EVALUATION AND IMPROVEMENT OF PRESENT PUMPING SCHEDULE IN MINNA WATER SUPPLY SYSTEM

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Abstract

The provision of safe and adequate drinking water to the growing urban population continues to be one of the major challenging tasks. The aim of this paper is to provide a pumping schedule so as to minimize the marginal cost of supplying water while keeping within physical and operational constraint. The constraints includes maintaining sufficient water within the system reservoirs to meet the time varying consumer demand and the determination of optimum pumping schedule required to improve the water supply of Minna. An efficient pumping schedule was designed based on water demand pattern together with parameters and attributes of components of the distribution system such as pumping station, pipeline and service reservoirs. The analysis clearly shows that it will take 53 minutes to fill the smallest reservoir which is 1000m^3 and 10 hours 30 minutes to fill the largest reservoir which is 10000m^3 with the pumps pumping at the rates of 1258m^3/h, 965m^3/h and 1258m^3/h based on the physically feasible operating pump combination. It will be appropriate to pump water twelve hours daily from 0000 hours to 0600 hours and 1200 hours to 1800 hours with a required storage capacity of 13648.58m^3. With these twelve hours of pumping it is possible to provide twenty four hours water supply for the people with the current population projected to be 358295.

Keywords: *Water Supply System; Pumping Schedule; Service Reservoir; Storage Capacity; Water Demand.*

Introduction

Water and air are essential elements for human life. Even then, a large population of the world does not have access to a potable water supply. Drinking water has been described as a physical, cultural, social, political and economic resource. The provision of safe and adequate drinking water to the burgeoning urban population continues to be one of the major challenging tasks. A safe supply of potable water is the basic necessity of mankind; therefore water supply systems are the most important public utility. Lack of safe drinking water could undermine the health and well-being of the people particularly the urban poor and economically weak.

The delivery of portable water to consumers depends on the integrity of the distribution system. The term distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage (Peavy*et al,.* 1985). Mays (2006) reported that the purpose of water distribution network is to supply the systems users with the amount of water demanded and to supply this water with adequate pressure under various loading conditions. A number of different loading conditions, which a municipal water supply may be subjected to include: fire demands at different nodes, peak daily demands, and series of patterns varying throughout a day; or a critical load when one or more pipes are broken. The ability of the system to operate under a variety of load patterns is required of a reliable network. AWWA (2007) describe the purpose of water distribution system infrastructure in simple terms, to supply water to all customers at sufficient pressure and volume to provide for their need as well as for fire suppression (water quantity aspect), while also protecting the quality of water as prescribed by various standards (water quality aspect).

Water distribution systems have three major components; pumping stations, distribution storage and distributing piping. Depending on the topographical relationship between the source of supply and the consumer, water can be transported by canals, flumes, tunnels and pipelines. Gravity, pumping or a combination of both pumping and gravity may be used to supply water to the consumer with adequate pressure (Peavy*et al,.* 1985). Gravity supply is used where the source of supply is at a sufficient elevation above the consumer so that the desired pressure can be maintained. In the gravity system of water supply it is often possible to supply water to one or more storage reservoirs within the system. This system is proven to be quite economical where it can be used.

In pumped supply, pumps are used to develop the necessary head (pressure) to distribute water to the consumer and storage reservoirs. Punmia, *et al.,* (2001) opined that such system is not desirable, because pumping is required first to pump raw water from source to the treatment work and then to pump purified water directly into the distribution mains. The pumps have to be run at varying speed according to the variations in the consumption. If there is power failure the entire water distribution system is disturbed, in addition the system requires constant attendance.

The third system which is pumped-storage supply, involves the use of storage reservoirs to maintain adequate pressure during periods of high consumers demand and under emergency conditions such as power failures. During periods of low water consumption excess water is pumped and stored in the storage reservoirs. The principal components in the distribution network are pipes, valves, fire hydrants, service connection, storage reservoirs and pumps.

To obtain the necessary head within the distribution system, water towers and elevated reservoirs are often used. Water tower, located at ground level can be constructed of prestressed concrete or steel. Elevated water-storage reservoirs are usually constructed of steel. Otun and Abubakar (2009) gave the capacity of storage reservoir to be the required volume to contain the excess when the supply is more than the demand, and also to provide the deficit when the demand is more than the supply. Provision should also be for requirements and break down storage. They gave the equalizing volume of reservoir to be about 1/6 to 1/3 of the total demand.

Generally water may be supplied to consumers by any of the following systems: 1.Continuous system: - In this system water is available to the consumers for all the 24 hours. This is the best system since water is available when it is needed but this may lead to wasteful use of water.2.Intermittent system: -in this type of system water is delivered to users for less than 24 hours in a day. This is the type of service found in developing countries.

Lucken, *et al.,* (2004) consider pumping scheduling problem having four objectives to be minimized – electrical energy cost, maintenance cost, maximum power peak, and level variation in a reservoir. Pumping schedule optimization has proven to be a practical and highly effective method to reduce pumping cost without making changes to the actual infrastructure of the whole system. Therefore, scheduling the pumps operation is a way of choosing the right combination of pumps that will be working at each time interval of scheduling period. While a pump schedule is the set of all pump combination chosen for every time interval of the schedule horizon.

Proper management of water system is crucial for ensuring sustainability of a given resources and maintaining high-quality water resources while maximizing a utility to profound operating condition. By taking a system perspective, water utilities can ensure must effective overall management of operation. As such,Jentgen, *et al.,* (2005) described a 'system's approach as a planned, comprehensive way to optimize operations and address the entire water system. And true optimization is achieved only by considering the system as a whole. Bouloso, *et al.,* (2000) proposed model that make use of the latest advances in genetic algorithm to automatically determine the least-cost pump scheduling and operation policy for each pump station in water distribution system while satisfying target hydraulic performance requirements.

The people of Minna have come to rely heavily on water vendors, hand dug wells, boreholes and rainwater harvesting which may not necessarily be safe. The consumption of water from these doubtful sources often result in the spread of water borne and water based diseases such as diarrhoea, cholera, typhoid fever, paratyphoid fever, hepatitis, ameobiasis among others (Muhammad, 2014).

