CHAPTER 3
FIELD SAMPLING PROCEDURES AND QUALITY ASSURANCE PLAN

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APPENDICES

3. FIELD SAMPLING PROCEDURES AND QUALITY ASSURANCE PLAN

3.1 INTRODUCTION

3.1.1 Scope

This chapter seeks to provide clear guidance on the level of detail and care that is required for the acquisition of samples during the environmental sampling programme at a timber treatment site. It is acknowledged that site-specific circumstances may require variation from the sampling protocols outlined here or even the adoption of different sampling techniques. In such cases it is important that variation in the application of these procedures be documented and carefully reviewed by appropriately qualified and experienced professionals.

The first part of the chapter involves a discussion of some aspects of quality assurance practice with regard to sampling, including the types and frequency of blank samples that may need to be acquired. Standard requirements on the keeping of field records and the cleaning of sampling apparatus in the field are also addressed.

Detailed sampling procedures for soil, groundwater, surface water, drain and sediment samples are provided in the second part of the chapter, accompanied by a discussion of the philosophy behind, and the information that is sought from, each sample type.

3.1.2 Chapter Summary

Guidance is given on the level of detail and care required to plan and carry out a programme of environmental sampling. QA/QC recommendations are provided on:

- sample blanks;
- field notes and record keeping;
- the cleaning of sampling apparatus and the use of equipment;
- procedures for obtaining samples of soil, surface water, and groundwater (including the installation and maintenance of groundwater bores).

3.1.3 Documentation

The following documentation should be prepared prior to initiating the field investigations:

- *Work Plan or Site Sampling Plan*
  Used to define the exact work requirements for a given site, including sample locations, depths, analytes, etc. Also used to document variations from the standard quality assurance procedures.
- *Health and Safety Plan*
  Used to inform workers of potential physical and chemical hazards, health and safety responsibilities, normal work precautions, monitoring requirements and action plans. An example table of contents for a Health and Safety Plan is included as Appendix A.

3.2 THE USE OF BLANK SAMPLES AND DUPLICATE SAMPLES AS QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

The two data quality indicators (see Section 2.2.4) most often used to assess measurement quality objectives in field sampling are bias and precision.

Bias is defined as a systematic deviation (error) in data. Precision is defined as random variation in data. Bias can be assessed by using a variety of blank sample types. They are discussed in Section 3.2.1. Precision is typically estimated using the practice of duplicate sampling, discussed in Section 3.2.3.

3.2.1 Blank Samples Used to Estimate Sampling Bias

Various types of blank samples can be used to assess the following sources of bias:

- the possibility that extraneous material has been introduced to the samples;
- whether the site of interest is truly different from surrounding sites;
- whether the sample matrix affects the sampling and analytical process.

Field blanks are samples of analyte-free media similar to the sample matrix. They are transferred from one vessel to another or exposed to the sampling environment at the sampling site. They measure incidental or accidental sample contamination during the whole sampling and analytical process (sampling, transport, sample preparation and analysis).

Equipment blanks (or rinsate blanks) are samples of analyte-free media (usually high-purity distilled water collected in a suitable container) that have been used to rinse the sampling equipment. They document adequate decontamination of the sampling equipment after its use. These blanks are collected after equipment decontamination and prior to re-sampling.

Material blanks are samples of construction materials such as those used in groundwater wells. They document the potential contamination of samples from use of these materials.

Trip blanks (or transport blanks) are test samples of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. They are used to measure cross-contamination from the container and preservative during transport, field handling and storage.

Background samples (or matrix blanks or field control samples) are samples of the media similar to the test sample matrix (dust, soil, surface water, etc.) and are taken near to the time and place where the analytes of interest may exist at background levels. The background sample measures the background presence of analytes of interest. Background samples assist in demonstrating whether the site of interest is contaminated or whether the elevated concentrations reported are naturally occurring.

Background samples can basically be taken from two different sorts of sites designated as “local control sites” and “area control sites”.

Local control sites are usually adjacent or very near to the test sample sites. The following principles apply to their use:

- Local control sites should be upwind or upstream of the sampling site.
- When possible, local control site samples should be taken first to avoid contamination from the sample site.
- Travel between local control sites and sampling areas should be minimised because of potential contamination caused by people, equipment and/or vehicles.

Area control sites are in the same area, e.g. city or district, as the sampling site, but are not adjacent to it. They are chosen where a suitable local control site cannot be found. All possible efforts should be made to make the sites identical except for the presence of the species of interest at the site under investigation. The principles applying to local control sites are also relevant for area control sites.

3.2.2 Number and Frequency of Blank Samples

It is prudent practice to acquire a range of the blank sample types described above.

Analysis costs are often the driving factor in determining the number of blank samples that are actually analysed from the pool of those collected. Where such costs are significant it may be possible to select an approach which minimises the number of blank samples that require analysis. For instance, if the field blanks show no sign of contamination, then any trip blanks can be discarded or stored as necessary. Similarly if the primary samples show analyte levels below the limit of detection or below levels considered significant, then there is a lesser requirement to run all blank types. This

approach is especially relevant for groundwater samples where there are likely to be a significant number of various blanks.

It is recommended that the following be collected:

- one field blank;
- one equipment blank;
- one trip blank;
- one duplicate sample (see 3.2.3).

per day or per 10 samples (whichever is more frequent) per collection apparatus.

Background samples for every matrix type should be acquired during the sampling exercise.

For groundwater samples the following additional blank samples are suggested:

- one standpipe material blank per batch of standpipe material;
- one filter pack (sand or gravel) material blank per batch of standpipe material;
- one drilling equipment blank per day;
- one sampling (e.g. pump, bailer, etc.) equipment blank per day or every 10 wells (whichever is the more frequent).

3.2.3 Duplicate Sampling to Estimate Precision

Duplicate samples are independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers and analysed independently. These duplicates are useful in documenting the precision of the sampling process.

3.3 RECORD KEEPING

A field log book will be maintained by each investigation work group. The log book will be used to record general progress, any deviation from the QA and Health and Safety Plans, changed conditions, any health and safety incidents and any other notable observations.

- **Sampling locations** will be located with reference to the site plan and by measuring distances from known features on the site plan. All sampling locations will be referenced by using a unique numbering system, for example, a location number and one of the following prefixes:

  HA Hand Auger
  BH Borehole
  TP Backhoe Test Pit
  GW Groundwater Monitoring Bore

A record of all sampling locations shall be kept. Test pits should be photographed with a measuring tape and the test pit number in the photo, where practical.

In addition, groundwater monitoring bores may need to be professionally surveyed and marked on a base map using an appropriate co-ordinate system, particularly where bore locations cannot be reasonably defined by reference to site features.

- **Sub-surface conditions** encountered at every borehole and auger hole will be logged on standard field log sheets. An example of the field log sheet is included in Appendix B.
- **All depths** will be **referenced** to the ground surface. All depths shall be recorded in metric units (metres). The elevation of each sample location, relative to an appropriate height datum, shall be determined by levelling by suitably experienced field personnel.

