ASSAY

A NEWSLETTER ABOUT ACID SULFATE SOILS

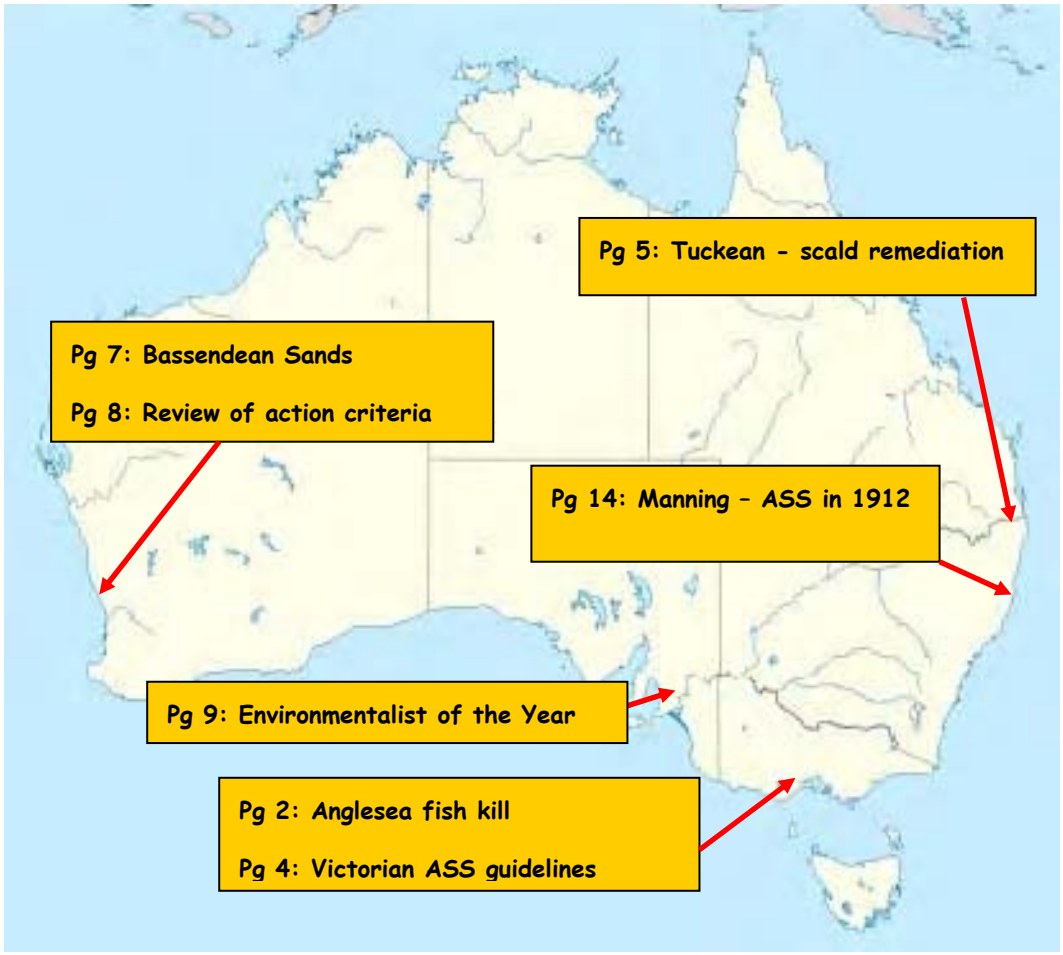
Issue # 54 **December 2010**

Into the future…

Well, its nearly the end of 2010 and the start of another decade! This is the final edition of ASSAY for the calendar year and it contains a dazzling array of stories from around the nation. In Western Australia, research is showing that soils developed on local sand dune systems with very low sulfur contents can still oxidise to produce pH values below 3. At Anglesea in Victoria, acid sulfate soils have been implicated in a series of recent fish kills. A historic news item reveals that some drained swamps in NSW were exhibiting signs of acidification from at least as early as 1912. The effectiveness of remediation techniques employed at the Tuckean, NSW are also highlighted. Last, but by no means least, congratulations go to Russell Seaman, who received the Prime Minister's Environmentalist of the Year award for his contributions to acid sulfate soil management of the Lower Lakes.