Muhammad, (2014) gave the major problem that the populaces of Minna are facing to be that of intermittent water supply. Majority of people in Minna get pipe borne water for 4 – 6 hours twice a week based on the schedule time table prepared by Niger State Water Board (NGWB 2012). Of course this situation is not satisfactory because of the following reasons; (1) The system does not operate as designed, (2) the capacity of the service reservoirs are grossly under-utilized, (3) water from intermittent water supply systems may not be safe to drink, because under vacuum conditions foul water can be drained into the pipes and (4) there is frequent wear and tear on the valves. In the light of these, therefore, this paper is aimed at providing a pumping schedule so as to minimize the marginal cost of supplying water while keeping within physical and operational constraints such as maintaining sufficient water within the system reservoirs to meet the time varying consumer demand and also to determine the optimum pumping schedule required to improve the water supply in Minna.

Research Methodology

Minna is a city in North Central Nigeria. It is the capital of Niger State and is the headquarters of Chanchanga Local Government Area. Since becoming the capital of Niger State in 1976, Minna has developed as an administrative Centre. Minna is made up of an area of about 324km^2. It is bounded by latitude $9^0 32^0$N and $9^0 42^0$N longitude $6^0 30^0$E and $6^0 40^0$E. The climate of Minna is like much of West Africa. The daylight temperatures vary from about 24^0C at middle of wet season to above 35^oC at peak of dry season. The seasonal rainfall regime gives rise to longer wet season of about seven months with average rainfall of 250 mm and dry season of five month with little or no rain.The climate of Minna usually alternate with dry and rainy season, with a total rainfall between 1270 mm and 1524 mm spread over the months of April to October. Fig 1 shows the map of Minna.

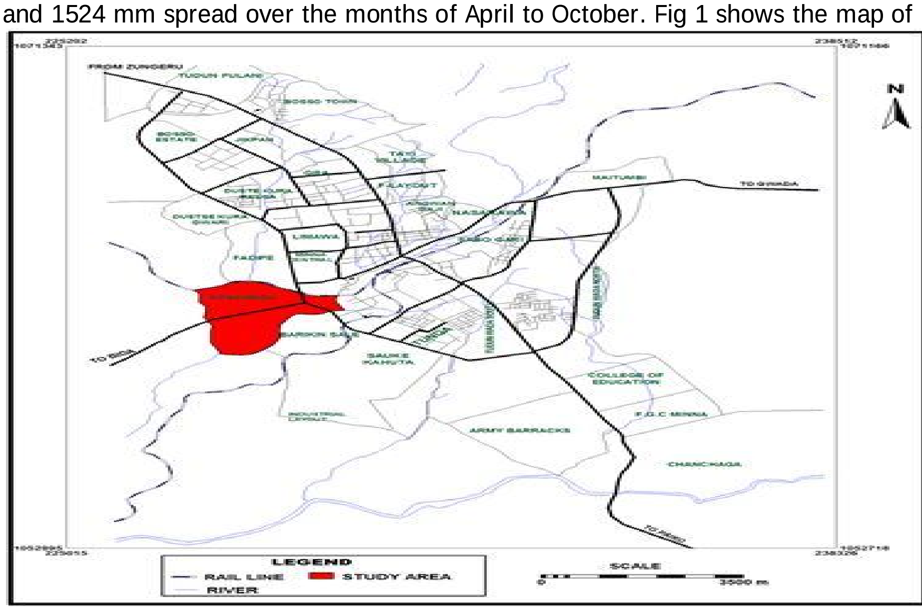

Fig 1: Map of Minna.

Description of the Treatment Plant

Minna and its environs are supplied with treated water from Chanchaga water works. The water works is made up of two independent water treatment plants named after the companies that constructed them. The first water work was constructed in 1979 by Costain International Engineering Construction Company. This water works was upgraded in 1982 by Biwater Holdings. It has a production capacity of 27,000m^3/day. Therefore, it is called Costain/Biwater water works. The second water works was constructed in 1995 by Impresit Construction Company. It has a total designed production capacity of 50,000m^3/day. The water works has a total design capacity of 77,000m^3/day.

Pump Stations

The distribution system has two pump stations Costain/Biwater and Impresit pumping stations. The pumps in the two stations were arranged in parallel. Their characteristics are shown in Table 1 below:

Table 1: Pumping Station Attributes

					Attributes of each pump			
Pump station	Pump	Design flow Q m^3/h	Design head H(m)	**Type**	**Speed (RPM)**	**Power (kw)**	**Manufacturer**	**Date Installed**
Costain /Biwater	1	350	150.03	Centrifugal	1490	230	KSB	2010
	2	558	150	Centrifugal	1490	335	KSB	2000
	3	558	150	Centrifugal	1490	355	KSB	2000
	4	350	150.3	Centrifugal	1490	230	KSB	2010
	5	350	160	Centrifugal	2900	230	Overman	2010
	6	350	150.3	Centrifugal	1490	230	KSB	2010
Impresit	1	490	190	Centrifugal	1470	300	Weir pump	Reinstalled 2012
	2	475	160	Centrifugal	2900	315	Mass Daft	2010
	3	608	180	Centrifugal	1490	315	Overman	2010
	4	475	160	Centrifugal	2900	315	Weir pump	2010

Source: Field work (2012).

Pipe lines

The water system piping consists of transmission system which are the raising mains and the distribution system which are the distribution mains. The transmission system consists of components that are designed to convey large quantity of water over a great distance from water works to the service reservoirs. The diameter of pipes in the transmission system ranges from 300 mm to 900 mm with a total length of 43,125 m. Then water is transported from service reservoirs and transmission pipe through the distribution pipe to the consumers. The distribution system consists of 100mm to 400mm diameter pipelines and a total length of 94,625 m. The pipelines in the system are made up of the following materials ductile iron, galvanized iron, asbestos cement and polyvinyl chloride (PVC). The diagram of Minna water distribution network is shown in Fig 2.

Resevoir/Booster Pump Station

There are seven service reservoirs in the distribution system. The reservoirs are located on topographical high areas within the town. Water is pumped directly from pumping station through the transmission line to the reservoirs and supplied to the consumers through the distribution mains from the reservoirs by gravity.

