

DRAFT

Report of Water Quality Monitoring in Azad Jammu & Kashmir (AJK)

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Acronyms & Abbreviations

ADP	Annual Development Plan
AJK	Azad Jammu & Kashmir
As	Arsenic
BHU	Basic Health Unit
Cd	Cadmium
CMH	Combined Military Hospital
Cond	Conductivity
Cu	Copper
DHQ	District Headquarters
EPA	Environmental Protection Agency
Fe	Ferium (Iron)
IUCN	IUCN - The World Conservation Union
LG	Local Government
LG&RD	Local Government and Rural Development
Pb	Lead
PCRWR	Pakistan Council for Research on Water Resources
pH	Concentration of hydrogen ions
PHED	Public Health Engineering Department
ppb	Parts per billion
ppm	Parts per million
RHC	Rural Health Center
SDO	Sub-Divisional Officer
SE	Superintendent Engineer
SEARO	South East Asia Regional Office (WHO)
TDS	Total Dissolved Solid
UNICEF	United Nation International Children Education Fund
WHO	World Health Organization
XEN	Executive Engineer

Executive Summary

1. A study was conducted to assess the quality of drinking water in five major towns in Azad Jammu & Kashmir (AJK). The towns selected for the water quality survey were Muzaffarabad, Bagh, Rawalakot, Kotli and Mirpur.
2. A four step methodology was adopted for the study: a literature search for secondary data collection on water quality issues, interviews with the relevant officials in the AJK Government and other institutions responsible for the provision of drinking water in urban areas, an intensive field survey of five towns and finally report writing.
3. The overall goal of the study is to promote and translate into practice the belief that :
“Water Quality issues address society's concern on public health and environment”.
4. The study's main objective is to assess the existing drinking water quality and suggest practical remedies for provision of safe drinking water in AJK.
5. No data is available on drinking water quality in AJK. One of the few studies that have been conducted was the rapid urban and industrial appraisal for the Natural Resource Management Project, which was carried out in 1996 (IUCN 1996). However, in 2003 IUCNP undertook detailed meetings with AJK-EPA, followed by a consultant's visit to determine the existing AJK-EPA capacities and issues related to water quality.
6. The appraisal team recommended that: a detailed survey be carried out to assess the drinking water quality of various sources and delivery systems in the five districts of AJK. Consequently a technical team led by a water expert from IUCNP conducted the water quality survey in AJK. Assistant Director Environment AJK-EPA also participated in the survey as team member.
7. The present work may be helpful for various agencies involved in water supply systems to develop water quality monitoring programmes, their need and selection of cost-effective criteria for monitoring. It may also provide useful information to professionals and other groups for designing and improving the quality of existing water supply systems in AJK.
8. The present study is also of national significance to Pakistan considering that AJK is a major source of water to Pakistan as well as an important watershed (River Jhelum). It is therefore quite pertinent to study water quality in AJK and to put in place a strategy and an action plan for ensuring quality on continuous basis.
9. A detailed survey was carried out to ascertain the existing drinking water quality and quantity issues in five major AJK towns– Muzaffarabad, Bagh, Rawalakot, Kotli and Mirpur and adjacent rural areas. The survey included site visits, meetings with the people concerned and review of the relevant documents. The survey revealed that there data is not available on drinking water quality and quantity issues in AJK. No detailed survey has ever been carried out to determine the water quality of the AJK water delivery systems and sources. Therefore, the water management section relies heavily on the data provided by the relevant departments, literature search and visits to the different cities and their water delivery systems and sources. Discrepancies in the data are possible since no detailed and authentic data pool is available. This section will review the existing water management practices in the five surveyed towns of AJK. The review of each city covers the existing situation with respect to organizational structure, management of water delivery systems, future plans, issues and recommendations. The water quality analyses of each city reveal the existing

- situation with respect to bacteriological, chemical and physical parameters of the water quality of drinking water sources.
10. For greater reliability and precision bacteriological testing was carried out on site. For this purpose portable Del-Agua water testing kits were used, which employ the membrane filtration method for bacteriological sampling. All the samples were processed in duplicates. At the end of each cycle a control sample of bottled mineral water was processed as means of quality control. The turbidity of the samples was measured in Turbidity Units by using the turbidity tube provided with the Del-Agua water testing kits. These turbidity tubes are graduated with a logarithmic scale and cover the range 5 to 2,000 TUs.
 11. Chemical samples were collected in acid washed polyethylene bottles and acidified with concentrated nitric acid. Preserved water samples were then transported to PCRWR for further analysis. Physical analysis was done at the source.
 12. At spring sources samples were taken from the spring eye. Representative water samples from delivery systems were taken from different locations.
 13. Rivers and springs are the main drinking water sources in the northern part of the AJK. In the southern area bore wells are the major source of drinking water of the AJK population who have access to piped water supply. The majority of the population in Muzaffarabad and Bagh prefer to use spring water sources for drinking purposes.
 14. The review of each city analyses the existing situation with respect to organizational structure, municipal waste, industrial waste, hospital waste, slaughterhouse waste and financial sustainability of the key institutions.
 15. Muzaffarabad is the state capital with three sub-divisions, and is the most populous town in AJK. According to 1998 census the existing population of Muzaffarabad is about 0.746 million, with a density of 136 persons per square kilometer. It is one of only two districts with divisional status in AJK (the other is Mirpur). The commercial sector here is not very large and the industrial sector is non-existent. The local administration in Muzaffarabad has been granted the status of Municipal Corporation. PHED is responsible for supplying the drinking water in the town area whereas in rural areas LG&RD is responsible for the provision of drinking water. Almost 70 percent of the town's population resides in the old areas where the roads are narrow and steep. According to 1998 census piped water supply coverage in urban and rural areas of Muzaffarabad is 99 and 55 percent respectively.
 16. River Neelum is the main water source for Muzaffarabad Water Treatment Plant (WTP) Raw water from the river is sucked through 6 electric pumps directly from the river bank to the inlet of the WTP. Alum is mixed with the raw water in the inlet chamber to reduce turbidity before the water is channelled to the clarifiers. The WTP comprises of an inlet chamber, alum mixer, two clarifiers, four roughing filters, and a chlorinator which is employed at the end point of the treatment.
 17. Bagh town is the headquarters of District Bagh, and has three sub-divisions. According to 1998 census the total population of the district is 0.39 million. The population of Bagh town is approximately 30,000, making it the fifth largest town in AJK. There are 2,980 housing units, of which 1,400 possess tap water connections. The entire town is located on hilly slopes. The basic economic activity is shop keeping. A significant number of the male population is working in other parts of Pakistan or overseas, which is a major source of revenue for a town with very limited employment opportunities. Piped water supply coverage in the urban and rural areas of District Bagh is 50 and 51 percent respectively.
 18. Piped water to Bagh town is supplied through a water supply complex. Spring and nallah water are the main sources for the water supply complex. Piped water is supplied to 1,200 registered consumers intermittently to different areas of the town. Batch chlorination is done in the rainy and summer seasons when source water becomes polluted.

