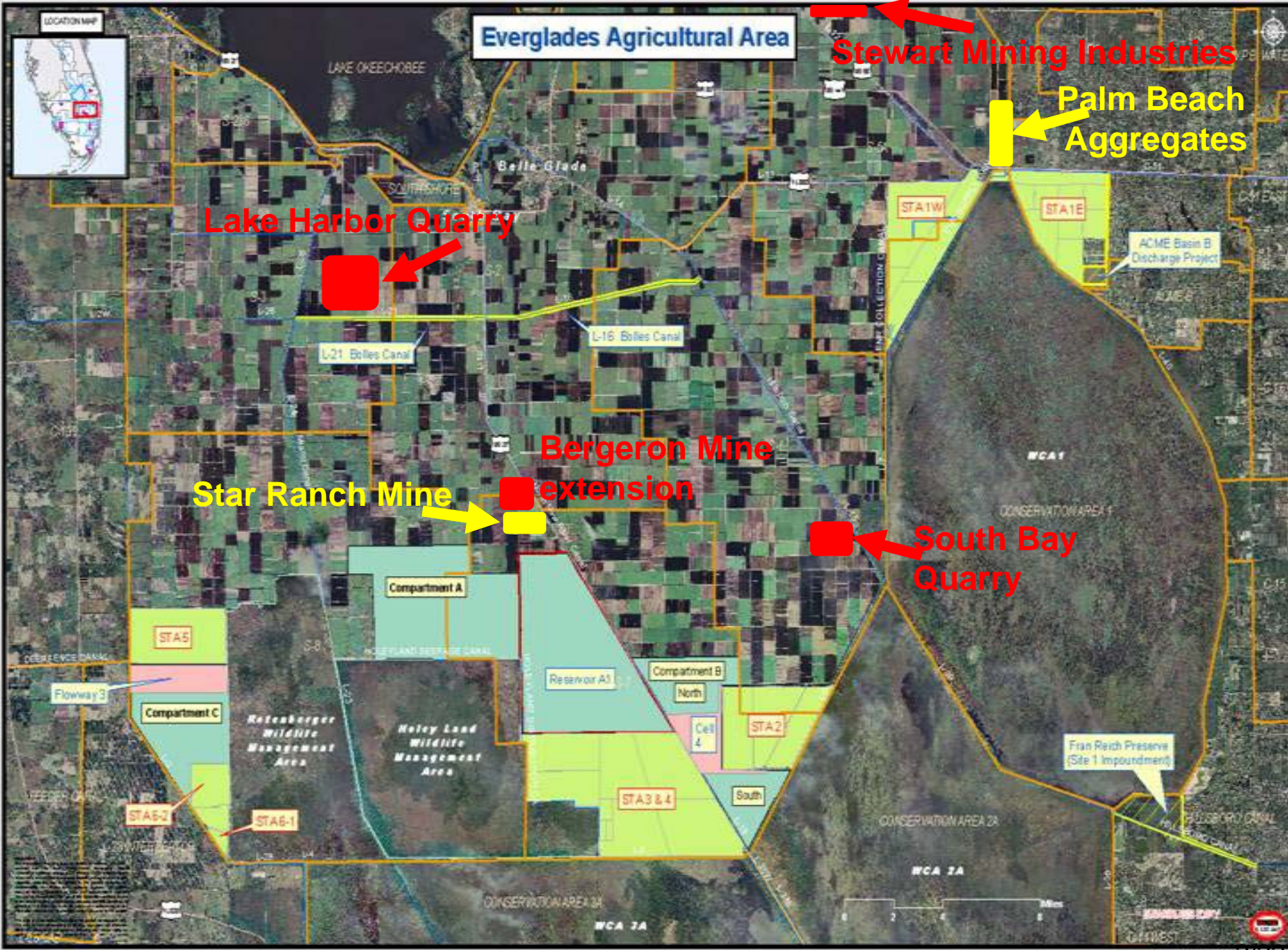


Rock Mining Operation Effects on Water Quality in the Everglades Agricultural Area

G. Melodie Naja

Everglades Foundation – Science Department

January 8, 2010



Star Ranch Mine will be ...