  A record of all **samples collected** shall be kept by the field supervisor. This record will incorporate the following information:
  - Job Number
  - Client/Job Name
  - Sampling Location Number
  - Sample Number (as defined in work plan. The Sampling Location Number and Sample Number may be the same number).
  - Sampling Depth (where appropriate)
  - Date
  - Initials of Sampling Personnel
- Each **sample** will be **labelled** with the following information, which correlates directly with the record of sampling to be kept by the field supervisor:
  - Job Number
  - Client/Job Name
  - Sampling Location Number
  - Sample Number (as defined in work plan)
  - Sampling Depth
  - Date
  - Duplicate (if the sample is a duplicate sample)
  - Triplicate (if the sample is a triplicate sample)
- **Chain-of-Custody** documentation shall be prepared by the field supervisor prior to delivery of the samples to the laboratory. A copy of a standard Chain-of-Custody form is included in Appendix B. A copy is to be retained by the field supervisor and a copy to be delivered to the laboratory with the samples.

Information to be recorded in the Chain-of-Custody will include:

- Job Number
- Project Name
- Date of Sample Collection
- Chemical Analysis Required
- Preservation requirements and maximum holding times
- Sample Numbers (as defined in work plan)
- Person delivering samples
- Person receiving samples

On submission of the samples to the laboratory, and the signing of relevant sections by the person relinquishing and the person receiving the samples, a copy of the Chain-of-Custody form will be sent to the assessor and the original Chain-of-Custody form will be returned with the certified results sheet.

The Chain-of-Custody documentation may also be used as the record of samples collected outlined above, if it is extended to include the appropriate information.

The field supervisor shall keep a record of any **change in conditions** encountered during field work, including unusual or unexpected sub-surface conditions, the presence of perched groundwater, odours or significant PID readings. This information should be recorded on the log sheets where relevant.

- Deviations from the documented health and safety, quality assurance and work plans should be noted by the field supervisor.

Additional specific record-keeping requirements are outlined in the following sections.

3.4 FIELD CLEANING PROCEDURES

An area will be established on-site where all sampling equipment may be cleaned without risk of contaminating areas to be sampled, or spreading contamination around or off the site. All field tools which are used for sampling and which come into direct contact with the material to be sampled must be cleaned and wrapped as described in this section.

The following **field cleaning procedure** will be utilised for cleaning field sampling equipment (e.g. hand augers, trowels, split barrel samplers, bailers, sampling pumps, etc.):

- Steam clean all field tools that cannot be readily washed using a detergent solution in a trough or similar (i.e. those prior to commencing the field sampling programme and prior to sampling at each location). Note: it is not practical or safe to steam clean small items of equipment using commonly available steam cleaning equipment.

- Wash in laboratory grade phosphate-free detergent.
- Rinse with tap water.
- Rinse with HPLC grade acetone where the sample is to be analysed for dioxins.
- Wipe over with a nanograde hexane soaked pad[1], where the sample is to be analysed for dioxins.
- Rinse with HPLC grade acetone, where the sample is to be analysed for dioxins, PCP (in oil) or PAHs.
- Rinse in high-purity analytical-grade deionised water.
- Sampling tools are to be stored in such a way as to prevent recontamination. Wrap in clean aluminium foil until the next use, where samples are to be analysed for dioxins.

If a drilling rig or backhoe is employed for soil sampling or groundwater bore construction, the drill string or backhoe bucket will be steam cleaned and the sampling equipment, e.g. split barrel sampler, will be subject to the above cleaning procedure. Wastes generated by equipment cleaning may be directed to the site waste treatment and disposal system, or drummed for off-site disposal as appropriate. Where tools such as crowbars and shovels do not come into contact with the material to be sampled, a less rigorous cleaning procedure, such as that used for a backhoe (i.e. steam cleaning), may be used.

Note: that where steam cleaning facilities are not available, suitable equipment may be hired or other rigorous cleaning procedures adopted. Steam cleaner and high pressure hot water washer are synonymous for the purposes of this document.

3.5 TYPICAL SOIL SAMPLING PROCEDURE

3.5.1 Outline of Field Investigation

The field investigations may involve the recovery of soil samples using a hand auger, backhoe, drill rig or other suitable equipment. This should be done in accordance with a documented field sampling plan, and a health and safety plan.

To penetrate the strata to be sampled, hand augering or other appropriate techniques will be used. Drilling or excavation using a backhoe may be necessary should difficult ground conditions be encountered, or excavations to depth be required.

[1] The pad must be of cotton, unbleached paper or cloth to eliminate a source of possible dioxin contamination.

Soil samples obtained may be analysed for a range of chemical parameters including:

- Pentachlorophenol
- Copper
- Chromium
- Arsenic
- Boron
- Dioxins and furans

It is noted that samples may be analysed for a range of other parameters as discussed in Chapter 2.

Many of these compounds, if present in soil samples, may be present in trace quantities which require very sensitive laboratory analytical procedures. Consequently it is important that soil sampling procedures are such that the quality of the samples obtained is assured.

Some samples may eventually be composited for analysis. Composite samples should be prepared from individually collected and documented sub-samples. It is recommended that compositing be performed in the analytical laboratory (refer Sections 2.6.2 and 4.5.3).

3.5.2 Hand Auger Sampling

The following procedures will be used when collecting shallow samples. As indicated in the sampling plan, where samples are collected from several positions within a given test location for later compositing by the laboratory, the same sampling tool and tray can be used, provided all loose dirt is removed from the tools.

The following is an indicative procedure for recovery of soil samples by hand augering.

Note: where the field cleaning procedure does not require wrapping of tools in aluminium foil, ignore such references in the following procedure.

Shallow Samples

- A clean area immediately adjacent to the sample location will be established, using a clean plastic sheet, on which all cleaned, and foil-wrapped equipment may be placed.
- Put on a clean pair of powder-free latex/PVC gloves.
- Unwrap a clean sampling trowel from the aluminium foil. Always rest the trowel on the foil.

- Remove grass etc. from the area to be sampled by hand or with the trowel.
- With the trowel remove soil to a depth of 100 mm from the sampling area and place directly in pre-cleaned glass sample jar.
- Depending on the analytical requirements, it may be appropriate to recover samples in more than one sample container, e.g. recovery of separate samples for PCP and dioxin analyses where these are to be completed by different laboratories.
- Label each sample jar as outlined in Section 3.3. Record the details of the sampling location and other pertinent data. Complete a chain-of-custody form for the samples.
- All samples to be analysed for organic constituents shall be stored at $<4^{o}C$ in a portable ice chest whilst in the field or in transit.
- If no further samples are to be taken at the location, then replace any surface soil removed from the hole.

