SECTOR H

WATER USE AND WATER RESOURCES

VOLUME 3: SUPPORTING REPORT

SECTOR H: WATER USE AND WATER RESOURCES

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SECTOR H WATER USE AND WATER RESOURCES

1. PRESENT WATER USE AND WATER RESOURCES

1.1 Present Water Supply Capacity in the Study Area

The present water supply in the study area is administrated by the three (3) independent entities; namely, (1) Capital Development Authority (CDA), (2) Water & Sanitation Agency (WASA) under Rawalpindi Development Authority (RDA), and (3) Rawalpindi Cantonment Board (RCB). Islamabad is wholly under jurisdiction of CDA. On the other hand, Rawalpindi is divided into jurisdiction areas of WASA and RCB.

The present water supply capacity for the study area is about 172.8 MGD (785.5 MLD) in total. Out of the total water supply, the service area of CDA (i.e., Islamabad) shares 111.6 MGD (64.6%), while the service areas of WASA and RCB share 27.0 MGD (15.7%) and 34.2 MGD (19.8%), respectively as listed in Table R.H.1.

Table R H.1 Water Supply Capacity for the Study Area

Service Area	Water Source	Treatment Plant	Dam Reservoir	Supply Capacity as of '02	
				MGD	MLD
Area of CDA*1	Kurang River	Korang	-	4.0	18.2
		Shadhara	-	1.6	7.3
	Soan River	Simly	Simply	42.0	190.9
	Haro River	Sangjani	Khanpur	16.5	75.0
	Lai Nullah	Said Pur	-	0.8	3.6
		Noor Pur	-	0.7	3.2
	Surface and groundwater	Augmentation		12.0	54.6
	Groundwater	-	-	34.0	154.6
	Sub-total for Area of CDA			111.6	507.3
Area of WASA*2	Kurang	Rawal	Rawal	8.0	36.4
	Haro River	Sangjani	Khanpur	1.0	4.5
	Groundwater	-	-	18.0	81.8
	Sub-total for Area of WASA			27.0	122.7
Area of RCB*3	Kurang	Rawal	Rawal	10.0	45.5
	Haro River	Sangjani	Khanpur	19.7	89.6
	Groundwater	-	-	4.5	20.5
	Sub-total for Area of RCB			34.2	155.5
Total of Study Area	Surface Water			116.3	528.7
	Ground Water			56.5	256.8
	Grand Total			172.8	785.5

Source:
*1: Water Manage Directorate, CDA, 2002
*2: PC-1 for Project Improvement of Water Supply and Sewerage & Drainage System of Rawalpindi City, WASA, RDA, 2002
*3: Sewerage Master Plan for Rawalpindi Cantonment Board (Phase III), 2002

The source of the above water supply capacity is divided into the surface water and groundwater. The groundwater in the study area is abstracted by about 450 tube wells (i.e., 182 wells in the area of CDA, 194 wells in the area of WASA and 74wells in the area of RCB). A particular attention is herein given to the high percentage of the groundwater as the water source, which takes about 33% of the total water supply in the study area: the service area of WASA in particular high percentage of about 67%, as shown in Table R H.2.

Table R H.2 Share of Surface Water and Groundwater as Water Supply Source for the Study Area

Supply Source	Area of CDA		Area of WASA		Area of RCB		Whole Study Area	
	Capacity	Share	Capacity	Share	Capacity	Share	Capacity	Share
	MGD	%	MGD	%	MGD	%	MGD	%
Surface	77.6	69.5	9.0	33.3	29.7	86.8	116.3	67.3
Groundwater	34.0	30.5	18.0	66.7	4.5	13.2	56.5	32.7
Total	111.6	100.0	27.0	100.0	34.2	100.0	172.8	100.0

The surface water supply capacity of 116.3 MGD (528.7 MLD) for the study area is defined as the total capacity of the existing seven (7) treatment plans, which abstract the raw water from the dam reservoirs, or directly from the natural flow discharge of the small tributaries. Among others, the principal surface water sources are Simly Dam on Soan River, Khanpur Dam on Haro River, Rawal Dam on Kurang River, which has a supply capacity of 97.2 MGD (441.9 MLD) or 84% of the total surface water supply capacity as listed Table R.H.3.

