Annex-1

1-1 : The Project Cost Estimation

Division	Amount (Japanese million yen)						Total
	Phase 1*	Phase 2*				Project for the expansion of water supply system	
	Single fiscal year matter (2004)	B-type Government bond matter				Single fiscal year matter (2010)	
		Term-1 (2008)	Term-2 (2009)	Term-3 (2010)	Sub-total		
Construction costs	496.7	435.9	1,917.9	1,917.7	4,271.5	805.3	5,573.5
Machine/Material procurement	4.8	—	—	—	—	—	4.8
Management fee for design and supervision	206.9	22.8	74.8	74.8	172.4	14.4	393.7
Total	708.4	458.7	1,992.7	1,992.5	4,443.9	819.7	5,972.0

* Amount of Phase 1 and Phase 2 is basis of E/N amount

1-2 : Cost to be borne by the Pakistani side

	Description	Basic Design Study (2004)		Implementation Review Study (2007)		Project for the expansion of water supply system (2009)		GOP Share As Per Rev. PC-I 2010
		Million Rs	Million ¥ (approx.) 1Rs=JY2.19	Million Rs	Million ¥ (approx.) 1Rs=JY2.15	Million Rs	Million ¥ (approx.) 1Rs=JY1.29	Million Rs
1.	Primary power supply	35.83	78.47	80.00	172.00	—	—	90.00
2.	Land acquisition	10.94	23.96	10.94	23.52	—	—	—
3.	Site clearance	0.90	1.97	0.90	1.94	—	—	—
4.	Road construction	101.69	222.70	80.00	172.00	—	—	133.01
5.	Installation of Enclosures	6.12	13.40	8.00	17.20	—	—	6.06
6.	Procurement of Equipment in pump station	11.44	25.05	8.00	17.20	—	—	4.75
7.	Site Preparation of premises for the booster pump station	6.12	13.40	6.00	12.90	—	—	1.78
8.	Project Supervision	48.00	105.12	48.00	103.20	—	—	43.97
9.	Vehicles for supervision	5.50	12.05	6.00	12.90	—	—	5.00
10.	Construction of residence	21.46	47.00	30.00	64.50	—	—	49.76
11.	Public relations	2.50	5.45	2.50	5.38	—	—	1.50
12.	Compensation for residence	—	—	60.00	129.00	—	—	—
13.	Banking commission	—	—	36.47	78.41	3.19	4.11	36.47
14.	Others	—	—	15.00	32.25	—	—	—
15.	Construction of three (3) Operator's Quarters, etc.	—	—	12.22	26.27	—	—	12.22
16.	Rehabilitation of road along transmission main	—	—	—	—	—	—	32.87
17.	Provision of security arrangements	—	—	—	—	—	—	12.00
18.	Provision for additional compensatory package in the affected area	—	—	—	—	—	—	80.00
	Total	250.50	548.57	404.03	868.67	3.19	4.11	509.41
	Balance	—	—	—	—	+3.19	+4.11	

Annex-2

Table 1 - 1 Physical/Social Environmental Impact Assessment List

Name of Executing Agency: Water and Sanitation Agency (FDA) Faisalabad

Category	Environmental Component	Environmental Questionnaire	Confirmed Measures
1. Approval & public relations	(1) EIA and Environmental Approval	a. Have the EIAR already been prepared? b. Have the EIAR been approved by the government ? c. Is the approval of the EIAR without any conditions ? In case of approval with conditions, can they be cleared? d. Have the EIAR been approved by the local authorities, in case it is required?	a. The EIAR was prepared in 2007. b. The EIAR was approved by the Environment Protection Agency of the Punjab government on March 19, 2008. c. The conditions for approval are measures for mitigation of impact, which will be responded later during the course of the project implementation. d. Not applicable.
	(2) Public relations with local residents	a. Will the responsible authorities hold public meetings with local residents for ensuring their understanding on the contents and impacts of the project? b. Will the requirements of local residents and concerned offices be responded?	a. After the release of information on the project through newspapers, there was an outbreak of public demonstration of local residents against the implementation of the project. The government side held public meetings with them several times for explanation of plans to mitigate their apprehension of water level decline. b. A compensation package programme amounting to a sum of 45 million Rps was already carried out for the villages likely to be affected by the project implementation after public hearing with the local residents. Continued contacts with such stakeholders have satisfied their requirement on the information about the project.
2. Measures to protect against contamination	(1) Air quality	a. Is there no risk of air pollution with Cl_2 gas leak from its injection/storage facilities? Does treatment of Cl_2 gas in work place meet the standards for work safety measure?	Not applicable in the scope of this component of the project.
	(2) Water quality	a. Does the quality of waste water generated by the operation of facilities meet the criteria for waste water effluent?	Not applicable
	(3) Waste	a. Does the treatment/disposal of waste such as sludge generated by the operation of facilities comply with the criteria for waste disposal?	Not applicable
	(4) Noise, vibration	a. Does the noise/vibration of running facilities such as pumps comply with the country's standard regulations?	Facilities are located far from the residential area. Noise level will have no adverse effect to residents.
	(5) Land subsidence	a. Is there any risk of land subsidence due to pumping of large quantities of groundwater?	The existing wellfield has been free from the phenomenon of land subsidence despite continued withdrawal of groundwater in large quantities. Similar technical design to minimize the decline of water level will be adopted in this project, and can prevent a risk of land subsidence (employment of good quality screen to prevent sand pumping, etc)

3. Environment	(1) Conserved reserve area	a. Is the project site located within the premises of a natural reserve appointed by the country's law or international treaty? Or is such a reserve free from environmental impact of the project?	a. The project site does not include the natural reserve.
	(2)Eco system	a. Is there a primeval forest, tropical rain forest, or ecologically important habitat (coral reef, mangrove trees, tidal flats, etc)? b. Does the project site include a habitat to be protected under the country's law or international treaty? c. Does the withdrawal of water resources (surface water or groundwater) in the project affect the aquatic life in water body such as streams? Does the project include any measure to mitigate impact on aquatic eco-system?	a. The project site does not include any such type of area. b. The project site does not include it. c. Not applicable d. No intervention in aquatic life.
4 Social environment	(1) Displacement	a. Will the involuntary displacement of local residents occur due to the implementation of the project? In case it occurs, is there any measure taken to minimize the influence of displacement for residents? b. Will the residents receive adequate explanation on the displacement and compensation prior to displacement? c. Will the survey for displacement be undertaken for formulating a displacement plan for proper compensation and recovery of basis of livelihood after displacement? d. Does the displacement plan include proper measures for the socially weak groups such as women, children, the aged, the poor, minorities, aborigines, etc.? e. Will the agreement of residents for the displacement be ensured before its implementation? f. Will the project be able to set up an organization to implement the displacement effectively together with arrangements for sufficient budget? g. Is there a plan for monitoring the impact of displacement?	a. Displacement does not occur in this project. b ~ g Not applicable since the acquisition of private land is not required.
	(2) Life and livelihood	a. Is the project likely to produce adverse effect on the life of residents? Is it possible to arrange measures to mitigate it, in case it is required? b. Will the withdrawal of water resources (surface water or groundwater) by the project affect the existing water use practice in the area?	a.b. The withdrawal of large quantities of groundwater in this project is likely to cause the decline of groundwater level across the project site, which may affect a part of private wells. Accordingly this project adopts technical arrangements in the design of tubewells and their layout in the wellfield to minimize the decline of water level. In case the decline should occur despite such arrangements, the increase of distribution of irrigation water from the canal may be planned.

	(3) Cultural heritage	Will any archaeological, historical, cultural or religious heritage be free from damage due to the project? Will protective measures be provided to such facilities in a manner prescribed under the national law?	Not applicable
	(4) Landscape	Is there any adverse influence to a specific landscape to be preserved in and around the site?	Not applicable
	(5) Minorities/ aborigines	a. Will the project comply with the law to protect the right of minorities/aborigines? b. Will the project arrange to mitigate the adverse effects on the culture and life style of minorities/aborigines?	Not applicable
5. Others	(1)Impact during construction stage	a. Has the project prepared a plan to mitigate adverse environmental effects such as noise, vibration, muddy flow, dust, gas exhaust, waste, etc.? b. Will the project be able to avoid adverse effect to eco-system during the construction work? c. Will the project be able to avoid adverse effect to social environment? Will the project prepare measures to mitigate such adverse effect whenever required? d. Will the project undertake training program of labor regarding traffic safety, public health, etc according to the needs during the works?	a. A plan for measures to mitigate adverse impacts to the public in and around the site has been prepared. The contractor will observe the guidelines in the plan under the control and supervision of the consultant. b. Not applicable in this project. c. Pipe installation work along the public roads may create adverse impacts to the public life during works. Measures to mitigate such effects include to minimize dust with frequent water sprinkling, to control traffic with proper posting of staff on traffic duty and safety devices and warning signs, etc. d. Training of labor will be carried out from time to time regarding traffic safety, public health and other security matters.
	(2) Monitoring	a. Will the executing agency plan and undertake a monitoring program of the aforementioned environmental components which may more or less be affected by the project implementation? b. Are the details of such monitoring program (items, method, frequency, etc.) suitable for the intended purpose? c. Will the executing agency organize a proper setup for the planned monitoring program (team, staff, budget, and their sustainability) ? d. Is there an established rule for the details in reporting (formality, frequency, etc) by the executing agency to EPA on the monitoring results ?	a. It will carry out the monitoring program of groundwater level. b. Details will be examined and decided in the later stage. c. Water levels will be monitored by the operators of the executing agency. They have been in charge of monitoring of existing tubewells. For the new project, they can train and supervise the new operators for monitoring. d. The monitoring report will be submitted monthly to the authorities in compliance with the requirements of the conditions for the approval of EPIR.
6. Remarks	Remarks for the assessment list	a. When it deems necessary, cross-boundary or global environmental impact may also be confirmed (in case of factors related to cross-boundary waste disposal, acid rain, disruption of the ozone layer, global warming effect, etc.)	Not applicable.

Table 1-2 Monitoring Plan

[During the construction stage]

Monitoring components	Venue	Frequency	Method/criteria	Officials in harge	Responsible organization	Reporting To:
Safety control	Roads, villages, public institutions such as schools/ hospitals in and around the construction site	Whenever works are in progress around/ At Regular safety meetings	Inspection with reference to the contractor's safety control plan	WASA Counterparts /consultant	WASA	EPA
Technology transfer to WASA counterparts & local contractors	Construction sites	During the progress of works and upon completion of major items of works	Inspection of technical training of local contractor's staff/labor by the Japanese experts during the works and the test operation of completed facilities	WASA Counterparts /consultant	WASA	EPA
Setup of supporting system for health/safety control	Construction sites	Before starting any major work/at regular safety control meeting	Inspection with reference to the contractor's safety control plan	WASA Counterparts /consultant	WASA	EPA
Materials control and management	Stockyard	During the progress of works	Inspection of materials in stock Confirmation of practice of stock material control and yard cleaning	WASA Counterparts /consultant	WASA	EPA
Traffic safety	Construction sites	During the progress of works	Supervision/cooperation of local traffic police will be ensured for traffic control measures undertaken by the contractor according to his traffic control plan. Inspection of officials in charge	WASA Counterparts /consultant	WASA	EPA
Compliance with EIA conditions		Before starting the construction works	Copies of EIAR will be provided to the contractor, and detailed discussions for compliance will be held.	WASA	WASA	EPA
Water sprinkling over unpaved road	Construction sites	During the progress of the works	Inspection	WASA Counterparts /consultant	WASA	EPA
Construction waste & debris	Construction sites And dumping sites	During the progress Of the works Once in a month	Inspection	WASA Counterparts /consultant	WASA	EPA
Noise and vibration	Construction sites	Whenever and wherever it seems necessary while the works are in progress	Inspection	WASA Counterparts /consultant	WASA	EPA

[During the operation and maintenance stage after commissioning]

Monitoring components	Venue	Frequency	Method/criteria	Officials in charge	Responsible organization	Reporting To:
Groundwater level	Tubewell pump stations	Daily measurement	Measurement with suitable water level meter.	WASA operators	WASA	EPA
Water quality	Tubewell pump stations (and Surrounding private tubewells when it seems necessary.	Once in 3 months	Chemical analysis by WASA laboratory	WASA Experts at laboratory	WASA	EPA

MINUTES OF DISCUSSIONS
IMPLEMENTING REVIEW STUDY ON
"THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY SYSTEM
IN FAISALABAD (REVISED)"
IN ISLAMIC REPUBLIC OF PAKISTAN

In response to a request from the Government of Islamic Republic of Pakistan (hereinafter referred to as "the Pakistan"), the Government of Japan decided to conduct an Implementing Review Study (hereinafter referred to as "the Study") on the Project for the Improvement of Water Supply System in Faisalabad (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Pakistan the Implementing Review Study Team (hereinafter referred to as "the Team"), which is headed by Mr. T. SHIMIZU, Senior Deputy Resident Representative, JICA Pakistan Office, and is scheduled to stay in the country from July 18 to August 6 2007.

The Team held discussions with the officials concerned of the Government of Pakistan and is conducting a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Implementing Review Study Report.

Lahore, July 21, 2007

Tsutomu SHIMIZU
Leader
Implementing Review Study Team
Japan International Cooperation Agency

Shahid Mahmood
Secretary
Planning and Development Department
Government of the Punjab

Muhammad Salcem Sethi
Joint Secretary
Economic Affairs Division
Ministry of Economic Affairs & Statistics
Islamic Republic of Pakistan

Shaukat Ali
Additional Secretary (Technical)
Housing, Urban Development and
Public Health Engineering Department
Government of the Punjab

Mahboob Elahi
Managing Director
Water and Sanitation Agency
Faisalabad

ATTACHMENT

1. Purpose of the Study:

The purpose of the Study is mainly to review the Project cost estimation, earlier prepared on the basis of the Basic Design Study of the Project (hereinafter referred to as "the B/D Study"), with consideration of current situation of social-economic situation of Pakistan.

2. Components of the Project:

The Pakistan side and the Team (hereinafter referred to as "Both sides") confirmed that the design and framework of the Project, such as the Project priority in the national development plan of the Pakistan, purpose, and contents of the Project etc. are same as confirmed in the B/D Study.

Both sides also confirmed that there is and will be no duplication to the Project by the other Donors, Organizations and Agencies.

3. Responsible and Implementing Organization:

3-1. The Responsible organization is the Housing, Urban Development and Public Health Engineering Department, Government of the Punjab.

3-2. The Implementing organization is Water and Sanitation Agency (hereinafter referred to as "WASA") and WASA implements the Project, which is a subsidiary of Faisalabad Development Authority (hereinafter referred to as "FDA").

3-3. Organization chart of implementing organization:

The organization chart of WASA is described in Annex-1-1 and FDA is in Annex-1-2.

4. Japan's Grant Aid Scheme:

4-1. The Pakistan side understood the Japan's Grant Aid Scheme explained by the Team, as described in Annex-2.

4-2. The Pakistan side will take the necessary measures and allocate necessary budget properly, as described in Annex-2, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

4-3. The Team clarifies the necessary measures and budget to be taken care by the Pakistan side, besides the general measures described in Annex-2, by further study.

4-4. The Pakistan side promised to implement the Project properly following to the "Guidelines of the Japanese Grant Aid for General Projects and for Fisheries" mentioned in "the Agreed Minutes" of "the Exchange of Notes" which is agreed upon by both Governments as Diplomatic document if the Project is approved by the Japanese Cabinet. The Guidelines is attached as Annex-3.

5. Schedule of the Study:

5-1. The consultant members will proceed to further studies in the Pakistan until 6 August, 2007.

5-2. JICA will prepare the draft report in English and dispatch a mission in order to explain its contents in November 2007 at the earliest.

5-3. In case that the contents of the report are accepted in principle by the Pakistan side, JICA will complete the final report and send it to the Pakistan by around January 2008 at the earliest.

5-4. The Pakistan side understood that the implementation of the Study did not imply and commit the implementation of the Project.

6. Exemption of Taxes and Duties:

The Team explained that the Pakistan side should take necessary measures to exempt Value Added Tax, custom duties and any other taxes and fiscal levies in the Pakistan arisen from the Project activities and they will be borne by beneficiary organizations in accordance with the implementation schedule.

The Pakistan side promised to take necessary measures for these taxes and duties exemptions.

7. Prioritization and Selection for the Project:

The Team explained that contents of the Project would be considered by the Government of Japan by evaluating the result of the Study.

Both sides agreed that the contents of the Project might be prioritized, selected and adjusted in accordance with the result of the Study and the budget allocated for the Project.

8. Components implemented by the Pakistan side:

When some components are adjusted from the Project after analyzing the result of the Study, the Team will inform the components to the Pakistan side immediately. In that case, the Pakistan side agreed to consider whether or not the Pakistan side could bear the components, then inform the results to the Team.

9. Other Relevant Issues:

9-1. Change of the Project Title:

If the Project is approved by the Cabinet of Japan, new Exchange of Notes (hereinafter referred to as "E/N") will be signed by both Governments. Then there might be two E/Ns for one same Project with same name, since present E/N for the Project is still effective.

In order to avoid confusion, the Team requested to change the Project title for new E/N.

The Pakistan side suggested not to change the title but to add the word "(Revised)"to the original title since they have to amend all the important documents of the Project which were approved under the original title and it will affect the smooth implementation of the Project.

In this document, new title is provisionally adopted.

9-2. Alternation and Addition to the Project:

Both sides agreed that major alternation and additional component to the Project are not accepted. However these alternation and addition might be considered by the Government of Japan if they are occurred by inevitable reason as well as are essential for the proper function of the Project.

9-3. Influence of the Election:

The Pakistan side confirmed that the election of the Parliament would not influence the priority and the implementation arrangement of the Project.

9-4. Environmental Impact Assessment (EIA):

The Pakistan side explained that they started the procedure for EIA approval and agreed to submit the relevant documents proving the approval of EIA to the Team through official channel.

Both side agreed that implementation of the Project would be postponed or cancelled if EIA is not completed by December 2007.

9-5. Land Acquisition for the Project Facilities:

The Pakistan side explained that the land has been secured in collaboration with the concerned Departments.

9-6. Procedure for PC-1:

The Team requested that the Pakistan side should complete revision and approval of the PC-1 by December 2007 as it is one of the prerequisites for the Japanese Government to make commitment of grant for the Project.

The Pakistan side explained that the original PC-1 for the Project was already approved by the Government of Pakistan, which fully enables the Government to start the implementation of the Project forthwith. No revision is therefore required at this stage except in case of upward revision (more than 15% of the approved cost of the Project) is necessary due to escalation in costs.

The Pakistan side requested the Team to provide the cost estimates by end of August 2007 to the Government of Punjab for processing of revised PC-1 for its approval by December 2007.

The Team explained that it might be difficult to give the formal cost estimation by end of August. It is only possible to provide cost estimation between November to December 2007 for the revision of the PC-1.

The Pakistan side confirmed that as soon as the Japanese side provides the formal cost estimation, the PC-1 will be revised accordingly and inform to the Japanese Government by official route.

9-7. Operation and Maintenance of Facilities and Equipments:

The Team explained that capability of operation and maintenance is one of the conditions for implementation and approval of the Project. The Team will evaluate the present capability of WASA comparing to the past when the B/D Study was conducted. If the Study indicates the necessity, the Team will propose necessary measures, allocation of additional budget and qualified personnel required for the proper and effective utilization of facilities and equipment.

The Pakistan side agreed to take necessary measures properly according to the proposal and suggestion by the Team.

9-8. Technical Assistance:

Although the technical assistance was not included in the B/D Study, The Team will study and analyze necessity based on the current situation and capacity of WASA.

9-9. Fair Implementation of the Project:

The Team explained that some information of the relevant Report should be dealt with carefully until the Tender is implemented, since the information will affect the fair implementation of Tender process.

The Pakistan side understood and promised to do so.

9-10. Arrangements for the Study:

As a response to the request by the Team, The Pakistan side agreed to arrange counterpart personnel for the Study and to provide promptly all the data and information relevant to the Project for the smooth implementation of the Study.

9-11. Safety and Security for the Team:

The Team explained that security measures are indispensable for effective study. The Pakistan side agreed to take any necessary measures to secure the safety of the member of the Team.

9-12. Lesson Learnt by the Past Cooperation by Japanese ODA:

The Team requested to the Pakistan side that outcome of technical transfer and the Grant Aid implemented in the past should be utilized to improve the living condition of the Pakistan people.

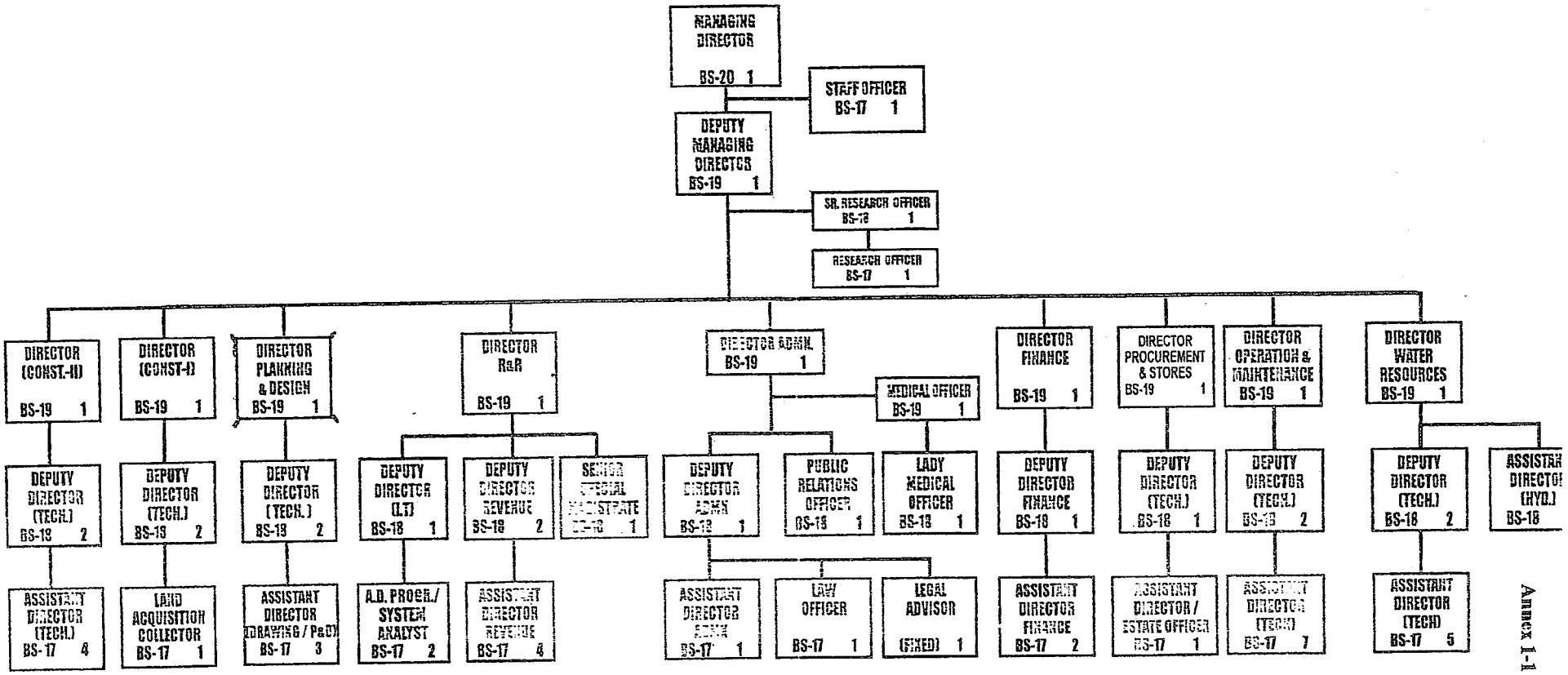
The Pakistan side agreed and promised to utilize the lesson learnt from the past cooperation.

Annex 1 : 1-1. Organization Chart of WASA
1-2. Organization Chart of FDA
Annex 2 : The Japan's Grant Aid Scheme
Annex 3 : Guidelines of the Japanese Grant Aid for General Projects and for Fisheries

End

WATER & SANITATION AGENCY, F[illegible]A, FAISALABAD.

ORGANIZATIONAL CHART



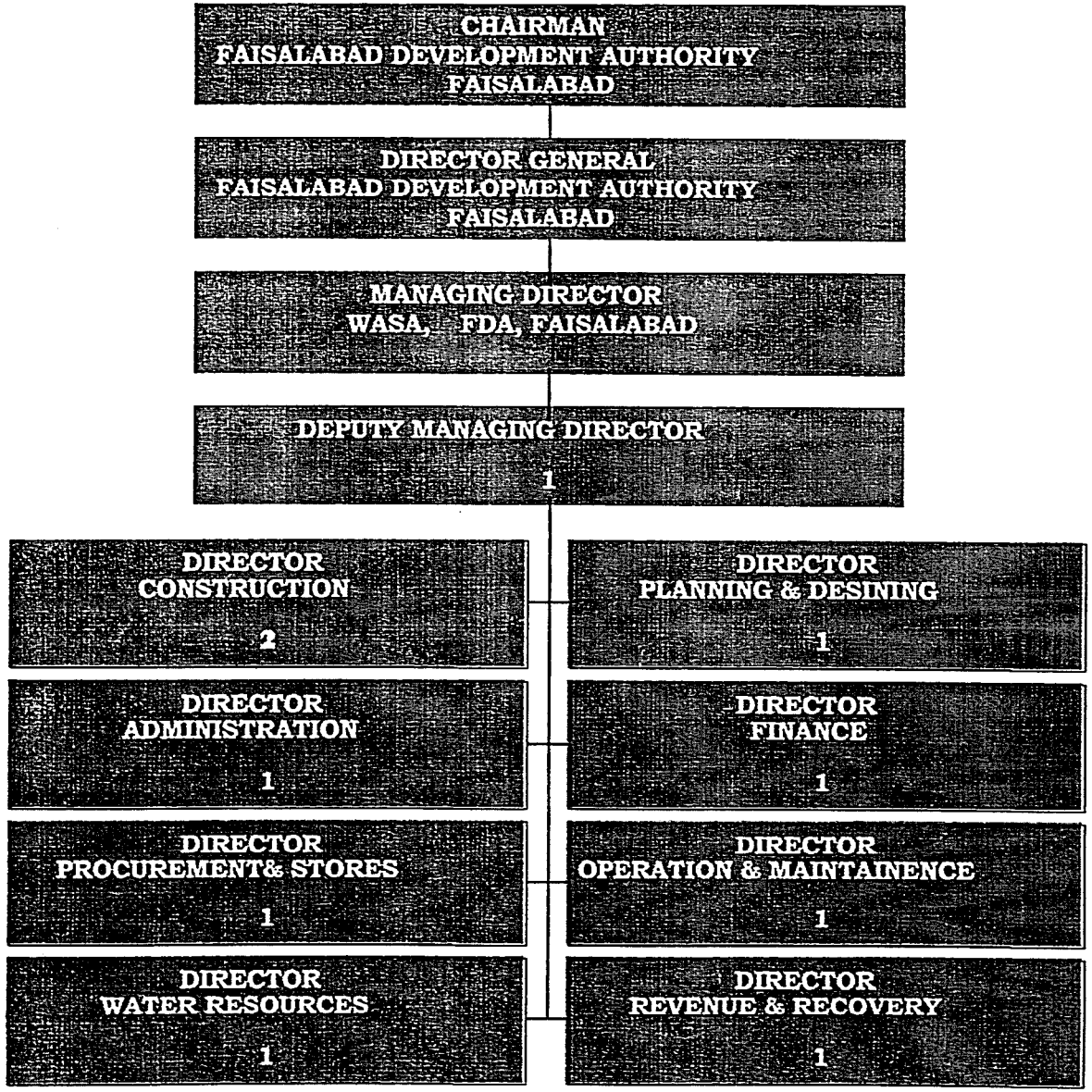
ONE POST OF OSD IN BS- 20 IS ALSO APPROVED.

Annex I-1

A-42

ORGANOGRAM

The Water and Sanitation Agency is under administrative control of Chairman FDA City District Nazim, Secretary HUD&PHE Department, Government of the Punjab and Director General FDA. The Agency is headed by a Managing Director. It has been organized into nine functional groups to carry out its activities. Each functional group called Directorate is headed by Director.



Total Strength = 2047-Nos.

Annex 1-2

A-43

MINUTES OF DISCUSSIONS
IMPLEMENTING REVIEW STUDY ON
"THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY SYSTEM
IN FAISALABAD"
IN ISLAMIC REPUBLIC OF PAKISTAN
(EXPLANATION OF DRAFT FINAL REPORT)

From July to August 2007, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Implementing Review Study Team on the Project for Improvement of Water Supply System in Faisalabad (hereinafter referred to as "the Project") to Islamic Republic of Pakistan (hereinafter referred to as "the Pakistan"), and through discussions, field survey, and technical assessment of the results, JICA prepared a draft report on this study.

In order to explain and to consult with the Pakistan on the contents of the draft report, JICA dispatched Draft Report Explanation Team (hereinafter referred to as "the Team") to the Pakistan, which is headed by Mr. Tsutomu SHIMIZU, Senior Deputy Resident Representative, JICA Pakistan Office.

In the course of discussions, both sides confirmed the main items described in the attached sheets.

Lahore, November 19, 2007

Tsutomu SHIMIZU
Leader
Implementing Review Study Team
Japan International Cooperation Agency

Shahid Mahmood
Secretary
Planning and Development Department
Government of the Punjab

Ms. Sabina Qureshi
Deputy Secretary (ADB/Japan)
Economic Affairs Division
Ministry of Economic Affairs & Statistics
Islamic Republic of Pakistan

Khizer Hayat Gondal
Secretary
Housing, Urban Development and
Public Health Engineering Department
Government of the Punjab

Mahboob Elahi
Managing Director
Water and Sanitation Agency
Faisalabad

ATTACHMENT

1. Components of the project

The Pakistan side agreed and accepted in principle, the components of the Draft Final Report explained by the Team.

2. Japan's Grant Aid Scheme:

2-1) The Pakistan side understood the Japan's Grant Aid Scheme and will take the necessary measures and allocate necessary and sufficient budget for smooth implementation of the Project, as the conditions for the Japanese Grant Aid to be implemented. The Grant Aid Scheme and necessary measures were described in the Annex of the Minutes of Discussions agreed by both sides on 21st of July 2007 (hereinafter referred to as "the Previous M/D").

2-2) Measures for some items and matters which are described in "Other Relevant Issues" in this document should also be undertaken timely and properly since these are indispensable to the whole Project Design.

2-3) The Pakistan side understood that conducting the Implementing Review Study (hereinafter referred to as "the Study") did not imply and commit the implementation of the Project.

2-4) Both sides agreed that some components might be excluded in the course of Japanese Cabinet approval even if the conditions are met by the Pakistan side.

2-5) The Pakistan side promised to implement the Project properly following to the "Guidelines of the Japanese Grant Aid for General Projects and for Fisheries" if the Project is approved by the Japanese Cabinet. The Guidelines was attached in the Previous M/D.

3. Schedule of the Study:

JICA will complete the Final Report in accordance with the confirmed items in this Minutes of Discussions and send it to the Government of the Pakistan around January 2008 at the earliest.

4. Exemption of Taxes and Duties:

The Pakistan side agreed to take necessary measures to exempt Value Added Tax, custom duties and any other taxes and fiscal levies in the Pakistan arisen from the Project activities and they will be borne by beneficiary organizations in accordance with the implementation schedule.

5. Responsible and Implementing Organization:

The Pakistan side explained that there is no change in the Organizations which was confirmed in the Previous M/D.

6. Title of the Project:

Both sides agreed not to change the title of the Project as "The Project for Improvement of Water Supply System in Faisalabad", in compliance with the request by the Pakistan side.

However final decision for the title will be made when both Governments sign the Exchange of Notes (hereinafter referred to as "E/N") for the Project.

7. Project Cost Estimation

Both sides agreed that the Project Cost Estimation described in Annex 1 should never be duplicated, released or revealed to any third parties before the signing of the all the Contract(s) for the Project.

Both sides also agreed that the Draft Final Report should never be duplicated, released or revealed to any third parties before the Final Report is released.

The Project Cost Estimation in Annex 1 is still under evaluation and it might be altered in the course of Japanese Cabinet approval.

8. Components implemented by the Pakistan side:

As the result of the Study, the Team requested that the Pakistan side should construct the following components and bear the construction cost by the Pakistan side.

- Construction of Three (3) Number of Operator's Quarters

The Team also requested that the Pakistan side should precede the revision of PC-1 for securing the construction cost for above components if these cost could not be covered by or within the cost secured by the Existing PC-1.

The Team explained that obtaining the approval of revision of PC-1, which includes cost of above components, would be prerequisite condition.

The Pakistan side agreed to implement these components and to start the procedure of revision of PC-1.

Besides those components, both sides agreed that component(s) of the Project might be adjusted or excluded in the course of Japanese Cabinet approval in accordance with the result of the Study and the budget allocated for the Project.

When component(s) are adjusted or excluded from the Project, the Team will inform the component(s) to the Pakistan side by the end of December 2007. In that case, the Pakistan side agreed to consider whether or not the Pakistan side could bear and implement the component(s), then inform the results to the Team. In this case, the schedule of the Project implementation and revision of PC-1 will be reconsidered.

9. Revision of the PC-1:

The Pakistan side explained that revision and approval of the PC-1 might be required since the Project Cost Estimation increased comparing to the previous Cost in the Basic Design Study. Besides, if the Pakistan side should implement component(s) as written in item 8 above in this M/D, it might require the revision of the PC-1.

