



# ASSAY

A NEWSLETTER ABOUT ACID SULFATE SOILS

Issue # 57

September 2011

## Spring has sprung!

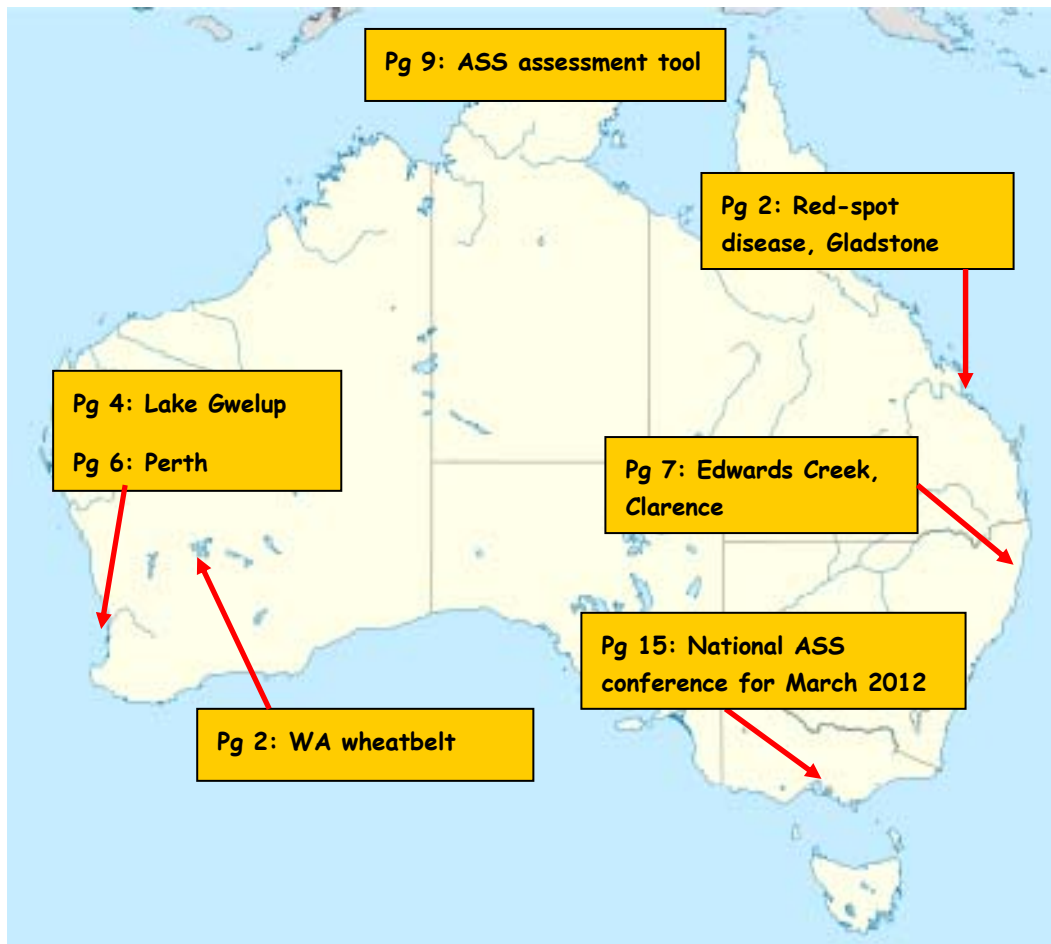
September's issue of ASSAY has hit the streets and paddocks. Once again, Western Australia continues to lead the charge on ASSAY contributions with three articles on recent research and management projects. Our colleagues from the west are showing the other states and territories just how well acid sulfate soil communications can be done. Can anyone tackle this friendly yet important challenge?

Talking about raising the bar on communications, a number of important fora on this topic are about to be held. Starting in November, the NATCASS committee members are gathering in Newcastle for their biannual meeting. Then in February next year, the 3<sup>rd</sup> National ASS Conference is being hosted by Southern Cross University's GeoScience centre in Melbourne, Victoria. Finally, the next International ASS Conference is being held in Vaasa, Finland during late August 2012.

In other news within this issue, a technique for rapid assessment of potential acid sulfate soils using 'induced polarisation' is featured and in an emerging story from Gladstone, Qld; fish have been found with red-spot disease and the cause is under investigation.

*Happy reading...Simon*

### Stories and places...



## Scientific panel appointed to probe Gladstone's sick fish

Paul Robinson and Megan Hendry

27th September 2011

Source: <http://www.efarming.com.au/News/agricultural/27/09/2011/151928/scientific-panel-appointed-to-probe-gladstone-s-sick-fish.html>

The Queensland Government has appointed a scientific panel to investigate fish diseases in the Gladstone Harbour in the state's central region.

A ban on fishing was imposed earlier this month after anglers reported fish with skin lesions and cloudy eyes.

A preliminary report has identified red-spot disease and a parasite.



Queensland Fisheries Minister Craig Wallace says testing of fish will continue, but the new panel will look into water quality and human health concerns.

The new study will be headed by the chief executive of the Australian Institute of Marine Science, Dr Ian Poiner.

Mr Wallace will also meet local authorities and anglers in Gladstone to discuss the issue.

Gladstone Mayor Gail Sellers says it is important decision makers realise the importance of the issue to local fisherman and the wider community.