Happy reading…Simon

Stories and places in this issue…..



Fish kill at Anglesea, Victoria - influence of coastal acid sulfate soils

Tammy Smith, Department of Sustainability and Environment
Doug Crawford, Department of Primary Industries
Rebecca Price, Department of Sustainability and Environment.

Image: Rob Leeson, Herald / Sun

In mid-September pH levels in the Anglesea River estuary dropped below 4, killing significant quantities of fish. Estuarine pH levels fluctuated between 3.5 and 6.5 as the region experienced exceptional rainfall following more than a decade of prolonged drought. The low pH's are attributed to a flush of acid water after heavy rainfall from tributaries that flow through marsh swamp (suspected to contain acid sulfate soil) and intersect with coal seams that have metal sulfides. As the acid water reached the estuary, the usually fresh surface water became acidified.

The first obvious sign of the acid water event was the crystal clear water caused by the aluminium released from the acid sulfate soils. The aluminium flocculates clay particles which then settle on the river bed. The water appeared translucent blue (due to aluminium complexes), which to the unsuspecting eye looked beautiful on that sunny September day.

The Surf Coast Shire in collaboration with the EPA and the Department of Human Services were quick to advise the public of the risk of swimming or eating fish caught in the river. Toxicology tests carried out by Fisheries Victoria on the dead bream and yellow eyed mullet, species known to inhabit the estuary, confirmed that the low pH and the aluminium compounds on the fish gills contributed to their deaths.

Rising community angst turned the spotlight onto the government agencies and large scale land use activities within the catchment. The EPA, in accordance with the Waterway Incident Response Guidelines, investigated the cause of the fish deaths and determined that they were a natural occurrence, due to the acid sulfate soils in the marsh swamps, and not a new phenomenon to the Anglesea River. The last major fish kill occurred in 2001.

Acid sulfate soils have been known to exist in the mid catchment for some time but their effects were exacerbated after the 1983 Black Saturday bushfires, when channels were dug through the peat swamps in Coogoorah Park, Anglesea, to extinguish the persistent peat fires. This site is now a favourite for demonstrating how to identify disturbed coastal acid sulfate soils, and the Australian Soil Science Society visited this site during a recent field day.

This location was also used as a training site for a recent professional short course for acid sulfate soils being run by Southern Cross University's GeoScience Centre, in collaboration with the Department of Sustainability and Environment and the Department of Primary Industries. Jarosite minerals were identified and pH recordings as low as 2.9 were taken during the training.

Coogoorah Park 1979 - before Ash Wednesday

Coogoorah Park 2009 - post Ash Wednesday

There is great community concern about the fish kills despite historical evidence that acid discharge events occur naturally within the catchment, particularly after droughts. What action can be taken to reduce the impact of these events? This is a modified river mouth that still maintains high biodiversity and ecosystem values but there are also conflicting industrial, tourism, recreational and aesthetics values.

The Corangamite Catchment Management Authority has contracted an investigation into the dynamics of the river and the potential impacts of any remediation works, including an artificial deep excavation of the sand bar to flush the acid water out to sea. The final report for the investigation will certainly inform not only actions in the immediate term but also the future management of the river. This includes the development of a local fish death incident action plan and the updating of Anglesea estuary management plan.

The knowledge and science of acid sulfate soils is continually evolving. At the state level two policy documents on acid sulfate soils have recently been released. The Victorian Acid Sulfate Soils Strategy (2009) recognises that acid sulfate soils pose a complex issue if disturbed and promotes awareness of how to avoid disturbing this soil type.

In October 2010 best practice guidelines for assessing and managing acid sulfate soils in Victoria were released (see the next article). These guidelines help users identify and avoid risks when working in acid sulfate soils. Hopefully this policy guidance and local investigations can assist in determining appropriate actions.

The silver lining to this event is that it has brought into the spotlight the ability of all the government agencies to come together and work collaboratively to investigate and manage this complex issue in this complex catchment.