19. Rawalakot is the headquarter of District Poonch and has three sub-divisions. The population of District Poonch is 0.449 million. It is the most densely populated area of AJK having a population density of 525 persons per square kilometer. Rawalakot is the third largest town in AJK with an estimated population of 40,000 and 6,402 housing units within the town limits.
20. In Rawalakot piped water as well as that from springs and boreholes (ground water) are the main sources for drinking water. Rawalkot Nallah is the primary source for the water supply system. There are 15,000 registered consumers and the current demand of the Rawalakot city is about 650,000 gallons/day, whereas the existing capacity of the Water Plant is about 400,000 gallons/day. To meet the current demand PHED has to supply water intermittently. Alum and Chlorine is used for treatment during the summer season when the water becomes turbid.
21. Kotli is the fourth largest town in AJK and the headquarters of District Kotli. The total population of the district is 0.62 million. The total area of the district is 1,862 square kilometers and it has three sub-divisions. Kotli town is spread over an area of six square kilometers and has a population of 39,000. It has 5,120 housing units within the town limits. The piped water coverage in urban and rural areas is 95 and 63 percent respectively. The landscape is mainly hilly and little flat area is available.
22. River Jehlum, ground water wells and springs are the major sources of drinking water for Kotli town. There are seven tube-wells in different parts of the city from where water is pumped to distribution reservoirs in different areas. The current demand for drinking water is 1.4 million gallons but the existing tube-wells and dug wells provide only 50 percent of the requirement. Therefore, water is supplied intermittently. There are 7,000 registered consumers, paying 50 PKR per month as water tariff. Chlorination is done in the summer season at distribution reservoirs. However, batch chlorination is undertaken daily in dug wells situated near the river bank.
23. District Mirpur is spread over an area of 1,010 square kilometres. It has three sub-divisions and a population of 0.36 million. The population density in the district is 359 persons per square kilometers. Mirpur is the second largest town of AJK and is spread over an area of 28 square kilometers. It has a population of 0.09 million and 14,700 housing units in the town limits. The economic situation of Mirpur is also significantly better than that of other AJK towns. Piped water supply coverage in urban and rural areas of Mirpur is 88 and 70 percent respectively.
24. Tube-wells are the only source of drinking water for Mirpur town. There are 20 tube-wells situated at Mangla Dam periphery providing 4.2 million gallons of water per day. Chlorination of drinking water is done only in the rainy seasons at distribution reservoirs.
25. Lack of coordination among various institutions working in the water sector is the main issue of concern. Other problems include lack of required capacity, lack of awareness on the importance of water quality and the absence of a water quality monitoring programme.
26. Altogether 42 water samples were collected from various drinking water sources and different points at the delivery system in five towns of AJK. Bacteriological water quality results revealed that 52 percent of the total water samples were in category A, and are safe for drinking. Of the total samples, 17 and 24 percent were in Category B and C respectively. Only 7 percent of the total samples were in category D (high risk) with contamination levels higher than 101 E.coli/100 ml as per WHO recommendations.
27. The results revealed that all water samples of different sources and delivery systems comply with WHO guideline values for selected parameters. The concentration of Arsenic was in the range of 0 - 2.87 with average and standard deviation of 0.5 and 0.65 ppb respectively (see Table A). The concentrations of lead, copper, mercury, cadmium and iron were observed to be in the range of

- 1.34 - 1.45, 0.29 - 13.6, 0 - 0.37, 0.02 - 0.06 ppb respectively. The concentration of iron was recorded in the range of 0 - 0.19 ppm.
28. The physical analysis of water samples was carried in-situ for Total Dissolved Solids, Conductivity, Salinity, Turbidity and pH. All water samples comply with WHO standards.
 29. Survey findings revealed that there is a dire need of synergy between different departments working in the water sector. It is imperative to develop a purposeful and cost effective water quality monitoring programme. This can only be achieved by enhancing the coordination between different organizations working in the water sector. An inter-sectoral coordination committee should be formed to develop a water quality surveillance programme
 30. Job-oriented training programmes in overall management of water delivery systems should be designed for operators and officials of PHED.
 31. No systematic sanitary inspection procedure was applied by technical staff of water delivery systems, and hence no quantitative risk assessment data is available. It is imperative to design sanitary survey forms for each of the main types of water resources in the area. This would reduce the likelihood of contamination to a great extent.

Water Quality Monitoring in Azad Jammu & Kashmir (AJK)

1. Introduction

1.1 Water and Health

Safe and adequate water for all is perhaps the most basic requirement for human survival. It is also one of the most pressing challenges on today's sustainable development agenda. Although the focus on water is nothing new, and the water sector has long formed the cornerstone of government and donor investment strategies, there has recently been a strong reiteration of the need to develop and fund water infrastructure. For example, one of the eight Millennium Development Goals aims to improve access to safe water supplies. The Johannesburg Plan of Action restates this target, and also flags the need to increase access to sanitation and to develop integrated water resources management and efficiency plans.

Water pollution and wasteful use of freshwater threaten development projects and make water treatment essential in order to produce safe drinking water. It has been unequivocally demonstrated that water of good quality is crucial to sustainable socio-economic development. The main factors responsible for water degradation include lack of sanitation facilities, absence of environmental legislations and competitive authority especially in the developing world.

The World Health Organization (WHO), has estimated that up to 80 percent of all sickness and diseases, and 30 percent of deaths in the developing world are caused by inadequate sanitation, polluted water, unavailability of water and poor hygiene. A recent survey carried out in developing countries shows that 1.2 billion people suffer from diseases caused by unsafe drinking water or poor sanitation, more than four million children die from water borne diseases and fifteen percent of children will die before reaching the age of five due to diarrhea that might be avoided with reasonable water and sanitation services (Juha I Uitoo et al, 1999). Similarly, in Pakistan 60 percent of child mortality is attributed to water borne diseases (Editorial, Daily Dawn, Nov.19, 1999)

The main cause of water related diseases is the presence of impurities in water. Water related diseases are of two types; infectious water related diseases that are caused by biological pollutants, and non-infectious water related diseases, which are caused by the chemical pollution water resources. Microbial contamination is the most critical risk factor in drinking water quality with a high potential of causing water borne diseases. The four distinct routes of transmission are categorized as a) faecal-oral (water borne and washed, b) water washed, c) water based and d) water related.

True water borne transmission occurs when a person or animal becomes infected after drinking pathogenically contaminated water. Water borne infections are classified in Category 1 of the environmental classification of water related diseases. This category consists of all types of diarrhoeal and dysentery infections that may be manifested by protozoal, bacterial and viral infections. These infections are also categorized as water washed diseases, as epidemiological studies worldwide indicate that they can be reduced to some extent by increasing adequate water quantity (see Table A).

Another route of transmission of water related diseases is known as water washed diseases which are grouped in Category 2 of environmental classification. The infections of this category consist of skin (bacterial skin sepsis, scabies) eye infections (trachoma),

louse borne typhus (*Rickettsia prowazeki*) and louse borne relapsing fever (spirochaete, *Borrelia recurrentis*) etc. The water washed diseases are defined as the diseases whose transmission can be reduced by increasing the volume of water used for hygienic purposes.

The third route of transmission of water related diseases are recognized as water based. Water based disease is one, whose pathogen spends a part of its life cycle in a water snail or other aquatic animal, and then infects the exposed person after acquiring the infectious stage. The examples of this category are Schistosomiasis, Guinea worm and Clonorchiasis (see Table A).

The fourth and final route of transmission of water related diseases is water related insect vector route. The potential vector responsible for disease transmission either breeds in water or resides near water. Malaria, yellow fever and dengue are common diseases of this group (see Table A)

1.2 **AJK at a Glance**

The State of Azad Jammu and Kashmir (AJK) lies in the north of Pakistan. It covers an area of 5,134 square miles (13,297 square kilometers). According to the population census of 1998, the total population of AJK is 2.915 million. The census categorizes 88 percent of the total population as rural and 12 percent as urban. The population density is 224 persons per square kilometer as against 164 in Pakistan. According to the 1998 census, the literacy rate in AJK is around 44 percent, which is significantly higher than the 28.3 percent reported in the 1981 census.

AJK lies between longitudes 73° and 75° and between latitudes 33° and 36°. The topography is mainly hilly and mountainous with numerous valleys and stretches of plains. A large portion of the area is under thick forest cover, with fast flowing rivers and winding streams. The forest cover is about 566,969 hectares, which is 42.6 percent of the total geographical area of AJK. The main rivers are the Jhelum, Neelum and Poonch. The elevation ranges from 360 meters in the south to 6,325 meters in the north. The climate is sub-tropical highland type with an average yearly rainfall of 150 cm.

AJK is divided into two divisions – Muzaffarabad and Mirpur. Muzaffarabad Division is further divided into four administrative districts: Muzaffarabad, Bagh, Poonch and Sudhnuti. The Mirpur Division is divided into three districts: Mirpur, Kotli and Bhimber. There are 202 Union Councils, 10 Town Committees, 30 Markaz Councils, 2 Municipal Corporations and 5 Municipal Committees, with 18 sub-divisions (three under consideration) and tehsils, and 1,646 villages. In the urban areas, 81 percent of the population has access to piped water and 3 percent through public stands. In the rural areas, 55 percent of the population has access to water supply.

According to the 1999 figures, there are 14 hospitals in the area with a total capacity of 1,382 beds. In addition to these there are 29 Rural Health Centers, 469 Basic Health Units/dispensaries, 544 BHUs & RHCs beds/Maternity & Child Health Centers, plus several other small health care facilities.

There are seven industrial estates in AJK. The total number of industries is 830, and includes wood works, food processing, flour mills, poultry farms, textile mills, printing presses, etc.

1.3 **State of AJK's Urban Environment**

Although AJK does not have a large urban population, the environmental problems in the urban centers are increasing at an alarming rate due to the mushroom urban growth and inadequacy of the present urban setup. Matters are made worse because of the lack of

primary data. To date, no detailed survey of the urban sector has been carried out. Lack of data is a major hindrance in the development of any feasible plans. One of the few studies conducted was the rapid urban and industrial appraisal for the Natural Resource Management Project, which was carried out in 1996 (IUCN 1996). The survey briefly looked at the water supply, wastewater, solid waste, transportation and industrial issues in the AJK. The survey reveals that due to lack of sewerage systems all kinds of domestic and industrial sewage is either discharged directly into the rivers or eventually ends up in them through streams, or leaches into the ground water. Similarly, no proper solid waste disposal system exists in any urban area. Most of the solid waste generated in AJK is either dumped into the rivers or on open ground. Other environmental issues such as air pollution caused by vehicular and brick kiln emissions also exists in AJK.

