

GROUNDWATER SAMPLING PROCEDURE

Livingstone Beef Processing Facility
Northern Territory



Australian Agricultural Company Ltd

2018

Document Control Record

Document Code:	ENV-EPL-WQMP-201802
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Submission Date:	25 th January 2018

DOCUMENT HISTORY

Version	Issue Date	Brief Description	Reviewer/Approver
ENV-EPL-WQMP-201801	18 Dec 2017	First Draft of the SOP	Patrick Vandewinkel
ENV-EPL-OEMP-0022018	25 Jan 2018	Document review by independent qualified person	Patrick Vandewinkel

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Table of Contents

1	Introduction	5
1.1	Purpose	5
1.2	Scope	5
1.3	Definitions and Abbreviations.....	5
1.4	Standards	6
2	Equipment, Safety and Training	7
2.1	Equipment	7
2.2	WHS Requirements	8
2.3	Training and Competency	9
2.4	Contamination Prevention Precautions.....	9
3	Procedure	11
3.1	Preparation.....	11
3.2	Travel to Sampling Site	11
3.3	Bore Purging	11
3.4	Sample Collection	12
3.5	Collection of Field Blanks, Split Samples and Duplicates.....	13
3.6	Pack up and Cleaning of Field Equipment.....	13
3.7	Sample Dispatch	13
Appendix A	Field Data Sheet - Groundwater Sampling	15
Appendix B	Calibration Record Sheet, Water Sampling Meters	16

Tables

Table 1:	Standard hazard management for surface water sampling	8
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Figures

No table of figures entries found.

1 Introduction

1.1 Purpose

Ensure sampling methods obtain samples representative of actual groundwater composition at the site. Also to ensure all sampling is consistent, undertaken in a safe manner and follows best-practice procedures in accordance with relevant standards.

1.2 Scope

This procedure applies to all groundwater sampling undertaken by AACo Environmental personnel undertaking groundwater sampling for compliance purposes. Groundwater quality monitoring is generally focussed on identifying any impacts on groundwater aquifers from the operational area, irrigation areas or surrounding contamination sources on the environmental, cultural, and domestic and agricultural water supply values (beneficial uses) of the groundwater.

This usually includes both the measurement of water quality parameters in the field (e.g. temperature, pH, electrical conductivity, dissolved oxygen, ORP and turbidity), and the collection of water samples for subsequent laboratory analysis (e.g. metals, major cations and major anions, hydrocarbons, microbiological indicators and nutrients).

1.3 Definitions and Abbreviations

COC – Chain of Custody form

DO – Dissolved Oxygen

EC – Electrical Conductivity

JSA – Job Safety Analysis

N.A.T.A – National Association of Testing Authorities

ORP – Oxidation Reduction Potential

pH – ranges between 1 and 14 and provides a measure of acidity/alkalinity

PPE – Personal Protective Equipment

QA / QC - Quality Assurance / Quality Control, which may include:

- Duplicate sample – collected during each sampling event (1 duplicate for every 10 sample sites) to detect both natural environmental variation, and any errors from field sampling methodologies.
- Split sample – collected during each sampling event (1 split for every 10 sample sites) and sent to a different laboratory to detect any Lab-based discrepancies.
- Field blank sample - collected during each sampling event to evaluate potential contamination from personnel and/or sampling equipment.

SWL – Standing Water Level; level of groundwater in meters below the ground level (mbgl) or meters below top of casing (mbTOC)

SWQ – Surface Water Quality

TOC – Top of Casing; top of bore casing above ground level

1.4 Standards

To ensure the quality and accuracy of measurements, these sampling procedures were developed in accordance with the following standards and guidelines:

- NT Department of Mines and Energy Methodology for the Sampling of Groundwaters, Advisory Note, 2009. Northern Territory Department of Mines and Energy (DME), NT Government, Darwin.
- Australian/New Zealand Standard on Water Quality Sampling - Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples (AS/NZS 5667.1:1998), Standards Australia, New South Wales.
- Australian/New Zealand Standard on Water Quality Sampling – Part 11: Guidance on sampling of groundwater (AS/NZS 5667.11:1998), Standards Australia, New South Wales.
- ANZECC & AMRCANZ 2000, Australian Guidelines for Water Quality Monitoring and Reporting, National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.
- ANZECC & AMRCANZ 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.

