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Environmental Policy and Technology Project

For the New Independent States
of the former Soviet Union

Prepared for
Bureau for Europe and the New Independent States
U.S. Agency for International Development

By
A USAID Project Consortium Led by CH2M HILL

Environmental Policy and Technology Project

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UKRAINE

General Schematic of Lviv Water System

Delivery Order #09, Task U2
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Bureau for Europe & the New Independent States
Office of Environment, Energy & Urban Development
Environment & Natural Resources Division

Prepared by
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Environmental Policy and Technology Project
For the New Independent States of the former Soviet Union

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PREFACE

Under the 1992 Freedom Support Act the United States Congress initiated a program to provide various forms of assistance to new independent states (NIS) of the former Soviet Union Cooperative Agreements were signed between representatives of the U S government and each country in which assistance was to be undertaken The U S Agency for International Development (USAID) was given the responsibility to coordinate all U S government assistance to the NIS under the Act

Through competitive bidding USAID awarded a multi year contract to a team managed by CH2M HILL International Services Inc (CH2M HILL) to support implementation of an environmental assistance program to republics of the former Soviet Union Under this contract termed the Environmental Policy & Technology (EPT) Project CH2M HILL is to assist USAID s missions in Moscow Kyiv and Almaty undertake a program to promote environmental improvements in the NIS The USAID mission in Kyiv supports environmental and other assistance programs to Ukraine Belarus and Moldova CH2M HILL established an office in Kyiv from which to perform services in these countries under the EPT Project

This report was prepared as a contractually required deliverable under a contract between USAID and CH2M HILL Although work on this report was conducted in cooperation with the assisted governments and USAID the findings and recommendations are those of the CH2M HILL team They do not necessarily represent official positions of the governments of the assisted countries nor of the United States of America

The CH2M HILL team includes the following organizations

- Center for International Environmental Law
- Clark Atlanta University/HBCUMI Environmental Consortium
- Consortium for International Development
- Ecojuris
- Environmental Compliance Inc
- Harvard Institute for International Development
- Hughes Technical Services Company
- International Programs Consortium
- International Resources Group Ltd
- Interfax Newsagency
- K&M Engineering
- Ogden Environmental and Energy Services Company
- Price Waterhouse
- World Wildlife Fund (US)

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NOTE ON TRANSLITERATION

Ukrainian personal, institutional, and place names used in EPT documents are transliterated into English from Ukrainian (not Russian), according to the modified U S Library of Congress standard for Ukrainian-to-English transliteration that has been adopted by many Western organizations and publications, including the *Encyclopedia of Ukraine* (University of Toronto Press, 5 vols, 1984-1993) and O Subtelny's authoritative *Ukraine A History* (University of Toronto Press, 1988, 2nd edition 1994), as well as by the Ukrainian Commission on Legal Terminology (Resolution No 9 dated 19 April, 1996)

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ABBREVIATIONS, ACRONYMS & GLOSSARY

CH2M HILL	CH2M HILL International Services, Inc A U S -based international environmental engineering consulting firm under contract to USAID to implement a large component of the EPT Project
DO	Delivery Order
e g	for example
EPT	Environmental Policy & Technology (Project) A USAID-funded program to provide environmental assistance to New Independent States of the former Soviet Union
LVK	Lviv Vodokanal (municipal public water utility)
m^3/d	cubic meters per day
NIS	New Independent States (of the former Soviet Union)
No	number
oblast	A government territorial-administrative unit in the former Soviet Union that is still in use following Ukraine's independence A U S analogue would be something between a state and a county
PS	Pump Station
USAID	U S Agency for International Development
vodokanal	A quasi-government agency responsible for municipal water supply and wastewater collection and treatment A U S analogue would be a water utility
WB	World Bank (International Bank for Reconstruction & Development)
ZhEK	A municipal entity responsible for operation and maintenance of houses and multi-apartment buildings owned by city administrations, as well as water, sewerage, gas, electricity, and heating systems within them

