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National Water Grid®

Water resource assessment for the Victoria catchment

A report from the CSIRO Victoria River Water Resource Assessment for the National Water Grid

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Important disclaimer

CSIRO Victoria River Water Resource Assessment acknowledgements

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Aspects of the Assessment have been undertaken in conjunction with the Northern Territory (NT) Government.

The Assessment was guided by two committees:

i. The Assessment's Governance Committee: CRC for Northern Australia/James Cook University; CSIRO; National Water Grid (Department of Climate Change, Energy, the Environment and Water); Northern Land Council; NT Department of Environment, Parks and Water Security; NT Department of Industry, Tourism and Trade; Office of Northern Australia; Queensland Department of Agriculture and Fisheries; Queensland Department of Regional Development, Manufacturing and Water

ii. The Assessment's joint Roper and Victoria River catchments Steering Committee: Amateur Fishermen's Association of the NT; Austrade; Centrefarm; CSIRO; National Water Grid (Department of Climate Change, Energy, the Environment and Water); Northern Land Council; NT Cattlemen's Association; NT Department of Environment, Parks and Water Security; NT Department of Industry, Tourism and Trade; NT Farmers; NT Seafood Council; Office of Northern Australia; Parks Australia; Regional Development Australia; Roper Gulf Regional Council Shire; Watertrust

Responsibility for the Assessment's content lies with CSIRO. The Assessment's committees did not have an opportunity to review the Assessment results or outputs prior to their release.

This report was reviewed by Dr Brian Keating (Independent consultant). Individual chapters were reviewed by Dr Rebecca Doble, CSIRO (Chapter 2); Dr Chris Pavey, CSIRO (Chapter 3); Dr Heather Pasley, CSIRO (Chapter 4); Mr Chris Turnadge, CSIRO (Chapter 5); Dr Nikki Dumbrell, CSIRO (Chapter 6); Dr Adam Liedloff, CSIRO (Chapter 7). The material in this report draws largely from the companion technical reports, which were themselves internally and externally reviewed.

For further acknowledgements, see page xxv.

Acknowledgement of Country

CSIRO acknowledges the Traditional Owners of the lands, seas and waters of the area that we live and work on across Australia. We acknowledge their continuing connection to their culture and pay our respects to their Elders past and present.

Photo

The Victoria River is the longest singularly named river in the NT with permanent water. Photo: CSIRO – Nathan Dyer

3 Living and built environment of the Victoria catchment

Authors: Marcus Barber, Danial Stratford, Seonaid Philip, Linda Merrin, Diane Jarvis, Thomas Vanderbyl, Rob Kenyon, Nathan Waltham, Simon Linke, Kristina Fisher, Heather McGinness, Caroline Bruce, Andrew R Taylor

Chapter 3 discusses a wide range of considerations relating to the living components of the catchment of the Victoria River. This includes the environments that support these components, the people who live in the catchment or have strong ties to it, and the existing transport, power and water infrastructure.

The key components and concepts of Chapter 3 are shown in Figure 3-1.

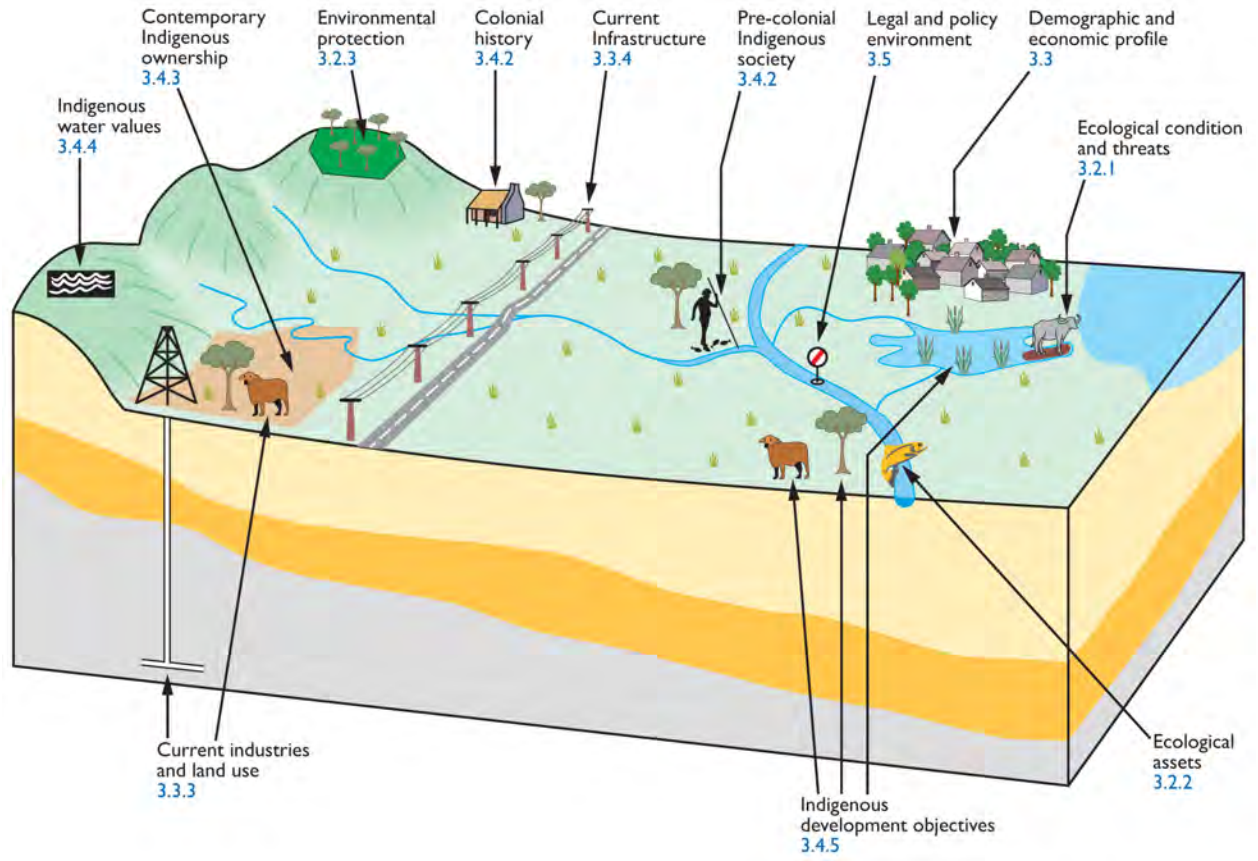

Figure 3-1 Schematic diagram of key components of the living and built environment to be considered in establishing a greenfield irrigation development

Numbers refer to sections in this chapter.

3.1 Summary

This chapter provides information on the living and built environment, including information about the people, the ecology, the infrastructure and the institutional context of the Victoria catchment. It also examines the values, rights, interests and development objectives of Indigenous Peoples.

3.1.1 Key findings

Ecology

The comparatively intact landscapes and associated water resources of the Victoria catchment support ecosystem health and biodiversity, providing crucial ecosystem services for human residence. Key human activities in the catchment that require intact landscapes include recreation, tourism, Indigenous cultural practices, fisheries (Indigenous, recreational and commercial), agricultural production (notably, cattle grazing on native pastures) and military training focused on tropical savanna environments. Within the freshwater sections of the Victoria catchment are extensive areas with high habitat values, including ephemeral and persistent rivers, wetlands, floodplains and groundwater-dependent ecosystems (GDEs), including two sites listed in the Directory of Important Wetlands in Australia (DIWA): Bradshaw Field Training Area and Legune Wetlands. For the marine and estuarine environments, the Victoria River provides some of the largest flows into the Joseph Bonaparte Gulf, supporting extensive intertidal, estuarine and marine communities.

The habitats of the Victoria catchment contain plants and animals that are of great conservation significance, such as the freshwater sawfish (*Pristis pristis*) and dugong (*Dugong dugon*). They also contain iconic wildlife species such as the saltwater (*Crocodylus porosus*) and freshwater (*Crocodylus johnstoni*) crocodiles and barramundi (*Lates calcarifer*).

Changes in land and water resources can have serious consequences for the ecology of rivers. Water resource development that changes the magnitude, timing or duration of either low or high flows can affect species, habitats and ecological processes such as connectivity. Water resource development can also facilitate or exacerbate other impacts, including the spread or establishment of invasive species, increases in other anthropogenic pressures, and changes to water quality, including the availability and distribution of nutrients.

Demographics, industries and infrastructure

The Victoria catchment has a population of about 1600, with a population density one 165th of Australia as a whole. The catchment contains no large urban centres, but there are several small towns and communities within the catchment, including Timber Creek (the regional centre), Yarralin, Nitjpurru (Pigeon Hole), Amanbidji, Bulla, Kalkarindji and Daguragu. The largest of these settlements is Kalkarindji (population 383 as at the 2021 Census). The typical resident of the catchment is younger, has a lower weekly household income and is more likely to identify as Indigenous than the typical resident of the NT and of Australia as a whole. The dominant land use, by area, in the catchment is grazing (62%) with conservation and protected land being 35% of the catchment. Note that, in terms of tenure, 31% of the catchment is held as Aboriginal freehold. The gross value of agricultural production (GVAP) in the Victoria catchment is approximately $110.2 million, beef cattle contributing the entire amount.

The Victoria catchment is serviced by two significant roads: the Victoria and Buntine highways. The only other road that permits Type 2 road trains (vehicles up to 53 m in length) is the unsealed Buchanan Highway. A sparse network of minor roads links to these three highways. A large percentage of the catchment's pastoral enterprises have access to the main highways and, via northern routes, to Darwin Port in the north via Katherine. The Buntine Highway carries more commercial traffic than the Victoria Highway, and all roads are subject to wet-season closures. The only access to a good-quality standard-gauge rail line is outside the catchment at Katherine in the north-east. The Victoria catchment is too remote to be covered by the main NT power networks. Off-grid electricity is provided to communities by hybrid electricity generation systems powered by diesel generators and in some cases supplemented with solar. There are no major dams or water transmission pipelines in the Victoria catchment. Urban water for domestic consumption, therefore, depends mainly on treated groundwater (from bores), which is the preferred source for larger settlements.

Indigenous values, rights, interests and development goals

The Assessment activity focused on Indigenous values, rights, interests and development goals provides a regionally specific account designed to help non-Indigenous decision makers understand general Indigenous valuations of water and wider connections to Country, and the rights and interests attached to those. The report also helps Indigenous decision makers (local, regional and national) understand the specific residential, ownership, natural and cultural resource management, and development issues relevant to Traditional Owners from the Victoria catchment. These are likely to be raised by Traditional Owners in future discussions about development proposals, community planning and Indigenous business objectives.

The investigation focused on gathering data and consulting individuals. It did not attempt to conduct community-based planning or to identify formal Traditional Owner group positions on any of the matters raised. The data comes from face-to-face interviews with 19 locally resident and predominantly senior Traditional Owners from major language groups in the Victoria catchment. These groups include the Gurindji and Ngarinyman language groups in the southern and central parts of the catchment, the Ngaliwurru and Nungali language groups in the Timber Creek area, and Gajerrong language groups in the far west.

Indigenous Peoples and the groups they belong to have significant land holdings and rights in Country through the Commonwealth *Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA) and the Commonwealth *Native Title Act 1993.* Thirty-one per cent of the Victoria catchment is freehold Aboriginal land under the ALRA. These holdings are an important focus for discussions about water and about sustainable development in the Victoria catchment. Indigenous objectives combine economic viability and sustainability with a range of wider social, cultural and environmental goals.

Participants in the activity provided crucial framing information about Indigenous culture, Country and people. Traditional Owners have particular obligations to past and future generations to maintain customary practices and knowledge and care for Country properly. These obligations entail responsibilities to near neighbours and downstream groups.

Key water issues for Traditional Owners in the Victoria catchment include:

- ensuring water of sufficient quality to maintain healthy landscapes (environmental flows) and sustain cultural resources and practices
- monitoring and reporting water availability and use, and any development impacts on water quality for informed decision making about future development
- maintaining good-quality water supplies for human consumption and recreation in communities, and outstations
- securing sufficient water reserves for current and future economic activity.

Through the Strategic Aboriginal Water Reserve (SAWR) process, some significant progress has been made on establishing water reserves in the NT. However, SAWR processes are only possible through the creation of a water plan, and there remain relatively limited means for Indigenous knowledge of water to be expressed in public policy and planning. The very small footprint of existing water control district declaration and associated water planning in the catchment means that Traditional Owners' knowledge of formal government-led water planning in the area was also found to be very low. Knowledge of catchment management institutions and processes was also found to be low.

Knowledge of water resource development options was more limited among participants in this Assessment than in previous assessments elsewhere in northern Australia. There is strong resistance across the catchment to the idea of instream dams. If water development were to occur, the general trend from most favourable to least favourable forms of development is: flood harvesting into smaller, offstream storages; sustainable bore and groundwater extraction; smaller instream dams inside tributaries or ancillary branches; and large instream dams in the main river channels.

With respect to Traditional Owners' development objectives and development planning, the Assessment identified five primary interrelated development goals:

- securing greater recognition of Traditional Ownership of water and/or management control over water
- ensuring water supply for human consumption and recreation in communities and outstations
- improving information flow and empowerment for Indigenous decision makers
- protecting and strengthening regional and catchment governance in line with customary connections
- developing new Country-based businesses and industries

Group or community-based planning can help communities prioritise options for wider development. These can include establishing stand-alone Indigenous businesses or joint ventures and participating in local and regional resource development monitoring and reporting programs.

Traditional Owners in the Victoria catchment possess valuable natural and cultural assets and represent a significant potential labour force. However, many people lack employment experience and skills in business development and operation. Indigenous development objectives and Indigenous development partnerships are best progressed through locally specific group- and community-based planning and prioritisation processes that are nested in a system of regional coordination. Indigenous Peoples can also act as substantial enablers of appropriate development. They seek to be engaged early and continuously in defining development pathways and options.

Legal and policy environment

Proponents must be aware of the complex legal, policy and regulatory landscape when contemplating and planning land and water developments within the Victoria catchment. As part of their due diligence process, proponents must secure appropriate land tenure, obtain the necessary authorisations to take water, and obtain a range of government approvals before commencing construction and operation of a development. The Victoria catchment is wholly located within the NT. Government powers and responsibilities for managing land and water resources in the Victoria catchment are shared between the Australian Government and the NT Government. Although the NT Government is responsible for land, water and environmental policy and laws and administers the planning system, the Australian Parliament retains a right of veto over all laws in the territory. The Australian Government has powers under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) relating to matters of national environmental significance (including those arising from the World Heritage Convention, the Ramsar Convention on Wetlands of International Importance and the Convention on Biological Diversity) and the native title rights of Indigenous Peoples.

3.1.2 Introduction

This chapter seeks to address the following questions. In the Victoria catchment, what are the existing:

- ecological systems
- demographic and economic profiles, land use, industries and infrastructure
- values, rights, interests and development objectives of Indigenous Peoples?

The chapter is structured as follows:

- Section 3.2 examines the ecological systems and assets of the Victoria catchment, including key habitats and biota and their important interactions and connections.
- Section 3.3 examines the socio-economic profile of the Victoria catchment, including current demographics, existing industries and infrastructure of relevance to water resource development.
- Section 3.4 examines the Indigenous values, rights, interests and development objectives of Traditional Owners from the Victoria catchment.

3.2 Victoria catchment and its environmental values

This section provides an overview of the environmental values and the freshwater, marine and terrestrial ecological assets found in the Victoria catchment. Unless otherwise stated, the material in this section is based on work described in the companion technical report on ecological assets (Stratford et al., 2024).

The comparatively intact landscapes and associated water resources of the Victoria catchment support ecosystem health and biodiversity, providing crucial ecosystem services for human residence. Key human activities in the catchment that require intact landscapes include recreation, tourism, Indigenous cultural practices, fisheries (Indigenous, recreational and commercial),

agricultural production (notably cattle grazing on native pastures) and military training focused on tropical savanna environments.

The Victoria River is a large perennial river (i.e. it maintains flow all year) that originates near Judbarra National Park. At over 500 km in length, it is one of the longest perennial rivers in the NT. The catchment area of 82,400 km^2 makes it one of the largest ocean-flowing catchments in the NT, and flows enter the south-eastern edge of the Joseph Bonaparte Gulf. The catchment and the surrounding marine environment contain a rich diversity of important ecological assets, including species, communities, habitats, processes and functions (see the conceptualised summary in Figure 3-2). The ecology of the Victoria catchment is maintained by the river's flow regime, shaped by the region's wet-dry climate and the catchment's complex geomorphology and topography and driven by patterns of seasonal rainfall, evapotranspiration and groundwater discharge.

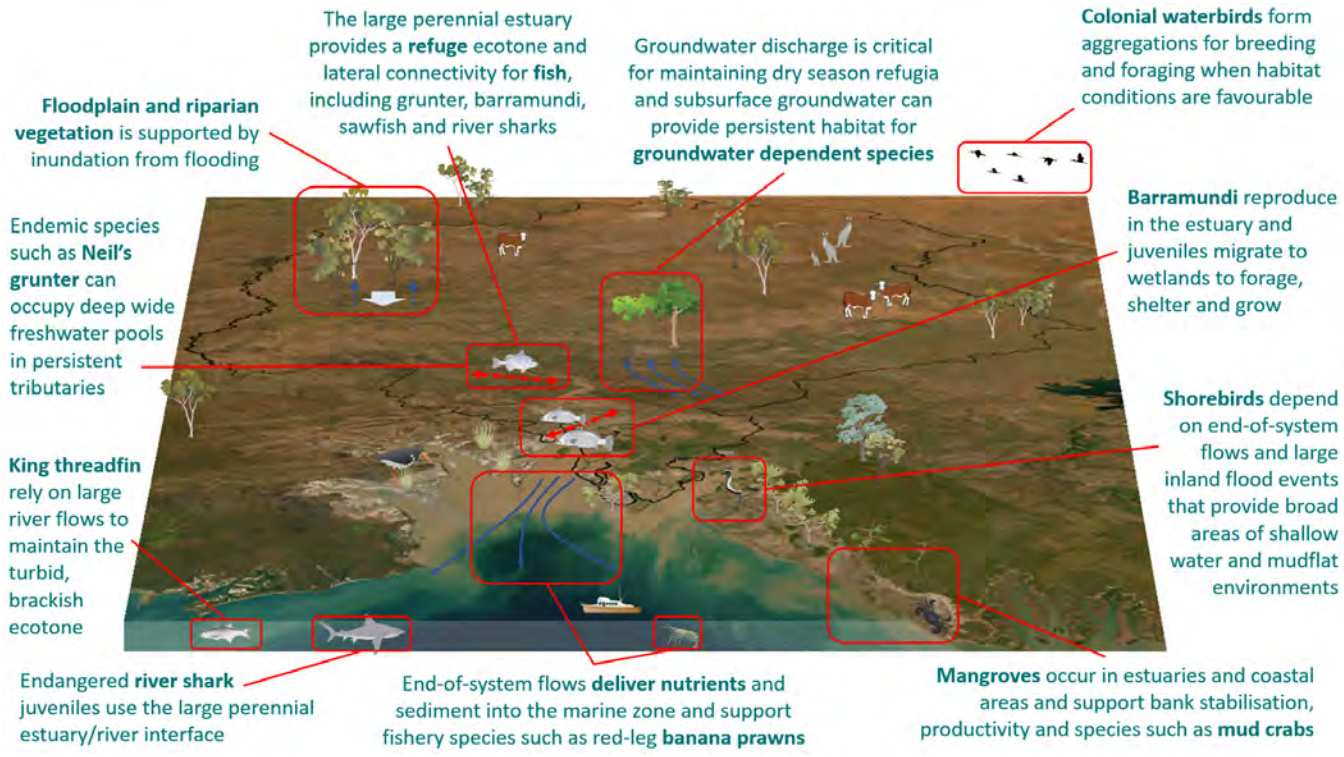

Figure 3-2 Conceptual diagram of selected ecological values and assets of the Victoria catchment

Ecological assets include species of significance, species groups, important habitats and ecological processes. See Table 3-2 for a complete list of the fresh water–dependent, marine and terrestrial ecological assets considered in the Victoria catchment.

Biota icons adapted from Integration and Application Network (2023).

Much of the natural environment of the Victoria catchment consists of rolling plans, mesas, escarpments and plateaux with savanna woodlands and various grasslands, including spinifex (Kirby and Faulks, 2004). The wet-dry tropical climate results in highly seasonal river flow with 90% of rainfall occurring between November and March (Kirby and Faulks, 2004). As typical for much of northern Australia, the dynamic occurring between wet and dry seasons provides both challenges and opportunities for biota (Warfe et al., 2011). During the dry season, river flows are reduced with many of the streams in the catchment receding to isolated pools. However, some of the larger tributaries in the catchment are perennial, including sections of Wickham River (upstream of Humbert River junction) and the Angalarri River (Midgley, 1981). In parts of the Victoria

catchment, the persistence of water during the dry season is supported by discharge from groundwater-fed springs that persist during most dry seasons (Bureau of Meteorology, 2017); these habitats support aquatic life and fringing vegetation. In the dry season, the streams and waterholes that persist provide critical refuge habitat for many species, both aquatic and terrestrial.

Many low-lying parts of the catchment flood during the wet season, inundating floodplains, connecting wetlands to the river channel and driving booms in productivity. While the extent of floodplain wetlands is comparatively moderate compared to many other tropical catchments, catchment topography means that flooding can be particularly evident in the floodplains, wetlands and intertidal flats of the estuary and around the junction of the Victoria River with both the West Baines and Angalarri rivers. Annual flooding delivers extensive sediment-rich discharges into the southern Joseph Bonaparte Gulf with sediment plumes that can extend large distances into the marine waters.