Deep Samples

- Change to a clean pair of latex/PVC gloves.
- Unwrap a new sampling trowel from the aluminium foil. Always rest the tool on the foil, not on the plastic, whilst sampling.
- Unwrap a new sampling tray from the aluminium foil.
- Unwrap a pre-cleaned auger or a pre-cleaned shovel or crowbar from the aluminium foil. Always rest the equipment on the foil, not on the plastic, whilst sampling.
- The deeper samples will be recovered by hand auger, taking care to select material such that the possibility for cross-contamination is minimised. In order to minimise the likelihood of smearing or cross-contamination between sampling depths, the initial sample will be recovered using a sampling spoon or 75 mm diameter auger. The hole will then be advanced using the 75 mm diameter auger before, say, a 62 mm diameter auger is used to recover the second sample. All equipment is cleaned in accordance with Section 3.4 of this plan between each sample point.
- Label each sample jar as outlined in Section 3.3. Record the details of the sampling location and other pertinent data. Complete a chain-of-custody form for the samples.
- Backfill the hole. If the hand auger hole approaches the water table or passes through an aquitard the hole may be sealed (e.g. using bentonite pellets) to minimise contaminant migration.

It is noted that recovery of samples by hand auger is limited by practical considerations to a depth of approximately 2 m, depending on soil type. In addition, the risk of cross-contamination increases with sample depth when using a hand auger and therefore caution should be exercised when selecting this technique for sample recovery.

3.5.3 Boreholes

Boreholes may be drilled to sample soil and/or groundwater where hand auger techniques are not appropriate. The hollow auger drilling technique, with sample recovery using a split barrel sampler, is commonly employed in assessing unconsolidated formations. Alternative drilling techniques include cable tool, mud rotary, air rotary and air hammer.

Techniques that involve the use of drilling fluids, or the introduction of other substances that may result in contamination of the bore should be avoided where possible. If drilling techniques requiring the use of drilling fluids (e.g. water, mud, air) are used then the importance of bore development and stabilisation, prior to sampling, is increased. In addition, it is important to implement measures to reduce the potential for cross-contamination associated with the oil commonly present as a mist in compressed air supplies.

Drilling

- The drill string will be steam-cleaned prior to commencing each borehole.
- All sampling equipment should be cleaned in accordance with the procedures in Section 3.4 prior to commencing the borehole and prior to obtaining each sample.
- Typically, samples of sub-surface material will be recovered from the following depths (although samples may be recovered from other depths as required):
  - 0.5 metres
  - 1.0 metres
  - 2.0 metres or as listed in the sampling schedule
- Every member of the field staff who will come into direct contact with the soil being sampled **must** change to a clean pair of gloves for collecting each sample.
- Samples of sub-surface material will be recovered by driving a Split Barrel Sampler or other similar sampling device into undisturbed material.
- All boreholes will be sealed with cement grout or bentonite at the completion of drilling unless used to establish a groundwater monitoring well.

Sample Collection

- Samples will be recovered from the ground using the techniques specified in the previous sections.
- All equipment used for drilling, augering, digging or extracting samples will be cleaned using the cleaning procedure specified in Section 3.4.
- Field personnel will wear clean PVC/latex gloves whilst handling sampling equipment and carry out sampling.
- Every sample jar will be labelled in the manner outlined in Section 3.3.
- Each sample shall be recorded on the chain-of-custody documentation.
- All samples to be analysed for organic constituents shall be stored at $<4^{o}C$ in a portable ice chest whilst in the field or in transit.

3.5.4 Backhoe Testpits

A backhoe may be used to recover soil samples where ground conditions make the use of a hand auger impractical. The following precautions will apply:

- The backhoe bucket and boom will be steam cleaned prior to each test pit and at the end of each day's work, ensuring residual grease and oil are removed.
- The backhoe will be in good condition and free of oil or hydraulic fluid leaks.
- Following excavation to the target depth, all loose dirt will be removed from the backhoe bucket and a sample representative of the material at the target depth will be recovered using the backhoe. Field staff **must not** enter the test pit greater than say, 1.0 m deep under any circumstances, unless it has been made safe in accordance with relevant occupational health and safety regulations.
- Samples will be recovered at depths as specified in the sampling plan. Additional samples may be recovered at the discretion of the field engineer.
- A sample will be recovered from the backhoe bucket using a cleaned sample spoon or trowel, taking care to select material that has not contacted the sides of the bucket. The sample will be placed in a cleaned glass jar. In some circumstances samples may be recovered directly using a scoop, rather than from the backhoe bucket.
- Field personnel will wear clean PVC/latex gloves whilst handling sampling equipment and whilst carrying out sampling.
- Every sample jar will be labelled in the manner outlined in Section 3.3.
- Chain-of-custody documentation will be completed for each sample.
- All soil samples to be analysed for organic constituents shall be stored at $<4^{o}C$ in a portable ice chest whilst in the field or in transit.

3.6 TYPICAL GROUNDWATER SAMPLING PROCEDURE

3.6.1 Outline of Field Investigations

The field investigations are designed to obtain representative groundwater information of the site in order to:

- define the geologic profile and aquifer characteristics beneath the site;
- assess the current nature and level of soil and groundwater contamination;
- identify the principal sources of contamination;
- estimate the rate and direction of contaminant flow, on and off-site;
- evaluate remediation requirements for the site;
- identify likely zones of discharge.

The primary contaminants of concern have been outlined in Section 3.5.1.

The field investigations may involve the following:

- Installation of groundwater monitoring bores as indicated in the site-specific sampling plan, including one bore suitable for a pump test.
- Recovery of groundwater samples and measurement of the groundwater level and floating hydrocarbon (if present) in all groundwater monitoring bores.
- Rising head permeability testing at each of the groundwater bores.
- Recovery of soil samples from selected depths during drilling (refer soil sampling requirements).

3.6.2 Drilling

The borehole numbering system adopted will conform with that specified in the sampling plan.

Material handling and quality control measures will be directed towards clean drilling conditions and the elimination of down-hole contamination as a result of drilling operations.

Specific measures will include:

- The drilling rig to be used will be in sound working order and free of oil leaks.
- A cleaning pad will be established on the site where the drilling rig and other large equipment can be cleaned without risk of contamination to sampling locations. Power and water will need to be located nearby to enable use of a steam-cleaning unit.

- On arrival at the site the drilling rig will be decontaminated by steam-cleaning. This is to include all drilling equipment which will go into or be used near the borehole. The drilling rig and all drilling equipment will also be cleaned between boreholes.

Logs of the soil encountered will be prepared on standard borehole log sheets. The soil will be logged using the Unified Method of Classification and standard abbreviations will be used (refer attached information sheets). Record of Progress sheets will itemise all activities carried out, and detail of equipment placed into the hole, decontamination procedures and sampling episodes.

Particular note will be taken of the nature of possible soil contamination including an assessment of appearance and odour. Where contamination by volatile organic compounds is suspected, field screening of samples using an organic vapour analyser (e.g. PID) may be warranted. All samples will be ranked using a scale ranging from 0 to 3 taking account of appearance and odour. All information is to be recorded on log sheets.

All drill cuttings are to be placed in sealable containers or a covered waste disposal skip on-site for subsequent disposal.