For more information on this topic:

http://www.ccma.vic.gov.au/documents/101105_Anglesea_FAQs9Nov2010No2.pdf

http://www.dse.vic.gov.au/DSE/nrencm.nsf/LinkView/8731022F1213F1FACA2572D000063C53DF4F1A9C76516D364A2567CA008177DF

Victorian coastal acid sulfate soil guidelines released

Rose Waters, Department of Sustainability and Environment, Victoria

In October 2010, the Department of Sustainability and Environment released the *Victorian best practice guidelines for assessing and managing coastal acid sulfate soils.* The guidelines have been produced to help landowners, developers and decision-makers assess and manage coastal acid sulfate soils (CASS). The guidelines apply to the potential development of new sites with possible CASS disturbance, and cover risks, site identification and considerations for CASS management plans.

The guidelines are the first action of the Victorian Coastal Acid Sulfate Soil Strategy released in August 2009. Work is now progressing on other strategy actions, including determining the most appropriate mechanisms for CASS risk management in Victorian planning provisions.

The guidelines were prepared by the Victorian CASS Implementation Committee; which comprises representatives from the Department of Sustainability and Environment, the Department of Primary Industries, the Department of Planning and Community Development, and the Environment Protection Authority, reflecting the cross-government nature of issues associated with CASS.

The guidelines launch coincided with a two day acid sulfate soils training course in Torquay on 19-20 October. The course was run by Southern Cross GeoScience with support from the Department of Sustainability and Environment, and Caring for Our Country funding. It brought together professional consultants, engineers, contractors, scientists, environmental officers and planners for a series of presentations from leading practitioners. It included practical exercises examining real-life examples and a field excursion to acid sulfate sites in Breamlea and Anglesea. It is hoped that further courses will be held next year.

The guidelines and strategy can be found at www.dse.vic.gov.au. If you would like a hard copy or further information, please contact Rose Waters at rose.waters@dse.vic.gov.au.

Acid-sulfate scald responds to treatment - Tuckean swamp, NSW

Paul Shaw

Photos: Richmond River County Council

A 1.2-hectare acid sulfate scald in the Tuckean Swamp, near Lismore in north-eastern NSW, is responding well to intensive remediation work. Richmond River County Council (RRCC) and the Northern Rivers Catchment Management Authority (NRCMA) undertook the project, on the Slattery property, about five kilometres south of Meerschaum Vale.

Scalded site prior to on-ground works

The NRCMA provided funding and RRCC and outside contractors carried out the work under the joint project management of now retired RRCC floodplain project officer Graeme Robertson and Gary Owers, formerly of Wetland Care, who recently joined RRCC as a floodplain project officer.

This is the largest scald RRCC has tried to remediate and it has been visible in aerial photographs since 2001. The site has acid-sulfate soils within one metre of the surface and is prone to shallow acidic groundwater discharge. Measurements in 1997 showed water in nearby drains had a pH of 3. The site includes a Landcare trial plot and is the subject of Southern Cross University (SCU) research which provided encouraging results for restoration of the site.

The project team adopted three major strategies to prevent further oxidation of acid-sulfate soil and encourage re-growth of native vegetation:

1. stock exclusion

2. groundwater control (including a bund in the Old Meerschaum Drain and filling in of side drains)

3. rotary hoeing, hilling, liming and mulching to promote re-establishment of grey rush (*Lepironia articulata*).

Site preparation – ridged & furrowed with lime applied

The team used tractor-drawn rotary hoes and hilling up cane boards to break the surface of the scald and create ridges and furrows.

The scald was treated with 4.4 tonnes of lime, giving an average dose of 3.67 tonnes per hectare, at a cost of $4,593.

The total project cost was $21,624,

representing $18,020 a hectare.

Members of Evans Excavations and Alfa Workforce Solutions joined the team for the mulching and drain work.

Graeme Robertson said the weather was an important factor in completing the remediation work. "I doubt that we could have brought in trucks of mulch, because even using cars with trailers brought soil moisture to the surface," he said. "The last attempt to undertake this work was made six years ago. It had to be abandoned due to rain and the imported mulch washed away."

