

LIDCOMBE LIQUID WASTE PLANT: TOWARDS ECOLOGICAL SUSTAINABILITY

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EXECUTIVE SUMMARY

Green Games Watch 2000 (GGW 2000) has been informed by Olympic catchment residents, that odours and potentially toxic air emissions from the Lidcombe Liquid Waste Plant (LLWP) are still causing a negative environmental impact upon their communities. The odour control measures undertaken by the plant during 1999 thus appear to be ineffective. These emissions will almost certainly impact upon the Athletes Village, which is located only 250 meters from the plant. The international media will be concerned that Australia permitted this environmental health hazard at the world's first Green Games.

This report outlines the immediate actions which the NSW Government should urgently consider to gain short term improvements and the longer term, strategic policies, required to minimise the need for liquid waste treatment through the progressive adoption of best environmental practices, clean production and a system of economic incentives. It is not recommending the refinement of existing linear technologies, it is advocating the rapid adoption of sustainable, cyclic technologies. It advances the spirit of the Environmental Guidelines for the Summer Olympic Games.

The report recommends the urgent formation of a task force which would aim to investigate if technical improvements or revised operational procedures could achieve immediate improved environmental performance.

The report also reviews the technical development of the LLWP from the initial pilot plant at Castlereagh Waste Tip, to the increasing landuse incompatibility of the plant with the encroaching Olympic developments, to projected future operational outputs within the prevailing waste management strategy. It details the liquid waste industry's non-compliance with the Waste Minimisation Act (1995) in terms of the new waste management hierarchy.

The report outlines an appropriate response to the legislative framework through the application of clean production. It also outlines a system of Tradeable Emission Rights which has proven to be the most effective economic instrument in achieving positive environmental outcomes around the world.

The report's recommendations present a outline which if followed can give the initiative back to the NSW government. With decisive and creative intervention, the 'Lidcombe Solution' could rate as one of the best legacies of the Green Games.

RECOMMENDATIONS

IMMEDIATE ACTIONS

1. NSW government must urgently appoint a task force, representative of the community and other relevant stakeholders, which aims to achieve zero odour and toxic air emissions detectable outside the boundaries of the LLWP. The task force would review the following:

- **existing technology and operational procedures,**
- **potential of initiating a more rigorous pollution control maintenance regime,**
- **availability of international best practice (zero emission) technology,**
- **performance of the plant relative to similar plants elsewhere,**
- **all recent air and water monitoring information,**
- **fugitive emission containment.**

If these measures can not achieve the desired environmental outcome, the plant should be relocated to an area with an effective buffer zone.

2. As our current self-regulatory system of monitoring pollutants is failing to deliver the positive environmental outcomes which the community wants, it is recommended that regular odour and chemical composition monitoring reports of the plant's environmental emissions, to air and water, be conducted by consultants, commissioned by the EPA, with the results communicated directly to an independent Olympic Catchment Community Environmental Monitoring Group and placed on-line. Testing to include the toxicity of chemical mixtures - both from this plant and from other industrial pollution sources in the Olympic Catchment.

3. NSW government to require the EPA to force the Liquid Waste Industry (LWI) into compliance with the Waste Minimisation Act (1995) through mandatory zero waste plans - with clear and achievable targets and timeframes. These measures could well be guided by the example of the Toxics Use Reduction Program (TURP) in the US state of Massachusetts.

4. NSW government to give seed funding to establish a taskforce advancing clean production throughout the LWI in accordance with the hierarchy detailed in the Waste Minimisation Act (1995). This could then become a private enterprise (Clean Production AustAsia) venture - which would liberate the power of the free market to achieve positive environmental outcomes.

5. NSW government to urgently establish a system of Tradeable Emission Rights for the LWI. The system would incorporate:

- a statewide ILW emissions cap at existing levels
- reformation of existing pollution licenses as tradeable permits
- 4% annual clawback available for public auction
- 10% annual reduction in emission rights
- Commonwealth government tax incentives to encourage research and development into waste minimisation and clean production technologies
- differential pricing relative to toxicity
- direct funds from 4% clawback sales to EPA for its additional monitoring costs.

6. EPA to set specific source reduction targets for all highly toxic pollutants.

STRATEGIC ACTIONS

7. Waste Service NSW to adopt a Sustainability Business Plan for LLWP based upon the framework advanced by The Natural Step (Sweden) - to facilitate the evolution of the plant towards an industrial zero waste consultancy, with specialised advisory, chemical testing and brokerage services.

8. Commonwealth government is urged to compile a comprehensive National Pollutant Inventory (NPI) - modelled upon the US Toxic Inventory - which details 750 chemicals and compounds. Such an NPI is essential to give the regulators the necessary information to achieve clean production and establish a Tradeable Rights System.

9. NSW government to seed-fund the establishment of an Industrial Chemical Waste, Re-use and Recycling on-line Brokerage Service. This total life cycle industrial resources brokerage service - will actively cross-match each firm's inputs and outputs. This service has the potential to become a private consultancy.

10. NSW government to recognise clean production ILW achievers - such as Watty Paints with special environmental awards and grants.

11. Environment Minister to commission a study, to investigate the treatment of leachates from Homebush Bay's waste mounds, as an alternative to remaining LLWP inputs.

- 12. Increase contractual flexibility of LLWP staff to encourage waste minimisation/clean production consulting to client industries.**
- 13. Extensive upgrading of the chemical testing facilities at LLWP, in order to permit a more accurate testing regime of inputs. Possibility of developing Australia's first dioxin testing facility should be explored.**
- 14. Environment Minister to commission a study to develop sustainable waste solutions for the treatment of biological and metal hydroxide sludges produced during the processes of the LLWP. These options should include bioremediation and silvicultural options.**
- 15. GGW 2000 strongly recommends that the solid waste 'filter cakes' and granulates continue to be landfilled in a dedicated area at an existing well engineered landfill until clean production and zero waste technologies eliminate these wastes. Incineration of these, in coal fired power stations, is a great leap away from sustainability. The future recovery of these buried wastes (to be used as feedstock in industrial processes) will only be economically possible with proper sorting and storage procedures at landfills. Waste Service NSW must redefine sustainable landfilling as (future) resource storage facilities.**
- 16. NSW government to formally recognise a representative community group to work in partnership with EPA, Waste Service NSW, Olympic Catchment industries and local governments, to achieve improved Olympic Catchment environmental outcomes.**
- 17. NSW government funding (drawn from the 4% clawback sales of Tradeable Emission Rights) to be made available to smaller liquid waste generators to assist them to pay for waste minimisation/clean production consultancy services.**
- 18. NSW government to adopt a best practice LWI transparency policy - to ensure freedom of information and sharing of relevant expertise and genuine community participation.**
- 19. All recommendations directed at LLWP are equally to be applied to the private liquid waste operators throughout NSW.**
- 20. EPA to review the soil injection of liquid wastes, to establish sustainability controls and extend their monitoring of this emerging industry.**
- 21. The Ministries of Environment and Olympics and the Premier's department to market the 'Lidcombe Solution' as an outstanding achievement in terms of sustainability and the search for business excellence.**

1 TECHNICAL REVIEW OF THE LLWP

1.1 Introduction

This review is being undertaken for GGW 2000 as an examination of future opportunities for the Lidcombe Liquid Waste Plant (LLWP) which are simultaneously consistent with both Ecologically Sustainable Development (ESD) and the NSW Waste Service's Corporate principles.

