adjacent to the pump station building is generally deemed to be low (1-3g/l) to moderate (3-5g/l), with some seasonal fluctuation. Hydrostatic water pressure has led to material degradation in joints, including the formation of noxious substances on the internal faces of the machine pit walls allowing seepage flow into the machine pit. Detailed investigations of the drainage situation should be undertaken during the detailed design phase of the subproject.

⁴² Page 30, Water – Critical Resource for Uzbekistan's Future, UNDP, Tashkent 2007

258. The 5 rising mains are deemed to require no replacement of pipes (see paragraph 252 above) except for a 50m length to link the new header to the existing rising mains delivering water to the stilling basin. However, as a precautionary measure the 4 rising mains leading to the stilling basin will each have a length of 450m replaced to ensure that this high pressure reach of the rising mains will perform without any risk of failure. The rising main supplying water for irrigation and to the fish ponds does not require any replacement except for linking the new pump set installations to the existing pipe line.

- Inter-farm canals and structures

259. Four rising mains deliver water to the stilling basin located on the outskirts of Besharyk town. Canals M-1 and M-2 take off from the stilling basin, M-1 in an easterly and M-2 in a westerly direction. A longitudinal profile for inter-farm canal M-1 has been available but not for inter-farm canal M-2. Inter-farm canal M-1 longitudinal profile shows it to be 4.9 km long, with the canal head reach designed for a maximum “forced” 5.5 m³/s flow rate and 4.6 m³/s “normal”⁴³ one. The forced flow is some 19.5% above the normal (peak) design flow, and thus exceeds the design norm by 30%. Canal cross section side slopes are given as 1:1.5 and bed width equals 1.5m. The maximum depth of flow has been calculated as 1.37 m while and freeboard equals 50 cm for canal M-1, which exceeds the 20 cm required by prevailing design standards and norms. Considering that inter-farm canal M-1 service area to not exceed 2,500 ha, the canal capacity is well above the requirement. Field measurements suggest that the canal cross section of inter-farm canal M-1 is identical with that of inter-farm canal M-2 in the head reach, but the latter being 6.3 km.

Table 29: Besharyk subproject service area - Structures on canals M-1 and M-2

No	Type of Structure	code	Canal M-1	Canal M-2
1	Off-takes to on-farm canals	PC	16	17
2	Hydropost	HP	19	24
3	Escape structure	EC	1	1
4	Bridges and pedestrian crossings	B	0	10
5	Siphon	IS	0	1
6	Aqueduct	A	0	1
7	Cross drainage culverts	CD	0	6
8	Total structures		36	60

Source: ADB TA 7061-UZB, September 2008

260. Both inter-farm canals were constructed with flow regulator structures – five on inter-farm canal M-1 between stations (ПК) 0.315 km and 3.252 km, and seven on inter-farm canal M-2 between stations (ПК) 0.760 km and 4.650 km. The regulators are simple concrete structures each with a single steel gate and have deteriorated to the extent that they require demolition and reconstruction. Though the type of regulator installed is intrinsically less good at providing a constant upstream water level than an overflow structure such as a duckbill or side weir, the latter will not be used to replace dilapidated works. Downstream of each regulator structure a gauging weir of the ISO 4360 type will be provided to ensure that the gate is set accurately to deliver the flow required; the provision of gauging weirs on the inter-farm canals will give a check that the water is being managed correctly.

⁴³ “normal” flow rate is equivalent to the calculated peak crop water requirement whereas “forced” flow equals “normal” flow multiplied by a safety margin – in the case of canals M-1 and M-2 the coefficient equals 1.15 of “normal” flow. For more details refer to Section II.B, Supplementary Appendix C.1.

261. The actual command areas of canals M-1 and M-2 are poorly defined as they extent into areas which earlier were principally supplied with water from either the BFC or the Isfara River (see paragraph 0 above). Though a number of such canals linking with inter-farm canals M-1 (stations (ПК) 0.250 km, 2.200 km, 2.850 km and 3.251 km) or M-2 (stations (ПК) 0.745 km, 2.605 km and 2.680 km) are reported to exist, only one such connection for canal “Navkat” (station (ПК) 2.680 km) could be verified. Construction of a sediment exclusion trap on Navkat canal before joining canal M-2 should be considered and the necessary planning undertaken during the detailed planning stage.

262. No design details for off-take structures on canals M-1 and M-2 and related on-farm service areas were available and neither required engineering surveys undertaken to identify canal M-2 design properties. However, to determine the status of irrigation infrastructure works and to identify basic repair and improvement requirements a detailed walk-through inspection of all canal works was undertaken by National TA Consultants in cooperation with UDI⁴⁴ and which forms the basis for all rehabilitation and improvement work.

263. The condition of concrete lining is generally poor with concrete surfaces badly degraded and panels partially crumbling, probably due to use of inferior quality concrete. The use of marginally suitable earth material for canal bank formation has let to strongly degraded canal embankments exacerbating the breaking up of canal concrete lining. Particularly affected is the lower reach of canal M-1 with a length of 1.7 km requires raising of the embankment top, re-cutting of the canal flow section and placing of concrete lining. Canal lining is commonly of unreinforced concrete, 150 mm thick, with construction joints at 5 m interval. Only the smallest canals will be constructed with lining 135 mm thick. Such lining thicknesses are about double the thickness recommended outside the CIS.

264. The canal bank tops of the inter-farm canals have degraded, particularly where used as inspection and service roads. Erosion on non-road embankments has been considerably more intense than on road embankments protected by hard surfacing materials. Rebuilding the banks of inter-farm canal M-2 provides an opportunity to create a hydraulically more efficient canal flow sections in the lower reach (see preceding paragraph). This will improve the performance of inter-farm canal M-2 but must be based on canal alignment survey and hydraulic review during the detailed design period.

265. Inter-farm canals M-1 and M-2 were constructed without tail end structures to control or monitor flows escaping from the system. Canal M-2 is reported to end at a gated cross regulator structure which is unsatisfactory rendering attempts to improve scheme water management obsolete. The project will install new fixed crest weir structures at the end of each inter-farm canal to ensure appropriate depth of flow in canals and to reduce unwarranted canal water losses. Below tail end structures gauging weirs of the ISO 4360 type shall be constructed, providing for proper monitoring of excess flows supplied by the pump station.

266. Access to and equity of water distribution within the subproject service area needs to be considerably improved. Uneven and untimely supplies of water for irrigation prevent farmers from achieving optimum yields and some from harvesting a crop at all. This together with expansion of the pump stations' service area (see paragraph 246 above and Figure 2) necessitates infrastructure modifications which will promote equity of distribution and timeliness of supply. To achieve this, the service area will be zoned into a lower and an upper part, whereby the lower area will receive its supplies from

⁴⁴ Design Institute “UZSUVLOYIHA”

pressure outlets on the rising mains and the upper area from inter-farm canals M-1 and M-2 supplying water directly to on-farm canal plus 2 to 3 secondary type canals on each inter-farm canal and constructed by modifying existing on-farm canals. Suitable candidate on-farm canals on M-2 may be the “Naukat” and “Tovul-3” canals at stations (ПК) 2.68 km and 3.93 km and having off-take structure capacities equal to 1.5 m³/s and 0.8 m³/s respectively. For canal M-1 suitable candidate on-farm canals are not easily identifiable but off-take structures at stations (ПК) 1.51 km or 1.70 km and stations (ПК) 3.00 km or 3.25 km may be most promising. The total length of modified on-farm canals is limited to 20 km within each sub-command area (canals M-1 and M-2), and assumes that about 50% of canal length requires construction. Modified on-farm canals would have a length of about 4.0 km on average, having a command area of some 500 to 800 ha each. Topographic and engineering surveys need to be carried out to confirm on-farm canals to be modified, their lengths and associated command area. Post construction, these distribution canals would best be re-designated to be transferred to the list of assets of BISA Syr Darya-Sokh.

267. Installation of 12 gauging weirs below regulator structures on canals M-1 and M-2 will facilitate improved scheme water management including equity of distribution and higher water use efficiencies at field and system level. A total of 27 inter-farm canal off-take structures connect inter-farm canals M-1 and M-2 to the on-farm canal system. All off-take structures require replacement including installation of new gauging weirs for accurate measurement of discharges. Flow measurement structures will be of the type pertaining to International Standard ISO 4360⁴⁵. These triangular profile gauging weirs have the following advantages:

- They are easy to construct accurately.
- They can pass fine sediment.
- Have low head loss across the weir.

268. Installation of gauging weirs below regulator structures on canals M-1 and M-2 will facilitate improved scheme water management including equity of distribution and higher water use efficiencies at field and system level.

- Drainage

269. Besharyk rayon has a total of 340 km primary, collector and inter-farm drainage channels and of which almost 80 km are located within the proposed boundaries of the Besharyk subproject. In addition some 265 km on-farm drainage channels exist within the subproject area. Details about the present status of drainage works are given in Section III.C, Supplementary Appendix C.1. Drainage infrastructure comprises of open trapezoidal channels only which is assumed to have silted up to 50% on average for on-farm works and to 20% for all other drains. Drainage installations are to improve the soil moisture status of the unsaturated zone and to control seasonally fluctuating groundwater levels, primarily caused by irrigation and leaching water applications. On-farm drainage channels generally ceased functioning due to excessive sediment inflows from agricultural lands deposited in the channels. Collector, primary and other inter-farm drainage channels have deteriorated more as a result of weak and deteriorating channel side slopes and the repeated erection of temporary check structures by farmers to retain drainage flows for application as irrigation water. In mid-2008⁴⁶ BISA Syr Darya-Sokh

⁴⁵ International Standard ISO 4360, Liquid flow measurement in open channels by weirs and flumes - Triangular profile weirs, Second edition - 1984-12-15

⁴⁶ Action Programme for 2008-2012 for “Support and rehabilitation, reconstruction and construction of melioration objects in the framework of complex improvement of land melioration condition” and based on Decree of the President, Number 3932, “Action for deep improvement of Land Reclamation System”, Tashkent, 27 October 2007 (Программа мероприятий на 2008-2012 гг. по обеспечению и

has assumed full responsibility for all open channel drainage works within its area of jurisdiction, including drains located within Besharyk subproject area.

2. Project Rehabilitation and Improvement

270. Besharyk subproject rehabilitation and improvement is based on the following criteria, and parameters and constraints:

- maintain the basic scheme configuration with its pressure pipe outlets on the four rising mains;
- no replacement of rising main pipes;
- limit replacement of equipment to pumps and motors with no more than 50% higher capacities to avoid excessive operational pressure increases in rising mains;
- no replacement of the existing electricity substations at Besharyk pump station site – constraints the number and size of motors driving the pumps.

271. The present intake channel conveying water from the Syr Darya River is inadequate to convey sufficient water to the Besharyk pump station to meet the seasonal peak water demand of the expanded service area. The modified intake channel will have sufficient capacity to meet the pump stations peak supply requirements and shall function as a settling basin.

272. Besharyk subproject irrigation and drainage infrastructure rehabilitation expands irrigation services to areas receiving no longer or only unreliable supplies of water for irrigation (see preceding paragraphs and Figure 2 above). This requires the present scheme configuration to be enhanced by dividing the service area into a lower section supplied by pressure outlets on the rising mains, and an upper section served by canals M-1 and M-2 and a number of modified on-farm canals to function as secondary distributors. This division contributes to:

- greater equity of water distribution,
- reduces the distance between source of water and fields to be irrigated,
- lower energy requirements than would otherwise be required, and
- leads to higher scheme operational and water use efficiencies.

