OZONE

Application In Waste / Water Treatment

Presented By Team Waterhouse

Waste Water Treatment

3,000 times more germicidal than chlorine

160 times more bactericidal than sulphur dioxide

37 times more bactericidal than formaldehyde

1.7 times more bactericidal than hydrocyanic acid

Waste Water Treatment

Ozone (O_3) is an allotrope of Oxygen (O_2). It is 1.5 times as dense as oxygen and 12.5 times more soluble in water and leaves no residuals or byproducts except oxygen and a minimal amount of carbon dioxide and water.

Ozone is highly unstable and must be generated on site.

Its oxidation potential (-2.07V) is greater than that of hypochlorite acid (-1.49V) or chlorine (-1.36V),

Application in WASTE WATER

- Oxidation of organic waste.
- Cyanide destruction.
- Ground water petrochemical oxidation.
- Heavy metal precipitation.
- Pulp & paper effluents.
- Textile Mill effluents.
- Textile Dye, Starch, FOG (Fate, Oil, Grease) elimination.
- Pesticide, herbicide and insecticide elimination.
- BOD reduction of domestic waste.
- Secondary treatments for municipal waste water.
- Mining heavy metal precipitation.

Waste Water Treatment

COLOUR REMOVAL

Surface waters are generally colored by natural organic materials such as humic, fulvic and tannic acids. These compounds result from the decay of vegetative materials and are generally related to condensation products of phenol like compounds; they have conjugated carbon/carbon double bonds. When the series of double bonds extend upwards of twenty, the color absorption shows up in the visible spectrum. Ozone is attracted to break organic double bonds. As more of these double bonds are eliminated, the color disappears. Surface water can usually be decolorized when treated with 2 to 4 ppm of Ozone.

Waste Water Treatment

REMOVAL OF HEAVY METALS

Ozone oxidizes the transition metals to their higher oxidation state in which they usually form less soluble oxides, easy to separate by filtration. e.g. iron is usually in the ferrous state when it is dissolved in water. With ozone it yields ferric iron, further oxidized in water to Ferric Hydroxide that is very insoluble and precipitates out for filtration.

Other metals: Arsenic (in presence of Iron), Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Nickel, Zinc - can be treated in a similar way. At Ozone levels above 4 ppm however, Manganese will form soluble permanganate, showing up as a pink color.

Waste Water Treatment

Treatment in Water

Ozone has been used for many years to treat pathogens such as bacteria and algae in water for applications such as drinking water supplies and air conditioning system cooling water. More recently, most water bottlers have adopted ozone. Ozonated water for treatment of fruit, vegetables, fish, etc. in the U.S. awaited the GRAS approval. Now that has happened, and projects are emerging everywhere. A basic difference over other ozone-in-water applications is that the ozone contact time with the food product must be very short. The carrots, fresh fish fillets, or whatever must be processed in an assembly line in at most a few minutes.

Waste Water Treatment

Treatment in Water (continue.)

Ozone concentrations in water of 1-10 ppm (1 ppm = 1 mg/L) are reported. About 2 ppm is a commonly reported concentration for treatment times of a few minutes. Tripling this concentration can reduce the treatment time to a minute or so in many cases. The concentration of ozone required to achieve a given reduction of CFU levels varies by fruit, vegetable, species of fish, etc. as well as ambient considerations. The concentration of the ozone in the water varies as a function of the feed gas ozone concentration (usually over 1% or over 10,000 ppm of ozone) and the water temperature (The maximum concentration increases with colder water). Ozone's effectiveness in wash water may be significantly reduced when the biological oxygen demand (BOD) of the water is more than 500 mg/L. In this case, the BOD must be reduced before the ozone treatment stage.

Waste Water Treatment

IMPROVED COAGULATION & TURBIDITY REMOVAL

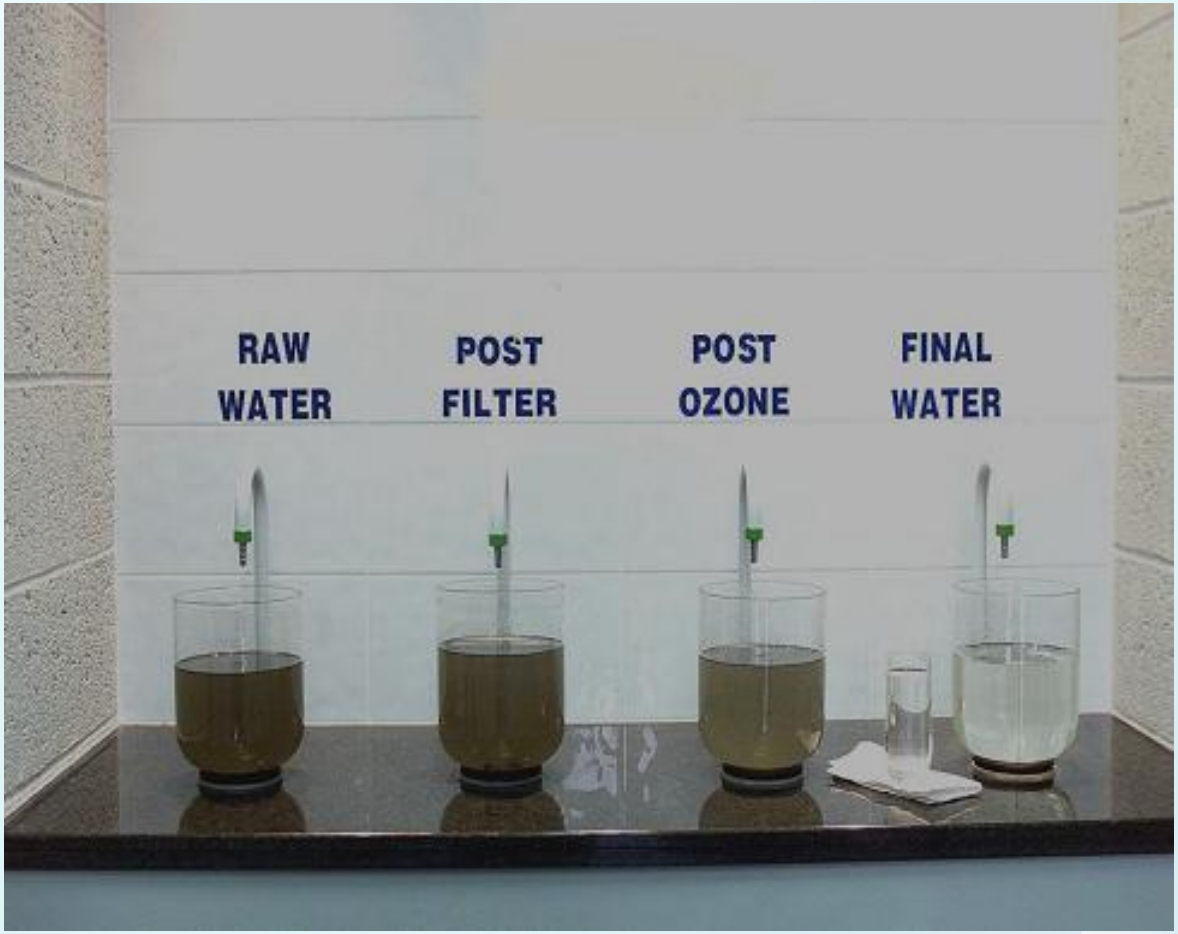
Oxidation of dissolved organic materials by Ozone results in polar and charged molecules that can react with Polyvalent Aluminum or Calcium to form precipitates. Treatment of a surface water with up to 0.5 ppm of Ozone results in a decrease in turbidity, improved settle ability and a reduction in the number of particles. Referred to as **pre-ozonation** this treatment destabilizes the colloid with a resultant reduction of the amount of coagulant needed to produce a clear filtrate.