- A range of drilling techniques may be used to install groundwater monitoring bores; however, preference should be given to techniques that do not rely on the introduction of drilling fluids (including air). Whilst hollow auger drilling techniques are frequently employed, the selection of a technique should be made on the basis of the expected ground conditions and the requirements for bore construction. On those sites covered by concrete paving, drilling will be preceded by concrete coring of a size to accommodate both drilling activities and subsequent borehole completion, including installation of borehead protectors.
- Accumulated drill cuttings will be removed from the borehead area as drilling progresses in order to prevent cuttings falling back into the borehole.
- Note that it is recommended that the background monitoring bore(s) be drilled first where possible.

3.6.3 Standpipe Installation

Records will be kept on the standard record sheets including all procedures adopted, materials used and the respective timing of the various stages of bore construction. Well completion reports may be used containing information on borehole configuration; piezometer configuration (e.g. screen location, casing length, diameter etc.); placement of screen filter pack and borehole seals; and bore development and completion details. All data will be recorded directly in the field and subject to physical measurement.

All materials placed in the hole will be free of any target contaminants listed in the project brief.

Prior to installation, standpipe materials will be subject to high pressure hot water wash, with phosphate-free detergent, followed by a rinse in potable quality water and final rinse with deionised water. Thereafter the standpipe materials will be handled only by field personnel wearing clean PVC/latex gloves.

Conventional solvent glues will not be used. Instead mechanical screw fittings will be used on all casing and screen joints.

The top of the screen generally will be placed between 1.0 m -1.5 m above the water table as logged during drilling or at the discretion of the field engineer/geologist, particularly where the depth to groundwater is less than 2.0 m. The intention is to identify the presence of any floating product and allow for fluctuations of the water table level. Following screen and casing installation, graded sand or gravel, sized to match the aquifer materials, will be placed around the screen and to a height of approximately 200 mm above the uppermost screen slots. The bentonite seal will be placed directly above the filter pack and will extend for a thickness of 1.0 m or more where possible.

The filter material will be pre-washed and screened to eliminate foreign material and should be appropriately graded to the aquifer material wherever possible. Sand or gravel will be brought on-site in bags and transferred directly from bag to hole when running the screen filter.

Holes will be back-filled above the bentonite seals to approximately 0.25 m below ground level, with final completion at the surface comprising a concrete collar seal and steel protective covers to provide security and prevent accidental damage. In most cases these covers will comprise cylindrical steel upstands fitted with lockable lids. Where vehicular traffic poses a problem, the installation will be finished flush with the ground surface using an appropriate protective cover. In this event, a sump will be provided around the top of the casing with sub-surface drainage installed to prevent build up of drainage water around the borehead. Generalised design drawings are included in Appendix C.

All loose material will be removed from the borehead working area prior to piezometer installation so as to avoid accidentally being dislodged into the open hole.

Final levels of both screen filter packs and bentonite seals will be verified by direct measurement using a slim probe lowered down the annular space between borehole wall and casing.

Monitoring bore basin and screens would typically be constructed from PVC pressure pipe of a nominal 50 mm diameter. Screen lengths will be determined on-site after drilling has established preferred screen zones. Typically, slot sizes will be nominal 0.5 mm width with two rows of slots per screen length and average spacing of 1 cm

between slots. Approximately 0.5 m of unslotted casing may be provided below each screen, to act as a sump for collection of any fines that may pass through the screens. Monitoring bores will be terminated with a fitted PVC end cap at the lower end and with a PVC cap at the surface.

The precise diameter, material and configuration of monitoring bores should be determined on a site-specific basis by a qualified professional. The above guidance provides an indication of a typical installation.

3.6.4 Bore Development and Aquifer Testing

Compressed air pumping, mechanical surging or other pumping will be used to achieve development depending on the aquifer characteristics, with gentle surging to promote removal of any residual fines. Development pumping will continue until water clears of residual sediment and yields stabilise. Adequate development will be verified on the basis of stabilisation of basic water chemistry parameters including electrical conductivity and temperature. Records of the above will be maintained.

The selection of an appropriate pumping system for bore development depends on the nature of the aquifer. However, care should be exercised to ensure the aquifer is not aerated. Some alternative pumping systems include compressed air with 'U' tube system to avoid aeration, Waterra pump, bladder pump, purge pump, Grundfoss pump or similar mechanical pumping systems. Pumping systems that avoid aeration of the samples are generally preferred.

On completion of development pumping, water levels will be in a depressed condition in the borehole. The groundwater recovery will be monitored by recording the rate of water level rise on cessation of pumping, and empirical analysis may be used to estimate permeability. Other tests may be necessary to characterise the aquifer, depending on site-specific conditions.

All items inserted into the bore will be decontaminated using high-pressure hot water used in conjunction with phosphate-free detergent, followed by final rise in potable-quality water and distilled water.

Effective construction and completion of the piezometers will be verified on the basis of recorded discharge and subsequent water level recovery data.

Data recording will include:

- Daily Record of Progress sheets, which will include details of all activities carried out, equipment installed, times and durations.
- Pumping Schedule, detailing pump operating periods and measurements or estimates of discharge volumes.

- Water Level Recovery Data, detailing time, elapsed period since pumping ceased and water level. Water levels prior to commencement of pumping will also be recorded.

3.6.5 Groundwater Sampling

Groundwater samples will be collected several days after the development pumping and recovery test phase. The borehole will be purged by removal of at least three bore volumes of water from each bore to remove any stagnant water or water which is not representative of the aquifer, before retaining any samples for analysis. During the purging process checks on temperature, pH and electrical conductivity will be carried out and pumping continued until these parameters stabilise. Records of temperature, pH and electrical conductivity measurements shall be maintained.

Samples will be collected in a stainless steel or teflon downhole bailer, or using an appropriate sampling pump (where disturbance of suspended solids must be minimised) which will be decontaminated between sampling sites by cleaning in accordance with the procedures specified in Section 3.4. Alternatively, a disposable bailer may be used for each sample, provided the bailer material is compatible with the suspected contaminants and is able to withstand the necessary solvent rinses when sampling for dioxins. Care will be taken when sampling to avoid any opportunity for excess aeration of the sample.

At the time of sampling, all samples collected will be transferred to storage at 4°C. Transfer to the analytical laboratory will be completed with 48 hours of sample collection.

Note: analysis for hexavalent chromium must be undertaken within 24 to 48 hours, so faster delivery to the laboratory is required for these samples.

Additional requirements are as follows:

(i) If a bailer is used, the bailer should be lowered gently to avoid disturbance of any sediment that may still be in the bore and to avoid damage to the bailer or the rope. Samples should be recovered from beside the slotted section of the standpipe.

(ii) Prior to commencement of sampling, a clean piece of plastic shall be placed on the ground beside the well. All equipment shall be placed on this sheet when not in use and all cleaning shall be carried out on the plastic sheet. As the bailer is removed from the well, care shall be taken to place the rope on the plastic sheet.

