

‘Closing the loop’: sustainable water supply and sanitation. The role of plumbing education in reaching this goal

Richard Hutchinson

An International Specialised Skills Fellowship

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i. EXECUTIVE SUMMARY

This Fellowship enabled Richard Hutchinson to complete a course of study 'Decentralised Water supply and Sanitation' at UNESCO IHE Institute for Water Education in Delft, The Netherlands.

The knowledge and skills gained from this course were enlightening to the Fellow. The concept of 'closing the loop' in our water and sanitation systems and the compelling reasons for this were cemented in the mind of the Fellow. We must be aiming towards providing sustainable water supply and sanitation to the populations of the world; where water supplies are sustainable, reliable, safe and environmentally responsible.

Sanitation, likewise, needs to be sustainable, affordable, environmentally responsible and maintainable. The products of sanitation need to be viewed as resources to be reused and reutilised in this 'loop'. This incorporates not only the re-use of water in our water supply systems, but the capture of nutrients from our waste water to be re-used in agriculture, helping to ensure our future nutrient security as well as water security.

Sustainability in this sense means solutions for water supply and sanitation systems which are not only possible through science, but are environmentally responsible, affordable, don't have large energy demands and simple enough in operation to be able to be replicated in different locations and be able to be maintained by local workers.

The importance of all stakeholders' participation in sustainable water and sanitation systems was highlighted to the Fellow during his studies. Systems at all levels are let down by the weakest link in the system. Water and sanitation systems of the future will need to be more technically advanced and therefore challenging for the plumbers to install and maintain.

The plumbing industry is a critical sector if sustainable water supply and sanitation systems are to be advanced and achieved. The plumbing industry's ability or inability to keep up with advancements in this sector could mean the difference between new systems installed correctly and maintained properly, enhancing the health of the population and environment; or whereby systems are let down by the people registered and licensed to install and maintain these systems.

Plumbing training must improve if it is to equip plumbers with these skills.

Victoria should be aiming to delivering 'worlds' best' plumbing training. Plumbing education in Victoria is currently not capable of this and changes are required in the plumbing training sector if we are able to achieve this. The goals to be aimed for in this industry are:

- Development of better learning resources, replacing workbooks with interactive working models and displays where possible
- The importance of sustainability and the important role which plumbers play in achieving this must become more heavily integrated into our plumbing courses
- Improved and ongoing teacher training for future and current plumbing teachers
- More full time rather than casual teaching staff for plumbing departments
- Stakeholders must work to maintain currency in the Plumbing Training Package
- Better funding and technical support for plumbing departments. VET institutions need to be willing to invest in the plumbing departments to develop a 'worlds' best' system of training.

I. EXECUTIVE SUMMARY

The benefits of achieving 'worlds' best' plumbing education allowing Victoria to achieve sustainable Water and Sanitation are:

- Greater water security in a time of increasing population and climate change
- Greater nutrient security for agriculture
- An improved natural environment associated with less nutrient pollution of water bodies
- The increased health benefits of better sanitation for the overall community, decreasing the risk of contamination to water supplies and improved and ongoing control of diseases associated with poor sanitation
- Economic flow on benefits nationally and internationally for the plumbing sector being recognised as 'worlds' best'.

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ii. ACRONYMS & ABBREVIATIONS

ASQA	Australian Skills Quality Authority
DWS&S	Decentralised Water Supply and Sanitation
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
ESV	Energy Safe Victoria
HESG	Higher Education and Skills Group
ISS Institute	International Specialised Skills Institute
NGO	Non Government Organisation
PSCIA	Plumbing, Sheetmetal, Coppersmithing, Instructors Association
PTMGA	Plumbing Trainers Moderation Group Australia
SARS	Severe Acute Respiratory Syndrome
TAFE	Technical and Further Education
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organization
VBA	Victorian Building Association
VET	Vocational Education & Training
WS&S	Water Supply and Sanitation

iii. DEFINITIONS

Pearson

Company that provides educational resources

Artibus

The Skills Service Organisation for the construction industry

Organica Food Chain Reactor

A complete wastewater treatment solution including solids removal, biological treatment/nutrient removal, phase separation and final treatment for reuse quality (if required), incorporated into a single structure

NIOO KNAW

Netherlands Institute for Ecology

1. ABOUT THE FELLOW

Richard Hutchinson is a registered plumber/gasfitter and full time teacher at Chisholm Institute of TAFE in Victoria, Australia. He is currently the first year coordinator of Certificate III Plumbing at the Frankston Campus and also teaches the following Certificate IV Plumbing classes:

- Design and size heated and cold water services and systems
- Plan, size and layout domestic plant disposal systems
- Design and size sanitary drainage systems
- Design and size stormwater drainage systems.

