Sampling manual for

environmental monitoring

by intensive livestock producers

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environmental monitoring

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This publication has been designed to assist owners and managers of intensive livestock enterprises obtain feedback for their effluent re-use practices and carry out their monitoring responsibilities under the *Environmental Protection (EP) Act (1994).*

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Contents

Important warning

Animal wastes may carry diseases injurious to human health. Care should be taken to avoid skin contact or ingestion of these materials. Do not refrigerate or freeze samples in fridges or freezers that are used to store food, or will be used to store food in the future.

Introduction

The purpose of this manual is to assist owners and managers of intensive livestock enterprises obtain feedback for their effluent re-use practices and carry out their monitoring responsibilities under the *Environmental Protection (EP) Act (1994).*

When producers undertake soil testing, it is important they contact the analytical laboratory to confirm the tests to be undertaken and the laboratory's requirements for storage, packaging and transport of samples. Laboratory staff will also advise on sample collection and may be able to provide alternative sampling protocols.

Every effort has been made to present the recommended sampling methods in simple terms. This manual is not intended to provide sampling standards for use by regulatory agencies for official environmental auditing purposes; sampling methods used for that purpose are likely to be considerably more stringent than those indicated in this document.

This manual sets out the sample collection and preparation techniques needed to fulfil the monitoring requirements of the EP Act intensive livestock licences (if applicable), for the following types of sample:

- soil;
- effluent;
- manure;
- sludge;
- surface water;
- groundwater.

The first edition of this manual was issued in September, 1998. Future editions will be numbered sequentially — 2nd edition, 3rd edition and so on. Intensive livestock facility managers and other manual users should ensure that they are using the latest edition.

The analyses required for each intensive livestock enterprise are listed in the Environmental Authority (licence or approval) issued by the administering authority delegate, and may include the following:

Soils

- pH (1:5 soil/water extract)
- Electrical conductivity (EC) (1:5 soil/water extract)
- Total nitrogen (N) or total kjeldahl N, and nitrate-N (KCl extract)
- Total phosphorus (P) or Colwell-P
- Exchangeable sodium percentage (ESP)
- Organic carbon
- Chloride

Water and effluent

- Total P
- Orthophosphate-P
- Sodium adsorption ratio (SAR)
- Electrical conductivity (EC)
- pH
- Total N or total kjeldahl N, ammonium N, and nitrate-N
- Potassium (K)

Sludge and manure

- Electrical conductivity (EC)
- Total N or total kjeldahl N, ammonium N, and nitrate-N
- Total P
- Total sodium (Na)
- Total magnesium (Mg)
- Total calcium (Ca)
- Total carbon
- Total potassium (K)

All sample analyses must be performed by a laboratory accredited by the National Association of Testing Authorities (NATA) or equivalent for the tests undertaken. Ask qualified laboratory personnel whether the laboratory is accredited for the analyses required.

Reducing the risk of sample contamination

It is in the interest of the producer to ensure that the samples collected are not contaminated with the nutrients or elements to be analysed. Potential for such contamination exists at each stage of sample collection and preparation. This risk may be minimised by the following means.

- Thoroughly clean all tools to be employed in the collection of samples. Foreign matter should be removed from their surfaces and they should be washed with clean water, then allowed to dry.
- Select clean work areas for sample processing to minimise potential for sample contamination.
- Contact between hands and sample material should be avoided.

Storage and transport requirements

Different sample types require different storage conditions and must be delivered to the laboratories within different time periods. This information is summarised below.

Table 1. Storage and transport requirements for samples.

Sample type	To be analysed for	Recommended maximum holding period (days)	Storage and transport temperature		
(refer to appropriate section in text)			**Room temp.**	**< 4ºC but not frozen**	**Freeze**
Air-dried soil	All	>28	**P**		
Effluent or water	All P types	28			**P**
	Nitrate-N	7			**P**
	Ammonium-N	7			**P**
	Total N	7			**P**
	EC	2		**P**	
	pH	2		**P**	
	SAR	7		**P**	Optional
	K	28	**P**	Optional	Optional
Sludge or manure	All P types	28			**P**
	Nitrate-N	7			**P**
	Ammonium-N	7			**P**
	Total N	7			**P**
	EC	2		**P**	
	pH	2		**P**	
	K	28	**P**	Optional	Optional

Soil sampling

Preparation for sampling

Contact the transport company and laboratory before sample collection to determine when they will be able to transport or process the samples. At this point it may be advantageous to discuss sampling methods and any special requirements the laboratory may have.

