Introduction

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Types of water

- * Rain water
- * Storm water
- * River water/ Lake water
- * Groundwater
- Ocean water
- * Industrial water
- * Drinking water
- * Agricultural water
- Irrigation water
- Brown water
- * Yellow water
- Grey water
- * Sewage etc.

HOW DO THEY APPEAR? Blue water = seems as if good quality water

HOW DO THEY APPEAR? Green water = seems as if nutrient-enriched water

HOW DO THEY APPEAR Brown water comes from swamps & force

Water pollution from poor land use practices



Algal bloom – sign of eutrophication

Choosing Water resources – Starting point of WQ interventions

- * Water Quality How good is it?
- * Affordability What does it cost?
- * Adequacy Can it supply enough water?
- * Reliability How long will it last?
- * Convenience How far away is it from homesteads?

TYPES OF DRINKING WATER STANDARDS

* PRIMARY

- * health related
- * enforced

TYPES OF DRINKING WATER STANDARDS

- * SECONDARY
 - non-health related contaminants that affect flavor, odor, color
 - * iron
 - manganese
 - sulfate
 - hydrogen sulfide
 - * chloride
 - recommended but not enforced

Abundance of Dissolved Constituents in Surface and Ground Water

Major Constituents (> 5 mg/L)

(~) !!!

- * Ca
- * Mg
- * Na
- * Cl
- * Si
- SO₄²⁻ sulfate
- * H_2CO_3 carbonic acid
- HCO₃⁻ bicarbonate

Abundance of Dissolved Constituents in Surface and Ground Water

* Minor Constituents

- * (0.01-10 mg/L)
- * B
- * K
- * F
- * Sr
- * Fe
- * CO32-- carbonate
- * NO3- nitrate

Abundance of Dissolved Constituents in Surface and Ground Water

* Trace Constituents

- * (< 0.1 mg/l)
- * Al
- * As
- * Ba
- * Br
- * Cd
- * Co
- * Cu

- *
- * Pb
- * Mn
- * Ni
- * Se
- * Ag
- * Zn
- * others

Drinking Water Standards

- * Pollutants/Contaminants Regulated
 - Microorganisms, Disinfectants & Disinfectant
 Byproducts, Inorganic Chemicals, Organic Chemicals,
 Radionuclides
- * Lists available at:
 - http://www.epa.gov/safewater/contaminants/index.htm

KINDS OF HEALTH RELATED STANDARDS

- Maximum Contamination Levels Goals (MCLG's)
 - * Level at which there are no known or anticipated adverse health effects.
 - * non-enforceable
 - * set at 0 for known carcinogens

KINDS OF HEALTH RELATED STANDARDS

- Maximum Contamination Level (MCL's)
 - set as close to the MCLG as is technically and economically feasible
 - * enforceable

KINDS OF HEALTH RELATED STANDARDS

- * Non-regulatory Health Advisory (HA's)
 - Informal technical guidance regarding concentrations of drinking water contaminants at which adverse health effects would not be anticipated to occur
- non-regulatory purposes
 - * guidance to state and local officials when emergency conditions occur

Drinking Water Health Advisories (HA)

* Lifetime HA: The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects over a lifetime of exposure, with a margin of safety.

Dose-Response Curves



Drinking Water Standards (EPA, May 1995)

A. Chemical	
1. Maximum Contaminant Level (mg/ I	L)
lead	.015
mercury	.002
nitrate (as N)	10.0
nitrite (as N)	1.0
alachlor (lasso)	0.002
aldicarb	0.007
atrazine	0.003
carbofuran (Furadan)	0.04

Drinking Water Standards (EPA, May 1995)

2. Secondary Maximum Contaminant Level (mg/ L) chloride copper iron pH sulfate total dissolved solids (TDS)

250 1 0.3 6.5 to 8.5 250 500

Drinking Water Standards (EPA, May 1995)

B. Physical color

odor

C. Bacteriological coliform bacteria

15 color units 3 odor units

none

Water Quality Problem

The MCL for atrazine is 0.003 mg/L. How much atrazine at this concentration would be in the water in a pond which has a surface area of 5 acres and an average depth of 8 feet?

