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Burns and Roe Enterprises, Inc.

ENVIRONMENTAL ASSESSMENT OF VOROTAN CASCADE REHABILITATION PROJECT

ARMENIA

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1.0 EXECUTIVE SUMMARY

The Vorotan Cascade has three hydroelectric generating stations with a combined capacity of 404 MW that are situated on the Vorotan River in the Sjunk region of Armenia. The three projects are the Tatev, 157 MW, Shamb, 171 MW and Spandarian, 76 MW. The plants were commissioned in 1970, 1978, and 1989 respectively. They are well maintained but require rehabilitation to ensure their reliable operation for the next 40 to 50 years.

The general arrangement of the Cascade hydroelectric projects and their principal features are shown in Figure 1. The uppermost project is Spandarian with a large reservoir for long-term storage. The water flows from the reservoir through a tunnel and then penstock to the Spandarian powerhouse. The discharge from the powerhouse is into the Angeghakot Reservoir. The outlet from this reservoir is a tunnel leading to the Tolors Reservoir. Then through a tunnel and penstock to the Shamb powerhouse. The water discharges into the Tatev Reservoir. The reservoir is also fed by a tunnel, which diverts water from the Laradzor River. The outlet from the reservoir is through a tunnel to the Daily Regulation Reservoir and then by penstock to the Tatev powerhouse. The powerhouse tailrace discharges into the Vorotan River.

There will be a provision in the future to transfer water from the Vorotan Cascade to the Lake Sevan to the north. A tunnel is being constructed that will divert water from the northern end of the Spandarian Reservoir to the Kechiri Reservoir, and from there through another tunnel to Lake Sevan. The present authorized annual diversion flow is 100 million cubic meters from the Vorotan River. There will be an additional annual diversion requirement of 60 million cubic meters at some point in the future. The diversion project is scheduled to be complete in 2000.

This Report is based on information available to the assessment team at the time of the site visits, previously published reports and information including *"Environmental Assessment of Armenian Energy Sector" June 1998 (USAID DO #22)*, and World Bank sponsored Reports *"Armenia: National Environmental Action Program" April 1999 and "Armenia: Lake Sevan Action Plan" April 1999.*

The assessment team received excellent cooperation from the Vorotan Cascade Manager Hakop Dingchian and from the facility engineers and operators.

This Report provides an environmental condition assessment of the existing hydropower plants (HPPs) and provides an evaluation as to the environmental impacts expected from the proposed rehabilitation project.

The primary findings of this assessment are as follows:

• Implementation of the proposed rehabilitation project of the Vorotan Cascade will provide an overall positive environmental impact, as many of the rehabilitation elements will eliminate leaks and spills into the Vorotan River.

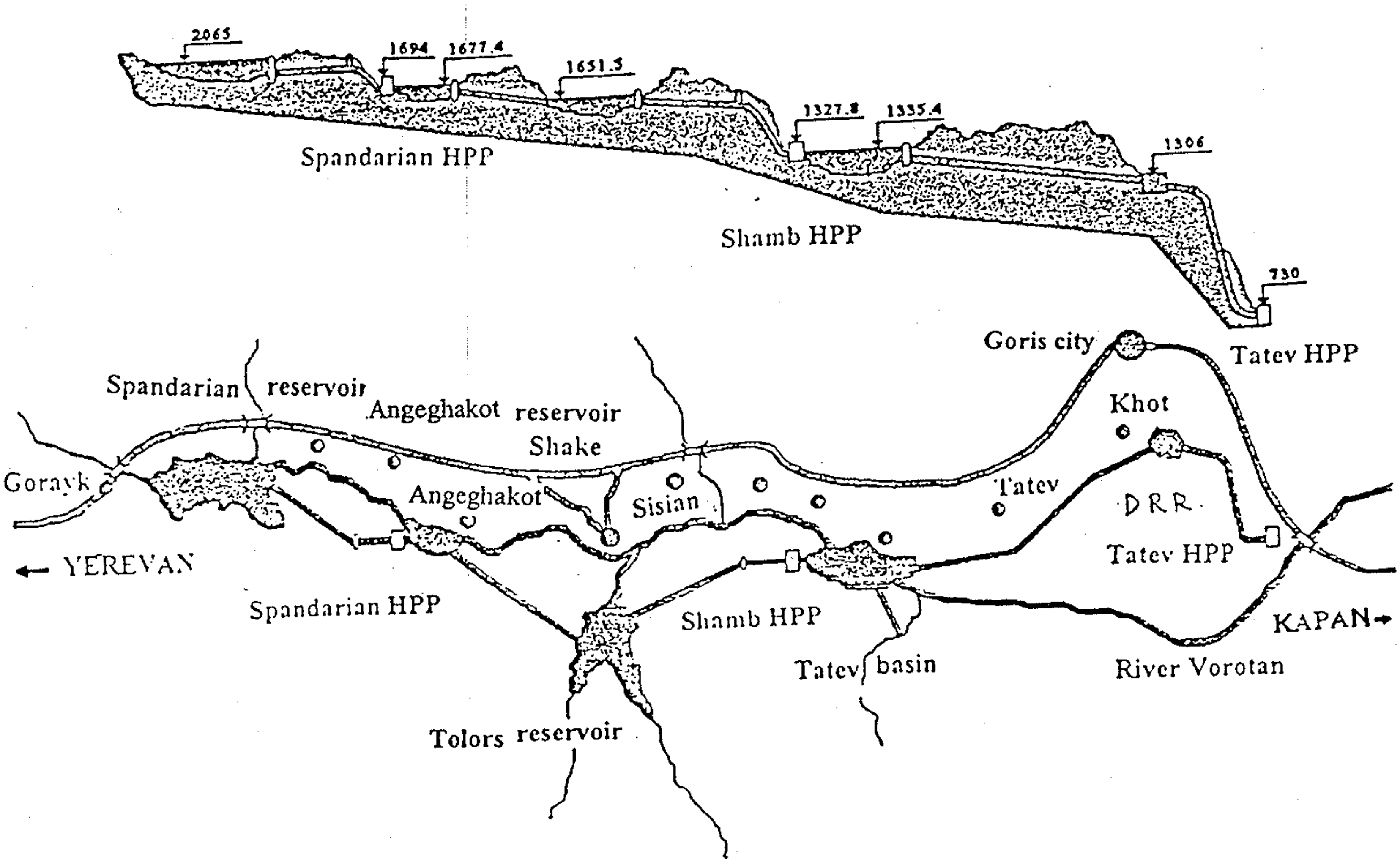
• Improved dependability of HPP electrical generating capacity due to the rehabilitation project may reduce the need for expansion of fossil fuel fired thermal power plants.

• The primary negative environmental impacts will occur at the construction stage (e.g., noise, dust, construction waste) and will be temporary and will not have substantial residual environmental impact.

• Rehabilitation of the transformer oil spill containment measures for the Tatev HPP should be expanded to include the transformer areas at Shamb HPP and Spandarian HPP.

• One potential negative environmental impact may arise from the improper disposal of spent station storage batteries. Since these batteries will be replaced at all three HPPs, shipment to a licensed recycling facility (outside Armenia) should be made part of the contract terms.

The above bullet items are discussed in detail in various Sections of this Report.



Structure of the Vorotan HPPs Cascade

Figure 1

Vorotan HPPs Cascade

2.0 OVERVIEW OF EXISTING CONDITIONS

The general overall condition of the assessed HPPs is very good considering the lack of spare parts and lack of preventative maintenance practices. General housekeeping issues were minimal and are based on design rather than lack of due diligence on the part of the facility management.

2.1 FACILITIES

Site evaluations were performed in September, 1999 at the three primary electrical production facilities on the Vorotan Cascade comprised of the Spandarian HPP, Shamb HPP, and the Tatev HPP. In addition, specific areas of interest were viewed at the Angeghakot, Tolors and Tatev Reservoirs. The assessment portion of the project focused on recording existing and historical practices at the facilities and performing a preliminary analysis on the environmental impacts of the proposed rehabilitation project. As a result of these visits, several recurrent themes were evident:

- Secondary containment and spill prevention measures were implemented at all of the HPP facilities;
- Stormwater runoff measures are generally not in place to control discharge to nearby bodies of water;
- Oil/Water separation devices are not provided (by original Soviet design);
- Spandarian and Tatev HPPs discharge untreated sewage, plant derived washwater, and cooling water directly to the associated water body as per original design;
- There was no knowledge of the presence/absence of PCBs within any of the facility's systems;
- Solid waste, hazardous waste, and/or contaminated materials originating from the facilities are either buried or burned at the sites, or are disposed of at a municipal dump. No post-burial monitoring is in place. No quantitative analysis of disposed materials is performed;

Following is a brief technical outline of the HPPs and Reservoirs visited. Figure 1 shows the locations of these facilities.