Section 1

INTRODUCTION

As part of a United States government bilateral assistance program, the U S Agency for International Development (USAID) is supporting environmental management in Ukraine Under direction from USAID, a consortium led by CH2M HILL International Services, Inc (CH2M HILL) is implementing part of USAID's Environmental Policy & Technology (EPT) Project by undertaking various tasks that have been agreed to by representatives of the governments of both countries

USAID authorized CH2M HILL to perform a series of tasks in Ukraine as part of Delivery Order (DO) No 9 Under Task U-2 (Urban Water Management Demonstration Lviv) of DO #9, CH2M HILL is to assist the local water utility, Lviv Vodokanal (LVK), strengthen its operations and improve service to its customers Task U2 includes a requirement (Subtask 2 1, Subsection 2 1 2)[1] for CH2M HILL to produce a general schematic of the water supply, conveyance, and delivery system

This report is in response to the USAID requirement

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[1] Delivery Order 9, Task U2 Subtask 2 1 Subsection 2 1 2 states in part (in "Article III-Scope of Work) *Produce a General Schematic of the System The contractor* [CH2M HILL] *will produce an outline of the type of drawings and schematics of the basic water production and delivery system and the methodology necessary to analyze operations so as to supply information to prepare a strategic for system improvement*

Using available data and discussions with operations and maintenance personnel in the Vodokanal the Contractor shall produce a general improved schematic of the overall water production and delivery system This would not be a be a [sic] *scaled map but will only contain the key facilities of the system such as the major well fields pump stations transmission mains and distribution sectors*

The Delivery Order further states (in "Article IV-Reports/Deliverables") that the contractor is to provide a *Report General schematic of the water system*

Section 2

EXISTING LVIV WATER SYSTEM

The water system for the city of Lviv includes remote water sources, conveyance from the sources to the city, and distribution within the city This system is described below, using information obtained by CH2M HILL since October 1995 from files of the Lviv Vodokanal and the Lviv Institute for the Design of Communal Services, as well as field observations and measurements Details are tabulated in Tables 2-1 to 2-3, and schematically in Appendix A

2 1 OVERVIEW OF LVIV WATER SYSTEM

Lviv, over 700 years old, currently has a population of about 800,000 people Its present public water supply and distribution system was started about 100 years ago The city's drinking water source is groundwater pumped from a series of grouped wells (called "wellfields") outside the city perimeter (Figure A-1) Water from the wellfields is conveyed (Figure A-2) to the city in transmission pipelines These pipelines generally terminate at large pump stations at the city boundary, where additional pressure is added in order to distribute water (Figure A-3) within the city Booster pumps and storage tanks within the city further assist the delivery of water to residents and other users The entire water system can be characterized by the following major components

- Water source, consisting of
  - a series of wells, grouped into wellfields
  - well pumps
- Water transmission, consisting of
  - transmission pipelines, conveying water from the wellfields to the city perimeter
  - transmission pumps, in pump stations along the transmission lines
- Water distribution, consisting of
  - distribution pumps, in pump stations at the end of the transmission pipelines
  - reservoirs, at distribution pump stations
  - chlorination, which is conducted at the distribution pump stations
  - distribution pipelines (water mains), to deliver water to end-users
  - water tanks, to store water within the city for use during periods of peak water demand
  - booster pumps, to increase water pressure within the distribution system in order to deliver water to customers at higher elevations or remote from the distribution pumps

2.2 WATER SOURCE

The city obtains its drinking water from about 170 wells in some 20 wellfields (Figure A-1) located outside the city boundary Table 2-1 provides data on characteristics of each wellfield The earliest public wellfield serving the city was developed about 1900 In order to obtain sufficient suitable water, the more-recent wellfields have been established as far away as 100 kilometers (km) from the city center Depth to groundwater is generally about 70 meters (m) for most wells, but older wells obtain water from gravel layers at about 25 m deep, whereas newer wells draw water from depths of over 300 m The use of groundwater has kept the supply system reasonably simple, and the only treatment that water receives is disinfection by chlorination

