AWS CJSC

Armenian Small Municipalities Water Project
Engineering, Design and Contracts Supervision

Proj. No. 610-1182

Detailed Design
Environmental Impact Assessment

REHABILITATION OF THE WASTEWATER NETWORK IN JERMUK

FICHTNER
WATER & TRANSPORTATION

"JRTUC" LLC

Armenian Small Municipalities Water Project
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Environmental Impact Assessment

JERMUK

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Volume I	**Detailed Design Report**
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Abbreviations

ASMWP	Armenian Small Municipalities Water Project
AWSC	Armenian Water Sewerage Company
Bank	European Bank for Reconstruction and Development
Client	Armenian Water Sewerage Company
CNR	Construction norm
Consultant	Fichtner Water & Transportation GmbH in association with Jrtuc LLC
DRR	Daily Regulation Reservoir
EBRD	European Bank for Research and Development
EN	European norm
FWT	Fichtner Water & Transportation GmbH
mg/l	milligram per litre
mg*eq/l	milligram equivalent per litre
WWTP	Waste Water Treatment Plant
LCGA	Local self-governance agency

Literature

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[2] The Red Book of the Flora of The Republic of Armenia, Yerevan, 2010

[3] The Red Book of the Fauna of The Republic of Armenia, Yerevan, 2010

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[5] "Procedure for assessment of the impact of the economic activities on the atmosphere", approved by the Decree of RA Government N91-N from 25 January 2005

[6] SNiP 2.04.02-84. Water Supply: External Networks and Structures.

[7] Magakyan A.K., Flora of Armenian SSR, Yerevan, 1941

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1. INTRODUCTION

Anthropogenic environmental impact of the human activities: The correct and complete environmental impact assessment during the implementation of any foreseen design has a significant role for the sustainable use of the ecosystems and for maintaining the harmony between the nature and human life activities. The environmental assessment shall include the forecast of the direct and indirect impacts, their description and shall be a base for the development of the necessary measures aimed at their prevention or possible mitigation.

In accordance with the RA Law "About the Environmental Impact Assessment Expertise", all types of the foreseen activities, which have an environmental impact, are subject to an obligatory environmental expertise.

The design for "The Reconstruction of the Wastewater Network of Jermuk Town" has been implemented in the administrative area of Jermuk town of RA Vayots Dzor Marz. The administrative area covers 5,4km^2 and is located at 2080m a.s.l.

The presented paper is developed in accordance with the requirements of the RA Law "About the Environmental Impact Assessment Expertise" and includes justifications for the data, calculations, which are necessary for implementing the environmental impact expertise of the foreseen activities.

2. THE MAIN CONCEPT AND OBJECTIVES OF THE DESIGN

The term of reference is the study report implemented by COWI-JINJ LLC joint venture.
The objectives of the future improvement of the wastewater system of Jermuk town are as follows:

- Detailed studies of the existing wastewater system,
- Preservation of the environmental resources.

The main objective for the future waste water system in the project towns are:

- Safe and hygienic collection and drainage of produced waste water towards the planned location of the WWTP,
- Organized disposal and treatment of sewerage

In order to reach these objectives, several parts of the existing wastewater network shall be rehabilitated and additional works shall be carried out.

3. DESCRIPTION OF BASELINE ENVIRONMENTAL CONDITIONS

Jermuk town is located in the south-east part of Armenia, in Vayots Dzor Marz, at the elevation of 2080m a.s.l. The town is 170km far from Yerevan; it occupies an area of 5.4km^2 and has population of 6300 people.

Jermuk town is located on one of the north-west branches of Zangezur mountain range – on a volcanic plateau. The town has its unique role with healthcare resort and touristic zones and landscapes and is a famous resort town.

The main industrial activity is the production of bottled "Jermuk" mineral waters, tourism and healthcare resorts, which have been developed based on the mineral waters.

3.1 Climate

The climate of Jermuk is a typical mountainous one - with mild summer and long-lasting snowy winter. The sunshine duration is high – 2300 hours annually. The average annual air temperature is 4.5 °C, the absolute minimal temperature is -30 °C, and absolute maximum is +32 °C. The average annual precipitation is 856mm, the average thickness of snow cover is 212cm and the soil frost depth is 128cm. The average annual relative humidity of the air is 68%.