2 Equipment, Safety and Training

2.1 Equipment

The following equipment list is provided for guidance and personnel should consider task-specific sampling requirements when preparing for field sampling:

- Map(s) showing monitoring sites
- GPS – with coordinates uploaded for locating sites
- Printed Job Safety Analysis (JSA) for the job. This includes all emergency contacts.
- Groundwater Sampling Field Data Sheet – enough for all sample sites plus some spares – See Appendix A
- Folder/clipboard and waterproof notebook
- Stationary: Pens / pencils, permanent markers for completing sample bottle labelling
- Sample bottles obtained from the relevant Laboratories being used (i.e. usually ALS, Envirolabs or AWQC). Make sure you have the specific bottle types required for each parameter to be tested. Remember also to prepare a full set of sample bottles for duplicate, split, and field blank samples (see definitions above). Also take some spares, especially the glass bottle types.
- Fox whistle or electronic dip meter for measuring standing water level (SWL)
- Bucket (20 L)
- Hand tools to open bore caps
- Calculator
- Watch/time keeper
- Eskies with frozen ice bricks
- Calibrated field test meters (pH, Temperature, EC, DO, ORP, Turbidity)
- Calibration solutions and copies of the Calibration Record Sheet (if in field for > 1 day) – See Appendix B for Calibration Record Sheet
- Camera
- Jug(s) for filling sample bottles if unable to fill bottles directly from hose
- Small folding table and shelter
- Tarpaulin to keep all equipment off the ground.
- Groundwater bore pump and associated equipment
- Instruction and maintenance manual for groundwater rig (see Vantage folder Q0601)
- Decon 90 solution mixed with deionised water (1:20) to clean equipment between sample sites
Deionised water for collection of field blanks and rinsing equipment between sample sites
- Syringes and Filters (for sampling dissolved metals)
- Powder-free gloves
- Spare batteries/charger for camera, GPS, field test meters and dip meter

- Chain of Custody (COC) forms from the relevant Laboratories (i.e. usually ALS, Envirolabs or AWQC); one for bulk of samples and one for Spilt samples
- Plastic sleeves (snap-lock bags) to protect COC forms inside the eskies
- Consignment (Con) Notes for Freighting samples to Laboratories pre-filled as much as possible with relevant Account Number, Laboratory Address, Contacts etc
- Tape and security seal for eskies; also stickers such as address label, fragile, keep chilled etc
- Communications equipment (e.g. mobile/satellite phone, radio, EPIRB)
- PPE – see below
- Garbage bag for used filters, syringes, gloves and other general waste generated during sampling.

2.2 WHS Requirements

Groundwater sampling tasks must be covered by a specific Job Safety and Environment Analysis (JSEA) relevant to current conditions. Standard sampling considerations are listed in Table 1.