3. Project Sub-components

a) River intake channel and excavation equipment

273. The primary work requirements are related to widening and deepening of the existing intake channel. Without detailed topographic data the required channel excavation has been estimated to amount to 86,000m³ of earthwork and partial leveling of spoil, plus nearly 500m³ of concrete and transitional lining work plus casting of a 5m wide concrete sill between settling reach and approach to intake pipes. This will improve water availability at the pump station and remove approximately 58,000m³ of sediment from the waters to be pumped to the stilling basin. It thus will contribute to improved machine operation and maintenance costs due to reduced sediment deposits in canals M-1 and M-2 and subsequently the on-farm water distribution works.

274. To facilitate regular intake channel maintenance it is proposed to procure a long boom (not less than 16m length) hydraulic excavator with a suitable desilting buckets.

восстановлению, реконструкции и строительства мелиоративных объектов в рамках комплексного улучшения мелиоративного состояния земель)

The equipment would best be stationed at Besharyk pump station. The procurement cost of such a unit is likely to reach \$ 0.25 million.

b) Besharyk pumping station

275. Rehabilitation of Besharyk pumping station aims at providing pumped water supplies for full irrigation of 7,100 ha with a peak flow requirement of 10.4 m³/s. The works to be undertaken can be summarized into four primary sub-items:

- inlet channel to the pumping station;
- pump station building repairs and modifications;
- equipment and machinery for pumping; and
- repairs to rising mains.

276. **Pump station building repairs and modifications:** involves the removal and replacement of ten pump set foundations for the installation of eight new pump sets for supply of irrigation water plus two pump sets for the supply of water to fish ponds; the laying of new machine pit concrete flooring to slope plus necessary internal drainage channels. Construction work includes new concrete pipe supports and thrust blocks inside and outside the pump house building, installation of new water proof valve and flow meter chambers within the pumping station area. If determined necessary, additional or extended switch gear room space needs to be constructed. The installation of new compressors and other hydro-pneumatic vessels for surge protection necessitates the casting of appropriate foundations. Other, general refurbishment of the pump house building includes installation of air vents in the roof, replacement of doors, windows, platforms, plastering of walls and wall painting, etc. Care must be taken to install external drainage facilities to prevent the building up of hydrostatic pressure on the walls of the machine pit and seepage flow to inside the pump house building. For the same reason, the walls of the machine pit require to be cleaned of accumulated salts and the surfaces externally and internally sealed so that the walls are water proof.

277. Inspection and testing of rising mains before completion of rehabilitation work on pipes will be mandatory.

278. **Equipment and machinery for pumping:** replacement and installation of eight new pump sets each with 1.5m³/s capacity at a 65m hydraulic head. Pumps are horizontal split case double suction, single stage, centrifugal pumps made of cast iron body, stainless steel (CF8M) impellers and casing wear rings, with mechanical seals, common base plate and all accessories. Each pump is to be attached to an induction motor (6kV, 3-phase, 50Hz, 750rpm) with closed circuit water cooling system. Replacement of pump sets includes suction and discharge piping, valves and dismantling joints, replacement of electrical system components comprising of switch gear panels, auxiliary transformer, lighting distribution boards, control panels (control desk), necessary cabling, pump house lighting, and grounding (earthing) etc.

279. Delivery and installation of a common discharge header including all isolation butterfly and non-return valves, surge protection equipment and a 200kVA, 0.4kV diesel generator set.

280. **Rising mains:** to be replaced for the first 500m of 4 rising main and includes necessary realignment of the initial 50m rising mains within the pump station area, between common header section and buried rising mains; installation of isolation and non-return valves and electro magnetic flow meters, pressure switches and pressure transmitters plus construction of protective valve and flow meter chambers. All chambers are to be water tight as they are located in an area of impeded drainage and including all

necessary excavation and back filling, and proofing of pipes against corrosion and lightning.

281. **Pressure off-takes on rising mains:** Installation of 16 pressure outlets on two rising mains delivering water to existing on-farm canals. The off-takes will effectively divide the subproject area into a lower and an upper area. The lower area will principally be served by the pressure outlets whereas the upper area by the inter-farm canals M-1 and M-2. Actual off-take locations are to be determined during detailed design stage. Each off-take will be connected to a mild steel pipe of varying length, but not exceeding 1,000m on average, and discharging into a distribution box delivering to on-farm canal works. Delivery pipes will have delivery valves and flow meter installed in water proof chambers and will vary in diameter from 200-500 mm depending on area to be served. The future 16 pipe off-takes are planned to abstract a total peak flow of 4.0m³/s while the volume to be diverted to the left of the rising mains (present pipe off-takes) shall not be less than the present peak flow volume of 1.8m³/s.

c) Inter-farm canal rehabilitation

282. Inter-farm canal rehabilitation aims at ensuring continued operation of the canal system with high conveyance efficiency and least losses of water, thus contributing to assured delivery of water to the on-farm canal network. The work included in rehabilitation of canal cross sections may be grouped as follows:

- canal lining repairs;
- earthworks on canal banks and inspection roads, and
- removal of sediment.

Table 30: Besharyk - Inter-farm Canals - Summary of work volumes

No	description	inter-farm canal M-1		inter-farm canal M-2		Sum quantities	
		length m	Qty m ³	length m	qty m ³	length m	qty m ³
1	Repair of concrete lining	4,900	4,270	6,370	4,452	11,270	8,721
2	Embankment work	2,624	3,675	1,911	4,778	4,535	8,453
3	Inspection road	2,450	2,573	3,185	3,344	5,635	5,917
4	Sediment removal	4,900	13,980	6,370	13,296	11,270	27,276

283. **Inter-farm canal lining repairs:** The canal lining will be repaired in where it has deteriorated; otherwise it will be left as it is apart from carrying out of deferred maintenance such as removing sediment from the canal bed and vegetation from the joints in the concrete lining. However, 65% of all inter-farm canal lining requires recasting, providing limited opportunities to adjust the dimensions of the canal cross section in the lower reaches of the inter-farm canals M-1 and M-2. In particular inter-farm canal M-1 reach between stations (ПК) 3.250 km to 4.900 km can be remodeled without any need for extra volumes of work. The design canal bed width of inter-farm canal M-1 in this reach is given as 1.5m but a canal bed width of 0.90m would improve the hydraulic efficiency of the canal. Earthwork to be executed within this reach may be used to create a narrower canal cross section. A hydraulic review of the inter-farm canal M-2, after completion of an alignment and canal cross section survey, would reveal further opportunities for reducing the canal cross section in the lower reach. The total volume of concrete lining repairs within Besharyk subproject is given in Table 30 above and amounts to 8,721m³ or 4,270m³ for inter-farm canal M-1 and 4,452m³ for inter-farm canal M-2 respectively.

284. **Earthwork on inter-farm canal embankments:** canal embankments have degraded, particularly where there is no inspection or service road. Loss of soil from an embankment commonly varies from a shallow 20 cm to as much as 1.0 m depth. This leaves the upper edge of the canal side lining panels unsupported causing it to break up and disintegrate. While erosion of embankments is not evenly spread throughout the scheme area, rebuilding canal banks is necessary to maintain an appropriate canal flow section. Rebuilding embankment tops will require scarifying operations before placement of additional earth material. Essential are selection of material suitable for embankment formation, proper mixing of scarified with newly brought-in fill material. Tight control of moisture for compaction of material is essential for achieving well compacted layers. The amount of earthwork to be executed on the lower reach of the inter-farm canal M-1 between stations (ПК) 3.250 km and 4.900 km should be used to narrow down the canal cross section. Reference volumes and dimensions are given in Table 30 above and amounts to 8,453m³ with 3,675m³ on inter-farm canal M-1 and 4,778m³ on inter-farm canal M-2.

285. **Inspection roads on inter-farm canal banks:** Canal side inspection roads facilitate scheme operation and maintenance, access to water monitoring installations and the on-farm infrastructure. They are essential for delivering inputs for agricultural production to fields and the speedy removal of harvested products from the area. Rehabilitation of roads comprises preparatory scarifying of existing road embankments, hauling in of material from sites not more than 2.0 km away from work sites, proper mixing of scarified and newly brought in material, prior to compaction. Compaction in conjunction with well controlled water applications is basic for achieving good quality works. The road surface layer is assumed to have a 4.0 m width plus shoulders on either side of not less than 0.5 m width on somewhat wider canal banks, and a 20 cm working depth for addition of material. The total volume of work on inspection roads is given in Table 30 above equal to some 5,917m³ being 2,573m³ on inter-farm canal M-1 and 3,344m³ on inter-farm canal M-2.

286. **Sediment removal:** Sediment deposits must be removed from canal cross sections to facilitate the execution of other works. Sediment in canals is primarily of the silt fraction causing no serious operational problems of pumps. Removing sediment from concrete lined canals often results in secondary damages due to use of inappropriate excavation equipment (draglines), old excavators which can not be accurately controlled, inexperienced or poorly skilled machine operators, or deployment of machinery at locations unsuitable for mechanical excavation. The total volume of sediment to be removed has been assessed as 27,276m³. Of this amount some 13,980m³ are to be removed from inter-farm canal M-1 and another 13,296m³ from inter-farm canal M-2 (for reference see Table 30 above).

d) Inter-farm canal structures

287. Work grouped under inter-farm canal structures includes rehabilitation of existing works, repairs to some and the installation of new works and may be summarized as including but not be limited to:

- the rehabilitation of existing regulators along inter-farm canals M-1 and M-2, and improvement of inter-farm canal tail ends,
- rehabilitation, improvement and new construction of canal off-takes; and
- adding of measuring structures along the two inter-farm canals M-1 and M-2 and below each off-take to the on-farm canal network.

Table 31 below provides a summary on works and volumes for each inter-farm canal in Besharyk scheme and for the scheme itself.

Table 31: Besharyk subproject - Structures - Summary of work volumes

no	Works	unit	inter-farm canal M-1	inter-farm canal M-2
1	number of structures	nos.	48	71
2	concrete works	m ³	798	1,078
3	gates, frames and lifts	nos.	15	26
4	electric drive and gear	nos.	30	14
5	Earthworks	m ³	15,316	12,359
6	asbestos cement pipes	m	142	105
7	concrete pipes	m	104	190
8	mild steel pipes	m	5	34
9	stainless steel sheets	m ²	18	9
10	Asphalt	ton	728	1,586

source: ADB TA 7061-UZB, September 2008

288. Inter-farm canal headwork structures to inter-farm canals M-1 and M-2: The existing head regulator structures on the stilling basin will be retained. Works foreseen is limited to replacement concrete superstructure and mechanical parts, particularly as no long section information available for the head reach section of inter-farm canal M-2 passing under a major road junction before becoming an open canal.

289. Cross regulators on inter-farm canals M-1 and M-2: Twelve cross regulator structures will be rehabilitated to their original design specification including concrete works and gates. This involves demolition and removal of degraded concrete works, including existing foundation work before laying new foundations, casting of structure wing walls and structure deck. Transitional works will be removed to the extent necessary, only, not creating additional or secondary level damage to existing works. Provisions include the delivery and installation of new gate frames, gates, lifting devices and all miscellaneous items and incidental works. It is foreseen to provide motorized gate lifting mechanisms for the reconstructed regulators. Summary details of primary work items including incidental tasks are included in Table 31 above.