Protected, listed and significant areas of the Victoria catchment

The protected areas located in the Victoria catchment include one gazetted national park (Judbarra), a proposed extension to an existing national park (Keep River), two marine national parks, two Indigenous Protected Areas and two Directory of Important Wetlands in Australia (DIWA) sites (Figure 3-3). Judbarra National Park is the second-largest national park in the NT, covering approximately 1,300,000 ha (Department of Climate Change, Energy, the Environment and Water, 2022b). It is popular for tourism, showcasing gorges, escarpment country and sandstone formations, boab trees and fishing. Once fully gazetted, the Keep River National Park will cover a total area of approximately 272,000 ha. This area includes the proposed extension of an additional 215,000 ha (from the neighbouring catchment of the Keep River into the Victoria catchment), which is intended to be gazetted by 2026 (Department of Climate Change, Energy, the Environment and Water, 2022b; Department of Environment Parks and Water Security, 2023). The Wardaman Indigenous Protected Area extends across the northern Victoria catchment and beyond and covers a total area of approximately 225,000 ha (Department of Climate Change, Energy, the Environment and Water, 2022b), while the Northern Tanami Indigenous Protected Area abuts the southern boundary of the Victoria catchment with only a minimal portion within the Victoria catchment. The Joseph Bonaparte Gulf Marine Park is a Commonwealth marine park of approximately 860,000 ha and depths of 15 to 100 m (Department of Climate Change, Energy, the Environment and Water, 2022a). This marine park straddles the offshore portion of the Victoria catchment marine region and has tides up to 7 m. It is home to the Australian snubfin dolphin (*Orcaella heinsohni*) (Department of Agriculture, Water and the Environment, 2021a; Parks Australia, 2023). The eastern edge of the North Kimberley Marine Park (WA) is adjacent to the Joseph Boneparte Gulf Marine Park and follows the WA coastline to the WA–NT border.

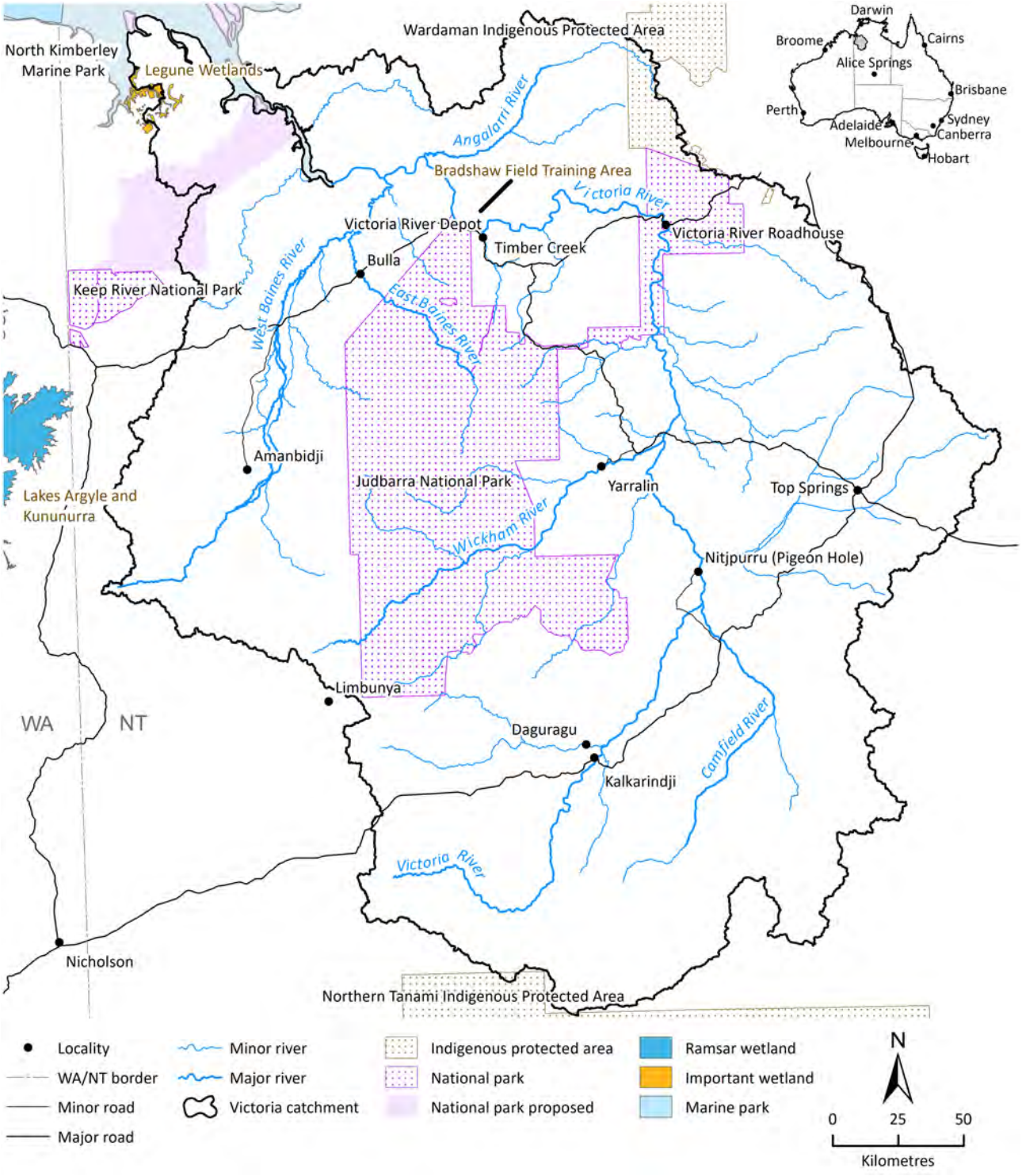

Figure 3-3 Location of protected areas and important wetlands within the Victoria catchment Assessment area

Protected areas include areas managed mainly for conservation through management intervention as defined by the International Union for Conservation of Nature (IUCN).

Data sources: Department of Agriculture, Water and the Environment (2020a); Department of Agriculture, Water and the Environment (2020b); Department of Agriculture, Water and the Environment (2021b); Department of Climate Change, Energy, the Environment and Water (2024)

The two DIWA sites are the Bradshaw Field Training Area and the Legune Wetlands (Figure 3-3). The Bradshaw Field Training Area is a military training area between the Victoria River and the Angalarri River in the northern part of the catchment. The Legune Wetlands span the border of the Victoria and Keep catchments adjacent to the upper estuary and salt flats of the Keep River. These two DIWA wetlands highlight the diversity of aquatic habitats that can be found within the Victoria catchment. The Victoria catchment contains no Ramsar sites, but the neighbouring catchment of the Ord River contains two: the Lakes Argyle and Kununurra Wetlands and the Ord River Floodplain.

The Bradshaw Field Training Area DIWA site lies north of the Victoria River near Timber Creek. It is bound by the Fitzmaurice River to the north and the Victoria River to the south. The site covers approximately 871,000 ha and includes two wetland complexes within the Victoria Bonaparte biogeographic region (Department of Agriculture, Water and the Environment, 2023a). Large areas of the wetlands are inundated each wet season by floods from both the Fitzmaurice and Victoria rivers, with flooding enhanced during coincidence with high tides. Some areas of the site retain permanent water during the dry season (Department of Agriculture, Water and the Environment, 2023a). The Bradshaw field training wetland site has very high species richness and wilderness value and includes areas of monsoon vine forest; it forms an important component of the conservation network within the Victoria catchment (Department of Agriculture, Water and the Environment, 2023a; Department of Climate Change, Energy, the Environment and Water, undated; NT Department of Lands, Planning and Environment, 1998). The Bradshaw Defence Area is also listed on the Australian Heritage Database for its rich vertebrate fauna. It has nationally significant species richness of mammals, reptiles and frogs, and it is considered a stronghold for species that have recorded declines in other locations, including the Gouldian finch (*Erythrura gouldiae*), the northern quoll (*Dasyurus hallucatus*) and the pale field rat (*Rattus tunneyi*). Over 850 flora species and 375 fauna species (comprising 22 frog, 77 reptile, 212 bird, 50 mammal and 26 fish species) are known to occur in the Bradshaw Defence Area (Department of Climate Change, Energy, the Environment and Water, undated).

The Legune Wetlands straddles the Keep and Victoria catchments, receiving inflows from surface water from local creeks and some additional inflows in wet years from major floods in the Keep River (Department of Agriculture, Water and the Environment, 2023b). The wetlands include areas identified as an Important Bird and Biodiversity Area (IBA) by BirdLife International, with surveys recording more than 15,000 individuals from over 45 species, including magpie goose (*Anseranas semipalmata*), brolga (*Antigone rubicunda*) and red-capped plover (*Charadrius ruficapillus*) (BirdLife International, 2023; Department of Agriculture, Water and the Environment, 2023b). Habitats of importance include seasonal marshes and swamps, freshwater mangroves, mudflats and salt flats, and the site provides important dry-season habitat for waterbirds (BirdLife International, 2023; Department of Agriculture, Water and the Environment, 2023b).

Important habitat types and values of the Victoria catchment

The freshwater sections of the Victoria catchment include diverse habitats such as perennial and intermittent rivers, anabranches, wetlands, floodplains and groundwater-dependent ecosystems (GDEs). The diversity and complexity of habitats, and the connections between habitats within a catchment, are vital for providing the range of habitats needed to support both aquatic and terrestrial biota (Schofield et al., 2018).

In the wet season, flooding connects rivers to floodplains. This water exchange means that floodplain habitats support higher levels of primary and secondary productivity than surrounding areas that are less frequently inundated (Pettit et al., 2011). Infiltration of water into the soil during the wet season and along persistent streams often enables riparian habitats to form an important interface between the aquatic and terrestrial environments. While riparian habitats often occupy a relatively small proportion of the catchment, they frequently have a higher species richness and abundance of individuals than surrounding habitats (Pettit et al., 2011; Xiang et al., 2016). Riparian habitats that fringe the rivers and streams of the Victoria catchment have been rated as having moderate to high cover and structural diversity for riparian vegetation (Kirby and Faulks, 2004). These riparian habitats include widespread *Eucalyptus camaldulensis* overstorey with *Lophostemon grandiflorus*, *Terminalia platyphylla*, *Pandanus aquaticus* and *Ficus* spp. *Acacia holosericea* and *Eriachne festucacea* occur as dominant understorey species across many parts of the catchment (Kirby and Faulks, 2004). Further away from the creeks and rivers, vegetation in the Victoria catchment becomes sparser.

In the dry season, biodiversity is supported within perennial rivers, wetlands and the inchannel waterholes that persist in the landscape. In ephemeral rivers, the waterholes that remain become increasingly important as the dry season progresses; they provide important refuge habitat for species and enable recolonisation into surrounding habitats upon the return of larger flows (Hermoso et al., 2013). Persistent waterholes provide habitat for water-dependent species, including fish, sawfishes and reptiles such as freshwater turtles and crocodiles, as well as providing a source of water for other species more broadly within the landscape (McJannet et al., 2014; Waltham et al., 2013).

GDEs occur across many parts of the Victoria catchment and come in different forms, including aquatic, terrestrial and subterranean habitats. Aquatic GDEs contain springs and river sections that hold water throughout most dry seasons due to groundwater discharge. Aquatic GDEs are important for supporting aquatic life and fringing vegetation, and in the wet-dry tropics they can provide critical refuge during periods of the late dry season (James et al., 2013). Vegetation occurring adjacent to the waterways in the Victoria catchment relies on water from a range of sources (surface water, soil water, groundwater) which are seasonally dynamic and highly spatially variable across riparian and floodplain habitats. Perennial floodplain vegetation often uses groundwater when it is within reach of the root network, particularly during the dry season or drought, but the origin of the groundwater used has only been infrequently investigated (e.g. Canham et al. (2021)). In some locations, vegetation may be sustained by water available in soils and so never use groundwater. In other locations, vegetation may use groundwater sourced from local alluvial recharge processes; alternatively, regional groundwater may be critical for maintaining vegetation condition. The latter situation applies to habitats of monsoon vine forest located within the Bradshaw Field Training Area DIWA site (NT Department of Lands, Planning and Environment, 1998). Subterranean aquatic ecosystems in the Victoria catchment include known sinkholes associated with the Montejinni Limestone that are mapped along the south-eastern edge of the Victoria catchment. These sinkholes may contain groundwater and support aquatic ecosystems throughout the dry season, but their connection to groundwater is currently unknown. Some subterranean species are distributed across a broad spatial range, while others have highly restricted ranges, which makes them more vulnerable to local changes where they occur (Oberprieler et al., 2021).

Marine and estuarine habitats in northern Australia are highly productive and have high environmental and cultural value. They include some of the most important, extensive and intact habitats of their type in Australia, many of which are recognised as being of national significance. The mouth and estuary of the Victoria River is up to 25 km wide and includes extensive mudflats and mangrove stands (Kirby and Faulks, 2004). Although mangroves and mudflats are prominent along coastal margins (Department of Climate Change, Energy, the Environment and Water, undated), the mangrove communities along the estuary are recognised as being low in species richness with about ten species recorded. Of these, the dominant mangrove species in the catchment is *Avicennia marina*, which is largely confined to the estuary (Kirby and Faulks, 2004). The Legune IBA extends along the south-west shores of the inner Joseph Bonaparte Gulf, from the mouth of the Keep River in the west to the mouth of the Victoria River in the east and then north beyond the Victoria catchment. The Legune IBA can support over 15,000 waterbirds across mudflats, salt flats and seasonally inundated wetlands (BirdLife International, 2023). Marine habitats in northern Australia are vital for supporting important fisheries, including banana prawn, mud crabs and barramundi, as well as for biodiversity more generally, including waterbirds, marine mammals and turtles. In addition, the natural waterways of the sparsely populated catchments support globally significant stronghold populations of endangered and endemic species (e.g. sharks and rays) that often use a combination of marine and freshwater habitats.

Significant species and ecological communities of the Victoria catchment

The aquatic habitats of the Victoria catchment support some of northern Australia's most archetypical and important wildlife species, including sawfishes, marine turtles, Australian snubfin dolphins and river sharks (Department of Agriculture, Water and the Environment, 2021a) that occur in the estuaries of the Victoria River and the coastal waters of the Joseph Boneparte Gulf. Recent surveys show the river to be a globally significant stronghold for three endangered species: freshwater sawfish (*Pristis pristis*; listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Critically endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species); speartooth shark (*Glyphis glyphis*; Critically endangered, EPBC Act and IUCN); and northern river shark (*Glyphis garricki*; Endangered, EPBC Act and IUCN). The speartooth shark is not among the species listed as Critically endangered in the catchment in Commonwealth's Protected Matters Search Tool (PMST), but recent surveys have identified the species in the estuarine habitats of the Victoria River (Dr Richard Pillans (CSIRO Environment, Brisbane), 2022, pers. comm.). Saltwater crocodiles (*Crocodylus porosus*) frequent the Victoria River and have been recorded considerable distances into freshwater reaches (Atlas of Living Australia, 2023).

Across the catchment are many lesser-known plants and animals that are also of great importance. Owing to healthy floodplain ecosystems and free-flowing rivers (Grill et al., 2019; Pettit et al., 2017), very few freshwater fish in the study area are threatened with extinction. Many of these fish species do not enter the marine environment, remaining within the riverine and wetland habitats of the catchment. Although habitats of the Victoria catchment have low levels of endemism (possibly due to the catchment forming a gradient between the biota of the Kimberley and the Top End) (Department of Climate Change, Energy, the Environment and Water, undated), Neil's grunter (*Scortum neili*) is endemic to the Victoria catchment and is listed as Endangered by the IUCN. Neil's grunter is restricted to sections of the East Baines and Angalarri rivers where it

inhabits narrow, deep sections of the river that have slow-flowing fresh water shaded by overhanging trees (Gomon and Bray, 2017). Species including the eastern curlew (*Numenius madagascariensis*; Critically endangered, EPBC Act), curlew sandpiper (*Calidris ferruginea*; Critically endangered, EPBC Act) and red knot (*Calidris canutus*; Endangered, EPBC Act) use habitats including the Legune Wetlands IBA as important stopover habitat (Department of Agriculture, Water and the Environment, 2023b). The night parrot (*Pezoporus occidentalis*; Endangered, EPBC Act; Critically endangered, IUCN) has been recorded in sandstone/spinifex country in the region of the nearby Keep River National Park (Department of Agriculture, Water and the Environment, 2021a; McKean, 1985). The purple-crowned fairy-wren (*Malurus coronatus*; Endangered, EPBC Act) and Gouldian finch (*E. gouldiae*; Endangered, EPBC Act) are also recorded as occurring within the catchment (Atlas of Living Australia, 2023; Department of Agriculture, Water and the Environment, 2021a).

3.2.1 Current condition and potential threats in the Victoria catchment

Land use practices and ecology

A range of economic enterprises, infrastructure and other human impacts occur in the Victoria catchment. The nature and extent to which human activities have modified the habitats and affected species of the Victoria catchment varies, but most sites have some level of impact (Kirby and Faulks, 2004). Previous assessments have rated the riverine habitat in the Victoria catchment as being of high or very high overall quality and largely intact with high wilderness value and predominantly unaffected by clearing or development at the time of assessment, although threatening processes operate. These include grazing, roads, river crossings and impacts from pest species, including both feral animals and weeds (Department of Agriculture, Water and the Environment, 2023a; Kirby and Faulks, 2004).

The study area includes the localities and towns of Timber Creek, Yarralin, Nitjpurru (Pigeon Hole), Top Springs, Kalkarindji and Daguragu, which provide Indigenous homelands, support a vital tourism industry and act as regional hubs for many of the stations across the catchment. While a moderate proportion of the catchment is under conservation reserves, the catchment does face environmental threats. Fishing in northern Australia is highly valuable, and the waters of the Victoria catchment and the nearby marine zone contribute to important recreational, commercial and Indigenous catches, including barramundi, redleg banana prawns (*Penaeus indicus*) and a variety of other species.

Northern Australia more broadly encompasses some of the last relatively undisturbed tropical riverine landscapes in the world with low levels of flow regulation and low development intensity (Pettit et al., 2017; Vörösmarty et al., 2010). Riparian vegetation characteristics of the Victoria catchment are considered not to be affected by extensive clearing or development, although impact that occurs is often associated with stock and pest species accessing watering points (Kirby and Faulks, 2004).

One of the most significant environmental threats to remote regions across northern Australia is that of introduced plants and animals. In the Victoria catchment, pig (*Sus scrofa*), water buffalo (*Bubalus bubalis*), camel (*Camelus dromedarius*), donkey (*Equus asinus*), cat (*Felis catus*) and cane toad (*Rhinella marina*) are among the invasive animals (Atlas of Living Australia, 2023; (Department of Agriculture, Water and the Environment, 2021a). Weed species of interest in and

around the Victoria catchment include 20 species of national significance. Invasive plants of concern include gamba grass (*Andropogon gayanus*), para grass (*Brachiaria mutica*), giant sensitive plant (*Mimosa pigra*) and prickly acacia (*Vachellia nilotica*) (Department of Agriculture, Water and the Environment, 2021a). Some of these, including sensitive tree and para grass, have significantly affected undeveloped rivers more broadly in northern Australia (Davies et al., 2008). Surveys within the Bradshaw Field Training Area indicated the presence of six feral species, namely, cats, horses, donkeys, pigs, wild cattle and buffalo (NT Department of Lands, Planning and Environment, 1998). eDNA analysis of water samples taken in this study detected cane toads, wild pig, cattle and dingo (*Canis familiaris*) at several sites (Stratford et al., 2024). Further details on biosecurity are provided in Section 7.

Water resource development and ecological changes

The importance of the natural flow regime for supporting environmental function has become increasingly well understood, as has the importance of rivers operating as systems, including the connection of floodplains via inundation, the distribution of refuges, and discharges into coastal regions. Globally, water resource development has a range of known impacts on ecological systems. The influence of each of these impacts depends upon a range of factors, including catchment properties (e.g. physical, geographic and climate characteristics), the kind of development (e.g. dams, water harvesting, groundwater development), the source location or distribution of the developments within the catchment, the magnitude and pattern of change, how any changes may be managed or mitigated, and the habitats and species that will be affected and their distribution.

Impacts associated with water resource development include the following, which are described below:

- flow regime change
- altered longitudinal and lateral connectivity
- habitat modification and loss
- increased invasive and non-native species
- synergistic and co-occurring processes both local and global.

Flow regime change

Water resource development including water harvesting and creating instream structures for water retention can influence the timing, quality and quantity of water that is provided by catchment runoff into the river system. The natural flow regime (including the magnitude, duration, timing, frequency and pattern of flow events) is important in supporting a broad range of environmental processes upon which species and habitat condition depend (Lear et al., 2019; Poff et al., 1997). Flow conditions provide the physical habitat in streams and rivers which determines biotic use and composition and to which life-history strategies are adapted. Flow enables movement and migration between habitats and exchange of nutrients and materials (Bunn and Arthington, 2002; Jardine et al., 2015). In a river system, the natural periods of both low and high flow (including no-flow events) are important to support the natural function of habitats, their ecological processes and the shaping of biotic communities (King et al., 2015). Through the attenuation of flows, water resource development can lead to impacts significant distances

downstream of the development, including into coastal and near-shore marine habitats (Broadley et al., 2020; Pollino et al., 2018).

Altered longitudinal and lateral connectivity

River flow facilitates the exchange of biota, materials, nutrients and carbon along the river and into the coastal areas (longitudinal connectivity), as well as between the river and the floodplain (lateral connectivity) (Pettit et al., 2017; Warfe et al., 2011). Physical barriers such as weirs, dams and causeways and road crossings, or a reduction in the magnitude of flows (and the duration or frequency), can affect longitudinal and lateral connectivity, changing the rate or timing of exchanges (Crook et al., 2015). These impacts can include changes in species' migration and movement patterns as well as altered erosion processes and discharges of nutrients into rivers and coastal waters (Brodie and Mitchell, 2005). Seasonal patterns and rates of connection and disconnection caused by flood pulses are important for providing seasonal habitat and enabling movement of biota into new habitats and their return to refuge habitats after larger river flows (Crook et al., 2020).

Habitat modification and loss

Water resource development can cause direct loss of habitat. For example, artificially creating a lake (inundated) habitat behind an impoundment results in loss of terrestrial and stream habitat. Agricultural development converts existing habitat to more-intensive agriculture. Infrastructure, including roads, can fragment terrestrial habitat, while streams and canals can artificially connect aquatic habitats that had been historically separated.