Mulched ridges and furrows.

Attempts to use a bobcat to make an access track proved to be difficult due to the grey rush and fallen timber, with the machine jamming every couple of metres, so the team decided to slash a 0.73 hectare alternative mulch site with *Eleocharis* growing on it, located to the north of the scald. Once the mulch material had dried, team members collected it and took it to the scald by trailer. They applied it thickly over the freshly limed surface.

"We were tempted to use the grey rush from along the track and on the periphery of the scald, however we ended up with the tractor having difficulty in slashing it and a tangled mess difficult to pick up," Graeme Robertson said. "Ultimately, I think that we went the right way and this still took 13 man-days to complete, starting at 6.30 am and trying to avoid the 36-degree-plus heat."

When it was inspected three months after the work began, the mulch site was recovering and the watertable had risen by 100 mm, due to the action of the bund and filling in of side drains.

Manipulation of the water table is expected to stem encroachment by *Melaleuca quinquenervia,* whose roots bring acid material to the surface.

The four sections of the scald site received different treatments.

The control section had groundwater manipulation only.

The northern section received the deluxe treatment with groundwater control and was rotary hoed, hilled, limed and mulched.

The middle section and southern section had groundwater control and were hilled and limed.

Successful regeneration following treatment.

The first inspection, on March 10, showed no response on the control section, varied response on the northern section with growth mainly in furrows, and moderate and varied response on the middle section, with growth on

ridges and furrows. The southern section had a good, but varied response, with growth on ridges and furrows.

The second inspection, in May, showed improved response in all sections, including the control.

Graeme Robertson said the team was very pleased with the results and the site had been inundated since flood rain in March. “We will continue to monitor the site, as this will give some good comparisons with the three different treatments adopted and some guidance for future scald rehabilitation project work,” he said.

At the time of the second inspection, brolgas appeared to have made the scald their home and there was further evidence of their grazing.

Perth Bassendean Sands can acidify at sulfur levels as low as 0.01%S.

Balbir Singh and Stephen Wong

A large part of the Perth metropolitan area overlies the Bassendean Dune System of the Swan Coastal Plain. The soils developed over the Bassendean Dune System are generally highly leached, containing negligible clays, little organic matter and no limestone to buffer against soil acidity.

The acid sulfate soil mapping program carried out by the Department of Environment and Conservation (DEC) found that these soils typically contained chromium reducible sulfur lower than 0.03%S. The pH_{FOX} however often drops below 3, suggesting these soils may severely acidify even at such low S_{Cr} levels.

DEC soil scientist Balbir Singh checks acidity levels of soils collected from across the Perth metropolitan area. The soil samples, in geological chip trays, have been checked for soil pH every two weeks.

DEC soil scientist Dr Balbir Singh recently carried out an incubation study using geological chip trays to determine if these soils would naturally acidify on exposure to air.

Continuous sections of soil profiles with pH_{FOX} <3.0 and low S_{Cr} levels were placed in chip trays and allowed to oxidise naturally in moist conditions. The soils were sprayed with deionised water, when necessary, to

keep them moist. Soil pH was measured fortnightly.

"This method has previously has been used by Fitzpatrick *et al.* (2010) as a direct and inexpensive technique to characterise the potential acidity of soil materials," said Balbir. He said the study showed that Bassendean Sands with S_{Cr} levels as low as 0.01%S can acidify within first two weeks. There is significant and consistent reduction in soil pH throughout the incubated soil profile.

"Within six weeks soil pH dropped below 3 for samples with S_{Cr} levels in the range of 0.007 to 0.02 %," Balbir said.

The lowest recorded soil pH in six weeks was 2.2 for S_{Cr} levels of 0.014%S. Soil pH for sandy soils with S_{Cr} content <0.005%S, however, remains well above 4.0 after six weeks.

Balbir said DEC's recent mapping project across the Perth metropolitan area revealed that a large proportion of the Swan Coastal Plain had recorded sulfur ranging between 0.01 to 0.03%S.