The LLWP was opened in 1988 to treat industrial liquid wastes (ILW) generated in the Newcastle, Sydney and Wollongong regions. Construction of the plant at Homebush (see location map opposite) commenced in 1985, when the surrounding area essentially consisted of brickworks, landfills, and the state abattoir. It was a highly degraded and alienated environment, and in such a context, the LLWP could be seen as an improvement on the existing landscape. Since that time however, Sydney secured the 2000 Olympics and reclamation and remediation of the area surrounding the LLWP has been dramatic and rapid. The location of the plant is now problematic, being prominently located between the Newington Village and the Olympic Stadium at Homebush Bay. This prominence will inevitably focus public attention on what used to be a relatively unknown facility. However this glare of publicity presents the government with a unique opportunity to initiate innovative solutions to industrial liquid waste treatment across the entire Hunter-Greater Sydney-Illawarra industrial axis. Industrial technologies could be advanced in a manner compatible with the ESD legacy offered by the Green Olympics.

1.2 The Role of the LLWP

The LLWP currently receives around 100 000 tonnes per year of industrial liquid wastes from approximately 1500 diverse sources in the Sydney, Hunter and Illawarra regions. These wastes are typically 80-90% water and include oil/water mixtures; paint manufacturing plant washings; spent acids, alkalis and electroplating liquors; interceptor pit pump-outs; solvents; and emergency process failure and transport accident residues. These wastes are not suitable for disposal to the sewer or solid waste landfill in an untreated form due to high contaminant levels and/or their ability to leach from the disposal site.

The LLWP also receives reticulated leachates from the remediation of past contaminated landfills at the Homebush Bay Olympic site. At this stage the leachates are relatively clean when compared to industrial wastes, yet it is considered environmentally preferable to process them rather than releasing them to the wider environment.

1.3 The Process at the LLWP

The LLWP breaks down and concentrates incoming wastes to produce the following residues requiring disposal: (refer also to accompanying process flow chart)

- clear oil-free water which is discharged into the sewer;
- metal hydroxide filter cake which can be landfilled or recycled (mainly iron and zinc hydroxides);
- recovered volatile hydrocarbons from the Hollow Flight Heat Exchangers (HFHEs) which are used as fuel to heat the thermal (heat transfer) oil used in the HFHEs. These recovered hydrocarbons may contain chlorinated hydrocarbons (formerly no more than 5%, but now no more than 2%). The resulting flue gas is alkaline scrubbed for acid gases and flyash;
- char which is landfilled. (char is a mixture of grit from the centrifuge, and charred tarry wastes from the heat exchangers) and could be expected to be rich in polycyclic aromatic hydrocarbons (PAHs); and,
- biological sludge filter cake which can be landfilled or recycled.

The biological and metal hydroxide sludges are typically re-combined before de-watering and production of filter cake. This greatly reduces the possibility of either waste product being able to be beneficially re-used or recycled. The potential for silvicultural use of the biological sludges as fertiliser needs to be examined more closely. Due to the likely presence of elevated contaminant levels it would be more appropriate for forestry use than food production.

The LLWP concentrates the contaminants in all wastes received to a point where the remaining aqueous component can be discharged to the sewer under a Sydney Water Corporation (SWC) Trade Waste Agreement (TWA), and the Thermal Oil Heater stack emissions comply with NSW EPA requirements (Clean Air Licence 003441).

It is disappointing that no significant recycling of residues was, or is, currently undertaken, and all 20 000 tonnes per annum of solid residue were combined and landfilled at Castlereagh Waste Management Centre (CWMC). With the closure of that facility in August 1998, the residues must now be physically and chemically stabilised to retain more of the contaminants, so that they may be disposed of at solid waste landfills under “special waste” protocols. To achieve this, a Residue Processing Plant was constructed during 1998-9 at the LLWP to de-water and stabilise the residues in either large one tonne blocks, or as pellets. Both forms are suitable for landfilling, but only the pellets may be burnt in furnaces.

The proposal to add coke “breeze” to the pelletised residues to increase their combustibility in order to use them as fuel in cement kilns, power stations and steam generators (granulates) is strongly opposed by a number of environment and community groups as they make a strong case for regarding it as being toxic waste incineration by default. (Luscombe, 1997; Divecha, 1997). These objections will be discussed in more detail later in this report.

1.4 History of the LLWP and Associated Facilities and Developments

1970 The Barton Report (*Report Upon Investigations into the Problems of Waste Disposal in the Metropolitan Area of Sydney*) condemns the disposal of liquid industrial wastes by absorption into poorly designed domestic garbage tips.

1974 Castlereagh Waste Management Centre established by Metropolitan Waste Disposal Authority (Waste Service predecessor) as an interim disposal site for industrial liquid wastes.

1977 Liquid Waste Treatment Pilot Plant established at Castlereagh Waste Management Centre to evaluate all liquid wastes coming into the depot, and to trial processes to treat them to make them suitable for disposal to sewer.

1982 Design parameters of proposed Liquid Waste Plant reduced to treatment of aqueous wastes only.

1985 LLWP construction commenced based on Castlereagh Pilot experience.

1988 LLWP opened. 55 000 tonnes per annum (t/a) initial capacity

1991 Capacity expansion completed to accept 90 000t/a due to tightening of Sydney Water Board (now Sydney Water) Tradewaste standards.