- 1- Less than 0.64 mile from a future reservoir or STA (Talisman proj., under construction)
- 2- Less than 7 miles from STA3/4 and STA2
- 3- Less than 11 - 14 miles away from Loxahatchee or WCA2

STAs and reservoirs are intended to:

- 1- Capture and store fresh water
- 2- Purify water using specific plants and microorganisms
- 3- Provide public access and **recreational** opportunities



Seepage (average year) 10cm x surface area (TVL)

Long Term and Cumulative Effects on Water Quality

Increasing interactions between Groundwater and Surface water



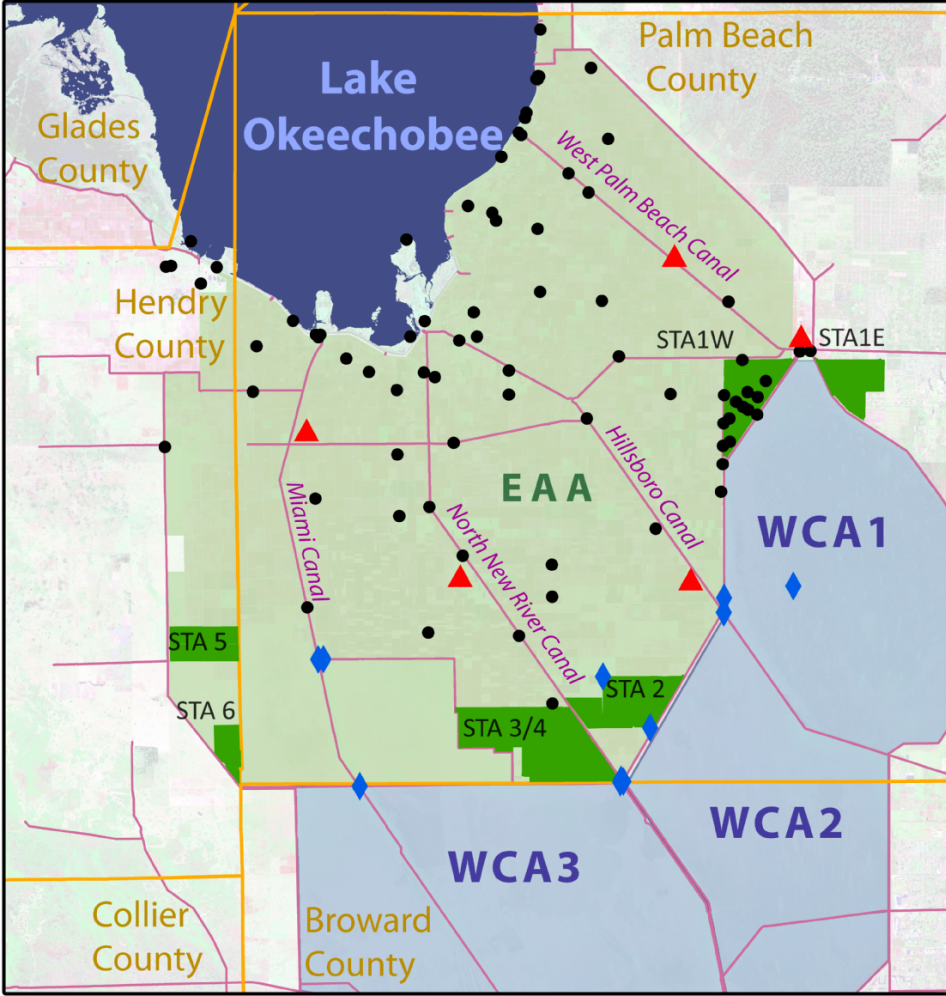
Different Chemistry !

What are the compounds of concern ?

- Surficial (< 200 m) groundwater chemistry in the EAA ?
- Surface water chemistry ?



- Groundwater wells
- ◆ Surface water monitoring locations
- ▲ Rock mining locations



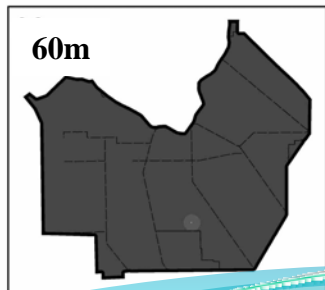
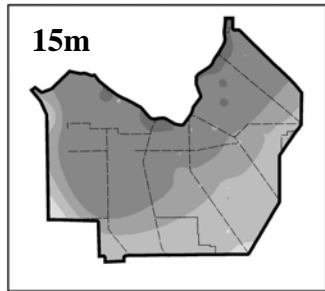
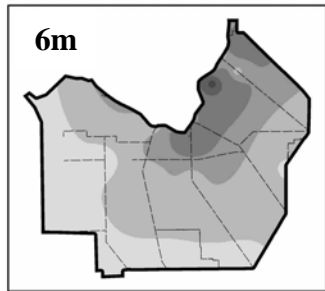
- 1- Haag, K. H. et al. (1996) - USGS
- 2- FDEP - Groundwater analysis
- 3- ENR - DBHYDRO
- 4- Harvey, J. W. et al. (2004) USGS- SFWMD
- 5- Miller, W. L. (1988) - USGS
- 6- Renken, R. A. et al. (2005)

↓ ◆
Everglades National Park

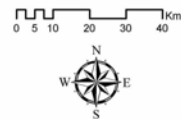
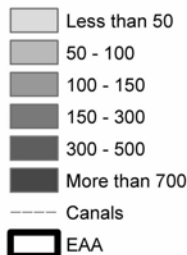
Groundwater chemistry and depth ...