Increased invasive and non-native species

Water resource development often homogenises flow and flow-related habitats, for example, through changed patterns of capture and release of flows or creation of impoundments for storage and regulation. Invasive species are often at an advantage in such modified habitats (Bunn and Arthington, 2002). Modified landscapes, such as lakes or homogenised perennial streams that were previously ephemeral, can be a pathway for the introduction of, and support the incidental, accidental or deliberate establishment of, non-native species, including pest plants and fish (Bunn and Arthington, 2002; Close et al., 2012; Ebner et al., 2020). Increased human activity can increase the risk of invasive species being introduced.

Synergistic and co-occurring processes both local and global

Along with water resource development comes a range of other pressures and threats, including increases in fishing; vehicles; habitat fragmentation; pesticides, fertilisers and other chemicals; erosion; degradation due to increased stock pressure; and changed fire regimes, climate change and other human disturbances, both direct and indirect. Some of these pressures are the direct result of changes in land use associated with or accompanying water resource development. Other pressures may occur locally, regionally or globally and act synergistically with water resource development and agricultural development to increase the risk to species and their habitats (Craig et al., 2017; Pettit et al., 2012).

To describe the ecology of the Victoria catchment and discuss the likely impacts of future water resource development on this system, a suite of ecological assets has been selected (Table 3-1). Assets are classified as species, species groups or habitats. They can be considered either partially

or fully dependent on fresh water, or terrestrial or marine dependent upon freshwater flows (or services provided by freshwater flows). This chapter considers a key subset of assets, as listed in Table 3-1. More information on the ecological assets of the Victoria catchment and their distribution is available in the companion technical report on ecological assets (Stratford et al., 2024). Chapter 7 presents results of the modelling and analysis to explore the potential of change to these assets as a consequence of water resource development.

Table 3-1 Freshwater, marine and terrestrial ecological assets with freshwater flow dependences

An asterisk (*) denotes an asset outlined in this report. All listed species, species groups and habitat assets are detailed in the companion technical report on ecological assets (Stratford et al., 2024).

ASSET GROUP	ASSET	SYSTEMS
Fish, sharks and rays	Barramundi (*Lates calcarifer*)*	Freshwater and marine
	Catfish (order Siluriformes)	Freshwater
	Grunters (family Terapontidae)*	Freshwater
	Mullet (family Mugilidae)	Freshwater and marine
	River sharks (*Glyphis* spp.)*	Freshwater and marine
	Sawfishes (*Pristis* and *Anoxypristis* spp.)	Freshwater and marine
	Threadfin (*Polydactylus macrochir*)	Marine
Waterbirds	Colonial and semi-colonial nesting wading waterbirds	Freshwater
	Cryptic wading waterbirds	Freshwater
	Shorebirds*	Freshwater and marine
	Swimming, grazing and diving waterbirds	Freshwater
Turtles, prawns and other species	Banana prawns (*Penaeus indicus*)	Marine
	Freshwater turtles (family Chelidae)	Freshwater
	Mud crabs (*Scylla serrata*)	Marine
Flow-dependent habitats	Floodplain wetlands	Freshwater
	Groundwater-dependent ecosystems	Freshwater and terrestrial
	Inchannel waterholes	Freshwater
	Mangroves*	Marine
	Saltpans and salt flats	Marine
	Surface water–dependent vegetation	Freshwater and terrestrial

3.2.2 Ecological assets from the Victoria catchment

Northern Australia's rivers, floodplains and coastal regions contain high diversity, including at least 170 fish species, 150 waterbird species, 30 aquatic and semi-aquatic reptiles, 60 amphibian species and 100 macroinvertebrate families (van Dam et al., 2008). The ecologies of the freshwater and fresh water–dependent terrestrial and marine systems are supported by, and adapted to, the highly seasonal flow regimes of the wet-dry tropics. Water resource development and climate change threaten to affect these habitats and species. This section provides a synthesis of the prioritised assets relevant to the Victoria catchment for the purpose of understanding the ecological outcomes of flow regime change. Table 3-2 lists the ecological assets used.

Barramundi (*Lates calcarifer*)

Barramundi are a large (>1 m standard length) opportunistic-predatory fish (order Perciformes) that occurs throughout northern Australia. The species is catadromous (i.e. it migrates down rivers to spawn in the sea) and occurs in 'catchment to coast' habitats throughout the west Indo-Pacific region, including estuaries, rivers, lagoons and wetlands across northern Australia (Crook et al., 2016; Pender and Griffin, 1996; Roberts et al., 2024; Russell and Garrett, 1983, 1985). The fish is long lived (living up to about 32 years) and fast growing. Individuals begin life as a male but change to female as they age (protandrous hermaphrodite). They occupy freshwater habitats as males in the first years of life and saltwater habitats as older females. The species is of ecological importance, capable of modifying the estuarine and riverine fish and crustacean communities (Blaber et al., 1989; Brewer et al., 1995; Milton et al., 2005; Russell and Garrett, 1985).

Barramundi is arguably the most important fish species for commercial, recreational and Indigenous subsistence fisheries throughout Australia's wet-dry tropics. It makes up a substantial component of the total commercial fish catch in northern Australia (Savage and Hobsbawn, 2015). In 2013–14, barramundi comprised 28% of the $31 million wild-caught fishery production in the NT. Commercial and recreational catches make up the largest proportions of all catches in the NT, though the Indigenous catch is not well documented and may be significant in some locations.

Barramundi is a fish of cultural significance for Indigenous communities as well as being an important food source (Jackson S et al., 2012). The movements of barramundi between habitats are indicators of the change in season for Indigenous communities across tropical Australia (Green et al., 2010). The movements relate to the barramundi's habitat requirements during its life cycle, which rely on seasonal variation in river flows to access habitats.

Barramundi life history renders the species critically dependent on river flows (Plagányi et al., 2023; Tanimoto et al., 2012). Large females (older fish) and smaller males (younger fish) reside in estuarine and littoral coastal habitats. Mating and spawning occur in the lower estuary during the late dry season to early wet season, and new recruits move into supra-littoral and freshwater habitats. Coastal salt flat, floodplain and palustrine (i.e. non-tidal wetland) habitats depend on overbank flows for maintenance and connectivity (Crook et al., 2016; Russell and Garrett, 1983, 1985).

Barramundi are abundant in the relatively pristine habitats of the estuarine and freshwater reaches of the Victoria River. However, there are few data on recreational or commercial catch or the presence or absence of barramundi in the Victoria catchment. The Victoria River currently experiences low levels of commercial fishing for barramundi, but barramundi are common in the river estuary, and commercial interest in fishing the river is increasing (Thor Saunders (NT Fisheries Research), 2022, pers. comm.). A large tidal range and strong currents within the estuary are deterrents to successful commercial fishing (Thor Saunders (NT Fisheries Research), 2022, pers. comm). The modelled distribution of barramundi showing the probability of occurrence is shown in Figure 3-4.

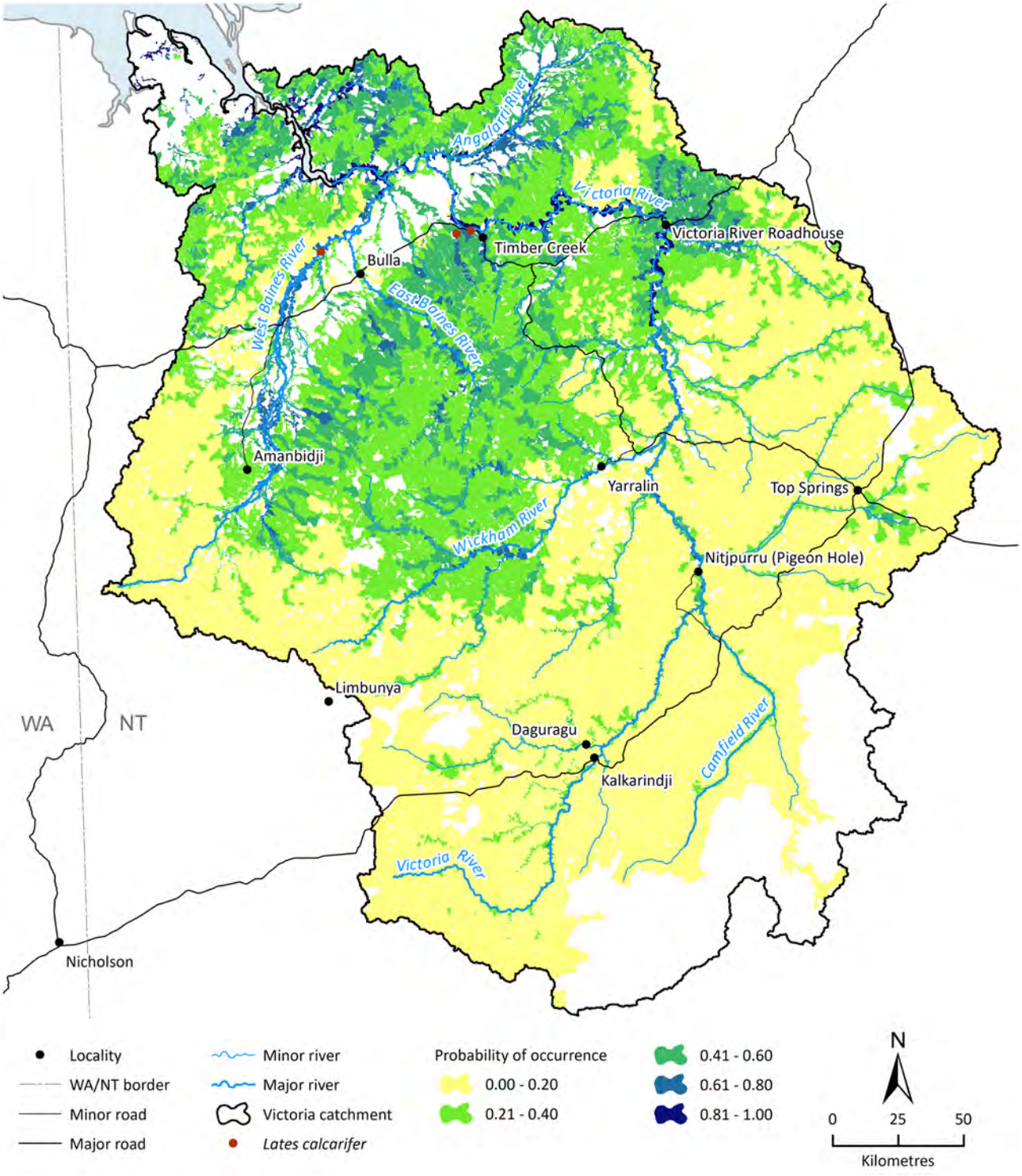

Figure 3-4 Observed locations of barramundi (*Lates calcarifer*) and its modelled probability of occurrence in the Victoria catchment

Probability of occurrence is based upon a general linear model with model predictors. For the species distribution models, only records later than 1960 that intersected with polygons that contain waterways and that had a stated coordinate uncertainty less than 5 km were used. Red points show locations from Atlas of Living Australia.

Data source: Atlas of Living Australia (2023)

Grunters

Northern Australia has 37 species of grunter from 11 genera, with the most species-rich genera being *Hephaestus*, *Scortum*, *Syncomistes* and *Terapon*. Grunters inhabit riverine, estuarine and marine waters. Many grunter species spend their entire lives in fresh water, while other species inhabit marine or estuarine waters, only sometimes venturing into fresh water (Pusey et al., 2004).

One of the most widespread species across northern Australia is the sooty grunter (*Hephaestus fuliginosus*). Sooty grunters are omnivorous and eat a diverse diet, including terrestrial insects and vegetation, fish, aquatic insect larvae, macrocrustacea (shrimps and prawns) and aquatic vegetation. Sooty grunters switch diet from being insectivorous while juvenile to being top-level predators as adults, often feeding on smaller fish as well as juvenile grunters. Juvenile grunters are often associated with flowing water, suggesting that water resource development that reduces or ceases flow could pose a threat. Tree root masses and undercut banks are also important microhabitat, especially for adult fish (Pusey et al., 2004). Grunters prefer medium to high oxygen levels as well as medium to low salinity (Hogan and Nicholson, 1987). Grunters will move out of the dry-season refugial habitats and into ephemeral wet-season habitats for spawning (Bishop et al., 1990).

The sooty grunter is an important recreational species, and in some of their range environmental flow is managed to maintain suitable habitat conditions (Chan et al., 2012). Because grunters are omnivorous and able to integrate many sources of food, as well as having a high total biomass, they are an important link in the overall food chain. They link lower trophic levels with top-level predators, such as long tom (*Strongylura krefftii*) and crocodiles. Grunters are also important species for Indigenous Peoples in northern Australia, both culturally (Finn and Jackson, 2011; Jackson et al., 2011) and as a food source (Naughton et al., 1986).

The composition of grunters in the Victoria catchment is slightly different to that in catchments that drain into the Gulf of Carpentaria. In addition to the widespread spangled grunter (*Leiopotherapon unicolor*) and barred grunter (*Amniataba percoides*), in the Victoria catchment, the western sooty grunter (*Hephaestus jenkinsi*) replaces the eastern species *H. fuliginosus.* Less-abundant species include the sharpnose grunter (*Syncomistes butleri*), Drysdale grunter (*Syncomistes rastellus*) and Neil's grunter (*Scortum neili*). Of these grunters, the western sooty grunter is the key species for recreational and cultural purposes (Chan et al., 2012). Grunters are likely widespread in the Victoria River, whose headwaters are spawning and nursery grounds for larger species as well as habitat for adults of the smaller species (e.g. spangled grunter). Waterholes on the main stem provide habitat for adult grunters.

Neil's grunter is of particular interest in the catchment as it is endemic to the Victoria catchment and is listed as Endangered on the IUCN Red List of Threatened Species. Adults occur in small, well-shaded, slow-flowing streams with mixed sand, silt and rock bottoms, and also in deeper rocky pools in gorges. Preferred water conditions are typically fresh and clear, between 21 and 28 °C, with a neutral or slightly basic pH. Occurrences of grunter species in the Victoria catchment are shown in Figure 3-5. The modelled probability of occurrence of spangled grunter (*Leiopotherapon unicolor*) is shown in Stratford et al. (2024).

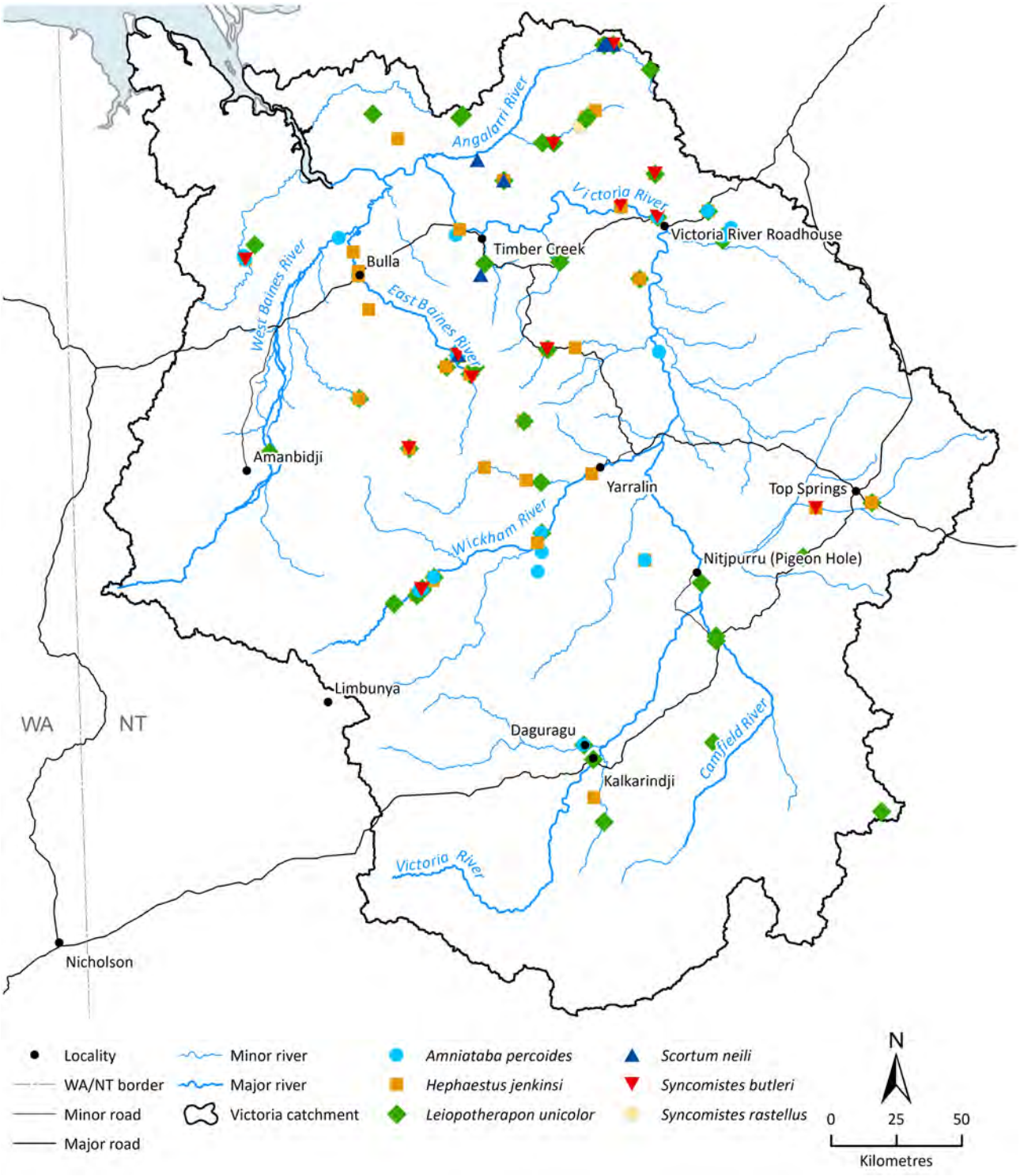

Figure 3-5 Observed locations of grunters in the Victoria catchment

Data source: Atlas of Living Australia (2023)

River sharks

River sharks is the generic term given to species of the genus *Glyphis*, found in the Indo-West Pacific, each of which is endangered or critically endangered (Last and Stevens, 2008; Morgan, 2011; Stevens et al., 2009). Two *Glyphis* species are found in Australian waters: the speartooth shark (*Glyphis glyphis*; Critically endangered, EPBC Act and IUCN) and the northern river shark (*Glyphis garricki*; Endangered, EPBC Act and IUCN). The speartooth shark occurs across Cape York, the north-west coast of the Top End, inshore Joseph Bonaparte Gulf and the southern coast of

Papua New Guinea (Pillans et al., 2009; White et al., 2015). The northern river shark occurs across the Kimberley and the Top End coast, as well as the Fly River, Papua New Guinea (Pillans et al., 2009; West et al., 2021; White et al., 2015). Tropical Australia and Papua New Guinea probably represent the last viable populations of the speartooth shark and the northern river shark across their global ranges (Pillans, 2014; Pillans et al., 2022).

River sharks are poorly studied, though studies of their population structure, niche partitioning, and estuarine habitat and prey have been undertaken in the past 5 years (Dwyer et al., 2019; Every et al., 2019; Feutry et al., 2020). Within large tropical river systems, the speartooth shark uses the mangrove-fringed upstream portions of the estuary and the riverine habitats where the estuary blends to become the river as its primary habitat (indicative habitat salinity is 1 to 28 parts per thousand (ppt) in the NT and 3 to 26 ppt in western Cape York, Queensland) (Dwyer et al., 2019; Pillans, 2014; Pillans et al., 2009). It has an ontogenetic shift in habitat preference: juveniles use the upper-estuarine and lower-freshwater reaches of rivers (up to 100 km upstream) and adults use estuarine environments (Pillans et al., 2009).

The northern river shark has been found in Cambridge Gulf and the Daly River, respectively west and east of the Victoria River. The species uses estuarine and freshwater habitats, but is more marine in habit than the speartooth shark. The northern river shark uses rivers (salinity 2 ppt), large tropical estuarine systems (salinity 7 to 21 ppt), macrotidal embayments and inshore and offshore marine habitats (salinity 32 to 36 ppt) (Pillans et al., 2009). It is thought adults use only marine environments and may be found outside estuaries. The northern river shark likely pups prior to the annual wet season with a litter size around nine. Neonates and juveniles are found in freshwater, estuarine and marine habitats, though capture locations indicate a preference for highly turbid, tidally influenced waters over muddy substrate (Stevens et al., 2005). No *Glyphis* species have been found in isolated freshwater habitats such as billabongs or refuge waterholes in river channels (Stevens et al., 2005).

Published data on the distribution of river sharks in the Victoria River are scant. Records for northern river shark exist for Cambridge Gulf and Daly River. No published records of speartooth shark exist for regions in the Joseph Bonaparte Gulf littoral or estuarine habitats. However, Dr Richard Pillans conducted surveys of freshwater elasmobranchs in the Victoria River in 2018 and 2019 and recorded both speartooth and northern river sharks in brackish-water reaches of the river (Dr Richard Pillans (CSIRO Environment, Brisbane), 2022, pers. comm.). These surveys were conducted as part of the Ord River Offset program, which inventories natural resources in the vicinity of expanded Ord River irrigation agriculture.

Dr Pillans caught three speartooth sharks and eight northern river sharks in the Victoria River upper estuary, from about 80 to 120 km upstream from Entrance Island. These new records of the presence of the two species in the Victoria River exemplify the paucity of biological data from remote tropical Australia.

Shorebirds

The shorebirds group consists of waterbirds with a high level of dependence on large inland flood events and end-of-system flows that provide broad areas of shallow water and mudflat environments. Flood events trigger production of significant food resources for these species – resources that are critical for fuelling long-distance migrations. Shorebirds generally eat fish or

invertebrates. Most species walk and wade when foraging, probing sediment, rocks or vegetation for prey (Garnett et al., 2015; Marchant and Higgins, 1990).