Table R H.3 Water Supply Capacity from Dam Reservoirs

Dam Reservoir as Surface Water Source	Service Area	Supply Capacity	
		MGD	MLD
Simly	Area of CDA	42.0	190.9
Khanpur	Area of CDA	16.5	75.0
	Area of WASA	1.0	4.5
	Area of RCB	19.7	89.6
	Sub-total	37.2	169.1
Rawal	Area of WASA	8.0	36.4
	Area of RCB	10.0	45.5
	Sub-total	18.0	81.9
Grand Total		97.2	441.9

1.2 Present Actual Supply Capacity and Per-capita Consumption

As described above, the present water supply capacity for the study area is 172.8 MGD. On the other hand, the actual daily water supply for sale to customers is limited to 85.9 MGD (390.5 MLD) or 49.7% of the supply capacity as listed in Table R H.4.

Table R H.4 Water Supply Capacity vs. Actual Water Supply for Sale to Customers

Service Area	(1) Supply Capacity		(2) Actual Supply to Customers		(1)/(2)
	MGD	MLD	MGD	MLD	%
Area of CDA	111.6	507.3	55.0*1	250.0	49.3
Area of WASA	27.0	122.7	19.4*2	88.2	71.9
Area of RCB	34.2	155.5	11.5*3	52.3	33.6
Total	172.8	785.5	85.9	390.5	49.7

Source *1: Water Management Directorate, CDA, 2002
*2: Water Supply Distribution System, Design Report, UWSSP-R, MMP, 1998
*3 Results of interview from RCB

The difference between the supply capacity and supply volume for sale could be attributed to several factors such as; (a) unaccounted water including leakage of water and water tapping, and (b) non-operation of the water supply facilities including part-time operation of tube-wells, troubles of supply facilities, and power cut. The present urban population of Islamabad and Rawalpindi is estimated at over 2 million, whereby its average per-capita water consumption is estimated at about 221 liter/person/day based on the aforesaid actual water supply for sale to customers as listed in Table R H.5.

Table R H.5 Gross Per-capita Consumption for Domestic, Public, Commercial and Industrial Use

Item	Unit	Islamabad	Rawalpindi	Whole Study Area
Average Daily Supply	(MLD)	250	161	411
Population	(persons)	621,000*1	1,455,000*2	2,076,000
Service Ratio	(%)	100*1	85*2	90
Served Population	(persons)	621,000	1,236,750	1,857,750
Gross Per-capita Consumption	(lit/person/day)	403	130	221

Source: *1: The Regional Study for Water Resources Development Potential for the Metropolitan Area of Islamabad-Rawalpindi, JICA, 1987.
*2: PC-1 for Project of Improvement of Water Supply and Sewerage & Drainage System of Rawalpindi City, WASA, RDA, July 2002

The above per-capita consumption includes the domestic, public, commercial and industrial use. Accordingly, the net-per capita consumption purely for the domestic use would be far smaller than the estimated value of 221 liter/person/day. According to results of the Study by JICA in 1988, the share of per-capita consumption for the domestic use to the total consumption in 2000 was estimated at 40% for Islamabad and 57% for Rawalpindi. Assuming these rates, the per-capita consumption for the domestic use is estimated as below:

Table R H.6 Per-capita Consumption for Domestic Use

Item	Islamabad	Rawalpindi	Whole Study Area
Gross Per-capita Consumption	403 lit./person/day	130 lit./person/day	221 lit./person/day
Share of Domestic Use	40%	57%	47%
Per-capita Consumption for Domestic Use	161 lit./person/day	74 lit./person/day	103 lit./person/day

Source: *: The Regional Study for Water Resources Development Potential for the Metropolitan Area of Islamabad- Rawalpindi, JICA, 1987.

