Assessment of New City Water Supply System Puli Khumri-Afghanistan

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Abstract

Humans need water for their daily activities such as for drinking, agriculture, industry, commercial purpose so it improves human life. Water is important for both health and economic aspects. From economic point of view, it is a driving wheel for industry and boosting agricultural activities and from the hygienic aspects a good quality water can guarantees human health. According to the importance of drinking water in human life, this research has done about Assessment of New city water supply network system of Puli Khumri, Afghanistan, having purpose of right solution for water supply problems. The research has done by field surveys and data gathered from governmental and private administrations, including the water supply department in Baghlan province. After assessment of this water supply system problems are being found in it, that are lack of water pumps to pump water to reservoir, disinfection of water and low reservoir capacity as compared needs of existing population. Considering the above problems, the water supply system has been re-design by water GEMS software and the parameters such as diameter of pipes, pressure in the pipes and reservoir volume have been analyzed and for extension of this network in the future a certain amount of pressure is being considered at the end of the network.

Keywords: *Water supply system, Water Pressure, Water Demand, Diameter of Pipes, Water GEMS*

1. Introduction

Groundwater and surface water make up Afghanistan's water resources. The most important water resources in Afghanistan are wells, springs, rainwater such as rains، hoarfrost and etc. Afghanistan has 75 billion cubic meters of freshwater a year, surface water of 57 billion cubic meters and groundwater 18 billion cubic meters. Before 1980, the annual volume of groundwater was about 18 billion cubic meters. The major mountains with snow-capped peaks and glaciers are the Hindu Kush Mountains and its small tributaries, these mountains cover almost 75% of Afghanistan's soil [3]. Water is an essential part of our life, plus it plays an important role in social and economical development of a country and water supply system is an essential infrastructure for conveying water from the main source to the consumers [1]. Water supply network is important infrastructure that supply water from water treatment plant to the consumers. Water supply network is made up of pipes, pumps, valves, reservoirs. Classification of water supply system can be done into two types which are intermittent system and continuous system. Intermittent system is one in which water is conveyed to the people for specific period in 24 hours. Where water is supplied during peak hour that is in morning 6 A.M to 9 A.M and evening 5 P.M to 8 P.M while in continuous water supply system, water is supplied to the users 24 x7 in a week [4]. This study aimed at performing the hydraulic analysis of New city, Puli khumri water supply network using Water GEMS Software.

1.1. Introduction to Water GEMS

WaterGEMS software has developed for analyze and design of water supply network. WaterGEMS software also used for extension of existing water supply networks [2].
Certain data like range for diameter of pipes, velocity of water, material of pipe and other required data is to be given in the software which can analyze and design the extensions to the existing water supply system.

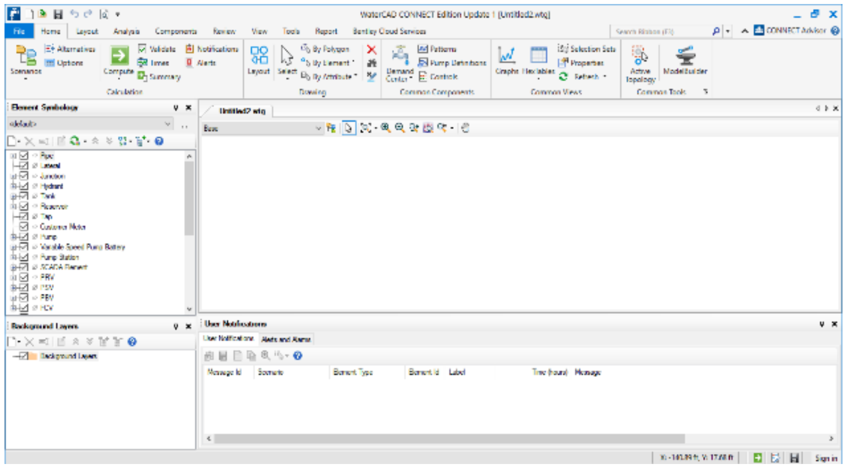

Figure 1. Water GEMS software window

1.2. Study Area

Puli Khumri a city in northern Afghanistan. Located about 230 kilometers in north of Kabul (capital of Afghanistan), Puli Khumri is the capital and largest city of Baghlan Province. The city of Puli Khumri has a population of 221,274 (in 2015). The coordinates of the city are 35°57′N 68°42′E.
Baghlan provincial water supply department was established in 2007 in Puli-Khumri city and totally has nine water supply networks.