1995 Cadmium discharges to sewer detected by Sydney Water

1996 NSW Environment Protection Authority (EPA) officer investigates odour detected from plant, prosecution initiated, which resulted in a \$12 500 fine

and \$8000 costs in 1998. (More significantly, this prosecution helped provide impetus to install more effective odour control infrastructure, resulting in the installation of a thermal odour destruction unit in 1998-9)

- 1997 Environmental Impact Statement (EIS) for Residue Processing Plant expansion released (July, closing date for responses August 1997)
- 1997 Plant throughput up to 100 000 t/a, anticipated to reach 125000t/a within seven years
- 1998 Residue Processing Plant completed
- 1998 Castlereagh WMC closed
- 1999 Granulation unit ready for trials
- 1999 NSW EPA charge brought against Waste Services NSW - Land and Environment Court ordered fine of \$17500 and \$7500 in legal costs. Charge resulted from sickness of ten workers on an adjacent construction site due to release of offensive odours. Carbon filter regime changed to seven day cycle - EPA makes this measure mandatory.
- 2008 Anticipated throughput of 150 000t/a

1.5 Trends in Tonnages of Incoming Wastes

With the conversion of the NSW State Pollution Control Commission (SPCC) to the NSW Environment Protection Authority (EPA) in 1992, any regulatory control over the nature and volume of the waste stream previously held by the Waste Service NSW was handed over to the NSW EPA. This has placed the Waste Service in a position where they have little control over the volume of the material they receive. Increasingly stringent requirements by the Sydney Water Corporation on its Trade Waste Agreements have progressively increased the costs of releasing wastes to the sewer, which has increased the volume of waste needing to be treated at the LLWP. The nature of the processing the LLWP provides, does permit the Waste Service to vet the types of materials they receive to some extent, such as scheduled wastes, radioactive materials and explosives. Pricing of treatment costs for each LLWP customer reflects the costs charged by SWC for specific contaminants discharged to the sewer.

1.6 The Immediate Future of the LLWP

Given the increasingly sensitive nature of the site due to its intimate proximity between the Newington Village and the Sydney Olympic Site, some difficult questions are now being raised regarding the appropriateness of such a facility in what is rapidly becoming a residential/recreational area. As a local community develops around the plant, bearing in mind that it was sited some eight years before the Olympics and the associated Newington Village were announced for Sydney, it is unlikely that new residents will tolerate the continued and increasing operation of the plant. Community objections are now focusing on operational and fugitive odour releases, toxic exposure and the potential for accidents. More wide reaching objections are also being raised over the need for such a facility at all, and its appropriateness at its current site.

It would be far better for the government to be able to respond to such opposition innovatively by demonstrating an ongoing and increasing commitment towards cleaner production. Arguments over the cleanliness or otherwise of the plant aside, the perception of the local community who will see and smell the plant from across Haslam's Creek are now resulting in calls for its closure. Rather than relocating the facility, the government must take a pro-active stance to reduce the need for such a facility in the first place. While arguments for its retention can be made based on siting grounds, cost, and the unique nature of the service it provides, (particularly in regard to processing emergency loads of waste from transport or process accidents) serious thought must be directed at how the operations of the plant may be scaled down in the long-term by implementing cleaner production policies more vigorously than they are at present. If it can be demonstrated to the local community that the volumes of waste being treated are decreasing each year due to effective waste minimisation efforts then it may be easier for that community to tolerate a sunsetting facility whose role will be vastly different within a decade.

1.7 Residue Disposal

While the treatment at the plant mitigates some of the more obvious hazards of the wastes received, (ie. high acidity, high alkalinity, high oil and grease contents) it does little to reduce the output of persistent organic pollutants (POPs) and heavy metals. These contaminants of concern pass through the system relatively unaltered, and their ultimate fate is largely dependent on the form in which they initially entered the plant. Aqueous contaminants can escape into the sewer via the licensed discharge, solid contaminants can find their way into the residues (sludges)

requiring landfilling, and volatile contaminants can enter the atmosphere via the oil heater burner.

The plant effectively concentrates 100 000 tonnes of incoming liquid waste per annum to 20 000 tonnes per annum of problematic process residues. The majority of the pollutants in the initial 100 000 tonnes end up in these residues. While there is a five-fold decrease in volume, there must necessarily be a corresponding five-fold increase in concentration. This is not waste minimisation; this is waste concentration.

The balance of material is either relatively clean water which is discharged to sewer (although exceedances for cadmium were detected in 1995), scrubbed exhaust gases emitted from the thermal oil heater stack (which is fuelled with hydrocarbons recovered from the Hollow Flight Heat Exchangers (HFHEs)). Waste Service figures for residues requiring disposal were at 20 000 tonnes per annum in May 1997, projected to rise to 30 000 tonnes per annum by 2008. This 50% increase in waste being processed over a ten year period is not sustainable, nor does it reflect any credible commitment to meaningful waste reduction. Despite this, the EIS for the Residue Processing Plant asserts that:

“The transfer of waste currently landfilled at the Castlereaugh WMC into a process that converts it into a fuel substitute fulfils the intent of the current legislation. [The Waste Minimisation and Management Act 1995]” (Kinhill 1997,p.23)

This assertion is difficult to reconcile with the fact that there are no plans to reduce the volume of wastes coming into or leaving the plant. The new plan is that the 20 000 tonnes per annum that was formerly disposed of at Castlereaugh is now being stabilised so that it can be disposed of elsewhere in less contained landfills. If these residues are further processed to enable their ultimate incineration, then it is even more inappropriate to suggest that burning waste is minimising it. To carry this particular line of argument to its logical conclusion, it could be proposed that all of Sydney’s domestic waste be incinerated, thus largely eliminating the need for landfills. Such an approach is particularly flawed, especially in the light of increasing evidence that Japan’s 1400 domestic waste incinerators are emitting harmful levels of chlorinated dioxins and furans which are accumulating in food crops.

The combustion products, bottom and fly ash components will all contain the same amounts of toxic metals as were contained in the pellets prior to incineration. The proposal to incinerate the process residues essentially makes the atmosphere the final disposal point for these wastes. This approach is predicated on the outdated assumption of the environment's assimilative capacity; that is, the assumption that the environment has a virtually unlimited ability to absorb and disperse pollutants to levels which pose no threat to its various organisms and systems.

This assumption has repeatedly been shown to be invalid, particularly in the case of persistent and bioaccumulative toxins (such as heavy metals and persistent organic pollutants) whose physical and biological properties are such that they are readily concentrated up to harmful levels by the well understood processes of bioaccumulation, bioconcentration along food chains, and the selective sequestering in specific biological tissues which are particularly vulnerable to their toxic effects. (Carson, 1962)

All incineration can achieve is to more widely disperse residues to the environment where biological processes will re-concentrate them again, or else concentrate them in the incinerator pollution control residues which will still require disposal in a landfill. Therefore concentration can not be viewed as a reduction in waste, merely reduction in volume and as such has no place in the rigorous application of the NSW government's waste management hierarchy.

