Despite efforts, many sites produce AMD and require treatment

Surface Mine Drainage

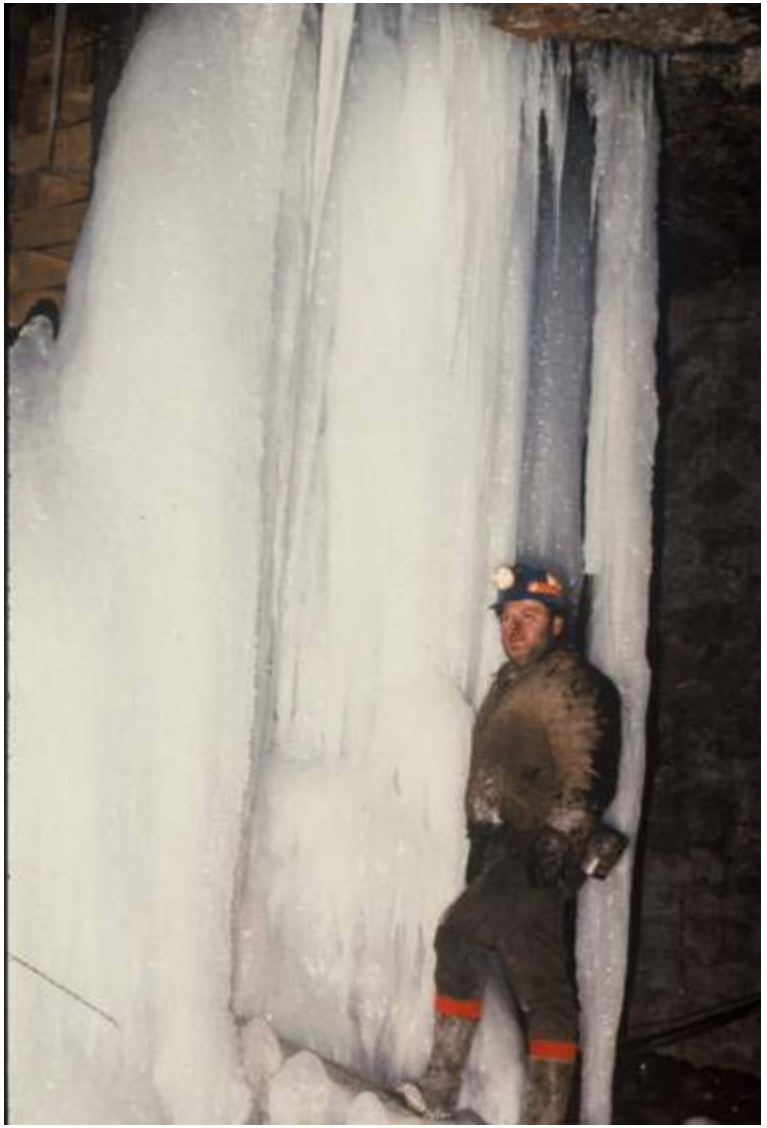
Passive Treatment

1 mg/L of dissolved oxygen can oxidize 7 mg/L of ferrous iron

Underground Mine Discharges

Wet Mines

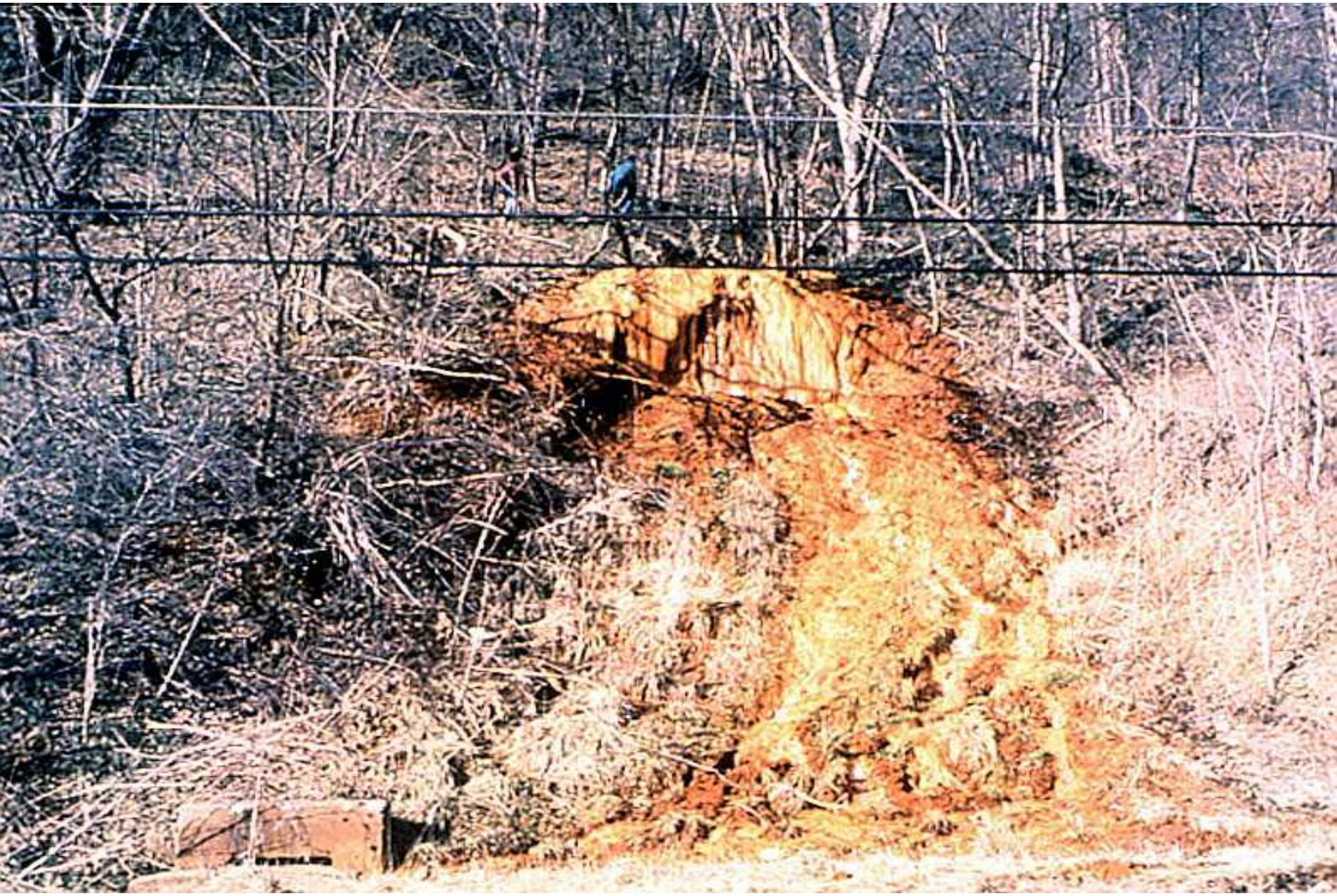
Leaking Mine Roof



Water Pumped to Surface

Surface Treatment at an Abandoned Underground Mine Site

Proper characterization of AMD is important for appropriate and efficient treatment (active or passive).



Passive Treatment

”WHAT WOULD THE WORLD BE,
ONCE BEREFT OF WET AND
WILDNESS?
LET THEM BE LEFT,
O LET THEM BE LEFT,
WILDNESS AND WET;
LONG LIVE THE WEEDS AND
THE WILDERNESS YET”

