~VALUATION OF WATER DISTRIBUTION SYSTEM IN A SATELLITE TOWN,

(A CASE STUDY OF OWNER OCCUPIER KUBWA, F.C.T.~ ABU1'~.)

BY

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PGD/AGRIC ENG/2004/185

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A PROJECT SUBMITTED TO AGRICULTURAL ENGINEERING DEPARTMENT, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.
IN PARTIAL FULFILLMENT OF THE AWARD OF POST GRADUATE DIPLOMA IN SOIL AND WATER ENGINEERING.

MARCH, 2005.

DEDICATION

This project is dedicated to my beloved wife Fausat Olanrewaju Ibrahim and my children Yusuf Ibrahim, Munirat Ibrahim, Habiba Ibrahim, and Ibrahim Tajudeen for their love and care that made me attain this greater height in life.

ACKNOWLEDGEMENT

I will first of all thank Almighty Allah for His guidance and mercies and for making the write-up a reality. I also like to thank my Head of Department Dr. Adgizdzi of Agric-Engineering Department, my Co-ordinator Dr. Mrs. Z.D. Osunde, And I'm also thankful to my Supervisor Engr. Bashir Mohammed for his wonderful advice and making the project a successful one. May Allah bless and guide everyone of them.

I also like to express my profound gratitude to my mother Hajia Munirat Ibrahim, my wife Fausat Ibrahim, my brother Kassim Ibrahim, my sister Rukayat Ibrahim for their support morally and financially towards the successful completion of the project. May Allah reward them accordingly.

I also like to thank my friend Arch. R.E. olagunju of Architecture Department Federal University of Technology Minna. And also my children and well-wishers for their prayers and co-operations towards the success of the write-up. May Allah crown their effort with success.

Finally, I like to thank Mallam Usman Bosso for accommodating me and Management of F.t.T., Water Board for sponsoring me for the Post Graduate Course of Soil and Water Engineering at Agric Engineering Department of Federal University of Technology - Minna. I prayed that the knowledge impacted to us will be used to contribute to the growth and development of the Board and Nigeria in general.

Long live F.C.T., Water Board, long live Federal Capital Territory, Federal Republic of Nigeria.

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ABSTRACT

This project ıs to evaluate an existing distribution system that is not functioning well; and to come out with useful engineering solutions that will improve the system. There is water in the Reservoir but water doesn't get to the people. That me~ns there is problem. Therefore, the distribution system should be evaluated. Population density of Kubwa was 30,928 in 199 I and population increades to 58,630 after projection for 10years in the year 200 I. From the topographic map Kubwa satellite town is at higher elevation so boaster 'station is required because of the people water cannot reach by gravity. If this is. done there is going to be improvement in the water distribution system.

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Chapter Three

Chapter four

CHAPTER ONE

1.1 INTRODUCTION

Kubwa satellite Town is one of the satellite town in Federal Capital Territory and of cause the largest in Africa. The source of its water supply is from Usuma Dam water works.

Water flows to kubwa through 1200mm~ trunk main from Lower Usuma Dam to 12,OOOm3 Reservoir Tank and finally water is release to the consumers.

Usuma Dam water works is situated in the Northern part of the Territory and at the highest level. Usuma Dam water works is in two phases with 120,OOOm3 or' water a day in each of the phase. This bting the total capacity to 240,OOOm3 per day when the two treatment plants are operational. The maximum height of the dam is 45meters. The raw water intake from the dam reservoir is through pipe openings at different levels in circular concrete intakes tower located within the reservoir. There are eight openings at four different levels giving the opportunity to select a particular level for raw water abstraction depending on its characteristics.

Due to the height of the dam there are three broad regions In the reservoir. The top 5 meters in which the effects of sunlight and air are felt is the epilinmon. The bottom 10 meters in which there is a complete ~bsence of sunlight and air is the hypolimnon. The region between the two is the metalimnon.

In the hypolunmion the raw water characteristics shows a presence of Ammonium ion, Hydrogen sulphide, dissolved iron, Manganese and aggressive.carbondioxide. This is because of the decaying vegetation in the area is devoid of oxygen and sunlight. However, in the Usurna , Dam reservoir, this is kept to the minimum as most of the reservoir area below water level was cleared of all vegetation before impoundment commenced.

The epilirnnon characteristics are linked to the characteristics or both the hypolimnion and the immediate surrounding of the reservoir.

During a change 111 season when the water at the surface cools down there is a tumover of the reservoir. The cool water sinks to the bottom while the relatively warm water at the bottom rises to the top. The presence of sunlight with the supply of Nitrogen and phosphorous from the decaying vegetation could lead to proliferation of algae at the surface.

The Usman Dam reservoir usually experience the turnover effect during December and the problem persists for up to three weeks. During this period, the turbidity of the water (measure of how clear water is rises to 7.4 NTU. The iron and manganese content of the water which i1 usually less 0.1 ppm rise to 0.8ppm. The metabolimnion shows characteristics of two layers. (Abuja Water News 1995)

1.2 BACKGROUND OF STUDY

Owner Occupier Kubwa is part of Kubwa Satellite town with more than 5000 inhabitants. Most of the houses in Owner Occupier Kubwa are Government Residential Houses and some private houses. There are different types of business set up in Owner Occupier. Based on the information collected from the Planning Department, Ministry of Federal Capital Territory. Abuja we can know the population of the residence of Kubwa. Average Vapour Pressure, 'Rainfall on monthly basis, Amount of rainy days, Average Daily Vapour Pressure, Average Daily Hours of Sunshine . . Average Minimum Temperature, in Kubwa, Relative Humidity in percent, Average Monthly Speed of wind. See result and discussion in chapter four.

1.3 AIM OF THE PROJECT

This project aim at evaluating the distribution of Kubwa Satell ite town with Ithe following speci fications: -

1. To evaluate an existing distribution system that is not functioning well and improve it.
ii. To come out with suitable solutions that will improve the distribution system.
1.11. To find out whether the distribution system is adequately design or under design.