Table 2: Service Reservoirs

Reservoir name	**Material**	**Shape**	**Vol (m^3)**	**Year of construction**	**Areas that they served**
Biwater tank	Bolted steel	Rectangular	4,500	1984	Shango, Barikin sale, Army Barrack New Secretariat
Shiroro Tank	Reinforced concrete	Rectangular	2,000	1982	Tunga, TungaLowcost, Shiroro Road
Tunga East Tank	Reinforced concrete	Rectangular	2,000	1995	Tunga, David Mark road, Tunga market, Top Medical road
INEC Tank	Reinforced concrete	Trapezoidal	1,000	1964	Police barracks, Bay clinic road, School of midwifery,

					Tunga-Dan boyi rail-way quarters
Uphill tank	Reinforced concrete	Circular	7,000	2000	Minna central, Old airport road, Maitumbi, Bosso road, 123 quarters, commissioners quarters
Paida hill Tank	Reinforced concrete	Circular	4,000	1995	Unguwan Daji, Unguwan Sarki, F-layout Zarumai, Abayi
Dutsen Kura Tank	Reinforced concrete	Circular	10,000	1995	Dutsen Kura Hausa,dutsen Kura Gwari, Bosso lowcost, Bosso Estate, Police Secondary School, Shanu Village. London Street.

Source: Field work (2012)

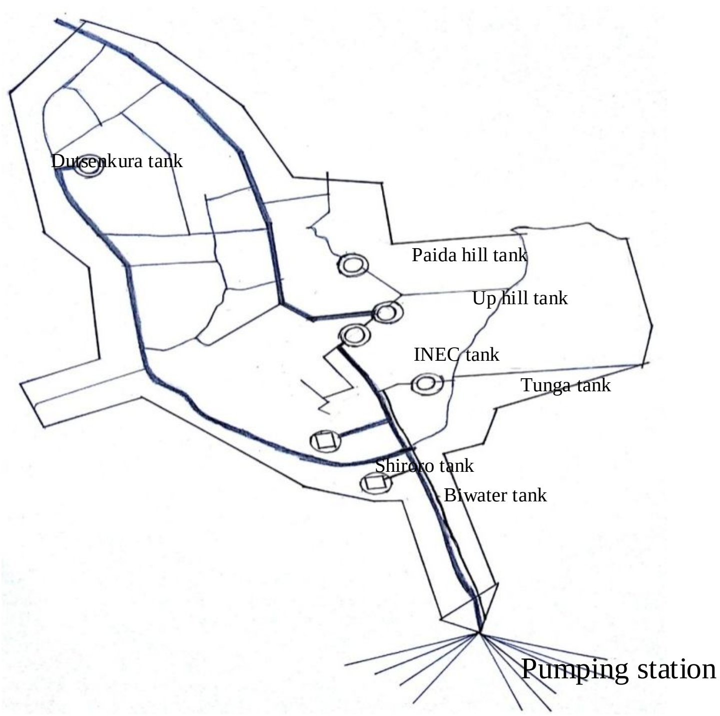

Fig 2: Schematic diagram of Minna water distribution network.

Booster pump station

It is only Dusten Kura reservoir that has a booster pump station. The Table 3 below gives the attribute of the pumping station.

Table 3: Booster Pumping Station

Attribute of Each Pump					
Pump	**Design flow m^3/h**	**Design Head m**	**Type**	**Speed RPM**	**Power**
1	300	150	Centrifugal	-	-
2	220	100.5	Centrifugal	2900	-
3	Nil	Nil	Centrifugal	-	-

Pumping Schedule

To design the pumping schedule plan of the water supply system the following parameters were assessed:

1. Length and diameter of the pipes
2. Properties of pumps in each pumping station i.e. head vs. discharge
3. Geometry of the service reservoirs
4. Water demand/consumption pattern of the populace.
5. Time required to fill each service reservoir

Equations 1 to 6 below were used to determine the time to fill each of the reservoirs in the distribution system;

$$Q = Q_1 + Q_2 \quad (1)$$

$$Q = VA \quad (2)$$

$$Q = \frac{D}{t}A \quad (3)$$

$$t = \frac{D.A}{Q} \quad (4)$$

$$Q = \frac{Vol}{t} \quad (5)$$

$$t = \frac{Vol}{Q} \quad (6)$$

Where,

Q = design flow rate of the pump
Vol = volume
D = pipe diameter
A = area
V = velocity
t = time

Results and Discussion

(a) Pumping Schedule

(i) Water Demand

Macdonald (2007) gave two different perspectives on water demand which result in two definitions. The older perspective is that water engineer operating at a time of resource plenty with no metered customers; according to this group water demand is the amount of water that is required to be put into supply distribution from the treatment works. As more customers become metered and water is recognized as a scarce resource and consequently as the economics of water allocation become more prominent, the demand for water by customer rose in importance. Accordingly today, water demand is the amount of water required by a customer (strictly at a specified price).

The preliminary survey conducted using structured interview, shows that the per capita water demand ranges from 40 liter per capita per day to 150liter per capita per day. But the water supply system was designed based on 120 lpcd. In most cases the peak demand occurs in the morning from 0530 hours to 1000 hours and in the evening from 1600 hours to 2000 hours. The average consumption is from 1200 hours to 1600 hours. During the night hours from 2000 hours to 0530 hours and late morning hours from 1000 hours to 1200 hours the consumption is below average. The water supply scheme should be able to meet this water demand pattern if it is properly managed. Presently, the existing water supply system provides water for an average of 4 to 6 hours per day on an average of 2 days per week. Water is being pumped into various reservoirs on rotational bases on the rational time table as shown in Table 4 below.

Table 4: Reviewed Niger State Water Board Supply Rationing Time Table

PUMPING DAY	RESERVOIR TANK TO BE FED	RELEASE DATE & TIME	AREAS TO BENEFIT
SATURDAY	a. Up – Hill	Sunday 6am-10am	Central Minna, Abayi close/F-Layout, AnguwanDaji, Central Mosque, Kwangila (Part), Limawa, Yoruba Road, Old Airport Quarters
SUNDAY	b. Tunga East c. Biwater	Monday 6am – 10am	Top Medical Area, Part of Aloe vera, TungaDanboyi, Police Barracks, Railway Quarters, Sauka – kahuta

	d. INEC		
MONDAY	e. Dutsen Kura	Tuesday 6am-10am	Dutsen Kura, Hausa and Gwari, Bosso Low-Cost & Estate, Shanu Village, London Street A&B, Police Secondary School
TUESDAY	f. Direct Pumping 'A'	Tuesday Night	123 Quarters, KetarenGwari, Kpakungu, Kuta Road, SabonGari Morning
	g. Shiroro Morning, Emir, Paida, Abayi, SAICO, Kuta Rd	Wednesday 6am-10am	Airport Quarters, TungaLowcost A & B, Niteco Road
WEDNESDAY	h. Biwater	Thursday 6am – 12 noon	Shango, Barracks, Chanchaga, Minna Central
THURSDAY	i. Dustenkura, Type B 3pmDkura	Friday 6am – 12noon	Dutsen Kura, Hausa and Gwari, Bosso Low-Cost & Estate, Shanu Village, London Street A&B, Police Secondary School
FRIDAY	j. Direct pumping 'B' k. Paida Hill	Saturday6am-10am	F/Layout, Tayi Village, Type 'B' Quarters, Lower part of Zarumai Quarters