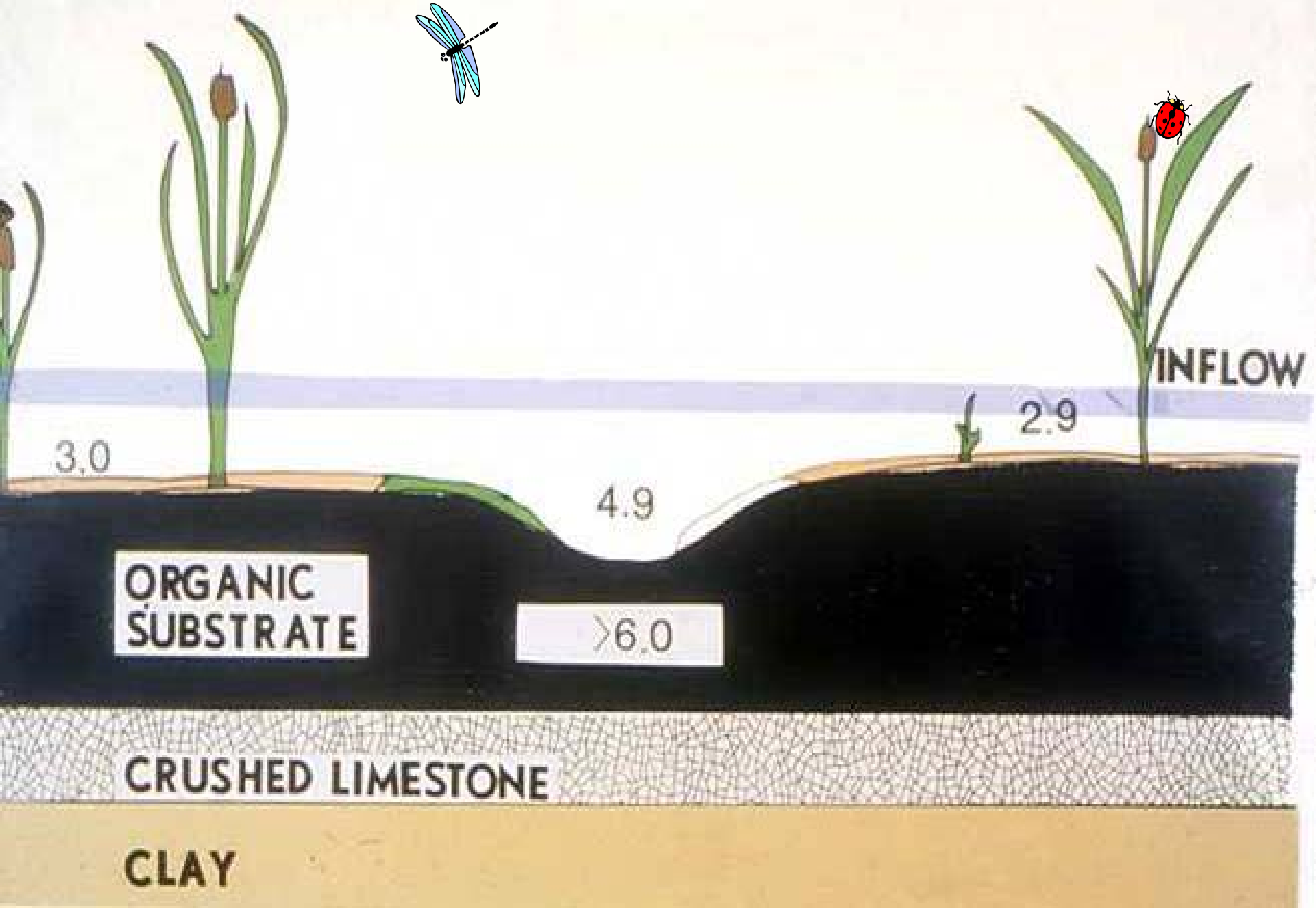
GERARD MANLEY HOPKINS

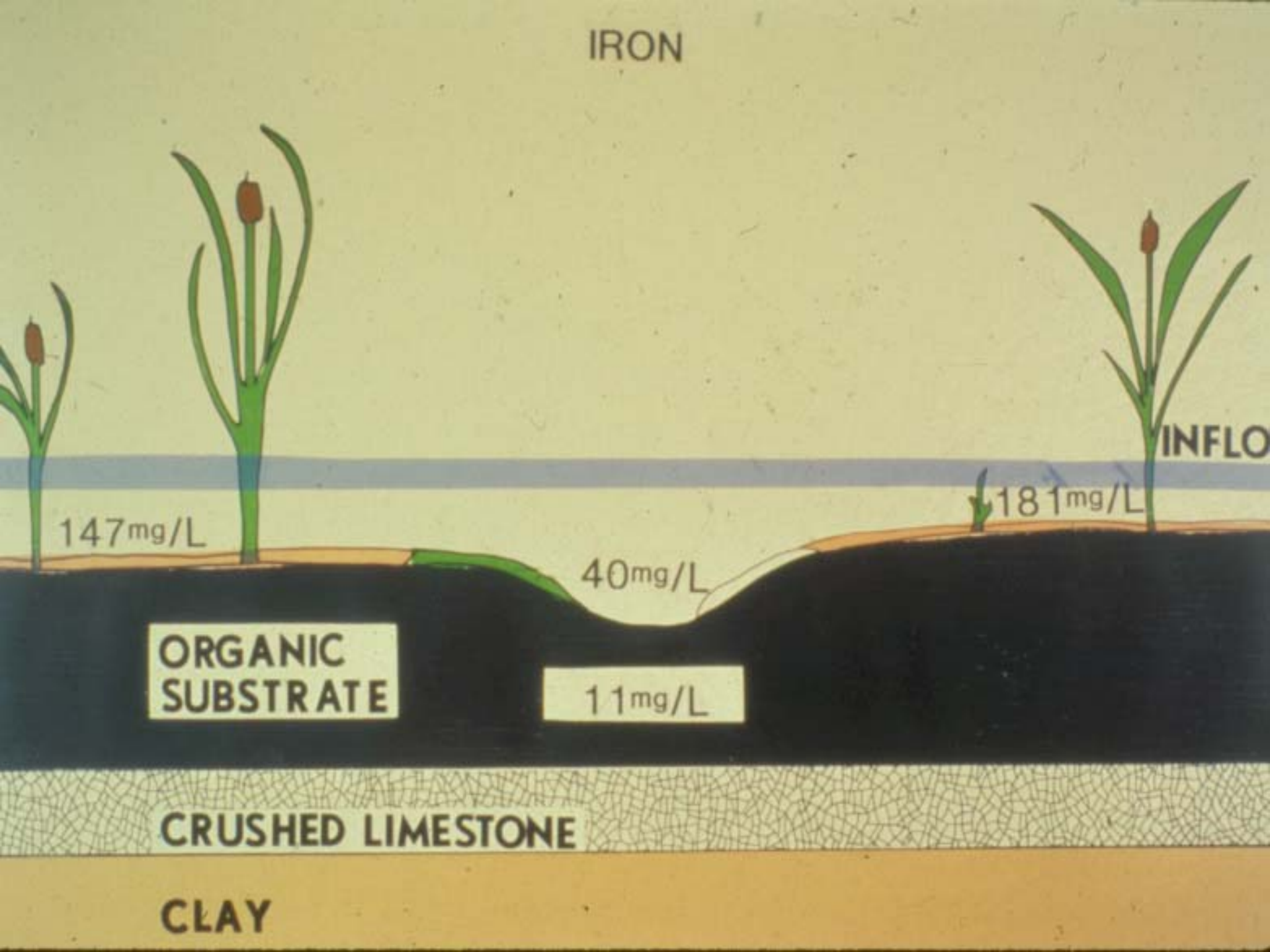
"A WEED IS A PLANT WHOSE VIRTUE HAS NOT YET BEEN DETERMINED"

HENRY THOREAU

Aerobic Wetlands and Ponds

- Net Alkaline Mine Drainage
- Oxidize Fe and Mn
- Precipitate Metal Hydroxides
- Settle Solids
- Removal Rates
- Fe: 10 – 20 $gd^{-1}m^{-2}$
- Mn: 0.5 – 1 $gd^{-1}m^{-2}$


INFLOW
2.9
3.0
4.9
ORGANIC SUBSTRATE
>6.0
CRUSHED LIMESTONE
CLAY


IRON
INFLO
181mg/L
147mg/L
40mg/L
ORGANIC SUBSTRATE
11mg/L
CRUSHED LIMESTONE
CLAY

Compost Wetland

- **Net Acidic Mine Drainage**
- **Ferric Iron or Aluminum**
- **Adds Bicarbonate Alkalinity**
- **Sulfate Reduction**
  - Metal sulfides less soluble than hydroxides
  - Cu, Pb, Zn, Cd
- **Acidity removal: 3.5 – 7 $gd^{-1}m^{-2}$**
  - Large land areas