290. Off-take structures to on-farm canals: A total of 27 canal off-take structures will be removed and rebuild. Two to three off-take structures on either inter-farm canal need to be identified or designed to be operated as canal headwork structures for secondary level distributor canals. This is linked to the need to remodel some of the existing on-farm canals into secondary level distributors. The locations of these off-takes on inter-farm canals M-1 and M-2, including their length and associated command areas must be determined prior to detailed design of the subproject. The volumes estimated include for removal of dilapidated work, excavation, earthwork, and making good of repaired works including all incidental materials (e.g. for sealing joints) required. Concrete head wall may either consist of precast concrete works or be cast in-situ. Table 31 above includes work items and quantities for all off-take structures.

291. Measuring structures (hydro posts): New gauging weirs of the International Standard ISO 436047 type will be installed downstream of cross-regulators and where sufficient head is available to install a gauge. Only an engineering survey of the canals will reveal the actual locations at which gauging weirs can be erected. Gauging weirs are also proposed to be installed downstream of the two inter-farm canal tail-ends. A similar ISO 4360 gauging weir will be provided downstream of the 27 off-takes to on-farm canals.

⁴⁷ International Standard ISO 4360, Liquid flow measurement in open channels by weirs and flumes - Triangular profile weirs, Second edition - 1984-12-15

292. **Tail end structures:** Tail end structures will be fixed crest side weirs, installed at the end of inter-farm canals M-1 and M-2 to maintain the water level upstream of the final off-take gate. The flows passing over the crest will be measured by a gauging weir. These tail end structures will be in the form of simple side weirs.

293. **Escapes:** Two escape structures are provided, one on inter-farm canal M-1 at station 3.251 km and one on inter-farm canal M-2 at station 0.000 km.

294. **Cross drainage structures:** A total of 44 pipe culverts and cross drainage structures on inter-farm canals M-1 and M-2 convey water across drainage channels and below and above canals. Commonly they are single or double barrel culverts. For all cross drainage structures adequate attention must be paid to rebuilding of structure transitions as original transitions were undercut by drainage flows, thus losing stability. In a number of cases drainage flow has eroded the channel bed on the downstream side of the structure.

295. **Road bridges and pedestrian crossings:** there are 13 bridges and pedestrian crossings in addition to canal crossings at cross regulator structures. Road bridges require limited repairs but pedestrian crossings are generally in a good state. Work comprises primarily of road surfacing work.

296. **Transforming on-farm canals into secondary distributors:** improving scheme water distribution within the command areas of inter-farm canals M-1 and M-2 requires transformation of up to six on-farm canals into secondary distributor canals. With the subproject area effectively separated into a lower and upper part, modified on-farm canals would be constructed in the upper part only and would have a length of 4.0 km on average. Topographic and engineering surveys need to be carried out to confirm candidate on-farm canals and to identify additional ones to be remodeled including their associated command areas. The total length of modified on-farm canals is estimated as 20.0 km providing about 10.0 km each along inter-farm canals M-1 and M-2 respectively. Overall work volumes for the 20 km canals are estimated to be equivalent or less than required to construct 10 km new canals.

e) Drainage

297. Within Besharyk district are some 340 km inter-farm and primary drains operated by government agencies. About 80 km of these are located within the service area of the Besharyk subproject. Water User Associations (WUA) operating within the subproject area are responsible for some 265 km on-farm drainage channels. Assuming a 20 percent loss of cross section area due to sedimentation and channel side slope deterioration, the volume of sediment within a collector drain amounts to between 3,300m³/km or 3.3m³/m and 8,500m³/km or 8.5m³/m drainage channel. The total sediment volume to be removed from such drainage channels amounts to 430,000m³. Similarly for on-farm drainage channels where the average volume of sediment per kilometre drainage channel amounts to between 3,500m³/km and 10,950m³/km, and the total volume to be removed to 1.716 million m³. Though rehabilitation of drainage channels is a priority for BISA Syr Darya-Sokh under the Action Programme for 2008-2012⁴⁸, removal of sediment from drainage channels will be executed under the Project.

4. Besharyk Cost Estimates

298. The costs of the Besharyk Subproject total \$24.524 million (SUM32,371.69 million) to be implemented over three years 2009 – 2011. A breakdown of the costs is shown below.

⁴⁸ Refer to footnote 8 above.

Table 32: Besharyk subproject - Summary of Subproject Costs

Item	\$ million	% of Total base costs
Besharyk pump station rehabilitation	9.159	43.3
Besharyk rising mains repair	2.537	12.0
Irrigation infrastructure rehab (M1 & M2)	2.451	11.6
Secondary canal reconstruction	1.050	5.0
New off-takes and pipe distribution system	4.231	20.0
Intake canal widening	0.420	2.0
Drainage rehabilitation	1.293	6.1
Total Base Costs	21.141	100.0
Contingencies 10%	2.114	10.0
Design & Supervision (6%)	1.268	6.0
Grand Total	24.524	116.0

Source: Consultants estimates.

299. The cost of rehabilitation of the pump station contributes 43% to the total costs with the pumps and motors making up 50% of this item. The repair of the Besharyk rising main costs \$2.537 million, or 12% of base costs. The rehabilitation of the M1 and M2 irrigation canals and infrastructure costs \$2.451 million or 12% of base costs. The rehabilitation costs for Besharyk also include provision for the reconstruction of the secondary distribution canals from the M1 and M2 canals to ensure that water can be more efficiently distributed to farms at an estimated cost of \$1.05 million and the development and rehabilitation of more off-takes from the rising mains in the lower part of the command area including the installation of a new pipe distribution system, at a cost of \$4.231 million (20% of base costs). The costs of desilting the inter-farm and on-farm drainage network are also included at a cost of \$1.29 million, of 6% of base costs. These additional items increase the costs to that extent that the total cost including contingencies and design and supervision of 16% amount to an average cost of \$3,136 per ha of the 7,820 ha command area, double that for the other Narpay subproject.

300. The costs of the Besharyk Subproject total \$22.445 million (SUM 29,627 million) to be implemented over three years 2009 – 2011. A breakdown of the costs is shown below.

5. Implementation Arrangements

301. Following loan approval it is assumed that a minimum six months will be required to identify and engage a suitably qualified Consultant for detailed design and supervision. A minimum of further 5-6 months will be required to complete the design work and to finalize tender and contract documents for the rehabilitation work. Rehabilitation works to be undertaken can be divided into the following packages:

- One ICB contract for pumps, motors, electrical, pipes and ancillaries

302. ICB contract will concern the rehabilitation of pumping station including supply and installation of pumps and motors, all associated and miscellaneous mechanical and electrical equipment plus necessary civil works for installation of pump sets and refurbishment of the pump station building. The package further includes the rehabilitation of the intake structure and the three four rising mains. The contract package could be a turnkey contract for the supply, installation, testing and commissioning of a complete pumping system and including provisions for training of local personnel, supervision of operation and maintenance of works for a period of one year from the date of commissioning and handing over. A minimum working period of 18

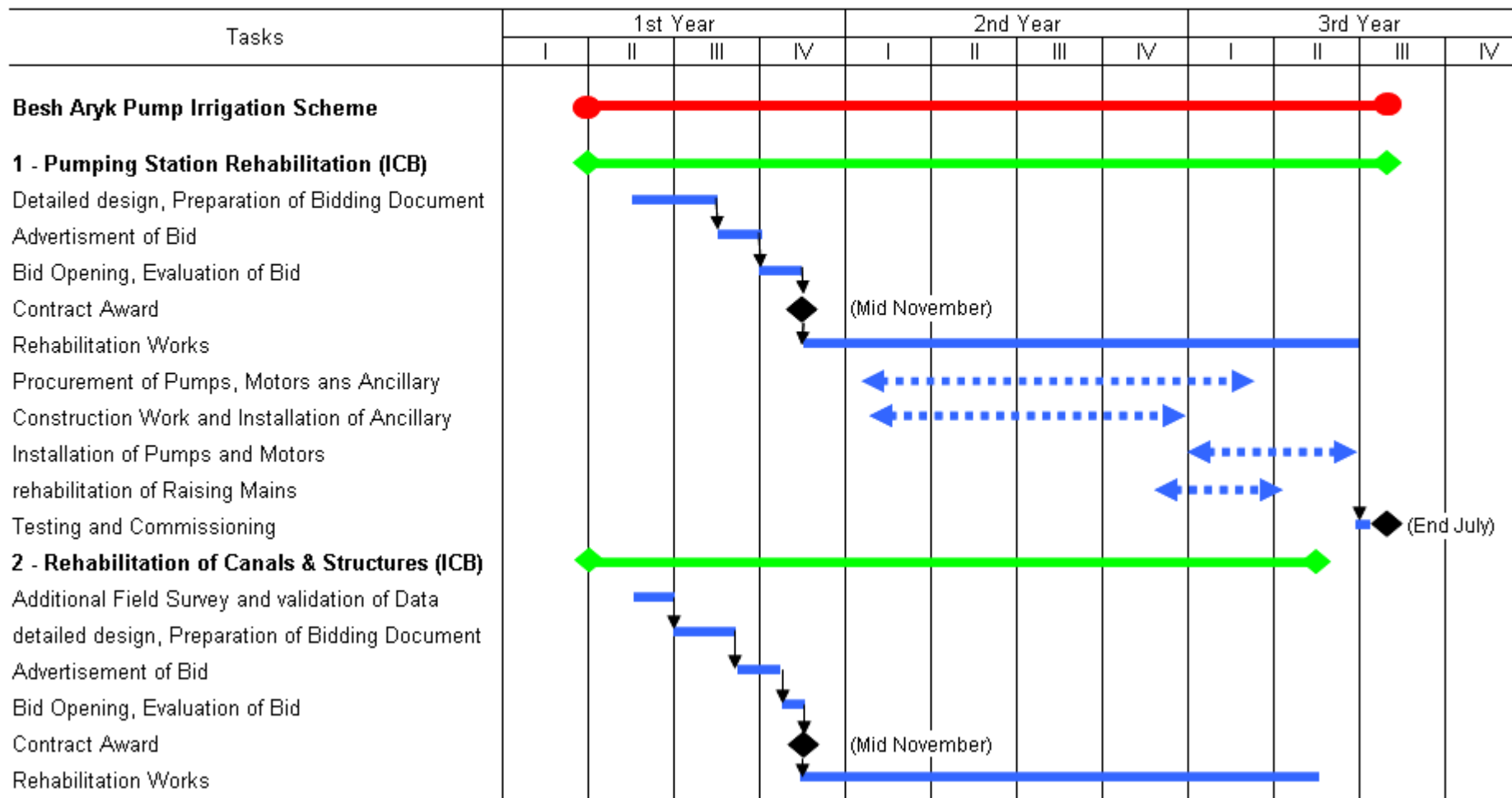
months extending up to 24 months will be required to complete the rehabilitation work of pumping stations. With pumps, electrical motors and valves having a delivery time of 8 to 12 months, actual rehabilitation work may likely be started by the end of 2009. Completion of contract may therefore be earliest by mid-2011.

