

Reuse possibilities in view of the existing legislation in Greece

A. Andreadakis, D. Mamais, C. Noutsopoulos, S. Malamis



**Sanitary Engineering Laboratory,
National Technical University of Athens**



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- ❖ Wastewater reuse is not very widespread in the EU and it is characteristic that there is a lack of a unifying specific relevant Directive. This may be due to the variable interest among member states regarding reuse possibilities, probably as a result of diverse environmental conditions and available water resources.
- ❖ It is in the Mediterranean region that reuse is considered more important, is more widely practiced and is usually regulated by national or local/regional legislation. In Israel and in Cyprus more than 80% of the produced effluents are reused, but of course one should recognize the acute water shortage in both countries. In other Mediterranean countries, such as Italy and France, the percentages are much lower. In Spain it stands at 10%, with anticipated possibilities to reach 30%.

At a country level in Greece the Water Exploitation Index (WEI) is below 20, so that the situation does not appear to be critical. However, (regionally (Thessaly, Aegean Islands, Crete) WEIs can be much higher (e.g. 40)

Taking into consideration the conditions prevailing (distribution of rainfall, distribution of demands, allocation of effluent producing plants, alternative sources for industrial demands) it has been estimated that that the potential for reuse does not exceed 8-10% of the totally produced effluents.

However currently reuse is practiced to not more than the level of 1% mostly (about 85%) for irrigation. To a significant extend this may be attributed to the until recently lack of a relevant to reuse national legislation, a weakness remedied by the 2011 KYA 145116 decree

Purpose and Scope

	Urban wastewater	Conventional Industries	Non Conventional Industries
Restricted Irrigation	✓	✓	✓
Unrestricted Irrigation	✓	✓	Not allowed
Industrial Reuse	✓	✓	✓
Groundwater Recharge	✓	✓	✓
Protected Groundwater Recharge	✓	✓	Not allowed
Urban Reuse	✓	✓	Not allowed
Amenity/Recreational	✓	✓	Not allowed

Not applicable to

❖ **Industrial recycle**

❖ **In house recycle**

❖ **Direct potable reuse**

❖ **Swimming Pools**

Parametric values and Treatment requirements

	Restricted Irrigation	Unrestricted Irrigation	Groundwater recharge	Protected Groundwater	Urban, amenity/recreation	
Sewage and conventional industrial wastewaters	Coliforms Agronomic Metals **	Coliforms Agronomic Metals ***	Coliforms Metals **/**	Coliforms Metals ****	Coliforms Metals ****	
Sewage from WWTPs serving more than 100,000 p.e	Coliforms Agronomic Metals Micropollutants **	Coliforms Agronomic Metals Micropollutants ***	Coliforms Metals Micropollutants **/**	Coliforms Metals Micropollutants ****	Coliforms Metals Micropollutants ****	
Other industrial wastewaters	Coliforms Agronomic Metals Micropollutants **	Not allowed		Coliforms Agronomic Metals Micropollutants **/**	Not allowed Not allowed	

