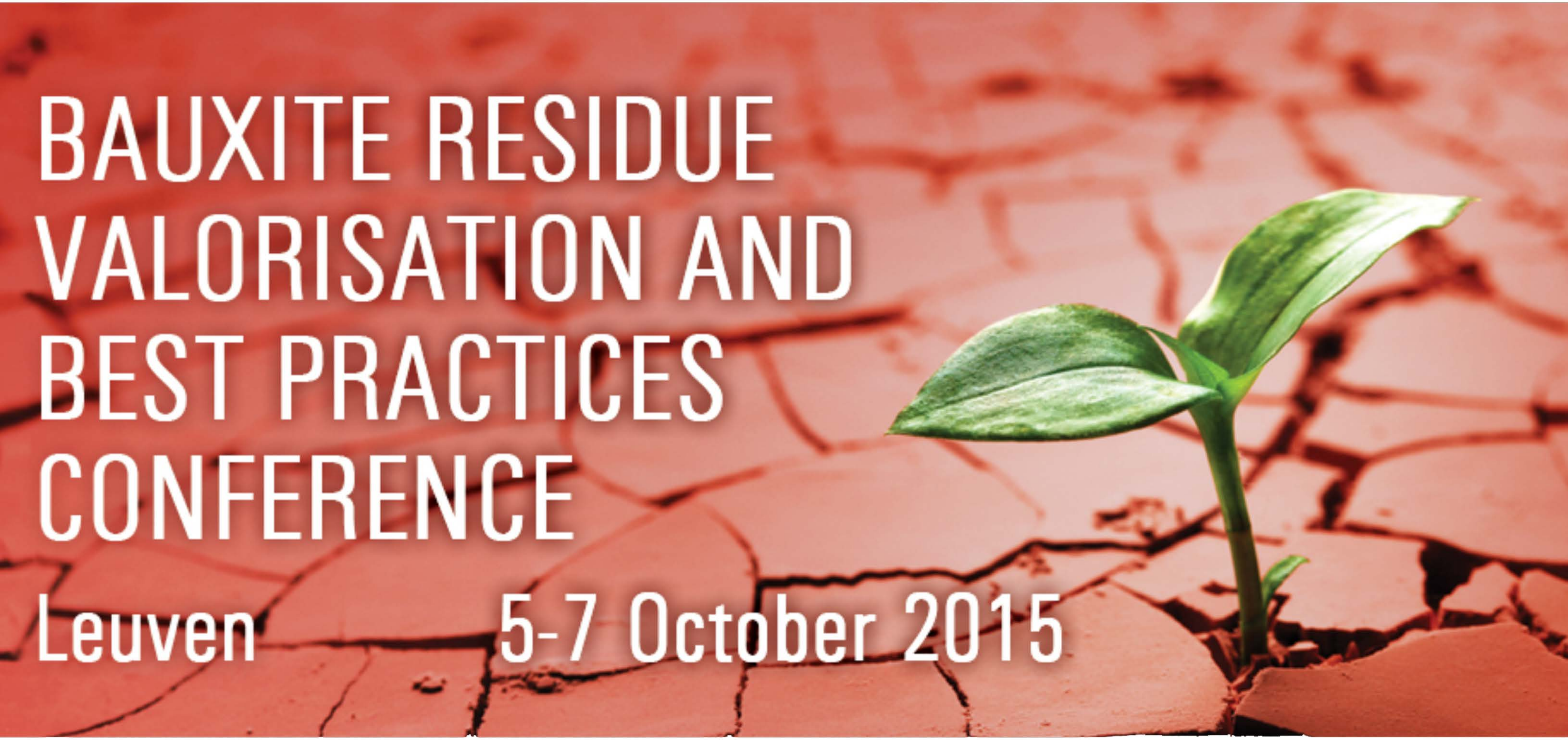
BAUXITE RESIDUE
VALORISATION AND
BEST PRACTICES
CONFERENCE
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MSSI

USE OF CONSTRUCTED WETLANDS FOR TREATING BRDA LEACHATE AND RUN-OFF

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Agenda

- **Importance of Leachate Treatment for Alumina Industry**
- **Constructed Wetland System**
  - Description
  - Benefits for BRDA Leachate Treatment
  - Development
- **Performance of a Trial Wetland System**
- **Potential Mechanisms**
- **Conclusions**
- **Future Work**