(iii) Water samples will be placed in screw-capped containers which will be supplied by the laboratory. Bottles supplied shall be polythene for metals and inorganics and glass for organics.

(iv) Water samples to be analysed for heavy metals may require filtration on-site to remove particles that could affect the concentration of metals (refer Appendix E

of Chapter 2). Filtering should take place before the water sample is added to the container with the preservative. Care must be exercised to minimise aeration of the sample during filtration. Alternatively, if relatively clear and low-turbidity samples can be collected, then the sample may be recovered without filtration and preservation, provided the sample is recovered without aeration (e.g. place outlet of pump directly into the base of the sample container and fill, allowing to overflow for several volume changes before sealing).

(v) A sample collection record form shall be completed for each sample collected.

3.6.6 Water Level Determination

Following well development, the standing water level shall be measured. Sufficient time will be allowed for stabilisation of water levels following development or other disturbance of the bore. The time required for stabilisation depends on the aquifer characteristics, and may range from minutes to days.

A cleaned dipper will be lowered down the well to ascertain the water level. The depth to the top of floating non-aqueous phase liquid (NAPL) will be determined using either a mechanical or electrical measuring device (e.g. interface probe). The depth to top of groundwater will be measured with a cleaned electrical dipper. The difference between the two is the thickness of floating NAPL. This thickness will be verified by bailing with a transparent bailer.

The cleaning procedure for these instruments shall be to wash copiously with tap water and then rinse with deionised water. If oil or grease is picked up on the bailer then additional washing with phosphate-free detergent will be required. The bailer may be rinsed with acetone to assist in removal of oil or grease, followed by rigorous rinsing with potable, then deionised water. Alternatively, a disposable bailer may be used.

Water levels will be referenced to ground surface and recorded to the nearest centimetre.

3.7 TYPICAL SURFACE WATER AND DRAIN SAMPLING PROCEDURE

3.7.1 Outline of Field Investigations

The field investigations are designed to obtain representative samples of water and/or sediment from site discharges, the appropriate receiving waters after mixing, and from various drains across the site. The primary contaminants of concern with regard to such investigations were outlined in Section 3.5.1.

It is noted that samples may be analysed for a range of other parameters as discussed in Chapter 2.

The field investigations may involve:

- Recovery of grab samples from selected locations in the receiving water body.
- Recovery of grab samples from selected locations within the site drainage system or at the point of discharge from the site.
- Recovery of sediment samples from selected locations within surface water bodies (including drains) in the vicinity of the site.

3.7.2 Stream Sampling

Samples will be recovered from the stream at locations designated in the sampling plan. All equipment used in stream sampling will be cleaned in accordance with the procedures outlined in Section 3.4 prior to the recovery of each sample.

Stream samples will be recovered from below the stream surface in order to prevent accidental sampling of surface slicks. A suitable sampling device, able to recover samples from a designated depth and prevent ingress of surface water, will be employed. Such devices are readily available. If possible, the sample will be taken directly into the sample container prepared by the laboratory.

Sampling should commence at the location furthest downstream, working back upstream in turn.

Care will be taken when sampling to avoid any opportunity for excess aeration of the sample.

All samples to be analysed for organic constituents will be stored at $<4^{o}C$ in a portable ice chest whilst in the field or in transit. Transfer to the analytical laboratory will be completed as soon as practical. Maximum recommended sample holding times are set out in Appendix D of Chapter 2.

Additional requirements are as follows:

(i) The sampling equipment should be lowered gently to avoid disturbance of any sediment.

(ii) Prior to commencement of sampling a clean piece of plastic shall be placed on the ground beside the sampling location. All equipment shall be placed on this sheet when not in use and all cleaning shall be carried out on the plastic sheet.

(iii) Water samples will be placed in screw-capped containers which will be prepared by the laboratory. Polythene bottles should be used for samples to be analysed for metals and inorganic constituents, and glass bottles should be used for samples to be analysed for organic compounds.

(iv) Only those samples which do not have preservatives in the bottles shall be filled to overflowing; those bottles with preservatives should be filled to maximum capacity but not to overflowing.

(v) Sample containers shall be placed in clean polyethylene bags to minimise the potential for cross-contamination.

3.7.3 Drain Sampling

Water samples will be recovered from various drains across the site, as designated in the sampling plan. All equipment used in the sampling of drains will be cleaned in accordance with the procedures outlined in Section 3.4, prior to the recovery of each sample.

Water samples may be recovered from drainage system manholes across the site using a stainless steel sampling container or glass jar. Sampling of the drains is likely to require field personnel to enter manholes in order to recover the samples. The following precautions will be adopted when entering manholes:

- The manhole cover will be removed using appropriate lifting equipment, and allowed to vent for a period of time.
- The atmosphere within the manhole will be monitored for explosive gases (using an explosimeter), oxygen deficiency and other volatile organics (using a photoionisation detector).
- One person will remain on the surface, at the manhole opening, as an observer.

During sampling the temperature and electrical conductivity of each sample will be recorded.

Care will be taken when sampling to avoid any opportunity for excess aeration of the sample.

All samples to be analysed for organic constituents will be stored at $<4^{o}C$ in a portable ice chest. Transfer to the analytical laboratory will be completed as soon as practical.

Additional requirements are as follows:

(i) The sampling equipment should be lowered gently to avoid disturbance of any sediment.

(ii) Prior to commencement of sampling a clean piece of plastic shall be placed on the ground beside the sampling location. All equipment shall be placed on this sheet when not in use and all cleaning shall be carried out on the plastic sheet.

(iii) Water samples will be placed in screw-capped containers which will be prepared by the laboratory. Bottles supplied shall be polythene for metals and inorganics and glass for organics.

(iv) Containers shall be filled to over-flowing except the metals container which shall have preservatives already added.

(v) A sample collection record form shall be completed for each sample collected.

3.7.4 Sediment Sampling

Sediment samples will be recovered from selected locations within streams, drains and other surface water bodies in the vicinity of the site, as designated in the sampling plan. Samples will usually be recovered from locations where sediment, associated with run-off from the site, is likely to collect, i.e. areas of lower flow velocity adjacent to, or downstream from, the site.

All equipment to be used in the recovery of sediment samples should be cleaned prior to the recovery of each sample, in accordance with the procedures outlined in Section 3.4. Sediment samples may be recovered using an appropriate scoop or other sampling tool in the case of shallow water bodies, or using purpose-designed sediment core sampling equipment for recovery of samples from deeper water bodies and where a vertical profile of the sediment is required.

Sediment samples shall be placed in clean glass sample jars, as for soil samples, or, where samples are recovered using core sampling equipment the sample may be retained in the coring equipment (e.g. plastic or aluminium tube), sealed and transferred to the laboratory for analysis. All samples to be analysed for organic constituents should be stored at <4°C, and transfer of the samples to the laboratory shall be completed as soon as possible. The maximum recommended sampling times are outlined in Appendix D of Chapter 2.

