

Part 6: Cleaner Production Guideline

1. Introduction to Cleaner Production

1.1 What is Cleaner Production?

Cleaner Production aims to prevent pollution, reduce the use of energy, water and material resources and minimise waste, profitably and without reducing production capacity. It involves rethinking conventional methods to achieve 'smarter' products, product components, and production processes.

The United Nations Environment Program (UNEP) defines Cleaner Production as *'the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce risks to humans and the environment'*. It includes:

Production processes: ... conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.

Products: ... reducing negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal.

Services: ...incorporating environmental concerns into designing and delivering services.

Cleaner Production requires changing attitudes, responsible environmental management and evaluating technology options.

1.2 How is Cleaner Production different?

Foundries use a lot of different materials and produce wastes that represent a cost to the company and can have an impact on the environment if they are not managed effectively. The wider community and governments may also face significant costs for treating and disposing of wastes and for repairing damage to the environment. These costs can be high and trends show that they are rising as pressure on the environment increases.

Traditional environmental protection focuses on what to do with wastes and emissions after they have been created. Treatment and disposal of waste generally only address the symptoms of an inefficient process. Waste is often an indicator that you are losing money unnecessarily.

The goal of *Cleaner Production* is to avoid generating pollution in the first place - which frequently cuts costs, reduces risks and identifies new opportunities. **Cleaner Production** aims to reduce waste and inefficiency at source and can help develop the most efficient way to operate processes, produce products and to provide services.

It can save your company money!

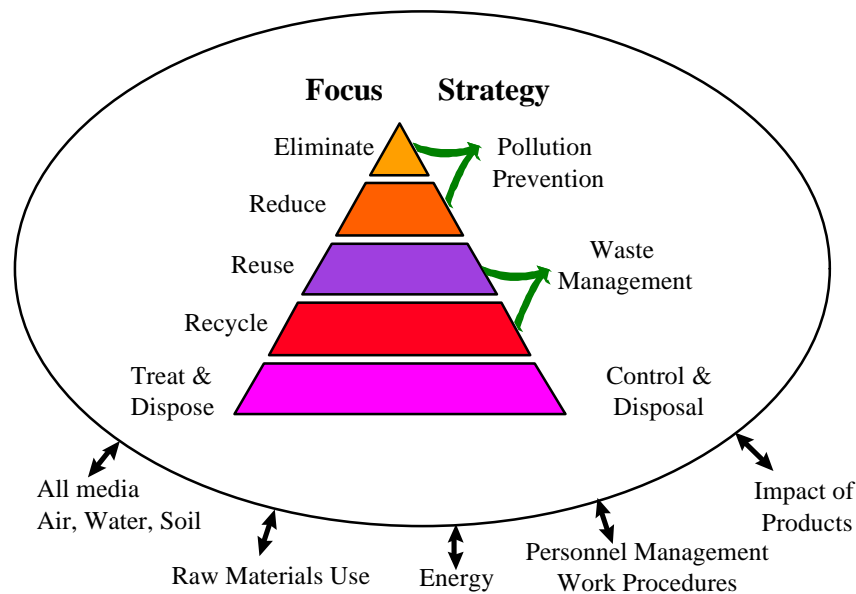
Improving environmental performance by reducing wastes and emissions is a major focus of Cleaner Production. Improved health and safety and also be an outcome of the process. Other benefits include new markets and business opportunities.

Cleaner Production provides an integrated approach that highlights both economic and environmental improvement. By using this approach, improving environmental performance and reducing the risk of causing environmental harm or nuisance becomes a natural outcome of running an efficient process.

1.3 The Cleaner Production Hierarchy

The Cleaner Production Hierarchy is a good tool to help think about Cleaner Production options in your operation and to focus on eliminating or reducing waste at source. In adopting a Cleaner Production philosophy, try to consider how wastes were created rather than how they can be treated. Typically, strategies higher up the hierarchy are more cost effective.

Figure 1: The Cleaner Production Hierarchy



1.3.1 Eliminate

Eliminating the need to use materials (particularly harmful products such as cleaning agents) can greatly reduce operating costs and reduce the potential harm to the environment, for example, by substituting hazardous materials with less harmful alternatives.

1.3.2 Reduce

The next step is to minimise the use of all materials in the process. This can include reducing errors in batch preparation, optimising cleaning operations to reduce the volume of water used and turning off equipment that is not in use.

1.3.3 Reuse

There are many opportunities to reuse 'waste products' in the foundry industry. This will reduce the demand for raw materials and the cost of treatment and disposal. It may be possible to reuse sand internally or to reclaim waste heat from one process for use in another.