(ii)Physically Feasible Operating Pumps Combination

Traditionally, the pumps are operated manually by the operators. Tables 5 and 6 below present the possible combination of the various pumps. Costain/Biwater pumping station pump water to the Biwater, INEC, Uphill and Paida Hill reservoirs while, impresit pumping station pump water to Dutsen Kura, Shiroro and Tunga East reservoirs.

Table 5: Pump Combination for Costain/Biwater Pumping Station

Pump combination	Pumps in combination							Flow m^3/h
	Design flow $Q(m^3/h)$	1	2	3	4	5	6	
		350	558	558	350	350	350	
1		X		X		X		1258
2			X		X		X	1258

Table 6: Pump Combination Impresit Pumping Station

Pump combination	Pumps in combination					Flow m^3/h
	Design from $Q(m^3/h)$	1	2	3	4	
		490	475	608	475	
1		X	X			965
2				X	X	1083

(iii)Time Required to Fill Each Service Reservoir

The time required to fill each of the reservoir was determined using the equations derived in section 2 and possible pump combinations for coastan/biwater and impresit pumping stations is as shown in Table 7 below;

Table 7: Time Required to Fill Each Service Reservoir

Reservoir Name	Capacity (m^3)	Length of pipe (m)	Equivalent diameter (mm)	Vol of water in pipe	Time to fill pipe (H)*	Time to fill Pipe (H) +	Time to fill the reservoir	Time to fill the reservoir

				(m^3)			**(H)***	**(H)+**
Biwater	4,500	5375	0.300	380	0.30	0.30	3.58	3.58
Shiroro	2,000	7875	0.714	4413	4.57	4.07	2.07	1.85
Dutsenkura	10,000	15250	0.501	6002	6.22	5.54	10.36	9.23
Tunga East	2000	7750	0.601	3657	3.79	3.38	2.07	1.85
INEC	1000	9125	0.450	1451	1.15	1.15	0.79	0.79
Uphill	7000	9250	0.450	1471	1.17	1.17	5.56	5.56
Paida hill	4000	11125	0.229	2001	1.59	1.59	3.18	3.18

(iv)Total water consumption per day

The population of Minna is estimated to be 304113 based on 2006 population census with a growth rate factor of 2.37%; the population is estimated to be 358295 in the year 2013.

Per capita consumption = 120 lpcd

Water consumption = 120 x 358295

= 42,995,400 litres

Assuming 10% for leakage

Total water consumption = 47,295,400 L

= 47,295.94m^3

(v) Required Storage Capacity

Using the analytical method, the required storage capacity for 24, 20, 18, 16, 14 and 12 hours of pumping is calculated and presented inthe appendix Tables A1-A21. The summary of the analysis is shown in Table 8.

Table 8: Required storage capacity

Duration of pumping	**Hour**	**Required reservoir capacity m^3**
12	(0 – 12)	19268.60
12	(0 - 6), (18 - 24)	2212.44
12	(0 – 6), (12 – 18)	13648.59
12	(12 – 24)	19134.80
14	(0 – 7), (12 – 19)	10781.22
14	(0 - 7), (17 – 24)	10781.22
14	(0-14)	16057.17
14	(5 - 24)	9920.92
16	(0 – 16)	12845.73
16	(0 – 8), (12 – 20)	8530.58
16	(0-8), (16 – 24)	14852.88
16	(8-24)	12745.38
18	(0 – 6), (12 – 24)	13827.03
18	(0 -2), (18 – 24)	11106.18
18	(6-24)	8742.24
20	(0 – 10), (12 – 22)	6021.437
20	(0 – 10), (14 – 24)	92932.87
20	(0 – 20)	5218.580
20	(4 – 24)	5620.01
24	(0 - 24)	5820.72

Pumping Schedule Analysis

Presently, Minna has seven service reservoirs located at different locations within the town with a total storage of 30,500m^3 capacities. Table 8 shows the summary of required storage for 12, 14, 16, 18, 20 and 24 hours pumping. Biwater pumping station pump water to Biwater, INEC, Uphill and Paida- Hill reservoirs, while the Impresit pumping station pump water to Dutsen Kura, Shiroro and Tunga East resevoirs. The Biwater station can pump water of 1258m^3/h for the two possible combinations while, the Impresit station can pump water at rate of 965m^3/h and 1083m^3/h for the two possible combination shown in Tables 5 and 6. The pumps were grouped together based on their characteristics such as pumping capacity and common control component (storage tank). This is in line with suggestion of Boules *et al.,* (2001).

Table 7 shows the time to fill each reservoir after satisfying the dead storage in pipe line. Assuming that there will be at least 10% leakage of the total water pumped into the reservoir, it will take about 53 minutes to fill the smallest reservoir which is 1000m^3 and it will take about 10 hours 30 minutes to fill the largest reservoir of 10,000m^3 – the remaining reservoir could be filled within six hours of pumping. It will be appropriate to pump water twelve hours daily from 0000 hours to 0600 hours and from 1200 hour to 1800 hours with a required storage of 13648.58m^3. Since the pumps are designed for eight hours continuous pumping. However, if there is constant monitoring of the water consumption rate which may varies from time to time. There may be need to put only one pump during off peak periods. This agreed with the findings of Lucken*et al.,* (2004).

This pumping schedule is an interesting proposal and highly effective method to achieve cost reduction in pumping station without making changes in the actual infrastructure of the whole system. With the decision of operating the pumps at the prescribed time period of 0000 hours to 0600 hours and 1200 hours to 1800 hours, the demand will be met, pressure conditions satisfied and total operating cost minimized. Also, with the pumping schedule it will minimize pump start and off, this will reduce transient and pressure variation which are the main course of pipe breaks and increase in water loss and energy consumption.

