F I N A L R E P O R T

Geelong Foundry Sands Project

Prepared for

Geelong Manufacturing Council &

Barwon Regional Waste Management Group

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Contents

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This report provides details of the investigations completed by URS and provides a list of the various companies that have expressed an interest in using the materials for such things as concrete and cement production, compost additive and flowable fill (alternative to stabilised sand).

As part of this project, the term "F-Sand" was coined to define by-products from a foundry that are classified as Solid Inert against the Victorian EPA criteria. This term was chosen to assist in promoting the sand as a resource rather than sand as a waste. This is considered to be important factor in removing any uncertainty associated with the reuse of a valuable commodity.

Some customers could provide a continual demand for the sand materials (concrete, cement, topsoil), which would be an attractive option to the foundries.

In contrast, some of the potential customers will need certain projects to create a demand for the F-Sand materials. For example Barwon Water is planning to decommission a local sewer main over the next 12 months and may require some type of flowable fill material to fill the old tunnels - F-Sand could be used for this purpose with the addition of cement. To supply projects with F-Sand would require an independent company that would take on the role of wholesaler and ensure that the materials were collected from the foundries as required. This scenario may require the establishment of an F-Sand bank to store and value add these materials as appropriate.

Based on the alternative cost of transporting and disposing the by-products to appropriate landfills, it is estimated that the beneficial reuse opportunities identified would result in the companies saving in the order of $600,000.

Introduction

SECTION 1

URS Australia was commissioned by the Geelong Manufacturing Council and the Barwon Regional Waste Management Group to undertake a study of the by-products from three foundries in the Geelong region and to commence the development of a market for these resources. The scope of the project was detailed in the URS proposal to the Geelong Manufacturing Council dated 12 December 2000.

Ford Australia, IXL Backwell and Central Foundry were the focus of the project with further support being provided on the steering committee by the EPA, EcoRecycle Victoria and Unimin, the company that supplies sand to the three foundries.

This report provides details of the investigations completed by URS and provides a list of the various companies that have expressed an interest in using the materials for such things as concrete and cement production, compost additive and flowable fill (alternative to stabilised sand). Throughout this report these parties are referred to as "potential customers".

As part of the project, URS also prepared documentation for the three foundries. This included letter reports that document the results of the analytical assessments that were completed on the by-products and draft letters that were prepared to assist the companies with their correspondence with the EPA.

This project was funded by EcoRecycle Victoria via a market development grant with additional contributions being made by the participating foundries.

Over the past decade in Victoria there have been numerous occasions where the issue of foundry sands has been the focus of the EPA and the foundry industry's attention. This has included various discussions between the EPA and the industry associations with respect to the classification of the waste foundry sands as well as the prosecution of a transport company in 1998 due to the inappropriate disposal of these types of materials.

A study commissioned by the industry in 1998 unfortunately fell short of providing information that could be used to classify the sands. This outcome was reflective of the confusion that was still present in the late 1990's. It is considered that this confusion has been caused by a number of factors including:

- Inadequate knowledge on the industry's part regarding the various criteria that need to be considered in the assessment of waste materials. As a result, analytical testing has not been sufficient in many cases, for the company to assess the risks of these materials being disposed offsite. For example only recently have the foundries assessed the elutriable fraction of target analytes such as phenols.

- Insufficient clarification by the EPA with respect to the criteria to be used for the classification of these waste materials. The EPA has advised for this project and past projects that the 'criterion' for Phenol (leachable fraction) is 0.2 mg/L. However, this criterion is not included in any EPA publication.

- Different criteria being proposed by the regulators in the various Australian States. The Environmental Guideline published by the Queensland EPA includes a 'threshold' for Phenol (total) of 10mg/kg.

- The complexity of the foundry industry in terms of potential environmental impacts. There is a myriad of process inputs present in foundries across the state. There are ferrous, non-ferrous and mixed metal foundries. Some foundries use phenolic based resins, some use more benign resins and others predominantly use "greensand" (silica, clay, carbon mix).

- Further knowledge about the impacts of industrial contaminants has emerged including the distinction between health risks (people) and environmental risks (eg. fauna, flora). For example phenols have been shown to be more of an environmental risk than a health risk and more stringent criteria apply for environmental protection. This distinction has lead to some confusion within the foundry industry.