If so required, the Team strongly requested that the Pakistan side should start the revision of the PC-1 and get approval at the earliest, utilizing the procedure of "Anticipatory Approval", by the end of February 2008 since the Japanese Cabinet, which would deal with the Approval for the Project, should be supposed to be held around between March to April 2008 and the approval for revision of the PC-1 would be one of the important prerequisite conditions for the Approval by Japanese side.

Accordingly, the Pakistan side promised to make every possible effort to get approval and

would inform the progress monthly to JICA Pakistan Office in writing and inform result by around March 2008 through an official channel with an authorized letter.

10. Other Relevant Issues:

10-1) Altered Design for New Terminal Reservoir

The Team explained the alteration of the New Terminal Reservoir and its relevant facilities. The Pakistan side understood and agreed to the alteration.

10-2) Measures to be taken by the Pakistan side:

The Team clarifies the necessary measures and budget to be taken care by the Pakistan side in the Draft Final Report and Final Report other than the general measures described in the Previous M/D. The Team also makes suggestions for better management and utilization of the Project in these Reports.

The Team particularly pointed out that securing these budgets is indispensable for the effective implementation of the Project although the budget increased more than the one already secured by the Pakistan side in existing PC-1.

The Pakistan side agreed to implement these matters timely and properly.

10-3) Relevant Permissions for the Project:

The Pakistan side explained that in order to get relevant permissions if necessary, coordination with relevant agencies and the provincial government will be undertaken.

The Team strongly requested the Pakistan side to get permissions if necessary, before the signing of E/N and the Pakistan side agreed.

10-4) Strengthening of Operation & Maintenance:

According to the result of the Study, the Team requested the Pakistan side to take necessary actions which were proposed in the Draft Final Report such as allocation of adequate budget, qualified personnel and improvement of water revenue system for proper, effective and sustainable operation and maintenance of equipment and facilities.

The Team strongly requested that the necessary actions should be taken in time for the construction of the facilities.

The Team particularly pointed out the inefficient water revenue system, which caused insufficient funds of effective operation and maintenance of the facilities and the Pakistan side agreed to improve the system.

The Pakistan side agreed to take necessary measures properly according to the proposal and suggestion by the Team. The Pakistan side also agreed to report to JICA Pakistan Office the progress of these measures in writing periodically.

10-5) Environmental Impact Assessment (EIA)

The Pakistan side explained the progress of the procedure for EIA approval is in process and EIA report was submitted to Environmental Protection Department for official approval. The Pakistan side agreed to submit the relevant documents proving the approval of EIA to the Team through official channel.

As agreed in the Previous M/D, the implementation of the Project would be postponed or cancelled if EIA approval is not completed by the end of December 2007.

10-6) Land Acquisitions for the Project Facilities:

The Pakistan side will submit the relevant documents proving that the lands for the Project have been secured in collaboration with the concerned Departments by the end of December 2007.

The No Objection Certificate for the transfer of the land for pumping stations issued by the District Officer (Revenue) Faisalabad is shown in Annex 2.

10-7) Changes of Circumstances:

As confirmed in the Previous M/D, there is no change of circumstances around for the implementation of the Project such as the priority and arrangement of the Project.

In case there were major changes of the circumstances which might influence the Project implementation, such as economic situation, security situation etc., the Pakistan side would inform the Team as soon as the changes are recognized.

The Pakistan side agreed that in case there were changes which might give negative impact to the Project, the Pakistan side would make every effort and take measures to mitigate the negative influences to the Project.

10-8) Public Relations of the Project:

The Pakistan side assured to do public relations for the Project affirmatively in order for the Pakistan citizens to understand that the Project is assisted by Japanese Official Assistance Development.

10-9) Safety and Security for the Team:

The Team explained that security measures are indispensable for effective implementation of the Project. The Pakistan side agreed to take any necessary measures to secure the safety of the member of the Project.

10-10) Lessons Learnt by the Past Cooperation by Japanese ODA:

The Team requested to the Pakistan side that outcome of Assistance of the Technical Transfer and the Grant Aid implemented in the past should be utilized to improve the living condition of the Pakistan people.

The Pakistan side agreed and assured to utilize the lessons learnt from the past cooperation.

Annex 1 : The Project Cost Estimation

Annex 2 : Document regarding Land Acquisition

End

Annex 1

1-1: The Project Cost Estimation

Division	Aomunt (Japanese million yen)					Total
	Phase 1	Phase 2				
	Single fiscal year matter (2004)	B-type Government bond matter				
		Term-1 (2008)	Term-2 (2009)	Term-3 (2010)	Sub-Total	
Construction costs	496.7	435.9	1,917.9	1,917.7	4,271.5	4,768.2
Machine / Material procurement costs	4.8	—	—	—	—	4.8
Management fee for dsign and supervision	206.9	22.8	74.8	74.8	172.4	379.3
Total	708.4	458.7	1,992.7	1,992.5	4,443.9	5,152.3

1-2: Cost to be borne by the Pakistani side

	Description	Basic Design Study		Implementation Review Study	
		Million Rs	Million yen (approx.) 1Rs=JY2.19	Million Rs	Million yen (approx.) 1Rs=JY2.15
1.	Primary power supply	35.83	78.47	80.00	172.00
2.	Land acquisition	10.94	23.96	10.94	23.52
3.	Site clearance	0.90	1.97	0.90	1.94
4.	Road construction	101.69	222.70	80.00	172.00
5.	Installation of Enclosures	6.12	13.40	8.00	17.20
6.	Procurement of Equipment in pump station	11.44	25.05	8.00	17.20
7.	Site Preparation of premises for the booster pump station	6.12	13.40	6.00	12.90
8.	Project Supervision	48.00	105.12	48.00	103.20
9.	Vehicles for supervision	5.50	12.05	6.00	12.90
10.	Construction of residence	21.46	47.00	30.00	64.50
11.	Public relations	2.50	5.45	2.50	5.38
12.	Compensation for residence	—	—	60.00	129.00
13.	Banking commission	—	—	36.47	78.41
14.	Others	—	—	15.00	32.25
15	Construction of three (3) Operator's Quarters, etc.	—	—	12.22	26.27
	Total	250.50	548.57	404.03	868.67
	Balance			+153.53	+320.10

The Cost to be borne by the Pakistani side increased about 210 million Rs (441 million JY) from Cost to be borne by the Pakistani side in Basic Design Study.

Annex 2

From:

The District Officer (Revenue),
Faisalabad.

To:

The Project Director/D.C-II,
WASA/FDA, Faisalabad.

No: 275-77/DDO(C)/Acctt(C)-15 Dated: 01-3-06

Subject: **TRANSFER OF LAND OF CHAK NO.49/JB TO WASA/FDA – IMPROVEMENT OF WATR SUPPLY PROJET FOR FAISALABAD.**

Memorandum

Kindly refer to your letter No.782/DC-II/WASA/05 dated 12.9.2005 on the above cited subject.

2. This office has no objection for transfer of land measuring 40-kanals 16-marlas comprising killa Nos.3,5/2,6,7/1,15,16,25 of Sqr. No.13 situated in Chak No.49/JB Tehsil Sadar Faisalabad subject to payment of price.

3. You are requested to move the case to Board of Revenue, Punjab Lahore for the purpose.

District Officer (Revenue),
Faisalabad.

No: 276-77/DDO(C)/Acctt(C) Dated: 01-3-06

A copy is forwarded for information to the:-

1. District Coordination Officer Faisalabad with reference to his letter No.3(22)/District Coordination Officer, Faisalabad/SG/2005/5128 dated 25.5.2005.
2. Executive District Officer (Revenue) Faisalabad with reference to his letter No.2830/EDOR/CA/MD-180 dated 16.9.2005.
3. Deputy District Officer (Revenue) Sadar Faisalabad.

District Officer (Revenue),
Faisalabad.

Minutes of Discussions
The Basic Design Study on
The Project for Improvement of Water Supply in Faisalabad
in Islamic Republic of Pakistan

In response to the request from the Government of Islamic Republic of Pakistan (hereinafter referred to as 'Pakistan'), the Government of Japan decided to conduct a Basic Design Study on the Project for Improvement of Water Supply in Faisalabad (hereinafter referred to as "the Project"), and entrusted the study to Japan International Cooperation Agency (hereinafter referred to as 'JICA').

JICA sent to Pakistan the Basic Design Study Team (hereinafter referred to as 'the Team'), which was headed by Mr. Yoshiki OMURA, Senior Advisor, Institution for International Cooperation, JICA, and was scheduled to stay in the country from December 9th to 18th, 2002.

The Team held a series of discussions with the concerned officials of the Government of Pakistan and conducted a field survey in the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further work and prepare the Basic Design Study Report.

Lahore, December 17th, 2002

Mr. Yoshiki OMURA
Leader
Basic Design Study Team
Japan International Cooperation Agency

Mr. Riaz Ahmed
Secretary
Housing, Urban Development &
Public Health Engineering Department
Government of Punjab

Mr. Muhammad Ashraf Khan
Joint Secretary
Economic Affairs Division
Ministry of Economic Affairs &Statistics
Government of Pakistan

Lt. Col (R) Engr Syed Ghias ud din
Managing Director
Water and Sanitation Agency
(WASA/FDA), Faisalabad

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve the water supply services in Faisalabad in order to supply safe and sufficient water for the residents.

2. Responsible and Implementing Organization

Water and Sanitation Agency (WASA/FDA), Faisalabad

3. Site of the Project

The Project site is as shown in Annex-1 (page 4).

4. Items requested by the Government of Pakistan

After discussions with the Team, the items described in Annex-2 (Page 5) were finally requested by Pakistani side. JICA will assess the appropriateness of the request in engineering, social and financial terms and will report the findings to the Government of Japan.

5. Japan's Grant Aid Programme

Pakistani side has understood the system and characteristics of Japan's Grant Aid Programme as described by the Team shown in Annex-3 (Page 6).

6. Necessary measures to be taken by the Pakistani side

Pakistani side will take the necessary measures, as described in Annex-4 (Page 10), for smooth implementation of the Project on condition that the Japanese Grant Aid is extended.

7. Further Schedule of the Study

a. The consultant members of the Team will proceed with further studies in Pakistani until January 16th, 2003.

b. JICA will prepare the Draft Basic Design Study Report in English and dispatch a mission in order to explain its contents around May 2003.

8. Other relevant issues

The Pakistani side and the Team have confirmed the following points:

a. The Pakistani side will obtain necessary consent in writing from inhabitants in and around the proposed well field to be developed under the Project.

b. The budget required for the land acquisition for the facilities in the Project including the tubewells, the collector main, the transmission main, and electric power supply will be allocated and executed by the time of the explanation of Draft Final Report. The Pakistani side will present the related documents of budgetary arrangements to the Draft Final Report Team.

c. The proposed booster pumping station is located inside the premises of the existing inline booster pumping station.

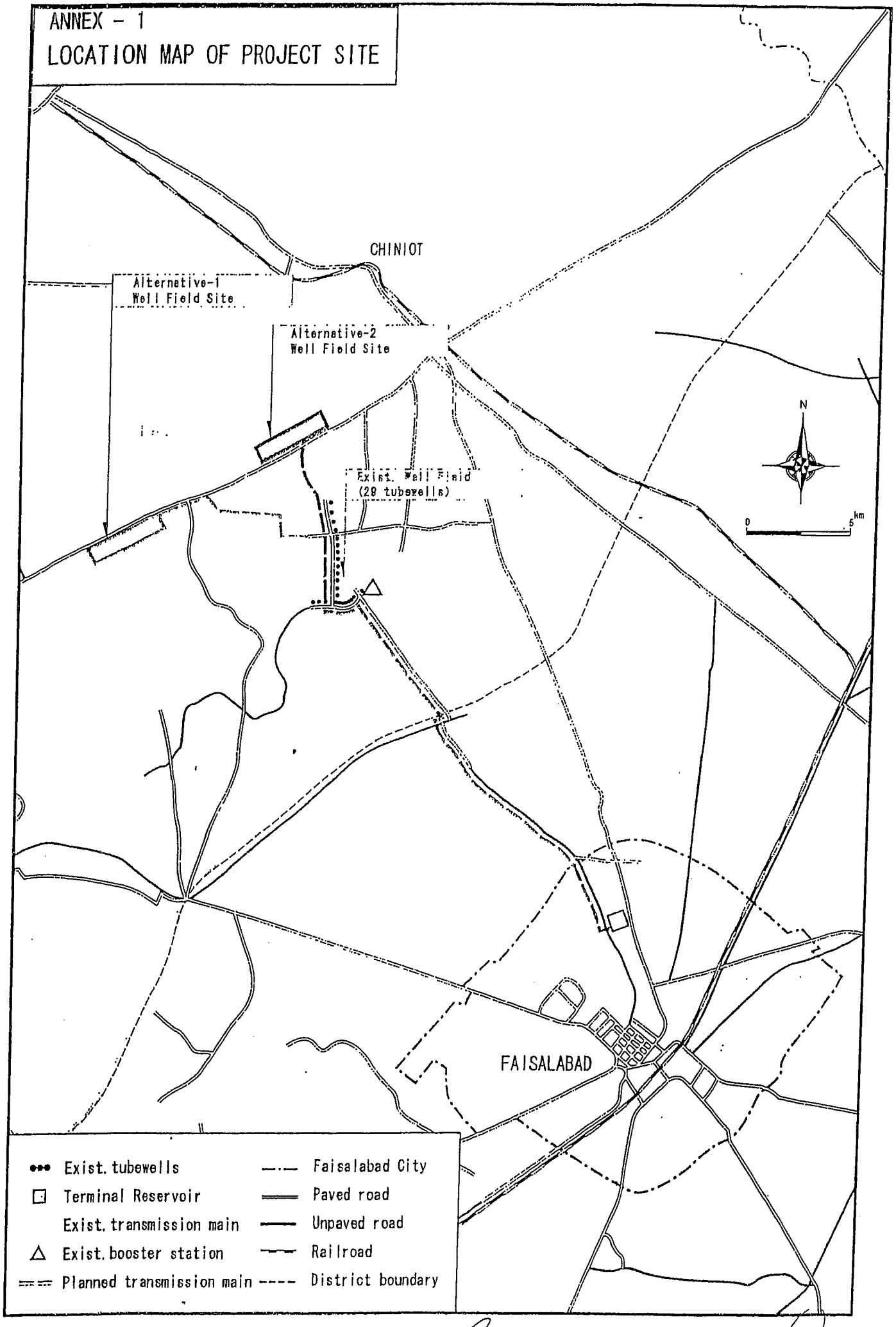
d. The proposed terminal reservoir and related distribution pumping facilities are located inside the existing terminal reservoir premises.

e. Pakistani side understood that as a prerequisite condition to providing Japan's grand aid program, the facilities to be constructed under the Project should be fully utilized without idling once commissioned.

f. The water supply facilities to be constructed by the Project shall properly be operated and maintained with necessary financial input to be generated by appropriate water tariff collection.

g. Pakistani side explained that a Federal government approval (PC-I) was prerequisite to project implementation and that PC-I shall be prepared and approval would be obtained within three months after receipt of Draft Final Report including information needed to prepare the said project document.

h. Pakistani side agreed to take a legal clearance for environmental protection from the Environmental Protection Authority/Department.


ANNEX - 1
LOCATION MAP OF PROJECT SITE
CHINIOT
Alternative-1
Well Field Site
Alternative-2
Well Field Site
Exist. Well Field
(29 tubewells)
N
0
5
km
FAISALABAD
Exist. tubewells
Terminal Reservoir
Exist. transmission main
Exist. booster station
Planned transmission main
Faisalabad City
Paved road
Unpaved road
Railroad
District boundary

Annex-2 List of Requested Items

Construction of new tube wells along the Chenab river area and a transmission system as followed:

1. Tubewells along the Chenab river area (12NOS)
2. Collector main
3. Transmission Main
4. Booster Pumping Station
5. Terminal Reservoir (including pumping facility)

Annex III

JAPAN'S GRANT AID SCHEME

1. Grant Aid Procedures

(1) Japan's Grant Aid Program is executed through the following procedures.

Application	(Request made by a recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

(2) Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

(1) Contents of the Study

The aim of the Basic Design Study (hereinafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Japanese Government. The contents of the Study are as follows:

1) Confirmation of the background, objectives, and benefits of the requested project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.

2) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

3) Confirmation of items agreed on by both parties concerning the basic concept of the Project.

4) Preparation of a basic design of the Project.

5) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consultant firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consulting firm(s) used for the Study is (are) recommended by JICA to the recipient country to also work in the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3. Japan's Grant Aid Scheme

(1) Grant Aid

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

(2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc. are confirmed.

(3) "The period of the Grant Aid" means the one fiscal year which the Cabinet

approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and a final payment to them must be completed.

However in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year by mutual agreement between the two Governments.

(4) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However the prime contractors, namely, consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

(5) Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

(6) Undertakings required of the Government of the Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

1) To secure land necessary for the sites of the Project, and to clear, level and reclaim the land prior to commencement of the construction.

2) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites.

3) To secure buildings prior to the procurement in case the installation of the equipment.

4) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid.

5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts.

6) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

7) Proper Use

The recipient country is required to maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

8) Re-export

The products purchased under the Grant Aid should not be re-exported from the recipient country.

9) Banking Arrangement (B/A)

(a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.

(b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an authorization to pay issued by the Government of the recipient country or its designated authority.

Annex-IV

MAJOR UNDERTAKING TO BE TAKEN BY EACH GOVERNMENT

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim sites and to prepare access roads thereto when needed		●
3	To construct gates and fences in and around sites		●
4	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
5	To ensure prompt unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
6	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contact such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contact		●
8	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
9	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities		●

<Reference>Minutes of Discussion on 2nd Basic Design Study (2)

Date: August 29, 2003

TECHNICAL NOTE
FOR
THE BASIC DESIGN STUDY
FOR THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY
IN FAISALABAD, PAKISTAN

The Basic Design Study for the Project for Improvement of Water Supply in Faisalbad has been underway since August 2, 2003. At the final stage of its field survey, the Water and Sanitation Authority, Faisalabad (WASA), the executing agency of the project, and the study team dispatched by the Japan International Cooperation Agency (JICA), discussed on the results of the study up to date as well as proposals by the executing agency, concentrating on the major project components as follows:

(1) Development groundwater sources for augmentation of water supply for the city
(2) Planning for new water supply facilities
(3) Improvement of existing water system in the city
(4) Proposal for procurement of equipment for operation and maintenance of the water system

The team continues the survey up to September 10, 2003, and the results will be examined in detail at home for reporting in draft by the team to the executing agency to be scheduled in November 2003.

(1) *Groundwater sources development*

1) The groundwater production for augmentation of water sources targeted by the project is 91,000 m3/day.

2) All the tubewells are planned to be installed in the land owned by the Government along the Jhang Branch Canal on its eastern side falling in the jurisdiction of the Faisalabad district, within an area extending from RD230 to RD270 (40,000 ft = approximately 12 km) along the canal.

3) The proposed land has already been secured by WASA through the notification of the District Government, Faisalabad under Section-4 of the Land Acquisition Act 1894.

4) WASA has completed its own pumping test of an existing tubewell in the planned area during

the survey by the team, and will further proceed to the execution of seepage test of the canal by the end of the survey, All the data and information obtained through these tests will be provided to the study team for its analysis of the hydrogeological features of the project area for finalizing the design for the feasibility of groundwater development for the project.

5) The results of the pumping test by WASA and the previous studies by international and local consultants/agencies indicate that the production of one tubewell in this area is estimated to be 2 - 3 cusec (=200-300m3/hr). The exact size will be decided after the test drilling program is completed by the study team, together with a proposal for the required number of tubewells as well as the layout of group tubewells across the planned site that could minimize the influence of operation of the targeted production.

6) The location of the site for groundwater development is shown at Annex 1 (attached).

(2) *Planning of new water facilities*

1) Planned water facilities are composed of the following items:
   a. Tubewells along the Jhang Branch Canal
   b. New intermediate pumping station with a reservoir
   c. Transmission main (about 12.5 km)
   d. New terminal reservoir and pumping station in the city

2) Among the planned facilities, the study team proposed to use the existing transmission main of 1,500mm in diameter running through the project site from the existing inline booster pump station, collecting the production from the existing 29 tubewells in the Chenab wellfield, since that line can accommodate the targeted production of 91,000 m3/day under the project.

3) WASA explained that this proposal will deprive it from the full utilization of the water production capacity of existing wellfield and its extension thereof and that the operation and maintenance cost will increase enormously due to extra electricity consumption. WASA is willing to agree to this proposal on the condition if it is technically and economically more feasible than the plan for installation of a new independent transmission line from the new intermediate pump station. WASA has requested for in-depth study on the technical and economical feasibility of both plans using full capacity of existing wellfield and prevailing electricity rates.

4) A new intermediate pumping station with a reservoir is planned to be in the land owned by the Government BAWA road in front of NEWAN rest house, along which the existing transmission main from the existing inline booster pump station is installed.

5) Among the basic design elements of water supply planning, WASA proposed to adopt the design capacity of existing tubewells in the Chenab wellfield totaling 11600m3/hour as well as the future extension of the existing wellfield. To this proposal, the study team responded to the effect that the data of the past operation records be provided to the team for employing a practically available production rate, taking into account ongoing drawdown of these wells affecting the surrounding areas. The data has since been provided and all the basic design elements will be further examined in detail by the study team for the formation of an appropriate new system, and the capacities of new facilities will be proposed, based upon the analyses of these factors.

6) For reference, the schematic diagram of two planned systems is shown in Annex 2. The location of a site for a new intermediate pump station is shown in Annex 3.

(3) *Improvement of existing water supply system in the city*

1) In order to ensure maximum effect by the implementation of the project, the study team carried out the survey to contribute to the improvement of WASA's existing water system in the city faced with non-uniform water distribution particularly in the east zone accounting for nearly one third of the whole city jurisdiction, which has been getting less water supply and as such facing acute shortage.

2) WASA suggested independent water supply line from terminal pump station to Jhal Khanuana water works with a new pump station and water storage there. As a result of the survey, fundamental improvement has proven to require huge investment. However, the following measures have been agreed to have an effect in improvement, though partially, of the existing system.

a. Construction of a new reservoir and pumping station in the extended Jhal Khanuana Head Water Works located in the central area of the east zone.
b. Improvement of water supply through augmentation of water flow into the east zone of the city by adding new section(s) of pipe line.

3) The proposed plans for additional new sections are as follows:

a. Plan(a) A section of pipe from Node No. 5 to a new reservoir proposed at Jhal Khanuana HWW. (Section -A, approx. 3.5 km) plus a section of pipe from the planned terminal reservoir to the bifurcation point of existing 1600mm arterial main into 1200mm and 1400mm lines

(Section C, approx. 2.5 km)

b. Plan (b) A section of pipe , Section- A, plus a section of pipe from Outlet No.2 to Outlet No.5(Section- B, approx. 4 km).

Among these plans, WASA has put the first priority on Plan (a).

4) The effects of the respective measures for reinforcement of arterial mains will be examined in detail for possible implementation under the project.

5) WASA underscored the necessity of employing an optimum size(s) of additional trunk lines effective for a long term use, in view of the specific characteristics of the arterial mains essential for water distribution.

6) The necessity of improvement of the existing terminal reservoir was also discussed for the effective distribution of water transmitted from the existing and new tubewells, since the lower half of the existing reservoir remains unused since its inception due to the characteristics of existing pumps. The measure proposed by the team is to connect the existing reservoir to a new terminal reservoir with a pipe so that the new pumps to be installed under the project can undertake pumping from this inactive lower half of the existing reservoir. As a result of the discussion, a planned pipe will be connected to either the suction header line to the existing pumps or the inflow bypass line from the inline booster pump station.

7) The locations of additional facilities and sections are shown in Annex 4.

(4) *List of equipment for maintenance and operation proposed by WASA*

1) The following list shows the items of equipment for operation and maintenance of the project proposed by WASA during the meeting:

a. For tubewells along the Jhang Branch Canal and other facilities under this project.

- Service rig for tubewells and borehole inspection TV camera.
- Mobile workshop with repair/rehabilitation tools for equipment and pipeline
- Telemetry system for collecting and recording data from scattered tubewell stations and booster pump stations.
- Voice Communication system for connection between tubewells ,maintenance crew , intermediate booster station, terminal pump station and Jhal Khanuana Head Water Works and

WASA Head Quarters.

Maintenance Vehicle- a Double-cabin pick-up truck (for tubewell maintenance and transportation of staff and materials.)

- Water quality testing kits/equipment for Na, SO4, NH3, NO2, NO3, Mn, Fe, Ar, F, Hg, Cd, Pb. Residual Chlorine.
- GPS meter

b. For pipeline service

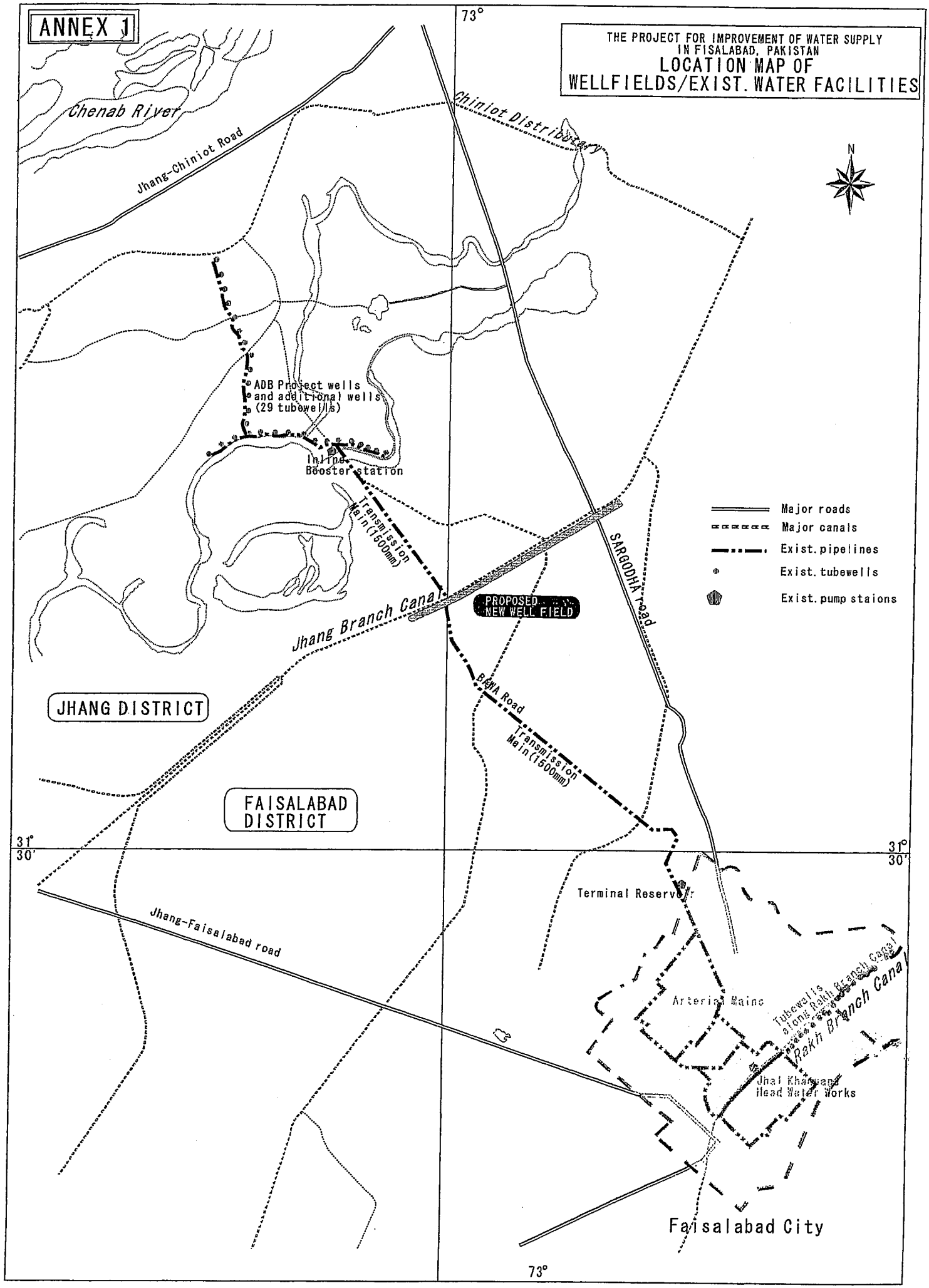
- Electronic leakage detection equipment
- Pump monitoring and testing kits.
- Water meters for consumers in connection with planned tariff reform
- Tapping drilling units for service connections (1/2" to 3" in size)

2) The details of requested equipment will further be examined by the study team and reported to the Government of Japan.