3.2 Water Resources

Jermuk town area is located at Arpi River basin, where the river network density coefficient is 1.2km/km^2 and the flow coefficient is 0.46. The length of the river is 56km; the feeding sources are as follows: snow - 40%, rain - 18%, underground - 42%. The flooding of the river starts in average at the end of March and ends in the beginning of July. The underground water basin of the area is rich with high-quality freshwaters and mineral waters.
The river waters belong to the hydrocarbonate class and have light mineralization of 100mg/l, very low hardness (content of Ca^{2+}+Mg^{2+} ions is less than 1.5 mg*eq/l), medium aggressiveness (the content of HCO_3^- does not exceed 1.0-1.5 mg*eq/l).
The mudflow activity of surface waters is average - once in 3-10 years.

3.3 Lands

The geological structure of the area includes volcanic flows of Quaternary age – basalts, which are covered with modern age formations of alluvial-delluvial origin of various strengths. From the morphography point of view the area of Jermuk town belongs to mountain plateau reliegh type, which is characterized by fragmented mountain ranges, shield mountain massives, deep canyons. The main morphography elements are cone-shaped hills with some funnel-shaped cavities and V-shaped river valleys. The reliegh fragmentation depth is 200-400m; the density of the valley-ravine network is high – the number of thalwegs is 50-100 per 1km^2. The inclination angle of the area surface is more than 30°, the area is rich with canyons. The exposition of the slopes is western.

The area lands belong to brown forest leached type. The content of humus in the 0-20 layer of the land is 4-6%. The erosion level of the area lands is 45-70%. The land is used mainly for agricultural purposes (orchards, arable lands). From the perspective of agro-industrial grouping, the area lands belong to heathland zone.

3.4 Flora

The flora of the area mainly belongs to meadow-heathland type, where the main components are Festuca versicolor Tausch, F. ovina L., F. valesiaca Gaudin, Hordeum violaceum Boiss et Huet, Carex humilis Leys, Trifolium ambiguum and other fractions. Meadow-heath groups can

be found in the field parts. Barberry, rose-hip and blackberry and hawthorn bushes are spread next to the forest flora in the rocky parts.
The main medical herbs are: Oregano (Origanum vulgare L.), absinthe wormwood (Artemisia absinthium L.), clary sage (Salvia sciarea L.), black elder (Sambucus nigra L.), eremurus (Eremurus spectabilis Bieb.) and others.

3.5 Fauna

The fauna of the area is versatile. The vertebrates include European buck, forest cat, brown bear, fox, marten and wolf. Reptiles are significanltly spread.

The forest is reach with birds – bullfinches, chaffinches, tomtits. The feathery predators include owls, eagle owls, common buzzards.

Invertebrates include locusts, crickets, grasshopers, bees, woodlice, ants, rainworm, mosquitos, large blue butterflies, flies.

3.6 Special Nature Protection Zones

There are no Special Nature Protection Zones in the rehabilitation works area of the project.

The construction works are carried out in the area of Jermuk town and no tree-cutting will be carried out during the works.

3.7 Social-Economic Conditions

The town occupies an area of 5.4 km^2, and the number of the population is 6300. Distance from Yerevan is 170km. It is located at 2080m a.s.l.

The conditions in Jermuk town are as follows:

1. Climatic conditions – typical mountainous climate zone, the average annual air temperature is 4.5°C
2. Provision with drinking and irrigation water - deficient
3. Town is gasificated
4. Condition of the roads - sufficient
5. Main occupation of the population – agriculture, service area

The town has:

1. Two basic schools
2. One high school
3. Two children art schools
4. One sports school
5. One chess school
6. One kindergarten
7. One central library

A branch of the Armenian State Art Gallery operates in the town.

4. DESCRIPTION OF THE FORESEEN ACTIVITY

4.1 General Information

The following objects are included in the structures of Jermuk town wastewater system:

- Sewerage collector
- Sewerage network

The main parameters for the rehabilitation of the wastewater system are presented in Tables 4-1 and 4-2.

Table 4-1. Reconstruction of the sewerage collector

Works	Unit	Length, m
Construction of collector from double-wall corrugated polyethylene sewerage pipes, OD 460 SN8	m	2538
Construction of collector from double-wall corrugated polyethylene sewerage pipes, OD 340 SN8	m	783
Construction of collector from double-wall corrugated polyethylene sewerage pipes, OD 230 SN8	m	120
Total	**m**	**3441**