"[Mr Wallace is] meeting with council, the port and the local member Liz Cunningham," Ms Sellers said.

"Also coming with [Mr Wallace] is Ian Fletcher, who is the director-general of DEEDI [Department of employment, Economic Development and Innovation] and also Maria Moore, who is the director of Fisheries Queensland."

## WA Wheatbelt ASS conditions associated with acidic saline groundwater

**Brad Degens, WA Department of Water**

Scientists at the Department of Water, in partnership with CSIRO, have continued leading investigations into the management of acidic groundwaters in the WA wheatbelt that create ASS conditions in floodways and lakes.

Characterisation of acidic groundwater hazards for much of the WA wheatbelt was finalised in late 2010 with the publication of the final of a series of reports on this issue (Degens & Shand 2010). This work indicated the extent of the issue and that the combination of sulfidic processes and formation of soils with ASS properties was central in the manifestation of impacts.

Further advances in understanding best approaches to manage the acidic waters have also been achieved. The findings from a 3-year field evaluation of pilot-scale anaerobic bioreactors for treating acidic saline drainage waters have recently been published (Degens 2011).

This is complemented by establishment of a permanent farm-scale demonstration site for in-drain treatment of acidic saline drainage water at Dumbleyung (300km SE of Perth), that has enabled ongoing investigation of the performance and management of such treatment systems.

Dr Brad Degens, in conjunction with Lynette Galvin and Dr Rick Krassoi (Ecotoxicity Services Australasia), has also developed locally relevant ecotoxicity tests for inland saline ecosystems in WA and applied these to evaluate existing guideline limits for the assessment and management of net acidity in discharge waters.



*Compacting straw to form a simple in-drain anaerobic treatment system for acidic saline discharge treatment*

#### **Recent publication:**

Degens B and Shand P (eds.) 2010. Assessment of acidic saline groundwater hazard in the Western Australian Wheatbelt: Yarra Yarra, Blackwood and South Coast. CSIRO: Water for a Healthy Country National Research Flagship. 152 pp. <http://www.water.wa.gov.au/PublicationStore/first/96996.pdf>

#### **Abstract:**

Groundwater drains used to manage saline watertables in the semi-arid zone of south-western Australia can discharge acidic saline water with high concentrations of metals to waterways. Mitigating the acidity impacts of the waters requires sulfate-reducing bioreactors capable of functioning under semi-arid conditions with limited source materials. Two simple pilot-scale

bioreactor designs using straw and sheep manure mixtures were evaluated over several years.

The bioreactors increased pH from <3.5 to >5.5 for 125–260 days, with concurrent evidence of sulfate reduction, >85% reductions in net acidity and >90% reductions in Al and most trace elements (e.g. Pb, Cu, Ni, Zn, Ce and La). When outflow pH < 5.5 (remaining greater than inflows), reduction in net acidity was 10–80% but concentrations of Pb, Cu and Ni remained >80% reduced over periods of 250 to >700 days.

Rates of alkalinity generation initially exceeded 10 g CaCO<sub>3</sub>/m<sup>2</sup>/day in both bioreactors thereafter decreasing to >1–2 CaCO<sub>3</sub>/m<sup>2</sup>/day. Al and Fe retention was implicated in trace metal removal when pH < 5.5, mediated by biological alkalinity generation. High evaporation rates limited bioreactor function by restricting outflows with no benefits to alkalinity generation rates.

This experiment showed that simple bioreactors can neutralise acidic waters and remove metals for short durations and show capacity for sustained reduction in acidity and metal concentrations over several years despite low alkalinity generation.



*Inland ASS surveys near Muckinbudin with Rob Fitzpatrick and Margaret Smith*

## Lake Gwelup at risk

**Steve Clohessy, Department of Environment and Conservation**

Arsenic, iron, nitrate, pyrite oxidation and declining groundwater levels are threatening the ecological integrity of Lake Gwelup in Western Australia.

This groundwater-dependent, flow-through wetland within the densely urbanised suburb of Gwelup is located 11 km north of Perth. The high social amenity of Lake Gwelup is reflected in the need to maintain its ecological attributes.

Horticultural activities dominated the Gwelup landscape for some 90 years until the 1970s when residential development increased. Unsewered urban development and fertiliser use left a legacy of elevated nutrient levels in groundwater. The lake is also located down-gradient of public water supply production bores (Gwelup Bore Field) which have operated since 1974.

Groundwater levels up-gradient of Lake Gwelup have declined by up to 5m since the 1970s. This is due to a combination of groundwater abstraction and reduced rainfall. Groundwater levels have ceased declining at rates indicative of the 1990s as groundwater abstraction from the Gwelup Bore Field has

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increased from the confined aquifers and eased slightly in the Superficial aquifer. Despite this, the lake has dried each summer since 2001. This is in contrast to it being recorded as dry on only three occasions in the preceding 80 years.

The progressive groundwater level decline has caused the oxidation of naturally occurring iron sulfide minerals such as pyrite contained in the lake sediments and near the watertable in Lake Gwelup's capture zone.

Lake Gwelup is also subject to sulfate and iron-enriched groundwater and drainage waters discharging into its eastern edge (Figure 1). Elevated levels of arsenic, aluminium and nitrate have been identified in groundwater of the lake's capture zone.