1.3.4 Recycle

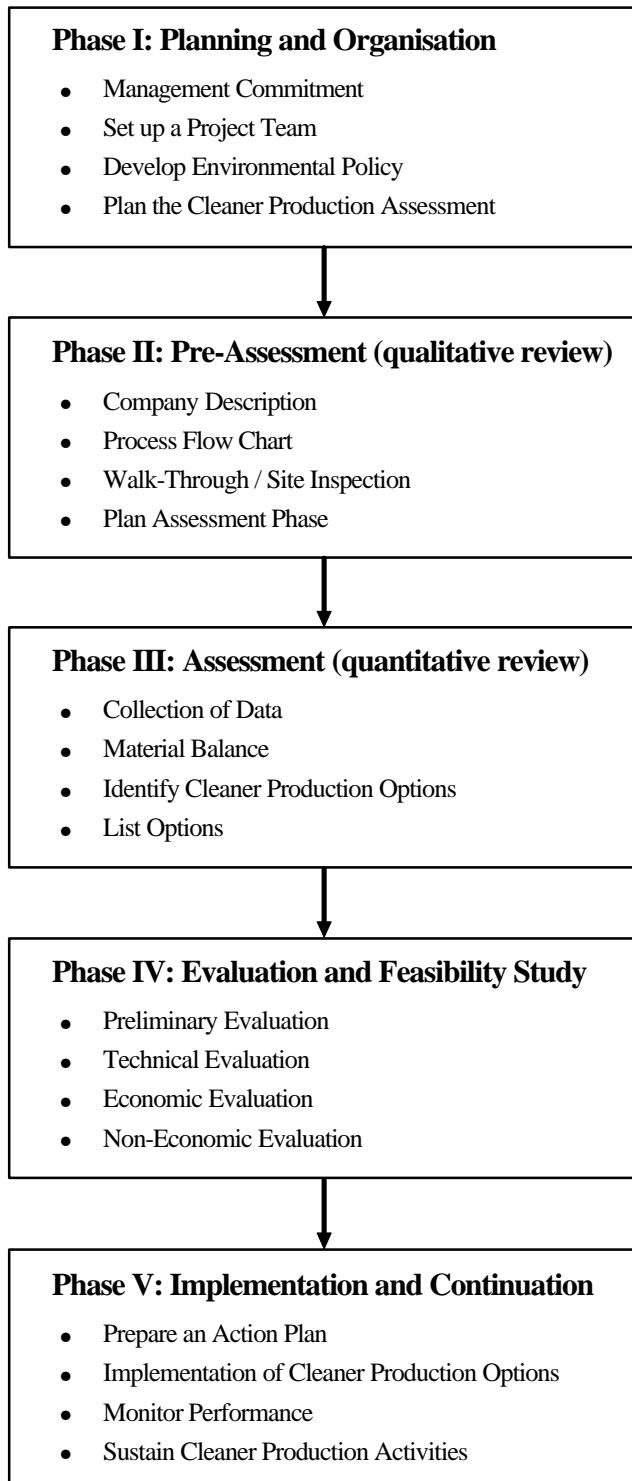
Are the wastes identified by your assessment really 'wastes'? Can some of these be reclaimed through simple treatment processes that enables them to be recycled on-site? Other by-products that cannot be used on site may be recycled off-site. In these cases there may be the potential to sell recyclable items and also save by the avoiding disposal costs.

1.3.5 Treat and Dispose

This option should only be considered after the other options have been exhausted. Generally these options are typically a cost to industry. However it may be essential to consider this as a part of your overall Cleaner Production strategy. The costs of treatment can be minimised by focusing on the previous options.

2. Implementing a Cleaner Production Project

Figure 2: Implementation Guide



A Cleaner Production assessment is a systematic approach to identify areas throughout the process where resource use, hazardous materials and waste generation can be reduced. While there are several approaches to undertaking CP assessments all of them have a similar underlying purpose - to encourage a formal / systematic examination of the company's operation, to capture all ideas in the system so they can be evaluated and implemented as appropriate, and to help maintain focus and progress towards the goals of the project.

Informal programs tend to start well but can lose drive over time as day-to-day pressures shift focus elsewhere. Non-systematic projects run the risk of focusing too much effort on areas with relatively modest potential gains.

The level of detail necessary varies between companies and should be guided by the potential benefits that can be gained from the program - including cost savings, environmental and other benefits.