Table 4-2. Reconstruction of the sewerage network

Works	Unit	Length, m
Construction of sewer from double-wall corrugated polyethylene sewerage pipes, OD 460 SN8	m	380
Construction of sewer from double-wall corrugated polyethylene sewerage pipes, OD 340 SN8	m	1976
Construction of sewer from double-wall corrugated polyethylene sewerage pipes, OD 290 SN8	m	1189
Construction of sewer from double-wall corrugated polyethylene sewerage pipes, OD 230 SN8	m	4457
Total	**m**	**8002**
Grand Total	**m**	**11443**
Reconstruction of the access bridge for the newly constructed PS	set	1
Reinforcement of the support wall at the PS area	set	1

5. DESCRIPTION OF THE ENVIRONMENTAL IMPACT DURING THE IMPLEMENTATION OF THE DESIGN (CONSTRUCTION) AND OPERATION OF THE SYSTEM

The environmental impact of the rehabilitation works for Jermuk town wastewater network is assessed both in the construction and operation stages.

5.1 Construction works

The total duration of the construction works implementation stage will be 10 months, including the preparatory works, earth works, installation of pipes and installation and testing of equipment. Each part of the works has its duration, based on which the environmental impact of the separate works has been assessed.

5.1.1 Impact on the atmosphere during the construction works

a) *Calculation of dust emissions during the excavation-loading works*

The calculations are done in accordance with the acting methodological procedure (5).

$$Q = (P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times G \times 10^6 \times B \times P_6)/3600 \text{ t/h, where (1)}$$

P_1 - is the share of dust fraction, 0.05
P_2 – is the share of 0-50 mkm sized particles in the spreading dust aerosol, 0.02
P_3 - coefficient, which takes into account the speed of wind in the area of operation of the construction machines, 1.0
P_4 - coefficient, which takes into account the humidity of the material, 0.2
P_5 - coefficient, which takes into account the largeness of the material, 0.5
P_6 - coefficient, which takes into account the terrain conditions, 1.0
B - coefficient, which takes into account the height of unloading, 0.6
G – the volume of the processed soil, 25078 m^3.

According to the working design time-schedule the duration of the earth works is 13 months,

13 months x 30 days/month x 8 hours/day = 3120 hours/constr.

G - 25078 m^3 : 3120 hours/constr. = 8,04 m^3/ hour or , taking into account the specific weight

7.3 m^3/ hour x 2.7 t/m^3 = 21.7 t/hour

$$Q = (0.05 \times 0.02 \times 1.0 \times 0.2 \times 0.5 \times 21.7 \times 10^6 \times 0.6 \times 1.0)/3600 = 0.36 \text{ g/s or}$$

0.36 g/s x 3120 hours/constr. x 3600s/hour : 10^6 = 4,04 t/constr. period.

b) *Emissions related to diesel fuel*

The emissions related with the diesel fuel are calculated in accordance with the methodological directive[1] about "Defining the volumes of emissions of hazardous substances from automotive transport".

The specific emissions from heavy automotive transport and machinery are presented in the Table below in accordance with the above mentioned methodological procedure.

Table 5-1. Specific emissions (g/kg of fuel)

Type of fuel	Substances						
	NO_x	CH	EOP	CO	N_2O	CO_2	SP
Diesel	42.3	0.243	8.16	36.4	0.122	3138	4.3

The adjustment coefficients for the hazardous emissions based on the average age and technical conditions of the vehicles are presented below:

Table 5-2. Adjustment coefficients for the hazardous emissions

Vehicle category	Hazardous substance	Impact coefficient	
		for average age of the vehicles	for technical conditions of the vehicles
Automotive transport with high load capacity	CO	1.33	1.8
	CH	1.2	2.0
	NO_x	1.0	1.0
	CO_2	1.0	1.0
	N_2O	1.0	1.0

The coefficients for carbon monoxide (CO), hydrocarbons (CH), and nitrogen oxides (NO_x) are taken from the "Methodological instructions for calculation of the emissions of hazardous substances to atmosphere from automotive transport" (Moscow, HydrometHrat -1983), whereas the coefficients for carbon dioxide (CO2) and nitrous oxide (N2O) have been assumed as 1, because no other values are proposed for them.

A total of 11 technical means, which use diesel fuel, will be operated during the construction works (3 trucks, 1 bulldozer, 1 mini excavator, 2 pipe-laying crane, 1 compactors, 1 wheel-based excavators, 1 asphalt compactor, 1 welding machines).

The average daily consumption of diesel fuel will be 435 liters and taking into account the specific weight - 435 x 0.85 = 370 kg/day.

The quantities of the machines and fuel used during the construction stage are shown in Table 5-3.

