

# ***Fish Processing***

SEA FISH INDUSTRY AUTHORITY GUIDELINES

**SEAFISH**

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**Guidance for Fish Processors  
on Water and Effluent  
Minimisation**

1st Edition, April 1999

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## 1. PURPOSE AND SCOPE

Fish processors are facing dramatic increases in costs for discharging their effluent. This results from EU environmental legislation and may threaten the viability of many processing businesses. However, there is scope for processors to considerably reduce both the quantity and strength of their effluent and so minimise the increases in costs.

This document provides background information to help processors understand the issues involved and provides guidance to help them tackle the problem. Guidance is given to help processors carry out water and effluent audits of their own businesses and also on practical waste minimisation measures. The emphasis is on the need for waste minimisation at source, although other possibilities including effluent treatment and direct discharge are considered.

This is a new problem for the industry and many of the practical issues involved are unique to the nature of fish and its processing. This document has been drafted by Seafish on the basis of detailed study of various types of fish processing businesses, together with some initial technical development of waste minimisation measures and dialogue with others active in the field. This is the first edition and it will be updated in the light of further experience. It will also be supplemented by Seafish Technical Information Sheets giving more detailed guidance on particular waste minimisation measures.

**The main purpose of this document is to help fish processors help themselves.**

## 2. AN INTRODUCTION TO THE PROBLEM AND HOW TO TACKLE IT

The processing of fish requires the use of considerable quantities of clean water which, after having been contaminated by the fish, are then discharged as effluent.

For obvious reasons, most fish processors are clustered around the major fishing ports. Until now, the effluent from these coastal towns has simply been discharged to the sea at negligible cost. Fish processors have come to rely on the ready availability of water and upon using their drains as a convenient and low cost means of getting rid of waste.

This will have to change. EU legislation demands that urban waste water will have to be collected and treated before discharge to the environment. This is necessitating the construction of costly sewer pipelines and treatment plants in coastal towns. The costs of construction and operation of these facilities will have to be borne by their users in accordance with the 'polluter pays' principle. The more effluent a processor discharges to the sewer and the greater the strength of that effluent, the larger will be the bill from the sewage undertaker.

Currently there are regional variations in trade effluent charges. There are also considerable variations between processors in the quantities of water they use and the strength of the effluent they produce. There will be great variations in costs but virtually all fish processors will face dramatic increases. For example, the calculated trade effluent bill for a typical small-scale white fish primary processor could increase from a current range of about £500-£5000 to about £15,000 per annum. That of a large-scale pelagic processor could rise from about £13,000 to over £400,000 per annum. These increases in costs could threaten the viability of many businesses.

However, detailed water and effluent audits of a range of types of fish processing businesses and initial development work on waste minimisation measures carried out by Seafish, have shown that there is considerable scope for processors to reduce water use and effluent strength and so minimise the increases in costs. Much of this can be achieved by simple low-cost or no-cost changes to practices and equipment. There is also likely to be benefit from making more fundamental changes to processes, equipment and premises.

The sewage undertakers will have to place limits on what can be discharged into their sewers. In some areas these limits will **necessitate** the reduction of waste by fish processors.

**The appropriate waste minimisation measures and their effectiveness will depend upon the particular circumstances of operation of each processor. There is still much to be learned from experience in developing and applying these measures but the experience to date indicates that savings of over 50% (and in some cases considerably more) of the full water and effluent costs can be achieved.**

After having applied measures to minimise waste at source, some large-scale businesses may still find it cost-effective or even necessary to invest in their own basic effluent treatment plant in order to further reduce the strength of their effluent prior to discharge. It may be feasible to discharge treated fish processing effluent directly to the sea through a pipeline by-passing the public sewerage system given a suitable location, a sufficient scale of operation and the necessary consent to discharge. Groups of businesses may choose to invest in joint treatment and/or discharge facilities.

The starting point for each business must be recognition by the management of the importance of this problem and the allocation of the necessary resources to tackle it. As each business is different and as so much is to be gained from waste minimisation at source, the first practical stage should be a thorough water and effluent audit of the business. This should determine where and how much water is used and is wasted and where and to what extent the effluent becomes contaminated. The appropriate waste minimisation measures can then be applied. The following sections of this document should help processors in doing this.

### **3. BACKGROUND INFORMATION**

#### **3.1 THE LAW RELATING TO EFFLUENT DISCHARGE**

##### **3.1.1 EU Legislation**

The Treaty of Rome establishes the EU's environmental policy. It stipulates a high level of protection for the environment and includes the principle 'that the polluter should pay'. This policy is enacted by numerous EU Directives, the most relevant of which is the Urban Waste Water Treatment Directive (UWWTD).

The UWWTD requires that the Member States collect and treat urban waste water prior to its discharge into the environment. Urban waste water includes domestic effluent and mixed domestic/industrial effluent. The Directive sets a number of deadlines depending upon local circumstances, the most important being the end of 2000 when the effluent from most coastal towns will have to be treated. Secondary treatment will generally be required. The officially estimated cost of implementing the Directive throughout the EU is 200 billion euro.

The main provisions of the UWWTD do not apply to the direct discharge of fish processing effluent if it is separate from domestic effluent but the Directive requires that such discharges are regulated by the Member States.

The UWWTD does not stipulate who should provide the waste water collection and treatment systems or how they should be paid for. These matters are left to the Member States. However, the proposed Water Framework Directive (currently in draft form and under discussion) includes the deadline of 2010 for 'full cost recovery' for all water uses.

A further Directive on Integrated Pollution Prevention and Control establishes more extensive environmental requirements for large-scale industrial plant, including fish processing plant, that has a product output capacity of greater than 75 tonnes/day. This Directive sets deadlines of October 1999 for new or substantially modified plant and September 2004 for existing plant, by which time a permit to operate must be obtained for each plant. This entails carrying out a comprehensive environmental analysis and establishing waste minimisation and emission monitoring schemes for each plant.

##### **3.1.2 UK Legislation and the System of Consents to Discharge**

UK legislation concerning water supply and effluent discharge is extensive and complex. There are substantial differences in the law and the Agencies, Authorities or private water companies involved in the various regions of the UK.

However, in practice there are only two options for trade effluent discharge:

- discharge to a public sewer
- or direct discharge to local waters. Both of these options require:
  - prior consent to discharge
  - with conditions attached to that consent
  - and the payment of charges.

**For discharge to a public sewer:** consent must be sought from the local sewage undertaker which will be one of the private water companies in England and Wales, one of the Regional Water Authorities in Scotland or the Water Service in Northern Ireland.

The sewage undertaker is not bound to grant consent and will not do so if the sewers and treatment plant cannot cope with the proposed discharge. The conditions of consent will limit the nature and the quantity of the discharge permitted and stipulate any monitoring requirements. It is to be expected that when the new treatment plants come 'on line' in coastal towns, the conditions of consent in some areas will limit the permissible strength of effluent discharged to below that currently discharged by many fish processors. The monitoring requirements can necessitate some large-scale dischargers installing metering and effluent sampling equipment.

In England and Wales the charging policy of the private water companies is based on hard economics and is highly regulated. These companies are, in effect, forbidden to cross-subsidise. They already have to levy realistic charges for the services actually provided to each customer on the 'polluter pays' basis. The considerable costs of the new sewage pipelines and treatment plant required by the UWWTD will be recovered from the effluent dischargers when those facilities come into operation. Businesses in inland locations where treatment is currently carried out, already have to pay high charges. In Scotland and Northern Ireland the sewage undertakers are having to move rapidly towards a similar basis of charging.

**For direct discharge to local waters:** consent must be obtained from the Environment Agency in England and Wales, the Scottish Environmental Protection Agency or Environment and Heritage in Northern Ireland.

The Agency must consider the nature of the discharge and the 'sensitivity' of the receiving waters. An environmental impact study must be carried out, funded by the applicant, to demonstrate that the proposed discharge will not cause harm. If granted, the consent will be conditional on the nature and quantity of the discharge permitted and will require controls to be set in place by the discharger. Monitoring of the discharge will also be carried out by the Agency and charges will be levied to



cover all their costs, although these charges are likely to be small in comparison to those for discharge to a public sewer.

UK Government policy and action is to restrict direct discharges into the environment. In practice, consent is likely to be given only if discharge is to the open sea and the effluent receives primary treatment prior to discharge. There are also further complications, including a licence and planning consents, for the necessary pipeline running out to sea.

**For all discharges:** the consents are subject to periodic review and variation. They are not an indefinite license to discharge. There are formal rights of appeal against decisions made.

It is an offence to discharge without consent or in breach of the conditions of consent. In serious cases this can result in heavy fines or even imprisonment.

## 3.2 THE BASICS OF EFFLUENT TERMINOLOGY AND TREATMENT

### 3.2.1 Effluent Strength

The following terms are commonly used to describe the nature and strength of effluent:

#### ***Biological Oxygen Demand (BOD)***

This is a measure of the amount of oxygen consumed whilst the effluent is broken down by bacteria over a 5 day period, normally expressed in mg/l. This is a fundamental measure of the strength of the effluent in relation to the loading it creates for biological sewage treatment plant.

#### ***Chemical Oxygen Demand (COD)***

Similar to BOD but faster and cheaper to carry out and hence more widely used, this is a measure of the amount of oxygen consumed when the effluent is broken down by a strong chemical agent, again normally expressed in mg/l. Typically the COD value will be somewhat higher than the BOD.

#### ***Suspended Solids and Settleable Solids (SS)***

These are simply measures of the amounts of solid matter in the effluent which can be removed by fine filtration (suspended solids) or settlement (settleable solids), again normally expressed in mg/l.

#### ***Settled COD (<sub>s</sub>COD)***

This is a variation of the COD measure. The effluent is left to stand for a period, usually one hour, for solids to settle out and then the COD of the liquid is taken.

#### ***Oils/Grease***

This term is sometimes used as high levels of oils/grease can cause blockages in sewers and harm the environment. It is simply a measure of the quantity of oils/grease present in the effluent, again normally expressed in mg/l.

The settled COD and suspended solids measures are those usually used in calculation of trade effluent charges.