The project scope also varies between companies. The pre-assessment phase (Phase II) should help to broadly define the scope of the project and the assessment phase (Phase III) should accurately measure resource use and waste throughout the process and identify process areas that are major contributors to the overall problem. This will help set priorities and ensure that your company's improvement actions will have the biggest impact for the effort expended.

3. Planning and Organisation

3.1 Getting Started

Is your company ready to implement a successful Cleaner Production program? There are a number of factors that appear to contribute most significantly to the success of company based programs, for example, getting top management support.

Think about the company culture and systems that help or inhibit Cleaner Production uptake.

3.1.1 Support

Companies are more likely to succeed when:

- management support the program for Cleaner Production / waste minimisation.
- top management drive change by communicating the benefits of Cleaner Production to all staff.
- sufficient time and resources have been allocated to achieve the Cleaner Production objectives.
- the company has a challenging Environmental Policy that encourages source reduction and continuous improvement.

3.1.2 Acceptance

Companies are more likely to succeed when:

- staff are aware of Cleaner Production.
- staff understand the economic and environmental importance of reducing waste.
- staff understand and support their role in achieving the objectives of the program.

3.1.3 Planning

Companies are more likely to succeed when:

- the Cleaner Production project is formalised and well planned.
- the project has an established framework, with a team leader, team members and clear roles and responsibilities.
- when the budget, timeframe, goals and success criteria are clearly defined and measurable.
- when progress is regularly reviewed and drive is maintained (by top management, the CP team leaders and everyone in the company).

3.1.4 Knowledge

Companies are more likely to succeed when:

- the project is based on good information. This can be gained from Cleaner Production / environmental or efficiency audits for energy, water, trade waste, materials etc..
- the company can set reasonable priorities based on the full value and impact of waste generated by the company.
- the procedures for identifying, evaluating and implementing Cleaner Production options are well known, supported and widely practised throughout the organisation.
- staff have sufficient training in correct waste minimisation procedures and know what to do with each type of waste (e.g. laminated signs posted around the site).
- staff know what to do with waste in the case of an accident / emergency.
- the company has an effective and timely materials accounting system in place - integrating purchasing, handling, inventory, process control and sales systems - to accurately track resource use, waste and produce variance reports (i.e. that compare actual and standard resource use and waste).
- orientation programs for new employees include Cleaner Production.

3.1.5 Skills

Companies are more likely to succeed when key staff have the necessary skills to:

- implement appropriate waste measuring and monitoring systems.
- undertake Cleaner Production assessments / audits.
- identify resources and product losses (emissions, wastewater and solid waste).
- identify Cleaner Production improvement opportunities.
- evaluate options (economic and non-economic analysis).
- implement viable options.

3.1.6 Improvement and Feedback

Companies are more likely to succeed when:

- progress is reviewed on a regular basis (e.g. annually) at a corporate level.
- staff are fully involved in the suggestion and improvement process.
- performance reviews include Cleaner Production goals.
- two-way communication exists between employees and management.

- feedback about achievements and improvements is regularly reported (e.g. KPI progress reports and wall charts).
- feedback is provided for all suggestions (even those that cannot be implemented).
- the cost of resource use (e.g. energy, water), waste generation, treatment and disposal and other overheads is allocated and charged to individual process units in accordance to the contribution of each.
- the goals of Cleaner Production are integrated into the overall business objectives of the organisation.

These success factors have been derived from a large number of Cleaner Production projects. Your project may, of course, succeed without some of these factors. They do not guarantee success, but they are a good guide based on previous experience.

4. Pre-Assessment

The pre-assessment is designed to give an overview of the organisation. This involves collecting or developing some basic process information that allows your company to set the broad scope of the Cleaner Production project. This information will also form the basis of the assessment and evaluation phases.