Shorebirds are largely migratory, mostly breeding in the northern hemisphere. They are in significant decline and are of international concern. Shorebirds depend on specific shallow-water habitats in distinct geographic areas, including northern hemisphere breeding grounds, southern hemisphere non-breeding grounds and stopover sites along migration routes such as the East Asian-Australasian Flyway (Bamford, 1992; Hansen et al., 2016). As the group is of international concern, various management and conservation strategies have been implemented (Department of Agriculture, Water and the Environment, 2021c), including bilateral migratory bird agreements with China (CAMBA), Japan (JAMBA), and Korea (ROKAMBA), the Bonn Convention on the Conservation of Migratory Species of Wild Animals (Bonn), and the Ramsar Convention on Wetlands of International Importance.

In northern Australia, this group comprises approximately 55 species from four families, including sandpipers, godwits, curlew, stints, plovers, dotterel, lapwings and pratincoles. Details are provided in the companion technical report on ecological assets (Stratford et al., 2024). Approximately 35 species are common, regular visitors or residents. Several species in this group are endangered globally and nationally, including the bar-tailed godwit (*Limosa lapponica*), curlew sandpiper, eastern curlew, great knot (*Calidris tenuirostris*), lesser sand plover (*Charadrius mongolus*) and red knot.

The eastern curlew is listed as Critically endangered under the EPBC Act and recognised through multiple international agreements as requiring habitat protection in Australia. Eastern curlews rely on food sources along shorelines, mudflats and rocky inlets, as well as roosting vegetation. Developments and disturbances, such as recreational, residential and industrial use of these habitats, have restricted habitat and food availability for the eastern curlew, contributing to population declines. The red-capped plover (Figure 3-6) is a shorebird that breeds in Australia rather than in the northern hemisphere. It is a small species that is widespread and common both inland and along the coast. It prefers open flat sediment areas such as mudflats and beaches for foraging and eats a range of small invertebrates, including crustaceans. It breeds in response to flooding or rain inland, and seasonally on the coast.

Figure 3-6 Red-capped plover walking along a shore

Photo: CSIRO

Mangroves

Mangroves are a group of woody plant species, ranging from shrub to large tree to forest, that are highly specialised to deal with daily variation in their niche within the intertidal and near-supra-littoral zones along tidal creeks, estuaries and coastlines (Duke et al., 2019; Friess et al., 2020; Layman, 2007). Their occurrence is a result of changes across temporal scales – from twice-daily tides to seasonal and annual cycles; mangroves have acclimatised to variable inundation, changing salinity, anoxic sediments, drought and floods, and sea-level change. Mangrove forests provide a complex habitat that offers a home to many marine species, including molluscs (McClenachan et al., 2021), crustaceans (Guest et al., 2006; Thimdee et al., 2001), birds (Mohd-Azlan et al., 2012), reptiles (Fukuda and Cuff, 2013) and numerous fish species. During periods of inundation at high tide, fish and crustaceans access mangrove forests for shelter against predation. Fish and crustaceans use mangroves as refugia during larval phases and settle there as benthic juveniles (Meynecke et al., 2010) or access them for food (Layman, 2007; Skilleter et al., 2005). Mangrove forests support many of the species and groups reported as biota assets in this Assessment (see Stratford et al. (2024)), particularly fishery species such as banana prawns, barramundi, mud crabs (*Scylla serrata*), threadfin (*Polydactylus macrochir*) and mullet (Blaber et al., 1995; Brewer et al., 1995).

In addition to providing habitat, mangrove forests provide a diverse array of ecosystem services, including stabilising shoreline areas from erosion and severe weather events (Zhang et al., 2012), and they play an important role in greenhouse gas emission and carbon sequestration (Lovelock and Reef, 2020; Owers et al., 2022; Rogers et al., 2019). Mangroves continually shed leaves, branches and roots, contributing approximately 44 to 1022 g carbon per m^2 per year from leaves and 912 to 6870 g carbon per m^2 per year from roots, though these rates continue to be explored (Robertson, 1986; Robertson and Alongi, 2016). Intertidal crabs living in mangrove forests play an important role in processing and storing mangrove carbon, either through burial in their burrows or uptake directly into production. The decomposition and processing of mangrove material is important also in the cycling of nutrients. If consumed and released, these nutrients support a local food web (Abrantes et al., 2015; Guest et al., 2004), and some of the organic carbon can be transported offshore where it supports fisheries production more broadly (Connolly and Waltham, 2015; Dittmar and Lara, 2001; Lee, 1995).

3.2.3 Environmental protection

A number of aquatic and terrestrial species in the Victoria catchment are currently listed as Critically endangered, Endangered or Vulnerable under the EPBC Act and by the wildlife classification system of the NT Government, which is based on the IUCN Red List of Threatened Species. Figure 3-7 shows the locations of these significant species.

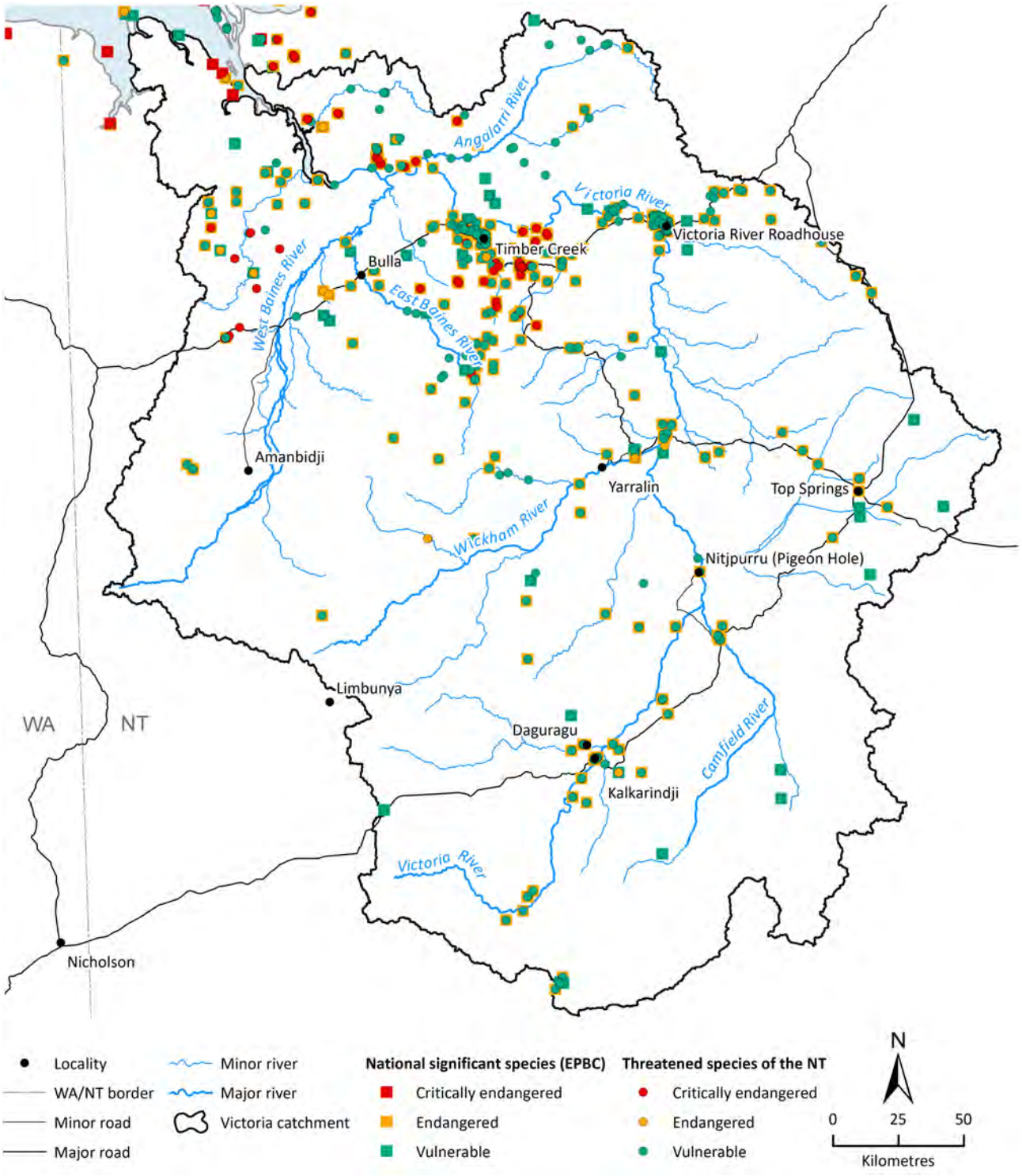

Figure 3-7 Distribution of species listed under the Environment Protection and Biodiversity Conservation Act and by the NT Government in the Victoria catchment

Datasets: Department of Environment Parks and Water Security (2019); Atlas of Living Australia (2023)

If a proposed development is predicted to have a significant impact on a matter of national environmental significance (e.g. populations of a nationally listed species, ecological communities, migratory species or wetland of importance), it requires approval to proceed under the EPBC Act (Table 3-2). This approval is required irrespective of local government policies. The Commonwealth's Protected Matters Search Tool lists 45 Threatened species for the Victoria catchment, four of which are listed as Critically endangered: Nabarlek (*Petrogale concinna*

concinna), Rosewood keeled snail (*Ordtrachia septentrionalis*), curlew sandpiper (*Calidris ferruginea*) and eastern curlew (*Numenius madagascariensis*). Also listed are 49 migratory species.

Table 3-2 Definition of threatened categories under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the NT wildlife classification system

REGULATION	CATEGORY	DEFINITION
EPBC Act	Matters of National Environmental Significance	World heritage properties, National Heritage places, wetlands of international importance (listed under the Ramsar Convention), listed threatened species and ecological communities, migratory species protected under international agreements, Commonwealth marine areas, nuclear actions (including uranium mines), and water resources, in relation to coal seam gas development and large coal mining development
	Critically endangered species	Meets any of the following criteria: It has undergone, is suspected to have undergone, or is likely to undergo in the immediate future a very severe reduction in numbers. Its geographic distribution is precarious for the survival of the species and is very restricted. The estimated total number of mature individuals is very low and evidence suggests that the number will continue to decline at a very high rate. The probability of its extinction in the wild is at least 50% in the immediate future
	Endangered species	Meets any of the following criteria: It has undergone, is suspected to have undergone, or is likely to undergo in the immediate future a severe reduction in numbers. Its geographic distribution is precarious for the survival of the species and is restricted. The estimated total number of mature individuals is low and evidence suggests that the number will continue to decline at a high rate. The probability of its extinction in the wild is at least 20% in the near future
	Vulnerable species	Meets any of the following criteria: It has undergone, is suspected to have undergone, or is likely to undergo in the immediate future a substantial reduction in numbers. Its geographic distribution is precarious for the survival of the species and is limited. The estimated total number of mature individuals is limited and evidence suggests that the number will continue to decline at a substantial rate. The probability of its extinction in the wild is at least 10% in the medium-term future
	Critically endangered ecological communities	Meets any of the following criteria: Its decline in geographic distribution is very severe. Its geographic distribution is very restricted, making it likely that a threatening process could cause its extinction in the immediate future. There is a very severe decline in the population of a native species that plays a major role in the community, making restoration of the community unlikely in the immediate future. The reduction in its integrity across most of its geographic distribution is very severe, as indicated by habitat degradation and disruption of important community processes. The rate of continuing detrimental change is very severe, with ongoing declines in geographic distribution and the population of a critical native species. The probability of extinction or extreme degradation across its entire range is at least 50% in the immediate future
	Endangered ecological communities	Meets any of the following criteria: Its decline in geographic distribution is severe. Its geographic distribution is restricted, making it likely that a threatening process could cause its extinction in the near future. There is a severe decline in the population of a native species that plays a major role in the community, making restoration of the community unlikely in the near future. The reduction in its integrity across most of its geographic distribution is severe, as indicated by habitat degradation and disruption of important community processes. The rate of continuing detrimental change is severe, with ongoing declines in geographic distribution and the population of a critical native species. The probability of extinction or extreme degradation across its entire range is at least 20% in the immediate future
	Vulnerable communities	Meets any of the following criteria: Its decline in geographic distribution is substantial. Its geographic distribution is limited, making it likely that a threatening process could cause its extinction in the medium-term future. There is a substantial decline in the population of a native species that plays a major role in the community, making restoration of the community unlikely in the medium-term future. The reduction in its integrity across most of its geographic distribution is substantial, as indicated by habitat degradation and disruption of important community processes. The rate of continuing detrimental change is serious, with ongoing declines in geographic distribution and the population of a critical native species. The probability of extinction or extreme degradation across its entire range is at least 10% in the medium-term future
NT wildlife classification†	Critically endangered	**A:** Reduction in population size of ≥80% over three generations or 10 years (whichever is longer) **B:** Geographic range of extent of occurrence <100 km² **C:** Small population size and decline (fewer than 250 mature individuals) **D:** Very small or restricted populations (fewer than 50 mature individuals) **E:** At least 50% chance of going extinct in the wild over three generations or 10 years (whichever is longer)

REGULATION	CATEGORY	DEFINITION
	Endangered	**A:** Reduction in population size of ≥50% over three generations or 10 years (whichever is longer) **B:** Geographic range of extent of occurrence <5000 km² **C:** Small population size and decline (fewer than 2500 mature individuals) **D:** Very small or restricted populations (fewer than 250 mature individuals) **E:** At least 20% chance of going extinct in the wild over five generations or 20 years (whichever is longer)
	Vulnerable	**A:** Reduction in population size of ≥30% over three generations or 10 years (whichever is longer) **B:** Geographic range of extent of occurrence <20,000 km² **C:** Small population size and decline (fewer than 10,000 mature individuals) **D:** Very small or restricted populations (fewer than 1000 mature individuals) **E:** At least 10% chance of going extinct in the wild over five generations or 100 years (whichever is longer)

†The NT wildlife classification categories are based on the IUCN Red List categories and criteria. An extract of each category is presented here. For the full definition see https://nt.gov.au/__data/assets/pdf_file/0010/192538/red-list-guidelines.pdf.

3.3 Demographic and economic profile

3.3.1 Introduction

This chapter describes the current social and economic characteristics of the Victoria catchment in terms of the demographics of local communities (Section 3.3.2), current industries and land use (Section 3.3.3), and existing infrastructure of transport networks, supply chains, utilities and community infrastructure (Section 3.3.4). Together these characteristics describe the built and human resources that would serve as the foundation upon which any new development in the Victoria catchment would be built.

Unless otherwise stated, the material in this section is based on findings described in the companion technical report on agricultural viability and socio-economics (Webster et al., 2024).

3.3.2 Demographics

The Victoria catchment lies within the NT and comprises around half of the Victoria Daly Regional Council local government area. The northern part of the catchment includes part of the NT electoral division of Daly, and the southern part of the catchment includes part of the NT electoral division of Gwoja. At the federal level, the catchment forms a part of the Division of Lingiari (which encompasses most of the NT, excluding the Division of Solomon that covers an area around Darwin).

Population density of the Victoria catchment is extremely low at one person per 51.4 km^2. This is about one-eighth of the population density of the NT and one 165th of Australia as a whole. The catchment contains no significant urban areas (population >10,000), but there are several small towns and communities including Timber Creek (the furthest north in the catchment), Yarralin, Nitjpurru (Pigeon Hole), Amanbidji, Bulla, Daguragu and Kalkarindji (the furthest south). The largest of these settlements is Kalkarindji (population of 383 as at the 2021 Census). Katherine (population 5980 in 2021) is the closest urban service centre in the NT and is located north-east of the catchment approximately 290 km from Timber Creek. The nearest major city and population centre is the NT capital of Darwin (population of the Greater Darwin area was 139,902 in 2021) approximately 600 km from Timber Creek. The demographic profile of the catchment, based on

data from the 2021, 2016, 2011 and 2006 censuses, is shown in Table 3-3. The Australian Bureau of Statistics (ABS) reports statistics by defined statistical geographic regions that are classified into a nested hierarchy of statistical areas. The Victoria River ABS Statistical Area Level 2 (SA2) region (702051068) broadly encompasses the Victoria catchment, extending beyond the catchment boundary in most directions (Figure 3-8). Small portions of the catchment reach into two other SA2 regions: Tanami (702011053) and Barkly (702021055). Thus, data are shown for: (i) Victoria River SA2 region – as the single region that most closely approximates the catchment boundary and (ii) Victoria catchment – estimated data based on combining appropriate portions of three ABS regions to best match the actual spatial coverage of the catchment (60.7% of Victoria River SA2 region plus small portions (less than 1%) of Tanami and Barkly SA2 regions).

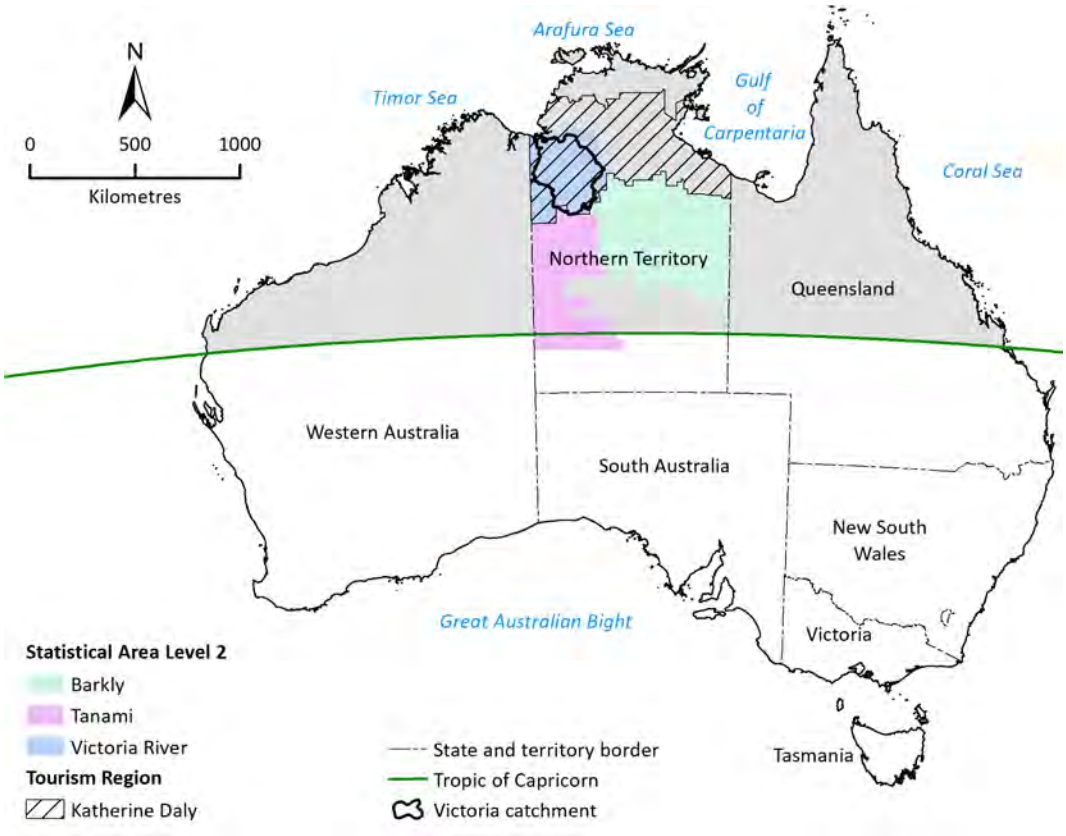

Figure 3-8 Boundaries of the Australian Bureau of Statistics Statistical Area Level 2 (SA2) regions used for demographic data in this analysis and the Katherine Daly tourism region

The typical resident of the catchment is younger, poorer and more likely to identify as Indigenous than the typical resident of the NT and of Australia as a whole. The catchment population is predominantly younger (median age 25 years in 2021) than is typical in the NT (33 years) and the country as a whole (38 years). However, the trend from 2011 to 2016 and to 2021 suggests that the median age is increasing a little. The population in the catchment contains a much larger proportion of Indigenous Peoples (close to 75%) than the NT (26.3%) and the country overall (3.2%). Median household incomes in the catchment were considerably below the average for the NT and the country as a whole in 2021. Furthermore, the proportion of households on low incomes (less than $650/week) was far higher, and the proportion on high incomes (more than $3000/week) far lower, than the proportion for the NT and the country as a whole (Table 3-3).

Table 3-3 Major demographic indicators for the Victoria catchment

INDICATOR	UNIT	VICTORIA RIVER SA2 REGION	VICTORIA CATCHMENT†	NORTHERN TERRITORY	AUSTRALIA
Total population 2021	People	2,609	1,600	232,605	25,422,788
Total population 2016	People	2,489	1,527	228,833	23,401,891
Total population 2011	People	2,516	1,544	211,946	21,507,720
Total population 2006	People	2,762	1,693	192,899	19,855,287
% change in population, from 2016 to 2021	%	4.82	4.80	1.65	8.64
% change in population, from 2011 to 2021	%	3.70	3.62	9.75	18.20
% change in population, from 2006 to 2021	%	−5.54	−5.49	20.58	28.04
Indigenous population 2021, as % of total	%	74.59	74.68	26.27	3.20
Indigenous population 2016, as % of total	%	73.40	73.53	25.45	2.77
Indigenous population 2011, as % of total	%	75.99	76.06	26.79	2.55
Indigenous population 2006, as % of total	%	76.36	76.46	27.82	2.29
Male population 2021, as % of total	%	50.36	50.35	50.53	49.35
Male population 2016, as % of total	%	50.70	50.68	51.81	49.34
Male population 2011, as % of total	%	49.28	49.29	51.67	49.44
Male population 2006, as % of total	%	50.58	50.57	51.52	49.35
Population density 2021, per 1000 ha	People	0.2	0.2	1.7	33.1
Median age 2021	Years	25	25	33	38
Change in median age, from 2016 to 2021	Years	No change	No change	1	No change
Change in median age, from 2011 to 2021	Years	1	1	2	1
Median weekly household income 2021	$	$1095	$1097	$2061	$1746
Change in median weekly household income, from 2016 to 2021	%	0.18	0.34	3.93	21.42
% of households with weekly household income less than $650/week	%	27.20	27.12	12.40	16.50
% of households with weekly household income more than $3000/week	%	8.70	8.67	28.80	24.30
Mean number of people per household 2021	People	4.1	4.1	2.8	2.5
Change in mean number of people per household, from 2016 to 2021	People	0.3	0.3	−0.1	−0.1

†Weighted averages of scores for SA2 regions falling wholly or partially within the catchment boundary.
Sources: ABS (2021), ABS (2016), ABS (2011) and ABS (2006) Census data

The Victoria catchment falls within the first decile for each of the Socio-Economic Indexes for Areas (SEIFA) metrics (Table 3-4), indicating that the catchment scores below 90% of the rest of the country on each measure. All three SA2 regions that fall within the catchment boundary (Victoria River, Tanami and Barkly) individually rank within the first decile for all four measures.