Previously Richard has taught and coordinated Certificate II in Plumbing. Before teaching full time, Richard was a sessional plumbing teacher for four years.

Previous to teaching, Richard ran a successful plumbing Business (R&S Hutchinson Plumbing) for over a decade, working in a wide range of plumbing disciplines. Prior to his own business, Richard worked for a number of plumbing companies.

As a plumbing apprentice, Richard won the Gold medal and Rose Curtis Awards for excellence in plumbing, at the State Training Awards and five other training based awards for excellence at Holmesglen TAFE.

Previous to undertaking his plumbing apprenticeship, Richard completed a Bachelor of Business (Property) at RMIT University in Melbourne.

Richard has a genuine interest in new environmental and sustainable technology in the plumbing sector and has done many short courses with this focus. Richard hopes to facilitate and contribute to the teaching of sustainable technology in the plumbing sector.



The Fellow attending UNESCO IHE

2. AIM OF THE FELLOWSHIP PROGRAM

The Fellow undertook the Fellowship with three key aims to work towards:

- To advance the Fellow's knowledge of Sustainable Water Supply and Sanitation and gain a sense of where Sustainable Water supply and sanitation was heading globally.
- Identify what challenges may exist for the Victorian Plumbing Training Sector in providing skills to plumbers to install and maintain future Sustainable Water Supply and Sanitation systems.
- Identify improvements needed to the Plumbing Training Sector in order to meet these challenges and achieve 'worlds' best' practice.

3. THE AUSTRALIAN CONTEXT

Sustainable Water Supply and Sanitation Systems (WS&S)

On a global scale, Australia is relatively advanced in its efforts to achieve sustainable WS&S. The process towards a sustainable goal for the industry is achievable in continual “steps up a ladder” as new technologies and techniques become more viable.

Australia’s need to become more sustainable in WS&S is largely driven by how dry the country is. It has long been recognised by the WS&S industry just how precious water is. Impacts of global warming and population growth is putting more pressure on water security. The State of Victoria has been actively taking steps towards achieving a sustainable water supply, with recycled water, urban rainwater harvesting used for non-potable uses, rural rain harvesting techniques, storm water retention and capture and desalination plants. Progress will continue to be made in order to bolster or supplement Victoria’s water supply.

Currently South East Water is planning many new technologies in the Aquarevo Estate in South East Melbourne, such as the use of rainwater for hot water services, an onsite decentralised sewerage treatment plant using an ‘Organica Food Chain Reactor’ producing recycled water for non-potable water uses and rainwater tanks connected to the Bureau of Meteorology enabling them to dump water when significant rainfall is expected. These are the current “steps up the ladder” towards sustainability.

The recognition of the environmental effects of releasing effluent into our water sources started to be addressed some time ago and is monitored by the EPA. Our major water and sewerage utilities have improved the treatment of the products of sanitation and rather than releasing nutrient rich waste into our water bodies, sewerage is better treated and increasingly the recycled water is being reused for non-potable uses.

Nutrient resource recovery is the final step of the sanitation ‘loop’. The ‘plant-available’ resources in our sewerage can be reused in agriculture. These nutrients - Potassium, Nitrogen and Phosphorus and micro nutrients such as Sulphur and organic matter - are passed through the human body. Phosphorus in particular will be viewed as a valuable resource as the possibility of ‘peak phosphorous’ is considered. Phosphorous is one of the three main components of chemical fertilisers used in commercial farming. Phosphate rock is mined from the ground and is found mostly in Morocco, with smaller deposits in China and other countries. The security and ongoing availability of these supplies is a concern to major agricultural countries like Australia. How long these deposits will last is an area of conjecture, with some sources suggesting we will begin running out in 30 to 40 years (Soil Association, 2010).

Currently nutrients are lost from the cycle of water and sanitation either in the form of environmentally damaging, nutrient rich waste discharge into a water source, or lost in the treatment process of our sewerage.

It is difficult to foresee what particular advances may be made in this area in the future. More biological process for the treatment of effluent such as in micro algae reactors may come into play (as seen by the Fellow at the Netherlands Institute of Ecology). Advancements may be made along the lines of urine separation and nutrient extraction such as with struvite reactors, or completely new technologies and techniques may come into play. Moreover, this is an area where great progress could possibly be made in the future.

Whatever progress is made up the ladder towards sustainable water and sanitation, plumbers will have an important part to play in implementing new systems, adapting existing plumbing systems and maintaining these systems. The ongoing effective training of plumbers will be a critical part of our journey towards ‘closing the loop’ and achieving sustainable water supply and sanitation.