2.1.1 *Spandarian Reservoir*

The Spandarian Reservoir comprises the head stage of the Vorotan Cascade and occupies the territory of the former villages of Gorhajk and Tskhuk. The Spandarian dam is 83 meters high and 315 meters long. The average total volume of water within the Reservoir is 257 million m^3 with a useful volume of 218 million m^3. The average surface area of the Reservoir is 11,700,000 m^2.

Water from the Spandarian Reservoir is directed through a 8.1 km long gravity fed tunnel to the Spandarian HPP.

2.1.2 *Spandarian HPP*

The Spandarian HPP consists of two (2) Russian made Francis-type turbines. The turbines were commissioned in 1989. The installed capacity of the power plant is 76 MW (2x39.2 MW units) and the rated head is 295 m.

2.1.3 *Angeghakot Reservoir*

The Spandarian HPP discharge in conjunction with the Angeghakot dam forms the Angeghakot Reservoir. The Angeghakot dam is 35 m high and 85.5 m long. The average total volume of water within the Reservoir is 3.4 million m^3 with a useful volume of 0.5 million m^3. The average surface area of the Reservoir is 400,000 m^2.

Water from the Angeghakot Reservoir is directed through a 10.5 km long gravity fed tunnel to the Tolors Reservoir.

2.1.4 *Tolors Reservoir*

The Tolors Reservoir receives water diverted from the Angeghakot Reservoir as well as inflows from the Sisian and Ajry Rivers. The Tolors dam is 69 m high and 188 m long. The average total volume of water within the Reservoir is 93 million m^3 with a useful volume of 80 million m^3. The average surface area of the Reservoir is 4,700,000 m^2.

Water from the Tolors Reservoir is directed through a 6.9 km long gravity fed tunnel to the Shamb HPP.

2.1.5 *Shamb HPP*

The Shamb HPP consists of two (2) Ukrainian made Francis-type turbines. The turbines were commissioned in 1978. The installed capacity of the power plant is 171 MW (2x87.4 MW units) and the rated head is 267.7 m

2.1.6 *Tatev Reservoir*

The Tatev Reservoir receives water from the Shamb HPP discharge as well as water diverted from the Laradzor River via a 0.7 km tunnel. The Tatev dam is 41 m high and 107 m long. The average total volume of water within the Reservoir is 13.6 million m^3 with a useful volume of 1.8 million m^3. The average surface area of the Reservoir is 1,120,000 m^2.

Water from the Tatev Reservoir is directed through a 18.4 km long gravity fed tunnel to the Daily Regulation Reservoir.

2.1.7 *Daily Regulation Reservoir*

The Daily Regulation Reservoir receives water from the Tatev Reservoir. The Daily Regulation Reservoir's volume is 80,000 m^3 the surface area of the Reservoir is 90,000 m^2. Water from the Reservoir is directed via a 1900 m penstock to the Tatev HPP.

2.1.8 *Tatev HPP*

The Tatev HPP has the distinction of being the highest-head plant built in the former Soviet Union. The Tatev HPP consists of three (3) Russian made Pelton-type turbines. The turbines were commissioned in 1970. The installed capacity of the power plant is 157 MW (3x54.6 MW units) and the rated head is 568.8 m.

2.2 MONITORING

As a result of several meetings (from previous environmental assessment activities in Armenia conducted by the author for USAID) with the Ministry of Environment regarding the availability of environmental monitoring data, it is apparent that past environmental monitoring has focused on the ambient quality of air and water resources. Existing facilities are not required to sample at the "end of pipe" and, therefore, data relevant to discharges from specific electrical production facilities is unavailable. Existing electrical energy production facilities do not have the equipment necessary to sample discharges from their facilities. No plant discharge databases were found.

Therefore, the current environmental health of the Reservoirs within the Vorotan Cascade cannot be quantified for this assessment.

2.3 DATA MANAGEMENT

The data that is collected from the Ministry-sponsored ambient monitoring programs is handwritten and kept in paper log files. Supplementary information such as maps, statistical analysis, weather conditions, etc., was not found. Monitoring and analysis is still performed based on Soviet era standards. There was no evidence of sampling procedures, protocols, or mechanisms to insure quality control of the data collected. It is assumed, therefore, that the credibility of monitoring data, if found, is likely to be suspect.

Data was not readily available regarding inventories of existing environmental resources. Previous requests for information such as the location of public water intakes or well locations could not be provided. This information is treated as delicate government intelligence information. A major deficiency exists in the availability of data for sensitive environmental resources. Without a thorough knowledge of such resources relative to energy production facilities, it is difficult to thoroughly assess environmental impacts.

2.4 WATER RESOURCES

Water resources in Armenia serve a variety of purposes including power generation, potable usage, irrigation and recreation. In many cases, water resources must meet multiple needs. Management of water resources from both a quantity and quality perspective is critical to the overall health of the Armenian environment and its people.

2.4.1 Water Quality

The government sponsored ambient monitoring system provides little information in terms of the direct impacts the electrical energy production sector has on water resources. The lack of readily available information regarding the juxtaposition of electrical energy production facilities relative to critical water resources makes it difficult to assess the relative impacts of the sector on water quality. There are, however, existing practices occurring at the facilities that are expected to have adverse impacts on water quality. They include the following:

- Analytical data from previous environmental assessment activities within Armenia indicate that PCBs may be present at all electrical energy production facilities. In many cases, spills or leaks of PCB-containing materials are discharged directly to water bodies;

- Spandarian and Tatev HPPs discharge untreated sewage directly to the associated water body;
- All 3 HPPs discharge plant-derived washwater, equipment leaks, and cooling water directly to the associated water body;
- Oil/Water separation devices are not provided at HPPs as per original design;
- Stormwater runoff from HPPs flows unimpeded into adjoining water bodies;
- Knowledge of the extent of contamination from hazardous substances such as PCBs and asbestos is very poor;
- Erosion from the disrepair of tunnels and auxiliary spillways contributes to sediment loading in the adjoining water bodies.

Given the extent of problems identified above, the potential quality impacts to both surface and groundwater supplies from electrical energy production can be significant.

The following table represents typical maximum allowable water discharge limits for thermal power plants (TPPs). An analog for hydropower facilities was unavailable in time for this report.

Table 2.4-1
TPP Maximum Pollutant Concentrations

Components	Max. Allowable Concentration, g/m^3	Max. Allowable Discharge Amount, g/hr
Chloride	375.7	43,130.36
Sulfate	609.6	69,982.08
Oil Products	0.542	62.22
Hazardous Materials	0.214	24.57
Dry Residue	1655.2	190,017

Source: Yerevan TPP Management. Data is approved for 1995-2000 by Ministry of Environment

The existing practice in Armenia is to consider a "preset" Ministry of Environment limit as actual until proven differently.

2.4.2 Water Quantity

The dependence of the electrical energy production sector on hydropower requires significant water usage that may or may not be compatible with other needs such as irrigation and preservation of Lake Sevan. Construction of the Vorotan-Arpa Tunnel to divert water from the Spandarian Reservoir through the Arpa-Sevan Tunnel to Lake Sevan is discussed in two reports sponsored by the World Bank entitled "Armenia: National Environmental Action Program" April 1999 and "Armenia: Lake Sevan Action Plan" April 1999. Therefore, issues relating to this diversion are not discussed within this Assessment Report.

The Vorotan Cascade Management maintains fairly detailed records regarding the flow of water through various structures within the Cascade (See Table 2.4.1 and 2.4.2). In addition, electricity production is carefully logged and reported (See Table 2.4.3).

As per discussions with the Cascade Manager, diversions from the cascade for irrigation needs is less than 5% of the overall volume.