1.4 JUSTIFICATION

There is water in the reservoir but water doesn't get to the people. That means there iSJroblem with the distribution system. There is no pressure in the line. The diameter of the pipe is larger and so water coming inside is small that is why water cannot get to the consumers adequately. Therefore, the diameter should be reduced . to smaller size.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION TO WATER DISTRIBUTION

Pipelines are essential part of water distribution system, facilitating the transportation of water in varied quanti ties from headwork through the treatment facilities to the service reservoirs and eventually to the consumers. Water distribution system are in two categories namely

a) The trunk main and
b) The distribution mains

The trunk main convey water from source to the treatment plant and to the service reservoir while the distribution mains hom part of the distribution net work and the service pipe connections are made on distribution main.

There are several advantages of pipeline transporting water for human consumption

1. Being hidden beneath the ground, a pipeline will not affect the natural environment.
2. A buried pipeline is reasonably secured against sabotage
3. A pipeline is iJJdependent of external influences such as traffic congestion and other services.

4. It is relatively easy to increase the capacity of pipeline by installing a booster' pump.

5. A pipeline can gtoss rugged terrain difficult for vehicle to cross

(Alayande 1998) further explained that there are also disadvantages associated with pipeline for distribution system.

i) The initial capital cost is often large

ii) There is often a high cost involve in filling a pipeline.

iii) Pipelines cannot be used for more than one material at a time (Although there are multi-product pipelines operating in batches.

IV) There are operating problems associated with the pumping of solids such as.blockages on stoppage.

v) It is often difficult to locate leaks or blockage.

2.2 SOURCES OF PORTABLE WATER

Untreated water otherwise called raw water may come from ground water sources or surface water such as lakes, reservoir and rivers the raw water is usually transported to a water treatment plant where it is processed to produce treated water also known as portable finished water. The degree to which the..raw is processed to achieve portability depends on the characteristics of the raw water relevant drinking water standard treatment processes used characteristics of the distri bution system.

Before leaving the plant and entering the water distribution system. treated surface water usually enters a unit called clear well services three main purposes 111 water treatment. First, it provide contact time for

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disinfectant S11chas chlorine that are added near the end of the treatment process. Adequate contact time is required to achieve acceptable level of disaffection second, the clear well provide storage that act as a buffer between the treatment plant and the distribution system. distribution system naturally fluctuate between periods of high and low water usage, thus the clear, well stores excess treated water during periods of 1O\\' demand and deliver iVciuring period of peak demand, Not only does this storage make it possible for the treatment plant to operate at a more stable rate but it also means that the plant does not need to be designed to handle peak demand.

Rather, it can be built to handle more moderate treatment rate which means lower construction and operational cost.

Thirdly, the clear well can serve as a source for back wash water for cleaning plant filters that when needed is used at a high rate for a short period of time.

In the case of ground water, not all source required continuos disinfectant residual is frequently recommended, however for protection against accidental contamination and micro-biology growth in the distribution system. Disinfection of ground water source di fferfrorn source infl uenced by surface water in that it is usually applied at the well itself and the disinfectant has a very short contact time (Wilson 1992)

2.3 PORTABLE WATER

This is the water free from pathogenic diseases suitable for human consumption portable water otherwise called clear water or treated water. Water supply system can easily be identified since they are existing to satisfy consumers n,eeds, This water is used for various purposes like home owner irrigation centres and other places source (John 1995)

2.4 SYSTEM CQNFIGURATION

Transmission and distr~bution system can either b e looped or branched as shown in the drawing below (fig 1). As the suggest. in looped systems there may be several different paths that the water can follow to get from the source to a particular consumer. In a branch system, also called a tree system the water has only one possible path from the source to consumers.

Looped

Branched

Fig 1

Looped system are generally more desirable than branched system because coupled with sufficient valuing they can provide an additional level of reliabUity.

For example a main break occurring near the reservoir 111 each system depicted in fig 2 in the looped system however, as of the consumers down stream from the break will have their water service interrupted unti I the repairs are finished. Another advantage of a looped configuration is that because there is more than one path for water to reach the user, the velocities will be lower and the system capacity greater (Wilson 1992)

2.5 LONG RANgE MATER PLANNING

Planners carefully research all aspects of a water distribution system, and try to determine which major capital improvement projects are necessary to ensure the quality of service for the future. This process called planning may be used to projelt system growth and water usage for the next 5, 10 and 20 years system growth and occur because of population growth, annexation, acquisition or whole sale agreement serves it. Consumers must be evaluated whenever system growth is anticipated.

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Not only can be model used to identify potential problem area (such as future low) pressure areas or areas with water quality size and locate new transmission main pumping stations and storage facilities to ensure that the predicted problems never occur. Maintaining a system at an acceptable level of service is preferable to having a rehabilitate a system that has been problematic. Source (Wilson 1992)

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2.6 REHABILITATION

Maintenance of water distribution pipeline whether routine or preventive is an unrelenting costly and major operational aspects of a water supply practice. its objective{s mainly to ensure that the system is functioning as required and that they do not fail at convenient moments by becoming blocked or leaning thus, not delivering the water at sufficient pressure.

Pipeline failures, such as structural cracking or ruptures and faults such as leakages, in accurate gradient 'or interference with proper flow are crucial areas that maintenance programm must focus. (Alayande 1998)

2.7 PROPERTIES OF FLUrD

This is the branch of science which deal with the behaviour of the fluid (liquid or gases) at rest as well as in motion. Thus this branch of science deal with the static, kinematics and dynamic aspects of liquid or fluids. The study of fluid in motion where pressure forces are not considered is called fluid kinematics and if the pressure forces are also considered for the fluids in motion that branch of science is called fluid dynamics. (Bansal 1987)

2.8 DENSITY AND MASS OF LIQUI D

Density or mass of a liquid is defined as the ratio of the mass of a fluid to it volume. Thus mass per unit volume of a fluid is called density. It is denoted by the symbol (J). The unit of mass density is metric slugs per cubic metre, i.e. msllnyl and in SI unit, it is expressed as kg per cubic metre i.e. kg/rrr'. The density of liquids may be considered as constant while that of gases changes with the variation of pressure and temperature.