**Figure 1. Iron-enriched Brushfield Wetland, which ultimately discharges into the eastern edge of Lake Gwelup via the Brushfield Drain.**

Nitrate in shallow groundwater may be due to either leaching from the unsaturated zone or nitrification. Nitrification is an acid generating process in oxidising conditions, converting ammonium ion ( $\text{NH}_4^+$ ) to nitrate ion ( $\text{NO}_3^-$ ). Reducing conditions and denitrification are evident at greater depths of the Superficial aquifer.

Groundwater investigations in Lake Gwelup's capture zone identified elevated levels of iron (up to 124 mg/L), aluminium (up to 6.28 mg/L), arsenic (up to 3.59 mg/L), sulfate (up to 821 mg/L) and total acidity (up to 446 mg/L) posing a long term risk to the ecological values of Lake Gwelup.

Sulfate was identified up to 430 mg/L ( $\text{SO}_4:\text{Cl} = 2.15$ ) and dissolved iron up to 4.9 mg/L at the base of the Superficial aquifer beneath the eastern edge of the lake (34 m below ground level). This may be due to pyrite oxidation.

Further investigation into the delineation of arsenic in groundwater is required given the use of unlicensed domestic bores and the likely presence of arsenopyritic peat lenses in the area known to contain high concentrations of arsenic and a significant store of acidity.

A hydrogeological report as part of the 'Perth Shallow Groundwater Systems Investigation' conducted by the Department of Water (DoW) details surface water-groundwater interactions and soil and groundwater quality at Lake Gwelup and its capture zone. This report is scheduled to be published by DoW in 2011.

### Brad Degens, WA Department of Water

Several ongoing projects undertaken by the Department of Water have produced a clearer understanding of the interconnectedness of ASS and shallow groundwater systems in the Perth Basin. This basin contains large areas of ASS that are associated with groundwater systems under pressure from climate change and water abstraction.

Potential ASS associated with wetlands (all >10m AHD) in the Perth region have been found to be common, but not ubiquitous. There is evidence that actual ASS have formed in some lakes as a result of declining watertables, affecting the water quality and ecology of lakes and some down-gradient groundwater systems (Searle *et al.* 2010).



#### **ASS coring in Lake Mariginiup**

Supplementation of one lake for terrestrial ecological purposes has averted significant ASS development and impacts on the lake (Searle *et al.* 2011). These findings are complemented with similar applied science projects determining the associations between ASS and groundwater systems and groundwater dependent ecosystems (GDEs) elsewhere in the Perth Basin (see the Hydrological record series of reports below).

In many of these areas, ASS benchmarks are increasingly being used as a proxy for setting environmental water requirements for GDEs. Soil coring including ASS assessment has been carried out at 25 GDEs in the southern Perth Basin (south of Bunbury) and 8 GDEs in the North Perth basin on the coastal plain to the north of Perth. Analysis of these investigations is in progress.

#### **Recent published reports:**

Department of Water 2011, *Perth shallow groundwater systems investigation: Loch McNess*, Hydrogeological record series report no. HG43.

<http://www.water.wa.gov.au/PublicationStore/first/97595.pdf>

Department of Water 2011, *Perth shallow groundwater systems investigation: Tangletoe Swamp*, Hydrogeological record series, report no. HG49.

<http://www.water.wa.gov.au/PublicationStore/first/98975.pdf>

Department of Water 2011, *Perth shallow groundwater systems investigation: Lake Yonderup*, Hydrogeological record series, report no. HG51.

<http://www.water.wa.gov.au/PublicationStore/first/98976.pdf>

Department of Water 2011. *Perth Shallow Groundwater Systems Investigation: Lexia Wetlands, Western Australia*. Department of Water, Hydrogeological record series, report no. HG44. <http://www.water.wa.gov.au/PublicationStore/first/98974.pdf>

McHugh, SL, Bathols, GR and Hammond, M 2011, *Perth shallow groundwater systems investigation: Egerton Seepage*, Department of Water, Perth. Hydrogeological record series, report no. HG53. <http://www.water.wa.gov.au/PublicationStore/first/99494.pdf>

Searle, JA, McHugh, SL, Paton, AC and Bathols, GR 2010, *Perth shallow groundwater systems investigation: Lake Mariginiup, Western Australia*. Department of Water. Hydrogeological record series, report no. HG 36. <http://www.water.wa.gov.au/PublicationStore/first/91255.pdf>

Searle, JA, Hammond, MJ and Bathols, G 2011, *Perth Shallow Groundwater Systems Investigation: Lake Nowergup*, Department of Water, Perth. Hydrogeological record series, report no. HG 40. <http://www.water.wa.gov.au/PublicationStore/first/99594.pdf>

### **In Press:**

Degens, BP, Hammond, MJ and Bathols GR 2011, *Perth Shallow Groundwater Systems Investigation: Lake Muckenburra, Western Australia*. Department of Water, Hydrogeological record series, report no. HG46.

## **Edwards Creek, Clarence River, NSW – a happy ending**

### **Stuart Murphy, Clarence Valley Council**

An innovative construction material, vinyl sheet piling, has proved its worth in an innovative trial of groundwater manipulation to better manage acid sulfate soils on the Clarence river floodplain.

