# The History of Kinghorn Loch

## introduced by Ron Edwards

**from creation to now.....**

A wonderful kettle hole lake

# In the beginning there was:

# ICE

From 2.6 million years ago until 13,000 years ago – when Kinghorn Loch was formed

# 13,000-11,000 years ago:

- As the weight of ice is removed, the land rebounds and is still doing so today, northern Britain is still rising.
- As the ice sheets melt the sea level rises.
- Result: initial relative sea level 45m higher, then fell back.


The tundra of Doggerland connected Britain to Europe about 11,000 years ago and became fertile farmland until it all disappeared by about 8,500-8,200 years ago. Hunter gatherers moved into Fife as the ice retreated.

After initial ice sheet retreat around 13,000 years ago, further glaciation occurred around 11,000 years ago. Deep meltwater gorges were gouged out and are buried in boulder clay at Craigencalt.

The tundra would have shown a landscape quite different from today.

# Profile of the loch

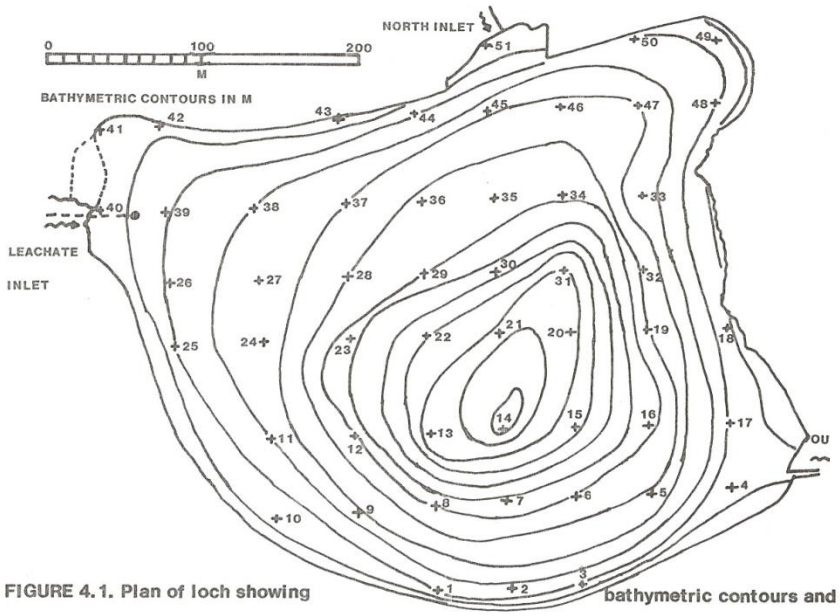
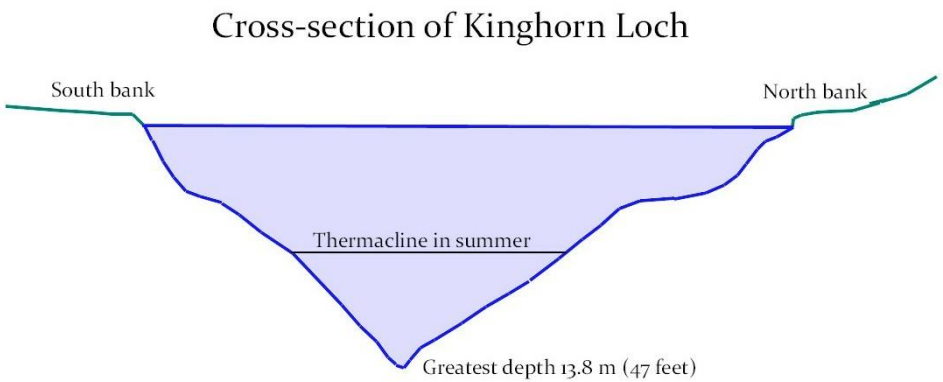
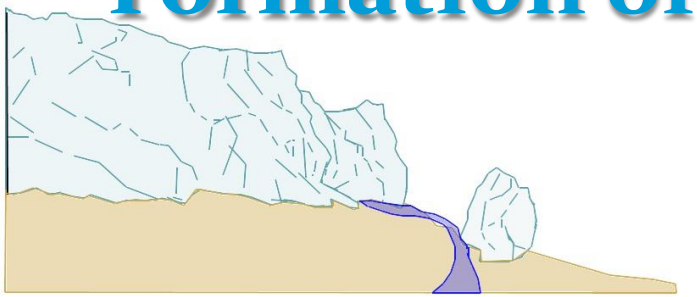



FIGURE 4.1. Plan of loch showing bathymetric contours and sampling stations.

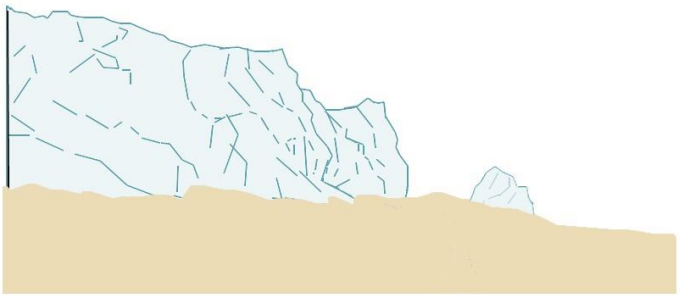



Kinghorn Loch is an example of a “kettle hole lake”, formed at the very end of the last Ice Age as the face of the Forth glacier retreated past Craigencalt.