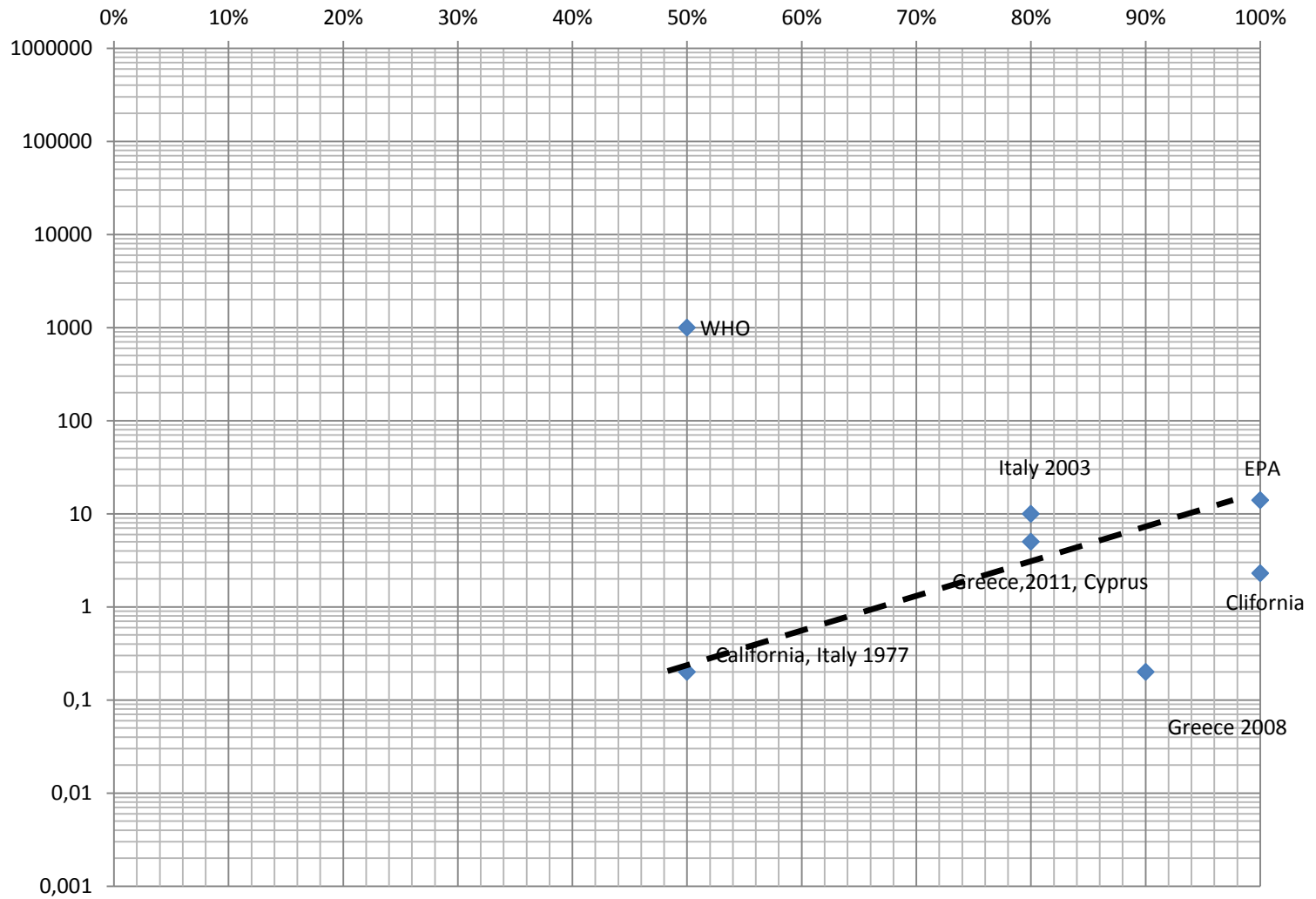
<i>Possible problem during irrigation</i>	<i>Units</i>	<i>Restrictions</i>		
		<i>Negligible</i>	<i>Small-moderate</i>	<i>Substantial</i>
Salinityα				
ECw	dS/m	< 0.7	0.7 - 3.0	> 3.0
TDS	mg/l	< 450	450 - 2000	> 2000
Permeability				
SAR = 0 - 3 καΙ ECw		> 0.7	0.7 - 0.2	< 0.2
3 - 6		> 1.2	1.2 - 0.3	< 0.3
6 -12		> 1.9	1.9 - 0.5	< 0.5
12-20		> 2.9	2.9 - 1.3	< 1.3
20-40		> 5.0	5.0 - 2.9	< 2.9
Ion toxicity				
<i>Sodium (Na)</i>				
Surface irrigation	SAR	<3	3-9	>9
Sprinklers	mg/l	<70	>70	
<i>Chlorides (Cl)</i>				
Surface irrigation	mg/l	< 140	< 140	< 140
Sprinklers	mg/l	140 - 350	140 - 350	140 - 350
<i>Boron (B)</i>				
		> 350	> 350	> 350
Other impacts				
Nitrogen (NO3-N)	mg/l	< 5	< 5	< 5
HCO3	mg/l	5 - 30	5 - 30	5 - 30
pH		Typical range 6.5 – 8.0		
Residual Cl	mg/l	<1	1-5	>5