1.8 Real and Perceived Problems of Incineration as a Disposal Solution

The NSW EPA's Draft Hazardous Waste Definition and Draft Environmental Guidelines: Solid Waste Assessment, (Dec 1996) clearly identifies the unstabilised residues from the LLWP treatment processes as close to or exceeding NSW EPA conventional landfill disposal guidelines (Toxicity Characteristic Leaching Procedure (TCLP) and Specific Contaminant Concentration (SCC)) for a range of metals and heavy metals, chlorinated hydrocarbons, phenols, polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPHs). It is difficult to understand how the Waste Service and the EPA expects that stabilising residues contaminated at these levels, and then destabilising them by combustion will be a more environmentally acceptable process than controlled landfilling of stabilised residues. The best outcome for these residues as they are currently produced would be to continue to chemical and physically stabilise them and dispose of them in a

dedicated area at an existing, well engineered landfill. Placing the material in cells from which it may easily be recovered in the future as a resource to be used as a feedstock in industrial processes which may be expected to be more efficient than at present, due to improvements in resource extraction processes, is a possibility which should also be given serious consideration.

However, recoverable landfilling should only be tolerated as an interim measure until more effective waste reduction initiatives take effect in the waste generating industries. Clearly, the treatment the LLWP provides is preferable to relatively untreated waste being disposed of to the sewer, and ultimately the ocean. However the current upgrading of the plant to stabilise the solid process residues for incineration is not an environmentally desirable endpoint. The argument that by incinerating the residues, and disposing of the ash to landfill, the Waste Service is helping to meet the NSW Government's stated target of reducing waste to landfill by 60% is disingenuous; it is just transferring the landfill to the sky! The more problematic contaminants in the residues, such as heavy metals and persistent organic pollutants (POPs) including polycyclic aromatic hydrocarbons (PAHs) and heavy metals, make the incineration proposal unacceptable. Heavy metals will remain unaltered through the combustion process, resulting in their dispersal to atmosphere, or accumulation in emission control residues and bottom ash. This will then require disposal to landfill, arguably at toxic concentrations higher than the original fuel pellets, and in a less physically and chemically stable form (Thornton, 1991, Kinhill 1997). Final concentrations will vary according to the efficiency and nature of the emission control systems: the more efficient they are, the more pollutants retained and the greater the contaminant concentration in the residues.

Combustion of organic contaminants, while usually more complete than that of heavy metals, can lead to the *de novo* synthesis of other persistent contaminants in the emissions and residues. Of particular concern is the creation of chlorinated dioxins and furans, which occurs in the presence of copper (as a catalyst), and chlorine and organic combustion products as reactants. (Costner 1997, Taucher 1994) While optimum combustion conditions minimise the production of these toxic, persistent and bioaccumulative pollutants, off-specification fuel pellets or burn upset conditions can lead to unanticipated surges in the emission of these contaminants. There has been a long and successful public environmental campaign against all forms of waste incineration here and overseas. Domestic and hazardous waste

incinerators have been identified as major sources of chlorinated dioxins and furans, and heavy metals. Major national and international environment organisations, working in concert with concerned local communities, have run strong and successful campaigns against incineration in the recent past. There is nothing to suggest that any future campaign would be any less vigorous. It would be far better to spend the time and money otherwise wasted on contesting such a campaign on researching and implenting cleaner production policies and practices, which will help provide a permanent solution to industrial liquid waste generation.

2 LEGISLATIVE FRAMEWORK

2.1 Narrowly Applied Waste Minimisation Policies

It is important to note in the 1997 Kinhill report that industries which at that time treated their own liquid wastes and then disposed of the residues directly to Castlereagh WMC:

“Will be encouraged by the EPA and Waste Service to closely examine waste avoidance and minimisation options.” (p.28)

The terms of the 1997 Development Consent, issued by DUAP, for the approval of the granulation plant - required that the applicant “consult with EPA regarding a strategy to minimise waste in accordance with the principles of the Waste Minimisation Act” (p.3) One wonders why waste producers which disposed of their waste at the LLWP weren’t also encouraged to equally closely examine their waste avoidance and minimisation options.

The current operating philosophy of the LWP seems to be that economic imperatives are being permitted to drive the volumes of waste through the plant ever upwards, with apparently no or little effort expended on reducing upstream waste generation. This appears to be a misapplication of the NSW Government’s stated waste minimisation policy as outlined in the NSW Waste Minimisation and Management Act 1995 (WMMA), and as such is out of step with community expectations and the search for best environmental practices. A recent draft waste minimisation proposal by the NSW Waste Service (OCT 1998) states that the combustion of pelletised residues results in an overall reduction in waste to landfill of some 62.5%. The NSW state government’s own waste reduction hierarchy, as clearly stated in the WMMA, is to:

- 1 Avoid
- 2 Reduce
- 3 Reuse
- 4 Recycle
- 5 Dispose

In a complete reversal of this hierarchy the operation of the LLWP is clearly focussed on the last resort; disposal. To assert that combustion of residues to gain thermal energy is recycling contradicts the waste services own definition of recycling:

“recycling: conversion of a waste material into another material of equivalent usefulness or properties.”

This definition has implicit in it, the ongoing ability to continually recycle a product, eg. a glass bottle can be recycled into another glass bottle, which can be recycled into another glass bottle *ad nauseum*. Combustion of a material can only occur once.

It is clear that disposal would not be as problematic as it is at present, if more effort and resources were placed on the higher priorities in the waste reduction hierarchy. The operating principles of the plant are firmly grounded in an older waste management paradigm, which regards the inevitability of increasing industrial waste as an unavoidable cost to be borne by the community and the environment. In short, it is viewed as the price of progress. This outmoded paradigm, accelerated by the corporately driven profit maximisation requirement inherent in the waste services current institutional structure, is leading to unsustainability in the management of industrial liquid wastes in the region. Nowhere is this more clearly borne out than in the NSW Waste Service’s information booklet, which states in its opening comments that:

“The manufacture of many products needed by us all results in the unavoidable production of liquid wastes for which there is no further beneficial use.”
(OCT 1994)

However, this assumption ignores the waste minimisation hierarchy as outlined in the WMMA. This hierarchy ranks the following steps to reduce waste in order of priority:

2.2 Avoidance

In the case of industrial toxic wastes, specific toxic reduction targets may be set for priority pollutants. This aim can be furthered by government making a commitment to funding research, development and implementation of improved industrial processes which eliminate the production of such pollutants. Clean production programs are already established overseas as effective means of reducing pollutant loads. For example, the US state of Massachusetts has implemented a Toxics Use Reduction Program (TURP), which aimed for a 50% reduction in toxic waste over its first decade of operation from 1987 to 1997. While not meeting this ambitious goal, reductions were made in total use of toxic chemicals (19%), byproducts generated (14%) and releases to the environment and sewer (8%). This was during a period of economic growth, and figures are normalised to account for increases in general productivity. (University of Massachusetts. 1996).