Mathematically, mass density is written as

Mass of fluid
Volume offluid

CA. K. Jain 1983)

2.9 VISCOSITY

(R. K. Bansal 1987) defined viscosity as property of a fluid which offers resistance to the movement of one layer of fluid over another adjacent layer of the fluid. When two layers of a fluid. a distance dy apart move one over the other at different velocities, say f.L and f-L + du as shown in fig. 2. The viscosity together with relative velocity CJllSeS a shear stress acting between the fluid layer

f.L + du

du

fig 2 .... f.L

The top layer causes a shear stress on the adjacent 100\'er layer while the lower layer cases a shear stress on the adjacent top layer. This shear stress is proportional to the rate of change of velocity with respect to y. It is denoted by symbol τ called tau.

Mathematically $\tau \propto \frac{du}{dy}$ equ. I

$$\therefore \tau = \qquad \text{equ2.}$$

Where f.l (called mu) is the constant of proportional ity and is known as the coefficient o dynamic viscosity or only viscosity.

$\frac{du}{dy}$ ·reptesents the rate of shear strain or rate of shear deformation or velocity gradient.

From equationI and 2 we have

$$= \frac{\tau}{\left[\sim\sim\right]} \qquad \text{equ. 3)}$$

Thus viscosity is also defined as the shear stress required to produce unit rate of shear strain.

2.10 KINEMATIC VISCOSITY

This is defined as the ratio between the dynamic viscosity and density of fluid. It is denoted by Greek symbol (v) called nu. Thus mathematically

$$v = \frac{\text{Viscosity}}{\text{Density}} =$$

The unit of kinematics viscosi ty is obtained as

$$v = \frac{\text{unit of f-L}}{\text{Unit of p}} = \frac{\text{Force} \times \text{Time}}{(\text{Length})^2 \times \frac{\text{I11<1SS}}{(\text{length})^3}}$$

$$= \frac{\text{Force} \times \text{Time}}{\frac{\text{mass}}{\text{length}}}$$

$$= \text{Mass} \times \frac{\text{llength}}{(\text{length})^2} \times \text{Time}$$

$$\therefore \text{Force} = \text{Illass} \times \text{Acc.}$$

$$= \text{mass} \times \frac{\text{length}}{\text{Time}^2}$$

$$= \frac{(\text{length})^2}{\text{Time}}$$

In MKS and SI, the unit of kinematic viscosity is *m2/sec.* while in CGS unit it is written as ern'/sec. In CGS unit kinematic viscosity is also known stoke thus one stoke = crrr/sec.

= [rloJ'

centistoke means $\frac{1}{100}$ stoke

(Bansal 1987)

2.11 NEWTONIAN AND NEWTONIAN FLU) 0

A fluid which obeys equations is known as a Newtonian fluid. Newtonian fluid have a certain constant viscosity i.e. the viscosity is independent of the shear stress- many common fluids such as air, water, light, oils and gasoline are Newtonian. Characteristics shear stress is not linearly

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dependent upon the velocity gradient. Non-Newtonian fluid. therefore do not follow Newton law of velocity expressed in equation 3. Common example of non-Newtonian fluid are human blood. lubricating oils, clay suspensions in water, molten rubber, printer ink, butter and sewage sludge. There is however evidence to believe tha~ Newtonian tluids may exhibit non-Newtonian characteristics under conditions of higher shear stress and hence the classification of a tluid may change with the condition of flow. The following chart gives the classi fication of tluid.

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Fluid

Newtonian
(Time independent)

Non Newtonian

Time independent
i) Dilatant
ii) Bingham
iii) Pseudoplastic

Time dependent
i) Thixotropic
ii) Rheopectic

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A general relationship between shear stress and velocity gradient (rate of shear strain for non-Newtonian fluks may be written as

'T = t1;J + B ________ equ. -J.

where A and B are constants which depends upon the type of tluid and conditions imposed on the flow (shear stress).

The fluids whlj,chobey equation are called power law tluids. The additive: constant B is zero for all fluids except Bingham plastic. Based on the value of power index n 111 equation 4 the non Newtonian fluids are classified as

a) Dilant, ifn > 1 (example - quick stand, butter. printing ink)

b) Bingham plastic if n = 1 (e.g. sewage sludge, drilling muds)

c) . Pseudoplastics n < 1 (e.g. paper pulp polymetric solution such as rubbers suspension paints).

A Newtonian fluid is a special case of power law fluid having n = I and . B = 0 and the constant A varying only with the type of fluid. (A. K. Jain 1983)

Ideal plastic

T = Share stress

Newtonian fluid

Fig. 4

Ideal fluid

dv/dy

Velocity Gradient

2.12 PIPELINE FAULTS AND FAILURE

(Adegoke '1998)Explained faults and failure in distribution line. pipeline on continous use can exhibit stress symtoms resulting either 11-0111 operational problems or environmental consequences such stresses could lead to the developmenj of faults and failures. Pipeline or distribution line failures refers to structural cracking or rapture while faults refers to leakage, inaccurate gradient or any other flow interference that could render the system inefficient.

2.13 OVER LOAD FAJL~RES

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This is characterized by the formation of cracks running longitudinally along the top. Over load cracking can result from such causes as poor bending, the use of pipes damages by careless handling, the imposition at some stages of surcharge loads in excess of these design for, the use of pipes of wrong strength of faulty manufactured or from mistakes in the pipeline design. (Alayande, 1988)

Fig. 5

IJ ~ () a

top view

I] 0J ~ b

side view

Q Hb: ~ c

side view

(2 ~ ~ d

Any position

Q tK ~ e

bottom view (sometimes top)

(Adegoke 1998,)

2.14 ABSOLUTE GAUGE ATMOSPHERIC AND VACUIVI PRESSURES

R.: K. Bansal explained that pressure of a fluid is measured in two different systems. In one system, it is measured above the absolute zero or complete vacuum and it is called the absolute pressure and in other system, pressure is measured above the atmospheric pressure and it is called gauge pressure.