Table 1: Standard hazard management for groundwater sampling

Job Steps	Potential Hazards	Hazard Management
Driving to and around site	Animals on road	<ul style="list-style-type: none"> • Do not swerve to avoid hitting fauna on the road, slow down and maintain line
	Other vehicles	<ul style="list-style-type: none"> • Maintain good observation when driving • Even on quiet roads, always assume the possibility of an oncoming vehicle
	Road conditions	<ul style="list-style-type: none"> • Stay within speed limits and drive according to conditions
	Flat tyres	<ul style="list-style-type: none"> • Carry spare tyres, jack and tools • All party members must be proficient in changing a tyre on the type of vehicle being used
	Bogging	<ul style="list-style-type: none"> • Avoid driving in wet areas • Use farm buggy if too boggy for 4WD vehicle • Maintain communications (i.e. phone, radio) • If bogged, call for assistance
	Mechanical failure	<ul style="list-style-type: none"> • Maintain communications (i.e. mobile phone, radio)
Groundwater sampling	Unsafe worksite	<ul style="list-style-type: none"> • Upon arrival to each site, perform an assessment of potential risks/dangers unique to the area and mitigate accordingly • Add any new hazards to JSA for further risk assessment.
	Cuts/abrasions	<ul style="list-style-type: none"> • Wear full PPE when performing sampling
	Pump and associated equipment operation	<ul style="list-style-type: none"> • Personnel must be appropriately trained or experienced in the use of the groundwater sampling equipment • Perform pre-start inspection on groundwater plant (particularly pressure fittings, fuel supply and exhaust) • Be aware of exhaust (if applicable) and do not touch to prevent burns • Avoid pinch points when retrieving hoses • Always secure equipment fully when moving between sites
	Snakes	<ul style="list-style-type: none"> • Correct PPE (i.e. sturdy boots, long pants/gators) • All personal have first aid training • Care taken when stepping over logs • Each person to carry snake bandage at all times

Job Steps	Potential Hazards	Hazard Management
	Feral animals (e.g. cattle, buffalo, pigs)	<ul style="list-style-type: none"> Assess each site for potential dangerous animals upon arrival Maintain safe distance from any animals Shelter in vehicle if required
	Ticks/Leaches	<ul style="list-style-type: none"> Check body and clothing for ticks/leaches at the end of each day Shirts to remain tucked into the trousers Ticks/leaches to be carefully removed to avoid squeezing the tick/leach Seek medical advice if a tick bite is found
	Tripping / slipping / strains	<ul style="list-style-type: none"> Care taken walking in rough / overgrown terrain (or seek alternative route) Use appropriate lifting techniques (i.e. bend knees), 2 person lifts and lift within capabilities
	Dehydration / heat exhaustion	<ul style="list-style-type: none"> Adequate water and electrolyte replacement carried for all personnel Competent first aid trained person within sampling group Correct PPE First aid is readily available
	Burns (re-fuelling)	<ul style="list-style-type: none"> Ensure that re-fuelling takes place in an open area Fire extinguisher fitted in each vehicle Engine off First aid kit carried Competent first aid trained person within sampling group Ensure no ignition sources are nearby (e.g. radios, monitoring equipment)
	Sunburn	<ul style="list-style-type: none"> Use sunscreen and wear correct PPE (i.e. hat, long sleeves)

The JSA shall also include details of personal protective equipment (PPE), such as:

- Sturdy boots
- Hat, safety/polaroid sunglasses, sunscreen etc. for sun protection
- Long pants and shirt

2.3 Training and Competency

All personnel conducting water sampling shall be familiar with this SOP and have received field training from experienced personnel or have previous experience in surface water sampling. This includes training in sample collection, using and calibrating field meters.

All personnel conducting water sampling shall have a current first-aid certificate.

2.4 Contamination Prevention Precautions

- 2.4.1. Keep hands away from sample bottle openings and the inside of bottle lids. Be aware that sources of contamination include smoking, permanent markers, insect repellent, sunscreen, deodorant, dust and perspiration.
- 2.4.2. Always wear powder free gloves and use new gloves for each sample site.
- 2.4.3. Do not allow the opening of sample bottles and bottle lids to touch the ground.
- 2.4.4. Only clean, sealed and pre-prepared preserved sample bottles obtained from a NATA accredited laboratory (usually ALS) are to be used.
- 2.4.5. Ensure equipment is cleaned thoroughly after each sample site with decon 90 solution (5 %) and rinsed with deionised water.

