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Tertiary Treated Waste water as a Promising Alternative for Potable Water for Non-Contact Domestic Use.

CaseStudy:RiqqaWastewaterTreatmentPlant

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Abstract
Watersecurityisavitalissueinaridcountrieslike Kuwait,wheredesalinatedwateristhe solesupplyoffresh water.Thispaper isacontributiontotheongoingefforts towardsrationalizationin potablewater consumption.In addition,itdiscusses therole of high-quality effluent water, from wastewater treatment plants in Kuwait, as a potential replacementfor potable water for non-contact domesticapplications as a oneway in savingin thisvaluablecommodity.

Key words – Desalination plants, wastewater treatment, potable water, non-contact, effluent, restricted irrigation,STP,tertiary.

I. Introduction

DesalinationPlantsarethemainsourceofsafefresh waterinmodernKuwait.Thefive existingdesalinationUnitsaredistributedgeographicallyintheCountrytosatisfyresidents Andbusinessesneedsofpotablewaterconvenientlyand comparativelyatextremelylow cost.

In June,2006, Kuwait experienced a severe drop in fresh water supply due to over consumption.Theannualfreshwaterconsumptionexceeded335millionimperialgallons Whereastheoverallcapacityofdistillationunitsisonly330millionimperialgallons, which forces authorities to compensate for this water supply shortages from the Strategic Reservoir.

This Reservoir, which contains more than 2.0 billion imperial gallons of fresh water, recordedunprecedenteddropin capacitytoreach1.6 billionimperialgallons

1.Thisincidentelevatedawarenessamongpublictotheimportanceofrationalizationinfresh waterconsumption.Inaddition,MinistryofEnergyhasinitiatedafullscalecampaigninearly2005inthisaspectthatyieldeda30milliongallonssavingsinfreshwateratthe end of2006.

2.Foratypicalhome,anywhere,freshwaterhasnoalternativeforinteriorusesuchasdrinking, cooking,andpersonalhygiene.However, ifaclean,safe,physicallyCompatible,andaboveallpsychologicallyacceptablereplacementtofreshwaterisintroduced for non-contact use, substantial amounts of fresh water can be saved and might add contributiontotheNationalwaterSecurityinKuwait.

Inthispaperthreemaintopicsarelaidfordiscussion; themagnitudeofover-consumptionin potablewaterinKuwait, exploring gavenuesforsavinginwaterwithinhousehold,andreasons andjustificationsbehindproposingtertiarytreatedwastewaterasapossiblealternativefor Freshwaterin toiletreservoirswithemphasisonRiqqaWastewaterTreatmentPlant.

A.Over-consumptionoffreshwaterin interiorhousehold

Becauseofthescarcityofriversorfreshwaterwells,State ofKuwaithasbecome entirelydependentondesalinatedwatertosatisfypopulationneedsforfreshwater.

Thereis anannualincreaseinconsumptionoffreshwaterby5%-6%.

Thiscanbereferredtothelowcostoffreshwater,theabsenceofstringentlawsthatcontrolAndgoverntheconsumptionoffreshwaterinadditiontoannualincreasein population.

Officialrecordsshowsthatannualoverallcapacityofthe existingdesalinationplantsinKuwait isaround330millionimperialgallons,whereas,therecordedfreshwater consumptionfor January,2005,andJanuary,2006was239 and263 millionimperialgallons,respectively.

Andalthoughtheincreaseinwaterconsumptionhasbeen estimatedtobe6%inMarch2006, theactualconsumptionexceededthisestimationtoreach 14%.

Basedonstatisticsabove,innovativemeanstosaveinthis valuablecommodityhastobeCreatedtowardsachievinguninterruptedfreshwatersupply andconsequentlywatersecurity.

B.AvenuesforsavinginFreshWater
Waterusedbyresidentialhouseholdsconsistsofwaterfo rinteriorusesuchasshowersand toiletsandwaterforexteriorusesuchaslawnwateringan dcarwashing.
All the above mentioned applications uses water for contact use (i.e. drinking, cooking,bathing…etc)exceptfortoilets,lawn watering,andcarwashing,however, thelateraremoreor lessrelativelyclosetobeing incontactusecategorysincewaterhastotouchhumanski nwhile carryingoutsuchactivities.
Eventually,toiletreservoirsareanon-contactitems,consumeaboutonethirdoftheresidential shareof potablewaterasshownin table1.

