REUSE OPTIONS FOR FOUNDRY WASTE SAND – F10

Energy eco-efficiency opportunities in Queensland Foundries

Facilitating beneficial reuse

Every year Queensland foundries generate thousands of tonnes of sand that is not suitable for continued use in the mould or core making process. Despite the fact that much of this sand is nonhazardous and suitable for a number of applications, only a small percent of this sand is currently being beneficially reused with the remainder being disposed of in local government landfills.

This fact sheet has been designed to assist:

- **foundry operators** take the necessary steps to understand the level of contaminants in their waste sand, potential reuse options and the process to achieve reuse
- **waste service contractors** to understand the steps to receiving foundry waste sand for reuse options
- **Sand users** to understand the potential of foundry waste sand as an input to their processes.

The benefits of finding smarter reuse options for spent foundry sand include:

- reduced tonnage to landfill and associated disposal costs
- possible source of revenue from waste converted to a valuable by-product or raw material for another process
- reduced demand on sand and quarry resources
- reduced energy consumed in the mining and preparation of the sand.

There are three basic types of reuse options[1]

1. **Reuse options where the sand is bounded (i.e. contained) and stabilised** in a manufactured product e.g. Portland cement, asphalt or concrete products such as pavers and masonry blocks.

COLLABORATION BRINGS SAVINGS TO ALL PARTIES[2]

A collaboration between the Australian Sustainability Industry Research Centre, Veolia, GM Holden and Blue Circle Southern Cement will now see over 10,000 tons of spent foundry sand being diverted from landfill every year. In September 2008, after three years of research, the first loads of recovered silica material from GM Holden were delivered to Blue Circle Southern Cement. The foundry sand is pre-processed then sent to the cement kilns where it is used instead of virgin sand.

1 US EPA, 2006, State Toolkit for Developing Beneficial Reuse Programs for Foundry Sands www.epa.gov/sectors/sectorinfo/sectorprofiles/metalcasting/toolkit.pdf

2 Sustainability Victoria, 2008, Veolia – Foundry Sand Reuse www.resourcesmart.vic.gov.au/for_businesses/case_studies_4232.html

2. **Reuse options where the sand is usually contained but not stabilised** in geotechnical applications such as road bases, embankments, construction fill and landfill.

INERT SAND USED FOR FILL[3]

A small aluminium and copper based casting foundry in Sydney tested its spent sand and found it was inert. Upon looking for an alternative disposal method to landfill they found a construction company willing to take the sand for use as fill in its drainage pipe channels.

3. **Reuse options where the sand is not usually contained or stabilised** such as the use of sands in agricultural products including soil amendments, compost, manufactured soil and top dressing.

SPENT SAND REUSE

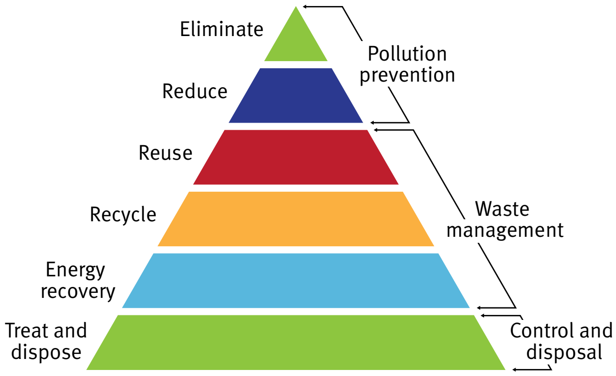
Bradken Foundry in Ipswich produces medium and large components for the rail and mining industries. The site transports approximately 400 tonnes per month of waste sand to Candy Sand who clean it for use in soil mixtures. Prior to giving the sand to Candy Sand the site was paying disposal costs to a local municipal landfill site. As part of the beneficial reuse agreement Candy Sand samples its soil every six months but to date the foundry has not been required to change its binders or other additives.

Sand reuse options need to be approved by the Queensland Department and Environment and Resource Management (DERM) to ensure appropriate consideration of environmental impacts. DERM look at the proposed reuse options on a case by case basis. The Draft DERM Guidelines for the Beneficial Reuse of Ferrous Foundry By-products provides advice on the likely options and considerations for foundries or interested third parties; DERM should be contacted for current advice.

Qld EPA, 1999, Draft DERM Guidelines for the Beneficial Reuse of Ferrous Foundry By-products can be found at: **www.derm.qld.gov.au/register/p00059aa.pdf**

The key steps in the process are provided below.

1. Demonstrate waste minimisation



Waste minimisation aims to reduce the source of waste and eliminate waste before it is produced, or reduce, reuse, recover or recycle it.

Before looking at external sand reuse opportunities, foundries need to demonstrate that all avenues to prevent and minimise the generation of spent sand have been explored.