This project has had the active support of all interested parties including the EPA and industry. The project has provided an excellent opportunity to tackle many of the issues that have historically been barriers to progress.

During this project the EPA has confirmed a criterion that should be used for assessing by-products from ferrous foundries in Victoria (refer Appendix A). In addition, as a result of the recent changes to *the Environment Protection (Prescribed Waste) Regulations 1998* (the "Regulations"), the EPA has made it easier for industry to gain an exemption if they find that materials exceed this criterion but can still be used in an environmentally friendly way. Both of these factors now provide greater clarity for companies wishing to divert ferrous foundry by-products to beneficial uses.

The Geelong Foundry Sands Project involved a number of tasks as follows:

1. Assessment of the by-products to determine their classification in line with the EPA criteria. This task included the preparation of reports the individual foundries could use to notify the EPA of their intention to divert the identified "Solid Inert" materials from landfill to a beneficial use.

2. Physical testing on some materials to provide further technical information to the potential customers.

3. Research into the options for reclaiming those foundry waste materials that cannot currently be classified as "Solid Inert" under the EPA criteria.

4. Identifying potential customers and introducing these organisations to the identified "Solid Inert" materials that are available immediately for a variety of uses.

5. Preparation of this report.

The remainder of this report documents the finding of our investigations and provides various recommendations for progressing the opportunities that have been identified.

4.1 Introduction

Prior to embarking on any market development activities, URS undertook an investigation to determine the classification of the by-products that are generated at the three Geelong foundries. This section provides a summary of these investigations and the findings. More detailed information was included in the individual reports that were prepared for the foundries, which were used to notify the EPA. This information has been excluded from this report for confidentiality reasons.

4.2 Site Diagnostic Surveys

URS visited each of the facilities to gain an appreciation of the processes involved at the site and the by-products that are generated. In reviewing the by-products, attention was given to the quantity, colour, and nature of the materials as well as the systems that are used to segregate, store and dispose of the different by-products.

The initial diagnostic surveys included a review of the data that had previously been generated for the by-products including chemical analyses, sieve analyses and generation rates. In addition, URS reviewed records of the EPA correspondence relating to the by-products.

The site survey allowed URS to design a sampling program to provide the necessary data for classifying the materials against EPA criteria that had been agreed with the EPA for this project. Given that the three foundries were primarily involved in the production of ferrous castings, phenols were the main compounds that were considered. However, URS recommended testing for other analytes where we considered that there was a chance that these may be present in the by-products.

4.3 Sampling & Analysis Program

4.3.1 Chemical Assessment

The IXL and Ford facilities were subsequently visited to allow representative samples to be taken of the by-products. A representative sample was collected by preparing a composite sample from sub-samples taken from across the stockpile of material. Sand lumps that were still held together by the resin binder were crushed to less than 25mm prior to the composite sample being taken from aggregated sub-samples. The samples were transported under cooled conditions to the ALS laboratory, which is NATA certified for the analyses that were required.

The resins used by the Central Foundry do not contain phenols and the foundry only produces ferrous castings. As a result of these processes and given the results of chemical analyses that had been conducted in 1998, URS considered that it was not necessary to conduct further sampling of the by-products generated at this foundry. The sands at this site were considered to be Solid Inert.

4.3.2 Physical Assessment

In order to characterise the physical features of the by-products a program was established with Ford that involved sieve analyses to report the grading of the various materials. This was supported by a review of the product specifications for the main additives to the Ford process including the silica sand, bentonite and 'Duracarb'. In addition, a review of the grading of the silica sand used by IXL was completed, which showed that the F-Sands generated by Ford & IXL are similar, apart from the fine grained fraction associated with the bentonite and carbon introduced for the Ford materials.

Table 1 is an example of a grading for an unwashed mould sand. The gradings of the by-products from the foundries, as described in Table 2, will vary according to the process.