1.3 Forecast of Future Water Demand and Deficit

Islamabad and Rawalpindi have recorded the annual population growth of 5.7% and 3.4%, in the recent ten (10) years, respectively. The population growth of Islamabad is the highest among the major cities in the country, and even the growth rate of Rawalpindi is the ninth highest. Such high urban population growth together with expansion of the government offices and other industrial/commercial entities would bring out the substantial increment of water demand year by year in the future. The future water demand for Islamabad and Rawalpindi was estimated in the previous relevant studies and/or the water supply development plans. According to them, the present water supply capacity for Rawalpindi (i.e., the area of WASA and RCB) falls below the present potential water demand leading to the chronic water shortage as listed in Table R H.7. On the other hand, the supply capacity for Islamabad (i.e., the jurisdiction area of CDA) could apparently meet the future incremental water demand for the time being. Nevertheless, the infrastructures for urban water supply in Islamabad have mostly completed their useful life and a lot of water leakage problems become abundantly visible in the city. Moreover the groundwater level is seriously dropping and causing difficulties in abstracting the water through tube-wells (refer to the following subsection 5.3.2). As the results, the CDA also could hardly secure the reliable water supply.

Table R H.7 Comparison between Average Daily Water Production and Water Demand

Area	Present Supply Capacity		Water Demand (Daily Max.)					
			In 2001		In 2003		In 2010	
	MGD	MLD	MGD	MLD	MGD	MLD	MGD	MLD
Area of CDA*1	112	507	102	461	105	478	119	541
Area of WASA*2	27	123	50	227	56	255	78	355
Area of RCB*3	36	165	44	200	n.a.	n.a.	n.a.	n.a.

*1: The Regional Study for Water Resources Development Potential for the Metropolitan Area
*2: PC-1 for Project of Improvement of Water Supply and Sewerage & Drainage System of Rawalpindi
*3: Sewerage Master Plan for Rawalpindi Cantonment Board (Phase –III)

1.4 Degradation of Groundwater as Water Resources

As described in the foregoing subsection 5.3.1, about 30% of the present water supply to the study area relies on the groundwater as the water source, which is abstracted through about 450 tube-wells. Thus, the groundwater is the major water source for the study area. According to the results of interview surveys with CDA, however, the groundwater level has seriously dropped with an annual average rate of about 2m for the recent five (5) year, and the present level has reached 35 to 40 m below the surface ground level. It is also reported by WASA[1] that the groundwater level has dropped from 12m to 45m below ground level during a period of 1982-2001. As the results, the quantity as well as quality of groundwater as the important water source is close to a crisis.

The major reasons of the dropping of the groundwater levels would be attributed to the degradation of recharge capacity, and the excessive abstraction of the groundwater in the study area as enumerated hereinafter:

1.4.1 Degradation of Recharge Capacity by Unfavorable Human Activities in Upstream Watershed

The natural forests in the Margalla Hills are regarded as the significant source for recharge of the groundwater in the study area. However, the excessive quarrying works eroded the

1 "Brief on Water & Sanitation Agency Rawalpindi for Tehsil Nazim/Chairman RDA, dated on August 22, 2002"

substantial extent of the forest. Moreover, the inhabitants also make unauthorized use of wood for cooking and heat in the area, and domestic cattle heads overgraze endangering the natural environment of the forest[2]. These unfavorable activities are likely to aggravate the recharging capacity by the forest in the Margalla Hills.

1.4.2 Degradation of Recharge Capacity due to Reduction of Unsealed Infiltration Area in Downstream Watershed

According to the estimates in the previous report[3], about 68% (70km^2) of the area in Islamabad is remained as the unsealed natural infiltration area in 1981, while the natural infiltration area is being reduced due to the intensive urbanization and going to be reduced to 30% in 2030 due to progress of urbanization. This dynamic reduction of infiltration area is obviously enumerated as one of the principal causes for reduction of recharge capacity of the groundwater.

1.4.3 Excessive Exploitation of Groundwater as Water Source

The exploitation of tube-wells has been made with less consideration on the recharge capacity of the groundwater. Any reliable hydraulic investigation on the present states of groundwater has never been made in the study area, and therefore, the appropriate rate of abstraction volume of the groundwater is unknown. Judging from the serious dropping of the groundwater level, however, the current abstraction volume of the groundwater would exceed the allowable limit.