Edwards Creek is a modified creek system in the lower Clarence estuary that discharges into the south arm of the Clarence River near the township of Maclean. The creek was deepened and the mouth floodgated in the 1960s as part of an extensive flood mitigation program. The works were designed to drain the large wetland to the east of the creek to allow for agriculture.

A combination of drainage, saline intrusion, grazing pressure and fire contributed to the creation of a persistent scalded area in one portion of the wetland. Investigations into the soil chemistry and hydrology were undertaken in 2005. Remediation works undertaken at the time included cattle



***Vinyl sheet piling was used for the weirs (as seen in ASSAY #50)***

exclusion, breaking the crusted surface (no mulching) and the installation of a secondary floodgate within the drainage catchment to reduce the risk of saline intrusion.

This combination of activities coupled with favourable wet conditions gradually reduced the size of the scalded area over the next 4 to 5 years. In 2009 further works were undertaken to actively assist in maintaining water levels within the wetland.

These works involved the installation of two fixed sill weirs to help maintain groundwater levels above the local potential acid sulfate soil layer. Benefits have included an improvement in the quality of water discharged into Edwards Creek

and better grazing productivity for the participating landholders.

Vinyl sheet piling supported by rock cobble was used in constructing the weirs. The construction process is relatively straight forward and does not require pouring concrete or coffering off the drain. Individual piles are interlocked before being pushed into the earth to the required depth and supported by rock fill. The sheets are light and easy to handle. The piles come in a variety of sizes.

They are inert to acid and provide a long lasting and a low maintenance management option. Another benefit is that they are basically a 'set and forget' option that does not require ongoing intervention to operate, making them cheaper and safer. This technique is particularly suitable for sites that do not require regular adjustment of water heights.

The accompanying photos show the clear benefits of raising groundwater levels on a formerly scalded swamp. This simple, yet effective technique has been a valuable tool in managing acid sulfate soils on the Clarence floodplain.



*Before*



*After*

**K Vozoff\*, J W Tayton, D Cramer (SMEC Australia) and P B Hostetler**

**\*PO Box 996, Spit Junction NSW 2088**

The difficulties of ASS management are well-known; they include sampling the soils over a range of depths, sealing and transporting them to a chemical analytical laboratory, and analysing them for a range of components including low levels of sulfur, iron, chlorine, etc. The process is slow and costly. A significant part of the time and cost can be bypassed using a well-established geophysical technique known as Induced Polarisation (IP) (or complex resistivity), to detect and qualitatively assess soils *in situ* (Kemna, Binley, Ramirez and Daily, 2000). In particular, it maps potential acid sulfate soils (PASS). With support from the Australian Government START program, the approach was evaluated in 1999 – 2005 by a group of private consultants and the major engineering group SMEC Australia.

The approach that we developed involved driving a narrow instrumented probe into the soil, typically to 3 m depth, and reading the electrical conductivities from an electrode array fixed on the probes at 5 to 10 cm intervals, over a range of frequencies appropriate to the problem. The electrodes were connected to a commercial impedance meter (Solartron 1260A) and the results output to a disk. The presence and concentrations of polarisable minerals, mainly pyrite but with marcasite and other species, were then plotted in the evenings, so that barren areas could immediately be mapped and sulfidic areas highlighted for further investigation. The method, called PASSFinder<sup>TM</sup>, was patented (Vozoff and Tayton, 1999).

### **Case Studies**

Case studies were conducted on a number of sites to determine the correlation between traditional and the PASSFinder methods. The trials included projects in:

#### **Homebush, Sydney. Site near Olympic Stadium:**

Soil conditions: Estuarine, recent fill, high rubbish content, very irregular surface

Measurements: Probe positions spaced 20-30m apart

Results: Very little PASSFinder response, in agreement with chemical analyses

#### **Berry, NSW 10 km NW of Shoalhaven Heads:**

Soil conditions: Estuarine silt and clay, dry but surface below watertable earlier in the year

Measurements: Probe positions located 80 m apart

Results: Weak PASSFinder responses near surface, increasing below watertable, in agreement with chemical analyses

#### **Newington, Sydney**

Soil conditions: Measurements in floor of excavation. Estuarine clays, tidal, visible acid burn

Measurements: Probe positions 20-30m apart

Results: Large PASSFinder response at shallowest depths, diminishing with increasing depth, in agreement with chemical analyses

#### **NSW Sand mine site**

Soil conditions: Sand, reworked in many but not all locations, variable water table

Measurements: Probe positions in several locations. Larger diameter probes required, with purpose built drill to allow probe insertion.

Results: Sampling done at same positions and same time. Analyses not yet completed

### Clothiers Creek, NSW Tweed catchment, 2-3 km west of Bogangar

Site of RTA Pacific Highway relocation

Soil conditions: Estuarine silt and clay, often below water table, much visible acid burn

Measurements: Probe positions 10-100m apart

Results: Samples collected at the same positions at the same time. Good agreement with Cr-reducible S analyses (Figure 1)

