Outfalls of Mine Water to the Sea:
EXAMPLES FROM THE UK AND FRANCE

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Overview

- Review some cases of discharge of polluted mine water to the sea / estuaries
- Derive some general lessons about:
  - Thresholds for significant visual impacts
  - Ecological impacts
- Highlight implications for engineering design

Cases

- UK metal mines (Wheal Jane, Skinningrove)
- Scottish coal mines (Frances and Michael Collieries (Fife); Dalquharran (Ayrshire))
- NE England coal mines (Spittal Main Coal Drift; Horden / Dawdon Collieries)
- French Coal Basin (Gardanne)

UK metal mine examples

Wheal Jane

Skinningrove

Wheal Jane (Cornwall, SW England)

- Tin / zinc mine, outfall to Carnon River ~ 1.5 km from tidal limit
- Threshold Fe loading for visible plume development:

  ~ 3000 Kg Fe/ d
- Plume enters area of moderate dispersion (Fal Estuary)
- Plume characteristics:
  - Restricted to surface of water column
  - Max area (1992 event):

    ~ 100 km^2
  - Extensive studies found no impacts on marine benthos

Wheal Jane (Cornwall, SW England)

Skinningrove (Cleveland, NE England)

- Two iron ore mines, both outfall to Kilton Beck ~ 1 km from coast
- Combined loading (1970s):
  ~ 600 Kg Fe/ d
- Enters area with strong and persistent N-S longshore currents
- Marine plume characteristics:
  - Area ~ 3000 m^2
  - Restricted to surface of water column

Scottish Coal Mine Examples

Frances and Michael

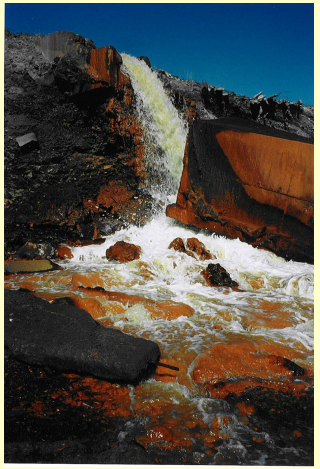
Dalquharran

Frances and Michael Collieries (Fife, Scotland) – pre 1995

- Two neighbouring coal mine discharged direct into marine waters (Firth of Forth)
- Sea currents here are moderately dispersive
- Frances Fe loading:
  ~ 108 Kg Fe/ d
  – no real plume
- Michael Fe loading:
  ~ 816 Kg Fe/ d
  – considerable plume (surface of water column); area ~ 4,000 m^2

Frances

Michael



Michael Colliery (1994)

Dalquharran Mine (1979)
(Ayrshire, Scotland)

- Major coal mine discharge into Girvan Water (stream) ~ 9 Km from coast
- Sea area of moderate to high dispersion
- Loading entering sea at Girvan harbour (1979):

  ~ 2920 Kg Fe/ d
- Marine plume characteristics:
  - Area ~ 25,000 m^2
  - Restricted to surface of water column