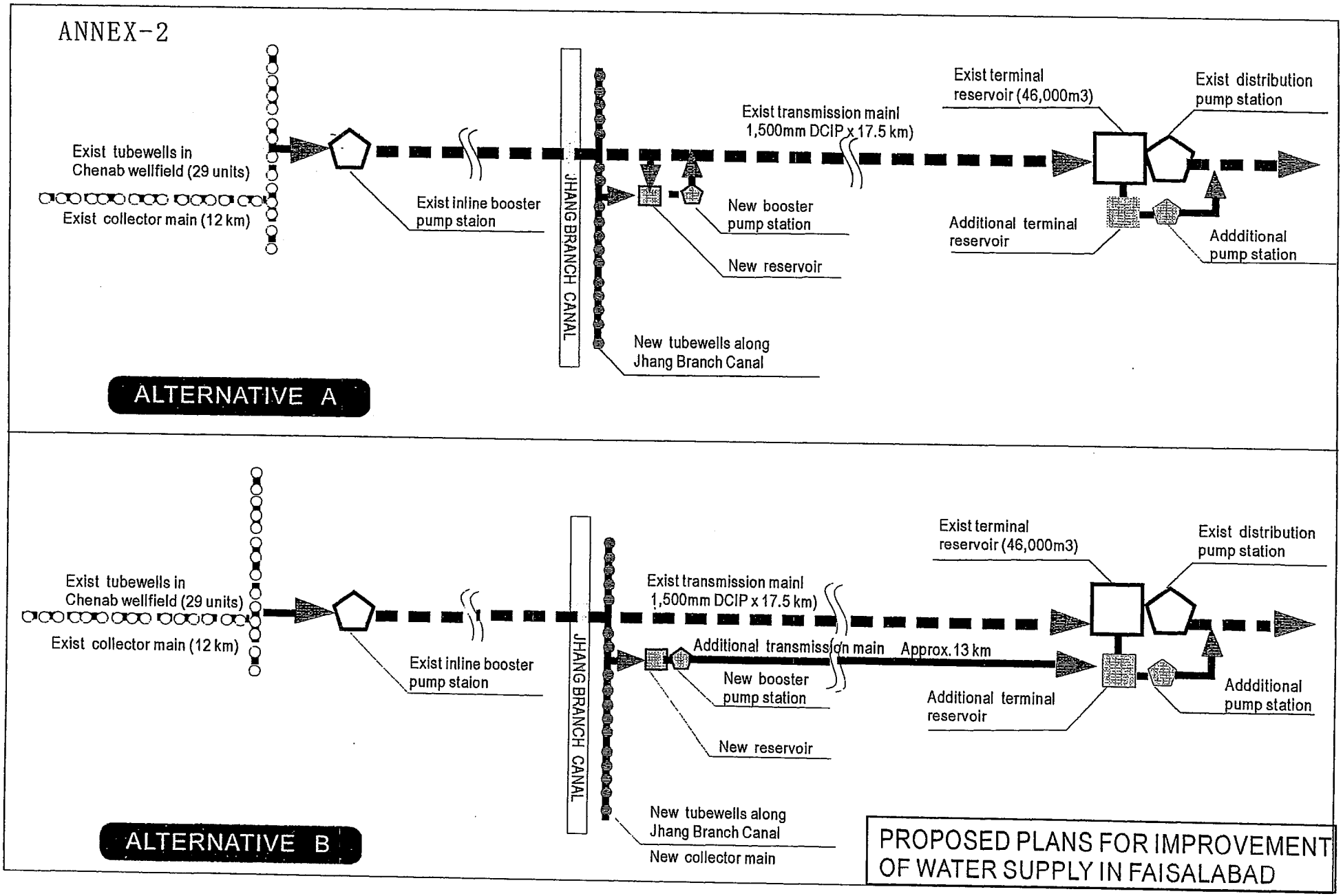
Date: August 28, 2003

LT. COL® ENGR SYED HIAS UD DIN
Managing Director,
Water and Sanitation Auhority(WASA)
FDA, Faisalabad

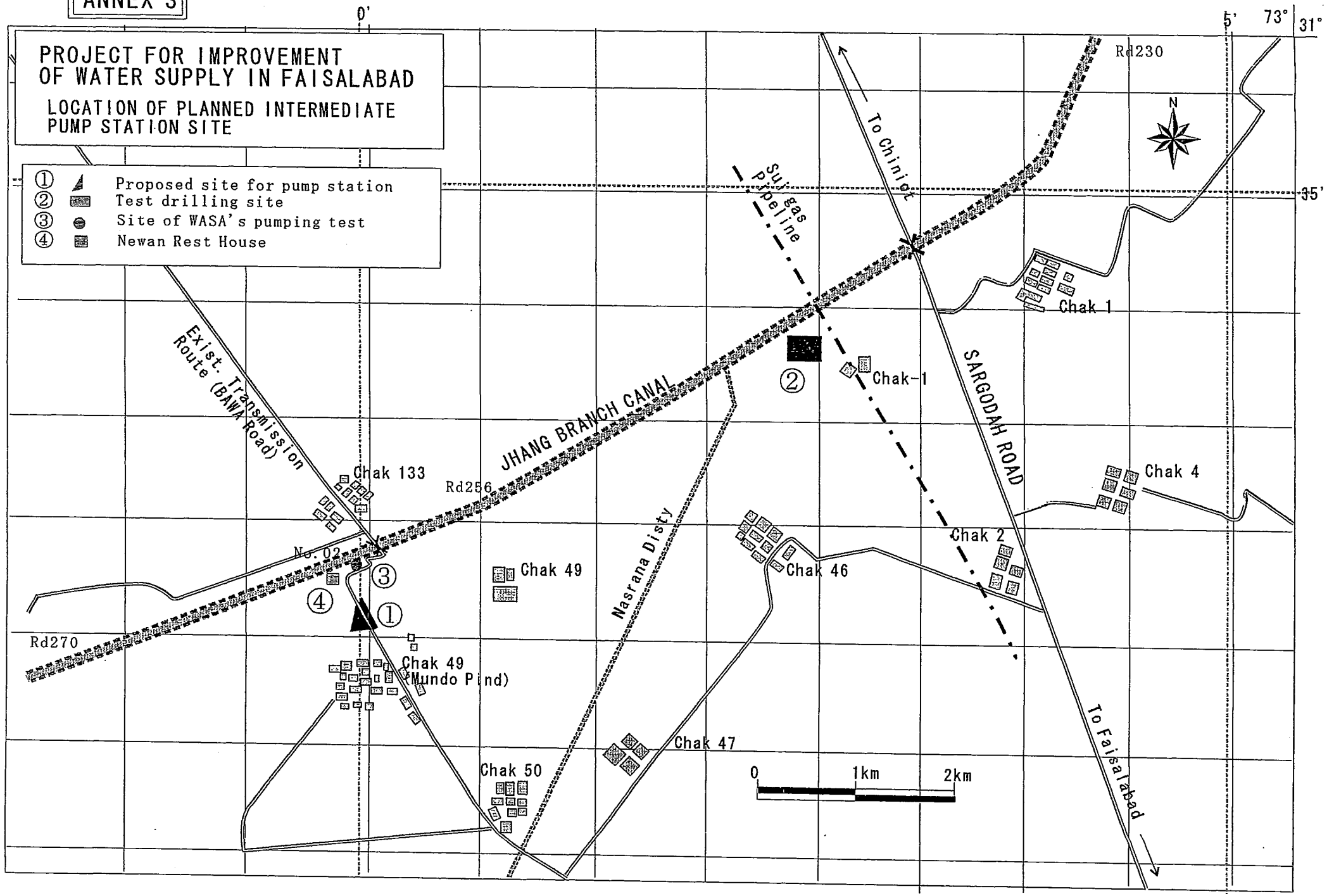
T. NIWANO, Chief Consultant
JICA Basic Design Study Team
for the Project


ANNEX 1
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FISALABAD, PAKISTAN
LOCATION MAP OF WELLFIELDS/EXIST. WATER FACILITIES
73°
Chenab River
Jhang-Chiniot Road
Chiniot Distributary
N
ADB Project wells and additional wells (29 tubewells)
Inline Booster station
Transmission Main(1500mm)
SARGODHA road
Major roads
Major canals
Exist. pipelines
Exist. tubewells
Exist. pump staions
PROPOSED NEW WELL FIELD
Jhang Branch Canal
BEWA Road
Transmission Main(1500mm)
JHANG DISTRICT
FAISALABAD DISTRICT
31° 30'
Terminal Reservoir
Jhang-Faisalabad road
Arterial Mains
Tubewells along Rakh Branch Canal
Rakh Branch Canal
Jhal Khanuana Head Water Works
Faisalabad City
73°

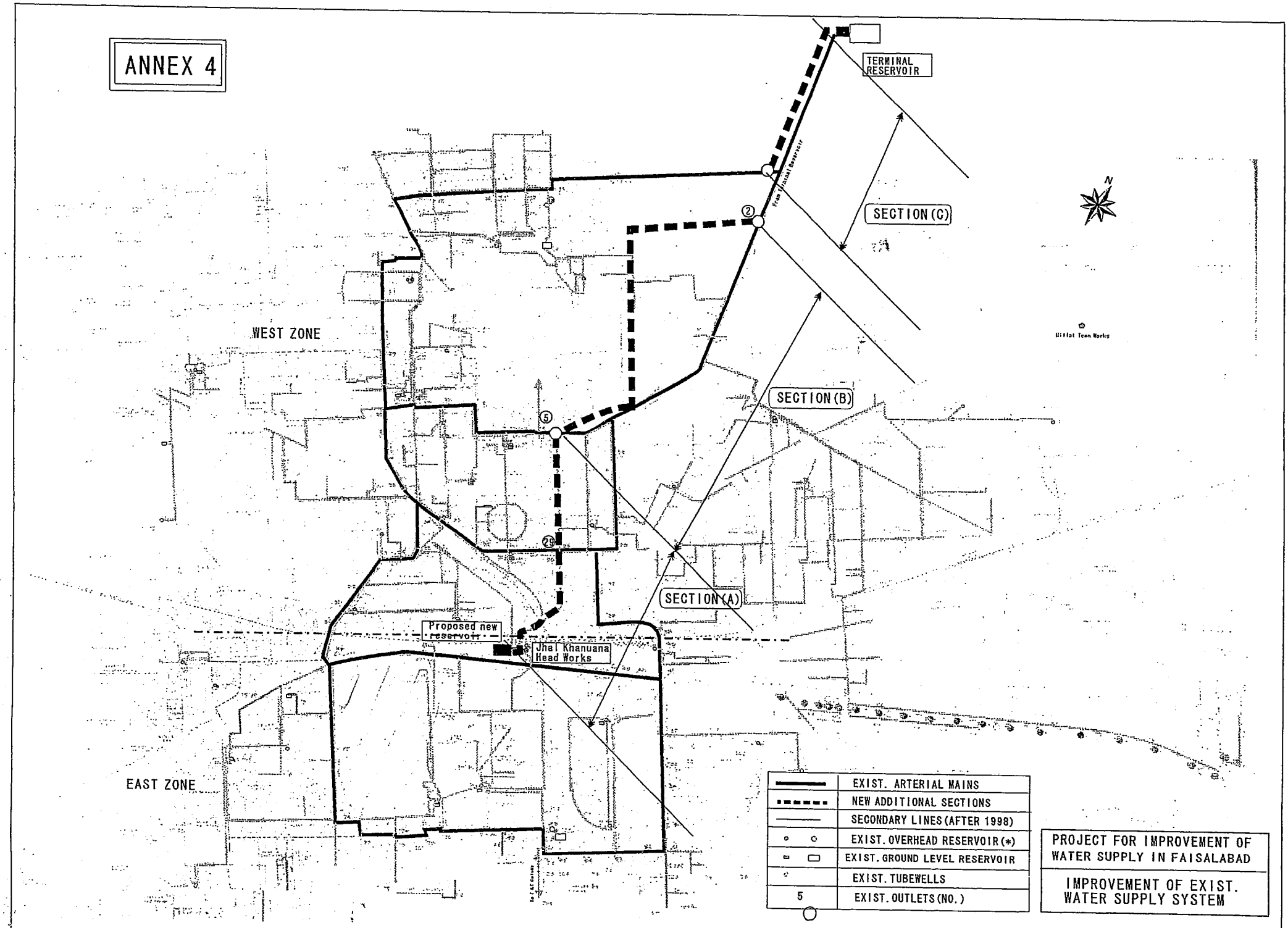
ANNEX-2


Exist tubewells in
Chenab wellfield (29 units)
Exist collector main (12 km)
Exist inline booster
pump staion
JHANG BRANCH CANAL
Exist transmission main
1,500mm DCIP x 17.5 km)
Exist terminal
reservoir (46,000m3)
Exist distribution
pump station
New booster
pump station
New reservoir
Additional terminal
reservoir
Addditional
pump station
New tubewells along
Jhang Branch Canal
ALTERNATIVE A
Exist tubewells in
Chenab wellfield (29 units)
Exist collector main (12 km)
Exist inline booster
pump staion
JHANG BRANCH CANAL
Exist transmission main
1,500mm DCIP x 17.5 km)
Exist terminal
reservoir (46,000m3)
Exist distribution
pump station
Additional transmission main Approx. 13 km
New booster
pump station
New reservoir
Additional terminal
reservoir
Addditional
pump station
New tubewells along
Jhang Branch Canal
New collector main
ALTERNATIVE B
PROPOSED PLANS FOR IMPROVEMENT
OF WATER SUPPLY IN FAISALABAD

ANNEX 3


PROJECT FOR IMPROVEMENT
OF WATER SUPPLY IN FAISALABAD
LOCATION OF PLANNED INTERMEDIATE
PUMP STATION SITE
① Proposed site for pump station
② Test drilling site
③ Site of WASA's pumping test
④ Newan Rest House
0'
5'
73°
31°
35'
N
Rd230
To Chiniot
Sui gas Pipeline
Chak 1
Chak-1
SARGODAH ROAD
Exist. Transmission Route (BAWA Road)
JHANG BRANCH CANAL
Chak 133
Rd256
No. 02
Chak 49
Nasrana Disty
Chak 46
Chak 2
Chak 4
Rd270
Chak 49
(Mundo Pind)
Chak 47
Chak 50
0
1km
2km
To Faisalabad

ANNEX 4


TERMINAL RESERVOIR
SECTION (C)
SECTION (B)
SECTION (A)
WEST ZONE
EAST ZONE
Proposed new reservoir
Jhal Khanuana Head Works
EXIST. ARTERIAL MAINS
NEW ADDITIONAL SECTIONS
SECONDARY LINES (AFTER 1998)
EXIST. OVERHEAD RESERVOIR (*)
EXIST. GROUND LEVEL RESERVOIR
EXIST. TUBEWELLS
5
EXIST. OUTLETS (NO.)
PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FAISALABAD
IMPROVEMENT OF EXIST. WATER SUPPLY SYSTEM

Minutes of Discussions
The Basic Design Study on
The Project for Improvement of Water Supply in Faisalabad
in Islamic Republic of Pakistan
(Explanation on Draft Final Report)

In December 2002, Japan International Cooperation Agency (hereinafter referred to as 'JICA') dispatched a Basic Design Study Team on the Project for Improvement of Water Supply in Faisalabad (hereinafter referred to as "the Project") to the Islamic Republic of Pakistan (hereinafter referred to as 'Pakistan'), and through discussions, field survey, and technical examination of the results in Japan, JICA prepared a draft final report of the study.

In order to explain and to consult with the Pakistan side on the contents of the draft final report, JICA sent to Pakistan the Draft Final Report Explanation Team (hereinafter referred to as 'the Team'), which was headed by Mr. Hiroshi Kurakata, Director, First Project Management Division, Grant Aid Management Department, JICA, and was scheduled to stay in the country from Mar. 16th to Mar. 28th, 2004.

As a result of discussion, both sides confirmed the main items described on the attached sheets.

Lahore, March 25th, 2004

H. Kurakata

Mr. Hiroshi Kurakata
Leader
Basic Design Study Team
Japan International Cooperation Agency

Mr. Muhammad Ashraf Khan
Joint Secretary
Economic Affairs Division
Ministry of Economic Affairs &Statistics
Government of Pakistan

Mr. Sohail Ahmad
Secretary
Planning & Development Board
Government of Punjab

Mr. Riaz Ahmed
Secretary
Housing, Urban Development &
Public Health Engineering Department
Government of Punjab

Mr. Rashid Ahmad Chaudhry
Managing Director
Water and Sanitation Agency
(WASA/FDA), Faisalabad

ATTACHMENT

1. Components of the Project

The Pakistan side agreed and accepted in principle the components of the draft final report explained by the Team.

2. Japan's Grant Aid scheme

The Pakistan side understood the Japan's Grant Aid Scheme and the necessary measures to be taken by the Government of Pakistan as explained by the Team and described in **Annex-III** and **Annex-IV** of the Minutes of Discussions signed by both sides on December 17th, 2002.

3. Schedule of the Study

The Team was informed of the revision of tariff system by WASA in March 2004.

The Team confirmed that JICA would complete the final report with employing a new tariff for its financial analysis and send it to Pakistan side by May 2004.

4. Other relevant issues

Both sides confirmed the importance of the following items in order to realize the Project smoothly and effectively.

(1) Information disclosure and public meeting

The Team requested the Pakistan side to disclose the information about the impact of the Project clearly through the public meeting with the participation of the residents who might be affected by the Project. The Pakistan side will take necessary measures to mitigate the impacts including appropriate compensationary development package up to the extent of Rs.50 million, which would be provided to upgrade the infrastructure system and to subsidize the installation/improvement of the tubewells in the affected area.

And also the Pakistan side confirmed to provide an undertaking in this regard to the Japanese side until 10th April 2004.

(2)Preparation of PCI

For the earlier approval of this project by the Government of Japan, it is a prerequisite for the Pakistan side to secure the approval of PC1 by the related agencies of the central government.

The Pakistan side confirmed to inform the Japanese side of its progress and the results on each of the following stages and whenever it would be deemed necessary:

1) WASA's submittal of PC1 form to the Punjab government
2) Approval of the Punjab government (PDWP)
3)CDWP
4) ECNEC

The Pakistan side also confirmed to take necessary steps to promote the procedure of approval, targeting its finalization by the end of June 2004.

(3) Environmental Impact Assessment

The Pakistani side explained to undertake the procedures required for environmental protection in compliance with the related regulations of Pakistan during the detailed design stage after the implementation agreement between the governments of Pakistan and Japan.

(4) Plan for Phasing of the Project

Both side agreed that the implementation of the Project would be planned to divide into the following two phases:

1) Phase 1	Improvement of existing distribution system (reinforcement of existing network with supplementary sections to arterial mains)
2) Phase 2	Construction of facilities for water source, collection, transmission and distribution (construction of tubewells, collector main, booster pump station, transmission main and terminal reservoir)

(5) Requirement for Personnel for Operation and Maintenance of Facilities

WASA will formulate an appropriate plan for recruitment, allocation and training of personnel for operation and maintenance of facilities to be constructed under the Project.

(6) Improvement of Existing Distribution Network

For the purpose of ensuring the maximum effect of increased water supply through the Project, WASA confirmed to carry out the improvement and rehabilitation of existing distribution network, particularly from secondary distribution lines to house connections.

(7) Monitoring System

WASA agreed to establish an appropriate monitoring system of water level in the planned wellfield to check the influence of the Project as well as water quality with reference to the proposal of the Japanese side.

(8)Grading and leveling of Land

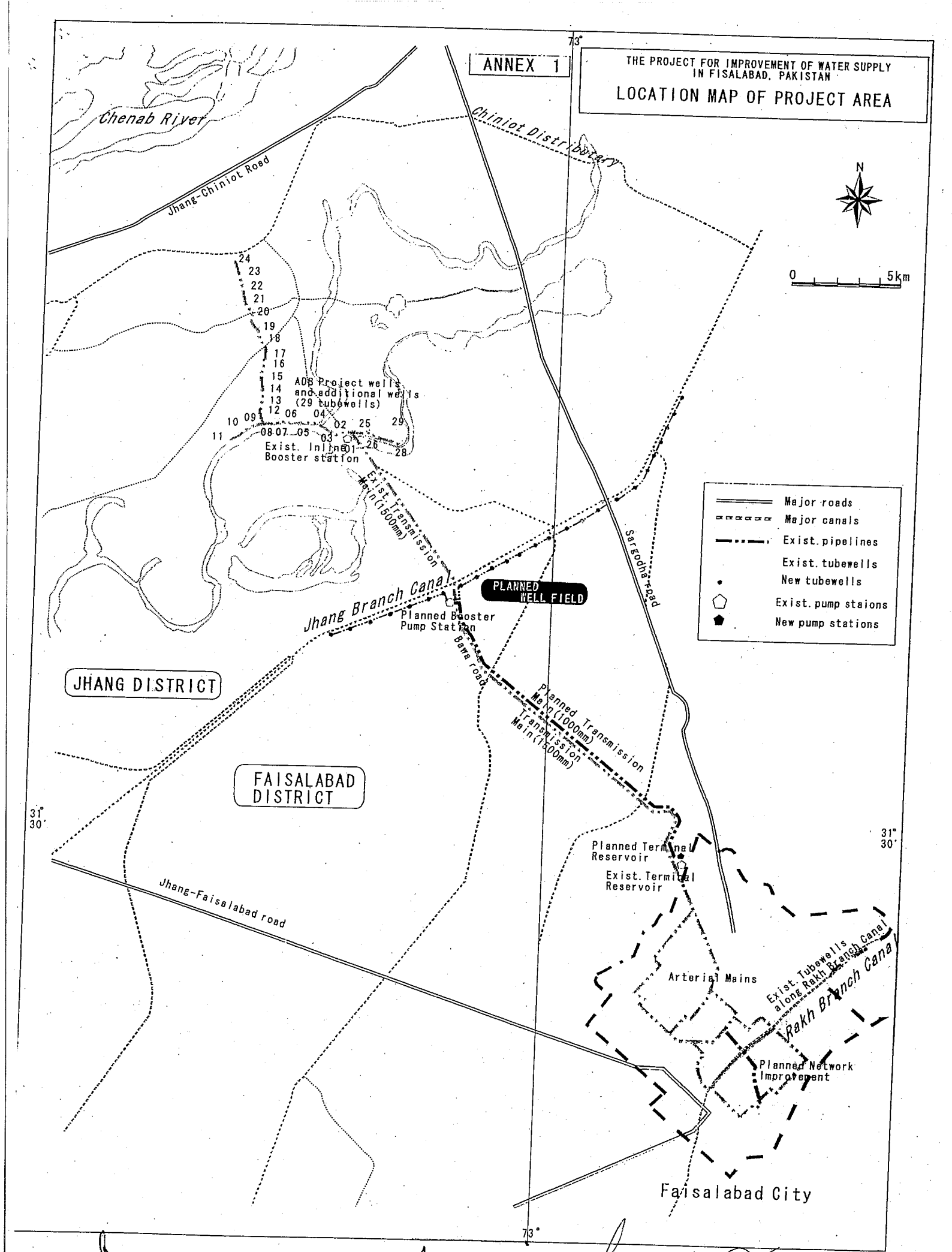
The Pakistani side confirmed to secure the land and to level the sites for the tubewells, the booster pump station and the terminal reservoir, prior to commencement of work on condition that Grant Aid is extended.

(9)Financial Improvement

With the implementation of the project, WASA agreed to take effective measures to secure sound financial status through the improvement of billing, tariff collection and acquisition of new clients.

(10)Tax Exemption

The Pakistan side confirmed to bear all the taxes including customs duties, the Value Added Tax (VAT) related to the Project .


ANNEX 1
THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY IN FISALABAD, PAKISTAN
LOCATION MAP OF PROJECT AREA
73°
Chenab River
Chiniot Distributary
Jhang-Chiniot Road
N
0
5km
24
23
22
21
20
19
18
17
16
15
14
13
12
06
04
10
09
02
25
29
11
08
07
05
03
01
26
28
AOB Project wells and additional wells (29 tubewells)
Exist. Inline Booster station
Exist. Transmission Main (1500mm)
Major roads
Major canals
Exist. pipelines
Exist. tubewells
New tubewells
Exist. pump staions
New pump stations
Sargodha road
PLANNED WELL FIELD
Jhang Branch Canal
Planned Booster Pump Station
Bawa road
JHANG DISTRICT
Planned Transmission Main (1000mm)
Transmission Main (1500mm)
FAISALABAD DISTRICT
31° 30'
Planned Terminal Reservoir
Exist. Terminal Reservoir
Jhang-Faisalabad road
Arterial Mains
Exist. Tubewells along Rakh Branch Canal
Rakh Branch Canal
Planned Network Improvement
Faisalabad City
73°

ANNEX II

LIST OF PLANNED FACILITIES

1.	Water Source Facilities		
	a.	Tubewells	25 Nos.
	b.	Pumps for tubewells	25 Nos.
	c.	Tubewell stations	25 Nos.
2.	Collecting facilities		
	a.	Collector mains	14,400m
3.	Transmission facilities		
	a.	Booster pump station	1 No.
	b.	Intermediate reservoir	1 No.
	c.	Chlorinator	1 No.
	d.	Transmission main	13,000 m
4.	Distribution facilities		
	a.	Terminal reservoir	1 No.
	b.	Terminal pump station	1 No.
5.	Improvement of existing network		
	a.	Installation of supplementary sections to existing network	6,000 m

Annex-III

Japan's Grant Aid Scheme

1. Grant Aid Procedures

1) Japan's Grant Aid Program is executed through the following procedures.

Application	(Request made by a recipient country)
Study	(Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

2) Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the Project to see whether or not it is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the Project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Japanese Government. The contents of the Study are as follows:

a) Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for Project's implementation.

b) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

c) Confirmation of items agreed on by both parties concerning the basic concept of the Project.

d) Preparation of a basic design of the Project.

e) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consultant firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consultant firm(s) used for the Study is(are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchanges of Notes, in order to maintain technical consistency.

3. Japan's Grant Aid Scheme

1) Grant Aid

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc. are confirmed.

3) "The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and a final payment to them must be completed.

However in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year by mutual agreement between the two Governments.

4) Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However the prime contractors, namely, consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

5) Necessity of the "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

6) Undertakings required of the Government of the Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the following:

(1) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction.

(2) To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities in and around the sites.

(3) To secure buildings prior to the procurement in case the installation of the equipment.

(4) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid.

(5) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts.

(6) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(7) Proper Use

The recipient country is required to maintain and use facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

(8) Re-export

The products purchased under the Grand Aid should not be re-exported from the recipient country.

(9) Banking Arrangement (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an authorization to pay issued by the Government of the recipient country or its designated authority.

ANNEX-IV

Major Undertakings to be taken by Each Government

NO	Items	To be covered by Grant Aid	To be covered by Recipient side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To construct the parking lot	●	
5	To construct roads		●
1)	Within the site	●	
2)	Outside the site		●
6	To construct the building	●	
7	To provide facilities for the distribution of electricity and other incidental facilities		
1)	Electricity		
a.	The distributing line to the site		●
b.	The drop wiring and internal wiring within the site	●	
c.	The main circuit breaker and transformer	●	
2)	Furniture and Equipment		
a.	General furniture		●
b.	Project equipment	●	
8	To bear the following commissions to a bank of Japan for the banking		
1)	Advising commission of A/P		●
2)	Payment commission		●
9	To ensure prompt unloading and customs clearance at the port of		
1)	Marine(Air) transportation of the products from Japan to the recipient country	●	
2)	Tax exemption and customs clearance of the products at the port of disembarkation		●
3)	Internal transportation from the port of disembarkation to the project	●	
10	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract		●
12	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
13	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

Appendix5 Other Relevant Data/Information

Appendix 5-1	Geophysical survey
Appendix 5-2	Summary of Test Drilling/Aquifer Test
Appendix 5-3	Analysis of Step Drawdown Test
Appendix 5-4	Examination of Aquifer Coefficients
Appendix 5-5	Examination of Extent of Influence
Appendix 5-6	Examination of Influence by Existing Tubewells in the Chenab Wellfield
Appendix 5-7	Structure of WASA's Standard Monitoring Well
Appendix 5-8	Water Analysis of Site and by WASA Laboratory of Samples from Tubewells
Appendix 5-9	Comparison of Population Projections
Appendix 5-10	Amount of Water Production and Water Supply
Appendix 5-11	Study on Existing Distribution and Water Supply Facilities
Appendix 5-12	Comparison of pipeline network calculation
Appendix 5-13	Socio-economic Survey on 2nd Basic Design Study (1) and Activities after the completion of the survey
Appendix 5-14	Socio-economic Survey on 2nd Basic Design Study (2)
Appendix 5-15	WASA's Water Tariff

Appendix 5-1 Geophysical Survey

1) Outline of the Survey

The geophysical survey of the proposed wellfield and its vicinity was carried out in an area about 12km long and 3 km wide along the Jhang Branch Canal to examine the vertical and horizontal continuity of prospective aquifers that can provide information on design for screen length, basic drilling depth in the wellfield, etc..

The outline of the survey was as shown in the following table.

Table 1 Outline of Geophysical Survey

	Item	Description
1.	Period of field survey	Aug. 15 to Aug. 21, 2003
2.	Type of the survey	Surface electrical resistivity survey
3.	No. of resistivity stations	24 stations
4.	Method of the survey	Wenner 4-electrode configuration
5.	Depth of measurement	200m
6.	Layout of stations	a No. 1 track just beside the embankment of left bank (11 stations) b. No. 2 track one km south of No. 1 (9 stations) 3. No. 3 track about one km south of No. 2 (4 stations) (Refer to Fig. 2-2-1-8 for locations.)

(Refer to Fig. 2 for the locations of survey stations.)

2) Survey Results

After the field survey, the data analysis was made, based upon geological information from the records of drilling carried out in and around the survey area. For this study, the following data is available:

a. Lithology of the test well installed by Binnie & Partners at RD259
b. Lithology of the test well installed by REC at RD245
c. Lithology of the test well under this study at RD 245

The results of analysis are summarized as follows:

a. Unconsolidated deposits continue from surface down to 200m and seem to compose a single continued aquifer as a whole. According to the analysis, this aquifer is divided into 3 sections, each one separated with an interbed of clayey formations with relatively low permeability, as follows:

* First section up to 30 m in depth
*Second section up to 76 to 140 m in depth
*Third section up to 170 m in depth

b. The main aquifer is the second section. Although it varies slightly in depth along the track from upstream to downstream, it is uniformly distributed through the area, showing the highest values of resistivity.

c. The occurrence of the third section seems to depend upon the location. Some stations lack this section. For the construction of production wells, it is planned to confirm it with the geophysical survey at the very points where they are to be drilled.

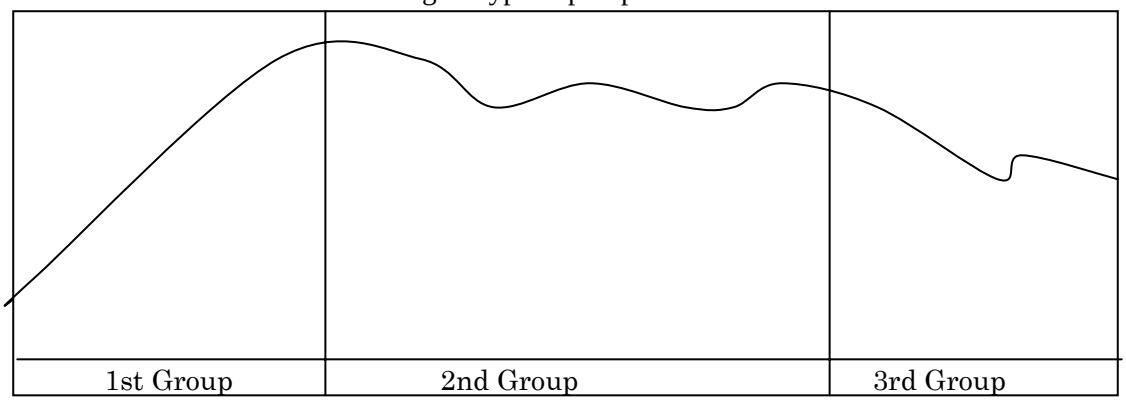
d. The horizontal relation of the second and the sections are confirmed through the analysis. Therefore, drilling depth is recommended to be the average of 150 and 170m, namely 160m.

e. The first section is composed of recent deposits of mainly sand where unconfined groundwater flows through. Irrigation tubewells tap this section, with a part of them further reaching the upper horizon of the second section.

f. The second and the third sections are interpreted to consist of Pleistocene alluvium of fine to medium sand. Each of the aquifers can further be subdivided into 3 to 4 layers from clayey materials to sand. Those showing high resistivity is sand, while those with low one is clayey materials.

The plotted curves of 24 stations are attached herewith, together with a sectional correlation of layers at the 11 stations along the first measurement line. All of the plots show similar trends in the pattern of their curves, indicating similar hydrogeological characteristics of the subsurface conditions along the measurement line. The typical trends of the plotted curves are shown in Fig. 1.

Fig. 1 Typical plot pattern



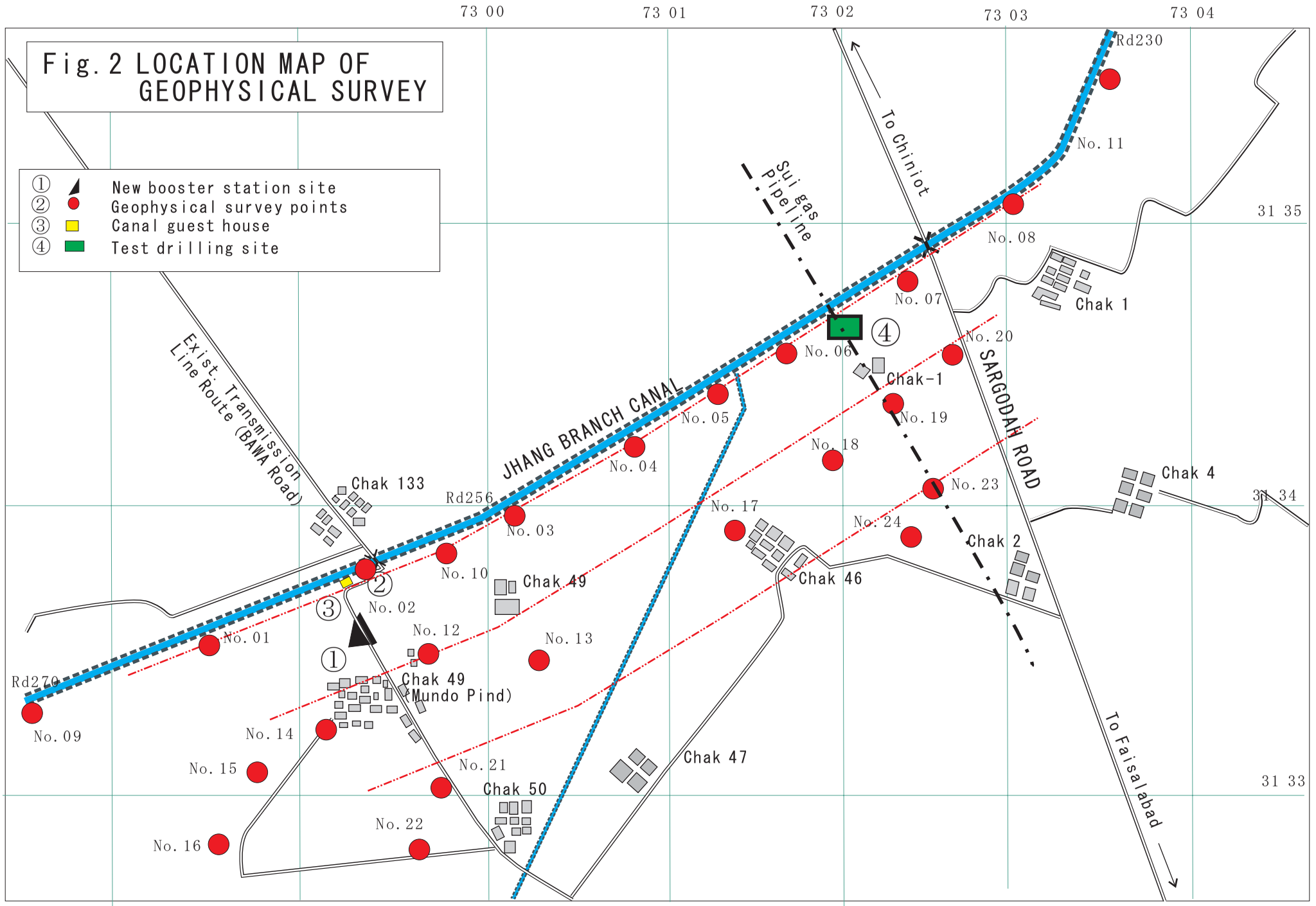


Fig. 2 LOCATION MAP OF GEOPHYSICAL SURVEY
① New booster station site
② Geophysical survey points
③ Canal guest house
④ Test drilling site
73 00
73 01
73 02
73 03
73 04
31 35
31 34
31 33
Rd230
Rd256
Rd270
To Chiniot
To Faisalabad
Sui gas Pipeline
Exist. Transmission Line Route (BAWA Road)
JHANG BRANCH CANAL
SARGODAH ROAD
No. 01
No. 02
No. 03
No. 04
No. 05
No. 06
No. 07
No. 08
No. 09
No. 10
No. 11
No. 12
No. 13
No. 14
No. 15
No. 16
No. 17
No. 18
No. 19
No. 20
No. 21
No. 22
No. 23
No. 24
Chak 133
Chak 49
Chak 49 (Mundo Pind)
Chak 46
Chak 47
Chak 50
Chak 1
Chak-1
Chak 2
Chak 4

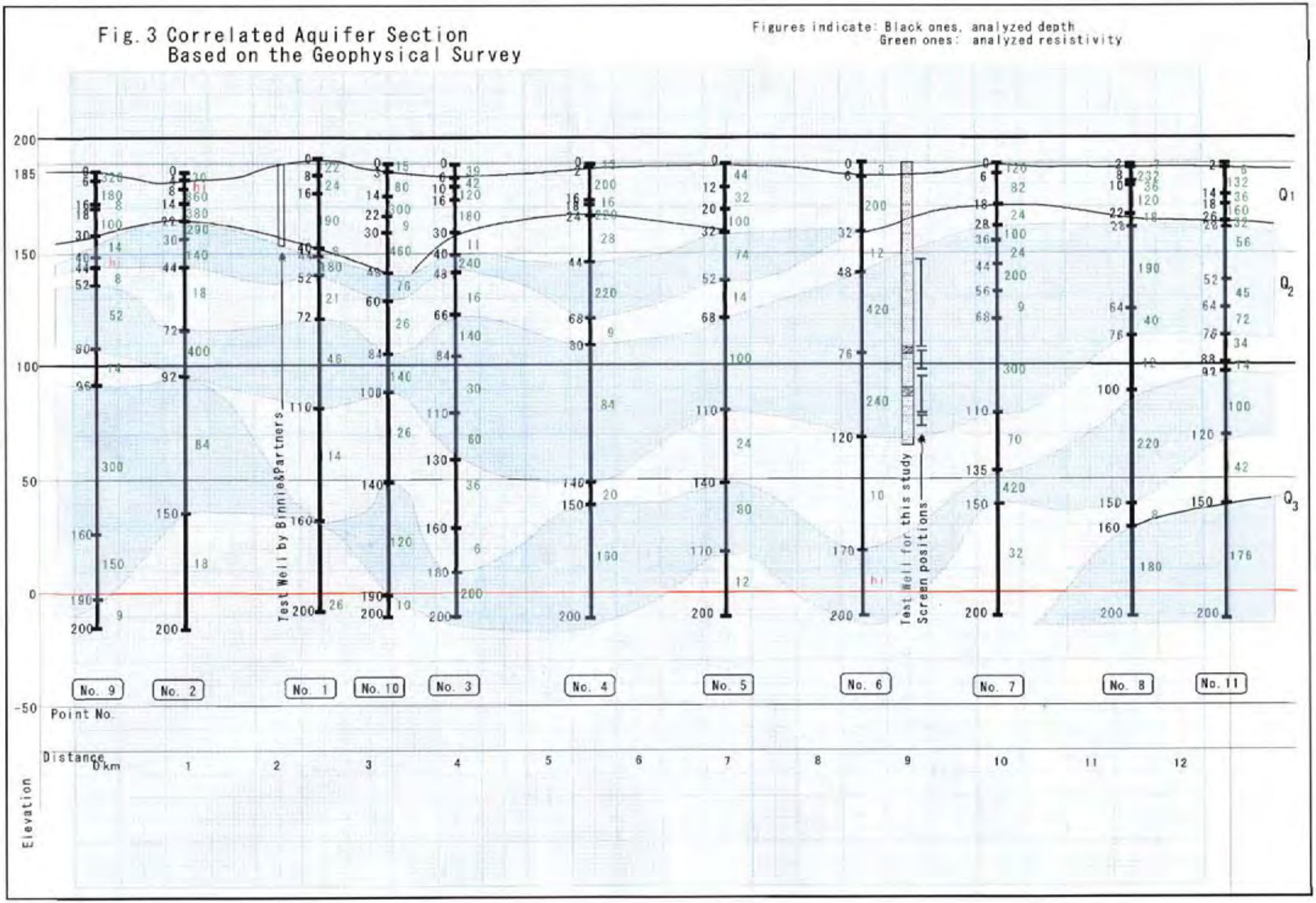


Fig. 3 Correlated Aquifer Section
Based on the Geophysical Survey
Figures indicate: Black ones, analyzed depth
Green ones: analyzed resistivity
Test Well by Binnie&Partners
Test Well for this study
Screen positions
Q1
Q2
Q3
No. 9
No. 2
No. 1
No. 10
No. 3
No. 4
No. 5
No. 6
No. 7
No. 8
No. 11
Point No.
Distance
0km
1
2
3
4
5
6
7
8
9
10
11
12
Elevation
200
185
150
100
50
0
-50

Appendix 5-2 Summary of Test Drilling/Aquifer Test

(1) Test Drilling Program

1) Components of the test drilling program

Test drilling in the second stage of this study consisted of the following works:

Table 1 Components of Test Drilling for the Study

	Test holes	Q'ty	Specification	Pumping test
1	Test well	1	Depth :150m Hole dia. 24" Casing: steel pipe, 20" and 10" Screen:slotted pipe of brass, 10"	a. Step Drawdown test b. Time drawdown test at a constant discharge rate (48hrs) c. Recovery test
2	Observation well	2	Depth: 120m Casing, screen: PVC make	d. Interference test (Simultaneous measurements of drawdown at observation wells)

2) Test drilling site

a. Prior to the commencement of test drilling, WASA took steps to carry out a pumping test with its own fund at an existing test well installed at RD260 by Binnie & Partners in 1970s. The drilled depth of the well is 40, tapping only the upper part of the aquifer. The test results showed it has a similar capacity as irrigation wells, discharging about 1 cusec.

b. The existing well tested by WASA was located in the downstream section of the canal. For this study, therefore, a site in the middle section of the canal was chosen near RD246, where existed another test well installed by REC in 1980s and later closed with sand. This time WASA provided assistance in this program, installing three observation wells at the site. The section of the canal around the site had a wide space of public land, adequate enough for an extensive operation of the testing program.

c. The layout of a test well, and 5 observation wells at the site is referred to in the map of Fig. 2-2 in the main report.