Table 3-4 Socio-Economic Indexes for Areas (SEIFA) scores of relative socio-economic advantage for the Victoria catchment

Scores are relativised to a national mean of 1000, with higher scores indicating greater advantage.

INDICATOR	VICTORIA RIVER SA2 REGION		VICTORIA CATCHMENT†		NORTHERN TERRITORY	
	SEIFA score	**(Decile)**	**SEIFA score**	**(Decile)**	**SEIFA score**	**(Mean decile)**
Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD)§	501	(1)	501	(1)	904	(5)
Index of Relative Socio-Economic Disadvantage (IRSD)*	678	(1)	678	(1)	945	(5)
Index of Economic Resources (IER)	557	(1)	557	(1)	887	(4)
Index of Education and Occupation (IEO)	819	(1)	819	(1)	976	(5)

†Weighted averages of scores for SA2 regions falling wholly or partially within the catchment boundary.
§Based on both the incidence of advantage and disadvantage.
*Based purely on indicators of disadvantage.
Source: ABS (2023)

3.3.3 Current industries and land use

Employment

The economic structure of the Victoria catchment differs substantially from that of the NT and Australia as a whole. The proportion of the adult population (aged 15 and older) within the labour force in the catchment is far smaller than in the NT (see participation rates in Table 3-5), indicating that a large proportion of the potential workforce is unable or unwilling to find work. Furthermore, unemployment rates are far higher than the NT and national averages (see unemployment rates in Table 3-5), indicating that a larger proportion of those who are willing and able to seek work have been unable to find work. Trends in the data appear unfavourable, with unemployment rates within the Victoria catchment higher and participation rates lower in the 2016 and 2021 censuses than in earlier periods. In contrast, rates remained broadly steady for the NT and Australia as a whole across the same time frame.

There are noticeable differences in the industries providing the most jobs within the catchment compared with the nation as a whole (Table 3-5). ‘Education and training’, ‘Health care and social assistance’ and ‘Construction’ are important employers in the catchment and nationally; however, ‘Retail trade’ and ‘Professional, scientific and technical services’ feature within the top five industries by employment nationally but are far less significant in the Victoria catchment. As is also the case in the NT as a whole, ‘Public administration and safety’ is relatively more important to the employment prospects of workers in the catchment than the average across the country. Of particular relevance to this Assessment, ‘Agriculture, forestry and fishing’ is the most significant industry within the Victoria catchment. Furthermore, the sector has been growing relatively more important in the catchment over time. Over the past three censuses (2021, 2016 and 2011), the percentage of employment in the agricultural sector nationally has been reported as 2.3%, 2.5% and 2.5%, respectively, and for the NT, 2.3%, 2.0% and 1.9%, respectively. That is, the proportion of employment in the agricultural industry has been small and fairly steady. In contrast, agricultural employment within the Victoria catchment is large and growing, having provided 26.3% of employment in 2011, 24.0% in 2016 and 29.2% in 2021.

The structural differences between this catchment and elsewhere can have a significant impact on the regional economic benefits that can result from development projects initiated within the catchment compared to development projects that may be initiated elsewhere.

Table 3-5 Key employment data for the Victoria catchment

	UNIT	VICTORIA RIVER SA2 REGION	VICTORIA CATCHMENT†	NORTHERN TERRITORY	AUSTRALIA
Unemployment rate 2021	%	20.85	20.82	5.61	5.09
Unemployment rate 2016	%	17.74	17.83	6.96	6.86
Unemployment rate 2011	%	6.83	6.92	5.28	5.63
Unemployment rate 2006	%	5.09	5.17	4.39	5.24
Participation rate 2021	%	44.99	44.87	61.72	61.08
Participation rate 2016	%	40.80	40.77	61.55	60.26
Participation rate 2011	%	52.97	52.91	63.86	61.38
Participation rate 2006	%	52.29	52.16	62.76	60.36
Major industries of employment – top five industries in Victoria catchment as % of employment 2021					
Agriculture, forestry and fishing	%	29.35	29.17	2.29	2.34
Public administration and safety	%	14.52	14.62	18.16	6.61
Education and training	%	14.52	14.53	9.38	8.81
Health care and social assistance	%	10.59	10.63	14.90	14.54
Construction	%	5.90	5.87	8.03	8.86
Major industries of employment – top five industries in Australia as % of employment 2021 that are not in list above					
Retail trade	%	3.93	3.98	7.23	9.13
Professional, scientific and technical services	%	0.61	0.61	4.85	7.84

†Weighted averages of scores for SA2 regions falling wholly or partially within the catchment boundary.
Source: ABS (2021), ABS (2016), ABS (2011) and ABS (2006) Census data

Land use

The Victoria catchment covers an area of about 82,400 km^2, much of which is conservation and natural environments (38%) (Figure 3-9). In the north of these protected lands lies the Bradshaw Field Training Area (7% of the conservation and natural environments), a facility owned by the Australian Government with a southern boundary following the Victoria River and a boundary that also extends outside the Victoria catchment in the north-east. A further 2.05% of the catchment is classified as water and wetlands, most of which is coastal and tidal waters, including reaches in the Angalarri River. Nearly all of the remaining catchment area (62%) is used for grazing natural vegetation. Intensive agriculture and cropping make up a very small portion of the catchment: dryland and irrigated agriculture and intensive animal production together comprise just 0.02% of the land area. The other intensive localised land uses are transport, communications, services, utilities and urban infrastructure (0.22%).

While not considered a land use under the land use mapping (because it is a tenure), it is worth noting that Aboriginal freehold title, held under the Commonwealth *Aboriginal Land Rights (Northern Territory) Act 1976* (ALRA), makes up 31% of the Victoria catchment. The title is

inalienable freehold, which cannot be sold and is granted to Aboriginal Land Trusts which have the power to grant an interest over the land. Just over half of this overall 31% holding comprises the Judbarra National Park, which is overlaid by a 99-year lease with the NT Government. Native title exists in parts of the native title determination areas that occur in an additional 34% of the catchment.

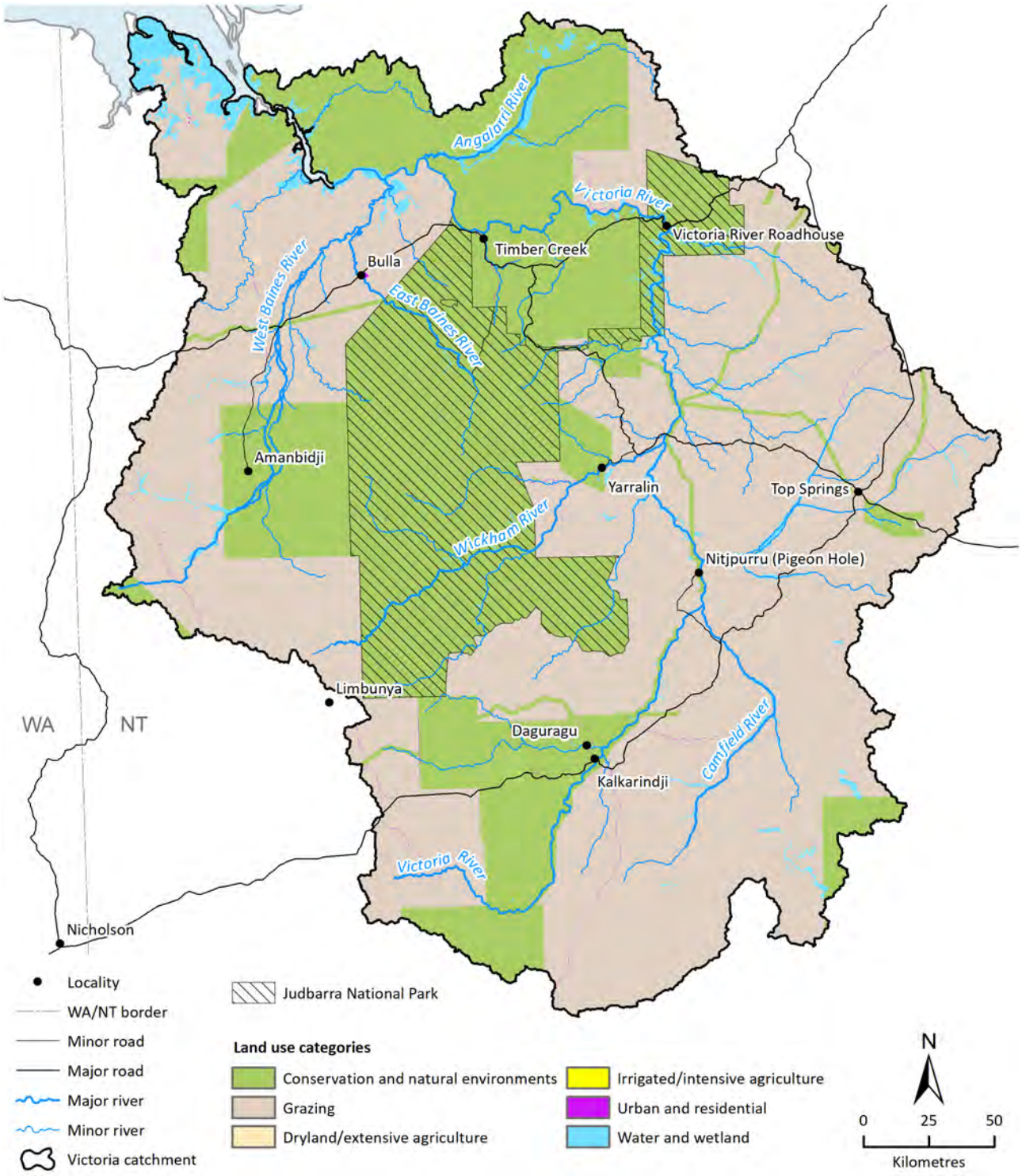

Figure 3-9 Land use classification for the Victoria catchment

Areas of some land uses (e.g. irrigated/intensive agriculture) are too small to be shown on the map. Note: land use data shown on this map is current to 2017.

Source: NT Department of Environment, Parks and Water Security (2013)

Value of agriculture

The estimated values of agricultural production for the Victoria catchment and the NT as a whole are given in Table 3-6. The catchment provides a substantial proportion of the revenue for livestock from the NT but has no cropping.

The most recent annual survey data from the ABS describing the value of agriculture by different types of industries (2021–22 survey) are only available at a much larger scale than the Victoria catchment (state and territory level), preventing estimation of the value of agricultural products within the catchment. Hence estimates have been presented for the previous year (Table 3-6) for which data were available at a finer spatial scale (SA2 level, as used for socio-economic and demographic catchment estimates).

Table 3-6 Value of agricultural production for the Victoria catchment (estimated) and the NT for 2020–21

	VICTORIA CATCHMENT† ($ MILLION)	NORTHERN TERRITORY ($ MILLION)
Total value of crops	0	$141.1
Total value of livestock slaughtered and other disposals	$110.2	$605.1
Total agriculture	$110.2	$746.2

†Weighted averages of scores for SA2 regions falling wholly or partially within the catchment boundary.
Source: ABS (2022)

Agriculture is the major source of employment in the Victoria catchment, providing 29% of the work (Table 3-5). This is much higher than the proportion of employment in agriculture at a national level.

Livestock production

Extensive grazing of beef cattle, valued at $110.2 million in 2020–21 (Table 3-6), dominates agricultural production in the Victoria catchment, and about 62% of the catchment by area is used for extensive cattle grazing (pastoralism). *The Big Run: the story of Victoria River Downs* (Makin, 1970) documents the early history of the district, development of the cattle industry and life of pastoral settlers at Victoria River Downs Station, once the world's largest cattle property.

The first pastoral lease assigned in the NT was in 1876 on the Katherine River. Beef cattle were first introduced to the Victoria catchment in about 1878, and by 1882, the pastoral lease Victoria River Downs had been established with an area of 41,154 km^2. The first cattle arrived there in 1883 (Makin 1970).

The first export shipment of live cattle, from Port Darwin to Hong Kong in 1885, included cattle from the Victoria catchment. The shipment turned into an expensive failure. Later attempts to export live cattle (to Singapore and to the Philippines) were also loss-making ventures, and the general lack of markets in the early years became a serious impediment to profitability. Local markets were insufficient to underwrite the profitability. The stations were remote, and the high cost of stocking them with supplies and equipment and finding suitable staff to work on them provided substantial constraints. Furthermore, the main market was in Darwin, and the cattle lost considerable weight in the overland journey, compounding the cost of droving them there (Makin, 1970).

A proposal to build the NT's first meatworks in the Victoria catchment in 1901 did not come to fruition. Subsequently, meatworks were built in both Darwin and in Wyndham in WA (Makin, 1970). Both of these are now closed.

The prospect of running sheep was also considered, with the aim of producing wool, which, once shorn, is less perishable than meat. One estimate was that the NT had the potential to run 30 million sheep. Indeed, sheep were brought on to Victoria River Downs in 1891 (Makin 1970). However, within a few years, the sheep were sold on, and shortly after there were no sheep in the Victoria catchment.

Many of the constraints to profitability of the early years remain today in the Victoria catchment. It is remote from the large domestic markets in southern Australia, and it is better suited to breeding cattle than to fattening or finishing them for local slaughter. This limits the number of markets which can be targeted. The long distance to services leads to high input costs. Finding skilled staff is difficult. Therefore, the industry continues to seek ways in which to overcome some of these constraints through economies of scale, technical advances in sensor networks and potentially the introduction of on-farm forage and hay supply.

Present-day cattle grazing occurs on dryland native and naturalised pastures. The within-year variation produced by the wet-dry climate is the main determinant for cattle production. Native pasture growth depends on rainfall, so pasture growth is highest from December to March. The total standing biomass and the nutritive value of the vegetation declines during the dry season. Changes in cattle liveweight closely follow this pattern with higher growth rates over the wet season than the dry season. Indeed, cattle often lose liveweight and body condition throughout the dry season until the next pulse of growth initiated by wet-season rains.

A whole-of-industry survey (Cowley, 2014) provides a snapshot of the industry as it was in 2010. While some of the survey results described below have inevitably changed since then, the general enterprise type has not changed significantly in the past decade, and the following can be considered still current. Cowley (2014) presents data for the whole of the Katherine region, broken into five districts: Roper, Sturt Plateau, Katherine/Daly, Victoria River and Gulf. The information below comes from the Victoria River district (VRD) except where noted to be from the Katherine region as a whole (i.e. across all five districts). The VRD is an NT pastoral district aligned to property boundaries, not identical to but comparable with the Victoria catchment boundary. Although it does not follow the Victoria catchment boundary, it can be considered representative of those properties within the catchment. Further detail can be found in the companion technical report on agricultural viability and socio-economics (Webster et al., 2024).

The VRD is characterised by large property sizes: most of those surveyed were between 2000 and 4000 km^2, and the median paddock size was 120 km^2 (Cowley, 2014). A large percentage of properties (56%) are company owned (Cowley, 2014) as distinct from 'owner-manager'. Often, these company-owned, or 'corporate', properties are run within a system of other properties which allow transfer of cattle between properties and sharing of staff and resources (Cowley, 2014). Corporate properties are typically the larger properties in the VRD and contain the most cattle; therefore, the overall proportion of land area and production from the corporate properties is much larger than 56%. Owner-manager properties were more likely to consist of only one property and be run as a stand-alone enterprise.

A large area of land is needed to maintain one unit of cattle (typically termed an AE, or adult equivalent). This carrying capacity of land is determined primarily by the soil (and landscape) type, the mean annual rainfall and its seasonality, and the consequent native vegetation type. NT Government estimates of carrying capacity in the Victoria River district range from a maximum of 12.5 to 23.0 AE/km^2 (i.e. 8.0 to 4.3 ha/AE) on the basalt-derived cracking clays of the Wave Hill land system in 'A' condition (from a four point condition scale where 'A' is highest and 'D' is lowest) to a low of 0.5 AE/km^2 (i.e. 200 ha/AE) on 'C' condition pastures of land systems within the Spinifex plains land type. Note that 'D' condition lands across the region have a recommended carrying capacity of zero AE/km^2 (Pettit, undated).

The typical beef production system is a cow-calf operation with sale animals turned off at weights to suit the live export market. About 78% of all cattle across the Katherine region were Brahman, with about another 17% being Brahman derived. The majority of surveyed properties in the VRD ran between 15,000 and 20,000 head of cattle. Most cattle in the VRD (68%) were bred for live export with 22% bred to be transferred and grown-out elsewhere. Across the broader Katherine region, 83% of cattle turned off made their way to live export, either directly or indirectly through floodplain agistment closer to Darwin, inter-company transfers or backgrounding. The most common live export destination was South-East Asia.

Across the Katherine region, most of the cattle are sold off-property early in the dry season, at the time of the first round of mustering. The most common sales months were May to July, with a secondary peak in September and October (Cowley 2014). These peaks correspond to the common practice of two rounds of mustering, with the first early in the dry season and the second late in the dry season.

While the cattle typically graze on native pastures, many properties supplementary feed hay to the weaner cohort, partly to train them to be comfortable around humans for management purposes and partly to add to their growth rates during the dry season when the nutritive value and total standing biomass of native pastures is falling. Urea-based supplements and supplements containing phosphorus are fed to a range of age and sex classes of the cattle. The urea-based supplements provide a source of nitrogen for cattle grazing dry-season vegetation. The phosphorus supplements, mostly provided over the wet season, are used because phosphorus is deficient in many areas yet is required for many of the body's functions, such as building bones, metabolising food and producing milk (Jackson D et al., 2012). Supplements were fed in 89% of the properties surveyed in the VRD.

Cropping

Despite more than a century of trying to establish crop industries in the NT, there is still very little irrigated or dryland cropping in the Victoria catchment (0.02% of the catchment area), and it is only for property requirements. Agricultural experiments were conducted around the time of the First World War. The Second World War prompted another wave of interest in facilitating northern agricultural development, which included creating a set of agricultural experimental stations. In 1942, approval was given to establish army experimental farms at Katherine and Mataranka (east of the Victoria catchment) with the aim of more efficiently supplying the fruit and vegetables needed to maintain the nutrition of troops. The army experimental farm at Katherine was initially established to test what fruit and vegetables were suitable for the area. After the war this became the Katherine Experimental Station, where a wider range of crops was explored. This

research station was run by the Australian Government until it was handed over to the NT Government in the 1980s. Several crops, such as peanuts in the 1950s, initially proved to be agronomically suitable for the local environment, but they could not be established as competitive local industries, partly because of difficulties with market access and high transport costs. The Victoria River Research Station, also known as Kidman Springs Research Station, commenced operations in 1960 and is the NT's principal pastoral research station, carrying out research on cattle productivity and sustainability of the pastoral landscape.

Aquaculture and fisheries

There is currently no active aquaculture in the Victoria catchment. An application for prawn aquaculture farming by Project Sea Dragon Pty Ltd was lodged with the NT Government in 2015. Significant milestones were completed in 2020 progressing the approval process, and initial construction contracts awarded. The project is currently awaiting secure funding. A comprehensive situational analysis of the aquaculture industry in northern Australia (Cobcroft et al., 2020) identified key challenges, opportunities and emerging sectors.

Offshore, the Victoria River drains into one of the most valuable fisheries in the country. The Northern Prawn Fishery (NPF) spans the northern Australian coast between Cape Londonderry in WA to Cape York in Queensland (Figure 3-10). Most of the catch is landed at the ports of Darwin, Karumba and Cairns. Over the 10-year period from 2010–11 to 2019–20, the annual value of the catch from the NPF has varied from $65 million to $124 million with a mean of $100 million (Steven et al., 2021). The Victoria catchment flows into the Joseph Bonaparte Gulf NPF region (Figure 3-10), one of the smallest regions by annual prawn catch.

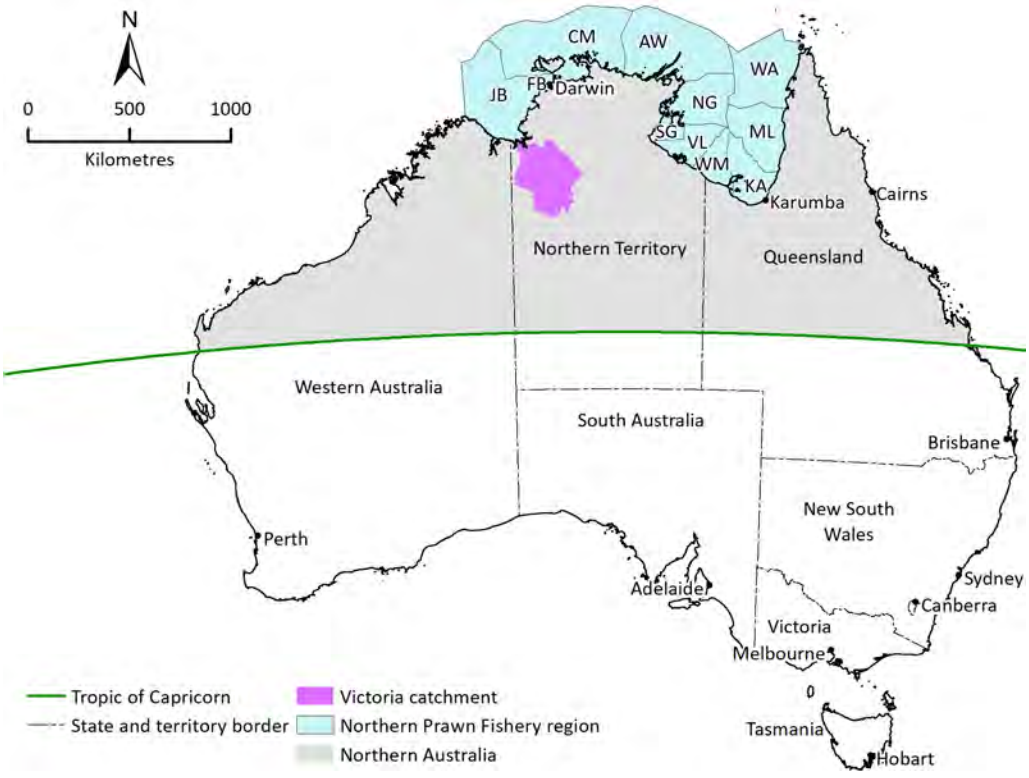

Figure 3-10 Regions in the Northern Prawn Fishery

The regions in alphabetical order are Arnhem-Wessels (AW), Coburg-Melville (CM), Fog Bay (FB), Joseph Bonaparte Gulf (JB), Karumba (KA), Mitchell (ML), North Groote (NG), South Groote (SG), Vanderlins (VL), Weipa (WA) and West Mornington (WM).