North-East England Coal Mine Examples

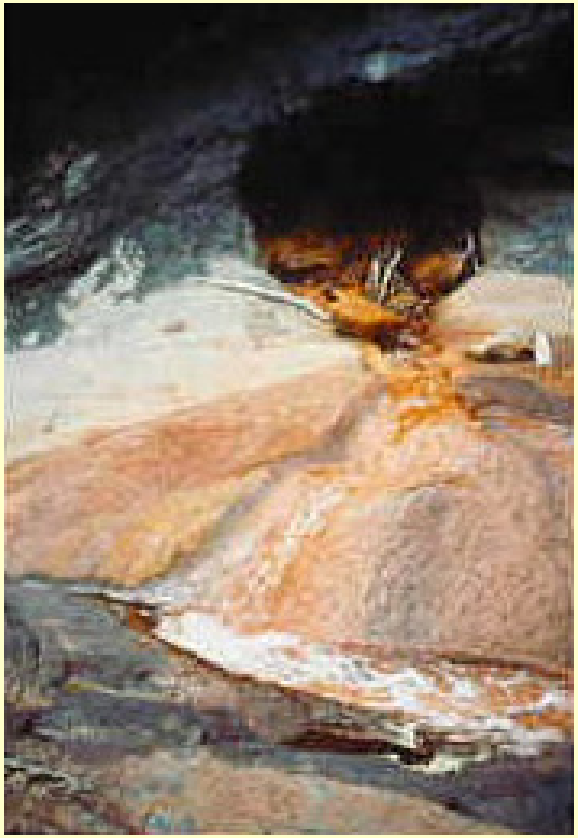
Spittal Main Coal Drift

Horden / Dawdon Collieries

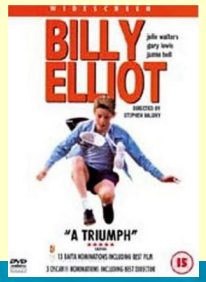
Spittal Main Coal Drift (Berwick, Northumberland)

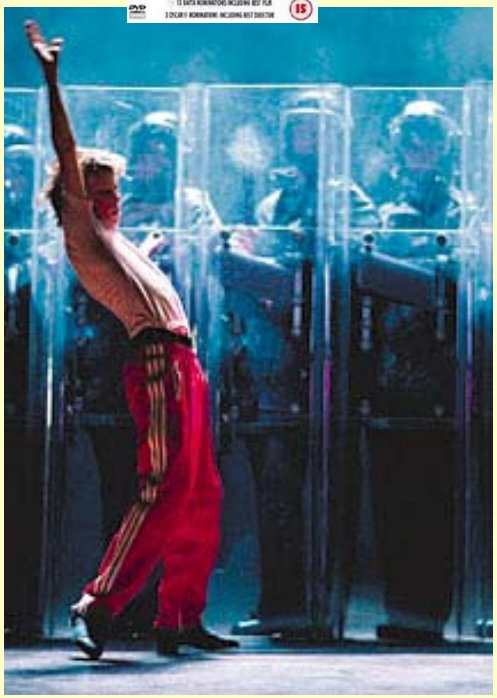
- Principal adit drainage to sea from Scremerston Coalfield
- Sea area of high dispersion; strong N-S longshore currents
- Loading entering sea:

  ~ 350 g Fe/ d
- All dispersed in swash zone; no plume visible



East Durham Coalfield

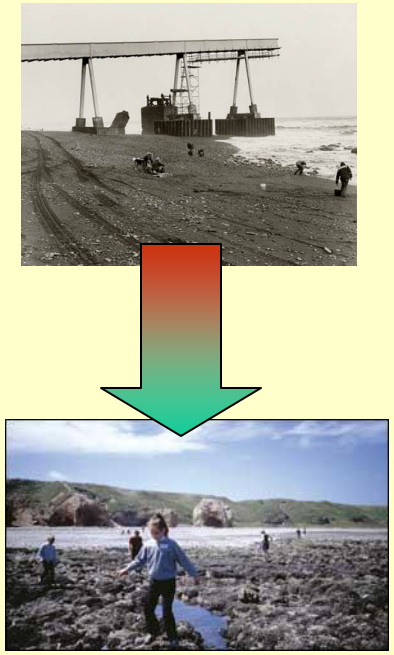




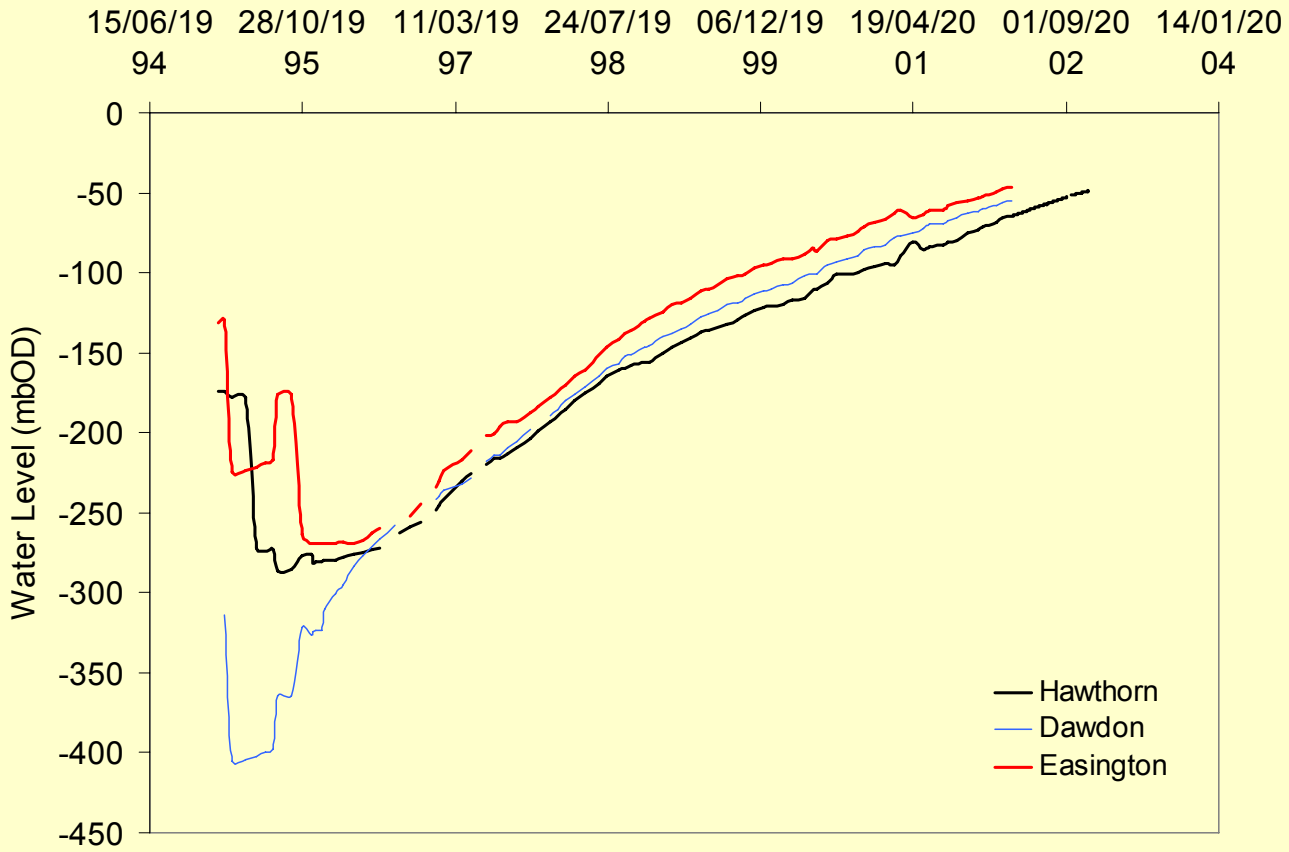
pre-1996: Devastation of East Durham's 'Coal Coast'