- 2.4.6. Ensure sample bottles are filled to the top leaving no headspace unless otherwise specified by the laboratory.
- 2.4.7. Do not overfill the bottle, particularly not for sample bottles with preservative.
- 2.4.8. For the bottles containing preservative, after sample collection, put the lid on and shake immediately.
- 2.4.9. After sample collection, ensure all sample bottles are tightly sealed and stored upright in an esky (with ice-bricks) or fridge at <math><4^{\circ}\text{C}</math>. Do not use ice as this can contaminate the samples if they are left in the melted ice water.

3 Procedure

3.1 Preparation

- 3.1.1. Prior to undertaking a field sampling trip, ensure that a JSA has been completed and that forecast and current weather conditions (e.g. stream levels, wind, etc.) do not pose a risk to personnel safety and/or obtaining an appropriate sample.
- 3.1.2. Get together all the equipment listed in Section 2.1 (and any additional task-specific equipment) ready to go, ideally packing most of the gear together into a large plastic crate.
- 3.1.3. Bottles may need to be ordered from the laboratory (e.g. ALS, Envirolabs or AWQC). Contact the laboratory for advice on what bottles are required (certain analytes require particular bottles and preservatives).
- 3.1.4. Put together a package of sample bottles for each site (i.e. in a large snap-lock bag), including bottles for duplicates, split samples and blanks.
- 3.1.5. Label each bottle with the site name, or duplicate, split, blank, etc.
- 3.1.6. For metals, tick the box on the bottle label for either *filtered* or *total*, depending on whether sample for metals analysis will be filtered in the field.
- 3.1.7. Calibrate the field test meters (e.g. pH, EC, Turbidity, DO, ORP) according to the laminated instruction card provided in the Calibration Folder and/or manufacturer's instructions. Fill out the Calibration Record Form and file in the Calibration Record Sheet Folder. See Appendix B for calibration record sheet.
- 3.1.8. Ensure camera and GPS (if required) are fully charged and have a cleared memory.
- 3.1.9. Depending on the number of sites being sampled, prepare a sufficient volume of Decon 90 solution (i.e. 1:20 Decon:de-ionised water) to use for cleaning sampling equipment in the field.
- 3.1.10. Ensure that ice bricks have been put in the freezer.
- 3.1.11. Remember to buy ice and put it in the esky on the way out to sampling. Ice is used to cool down the collected samples in the field only (ice bricks used for transport to laboratory)
- 3.1.12. Print out required number of blank Field Data Sheets (Appendix A), COC forms and maps.
- 3.1.13. Collect ice from cold stores prior to travelling to site

3.2 Travel to Sampling Site

- 3.2.1. Review JSA prior to travel to ensure that all safety risks are covered and personnel are familiar with any risks.
- 3.2.2. The map, photos and marked GPS locations should be used to confirm the correct location.
- 3.2.3. Previous surface water sampling reports also contain photographs that can be utilised to confirm the correct sampling location.

3.3 Bore Purging

- 3.3.1. The water standing within a monitoring bore is not representative of the surrounding groundwater. Sampling of a monitoring bore must be undertaken in such a way that groundwater surrounding the bore is sampled and not the standing water within the bore (or a mixture of both).