Source: Dambacher et al. (2015)

Like many tropical fisheries, the target species exhibit an inshore–offshore larval life cycle and are dependent on inshore habitats, including estuaries, during the postlarval and juvenile phases (Vance et al., 1998). Monsoon-driven freshwater flood flows cue juvenile prawns to emigrate from estuaries to the fishing grounds, and flood magnitude explains 30% to 70% of annual catch variation, depending on the prawn fishery region (Buckworth et al., 2014; Vance et al., 2003). Fishing activity for banana prawns and tiger prawns (*Penaeus* spp.), which combined constitute 80% of the catch, is limited to two seasons: a shorter banana prawn season from April to June and a longer tiger prawn season from August to November. The specific dates of each season are adjusted depending on catch rates. Banana prawns generally form the majority of the annual prawn catch by volume. Key target and by-product species are detailed by Woodhams et al. (2011). The catch is often frozen on-board and sold in domestic and export markets.

The NPF is managed by the Australian Government (via the Australian Fisheries Management Authority) through input controls, such as gear restrictions (number of boats and nets, length of nets) and restricted entry. Initially comprising over 200 vessels in the late 1960s, the number of vessels in the NPF has reduced to 52 trawlers and 19 licensed operators after management initiatives including effort reductions and vessel buy-back programs (Dichmont et al., 2008). Given recent efforts to alleviate fishing pressure in the NPF, there is little opportunity for further expansion of the industry. However, it is generally recognised that development of water resources in the Victoria catchment would need to consider the downstream impacts on prawn breeding grounds and the NPF.

Mining

Mining includes extraction of minerals (including coal), petroleum and gas, and quarrying. Despite mining (minerals) and petroleum production contributing $4.4 billion and $228 million, respectively, to the NT economic output (NT Department of Treasury and Finance, 2023), no mine or petroleum projects are currently operating in the Victoria catchment. Nonetheless, approximately 61% of the Victoria catchment is covered by either mineral or petroleum exploration licence with areas without exploration licences predominantly being inside Judbarra National Park and the Bradshaw Field Training Area (Figure 3-11).

Commodities, including critical and strategic minerals identified as occurring within the Victoria catchment, are mainly lead and copper in the centre of the catchment, manganese in the east and zinc in the far north-west. Several occurrences of barite have been identified in the catchment. The NT Government has programs to attract investment in critical mineral exploration and infrastructure.

Water is central to the minerals and petroleum industries. Mining uses water in a variety of ways, including for transporting materials, chemical or physical processing, cooling, disposing of and storing waste materials, washing, and suppressing dust. Potable water is used in areas that house mining staff (Prosser et al., 2011). Water is also extracted or ‘used’ during de-watering at mines that extend below the water level. Petroleum companies, which use relatively small volumes of water, produce water as a by-product of extraction. Water extracted during de-watering or as a by-product of petroleum extraction must be safely discharged and may need treatment.

Water consumption at mining operations is highly variable (Table 3-7). The variations are due to a range of factors, including different mining methods, ore types, ore grades, processing treatments

and definitions of water usage. The overall water balance on a site depends on climate conditions, which affect water availability at the site, and the ability to reuse and recycle water within processing facilities (Northey and Haque, 2013). While not mined in the Victoria catchment, coal is by far the largest user of water in the mining sector. The water used by mining enterprises does not need to be of potable quality.

Table 3-7 Global water consumption in the mining and refining of selected metals

PROCESSING STAGE	MEAN WATER CONSUMPTION* (M^3/TONNE OF METAL)	RANGE OF WATER CONSUMPTION§ (M^3/TONNE OF METAL)
Copper concentrate†	43.235	9.673–99.550
Lead concentrate†	6.597	0.528–11.754
Zinc concentrate†	11.93	11.07–24.65
Manganese concentrate†	1.404	1.390–1.410
Uranium concentrate (U_3O_8)†	2,746	46.2–8207
Gold metal‡	265,861	79,949–477,000
Platinum metal‡	313,496	169,968–487,876
Palladium metal‡	210,713	56,779–327,874

†Metal concentrates are typically produced at the site where the ore is mined.
‡Includes mining, smelting and refining of pure metals, assuming mining and processing are all located within a single region or separate regions but with similar water characteristics,.
*Mean water consumption value per tonne of metal equivalent in the concentrates or refined metals.
§Minimum and maximum water consumption value per tonne of metal equivalent in the concentrates or refined metals.

Source: Meissner (2021)

Because water is typically a very small fraction of total input cost, and mining produces high-value products, mining enterprises usually develop their own water supplies, which are often regulated separately to the water entitlement system (Prosser et al., 2011). Based on the mineral occurrences in the Victoria catchment (Figure 3-11), potential water demands by mining are likely to be modest.

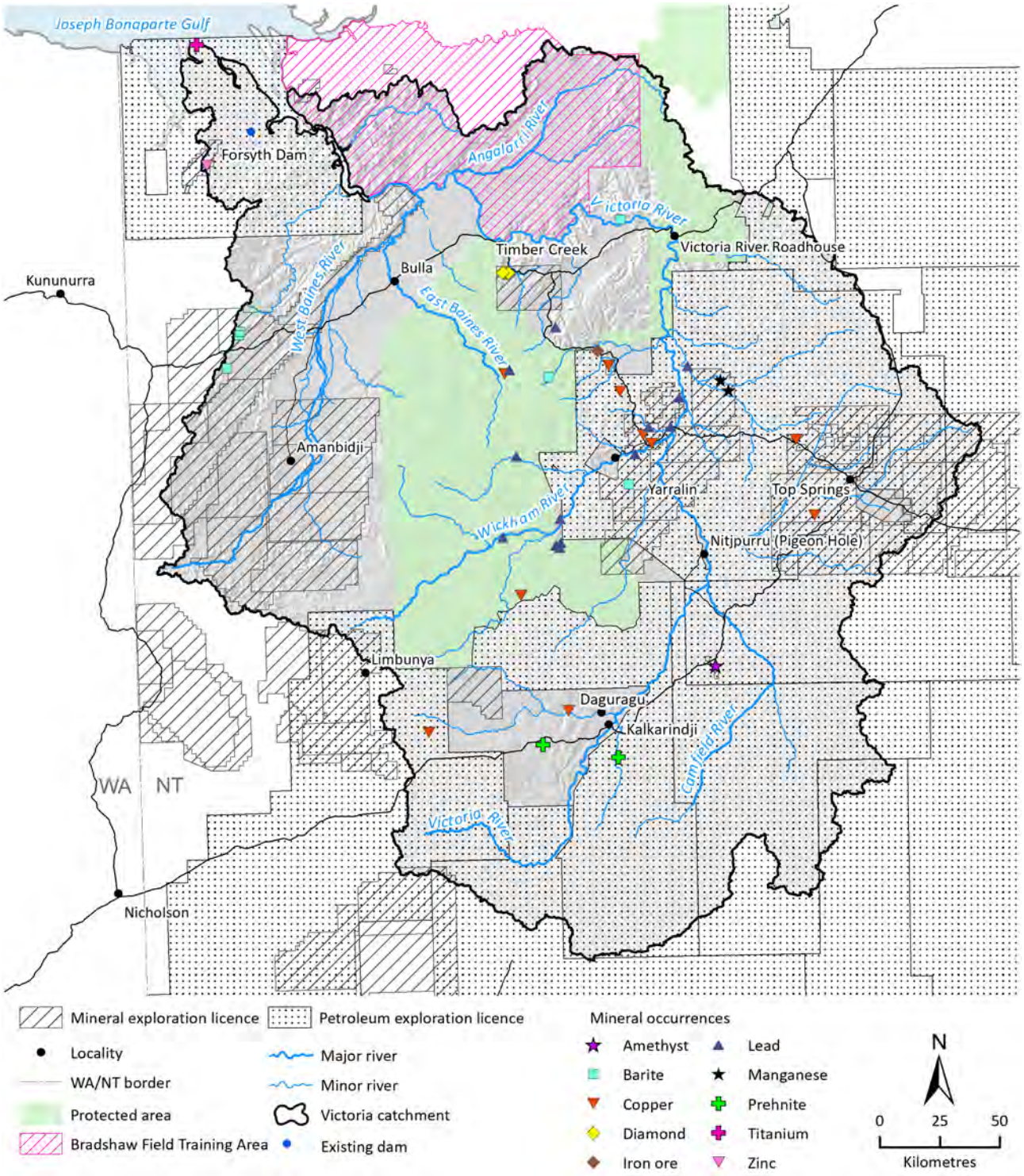

Figure 3-11 Main commodity mineral occurrences and exploration tenements in the Victoria catchment

Source: NT Geological Survey (2024)

Tourism

The Victoria catchment has a relatively low volume of tourist visitation, due largely to its remoteness, sparse population and little tourism development (Tourism NT, 2023). Most of these tourism visits are from self-drive tourists along the Victoria Highway (part of National Highway 1), which traverses the northern part of the catchment. Timber Creek is the gateway to Judbarra National Park (Figure 3-9) and Jasper Gorge (Figure 3-12) and is an important half-way stopping point between Katherine (289 km east) and Kununurra (226 km west).

Figure 3-12 Jasper Gorge is seasonally accessible on the Buchanan Highway

Source: CSIRO

Access to much of the Victoria catchment north and south of the Victoria Highway is via unsealed roads that usually require four-wheel-drive (4WD) vehicle access. The nearest domestic airports to the Victoria catchment are located in Darwin and Katherine in the NT and Kununurra in WA. Airstrips for public use are at Timber Creek, Victoria River Downs Station and Kalkarindji.

Major attractions in the Victoria catchment include the scenic Judbarra National Park, the second-largest national park in the NT (Tourism NT, 2024a), and fishing in the Victoria River and major tributaries. Fossicking is promoted as a popular activity near Kalkarindji, a locality known for an abundance of geodes on the ground (NT Government, 2016).

As well as economic and employment opportunities, tourism can cause impacts such as native habitat loss, and foot traffic, bikes or vehicles may cause environmental damage such as erosion and a loss of amenity to local residents (Larson and Herr 2008). Other risks include the spread of weeds (Section 7) and root rot fungus (*Phytopthora cinnamomi*) carried on vehicles and people (Pickering and Hill, 2007).

The Victoria River SA2 region (Figure 3-8), which closely corresponds to the Victoria catchment, received 27,000 visitors in the year ending December 2022 (Tourism NT, 2023), about 9% of the 287,000 visitors to the Katherine Daly tourism region (Figure 3-8). Visitor expenditure in the Victoria catchment was estimated at no more than $20 million/year. Across the broader Katherine Daly region (Figure 3-8), which encompasses the Victoria catchment, only 1% of visitors were of international origin, while 62% were from within the NT and 37% were from interstate. Of the intra-territory and interstate visitors, 43% and 21%, respectively, were travelling for business.

Like in much of northern Australia, high summer temperatures and humidity, and wet-season rains, mean that most tourists visit during the drier, cooler months between May and October (Tourism NT, 2024b). Tourist visits across the Katherine Daly region pre-COVID-19 show peak visitation (between 33% and 45% depending on origin – interstate, intrastate or international) during the September quarter (dry season), and least visitation (between 5% and 13% depending on origin) during the March quarter (wet season) (Tourism NT, 2019). However, the lack of all-weather sealed roads in the Victoria River SA2 means tourism in the Victoria catchment is likely to be considerably more seasonal than in the broader region. In the broader region, the data are highly skewed to Katherine, which accounted for approximately half the visitors to the Katherine Daly region pre-COVID-19.

For the 3-year reporting period to the end of 2022, approximately 34% of overnight visitors to the Katherine Daly tourism region visited national parks, while 12% participated in fishing, 10% took part in charter boat or river cruise tours, and 9% participated in Indigenous cultural experiences (of these last two activities, there are currently no businesses in the Victoria catchment). Fishing is one of the Victoria catchment's biggest drawcards.

A pre-COVID-19 profile of the Victoria Daly region local government area indicates that 20 tourism businesses were operating in this region at the time of their 2019 survey. Of these 20 businesses, 12 were 'non-employing', four had fewer than five employees and three had more than 20 employees (Tourism Research Australia, 2019).

Tourism development opportunities and considerations

The state of northern Australia's tourism economy is closely tied to the state of its ecosystems (Prideaux, 2013). With a large proportion of the Victoria catchment in a relatively 'natural' state, there is potential for growth in nature-based tourism. However, like other remote areas of northern Australia, the region's remoteness and distance from urban centres (Bugno and Polonsky, 2024), lack of supporting infrastructure, limited human capital and financial resources, and low awareness of tourism system characteristics (Summers et al., 2019) considerably constrain its potential. The seasonality of visitation also limits enterprise profitability (Bugno and Polonsky, 2024) and permanent employment opportunities. Also important to consider is that much of the catchment's appeal to self-drive visitors is likely to be the absence of human presence and commercial infrastructure, which present opportunities for exploration and solitude (Lane and Waitt, 2007; Ooi and Laing, 2010). Hence, development that alters the region's current characteristics could be alienating to some current visitor markets.

While water resource development for agriculture has the potential to negatively affect tourism and future opportunities in the Victoria catchment, for example, through declining biodiversity and perceived reduced attractiveness (Pickering and Hill, 2007; Prideaux, 2013), such development may present opportunities to foster tourism growth. For example, Lake Argyle in the East Kimberley region (WA), developed as an irrigation dam to supply the Ord River Irrigation Area, is now advertised as being one of northern WA's major attractions. It offers a wide range of tourism activities and hosts a diversity of wildlife (https://www.australiasnorthwest.com/explore/kimberley/lake-argyle/). While visitors to the Kimberley region reportedly perceived Lake Argyle in the same way they perceived some 'natural' local attractions such as billabongs, irrigated agriculture of the Ord River Irrigation Area is perceived differently, as being 'domesticated' (Waitt et al., 2003).

Elsewhere in northern Australia, water resource infrastructure, including Fogg Dam (NT), Tinaroo Dam (Queensland) and Lake Moondarra (Queensland), has resulted in increased visitation by tourists for the enhanced wildlife or recreation opportunities they provide. However, the ongoing contributions of dam to their local economies vary. For example, the value of recreational fishing varies between dams depending upon whether there are other dams nearby and their proximity to tourism traffic (Rolfe and Prayaga, 2007). The relatively low visitation to the Victoria catchment suggests that the recreational fishing value of a new dam in the Victoria catchment would be limited, particularly in those parts of the Victoria catchment near Lake Argyle.

Agritourism opportunities, for example, through accommodation on pastoral properties and other travel support (fuel), offer an opportunity for revenue diversification, although impediments such as highly variable seasonal demand limit profitability (Bugno and Polonsky, 2024).

Tourism has the potential to enable economic development within Indigenous communities because Indigenous tourism enterprises, usually microbusinesses, often have some competitive advantages (Fuller et al., 2005). Successful tourism developments in regional and very remote areas such as the Victoria catchment are highly likely to depend on establishing private and public sector partnerships, ensuring effective engagement and careful planning with Traditional Owners and regional stakeholders, and building interregional network connectivity and support (Greiner, 2010; Lundberg and Fredman, 2012).

Given the importance of climate on tourism seasonality, demand and travel patterns in northern Australia (Hadwen et al., 2011; Kulendran and Dwyer, 2010), the increased temperatures and occurrence of extreme weather-related events (e.g. drought, flood, severe fires and cyclones) associated with climate change are likely to be significant threats to the industry in the future. These will likely negatively affect tourist numbers, the length and quality of the tourist season, tourism infrastructure including roads, and the appeal of the landscape and its changing biodiversity (Amelung and Nicholls, 2014; Prideaux, 2013).

3.3.4 Current infrastructure

Transport

The Victoria catchment is serviced by two significant roads: the Victoria and Buntine highways (Figure 3-13). The Victoria Highway is one of many highways that make up Australia's National Highway 1. It runs east−west for a distance of 557 km, linking the Stuart Highway (the major north−south highway through the centre of Australia) at the town of Katherine to the Great Northern Highway west of Kununurra in WA. Although sealed and well trafficked by both tourist and commercial vehicles (Figure 3-13), few services exist on this route within the catchment. Groceries and fuel can be purchased from smaller stores at locations such as Timber Creek, Kalkarindji and Yarralin. Roadhouses at Victoria River Roadhouse and Top Springs also supply fuel. Flooding causes road closures during the wet season.

The Buntine Highway leaves the Victoria Highway just outside the north-east of the catchment and travels through Top Springs and Kalkarindji (sealed) before crossing into WA (unsealed west of Kalkarindji), where it intersects Duncan Road, which continues to Halls Creek. The Buntine Highway carries more commercial traffic than the Victoria Highway (Figure 3-18), largely to service the cattle industry. It provides access to Victoria River Downs Station and other stations in the

central and east of the catchment and is also a popular tourist route through the scenic Jasper Gorge.

Apart from these highways, the Victoria catchment is serviced by a sparse network of mainly unsealed roads, all subject to flooding and wet-season closures. Figure 3-13 shows the network of roads within the Victoria catchment categorised by rank and type of road surface. All road network information in this section is from spatial data layers in the Transport Network Strategic Investment Tool (TraNSIT; Higgins et al., 2015).

Figure 3-14 shows the heavy vehicle access for roads within the Victoria catchment, as determined by the National Heavy Vehicle Regulator. Type 2 road trains are vehicles up to 53 m in length, typically a prime mover pulling three 40-foot (approximately 12 m) trailers (Figure 3-15). The Victoria, Buntine and Buchanan highways are the only roads in the catchment classified to carry Type 2 road trains (Figure 3-14). However, Type 2 road trains can also access all unclassified non-residential roads in the study area. Despite the poorer road conditions of many of the local unsealed roads, large (Type 2) road trains are permitted due to minimal safety issues from low traffic volumes and minimal road infrastructure restrictions (e.g. bridge limits, intersection turning safety). Drivers would regularly use smaller vehicle configurations on the minor roads due to the difficult terrain and single lane access, particularly during wet conditions.

Figure 3-17 shows the mean speed achieved for freight vehicles for the road network. The road speed limits are usually higher than the mean speed achieved for freight vehicles, particularly on unsealed roads. Heavy vehicles using unsealed roads would usually achieve mean speeds of no more than 60 km/hour, and often lower when transporting livestock.

The nearest access to a good-quality standard-gauge rail is outside the catchment at Katherine in the east. This provides freight access to Darwin Port (East Arm Wharf) to the north and to major southern markets via Alice Springs. The rail line is primarily used for bulk commodity transport (mostly minerals) to Darwin Port. There are no branch lines in the Victoria catchment, so goods must be transported to and from loading points by road.

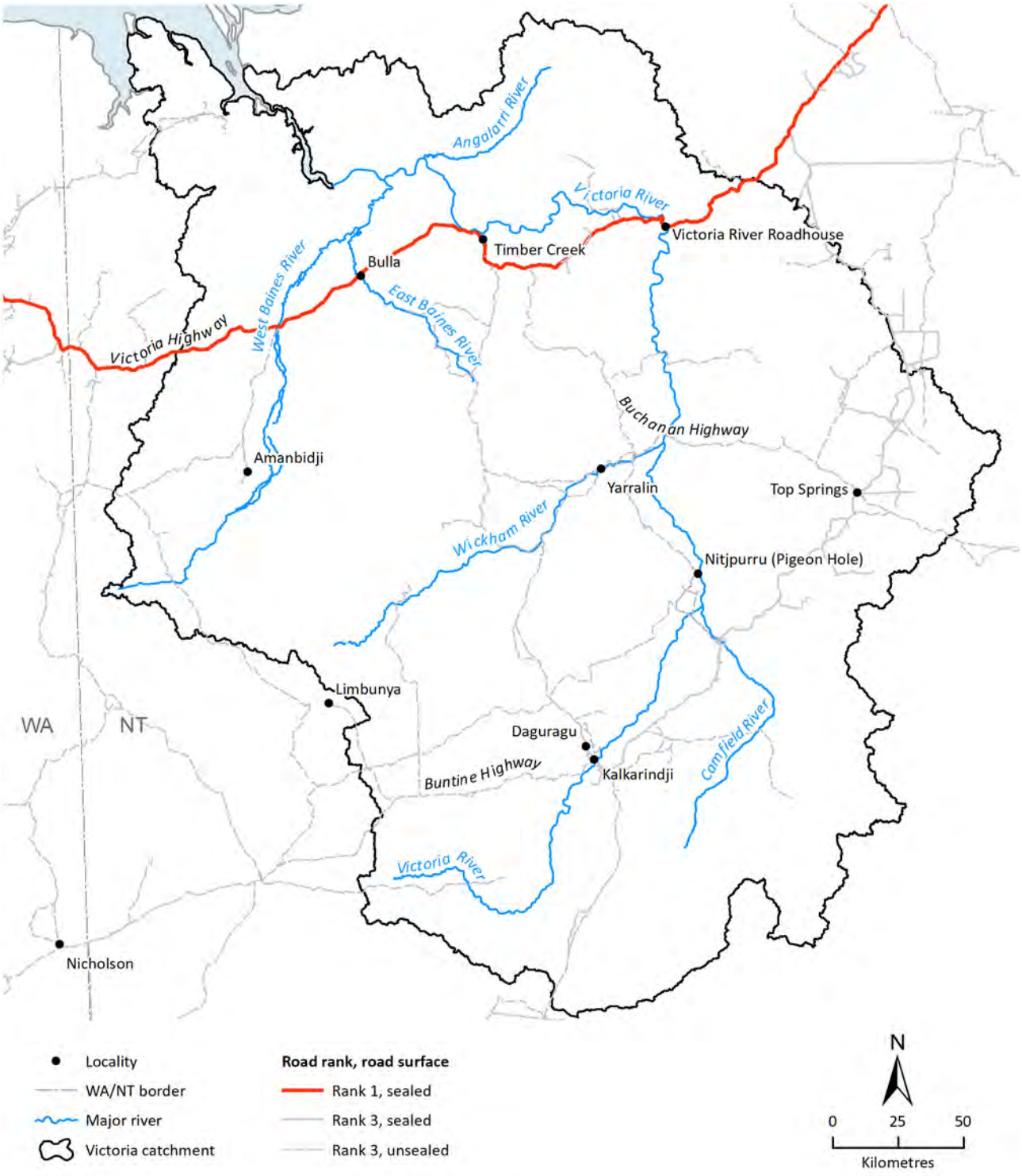

Figure 3-13 Road rankings and conditions for the Victoria catchment

Rank 1 = well-maintained highways or other major roads, usually sealed; Rank 2 = secondary 'state' roads; Rank 3 = minor routes, usually unsealed local roads. The 'Rank 1' road is the Victoria Highway, which runs from Katherine (in the east) to Kununurra (in WA).