Anoxic Limestone Drains (ALDs)

Net Acidic → Net Alkaline

$CaCO_3 \rightarrow Ca^{2+} + HCO_3^-$

$Fe^{2+} \rightarrow Fe^{2+}$

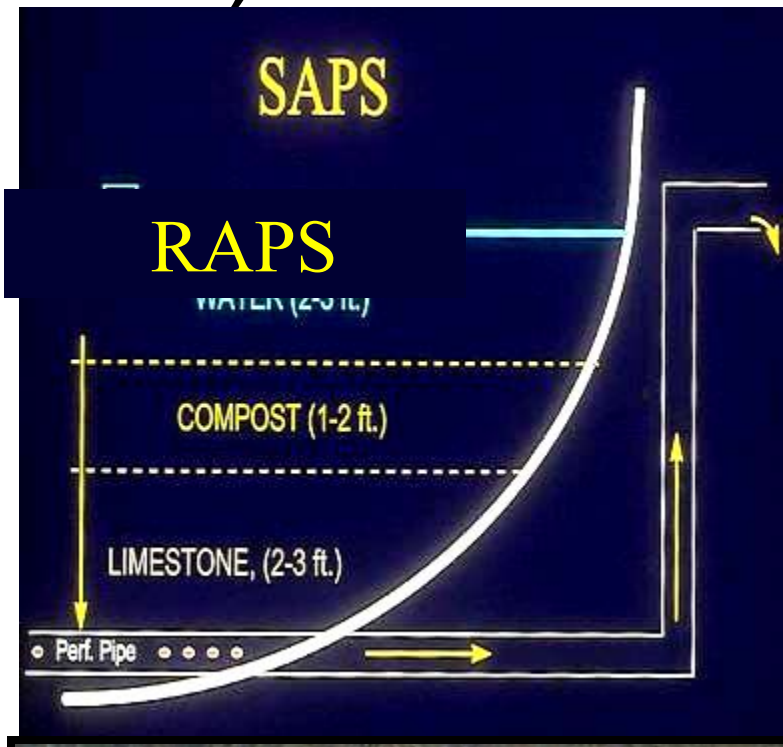
$Mn^{2+} \rightarrow Mn^{2+}$

Anoxic Limestone Drains (ALDs)

- **Net Acidic Mine Drainage**
- **No Ferric Iron or Aluminum**
- **Adds Bicarbonate Alkalinity**
- **Alkalinity Buffers pH when Metals Hydrolyze**
- **~15 hrs for Max Alkalinity**

Reducing and Alkalinity Producing Systems (RAPS)

- **Net Acidic Mine Drainage**
- **Ferric Iron or Aluminum**
- **Adds Bicarbonate Alkalinity**
- **Sulfate Reduction**
  - Metal sulfides less soluable than hydroxides
  - Cu, Pb, Zn, Cd
- **Acidity removal: 15 – 60 $gd^{-1}m^{-2}$**



Semi-Passive Treatment

- Low to High Capital Costs
- Lower Operating Costs
  - Alternate Power Source
    - Water
    - Wind
- Limestone
- Sludge Removal

