Evolution of Mine-Pool Chemistry at the Sydney Coal Mines, Nova Scotia, and Its Impacts on Decommissioning Strategy

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13th British Columbia MEND ML/ARD Workshop

Vancouver, November 29-30, 2006

Acknowledgement

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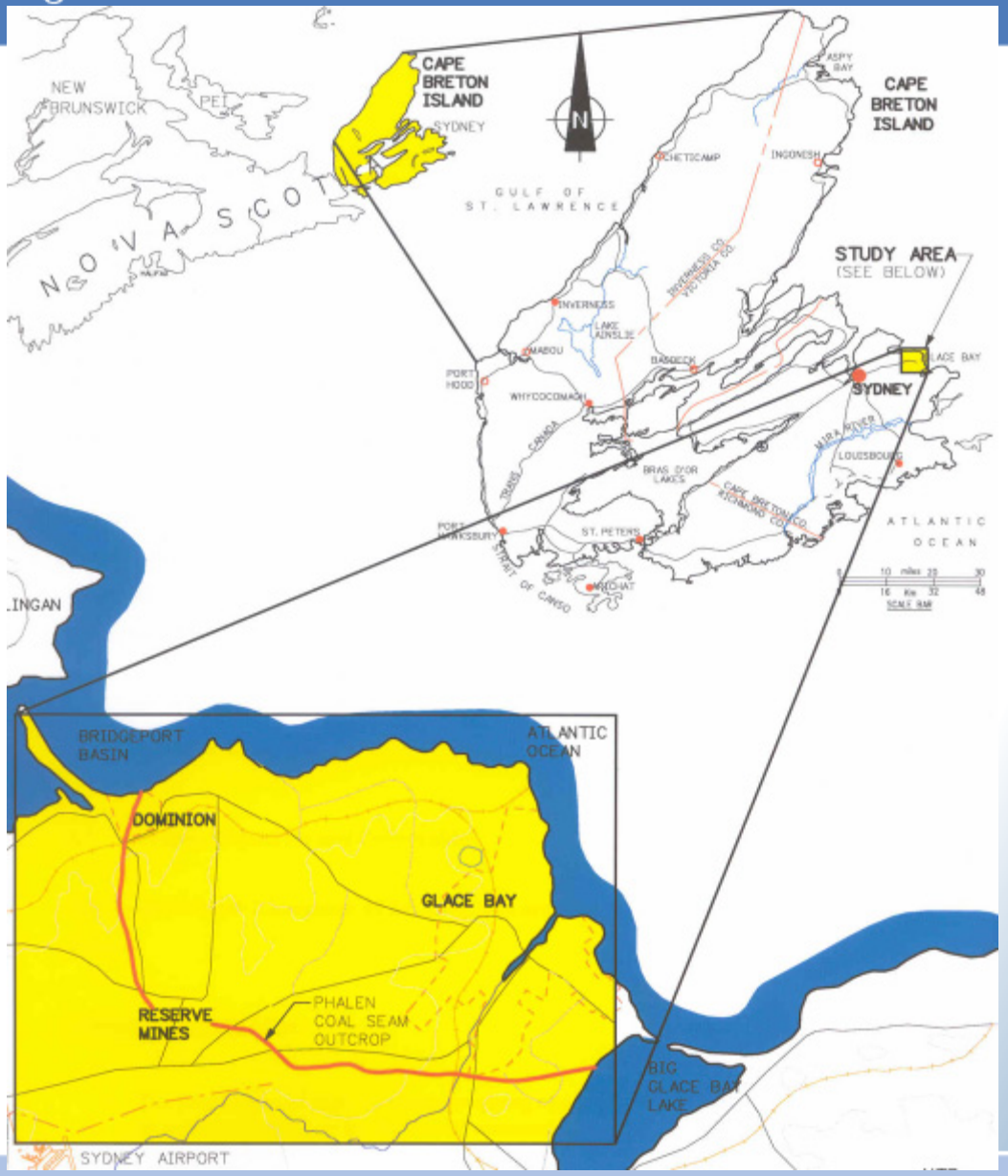
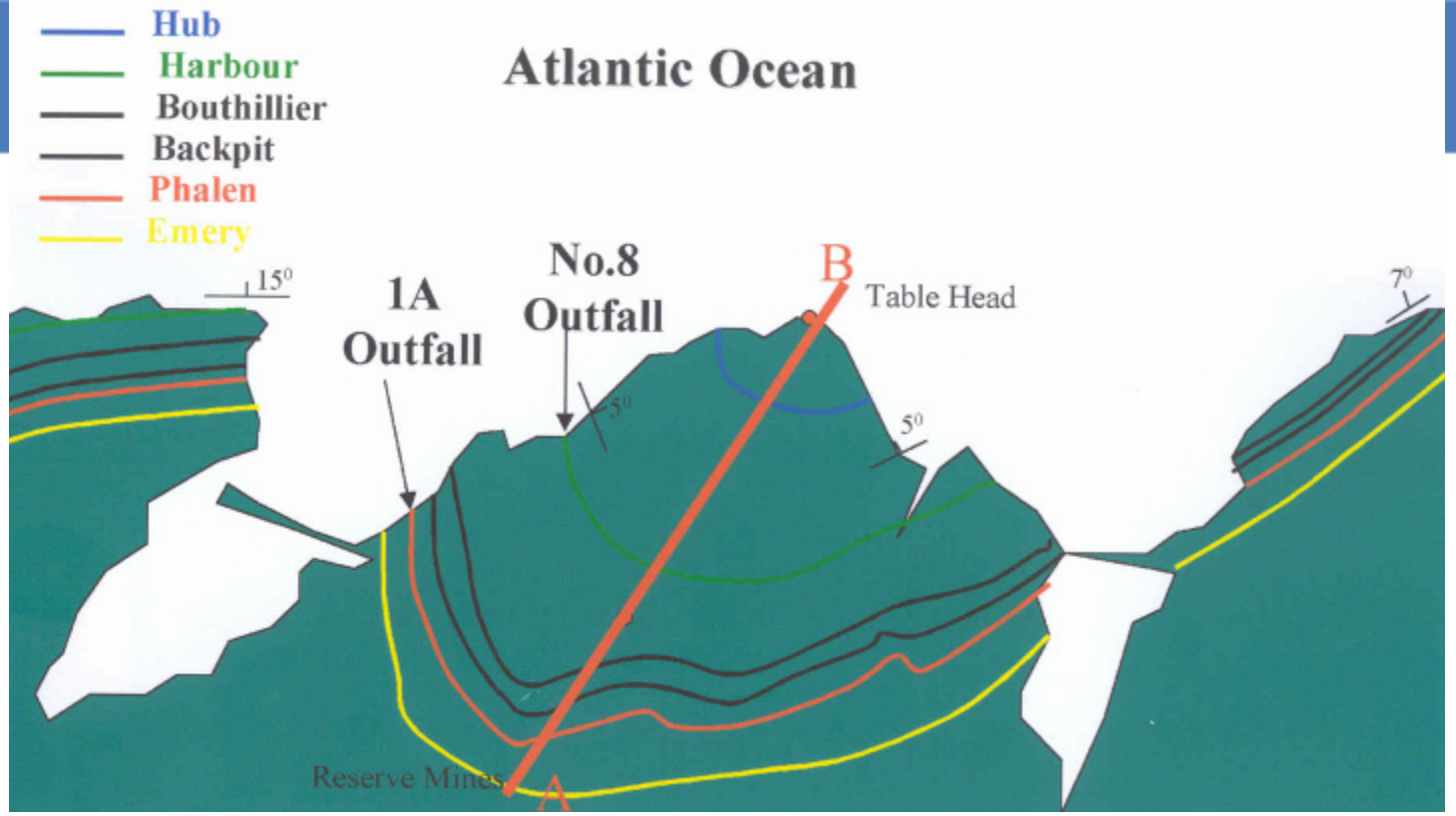
Presentation Outline

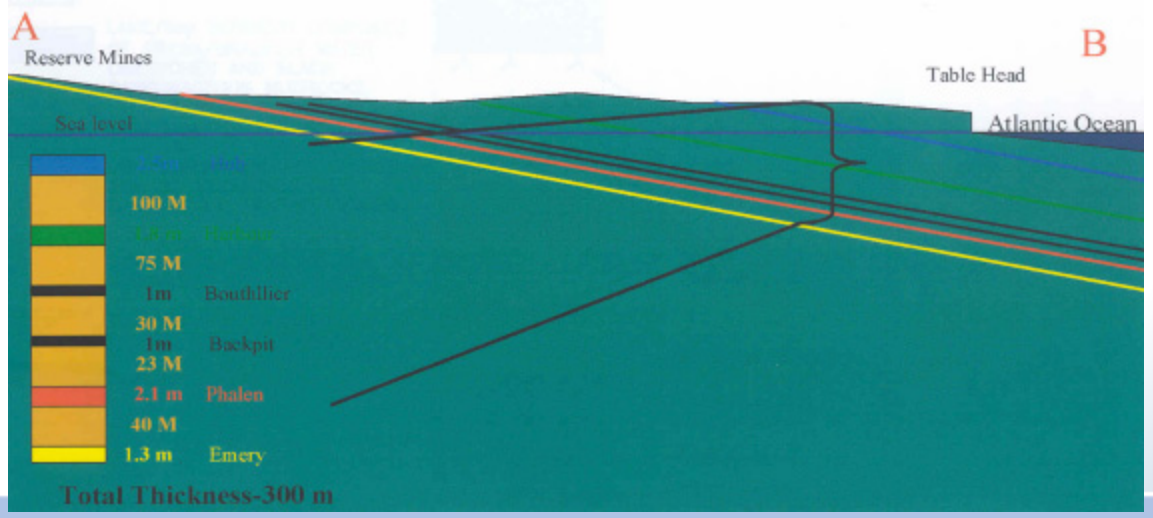
- General setting of the Sydney coal mines
- History of mine water-related issues
- Controls of mine water chemistry
- Decommissioning alternatives

