6. Recommendations

This review of basin resource management methodologies, Western Australian regulations and experience from other jurisdictions helps inform management options for the development of subsurface resources in the northern Perth Basin.

6.1. General considerations

There are different ways of managing the co-development of, and potential conflicts between, various subsurface resources. These are based on different drivers (economic, environmental, societal), which lead to different forms of prioritisation.

- The most straightforward option would be a **clear ban or prioritisation** of one resource over the other, which provides certainty and avoids lengthy and costly arbitration hearings. However, economics and priorities can change, which would require regulations to be updated in the future.
- **Co-development** of resources and avoidance of detrimental impacts is, in most cases, more economical, but requires more detailed regulatory considerations.
    - Generally, direct impacts (such as contamination of one resource by the operations of another) are relatively easy to identify, and compensation can be paid based on lost revenue if impacts are impossible to mitigate.
    - Pressure impacts, on the other hand, are harder to predict and more difficult to attribute to a source. They are not necessarily detrimental, and in some cases, may even be favourable.

Prior to development, hydrodynamic modelling or reservoir simulations are required to predict resource interactions and identify monitoring locations and **trigger values**. Having clear trigger values for acceptable pressure changes in neighbouring reservoirs or storage resources provides certainty and helps parties agree on monitoring and compensation solutions before any conflict arises. This is particularly important in cases where the pressure impact is detrimental (for example, in cases where both parties rely on pressure reduction or increase to develop their respective resources).

6.2. Suggestions for the management of subsurface resource development in the northern Perth Basin

Existing resources and groundwater regulations in Western Australia provide frameworks and guidelines for managing certain resource development interactions (for example, the protection of groundwater resources and co-development of petroleum and geothermal resources). However, the latter case has not yet been tested because there are no geothermal energy projects currently operational in the northern Perth Basin. Also, existing regulations are currently being updated to account for CO_2 geological storage. In the case of expected detrimental impacts, the government,

in consultation with industry and community stakeholders, may need to prioritise one resource over another and ensure that adequate compensation provisions are in place. The scale of future CO_2 storage and geothermal resource developments is still uncertain and conflicts may never reach a level of concern. The first new operations will provide important experience and information regarding the adequacy of existing assessment methodologies and regulations.

Additionally, while direct interactions between deep resources and groundwater are unlikely, structural complexities in areas such as the Dongara-Beharra Springs-Donkey Creek Terraces must be closely monitored. High well integrity standards, fault permeability assessments and enhanced groundwater monitoring will be key to ensuring resource coexistence while protecting water supplies.

Based on the interaction maps, thematic interaction maps and cumulative interaction maps, several management challenges and strategies can be identified for balancing resource extraction, CGS, UGS, geothermal energy production and groundwater protection.

Suggested management approaches are provided for various aspects of resource management, some of which are already embedded in current resources and regulations in Western Australia.

6.2.1. Integrated subsurface planning for overlapping resources

CGS and petroleum resources show the highest interaction potential in the northern Perth Basin, particularly in Permian reservoirs, due to their shared reliance on the same geological formations for storage and extraction. UGS (and UHS) sites are primarily aligned with depleted petroleum fields, reinforcing the need for strategic planning to repurpose hydrocarbon reservoirs for gas storage or CO_2 sequestration. Therefore, regulatory coordination is required to ensure that one resource development does not compromise another, particularly where storage operations (CO_2 or UGS) could affect pressure dynamics in petroleum reservoirs.

Suggested management approach:

- Prioritise subsurface resources based on their economic and/or environmental values.
- Provide regulations that either give priority to one resource over the other, or provide a regulatory framework that allows for co- or staggered resource development.
- In the case of co-development, identify the potential for direct impacts like contamination of one resource by the operations of another and require plan for mitigation and/or compensation to be paid based on lost revenue.

6.2.2. Pressure and flow management across resource boundaries

Pressure changes from resource extraction and storage (for example, CGS injection and gas extraction) can affect adjacent resources, particularly in zones of high interaction, and potentially compromise containment integrity.

Suggested management approach:

- Make hydrodynamic modelling or reservoir simulations of resource interactions a requirement before approving injection or withdrawal projects. This is particularly important for high-interaction clusters in the Dandaragan Trough, Beharra Springs Terrace, Dongara Terrace and Donkey Creek Terrace.
- Require a geomechanical assessment of the cumulative pressure impacts on fault stability and seal integrity.
- Agree on pressure monitoring locations and trigger values.

6.2.3. Fault and well integrity considerations for groundwater protection

The deep resources and shallow aquifers are largely stratigraphically separated, minimising the likelihood of direct hydraulic interactions. However, faults and deep wells may serve as potential migration pathways between deeper formations and groundwater systems. For example, the Dongara-Beharra Springs-Donkey Creek region has a high density of structural discontinuities, particularly faults that may displace regional seals like the Kockatea and Cadda formations.

