Environmental Policy and Technology Project

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KAZAKHSTAN

FIELD REPORT

Proposed Transmission System Improvements at Regional Water Systems: Kyzl Orda Oblast, Kazakhstan

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Environmental Policy and Technology Project
For the New Independent States of the former Soviet Union
A USAID Project Consortium Led by CH2M HILL

PROPOSED TRANSMISSION SYSTEM IMPROVEMENTS AT REGIONAL WATER SYSTEMS: KZYL-ORDA, KAZAKHSTAN

BACKGROUND

This project is a part of the program as defined in the Memorandum of Understanding executed between the Government of the United States and the Government of Kazakhstan on 18 February 1994 to "promote improved environmental health" in the environmental disaster areas lying around the Aral Sea.

The Environmental Policy and Technology Project (EPT) Field Report "Interim Field Investigations in Kazakhstan: Regional Water Systems in Kzyl-Orda Oblast" dated October 1994 included recommendations for providing a variety of new equipment to upgrade and improve the regional water systems. This equipment included: (a) laboratory equipment for the existing laboratories in Aralsk and NovoKazalinsk (b) new chlorination equipment for booster pump stations along the federal transmission pipeline, and at the NovoKazalinsk water treatment plant, (c) replacement pumps for the booster pump stations, (d) new submersible well pumps for the Kozaman and Berdykol well fields, (e) ~~mobile generators~~, (f) diesel welding units, (g) backhoe excavators, and (h) water distribution pipe for the rayons of Aralsk and NovoKazalinsk. The Report also identified the need to establish more information on methods to repair leaks in the transmission main and on methods to complete the connection of NovoKazalinsk to the transmission main.

Meetings were held in December 1994 and February 1995 with federal engineers, oblast representatives and field engineers to review and revise as necessary the above recommended improvements. This EPT Field Report summarizes the recommended improvements based of those meetings and on associated observations from site visits.

The current status of the proposed improvements is as follows:

- Laboratory equipment has been delivered to the five laboratories (February 1995) and installed with initial training in the use of all equipment.

- Chlorination equipment has been bid with contract award planned for March 1995. This will be followed by assembly and shipping. Installation, startup and training is scheduled be completed during August 1995.

- The proposed replacement pumps for the distribution pump stations are summarized in this report.

- The proposed well field improvements are summarized in this report.

- Mobile generators will be deleted from the proposed deliverables based on the lack of fuel for operation as determined from the above referenced meetings.

- Diesel welding units should be provided based on the above referenced meetings and total of 6 units are recommended. Procurement documents will be prepared in April followed by bidding, shipment and delivery by June 1995.

- The decision to provide backhoe excavators will be based on remaining available funds after purchase and delivery of the other equipment listed above.

- Water distribution pipe for the rayons of Aralsk and NovoKazalinsk will be evaluated in a later review. The final decision of pipe procurement will be based on available funds, clarification of design considerations, and satisfaction of ability to install the pipe as designed.

Current status on repair of the leaks in the water transmission main have been determined to be beyond the funding capability of this project and will be referred to other donors such as the World Bank for funding.

DESCRIPTION OF FACILITIES

The project area is shown in Figure 1. The regional water systems consist of: (a) a federal system owned and operated by the Federal Water Resource Commission (FWRC) consisting of two well fields, a 236 kilometer (km) pipeline and six (6) booster pump stations, (b) the city (rayon) of NovoKazalinsk's system includes an intake pump station which draws water from the Syr Darya (river) and pumps water either directly into the city's distribution system without treatment or to the city's water treatment plant from where filtered and disinfected water is pumped to their distribution system, and (c) the city of Aralsk's system which consists of a pump station and distribution piping. Aralsk obtains all of its water from the FWRC system through a tap into the transmission pipeline just upstream of PS 3.

In the federal system, water from the well fields is pumped into reservoirs as show in Figure 2 from where it is subsequently repumped into the transmission pipeline via PS 1 at the Kosaman field and PS 2 at the Berdykol field. PS 1 pumps to reservoirs at PS 2. PS 2 repumps the flow from PS 1 along with the flow from the Berdykol field to reservoirs at PS 3, likewise, PS 3 pumps to PS 4, PS 4 pumps to PS 5, and PS 5 pumps to PS 7. There is a PS 6 in the system; however, it is not a booster station and was not evaluated as part of this project.

Wellfields

During the EPT site visit to the well fields in June 1994 it was reported that 16 (53 per cent) of the 30 wells at the Kosaman field were operational. At the Berdykol field, 5 (62 per cent) of the 8 wells were operational. In February 1995, the federal field engineer reported that while 5 of the 8 wells are still operational at Berdykol, only 11(37 per cent) of the Kosaman wells are operational. The reasons given for well failure is excessive pumping of sand which is destroying pump impellers. Also, lack of adequate controls appears to be causing motor burnouts.