3 NSW Department of Environment and Climate Change, 2008, Waste Management - Some ideas on How Foundries can Reduce Waste **www.environment.nsw.gov.au/sustainbus/FoundryWaste.htm**

NO WASTE AT BRADKEN

Bradken Foundry at Ipswich has been looking for alternative options to landfill for all of its waste streams. The site's solutions clearly illustrate in practice the waste minimisation hierarchy discussed above.

- ELIMINATE – clean swarf is returned to the furnace
- REDUCE – runner sizes have been reduced also reducing energy consumption (see fact sheet Melting efficiency (F1) of this series)
- REUSE – oily and greasy swarf is sent to the Bradken Foundry at Runcorn where their electric arc furnace can accept this waste.
- RECOVER - slag is purchased by a reprocessing company who can recover valuable alloys and baghouse dust is sent to bio-energy company
- RECYCLE – agreements with customers to return worn-out products and timber from the mould boxes are recycled

Opportunities to reduce sand use include:

- improving cast design so more units can be added for each box to improve the sand to metal ratio
- removing corners and areas of excess sand which do not contribute directly to the integrity of the mould
- using a range of flask sizes so each cast is made with the most appropriate flask
- inserting blocks or other materials to fill voids in flasks
- using new sand for the metal/sand interface only and back filling with reclaimed sand
- minimising sand spillage
- optimise sand mixing system
- consider a secondary sand reclamation system if large numbers of high quality cores are produced
- optimise sand reclamation and investigate sand reclamation options by visiting the UK Envirowise website " Sand Management in Foundries" **www.envirowise.gov.uk/uk/Our-Services/Publications/EG005-Foundry-Greensand-Use-and-Reclamation-Guide.html**

Other opportunities to reduce waste throughout the process including selecting alternative inputs, improving metal yields, minimising foundry by-products and production planning and improvement can be found in the "Cleaner Production Manual for the Queensland Foundry Industry" at **www.ecoefficiency.com.au/Ecoefficiencystages/OpportunitiesforImprovement/Foundry/tabid/3640/Default.aspx**

BINDER OPTIMISATION IMPROVES RECLAMATION

To reduce costs and improve its sand reclamation process that was recovering around 60%, Bradken Foundry at Ipswich tested the impact of reducing the amount of binder it added to its sand and the effect on product quality. The site was able to reduce the binder by 1.5% without any product deterioration allowing 80% of the sand to be reclaimed. The site has found 75% reclaimed sand to 25% new sand is the optimal mix, an increase recovery rate of 15%.

2. Assesses for environmental and human health impacts

An initial analysis of the sand must be undertaken to determine the level and distribution of any contaminants throughout any stockpile. Table 1 can be used as a basis for assessing if the concentration of contaminants exceed environmental or health thresholds. If levels exceed the threshold further assessment may be required to determine its potential harm.

Some fine silica dusts and contaminants such as heavy metals (copper lead and chromium), inorganic chemicals (nitrogen and fluoride) and organics (phenol and formaldehyde) can limit reuse options.

Table 1: Investigation thresholds [4]

Type of contaminant	Background levels for soil (mg/kg)	Environmental investigation levels (mg/kg)	Health based investigation levels (mg/kg)
Metals/ metalloids			
Antimony	4-44	20	
Arsenic	0.2-30	20	100
Barium	20-200		
Beryllium			20
Boron	1-75		
Cadmium	0.04-2	300	20
Chromium (III)	0.5110	50	12%
Chromium (IV)			100
Cobalt	2-170		
Copper	1-190	60	1000
Lead	<2-200	300	300
Manganese	4-12600	500	1500
Mercury	0.001-0.1	1	15
Methyl mercury			10
Molybdenum	<1-20		
Nickel	2-400	60	600
Tin	1-25	50	
Zinc	2-180	500	7000
Monocyclic aromatic hydrocarbons			
Benzene		1	
Toluene			
Polycyclic aromatic hydrocarbons			
PAH (total)	0.95-5		20
Benzo(a) pyrene			1
Other chemicals			
Phenol		10	8500
Formaldehyde		10	
Fluoride		500	
Cyanides		500	500
Sulphate	35-1000	2000	
pH	6-8		

If any contaminants are not identified on the above table, foundries could refer to international guidelines such as Netherlands Department of Soil Protection, The New Dutchlist of soil contaminants as detailed in the Intervention Values and Target Values - Soil Quality Standards - www.contaminatedland.co.uk/std-guid/dutch-l.htm

4 Based on ANZECC/NHMRC thresholds for contaminated soils and national and international criteria (phenol, formaldehyde, fluoride, chromium (III) and zinc).

3. Select potential reuse options for spent foundry sand

There are numerous potential reuse options for foundry by-products. The quality and quantity suitability of the by-products must be verified before deciding on possible reuse options. Table 2 provides a list of potential reuse options for various foundry by-products.