- 3.3.2. Purge a minimum of 1 casing volumes-worth of water from the bore prior to sampling and/or to pump water at a steady state equal to the groundwater recharge rate from the bore until successive readings of water quality parameters remain stable (within 5%).
- 3.3.3. Back the ute up so the groundwater rig is over the bore so the pump can be lowered directly into the bore.
- 3.3.4. Fill in the Groundwater Sampling Data Sheet with the Bore ID, date, time, your name, bore head condition, casing height, etc
- 3.3.5. Open bore cap using hand tools and key if locked.
- 3.3.6. Lower whistle/or electronic dip meter into the bore and measure the SWL.
- 3.3.7. Record this initial SWL on Data Sheet.
- 3.3.8. Calculate the volume of water in the bore using this calculation:
- 3.3.9. Water Volume (Litres) = $\pi r^2 (D-SWL) \times 1000$
 r = radius of inner bore casing (in meters)
 π = pi (3.14)
 D = total depth of the bore (in meters)
SWL = Standing Water Level (distance from ground to water level – in meters)
Obtain radius of the inner bore casing and depth of bore from the bore reports to calculate volume of water using above equation.
- 3.3.10. Lower pump into bore to the level where the bore casing is slotted (known from the bore report).
- 3.3.11. Lower dip meter back into bore so that SWL can be continuously measured during pumping – the pumping rate must be adjusted so that change in SWL is minimal i.e pumping rate = recharge rate.
- 3.3.12. Record time pumping is started on the Data Sheet.
- 3.3.13. Place end of hose into a 20 L bucket and let the bucket fill and spill over making sure the water flows well away from the bore – make a small channel using a shovel if required.
- 3.3.14. Continue to pump and observe any reduction in SWL to match pumping rate with recharge rate.
- 3.3.15. After about 5 minutes of pumping take a photo of the water colour and make any observations such as colour, sediment, odour or contamination etc
- 3.3.16. Record time, SWL and flow rate on the Data Sheet.
- 3.3.17. Connect flow through cell with field meter probes and take stabilised readings.
- 3.3.18. Lower pump into bore to the level where the bore casing is slotted (known from the bore report).
- 3.3.19. Lower dip meter back into bore so that SWL can be continuously measured during pumping – the pumping rate must be adjusted so that change in SWL is minimal i.e pumping rate = recharge rate.

3.4 Sample Collection

- 3.4.1. Wear powder-free gloves
- 3.4.2. Take out the required pre-labelled sample bottles.
- 3.4.3. Ensure when taking lids off that you don't touch the opening of the bottle or contaminate the inside of the bottle lid.

- 3.4.4. Fill the bottles from the hose making sure they are completely full with no headspace. Be careful not to overfill bottles which contain preservatives. If the flow rate is very rapid it may be required to fill the bottles containing preservative using a jug (pre-cleaned with decon and de-ionised water).
- 3.4.5. For samples requiring field filtering (e.g. dissolved metals), draw some water from the jug into a syringe, put a filter on the end of the syringe, rinse the filter by pushing a few drops of the sample through onto the ground, then fill the bottle leaving no headspace. Depending on the size of the syringe, it may be necessary to draw several syringes-full of water to fill the sample bottle.
- 3.4.6. Once all bottles are filled and tightly capped with lids, place them upright into the esky and store below 4°C.
- 3.4.7. For parameters that are recorded in situ, use a flow through cell to improve the quality of samples taken.

3.5 Collection of Field Blanks, Split Samples and Duplicates

- 3.5.1. To collect a field blank, simply follow the steps outlined in 3.4 above using de-ionised water instead of water from the site being sampled.
- 3.5.2. For split samples and duplicates, repeat all the above steps outlined in 3.4 above at the site(s) chosen for these samples (generally at least 1 in 10 sample sites). Be sure to note collection of these samples on the Groundwater Sampling Data Sheet otherwise it will not be possible to track which site these samples were collected because the site name is not permitted to be recorded on the bottle.

3.6 Pack up and Cleaning of Field Equipment

- 3.6.1. Wind up hose and bring pump out of bore.
- 3.6.2. Place pump into the 20 L bucket with deionised water to flush the hose and also rinse the external hose.
- 3.6.3. Turn off air compressor.
- 3.6.4. Pack all gear back into vehicle.
- 3.6.5. Close the bore cap.
- 3.6.6. Clean all meter probes, small jug and other equipment with the decon solution and rinse all equipment with deionised water (if not already done so for collecting a rinsate blank sample).
- 3.6.7. Be sure that all equipment is cleaned and rinsed using the above steps after sampling each bore.
- 3.6.8. Dispose of used filters, syringes, and gloves appropriately.