By setting such goals and facilitating and encouraging industry to make product substitutions, increasing process efficiency and reductions in effluents requiring treatment offsite, government policy can have a beneficial effect on overall toxic synthesis, use and disposal. This is in marked contrast to the current situation in NSW, where in the absence of any such program, toxic wastes requiring treatment are expected to increase by 50% over the next 10 years. The government which has the foresight to introduce such measures could expect to be rewarded with only having to deal with approximately 85 000 tonnes of liquid industrial wastes in 2008, instead of the anticipated 150 000 tonnes. Aside from the obvious environmental gains, clean production programs also engender an industrial culture of increased efficiency and productivity, and nurture a climate of research and development in pursuit of these goals. Ultimately such measures can only be economically beneficial to industry and the wider community in the state where it is implemented.

2.3 Reduction

Where it is difficult to eliminate pollutants, effort should be directed at reduction of the pollutant in question. This may be achieved through process improvements, product substitution, and/or plant upgrading. Careful analysis of industrial requirements may help to identify areas where significant reductions in liquid waste can be made by asking if the process which creates a particular volume of waste is necessary, or if it cannot be run in such a manner to produce lower volumes.

Alternative process with lower waste volumes should be considered and encouraged during upgrades. Such an approach benefits the industry applying it economically as well as providing community environmental benefits.

Due to the diverse sources of waste entering the LWP, there must be equally diverse approaches to minimising the waste before it even reaches the plant. Within Waste Service there exists comprehensive engineering, technical and scientific expertise. It should be possible to draw upon this to assist and advise industries in ways to reduce waste needing to be disposed of at the plant. The NSW EPA also has a Cleaner Production Unit, which aims to minimise waste at source. The key problem is that neither EPA nor the Waste Service have an incentive to advance clean production and waste minimisation. Private enterprise would be the most efficient provider of this service. When the environmental rule of law is firmly enforced, it will create a dynamic market for such services. While waste minimisation may initially seem counterproductive to the Waste Service's semi-corporatised aim of returning a profit from disposing of industrial liquid waste, there are economic instruments which can ensure that overall revenue does not fall.

It may be appropriate to institute a performance linked bonus scheme related to achievement of clean production targets, to be funded by government levies on certain problematic waste streams, which can improve performance at the coal face. Across the board pricing structures can also be implemented to accurately reflect the external costs of a particular pollutant at a particular concentration and volume. While a problematic area, there are ways of objectively assessing the biological impacts of particular substances and mixtures, and this data could be used to generate a pricing schedule which would discourage generation of the most harmful, or large volumes of wastes. The introduction of cleaner technologies upstream of the LLWP will obviously entail cost, and it is anticipated that these higher costs will be offset by a combination of government funding initiatives, coupled with customer pricing structures which will gradually increase the disincentive to produce the waste in the first instance. This would make it cheaper to reduce the liquid waste output than to treat it. A more detailed examination on the nature of such pricing and policy mechanisms is discussed in the following economic section of this report.

2.4 Re-use

Research and development can be directed at identifying and implementing improved on-site re-use of by products. Identification of off-site re-use opportunities in other facilities could also be explored. Given the diverse nature of industries in the area feeding the plant, it seems likely that one plant's effluent could be another plant's feedstock. What is required is an industrial chemical waste re-use and recycling brokerage service which seeks to actively cross-match each plant's inputs and outputs. A relational database could be developed to keep track of the flows. A reasonable amount of effort would need to be directed into such a project to keep it current and accurate, but the resulting benefit in reducing waste requiring processing would offset and potentially outstrip the costs required for its operation.

By diversifying into industrial waste reduction consultancy, advisory and brokerage services, the Waste Service would be increasing the product base that they operate on. They could consider a name change to reflect the shift from viewing industrial effluent as a waste needing disposal, to an untapped resource waiting to be utilised. The Waste Service seems to be well placed institutionally to rapidly capitalise on such a business opportunity.

2.5 Recycling

Where the nature of the pollutant and its contaminants, or the lack of demand for it, indicates that it cannot be beneficially re-used, recycling or purifying this part of the waste stream into simpler constituents in order to provide feedstocks for other processes could be considered. The current development of the National Pollutant Inventory (NPI), also provides an opportunity to more readily identify under-utilised resources currently being treated as wastes. Accurate information on volumes, nature and availability of these under-utilised resources were widely and readily available. The NPI therefore has the potential to help address these gaps in information from an industrially beneficial perspective, as well as aid in the tracking of potentially harmful pollutants. This provides a strong impetus for more comprehensive reporting and disclosure under the NPI requirements, so that the NPI is viewed by industry as being an economically useful tool, instead of a source of potentially embarrassing pollutant information for the wider community to point accusing fingers at dirty industries.

2.6 Disposal

When the pollutant in question can not be subject to any of the above processes, then, and only then, should disposal be considered. The LLWP in its current operational capacity, prioritises the final disposal option for industrial wastes. In order to be contemporary in its approach to industrial waste management, much greater emphasis must be placed on the strategies higher in the waste minimisation hierarchy, with the current over-emphasis on disposal taking its appropriate position in the waste minimisation hierarchy.

3 Clean Production

3.1 Clean Production Policies

Given the unlikelihood of the wider community accepting the residues being disposed of by incineration, and the generally undesirable disposal route in conventional landfill, it is apparent that the only ecologically sustainable way forward is via a more rigorous application of the waste management hierarchy, and development of realistic clean production initiatives by industry and government.

The majority of current industrial processes require vast amounts of raw materials and energy resources to produce and transport goods. Most industrial systems are highly linear, with little cross-flow of surplus materials or energy from areas of excess to areas or processes where they may be in demand. There is insufficient internal recycling/reuse within plants of materials, water or energy, and much is disposed of to the wider environment as waste products. The toxicity of waste produced determines its hazard, and the mechanisms whereby they enter and circulate in the environment determines its availability to harm biological systems. Chemical impacts on ecosystems invariably reduce diversity, until only those species most tolerant to that particular suite of toxins remain.

Clean production, on the other hand, aims to meet the same needs in a far more sustainable and renewable manner. That is, it seeks to use non-hazardous materials, use energy efficiently, maximise internal reuse and recycling, and most importantly, questions the need for the product in the first place. Making the transition towards cleaner production involves more than just technical solutions. Economic, political and even cultural assumptions need to be reviewed and modified to effect lasting change. For instance, withdrawal of counterproductive industrial subsidies to sectors which have traditionally had little or no reason to

become more efficient due to being protected from the impacts of real market forces by those very subsidies. No primary producer is going to become a more efficient user of diesel fuel as long as it is exempt from federal taxes and levies.

The Four Elements of Clean Production

3.2 A Precautionary Approach

At its simplest, the precautionary approach places the burden of proof of no harm on to the producer of the waste, as opposed to the existing status quo, which places the burden of proof of harm on to the wider community. This approach recognises the limits of science in determining the extent of negative impacts, especially of complex chemical mixtures on complex biological systems. Essentially it is an application of extended producer responsibility. For example the pharmaceutical industry already has a well developed precautionary approach. If a manufacturer of pharmaceuticals wants to research, develop, produce and market a drug, the burden of proof lies heavily on them to ensure that all reasonable care is taken to test for any adverse reactions. The company can not simply release a drug onto an unsuspecting market and only react to problems after they arise. There are a range of national and international systems in place to ensure that this does not occur.

