Hydrology and nutrient transport processes in groundwater/surface water systems (CRCWSC project B2.4)

Outcomes workshop, Friday 25 November 2016, University Hall
Workshop notes

Attendees

Emma Yuen	Aboriginal Housing Services	Michael Lambert	Eclipse Soils
Trevor Lynn	Bioscience	Hilary Nath	Eco Advise
Neil Burbridge	City of Armadale	Karen Warner	EMRC
Rebecca Ferguson	City of Bayswater	Wayne Pluske	Equii
Orla O'Donnell	City of Bunbury	Shelley Shepherd	Essential Environmental
Linda Metz	City of Cockburn	Halinka Lamparski	Essential Environmental
Wayne van Lieven	City of Gosnells	Helen Brookes	Essential Environmental
Richelle Bunbury	Coffey	John Savell	Housing Authority
Rebecca Epworth	Coterra Environment	Suzanne Smart	Hyd2o
Sonja Davidson	CRCWSC	Ross Sheridan	Hydro-SMART
Christie Atkinson	Department of Parks and Wildlife	Greg Ryan	Landcorp
Kate Bushby	Department of Parks and Wildlife	Nick Evelegh	Rockwater
Jane McCredie	Department of Planning	Jeanette Jensen	UWA
Joel Hall	Department of Water	Jen Middleton	UWA
Krish Seewraj	Department of Water	Carolyn Oldham	UWA
Don Crawford	Department of Water	Carlos Occampo	UWA
Antonietta Torre	Department of Water	Suzi Wild	
Robert Graieg	Development Engineering Consultants	Marco Pratissoli	

Introduction

The introduction to the workshop was given by Don Crawford, Director, Water & Land Use, Department of Water. Don provided some background to the workshop, noting the importance of research into development in areas of high groundwater which was necessary to support innovative urban design and water management approaches to minimise environmental impacts. enhance natural assets, and provide affordable, healthy and liveable urban areas.

Don noted that from a Western Australia context, it is important to have this local scientific research based at the University of Western Australia to build local capacity and train our future workforce to

address WA's different climate, geological and hydrologic conditions. He thanked the participants for attending, noting the need to engagement with industry to ensure the translation of research findings into on-ground practice.

Don introduced the facilitator, Shelley Shepherd who outlined the agenda for the day. She noted the objective of the workshop was to:

- understand key findings regarding hydrology and nutrient transport processes in groundwater/surface water systems and discuss implications for future urban development.

Shelley then introduced Professor Carolyn Oldham and Dr Carlos Ocampo who would present the research findings.

Presentations of research findings

Presentations included an over view of CRCWSC project B2.4: Hydrology and nutrient transport processes in groundwater/surface water systems and the findings and outputs of this project. Special consideration was also given to whether nutrients attenuated in WSUD elements were impacted by groundwater; the impact of infiltration and sub-surface drainage on nutrient retention in urban areas with shallow groundwater; and the implications for urban development planning. A brief summary is as follows. The presentations are available on the NWW website.

Attendees were introduced to the concept of "urban karst", where urban development fundamentally alters our subsurface hydrology, creating preferential flow pathways (via drains and pipes) that reduce the travel time of nutrients and impact on their cycling. Water balances across a range of urban stormwater management elements showed that infiltration was occurring in areas assumed "impervious" and water was recharging and moving faster than previously assumed.

Nutrient treatment performance was highly variable across day, season and yearly timeframes, largely in response to dissolved oxygen and redox conditions. The preferential flow pathways created by urban karst continually injected oxygen into systems that ideally should be anoxic for optimal nutrient removal. Seasonal interception of the elements by groundwater also added complexity to the oxygen and nutrient dynamics. There was often reduced nutrient removal under high groundwater conditions and under these conditions some of the systems were dominated by organic nutrients.

A major recommendation from the research was to design stormwater treatment systems specifically to slow down flows and manage dissolved oxygen and redox conditions, and to consider a catchment-scale treatment train approach using multiple elements with alternating redox conditions. Monitoring stormwater management elements in high groundwater environments requires the establishment of a water and nutrient mass balance, and attendees learnt how to separate a hydrograph to identify the different contributions from stormwater and groundwater sources.

The research findings will help guide alternative approaches to urban development in high groundwater environments. The current approach in Western Australia of importing large volumes of sand fill and installing subsoil drainage is not sustainable, and the research has shown that the drainage is altering nutrient flow pathways by perturbing the redox conditions. An alternative approach is required.

Workshop session

Workshop participants were asked to break into groups according to their key role/discipline. The groups were science policy; river/wetlands managers; local government and industry. The session included discussion around key questions as follows:

1. From what you have learnt today, how might these findings inform how you manage urban water?
2. How would you best like the information to be presented so it is practical and useable?
3. Following on from the findings discussed today, what are the persisting and emerging research questions?