1.4 International Guidelines

To intervene the spread of these infectious diseases via water, WHO published International Guideline values for drinking water in 1983. These guideline values have been revised several times. According to WHO guidelines the faecal contamination levels of drinking water must be 0 E.coli / 100 ml for safe drinking water. However, for developing countries WHO has recommended 0-10 E.coli /100 ml in drinking water as acceptable limits. According to WHO/SEARO (recommendations of WHO/SEARO member states conference held in Khatmandu, September 1996) the water can be divided into four groups with reference to the contamination levels (see Table A)

Table A: Classification of Faecal Contamination Levels as per WHO Guidelines

Grade	Faecal coliform / 100 ml	Health Risk
A	0	No risk
B	1-10	Low risk
C	11-100	High risk
D	101-1000	Very high risk

1.5 Background of the Survey

Like other developing countries water quality is a major concern in AJK. A number of studies conducted here reveal water quality and water borne diseases as a major concern here. The AJK Environmental Protection Agency (AJK-EPA) soon after its establishment in 1999 - 2000, realized that drinking water quality is an important issue and is the main contributor to water borne illness in AJK. In order to reduce the risk of water borne disease burden on the AJK population, AJK-EPA focused its attention on water quality issues. In this connection in the past few years a water quality monitoring laboratory has been established in AJK-EPA at Muzaffarabad. In 2002 The United Nations Development Program, under its Area Development Program commissioned a project to assess the water quality in AJK. As a result of various meetings held with UNDP and AJK-EPA, IUCN Pakistan (IUCNP) undertook the water quality survey of drinking water sources and systems of AJK. It was initially agreed that water the quality survey be conducted in five AJK cities namely Muzaffarabad, Bagh, Kotli, Rawlakot and Mirpur, plus three rural areas. Based on the findings of the survey IUCNP would develop a water quality monitoring strategy and action plan for the entire AJK. IUCNP would also provide support for setting up of AJK-EPA laboratory and would train one staff member on water quality assessment. In November 2004, a water quality expert from IUCN Northern Areas Programme had a detailed meeting with Director General AJK-EPA for the selection of sampling sites, parameters and time-frame for the water quality survey. Consequently a team comprising water quality expert from IUCNP Northern Areas Programme and the Assistant Director Environment AJK-EPA conducted the survey in the last week of December 2004.

1.6 Scope of Study

As in other developing countries, the concept of having a comprehensive water quality monitoring programme is quite new to Pakistan and hence to AJK. The main reasons of this negligence include funding constraints, lack of required skill and more importantly lack of responsiveness by the authorities. However, today the authorities involved in supplying drinking water have become more conscious about water quality rather than quantity as compared to the past. This awareness can be attributed to the high prevalence of water borne diseases as well as the pressure of donor agencies. The present work may be helpful for various agencies involved in water supply systems, to develop water quality monitoring programmes and select cost-effective criteria for monitoring. It would also provide useful information to professionals and other groups for designing and making improvement in the quality of existing water supply systems in AJK.

The proposed study is of national significance to Pakistan considering that AJK is an important source of water for the country as well as a major watershed (River Jhelum). It is therefore quite pertinent to study water quality in AJK and to put in place a strategy and action plan for ensuring quality on continuous basis.

1.7 Objectives

The overall objective of the present work is to assess the quality of drinking water sources and delivery systems. The specific objectives of the survey are:

- To investigate bacteriological contamination at source and delivery systems;
- To assess important heavy metal concentrations in drinking water sources and delivery systems;
- To check the physical quality of drinking water; and
- To develop a water quality monitoring strategy for AJK-EPA that might be replicated by other institutions involved in the provision of drinking water in AJK.

1.8 Methodology

The following approach was adopted to conduct the water quality survey in AJK.

1. Literature search was conducted to collect secondary data (including library and internet searches).
2. Meetings were undertaken with the relevant people in the AJK-EPA in Muzaffarabad and PHED departments to get their point of view on the issue of water quality in the AJK.
3. Visits were made to the five district headquarters and rural areas in AJK to meet officials of the PHED in order to gain first hand information on existing water delivery systems and future plans.
4. Field visits were made to various drinking water sources and water delivery systems in the five districts of AJK.
5. The report has been compiled based on the observations and data collected during the visit.
6. For greater reliability and precision bacteriological testing was undertaken on site. Portable Del-Agua water testing kits were used, which employ the membrane filtration method for bacteriological sampling. All the samples were processed in duplicates. At the end of each cycle a control sample of bottled mineral water was processed as means of quality control.
7. The turbidity of the samples was measured in Turbidity Units by using the turbidity tube provided with the Del-Agua water testing kits. These turbidity tubes are graduated with a logarithmic scale and cover the range 5 to 2,000 TUs.

In the membrane filtration technique a known volume of water is sucked through the membrane (fitted in the sterile membrane filtration unit) with the help of vacuum pump. The membrane is then placed on the absorbent pad saturated with membrane lauryl sulphate broth in a sterile aluminum petri-dish. The plates are then incubated for 18 hours at 42 - 44°C. After completion of the incubation period all yellow colonies on the membrane are counted and reported in per 100 ml of water. In case of a dilution the following formula is used for calculating the result:

$$\frac{\text{Total number of colony count}}{\text{Volume filtered}} * 100$$

8. Samples from springs were generally taken at the spring outlet, which would also be a collection point for domestic usage. Samples from the household containers were also taken during sampling in the village. However, a clear relationship of these samples with the specific source/s and the quality of water at the fetching time was not established, especially when the storage time varied from half an hour to about six hours in some cases.
9. The groundwater wells were generally covered and fixed with hand pumps. Samples were taken from the pump outlets. Samples from the traditional water pits were collected directly from the pits using the sterile sampling cup.
10. Chemical samples were collected in acid washed polyethylene bottles and acidified with concentrated nitric acid. Preserved water samples were then transported to PCRWR for further analysis.
11. In-situ physical analysis of water was done at the water sampling point.
12. Information was collected from the people present at the sampling source.

2. Water Management

2.1 Drinking Water Sources in AJK

Rivers and springs are the main drinking water sources in the northern part of the AJK. On the other hand bore wells are the major source of drinking water in the southern part. In the urban areas of AJK, 81 percent of the population has access to piped water supply, while 55 percent of the population of rural areas has been provided with piped water. However, the majority of the population prefers to use spring water sources for drinking purposes.

Out of the five surveyed districts, spring sources are widely used in two districts for drinking purposes. In Muzaffarabad town alone more than 20 springs are used for collecting drinking water. Only the few springs situated in the posh areas of the city or in Cantt are well protected, while all others are unprotected. During the water sampling in Muzaffarabad, a large number of people were seen collecting water from the springs in pitchers and buckets. The surroundings of the majority of these springs were very dirty. Filth and animal waste was dumped near and around the spring eye of a spring sampling



An unprotected spring in Muzaffarabad.



site in Muzaffarabad from where more than 1,500 households and nearby hotels fetch water for drinking purposes. A cattle shed is also situated near this particular spring. Similar conditions were observed in Bagh District, from where a large number of households fetch water for drinking purposes. No government institution including the PHED or LG are responsible for managing these spring sources.

2.2 Demography of Sampled Districts

2.2.1. Muzaffarabad

Muzaffarabad town is the state capital with three sub-divisions and is the most populous town in AJK. According to the 1998 census the existing population of Muzaffarabad is about 0.746 million, with a density of 136 persons per square kilometer. Muzaffarabad is one of the only two districts with divisional status in AJK (the other is Mirpur). The commercial sector is not very large and the industrial sector is non-existent. The local administration in Muzaffarabad has been granted the status of Municipal Corporation. PHED is responsible for supplying the drinking water in the town area whereas in rural

areas LG&RD is responsible for the same. Almost 70 percent of the town's population resides in the old areas where the roads are narrow and steep. According to the 1998 census, piped water supply coverage in urban and rural areas of Muzaffarabad is 99 and 55 percent respectively.