This study suggests that Bassendean Sands with such low S levels can acidify to a pH of below 3 on exposure to air." he said.

WA moves to lower ASS action criteria

Clare Nixon and Stephen Wong

Western Australia is proposing changes to the ASS action criteria for sandy soils (Bassendean Sands) after investigations found current national triggers were not appropriate.

The Department of Environment and Conservation's (DEC) ASS section manager Stephen Wong said the State's current ASS action criterion was based on the coastal landscapes of Queensland and New South Wales.

"In the Eastern states, clay-rich sediments and silt are common," he said. "Bassendean Sands, which underlie much of the Perth metropolitan area, have significantly different properties to soils on the eastern seaboard and, in particular, have very poor acid buffering capacity. Consequently, lower action trigger criteria are required for WA soils."

Stephen said Bassendean sands on the Swan Coastal Plain were characterised by pale, leached sands and dark brown "coffee rock" materials which contained very little clay and no carbonate. "They are, therefore, unable to buffer changes in soil pH," he said.

In recent years, DEC has carried out an extensive ASS risk mapping project as well as many field investigations and laboratory-based research projects in conjunction with the University of Western Australia, all highlighting the acute acidifying behaviour of Bassendean sands.

"All of our research has indicated that using the current action criterion of 0.03%S for sandy soils is not sufficient in this State," said Stephen. "It may not be enough to protect groundwater from being impacted by acidity and metals when Bassendean sands, containing low concentrations of sulfides, are allowed to oxidise through groundwater dewatering, excavation or drainage."

DEC intends to lower the inorganic sulfur action criterion for the management of sulfides in Bassendean sands from 0.03% (equivalent acidity 18.7 moles H^+/tonne of soil) to 0.01% (equivalent acidity 6.2 moles H^+/tonne).

The change, which is supported by the National Committee for Acid Sulfate Soils (NatCASS), will be incorporated into the revision of DEC's acid sulfate soil management guidelines.

"The change is necessary to ensure that management of Bassendean sands in Western Australia is in

line with the national objective of managing soils throughout Australia to protect groundwater quality and other environmental values," said Stephen.

DEC has published a discussion paper on the proposed action criterion change and is inviting submissions. The paper can be found at www.dec.wa.gov.au/ass

Closing date for submissions is February 21, 2011 and they can be sent to:

Contaminated Sites Branch
Department of Environment and Conservation
Locked Bag 104,
Bentley Delivery Centre, WA 6983

or by email to ass@dec.wa.gov.au

Ecologist honoured for excellence

Wetlands ecologist Russell Seaman has been named the Prime Minister's Environmentalist of the Year for outstanding environmental achievement at a national or international level. Russell is the environmental manager for the Coorong, Lower Lakes and Murray Mouth (CLLMM) program in the SA Department of Environment and Natural Resources.

He received the award at the 2010 Banksia Awards where the CLLMM program itself won the Land and Biodiversity – Preserving Our Ecosystems category.

Russell was recognised for his efforts in preventing the ecological collapse of the drought-affected Coorong and Lower Lakes region. He profiled the plight of several threatened fish species and habitats, and secured funding for fish rescue projects and surrogate breeding sites. He played a key role in water security projects in the region, and worked with scientists to implement research supporting the management of the site. That research led to pioneering techniques in managing acid sulfate soils by using carbon to stabilise wetland environments and mitigate the threat posed by acidification.

The ASS issues he faced are illustrated in this photo which featured in his recent River Symposium presentation about the fight to save the Coorong.

If you would like to know more about Russell's work, have a look at the presentation at the site below.

http://www.riversymposium.com/index.php?element=Thur_s1_A3_Russell+Seaman.pdf

http://denr.sa.gov.au/cllmm/pdfs/community-update-oct2010.pdf

GeoScience ASS short-courses

Chrisy Clay, Southern Cross University

Torquay, Victoria

During October the ASS short course was held at Torquay, Victoria. The course was met with great interest from local stakeholders, with registrations filling six weeks before the course was held. A highlight of the course was the demonstration given by Doug Crawford from Victoria Department of Primary Industries on how to sample for acid sulfate soils in the field, and a visit to the Anglesea River which recently experienced a pH-related fish kill.