The reverse situation exists with regard to industrial chemical products. The burden of proving harm has fallen to the community, and in the presence of many pollutants from a diverse range of sources, it is often impossible to prove which particular one or combination of them is causing a specific effect. In the real world, all pollutants in a particular system play a part in the collective impacts, varying according to the nature of the pollutants and the systems affected. Only in rare cases, where the effect of exposure to an harmful substance is uniquely linked to a specific disease state, eg asbestos and mesothelioma, is exposure and subsequent harm readily acknowledged.

3.3 A Preventative Approach

It is cheaper (and arguably much more effective) to prevent impacts from toxic chemicals before the fact than afterwards. This requires turning off the tap, rather than just continuing to mop up with the tap still going. Prevention of waste is more effective than trying to engineer end-of-pipe solutions. The NSW WMMA recognises

this principle by seeking to avoid and reduce pollutants of concern, before they become disposal problems.

3.4 Democratic Control

To be effective, clean production must involve all stakeholders. Not only workers, but also consumers and communities. Equal and open access to information and involvement in decision making ensures democratic control. Open access to information on waste transfers to and from the plant should be as transparent, complete and accurate as possible. Public access to inventories of major contributors to the LLWP, and the nature and volumes of their wastes can be a powerful catalyst in pressing those companies to adopt reduction targets.

Toxic use reduction plans, and other instruments, which disclose operating parameters for industries, must be publicly available in order for communities to decide for themselves if goals are being met, or if there is room for improvement. The development and implementation of the National NPI, goes some way towards filling the current information gap, not only for the wider community, but also for industry.

3.5 Integrated and Holistic Approach

In its current configuration, the LLWP only seems to reduce waste. To a very minor extent it does reduce waste in the thermal oil heater unit, (but in the process can create new toxic wastes which are released to the atmosphere, or end up in the scrubber residues). Overall, the LWP essentially regulates the transfer of pollutants from one environmental medium to another. The waste enters in liquid form, goes through a range of separation processes, and leaves in liquid form to the sewer, gases through stack emissions and evaporation, and solids to landfill, or dispersed to air and landfill if the thermopellet process is ever fully realised.

The NSW Waste Service and the LLWP in particular are centrally placed with the resources, information and infrastructure to coordinate the transfer of waste products from source to potential re-users. Such a reinvention of the NSW Waste Service into waste brokerage, rather than management by disposal, could provide the impetus for fundamental change in waste handling in NSW.

3.6 Instruments and Strategies for Clean Production - The Way Forward

Government has a key role in driving clean production, by setting the standards demanded by the community. Ultimately, it would be ideal if there was no need in Sydney for a facility like the LLWP, either privately or publicly owned. However, the current state of industrial processes is such that such a facility is needed, even if only occasionally to deal appropriately with wastes generated from industrial emergencies. The important point to consider is that this does not always need to be the case. Maximum effort and policy direction could be focussed on reducing and eventually eliminating industrial liquid wastes which need to be handled in this manner.

In much the same way as the NSW government is currently focussed on largely solid wastes going to landfill, there needs to be an across the board commitment to reduction in liquid industrial wastes, and indeed wastes from all sources going to all disposal methods. The interests of the environment and community would not be well served if waste to landfill is reduced to meet legislated targets by incinerating it or dumping it at sea instead. Without setting targets for all modes of disposal, the government has created a regulatory climate where policy can be used to justify otherwise unacceptable disposal options. To allow this situation to continue risks making a potentially far-reaching piece of valuable legislation merely an instrument for justifying the transfer of waste from one end-point to another without any real reductions in the amounts of waste being produced, yet still calling it waste minimisation. To ensure that such an approach to waste disposal is not inadvertently encouraged, the WMMA should be amended with tighter control of disposal to all foreseeable end points. At the same time, new or amended legislation and needs to be introduced and enforced to ensure that trade is not lost to private sector waste handlers who have no political, environmental or social reasons to decrease business. At no point should the LLWP be closed down prematurely, causing the loss of a valuable state resource, no reduction in liquid waste production, and a lost waste reduction opportunity.

An overall waste reduction plan encompassing all modes of disposal would do much to focus a largely fragmented regulatory system around a preventative, precautionary and integrated framework based soundly on waste prevention rather than managing or transferring it once it has been created.

3.7 Establishment of an Integrated Regulatory Framework

Access by government to their customers at LLWP gives them a ready made list of those companies who produce, collect, transport or dispose of the most liquid waste. Using that list as a starting point, liquid waste reduction plans could be drawn up with the existing clients, with increased processing costs as a disincentive to maintain waste production at current levels. By utilising the expertise already intrinsic to the LLWP in consultative and advisory roles, reductions in throughput could be achieved with no or little loss in revenue.

Additionally, waste production might also be capped at current levels by the introduction of tradeable emission rights. These could be established to make any increases in emissions over current levels a costly exercise, and also encourage existing industries to minimise emissions, which would free up emission rights which could be traded for profit or other bonuses. This would provide a strong incentive for progressive companies to invest in clean production research and development.

Economic instruments may also include tariff structures which reward reductions in toxicity and volume and penalise profligate or noxious production. Such measures will help drive liquid waste levels down. As stressed earlier, the aim of this process is to reduce liquid waste levels, not drive the LLWP's business away to the private sector with no overall reduction in waste. Therefore such economic instruments must apply equally to all waste treatment facilities, so that those private waste companies prepared to help waste-producing clients to reduce waste can also benefit from a change in the waste management paradigm. The current situation, which permits distorted market forces to encourage the production of waste is a disincentive to the development of more advanced clean production technologies. Ultimately the current system of waste management and its regulatory framework may be seen as retarding economic, technological and environmental development in NSW, with consequent loss of competitive status and jobs. The current situation is also counterproductive for the simple reason that it means the more waste being generated, the more profits for the waste handlers and disposers. While the LLWP attempts to compete on these grounds, it can only get bigger, handle more problematic wastes, and get more adept at the transfer of wastes with little or no reduction in toxicity.

4 TRADEABLE RIGHTS

4.1 Introduction

The industrial liquid waste producing and processing industry could increase profits and move to a closed loop production system. Even those who believe this goal is desirable are unsure of how this transformation is possible. This section makes it clear why this transformation, focussing on the LLWP is achievable. It is a worthy Olympic challenge for the NSW government and the industry, and consistent with the spirit and application of the Environmental Guidelines for the Summer Olympic Games.

