

---

## Case Study X\* - Moscow Region, Russia

---

*\* This case study was prepared by V. A. Vladimirov*

### X.1 Introduction

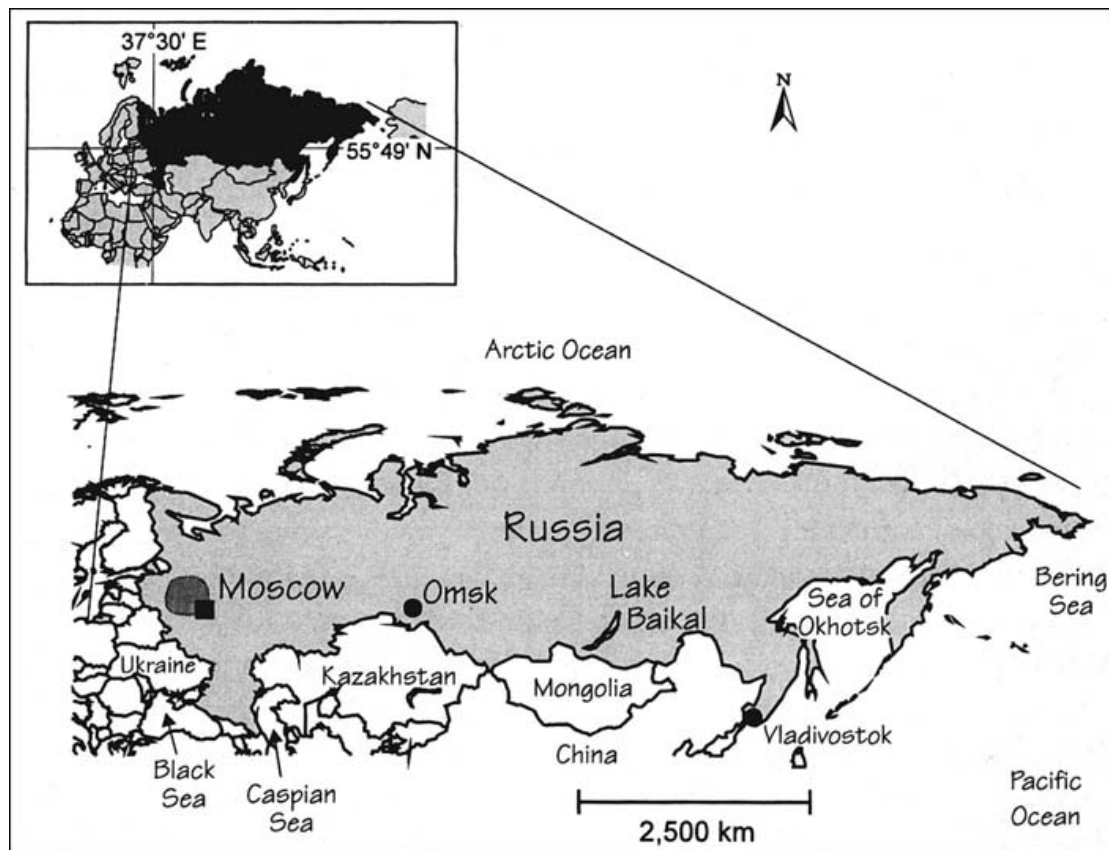
The Russian Federation state report "Drinking Water" issued in 1994, highlighted among other things the ongoing deterioration in water quality and in the reliability of the Moscow region drinking water supply (State Report, 1994). Almost all studies undertaken in the region in recent years, have indicated that the inadequate technical and sanitary condition of the water sources could lead to risks to human health for the population in this vast and important area (Anon, 1992). These potential problems with the Moscow region drinking water supply are of great concern to the Government of the Russian Federation, the authorities of Moscow City, Moscow, Smolensk and Tver Oblasts, to the mass media and to non-governmental organisations (NGOs). However, it was recognised that the policy and strategy for improvement of the region's water supplies should be based on a comprehensive and environmentally-sound approach.

The Ministerial Conference on Drinking Water and Environmental Sanitation "Implementing UNCED Agenda 21" (held in Noordwijk, the Netherlands, March 1993) set forth guiding principles for safe drinking water supply schemes, thereby providing the basis for immediate action by national government and supporting agencies and institutions (UNDP, 1994). In formulating the "Program of Water Quality Improvement in the Sources of Moscow Drinking Water Supply", which was completed in 1994, some efforts were made in the Moscow region to apply those principles in order to attain overall environmental quality and sustainable development objectives.

### X.2 Description of the region

The Moscow region (Figure X.1) is located in the western part of the Upper Volga river basin and encompasses the catchment areas of the Volga river with its tributaries (from headwater down to the Ivankovskoye Reservoir dam) and the Moscow river (from headwater down to Moscow City). Administratively, the area comprises part of the territories of Moscow, Smolensk, Tver Oblasts and Moscow City and covers about 55,000 km<sup>2</sup>. The region has a moderately continental climate with an average annual air temperature of 3-4 °C and an average annual precipitation of 720-800 mm. The evaporation rate in the area is 550-575 mm a<sup>-1</sup> and is estimated to be 70-80 per cent of total precipitation.