3. THE AUSTRALIAN CONTEXT

Existing challenges in the plumbing training sector

The plumbing industry needs to keep up with changes in the WS&S sector in the future. It is difficult to envisage what these changes will be, just as it would have been difficult for a plumber thirty years ago to imagine the added complexities to the plumbing of an average new unit in urban Melbourne (rainwater harvesting used for non-potable uses, water saving fixtures and tapware, solar hot water systems, recycled water, water retention systems on our storm water systems are all standard features now in 2016). Future developments are most likely to become more technologically advanced and will challenge the plumbing training sector to maintain current.

Challenges for the Plumbing training sector are:

- There is feedback from the water and sanitation services industry that what we are teaching is not current. Water and Sanitation utilities such as South East Water currently report costly damage to assets caused by plumbers who are not adequately educated in current water and sewerage requirements. The majority of new commercial water meters and backflow devices are being incorrectly installed. Incorrectly installed food and oil interceptors have caused many Victorian water and sewerage utilities to require extra training and registration for plumbers due to costly blockages to their assets from incorrectly installed interceptors.
- Learning resources are often inadequate. While some units of competency are covered well, many are not. Some are rehashed resources from older training packages which may or may not have been updated to suit changes in regulations and standards. Some are in the form of purchased learning resources from publishers such as Pearsons which may or may not directly relate to particular units of competency and are written to a level above Certificate III level. Some resources are not to current industry standards. Other new units are covered as best as can be from manufacturer's literature, parts of other learning resources and videos relating to other courses. All in all, a patchwork of learning resources is currently in use which are hard to use for teachers and disengaging for students.
- Numbers of full time teaching staff have fallen in our plumbing departments are in favor of more casual teachers. From current experience and knowledge, the number of fulltime teachers in TAFE institutes have dropped by up to 40 per cent and this has significant consequences for student learning, engagement and consistency of education quality.

The size of the Certificate III in Plumbing training package makes it difficult for a small staff team to maintain and improve. There are around 90 units of competency to maintain. In 2015 there were six updated National Standards relating to plumbing. Merely updating units of competencies, learning resources, work stations and assessments for these changes is a daunting job.

- Teacher training for tradesmen and women moving into trade teaching is often considered poor by new teachers who feel the current Certificate IV TAE does not prepare them with adequate teaching skills. The course is too heavily based on compliance issues. Skills are not built in creating resources or classroom management. Our students suffer because of this. This reflection is consistent to thinking across the sector, "The Certificate IV in Training and Assessment may require more explicit content in relation to assessment if it is to provide teachers and trainers with the levels of underpinning knowledge and practice sufficient for undertaking quality assessments" (Sian Halliday-Wynes, 2013).
- Plumbing teachers coming into teaching are often not receiving adequate induction and support as new teachers in the form of mentoring (Hugh Guthrie, 2011). New teachers can at times lack effective digital based skills required to use and produce quality learning resources. This is due to the transition from a mainly hands on industry to a teaching environment and this is another area where extra assistance is needed.

3. THE AUSTRALIAN CONTEXT

- ASQA audits have criticised teachers as not being current in their teaching skills. More investment needs to be made into plumbing teachers teaching skills.
- The recent history of the Victorian VET sector, where many courses have had funding reduced or frozen, has meant there are limited funds available to improve training. Compliance for funding has also become more arduous meaning more of teachers' energy goes into compliance work and less into bettering the educational experience for students.
- Greater competition between the training providers has changed the culture which once existed between plumbing departments of different VET providers. Where once there was open and active co-operation in regards to the sharing and developing of resources, individual institutions are driven by competition for student numbers and funding.
- Assessments for plumbing registration and licensing is often perceived as not current by students and employers.

The sector's ability to meet industry expectations to remain relevant and current has been hampered by all of the aforementioned factors.

4. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

Victoria needs to aim towards 'Closing the Loop' and achieve sustainable Water Supply and Sanitation. A 'world's best' plumbing training package will be needed to achieve this. The skill levels of plumbers must keep progressing. Plumbing training needs to improve or we will have a system where plumbers become the weaker link holding us back from achieving this sustainability.

This report identifies the following skill enhancement areas for plumbing industry training:

a) Understanding the principals of sustainable water supply and sanitation and the direction which it may head in the future including the use of recycled water, nutrient re-use in agriculture, and sustainable waste management which protects the environment.

- Sustainable Water Supply and Sanitation is an evolving process; there will be many steps on this path to gaining a system where we 'close the loop'. The Plumbing Training sector needs to accept the ever evolving nature of our climb towards sustainability and be constantly advancing our training to meet the needs of tomorrow's plumbers and plumbing industry.
- Sustainability in our water supply and sanitation systems needs to be our long term aim if we are to guarantee water, environmental and agricultural security in the future.

b) The plumbing training sector should aim towards 'worlds' best' practice in the training of our future plumbers.

The future role of plumbers is important, just as it has been important in the past. Greater focus needs to be put on the quality of education to our plumbing sector.

