Water Utility Journal 1: 49-55, 2011.

Regulation of the water pressure in the water supply network in the residential areas of Burgas

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Abstract: The water supply network of the central area and the residential areas of "Bratja Miladinovi", "Vuzrajdane", "Akaciite" and "Lagera" of the town of Burgas has a total length of 104,8 km, of which 64,9% are asbestocement pipes and 19,5% are steel pipes. All of them exceeded their depreciation period. Because of the pressure of the water in the supply system, which is higher than needed, high water losses and number of failures have been registered. In 2010, measurements of the water consumption in the inlet of the mains, which are cast-iron pipes with DN 800 and DN 600, laid under the streets "Struga" and "Stefan Stambolov" were carried out. Ultra-sonic flow meters were used. Simultaneously with these measurements, the variations of the water pressure at key points of the water supply network were registered with data loggers. Based on the analyses of the collected data, two water pressure reducing valves with DN 600 and DN 400 are suggested to be installed at the inlets of the two investigated cast-iron pipes. It is expected that the effect of this action will be a reduction of the water losses by 1 100 000 m3/year as well as the number of the failures by 300 per year.

Key words: water pressure management, urban water supply, pressure regulators

1. INTRODUCTION

The water losses and the frequency of failures in the water supply networks in the most settlements in Bulgaria are mainly due to two reasons: most of the networks were in use for a time which goes well beyond their nominal depreciation period and the maintaining of higher water pressure in the system. On the other hand, the water resources in Bulgaria are limited and unevenly distributed by territory, so during the summer months water supply restrictions are often applied in number of settlements.

There are two ways to reduce water losses: complete replacement of the depreciated water supply network or pressure regulation and selective replacement of the most deteriorated pipe sections. For the first option, significant investments are needed and there will be long period of realization and slow return rates, while in the second option the reduction of water losses is achieved in a short period of time with significantly smaller investments.

Our experience (Dimitrov 2005, 2011a,b) and the foreign experience (Charalambous and Kanellopoulou 2011) shows that pressure control is an effective measure for:

- reduction of potable water losses
- reduction of the frequency of emergencies and the necessary additional funds for pipes, fittings, excavation and restoration of road pavements
- prevention of water supply interruptions and traffic disruptions in the streets
- extended operational period of the water supply network
- continuous provision of the necessary water quantities for the water consumers
- reduction of the operating costs (electricity, reagents etc.) for the maintenance of the existing water pumping stations and treatment plants.

2. MEASUREMENTS AND ANALYSIS

In order to reduce water losses and the number of failures, the water supply network of the downtown area - "Br.Miladinovi", "Vazrazhdane" quarters as well as "Akatsiite" and "Pobeda" quarters (Fig. 1) was analyzed:

- the variation of pressure in different points of the water supply network
- the location and the condition of the water supply network
- the variation of the incoming water flow in the two cast-iron water mains DN 800 and DN 600, passing respectively "Struga" boulevard and "Stefan Stambolov" street.

The area covers 40 000 supply contracts (100 000 inhabitants), and the total length of the water supply network is 104 817 m, of which 64 902 m asbestos cement, 11 585 m cast iron, 8 829 m HDPE and 19 501 m steel pipes. The main part of the network - 84 403 m consists of asbestos and steel pipes, which are old, worn out and in very bad shape which causes high water losses and frequent failures. Most of the house connections consist of corroded galvanized pipes which lead to all sorts of operational problems.

