Environmental Health is a quarterly, international, peer-reviewed journal designed to publish articles on a range of issues influencing environmental health. The Journal aims to provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region.

The Journal publishes articles on research and theory, policy reports and analyses, case studies of professional practice initiatives, changes in legislation and regulations and their implications, global influences in environmental health, and book reviews. Special Issues of Conference Proceedings or on themes of particular interest, and review articles will also be published.

The Journal recognises the diversity of issues addressed in the environmental health field, and seeks to provide a forum for scientists and practitioners from a range of disciplines. Environmental Health covers the interaction between the natural, built and social environment and human health, including ecosystem health and sustainable development, the identification, assessment and control of occupational hazards, communicable disease control and prevention, and the general risk assessment and management of environmental health hazards.

**Aims**

- To provide a link between the science and practice of environmental health, with a particular emphasis on Australia and the Asia-Pacific Region
- To promote the standing and visibility of environmental health
- To provide a forum for discussion and information exchange
- To support and inform critical discussion on environmental health in relation to Australia's diverse society
- To support and inform critical discussion on environmental health in relation to Australia's Aboriginal and Torres Strait Islander communities
- To promote quality improvement and best practice in all areas of environmental health
- To encourage contributions from students

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Guest Editorials address topics of current interest. These may include Reports on current research, policy or practice issues, or on Symposia or Conferences. Editorials should be approximately 700 words in length.

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**Practice, Policy and Law**
Articles and reports should be approximately 3000 words in length and can include articles and reports on successful practice interventions, discussion of practice initiatives and applications, and case studies; changes in policy, analyses, and implications; changes in laws and regulations and their implications, and global influences in environmental health. Up to six key words should be included. Name/s and affiliation/s of author/s should be included at start of paper and contact details including email address at the end.

**Reports and Reviews**
Short reports of topical interest should be approximately 1500 words. Book reviews should be approximately 700 words and Review Articles should not exceed 3000 words in length.

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The Environmental Health Committee (enHealth) is a sub-committee of the Australian Health Protection Committee (AHPC) which reports to the Australian Health Ministers’ Advisory Committee.

**OUR MISSION**

The quality of life and health of Australians are underpinned by having clean water and air, safe food and housing, protection from pollutants and a program to intervene in the environment to prevent and control disease. enHealth will identify the Australian environmental health sector’s role in developing and supporting infrastructure for health protection.

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- providing nationally agreed health policy advice
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- consulting with key stakeholders and consumers
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- targeted training to enhance professional capacity

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The Environmental Health Committee (enHealth) sponsorship of the International Federation of Environmental Health 10th World Congress on Environmental Health received funding from the Australian Government, and the State Governments of Victoria, New South Wales, South Australia, Western Australia and Northern Territory.
Editorial

This issue contains five significant contributions to environmental health in the areas of community attitudes and sustainability, self reported chemical sensitivity in the community, local government initiatives on sun protection, and two international contributions, which are concerned with the assessment of metal contaminants on a river ecosystem in the Democratic Republic of the Congo and hazard assessment of contaminants to water quality in Indonesia.

An important and often forgotten ingredient in assessing the development of renewable energy technology is the views and attitudes of the community to such developments particularly if it involves the not in my back yard (NIMBY) syndrome. Bond explores the attitudes of communities to the development of wind farms in Western Australia and finds that the majority of respondents to her survey thought of wind farms in a positive way and that proximity to the wind farm forms an important aspect of this community attitude. The survey showed that over one third of respondents stated that they would pay 1-9% less for their property due to the presence of a wind farm nearby. As observed by the author the results of the study should be of particular interest to power companies in the siting of wind farms. The findings have an important implication for state and local planning authorities as they must approve the siting of these farms.

Fitzgerald’s research also involves the community and the prevalence of self reported Multiple Chemical Sensitivity (MCS). As the author points out MCS is a chronic condition the sufferers of which maintain that a wide range of environmental chemicals can trigger symptoms. However, the causation is difficult to prove scientifically thus making for controversy. The findings of the study are that from the surveys of 4000 adults, 1% self-reported MCS prevalence and a more general hypersensitivity prevalence of about 16%, which is a significant proportion of the survey population. Examination of the symptomology and symptom severity suggested that there was a significant negative impact of environmental chemicals in the community. This study also reinforces the importance of community perceptions to environmental health issues and the need for further research to better understand these perceptions.

Hoskin et al. examine the environmental health role in reducing exposure to ultraviolet radiation. This is an important environmental health risk issue given that Australia has the highest rate of skin cancer in the world and at least one in every two Australians being diagnosed with skin cancer in their lifetime. The local government survey found that although few councils had what would be considered a comprehensive approach to sun protection, there are a number of sun protection practices in place in most councils. More can be done by councils for, as the authors pointed out, local councils are quite influential from the broad community perspective in their role as town planners, have responsibilities for granting planning and development approvals, and they control and operate a range of recreational and community facilities.

Shengo et al. undertook an initial assessment of environmental impacts on a river ecosystem posed by the discharge of liquid wastes from three metallurgical factories. Initial findings indicate elevated levels of cobalt, lead and manganese. The authors recommend that a further
study is required to investigate the levels of metal contaminants in the receiving environment for the effluent so that an assessment can be made as to the degree of the contamination of the Kafubu River ecosystem. Susanna and Rahman undertook a similar study in Indonesia in which an assessment was made of the potential hazards posed by surface water contaminants near pulp and paper mills on the Kampar River. The findings from this study indicated that wastewater effluent from the pulp and paper mills could be tolerated by the existing aquatic system of the Kampar River.

This issue also contains a report about the need for changes in professional practice amongst environmental health officers in response to the challenges associated with climate change and sustainability. Climate change and sustainability are complex matters and require the development of robust environmental health practice and use of additional and more sophisticated practice tools.

For the information of readers, the final issue for this year is scheduled for publication in February 2009. All the Editorial Team would like to wish our readers and contributors a Very Merry Christmas and a Happy New Year.

Jim Smith Dr PH LFEHA
Editor-in-Chief
Sun Protection Policies and Practices of Western Australian Local Governments

Lanny Hoskin¹, Melissa Stoneham², Terry Slevin³ and Kerry O’Hare¹

¹SunSmart, The Cancer Council Western Australia,  
²Stoneham and Associates, Public Health and Local Government Consultants, South Fremantle, & ³Education and Research, The Cancer Council Western Australia and Centre for Behavioural Research in Cancer Control, Curtin University

The local government sector is well placed to support efforts to reduce exposure to ultraviolet (UV) radiation in the community. This paper details the results of a survey conducted by The Cancer Council Western Australia in May 2007 that examined the sun protection policies and practices of local councils in Western Australia. The results of the survey showed that while few local councils had a comprehensive approach to sun protection, most implement sun protection practices across a range of different council departments.

Key words: Local Government; Sun Protection; Shade; Policy

Australia has the highest rate of skin cancer in the world, with at least one in every two Australians being diagnosed with skin cancer in their lifetime (National Cancer Control Initiative 2003). A national survey of sunburn incidence and sun protection revealed that the most common settings or activities where Australians reported being sunburnt were at the beach or other water activities (Dobbinson et al. 2008). More action is needed to address sun protection by incorporating effective shade provision and access to sun protection at popular outdoor recreational settings such as beaches, parks and playgrounds.

The local government sector is well placed to support efforts to reduce exposure to ultraviolet (UV) radiation in the community. Local councils play an integral role in the town planning process, are responsible for granting planning and development approvals and also control and operate a range of recreational and community facilities. Additionally, a significant proportion of the local government workforce work outdoors for part or all of the day.

Previous research in a number of Australian states and New Zealand have examined sun protection polices and practices within the local government sector (Dean 1996; Dobbinson et al. 2006; Reeder & Jopson 2006; The Cancer Council South Australia 2006; van Kemenade 2006). Using this research as a guide, the Cancer Council Western Australia conducted a similar survey in May 2007. The aims of the survey were to broadly determine the extent of sun protection policy and practice within the Western Australian local government sector and identify areas for improvement within each local council. It was expected that this process would provide a foundation for future collaboration with this sector and inform future local government sun protection initiatives.
Method

The survey consisted of a self-report questionnaire that was divided into five sections: general information; outdoor workers; outdoor swimming pools; outdoor areas and facilities; and planning and development. This format was chosen to reflect the diverse nature of the local government sector and the areas where sun protection could be addressed. The format also allowed different business units to complete the survey if preferred. Additionally, respondents were asked to submit copies of any policy or plan that mentioned sun protection or shade, so that constructive feedback could be given on how these policies could be improved.

In May 2007, the questionnaire and a cover letter were sent to the Chief Executive Officer (CEO) of each local government in Western Australia. The cover letter outlined the purpose of the research and asked the CEO to nominate a staff member to coordinate the survey within their council. The letter also explained that councils, which completed the survey would receive a confidential and tailored report outlining areas of strength and suggested strategies for improvement, and a copy of The Shade Handbook: A Practical Guide for Shade Development in Western Australia (valued at $AU39.95). It was anticipated that these items would act as incentives for councils to participate. Due to the slow return rate of surveys, the original submission date was extended several times. In order to increase response rates, contact was made with local councils on at least four occasions via post, email and telephone.

A combination of closed and open-ended questions was included in the questionnaire. Quantitative data were analysed using SPSS version 15.0, with responses to closed questions reported as frequencies and per cent of councils indicating each response. Responses to open-ended questions were compiled and grouped into common themes. Sun protection policies submitted were evaluated against standard policy templates developed from recommendations made by The Cancer Council Australia.

Of the 142 local governments in Western Australia, 72 participated in the survey, a response rate of 50.7%. Of the remaining councils, 24 local councils (16.9%) declined to participate and 46 local councils (32.4%) did not respond. Participation was spread across the state, with at least one council participating from each of the 17 local government zones (Figure 1). Twenty-one metropolitan and 51 non-metropolitan councils participated (Table 1).

<table>
<thead>
<tr>
<th>Participating councils</th>
<th>Total eligible councils</th>
<th>Participation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan councils</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Non-metropolitan councils</td>
<td>51</td>
<td>112</td>
</tr>
<tr>
<td>TOTAL</td>
<td>72</td>
<td>142</td>
</tr>
</tbody>
</table>

Results

Outdoor workers

Eighty-seven percent of councils (n=60) reported that they provided training and information to outdoor workers to raise knowledge about sun protection and skin cancer. This was most commonly delivered through ‘toolbox’ or team meetings, education sessions and occupational safety and health (OSH) training. Qualitative data also indicated that councils commonly provided workplace skin cancer screening for staff, usually conducted by a visiting doctor as part of an annual health assessment.
Figure 1: Local Government Zones in Western Australia

Table 2: Provision of individual sun protection items to staff

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes %</th>
<th>No %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunscreen (SPF 30+, broad spectrum and water resistant)</td>
<td>98.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Sunglasses</td>
<td>98.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Long sleeved shirts</td>
<td>97.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Trousers or long pants</td>
<td>97.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Hats – broad brimmed, bucket or legionnaire style</td>
<td>94.3</td>
<td>5.7</td>
</tr>
<tr>
<td>Hats – caps or visors</td>
<td>68.3</td>
<td>31.7</td>
</tr>
<tr>
<td>Hard hat brims</td>
<td>65.6</td>
<td>34.4</td>
</tr>
</tbody>
</table>

The provision of sun protective items for outdoor workers was widespread, with the majority of councils providing sunscreen, sunglasses, sun protective clothing and sun protective hats to staff members who work outdoors (Table 2). Qualitative data showed that outdoor staff members were often given the choice to wear short...
sleeved shirts or shorts, provided sunscreen was used on areas of skin exposed to the sun. Additionally, the majority of councils (90%) reported that it was a requirement that worksite supervisors demonstrate good sun protection behaviour at work.

The use of engineering controls to protect against UV radiation was not as widespread with only 38% \((n=27)\) of councils providing portable shade for outdoor workers. However, the qualitative data showed that shade was often obtained from other sources, such as surrounding trees, built structures or inside vehicles. In terms of administration controls to protect against UV radiation, 62% of councils \((n=44)\) either ‘sometimes’ or ‘always’ organised outdoor work tasks to limit the time outdoor workers were in the sun between 10am and 3pm, the period of time when UV radiation is most intense (Australian Radiation Protection and Nuclear Safety Agency 2003).

Outdoor swimming pools
Forty councils (56.3%) indicated that they managed an outdoor swimming pool facility. Within these facilities there was a total of 98 outdoor swimming pools. In this survey ‘adequate shade’ was defined as a situation where ‘most patrons who seek shade at a particular time can find and access it’. Encouragingly, over two-thirds (67.4%) of toddler pools were fully shaded and almost all of the remaining toddler pools (28.3%) were partly shaded. However, the majority of full-sized pools (78.0%) and dive pools (90.9%) were not shaded at all. Recreational leisure areas and marshalling and spectator areas were more likely to be adequately shaded than water-based activity areas.

Almost all councils provided sunglasses and adequate shade to staff who worked at pool facilities and over three-quarters of councils provided broad brimmed hats, long sleeved shirts and trousers or long shorts to these staff. Thirty-one councils (81.6%) reported that training and information on sun protection measures were provided to pool staff to raise awareness and knowledge about sun protection and skin cancer.

Nineteen councils (48.7%) reported that they provided a point of sale for sun protection items at their outdoor pool facilities, with all 19 councils indicating that they sold sunscreen. Additionally, three councils sold hats, three sold long sleeved shirts, two sold sunglasses and one council sold portable shade such as umbrellas. Over two-thirds of councils (68.4%) provided free SPF 30+ sunscreen to pool users. Almost one-third of councils (32.4%) had permanent signs in place encouraging sun protection and just over one-third of councils (39.5%) displayed or provided the public with information about sun protection or skin cancer.

Outdoor areas and facilities
Recreation facilities, parks and gardens, and playgrounds were most likely to be adequately shaded; beaches were the least likely to be shaded. Interestingly, recreation facilities, parks and gardens, and playgrounds were identified as areas where councils planned to increase the amount of shade, followed closely by waterside recreation areas and sporting facilities. Councils who were not planning to increase the amount of shade at outdoor areas and facilities most commonly cited one of the following reasons for inaction: the belief that adequate shade already existed; budgetary constraints; shade not being a priority; and low feasibility given low usage of facilities.