'Turning the Tide':
1996 – 2001: Clean-up of Coal Coast

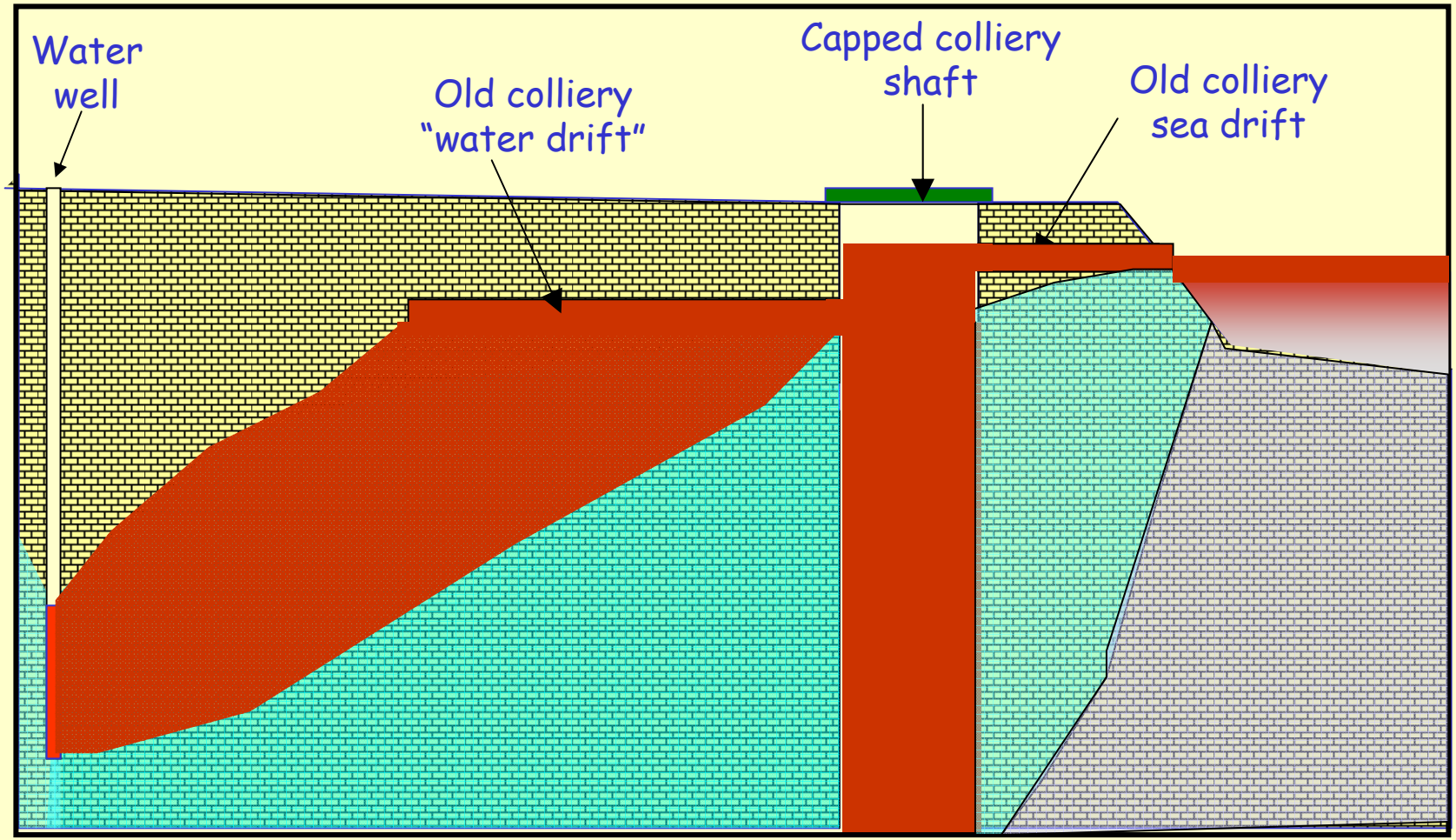
- Millennium project
- 18km of coast cleaned-up in 5 years, at cost of £10M
- 1.3 M tonnes of spoil removed from Horden and Easington beaches
- In 2002, coast was declared a 'Heritage Coast'



Mine water recovery in E. Durham



The pollution threat in E Durham



Horden / Dawdon (East Durham Coalfield)

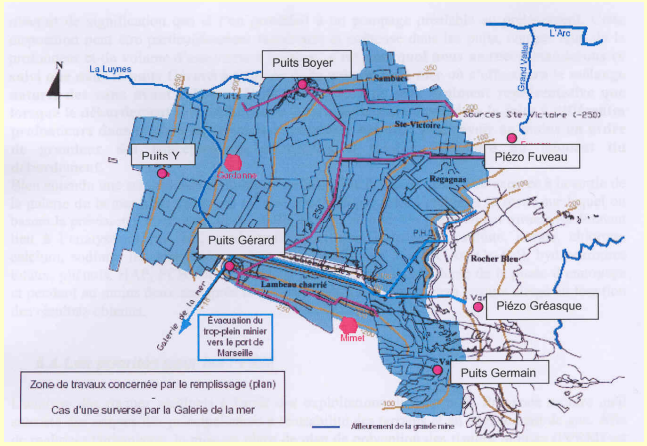
- Major undersea collieries connected to one of world's (and longest-mined) coalfields inland
- Sea area of high dispersion; strong N-S longshore currents
- Predicted loading which would enter sea without pump-and-treat system:
  ~ 2000 Kg Fe/ d
- Highly visible plume predicted - not acceptable given recent 'Turning the Tide' project