Soil sampling can be labour intensive. Manual collection of 5 cores to a depth of 1m is likely to be several hours work. Where greater numbers of sample cores, or cores to greater depths, are required, it may be cost effective to hire a motorised hydraulic soil-sampling rig. Producers should ensure that any consultants engaged are appropriately accredited in soil science and soil sampling procedures.

Selecting a monitoring site

The monitoring plot or clustered sample method has been selected to monitor the effects of intensive livestock industries on soil as it is inexpensive relative to other methods, and it ensures that useful data is obtained. A 10m radius monitoring plot should be selected that is representative of the effluent, manure or sludge disposal area most at risk of excessive salt or nutrient leaching. Factors that should be considered in the selection of monitoring plots include:

- **Soil type**. In general, application of waste (effluent, sludge, or manure) to non-cracking soils with moderate clay content is less likely to result in nutrient mobility than is application on cracking or sandy soils. Sites should be selected that are representative of a single soil type and that do not contain atypical features such as rocky areas (unless these are common throughout the soil), tracks, tree stumps or ash after burning.
- **The effects of management practices**. The monitoring site should be selected to represent the area most at risk in relation to management practices. For example, where flood irrigation of effluent is the major form of disposal, a monitoring site may be selected that is close to the outlet source and so receives effluent with each irrigation. If topography and management practices result in concentration of effluent in low-lying portions of the effluent disposal area, then these areas may be appropriate monitoring sites. Monitoring plots should be well away from fence lines and centrally located in the effluent disposal area.
- Once a monitoring site has been selected, it is intended that samples be collected from that site throughout the period of operation. Changes to management practices, however, may require the selection of new monitoring sites. For this reason, monitoring sites should not be selected on the basis of short-term management practices. Managers should ensure that exact monitor plot locations are recorded and provided to the administering authority with the annual return.
- **Selection of a background reference plot**. Under some circumstances it is recommended that a background reference site be sampled to establish the characteristics of a soil prior to effluent irrigation or other waste application. Reference plots should be selected from areas of the same soil type as the monitor plot that have not received wastes either directly or by run-off or over-spray. Reference site selection should consider all the other aspects of site selection discussed above. An adjacent uncultivated paddock of the same soil type may be a good location for collection of background data.

It is important that producers select monitoring sites that, in their best judgment, satisfy the above criteria. Random auditing may be carried out to confirm the suitability of monitoring sites.

Figure 1. A simple, effective tool for surface soil sampling. The foot plate is adjustable to allow sampling to different depths.

Selecting a time to sample

The weather and season can influence soil conditions. Annual soil monitoring should be carried out when remaining nutrients are most vulnerable to leaching, and at approximately the same date each year. The end of a cropping cycle may be a good sampling time. Although managers should avoid sampling following prolonged rainy weather, slightly moist soil is often much easier to sample manually than is very dry soil.

Materials and equipment

Consumables and miscellaneous equipment

The equipment required for the sampling includes:

- trays for soil drying;
- a plastic bucket;
- a stainless steel or plastic spatula or knife;
- new, clean polyethylene sheeting;
- new, clean plastic bags suitable for the collection of 400 to 500g samples;
- durable containers or poly-weave bags (not fertiliser bags) for transport of bagged samples.

Selecting sampling tools

The sampling tools employed must allow samples to be accurately removed from the desired soil depth interval, and prevent the samples from being contaminated with the soil of other intervals.

- A clean shovel and ruler may be used to collect acceptable surface samples (0–100mm). Foot samplers are also ideal for this depth interval (Figure 1).
- For sampling depths greater than 300mm, an inexpensive, effective option may be a combination of post-hole auger (Figure 2) and drive or push-type core sampling tube (Figure 3). In unstable soil, however, take care to ensure that deep samples are not contaminated with high nutrient surface soil due to wall caving.
- Other equipment may be available that allows accurate collection of samples from selected depth intervals while preventing contamination of the sample with soil from other levels.