Participants visited Anglesea River and discussed the recent fish kills as part of the course field trip.

Doug Crawford testing the pH of water near the Anglesea River. Acid conditions were still present some weeks after the initial fish kill.

Doug Crawford from Victoria Department of Primary Industries explains how to use the Munsell colour system to describe soil.

Perth WA

The Perth course highlighted the need for careful ASS management on the Swan Coastal Plain where sandy sediments which are easily oxidised and poorly buffered.

Leigh Sullivan describes the processes occurring in the acidified lake at Stirling, WA .

Darwin NT

To finish off the 2010 program, the short course was held in Darwin in early December. True to form, everything is bigger and better in the Top End. NT has the highest distribution of acid sulfate soils in Australia, and possibly the hottest soils, with one soil recording 10.5% sulfur!

The Darwin short course included a field visit to the harbour's mangrove forests to examine acid sulfate soils first hand.

Course participants use the field sampling equipment.

It was a muddy trip, but soil scientists don't seem to mind getting dirty!

The perfect end to a hot and sticky day in the Top End….an afternoon storm.

Southern Cross GeoScience, with the support of Caring for our Country, has continued to roll out its professional acid sulfate soil short course program. The course has been very well received by its target audience, and has significantly improved participants' skills, knowledge and confidence in managing acid sulfate.

For further information on the courses, and where they will be held during 2011, visit www.scu.edu.au/geoscience/index.php/15

Sea level rise, saltwater and acid sulphate soils on the NSW North Coast

Peter Haskins

Inundation of coastal lowland acid sulfate soils with saline tidal waters has been frequently proposed as one remediation mechanism to counter acid discharges from such soils using the potential neutralising capacity of seawater.

Now Dr Vanessa Wong from Southern Cross University and her research colleagues have published their research simulating the short term impacts of such inundation, in the context of sea level rise on actual acid sulfate soils from sites at Shark Creek, Rocky Mouth Creek and Tuckean Swamp.

Location map: Sample sites at the Tuckean Swamp (TK),

Rocky Mouth Creek (RMC) and Shark Creek (SC).

This research has clearly shown that the simulated inundation of both the organic topsoil and sulfuric horizons of the acid sulfate soil profile at each sample site leads to an initial decrease in pH and a corresponding rise in acidity as cation exchange takes place. Mobilisation of a range of metal ions in the sulfuric horizon was also demonstrated. However, prolonged seawater inundation will lead to reductive processes, causing acidity to decrease and pH to increase over longer time periods.

Given that the upward creep of sea level rise is slow, it is easy to see that this may lead to significant changes to the soil and water regime at these and similar sites over the short term, and in such incidences such as storm surge or king tide events.

Dr Wong's paper can be found at www.elsevier.com/locate/geoderma in *Geoderma*, Volume 160, Issue 2 (2010) pp. 252—263 under the title 'Seawater causes rapid trace metal mobilisation in coastal lowland acid sulfate soils: Implications of sea level rise for water quality'.

Recent publications

Ljung K, Maley F and Cook A (2010)

Canal estate development in an acid sulfate soil: Implications for human metal exposure.

Landscape & Urban Planning 97(2):123-131

Abstract: The adverse environmental outcomes of disturbing acid sulfate soils have long been known, and there is a general consensus that avoiding disturbance is the most cost-efficient solution. However, canal estates are increasing in popularity on the west coast of Australia, in spite of a large proportion of the country's acid sulfate soils being located along its coast. This study examined the mobility and concentration of metals in surface soil, dust and water sampled from one of the earliest canal developments in Western Australia.

Soil metal concentrations were significantly elevated compared to an undisturbed reference site. While the dust fraction generally held higher metal concentrations in the original soil of the area, the total metal load was higher in the dredged and deposited material. None of the samples were above guideline values.