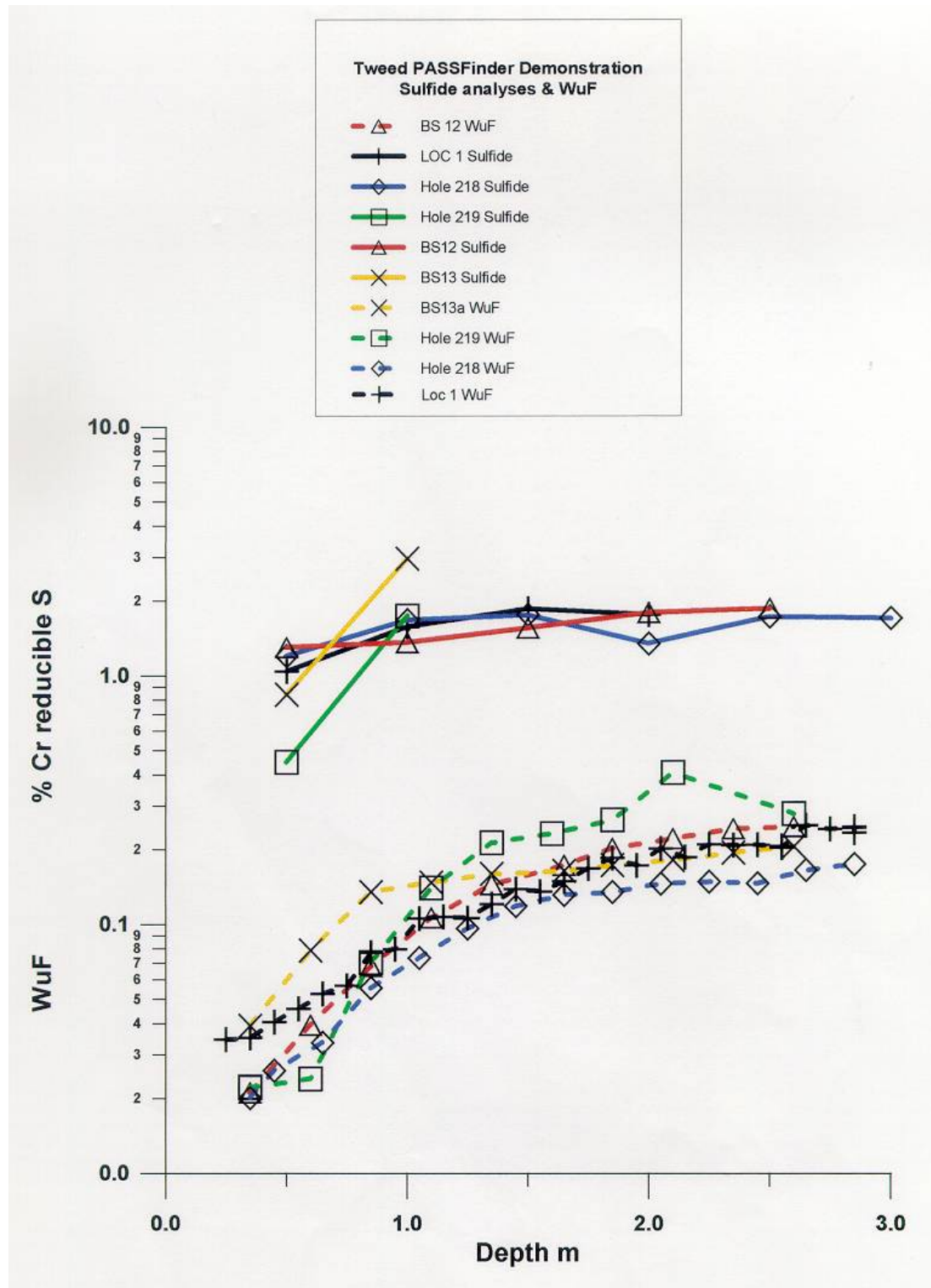


Figure 1: Clothiers Creek Results

The upper plot shows percent Cr-reducible sulfur and the lower plot shows WuF, the quantity derived from the PASSfinder measurements (in different units). The two sets of results are highly correlated, having a ratio of about 10/1, so that %S can be predicted from WuF.

## Economics

Six locations at the Tweed RTA site, done in one day with two men using laboratory equipment, yielded estimates of potential acid sulfate concentration at 86 points that same evening. To obtain the same number of estimates by conventional means would require 10-15 days. With purpose-built equipment the production rate can be increased significantly. The system can be backpack-able and results are produced in real time. The increased accuracy of the assessment for regarding both extent and degree of PASS allows an improved estimation of volumes and thus improved management planning and subsequently better cost control and significant cost reduction.

## The future

In the past few years the approach has attracted the interest of soils scientists, who are interested in the details of the mineral species present and implications as regards the formational genesis (e.g Ntarlagiannis, Doherty, and Williams, 2010). Our approach is only a shortcut in that direction, but it drastically changes the economics of ASS management. The application of our approach can be easily extended by modifying the probes so as to measure pH, and possibly other properties as well. An Australian company is now manufacturing instruments of the kind necessary for these measurements.

## References

Kemna, A, Binley, A, Ramirez, A, and Daily, W, 2000. Complex resistivity tomography for environmental applications: *Chemical Engineering Journal*, 77, 11-18.

Ntarlagiannis, D., Doherty, R., Williams, K. H., 2010. Spectral induced polarization signatures of abiotic FeS precipitation: *Geophysics*, 75, F127-F133.