**Figure X.1 Location map of the Moscow region**



Geologically, the catchment area is composed of mineral coal and Permian and Jurassic bedrocks (limestones, sands and clays). The surface layers consist of glacial and Holocene formations, i.e. boulder loams and sandy loams, as well as lacustrine and fluvioglacial sands and clays. The soils are predominantly of the soaic/podzolic type with medium and light sand loams being prevalent. In depressions in the landscape, marshy and peat bog soils occur. The landscape is mainly low hills of 150-300 m above sea level. The areas of small, flat-top hills (Valdai, Smolensk-Moscow) and ridges (Gzhatsk-Mozhaisk, Klin-Dmitrov) are separated by shallow river valleys and plains. Forest cover in the watersheds varies from 66 per cent of the area at the Volga River headwater to 39 per cent at the site of the Ivankovskoye Reservoir dam. Native birch and aspen tree forests are dominant but pine tree forests cover the junction area of the Volga, Tma and Tvertsa rivers.

Within the basins of the Vazuzskaya and Moskvoretskaya Water Systems there are 10 administrative districts, nine cities and towns and 19 settlements. The total population is 922,100 people, including 576,000 urban and 346,100 rural residents. In the basin of the Volzhskaya Water System there are 17 administrative districts, 11 cities and towns and 22 settlements with a total population of 1,176,500 people, of which 885,900 are urban and 290,600 are rural residents. The average population density in those basins is 71 persons per km<sup>2</sup> but in the rural area it is only 27 persons per km<sup>2</sup>. In total, the water systems of the region provide drinking water to approximately 14 million people, including those of Moscow City.

The economic infrastructure of the region is well developed with numerous types of industry (ferrous and non-ferrous metallurgy, metal works, machinery, electronics, construction, chemical/petrochemical, power generation, mining and textiles), agriculture (crops, livestock, processing of agricultural products), and transport (automotive, railways, inland navigation, airways).