2.2.2 Bagh

Bagh is the headquarters of district Bagh and has three sub-divisions. According to the 1998 census the total population of District Bagh is 0.39 million. The population of Bagh town is approximately 30,000, making it the fifth largest town in AJK. There are 2,980 housing units out of which 1,400 have tap water connection. The entire town is located on hilly slopes. The basic economic activity is shop keeping. A significant number of the male population is working in other parts of Pakistan or overseas, which is a major source of revenue for a town with very limited means of employment. Piped water supply coverage in urban and rural areas of District Bagh is 50 and 51 percent respectively.

2.2.3 Rawalakot

Rawalakot is the headquarters of District Poonch with three sub-divisions. The population of District Poonch is 0.449 million. District Poonch is the most densely populated areas of AJK having a population density of 525 persons per square kilometer. Rawalakot is the third largest town in AJK with an estimated population of 40,000 and 6,402 housing units within the town limits. The piped water supply coverage in rural and urban areas is 75 and 85 percent respectively. The principal economic activity in the city is shop keeping. No major source of employment exists except for a few government offices. The town has 2,000 shops and 12 small hotels.

2.2.4 Kotli

Kotli is the fourth largest town in AJK and the headquarters of District Kotli. The area of the district is 1,862 square kilometers and it is divided into three sub-divisions. The district's total population is 0.62 million. Kotli town is spread over an area of 6 square kilometers and has a population of 39,000. It has 5,120 housing units in town limits. The piped water coverage in urban and rural areas is 95 and 63 percent respectively. The landscape is mainly hilly with little flat area available. The major economic activity is shop keeping. The sources of employment are very limited forcing males to find jobs in other parts of Pakistan and overseas, mostly in the Gulf states.

2.2.5 Mirpur

District Mirpur is spread over an area of 1,010 square kilometers with three sub-divisions and a population of 0.36 million. The population density in District Mirpur is 359 persons per square kilometer. Mirpur is the second largest town of AJK and is spread over an area of 28 square kilometers. It has a population of 0.363 million and 14,700 housing units in the town limits. The per capita income is substantially higher than of other AJK towns. Located in close proximity to the Mangla Dam, the entire city was relocated in the early sixties at the time of construction of the Dam. The city was originally designed for a population of 15,000, which has now increased almost eight-fold. The majority of the population has links with the United Kingdom, where large numbers of locals have settled. This is the major reason for Mirpur's reputation of being an aware society, well informed on issues such as the environment. The economic situation of Mirpur is also significantly better than that of other AJK towns. Piped water supply coverage in urban and rural areas of Mirpur is 88 and 70 percent respectively.

2.3 Management of Drinking Water Delivery Systems

A detailed survey was carried out to ascertain the existing drinking water quality and quantity issues in five major AJK towns – Muzaffarabad, Bagh, Rawalakot, Kotli and Mirpur and adjacent rural areas. The survey included site visits, meetings with the people concerned and review of relevant documents. The survey revealed that data is not

available on drinking water quality and quantity issues in AJK. No detailed survey has ever been carried out to ascertain the water quality of the AJK water delivery systems and sources. Therefore, the water management section relies heavily on the data provided by relevant departments, literature search and visits to different cities and their water delivery systems and sources. Discrepancies in the data are possible since no detailed and authentic data pool is available. This section will review the existing water management practices in the five surveyed towns of AJK. The review of each city covers the existing situation with respect to organizational structure, management of water delivery systems, future plans, issues and recommendations.

2.3.1. Muzaffarabad

River Neelum is the main water source for Muzaffarabad Water Treatment Plant (WTP). Raw water from the river is sucked through 6 electric pumps directly from the river bank to the inlet of the WTP. Alum is mixed in the raw water in the inlet chamber before passing it on to clarifiers when the raw water becomes turbid in the rainy and summer seasons. WTP comprises of the inlet chamber, alum mixer, two clarifiers, four roughing filters and a chlorinator. Chlorination is carried out at the final stage of the treatment.

The Supervisor of the treatment plant revealed that initially the Plant had been designed to treat 3,375 gallons/minute (15,188 l/min). However due to the increased demand, they now have to treat 4,400 gallons/minute (19,800 l/min). He maintained that they are meeting the demand of 50,000 registered consumers; however, almost a same number of unregistered consumers are also being supplied water from this treatment plant.

2.3.2 Bagh

Piped water is supplied to Bagh town through a water supply complex. Spring and nallah water is the main source for this complex. Piped water is supplied to 1,200 registered consumers intermittently to different areas of the town. Batch chlorination is carried out in the rainy and summer seasons when source water becomes polluted.

Like Muzaffarabad, inhabitants of Bagh mostly use spring sources for drinking purposes. Most of the spring sources are unprotected, people fetch water directly from spring eye, or some times from small tanks near the spring source where the water collects.

2.3.3. Rawalakot

The main water sources for drinking water in Rawalakot are piped water supply, springs and boreholes (ground water). Rawalakot Nallah is the main source for the water supply system. The XEN PHED, Mohammad Afroz Khan, maintained that there are 15,000 registered consumers and the current demand of the Rawalakot city is about 650,000 gallons/day, whereas the existing capacity of the water plant is approximately 400,000 gallons/day. To meet the current demand PHED has to supply water intermittently. Alum and Chlorine are used for treatment in the summer season when the water becomes turbid. The XEN stated that the construction of the Greater Water Supply is in progress with the financial assistance of the World Bank. All components necessary for surface water treatment, like pre-sedimentation, sedimentation, slow sand filtration and chlorination are part of the water treatment plant. The provision of laboratory to test both raw and treated water at the water filtration plant is also part of the Greater Water Supply system. According to the XEN, water quantity would remain a problem, since seasonal variations have been observed in the proposed source of water for the water treatment plant. During the periods of water shortage, people have to fetch water from remote areas from either springs or individual bore wells. The total cost of one drum of drinking water in the dry season ranges from 100 - 200 rupees.

2.3.4 Kotli

River Jehlum, ground water wells and springs are the major sources of drinking water for Kotli town. There are seven tube-wells in different parts of the city from where water is pumped to distribution reservoirs in different areas. About 100 households in Mandi Nara obtain their drinking water from springs. The XEN PHED, Fazal Karim Khokar informed the Survey Team that the current demand of drinking water is 1.4 million gallons, whilst the existing tube-wells and dug wells provide only 50percent of the demand. Therefore, water is supplied intermittently. There are 7,000 registered consumers, paying 50 PKR per month as water tariff. He maintained that to meet the current and future drinking water demands, two proposals - one for construction of more tube-wells and the other for the Greater Water Supply system at river Jehlum - are in the pipeline. He further added that chlorination is undertaken in the summers at distribution reservoirs. However, batch chlorination is done daily in dug wells situated near the river bank.

