BLENDING OF DRINKING WATER IN GAZA CITY (BRACKISH WITH FRESH)

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INTRODUCTION

Gaza city is one of the oldest in the region its located in the southern part of Palestine at the Mediterranean Sea. The total area of the city is 40 km^2 and the population until the year 1999 is around 350,000 which clearly indicates that the city is over populated. However the city depends totally on underground water resources which has got a high percent of saltiness which continuously increases as the consumption increases. It is the fact that the amount of a annual rain (371 mm/ year) is in no way could substitute the consumed a mount of underground water. Some though was taken into consideration to sweating drinking water, but due to low living standard which make the people unable to bear the expense of sweating also due of materials make option impossible to achieve. The municipality is heading toward the north part of the city crossing the boarders of Jabalya for digging new wells, the saltiness of these wells reach about 100mg.cl/letter while digging. The number of these wells is 5 with overall capacity 900 meters/hour. Out of this project we are trying to find the best way to mix the salt water coming out of old well with the fresh water from new wells in northern side of the city just to create balance and to maintain the quality of water.

Present Condition of Water Wells in Gaza City

The city is supplied with drinking water from underground wells, which could be of 80-100 meter in depth. These wells are located in three zones as shown in the attached map. The amount of pumped water is 60,000 meter / day which is directly pumped to the city network with no reservoir in between. The number of wells is 20. In addition to the above 20 wells, there are 3 more wells underconstruction and are located in the north in side of the city. The current water network is made of pipes with small diameters. The design and installation was made long time ago. However existing wells were drilled by percussion method to a depth of 100 meter due to above the wells are characterized to last to 10-15 years only.

Gaza City Water Network

The city network mainly depends on few major pipelines interconnected all together. These are made of steel and asbestos in combinations. The diameter varies between 8 to 20 drinking water are fed directly to these major pipes later it is distributed through minor pipe lines with 1, 2 and 3 diameters. Total Length of the major pipelines is about 60Km.

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Water Reservoirs

The existing reservoirs are all obsolete with small size except one, which is of 5000 m^3 of capacity. Filling of these reservoirs is possible only by shutting of the water from main net work and directs it to the reservoir. Finally, dividing the water equally among different areas distribution. This is done to insufficient amount of water.

Problems

1. Lack of water reservoir for storing and distribution of water
2. Water pressure in the pipelines is very low.
3. Water network in the city is not suitable and can no more meet the city requirements.

GAZA CITY WATER SUPPLY SYSTEM

Existing city wells data:

The existing water supply system to the city is presented in map No 1 the city owns some 20 wells from which it supplies close to 14 million cubic meter per year to its population the data of the existing wells is presented in table (1).

Table (1): Chemical analysis of water wells 1999:

No	*Name of well*	*Q M3 / hr*	*CL. mg/l*	*Nitrate g/l*	*Fluoride g/l*
1.	Sheikh Radwan 1	180	273	135	0.78
2.	Sheikh Radwan 1A	180	245	140	0.5
3.	Sheikh Radwan 3	150	1015	135	0.5
4.	Sheikh Radwan 4	180	1085	90	0.75
5.	Sheikh Radwan 7	180	553	175	0.8
6.	Sheikh Radwan 7A	180	485	115	0.87
7.	Sheikh Radwan 8	150	133	80	0.80
8.	Sheikh Radwan 9	190	133	90	0.9
9.	Sheikh Radwan 10	190	90	60	0.7
10.	Sheikh Radwan 11	190	110	80	0.6
11.	Sheikh Radwan 12	180	110	45	0.5
12.	Sheikh Radwan 13	180	460	200	0.99
13.	Sheikh Radwan 15	180	110	45	0.5
14.	Sheikh Radwan 16	180	110	45	0.5
15.	Sheikh Ejleen 1	150	810	110	1.7
16.	Sheikh Ejleen 2	120	440	80	1.7
17.	Saffa well 1	200	600	225	0.6
18.	Saffa well 2	150	400	125	1.4
19.	Saffa well 3	100	740	215	1.5
20.	Saffa well 4	180	590	110	1.9
21.	Sorany well 4	100	350	135	0.54
22.	Ramadan well 3	100	790	90	0.35
Total discharge per day			**60,000m^3**		

A COMPREHENSIVE ANALYSIS OF THE CITY WELLS CONDITIONS:

The total number of wells is comprised of three groups:

A. Sheikh Radwan wells
B. Sheikh Ejleen wells
C. Safa wells

Group A:

It could be subdivided into three subgroups as follows:

A.1) Radawan No 3& 4, which are, distanced about 1600 m from the sea. The salinity in these wells is presently above 1000 mg of chlorides per liter and it is rapidly increases at an average rate of about 170-mg per year. It is apparent that there is a significant encroachment of seawater into the aquifer and salinity most probably considerably increase in the next few years.