Permanent signage encouraging sun protection was not widely used at outdoor areas and facilities. Only three councils reported that they had permanent signage in waterside recreation areas.
Two councils had signage in sporting facilities, one council had signage in recreation facilities and one council had signage in playgrounds. Eleven councils (16.4%) indicated that they provided a point of sale for sun protection items at any of their outdoor facilities. Sunscreen was most commonly available with nine councils reporting that they offered it for sale.

**Planning and development**

Generally, sun protection or shade was considered by few councils within planning and development frameworks. Less than half of responding councils considered shade or sun protection in the area of public open space (47.5%) or community and public purpose development (44.3%), such as recreation facilities. Less than a third of councils considered shade or sun protection in the areas of residential development or commercial/industrial development.

A number of councils referred to the Residential Design Codes (Western Australian Planning Commission 2002) which recommend the siting and design requirements of residential development in Western Australia. However, it was acknowledged that these Codes can have an adverse effect on sun protection, as demonstrated by the following quote from a survey respondent:

*Policies, such as the residential design codes and building codes, actually promote the opposite - that is, maximising solar access through building design for energy efficiency reasons and minimum unshaded private open space/yard areas.*

However, it was recognised by local councils that they could adapt the Residential Design Codes to suit local climate conditions, yet few have achieved this. Further research in this area is highly recommended.

**Policy**

Results show councils were most likely to include sun protection or shade issues in policies that relate to occupational safety and health. Almost two thirds of councils (61.5%, n=40) reported that sun protection was included in their OSH policies, and these were the most common type of policy submitted for review. Additionally, forty-two councils (59.2%) indicated that they had a sun protection policy outlining the responsibilities of council management and outdoor workers.

Less than half of councils (42.9%, n=30) indicated that their council had a general, overarching sun protection policy that referred to the full range of activities conducted throughout their council. Additionally, a minority of councils had sun protection or shade policies in distinct areas of council. For example, 11 councils (16.2%) had a policy for outdoor areas or outdoor facilities, seven councils (17.5%) had a policy for their outdoor pool area and nine councils (14.3%) had a policy relating to planning and development.

Forty-four councils (61.1%) submitted at least one policy with the survey, and a total of 83 policies were received for review. Very few policies comprehensively addressed sun protection with no inaccuracies. A small number of policies did not address sun protection in a meaningful way, while the majority of policies did not have a set date for review. Generally, the outcomes of the review process suggest that there is a large scope to improve the quality of council policies relating to sun protection.

A comprehensive approach to sun protection would involve adopting multiple strategies to minimise sun exposure across a number of council departments. Such a comprehensive approach would incorporate the following key elements:
• Risk assessment of the UV exposure risk to all employees
• The introduction and maintenance of sun protection control measures
• Training employees to work safely in the sun
• A written sun protection policy that addresses:
  a. Access to personal protective items such as clothing including long sleeved shirts and long trousers or long shorts, broad brimmed hats, wrap-around style sunglasses that meet the Australian Standard and broad spectrum water resistant SPF30+ sunscreen.
  b. Access to effective shade at public facilities.
  c. Organisation of outdoor work tasks to maximise use of shade and minimise time spent outside during peak UV periods (between 10am and 3pm).
• A process to determine the effectiveness of the program and identify changes that may further reduce exposure

Discussion
This study has provided useful results in terms of determining the extent of sun protection policy and practice within Western Australian local governments (Refer to Table 3). Generally, the protection of outdoor workers was an area of strength for councils, with most providing a range of administrative and engineering controls, as well as the provision of sun protective equipment and education and training. This area was also the strongest in terms of policy development, with over half of councils addressing sun protection for outdoor workers in a policy document, most typically an occupational health and safety plan. This is somewhat expected given that this area is underpinned by legislation, the Occupational Safety and Health Regulations 1996 (Western Australia 1996). Studies undertaken in other Australia states also identified that the majority of council’s addressed sun protection through occupational health and safety policy (The Cancer Council South Australia 2006, Dobbinson 2004).

Generally, however, there were few policies or plans that addressed sun protection or shade in a meaningful way, and this represents an area for urgent action. To maximize effectiveness local governments are encouraged to develop policies and plans that cover all activities throughout council. As Reeder and Jopson (2006) indicate, this can have a range of benefits, such as the acknowledgement of the ubiquitous nature of sun protection and a comprehensive approach across different council departments. The latter will be key to developing comprehensive policy, given that previous research by Stoneham (2001) notes that shade is usually considered by different council departments in isolation. The challenge will be to facilitate collaboration between these departments so that sun protection is no longer ignored or considered in a haphazard way.

Encouragingly though, a comparison of these results with those from a previous study in Western Australia (Dean 1996) suggest that positive progress has been made over the past decade. For example, in 1996 approximately 50% of wading pools were shaded; in 2007 96% of toddler pools were shaded. In 1996 44% of councils indicated they had a written policy for the protection of outdoor workers; in 2007 this increased to 59.2%. In 1996 none of the councils surveyed had a written policy for providing shade in parks and gardens;
in 2007 30 councils (43%) reported that they have a general, overarching sun protection policy. Although these results must be interpreted with caution given that the surveys are not directly comparable, they do suggest that the local government sector in Western Australia has improved sun protection policies and practices over time.

**Limitations**

There were three main limitations to this survey. Firstly, as the survey was self-report it was difficult to determine if a reported policy or plan actually existed. It was also difficult to determine the quality of any reported policy, unless the policy was returned with the survey. This may have lead to over-reporting of the number of valid sun protection policies. Secondly, as the five sections of the survey were often completed by different staff members, responses were open to subjectivity and inconsistency across council departments. The third limitation relates to potential sampling bias. It is possible that councils who were most active in sun protection policies and practices were more likely to respond to the survey. Nonetheless, this survey provided a good starting point to address sun protection in the local government sector in Western Australia.

**Conclusion**

The results of this survey, like similar studies in other states of Australia, suggest that very few local councils have a comprehensive approach to sun protection. Encouragingly though, the evidence suggests that sun protection is addressed across many areas of council activity, particularly with regard to the protection of outdoor workers as well as staff and patrons of outdoor swimming pools. It is clear, however, that gaps exist and a more comprehensive approach

<table>
<thead>
<tr>
<th>Table 3: Summary of results</th>
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<tbody>
<tr>
<td>Area of council responsibility</td>
</tr>
<tr>
<td>Occupational Safety and Health (OSH)</td>
</tr>
<tr>
<td>Provision of sunscreen to outdoor workers</td>
</tr>
<tr>
<td>Provision of sun protective hats to outdoor workers</td>
</tr>
<tr>
<td>Provision of training and information to outdoor workers</td>
</tr>
<tr>
<td>Organisation of work tasks to limit time in the sun between 10am and 3pm</td>
</tr>
<tr>
<td>Policy</td>
</tr>
<tr>
<td>Sun protection included in OSH policy</td>
</tr>
<tr>
<td>General sun protection policy for all activities across council</td>
</tr>
<tr>
<td>Sun protection policy for outdoor pool area</td>
</tr>
<tr>
<td>Sun protection policy for outdoor areas or facilities</td>
</tr>
<tr>
<td>Shade provision</td>
</tr>
<tr>
<td>Toddler pool fully or partly shaded</td>
</tr>
<tr>
<td>Full-sized pool fully or partly shaded</td>
</tr>
<tr>
<td>Diving pool fully or partly shaded</td>
</tr>
<tr>
<td>Planning and development</td>
</tr>
<tr>
<td>Sun protection considered in public open space planning</td>
</tr>
<tr>
<td>Sun protection considered in community and public purpose development</td>
</tr>
<tr>
<td>Sun protection considered in residential development</td>
</tr>
<tr>
<td>Sun protection considered in commercial or industrial development</td>
</tr>
</tbody>
</table>

in 2007 11 councils (16.2%) had a policy for outdoor areas or outdoor facilities. Most strikingly, in 1996 no councils had a written policy on the provision of shade;
is necessary to reduce exposure to UV radiation in the community.

Therefore, the challenge for The Cancer Council WA is to promote the importance of sun protection in the local government sector, as well as to continue to support individual local councils to develop and enhance sun protection practices. The Cancer Council WA will now commence with advocacy to implement sun protection policies, as well as the development and dissemination of policy templates and information resources. Future research and evaluation will provide insight into the effect of these strategies on the local government sector and, ultimately, the level of UV radiation exposure in the community.

Acknowledgments
This research was conducted with funding from the Western Australia Department of Health.

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Attitudes towards the Development of Wind Farms in Australia

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*The Australian government is supporting the development of renewable energy technology, such as wind power, in its efforts to reduce greenhouse gases in line with the Kyoto agreement. While wind technology offers many advantages, property owners have voiced opposition to the siting of wind farms due to concerns over changes in neighbourhood aesthetics, noise, loss of bird life, and loss in property values. Such opposition can result in planning permission being declined and a restriction in the ability to meet Kyoto targets. This paper outlines the results of research carried out in Western Australia in 2008 to investigate the attitudes of residents towards the development of a wind farm. The results indicate that the majority of the respondents think of a wind farm in positive terms. The proximity to the wind farm is an important aspect that could determine attitudes with many respondents reporting that they would not want to live “near” a wind farm, usually stated as between 1-5km. Over a third (38%) of the respondents would pay 1-9% less for their property due to the presence of a wind farm nearby. These results will be of interest to power companies in helping to plan the siting of wind farms.*

**Key words:** Wind Farms; Public Attitudes; Property Values

According to the former Premier of Western Australia (WA), Alan Carpenter, there is no bigger threat to WA’s environment, economy and unique lifestyle than climate change (Government of Western Australia 2007). Scientists have estimated with a high level of certainty that greenhouse gases contribute the most to global warming, with increases in carbon dioxide (CO₂) as the greatest contributor. The large-scale use of fossil fuels alone is responsible for about three-quarters of the CO₂.

The Australian Government is committed to its internationally agreed target of limiting greenhouse gas emissions to 108% of 1990 levels between 2008 and 2012 under the Kyoto Protocol. A method supported by the Australian Government to reduce greenhouse gas emissions is the use of renewable energy; power produced from wind, water or solar sources. The Government’s Mandatory Renewable Energy Target (MRET) currently requires a 20% share for renewable energy in Australia’s electricity supply by 2020. This has generated a surge of interest in renewable energy, and particularly wind power. Globally, in its best year, the wind industry installed over 20,000 MW in 2007 (Global Wind Energy Council 2007). This development was lead by the United States (US), China and Spain, and it brought the world-wide installed capacity to 94,123 MW. This is an increase of 31% compared with the 2006 market.

In Australia, the total operating wind capacity at the end of 2007 was 824 MW. Over 400 MW of projects received planning approval during 2007. Nine projects (over 860 MW) were commissioned although they are not yet operating as at December 2007; these included three new projects totalling 290 MW of capacity. According to the Australian Wind Energy Association,
150 wind turbines have been built in Western Australia on 14 wind farms. There are 554 wind turbines on 42 wind farms Australia-wide (Australian Wind Energy Association 2007).

To meet renewable energy targets many of the current barriers in the planning and siting process will have to be reduced. Between 30 to 50% of contract failures are attributable to siting and permitting issues (British Wind Energy Association 2003, cited by Loring 2007; California Energy Commission 2006). Among these siting challenges are claims that wind farms cause changes in neighbourhood aesthetics, noise, light flicker, loss of bird life, and reductions in property values. In order to examine whether there is any substance to these claims, and to monitor the effects on residential property values affected by wind farm developments, research is needed. This study aims to determine residents’ attitudes towards a wind farm development in WA. This will inform local government and power companies of any negative attitudes that need to be addressed to help increase the success rate of planning applications.

**Previous Research**

There has been very little authoritative research on either public perceptions towards wind farm development or the impact of wind farms on property prices in Australia. However, some insights into the likely effects can be gained from recent overseas studies.

**United States**

The best known wind farm study was carried out in the US by Sterzinger, Beck and Kostiuk and sponsored by the Renewable Energy Policy Project (REPP 2003). They analysed some 25,000 transactions of properties that were within five miles of wind turbines at 10 wind energy projects, over a six year period (1999-2001), to determine whether, and the extent to which, the presence of a wind power project had an influence on the sales prices of proximate property. They looked at changes in property prices (and the “viewshed”) before and after the construction of each project and in comparison to similar communities without a wind farm. A “viewshed” is the total area that is visible from a particular vantage point.

The results indicate that there was no evidence that wind turbines sited within a five mile radius of property had a negative impact on value. However, this study does not make any allowance for property characteristics in the regression analysis and thus the rate of value increase in each of the areas might be explained by other factors, such as better locational characteristics, or more desirable housing. This is the study’s weakness. Further, the regression models do not fit the data well. In many cases the R² is less than 50% and less than 10% in more than a dozen cases.

Perhaps the most comprehensive, longitudinal study is being carried out by Hoen and Wiser (2007). They are investigating the extent to which aesthetic or other concerns of wind energy developments affect local property values. The study will investigate the effects of multiple (6 to 10) wind power projects in the US on local property values between September 2006 and March 2010. They will use a hedonic pricing model that will incorporate field visits to all homes that have sold in the selected areas. The field visits will enable factors such as the scenic vista and view of the turbine from the home to be determined and controlled for in the model. To date, data on four facilities have been collected. The sample size comprises over 350 residential property transactions at each site within 7 miles of the turbines. The preliminary results indicate that there is no statistical
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There is evidence that homes within 4-7 miles of a wind farm are affected adversely based on either proximity or having a view of the turbines.

**United Kingdom**

There have been a number of recent studies in the United Kingdom (UK). They are principally concerned with public attitudes towards the construction of proposed wind farms (see for example, Impact Assessment Unit, Oxford Brookes University 2003). The results of these studies generally suggest a high level of support for this technology, although the results are mixed. For example, concern has been raised about the noise, and in particular the visual impact, since wind turbines tend to be located in highly valued landscapes.