- One to three ICB contracts for rehabilitation of canals & structures

303. ICB(s) will relate to the improvement of the intake channel, the rehabilitation of canals and structures. Particular attention will be required for modification, widening and deepening of the intake channel which must be preceded by comprehensive engineering surveys and proper timing of implementation to avoid interruption of irrigated crop production. Implementation of civil works contracts on canals M-1 and M-2 requires closure of the canal network. Issue of more than one contract for implementation of rehabilitation works will be advantageous as it would permit completion of works during two canal closure periods. Hence civil works contracts may require a period of 15 to 18 months, thus allowing for two canal closure periods within the contract time. Thus work could possibly be started by the end of 2009 and completed by spring 2011.

Figure 4: Besharyk subproject implementation schedule

**Besh Aryk Pump Irrigation Scheme
Implementation Schedule**



6. Financial and Economic Analysis

a) Project area and beneficiaries

304. The Besharyk scheme's net command area (potential irrigable area) is assessed as 7,820 ha is made up of three zones: zone 1 an area of 4,116 ha currently irrigated from the Besharyk pump station; zone 2 composed of 1,446 ha is to the east of the command area and currently partly irrigated from the Big Fergana Canal supplemented with irrigation from drains; and zone 3 which lies to the west made up of 1,809 ha of land that was formerly irrigated by the Isfara River, but is currently unirrigated except for limited amounts from drain water. Zone 2 and 3 have never received irrigation water from the Besharyk pump station but would be included in the rehabilitated scheme area to be served from the pump station.⁴⁹ Around 14% of this area is currently abandoned because of water shortage. (The details are shown in the following table).

305. The number of private farmers in this area is assessed as 192 who control an area of 7,371 ha, which implies an average holding size of 38 ha. The area of *dekhan* farms is estimated to be 449 ha, which based on an average holding size of 0.10 ha indicated that there are around 4,500 *dekhan* holdings in the scheme area. The majority of this land is within the community settlements in the scheme area. The total population within the Besharyk area is estimated to from the socio-economic household survey conducted as part of the feasibility study as being 32,300 in 7,560 households (average 4.27 per hh). The population density is relatively high and in addition to the areas of *dekhan* farms there is also a considerable areas of household plots.⁵⁰

306. Farmers are organized into WUA responsible for water scheduling and the maintenance on on-farm irrigation facilities and WUA will be the main means of building farmers' capacity.

b) Key assumptions in the financial and economic analyses - prices

307. The feasibility study used prices prevailing in mid 2008. For traded commodities (cotton, wheat, and fertiliser) economic prices were prepared based on border parity using the World Bank's commodity price forecasts of May 2008. Prices of non-traded goods and services are in mid 2008 prices based on prevailing prices in the Besharyk subproject area collected during the feasibility studies. Farm machinery costs were based on average current rates for services provided by machinery service providers in Fergana with a 25% increase to allow for recent price increases. These financial prices were considered as being similar to the economic price and no adjustment was made in the economic analysis.⁵¹ Agricultural wage rates vary widely and sometimes include payment in kind. The standardized norms stipulated by government no longer apply and private farmers negotiate rates with individual workers. In view of the high rates of unemployment and underemployment in the province, agricultural labour is given a shadow value of 0.85. The current rates for land tax (based on the *bonitet* score) and WUA fees are included in the crop budgets, although the land tax is excluded from the economic analysis as it is a transfer payment. No charge is included for water as currently farmers are not required to contribute to water costs, except for a very low

⁴⁹ The potential area that could be irrigated by the Besharyk pump station is constrained by the capacity of the rising main to convey water, and is determined by the crop water requirements for the cropping pattern during the peak period of demand June to August.

⁵⁰ Almost 100% of the household surveyed for the socio-economic survey indicated that they had access to a household garden plot.

⁵¹ Subsidies on machinery services were removed in 2006, but there is still a wide variation in the rates between different providers of Machinery Tractor Parks.

nominal charge.⁵² Maintenance of on-farm irrigation infrastructure is the responsibility of the WUA, and is covered by the WUA charge, which is assumed to increase four times in the future with project situation.

308. The economic cost of electricity is assumed to be \$ 5 cents per kWh (SUM66) which is comparable with the current financial price of SUM 52.5 /kWh in Uzbekistan⁵³. For the derivation of the economic costs of investment in rehabilitation works, a standard conversion factor of 0.85 was applied in order to reflect the removal of taxes and duties and inefficiencies in the economy. An exchange rate of \$ 1.0 = SUM 1320 has been used. The economic and financial analyses are undertaken in constant 2008 prices assuming a project life of 30 years and assuming an opportunity cost of capital of 12%.

c) Project benefits

309. The project benefits will emanate from the three main interventions of the project: first, the rehabilitation of the Besharyk pump station to properly serve the command area, including replacement of a portion of the rising main and the rehabilitation and upgrading of the inter-farm irrigation system and development of a new piped distribution system to the bottom of the scheme area; second the expansion of the irrigated area to include zone 2 and zone 3 which are currently supposed to be served from other gravity schemes but are presently do not have reliable irrigation, and lastly the impact of improved water management from the support to the Fergana BISA and WUAs serving the Besharyk subproject area. The benefit from the support to the BISA and WUAs will have a direct impact on water management, irrigation efficiency and farm productivity. Enhanced on-farm water management is expected to result from the rehabilitation of irrigation infrastructure as well as better irrigation scheduling and in-field water control. The installation of a dedicated pump operating at a much lower head to serve the area of fish pond will result in an estimated 65% saving in the electricity required to deliver water compared to the present arrangement. This is also included as a benefit.

310. The change in the trans-boundary water supply regime following the use of water resources stored in the Toktagul reservoir in Kyrgyzstan for winter power generation has fundamentally shifted Uzbekistan's irrigation supply regime during the summer months leading to water shortages in downstream areas at crucial times. The "without project" situation for gravity schemes is a decline in productivity through the failing irrigation delivery infrastructure, and lack of water for crucial irrigation. Inadequate water management may also lead to problems of water logging and mineralization resulting from poor water delivery management and in-field practices. The benefits of rehabilitation of the irrigation and drainage infrastructure and support for improved water management and WUA capacity building will also apply, but the without project situation is not expected to be as serious as for a pump scheme facing failure and resultant loss of the command area.

- The Without Project situation

311. **Zone 1.** In the without project situation it is assumed that the Besharyk pump station, its rising main and the irrigation system will continue to deteriorate with a resultant decline in the volume of water delivered to the command area especially during the peak period of demand from June to September. The Besharyk pump station was constructed in the late 1970s, its pumps and motors are well past their design life. They are failing and need replacement. MAWR staff consider that the remaining life of the pumps for Besharyk, despite their efforts is no more than five years. For the last five

⁵² Some WUA charge an amount of 23 Tiyn per M3 for water, which for a typical consumption of 20 kilo m3 per ha is equivalent to SUM4,600 per ha, or \$3.49. This may be included in the WUA fee.

⁵³ UK Energy Research Centre. Review of Electricity Unit Cost Estimates. May 2007. This study estimated the levelised costs of gas electricity generation to be £3 pence per kWh, equivalent to \$ 5 cents/kWh.

years the pump station has operated well below its design capacity with only four pumps operational delivering an average volume of water of 58.5 million m³, sufficient to only fully irrigate an area of around 3,800 ha of the command area of 4,116 ha.

312. A reduced water supply will lead to a reduced area planted and declining agricultural productivity on the remaining irrigated area, with reduced yields and less intensive cropping. As irrigation supply becomes more unreliable, because of more frequent pump breakdown farmers will lose confidence in the irrigation system and reduce their investment in agriculture accordingly – lower use of fertiliser and less attention to good crop practices, and eventually abandon their land.

313. **Zone 2:** This area of 1,446 ha currently receives an unreliable supply of water from the Big Fergana Canal (BFC), supplemented with pumped drainage water. Currently 11% of the irrigable area is abandoned. As mentioned in para 246 above the water shortage situation is expected to continue to deteriorate in the future. For zone 2 there is likely to be a progressive reduction in the irrigated area and it is assumed that eventually only 28% of the irrigable area receives water.

314. **Zone 3:** This zone includes an area of 1,809 ha to the west of the scheme area that is designated to receive irrigation water from the Isfara water which originates over the border in Tajikistan. It has never received water from the Besharyk pump station. However since the change in the operational use of the Toktagul reservoir in Kyrgyzstan for winter power generation has reduced summer water supply to Uzbekistan and into the BFC, the release of water into the Isfara River from Tajikistan, its source the supply, has virtually stopped and this area no longer receives any significant irrigation water, and agriculture is now virtually reliant on drain water and the high water table. This has resulted in a progressive abandonment of the land due to crop failure and low yields which is expected to continue in the future to a point where only 20% of the irrigable area is assumed to remain in production in the future without situation.

- Future With project situation

315. The “future with” project situation for Besharyk is that the pump station will be restored to a capacity to fully satisfy water demand in the command area of 7,820 composed of the three zones, with improved energy efficiency due to the new modern pumpsets. Some savings in the operation and maintenance costs of the pumps and motors will also occur, in the initial years at least, as the new equipment will not require the same level of repairs and maintenance as is the case now. However adequate levels of O&M must be provided to ensure that the equipment is kept up to standard and able to function throughout its design life and deferred maintenance does not occur. Agricultural productivity would be restored to the full level for the command, combined with an increase in yields and an increase in cropping intensity because of the gains in water use efficiency brought about by the associated support to water management and the WUAs. Rehabilitation of the irrigation infrastructure will reduce water losses and allow better water management and the extra water will be utilised to increase the potential area irrigated.

316. A summary of the main assumptions concerning the “future without” and “future with” Project situations for the financial and economic analysis of the Besharyk pump scheme subproject is presented as follows.

- Future Without Situation

- **Zone 1,** (currently irrigated from Besharyk PS 4,116 ha): The four pumps currently in operation progressively decline to only two pumps delivering 30% of the current volume of water by 2016 (year 8) resulting in a 80% reduction in the irrigated area for private

farms and a 50% reduction in irrigated area of *dekhan* farms. (*dekhan* farms are likely to be able to maintain some irrigation from alternative sources and from ground water). This level of irrigation would then be maintained for the duration of the project, to ensure continuity of water supply for the domestic needs of people living in the command area.

- **Zone 2:** (currently unreliably irrigated from the BFC and drains, 1,445 ha): Progressive deterioration in the irrigation supply leading to a 75% reduction in the cropped area over an 8 year period.
- **Zone 3:** (formerly irrigated from the Isfara River, 1,809 ha): Progressive abandonment of land by 80% over an 8 year period.
- Overall the irrigated area to decline from a current irrigated area of 6,735 ha from the command area of 7,820 ha (86%) to an irrigated area of 1,775 ha (23%) after 8 years.
- A reduction in crops yields of 10% over a period of eight years.
- Expenditure on operation and maintenance for Besharyk PS to reduce by 50% in 2016, reflecting the fewer pumps in operation. Electricity consumption to reduce in line with the reduced volume of water pumped.