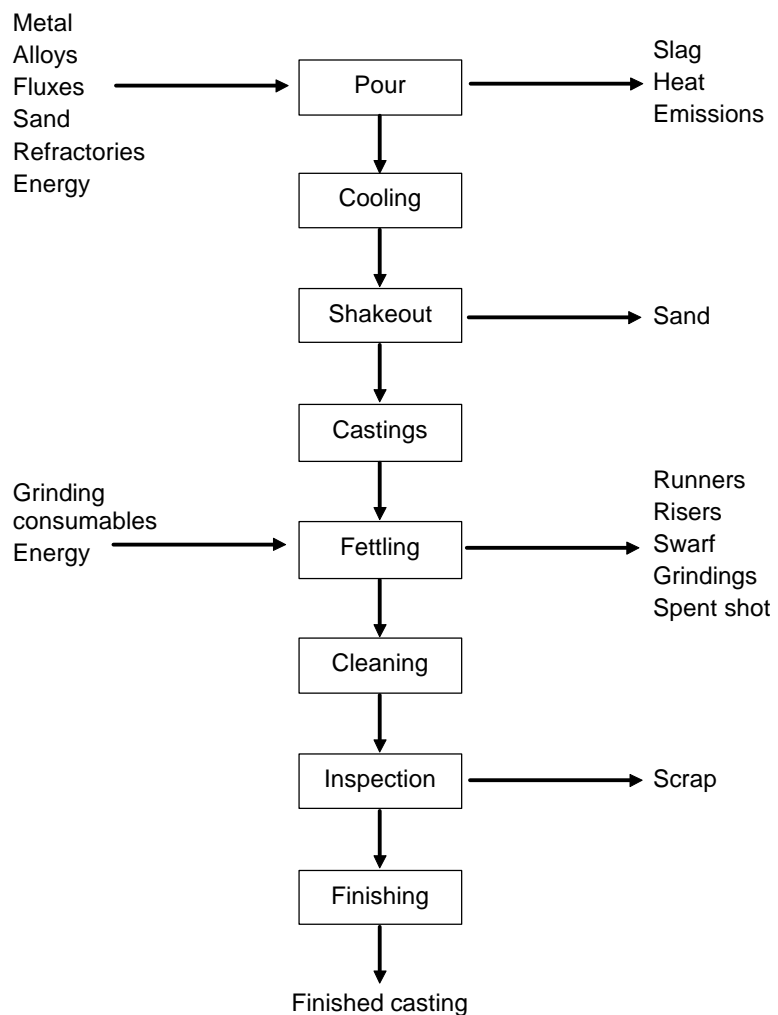
Process Flow Diagrams

One of the best methods for collecting this information is to develop process flowcharts for each process in the operation. These flowcharts should identify (at least) the major inputs and outputs (including by-product and wastes) in each process step. A simple example is shown in Figure 3.

The Walk Through Assessment

One method of undertaking a simple pre-assessment is to undertake a Walk Through Assessment. This is a simple method that takes the CP team through each step of the process and encourages them to identify waste problems and to identify opportunities for improvement.

Figure 3: Simplified Foundry Flowchart



The assessment can be done away from the process area by using process flow diagrams but it is often better to physically walk through the area as this will provide lots of cues (e.g. waste on the floor, sounds of air leaks etc.) and allow you to talk to process staff.

4.1 Steps

1. Form a team for the Walk Through Assessment. Include people who understand the process and some from outside the process who might question things that those close to the process take for granted.
2. Schedule an appropriate time for the assessment - you may need one to two hours depending on the scale of the operation.
3. Start by reviewing the process (use a process flow diagram) to ensure everyone on the team understands the key process steps.
4. Walk through the process considering all aspects of waste, resource use and efficiency.
5. Record all the waste problems and improvement ideas you identify.
6. Prioritise the problems and opportunities. Use this information to plan the assessment phase.

The purpose of this process is to identify the range of issues and opportunities facing the company and begin to assess the priority areas that are likely to have a significant positive impact on the company's performance. This information should be used to plan the Assessment phase and set broad priorities. Don't eliminate areas from the assessment at this stage. More detailed and quantitative analysis in the assessment phase (e.g. mass balances, monitoring and measuring programs) will provide a more systematic approach to targeting your improvement actions.

The following checklist may provide a useful approach for thinking about the key issues and recording problems and opportunities that are identified in the process. This is a very broad checklist designed to flag major issues in the short amount of time typically available for the assessment. More exhaustive checklists are provided in the Cleaner Production Checklist series. You may prefer to use these (and any other ideas you have) to develop a checklist that is more relevant to your operation.

Table 1: Simple Walk-through Assessment Checklist

Questions	Notes (Problems Identified)
Inventory Issues	
Are products stored and handled to minimise breakages, spoilage etc.?	
Do we maintain an effective inventory system(e.g. first in - first out, Just-in-Time)?	

Questions	Notes (Problems Identified)
Do errors in the materials make-up area and procedures create waste?	
Does the type and quality of our inputs lead to waste?	
Process Issues	
Are there any drips or leaks in the area?	
Are there any spills on the ground? Can they be avoided or reused? Where do they go?	
Are there any areas where spills or process foul-ups can occur?	
Are there any bottlenecks where production is held up?	
Is the machinery and equipment operating at its designed capacity / efficiency?	
Is energy being wasted?	
How does the layout of the plant impact on the efficiency of the operation?	
Is there any equipment available that could increase efficiency?	
Housekeeping Issues	
Are there any obvious signs of poor housekeeping practices?	