A number of the studies suggest that when wind farm developments are first announced, property prices might decline, but prices are likely to recover after the wind farms start operating as communities learn more about the actual impacts of wind developments (see Braunholtz 2003; Dudleston 2000; Haughton et al. 2004; Khatri 2004; Warren et al. 2005). For example, a survey sent to 1942 members of the Royal Institute of Chartered Surveyors (RICS) by Khatri (2004) found that 60% of the 405 respondents suggested that proximate wind farms would decrease property values when the turbines are in view. However, the results from a follow-up study by the RICS of this specific respondent group found that 67% believe that this value decrease starts at the planning stages of a wind farm and lessens with time.

A further follow-up RICS-sponsored study was conducted by Dent and Sims (2007) to test whether the proximity to wind farms impacts negatively on property values through an analysis of property transaction prices. They investigated two areas in North Cornwall: St Bereock and St Eval that had 27 turbines constructed (11 and 16 in each respectively). They analysed 919 transactions that had taken place within five miles of the wind farms since April 2000. Despite initial evidence that there was an effect, when they investigated more closely, there were generally other factors which were more significant than the presence of a wind farm.

**New Zealand**

A study by Watts, Schluter and Whiting (2005) to investigate the attitudes of local community members to the proposed Awhitu wind farm involved a postal survey of 500 Franklin residents. A 46% response rate was achieved (211). Over two-thirds of the respondents (70%) supported a wind farm being built in their area, with 17% neutral, and only 13% against the farm. Contrary to the assertions of several lobby groups, the majority of local residents support the construction of the Awhitu wind farm. Despite this, several community groups claiming to represent the majority opposed this application and in September 2004 consent was declined.

**Australia**

There are few, if any, known published studies of the impact of wind farms on property values in Australia. However, some polls have been conducted in various states to determine the public perception towards wind farm development. In 2001, a poll in Victoria showed that 94% of respondents described wind generators as ‘interesting’ and 74% as ‘graceful’ (Auspoll 2001). A subsequent survey showed that 95% of respondents supported the construction of more wind farms (Auspoll 2002). This result was again backed up in a national poll by AusWEA in 2003 which found that 95% support (27%) or strongly support (68%) building wind
farms to meet Australia’s rapidly increasing demand for electricity (Australian Research Group 2003).

Conversely, other evidence exists of public opposition to wind farms. For example, the energy company Australian Gas Light withdrew an application to build 48 wind turbines at Dollar in South Gippsland apparently on economic grounds. According to the State National Party member for Gippsland South, Peter Ryan, it was a great result for residents opposed to the project and for the council who did not support it (ABC News 2007).

In summary, there is ongoing controversy about the impact of wind farms on property values with no one study providing conclusive evidence of any impact. As noted by Boffa Miskell (2003), surveys suggest that attitudes of total opposition are a minority viewpoint. In summarising findings from various public surveys, undertaken at pre and post-construction stages of wind farms, they make the following valid points that are relevant to this study:

- people in favour of renewable energy and wind power are more positive about turbines and wind farms in the area;
- attitudes towards wind farms in areas where a wind farm is present are more positive than in those areas with no experience of wind farms. The ‘NIMBY’ syndrome (Not In My Backyard) has the strongest effect in areas where there is no or very little knowledge about wind power;
- public acceptance of wind energy increases with the level of information provided;
- the size of a wind farm project only insignificantly influences public attitude towards a project and size is a poor predictor of public attitude; and
- public involvement and consultation has a positive effect on people’s attitudes and level of acceptance.

**Methodology**

As noted above there is limited robust research of the impact of wind farms on property values. However, the impact of proximity to similar structures such as high voltage overhead transmission lines (HVOTLs) has been more extensively researched. Studies of HVOTLs within the UK and New Zealand (NZ) have focused on opinion based surveys (Bond 1995; Gallimore & Jayne 1999; Sims & Dent 2005). Priestley and Ignelzi (1989) in the US developed a sound standardised methodology for assessing environmental impacts in residential communities using both postal surveys and hedonic modelling (regression analysis of sales transactions). This latter approach is preferred. However, due to the distance of the Albany wind farm from residential areas (over 10 km) proximity impacts on sales prices are likely to be minimal. This research will focus on the use of postal surveys (Part I) while future research (Part II) will involve sales transaction data analysis in an area where a wind farm is located near homes (within 5 km). Part I is reported here.

Attitudinal (or perception) studies give a qualitative feel for the effects of wind farms, rather than a quantitative measure of degree of impact. These studies examine how property owners perceive the effects of wind farms on the sale price of property. The research commenced with an investigation into the location of wind farms in WA. A case study approach was used to examine public attitudes towards a wind farm. This involved the following steps:
a. Selection of an appropriate case study area (based on the year the wind farm was commissioned, the number of wind turbines and density of residential properties nearby);

b. Administration of a postal survey to a sample of residents living in the case study area to determine their attitudes towards the wind farm;

c. The responses were individually coded, entered into a computerised database, and analysed.

**Study area**
The area selected for the case study is Albany, a southern coastal regional centre located 409 km (254 miles) south of Perth, the capital of Western Australia (Appendix A). The median house price for Albany as at March 2008 was $462,500AU ($410,000AU for the wider Albany Urban Area). This is considered quite high for a regional centre compared to Perth Metropolitan Area of $460,000AU. Albany has a population of approximately 1500 (33,000 in the Albany Urban Area). The median age is 39 years.

Albany wind farm is about 12km south-west of the city (Appendices A and B). It is in an elevated position of approximately 80m above the Southern Ocean. This height, nearness to the coastline (coastline is where most wind is produced) and small distance to the main electricity transmission system makes this an outstanding wind farm site. The turbines produce a reported average of 75% of electricity for Albany.

The Albany wind farm was the biggest wind farm in Australia when it was first commissioned in October 2001 with 12 1800kW wind turbine generators situated on it. The turbines are fitted to 65m towers and at the time of commissioning were the largest to have been installed in the southern hemisphere. The turbines operate automatically, with three 35 metre long blades adjusted to make best use of power output from any wind direction or strength.

According to the report by Sinclair Knight Merz (2001), one important aspect of the Albany wind farm was the Biblimum Track, Western Australia’s premier walking track. A portion of the track traverses the wind farm site and Western Power had to ensure that this was taken into account. The track needed to be altered and re-aligned towards the coastal cliffs, and the track surfaces hardened. The company also upgraded the road at a cost of $400,000AU for tourist traffic. A further $200,000AU was spent on board walks, viewing towers, lookouts, picnic areas, and interpretive displays to enhance the visitor experience at the wind farm. Sinclair Knight Merz also predicted a 100-fold increase to the tourist numbers to the region due to the wind farm. The wind farm is still a novelty and has created a great deal of interest from both locals and tourists.

**Summary of Case Study Findings**
Of the 800 questionnaires mailed to homeowners and tenants in the study area, 38% were completed and returned. The majority (98.7%) of respondents were homeowners with the remainder being tenants. Nearly two thirds (64.6%) had lived at the same address for five years or more.

**Preferences for generation options to meet Australia’s future electricity needs**
To determine respondents’ preferences for power generation options, respondents were asked to rank various options in terms of their preferences from 1 (most preferred) to 8 (least preferred). Table 1 below shows the order that respondents ranked the various options, with wind
being most favoured, followed by solar and wave/tidal. The reasons put forward for these preferences are that they are ‘clean’, reliable, and readily available in Albany (wind and solar, particularly). Although some thought these options had high maintenance requirements or were costly (solar), and were ugly with low output/limited base load (wind).

Coal and nuclear were ranked as least preferred options mostly due to the polluting (green house gas emissions) or potentially dangerous nature of these options. Other options suggested by respondents were: geothermal, bio-fuel, hydrogen, nuclear fusion, biomass, and hot rocks.

Table 1: Preferences for generation options

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wind</td>
<td>52%</td>
</tr>
<tr>
<td>2. Solar</td>
<td>41%</td>
</tr>
<tr>
<td>3. Wave/Tidal</td>
<td>48%</td>
</tr>
<tr>
<td>4. Hydro</td>
<td>39%</td>
</tr>
<tr>
<td>5. Gas</td>
<td>43%</td>
</tr>
<tr>
<td>6. Coal</td>
<td>37%*</td>
</tr>
<tr>
<td>7. Nuclear</td>
<td>34%</td>
</tr>
<tr>
<td>8. Other</td>
<td>29%</td>
</tr>
</tbody>
</table>

Note: *Although 41% ranked this as 7th

The reasons for their favouring the proposal were that they saw the benefits in producing ‘clean’, sustainable, renewable energy. Further, they felt that wind energy is ideal for Albany’s windy conditions and that it provided a tourist attraction. However, some respondents had concerns about damage to the coastal vegetation and coastline and thought that this area should not have been exploited for power. Further, there was concern that the wind farm would impose on the view of the pristine coastal scenery and cause ‘visual pollution’.

Nearly two thirds (61.1%) of the respondents felt more in favour of the wind farm after it was constructed. The reasons they suggested for this change in feelings was that it was more aesthetically pleasing and quieter than expected, the road to the surf beach was upgraded, and it provided a popular tourist attraction. Fewer than 2% (1.7%) felt more opposed to the development after it was constructed as it was found the wind farm was much less efficient than proposed so cost of production was greater. Another respondent commented that the public was not privy to the test results of other sites considered.

Table 2: Feelings about the proposal for the development of a wind farm

<table>
<thead>
<tr>
<th>Feelings</th>
<th>Frequency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not live in Albany prior to 2001</td>
<td>19.2</td>
</tr>
<tr>
<td>Strongly opposed</td>
<td>1.3</td>
</tr>
<tr>
<td>Moderately opposed</td>
<td>3.3</td>
</tr>
<tr>
<td>Did not bother me</td>
<td>7.9</td>
</tr>
<tr>
<td>Moderately in favour</td>
<td>10.6</td>
</tr>
<tr>
<td>Strongly in favour</td>
<td>57.6</td>
</tr>
</tbody>
</table>

To prevent the responses to this question from being contaminated by the probing questions about specific wind farm effects, the above question was posed early in the questionnaire before the subject of wind farms was introduced. When asked if they had visited a wind farm with more then one turbine, 98% responded that they had. They were then asked about their feelings about the proposal for the development of a wind farm in the Albany area prior to it being built in 2001 to determine if their feelings changed before and after construction. Over two thirds (68%) of the respondents were either moderately or strongly in favour of the development, 8% were not concerned, and 19% did not live in Albany prior to the wind farm being built. Only 4.6% were either moderately or strongly opposed to the proposal. Table 2 below, outlines these results.
When 59.5% of the respondents purchased or began renting their home the wind farm was not yet constructed. For the majority of them (96.2%) the proximity of the wind farm was not a concern. Similarly, when asked if they had known at the time of purchase/rental that a wind farm was to be developed 98.3% would have still gone ahead with the purchase/rental. The reason put forward for this was because the wind farm is not close to residential areas and they cannot see it so it was not a concern. As noted by one resident “the buffer area seems adequate for the noise”. Some residents said that their answer would depend on how close the wind farm was to them. Two respondents noted that the process of site selection was not free from bias. A few residents responded in the negative, stating that they do not want a wind farm near them and had they known that one was to be built they would not have purchased/rented. Further, they were not happy about the coastal reserve being used for the construction of the wind farm.

The reasons put forward for the proximity of the wind farm being a concern to some residents (3.8%) was that they felt the current wind farm location is pristine and if any more turbines are to be built that they should be built inland, or on rural farmland slightly more remote. Another resident reported that the wind farm is not close but if it had been the noise and size would have concerned them.

### Wind farm impacts

When asked whether the wind farm is audible from their home most respondents (99%) said it was not.

Table 3, below, summarises the ways in which the presence of a wind farm nearby would affect respondents’ purchase/rental decision. For over two-thirds (70%) of them, the presence of a wind farm nearby would not influence the price they would be prepared to pay, while 17% reported they would be prepared to pay a little less. When asked to specify this effect as a percentage of total property price, 38% said they would pay 1-9% less for their property, 26% would be prepared to pay 10-19% less, 10% would pay 20% or greater less. However, 18% would be prepared to pay 1-9% more for their property if a wind farm was nearby. Interestingly, some who answered that the wind farm would have no influence on the price/rent they would be prepared to pay for their property responded to the next question on the percent effect on price from proximity to a wind farm that they would be prepared to pay some percentage more or less for their property, contradicting their answer to the previous question.

<table>
<thead>
<tr>
<th>Table 3: Effect on property price/rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price effects</td>
</tr>
<tr>
<td>Substantially more for this property</td>
</tr>
<tr>
<td>A little more for this property</td>
</tr>
<tr>
<td>A little less for this property</td>
</tr>
<tr>
<td>Substantially less for this property</td>
</tr>
<tr>
<td>It would not influence the price</td>
</tr>
<tr>
<td>As % of price/rent:</td>
</tr>
<tr>
<td>20% higher or more</td>
</tr>
<tr>
<td>10% to 19% more</td>
</tr>
<tr>
<td>1% to 9% more</td>
</tr>
<tr>
<td>1% to 9% less</td>
</tr>
<tr>
<td>10% to 19% less</td>
</tr>
<tr>
<td>20% or a greater reduction</td>
</tr>
</tbody>
</table>
Advantages and concerns associated with wind farms

Respondents were asked about their feelings on a number of advantages commonly associated with wind farms, and their turbines. The majority agreed with most of the items listed: environmental friendliness/non-polluting (96% agreed); low cost energy source (70.5%); renewable resource (94.3%); boost to tourism/local economy (85.5%). There was only some uncertainty about employment opportunities with 43.5% agreeing with this advantage and 47.3% unsure. Other advantages noted by respondents of the wind farm were the prestige it creates for the community of being "environmentally, sustainable", the educational aspects, and that it is a good place to take visitors. Other respondents commented that they felt the wind farm was only a boost to tourism in the early days and that it was only a low cost energy source if the initial cost is not taken into account. One respondent noted that the wind farm is not as efficient as the public were led to believe.