Sulfate :

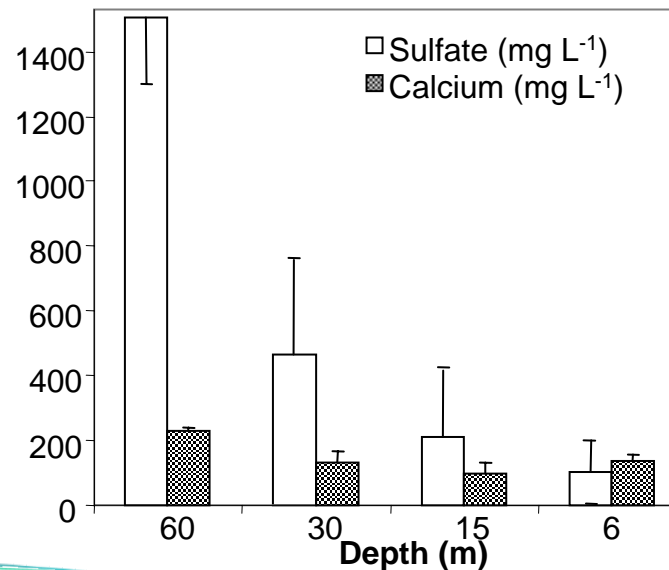
- 1- Location dependant
- 2- Increase with depth
- 3- Reach 1500 mg L^{-1} at 60 m depth in some locations



Sulfate (mg/L)



Chemical composition of groundwater



Groundwater chemistry and depth ...

At **15 meters** (50 feet) depth, sulfate concentrations will be around 250 mg/L and reaching 400 mg/L in some spots. At 60 meters depth, sulfate is reaching 1,500 mg/L.

Sulphate levels in lakes typically range from 3 to 30 mg/L.

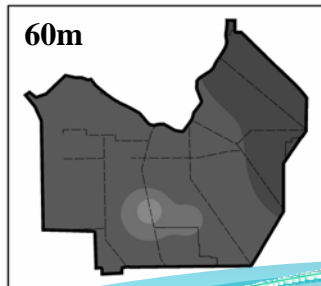
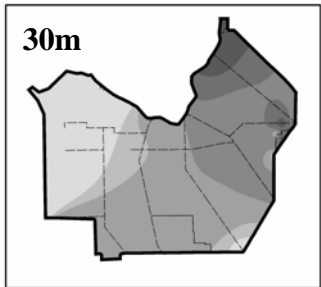
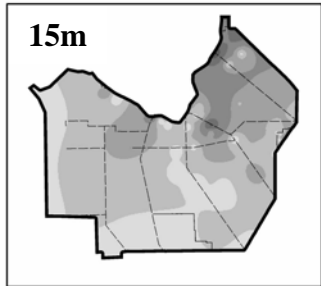
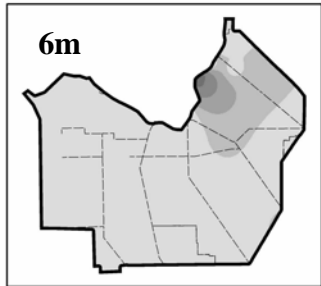
Sulphate levels in seawaters is typically around 2700 mg/L

National Research Council of Canada -
NRCC No. 15015 - Associate Committee
on Scientific Criteria for Environmental
Quality, 1977.

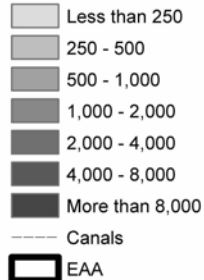
Groundwater chemistry and depth ...

Chloride :

- 1- Location dependant
- 2- Increase with depth
- 3- Reach 8000 mg L^{-1} at 60 m depth in some locations