Table 1

Typical Grading Analysis of Raw Sand Material

Screen (mm)	Screen AFS	%Weight Retained
0.850	20	0.30
0.600	30	1.10
0.425	40	17.35
0.300	50	31.90
0.212	70	33.90
0.150	100	13.36
0.106	140	1.89
0.075	200	0.20

4.3.3 EPA Criteria

As discussed in Section 2, the EPA has specified a criterion for the elutriable fraction of Phenol (total), which is 0.2 mg/L (refer Appendix A). Therefore if the elutriable fraction of phenols is less than this limit, the ferrous foundry by-product can be classified as Solid Inert. This is the classification used for non-hazardous industrial wastes. By-products transported from any site with an elutriable fraction of phenols greater than 0.2mg/L are classified as Prescribed Industrial Wastes.

Historically, ferrous foundries that produce Grey iron, SG iron and CG iron casting have not needed to focus on heavy metals given the low level of alloys in the casting mix. The EPA has therefore not in the past been requested to establish criteria for the assessment of these materials. However, in the case of emission dusts that are captured at the foundries (eg. in baghouses), the presence of heavy metals may result in these types of materials being classified as Prescribed Industrial Wastes under the Regulations.

Whilst specific criteria for industrial wastes have not been established by the EPA, the 'Fill Material' criteria presented in Table 2 of EPA Publication 448 provide a reasonable guide in the first instance. If the heavy metal concentrations are above these limits, foundries will need to apply to the EPA for an exemption from the Regulations if they wish to facilitate the beneficial reuse of these materials. In assessing an exemption application, the EPA will consider the proposed use of the materials and the chemical and physical state of the materials (eg. baghouse dusts). The Authority may also require leachability data to be presented for the subject materials.

We understand that the EPA is currently communicating with the other States to confirm the approaches that are being used in Australia to assess these types of materials. In the interim, companies seeking an exemption from the Regulations are advised to develop a case for their materials based on available scientific evidence and submit this to the EPA regional office for consideration. Further information on managing prescribed industrial wastes is presented in Section 7.3.

4.4 Material Classification

Based on the results of the investigations completed as part of this project, there are approximately 145 tonnes per week of Solid Inert material currently being generated in the Geelong region (refer Table 2). This material is available for immediate reuse given that no approval is required from the EPA for these materials. However, companies should advise the EPA of their intention to direct these materials for beneficial reuse and update the relevant Regional EPA offices when a beneficial user has been identified.

As part of this project, the term "F-Sand" was coined to define by-products from a foundry that are classified as Solid Inert against the Victorian EPA criteria. This term was chosen to assist in promoting the sand as a resource rather than sand as a waste. This is considered to be an important factor in removing any uncertainty associated with the reuse of a valuable commodity.

In classifying the by-product materials a number of categories were identified that either suit a target user or require different management practices for disposal. Table 2 provides a list of material categories and a description of each. The classification names are used later in this report to present the recommendations for specific material streams.

Table 2
Material Classifications

Category	Quantity generated / week (tonnes)[1]	Physical Description	EPA Classification[2]
F-Sand 1	85	Mostly fine black sand with some small off-white core lumps	Solid Inert
F-Sand 2	60	Hard off-white and brown sand lumps and fine sand	Solid Inert
PIW - 1	70	Fine sand	Prescribed Industrial Waste - Category C(2)
PIW - 2	25	White and off-white sand lumps (cured sand)	Prescribed Industrial Waste - Category C(2)
PIW - 3	15	Uncured core sand and dusts containing elevated heavy metals	Prescribed Industrial Waste - Category B
Total	255 tonnes / week		
Suitable for beneficial reuse	240 tonnes / week		

1. Estimated quantities for Geelong region. Ford production currently lower than last year.
2. Refer to EPA letter in Appendix A and Industrial Waste Management Policy (Prescribed Waste) for descriptions of EPA classifications.

Further information about the classification of the by-products at each of the foundries is included in the individual reports that have been prepared for the participating companies.

5.1 Introduction

There were a number of tasks completed in developing a potential market for the F-Sand materials. The tasks included:

1. Literature review
2. Discussions with foundry industry representatives regarding past attempts to develop a market for these materials
3. Preparation of promotional information for distribution to potential customers
4. Discussions with potential customers to identify the level of interest in the available resources. This included a visit to the Ford Casting Plant to allow interested parties to observe the materials and collect a sample for their own assessment.

5.2 Literature Review

URS was provided with a collation of case studies that had been prepared by the IXL foundry. These included examples of beneficial reuse and reclamation from sites in the USA, Canada and Europe.