4.2 Olympic Spirit: Does the Government and Liquid Waste Industry Have What It Takes?

The Olympic games will soon be staged in Sydney. These 'Green Games' will be immediately adjacent to the LLWP. This plant is part of an industry that is processing industrial liquid waste (ILW) throughout NSW. A comparison could be made between the Olympic athletes inside the ground, striving to produce their personal best, and the ILW industry. Is the government and the ILW industry trying hard enough to reduce waste? The public could be forgiven for thinking that government and industry find it easier to celebrate the Olympic spirit than to apply it in the pursuit of environmental and economic excellence.

This report identifies a path by which the government, the LLWP and the wider industrial waste industry can reach an Olympic outcome of their own - increase profits whilst reducing and eventually eliminating discharge of ILW residues to the environment, through the creation of closed loop production systems.

4.3 Win-Win Government Policy Framework

We propose that government seek a policy framework that will produce win-win outcomes in the ILW industry. The policy framework must seek to reward those companies who pro-actively pursue ecologically sustainable outcomes. We have recommended capping industrial liquid waste production by issuing tradeable rights in the capacity to discharge ILW to the environment. The cap will be reduced on an annual basis over ten years. The emission of waste to the environment will also be subject to a per unit discharge tax. The policy framework has the following main components:

- Cap the statewide emission of ILW (and/or the residues of processing ILW) to the environment. This limits the volume of ILW to present levels by restricting the right to discharge the output from ILW processing to the environment;
- Affirm existing license conditions to existing producers/waste processors to dispose of the existing quantities by existing means;
- Reformulate licenses as tradeable permits subject to meeting suitable disposal conditions at least equivalent to the existing standard - this will permit the trading of ILW permits;
- Allow tradeable permits to be included as assets of the holding companies - the tradeable permit regime formalises existing rights for the incumbent firms;
- Clawback 4% of the remaining right each year for public auction. The existing parties are allowed to bid to buy back their rights. The revenue is used to fund research, development and commercialisation programs.
- Tax the capped emissions at a set and growing rate per tonne (or other suitable unit of measurement) of contaminated material;
- Reduce the right to emit by a set per centage every year (recommended to be 10% of the starting volume - ie discharge of ILW is eliminated over ten years);
- Establish a joint private/government funded research program to fund and commercialise new technologies and other methods, which reduce ILW production.
- Encourage the Commonwealth government to extend tax based research and development initiatives (such as accelerated write off of approved cleaner production investments) used to encourage plantation and rural environmental improvement to urban and industrial areas.
- Adopt a transparency policy to ensure that the community has complete information about the discharges from industrial sites in their vicinity. Such information should be publicised on billboards erected at the plant and on the internet where the public can readily access it.

The above framework must only be regarded as an introductory approach. Further work needs to be done to refine the key concepts. The discharge of ILW at new

sites will be subject to the new restrictions. This will give the incumbent firms some advantage. However, these firms will need to adapt their business to the prospect of achieving closed loop production systems within ten years.

The standard reaction to this is to assume that this will be very costly and hence will drive these firms to bankruptcy or offshore or into another state. This will not be the case unless a firm deliberately adopts a go-slow attitude. There is conclusive evidence that the cost of such environmental initiatives is a relatively small proportion of total corporate expenditure. The policy framework will ensure that laggards will suffer financial penalties - but aggressively competitive firms stand to reap major financial rewards from growing their businesses in new directions whilst improving the environment for the entire NSW community. The community wants rapid improvement in the environmental discharge standard. At present, the existing system does not align this public interest closely enough with the private sector investment actions of ILW companies.

Governments implement tradeable rights regimes in order to align the interests of companies with those of society and to internalise currently externalised costs in the interests of improved corporate accountability. Tradeable rights will facilitate the balance sheet capitalisation of rights that presently do not figure significantly in annual reporting. These rights can be bought, sold leased and banked. These rights provide massive flexibility. A company who has done the right thing (by society and the environment) in seeking new solutions to the problem of ILW will be well placed to exploit this situation by selling down its stock of emission rights in order to offset the costs of taking up new technological opportunities. These technological opportunities, if they are properly configured, will bring new profit centres in their own right. These new profit centres will create new jobs and investments that are sustainable in a financial and environmental sense giving greater industrial stability and economic prosperity to NSW than presently exists. The government facilitates this transformation by providing matching public funding for research, development and commercialisation work required by private companies to take up new technological opportunities.

The system we advocate has been summarised as follows;

“Tradeable permit systems are environmental quotas or ceilings on pollution levels that, once determined by the environmental authority, can be subject

to a set of prescribed rules. They give environmental authorities more direct control over levels of pollution compared to other economic instruments and have the potential for significant cost-savings compared to direct regulation on its own. They are particularly suitable if gradual tightening of environmental standards is desired. Permits might have 'sinking caps' or emission limits declining with time, so as to achieve significant reductions in overall emissions over time. In effect, what the tradeable permit systems do is to add the flexibility of trading to a basic licensing system" (Izmir and Shepherd, 1995)

In terms of the international experience, tradeable rights appear to offer the most effective economic instrument to achieve ecological sustainability in the LWI. The tradeable rights framework and government funding of research can only go so far. The environmental impacts of production processes are fundamentally under the control of private companies. Whilst governments can make the rules and restrict pollution output, it is only companies that can decide to make a difference. The future of environmental improvement is dependent on the attitudes of companies. In the same way that Olympic performance is dependent on the attitudes of athletes, the performance of companies will be determined largely by their own attitude.

5 CORPORATE PROFITABILITY AND ECOLOGICAL SUSTAINABILITY

5.1 Profitability and Zero Waste: Government Policy and Corporate Innovation

There are three dominant aspects of the change process:

- Are profitability and ecological sustainability compatible?
- If profitability and ecological sustainability are compatible, what policy framework, on the part of government will deliver a win-win outcome; and
- How does a company go about transforming itself into a profitable and ecologically sustainable business even if its competitors are taking the opposite route and government remains indifferent?

This section demonstrates that profitability and ecological sustainability can be mutually compatible. The government can begin to realise this achievement by implementing an appropriate policy framework that rewards winners and changes slow movers into fast movers. Companies can reap the rewards of cleaner production for themselves, even without government, if they take a pro-active interest in reducing their environmental impact whilst seeking new ways to create profit, employment and investment opportunities. Each of these points has been demonstrated by those companies who have already ventured down the path of eco-efficiency. The key factor in this is that all parties must believe that the outcome is achievable - millions of years of human innovation have not come to an abrupt end. Business must be profitable and sustainable or we have a looming disaster on our hands. We must understand why it is rational to hold the belief that profitability and sustainability are not mutually exclusive.