Vozoff, Keeva and Tayton, James W., 1999. Detection of potential acid sulfate soils. *Australian Patent No. 42505/99*

## Latest publications

**Amaral V. Cabral HN. Bishop MJ. (2011). Effect of runoff from acid-sulfate soils on pneumatophores of the grey mangrove, *Avicennia marina*. *Marine & Freshwater Research*. 62(8):974-979.**

Runoff from acid-sulfate soils (ASS) is increasingly threatening the structure and function of estuarine ecosystems worldwide. Along the eastern coast of Australia, sulfuric acid is known to affect the growth and survival of mangrove saplings; however, impacts of ASS runoff on the structure and function of established mangrove trees are unclear.

Pneumatophores, the aerial roots produced by some species of mangrove, are critical sites of gas exchange, allowing these species to persist in waterlogged soils. They also provide physical structure in estuarine sediments, facilitating communities of algae, invertebrates and, at high tide, fish. We tested the hypotheses that *Avicennia marina* (Forsk.) Vierh. pneumatophores would be less abundant, shorter, thinner and weaker close to major ASS outflow drains.

Sampling at sites close to and away from drains within each of two estuaries of New South Wales, Australia, showed no effect of exposure to runoff on pneumatophore density or thickness. Pneumatophores were, however, shorter (similar to 2 cm) and weaker (up to two-fold) at ASS-affected than reference sites.

Although the reduced length and strength of pneumatophores at acidified sites may limit the number of epifaunal molluscs they can support, the persistence of dense pneumatophores indicates that the capacity to benefit invertebrates and fish remains.

**Regmi G. Indraratna B. Nghiem LD. Golab A. Prasad BG. (2011) Treatment of acidic groundwater in acid sulfate soil terrain using recycled concrete: column experiments. *Journal of Environmental Engineering-ASCE*. 137(6):433-443.**

Acidic groundwater generated from pyrite oxidation in acid sulfate (AS) soil is a major geo-environmental problem in Australia. This study aims to evaluate recycled concrete as a reactive material in permeable reactive barriers (PRBs) for the remediation of acidic groundwater in low-lying AS soil floodplains.

Laboratory experiments were systematically conducted to investigate the acid neutralization behaviour of recycled concrete and its potential to remove dissolved Al and Fe. The results confirmed that recycled concrete could effectively treat acidic groundwater from an AS soil terrain, resulting in near neutral effluent over a long period with complete removal of Al and Fe.

The major mechanisms involved in neutralising acidic groundwater are thought to be the precipitation of Al and Fe as oxides, oxyhydroxides, and hydroxides. However, the accumulation of secondary minerals could decrease the reactivity of the recycled concrete. For example, chemical armouring could decrease the neutralising capacity of recycled concrete by up to 50% compared with the theoretical acid neutralisation capacity of this material.

The results reported here also show that the neutralisation capacity and reactive efficiency of recycled concrete are dependent on the initial pH value and also the concentration of Al and Fe in acidic groundwater.

**Uzarowicz L. and Skiba S. (2011). Technogenic soils developed on mine spoils containing iron sulfides: Mineral transformations as an indicator of pedogenesis. *Geoderma* 163(1-2):95-108.**

Technogenic soils (*Technosols*) containing iron sulfides, developed on mine spoils located in three abandoned industrial sites in Poland (the "Siersza" hard coal mine in Trzebinia, "Staszic" pyrite mine in Rudki, and pyrite mines in Wiesciszowice), were investigated in order to identify the most important mineral transformations occurring in the soils.

The X-ray diffraction (XRD), scanning electron microscope-energy dispersive spectrometry (SEM-EDS) techniques, and selective extraction methods were applied in the examination of soil mineralogy. The soils studied represented weakly developed soil formations in which organic matter accumulation increasing with age was observed, along with intense weathering of parent materials containing iron sulfides.

The degree of sulfide transformations is age-dependent. In young soils from Trzebinia and Rudki, poorly weathered iron sulfides occurred, whereas in old soils from Wiesciszowice, iron sulfides were almost entirely transformed. The main products of sulfide weathering are iron oxides and sulfate minerals (gypsum and jarosite group minerals mainly). Inherited phyllosilicates and pedogenic clay minerals (smectite, vermiculite, kaolinite, and mixed-layer minerals) were present in the soils studied.

The development of Al-hydroxy interlayers and the possibility of the formation of poorly crystalline Al phases were also documented. The processes seem to be pH-dependent and occur at pH ranging from 4.3 to 4.4. The development of iron oxides and sulfate minerals in the process of sulfide weathering, as well as phyllosilicate transformations (e.g. the development of swelling clay minerals at the expense of inherited mica and chlorite, and the formation of hydroxy interlayers in clay

minerals) are the main mineralogical aspects of pedogenesis of technogenic soils developed on mine spoils containing iron sulfides.

The WRB and Soil Taxonomy systems require more precise solutions concerning the classification of technogenic soils investigated. The *thionic* horizon (WRB) and *sulfuric* horizon (Soil Taxonomy) definitions, as well as the *sulphidic material* (WRB) and *sulfidic material* (Soil Taxonomy) definitions need to be supplemented. The paper suggests the introduction of the *Sulfic Udorthents* taxon in the Soil Taxonomy, as well as the introduction of "Thionic" suffix qualifier to the key to the *Technosols* in the WRB.