- Ohio State was one of the early movers in the US where foundry sands were being used for flowable fill and construction fill in the early to mid 1990's. In 1999, this initiative was further consolidated with the establishment of a recycling consortium called FIRST, which stands for "Foundry Industry Recycling Starts Today". FIRST is an industry-sponsored consortium whose mission is to create sustainable markets for foundry industry by-products. Active in this program is the Ford Motor Company's Cleveland Casting Plant. The materials are also used for the manufacture of topsoil for golf courses and other recreational applications.
- In Ontario Canada, the use of spent foundry sand as an aggregate in hot-mix asphalt has been occurring since the early 1980's. This application has been shown to benefit both the foundries and the quality of the hot-mix.
- Work undertaken by Tarmac Topblock in Derbyshire, UK has shown how alkaline phenolic foundry sands can be used profitably for the manufacture of light weight concrete blocks for the construction industry.

The draft Environmental Guidelines (1999) produced by the Queensland EPA, provides details of the pro-active approach that is being encouraged by the Agency together with the foundry and recycling industries for the management of foundry by-products. Appendix 2 of the Queensland Guidelines presents a table of the potential reuse options for various foundry by-products, which suggests that there are many similar uses for the green sands and alkaline phenolic bonded sands generated in the Geelong region.

Literature reviewed as part of this project is presented in Section 9.1.

5.3 Local Foundry Industry Experience

Discussions with representatives from the Ford, IXL Backwell and Central Foundry highlighted the investigations that have been conducted by these companies in the past to develop beneficial reuse opportunities. Both IXL and Central have previously had sand by-products collected by Local Mix for use in the production of concrete. This is an initiative that was progressed with the approval of the EPA and involved the foundries paying Local Mix for the collection of these materials from the sites. This initiative has been continued by IXL during this project as a result of the recent analysis program.

Ford Australia has previously had by-products from its casting plant classified by the EPA as Solid Inert with the total phenols (elutriable fraction) being less than 0.2mg/L. In 1998, Local Mix collected the materials and with the addition of a small quantity of cement produced a flowable fill material, which can be used as a substitute for stabilised sand. The flowable fill was used for the lining for the two water storage reservoirs that are located in the north-western corner of the Ford Casting Plant in Geelong. The local contractor who completed this work, Dimac, confirmed that this was very good material to use for the lining of the reservoirs and compares favourably to stabilised sand given that it "stands up" better.

The production of flowable fill did not continue once the demand for materials at the water reservoirs had been met. Since this time we understand that Ford's waste management contractor has conducted some trials for using the materials as a soil conditioner, although these trials ceased during 2000 pending the outcomes of this project.

5.4 Promotional Material

URS developed some promotional material as part of this project for distribution to potential customers. This included a materials information sheet with the term "F-Sand" being given to the Solid Inert materials that are available from the Geelong foundries (refer Appendix B). Whilst this was generic information and not a material specification as such, it provided preliminary information that was considered to be useful by the potential customers in gaining an appreciation of the general nature of the available resource.

The information sheet was supported by further technical information that was provided to potential customers on request. This included grading analyses of the sand materials as well as specific data for the bentonite and Duracarb material that is added to the green sand at the Ford plant.

5.5 Identifying Potential Customers

Various people were contacted throughout the Geelong region to identify organisations that may have an interest in the F-Sand material (refer acknowledgments at end of this report). Table 3 provides details of

the organisations that expressed an interest in the materials.

Table 3

Organisations potentially interested in F-Sand Materials

Company	Possible Use
Dimac (Contractor)	Flowable fill - project related.
Local Mix	Concrete, loam, stabilised sand (flowable fill), NDCR
Blue Circle	Cement production
Organic Recyclers	Compost blend
Geelong City Council	Construction works & maintenance works - project related
Transwest	Compost blend
Geelong Wool Combing	Compost blend
Lara Garden Supplies	Topsoil manufacture
Barwon Water	Flowable fill for filling decommissioned sewers and possibly filling voids above collapsed sewers - project related.
Corio Tip	Cover material
Ford Australia	Use material for landscaping and rehabilitation at the Lara Proving Ground.

Table 4 lists other companies that were contacted by URS but which do not currently have a use for the materials in the Geelong region.