Table 5-3. The quantities of the machines and fuel used during the construction stage

N/N	Name of machine	Quantity	Daily normative fuel consumption	Amortisation coefficient	Daily fuel consumption	Cumulative fuel consumption
		pcs	l/day		l/day	l
1	Mini excavator	1	50	1	50	7650
2	Wheel-based excavator	1	80	1	80	6640
3	Crane	2	30	1.2	72	11592
4	Compactor	1	15	1.2	18	2304
5	Dump truck	3	40	1	120	23160
6	Welding machine	1	30	1	30	180
8	Asphalt compacting machine	1	25	1.2	30	660
9	Bulldozer	1	35	1	35	385
	Total	**11**			**435**	**52571**

The operation of the heavy machines and trucks will be done for 6 months and the volumes of emissions during that period will be as follows:

6 months x 30 days x 435kg/day = 78300 kg/constr. period.

Table 5-4. Specific volumes of emissions

Vehicle category	Hazardous substance	Specific emissions, g/kg	Emissions, t/constr. period	Emissions, g/s
Automotive transport with high load capacity	CO	87.14	6,8	1.5
	NO_x	42.34	3,3	0.73
	Hydrocarbons	8.4	0.6	0.15
	Solid particles SP	4.3	0.3	0.07

Sulfur Dioxide

The emissions of sulfur dioxide (SO_2) are calculated based on the approach, where all the sulfur contained in the fuel fully transforms into SO_2. In this case the formula of CORINAIR inventory system is used:

$$ESO2 = 2\Sigma ksb, \text{ where}$$

ks - is the sulfur content in the fuel - 0.002 kg/kg

b – is the fuel consumption - 323 kg, or 0.3 t/constr. period

SO_2 = 2 x 78300 kg x 0.002 = 313,2 kg/constr. period, or

313,2 x 1000 : 6 : 30 : 8 : 3600 = 0.06 g/s.

c) Emissions related to the welding works

The welding works are implemented using E42A type electrodes, which results in emissions of welding aerosol - 17 g/kg, manganese oxides - 1.1g/kg and chrome oxides - 0.43g/kg. The welding works are carried out during 22 days.

It is foreseen to consume up to 6 kg of electrodes per day, thus the emissions will be:

- welding aerosol - 0.01 g/s or 0.007 t/constr. period
- manganese oxides - 0.0006 g/s or 0.0004 t/constr. period,
- chrome oxides - 0.0003g/s or 0.0002 t/constr. period.

d) Bitumen works

During the bitumen works performed on the pipes, concrete and metallic constructions, there are evaporation of solvents used for thinning of bitumen, as well as emissions of hydrocarbons. The calculation of emissions has been done in accordance with Corinair (6) methodological procedure (SNAP CODE 040611).

$G = V_{asf} \times K_1 \times K_2$, where

G – emission of organic solvent during construction period, t/const.

V_{asf} - bitumen volume, 0,4 m^3,

K_1 - solvent containing ratio, 0.25

K_2 - share of hydrocarbons emission according to solvent volume, 0.05;

G = 0,4 x 0.25 x 0.05= 0.005 t/const. period

Bitumen works are implemented during 1 month; however their total duration is 3 days.

G = 0.005t x 10^6 g/t : 0,1 months : 30 days/month : 8 hours/day : 3600 s/hour = 0.05 g/s

Table 5-5 presents the volumes of emissions for both short-term and the whole construction period by the types of works.

Table 5-5. Emission volumes to the atmosphere during the construction period

Stages of construction works	Hazardous emission volumes, t/const. period (g/s)								
	Dust	**CO**	**NO_x**	**Hydrocarbons (CH)**	**Solid particles (SP)**	**SO_2**	**Welding aerosol**	**Manganese compounds**	**Chrome oxides**
1	2	3	4	5	6	7	8	9	10
1.Excavation-loading works	4,0 (0.36)	-	-	-	-	-	-	-	
2. Emissions related to diesel fuel	-	6,8 (1.5)	3,3 (0.73)	0.6 (0.15)	0.3 (0.07)	0.3 (0.06)	-	-	-
3. Welding works	-	-	-	-	-	-	0.007 (0.01)	0.0004 (0.0006)	0.0002 (0.0003)
4. Bitumen works	-	-	-	0.005 (0.05)	-	-	-	-	-
TOTAL	**4,0 (0.36)**	**6,8 (1.5)**	**3,3 (0.73)**	**0,605 (0.2)**	**0.3 (0.07)**	**0.3 (0.06)**	**0.007 (0.01)**	**0.0004 (0.0006)**	**0.0002 (0.0003)**

The data of the table shows, that the emission volumes are not high during the construction period and they cannot have significant environmental impact.