- The Sydney Coalfield, located on Cape Breton Island, is the largest in Atlantic Canada
- About 100 coal mines with varied lifespans have been opened since 1720
- Coal has been mined from the Glace Bay sub-basin since 1980s

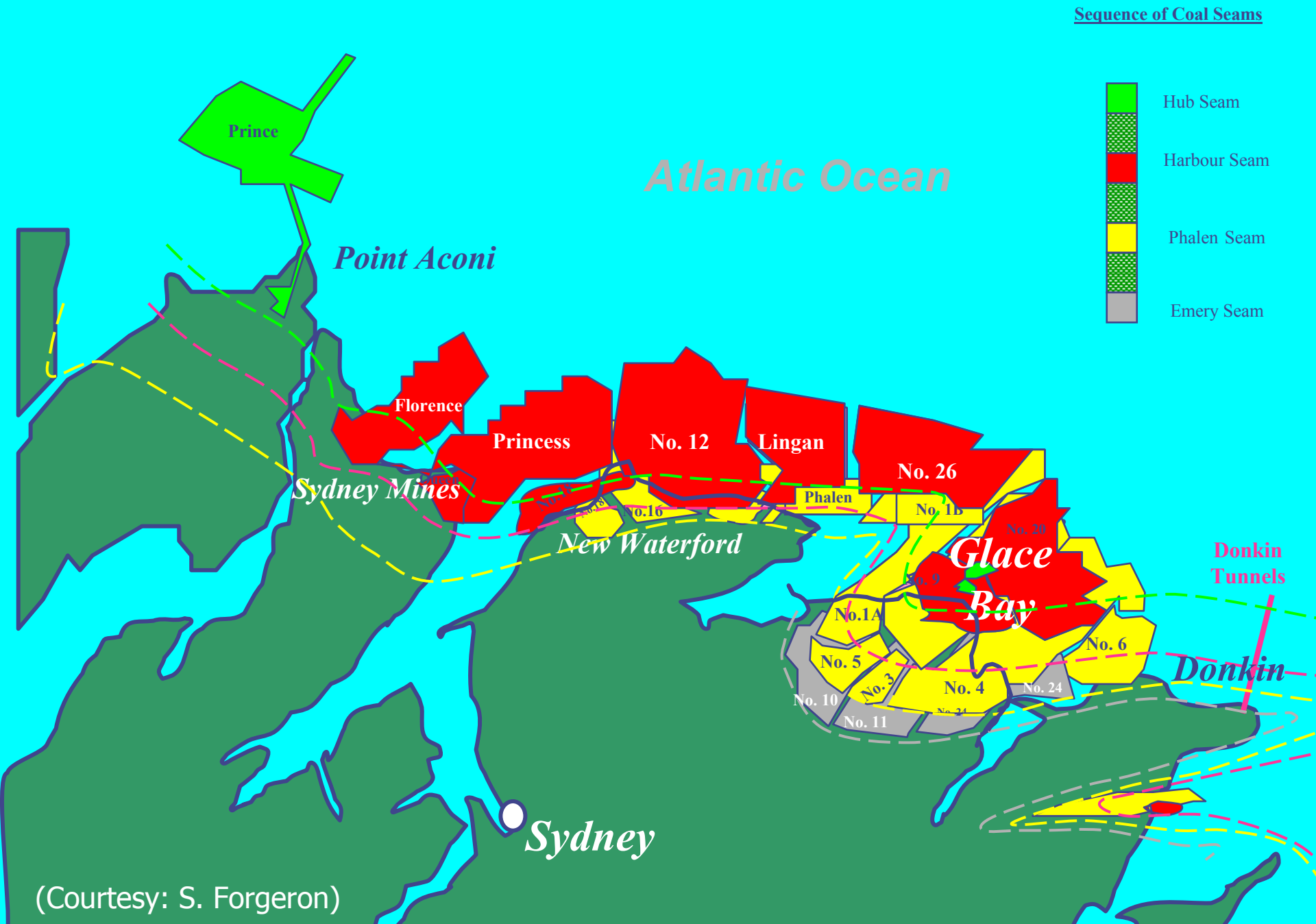


- Seams dip N & NE at -4° to -15°
- Coal mined at >1200 m depth and 11 km from coastline
- Coal is pyrite-bearing



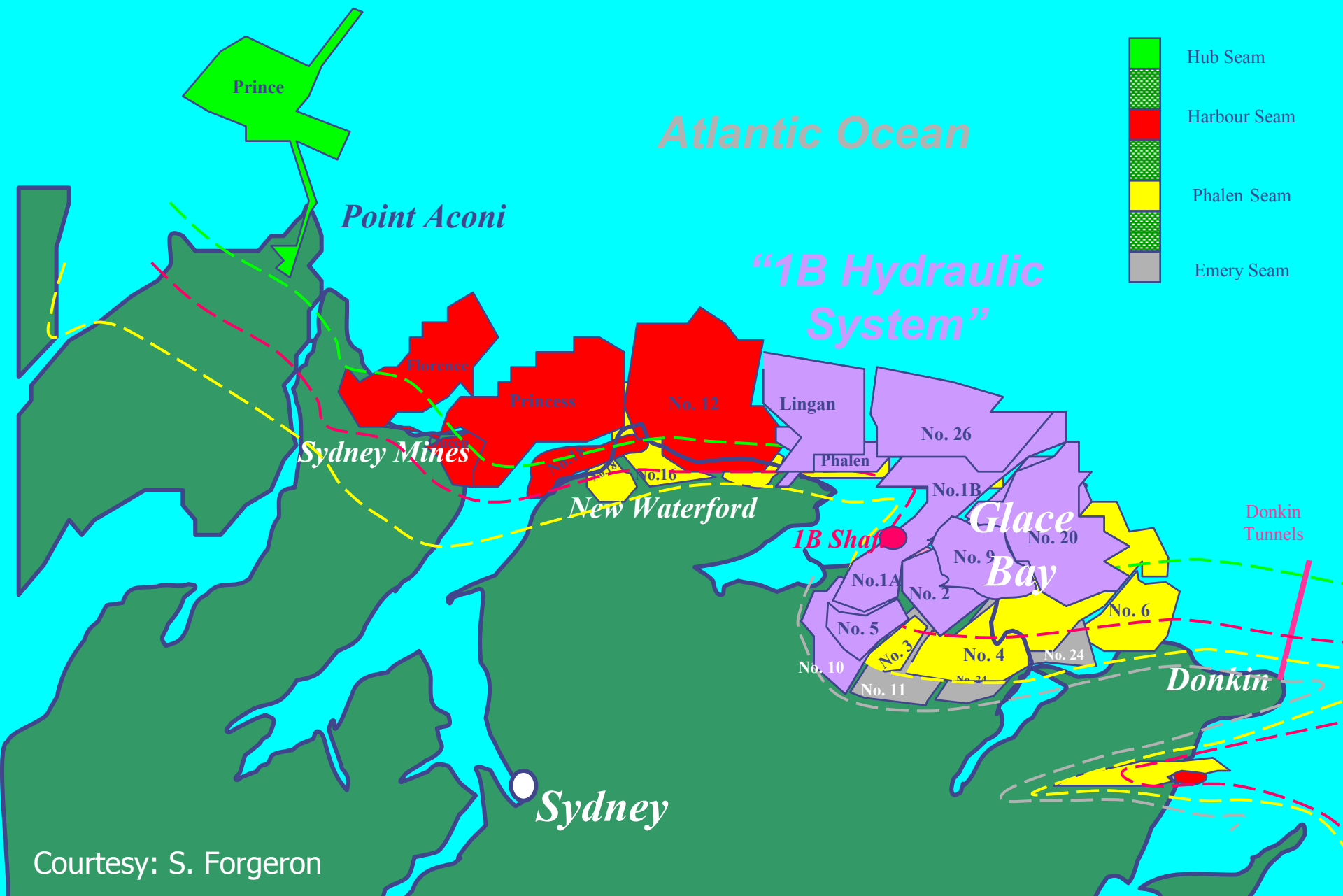


Mine locations and coal seams exploited



(Courtesy: S. Forgeron)

Connected mines of the "1B Hydraulic System"



