PART 1: BACKGROUND

1. Foundry Industry in Queensland

The casting of metal in foundries has been undertaken for thousands of years and is one of the oldest and largest recycling industries in the world. Virtually all scrap metal collected for recycling goes to foundries to make new products, in particular scrap metal from the automobile and heavy industries. For Australia as a whole, the foundry industry is a large and important part of the countries industrial base.

About 40 of Australia's 200 foundries are located in Queensland. The Queensland foundry industry produces 44000 tonnes of castings annually, which is one-third of the national total and more than a quarter of this is supplied to the export market. The industry in Queensland employs more than 1100 people (EPA, 1999).

Foundry operations in Queensland range from very small operations producing high quality castings in jobbing operation to companies employing more than 400 people and producing products such as agricultural and mining equipment, construction components, railway rolling stock and pipework fitting on a large scale. Fourteen foundries were visited as part of this project. Table 1 provides a listing of these foundries including an indication of the types of products they produce and their scale of operation. These companies account for about 90% of foundry production in the State. There are an additional 20-30 small foundries in the state, predominantly ferrous and non-ferrous jobbing shops that serve local markets.

The industry can be divided into two sectors; ferrous and non-ferrous. Ferrous foundries cast iron and steel products while non-ferrous foundries cast a variety of other metals such as aluminium, copper, zinc, lead, tin and nickel. More than 75% of products by volume is ferrous. Although non-ferrous industries use the same basic moulding and casting techniques, by-products can be different from those produced from ferrous industries (EPA, 1999).

The majority of foundries in Queensland use modern electric furnaces, either electric arc or electric induction. Many of the electric furnaces in operation have been installed in the past five years in an effort to improve energy efficiency, environmental performance and increased throughput.

A flat or declining domestic market and significant competition from overseas foundries over the past two decades has placed pressure on the profitability Australia's foundry industry. This has led to significant restructuring in the industry. The number of foundries has decreased with those companies still in operation being the larger, more competitive, export oriented foundries or those with more diversified operations. As a result, the industry has tended to take a cautious approach to capital investment which has weakened international competitiveness and limited local research and development (CoA, 1985).

Table 1: Major foundries in Queensland

	Metal cast	Major products	Capacity
ANI Bradkin - Ipswich Foundry	Ferrous	Large industrial castings.	Medium
ANI Bradkin - Runcorn Foundry	Ferrous	Large castings for the mining, transport and other industry	Large
Austcast Foundry	Ferrous	Small to medium sized steel and iron castings.	Medium-Large
Bundaberg Foundry	Iron / steel & some brass and bronze	Agricultural, milling and mining equipment, pumps, gears and gear casings	Medium-Large
Bundaberg Metal Industries	Ferrous	Predominantly pipes and fittings.	Small
Investment Casting QLD	Ferrous, non-ferrous, specialty alloys.	Precision engineering components, feature castings and artwork.	Small
Nu-Spray Foundry	Non-ferrous (aluminum & some gunmetal, brass & bronze)	Small volume, high quality castings	Small
Qalcast Foundry, Gold Coast	Non-ferrous (bronze, aluminium)	Small volume, high quality castings	Small
Reliance Manufacturing Company	Non-ferrous (gunmetal)	Water meters and specialty valves	Medium
Toowoomba Foundry	Ferrous	Agricultural, mining, & transport equipment & building components	Medium-Large
TYCO - Gold Coast Foundry	Ferrous	Pipeline valves & fittings	Medium-Large
WareTech	Ferrous	Specialty Engineering products	Medium
Walkers Foundry, Maryborough	Ferrous	Railway rolling stock, sugar milling equipment and general industrial castings.	Large

Key

Large: >10000 tonnes per year;
Medium: > 2000 tonnes per year;
Small: < 2000 tonnes per year.

2. By-product Management Issues for the Industry

Although the foundry industry is traditionally been viewed as dirty and hazardous, modern foundry processes are relatively clean and impacts are generally related to environmental nuisance issues such as noise and odour rather than impacts that are hazardous to human health and the environment.

Most foundries have made considerable effort to minimise these impacts and foundries located in build up areas, have developed sophisticated noise and odour management systems and regularly monitor emissions from the site.

The most significant waste management issues for the foundry industry is the generation of large quantities of spent sand and other solid by-products such as baghouse dust and slag. Table 2 provides quantities of sand and other solid wastes generated by the foundry industry in Queensland. Historically, many foundries disposed of these materials on site, however this practice has given way to landfill disposal. As the costs of landfill disposal continue to rise, alternatives to disposal are being pursued.