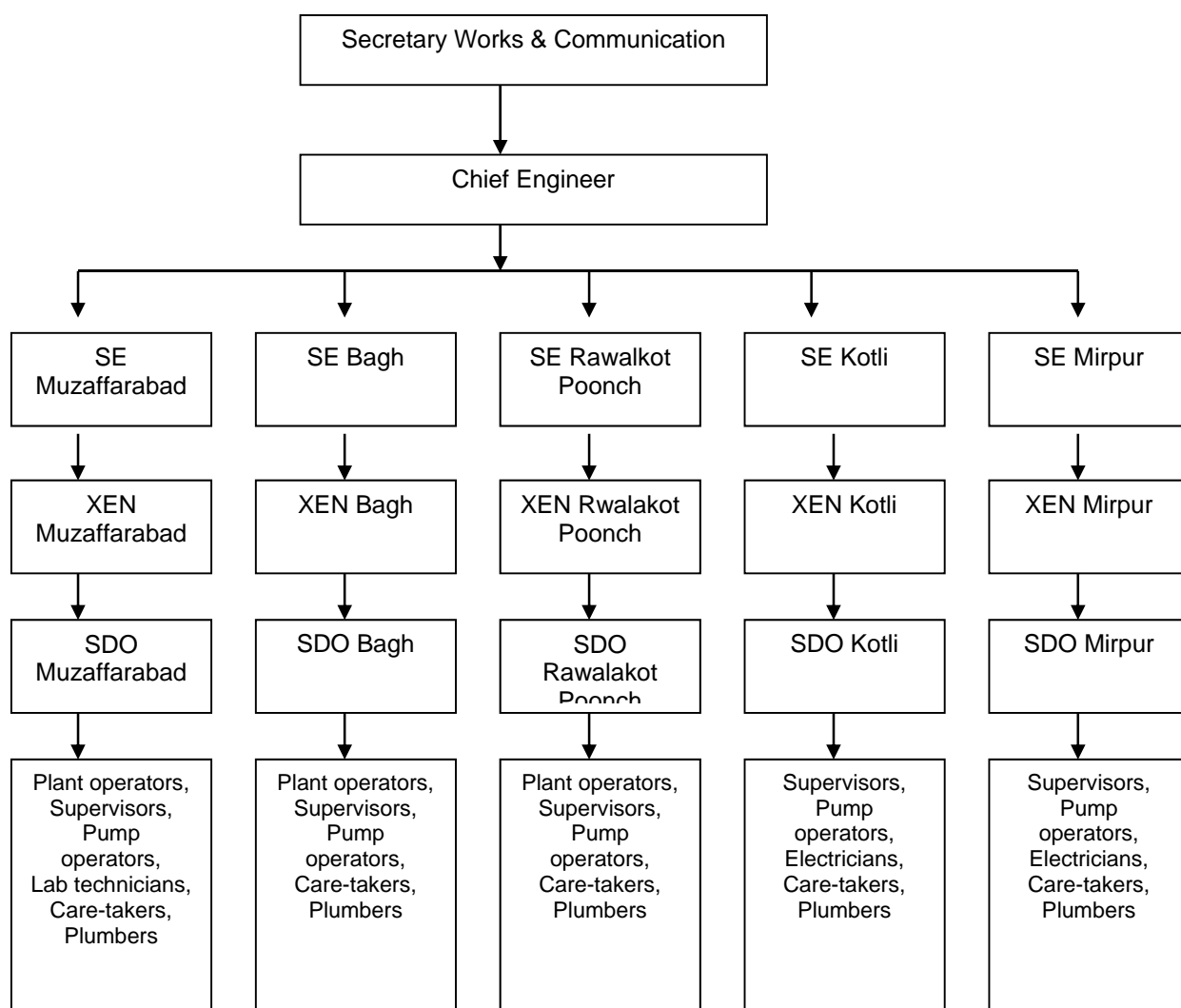
2.3.5 Mirpur

Tube-wells are the only source of drinking water for Mirpur town. There are 20 tube-wells situated at Mangla Dam Periphery, providing 4.2 million gallons of water per day. There are 2,120 registered consumers. The proposal of Greater Water Supply system, which be fed by Mangla Dam, is in the pipeline and will be undertaken soon after the completion of the raising of the Dam. Chlorination of drinking water is done only at distribution reservoirs during the rainy seasons.

2.3.6 Organizational Structure

The Public Health Engineering Department (PHED) is responsible for the supply of drinking water in AJK. At the AJK level, PHED is headed by Secretary Works and Communication, whereas at the district level the Superintendent Engineer heads the department.

Figure 1: Organizational Structure of Public Health Engineering Department (PHED)



2.4 Issues in Water Management

2.4.1 *Lack of Coordination*

There is very little coordination between the relevant institutions that are concerned with water quality monitoring in urban and rural areas of AJK. LG&RD has state-of-the-art facilities to monitor both the chemical and bacteriological quality of water. PHED also possesses a water quality testing laboratory in Muzaffarabad. Similar water quality testing laboratories will be established in all districts of AJK under the Greater Water Supply systems. Recently, the Ministry of Environment has also planned the establishment of hi-tech laboratories in three districts of AJK with the financial assistance of UNICEF. This results in overlap, duplication of efforts and wastage of financial and human resources.

2.4.2 *Lack of Expertise*

Expertise on environmental issues in general, and ensuring the provision of safe drinking water in particular, is very limited in AJK. By and large, those who are not aware of the technicalities of water treatment are calling the shots, which results in adverse effects (such as taste problems) on the water from water treatment plant. Consequently the majority of the population prefers to use spring water sources for drinking purposes. Lack of technical expertise in PHED is the main hindrance to adopting modern water filtration techniques and to designing water delivery systems as per local needs. At the moment no educational institution in AJK offers any courses in water related issues and hence there is an acute shortage of qualified professionals. Although such expertise is available in Pakistan, the lack of resources makes it difficult to induct such professionals.

2.4.3 *Lack of Awareness*

The level of awareness on water quality issues in PHED is quite low. Very few professionals know the technicalities of water treatment. None of the institutions in AJK have initiated any awareness raising campaigns. As a result, the general public is not using tap water and is dependent on other sources such as springs, boreholes and rivers.

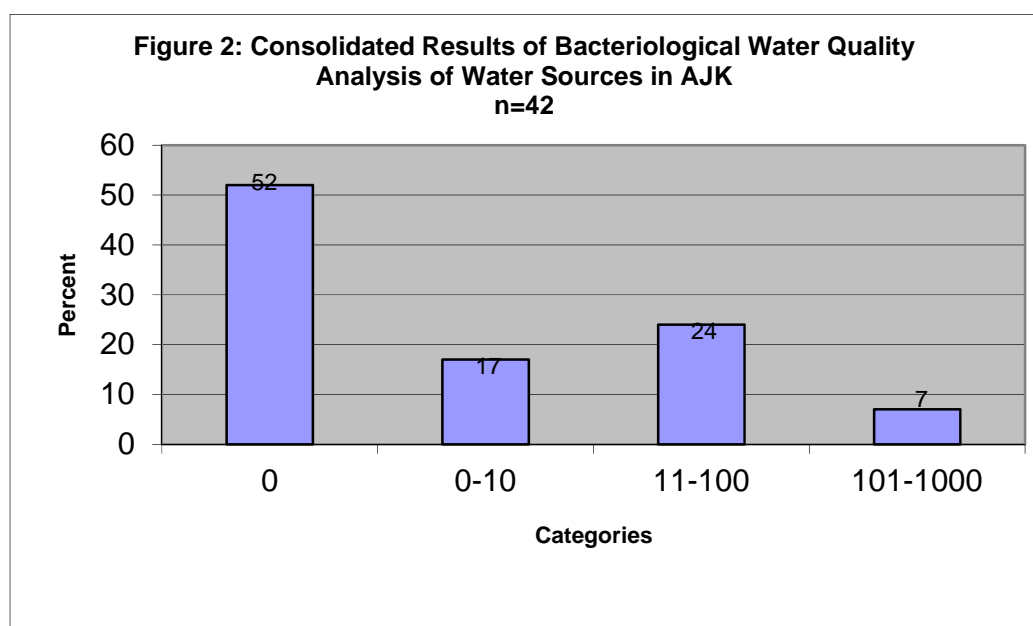
2.4.4 *Lack of a Monitoring Programme*

With the exception of the Muzaffarabad WTP, none of the PHED departments in other districts of AJK have water quality monitoring strategies or facilities. Even here, water quality is checked only at the treatment plant. No strategy exists to monitor the quality of water in distribution. However, there is a provision of water quality monitoring laboratories in the Greater Water Supply system.

3. Results of Water Quality Monitoring

3.1 Water Quality in AJK

Altogether 42 water samples were collected from various drinking water sources and different points of the delivery system in five districts of AJK. Bacteriological water quality results revealed that 52 percent of the total water samples were in category A, and are safe for drinking. 17 and 24 percent of the total samples were in Category B (low risk), and C (high risk) respectively. Only 7 percent of the total samples were in category D (very high risk), with contamination levels greater than 101 E.coli/100 ml as per WHO recommendations (see Figure 1). It is worth mentioning that faecal contamination levels may be significantly higher in the summer seasons.



The water samples were chemically analyzed for Arsenic, Lead, Copper, Mercury, Cadmium and Iron. The results revealed that all water samples from different sources and delivery systems comply with WHO guideline values for selected parameters. The concentration of Arsenic emerged to be in the range of 0 - 2.87 with average and standard deviation of 0.5 and 0.65 ppb respectively (see Table A). The concentrations of Lead, Copper, Mercury, Cadmium and Iron were observed to be in the range of 1.34 - 1.45, 0.29 - 13.6, 0 - 0.37, 0.02 - 0.06 ppb respectively. The concentration of Iron was recorded in the range of 0 - 0.19 ppm. All 42 water samples collected from different sources and water delivery systems in the five districts were analyzed in PCRWR using atomic absorption. (see Table B).

Table B: Consolidated Results of Chemical Water Quality Analysis of Water Sources in AJK

S.no	Parameters	Sample Numbers	Range	Average	Median	SD	WHO Guidelines
1.	Arsenic	41	0-2.87	0.5	0.34	0.65	10 ppb
2.	Lead	41	1.34-1.45	0.45	0.018	1.2	10 ppb
3.	Copper	41	0.29-13.6	1.4	0.6	2.3	2000 ppb
4.	Mercury	41	0-0.37	0.03	0	0.09	1 ppb
5.	Cadmium	41	0.02-0.06	0.02	0.02	0.007	3 ppb
6.	Iron	41	0-0.19	0.02	0.015	0.033	0.3 ppm

The physical analysis of water samples was carried in-situ for Total Dissolved Solids, Conductivity, Salinity, Turbidity and pH. All water samples comply with WHO standards.

