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

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Star Ranch Mine will be ...

1- Less then 0.64 mile from a future reservoir or STA (Talisman proj., under construction)
2- Less then 7 miles from STA3/4 and STA2
3- Less then 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
Groundwater chemistry and depth ...

Sulfate:

1- Location dependent
2- Increase with depth
3- Reach 1500 mg L\(^{-1}\) at 60 m depth in some locations
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.
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

Chemical composition of groundwater

Chloride (mg/L)
- Less than 250
- 250 - 500
- 500 - 1,000
- 1,000 - 2,000
- 2,000 - 4,000
- 4,000 - 8,000
- More than 8,000

Sodium (mg L$^{-1}$)
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 μS/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
- Groundwater wells
- Surface water monitoring locations
- Rock mining locations
Groundwater / surface water

**Groundwater at 50 ft in the EAA:**
- Chloride 350 - 1000 mg/L
- Sulfate 250 - 400 mg/L
- 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)  Pionke et al. (1985)  Reed et al. (1985)
Brady et al. (1996)  Scalf et al. (1996)
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.

\[
\text{SO}_4^{2-} + 2\text{CH}_2\text{O} \rightarrow \text{H}_2\text{S} + 2\text{HCO}_3^-
\]

**USGS:**

"Mercury methylation requires the presence of sulfate"

\[\text{HgS} \rightarrow \text{SRB} \rightarrow \text{CH}_3\text{Hg}^+\]

Available for accumulation in organisms.

**EPA:**

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

Fish Consumption Advisories 16/22
Eutrophication and toxic algae

Phosphate cycle

Iron

Sulfate

Mercury cycle

Bioaccumulation of methylmercury

More P in the system

Carbon cycle

ALL CYCLES INTERCONNECTED!

more P and C
more acidic soil

more P in the system

Mercury

CH₃Hg⁺

H₂S

Fe-phosphate

PO₄³⁻

SO₄²⁻
Effects of Chloride?

- **High chloride =>**
  

  “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

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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