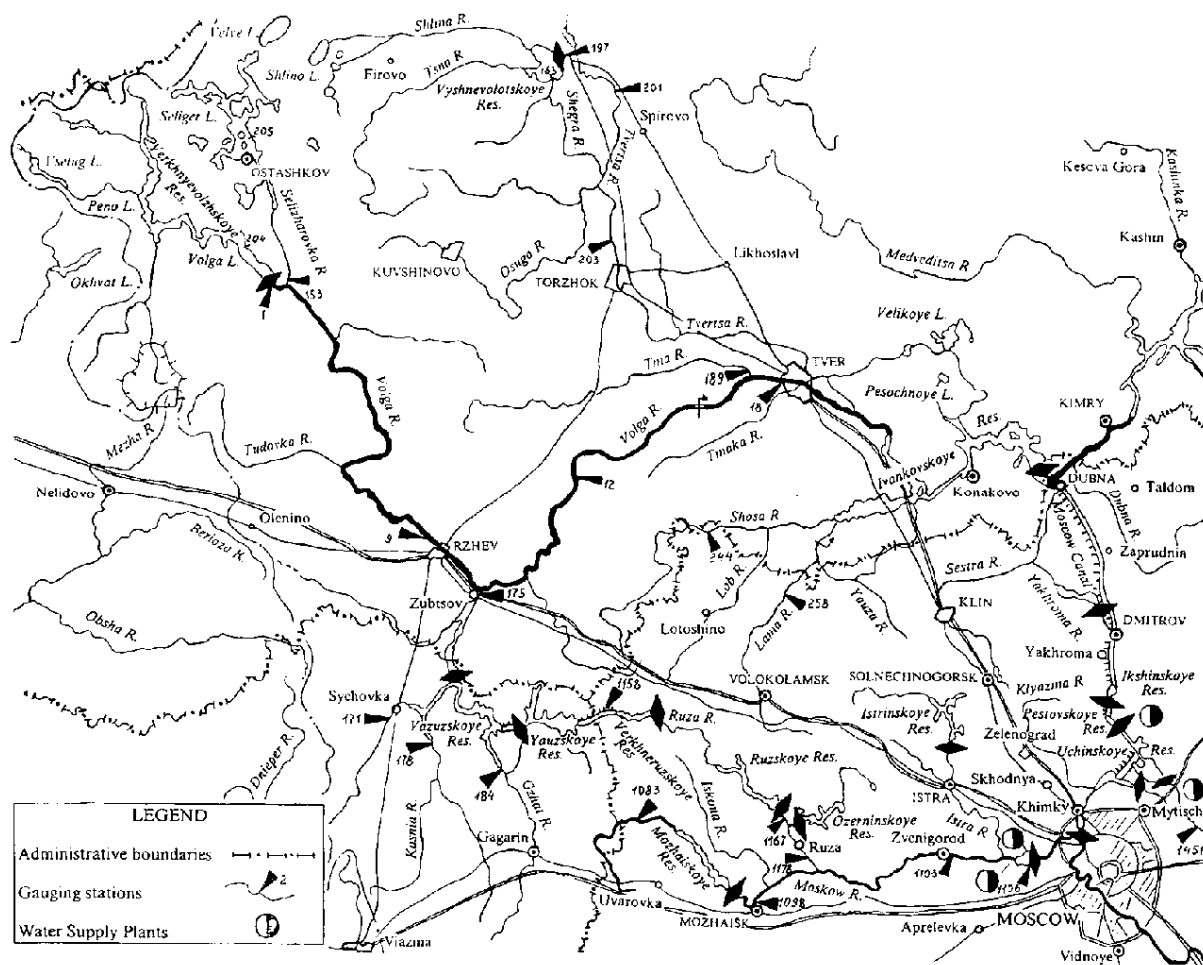
### **X.3 Water systems**

The drinking water supply of Moscow City and the adjacent vicinity is maintained mostly by surface water conveyed from the Vazuzskaya, Moskvoretskaya and Volzhskaya water systems, located within the territories of the Smolensk, Moscow and Tver Oblasts (Figure X.2). The water systems comprise rivers, lakes, reservoirs, canals and hydraulic units. The major water bodies are listed in Table X.1.

The Vazuzskaya water system augments the water supplies and provides water for inter-basin transfer to the Moskvoretskaya water system and to the Volga river. The system incorporates linked canals, pumping and hydro-power plants. The reliable water supply (i.e. 95 per cent probability for the year) is  $19\text{ m}^3\text{ s}^{-1}$  for the Moskvoretskaya water system,  $5\text{ m}^3\text{ s}^{-1}$  for the Volga river and  $1\text{ m}^3\text{ s}^{-1}$  for local water use. The Moskvoretskaya water system comprises the Moscow river and its tributaries, with storage reservoirs and diversion dams, and provides a reliable water supply of  $51\text{ m}^3\text{ s}^{-1}$  (with 95 per cent probability for the year) and  $46\text{ m}^3\text{ s}^{-1}$  (with 97 per cent probability for the year). The system conveys water for the Rublevskaya and Western water supply plants with a total diversion of  $96.7\text{ m}^3\text{ s}^{-1}$ .

The Volzhskaya water system includes the Volga river headwater, linked lakes, reservoirs and the Moscow Canal with a series of tandem reservoirs, pumping plants, navigation locks and other structures. The reliable water supply from the system is  $82\text{ m}^3\text{ s}^{-1}$  with 95 per cent probability for the year and  $78\text{ m}^3\text{ s}^{-1}$  with 97 per cent probability for the year. The total diversion to the northern and eastern water supply plants from the reservoirs of the Moscow Canal is  $36.6\text{ m}^3\text{ s}^{-1}$ . The major facilities of the water system were completed in the period 1935-67 and they now require technical restoration and/or remodelling.

**Figure X.2 Map of the basins of the Moscow region that are used for drinking water supplies**



**Table X.1 The major water bodies of the Moscow region water systems**

Vazuzskaya System		Moskvoretskaya System		Volzhskaya System	
Water body	Location (Oblast, City)	Water body	Location (Oblast, City)	Water body	Location (Oblast, City)
<i>Rivers</i>					
Vazuza	Smolensk/Tver Oblasts	Ruza	Moscow Oblast	Volga	Tver Oblast
Osuga	Tver Oblast	Moscow	Smolensk/Moscow Oblasts	Donkhovka	Moscow/Tver Oblasts
Kasnya	Smolensk Oblast	Lusyanka	Moscow Oblast	Doibitsa	Tver Oblast
Gzhat	Smolensk Oblast	Koloch	Moscow Oblast	Shosha	Tver/Moscow Oblasts
Ruza	Smolensk Oblast	Ozerna	Moscow Oblast	Kotlevlya	Tver Oblast

Yauza	Smolensk Oblast	Istra	Moscow Oblast	Lama	Moscow/Tver Oblasts
				Iksha	Moscow Oblast
				Ucha	Moscow Oblast
				Klyazma	Moscow Oblast
				Tvertsa	Tver Oblast
				Shlina	Tver Oblast
<i>Lakes</i>					
				Dolgoye	Tver Oblast
				Vitbino	Tver Oblast
				Seliger	Tver Oblast
				Shlino	Tver Oblast
				Velikoye	Tver Oblast
				Pesochnoye	Tver Oblast
<i>Reservoirs</i>					
Vazuzskoye	Smolensk/Tver Oblasts	Ruzskoye	Moscow Oblast	Verkhnevolzhskoye	Tver Oblast
Yauzskoye	Smolensk Oblast	Mozhaiskoye	Moscow Oblast	Vyshnevolotskoye	Tver Oblast
Verkhneruzskoye	Moscow Oblast	Istrinskoye	Moscow Oblast	Ivankovskoye	Tver Oblast
		Ozerninskoye	Moscow Oblast	Yakhromskoye	Moscow Oblast
				Pestovskoye	Moscow Oblast
				Ikshinskoye	Moscow Oblast
				Pyalovskoye	Moscow Oblast
				Klyazminskoye	Moscow Oblast
				Khimkinskoye	Moscow Oblast/Moscow City
<i>Canals</i>					
Yauza-Ruza Canal	Smolensk/Moscow Oblasts			Moscow Canal	Tver/Moscow Oblasts
Gzhat-Yauza Canal	Smolensk Oblast				