3.2 Muzaffarabad

Overall, 8 water samples were collected in Muzaffarabad, out of which five water samples represent spring water sources used by the majority of the population for drinking purposes. Only the springs that are located in posh areas or in the center of the town are well-protected. Out of the 5 sampled springs, 2 were found to be contaminated with faecal material in the range of (7 - 44 E.coli/100 ml). The other 3 were not contaminated. (see Table 1)

Four water samples were collected from different locations of Muzaffarabad Water Treatment Plant and its distribution system. Only the Neelem River, the main source of water for WTP, was faecally contaminated. However, contamination levels were determined in the treated water. Due to the unavailability of water in the distribution network, water sampling could not be undertaken here (see Table 1).

Water samples collected from different points were chemically analyzed at PCRWR. The results reveals that all sampled sources are chemically fit for drinking purposes as per WHO guidelines (see Table 2).

Similarly, survey results reveal that the physical quality of sampled water for selected parameters are under recommended range of WHO (see Table 3).

3.3 Bagh

Out of 8 water samples, 4 were collected from spring sources in the vicinity of Bagh. The results reveal that 3 spring sources were contaminated with levels in the range of 2 - 56 E.coli/100 ml. Only one spring source was found to be fit for drinking purposes as per WHO recommendations (see Table 4). To judge the water quality in the water delivery system, 4 representative water samples were collected from the water delivery system and distribution network. Low faecal contamination levels were found in influent and effluent water samples. High contamination levels were observed at communal taps (see Table 4).

Chemical analyses of water samples reveals that all sources and tapped water is fit for drinking purposes as per WHO drinking water standards (see Table 5).

The physical parameters checked at different sampling points were also found to be within the limits (see Table 6)

3.4 Rawalakot

In Rawalakot spring water is rarely used for drinking purposes due to the limited number of spring sources in town. The majority of the town population uses bore hole water for drinking purposes. Overall, 9 water samples were collected from different points including spring sources, bore holes, water delivery systems and networks, CMH-UV filter and proposed source of water for the Greater Water Supply complex.

High faecal contamination levels were found in spring, UV filter and proposed source for Greater Water Supply system. The contamination levels recorded as 44, 48 and 120,000 E.coli/100 ml respectively. There was no faecal contamination at the inlet of the existing water delivery system. However, samples taken from the distribution networks showed such contamination. Water from all sampled bore holes was found to be fit for drinking purposes as per WHO drinking water standards (see Table 7)

Chemical analysis showed that all samples are fit for drinking purposes (see Table 8). All physical parameters were found to be within the range of WHO permissible limits (see Table 9)

3.5 Kotli

The majority of the population of Kotli town depends on ground water (tube and dug wells) for drinking purposes. Eight representative samples from tube and dug wells were collected in different areas. Out of five tube wells, one at Parthan was found to be faecally contaminated. Three dug wells, the main source of water for the existing water supply system, were also sampled. Out of these, two were contaminated bacteriologically with contamination levels of 7 and 20 E.coli/100 ml.

The chemical analysis of water samples revealed that all sampled sources are fit for drinking purposes (see Table 11). Physical parameters analyzed were found to be within the range of WHO recommended guidelines (see-Table-12).

3.6 Mirpur

In Mirpur, groundwater is the only source of drinking water. Water samples were collected from 4 tube-wells, a distribution reservoir and three taps. Out of the 4 tube-wells, only one was contaminated with faecal material with contamination levels of 44 E.coli/100 ml. Water of the remaining three tube wells was found safe for drinking purposes as per WHO standards for drinking water. Low contamination levels also observed in the distribution reservoir (7 E.coli/100 ml). Out of three tap samples only one tap was faecally contaminated (see Table 13).

All water sources and distribution networks are chemically fit for human consumption (see Table 14 & 15).

4. Recommendations

4.1 Water Quality

Only 52 percent of the total water samples comply with the WHO standards for drinking water. The remaining 48 percent falls in the categories of low to very high risk. It is worth mentioning that contamination levels may be doubled in the summer seasons due to high animate activities in the catchment area. The following steps are necessary to improve the existing water quality of different water sources and delivery systems;

1. All spring sources should be protected and tapped.
2. Flow rates in the water treatment plants should be regulated as per design.
3. Water delivery systems should be chlorinated as per WHO recommendations, especially in summer seasons.
4. Leakages in old water networks should be repaired immediately.

4.2 Inter-Sectoral Coordination

The findings of the water quality survey indicate that there is a dire need of synergy between different departments working in the water sector and that it is imperative to develop a purposeful and cost effective water quality monitoring programme. This can only be achieved by enhancing the coordination between different organizations working in the water sector. The LG Department of AJK has modest and user-friendly equipment for bacteriological, physical and chemical water quality testing in all seven districts of AJK. This equipment could be used for water quality monitoring under the supervision of AJK-EPA. However, AJK-EPA should develop a water quality monitoring programme for whole AJK, keeping in view the existing resources of LG and PHED. The role of AJK-EPA should be that of a surveillance and monitoring agency. The Department of Health must also be involved in the water quality monitoring programme since it can play a vital role in awareness raising campaigns on water handling practices and the importance of tap water. The following steps need to be taken:

1. An inter-sectoral coordination committee should be formed to develop water quality surveillance programme. The main responsibilities of this committee should be:
 - a) To formulate and revise technical standards for the control of drinking water quality;
 - b) To promote the development of water quality control at the health area level;
 - c) To promote and advise on the implementation of water quality control and water surveillance laboratories; and
 - d) To recommend and support the training of quality control and surveillance staff.
2. Strong linkages should be developed with environment section LG to monitor the rural water supply systems.
3. PHED should be given the full responsibility for water quality monitoring in AJK towns.
4. AJK-EPA should take the lead role in water quality surveillance of whole AJK rather than direct involvement in water quality monitoring.

4.3. Capacity Building and Infrastructure:

In discussions with PHED staff during the water quality survey, it was felt that job oriented capacity building programmes are necessary to improve the existing management. Hence the following should be undertaken:

1. Job-oriented training programmes targeted at the over all management of water delivery systems should be designed for operators and officials of PHED.
2. PHED laboratories should be established in other districts of AJK for bacteriological, physical and chemical testing of drinking water. In this connection user friendly and low-cost water testing kits should be used.
3. A three-tier infrastructure approach should be adopted to establish laboratories in the region:

Central Laboratory

At the highest level there should be a central or national reference laboratory. This laboratory should be well staffed and equipped with conventional and advanced equipment. It should eventually be capable of analyzing all WHO guideline parameters.

Regional Level

These laboratories should be located in district headquarters and staffed and equipped to analyze up to 35 parameters.

Basic Laboratories

Basic laboratories may be established at the tehsil level and equipped to analyze 5 - 10 parameters. However, initially they may be equipped to analyze faecal Coliform counts, turbidity and residual Chlorine. For this purpose water testing kits of LG could be used.

4.4 Sanitary Inspection and Risk Assessment:

No systematic sanitary inspection procedure was applied by the technical staff of water delivery systems, and hence no quantitative risk assessment data was available. It is imperative to design sanitary survey forms for each of the main types of water resources in the area. This would reduce the likelihood of contamination to a greater extent. The report form should intend to serve the following purposes:

1. identify all the potential sources of contamination of the water sources and supply system;
2. quantify the level of risk of each drinking water facility; and
3. provide clear guidance for PHED or other relevant institutions for remedial actions.

