OPERATOR TRAINING COMMITTEE OF OHIO

WATER WORKSHOP

"MANGANESE IN DRINKING WATER"

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WHAT'S THE PROBLEM?

- Normally present in water in conjunction with Iron (Fe++)
- Manganese may also be present as Mn++
- RMCL for Iron is 0.3 mg/L
- RMCL for Manganese is 0.05 mg/L
- However USEPA does not consider Mn an issue until the concentration is about 0.50 mg/L
  - Ohio EPA is studying issues of manganese in drinking water

HEALTH EFFECTS OF MANGANESE

- In normal concentrations, soluble manganese is not a health issue
  - Bathing and showering in water containing manganese is not an issue because manganese does not penetrate the skin, and does not get into the air
- However, elevated exposure to manganese has been associated with toxicity to the nervous system, producing a syndrome that resembles Parkinsonism
- Anorexia (severe weight loss)
- Muscle pain
- Nervousness
- Irritability (emotionally upset), and headaches

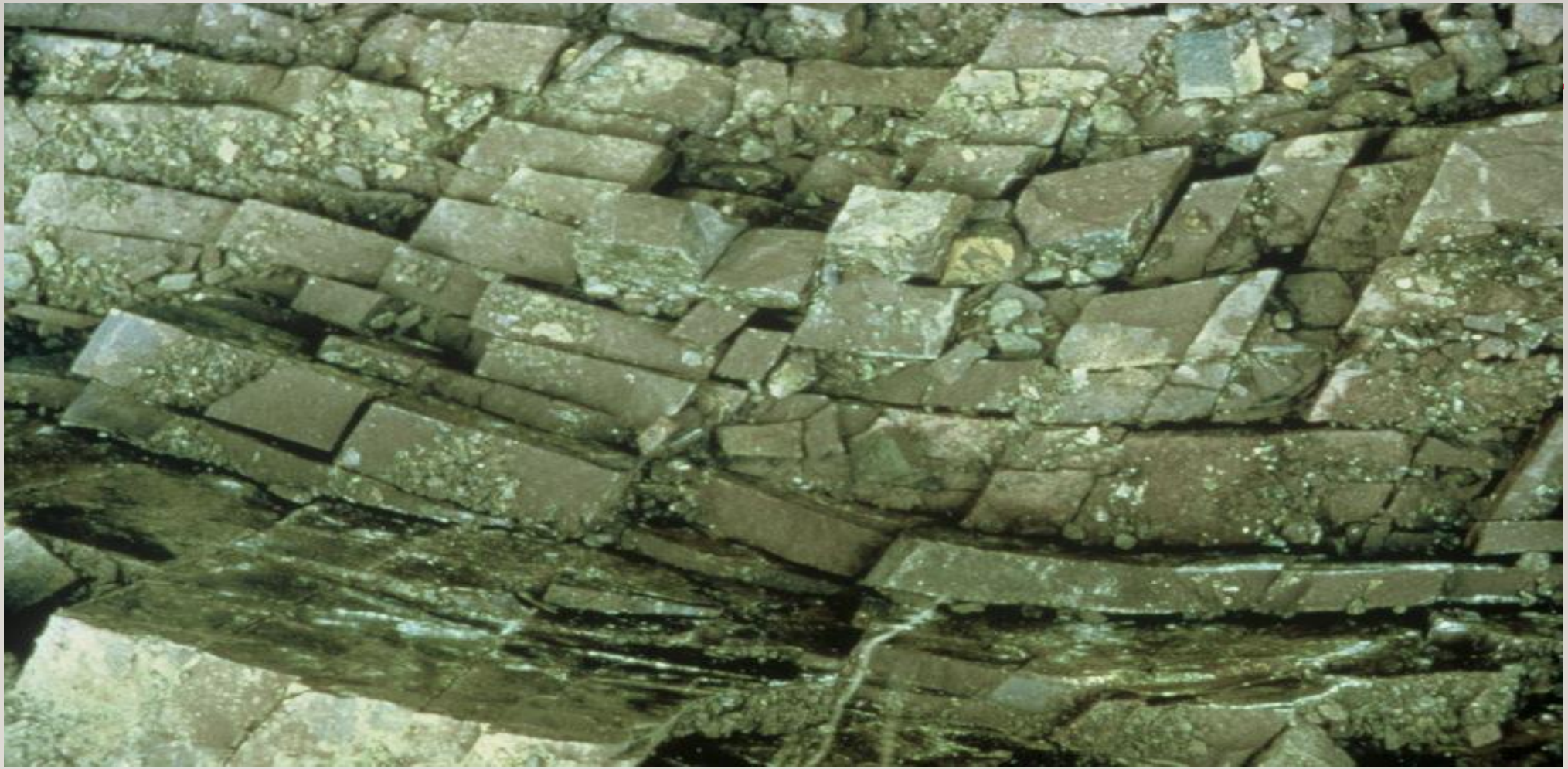
PROBLEMS

- Aesthetic effects
  - Undesirable tastes and odors
  - Big public relations problems
- Cosmetic effects
  - Discoloration
- Technical effects
  - Damage to other equipment
  - Reduced effectiveness of treatment for other contaminants
- The bottled water industry is thriving because we failed to do our job

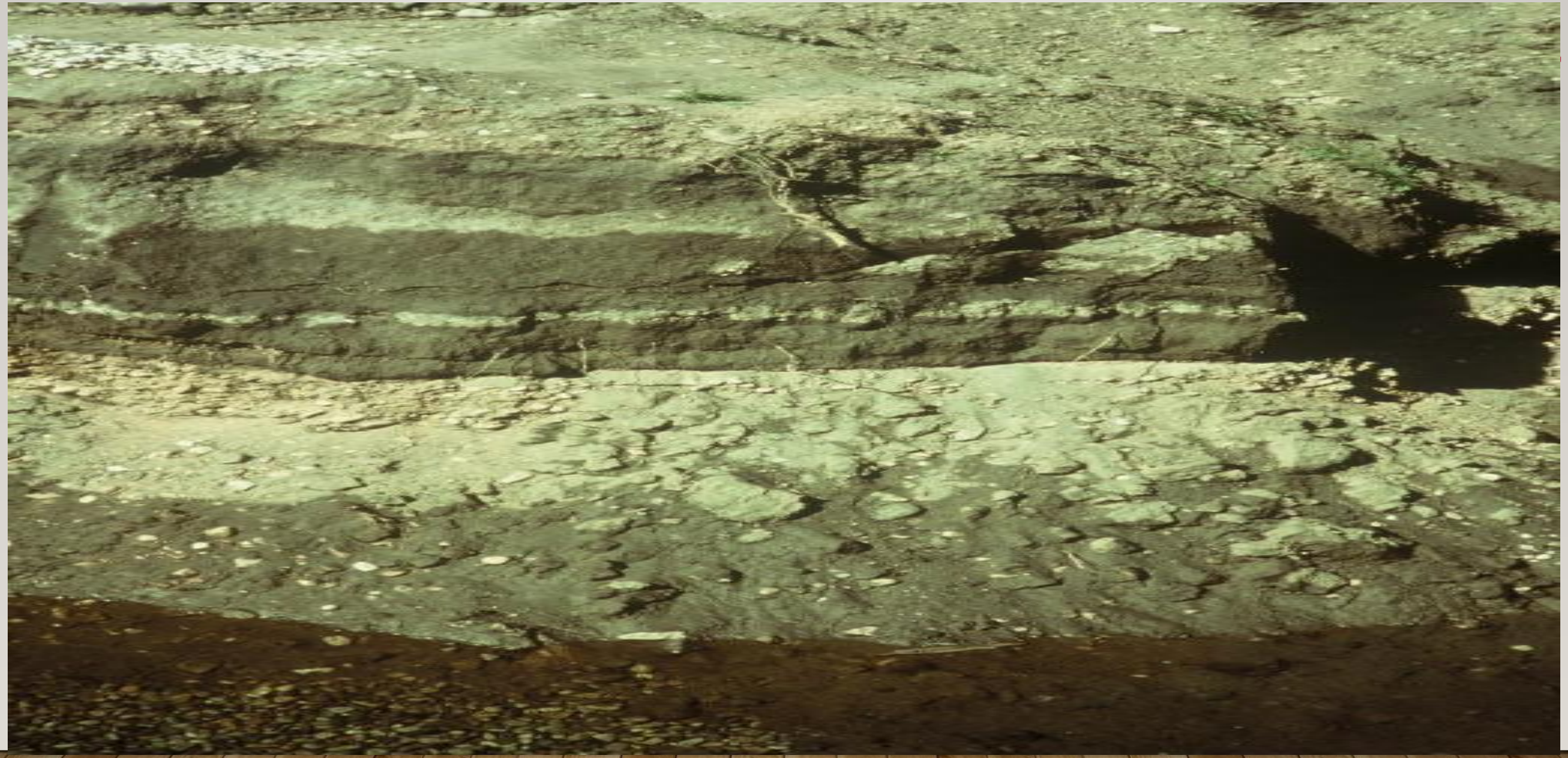
HOW IS Fe & Mn FORMED (GROUND WATERS)