# Formation of a kettle hole lake



A huge chunk of ice may break off the face of the glacier or ice sheet



It becomes buried in outwash moraine gravels, sands and bounder clay

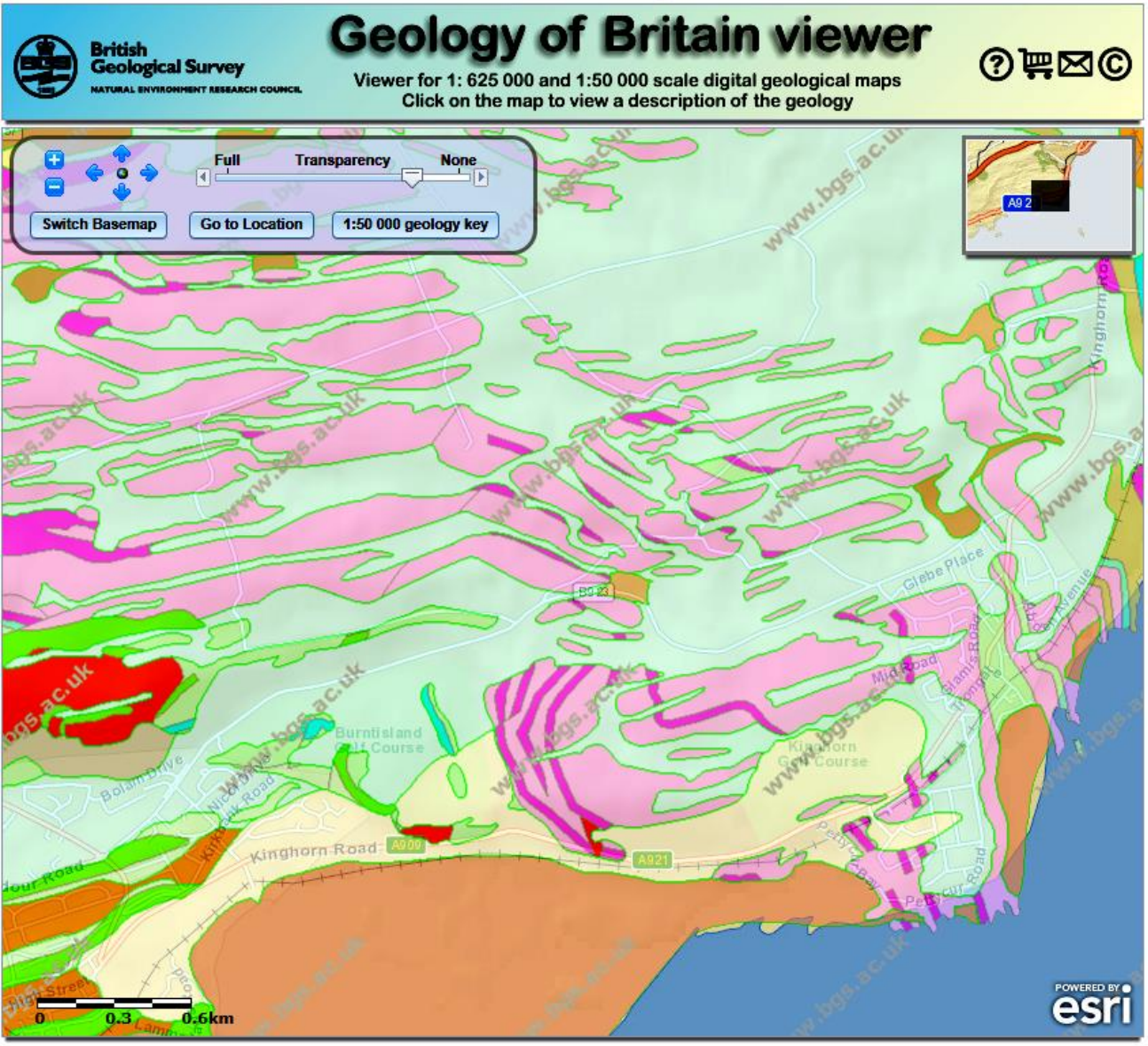
The ice melts and the hole fills up as a round loch

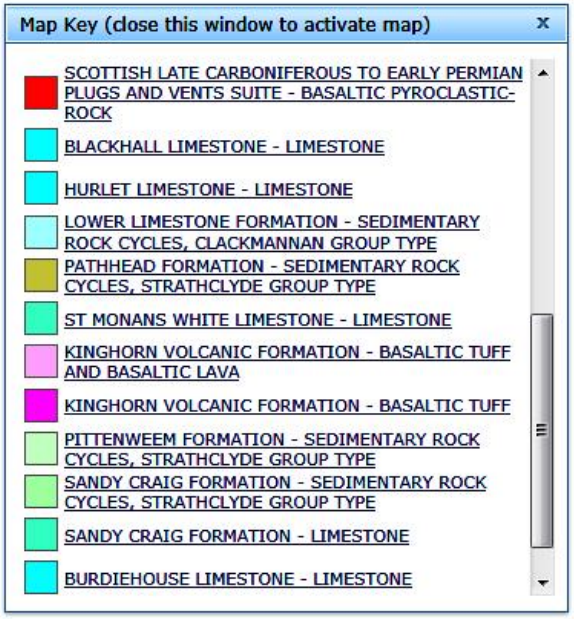
# Topography of the loch area.

- The hills and dips around the loch are caused by hard basalt lava rocks forming the ridges and soft sandstones and limestones forming the shallow valleys and dips in between.
- These were dramatically emphasised by the scouring of the ice giving lochans and bog in the low areas and rocky ridges above – all of which has been softened in the millennia since.
- Deep rocky gorges were formed through Craigencalt to the loch and through to Linton Court by glacial meltwaters, most of which has filled with deposits.
- Craigencalt probably means “gorge of the wildcat”.

Pink shows each lava bed.

Red volcanic plug and green sills are also seen.