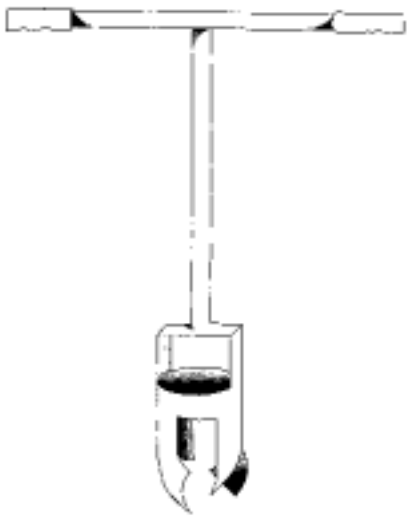

Figure 2. A hand operated soil auger, suitable for the collection of samples, although sample collection at depth is likely to be labour intensive.

Sample collection and preparation

At each monitoring site, randomly located cores within a 10m radius must be collected from each of the depth intervals stated in the Environmental Authority (licence or approval). These are generally 0–100mm, 200–300mm, 500–600mm, or deeper. Collected samples should be treated with care and processed as rapidly as possible. If delay is unavoidable, place samples in polyethylene bags and leave them, unsealed, in the shade to avoid sweating.

An important note on numbers of cores: Where surface samples are collected (0 to 100mm), rapid collection of 25 cores is relatively easy and will provide sufficiently accurate information for most purposes. Manual sample collection at depth, however, can be labour intensive. Where the purpose of sampling is to establish whether there has been any increase in nutrient concentrations above background levels at depth, 5 to 8 core samples may be sufficient. However, if elevated nutrient levels have already been detected at depth, a more detailed investigation may be required. In this case, up to 25 cores may be required to demonstrate that any changes to management practices have been effective in reducing soil nutrient or salt levels.

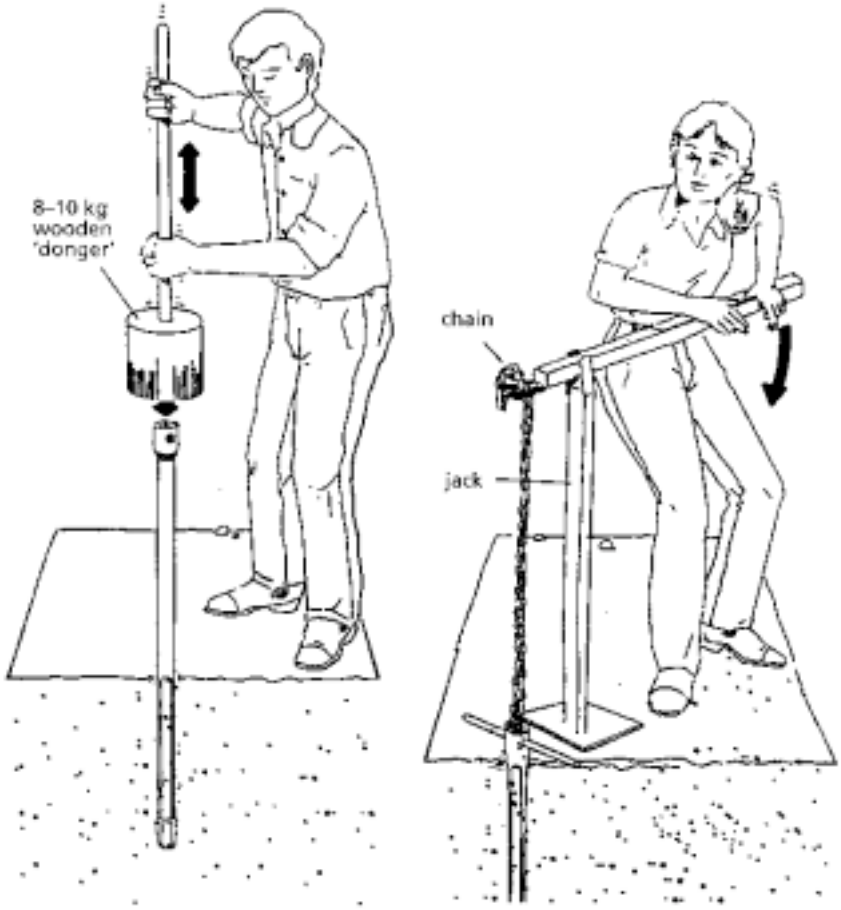

Figure 3. A good hand-operated tool for sampling at up to 1m depth. The sampling tube is constructed from exhaust tubing. (Picture reproduced with the permission of the Agricultural Production Systems Research Unit).