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Metal	Max. Concentration (mg/l)	Metal	Max. Concentration (mg/l)
Al	5	Mn	0.2
As	0.1	Mo	0.01
Be	0.1	Ni	0.2
Cd	0.01	Pb	0.1
Co	0.05	Se	0.02
Cr	0.1	V	0.1
Cu	0.2	Zn	2.0
F	1.0	Hg	0.002
Fe	3.0	B	2
Li	2.5		

- ✓ Whenever **microorganics** become an issue some 40 parametric values are set

Regulation	TC/100ml	FC/100ml	EC/100 ml	% samples	Proposed Treatment
WHO		200-1000		50	Oxidation ditches
California	2,2/23			50/max	Secondary +Filtration
Italy-1977	2			50	
Italy-2003			10 (50-100)	80	
EPA		14		max	
Cyprus		5-50		80	Secondary +Filtration
Greece (2008)	2			90	Secondary +Filtration
Greece – restricted (2011)		200		50	Secondary
Greece – unrestricted (2011)		5 (50)		80 (95)	Secondary +Filtration
Greece –recharge of protected groundwaters (2011)	2 (20)			80 (95)	Secondary +Membranes



assuming that 1 FC/100 ml=1EC/100 ml and 1FC/100 ml =10 TC/100 ml

Typical characteristics of secondary effluents in Greece (before disinfection)-*SEL survey from 20 major WWTPs*