The risks of not investing more in plumbing training results in the public being more at risk. Ineffective plumbing systems can negatively affect public health and possible risks include:

- Cross connections between other water sources and our potable water supply which is common in other countries
- Ineffective sanitary drainage design can lead to sewer gases and pathogens entering buildings when water traps are ineffective. Outbreaks such as the SARS virus and mosquito-borne diseases are more prevalent in areas where plumbing is poor. Sitting surface water allows breeding grounds for mosquitos. Diseases such as Dengue, Malaria, Cholera, Typhoid and Zika virus, all have a strong link to poor sanitation and water systems.

The positive effects of a world class plumbing sector is, other than the immediate health benefits to the local population, the flow on effects to the Australian plumbing industry from this reputation. An industry held in high regard is more competitive worldwide. Australian companies operating to Australian standards would be held in higher regard and able to compete better on the world market. Our current plumbing standards are high, particularly in comparison with much of Asia. This currently allows business such as Rheem to trade successfully with our neighbours using Australian standards. The flow on effect to Australian manufacturers of plumbing products could further benefit from achieving 'worlds' best' reputation. The Netherlands benefit greatly from their renowned reputation in water technologies and the link between their research institutes and industry.

There is a market for the export of 'worlds' best' education products. With a reputation as a world leader in a field, the door is open for Australian educational institutions, plumbing companies and manufacturers. All the countries of the world are climbing the ladder towards sustainable WS&S. The advantages of lifting to 'worlds' best' plumbing training would be well worth the effort in getting there.

4. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

c) Skills enhancements required to achieve 'worlds' best' plumbing training.

For the plumbing training sector to provide future industry relevant training and to achieve 'worlds' best' practice, several areas will need to be improved:

- Maintaining industry currency will require continuing and strengthened links with employers, industry bodies, regulators such as the VBA and ESV, water, sewerage authorities and unions. The Plumbing Training package must be kept current through an increased input from all stakeholders through groups such as Artibus
- Continual need for Plumbing teachers to remain current in plumbing practices. They need to become educated in new areas of plumbing and gain in-depth knowledge in areas of specialised skills for them to effectively teach these skills
- The Plumbing training sector needs to focus on producing high quality learning resources for our plumbing students. A focus shift needs to occur from whether resources (and assessments) are purely compliant, to whether they are engaging, relevant, current and educationally effective. A shift should be made away from traditional methods of using predominantly printed book based learning to a mixed approach of videos, class lessons with more student discussion and participation and online learning. Apprentice plumber training should endeavor to remain as much workshop based as possible, students learning hands on practical skills by installing plumbing systems and also by the use of more working models and displays in the workshop.

To achieve better learning resources, there will need to be a more supportive approach from management in VET institutions in the form of funding and professional technical support if top quality learning material is to be produced. More focus and resources need to be given to the development and constant evolution, updating and currency of these resources. Quality is what is missing in regards current learning resources.

If we are to be driven by market forces as individual education providers, then there would be an economic benefit for the institution that invests in their learning resources and teaching capacity to provide a better product for the market place. However, VET providers need to be prepared to invest time, money and resources to achieve this.

- There needs to be a move away from the casualisation of our plumbing departments by the VET providers. With less full time teachers within plumbing, a greater percentage of full time teachers' non-teaching time is spent in administrative duties, with less ability to produce and update learning resources. Employing more full time teachers would enhance plumbing departments' ability to stay current with the WS&S industries training needs.

There is evidence that the 'sessionalisation' of teaching departments could be having an effect on teaching staff morale with more teachers having time off with stress leave. The current environment is not one from which 'worlds' best' practices can be achieved.

- A better level of teacher training to plumbing teachers: Certificate IV Training and Assessment in the past has not given our teachers certain skills needed to be good educators (Sian Halliday-Wynes, 2013). As initial training for people in industry to make the transition to teaching, there has been very little content in regard to teaching skills, or skills needed to produce quality learning resources. As a course for industry people with no teaching background wanting to get into teaching, it would be beneficial if more focus was put into teaching skills and techniques with modules about compliance related issues coming after new teachers had exposure to the classroom (Hugh Guthrie, 2011). New staff have current industry knowledge so their main need as they embark on a teaching career is assistance in learning ways to effectively convey this knowledge to their students.
- Support needs to be freely available from VET institutions for mentoring programs. The learning of digital skills should be promoted for new plumbing teachers. There needs to be a willingness from

4. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

VET providers to invest in upskilling their staff in these areas.