Next, respondents were asked about their feelings towards a number of concerns commonly associated with wind farms, and their turbines. The majority reported that they do not worry about the items listed: visual intrusion (88.9% do not worry); noise intrusion (81.4%); effect on your property’s value (85.7%); radio interference (84.9%), and sun/light flicker (89.8%). Only the potential harmful impact on wildlife worried them somewhat to a lot (32.1%). Table 4, opposite, summarises these responses.

Other concerns which respondents had about wind farms/turbines were the dehydration of natural vegetation that the development causes, the traffic noise and rubbish created from tourists and locals visiting the wind farm, the supplementary fuels used for power when there is no wind, the possible lack of generation capacity if the region is heavily dependent on wind power, and that the general public were not given enough information to make an informed decision about the wind farm site selection.

Lastly, 85.7% of the respondents would favour the construction of a wind farm nearby. The reasons cited for this were: the need for non-polluting green power; wind farms are aesthetically pleasing; they increase tourism; and such construction would lead to the city being viewed as a leader in renewable energy.

Many respondents commented that their responses were conditional on how near ‘nearby’ is (as stated in the questionnaire). Some would be in favour of the construction of a wind farm nearby but only if it was a certain distance from their home, however, respondents’ perceptions of how far this distance needed to be varied from more than 0.5km to more than 5km away from their home. Further, respondents would

Table 4: Concerns about wind farms & their turbines

<table>
<thead>
<tr>
<th>Concern</th>
<th>Don’t worry very much</th>
<th>Worry somewhat</th>
<th>Worry a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual intrusion/aesthetic impact</td>
<td>88.9%</td>
<td>7.7%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Noise intrusion</td>
<td>81.4%</td>
<td>15.9%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Effect on property’s value</td>
<td>85.7%</td>
<td>11.9%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Radio Interference</td>
<td>84.9%</td>
<td>12.7%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Potential harmful impact on wildlife</td>
<td>67.8%</td>
<td>25.3%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Sun/light flicker</td>
<td>89.8%</td>
<td>8.5%</td>
<td>1.7%</td>
</tr>
</tbody>
</table>
be in favour of wind farm construction nearby but only if it fits into the landscape, produces cheaper, cleaner energy, cannot be heard, and is not an eyesore.

The reasons given by respondents who would not be in favour of a wind farm nearby included: it detracts from Albany’s spectacular coastal scenery; it creates more traffic by people visiting the area; the visual pollution; the noise created by the turbines, and that wind farms would need to become more cost effective if they are to contribute to future energy needs. This latter comment was followed by the perception that Western Power has driven a biased campaign when quoting capacity and contribution of the wind farm. Another respondent thought the wind farm should not be on Crown land and should be away from tourist areas as they felt that the novelty of a wind farm would wear off in a few years and they will then be viewed as unsightly rather than as a tourist attraction as they currently are.

Evaluation of the responses to the questionnaire’s background questions revealed that 62% of the respondents were male and 38% were female. The average age was 50-59 years (77% were over 50 years of age), 41.4% work full-time and 37% are retired. Over three quarters (77.6%) had no children under the age of 18 living at home.

Finally, respondents were invited to make additional comments. The comments indicate that residents felt that the information provided to the community about how much power the wind farm would produce once built or how efficient and cost effective it would be was not accurate.

**Summary**

From the above results and comments it appears that the majority of respondents are very supportive of the wind farm and think of it in positive terms: provision of renewable, clean energy; aesthetically pleasing (more so than anticipated before construction); far enough away from homes to not affect property owners in terms of noise, or traffic; educational benefits, and the increased tourism to the city. However, there are some respondents who think of the wind farm in negative terms: too noisy; ruining coastal landscape, and more particularly concerns about the accuracy of the information (or lack thereof) they were given about the capacity of the wind farm and how energy efficient and cost effective it would be.

This study investigated the attitudes of residents to the development of wind farms in 2008. It must be recognised, however, that these attitudes might vary over time. From more recent research it does appear that perceptions have changed compared to earlier studies of public attitudes towards wind farms. Residents are generally very supportive of wind farm technology, probably due to the wide media coverage on climate change globally, and the focus of many governments to reduce greenhouse gas emissions through the use of renewable energy sources such as wind. Further, residents' feelings towards the Albany wind farm improved after it was built.

**Limitations**

A limitation specific to the study area is the distance from the wind farm. Previous research has shown that turbines and similar structures are not highly noticeable beyond 8km (see Bond & Hopkins 2000; Bond & Squires 2006; Des Rosiers 2002; REPP 2003, and Reichert 1997). Thus, had the wind farm been much closer to where homes are located the residents' perceptions might have been quite different. As many noted in their responses, they were supportive of wind farms if they were not close to their homes and thought that the Albany
wind farm was far enough away so as not to have any negative impact on the enjoyment of their homes. However, many respondents commented that if the wind farm was closer it might have been a concern to them.

It must be kept in mind that these results are the product of a single case study carried out in a specific geographic location at a specific point in time and that great caution must be used in making generalisations from them or applying them to other locations. Residents of Denmark, a town which is only 53 km from Albany, fought strongly against the development of a proposed wind farm in their town. This shows how location-specific resident attitudes can be.

**Conclusion**

Briefly stated, the results of this study indicate that the majority of the respondents think of the wind farm in positive terms. The proximity to the wind farm is an important aspect that could determine attitudes with many respondents reporting that they would not want to live near (usually stated as between 1-5km) a wind farm. The only area of minor concern associated with wind farms and their turbines reported was the potential harmful impact on wild life.

For over two-thirds (70%) of the respondents, the presence of a wind farm nearby would not influence the price they would be prepared to pay for their property, however, nearly a quarter (24%) reported they would be prepared to pay less. Over a third (38%) said they would pay 1%-9% less for their property, while 26% would be prepared to pay 10%-19% less. It would be interesting to investigate actual transaction prices to see whether the perceived negative attitudes are reflected in the price actually paid for property.

According to a study by Loring (2007) if governments want to promote the further development of on-shore wind turbines they will not only need to encourage public participation in the early stages of wind energy projects, but also find ways to address or counter the strong networks of opponents to these projects. It appears from the success of the Albany wind farm project that the WA government handled this aspect very well. This also highlights the advantages of community consultation and careful site selection away from residential areas.

**Acknowledgments**

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Appendix A: Location of wind farm

Appendix B: Albany wind farm from Albany city

Source: Sandy Bond, August 2008
Studies on Self-Reported Multiple Chemical Sensitivity in South Australia

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The prevalence of Multiple Chemical Sensitivity (MCS) in South Australia is unknown and was sought through population-based telephone surveys of approximately 4000 adults. These surveys revealed a 1% self-reported MCS prevalence but also a more general hypersensitivity prevalence of about 16%. Symptomology and symptom severity suggest a significant negative impact of environmental chemicals in the community.

Key words: Multiple Chemical Sensitivity; Hypersensitivity

Multiple Chemical Sensitivity (MCS) is a chronic condition characterised by fatigue, headaches, fibromyalgia, anxiety, nausea, depression, dizziness and various other non-specific symptoms (Graveling et al. 1999; Labarge & McCaffrey 2000; Pall 2007). Sufferers consider that low doses of a wide range of environmental chemicals can trigger these symptoms, though such causation is scientifically difficult to prove (Bornschein et al. 2007; Staudenmayer 2001). Due to this, MCS is a controversial condition, and it is reported as having aspects of toxicogenic and psychogenic aetiology. Detractors from a toxicogenic origin prefer the descriptor Idiopathic Environmental Intolerance (Staudenmayer et al. 2003a,b) and have demonstrated psychiatric comorbidity among patients with MCS, including anxiety, panic disorder and depression (Bailer et al. 2004; Bornschein et al. 2002; Caccappolo-van Vliet et al. 2002). Supporters of a toxicogenic origin have given consideration to a range of mechanisms, including toxicant-induced loss of tolerance (Miller 2000), elevated nitric oxide/peroxynitrile (Pall 2003, 2007), immunological dysregulation, neurogenic inflammation, and limbic kindling/neural sensitisation (Graveling et al. 1999). Currently, there are no biomarkers for MCS, and there are no diagnostic or clinical management guidelines for MCS in Australia. Yet it is evident that some medical practitioners attempt to diagnose and treat MCS.

In the late 1990s, the South Australian Department of Health became increasingly aware of cases of MCS. At that time, claims were being made of a high prevalence of MCS in the community. In order to inform this issue, the South Australian Department of Health commissioned two randomised population-based surveys the results of which form the basis of this paper.

Methods

Self-reporting data were obtained from computer-aided telephone interviewing (CATI), arranged through the South Australian Department of Health’s Population Research & Outcome Studies Unit in collaboration with Harrison Health Research, Adelaide. Responses to questions were entered directly into the computer and the CATI system enforces a range of checks with most questions having a set of predetermined response categories. Response categories can also be automatically rotated when required, to minimise bias. Open-ended responses were recorded verbatim by the interviewer.

The survey methodology is reported in detail elsewhere (Population Research &
Outcomes Studies Unit 2002); however, in brief, all households in South Australia, with a number listed in the Electronic White Pages were eligible for selection in the sample. Telephone numbers were selected randomly and approximately 2000 interviews were conducted on people aged 18 years and over (n=2007 in September 2002 [Phase 1] and n=2002 in June 2004 [Phase 2]). A letter was sent to each selected household introducing the survey. Within each household, the person who had their birthday last was selected for interview. There was no replacement for non-respondents. Data were weighted by probability of selection in the household and by age, sex and area of residence to the most recent Australian Bureau of Statistics Estimated Resident Population for South Australia for 30 June 2001 (Phase I) or for 30 June 2002 (Phase II).

Results and Discussion

Prevalence, age and gender distribution

Phase I and Phase II each included one key question to determine MCS prevalence:

**Phase I**

“Have you ever been told by a doctor that you have any of the following conditions? - asthma, other respiratory problems, chronic fatigue syndrome, heart disease, multiple chemical sensitivity?”

**Phase II**

“Have you been told by a medical doctor that you currently have any of the following conditions? - asthma, other respiratory problems, chronic fatigue syndrome, heart disease, multiple chemical sensitivity, fibromyalgia (muscle pain)?”

The Phase II question thus specified the type of doctor, a current diagnosis, and added one of the common symptoms of MCS, that is, fibromyalgia. Otherwise, the two questions are the same. In both phases, the incidence of adult asthma was similar (11.5% and 11.7%), and corresponded to the known incidence of asthma in the community (Wilson et al. 2006), indicating that the sampled cohorts were representative of the population at large.

The MCS prevalence data from these initial questions are shown in Table 1. These reveal an MCS prevalence of 0.7 to 1.0% in the adult population. The slightly lower rate in Phase II could reflect the use of the present tense in the question, and which, though the number of cases is small, might suggest a degree of recovery from the condition.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>% of total population^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>4</td>
<td>17</td>
<td>21</td>
<td>1.0%</td>
</tr>
<tr>
<td>II</td>
<td>4</td>
<td>10</td>
<td>14</td>
<td>0.7%</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>27</td>
<td>35</td>
<td>0.87%</td>
</tr>
</tbody>
</table>

Notes:
1. See text for specific questions
2. Based on 2007 people interviewed in Phase I, and 2002 in Phase II

Within the confines of self-reporting, it has been shown that false negatives might comprise about 50% of the true number of cases (Baker et al. 2004). It is thus possible that an MCS prevalence of up to 2% or down to 0.5% actually exists in the South Australian community.

This, therefore, is the first attempt to gain an understanding of MCS prevalence in South Australia. Similar prevalence has been reported in Denmark (Danish Ministry of the Environment 2006), while several other surveys report a prevalence of 2%-6% (Caress & Steinemann 2003; Gibson 2006; Kreutzer et al. 1999; Meggs et al. 1996) although some sought a diagnosis of ‘MCS or environmental illness’. In a NSW survey, with the question “Have you ever been
diagnosed with a chemical sensitivity?”, the prevalence was 2.9% (NSW Public Health 2003). It must be borne in mind that the survey data depend on the question that is asked, on how the medical profession view and diagnose chemical sensitivity, and on how patients interpret and relate a medical diagnosis.

Regarding age distribution, the MCS cases from both phases were summed, were age-stratified and the prevalence calculated per population size in seven age groupings. Figure 1 shows no cases in the 18-24 year group, then a Gaussian-type distribution with peak prevalences of 1.5%, 1.12% and 1.53% in the 45-54 year group, 55-64 year group, and the 65-74 year group, respectively. These data may suggest a late onset of MCS, though this survey did not include adolescents or children. This contrasts with the significant number of hypersensitive cases in these early age groups (data not shown; Caress & Steinemann 2003).

These data indicate a greater proportion of female MCS cases, being 4.25-fold in Phase I and 2.5-fold in Phase II (average 3.4-fold overall; total $\frac{\hat{f}}{\hat{m}} = 1.05$). This could be explained if more females than males with the condition visited doctors; nevertheless this predilection toward female cases is in accordance with other surveys (Caress & Steinemann 2003; Joffres et al. 2001; Kreutzer et al. 1999; NSW Public Health 2003). If this is a real phenomenon, it suggests an underlying gender-specific mechanism.

**City versus country**

It has been suggested that compared to city environments, country environments are less polluted and would, therefore, be less likely to impact on chemically-sensitive individuals. In reality, many country environments are subject to regular agricultural spraying. Notwithstanding, the present survey examined this issue, revealing an MCS prevalence of 0.8%
in metropolitan Adelaide and 1.1% in country SA. A lack of significant difference between city and country MCS prevalence was also found in a NSW survey (NSW Public Health 2003).

Anecdotally, some MCS sufferers move to the country to seek ‘cleaner’ air, thus these data might reflect this demographic. Alternatively, the data could simply suggest that country environments might not be healthier for those with MCS.

**Household income**

The surveys included a question to all respondents regarding household income, and Figure 2 shows MCS prevalence as a function of this parameter. The data indicate a significant trend towards decreased MCS prevalence with increasing household income. Unfortunately the data did not lend itself to determining the gender stratification by household income, but this would be interesting to ascertain in future. This same relationship among hypersensitive individuals of decreased prevalence with increasing household income was also reported by others (Caress & Steinemann 2003; Joffres et al. 2001), with a bi-modal relationship reported by Kreutzer and colleagues (Kreutzer et al. 1999).