Annexures

Annex 1

Water Quality Analysis – Bacteriological, Chemical and
Physical Parameters

Table 1: Bacteriological Water Quality Analysis – Muzaffarabad

S.No.	Sampling point	Location	E.Coli/100 ml	WHO Guidelines	Remarks
1.	Spring outlet	Sathra under bridge	0	0 E.coli/100 ml	Fit for drinking
2.	Spring outlet	Near Agriculture Research Center	4	0 E.coli/100 ml	Not fit for drinking
3.	Spring outlet	Near AJK Taxation council	44	0 E.coli/100 ml	Not fit for drinking
4.	Spring outlet	Army Camp	0	0 E.coli/100 ml	Protected
5.	Spring outlet	Dumial, near service station	7	0 E.coli/100 ml	Not fit for drinking
6.	Neelum River	Intake of WTP	20	0 E.coli/100 ml	Not fit for drinking
7.	Outlet of WTP	WTP	0	0 E.coli/100 ml	Fit for drinking
8.	Distribution reservoir	M-1 Gulshan Colony	0	0 E.coli/100 ml	Fit for drinking
9.	Pumping station & Distribution reservoir	Chatter	0	0 E.coli/100 ml	Fit for drinking
	Control				

Table 2: Chemical Water Quality Analysis – Muzaffarabad

Parameters			As	Pb	Cu	Hg	Cd	Fe
Units			<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppm</i>
Permissible limit (WHO)			10	1	20	1	3	0.3
S.No.	Sampling point	Location						
1.	Spring outlet	Sathra under bridge	0.54	0.00	0.34	0.00	0.02	0.00
2.	Spring outlet	Near Agriculture Research Center	0.35	0.00	0.29	0.00	0.02	0.00
3.	Spring outlet	Near AJK Taxation council	0.83	0.00	0.81	0.00	0.02	0.19
4.	Spring outlet	Army Camp	2.87	0.02	0.76	0.00	0.02	0.074
5.	Spring outlet	Dumial, near service station	0.39	0.00	0.38	0.00	0.02	0.00
6.	Neelum River	Intake of WTP	1.45	0.05	0.48	0.00	0.02	0.00
7.	Outlet of WTP	WTP	1.57	0.00	0.51	0.00	0.02	0.00
8.	Distribution reservoir	M-1 Ghulshan Colony	1.45	0.00	0.42	0.00	0.02	0.016

Table 3: Physical Water Quality Analysis – Muzaffarabad

Parameters			TDS	Salinity	Conductivity.	pH	Temperature
Units			<i>mg/l</i>	<i>ppm</i>	<i>μS/cm</i>		<i>°C</i>
S.No	Sampling point	Location					
1.	Spring outlet	Sathra under bridge	334	0.3	686	7.0	18
2.	Spring outlet	Near Agriculture Research Center	301	0.3	620	7.0	20
3.	Spring outlet	Near AJK Texation council	368	0.4	754	7.0	19
4.	Spring outlet	Army Camp	327	0.3	672	7.3	18
5.	Spring outlet	Dumial, near service station	398	0.4	815	7.4	18.6
6.	Neelum River	Intake of WTP	97.1	0.1	203	7.5	6.5
7.	Outlet of WTP	WTP	94.3	0.1	197.5	7.3	6.4
8.	Distribution reservoir	M-1 Ghulshan Colony	95.3	0.1	199.3	7.0	6
9.	Pumping station	Chatter	95	0.1	198.2	6.3	6

Table 4: Bacteriological Water Quality Analysis – Bagh

S.No.	Sampling point	Location	E.Coli/100 ml	WHO Guidelines	Remarks
1.	Spring outlet	Near Degree College Dirkot	2	0 E.coli/100 ml	Protected
2.	Spring outlet	Arj Near Police station	56	0 E.coli/100 ml	Protected
3.	Spring outlet	Hair Gill Nagran	0	0 E.coli/100 ml	Protected
4.	Spring outlet	Near Mosque near NAPRA Bazar	6	0 E.coli/100 ml	Protected
5.	Inlet of water supply system		7	0 E.coli/100 ml	Protected
6.	Distribution reservoir		20	0 E.coli/100 ml	
7.	Public hydrant	Goyal Bazar	41	0 E.coli/100 ml	
8.	Public hydrant	Mashad Chowk	44	0 E.coli/100 ml	Protected
9.	Control		0		

Table 5: Chemical Water Quality Analysis – Bagh

Parameters			As	Pb	Cu	Hg	Cd	Fe
Units			<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppm</i>
Permissible limit (WHO)			10	1	20	1	3	0.3
S.No.	Sampling point	Location						
1.	Spring out let	Near Degree College Dirkot	0.1	0.00	0.00	0.22	0.02	0.00
2.	Spring outlet	Arj Near Police station	0.34	0.00	0.00	0.35	0.02	0.037
3.	Spring outlet	Hair Gill Nagran	0.39	0.00	0.00	0.18	0.02	0.013
4.	Spring outlet	Near Mosque near NAPRA Bazar	0.34	0.00	0.00	0.00	0.02	0.006
5.	Inlet of water supply system		0.19	0.04	0.04	0.00	0.02	0.010
6.	Distribution reservoir		0.18	0.08	0.08	0.00	0.02	0.023
7.	Public hydrant	Goyal Bazar	0.21	4.12	4.12	0.00	0.02	0.008
8.	Public hydrant	Mashad Chowk	0.47	0.01	0.42	0.00	0.02	0.022

Table 6: Physical Water Quality Analysis – Bagh

Parameters			TDS	Salinity	Conductivity.	pH	Temperature
Units			<i>mg/l</i>	<i>ppm</i>	<i>μS/cm</i>		<i>°C</i>
S.No.	Sampling point	Location					
1.	Spring outlet	Near Degree College Dirkot	259	0.3	533	7.4	13.8
2.	Spring outlet	Arj Near Police station	410	0.4	843	6.7	15.4
3.	Spring outlet	Hair Gill Nagran	192	0.2	400	7.0	19
4.	Spring outlet	Near Mosque near NAPRA Bazar	301	0.3	618	7.0	18.1
5.	Inlet of water supply system		171.3	0.2	355	7.3	17
6.	Distribution reservoir		1678	0.2	348	7.6	16.7
7.	Public hydrant	Goyal Bazar	143.4	0.1	299	8.2	13.7
8.	Public hydrant	Mashad Chowk	168.5	0.2	350	7.0	16.6

Table 7: Bacteriological Water Quality Analysis – Rawalakot

S.No	Sampling point	Location	E.Coli/100 ml	WHO Guidelines	Remarks
1.	Spring outlet	Pothee	0	0 E.coli/100 ml	Unprotected
2.	Outlet of UV filter	CMH Rawalakot	48	0 E.coli/100 ml	Not fit for drinking
3.	Spring outlet	Roka Nara, near DHQ	44	0 E.coli/100 ml	Not fit for drinking
4.	Inlet of water supply system	Army Camp	0	0 E.coli/100 ml	Fit for drinking
5.	Distribution reservoir	Roka Nara near DHQ	22	0 E.coli/100 ml	Not fit for drinking
6.	Public Hydrant	Main Hajera Road	160	0 E.coli/100 ml	Not fit for drinking
7.	Bore well	Butcher Bazar	0	0 E.coli/100 ml	Fit for drinking
8.	Bore well	PAD Housing scheme	0	0 E.coli/100 ml	Fit for drinking
9.	Nallah	Proposed source for greater water supply	1300	0 E.coli/100 ml	Not fit for drinking
10.	Control		0		

Table 8: Chemical Water Quality Analysis - Rawalakot

Parameters			As	Pb	Cu	Hg	Cd	Fe
Units			<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppm</i>
Permissible limit (WHO)			10	1	20	1	3	0.3
S.No.	Sampling point	Location						
1.	Spring outlet	Pothee	0.00	0.00	0.32	0.22	0.02	0.022
2.	Outlet of UV filter	CMH Rawalakot	0.15	4.73	7.8	0.35	0.02	0.004
3.	Spring outlet	Roka Nara, near DHQ	0.14	0.00	0.35	0.18	0.02	0.061
4.	Inlet of water supply system	Army Camp	0.25	1.22	0.41	0.00	0.02	0.006
5.	Distribution reservoir	Roka Nara near DHQ	0.00	0.00	0.04	0.00	0.02	0.000
6.	Public Hydrant	Main Hajera Road	0.50	4.6	13.6	0.00	0.06	0.000
7.	Bore well	Butcher Bazar	0.12	0.13	0.82	0.00	0.02	0.000
8.	Bore well	PAD Housing scheme	1.92	0.19	0.5	0.00	0.02	0.000
9.	Nallah	Proposed source for greater water supply	0.83	0.018	0.8	0.00	0.02	0.064

Table 9: Physical Water Quality Analysis – Rawalakot

Parameters			TDS	Salinity	Conductivity	pH	Temperature
Units			<i>mg/l</i>	<i>ppm</i>	<i>μS/cm</i>		<i>°C</i>
S.No	Sampling point	Location					
1.	Spring outlet	Pothee	270	0.3	557	7.2	15.7
2.	Outlet of UV filter	CMH Rawalakot	171	0.2	354	8.1	7.5
3.	Spring outlet	Roka Nara, near DHQ	352	0.4	722	6.5	15.2
4.	Inlet of water supply system	Army Camp	199	0.2	415	8.3	8.6
5.	Distribution reservoir	Roka Nara near DHQ	198	0.2	419	7.5	8
6.	Public Hydrant	Main Hajera Road	201	0.2	416	8.2	8
7.	Bore well	Butcher Bazar	359	0.4	733	7.0	14.5
8.	Bore well	PAD Housing scheme	240	0.2	500	7.1	15.8
9.	Nallah	Proposed source for greater water supply	240	0.2	505	8.2	9.4