2 4 WATER TRANSMISSION

Expansion of the water infrastructure in Lviv occurred to match growth of the city In general, this was done by establishing and/or expanding wellfields adjacent to the side of the city where new development was to occur This avoided the need to transfer water across the center of the city, a task which became more difficult as the city grew The overall system of supply now resembles a wheel, with the city being the hub and the spokes being the supply lines bringing-in water (see Figures A-1 and A-2) The result is that the water infrastructure can supply and deliver water into the old (central) city, which is generally at a lower elevation, but it is very difficult, due to the capacity of pipes in the center and the higher elevations at some parts of the distribution area, to move significant quantities of water from one side of the city to the other

2.4 WATER DISTRIBUTION

The water distribution system within the city of Lviv (Figures A-3 and A-4) includes the following

- nine pump stations (and associated storage tanks), generally on the city perimeter (Table 2-2, Figure A-4)
- some 180 km of water distribution mains

General characteristics of the distribution pumps are presented in Table 2-2, and their associated reservoirs in Table 6 Water is also chlorinated at some of these pump stations (see Table 2-2) Details of the distribution system within the city is presented in Table 2-3

The city itself is built on a series of low hills, with an elevation difference of about 150 meters In 1995, an average of about 335,000 m^3/d was pumped into the city's water distribution system This system has been divided into six distribution zones (Figure A-3), each of which is generally associated with a water source, well field, transmission line, and city boundary pump station

Table 2-1
Lviv Well Field Characteristics

No	Well Field Name	Year Built	No Of Wells	Dist to Lviv	Static Water Level	Capacity			Average Daily Production		Problem Constituents	Number of Operating Personal	Remarks
						Safe Yield	Added Yield	Total	1987	1995			
				km	m	m^3/d	m^3/d	m^3/d	m^3/d	m^3/d			
	North												
1	Rava Ruska	1972	8	48 0	3 3	17 000		17 000	17 000	16 932	Strontium	8	
2	Maheriv	1971	4	40 5	3 8	17 200	9 800	27 000	8 800	8 466	Strontium	3	
3	Shostaky	1972	3	39 5	3 8	3 400		3 400	3 400	6 350		2	
4	Krekhiv	1970	5	29 5	4 8	15 600		15 600	13 500	13 611	Strontium	5	
5	Kunin	1970	2	30 5	4 8	5 700		5 700	5 400	5 444		2	
6	Mokrotyn	1966	7	19 8	4 0	16 100	8 000	24 100	18 000	16 222	Strontium	7	
7	Zarudtsi	1965	16	12 5	3 8	19 700	8 000	27 700	24 200	20 927	Strontium	16	
	Group total		**45**			**94,700**	**25,800**	**120,500**	**90,300**	**87,952**			
	West												
8	Volia Dobrostanska	1901	5	26 6	15 0	18 500	3 500	22 000	16 800	7 026		13	
9	Velykopole	1926	5	23 9	5 6	8 000	5 000	13 000	13 200	7 015		13	
10	Kamianobrody	1952	4	20 0	3 6	23 000	10 000	33 000	16 100	15 289		13	
11	Malchytsi	1967	9	11 6	7 0	15 700	5 600	21 300	10 300	15 868		6	
12	Budzen	1956	22	20 5	6 5	45 200	9 000	54 200	32 200	31 568	Iron Strontium	12	No removal
13	Kernytsia	1969	8	20 5	6 5	9 000	6 400	15 400	12 000	11 479		4	
	Group total		**53**			**119,400**	**39,500**	**158,900**	**100,600**	**88,245**			
	South												
14	Stryi	1982	34	75 0	4 0	140 000	-	140 000	122 200	126 578		16	
15	Hlynna Navaria	1971	12	14 5	1 2	14 700	4 300	19 000	10 000	14 238		13	
16	Bibrka	1973	12	15 9	4 5	13 300	6 700	20 000	17 600	24 192	Iron	14	No removal
17	Malechkovychi	1932	1	7 0	1 2	5 000		5 000	5 000	4 910		5	
	Group total		**59**			**173,000**	**11,000**	**184,000**	**154,800**	**169,918**			
	East												
18	Remezivtsi	1986	4	72 0	2 6	34 500	24 800	59 300	7 000	7 377	Iron	Purchased water	No removal
19	Pluhiv	1989	8	74 0	2 0	70 000	20 000	90 000	30 200	50 572	Carbon dioxide hydrogen sulfide	14	Air stripping to reduce hydrogen sulfide (H_2S)
20	Vilshanytsia	1989	4	40 0	3 0	16 400	10 500	26 900		8 577		10	
	Group total		**16**			**120,900**	**55,300**	**176,200**	**37,200**	**66,526**			
	Total		**173**			**508,000**	**131,600**	**639,600**	**382,900**	**412,641**			