As seen in the table, the emission volumes are not high and cannot have significant environmental impact. The works are of a temporary nature and emissions will stop after the completion of the works.

5.1.2 Water resources

Water usage

During the construction works the water is used for domestic and technical needs of the staff and for watering (dust prevention).

a) The domestic water usage for the staff if calculated as follows:

$W_{d.t.}$ = (n x N + n_1 x N_1) x T, where
n – ET staff 5 persons
N– ETS water usage normative 0.016 m^3day/person
n_1– service staff (including drivers)` 22 persons
N_1 - service staff water usage normative 0.025 m^3day/person
T - number of working days 286 days
$W_{d.t.}$ = (5 x 0.016 + 22 x 0.025) x 286= 180,2 m^3/const. period or 0.63 m^3/day.

Drinking water will be provided by water trucks and will be stored in a special tank.

b) Water consumption for watering is defined as follows:

$$M_1 = S_1 \times K_1 \times T, \text{ where:}$$

S_1 – surface of watered area, 35400 m^2 (working site),
K_1 –1 m^2 daily watering norm, 0.0015 m^3,
T – number of warm and dry days, 90
M_1 = 35400 x 0.0015 x 90 = 4779 m^3/const. period or 53.1 m^3/day.
Total water usage will be 53,7 m^3/day.

Wastewater

Water consumption for watering (dust prevention) is categorized as non-returning and there is no generated outflow. Wastewater from the domestic water consumption is calculated using the following formula:

$$W_{w.w.d.} = W_{d.t.} - (W_{d.t.} \times LS) \text{ , where LS is water losses ratio - 0.05,}$$

$$W_{w.w.d.} = 180,2 – (180,2 \times 0.05) = 171,2 \text{ } m^3\text{/const. period or } 0,6 \text{ } m^3\text{/day.}$$

Bio-toilets will be installed for the staff, which will be uninstalled and transported elsewhere after the completion of the works.

5.1.3 Soil resources

Total earth mass will be 25078 m^3/const. period, backfill - 22834 m^3/const. period. Up to 2244 m^3 of excessive soil will be generated during the construction works, which will be transported to the site allocated by the local governing body.
A total of 4307m^3 of soil will be extracted during the construction works, which will be stored in separate piles. After the completion of the construction works this humus will be used during the recultivation works.

5.1.4 Biodiversity

The construction works will be carried out in an urban area, thus no vegetative cover will be damaged, no trees and bushes will be cut and fauna will not be endangered during excavation of

the pipeline trench. The biodiversity of the area will not be damaged during the implementation of the works planned within the project.

5.2 Operation stage

The environmental impact in the operation stage is assessed to be positive. Due to the rehabilitation of sewerage collection network and collector, the wastewaters of Jermuk town will be directed to the treatment plant and will not be discharged to Arpa river bed anymore. This will contribute to the protection of Arpa river water resources from pollution. The implementation of the works will contribute to the improvement of social-economic condition of the population.
The funds foreseen for the environmental protection measures are included in the cost-estimate of the design and are based on the corresponding work volumes.

6. POSITIVE AND NEGATIVE ENVIRONMENTAL AND SOCIAL IMPACTS

The activities for improvement of water supply system of Jermuk will have essential positive environmental and social impacts.

Positive impacts are:

- Reduction of water losses,
- Increase of the usage of water resources efficiently due to the implementation of water measure system
- Protection of water resources from inefficient usage,
- Sustainable water supply
- Increase of water supply duration
- Provision of appropriate quality of drinking water
- Reduction of drinking water contamination
- Prevention and elimination of penetration of infections in drinking water
- Improvement of health condition of residents.

Rehabilitation of the water distribution network will result in satisfying population's water demand and in eliminating high water losses. Thus the water resources will be used more efficiently and economically.

By-passing of the cemetery area will sharply reduce population risks to diseases and solve health problems. Improvement of the distribution network will assist in improving the livelihood and social condition of the town's population.

During implementation of works it is intended to prepare the mitigation measures in order to prevent or mitigate the possible negative impacts.

The initial evaluation showed that no irrevocable negative impact is expected in the residential areas of the improvement of water supply system.

The possible negative impacts are related to construction works, therefore they are limited and short. Under the project scope the Environmental Management Plan has been developed, where the activities for mitigation or preventing the negative impacts are projected.