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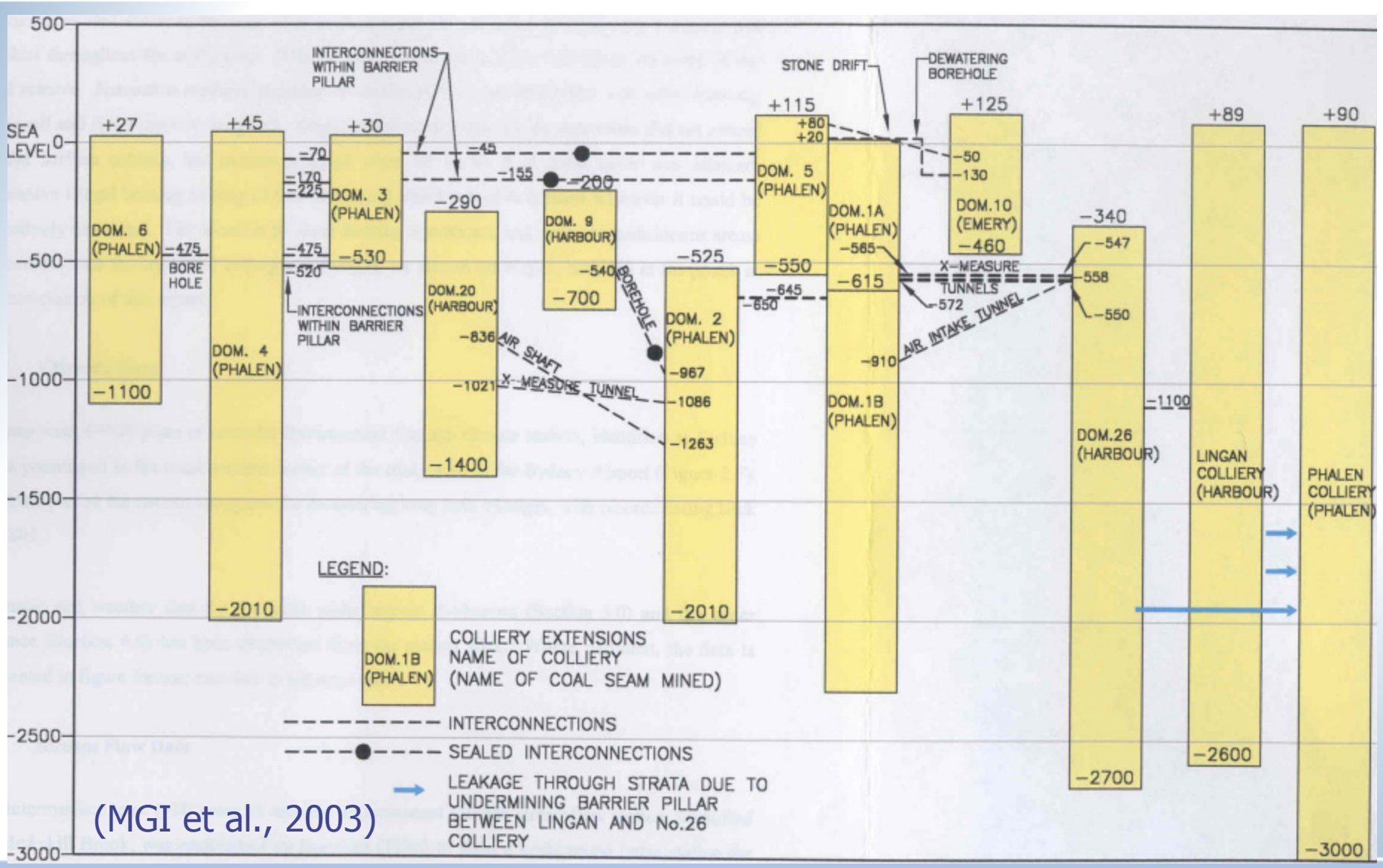


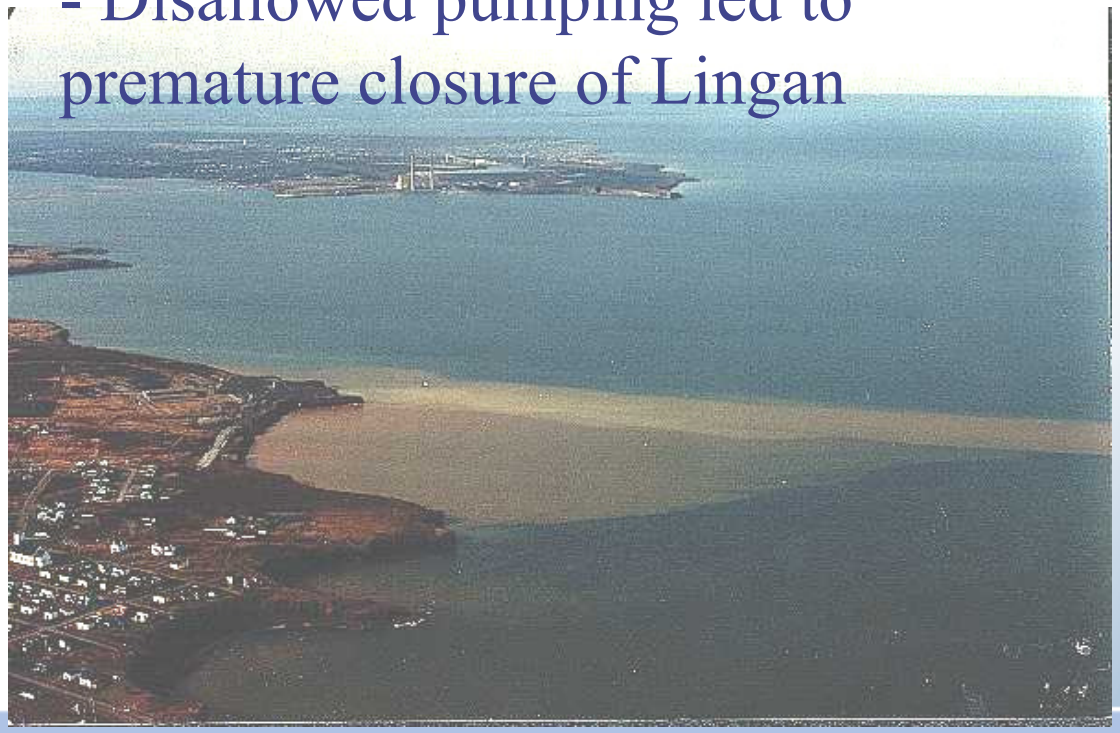
(MGI et al., 2003)

Selected Mine Water Chemistry

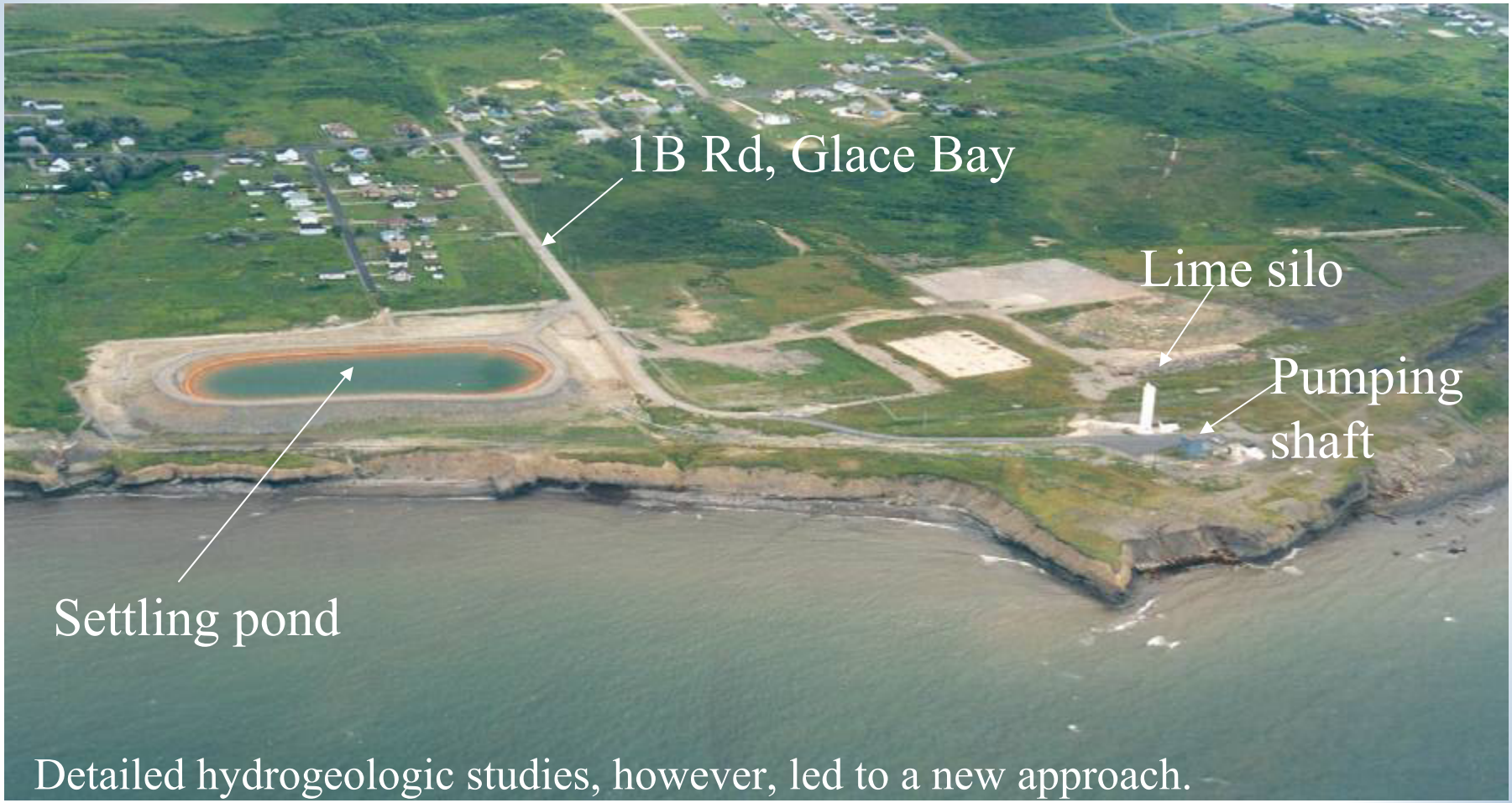
PARAMETER	1 B Shaft	1A Borehole	No. 5 Colliery	No. 3 Colliery
pH	4.1	3.8	7.4	7.0
Fe (mg/L)	1,640	745	0.56	3.1
HCO_3^- (mg/L)	8	1	285	213
SO_4^{2-} (mg/L)	6,870	6,650	1,128	837
Conductivity (µS/cm)	13,300	6630	2,560	2,130