Figure 2. Puli khumri, Afghanistan

Table 1. Baghlan province water supply networks

No	District	Number of water Supply system	Covered Population
1	First	2	7000
2	Second	5	20000
3	Third	2	6600

1.3. Details of Water Supply Network

New city, Puli Khumri water supply network has been designed by a German company in the form of a circular design and implemented by an Afghani company (EPCC) 1260 m in the length and this system cover approximately 430 family.

In this water supply system water pump to the reservoir (260m^3) by pump but distribution of water to the customers is in gravity form.

Figure 3. Study area (New city, Puli khumri, Afghanistan)

2. Research Methodology

Methodology Flow Chart consist of following steps.

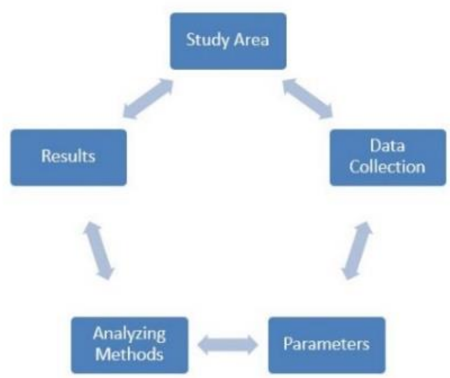

Figure 4. Methodoloy Flow chart

2.1. Study Area

Selection of study area is based on problems faced by local people and productivity of agriculture land. It was founded that people of Puli Khumri, Afganistan are facing many problems related to drinking water deseases, less drinking water availble and reduction in growth of crops.

2.2. Data acquiring

For analysis in the hydraulic software all required input data was acquired from Baghlan provincial Water supply department.

2.3. Parameters

Those parameters analyzed have their data from:

- Water Demand
- Pressure in Network

- Diameter of pipes
- Capacity of water tank

2.4. Analyzing Methods

- Manual calculations
- Use of software

2.5. Results

- Water demand and water pressure graphs
- Hydraulic grade lines
- Counter lines of Pressure and Area
- Chart for diameter of pipes.

3. Result and Discussion

The graphs and bar charts of hydraulic grade line profile, Water demand and pressure at the beginning, middle and end is being plotted in Chart 1, 2, Fig. 5,6 and 7.