Figure 3-14 Roads accessible to Type 2 vehicles across the Victoria catchment: minor roads are not classified

Type 2 vehicles are illustrated in Figure 3-15.

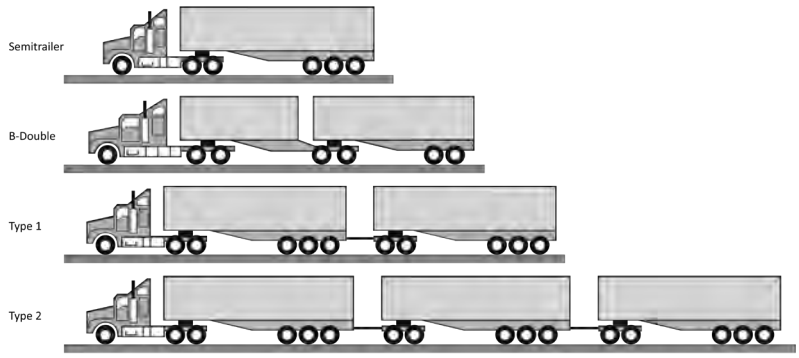

Figure 3-15 Common configurations of heavy freight vehicles used for transporting agricultural goods in Australia

Figure 3-16 Road condition and distance to market impact the economics of development in the Victoria catchment

Photo: CSIRO – Nathan Dyer

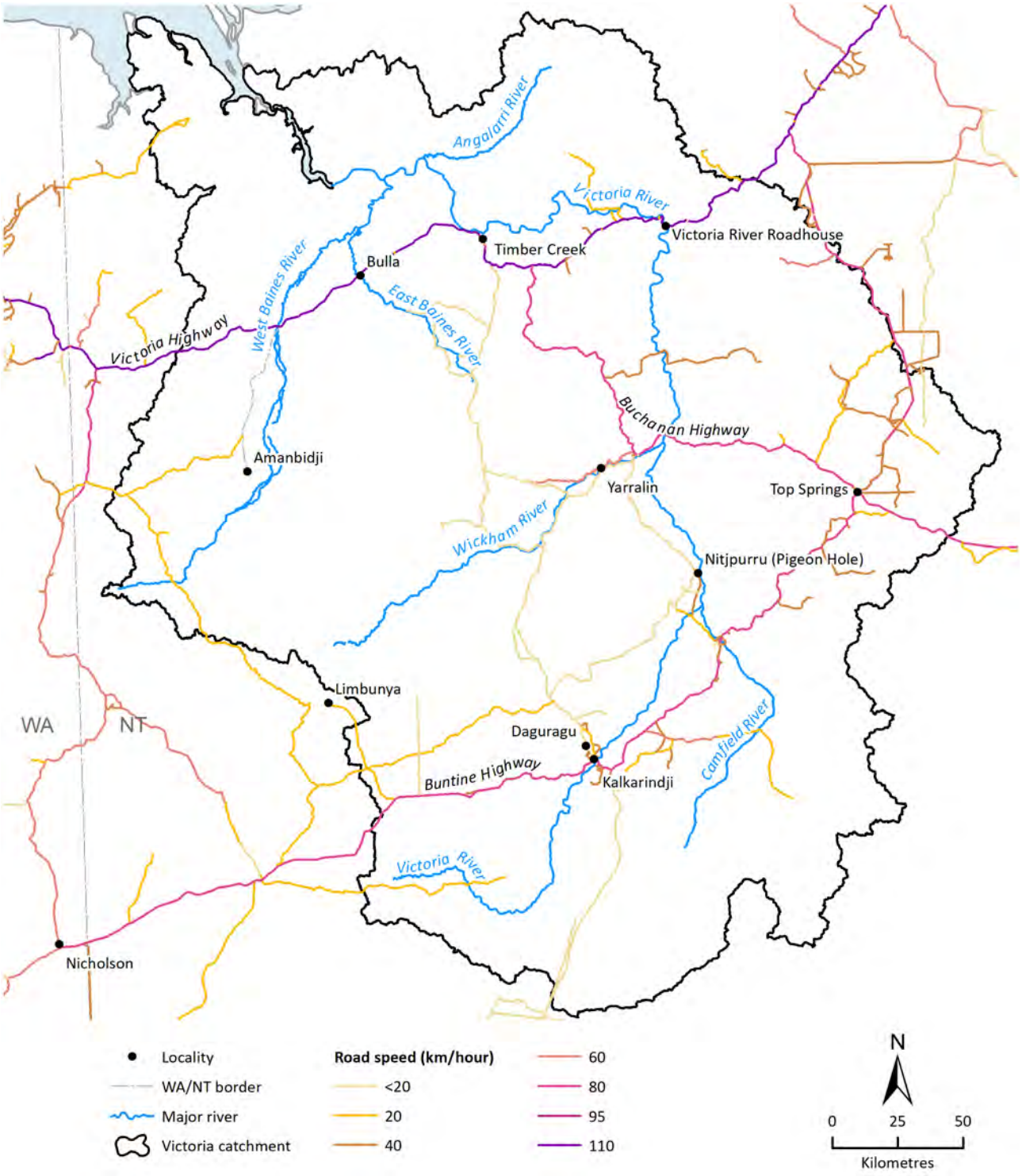

Figure 3-17 Mean speed achieved for freight vehicles on the Victoria catchment roads

Source: Spatial dataset of the location and attributes of roads and ferries sourced from HERE Technologies (2021)

Supply chains and processing

Table 3-8 provides the volumes of commodities annually transported into and out of the Victoria catchment, and Figure 3-18 shows the locations of existing pastoral enterprises in the catchment and trucking movements on regional roads. As previously noted, agricultural production is currently dominated by beef cattle. This is reflected in the annual volumes of commodities transported across the road network with large volumes of freight transporting cattle, mainly via the Buntine Highway. Live export of cattle via Darwin Port accounts for most cattle movements, but there are also substantial transfers of cattle between properties and smaller volumes directed to domestic markets via abattoirs and feedlots.

Table 3-8 Overview of commodities (excluding livestock) annually transported into and out of the Victoria catchment

Indicative transport costs are means for each commodity and include differences in distances between source and destinations.

COMMODITY	DESTINATION	INBOUND (t)	OUTBOUND (t)	INDICATIVE COST ($/t)
Construction	Construction site	30,081	9,000	122.18
Fuel	Fuel station	11,537	0	85.90
General	Supermarket	852	0	46.87
Horticulture	Supermarket	687	0	83.03
Other food	Supermarket	290	0	68.60
Processed food	Supermarket	1,085	0	75.70

Source: 2021 data from TraNSIT (Higgins et al., 2015)

There are currently no processing facilities for agricultural produce within the Victoria catchment. The Katherine cotton gin, the nearest processing facility, will see its first season of operation in 2024 and could support producers in the catchment. Dryland and irrigated agriculture (0.02% of the catchment) is currently solely for property requirements. The closest meatworks was run by Australian Agricultural Company at Livingstone, about 40 km south of Darwin, but has not operated since 2018. When operating, the meatworks had all-weather road access by large (Type 2) road trains from the Victoria catchment boundary.

The closest port for bulk export of agricultural produce from the Victoria catchment is in Darwin. Darwin Port, operated by Landbridge Group, handles about 20,000 to 30,000 20-foot equivalent units each year, split roughly evenly between imports and exports. The main exports are dry bulk commodities (mainly manganese) and livestock, but there are also exports of agricultural produce in refrigerated containers. Exports of new bulk agricultural produce would require construction of a new storage facility. As export opportunities arise, the Port of Wyndham, 334 km west of Timber Creek in WA, may develop and provide these services.

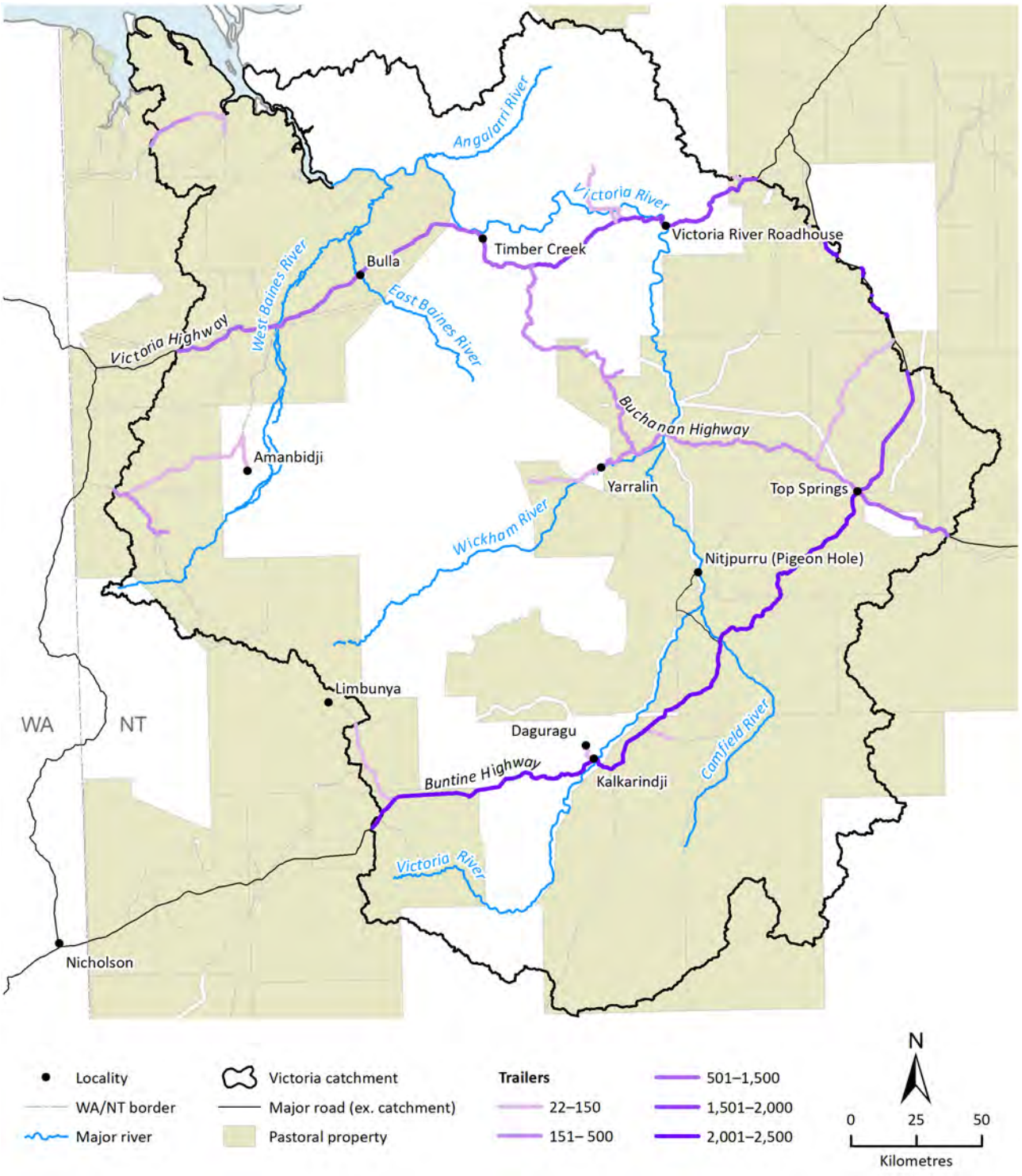

Figure 3-18 Annual amounts of trucking in the Victoria catchment and the locations of pastoral properties

The thickness of purple lines indicates the volume of traffic (as number of trailers per year) on regional roads connecting local properties.

Energy

The Victoria catchment is in a very remote part of the NT that does not have access to major electricity networks, and the small communities rely on diesel generators or hybrid diesel – solar photovoltaic systems provided by Power and Water Corporation.

The two largest off-grid remote communities in the Victoria catchment rely on hybrid systems powered by diesel generators supplemented with solar: Kalkarindji (408 kW solar system) and Timber Creek. Distribution lines link nearby smaller settlements to these off-grid sources of electricity, in the Victoria catchment Daguragu is connected to Kalkarindji.

The largest electricity network in the NT is the Darwin–Katherine Interconnected System (DKIS), which connects the capital of Darwin to Katherine further south by a 132 kV transmission line (Figure 3-19). Katherine is about 200 km from the Victoria River Roadhouse in the north-east of the catchment. Even if transmission lines were to connect the Victoria catchment to the DKIS, the DKIS is electrically isolated from other grids in Australia (see inset in Figure 3-19 for NT electricity and natural gas transmission system interconnections), so hence any large-scale electrical generation infrastructure in the Victoria catchment would still be disconnected from the National Electricity Market.

Historically, gas pipelines have been a cheaper way of transporting energy than electrical transmission lines (DeSantis et al., 2021; GPA Engineering, 2021). Consequently, a network of natural gas pipelines has been a cost-effective way of linking energy supplies across the NT by connecting sources of gas to electricity generators and other demand centres. However, gas power generation is not available in the Victoria catchment. The Amadeus Gas Pipeline is a bi-directional pipeline running from the gas fields of the Amadeus Basin near Alice Springs in the south northwards to Darwin (Figure 3-19). The McArthur River Pipeline connects to the Amadeus Gas Pipeline at Daly Waters and runs east to the generator at the McArthur River Mine (zinc and lead). The Northern Gas Pipeline, which runs 622 km between Tennant Creek in the NT and Mount Isa in Queensland (south of the Victoria catchment), provides a connection between the energy systems of the NT and the eastern states.

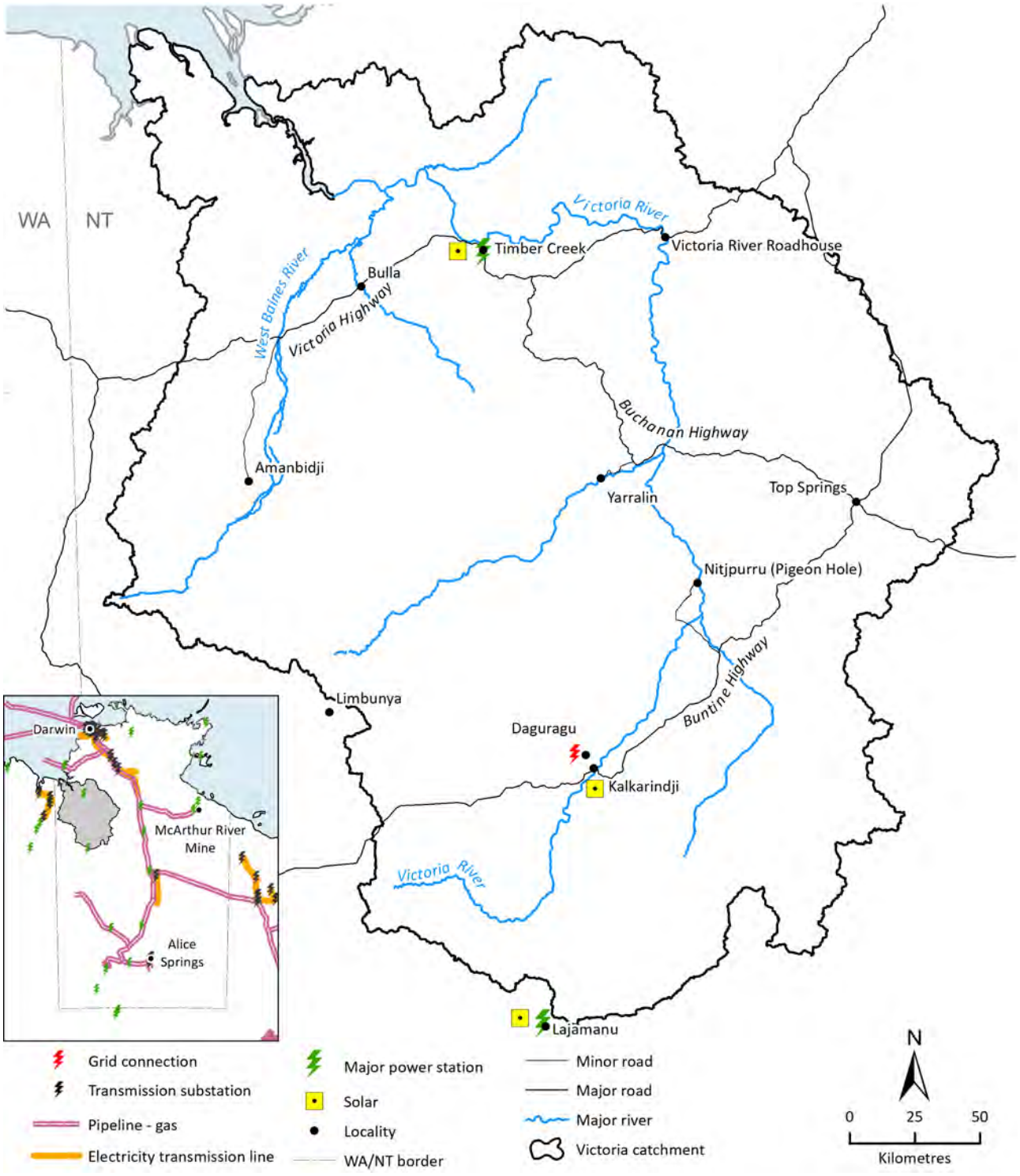

Figure 3-19 Electricity generation and transmission network in the Victoria catchment

Distribution networks are not shown, but communities marked with red lightning symbols are connected to nearby generation or transmission sources of electricity. The inset shows the pipeline and transmission network across the Northern Territory with the Amadeus Gas Pipeline running north–south (bi-directional) through Katherine.

Renewable energy potential in the Victoria catchment

The Victoria catchment has some of the best solar resources in Australia and a low to modest wind resource relative to other locations in Australia. A convenient metric for comparing renewable energy technologies is using the capacity factor of an energy plant, which is the ratio of electricity generated over one year to the nameplate capacity of the solar or wind farm. For example, for a capacity factor of 0.25, each 1 MW of a solar or wind farm will generate about 2190 MWh of electricity per year. In the Victoria catchment, solar photovoltaic capacity factors are uniformly high, ranging between 0.24 and 0.25. In contrast, in southern Australia and along the east coast the capacity factor can be as low as 0.12 (Figure 3-20).

Wind resources for the Victoria catchment are shown in Figure 3-21 as a capacity factor at a turbine hub height of 150 m, which is a typical height for a commercial wind turbine. Although wind capacity factors in the Victoria catchment are comparable to solar capacity factors, wind farms have a higher capital cost, which can result in a higher cost of electricity production. This is particularly the case for smaller wind turbines than those whose results are shown in Figure 3-21. The generation capacity of these smaller turbines is more likely to be commensurate with the energy requirements of a farm-scale irrigation enterprise. Furthermore, solar is modular and scalable and is easier to maintain in remote locations than wind turbines. Wind energy is a relatively mature technology, and projections of the levelised cost of wind in 2040 suggest that its cost is plateauing. In contrast, solar photovoltaic is projected to steadily decrease such that by 2040 the levelised cost of solar photovoltaic would be 26% to 34% lower than the cost of wind on average (Graham et al., 2023).

At Timber Creek in the Victoria catchment it was found that, based on current capital costs and diesel cost of $1.50/litre (including any rebate), diesel generators were the most cost-effective technology for supplying power to farm infrastructure requiring electricity 24 hours/day or requiring electricity for 30% or fewer days per year. For farm infrastructure operating more than 50% days of the year, and for 12 hours/day or less, a hybrid diesel – solar photovoltaic farm with the renewable fraction between 50% and 75% is the most cost-effective technology. The exception is for farm infrastructure requiring electricity for 4 hours/day and 365 days/year, for which a 100% solar photovoltaic farm (with batteries) was most the cost-effective way to provide power. Under a higher cost of diesel ($2.50/litre including rebates), the results were similar except a 100% renewable system with batteries was most cost-effective when electricity had to be supplied for 80% of days or more. By 2040, it was projected that hybrid diesel – solar photovoltaic systems (with batteries) were most cost-effective when farm infrastructure was operated for 30% of days/year or higher for 12 to 24 hours/day, or 10% of days/year when only operated for a maximum of 4 hours/day. See the companion technical report on techno-economic analysis of electricity supply (Graham, 2024) for more detail.