### **3.2.2 Effluent Treatment**

Treatment is commonly categorised according to the following stages:

#### ***Preliminary Treatment***

This is the initial separation of the large solids by screening. Various types of static and mechanical screens are used. Screens used by fish processors are prone to 'blinding' or blockage by the effluent but a number of types of 'wedge wire' screens have been found effective. Preliminary treatment can also include the operation of 'balancing tanks' used to even out the flow and strength of effluent for subsequent treatment.

#### ***Primary Treatment***

This is the removal of oils/grease and small suspended solids by settlement or flotation. This can include the use of settlement tanks, centrifugal separators, fat traps and dissolved air flotation (DAF) techniques. DAF systems operate by passing small air bubbles through the effluent. The contaminants are lifted by the bubbles and are then skimmed off at the surface. This can be assisted by adding chemicals to the effluent which improve separation. DAF systems are quite compact and are known to be effective for treating highly contaminated pelagic fish effluent but they are also complex and expensive and the 'sludge' has to be disposed of.

#### ***Secondary Treatment***

This is biological treatment using 'friendly' bacteria to remove the organic materials not taken out by earlier treatments, including substances dissolved in the water. Treatment is either anaerobic (without air) or aerobic (with air), each dependant on different types of bacteria to break down the effluent. The use of anaerobic reactors is usually as a first stage treatment to break down particularly high strength effluent prior to final aerobic treatment. Both processes are relatively slow in operation, generally taking periods of days to be effective. Aerobic treatment is usually in large tanks or ponds but more compact systems are available, at a cost. Biological treatment is a sensitive process requiring controlled conditions of operation and of effluent supply. In general it is in the province of the sewage undertakers and could only be operated economically by the largest of effluent producers or those facing particularly strict conditions of consent.

#### ***Tertiary Treatment***

This is a final cleansing stage used if necessary to remove any remaining traces of contamination. Treatment processes can include fine filtration, nitrification and disinfection. Tertiary treatment is not usually necessary unless the water is to be recycled but sewage undertakers are increasingly using UV sterilisation where discharge of domestic effluent is close to bathing beaches and there is risk from human pathogens.

### **3.3 WATER USE AND EFFLUENT PRODUCTION IN FISH PROCESSING**

#### **3.3.1 Water Supply**

The Food Safety Regulations demand that the water used by fish processors is clean water, to drinking water standards, or clean seawater except for that used for firefighting, steam production and cooling refrigeration equipment. Any supplies of lower quality water for these non-food purposes must be in separate and identified pipework systems.

The great majority of processors use public mains water which has already been treated to drinking water standards by the water service provider. Processors can use alternative supplies of fresh water, such as a private borehole, provided that the necessary system of treatment (e.g. disinfection), monitoring and control is set in place to ensure that the drinking water standards are met. Any use of seawater is subject to similar constraints of treatment, monitoring and control. Seafish recommends that the Local Environmental Health Officer is consulted if supplies other than public mains water are to be used. Licences are required for any abstraction of water, on a similar basis to those required for discharge to the environment.

Seawater is not widely used by processors ashore. Most uses are for the holding of live shellfish and for the landing and some primary processing of pelagic fish. Particular care needs to be taken over the siting of seawater inlets to avoid contamination from harbours and outfalls, etc. The use of seawater can lead to problems of corrosion of equipment and deterioration of the fabric of premises. If seawater is discharged into the public sewer, the salt can interfere with the standard COD test procedure and give falsely high results. If large quantities are discharged the salt may disrupt the sewage undertaker's biological treatment plant. The sewage undertaker may prohibit the discharge of seawater into the sewer.

#### **3.3.2 Water Use**

The use of water in cleaning is essential for maintaining the high standards of hygiene demanded by the Food Safety Regulations. Seafish guidance to processors recommends frequent cleaning to prevent fish residues from drying on surfaces, simply using water and elbow grease. The periodic use of cleaning chemicals or disinfectants must be followed by further and thorough rinsing with clean water to remove any residues of those chemicals.

The use of water is also an essential part of the processing operations themselves, starting with washing the incoming raw material and the primary processes of gutting, filleting and skinning. The operation of most fish processing machinery is dependant upon water jets to lubricate knives, chutes and mechanisms, to remove debris and provide continuous cleaning. Water is also essential to many secondary processes such as brining and shellfish cooking.

Water is often used in large quantities for thawing fish prior to processing although there are alternative methods of thawing. Water is sometimes used for transporting fish in flumes although the use of mechanical conveyors is more common.

Despite the essential uses of water, detailed Seafish audits of fish processing businesses have shown that a large proportion of actual water use is unnecessary. Water is simply wasted by leaving taps on and valves open when not required. It is used inefficiently by having unnecessarily high flow rates and is used when there are alternative 'dry' methods of operation.

In practice the quantities of water used vary considerably, not only with the types of processes carried out but also between different businesses carrying out similar processes. Variations between audited businesses are shown below:

Type of business	Number audited in detail	Water used to produce 1 tonne of product (m <sup>3</sup> )
White fish filleting	3	5.0 - 7.4
White fish thawing and filleting	3	9.5 - 24.0
White fish thawing, filleting, enrobing and freezing	1	23.4
Pelagic fish primary processing ①	2	3.2 - 6.6
Nephrops primary and secondary processing	1	38.7

① Not including fish landing operations.

**Clearly there is enormous scope for processors to reduce the quantity of water used.**

### 3.3.3 Effluent Production

Inevitably the water used becomes contaminated, to varying degrees, by the organic materials of the fish. Significant amounts of these materials are water soluble and once dissolved in the water they are difficult to remove. Screening or even DAF treatment does not remove dissolved contamination.

**The strength of the effluent produced depends not only on the amount of pieces of fish mixed with the water but also on the parts of the fish involved, the types of fish and crucially on the size to which the pieces of fish are cut or ground and the period for which they are left to soak in the water.**

Fish guts, livers and roe, particularly if softened by spoilage and 'mashed up' by mechanised processing, rapidly mix into the water to produce high strength effluent.

The oils in fish livers and in the flesh of pelagic fish add to the strength of the effluent. Scraps of fish left soaking in water or in running water rapidly lose their soluble materials to the water stream. Materials used in secondary processing, such as batter mixes and cooking oils, produce high strength effluent if allowed to pass into the drains. Shellfish boiling water becomes heavily contaminated by dissolved organic material.

Despite the inevitability of some contamination, the audits of fish processing businesses and the work on waste minimisation have again shown that a large proportion of the contamination actually occurring is unnecessary. It results from not separating the solid waste from processing operations and often deliberately directing it into the drains, from waste falling onto the floor and then often deliberately being flushed into the drains during cleaning, from fish and waste left soaking in water or in running water and from using 'wet' process methods when there are 'dry' alternatives.

In practice the strengths of the effluent produced again vary considerably, not only with the types of processes carried out but also between different businesses carrying out similar processes. Variations between the audited businesses are shown below:

Type of business	Number audited	Effluent strength	
		SS (mg/l)	sCOD (mg/l)
White fish filleting	3	212 - 576	930 - 3078
White fish thawing and filleting	3	13 -288	306 -1,748
White fish thawing, filleting, enrobing and freezing ①	1	10,518	11,547
Pelagic fish primary processing ②	2	1,002 - 6,202	2,295 - 10,050
Nephrops primary and secondary processing	1	249	1,000

① This was a particularly wasteful business.

② There are large species and seasonal variations for pelagic fish.

**Again it is clear that there is enormous scope for processors to reduce the strength of the effluent they produce.**

### 3.4 WATER AND EFFLUENT CHARGES

#### 3.4.1 Calculation of the New Sewage Charges (Mogden Formula)

The current charges levied by the sewage undertakers for the discharge of trade effluent vary considerably. In some places outside of England and Wales the charges are on a purely nominal basis of 'rateable value'. In others they reflect the fact that the sewage undertaker is only carrying out preliminary treatment. However, the 'Mogden formula', already used by the private water companies, is becoming the

standard method of calculating these charges. The quantity and the strength of the effluent discharged by each business are measured and then the formula is applied.

The formula approximates to the actual costs (plus profit) to the sewage undertaker in dealing with the effluent. It includes separate elements to account for the costs of the sewer system collecting the waste, of preliminary and primary treatment, of secondary biological treatment and of the treatment and disposal of the sludge. The actual costs vary regionally and so the various factors used in the formula by each sewage undertaker are established on a local basis. Both operating and capital costs are accounted for as necessary.

The formula is:

$$C = R + V + \left[ B \frac{O_t}{O_s} \right] + \left[ S \frac{S_t}{S_s} \right]$$

Where:

- C = The calculated effluent charge (pence/m<sup>3</sup>).
- R = The reception and conveyance charge for using the sewer system (pence/m<sup>3</sup>).
- V = The volumetric/preliminary/primary treatment charge (pence/m<sup>3</sup>).
- B = The biological secondary treatment charge (pence/m<sup>3</sup>).
- O<sub>t</sub> = <sub>s</sub>COD of the discharge (mg/l after 1 hr settlement).
- O<sub>s</sub> = Mean <sub>s</sub>COD of sewage in the region (mg/l after 1 hr settlement).
- S = The solid waste treatment and disposal charge (pence/m<sup>3</sup>).
- S<sub>t</sub> = Suspended solids of the discharge (mg/l).
- S<sub>s</sub> = Mean suspended solids of sewage in the region (mg/l).

The particular details of the formula to be used in each region can be obtained from the sewage undertaker.

The volume of discharge used to calculate each business's bill is usually based on the meter reading of the fresh water supplied. However, if there are further supplies of water or if water is incorporated into the products or ice leaving the premises and doesn't go down the drain, this should be accounted for. The <sub>s</sub>COD and SS are usually determined by spot sampling by the sewage undertaker together with accumulated knowledge of the type of business concerned. However, in many old premises it is difficult to determine the drainage routes and to obtain representative samples of the discharge. The discharges of each business will also vary considerably throughout the working day and often with the seasons.

Although the cost factors vary regionally and there are very considerable variations in effluent strength between businesses, applying typical cost factors to typical current effluent strengths from the processor audits gives the following indication of calculated future charges:

Type of business	Indication of future trade effluent charges (£/m <sup>3</sup> )
White fish filleting	1.30
White fish thawing and filleting	1.02
White fish thawing, filleting, enrobing and freezing ①	13.36
Pelagic fish primary processing ②	4.59
Nephrops primary and secondary processing	1.07

① This was a particularly wasteful business.