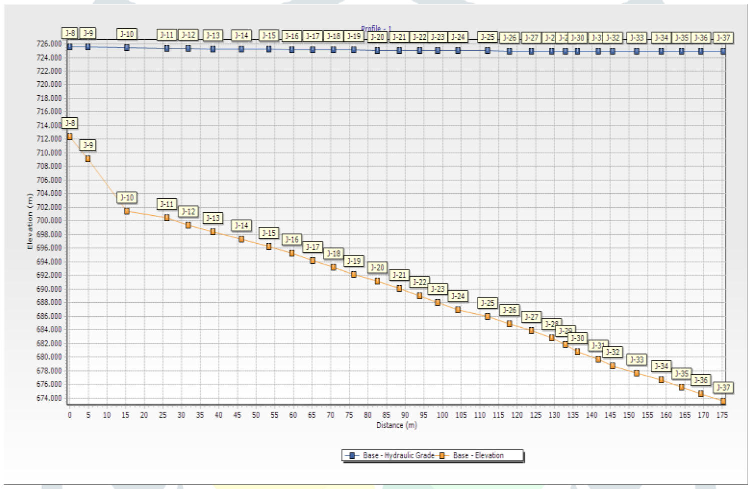

Chart 1. Hydraulic grade line profile at beginning of network

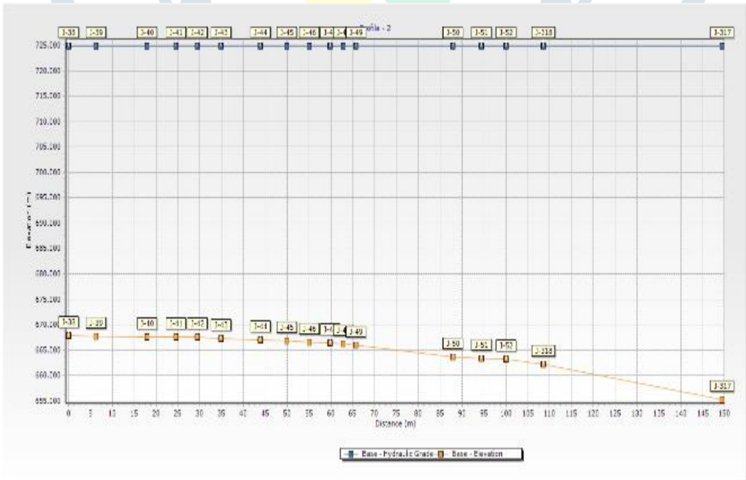

Chart 2. Hydraulic grade line profile at end of network

Chart 1 show the hydraulic grade between 1st and 10th junction is so more and because of this the velocity of water gets high. Totally velocity of water at the beginning of network is more. Chart 2 show that hydraulic grade become regular and velocity of water at end of network is less than velocity of water at the beginning.