5.2 Profitability and Ecological Sustainability: Are They Incompatible?

The manner in which we think about the problem of profitability and sustainability limits our ability to move forward. Companies, governments and society at large suffer from information asymmetries or bounded rationality (translated as limited vision). That is, we can only see around us with limited vision - like a mountaineer on the summit of a mountain we can see a reasonable distance but there is a limited range to our vision. As a very visual species, humanity tends to believe that what it can see is all that is possible. Thus with respect to new industrial opportunities we think that the best we can do is make the existing technologies work well. To expect that we can radically improve those technologies is anathema. Economic theory has formalised this process into an approach that suggests that we should optimise our production process using the existing technology. This optimisation paradigm implies that we cannot achieve any better outcome than refinements of what we observe around us.

The optimisation mode of thinking accounts for the paralysis that is induced by the environmental challenge. If you have an optimality view of the world you expect that profit and environmental performance must necessarily be traded-off against each other. This is because the only options available are the existing process, which if subject to known approaches will result in increasing costs to reduce pollution. Yet there is now overwhelming evidence of companies who have

achieved profitable outcomes at the same time as reducing or eliminating environmental discharges. The evidence points to a deep flaw in the optimality paradigm. Decision-makers all too easily assume that they can see everything when, in fact, their vision is strictly limited. This bounded rationality is a hidden assumption but not explicitly incorporated into the paradigm and hence does not figure in the management strategies of companies.

We have identified a more complete paradigm. The prospecting paradigm explicitly incorporates uncertainty with optimality. It suggests that any company has limited knowledge, and should optimise its approach to known technologies. However, beyond the existing knowledge boundary lies unknown terrain, which contains future technological opportunities waiting to be uncovered. The task of the company is to efficiently explore this unknown territory to uncover new opportunities that are environmentally sustainable and profitable. The company which efficiently and optimally explores this territory will make considerable gains over its competitors. Such companies, in exploring beyond the knowledge boundary, must balance up their use of resources with their ability to locate new opportunities. The management and economic paradigm for explaining why ecological sustainability and profitability are compatible can be explained in a child's computer game. They must explore unknown territory efficiently with limited resources whilst ensuring that they achieve sufficient success to make the exploration process profitable. The success must at least match that of their competitors. The firm that manages this process best will draw ahead of its competitors assuming that all other factors are managed efficiently. In the process of exploration they will uncover a range of new technologies. Some will not be relevant, some will be profitable but environmentally bad, some will be environmentally good but unprofitable and some will be both profitable and environmentally good. For the purposes of advancing ecological sustainability and profitability it is only the latter category which must be emphasised.

The task of management is to locate these technological opportunities in a systematic and rapid fashion. This change will increase company profitability and will hasten the achievement of truly closed loop processes with respect to ILW. The task for government is to facilitate this process of change by harnessing the in-built competitive strength of the market. The role of companies is to systematically explore and acquire these technological opportunities.

5.3 Corporate Transformation: Systematically Seeking

Eco-Competitive Advantage

The reactive company will take a lot longer to realise the profits from eco-efficiency. Eco-efficiency is the process of improving the efficiency with which the company uses environmental inputs. It implies reducing the per unit rate of use of environmental resources, at such a speed that the aggregate impact begins to fall, even if the company is growing its output. Eco-efficiency implies that company profitability at worst is unaffected by this process or is enhanced. This process then realises an eco-competitive advantage, where the company has achieved improvements in its environmental impact, widening the set of possible strategic options and increased its profitability as well. A proactive company will achieve these goals a lot more rapidly.

It is also feasible that a pro-active company can achieve these goals in the face of competitors pursuing alternative strategies and even in the face of regulatory indifference on the part of government. The key is that the changes are profitable as well being environmentally beneficial. These gains will enhance the pro-active company's strategic position relative to all other companies. The liberation from environmental impacts will create strategic opportunities that the company can exploit to gain further market advantage.

This report provides a stepwise process by which a company can begin to realise its eco-efficiency goals. These steps do not guarantee a good outcome but they make the attainment of that outcome more certain. The key concept is that the company must act like a successful mining company. It must explore its knowledge boundary and uncover new opportunities. This is a process of explicitly managing risk and uncertainty. As a result outcomes cannot be guaranteed but results can be made more rather than less certain. Many companies, in the past decade, have moved to systematically explore new opportunities as part of an innovation strategy. These companies are producing many patents per year. They are also moving to systematically exploit these technologies in start up companies and other vehicles. All of these companies are looking to create the next Microsoft as a means of growing their business. This report recommends adopting the same strategic approach to the exploitation of new environmental technologies. This

report adapts these approaches so that ILW companies can independently seek these new opportunities in order to pursue eco-efficiency.

The steps that we have identified, include:

- Step 1. Define the goal: creating an ecologically sustainable company requires the modification of the companies ecological impact (ie an improvement in the eco-efficiency of the firm by which we mean reducing the environmental impact per unit of output.)
- Step 2. Measure their environmental impact in per unit output terms and in aggregate terms;
- Step 3. Appoint some outside advisers to provide input, critique company processes and extend the company information network;
- Step 4. Define the ecologically sustainable but profitable opportunities that appear to be available;
- Step 5. Envisage the revenue streams which would provide the profit in a ecologically sustainable context;
- Step 6. Define the technological requirements which underpin each profit centre in the ecologically sustainable business;
- Step 7. Map the existing research on a global basis which can assist the creation of these profit centres;
- Step 8. Develop a research and information clearing centre for the whole company which can provide input to the transformation process;
- Step 9. Consider a joint industry - wide research organisation to conduct basic research for the industry as a whole, along the lines of an ILW research and development corporation, funded by industry levies;
- Step 10. Decide that change is profitable, ecologically sustainable and achievable;
- Step 11. Decide on a explicit company policy towards mistakes and failures (ie tolerance and blame free analysis - how can it be done better next time and what lessons can be learnt) and towards successes (tangible real rewards for performance);
- Step 12. Form company wide teams to develop business plans, establish company structures providing profit shares as incentives to team members and the company overall.

- Step 13. Develop a business plan for each profit centre to describe the resources and process by which it is to be implemented;
- Step 14. Develop a business plan for the whole enterprise which coordinates the evolution of each new profit centre whilst integrating existing processes and revenue streams;
- Step 15. Allocate resources to each potential profit centre in accordance with the overall business plan and the financial constraints on the company;

The above steps are only the first in a complex process. Industrial and post-industrial capitalism is at crucial stage. We have a capacity to systematically explore knowledge in a manner via information technology innovation that was simply not available to previous generations. At the same time we face immense environmental challenges that previous generations also did not face. The above steps open the window to wider opportunities that will positively revolutionise human impact on the environment whilst realising improvements in economic output. NSW can lead the world in this change but governments and companies must independently or together make a decision to seek out those new opportunities. We hope that the NSW Government and the ILW industry, find the adventurous, entrepreneurial, Olympic spirit to pursue these opportunities.

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