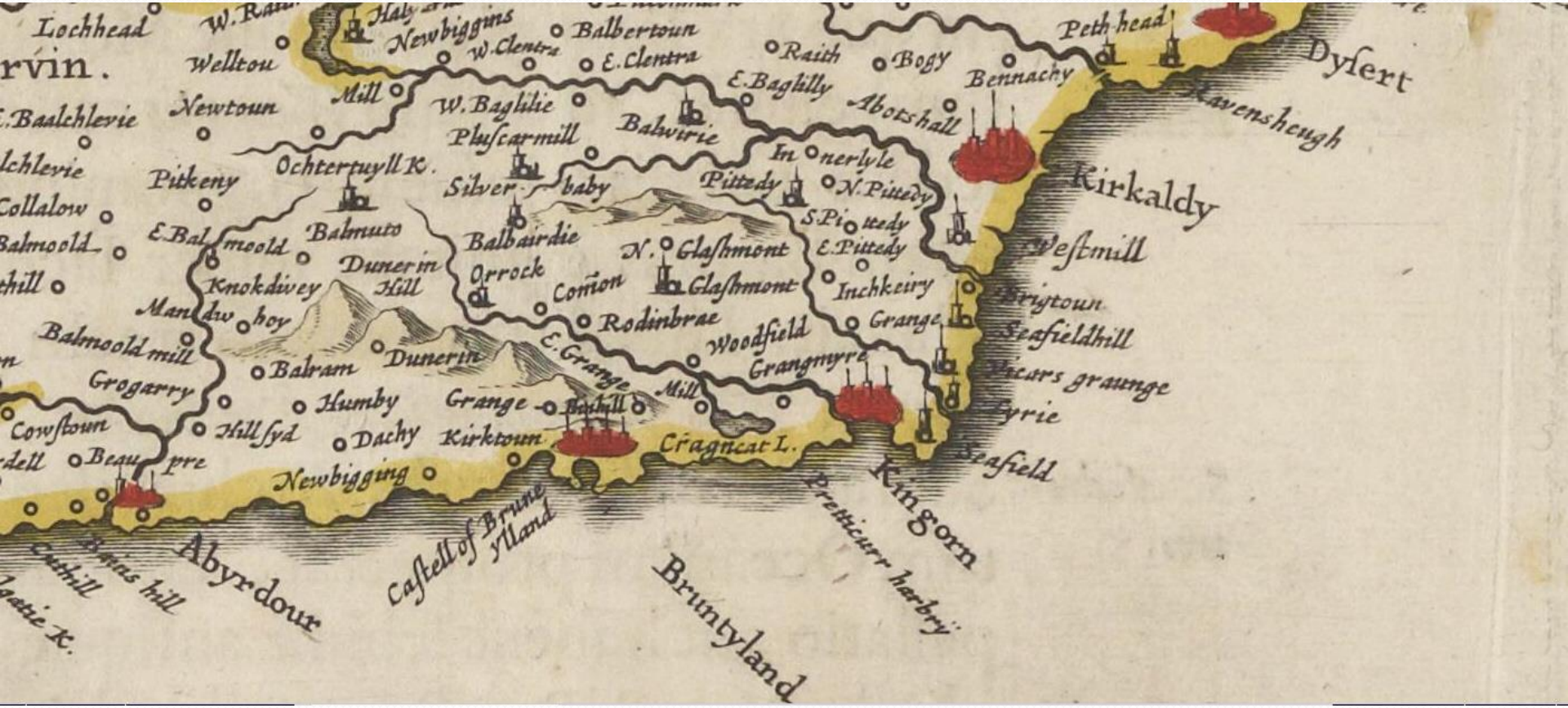

bright green is microgabbro sills

# Kinghorn Loch up to the late Nineteenth Century

## milling and water supply

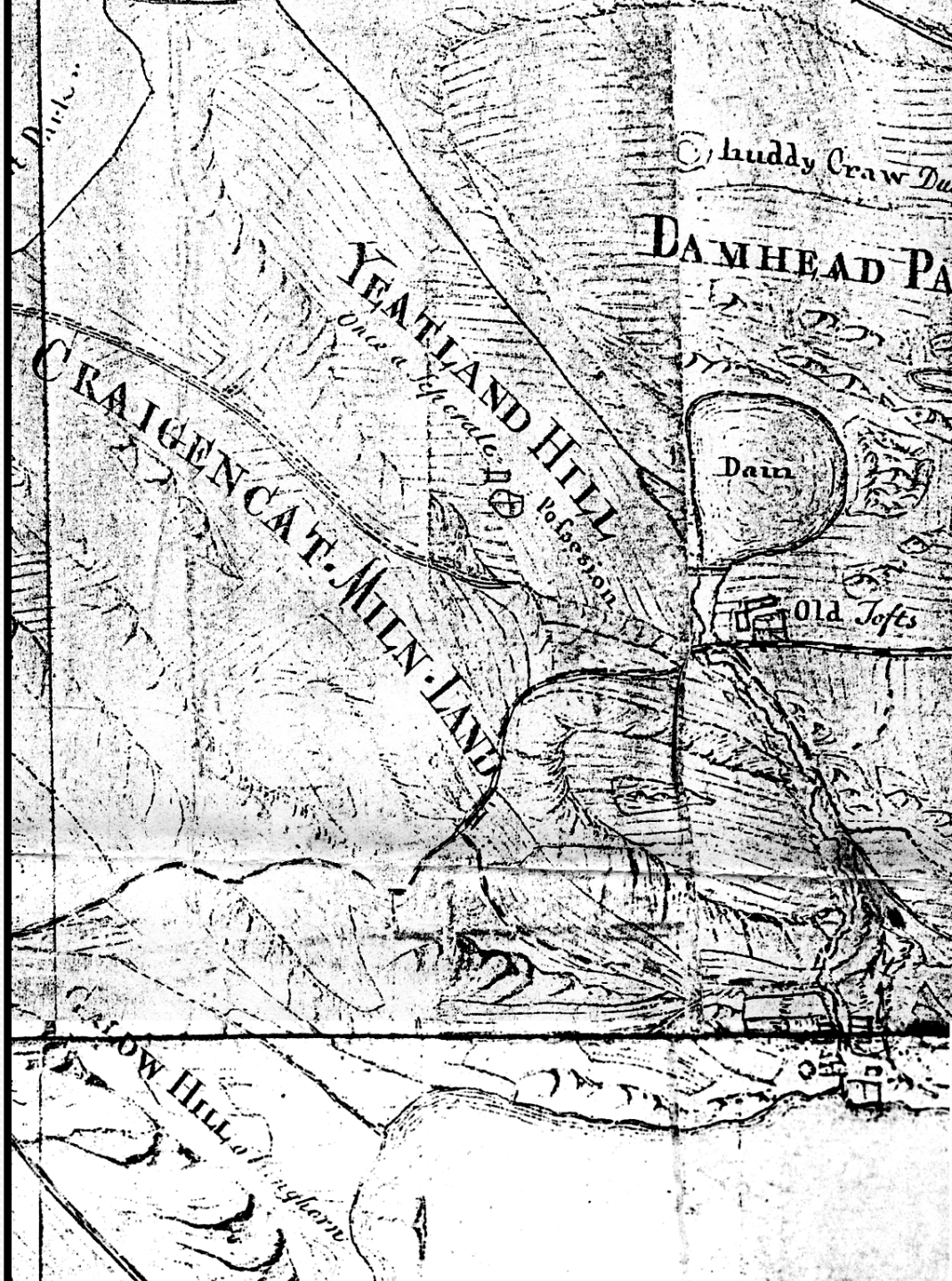
- The loch was part of Kinghorn Common Good.
- The Boswell family probably had a mill here in the fifteenth century.
- The Banchory Burn  was diverted to the loch by seventeenth century, probably both for the mills and to provide water  for Kinghorn.
- By 1682, the mill buildings were in dire need of repair.

# Craigencat Loch & Mill from old maps.




Blaeu Atlas of Scotland in 1654

# Raith Estate Map of Craigencat Mill, 1757.



# Craigencalt Mill in the Nineteenth Century.

The corn mill that was centred on the “Hermitage”. The large threshing mill was built around 1790-1800. It ceased to be a water mill by about 1860, when the Robert and William Young, the tenants, died. Craigencalt Mill and later farm were owned by the Philp Educational Trust from 1830 to 1919.

Craigencat Farm had been at Grange but there was no connection by the nineteenth century. The present Craigencalt Farm was built in 1891 to consolidate the agricultural holding.