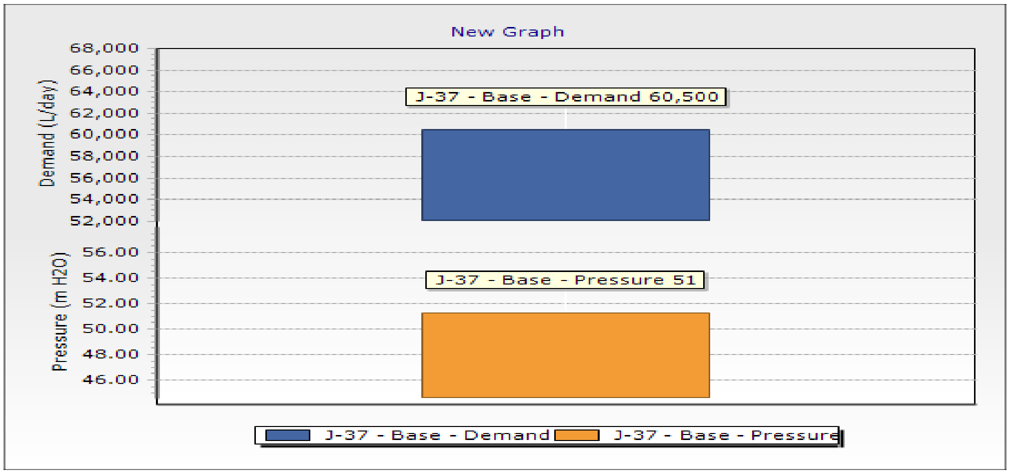

Figure 5. Water demand & water pressure graph at end of network

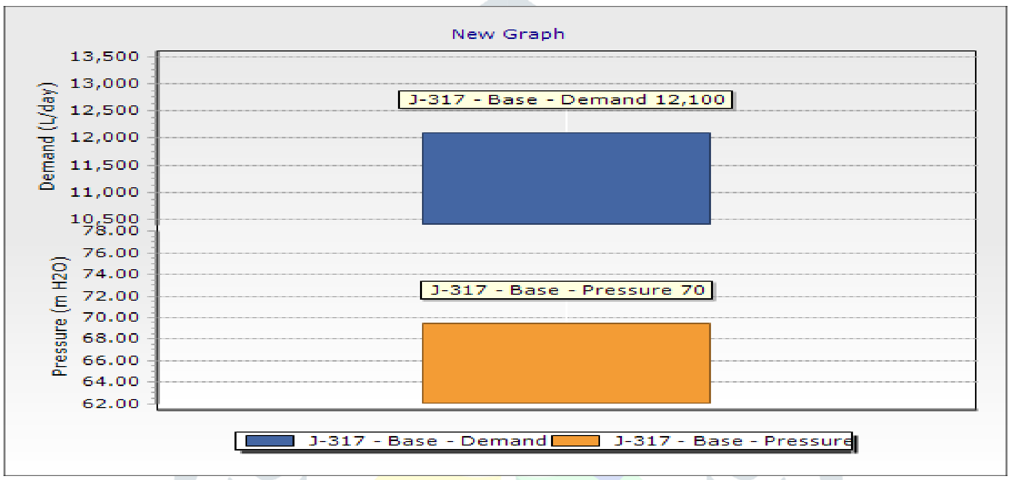

Figure 6. Water demand & water pressure graph at middle of network

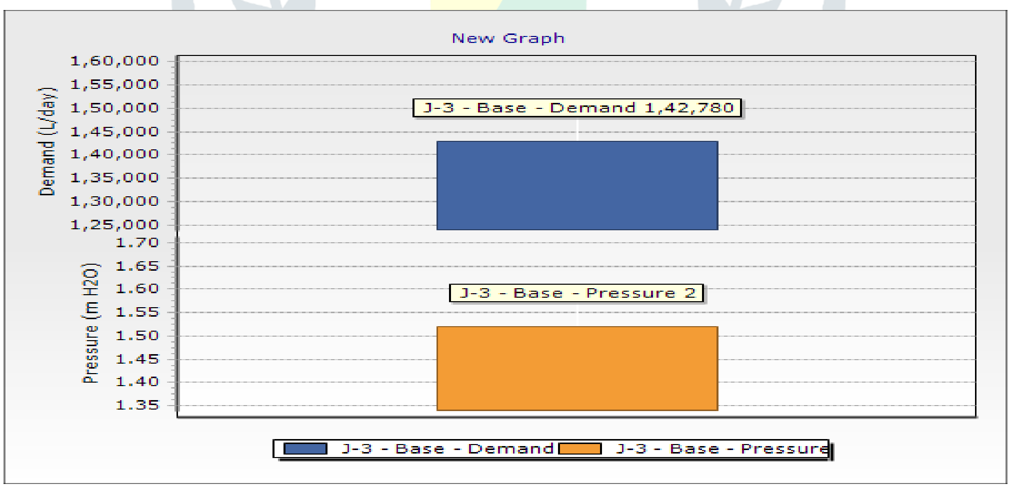

Figure 7. Water demand & water pressure graph at beginning of network

It can be predicted from Fig 5, 6, 7 which shows that the water demand and water pressure at the beginning of network is less than at end of network. Water pressure in water supply network according Afghanistan condition is consist in (Minimum pressure: 14mH_2O & Maximum pressure: 70mH_2O) and due to this pressure is select diameter of pipes [3]. The different parameters are being entered in the software to have velocity, pressure and flow in liter/day and the results are analyzed to find extension in current water supply system.