Conclusion

An appropriate pumping schedule was designed for Minna water supply system based on the water demand pattern so as to minimize the marginal cost of supplying water while keeping within physical and operational constraint. The pumps in the pumping stations were combined so as to have an optimal flow rate in the distribution network. The analysis clearly shows it is possible to provide twenty four hours water supply with twelve hours of pumping from 0000 hour to 0600 hour and 1200 hour to 1800 hour. To further improve on the performance of the water supply system it is recommended that optimization of the system is carried out.

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APPENDICES

Table A-1: Twenty four Hours of Pumping

Time	draft in %max daily requirement	cum draft	inflow in %of max daily requirement	inflow-draft	∑(5)in % of max daily requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	4.1667	2.1667	2.1667
1-2	2	4	4.1667	2.1667	4.3334
2-3	2	6	4.1667	2.1667	6.5
3-4	3	9	4.1667	1.1667	7.6667
4-5	3	12	4.1667	1.1667	8.8334
5-6	6	18	4.1667	-1.8333	7
6-7	7	25	4.1667	-2.8333	4.1667
7-8	7	32	4.1667	-2.8333	1.3334
8-9	6	38	4.1667	-1.8333	-0.5
9-10	6	44	4.1667	-1.8333	-2.3333
1011	4	48	4.1667	0.1667	-2.1666
1112	4	52	4.1667	0.1667	-2
1213	4	56	4.1667	0.1667	-1.8333
1314	4	60	4.1667	0.1667	-1.6666
1415	4	64	4.1667	0.1667	-1.5
1516	4	68	4.1667	0.1667	-1.3333
1617	6	74	4.1667	-1.8333	-3.1666
1718	5	79	4.1667	-0.8333	-4
1819	5	84	4.1667	-0.8333	-4.8333
1920	5	89	4.1667	-0.8333	-5.6666
2021	3	92	4.1667	1.1667	-4.5
2122	3	95	4.1667	1.1667	-3.3333
2223	3	98	4.1667	1.1667	-2.1666
2324	2	100	4.1667	2.1667	3.1E-10

Table A-2: Twelve Hours of Pumping

Time	Draft in %of max daily requirement	cum draft	inflow in % of max daily requirement	inflow - draft	∑(5)in % of max daily requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	8.3333	6.3333	6.3333
1-2	2	4	8.3333	6.3333	12.6667
2-3	2	6	8.3333	6.3333	19
3-4	3	9	8.3333	5.3333	24.3333
4-5	3	12	8.3333	5.3333	29.6667
5-6	6	18	8.3333	2.3333	32
6-7	7	25	0	-7	25
7-8	7	32	0	-7	18
8-9	6	38	0	-6	12
9-10	6	44	0	-6	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	0	-4	-6
13-14	4	60	0	-4	-10
14-15	4	64	0	-4	-14
15-16	4	68	0	-4	-18
16-17	6	74	0	-6	-24
17-18	5	79	0	-5	-29
18-19	5	84	8.3333	3.3333	-25.6667
19-20	5	89	8.3333	3.3333	-22.3333
20-21	3	92	8.3333	5.3333	-17
21-22	3	95	8.3333	5.3333	-11.6667
22-23	3	98	8.3333	5.3333	-6.3333
23-24	2	100	8.3333	6.3333	1.5E-14

Table A -3: Twelve Hours of Pumping

time	draft in %max daily requirement	cum draft	inflow in %of max daily requirement	inflow-draft	∑(5)in % of max daily requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	8.3333	6.3333	6.33333
1-2	2	4	8.3333	6.3333	12.6667
2-3	2	6	8.3333	6.3333	19
3-4	3	9	8.3333	5.3333	24.3333
4-5	3	12	8.3333	5.3333	29.6667
5-6	6	18	8.3333	2.3333	32
6-7	7	25	8.3333	1.3333	33.3333
7-8	7	32	8.3333	1.3333	34.6667
8-9	6	38	8.3333	2.3333	37
9-10	6	44	8.3333	2.3333	39.3333
10-11	4	48	8.3333	4.3333	43.6667
11-12	4	52	8.3333	4.3333	48
12-13	4	56		-4	44
13-14	4	60		-4	40
14-15	4	64		-4	36
15-16	4	68		-4	32
16-17	6	74		-6	26
17-18	5	79		-5	21
18-19	5	84		-5	16
19-20	5	89		-5	11
20-21	3	92		-3	8
21-22	3	95		-3	5
22-23	3	98		-3	2
23-24	2	100		-2	2.1E-14

Table A-4: Eighteen Hours of Pumping

time	draft in %max daily requirement	cum draft	inflow in %of max daily requirement	inflow-draft	∑(5)in % of max daily requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
1-2	2	4	5.5556	3.5556	7.1111
2-3	2	6	5.5556	3.5556	10.6667
3-4	3	9	5.5556	2.5556	13.2222
4-5	3	12	5.5556	2.5556	15.7778
5-6	6	18	5.5556	-0.4444	15.3333
6-7	7	25	5.5556	-1.4444	13.8889
7-8	7	32	5.5556	-1.4444	12.4444
8-9	6	38	5.5556	-0.4444	12
9-10	6	44	5.5556	-0.4444	11.5556
10-11	4	48	5.5556	1.5556	13.1111
11-12	4	52	5.5556	1.5556	14.6667
12-13	4	56	0	-4	10.6667
13-14	4	60	0	-4	6.6667
14-15	4	64	0	-4	2.6667
15-16	4	68	0	-4	-1.3333
16-17	6	74	0	-6	-7.3333
17-18	5	79	0	-5	-12.3333
18-19	5	84	5.5556	0.5556	-11.7778
19-20	5	89	5.5556	0.5556	-11.2222
20-21	3	92	5.5556	2.5556	-8.6667
21-22	3	95	5.5556	2.5556	-6.1111
22-23	3	98	5.5556	2.5556	-3.5556
23-24	2	100	5.5556	3.5556	-3.E-15