**Other MCS-specific questions**

Though the number of cases was small, a range of other questions was posed to those identifying with MCS in Phase II (Table 2). The responses tend to confirm what is generally known, namely that stress might be a major aetiological factor in MCS onset and that the family or social life of MCS sufferers is often significantly affected. Regarding those cases who could identify the origin of their sensitivity, it has been observed elsewhere that such cases were more likely to report severe symptoms than those who did not know the original cause (Caress & Steinemann 2003).

![Figure 2: MCS prevalence as a function of household income (Phase I and II combined)](image_url)
General chemical hypersensitivity

Both phases of this investigation included questions to all respondents about general sensitivity to environmental chemicals. The Phase I question and data are given in Table 3, revealing prevalence of 3-10% across the genders for perfume, traffic pollution, household and workplace chemicals.

In Phase II, the question posed to non-MCS cases was different: “Do you consider yourself especially sensitive to everyday chemicals found in household cleaning products, perfumes, insect sprays, new carpets, fresh paints, etc?” To this, 9.9% of males and 21.7% of females responded in the affirmative, with an average of 15.9%. This gender bias and average are similar to other reports (Caress & Steinemann 2003; Kreuter et al. 1999).

Considering hypersensitivity in country versus metropolitan areas, the prevalence was 15.3% and 16.1%, respectively. Considering symptoms reported by hypersensitive individuals, 40% experienced headaches, 37% had asthma or other breathing problems, 31% had burning eyes, nose or throat, 18% had nausea or stomach problems, 17% had eczema, 9% had fatigue and 9% experienced dizziness or fever as a result of chemical exposure. These are, therefore, not insignificant reactions.

Further, 8.4% of hypersensitive males and 15.7% hypersensitive females considered that their symptoms were moderate to severe.

In response to the question, “Have you received any medical treatment for your chemical sensitivity?”, 15.3% of males and 31.9% of females within the hypersensitive subset answered in the affirmative. Together, this represents an overall 4.3% of the total population seeking medical treatment due to chemical sensitivity. This is similar to the 6.7% reported by others (Caress & Steinemann 2003).

To ascertain more specifically the chemical triggers involved, respondents who identified with hypersensitivity were asked about specific chemical classes. Data in Table 4 indicate, first, that many individuals were affected by more than one chemical (and, therefore, could be undiagnosed MCS cases), and second, that a wide range of common environmental agents must be avoided to reduce risk of adverse reaction.

Given that MCS is a controversial area of environmental medicine, a final question was put to Phase II non-MCS respondents: “Do you agree or disagree with the following statement? “Chemical sensitivity

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
</table>
| Were you under any particular stress at the time when you first developed symptoms of MCS? | 3/4 males Yes  
2/10 females Yes |
| Do you have any idea what initially caused your chemical sensitivity? | 11/14 Yes |
| To what extent does your condition affect your family or social life? | 5/14 To a great extent  
2/14 To some extent |

Table 2: MCS-specific questions in Phase II

Table 3: Phase I data on general chemical hypersensitivity

<table>
<thead>
<tr>
<th>Is your health seriously affected by exposure to any of the following?</th>
<th>% males</th>
<th>% females</th>
<th>% total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfume</td>
<td>4.5</td>
<td>9.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Traffic pollution</td>
<td>5.3</td>
<td>6.4</td>
<td>5.9</td>
</tr>
<tr>
<td>Household chemicals</td>
<td>2.8</td>
<td>8.2</td>
<td>5.6</td>
</tr>
<tr>
<td>Workplace chemicals</td>
<td>7.2</td>
<td>5.2</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Notes:
1 Based on 2007 people interviewed
is a valid health condition with valid symptoms.” An overwhelming 86% agreed or strongly agreed with this statement. This may augur well for achieving success when those with MCS or chemical hypersensitivity seek understanding from the wider community and when plans are implemented to reduce specific chemical exposures in the community.

**Conclusion**

These two population-based surveys reveal a self-reported MCS prevalence in South Australia of about 1% and also indicate that about 16% of the adult population identifies as having some chemical hypersensitivity. Since there are no diagnostic or clinical guidelines for MCS in Australia, it is possible that the 1% MCS prevalence is an under-reporting, and that some chemically hypersensitive individuals have symptomology more aligned with that of MCS cases. The prevalence of hypersensitivity and the severity of symptoms suggest an adverse effect of common environmental chemicals in a significant portion of the population.

**Acknowledgments**

The author acknowledges Sam Mangas for technical assistance; Peter Evans and Cathie Powell who assisted with question design in Phase II; and staff of the Department of Health’s Population Research & Outcome Studies Unit who aided study execution and statistical analysis.

**References**


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Adelaide, South Australia, 5000
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Survey of Metal Contaminants in the Effluent Generated by Three Factories in Lubumbashi, Democratic Republic of the Congo

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¹Chemistry Department, Faculty of the Sciences, University of Lubumbashi, RDC, & ²Industrial Chemistry Department, Faculty of Applied Sciences, University of Lubumbashi

A preliminary assessment of the quality of three significant discharges (Snc-Lavalin International 2003) to the Kafubu River has been undertaken with a view to assessing the environmental impacts on the ecosystem of the river. Indeed, the liquid wastes from three metallurgic factories discharge directly into the river. The three factories are: The Society for the Treatment of the Slagheap of Lubumbashi (STL), Gecamines (GCM), and Nova Mining. This survey measured metals in the liquid wastes at the point of their exit from the factories. At the end of the survey, the results indicated that the effluent presented potential risks for pollution of the environment. Thus, results for STL effluent analysis showed elevated levels for cobalt (0.005-0.036 mg/L) and lead (0.07-0.154 mg/L) and the same for the effluent from GCM, whereas the results for Nova Mining showed elevated levels for manganese (1.261 mg/L), cobalt (0.139-0.267 mg/L), copper (0.323 mg/L) and iron (0.374 mg/L). A complementary study, investigating the levels of metal contaminants in the receiving environment for the effluent, is needed to assess the degree of the contamination of the ecosystem of the Kafubu River due to effluent from these factories. Further research is required to assess the water quality of the Kafubu River and its ecosystem.

Key words: Metals; Contaminants; Effluent; Pollution

The artisan exploitation of mineral ores, such as copper, cobalt or gold, has been common for many years in the Katanga Province. Some small mining and metallurgic industries across the Province invest in the treatment of ores. These industries give work to a number of local people. The development of these new industries raises problems with regard to the management of the environment due to the pollutants associated with mining processes (Emmanuel 2003). The environmental concerns are in relation to the threat of pollution (Calamari & Naeve 1994) of air, water and soil due to the effluent coming from these industries, as well as their impact on the receiving ecosystems. The threat of pollution of the water tables by mineral substances due to industrial activity has previously been reported (Kakoma 2004). These water tables provide water to a large part of the population of the city of Lubumbashi (Twite 2004). Indeed, the population living in the villages that border the Kafubu River complain about the poor quality of the water (Gazette de Lubumbashi 2006), as do the people in the city of Lubumbashi and its vicinity (Kakoma 2004; Twite 2004). There is concern that water might be contaminated by the industrial waste that some industries release there and the practice some artisan mining operators have of washing ores in the river (RNN
Survey of Metal Contaminants in Effluent

Materials and Methods

This study was conducted over the period May to September 2006. During this time the concentrations of copper, cobalt, manganese, iron, nickel and lead in the effluent coming from Nova Mining, STL and GCM were measured. This study also measured the pH, electrical conductivity and the salinity of the effluent. These results represent the average values of four analyses done each month at the exit point of the effluent from the industries central to our research. The determination of the content of metal contaminants has been made using a spectrophotometer UV-Visible DR 2000 and also an atomic absorption spectrophotometer Perkin Elmer 2280. The pH and the electric conductivity of the effluent have been determined by measurements in solution using a spectrophotometer UV-Visible DR 2000. The effluent samples from the factories were collected in polyethylene bottles of 500mL and acidified with concentrated nitric acid until they reached a pH below 2 for the analysis of the mineral pollutants. As solutions of standardisation for the analysis, distilled water, the aqueous solutions of known concentrations of mineral elements of interest and the samples of effluent have been used. The interpretation of the results has been done while using the EU and the Congolese guidelines (Journal Officiel de la RDC, 2003) for the protection of an aquatic environment against the pollution by liquid effluent (Kalenga et al. 2006; Moll 1999-2006; Plea et al. 2004) and the Canadian Metal Mining Liquid Effluent Regulations (MMLER) (Canada Gazette 2002).

Results and Discussion

Concentrations of metal contaminants contained in the effluent from Nova Mining

The effluent samples coming from the factories were submitted during five months to four one-per-month
physicochemical analyses. The results of the effluent samples from Nova Mining are presented in Table 1. The analysis of these results revealed that the concentration of manganese observed during the month of August (1.261mg/L) was above the levels recommended by the Congolese mining regulation for liquid effluent (Kalenga et al. 2006). When using only the Congolese mining regulation, the results also indicate that the concentrations in other metal contaminants (Cu, Fe, Co, Ni and Pb) contained in the effluent produced by the Nova Mining present no risk of pollution of the surface waters. In relation to the European guidelines for liquid effluent (Kalenga et al. 2006), our results indicate that the concentrations of cobalt (0.058-0.331mg/L) and iron (0.374mg/L) sometimes exceeded the recommended values. However, the other contaminants remained below safe levels defined by the EU guidelines (Kalenga et al. 2006). In the effluent from the STL factory, the concentrations of lead and nickel are below values permitted in toxic substances for the Canadian Regulation for effluent from metals mines (Canada Gazette 2002), which fix the limits of concentration to 0.20mg/L for lead and to 0.50mg/L for nickel, respectively. Indeed, the nickel contained in the effluent samples varied from 0.0320 to 0.204 mg/L at the time of our investigation. The lead concentrations varied from 0.001 to 0.014 mg/L.

Concerning the analyses carried out for the determination of pH, electrical conductivity and the salinity of the effluent, results are provided in Tables 1, 2 and 3. These results showed that the pH of the effluent from Nova Mining remained basic and their electric conductivities were compatible with the guidelines for liquid effluent (Lenntech 1998-2005). This observation is also true for the other effluent samples as far as their salinities are concerned. Thus, they do not present any risk to the soil, especially in the arable areas where the water could be absorbed, since the maximal limit of conductivity does not exceed 0.75dS/m or 750µS/cm (Lenntech 1998-2005). However, on one hand, it is during the month of August that a strong salinity has been noted in the effluent samples and in particular in those from Nova Mining. On the other hand, the effluent from Nova Mining, although having presented values of electrical conductivity of 324.3 and 338µS/cm during the first and the last month of the observation, its mineral load showed important variations during the intermediate months. Indeed, after reaching a minimum of 265µS/cm in the month of June, the conductivity reached a maximum of 711µS/cm in the month of August. This increase in the

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cu (mg/L)</th>
<th>Co (mg/L)</th>
<th>Fe (mg/L)</th>
<th>Mn (mg/L)</th>
<th>Ni (mg/L)</th>
<th>Pb (mg/L)</th>
<th>pH</th>
<th>EC (µS/cm)</th>
<th>TDS (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2006</td>
<td>0.185</td>
<td>0.331</td>
<td>0.109</td>
<td>0.267</td>
<td>0.147</td>
<td>0.014</td>
<td>8.10</td>
<td>324.3</td>
<td>208</td>
</tr>
<tr>
<td>June 2006</td>
<td>0.089</td>
<td>0.054</td>
<td>0.101</td>
<td>0.051</td>
<td>0.068</td>
<td>0.012</td>
<td>7.07</td>
<td>265</td>
<td>170</td>
</tr>
<tr>
<td>July 2006</td>
<td>0.08</td>
<td>0.058</td>
<td>0.374</td>
<td>0.053</td>
<td>0.032</td>
<td>0.009</td>
<td>9.11</td>
<td>387</td>
<td>248</td>
</tr>
<tr>
<td>August 2006</td>
<td>0.323</td>
<td>0.301</td>
<td>0.072</td>
<td>1.261</td>
<td>0.204</td>
<td>0.003</td>
<td>9.13</td>
<td>711</td>
<td>455</td>
</tr>
<tr>
<td>September 2006</td>
<td>0.11</td>
<td>0.289</td>
<td>0.065</td>
<td>0.153</td>
<td>0.075</td>
<td>0.001</td>
<td>8.07</td>
<td>338</td>
<td>216</td>
</tr>
</tbody>
</table>

Notes:
1. EU guidelines for liquid effluent (MOLL, D. 1999-2006)
2. Above EU guidelines for liquid effluent (1mg/L)
Survey of Metal Contaminants in Effluent

The results of the analysis of the effluent from STL are reported in Table 2. At first glance, it can be seen that concerning Congolese mining regulations, effluent produced by STL presents no risk of pollution of the surface waters. Indeed, no metal contaminant met within has a concentration above the norm. In relation to the European guidelines for liquid effluent (Kalenga et al. 2006), only the concentrations of cobalt (0.036mg/L) and lead (0.07-0.154mg/L) were above the recommended limits during the month of June and one at the end of August.