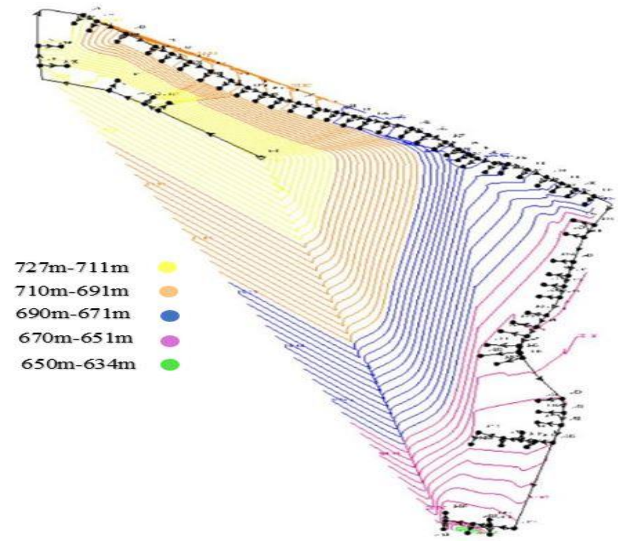

Figure 8. Water supply network elevation contour lines

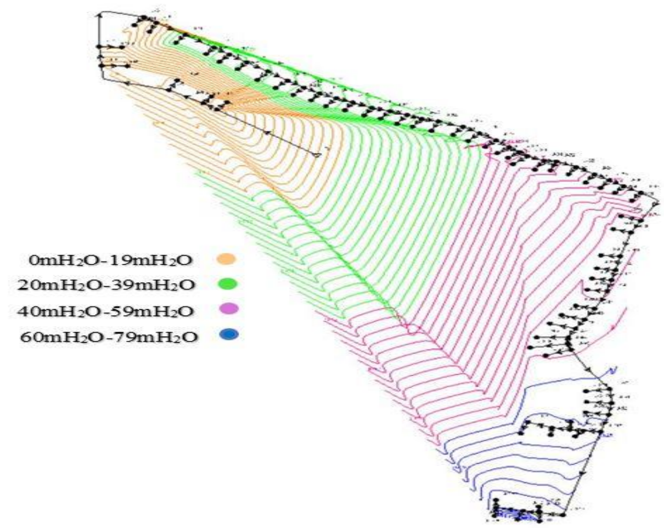

Figure 9. Water pressure contour lines at different elevation of network

Fig 8 show the elevation of water supply network above the sea level. Although the distribution of water at New city water supply network is in gravity form for this reason a good elevation has their influence in the velocity of water.