Table 2-2
Lviv Water Distribution Pump Stations

Pump Station	Number of Pumps		Pump Characteristics			Pump Shaft Elev	Year		Design Daily Capacity	Average Daily Flow 1995	Annual Flow 1995	Power Supply Category	Power Usage in 1995		Disinfection
	Working	Stand-by	m^3/h	atm	kW	m	Built	Rebuilt	m^3/d	m^3/d	1000 m^3		kWh	kWh/m^3	
North															
Zarudtsi	2	2	2,300	6 5	800	274 7	1965	-	110,400	87 953	32,103	II	13 689,900	0 426	yes
West															
Volia Dobrostanska	2	2	1,200	6 8	500	282 9	1901	1936	22,000	7 026	2,564	II	3,769,900	1 470	no
Velykopole	2	1	360	9	190	282 1	1928	1936	13,000	7,015	2 560	II	2,337 400	0 913	no
Kamianobrody	2	-	540	7	250	274 4	1952	-	23,000	15,289	5 580	II	3 241,400	0 581	no
	-	1	720	7	190										
Budzen II	2	2	1 250	12 5	630	277	1964	-	45 000	43,047	15 712	II	17,988 900	1 145	yes
South															
Mykolaiv	2	2	3,000	19 7	1600	265 0	1978	-	140,000	117 655	42 944	I	24 087 800	0 561	no
Hlynna-Navaria	1	1	720	8 9	250	327 0	1971	-	19,000	14 238	5,197	III	5 405,100	1 040	yes
Stare Selo	2	1	560	7	160	302 1	1973	-		24,192	8,830	III	5 846,500	0 662	yes
East															
Pluhiv	2	-	1,250	6 5	250	285 1	1982	-	37,000	50,572	18 459	II	6,581,800	0 357	no
Total									**409,400**	**366,987**	**133,950**		**82,948,700**	**0 619**	

Table 2-3
Characteristics of Distribution Piping of 200 mm or Larger Diameter

Diameter, mm	Total Length, m	Steel				Cast Iron			
		Length, m	by 1945	by 1970	by 1995	Length, m	by 1945	by 1970	by 1995
200	8 160	850	-	850	-	7 310	-	3,130	4,180
250	6,350	-	-	-	-	6,350	2,850	-	3,500
300	41 148	3,318	-	980	2,338	37 830	-	18 235	19,595
350	14,300	12,930	-	12 930	-	1 370		1,370	-
400	40,513	19 478	1 870	14,228	3,380	21,035	-	10 710	10,325
500	21,045	20 845	-	3 945	16 900	200	-	200	-
600	37,343	9 960	-	2,780	7 180	27 383	7,540	19,843	-
700	5 895	5,895	-	3,945	1,950	-	-		-
900	2,780	2 780	-	-	2,780	-	-	-	-
1,200	750	750	-	-	750	-	-	-	-
1 400	3,500	3 500	-	-	3,500	-	-	-	-
Total	**181,784**	**80,306**	**1,870**	**39,658**	**38,778**	**101,478**	**10,390**	**53,488**	**37,600**