**Nguyen TVH. Takizawa S. Oguma K. Phuoc NV. (2011) Sources and leaching of manganese and iron in the Saigon River Basin, Vietnam. *Water Science & Technology*. 63(10):2231-2237.**

High concentrations of manganese and iron in the Saigon River are major problems for the water supply in Ho Chi Minh City (HCMC), Viet Nam. To identify their sources and leaching processes, we surveyed water quality along the Saigon River and ran batch leaching tests using soil and sediment samples.

Two important leaching processes were identified: acidic leaching from acid sulfate soil (ASS) in the middle reaches of the river, and Mn dissolution and Fe reduction from sediments in the downstream reaches. Low pH caused the concurrent release of Fe and Mn from the ASS. In contrast, anoxia caused the release of Fe but not Mn from the sediments, whereas low pH facilitated Mn dissolution.

Sediments are a more important source of Mn because of their higher Mn contents (10 times) and release rates (14 times) than those from ASS.

**Lyons DJ. McElnea AE. Finch NP. Tallis C. (2011). Ultra-fine grinding is not essential for acid sulfate soil tests. *Soil Research*. 49(5):439-443.**

Australian Standard methods for acid sulfate soils (ASS) require the grinding of soil to <0.075 mm. A ring-mill or similar grinding apparatus is therefore needed. We investigated whether ring-mill grinding is required for accurate and reproducible test results and associated calculations (such as acid-base accounting), or if more conventional fine-grinding (i.e. <0.5 mm) is sufficient to obtain acceptable results.

An initial experiment (unreplicated) was conducted on 52 soils comparing ring-mill and fine-grinding treatments, and this information was used to formulate final, more detailed experimental work on five soils from the same dataset. Soils from an ASS survey in coastal central Queensland were chosen to reflect the range of chemical properties found in ASS. Soils were analysed by the Chromium and SPOCAS suite of tests for the two grinding treatments.

For those tests that follow a relatively vigorous extraction carried out with heating [such as chromium-reducible S, peroxide-oxidisable S and acid-neutralising capacity by back titration (ANC(BT))], results were similar for the two grinding treatments. However, for those tests that follow a relatively mild extraction without heating (such as KCl-extractable S, HCl-extractable S and titratable actual acidity), significantly higher values ( $P < 0.05$ ) were obtained for ring-mill ground soil.

There was no significant difference in calculated net acidity between ring-mill grinding and fine-grinding for soils without excess ANC. For self-neutralising soils, fine-grinding gave significantly lower values of ANC than ring-mill grinding. It is uncertain whether ring-mill grinding gives a true reflection of the ANC available in the natural environment.

**Claff SR. Burton ED. Sullivan LA. Bush RT. (2011). Metal partitioning dynamics during the oxidation and acidification of sulfidic soil. *Chemical Geology*. 286(3-4):146-157.**

The oxidation and acidification of sulfidic soil can lead to changes to metal mobility that can have far-reaching environmental consequences. In this study, we examined changes in the partitioning and mobility of Fe, Cr, Cu, Mn, Ni and Zn in four sulfidic soils, due to sulfide oxidation driven acidification, over a 90 day period.

These changes were examined using a novel six-step sequential extraction procedure specifically developed for acid sulfate soil materials. The results demonstrate two distinct steps for the mobilisation of metals in disturbed acid sulfate soil materials, associated with (i) oxidation and (ii) acidification. Initially, oxidation causes metals to be redistributed from the "pyritic" and "organic" fractions to the "acid-soluble" fraction. Subsequent acidification, due to exceedance of the acid neutralising capacity of the soil, drives the release of metals to the "labile" fraction.

This study demonstrates the importance of these metal pools in understanding the short-term processes which mobilise metals in sulfidic soils.

**Kinsela AS. Denmead OT. Macdonald BCT. Melville MD. Reynolds JK. White I. (2011). Field-based measurements of sulfur gas emissions from an agricultural coastal acid sulfate soil, eastern Australia. *Soil Research*. 49(6):471-480.**

The emissions of biogenic hydrogen sulfide (H<sub>2</sub>S) and sulfur dioxide (SO<sub>2</sub>) play important roles in the global atmospheric sulfur (S) cycle. Field-based investigations using ultraviolet fluorescence spectroscopy show that drained acid sulfate soils (ASS) are a potentially unaccounted source of biogenic H<sub>2</sub>S and SO<sub>2</sub>.

Significant diurnal variations were evident in SO<sub>2</sub> fluxes, with average daytime measurements 9.3-16.5-fold greater than night-time emissions. Similar diurnal patterns in H<sub>2</sub>S fluxes were observed but proved statistically insignificant. The results from simultaneously collected micrometeorological measurements suggest that emissions of SO<sub>2</sub> and H<sub>2</sub>S are most likely occurring via different processes. The SO<sub>2</sub> fluxes are closely linked to surface soil temperature and moisture content, whereas H<sub>2</sub>S is constantly emitted from the land surface at the two study sites.

Drained ASS are most likely mapped as agricultural lands rather than drained backswamps. Therefore, these areas are likely to be assigned H<sub>2</sub>S and SO<sub>2</sub> flux values of zero in greenhouse gas species inventories. These findings suggest a need to expand these measurements to other drained ASS areas to refine regional (and possibly global) atmospheric S budgets.

Further research is necessary to elucidate the sources of measured S compounds, and specifically whether they are limited to individual agricultural drainage patterns in ASS.