Waste Water Treatment

ALGAE REMOVAL

Ozonation of a water contaminated with Algae oxidizes and floats the Algae to the top of the reservoir. The ozone will also oxidize the metabolic by-products of the Algae and remove the undesirable odor and taste.

Waste Water Treatment

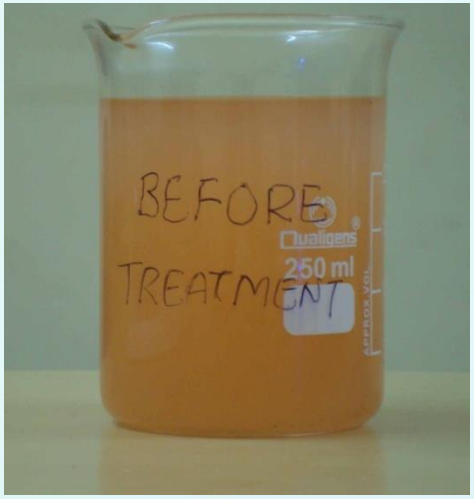


Waste Water Treatment

Coolant Before Treatment

After Ozone Treatment & Post Filtration

Waste Water Treatment



Before Process

After Ozone Process

Waste Water Treatment

Worldwide there are many installations using conventional ozone generators with a concentration of 1 -2 % by weight.

EnviroSafe's high concentration ozone generators deliver ozone grater then above output by weight speeding up process by POU & POE.

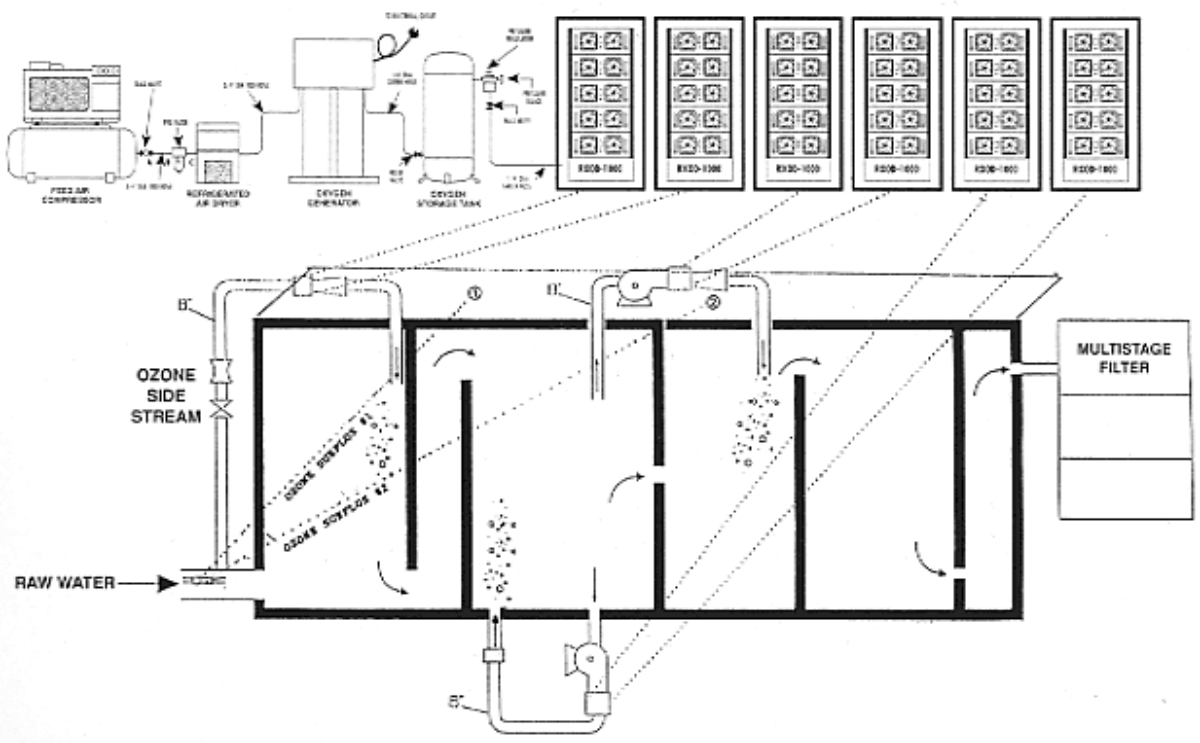
By utilizing our high concentration ozone generators in your process... You can save time & money. Let us show you how.

Below is a typical layout with ozone used also as a flocculants in the process.

Note: A treatment scheme can only be determined after review of a complete analytical report on the water.