The recommended procedure for collection of soil samples is:

1. Thoroughly clean all tools and trays employed in the collection of samples before use, including spatulas, plastic buckets and sampling equipment. Remove all foreign matter from their surfaces, wash them with clean water and allow them to dry. To reduce cross contamination between samples of different depths, remove soil from tool surfaces between collection of each core.

2. Collect cores or surface samples as required. The techniques necessary for this will be determined by the sampling tools selected for the task. Samples collected from the same sampling depth interval (as specified in your licence or approval) can be placed together in a clean polyethylene bag, labelled with sample location data and placed in the shade. Leave the bag open to prevent the sample sweating.

3. Refill deep core holes (>0.15m) with clean soil, clay, or bentonite that is not contaminated with nitrate, nitrite, ammonium or phosphorus. This step may be important, as it prevents effluent flow down core holes that could lead to incorrect or misleading results in the future if this core hole were sampled again. Observations may indicate that refilling core holes is unnecessary in some soils if the core holes close soon after sampling.

4. Combine the cores collected from the same depth interval, break them up and mix them with a clean spatula. Rock fragments greater than 2cm diameter and large fragments of roots should be removed from each of the samples. If the soil is very strongly aggregated and the samples consist of large clods, it may be easier to air dry them first(see step 6 below) and then break up aggregates before cores from a single depth are bulked together.

5. Use the ‘coning and quartering’ technique to collect a representative sub-sample of cores from each depth interval. Coning and quartering is carried out by laying a clean plastic sheet on a horizontal surface and pouring the thoroughly mixed core sample onto it to form a heap shaped like a cone. Make two cuts down the centre of the cone from top to bottom to separate out a quarter of it. Remove the unwanted three quarters of the cone and lay the sheet down flat again. Remix the quarter that you kept, pour it onto the sheet to form a cone and take one quarter of the new cone. Repeat the coning and quartering process until you have reduced the weight of the core sample to approximately 400 to 500g.

Figure 4. An air-dried soil sample undergoing ‘coning and quartering’ to ensure that the sub-sample collected is representative of the whole sample.

6. Prepare the samples for transport without delay. The samples should be spread out in trays lined with new, clean plastic sheeting. Spread each composite sample in a separate tray and label the tray with the site location. To ensure rapid drying, don’t spread the soil any deeper than 2cm. Alternatively, use multiple trays for each composite sample. Place the trays where the samples can air dry but will not be contaminated and will not be exposed to direct sunlight or temperatures above 40∀C. Alternatively, samples may be dried in a fan-forced oven at temperatures less than 40∀C. The samples are allowed to dry until they are ‘air dry’, which takes at least 24 hours at 40∀C and longer at lower temperatures. Soil is air dry when no further moisture is lost on continued exposure to air. Drying may be accelerated by turning the sample occasionally with a clean spatula or knife.Seal the air-dried sample in a durable polyethylene

bag and place the sample bag into a second polyethylene bag. A labelled tag should be inserted between the two bags, and a second labelled tag attached to the seal of the outer bag. The tags should show: property name;date of collection;sample location (i.e., where the sample was taken from);analyses required.

7. For future reference, and to satisfy the requirements of the administering authority delegate, record the date of sampling, sampling location (with reference to property landmarks, to allow the monitoring plot to be identified with confidence within 1 metre), weather and soil conditions (e.g. muddy, compacted by vehicles, or dry) at the time of sampling.
8. Samples should then be forwarded together to the NATA or equivalent accredited laboratory.
9. Confirm that the laboratory has received the samples and has the information necessary to process them.