Suggested management approach:

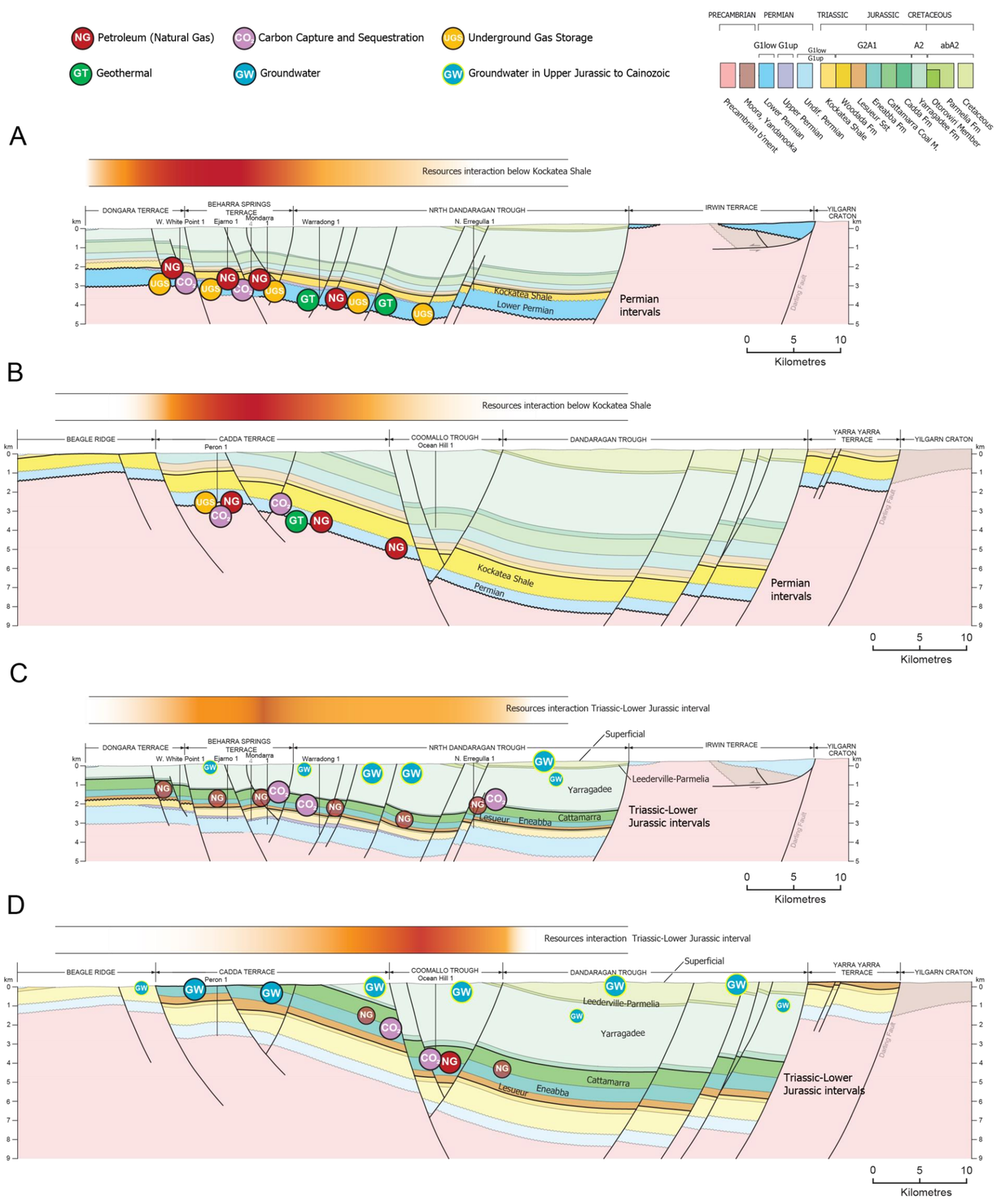
- Conduct an assessment of fault permeability in areas where CGS or petroleum development overlaps with groundwater aquifers.
- Require regular well integrity monitoring and decommissioning for legacy petroleum wells to prevent unintended fluid migration into potable water sources.

6.2.4. Managing soft interactions between deep resources and groundwater

The Yarragadee aquifer, covering much of the northern Perth Basin, overlaps with high and moderate resource interaction zones, suggesting that if migration pathways exist, localised groundwater impacts could occur. The Lesueur-Eneabba-Cattamarra and Leederville-Parmelia aquifers have lower interaction potential, but specific geological structures could still create localised risks.

Suggested management approach:

- Require groundwater monitoring in areas of potential deep resource interaction, particularly where faults could enhance fluid movement.
- Use salinity and pressure data from deep and shallow formations to assess hydraulic connectivity risk.