1.5 Water Resources and Water Supply Development Project

Enumerated as the on-going and proposed bulk water supply development projects for the study area are (1) Metropolitan Water Supply Project, Phase-1 and 2 (Khanpur-I and II), and (2) the Urban Water Supply & Sanitation Project Rawalpindi, Phase I (UWSSP-I). Through these projects, the study area could increase the present water supply capacity of 172.8 MGD (785.5 MLD) to 265.9 MGD (1,208.8 MLD) in total as listed below:

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2 There exist about 56 quarries and 34 villages in and around the Natural Park with over 26,000 inhabitants.

3 Refer to “Sustainable Groundwater Exploitation of the Lei-Nullah in 24th WEDC Conference” by Dr. Amir Haider Malic, 1998.

Table R H.8 Present and Future Water Supply Capacity for the Study Area

Year	Supply Capacity (MGD)				Remarks
	Islamabad	Rawalpindi		Total	
	CDA	WASA	RCB		
Present (2002)	111.6 MGD (507.3 MLD)	27.0 MGD (122.7 MLD)	34.2 MGD (155.5 MLD)	172.8 MGD (785.5 MLD)	Refer to Table R H.1
Future (2003)	111.6 MGD (507.3 MLD)	49.6 MGD (225.5 MLD)	53.9 MGD (245.1 MGD)	215.1 MGD (977.9 MLD)	• Increment of 13.6 MGD for WASA and 19.7MGD for RCB by expansion of Khanpur filtration plant under Khanpur-I • Increment of 8MGD for WASA by expansion of Rawal dam filtration plant under UWSSP-1 • Increment of 2MGD for WASA by expansion of tub-well capacity under UWSSP-I
Future (Indefinite)	128.1 MGD (582.3 MLD)	64.2 MGD (291.9 MLD)	73.7 MGD (334.6 MLD)	265.9 MGD (1,208.8 MLD)	Following increment of supply capacity would be made by expansion of Khanpur filtration plant under Khanpur II • Increment of 16.5MGD for CDA • Increment of 14.6MGD for WASA • Increment of 19.7MGD for RCB

The Metropolitan Water Supply Project (Khanpur-I) was proposed to have the daily water supply capacity of 51 MGD from the source of Khanpur dam reservoir to Islamabad and Rawalpindi. Out of the supply capacity, 16.5 MGD was shared to Islamabad, and its treatment plan as well as water distribution system was completed in 2000 with the financial assistance from Overseas Economic Cooperation Fund (OECF), Japan and now under operation.

The remaining 34.5 MGD is shared to Rawalpindi, and its treatment plant/distribution system is going to be completed by 2003 through the Urban Water Supply & Sanitation Project Rawalpindi, Phase I (UWSSP-I) by WASA with financial assistance from ADB.

Succeeding to Khanpur-I, Khanpur-II is now being proposed to expand the water supply capacity for Islamabad and Rawalpindi, although its completion time has not been fixed yet. Upon completion, Islamabad and Rawalpindi would have the supply capacity of 102 MGD. The share of water supply capacity under Khanpur-I and II is as listed in Table R H.9.

Table R H.9 Phased Development of Water Supply Capacity from Khanpur Dam reservoir

Supply Area	Water Supply Capacity				Remarks
	Phase-1		Phase II		
	(MGD)	(MLD)	(MGD)	(MLD)	
Islamabad	16.5	75.0	33.0	150.0	Phase-I was completed in 1996
Rawalpindi (Area of WASA)	14.8	67.3	29.6	134.6	Phase I is to be completed by 2003
Rawalpindi (Area of RCB)	19.7	89.6	39.4	179.1	Phase I is to be completed by 2003
Total	51.0	231.8	102.0	463.7	

Source: PC-1 for Project of Improvement of Water Supply and Sewerage & Drainage System of Rawalpindi City, WASA, RDA, July 2002

The treatment capacity of the Rawal Lake Filtration Plant is now expanded as a component of the aforesaid UWSSP-I. This project component is scheduled to complete in 2002, and upon completion, the service area of WASA would increase the water supply capacity from Rawal dam reservoir from the present 8 MGD to 15 MGD. Installation of 20 new tube-wells and rehabilitation of 100 existing tube-wells are also being implemented through UWSSP-1. Moreover, WASA further intends to install the new tube-wells year by year with using the WASA's own fund. Through these installations/rehabilitations of tube-wells, the groundwater supply capacity is projected to increase from 18MGD in 2002 to 22 MGD in 2010.