According to the latest inventory, 92 wastewater treatment plants are located in the area, 17 of which use mechanical, four use physical/chemical and 71 use biological technology. Beginning in 1978, biological wastewater treatment facilities were constructed in almost all cities and towns but their combined total capacity is only about 75 per cent of that required and the treatment efficiency does not comply with the existing standards for water sources of Class II (all drinking water supply sources are sub-divided into three classes depending on their quality). The wastewater of Moscow City is treated at the Kuryanovskaya and Luberetskaya secondary biological treatment stations which discharge treated effluents to the Moscow river downstream of the city.

In the period 1940-84 numerous statements were issued by the Council of Ministers of the Russian Federation devoted to the problems of setting up water protection zones and zones of sanitary protection, of alleviating waste-water pollution, and of improving the technical and sanitary condition of reservoirs and water systems. At present, the legal acts most applicable for enforcing the improving and maintaining of the drinking water supply to the required quality are as follows:

- Existing laws of the Russian Federation, namely "On Protection of the Natural Environment", "On Sanitary and Epidemiological Welfare of the Population", "On Protection of Consumers Rights" and "On Local Administration".
- Draft laws, namely "Water Code of the Russian Federation".
- The Land Code of the Russian Federation.

The operation and maintenance of the Vazuzskaya and Moskvoretskaya systems and water supply plants are carried out by systems operation offices which come under the Moscow municipal enterprise "Mosvodokanal". The Moscow Canal is operated by "Rechflot". The overall organisational management of water users, and of enforcement and compliance related to water use in the area is the responsibility of the Moscow Oka Basin Water Management Office which comes under the Committee on Water Management. The Oblast Committees on Environmental Protection under the Ministry of Environmental Protection and Natural Resources, and the local offices of the State Committee on Sanitary and Epidemiological Survey are responsible for compliance with existing regulations and standards related to wastewater discharges, water quality and other environmental and human health issues. The water quantity and quality monitoring networks are operated by the Federal Survey on Hydrometeorology and Environmental Monitoring and by Mosvodokanal.

## **X.4 Water resources assessment**

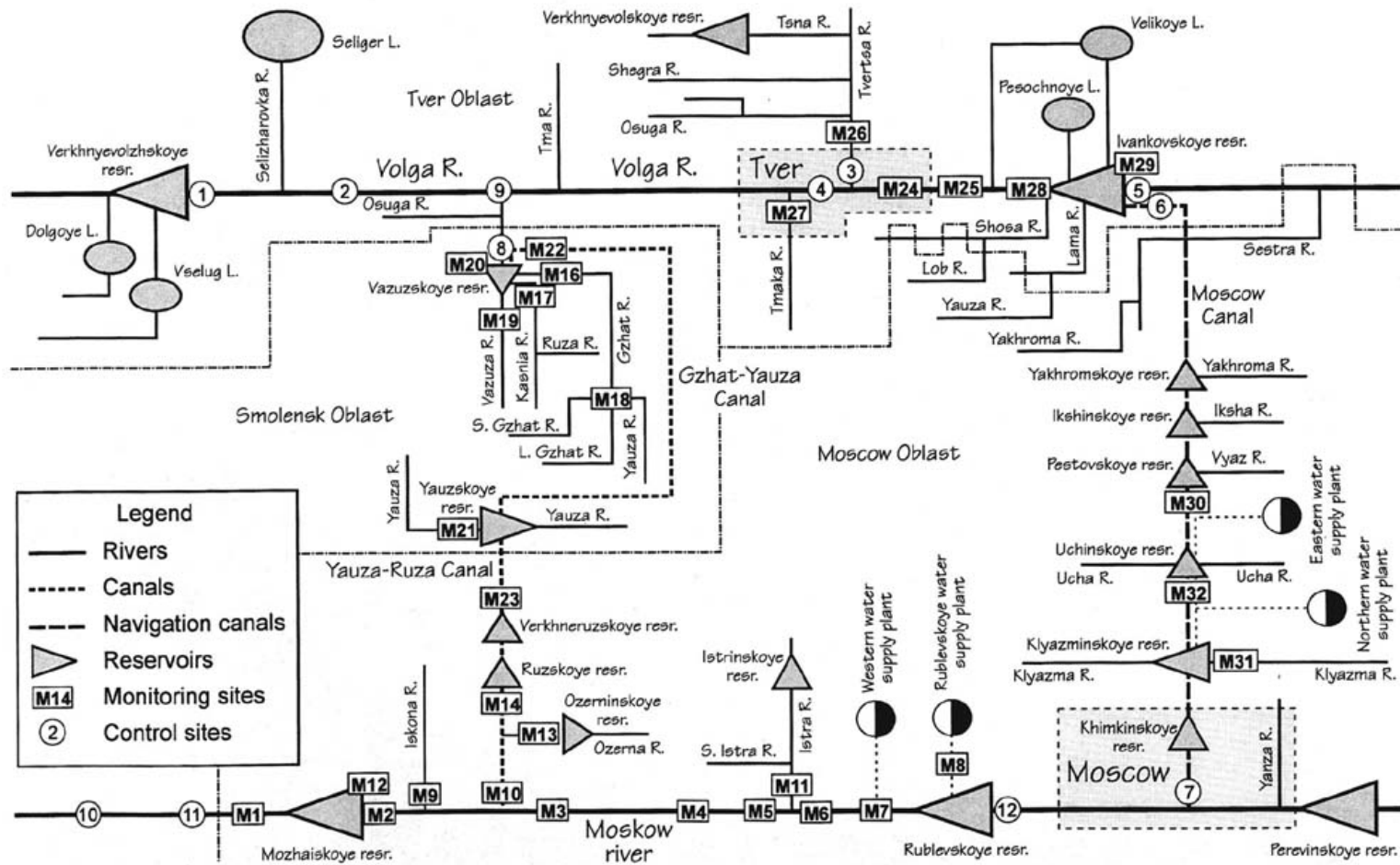
The river network of the area is well developed with a density of 0.12-0.35 km km<sup>-2</sup>. Snowmelt is the principal source of stream flow. The annual average run-off is 6.5-9.0 l s<sup>-1</sup> km<sup>-2</sup>, with the spring flood flows accounting for 40-60 per cent and summer flows for 10-20 per cent of the annual stream-flow. The existing stationary hydrological network consists of gauging stations maintaining regular hydrometric and hydrochemical observations. Water quality studies are also carried out using surveillance and monitoring data. The assessment of water resources in the basins of the Moscow City drinking water supply is carried out by approved water management sub-regions using selected control points (Figure X.3).

