EDU FOR 02B: 2018 STUDENT PROJECT PROPOSAL PART 1

Instructions:
The purpose of this document is to identify a student project. Part 1 is to be submitted by the applicant initiating the process.

- Sponsoring Organisation must also submit Part 2
- Research Organisation must also submit Part 3
- The Student submits Part 4

This document is to be submitted as a word document.

PART 1 - STUDENT PROJECT PROPOSAL

1. Type of Project (e.g. PhD / Masters by Research, / Masters by Coursework / Honours)
   PhD

2. With which focus group does the project align?
   G - Sustainable Management of Environmental Impacts; H - Resource Recovery & Reuse
   A  Economic, Regulation, Framework & Productivity  F  Climate Change
   B  Customers & Community Engagement & Perceptions  G  Sustainable Management of Environmental Impacts
   C  Managing Contamination in Water  H  Resource Recovery & Reuse
   D  Managing Source Water  I  IT Capability & Data Analysis
   E  Operational (service)  J  IWM & WSUD

3. Short Project Title (Please provide a brief project title <12 words)
   Understanding water-energy-nutrient-GHG nexus in the urban wastewater management for sustainable development

4. Long Form Project Title (100 character limit for use on www.waterra.com.au and WaterRA Publications)
   Developing a framework for optimum recovery and recycling of water, energy and nutrients from urban wastewater for sustainable agricultural production: A water-energy-nutrient nexus approach

5. Keywords (Please supply keywords to assist search queries on www.waterra.com.au)
   Water, Energy, Phosphorus, Nitrogen, GHG emission, Urban, Wastewater management, Recycling

5. Abstract (Project teaser for use on WaterRA website) (Max 200 words)
   Understanding the water-energy-nutrient-GHG nexus at the urban wastewater management system is essential for making an appropriate decision towards socio-economic and environmental sustainability. Based on the substance flow analysis and life cycle assessment methods, this study will perform a comprehensive assessment of the nexus of water-energy-nutrient-GHG at the urban wastewater management systems of the Melbourne city to identify the potential for enhanced resource (e.g., water, energy, nutrient) recovery and reducing environmental footprint. Based on the preliminary assessment and a review of the existing literature on sustainable urban wastewater management technologies around the world, this study aims to develop a framework of sustainable wastewater management system for Melbourne that ensures optimum water, energy and nutrient...
recovery with minimum GHG emissions. These recovered resources can be utilized for minimizing the inputs of fossil-based resources in the agricultural system. This framework could be widely utilized for sustainable wastewater management in other cities having similar socio-economic and environmental conditions.

6. Start Date (indicative at the time of submission)  |  7. Project Duration (months)
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1st of March, 2017 | 3 years

7. List the preferred skills / interests / degree required by student (Briefly indicate the preferred skills and knowledge as well as current undergraduate degree/s which will be suitable for the project)

BSc(Hons.) in Environmental Science, MSc in Environment and Sustainable development; have research experience in waste management and nutrient management.

8. Location (List the location/s where the student / project will primarily be based)

RMIT University, Melbourne, Victoria, Australia

9. Is this proposal associated with another project? (If yes, explain clearly the association including the name of other relevant projects and project numbers if applicable etc)  |  No
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10. Project Background and Scope (Identify the specific problem the project will solve, the current state of industry knowledge or practice, and how the project advances knowledge or practice) (Max 400 words)

Water, energy, and nutrient are three critical environmental resources, where understanding the nexus of these key resources is essential for providing holistic solutions towards environmental sustainability and food security. An extensive review of available literature indicates that there is a limited understanding of the nexus of water-energy-nutrient-GHG in the context of urban wastewater management system. However, assessing this nexus is important for several reasons i.e. ‘a certain amount of water and nutrient recovery from wastewater is achieved with a certain amount of energy use and associated GHG emissions’, ‘the amount of nutrient recovery depends on the quality and quantity of wastewater treated, hence the amount of water recycled’ and ‘amount of energy (i.e. CH₄) produced from the anaerobic digestion of certain amount of wastewater/sludge’. It is essential to know these trade-offs to ensure optimum recovery of water, nutrient and energy from wastewater with minimum GHG emissions. This present review has identified the following knowledge gaps:

- Lack of a comprehensive understanding of the ‘water-energy-nutrient-GHG’ nexus at the urban wastewater management system.
- Lack of a framework to offer appropriate methods of wastewater management to ensure optimum recovery of water, energy and nutrient with minimum GHG emissions.
- Limited understanding of the potential for utilizing the recovered water, energy and nutrients from wastewater for sustaining crop production.
### 11. Project Aims (Specific, high level. No more than 5 dot points)

- To present a comparative assessment of the advantages and limitations of existing urban wastewater treatment methods/techniques in terms of water, energy and nutrient recovery and GHG emissions.
- To gain a comprehensive understanding of the water-energy-nutrient-GHG nexus at the urban wastewater management system.
- To assess the current status of urban wastewater management system of Melbourne in terms of water, energy, nutrient recovery and GHG emission to identify potential areas for improvement.
- To develop a framework of sustainable urban wastewater management system for Melbourne to ensure optimum water recycling with optimum energy and nutrient recovery with minimum GHG emissions.
- To assess the potential for utilizing the recovered water, energy and nutrient for replacing the use of fossil based resources at the agricultural production system.

### 12. Proposed Methodology (Specific, high level. No more than 5 dot points)

- A systematic and in-depth review of all relevant literature to identify necessary data and information for the proposed analysis.
- Collection of necessary water, energy, nutrient and GHG emissions data relating to two major wastewater treatment plants of Melbourne Water (i.e., ETP and WTP).
- Systematic quantitative analysis of the collected water, energy, nutrient and GHG emissions data relating to the ETP and WTP of Melbourne Water using ‘material flow analysis’ method that applies the mass balance principle for the quantitative analysis of material flow in a system defined in space and time.
- A lifecycle assessment of the existing wastewater treatment technologies of the treatment plants of Melbourne Water using LCA software such as SimaPro.
- Development and analysis of sustainable urban wastewater management framework in MATLAB/Simulink® software platform.

### 13. Project Outcomes (Specific, high level. No more than 5 dot points)

- An understanding of the existing knowledge base and knowledge gap relating to the water-energy-nutrient-GHG nexus in the wastewater management system.
- Identification of the key areas for improving wastewater management system of Melbourne city for better resource recovery with low environmental footprint.
- A framework tool of sustainable wastewater management system that would allow achieving optimum recovery of water, energy and nutrients from the wastewater with minimum GHG
emissions.

- An understanding of the potential for utilizing the recovered water, energy and nutrient from urban wastewater in the agricultural production system.

### 14. Industry Benefits
(Briefly indicate the benefits that the project will deliver to the water industry and how the knowledge outcomes will be transferred/applied) (Max 400 words)

This project will identify the shortcomings of existing wastewater management system of Melbourne Water and recommend the potential areas for improvement in terms of better water, energy and nutrient recovery with reduced GHG emissions. This project will also develop a framework of sustainable wastewater management system for Melbourne that could be utilized by Melbourne Water for achieving optimum water, energy and nutrient recovery with minimal GHG emission in its two major wastewater treatment plants. This study will also recommend the best possible ways of utilizing the recovered resources in the agricultural production system. The knowledge developed in this project could be transferred for improving urban wastewater management systems of cities having similar socio-economic and environmental condition.

### 15. Communication Activities/Knowledge Transfer
(Briefly indicate the key strategies for communicating project outcomes with project collaborators and WaterRA members) (Max 400 words)

This project aims at producing at least four key scientific papers that will be published in renowned international journals in the field of water research. On a regular basis the findings of this project will be communicated and presented in seminars, workshops and conferences on water research at home and abroad. Any relevant findings will be communicated to collaborators from Melbourne Water and WaterRA for publishing in their newsletters or websites. Moreover, all professional and social research networking medias i.e. ResearchGate, Academia, LinkedIn, Facebook, Twitter, and other medias will be utilized for disseminating the findings of this research project.