J

Thus:

Let h2 = Height oflight liquid above the datum line

hi = Height of Heavy liquid above the datum line

SI = Specific gravity of light liquid

S2 = Specific gravity of Heavy liquid

As the pressure or pressure head is the same for the horizontal surface, hence pressure head above the horizontal datum line A - A in the left column in the right column of U-tube manometer should be same.

Pressure head above A - A in left column =

Pressure head above A - A in right column = h:: S2

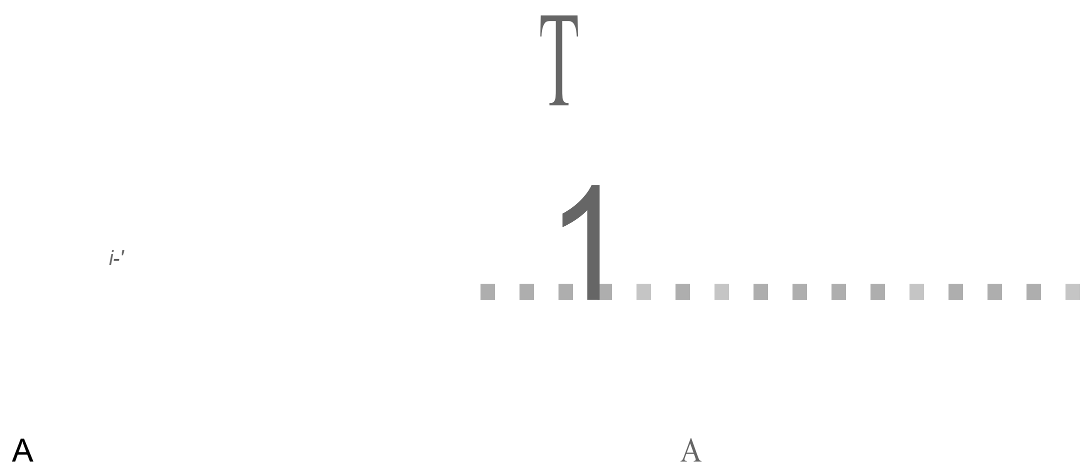
Hence equating the two pressure

h + h2 S I = h2 S2

h(h2 S2 - hi S.l) = equ. 5

b) For vaC?~m pressure: for measuring vacuum pressure the level of the heavy liquid in the manometer will be as shown in fig. 6

fig. 6



1. Absolute Pressure: Is defined as the pressure which IS measured with reference to absolute vacuum

2. Gauge Pressure: Is defined as the pressure which is measured with the help of a pressure measuring instrument in which the atmospheric pressure is taken as datum. The atmospheric pressure on the scale is marked zero.

3. Vacuum Pressure: Is defined as the pressure below the atmospheric pressure. The relationship between the absolute pressure gauge pressure and vacuum pressure are shown

Gauge pressure

-Absolute pressure

Vacuum pressure

Absolute zero pressure

Mathematically

i) Absolute pressure = Atmospheric pressure + Gauge pressure

ii). Vacuum pressure = Atmospheric pressure - Absolute pressure

2.15 MEASUREMENT OF PRESSURE

The pressure of a fluid is measured by the following devices

a) Manometers: Manometers are defined as the devices used for measuring the pressure at a point in a liquid by balancing the column of fluid by the same of or another column of the fluid. They are classified as:

   a) simple manometer

   b) differential manometer

b) Mechanic Gauge: Mechanic gauges are defined as the devices used for measuring the pressure by balancing the fluid column by the spring or dead weight. The commonly used mechanical pressure gauge are

   a) Diaphram pressure gauge

b) ~ourdon tube pressure gauge

c) Dead weight pressure gauge

d) Bellows pressure gauge

(A. K. Jain 1983)

2.16 FIRE PROTECTION STUDIES

Water distribution system are often required for five fighting purposes. designing the system to meet the fire protection requirements is essential and normally has a large impact on the design of the entire network. The Engineer determines the fire protection requirements, and then uses a model to test the ability of the system to meet those requirements. If the maintain adequate pressure the model may also be used for sizing hydraulic elements (pipes, pumps, etc.) to correct the problem (Wilson 1992).

2.17 WATER QUALITY INVESTIGATION

Some model provide water quality modeling in adition to hydraulic simulation capabiliti-ls water age, source tracing and constituent concentration analyses can be modeled throughout a network. For example chlorine residual maintenance can be studied and planned more effectively, disinfection by product formation (DBP) in a network can be analyzed or the impact of storage tank on water quality can be evaluated. Water quality model are used to study the modification of hydraulic operations to improve water quality. (Abuja water news 1997).

2.18 ENERGY MANAGEMENT

Adejoke, 1998 explained that Energy management is next to infrastructure maintenance and repair costs, energy usage for pumping is the largest operating expenses of many water utilities. Hydraulic simulations can be used to study the operating characteristics and energy usage of pumps, along with the behaviour of the system. By developing and testing different pumping strategies, the effect on energy consumption can be evaluated and the utility can make an educated effort to save on energy list.

2.19 LOSS OF ENERGY IN PIPES

(R. K. Bansal 1987 explained loss of energy in pipes as when flood is flowing through a pipe, the flood experiences some resistance due to which some of the energy of flood of lost.