- Contact with Iron and Manganese bearing rock for a extended periods of time as the water passes through the layers of the aquifer formations
- Fe and Mn concentration in ground water is fairly constant year around
- May vary as flow is varied

CONSOLIDATED FORMATIONS



UNCONSOLIDATED FORMATIONS



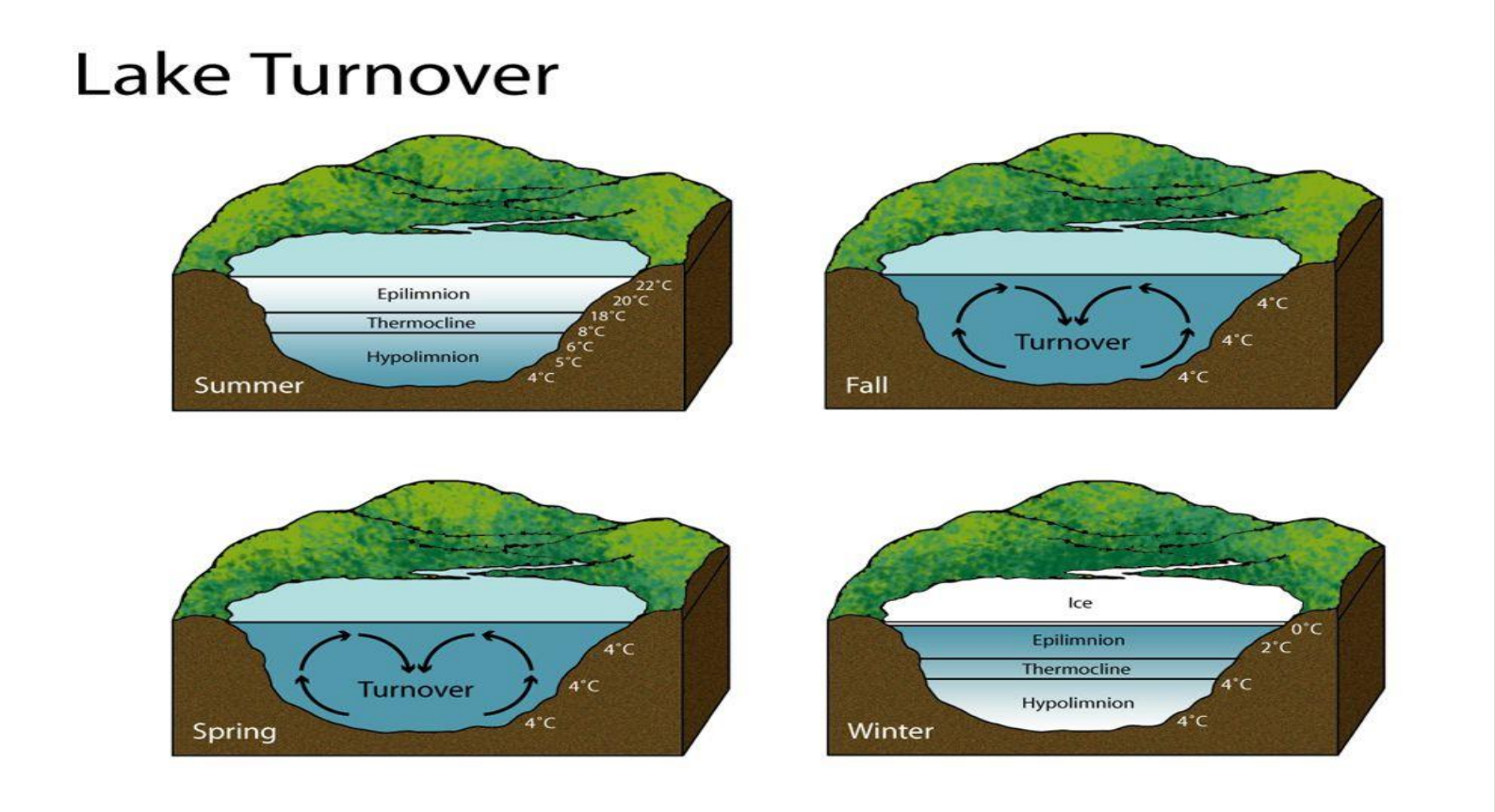
THERMAL STRATIFICATION & DESTRATIFICATION