# Kinghorn Loch in the late Nineteenth Century

## water supply and pollution


Right of residents of Kinghorn to the loch water for spinning and domestic use.

The Candle Works caused pollution that killed fish and water unfit to drink.

# Advent of Burntisland Oil Refining.


- Prior to 1878 George Simpson of Edinburgh processed some oil shale but then formed the Binnend Oil Company with a partner.
- John Waddell bought the successful company in1881 to form the Burntisland Oil Company. The company mined 500 tonne of oil shale each day, producing 15,000 gallons of paraffin, plus candle wax, lubricating oils, other light oils, bitumen and tars and sulphate of ammonia (fertiliser). Nearly 1000 men were employed.
- Dividends were excellent (up to 20%) until 1887 when 7% was paid and then production became interrupted and men laid off at times, until 1892 when it ceased. In 1892, it was proposed to develop a large, new oil field under Grangehill by lease from the Philp Trust. However, the company went into liquidation.
- In 1893 only 50 workers remained and a new company was formed. No significant work was ever done.
- The works were dismantled after 1894 (except the Candle Works) and liquidated in 1905.

# Saving the Whale

**The early oil industry stopped the need to kill whales and seals for their oil.**

**By 1880's the slaughter of whales was a disaster.**

By 1864 the use of oil lamps had increased greatly for domestic and industrial lighting. There was also increasing demand for lubricating oils in industry. The usual source was from marine mammals.

In 1816 one British vessel (of estimated 700) landed 40 whales, but by 1860s only 18 to 216 whales a year were landed by the whole of the British whaling fleet. Turning to Hair Seals, 875,000 were killed annually and by the 1880's the situation was disastrous.

The early oil industry, pioneered by James (Paraffin) Young, firstly from coal and then oil shale, produced millions of gallons of paraffin per year (by 1886) to light our homes.

# The Candle Works, Kinghorn Loch

- Swan Brothers had Upper, Mid and St Leonards Flax Mills and Tyrie Bleachfields in Kinghorn and 13500 spindles and 1160 workers in Fife and Dundee together with ships for export. Bankrupt in 1886.
- The Upper Mill was rebuilt and opened as the new Candle Works in 1887. This produced paraffin burning oil and wax, lubricating oils and sulphate of ammonia.
- There were probably 200-300 men employed at the Candle Works. Closed in 1894.


The Burntisland Oil Company was one of a number of smaller shale oil companies that produced its own candles.
This blue card with an engraved label was presumably the top of a box of candles. The lettering reads "Burntisland Holyrood Paraffin Candles. 8s. Burntisland Oil Co Ltd." the main illustration is of Holyrood palace with images of ornate candlesticks and the trademark of the Burntisland company; a star with an oil barrel in the centre.

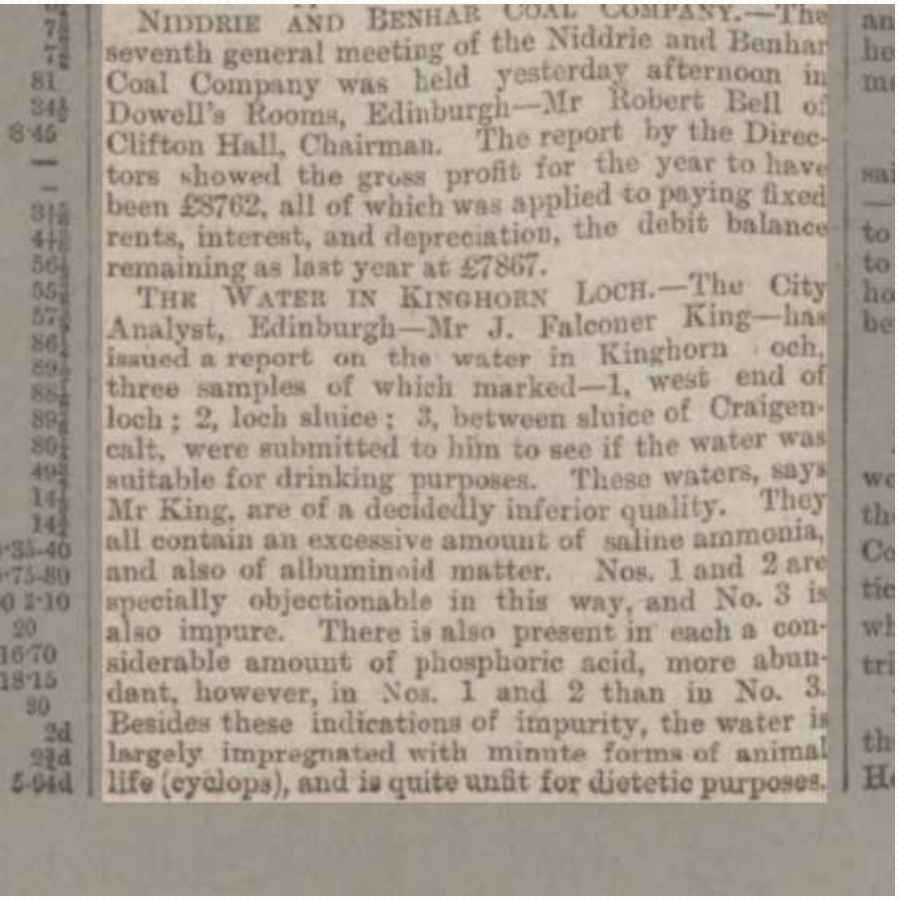
Image Courtesy of SCRAN

- The process, by law, required careful refining of the crude wax and paraffin and this is evidenced by the number of fatal fires caused by less safe American lamp oil (in 1895 in London there were 3633 fires from lamps accounting for 25% of all fire related deaths).

# Protection of Kinghorn Loch

- The bed (solum) of Kinghorn Loch was owned by the oil company but the water was owned by Kinghorn Town Council and free to use for the flax mills throughout Kinghorn. The free and effective supply of water to the mills and spinners was essential. **(This is obviously where our free use of the loch originated)**
- In 1882 the oil company diverted water (presumably at Common) for its use and water stopped flowing to the loch. Investigations found the company had diverted with a 3" pipe and not a 1" pipe to raise steam as they claimed. Kinghorn Town Council were vindicated.
- In 1886 when the railway was built, it broke the banks of Whinnyhall lochans and reduced water flow to the loch. It stopped the mills for a while.
- In 1887, the Upper Flax Mill of Swan Brothers was sold for the Candle Works and the oil company started abstracting water from the loch without paying for it. Litigation once more.
- Fortunately, the oil company did not permanently pollute the loch in the way that it fouled the Kirkton Burn down through Burntisland.