- Investment in professional development for our teachers is important if we are to provide an effective, modern learning environment. Methods of teaching and providing different modes of learning for our students is changing all the time. We need to equip our teachers with these new skills.
- Better funding of our plumbing departments will be needed for them to produce ‘worlds’ best’ training for plumbers. Two changes would be useful to give plumbing departments the financial resources needed to allow them to meet students and the industry needs:
 - » The identification by the Victorian government of the importance of plumbing training to the future sustainability of WS&S in Victoria, resulting in plumbing receiving a higher funding level to help achieve this
 - » VET providers providing suitable financial resources and assistance to plumbing departments to provide and develop their educational programs. Due to the large number of plumbing students doing plumbing courses with large funding hours attached to these courses, Plumbing departments bring in substantial income to the VET providers.

Funding cuts for ‘full service providing provision’ have adversely effected TAFE colleges. The effect on plumbing departments is that funding produced by plumbing departments has been needed by TAFE colleges to support other services.

Plumbing departments need to attract a fair share of the funding they bring into educational institutions to allow them to provide ‘worlds’ best’ training.

Regulatory bodies, such as the VBA, would need to be on board with a “top down approach” in regulation assessment, licensing and enforcement. The VBA needs to continually evolve and update their registration and licensing exams to remain relevant with industries requirements.

5. THE INTERNATIONAL EXPERIENCE

The Fellow completed a three-week short course 'Decentralized Water and Sanitation Systems', at UNESCO IHE, Delft, Netherlands. The unit studied is part of the master's course run at the university.

The students participating in the unit of study were either completing a Masters in Environmental sciences, urban water and sanitation, water management or water sciences and engineering programs. There were 21 students studying this unit and six were doing it as a short course. The students were from all parts of the world: a large number from Africa, South East Asia, South and Central America, India, with a small contingent from Western countries.

The Fellow was accompanied by another Fellow, Robert Funston; Senior Educator at Frankston Chisholm Plumbing Department. We were able to study together and shared lodgings. This was a beneficial arrangement for both Fellows, as it allowed for the Fellows to inspire and assist each other through the course including assignment work and after hours' discussions of course related material.

The experience of doing this course was incredible. It gave the Fellow a broad appreciation of the issues related to water supply and sanitation to populations around the world. The course was taught by a group of experienced lecturers with vast experience in implementing water supply and sanitation systems throughout the world. All lecturers are involved in WS&S projects around the world on an ongoing basis. The course used two guest lecturers from industry. One travelled from Berlin for two days of teaching and one from Switzerland. These were great classes, providing great currency.

The lecturers made themselves available after class time and out of class discussions were had with Saroj Sharma and Mariska Ronteltap in particular. From these discussions it was clear how well UNESCO IHE was respected in the Water and Sanitation Industry and also how they were able to maintain currency through good links with industry. UNESCO IHE is well resourced, gaining funding from government, international sources (which also allows them to offer Fellowships to students from developing countries), as well as directly from student fees.



Decentralised Water and Sanitation Class

5. THE INTERNATIONAL EXPERIENCE

The Dutch are highly regarded worldwide in many aspects of water management and the industry connections between their universities, research bodies and educational institutions was seen as beneficial for all parties. Many students are drawn to The Netherlands to study water technology related courses because of their highly regarded institutions. Industry benefits from funding research through the universities with PhD programs and the ability to employ from a high number of skilled graduates. According to lecturers at UNESCO IHE, there were identified flow on benefits for Netherlands from their highly regarded international reputation in water technology.

The Fellow in his time at UNESCO IHE has become aware of the difficulties faced by Government, Non-Government and community organisations in implementing WS&S Systems in different localities with different environmental, political, social and community restraints. Classes in this unit followed a similar format: a lecture with discussions about the subject and how it relates to different student perspectives and backgrounds; case studies were looked at of WS&S systems which have failed and succeeded. This was often followed by a group assignment which was either done entirely in class or both in class and as homework.

Most of the group assignments involved the students being given a scenario in a specific location in the world. Basic statistics would be presented in regards population, demographics, geographical constraints such as water table data and topography, existing water or sanitation systems and practices, community structure, religion, economic resources etc. From this background, the group was required to formulate a plan to implement the required project.



Group assignment work at UNESCO IHE

5. THE INTERNATIONAL EXPERIENCE



The Fellow's presentation on Rainwater Harvesting

The group assignments were a great learning environment, because of the student diversity and the perspectives and skills brought by each student (not only because of their different nationalities, but also their graduate backgrounds). The majority of students were from an engineering background, but also architecture, town planning, Non-Government Organisation (NGO) work, Health Department, solid waste, academic etc. The different view point brought by each student made for a fertile learning environment.

Every participant was required to make a PowerPoint presentation about a WS&S issue which they had experience in, highlighting both success and failures of systems from around the world, from which great discussions resulted. This exercise was greatly appreciated by all students, including the lecturer who kept a copy of all presentations.