Average yield of the Kosaman wells is reported by the field engineer to be approximately 20 l/s (0.4 mgd) each. Total production of the Kosaman field based on 11 functioning wells is therefore 220 l/s (5.0 mgd). Average yield of the Berdykol wells is also estimated to be about 20 l/s giving a total production of the field of 100 l/s (2.2 mgd).

These estimates of individual well yields are higher than the 11 l/s reported to the EPT team in June 1994. The net effect is that even though fewer wells are reported to be operational, the total production of the two fields is now stated to be higher than originally (reported, i.e, 220 l/s vs 176 l/s at Kosaman, and 100 l/s vs. 55 l/s at Berdykol). Assuming these yields are reasonably accurate, the total existing production of groundwater is about 320 l/s (7.2 mgd).

Figure 2 summarizes the estimated present and future demands of water within the regional systems. These demands were estimated by federal engineers in Almaty. Based on the above reported production of the two well fields, there is not enough water available to meet existing demands. It is therefore impractical to design for the future demands. Existing demands from Aralsk, the rural settlements, and the city of Kazalinsk total approximately 520 l/s (11.7 mgd). As existing total production of the well fields is estimated at 320 l/s, the production shortage to meet existing demands is 200 l/s (4.5 mgd). If each well can produce 20 l/s, ten new wells are needed to upgrade the production capacity to meet present demands. In that the Kosaman wells are continuing to fail, it is recommended that a total of fourteen (14) new wells be installed, twelve (12) at Kosaman and two (2) at Berdykol. This proposal is basically consistent with the request by federal level engineers for fourteen new (14) wells at Kosaman and two (2) new wells at Berdykol. In that the major cause of failure of the existing wells appears to be related to well construction and development, it is recommended that improvements to the well fields be based on installing completely new wells rather than attempting to install new submersible pumps in existing wells. Figure 3 shows typical well construction for a new well located either at the Kosaman or Berdykol fields. The only difference in design relates to the total depth of casing required for either location.

Installation of the new wells would be based on all materials as listed in Table 1, including casings, screens, pumps, piping, electrical, cement grout, and filter sand, being provided under the USAID contract. Special equipment as listed would also be provided. All labor and equipment necessary to drill the wells, set the pumps, and extend power to the well heads would be provided by the Government of Kazakhstan. An EPT construction manager would be assigned to the project to overview the well installations.

Transmission Pipeline

The transmission pipeline delivers water to all downstream pump stations and settlements along the pipeline and terminates at PS 7 at NovoKazalinsk. PS 7 pumps water to several settlements around NovoKazalinsk and to "old" Kazalinsk but not to NovoKazalinsk which presently has its own water system as described below

(there is a possible connection to part of NovoKazalinsk, however, it is not clear and there is a lack of storage).

The pipeline is predominantly a concrete pressure pipe, however, there are several sections of steel and PVC pipe located as shown in Figure 2. These sections were installed to replace leaking sections of smaller diameters of the concrete pipe in the locations shown. There are several known leaks in the concrete pipe with the largest number occurring between PS 2 and PS 3. Repair of these leaks is a priority need, however, due to the cost to repair these leaks (estimated in excess of US$5 million), and this work is beyond the scope of the EPT project and is referred to other donors, including the World Bank.

The diameter of the pipeline varies along its length as shown in Figure 2. It begins as a 1 meter (m) diameter pipe at PS 1 and reduces to 0.8 m at PS 3, then further reduces to 0.6 m (steel) and 0.7 meter (PVC) pipe downstream of PS 5. There is a 4.5 km length of 0.8 m pipe and 2.1 km length of 0.5 m pipe just upstream of PS 2 on the downhill side of a 60 m (200 ft) hill between PS 1 and PS 2. The terrain is intermittently hilly and flat between PS 1 and PS 3. Between PS 3 and PS 7 the land surface gradually rises in the order of 15 meters (50 feet) between each pump station.

NovoKazalinsk Water Treatment Plant

NovoKazalinsk has its own water treatment plant which treats contaminated water from the river. Evaluation of this plant was not within the scope of work for this project, however, two brief visits were made to the plant and the following observations are made. Treatment consists of sand filtration and chlorine disinfection; however, neither of these treatment processes are working properly. Control valves on the filter beds are not operational and most of the sand media has been lost due to uncontrolled backwash rates. The chlorine system leaks chlorine gas into the chlorine room and access was not possible due to this unsafe condition. It is obvious from these visits that water from the plant is only marginally treated. Further, as mentioned above, when the water plant is not working, the city pumps river water direct to its distribution system with the river intake pumps.

It is the expressed interest of USAID and federal authorities in Kazakhstan to get NovoKazalinsk "off" the river and onto the federal transmission main; however, the city is hesitant to tie into the federal system because of the following reasons:

- It presently costs the city 2 tenge ($1= 60 tenge) to produce a cubic meter of water from the plant. They sell it to the users for 4 tenge per cubic meter. If they tie into the federal system, they will have to pay the FWRC 45 tenge per cubic meter. City officials have made statement to EPT field team members that for them to tie into the federal system, someone would have to subsidise the additional cost of water. Intergovernmental agreements are needed to resolve this problem.