November 1992:

- Flooding of Lingan Colliery due to breach of a 325m coal barrier adjacent to the flooded No.26 Colliery
- Pumping AMD from No.26 to save Lingan gave rise to plume in the ocean
- Disallowed pumping led to premature closure of Lingan

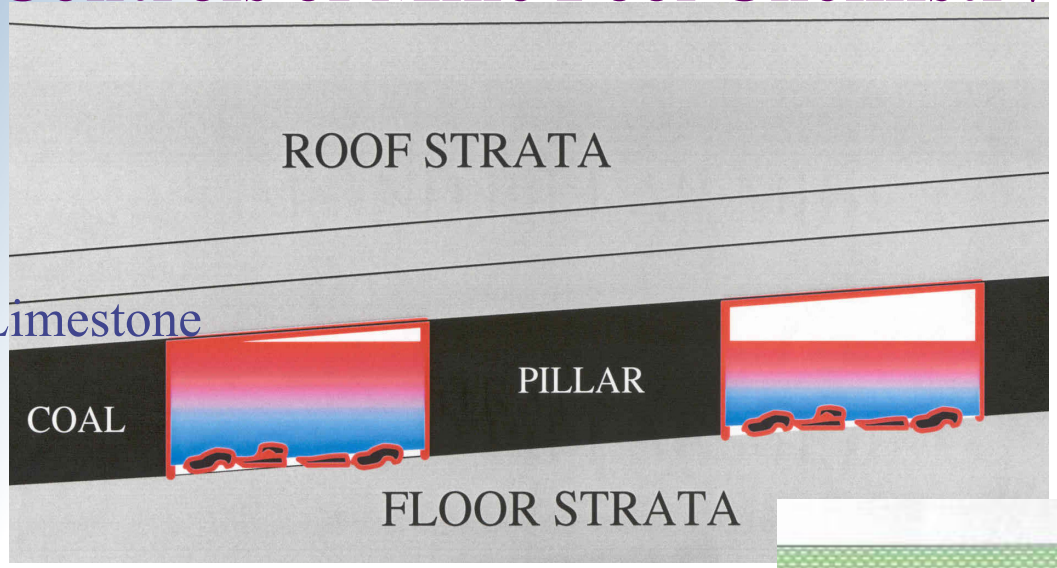


In 2002 when discharge from the 1A Outfall appeared imminent, CBDC was prepared to pump and treat water from the 1B shaft prior to disposal at sea.



Detailed hydrogeologic studies, however, led to a new approach.

Controls of Mine Pool Chemistry

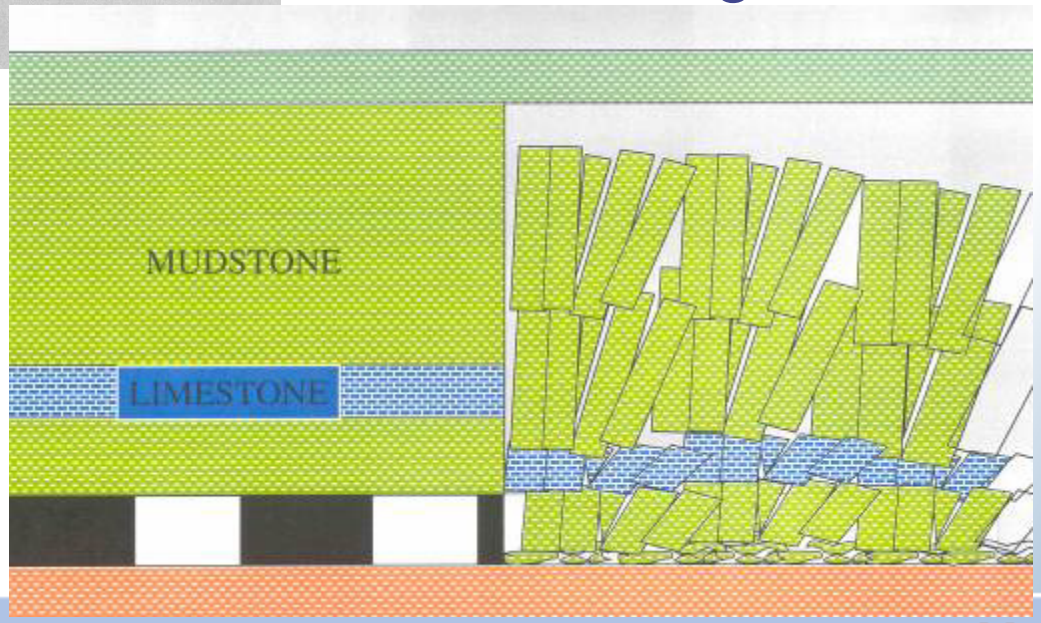


1A Colliery

- 92% room & pillar with minor pillar removal
- 45% coal removal
- AMD from stored acidity in efflorescent salts
- Little flushing