These waste and by-product streams are relatively benign, particularly those generated from ferrous foundries. Most chemical additives used for sand binding are inert or of organic origin which biodegrade relatively quickly (EPA,1999). For ferrous foundries, waste sand typically passes toxic characteristic leaching procedure (TCLP) tests and can therefore be sent to non-secured landfill. Non-ferrous foundry sands are usually sent to secured landfill due to the presence of heavy metals. Baghouse dust from ferrous foundries is also sent to secured landfill, due to the fact that the dust is extremely light so is a potential occupational health and safety issue.

In total, about 46000 tonnes of spent foundry sand is generated per year in Queensland, 85% of which is disposed to landfill. Around 4,920 tonnes is being used as night cover at landfill sites and a further 2,280 tonnes is being used as a composting material. Therefore around 15% of the total spent sand is currently being used for some form of beneficial reuse.

In response to the increasing costs of landfill disposal, beneficial reuse of foundry byproducts has received considerable attention by the industry in recent years, culminating in the development by the Queensland EPA of an Environmental Guideline, *Beneficial re-use of ferrous foundry by-products.* Five of the major ferrous foundries in Queensland hope to achieve 100% beneficial reuse for their major waste streams, (i.e. sand, baghouse dust and slag) within the next five years. If these companies achieve their stated goals, the volume of material diverted from landfill could be realistically increased from the current level of 15% to around 70% over the next five years. This would reduce the volume of material going to landfill by 25,000 tonnes per year. Beneficial reuse options are generally more limited for non-ferrous foundries, small foundries, and foundries that are located a long way from potential users of the by-products.

Table 2: Quantities of sand and other solid wastes generated by Queensland foundries

Waste	Tonnes/year
Spent green sand	11,322
Spent phenolic bonded sand	9,799
Spent silicate bonded sand	17,688
Spent furan-bonded sand	3,496
Resin coated sand	3,913
Spent silicate bonded zircon	8
Core sand	1,140
Baghouse dust (FFDC Dust)	3,023
Shot-blast dust	616
Furnace slag	2,465
Dross	127
Induction furnace lining	114
standard firebrick	8
ladle lining	807
Furnace consumables - thermocouples etc.	48
Sand reclamation dust	132
Shot blast sand	72
Clay graphite used pots (borden)	1
General waste which cannot be recycled	1
Approximate Total	**54,780**

Note: This table does not include the Maryborough and Bundaberg foundries. A survey conducted in 1995 by the MITA (now the Australian Industries Group) estimated the State's waste foundry sands (including these foundries) to be approximately 75,690 tonnes per year. The economic downturn has reduced the volume of waste generated by the industry in recent times.

Source: (EPA, 1999)

While beneficial reuse will play an important role in by-product management, greater potential value can be gained from Cleaner Production. Beneficial reuse is an 'end-of-pipe' strategy that reduced the cost of waste once it has been generated. Cleaner Production stops the waste occurring in the first place so can potentially reduce the cost of purchasing materials as well as reducing the cost of unnecessary processing, handling and disposal costs.

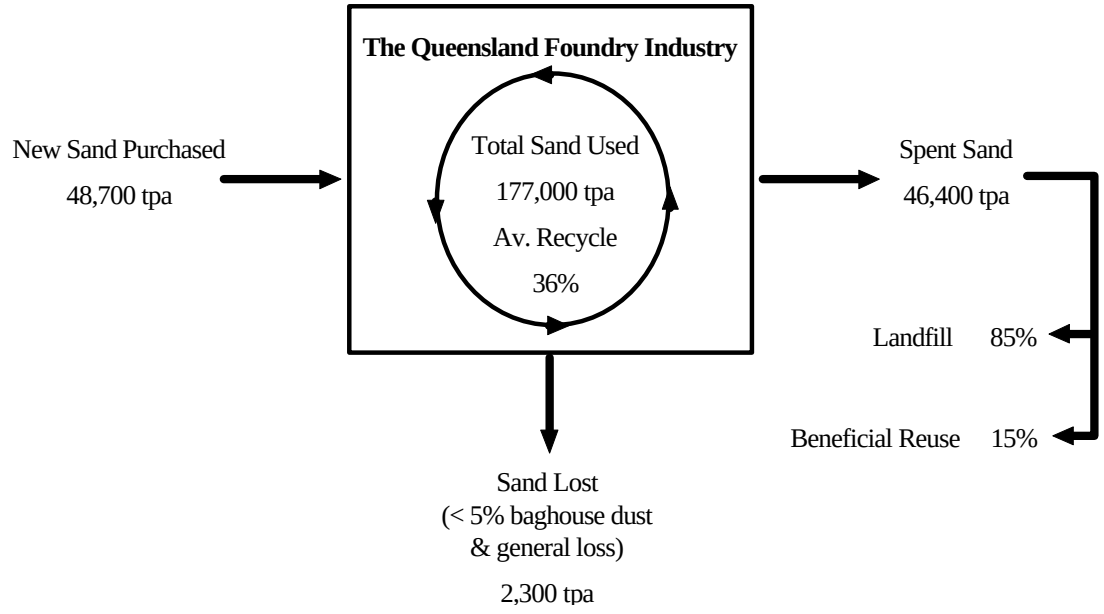
In general, the outlook for Cleaner Production in Queensland's foundry industry is quite promising with many of the ideas presented in this manual already being undertaken. Based on a recent survey of Queensand's major foundries, companies have actively sought to minimise waste and maximise resource efficiency in a number of areas throughout the foundry. Some of the most interesting examples include:

- Beneficial reuse of industry byproducts, particularly sand, baghouse dust and shotblast;
- On-site and off-site sand reclamation and reuse;
- Energy efficiency programs (eg. covering ladles, energy management and production scheduling, ensuring equipment is turned off when not in use, capturing waste heat from the furnaces and heat treatment processes);
- Increasing on-site recovery and reuse of metals including shotblast, machining fines and baghouse dust metals;
- Better segregation of shotblast from sand to increase reclamation;
- Conversion of baghouse dust to slag to reduce disposal costs or increase beneficial reuse options;
- Regenerating machine cutting oils;
- Investigation of new resin systems;
- Changing energy sources (e.g. grid power to bagasse, propane to natural gas, diesel to electricity); and
- Improving layout and housekeeping practices.

Reclaiming sand for reuse within the foundry process is seen as an important means of reducing the amount of sand disposed to landfill. Many of the larger foundries currently undertake manual sand reclamation. For foundries that produce large, iron castings sand recovery rates for manual reclamation can be as high as 90-96%, however for most operations in Queensland, recovery rates for those foundries undertaking reclamation is typically around 70-80%.

A number of Queensland companies are in the process of installing manual sand reclamation systems or optimising the systems to increase recovery rates. Thermal reclamation has not been widely adopted in Queensland due to the high cost of the systems and the relatively small volumes of sand generated in the state. One Queensland foundry, using a shell casting process, has recently commenced thermal sand reclamation to recover 100% of its waste sand. Many of the conventional sand casting operations have investigated thermal reclamation and may invest in these systems in the future.

Figure 1: Sand Flows in the Queensland Foundry Industry



As depicted in Figure 1, the average rate of internal sand reclamation for the Queensland foundry industry as a whole is currently 36%. Based on stated plans by several Queensland foundries, the industry average could potentially increase to 50% within the next two years.

Moving beyond 50% recovery will be relatively difficult. A further 5% may be gained if companies improve the efficiency of the current systems. Further gains will probably only be possible through the greater use of thermal reclamation, by improving moulding techniques to reduce the sand input, by changing to different casting processes or by identifying cost effective methods for sand reclamation at small foundries.

While significant work has already been undertake, most Queensland foundries recognise that there are many opportunities for continuous improvement in terms of by-product minimisation and for improving resource efficiency. Key areas identified by the sector include improved sand reclamation, metal yields, energy efficiency and the beneficial reuse of byproducts. All of these opportunities are discussed in further detail in this report.