- The federal system is recurrently shut down due to scheduled power outages from the Uzbekistan power supply source. NovoKazalinsk apparently has an independent source of power in that they can operate their intake pumps when the federal system is without power. Thus, in their opinion, their system is more reliable than the federal system and they are not willing to subject their customers to such recurrent system shutdowns. Agreements as to the priority of power supply are needed to resolve this problem.

- The planned method to tie in the city to the federal system was via a new pump station and associated reservoir located next to federal PS 7. This station was under construction but work abandoned in 1992 subsequent to collapse of the Soviet Union in 1991 and consequent termination of funding sources. When completed the station would have been owned and operated by the city, however, the city has no available funding available to complete the station. Definition of funding sources is needed to resolve this problem.

As a result of these problems, it would appear that NovoKazalinsk will continue to operate its water plant into the foreseeable future. Accordingly, as part of this overall project, new chlorination equipment will be installed in the water treatment plant. No other improvements, however, are presently planned for the plant. Decisions need to be made with USAID relative to other possible improvements to the plant which include new intake and transfer pumps, new filter control valves, etc.

Also, the costs to complete the new pump station should be defined. This cost may be beyond the funding capability of USAID projects in which case the completion (following resolution of the other problems as mentioned above) could be accomplished by other donors.

Booster Pump Stations

Booster pump stations along the federal transmission pipeline repump water from their reservoir to the next downstream reservoir via the pipeline. All reservoirs are covered precast concrete and are partially buried to protect them from freeze damage. There are six (6) stations located along the pipeline as shown in Figures 1 and 2. Two other significant pump stations in the regional water system are the city of Aralsk's pump station which receives water from the transmission main just upstream of PS 3, and the city of NovoKazalinsk's pump station described above. These two stations are operated by the cities as distinguished from the booster pumps which are operated by the FWRC.

Estimates of present and future flows at each of the booster pump stations as well as for withdrawals along the pipeline are summarised in Figure 2. These flow estimates were provided by FWRC engineers in Almaty, however, discussions with field engineers indicate that present flows may be less than the present flows as estimated by the FWRC engineers. In that there are no flow measuring facilities anywhere in the system, it will be assumed that the flow estimates as summarised in

Figure 2 are reasonably accurate and will be the basis for the design of replacement pumps.

An inventory of existing pumps in each of the booster pump stations is summarised in Table 2. Each of the stations has one or more large booster pumps, i.e., 1250 m3/hr (7.9 mgd), one or more small booster pumps, i.e., 200 m3/hr (1.3 mgd), and one or more settlement pumps 80 m3/hr (0.5 mgd). Almaty federal engineers have requested that new replacement pumps be based on the larger booster pumps in that these pumps are designed to pump the future flows as shown in Figure 2. However, interviews with field engineers indicate that most of the time only the smaller booster pumps are used because of the severity of the leaks in the transmission pipeline. They are reluctant to use the large pumps due to concern of rupturing the pipeline with the higher pressures with the larger pumps.

As noted above the federal system is subject to recurrent shutdowns due to scheduled power stoppages from Uzbekistan power supply sources. Apparently, the Kazakhstan federal water supply system is low on the Uzbekistan priority list for continuous power supply. This situation results in regular water stoppages in Aralsk and all settlements served by the system. This situation needs to be improved in that one of the basic conditions for a safe water supply is a continuously pressurised system to prevent cross contamination.

In light of the concerns expressed by the federal field engineers that use of the larger pumps will result in rupturing of the transmission pipeline and pose serious risks to the system's ability to deliver water, it is recommended that new replacement pumps be based on capacities to meet the existing flows, not future flows, as summarised in Figure 2. Providing new pumps based on meeting existing demands is also consistent with well field production capacity as discussed above. These new pumps will be of similar head and capacity to the existing small booster pumps located in each station.

Recommended number and sizes of pumps are summarised in Table 3. Typical detail of the recommended pump is shown in Figure 4. The design concept will be to meet the design flow (existing demand) with two pumps operating. Three pumps will be provided for each station with the third pump being a standby pump. All pumps will be base mounted for ease of installation. The large pumps in each station will be left in place and used at the descretion of the field engineers and operators. A compliment of fittings and valves (isolation and check) will be provided with each pump. Also provided will be a flow totalizer for each pump, wall mounted motor starters, and associated conduits, and switches. Installation of the pumps will be accomplished by Kazakh labour and equipment with overview provided by an EPT construction manager.

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SUMMARY OF RECOMMENDATIONS

The following improvements are recommended to the regional water transmission systems in Kyzl Orda Oblast, Kazakhstan:

- Chlorination Equipment - is to be provided in all FWRC booster pump stations plus the city of Aralsk's pump station and the NovoKazalinsk water treatment plant. Contract award for equipment assembly was completed in March 1995 and equip-ment will be delivered beginning July 1995.