Energy Losses

Fig. 7

I. Major Energy losses

This is due to friction and it is calculated by the flowing formula

a) Darcy - Weibatch formula

b) Chezy's formula

Minor Energy losses

This is due to

a) Sudden expansion of pipe

b) Sudden contraction of pipe

c) Bend in pipe

d) Pipe fittings etc

e) An obstruction in pipe

2.20 LOSS OF ENERGY DUE TO FRICTION

a) Darcy 7 Weisbach formula

This loss of lead (or energy) in pipes due to friction is calculated from Darcy- Weisbach equation which has been derived and given as:

$$hf = \frac{4 \times f \times L \times V^2}{d \times 2g} \qquad \text{equ. 6}$$

where hf = loss of head due to friction

f = co-efficient of friction which is a function of Reynold number

$= \frac{16}{Re}$ for Re < 2000 (viscous flow) _equ. 7

$= \frac{0.079}{Re^{1/4}}$ for Re varying from 4000 to 10(1

L = length of pipe

V = mean velocity

d = diameter of pipe

(A. K. Jain 1983)

2.21 CHEZY'S FORMULA FOR LOSS OF HEAD DUE TO FRICTION IN PIPES

The equation is given as

$$hf = \frac{f}{w} \times \frac{12}{A} \times L \times V^2 \qquad \text{equ. 9}$$

where hf = loss of head due to friction

p = wetted perimeter of pipe

A = Area of cross-sectional pipe

L = length of pipe

Y = mean velocity of flow

Now the ratio-of A (Area of flow)
p ~enmeter wett~

This is called hydraulic mean depth or hydraulic radius and denoted by III.

hydraulic mean depth

m = A
P

= 1Td2

4
1Td

= d
4 equ.10

Substituting = A = m or p = 1 _ equ. 11
p A m

hf = f x L x y2

w

y2 = hf x w x m x 1
f L

= w x m x hf
f L

Y = ~ x m x hf
L

t-,

equ.12

Let j(= c where c is a constant known as Chezy's constant

and hf =
L

where I is loss of head per unit length of pipe.

substituting the value of~
~ ~r

andjtf equ. 13

and finally V = c~ml equ. 14

(Bansal 1987)

2.22 DESIGN OF PIPE DIAMETER

To design a pipe diameter with length of 2000m when the rate of flow of water throught_,the pipejs 200 litres/sec and the head lost due to friction is 4m. Take the value of c = 50 in Chezy formular.

Solution

Given length of pipe = 200m

Discharge = Q = 2001itres/sec = 0.2nyl/sec

Head loss due to friction, hf = 4m

Value of Chezy constant = c = 50

Let the diameter of pipe = d

t-,

Velocity of flow, $V = \dfrac{\text{Discharge}}{\text{Area}} = \dfrac{Q}{\frac{\pi}{4}d^2}$

$$= \frac{0.2}{\frac{\pi d^2}{4}} = \frac{0.2 \times 4}{\pi d^2}$$

Hydraulic mean depth $m = \dfrac{d}{4}$

loss of head per unit length $i = \dfrac{h_f}{L} = \dfrac{4}{2000}$

$$= 0.002$$

Chezy formula is given by equation as $V = C\sqrt{mi}$

substituting the value of V, m, i, and c we get

$$\frac{0.2 \times 4}{\pi d^2} = 50\sqrt{\frac{d}{4} \times 0.002}$$

$$\text{or} \quad \sqrt{\frac{d}{4} \times 0.002} = \frac{0.2 \times 4}{\pi d^2 \times 50}$$

$$= \frac{0.00509}{d^2}$$

$$\frac{d}{4} \times 0.002 = \frac{0.0000259}{d^4}$$

$$d^5 = \frac{4 \times 0.0000259}{0.002}$$

$$= 0.0518$$

$$d = \sqrt[5]{0.0518}$$

$$= (0.0518)^{1/5}$$

$$= 0.553111$$

(Jain, 1983)

2.23 DAILY OPERATIONS

Adegoke 199~ explained daily operations that individuals who operate water distribution system are 'generally responsible for making sure that system wide pressures flows and tank water levels remains within acceptable limit. The operator must monitor these incisedo and take action when a value fall outside of the acceptable range. By turning on a pump adjusting a value for example, the operator can adjust the system so that if function at an appropriate level of service. A hydraulic simulation can be , used in daily operations to determine the impact of various possible actions providing the operations to determine the impact of various possible providing the operator with better information for decision making.

2.24 OPERATOR TRAINING

Most water distribution system operates do their job very well. As testimony to this fact, the majority of systems experiences very few water out ages and those that do occur are rarely casual by operator error. Many operators, however only gain experience and confidence in their ability to operate the system over? long period of time and sometimes the 1110st critical experience is only gained under conditions of extreme dress

Hydraulic simulations offer an excellent opportunity to train system operators in how their system will have different loading conditions with various control 'strategies and in emergency situations (Alayande 1998)

CENTRIFUGAL PUMPS

Jain 1983 described tlJ principle part of a centri fugal pump are the impeller with its shaft and the casing which surrounded a centrifugal pump thus consist of an impeller rotating inside a spiral or volute casing. Liquid is admitted to the impeller in an axial direction, through a central opening in each side called the "EYE". It then flows radial outwards and is discharged around the entire circumference into a casing. As the liquid flows through the rotating impeller energy is imparted to the fluid with results in increases in both the pressure and the kinetic energies, since a large part of the energy of liquid leaving the impeller is kinetic, it is necessary to reduce the absolute velocity of flow and transform a large portion of this velocity head into pressure head.

The naming ef the pump "centrifugal" is derived from the fact that the discharge of the liquid from the rotating impeller is due to the centrifugal head created in it. A pressure rise throughout the mass, the rose at any point being proportional to the square of angular velocity and the distance of the point from the axis of rotation. This high pressure near the impeller outlet forces the liquid out and causes it to rise in the delivery pipe. At the eye of the impeller a partial vacuum is created and the atmospheric pressure III the sump forces the liquid throughout the suction pipe to replace the liquid .that is being discharged from the impeller.

Impeller

Eye

Volute tye

2.26 DESIGN OF CENTRIFUGAL PUlVIP

A. K. Jain 1983 explained that a constant speed test of a centrifugal pump resulted in the following relationship.

$$H = 43.8 + 251Q - 3769Q^2$$

where H = total head in (meter).

Q = discharge m^3/sec.

Assume that, the pump is to be used to deliver water through a pipeline 1km long

D 35cm

= 0.5m

static lift being 25.8111~ 0.26m

To determine the operating head and the pump discharge taking the friction factor as 0.03 and neglecting the velocity head. For the particular Hand Q point a which the pump operates determines the power required to drive the pump if the over all efficiency is 72%.

