

ATTACHMENT 14 - TABLE OF MITIGATION MEASURES (WATER)

The below tables summarises the water mitigation measures and their hierarchy. These will be included in an Environment Plan for assessment and acceptance under the *Petroleum and Geothermal Energy Resources Act 1967 (WA)* and are included as the suite of mitigation measures in the *Environmental Protection Act 1986 (WA)* Environmental Review Document.

Table 1: Proposed mitigation measures – water

Mitigation hierarchy	Mitigation measure	Further information
Avoid	Geomechanical risks assessment	A comprehensive geotechnical risk analysis has been conducted. Further geotechnical risk assessment will be completed after each well has been constructed and prior to any HFS taking place. The site-specific geotechnical risk assessment will also utilise information gathered during the installation of the groundwater monitoring bores.
Avoid	Early warning system for detecting geomechanical events	An early warning system for detecting geomechanical events has been developed and will be implemented for the Proposed Action. The detection system includes monitoring for one-month pre and post any HFS activities.
Avoid	HFS not located within 2,000 m of a PDWSA	The wells are not located within 2,000 m of a Public Drinking Water Source Area
Avoid	HFS treatment will have more than 600 m vertical separation to the nearest useable aquifer.	As is good industry practice (in the absence of a state Code of Practice), BNR will ensure that HFS will not occur in formations that have <600 m vertical separation to the nearest useable aquifer. This will be checked and confirmed once each well has been constructed, along with a geotechnical risk analysis.
Avoid	Surface casing cemented across all useable freshwater aquifers	In accordance with the Guidelines for the protection of surface and groundwater resources during exploration and appraisal drilling (DMPR, 2002), the potential for contaminating groundwater resources will be managed by installing casing that is secured / sealed by a sealing material such as cement.
Avoid	Well Management Plan	In accordance with Regulation 10 of the PGER (Resource Management and Administration) Regulations 2015, every new well is required to have a WMP in place to ensure the well is designed and managed in accordance with sound engineering principles and industry good practice, including identification of risks. The WMP specifically describes and addresses well integrity risks and includes the requirements for the operator to manage these accordingly. Specifically, the WMP will address casing integrity management that will then be assessed and accepted by DEMIRS before HFS commences. Therefore, well management plans will be developed and approved prior to each well being constructed.
Avoid	Well integrity assessment	To further ensure well integrity and thus environmental protection and public safety, well design, construction, and testing will be assessed by an independent / certified expert well examiner approved by DEMIRS.
Avoid / Minimise	Part IV Groundwater Management Plan	BNR has developed a GWMP that documents the groundwater monitoring requirements along with management actions associated with trigger and threshold criteria that must be implemented. BNR believes that with the triggers detailed in the GWMP, groundwater sensitivities (such as subterranean fauna) will be protected. BNR will ensure the location of all monitoring bores is completed in consultation with DWER and DEMIRS. BNR will complete all groundwater monitoring (including local baseline sampling) in accordance with the Part IV Groundwater Management Plan.
Minimise	Produced formation water storage pond design	As per WQPN 26 (DoW, 2013), all lined storage compounds will have sufficient freeboard (at least 500 mm) maintained to prevent unintended overflow of water from storms with an average return frequency of at least 20 years, plus capacity to store rainfall resulting from a 90th percentile wet season, after allowing for any evaporative water loss and the effects of any water re-use recovery system. All water storage ponds will be designed to meet these requirements.

Mitigation hierarchy	Mitigation measure	Further information
Minimise	Groundwater monitoring bore installation	<p>Installation and drilling of all water bores (including abstraction bores) will be hydro stratigraphically logged in detail and geophysical interpretation of groundwater quality collected, for the interval where fresh aquifers are known to be present (including through the Grant formation).</p> <p>Annulus seals and gravel packs will be used, where necessary, to isolate the zone being monitored and prevent potential cross contamination via the bore casing as required by the Minimum Requirements for Water Bores in Australia (National Uniform Drillers Licensing Committee, 2011) required to be followed as detailed in the Groundwater monitoring in the onshore petroleum and geothermal industry guideline (DMP & DoW, 2016). BNR will conduct validation water samples (along with QA/QC samples of any fluids or water used for the bore installation process) at a point of discharge from the circulation system to understand if cross contamination may be occurring as evidenced by fluid constituent presence associated with bore installation. This may involve the use of tracer dyes, but these specifics are subject to local conditions, aquifer depths and will be directed by a hydrogeologist during bore installation.</p>
Minimise	Petroleum well installation	BNR will hydrostratigraphically log the petroleum well during drilling activities and collect a geophysical interpretation of groundwater aquifers.
Minimise	Pond design	<p>In accordance with WQPN 26 (DoW, 2013), surface ponds used for short-term containment of wastewater or solids that may leach contaminants, require synthetic membranes and need to meet specific requirements, including:</p> <ul style="list-style-type: none"> • all fluid containment liners should have a coefficient of permeability of less than 2×10^{10} m/s • a minimum thickness of 0.75 mm • dual liners • leak detection <p>All surface ponds will be constructed to meet these requirements.</p>
Minimise	Chemical inventory	A chemical inventory has been developed for the Proposed Action.
Minimise	Low-toxicity mud system	BNR plans to use a low-toxicity mud system for the top-hole section that, if lost to the environment, is not expected to result in environmental impacts.
Minimise	Fugitive discharges are monitored and reported	As per Regulation 15 of the PGER(E)R 2012, BNR will monitor, and record volumes of fluids not recovered during circulation.
Minimise	Groundwater licences for extraction bores	In accordance with the RIWI Act, all water extraction must be licensed prior to take because the Development Envelope is located within a proclaimed groundwater area (DoW, 2010). BNR will ensure all groundwater licences are in place and kept up to date.
Minimise	Meter calibration and monitoring for extraction bores	As described in the Measuring the taking of water guidelines (DoW, 2016), Clause 46 of Schedule 1 of the RIWI Act state that licensees may be subject to metering, which is recognised as an accurate and reliable measuring technique. This is further expressed in the RIWI Regulations 2020, which now require water licences with annual water entitlements of between 10 – 50ML per year to install meters. Meters will be installed as required.
Monitor	Site water audit	<p>All water wastes and emissions, including formation water produced during well testing, resulting from the Proposed Action will be recorded and monitored.</p> <p>A site water audit on completion of HFS at each well site will be undertaken, accounting for water produced, evaporated and disposed, to detect significant leakage of fluids and determine whether remedial action to track any contaminants is warranted.</p>
Monitor	Ecotoxicology testing on produced formation water	Ecotoxicology testing of produced formation waters at each wellsite will be conducted by an independent NATA endorsed laboratory, either through the sea urchin fertilization test using <i>Helicoidaris tuberculata</i> or other appropriate methodology. Reporting will be done in accordance with annual compliance reporting to DMAs.