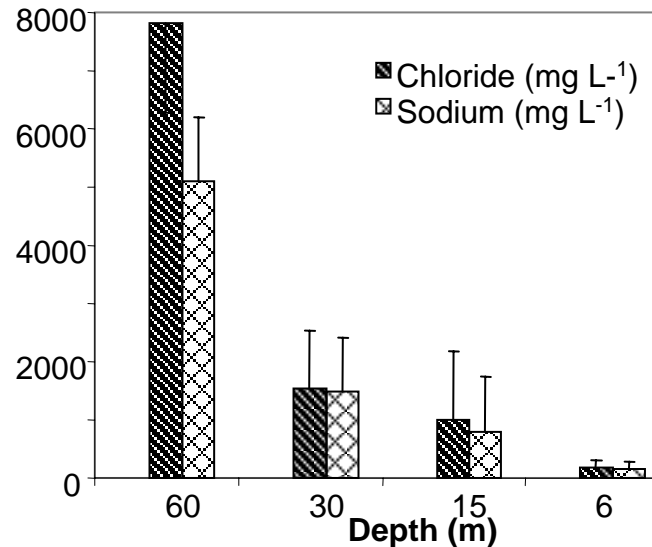
Chloride (mg/L)



0 5 10 20 30 40 Km



Chemical composition of groundwater



Groundwater chemistry and depth ...

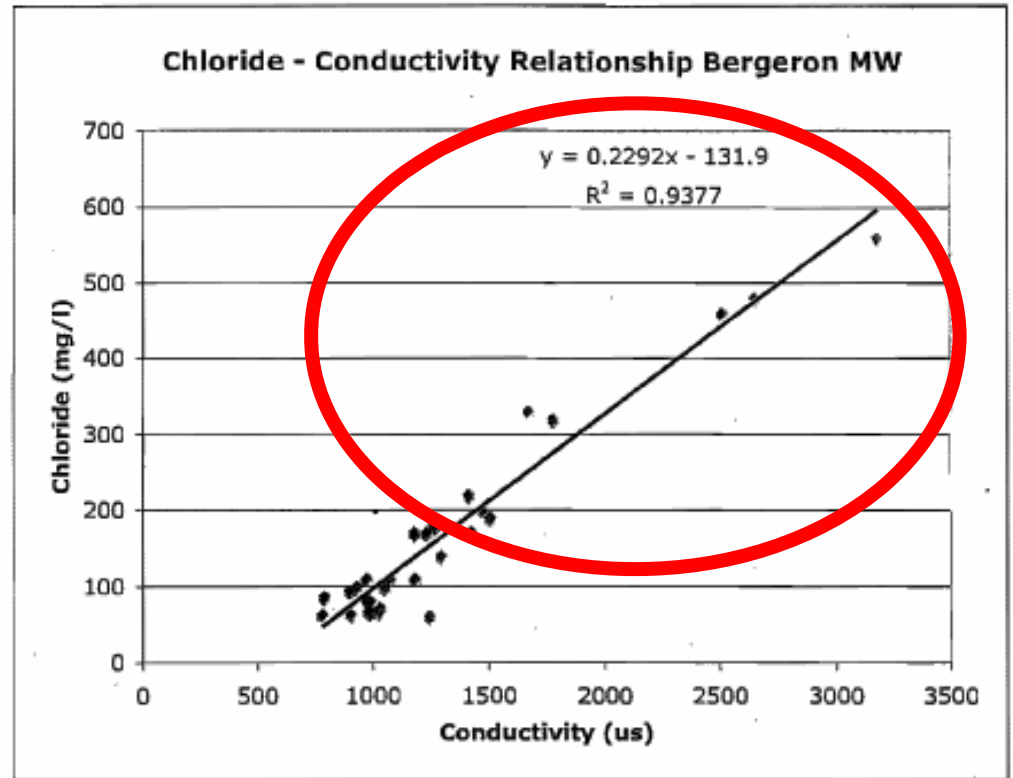
At **15 meters** (50 feet) depth, chloride concentrations will be between **350 – 1000 mg/L** and the conductivity is **> 2,500 $\mu\text{S}/\text{cm}$** .

Normal chloride range in rivers is **45 – 155 mg/L**
EPA drinking water regulations: chloride maximum level is **250 mg/L**