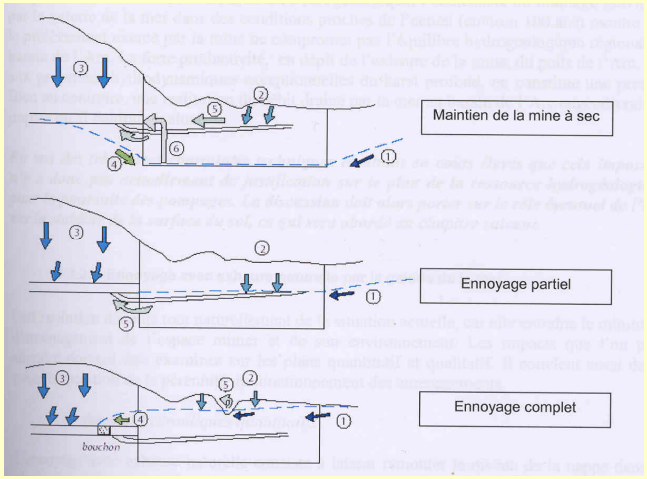
French Coal Mine Example

Gardanne Coal Basin:
La Galerie a la Mer, Marseille

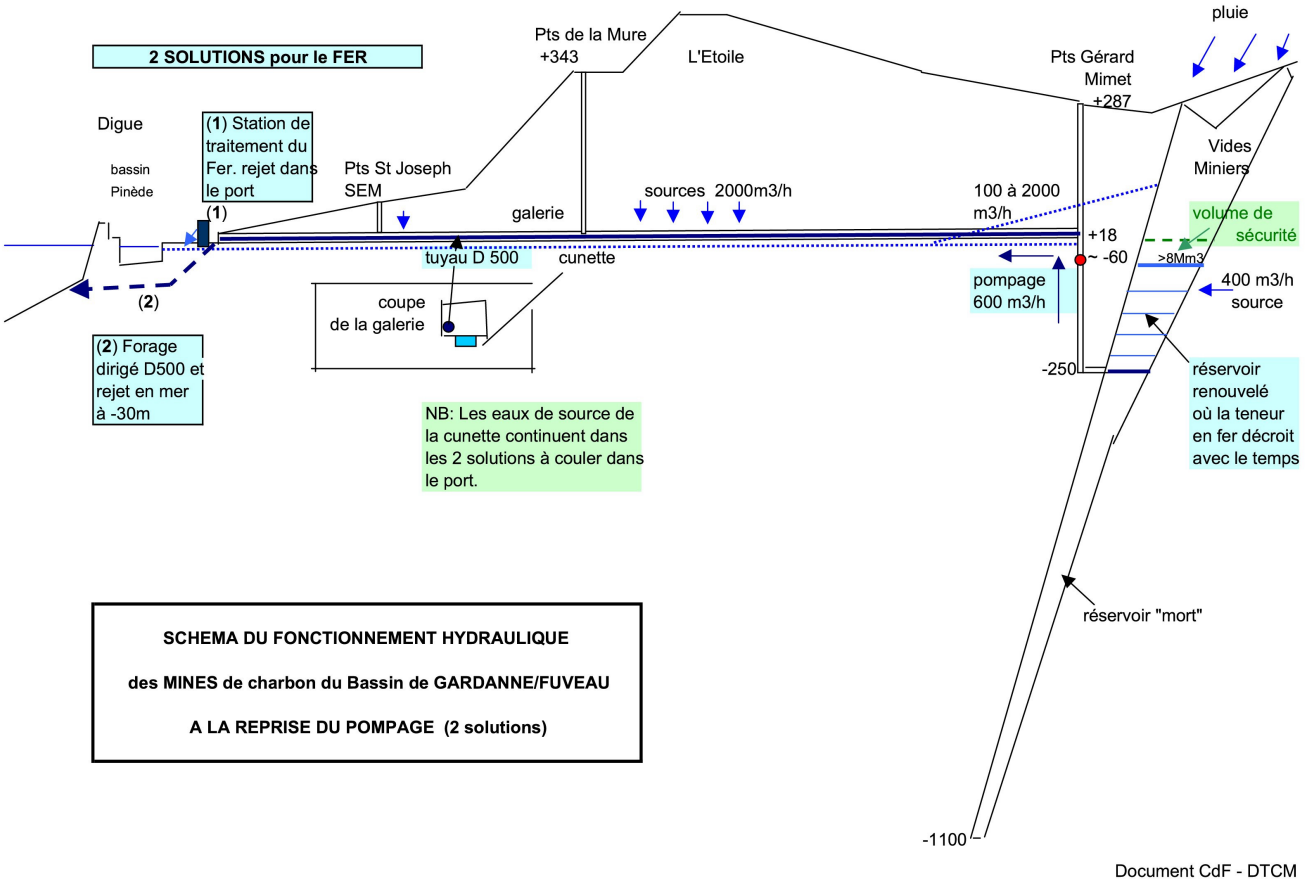
Gardanne Coal Basin (near Marseille, France)