The total water resources allocated for Moscow City and diverted from surface water sources amounts to  $124 \text{ m}^3 \text{ s}^{-1}$  (with 97 per cent probability for the year), including the conveyance of  $73 \text{ m}^3 \text{ s}^{-1}$  of water to the Mosvodokanal system,  $45 \text{ m}^3 \text{ s}^{-1}$  released to the Moscow, Yauza, Klyazma and Ucha rivers,  $3 \text{ m}^3 \text{ s}^{-1}$  released to the Cherkizovskaya system and conveyance losses from the Moscow Canal of  $3 \text{ m}^3 \text{ s}^{-1}$ . Of the total amount of water diverted to the Mosvodokanal system,  $35.1 \text{ m}^3 \text{ s}^{-1}$  (55 per cent) is used for domestic needs,  $22.5 \text{ m}^3 \text{ s}^{-1}$  (17 per cent) is used for industry and  $4.5 \text{ m}^3 \text{ s}^{-1}$  is used for miscellaneous needs. In industry, water is used for domestic and drinking purposes ( $5 \text{ m}^3 \text{ s}^{-1}$ ) and for technological needs ( $9.7 \text{ m}^3 \text{ s}^{-1}$ ).

Apart from water diversions by the Water Supply Plants for the Moscow City water supply, some 40-51 per cent of available resources in the basins are released for ecological, power, navigation and other uses, 24-32 per cent for inter-regional water transfers, 2 per cent for consumptive water use and losses, and 1-2.6 per cent for filling reservoirs.

At present, the total water withdrawals from groundwater sources (the Moscow artesian basin) are about  $5 \text{ m}^3 \text{ s}^{-1}$ . With the aim of improving the reliability of the Moscow City drinking water supply, the feasibility of using groundwater is being studied, based on the following groundwater withdrawal sites: northern (Klin/Dmitrov/Dubna), western (Ruza/Zvenigorod), southern (Oka) and eastern (Shatura). The total groundwater potential of the sites has been assessed as  $41.8 \text{ m}^3 \text{ s}^{-1}$ . As a first step, it was recommended to commence use of the southern and northern groundwater sites with prospective resources of  $8.5$  and  $9.3 \text{ m}^3 \text{ s}^{-1}$ , respectively.

**Figure X.3 Schematic diagram of the hydrographic regime in the basins of the Moscow region used for drinking water supplies**



Water quality is assessed using sampling data for a defined set of physical and biological indicators using the appropriate water quality standards of the Russian Federation. It is, however, noticeable that assessments made by different agencies and institutions sometimes differ as a result of the uncoordinated sampling and methods applied. The conclusions of the sanitary and epidemiology survey was that the Vazuza system water conformed to Class II.

Water quality trend analyses compiled for the Moskvoretskaya system showed that in the 14 years prior to 1992 the average annual concentrations of heavy metals increased 2-5 times and nitrates by 5 times. When compared with maximum allowable concentrations (MAC) the following increases were also observed at the Rudlevskaya Plant site: phenols (8-12 times the MAC), oil products (2-5 times the MAC), and severe microbial pollution (coliform index of 100,000). The water source shows extensive eutrophication, with permanent odour and colour, especially in the spring period, that excludes it even from Class III.