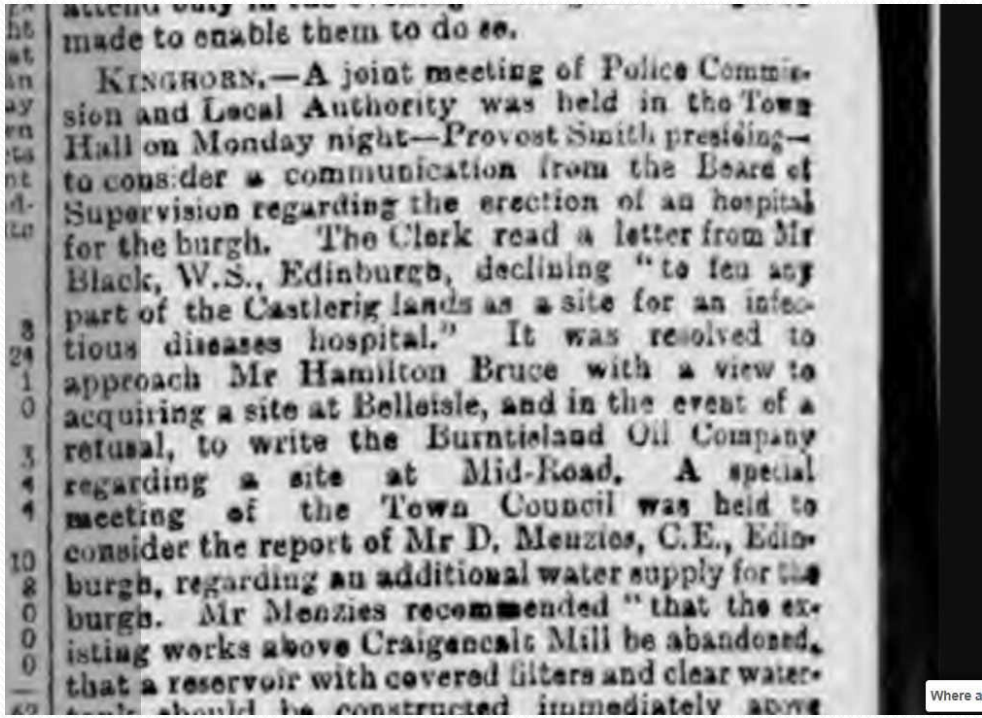
# Town Council takes company to court.



NIDDRIE AND BENHAR COAL COMPANY.—The seventh general meeting of the Niddrie and Benhar Coal Company was held yesterday afternoon in Dowell's Rooms, Edinburgh—Mr Robert Bell of Clifton Hall, Chairman. The report by the Directors showed the gross profit for the year to have been £8762, all of which was applied to paying fixed rents, interest, and depreciation, the debit balance remaining as last year at £7867.

THE WATER IN KINGHORN LOCH.—The City Analyst, Edinburgh—Mr J. Falconer King—has issued a report on the water in Kinghorn Loch, three samples of which marked—1, west end of loch; 2, loch sluice; 3, between sluice of Craigencalt, were submitted to him to see if the water was suitable for drinking purposes. These waters, says Mr King, are of a decidedly inferior quality. They all contain an excessive amount of saline ammonia, and also of albuminoid matter. Nos. 1 and 2 are specially objectionable in this way, and No. 3 is also impure. There is also present in each a considerable amount of phosphoric acid, more abundant, however, in Nos. 1 and 2 than in No. 3. Besides these indications of impurity, the water is largely impregnated with minute forms of animal life (cyclops), and is quite unfit for dietetic purposes.

Dundee Courier - 13th July 1888



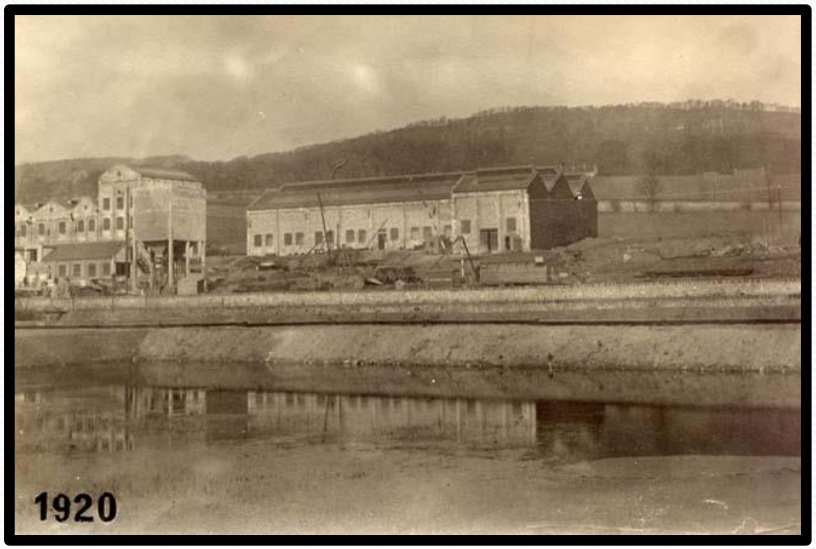
made to enable them to do so.

KINGHORN.—A joint meeting of Police Commission and Local Authority was held in the Town Hall on Monday night—Provost Smith presiding—to consider a communication from the Board of Supervision regarding the erection of an hospital for the burgh. The Clerk read a letter from Mr Black, W.S., Edinburgh, declining "to feu any part of the Castlerig lands as a site for an infectious diseases hospital." It was resolved to approach Mr Hamilton Bruce with a view to acquiring a site at Belleisle, and in the event of a refusal, to write the Burntisland Oil Company regarding a site at Mid-Road. A special meeting of the Town Council was held to consider the report of Mr D. Menzies, C.E., Edinburgh, regarding an additional water supply for the burgh. Mr Menzies recommended "that the existing works above Craigencalt Mill be abandoned, that a reservoir with covered filters and clear water-

Glasgow Herald – 18th July 1888.
Proposal for water treatment plant at Mid Road.

# Kinghorn Loch in Twentieth Century

## pollution and recovery




British Aluminium started tipping Red Mud at Whinnyhall tip in 1950s.

By 1960 the loch was being polluted and fish and water plants died out. By 1980s only midge larvae, blue green algae, swallows and canoeists thrived.

# Tannery.

- For a number of years the Tannery had an abstraction licence to take water from the loch via the Tannery Pond.
- The water level fluctuated a great deal.
- Eventually the Tannery made other arrangements as the polluted state of the water became a problem to them.
- The water level was stabilised by 1983.