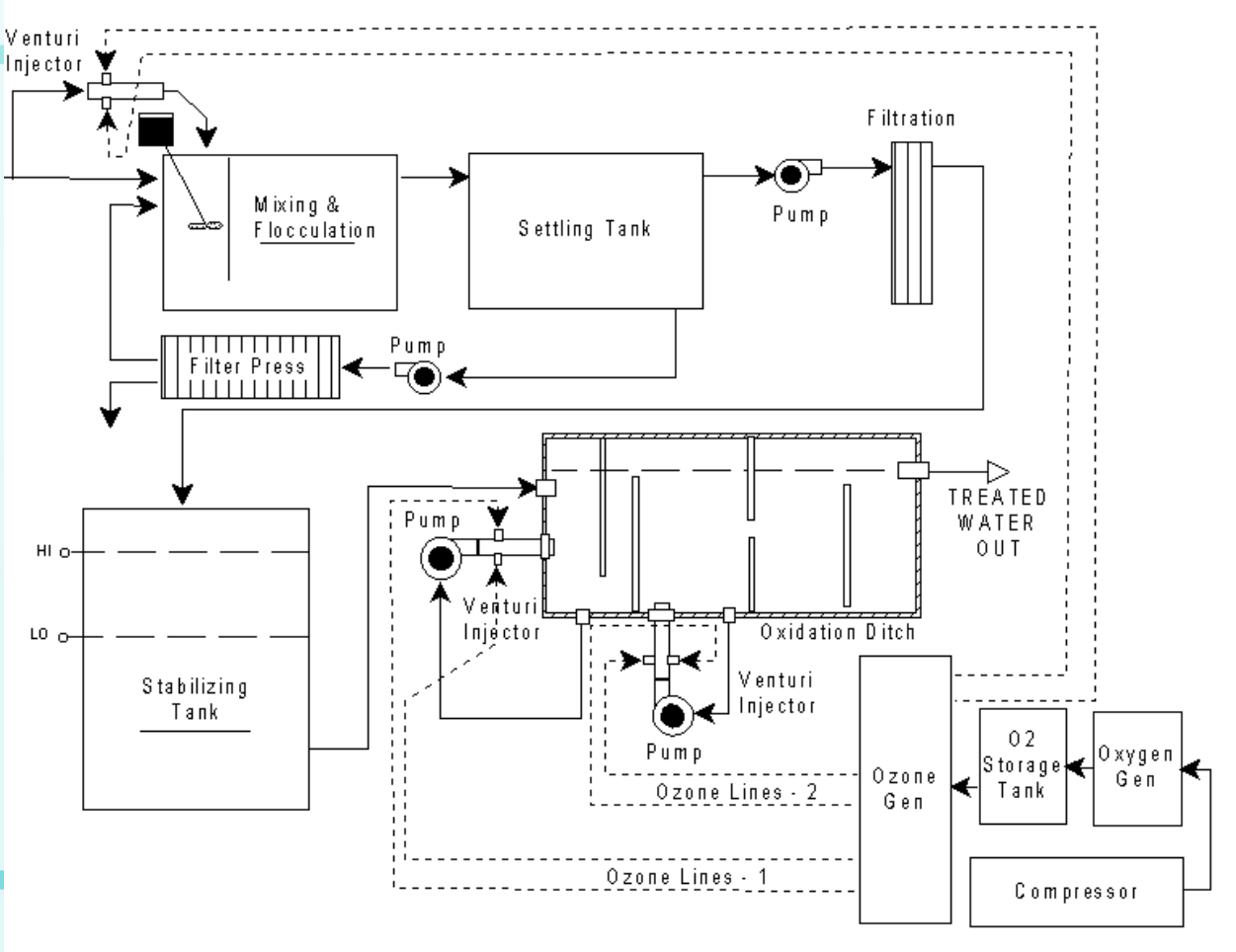
Waste Water Treatment

Waste Water Treatment



Waste Water Treatment

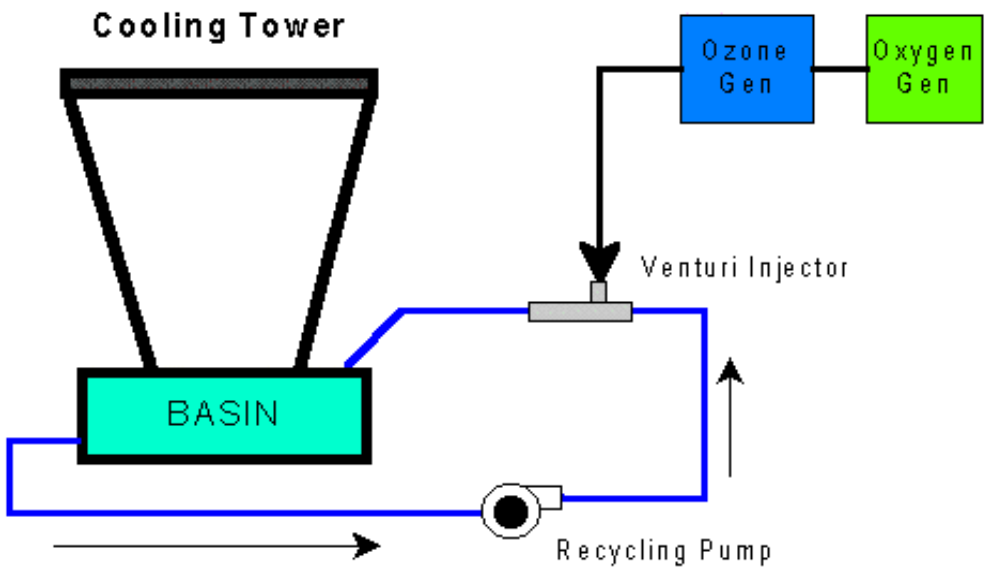
Textile Dye Removal



Waste Water Treatment

COOLING TOWER

OZONE has a firm track record in cooling tower treatment, Find out how EnviroSafe can help you to greatly cut your energy costs and water consumption with ozone. Please contact us and tell us about your application for ozone.

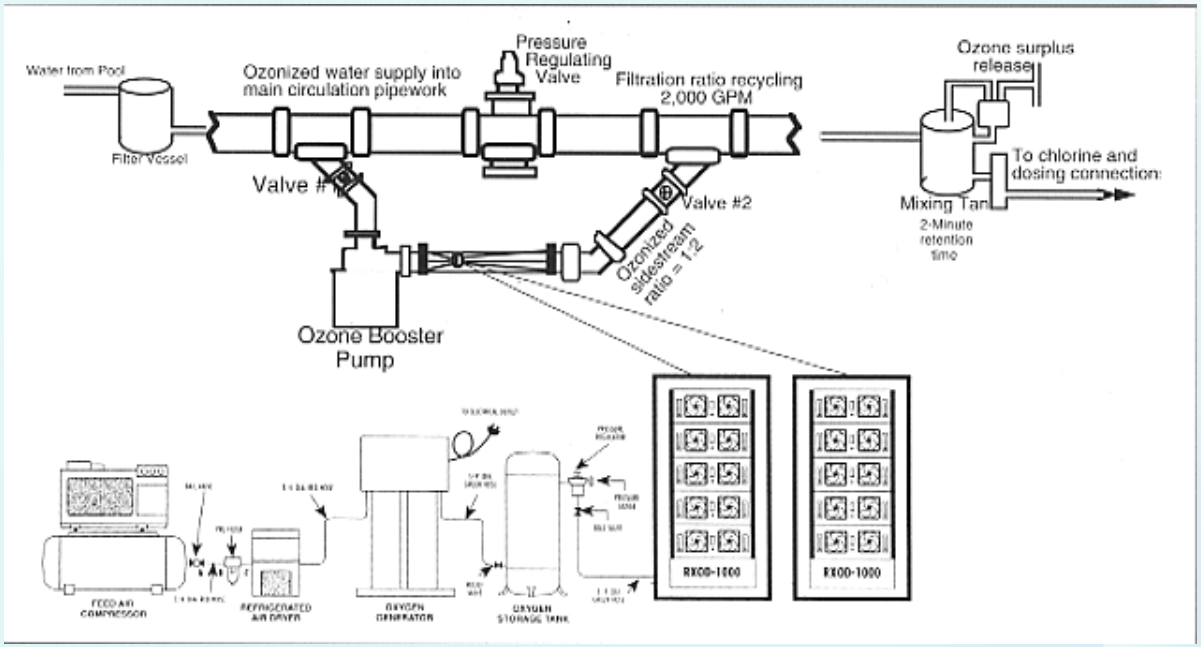


Treatment in the above layout is done directly in the pipe (after the venturi) and also in the cooling tower basin with a side-stream recycling loop.Utilizing a fully automated system may be employed, thus controlling the cycling (ON/OFF) of the Oxygen and Ozone generators as well as the Recycling pump as the ozone demand of the tower water changes.

This information is provided
by
The U.S. Department of Energy
&
Other Resources

Waste Water Treatment

Connection Diagram in Swimming Pools



Why Ozone ?

- Powerful disinfectant
- No residual (compared to chlorine)
- Stronger oxidant (compared chlorine/UV)
- Three ozone plants in Southern Nevada
  - AMS 600 MGD drinking water
  - River Mountains 300 MGD drinking water
  - Big Bend (Laughlin) 20 MGD drinking water
- Ozone proven technology for disinfection & contaminant removal

Emerging Contaminants

- 1994: Britain discovers fish below WWTP outfalls with symptoms of exposure to estrogenic compounds
- 1996: USGS reports similar findings in carp from the Las Vegas Bay, Lake Mead
- 1996: EPA reports endocrine disruption in fish from Minnesota near WWTPs
- 1996: Amendment to SDWA mandates EPA develop a screening program for EDCs
- 1997: SNWA initiates monitoring and fish studies for EDCs

Sewage Altering Fish, Study Reports

Male bottom-dwellers with female sex characteristics are found near outfall pipes in waters off Los Angeles and Orange counties.

