



KREMLIN

WATER MAINS

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The first Moskva River settlers did not suffer from a shortage of water with the river itself, its enormous tributaries and ground water all available. Numerous written sources indicate that Russians were very experienced at sourcing water from the ground which was important for domestic use as well as defending the city during a siege. Secret underground tunnels were built from the city to the nearest water source which also provided communication with the outer world in the event of a blockade. Sometimes 'water gates' were built. These were small pathways to the water source from the fortress wall foundation. The Moskvoretskie gates of Kitay-Gorod and the Kosmodemyanskie gates of the Kremlin were used as water gates (5).

Water was taken from the Moskva River through the Borovitskie Gates during the first centuries of the Kremlin's existence. Borovitskaya tower is the most ancient and nearest exit way from the Kremlin to the river. Access to water from other gates was quite difficult and less secure

during a siege so it was easier to make a zigzag pathway from the Borovitskie gates. It is likely there was also a secret tunnel to the river. Other examples of secret tunnels are the underground brick tunnel to Moskva River that was found in 1909 at the Novodevichy Monastery and the similar underground tunnel found at the Simonov Monastery in 1911 (6).

During the blockade, water was taken from the water wells at the Tainitskaya, Arsenalnaya and Vodovzvodnaya (Sviblova) towers of the Kremlin. According to the Complete Collection of Russian Chronicles, the Sviblova tower was built in 1488. It was designed for military purposes and for water supply. The tower had a secret water well which was used in the event of lengthy blockades. Secret water wells were guarded and only trustees had access to them. Water was taken with scoop wheels using a chain and tread-wheel mechanism (10).

Increased consumption of water in the beginning of XVII century and exhausting delivery methods led to new ways of

water supply. This is when the first water pipelines were designed.

In 1339, Prince Ivan Kalita built a pipeline made of carved oak wood from the Moskva River to the secret water well in the Kremlin. Water lifting was done by tread-wheel. The water well of the Troitse-Sergievskiy Monastery was described by Paul of Aleppo (7): "Then they showed us a very deep water well with a huge wide wheel with wooden plates attached crosswise, similar to dog-wheels. Two men enter inside the wheel and step from plate to plate (like a dog runs inside the wheel) and the wheel starts spinning fast. The wheel has thick ropes with a barrel attached. When water fills the barrel it is passed to two other men who put water in the pipe leading to the kitchen where they make honey, beer and other drinks."

There were at least two pipelines in the Kremlin in the XVI and XVII centuries. These pipelines had different sources: spring and river water. They are identical to the Mytischinskiy ground water and Moskva River water pipelines built in 1804 and 1852 respectively.

We know from chronicles about infrastructure of Kiev and Novgorod in XI–XII that the Kremlin water pipelines were not the first pipelines in Russia.

During the 1938 excavations lead by Professor A.V. Artsikhovskiy in Novgorod, a gravity water pipeline was found 3.5 metres under Yaroslavskiy Yard which connected the water springs and the Prince's palace in XI. The pipes consisted of two unfixed halves of 300 mm diameter tree trunks with birch bark used as insulator for the pipe joints. Clear spring water was still running in the pipeline during the excavations (Artsikhovskiy, 1954). This was the first pipeline with clear spring water in Northern Europe.

The first Kremlin gravity water pipeline was built in XV–XVI from a spring next to the Arsenalnaya tower. The pipeline was built to provide a water supply in the event of siege.

The gravity pipeline in the Kremlin in Moscow was built in 1492. Spring water intercepted from under the Arsenalnaya (Sobakina) tower supplied "pure odourless water" to a gravity pipeline made of brick and laid along the underground walkways to the Troitskie and Nikolskie gates of the Kremlin. It was built by Peter Fryazin, the master of water lifting by the order of Moscow Prince, Ivan III.

According to the chronicles of Peter Krekshin: "By the order of Prince Ivan Vasilyevich, Peter Fryazin built two gatehouses or secret compartments and a number of underground chambers with running water flowing in the foundations, like rivers flowing throughout the Kremlin." (1)

One of the outstanding creations of Ivan III's times is the massive gatehouse above the Neglinnaya tower with very deep foundations. Its lower part was very wide and consisted of 18 sides which made it very stable. Six-sided walls reached 4 metres in thickness. These were designed for the defense and security of the secret underground water well.

Excavation works were carried out in 1894 under the tower to a depth of 6 metres (10). The water was pumped out and researchers found a well with a pine log frame which was no more than 50 years old. The well depth was 3.5 metres and the water was very clear and odourless. The researchers were surprised that the tower did not show any signs of dampness because the archive notes stored there were absolutely dry. Attempts to pump out the water were unsuccessful, and despite constant pumping operations, the water kept coming at 22 mm per minute (about 10–15 litres per second) and flowed to the tunnel/walkway in the direction of the Troitskaya tower. The width of the walkway was 1.8 metres. The height was still unknown because it was impossible to reach the bottom although 3 metres of height was cleared during excavation. Only 5 metres of walkway was cleared due to a blockage in the pathway from a white arsenal post.

Researchers tried to determine the type of the well. They added 6 rows of logs, dug 2 metres and put puddle clay around it. The water did not rise but flooded the whole walkway. After the walkway floor research it turned out that the floor was only made from soil and rubbish. This is how builders had tried to stop the water flooding into the basement works. It is obvious that the water was forced out from the ground and flooded the base of the tower which led towards Moskva River.