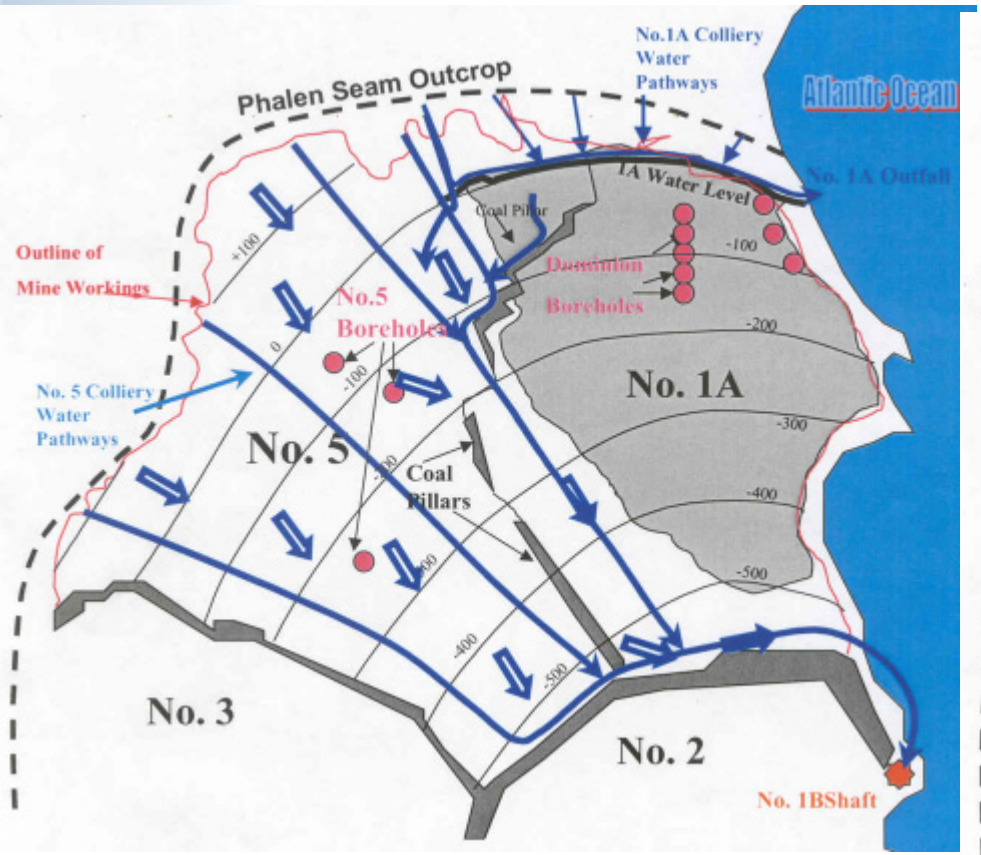
No.5 Colliery

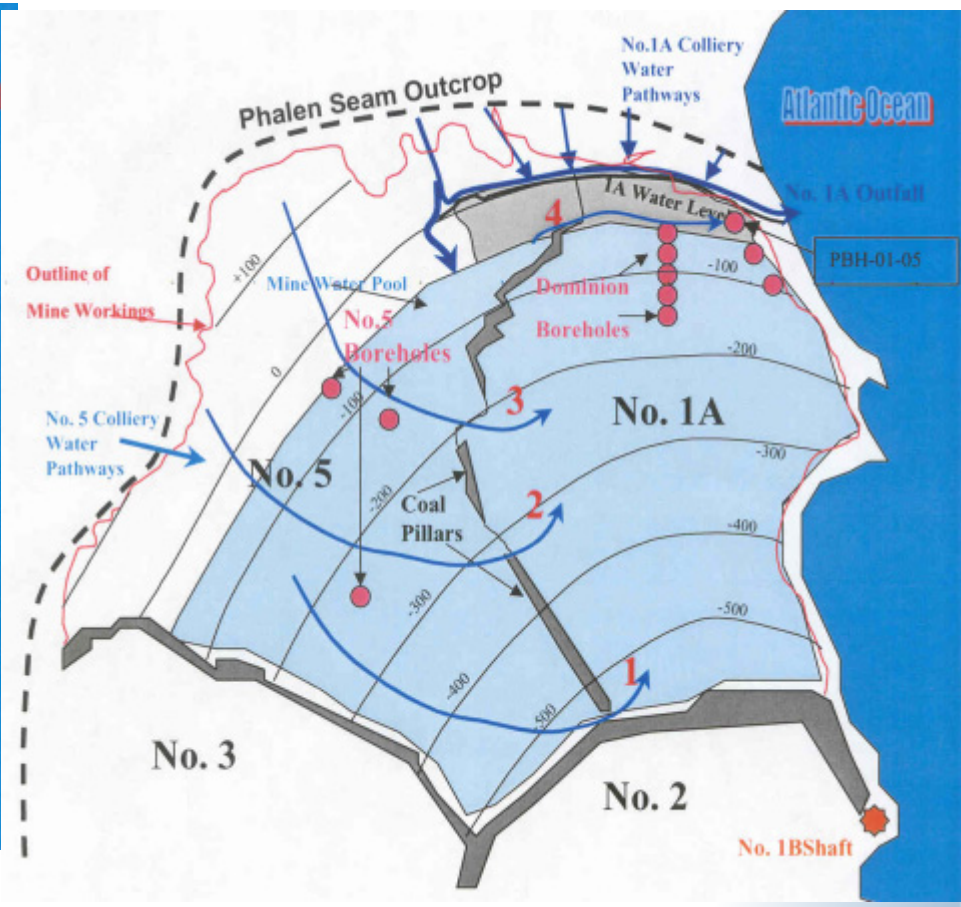
- 75% room & pillar with extensive pillar removal
- 85% coal removal
- Acidity neutralized by collapsed limestone
- Flushed system



Efflorescent salts observed in underground workings at CBDC

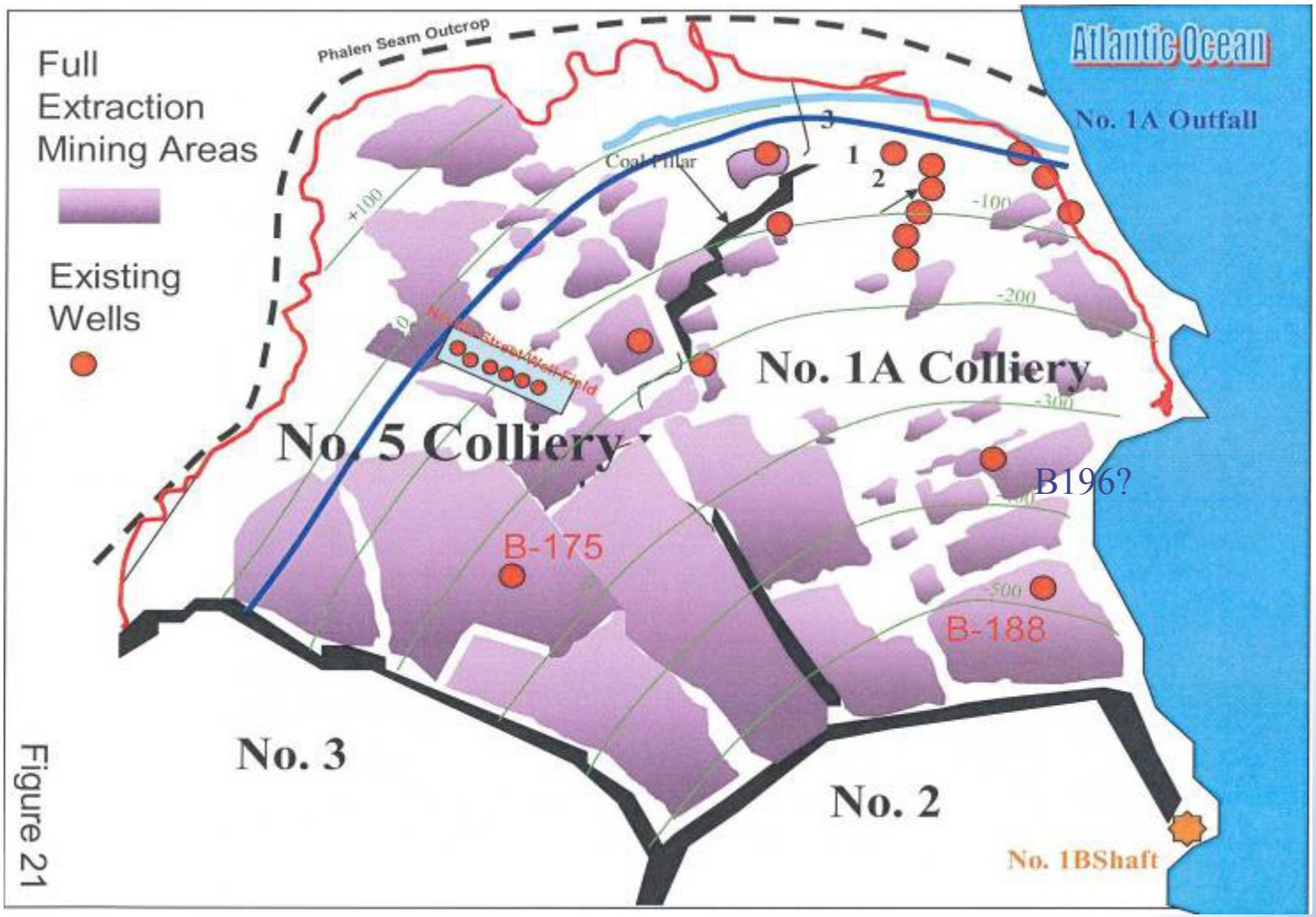
Perceived Water Flow Paths Before and During Mine Flooding