- Water is most dense at 39°F (4°C)
- Normally thermal stratification begins to occur in the Spring of the year, and thermal destratification occurs in the fall of the year
- The hypolimnion is formed as a result of thermal stratification of a body of water. The thermal layers of water are
  - Epilimnion
  - Medilimnion, also called thermocline
  - Hypolimnion
- As the water warm, the above three layers are formed

HOW IS Fe & Mn FORMED (SURFACE WATERS)

- In surface waters, Fe & Mn is formed in the anoxic layer called the "Hypolimnion"
- The anoxic hypolimnion causes Fe & Mn to be released from the decay of organic matter on the bottom of the body of water
- Fe & Mn is developed at the interface of the bottom soils of the body of water and the surface of bottom soil and sediments under anoxic conditions
- The more organic material on the bottom of a lake the more Fe and Mn are formed

WATER TURNOVER OCCURRENCES



ROCKDALE COUNTY, GA

ROCKDALE COUNTY, GA

FAJARDO, PR

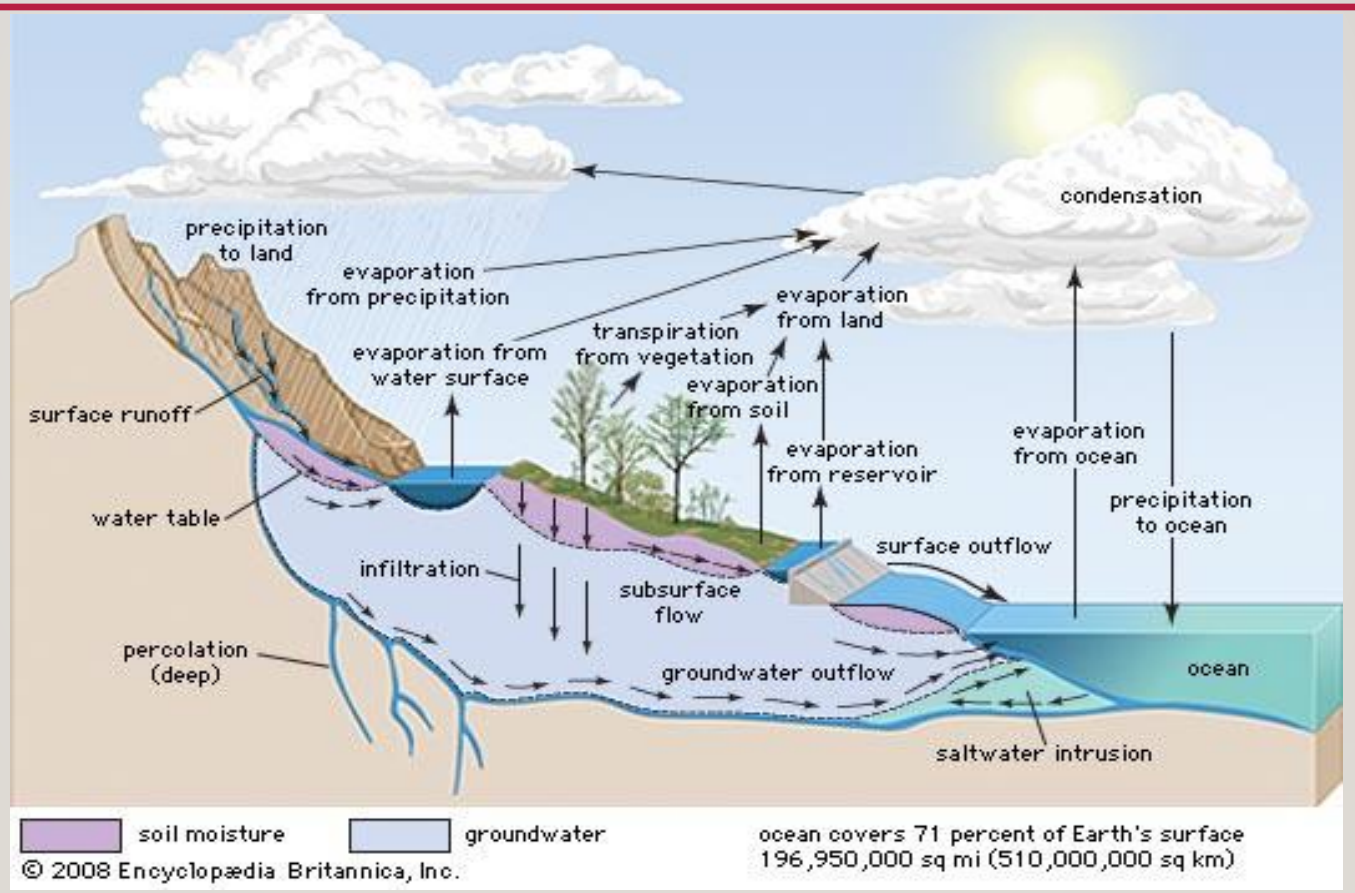
HARSHA LAKE
CLERMONT COUNTY, OHIO

GRINDSTONE LAKE
RUIDOSO, NM

HYDROLOGIC CYCLE

- The Hydrologic Cycle is a phenomenon the occurs day in and day out as long as there is reasonable moisture in the environment to support

HYDROLOGIC CYCLE



LONDON IRON FILTERS

LONDON IRON FILTERS AND ION EXCHANGE SOFTENERS

HOW TO CONTROL FE & MN FORMATION

- Sequestration
- Remove it by oxidation and filtration
  - Aeration
  - Lime Softening
  - $KMnO_4$
  - Free Chlorine
  - Chloramine
  - Chlorine dioxide
  - Ozone
- Don't let it get started
  - Limnetic Aeration