3) Summary of drilling work

The drilling work for the installation of the test well and observation wells showed the following geological features of the wellfield.

a. At the drilling site of the test well, formations composing the main aquifer lie below 40m, featuring alternate beds of medium and fine sand, which corresponds to the second section of the aquifer identified as a result of the geophysical survey.

b. However, the site lacks the third section at the lower section than 120m, where clay and silt is predominant. Accordingly the test well was completed with casing and screen to a depth of 130m.

c. Lithology of the test well is shown in Fig. 2-3 in the main report

(2) Aquifer Test

After the drilling work was completed, the aquifer test consisting of a series of pumping tests was conducted, involving the test well and 5 observation wells. The summary of testing is as follows:

1) Step drawdown test

This test examined the safe yield and the well efficiency of the drilled test well. The test used four different discharge rates (steps) for examining the drawdown at the respective rates as follows:

First step	1.50 cusec
Second step	2.25 cusec
Third step	3.09 cusec
Fourth step	3.75 cusec

As a result of the test, the highest rate is still in the range of safe yield. The capacity of the test well is in the same level or more than those of the existing wells in the Chenab wellfield discharging 4 cusec/well.

2) Time drawdown test

a. The time drawdown test (or "sustained yield test") was carried out at a constant discharge rate of 3.0 cusec for 48 straight hours. While pumping continued, drawdown at the respective observation wells was monitored through the simultaneous measurements of their levels. With a static water level at 5.3m, the drawdown after 48 hours of pumping was 2.5m at the test well.

b. The test showed a remarkable performance of recharge from the nearby canal during the test, with the level at the well stabilizing in about 360 minutes after pumping started. After this time, the well kept the same level until pumping is stopped. That means recharge from the canal equaled to the rate of discharge, 3 cusec as long as pumping continued.

c. As a result of the time drawdown test, the two key factors related to the functions of aquifers, "T"=*coefficient of transmissibility* and "S"=*coefficient of storage*, were calculated to estimate various performances of proposed tubewells and to predict on their influence to the vicinity of the wellfield. The sizes of T and S thus obtained turned out to stand in a similar range as those calculated in the previous studies. Hydraulic calculation in this report employed the factors from the latest test, referring to those in the previous tests.

3) Time recovery test

The time recovery test followed the time drawdown test, with the measurements of water level starting just after the pump is stopped. The measurements of the recovery of level were simultaneously made at the test well and 5 observation wells until their levels returned just or near to the initial ones. "T" and "S" were calculated from the test results in a similar manner as those of the time drawdown test.

4) Water analysis

Samples were taken from the test well at the end of the time drawdown test for analysis by WASA Laboratory, which resulted in an acceptable quality of a TDS concentration of 480 mg/lit. On the left side of the Jhang Branch Canal, however, the quality of groundwater tends to worsen towards the city and WASA set the upper limit of TDS concentration up to 1,000 for tubewells in this area. Since the tubewells are to be installed just beside the left bank of the canal, the better quality is likely to be ensured, thanks to seepage from the canal, as WASA experienced in the wellfield along the Rakh Branch Canal within the city.

Appendix 5-3 Analysis of Step Drawdown Test

1. Purpose of step drawdown test

Step drawdown test was conducted in this study as a part of aquifer test for various purposes. In this test the pumping rate is stepped up successively and drawdown for each step is recorded.

Its purposes are focuses on the following:

(a) to define the most appropriate pumping rate

(b) to calculate head loss of groundwater when it moves from an aquifer towards the well (called "*aquifer loss"*: "*B*") and another loss when water is pumped through the well screen (called "*well loss*" "*C*"). The sum of the well loss and the aquifer loss is drawdown of the well.

(c) to determine the well efficiency "*E*" (the ratio between aquifer loss and well loss at a certain pumping rate. If 2 sets of values of "E" at different periods are compared, it is possible to quantify and evaluate the degradation of well capacity.)

B, C and E are the indices of the tubewells as follows:

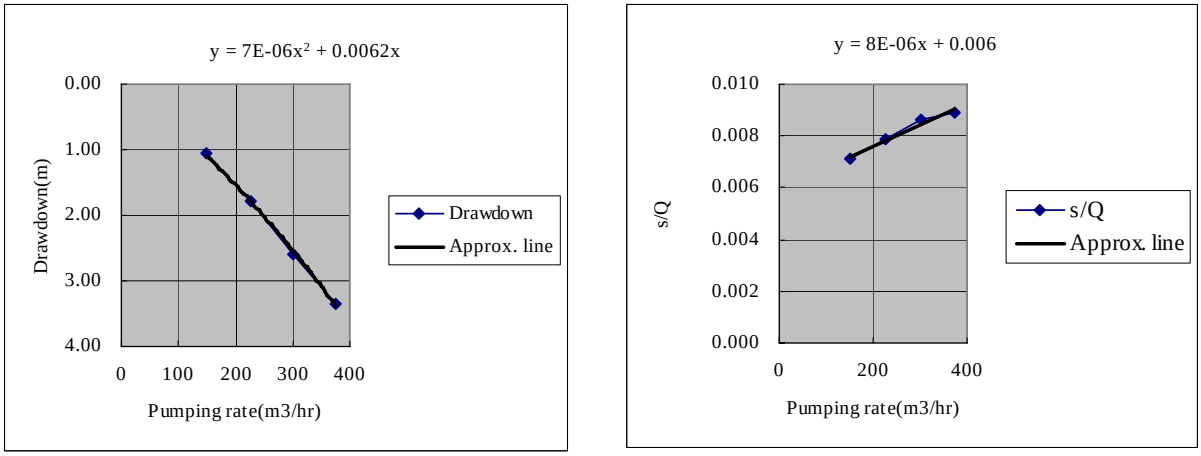
- if B is increasing the loss of the aquifer is increasing
- if C is increasing the loss of the well is increasing
- through the comparison of the ratio C/B, it is possible to evaluate which loss is increasing
- by comparing E, it would be possible to find out how much the efficiency has changed
- larger E indicates better well efficiency

1-1 Analysis of the relationship between pumping rate and drawdown

(1) Evaluation of optimum pumping rate

From the results of the step drawdown test of this survey, the graphs showing the relationship between the pumping rates (steps) and drawdown, and the relationship between the pumping rates and the reciprocal of specific capacity are plotted in Fig. 1.

Fig. 1 Analysis of Step Drawdown Test



In this test the maximum pumping rate was set at 3.7cusec. The analysis showed the change in the pumping rate produced little change in the specific capacity, resulting in the same range of aquifer loss, even in this maximum pumping rate. It indicates the maximum rate is still within a range of safe yield.

(2) Calculation of aquifer loss (B) and well loss (C)

The relationship between B and C is given as below:

$s = BQ + CQ^2$

where

s = drawdown level (measured value)

Q= pumping rate (measured value)

B= aquifer loss coefficient (BQ = aquifer loss)

C= well loss coefficient (CQ^2= well loss)

The results of the calculation are listed in the following table:

Table 1 Coefficient of Losses in the Test Well

Coefficient	unit	Primary approximation
B	hr/m^2	0.0059
C	hr^2/m^5	9.00E-06
C/B	$1/m^3$	1.53E-03

- From the results of the calculations of B and C, it turned out that drawdown was mainly caused by aquifer loss. The drawdown occurs in proportion to the increase of the pumping rate. The limit of the rate is around $600m^3$, and if the pumping rate goes over this volume, drawdown caused by the well loss dramatically increases.
- At a pumping rate of $200m^3$/hr, proposed for the project, aquifer loss is 1.18m and well loss is 0.36m, meaning that the drawdown will be approximately 1.5m. The reason why the drawdown is small even if the pumping rate is great is that the ability of the aquifer is excellent.

1-2 Calculation of well efficiency E

Well efficiency is calculated from B and C, and by comparing with the data of the existing wells in the Chenab wellfield, the performance of the planned tubewells can be evaluated.

From the formulation E=1/ ［1+(C/B)*Q)］, well efficiency at each pumping rate is calculated in the following table

Table 2 Well efficiency of the test well

Pumping rate	Well efficiency E
m^3/hr	E=1/［1+(C/B)*Q)］
0	
150	0.84
225	0.77
300	0.72
375	0.67

In the study area around the planned wellfield, there are existing tubewells such as those of the ADB project with a similar structure to the planned wells, drilled to the depth targeted by this project as well. So the well efficiencies of those wells are compared for analysis as follows:

(1) Comparison of the Sepcification of the Tubewell

Table 3 Comparison of the structure of the test well and existing well

	unit	This survey	ADB 18	ADB 23	NSC
Well depth	m	120	128	the same as No.18	95
Screen material		Brass	Johnson	Johnson	Unknown
Screen length	m	60	48.7	the same as No.18	50
Screen opening area	%	6	15 (not verified)	the same as No.18	12
Slot size	mm	1	1 (not verified)	the same as No.18	1.5

(2) Comparison of Coefficients of Loss

Aquifer loss and well efficiency of the test well and the existing wells are compared in the table below.

Table 4 Comparison of Loss Coefficients

	unit	This study	ADB 18	ADB 23	NSC
B	hr/m^3	0.0059	0.0114	0.0116	0.0095
C	hr^2/m^5	9.00E-06	2.00E-06	1.00E-06	4.00E-06
C/B	$1/m^3$	1.53E-03	1.75E-04	8.62E-05	4.21E-04

Table 5 Comparison of well efficiency (E)

This study		ADB 18		ADB 23		NSC	
pumping rate	This study	pumping rate	ADB11	pumping rate	ADB11	pumping rate	NSC
m^3/hr	E	m^3/hr	E	m^3/hr	E	m^3/hr	E
0		0		0		225	0.88
150	0.84	300	0.95	300	0.95	306	0.86
225	0.77	400	0.93	400	0.93	356	0.84
300	0.72	500	0.92	500	0.92	397	0.82
375	0.67	600	0.90	600	0.90	459	0.80

- The aquifer loss coefficient of the test well is a half (1/2) of ADB No.18 / 23 wells, and two thirds (2/3) of the NSC well.
- On the other hand, the well loss coefficient of the test well is four times to that of ADB No.18/23 wells and a half of the NSC well.

As a result of the analysis of step drawdown test, the capacity of the planned tubewells along the Jhang Branch Canal is estimated as follows:

- The aquifer around the Jhang Branch Canal is better in performance than that in the Chenab wellfield.

- The test well was installed with screens of brass make with 6 % of open area, The tubewells for the ADB project used wire-wound type stainless steel screen with around 20% of open area and NSC had screens with 12 % of open area. The percentage of open area is proportional to well efficiency.
- Taking the above analysis into account, wired type screen is planned for the well screen in this project. However, it must be noted that well loss coefficient depends on the penetration ratio against the whole thickness of the aquifer, in addition to percentage of the open area. Since the wire-wound type stainless steel screen having enough length will be expensive, so economic factors must be taken into account for final determination.

Appendix 5-4 Examination of Aquifer Coefficients

(1) AQUIFER TEST

The aquifer test in this study consisted of step drawdown test (Appendix 5-5) , time drawdown test followed by time recovery test for estimating the characteristics of the aquifer through hydraulic calculation, employing the coefficients of aquifer, “T” and “S” deriving from the analysis of the results of the latter two tests. These tests were carried out, involving one test well (completed depth, 120m) and 2 observation wells (120m), together with 3 observation wells (18.5m) provided by WASA.
The summary of time drawdown test and time recovery test was as follows:

Table 1 Summary of Aquifer Test

Well for testing	Time drawdown test	Time recovery test
	The test well was pumped at a constant rate of 300m^3/min for 48 consecutive hours (2,880 minutes)	It followed time draw test immediately after the pump was stopped. Duration of test was 720 minutes.
1. Test well	Continuous measurements of discharge and water level	The level recovered to its static water level in 360 minutes after the pump was stopped.
2. Observation well No. 1	Continuous measurements of water level	Residual drawdown was 0.0254m in 720 minutes.
3. Observation well No. 2	Continuous measurements of water level	Recovered to its initial water level in 720 minutes
4. Observation well No. 3	Continuous measurements of water level	Recovered to its initial water level in 720 minutes
5. Observation well No. 4	Continuous measurements of water level	Recovered to its initial water level in 720 minutes
6. Observation well No. 5	Continuous measurements of water level	Residual drawdown was 0.0254m in 720 minutes

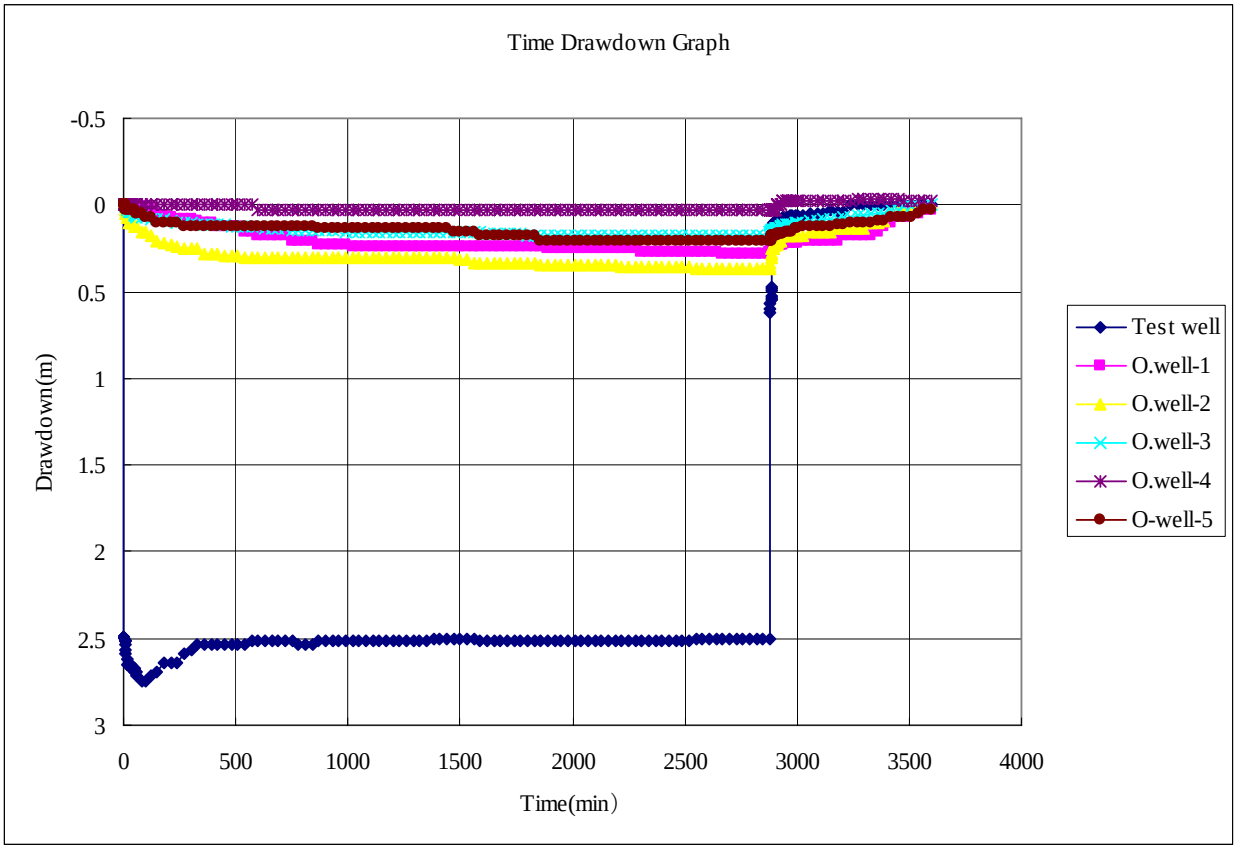
(2) Summary of Test Results

The results of the tests at five wells, relation of time to drawdown, are plotted in Fig. 1.
The specific features of the test results were as follows.

a. The pumping (dynamic) water level at the test well stabilized in 100 minutes after pumping started. Thereafter no further lowering of the water level occurred.

Static Water level	5.334m
Stabilized level	7.8486m
Drawdown	2.50m

Fig. 1 Time drawdown graph



The dynamic water level at the test well was stabilized at a depth of 7.8486 with drawdown of 2.50m. The same level was maintained thereafter until the end of pumping in 2,880 minutes. It indicates that soon after the pumping started, the forced recharge from the canal began as the enlarged cone of influence encountered the source of recharge.

b. The same characteristics were witnessed at the observation wells, notably in No. 1 and No. 2 installed beside the channel of the canal.

c. Such a recharged condition encountered during the test made it difficult to analyze the obtained data. The following data, however, are considered useful for hydraulic analysis.

* Data on the relation ship of time and drawdown at each well before they received recharge, namely test data from the start of pumping to 100 minutes of continuous pumping (However, since the data from a single well was found irrelevant for analysis, the time-distance relationship of 5 wells was employed

* Data of recovery test at the observation wells, No. 2 and No. 3 (Those of the test well and other observation wells were found out irrelevant, with their hydraulic analysis yielding unpractical results.)

d. Since the remarkable effect of recharge affected a greater part of the test results, the hydraulic calculation in this study refers to the results of the past studies, particularly those by REC, carried out in 1980 at the same location along the canal. (The test well was installed just beside the REC's test well, now abandoned due to clogging by sand deposits inside.)

(3) Calculation of Aquifer Coefficients

Based upon the selected data and method as explained in the foregoing section, the coefficients of an aquifer, "T", Coefficient of Transmissibility, and "S", Coefficient of Storage, were calculated.

a. Coefficient of Transmissibility

Coefficient of Transmissibility, T, of an aquifer indicates how much water will move through the formation. It is the rate at which water will flow through a unit vertical section of the aquifer and extending through the full saturated thickness under a hydraulic gradient of 1.00. It equals the *coefficient of permeability, K*, multiplied by the thickness of an aquifer. In this study, the Jacob-Cooper method was employed for the calculation of "T" and "S". The unit is generally m^2/day.

$$T = \frac{0.183Q}{\triangle s} \qquad (1)$$

where,

Q = Discharge (m^3/day)

$\triangle s$= Slope of the time-drawdown graph expressed as the change in drawdown between any two values of time on the log scale whose ratio is 0. (m)

b. Coefficient of Storage, S, of an aquifer indicates how much water can be moved by pumping through a unit cross section of an aquifer.

$$S = \frac{2.25Tt_0}{r^2} \qquad (2)$$

where,

T = Coefficient of transmissibility, from equation (1) (m^2/day)

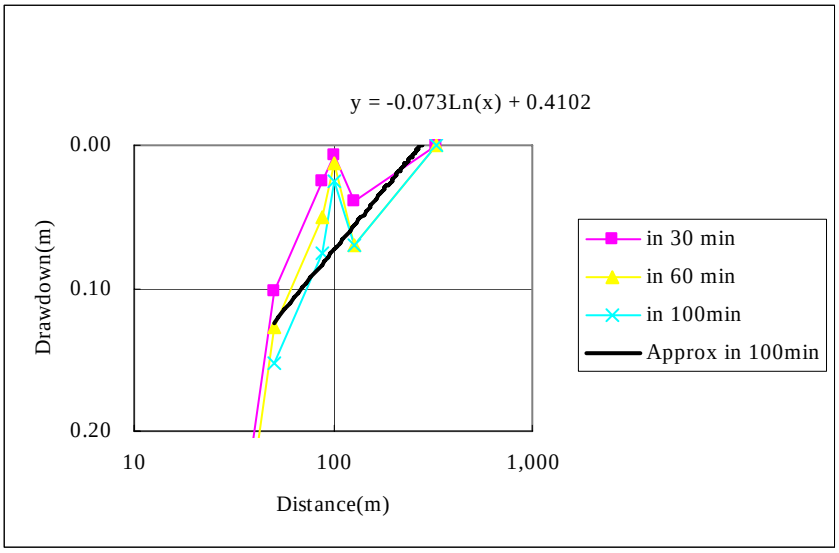
t_0 = Intercept of the straight line at zero drawdown (day)

r^2 = Distance from pumped well to observation well where drawdown measurements were made (m)

1) Calculation –I, based upon the relationship of the test well and the observation wells during time drawdown test

Case I-1: Calculation based upon the distance-drawdown relationship among 5 observation wells, excluding the test well, employing the data for 100 minutes after the pump started, while the influence of recharge remained inconspicuous.

Fig. 2 Approximate Relationship of Drawdown versus Distances of Observation Wells



Through the graphical analysis, the relationship of distances of the observation wells with drawdown is approximated into an equation (slope), y=0.073Ln(x) +0.4102. From this equation, drawdown per a unit log cycle of time is calculated as ⊿s=0.168 m.

As a next step, the calculation of "T" employs the following equation derived from the previous basic equation (1) as follows:

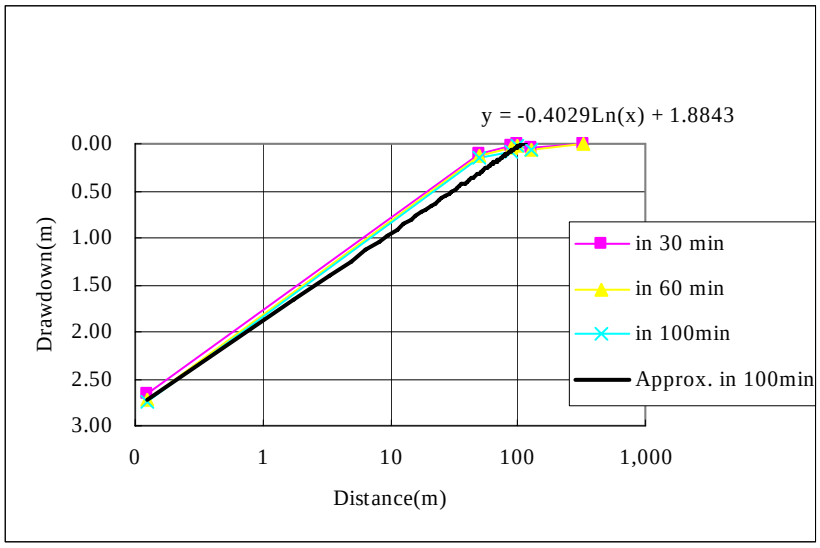
$$T = \frac{0.366Q}{\Delta s} = \frac{0.366 \times 7{,}200\ m3/day}{0.168} = 15{,}686\ m2/day = 654\ m2/hr$$

The calculation of "S" is as follows, based upon the equation (2).

$$S = \frac{2.25xTx\ t}{r_0\hat{}2} = \frac{2.25 \times 15{,}686\ m2/day \times 6.94E\text{-}02\ day}{276\ \hat{}\ 2} = 3.22E\text{-}02$$

2). Calculation –II: Calculation based upon the data at 5 observation wells plus the test well

Fig. 3 Approximate Relation ship of Distances and Drawdown
of Test Well/Observation (Data from the start of pumping to 100 min.)



The same process as for the Calculation-I is applied.

*Approximate relationship of the distances of 1 test well and 5 observation wells and drawdown is :
y = - 0.4029Ln(x) +1.8843

* ⊿s = 2.30 x 0.4029 = 0.928 m

Therefore,

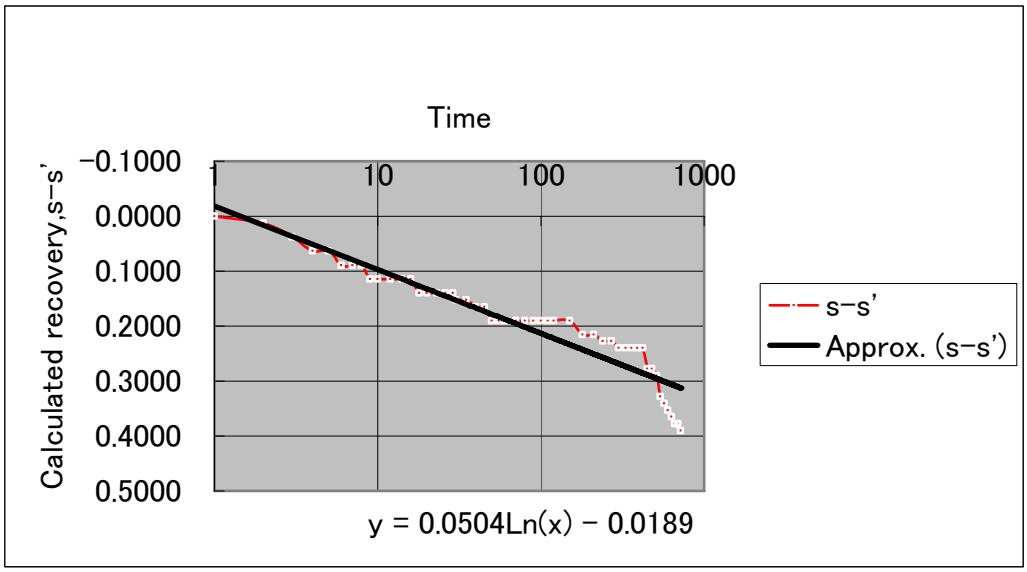
$$T = \frac{0.366Q}{\Delta s} = \frac{0.366 \times 7,200\ m^3/day}{0.928} = 2,840\ m^2/day = 118\ m^2/hr$$

$$S = \frac{2.25xTx\ t_0}{r^{\wedge 2}} = \frac{2.25 \times 2,840\ m^2/day \times 6.94E\text{-}02\ day}{107^{\wedge 2}} = 3.88E\text{-}02$$

3) Calculation-III, based upon the data of recovery test at observation well No. 2

The time-recovery relationship at the observation well No. 2 is plotted in Fig. 4. For the calculation of the coefficients based upon this relation, the calculated drawdown instead of residual drawdown was used. The vertical axis indicates this calculated drawdown (s=extended drawdown assuming pumping continued after it was stopped) – (s'=Residual drawdown)..

Fig. 4　Time Recovery Graph of Observation Well No.2



From the time recovery graph,

*Approximate relationship　(s-s')=0.0504Ln(t) - 0.0189

*Drawdown per a unit log time cycle　⊿(s-s')=0.1008m、

*Intercept of the line at zero drawdown

t^0=1.038212min=7.2E-04day

*Distance between the test well and the observation well No. 2

r = 50m

*Discharge at the test well　Q=300m^3/hr=7,200m^3/day

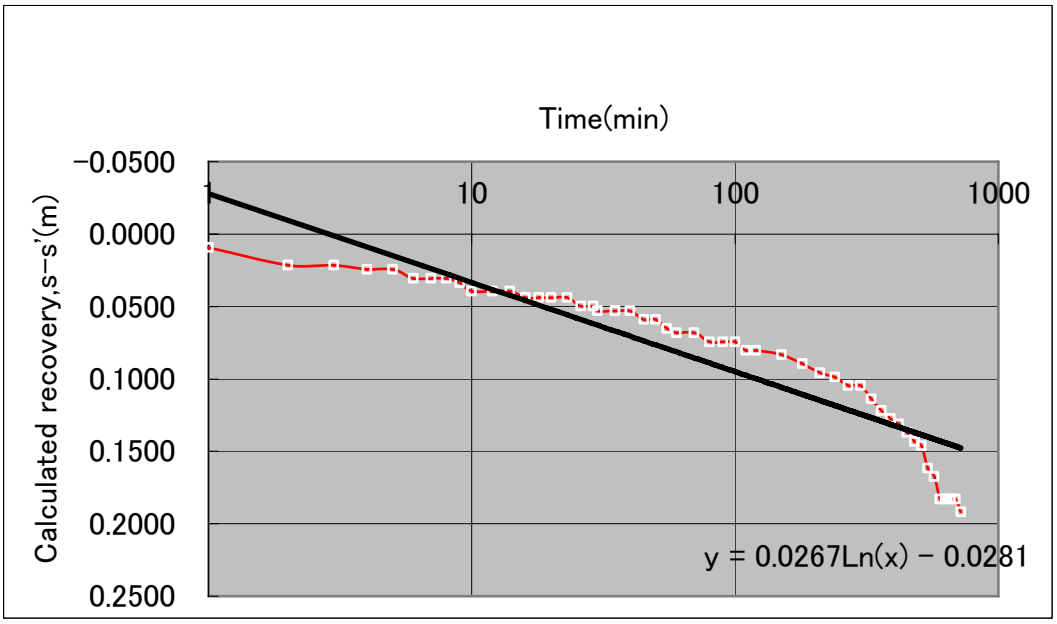
The following equation is used for the calculation of “T” and “S”.

$$T = \frac{0.183Q}{\Delta(s-s')} = \frac{0.183 \times 7,200\ m^3/day}{0.1008} = 13,071\ m^2/day = 545\ m^2/hr$$

$$S = \frac{2.25xTx\ t_0}{r^{\wedge 2}} = \frac{2.25 \times 13,071\ m^2/day \times 7.20E\text{-}04\ day}{50^{\wedge 2}} = 8.47E\text{-}03$$

4) Calculation IV: based upon the data of recovery test at observation well No. 3

Fig. 5 Time Recovery Graph of Observation Well No.3



From the graph in Fig. 5

* Approximate relationship (s-s')=0.0267Ln(t) - 0.0281
* Drawdown per a unit log time cycle ⊿(s-s')=0.0534m、
* Intercept of the line at zero drawdown t^0=2.865min=2.0E-03days
* Distance between the test well and the observation well No. 3 r = 89m
* Discharge at the test well Q=300m^3/hr=7,200m^3/day

The calculation of "T" and "S" is as follows:

$$T = \frac{0.183Q}{\Delta(s-s')} = \frac{0.183 \times 7,200\ m^3/day}{0.0534} = 24,674\ m^2/day = 1,028\ m^2/hr$$

$$S = \frac{2.25xTx\ t_0}{r^2} = \frac{2.25 \times 24,674\ m^2/day \times 2.00E-03\ day}{89^2} = 1.40E-02$$

(4) Results

The results of the foregoing calculations are shown in the following table, together with the data obtained in the studies in the past, REC's study in 1980 and drilling reports of the ADB project wells.