Solution ./-,

Head developed by pump (H)

= static lift + head loss in pipe friction

$$= 25.8 + \frac{fL}{2gd} \left(\frac{1Q'''}{\Pi Td}\right)^?$$

$$= 25.8 + \frac{0.03 \times 1000}{2 \times 9.81 \times 0.35} \sim\times \frac{40}{0.35 \times O\sim'}$$

Also = 25.8 + 475Ql

H = ~3.8 + 25Q - 360Q2.

from the two expressions for head, we obtain

or 4235Ql - 251 Q - 18.0 = 0

from ,which the pump discharge

Q = 0.097m3/s ~ 97Iitres/sec.

1-'

operating head $H = 25.8 + 475(0.097)2$

$30.265m$

power output of the pump

$$P_v = \frac{YQH}{75}$$

$$= \frac{1000 \times 0.097 \times 30.265}{75}$$

$= 391$ hp.

1-'

Power required to drive the pump

=

$$= \frac{39.1}{0.72}$$

$= 54.3$h.p.

ans. $= 54.3$h.p.

(-'

(-,

CHAPTER THREE

METHODOLOGY

These was based on Recomainssance, Questionnaire and Topographic map

3_1 RECONAINSSANCE

This was the site investigation conducted from one house to another to find out whether residents of owner occupier Kubwa are getting water or not. If they are not getting water whlt was the reason for not getting water. During the investigation I checked the pressure of water through the standing tap installed in each flat. Pressure of water coming from the standing tap in each flat will enable me to know if water supply is adequate or not.

There were hundred flats in the estate and I went to one flat after the other to find out if water is adequate, moderate or low or no water supply at all.

It was also part of my site investigation to find out if the initial design was under design or over design. And also to find out if are the necessary facilities in place ornot .such as street valves, Fire - hydrant, Air release valve and wash out etc. If all these things were okay then the design should be changed to ensure . effective distribution system.

In the estate of 1, 2, 3, and 4 bed units, I went round the whole estate to know why residence of the owner occupier were not getting water adequately.

3.2 QUESTIONNAIRE

Questionnaire was distributed to lOOflats in the estate for a good result. Thus questionnaire was shared to know everybody's mind why water doesn't reach them.

An finally the questionnaire will assist me to know the number of peoplethat are getting water and the number of people that are not getting water. From there I will be able to work it in percentage. The percentage of the people getting water and the percentage of the people who are not getting water.

Infect from the questionnaire I will be able to know a lot of things. The type of flat thy occupant is staying, is the house watered or not. are they getting water or not. Response of water authorities, how much they are paying per flat, etc. for effective result the questionnaire will enable me to know a lot of things.

)

3.3 TOPOGRAPHIC MAP

1 want to appreciate Fola Consult for providing me topographic map of owner occupier kubwa. This also assist me to know the elevations in the owner occupier housing Estate, the road network the drainage system. There are so many information in the topographic map. Which will assist the project writer to come out wish good result.

3.4 POPULATION DATA

I went to National Population Commission and I was provided with population data of Kubwa Satellite town.

CHAPTER 4

4.1 RESUL T AND DISCUSSION

In this chapter my result and discussion is base on the following.

I) Respond from the residence of owner occupier Kubwa Abuja.

2) Result from site investigations

3) Result from topographic map

Most of the residence of owner occupier are not getting their adequate supply because the job was wrongly done by the contractor, and all the facilities that were suppose to be in placed were not included in the pipe laying during construction. Facilities like pumping machine pump house, and generator. Five hydrant and street valves were not installed. All these are associated to wrong job done by the contractor. During my site investigation I found out that all these things were not in placed

This off course is there reason why residence of owner occupier were not getting their adequate supply and therefore there is need to improve the system.

Further more; I want to appreciate Fola Consults Town Planners and Engineers who made the topography - map of owner occupier Kubwa available to me.

From the topographic maps, it was observed the owner occupier is at the highest level that is why water cannot flow by gravity to reach all the consumers that is why pumping machine becomes very important and generator.

During my site investigation I also found out that there were not enough street valves. You can imagine the whole of owner occupier estate only I shace valve, I hydrant. This is not ~dequate. That is why during maintenance consumers suffered a lot. It is difficult to isolate the affected areas because the whole estate has one control valve.

If we can bring all these facilities that were not put in placed, definitely there is going to be a lot of improvement in consumers supply. Most consumers in owner occupier get water at night when the demand is low. During those hours some consumers stored water in their reserve tanks continue to suffer.

During the daytime few people get water because their houses are located at the lowest level. Since consumers are not getting water adequately in owner occupier Kubwa, revenue is very low.

My result is based on consumers responds from questioner distributed to residence of owner occupier Kubwa. And also observations found physically during site investigation and finally result from the topographic map. Showing the contors, road, houses, open spaces, elevations of ground levels etc.

AREA AND CLIMATE

TABLE 4.1

Area and F.C.T. State by L.C. As And population Density.

Area Councils	1991 Population	Area (sq krn)	Population per squ_ar~ k~~~
Abaji	21,081	1,300	10.5
Gwagwalada	45,340	2, 200	36.7
Kuje	44,338	1,700	36.0
Kubwa	30,928	-	-
Kwali	33,966	-	-
Municipal	19~,021	2, 800	76.0
Total	378 , 671	80,000	47.3

Statistical year book 2002

TABLE 4.2

Average Minimum Temperature in Kubwa F.e.T., 1998 to 2002

Year	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	21	21	21	21	21	19	19	20	19	19	20	17
1999	22	22	23	25	22	20	20	19	19	20	22	19
2000	19	22	24	23	21	17	19	19	19	20	20	17
2001												
2002												

TABLE 4.3

Average Minimum Temperature in Kubwa F.e.T., 1998 to 2002

Year	Jan	Feb	Mar	Apr	May	Jun	Jut	Aug	Sep	Oct	NOY!	Dcc
1998	36.1	37.6	37.2	34.1	32.0	31.0	29.5	29.5	30.9	31.3	33.2	32.1
1999	35.3	38.0	38.1	37.6	33.4	31.3	29.1	28.3	29.7	31.1	34.5	35.2
2000	35.4	36.8	36.9	36.0	32.7	31.0	28.9	~8.8	29.4	30.7	34.2	35.2
2001												
2002												

Statistical year book 2002.