Table 4
Companies not able to use F-Sands in Geelong region

Company	Use	Barrier
Nubrick	Bricks/Pavers	Distance -manufacture in Scoresby and Craigieburn
Boral Masonry	Bricks/Pavers	Distance - manufacture in Thomastown
CMW	Bricks	No longer manufacture bricks
Selkirk Bricks	Bricks	Distance - manufactured in Ballarat

Whilst there remain numerous potential customers outside of the Geelong region, the level of interest experienced during this project suggests that the F-Sand could be used in the Geelong region and thereby minimise the requirement for high transport costs.

A visit to the Ford Casting Plant was conducted on April 27 2001 and was hosted by Terry Beardsmore from Ford. The site visit included inspections of the:

- F-Sand materials available at the Sand Plant
- F-Sand materials available from the Scrap Sand Plant
- Water storage reservoirs where the flowable fill has been used.

During the various telephone conversations and the discussions during the site visit, it became evident that the interest in the foundry by-products extended beyond the F-Sand to include the other materials (prescribed industrial wastes) included in Table 2. However, given the focus of this initial site visit was on the F-Sand material the other materials were not included in the inspection. Some discussion of these other materials is presented in the following section of this report.

6.1 Introduction

This section of the report documents the various management strategies that should be considered by each of the foundries for the improved management of the foundry by-products including the Solid Inert, F-Sand materials.

We have initially included a discussion on the approach that the foundries should take to realise the immediate opportunities that have been identified in the Market Development section of this report (refer Table 3). This is followed by information that relates to by-products that cannot be classified as Solid Inert at this point or where there is opportunity for the by-products to be reintroduced to the process.

6.2 Handling of Foundry By-Products

The foundry sands contain a fine particle fraction that can sometimes lead to dust generation, particularly for the green sands from the Ford facility. Similarly to the handling of other fine silica materials, the dust needs to be controlled to ensure that no health or environmental issues result from the treatment, handling or storage of the foundry materials. Water sprays or covers will therefore need to be considered when these materials are to be stored in the open.

6.3 Beneficial Reuse of Solid Inert Material

6.3.1 Prospective Options

Based on the literature review and the discussions with the various industry contacts, there is a range of options that are available for the beneficial reuse or recycling of the F-Sand materials. Possible uses include:

- Concrete production
- Bitumen production
- Flowable fill (replacement for stabilised sand)
- Agricultural soil conditioner
- Loam production
- Cement production
- Roadbase/crushed rock
- Brick & paver manufacture

- Drainage sand
- Compost additive
- Bedding sand.

Given that these materials have been classified by URS as Solid Inert these opportunities can be progressed immediately, although in some cases specific use may require further testing to characterize particular physical characteristics (such as grading). It has been recommended that long term contracts be considered carefully given that market forces may provide a more attractive option for the foundries once the value of the F-Sand materials is recognised in comparison to substitute materials such as virgin sand.

6.3.2 Key Benefits to Prospective Customers

The F-Sand materials can provide real benefits to customers although each potential customer will value the materials differently given that they will be comparing the F-Sand materials to substitute/competing materials. Table 5 highlights some of the key benefits that would be realised by customers through the use of F-sands in their processes.

Table 5
Key Benefits of F-Sand

Reuse Option	Key Benefits
Soil conditioner	Dark colour of green sand is appealing to final users (households) Trace elements are advantageous for agricultural uses F-Sand turns compost into loamy topsoil Alkaline sands can be used for pH adjustment of acidic soils Can increase drainage characteristics of clayey soil
Cement production	Silica is a key ingredient of cement F-Sand includes alumina and iron oxide, which are also ingredients of cement
Flowable fill	Low cost option to stabilised sand Bentonite reduces permeability, which can be advantageous for applications such as collapsed sewer rehabilitation and trench backfilling Bentonite provides support for sand particles therefore is easier to use

	than stabilised sand
Concrete production	Low cost alternative to virgin sand Likely to be readily blended with other sand ingredients

6.3.3 Perceived / Real Barriers to Reuse

Given that there are so many options available it is to some extent surprising that the F-Sand materials have not been more attractive to the market in the past. However, as discussed in Section 2, there has been a degree of confusion regarding the suitability of these materials for reuse.