Table 2.4.1

INFORMATION ABOUT THE ACTUAL FLOW QUANTITY OF INLETS OF SISIAN-GORIS BRANCHES

Name of the Branch	Location of the Inlet	Measure ment Unit (1000 m³)	April	May	June	July	August	September	October	Total
Sisian	Spandarian HPP Penstock	Given		0.864	0.864	0.864	0.864	0.864	0.864	5.38
		Increasing		0.864	1.724	2.588	3.456	4.520	5.38	
	Brnakot Pump Station	Given	4.320	4.320	4.320	4.320	4.320	4.320	4.320	30.240
		Increasing	4.320	8.640	12.960	17.280	21.600	25.920	30.240	
	Tolors Reservoir	Given		1071	1071	1071	1071	1071	1071	6446
		Increasing		1071	2142	3213	4284	5375	6446	
	Shamb HPP Tunnel	Given	536	536	536	536	536	536	536	3752
		Increasing	536	1072	1608	2144	2680	3216	3752	
Goris	Halidzor Gate	Given	155.5	155.5	155.5	155.5	155.5	155.5	155.5	1088
		Increasing	155.5	311	466.5	622	777,5	933	1088.5	
	Village of Khot	Given	105	105	105	105	105	105	105	535
		Increasing	105	210	315	420	425	430	535	
	Shinuhair Gate	Given	105	105	105	105	105	105	105	
		Increasing	105	210	315	420	525	630	735	
	Tatev HPP Daily Regulation Pond	Given	514	1348	692	798	2670	3360	2315	9382
		Increasing	514	1862	2554	3352	6022	9382	--	
Total (1000 m³)										**20630**

Table 2.4.2

INFORMATION ABOUT THE INLETS OF SISIAN, GORIS AND MEGRI-KAPAN BRANCHES

Names of the Branches	Names of Inlets		Measurement Unit	March	April	May	June	July	August	September	October	November
Sisian	Tolors Tunnel	Required	$1000m^3$			1071.4	1036.8	1071.3	1071.4	1036.8	1071.3	
			increasing			1071.4	2108.2	3179.5	4250.9	5287.7	6359.0	
		Actual	$1000m^3$			46.7	382.1	552.6	490.5			
			increasing			46.7	428.8	981.4	1471.9			
	Spandarian Canal	Required	$1000m^3$			1874.9	1814.4	1874.9	1874.8	1814.4	1874.9	
			increasing			1874.9	3689.3	5564.2	7439.0	9253.4	11128.3	
		Actual	$1000m^3$			13.3	259.3	263.3	262.8			
			increasing			13.3	272.6	535.9	798.7			
	Shamb Tunnel	Required	$1000m^3$			535.7	518.4	535.7	535.6	518.4	535.7	
			increasing			535.7	1054.1	1589.8	2125.4	2643.8	3179.5	
		Actual	$1000m^3$				88.5	66.2	148.3			
			increasing				88.5	154.7	303.0			
Total for Sisian Branch		Required	$1000m^3$			3482.0	3369.6	3481.9	3482.8	3369.6	3481.9	
			increasing			3482.0	6851.6	10333.5	13815.3	17184.9	20666.8	
		Actual	$1000m^3$			60.0	729.9	882.1	901.6			
			increasing			60.0	789.9	1672.0	2573.6			
Goris	Tatev Daily Regulation Pond	Required	$1000m^3$		2590.0	4017.6	6480.0	6696.0	6696.0	2592.0	2315.5	
			increasing		2590.0	6609.6	130089.6	19785.6	26481.6	29073.6	31389.1	
		Actual	$1000m^3$				693.0	2900.0	623.0			
			increasing				693.0	3593.0	4216.0			
Kapan-Megri		Plan	$1000m^3$		321.0	625.0	657.0	699.0	679.0	302.0		90.0
			increasing		321.0	946.0	1603.0	2302.0	2981.0	3283.0	3283.0	3373.0
		Actual	$1000m^3$	165.0	495.0	566.0	906.0	1611.0	1032.0			
			increasing	165.0	660.0	1226.0	2132.0	3743.0	4775.0			
Total		Required	$1000m^3$		2913.0	8124.6	10506.6	10876.9	10856.8	6263.6	5797.4	90.0
			increasing		2913.0	11037.6	21544.2	32421.1	43277.9	49541.5	55338.9	55428.9
		Actual	$1000m^3$	165.0	495.0	626.0	2328.9	5393.1	2556.6			
			increasing	165.0	660.0	1286.0	3614.9	9008.0	11564.6			

R. Grigorian (Signature), Head of the Water Industry and Melioration Department

Table 2.4.3

ELECTRICITY GENERATED AND DELIVERED DURING 1997

No.	Month	Generated kWh	Internal Needs kWh	Delivered Quantity
1	January	65 584 200	272 124	65312076
2	February	58 327 320	251627	58 075 693
3	March	82 239 560	272641	81 966919
	First Quarter	206 151 080	796392	205 354 688
4	April	54 109 800	212645	53 897 135
5	May	64061 940	194 923	63867017
6	June	45 381 840	192 134	45 189706
	Second Quarter	163 553 580	599 722	162 953 858
7	July	45 048 320	152622	44 895 098
8	August	33 056 560	205 120	32 851 440
9	September	46 695 040	859 974	45 835 066
	Third Quarter	124799920	12)7716	123 582 204
10	October	59 622 820	213445	59 409 375
11	November	98 620 940	340 637	98 280 303
12	December	107 021 340	667 358	106 353 982
	Fourth Quarter			
	TOTAL	**759 769 680**	**3 835 270**	**755 934 410**

ELECTRICITY GENERATED AND DELIVERED DURING 1998

No.	Month	Electricity Generated kWh	Internal Needs kWh	Losses	Delivered Quantity kWh
1	January	72 561 468	315 252	57 401	72 678 807
2	February	89 655 560	362 254	559 022	88 734 284
3	March	84 743 900	217670	619 091	83 907 139
	First Quarter	**247 960 920**	**895 176**	**1 745 514**	**245 320 230**
4	April	73 486 580	193 524	556 200	72 736 856
5	May	74 875 660	194578	584 498	74 096 584
6	June	75 213 798	181 906	552 453	74 479 439
	Second	**223 576 038**	**570 008**	**1 693 151**	**221 312 879**
7	July	71 179 600	219 722	583 974	70 375 904
8	August	68 539 952	303 720	563 695	67 672 537
9	September	77 290 020	268 788	567 792	76 453 440
	Third Quarter	**217 009 572**	**792 230**	**1 715 461**	**214 501 881**
10	October	98 553 948	350 082	654 495	97 549 371
11	November	85 011 972	306 253	594 288	84 111 431
12	December	79 714 644	345 438	1 178 130	78 191 076
	Fourth Quarter	**263 280 544**	**1 001 773**	**2 426 913**	**259 851 878**
	TOTAL	**951 827 094**	**3 259 187**	**7 581 039**	**940 980 868**

2.5 RESIDUAL MANAGEMENT

In addition to potential impacts to water resources from the HPP's, residual management practices are of concern. Specifically, the disposal of used equipment, and contaminated soil and gravel raise long term health and safety issues for the Armenian population. Mechanisms for tracking disposal of waste materials were not readily available.

Most facilities use a combination of onsite disposal, onsite burning, and offsite municipal disposal for residual and solid wastes. As was evident throughout Armenia, air emissions resulting from the uncontrolled burning of residential and commercial solid waste is a contributing factor to diminished air quality. Of immediate concern in the energy sector, is the practice of burning paper filters and residual wastes derived from the cleaning of transformer oil. Since PCBs were discovered in samples at previously assessed facilities visited in August 1997, significant health effects can result due to burning PCB containing materials. In addition, burial of PCB contaminated materials poses long-term health threats to energy workers and the general population.

2.6 APPLICABLE ENVIRONMENTAL REGULATIONS

A fee and fine mechanism is in place for air and water emissions. Fees are paid based on the volume of planned/estimated annual emissions. Fines are imposed for any exceedence of the planned/estimated emissions.

The World Bank has extensively addressed the state of Armenian environmental regulations and legal and institutional issues in their Lake Sevan Environmental Action Program (April 1999) and National Environmental Action Program (April 1999) Reports.