Table 2 List of Coefficients of Aquifer in the Study Area

Test wells	Method for calculation	Coefficient of Transmissibility, "T" (m^2/day)	Coefficient of Storage "S" (non dimensional)
This study (one test well & 5 observation wells)	*Distance-drawdown analysis(1) of 5 observation wells	15,686	3.22E－0.2
	*Distance-drawdown analysis(2) of one test well/5 observation wells	2,840	3.88E－0.2
	*Recovery method (No. 2 well)	13,071	8.47E－0.3
	*Recovery method (No. 3 well)	24,674	1.40E－0.2
Study by REC	*Recovery method (RTW1 well)	5,312	2.50E－0.2
	*Recovery method (RTW2 well)	7,080	1.27E－0.2
ADB tubewells in the Chenab	*Pumping test (No. 18 well)	11,094	
	*Recovery method (No. 18 well)	9,861	

Note: The data for the ADB tubewells is from the report of completion of drilling works. The coefficient of storage is not calculated. The report shows that an average value of "T" from the pumping tests at 23 tubewells was 12,000m^3 /day.

With the coefficients of the aquifer calculated on the basis of the test in this study, the following points should be taken into due consideration.

a. All of the wells for testing in this study were installed in the site close to the canal channel. The water levels were more or less affected by rapid recharge from the canal. Accordingly, the results of the calculation may involve the influence of recharge, although the data was selected, and their accuracy appears limited to a certain extent.

b. Although the results of the calculation may not honestly represent the characteristics of the aquifer, the values of "T" and "S" are still within a tolerable range, compared to those presented by the past studies.

c. Storage coefficients, which are in the order to the minus 1 st to minus 2nd power of 10, generally indicate the characteristics of an unconfined aquifer, while smaller numbers in the order to the power of the minus 3rd power of 10 are interpreted to mean confined aquifers. Except for the case of No. 3 observation wells, all the calculated values of "S" indicate the aquifer in the study area is classified as unconfined one.

As a result of extensive hydrogeological studies in the study area, it is known that the aquifer there is basically of unconfined nature. The test well tapped the aquifer deeper than 40m underlying beneath an impervious silty bed. It is partly or locally in confined condition, and deeper groundwater may feature a flow pattern differing from the one of shallow groundwater under command of canal recharge. In this view, the aquifer in this area partly bears a nature of semi-confined formations.

Appendix 5-5 Examination of Extent of Influence

The extent of influence by pumping at the planned tubewells is examined, employing the values of "T" and "S" in this section.

(1) Equation for the Calculation

The equation for the calculation of the radius of influence is derived from that for "S", Storage Coefficient.

$$S = \frac{2.25xTx\ t}{r_0\hat{}2}$$

where,
S= calculated value of storage coefficient
T=calculated value of transmission coefficient (m^2/day)
t= Duration of pumping (day)
r_0= Radius of influence (m)

The foregoing equation is modified in the following relationship:

$$r_0 = SQRT \frac{2.25xTx\ t}{S} \qquad (3)$$

(2) Calculation of Radius of Influence

The radius of influence (r_0) is calculated, based upon the equation (3), assuming the following conditions:

*T and S	various values of "T" and "S" calculated in Appendix 4-7
*Q=discharge	the unit rate of discharge of the project wells =200 m^3/hr=7,200m^3/day
*Duration of pumping	20 hours a day in accordance with the plan for the project (However, since a part of values employed the data from the start of pumping to 100 minutes, r_0 in 100 minutes was also calculated for reference.

The results of the calculation are listed in the following table.

Table 1 Calculated Radius of Influence

(Discharge =200m^3/hr、Pumping duration=20hrs/day)

Origin of "T" & "S"	Method of Calculation of T and S	T (m^2/day)	S	Radius of influence (m)	
				in 100	in 20 hrs
This Study: Test well and observation wells	Distance-drawdown method (1), observation wells only	15,686	3.22E-02	277	954
	Distance-drawdown method (2)test and observation wells	2,840	3.88E-02	65	369
	Time-recovery method (Observation well No. 2)	13.071	8.47E-03	299	1,697
	Time-recovery method (Observation well No. 3)	24,674	1.40E-02	320	1,813
REC's Study test well RTW1	Time recovery method	5,312	2.50E-02	111	630
RTW2	Time recovery method	7,080	1.27E-01	56	323

As a result of the calculation in Table 1, the following situation can be estimated:

a. This study proposes 600m for the distances of the respective tubewells. If a radius of influence is less than 300m, half of 600m, the interference of neighboring tubewells will not occur. According to the calculation, all the radii extend beyond this limit at the end of pumping for 20 hours, ranging from a minimum 323 to a maximum 1,813m

b. However, during the test, the water levels at test well and observation were stabilized in about 100 minutes after the start of pumping due to direct recharge from the canal, and they remained at the same depth until the end of pumping for 48 hours. This means the test well received recharge equaling to discharge, and its effect extended to the observation wells. It suggests that the radius of influence of pumping at the respective wells no more enlarges.

Compared to the radii of influence in 20-hour pumping, those in 100 min are all within 300m with one exception slightly over 300m. Therefore, it is highly possible that the radius of influence can remain within 300 m for a duration of pumping for 20 hours at a rate of 200m^3/hr, with no interference occurring among the neighboring wells..

c. On the other hand, the canals are all closed during the winter season for about one month for their maintenance and repair. There is no recharge during this season, and the first calculation becomes realistic.

Since the closure of canals continues one month, the extent of influence of pumping at the project wells were estimated, employing the same conditions as for the preceding calculation.

Table 2 Extent of Radius Influence during Canal Closure

Origin of "T" & "S"	Method of Calculation of T and S	T (m^2/day)	S	Radius in 30 days(m)
This Study: Test well and observation wells	Distance-drawdown method (1), observation wells only	15,686	3.22E-02	5,736
	Distance-drawdown method (2)test and observation wells	2,840	3.88E-02	2,437
	Time-recovery method (Observation well No. 2)	13.071	8.47E-03	4,914
	Time-recovery method (Observation well No. 3)	24,674	1.40E-02	6,708
REC's Study test well RTW1	Time recovery method	5,312	2.50E-02	3,337
RTW2	Time recovery method	7,080	1.27E-01	3,852

As a result, it is estimated that before the canals restart delivery, the radius of influence enlarges as far as 4.5 km from the wellfield as an average of the calculation results, causing the lowering of regional groundwater level. The amount of lowering in this case is examined in the following section.

(3) Lowering of Groundwater Level during Canal Closure

For the purpose of predicting the lowering of water levels related to distances, the previous approximation of their relationship presented in Fig. 3 in Appendix 5-6 is used. (the distance-drawdown relationship based upon the test well and observation wells)

The equation is as follows:

$$s = -0.4029 \times \mathrm{Ln}(r) + 1.8843 \qquad (4)$$

where

s = drawdown (m)

r = distance from test well (m)

Since the approximation was based upon a discharge rate of 300$m^{3/}$hr, the equation is modified to adapt to a situation at a discharge of 200$m^{3/}$hr, as follows:

* Unit discharge rate 200$m^{3/}$hr
* Duration of daily operation 20 hours
* Daily discharge per well 4,000$m^{3/}$day
* Ratio of planned discharge to testing discharge =4,000/7,200 =0.556

Under these conditions, the slope of the approximation is modified as follows:

$$s = -(0.4029 \times 0.556) \times Ln(r) + 1.8843 = -0.224Ln(r) + 1.8843 \quad (4)'$$

The equation (4)' is expressed in a simple form as follows:

$$s = A \times Ln(r) + C \quad (5)$$

For the calculation, the following conditions are assumed:

* In the radius of influence, drawdown =0m S0 (m)
  distance from pumped well to S0r0 (m)
* In the radius of influence, drawdown=1m S1 (m)
  distance from pumped well to S1r1 (m)

(Drawdown of 1m is assumed for the calculation, since that amount of drawdown is the critical range for many irrigation tubewells.)

From the equation (5), therefore,

$s_0 = A \times Ln(r_0) + C$

$s_1 = A \times Ln(r_1) + C$

Combining the two equation,

$s_1 - s_1 = A \times Ln(r_1) - A \times Ln(r_0) = A \times Ln(r_1/r_0)$

Therefore,

$r_1 = r_0 \times EXP(s_1 - s_0/A) \quad (6)$

The equation (6) thus derived is employed for the calculation of estimated drawdown related to the distance. As a specific condition for the calculation in this study, the drawdown is assumed as 1m. The results of the calculation are shown in the following table:

Table 3　Radius of Influence of Pumping at a Project Tubewell and Predicted Drawdown In the Surroundings in One Month after Canal Closure

(Unit discharge rate =200m^3/day/well、20-hour operation/day)

	Method of calculation T & S	T (m^2/day)	S	Radius of influence (m)			
				Drawdown			
				0m	0.25m	0.5m	1.0m
This study	Distance-drawdown method (1), 5 observation wells	15,686	3.22E-02	5,736	1.879	615	66
	Distance-drawdown method(2): test and observation wells	2,840	3.88E-02	2,437	727	238	26
	Time-recovery method (Observation well, No. 2)	11.520	7.47E-03	4,914	3,343	1.095	118
	Time-recovery method (Observation well, No. 3)	21,466	1.22E-02	6,708	3.573	1,170	126
REC-	Time recovery method (RTW1 well)	5,312	2.50E-02	3,337	1,240	406	44
	Time recovery method (RTW1 well)	7,080	1.27E-01	3,852	635	208	22

To predict the influence of pumping during the closure of canals based upon the results of calculation in the foregoing table, the two sets of values out of four resulting from this study are selected, as they are in the medium range and nearly correspond to those from the REC's study, namely the results employing T and S derived from the distance-drawdown analysis of observation wells only, and those from the same analysis involving the test well. Since the former is larger than the latter, it is assumed to take the former as a maximum and the latter as a minimum. Reality may further converge into the middle range of these two.

a. In case of the minimum influence, groundwater level will be lowered by 0.25m at a distance of 730 m from a pumped well in 30 days after the canal is closed. In case of the maximum, the lowering of the same level will be seen at a distance of 1,900m from the well. In either case, the range of the radius is more than 300m, the lowering will increase due to interference of adjacent wells. The actual drawdown will be nearly doubled.

b. It is not clear whether the thus lowered levels could be restored to its initial ones before the canals are closed, after canals restarts delivery. Probability is the levels remain at their lowered depths, since the recharge from the canal was assumed to be fully consumed by irrigation wells and the project wells. In case of such a worst scenario, regional groundwater level will continue to go down, and the area at a distance of 1km from them may witness groundwater level has been lowered by 1

m within 5 years after the operation of the project wells started.

(4) Conclusion

The prediction based upon the test results in this study will not necessarily be realized, due to the limit of accuracy in the values of T and S, explained in Appendix 4-7. Moreover, since the hydraulic calculation is based upon lots of assumption, it has its own limit of accuracy. However, in this case the analysis may have yielded more optimistic results with strong aid of canal recharge. Reality may be more severe. If this assumption is true, the influence will be much more than the predicted one.
The conclusion of this analysis is as follows:

a. Pumping by the project wells will hardly affect groundwater level in the surroundings as long as the canal continues delivery.

b. However, during its closure for one month during winter, regional groundwater is likely to be affected. The range of influence is the lowering of 0.25 to 0.5 m in the area at distances of 500 to 1,000m from the project wells for the first year when the operation starts.

c. The recovery of the lowered levels after the restart of canal delivery is unknown. The levels are more likely to remain at the lowered depths, since withdrawal of irrigation wells and the project wells seems to nearly equal to recharge. In such a case, regional groundwater level will continuously be lowered. The calculation indicates that an area 1 km away from the project wells will witness the lowering of 1 m within 5 years.

Finally, aside from the influence of the project wells, this area seems under threat of another influence extending from the existing tubewells in the Chenab wellfield. This risk will be separately being examined in Appendix 5-9.

Appendix 5-6 Examination of Influence by Existing Tubewells in the Chenab Wellfield

(1) Outline of ADB Tubewells

The main water source of WASA's water supply system is currently the tubewells installed under the ADB project in the Chenab wellfield lying 5 to 10 km north of the Jhang Branch Canal. Since the commissioning in 1992, these wells have been producing discharge at a unit rate of 400m^3/hr per well, totaling 200,000 to 160,000m^3/day. The number of tubewells installed by the ADB project was 25, with four added later by WASA.

Compared to the tubewells under planning for this project, those in the Chenab wellfield were designed to discharge a rate twice the one for this project, with their distances spaced at 400m. Immediately after the operation of those well started, groundwater level in the vicinity began to lower, with the influence gradually extending to irrigation wells, and it didn't take long for the residents to find difficulties in pumping their own wells. Conflicts occurred between WASA and neighboring residents. The influence soon developed in a wide range. The water levels at the tubewells themselves have considerably been lowered these ten years.

Since the Chenab wellfield is close to the planned new wellfield along the Jhang Branch Canal with its southern end located 5 km north of the latter, there is a risk their influence might soon extend to the latter. To idenfity foreseeable influence from that area, the conditions of the existing tubewells were examined under this study in relation to its own efforts to minimize the influence by pumping to irrigation tubewells.

(2)Conditions of the ADB wells

2-1 Progress of Level Lowering

The progress of the static water levels at the respective tubewells in the Chenab wellfieldss since its commencement of operation in 1992 to 2002 is shown in the graphs in Fig. 1, in which the plots are approximated to straight lines, allowing to predict their future.

2-2 Features of Levels

1) Initial levels

The range of initial levels at the tubewells is represented by the data on No. 18 well as follows:

* Static water level at the time of construction 19 ft. 9 in. (6.0236m)

* Dynamic water level	35 ft. 9 in.(10.90m)
* Drawdown	16 ft (4.88m)

2) Features of change in levels

* Immediately after the start of operation, the static water levels lowered by a range of 2m to 5m. (Excessive lowering of 8m was seen at No. 19 and No. 22. The reason for this change is not clear.)
* The difference of levels among the wells was roughly 4m in the initial stage of operation. After 10 years, it enlarged to 6m.
* The progress of level lowering has the following features:
  - The levels were nearly stabilized from January 1996 to December 1998.
  - Progressive lowering occurred in the year 2000.
  - Since 2001, lowering was relaxed.

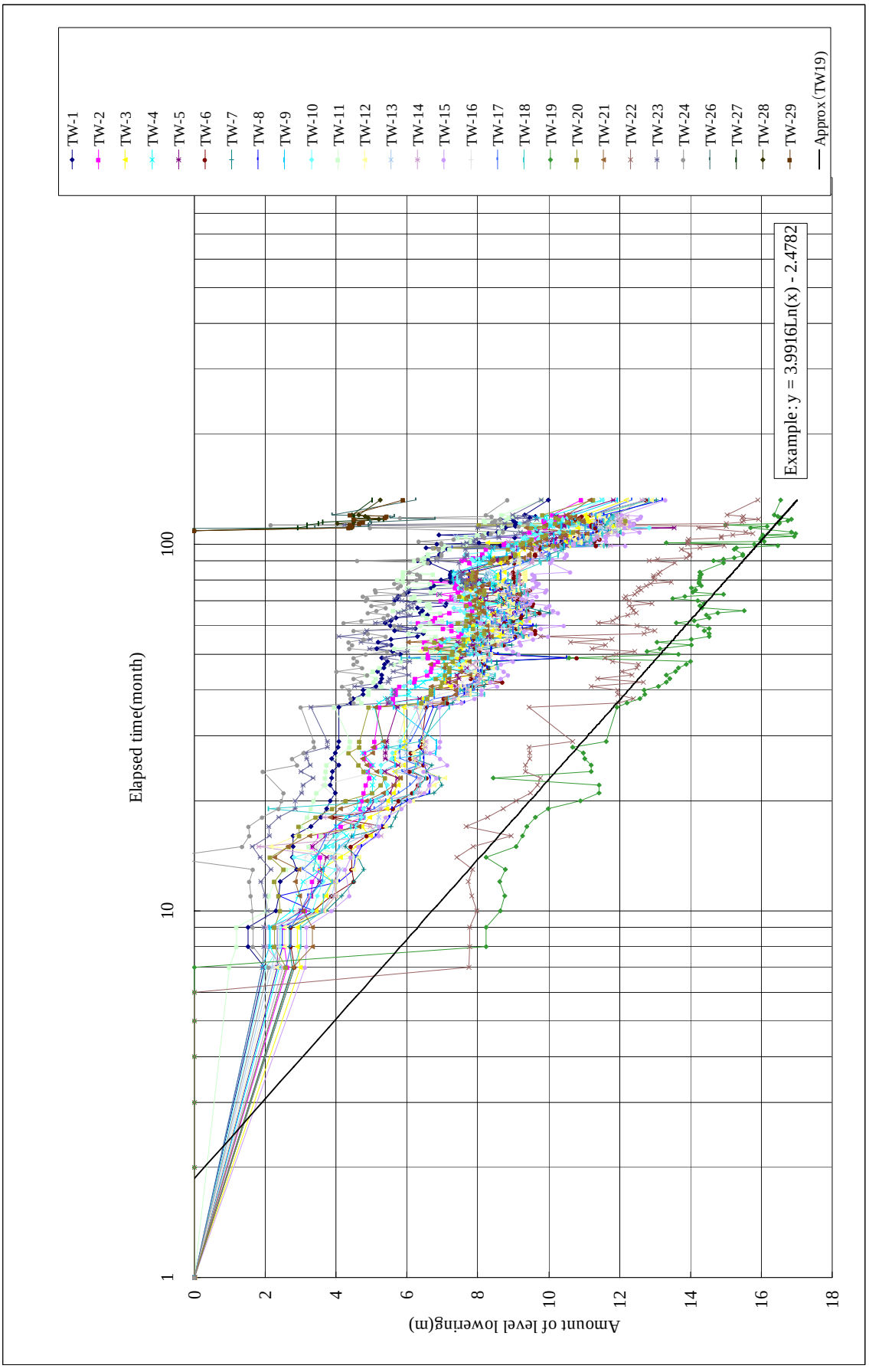


Fig.1 Progress of Level Lowering at ADB Wells(1992～2002)

2-3 Prospects of Levels in the Future

The change in levels at the tubewells is predicted on the following process.

a. The change in the water levels is approximated to the time-drawdown relationship (Refer to Fig. 1). The levels in the future are derived from the calculation of the approximate equation.

b. The static water level is represented by the one at No. 18 as an average ranges at all the wells.

.

Based upon this assumption, the prospective levels of the respective wells are listed in Table 2.

Table 1 shows the list of the tubewells in the order of a larger rate of drawdown. This list indicates the following situation:

* Those installed at the periphery of the wellfield have a gentle slope of drawdown.
* Those located in the central part of the wellfield tend to have a steeper slope of drawdown. (No. 14 to No. 19)

(For the locations of the respective wells, refer to the map in Fig.2-4 of the Basic Design Study Report.)

Table 1

No.	Slope
TW25	2.232
TW24	2.3176
TW11	2.3965
TW01	2.4027
TW10	2.5242
TW02	2.5314
TW23	2.5779
TW09	2.627
TW03	2.7029
TW04	2.7294
TW05	2.72941
TW07	2.7636
TW21	2.7706
TW13	2.7889
TW08	2.7916
TW06	2.8195
TW20	2.8219
TW12	2.9394
TW17	2.9537
TW16	2.9825
TW15	3.04271
TW18	3.0478
TW14	3.0678
TW22	3.47
TW19	3.9916

Table 2 Prospect for Future Drawdown & Water Level of ADB Wells

		10 years			Level	20 years			Level	30 years			Level	40 years			Level	50 years			Level
		Drawdown			6.02	Drawdown			6.02	Drawdown			6.02	Drawdown			6.02	Drawdown			6.02
Well	Slope	m	y	Log e(m)	(m)	m	y	Log e(m)	(m)	m	y	Log e(m)	m	m	y	Log e(m)	(m)	m	y	Log e(m)	m
TW01	2.4027	120	10	11.50	17.52	240	20	13.17	19.19	360	30	14.14	20.16	480	40	14.83	20.85	600	50	15.37	21.39
TW02	2.5314	120	10	12.12	18.14	240	20	13.87	19.89	360	30	14.90	20.92	480	40	15.63	21.65	600	50	16.19	22.21
TW03	2.7029	120	10	12.94	18.96	240	20	14.81	20.83	360	30	15.91	21.93	480	40	16.69	22.71	600	50	17.29	23.31
TW04	2.7294	120	10	13.07	19.09	240	20	14.96	20.98	360	30	16.07	22.09	480	40	16.85	22.87	600	50	17.46	23.48
TW05	2.72941	120	10	13.07	19.09	240	20	14.96	20.98	360	30	16.07	22.09	480	40	16.85	22.87	600	50	17.46	23.48
TW06	2.8195	120	10	13.50	19.52	240	20	15.45	21.47	360	30	16.60	22.62	480	40	17.41	23.43	600	50	18.04	24.06
TW07	2.7636	120	10	13.23	19.25	240	20	15.15	21.17	360	30	16.27	22.29	480	40	17.06	23.08	600	50	17.68	23.70
TW08	2.7916	120	10	13.36	19.38	240	20	15.30	21.32	360	30	16.43	22.45	480	40	17.23	23.25	600	50	17.86	23.88
TW09	2.627	120	10	12.58	18.60	240	20	14.40	20.42	360	30	15.46	21.48	480	40	16.22	22.24	600	50	16.80	22.82
TW10	2.5242	120	10	12.08	18.10	240	20	13.83	19.85	360	30	14.86	20.88	480	40	15.58	21.60	600	50	16.15	22.17
TW11	2.3965	120	10	11.47	17.49	240	20	13.13	19.15	360	30	14.11	20.13	480	40	14.80	20.82	600	50	15.33	21.35
TW12	2.9394	120	10	14.07	20.09	240	20	16.11	22.13	360	30	17.30	23.32	480	40	18.15	24.17	600	50	18.80	24.82
TW13	2.7889	120	10	13.35	19.37	240	20	15.28	21.30	360	30	16.42	22.44	480	40	17.22	23.24	600	50	17.84	23.86
TW14	3.0678	120	10	14.69	20.71	240	20	16.81	22.83	360	30	18.06	24.08	480	40	18.94	24.96	600	50	19.62	25.64
TW15	3.04271	120	10	14.57	20.59	240	20	16.68	22.70	360	30	17.91	23.93	480	40	18.79	24.81	600	50	19.46	25.48
TW16	2.9825	120	10	14.28	20.30	240	20	16.35	22.37	360	30	17.56	23.58	480	40	18.41	24.43	600	50	19.08	25.10
TW17	2.9537	120	10	14.14	20.16	240	20	16.19	22.21	360	30	17.39	23.41	480	40	18.24	24.26	600	50	18.89	24.91
TW18	3.0478	120	10	14.59	20.61	240	20	16.70	22.72	360	30	17.94	23.96	480	40	18.82	24.84	600	50	19.50	25.52
TW19	3.9916	120	10	19.11	25.13	240	20	21.88	27.90	360	30	23.49	29.51	480	40	24.64	30.66	600	50	25.53	31.55
TW20	2.8219	120	10	13.51	19.53	240	20	15.47	21.49	360	30	16.61	22.63	480	40	17.42	23.44	600	50	18.05	24.07
TW21	2.7706	120	10	13.26	19.28	240	20	15.18	21.20	360	30	16.31	22.33	480	40	17.11	23.13	600	50	17.72	23.74
TW22	3.47	120	10	16.61	22.63	240	20	19.02	25.04	360	30	20.42	26.44	480	40	21.42	27.44	600	50	22.20	28.22
TW23	2.5779	120	10	12.34	18.36	240	20	14.13	20.15	360	30	15.17	21.19	480	40	15.92	21.94	600	50	16.49	22.51
TW24	2.3176	120	10	11.10	17.12	240	20	12.70	18.72	360	30	13.64	19.66	480	40	14.31	20.33	600	50	14.83	20.85
TW25	2.232	120	10	10.69	16.71	240	20	12.23	18.25	360	30	13.14	19.16	480	40	13.78	19.80	600	50	14.28	20.30
Ave	2.80	120	10	13.41	19.43	240	20	15.35	21.37	360	30	16.49	22.51	480	40	17.29	23.31	600	50	17.92	23.94
Max	3.99	120	10	19.11	25.13	240	20	21.88	27.90	360	30	23.49	29.51	480	40	24.64	30.66	600	50	25.53	31.55
Min	2.23	120	10	10.69	16.71	240	20	12.23	18.25	360	30	13.14	19.16	480	40	13.78	19.80	600	50	14.28	20.30

2-3 Examination of Drawdown in the Future

As shown in Fig. 2, the slope of drawdown goes gentle as time elapses. For the first 10 years, it was 10 to 19 meters. In 30 years the prospect is 16.5 to 23.5m. The levels in the future are summarized in the following table:

Table 3 Prospected Water Levels of ADB Wells in the Future

		2002		2012		2022		2032		2042	
	Slope	A	Level	A	B	A	B	A	B	A	B
Ave	2.80	13.41	19.43	15.35	1.94	16.49	3.08	17.29	3.88	17.92	4.51
Max	3.99	19.11	25.13	21.88	2.77	23.49	4.39	24.64	5.53	25.53	6.42
Min	2.23	10.69	16.71	12.23	1.55	13.14	2.45	13.78	3.09	14.28	3.59

Note: A= Amount of lowering since the start of operation in 1992

B= Cumulative drawdown after 2002

(3) Examination of the Extent of Influence

3-1 Distance-Drawdown Relationship

In order to examine the extent of influence by pumping at the ADB wells, the approximation of the distance-drawdown relationship was made in the following process.

1) Assumption

To define the distance-drawdown relationship, No. 1 well is assumed as a pumping well and No. 25 well 400 m away from No. 1, as an observation well.

2) Estimate of coefficients of approximate relationship

Drawdown is expressed by the following relationship:

$$\text{Amount of level lowering} = -\ a \times \log e\,(\text{Time}) + b \qquad \text{(A)}$$

$$\text{Amount of level lowering} = -\ a' \times \log e\,(\text{Distance}) + b \qquad \text{(B)}$$

$$(a' = 2 \times a)$$

Coefficients (a) and (b) in the above relationship are calculated, based upon the assumption in (1), as follows:

* In the relationship (A), the value of "a" (slope of the time-drawdown relationship) at No. 25 by pumping at No. 1 is already known by the preceding approximation, which was 2.23.

*Therefore, the value of "a'" in the relationship (B) is ("a" x 2) = 4.46

*Once "a'" is defined, the value of "b" is calculated from (B), since the distance from the pumped

well No. 1 is 400m as follows

b = Amount of level lowering (each year) +"a" x log e(distance)

("b" is a variable, since the level of No. 1 as the observation well is continuously lowering.

*Radius of influence = exp^ (b/a)

The values of "a"', "b" and the radius of influence are listed in the following table:

Table 4 List of Parameters of Approximate Relationship

	0 year level	10-year level	2-year level	30-year level	40-year level	50-year level	
Slope of time-drawdown at No25	0.691	0.691	0.691	0.691	0.691	0.691	time∆s
Slpe of time-distance at No.25	1.382	1.382	1.382	1.382	1.382	1.382	a
b	8.28	11.59	12.07	12.35	12.55	12.71	b
Radius=x at y=0	400	4,396	6,219	7,619	8,800	9,840	e ^ (b/a)

4) Long term forecast for the extent of influence

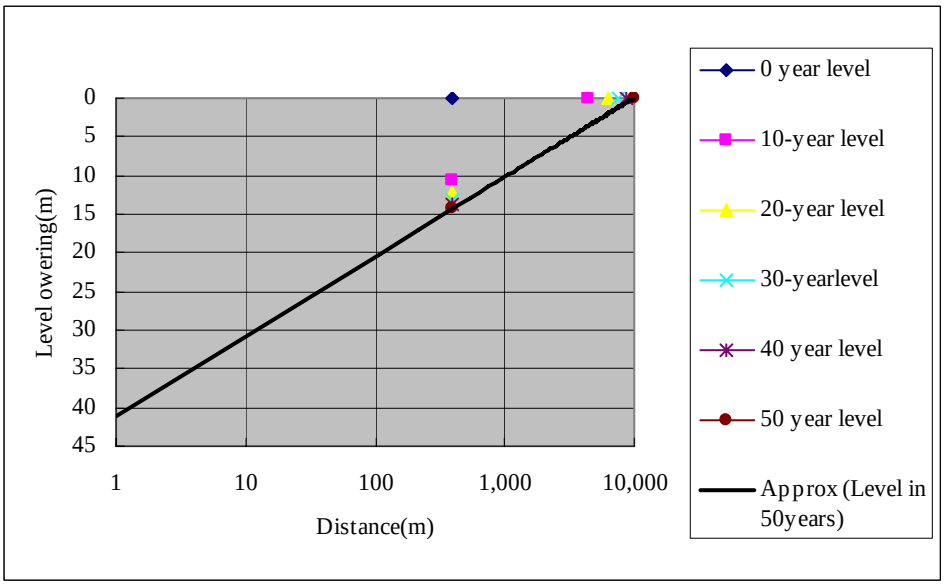
Based upon the defined approximate relationship, the radius of influence (x) in each decade is calculated in the following table:

Table 5 Forecast for Radius of Influence of the ADB Wells

Distance from No. 1Well (m)	0 year level	10-year level	20 year level	30-year level	40 year level	50 year level	
1							
10							Av
100							Max
400	0	3.31	3.79	4.07	4.27	4.43	Min
1,000							
4,391		0					
6,212			0				
7,610				0			
8,788					0		
9,826						0	

Ten years have passed since the tubewells started the operation. The calculated radius of influence is about 4.4 km. Compared to the water level contour map in Fig. 3 in the main report, it almost corresponds to the actual extent of influence.

Fig. 2 Progressive Change of Radius of Influence



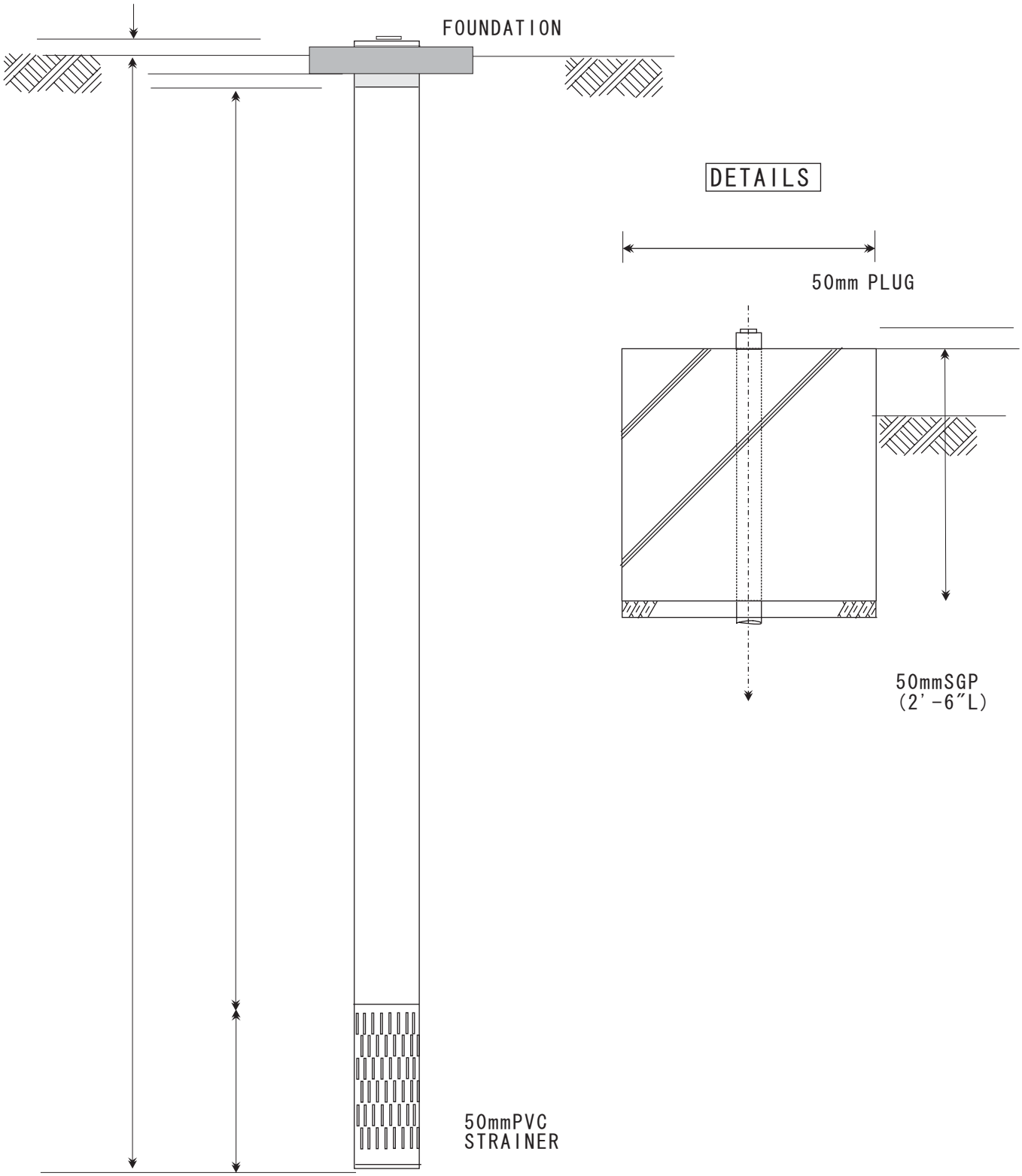
(4)Conclusion

The foregoing analysis is entirely based upon the record of the water levels measured by WASA. Since the Chenab wellfield is close to that along the Jhang Branch Canal, there is a high risk warned by this analysis.