- **Future With situation**

- Besharyk pump station rehabilitated with a capacity to service a command area of 7,820 ha including 7,371 ha of private farms and 449 ha of *dekhan* farms.
- New pumps and motors have a 20% improvement in energy efficiency.
- Crop yields to increase according to the zone; by 20 – 50% for cotton and 27 – 43% for wheat from current levels
- Cotton and wheat continue to be the dominant crops in the cropping pattern.
- New pumps to be fully operational by the end of July 2011 with benefits to accrue over three years from the completion of rehabilitation.
- Water use efficiency to increase by 10% over a period of 10 years after rehabilitation of the scheme and the associated support to the BISA and WUA training resulting in an corresponding increase in the irrigated area

d) Financial analysis

- Crop yields and gross margins

317. Crop budgets in financial and economic prices for the range of crops found in the Besharyk scheme were prepared including cotton, wheat, maize silage/fodder, vegetables, melons, potato, annual forage and fruit trees representing the current situation and “future with” project situation. Crop budgets were prepared for private farms in the three zones and for *dekhan* farms to reflect the different levels of productivity in the three zones and the higher level of productivity for *dekhan* farms and greater labour input, mostly family. The crop yield data are an average of the three years 2005 – 2007 based on an analysis of the official statistics for the area broken down for the three zones. The crop budgets are in 2008 financial prices based on prevailing prices in mid 2008. A summary of the yields and gross margins private and *dekhan* farms is presented in Table 33.

Table 33: Besharyk subproject - Summary of Crop Budgets

Private farms - Zone 1						
Crop	Yields kg per ha			Gross margin Sum'000 per ha		
	present	Future w/o	Future with	present	Future w/o	Future with
Cotton	2,000	1,800	3,000	- 41.1	- 31.1	171.5
Wheat	3,500	3,150	5,000	232.6	173.9	465.2
Maize silage	20,000	18,000	25,000	178.1	109.0	416.1
Lucerne fodder	10,000	9,000	15,000	221.4	163.8	515.9
Vegetables	18,000	16,200	18,900	1,519.5	1,285.2	1,610.1
Melon	15,000	13,500	15,750	1,480.1	1,273.9	1,562.2
Potato	19,000	17,100	19,950	2,466.1	1,876.5	2,715.3
Orchards	4,370	3,933	4,589	843.7	720.5	885.6
Private Farms - Zone 2						
Cotton	2,500	2,250	3,000	78.0	59.1	158.7
Wheat	4,500	4,050	5,700	438.8	359.4	678.8
Maize silage	20,000	18,000	25,000	178.1	109.0	416.1
Lucerne fodder	10,000	9,000	15,000	221.4	163.8	515.9
Vegetables	18,000	16,200	18,900	1,519.5	1,285.2	1,610.1
Melon	15,000	13,500	15,750	1,480.1	1,273.9	1,562.2
Potato	19,000	17,100	19,950	2,466.1	1,876.5	2,715.3
Orchards	4,370	3,933	4,589	843.7	720.5	885.6
Private Farms - Zone 3						
Cotton	2,500	2,250	3,000	78.0	59.1	158.7
Wheat	4,300	3,870	5,600	419.4	341.9	605.3
Maize silage	7,500	15,750	25,000	77.8	18.8	416.1
Lucerne fodder	9,000	8,100	15,000	154.7	102.7	515.9
Vegetables	7,500	15,750	18,900	1,519.5	1,285.2	1,610.1
Melon	5,900	14,310	15,750	1,480.1	1,273.9	1,562.2
Potato	9,000	17,100	19,950	2,466.1	1,876.5	2,715.3
Orchards	4,370	3,933	4,589	843.7	720.5	885.6
Dekhan Farms						
Wheat	5,000	4,500	6,000	569.5	490.3	770.9
Maize silage	25,000	22,500	26,250	785.8	680.9	798.6
Vegetables	23,000	20,700	24,150	1,881.2	1,602.8	1,993.8
Melon	25,000	22,500	26,250	3,460.8	3,098.6	3,640.9
Potato	19,000	17,100	19,950	2,466.1	1,876.5	2,715.3
Orchards	6,000	5,400	6,300	843.7	720.5	885.6

Source: Consultants estimates based on Dept. Agriculture data

Note: Zones 1, 2 and 3 are defined in Section V.B.6 above, para 304, then paras 311, 313 and 314.

318. The gross margins for *dekhan* farms are considerably higher than for private farms reflecting the higher productivity and the use of family labour at no financial cost, compared to mechanical cultivation and hired labour for private farms. Vegetables, melon and potato show the highest return while the gross margin for wheat is currently significantly more than that for cotton, which indicates a negative return for private farms in zone 1.

- Command area and number farmers

319. The potential command area (i.e. land that could be irrigated) for Besharyk scheme is assessed to be 7,820 ha, although this is dependent on the irrigation efficiency and an unknown amount of supplementary irrigation. It is evident from the records of the volume of water pumped by the pump station in recent years (average 58.5 million m³ per year) that only around half this area (4,116 ha) has been served by the pump station. The other land in zone 1 and zone 2 has never been irrigated from the pump station. This land will be included in the pump scheme irrigated area after rehabilitation.

320. There are two categories of farms in Besharyk scheme: an estimated 7,371 ha of private farms with an average holding size of around 38 ha leased from the State and 449 ha of *dekhan* farms, with an average holding size of 0.1 ha. In addition to the private and *dekhan* farmers it is estimated that a further 2,500 agricultural workers are attached to the land in permanent employment. A large number of people are also employed as seasonal workers, especially to harvest cotton and vegetables.

- Cropping patterns and production

321. The predominant crop is cotton which is grown on 47% of the area with winter wheat the next most important crop with 36%. A summary of the present land use in the command area based on the recorded crop areas for 2007 for the three zones is shown in the table below. This information is based on data provided by the District Department Agriculture and Water Resources and has been adjusted to represent three zones in the potential command area of 7,820 ha. Currently the cropping intensity for private farms is 100% while for *dekhan* farms it is 143%, with an over all cropping intensity of 108%. However, as noted above the volume of water currently being pumped is not likely to be sufficient to adequately irrigate all this area, and some other supplementary irrigation, from canal, or river is also utilized.

Table 34: Besharyk subproject - Summary of Land Use 2007

Category	Besharyk PS Potential Irrigable Area			Private Farms supplied with water from:		
	All Categories of Farms	Including: Private Farms	Dekhkan	Besharyk pumping station	BFC	Isfara river
Total Irrigable land area, ha	7820	7371	449	4116.4	1445.8	1808.9
Actually irrigated area, ha	6735	6286	449	3845.4	1282.8	1157.9
Abandoned land area, ha	1085	1085		271	163	651
Crop area, total, ha	6598	6260	338	3819.4	1282.8	1157.9
Wheat	2256	2111	145	1297.9	432.7	380.8
Cotton	3126	3126		1880	645	601
Potato	55		55			
Vegetables	74	30	44	20	10	
Melons	2	0	2			
Maize for silage	1037	945	92	573.5	195.1	176.1
Alfalfa	48	48		48		
Cropping pattern (%) Main crop	100	100.0	100	4090.4	1445.8	1808.9
Wheat	36.2	33.7	32.3	34.0	33.7	32.9
Cotton	46.7	49.9	0.0	49.2	50.3	51.9
Potato	0.8	0.0	12.2	0.0	0.0	0.0
Vegetables	1.1	0.5	9.8	0.5	0.8	0.0
Melons	0.0	0.0	0.4	0.0	0.0	0.0

Maize for silage	14.4	15.1	20.5	15.0	15.2	15.2
Alfalfa	0.7	0.8	0.0		1.3	0.0
Second crops, ha	574	489	85	300	102	87
Maize for silage	547	473	74	288	98	87
Potato						
Vegetables	27	16	11		12	4
Perennial plantation, ha	137	26	111		26	
Orchards, total	107		107			
including mature	95		95			
Vineyards, total	4		4			
Including mature	4		4			
Mulberry trees	26	26				

Source: District Department of Agriculture and Water Resources

322. Combining the cropping pattern with yields indicates that total annual production is 6,750 ton of cotton, 7,400 ton of wheat and around 40,000 ton of other products – mostly maize for silage and fodder.

323. The subproject area also has a significant number of livestock, most belonging to the households and *dekhan* farm and fed with fodder grown on household plots. Livestock numbers are estimated as 12,000 head of cattle including 4,800 cows and over 6,000 sheep. Most households also have poultry, which contribute to the household consumption, with surplus production marketed locally proving additional household income.

324. In the “future with” Project situation the average cropping intensity for private farms is expected to increase to 108% and to remain at 143% for *dekhan* farms, but with increased production as a result of the increase in yields. The percentage of cotton and wheat is projected to reduce marginally to 81% of the irrigated area, (assuming that the government’s mandatory requirement for farmers to grow cotton and wheat continues), while the area of lucerne increases to 8.5% in recognition its value as a restorative crop in the cropping pattern. A summary of the assumed “future with” project cropping pattern for the scheme area divided by zone is shown in the following table.

Table 35: Besharyk - Summary of Future with Cropping Pattern for Private Farms

Crop	Besharyk PS Zone 1				
	Present		Inc ha	Future with	
	ha	%		Tot ha	%
Wheat	1,297.9	33.75%	230.0	1,527.9	37.12%
Cotton	1,880.0	48.89%	-	1,880.0	45.67%
Vegetables	20.0	0.52%	20.0	40.0	0.97%
Maize fodder	573.5	14.91%	273.5	300.0	7.29%
Alfalfa	48.0	1.25%	273.5	321.5	7.81%
Potato	-	0.00%	21.0	21.0	0.51%
Fruit trees	26.0	0.68%	-	26.0	0.63%
Total area irrigated	3,845.4	100.0%	271.0	4,116.4	100.0%

Crop	Zone 2 – BFC				
	Present		Inc ha	Future with	
	ha	%		Tot ha	%
Wheat	432.7	33.7%	76.6	509.3	35.10%
Cotton	645.0	50.3%	-	645.0	44.46%
Vegetables	10.0	0.8%	5.0	15.0	1.03%

Maize fodder	195.1	15.2%	- 45.1	150.0	10.34%
Alfalfa	-	0.0%	131.5	131.5	9.06%
Potato	-	0.0%	-	-	0.00%
Fruit trees	-	0.0%	-	-	0.00%
Total area irrigated	1,282.8	100.0%	168.0	1,450.8	100.0%

Crop	Zone 3 - Isfara River				
	Present		Inc ha	Future with	
	ha	%		Tot ha	%
Wheat	380.9	32.9%	252.2	633.1	35.00%
Cotton	601.0	51.9%	200.0	801.0	44.28%
Vegetables	-	0.0%	20.0	20.0	1.11%
Maize fodder	176.1	15.2%	-	176.1	9.73%
Alfalfa	-	0.0%	178.8	178.8	9.88%
Potato	-	0.0%	-	-	0.00%
Fruit trees	-	0.0%	-	-	0.00%
Total area irrigated	1,158.0	100.0%	651.0	1,809.0	100.0%

- Farm budget analysis

325. An analysis of a typical farm budget for an average farm of 30 ha has been done to indicate the impact of the Project on net farm income. The farm model is based on the information on cropping pattern, yields, and inputs used in preparing the gross margins for zone 1. Farms in the Besharyk command area do not have much variation in their cropping patterns as the private farms are required by Government to grow a certain proportion cotton and wheat on their land and do not have any choice. *Dekhan* farms do have freedom of choice but as they only make up 5.5% of the command area, a separate farm model as not been shown. The objective of the financial analysis of a typical farm is to show the effect of the project on the farm households' net income and returns to labour as an indication of financial viability and to indicate the incentive farmers have to participate in the Project. For the farm budget analysis of the Besharyk scheme the financial analysis is not as meaningful than for more usual irrigation development as the collapse of the pump station will lead to a reduction of the irrigated area to around a third of the potential command area, resulting in a drastic reduction in farm income per farm, and inevitably the financial ruin of many farmers. Moreover the farmers are not currently required to make any contribution to the Project, either as equity or voluntary labour, as a result of the rehabilitation they will receive the benefits with no costs. Currently farmers are not required to contribute to the pumping costs of water or to repay any of the investment costs except through the WUA fee.