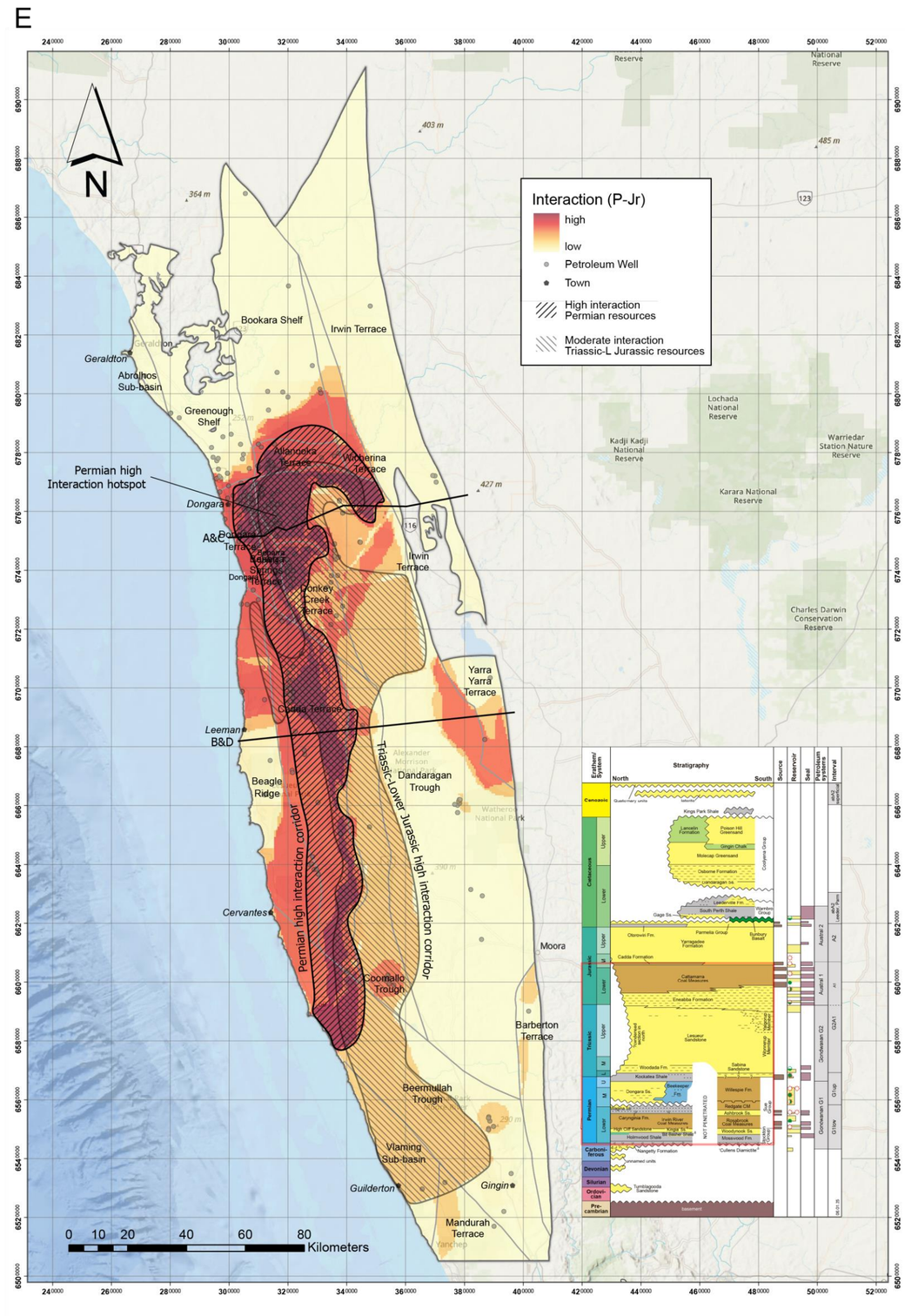


Figure 55. Summary of resource interactions. A) E-W cross-section across the northern interaction hotspot for the Permian intervals; the resources are shown schematically on the intervals; CGS and petroleum are the main interacting resources, geothermal and UGS are secondary resources; high-interaction hotspot aligns with the western flank of the basin, B) E-W cross-section across the N-S interaction corridor for the Permian intervals; the resources are shown schematically on the intervals; CGS and Petroleum are the main interacting resources; high-interaction corridor aligns with the western flank of the basin, C) E-W cross-section across the northern part of the interaction corridor for the Triassic-Lower Jurassic intervals; the resources are shown schematically on the intervals; CGS and petroleum are the main interacting resources; high-interaction corridor aligns with the western flank of the basin; groundwater resources in the Upper Jurassic-Cainozoic intervals are shown with a yellow outline, D) E-W cross-section across the southern part of the interaction corridor for the Triassic-Lower Jurassic intervals; the resources are shown schematically on the intervals; CGS and petroleum are the main interacting resources; groundwater is present to the west where the intervals outcrop; high-interaction corridor aligns with the western flank of the basin; groundwater resources in the Upper Jurassic-Cainozoic intervals are shown with a yellow outline, E) cumulative interaction map showing aggregated interaction data across Lower Permian-Lower Jurassic intervals.