Importance of Local Controls on Water Chemistry

Relatively good-quality water is found in full extraction mining areas



No. 5 Pumping System

<= October 2002

Late fall 2003 =>

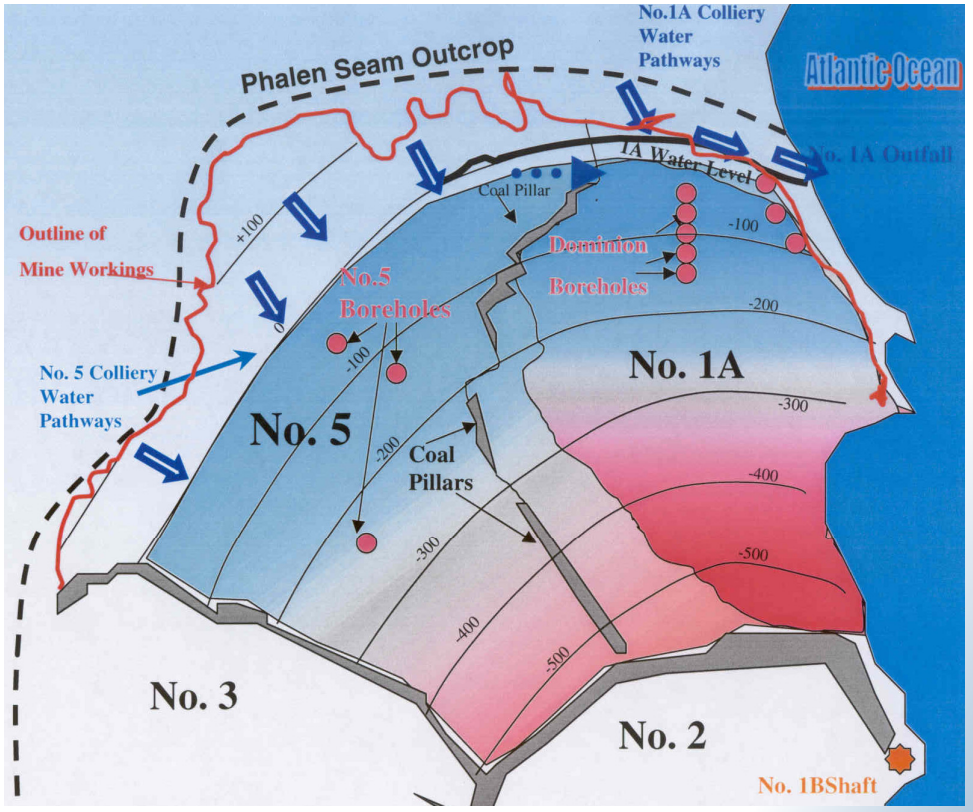
Well Discharge Locations

<= Cadegan Brook

Constructed pond at =>
Neville Street

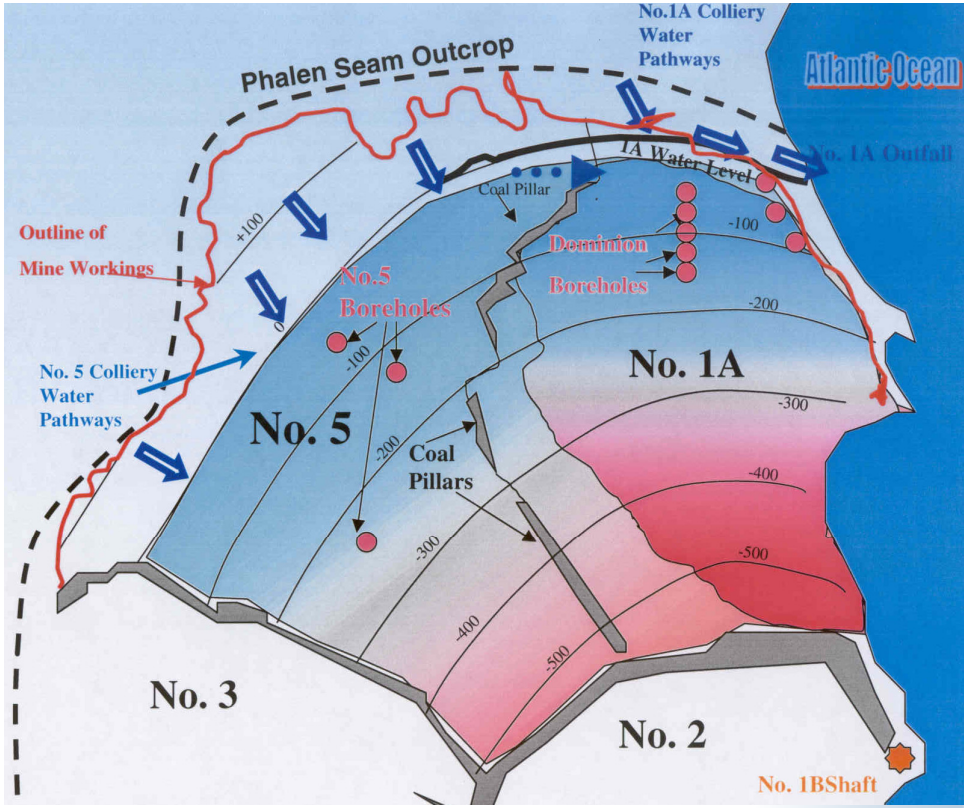
- Largely stratified, stagnant mine pool with very poor-quality water at the bottom and progressively better water at shallow depth except locally near the 1A outfall
- Except where locally broken, the coal pillars effectively prevent mixing and exchange of water from the No.1A and No.5 mine pools
- The same presumably applies to pillar barriers between other mine pools

Scenario prior to water extraction from No.5 Mine to control water level at 1A

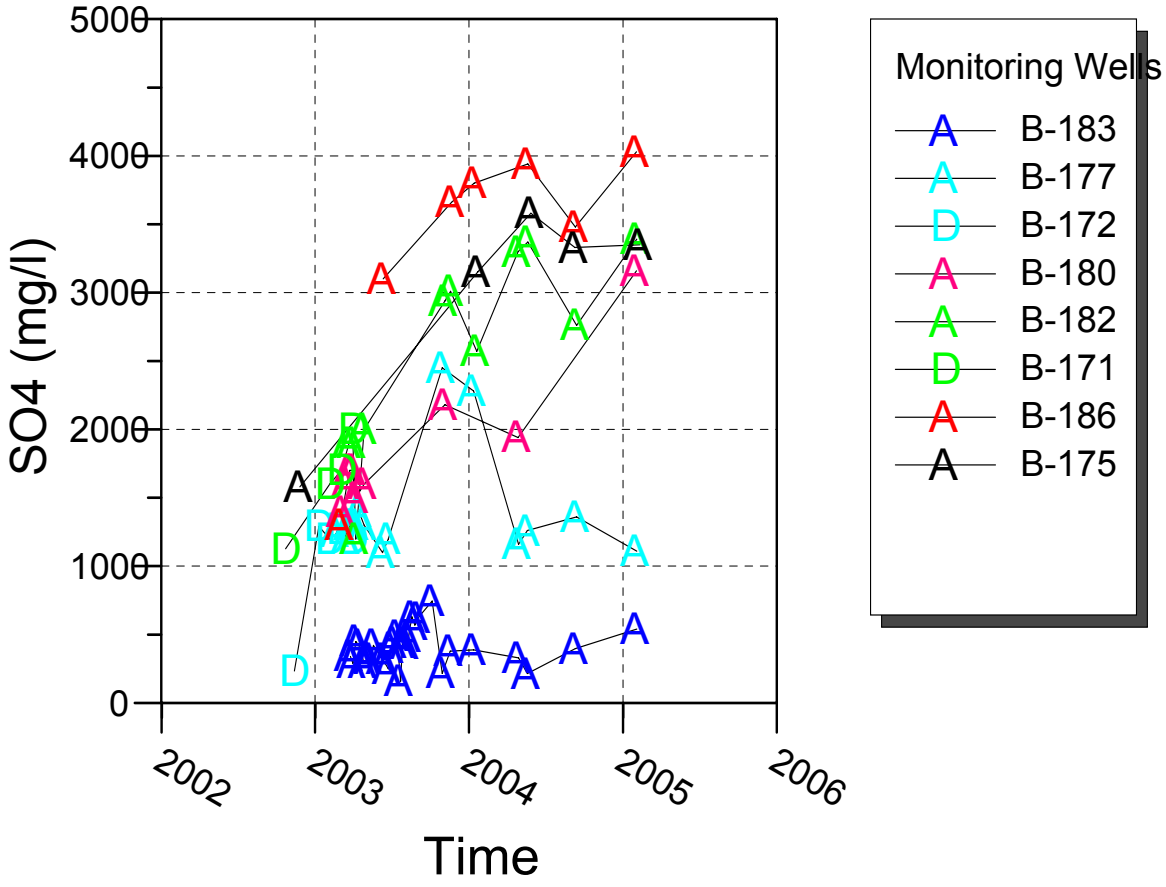


Looking Ahead for Mine Decommissioning Strategy

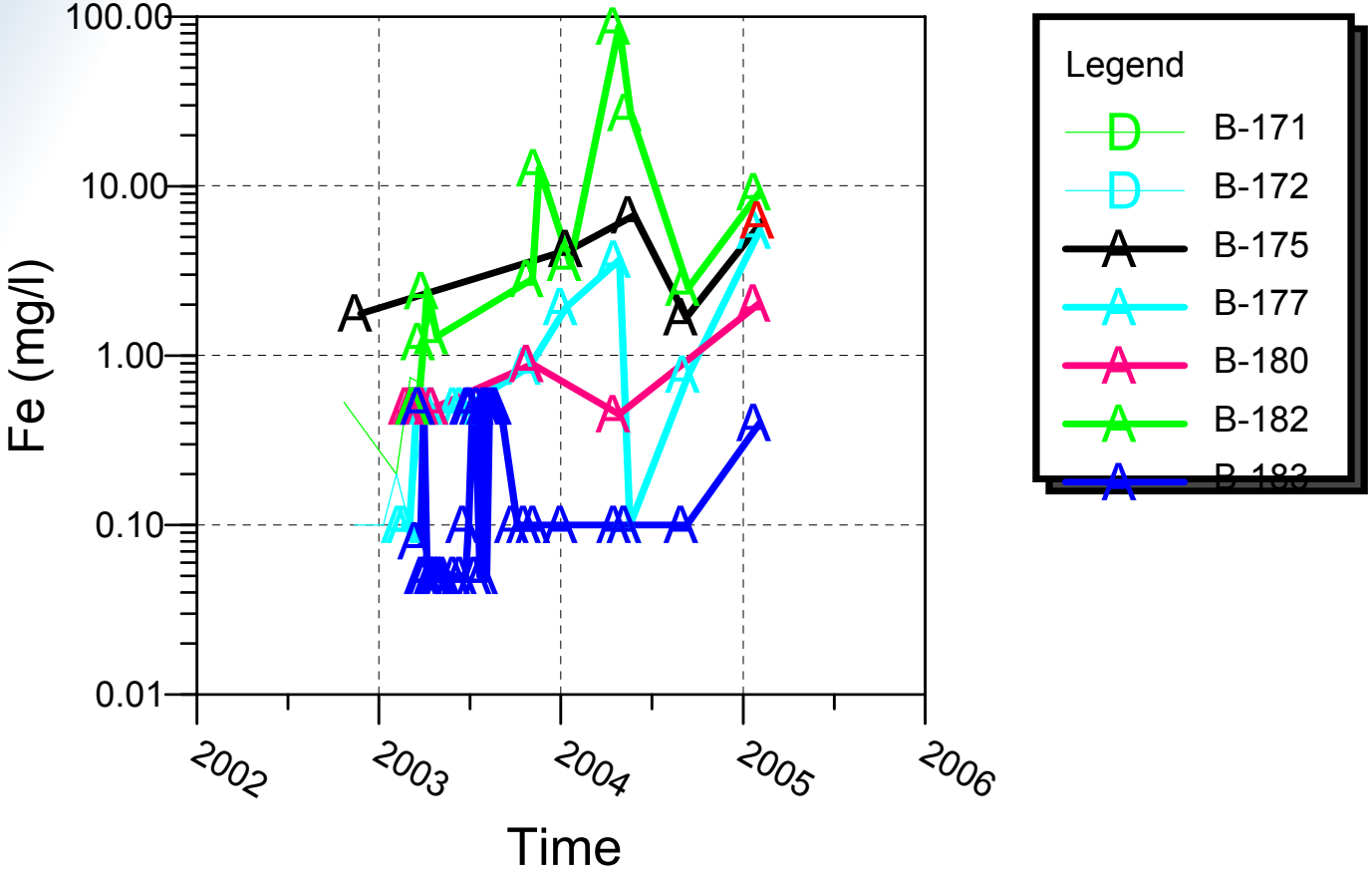
- Pumping water from No.5 has so far maintained water level at No.1A below sea level and saved $0.5M per year for treatment
- Concern: Will No.5 water quality deteriorate with further pumping?
- Opportunity: Will the 1A discharge be of acceptable quality if the system is allowed to fill up?