### 16. Identify support for project
(Identify any “additional” support you may have secured for the project, including expert staff, access to specific equipment/data, financial support or other contributions. No more than 5 dot points). This is to demonstrate suitable resources and support is available for the student and project

- A PhD student with strong academic and research background in environmental science, and a co-supervisor (Prof Jega Jegatheesan of RMIT) with huge expertise in the wastewater field are selected to carry out the project.
- Student secured RTP stipend at the rate of AUD 35,000.00 per annum for 3 years.
- We already got necessary data from Melbourne Water and signed an agreement between RMIT and Melbourne Water regarding data sharing and acknowledgement.
- Student gained unlimited access to key life cycle assessment software called SimaPro (worth AUD 15,000) and MATLAB software necessary for the project.
- Student already started collaboration with academic and industrial researchers working in the similar field.
**17. Comments** (Include any other information which is relevant to the project e.g. supervision experience or number of publications in relation to this research by supervisors or specific logistics e.g. student currently overseas awaiting visa)

Student already made substantial progress in revising the project proposal, collecting necessary data and performing the processing and preliminary analysis of the data. Student is planning to write a scientific article based on the preliminary analysis of Melbourne Water data. Student also taking necessary software training and research skill courses necessary for the project. Student frequently meets the supervisors to discuss and receive feedback on research findings.

**Publications**


Wang, H., Tan, W., Li, G., Peng, J., Jegatheesan, V., Shu, L., Yang, M. and Ning, P. 2017, 'Optimizing the preparation of activated carbon from lugi pressurized gasifier (LPG) slag by microwave-assisted potassium hydroxide activation', in *Desalination and Water Treatment*, Taylor and Francis, United Kingdom, vol. 61, pp. 82-87 ISSN: 1944-3994


18. As per the Members Agreement, the Company and members have access for non-exclusive, royalty-free license for purposes of the project. Are there potential concerns or any restrictions to publication of this project?
(List existing background IP and potential new IP that the project may generate if relevant. If this is a sponsored project, include the percentage of IP ownership as agreed between sponsor and university)

No

If yes, how does your organisation plan to capture this new IP?

19. Project Plan (insert lines as required) Insert basic/preliminary project outline including conference attendance

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<thead>
<tr>
<th>Date</th>
<th>Task</th>
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<tr>
<td>Year 1</td>
<td>Literature review, methodology development, and refining research proposal (4 month)</td>
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<td>Data collection, processing and analysis to gain a preliminary assessment of the current situation of wastewater management system in Melbourne (4 month)</td>
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<td>Submitting one review paper, and one paper based on preliminary analysis (4 month)</td>
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<td>Year 2</td>
<td>Further collection of data and refine the analysis for better understanding (3 month)</td>
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<td>Revision of submitted paper, attend a conference (3 month)</td>
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<td>Identify information and perform analysis for framework development (3 month)</td>
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<td>An assessment of the developed framework in terms of its efficiency in sustainable management of urban wastewater system in Melbourne (3 month)</td>
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<td>Year 3</td>
<td>Submit a paper based on the framework developed and attend conference (3 month)</td>
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<td>Perform necessary analysis to assess the potential utilizing the recovered resources for sustaining agricultural practice (3 month)</td>
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<td>Submit a paper on the potential for utilizing the recovered resource from wastewater management system to agriculture (3 month)</td>
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<td>Revised the submitted papers, attend conference, preparing thesis (3 month)</td>
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<td>Year 3</td>
<td>Submission of thesis</td>
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<td>TBA</td>
<td>Final presentation as determined between WaterRA, the supervisors and the student</td>
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<td>Month/year</td>
<td>Thesis to WaterRA</td>
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<td>PhD and Masters by Research students – must provide to WaterRA upon notification of conferral, one bound hard copy of thesis and electronic version for WaterRA website</td>
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