- Booster Pumps - recommended replacement pumps for the booster pump stations are summarised in Table 3. Procurement would be based on a total of eighteen (18) booster pumps for the FWRC system, twelve (12) settlement pumps to be located in the FWRC pump stations, and two (2) service pumps for the city of Aralsk's pump station. All pumps would be individually skid mounted for ease of installation and would include suction and discharge piping along with valves and fittings. Also included would be wall mounted motor starters, electrical cables and conduits, and control switches. Totalizer meters would be installed with each pump to establish reliable flow measurements. Installation would be accomplished with local forces with overview provided by an EPT construction manager.

- Supply Wells - fourteen (14) new supply wells are recommended, twelve (12) for the Kosaman field and two (2) for the Berdykol field. Procurement would be based on materials as listed in Table 1. Wells would be drilled by local forces with overview provided by an EPT construction manager.

- Diesel Welding Units - six (6) diesel welding units are recommended for procurement to improve operation and maintenance of the regional systems. Specific assignments of the six units are as follows:

  - One for the Kosaman well field
  - One for the Berdykol well field
  - One for PS 3
  - One for PS 7
  - One for Aralsk
  - One for NovoKazalinsk

- Other Materials and Equipment - other materials and equipment that could be procured but should be delayed pending availability of funds and further clarification of need include backhoe excavators and water distribution pipe including fittings and valves. The latter, if provided, would have to be based on design drawings provided by the Government of Kazakhstan to establish all fittings and valves associated with the project. Also required will be a better understanding of how and by whom the piping would be installed within the urban areas.

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TABLE 1

LIST OF MATERIALS FOR
NEW WATER SUPPLY WELLS

ITEM	DESCRIPTION	QUANTITY
	Permanently Installed Equipment	
1	Surface casing, steel	7,000 ft
2	Inner casing, steel	2,500 ft
3	Well screen, steel	1,400 ft
4	Well screen accessories	14 each
5	Pump, motor, riser pipe	14 each
6	Wellhead piping, electrical and controls	14 each
7	Cement grout	8,000 cf
8	Filter pack sand	2,500 cf
	Special Equipment and Expendable Supplies	
1	Drilling fluids and chemicals	60,000 lbs
2	Spares: hoses & drill head	each
3	Air compressor, tubing and piping for well development	each
4	Water level gauges, tapes, hand tool, etc.	each

TABLE 2

INVENTORY OF EXISTING PUMPS

PUMP STATION	DESCRIPTION	NUMBER
A.Booster Pumps		
PS 1	D1250-65H, 200 kW	1
	D400-65H	1
	Future large pumps in storage	2
	D2000-100H, 630 kW	
PS 2	D350-90H, 132 KW	2
	D200-90H, 75 KW	1
PS 3	D1250-65H, 200 KW	1
	D200-90H, 90 KW	2
PS 4	D1250-65H, 200 KW	1
	D200-90H, 42 KW	2
PS 5	D1250-65H, 55 KW	1
	D200-90H, 42 KW	1
PS 7	D200-90H, 75 KW	3
B. Settlement Pumps		
PS 1	K90-50H, 15 KW	1
PS 2	K160-30H	4
PS 3	None	0
PS 4	None	0
PS 5	K90-50H, 15 KW	3
PS 7	K100-65H, 30 KW	2
C. Aralsk		
	D300-50H	1
	D200-50H	2
D. NovoKazalinsk	Not Documented	3

TABLE 3

RECOMMENDED PLACEMENT PUMPS

PUMP STATION	CAPACITY (GPM)	HEAD (FT)	POWER (HP)	NUMBER
Booster Pumps				
PS 1	3325	315	330	3
PS 2	4900	207	300	3
PS 3	2100	110	70	3
PS 4	2100	110	70	3
PS 5	2100	155	110	3
PS 7	1000	250	80	3
Settlement Pumps				
PS 1	400	150	20	2
PS 2	700	100	20	4
PS 3				none
PS 4				none
PS 5	400	150	20	3
PS 7	500	250	40	2
C.Aralsk	1500	150	70	1
	900	150	40	2