The calculation indicates that the radius of influence from the Chenab wellfield enlarged by about 4 km in 10 years after the operation there started. Since the planned wellfield is located about 5 km from the southern periphery of the wellfield, there is possibility of the influence affecting the tubewells in the wellfield for the project.

In this view, proper measures for risk management will be required to avoid conflicts with local communities in the future.

APPENDIX 5-7 STRUCTURE OF WASA'S STANDARD MONITORING WELL



Appendix 5-8 Water Analysis on Site and by WASA Laboratory of Samples from Tubewells

(1) WATER ANALYSIS AT IRRIGATION WELLS

1) For the locations of tubewells, refer to Fig. 2-2-1-13 for the well number.

2) Affix "N" for the well No. means the tubewells in the area north of the Jhang Branch Canal, surveyed during the first stage (Dec. 2002)

3) The numbers without affix mean tubewells south of the canal. No. 101 is the test well installed for the study in the second stage. This area was surveyed both in the first and second stages (Dec. 2002 and Aug. 2003)

4) Analyses by WASA laboratory has a mark of circle in the column of remarks。

5) Water analysis of WASA tubewells in the Chenab wellfield is shown in Section 2.

	Well No.	Time of analysis	T ℃	p H	EC μM/cm	Turbidity NTU	TDS mg/ℓ	Ca mg/ℓ	Mg mg/ℓ	Total hardness mg/ℓ	Cl mg/ℓ	Total Nitrogen mg/ℓ	NO3 mg/ℓ	NH4 mg/ℓ	Total Phosphorus mg/ℓ	Re-marks
1	N01	Dec. 2002	22.4	7.36	1450	0	986	51	163	780	183	0	0	0	0.03	○
2	N02	Dec. 2002	23.2		1934											
3	N03	Dec. 2002	24.4		1700											
4	N04	Dec. 2002	24.1		1336											
5	N05	Dec. 2002	22.1	7.49	1047	0	695	48	77	428	94	0	0	0	0.039	○
6	N06	Dec. 2002	23.1		1041											
7	N07	Dec. 2002	22.1	7.28	1291	0	869	52	106	556	64.3	0	0	0	4.0	○
8	N08	Dec. 2002	23.3	7.60	351	0	287	26	59	300	29.7	0	0	0	0.06	○
9	N09	Dec. 2002	23.8		1945											
10	N10	Dec. 2002	24.0		941											
11	N11	Dec. 2002			750											
12	N12	Dec. 2002	24.2	7.09	896	5	613	62	52	360	41.0	0	0	2	0.01	○
13	N13	Dec. 2002	24.3		726											

	Well No.	Time of analysis	T ℃	p H	EC μM/cm	Turbidity NTU	TDS mg/ℓ	Ca mg/ℓ	Mg mg/ℓ	Total hardness mg/ℓ	Cl mg/ℓ	Total Nitrogen mg/ℓ	NO3 mg/ℓ	NH4 mg/ℓ	Total Phosphorus mg/ℓ	Re-marks
14	N14	Dec. 2002	24.4		672											
15	N15	Dec. 2002	24.7		555											
16	N16	Dec. 2002	24.1	7.95	867											
17	N17	Dec. 2002	25.2		1003											
18	N18	Dec. 2002	25.0		1464											
19	N19	Dec. 2002	22.1	7.07	1358	4	957	64	72	448	156	0	0	0	0.04	○
20	N20	Dec. 2002	24.8		807											
21	N21	Dec. 2002	25.2	7.19	940	0	641	44	94	484	50	0	0	0	0.07	○
22	N22	Dec. 2002	24.4		1209											
23	N23	Dec. 2002	25.9		794											
24	N24	Dec. 2002	25.0		1228											
25	N25	Dec. 2002	25.3	7.31	794	0	535	56	98	532	32	0	0	0	0.05	○
26	N26	Dec. 2002	24.4		994											
27	N27	Dec. 2002	25.6	7.24	782	0	538	60	101	556	25	0	0	0	0.06	○
28	N28	Dec. 2002	25.0		796											
29	N29	Dec. 2002	25.9		906											
30	N30	Dec. 2002	25.4		806											
31	N31	Dec. 2002	26.1	6.96	944											
32	N32	Dec. 2002	23.8	7.47	1115	0	840	77	121	680	69.3	0	0	0	0.05	○
33	N33	Dec. 2002	24.7		1135											
34	N34	Dec. 2002	24.7	7.2	2960	0	1940	46	150	720	222	2	7	2	0.1	○
35	N35	Dec. 2002	24.9		899											

36	N36	Dec. 2002	23.2	7.68	1168	0	747	39	52	308	49.5	0	0	0	0.07	○
	Well No.	Time of analysis	T ℃	p H	EC μM/cm	Turbidity NTU	TDS mg/ℓ	Ca mg/ℓ	Mg mg/ℓ	Total hardness mg/ℓ	Cl mg/ℓ	Total Nitrogen mg/ℓ	NO3 mg/ℓ	NH4 mg/ℓ	Total Phosphorus mg/ℓ	Re-marks
37	101	Sep. 2003	24.0	7.8	230	1.5	480	24	10	100	36	0	0	0		Lahore
38	102	Dec. 2002	22.3	7.91	260	0	194	32	41	244	29.7	0	0	0	0.09	○
39	103	Aug. 2003	24.7	8.30	232		200	54	26	240	50	0	0	0	0	○
40	104	Aug. 2003	26.3	8.7	1410		920	53	80	456	92	0	0	0	0.08	○
41	105	Dec. 2002	26.4	7.33	1882		1220	80	145	780	149	1	1	3	0.04	○
42	106	Dec. 2002	26.5	7.64	1265		834	58	71	428	99	0	0	0	0.05	○
43	107	Sep 2003	25.3	8.7	1374		928	53	71	416	92	0	0	0	0.09	○
44	108	Dec. 2002	24.8	8.6	1478		1030	55	98	528	95	0	0	0	0.13	○
45	109	Dec. 2002	26.5	8.7	1277		766	42	36	244	40	0	0	0	0.10	○
46	110	Dec. 2002	26.5	8.7	1277		766	42	35	244	40	0	0	0	0.10	○
47	111	Dec. 2002	25.6	8.7	1215		766	44	38	260	44	0	0	0	0.05	○
48	112	Dec. 2002	27.8	8.6	1708		1238	72	65	440	185	1	3	1	0.03	○
49	113	Dec. 2002	23.1	7.62	1275		846	96	98	632	74.3	0	0	0	0.01	○
50	114	Aug. 2003	26.7	8.6	1567		1104	36	30	210	176	0	0	0	0.03	○
51	115	Dec. 2002	25.8		1136											
52	116	Dec. 2002	26.2		993											
53	117	Dec. 2002	25.6		1477											
54	118	Dec. 2002	25,9		1175											
55	119	Dec. 2002	25.0		1442											

(2) WATER ANALYSIS FOR WASACHENAB TUBEWELLS

Item	T.D.S (mg/ℓ)				Ca (mg/ℓ)				Cl (mg/ℓ)			
Time	98Feb	00Jun	01Jul	02Jun	98Feb	00Jun	01Jul	02Jun	98Feb	00Jun	01Jul	02Jun
Well No.												
TW-1	340	368	372	390	40	32	36	30	38	30		
TW-2	440	434	380	375	52	48	32	29	46	46		60
TW-3	620	586	562	520	55	56	54	41	92	88		60
TW-4	466	444	436	470	47	52	50	35	66	62		99
TW-5	506	450	400	490	49	54	48	36	56	44		108
TW-6	400	384	392	345	52	50	50	35	38	40		106
TW-7	370	370	400	295	54	49	50	35	38	38		74
TW-8	368	410	440	350	52	52	52	26	40	42		60
TW-9	360		386	395	50		50	35	36			45
TW-10	428	460	446	485	54	51	53	28	38	70		84
TW-11	528	482	500	445	55	54	54	51	43	70		79
TW-12	480	456	466	425	56	52	54	74	44	66		84
TW-13	470	400	410	465	56	50	49	33	42	40		99
TW-14	400	432	466	435	52	54	52	40	45	44		89
TW-15	402	398	432	460	48	48	48	50	36	38		43
TW-16	330	386	434	400	46	50	51	46	34	50		47
TW-17	324	420	400	360	42	48	49	41	25	36		40
TW-18	306	332	340	320	40	38	42	34	26	32		25
TW-19	320	348		322	36	43		32	24	30		24
TW-20	318	350	330	316	34	44	32	30	23	28		22
TW-21	322	328	312		34	40	40		21	26		
TW-22			312	300			30	29				21
TW-23		330	316	310		36	28	28		24		23
TW-24												
TW-25		582	430			52	68			86		

Appendix 5-9　Comparison of Population Projections

Year	Actual Figures			Rate of Change Formula (Adopted)			Rate of Change Formula			Power Law Curve Formula	Logistic Curve Formula
	Collected Data	Adjusted Figure	Difference	Calculated Figure	Difference	Growth Rate	Calculated Figure	Difference	Growth Rate		
1991	**1,583**	**1,583**		1,607			1,583			1,583	1,598
1992		1,656	73	1,666	59	3.5%	1,636	53	3.2%	1,661	1,661
1993		1,729	73	1,725	59	3.4%	1,691	55	3.2%	1,727	1,724
1994		1,802	73	1,783	59	3.3%	1,747	57	3.2%	1,790	1,787
1995	**1,875**	**1,875**	73	1,842	59	3.2%	1,806	58	3.2%	1,851	1,848
1996		1,916	41	1,901	59	3.1%	1,866	61	3.2%	1,910	1,908
1997		1,956	41	1,960	59	3.0%	1,929	62	3.2%	1,968	1,966
1998	**1,997**	**1,997**	41	2,019	59	2.9%	1,993	65	3.2%	2,024	2,024
1999		2,065	68	2,077	59	2.8%	2,060	67	3.2%	2,080	2,079
2000		2,132	68	2,136	59	2.8%	2,129	69	3.2%	2,136	2,133
2001	**2,200**	**2,200**	68	2,195	59	2.7%	2,200	71	3.2%	2,190	2,184
2002				2,254	59	2.6%	2,274	74	3.2%	2,244	2,234
2003				2,313	59	2.5%	2,350	76	3.2%	2,298	2,282
2004				2,371	59	2.5%	2,428	79	3.2%	2,351	2,327
2005				2,430	59	2.4%	2,510	81	3.2%	2,403	2,371
2006				2,489	59	2.4%	2,594	84	3.2%	2,456	2,412
2007				2,548	59	2.3%	2,680	87	3.2%	2,508	2,452
2008				2,607	59	2.3%	2,770	90	3.2%	2,559	2,489
2009				2,666	59	2.2%	2,863	93	3.2%	2,610	2,524
2010				2,724	59	2.2%	2,958	96	3.2%	2,661	2,557
2015				3,018	59	1.9%	3,488	113	3.2%	2,912	2,696
Correlation Coefficient							0.993			0.998	0.997

Average Rate of Change Equation　y=a×x+b　a=58.80606, b=1,548.16364、

Since collected data were incomplete, the missing data were calculated by proportional distribution.

Adjusted power law was simplified. Refer to Guideline for Design of Waterworks (Projection Method)

Appendix 5-10 Amount of Water Production and Water Supply

(1) 1ST Study (Dec./2002 ～ Jan./2003)

Operation Record of Water Production Amount of Chenab Wellfield and Water Supply Amount distributed from Terminal Reservoir are shown in the next table.

(December/2001 and Jun/2002 are chosen as an example of recent characteristic data of winter and summer season water supply)

1) Dec./2001

	Chenab Wellfield				Terminal Reservoir			Remarks
Dec./ 2001	Number of working wells	Monthly working hour	Daily working hour (hour/day)	Amount of Water Production (m3/day)	Distribution Pump working hour (hour/day)	Water Supply hour by Gravity Flow (hour/day)	Amount of Water Supply (m^3/day)	
1	21	468	22.3	183,784	10	14	173,100	
2	21	464	22.1	180,385	9	15	175,300	
3	21	460	21.9	176,529	10	14	168,200	
4	21	461	22.0	172,873	10	14	171,700	
5	22	448	20.4	173,626	10	14	169,800	
6	21	418	19.9	161,818	8	16	159,800	
7	21	454	21.6	174,096	11	13	175,500	
8	21	456	21.7	179,061	11	13	178,500	Max.
9	20	441	22.1	170,481	10	14	176,700	
10	20	438	21.9	166,189	10	14	171,400	
11	22	426	19.4	159,757	10	14	168,000	
12	22	412	18.7	159,780	10	14	150,600	
13	21	406	19.3	155,912	9	15	155,800	
14	23	408	17.7	160,605	8	16	153,000	
15	20	396	19.8	154,355	8	16	154,400	
16	21	402	19.1	154,496	8	16	154,500	
17	21	408	19.4	149,762	7	17	157,600	
18	20	393	19.7	150,223	8	16	150,300	
19	20	398	19.9	153,549	8	16	156,200	
20	23	392	17.0	149,319	9	15	154,200	
21	23	420	18.3	157,987	9	15	153,400	
22	23	491	21.3	149,130	8	16	152,800	
23	22	396	18.0	154,490	9	15	149,000	
24	21	364	17.3	141,117	8	16	147,500	
25	22	387	17.6	153,933	7	17	145,700	
26	21	392	18.7	151,892	10	14	154,100	
27	22	402	18.3	157,021	9	15	150,400	
28	23	410	17.8	161,611	9	15	106,200	
29	23	313	13.6	119,998	5	19	116,700	
30	21	388	18.5	149,334	7	17	138,200	
31	21	370	17.6	144,210	5	19	145,200	
Total	664		602.9	4,927,323	270	474	4,833,800	
Daily Ave.	**21.4**	28wells)	**19.4**	**158,946**	**8.7**	**15.3**	**155,929**	98.10%

2) Jun/2002

	Chenab Wellfield				Terminal Reservoir			Remarks
Jun/ 2002	Number of working wells	Monthly working hour	Daily working hour (hour/day)	Amount of Water Production (m3/day)	Distribution Pump working hour (hour/day)	Water Supply hour by Gravity Flow (hour/day)	Amount of Water Supply (m^3/day)	
1	23	445	19.3	168,701	8	16	168,200	
2	23	450	19.6	169,738	8	16	160,700	
3	23	448	19.5	171,875	8	16	168,700	*
4	22	438	19.9	169,492	8	16	156,000	
5	26	457	17.6	173,296	8	16	162,100	
6	25	398	15.9	135,272	9	15	151,600	
7	23	449	19.5	173,965	8	16	161,200	
8	24	433	18.0	173,089	8	16	165,300	
9	24	443	18.5	169,198	8	16	168,900	
10	22	437	19.9	167,289	8	16	165,100	
11	25	337	13.5	130,189	6	18	126,900	
12	24	450	18.8	169,683	8	16	163,400	
13	24	406	16.9	154,120	8	16	150,200	
14	23	437	19.0	164,114	8	16	156,000	
15	24	447	18.6	168,720	8	16	162,400	
16	22	425	19.3	160,338	8	16	161,800	
17	23	441	19.2	165,646	8	16	159,300	
18	22	443	20.1	168,546	8	16	165,000	
19	23	425	18.5	159,651	8	16	160,000	
20	24	421	17.5	156,863	8	16	164,700	
21	24	395	16.5	145,995	6	18	137,800	
22	26	421	16.2	162,260	6	18	165,200	
23	26	437	16.8	170,990	8	16	163,300	
24	24	449	18.7	164,981	8	16	165,500	
25	23	427	18.6	157,057	8	16	159,200	
26					8	16	163,300	
27	24	425	17.7	164,829	8	16	160,800	
28	23	446	19.4	170,215	8	16	160,200	
29	24	416	17.3	158,252	8	16	162,000	
30	24	444	18.5	160,187	8	16	157,300	
Total	687		528.8	4,724,551	235	485	4,792,100	
Daily Ave.	23.7	(In 28wells)	18.2	**162,916**	7.8	16.2	**159,737**	98.05%

(2) 2nd B/D Study (Aug./2003)

Water supply amount from Terminal Reservoir in summer season（Jun/2003 – Aug./2003）

1. Water supply amount from Terminal Reservoir（Operation record: meter reading）

Jun.		July		Aug.		Remarks
Day	Water supply amount	Day	Water supply amount	Day	Water supply amount	
1		1	151,200	1	162,500	
2		2	149,900	2	165,000	
3		3	150,800	3	163,500	
4		4	153,500	4	163,500	
5		5	160,500	5	163,500	
6		6	150,000	6	161,500	
7		7	148,000	7	161,000	
8		8	149,000	8	*(159,000)	Day of 7－8
9		9	151,000	9	*(169,000)	Day of 8－9
10		10	140,000	10		
11		11	149,500	11	163,500	OHR Inflow
12		12	156,000	12	164,500	was measured
13		13	153,500	13	164,500	
14		14	152,000	14	160,000	Arterial Main
15		15	151,500	15	165,500	Flow was
16		16	151,300	16	164,500	measured in
17		17	148,800	17	160,000	this term
18		18	146,400	**18**	**169,000**	
19		19	150,000	19		
20		20	147,500	20		
21	144,500	21	159,500	21		
22	144,300	22	158,000	22		
23	119,900	23	162,000	23		
24	105,100	24	164,000	24		
25	141,500	25	154,500	25		
26	146,000	26	153,500	26		
27	146,000	27	163,000	27		
28	153,000	28	163,000	28		
29	140,500	29	162,800	29		
30	152,600	30	159,500	30		
31	-	31	159,200	31		

※ Flow Measurement: from 13:00 to 13:00

2. Water Production（Operation record of existing inline booster pump station）

Aug.		
Day	Water Production	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11	171,450	
12	168,660	
13	168,247	
14	174,943	
15	163,798	Transmission
16	173,378	Main
17	164,000	Pressure was
18	164,038	measured in this
19		term
20		
21	159,050	
22	169,409	
23	174,049	
24		
25		
26		
27		
28		
29		
30		
31		

Appendix 5-11 Study on Existing Water Supply Facilities

For planning of water supply facilities, the survey on the present situation of the city's existing water supply system was carried out during the study. The major findings of the survey concerning the facilities planning are described hereunder.

(1) Topography of the supply area

The topography of the city area is mostly flat, with the northeast zone being slightly higher and the level falling a couple of meters toward southwest. The area where the T/R is located is the highest (GL185m) in the city, although a part of the east side is at the same level (GL 185m - 183m). The west side zone ranges from GL185m to 181m. The HWL of T/R is GL 188m, with its LWL at 3m lower than the HWL (GL 185m), which is the same as the ground level.

(2) Method of distribution from T/R

One of the remarkable features of WASA's water supply is that distribution by pumps to the city is limited to 4-6 hours a day with pumps being run only during time zones when demand rises to peak. For the rest of the day, the water is fed by gravity into arterial mains depending on the ground level at the T/R. Since water pressure along the lines remains low through duration of gravity-flow (slightly over negative pressure), the substantial supply is achieved simply while pumps are run.

Table 1 Current practice of WASA water supply at T/R（Dec. 2002）

Supply method		Time for pumped supply（Dec. 2002）	Duration (hrs)	Hourly supply rate（m^3/hr）	Daily maximum supply rate(m^3/day）
	Morning	6：00－7 ：30	1.5-2hrs	14,000～17,000	
	Afternoon	12：00－13：00	1.5-2hrs		
	Evening	17：00－18：30	1-2hrs		
Total outflow of pumped supply			4-6hrs		100,000
Total outflow by gravity		Rest of the day	16-20hrs	4,000～	80,000
Total outflow				Ave.7,500 m^3/h	180,000
＊Rated head of the existing pumps：45m ＊Rated pump discharge： 2,250m^3/hrs×7 units、2,070 m^3/hrs×3 units、plus 1 standby Maximum 14,000m^3/hr、335,000 m^3/day					

The current condition of WASA's water service by pumps and by gravity in Faisalabad in December 2002 is summarized in Table1. (The duration of pump operation and supply rate of the pumps vary day to day). The current practice of water supply for the city is far from normal 24- hour service, and the

main reasons for this situation involve the insufficient production of water sources, lack of reservoir capacity and further pump malfunctioning due to the imbalance of demand and supply. (Although the existing reservoir has an adequate capacity for regular supply, its lower half remains unused since its inception apparently due to the defective design in the structure of pump suction.)

3) Present state of the distribution network

The production in the Chenab wellfield accounts for nearly 80% of water supply currently available to WASA. It is transmitted from the wellfield about 20 - 25km north east of the city via the booster pump station to the T/R, and then is distributed from the T/R to the service area of the city through the arterial mains (primary network system). All of these facilities were constructed in the preceding project completed in 1992. The arterial mains consist of 1,600mm to 500mm-diameter ductile cast iron pipes approximately 50km long in all. The lines gradually reduce their sizes as they run from the T/R at the western fringe down to the east side of the city, and at the eastern end, the water pressure remarkably shrinks.

①Water pressure of the arterial mains

The water pressure of the arterial mains in the city ranges from under 0.5kg/cm^2 to 2.5kg/cm^2. (The discharge pressure of the T/R supply pumps was designed at 4.5kg/cm^2, but presently their working pressure is around 3kg/cm^2).

- West side zone of the city: The water pressure through the arterial mains is about 2.5kg/cm^2-1kg/cm^2 in this area.
- East side: Over the east side zone, which is separated from the west side by the channel of the Rakh Branch Canal and the railroad running in parallel, the water pressure in the lines decreases to a low range of 0.5 kg/cm^2 while the pumps are run at T/R. It finally falls to 0 when the pumps are stopped. The pressure zero condition persists while the pumps are idling.

The following table shows the results of pressure measurements during this study at main sections of the arterial mains with auto-recording electromagnetic pressure meter.

Table 2 Results of the pressure survey (Dec. 2002)

		T/R	West side			East side		
			Up-stream area	Central area	End of down-stream	Up-stream area	Up-stream area	End of down-stream
Junction Node No.		101	3	36	31	45	57	70
Max	Registered pressure (m)	3.2	2.5	1.2	1.5	0.5	0.5	0.5
Min	Registered pressure(m)	0.1	0.5	0	0	0	0	0.1

The pumps are run daily for 4 to 6 hours in total in time to peak demand within the city. While they are run, a greater part of the west side can enjoy a satisfactory level of water service and even the east side can receive the delivery of supply although pressure is quite low (0.5kg/cm^2). One of the measures to improve the water supply is the continuous operation of the pumps, although the shortage of supply from the existing sources makes it difficult at present. If additional water sources are ensured through the implementation of this project, the duration of pump operation can be extended, eventually resulting in the change in the pattern of citizens' consumption, which is now keenly concentrated in intermittent hours while the pumps are run.

②Water supply ratio to the service areas

The daily rate of supply differs largely between the west side close to the T/R and the east side away from it. During the second stage of this study, water flow was measured with an ultrasonic flow meter along 2 sections of arterial mains of 600 mm and 800mm in diameter, which transport the water flow to the network loops in the east side. (August 2003).

The served populations of the west and the east sides were estimated on the basis of the water service area map prepared by WASA (Fig. 2-12 in the Basic Design Study Report). The results are as follows:

Table 3 Estimate of served populations of the service areas

	West side	East side	Total
Ratio of the service area	65%	35%	100%
Ratio of total served population	35.7%	19.3%	55%
Estimated served population	825,000	448,000	1,273,000

The flow measurements revealed that the inflow to the east side was 31,000m^3/day out of the total supply of 163,000m^3/day from the T/R relying upon the production of the Chenab source. Comparing the rates of total daily supply to both areas obtained through the field measurements and the respective served population estimated in the above table, the ratio of supply to the east side is calculated at 64% against 100% to the west side. This proves the present unbalanced situation of water distribution even though the east side is fed with supplementary supply from Jhal Khanuana Head Waterworks located in the east side. The detailed record of flow measurements and calculation results are shown in Tables (1) and (2) attached.

③ Existing pipelines for distribution

The total extension of the arterial mains, secondary mains and branches for distribution of 75mm and larger in size is now about 1,000km. The arterial mains composed of ductile cast iron pipes with the diameters ranging from 500 to 1,600mm accounts for 5%. 88% consists of asbestos cement pipes

(ACP) of diameters of 600mm and under, and 7%, PVC pipe less than 400mm in size.

Since 1998, WASA was engaged in a project for extending and reinforcing the existing network, in which it installed some 40 km of pipeline (or 4% of total extension) financed by the Punjab government.

The list of the existing lines for distribution is shown in the table below.

Table 4 Extension of main and branch pipes

Arterial mains, secondary mains, branches of 80 mm and larger in diameter	Type	Extesion（km）	Ratio
1,600mm to 500mm	DIP	50	5%
Distribution lines smaller than 600mm	ACP	833	87%
Main pipes under 400mm	PVC	77	8%
Total	Installed before 1998	About 960km	100%
	Present （＋40km since 1998）	About 1,000km	

The east side shares 43% of the total extension of the arterial mains (Population ratio is 35%). Refer to the table below.

Table 5 Extension and average diameter of arterial mains

(Diameters ranging from 500mm to 1,600mm)

Unit	Extension(m)	Ratio	Ave. diameter (mm)	Pipe capacity ratio
1. West side	28,000	57%	890	89%
2. East side	21,000	43%	580	11%
Total	49,000	100%		100%

④ Examination of the arterial mains for future distribution

In order to examine the capacity of the existing arterial mains for distributing increased supply after the implementation of the project, the network analysis were conducted assuming 3 types of design hourly maximum. The following table outlines the results with details shown in Fig. (4) Result of Arterial Main Network Calculation attached.

Table 6 Network analysis summary

			T/R	West side			East side		
				Up-stream	Central zone	Down-stream	Upstream (North)	Upstream (South)	Down-stream.
	Node No		101	102	31	34	46	49	70
Ongoing	Case 1 Hourly max.= 1.9	Water head (m)	30	28	17	16	8	8	4
After the project	Case 1 Hourly max.= 1.9	Water head (m)	40	33	9	8	-8	-15	-19
	Case 2 Hourly max.= 1.5	Water head(m)	40	37	21	20	11	7	5
	Case 3 Time coeff. 1.7	Water head(m)	35	30	11	9	-2	-8	-9

From the results shown in the above table, the supply condition of the existing network can be estimated as follows:

*Maximum daily water supply rate 230,000+91,000=321,000m^3/day

*Target design maximum hourly distribution rate

Case 1: 321,000/24 (hrs) x 1.9= 25,400 m^3/hr

Case 2: 321,000/24 (hrs) x 1.5= 20,000 m^3/hr

Case 3: 321,000/24 (hrs) x 1.7= 22,700 m^3/hr

*Calculation results

For cases of hourly maximum of 1.9 or 1.7, the pressure will be negative at the downstream of the network in the east side, possibly resulting in an extremely poor service condition there. Only in the cases of hourly maximum rate of 1.5 the pressure can be retained in a similar range as at present, allowing the supply, but the unbalanced service between the west and the east sides will persist. If the water sources are increased through the project, water supply may be improved compared to the present situation, but without any improvement on the existing system, the conditions close to the one shown in case 3 is likely to occur.

4) Storage capacity

The number of water storage facilities of WASA within the city totals 38, consisting of T/R, underground and overhead tanks. While the total capacity of storage amounts to 86,000m^3, the capacity of working tanks of 13 in number is limited to 46,000m^3. The table below shows the comparison between the existing capacity and the ongoing working capacity.

Table 7 Present situation of storage facilities

		Existing facilities		Working facilities	
		Number	Capacity (m^3)	Number	Capacity (m^3)
1, Terminal Reservoir		1	48,000	1	24,000
2. Underground/ Overhead tanks		37	38,000	13	22,000
	West side	23	23,000	4	9,000
	East side	14	15,000	9	13,000
Total capacity		38	86,000	14	46,000
Storage capacity			for 9 hours		for 4.8 hours

Most of these tanks scattered around the city were constructed with local funds long before 1992 when the main facilities of the present system were completed by Phase 1 financed by the ADB. They were used for supply of groundwater from the existing tubewells within the city, mainly along the Rakh Branch Canal penetrating the city. Since the completion of Phase 1, the existing tanks have had a different function to compensate the low water pressure of the arterial mains, particularly in the east side zone. In the west side where pressure is generally adequate for direct supply from the network to households, most of the tanks have ceased working. Some of them have capacity totaling over 3,000m^3, but most are a combination of an underground tank of less than 1,000m^3 and an overhead one mostly of 230 m^3 in capacity with a booster pump station. When the T/R pumps are operated, the water flows into the underground tanks to be pumped up to the overhead tanks by the booster pumps), and then it is supplied from the latter to households for about 2 hours in 3 times (totaling 6 hours) everyday. There are many families who have set their own tanks on top of the roof together with booster pumps.
A list of the existing storage facilities in the city is shown in Table (3) attached.

5) Issues in the distribution system

As a result of the survey on the existing facilities, the distribution system has issues as mentioned before, which causes the unbalanced water supply condition in the city. To deal with these issues, there are needs to revise the water service master plan according to the future development policy of the city,

and to take actions having consistency with the whole plan.

The main purpose of this project is to increase the water supply as a top priority. However, even after the augmentation of water supply is achieved through the implementation of the project, it is most likely that the unbalanced water supply now prevailing is left unimproved as examined through the network analysis (Refer to 3 ④ this section). Therefore, various measures for the improvement were examined and were discussed with WASA during the survey, and at the end of the second stage of the study, WASA proposed its own measures for the improvement of system as stated in Appendix 1 “Technical Note" in the Basic Design Study Report. To enhance the effectiveness of the project, it is necessary to take an effective measure to contain difficulties in distribution. Through the review of WASA's proposal, this project intends to include an appropriate measure for the improvement of the existing system as one of its components. The details are described in section 2-2-2-3-(2)-5) "Plan for Improvement of Distribution System in the City” in the Basic Design Study Report.