# British Aluminium at Burntisland

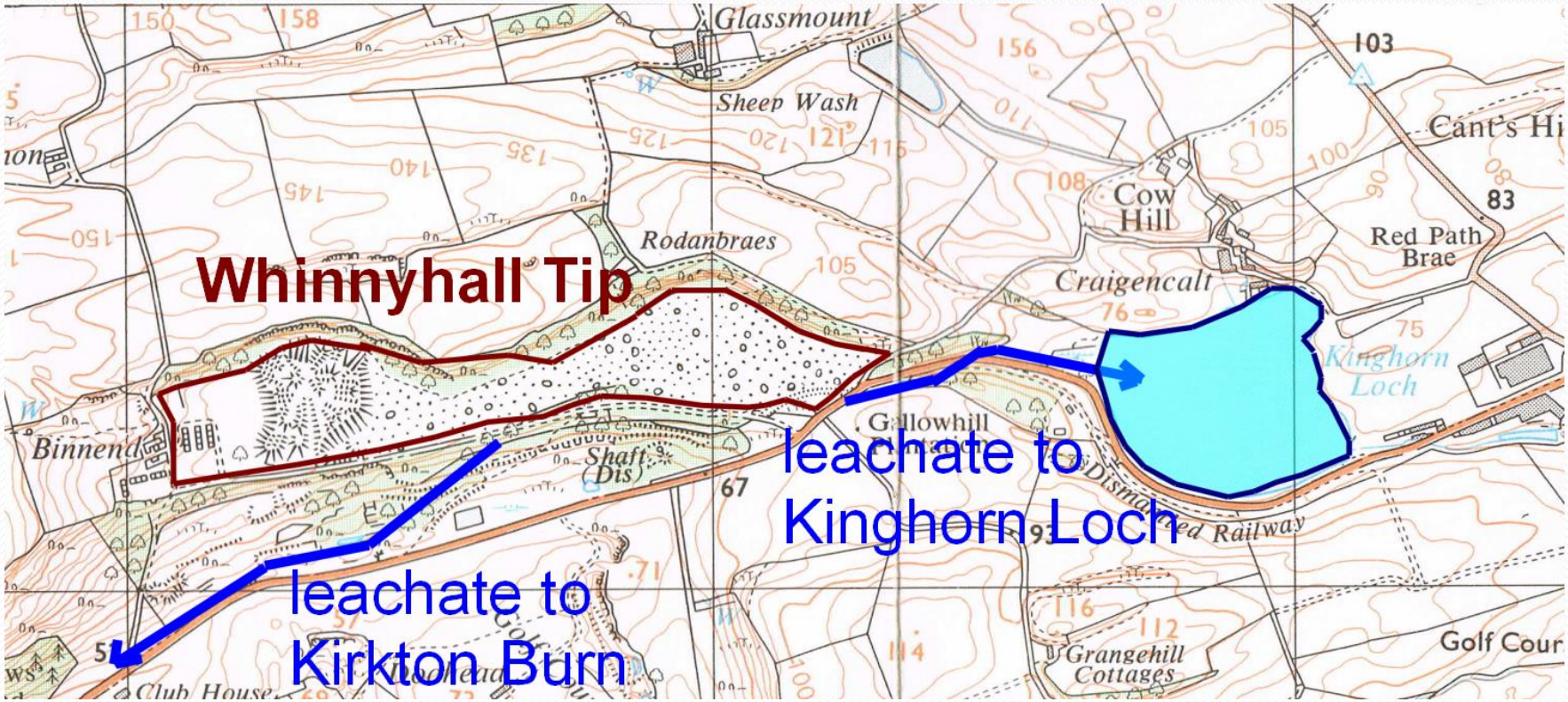
- Bauxite, an impure ore of hydrated aluminium oxide and iron oxide, was processed at Burntisland and Newport (Monmouthshire) from 1916.
- Pure alumina was produced by dissolving up the aluminium oxides in caustic soda and then depositing, washing and retorting in a kilns.
- The alumina was used in refineries elsewhere to produce aluminium and later also for ceramics and toothpaste, etc.
- The waste, mainly iron oxide, formed Red Mud, together with residual caustic liquors.

# Deposition of Red Mud

- Red Mud was deposited in the Sea Mill Dam sea inlet up until 1950s.  Disposal at sea was a common and effective solution to Red Mud disposal throughout the world.
- Disposal to Whinnyhall commenced in the 1950s and as production increased so did the tonnage of Red Mud.
- Up until 1983, leachate escaped from the tip to pollute the Kirkton Burn and Kinghorn Loch.
- From 1983, the leachate was treated before discharge to sea.