3.7 Sample Dispatch

- 3.7.1. Once sampling is completed, pack the samples securely in an esky with ice bricks. Ensure that samples have sufficient contact with the ice bricks to stay as cool as possible.
- 3.7.2. Fill out the COC, put in a plastic sleeve (snap-lock bag) and place inside the esky.
- 3.7.3. If required, provide a copy of the COC to the client.
- 3.7.4. Samples must be dispatched to the laboratory within the required holding times, noting that:

- Samples must be dropped off at the ALS office in Woolner (Unit 4, 16 Charlton Ct) no later than 3pm each day.
- Sample dispatch on Fridays and Saturdays is not acceptable for sample analysis with short holding times (e.g. microbiological, nutrients) as samples will not be delivered to the labs until Monday morning. Other parameters with longer holding times can be kept in a fridge until dispatch on Sunday or Monday.

3.7.5. 3.7.5 If sending samples direct to the laboratories:

- Tape up the esky and put on address label and stickers as appropriate (e.g. fragile, keep chilled etc).
- Fill out consignment note and stick on esky.
- Deliver samples direct to freight company or organise pick-up, ensuring that samples will be dispatched in time to meet laboratory holding times (usually by 16:00 on day of sampling for overnight priority service).

3.7.6. 3.7.6 Remember to also prepare a small esky containing the split sample for sending to a separate laboratory.

Appendix A Field Data Sheet - Groundwater Sampling

Site:
Sample Date:
Bore Name:
Sampled by:
Bore head condition:
Total depth (mbgl):
Screen intervals (mbgl):
Pump depth:

SWL Initial (m below top of casing):			
Casing height (m above ground):			
SWL Initial (m below ground level):			
Casing:	Colour at Start:	Odour:	Equip?
PVC		Nil	Y N
Steel	Colour at End:	H ₂ S	Psi
Other		Other	L/s
Comments:			

Time started Pump/Purging:									
Time									24hr
EC									µS/cm
pH									
Temp									°C
Turbidity									NTU
Salinity									Ppt
TSD									G/L
ORP									mV
DO									%sat
SWL									mbtoc
Flow Rate									L/min

Time									24hr
EC									µS/cm
pH									
Temp									°C
Turbidity									NTU
Salinity									Ppt
TSD									G/L
ORP									mV
DO									%sat
SWL									mbtoc
Flow Rate									L/min

Time Lab Samples Delivered:
Comments:

Appendix B Calibration Record Sheet, Water Sampling Meters

Date:				Calibrated by:							
Probe Calibrated: <small>(Enter ID of each probe)</small>		pH:		EC:		DO:		Turbidity:			
Pre-Calibrated Reading:				Post Calibrated Reading (Checking):							
pH											
pH 7.00 Standard:			pH 4.01 Standard			pH 7.00 Standard:			pH 4.01 Standard		
pH:		Temp:		pH:		Temp:		pH:		Temp:	
pH readings (circle): Good Some Problems (explain):											
EC											
EC Calibration Solution Used (circle): 447µS/cm 1413 µS/cm 2570 µS/cm 12880 µS/cm											
EC µS/cm:		TDS f/L:		Sal ppt:		EC µS/cm:		TDS f/L:		Sal ppt:	
EC readings (circle): Good Some Problems (explain):											
Turbidity											
Turbidity Standard 10 NTU:					Turbidity Standard 10 NTU:						
Turbidity 20 NTU:			Turbidity 100 NTU:			Turbidity 800 NTU:					
Turbidity readings (circle): Good Some Problems (explain):											
DO											
Barometric Pressure (mb) entered for DO: <small>Look up on BoM website for your locality</small>					Salinity (ppt) entered for DO: <small>i.e. zero if samples will be freshwater or 35 ppt for marine samples</small>						
DO 100% sat:					DO 100% sat:						
DO readings (circle): Good Some Problems (explain):											
DO											
Probes require servicing? (e.g. DO membrane needs changing, probes need to be cleaned or sent away, batteries need replacing)											
							Action (tick): <input type="checkbox"/>				
							Date:				
Any other actions required? (e.g. order more calibrations or DO replacement membrane)											
							Action (tick): <input type="checkbox"/>				
							Date:				
Signature:											