3. What is Cleaner Production & what are its Benefits?

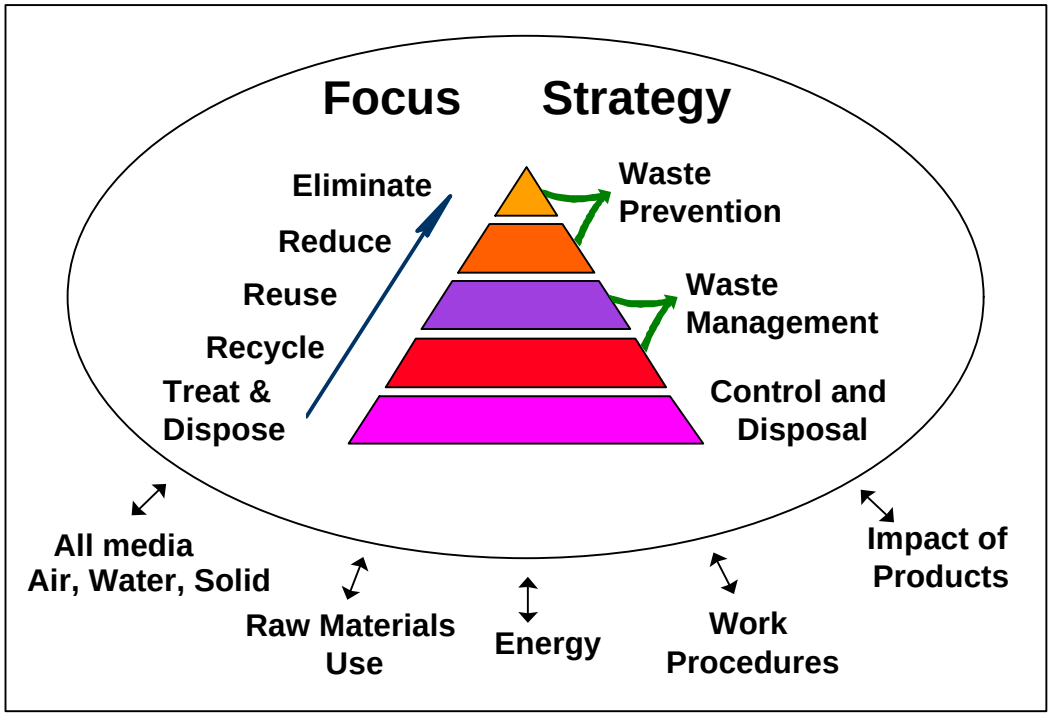
Cleaner Production focuses on eliminating waste and inefficiency at their source, rather than finding 'end-of-pipe' solutions once the wastes have been generated. It involves rethinking conventional methods to achieve 'smarter' production processes and products to achieve sustainable production.

In adopting the Cleaner Production approach, try to consider how wastes can be avoided in the first place rather than focusing on how to manage or treat them once they have been generated.

Waste avoidance and reduction should be considered as the first options. Once all avoidance and reduction options have been eliminated, then options for on-site reuse and recycling can be considered. Only as a last resort should treatment and disposal options be considered. This approach is depicted in the Cleaner Production Hierarchy shown in Figure 2.

Cleaner Production has been the major environmental initiative for industries in the 1990's. Thousands of manufacturing companies, including foundries have taken up Cleaner Production approaches to manufacturing.

Figure 2: The Cleaner Production Hierarchy



3.1 Saving money

Cleaner Production can save money; money which would have otherwise been spent on wasted resources, waste treatment, disposal and compliance costs.

Cleaner Production strategies typically cost less than treatment and disposal (so called 'end-of-pipe') technologies. Complying with the emission limits established by government through on-site treatment can be a significant cost; may require specialist knowledge and attention, and generally provide no profit for the organisation.

Many strategies, such as general housekeeping and process improvements can be implemented at low cost and can have immediate benefits, up to 30% in some cases. Substantial process modifications or technology changes will require capital investment, however numerous case studies demonstrate that pay-back periods can be as little as months to 2 years.

3.2 Preventing pollution

Pollution prevention by reducing energy, water and resource consumption and minimising waste is at the core of Cleaner Production. With the emphasis on reducing waste at the source rather than controlling pollution after it has been generated with 'end-of-the-pipe' solutions, many pollution problems can be eliminated.

3.3 Complying with environmental legislation

Working toward Cleaner Production will greatly assist in complying with stricter environmental legislation, bringing the benefits of reduced liability, reduced regulation, reduced monitoring costs, potentially reduced licensing charges and better control over your business. Environmental regulations and standards are becoming tighter and more comprehensive and this trend is expected to continue in the future.

The Environmental Protection (Waste Management) Policy embraces the waste management hierarchy and in some cases requires businesses to prepare a Cleaner Production Plan. Table 3 contains the type of information that must be included in Cleaner Production Plans.

Table 3: Contents of a Cleaner Production Plan

A Cleaner Production Plan must contain details of:	A Cleaner Production Plan may need to address other issues such as:
• Current waste management practices; • Material, energy and resource inputs; • Material, waste and energy outputs; • Impacts of the production process on environmental values; • Opportunities and actions to be taken to avoid and reduce waste (including toxicity, energy and water); • Opportunities and actions to be taken to recycle wastes; • Recommendations of any life cycle assessment conducted; • Targets and goals; • Program of action and timeframes; • Any certified or approved quality assurance or environmental management system or standard; • Monitoring and reporting program.	• input substitution—replacing an input with a non-hazardous or less hazardous substance; and/or • product reformulation—substituting an alternative end product which is non-hazardous or less hazardous upon use, release or disposal; and/or • production process modification—upgrading or replacing existing production process equipment and methods with other equipment and methods, and/or • improved operation and maintenance of production process equipment and methods—modifying or adding to existing equipment or methods; and/or • closed-loop recycling—recycling or extended use of substances which become an integral part of the production process.