The water of the Volzhskaya system normally does not exceed MACs but elevated concentrations of metals and phosphorus-based organic pesticides have occurred during floods and during the growing season. An integrated assessment puts the Volzhskaya system in Class II. According to the data obtained from the system by Mosvodocanal and the sanitary and epidemiology survey, an integrated toxicity indicator for Class 1 and 2 hazardous substances exceeds the prescribed standards for all water treatment and supply plants.

## **X.5 Pollution sources**

Serious anthropogenic impacts on the water bodies and watersheds of the region imply increasing concentrations of contaminants in the sources of drinking water supplies. Point sources of pollution in the basins of the Moscow City drinking water supplies come mainly from industrial, municipal and agricultural wastewater discharges. According to the state water use accounting data, in 1992  $1,917.3 \times 10^6 \text{ m}^3$  of wastewater effluents were discharged into surface water bodies in the area, including  $147.5 \times 10^6 \text{ m}^3$  of untreated and inadequately treated wastewater. Diffuse sources of pollution arise mostly from:

- Contaminated precipitation falling within watersheds.
- Soil leaching and erosion.
- Run-off containing fertilisers, pesticides and herbicides.
- Run-off, for example, from construction sites, dumps, mining pits, solid waste disposal sites, fertiliser storage, toxic chemical warehouses and leaks from oil and gasoline storage.
- Nutrients in drainage from livestock farms and poultry factories.

**Table X.2** Total pollution loads for selected variables arising from all sources in the Moscow City drinking water supply systems in 1992

Variable	Total pollution load (t a <sup>-1</sup> )
BOD <sub>total</sub>	1,440,000
Chlorides	105,031
Chromium	90
Grease/oils	1,950
Hydrogen sulphide	87
Iron	900
Potassium	4,850
Nitrogen, ammonium	16,012
Nitrogen, nitrate	1,657
Nitrogen, nitrite	2,501
Oil products	4,452
Phosphorus, total	6,012
Sulphates	90,698
Suspended solids	330,015
Synthetic surface active substances	331
Zink, nickel, cadmium, copper	291

Existing pollutant loads from all sources are given for major water quality variables in Table X.2.

## X.6 Major problems

The problems affecting the reliability of the quality of the drinking water supply for Moscow City and the surrounding area are as follows:

- Inadequate enforcement and inadequate legal acts and regulations relating to water, including economic instruments.
- Weak institutional and organisational infrastructure for the efficient operation of water systems in relation to environmental and human health issues.
- Inadequate technical and sanitary conditions of the water systems.
- Lack of compliance with the required controls on human activities in water protection zones, riparian belts and sanitary zones.
- Lack of contemporary wastewater treatment facilities for industries, municipal storm sewer systems and other problem areas.

- Improper operation of livestock and poultry farms, and agricultural processing plants that are inappropriate for the watershed environment.
- Current agricultural practices involving the widespread application of mineral fertilisers and toxic chemicals.
- Unsatisfactory condition of the existing water quantity and quality monitoring and assessment network.

## **X.7 The programme**

In October 1993, the Moscow City Government, the Administration of Moscow, Smolensk and Tver Oblasts, the Ministry of Environment Protection and Natural Resources and the Committee on Water Management concluded the Agreement on Joint Water Resources Use and Conservation in the Basins of Moscow City Drinking Water Supply in the Territories of Moscow, Smolensk and Tver Oblasts. Clause 5 of the Agreement stated that *"... a long-term planning document shall be in the form of 'Federal Program of Water Quality Improvement in the Sources of Moscow City Drinking Water Supply', formulated on the basis of regional programmes proposed by Moscow, Smolensk, Tver Oblasts and the Moscow City"*. The Program of Water Quality Improvement in the Sources of Moscow City Drinking Water Supply was also initiated in accordance with the Environmental Action Plan of the Government of the Russian Federation for 1994-95, approved by Government Statement No. 496 of 18 May 1994.

The Program of Water Quality Improvement in the Sources of Moscow City Drinking Water Supply was prepared in 1994 by the Committee on Water Management, the Moscow City Government and the administrations of Moscow, Smolensk and Tver on a collaborative basis as a sub-programme of the Federal programme Water Resources Conservation and Rational Use in Moscow City and Enhancement of its Water Supplies for the Period up to 2010. The Moscow-Oka Basin Water Management Office of the Committee on Water Management of the Russian Federation will be responsible for the general management of the programme. The general manager, jointly with the regional managers of Moscow City, takes responsibility for the implementation and co-ordination of the programme under the supervision of the Expert Council organised in accordance with the Clauses 8 and 10 of the above mentioned agreement.

### **X.7.1 Programme objectives and scope of activities**

The major objectives of the programme comprise the development of efficient measures on:

- Protection of drinking water sources from pollution.
- Restoration and management of the water quality of water supplies, with the aim of reliable delivery of safe drinking water to the populations of Moscow, Smolensk and Tver Oblasts.