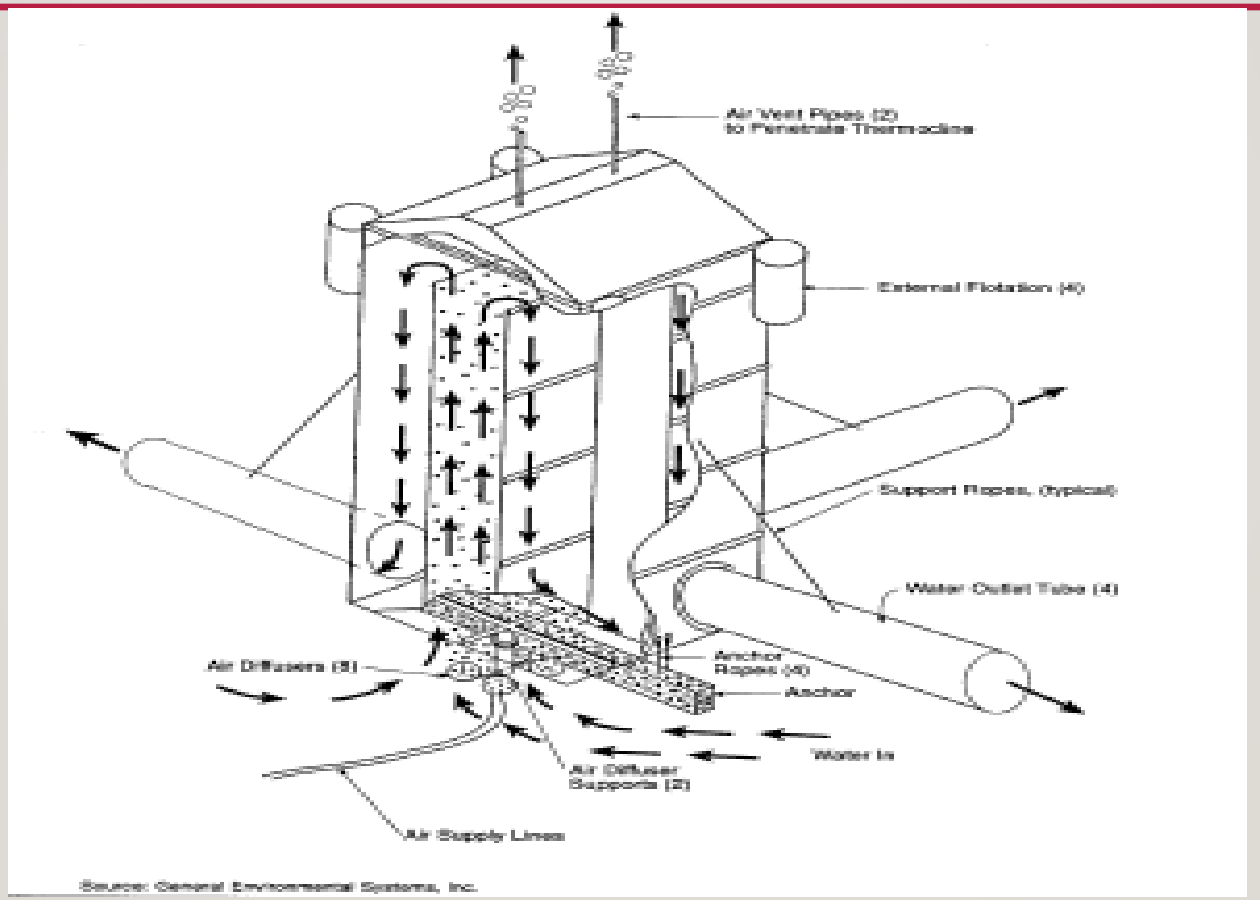
OXIDANT DEMAND

- Iron
  - O_2 = 0.14 mg/L per mg/L Fe
  - O_3 = 0.43 mg/L per mg/L Fe
  - HOCl = 0.64 mg/L per mg/L Fe
  - $KMnO_4$ = 0.94 mg/L per mg/L Fe
  - ClO_2 = 0.24 mg/L per mg/L Fe
- Manganese
  - 0.29 mg/L per mg/L Mn
  - 0.88 mg/L per mg/L Mn
  - 1.30 mg/L per mg/L Mn
  - 1.92 mg/L per mg/L Mn
  - 2.45 mg/L per mg/L Mn