Importance of Leachate Treatment for Alumina Industry

- **Bauxite Residue Disposal Area (BRDA) Closure**
  - Long-term environmental liability
- **BRDA leachate**
  - High alkalinity

	pH
Residue leachate	**10.0 - 13.5**
At closure (run-off dilution)	**9.5 - 11.5**
Licence Condition	**<9.0**

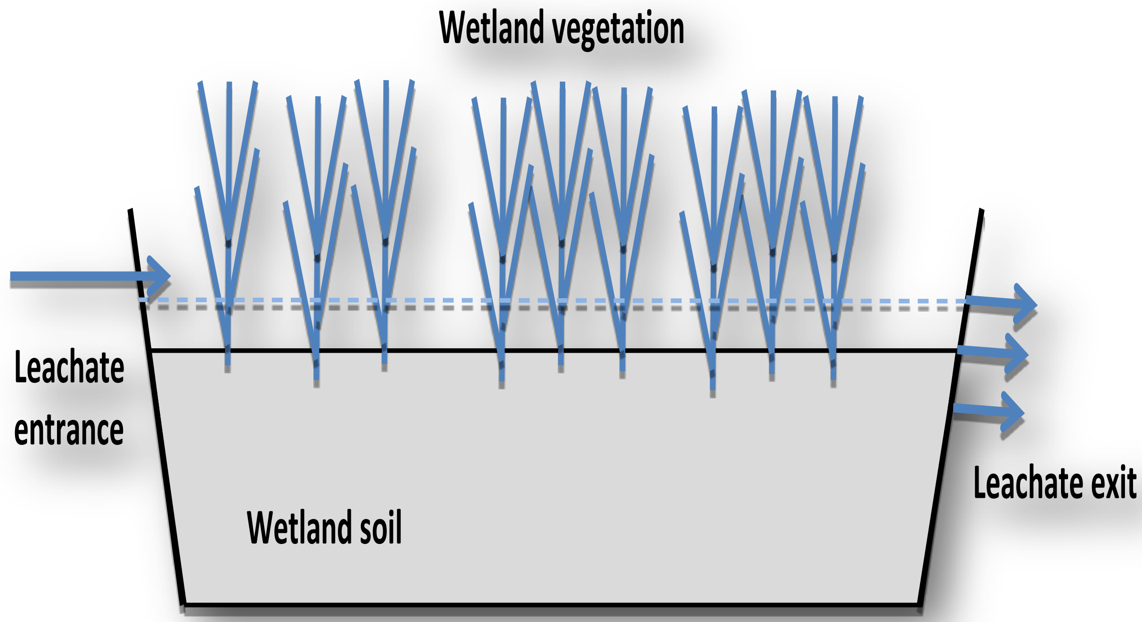
- **Conventional treatment is expensive:**
  - Potentially several €M post-closure

Importance of Leachate Treatment for Alumina Industry

Alternative Leachate Treatments	
Treatment	**Issue**
Conventional treatment	Reserve alkalinity may maintain leachate pH ca. 13 for in excess of 20 years (Thornber et al. ,1985) Treatment of drainage waters by conventional methods is likely to be expensive, especially if it is to be continued for many decades after closure'(Hua et al., 2015)
Seawater neutralisation	Further treatment of leachate (pH 10) (Menzies et al 2009)
Carbonation	Leachate 'not suitable for direct discharge' (Cooling, 2007)