By Marla Cone
Times Staff Writer

November 14, 2005

Male fish with female characteristics have been discovered in ocean waters off Los Angeles and Orange counties, raising concerns that treated sewage released offshore contains hormone-disrupting compounds that are deforming the sex organs of marine life.

Scientists around the world have found sexual abnormalities in frogs, fish, alligators and other wild animals exposed to sewage effluent and industrial contaminants that mimic estrogens and other hormones. But the latest research in the waters off Southern California is among the first to find such effects in ocean creatures.

Eleven male bottom-dwelling fish out of 64 caught between Santa Monica and Huntington Beach had ovary tissue in their testes. No such sexual defects were found elsewhere off Southern California, even though fish were collected from Point Conception to the U.S.-Mexico border.

Two other studies found other signs of feminized fish in the same ocean areas. Two-thirds of male turbot and sole caught near Orange County's sewage outfall had egg-producing proteins. And when males were exposed in a laboratory to ocean sediment collected off the Palos Verdes Peninsula and Huntington Beach — where huge volumes of sewage effluent are pumped out to sea — all of them developed female egg proteins.

SNWA EDC Research

- 1997: Initial screening of LV Wash & Lake
  - Estrogen compounds detected in Wash & Bay
  - No estrogens detected in drinking water
  - First detection of pharmaceuticals
- 1998: Fish caged in Lake Mead
  - Subtle differences in fish from LV Bay, but not dramatic as seen in USGS studies
- 2000: DOD funded study of fish
  - Small differences among LV Bay & Overton
  - Perchlorate not related to EDC effects in fish
- 2003-Current: Monitoring of Lake Mead

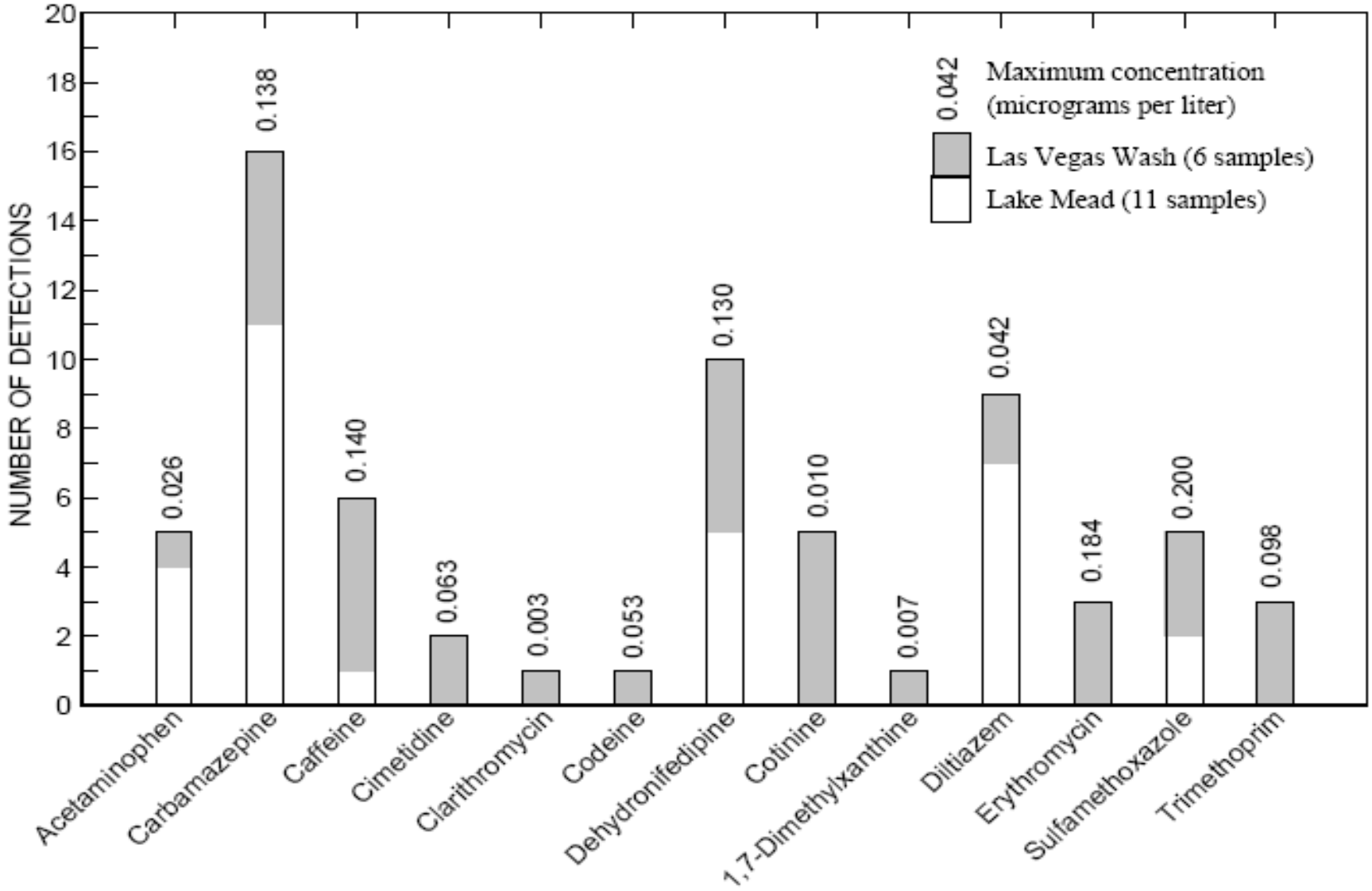


Figure 3. Summary of human-health pharmaceutical compounds detected in water samples collected from Lake Mead, Nevada and Arizona, and Las Vegas Wash, Nevada, October 2000–August 2001.

Adapted from USGS Report 02-385 *Boyd & Furlong*

Acetaminophen	Analgesic; anti-inflammatory
Amoxicillin	Antibiotic
Azithromycin	Antibiotic
Caffeine	Stimulant
Carbamazepine	Antiepileptic; analgesic
Cephalexin	Antibiotic
Cimetidine	Antiulcerant; stomach-acid reducer
Clarithromycin	Antibiotic
Codeine	Narcotic; analgesic
Cotinine	Metabolite of nicotine
Dehydronifedipine	Metabolite of Procardia (vasodilator)
Digoxigenin	Metabolite of Digoxin (antianginal)
Digoxin	Antianginal (cardiac stimulant)
Diltiazem	Antianginal
1,7-dimethylxanthine	Metabolite of caffeine
Diphenhydramine	Antihistamine
Enalaprilat	Antihypertensive
Erythromycin	Antibiotic
Fluoxetine	Antidepressant
Furosemide	Edema medication; diuretic
Gemfibrozil	Cholesterol regulator
Ibuprofen	Analgesic; anti-inflammatory
Lisinopril	Antihypertensive
Metformin	Antiglycemic
Miconazole	Antifungal
Paroxetine metabolite	Metabolite of Paroxetine (antianxiety)
Ranitidine	Antiulcerant; antacid
Salbutamol (albuterol)	Anti-inflammatory; bronchodilator
Sulfamethoxazole	Antibiotic
Thiabendazole	Anthelmintic (intestinal wormer)
Trimethoprim	Antibiotic
Urobilin	Metabolite of human excrement
Warfarin	Anticoagulant