Questions	Notes (Problems Identified)
Are there any methods available to improve cleaning practices?	
Does the layout of the plant make housekeeping, cleaning and maintenance difficult?	
Staff Issues	
Do the operating procedures lead to the generation of waste? Can they be changed?	
Do staff have any other ideas for how waste can be reduced?	
Are procedures being followed? If not, why not? What procedures do the staff have difficulty with? Do they have any suggestions for how they might be improved?	
Have staff had the opportunity to suggest and make changes that improve efficiency?	
Waste Issues	
How are wastes removed from the process area?	
Are wastes segregated?	
Are there any opportunities for reuse or recycling of wastes?	
Is waste treated on site? Could any wastes be recycled after treatment?	

Questions	Notes (Problems Identified)
How is waste removed from the site?	
Marketing Issues	
What are the product specifications and customer requirements? How do these impact on the creation of waste? Can they be changed?	
Are there any potential marketing benefits to be gained from our Cleaner Production program?	
Broad Issues	
Can we suggest any changes to the company's overall policies and systems that would help implement Cleaner Production in this area?	
Are there any long term changes to equipment, facilities, markets that should be considered?	

5. The Assessment

The assessment phase involves the collection of data that enables you to evaluate the environmental performance, production efficiency and wastes generated by the company. Information should be collected at the company level to allow overall performance to be measured, for targets to be set and for progress to be monitored. Process information is also necessary to identify the sources of problems and opportunities for improvement.

5.1.1 Collecting Information

Information can be sourced from a large number of areas. The main types of information and possible sources include:

External Requirements

- Relevant environmental laws and regulations and likely trends.
- Environmental Management Systems and Standards.
- Industry codes of practice.

Cleaner Production Information

- Manuals, checklists, guidelines.
- Case studies, demonstration projects.
- Consultants, government departments, universities.

Process information

- Process flow diagrams.
- Design and actual layouts.
- Operating manuals and process descriptions.
- Equipment layout and logistics.
- Equipment specifications and data sheets.

Operational Information

- Product composition and batch sheets.
- Material Safety Data Sheets.
- Product and raw material inventory records.
- Operator data logs.
- Operating procedures.
- Production schedules.

- Production and scheduling records.
- Process and equipment specifications.
- Quality assurance procedures and records.
- Information from suppliers.
- Flow meters and process control data.

Cost Data

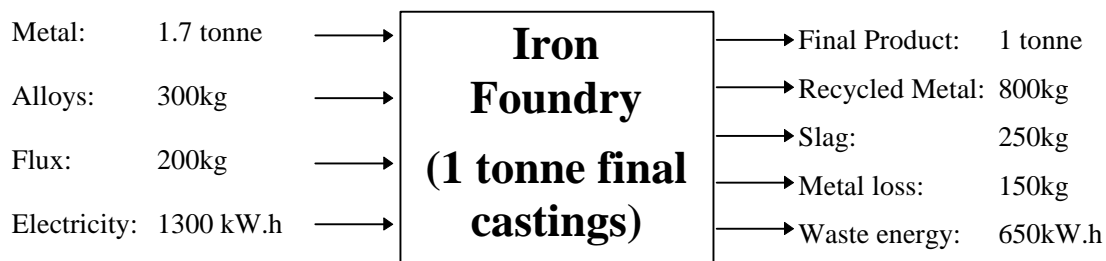
- Council rates notices, trade waste statements and waste management contracts.
- Waste handling, treatment, and disposal costs.
- Water and sewage costs, including surcharges.
- Costs for non-hazardous waste disposal (e.g. scrap metal, cardboard).
- Product, energy and raw material costs.
- Operating and maintenance costs.
- Purchasing, invoice and inventory records.
- Wages.
- Treatment cost records.
- Licensing Costs.

Where information is not available it may be necessary or desirable to undertake specific monitoring programs to collect data. These may include energy / resource efficiency or waste (solid waste, wastewater etc.) assessments.

5.1.2 Materials Balance

Developing a materials balance is a systematic approach to tracking materials through the operation. A thorough analysis would include solids, liquids, gasses and energy flows. The basic principle is that “what goes in - must come out”. This enables you to identify losses in the process and identify where they are coming from. It also helps determine the significance of each area of loss and target the most important losses. A simple materials balance is shown in Figure 4.

Figure 4: Partial Materials Balance for a Typical Foundry



Note: data is indicative only.