The key learnings from attendees were in relation to:

- The importance of measuring both loads and concentrations;
- The higher levels of infiltration that are occurring than are accounted for/predicted;
- The importance of dissolved oxygen and redox conditions in nutrient performance, as well as compartmentalisation; and
- Concern that the way we are currently designing may not be the most effective.

The key implications for the design and management of vegetated WSUD assets going forwards are summarised below according to role.

Stakeholder group	What are the implications for your role?	What information is required?
Science Policy	• Test the design runoff rates and ensure systems are not being over-designed • Inform how to design in terms of redox • Whole of government and industry approach to pursue different (more suitable) urban development approaches for different environments • More strategic and coordinated approach to monitoring and considering monitoring requirements as part of design (instead of having to retrofit) • Better use of disconnected drainage systems • Implications for affordability eg alternative approaches to decreased development costs (future research on business case)	• Position statements eg by DoW • Update guidelines eg Stormwater Manual • Statutory targets eg as per Peel Harvey (locally relevant) • Statutory objectives for urban water management (locally relevant)
River/wetlands managers	• Look at design for redox and incorporate compartments where possible • Media chemistry is important and complex • Retrofit systems based on performance • Effectiveness of monitoring – what is critical? Prioritise	• Review WSUD principles and guidelines • Cost/benefit information • Information that resonates with the community and construction industry.
Local governments	• Think about dynamic systems • Where is infiltration right? • Delivery of multifunction systems	• Targets and methods/protocols of effective reporting

Stakeholder group	What are the implications for your role?	What information is required?
	• Catchment scale approach – how can this be delivered? What are the priorities? • Site specific responses are critical • Consider structural aspects of no fill/drain	• Tools to prioritise and quantify actions and benefits
Industry	• "Overdesign" of systems • Link between community perceptions and outcomes/criteria • Market driven system • Local conditions should drive design • Function of post development monitoring	• Hook into economic research • UNDO and water quality targets • Present information appropriate to user • Links to liiveable communities

Tranche 2: Where should the research go from here?

Groups further explored the persisting and emerging research questions and needs. A summary is provided below with table notes transcribed in Attachment 1. It was noted by workshop participants that some of the research identified below goes beyond the likely scope of the next phase of the project.

Science Policy

- Which Nitrogen species should we manage and how?
- Better understanding of hydrogeological performance of different urban typologies including recharge and runoff rates
- Economic evaluation of all costs and benefits (life cycle & TBL)
- Long term data on performance including metals, permeability, maintenance etc

Managers

- How to design for optimal performance in different conditions and scales
- What can we use nutrient rich groundwater or "used" media for?
- Water quality monitoring – how what when?
- How can a "Whole of catchment water vision" be achieved.

Local Governments

- How do we ensure value for money particularly for the ongoing community, managing risks appropriately?
- Designing for different conditions and scales
- What do different oxygen and nutrient (organic vs inorganic) conditions mean for design and maintenance? What is the fate of DON?
- Prioritising for retrofit from water quality perspective
- Microclimate benefits of increased groundwater
- Land use change implications for water quality. What should we address as a priority?

Industry

- Cost benefit and prioritisation of retrofits
- Runoff/ recharge rates vs density/urban form
- Maintenance to optimise performance
- Economic/social research to challenge the business and usual form of development
- Improved access to data
- Models – when/what do we need?
- What is an effective monitoring protocol?

Summary and next steps

Key priorities from the stakeholders for the next phase of research were summarised as follows:

- How should we manage for organic nutrients – what is the fate of DON?
- Recharge and runoff rates for all urban typologies, including those with lower water tables.
- Designing for optimal treatment effectiveness under a range of hydrogeological conditions and development scales
- Optimising water quality monitoring
- Challenging business as usual development – considering different development construction and catchment-scale solutions

The next steps were agreed as follows:

- Write up notes from workshop
- Consultation with other regions across Australia with shallow groundwater to identify their research
- CRCWSC T2 IRP#5 workshop in March 2017
- Finalise research proposal April 2017
- Commence 1 July 2017

All the participants were thanks for their time and contribution.

Attachment 1: Workshop table notes

Local Government

What have we learnt?

- Status quo not working
- Needs to be dynamic not static
- Correct locations for infiltration? →
- Multi system approaches – 'treatment train'
- Ones and depths within system
- Thinking larger – zones and multiple stages in catchment management

What information we now want

- Site specific
- Locations for infiltration – which WSUD elements and where?
- Other methods – maybe utilise skills from over east
- Clarification of catchment manager
- Involvement/role of developer
- All players to the table – LG, DoW, WC, developers, consultants….
- Targets and how to report – clarify and for areas

Where to from here?