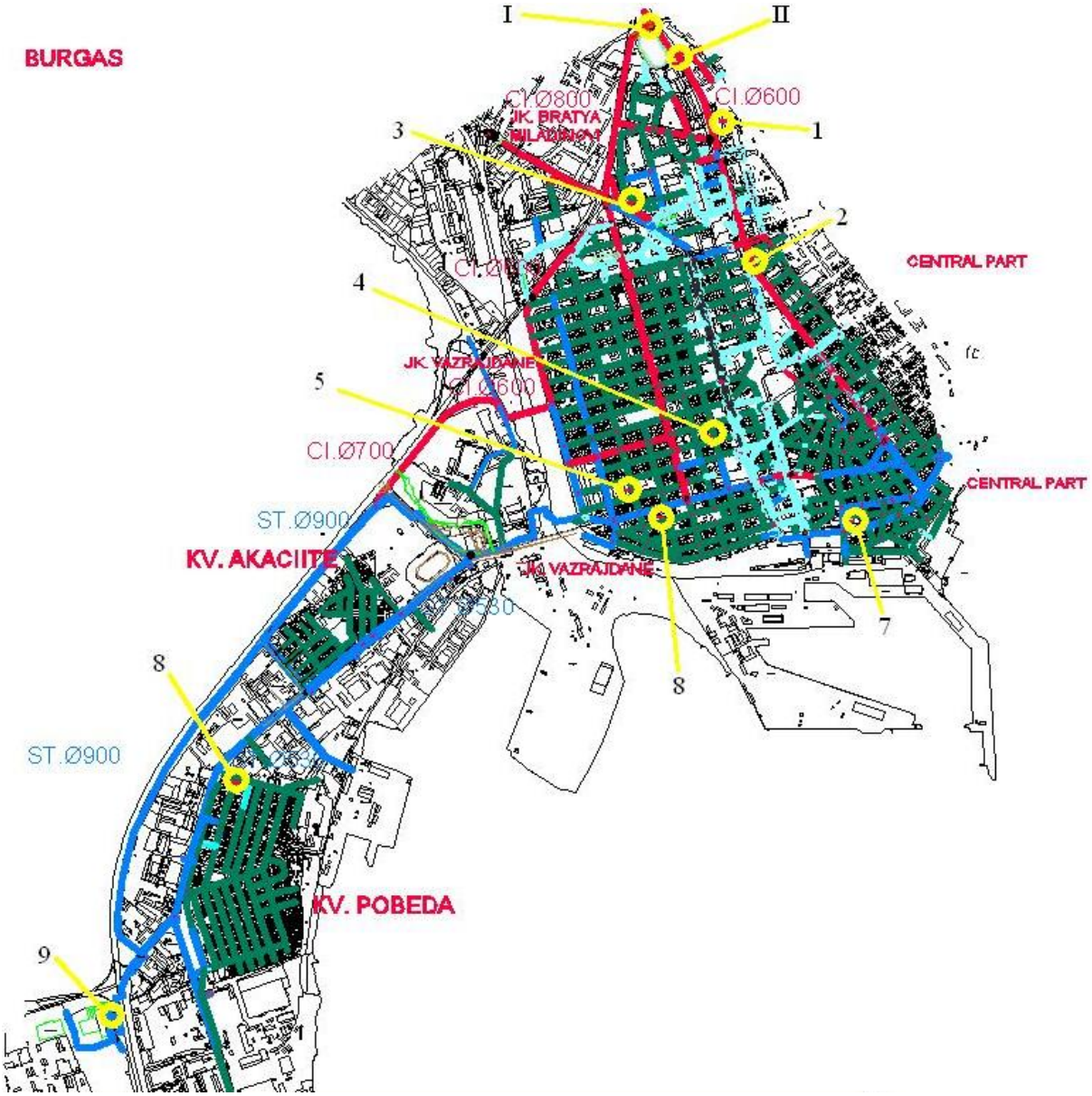

Figure 1. Situation of the surveyed water supply network in Burgas residential areas I and II – Measurement of water consumption, from 1 to 9 – measurement of water pressure

Pressure change measurement at different points of the water supply network:

Each residential area is supplied through multiple pipe connections from DN 600, DN 700, DN 800 and DN 530 cast iron water mains, which causes some difficulties in the differentiation of separate DMA zones (Fig.1). The same water mains deliver the necessary water volume to "Pobeda" pumping station for the water supply of "Meden Rudnik" quarter. The pumps of this station are directly connected to the water main.

The individual residential areas have ground level elevations from 35m to 1m (Table 1).

Data loggers were installed in 9 points in areas with different elevations to establish the dynamic pressures in June, July and August 2010 (Table 1). Data for the recorded medium and maximum pressures are listed in Table 1. Charts for pressure variation on 10.08.2010 at the High School for Construction and Architecture, Bratya Miladinovi Str. 57 and Fotinov Str. 1 are shown in Figures 2, 3 and 4 respectively.