Table 10: Bacteriological Water Quality Analysis – Kotli

S.No	Sampling point	Location	E.Coli/100 ml	WHO Guidelines	Remarks
1.	Tube-well	Pang Peeran Housing scheme	0	0 E.coli/100 ml	Fit for drinking
2.	Tube-well	Plather	0	0 E.coli/100 ml	Fit for drinking
3.	Tube-well	Parthan	0	0 E.coli/100 ml	Fit for drinking
4.	Tube-well	Khowaja Bazar	0	0 E.coli/100 ml	Fit for drinking
5.	Dug well	Shahi Mosque Muhallah	7	0 E.coli/100 ml	Not fit for drinking
6.	Dug well	Thalier near river bank	20	0 E.coli/100 ml	Not fit for drinking
7.	Dug well	Thalier near river	0	0 E.coli/100 ml	Fit for drinking
8.	Tube-well	Mandiger	350	0 E.coli/100 ml	Not fit for drinking
9.	Spring outlet I	Badali Sharif	0	0 E.coli/100 ml	Fit for drinking

Table 11: Chemical Water Quality Analysis – Kotli

Parameters			As	Pb	Cu	Hg	Cd	Fe
Units			<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppm</i>
Permissible limit (WHO)			10	1	20	1	3	0.3
S.No	Sampling point	Location						
1.	Tube-well	Pang Peeran Housing scheme	0.00	0.14	1.94	0.37	0.02	0.017
2.	Tube-well	Plather	0.39	0.04	1.81	0.14	0.02	0.015
3.	Tube-well	Parthan	0.00	0.00	1.97	0.00	0.02	0.020
4.	Tube-well	Khowaja Bazar	0.00	0.15	2.51	0.00	0.02	0.007
5.	Dug well	Shahi Mosque Muhallah	0.37	0.00	0.50	0.13	0.02	0.012
6.	Dug well	Thalier near river bank	0.46	0.00	0.50	0.00	0.02	0.018
7.	Dug well	Thalier near river	0.12	0.00	0.83	0.00	0.02	0.021
8.	Tube-well	Mandiger	0.00	0.00	0.91	0.00	0.02	0.022
9.	Spring outlet I	Badali Sharif	0.13	0.00	0.41	0.00	0.02	0.015

Table 12: Physical Water Quality Analysis – Kotli

Parameters			TDS	Salinity	Conductivity.	pH	Temperature
Units			<i>mg/l</i>	<i>ppm</i>	<i>μS/cm</i>		<i>°C</i>
S.No.	Sampling point	Location					
1.	Tube-well	Pang Peeran Housing scheme	467	0.5	952	6.5	22.5
2.	Tube-well	Plather					
3.	Tube-well	Parthan	352	0.4	724	6.5	22.4
4.	Tube-well	Khowaja Bazar					
5.	Dug well	Shahi Mosque Muhallah	136.7	0.1	286	8.7	14.6
6.	Dug well	Thalier near river bank	163.7	0.2	341	7.3	17.5
7.	Dug well	Thalier near river	250	0.2	517	7.3	17.5
8.	Tube-well	Mandiger	369	0.4	758	6.9	20.2
9.	Spring outlet I	Badali Sharif	413	0.4	844	6.9	20.6

Table 13: Bacteriological Water Quality Analysis – Mirpur

S.No	Sampling point	Location	E.Coli/100 ml	WHO Guidelines	Remarks
1.	Tube-well-5	Sector C-1	0	0 E.coli/100 ml	Fit for drinking
2.	Tube-well-2	Singot	0	0 E.coli/100 ml	Fit for drinking
3.	Tube-well-3	Bhalote village	0	0 E.coli/100 ml	Fit for drinking
4.	Tube-well-4	Sector B-3	0	0 E.coli/100 ml	Fit for drinking
5.	Distribution reservoir	Sector C-1 & C-3	18	0 E.coli/100 ml	Not fit for drinking
6.	Public hydrant	Stadium chowk	20	0 E.coli/100 ml	Not fit for drinking
7.	Public hydrant	Chachian Road	35	0 E.coli/100 ml	Not fit for drinking
8.	Communal tap	Near Central Jail	3	0 E.coli/100 ml	Acceptable
9.	Control		0		

Table 14: Chemical Water Quality Analysis – Mirpur

Parameters			As	Pb	Cu	Hg	Cd	Fe
Units			<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppb</i>	<i>ppm</i>
Permissible limit (WHO)			10	1	20	1	3	0.3
S.No	Sampling point	Location						
1.	Tube-well-5	Sector C-1	0.21	1.56	1.96	0.00	0.06	0.05
2.	Tube-well-2	Singot	0.00	0.37	2.69	0.00	0.02	0.00
3.	Tube-well-3	Bhalote village	0.17	0.04	1.35	0.00	0.02	0.001
4.	Tube-well-4	Sector B-3	0.00	0.14	2.01	0.00	0.02	0.00
5.	Distribution reservoir	Sector C-1 & C-3						
6.	Public hydrant	Stadium chowk	0.00	1.96	1.45	0.00	0.02	0.023
7.	Public hydrant	Chachian Road	0.00	0.78	1.34	0.00	0.02	0.023
8.	Communal tap	Near Central Jail	0.13	0.08	1.22	0.00	0.02	0.017

Table 15: Physical Water Quality Analysis – Mirpur

Parameters			TDS	Salinity	Conductivity	pH	Temperature
Units			<i>mg/l</i>	<i>ppm</i>	<i>μS/cm</i>		<i>°C</i>
S.No.	Sampling point	Location					
1.	Tube-well-5	Sector C-1	480	0.5	979	6.5	24.6
2.	Tube-well-2	Singot	769	0.4	766	7.0	24.1
3.	Tube-well-3	Bhalote village	410	0.2	408	7.3	26.0
4.	Tube-well-4	Sector B-3	514	0.5	1045	7.0	23.0
5.	Distribution reservoir	Sector-F3, C-1, C-3	701	0.3	700	7.1	19.6
6.	Distribution reservoir	SectorF-2.	301	0.3	616	7.1	23.7
7.	Public hydrant	Stadium chowk	388	0.4	789	7.1	22.5
8.	Public hydrant	Chachian Road	804	0.4	795	7.1	23.4
9.	Communal tap	Near Central Jail	387	0.4	795	7.3	22.2

Annex 2
Terms of Reference

Terms of Reference

The Water Quality Technical Assistance for AJK would have three main components: setting up of the water quality monitoring laboratory, training of AJK EPA staff in water quality testing, and undertaking a rapid water quality situational analysis of three AJK cities.

The basic assumptions while putting together the Terms of Reference for this TA were:

1. The necessary infrastructure for the setting up of the laboratory has already been undertaken such as structural adjustments of the laboratory premises, procurement of equipment, chemicals and other necessary consumables;
2. Each component of the study will be handled independently or as considered convenient by the consultant;
3. Specific timeline will be conveyed to AJK EPA/UNDP at a later date;
4. The needs assessment survey for water quality monitoring training has been undertaken;
5. Not more than three people will be trained in water quality monitoring; and
6. The situational analysis will be a rapid survey of three cities, which would include basic in-situ and ex-situ (laboratory) testing.

Setting up of Water Quality Monitoring Laboratory

- To setup the water quality monitoring laboratory at the premises provided by AJK EPA with the equipment and chemicals procured by AJK EPA for the laboratory;
- To install and setup laboratory equipment at the site already arranged with necessary infrastructure adjustments and electrical connections for the purposes of setting up the laboratory;
- To identify deficiencies in equipment, chemicals and other necessary items necessary for an effective water quality laboratory; and
- To advise AJK EPA in safety and other precautionary measures necessary for a laboratory as per international standards.

Training of AJK EPA staff in Water Quality Testing

- To train a maximum of 3 AJK EPA officers in water quality testing;
- To provide theoretical and practical training to trainees in water quality testing;
- To familiarize trainees with the modern in-situ and ex-situ water quality monitoring techniques;
- To provide hands-on training on the equipment procured by AJK EPA; and
- To identify additional water quality monitoring training needs for AJK EPA.

Situational Analysis of Three AJK Cities

- To conduct situational analysis of five AJK cities and 3 villages for water quality;
- To undertake in-situ water quality analysis of basic water quality parameters (pH, temperature, dissolved oxygen, total dissolved solids, turbidity, conductivity) of major water supply sources of the three cities;
- To collect samples and analyze them in the laboratory for key water quality parameters;
- To analyze collected data and identify water quality problems of the three cities;
- To prepare a plan on how to improve the water quality of the three cities; and
- To submit a detailed report including all the three TA components and their sub-components.