BOD 10-25 mg/l

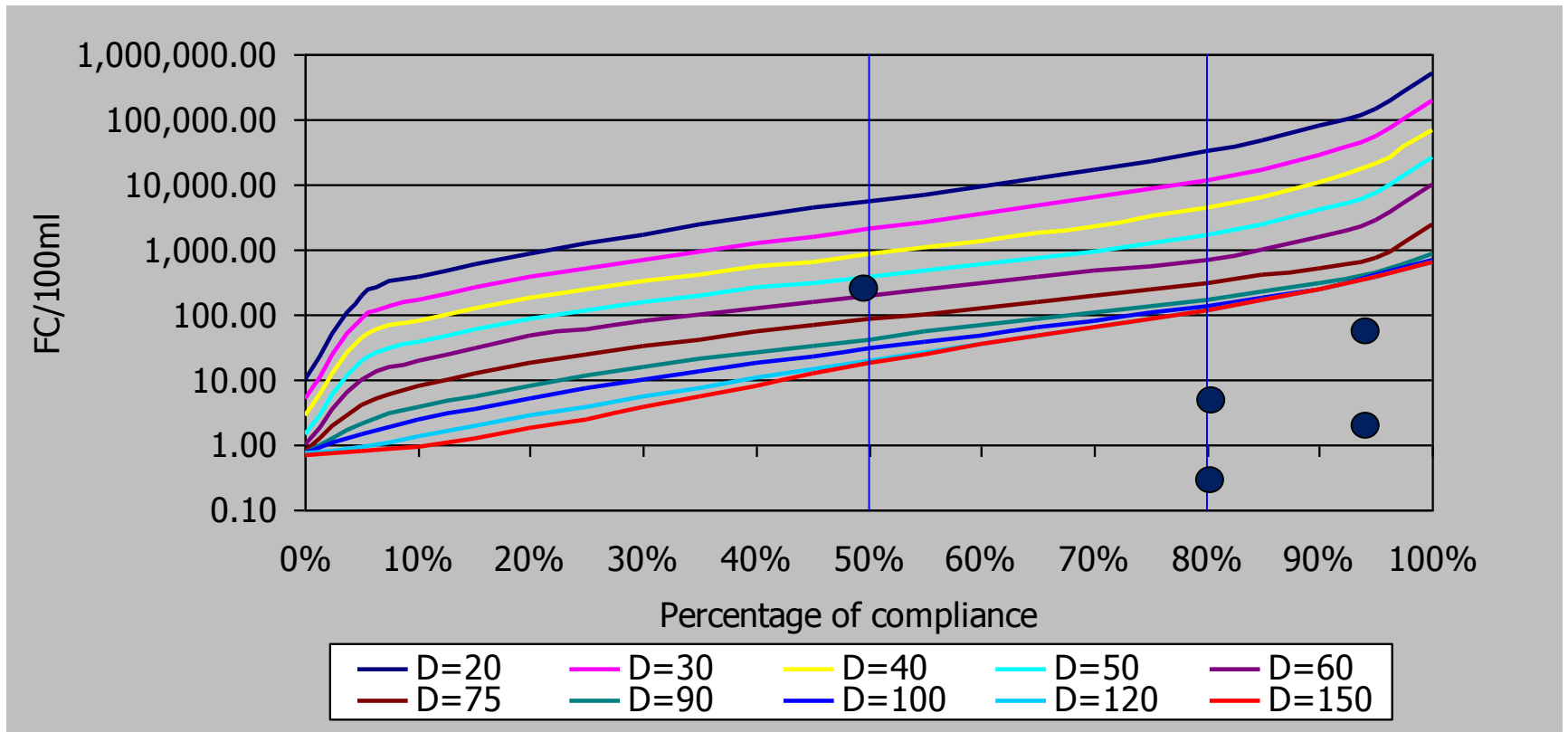
SS=10-35 mg/l

Turbidity 2-10 NTU

Transparency <70%

FC 10^5 - 10^6 per 100ml

UV dose after secondary treatment vs remaining FC



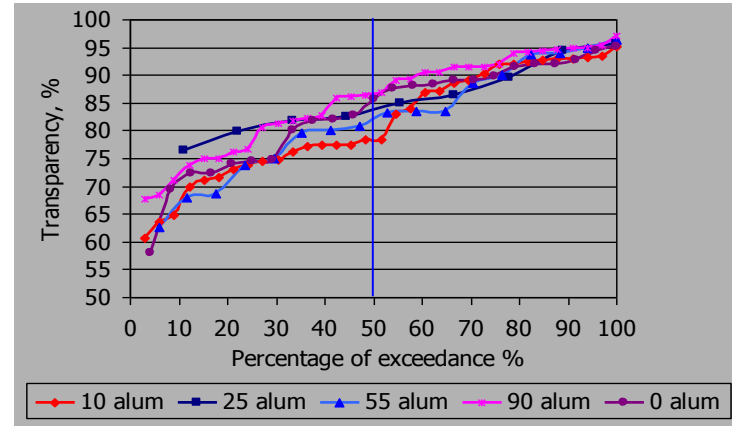
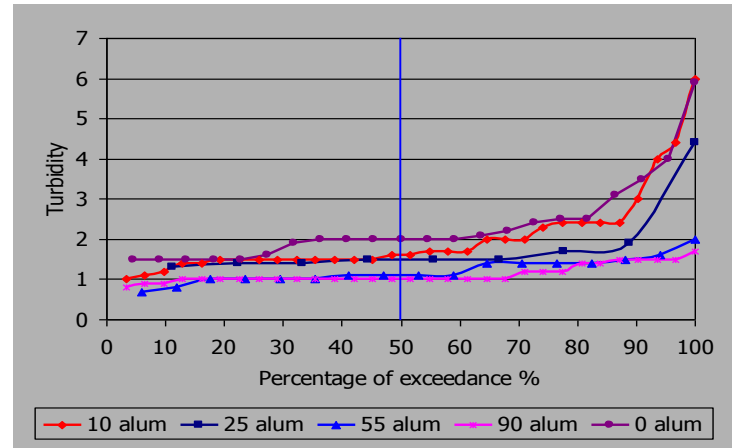
Preliminary requirements before final disinfection for unrestricted reuse