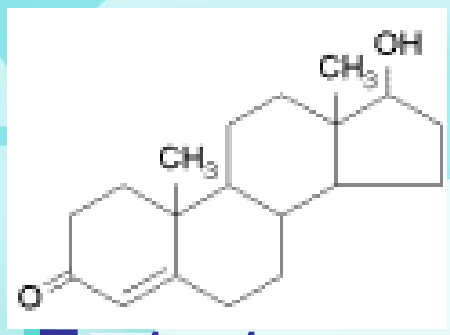
2001-2002 USGS Monitoring of Lake Mead

Adapted from
USGS Report 02-385
Boyd & Furlong - 2002

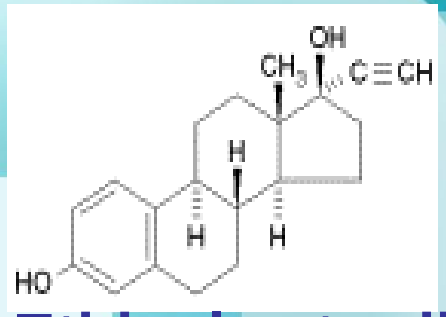
Southern Nevada WWTPs 2003 (ng/L)

	WWTP#1	WWTP#2	WWTP#3
Analyte	ppt	ppt	ppt
Hydrocodone	64	<1.0	44
Trimethoprim	24	<1.0	<10
Acetaminophen	<1.0	1.2	<10
Caffeine	39	64	38
Erythromycin	262	<1.0	507
Sulfamethoxazole	141	15	20
Fluoxetine	9.9	5.3	52
Pentoxifylline	<1.0	16	<10
Meprobamate	195	594	571
Dilantin	57	78	244
TCEP	122	187	155
Carbamazepine	91	86	67
DEET	279	269	<10
Atrazine	<1.0	<1.0	<10
Diazepam	2.0	1.9	<10
Oxybenzone	4.2	4.3	<10
Estriol	1.6	2.1	<100
Ethynylestradiol	<1.0	<1.0	<10
Estrone	<1.0	2.5	<25
Estradiol	<1.0	<1.0	<10
Testosterone	2.0	6.8	<10
Progesterone	<1.0	<1.0	<10
Androstenedione	<1.0	3.0	<10
Iopromide	82	29	101
Naproxen	5.0	<1.0	<10
Ibuprofen	6.1	7.0	110
Diclofenac	6.9	<1.0	<10
Triclosan	15	19	<10
Gemfibrozil	14	8.4	<10