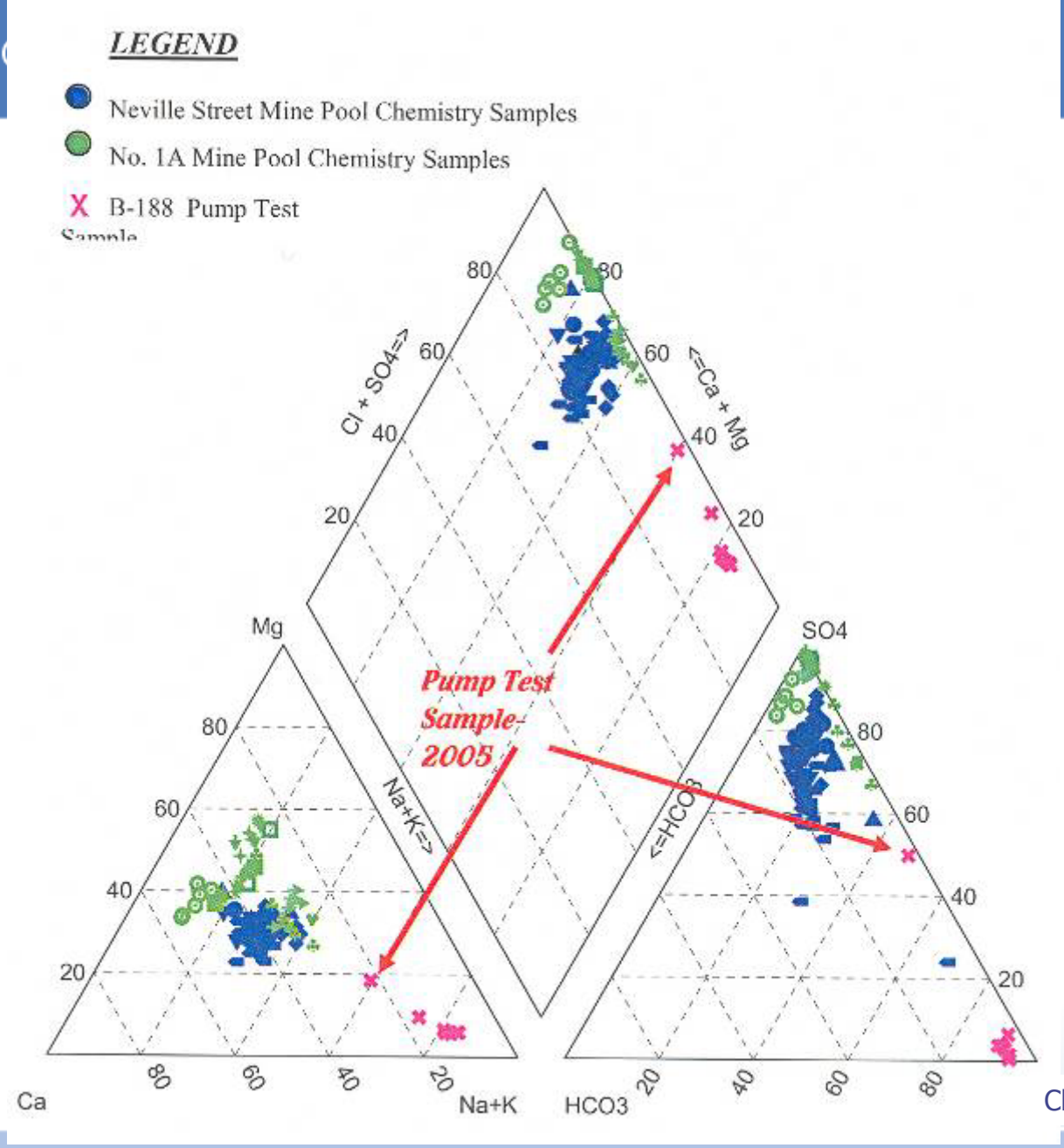
Sulphate at Neville Street



Total Iron at Neville Street

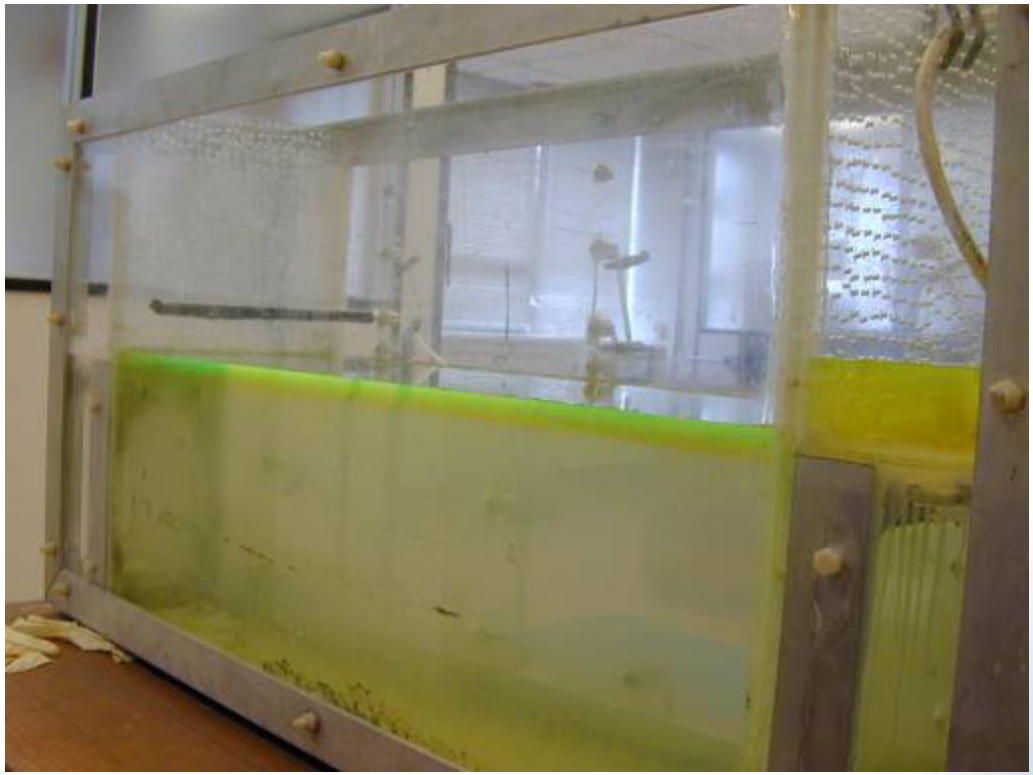


Pumping at rates in excess of inflow rate at B-188 showed evidence of mixing



Will a fresh water lens form on top of the 1A mine pool with the elimination of the water level?