Constructed Wetland System
Description

- Man-made systems which exploit characteristics of natural wetland ecosystems

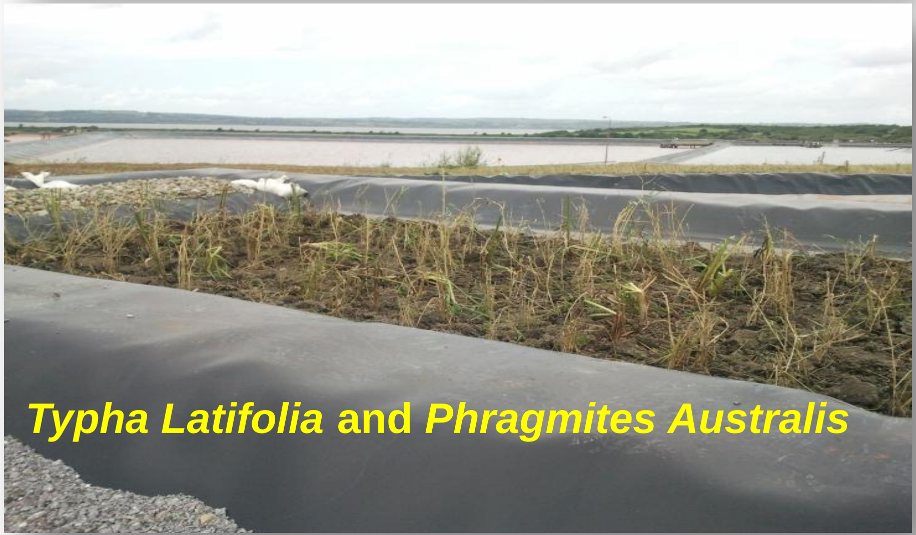


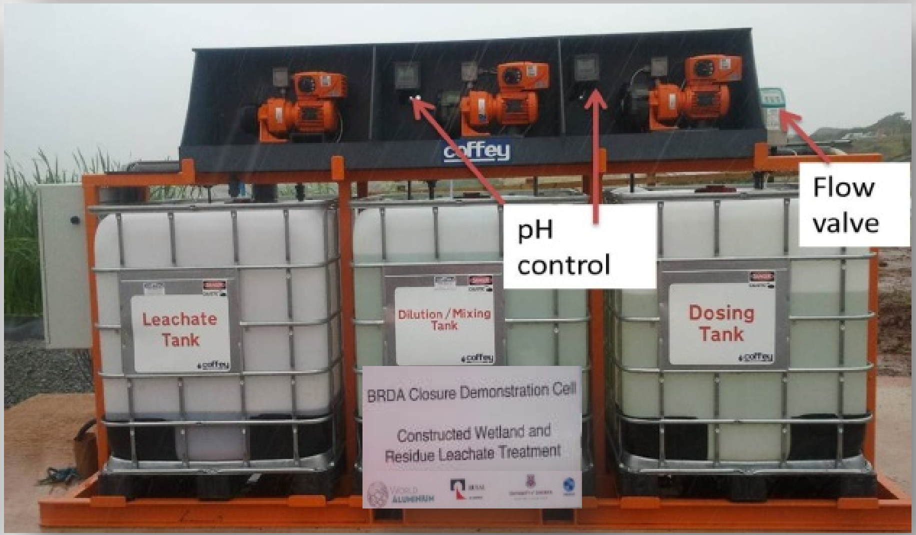
- Developed and effectively applied for treatment of domestic and industrial wastewaters

Constructed Wetland System
Benefits for BRDA Leachate Treatment

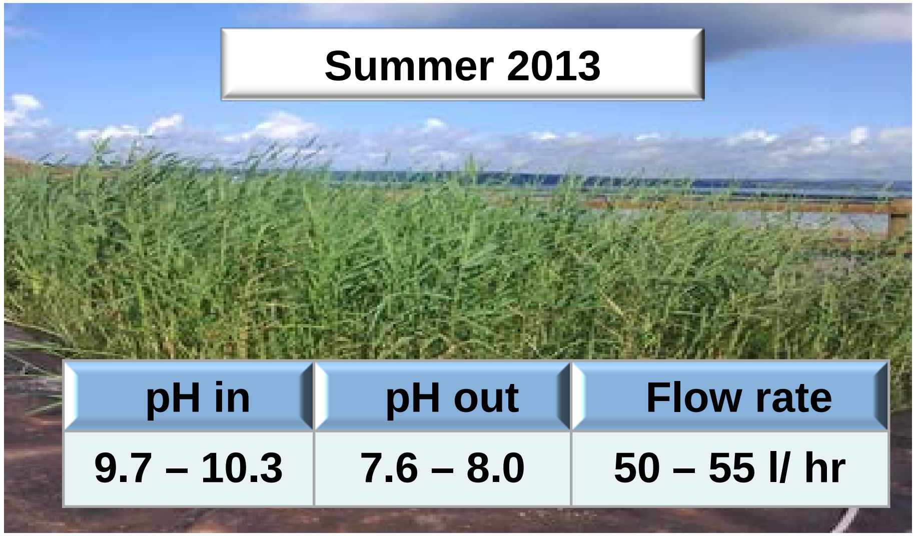
- Passive management
- Less expensive treatment system to operate
- Avoids addition of chemicals
- Avoids sustained capital input
- Reduces post-closure funding
- Ecological benefits