The programme activities are grouped into the following categories:

- Measures to protect Moscow City's drinking water sources from pollution, i.e. planning and setting up water protection zones, including the relocation and remodelling of livestock farms and poultry factories, mineral fertiliser and toxic chemical warehouses and other agricultural units, the introduction of new agricultural practices for the rational application of fertilisers and pesticides, and the construction and rehabilitation of wastewater treatment facilities.
- Water protection measures such as enforcing compliance with regulations by economic enterprises in water protection zones, riparian belts and sanitary zones.
- Control of wastewater pollution to drinking water sources arising from (a) industrial, agricultural and municipal wastewater, and (b) storm-water from urban and other residential areas.
- A water quality monitoring system: 10 monitoring sites in the Vazuzskaya system, 19 in the Moskvoretskaya system, 11 in the Volzhskaya system, 10 additional hydrometric gauging stations and a water quality centre.
- An automated management system for water conservation: telemetry, computer networks, data banks, simulation modelling and decision support systems.

#### **X.7.2 Implementation and estimated cost and efficiency**

The total cost of implementing the programme was estimated as  $666.94 \times 10^9$  roubles (at 1994 exchange rates) of which  $375.25 \times 10^9$  roubles would be allocated from the Federal budget and  $291.69 \times 10^9$  roubles would be allocated from the Oblasts and Moscow City budgets. The remainder would come from enterprise funding and non-budgetary sources. In an evaluation of economic efficiency, the investment return period was estimated at four and a half years.

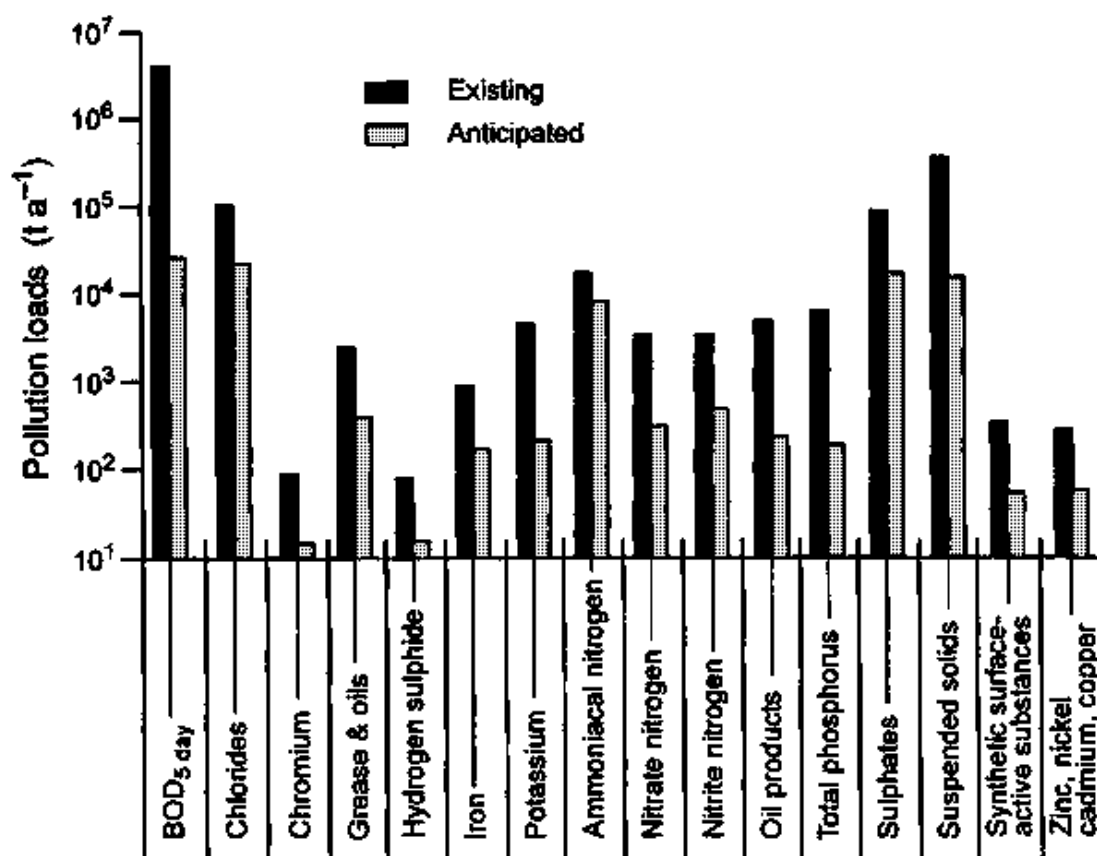
The implementation of the programme was envisaged for the period 1995-2000. A set of priority measures were included in an immediate action plan comprising reduction of wastewater pollution loads from municipal sewerage works, industrial and agricultural plants and other point sources, and planning of water protection zones. The implementation period for this plan was 1995-97.

In assessing the efficiency of the proposed programme activities two water quality scenarios were used:

- Retention of existing water use and conservation trends and practices at the present level.
- Integrated approach to water quality and watershed management.

Water quality forecasts compiled for both alternatives clearly identified that the second scenario could provide a viable basis for attaining the programme objectives in a definite time-frame and for reducing contamination by 40-50 per cent. Existing and anticipated (target) pollution loads from all sources are illustrated in Figure X.4.