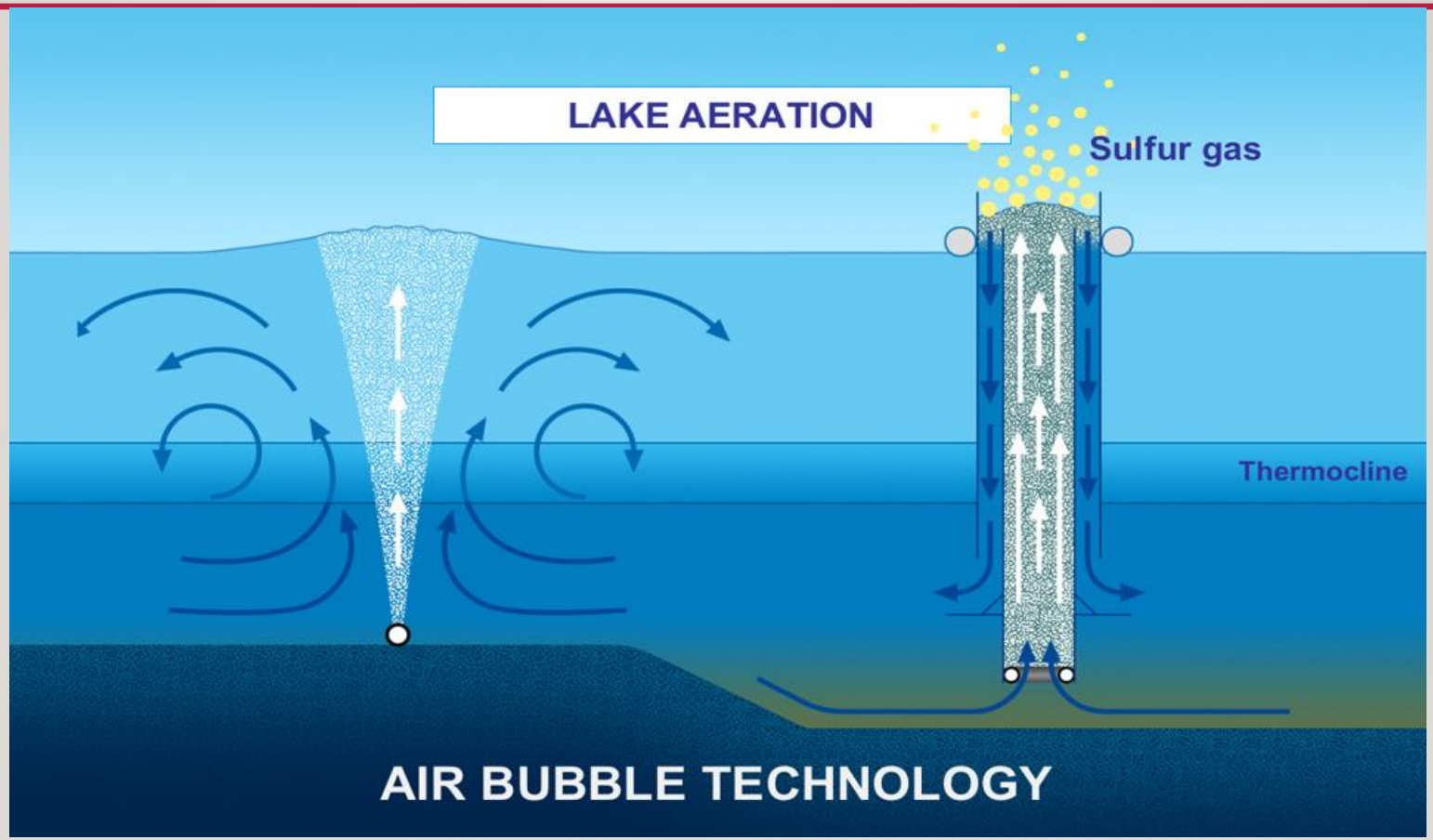
THE BEST WAY TO TREAT FOR IRON & MANGANESE IN WATER IS TO PREVENT ITS FORMATION

- Aeration of the water will remove the soluble Iron, but only minimally reduce the soluble Manganese depending on the raw water pH
- Hypolimnetic Aeration will add oxygen to the anaerobic hypolimnetic layer of water
- The oxygen will stabilize the bottom soils and reduce or eliminate the formation of Iron and Manganese
- Ravenna, Ohio experience

HYPOLIMNETIC AERATOR



HYPOLIMNETIC AERATOR



HYPOLIMNETIC AERATION

- Will freshen the water supply by adding O_2 to the water
- Will reduce taste and odor formation
- Will reduce other oxidant demands
- Prevent Iron and Manganese formations when possible
- Control Iron and Manganese by reducing it in the treatment process

OTCO WATER WORKSHOP

Questions???