Dunkelberger
Engineering and Testing

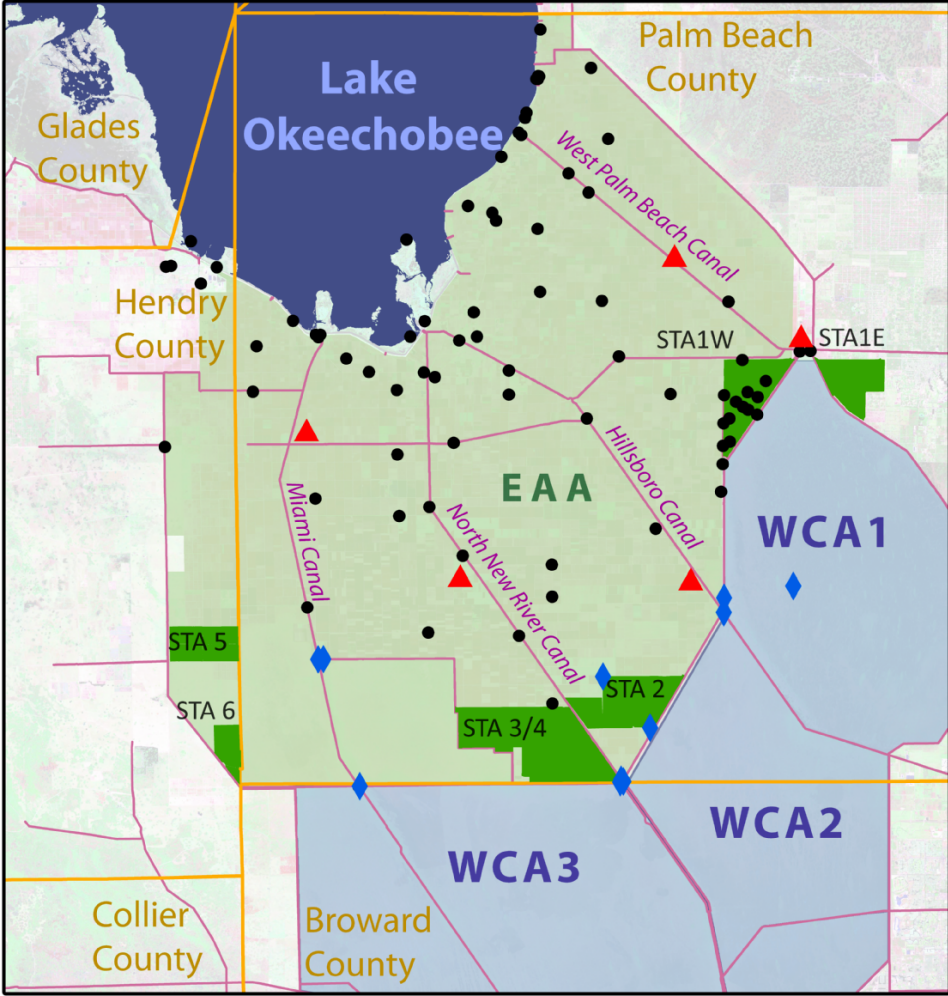
Water samples from the large
Lake east of the Bergeron
Star Rock Mine

December 2008



Depth Feet	East Center of Lake		West Center of Lake	
	Cond us	cl mg/l	Cond us	cl mg/l
0 (surface)	1383	185	1320	171
10	1383	185	1323	171
20	1336	174	1323	171
30	1327	172	1322	171
35-40	1327	172	1320	171

- Groundwater wells
- ◆ Surface water monitoring locations
- ▲ Rock mining locations