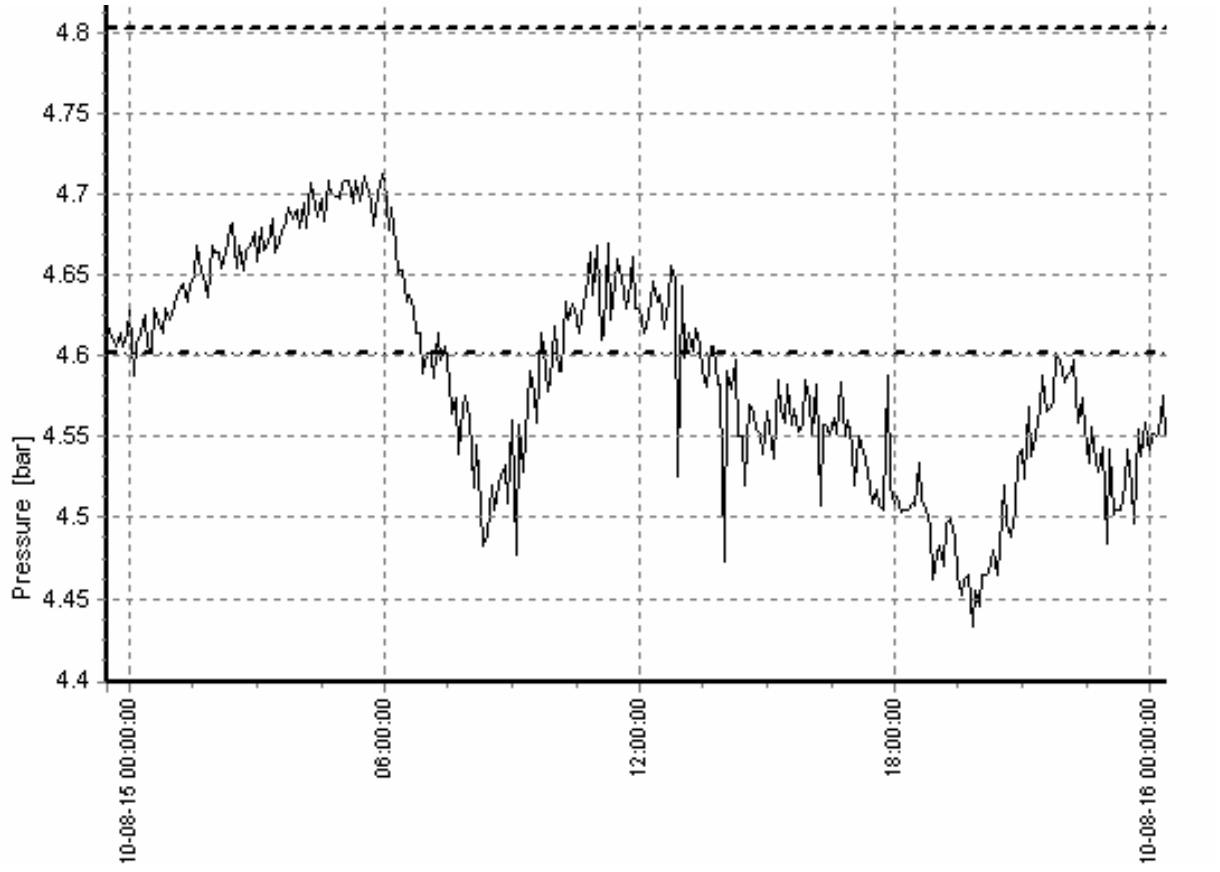

Fig.2. Water pressure variation on 10.08.2010 at the High School for Construction and Architecture

Table 1. Data from pressure measurement

№	Location of the pressure loggers	Ground elevation	Measured pressure, bar		
			minimum	medium	maximum
1	Professional School for Construction and Architecture	35	4,21	4,48	4,81
2	"Republikanska" str. 131	27	5,40	5,76	6,25
3	"Bratya Miladinovi" str. 57	23	5,00	5,66	5,90
4	"Ferdinandova" str. 78	20	5,30	5,90	6,20
5	"Sheinovo" str.	17	5,90	6,30	6,90
6	"Kaloyan" str. 24	15	5,50	6,10	6,60
7	"Fotinov" str. 1	9	6,25	6,70	7,09
8	"Baykal" str.	3	3,80	4,40	5,70
9	PS "Pobeda" str.	1	7,95	8,10	8,70