2. DEVELOPMENT OF WATER RESOURCES BY THE PROPOSED FLOOD MITIGATION FACILITIES

As described in subsection 5.3, the study area is now suffering from the chronic water shortage, and the competent agencies (i.e., CDA, WASA and RCB) have an attempt to increase the water supply capacity. However, the service area of WASA in particular could not meet the full water demand in 2001 even after completion of the on-going water supply project under UWSSP-I.

Moreover, the current practices for water supply are oriented more to expansion of the treatment capacity and/or the abstraction capacity of tube-wells, but less to development of the new water resources. Such unbalanced way of water resources development brings out a big gap between the treatment capacity and the actual water supply capacity. Difficulties in abstracting the groundwater also occur due to the serious drawdown of the groundwater level.

Under the above conditions, a particular attention is given to the subsidiary effects of flood mitigation facilities on water resources development. That is, among the potential flood mitigation facilities as identified in the foregoing subsection 7.2, the reservoir of the flood mitigation dam proposed at Block E-11 in Islamabad could be used as the water supply sources, and the community pond at the Fatima Jinnah Part in Islamabad may have a potential function for recharging to the groundwater. The on-site flood detention facilities would have also the function of rainwater harvesting and/or recharging to the groundwater. From these viewpoints, the potentials of water resources development by the flood mitigation facilities and the major issues for development are preliminarily clarified at this study stage. The results of clarification will be finally incorporated into the selection of the optimum flood mitigation plan.

2.1 Flood Mitigation Dam Proposed at Block E-11 in Islamabad

The present water quality of the dam inflow discharge is kept to be non-polluted, and the water stored in the dam reservoir could be the water source particularly for domestic use in Islamabad and Rawalpindi. The following major issues and/or difficulties are, however, identified in developing the dam reservoir as the water supply source:

(1) The dam site is located adjacent to the urban center of Islamabad, and the upper catchment of the dam site is likely to have the significant land value for urban development. In fact, the land development around the dam site is in progress, although it is not legally approved by CDA. In order to maintain the present suitable water quality of the dam inflow discharge, however, it is indispensable to reserve the upper catchment (19.7km^2) of the dam site as the "Controlled Area" to prohibit any type of land development.

(2) The maximum live storage capacity and the catchment area of the proposed dam reservoir are about 1.5 million m^3 and 19.7km^2, respectively which are far smaller than those of the existing three (3) dam used as the present water supply source for the study area as listed below. Accordingly, the proposed dam reservoir could not be the fundamental solution for the current serious water shortage of the study area.

Table R H.10 Comparison of Existing Dam Reservoirs and the Proposed Dam Reservoir

Name of Dam	Catchment Area (km2)	Live Storage (MCM)
Khanpur	778	113
Simply	153	25
Rawal	275	53
The proposed dam at Golra	**19.7**	**1.5**

2.2 Community Pond at Fatima Jinnah Park

The proposed community pond receives the flow discharge of Tenawali Kas, and the diverted discharge from the adjacent eastern tributary of Bedarawali Kas. The water quality of the discharge from Tenawali Kas is seriously polluted getting off an offensive odor due to effluent of the non-treated wastewater from the upper built-up area. On the other hand, the substantial part of the catchment area of Bedarawali Kas is remained as the non-built up area, and the water quality of the tributary is not aggravated.

In due consideration of the water quality of the inflow discharges, the proposed community pond is designed to impound the inflow only from Bedarawali Kas but not from Tenawali Kas during a dry season. The water impounded in the pond could be used as the source for recharge to groundwater. In order to sustain the present water quality from the eastern tributary of Bedarawali Kas, however, it is required to reserve the catchment area of the tributary (9.9km^2) as the non-built-up area just like the aforesaid case of the dam catchment area of Golra.