Table (1) Measurement of Water Flow in Arterial Mains in the East Side Area

: Dia800mm, Flows from TR

: Pump operation

Date	Hour	Min.	Ave 30min. Hourly flow rate		No. of operating pump	Pump operating time	Water supply amount	Pump Head	Water level TR	No. of operating wells
			(m^3/hr)			(hour)	(m^3/hr)	(kg/cm^2)	(HWL 6m)	
14-Aug	12	0	921		1		12,200	2.0	5.3	16
Pump operating in noon time		30	2,372		5			2.0		
	13	0	1,568		5	1.3	7,000	2.0	4.6	16
		30	394							
	14	0	436		0		3,500	0	4.4	16
		30	452							
	15	0	442		0		3,600	0	4.7	16
		30	490							
	16	0	510		0		4,000	0	5.0	16
		30	588							
	17	0	652		0		7,800	0	5.3	18
Pump operating in the evening		30	1,054		1					
	18	0	2,767		6		18,000	3.0	5.5	23
		30	2,608		6			3.0		
	19	0	2,480		6		17,000	3.0	4.4	23
		30	2,486		5	2.3		2.4		
	20	0	686		0		3,200	0	3.5	23
		30	492							
	21	0	562		0		4,000	0	3.9	23
		30	594							
	22	0	640		0		4,000	0	4.6	23
		30	644							
	23	0	650		0		3,800	0	4.9	12
		30	652							
15-Aug	0	0	514		0		4,000	0	4.9	12
		30	636							
	1	0	642		0		4,000	0.0	4.9	12
		30	634							

	2	0	634		0		4,000	0	4.9	12
		30	636							
	3	0	654		0		4,000	0	4.9	12
		30	648							
	4	0	678		0		9,000	0	5.3	22
Pump operating In the morning		30	1,246		1					
	5	0	**2,786**		6		17,200	3.1	5.5	22
		30	2,688		6			3.1		
	6	0	2,610		6		**17,900**	3.0	4.4	22
		30	2,748		6	2.3		3.0		
	7	0	462		0		2,200	0	**∗3.3**	22
		30	-68							
	8	0	-104		0		14,000	0	3.9	22
		30	8							
	9	0	143		0		1,800	0	3.9	18
16-Aug	9	30	10							
	10	0	128		0		3,700	0	4.6	18
		30	334							
	11	0	418		0		4,400	0	5.0	18
		30	442							
Daily		**Total**	**22,334**	m^3/day		**5.9**	163,000			
Hourly Ave.		T.F=3.0	**931**	m^3/hr		T.F=2.6	6,792	Capacity =4.5		
			Detective value		Operation record of TR					

(2) Measurement of Water Flow in the Arterial Mains in the East Side Area

: Dia600mm, Water flows from the TR

: Pump operation

Date	Hour	Min.	Ave 30min. Hourly flow rate (m^3/hr)		No. of operating pump	Pump operating time (hour)	Water supply amount (m^3/hr)	Pump Head (kg/cm^2)	Water level TR (HWL 6m)	No. of operating wells
17-Aug-03	16	0	228				4,200	0	5.0	16
		30	268							
	17	0	298				7,000	0	5.3	16
Pump operating in the evening		30	526		1					
	18	0	**838**		6		17,100	3.0	5.3	23
		30	830		6					
	19	0	818		6		17,700	3.0	4.1	23
		30	726		5	2.3		2.4		
	20	0	206				3,200	0	3.3	23
		30	232							
	21	0	216				3,300	0	4.4	23
		30	228							
	22	0	230				4,000	0	4.9	23
		30	252							
	23	0	276				4,000	0	4.9	12
		30	280							
17-Aug-03	0	0	276				4,000	0	4.9	12
		30	262							
	1	0	254				4,000	0	4.9	12
		30	254							
	2	0	256				4,000	0	4.9	12
		30	250							
	3	0	256				4,000	0	4.9	12
		30	236							
	4	0	238				9,200	0	5.0	16

Pump operating in the morning		30	406		1						
17Aug03	5	0	826		6		16,900	3.2	5.2	22	
		30	616		6						
	6	0	770		6		16,500	3.0	4.3	22	
		30	798		6						
	7	0	660		6	2.5	800	3.0	**＊3.0**	22	
		30	126								
	8	0	132				1,000	0	3.7	16	
		30	132								
	9	0	184				1,900	0	4.3	16	
		30	280								
	10	0	372				3,700	0	4.9	16	
		30	364								
	11	0	330				4,600	0	5.2	16	
		30	324								
	12	0	444		1		12,500	2.0	5.3	16	
Pump operating in noon time		30	740		5						
	13	0	472		3	1.3	6,600	2.6	4.6	16	
		30	206								
	14	0	246				3,500	0	4.4	16	
		30	258								
	15	0	274				3,500	0	4.7	16	
		30	280								
		Total	**8,987**	**m^3/day**		6.1	**157,200**				
Hourly Ave.			**374**	m^3/hr			11,229	Capacity =4.5			
			Detective value		Operation record of TR ＊3.0m:Minimum Water Level						

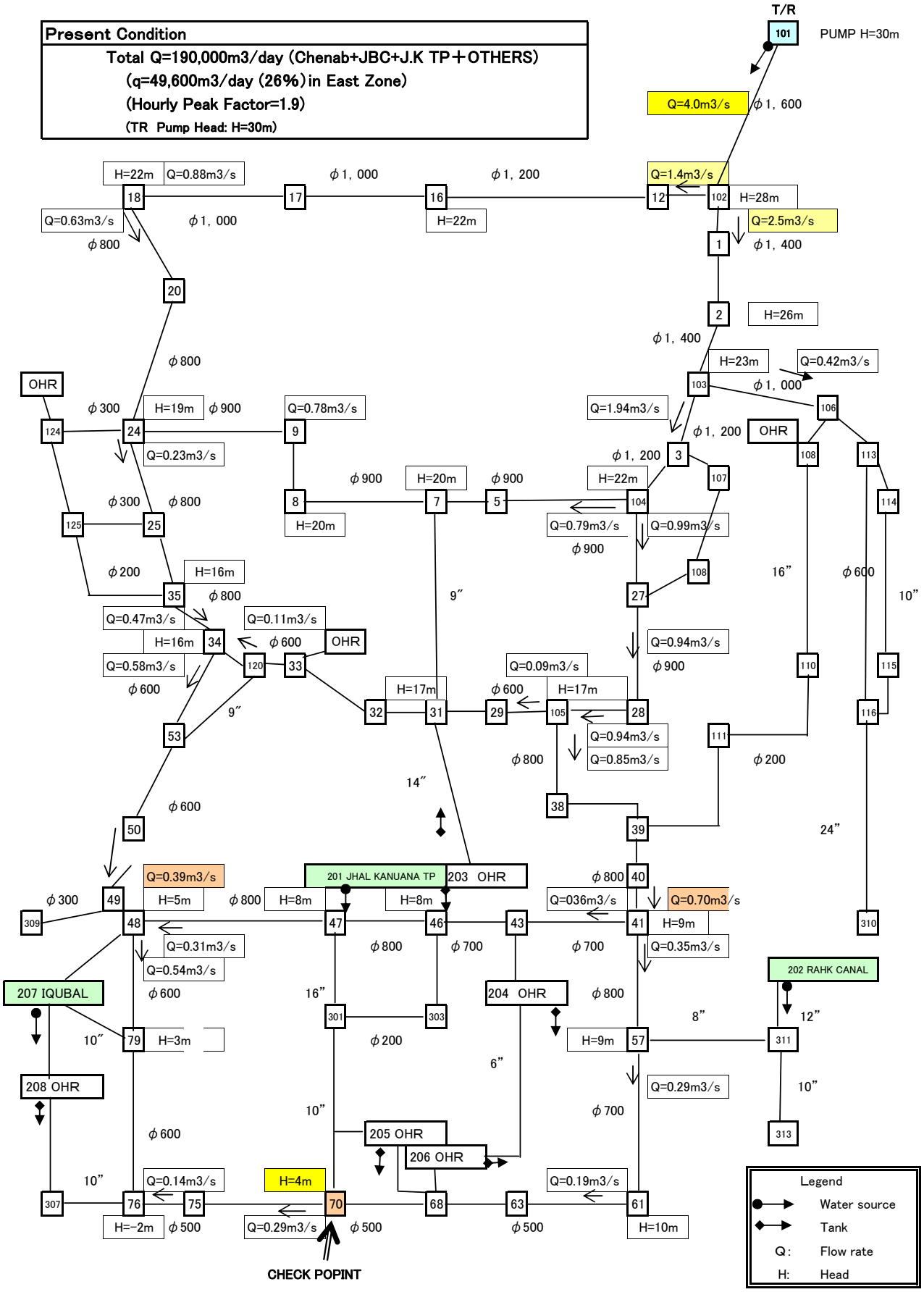
(3) List of Existing Reservoirs in the City

Tank No.	Location	Overhead reservoir	Ground reservoir	total		Node No.	Operating condition
West side		(MG)	(MG)	(MG)	(m^3)		
W-01	Civil Line Bagh-e-Jinnah	0.05	0.1	0.15	682		×
W-02	Gujjiar Basti	0.05	0.15	0.2	909	A/M NO.7	×
W-03	Dhobi Ghat	0.03	0.1	0.13	591		×
W-04	Muhammad Pura	0.1	0.1	0.2	909	A/M NO.9	×
W-05	Jinnah Colony	0.05	0.13	0.18	818	A/M NO.10	×
W-06	Karkhana Bazar	0.05	0.03	0.08	364		×
W-07	Gulberg	0.05	0.2	0.25	1,137	A/M NO.11	×
W-08	Afghan Abad	0.2	0	0.2	909	A/M NO.11	×
W-09	G.M.Abad Water Works	0	0.5	0.5	2,273	A/M NO.14,16	×
W-10	Latif Chowk/Chohar Majra	0.05	0.2	0.25	1,137	A/M NO.17	×
W-11	Admn Chowk	0.05	0	0.05	227	A/M NO.9	○
W-12	Kanak Basti	0.025	0	0.025	114	A/M NO.13	×
W-13	Islam Nagar	0.1	0	0.1	455		×
W-14	Jhang Bazar	0.05	0	0.05	227		×
W-15	212 R.B./Chamra Mandi	0.05	0.2	0.25	1,137	A/M NO.51	○
W-16	213 R.B.	0.05	0	0.05	227		×
W-17	Amin Pur Bazar	0	0.05	0.05	227		×
W-18	Gulistan Colony	0.5	1	1.5	6,819	A/M NO.2	○
W-19	Gulistan Colony- II	0.05	0.2	0.25	1,137		×
W-20	Nazim Abad	0.05	0.1	0.15	682		×
W-N1	Kaleem haheed Colony No.1	0.04	0.05	0.09	409	A/M NO.18	×
W-N2	Kaleem haheed Colony No.2	0.04	0.05	0.09	409	A/M NO.18	×
W-21	Gulfishan Colony	0.1	0.05	0.15	682		○
Total volume of reservoir in western zone (MG)		1.735	3.21	4.945			
Total volume of reservoir in western zone (m^3)		7,887	114,593		22,480		
Total volume of reservoir in western zone under operation (MG)		**0.70**	**1.25**	**1.95**			
Total volume of reservoir in western zone under operation (m^3)		**3,182**	**5,683**		**8,865**		

East Side			(MG)	(MG)	(MG)	(m^3)	
E-01	Abdullah Pur	0.05	0	0.05	227	A/M NO.40	×
E-02	Peples Colony OHR-1	0.05	0.2	0.25	1,137	A/M NO.43,45	○
E-03	Peples Colony OHR-2	0.05	0	0.05	227	A/M NO.63	×
E-04	Head Water Works Jhal	0.05	1.2	1.25	5,683	A/M NO.32	△
E-05	Waris Pura	0.05	0.1	0.15	682	A/M NO.70	○
E-06	Baber Chowk / Batala Col.	0.05	0.1	0.15	682	A/M NO.70	○
E-07	Allama Iqubal Colony OHR +W.W.	0.1	0.2	0.3	1,364	Tube Well (106,106/A)	○
E-08	D-Type Colony	0.05	0	0.05	227	Tube Well (106,106/A)	○
E-09	Ahamed Nagar	0.03	0.05	0.08	364		○
E-10	Samanabad (Qadri Chowk)	0.03	0	0.03	136	A/M NO.49	×
E-11	Samanabad (OHR No Ⅱ)	0.05	0	0.05	227	A/M NO.67	×
E-12	OHR 17-W	0.5	0.25	0.75	3,410	A/M NO.50	○
E-13	Madina Town-	0.1	0	0.1	455	Tube Well (1,2,3,4,5)	×
E-14	Madina Town-	0.1	0	0.1	455	Tube Well (1,2,3,4,5)	○
Total volume of reservoir in eastern zone (MG)		1.26	2.1	3.36	15,275		
Total volume of reservoir under operation in eastern zone (MG)		**0.90**	**2.05**	2.95			
Total volume of reservoir under operation in eastern zone (m^3)		**4,091**	**9,319**		**13,411**		
Total volume of reservoir in whole city (MG)		3.00	5.31	8.3			
Total volume of reservoir in whole city (m^3)		**13,615**	**24,139**		**37,755**		
Total volume of reservoir under operation in whole city						Total volume of water supply	
Total volume of reservoir under operation in whole city (m^3)					**22,300**	230,000	(m^3/d)
Total volume of terminal reservoir under operation (m^3)					**24,000**	Detention time	
Total (m^3)					**46,300**	4.8	(hour)

① RESULT OF ARTERIAL MAIN NETWORK CALCULATION (PRESENT CONDITION)

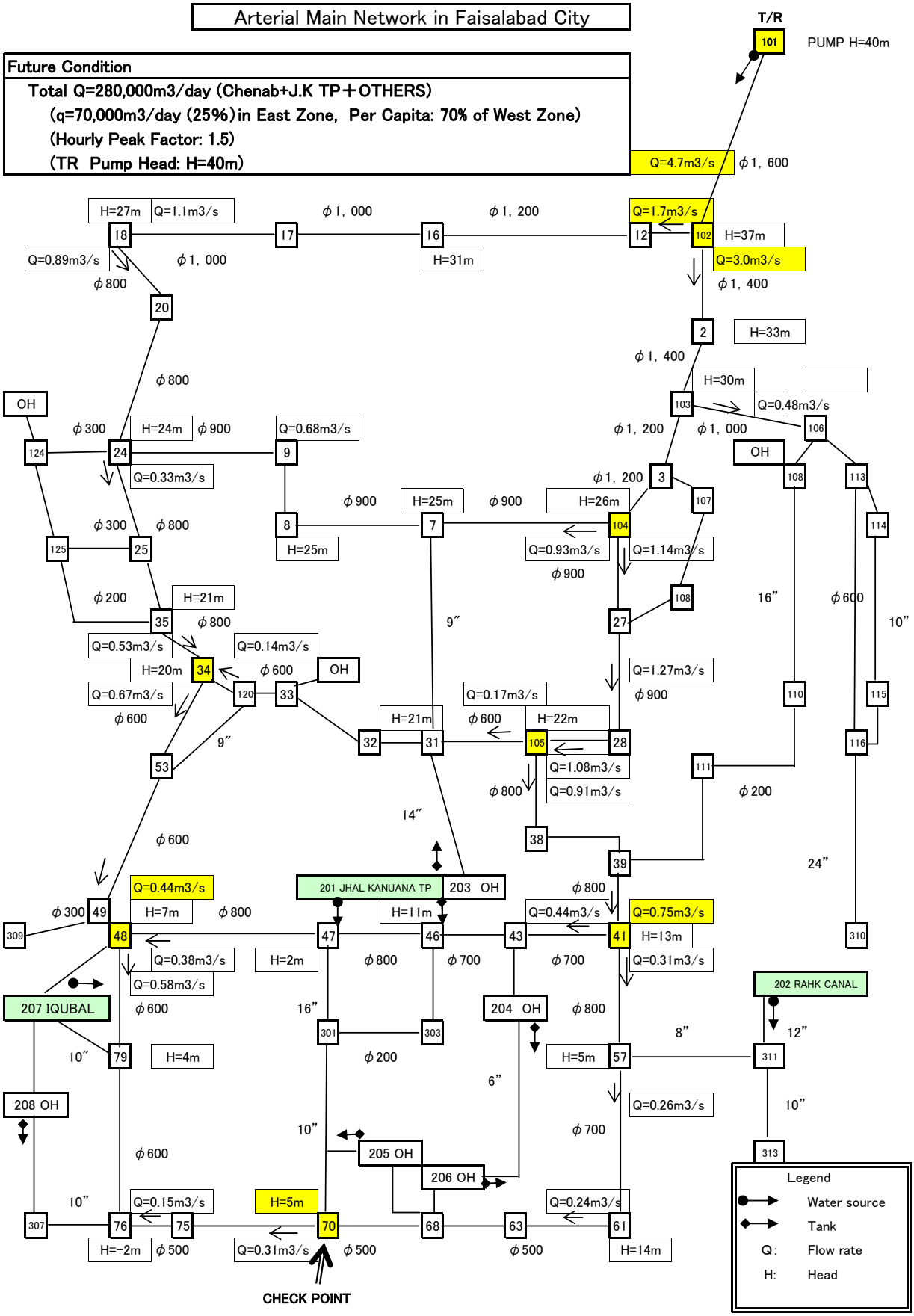
Arterial Main Network in Faisalabad City



② RESULT OF ARTERIAL MAIN NETWORK CALCULATION

*AFTER WATER SOURCE DEVELOPMENT

*PRESENT PIPELINE



③ RESULT OF ARTERIAL MAIN NETWORK CALCULATION

*AFTER WATER SOURCE DEVELOPMENT

*AFTER PIPELINE STRENGTHEN

Arterial Main Network in Faisalabad City

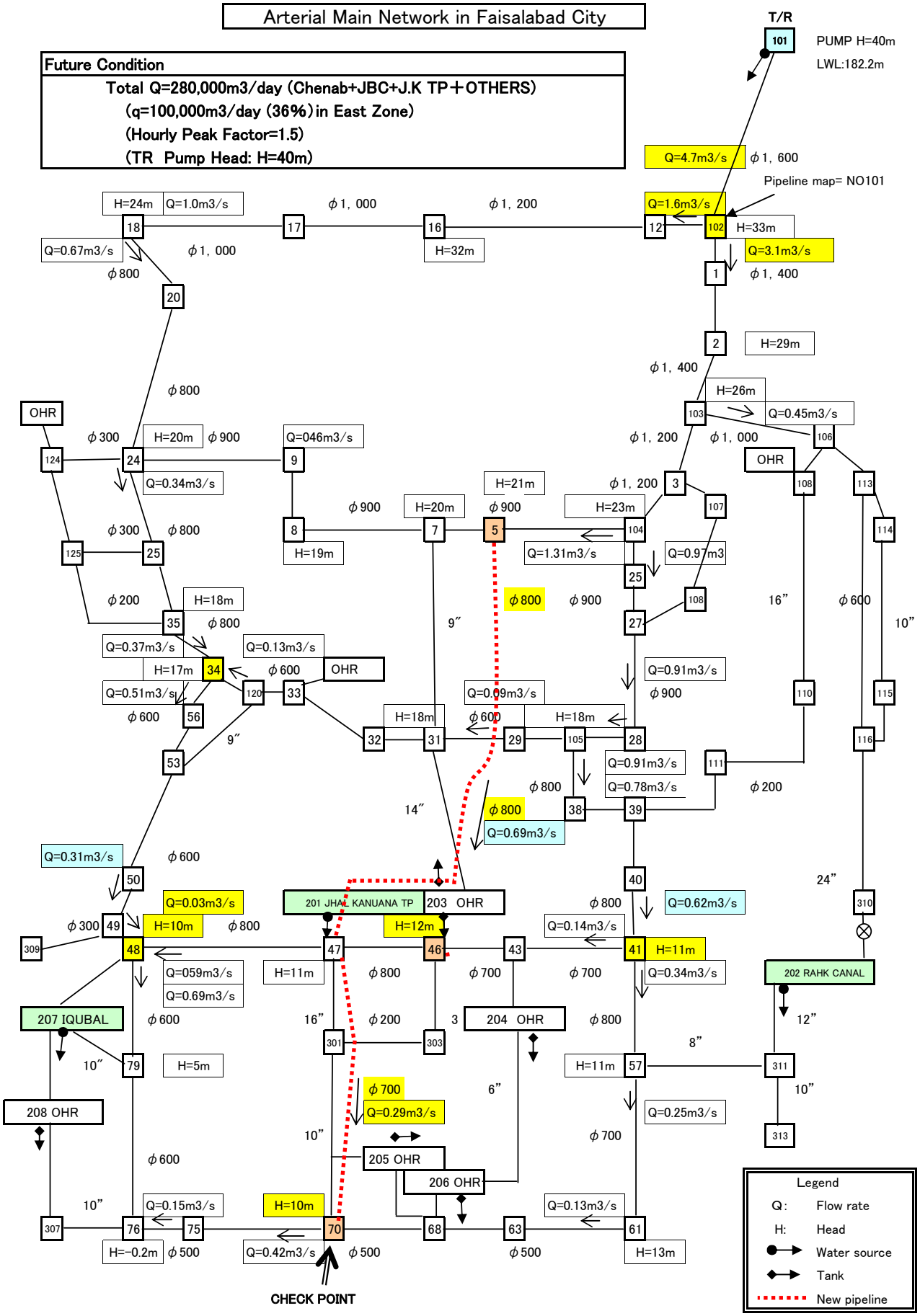
Future Condition

Total Q=280,000m3/day (Chenab+JBC+J.K TP＋OTHERS)

(q=100,000m3/day (36%) in East Zone)

(Hourly Peak Factor=1.5)

(TR Pump Head: H=40m)



Appendix 5-12 Comparison of pipeline network calculation

Strengthen Pipeline route		Node NO & Hydrodynamic Head（m）								Remark
		West Zone						East Zone		
		NO102	NO5	NO 18	NO 29	NO34	NO50 -51	NO47	NO70	
		1600mm branch	Start popint of Strengthen Pipe				West zone pipe end	End of Strengthen Pipe	Eest Zone pipe end	
1. Present condition										
	① Actual Head						**5**	**5**	**2～5**	Insufficient water supply
	②Calculation result（Per Capita Supply in East Zone）	28	20	22	17	16	8	7	4	
2. After project(equal per capita supply whole the city)										
	① Present Pipeline	**37**	**26**	**28**	**22**	**21**	**1**	**3**	**-6**	
(1) WASA proposal	②「Route 1」（φ700,l=3.5km）	37	25	28	23	21	11	16	4	Booster Pump is necessary In East Zone
	③Route 3（φ800,l=2.5km）	40	27	29	24	22	5	4	-5	
	④Route1 + Route3 (φ700-φ800,l=5.7km)	38	26	29	26	22	12	17	4	
	⑤Route1 + Route2 (φ700-φ800,l=7.6km）	37	28	29	26	23	14	18	5	
(2) Adopted Plan (Alternative)	**⑥「Route1」＋[Route；Inside of East Zone]（φ800- φ700, l=6km）**	**33**	**21**	**24**	**18**	**17**	**10**	**11**	**10**	**Good**
(3) Reference	Direct supply from TR to Jhal Kanuana T.P. (φ1,000,l=11km)	39	32	32	31	28	20	29	15	Good

Appendix 5-13 Socio-economic Survey on 2nd Basic Design Study (1) and Activities after the completion of the survey

(1) Background and Objectives of the Survey

In 1998 JICA dispatched a study team to Pakistan for 2nd Basic Design Study for the project for improvement of water supply in Faisalabad. It was, however, cancelled on the way due to the economic sanctions imposed on Pakistan due to its execution of nuclear testing. Before the study ceased, the team had been faced with an intense rejection against test drilling by residents in and surrounding the proposed wellfield site along the Chenab river. After that incident, WASA, executing agency of the project, took steps to procure a piece of land for testing in an alternative site about 5 km upstream the initially proposed site. For the present study undertaken in 4 years since the initial study, therefore, WASA had an intention to target the second wellfield site for groundwater development.

The proposed sites along the Chenab river were under jurisdiction of *Tehsil* Chiniot of the Jhang District, while Faisalabad city, the target of the project, is in another district of Faisalabad. Taking such a specific local condition into account, the renewed study proposed to carry out the social survey of households in both of the proposed sites (No. 1 and No. 2) for the wellfield. The objectives of the survey were (a) to examine the views of stakeholeders in both sites, (b) to confirm the conditions, if any, for their approval of the project, and (c) to propose to WASA findings and recommendations for securing agreement with them in either of alternative sites, since the Japanese side asked for definite verification of stakeholders' approval for the project implementation. The survey intended to support WASA's efforts for that target.

It turned out, however, that despite such a strategy of the current study, the residents' rejection popped up while it was underway, this time in No. 2 wellfield site. Immediately on completion of the household survey, WASA found itself in a position to enter direct negotiations with local stakeholders. At the end of January 2003, this process ended up with WASA's decision to suspend an addition development of the Chenab wellfield and to move the site from the initially proposed Chenab area to a new one along the Jhang Branch Canal some 15 km south of the river, as is outlined in Section (4).

As a result, those targeted directly in this social survey have now turned into just neighbours. However, their socio-economic situation revealed through the survey represents a section of general characteristics of those engaging in agricultural production throughout the region where WASA has been continuing the operation of existing tubewells, and their views should be referred to in planning the project in a newly-proposed site.

(2) Survey Areas

This social survey for the development of a new wellfield targeted No. 1 and No. 2 wellfield sites

along the Chenab river initially proposed by WASA for the project. The No. 1 site is represented by the village of Bukharian and the No. 2, about 5 km upstream, by Metha.

Both sites belong to Tehsil Chiniot of the Jhang District, while Faisalabad city is the capital of the adjoining Faisalabad District. WASA already has an existing wellfield in the Chenab area, which was commissioned in 1992 and has since been the major sources for water supply for Faisalabad. The villages covered by the present study involved 18 in total including Bukharian and Metha, as shown in the attached map (Fig.1).

(3) Survey Period

1) Field survey including discussions with WASA
From 18 December 2002 to 24 December 2002

2) Preparation of the report
From 24 December 2002 to 27 December 2002

(4) Survey Team

Since a great majority of villagers understands only Punjabi, a local language commonly spoken over a vast area throughout the Punjab province, the survey was entrusted to a local authority as follows:

Supervisor overseeing the survey:

Dr. Mohammed Zakaria Zakar
Chairman, the Social Department of Punjab University, Lahore

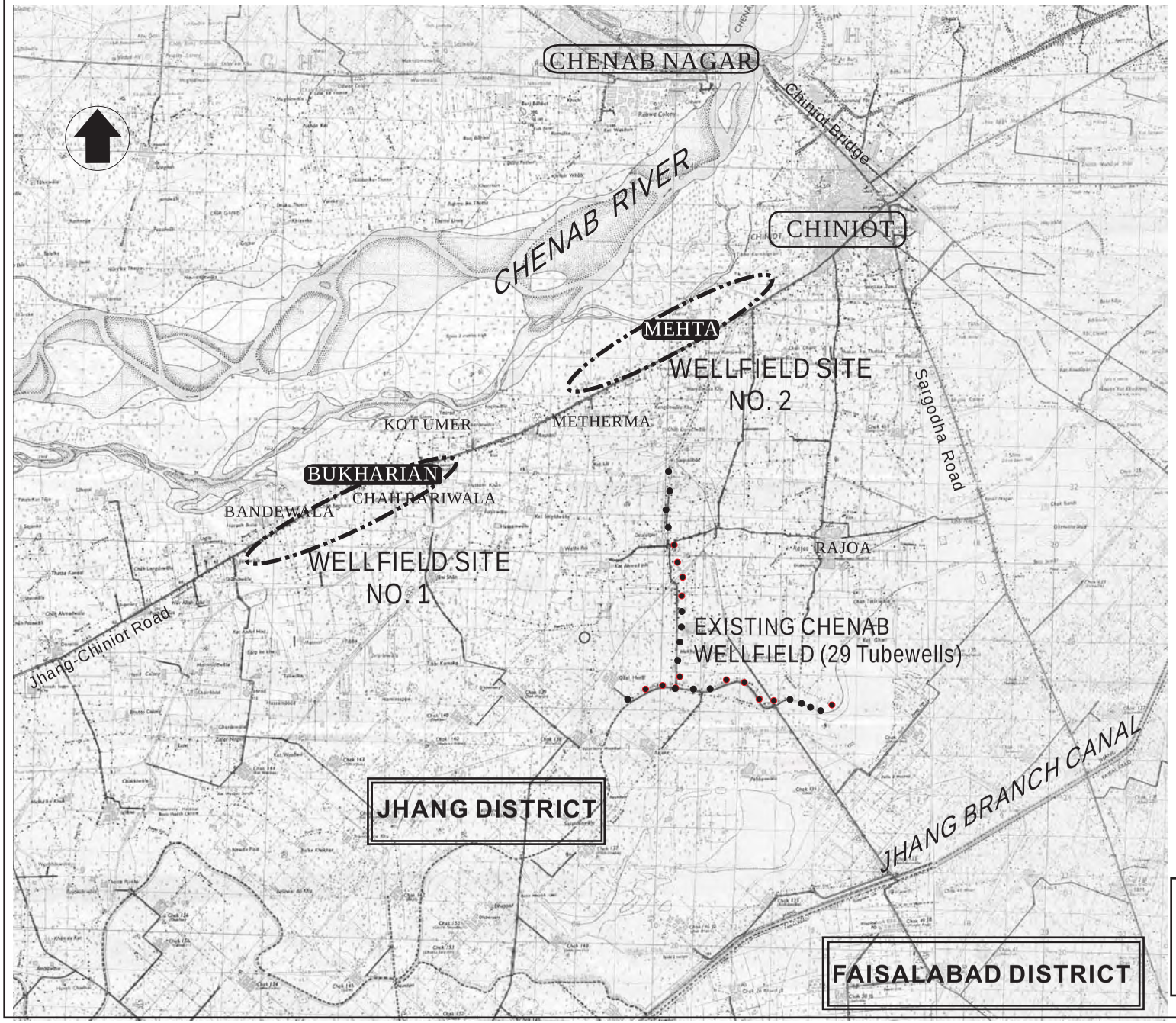


Fig.1
LOCATION MAP OF RELATED COMMUNITIES FOR PROPOSED WELLFIELDS

(5) Methodology

An extensive field research was conducted to find out baseline information and attitude of targeted villagers towards the project. The following methodologies were used.

□Sample survey

A sample survey was conducted against almost 10% of total household in the project area by semi-structured interview schedule. Population, size of household, no. of villages and no. of respondents are as below.

Table 1 Population, size of household, no. of villages and no. of respondents

Project sites	Total villages	No. of respondents	No. of household	Population
Bukharian	10	100	1,121	5,670
Mehta	8	100	904	7,400
Total	18	200	2,025	13,070

An accidental sampling procedure was adopted to approach the respondents for interviewing. Tools for data collection were constructed in English. However the local consultants as field researcher interviewed with respondents in local language.

□Village profile concerning socio-economic conditions in each village

Socio-economic conditions and demographic data of each affected village were profiled by interview schedule and village survey.

□Group Focus Discussion: GFD

GFD was conducted for villagers in each of 18 villages in the targeted areas. The above semi-interview schedule with questionnaire provided quantitative data, while GFD was conducted to get qualitative data in order to complement the former approach.

□Interviews with the Local Leaders, Influentials and Politicians

This survey was conducted to interview with politicians voted by the will of villagers, influentials such as landlords who have strong social influence and local leaders who have a sense of their obligation to look after the perceived interests of the people. From each village at least 2 representatives such as village leaders/influentials ware interviewed, and at the local center of Chiniot city, the *tehsil nazim* (chief of Tehsil Chiniot), police master, etc, were interviewed.

(6)Summary of social survey results

From social survey results, socio-economic profile provided perceived interests of people regarding

construction of tube wells.

1) General socio-economic situation

People are mainly depended on agriculture for their livelihood. From results of sample survey, 63% of respondents were farmers by occupation. In case that livestock holding is added, the data become 71%. Then 9.5% of respondents were business; 9.0 of respondents were labour; and 6.5% of respondents were employed persons. 72% of respondents owned self cultivated land, with 52.5% having land holdings ranging from 1 to 12 acres. However, 13.5% of big landlords hold more than 25 acres and are infulentials in the project area. Though 28% of respondents were landless farmers, 21.8% of them were employed by landlords for their income. And 95.2% of households keep livestock.

The annual incomes of 74% of households are lower than Rs. 40,000 (about ¥80,000). Since the average number of household members is 7 in Tehsil Chiniot, based on the 1998 census, an average person is in extreme poverty, living on less than ¥30 a day. The survey results exemplify the typical social structure of the region under control of a small number of landlords over an overwhelming majority of people in a level of extreme poverty

Regarding the situation of infrastructure in the project area, 90.12% of houses are electrified. However, 95.06% of housing units of the project area are without latrines and telephone facilities. It is noteworthy that the civic facilities like gas, water and sewerage/drainage systems are nonexistent in the entire project area.

Their livelihood depends on agriculture by irrigation in the project area. Out of 18 villages only 5 villages are nominally (10%-20%) dependent on river pumping and canal water for irrigation, whereas an overwhelming majority of remaining 13 villages are dominantly (80%-100%) irrigating their agricultural lands from privately installed tube wells. The entire population of the project area is significantly (80%-90%) dependent on ground water pumped by electric motor pumps or hand pumps.

According to sample survey data, 41.5% of the respondents and their wives (88.6%) are illiterate, and 36% of the respondents and their wives (4.7%) in educational background are more than primary level.

2) Perceived interests regarding construction of tubewells

There are four dominant castes in the project area; these include Khokhar, Wainse, Ansari and Sehdhan. The caste system play a major role in the collective and consensus decision making and formulating the public opinion. Blood and social relations within the caste are very strong and closely knit the entire area and its vicinity. Therefore any threat to any village/community became a matter of concern for the whole area.

82% of the respondents have been aware of WASA planning for additional tubewell construction.

83.0% of respondents perceive the scope of the project and reported that the beneficiaries are citizens of Faisalabad. (9.5% of respondents: the beneficiaries are government. 7.5% of respondents: don't know)

87.5% of respondents have no willingness to provide land to government regarding to construction of tubewell; 73% among them is against due to the lowering of water level. The remaining 27% is against due to opposition to landlords that agree to construction of tubewells.

The background of objections by people is in the commonly shared experience that groundwater level in private wells had been lowered due to continuous pumping of tubewells installed under the ADB project in the past. Their livelihood depended on agriculture by irrigation from pumping up private tube-well in the project area. They had a common fear that the lowering of groundwater level would further increase cost of their economical activities. In addition, as their domestic life and livelihood also depended upon groundwater from private wells, their fear was aggravated. The following table shows social, economical and environmental impact assumed by respondents on village life resulting from the construction of tubewells.

Table 2 Social, economical and environmental impact assumed by respondents on village life resulting from the construction of tubewells

Nature of Impact	Frequency	Ratio（%）
Drought like conditions will happen	136	68.0
Agriculture and livestock would perish	28	14.0
Population would be compelled to migrate	5	2.5
Cost of agricultural farming will increase	19	9.5
Hunger and thirst will prevail	7	3.5
Eco-system will be destroyed	5	2.5
total	200	100

68.0% of respondent feared "Drought like conditions will happen". As "cost of agricultural farming will increase", respondents assume the reinstallation of tubewells and motor pumps due to the lowering of water level. In the past, respondents used the hand pumps. However, people reinstalled motor pumps in the individually owned tube-wells by themselves due to the lowering of water level by the ADB project. Respondents shared the same experience. Therefore almost all answers from respondents attributed the lowering and shortage of ground water to the former WASA project. 96.5% of the respondents (had fear about the effects of tubewells on groundwater level. (No effect: 3%, Don't know: 0.5%)

The respondents thought that there would be no natural way to compensate the shortage of water caused by tubewells installed by a new project. However, the respondents had come up with some

proposals to minimize the worst effects of installation of tubewells causing shortage of water in the project area by measures listed in the following table:.