Foundries should not deliberately promote a reuse option knowing that the waste stream contains contaminants that might at any time expose human health or the environment to levels of risk beyond prescribed limits. Consideration should be given to the whole of life of a product. For example, if sand is used to make bricks, the bricks may ultimately be crushed and reused elsewhere. Therefore the reuse option may not be the final resting phase of the by-product. Foundries have a responsibility under the draft DERM Guidelines for the Beneficial Reuse of Ferrous Foundry By-products to consider the human health and environment impacts of any remobilised contaminants.

Table 2: Potential reuse options for various foundry by-products[5]

By-prduct	A	B	C	D	E	F	G	H	I	J	K	L	M
Green sands	■	■	■	■	■	■		■	■	■	■	■	■
Alkali phenolic-bonded sand	■	■	■	■	■	■	■	■	■	■	■	■	■
Silicate-bonded sand	■	■	■	■	■	■	■	■	■	■	■	■	■
Furan-bonded sand	■	■	■	■	■	■	■	■	■	■	■	■	■
Resin-coated sand			■		■		■	■					
Core sand and core shop spills			■		■		■	■					
Furnace slag	■	■	■			■							
Furnace and ladle lining	■	■	■			■	■	■	■				
Sand reclamation plant baghouse dust			■		■		■	■					
Furnace baghouse dust			■		■		■	■					
Shotblast baghouse dust			■		■		■	■					
Shotblast fines			■		■		■	■					

Legend
A – Ingredient in the production of cement
B – Additive in concrete and concrete products e.g. blocks
C – Additive in fired products such as paved and bricks
D – Colouring agent in concrete products
E – Colouring in fired products
F – Component in road base
G – Constituent in asphalt manufacturer
H – Stock material for pelletisation to ceramic stage (filters for ponds or decorative pebbles)
I – Stock material for pelletisation to porous stage
J – Municipal landfill cover
K – Flowable construction fill
L – Filling/aeration agent in compost
M – Soil conditioner in agriculture

4. Approach potential reuse contractor with proposal

Foundries and interested third parties will need to determine the specifications of the reuse option and match the by-product with these specifications. An assessment of the potential human health and environmental impacts from the by-product must be undertaken by the foundry and third party.

Ideally foundries will verify the processing procedures involved and include a final product analysis that demonstrates the contamination is below environmental investigation levels. The foundry and reuse contractor must determine the reliability and means of supply over time and perform a cost benefit analysis to demonstrate a financial return.

5 Qld EPA, 1999, Draft DERM Guidelines for the Beneficial Reuse of Ferrous Foundry By-products
www.derm.qld.gov.au/register/p00059aa.pdf

5. Enter into an agreement with the reuse contractor

The draft DERM guidelines state that the foundry is accountable for the ultimate placement of the by-product. Long term stockpiling of the by-product before reuse may result in the by-product becoming airborne or eroded by rain. This may also result in an alteration in the composition of the by-product which can potentially make the by-product unsuitable for reuse. If the by-product requires careful management or is stockpiled prior to reuse, foundries should consider entering into an agreement with the reuse contractor to ensure the reuse contractor has the appropriate approvals and a management plan in place or that the contractor accept responsibility.

6. Continued segregation and on going quality assurance

Segregation remains a vital practice to ensure quality of the supplied by-product. Continuous sampling and testing may also be necessary. The parameters set for testing will depend on the potential contaminants and the reuse option. To ensure quality testing, foundries should summit duplicate samples known to be identical to ensure laboratories are producing reliable results. Sampling must be consistent with the Australian Standards AS1141.3.1

7. Submit to DERM for approval

Before a reuse option can be undertaken, approval must be obtained from DERM. As part of the approval process, the foundry must prepare a suitable environmental impact assessment and demonstrate that they are taking full responsibility to ensure any final end products will not harm the environment. They must provide justification for the frequency and location of sampling and the procedures that will be followed.

They should demonstrate a stable arrangement exists between the foundry and reuse contractor that includes a quality guarantee that meets the reuse contractor's specifications. Any regulated waste such as baghouse dust must be transported by a licensed operator. If the by-product is reused in an environmentally relevant activity under the *Environmental Protection Act 1994* the consumer must contact the administrating authority to check any requirements.

Other useful documents and websites:

Foundry Industry Recycling Starts Today, USA: **www.foundryrecycling.org**

URS, 2001, Geelong Foundry Sands Project: **www.brwmg.vic.gov.au/grants/reports/FinalFoundrySandsReport.pdf**

USEPA, 2006, State Toolkit for Developing Beneficial Reuse Programs for Foundry Sand: **www.epa.gov/sectors/sectorinfo/sectorprofiles/metalcasting/foundry.html**

This series of fact sheets provides examples and suggestions to the modern foundry operator on how to achieve both economic and environmental benefits from eco-efficiency. Visit the project website **www.ecoefficiency.com.au** for more ideas and case studies.

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The eco-efficiency for the Queensland manufacturers project is an initiative of the Department of Employment, Economic Development and Innovation and the Department of Environment and Resource Management with technical information provided by UniQuest through the Working Group for Cleaner Production. For further information visit the project website www.ecoefficiency.com.au

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