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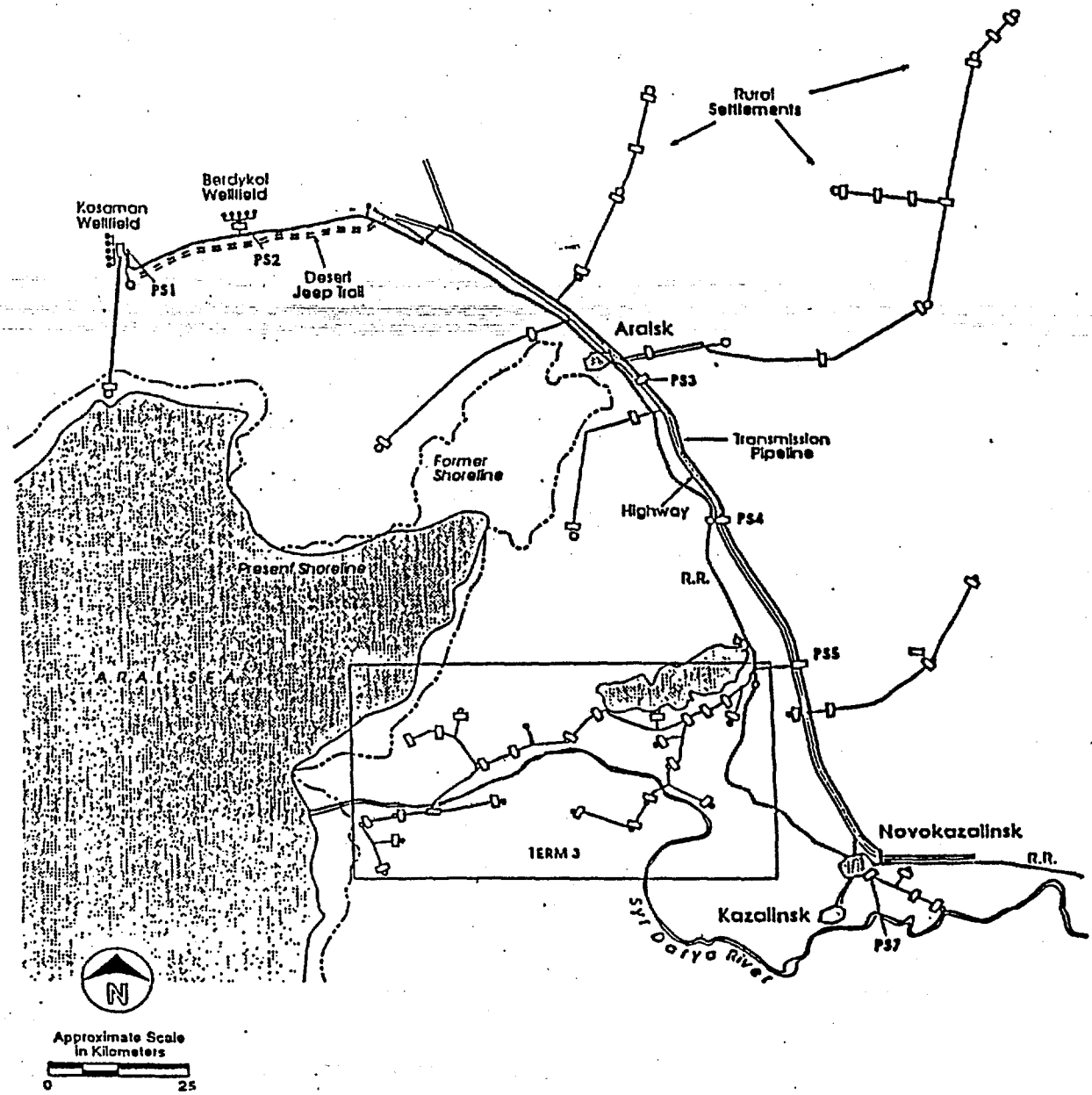