② There are large species and seasonal variations for pelagic fish.

### 3.4.2 The Total Water and Effluent Bill

The total bill for each business will include the metered water supply charge as well as the calculated trade effluent charge. There are also likely to be smaller fixed charges and there may be separately itemised charges for the domestic waste of the employees and any rainwater run-off from the premises into the sewer.

Again there are regional variations but a typical cost for clean water supply is about £0.66/m<sup>3</sup>. Even if that water is discharged clean, without any contamination, it will still attract a trade effluent charge of about £0.46/m<sup>3</sup>. At these levels of cost it can be seen that water use forms a significant part of the total water bill.

**Waste minimisation can be doubly effective. Reducing water usage decreases the continuing water supply costs as well as the future trade effluent discharge costs.**

## **4. GUIDANCE FOR BUSINESS MANAGEMENT ON HOW TO ADDRESS THE PROBLEM**

**Substantially reducing water use and effluent production is likely to be crucial to the profitability of most fish processing businesses.**

**Management must recognise this new problem and take action to deal with it if their business is to survive.**

**It is recommended that all businesses establish a waste minimisation programme.**

Fish processing businesses vary enormously, from corporate multi-nationals with hundreds of employees producing added-value products down to the smallest of primary processors with only a couple of employees. The management style and resources of these businesses similarly vary but all face the same basic issues. For each business, the management will first have to identify their particular water and effluent problem areas and then implement the waste minimisation measures appropriate to their business.

The following sections give further guidance on how to plan and implement a waste minimisation programme.

### **4.1 MANAGEMENT COMMITMENT AND A PLAN OF ACTION**

**The commitment of the management to a high priority programme of waste minimisation, together with the necessary allocation of resources, should be established at the start and be communicated throughout the business.**

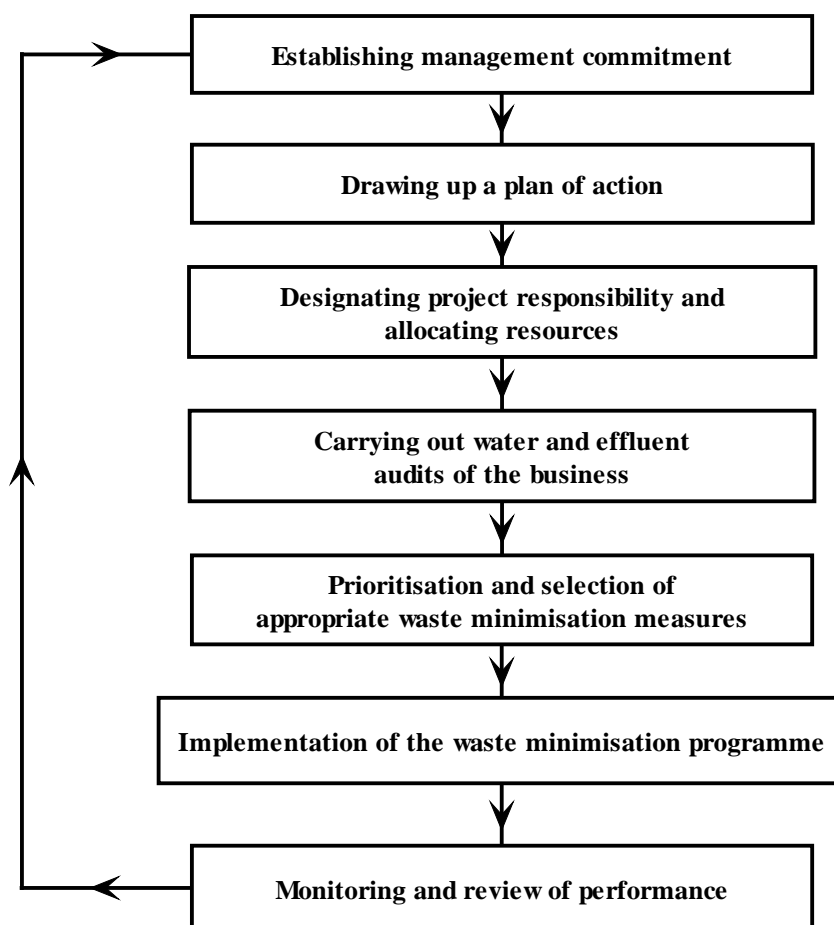
**Management should draw up a plan of action to identify and deal with the particular problems faced by their business.**

All staff should be made aware of the importance of the project to the future of the business and of the commitment to a programme of waste minimisation. They should be kept informed of progress.

The key stages of an action plan are shown overleaf.

The extent of detail and documentation appropriate to the plan will depend upon the size and nature of the business. Large businesses with extensive management structures will wish to adopt rigorous procedures. In the smallest of businesses, waste minimisation will simply amount to the application of common sense.





## 4.2 DESIGNATION OF PROJECT RESPONSIBILITY AND ALLOCATION OF RESOURCES

It is recommended that a project leader is designated to take overall responsibility for carrying out the action plan. The project leader must be given the full support of management, the authority and the resources necessary to do the job.

In the first place, resources should be allocated to carry out the initial stages of the plan, including the water and effluent audits, leading to selection of the preferred waste minimisation measures. Further resources will then have to be allocated to implement those measures, depending upon the costs involved.

Ideally the project leader should be a senior person with practical capability and a good working knowledge of the business. The project leader will need the support of other staff as necessary.

The initial resources to be budgeted for include:

- the staff time required to do the work
- any equipment necessary for measuring water use and effluent production
- analytical services for measuring effluent strength
- and any external assistance required.

There are numerous environmental consultants offering their services to audit businesses. There are also a number of manufacturers offering 'end of pipe' treatment equipment. Fish processors are advised to be cautious. Few consultants have detailed knowledge and experience of fish processing operations. 'End of pipe' treatment is unlikely to be an effective alternative to waste minimisation.

### **4.3 WATER AND EFFLUENT AUDITS**

**The purpose of these audits is to determine where and how much water is used and where and to what extent the effluent becomes contaminated.**

**This involves:**

- **mapping the flow of water and effluent streams throughout the business, identifying uses of water and sources of contamination**
- **observing the working practices of the business to identify the obvious problems such as taps being left on, waste being flushed into the drains and catch baskets being left un-emptied, etc**
- **measuring water usage and effluent strength**
- **and recording the data for analysis.**

**All this should be done over a sufficient period of time to account for the full range of activities and variations in the operation of the business. A period of about one working week during typical operation of the business is recommended.**

**The necessary hygiene and health and safety requirements must be complied with during the audits.**

The emphasis of the audits should be on identifying the major uses of water and sources of contamination and particularly any areas of wastage and unnecessary contamination.

Simple observation of the working practices of the business, noting the obvious shortcomings, can be invaluable. This needs a critical 'eye' and the

auditor(s) should be wary of production staff being on their 'best behaviour' during the audit. It serves no useful purpose to hide the truth about the business.

The extent of the quantitative measurements of water and effluent and the appropriate detail of recording will depend on the scale of the problems and the resources of the business.

The audits must account for the variations in activities and operations of the business throughout the working day and week. For example, it may be necessary to monitor overnight thawing, processing operations during the day (noting what happens during refreshment breaks) and cleaning at the end of the day. If there are large seasonal variations in activity, more than one period of audit may be necessary.

It must not be forgotten that a food business is being carried out. The necessary standards of hygiene must be observed during the audits. Any equipment used and its cleanliness must satisfy the hygiene requirements of the business.

There are also health and safety hazards involved in lifting drain covers to trace effluent streams and in taking samples from the drains. The hazards are primarily from fumes and potentially of disease from the drains. It is recommended that this is not done alone and that suitable waterproof clothing is worn, including gloves. Thorough washing afterwards is, of course, essential.

For obvious public health reasons, the domestic waste drainage system carrying human sewage should be separate from the processing effluent drainage system until final discharge from the premises. **The taking of samples from any drains carrying domestic waste is not advised.**

#### **4.3.1 Mapping the Water and Effluent Streams**

**The flow of water, the flow of fish, the flow of waste and the flow of effluent should be traced throughout the business, from supply through to dispatch or discharge.**

**Points of water use and wastage, of waste and effluent production and spillage, and of any waste screening or separation should be noted.**

**It is recommended that this is recorded on plans or diagrams and tabulated notes.**

The following procedures are recommended:

- use a basic plan of the factory to trace the water supply. Locate the main site water meter and any sub-meters. Trace the distribution of water around the factory and locate all water supply points

- similarly trace the drainage system. Locate the point drains and drainage channels within the factory and trace the pipes to the discharge outlet(s), noting any points of waste separation or screening such as drain covers and catch baskets
- overlay on this the process operations. Note the sources of waste and effluent, where the waste and effluent is directed to and any points of spillage
- and include the subsidiary operations such as storage, thawing and cleaning as well as the main process operations.

In practice, it is often difficult to identify the drainage routes and outlets in old premises. It may help to work outside of business hours, to lift the manhole covers and direct water separately down the various drains within the factory or to use milk or another safe means of dyeing the water to determine the drainage routes.

#### **4.3.2 Measuring Water Use**

**The overall quantity of water used by the business should be measured together with the quantities used by the separate processes and activities. Where it is impractical to make measurements for all the separate processes and activities, estimates should be made. The sum of the separate uses should approximate to the total usage.**

**Water usage should be measured whilst the business is in typical operation when the water pressures are at their usual levels.**

**Note should be made of any water that is bound into the product or is used to make ice which leaves the premises and does not go down the drain.**

**The use of water meters (totalisers) is recommended for measurement wherever practical as they provide a cumulative record of water use over extended periods of time, accounting for the variations in flow that occur in practice.**

**Alternatively, the rates of flow to the separate processes and activities can be measured and water usage calculated from the flow rates and the time periods of operation.**

**Further useful sources of data include previous water bills, manufacturers specifications for processing equipment and standard figures used for the domestic consumption of staff.**

**It is recommended that all the data is tabulated.**

The overall water consumption is simply read from the main supply meter. The previous water bills provide further information for the purposes of comparison. If the bills cover an extended period of time they will also identify trends and any major seasonal variations in consumption.