Appendix A

LVIV WATER SYSTEM SCHEMATICS

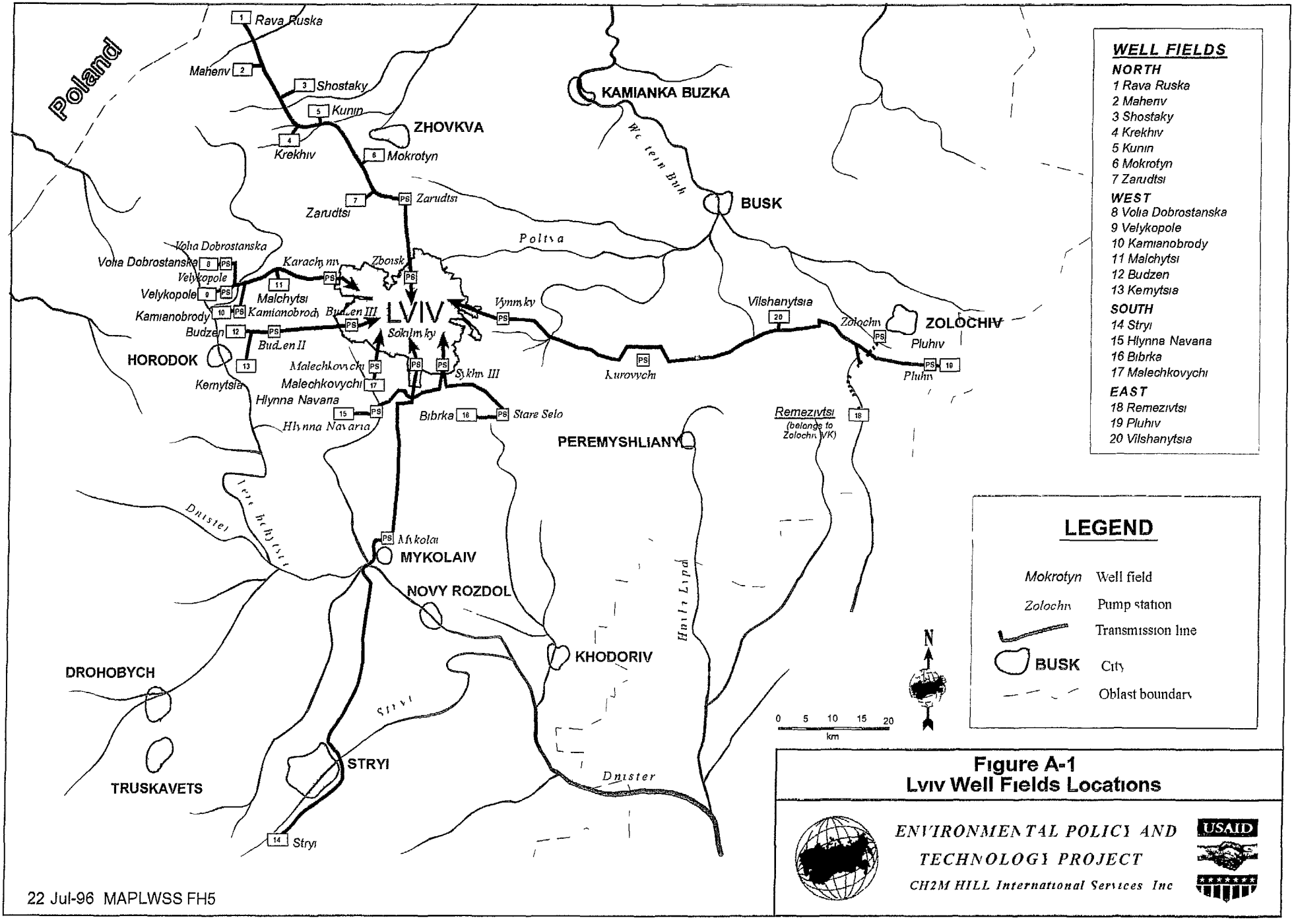

Figure A-1
Lviv Well Fields Locations

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