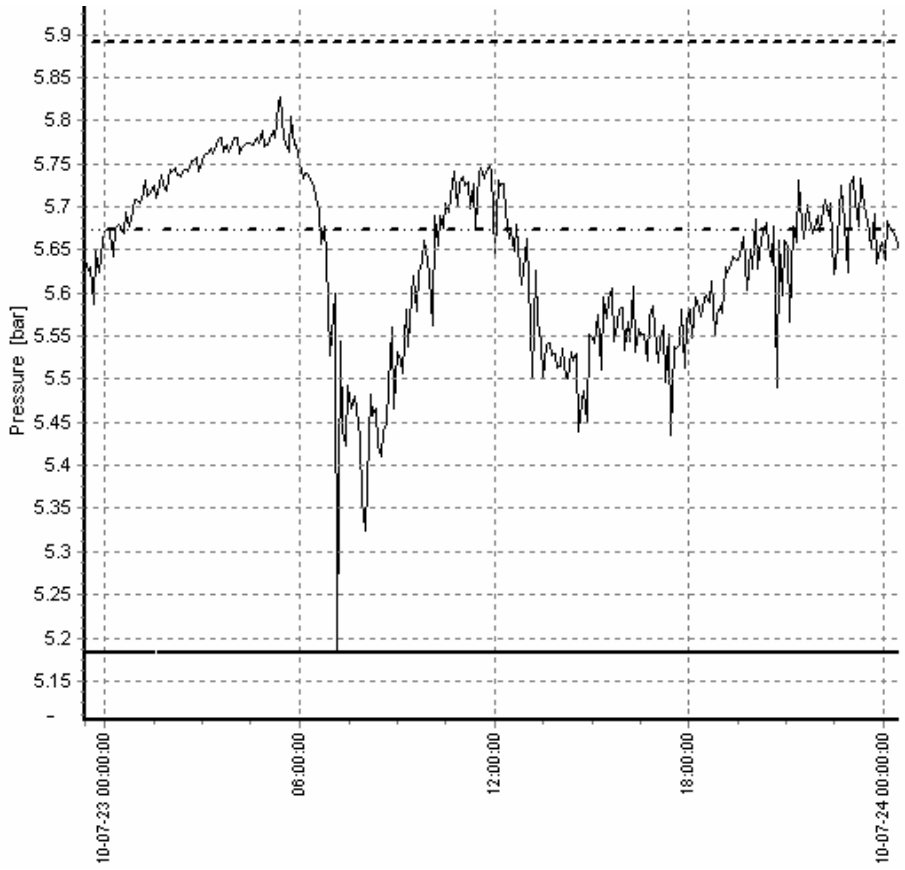

Fig.3. Water pressure variation at Bratya Miladinovi Str, 57

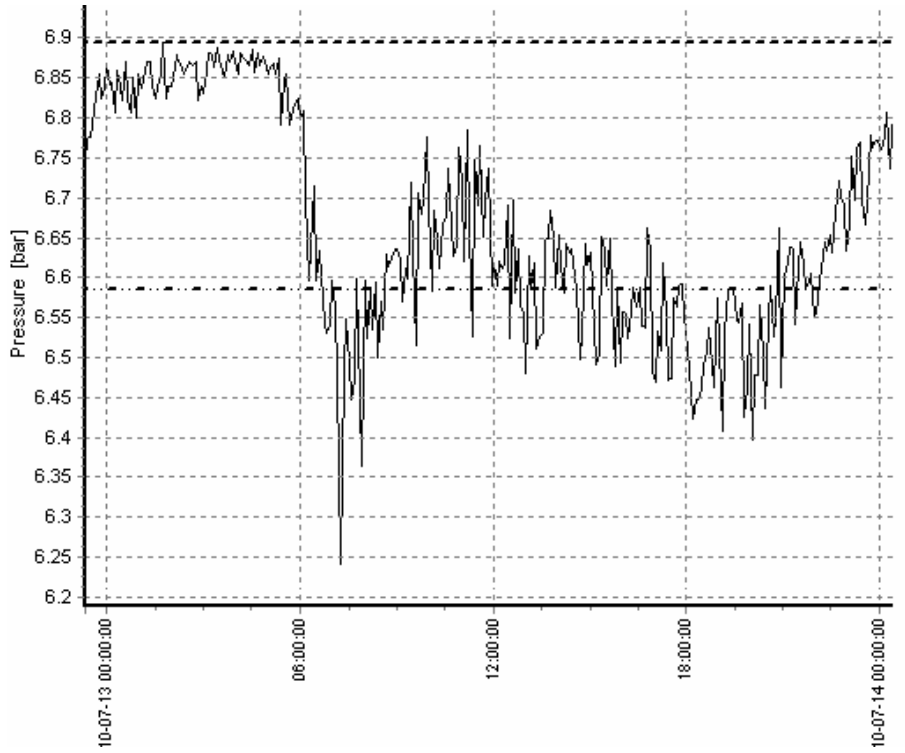

Fig.4. Water pressure variation at Fotinov Str. 1 (10.07.2010)

It is seen that the lowest water pressure are at the beginning of the zone (Professional School for Construction and Architecture), where four-five-storey buildings are located. Nine-storey buildings are located in “Fotinov” 1 street and “Ferdinandova” 78 street, and there the water pressure ranged

from 6,25 bar to 7,09 bar and 5,30 bar to 6,20 bar (Table 1). The maximum of 6 bar according to the standard (Ordinance 4; Technika 2005) in areas with elevations of the terrain less than 20 is exceeded. The lower water pressure measurements on "Baikal" str. (min. 3,8 bar and max 5,7 bar) are due to the partially closed stop valves.

3. SOLUTION

The analysis of the data for the measured pressures, the location and number of floors of the buildings, and the possibility of deployment of pressure regulating valves, covering the whole area, shows that is possible to execute pressure management by two pressure regulators. They are intended to be placed on the cast iron water mains DN 800 ("Struga" blvd.) and DN 600 ("Stefan Stambolov" str.).

In order to establish the diameters of the pressure regulators, monthly measurements were carried out with portable ultrasonic flow meters on the water mains DN 800 and DN 600 (Fig. 1).

The variation of the water consumption along the water mains DN 800 and DN 600 is shown on Figures 5 and 6.