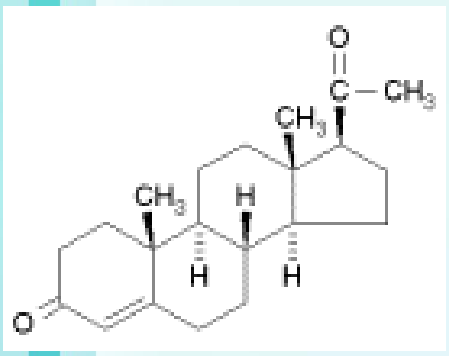
Steroids



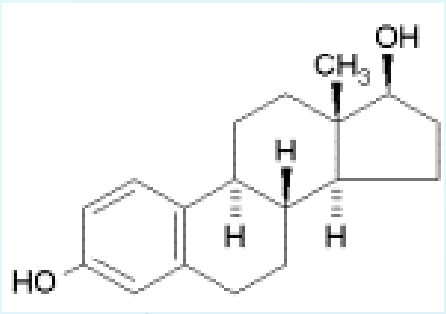
Testosterone



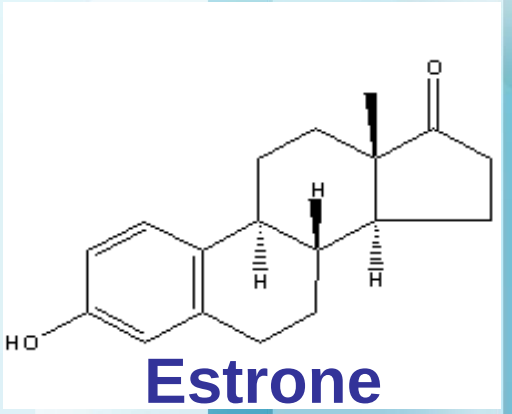
Ethinyl estradiol



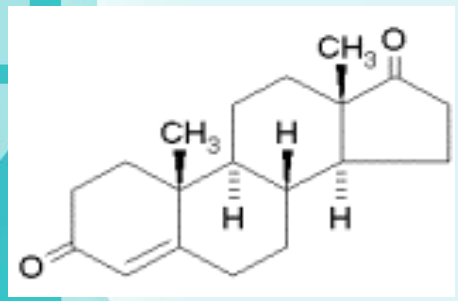
Progesterone



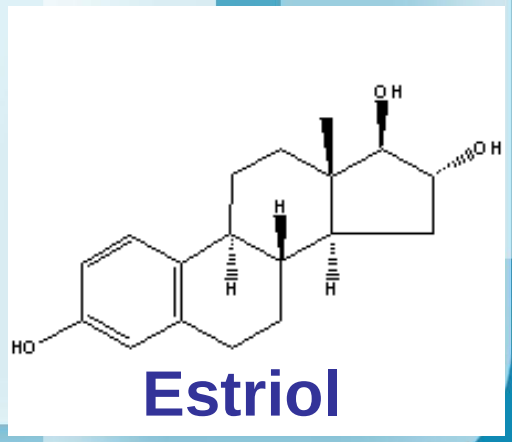
17β Estradiol



Estrone

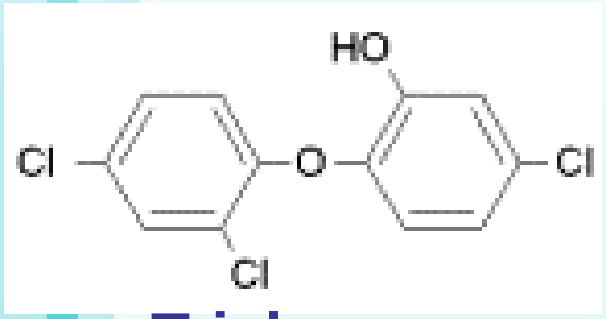


Androstenedione

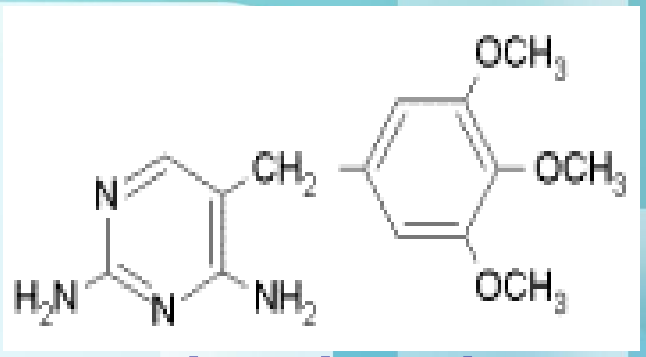


Estriol

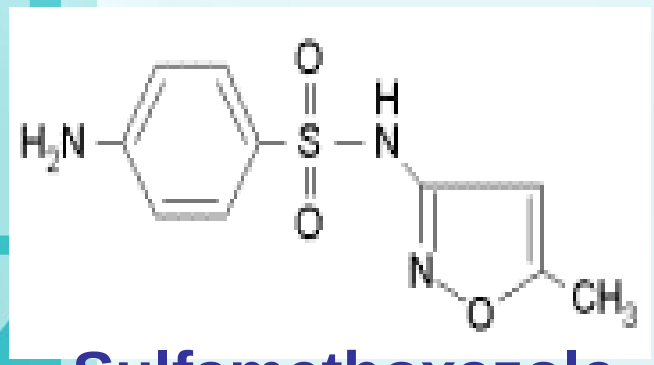
Antimicrobials



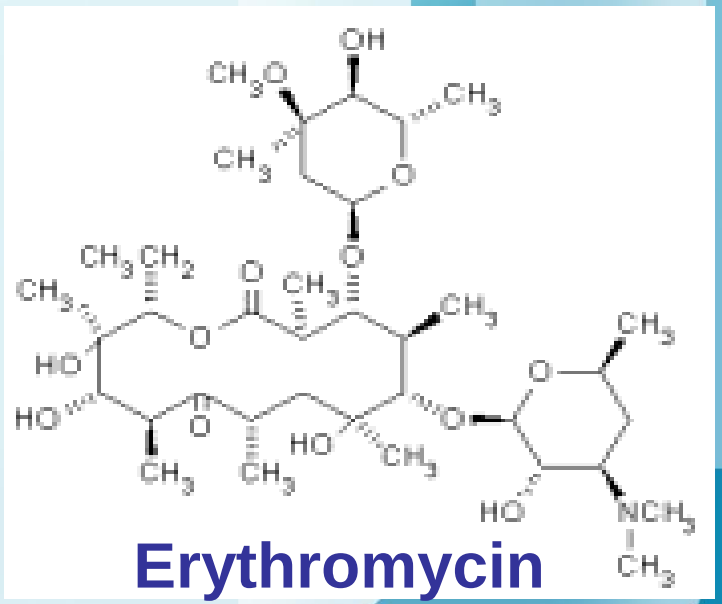
Triclosan



Trimethoprim

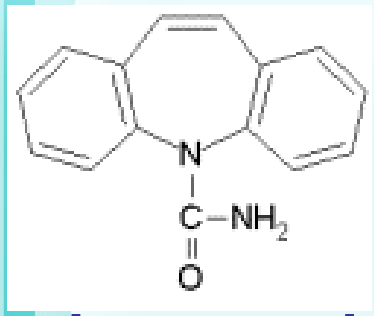


Sulfamethoxazole

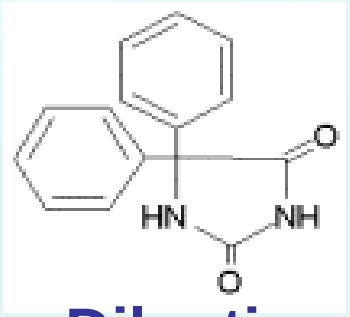


Erythromycin

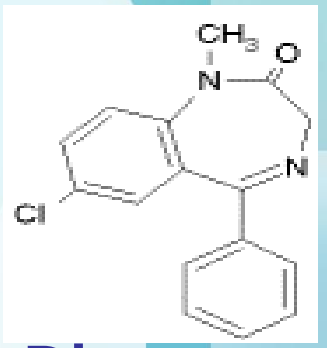
Psychoactive



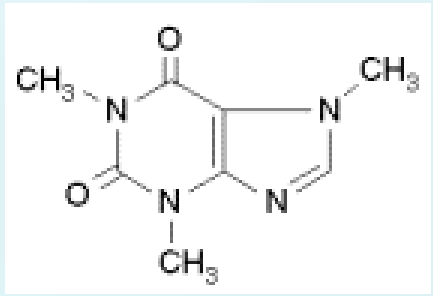
Carbamazepine



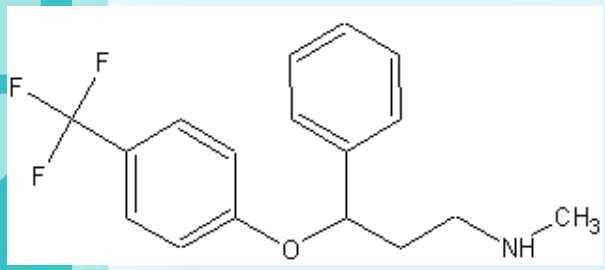
Dilantin



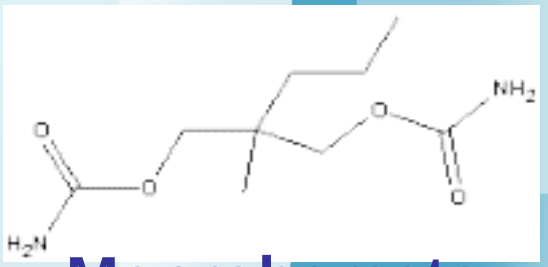
Diazepam



Caffeine

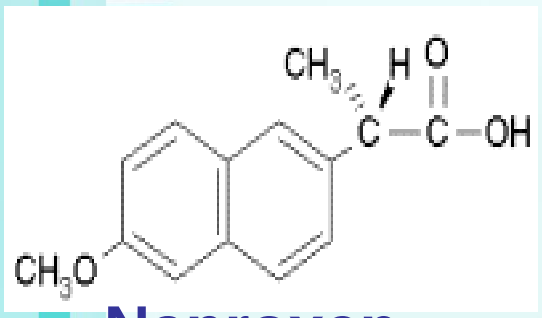


Fluoxetine

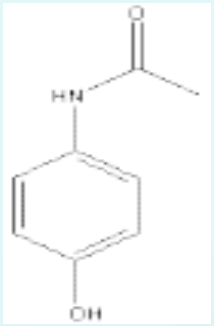


Meprobamate

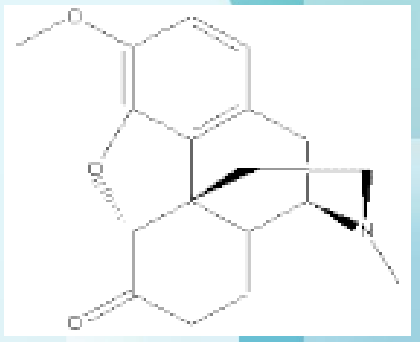
Analgesics



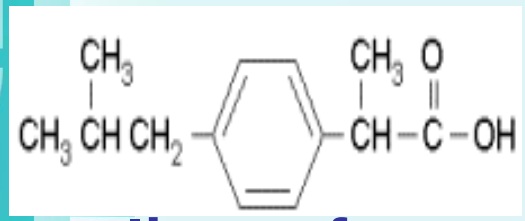
Naproxen



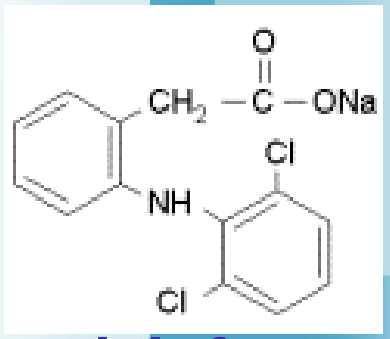
Acetaminophen



Hydrocodone

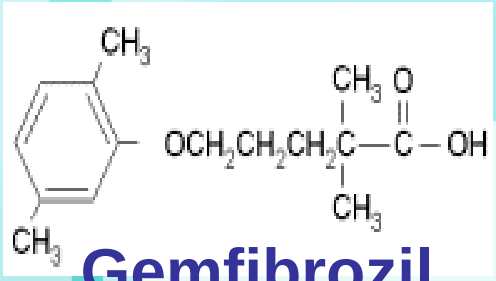


Ibuprofen

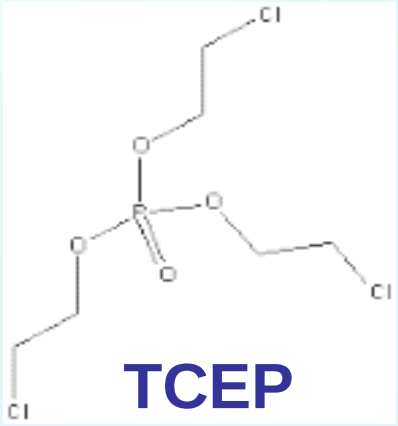


Diclofenac

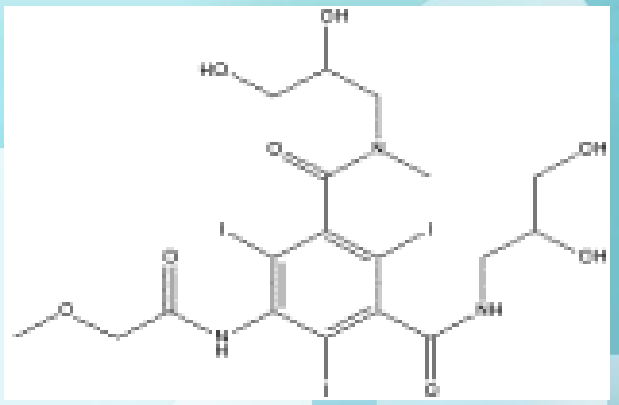
Others



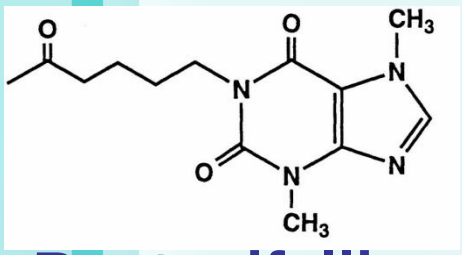
Gemfibrozil



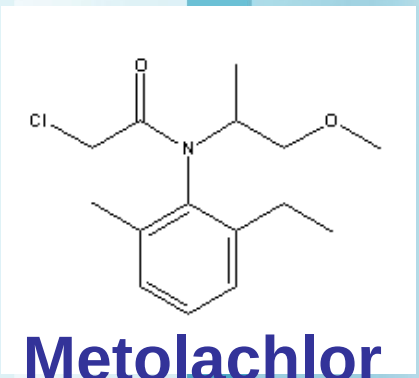
TCEP



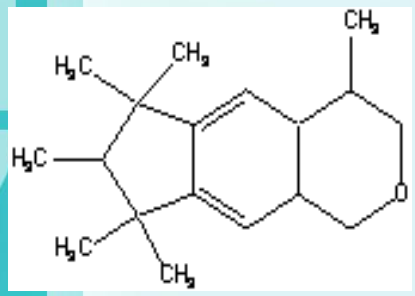
Iopromide



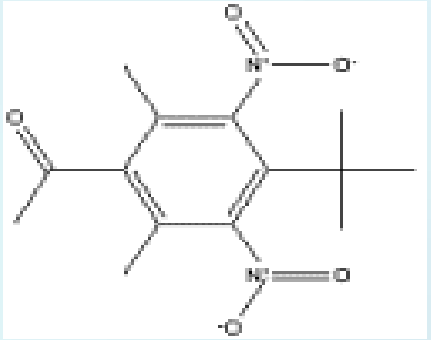