- How do we tailor our designs under different conditions
- What do we do with DO information
- How do we prioritise retrofitting and make this decision
- New developments – what do we want to focus on at different scales – catchment/local
- What land use/areas are high priorities, and how to classify it? Means different things to different managers.
- Fate of dissolved organic nitrogen
- Site specific information and guidance
- How to engage with engineers
- Management of risk failure – impact on residents (water flooding) vs risk to environment

Industry

What we learned and how might these inform urban water management?

- Over-design of systems not effectively managing nutrients
- Community perception? Eg: standing water in POS
- What's driving development? Market and community perception

How to present information?

- More strategic understanding of local water quality conditions
- Ore science based guidance for design. Eg lined / unlined systems
- Urban Qvt? Fragmented land ownership
- Information to regulators required. Eg: 21% infiltration?
- Information that is practical and useful to designers

- What happens with post-development data collected? More strategic approach to monitoring
- DOW consistent approaches ad increased processes

Research Question

- LGA specific to cover spatial expanse
- Retrofitting
    - Before/after studies
    - CBA
    - Finding further opportunities
- Drainage vs density, finding options for differing densities
- Maintenance to optimise infrastructure performance
- How do we challenge business-as-usual? Economic/social research
- Can individuals access data/information?
- Use of models/relevance

Policy

How findings inform how you manage urban water?

- Improvement in design runoff rates
- Guidance on design of infiltration systems
- Inform how to design in terms of redox (eg update stormwater Management Manual for WA)
- Whole of government and industry approach to pursue different (more suitable) urban development approaches for different environments
- More strategic and coordinated approach to monitoring and considering monitoring requirements as part of design (instead of having to retrofit)
- Better use of disconnected drainage systems
- Implications for affordability eg alternative approaches to decreased development costs (future research on business case)

How best to present findings?

- Position statements eg by DoW
- Update guidelines eg Stormwater Manual
- Statutory targets eg as per Peel Harvey (locally relevant)
- Statutory objectives for urban water management (locally relevant)

B2.4 products

- Project summaries and key points highlighted
    - Plain English
    - Diagrams eg water/nutrient balance
    - Sell benefits (hook into economics research outcomes) – engage politically
    - Focus on recommendations
    - Highlight importance of….

Research – what do we need to know next?

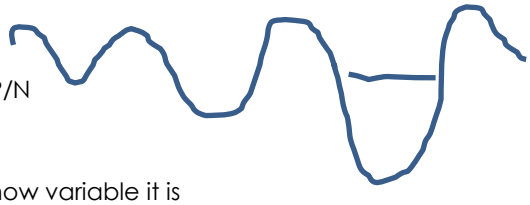
1. Which species of Nitrogen should we manage and how
2. What are the optimal urban forms/drainage in different land forms

3. Recharge and runoff rates for different urban forms/site conditions
4. Economic evaluation of existing vs proposed urban forms and drainage management
5. Continue monitoring of current sites to create longer term data set of performance →add additional parameters

Managers

Managing urban water

- 21% loss to impervious areas
- Load value important
    - Monitoring times/season/regime
    - Investment in loggers/auto samplers valuable
- Importance of DO_2
- Design – compartmentalisation
    - REDOX
    - Organic P/N vs inorganic P/N
    - Media
    - Materials
- Scale of groundwater influence – how variable it is



Q: How to best manage for performance efficiency → retrospective

Q: sediment removal vs vegetation – are there better materials/media to address organic P and N

Comment: if not managed → contribute to problem

Q; how much monitoring is too much – what is the critical threshold to give best picture of what's happening?

Q: Does WSUD still work – does it need to be tweaked → some systems better than others

Q: prioritisation of monitoring – what systems need to be monitored eg constructed vs natural, bioretention basins or nutrient stripping swales

Presented:

- Engage sector
    - Top level policy
    - Connect with designers (road)
    - Planners
- Engage community more – people don't understand what happens to their water/what systems are used
- Target construction industry
- Free ourselves from status quo → incentives innovation
- Cost benefit rate of improving water assets

Research

- How do we design, build and manage these systems to <u>effectively</u> strip nutrients on the Swan Coastal Plain – and how do we prove this?
- We need to know:
    - How to better use and create multiple benefits fro nutrient rich water sources – reuse?

    - Media use and reuse
    - How to make WSUD more resilient
    - Water quality monitoring – how, why, what, when
    - Increased understanding of groundwater and surface water interactions – we know surface water and groundwater dynamics but not in between.
- Novel infrastructure and adding flexibility into systems → habitat aesthetics
- Integrate and create catchment scale vision
- How to sell alternatives to standard piping systems to the community