Additional to secondary treatment aiming at

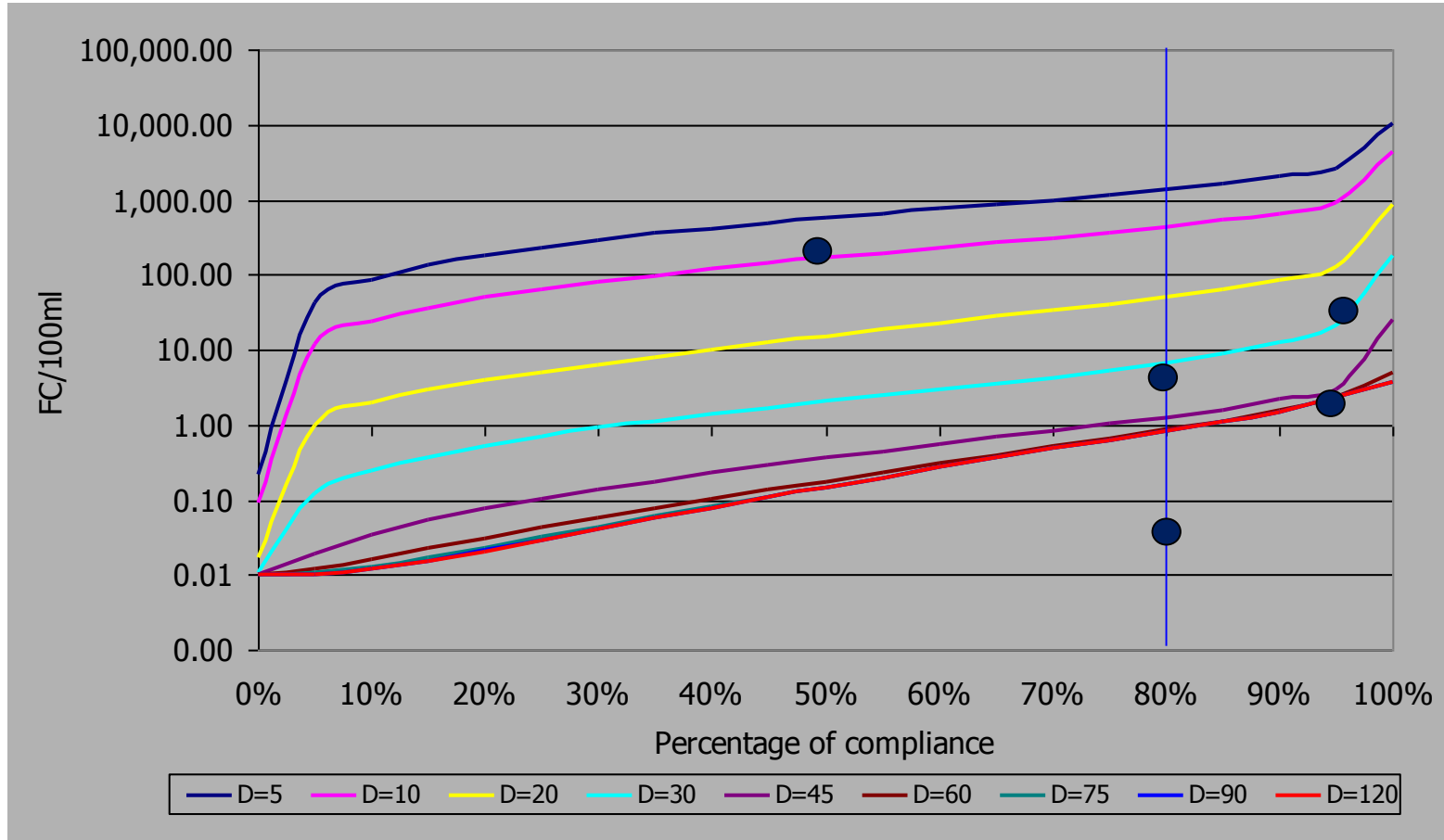
BOD, TSS ≤ 10 mg/l
Turbidity ~ 2 NTU
Transparency $\sim 70\%$ or higher