Table1
Typicaldistributionofresidentialinterioruse3

Use	% of Total
Baths	8.9
Dishwashers	3.1
Faucets	11.7
Showers	21.2
Toilets	28.4
Toilet Leakage	5.5
Washing Machines	21.2
	100

Oneoftheideasthatmightcontributeinsavinginfreshwa tersupplywithinhomevicinityisby Startingusingtertiarytreatedwaterin toiletreservoirs insteadof potablewater.

Records of RiqqaWastewater Treatment Plant show that the average daily incoming wastewaterwas129,000m3 (34millionU.Sgallon),(2006) thereforebycalculatingindividual consumption(share)offreshwater,withinthePlant'scat chments,eachpersongetsnoless than of68.0 gallonsperday.

Table2
Typicaldistributionofresidentialinteriorwateruses

Use	Flow,gal/capita.d
Baths	6
Dishwashers	2
Faucets	8
Showers	15
Toilets	19
Toiletleakage	4
Washingmachines	14
Total	68

Basedonwaterdistributionillustratedintable2,atleast2 0.0gallonsoffreshwatercanbe saved daily,andhence11.0milliongallonssavedoffreshwater withinthecatchments,iffinaleffluentisusedinstead.
Thesameideacanbeappliedtotherestofcitiesin Kuwait providedthattheAlternativewater isofhighquality(i.e. physically,chemically, andbiologicallycompatibletopotablewaterand, aboveall,enjoys publicacceptance.
Extensivelaboratorytestshasbeendoneonfinaleffluent sofWastewaterTreatment Plantsin Kuwait,includingRiqqaWastewater TreatmentPlant,shows clearly thatthis tertiary water worthreconsiderationassuccessfulalternative.
RiqqaPlanthasdemonstratedremarkable treatment fficiencyintermsofhighqualityeffluentAnditisselecte dtosupporttheconceptofthisresearch.

C. RiqqaWastewaterTreatmentPlant
RiqqaWastewaterTreatmentPlantisoneoffourgovern ment-ownedtreatmentPlants,Located 45kmsouthofKuwaitCity,thisfacilitywasestablishedi n1982inaccordancewiththeState's Policyofenvironmentprotectionand utilizationof reused waterforrestricted irrigationand landscaping.

Adaptingsingle–stagenitrification,extendedaeration, activatedsludgemethod, andservinga populationof500,000,thePlant currentlyreceivesanaveragedailyinflowof129,000m3 ofdomesticwastewater(2006).
ThePlantliesonanareaof70,000m2 andcomprisesofthreemainstages,preliminary, secondary, andtertiary, Fig.1.
Thefinaleffluentismeanttobeusedeventuallyforirrigat ionand landscapingpurposes.