2.7 DESCRIPTION OF SURROUNDING ENVIRONMENT

Based on visual observations at the time of the assessment and previously published land use maps, the primary land use along most of the Vorotan Cascade is agricultural. A number of small villages are in close proximity to Cascade Reservoirs. It is not known whether these villages withdraw water from Cascade Reservoirs for potable use or whether the villages have point source discharges to the Cascade.

South of Tatev, land use shifts from primarily agricultural to forested land.

3.0 SITE VISITS AND OBSERVATIONS

3.1 SPANDARIAN HPP

3.1.1 OBSERVATIONS

There was a substantial amount of water evident on the floor below the primary inlet valve (see Photo #1). The interior wall of the penstock had visible moisture damage. According to HPP personnel, all leaks and washdown water are directed to a drainage chamber and is then pumped to the Vorotan River. No oil/water separator is present within the drainage chamber nor anywhere else in the facility. Total flow to the drainage chamber was estimated by plant personnel to be 2 liters/sec. The 200mm drainage chamber discharge pipe is shown in Photo #2. There was 38 MW of electricity being produced at the time of the visit.

The oil/water heat exchanger has experienced leaks "very often."

The battery storage area is in an isolated room that does not contain floor drains.

3.1.1.1 <u>Water Issues</u>

- The transformers are situated outside the main building and appeared well-maintained. They have not had a significant leak in 10 years of operation. Minimal staining was observed on the gravel under the transformers. According to plant personnel, a gravity underdrain exists below the transformers. This underdrain is directed to the drainage chamber outflow which is then pumped to the River.

- The onsite tank farm is comprised of 3, 120 ton capacity transformer oil tanks and 3, 60 ton capacity turbine oil tanks. The tanks have been empty for 8 years due to lack of funds/oil. The tank farm is completely enclosed by a concrete dike with no drainage outlet. Therefore, this area currently poses no risk to water quality.

- Plant derived sewage is discharged untreated to the Vorotan River.

3.1.1.2 <u>Residual Management Issues</u>

- The facility employs a centrifuge and filter system to clean transformer oil. Currently have had trouble finding replacement paper filters. In the past, the oil from replaced circuit breakers was used as fuel. As previously noted, PCBs have been detected in the transformer oil and circuit breakers of other energy facilities in Armenia.

Combustion of PCBs creates a heightened health concern as more toxic dioxins are produced.

3.1.2 ISSUES RELATED TO THE PROPOSED REHABILITATION

A complete discussion of the proposed rehabilitation plans for this facility can be found in other documents. Selected areas of the proposed rehabilitation plan that may have environmental impacts were assessed as follows:

- Spherical inlet valves – The proposed replacement of these valves will reduce current loading to the drainage chamber and would reduce the amount of entrained oil and sediment currently being discharged to the River.

- Governors – The proposed replacement of the governors may reduce the risk of leaks from the current common pressure oil system.

- Generator cooling water heat exchangers – The proposed replacement of these heat exchangers will reduce the amount of oil being discharged to the River as the current system has experienced leaks "very often."

- Storage batteries – The proposed replacement of the storage batteries will result in an improved worker safety condition as the risk of leaks/rupture will be eliminated. However, conscientious disposal of the old batteries is required in order to avoid hazardous materials contamination of soils, surface water, or groundwater.

- Transformer oil spill containment – The proposed rehabilitation plans do not address the existing transformer underdrain system that currently discharges directly to the River. Provision of a shut-off valve and/or diversion to a catch tank and/or diversion to an oil/water separator is recommended in order to prohibit transformer oil leaks from being discharged to the Vorotan River.

3.2 SHAMB HPP

3.2.1 OBSERVATIONS

The Shamb facility had less water on the floor than Spandarian HPP but Shamb was only generating 10 MW at the time of the site visit. Unit #2 was offline at the time of the site visit and still had significant leakage being directed to one of two drainage chambers (see Photo #3). Total flow to each of the two drainage chambers was estimated by plant personnel to be 4 liters/sec and 6 liters/sec.

The battery storage area is in an isolated room that does not contain floor drains.

3.2.1.1 Water Issues

- The transformers are situated outside the main building and appeared well-maintained. Minimal staining was observed on the gravel under the transformers. According to plant personnel, a gravity underdrain exists below the transformers. This underdrain is directed to the drainage chamber outflow which is then pumped to the River.

- Oil-filled circuit breakers showed no evidence of leakage or weeping.

- The onsite tank farm is identical in design to the Spandarian HPP and is comprised of 3, 120 ton capacity transformer oil tanks and 3, 60 ton capacity turbine oil tanks. The tanks have been empty for at least 6 years due to lack of funds/oil. The tank farm is completely enclosed by a concrete dike with no drainage outlet. Therefore, this area currently poses no risk to water quality.

- Plant derived sewage is directed to an onsite septic tank which is regularly pumped into a septic truck.

3.2.1.2 Residual Management Issues

- The facility employs a centrifuge and filter system to clean transformer oil. Currently, the facility has trouble finding replacement paper filters. As previously noted, PCBs have been detected in the transformer oil of other energy facilities in Armenia. Disposal of transformer oil filter products may result in the discharge of a known carcinogen.

3.2.2 ISSUES RELATED TO THE PROPOSED REHABILITATION

A complete discussion of the proposed rehabilitation plans for this facility can be found in other documents. Selected areas of the proposed rehabilitation plan that may have environmental impacts were assessed as follows:

- Powerhouse leakage and dewatering and Spherical Inlet Valves – The proposed rehabilitation of these structures and valves will greatly reduce current loading to the drainage chamber and would reduce the amount of entrained oil and sediment currently being discharged to the River.

- Generator cooling water heat exchangers – The proposed replacement of these heat exchangers will reduce the risk of oil being discharged to the River.

- Storage batteries – The proposed replacement of the storage batteries will result in an improved worker safety condition as the risk of leaks/rupture will be eliminated. However, conscientious disposal of the old batteries is required in order to avoid hazardous materials contamination of soils, surface water, or groundwater.

- Transformer oil spill containment – The proposed rehabilitation plans do not address the existing transformer underdrain system that currently discharges directly to the River. Provision of a shut-off valve and/or diversion to a catch tank and/or diversion to an oil/water separator is recommended in order to prohibit transformer oil leaks from being discharged to the Vorotan River.

3.3 TATEV HPP

3.3.1 OBSERVATIONS

The Tatev HPP had the least amount of water on the turbine floor of the three facilities visited. Total flow to the drainage chamber was estimated by plant personnel to be 1 liter/sec. The facility was generating 59 MW of electricity at the time of the visit and was receiving 150 MW from Iran due to the Armenian Nuclear Power Plant shutdown.

The battery storage area is in an isolated room that does not contain floor drains.

3.3.1.1 Water Issues

- The transformers are situated outside the main building and appeared well-maintained. The area does not currently have an underdrain system and any leaks would currently flow unimpeded to the Vorotan River.

- The onsite tank farm is comprised of 3, 120 ton capacity transformer oil tanks and 3, 60 ton capacity turbine oil tanks. The tanks have been empty for 8 years due to lack of funds/oil. The tank farm is completely enclosed by a concrete dike with no drainage outlet. Therefore, this area currently poses no risk to water quality.

- Plant derived sewage is discharged untreated to the Vorotan River.

3.3.1.2 Residual Management Issues

- The facility employs a centrifuge and filter system to clean transformer oil. Currently, the facility has trouble finding replacement paper filters. As previously noted, PCBs have been detected in the transformer oil of other energy facilities in Armenia. Disposal of transformer oil filter products may result in the discharge of a known carcinogen.

3.3.2 ISSUES RELATED TO THE PROPOSED REHABILITATION

A complete discussion of the proposed rehabilitation plans for this facility can be found in other documents. Selected areas of the proposed rehabilitation plan that may have environmental impacts were assessed as follows:

- Turbine Nozzles – The proposed refurbishment and upgrade of the existing nozzles will eliminate the current oil leakage at the seals and result in less oily water being discharged to the Vorotan River.

- Spherical Inlet Valves – The proposed rehabilitation of these valves will reduce current loading to the drainage chamber and would reduce the amount of entrained oil and sediment currently being discharged to the River.

- Generator cooling water heat exchangers – The proposed replacement of these heat exchangers will reduce the risk of oil being discharged to the River.