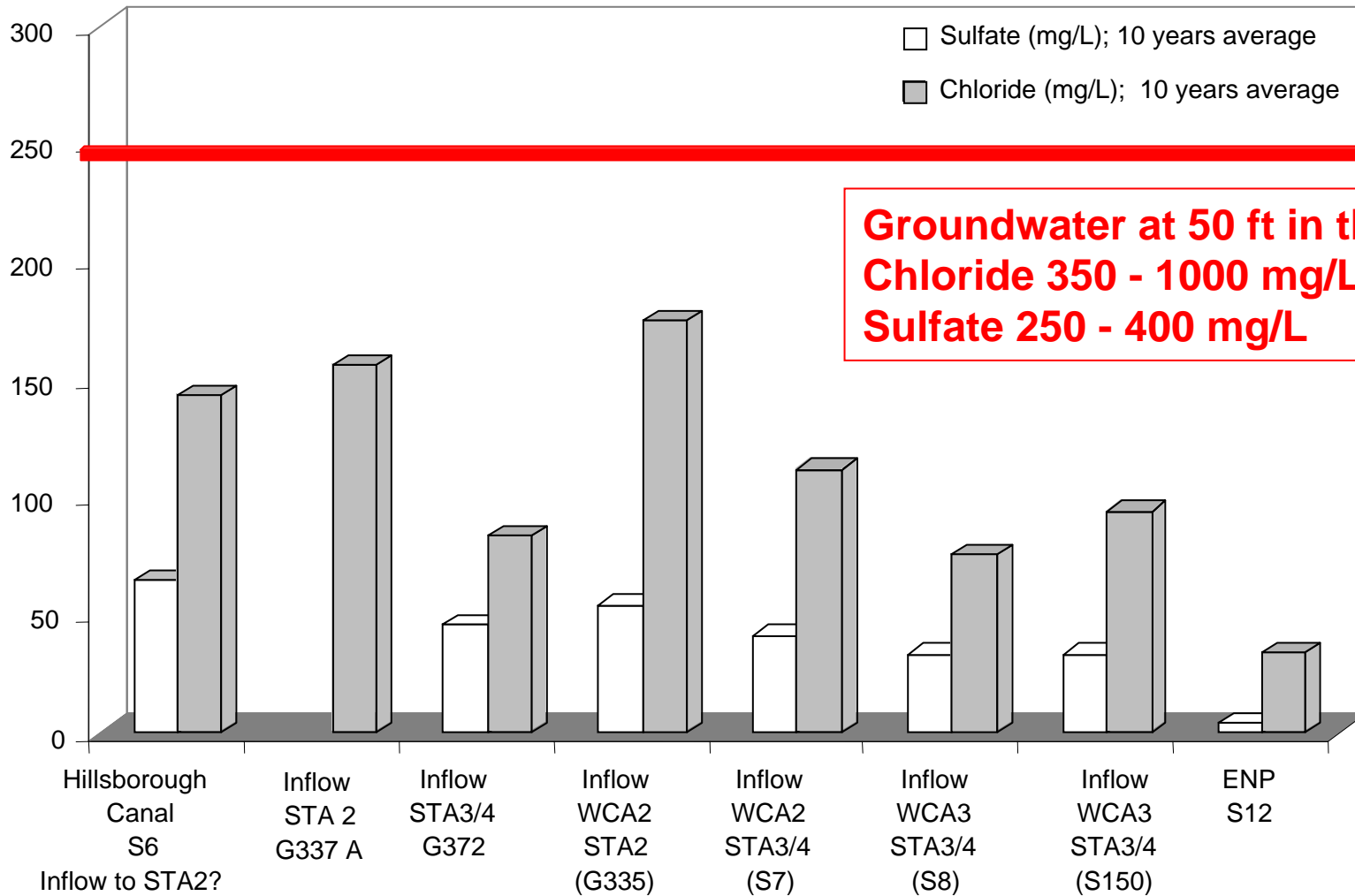


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 Everglades National Park

Groundwater /surface water

Water quality



Agriculture and its Effects on Groundwater



Soil and groundwater pollution
Virginia Tech

- Intensive agricultural land use

- * Degradation of the ground and surface water quality
- * Several studies indicated that concentrations of nitrate and phosphate are 5 to 7 times higher in groundwater when compared to surface waters.

Heatwole et al. (1996)

Brady et al. (1996)

Pionke et al. (1985)

Scalf et al. (1996)

Reed et al. (1985)

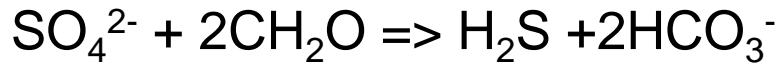
Altered surface water quality

In brief:

**Higher Sulfate, Chloride,
Nitrate, Phosphate ,...**

Effects of sulfate ?

- Transformation of **sulfate** and its reaction with **mercury** (natural atmosphere deposition) will lead to **methylmercury** accumulated by all the living organisms

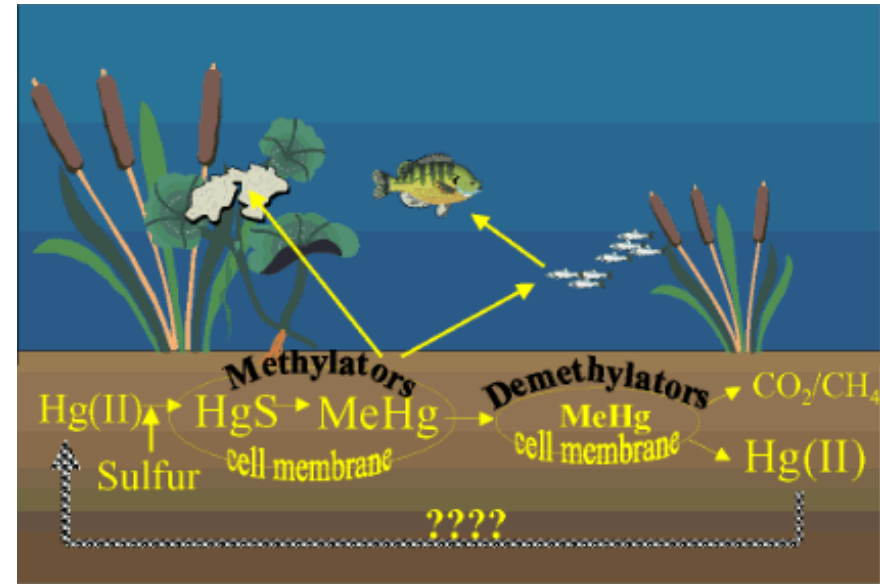


USGS :

“Mercury methylation requires the presence of **sulfate**”