The surface water of the canals had concentrations of iron and arsenic above the Australian drinking water guideline value while nickel concentrations were above the ecological guideline value. The pH of the water was not affected. The human health consequences of these findings may not be severe as the water is not used for drinking.

However, the results highlight the need for transparency in the land development process, where developers are responsible for informing home buyers of the consequences related to developing acid sulfate soil areas and the steps that are being taken towards remediation or avoidance. Moreover, the results show the importance of monitoring metal concentrations in addition to pH in waters potentially affected by acid sulfate soils.

Claff SR, Burton ED, Sullivan LA and Bush RT (2010)

Effect of sample pretreatment on the fractionation of Fe, Cr, Ni, Cu, Mn and Zn in acid sulfate soil materials.

Geoderma 159(1-2):156-164.

Abstract: A sequential extraction procedure was applied to acid sulfate soil materials from a soil profile to investigate the effect of sample pre-treatment on the geochemical fractionation of selected metals. The samples were prepared for analysis by oven-drying, sieving and grinding the soil, or were examined as collected in field condition. The soil profile encompassed oxidising conditions near the surface, through to reducing conditions at depth.

Six metals (Fe, Cr, Ni, Mn, Cu, and Zn) were measured during the sequential extraction procedure, and their fractionation determined in the oxidised and in the reduced zone. Although cumulative totals (the sum of all steps in the sequential extraction procedure) for the metals extracted from both the field condition and dried/ground samples were similar, some significant differences in fractionation within individual extraction steps were observed.

Of particular interest was the redistribution of metals from the sulfide-bearing (pyrite-bound) fraction to the more readily available fractions (i.e. labile and acid-soluble), as a result of oven-drying and grinding. The results indicate that when assessing metal fractionation in acid sulfate soil materials, samples should be analysed in field condition in order to avoid the considerable metal fractionation artifacts that are induced by drying and grinding.

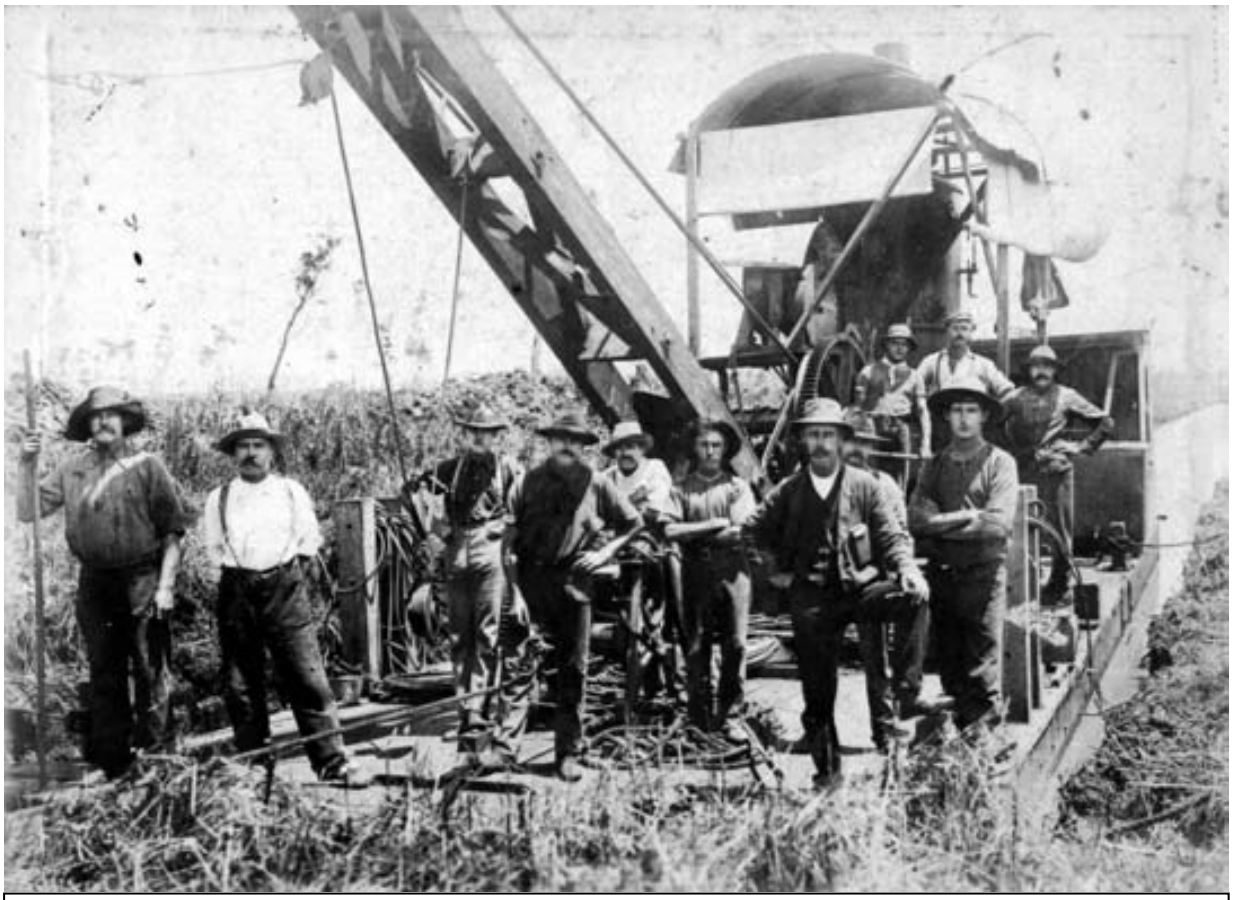
1912 newspaper article: "Failure of a drainage scheme" – Manning NSW