- Storage batteries – The proposed replacement of the storage batteries will result in an improved worker safety condition as the risk of leaks/rupture will be eliminated. In addition, the proposed completion of the ducting to the exhaust hood will eliminate acid-containing air from the adjacent room to which it is currently being discharged. However, conscientious disposal of the old batteries is required in order to avoid hazardous materials contamination of soils, surface water, or groundwater.

- Transformer oil spill containment – The proposed rehabilitation plans will address the absence of a transformer underdrain collection and storage system. This system will collect spills and direct them to an oil storage tank. The current system would allow leaks to flow directly into the River.

3.4 GENERAL RESERVOIR ISSUES

Although civil engineering and structural integrity concerns of the reservoirs and associated dams and spillways of the Vorotan Cascade are addressed in other documents reviewed as part of this Assessment, the following observations are offered for consideration:

• In the "Analysis of Seismic Stability of Tolors Dam Shamb Hydro Power Plant" (30 July 1998), the Ministry of Energy concludes that the slope of the dam must be modified and that an additional 449,000 m^3 of material should be placed in the dam body. Based on surficial observations and past experience with loamy/unconsolidated materials, a review of the applicability/suitability of geotechnical products such as gabions and geogrid/geotextile use is recommended. The use of geotechnical products in similar applications has eliminated the need for expensive hauling in of preferable offsite fill materials and these products also allow a wider range of slope geometry.

• In the "Documentation for Vorotan HPP Cascade's Dams and Civil Constructions Rehabilitation Programs Development" (Goris 1999), it did not appear that the Tatev Dam was considered for refurbishment. Based on surficial observation of the Tatev Dam (see Photo # 4), it appeared that, in an overflow condition, the soil dam surface would be highly erodible. Armoring/reinforcement of the soil dam surface with a geotechnical product might be an inexpensive means of ensuring the structural integrity of this structure.

4.0 LOCATION OF SENSITIVE ENVIRONMENTAL RECEPTORS

With regard to special protected areas, the Sevlich Nature Preserve to the north of the Cascade and the Shikahough Nature Preserve to the south are outside the Vorotan Cascade drainage basin area of influence and would therefore be unaffected by the proposed rehabilitation project.

More localized areas of cultural or natural importance were not observed during the assessment.

Another area of interest, from a receptor standpoint, is the environmental effect the proposed rehabilitation project would have on recreational users of the Vorotan River and Cascade Reservoirs, foodstuffs, and consumers of those products that receive irrigation water from the Cascade. Only one fisherman was observed on the entire Cascade system during the assessment. It may be assumed that other seasonal recreational uses of the Cascade Reservoirs would include swimming.

5.0 ALTERNATIVES TO THE PROPOSED PROJECT

Since the proposed project is a rehabilitation of existing facilities, the No Action Alternative was the only alternative considered under this assessment.

5.1 NO ACTION ALTERNATIVE

As is evidenced by a review of the "Issues Related to the Proposed Rehabilitation" sections of this report, the primary long term impacts to the environment from the proposed rehabilitation project are positive. That is, many of the proposed project components will reduce oil and sediment discharges to the Vorotan River and improve worker safety. In addition, based on previous assessment activities within the Armenian electrical production sector, PCBs may be present in transformers and circuit breakers. Although improvements of only one transformer area (Tatev HPP) is currently included in the proposed rehabilitation project, leaks and spills from the Spandarian HPP and Shamb HPP can inexpensively be eliminated.

If the No Action Alternative was accepted and the proposed rehabilitation project not implemented:

- There would be an increase in mechanical failures within respective facility components resulting in increased oil discharges and decreased worker safety.

- As equipment failures occur and repair becomes more unlikely, the overall amount of hydroelectricity production is further decreased. Thus additional thermal generating resources (with their resultant pollutants) would be required to offset the loss of hydropower.

- In the case of Tatev, which provides voltage and frequency control for the whole electrical system, the Vorotan Cascade would impact the quantity and quality of electrical power production throughout Armenia.

- The lack of assessment and rehabilitation of reservoir structures would ensure their continued structural uncertainty to the potential detriment of the downstream population in the event of failure.

Thus the No Action Alternative is not a viable option and no further consideration should be given to its implementation.

6.0 IMPACT ASSESSMENT

Since the proposed activity is the rehabilitation of existing Cascade facilities and structures, it has been assumed that there will be no new environmental impacts due to the continuing operation of the facilities and structures. As was evident in the "Issues Related to the Proposed Rehabilitation" section of this Report for each respective facility, the overall environmental impact of the proposed project is positive. Therefore, the primary detrimental impacts to the environment will occur during construction activities.

Table 6.1 details potential environmental impacts due to construction activities

Table 6.1

Potential Impacts During Construction

Direct Impacts	Damage Prevention/Mitigation Measures
Sediment accumulation increase in run-off caused by soil erosion at construction sites due to land excavation. Soil removal, waste accumulation.	Protection of sensitive surfaces by ground cover. Planting on surfaces subject to erosion.
Soil and water pollution by fuel, grease and other lubricants, from vehicles.	Collection and sensible disposal of lubricants. Prevention of accidental fuel and lubricant spills by following good practices and safety rules.
Dust accumulation. Noise.	Periodic watering of temporary roads or sprinkling of bitumen emulsion for dust agglutination. Mounting mufflers on equipment.
Air pollution and noise caused by traffic passing through rural areas.	Mandatory observation of rules, regulations and schedules of maintenance to decrease air pollution. Effective traffic and passenger transportation organization.
Waste accumulation along the roads.	Cleaning activities using technical means. Assist in adoption of construction laws and resolutions stipulating imposition of littering fines.
Poor sanitary conditions, lack of collection and disposal of solid waste in compounds and at the construction sites.	Proper location and maintenance of lavatories.
Formation of temporary mosquito propagation areas (for example, in water reservoirs with stationary water warmed up by the sun). Mosquitoes can be carriers of infections.	Determination of infection carriers' ecology and preventive measures against favorable conditions for their habitat and propagation.
Poaching by workers.	Urge employees against poaching at hiring stage.

7.0 MITIGATION MEASURES

It is assumed that a local work force will be used for the bulk of construction activities. Therefore, socio-economic impacts such as public services, infrastructure, etc. have not been evaluated as an impact due to construction activities.

Table 7.1 details mitigation measures that can be employed during construction to reduce environmental impacts.

Table 7.1

Impacts and Mitigating Measures

Impacts	Mitigating Measure
Reduced air quality due to emissions from construction equipment, trucks, earth moving machinery, and temporary compressors, etc.	The bulk of the rehabilitation activities are approximately 2 km away from the nearest populated area which effectively eliminates the impact of reduced air quality on the local population. All diesel and gasoline powered equipment used on site will be properly maintained to ensure efficient operation.
Increased turbidity in surface waters due to erosion from site clearing, earthwork, and road and building construction.	Silt fences and/or hay bales will be erected in the areas of soil disturbing activities. Vegetation will be maintained and/or replaced as necessary.
Pollution of surface waters from sanitary sewage, construction waste disposal, and site stormwater runoff.	Sanitary sewage will be collected and removed by tank truck. Construction waste will be disposed according to local regulations. Site stormwater runoff will be directed to an onsite stormwater retention pond, if necessary, intended to reduce siltation and allow for floating oil to be skimmed.
Pollution of surface waters from fuel or other hazardous material spills.	Fuel storage tanks will have secondary containment sufficient to hold the volume of the largest tank plus 10%. Hazardous materials will be stored in approved structures providing fire prevention and secondary containment capabilities. An Emergency Response Plan will be prepared detailing the procedures to be followed by the contractor's onsite emergency response team to prevent spilled material from reaching surface waters. In the event spilled material reaches a surface water body, procedures to minimize the impact by rapid

	containment prior to cleanup will be implemented.
Destruction of vegetation during site preparation, earth work, and road, building, and construction.	Vegetation on offsite areas will be restored to its condition prior to construction.
Erosion of destabilized soils during storm events as a result of site clearing, earth work, and road, building and construction.	Use of erosion control devices such as silt fences, hay bales, and riprap in stormwater conveyances. Replacement of vegetation with perennial grasses along road sides and in construction areas no longer subject to earth moving activities.
Excessive noise levels from construction activities, vehicular traffic, and heavy equipment.	The bulk of the rehabilitation activities are approximately 2 km away from the nearest populated area which effectively eliminates the impact of excessive noise levels on the local population. Onsite workers will be required to wear hearing protection when around activities producing sound levels in excess of 85 dba.
Excessive dusting created by site clearing, vehicular traffic, earth work, and construction activities.	The bulk of the rehabilitation activities are approximately 2 km away from the nearest populated area which effectively eliminates the impact of excessive dusting on the local population. The use of water spray may be provided as necessary.
Physical dangers of the construction site to unauthorized persons trespassing on the site after hours.	Specific onsite hazardous areas, such as open excavations, will be enclosed with temporary barricades. The contractor will provide personnel to maintain onsite security during non-construction hours.