Sand Filtration

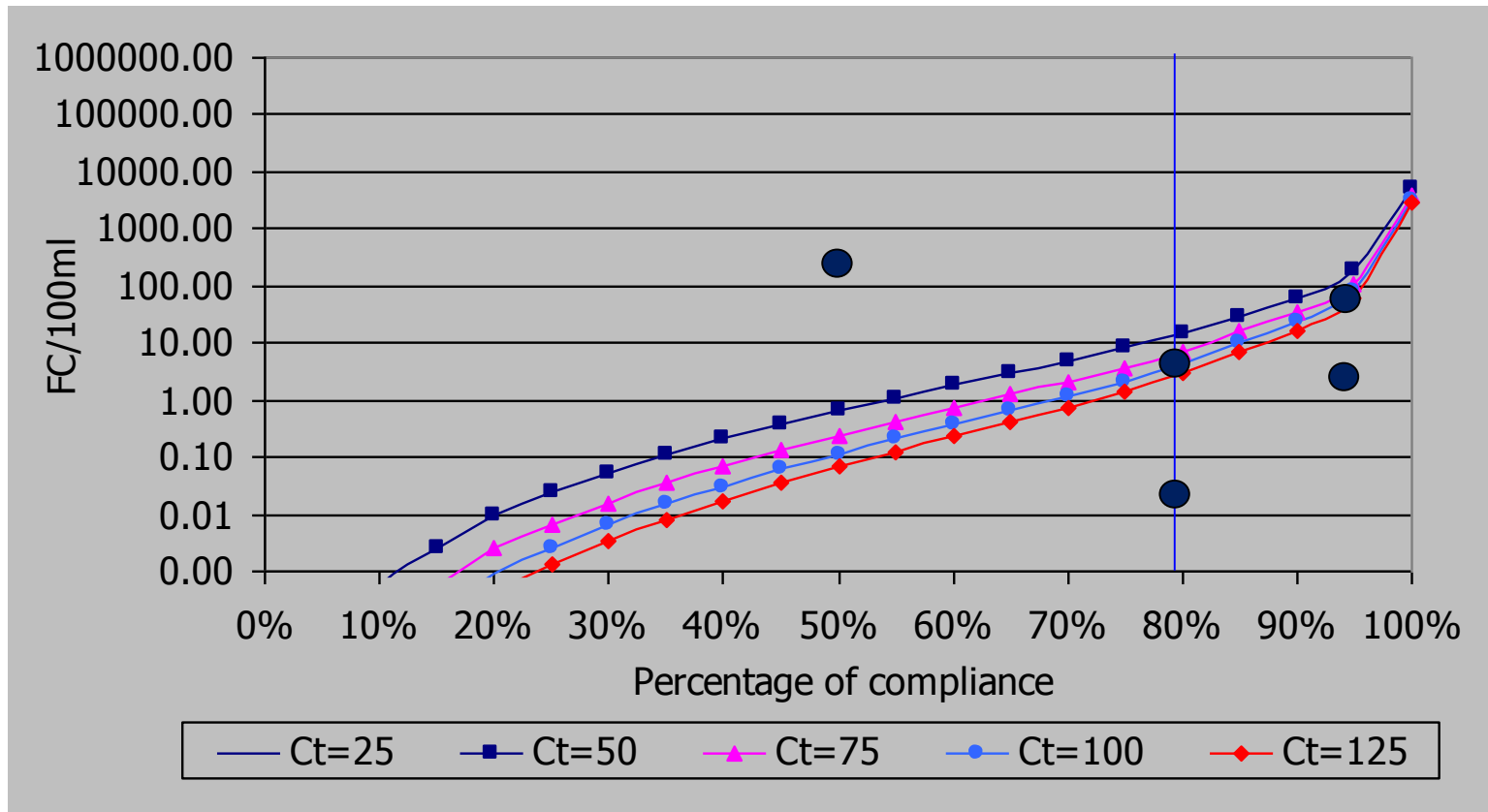
$q = 8 \text{ m}^3/\text{m}^2/\text{hr}$
 $De = 1 \text{ mm}$
 $u = 1.45-1.60$
 $L = 1.40 \text{ m}$
Alum = 10 -90 mg/l