A.2) Radwan No 1-1A, which are distanced about 1700 m from the sea.

A.3) Radwan No8-9-10-11-12 are distanced about 2100-2500 m from the sea. Salinity in these wells is still within reasonable limits and they may continue to operate a considerable of years.

Group B:

Sheikh Ejleen No 1-2 are distanced some 1400-m from the sea. Their present salinity is close to 700mg CL/Lit.

Group C:

Safa wells are situated at a local hydrological depression in which the present round water level is about -1.5. There is a gradient of flow towards same depression from the south east direction the salinity of aquifer in the south and south east is rapidly increasing from about 500mg.cl/lit to a 100 mg and above.

Slow increases in salinity have been observed in these wells. The average salinity of the total four wells is presently about 518 mg.cl/lit, which is still tolerable.

CALCULATION OF THE PIPS AND BOOSTERS:

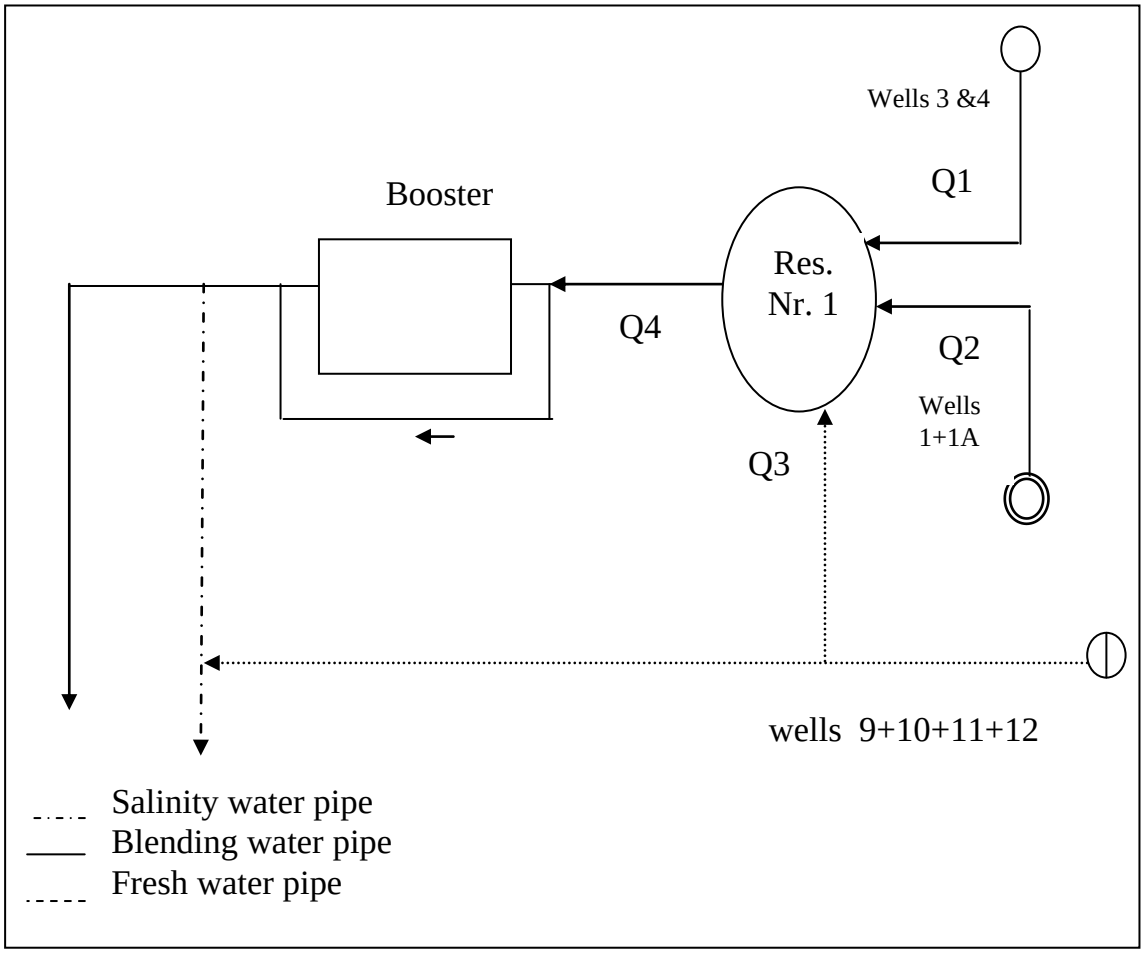
Group A:

Q1: Quantity of water from well No 3+4 =100 m^3/hr
S1: Salinity of water from well 3+4=1000mg.cl/L
Q2: Quantity of water from well No 1+1A=100m^3/hr
S2: Salinity of water from well No 1+1A = 250mg.cl/L
Q3: Quantity of water from well No 9+10+11+12 = 300m^3/hr
S3: Salinity of water from well No9+10+11+12= 100 mg.cl/L
Q4: Quantity of outlet water from reservoir = 350m^3/hr
S4 : Salinity of water after blending = 370 mg.cl /L

Q (Total) = Q1+Q2+Q3
= 100+100+300
Qt = 500m^3/hr

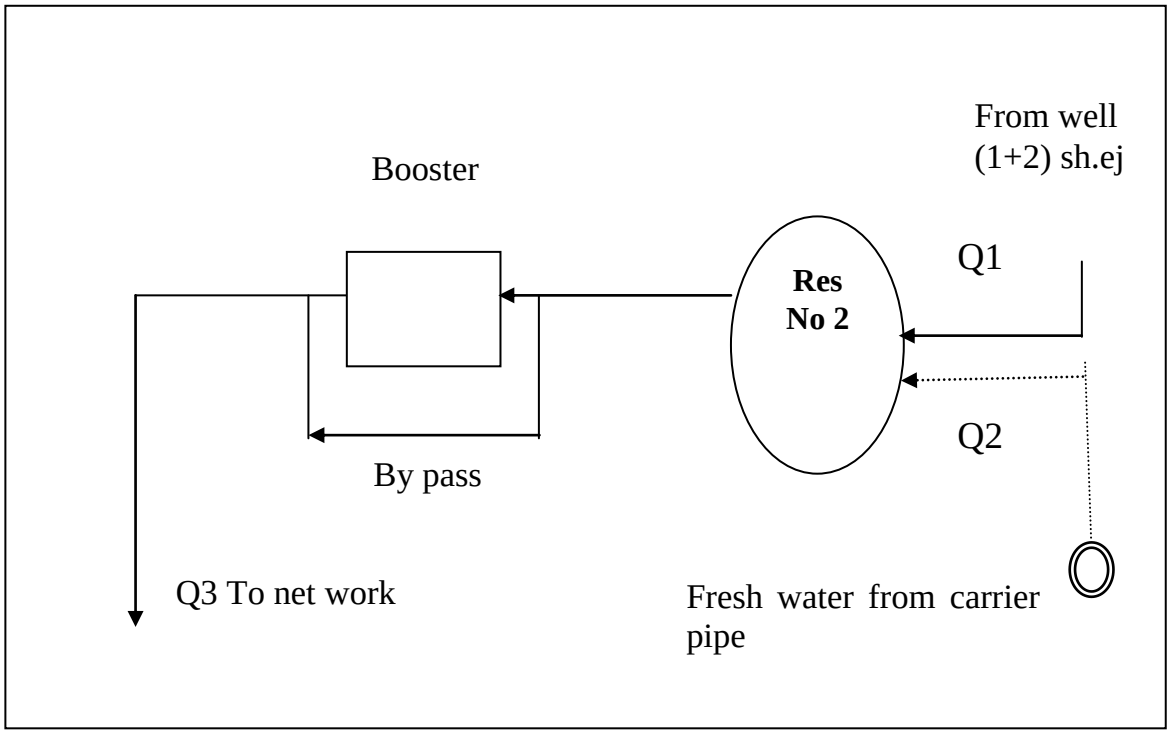
THE PROPOSED PLAN OF BLENDING SYSTEM:

Group A:
Blending of water in reservoir No 1:



Q (booster) = 350m^3/hr (assumed)
A= Qp/V = 350/3600 ×1/1.5= 0.264 m^2
0.064= D^2/4
D^2= 0.082 m^2
D= 0.287m
Choose = 12 pipe
From chrat the
H = 90H
H = 50m
Q = 350m^3/hr
HP = Q.H/y × 270
= 350×50/0.70×270
HP = 90

Group B:
Blending reservoir No2 (Sheikh Ejleen area)