**Toivonen J. Osterholm P. (2011). Characterization of acid sulfate soils and assessing their impact on a humic boreal lake. *Journal of Geochemical Exploration*. 110(2):107-117.**

Due to acidity and metals from acid sulfate soils (a.s. soils), many watercourses in midwestern Finland have since 1960s regularly experienced short but intensive periods of poor water quality during high water flow. This has led to occasional massive fish kills and a significant decline in fish populations.

However, many watercourses in northern Europe are often also characterized by low pH caused by naturally occurring organic acids, non-carbonate bedrock and previously a large input of acid rain. Therefore the role of acid sulfate soils has not always been properly addressed.

This study was done on Larsmo and Oja Lake, a freshwater reservoir embanked from the alkaline Bothnian Bay in the 1960s. Since that, events of severe acidity and fish kills have been documented on several occasions. Severe but heterogeneous a.s. soils with relatively coarse grain sizes were found in the catchment. These soils were found to leach metals typical for a.s. soils such as Al, Cd, Co, Ni and Zn to recipient streams, but in contrast to other a.s. soils studied in Finland, some of them even seem to be leaching large quantities of Fe.

Patterns of acidity, sulfate, sulfur isotopes, organic carbon and metals in rivers, streams and the lake revealed that (1) a.s. soils in the catchment are by far the most important source of acidity and metals in the lake i.e. the main reason for fish kills, (2) the load from discharge of organic (humic) acids and dredging operations is insignificant on the lake as a whole, (3) young near-field sediments comprising only 7% of the whole catchment accounted for roughly 20-30% of the total acidic load, (4) most of the acid/metal load entered the lake system from the south, and (5) by regulating outlets to the sea it seems to be possible to prevent this load from dispersing into the northern part of the lake system.

## Conferences and workshops



### Call for papers

The conference organisers invite you to participate in the 3rd National Acid Sulfate Soil Conference, and are calling for oral and poster presentations. If you are undertaking research, developing or implementing policy, managing development activities or remediating broad acre disturbance; we encourage you to share your experiences and ideas at the conference.

Acid sulfate soil management is now a specialist activity involving many hundreds of professionals in both the private and public sector. The conference is an opportunity for such professionals to showcase the best and most innovative practices in Australia. The conference organisers look forward to receiving a range of high quality abstracts capturing current best practice and issues of the day.

### Key dates

Call for papers close:	Friday 4th November, 2011
Presenter Notification close:	Monday 14th November, 2011
Early Registration close:	Friday 9th December, 2011

### Program themes

Presentations and posters should address one or more of the Conference program themes:

- understanding the nature of ASS, their impacts and distribution
- assessment techniques and laboratory analysis

- policy, regulation and education
- managing ASS and groundwater during development, and mitigating the impacts
- understanding inland ASS
- broad acre remediation of ASS disturbance in wetlands and agricultural landscapes.

### **Presentation types**

An extended abstract of no more than 500 words is required for both oral and poster presentations.

Oral presentations: 15 minute presentation with an additional 5 minutes for questions within themed Conference sessions.

Poster presentations: will be displayed throughout the conference with an allocated time for the author to be available for queries.

### **How to submit your abstract**

Abstract submission will only be available via the Conference website

[www.scu.edu.au/nationalassconference](http://www.scu.edu.au/nationalassconference)

A template is available online to assist you in preparing your abstract in the correct format.

To submit your abstract, please visit the Call for Papers page and click on the 'Submit Abstract' link.

## **Acid Sulfate Soil Short Course Update**

**Chrysy Clay, Southern Cross University GeoScience**



Registrations are now open for the next acid sulfate soil short course at Perth, Western Australia on the 22nd and 23rd of November.

The course, which covers how to manage acid sulfate soils during development, has been specifically focused to meet the needs of consultants, engineers, contractors, environmental officers and town planners. The course is state-specific and adapted to suit the legislative framework and unique acid sulfate soil characteristics of each state or territory.

Organisers have found that even experienced practitioners, who have been working in the field for some years, are improving their knowledge, skills and confidence by attending the course.

In particular participants are interested in further information on the detailed analysis of acid sulfate soils and how to interpret laboratory results. This, as well as, conducting a desktop and preliminary assessment, identifying suitable management options and writing a management plan is all covered during the course.

Future courses will now be run according to demand. People wanting to attend future courses are encouraged to register their interest with organiser Chrisy Clay.



For further information on the acid sulfate soil short course, visit [www.scu.edu.au/geoscience](http://www.scu.edu.au/geoscience) and to contact the organiser, email [chrisy.clay@scu.edu.au](mailto:chrisy.clay@scu.edu.au)

## ASSAY contact details

Previous issues of ASSAY are available from:

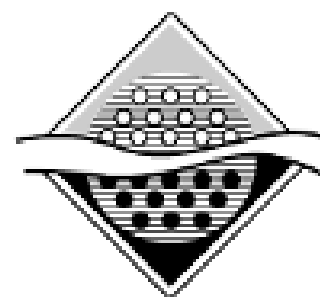
<http://www.dpi.nsw.gov.au/aboutus/resources/periodicals/newsletters/assay/>

**ASSAY is a free, quarterly newsletter about acid sulfate soils around Australia, and is available to all people interested in this issue.**

**It is produced by NSW Department of Primary Industries with funding assistance from the Federal, State and Territory governments.**

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

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**ACID SULFATE SOILS**

information and awareness



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