The materials balance can be developed broadly for the entire operation. At the process level, the analysis will be more meaningful and allow better decisions to be made. The level of detail should be dictated by the importance of the decision. If company wide material balance indicates significant opportunities for improvement then a more detailed analysis may be justified.

In order to develop priorities, this resource balance should include the volume of the material, the nature of the material (e.g. potential risks) and the full economic value of the material to the company. This will help to target the areas that have the most significant environmental risk and represent the most significant economic cost to the company.

If it proves to be very difficult to undertake a materials balance it may point to opportunities to improve process control and materials accounting practices.

5.1.3 Developing Costing Information

Calculating the actual costs of production is crucial in setting priorities for improvement and persuading yourself and others of the benefit of Cleaner Production. For most companies, the most accurate data available is typically site-wide data such as purchasing records, total production / sales, inventory stock takes etc.. Therefore, the easiest approach to allocating costs at the unit operation level is typically a breakdown method. The steps for this method are:

Step One - estimating overall cost of each waste stream to the company.

This calculation will include the cost of:

- materials purchasing and handling.
- production.
- cleaning and maintenance.
- monitoring, treatment, disposal.
- compliance.

There may be a wide range of other on-costs and overheads that need to be considered.

The site wide materials balance should provide data for each material on the quantity purchased, the amount leaving as valuable products and the amount that ends up as waste. This ratio of inputs to waste outputs will help calculate the proportion of materials costs that should be assigned to waste.

For example:

Table 2: Calculating the full cost of resources

Input	Monthly Input	Monthly Waste	Proportion Waste	Monthly Cost of Inputs	Monthly Cost of Wastes
Metal	600 tonnes	12 tonnes	2%	\$96,000	\$1,920

Note: Data provided is for example only.

The other costs can be assigned to individual waste streams based on their contribution to various costs. This could be calculated by volume (e.g. waste accounts for 2% of total material intake, therefore, the full cost should include 2% of production, cleaning and maintenance costs). There may be other methods of allocating costs (e.g. risk based) that may be appropriate.

Step Two - estimate the cost per unit of waste

Dividing the total cost of each waste stream by the total quantity generated in the period will provide an estimate of the unit cost of the waste. In the example above, the unit cost for waste metal is \$4000 / tonne.

Step Three - assign waste costs of unit processes.

Undertaking a detailed mass balance will provide data on the volume of materials wasted in each unit process. Unit costs of waste can then be used to assign total costs of waste to each unit process. This will help identify which processes contribute most significantly to the costs of waste. This approach can be used to calculate total cost for unit operation or show the contribution of all unit processes for an individual waste stream.

For example:

Table 3: Unit - Melting

Input	Quantity	Cost
Metal	600t	\$96,000
Alloys	20t	\$6,000
Fluxes	5t	\$1,600
Total		\$103,600

Note: Data provided is for example only.

Table 4: Waste Stream - Metal

Unit Process	Quantity (%)	Cost
Metal loss on ignition	.6	\$576
Spills and pigged metal	.8	\$768
Scrap /grinding loss	.6	\$576
Total	2	\$1,920

Note: Data provided is for example only.

5.1.4 Identifying Causes of Waste

Once you have measured the quantity and cost of waste, the next step is to identify the causes. Some causes of waste may be unavoidable. For others the cost of fixing the problem may be greater than the benefits that will be gained. However, experience shows that many causes are avoidable.

Identifying causes may require brainstorming, further investigation or expert advice. Typical causes include:

- storage and product conveyance (e.g. leaking tanks, pipes, spillages);
- poor process control or lack of process optimisation;
- faulty or old equipment;
- inappropriate or poorly followed operating procedures;
- poor maintenance routines; and
- poor housekeeping practices.

Identifying the real cause of waste is necessary for the next step - generating appropriate CP options.

5.1.5 Generating CP Options

There are a wide range of methods that your company can adopt to generate ideas for Cleaner Production improvements. Whatever methods you choose, it is important to ensure that:

- participation in the process is encouraged.
- that the ideas are documented and not lost.
- that all ideas are given an appropriate level of consideration.
- timely feedback is given for each idea (even unsuccessful ones).
- good ideas are rewarded.

Your idea generation method may be as simple as providing suggestion boxes or asking staff for their opinion.

You may also develop a more formal improvement suggestion process. For example, Quality Assurance and Environmental Management systems typically include the use of improvement suggestion forms which can be used for this purpose.