# Whinnyhall Landfill Site

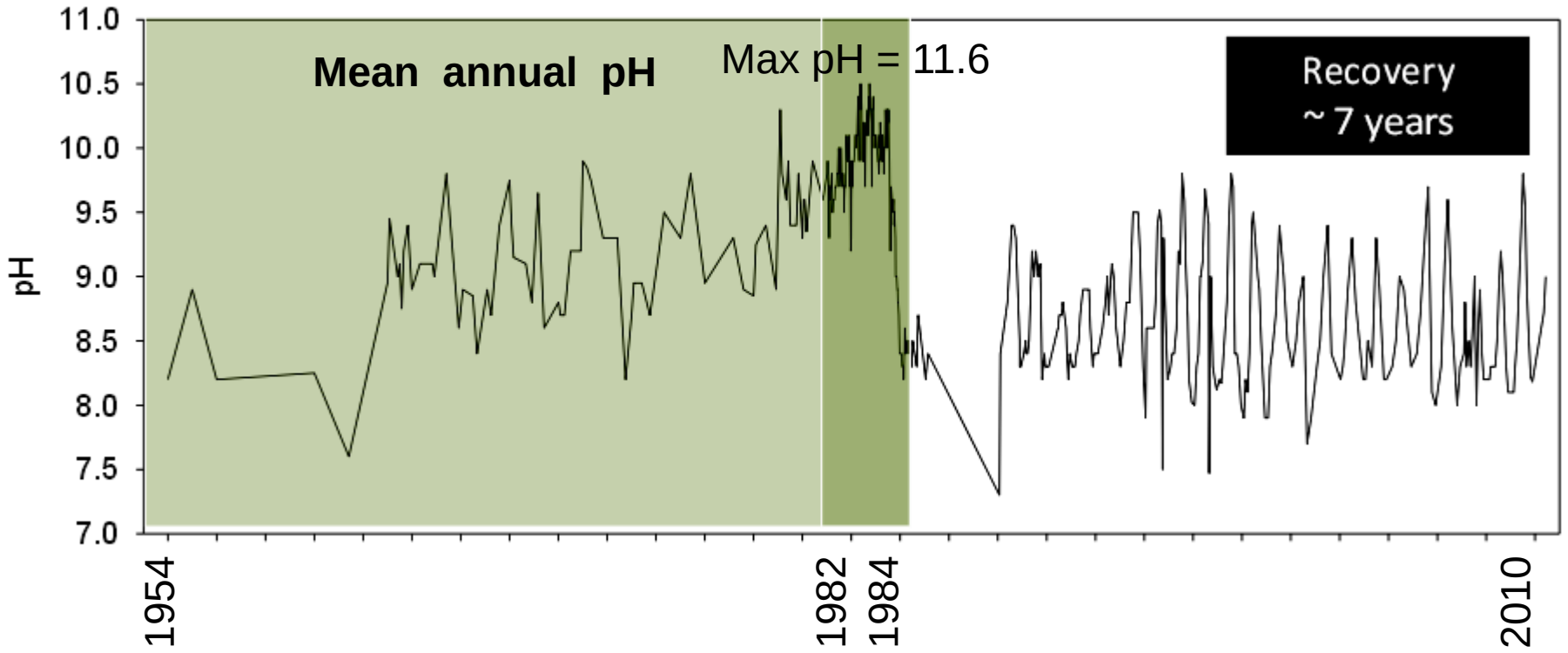
# Source of the leachate




**Both leachates redirected for treatment by 1983**

# Researching the problem


# Rising pH of the loch water



# Which pollutants were present?

- Sodium carbonate ("Washing Powder" in solution)
- Sodium bicarbonate ("bicarbonate of soda" in solution)
- Hydrated iron oxides (as fine mud, silt and sand)
- Sodium arsenite & arsenate (traces in solution)
- Phosphates
- Vanadium and other metals (traces of salts in solution)

# Significance of pollutants.

- Sodium carbonate and bicarbonate raised the pH of the water, which, together with depositing “lime” on plants, killed all plants and fish.
- Dissolved arsenic was ten times the Environmental Quality Standard and the highest in any water body in UK. Midge larvae was dominantly Chironamus plumosis, an arsenic tolerant midge.
- Dissolved aluminium was deposited in the sediment.
- Phosphates together with natural levels of nitrate allowed rampant development of algal blooms.
- The significance of vanadium remains unknown.

# Researching the problem

-Thick layer of iron rich sediments

-Soaking up arsenic and phosphorus into sediments

-Local waters are nitrate rich

-Phosphorus is the limiting nutrient

1985

# Some unusual effects.

The pollutants in the loch reacted with chemicals in the burn entering the loch.

- Calcium ("hardness") was deposited as aragonite – an unusual form of calcite (calcium carbonate).
- Dissolved silica in incoming burn water reacted with aluminium to form a range of clay minerals.
- Because of the negative electrostatic charge that formed on iron hydroxides at high pH, iron sludges were two metres thick and thixotropic. At normal pH these collapsed to only ten or so centimetres thick.

# Fate of pollutants after leachate was diverted in 1983.

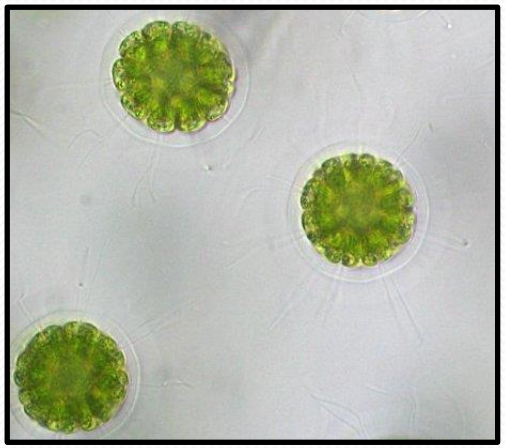
- Sodium carbonate and bicarbonate was washed from the loch and the pH returned to normal within months.
- The very voluminous hydrated iron oxide deposits collapsed to a dense layer as pH dropped.
- Arsenic and phosphate was adsorbed into the iron oxide deposits in the sediment.
- Vanadium was also adsorbed into sediments.
- Trout was introduced by the research team to monitor the quality of water in the loch.
- Water Hyacinth and other rarer plants came.

# Funny fishy behaviour.

- Strangely people started to introduce various fish into the loch.
- Pike was introduced – which had been the original fishery up to 1960s.
- Perch, roach and carp were also put into the loch in a haphazard manner.
- Stickleback and minnows also arrived.

# The pure water in 1985 did not last.

Unfortunately the high nitrate content of native waters, together with phosphate leaching out of the sediment, led to the re-development of rampant algal blooms.



# Dominance of blue-green algal blooms.

**from 1990, algal blooms once again became rife. Lasting all year on occasions.**

**formation of Kinghorn Loch Users Group:**

By the following active members from 2001:

-Kinghorn Community Council
-Canoe club
-Sailing club
-Scottish Carp Group
-Rio Tinto Alcan
-Craigencalt Farm
-SEPA
-Fife Council

Mediterranean blue water
- indicative of bloom.

# Coming together to treat the problem.

-Barley Straw rafts since 2001

-Six bales put out, twice a year, has to be totally feathered to be effective

-Rafts were designed by KLUG and built mainly with donated material

-Straw is donated by a local farm

# Chemical and ecological recovery of Kinghorn Loch (Fife, Scotland) following red mud pollution.

Justyna Olszewska[1], Bryan Spears[1], Amy Anderson[1], Clare McDonald[1], Ron Edwards[2],Tim Foster[3], Ian Winfield[4], Xintong Li[5], and Kate Heal[5]