FIGURE 1. Overview of Transmission System in Kzyl Orda Oblast

Рис 1. Обзор магистральной линии водовода в Кзыл–Ординской области

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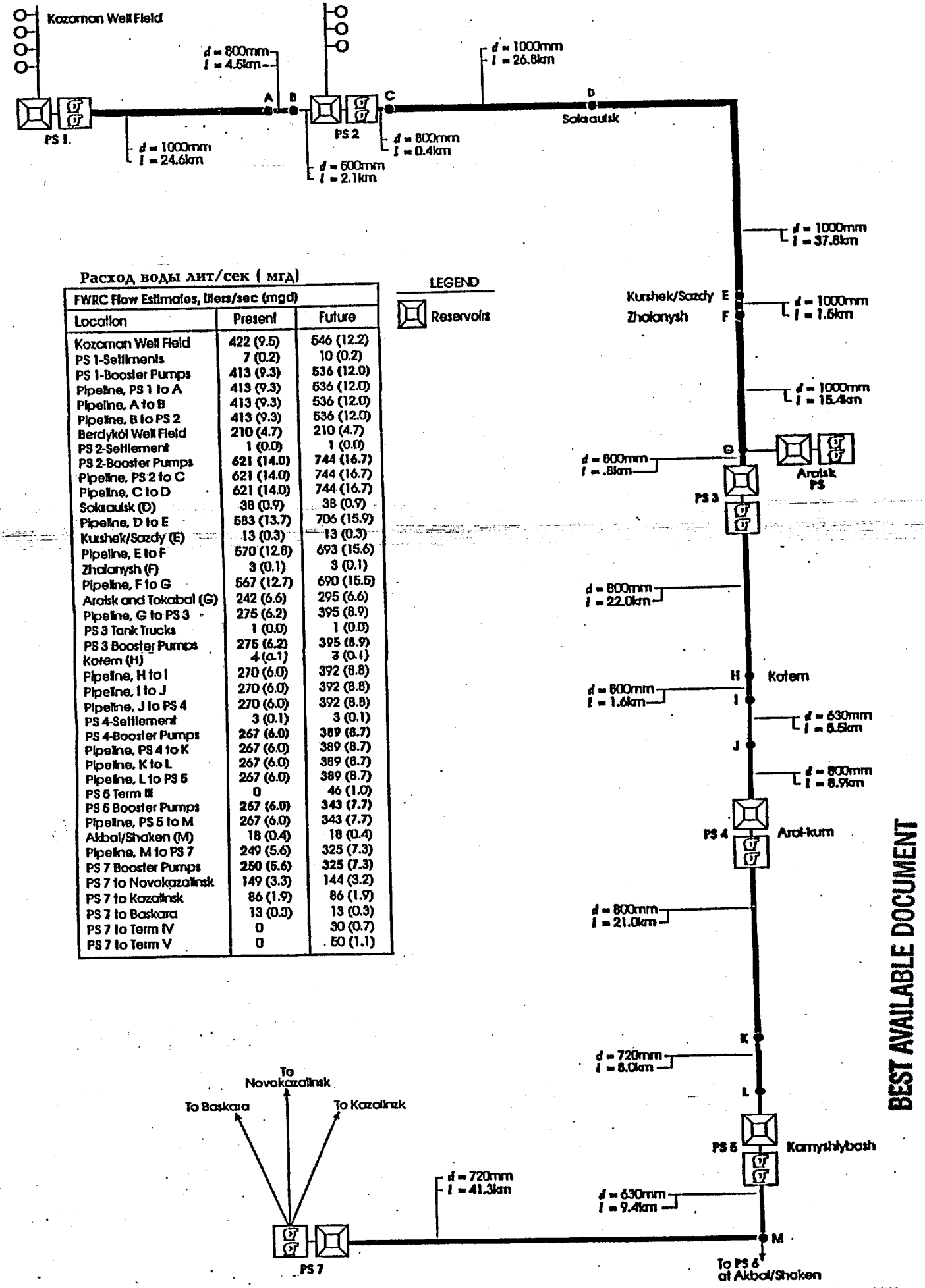

Расход воды лит/сек (мгд)

FWRC Flow Estimates, liters/sec (mgd)		
Location	Present	Future
Kozaman Well Field	422 (9.5)	546 (12.2)
PS 1-Settlements	7 (0.2)	10 (0.2)
PS 1-Booster Pumps	413 (9.3)	536 (12.0)
Pipeline, PS 1 to A	413 (9.3)	536 (12.0)
Pipeline, A to B	413 (9.3)	536 (12.0)
Pipeline, B to PS 2	413 (9.3)	536 (12.0)
Berdykol Well Field	210 (4.7)	210 (4.7)
PS 2-Settlement	1 (0.0)	1 (0.0)
PS 2-Booster Pumps	621 (14.0)	744 (16.7)
Pipeline, PS 2 to C	621 (14.0)	744 (16.7)
Pipeline, C to D	621 (14.0)	744 (16.7)
Saksaulsk (D)	38 (0.9)	38 (0.9)
Pipeline, D to E	583 (13.7)	706 (15.9)
Kurshek/Sazdy (E)	13 (0.3)	13 (0.3)
Pipeline, E to F	570 (12.8)	693 (15.6)
Zhalanysh (F)	3 (0.1)	3 (0.1)
Pipeline, F to G	567 (12.7)	690 (15.5)
Aralsk and Tokabal (G)	242 (6.6)	295 (6.6)
Pipeline, G to PS 3	275 (6.2)	395 (8.9)
PS 3 Tank Trucks	1 (0.0)	1 (0.0)
PS 3 Booster Pumps	275 (6.2)	395 (8.9)
Kotem (H)	4 (0.1)	3 (0.1)
Pipeline, H to I	270 (6.0)	392 (8.8)
Pipeline, I to J	270 (6.0)	392 (8.8)
Pipeline, J to PS 4	270 (6.0)	392 (8.8)
PS 4-Settlement	3 (0.1)	3 (0.1)
PS 4-Booster Pumps	267 (6.0)	389 (8.7)
Pipeline, PS 4 to K	267 (6.0)	389 (8.7)
Pipeline, K to L	267 (6.0)	389 (8.7)
Pipeline, L to PS 5	267 (6.0)	389 (8.7)
PS 5 Term III	0	46 (1.0)
PS 5 Booster Pumps	267 (6.0)	343 (7.7)
Pipeline, PS 5 to M	267 (6.0)	343 (7.7)
Akbal/Shaken (M)	18 (0.4)	18 (0.4)
Pipeline, M to PS 7	249 (5.6)	325 (7.3)
PS 7 Booster Pumps	250 (5.6)	325 (7.3)
PS 7 to Novokazalinsk	149 (3.3)	144 (3.2)
PS 7 to Kazalinsk	86 (1.9)	86 (1.9)
PS 7 to Baskara	13 (0.3)	13 (0.3)
PS 7 to Term IV	0	30 (0.7)
PS 7 to Term V	0	50 (1.1)