Table A-5: Twelve Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	8.3333	6.3333	6.3333
1-2	2	4	8.3333	6.3333	12.6667
2-3	2	6	8.3333	6.3333	19
3-4	3	9	8.3333	5.3333	24.3333
4-5	3	12	8.3333	5.3333	29.6667
5-6	6	18	8.3333	2.3333	32
6-7	7	25	0	-7	25
7-8	7	32	0	-7	18
8-9	6	38	0	-6	12
9-10	6	44	0	-6	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	8.3333	4.3333	2.3333
13-14	4	60	8.3333	4.3333	6.6667
14-15	4	64	8.3333	4.3333	11
15-16	4	68	8.3333	4.3333	15.3333
16-17	6	74	8.3333	2.3333	17.6667
17-18	5	79	8.3333	3.3333	21
18-19	5	84	0	-5	16
19-20	5	89	0	-5	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	1.4E-14

Table A-6: Twelve Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	0	-2	-2
1-2	2	4	0	-2	-4
2-3	2	6	0	-2	-6
3-4	3	9	0	-3	-9
4-5	3	12	0	-3	-12
5-6	6	18	0	-6	-18
6-7	7	25	0	-7	-25
7-8	7	32	0	-7	-32
8-9	6	38	0	-6	-38
9-10	6	44	0	-6	-44
10-11	4	48	0	-4	-48
11-12	4	52	0	-4	-52
12-13	4	56	8.3333	4.3333	-47.6667
13-14	4	60	8.3333	4.3333	-43.3333
14-15	4	64	8.3333	4.3333	-39
15-16	4	68	8.3333	4.3333	-34.6667
16-17	6	74	8.3333	2.3333	-32.3333
17-18	5	79	8.3333	3.3333	-29
18-19	5	84	8.3333	3.3333	-25.6667
19-20	5	89	8.3333	3.3333	-22.3333
20-21	3	92	8.3333	5.3333	-17
21-22	3	95	8.3333	5.3333	-11.6667
22-23	3	98	8.3333	5.3333	-6.3333
23-24	2	100	8.3333	6.3333	2.3E-14

Table A-7: Eighteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	5.5556	3.5556	3.5556
1-2	2	4	5.5556	3.5556	7.1111
2-3	2	6	5.5556	3.5556	10.6667
3-4	3	9	5.5556	2.5556	13.2222
4-5	3	12	5.5556	2.5556	15.7778
5-6	6	18	5.5556	-0.4444	15.3333
6-7	7	25	5.5556	-1.4444	13.8889
7-8	7	32	5.5556	-1.4444	12.4444
8-9	6	38	5.5556	-0.4444	12
9-10	6	44	5.5556	-0.4444	11.5556
10-11	4	48	5.5556	1.5556	13.1111
11-12	4	52	5.5556	1.5556	14.6667
12-13	4	56	5.5556	1.5556	16.2222
13-14	4	60	5.5556	1.5556	17.7778
14-15	4	64	5.5556	1.5556	19.3333
15-16	4	68	5.5556	1.5556	20.8889
16-17	6	74	5.5556	-0.4444	20.4444
17-18	5	79	5.5556	0.5556	21
18-19	5	84	0	-5	16
19-20	5	89	0	-5	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	7.1E-15

Table A-8: Eighteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	5.5556	3.5556	3.5556
1-2	2	4	5.5556	3.5556	7.1111
2-3	2	6	5.5556	3.5556	10.6667
3-4	3	9	5.5556	2.5556	13.2222
4-5	3	12	5.5556	2.5556	15.7778
5-6	6	18	5.5556	-0.4444	15.3333
6-7	7	25	0	-7	8.3333
7-8	7	32	0	-7	1.3333
8-9	6	38	0	-6	-4.6667
9-10	6	44	0	-6	-10.6667
10-11	4	48	0	-4	-14.6667
11-12	4	52	0	-4	-18.6667
12-13	4	56	5.5556	1.5556	-17.1111
13-14	4	60	5.5556	1.5556	-15.5556
14-15	4	64	5.5556	1.5556	-14
15-16	4	68	5.5556	1.5556	-12.4444
16-17	6	74	5.5556	-0.4444	-12.8889
17-18	5	79	5.5556	0.5556	-12.3333
18-19	5	84	5.5556	0.5556	-11.7778
19-20	5	89	5.5556	0.5556	-11.2222
20-21	3	92	5.5556	2.5556	-8.6667
21-22	3	95	5.5556	2.5556	-6.1111
22-23	3	98	5.5556	2.5556	-3.5556
23-24	2	100	5.5556	3.5556	-5.3E-15

Table A-9 Eighteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) =∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	0	-2	-2
1-2	2	4	0	-2	-4
2-3	2	6	0	-2	-6
3-4	3	9	0	-3	-9
4-5	3	12	0	-3	-12
5-6	6	18	0	-6	-18
6-7	7	25	5.5556	-1.4444	-19.4444
7-8	7	32	5.5556	-1.4444	-20.8889
8-9	6	38	5.5556	-0.4444	-21.3333
9-10	6	44	5.5556	-0.4444	-21.7778
10-11	4	48	5.5556	1.5556	-20.2222
11-12	4	52	5.5556	1.5556	-18.6667
12-13	4	56	5.5556	1.5556	-17.1111
13-14	4	60	5.5556	1.5556	-15.5556
14-15	4	64	5.5556	1.5556	-14
15-16	4	68	5.5556	1.5556	-12.4444
16-17	6	74	5.5556	-0.4444	-12.8889
17-18	5	79	5.5556	0.5556	-12.3333
18-19	5	84	5.5556	0.5556	-11.7778
19-20	5	89	5.5556	0.5556	-11.2222
20-21	3	92	5.5556	2.5556	-8.6667
21-22	3	95	5.5556	2.5556	-6.1111
22-23	3	98	5.5556	2.5556	-3.5556
23-24	2	100	5.5556	3.5556	8.8E-15

Table A -10: Twenty Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	Σ(5) in % of Max Daily Requirement
(1)	(2)	(3) =Σ(2)	(4)	(5) =(4)-(2)	(6) = Σ(5)
0-1	2	2	5	3	3
1-2	2	4	5	3	6
2-3	2	6	5	3	9
3-4	3	9	5	2	11
4-5	3	12	5	2	13
5-6	6	18	5	-1	12
6-7	7	25	5	-2	10
7-8	7	32	5	-2	8
8-9	6	38	5	-1	7
9-10	6	44	5	-1	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	0	-4	-6
13-14	4	60	0	-4	-10
14-15	4	64	5	1	-9
15-16	4	68	5	1	-8
16-17	6	74	5	-1	-9
17-18	5	79	5	0	-9
18-19	5	84	5	0	-9
19-20	5	89	5	0	-9
20-21	3	92	5	2	-7
21-22	3	95	5	2	-5
22-23	3	98	5	2	-3
23-24	2	100	5	3	0