The researchers came to conclusion that the tower was built skillfully as it was protected from the dampness while the water well occupied its entire base. The water from this chamber freely flowed in the underground conduit supplying the Kremlin with water (2).

The well existed until XIX and had very clean odourless water. Indeed, the water was still of good quality 400 years after construction. It disappeared with the construction of a sewage collection operation near the tower.

The second Kremlin water main – pressure pipeline (1631–1633)

Demand for water in the Kremlin was increased after the construction of the Prince's kitchen in Kormovyi Yard. The only good source was Moskva River where water was cleaner than in Neglinnaya.

Water-lifting machinery was the only way to supply water to the Kremlin hill. This was done by Christopher Galloway and Russian masters Antip Konstantinov and Trefil Sharutin in 1631–1633. Christopher Galloway, an expert in clock-making and water lifting, came from England to Moscow to serve the Tsar in 1621. Galloway was very talented and knew water-lifting very well because of its rise in popularity in England. Peter Morice was the first to install waterwheel under an arch of London Bridge which powered vertical pumps. The pumps forced a jet of water over the spire of the Church of St Magnus from the Thames into the wooden pipes. No one had done this before (3).

The Kremlin pipeline was the most sophisticated because water was connected to lead pipes leading to a great height and the system was designed to compensate for hydraulic impact.

The mechanism of the first Russian pressure pipeline worked like this: water from the Moskva River flowed to a white stone well which was 5 metres in diameter and 9 metres deep under the Sviblova Tower. Horse driven water-lifting machines would lift water to the top of the tower to a special tank made of lead. Then water was supplied to the Kremlin gardens and Royal Palaces through the lead pipelines.

The first attempt to build a pressured water pipeline in the Kremlin was in 1631 when masters Antip Konstantinov and Trefil Sharutin built the stone kitchen in Kormoviy yard with a supply from the Moskva River using a waterwheel. Two years later the waterwheel was installed at the top floor of the Sviblova tower which supplied the Sytniy and Kormovoi palaces and kitchens with culinary water.

According to eyewitnesses, the system cost several casks of gold and was powered by a horse which walked around in circle, pumping water from the lower part of the white-stone well and the pipeline from Moskva River. Clean water from Moskva River was filling the lead tank in the tower and then went through the pipeline to the controlling reservoir on the top of the tower next to Top Nabereznyi garden and Denezhnyi yard. Water from here spread to the top garden, Sytniy yard, Kormovoi, Chlebnii, Konyushennii, and Poteshnyi palaces and other chambers with lead water storage tanks (5).

The length of the gravity pipeline was about 50 metres and the distance from the Sviblova tower to the far end of the pipeline was around 400 metres. Pressure at the Sviblova tower was 2–2.5 bar (Falkovskiy, 1939, page 92).

Galaktion Nikitin, water-lifting contractor said: "There is lead pipe underground leading from the water-lifting tower to the water-lifting chamber at Sytniy Palace, which has another two underground lead pipelines laid to the Palace and to the corner of the Khlebnii Palace under the churches of Peter and Paul".

From then, the Svoblova Tower was called the Tower of Water-Lifting. A few years later it was renamed to Vodovozvodnaya, which means "water-lifting".

Macarios, Patriarch of Antioch, was visiting Moscow in XVII with his son Archdeacon Paul of Aleppo. Paul described the 'Kremlin wonder': "The Kremlin never had water inside, water for royal kitchen was always delivered by a bucket wheel from the Moskva River, but during the reign of the present Tsar (Michail Fedorovich Romanov – authors) they invited one of the Aliens (Christopher Galloway – authors) who built a huge tower by the river bank. The water was lifted by the wheel day and night with no effort and supplied the Tsar's Yard for different needs. He made 4–5 huge water wells and built domes above them, put pipes and an iron wheel. If you need water you turn the wheel with one

hand and water galore starts flowing when needed. This is what we saw with our own eyes..." (7).

The Kremlin water systems expanded with time. The lead water reservoir was built in Verkhny garden in 1681 and water was supplied by lead pipelines from the Vozvodnaya tower. Young Peter I floated in the water reservoir in his pleasure boats.

Growing demand for water lead to the construction of the additional water-lifting tower and machine next to the Verkhny garden in 1687 (4).

The pipeline maintenance was done by masters of water-lifting, Ivan Korela, Ivan Erokhov and Galaktion Nikitin (9).

In the beginning of the XVIII century, after the transfer of the Capital to Saint Petersburg, the Kremlin lost its status as royal residence and the water systems fell into decay. In 1706, by the order of Peter I, the Kremlin's lead pipes were taken out and sent to Saint Petersburg. After the Great Fire in 1737, the Kremlin water systems were destroyed. We still don't know what happened to the water-lifting machine.

The first Kremlin water systems were the biggest hydraulic structures of their time. These Kremlin pressure water pipelines were built earlier than in most of the Western European countries.

Technically they were as sophisticated as most of the Western European wooden pipelines (e.g. Peter Morice's pipeline in London) which were often damaged by water pressure.

Kremlin style water systems were built in the Kolomenskiy and Izmailovskiy Palaces. The hydraulic facilities at the time encouraged an increase in water pipeline specialists.

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