2.3 Channel Deepening of Lai Nullah

The channel deepening of Lai Nullah is considered as one of possible flood mitigation measures. The channel deepening drops the riverbed level by 2m, which would cause lowering of the river water stage during low flow discharge.

Lowering of river water stage during low flow discharge may cause, in general, the adverse effect on the groundwater level. Nevertheless, the present groundwater level in the study area is 40m below the ground level, while the depth of the river channel upon completion of the channel deepening is 7.5m, which is far higher the present groundwater level. Accordingly, the adverse effect on the groundwater level by channel deepening could be evaluated to be minimal.

2.4 Flood Diversion Channel

The proposed flood diversion aims at diverting the flood runoff discharge from Lai Nullah basin to the external Kurang river basin. Should the whole of the basin runoff discharge be diverted to the external basin during the non-flooding period, the present natural recharging capacity to the groundwater in the basin may be dropped. In order to avoid such adverse effect, the flood diversion structure is designed to divert only the flood discharge over the channel flow capacity of the downstream channel but to remain the non-flood discharge within Lai Nullah basin.

2.5 On-site Flood Detention Facility

Among the various types of the on-site flood detention facility, the storage tank installed at an individual house lot and the infiltration facility would be useful to the water resources development as the supplementary effect of flood mitigation.

2.5.1 Storage Tank Installed at Individual House Lot

The storage tank could effect the reduction of peak runoff discharge from each of house lots. At the same time, the rainwater stored in the tank could be used for washing, watering to garden and other various secondary water uses other than use for drinking.

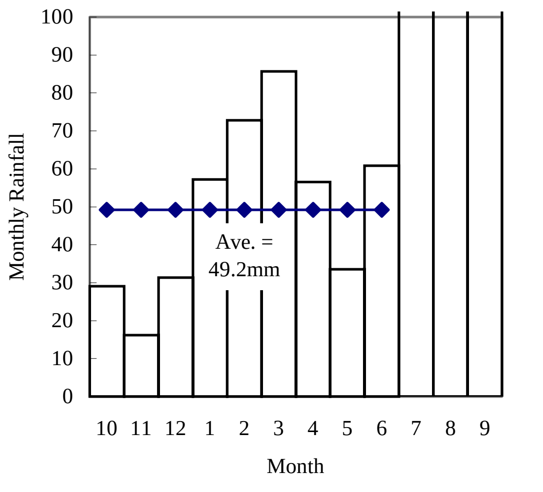

Fig. R H.1 Monthly Average Rainfall at Chaklala

According to the rainfall records at Chaklala gauging station, the Lai Nullah basin could receive about 49mm per month in average even during a dry season from October to June. Assuming a roof top of $50m^2$ as the space to collect the rainfall, the daily average rainwater volume to be stored in the tank is estimated at about 80 litters/day/house (=49mm x $50m^2 \div 30$days). The standard type of the storage tank has a capacity of 2,000 litters, which would be enough for storage and use of the whole rainwater during a dry season.

If the number of residents per one unit of house is assumed at 5 personnel, the daily average rainwater volume of 80 litters/day/house could cover the water consumption of about 16 litters/person/day (=80 litters/day/house÷5personnel/house). This consumption fed by the rainwater harvesting corresponds to 22% of the present per capita water consumption in the service area of WASA (=74 litters/day/person). Thus, the significant rate of the water consumption could be fed by the rainwater harvesting, and therefore, the storage tank installed at individual house lot would be useful as the subsidiary water supply source.

2.5.2 Infiltration Facility

There are various infiltration facilities to retain the flood runoff discharge such as soak pit, infiltration gutter and trench as proposed in the foregoing subsection 7.2. These infiltration facilities are also expected to effect on recharging to the groundwater. Nevertheless, the difficulties are foreseeable in estimating the definitive infiltration capacity of the facilities. The infiltration capacity of the facilities also easily drops down due to clogging of the filter. In order to clarify the definitive infiltration capacity and maintain the infiltration effect of the facilities, the field infiltration test together with the soil mechanical test as well as the sustainable maintenance works for the facilities are indispensable.