FIGURE 2. Schematic Configuration of Transmission System

Рис. 2 Схематическая конфигурация магистральной линии водовода

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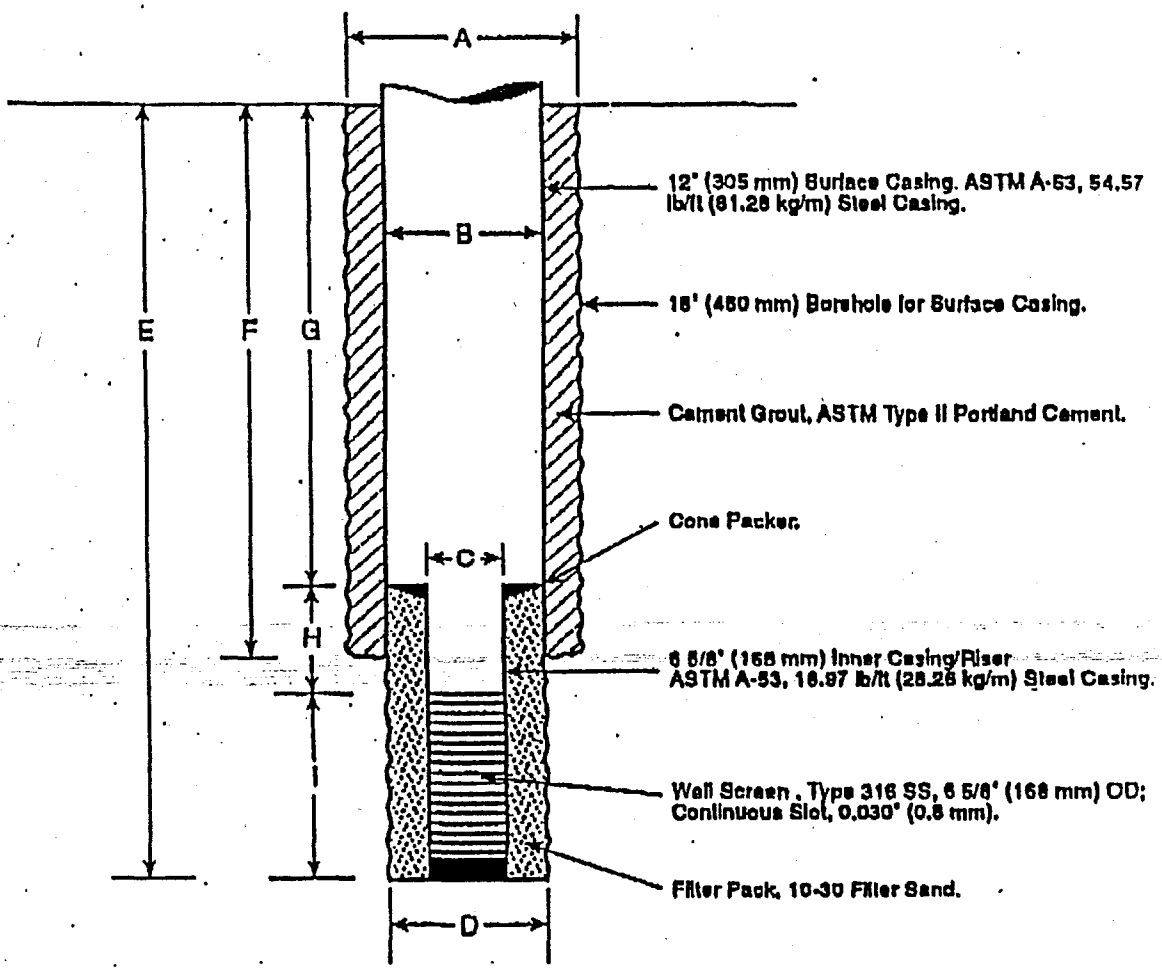

Dimension	Berdykol Wells	Kosaman Wells	Description
A	460 mm	460 mm	Drill Hole for Surface Casing
B	323.8 mm	323.8 mm	Surface Casing Outside Diameter
C	168.3 mm	168.3 mm	Inner Casing Outside Diameter
D	292 mm	292 mm	Drill Hole for Inner Casing & Screen
E	180 M	230 M	Approximate Depth of Well
F	110 M	150 M	Depth of Surface Casing
G	90 M	130 M	Depth to Top of Inner Casing
H	60 M	50 M	Length of Inner Casing
I	30 M	30 M	Length of Screen