TABLE 4.4

Relative Humidity percent in KUBWA F.e.T., 1998 to 2002

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Months											
1998	Mean 0900z (IO.OOam LT)	-40	22	49	72	78	81	87	87	81	79	67	44
	Mean 1500z (4.00pm)	27	15	33	53	62	68	71	72	67	71	52	35
1999	Mean 0900z (lO.OOam LT)	38	35	55	65	77	80	86	87	84	79	58	43
	Mean 1500z (4.00pm LT)	25	25	23	42	59	59	73	76	71	66	39	29
2000	Mean 0900z (10.00am LT)	43	51	62	62	76	81	86	87	83	78	60	36
	Mean 1500z (4.00pm LT)	27	31	36	41	58	-	74	72	70	66	41	23
2001	Mean 0900z (4.00pm LT)												
	Mean 1500z (4.00pm LT)												
2002	Mean 0900z (J O.OOam LT)												

TABLE 4.5

Amount of Rainy days in Kubwa F.e.T., 1998 to 2002

Year	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	0	0	2	6	17	14	18	20	18	20	2	2
1999	0	2	2	6	12	15	18	20	21	20	0	0
2000	0	0	3	10	15	16	18	17	17	14	1	0
2001												
2002												

Statistical year book 2002

TABLE 4.6

Amount of Rain fall by month Kubwa F.e.T., 1998 to 2002

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Noy	Dec
	Amount for Months (measured in mm)											
1998	TR	0.D	27.0	76.0	166.6	193.8	186.9	225.0	[illegible]	198.3	9.[illegible]	[illegible]
1999	0.0	28.7	9.9	86.5	102.1	195.4	310.0	196.1	181.4	322.0	0.0	0.0
2000	0.0	0.0	20.6	81.9	227.8	162.1	345.4	344.5	282.5	114.9	8.0	0.0
2001												
2002												

Statistical year book 2002

TABLE 4.7

Average Daily hour of sunshine in Kubwa F.e.T., (1998 to 2002)

Year	Jan	Feb	Mar	Apr	May	Jun	Jui	Aug	Sep	Oct	Nov	Dec
						Months						
1998	8.7	xx	xx	7.7	7.4	xx	4.4	xx	6.1	xx	17~	8.4
1999	6.1	5.7	7.1	7.2	xx	xx	xx	xx	6.5	8.6	7.9	
2000	7.7	7.3	8.1	6.5	xx	xx	xx	xx	xx	6.2	xx	xx
2001												
2002												

Statistical year book 2002

TABLE 4.8

Average Monthly Speed of Wind in Kubwa F.e.T., (1998 to 2002)

	Months											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	2.8	3.0	3.5	2.9	3.2	2.9	3.0	2.5	2.9	4.7	3.6	3.4
1999	3.5	3.6	3.2	3.9	4.4	4.9	4.0	4.0	4.7	5.6	3.6	3.8
2000	3.3	3.3	4.4	4.3	5.5	3.8	4.2	4.5	4·.5	4.1	3.8	3.1
2001												
2002												

Statistical year book 2002.

TABLE 4.9

Daily Average Vapour Pressure in Kubwa F.e.T., (1998 to 2002)

Year	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	19.6	16.1	16.6	15.1	27.5	27.5	27.4	27.4	27.2	19.6	16.5	17.3
1999.	19.2	16.8	14.8	16.3	22.2	26.5	26.4	27.3	27.1	25.0	16.8	17.4
2000	19.6	16.ıt	20.2	27.9	27.9	27.0	26.9	26.5	26.5	26.0	17.4	16.4
2001												
2002												

Statistical year book 2002.

J

TABLE 4.10

POPULATI0N OF FCT BY AREA COUNCIL A~D SEX, 1991

Area Councils	1991 Population (000)		
	Males	Females	Total
.Abaji	10,833	10,248	21,081
Gwagwalada	24, 855	20,485	45,340
Kuje			
Kubwa			
Kwali			
Municipal (_,			

Statistical year book 2002.

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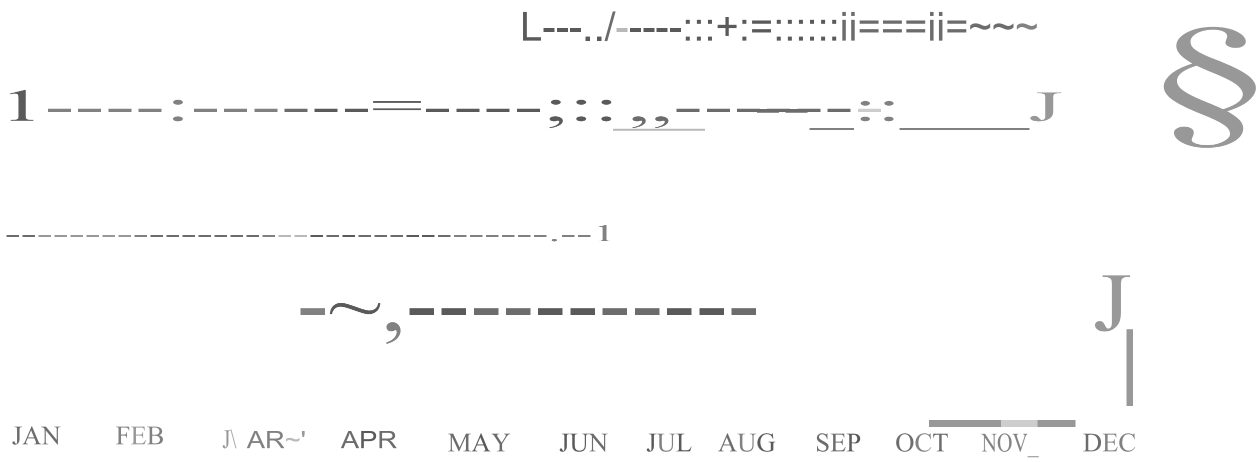
AVERAGE MAXIMUM TEMPERATURE IN KUBWA F.C.T.(1998-2000)