The 'Ecological Sanitation' class was insightful, giving the Fellow a view of where WS&S worldwide is heading. A system which is sustainable. The term 'Closing the Loop' was discussed as a goal; where water and sanitation systems become sustainable through the treatment of waste water through sustainable means so it can be re-used (potable and non-potable). The re-use of nutrient and mineral assets from human waste for re-use in agriculture, instead of it being lost from the loop (either as nutrient rich pollution discharged and polluting water systems, or lost through the purification process).

Ecological Sanitation: In basic terms (and oversimplified for the purpose of this report), the three main elements required to sustain a food crop are Nitrogen (N), Potassium (P), and Phosphorus (K). These are ingested and passed through the human body from the food we eat and excreted in human waste in the same quantities required to grow enough cereal crop to sustain the human existence. This is a simplified chemical example of 'closing the loop'. Unfortunately, this loop is not currently closed and most nutrients from human waste is not captured for re-use in agriculture and in the majority of cases is released into the environment in the form of nutrient rich pollution of our water sources. The loss of these elements will become more critical in coming years when the world could possibly run out of phosphate rock, used to create chemical fertilizers used in large scale agriculture world-wide.

5. THE INTERNATIONAL EXPERIENCE

A common theme the Fellow picked up during this course was the “steps of the ladder” towards sustainable WS&S. All nations of the world are working towards the same goal of Sustainable WS&S. For a poor country where water supply is unimproved and open defecation is still common, this may mean the next step up the ladder may be a village hand pump for their water supply and a pit toilet as a form of sanitation. For a developed country, this may mean multiple water supplies to the house, such as what is common in many new houses in Melbourne at present with potable and rainwater being used. Both scenarios are just different steps of the WS&S ladder towards sustainability.

Australia as a developed country had vast numbers of houses in the suburbs of our capital cities without sewerage connections in the 1970s and many Australians can remember the visit of the “dunny can man” during their lifetime. Most of our rural population rely on rainwater as a water source, a sustainable solution shared with many developing people of the world. In many cases Victoria is only one generation ahead of where many developing countries are now.

The DWS&S course covered technologies at their developmental stages, such as Micro Algae Anaerobic Treatment Systems, Struvite reactors and other systems for retrieving and separating the resources from our faecal sludge and urine. The goal is to find better, more sustainable solutions for our water supply and sanitation problems. Sustainable in this sense meaning solutions which are not only possible through science, but are affordable, don't have large energy demands and simple enough in operation to be able to be replicated in different settings around the world and be able to be maintained by local workers.



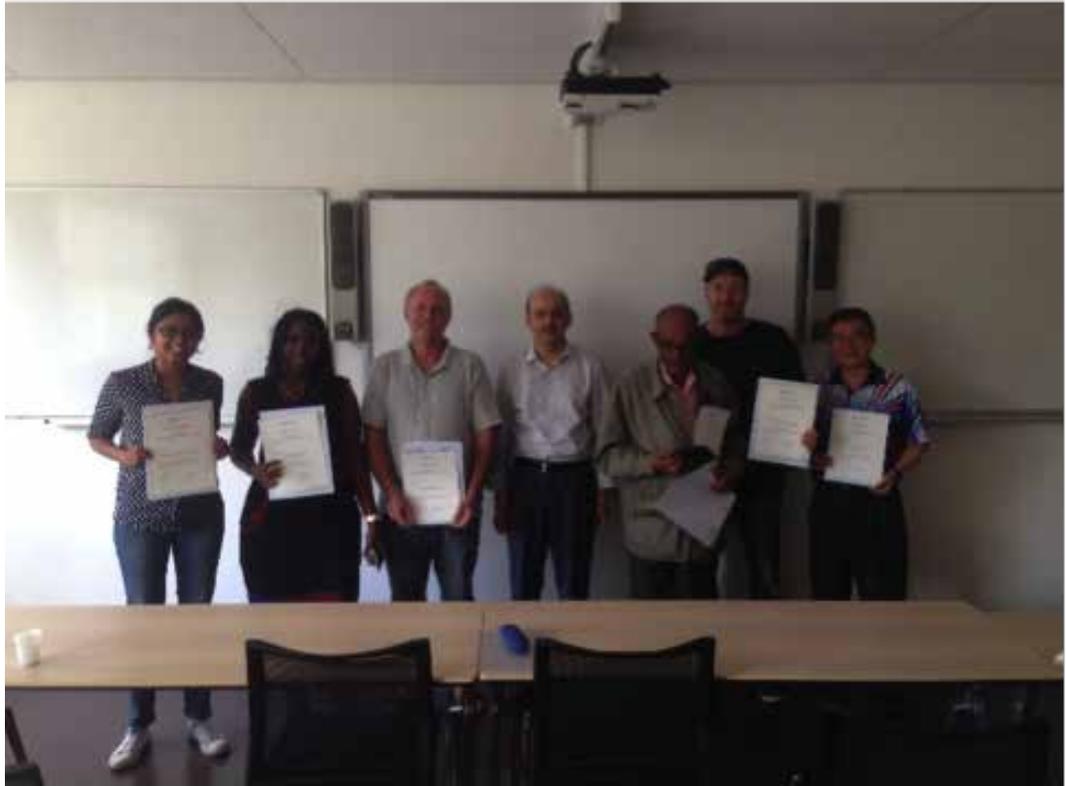
Micro Algae Anaerobic Treatment System at NIOO KNAW