For many businesses, taking readings from the main supply meter at selected times of the day and night can also provide considerable further information on water usage in the separate processes and activities. For example, if thawing is carried out overnight whilst other operations are halted, the water used in thawing can be measured. If all process operations halt during refreshment breaks yet the supplies remain turned on, an indication of the wastage can be obtained. If process operations halt prior to cleaning at the end of the day, an indication of the water used during cleaning can be obtained. If everything is turned off at night, any leakage can be measured and perhaps by the selective closing of valves the leaks can be identified.

Nevertheless, it is usually necessary to separately measure or estimate the water used in some of the separate processes and activities. The appropriate extent of this and the techniques used will depend upon the particular circumstances of the business concerned. The priority for measurement should be on the processes and activities that use the most water and cause the most contamination.

If there is a significant amount of the water supplied that does not go down the drain, it should be measured and the trade effluent charges reduced accordingly. Conversely, if a significant quantity of ice is brought into and melts within the factory, it should be included in the effluent charge.

Processes or activities with variable flow rates and large volumes are best monitored by water meters. In practice, even processes with an apparently steady flow are often subject to variation due to changes in water pressure caused by water use elsewhere in the premises or are supplied by valves which can be opened to varying degrees.

Suitable water meters cost from about £50. The further cost of installation has to be included but there may be long-term benefit in leaving the meter in situ for monitoring purposes. More sophisticated, non-invasive, strap-on meters are available but at a considerably higher cost (from about £3,000) and they may not be as accurate, particularly on flexible pipes.

Processes or activities with stable flows can be monitored by spot checks of the flow rate. There is little benefit in installing devices to measure flow rate instead of water meters (totalisers), but often flow rates can be measured simply with a bucket or tank and a stopwatch. For example, if it takes 20 seconds to fill a 25 litre bucket from the process inlet or outlet pipe, this amounts to a flow rate of 75 litre/minute or  $4.5\text{m}^3$ /hour ( $1\text{m}^3=1000$  litre). It is still recommended to make several measurements during the day to account for any variations.

Some processes, such as brining, merely involve the periodic filling and emptying of a tank. The water used can simply be calculated from the measured volume of the tank and the number of times it is filled.

Manufacturers of fish processing equipment generally specify a nominal water consumption, although in practice consumption can vary considerably with water pressure and the setting of valves.

The water service providers commonly use standard figures to estimate the domestic consumption of staff on the site. Typically these will be :

<b>Site facilities</b>	<b>Domestic consumption (litre/person/day)</b>
Toilet and handwashing only	50
With canteen	65

When tabulated, the sum of all the separately measured and estimated uses of water during the audit period should approximate to the overall metered water consumption. As a guide, the sum should be within about 10% of the overall metered quantity.

#### **4.3.3 Measuring Effluent Production**

**The overall effluent produced by the business should be measured together with that from the separate processes and activities. Where it is impractical to make measurements for all the separate processes and activities, observation should be made of the apparent extent of contamination occurring.**

**Both the quantity and the strength of the effluent are required. The quantity is normally available from the water supply data but the strength of the effluent has to be measured.**

**Samples of the effluent should be taken whilst the business is in typical operation and the strength of the effluent is at its usual levels.**

**It is recommended that the samples are sent to an accredited laboratory for analysis, which should be for suspended solids and  $s_{COD}$ . The analysis methodology should be the same as that used by the local sewage undertaker for calculating the trade effluent charges.**

**It is recommended that 'composite' samples are taken at each sampling point, producing an averaged sample over a period of time to account for the large variations in effluent strength that occur in practice.**

**It is recommended that all the data is tabulated.**

The overall effluent production should be sampled from the drainage outlet where it leaves the factory, after any final screening of the effluent. If there is more than one outlet pipe, they should all be sampled.

It may be difficult to obtain representative samples from all of the separate processes and activities and it will be costly to have them all analysed. The appropriate extent of sampling will again depend upon the particular circumstances of the business. Again the priority for sampling should be on the processes and activities that use the most water and cause the most contamination. As a minimum, where there are different types of process lines within the business, the effluent from each line should be sampled. Ideally the samples should be taken from the particular drain into which the effluent from the process or line discharges after any initial screening but often the effluent from several processes or lines is mixed at that point. It may be necessary to intercept the effluent en-route to the drain.

In many circumstances, simple observation will have identified the major sources of contamination, such as waste being flushed down the drain during cleaning, etc.

There is little point in knowing the effluent strength if the associated volume of effluent is unknown. Sampling should generally be geared to points at which the flow rate is known. Although the water supply data will generally provide this information, effluent flow meters are available. These can be portable or fixed installations but they are expensive (from about £2,500), require maintenance and are prone to inaccuracy when there are large quantities of solids in the effluent.

Samples of effluent should be collected in clean, sealable 1 litre containers. The samples should preferably be taken from a flowing stream of effluent. They should be taken directly from the flow. If the effluent has settled in a tank or sump, it should be gently agitated prior to taking the sample. The sample bottles should not be unnecessarily agitated after filling as this can affect the results. They should be sent directly for analysis or can be held for a short period in chilled storage (0-4°C).

Any local NAMAS accredited analytical laboratory should be able to carry out the analysis. The local sewage undertaker can advise the laboratory on analysis methodology and may themselves offer competitive analytical services. Costs of about £10-£20 per sample (SS and  $s$ COD) can be expected.

Single, 'spot' samples have relatively little value because of the variations in effluent strength. 'Composite' samples involve taking a number of small samples from a particular point over an extended period of time and then mixing the samples to obtain an averaged sample. It is recommended that composite samples are taken of the overall effluent and from each process and activity, the sampling covering the relevant total period of operation of the business in each case.

Composite samples can be taken manually or with purpose designed sampling equipment. Portable, self-contained sampling units are available. They operate via a flexible tube lowered into the drain and are programmed to suck up samples at the required intervals and mix them in a holding tank. These are very useful items of equipment but unfortunately they are expensive, costing from about £3,000 although they can be hired. Fixed installation composite samplers are also available and may be valuable for the long term monitoring of overall effluent production.

#### **4.4 PRIORITISATION AND SELECTION OF APPROPRIATE WASTE MINIMISATION MEASURES**

**The key to effective analysis and prioritisation is tabulating the data by process or activity and including the calculated water and effluent costs.**

**It is recommended that the measurement data and calculated costs are tabulated as shown overleaf, with a further page of notes for each process or activity based on the observations made during the audits.**

**Prioritisation should be based on the levels of water and effluent costs and the potential improvements that can be made by the appropriate waste minimisation measures, accounting also for any further costs and other difficulties associated with introducing those measures.**

**The guidance given in Sections 5 and 6 of this document will assist in identifying areas for savings and the appropriate waste minimisation measures.**

The measurement data is often incomplete and a degree of judgement may be necessary to estimate the water and effluent costs of some processes and activities. This can be checked against the overall costs for the business calculated from the overall measurements.

The appropriate waste minimisation measures will depend upon the particular circumstances of the business. They will normally include a mixture of short-term and longer term changes to working practices and to the equipment and premises of the business.

It is likely that there will be a number of obvious areas of wastage, such as leakage and leaving taps on, with obvious no-cost or low-cost solutions that can be adopted immediately.

The importance of simple changes to working practices, such as not sweeping waste into the drains, should not be underestimated.

Other waste minimisation measures may require longer term alterations to equipment and premises with associated costs and disruption of the business, which necessitate more extensive cost/benefit analysis and planning.



## TABULATION OF AUDIT DATA

Process or Activity ①	Volume of water used (per day or week) (m <sup>3</sup> ) ②	Volume of effluent produced (per day or week) (m <sup>3</sup> ) ③	Measured effluent strength		Calculated costs (£) ④				
			SS (mg/l)	sCOD (mg/l)	Water supply (per day or week)	Trade effluent discharge (per day or week)	Total water costs (per day or week)	Total water costs per tonne of product produced ⑤	
Process 1									
Process 2									
Process 3									
Etc									
Overall									

### Notes:

- ① All the processes and activities should be listed, including cleaning and domestic usage, even if the full data is not available for each.
- ② & ③ Will normally be the same unless water is bound into the product or ice is made or brought in.
- ④ Costs should be calculated using the relevant data from the water service provider including the Mogden formula details.
- ⑤ Where different products are produced via different processes and activities, the cost per tonne of product should relate to each product and the relevant processes and activities.

## **4.5 IMPLEMENTATION OF THE WASTE MINIMISATION PROGRAMME**

**There should be a planned programme of waste minimisation, including:**

- **the measures to be taken**
- **a schedule for their introduction**
- **the estimated costs involved**
- **the specification of responsibilities**
- **staff training and instruction**
- **targets for waste minimisation**
- **and any performance incentives.**

It is recommended that the specification of responsibilities includes not only the responsibilities for introducing the measures but also the delegation of continuing responsibilities for ensuring waste minimisation in each process or activity area. This will be helped by staff training and instruction and the setting of targets and performance incentives.

Performance incentives are commonly given for product output (which may in fact encourage a wasteful approach) but could for example, include a percentage of the income from the solid waste recovered and so discourage flushing it down the drain.

## **4.6 MONITORING AND REVIEW OF PERFORMANCE**

**A continuing system of monitoring and review of performance should be included as an integral part of the waste minimisation programme.**

**It should include the periodic measurement of water use and effluent production and the keeping of records in order to review performance.**

The experience gained from the audits should provide the basis for devising a monitoring scheme. The extent of measurement required will depend on the particular circumstances of the business.

Checks on water use and effluent production should be made after the waste minimisation measures have been put in place and then at regular intervals thereafter. If other substantial changes are made to the business, further checks should be made after those changes. At somewhat longer intervals, it will be beneficial to carry out an overall review of waste minimisation in the business, particularly in view of the technological development likely in response to this new problem.

As a minimum, the overall water consumption of the business should be monitored from the main supply meter, for example on a weekly basis. It is also recommended that the overall strength of the effluent produced is measured periodically. This is also useful for checking the trade effluent charges. Depending on the particular circumstances of the business, it may also be beneficial to more closely monitor the performance of particular processes and activities, particularly via the installation of sub-meters on the various water supply lines.

#### **4.7 THE IMPORTANCE OF STAFF INVOLVEMENT, TRAINING AND INSTRUCTION**

**It is essential to inform and motivate the staff, as success or failure in waste minimisation will depend largely on their day to day actions.**

**This is a new problem that will require a substantial change in the 'culture' of fish processing businesses. Training will be required at all levels of the business.**

**Staff instruction will be required at the shop floor level to ensure that the new procedures are followed.**

Involving the staff will also enable them to contribute to identifying and dealing with problems.