3.8 TYPICAL BUILDING DUST SAMPLING PROCEDURE

3.8.1 Outline of Field Investigations

The field investigations are designed to obtain representative samples of dust from buildings across the site, and on adjacent land, with the objective of assessing the risk to site workers and residents. The sampling should be directed to characterising the concentration of various contaminants in dust within those buildings regularly occupied, either by site workers or residents e.g. main work areas, tea rooms and residences. Two types of dust samples may be recovered, as follows:

- dust samples recovered from surfaces within the living areas of residences, or main work areas and surfaces of timber processing buildings;
- dust samples recovered from surfaces where dusts may accumulate without disturbance, e.g. ledges, the roof space of residences.

The primary contaminants of concern with regard to such investigations are as outlined in Section 3.5.1. Where PCP has been used on-site, particular attention should be focussed on characterising the dioxin concentrations in the dust. Samples may also be analysed for a range of other parameters as discussed in Chapter 2.

The field investigations involve the recovery of samples of dust from selected locations, as defined in the site-specific sampling plan. Frequently, several samples will be recovered from a single building and composited for analysis.

3.8.2 Dust Sampling

Building dust samples will be recovered at locations designated in the sampling plan. All equipment used in dust sampling will be cleaned in accordance with the procedures outlined in Section 3.4, prior to the recovery of each sample.

Due to the nature of dust sampling, the exact sampling methods must be determined on a site-specific basis, however, some examples are presented as follows:

- where dust is to be recovered from ledges or other locations where dust may accumulate without disturbance, samples may be recovered by scraping or scooping the dust into a screw-capped glass sample jar, using a stainless steel implement;
- where dust is to be collected from living areas of residences or similarly disturbed work areas, a vacuum sampling device may be used. The collected dust may be transferred to a screw-capped glass sample jar.

Dust samples from more than one location may need to be composited in order to obtain sufficient sample for analysis.

A rigorous sampling protocol should be developed by the site assessor, in accordance with the QA/QC framework outlined in Chapter 2, prior to beginning sampling.

Each sample should be labelled in accordance with the procedures outlined in Section 3.3. Details of each sampling location and other pertinent observations should be recorded, and a chain-of-custody form should be completed for all samples.

All samples to be analysed for organic constituents will be stored at $<4^{o}C$ in a portable ice chest in the field and in transit to the laboratory. Maximum recommended sample holding times are set out in Appendix D of Chapter 2.

3.9 DISPOSAL OF WASTES

A range of wastes may be generated as part of any sampling programme. Examples of such wastes include:

- washwater and solid residues from cleaning procedures;
- waste foil, cloth pads, plastic sheeting, etc. from cleaning and wrapping tools;
- excess spoil from sampling locations; and
- groundwater from bore development and purging.

Each of these wastes may be contaminated and should be packaged and disposed of in accordance with the relevant health and safety, dangerous good and landfill disposal regulations.

Contaminated wastewaters may be disposed of via the site wastewater treatment system, if available, subject to the necessary approvals. Planning for a field sampling programme should include planning for the disposal of waste materials.

APPENDIX A
SITE SPECIFIC HEALTH AND SAFETY PLAN FOR INVESTIGATION OF SUBSURFACE CONTAMINATION AT TIMBER PROCESSING SITES

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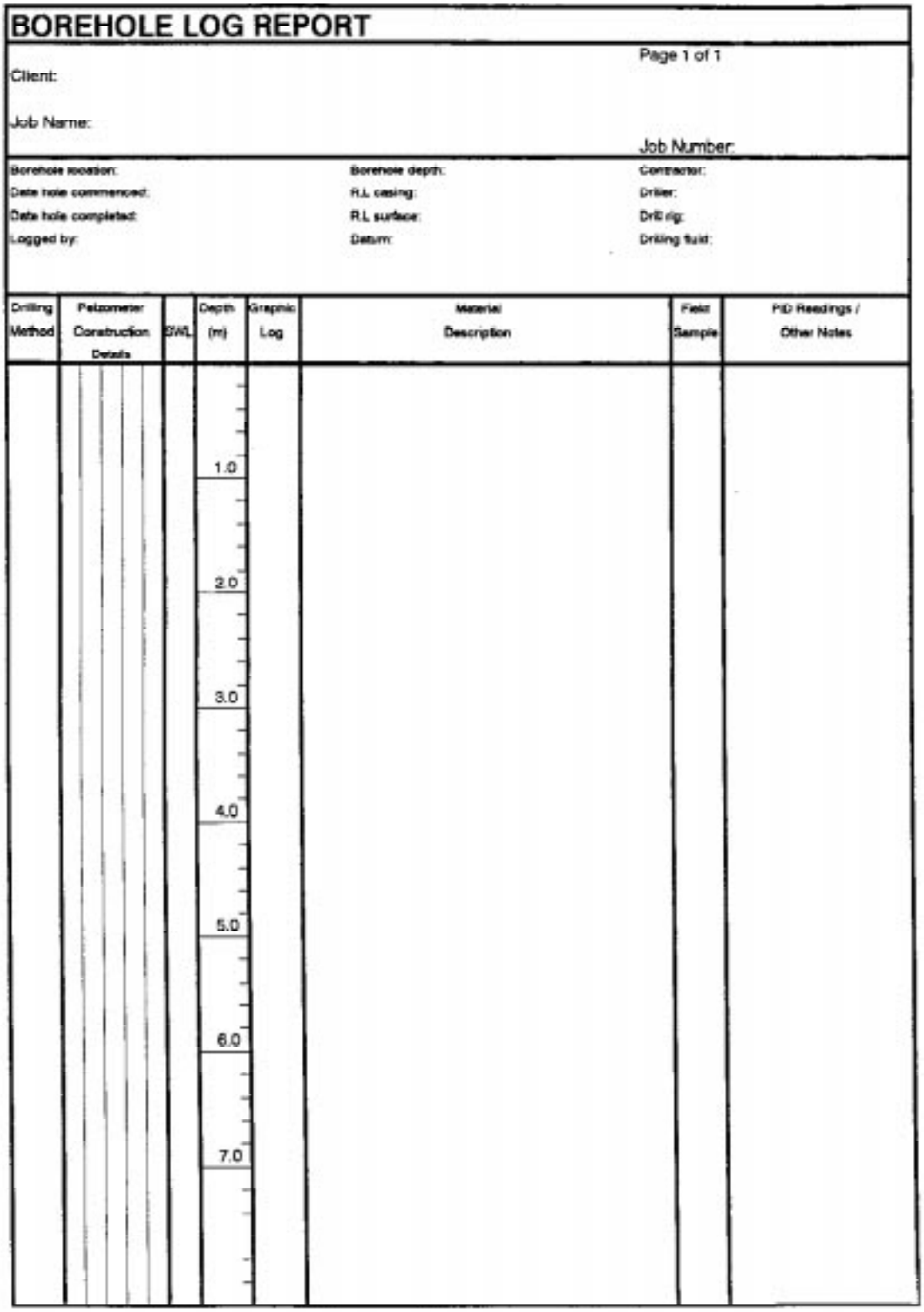
APPENDIX B
EXAMPLE FIELD RECORDS