Whilst this project has shown that there are real opportunities associated with the reuse of the F-Sand there are a number of matters that will need to be managed by the foundry industry including:

- Consistency of supply in terms of quantity - this is obviously linked to foundry production, which is dynamic to some extent
- The variability of the product in terms of colour, grain size and in some cases the presence of tramp metal and other litter, which will be of concern to some customers.
- The opinion that the F-sand is a waste rather than a resource - this will only change with ongoing education of potential users plus the active support of the EPA, foundry industry and those who are already benefiting as a result of using the materials. The education program should be aimed at increasing the demand for the F-Sand materials.

6.3.4 Potential Value of F-Sand

There are a number of factors that will determine the value that is given to the F-Sand materials currently being generated in the Geelong region including:

- The values of existing materials such as virgin sand, which costs in the order of $5-12/tonne (ex-bin).
- The market demand and price of topsoil, which can be produced by mixing F-Sand with compost. Topsoil can be purchased wholesale for about $18/tonne (ex-bin), with compost itself costing about $10-12/m^3 (ex-bin).
- The cost to transport materials to the customer's site. Transport within Geelong region would be in the order of $4-7/tonne whereas transport from outside Geelong would be >$7/tonne.
- The inherent value of the green sand materials for some applications that may find value in the bentonite and/or carbon.

A foundry in Queensland is currently selling sand by-products to a company that is blending the material with compost for sale to the commercial and domestic markets. The company is understood to be receiving $8/tonne from the customer who also pays for the collection of the sand from the foundry site.

At the other end of the spectrum is the use of F-Sands for cover material at the local landfill. In the case of the Corio tip there would be no gate charge for these materials and the transport costs for the participating companies would be in the order of $6-8 / tonne.

Table 6 provides a range of values that could be expected during 2001 for the various potential uses in the Geelong region for both F-Sands and materials that have been classified as prescribed industrial wastes (refer Table 2). Figures are presented as total revenues to the company per tonne of material. Total costs (including transport costs) are shown as a negative revenue.

Table 6
Potential value of By-Products in Geelong Region

Potential Use	F-Sand-1	F-Sand-2	PIW-1	PIW-2	PIW-3	Limitation
Cement production	$1 to $8	$1 to $5	-$50 to $0	-$50 to $0	NA	May need to treat PIW. Otherwise gain an exemption.
Concrete production	-$3 to $3	-$3 to $5	-$50 to $0	-$50 to $2	NA	May need to treat PIW. Otherwise gain an exemption.
Topsoil production	-$5 to $7	-$7 to -$3	-$50 to -$15	-$50 to -$15	NA	Need to treat PIW and gain an exemption.
Flowable fill (stabilised sand)	$2 to $7	-$3 to $3	-$50 to $0	-$50 to $0	NA	Project demand related
Drainage material	NA	-$3 to $3	NA	NA	NA	Perception; fines content
Fill material / landfill cover	-$7 to -$5	-$7 to -$5	-$50 to -$15	-$50 to -$15	NA	Need to treat PIW and gain an exemption.
Disposal	NA	NA	-$120	-$120	-$120	Assuming no treatment

In arriving at these cost/revenue ranges the following assumptions have been made:

- Prescribed wastes, PIW-1 and PIW-2 could be remediated using bioremediation/aeration techniques at the foundry. Materials could be treated separately to clean low level residues quickly with further effort given to materials with higher phenolic concentrations.
- PIW-1 and PIW-2 materials may not need to be treated for cement and/or concrete production if an exemption is granted.
- PIW-3 wastes are unlikely to be suitable for beneficial use
- Crushing of lumps through a power screen would cost in the order of $2-3 / tonne. This may be required for some applications.

6.4 Prescribed Industrial Waste

Ferrous foundry by-products that exceed the EPA criteria (refer Section 4.3.3) are classified as Prescribed Industrial Wastes. These by-products generally include either elevated levels of phenols or heavy metals. It is unlikely that by-products that include elevated levels of heavy metals will be able to be treated cost effectively to product Solid Inert materials. However, where only phenols are an issue, it may be practical to treat these materials on-site to produce Solid Inert materials.

6.4.1 Treatment of Prescribed Industrial Wastes

Companies may choose to treat prescribed industrial wastes on site so that they can be classified as Solid Inert when they are transported from the site. In this case the materials would be suitable for beneficial reuse prior to leaving the site and therefore no exemption from the Regulations would be required. However, it should be noted that companies might require a Works Approval if on-site treatment is proposed.