All staff should be made aware of the basics of water and effluent minimisation. The technical staff and particularly those involved in carrying out the audits and the waste minimisation programme will require further training.

This document may serve as a basis for staff training and instruction. Seafish Training and Standards Division is developing training schemes for the industry to be delivered locally by the Group Training Associations.

## **5. THE PRINCIPLES OF WATER AND EFFLUENT MINIMISATION AT SOURCE**

**Minimising water use and effluent contamination at source is recommended as the most effective way of reducing costs.**

**Particular effort should be focussed on minimising the effluent problem as close as possible to its source in order to achieve the greatest savings for the minimum of effort or outlay.**

**It is recommended that any 'end of pipe' effluent treatment is considered only after having carried out waste minimisation at source.**

**Waste minimisation at source is the key to:**

- **minimising both water supply and trade effluent charges together**
- **generating revenue from the recovery and sale of the fish waste instead of it being an effluent cost**
- **minimising the extent and hence the costs of any further 'end of pipe' treatment that may be required.**

Minimising water use not only reduces the water supply bill but by reducing the volume of effluent it also reduces the discharge costs. The discharge bill is reduced directly by reducing the volume charge and also indirectly by minimising the amount of water washing through the waste and hence the transfer of contamination to the water.

Separating the solid waste from the effluent as close as possible to source is vital in minimising this transfer of contamination, particularly of the soluble organic materials. Once dissolved, these materials are difficult to remove from the effluent at a later stage except by biological secondary treatment.

Separating the solid waste at source has the further benefit of maximising the quantity and the quality of the by-product recovered. This can then be sold to generate revenue, if only at fish meal prices. Specific materials such as trimmings, if separately and hygienically recovered, can be used in higher value co-product such as fish cakes or be sold at higher prices for that purpose.

Waste minimisation at source will also reduce any need for expensive 'end of pipe' effluent treatment or at least reduce the size and cost of the equipment required.

## 5.1 WATER MINIMISATION

The main principles of minimising water use include:

- turning off the water when it is not needed
- using the water efficiently where it is needed
- and considering alternative 'dry' processes instead of the usual 'wet' processes.

**Application of these simple principles can result in dramatic savings.**

**However, the necessary hygiene standards must be maintained.**

Large quantities of water are wasted in many businesses simply through leakage or leaving taps on and hosepipes running when not serving any useful purpose.

Most fish processes consume more water than is necessary for effective operation of the process, in many cases this is considerably more than is necessary. The water flow to processes is often arbitrarily set by valves on the supply lines and is rarely controlled down to the minimum necessary. The fitting of inexpensive flow restrictors can overcome this problem. Many processes involve flooding with water or using powerful water jets, when sprays from well designed nozzles would suffice.

'Wet' processes are commonly used when there are 'dry' alternatives that consume much less water. For example, large quantities of running water are still used for thawing frozen raw material although there are preferable air thawing techniques and equipment. Hoses are still used to 'chase' waste around the floor instead of using squeegees. Water flumes are still used for transporting fish or waste instead of using containers or conveyors.

The Food Safety Regulations demand high standards of hygiene. Seafish continues with its recommendation that this is best achieved by frequent washing down with clean water. However, the efficiency of using water for this purpose can often be improved, for example by using trigger controlled nozzles instead of open ended hoses.

## 5.2 EFFLUENT MINIMISATION

The main principles of minimising effluent strength include:

- separating the solid waste from the water as close as possible to its source
- avoiding unnecessary cutting up or mashing of the waste

- **not soaking the waste in water or passing running water through the waste**
- **and removing the waste from the processing area.**

**Further essential practical points include:**

- **where possible keeping waste off the floor**
- **keeping waste out the drain if it falls on the floor**
- **and separating any solids from the effluent in the drains before it leaves the premises.**

The longer the waste remains in the water and the more finely it is cut or 'mashed up', the higher will be the effluent strength.

Much fish processing waste is allowed to flow directly into the drains. Dramatic reductions in effluent strength can be achieved by inserting simple wedge wire screens into the exit chutes from fish processing equipment. This separates the solid waste from the water close to its source and before it enters the drains.

Particular care should be taken with materials such as livers and gut contents which are readily broken up and very rapidly bind with the water to produce high strength effluent. Where possible, even in processing machines, these materials should be recovered intact rather than being mashed up and emulsified. The pumping of effluent also causes mashing and emulsification.

Waste is often left soaking in filleting tubs and in poorly designed catch baskets or is continuously washed through by running water in poorly designed screens and baskets. Dramatic reductions in effluent strength can again be achieved by avoiding soaking in the process equipment and by good design of screens and catch baskets. This equipment should not only separate the solid waste from the water but also keep the separated waste out of the water.

The Food Safety Regulations demand that waste does not accumulate in processing areas, that it must be continuously removed or placed in leakproof containers and be taken to a hygienic storage area. These practices also help minimise any further seepage into the drains and provide a basis for maximising the value of the recovered material.

In practice, large quantities of fish waste often end up on the floor in processing areas rather than in the waste bin. High effluent strength materials from secondary processing, such as batter mixes and cooking oils, also leak or spill onto the floor. This waste is then subject to being trampled and mashed underfoot and often lies in water running across the floor to the drain. Furthermore, during cleaning operations

this waste is often deliberately flushed into the drains rather than being shovelled up. The catch baskets in those drains are often ineffective and in many businesses are rarely emptied. These practices greatly contribute to the resulting high strength of the effluent.

### **5.3 WATER RE-USE?**

**Any re-use of water is severely restricted by the Food Safety Regulations which demand that only clean water is used in fish processing.**

**For most businesses it would be more cost-effective to use yet more clean water from the public mains rather than to treat 'used' water to the necessary drinking water standards.**

**This does not preclude the re-use of screened water in 'low risk' fish processing applications but this should be approached with caution. It is recommended that the local Environment Health Officer is consulted on any re-use of water.**

**The contamination levels of re-used water are also likely to accumulate and so the overall benefit of reduced charges may not be very great.**

**However, the re-use of water in non-food applications, particularly any water used for cooling refrigeration plant, is not subject to restriction and can lead to considerable savings.**

It would normally require at least biological secondary treatment and possibly tertiary treatment of the effluent to convert it back to drinking water standards. There would also have to be a system of monitoring and control set in place to ensure that those standards are achieved.

It may be acceptable to re-use some mildly contaminated water in low risk applications using the 'counter current' principle i.e. taking water from a relatively clean part of the process and using it in an earlier, dirtier part of the process.

However, in practice the storage tanks, pumping and re-use involved are likely to further increase the contamination levels in the water and reduce the expected benefits.

Considerable savings can be made in re-using any refrigeration plant cooling water by recirculating it through an air cooler.

## 6. FURTHER GUIDANCE ON PARTICULAR PROCESSES AND PROBLEM AREAS

The guidance in this section will be updated as further experience is gained throughout the industry in the practical application of waste minimisation measures. It will be supplemented by Technical Information Sheets giving further technical details on particular waste minimisation measures.

### 6.1 WATER WASTAGE

#### *Problems*

**Surprisingly large quantities of water are wasted through leakage, through leaving taps and hoses running when not needed and through leaving supplies to equipment turned on during breaks.**

**The water flow rates to processes and equipment are often far higher than is necessary.**

By way of example, a dripping tap would cost about £10.00 per annum in water and effluent charges. A hose left running for an 8 hour day over a 300 working day year would cost about £6,500 per annum.

Seafish audits have found that flow rates to processes and equipment are often several times that necessary. Water flow rates are often uncontrolled and depend upon the setting of taps and valves by operators. Identical processes and equipment in a single factory often run at widely different flow rates.





### **Solutions**

**Find and fix leaks. Train, instruct and supervise staff to prevent wastage. Consider fitting solenoid valves to shut off water during breaks.**

**Adjust the water flow rates to the minimum necessary for correct operation of processes and equipment. Fit simple flow restrictors into the water supply lines to limit the flows to the optimum settings.**

For processes and equipment that consume large quantities of water, it may be cost effective to fit solenoid valves to automatically shut off the water during breaks. These valves can cost from about £100 upwards, plus installation.

Simple flow restrictors cost from about £10.00, plus installation. Their cost can be saved in only a few hours of operation. They should be fitted upstream of the process or equipment and then be adjusted and set (effectively tamper proof) to maintain the optimum flow rate. The water on/off control remains local to the process or equipment.



## 6.2 SEPARATING SOLID WASTE AT SOURCE

### *Problems*

**Solid waste is often not separated at source and simply flows into the drains.**

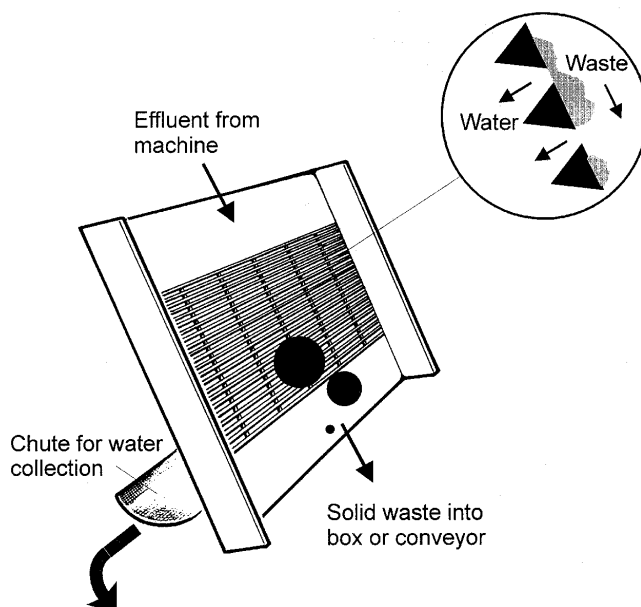
**Where baskets are placed under equipment to catch waste, the water continuously flows through the waste in the baskets.**

These practices add very considerably to the strength of the effluent and they increase the amount of dissolved or organic material that will not be removed by subsequent screening or even by DAF treatment.