Figure 5. A hydraulic soil sampling rig, ideal for collecting multiple soil cores to depth while ensuring the integrity of the samples collected.

Effluent sampling

Before sampling

To ensure that samples are analysed before expiry of maximum holding times (Table 1), it is necessary to:

1. Determine the time required for sample collection and preparation. To do this read the sampling procedure below.
2. Before collecting samples, contact transport companies and the laboratory to determine when they will be able to transport and process the samples. If samples are refrigerated, ensure that they will reach the laboratory within 2 days of sampling. If frozen, 7 days between sample collection and delivery to the laboratory is acceptable.

Materials and equipment

Containers used for storage of effluent samples must have been prepared according to the procedures set out in AS2031.1—1986. Containers prepared to those specifications can be obtained from Queensland Health Scientific Services, Environmental Waters Section (contact details are at the back of this manual). Some other laboratories may also supply pre-cleaned containers. Standard AS2031.1—1986 sets out the way that the containers are to be washed to reduce sample contamination.

Unused 1L water-washed polyethylene bottles prepared according to this standard would be suitable. If samples are to be collected from an irrigation pump, only one bottle of this type will be required, but two bottles are required for pond sampling. The equipment required for the collection of effluent samples includes:

- a rod with a large clamp at one end to hold sample bottles, to allow more convenient sampling;
- a plastic bucket;
- insulated carrier boxes (e.g. polystyrene foam ‘Eskies’);
- crushed ice.

Figure 6. Licence conditions may require the collection of effluent samples from the surface of the final pond.

Sampling

Sample collection points

It is sometimes appropriate to collect effluent samples from the final pond. In many cases, however, it is more appropriate to collect the effluent sample from the sample stopcock or priming plug of the irrigation pump (Figure 7), as this may better represent the effluent being applied to the irrigation area.

Sample collection and preparation

The procedure for the collection of the single effluent sample necessary for these analyses is:

1. The plastic bucket to be used in the collection of effluent samples should be free from any dirt or foreign material. Wash the bucket three or four times with clean water, then rinse it several times in effluent from the surface of the effluent pond to be sampled.
2. **If sampling from an irrigation pump’s sampling stopcock or priming plug:**
   Allow the pump to irrigate effluent for at least 10 minutes before sample collection. Collect 250–500mL quantities of effluent in the bucket at intervals of several minutes until 3 to 4 litres of effluent has been collected. Hands or foreign objects should not contact sampled effluent or the inside of the sample vessel. The 1L water-washed sample bottle should then be filled to the brim with the thoroughly mixed effluent from the bucket. Since this sample will be frozen, squeeze out enough water to allow for expansion, then recap the bottle before releasing hand pressure (to prevent entry of air).

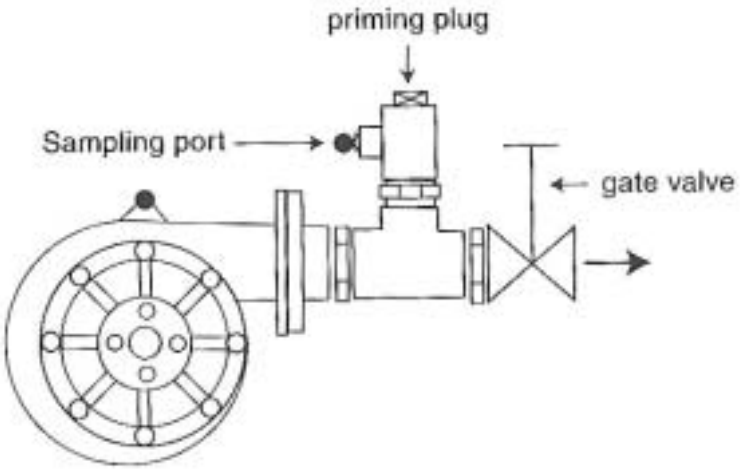

Figure 7. Sampling effluent form the sampling port or the priming plug of an irrigation pump is a good strategy for monitoring the effluent applied to land.