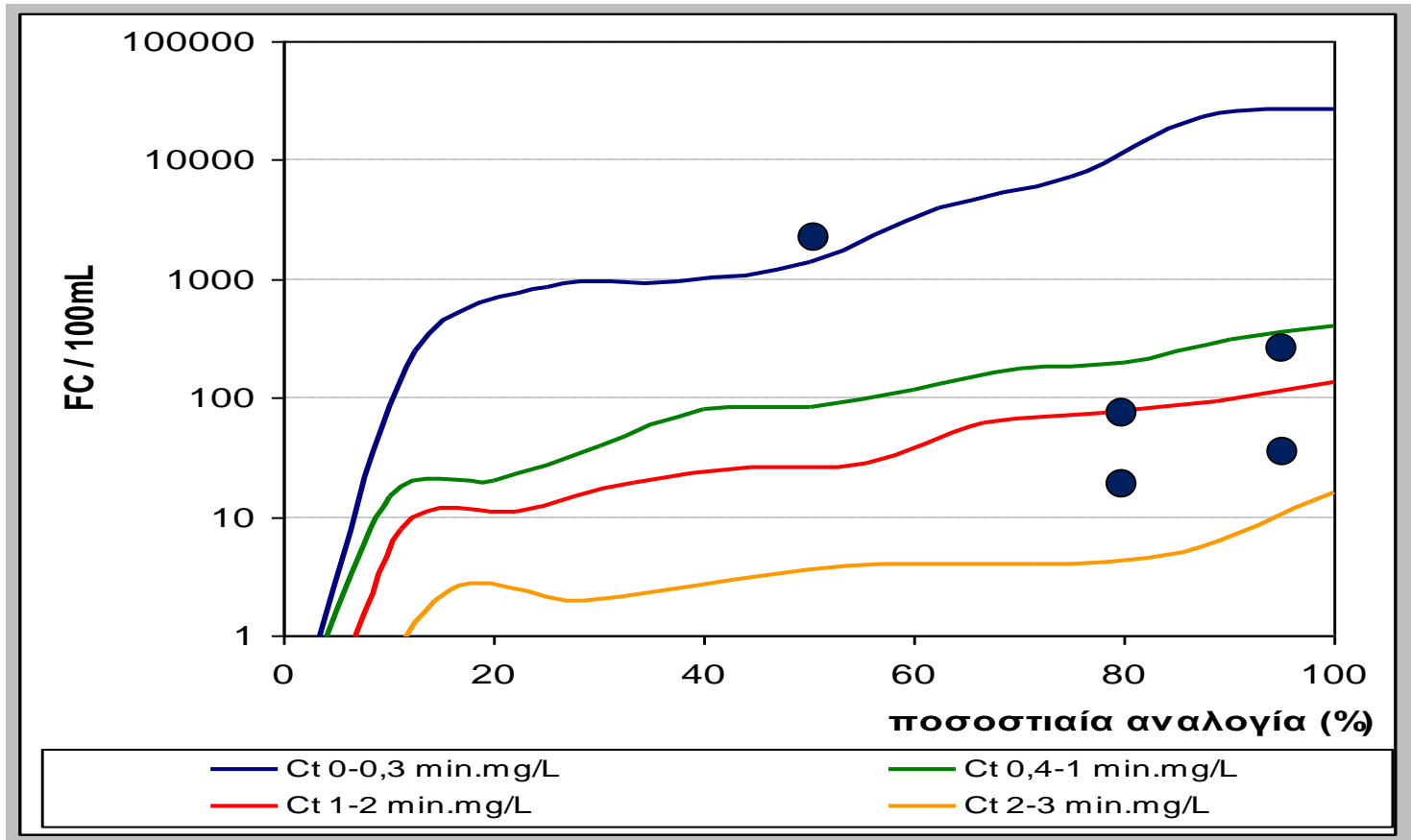
UV dose after tertiary treatment vs remaining FC



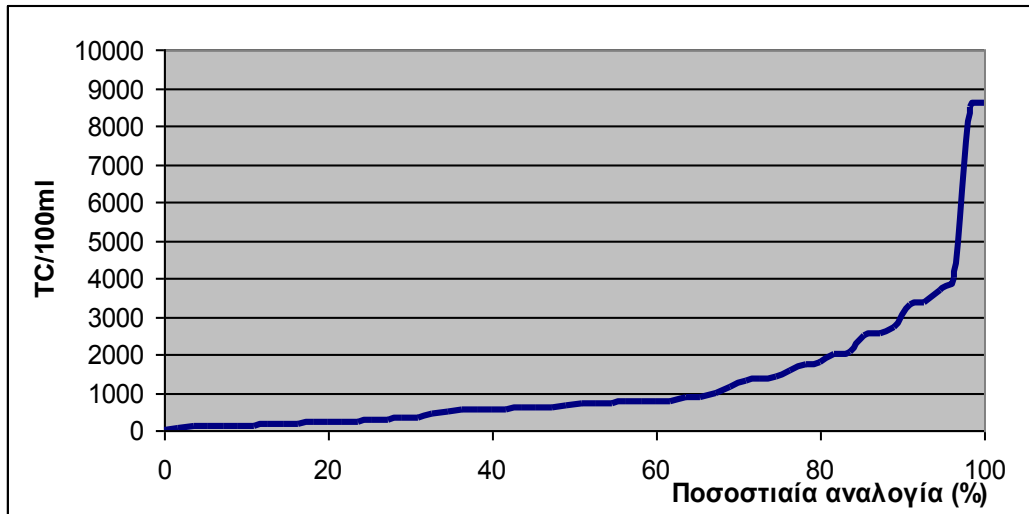
CI dose after tertiary treatment vs remaining FC