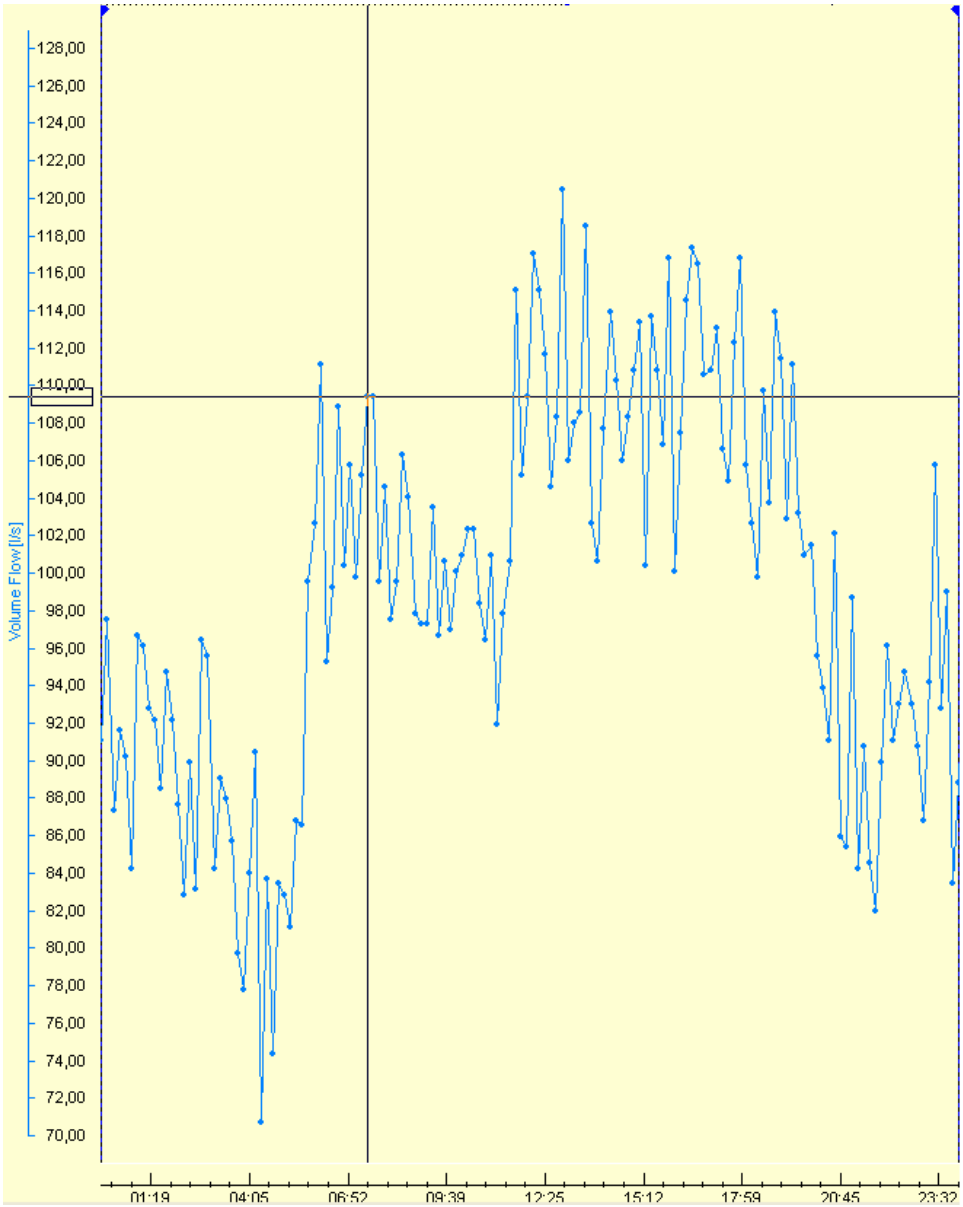

Fig. 5 Water consumption, measured on 16.07.2010 pipeline DN600, passing along Stefan Stambolov Str. (Fig. 1)