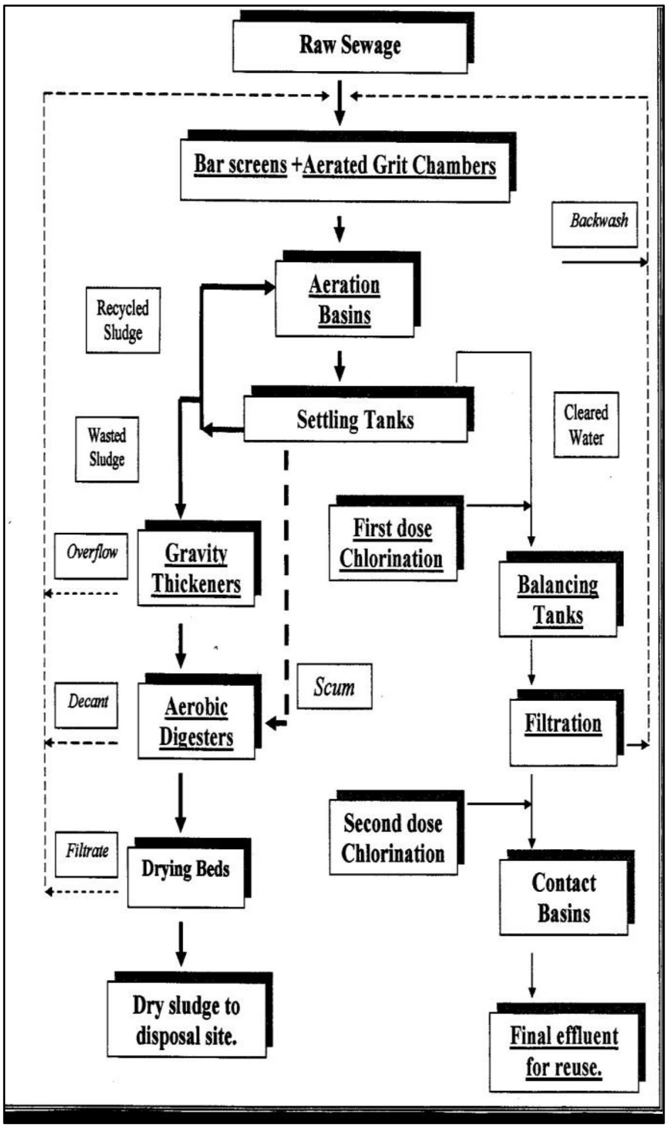

Fig.1.ProcessChartforRiqqaWastewaterTreatmentPlant

ThehigherpercentageofthePlant'seffluentispumpedtoDataMonitoringCentrewhere animalfeedfarmsareirrigated.Almost12 %is pumpedtoheadertanks for landscaping irrigation,andabout2 %isusedforin-houseirrigation(2006),Fig.2.

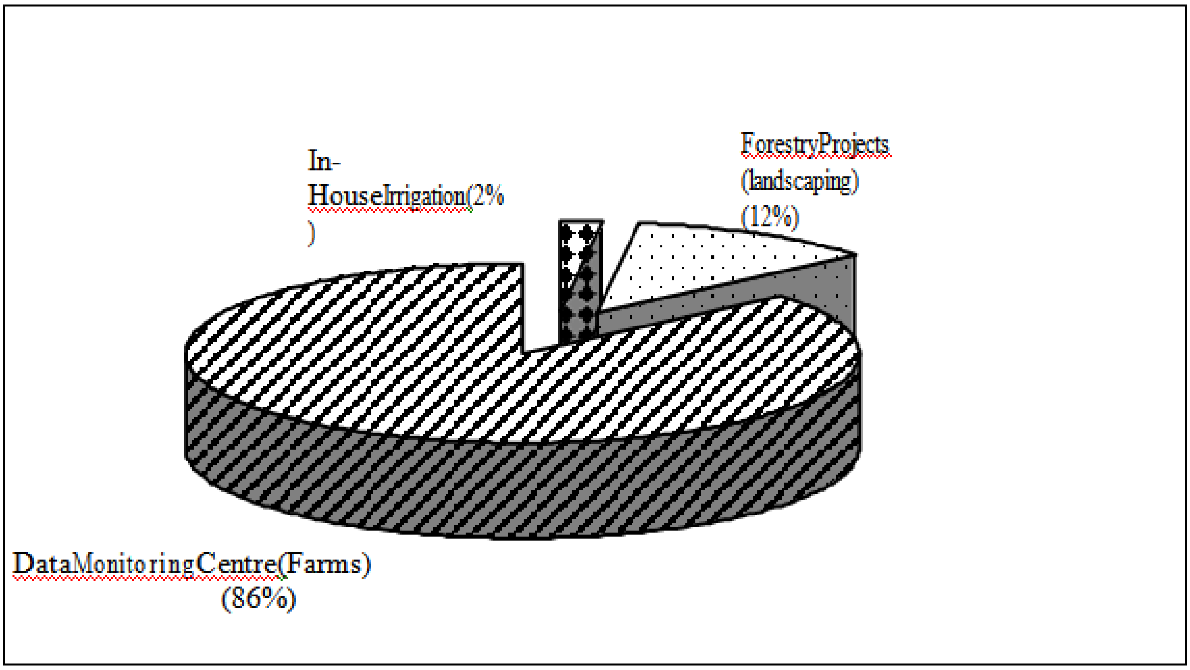

Fig.2.DistributionofEffluentWater

II. TertiarytreatedEffluent:Chemical,Physical,andMicrobialCharacteristics

InThis sectionoftheresearch,whichrepresentsthecoreofthispaper,resultsofthetests that havebeenperformedonthefinaleffluentwerecompared tothosesetbyhighly recognized environmentalagenciesfordrinkingwaterstandards.