Pentoxifylline



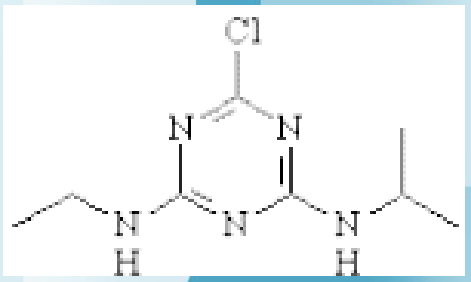
Metolachlor



Galaxolide



Musk Ketone



Atrazine

<30% Removal	30-70% Removal	>70% Removal
Testosterone	Sulfamethoxazole	
Progesterone	Triclosan	
Androstenedione	Diclofenac	
Estriol	Acetaminophen	
Ethynylestradiol		
Estrone		
Estradiol		
Erythromycin-H_2O		
Trimethoprim		
Naproxen		
Hydrocodone		
Ibuprofen		
Caffeine		
Fluoxetine		
Meprobamate		
Diazepam		
Dilantin		
Carbamazepine		
DEET		
Atrazine		
Galaxolide		
TCEP		
Iopromide		
Pentoxifylline		
Metolachlor		
Gemfibrozil		
Musk Ketone		

UV 40mJ/cm^2

Chlorine 3.5 mg/L 24 hr

<30% Removal	30-70% Removal	>70% Removal
Testosterone	Ibuprofen	Estriol
Progesterone	Metolachlor	Ethynylestradiol
Androstenedione	Gemfibrozil	Estrone
Caffeine		Estradiol
Fluoxetine		Erythromycin-H_2O
Meprobamate		Sulfamethoxazole
Diazepam		Triclosan
Dilantin		Trimethoprim
Carbamazepine		Naproxen
DEET		Diclofenac
Atrazine		Hydrocodone
Galaxolide		Acetaminophen
TCEP		Musk Ketone
Iopromide		
Pentoxifylline		

Ozone 2.5 mg/L

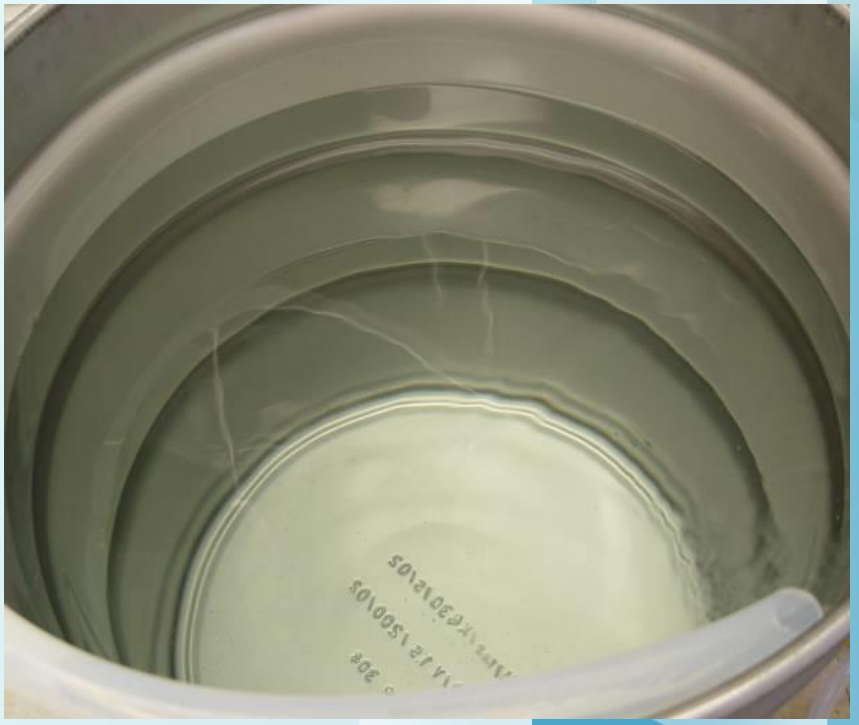
<30% Removal	30-70% Removal	>70% Removal
Musk Ketone	Meprobamate	Testosterone
TCEP	Atrazine	Progesterone
	Iopromide	Androstenedione
		Estriol
		Ethynylestradiol
		Estrone
		Estradiol
		Erythromycin-H2O
		Sulfamethoxazole
		Triclosan
		Trimethoprim
		Naproxen
		Diclofenac
		Ibuprofen
		Hydrocodone
		Acetaminophen
		Carbamazepine
		Dilantin
		Diazepam
		Caffeine
		Fluoxetine
		DEET
		Metolachlor
		Galaxolide
		Pentoxifylline
		Gemfibrozil