Available for accumulation
in organisms



SOFIA

H₂S is a phytotoxin H₂S / O₂ competition =>
plants death =>

more nutrients => more P

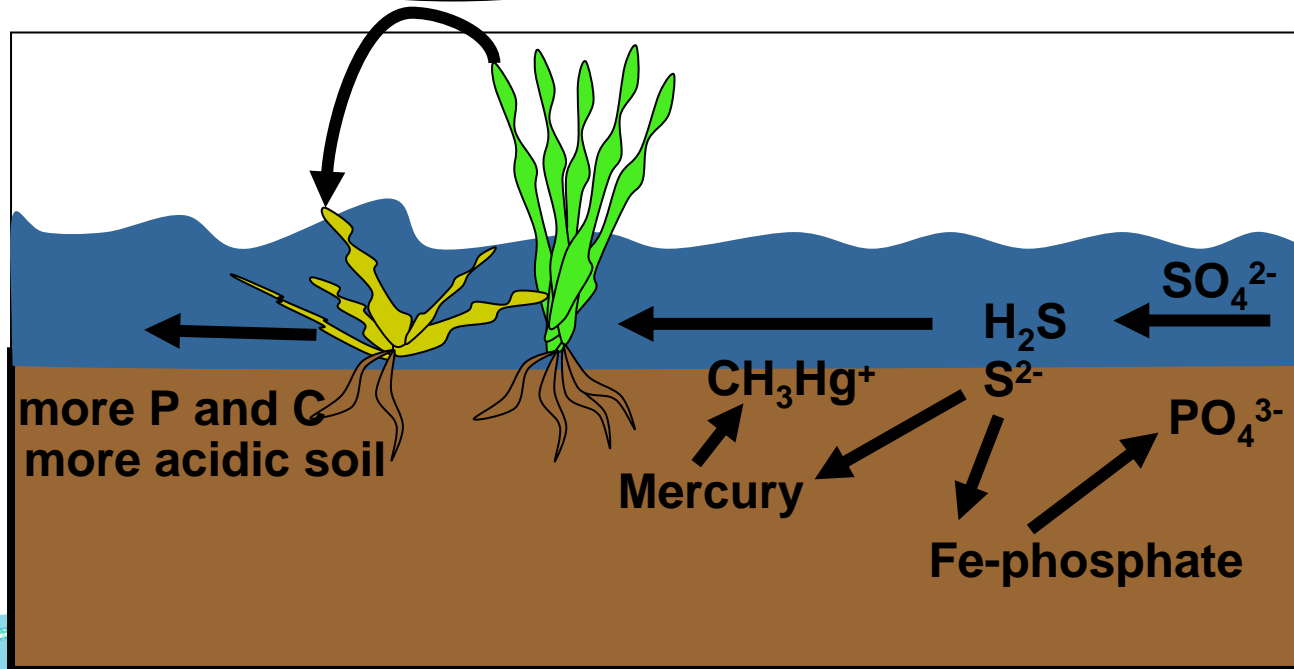
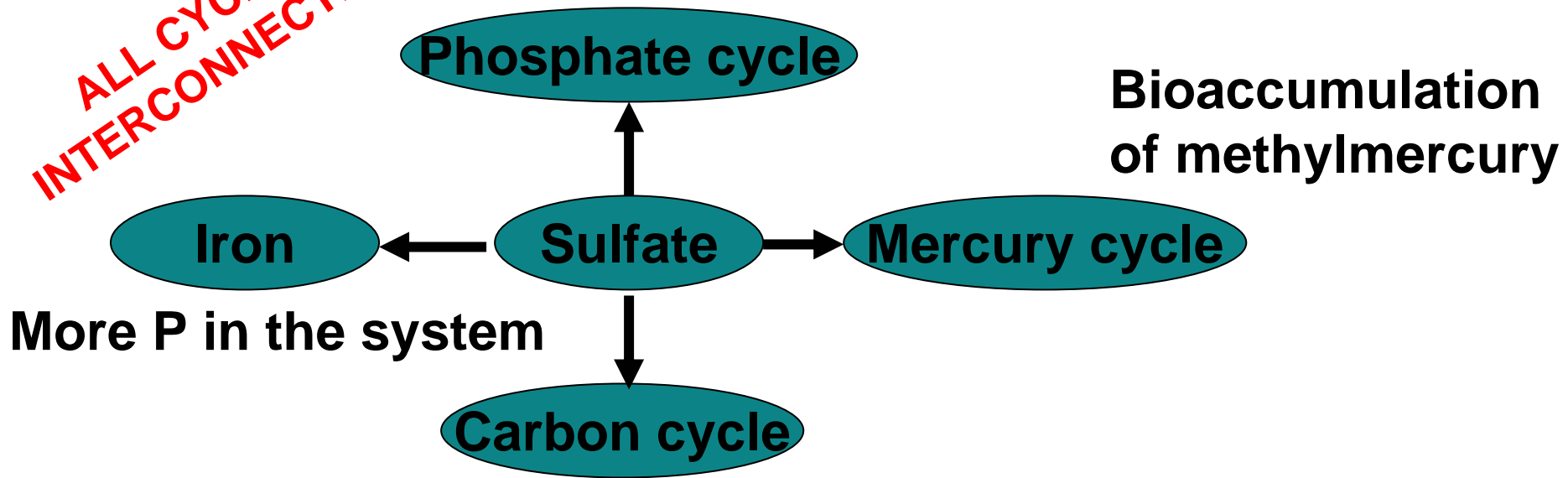
H₂S + Fe²⁺ will release P linked to iron from soils