5. THE INTERNATIONAL EXPERIENCE

During the course, case studies around the world were looked at where new W&SS were implemented and failed. In all cases a weak link in the process was identified. Often it was not adequately planned such as flush toilets installed in a community with inadequate water supply. More often than not, it would be lack of community consultation, e.g. sit toilets for a community where people were accustomed to squatting. Lack of community ownership, or buy-in is a common theme; a sense of ownership needs to be created in a community for a new system. It also needs to be economically sustainable. Covering the capital costs for building a new system (often coming from government or NGO grants) is one thing, but if there is no revenue source, or desire from the community to cover the operation and maintenance cost, it will fail. A sustainable means of continual operation and maintenance is critical.

Consultation with all stakeholders to determine responsibility for all aspects of a system is paramount. From case studies looked at in the classes, the lack of planning in only one area can lead to a system being not sustainable.

Education is also a key ingredient. Successful systems were seen to be driven from a community educated in the need for change in WS&S systems. This creates a “bottom up approach” driven by the community. The change in public views to the use of rainwater harvesting in Melbourne’s urban areas for non-potable water uses is such an example: water tanks are a part of everyday life for Melbournians since the drought of the early 2000s. The population embraced the need for rainwater harvesting to supplement our reticulated water system.



Certificates of Completion for short course participants

This is not to say that a “top down” approach is not needed. Another key ingredient can be seen in the need for regulation, standards and monitoring, which can only be successfully done when

5. THE INTERNATIONAL EXPERIENCE

implemented by government. Many countries around the world have systems which are let down by inadequate standards, minimum training standards or monitoring of their water and sanitation systems.

Case studies in the course as well as discussions and interviews with fellow students showed many systems failed due to poor training of plumbing and water professionals. In many countries water supplies are treated to adequate drinking standards by water authorities, but due to a lack of regulation in water connections and plumbing standards, the water is heavily polluted by the time it reaches the end user. Cross connections, backflow from polluted water sources and illegal water tap-ins are common when plumbing is not a well-trained and regulated trade. Lack of standards and regulation in the sanitation side of plumbing leads to poor operation of sanitation systems, such as stormwater connected to reticulated sewers overloading treatment plants during heavy rains.

Likewise, formal training in many countries for water and sanitation treatment plant operators is often not required leading to huge variations when water quality tests are carried out throughout a single country. This is the case in Indonesia, where the training is not standardised country wide and the water and waste testing shows big discrepancies linked to local governments' abilities or desire to employ, train and set standards for their workers. In countries that do not have a regulated plumbing sector with adequate standards, or training for treatment plant operators, the public perception of such jobs is low, leading to poor quality human resources in the sectors.

The Fellow's concluding thoughts from his time at UNESCO IHE is that plumbing training becomes more critical as our systems become more advanced. The weakest link causing failure in our 'steps up the ladder' towards sustainable water supply and sanitation will be our under educated Plumbing sector.

6. KNOWLEDGE TRANSFER: APPLYING THE OUTCOMES

What:

Victoria needs to aim towards a 'world's best' plumbing training package if it is to 'Close the Loop' and achieve sustainable WS&S. Plumbing training needs to improve to 'world's best' or we may have a system where plumbers become the weaker link in our WS&S systems, holding us back from achieving this sustainability.

Why:

The future role of plumbers is important, just as it has been important in the past. Education will play an even greater role in giving plumbers the skills they will need as plumbing systems become more complicated. Greater focus needs to be put on the quality of education to our plumbing sector. Ineffective plumbing systems can effect public health.

The positive effects of a world class plumbing sector is (other than the immediate health benefits to the local population) the flow on effects to the plumbing industry from this reputation.

Who:

An industry wide approach would need to take place to achieve world's best practice in plumbing, but should be driven by plumbing training through the VET sector.

Regulatory bodies such as the VBA would need to be on board with a "top down approach" in regulation assessment, licensing and enforcement. The whole plumbing industry, including plumbing companies, employer groups, plumbing unions, water, sewerage and gas authorities, ESV, and VET institutions, have a collaborative role to play in developing a better plumbing education sector.