### *Solution*

**Seafish have been developing a simple wedge wire screen to be incorporated into processing equipment effluent exit chutes. The screen effectively separates the solid waste from the water.**

Most processing equipment either has or can be fitted with a waste catch tray which directs the effluent to an exit chute. Seafish trials have shown that fitting a simple section of wedge wire screen into the exit chute can be highly effective.



The solid waste passes over the screen and into the waste container. The water 'trips' on the wedge wire, falls through the screen and is diverted away to the drain before it reaches the waste container. When tested on a skinning machine, this reduced the effluent strength by about 60% compared to the original system of allowing the water to wash through the skins collected in a basket under the machine.

The design principles involved are applicable to most processes and equipment but will require further development for each situation. The detail design of the screen will depend upon the flow rates and the nature of the effluent. For the skinning machine, a gap size of 1 mm, a screen length of 250 mm, width of 500 mm and an angle of 55° to the horizontal were found effective.

### **6.3 WASTE COLLECTION AND STORAGE**

#### ***Problems***

**Solid waste is often directed straight into the drains or falls onto the floor to be trampled underfoot prior to ending up in the drains, rather than being hygienically collected and stored for sale as a food co-product or as a by-product.**

**The conditions of waste storage are often unchilled and detract from its value.**

Not only do these practices add to the effluent costs and lose possible income but they detract from the hygiene of the business.

#### ***Solutions***

**Solid waste should be directed into containers in the process area and then taken to the storage area, or be continuously conveyed away to the storage area.**

**Bins used for waste storage must be used only for that purpose. They must be leak proof and lidded.**

**It is recommended that the waste storage area is chilled.**

**Higher grade material for food co-product, such as fillet trimmings, must be kept separate from waste and be handled to the same hygiene standards as other food materials.**

Staff training, instruction and supervision are crucial to efficiency and hygiene in dealing with waste.

The waste handling system should be such that the solid waste falls or is elevated directly into the waste containers without spillage. Having to throw

waste into bins should be avoided. The waste containers in the processing area should be emptied regularly.

The containers used for initial reception of waste in the processing area need not be leak proof where, for example, the waste is still very wet and needs to drain and of course they need not be lidded.

Chilling the waste storage area will slow the deterioration of the waste which can be rapid at ambient temperatures. It also improves the hygiene of waste storage.

Materials such as fillet trimmings and heads intended for further processing as food co-product, must be directed to separate containers and must of course be stored in chilled conditions.

## 6.4 THAWING

### *Problems*

**Many businesses use makeshift water thawing techniques which are largely uncontrolled and which use very large quantities of water, producing large volumes of low strength effluent.**

Typically fish are laid out under water sprays or are immersed in large containers of water and are left overnight with the water running. Some of the fish may thaw rapidly whilst others may remain partially frozen. Thawing in stacked containers is particularly inefficient.

Typically this water thawing consumes about 9.4m<sup>3</sup> of water per tonne of fish and produces an effluent SS of 32 mg/l and <sub>s</sub>COD of 386 mg/l. The water and effluent cost would be about £13.34 per tonne of fish.

### *Solutions*

**Use ambient air for initial thawing or for thawing small quantities of fish.**

**Improve the design and control of water thawing systems.**

**Or use purpose designed warm air thawing equipment.**

Initial thawing in ambient air reduces the need for subsequent use of water or heated air.

Water spray thawing systems can be improved by ensuring an even distribution of fine sprays over the blocks and also by inserting thermocouples into the centre of some of the blocks to automatically turn off the water supply when the fish have thawed.

Various types of purpose designed thawing equipment are available, in a wide range of capacities to suit most businesses.

Seafish has carried out an audit of a steam heated moist air thawing unit. The particular unit tested had a capacity of 4 tonnes of fish in a 6 hour thawing cycle and a capital cost of about £60,000. The unit used about 0.3m<sup>3</sup> of water per tonne of fish and produced an effluent SS of 408 mg/l and <sub>s</sub>COD of 2497 mg/l. The total operating cost including power, water supply and calculated future effluent charges was about £2.04 per tonne of fish.

Although the capital cost of such thawing units is high, they should pay for themselves within a few years of use. There are further advantages of occupying only a small amount of space and of control over the thawing process. The latter is claimed to result in fish quality and process yield advantages.

## 6.5 FISH WASHING

### *Problems*

**Many 'so-called' fish washers are simply overflowing tubs which are ineffective as washers whilst using large quantities of water.**

Simply soaking the fish does not effectively clean it and can lead to softening of the flesh.

The water supplied to tubs does not necessarily flow around the fish. Much of it may simply be wasted.

### *Solutions*

**Use a purpose designed fish washer which employs rotation or agitation and water jets or sprays to effectively clean the fish with the minimum of water.**

A brief active wash is preferable to a long soak.

Where soaking is considered necessary, for example to prevent ice passing into a mechanised production line, a clean water spray wash can be used on a mesh elevator leading from the tub, with the spray water draining back to supply the tub and conserving water.

## 6.6 PRIMARY PROCESSING (MANUAL)

### *Problems*

**Most manual fish cutting operations are carried out on basic filleting benches/tubs which are wasteful in operation.**

**The flow of water to the tub is often uncontrolled and excessive.**

**Much of the solid waste ends up either on the floor around the bench or soaking in the tub, producing excessive effluent strength. This is a particularly acute problem when ungutted fish are processed.**

**The fish are left to soak in the tub and the fillets are commonly dipped into the dirty water for their final wash.**

Most white fish primary processing in the UK is carried out manually.

Some filleters leave hoses running continuously in the tubs whilst others batch fill the tubs, empty them when the water is considered dirty and then refill them. The continuous flow typically uses about 11m<sup>3</sup> of water per tonne of product whilst the batch system typically uses about 4m<sup>3</sup>/tonne.

Trimblings are commonly flicked into the tub and soak in the water, whilst the frames are thrown into a bin. Much of the waste accumulates on the floor around the bench and is trampled underfoot. The strength of the effluent can increase considerably during the day as a result of the accumulation of waste. Typically when filleting white fish, the process area will produce an effluent SS of about 311 mg/l and <sub>s</sub>COD of about 1299 mg/l. However, a Seafish audit of an ungutted dogfish processing line revealed an SS of 10,000 mg/l and <sub>s</sub>COD of 37,275 mg/l, which would attract a future trade effluent charge of over £20/m<sup>3</sup>.

The rinsing of the fillets in the dirty water is clearly unhygienic.



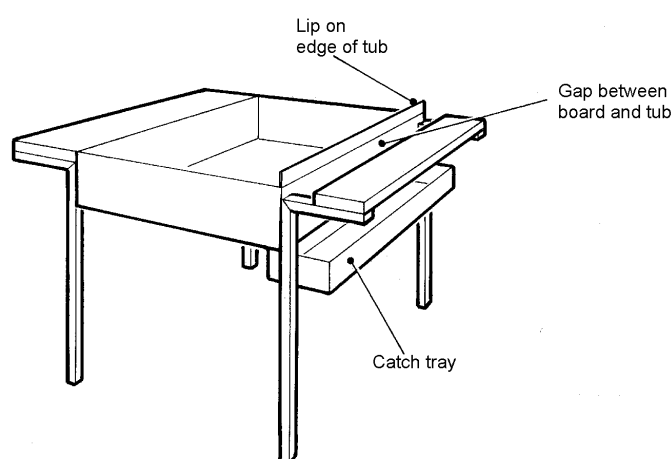
### **Solutions**

**The flow of water to existing tubs can be regulated.**

**The detail design of filleting benches/tubs can be improved to incorporate lips and chutes around the cutting board to direct the waste into bins rather than into the tub or onto the floor.**

**The alternative 'dry' filleting technique can be used in which the fish is pre-washed and only a clean water spray is located at the cutting station.**

Seafish has been developing improvements to the traditional design of the filleting bench. A simple means of separating and collecting the trimmings has been demonstrated. The cutting board is separated from the tub by a gap of about 50 mm and a removable catch tray located underneath. A lip about 40 mm high is positioned on the side of the tub. The trimmings are flicked off the board and fall into the tray. Similar methods can be used at the ends and in front of the cutting board to direct the waste into containers.



A few businesses use 'dry' filleting lines with an initial fish washer feeding an integrated conveyor line filleting system. The conveyors deliver the fish to a number of cutting stations and carry the product and the waste away. A flexible hose with a trigger operated spray nozzle is provided at each cutting station. Potentially these lines are very efficient but in practice the fish washer design may be wasteful and poor detail design of the cutting stations may still result in a considerable amount of waste on the floor.

The principles of this 'dry' filleting can be applied to separate filleting benches without conveyor systems. Seafish has modified a filleting bench to incorporate a small nozzle positioned over the cutting board. This provides the necessary knife lubrication and cleaning without using a tub. The water jet is triggered by the filleter via a knee operated tap and is controlled by a flow restrictor. The fish has to be pre-washed but the system has proven efficient and to the liking of the filleters.

## **6.7 PRIMARY PROCESSING (MECHANISED)**

### ***Problems***

**Most fish processing machinery installations depend for their operation on using large quantities of water.**

**Beyond this necessary use of water, the flow of water to these installations is often uncontrolled and excessive.**

**The waste is often cut or mashed up and mixed with the water by the action of the machines which produces a high strength effluent. This is a particular problem when processing ungutted and high oil content pelagic fish.**

**The solid waste from the machines is often not effectively separated at source. It often ends up on the floor around the installations.**

**The faults lie not only in the processing machines themselves but also in the systems of catch trays, chutes, conveyors and flumes commonly built around them to transport the fish, products and waste.**

The great majority of processing machines were designed and installed before water use and effluent production became costly problems. They were designed primarily for high throughput, reliability of operation and product yield rather than waste minimisation. They depend upon using large quantities of water for 'mechanical' purposes as well as for continuous cleaning. Water jets are used to lubricate knives and surfaces over which the fish and waste must slide and are used to exert force to position the fish and to move fish and waste around.

Beyond their designed high water consumption, uncontrolled flow rates of up to double the machinery manufacturer's specifications have been measured during Seafish audits. In one of the factories audited, the water used beyond the manufacturer's specifications would during peak production amount to a further water and effluent cost of over £500/day.