Constructed Wetland System
Development



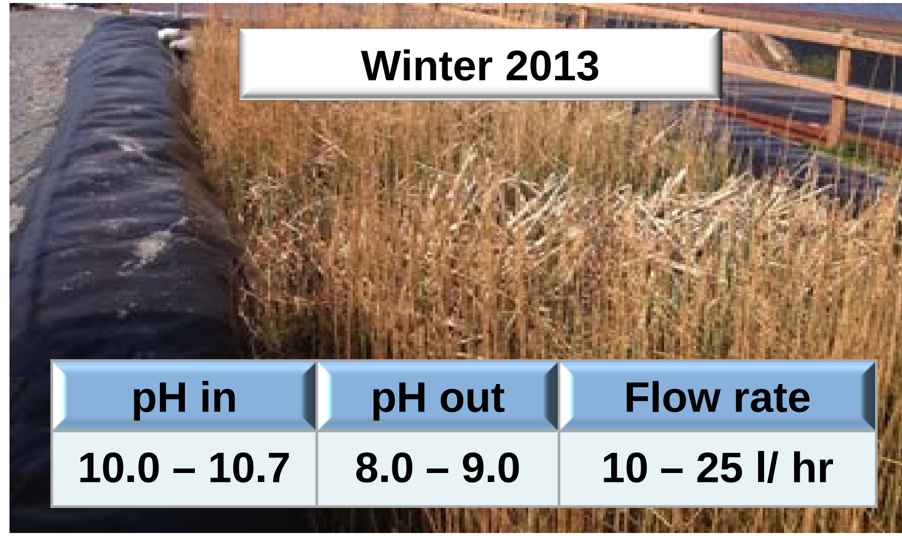


Performance of a Trial Wetland System



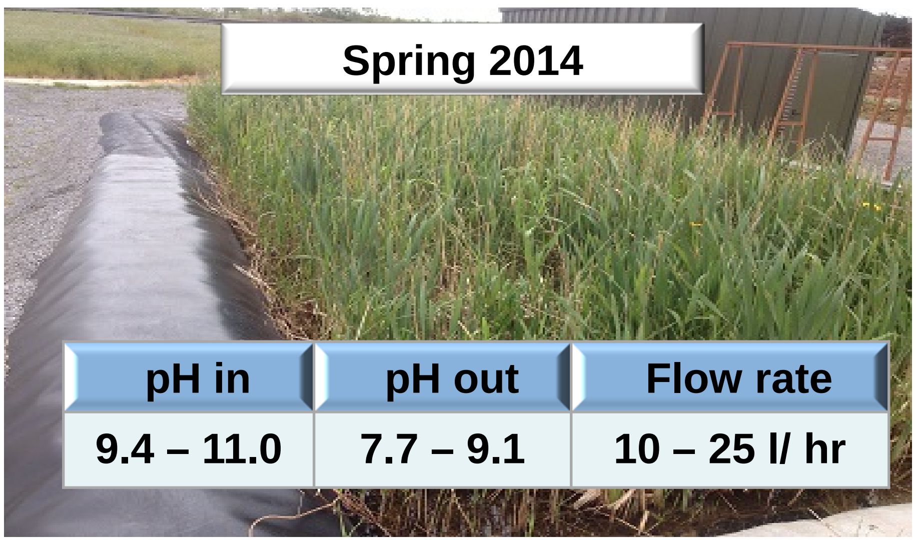
Summer 2013

pH in	pH out	Flow rate
9.7 – 10.3	7.6 – 8.0	50 – 55 l/ hr