EPA :

“ Effects of methylmercury exposure on wildlife can include mortality (death), reduced fertility, slower growth and development and abnormal behavior that affects survival...”

Eutrophication and toxic algae

ALL CYCLES INTERCONNECTED!



Effects of Chloride ?

● High chloride =>

US EPA report published in 2000 gives an excellent overview of the effect of increased water salinity on the ecology.

“Biological Criteria for Inland Freshwater Wetlands in Florida: A Review of Technical & Scientific Literature” (1990-1999)

“ The shift in algal and plant communities due to the increased water salinity could certainly be expected. “

● High chloride =>

STA's will not perform as well as planned

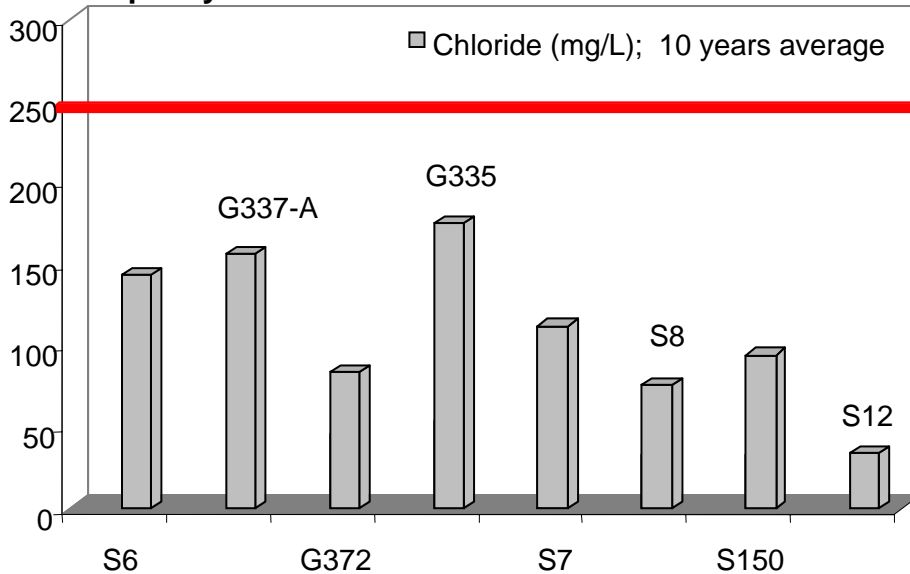
The **salinity will induce nutritional disorders to the plants in the STA which will result in a competitive uptake (P, Cl) transport or partitioning within the plant =>**

poor water quality to the Everglades

● Star ranch mine is < 0.6 mile away from a future STA

Groundwater / surface water

Water quality



**Groundwater at 50 ft in the EAA:
Chloride 350 - 1000 mg/L**

The 250 ppm chloride level requirement is above the average chloride level feeding the STAs and the WCAs

As a reminder, the normal chloride concentration range in rivers is 45 - 155 mg L⁻¹.

Effect of this new altered surface water quality on the surrounding areas

- **ENVIRONMENTAL DAMAGE**
- **NEGATIVE EFFECT ON WATER QUALITY**
- **COMBINED IMPACT OF ALL THE EXISTING AND PROPOSED MINES**

(7000 ac Lake Harbor Mine, 3700 ac South Bay Mine, 945 ac Bergeron Mines, 5400 ac Stewart mine and 350 ac Star Ranch)

EXPONENTIAL WITH THE NUMBER OF MINES IN THE REGION

THE ENVIRONMENTAL DAMAGE SHOULD BE TAKEN INTO ACCOUNT BEFORE ANY NEW PERMIT IS ISSUED

Many remaining questions still unanswered ...

- **Blasting agent.**
- **Effect of blasting and the shock waves (even under water).**
- **Total suspended solids and the colloidal particles.**

Thank You

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