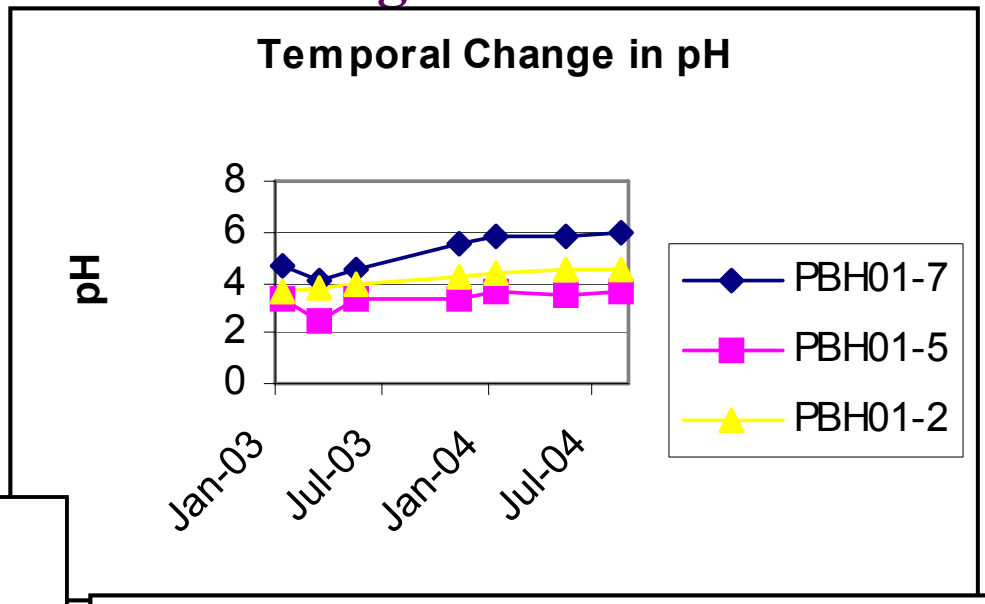
- A “hydrologic bathtub” does not necessarily mean a homogeneous mine pool
- Numerous pit lakes (e.g. Island Copper, the Berkeley Pit) are stratified

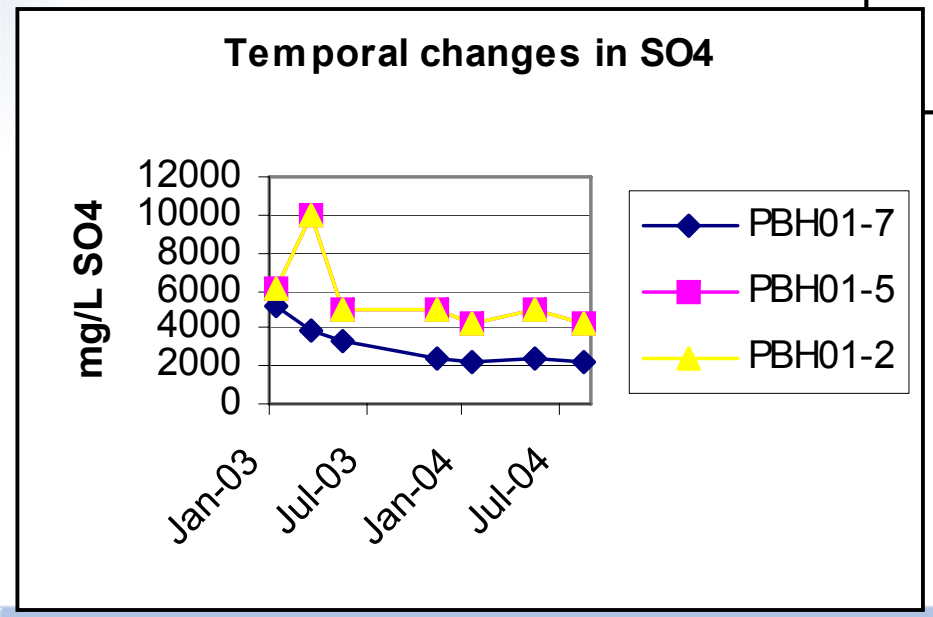


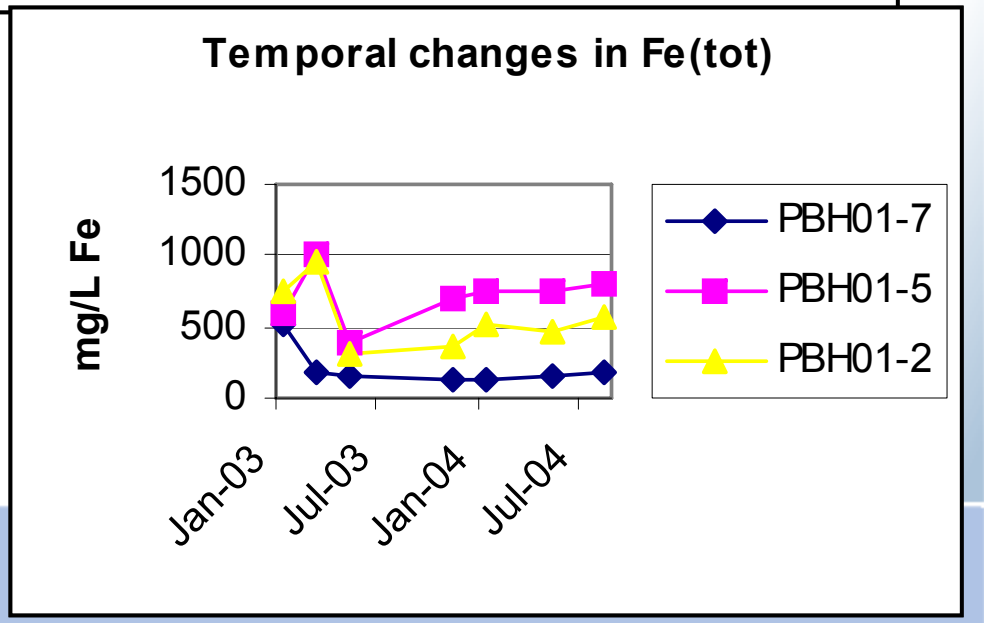
A laboratory demonstration of maintaining a fresh water cover (dyed with fluorescein) on seawater without mixing

Stratification is also apparent at monitoring wells near the 1A Outfall

The shallowest hole (62’ deep) has higher pH and lower Fe and SO_4 compared to the deeper holes (123’ & 215’)

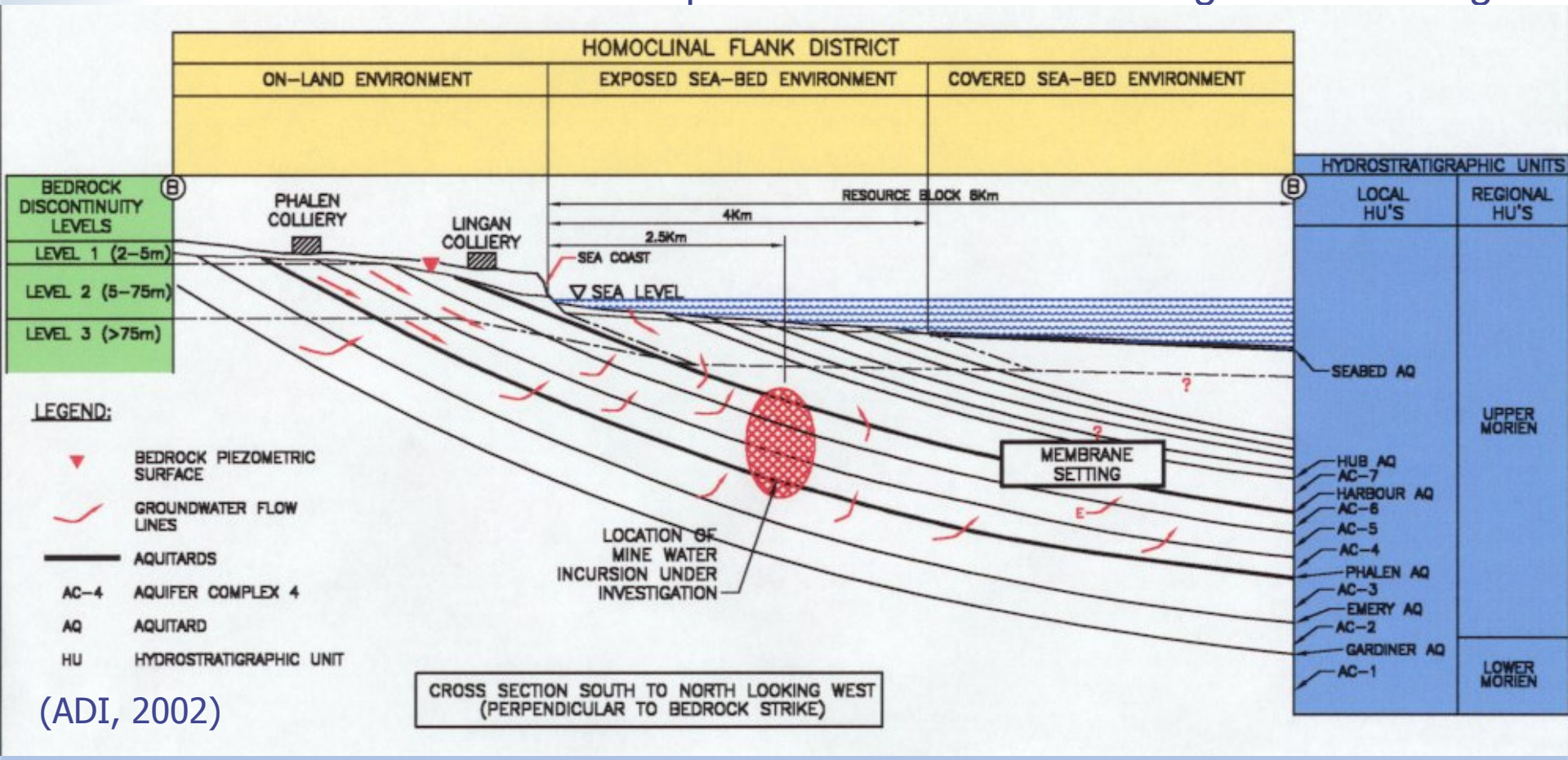






To determine if perpetual active treatment is unavoidable or a passive, walk-away solution is possible

- Field monitoring coupled with laboratory simulation and modeling exercise to confirm mine pool stratification and its long-term stability
- Research to establish if the mine pools can ever be flushed given its setting



(ADI, 2002)

Thank you for your attention!

Questions?