326. Currently is estimated that an average farm of 30 ha generates an annual net income of around SUM 13.5 million (\$10.250), or around \$340 per ha. In the "without project" situation this would deteriorate to a net return of only \$52 per ha across the command area. (These are average figures and assume that all farms would experience a similar reduction in their irrigated area, whereas those farms in the tail-end of the scheme would suffer a disproportionate greater reduction in irrigation, and some would not receive any water). In the "with project" situation the average farm would generate a net income of SUM 30.5 million (\$23,000) a 125% increase from the current situation. The incremental income per ha per year as a result of the project i.e. average returns per ha between the "present" and "future with" project situation is estimated as SUM 562,000 per ha (\$426) which for the average sized farm of 30 ha represents an increase of over SUM 16.50 million, or \$12,700 per farm. However not all the current number of farms would still be operating in the without project situation so this does exaggerate the average farm situation. The change in income per ha between the "future without" and

the “future with” project situation is even more dramatic as it shows the difference between the almost closure of irrigation to the restoration of the full irrigable area.

327. This shows that the prevention in the loss of the irrigated area through rehabilitating the pump station is the major source of the benefits. Farmers will have sufficient benefits and incentive to participate in the Project, and the additional returns would allow them to contribute to water costs if the government continues with its policy of introducing charges for recovering the cost of delivering irrigation water.

e) Economic analysis

- Project costs

328. The total rehabilitation cost of the Besharyk subproject is estimated at \$21.14 million to which has been added 16% for physical contingency and design and supervision making a total cost of \$24.524 million, or \$3,136 per ha of the 7, 820 ha command area. A summary of the rehabilitation costs is shown in the following table.

Table 36: Besharyk subproject - Summary of Rehabilitation Costs

Capital Works	\$ million	% of base costs
Besharyk pump station rehabilitation	9.159	43.3
Besharyk rising mains repair	2.537	12.0
Sub-total	11.696	55.3
Irrigation infrastructure rehab (M1 & M2)	2.451	11.6
Secondary canal reconstruction	1.050	5.0
New off-takes and pipe distribution system	4.231	20.0
Intake canal widening	0.420	2.0
Drainage rehabilitation	1.293	6.1
Total Base Costs	21.141	100.0
Contingencies 10%	2.114	10.0
Design & Supervision (6%)	1.268	6.0
Grand Total	24.524	116.0

329. The rehabilitation of the Besharyk pump station involving the replacement of 10 pumps and motors is the most significant cost contributing 43.3% to the base costs. The costs include replacement of the first 500 m of the rising mains. Rehabilitation of the existing irrigation infrastructure is estimated to cost \$1.05 million, 11.6%. The rehabilitation costs include the installation of additional offtakes from the rising main and a piped distribution to serve the lower portion of the irrigated area, an area that is poorly served by the present distribution system. An allowance for desilting inter-farm and on-farm drains is also included amounting to \$1.29 million. The project costs were converted to economic value by applied the conversion factor of 0.85.

- O&M Costs

330. Future operation and maintenance costs of the rehabilitated scheme are based on a percentage of the cost of the physical works and are estimated to total SUM 681 million per year (\$516,000), mostly for the maintenance of the pumps. However the application of the full O&M cost is delayed for five years after completion of the project because the new pumps are expected to require little maintenance in their initial years of operation and there is provision in the cost estimates for a supply of spare parts sufficient for the first five years of operation. The O&M costs were converted to economic costs using the SCF of 0.85. The total cost of electricity per year is estimated to be SUM 1,901 million (\$1.44 million) per year based on an economic cost of electricity of \$0.05 per kWh. For the Besharyk subproject electricity costs are assumed to be 8.75% less for

the same volume of water as in the current situation. Although the new pumps and motors are assumed to be 20% more energy efficient, the new pumping configuration will involve an increased in the dynamic head resulting in an overall efficiency gain of 8.75%.

331. In addition to the rehabilitation of the pumps the project will install a new dedicated pump to provide water for the 500 ha of fish ponds in the area adjacent to the pump station. Currently the fishponds are supplied by the existing pumps, which operate at a much higher head, so the new pump will operate with a saving of 65% of energy for the same volume of water. This saving in economic costs of electricity has also been included.⁵⁴

332. The crop budgets were adjusted for economic prices of inputs and outputs and taxes and transfer expenditure such as land tax excluded, then combined with the cropping pattern to show the cash flow of net benefits.

- Project benefits

333. The main Project benefit is the prevention of the reduction in the irrigated areas for the three agricultural zones which would happen in the absence of the rehabilitation. Crop yields are assumed to increase between 5 to 50% depending on location and crop. There would be a net efficiency gain of 8.75% in the amount of electricity used for the operation of the pumps and an a gain of 10% in the efficiency in the use of water, which results in a lower volume having to be pumped to satisfy crop water requirements. The gain in available water brought about by improved water use efficiency is assumed to be used to increase the irrigated area buy a corresponding percentage, i.e. a 10% increase in efficiency results in a 10% increase in irrigated area.

- Results of the economic analysis

334. The Besharyk Project is found to be economically viable; the economic internal rate of return (EIRR) is 13.3%. At a 12% discount rate the net present value (NPV) is SUM1,993 million (\$1.51 million) and the benefit cost ratio is 1.06. The most important benefits are those generated by the Project through the prevention of the reduction in irrigation through pump failure, the increase in irrigable area and to a lesser extent the saving in electricity consumption through more efficient pumps and the improvement in water use efficiency through support for water management and training WUAs.

335. The estimates of the benefits made possible by the Project are considered to be conservative, because the economic evaluation not does consider that the Besharyk pump station will stop operating completely in the “future without” project situation but is assumed to continue to operate at about one third of its current capacity. Even with this situation, there is likely to be major social dislocation in the project area because of the reduction in the irrigated area and loss of employment in agriculture, which would require some families to relocate to other areas. These costs have not been quantified and the actual benefit from the Project could substantially exceed those quantified for the analysis. A summary of the cash flows for the economic analysis is presented in Table 38.

- Sensitivity analysis

336. The EIRR calculation was subjected to sensitivity analysis to test the effects of negative changes in the key parameters that determine the benefits and costs of the

⁵⁴ Apart from the reduced energy costs for pumping no economic benefit from the fish pond has been included in the analysis as it is assumed that the fish ponds would remain in production in the without project situation.

Besharyk subproject. The sensitivity analysis found that the Besharyk subproject is sensitive to changes in the main parameters. In the face of a 20% increase in costs the EIRR would fall below 12%. With a 20% increase in O&M costs the EIRR reduces to 12%. The switching value for increased rehabilitation capital costs was determined to be 9.5%, and the switching value for decreased benefits and the price of wheat and cotton was determined to be -4.5%. The analysis is not so sensitive to the economic price of electricity with a switching value of 19% indicating that the price of electricity could increase from \$5 cents to \$6 cents per kWh. Similarly a reduction in the irrigated area to zero in the without project situation after 10 years did not affect the EIRR significantly.

337. Overall, the economic analysis is most sensitive to a reduction in the economic price of wheat and cotton as indicated by the Sensitivity Indicator (SI) of 21.7, and the overall reduction in net agricultural benefits (SI 26.6). The switching values in the above table show the percentage increase in a cost variable or decline in a benefit variable required for the NPV to become zero, which is the same as the EIRR reducing to the cut-off level of 12%.

Table 37: Besharyk subproject - Sensitivity Analysis and Switching Values

Test Case	Test Variation (+/- %)	NPV SUM'000	EIRR	Sensitivity Indicator	Base case Value of Parameter	Switching Value (+/-%)*	Switching Value
Base (reference case)		1,993,476	13.3%				
Increases in Costs							
Initial Capital Cost	20%	-2,288,732	10.78%	10.74	\$24,510,104	9.50%	\$26,838,564
O&M Costs	20%	-694,067	11.55%	6.74	\$1,926,594	15.00%	\$2,215,583
Economic Cost of Electricity	20%	-46,461	11.97%	5.12	5 cents/kWh	19.00%	5.9cents /kWh
Decreases in Benefits							
Decrease in net benefits	-20%	- 5,226,221	8.50%	18.11		-5.50%	
Total scheme failure by 10 years		2,844,895	13.73%			-100.00%	- F
Price wheat & cotton	-20%	-8,166,206	6.29%	25.48		-4.50%	

* A switching value of "-100%" indicates that the parameter has no practical switching value, when all other benefits are held constant.

Table 38: Besharyk subproject – Economic Analysis Summary Cash Flows

Calculation of the EIRR										
Constant 2008 SUM million										
Year	Economic Costs				Net Economic Benefits				Total Benefits	Net Benefits
	Capital Cost	Incremental O&M	Saving in Fisheries Pumping	Total Incremental Project	Zone 1 BPS	Zone 2 BFC	Zone 3 Isfara R.	Dekhan farms		
1 2009	2,750.03	-	-	2,750.03	-	-	-	-	-	- 2,750.03
2 2010	15,675.19	-	-	15,675.19	-	-	-	-	-	- 15,675.19
3 2011	9,075.11	277.63	61.88	9,290.86	2,034.32	608.20	883.97	214.89	3,741.38	- 5,549.47
4 2012	-	1,856.34	123.77	1,732.58	2,500.09	798.54	1,097.34	290.98	4,686.95	2,954.37
5 2013	-	2,051.69	123.77	1,927.92	2,723.78	920.72	1,223.08	353.01	5,220.59	3,292.67
6 2014	-	2,218.87	123.77	2,095.10	2,942.49	1,027.41	1,339.13	414.18	5,723.22	3,628.11
7 2015	-	2,242.23	123.77	2,118.47	3,012.51	1,066.92	1,371.46	451.75	5,902.64	3,784.17
8 2016	-	2,270.49	123.77	2,146.72	3,098.92	1,121.24	1,420.11	478.32	6,118.58	3,971.86
9 2017	-	2,526.70	123.77	2,402.94	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,897.77
10 2018	-	2,526.70	123.77	2,402.94	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,897.77
11 2019	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
12 2020	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
13 2021	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
14 2022	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
15 2023	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
16 2024	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
17 2025	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
18 2026	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
19 2027	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
20 2028	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
21 2029	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
22 2030	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
23 2031	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
24 2032	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
25 2033	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
26 2034	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
27 2035	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
28 2036	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
29 2037	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37
30 2038	-	2,543.10	123.77	2,419.34	3,185.32	1,155.82	1,460.69	498.88	6,300.70	3,881.37

NPVs:	21,411	13,438	-	744	34,105	18,522	6,487	8,403	2,686	36,098	1,993
% NPVs:	63%	39%	-	-2%	100%	51%	18%	23%	7%	100%	13.30%
EIRR:											
EOCC =	12%										

- Benefit distribution and poverty analysis

338. The most recent information on the overall incidence of poverty in Uzbekistan is from the World Bank Living Standards report 2007⁵⁵, which based on 2003 data assessed the head count poverty rate as being 27.2 nationally and 29.8 for rural areas. The poverty rate for the Fergana economic region where the Besharyk subproject is located was 28.3. The results of the household survey of the Besharyk subproject area conducted as part of the PPTA studies indicated a poverty rate of 19.5% (based on a consumption of 2100 Kcal per person per day as the poverty line).