- Major inter-montane coal basin (Cretaceous – very high sulphur seams interbedded with limestones)
- Principal adit for basin C19. 'Galerie a la Mer'
- Predicted loading which would enter sea without pump-and-treat system: ≤ 1400 Kg Fe/ d
- Mediterranean Sea is tideless and thus very low dispersion
- Highly visible plume likely in Marseille Port: tracer tests
- Plan for deep seabed outfall

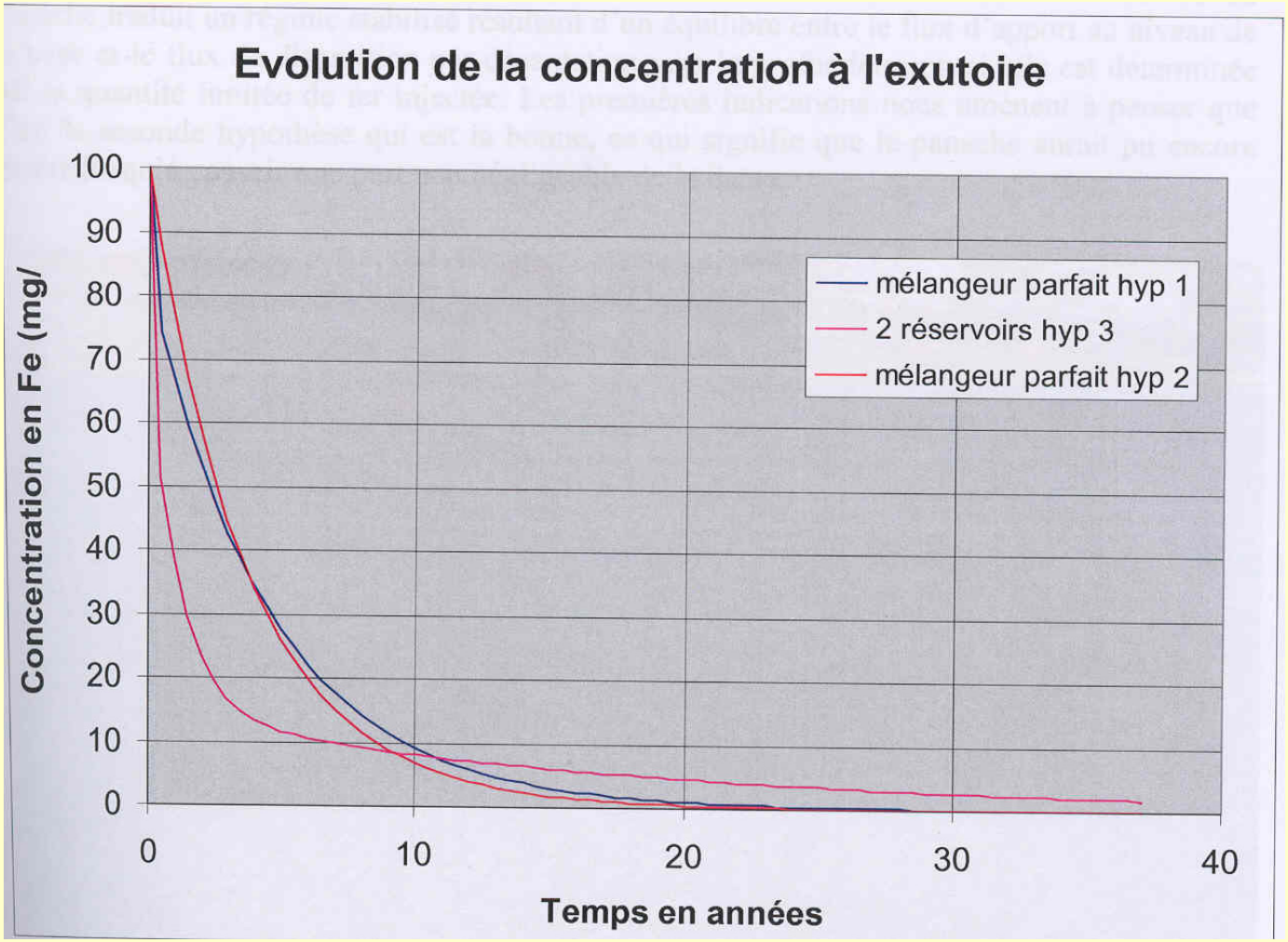




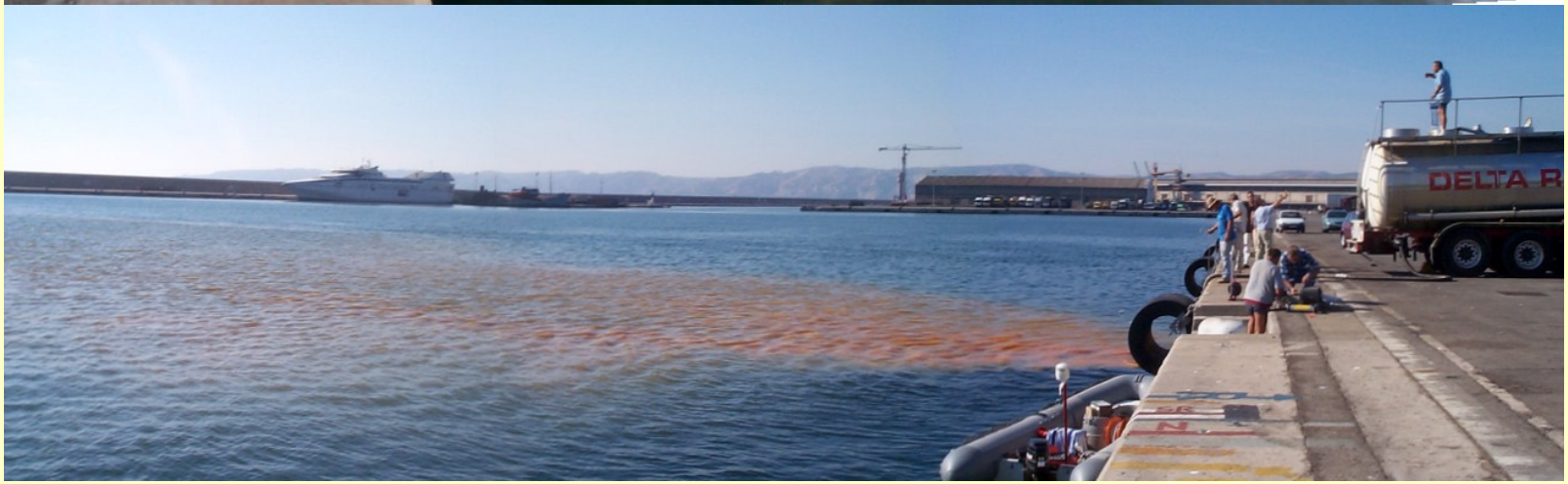
Gardanne Coal Basin