How:

The Fellow intends to disseminate knowledge gained by a number of means:

- This report will be distributed to staff at Chisholm Institute of TAFE; staff of the plumbing department, Senior Educators, Managers and other related staff. The report will be also sent to the Water Industry department of Chisholm
- The report will be made available to all plumbing departments and plumbing teachers through the PTMGA.
- The report will be distributed to VBA, South East Water and other industry groups
- A presentation will be given to plumbing staff of Chisholm Institute of TAFE outlining our study trip and the outcome of this report
- A presentation will be given at the annual Plumbing, Sheet-metal, Coppersmith's Instructors Association (PSCIA) meeting in Albury, July 2017. This is the annual meeting of all plumbing teachers for Victoria. The presentation will outline the Fellow's trip and the recommendations of this report
- Knowledge gained from the Fellow's research will be integrated into plumbing resources. Units of relevance where specific skills can be directly incorporated would be 'Install and maintain domestic water treatment systems', 'Work effectively in the plumbing & services sector', 'Connect & inst. storage tanks to domestic water supply', 'Install pre-treatment facilities', 'Collect and store roof water', 'Certificate IV Design and size domestic treatment plant disposal systems', 'Design and size heated and cold water services and systems', 'Design and size sanitary drainage systems', 'Design and size sanitary plumbing systems' and 'Commission and maintain backflow prevention devices'. All subjects in Plumbing training have sustainability aspects which have some degree of relevance.

7. RECOMMENDATIONS

To develop a 'world's best' plumbing training sector enabling plumbers to play their part in a sustainable water supply and sanitation system, actions will be needed by the following invested parties.

Government

- Commit to the goal of 'closing the loop', obtaining sustainable water and sanitation for the state of Victoria.
- Recognise the important role plumbing plays in the obtaining the goal of sustainable water and sanitation.
- Recognise the importance for the plumbing industry to remain current, up to date with advancements in sustainable water and sanitation.
- Recognise the importance of the Plumbing Training sector in keeping currency in the plumbing industry and the goal of achieving 'worlds' best practice'.
- Funding to Plumbing Education to be made a priority in the VET sector.

Professional Associations/ Regulating Bodies: Victorian Building Association (VBA)

- Recognise the importance of constantly progressing the skill levels of Victorian plumbing if sustainable water supply and sanitation is to be achieved.
- Recognise the importance of the current registration and licensing exams in maintaining the standard of plumbing training in Victoria.
- Recognise the importance of remaining current with their registration and licensing exams if the level of 'worlds' best practice' is to be achieved in Victorian Plumbing training.
- Continual professional development should be considered as a requirement for ongoing plumbing licensing.

Industry:

- Better connections between industry and plumbing training providers to maintain currency in our training.

Water and Sanitation Authorities:

- Water and Sanitation Authorities to commit to constant steps to continually move towards 'closing the loop' in sustainable water supply and sanitation.
- Authorities to strengthen connections with the Victorian plumbing training providers to help maintain currency in training.

7. RECOMMENDATIONS

Education and Training:

- VET providers to recognise the role which plumbing training plays in the goal of sustainable water supply and sanitation.
- VET providers to provide increased funding and resources to plumbing departments to improve learning resources for Plumbing Departments. Enabling them to work towards ‘worlds’ best’ practice in plumbing training.
- VET providers to provide adequate full time teaching staff numbers to better enable plumbing departments to provide ‘worlds’ best’ practice in plumbing education.
- Plumbing teachers to educate plumbing students about sustainable water and sanitation and the role plumbers play in achieving this.
- Plumbing teachers to remain current to industry standards and practices.
- Plumbers moving into teaching to be given better training than what is currently being provided, real practical “teaching skills” needed.
- Plumbing teachers to maintain professional currency with their teaching skills.
- VET Providers to provide access to quality professional development for teachers to improve teaching skills.
- Continue work done by PTMGA in developing, moderating and sharing resources.

Community:

- Make the community aware of the need for us to move towards a sustainable water and sanitation system.

8. REFERENCES

Conradin, K. (2010). *Linking up Sustainable Sanitation, Water Management and Agriculture*.

Hugh Guthrie, A. M. (2011). *Initial training for VET teachers: a portrait within a larger canvas*. National Centre for Vocational Education Research.

Sian Halliday-Wynes, J. M. (2013). *Assessment issues in VET: minimising the level of risk*. NCVER.

Soil Association. (2010). *A rock and a hard place - Peak phosphorus and the threat to our food security*. Bristol, UK: Soil Association.

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4. Industry:

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5. Professional Associations/ Regulating Bodies:

- Victorian Building Association (VBA).

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- Plumbing Trainers Moderation Group Australia (PTMGA)
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- Report writing mentor: Elizabeth Keane, Executive Director, Savi Solutions
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