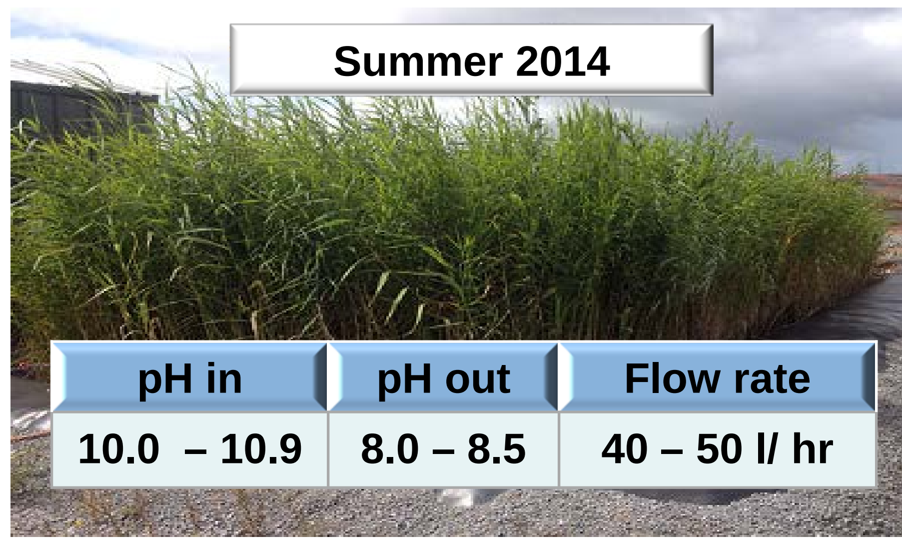
Winter 2013

pH in	pH out	Flow rate
10.0 – 10.7	8.0 – 9.0	10 – 25 l/ hr



Spring 2014

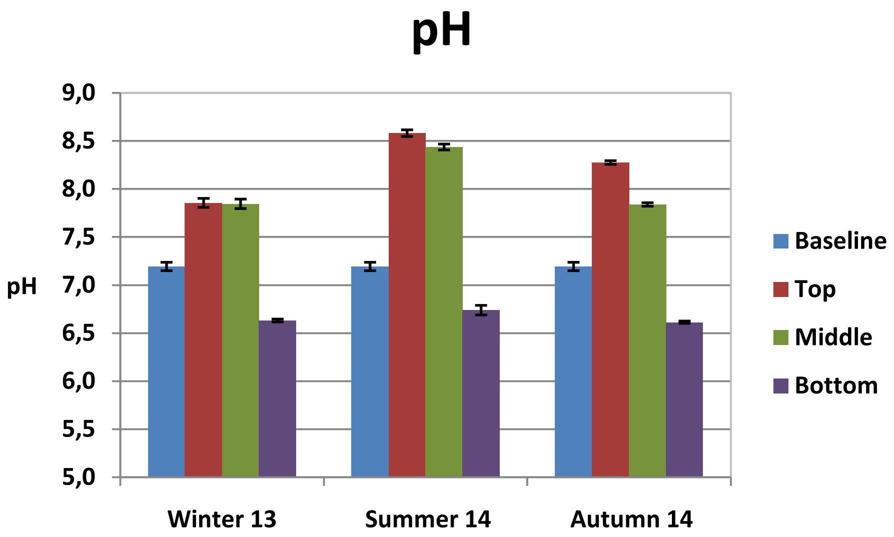
pH in	pH out	Flow rate
9.4 – 11.0	7.7 – 9.1	10 – 25 l/ hr