8.0 INSTITUTIONAL NEEDS

Based on conversations with the Vorotan Cascade management, there are a number of items that would aid the Cascade in the areas of training, safety, and privatization. A list of these items is included as Appendix A.

9.0 INTERAGENCY COORDINATION AND PUBLIC/NGO PARTICIPATION

In an effort to provide relevant follow-on information in the event the rehabilitation project goes on to the next phase, the Environmental Public Advocacy Center (EPAC) in Yerevan was contacted regarding non-governmental organizations (NGOs). EPAC was asked to provide a list of NGOs who might be interested in attending a public meeting to discuss the rehabilitation project. This list of NGOs is included as Appendix B.

10.0 RECOMMENDATIONS

10.1 RECOMMENDATIONS FOR PHYSICAL IMPROVEMENTS FOR ENVIRONMENTAL PROTECTION

As was previously mentioned, many of the elements of the proposed rehabilitation project will improve environmental performance at the Cascade facilities. There are, however, other project elements that can be augmented to further improve environmental protection. These elements are outlined below:

- As previously noted, transformer oil spill containment measures are included in the proposed rehabilitation project for the Tatev HPP. However, both Spandarian and Shamb HPP have transformer oil spill collection structures that collect spills and discharge via pipeline to the respective water body. Therefore, a collection and storage tank should be added to the current Spandarian and Shamb spill collection structures. This will prevent any transformer oil leaks/spills from reaching surface water.

- Since the station storage batteries will be replaced at each of the three HPPs, proper disposal and/or recycling of the used batteries should be contractually binding to the contractor involved with that portion of the proposed rehabilitation project

- Existing transformers and oil-filled circuit breakers should be tested for the presence of PCBs. Previous assessment activities in Armenia determined that PCBs were present (up to 150 ppm) in all TPPs and other HPPs in the Armenian system. In addition, soils should be tested for PCBs in areas adjacent to transformers and circuit breakers that will be the subject of excavation activities as part of proposed rehabilitation activities.

- The three assessed facilities do not have oil/water seperation equipment. It is estimated that, after the rehabilitation is complete the average inflow into the drainage chambers at all facilities will be approximately 1 liter/sec. The current drainage chamber effluent should be sampled and analyzed for oil and grease. If the overall concentration exceeds international norms, oil/water seperation devices should be installed at the respective facility.

• With regard to spillway structures and dams: Consideration should be given to the use of geotechnical products (gabions, geogrids and geotextiles) to offset the low technical quality of onsite fill materials. These products have been in use (in synthetic derivatives) in the west for the last 20 years and in historic use (in natural derivatives) since Roman times and do not require specially trained personnel or high tech installation practices.

10.2 NON-STRUCTURAL MANAGEMENT RECOMMENDATIONS FOR ENVIRONMENTAL PROTECTION

The following Section will make recommendations for non-structural solutions to environmental issues that historically have not been addressed in the legacy Soviet policies. The recommendations will focus on management strategies that will aid in reducing impacts from the HPPs. The development of non-structural management opportunities for reducing both discharges and the potential for discharges is often more cost effective than structural emission control and treatment systems.

Although the Ministry of Energy may need to buy off on the proposed management programs outlined below, cooperation may be ensured via a link between programmatic ES&H improvements and facility mechanical investment.

10.2.1 PCB SPILLS, USE AND MANAGEMENT

If PCBs are found as a result of onsite testing then the following recommendations will enable facility managers to reduce and/or eliminate future discharges of PCB containing materials and begin to phase out the current stockpile of PCB containing transformer oil.

10) Since facility managers and power plant employees are unaware of the presence and hazards of PCBs at their facilities, education and familiarization should be the first step in addressing PCBs. An onsite PCB awareness seminar at each facility to include the Director, Lead Engineer and transformer yard maintenance personnel as well as presentations on fate-transport scenarios of PCBs would develop appropriate "stakeholder" dedication on the part of the participants. Appendix C presents an example outline of such PCB training.

2) Implementation of spill response plans primarily addressing transformer oil but modularly expandable to include other onsite liquids should be the second step. These plans can be based on generic spill response plans with site specific modifications

agreed to and debated among seminar attendees to ensure implementation and workability at each facility. Once a consensus is reached and roles and responsibilities assigned, additional steps may include closure of drainage channels at transformer yards and other low cost methods to reduce migration of existing contaminants. All above mentioned items can be highlighted during the PCB awareness seminar if such activities are authorized by USAID.

3) The most direct way to begin to phase out PCB containing transformer oil is to institute acceptance testing at the facility level via onsite immunoassay test kits prior to unloading/receiving transformer oil. Current standards (GOST standard) in the electrical energy production sector prohibit PCB additives in transformer oil. Reliance on such a broad based standard has obviously not worked since PCBs were detected in various degrees at all previously assessed facilities. Therefore, simple and low-cost testing of each transformer oil delivery would eliminate additional PCBs from coming into the facilities. Appropriate training sessions for use of the test kits could be conducted with appropriate plant personnel.

4) As part of the PCB phase out program, a testing and tagging procedure could be employed to identify PCB and non-PCB containing transformers. For example, as maintenance is performed or equipment is upgraded in transformer areas, a dated tag could be affixed to non-PCB containing equipment. Likewise, as production units are off-line for maintenance and repairs, associated transformer banks could be tested for a threshold value of PCBs and appropriately tagged. In this way, the gradual elimination of PCBs from electrical production facilities becomes a manageable issue. The same immunoassay test kits discussed in item 3) above could be used to test the transformer oil.

5) One obvious deficiency in the management of PCBs in Armenia is the absence of hazardous waste facilities to receive and safely process PCB containing materials. Establishment, through the Ministry of Energy, of a facility capable of safely disposing of PCB containing material is one option.

10.2.2 UNCONTROLLED DISCHARGE OF RAW SEWAGE

In addition to physical improvements outlined in previous sections, a point source inventory is recommended to establish all existing energy production, industrial, agricultural, and municipal/village discharges to the Vorotan Cascade System. Such a study would be required to enumerate regional contributors in order to fully understand the scope of necessary infrastructure improvements. It is anticipated that residential and agricultural sector sources are the major contributors of effluent to the Vorotan Cascade System with the HPPs having a smaller share of the discharges.

The location and capacity of existing sewage treatment works in the region and capital improvements required therein would also be cataloged. Existing information sources would be ground-truthed so realistic predictions and plans could be made. Logical groupings of electrical production facilities with associated villages and other industries may offer a cost effective benefit to all parties.

The current volume of flow has evidently diluted the discharged sewage to the point that it has not affected recreational and agricultural use of these waters. However, if flow of the Vorotan Cascade continues to be reduced due to reduced precipitation or as part of the Lake Sevan restoration effort, serious health issues may arise in the communities bordering the Cascade System.

As the World Health Organization states: "Lack of a supply of safe water and adequate means of sanitation is blamed, at least in part, for as much as 80% of all disease in developing countries. Contaminated drinking water is a prime cause of diarrhoeal disease - a major killer of infants and young children. It also costs many millions of working days each year for adults and massive expenditure on health care. Cholera epidemics, frequently also transmitted by unsafe water, are on the increase, aggravated by the rapidly growing populations in urban settlements. Great strides have been made in the last ten years in developing low-cost solutions and sustainable community management approaches, so governments have all the tools they need to implement cost-effective programmes for improved water supplies and sanitation facilities, benefiting health, the environment and the national economy."