Cleaner Production workshops and brainstorming sessions are also used to generate ideas, often as part of training programs. There are many brainstorming techniques that you can use. The idea of these techniques is to encourage staff to look at processes from a Cleaner Production perspective. Being closely involved in a process can make it difficult to see problems and opportunities for improvement. Therefore it is necessary to use techniques that encourage you to see the process with 'a new set of eyes'.

One good method is to use Cleaner Production checklists. For example, the walk-through assessment you undertook as part of the pre-assessment should have uncovered a number of options that were immediately apparent. Discussing each of the problem areas identified in the walk-through should help develop many more. The Cleaner Production ideas section (see Part 2) provides a lot of ideas which are summarised in the self assessment guide (see Part 4).

You may choose to use some brainstorming exercises that you can use to help think laterally about possible solutions. The following questions may help.

1. Think about each of the key words from the hierarchy in turn - elimination, minimisation, reuse, recycling, treatment, disposal. What options does this generate?
2. Think about the possible Cleaner Production strategies - housekeeping, input change, simple process change, major process / technology change, product or market change. What options does this generate?
3. Try to distinguish the causes from the symptoms. Waste on the floor is a symptom of a bad procedure or faulty equipment. What is the cause of the problem and how can these be fixed?

4. What assumptions are you making? Just because this is always how it has been done doesn't mean it is the only way.
5. What are the rules, procedures, and guidelines that affect the area? Do these cause unnecessary waste?
6. Where does the waste go and what problems does this cause? Is there anything else that could be done to this waste?
7. What can you do today? The best solution may take a long time to implement. This doesn't mean something couldn't be done in the meantime. What is the simplest solution to the problem that you could implement today?
8. No matter what you do someone will be there to say 'it can't be done'. What negative reactions can you expect? What excuses could be made to stop progress? What are the impediments to minimising waste? How can you overcome these?

6. Evaluating Cleaner Production Options

Many improvement options are relatively simple so costs and benefits of implementing them are fairly clear. For more complex options it may be necessary to undertake an evaluation to ensure it is beneficial to the company in the long term. Also, you may have developed a number of potential projects and need to establish which ones to implement within budget limitations. Simple options with clear benefits should be implemented immediately.

For more complex decisions, option evaluation should be undertaken to the appropriate level and should include both economic and non-economic criteria. The economic analysis will provide an idea of the cost involved in implementing the options, on-going costs associated with the change and the potential benefits associated with reduced costs, increased sales and profits. The non-economic analysis will consider how the change will impact on the organisation.

The detail of the analysis should match the importance of the decision. Projects that are costly and involve significant changes will have to go through a more detailed evaluation process as part of the company's overall planning process. Simple projects with obvious benefits may get immediate approval.

6.1 Economic Analysis

In order to complete the economic analysis, you will need to estimate all major costs and benefits associated with the project. The table below will show you most of the categories you should consider.

1. Determine the likely cost of equipment and installation and any other up-front costs associated with change - e.g. housekeeping changes are typically cheap.
2. Estimate the likely on-going costs such as running costs, maintenance, materials, labour, etc.

3. Is the change likely to lead to increased sales of current or new products - what range may be likely?
4. What level of savings may be possible from the change in terms of materials, water, energy, treatment, disposal etc?
5. Are there any other costs or benefits associated with the change? Can they be quantified?
6. Estimate the total costs and the total benefits for the option.
7. Calculate the net annual benefit by subtracting the total costs from the total benefits.
8. Calculate the payback period using the following formula:

$$\text{Payback} = (\text{capital costs} / (\text{annual benefits} - \text{annual costs})) * 12$$

This will tell you the approximate number of months it will take to recover the capital costs associated with the change.

Table 5: Economic Analysis

CP Option	Item	Value
Capital Costs	Equipment	
	Installation	
Total Capital Costs		
Annual Costs	Running Costs	
	Maintenance	
	Materials	
Total Annual Costs		
Annual Benefits	Increased Sales	
	Sale of By-products	
	Annual Savings:	
	Materials	
	Water	
	Energy	
	Treatment / Disposal	
Total Annual Benefits		
Net Annual Benefits		
Payback Period		

Value Range: 1: < \$500; 2: \$500 - \$5000; 3: \$5000 - \$20000; 4: \$20000 - \$100000; 5: > \$100,000

For example: Installing drip guards may cost \$500 and involve no on-going costs. Cost savings amount to \$50 per week or \$2600 a year.

Capital costs = \$500

Annual costs = \$0

Annual benefits = \$2600

Payback = $\$500 / (\$2600 - 0) * 12 = 2.3 \text{ Months}$

Note: If you only require a fairly simple analysis or if accurate estimates of costs and benefits are not available, use the broad value ranges at the bottom of the table for each item.