The analysis of the results reported in Tables 2 and 3 also suggests that the mineral loads of the effluent from STL and GCM behaved similarly during the period under study. They displayed values of electrical conductivity in the range of 300 to 500µS/cm during the whole length of the observation. In July, after a regular decrease, a rise of conductivity was recorded. This rise of the electrical conductivity continued until a maximum of 402 and 485µS/cm in the month of August was reached for the two types of effluent. It is interesting to note that the electric conductivity of the effluent of STL remained above that of GCM. There is a large degree of similarity between the variations of their salinity (TDS) that remain in the range of 200 to 350 mg/L whereas variations (Table 1) in the salinity of effluent from the Nova Mining factory

**Table 2: Concentration of contaminants in the effluent from STL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Time (month)</th>
<th>Cu (mg/L)</th>
<th>Co (mg/L)</th>
<th>Fe (mg/L)</th>
<th>Mn (mg/L)</th>
<th>Ni (mg/L)</th>
<th>Pb (mg/L)</th>
<th>pH</th>
<th>EC (µS/cm)</th>
<th>TDS (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2006</td>
<td>0.121</td>
<td>0.003</td>
<td>0.044</td>
<td>0.047</td>
<td>0.224</td>
<td>0.036</td>
<td>8.39</td>
<td>364</td>
<td>233</td>
<td></td>
</tr>
<tr>
<td>June 2006</td>
<td>0.115</td>
<td>0.036</td>
<td>0.06</td>
<td>0.039</td>
<td>0.126</td>
<td>0.147</td>
<td>7.90</td>
<td>325</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>July 2006</td>
<td>0.182</td>
<td>0.005</td>
<td>0.066</td>
<td>0.064</td>
<td>0.016</td>
<td>0.07</td>
<td>8.72</td>
<td>323</td>
<td>207</td>
<td></td>
</tr>
<tr>
<td>August 2006</td>
<td>0.103</td>
<td>0.004</td>
<td>0.021</td>
<td>0.026</td>
<td>0.037</td>
<td>0.154</td>
<td>7.69</td>
<td>402</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>September 2006</td>
<td>0.119</td>
<td>0.004</td>
<td>0.061</td>
<td>0.042</td>
<td>0.071</td>
<td>0.007</td>
<td>7.86</td>
<td>398</td>
<td>258</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. EU guidelines for liquid effluent (Kalenga, N.M et al. 2006).

**Table 3: Concentration of contaminants according to time in the GCM effluent**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Time (month)</th>
<th>Cu (mg/L)</th>
<th>Co (mg/L)</th>
<th>Fe (mg/L)</th>
<th>Mn (mg/L)</th>
<th>Ni (mg/L)</th>
<th>Pb (mg/L)</th>
<th>pH</th>
<th>EC (µS/cm)</th>
<th>TDS (mg/L)</th>
</tr>
</thead>
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<tr>
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<td>0.003</td>
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</tr>
<tr>
<td>June 2006</td>
<td>0.115</td>
<td>0.036</td>
<td>0.06</td>
<td>0.039</td>
<td>0.126</td>
<td>0.147</td>
<td>7.90</td>
<td>325</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>July 2006</td>
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<td>0.005</td>
<td>0.066</td>
<td>0.064</td>
<td>0.016</td>
<td>0.07</td>
<td>8.72</td>
<td>323</td>
<td>207</td>
<td></td>
</tr>
<tr>
<td>August 2006</td>
<td>0.103</td>
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<td>0.021</td>
<td>0.026</td>
<td>0.037</td>
<td>0.154</td>
<td>7.69</td>
<td>402</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>September 2006</td>
<td>0.119</td>
<td>0.004</td>
<td>0.061</td>
<td>0.042</td>
<td>0.071</td>
<td>0.007</td>
<td>7.86</td>
<td>398</td>
<td>258</td>
<td></td>
</tr>
</tbody>
</table>
were between 150 and 460 mg/L with a minimum of 170mg/L in the month of June and a maximum of 455mg/L in the month of August.

**Conclusion**

This preliminary investigation has shown that the effluent produced by these three industries, and considering their content of mineral origin: notably concentrations of cobalt and lead for STL of 0.005-0.036mg/L Co, 0.07-0.0154mg/L Pb; for GCM cobalt and lead concentrations of 0.139-0.267mg/L Co, 0.073-0.096mg/L Pb; for Nova Mining levels of manganese of 1.261mg/L, of cobalt of 0.058-0.331mg/L, of copper of 0.323mg/L, and of iron of 0.374mg/L, currently present a risk of pollution of the environment. But a complementary research study will be necessary to assess the potential impact of the pollution of the water of the Kafubu River. This complementary research should study the development of the concentrations of different pollutants of mineral origin contained in the liquid wastes, according to the distance in relation to the point of fall, during their routes to the receiving environment. This research should take into account the impact of the chemical composition of the liquid wastes or their concentrations in pollutants, and other exogenous factors, such as seasonal variations and the contribution of pollutants due to the cleaning of ores in the rivers by artisan mining operators.

**Acknowledgments**

The authors thank Mr Lwangu Ngoy for his contribution to the completion of this survey; notably his participation in the sampling and analyses of the metal contaminants.

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Hazard Assessment of Surface Water Contaminants Near Pulp and Paper Mills in Pelalawan District, Province of Riau, Indonesia

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To assess the potential hazard of surface water contaminants near pulp and paper mills, 30 water quality parameters were quantified. Grab samples of surface water were collected in August 2006 from 7 sampling sites at Kampar River, in the Province of Riau, and analysed by an accredited laboratory using Indonesian Standard (SNI) methods. Numerical values of each water quality parameter were compared with the existing legal standard (PP 82/2001) and transformed into a Control Chart with UWL/LWL and UCL/LCL set at ± 2 SD and ± 3 SD, respectively, to give the ecological tendency of the river water. Control Charts of water quality parameters show that the current concentration of water contaminants exceeding the legal standard (PP 82/2001) could be tolerated as the highest levels were not above the corresponding Upper Control Limits. Kampar River could be mostly neutralised although Chemical Oxygen demand (COD), boron, oil and grease, surfactant, and chloroform tend to increase as you move from the upper levels to downstream of the rivers. In addition, the immediate influence of wastewater from the pulp and paper mills is observed by the elevation of TSS, phosphate, and nitrate levels and a decreasing oxygen level just downstream of the effluent discharge site. While the COD level tends to increase, phosphate and nitrite concentrations drop off and oxygen levels increase to the initial levels from the upper levels to downstream in the Kampar River. It is concluded that wastewater effluent of pulp and paper mills can be tolerated by the existing aquatic system of the Kampar River. It has been demonstrated also that the Control Chart technique is more sensitive to evaluate environmental hazard than conservative legal appraisal.

Key words: Pulp and Paper Mills; Surface Water; Chemical Hazard; Control Chart

The pulp and paper industries in Indonesia have contributed to the Indonesian economy in foreign exchange and finance, job provision, and the development of other economic sectors associated with industry, particularly in pulp and paper production. However, pulp and paper mills always create inevitable impacts on human health and the environment, which in principle cannot be eliminated but can only be managed. The environmental issues of pulp and paper mills are generally derived from raw materials handling, such as cutting wood, transport, and storage. Then there are the problems arising from chipping, production processes, product storage, solid and liquid wastes and gas emission, and products’ transport, use, and disposal leading to air, water, and soil pollution. The pollution can be detrimental to the environment and lead to its deterioration and in turn impact on
human health through various modes of exposure or contact.

Pulp and paper production consists of pulping and paper making processes. Pulping of wood chips consists of wood preparation by cooking, washing, bleaching, and eventually finishing by producing pulp sheet. Of these steps, wood chip cooking, washing and bleaching are critical to the environment and human health due to the extensive use of chemicals.

Based on the process of pulp and paper production as described in the 2003 AMDAL document, pulp and paper mills have a potential impact directly on air and water quality. Hazardous chemicals in wastewater effluent potentially impact human health and the aquatic ecosystem. These chemicals originate largely from the wood chip pulping and bleaching processes. Even though the Minister for the Environment has standardised the effluent by pH, BOD, COD, TSS, and Maximum Waste Debit by Kep-51/MENLH/10/1995 on the Wastewater Standard for Industrial Activities (MenLH 1995), some bleaching by-products are not regulated. The bleaching by-products including chlorinated organic compounds are critical since most of them are carcinogens or mutagens. However, for the drinking water ingestion pathway, the chlorinated organic compounds’ intake might not be significant since these contaminants are partially, if not totally, evaporated during boiling. Other exposure routes such as bathing and washing are also important pathways. By these exposure pathways, hazardous chemicals of concern might be shifted from carcinogen or mutagen-related compounds to those responsible for skin cleanliness. Toxic metals and associated agents are of importance in dermal complaints.

The residential community could have concerns about wastewater effluent. Although the wastewater possibly has been appropriately treated before discharge, its physical appearance might indicate that the wastewater is not completely safe to human health and the environment. Using contaminated water for domestic purposes is usually considered to be responsible for skin problems and other waterborne diseases. Yet, currently reproductive effects of wastewater effluent might not of community health concern. However, as these effects usually have a long latency period, associated health consequences with carcinogens or mutagens and related chemicals are regarded also as of potential community health concern.

Although the chemicals from pulp and paper mills that might be responsible for reproductive disruption are unknown, a prospective study indicated that menstrual cycle function and early pregnancy loss in reproductive age women, 18-39 years old, were associated with drinking some by-products of water chlorination (Windham et al. 2003). This study investigated the reproductive effects of the consumption of tap water containing trihalomethanes (THM) as chlorination by-products of drinking water disinfection. It was found that tap water consumption reduces the menstrual cycle length with increasing THM exposure. Some previous studies reported that consumption of THM-containing tap water was associated with increasing spontaneous abortion (Neutra et al. 1992; Swan et al. 1992; Swan et al. 1998; Windham et al. 1992). So far, the effects of halo-organic compounds generated from pulp and paper mills on human reproductive health have not been studied extensively.

Wastewater from pulp and paper mills is of significant concern. Recent toxicity studies have indicated reproductive abnormalities in freshwater fishes exposed to wastewater effluent. In Pearl River at Bogalusa, Los Angeles, in the United States, a reproductive disruption in wild longear sunfish (Lepomis megalotis) exposed to the
Kraft Mill effluent was observed (Fentress et al. 2006). Female fish testosterone and vitellogenin levels (both are sex steroid hormones) were suppressed, although male reproductive physiology was not affected and masculinisation was not observed.

Similar consideration should also be given to water pollutants at sites where an ‘at risk’ population is exposed. Wastewater chemicals of concern by type, media, and concentration might be limited mostly to those having direct exposure to water use such as drinking, washing, or bathing. Indirect exposure, for example, through the food chain, such as fish consumption, is of significance if its existence in the corresponding environmental media can be identified and accurately quantified.

Adverse health effects associated with particular environmental agents were defined using decision logic as depicted in Figure 1, showing that a particular health outcome could be logically traced from the physicochemical and biological properties of the environmental agents.

**Purpose and Objectives**

To prevent air pollution from industrial activities including pulp and paper mills, the Minister for the Environment has enacted a ministerial decision of Kep-51/MENLH/10/1995, which regulates BOD, COD, TSS, pH, and Maximum Waste Debit as wastewater parameters. The purpose of the study is intended to present actual and potential human health risks, the management options to prevent, handle, and remediate those risks, and risk communication to support management implementation through the engagement and involvement of the community.

The ultimate goal of the study is to help to protect the environment and human health from the adverse impact...
of exposure to contamination from pulp and paper mills. From this, it is hoped that a critical mass of productive people with optimal health status can live in a healthy environment. This can perhaps be achieved by managing appropriately the physical and social environmental risk factors. The success of these aims is dependent on the achievement of the objective to assess the potential hazards of surface water contaminants near pulp and paper mills.

**Method**

For water quality parameters refer to Attachment B.V of the Minister for the Environment’s decision of Kep-51/MENLH/10/1995 on the Wastewater Standard for Industrial Activities and Class B water of the PP 82/2001. These parameters were TDS, TSS, pH, BOD, COD, DO, PO$\text{4}^{3-}$, NO$\text{3}^{-}$, NH$_3$, As, Co, Ba, B, Se, Cd, Cr(VI), Cu, Fe, Pb, Mn, Hg, Zn, Cl$^{-}$, CN$^{-}$, F$^{-}$, NO$\text{2}^{-}$, SO$\text{4}^{2-}$, Cl$_2$, S$_2$, fecal coliform, total coliform, grease and oil, detergent, and phenol. Radioactivity parameters are excluded since radioactive substances are not used in pulp and paper mills.

Surface water samples were collected from seven sites and these are shown in Table 1. It should be noted that water samples from upstream were required to know whether or not the wastewater effluent has a significant impact on the river water.

Water samples were collected during the daytime from July to September 2006. The analyses were conducted by accredited laboratories. The water analysis quality analysis methods were adopted mostly from Standard Methods for the Examination of Water and Wastewater (Clesceri et al. 1998). All original results of air and water quality analyses, officially in Bahasa Indonesia are signed by the relevant authority.

**Results and Discussion**

For AMDAL documentation of water quality refer to Class water of PP No. 82.2001 (RI 2001). Environmental quality is conventionally evaluated using environmental standards or guidelines. In most instances, this technique is not sufficient to recognise environmental changes if the standards or guidelines are not exceeded. Alternatively, environmental quality can be evaluated using a Control Chart, one of seven control measures commonly used in quality improvement techniques. It was first introduced in 1924 by Walter Andrew Stewart of US Bell Telephone Laboratories to eliminate abnormal variation by separating special and common causes (Miller & Miller 1995).

Since environmental quality is a dynamic product of ecological processes, the quality can be measured by a Control Chart. Of the environmental quality measured, surface water parameters, summarised in Table 2, are eligible for Control Chart construction. Air quality cannot be evaluated by Control Chart since the sampling sites do not reflect ambient ecosystem as water does. Similarly, groundwater quality is not appropriate for Control Chart construction due to inadequate data points.

Based on statistical requirements, there were 30 parameters included for the Control Chart construction. Temperature is less meaningful for water

<table>
<thead>
<tr>
<th>Code</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>SWS1</td>
<td>water intake</td>
</tr>
<tr>
<td>SWS2</td>
<td>upstream of waste-water effluent</td>
</tr>
<tr>
<td>SWS3</td>
<td>around wastewater effluent</td>
</tr>
<tr>
<td>SWS4</td>
<td>downstream of waste-water effluent</td>
</tr>
<tr>
<td>SWS5</td>
<td>Pelalawan village</td>
</tr>
<tr>
<td>SWS6</td>
<td>upstream of Port</td>
</tr>
<tr>
<td>SWS7</td>
<td>downstream of Port</td>
</tr>
</tbody>
</table>
quality parameters unless expressed as temperature deviation between air and water. Arsenic, barium, selenium, lead, mercury, dichlorobromomethane, dibromochloromethane, and bromoform were excluded due to incomplete data. The Control Chart requires construction of integer numerical values. Therefore, parameters with more than one ‘not detected’ (ND) data point cannot be computed to construct a Control Chart. In addition, concentrations expressed as ‘<n’ (n is an integer) cannot be actually subjected to Control Chart construction.