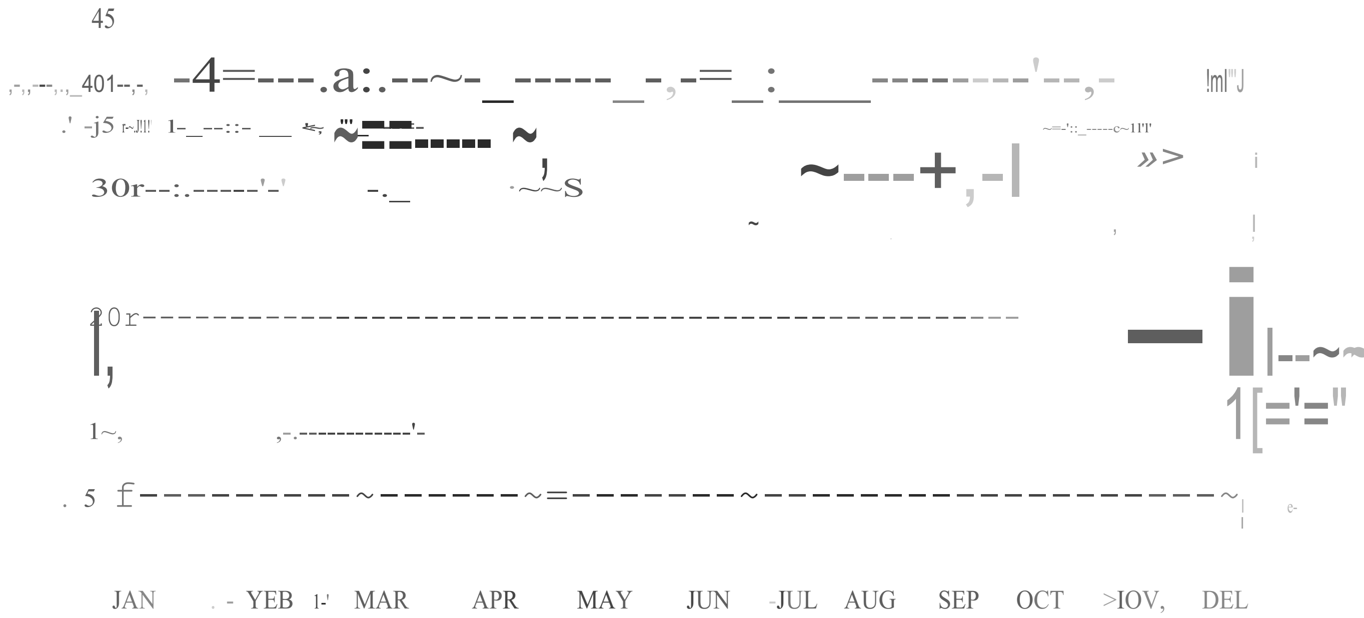
AVERAGE DAILY MAXIMUM TEMPERATURE IN KUBWA F.e.T. (1998-2002)



Statistical year book 2002

AVERAGE DAILY MAXIMUM TEMPERATURE

I-N ~l!B_WA F.C.T.(1998-2002)



Staljsl yearbook 2002

CHAPTERS

5.1 CONCLUSION AND RECOMMENDATIONS

CONCLUSION:- If all the Engineering solutions is followed, definitely the system will work very well. And if these precautions are not followed then consumers in owner occupier Kubwa will continue to suffer for water.

S.2 RECOMMENDATIONS

1. For adequate water supply to consumers at owner occupier Kubwa pumping station should be established at a nice location with pumping machine and generator.
2. Street valves should also be introduced so that during maintenance only the affected area will not have water supply other consumers will continue too have water. Introduction of street valves have tremendous advantages if it is properly implemented isolation of affected areas becomes very easy. Presently, only one valve lock the whole of owner occupier and that is why consumers suffered a lot during maintenance because isolation is not possible
3. More fire - hydrants should be introduced along the pipeline. Presently only twp fire hydrants are in owner occupier Kubwa and they were located at 1 bedroom unit and 2 bedroom *unit.* Noon in 3 bedroom and 4 bedroom unit. During fire disaster, it wi1l bee dangerous especially where 3 bedrooms flat and 4 bedrooms flat were constructed.

4. Servicing all the existing valves whether slice valve or butterfly valve. All the blocked meters should also be serviced. This will increase the pressure of water.
5. Existing line at owner occupier should be traced so that leakages and burst pipe on pipeline should be maintained. All these minor losses are reducing the quantity of water that is supposed to reach the consumers.
6. Finally if all listed above can come to the pipeline design, there will be improvement in consumers supply and consumers will be ready to settle their bills. There is no justification if you force consumers to pay water bills which they are not enjoying the services of the water authorities.

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APPENDIX 1

l-i

QUESTIONAIRE

I. What is the source of your water supply?

Are you getting water adequately? Yes D No D

3. What type of flat are you occupying?

one bedroom flat D two bedroom flat D three bedroom flat D

none of the above . D

4. How lpany are you in a flat? .

1-'

5. Did you complain to water authority? Yes D No D

6. What is .the response of the water board? ..

7. What is the purpose of your water supply?

8. Is your flat metered? Yes D No D

9. Are you getting your water bill regularly? Yes D No [J

10. How many 1 bedroo!J4 flat? ..

11. How many 2 bedroom flats?

12. How many 3 bedroom flats?

13. How many 4 bedroom flats? .

1-'

14. What is the colour of your water? ..

15. Did you have any leakage around? Yes D No D

16. Did you have any burst pipe around? Yes D No D

17. How many litres of water did you consume in a day? .