If sampling from the final effluent pond:
Collect the effluent directly with one of the sample containers by attaching the sample container to the sampling rod and immersing it in the effluent pond. Take the sample from close to the surface of the pond, excluding surface crust material, and then tip the sample into the rinsed plastic bucket. Collect samples from 5 positions randomly distributed about the pond and mix them together in the plastic bucket. Hands or foreign objects should not contact sampled effluent or the inside of the sample vessel. The second 1L water washed sample bottle should then be filled to the brim with the thoroughly mixed effluent from the bucket. Since this sample will be frozen, squeeze out enough water to allow for expansion, then recap the bottle without allowing the entry of air.

3. Freeze or refrigerate the sample.
4. Put crushed ice in the insulated carrier box. Crushed ice has the advantage that it can be packed in close contact with the samples, although extreme care needs to be taken to ensure that melt water does not invade sample containers. The carrier box should be large enough to contain the two 1L sample bottles and enough ice added to ensure that significant quantities of ice remain frozen on arrival at the laboratory.
5. Clearly mark sample details on an adhesive label attached to the container, including date of collection, sample type, analyses required, sample location, enterprise name and contact details. The container should then be placed into a plastic bag and the bag sealed. The bag should then be tagged with the same details marked on the sample container. Pack the bag in crushed ice inside the carrier container, or between frozen tetra-packs, with the sample bottle upright. Mark the insulated carrier container ‘this way up’.
6. Update your monitoring records. All details of the monitoring should be recorded by the manager for future reference and to enable accurate reporting (if required) to the administering authority delegate.
7. Deliver or send the samples to the NATA or equivalent accredited laboratory, and later confirm that the laboratory has received them and has the information necessary to process the samples. **Samples must arrive at the laboratories within 7 days of collection if frozen, or within 2 days if refrigerated**.

Manure and sludge sampling

Before sampling

To ensure that samples are analysed before expiry of maximum holding times (Table 1), it is necessary to:

1. Determine the time required for sample collection and preparation. To do this read the sampling procedure below.
2. Before collecting samples, contact the transport companies and the laboratory to determine when they will be able to deliver and process the samples.

Maximum holding times for sludge and manure samples for each analysis are:

- 7 days from the collection date for total or ortho P analyses, total N, total kjeldahl N, ammonium N, nitrate-N, total K, total magnesium, total sodium and total calcium.
- 2 days from the collection date for EC, total carbon and pH.

Figure 8. Where screening of solids is employed at piggeries, licence conditions my require collection of screenings samples.

Materials and equipment

The equipment required for collection of manure and sludge samples includes:

- a shovel;
- a 20L plastic bucket;
- a small garden trowel;
- insulated carrier boxes (e.g. polystyrene foam ‘Eskies’).

The consumables necessary for the collection of samples include:

- 1L polyethylene wide-mouth bottles;
- frozen tetra-packs or crushed ice;
- plastic bags to seal sample containers in.

Figure 9. Licence conditions may stipulate that sludge stockpiles should be sampled regularly.

Sample collection and preparation

The procedure for the collection of the single manure or sludge sample necessary for these analyses is:

1. Wash the sample mixing bucket. The plastic bucket to be used in the collection of manure or sludge samples should be free from any dirt or foreign material. Wash the bucket three or four times with clean water, then allow it to dry.
2. Wash the shovel thoroughly with clean water, remove all material from its surface, then allow it to dry.
3. Rinse the 1L wide-mouth polyethylene sample bottles three times with clean water and allow them to dry.
4. Thoroughly wash the small garden trowel with clean water, remove all material from its surface, then allow it to dry.
5. From the stockpile or a truckload of accumulated manure screenings collect 25 samples (approximately 250g each) from random locations and depths. Mix these samples in the plastic bucket using a garden trowel. A representative sub-sample of this material should then be transferred to a 1L container. Since this sample will be frozen, leave enough of the vessel unfilled to allow for expansion. Freeze the sample overnight.
6. Place frozen tetra-packs or crushed ice in the insulated carrier boxes. Crushed ice has the advantage that it can be packed in close contact with the samples, though care must be taken that melt water does not invade the samples. The carrier box should be large enough to contain the sample bottles in an upright position, and enough ice added to ensure that significant quantities of ice remain frozen on arrival at the laboratory.
7. Clearly mark sample details on an adhesive label attached to the container, including date of collection, sample type, analyses required, sample location, enterprise name and contact details. The container should then be placed into a polyethylene bag, the bag sealed, and a second label containing the sample details attached to the bag. Place this bag into the insulated carrier and

surround it with crushed ice. Store the sample bottles upright and mark the insulated carrier container ‘this way up’.