Table 2: Water quality parameters of surface waters in Pelalawan District, Province of Riau, Indonesia, 2006

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Standard±</th>
<th>SWS1</th>
<th>SWS2</th>
<th>SWS3</th>
<th>SWS4</th>
<th>SWS5</th>
<th>SWS6</th>
<th>SWS7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TDS</td>
<td>1000 mg/L</td>
<td>19</td>
<td>13</td>
<td>1,520</td>
<td>1,450</td>
<td>24</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>TSS</td>
<td>50 mg/L</td>
<td>9.5</td>
<td>16</td>
<td>23</td>
<td>26</td>
<td>4</td>
<td>33</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>pH</td>
<td>6 – 9</td>
<td>6.0</td>
<td>6.0</td>
<td>7.6</td>
<td>7.6</td>
<td>6.2</td>
<td>5.2</td>
<td>5.2</td>
</tr>
<tr>
<td>4</td>
<td>BOD</td>
<td>3 mg/L</td>
<td>1.3</td>
<td>16</td>
<td>17</td>
<td>15</td>
<td>12</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>COD</td>
<td>25 mg/L</td>
<td>8.2</td>
<td>29</td>
<td>30</td>
<td>28</td>
<td>28</td>
<td>40</td>
<td>63</td>
</tr>
<tr>
<td>6</td>
<td>DO</td>
<td>4 mg/L</td>
<td>3.5</td>
<td>3.8</td>
<td>2.5</td>
<td>0.9</td>
<td>3.2</td>
<td>3.3</td>
<td>2.94</td>
</tr>
<tr>
<td>7</td>
<td>PO₄³⁻</td>
<td>0.2 mg/L</td>
<td>0.01</td>
<td>0.4</td>
<td>0.99</td>
<td>1.16</td>
<td>0.25</td>
<td>0.76</td>
<td>0.83</td>
</tr>
<tr>
<td>8</td>
<td>N-NO₃⁻</td>
<td>10 mg/L</td>
<td>0.45</td>
<td>0.418</td>
<td>3.478</td>
<td>4.022</td>
<td>0.3527</td>
<td>0.047</td>
<td>0.007</td>
</tr>
<tr>
<td>9</td>
<td>N-NH₃⁻</td>
<td>(-) mg/L</td>
<td>0.12</td>
<td>0.2</td>
<td>0.32</td>
<td>0.24</td>
<td>0.1</td>
<td>0.27</td>
<td>0.18</td>
</tr>
<tr>
<td>10</td>
<td>Co</td>
<td>0.2 mg/L</td>
<td>&lt;0.02</td>
<td>0.01</td>
<td>0.1</td>
<td>0.001</td>
<td>0.001</td>
<td>ND</td>
<td>0.01</td>
</tr>
<tr>
<td>11</td>
<td>B</td>
<td>1 mg/L</td>
<td>&lt;0.01</td>
<td>0.6</td>
<td>0.9</td>
<td>0.7</td>
<td>0.9</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Cd</td>
<td>0.01 mg/L</td>
<td>&lt;0.003</td>
<td>0.002</td>
<td>0.015</td>
<td>0.013</td>
<td>0.009</td>
<td>0.001</td>
<td>ND</td>
</tr>
<tr>
<td>13</td>
<td>Cu</td>
<td>0.05 mg/L</td>
<td>&lt;0.01</td>
<td>0.2</td>
<td>0.18</td>
<td>0.14</td>
<td>0.03</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>14</td>
<td>Fe</td>
<td>0.02 mg/L</td>
<td>&lt;0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>ND</td>
<td>0.02</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>15</td>
<td>Mn</td>
<td>(-) mg/L</td>
<td>0.41</td>
<td>0.93</td>
<td>1.02</td>
<td>0.352</td>
<td>1.009</td>
<td>0.698</td>
<td>0.75</td>
</tr>
<tr>
<td>16</td>
<td>Zn</td>
<td>0.05 mg/L</td>
<td>&lt;0.02</td>
<td>0.58</td>
<td>1.17</td>
<td>1.15</td>
<td>0.4</td>
<td>0.048</td>
<td>0.055</td>
</tr>
<tr>
<td>17</td>
<td>B</td>
<td>1 mg/L</td>
<td>&lt;0.01</td>
<td>0.6</td>
<td>0.9</td>
<td>0.7</td>
<td>0.9</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>CN⁻</td>
<td>0.02 mg/L</td>
<td>&lt;0.005</td>
<td>0.008</td>
<td>0.005</td>
<td>0.001</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>19</td>
<td>F⁻</td>
<td>1.5 mg/L</td>
<td>&lt;0.01</td>
<td>0.03</td>
<td>0.74</td>
<td>0.72</td>
<td>0.11</td>
<td>0.15</td>
<td>0.11</td>
</tr>
<tr>
<td>20</td>
<td>Cu</td>
<td>0.06 mg/L</td>
<td>&lt;0.002</td>
<td>0.022</td>
<td>0.035</td>
<td>0.033</td>
<td>0.024</td>
<td>0.039</td>
<td>0.043</td>
</tr>
<tr>
<td>21</td>
<td>SO₄²⁻</td>
<td>(-) mg/L</td>
<td>&lt;0.3</td>
<td>5.919</td>
<td>286.69</td>
<td>277.75</td>
<td>7.744</td>
<td>22</td>
<td>26</td>
</tr>
<tr>
<td>22</td>
<td>S-H₂S</td>
<td>0.002 mg/L</td>
<td>&lt;0.002</td>
<td>0.034</td>
<td>0.249</td>
<td>0.247</td>
<td>0.037</td>
<td>0.161</td>
<td>0.33</td>
</tr>
<tr>
<td>23</td>
<td>FeCl₂</td>
<td>0.03 mg/L</td>
<td>&lt;0.01</td>
<td>0.05</td>
<td>0.15</td>
<td>0.12</td>
<td>0.04</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>24</td>
<td>Fecal Coliform</td>
<td>10² colony/100 mL</td>
<td>0</td>
<td>35,000</td>
<td>15,000</td>
<td>17,000</td>
<td>4,600</td>
<td>11,000</td>
<td>790</td>
</tr>
<tr>
<td>25</td>
<td>Total Coliform</td>
<td>10² colony/100 mL</td>
<td>0</td>
<td>54,000</td>
<td>51,000</td>
<td>54,000</td>
<td>7,000</td>
<td>16,000</td>
<td>2,800</td>
</tr>
<tr>
<td>26</td>
<td>Oil and Grease</td>
<td>1 mg/L</td>
<td>&lt;0.2</td>
<td>1,600</td>
<td>1,456</td>
<td>915</td>
<td>1,155</td>
<td>28</td>
<td>51</td>
</tr>
<tr>
<td>27</td>
<td>Surfactant</td>
<td>0.2 mg/L</td>
<td>0.04</td>
<td>221</td>
<td>136</td>
<td>36.1</td>
<td>70.5</td>
<td>181</td>
<td>156</td>
</tr>
<tr>
<td>28</td>
<td>Phenol</td>
<td>0.001 mg/L</td>
<td>&lt;0.001</td>
<td>0.09</td>
<td>0.767</td>
<td>0.5</td>
<td>0.1</td>
<td>0.17</td>
<td>0.12</td>
</tr>
<tr>
<td>29</td>
<td>CHCl₃</td>
<td>(-) mg/L</td>
<td>0.002</td>
<td>0.0012</td>
<td>0.0012</td>
<td>0.0014</td>
<td>0.0015</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Source: Abadi, E.K, 2007

Notes:
1. Governor of Riau regulation of No. 23 of 2003 for Class II water; numerically the same as PP of No. 82/2001; (-) = not regulated. SWS1 = water intake for pulp and paper mills; SWS2 = upstream of wastewater effluent; SWS3 = around wastewater effluent; SWS4 = downstream of wastewater effluent; SWS5 = Pelalawan village; SWS6 = upstream of Port; SWS7 = downstream of Port; ND = not detected.
Yet, in order to understand ecological influences on existing water quality, the ‘<\text{n}’ values were included as n values with caution. However, parameters with more than one ‘<\text{n}’ data point were excluded as the constructed Control Chart gives no sense of ecological features.

The procedure to construct the Control Chart has been described elsewhere (Rahman et al. 2004) and all constructed Control Charts are presented in Appendix A. For sampling site codes refer to Table 1 above.

Control Charts of surface water quality parameters are interpreted ecologically. The Control Chart consists of Mean, 2 pairs of 2 Standard Limits (2.0SL and -2.0SL), and 2 pairs of 3 Standard Limits (3.0SL and -3.0SL). Mean value is simply an arithmetic mean of observed data points, while Standard Limit is Standard Deviation of observed data points statistic. In quality improvement, 2SL and 3SL are called Warning Limit and Control Limit, respectively. The most important feature of the Control Chart is Control Limit. This limit is considered as the natural tolerance of the system. Numerical values outside the Control Limit indicate that the system cannot naturally tolerate any more pollution load. Consequently, cause variations should be controlled to make certain the process is in the best condition. Warning Limit, on the other hand, gives the signal that the process is probably going to get worse, although control action is not necessary.

Except COD, iron, oil and grease, detergent or surfactant, and chloroform, generally, the constructed Control Charts of surface water parameters show a similar tendency in that the concentration of chemicals or the quantity of microorganisms increase after receiving wastewater effluent, then decrease so that they are approaching the initial level. COD, iron, oil and grease, detergent or surfactant, and chloroform tend to increase, as shown in Graph 5 (COD as an example). This tendency suggests that domestic activities may contribute somewhat more than industry. However, except COD all parameters have not exceeded the corresponding Control Limit so no action was required in controlling them. In other words, the impact of wastewater effluent can be naturally tolerated by the existing aquatic ecosystem.

In the constructed Control Charts, the impact of wastewater effluent can be observed from the increasing level of the surface water parameters at SWS3 (around wastewater effluent in Sering) where the wastewater is discharged to the water body. Of the 30 parameters quantified (Table 2), only chromium, cyanide, fecal coliform, total coliform, oil and grease, and surfactant, are not influenced by wastewater effluent. Specifically, the immediate impact is observed in the elevation of TSS, phosphate, nitrate and chloroform, and the fall in the oxygen level. However, except COD, iron, grease and oil, and surfactant this influence can be self minimised as demonstrated by decreasing the phosphate and nitrite concentrations to initial levels.

The Control Chart of COD shows a specific characteristic of the aquatic system. The COD level increased as the water flows away from the wastewater effluent, although its Control Limit had not been exceeded. Since the COD represents the quantity of chemicals in water, this characteristic implies an increasing cumulative contribution of chemicals in the system. From an ecological point of concern, the chemicals that might be responsible for COD elevation might include phosphate, nitrite, grease and oil, detergent or surfactant, and chloroform as previously mentioned. From a legal perspective, 50% of Control Chart-constructed parameters, or about 23% of all quantified parameters, do not completely comply with the Class II water quality standard. It includes TDS,
Dewi Susanna and Abdur Rahman

Table 3: Critical water quality parameters generated from ecological and legal evaluations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ecological (Control Chart)</th>
<th>Legal (PP No. 82/2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS</td>
<td>Worse warning at SWS3 and SWS4; decreasing tendency to down stream</td>
<td>Exceeds standard at all sites except SWS1</td>
</tr>
<tr>
<td>TSS</td>
<td>Worse warning at SWS4, decreasing tendency to down stream</td>
<td>No legal disobedience</td>
</tr>
<tr>
<td>BOD</td>
<td>Decreasing tendency to down stream</td>
<td>Exceeds standard at all sites except SWS1</td>
</tr>
<tr>
<td>COD</td>
<td>Little elevation tendency to down stream</td>
<td>Exceeds standard at all sites except SWS1</td>
</tr>
<tr>
<td>DO</td>
<td>Deteriorate by wastewater effluent</td>
<td>Exceeds standard at all sites</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Shows direct impact of wastewater effluent, but decreasing tendency to down stream</td>
<td>Exceeds standard except at SWS1</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Shows direct impact of wastewater effluent but decreasing tendency to down stream</td>
<td>No legal disobedience</td>
</tr>
<tr>
<td>Boron</td>
<td>Elevation tendency after wastewater effluent to down stream</td>
<td>No legal disobedience</td>
</tr>
<tr>
<td>Chromium</td>
<td>No ecological problem; tend to lower to down stream; tolerable</td>
<td>Exceeds standard except at SWS1 and SWS5</td>
</tr>
<tr>
<td>Copper</td>
<td>Warning limit at wastewater effluent site; decreasing tendency to down stream</td>
<td>Exceeds standard at SWS3, SWS6, and SWS7</td>
</tr>
<tr>
<td>Zinc</td>
<td>Approaching warning limit at wastewater effluent site; decreasing tendency to down stream</td>
<td>Exceeds standard at all sites</td>
</tr>
<tr>
<td>Nitrite</td>
<td>Elevation tendency to down stream</td>
<td>No legal disobedience</td>
</tr>
<tr>
<td>Free chlorine</td>
<td>No elevation tendency</td>
<td>Exceeds standard at SWS2 to SWS5</td>
</tr>
<tr>
<td>Sulfide</td>
<td>Approaching warning limit at wastewater effluent site; tendency to down stream</td>
<td>Exceeds standard at all sites except SWS1</td>
</tr>
<tr>
<td>Fecal coliform</td>
<td>Decreasing tendency to down stream</td>
<td>Exceeds standard except SWS1</td>
</tr>
<tr>
<td>Total coliform</td>
<td>Decreasing tendency to down stream</td>
<td>Exceeds standard except SWS1</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>Elevation tendency to down stream</td>
<td>Exceeds standard at all sites except SWS1</td>
</tr>
<tr>
<td>Detergent</td>
<td>No ecological problem</td>
<td>Exceeds standard at all sites except SWS1</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Not legally regulated</td>
<td>Elevation tendency to down stream</td>
</tr>
</tbody>
</table>

BOD, COD, DO, phosphate, chromium, copper, zinc, free chlorine, sulfide, fecal coliform, total coliform, oil and grease, and surfactant or detergent. While phosphate and detergent might originate from domestic uses as well, most substances might be exclusively generated from pulp and paper mills.