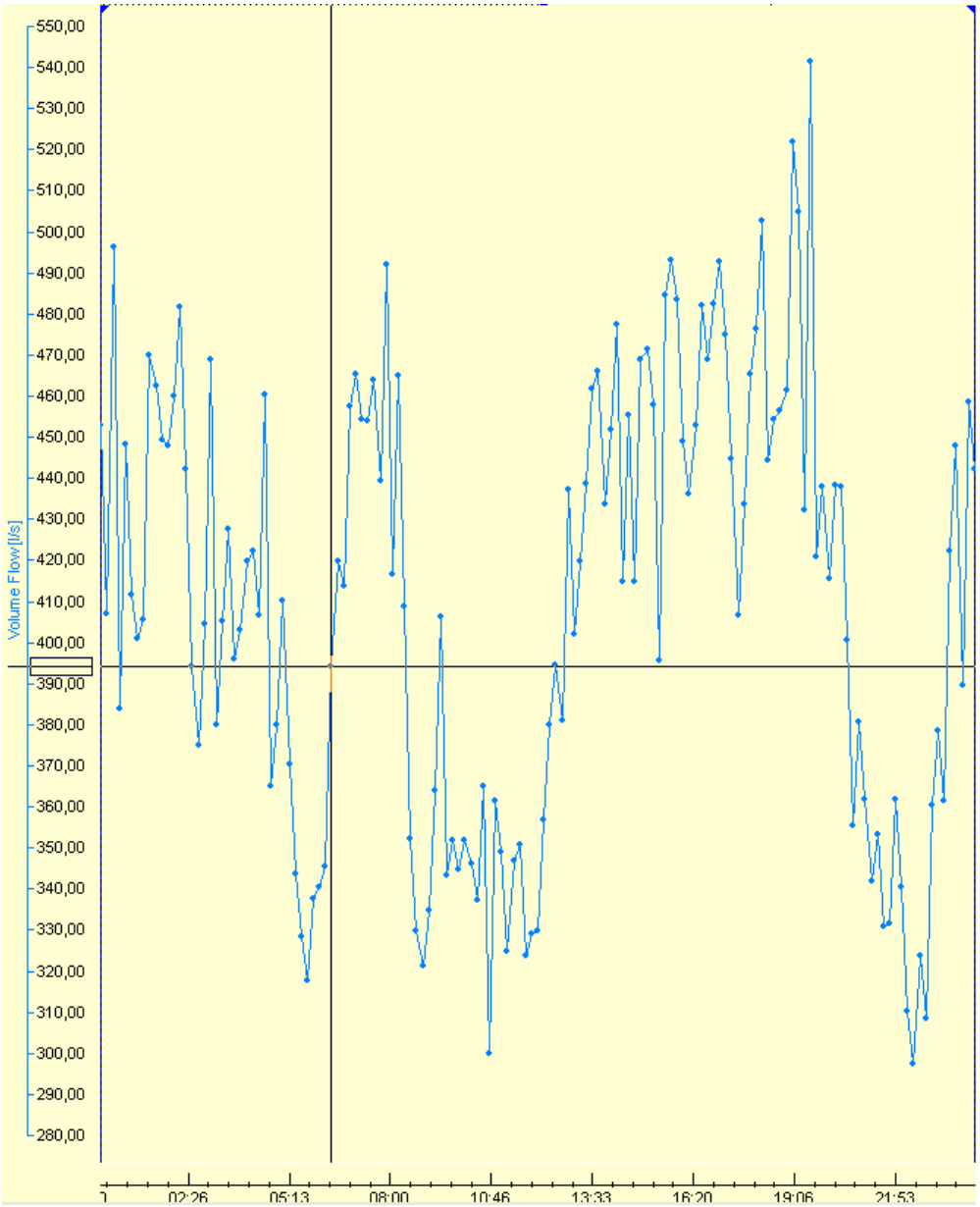

Figure 5. Water consumption, measured on 16.07.2010 pipeline DN800, passing along Struga Str. (Fig. 1)

The water consumption along water main DN 800 for the period of measurement is 1055 m³/h to 1980 m³/h, and along water main DN 600 - 300 m³/h to 405 m³/h. The total minimum water consumption per night of both water mains (DN 800 and DN 600) is 1055 m /h. At the same time 300 m³/h of the quantity is pumped by PS "Pobeda". The minimum water consumption per night from the area is 1005 m³/h.

Two membrane pressure regulators with a V-port output (type M5 Bermad-Israel), DN 600 and DN400 respectively were selected in accordance with:

- data for the measured water levels in the area supply pipes DN 800 and DN 600 (Fig. 1),
- the requirements of Burgas Water Company for possible future increase in water consumption,
- the measured dynamic pressures,
- pipes and buildings situation,
- the terrain elevations.

They will be set up so as to reduce the inlet pressure by 1 bar. Control of the output pressure after the debit regulators or of the pressure at the critical point is not provided due to the beneficial

impact of the high fore-pressure on the pump's electricity cost at PS "Pobeda".

The expected effect for one year from the proposed technical solution is to reduce the loss of potable water by 1 100 000 m³/d (a linear dependence between pressure and water loss is applied) and the number of accidents with three hundred. The period for the refund of the investments is less than one year.

4. CONCLUSIONS

Based on the conducted studies on the water supply network in the area covering the downtown area, "Br.Miladinovi", "Vazrazhdane" quarters, and "Akatsiite" and "Pobeda" quarters in Burgas, the following conclusions could be made:

1. The measurements of the water pressure in the characteristic points of the area and the incoming water quantities into it are analyzed.
2. Based on: (a) results of the measurements of water pressure and water consumption in the two water mains DN 800 ("Struga" blvd.) and DN 600 ("Stefan Stambolov" str.), (b) the topography of the terrain and (c) the height of the buildings, two pressure regulators from the company Bermad – Israel, DN 600 and DN400, type M5 with V-port were selected.
3. The reduction of the pressure by 1 bar in the area leads to a reduction of water losses by about 20% or 1 100 000 m³ / year and the number of failures by 300.
4. A separation of DMA areas in the studied zone and additional local pressure regulation in them is still to be done.

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