PHOTOGRAPH LOG

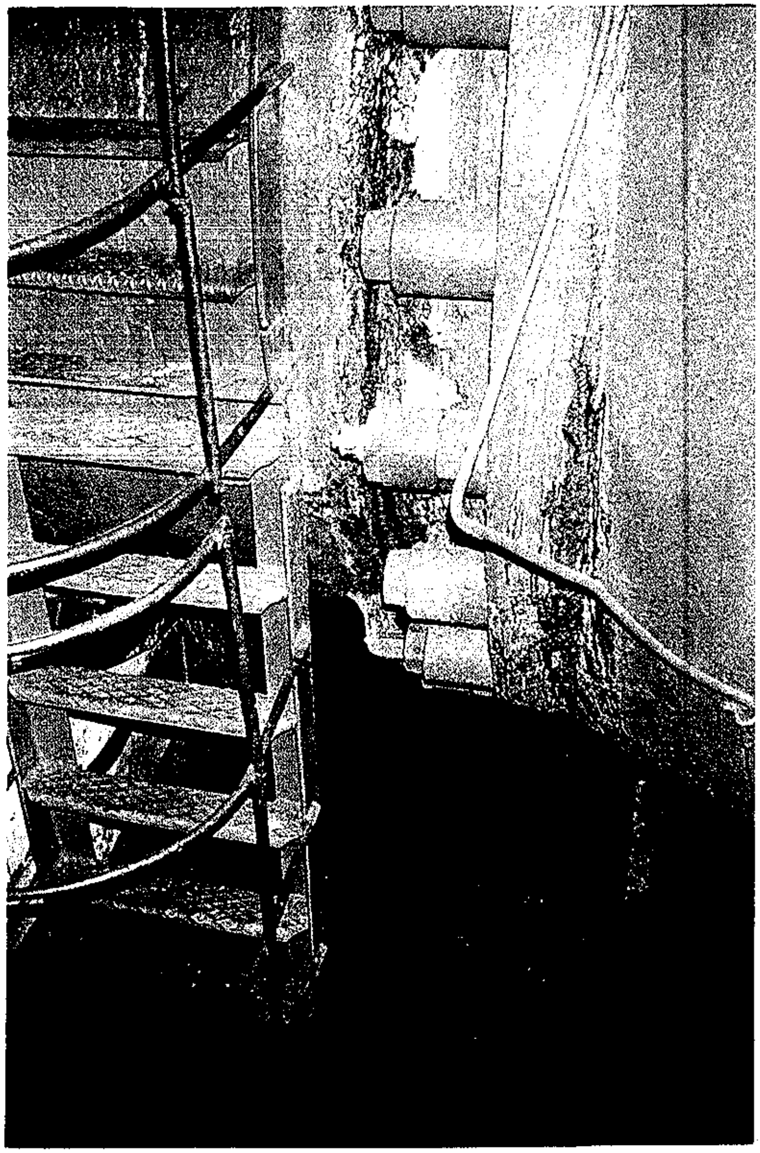


Photo # 1
Spandarian Inlet Valve and Interior
Penstock Wall

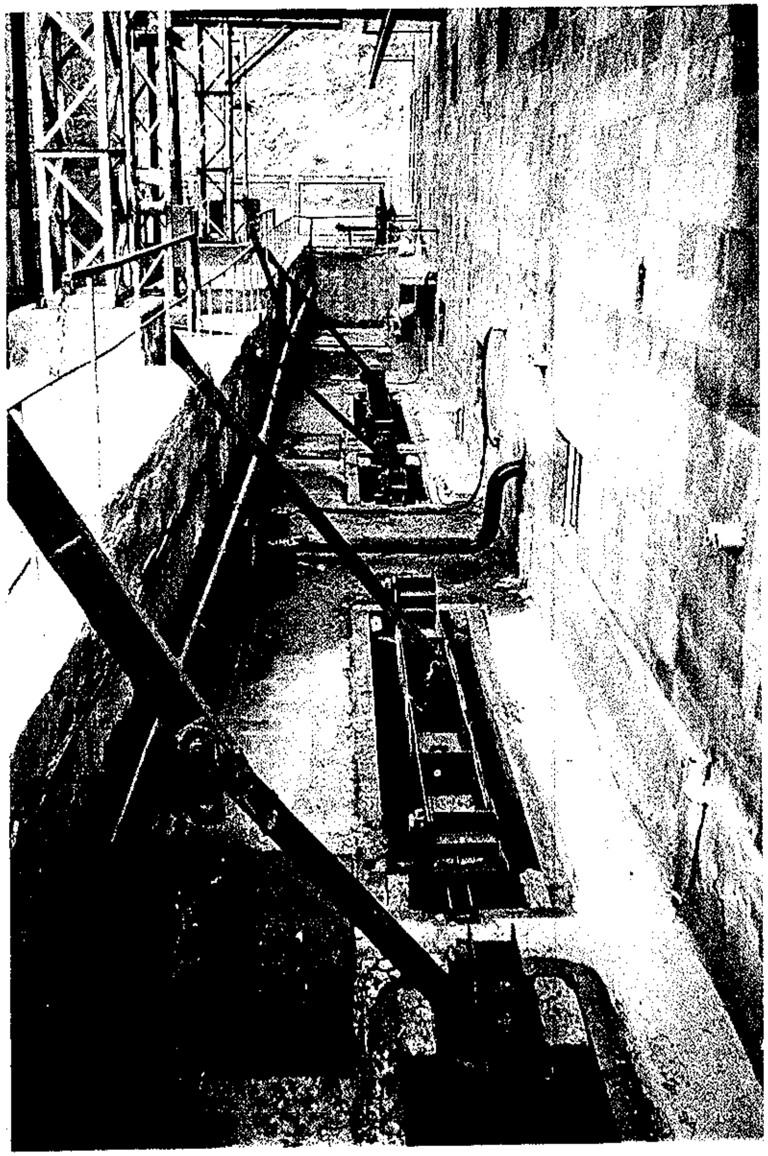


Photo # 2
Spandarian Drainage Chamber Pipe
(right To left, center of photo)

Photo # 3
Shamb Drainage Chamber Leakage

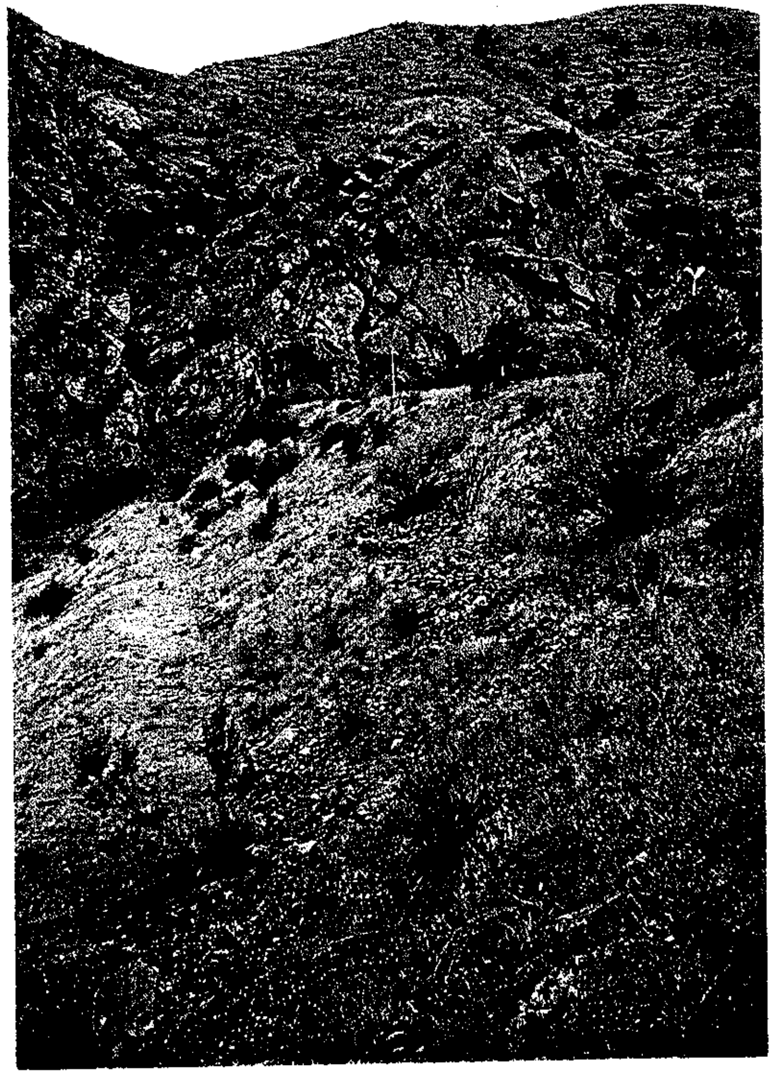


Photo # 4
Tatev Reservoir Soil Dam

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APPENDIX A

INSTITUTIONAL NEEDS (continued)

The following list was compiled based on the Cascade management request for equipment to aid in training, safety, and privatization efforts:

- Overhead projector with spare bulbs and screen.
- 4 walkie-talkies per facility to aid in internal communications between floors. (Note: 3 years ago there was a near mishap between the overhead crane operator and the cable fitter 2 floors below him at Shamb HPP)
- Modified intercom/headphone system for simultaneous translation.
- Large format copier (for engineering drawings) and 3 computer workstations (for internal reporting).
- Analytical equipment for the analysis of turbine and transformer oil performance testing.