Gardanne Coal Basin



Gardanne – tracer tests in Port of Marseille



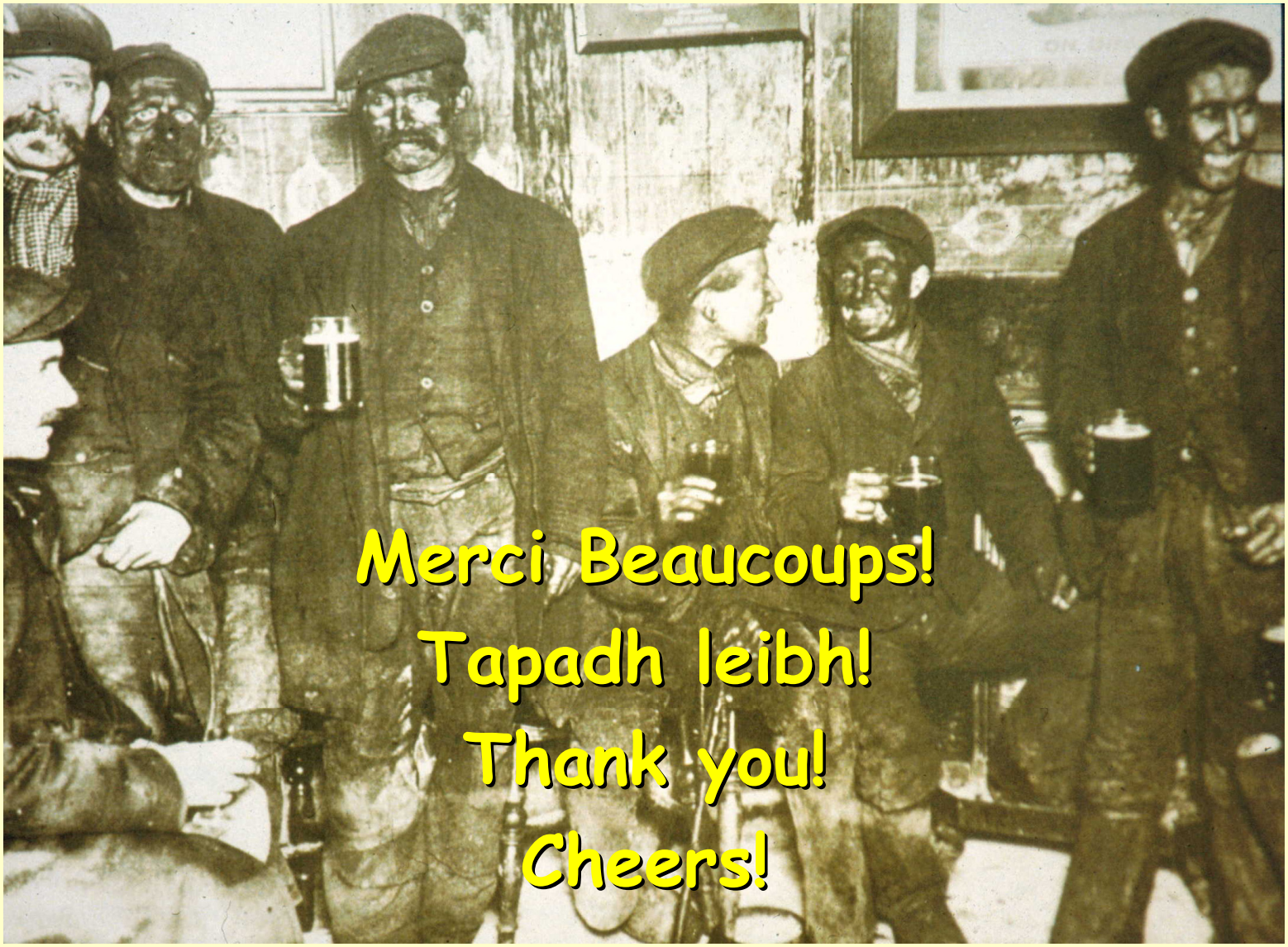
Gardanne – tracer tests in Port of Marseille

Some general lessons

- Thresholds for discolouration:
  - Major plume anticipated, even in coastal area of high natural dispersion, if Fe loading exceeds ~ 500 Kg/d
- Surficial nature of mine water dispersal in the sea:
  - Reflects stratification (salinity (= density / viscosity), temperature)
  - Results in mine water spreading over wider area before eventual settlement of precipitates

Design implications

- Deep seabed outfall without treatment:
  - might ameliorate pollution visible from shore
  - BUT may increase local impact of discharge on marine ecology (more focused deposition of metals on seabed)
- Better from ecological perspective to use treatment processes to reduce Fe loading below threshold of ~ 250 Kg/d (lower in areas of low natural marine dispersion?) and then discharge direct to ocean


Merci Beaucoups!
Tapadh leibh!
Thank you!
Cheers!