The following negative environmental and social impacts may occur during rehabilitation of Jermuk's water supply and wastewater systems:

- Air pollution
- Noise
- Soil erosion and landslide processes
- Pollution of the environment by construction waste and garbage
- Contamination of soil and water resources by fuel and lubricants
- Contamination of soil and water resources with chloride.

The description of possible negative environmental and social impacts during implementation of works and their prevention and/or mitigation measures are presented in the following chapters.

7. ENVIRONMENT AND SOCIAL IMPACT MITIGATION MEASURES

The following preventive and mitigation measures have to be implemented in order to mitigate negative environmental and social impacts:

1. Prior to commencement of water supply system's rehabilitation works relevant permits and agreements shall be obtained from local authorities, in particular for disposal of excessive soil and construction wastes in special locations. If wastes contain high rate of harmful components, the appropriate passport of the Ministry of Nature Protection of the RA shall be obtained for their removal and location.

2. The location of access roads, construction sites, vehicles and heavy equipment parking stations, warehouses for construction materials and equipment, warehouses or accumulation sites for storage of dismantled pipes, units, liquid wastes and others shall be determined in advance and be organized in a manner not harming the environment. In particular, where possible the construction site shall be fenced by plastic material. The parking sites for vehicles and heavy equipment, the warehouses and the sites of preliminary accumulation (if relevant) of construction materials and dismantled equipment, liquid wastes and others shall be clearly delimited from the surroundings. The leakage of fuel/lubricants, spreading of wastes or their storage in arbitrary places shall be excluded. After completion of rehabilitation activities those warehouses and accumulation sites shall be completely eliminated and the original appearance of the area be restored.

3. The demolished asphalt has to be adequately collected placed in the special places allocated for the construction waste.

4. Special tanks shall be prepared for collection and storage of liquid wastes. Leakage of liquid wastes into the environment shall not be allowed. The liquid wastes shall be reused or removed according to procedures specified by the Armenian legislation.

5. At the beginning of construction works the fertile soil layer shall be removed and stored and used after construction works for restoring the original appearance of the area (recultivation). While restoring the original appearance of the site, plants typical for the landscape shall be used.

6. Only trucks and construction machines in good technical state shall be used as their emission is within the permissive standards.

7. Use closed/covered trucks for transportation of dusting construction materials and wastes. Regularly water construction sites to reduce dust. Construction sites shall be washed periodically in order to prevent the spread of dust

8. As the construction works will be implemented within inhabited areas, maximally new and good machinery shall be used to reduce noise and vibration as much as possible. The working hours shall be agreed with local authoritative body to disturb them as little as possible.

9. The garbage shall not be stored or removed to places not allocated for that purpose in order not to damage flora and fauna. It is prohibited to use and store very explosive and poisonous

substances. It is prohibited to park, wash, repair vehicles and heavy construction equipment in places not allocated for that purpose. It is prohibited to collect or destroy plants including cutting shrub and trees.

10. The labor shall be ensured with adequate working clothes and personal protecting equipment, in particular with helmets, gloves and others.

11. If historical and cultural monuments and artifacts are found during construction works, the works shall be ceased immediately and the appropriate agency of Ministry of Culture of the RA be informed.

The Environment Management Matrix is presented in Annex 1.

8. ENVIRONMENTAL MANAGEMENT

The organizational obligations for the implementation of proposed mitigating measures are distributed among the following agencies:

8.1 Agencies responsible for obtaining permits for project implementation

At the design stage, prior to commencement of works, the **Consultant** (JV Fichtner Water & Transportation GmbH/ Jrtuc LLC) has obtained the required agreements, consents and permits from the State and local authorities, including:

- written consent from the local governing authorities for the sites allotted for transportation of excessive soil and construction wastes.

Upon commencement of construction works, **AWS CJSC** shall obtain the following permits and certifications:

- electric supply technical condisions and land usage permissions,
- written consent for crossing the infrastructures/communications (gas pipes, electric and telecommunication cable, water pipes) from utility operators;
- construction permits;
- architectural and planning assignments.

Contractors (responsible for construction works implementation, to be selected through tendering) will be responsible for physical implementation of mitigating measures planned under the EMP and for obtaining any additional permissions/consents if a need for such documents emerges during construction. This includes, but may not be limited to obtaining of:

- permission from the State Agency for Protection of Historical and Cultural Monuments in case of encountering chance finds in the course of earth works.