Active Treatment

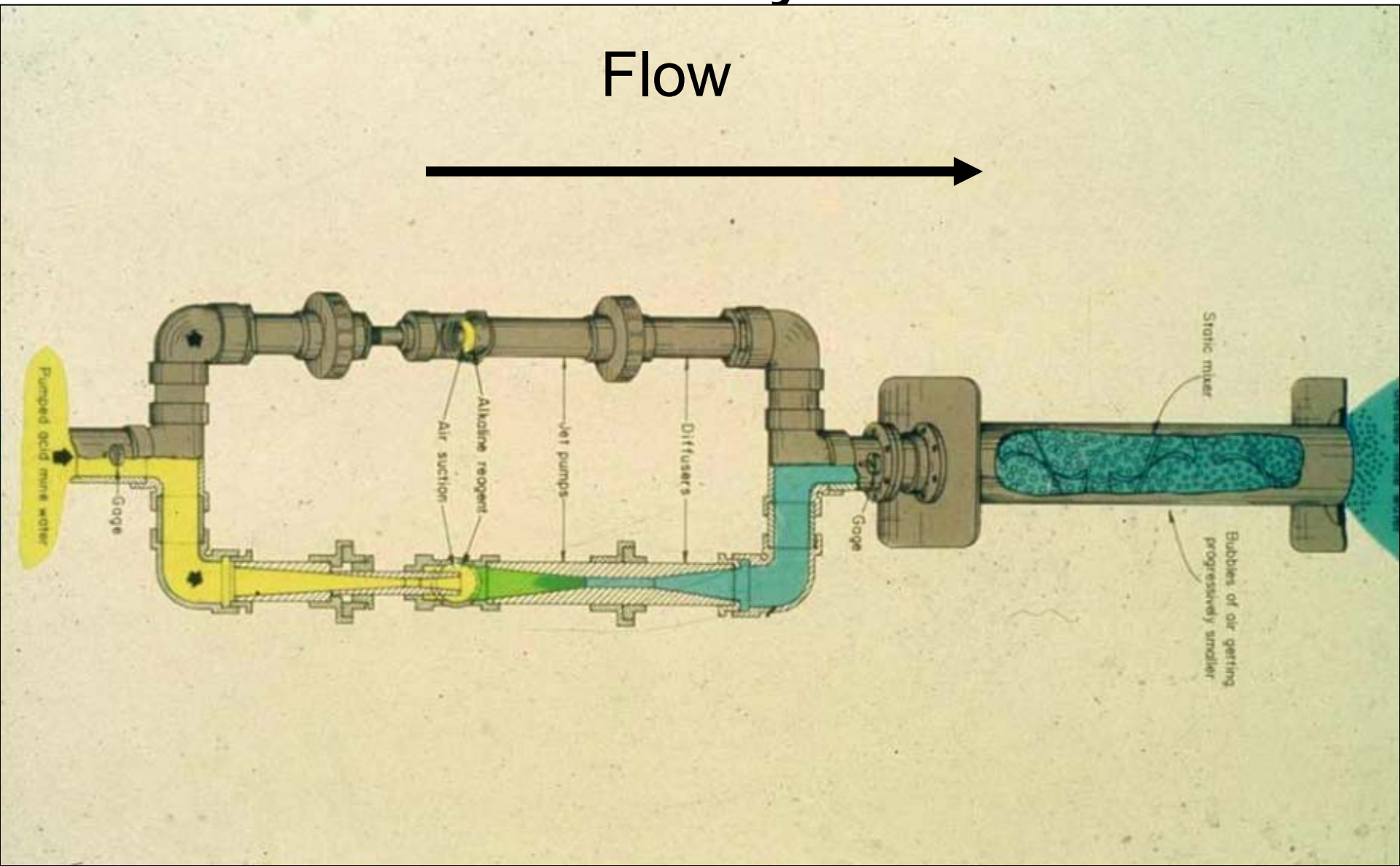
Lime + mechanical aeration

Conventional Treatment is Often Inefficient

Jet Pump (or Eductor) Component

- Broad range of sizes for a capability of treating a broad range of flows.
- Can be used in parallel to increase treatment capacity.
- Jet pumps can be used to feed liquid reagents to jet pumps.
- Easy Maintenance.