Figure X.4 Existing and anticipated pollution loads following the implementation of the Immediate Action Plan in the basins of the Moscow Region used for drinking water supplies



## X.8 International co-operation

A co-operative programme Improved Drinking Water Protection and Management for the Moscow Region is being implemented as a partnership between Russia and the USA under the auspices of a Joint Commission of V. Chernomyrdin of the Russian Federation and A. Gore of the USA which was established in December, 1993. This programme has two major pilot projects which focus on the protection and enhancement of drinking water supplies in the Moscow region:

- Small River Watershed Management, Moscow River Basin, Istra District.
- Improved Wastewater Compliance and Enforcement, Moscow, Tver and Smolensk Oblasts.

The first project is mostly orientated towards reducing pollution from agricultural and rural land uses which are causing contamination of drinking water sources from the Istra River located in the Istra District of the Moscow Oblast. It will introduce and disseminate low-cost technology and management practices for controlling agricultural and other rural point and diffuse sources of contamination, i.e. large poultry factories and livestock

farms, run-off containing sediments from cultivated land, pesticides and fertilisers, and small settlements and recreational facilities constructed without appropriate sewerage and waste treatment capacities. The second project is focused on the, control of point-source pollution from certain facilities in Dmitrov, Tver and Gagarin cities.

The projects are funded through an inter-agency agreement between the US Environmental Protection Agency (EPA) and the United States Agency for International Development (USAID) and are implemented from the USA by EPA Regions 5 and 7, the Iowa State University, the US Department of Agriculture, the US Geological Survey and the Minnesota Pollution Control Agency. The Russian counterparts include the Ministry of Environment Protection and Natural Resources, the Committee on Water Management, the Federal Survey for Hydrometeorology and Environmental Monitoring, the State Sanitary and Epidemiology Survey, and the Ministry of Agriculture and Regional Committees on Water Management and Nature Protection.

Major activities under the programme started in 1994 with agreements formulated for a three-year period. In line with the project objectives, an Agreement on Co-operation in the Istra River Basin Small Watershed Management was signed in 1994 between the EPA, USAID and the involved Russian parties. In order to support programme activities, some additional efforts were made by the EPA to provide water quality laboratory assistance through an application to the USAID Commodity Import Program, filed by the Russian Ministry of Environment Protection and Natural Resources in August 1994. Assistance with the microbiological analysis of drinking water is planned by the USEPA.

Further activities on environmental economics and policy are also underway within the Moscow region. The government of the USA is assisting Russian policymakers with environmental policy issues and sustainable development during the country's transition to a market economy. Initial efforts focus on environmental priority-setting based on:

- Economic incentives for private enterprises.
  - The use of cost-effectiveness analyses.
  - Techniques for identifying the lowest unit-cost options for reducing risks.
- Subsequently, policies and programmes will be developed and carried out based on this priority setting approach. In the meantime, efforts should be made to achieve closer co-ordination between the technical assistance from the USA and the programme.

## **X.9 Conclusion**

The Program of Water Quality Improvement in the Sources of Moscow City Drinking Water Supply could be considered as an effort to create, collaboratively, an instrument for integrated environmental and socio-economic management in an important region of Russia. The programme has been reviewed by the Government of the Russian Federation and is in the early stages of implementation.

## **X.10 References**

Anon. 1992 *Ekologicheskie Issledovaniya v Moskve i Moskovskoi Oblasti. Sostoyanie vodnykh sistem. Otdelenie obshei biologii RAN, Institut vodnykh problem RAN, Tsentr Ekologicheskikh Proektov, MosvodokanalNIiproekt, (Ecological Studies in Moscow City*

*and Moscow Oblast, Status of Water Systems*, Department of General Biology of RAS, Institute of Water Problems of RAS, Centre of Ecological Projects, MosvodocanalNIiproekt), Moscow.

State Report 1994 *Voda pityevaya*, Ministerstvo okhrany okruzhayushei sredy i prirodnnykh resursov Rossiiskoi Federatsii, Gosudarstvenny Komitet Sanitarno-Epidemiologicheskogo Nadzora Rossiiskoi Federatsii, Komitet Rossiiskoi Federatsii po Vodnomu Khozyaistvu, Gosudarstvenny Komitet Rossiiskoi Federatsii po voprosam arkhitektury i stroitelstva, Komitet Rossiiskoi Federatsii po Geologii i ispolzovaniyu nedr, Federalnaya sluzhba Rossii po gidrometeorologii i monitoringu okruzhayushei sredy (*Drinking Water*, Ministry of Environment Protection and Natural Resources of the Russian Federation, State Committee on Sanitary and Epidemiological Survey of the Russian Federation, Russian Federation Committee on Water Management, Russian Federation State Committee on Architecture and Construction, Russian Federation Committee on Geology and Underground Resources Use, Federal Survey of Russia on Hydrometeorology and Environmental Monitoring), Moscow.

UNDP 1994 *Water and Sanitation for All; A World Priority*. United Nations Development Programme, New York.

---