TheU.S.EnvironmentalProtectionAgencyhasbeenselectedinthisresearchasaninternational referenceforwaterandwastewatercriteria. TestsperformedonPlant'seffluentsfollowtheproceduresoutlinedin"StandardMethodsfor TheExaminationofWaterandWasteWater".4,asasolereference.

Finaleffluentlabresults areillustratedin table3.

Table3
TestResultsforFinalEffluent

Test	Units	RiqqaWWTP, Kuwait	EPA DrinkingWaterRegulations[5] MaximumContaminantLevel
Chemical			
BOD5	mg/l	4.2	N/A
COD	mg/l	8.0	N/A
Residual FreeCl2	mg/l	.5-1.0	N/A
NH3	mg/l	.03	N/A
Nitrate	mg/l	<7.5	10
Nitrite	mg/l	<0.265	1.0
Chloride	mg/l	5.0	250
Sulfate	mg/l	175	250
Physical			
Turbidity	NTU	7.2	.5-5.0
pH	-	7.33	6.5-8.5
TDS	mg/l	<800	550
Alkalinity (HCO_3^-)	mg/l	<54	N/A
Hardness	mg/l	< 118[a]	N/A
Salinity	mg/l	0.90[b]	N/A
Microbial			
Totalcoliform	CFU/100ml	99.99% Reduction	
Coliform	CFU/100ml	99.99% Reduction	Nomorethan5% positiveandall
Fecal-Coliform	CFU/100ml	99.99% Reduction	positivesmustbe testedfor presenceof
Fecal-Str.cocci	CFU/100ml	99.99% Reduction	FecalcoliformsorE.-coli
Salmonella	CFU/100ml	99.99% Reduction	

A.sometextbooksdefinehardwaterasawaterwithhardness>100mg/lasCaCO3
b. Salinityoftabwateris0.30mg/l

Micro-organismreductioninthefinaleffluentcanbebestviewedgraphically. Figs.(3)And(4)illustratethemicrobialstateinthefinaleffluentforTotalColiform,Fecal Coliform,andSalmonella,respectively.

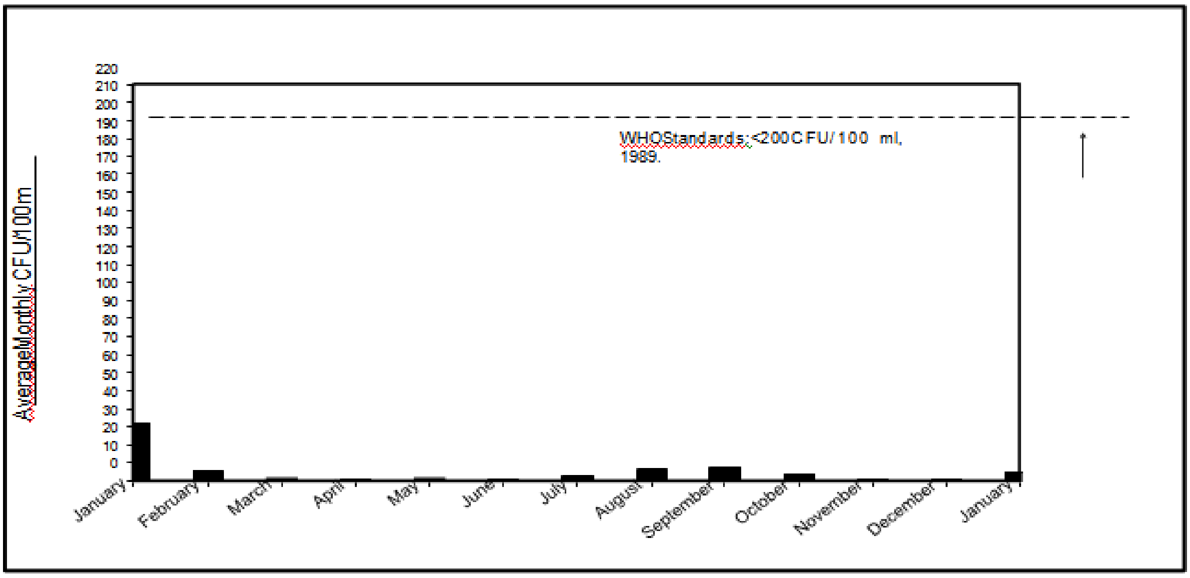

Fig.3.FecalColiformintheFinalEffluent(2006)