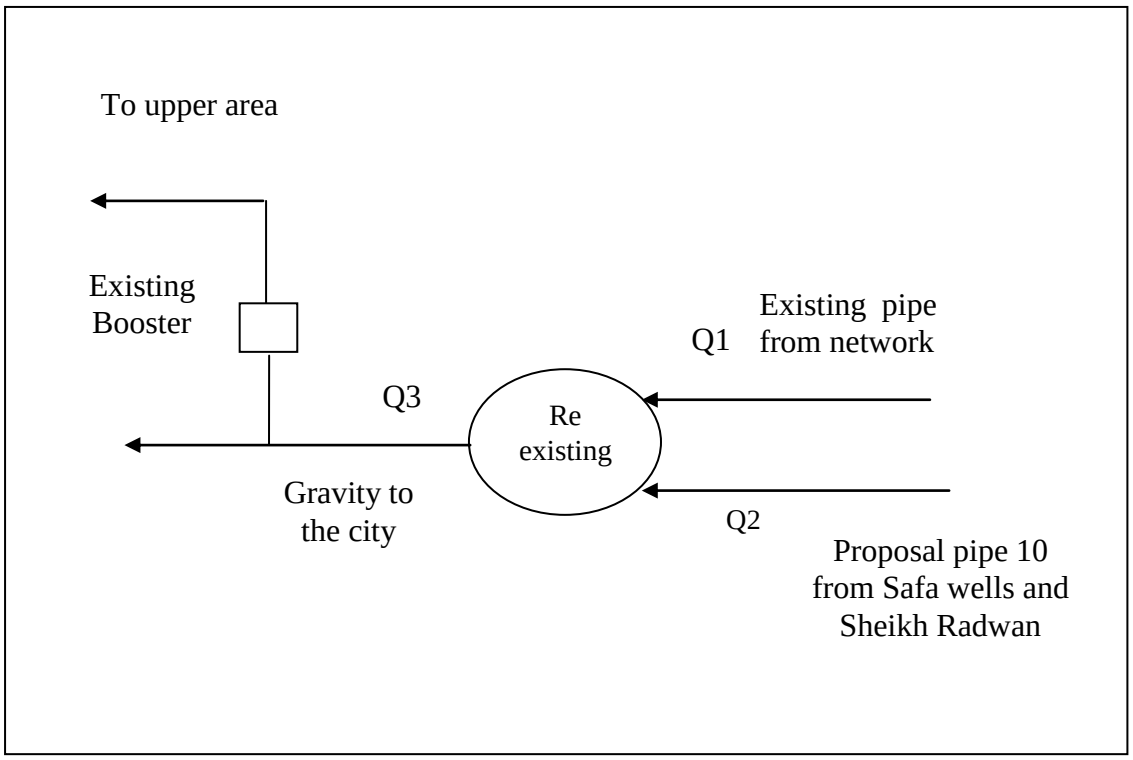
$Q1=100 m^3/hr$
$Q2=150 m^3/hr$
$Q3=200\ m^3\ /hr$
S1= 800mg.cl/L
S2= 100 mg.cl/L
S3=350mg.cl/L (After blending)

Booster station No. 2:
Q (booster)= 250 m3/h
Assume velocity in pipe = 1.5m/s
A= Q/V
$= 250 /3600 \times 1/1.5 = 0.046 m^2$

$0.046= D^2/4$
$D^2=0.58 m^2$
D= 0.24m
Choose 10 pipe

Group C:

Reservoir No 3 (Montar area)



Q1= 50 m 3/hr
Q2= 150m3/hr (safa wells+ sheikh Radwan wells)
Q3 = 150 m3 / hr (brachish + Fresh)
Sl= 600 mg.cl /L
S2= 100 mg.cl/L
S3 (out) = 350 mg.cl/L

WATER BALANCE:

	Source	*Discharge cu.m./hr*	*Salinity mg.cl./L*
Group A	Radwan 3+4 Radwan 1+1A Carrier pipe (9+10+11+12) Booster (after blending)	100 100 300 350	1000 250 100 370

	Source	*Discharge cu.m./hr*	*Salinity mg.cl./L*
Group B	Sheikh Ejleen 1+2 Carrier pipe Booster (after blending)	100 200 200	600 100 350

	Source	*Discharge cu.m./hr*	*Salinity mg.cl./L*
Group C	Saffa wells Carrier pipe After blending	200 200 300	600 100 350

COST ESTIMATION

Group A:

Item	Cost in thousand $ US
Reservoir capacity 500 m3	500
Brackish water collection from well 3+4	30
Brackish water collection from well 1+1A	30
Booster station	120
Carrier pipe and connections	250
	880

Group B:

Item	Cost in thousand $ US
Reservoir capacity 500 m3	500
Brackish water collection from well 1+2	30
Booster station	120
Carrier pipe and connections	250
	850

Group C:

Item	Cost in thousand $ US
Carrier pipe and connections	200

Grand total	**1,930,000$**