8. Update your monitoring records. All details of the monitoring should be recorded by the manager for future reference and to enable accurate reporting (if required) to the administering authority delegate.
9. Arrange for delivery of samples to the laboratory, and later confirm that the laboratory has received them and has the information necessary to process the samples. **Samples must arrive at the laboratory within 2 days of collection if refrigerated or 7 days if frozen.**

Stream sampling

Intensive livestock licences may stipulate the collection of stream samples. The licence itself will indicate the sampling time and frequency, and these directions must be adhered to. This section gives the methods to be used for collection of these samples.

Before sampling

To ensure that samples are analysed before expiry of maximum holding times, it is necessary to:

1. Determine the time required for sample collection and preparation. To do this read the sampling procedure below.
2. Before collecting samples, contact the transport companies and the laboratory to determine when they will be able to deliver and process the samples.

Materials and equipment

Containers used for the storage of effluent samples must have been prepared according to the procedures set out in AS2031.1—1986. Containers prepared to these specifications can be obtained from Queensland Health Scientific Services, Environmental Waters Section (contact details are at the back of this manual). This standard sets out the way the containers are to be washed to reduce sample contamination. Unused 1L water washed polyethylene bottles will be required for sample collection.

The equipment required for collection of effluent samples includes:

- a plastic bucket;
- insulated carrier boxes (e.g. polystyrene foam ‘Eskies’);
- crushed ice.

Sampling

Sample collection points

Select sampling locations that comply with the conditions stipulated in the licence and that will be representative of the main body of flow of the stream (Figure 10). Avoid sampling stagnant water from stream margins or water that is isolated from the main stream flow.

Sampling procedure

The procedure for collecting samples for these analyses is as follows:

1. The plastic bucket to be used in the collection of stream samples should be free from any dirt or foreign material. Wash the bucket three or four times with clean water, then rinse it several times in water from the stream to be sampled.
2. Collect the sample directly with one of the sample containers by attaching the sample bottle to the sampling rod and holding the sample bottle at least 10cm below the surface until it fills. Avoid collecting material floating at the surface. Collect 5 samples from the area to be sampled and mix them together in the plastic bucket. Hands or foreign objects should not contact

sampled water or the inside of the sample vessel. The second 1L water washed sample bottle should then be filled to the brim with the thoroughly mixed water from the bucket. Since this sample will be frozen, squeeze out enough water to allow for expansion, then recap without allowing the entry of air.

3. Freeze or refrigerate the sample.
4. Place frozen tetra-packs or crushed ice in the insulated carrier boxes. Crushed ice has the advantage that it can be packed in close contact with the samples, although extreme care needs to be taken to ensure that melt water does not invade sample containers. The carrier box should be large enough to contain the two 1L sample bottles and enough ice to ensure that significant quantities of ice remain frozen on arrival at the laboratory.
5. Clearly mark sample details on an adhesive label attached to the container, including date of collection, sample type, analyses required, sample location, enterprise name and contact details. The container should then be placed into a plastic bag and the bag sealed. The bag should then be tagged with the same details marked on the sample container. Pack the bag in crushed ice inside the carrier container, with the sample bottle upright. Mark the insulated carrier 'this way up'.
6. Update your monitoring records. All details of the monitoring should be recorded by the manager for future reference, and to enable reporting of information (if required) to the administering authority delegate.
7. Arrange for the delivery of the samples to the NATA or equivalent accredited laboratory, and later confirm that the laboratory received them and has the information necessary to process the samples. **Samples must arrive at the laboratories within 7 days of collection if frozen, or 2 days if refrigerated.**

Groundwater sampling

Intensive livestock licences may stipulate the collection of groundwater samples. The licence itself will indicate the sampling time and frequency, and these directions must be adhered to. This section gives the methods that may be used for collection of these samples. The nature of the bores or piezometers to be sampled, however, may dictate the methods that are most appropriate. Methods of sampling to be used should be discussed with the administering authority delegate before the first sampling, and the agreed method should be adhered to in subsequent years. If changes to the operation of the piggery make the agreed method impractical, the administering authority delegate should be consulted to choose a more appropriate method.