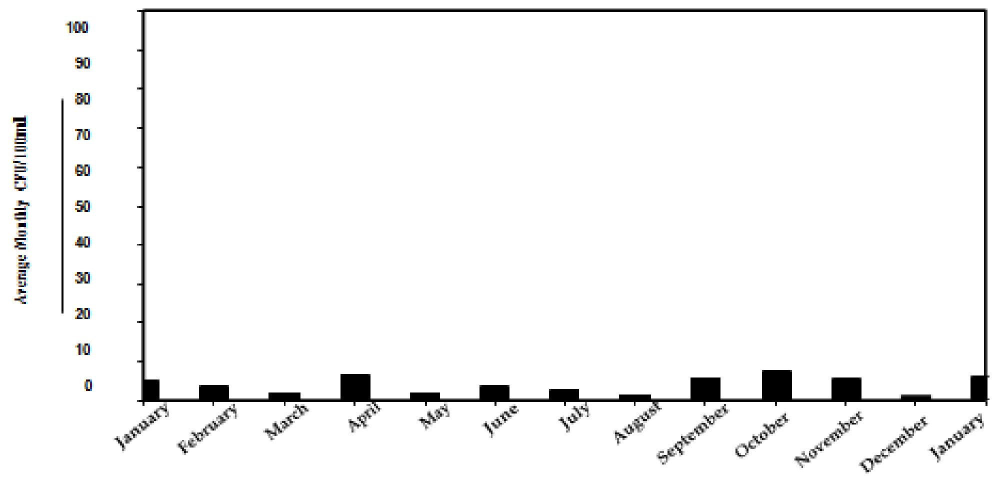

Fig.4. SalmonellaintheFinalEffluent(2006

III. Discussion

IncomparingPlant'sfinaleffluentlabresultswiththoseofdrinkingwaterstandards,the comparisonseems-in myopinion-highly unfair,simplybecause this effluentis deemed Wasteddownin thetoilets,andshallnotbeusedeveninyardwashing Andhence,compatibilitytodrinkingwaterorevenclean watercriteriamustnotberaised. Nevertheless, ifthissubjectislookedatfromtheeyesofthepublicwhohas reasonable doubts aboutreusedwastewater,this argumentwilltakedifferentperspective.

Itisnecessary, ifafull-scalewastewaterreuseplanisconsidered,toexplaintothepublic thefollowingfacts:

1. Effluentfromwastewatertreatmentplantsiscleanand safe.
2. Usingfinaleffluentwillsaveinfreshwater
3.Usingfinaleffluentinhomes isrestrictedontoiletreservoirs andwillbeina totallyisolatedmanner.

Itisveryimportanttobreakdownthepsychologicalbarrier betweenconsumerand Treatedwaterbymakingfactsaboutthiswatermoreaccessibleandeasytounderstand, perhapsfinaleffluentswillfindmoreapplicationsinside ourhomesin thefuture.

IV. Conclusion

Labresultsofthefinaleffluent,table3,indicateclearlythatfinaleffluentcanbeutilized inapplicationsotherthanlandscaping.ComparedtoU.S. EPA,resultsoffinaleffluentis Relativelyclosetodrinkingwaterstandards.However,somephysicalparametersoffinal Effluentliketurbidity,andTDSareslightlyhigherthanEPAstandards.

Microbiologicalcultivation tests show a remarkablerecord in reduction (99.90%) of Coliform colonies in the final effluentwhich is consistentwith EPA regulations for drinkingwaterforE-coli,Legionella,andSalmonella,respectively.

Therefore,asanalternativeforpotablewaterfornon-contactand/ortoiletreservoir, finaleffluentdeservesreconsideration.

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