Simon Walsh

I have recently been working on a project looking at the historic occurrence of major fish kills on the Richmond River, NSW. This process involved an examination of records in old newspapers, government archives, diaries and reports for references to major fish kills, floodplain drainage construction and acid sulphate soils. Over the next couple of issues of ASSAY, some of the more interesting and relevant articles will be published, such as this one from the Manning River in NSW…

WINGHAM.-The Big Swamp, situated some seven and a half miles from Coopernook, comprises about 6000 acres. A scheme for draining this area was completed about six years ago, at a cost of £7600, but it has proved a failure. At the present time there is an average depth of two feet of water all over this swamp, and the main canal and the feeding drains are about as good as useless, as far as getting rid of the water is concerned.

If the water was any good some use might be made of it, but nothing will live in it, and stock will not touch it - though it is clear and sparkling, and would have one to believe it is absolutely pure.



Drainage construction workers on a floating steam shovel ***Source: Lismore Historical Society***

However, the taste of it is most objectionable. Mr. L. V. Hill, who has been teaching a school in the vicinity of this extensive sheet of water for the past nine years, asserts that even eels and frogs die quickly if put into it.

Strange to relate, however, about 12 years ago, on the higher portions of this swamp, Mr. Juhl and others grew maize profitably - the stalks growing to a great height and the cobs filling well. Rice was also grown there, and was marketed. Now herbage of any kind will not thrive, and tracts of marshy land where once flourished vegetation peculiar to such localities are now absolutely bare.

Mr. Hill asserts that the only logical explanation of the matter is that some poisonous matter has come up from the earth. In other words, in a dry time the alkalis rose up, and they appear to have been of two kinds - white and red. The white rose first, and then a reddish dust appeared on the vegetation. The Big Swamp Trust has, it is understood, been dissolved, and Mr. Lee has been appointed to control the area. Had the drainage scheme been successful, the idea was to have the land put to some practical use, but it now looks as though such an aim is beyond the realms of realisation.

Source: Sydney Morning Herald – 28 February 1912

Erratum

ASSAY # 53 contained an incorrect spelling of Clint McCullough's name. Our apologies, Clint.

ASSAY contact details

Back-issues of ASSAY are available from: http://www.dpi.nsw.gov.au/aboutus/resources/periodicals/newsletters/assay/

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To subscribe, email the editor, Simon Walsh with "Subscribe ASSAY" in the subject line:

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ACID SULFATE SOILS

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