Most pelagic fish primary processing in the UK is carried out mechanically. The machines have a very high throughput and their action is often to mechanically 'whisk' the oil and gut contents into the water. They produce



large quantities of highly contaminated effluent. A single herring processing machine during peak production could result in a water and effluent cost of over £400/day.

These problems are commonly exacerbated by the systems of catch trays, chutes, conveyors and flumes built around the processing machines. These systems seldom effectively separate the solid waste at source, indeed they often introduce yet further water to transport the waste and so increase the amount of dissolved organic material. Through poor design they often result in considerable spillage onto the floor.

### ***Solutions***

**By extensive application of waste minimisation at source, Scandinavian fish processors are reported to have reduced both the water consumption and the effluent strength of their mechanised fish processing lines by about 70%.**

**Much of this can be achieved by the basic measures of minimising and regulating water flow rates, separating solid waste at source, not using water flumes and preventing waste from falling on the floor.**

**Beyond these basic measures, considerable further savings can be made by changes to the design of processing machines to use less water and to incorporate vacuum evisceration.**

With a reduction in both water use and effluent strength of 70%, the water and effluent cost for a pelagic fish processor would be reduced by over 80%.

Seafish trials with skinning machines have shown that sometimes the water flow rate can be reduced to considerably below that specified by the manufacturer without affecting operation, although this will not necessarily be the case with more complex equipment such as filleting machines.

Waste can be separated at source by simple wedge wire screens. Flumes can be replaced by conveyor belts.

Changes to processing machinery design are altogether more complex and processors are advised to seek guidance from the machinery manufacturers or the expert engineering consultancies that have been working on these problems in Scandinavia. Although critical, relatively simple measures such as replacing inefficient nozzles and making small mechanical changes are known to result in substantial reductions in water use. Vacuum evisceration is a more fundamental and costly alteration but can reportedly reduce contamination from this source by over 90%.

The design of conveying systems is dealt with in Section 6.9. An important factor in relation to processing machines is that they should, if necessary, be raised off the ground so that there is sufficient height for the installation of

catch trays, separator screens and chutes feeding the waste directly into containers or onto conveyors. There should be no need for further water jets to make the waste flow down shallow inclines.

## **6.8 SECONDARY PROCESSING**

### ***Problems***

**Secondary processing businesses often have a high water consumption per tonne of product.**

**Many of the materials used in secondary processing such as batter mixes, cooking oil, brine and marinades have high COD values and result in a high effluent strength if they spill or are disposed of into the drains.**

**Shellfish processing involving boiling and peeling or shucking can result in particularly high water usage and effluent strength.**

Secondary processing often involves a multiplicity of processes and a considerable amount of cleaning. This consumes large quantities of water and presents similarly numerous opportunities for waste. For example, of two companies audited by Seafish that were glazing frozen products, one used a continuous water supply to an overflowing dip bath that consumed 12.3m<sup>3</sup> of water per tonne of product whilst the other filled and emptied the bath as necessary and consumed 0.35m<sup>3</sup> of water per tonne of product.

The audits have shown similar variations in practice in making up and using batter mixes, brine and marinades, with some businesses allowing considerable spillage or frequently making up new batches and disposing of the previous batch down the drain. From the audit data, the trade effluent cost of discharging neat batter mix would be about £408.00/m<sup>3</sup>, that of brine after use for dipping fillets prior to smoking would be about £11.50/m<sup>3</sup> and that of acetic acid based marinade after use would be about £24.50/m<sup>3</sup>.

Scandinavian data indicates that shrimp boiling and peeling lines will face particularly high water and effluent costs. No-doubt much of the contamination from these processes is dissolved organic material.

### ***Solutions***

**Minimise and regulate water use in the various process operations and in cleaning. Separate solid waste at source.**

**Avoid spillage of high effluent strength materials such as batter mixes, brine and marinades and regulate their production to minimise any need for having to dispose of them.**

**Some large-scale secondary processing businesses may find 'end of pipe' treatment options cost effective.**

Much secondary processing is carried out by large-scale businesses which operate continuously, often using frozen raw material. This produces a large and steady flow of often highly contaminated effluent, for which 'end of pipe' effluent treatment may be practically feasible and cost effective.

## **6.9 CONVEYING**

### ***Problems***

**Through poor design, conveying systems often contribute significantly to water use and effluent strength.**

**Water flumes are used in some businesses to transport fish and waste.**

**Catch trays and chutes are sometimes dependent on additional water jets to make the fish flow.**

**Spillage onto the floor often occurs at the intersections between chutes, conveyors and bins, etc.**

**Conveyors may require continuous cleaning jets.**

The use of water flumes and additional water jets to make the material flow is directly counter to the principles of waste minimisation and results in unnecessarily high contamination, particularly when used to transport waste.

It can be difficult to keep mechanical conveyors in a hygienic condition, particularly those carrying small pieces of waste which tend to stick to belts and wrap around mechanisms. This can necessitate the use of continuous cleaning jets and/or considerable effort and water usage in daily cleaning.

### ***Solutions***

**Care must be taken in the design of catch trays, chutes and conveyor systems to ensure effectiveness and hygiene.**

**Don't use water flumes and additional water jets.**

**For many businesses, particularly the smaller businesses, the use of boxes and bins for the transport of fish and waste will be preferable to conveying.**

The need for expert knowledge and attention to detail in the design and manufacture of fish handling systems is often underestimated.

Catch trays and chutes should have smooth stainless steel surfaces and be angled such that they do not need additional water jets.

Smooth belt conveyers are easier to keep clean than link or flighted conveyors and can be fitted with simple scrapers and deflectors to positively discharge the

conveyed materials. This can overcome the common problem of the materials 'wrapping' around the ends of conveyors and falling on the floor.

However, for many businesses the use of boxes and bins instead of conveyors will be the simplest and most hygienic solution.

## **6.10 CLEANING**

### ***Problems***

**Cleaning uses large quantities of water yet is often poorly controlled and wasteful.**

**Open ended hoses are commonly used to 'chase' waste around the floors.**

**The waste is often deliberately flushed down the drain.**

In the businesses audited by Seafish, the proportion of their total water consumption used in cleaning varied between about 5% and about 40%. In one large pelagic processing business which used about 35% of its water in cleaning, over 20% was used when there were no fish to process and the staff were instead put on cleaning duty.

The majority of water consumed in cleaning is used in the first phase of gross solids removal i.e. hosing down the equipment and then the floors to flush the waste away. This is often done with open ended hoses or even in some instances by filling large bins with water and then using fork lifts to tip them over the floor.

The drain covers are often deliberately lifted during cleaning to allow the waste to flow unimpeded into the drains.

### ***Solutions***

**Cleaning should be carried out according to a schedule that specifies when it should be done, how it should be done and who is responsible.**

**Hoses should be fitted with adjustable trigger action spray nozzles to conserve water.**

**It is recommended that 'squeegees' are used to gather the waste on the floor which should then be shovelled up and put into the waste bins.**

Cleaning remains an essential requirement but it can be done efficiently. Staff training, instruction and supervision are crucial.

Adjustable trigger action spray nozzles not only consume much less water than open ended hoses which are left turned on at the tap but are also likely to be more effective in cleaning down.

The solid waste on the floors should be 'squeegeed' into heaps and shovelled up **before** the floors are hosed down.

## **6.11 THE DRAINAGE SYSTEM**

### ***Problems***

**Drain covers are often ineffective in preventing large solids from entering the drains.**

**Drain catch baskets are usually poorly designed and ineffective in preventing the smaller solids from contaminating the effluent.**

**Catch baskets are often infrequently emptied and are sometimes deliberately taken out and left out.**

Drain covers often have large slotted holes that will allow an entire fish frame to pass into the drain.

Catch baskets are usually simple mesh baskets. All of the effluent passes through the waste trapped in the basket and so washes out further contamination. The baskets are often large and deep and often extend below the water level so that the waste remains fully immersed in the drain.

Removal and cleaning of these poorly designed baskets can be a very mucky, smelly and laborious task. Staff don't like doing it and will leave them unattended for many days or take them out and leave them out.

In total, the effectiveness of these baskets is often minimal.

### ***Solutions***

**Smaller holes should be used in the drain covers.**

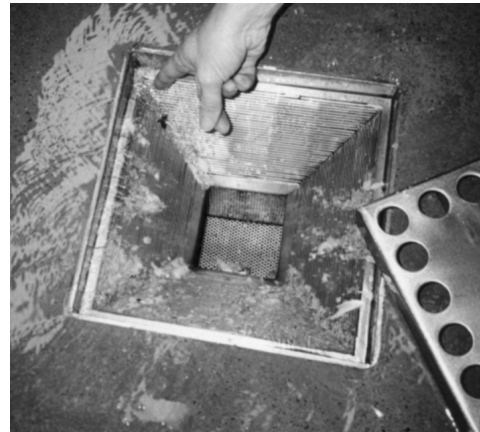
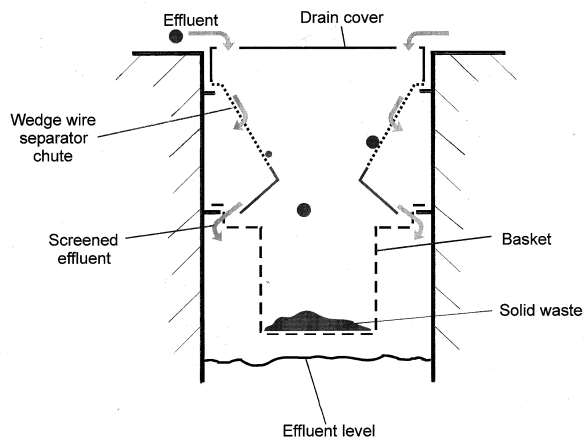
**Catch baskets should be emptied frequently as part of the cleaning schedule.**

**Seafish have been developing an improved design of catch basket incorporating a simple wedge wire screen that effectively separates the solid waste from the water.**

The design of drain covers is a compromise in order to prevent the large solids from passing through but without the holes blocking and causing flooding of the floor. Preventing the waste from falling onto the floor in the first place is the best solution. In Seafish trials, simple 'punch plate' covers with 15 mm diameter holes taking up 11% of the total area of the covers have been found effective. Consideration could

also be given to 'keying' the covers in position so that they cannot be lifted without a special tool.

The new design of catch basket incorporates a short length of wedge wire screen over which the effluent flows before reaching the basket itself. The water falls through the screen and into the drain, whilst the solids pass over the screen into the basket where they are held out of the water.