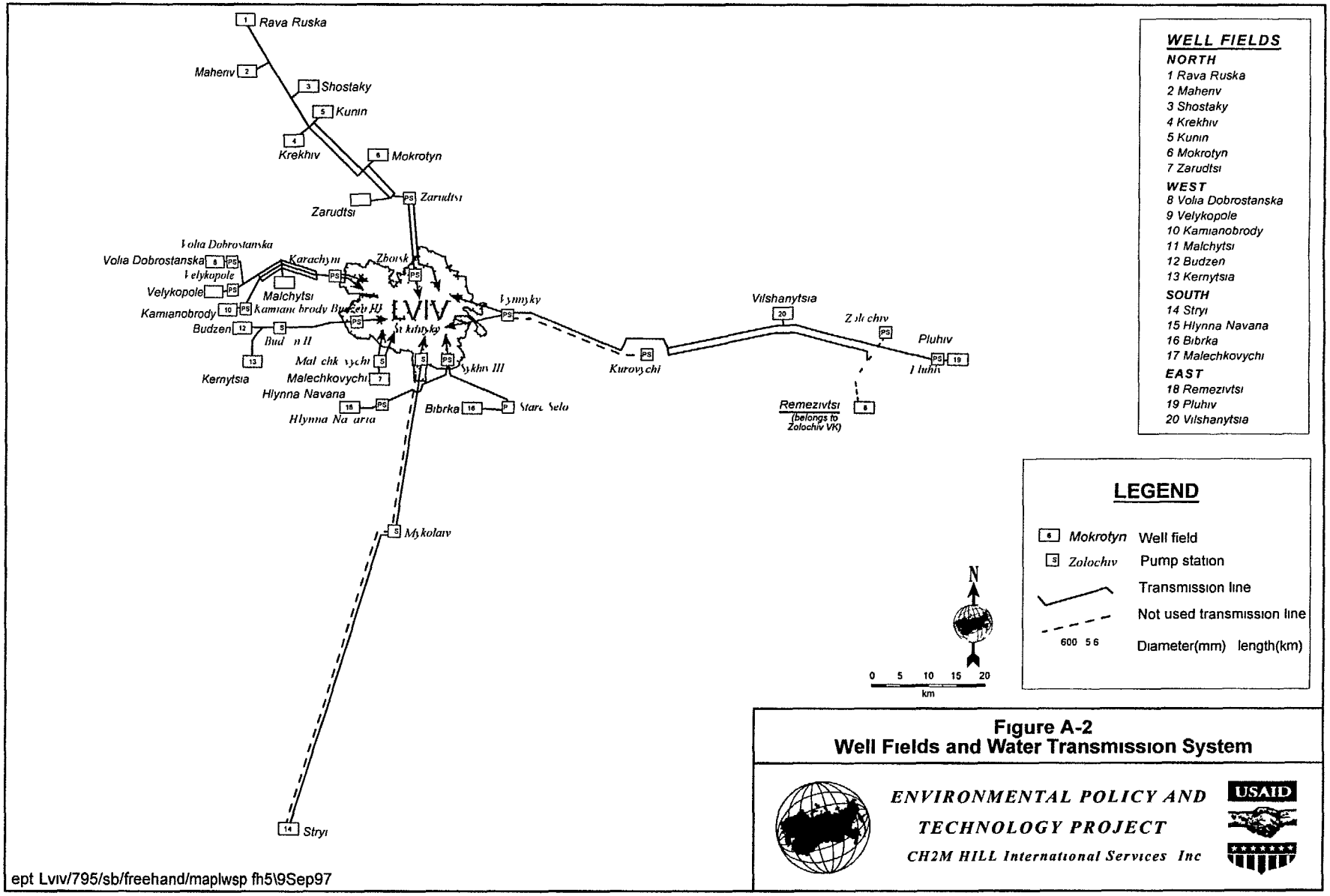

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Figure A-2
Well Fields and Water Transmission System