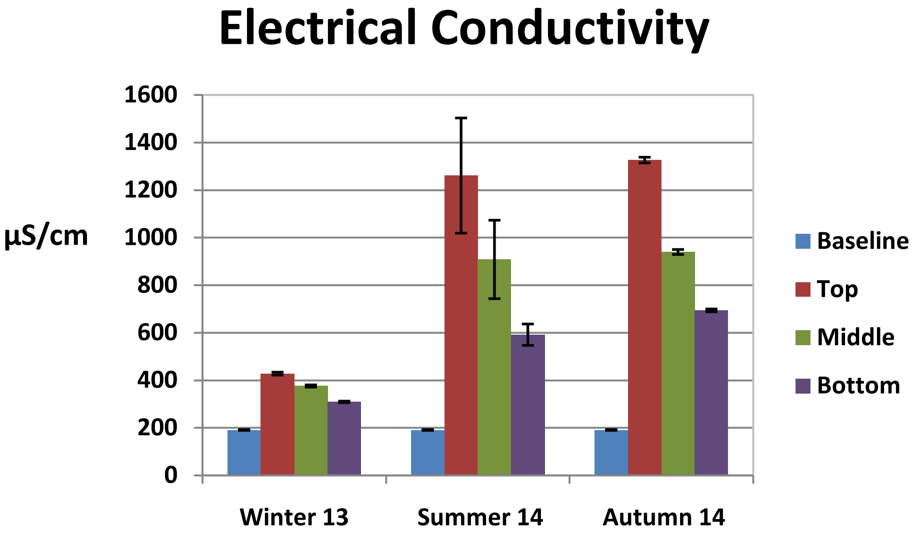


Summer 2014

pH in	pH out	Flow rate
10.0 – 10.9	8.0 – 8.5	40 – 50 l/ hr

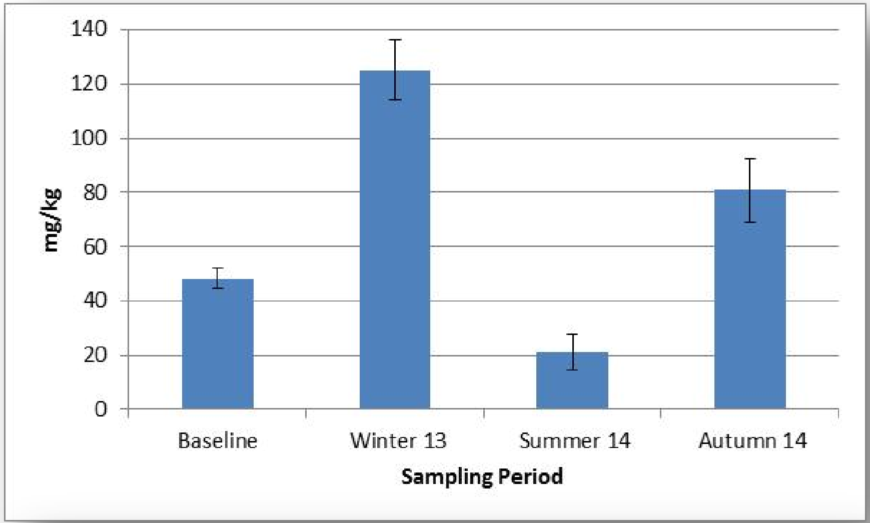
Performance of a Trial Wetland System
Soil