Materials that are only impacted by organic materials such as phenols and petroleum hydrocarbons can be cleaned using natural techniques including aeration and bioremediation provided that it is consistent with current EPA policies. Waste heat from the foundry process could also be used to drive off the semi-volatile organic residues. Depending on the layout of the plant and the capacity to tap waste heat, this technique may be a cost-effective option for the more highly impacted materials such as uncured core sands.

Constraints such as available space or capital will determine whether or not these types of treatments can be completed on-site. Where capital is a constraint, there may be an opportunity for a third party to establish a treatment plant at the site and charge the foundry a fee for this service. Treatment of these materials will be a cost-effective option for most of the Prescribed Industrial Wastes generated at the facilities given the high cost of disposing these materials at landfill.

Treatment methods that use bio-remediation techniques could include landfarming techniques where the sand materials are blended with an organic product such as mulch or compost and the material is periodically aerated and mixed using mechanical equipment such as backhoe or bobcat. However, as part of this project a simple aeration treatment trial was conducted by Ford, which showed that the levels of leachable phenol could be reduced from 0.4mg/L to 0.2mg/L in less than four weeks.

An alternative approach, which requires less space and is more rapid, is in-vessel composting. It is understood that there has been some discussion in Geelong regarding the use of former cement kiln for this purpose. The technique involves an accelerated composting process where temperature, moisture and nutrients are closely controlled. This process could be used to treat by-products that contain elevated levels of organic residues.

6.4.2 Prescribed Waste Exemptions

If prescribed industrial wastes are transported from the foundry and taken to a non-licensed facility an exemption from the Prescribed Waste Regulations will need to be obtained from the EPA. Applications made to the EPA should include details of:

- Chemical characteristics of the materials (total concentration & leachability)
- Proposed destination of the material including any treatment proposed
- Intended final use of the material.

An application for exemption should be made for both the material and the transportation of these materials. Should the exemption be successful, Waste Transport Certificates may not be required.

An exemption from the Regulations is likely to be a cost-effective option and would be suitable if a company wishes to transport prescribed industrial wastes to another site for either treatment or use. In cases such as concrete production, treatment of these materials may not be required given that the processes involved in these products would secure any phenolic residues - in this case an exemption from the EPA may be feasible.

6.5 Sand Reclamation

Sand reclamation remains an option for the participating foundries although this would require a significant capital outlay with an anticipated payback of about 2 years at current rates. The purpose of reclamation is to allow greater reuse of sands and thereby minimise purchases of virgin sand.

The two main types of reclamation are mechanical and thermal. There are a number of examples of mechanical sand reclamation in Australia with these being used for the treatment of chemically bonded sands such as those at IXL Backwell. Alan Beckwith Macbro in Melbourne has recently commissioned a thermal reclamation plant. Ford currently sends shell sands from its Aluminium Casting Plant in Geelong

to this facility where sands are reclaimed and then sold back to Ford. However, this technology is not suitable for the alkaline phenolic sands generated at Ford's ferrous Casting Plant nor the IXL foundry.

A company in Queensland called Nat Tec has a patented microwave sand reclamation process that is suitable for any sand type. However, it is understood that this technology has not been developed for full-scale usage at this stage. The estimated energy costs are $10-20 / tonne for this process, which are substantially less than gas fired thermal reclamation equipment.

Reclamation is not likely to be an option for the participating companies at this stage given the large capital outlay.

7.1 Range of Opportunities

The Geelong Foundry Sands Project has identified a range of opportunities that can now be pursued by the industry to ensure that valuable resources can be diverted from landfill for beneficial use. As detailed in Table 4, there are a number of organisations operating in the Geelong region that are interested in investigating the options available for reusing the F-sand materials.

Some customers could provide a continual demand for the sand materials (concrete, cement, topsoil), which would be an attractive option to the foundries.

In contrast, other potential customers will need certain projects to create a demand for the F-Sand materials. For example Barwon Water is planning to decommission a local sewer main over the next 12 months and may require some type of flowable fill material to fill the old tunnels - F-Sand could be used for this purpose with the addition of cement. To supply projects with F-Sand would require an independent company that would take on the role of wholesaler and ensure that the materials were collected from the foundries as required. This scenario may require the establishment of an F-Sand bank to store and value add these materials as appropriate.