Table A-11: Twenty Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow -Draft %	Σ(5) in % of Max Daily Requirement
(1)	(2)	(3) =Σ(2)	(4)	(5) = (4) (2)	(6) = Σ(5)
0-1	2	2	5	3	3
1-2	2	4	5	3	6
2-3	2	6	5	3	9
3-4	3	9	5	2	11
4-5	3	12	5	2	13
5-6	6	18	5	-1	12
6-7	7	25	5	-2	10
7-8	7	32	5	-2	8
8-9	6	38	5	-1	7
9-10	6	44	5	-1	6
10-11	4	48	5	1	7
11-12	4	52	5	1	8
12-13	4	56	5	1	9
13-14	4	60	5	1	10
14-15	4	64	5	1	11
15-16	4	68	5	1	12
16-17	6	74	5	-1	11
17-18	5	79	5	0	11
18-19	5	84	5	0	11
19-20	5	89	5	0	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	0

Table A-12: Twenty Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	Σ(5) in % of Max Daily Requirement
(1)	(2)	(3) Σ(2)	(4)	(5) = (4) - (2)	(6) = Σ(5)
0-1	2	2	5	3	3
1-2	2	4	5	3	6
2-3	2	6	5	3	9
3-4	3	9	5	2	11
4-5	3	12	5	2	13
5-6	6	18	5	-1	12
6-7	7	25	5	-2	10
7-8	7	32	5	-2	8
8-9	6	38	5	-1	7
9-10	6	44	5	-1	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	5	1	-1
13-14	4	60	5	1	0
14-15	4	64	5	1	1
15-16	4	68	5	1	2
16-17	6	74	5	-1	1
17-18	5	79	5	0	1
18-19	5	84	5	0	1
19-20	5	89	5	0	1
20-21	3	92	5	2	3
21-22	3	95	5	2	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	0

Table A-13Twenty Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requiremen t	Inflow - Draft %	Σ(5) in % of Max Daily Requiremen t
(1)	(2)	(3) =Σ(2)	(4)	(5) = (4) (2)	(6) = Σ(5)
0-1	2	2	0	-2	-2
1-2	2	4	0	-2	-4
2-3	2	6	0	-2	-6
3-4	3	9	0	-3	-9
4-5	3	12	5	2	-7
5-6	6	18	5	-1	-8
6-7	7	25	5	-2	-10
7-8	7	32	5	-2	-12
8-9	6	38	5	-1	-13
9-10	6	44	5	-1	-14
10-11	4	48	5	1	-13
11-12	4	52	5	1	-12
12-13	4	56	5	1	-11
13-14	4	60	5	1	-10
14-15	4	64	5	1	-9
15-16	4	68	5	1	-8
16-17	6	74	5	-1	-9
17-18	5	79	5	0	-9
18-19	5	84	5	0	-9
19-20	5	89	5	0	-9
20-21	3	92	5	2	-7
21-22	3	95	5	2	-5
22-23	3	98	5	2	-3
23-24	2	100	5	3	0

Table A-14: Fourteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) ∑(2)	(4)	(5) = (4) (2)	(6) = ∑(5)
0-1	2	2	7.1428	5.1428	5.1428
1-2	2	4	7.1428	5.1428	10.2857
2-3	2	6	7.1428	5.1428	15.4285
3-4	3	9	7.1428	4.1428	19.5714
4-5	3	12	7.1428	4.1428	23.7142
5-6	6	18	7.1428	1.1428	24.8571
6-7	7	25	7.1428	0.1428	25
7-8	7	32	0	-7	18
8-9	6	38	0	-6	12
9-10	6	44	0	-6	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	0	-4	-6
13-14	4	60	0	-4	-10
14-15	4	64	0	-4	-14
15-16	4	68	0	-4	-18
16-17	6	74	0	-6	-24
17-18	5	79	7.1428	2.1428	-21.8571
18-19	5	84	7.1428	2.1428	-19.7142
19-20	5	89	7.1428	2.1428	-17.5714
20-21	3	92	7.1428	4.1428	-13.4285
21-22	3	95	7.1428	4.1428	-9.2857
22-23	3	98	7.1428	4.1428	- 5.142857143
23-24	2	100	7.1428	5.1428	0

Table A-15: Fourteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requiremen t	Inflow - Draft %	∑(5) in % of Max Daily Requiremen t
(1)	(2)	(3) =∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	7.1428	5.1428	5.1428
1-2	2	4	7.1428	5.1428	10.2857
2-3	2	6	7.1428	5.1428	15.4285
3-4	3	9	7.1428	4.1428	19.5714
4-5	3	12	7.1428	4.1428	23.7142
5-6	6	18	7.1428	1.1428	24.8571
6-7	7	25	7.1428	0.1428	25
7-8	7	32	0	-7	18
8-9	6	38	0	-6	12
9-10	6	44	0	-6	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	7.1428	3.1428	1.1428
13-14	4	60	7.1428	3.1428	4.2857
14-15	4	64	7.1428	3.1428	7.4285
15-16	4	68	7.1428	3.1428	10.5714
16-17	6	74	7.1428	1.1428	11.7142
17-18	5	79	7.1428	2.1428	13.8571428 6
18-19	5	84	7.1428	2.1428	16
19-20	5	89	0	-5	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	0

Table A-16Fourteen Hour of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow -Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) =∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	7.1428	5.1428	5.1428
1-2	2	4	7.1428	5.1428	10.2857
2-3	2	6	7.1428	5.1428	15.4285
3-4	3	9	7.1428	4.1428	19.5714
4-5	3	12	7.1428	4.1428	23.7142
5-6	6	18	7.1428	1.1428	24.8571
6-7	7	25	7.1428	0.1428	25
7-8	7	32	7.1428	0.1428	25.1428
8-9	6	38	7.1428	1.1428	26.2857
9-10	6	44	7.1428	1.1428	27.4285
10-11	4	48	7.1428	3.1428	30.5714
11-12	4	52	7.1428	3.1428	33.7142
12-13	4	56	7.1428	3.1428	36.8571
13-14	4	60	7.1428	3.1428	40
14-15	4	64	0	-4	36
15-16	4	68	0	-4	32
16-17	6	74	0	-6	26
17-18	5	79	0	-5	21
18-19	5	84	0	-5	16
19-20	5	89	0	-5	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	7.1E-15