					TASFİYE TESİSİ ORTALAMA KALİTE DEĞERLERİ (GENEL CIKIŞ)			(IKIŞ)		
Parametre	TÜRK STANDARTLARI TS 266 2005	DÜNYA SAĞLIK TEŞKİLATI (WHO) 1993	ABD ÇEVRE KORUMA AJANSI (EPA) 2003	AVRUPA BIRLIĞİ (EC) 1998	B.çekmece	iktelli	Kağıthane	Ömerli (Emirti)	Ömerli(Mur Orthaniye)	Ömerli (Osmaniye)
Bulanıklık	1.0	5.0	1.0	1.0	0.2	0.3	0.2	0.2	0.2	0.1
BIRINCIL STANDARTLA	R (MIKROBIYO	OJIK) EMS	(100 ml	.,	U , E	6,6	v , -	0 ,2	-,-	
Koliform Bakteri	2 1	0	< 1	0	0	0	0	0	0	0
BIRINCIL STANDARTLA	R (Dezenfeksiv	on Yan ürün	eri). ua/l	0	v	v	v	v	v	v
Tealam Tribalamataalaa	100	460	00	100	20.6	0.6	0.4	0.5	7.0	0.4
Toplam Trinaiometaniar	100	460	80	100	30,6	9,6	8,4	8,5	7,8	8,4
Bromat	10	10	10	10		< 2	<2		< 2	<2
BIRINCIL STANDARTLA	AR (INORGANIK	KIMYASALI	.AR), mg/L							
Alüminyum	0,20	0,20	0,20	0,20	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05	< 0,05
Arsenik	0,01	0,01	0,01	0,01	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002
Baryum	-	0,7	2,0	-	0,05	0,02	0,02	0,03	0,02	0,02
Kadmiyum	0,005	0,003	0,005	0,005	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002
Krom (Toplam)	0,05	0,05	0,10	0,05	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Bromür	-	-	-	-	0,08	0,06	0,06	< 0,05	< 0,05	< 0,05
Florür	1,5	1,5	2,0	1,5	0,19	0,07	0,05	0,08	0,06	0,05
Siyanür	0,05	0,07	0,20	0,05	< 0,02	< 0,02	< 0,02	0,02	< 0,02	< 0,02
Kurşun	0,010	0,010	0,015	0,010	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01
Civa	0,001	0,001	0,002	0,001	0,000	0,000	0,000	0,000	0,000	0,000
Nitrat (NO ₃ ⁻)	50	50	45	50	1,00	0,58	0,64	4,46	2,30	2,31
Selenyum	0,01	0,01	0,05	0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01
Gümüş	-	0,10	0,10	-	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Antimon	0,005	0,020	0,006	0,005	< 0,005	< 0,005	< 0,005	< 0,005	< 0,005	< 0,005
Berilyum	-	-	0,004	-	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002
IKINCIL STANDARTLAR	(ESTETİK), mg	/L								
Klorür	250	250	250	250	76	31	30	43	25	25
Renk (birim)	20	15	15	-	2.5	2.5	2.5	2.5	2.5	2.5
Bakır	2.0	2.0	1.0	2.0	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Demir	0.2	0.3	0.3	0.2	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Mangan	0.05	0.1	0.05	0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Koku Yanan Geosmin	-	-	-	-	11	1.8	0.7	13	2.2	8.0
Maddeler ng/L MIR	-	-			52	0.4	< 0.5	21	0.8	1.4
PH	65.95	65-80	65.85	65.95	7.5	7.3	7.0	7.4	7.3	7.3
Sülfat	250	500	250	250	92.9	38.0	45.1	12.3	35.4	39.3
Toolam Cözünmüs	200	000	200	2.50	92,9	50,0	10,1	12,9	55,4	33,3
Madda		1000	500		372	210	220	241	202	208
Cinko	-	3.0	50	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	<01
	2 ma/l	0,0	0,0	-	S 0,1	S 0,1	- 0,1	< 0,1	< 0,1	× 0,1
ILAVE PARAMETRELE	K,mg/∟	000			10.0		10.0	50.1	00.5	10.1
Kaisiyum	-	300	-	-	46,9	44,1	43,8	59,1	39,5	40,1
Sertlik (CaCO ₃ olarak)	-	500	-	-	180	134	146	192	137	140
Magnezyum	-	-	-	-	15,6	4,2	4,9	5,6	6,6	6,3
Potasyum	-	-	-	-	4,67	1,86	2,02	1,56	2,35	2,36
Sodyum	200	200	-	200	47,2	14,7	15,5	8,5	13,3	13,5
Serbest Klor	-	5,0	4,0	-	1,5	1,6	1,4	1,6	1,5	1,7
Amonyum	0,5	1,5	-	0,5	< 0,03	< 0,03	< 0,03	< 0,03	< 0,03	< 0,03

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Water Classification

* How?

- * Compare ions with ions using chemical equivalence
- Making sure anions and cations balance
- * Use of diagrams and models
- * Why?
 - * Helps define origin of the water
 - Indicates residence time in the aquifer
 - Aids in defining the hydrogeology
 - Defines suitability

What is Chemical Equivalence?

* Chemical analysis of groundwater samples

- Concentrations of ions are reported by
 - * weight (mg/L)
 - * chemical equivalence (meq/L)
- * Takes into account ionic charge
- * Equivalent Concentration

Equivalent Concentration =

Concentration

 $\left(\frac{Formula Weight}{Charge}\right)$

Ion Balance

- * If all ions are correctly determined by a lab
 - * sum of cations should equal sum of anions (all in meq/L)
- * Errors in analysis and chemical reactions in samples
 - * 5% difference is considered acceptable
 - * > 5%, question the lab results

Calculating Equivalence

Parameter	Sandstone Aquifer		
	mg/L	Meq/L	
Na ⁺	19	0.827	
Cl-	13	0.367	
SO ₄ ²⁻	7	0.146	
Ca ²⁺	88	4,391	
Mg^{2+}	7.3	0.6	
HCO ₃ -	320	5.245	
Total Anions		5.758	
Total Cations		5.818	
% Difference		1%	

Equivalent Concentration =

For instance:

The atomic wt. of Sodium (valence of one) = 22.989

And its charge is one

Dividing the concentration of sodium in the sample (19 mg/L) by its "combining wt." = 0.827 meq/L or its equivalent concentration.

 $\frac{19}{\frac{Formula Weight}{Charge}} = \frac{19}{\left(\frac{22.989}{1}\right)}$ = 0.827

Aquatic Freshwater Protection Criteria (USA EPA Guidelines)

Criteria	Recommended Standard
рН	6.5-9.5
Alkalinity	20 mg/L or more
Dissolved Oxygen	30 day average 5.5 mg/L (warm water fish)
Suspended Solids	Should not reduce Photosynthesis by more than 10% in the water

Drinking Water Criteria (USA EPA Guidelines)

Criteria	Recommended Standard	Reason	
Coliform Bacteria	0 colonies/ml	Health	
рН	6.5-8.5	Aesthetic	
Barium	2 mg/L	Health	
Nitrate	10 mg/L	Health	
Total Dissolved Solids	500 mg/L	Taste	

Secondary - Drinking water standards (EPA)

Contaminant	Secondary Standard
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	noncorrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
рН	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 ma/l