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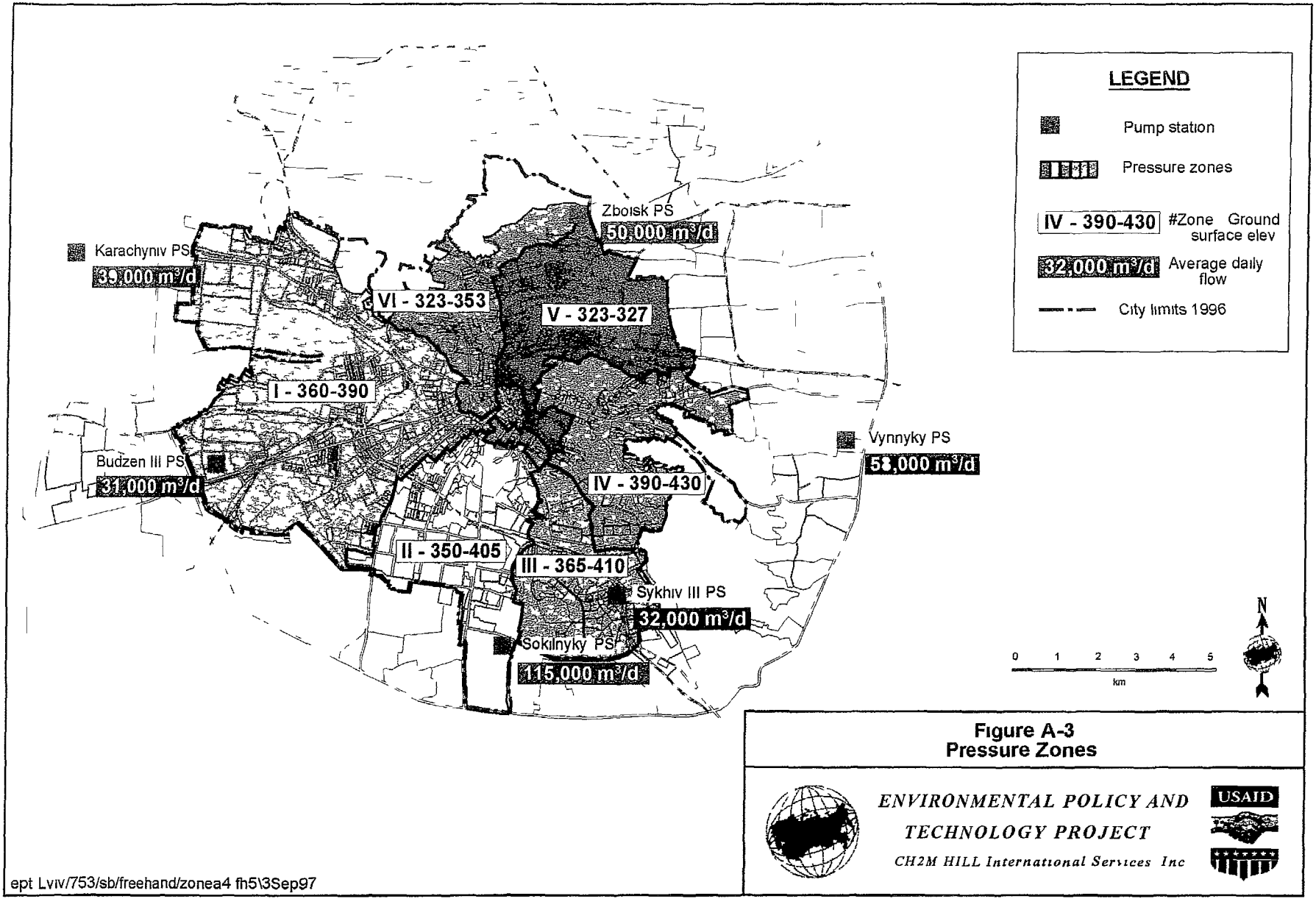