	Raw Sewage-AVE	Secondary Effluent AVE	O_3 3 mg/L	O_3 6 mg/L	O_3 8 mg/L
Analyte	*ng/L*	*ng/L*	*ng/L*	*ng/L*	*ng/L*
Hydrocodone	218	240	ND	ND	ND
Trimethoprim	319	35	ND	ND	ND
Acetaminophen	43750	ND	ND	ND	ND
Caffeine	97800	51	ND	ND	ND
Erythromycin-H_2O	285	133	ND	ND	ND
Sulfamethoxazole	590	841	3.1	ND	ND
Pentoxifylline	46	ND	ND	ND	ND
Meprobamate	739	332	140	63	42
Dilantin	94	154	17	3.4	ND
TCEP	453	373	427	352	334
Carbamazepine	99	210	ND	ND	ND
DEET	413	188	39	10	3.4
Atrazine	251	ND	ND	ND	ND
Oxybenzone	2925	6	8.2	ND	1.5

	Raw Sewage-AVE	Secondary Effluent AVE	3 mg/L	6 mg/L	8 mg/L
Analyte	*ng/L*	*ng/L*	*ng/L*	*ng/L*	*ng/L*
Iopromide	37	22	6	2	ND
Naproxen	13200	13	ND	ND	ND
Ibuprofen	11950	19	ND	ND	ND
Diclofenac	28	54	ND	ND	ND
Triclosan	1590	85	112	50	72
Gemfibrozil	1105	ND	ND	ND	ND
Galaxolide	1680	1169	46	ND	ND
Musk Ketone	225	133	83	72	42
EEq ng/mL	>40	0.626	ND	ND	ND
Total Coliform	>16,000,000	6750	<2	<2	<2
Fecal Coliform	>16,000,000	2675	<2	<2	<2

Before Ozonation

After Ozonation



Ozone is effective for disinfections and removal of emerging contaminants

- No perfect treatment
  - RO/NF membranes = brine and water loss
  - Activated carbon = disposal/regeneration
  - Disinfection = byproducts
- Ozone can remove cellular estrogenicity
  - Effects on fish should be evaluated
  - European scientists found same effect

Conclusions

- Southern Nevada has extensive history & expertise in ozone technology
- Costs for ozone and UV are comparable for disinfection in reuse application
  - UV is not oxidative at disinfect dose
  - Ozone provides disinfection & oxidation
  - UV subject to regrowth post-disinfection
  - Neither UV nor ozone have residual issues
- Contact times from pilot would be realistic
  - ≈ 8-20 min contact time for ozone
  - ≈ 90 min contact time for chlorine

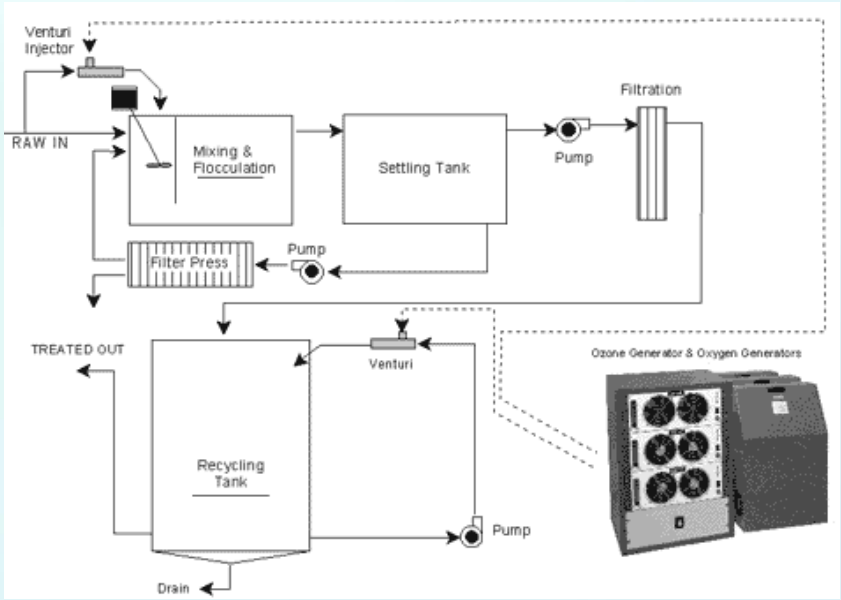
Waste Water Treatment

Benefit of Swimming Pools

- Eliminate red, irritated eyes
- Reduce handling and storage of unsafe chemicals
- Reduce traditional chemical (chlorine/bromine) use 60%-90%
- Eliminate foul chlorine/chloramines odors
- Eliminate foaming / “bathtub ring”
- Eliminate constant repurchase of chemicals
- Eliminate costly replacement of faded swimwear
- Eliminate environmental worries

Waste Water Treatment

Hospital Wastewater Treatment



Ozone can be utilized to treat wastewater generated from hospitals and the medical community. Due to the superior oxidation properties of ozone over conventional treatments and our CD OZONE's high ozone concentration at over 6% by weight, we can (and have) gone after these complex waste streams with very good results. If you have a specific problem you are trying to resolve, please contact us with more details and see how ozone may be employed for your case.

Waste Water Treatment

Ozone is effective against a large variety of water treatment problems. In general, the more problems in the water to be treated with ozone, the less an ozonation system costs when compared to other traditional treatment methods. When comparing the cost of an ozonation system with other treatment systems there are some key factors to consider; here are a few:

- There is no need to purchase, ship or store chemical oxidants or disinfectants
- There is no labor for handling.
- Many health and safety concerns are reduced or eliminated.
- Because ozone reacts so much more quickly there is opportunity for substantial savings in space requirements for the treatment system.
- Because ozone treatment design is flexible, one of the variety of installations can be adapted to any fit any design circumstance.
- It is likely that much of your existing treatment facilities are adaptable to an ozone based treatment system.
- The pay back of your investment can be surprisingly short.

ECONOMIES

Team Waterhouse Group

Offices :
DENMARK : Birkhøjvej 7, 2800, Kongens, Lyngby, Copenhagen
AUSTRALIA : Nysha Trust, 28 McKee Crescent, Mango Hill, 4509 Brisbane
SOUTH AFRICA : 16 Andries Pretorius Drive, Eastleigh Edenvale, Gauteng, Johannesburg - 1609
INDIA : C2/23 G L Roy Rd, S M Nagar Sarkarpool, Maheshtala, Kolkata West Bengal - 700143

Email :info@OzonePedia.com, office@teamwaterhouse.com

Websites : https://OzonePedia.com
https://OxyzoneTherapy.com

Looking forward to a long-lasting association.