Before sampling

To ensure that samples are analysed before expiry of maximum holding times, it is necessary to:

1. Determine the time required for sample collection and preparation. To do this read the sampling procedure below.
2. Before collecting samples, contact the transport companies and the laboratory to determine when they will be able to deliver and process the samples.

Materials and equipment

Containers used for the storage of effluent samples must have been prepared according to the procedures set out in AS2031.1—1986. Containers prepared to these specifications can be obtained from Queensland Health Scientific Services, Environmental Waters Section (contact details at the back of this manual). This standard sets out the way the containers are to be washed, to reduce sample contamination. The containers required are 1L water washed polyethylene bottles.

The equipment required for the collection of water samples includes:

⁄# a plastic bucket;

- insulated carrier boxes (e.g. polystyrene foam ‘Eskies’);
- crushed ice.

Sampling

Sample collection points

Select sampling locations that comply with the conditions stipulated in the licence and that will be representative of the aquifer water. Sampling locations may depend on the role of the water bores in the operations, and the location of the sampling point should be decided in consultation with the administering authority delegate. Where piezometers or observation bores have been installed specifically for groundwater sampling, with the water being raised by a submersible or permanently installed pump, the appropriate sampling point may be at the well head. Although it is preferable to sample the water at the well head, it may be more convenient to sample the water at the point of use if groundwater is used day-to-day. In this case, groundwater should be collected directly from the outlet pipe, ensuring that no contamination of the water occurs.

Sample collection

Following is the procedure for the collecting groundwater samples.

1. Purge the borehole. In the 24 hour period immediately before sample collection a volume of water in excess of three times the water volume in the bore should be pumped and used, stored, or disposed of. This volume of water can be calculated from the formula

   Purge volume = 9420 x (hole radius)^2 x water depth

   where the purge volume is in litres and the depth and radius are in metres.
2. Collect enough water to fill the sample vessel. Hands or foreign objects should not contact sampled water or the inside of the sample vessel. Since this sample will be frozen, squeeze out enough water to allow for expansion, then recap without allowing the entry of air.
3. Freeze or refrigerate the sample (Table 1).
4. Place crushed ice in the insulated carrier boxes. Crushed ice has the advantage that it can be packed in close contact with the samples, although extreme care needs to be taken to ensure that melt water does not invade sample containers. The carrier box should be large enough to contain the two 1L sample bottles, and enough ice added to ensure that significant quantities of ice remain frozen on arrival at the laboratory.
5. Clearly mark sample details on an adhesive label attached to the container, including date of collection, sample type, analyses required, sample location, enterprise name, and contact details. The container should then be placed into a sealable plastic bag and the bag sealed. Tag the bag with the same details marked on the sample container. Pack the bag in crushed ice inside the carrier container, with the sample bottle upright. Mark the insulated carrier container ‘this way up’.
6. Update your monitoring records. All details of the monitoring should be recorded by the manager for both future reference and to enable accurate reporting (if required) to the administering authority delegate.
7. Arrange for delivery of the samples to the laboratory, and later confirm that the laboratory has received them and has the information necessary to process the samples. **Samples must arrive at the laboratories within 7 days of sampling if frozen, or within 2 days if refrigerated.**

Locating suppliers

- Bottles cleaned to the standard required for effluent or water collection can be obtained from Queensland Health Scientific Services, phone (07) 3274 9066, or (07) 3274 9067.
- Soil sampling equipment can be obtained from laboratory and scientific suppliers, or can be manufactured from commonly available materials (for construction plans see APSRU, 1983 *Exploring the Soil on Your Farm*. 20 pages. Published by APSRU, DPI, PO Box 102, Toowoomba, 4350).
- Soil testing contractors often have the appropriate equipment for taking the soil samples described in this document. If you intend using their services, ensure that they follow the sampling protocol outlined in this manual (as a minimum).