Figure A-3
Pressure Zones

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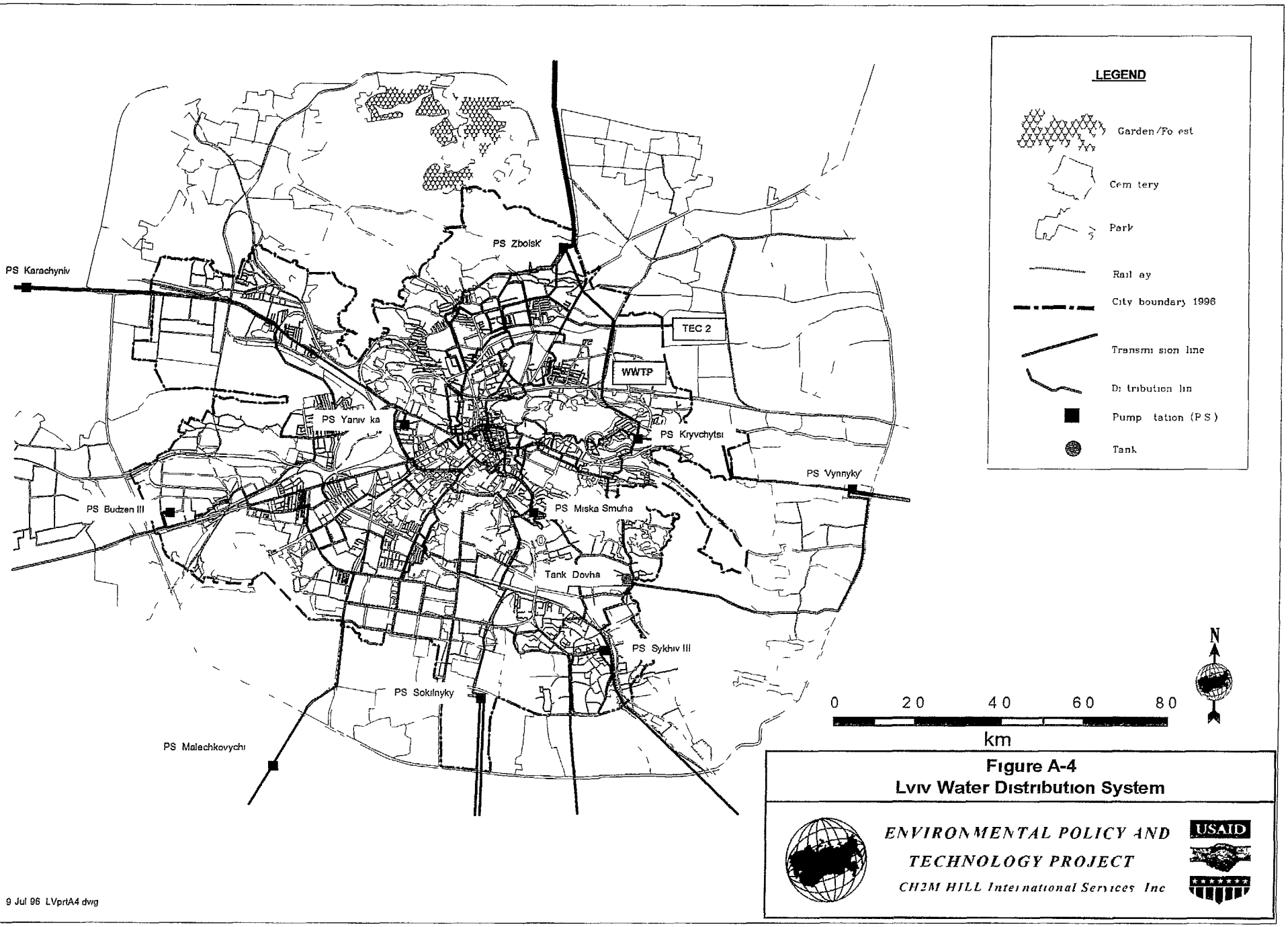

Figure A-4
Lviv Water Distribution System

ENVIRONMENTAL POLICY AND TECHNOLOGY PROJECT
CH2M HILL International Services Inc
USAID

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

CH2M HILL International Consortium of Subcontractors Center for International Environmental Law Clark Atlanta University/Historically Black Colleges Universities and Minority Institutions Technology Consortium Consortium for International Development Ecojuris Environmental Compliance Inc Harvard Institute for International Development Hughes Technical Services Company International Programs Consortium International Resources Group Interfax K&M Engineering Ogden Environmental and Energy Services Price Waterhouse the World Wildlife Fund and numerous local subcontractors and cooperators throughout the NIS

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