Ozone dose after tertiary treatment vs remaining FC



EFFLUENT FROM MBR (TC-FC)



700TC/100ml (50%)

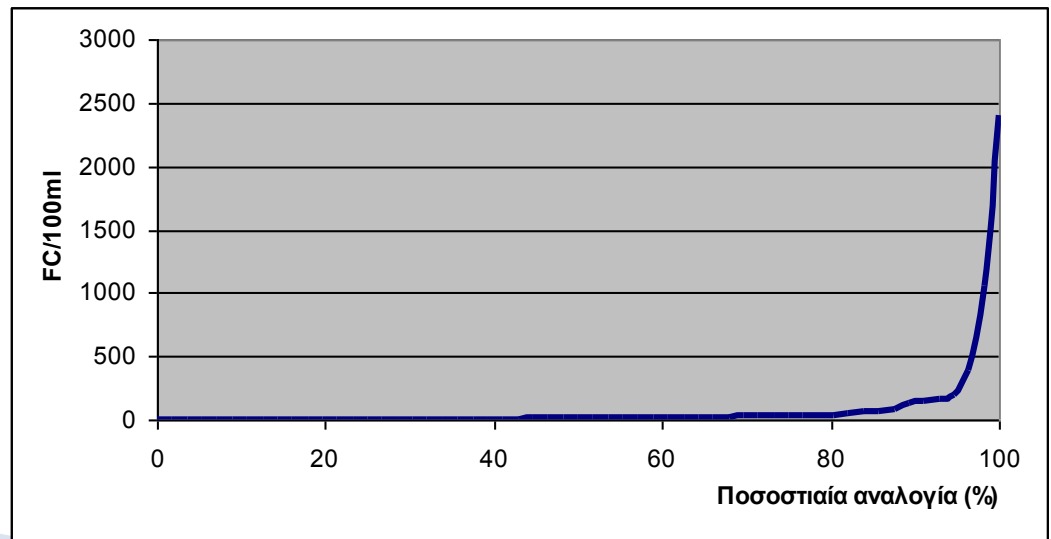
1800TC/100ml (80%)

3700TC/100ml (95%)

10FC/100ml (50%)

40FC/100ml (80%)

200FC/100ml (95%)



MBR-CHLORINE DISINFECTION-TC

	Dose Cl ₂ (mg min/lit)						
% of samples	MBR effluent	5	10	25	50	75	100
50%	530	190	12	0	0	0	0
80%	1410	605	180	23	1	0	0
95%	2900	800	420	45	6	0	0

MBR-UV DISINFECTION-TC

	Dose UV (mW-sec/cm ²)						
% of samples	MBR effluent	3	5	10	20	30	40
50%	475	76	48	17	3	0	0
80%	820	140	92	44	6	0	0
95%	2050	480	360	200	84	16	4

Conclusions

- ▶ The current Greek legislation concerning reuse is consistent with other existing regulations
- ▶ Due to the existing EU legislation concerning effluent discharge limitations, secondary biological treatment is the minimum treatment employed, usually with full or partial nitrogen removal in about 80% of the cases. Therefore, restricted wastewater reclamation is an already feasible possibility.
- ▶ The quality needed for most cases of unrestricted reuse can be achieved at a moderate cost, through upgrading of existing plants (e.g. sand filtration)
- ▶ For the particular case of recharge of a protected groundwater a more advanced treatment involving membrane technologies may be needed
- ▶ Provision is made for on site and small scale plants so that appropriate technologies suitable for such installations may be adequate for certain types of reuse (mostly restricted)



Thank you for your attention