8.2 Supervising agencies responsible for controlling implementation of the EMP measures

- The **Consultant** (JV Fichtner Water & Transportation GmbH/ Jrtuc LLC) will provide technical supervision of the construction works, including environmental and safety supervision. Technical supervisors will implement control of in time, due and reliable implementation of mitigating measures during the construction, prepare regular reports (quarterly) and submit to the Client.

- Environmental and Social Impact Specialist of AWSC will be responsible for timely, due and reliable implementation of the works and measures provided under the EMP. The Environment and Safety Specialist of the Consultant and the Environmental and Social Impact Specialist of AWSC will regularly visit the construction sites to supervise due imple-

mentation of the measures aimed at mitigation of work impact. During the visits the possible shortcomings and omissions will be identified in implementation of mitigating measures and infringement by the Contractor during construction will be discovered. AWSC's environmental and social impact specialist oversees performance of the Technical Supervision Company from the environmental perspectives. For provision of quality assurance of environmental works, TSC should present quarterly reports to the AWSC`s environmental and social impact specialist.

8.3 State monitoring agencies responsible for controlling EMP implementation efficiency

- State Environmental Inspectorate of RA Ministry of Nature Protection,
- State Hygiene and Anti-Epidemiological Inspectorate
- The State Agency for Protection of Historical and Cultural Monuments, if needed,
- The RA local governance bodies,
- The RA Ministry of Transport and Communication, if needed.

9. SUBMISSION OF REPORTS

Taking into account the launching period for rendering the services, the Consultant will submit Quarterly Progress Reports by the fifteenth day of the following quarter.

The report shall be submitted in Armenian and English and will include description part (quarterly progress on environmental and social), photos and environmental mitigation measures monitoring table.

10. ENVIRONMENT MANAGEMENT PLAN

The EMP has been developed based on the results of environmental screening under the investment program and includes appropriate mitigation measures.

EMP consists of two components:

- **Mitigation measures and agencies responsibilities for implementation**;
  The **Contractor** shall strictly follow the environmental mitigation measures prescribed in the EMP. The costs foreseen for the implementations of all the measures prescribed in the EMP are included the total value of the Contract and reflected in the bill of quantities.
- **Environmental monitoring**. On a quarterly basis Consultant should update information on monitoring of environmental mitigation measures and incorporate that table in quarterly report (during construction).

Notice on the failure to implement measures prescribed by the **Consultant** or the **Client** would be sent to the **Contractor** in written. After the Notice to Correct, the next recorded violation would trigger charging of liquidated damages in the amount of 0,1% of the total value of the contract. The liquidated damages do not relieve the **Contractor** from remedying the violation. The recorded violation should be remedied in two working days period. Liquidated damages would be retained from the next Performance Certificate and after the completion of the construction activities the liquidated damages for the recorded violation will be retained from the Retention Money. In case of three liquidated damages the Contract may be terminated unilaterally.
The above described paragraph of EMP violation will be included in the Contract for provision of works concluded by AWSC under the Project.