6.2 Non-economic Analysis

Non-economic factors also need to be considered to ensure that the change will not impact negatively on other functional areas in the operation. For each option being considered, consider the impact on the change on product quality, safety, customer expectations, environmental performance, and other management systems in the company.

Table 6: Non-Economic Analysis

Non-economic Factor	Comment
How will the change affect product quality (positive/negative)? Are any trade-offs acceptable?	
How will the change affect health and safety (positive/negative)?	
What are your customers expectations? Would they care about the change? What changes would they accept or even find desirable?	
What impact will the change have on the environmental performance of the company (i.e. reduce the toxicity or impact of wastes, reduce environmental liability etc.)?	

<p>What are the requirements of people in different departments (i.e. purchasing, cleaning, production, maintenance)? What is the best compromise solution?</p>	
<p>How easy will it be to implement the change? How much time, and expertise will be needed? Are these resources readily available?</p>	

7. Implementation and Review

7.1.1 Project Implementation

While the actual implementation plan for successful options will have different features depending on the management strategy of the company carrying out the CP program some desirable features are to:

- Develop the project budget.
- Develop implementation time tables for all recommendations and allocate tasks to staff members.
- Establish milestones for tasks and monitor their progress.
- Regularly report on progress to CEO.
- Review the results.

7.1.2 Monitoring Performance

Just as measuring waste and resource efficiency is necessary to setting priorities and developing and implementing action opportunities, monitoring performance over time is an essential component of your improvement program.

Many companies use Key Performance Indicators to track changes in performance. With appropriate monitoring programs, environmental and waste criteria can be developed. These should include totalised indicators that monitor the overall environmental impact of the operation (e.g. tonnes of waste produced per month) and normalised indicators (e.g. resource consumption per tonne of product, waste generation per unit of production or per unit of input etc.) that monitor the efficiency of the operation.

Monitoring may also be continuous (e.g flow meters, process control data loggers) or periodic (e.g waste audits, wastewater monitoring, manual stock takes). The cost and complexity of the system may also vary from simple manual systems to sophisticated real time process monitoring systems that integrate purchasing, inventory, dispensing and production to allow detailed materials accounting throughout the process. In general, your monitoring system will add value to the organisation if the value of the information is greater than the cost of the system.

In the foundry sector, the full costs of waste and resource inefficiency are typically high and many companies are realizing the benefits of developing sophisticated process monitoring systems. These systems can be used to generate variance reports that compare real time resource use and waste data with established norms. Major differences (in terms of value and volume) can be highlighted and associated with a specific process and time period. This enables the supervisor / manager to pinpoint the problem and deal with it quickly - before the cause is forgotten or further waste of created.

7.1.3 Continuous Improvement

To achieve continuous improvement the momentum of the Cleaner Production project must be maintained over time. Some of the factors that will help achieve this include:

Providing Timely Feedback

Most Cleaner Production solutions are not purely technical in nature. Therefore sustaining and building on improvements over time requires active staff participation. This is most likely to occur when staff can identify tangible personal benefits from their involvement. These may be both financial and non financial rewards. The desire for recognition, perceived meaningfulness and pride in work (e.g. that their company is responsibly caring for the environment etc.) are all sources of motivation.

Providing timely feedback to staff and acknowledging and rewarding success is, therefore, essential for achieving continuous improvement. This feedback should include circulating Key Performance Indicators and assessment / audit results, promoting all successes and giving timely responses to all improvement suggestions (even unsuccessful ones).

Integrating Cleaner Production

Your Cleaner Production program will be more sustainable if the program is integrated into the overall company culture. Rather than being treated as a separate project, Cleaner Production should be integrated with and have equal status to programs such as quality assurance, health and safety, environmental management, hazard analysis etc.

Cleaner Production should be built-in to the decision making process of the organisation. This will mean that projects that require long term commitment can be evaluated along with other demands for capital in the company and be included in long term financial plans.

Changing the culture of a company does not happen overnight, but making Cleaner Production the way people work will contribute to making your organisation a dynamic learning environment.

Periodic Evaluation and Review

Progress towards Cleaner Production goals should be reviewed at the senior management level on a periodic basis. Once a year should be appropriate in most cases. This should include a detailed review of all improvements, results of monitoring programs and future plans. At the project level, progress should be reviewed more frequently.

Including Cleaner Production responsibilities and targets in staff job descriptions and performance appraisal procedures may also be an appropriate method of periodic review that encourages and rewards on-going involvement.