Table 2. Water supply network diameter of pipes

	ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/day)	Velocity (m/s)	Headloss Gradient (ft/ft)	Velocity (Maximum) (m/s)	Velocity (Minimum) (m/s)
39: P-5	39	P-5	5	J-3	J-4	200.0	Ductile Iron	130.0	4,154,358	1.53	0.012	1.53	1.53
41: P-6	41	P-6	12	J-4	J-5	200.0	Ductile Iron	130.0	4,011,578	1.48	0.011	1.48	1.48
43: P-7	43	P-7	27	J-5	J-6	200.0	Ductile Iron	130.0	3,871,218	1.43	0.010	1.43	1.43
45: P-8	45	P-8	9	J-6	J-7	200.0	Ductile Iron	130.0	3,733,270	1.38	0.010	1.38	1.38
49: P-10	49	P-10	5	J-8	J-9	200.0	Ductile Iron	130.0	3,464,659	1.28	0.009	1.28	1.28
51: P-11	51	P-11	10	J-9	J-10	200.0	Ductile Iron	130.0	3,333,979	1.23	0.008	1.23	1.23
53: P-12	53	P-12	11	J-10	J-11	200.0	Ductile Iron	130.0	3,205,719	1.18	0.007	1.18	1.18
55: P-13	55	P-13	6	J-11	J-12	200.0	Ductile Iron	130.0	3,079,879	1.13	0.007	1.13	1.13
57: P-14	57	P-14	7	J-12	J-13	200.0	Ductile Iron	130.0	2,956,469	1.09	0.006	1.09	1.09
59: P-15	59	P-15	8	J-13	J-14	200.0	Ductile Iron	130.0	2,835,460	1.04	0.006	1.04	1.04
61: P-16	61	P-16	7	J-14	J-15	200.0	Ductile Iron	130.0	2,716,880	1.00	0.005	1.00	1.00
63: P-17	63	P-17	6	J-15	J-16	200.0	Ductile Iron	130.0	2,600,720	0.96	0.005	0.96	0.96
65: P-18	65	P-18	6	J-16	J-17	200.0	Ductile Iron	130.0	2,586,980	0.95	0.005	0.95	0.95
67: P-19	67	P-19	6	J-17	J-18	200.0	Ductile Iron	130.0	2,475,680	0.91	0.005	0.91	0.91
69: P-20	69	P-20	5	J-18	J-19	200.0	Ductile Iron	130.0	2,366,760	0.87	0.004	0.87	0.87
71: P-21	71	P-21	6	J-19	J-20	200.0	Ductile Iron	130.0	2,260,380	0.83	0.004	0.83	0.83
73: P-22	73	P-22	6	J-20	J-21	200.0	Ductile Iron	130.0	2,156,220	0.79	0.004	0.79	0.79
75: P-23	75	P-23	6	J-21	J-22	200.0	Ductile Iron	130.0	2,054,580	0.76	0.003	0.76	0.76
77: P-24	77	P-24	5	J-22	J-23	200.0	Ductile Iron	130.0	1,955,360	0.72	0.003	0.72	0.72
79: P-25	79	P-25	5	J-23	J-24	200.0	Ductile Iron	130.0	1,858,560	0.68	0.003	0.68	0.68
81: P-26	81	P-26	8	J-24	J-25	200.0	Ductile Iron	130.0	1,764,180	0.65	0.002	0.65	0.65
83: P-27	83	P-27	6	J-25	J-26	200.0	Ductile Iron	130.0	1,672,220	0.62	0.002	0.62	0.62
85: P-28	85	P-28	6	J-26	J-27	200.0	Ductile Iron	130.0	1,582,680	0.58	0.002	0.58	0.58
87: P-29	87	P-29	5	J-27	J-28	200.0	Ductile Iron	130.0	1,495,560	0.55	0.002	0.55	0.55
89: P-30	89	P-30	4	J-28	J-29	200.0	Ductile Iron	130.0	1,410,860	0.52	0.002	0.52	0.52
91: P-31	91	P-31	3	J-29	J-30	200.0	Ductile Iron	130.0	1,328,580	0.49	0.001	0.49	0.49
93: P-32	93	P-32	5	J-30	J-31	200.0	Ductile Iron	130.0	1,248,720	0.46	0.001	0.46	0.46
95: P-33	95	P-33	4	J-31	J-32	200.0	Ductile Iron	130.0	1,171,280	0.43	0.001	0.43	0.43
97: P-34	97	P-34	6	J-32	J-33	200.0	Ductile Iron	130.0	1,096,260	0.40	0.001	0.40	0.40
99: P-35	99	P-35	7	J-33	J-34	200.0	Ductile Iron	130.0	1,023,660	0.38	0.001	0.38	0.38
101: P-36	101	P-36	5	J-34	J-35	200.0	Ductile Iron	130.0	953,480	0.35	0.001	0.35	0.35
103: P-37	103	P-37	5	J-35	J-36	200.0	Ductile Iron	130.0	885,720	0.33	0.001	0.33	0.33
105: P-38	105	P-38	6	J-36	J-37	200.0	Ductile Iron	130.0	820,380	0.30	0.001	0.30	0.30
107: P-39	107	P-39	18	J-37	J-38	200.0	Ductile Iron	130.0	757,460	0.28	0.001	0.28	0.28
109: P-40	109	P-40	6	J-38	J-39	200.0	Ductile Iron	130.0	696,960	0.26	0.000	0.26	0.26
111: P-41	111	P-41	12	J-39	J-40	200.0	Ductile Iron	130.0	638,880	0.24	0.000	0.24	0.24
113: P-42	113	P-42	7	J-40	J-41	200.0	Ductile Iron	130.0	583,220	0.21	0.000	0.21	0.21
115: P-43	115	P-43	5	J-41	J-42	200.0	Ductile Iron	130.0	529,980	0.20	0.000	0.20	0.20
117: P-44	117	P-44	5	J-42	J-43	200.0	Ductile Iron	130.0	479,160	0.18	0.000	0.18	0.18

4. Reservoir Size

New city, Puli Khumri, Afghanistan water supply network designed for 2 decade and 3160 person with 110 lpcd.

$$347600\frac{Liter}{Day}\times 0.001\frac{m^3}{Liter}=347.6\,m^3\cong 350\,m^3$$

5. Conclusion

1. The diameter of the pipes and other components of the network has been properly received with a view to increasing water demand in the future.
2. Distribution of pressure in the water supply system is done correctly and there is additional pressure to develop the network in the future.
3. Hydraulic level difference line represents suitable slope conditions for the pipes.
4. The velocity of the water across the system is with the requirements of the code and does not corrode the inside of the pipes.

Future Scope

1. Analyze of water supply network based on variable type loading (hourly, daily and monthly).
2. Analyze of water supply network using other programs (Epanet and Loop) to validate the work.

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