The prototype basket was designed to replace an existing basket of conventional design in a point drain set into the floor of a white fish processor. The drain is square in plan view and the effluent enters from all sides. A four sided wedge wire screen with 1 mm gaps was set around the periphery of the drain, under the cover, with the catch basket set into the centre. The holes around the periphery of the cover direct the effluent onto the screen. In extended trials the new basket has reduced the effluent strength in the drain by about 50%.

The design principles involved are equally applicable to other drain layouts but will require further detail development for each situation.

## 7. CONSIDERATION OF EFFLUENT TREATMENT AND DIRECT DISCHARGE

After carrying out waste minimisation at source, 'end of pipe' treatment of the effluent prior to discharge may still be cost-effective for businesses producing large quantities of strongly contaminated effluent.

Direct discharge of treated effluent is also likely to be cost-effective in these circumstances, given a suitable location and the necessary consent to discharge.

However, effluent treatment and direct discharge involve considerable initial investment. Effluent treatment also involves continuing operating complications and costs. These are unlikely to be feasible options for small businesses.

Businesses may also lack the space necessary for primary or secondary effluent treatment or be in an unsuitable location for the operation of such facilities.

There are economies of scale. Groups of businesses may find it cost-effective to share joint treatment and/or discharge facilities. It is recommended that consideration is given to joint facilities being operated by a separate water treatment business.

These options may well be feasible for large-scale pelagic processors or other businesses producing high strength effluent. The savings to be made in the trade effluent charges or their elimination in the case of direct discharge, may be greater than the costs involved in effluent treatment and direct discharge. These options are less likely to be feasible for white fish primary processors who can reduce their effluent strength to relatively low levels by waste minimisation at source. However, effluent treatment may be **necessitated** in some instances where, for local reasons, the consent to discharge specifies a particularly low effluent strength.

Both primary and secondary treatment facilities require a significant amount of space and, for environmental reasons, may not be acceptable in city centre or other 'sensitive' locations.

Both primary and secondary effluent treatment facilities are also far from being 'fit and forget'. They require considerable expertise, monitoring and control if they are to operate efficiently. These requirements are beyond the resources of most fish businesses. Any direct discharges have to be carefully monitored.

Sharing joint facilities would result in obvious cost savings if the businesses are suitably located and can be cost-effectively piped into those facilities. However, the management of such joint ventures and the liabilities involved need careful consideration. The costs need to be fairly apportioned and the input of effluent from each business needs to be monitored and controlled. Someone will be liable if the joint facility breaches its discharge consent. These considerations, together with the desirability of such facilities being operated by experts, suggest that it may be preferable to set up a separate business to operate shared facilities.

## **7.1 EFFLUENT TREATMENT**

**The type of treatment and equipment required will depend upon the nature and quantity of the effluent and on the conditions of consent to discharge.**

**It is recommended that businesses carry out thorough technical investigation and cost/benefit analysis before investing in equipment.**

### ***Choosing the Right Equipment***

The first step is to analyse samples of the effluent. This should be done after the waste minimisation measures have been put into place as they will greatly affect the nature as well as the quantity of the effluent.

If the effluent contains a significant proportion of suspended solids, screening (preliminary treatment) may be effective. To remove smaller solids and oils/grease, DAF systems (primary treatment) can be effective. If the effluent contains little suspended material yet has a high COD, it contains dissolved organic material and will normally require biological (secondary) treatment to substantially reduce its strength.

The variations in the effluent to be treated must also be considered. This is particularly so for pelagic fish processors whose processing throughput and effluent output is highly seasonal. Both the quantity and the nature of the effluent vary. Herring processing, particularly in the spawning season, can result in extremely high levels of suspended solids whereas mackerel processing may result in lower overall effluent strengths but high levels of dissolved organic material. The effluent treatment facilities must be capable of dealing with all these variations and may have to be designed on a 'worst case' basis. These facilities may then not be efficient when the effluent output is low.

Laboratory simulations and pilot-scale trials can be carried out with samples of effluent to determine the likely effectiveness of the treatment methods. Equipment manufacturers may offer these services although processors are advised to take a cautious approach to the likely degradation of performance in service. This may be considerable if there is a lack of expertise in operating these systems. This should be allowed for in cost/benefit analysis.



### **Screening**

Screens are prone to 'blinding' or blockage by fish effluent. Wedge wire screens have been found the most effective. The most basic is the static parabolic or 'J' screen but self-cleaning rotary wedge wire screens are more commonly used by fish processors. These rotary screens cost from about £10,000 upwards.

The effectiveness of screens depends upon the nature of the effluent. In Seafish trials a 0.25 mm gap rotary wedge wire screen was found effective for treating herring effluent but blinded with white fish effluent. A 1 mm gap screen was found effective for white fish. Reductions in effluent strength of up to 40% were achieved when treating high strength herring effluent which had not been minimised at source, but much smaller reductions could be expected in most circumstances and particularly if following waste minimisation at source.

### **DAF Systems**

DAF systems are already used by a few fish processors. In addition to the basic DAF unit, which is relatively compact, a large balancing tank, a chemical flocculation unit and sludge storage tank are required. A sludge de-watering system may also be beneficial. Preliminary screening is usually carried out prior to DAF treatment. The cost of a full installation for a large-scale pelagic processor could be over £250,000.

The balancing tank is required to even out the flow and the strength of the effluent. Adding chemical 'flocculents' to the effluent improves the efficiency of separation. The cost of the chemicals is about £0.50 per m<sup>3</sup> of effluent.

The effectiveness of DAF systems will again depend upon the nature of the effluent. In Seafish pilot-scale trials treating pelagic and white fish effluent which had not been minimised at source, a chemically flocculated DAF system when operated in optimum conditions reduced the strength of the effluent by about 90%. However, there is considerable expertise involved in maintaining the optimum 'balance' of DAF systems including the correct chemical mix. Without chemical injection, the performance in the trials was greatly reduced. In commercial operation of the system by the pelagic fish processor, reductions in SS of about 70-90% and in <sub>s</sub>COD of about 50-70% are being achieved.

The disposal of the 'sludge' can be a further problem, particularly if chemical flocculents are used which may make the sludge unacceptable to fish meal manufacturers. There will then be a continuing sludge disposal cost, for example to landfill. There are alternative organic flocculents but these are more expensive and less effective.

### **Biological Treatment**

Biological treatment systems are already used by a small number of fish processors where there are particularly tight limits on the strength of effluent discharged or where the costs of discharge to public facilities are very high.

The type of system suitable depends upon the scale of operation and the space available. The practicalities and economics of the process are likely to require preliminary screening and primary (probably DAF) treatment prior to secondary, aerobic, biological treatment. This final biological treatment can reduce the COD of the effluent to below 50 mg/l.

The relatively compact high performance types of aerobic bioreactors are more likely to be suitable for processors in their existing locations than extensive pond or tank systems. Total system cost for a large-scale pelagic processor including screening, DAF and biological treatment, could be over £400,000.

Biological systems can be temperamental in operation. They can require 'start up' periods of several weeks before working efficiently and then require controlled 'feeding' to maintain optimum conditions. Keeping the reactor 'alive' in periods of short fish supply may be difficult.

Biological systems can be made to operate on either fresh water or seawater based effluent, using different types of bacteria, but will not effectively switch between the two.

The sludge produced will have to be disposed of, probably at a cost, and a full time operator is likely to be required for the entire treatment system.

## **7.2 DIRECT DISCHARGE**

**A suitable location and consent from the appropriate environment agency are essential for direct discharge.**

**In practice, consent is likely to be granted only if the discharge is to the open sea and primary treatment is carried out prior to discharge.**

Businesses must be prepared to risk a considerable sum in making an application for consent to discharge, which may not be granted, and then to invest further in the pipeline likely to be required. If successful, however, the continuing operating costs will be very low in comparison to discharge to a sewer.

The environmental studies usually required in support of an application include:

- hydrographic surveys of currents and discharge dispersal routes
- bathymetric surveys in relation to laying a pipeline, outfall position and seabed habitat
- and modelling of the impact of the discharges on the marine environment.

These studies could cost over £50,000.

If fish processing effluent is kept separate from domestic effluent, the effects of its discharge into the marine environment are relatively benign in comparison to the human pathogens and other 'nasties' in urban waste water. Discharge of fish effluent simply returns the nutrients into the sea from where they originated. This can stimulate healthy growth in the marine environment provided that the effluent is well dispersed and is not in excessive quantities that cause oxygen depletion. Discharge into rivers or areas of low dispersal is more likely to cause environmental problems.

If a number of businesses in an area are to make direct discharges, their cumulative effects must be considered. The licencing agency may be more receptive to a proposal for a joint discharge. This will also greatly reduce the costs for each partner.

Any consent to discharge will no-doubt require a pipeline extending beyond the low water mark. Further planning consents and a licence from the appropriate marine agency will be required for the pipeline. The construction costs of the pipeline could be over £1,000/m.

The operator of the pipeline will be required to monitor and control the discharges and this will involve some continuing cost in addition to the charges levied by the environment agency for their own costs.

## 8. FURTHER SOURCES OF INFORMATION AND ADVICE

Technical advice is available from Seafish Technology at the following address:

Seafish House  
St. Andrews Dock  
Hull  
HU3 4QE. Tel. 01482 327837, Fax. 01482 223310.

Seafish will also be publishing a number of Technical Information Sheets giving further technical details on particular waste minimisation measures.

Information on the provision of training is available from Seafish Training and Standards, at the above address.

The regional water service provider will give detailed information on the water and effluent charges and the consent conditions that apply locally. They may also offer further technical and advisory services.

Further information on the abstraction of water and the direct discharge of effluent can be obtained from:

The Environment Agency  
Rio House  
Waterside Drive  
Aztec West  
Almondsbury  
Bristol  
BS32 4UD. Tel. 01454 624400, Fax. 01454 624409.

The Scottish Environmental Protection Agency  
Erskine Court  
Castle Business Park  
Stirling  
SK9 4TR. Tel. 01786 457700, Fax. 01786 446885.

Environment and Heritage Service  
Calvert House  
23 Castle Place  
Belfast  
BT1 1FY Tel. 01232 254754, Fax. 01232 254865.