Table A-17:Fourteen Hours Of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow -Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) =∑(2)	(4)	(5) = (4) (2)	(6) = ∑(5)
0-1	2	2	0	-2	-2
1-2	2	4	0	-2	-4
2-3	2	6	0	-2	-6
3-4	3	9	0	-3	-9
4-5	3	12	0	-3	-12
5-6	6	18	7.1428	1.1428	-10.8571
6-7	7	25	7.1428	0.1428	-10.7142
7-8	7	32	7.1428	0.1428	-10.5714
8-9	6	38	7.1428	1.1428	-9.4285
9-10	6	44	7.1428	1.1428	-8.2857
10-11	4	48	7.1428	3.1428	-5.1428
11-12	4	52	7.1428	3.1428	-2
12-13	4	56	7.1428	3.1428	1.1428
13-14	4	60	7.1428	3.1428	4.2857
14-15	4	64	7.1428	3.1428	7.4285
15-16	4	68	7.1428	3.1428	10.5714
16-17	6	74	7.1428	1.1428	11.7142
17-18	5	79	7.1428	2.1428	13.85714286
18-19	5	84	7.1428	2.1428	16
19-20	5	89	0	-5	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	0

Table A-18:Sixteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	6.25	4.25	4.25
1-2	2	4	6.25	4.25	8.5
2-3	2	6	6.25	4.25	12.75
3-4	3	9	6.25	3.25	16
4-5	3	12	6.25	3.25	19.25
5-6	6	18	6.25	0.25	19.5
6-7	7	25	6.25	-0.75	18.75
7-8	7	32	6.25	-0.75	18
8-9	6	38	0	-6	12
9-10	6	44	0	-6	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	0	-4	-6
13-14	4	60	0	-4	-10
14-15	4	64	0	-4	-14
15-16	4	68	0	-4	-18
16-17	6	74	6.25	0.25	-17.75
17-18	5	79	6.25	1.25	-16.5
18-19	5	84	6.25	1.25	-15.25
19-20	5	89	6.25	1.25	-14
20-21	3	92	6.25	3.25	-10.75
21-22	3	95	6.25	3.25	-7.5
22-23	3	98	6.25	3.25	-4.25
23-24	2	100	6.25	4.25	0

Table A-19: Sixteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow -Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) =∑(2)	(4)	(5) = (4) (2)	(6) = ∑(5)
0-1	2	2	6.25	4.25	4.25
1-2	2	4	6.25	4.25	8.5
2-3	2	6	6.25	4.25	12.75
3-4	3	9	6.25	3.25	16
4-5	3	12	6.25	3.25	19.25
5-6	6	18	6.25	0.25	19.5
6-7	7	25	6.25	-0.75	18.75
7-8	7	32	6.25	-0.75	18
8-9	6	38	0	-6	12
9-10	6	44	0	-6	6
10-11	4	48	0	-4	2
11-12	4	52	0	-4	-2
12-13	4	56	6.25	2.25	0.25
13-14	4	60	6.25	2.25	2.5
14-15	4	64	6.25	2.25	4.75
15-16	4	68	6.25	2.25	7
16-17	6	74	6.25	0.25	7.25
17-18	5	79	6.25	1.25	8.5
18-19	5	84	6.25	1.25	9.75
19-20	5	89	6.25	1.25	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	0

Table A-20: Sixteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) =∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	6.25	4.25	4.25
1-2	2	4	6.25	4.25	8.5
2-3	2	6	6.25	4.25	12.75
3-4	3	9	6.25	3.25	16
4-5	3	12	6.25	3.25	19.25
5-6	6	18	6.25	0.25	19.5
6-7	7	25	6.25	-0.75	18.75
7-8	7	32	6.25	-0.75	18
8-9	6	38	6.25	0.25	18.25
9-10	6	44	6.25	0.25	18.5
10-11	4	48	6.25	2.25	20.75
11-12	4	52	6.25	2.25	23
12-13	4	56	6.25	2.25	25.25
13-14	4	60	6.25	2.25	27.5
14-15	4	64	6.25	2.25	29.75
15-16	4	68	6.25	2.25	32
16-17	6	74	0	-6	26
17-18	5	79	0	-5	21
18-19	5	84	0	-5	16
19-20	5	89	0	-5	11
20-21	3	92	0	-3	8
21-22	3	95	0	-3	5
22-23	3	98	0	-3	2
23-24	2	100	0	-2	0

Table A-21: Sixteen Hours of Pumping

Time (Hour)	Draft in % of Max. Daily Requirement	Cum. Draft	Inflow in % of Max. Daily Requirement	Inflow - Draft %	∑(5) in % of Max Daily Requirement
(1)	(2)	(3) = ∑(2)	(4)	(5) = (4) - (2)	(6) = ∑(5)
0-1	2	2	0	-2	-2
1-2	2	4	0	-2	-4
2-3	2	6	0	-2	-6
3-4	3	9	0	-3	-9
4-5	3	12	0	-3	-12
5-6	6	18	0	-6	-18
6-7	7	25	0	-7	-25
7-8	7	32	0	-7	-32
8-9	6	38	6.25	0.25	-31.75
9-10	6	44	6.25	0.25	-31.5
10-11	4	48	6.25	2.25	-29.25
11-12	4	52	6.25	2.25	-27
12-13	4	56	6.25	2.25	-24.75
13-14	4	60	6.25	2.25	-22.5
14-15	4	64	6.25	2.25	-20.25
15-16	4	68	6.25	2.25	-18
16-17	6	74	6.25	0.25	-17.75
17-18	5	79	6.25	1.25	-16.5
18-19	5	84	6.25	1.25	-15.25
19-20	5	89	6.25	1.25	-14
20-21	3	92	6.25	3.25	-10.75
21-22	3	95	6.25	3.25	-7.5
22-23	3	98	6.25	3.25	-4.25
23-24	2	100	6.25	4.25	0