339. The population in the Besharyk subproject is relatively dense, and area as confirmed by the socio-economic survey has a high dependency on agriculture for employment and sustenance, with little opportunity for alternative employment. This means that there would be a sharp increase in poverty if the pumps were to fail and rehabilitation did not happen. For most poor household's production from dekhan farms and household plots and domestic livestock (cattle, sheep and poultry) is important for their subsistence and for generating some extra income, which would be seriously

⁵⁵ World Bank Republic of Uzbekistan Living Standards Assessment Update. August 2007

affected if water supplies were to be limited. Poor households are expected to benefit from the increased agricultural productivity resulting from rehabilitation, and the attention given to improved water management, particularly from the extra employment generated from increased production. For the Besharyk subproject it is estimated that the rehabilitation of the scheme would generate an additional 385,000 person days (1,600 person years) per year of employment after full development compared with the present situation and avoid in the “without project” loss of a much greater number of person days. Most of the additional employment is expected to accrue to rural agriculture workers and poor households. Therefore the poverty impact is likely to be pro poor.

7. Environmental Assessment

340. An IEE and a SIEE were prepared for the Besharyk subproject. The Besharyk subproject is located within the Fergana valley one of the most highly developed and intensively settled irrigated areas in Uzbekistan. The environment in which the subproject is located has been extensively altered by the development of the irrigation system and the construction of the original pumping station in 1978. Some of the soils of the area are saline and highly mineralized. Elements include Na⁺ and Ca⁺⁺ which can be attached to chlorides, sulphates and carbonates. With poor water management these produce saline soils.

341. The environmental assessment considered a range of technical and water management alternatives and the option selected was to continue with a similar project design. In future better options may be the use of technology that can conserve winter flows and improvements in water use efficiency through the use of market forces. An EMP was prepared that identified issues during pre-construction, construction and operation. The main design issues concern the need for the provision of health and safety issues in the redesign of the buildings, improvements in design of the sand trap in front of the pump intakes, provision of oil and water separators in the pump house, development of a worker safety plan for the pumping station operators, evaluation of the rising main as an above ground structure to move it out of the saline environment, improvement of drainage in the irrigation area, provision of a land rehabilitation and protection program using vegetative technology, provision of canal crossings, inclusion of environmental conditions in procurement requirements, incorporation of the EMP conditions in the bid document, and evaluation of the contractors bid with regard to addressing environmental compliance requirements. Construction issues identified in the EMP include the need to undertake additional public awareness prior to construction commencing to advise farmers of the work schedule and how this will affect water supplies, induction of the contractor to site, removal of trees along the canals, loss of livelihood caused by interrupted water flows, removal and disposal of excavated materials, opening of borrow areas, storage and handling of materials brought to site, noise and dust, solid and liquid waste management and rehabilitation and closing of sites. During operation the main issues identified in the EMP are: application of the training programs provided with the supply of the equipment for the sustainable maintenance and safe operation of the equipment, and monitoring of water quality.

342. Both informal and formal public consultation has been held and comments received from the formal consultation have been incorporated in the EMP. The PMO through the Safeguard Officer and the assistance of the TA Consultant Environment Specialists will be in charge of the EMP during Project implementation. At the conclusion of the WRMP the responsibility will be to the MWRA. The EMP for the whole project has been costed at \$160,000⁵⁶.

⁵⁶ i.e. \$20,000 per subproject

343. The subproject will not increase the amount of water or the area that was originally designed for the subproject. The EMP has been able to address all of the impacts and it is concluded that an EIA is not required.

8. Resettlement Issues

344. Land Acquisition and Resettlement Framework (LARF) has been prepared according to ADB guidelines. The Subproject falls under Involuntary Resettlement Category C and does not require for LARP. However, the R&U may also have temporary impacts on land but it will not affect any person, crops, properties or structure. Temporary impacts shall arise when the four rising mains, buried 1.0 m deep on soil, have been excavated. Each four rising mains has length of 13.25 km. Both excavation and R&U shall be undertaken in three months time which shall be scheduled from mid-November to mid- February to avoid disruption on water distribution and planting activities in the farms. Covered by the excavation are the barren and gravelled flood plains where the first 500 m at the lower portion of high pressure will be excavated for the R&U. The affected lands will be restored to their original condition. But in case of delay, the EA will have to pay compensation to farmers, equivalent to the value of crops grown on that portions of affected lands, which is provided for in the Subproject's Due Diligence Report (Supplementary Appendix E.2).

VI. Project Social and environmental safeguards

A. Environmental assessment

1. Comparison of ADB's Environmental Safeguards with existing Government of Uzbekistan (GoU) legislation

345. A comparison of the ADB environmental safeguards and the requirements of the Government of Uzbekistan which have been formulated by the Main Directorate for State Ecological Expertise (*Glavgosecoexpertiza*) or SEE shows that both requirements are quite similar.

- Both systems adopt a **screening** process at the start of the project cycle to with the objective of categorizing the project. Depending on the category determines the extent of environmental assessment – i.e. whether it is an IEE, or EIA or no assessment is required. The SEE has determined 4 categories depending on the assessed risk of the project. Apart from the local impact least risk project all other projects commence with an IEE and depending on the outcome of the IEE determines whether the project should progress to a more detailed assessment.
- **Alternatives** are assessed under the ADB EIA system but are not specifically required in the IEE, whereas the SEE system requires alternatives to be assessed including the definition of the “zero impact” option.
- Both systems require **assessment of the environment** including the physical, biological, socio-economic and cultural resources.
- A detailed **EMP** is required under the ADB safeguards systems for both IEE and EIA, while the SEE system requires that the proponent produces technical solutions and activities are developed at an initial stage which then proceeds to a more detailed assessment at the EIA stage.
- Both systems provide a detailed outline of the **report structure**. The ADB report will be presented in English while the SEE report will be presented in Russian. This will require the ADB report to be translated and reformatted to the SEE format.
- **Public consultation and disclosure** procedures are used by both systems.
- The SEE system uses a set of environmental standards for air, water, soil and waste management.

2. Government of Uzbekistan Environmental Requirements

346. Protection of the environment is included as a section of the Uzbekistan Constitution, while the main enabling legislation is the 1992 Law on Nature Protection. The law empowers the State Committee for Nature Protection *Goskompriroda* as the agency responsible for implementing the law. The Republic of Uzbekistan has enacted 10 supporting laws and 10 statutes for environmental management and is party to 13 international and regional environmental agreements and conventions, including: Air pollution, [Biodiversity](#), [Climate Change](#), [Desertification](#), Hazardous Wastes, [Ozone Layer Protection](#), Trans-boundary Water Courses and [Wetlands](#) (Ramsar).

347. The *Goskompriroda* has a wide scope of activities including assessing and monitoring the environmental resources of the nation, establishing environmental quality standards and monitoring pollution levels of agricultural and industrial production systems, the establishment of protected areas and the protection of natural ecological resources.

348. Environmental assessment is the responsibility of the Main Directorate for State Ecological Expertise (*Glavgosecoexpertiza*) or SEE a directorate of *Goskomprida*. The SEE operates according to the 2000 Law on Environmental Expertise which establishes

the relationships between the state and local government levels and sets out the environmental assessment and monitoring procedures.

349. Wastes are addressed by the Code of Uzbekistan “About Wastes” (April 2002).

3. Project Environmental Assessment and Review Procedures

350. An EARP has been developed which has been prepared to comply with the ADB format and to be compliant with the Government of Uzbekistan’s environmental assessment requirements which are established by the Nature Protection Committee (NPC) and managed by the Main Directorate for State Ecological Expertise (*Glavgosecoexpertiza*) or SEE. An analysis of these procedures shows that there is basic consistency with both systems and both include the basic steps of environmental scoping, assessment of the environment, evaluation of impacts and establishing mitigation measures, monitoring and public consultation. The ADB IEE format will be used and will additionally include of a short section on alternatives and evaluation of the “zero project” situation to meet the NPC’s requirements. The IEE will need to be translated to Russian and reformatted to meet SEE requirements.

351. The Project Environmental Assessment and Monitoring will be the responsibility of the Safeguard Officer attached full time over the first five years to the PMO with the assistance of the TA Consultant Environment Specialists⁵⁷. The Safeguard Officer will be trained regarding environmental assessment and monitoring by the Consultant Environment Specialists. The PMO Safeguard officer will undertake all environmental assessment and comply with both the ADB and Government of Uzbekistan’s environmental safeguards and requirements. The PMO Safeguard Officer will undertake all assessments and monitoring of the EMPs in accordance with the EARP. A local NGO⁵⁸ will be mobilized to provide external monitoring of EMPs.

352. The NPC through its Provincial State Ecological Expertise (PSEE) unit will review and issue the development consent for the project, provide clearances for removing trees and undertake monitoring as required.

353. The ADB will approve the IEE, arrange the 120 day public disclosure of the IEE on its website and ensure that the development consent has been issued by the PSEE.

354. Each subproject is to have an IEE prepared for it. The EARP establishes the procedures that will be used to prepare the IEE, details public consultation requirements and who is responsible for approving the IEE. Each IEE will contain an EMP that establishes the mitigation measures, responsibilities and monitoring requirements. During preconstruction the section of the EMP that deals with construction activities will be extracted and attached to the bid and contract documents as a construction environmental management plan (CEMP). The bid will need to address the CEMP as well as identifying a person within the contractor’s organization who will be responsible for implementing the CEMP during construction.

355. During construction, monitoring of the CEMP will be carried out by the contractor who will be supervised by the Project Supervising Engineer (PE). The PE will be assisted by the PMO Safeguard Officer.

356. The EARP contains a reporting framework that requires the contractor to complete a monthly CEMP compliance report. This will be submitted to the PMO

⁵⁷ One International Specialist (5 months) and one National Specialist (17 months) over the first 3 years of the project implementation

⁵⁸ Alternatively a local Consultant

Safeguard Officer who will forward a copy of the report together with monitoring that has been carried out to meet ADB reporting requirements.

B. Land Acquisition and Resettlement Framework

357. The Land Acquisition and Resettlement Framework (LARF) has been prepared according to ADB guidelines as a guide for the preparation of Resettlement Plan (RP) in case there are persons that shall be affected by any of the subprojects assisted by ADB under the Project. While land acquisition is unlikely in the two core subprojects, the LARF (Appendix 8) is a required document prior to loan negotiation with ADB, to ensure that there is adequate social safeguard for persons that shall be affected by permanent or temporary land acquisition. All RPs under the Project shall be prepared by the EA according to Bank's involuntary resettlement policy, subject to consultation and agreement with affected persons before submission for review and approval by ADB. In all RPs, the Bank sees to it that there are adequate provisions to meet the following principles of involuntary resettlement: (i) replacement of assets or properties lost; (ii) rehabilitation of affected persons; and (iii) restoration of their incomes, or better, from pre-project level.