BOREHOLE LOG REPORT

Page 1 of 1

Client:

Job Name:

Job Number:

Borehole location:	Borehole depth:	Contractor:
Date hole commenced:	R.L casing:	Driller:
Date hole completed:	R.L surface:	Drill rig:
Logged by:	Datum:	Drilling fluid:

Drilling Method	Piezometer Construction Details	SWL	Depth (m)	Graphic Log	Material Description	Field Sample	PID Readings / Other Notes
			1.0				
			2.0				
			3.0				
			4.0				
			5.0				
			6.0				
			7.0				

TESTPIT LOG REPORT

Client:

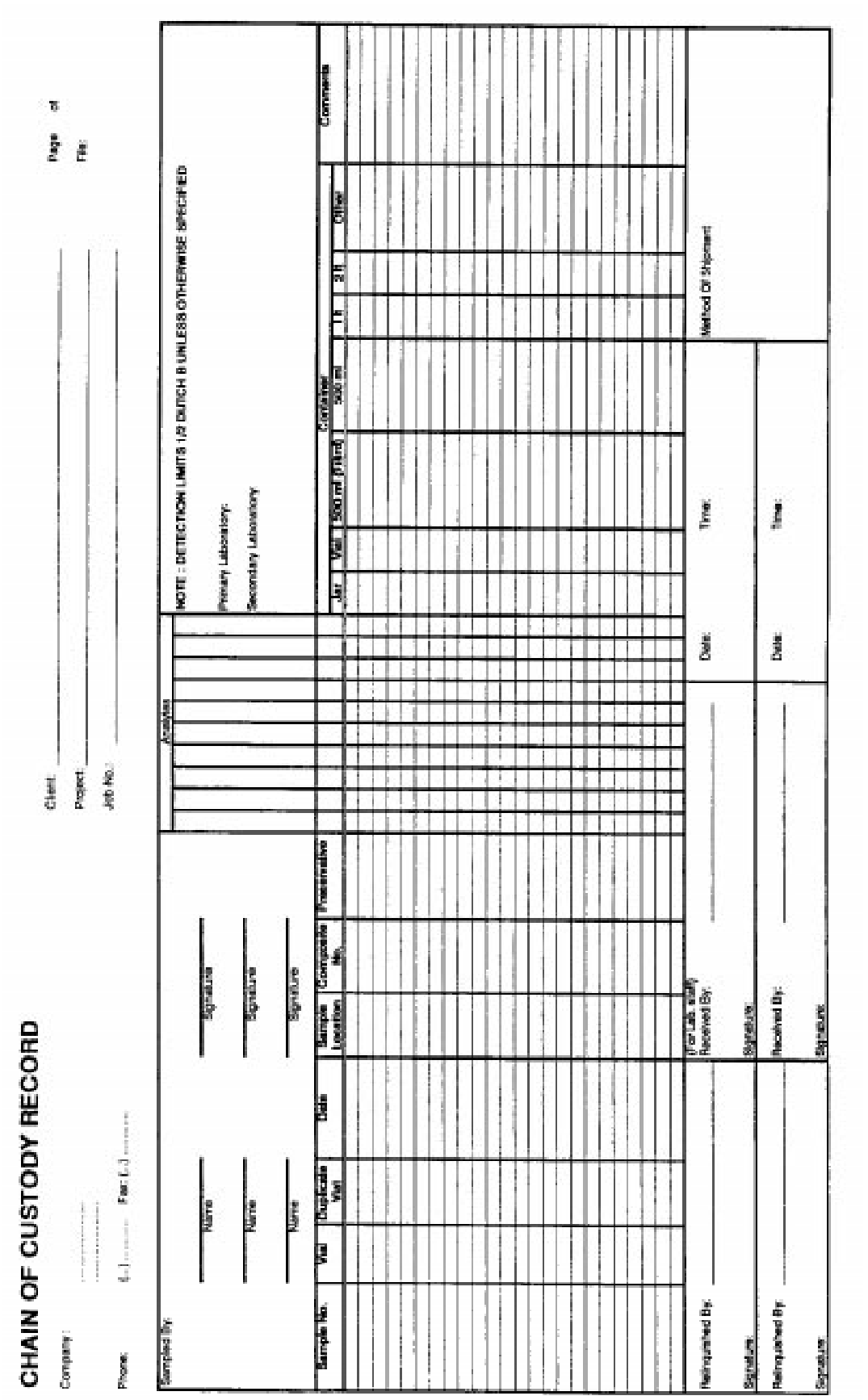
Job Name:

Job Number:

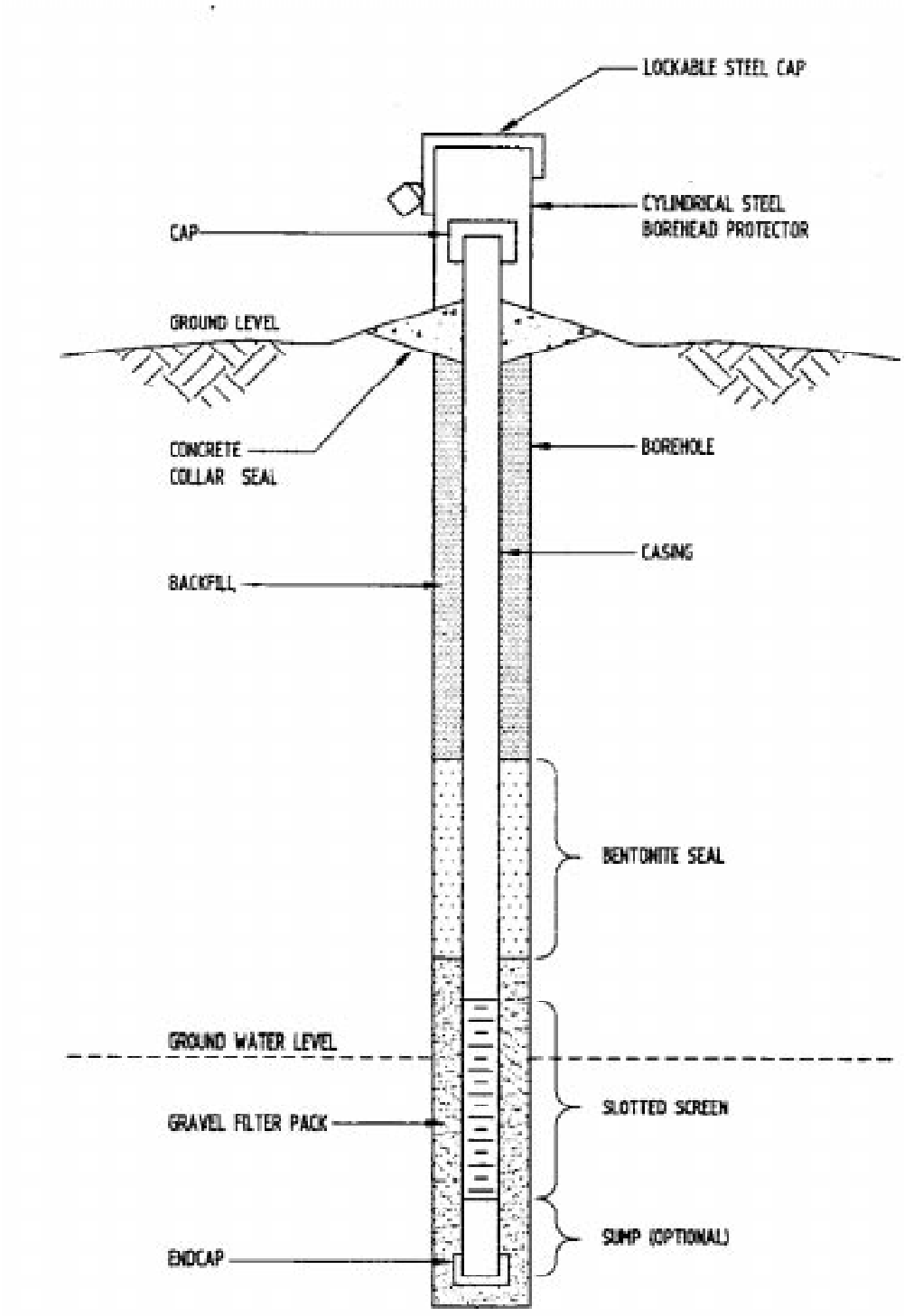
Testpit location:
Date pit commenced:
Date pit completed:
Logged by:
Checked by:

Contractor:
Excavator:
Bucket:
Testpit depth:

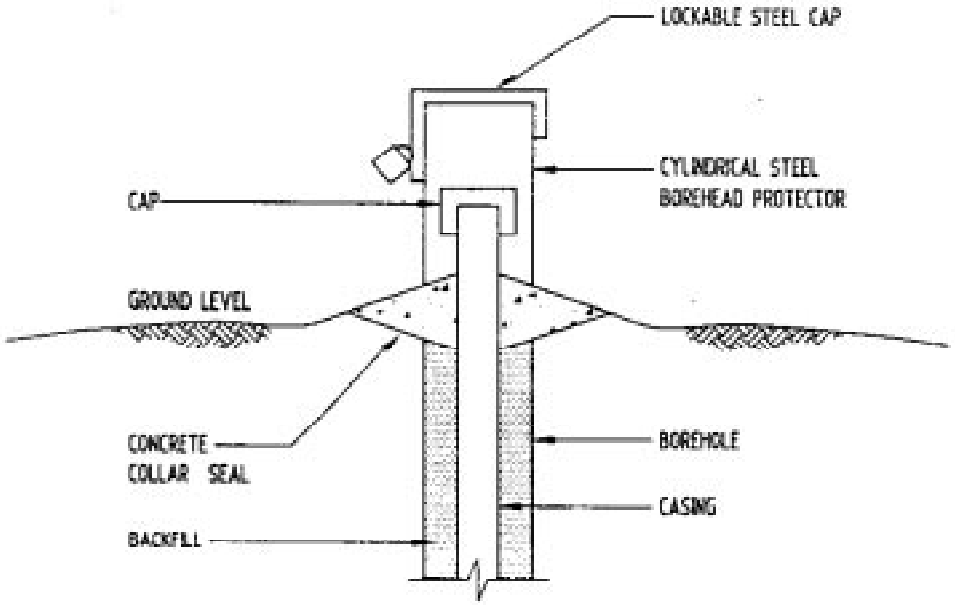
Depth (m)	SWL	Graphic Log	Material Description	Field Sample	Field Rank (0 – 3)	PID Readings / Other Notes
0.5						
1.0						
1.5						
2.0						
2.5						
3.0						
3.5						
4.0						


CHAIN OF CUSTODY RECORD
Company:
Phone:
Client:
Project:
Job No.:
Page of
File:
Sampled By:
Name
Signature
Name
Signature
Name
Signature
Sample No.
Vial
Duplicate Vial
Date
Sample Location
Composite No.
Preservative
Analytes
NOTE : DETECTION LIMITS 1/2 DUTCH B UNLESS OTHERWISE SPECIFIED
Primary Laboratory:
Secondary Laboratory
Container
Jar
Vial
500 ml (Pint)
500 ml
1 lt
2 lt
Other
Comments
(For Lab staff)
Received By:
Signature
Date:
Time:
Method Of Shipment
Relinquished By:
Signature
Received By:
Signature
Date:
Time:
Relinquished By
Signature

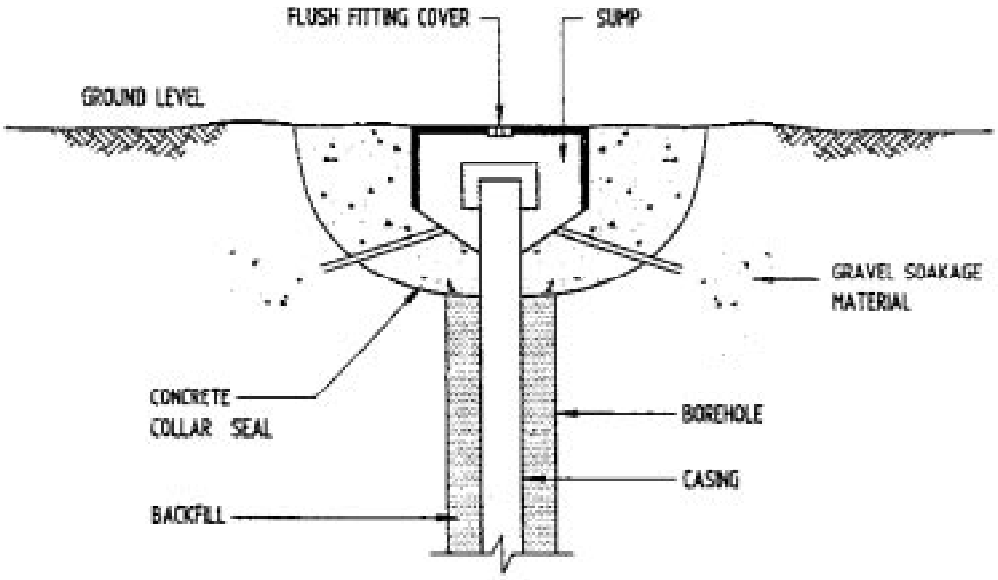
APPENDIX C
GENERALISED MONITORING BORE DESIGN



GENERALISED CONSTRUCTION DETAILS FOR GROUNDWATER MONITORING BORE



(a) ABOVE GROUND



(a) BELOW GROUND

GENERALISED BOREHEAD CONSTRUCTION DETAILS FOR GROUNDWATER MONITORING BORE