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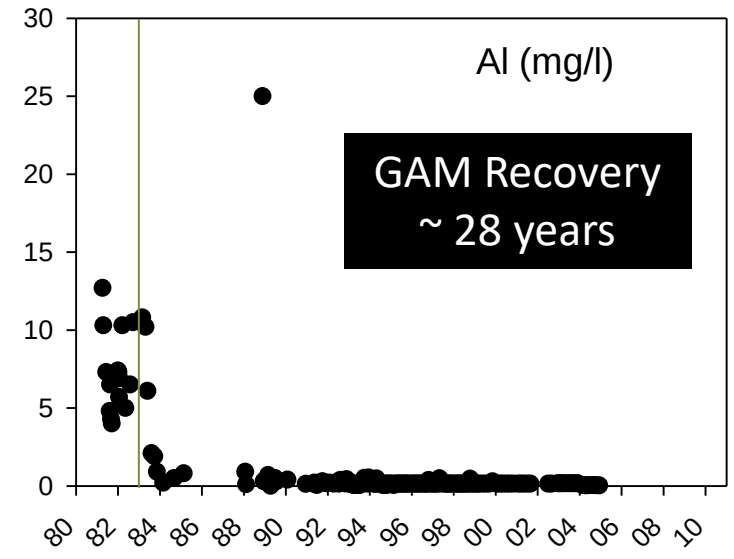
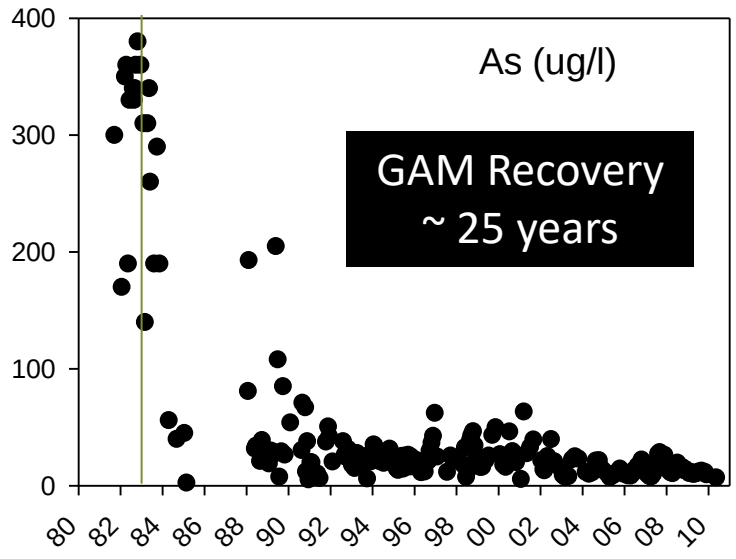
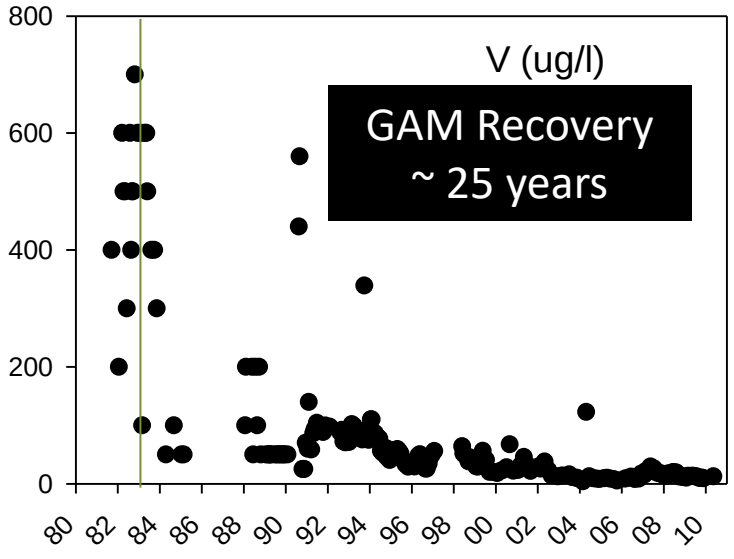
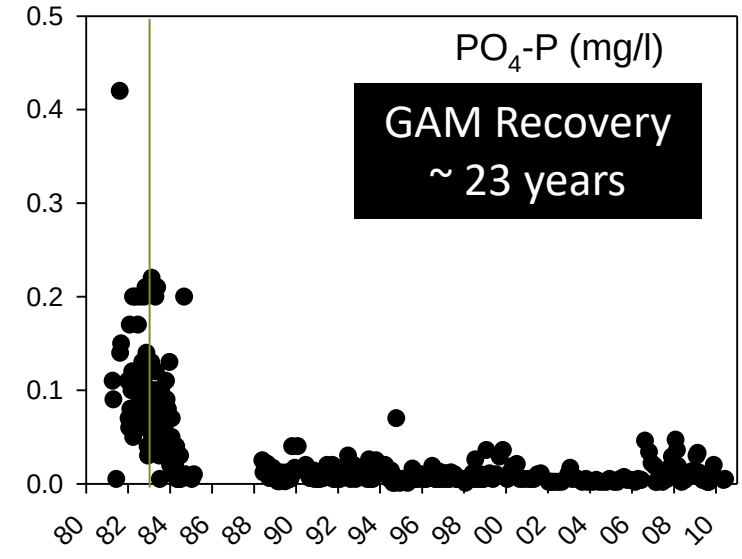
[3] Scottish Environment Protection Agency; Glenrothes, Fife, UK
[4] Centre for Ecology & Hydrology – Lancaster, University of Lancaster, UK
[5] School of Geosciences, University of Edinburgh, UK

# The long term chemical recovery in the water column



# Summary – recovery in Kinghorn Loch

- Red mud pollution appears to drive multiple ecological pressures in contaminated lakes
- Recovery can take decades and is pollutant specific
- Sediments in Kinghorn Loch are still contaminated after 30 years
- Pollutant cycling between sediments and water column is still evident 30 years following management
- Metals and metalloids are accumulated in aquatic food web after 30 years of recovery

Taken from: Olszewska, J et al, "Chemical and ecological recovery of Kinghorn Loch following red mud pollution".

NERC SCIENCE OF THE ENVIRONMENT

# Improvement in loch environment

**Algal blooms have been replaced by:**

-Blanket Weed – macro algae
-Rooted plants
    -these soak up nutrients
    -starve algae blooms
-More sunlight reaching the bottom sediment, the more rooted plants get established and the less nutrients available to blooms

-Not 100% removed, some strange, very short-lived blooms still occur but very rarely.

# Support for the new jetty.


- Burntisland Development Trust
- Alcan directly, specifically for Training Jetty

# Further projects on the loch.

Craigencalt Rural Community Trust

- Kinghorn Loch Users Group
- Kinghorn Pathways
- Walking Group
- Birdwatchers

Projects

- Information Kiosk
- Nesting platforms
- Designation of closed "wildlife area"
- Path, interpretation panels, information boards, signage and further jetty improvements.

# Whinnyhall Landfill site.

Now green and pleasant and hosting Rodanbraes and Binnend Paths.

Leachate treatment plant will be in operation for at least 50 years.

# The future of Kinghorn Loch and surrounding area with CRCT:

-Over 30 years , a number of regulators, landowners, commercial enterprises have been involved;
-Worked very well together;
-Common denominator that has kept the direction and purpose has been the community including landowners in co-operation;
-CRCT intends to see this continue, with the help of Rio Tinto Alcan, Craigencalt Farm and the other landowners;
-To benefit the community, and improve the environment.

www.CraigencaltTrust.org.uk