Specifically, DO and zinc levels have exceeded the standard at all sites while TDS, BOD, COD, phosphate, sulfide, fecal coliform, total coliform, oil and grease, surfactant, and phenol have at SWS2 to SWS7. Chromium, copper and free chlorine levels show an irregular exceeding characteristic. The standards
have been exceeded except at SWS1 and SWS5 for chromium and at SWS2 to SWS5 for free chlorine. Copper levels, on the other hand, have exceeded its standard at SWS3, SWS6, and SWS7. It is clear, however, that water quality evaluation from ecological and legal viewpoints gives different outcomes in terms of specific parameters and sampling sites. Table 3 summarises the evaluation outcomes, which is important for environmental monitoring and management.

The Control Chart technique has been applied previously to evaluate the water quality of Asahan River, North Sumatra (Rahman et al. 1998). It has been able to detect huge water quality changes due to pulp and rayon wastewater effluent, even though the legal standards had not been exceeded. It has been useful as well to evaluate unregulated critical parameters. For example, wastewater effluent has dramatically elevated the color unit to an intolerable level (exceeding the Upper Control Limit) whereas this parameter was not regulated by PP 20/1990 (RI 1990).

Similar evaluation techniques as applied in Asahan River (Rahman et al. 1998) are employed in the current study. As shown in Table 3, some parameters such as TSS, nitrate, boron, and nitrite are officially not of particular concern since the levels at all sampling sites do not exceed the legal standards. However, their Control Charts show that a more detrimental tendency occurs as the water flows. TSS, boron, and nitrite levels tend to rise while the water flows downstream. Although tolerable levels have not been exceeded yet, this tendency warns water quality management to prepare corrective action or, at least, maintain the existing levels. The Nitrate Control Chart, on the other hand, explicitly shows that wastewater effluent has directly resulted in the deterioration of the aquatic system. At the wastewater effluent site (SWS4), nitrate concentration approaches the maximum tolerable level (Upper Control Limit), although this impact drops off following water flow to downstream.

**Conclusion and Recommendations**

All the data sets have been thoroughly analysed and their meaning, importance, and comparison with other relevant study results discussed. It can be concluded that:

i. Generally concentrations of pollutants in the surface water are not of great concern. Current levels of water quality parameters exceeding the legal standard (PP 82/2001) can be tolerated by the existing aquatic system. However, COD, boron, iron, oil and grease, detergent or surfactant, and chloroform tend to increase following the water flow from upstream to downstream.

ii. Generally, wastewater effluent can be self-neutralised by the existing aquatic system. However, an immediate influence is observed in the elevation of TSS, phosphate, and nitrate levels and decreasing oxygen levels. While the COD levels continue to increase, phosphate and nitrate concentrations drop off and oxygen increases to initial levels as water flows from upstream to downstream.

iii. Wastewater effluent from the pulp and paper mills can be tolerated by the existing aquatic system of the Kampar River. It has been demonstrated also that the Control Chart technique is more sensitive for the evaluation of environmental hazards than perhaps the more conservative legal appraisal.
In addition to its success, the current study leaves some unfinished analyses, a discrepancy in results, and uninvestigated issues. To some extent these problems are due to incorrect initial data and information, improper methods and techniques, and, most importantly, to new findings as discussed. To address these issues, the study team recommends the following:

i. The impact of wastewater effluent on the body of water is monitored more frequently by measuring TSS, COD, DO, phosphate, nitrate, iron, boron, and chloroform at and downstream of wastewater effluent sites.

ii. The Community Involvement Forum, lead by officials from the Local Health Office Districts, should implement one of their key functions, that is to organise target populations eligible for a health survey for anthropometric exposure factors measurement, physical examination for disease diagnosis, and, if required, for biomarker sampling.

References
Abadi, E.K. 2007, Public Health Assessment (PHA) Study of Pulp and Paper Mills in Pelalawan and Siak Districts Provinsi Riau, Jakarta,


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Appendix A: Construction of Control Charts

Graph 1: Total dissolved solid (TDS) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 2: Total suspended solid (TSS) of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 3: pH of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 4: Biochemical oxygen demand (BOD) of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 5: Chemical oxygen demand (COD) of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 6: Dissolved oxygen (DO) of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 7: Total phosphate (PO$_4^{3-}$) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 8: Total nitrate (as nitrogen NO$_3^-$) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 9: Ammonia (as nitrogen NH₃) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 10: Cobalt (Co) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 11: Boron (B) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 12: Cadmium (Cd) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 13: Chromium (as Cr^{6+}) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 14: Copper (Cu) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006. (Site SWS4 = not detected)
Graph 15: Iron (Fe) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 16: Manganese (Mn) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 17: Zinc (Zn) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 16: Chloride (Cl⁻) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
**Graph 19:** Cyanide (CN⁻) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

**Graph 20:** Fluoride (F⁻) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 21: Nitrite (as nitrogen $\text{NO}_2^-$) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 22: Sulfate ($\text{SO}_4^{2-}$) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 23: Free chlorine ($\text{Cl}_2$) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 24: Reduced sulfur (as $\text{H}_2\text{S}$) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 25: The number of fecal Coliform colony of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 26: The number of total Coliform colony of surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
Graph 27: Oil and grease in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006.

Graph 28: Detergent/surfactant (as MBAS) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006.
Graph 29: Phenolic compound (as phenol) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006

Graph 30: Chloroform (CHCl₃) in surface water at 5 sampling sites in Pelalawan District, Province of Riau, Indonesia, 2006
The Future of Environmental Health Officer Practice and the Role of Environmental Health Australia

Jim Smith

National President, Environmental Health Australia

Each of the six branches of Environmental Health Australia (EHA) conducts an annual conference during which the environmental health issues of the day are identified and discussed by speakers and conference delegates. In 2007 and 2008 a particular theme was pursued by three branches which related to the challenges and changes to environmental health practice at the local level within a context of global climate change. The Tasmania Branch Conference theme in 2007 was Rising to the Challenge; the Victorian Branch and NSW/ACT Branch Conferences, both held in 2008, had the respective themes of Warming to the Challenge and A Pathway to Change: Responding to Changes and Offering Solutions to Meet New Expectations.

Responding to the environmental health challenges of the future requires an examination of current approaches to, in this case, environmental health officer practice in local government and consideration of practice changes demanded by global climate change, local communities, and by government. EHA is the premier professional body concerned with environmental health and was first established in 1935. The EHA Constitution outlines its mission and objectives as contributing to the improvement in environmental health standards in Australia by, inter alia, developing and advancing the practices and policies of the environmental health profession and promoting excellence in environmental health practice (EHA 2008). There are approximately 1300 members of EHA the majority being environmental health practitioners, or environmental health officers (EHOs), employed in local government. EHOs are the primary organised national workforce, the environmental health front line, which undertakes the fundamental local environmental health protection services for the community.

This paper considers EHO practice and EHA’s role in leading and developing EHO practice to meet the future environmental health challenges.

EHO Professional Practice: Past and Future

EHOs are close to environmental health change as they deliver services on behalf of their respective local government organisations which, in turn, are close to the community they represent. EHOs and councils play an important role in the administration of public and environmental health legislation as a significant amount of this is delegated to councils by the respective parliaments (Neutz 1974). The challenges for practitioners in local government come from four sources associated with:

- communities, their health issues and expectations;
- changes in government public and environmental health policy and legislation;
- changes in government structure (new public management and new governance); and
- changes in the physical environment.

These challenges, or issues, have demanded in the past and will in the...
future a response which will require changes in practices and priorities. These environmental health challenges can be considered in three waves.

The first wave of public and environmental health challenges came in the 1850s at the time of the gold rushes in Australia and was associated with the threat of epidemic disease (Cumpston 1989). This threat originated from the poor sanitary conditions associated with the pollution of the immediate built environment, lack of infrastructure and unregulated community behaviour. The response was sanitary reform which required government intervention, the development of legislative standards, regulation of community and business behaviour, and allocation of resources. It also required the development of a workforce that was capable of applying legislation in the community to improve housing standards, prevent overcrowding, manage waste through the provision of drainage systems, and remove and prevent health nuisances. The application extended to ensuring the safety of food and water. The threat of epidemic disease was controlled and public health improved:

... reasons for these changes are obvious. The gradual development of education, good housing, safe water supplies, safe sewage and garbage disposal and most importantly, the general availability of good food ...’ (Lawson 1991).

The second wave of public and environmental health challenges came from the interaction between prosperity and related consumerism, with lifestyle choices and with risk taking behaviour. These interactions resulted in poor nutrition, tobacco smoking, obesity, lack of exercise, road trauma, radiation exposure, and drug abuse. In addition, there were underlying public health concerns of increasing chronic disease, disability, and mental illness.

The response at the environmental health practice level was the realisation that the scope of environmental health and its

| Table 1: Environmental health challenges and the focus of environmental health practice |
|-------------------------------|-----------------------------------------------|
| Environmental health challenge | Focus of environmental health practice         |
| First Wave                     | • Development and administration of legislation |
|                                | • Regulation of community and business behaviour |
|                                | • Environmental health services                |
| Second Wave                    | • Development and administration of legislation |
|                                | • Regulation of community and business behaviour |
|                                | • Environmental health services                |
|                                | • Health promotion                             |
|                                | • Environmental health planning                |
|                                | • Education                                    |
| Third Wave                     | • Development and administration of legislation |
|                                | • Regulation of community and business behaviour |
|                                | • Environmental health services                |
|                                | • Health promotion                             |
|                                | • Environmental health planning                |
|                                | • Education                                    |
|                                | • Evidence based practice (e.g. Health Impact Assessment; Environmental Impact Assessment) |
|                                | • Risk identification, management and communication |
practice was broader than just legislation and its administration, or just the physical environment, and that it included the social dimension as well. This is described by the Royal Environmental Health Institute of Scotland (2008) as ‘life circumstances’:

Environmental health is that area of Public Health activity which strives to improve, protect and maintain health and well being through action on the physical environment and on life circumstances (Royal Environmental Health Institute of Scotland 2008).

The third environmental health challenge is associated with sustainability and global climate change. The probability of extreme weather events and increased natural disasters, adequacy of housing stock, rising sea levels, disproportionate impacts on poorer Australians, emergent and re-emergent infectious diseases, and resulting economic consequences signal the need for a broader understanding of environmental health and the interactions between the natural and built

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<th>Table 2: EHA Professionalisation Strategies</th>
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<td>EHO University Course Accreditation</td>
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environment with the social and economic environments. From the practice point of view it requires the use of a larger and more complex set of practices and practice tools.

Table 1 outlines the focus of environmental health practice with each environmental health challenge.

The implication from the above table is that environmental health practice is becoming broader in scope, requires the use of a cumulative number of practice approaches and tools, and requires that practitioners actively adopt, develop and maintain their professional skills.

**Environmental Health Australia’s Response**

EHA considers that there are two issues, the acute shortage of local government EHOs and continuing professionalisation of EHOs that need to be addressed so that there is environmental health capacity to meet the third wave of environmental health challenges. The management of acute workforce shortages is a joint responsibility between all stakeholders - local government, state government, university providers and EHA. EHA is advocating for coordinated action between stakeholders to attract and retain EHOs in local government. At the same time it is recognised that the local government environmental health workforce needs to be a diverse one as a number of functions do not require degree qualified practitioners. The other issue is concerned with the quality, or continuing professionalisation, of the workforce. This is a major role for EHA.

EHA considers that it needs to provide the opportunities and incentives for practitioners to continue developing their skills and knowledge and to develop best practice through formulating professional standards of practice for all practitioners. To this end the following professionalisation strategies have been, or are about to be, developed. See Table 2.

**Conclusion**

The overall purpose of the above strategies is to develop the professional status of EHOs within the eyes of government, the community and with peers and this, in turn, will increase the interest in and attraction to the EHO profession.

**Note**

This paper is based on presentations that have been made to the EHA Tasmanian, Victorian and NSW/ACT Branch Conferences in 2007 and 2008.

**References**


Environmental Health Australia 2008, *Constitution of Environmental Health Australia*, Brisbane.


Communicable Disease Control: An Introduction

Aileen Plant and Charles Watson


With new and re-emerging communicable diseases proving to be a real threat to public health, Australia is not immune to the global reach of infectious disease. As the potential impacts from an outbreak of an existing or emerging disease is a daily consideration for public health practitioners, the release of the new text, Communicable Disease Control: An Introduction, is both welcome and timely.

What makes this text unique is that it has a distinct Australian emphasis. In addition, the text has been written for practitioners by practitioners and, therefore, the content is directly relevant and immediately usable. The basic premise of the text is that controlling infectious diseases never relies on just one strategy. As such, the core of the text is devoted to describing a range of the key control strategies. The text has also been written to ensure that each of the chapters is ‘stand alone’ and thus allows the reader to peruse a particular topic without having to read the preceding text.

Even though the text is not structured into specific sections, the chapters do seem to be grouped into broad themes. The first series of chapters describe basic issues for practical communicable disease control. These include discussion of risk management and its role for communicable disease control, which is quite interesting and refreshing, the role of government and laws relating to disease control, a discussion on emerging communicable disease, and an overview on the current international response mechanisms and Australia’s role in the global disease control system.

The next series of chapters then cover the key control strategies. These include chapters on communicable disease surveillance, sanitation and personal hygiene, immunisation, case finding and contact tracing, isolation and quarantine, outbreak investigation, and public communication in the management of an outbreak.

The remaining chapters discuss more specific issues related to communicable disease control. These include antimicrobial agents, vulnerable groups for infection, infections acquired in health-care settings, international travel, and the use of biological weapons.

Each of the chapters provides useful and comprehensive information without being dense and overly complicated. In addition, the core concepts are extremely well illustrated through the extensive use of tables, figures and case studies that practitioners can connect with easily.

Overall, Communicable Disease Control: An Introduction, provides a comprehensive and easy to read review of the principles and practice of communicable disease control. I would, therefore, highly recommend this text to all environmental health practitioners. It provides a fitting tribute to Professor Plant who was one of Australia’s leading authorities on communicable disease control, and who sadly passed away while the text was being finalised.

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