11. ANNEXES

Annex 1: Environmental management matrix
Annex 2: Meeting Photos

ANNEX 1

Environmental management matrix

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
Disruption of the natural and urban landscapes and loss of biodiversity	Selection of routes of water mains and internal network taking into account engineering-geological conditions of the area, minimizing the adverse impact on natural and urban landscapes.	Presence of instructions in design documents	Review of design documents	Upon delivery of draft design documents	Consultant	AWSC, LSGB
	Instructions provided for washing and disinfecting the water main and the network with chlorine, with reference to formal guidelines.					
Activation of land erosion and landslide process	Selection of routes of water mains taking into account engineering-geological conditions of the area	Sensitivity of design to geological conditions of the project site	Review of design documents	Upon delivery of draft design documents	Consultant	AWSC LSGB
Construction and household wastes (garbage) accumulation and transportation	On-site collection of waste in the designated locations and timely out-transportation to the destinations of final disposal	Construction sites free of litter and scattered construction waste	Site inspection	During construction works	Contractor	TSC, AWSC
	Obtaining written consent for disposal of construction waste from local self-governing bodies	Presence of waste disposal permission	Inspection of documents at Contractor's office	Before commencement of construction works	Contractor	
	Waste disposal to the formally designated locations	Absence of large volumes of the household and construction waste	Field visit	During construction Prior to hand	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
		at the construction site Absence of waste on site upon completion of construction		over of the completed works		
Generation of dust	Dust emission from transportation of construction materials	Use of closed/covered vehicles for transportation of powdery construction materials	Field visit	During construction	Contractor	TSC, AWSC
	Regular watering of construction sites in populated areas	No excessively dusty conditions on-site	Field visit	During construction	Contractor	TSC, AWSC
Contamination of soil and water with fuel and lubricants	Storage and application of fuel/ lubricants in the conditions excluding spillage and leakage	Area allocated for storage and application of fuel/lubricants insulated and confined No fuel and/or lubricant spills observed on-site	Field visit	During construction	Contractor	TSC, AWSC
	On-site storage and storage and safe disposal of used lubricants and their removal to designated disposal sites or recycling facilities	Presence of containers for storing used lubricants Presence of formal arrangements for disposal or hand over of used lubricants	Field visit, Inspection of documents	During construction	Contractor	TSC, AWSC
Noise and vibration	Limiting of construction works to working	No excessive noise out of working hours No complaints from affected communities	Field visit, Consultation with affected communities	During construction	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
	Technical condition of construction vehicles and machinery	Absence of excessive noise from engines No complaints from affected communities	Field visit	During construction	Contractor	TSC, AWSC
Safety of pedestrians and traffic in and around construction sites	Installation of appropriate road signs and provision of temporary by-pass arrangements as required	No disruption of traffic and no constraint for pedestrian access	Field visit, Consultation with affected households	During construction	Contractor	TSC, AWSC
Impact on archaeological monuments	Immediate termination of earth works in case of chance finds and prompt communication to the Agency of Protecting Cultural Heritage	No damaged archaeological items	Field visit	During construction	Contractor	TSC, AWSC RA MC
Landscape degradation and soil erosion	Separate storage of top soil and its restoration upon completion of construction works	Top soil stored in separate piles Top soil re-deposited over the construction site	Field visit	During construction	Contractor	TSC, AWSC
	Timely backfilling of excavated trenches	No trenches left open for excessive periods of time	Field visit	During construction	Contractor	TSC, AWSC
	Installation of gabions for laying pipelines in the sloped terrain	Presence of gabions	Field visit	During construction	Contractor	TSC, AWSC
	Harmonization of construction sites with landscape promptly upon completion of works	Construction site restored to quasi-original condition to the permissive extent	Field visit	Prior to hand over of constructed infrastructure	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
Environment pollution with chlorine use for disinfection of newly constructed pipelines	Prevention of release active and highly concentrated disinfectants to nature	Deactivation and delusion of chlorine prior to release of disinfectant to nature	Field visit	During disinfection of pipelines	Contractor	TSC, AWSC
Workers' exposure to dust and noise	Provision of protective gear (masks, ear phones) to workers for the use industry and noisy environment	Workers equipped with- and wearing protective gear	Field visit	During construction	Contractor	TSC, AWSC
Maintenance of work site and work camp (if existing)	Provision of water, sanitation, and household waste containers on work site	Satisfactory sanitary conditions	Field visit	During construction	Contractor	TSC, AWSC
Safety of construction machinery	Standard technical condition of construction machinery formally certified	Presence of positive expertise reports for operating cranes and other machinery deployed at the construction site	Inspection of documents at Contractor's office	During Construction	Contractor	TSC, AWSC
Conduct of excavation works	Demarcation of open trenches and other dig-outs	Open trenches and other dig-outs demarcated	Field visit	During Construction	Contractor	TSC, AWSC
Preparedness for accidents at work site	Provision of the first aid medical kits and fire-fighting equipment	The first aid kits and fire-fighting equipment present on site	Field visit	During Construction	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
Safety of staff involved in chlorination processes[2]	Continuous control of chlorination stations Training of operators (conducted by HTH tablets providers) Provision of protection and emergency response equipment for operators	No health damage of operators of chlorination stations incurred from exposure to chemicals	Visit to chlorination stations	During operation of the water supply system	AWSC	SCWM
Soil and water contamination by water treatment sludge (river, well, spring catchments)	Sludge disposal strictly at the sites formally designated according RA legislation	Sludge safely disposal at approved sites	Visit to treatment station, observation	During operation of water supply system	AWSC	SCWM
Pollution of water sources from domestic sources and domestic animals	Protection of sanitary zones from trespassing	Sanitary zones secure and clean	Visits to sanitary zones	During operation of water supply system	AWSC	SCWM

[2] RA Government Decree N-529Ա dated April 21, 2011 on "Approval of safety rules during production, use, storage and transportation of chlorine".

ANNEX 2

Meeting Photos

Meeting in the WASC head office

Field investigation in Jermuk

Field investigation in Jermuk