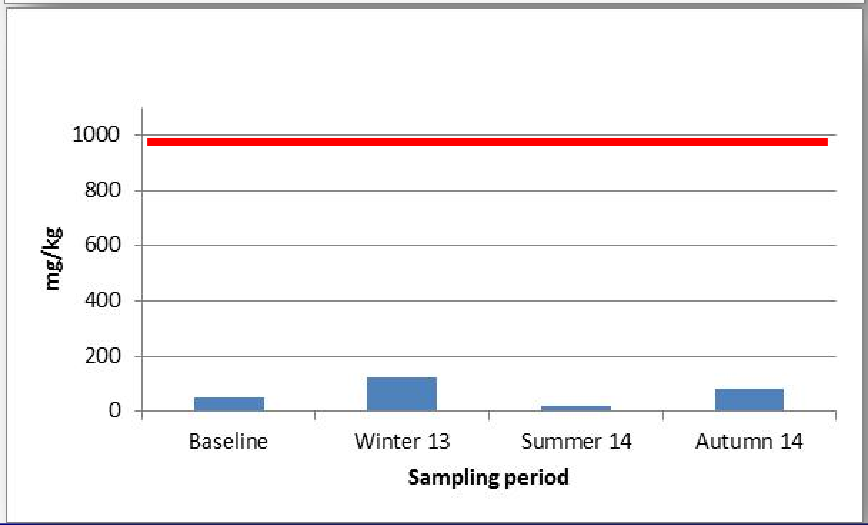




Performance of a Trial Wetland System
Herbage

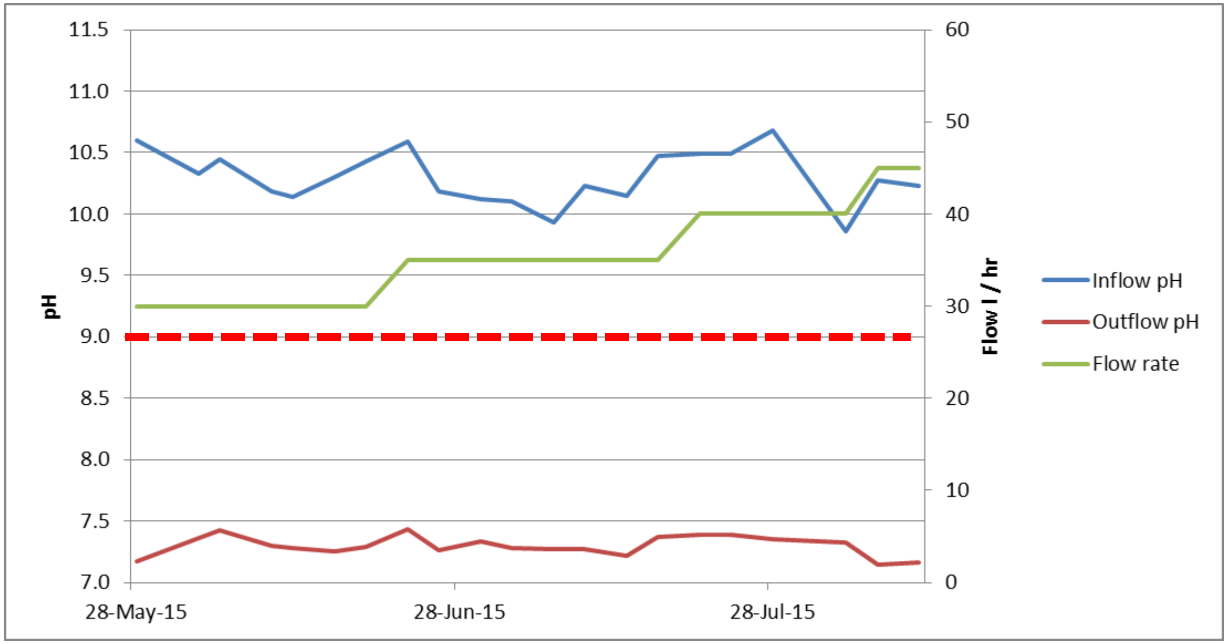
Al content in Phragmites australis





Wetland performance

- New feed (Deionised water)



Potential Mechanisms

- **Microbial activity/ CO_2**

$$CO_2 \rightarrow CO_2\,(aq) \qquad (1)$$

$$CO_2\,(aq) + H_2O \leftrightarrow H_2CO_3 \qquad (2)$$

$$H_2CO_3 \leftrightarrow H^+ + HCO_3^- \qquad (3)$$

$$HCO_3^- + OH^- \rightarrow H_2O + CO_3^{2-} \qquad (4)$$

$$Ca^{2+} + CO_3^{2-} \leftrightarrow CaCO_3 \qquad (5)$$

- **Organic acid production**
- **Cation exchange**
- **Precipitation**

Conclusions

- **Proven Wetland ability to treat BRDA leachate**
  - 2 year + operation
  - Efficiency decreases in winter
  - Full system recovery Spring/ Summer season
- **Ability repeated for leachate with negligible Ca content**
  - Two seasons so far
- **Mechanism is driven by biological activity and *precipitate* formation – Ca / Na**
- **Size estimate for 180 ha BRDA**
  - 12 Hectares - 50 Hectares (seasonal)

Future Work

- Microbial / biological health
- Plant characteristics
- Fate of key elements
- Evaluation of sizing requirements
- Maintenance requirements

Thank you