C. Poverty and Social Assessment

1. Sources of data - Survey

358. The statistical and qualitative information used in the Poverty and Social Assessment (PSA) under the Project were obtained from both the primary and the secondary sources. The primary sources were based on the surveys carried out in July and September 2008 within the influence areas of Narpay and Besharyk Subprojects, respectively. Using a sample of 400 households in each subproject area, in-depth interviews were carried out with main stakeholders, such as, farmers, households, specialists of the system of BISA and MAWR, representatives of the district *khokimiyat* and *makhallas*. Both surveys have covered the demographic and socioeconomic characteristics, access to services and the WUAs as well as their awareness and willingness to participate in the Project. Information on social infrastructure such as enterprises, social infrastructure facilities – educational establishments and medical institutions, were obtained from the Rural's Citizens' Assemblies.

359. As to secondary sources, the information were obtained from the 2003 – 2007 government-sponsored study on poverty that has been the basis for the preparation of the National Welfare Improvement Strategy (WIS), which the Government has endorsed in 2007. Reference was also made on Household Budget Survey by the State Committee on Statistics (Goskomstat) of Republic of Uzbekistan in which findings are consistent with that of the World Bank. In that survey, it disclosed that the average poverty level in Samarkand Oblast and Fergana Oblast was 23.9% and 15.8%, respectively in 2005. Both poverty levels are lower than the country's average of 25.8% in the same period.

360. The social survey conducted for the Project has adopted the methodology similar with that of the World Bank, which was also used in the preparation of the National Strategy on Improvement of Population Welfare (NSIPW).

2. Social Survey data on Narpay and Besharyk Project Areas

361. According to the households survey, in June 2008, in Narpay rayon of Samarkand province the poverty rate in populated localities within the command area of the Narpay machine canal, was 30.5%. According to the survey, the cost of minimum food basket, which ensures the required energy nutrition value (2,100 kcal per person per day), was 35,000 UZS per person per month (about 26 USD). In June 2008,

average total monthly income in surveyed households was 251,000 UZS, or 47,200 UZS per family member.

362. The poverty rate in populated localities within the command area of the Besharyk pumping station was 19,5%. In August 2008 average total income of households accounted for 335,400 sums and per family member – 55,700 sums. Each fourth family had incomes below the minimum set of product – 33,000 sums

363. The results of the social survey show that the most significant for families, regardless of their level of well-being, is income from hired employment in the non-agricultural sector. Employment in the non-agricultural sector (including entrepreneurial activities and labor migration) brings about 60% of the households' income in Narpay and Besharyk project areas.

364. Households located in the project areas have limited access to certain municipal services, and accessibility of these services has no dependence on the family's living standard.

365. Water shortage negatively affects productivity of domestic livestock breeding. 95% of families, who raise livestock, suffer from the insufficiency of irrigated pastures;

366. The Social Survey results demonstrated that key factors of poverty in the Project areas are low level of economic activity against the background of a relatively high unemployment. Additional poverty factors are demographic characteristics of households, which create a significant dependency burden for households' working members: the share of underage and adult incapable members is 43% for poor families, and 37% for non-poor families. Most of surveyed households, both poor and non-poor, are concentrated near the poverty line. So even minor changes in family composition and structure (birth of a child, retirement, disability, loss of a job) have a considerable effect on income and consumption levels and, therefore, on poverty level as well. At the same time, a poverty risk is much higher for young families with small children, where mothers have limited opportunities for employment.

367. The most important poverty determinant in the Project areas is limited opportunity for employment in the agricultural sector. The number of jobs in non-agricultural spheres is not so high to provide work to the capable population.

368. The Project will have positive effect on the growth of productivity of households in the Project areas. According to respondents' estimates, if water supply will be more reliable, crop yield in *dehkan* farms will increase, on average, by 43% (up to 255,000 UZS per year), given that current crop structure and prices for agricultural products will remain. Growth of productivity will be more pronounced on land plots of poor households (46%), and average total output of agricultural products will be 300,000 UZS per year.

369. Currently, less than 4% of households in the Project areas get income from marketing agricultural products, raised by the *dehkan* farms. In conditions of irrigation water famine, which makes impossible to produce crops for marketing, population tends to rely on other sources of income. Results of qualitative survey indicate that if irrigation water supply becomes stable, households are ready to return to traditional types of agricultural activities and raise agricultural products for the market.

370. The results of the Social Assessment confirm that the Project on rehabilitation of the Narpay and Besharyk pumping stations is demand-driven and of particular importance. Undoubtedly, ensuring permanent water supply is a priority for both economic and social development, and it is directly linked with prevention and reduction

of poverty. If the Project is not implemented, Project areas may face a critical situation, when farmers and families will be at the verge of poverty due to shrinking the area of cultivated land, low productivity and loss of income.

371. It should also be noticed that the Narpay and Besharyk canals systems are important sources of water for domestic and even drinking needs of a majority of Project area population. For this reason, the Project is supported by all stakeholders: the Government; practitioners; large and small agricultural producers; households.

372. Table 39 below highlights the important baseline indicators extracted from the PSA report.

Table 39: Narpay & Besharyk - Baseline Indicators from IPSA HH Surveys

Key Indicator	Specific Indicator	Besharyk Baseline Indicator	Narpay Baseline Indicator
Beneficiaries	Population of the project area, thousands	32.3	13.7
	Number of HHs in the project area, thousands	7.56	2.97
	Share of rural population, %	100	100
Information is relevant for project settlements only (not for RACs)	Number of Makhallas covered by the project	15	4
	Number of kindergartens/nurseries in the Project Area RACs	9	15
	Number of schools in the Project Area	9	18
	Number of colleges in the Project Area	1	0
	Number of Rural Medical Stations and polyclinics, rural out-patient medical institutions, paramedic and obstetric stations	6	16
	Number of hospitals, in-patient medical institutions, maternity hospitals	6	0
	Number of operating public bath in the Project Area	1	2
	Number of large Enterprises and Businesses in the Project Area	2	1
	Number of small Enterprises and Businesses in the Project Area in agricultural sector	2	6
	IPSA survey coverage information	Number of HHs covered by IPSA survey	400
Number of HHs members in the HHs covered by IPSA survey, thousands		2.4	2.1
Share of HHs covered by IPSA survey, %			13.5
Population & Demography	Average household size, people	6	5.32
	Average household size, poor HHs	6.64	5.77
	Average household size, non-poor HHs	5.86	5.12
	Share of children under 7	13.3	14
	Share of children under 16	30.2	32
	Share of pensioners and disabled	11.6	7.3
	Share of families with at least 1 labour migrant	8.8	10.8
Poverty & Incomes	Share of households living in poverty, using consumption of 2100 Kcal per person a day as a poverty line, %	19.5	30.5
	Number of people living in poverty, thousands	6.3	4.2
	Number of HHs living in poverty, thousands	1.47	0.9
	Poverty line, \$ per person per months <i>(for July 2008, 1USD=1310 USZ official rate used)</i>	32,940 25 \$ <i>(for August 2008, 1USD=1320)</i>	34,980 SUM 26.7 \$ <i>(for July 2008, 1USD=1310 USZ)</i>

		<i>USZ official rate used</i>	<i>official rate used</i>
	Average household income, SUM per month	335.5	165.1
	Average incomes, SUM per person a month	55.7	47.2
	Average incomes in the poor HHS, SUM per person a month	47.5	36.5
	Share of expenditures for food (paid in cash), as % of HHS expenditures	45.7	46.9
	Share of expenditures for food, (paid in cash) as % of poor HHS expenditures	45.1	53.7
Coverage of households with other municipal services	Share of HHS with access to stable gas supply	15.5	57.5
	Share of HHS with access to stable electricity supply	73	98.3
Livestock	Share of HHS with Cows, bulls, calves, etc.	87	65
	Share of HHS with Sheep and lambs	20.5	17.3
	Share of HHS with Poultry	26.3	34.8
	Share of HHS with livestock who faced with problem of reduction of irrigated pastures	70.8	94.9
	Share of HHS with livestock who faced with problem of reduction of watering places	74.8	90.1
	Share of HHS with livestock who faced with problem of Water shortage for livestock watering	61	54.7
Land and water use	Share of HHS with access to land (at least having garden plot)	99.5	93.8
	Share of poor HHS with access to land (at least having garden plot)	100	93.4
	Share of HHS who paid for irrigation water delivery for garden and dekhan plots during last 12 months (Officially and not officially)	13.2	0.25
WUAs	Share of HHS informed that there are WUAs operating in the project area	18.5	20.2
	Membership in WUAs (% of HHS)	0.5	1.25
	Of those HHS, who informed about WUAs existence: Think that WUAs manages water supply function successfully	16.2	22
	% of HHS in the project area not willing to be members of WUAs	55.3	58.5
Health & Sanitary	Share of HHS which have expenditures for healthcare in July 2008	36.8	39
	Share of expenditures for drugs and doctors, as % of HHS expenditures	6	8
	Average water consumption, liters per person a day	9.3	12.6
	Average water consumption, liters per person a day, poor families	8.6	11.4
	Share of Households with functioning or partly functioning Centralized Water supply at house/yard	6.5	3.2
	Water supply system non functioning at all (it is never operating)	1	10.3
	No centralized water supply pipeline in house/yard at all	92.5	86
	Share of HHS having water from pipeline in the house/ in the street (close to house) even irregularly	82.7	13.3
	Share of HHS buying water from a water vendor	0.5	31.5
	Share of HHS brining water from water reservoir	0.3	7.5

	Share of HHs having water from wells	12	0.5
	Share of HHs relying on surface water (river, canal)	16.3	75
	Share of expenditures for potable water delivery, as % of average family expenditures	0.3	1
	% of HHs with where woman and children have to go to get water more often than men	68.8	76.3
Awareness & willingness to participate	% of HHs confident that have heard about the proposed Project	13	18.5
	% of HHs confident that pumps at Besharyk / Narpay pumping station have to be repaired urgently	79.5 (19.3 can not say anything about this issue)	79.5 (19.5 can not say anything about this issue)

D. Gender Action Plan

373. Several surveys, conducted in different regions of Uzbekistan on women's participation in water resources management showed that rural women face a number of problems, related to their status. For example, women are involved in nonqualified work, and / or mostly involved in seasonal types of low paid agriculture works.

374. Welfare Improvement Strategy (WIS) for Uzbekistan accepted in 2007 identified main challenges in achieving gender equality in Uzbekistan: lack of full financing in implementing measures on gender policy, especially in the area of employment; insufficient use of gender approaches in implementing economic and social policy and in state decision making in general; lack of readiness of government employees to resolve gender issues, as well as a lack of a specific understanding of the role of women in society and the importance of ensuring gender equality; existence of gender stereotypes and a patriarchal way of life both in the understanding of society as a whole and at the decision making level.

375. In order to increase the women's participation in development and water resource management it is needed the following:

- To initiate a campaign on increasing gender awareness of the employees of key structures operated in water resource sector.
- Ensure women's involvement, representatives of communities, *makhalla* committees, *rayon khokimiyats* into participatory planning workshops in the Project area.
- Support the initiatives of local women –leaders to establish Water Users Groups under the local administrative bodies, *makhalla*'s to provide various services on water management demanded by the population
- Organize special trainings for women - leaders in selected areas: on entrepreneurship skills development, leadership, establishing associations, cooperatives, legal literacy, community mobilization, etc.

A Gender Action Plan was prepared for the project. It is detailed in Appendix 11 to the present report, with the target of having men and women participating in a balance way to all activities of the project at planning, implementation, management and monitoring stages.