7.2 Potential Financial Savings for Foundries

Based on the alternative cost of transporting and disposing the by-products to appropriate landfills, it is estimated that the beneficial reuse opportunities identified would result in the companies saving in the order of $600,000.

This is based on there being approximately 240 tonnes out of a total of 255 tonnes that could be made available for reuse each week. Of this amount, there is estimated to be 95 tonnes of material per week that may need to be treated before it is suitable for use.

Based on discussions with the potential customers there is considered to be more than adequate capacity across the Geelong industry to absorb the quantity of sand material being generated each week.

7.3 Initiation of Treatability Trials

For materials that have elevated levels of organic compounds such as phenols, it is recommended that bioremediation/aeration trials be initiated in consultation with EPA to assess the effectiveness of natural processes. If space is available on the sites then this will be the best option given that an exemption from the Regulations may not be required. Companies will need to check to see whether a Works Approval is required for this type of treatment program.

Another option is to transport the prescribed industrial wastes to another site for treatment. This will require an exemption from the Regulations. It would be preferable if this site actually required a sand material so that the double handling costs are avoided. As an example, the Ford Lara Proving Ground could use the inert material to assist with any landscaping and rehabilitation works.

7.4 Centralised F-Sand Bank

As discussed previously, an independent party may be interested in establishing a broker service for handling all of the foundry by-products. To handle any overflow, an F-Sand bank would likely need to be established within the Geelong region to store/value-add these materials. The F-Sand bank would allow materials to be deposited on a regular basis and either on-sold in raw form or processed into other materials such as loam, flowable fill or sand. If the F-sand was located within or adjacent to a concrete plant or gravel pit, the F-Sands would also be able to be blended into concrete and/or crushed rock.

The F-Sand bank could also be established to enable any materials with elevated levels of organics to be treated to produce additional Solid Inert material. This would require the facility gaining an exemption from the Regulations.

7.5 Expansion of EPA Criteria

Whilst a criterion for Phenols was agreed with the EPA for this project, it is recommended that the foundry industry work with the EPA to determine the criteria for the assessment of heavy metal concentrations in by-products that are generated at ferrous and non-ferrous foundries. These criteria would allow the companies to proceed with further investigations confidently based on the knowledge that their materials will satisfy all of the EPA's requirements.

7.6 Housekeeping & Segregation

As the participating companies proceed to negotiate contracts for the sale of F-Sands, they will need to ensure that the current site controls ensure a consistent quality product is provided to the customer. Just as the production of castings is managed by a quality system, so too the segregation and handling of F-Sands needs to be managed in line with a quality system.

Companies need to ensure that materials such as tramp metal, litter and other waste materials do not enter the by-product streams. In implementing these controls, companies may need to conduct awareness training for key staff who are associated with the handling of the F-sand materials so that they can be active in the production of a product that meets the customer's specifications. Clear responsibilities need to be allocated for this type program to ensure that the quality standards are achieved.

7.7 Ongoing Analysis of By-Products

The analyses completed as part of this project provided a broad characterisation of the by-products generated at the facilities. To ensure that the companies continue to meet their legal requirements it is recommended that they conduct periodic sampling and analysis programs to verify past results. This is particularly the case where a change to the process or ingredients occurs which may change the chemical composition of the by-products. For some markets regular quality control analyses may be required for physical attributes of the material.

We have prepared this report for the Geelong Manufacturing Council and the Barwon Regional Waste Management Group in accordance with generally accepted consulting practice and within the limitations imposed by the brief, time and access restraints. It may not contain sufficient information for the purposes of other parties or for other uses. No other warranty, expressed or implied, is made as to the professional advice indicated in this report.

This report does not, and does not purport to, give legal advice on the actual or potential environmental liabilities of any individual or organisation, or draw conclusions as to whether any particular circumstances constitute a breach of relevant legislation. This advice can only be given by qualified legal practitioners.

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The bibliography, acknowledgments and appendices follow and complete this report.

Respectfully Submitted
URS Australia Pty Ltd

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Appendix A

Appendix B