Table 3 Proposal remedial measures

Proposal remedial measures	frequency	Ratio（%）
Supply of sufficient canal water	43	21.5
Construction of dam on river Chenab	39	19.5
Non installation of tube-wells	45	22.5
Reliance on nature's reaction	23	11.5
Rain flood water	11	5.5
No substitute	39	19.5
Total	200	100.0

58% of respondents proposed various measures like supply of sufficient canal water to the project area (43%), construction of dam (19.5%), reliance on nature's reaction (11.5%) and rain flood water (5.5%) to make up the anticipated shortage of water in their area. These constructive answers are worthy of remark. The project is able to reach the settlement with villagers in case that sufficient compensations and correspondences would be provided to them.

The difficulties of settlement with villagers are suspected to be caused by their mistrust in WASA and insufficient correspondences in the past. The affects of the area were not consulted and took into confidence while the installation of tubewells during the ADB project in the past. They feared that the same practice would be repeated.

Comments of the respondents regarding the installation of tubewell were as follws.

Table 4 Comments of the respondents regarding the installation of tubewell

Comment	Frequency	Ratio（%）
The Government may only install the tubewells by using state power, disregarding the opposition of the affectees	17	8.5
The Government will provide only temporary compensation for pacifying the resistance of local people	25	12.5
The Government is not trustworthy because in past no meaningful compensation was provided to the affectees owning private tubewells in the project area	129	64.5
The Government never consulted the local population	29	14.5
total	200	100

Comments of local leaders were the same as those in the above table.

3) Conclusion of the survey

Summing up the results of the survey, the recommendations for promoting the project in the area where hostility has been lingering are as follows:.

 A relationship of trust needs to be established between WASA and local population through direct dialogues.
 WASA with support and cooperation of the Government should present effective proposals to local population to compensate the probable lowering of groundwater levels.

A possibility to reach agreement with local population might be created through WASA's continuous efforts.

(7) Activities after the completion of the survey

1) On completion of the field survey of the households in the targeted villages, the Consultant discussed with the WASA's representatives on the survey results, requesting them to take initiatives in the matter, starting the negotiations with the local population, first with the regional leaders such as Nazim Tehsil Chiniot, influential landlords, etc.

2) Notwithstanding such movement on the side of the execution agency, people's resistance broke out on December 23, 2002 when a drilling machine was delivered to the site for soil testing under the Basic Design Study. A crowd of some 100 residents around the No. 2 wellfield site, led by a provincial parliament member, gathered near the site and demanded to withdraw the equipment.

3) Faced with this incident, WASA was abruptly thrown into direct negotiations with local population. The subsequent events turned and twisted around persistent resistance of people, along with the interference of the government. The situation proceeded as presented in the following table:

Table 5 The situation proceeded as presented

Year	Date	Event	Description
2002	Dec. 23	Resistance of local population came to surface.	A gathered crowd of some 100 demanded to withdraw the study team to withdraw survey machine.
	Dec. 24	Dialogue between WASA and local population	In Chiniot city, Chairman and Deputy chairman of WASA had talks with representatives of Tehsil Chiniot and local residents
	Dec. 31	Local conference for discussions on the matter	At the public office of Metherma village, near the No. 2 site, representatives of related villages held a meeting to discuss on the matter with presence of WASA top officials and Nazim Tehsil Faisalabad.

2003	Jan. 8	Conference at Lahole chaired by the Chief Secretary, provincial government	Under the direction of the Chief Minister, the Chief Secretary called for the meeting of local authorities concerned about the matter. The conference concluded to support to continue the study.
	Jan. 18	No. 3 wellfield site was offered by an influential landlord.	As a solution for dispelling local resistance, a new land for the study (No. 3 site) was offered to WASA by an influential landlord in Metherma village located between the No. 1 and No. 2 sites. WASA and the study team inspected the proposed site, which was judged to be a relevant site for the study.
	Jan. 20	Mobilization of equipment to No. 3 site was cancelled due to resistance of people.	While preparing for mobilization of testing equipment to No. 3 site, a crowd of people gathered around the site to demonstrate their objection Chiniot police interfered in confrontation and WASA accepted police advice not to force mobilization. As a result of this incident, WASA decided to suspend the development of an additional wellfield in Chenab area for fear of stirring violence among resistant local population, and proposed to the study team to move the site to an alternative site along the Jhang Branch Canal.
	Jan. 22	Japanese side decided to cease the study for groundwater development	Since the new proposal by WASA had no assurance of agreement of stakeholders in a new site and lacked technical feasibility, the Japanese decided to cease the study for this part.
	Jan. 22	Site visit by the Minister and Secretary of HUD/PHD Dept.	Top officials of the HUD/PHD Dept visited Chiniot, in the hope of solving the matter through direct talks with local representatives around the site. The situation was found unfavourable for the project.
	Jan. 24	Conference between the Pakistani and the Japanese sides at EAD Islamabad	An official meeting of responsible officials on both sides was held at EAD in Islamabad under chair of Joint Secretary of EAD with the Pakistani side represented by the Minister of HUD/PHE Dept, Chairman of WASA, etc and the Japanese side by officials from the Embassy of Japan and JICA. During the meeting, the Pakistani side proposed to the Japanese side to continue the study in an alternative site along the Jhang Branch Canal, while the Japanese side informed of its intension to close the study this time since a new site had no guarantee for security as well as technical feasibility. The conference was closed with a conclusion that the Pakistani side will renew an official request for the study in the alternative site, supported by documents verifying consensus of stakeholders in the new site as well as technical feasibility.

Appendix 5-14 Socio-economic Survey on 2nd Basic Design Study (2)

1. Introduction

Project area was situated near Faisalabad city along the left bank of Jhang Canal on Faisalabad-Sargodha road. It was consisted of nine villages/towns stretched in almost 36 sq kilometers (12kmx3km). Land of the project area was fertile and almost all the area was under cultivation. The present project area under study was selected for the installation of tube wells for water supply to Faisalabad city.

Naturally, people might have their concern about the depletion of ground water level and socioeconomic implications on their produce and livelihood. Given this context, this socioeconomic survey was conducted to get baseline information about knowledge and perceptions of the people about the installation of the tube wells in their area, and its likely implications on their existing socioeconomic support systems. Furthermore, the nature of water resources, water needs of the people and the extent of their dependencies on the existing water resources in connection with their socioeconomic conditions were major concern of this study.

2. Methodology

The nine villages of the project area and three localities of Faisalabad city were selected for conducting survey. A team of local experts and social researchers carried out the survey to explore perceptions and concerns of the population of the study area. (Refer to the attached map)

Site-A. Project Area: Nine villages/towns along the Jhang Canal on Sargodha road near Faisalabad city where tube wells of the project are proposed to be installed.
Site-B. Faisalabad City Area: Three selected localities with different socioeconomic profile.

A representative sample of 220 households from nine villages of the project area was selected and interviewed by using quota-sampling procedure. An accidental random sampling was adopted to approach the head of the households/respondents of the villages. The village-wise detail of population, number of households and sample size of respondents is given in Table 1.
Similarly, three localities of Faisalabad City area with different socioeconomic characteristics were selected by adopting purposive sampling procedure. A sample of 82 households were selected by random sampling and interviewed by following quota-sampling procedure. The localities-wise sample size is shown in Table 2.

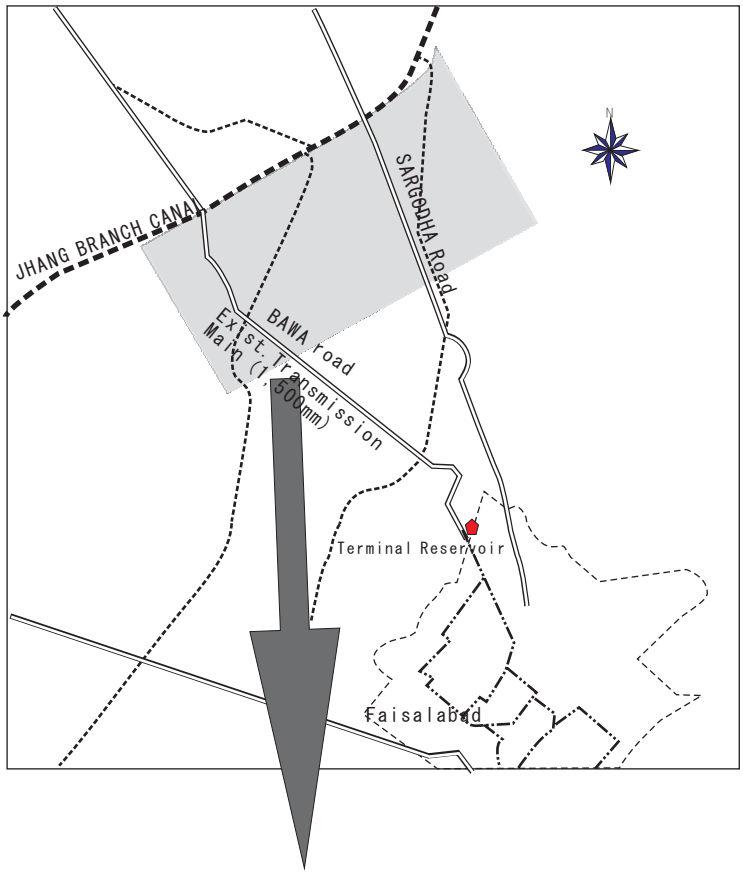


Fig. 1
LOCATION MAP OF VILLAGES FOR THE SOCIAL SURVEY IN THE 2nd STAGE

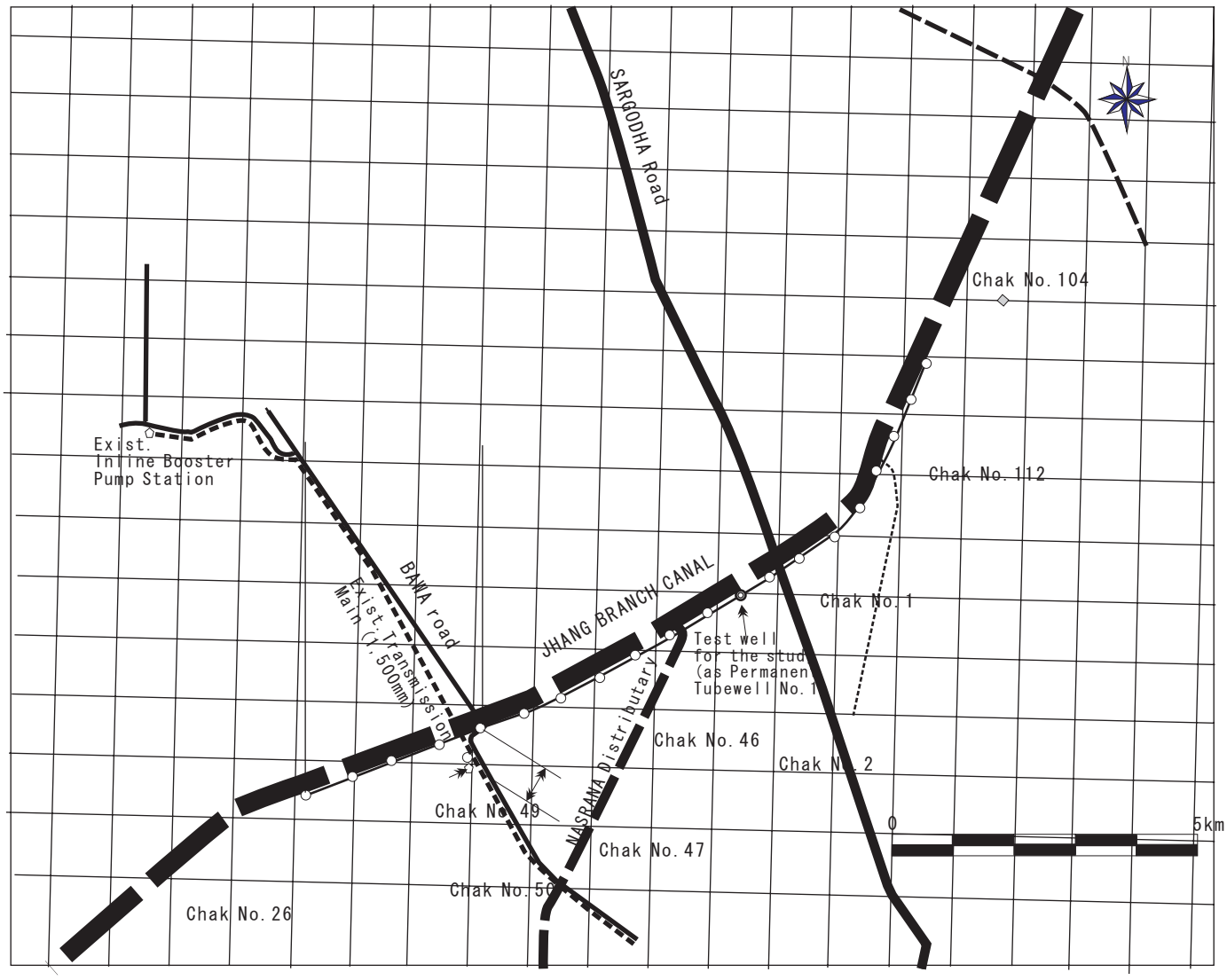


Table 1 Village-wise sample size of the households of project area

No	Chack No. / Village name	Population	Households	Sample Size	% of Households
1	1/R.B (Rasool Pur)	3,527	490	11	5.0
2	2/R.B (Ram Dewali)	4,713	733	14	6.4
3	26/R.B (Hargobind Pura)	10,654	749	24	10.9
4	46/R.B (Dhandra)	3,936	573	13	5.9
5	47/R.B	3,441	467	20	9.1
6	49/R.B (Munda Pind)	10,892	2.133	58	26.3
7	50/R.B (Sathyala)	8,463	1,783	48	21.8
8	104/R.B (Harmoay)	5,212	740	18	8.2
9	112/R.B (Kharral Wala)	3,639	542	14	6.4
	Total	54,477	8,210	220	100.0

Table 2 Sample size of the households from selected localities of Faisalabad City

Name of Locality	Sample Size	Percent (%)
Gulistan Colony	34	41.5
Hajvery Town	24	29.3
People's Colony	24	29.3
Total	80	100.0

The following tools and techniques of data collection were used to collect comprehensive and detailed information related to the project.

(a) Sample survey

A representative sample comprising of 320 respondents including 20 local leaders/influential from both the sites i.e. nine villages of the project area and three selected localities of Faisalabad city were interviewed.

(b) Interviewing and interview schedule (Questionnaires)

By applying interview technique for data collection for two different sites, two separate semi-structured interview schedule (questionnaires) were used. A separate interview guide (checklist) for interviewing the influential of the project area was used to conduct their in-depth interview. Copies of the questionnaires and checklist are attached in the appendix-I and II.

(c) In-depth interviews with the local leaders/influential

From each village of the project area at least two local readers/influential were interviewed by using interview guide as tools for data collection (copy attached as Appendix-III). It enable to have free and frank conversation with the influential of the project area to extract their understanding and perceptions about the installation of tube wells of the project for water supply to Faisalabad city.

3-1 Salient Findings (Site-A Village Area)

(1) Age and occupation of the respondents

83.1% of the respondents was in age-bracket of 21-60 years and 81.4% were the head of their

households. 74.1% of the respondents were engaged with agricultural farming by occupation demonstrating their dominant agrarian economic activities. Less than one tenth of the respondents were doing business whereas rest (18.2%) was either employed in private sector or working as labor most probably in nearby city Faisalabad.

(2) Employment status of family members

92.2% of respondents had large family size composing of 4-15 family members. It indicated a dominant feature of a joint family system prevalent in the project area. Further, no family member of 60.9% of the respondents was employed. Rather families of two fifth of the respondents (41.8%) had no student (any family member attending any educational institution). It was an indication that mostly poor people of the project area had least preference to send their children to school.

(3) Major sources of family income and expenditure

60.9% of reported their monthly income less than Rs 5,000/- and correspondingly almost the same percentage (64.6%) mentioned their monthly expenditure less than Rs 5,000/-. It depicted the dominant prevalence of poverty in the project area. 81.8% of the respondents ware engaged in agriculture and (36.4%) in cattle farming. Almost a little less than one third (31.0%) of the respondents reported labor activities as their major source of income. Majority of them was working in the textile factories in the nearby city Faisalabad. Table 3, 4 and 5 are evident to these findings.

Table 3 Monthly expenditure

Monthly Expenditure	Frequency	Percent (%)
3,000 and below	86	39.1
3,001 – 5,000	70	31.8
5,001 – 10,000	53	24.1
10,001 – 15,000	9	4.1
15,001 – 20,000	2	0.9
Total	220	100.0

Table 4 Monthly income

Monthly Income	Frequency	Percent (%)
3,000 and below	73	33.2
3,001 – 5,000	69	31.4
5,001 – 10,000	54	24.5
10,001 – 15,000	16	7.3
15,001 – 20,000	4	1.8
Above 20,000	4	1.8
Total	220	100.0

Table 5 Majority source of family income

Response	Frequency	Percent (%)
Agriculture farming	180	81.8
Cattle Farming	80	36.4
Farming Labor	10	4.5

Business/Trade	21	9.5
Other (i.e. labor on looms in Fsd.)	58	26.4

(4) Agriculture land, farming and livestock/ Means of living

61.8% of the respondents had self-owned small cultivated land holdings ranging from one to five acres. Mostly, being the self-cultivators of their agricultural land, 83.6% of the respondents was engaged in agricultural farming. However, a little less than one fifth (18.6%) of the respondents were either tenants or lessees of the agricultural land. They usually cultivate wheat and fodder for self-consumption and for their livestock respectively. Sugarcane was their major cash crop that needed plenty of water round the year.

Cattle farming were the second major source of income of the people in the project area. 74.1% of the respondents owed their cattle and majority had 2-3 buffaloes and cows for selling milk to supplement their family income. However, goats and sheep were the second major strength of the livestock of the project area.

(5) Water resources for domestic and farming use

Hand pumps and electric motor pumps were the major source of water for domestic use and livelihood whereas canal water and tube wells were the only two sources of water for irrigation of agricultural land of the project area. 75% of the respondents, however, reported the non-availability of canal water found the year and correspondingly almost equal percentage (74.5%) regarded tube wells as the only major substitute source of canal water for irrigation of their agricultural land. However, 67.7% of the respondents considered tube wells as an expensive and not affordable source of water for irrigation, and 39.5% of them attributed the high expenses of tube well water to costly instruments and maintenance. Thus, considering a cheaper option, people showed their preference for canal water supply for their agriculture instead of ground water.

(6) Lowering of ground water level

However, 48.6% of the respondents were able to relate the lowering of table/ground water level with the installation of privately owned tube wells for extracting water for irrigation of agricultural land, and 41.8% linked it with drought like conditions due to no rains in the entire country during the previous year (Table 6). At the same time, 80.9% of the respondents were able to relate rain and nearby canal water with recharging of the ground water level in the project area (Table 7).

Table 6 Knowledge about causes of lowering the ground water level

Response	Frequency	Percent (%)
No rain	92	41.8
More tube wells (over pumping)	107	48.6
Other (specify)	5	2.3
Total	204	92.7

Table 7 Knowledge about source of recharging the ground water level

Response	Frequency	Percent (%)
Rain water	163	74.1
Nearby canal water	15	6.8
Don't know	21	9.5
Other (specify)	12	5.5
Total	211	95.9

(7) Installation of privately owned tube wells in project area

95% of the respondents were aware about the installation of the privately owned tube wells in the project area and they identified the local landowners as the installers. According to 61.4% of the respondents any one who was in need of more water for irrigation installed tube wells and expect 10% of the respondents no one had objected on the installation of privately owned tube wells in the project area. Rather, they were least concerned to install tube wells in their self-owned land.

(8) Reasons of no objection on installation of private tube wells

Three major reasons of such no objection on the local installation of tube wells in the project area were the common need of tube well water for irrigation of agricultural land (sharing of tube well water by purchasing), installation of tube well in self-owned land and "no reason." A little less than half (46.4%) of the respondents reported the purchase of tube well water and almost an equal percentage (43.6%) considered it as an expensive source of water. At the same time an overwhelming majority of the respondents was not satisfied with the available quantity of canal water and tube well water to fulfill their present needs of water for irrigation. Table 8 represented the aforesaid findings.

Table 8 Objection on installation of private tube wells

Response	Reason	Frequency	Percent (%)
Yes	Water level will decrease	22	10.0
No	Sharing water from tube wells on payment	85	38.6
	Due to installation of tube wells In self-owned land	48	21.8
	No reason	36	16.4
	Other (Specify)	5	2.3
	Not applicable	24	10.9
	Total	220	100.0

(9) Knowledge about the installation and benefits of the project tube wells

83.6% of the respondents were aware about the project site for the tube wells installation and almost an equal percentage (70.9%) reported the purpose of the project tube wells was water supply to Faisalabad City. One fifth (20.9%) of the respondents, however, were not familiar about the installation of tube wells of the project in their area.

Table 9 Knowledge about the purpose of installing the project tube wells

Response	Frequency	Percent (%)
Water supply for Faisalabad	156	70.9
Water supply for native land/people	10	4.5
Don't know	46	20.9
No response	8	3.6
Total	220	100.0

Almost one third (35.4%) of the respondents foresaw job opportunities for the local people during and after installation work of tube wells of the project. Considering a water supply project almost one fifth of respondents expected water supply to their village, and two fifth (41.8%) reported no benefit for the project area rather they foresaw loss for their area.

(10) Social organization and stratification

People of the project area had great regard to their elders and traditional authority figures. Normally they prefer consensus-based decision making and collective response to the issues by following the norms of mutual consultations. They showed their trust and respect to their local leadership. Anyhow, they also watched carefully the conduct and integrity of their local leaders to ensure their collective interests.

Due to small land holdings and farming patterns of typical agrarian society, people of the project area had many socioeconomic commonalities among them. They had almost similar nature of sources of income and dependencies on the local support systems. Such a common socioeconomic features depicted the homogeneous character of the local population. Given this context, they had common problems and concerns with the installation of tube wells of the project.

(11) Local perceptions about the installation of tube wells

Shortage of canal water compelled the farmers of the project area to install tube wells for irrigating their agricultural land. Their increasing dependency on ground water led them to install more tube wells in the project area. Ultimately, it caused lowering of ground water level

Understandably, almost majority of the respondents anticipated shortage of ground water by linking it with lowering of ground water level due to the installation of tube wells of the project. Anyhow their concern was only with the quantity of canal water for irrigation of their agricultural land regardless tube wells costly source of water for irrigation with negative effects on the fertility of their lands. Canal water was considered with twofold benefits i.e. irrigation and improvement of fertility of agricultural land.

(12) Local apprehensions about the installation of tube wells

Considering the installation of tube wells in their area, village people of the project area anticipated without sufficient supply of canal water they would be deprived of their only major substitute source

of water i.e. ground water. With such understanding people of the project area foresaw serious set back to their agriculture and livestock, which were their major source of income, livelihood and habitat.

At the same time, they were equally conscious about the water needs of the citizens of Faisalabad City and had feelings of in-group with them. They showed their conditional consent for supplying water to Faisalabad City from area if they were provided sufficient canal water for irrigation of their agricultural land.

3-2 Salient Findings (Site-B Faisalabad City)

(1) Water supply and its use

Public water supply was the only source of water especially for drinking purposes. People reported acute shortage of water supply especially in shanty-towns (poor localities). Duration and pressure of public water supply was not adequate to fulfill the water needs of the citizens. Similarly, people had complaints about the quality of water as well as quantity of water.

(2) Awareness about the project

Nearly half of the respondents (53.7%) living in the city area were not aware about the installation of tube wells of the project under study. Knowing about it through the interview, however, all the respondents welcomed such a project meant for water supply to Faisalabad City. Relevant table is attached below.

Table 10 Knowledge of respondents of Faisalabad City about the project

Item	Response	Frequency	Percent (%)
Installation of tube wells	Yes	38	46.3
	No	44	53.7
Name of execution agency	Yes	6	7.3
	No	56	68.3
Area of tube well installation	Yes	22	26.9
	No	60	73.1
Source of public water supply	Yes	43	52.5
	No	39	47.5
Purification of public water supply	Yes	21	25.6
	No	61	74.4
Distribution of public water supply	Yes	27	32.9
	No	55	67.1

Although, they were not satisfied with the performance of WASA regarding its responsibilities to supply sufficient water to the city.

4. Conclusion and Recommendation

(1) Conclusion

(a) The two major sources of income of the people of the project area are agriculture and

employment/labor work in Faisalabad City. Their agriculture depends on the source of water, and their employment/labor work is connected with the people of Faisalabad City. Both of the means of income are equally important to them.

(b) There is efficient network of canal water distribution in the project area with insufficient supply of canal water. Ground water is the secondary and costly source of water for irrigation of the agricultural land of the people. People of the project area preferred canal water to ground water for irrigation.

(c) People of the project area had in-group feelings with the citizens of Faisalabad City. They had no objection on installation of tube wells by the local agricultural landowners in their land. It may equally be applicable for government project if the tube wells would be installed in governmental owned land.

(d) People of the project area considered the installation of tube wells as a public welfare project meant for supplying drinking water to the citizens of Faisalabad City. However, if their canal water needs for irrigation of their agricultural land is fulfilled, they had no objection on the installation of tube wells of the project.

(2) Undertakings/countermeasures by the project

(a) A workable dialogue with the representatives of the locals of the project area is needed to minimize the chance of misunderstanding amongst the locals and the execution of the project.

(b) Participation of the locals in the project activities during its execution and after completion must be ensured so that they may have share in economic benefits and employment opportunities of the project.

(c) A regular and institutionalized interaction of the project execution agency with the locals of the project area be maintained. For this purpose, establishment of Project Liaison Committee (PLC) is recommended which should manage and monitor the implication of the project.

(d) The nominee of the project execution agency and the representatives of the local population may represent the PLC. A local norm of consultation and consensus-based decision making must be adhered to ensure the participation of the local population to own the decisions about the project.

(3) Recommendations to Pakistan government

(a) Viable substitute source of water especially the canal water should be ensured for the fulfillment of irrigation needs of the project area.

(b) The genuine socioeconomic problems especially the sewerage system of the villages be addressed by taking the matter with the agencies concerned.

(c) A meaningful progress of the mitigation measures regarding the plentiful supply of canal water to the project area may be helpful in trust building and winning the cooperation of the population of project area. Therefore mitigation measures of the likely adverse impacts of the project on the local population are recommended to be the integral part of the project activities.

Appendix 5-15 WASA's Water Tariff

(Comparison of the revised tariff on January, 2004 with the revised tariff on January, 2007)

1. Tariff for Water Supply

	Category	Meter	Dia.	Plot size	Conversion into metric system	Rate (Rs/Month) 2004/Jan	2007/Jan
1)	Domestic	Without	1/4"	~2.5 *Marla*	~60 m^2	72	83
				2.5~3.5 *Marla*	60~88.5 m^2	108	124
				3.5~5 *Marla*	88.5~126.5 m^2	126	145
				5~10 *Marla*	126.5~250 m^2	210	242
				10~20 *Marla*	250~500 m^2	280	322
				20~40 *Marla*	500~1,000 m^2	560	644
				40~ *Marla*	1,000 m^2 ~	840	966
	Conversion: 1 *Marla* = 272 ft^2 = 25.3 m^2, 1 *Kanal* = 20 *Marla*, 1 acre = 8 *Kanal*						
	Note 1: In case of more than ID1/2", the rate will be charged as double of the above rate.						
	2: The above mentioned rates will be charged up to three story's. On above 33.33% the rate will be charged to each story.						
2)	Domestic	With	-	~5,000gallon/Month	~22.75 m^3/Month	34	39
				5,000~10,000 gallon/Month	22.75~45.5m^3/Month	35	40
				10,000~ gallon/Month	45.5~ m^3/Month	42	48
	Conversion: 1,000 gallon = 4.55 m^3						
3)	Industrial commercial & other non residential properties	Without	1/4"	~3 *Marla*	76 m^2	322	322
				3~6 *Marla*	76~150 m^2	483	483
				6~10 *Marla*	150~250 m^2	805	805
				10~20 *Marla*	250~500 m^2	1,288	1,288
				1~2 *Kanal*	500~1,000 m^2	2,415	2,415
				2~ *Kanal*	1,000~ m^2		3,220
	Conversion: 1 *Marla* = 272 ft^2 = 25.3 m^2, 1 *Kanal* = 20 *Marla*, 1 acre = 8 *Kanal*						
4)	Industrial commercial & other non residential properties	With		/1,000 ｶﾞﾛﾝ	/4.55 m^3	46.5	53
	Conversion: 1,000 gallon = 4.55 m^3						
	Note1: Incase of defected meter, the average rate of last 12months shall be applied. Incase of temporary disconnection, consumer have to pay 15% of the average rate of last 3 months. Consumer shall report within 24 hours						

5)	Industrial commercial & other non residential properties	Without	Above 1/4"	1/2", ～10 *Marla*	～250 m^2	700	1,610
				1/2", 10～20 *Marla*	250～500 m^2	1,120	2,576
				1/2", 20～ *Marla*	500～ m^2	1,960	4,025
	Conversion : 1 *Marla* = 272 ft^2 = 25.3 m^2, 1 *Kanal* = 20 *Marla*, 1 acre = 8 *Kanal*						
6)	Industrial commercial & other non residential properties	Without	3/4"			2,100	5,175
			1"			2,800	5,750
			1-1/2"			8,400	9,660
			2"			16,800	19,320
			3"			42,000	48,300
			4"			84,000	96,600
			6"			280,000	322,000
	Note :	More than 6" connection size, the rate will charged as below mentioned formula (6"/month) × D × D × 4, D : Connection size (ft)					
7)	The Government registered religious/charity units/departments & Mosques will be charged as 70% domestic rate					–	

2. Aquifer charges (Fee on tube wells)

	Category	Property of tubewell	tariff/Rs/Cusec/Month	
1)	Tubewell	Industrial, Commercial, Government, Semi Government, Irrigation Dept., Agency, Local organization	11,200	12,880
		Textile Processing and Hosiery units	9,100	10,465
	Conversion : 1 Cusec = 1.7 m^3/min			
	Note :	Incase of more than Dia 2" of Pump and tubewell, the above rate will be applied		

3. Tariff for Sewer/Drainage

	Category	Plot size	Conversion into metric system	Rate (Rs/Month) 2004/Jan.	2007/Jan
1)	Domestic	～2.5 *Marla*	～60 m^2	42	55
		2.5～3.5 *Marla*	60～88.5 m^2	56	83
		3.5～5 *Marla*	88.5～126.5 m^2	105	97
		5～10 *Marla*	126.5～250 m^2	175(～177m3) 210(～250m3)	161
		10～20 *Marla*	250～500 m^2	350	242
		20～40 *Marla*	500～1,000 m^2	490	403
		40～ *Marla*	1,000 m^2 ～	770	644
	Conversion: 1 *Marla* = 272 ft^2 = 25.3 m^2, 1 *Kanal* = 20 *Marla*, 1 acre = 8 *Kanal*				
	Note1:	The above mentioned rates will be charged up to three story's. On above 33.33% the rate will be charged to each story.			
	2:	In case that consumers drain away to WASA's sewerage line through open sewer, they will charged as 70% of domestic rate upto the insatallation of sewerage line.			
2)	The Government registered religious/charity units/departments & Mosques will be charged as 70% domestic rates.			-	
3)	Commercial	Shop and Department store (per point having one toilet/wash basin/sink tap etc.)		105	121
		Hotel(per bed/bath/bed room/toilet/wash basin)		70	81
		Restaurant(per toilet/wash basin/tap)		70	81
		Private hospital, Clinic and Clinical laboratories (per bed/bath/wash basin/tap)		50	58
		Car service station (per lift/bay)		1,260	1,449
		Motor service station etc		170	201
		Hair cutting salon, Beauty parlor and Hamam (Public bath) (per wash basin/tap)		50	58
		Multi-story commercial plaza, Bank and Marriage hall (per 1,000ft^2=92.9m^2 covered area)		350	403
		Governmental office (per 1,000ft^2=92.9m^2 covered area)		175	201
		Private education dept., Schools, Collages and Institution (per 1,000ft^2=92.9m^2 covered area)		252	290
		Luxury hotel (per 1acre=4,047m^2 covered area)		2,800	3,220
		Other units (per 1,000ft^2=92.9m^2 covered area)		252	290

		Category	Rate/Rs/Year/ft²	
			2004/Jan	2007/Jan
4)	Industrial	Limited waste and used water discharged factories (cotton, ice making, cold storage, tea, textile, accessory, confectionery production and pharmaceutical factory)	3.0	3.5
		Waste and used water discharge small units (Cast metal, coating material, soap, piping material, pottery and plastic factory)	1.5	2.0
			料金 (Rs/月/Cusec)	
5)	Industrial	Bulk waste and used water discharge	40,600	46,690
	Conversion: 1 Cusec = 1.7 m^3/min			

4. Other tariff

	Category	Detail	Rate	
1)	Water connection	Domestic 1/4″ferrule size	483	Rs/Connection
		1/2″ ferrule size and above	3,220	
	Note: Consumer will prepare necessary materials			
2)	Sewer /Drainage connection	Domestic	322	Rs/Connection
		Commercial	805	
		Industrial	3,220	
	Note: Consumer will prepare necessary materials			
3)	Re-connection	Re-connection for water and sewer will be half of connection fee.	–	Rs/Connection
4)	Bond	Domestic: Bond for water and sewer will correspond to payment for 3 months	–	Rs
		Commercial: ditto	–	
		Industrial: ditto	–	
5)	Water : Nomalization of illegal connection	Domestic	483	Rs
		Commercial: Correspond to payment for 3 months	–	
		Industrial: ditto	–	
	Note: Same condition for normalization of illegal use of tubewell			
6)	Sewer : Nomalization of illegal connection	Domestic	322	Rs
		Commercial: Correspond to payment for 3 months	–	
		Industrial: ditto	–	