FIGURE 3. Typical Detail of Proposed Well Construction

Рис. 3 Типичная деталь предлагаемой конструкции скважины

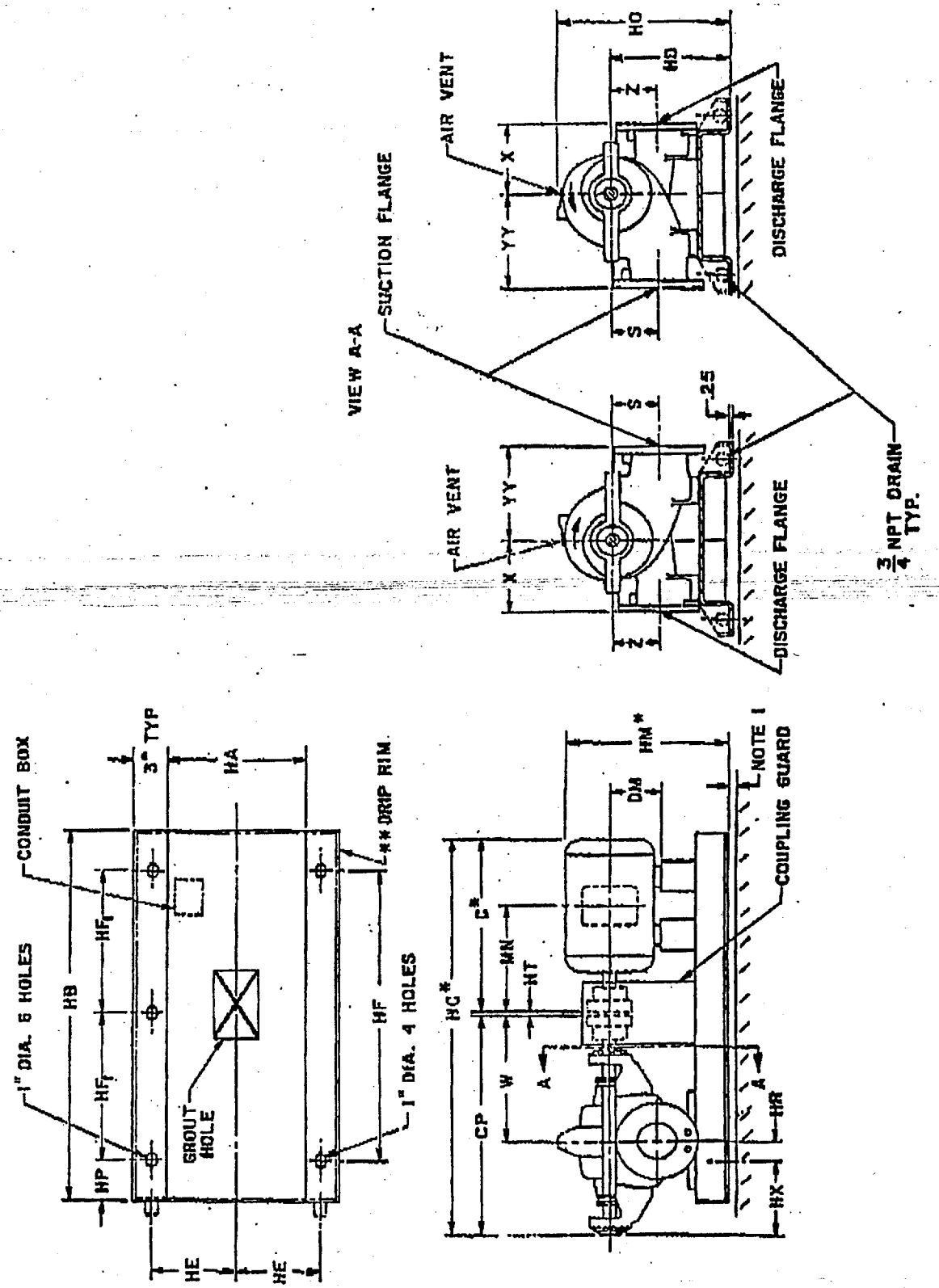

FIGURE 4. Typical Detail of Single Stage Horizontal Pumps

Рис. 4 Типичная деталь секции горизонтальных насосов

New Independent States (NIS)

★ **EPT Regional Offices**

The Environmental Policy and Technology (EPT) Project: Environmental degradation and natural resource mismanagement threaten public health, biodiversity and economic vitality in the New Independent States (NIS). To assist the NIS in alleviating these problems, the U.S. Agency for International Development (USAID) began the EPT Project in 1993. EPT provides technical assistance and policy advice in the environmental sector and promotes environmentally sound economic development through public and private, U.S. and NIS partnerships. The EPT Project is managed by USAID with support from the U.S. Environmental Protection Agency (USEPA). For assistance in project design, management and implementation, USAID has agreements with CH2M HILL International, Harvard Institute for International Development and ISAR. As the primary EPT contractor, CH2M HILL International has the lead role in delivering technical assistance, logistical support and policy support for selected projects. EPT Regional Offices are located in: Washington, D.C.; Moscow, Russia; Kiev, Ukraine; and Almaty, Kazakhstan.

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