APPENDIX B

REFERENCE BOOK OF ARMENIAN NON-GOVERNMENT COMPANIES FOR ENVIRONMENTAL PROTECTION

Altayir
President: Armen Buniatyan
Address: 29 Nalbandyan str, apt 8, Yerevan
Ph.: 55 88 61 (Vahan Hakobyan)

"Ani" Charity Organization
President: Laura Teknedjyan
Address: 49 Nalbandyan str, apt 4
Ph.: 52 18 46 (Armen Hakhnazaryan)

"Ardzagank" Charity Center
President: Armenuhy Brutyan
Address: 29 Erkatgtsi str, apt 15
Ph.: 57 23 19

"Byurakn"
President: Melanya Davtyan
Address: 19 Nalbandyan str, apt 34
Ph.: 52 44 84

Youth Ecology Group
President: Sergey Arevshatyan
Address: 68 Abovyan str.
Ph.: 58 23 22; 72 07 98

"Ecoteam"
President: Artashes Sargsyan
Address: 22a Abovyan str, apt 53
Ph.: 52 92 77
e-mail: artash@acc.am

Ecology Viability
President: Dshkhuhy Sahakyan

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Address: 24d Baghramyan str
Ph.: 27 92 68; 27 93 35

Armenian Branch of the Academy of Science for Safety of Ecology and Biological Activities
President: Gevorg Pirumyan
Address: 40 Tigran Metsy str., apt 6
Ph.: 55 86 35

Ecotourism Company
President: Zhanna Galyan
Address: 44 Abovyan str., apt 2
Ph.: 39 75 52; 56 86 90

Sustainable Development
President: Victorya Ter-Nikoghosyan
Address: 1a Rubinyants str, apt 45
Ph.: 39 71 47 (res)

Khachtarak
President: Derenik Kamalyan
Address: Republic Square, House of Unions, room 117
Ph.: 62 55 79 (Serouzh Gulakyan)

"Rainbow" Ecology Center
President: Ferdinand Grigoryan
Address: Vanadzor
Ph.: 4 01 17; 4 02 30

Sustainable World
President: Serozh Gulakyan
Address: 3/2 Avan, 31 Duryan str, apt 36
Ph.: 62 55 79

Fauna Protection Union
President: Zarmahir Benklyants
Address: 26 Khachatryan str, apt 1
Ph.: 26 53 70; 27 22 33

Union of Armenian Ecologist
President: Rafael Hovhannisyan

Address: 24d Baghramyan ave, 11,12 rooms
Ph.: 56 85 54

Armenian Council for Computerized Control
President: Vardan Mkrtchyan
Ph.: 26 81 04; 53 87 35 (Sargis Simonyan)
e-mail: aacc@scua.am

Armenian Center for Alternative Education and Art
President: Marine Khachatur
Address: 13 Kochar str, apt 23
Ph.: 27 37 24 (res); 27 07 21 (bus)

Armenian Union of Ecology Organizations
President: Armen Saghatelyan
Address: 68 Abovyan str
Ph.: 56 93 31

Armenian Ecology Fund
President: Boris Mehrabyan
Address: 49 Komitas str, 302-304 rooms
Ph.: 23 69 00; 22 30 58

Armenian Women Ecology Conference
President: Rita Ayvazyan
Address: 68 Abovyan str
Ph.: 26 80 04; 56 03 57

Armenian Green Union
President: Hakob Sanasaryan
Address: 47/13 Mamikonyants str.
Ph.: 25 76 34; 28 14 11

Ecology Branch of Armenian Women Union
Head: Sona Mardanyan
Address: 40 Tigran Metsy str., apt 6
Ph.: 55 86 35

"Armenian School" Educational-Cultural Union for Environment Protection
President: Karen Asatryan

Address: 2 Nork massif, building 92, apt 11
Ph.: 52 18 37; 62 89 65; 151 795(fax)

"For Human Sustainable Development" Association

President: Karen Danielyan
Address: 33/18 Khanjyan str.
Ph.: 52 23 27

Armenian Association of Forest Developers

President: Karen Ter-Khazaryan
Address: 13 Nalbandyan str.
Ph.: 58 36 55; 58 06 72; 53 07 31 (Ruzan Goroyan)

Ecology Department of the UNESCO Union of Armenian Clubs

President: Armen Gevorgyan
Ph.: 65 72 10 (res)

"Khazer" Fund of Investment for Initiatives

President: Aram Gabrielyan
Address: 35 Moskovyan str
Ph.: 53 49 82; 53 46 52

"Nor Dar" Youth Union

President: Tigran Tovmasyan
Address: 8 Abovyan str.
Ph.: 56 14 03

"Shogher" Union

President: Hasmik Aslanyan
Address: 47 Khorenatsu str, apt 108
Ph.: 55 47 12

Armenian Branch of the Russian Ecology Academy

President: Hamlet Zakaryan
Address: 49/4 Komitas str, 12 floor
Ph.: 23 45 48; 26 61 76

Social-Ecology Association

President: Srbuhy Harutunyan
Address: 30 Chaykovsky str, apt 1

Ph.: 42 26 37

"Tapan" EcoClub
President: Hrant Sargsyan
Address: B-2 South-Western district, building 21, apt 23
Ph.: 73 33 22; 56 60 16
e-mail: grant@tapan.infocom.amilink.net

Flora
President: Sveta Mkrtchyan
Address: 12 Krityan str, Gyumry
Ph.: 3 94 36; 3 35 86
Goal: creation of a legal center for environment protection, organization of tree plantings, sewerage system renovation, retention of historical monuments.

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APPENDIX C

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Appendix C

Proposed Outline for PCBs Awareness Training

1.0 PCBs General Overview

- 1.1 PCBs Nomenclature
- 1.2 Basic PCBs Chemistry
- 1.3 PCBs Properties

2.0 History of PCBs

- 2.1 PCBs Production
- 2.2 Use of PCBs
- 2.3 Initial PCBs Regulations and their Applicability to Armenia
- 2.4 Environmental Transport of PCBs

3.0 Health Implications of PCBs

- 3.1 PCB Toxicology
- 3.2 Health Studies
- 3.3 Occupational Exposure Criteria

4.0 PCBs Analysis

- 4.1 PCBs Identification
- 4.2 PCBs Testing
  - 4.2.1 Field Testing
  - 4.2.2 Detailed Analysis
- 4.3 PCBs Data Collection
- 4.4 Investigations
- 4.5 Management Strategy
- 4.6 Remediation Planning
  - 4.6.1 Technical Feasibility
  - 4.6.2 Implementation Feasibility
  - 4.6.3 Environmental Feasibility
  - 4.6.4 Economic Feasibility
- 4.7 Project Planning
  - 4.7.1 Risk Management and PCBs

5.0 Selection of Remedial Technologies

5.1 Identification of Applicable Requirements
5.2 PCB Guidelines and Regulations
5.3 Cleanup Levels
5.4 Identification of General Response Actions
5.5 Screening of Technologies
5.6 Alternatives

6.0 Institutional Evaluation

6.1 Legal Basis in Armenia
6.2 Long- Short-Term Effects
6.3 No Action Plan Limitations in Armenia