Schematic of 1st Generation In-Line System



Two Types of Static Mixers: *Horizontal Design*

Two Types of Static Mixers: *Horizontal Design*

Two Types of Static Mixers: *Vertical Design*

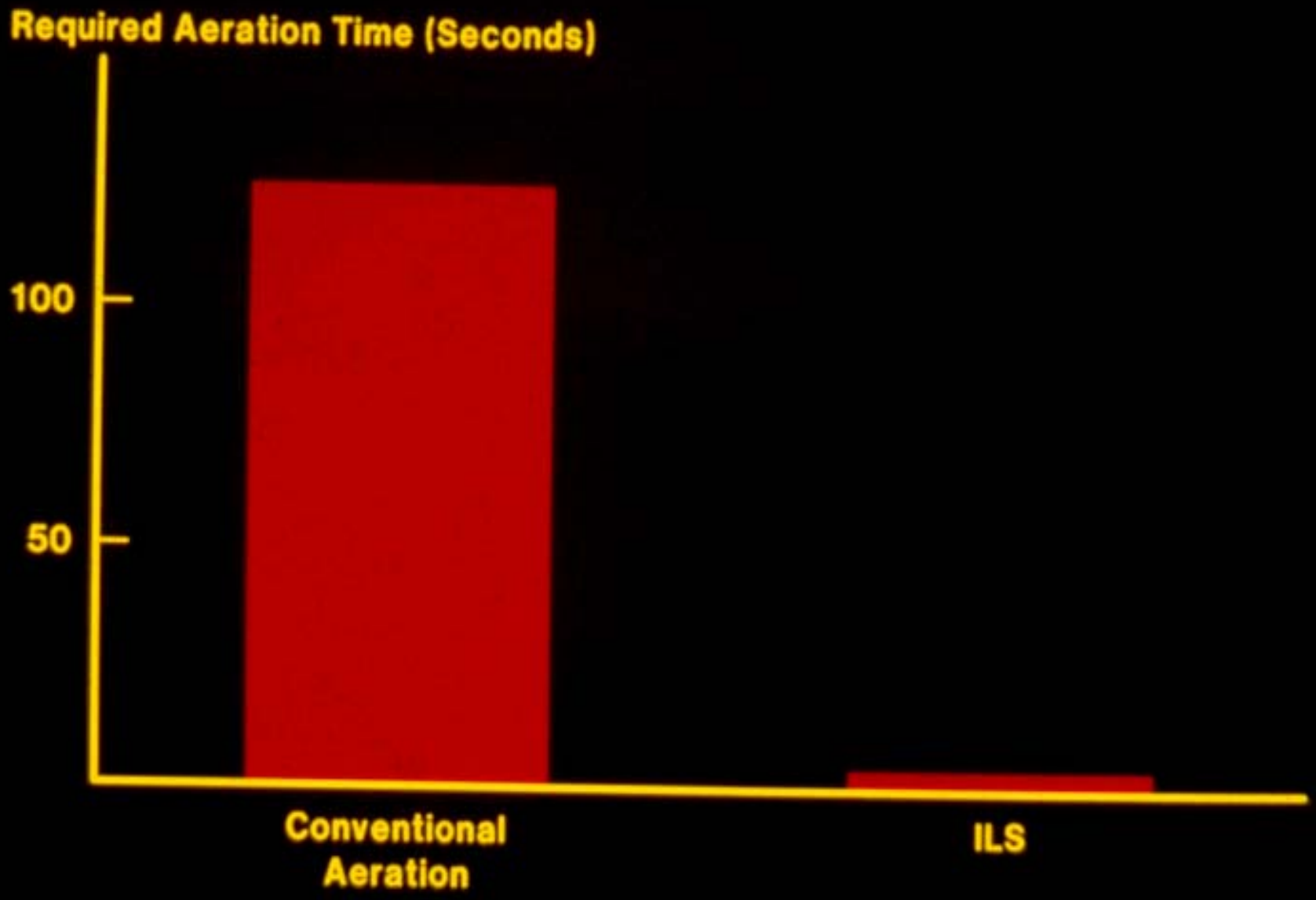
Trickling Media

Variety of Sizes

Packed in Standard Pipe

Easily Cleaned

AT pH 7.5


Required Aeration Time (Seconds)
100
50
Conventional Aeration
ILS

Advantages

- Simultaneous aeration and neutralization.
- Reduced capital, operating, maintenance and alkalinity costs.
- ILS can be permanent or portable.
- No moving parts.
- Easy to install.
- Easy to operate.
- Can operate passively with >50 feet of head.
- Electrical power need not be located at treatment site.

In-mine water treatment using Aquafix unit and the ILS

AMD Sludge Disposal

QUESTIONS?