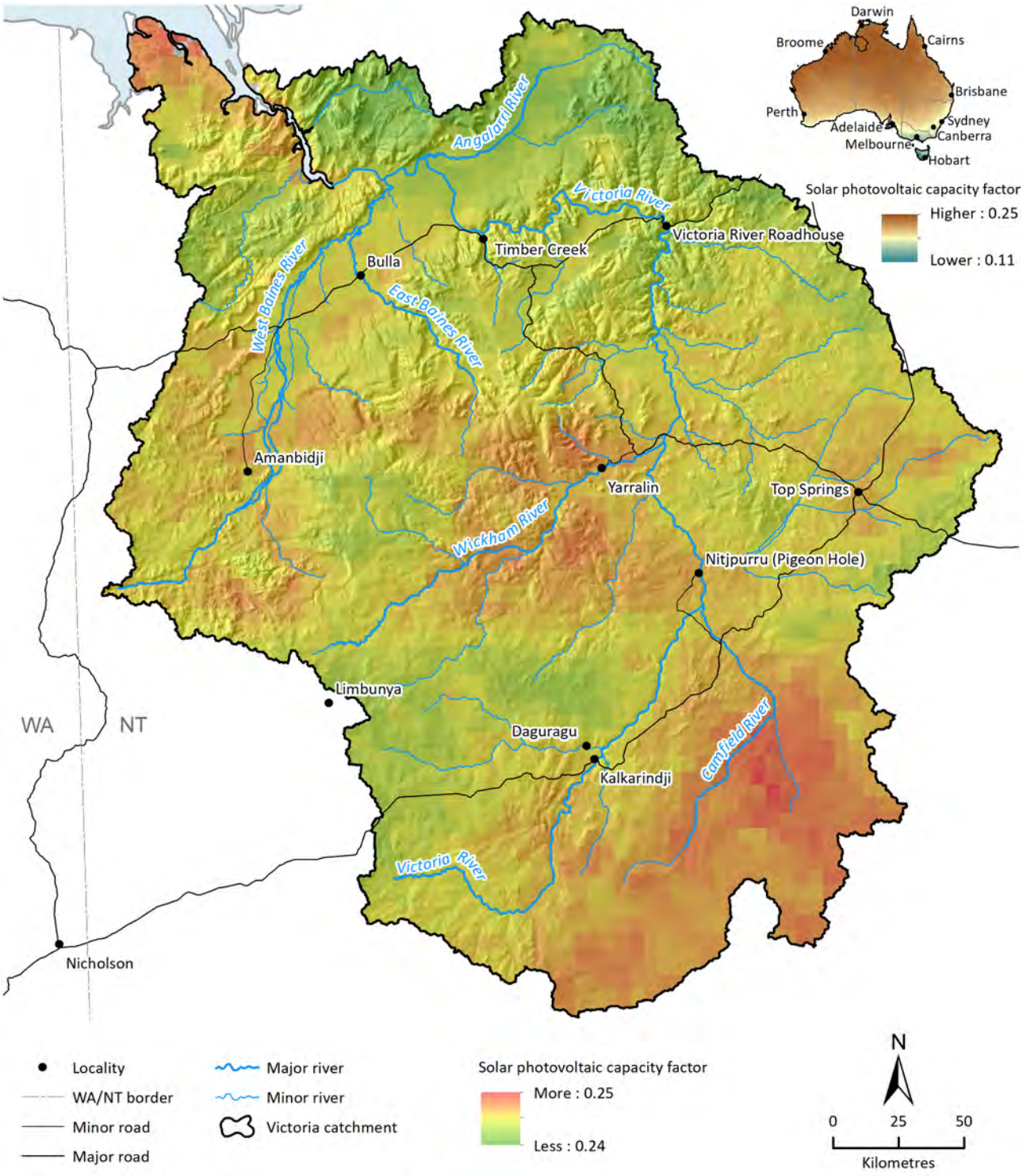

Figure 3-20 Solar photovoltaic capacity factors in the Victoria River catchment

Inset shows solar photovoltaic capacity factors across Australia. Note: the inset map uses a different colour ramp.

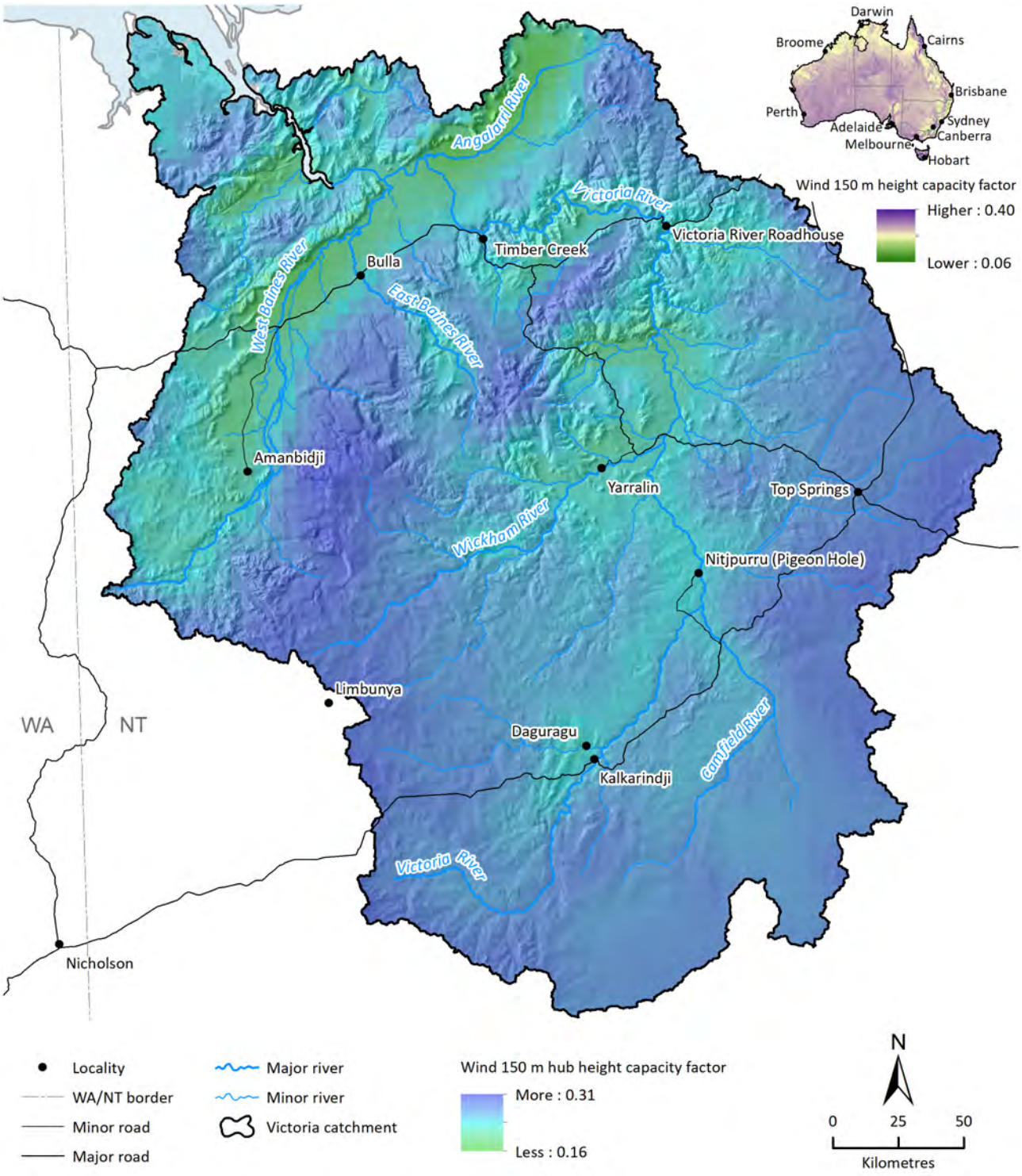

Figure 3-21 Wind capacity factors in the Victoria River catchment

Inset shows wind capacity factors across Australia. Note: the inset map uses a different colour ramp.

Water

Most communities in the Victoria catchment source their stock, domestic and community water supplies from groundwater. Surface water is also pumped from streams for stock and domestic use, and also from a few dams for use in agriculture and aquaculture. There are no major water transmission pipelines in the catchment and only a few small dams, except for Forsyth Creek Dam which holds up to 35 GL (CO_2 Australia Pty Ltd, 2016). Almost all water use in the catchment occurs outside water control districts or water allocation plan areas. The Victoria catchment mostly lies to the west of the Daly Roper Beetaloo Water Control District, though a small portion of the district occupies the eastern margin of the catchment to the north and south of Top Springs (Figure 3-22). The only water allocation plan currently applicable to the Victoria catchment is the Georgina Wiso Water Allocation Plan, which coincides with a small portion of the eastern margin of the catchment to the east of Top Springs (Figure 3-22).

Surface water entitlements

Licensed surface water entitlements are sparse across the Victoria catchment. Four surface water licences have been granted for a combination of use for agriculture and aquaculture, all occurring in the northern parts of the catchment (Figure 3-22). The largest entitlement (of 100 GL/year) is for use in aquaculture with the water sourced from Forsyth Creek near the mouth of the Victoria River (Figure 3-22). The second-largest entitlement is 50 GL/year for use in agriculture with the water sourced from Forsyth Creek Dam in the upper reaches of Forsyth Creek in the north-western part of the catchment (NT Department of Environment, Parks and Water Security, 2018). Two smaller surface water entitlements exist for agricultural use: one sourced from Weaner Dam (1.2 GL/year) in the north-western Victoria catchment and the other from the Victoria River (0.7 GL/year) in the northern Victoria catchment (Figure 3-22).

Groundwater entitlements

There are currently no licensed groundwater entitlements in the Victoria catchment. However, there are three licensed entitlements totalling 7.4 GL/year for use in agriculture to the north-east of the Victoria catchment, occurring in the proposed Flora Tindall Water Allocation Plan area (NT Department of Environment, Parks and Water Security, 2018). The groundwater is sourced from the Tindall Limestone Aquifer, which is connected to the limestone aquifer hosted in the Montejinni Limestone along the eastern margin of the Victoria catchment. However, the closest of the three licensed bores occur far outside of the Victoria catchment, approximately 110 km to the north-east of the Victoria River Roadhouse, and approximately 150 km to the north-east of Top Springs. The Montejinni Limestone hosts the largest and most productive regional-scale groundwater system in the catchment.

Groundwater resources from a variety of local- to intermediate-scale groundwater systems hosted mostly in fractured and weathered rock aquifers provide important sources of community water supplies. The annual volume of groundwater extracted for community water supplies is only small (i.e. <0.2 GL/year), so a groundwater licence is not required (Figure 3-22). Groundwater is also widely used across the catchment in small quantities for stock and domestic water supplies for which a groundwater licence is also not needed. For more information on groundwater resources of the Victoria catchment, see the companion technical report on hydrogeological assessment by Taylor et al. (2024).

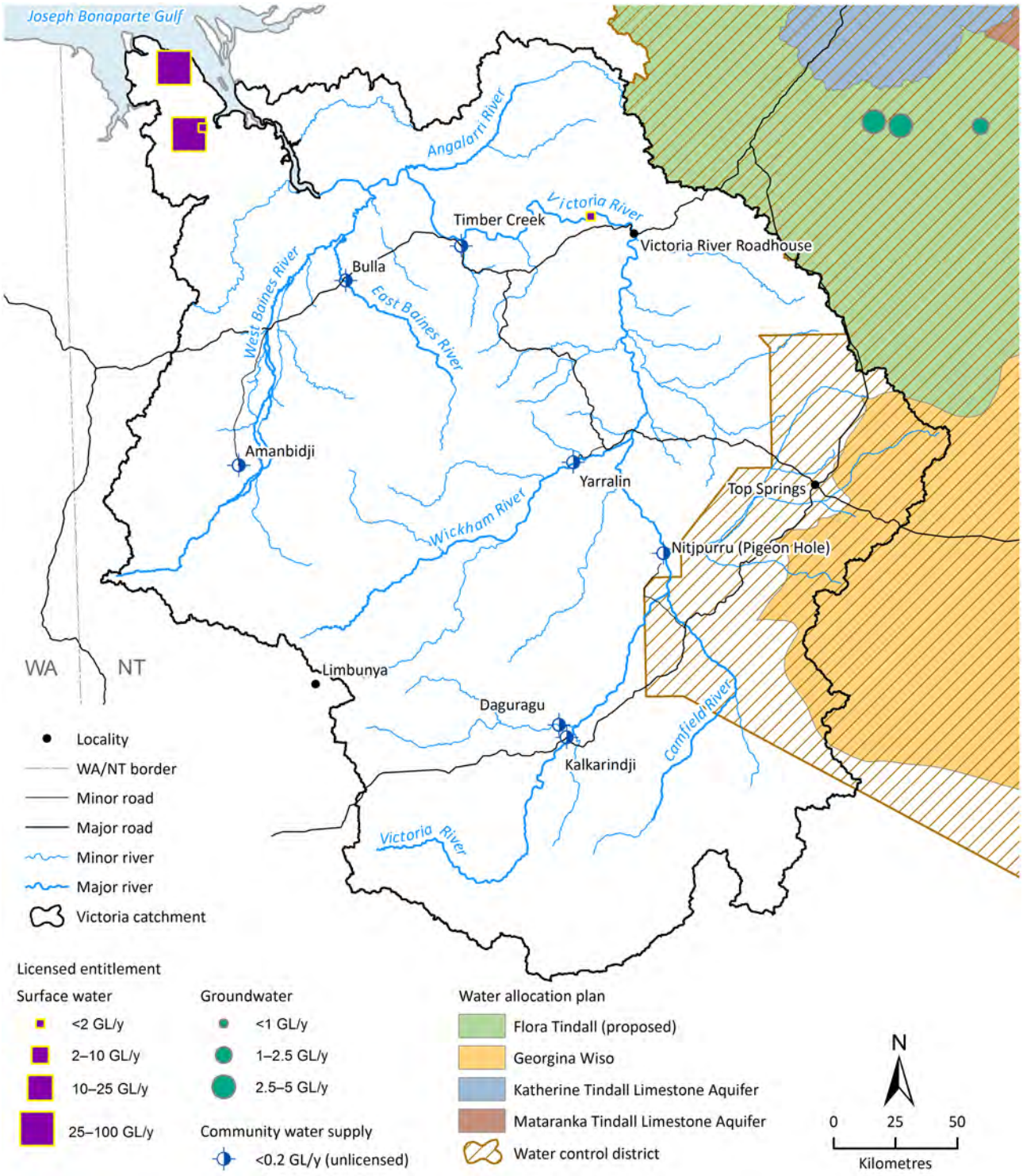

Figure 3-22 Location, type and volume of annual licensed surface water and groundwater entitlements

Data source: Water allocation plan areas and the Daly Roper Beetaloo Water Control District sourced from the NT Department of Environment, Parks and Water Security (2024a, 2024b)

Community infrastructure

The availability of community services and facilities in remote areas can play an important role in attracting people to or deterring people from living in those areas. Development of remote areas, therefore, needs to consider whether housing, education and health care are sufficient to support the anticipated growth in population and demand, or to what extent these would need to be expanded.

There are no hospitals in the Victoria catchment, but like most remote parts of Australia, the area is serviced by a primary health network (PHN). Australia is divided into 31 PHNs, and one of these covers the whole of the NT. General practitioners and allied health professionals provide most primary health care in Darwin and the regional centres within the NT PHN, while smaller communities are supported by remote health clinics (NT Primary Health Network, 2020). The Victoria catchment falls within the Katherine Health Service District (HSD) (also known as the Big Rivers Region) of the NT PHN where the Sunrise Health Service Aboriginal Corporation and Katherine West Health Board provide remote health services. PHNs work closely with local hospital networks, and for the Katherine/Big Rivers Region the associated hospital is Katherine Hospital, which is located approximately 150 km by road outside the eastern border of the Victoria catchment. This hospital has 60 beds and provides emergency services, surgical and medical care, paediatrics and obstetrics (NT Primary Health Network, 2020). There are three health centres in the Victoria catchment (Kalkarindji, Timber Creek and Yarralin) staffed daily, and health clinics in four communities (Amanbidji, Bulla, Lingara and Nitjpurru (Pigeon Hole)).

A network of six government schools covers the small communities throughout the Victoria catchment. A total of 321 full-time equivalent (FTE) students are enrolled in these schools with 40.3 teachers (FTE) in 2022 (Table 3-9). The largest school in the catchment is at Kalkarindji. There are a further six schools in Katherine, outside the Victoria catchment and about 290 km north-east of Timber Creek, and there is also a school of the air in Katherine that serves 183.1 students (FTE) across the region.

Table 3-9 Schools servicing the Victoria catchment

SCHOOL NAME	SCHOOL TYPE	YEAR RANGE	STUDENTS (FTE†)	TEACHERS (FTE)
Schools in the Victoria catchment				
Amanbidji School	Combined	Preschool – Year 9	15	4.2
Bulla Camp School	Combined	Preschool – Year 9	13	1.5
Kalkarindj School	Combined	Preschool – Year 12	184	18.6
Pigeon Hole School (Nitjpurru)	Primary	Preschool – Year 6	19	4
Timber Creek School	Combined	Preschool – Year 9	37	3
Yarralin School	Combined	Preschool – Year 9	53	9
Schools in Katherine (outside the Victoria catchment)				
Casuarina Street Primary School	Primary	Preschool – Year 6	344.6	25
Clyde Fenton Primary School	Primary	Preschool – Year 6	157	11.2
Katherine High School	Secondary	Year 7 – Year 12	475.6	44.2
Katherine School of the Air	Combined	Preschool – Year 12	183.1	13.3

SCHOOL NAME	SCHOOL TYPE	YEAR RANGE	STUDENTS (FTE†)	TEACHERS (FTE)
Katherine South Primary School	Primary	Preschool – Year 6	275	15.6
Kintore Street Special School	Special	Preschool – Year 12	61	11.8
MacFarlane Primary School	Primary	Preschool – Year 6	174.2	12.8

†FTE = full-time equivalent.
Source: ACARA (2023) (data presented with permission)

At the time of the 2021 Census, about 22% of private dwellings were unoccupied, which is higher than the national and NT means, although the absolute number of unoccupied dwellings is small (Table 3-10). This suggests that the current pool of housing may have some capacity to absorb small future increases in population, notwithstanding natural disasters such as fire and flooding as experienced in 2023 and 2024.

Table 3-10 Number and percentage of unoccupied dwellings and population for the Victoria catchment

INDICATOR	UNIT	VICTORIA RIVER SA2 REGION	VICTORIA CATCHMENT†	NORTHERN TERRITORY	AUSTRALIA
Total population 2021	People	2,609	1,600	232,605	25,422,788
Total unoccupied private dwellings 2021	Dwellings	135	83	10,404	1,043,776
% private dwellings that are unoccupied	%	22.20	22.29	12.83	10.12

†Weighted averages of scores for SA2 regions falling wholly or partially within the catchment boundary.
Source: ABS (2021) Census data

3.4 Indigenous values, rights, interests and development goals

3.4.1 Introduction and research scope

This section gives an overview of the information needed on Indigenous water issues in the Assessment area to provide foundations for further community and government planning and decision making. It provides some key background information about the Indigenous Peoples of the Victoria catchment and their specific values, rights, interests and goals in relation to water and irrigated agricultural development. Unless otherwise stated, the material in this section is based on findings described in the companion technical report on Indigenous values, rights, interests and development goals (Barber et al., 2024).

Indigenous Peoples represent a substantial and growing proportion of the population across northern Australia, and they have secured rights and interests in over 70% of the land. They control significant natural and cultural resource assets, including land, water and coastlines. Indigenous Peoples are crucial owners and will increasingly become critical partners, co-investors and stakeholders in future development. Understanding the past is essential to understanding present circumstances and forms of organisation to engage with development options and future possibilities.

The material provided here begins with historical information and a description of the contemporary ownership of the Assessment area. Section 3.4.2 describes the past habitation by Indigenous Peoples, the significance of water in habitation patterns, and the impact of exploration and colonisation processes. Section 3.4.3 reviews the contemporary situation with respect to

Indigenous Peoples' residence, land ownership and access. Section 3.4.4 outlines Indigenous water values and responses to development, and Section 3.4.5 describes Indigenous-generated development objectives. There has been some previous publicly available information about Indigenous connections to land and waters in the Victoria catchment, but there is far less consideration of Indigenous perspectives on general water development and associated irrigated agricultural development in the catchment. The Assessment technical report directly addresses these data needs (Barber et al., 2024).

Engagement with Indigenous Peoples is a strong aspiration across governments and key industries. Nevertheless, models of engagement vary considerably, and competing understandings of what 'engagement' means (e.g. consultation, involvement, partnership) can substantially affect successful outcomes. Standard stakeholder models can also marginalise Indigenous Peoples' interests, reducing what Indigenous Peoples understand as prior and inalienable ownership rights to a single 'stake' equivalent to all others at the table.

Guided by advice from the Northern Land Council (NLC) and the Central Land Council (CLC), the Assessment undertook one-on-one and small group interviews with 19 predominantly senior Traditional Owners from within the Victoria catchment to establish a range of views regarding water and agricultural development. Comments from these interviews were analysed and major themes and issues identified. The Assessment does not try to facilitate or provide Traditional Owner group positions about any of the issues raised and is not a substitute for formal processes required by cultural heritage, environmental impact assessment, water planning or other government legislation. Nevertheless, the Assessment identifies key principles, important issues and potential pathways to guide future planning and formal negotiations with Traditional Owners.

3.4.2 Pre-colonial and colonial history

Pre-colonial Indigenous societies

Northern Australia contains archaeological evidence of Indigenous habitation stretching back many thousands of years (Clarkson et al., 2017). Resource-rich riverine habitats were central to Indigenous economies based on seasonally organised hunting, gathering and fishing. Rivers were also major corridors for social interaction, containing many sites of cultural importance (Barber and Jackson, 2014; McIntyre-Tamwoy et al., 2013). Pre-colonial Indigenous societies are characterised by long residence times; a detailed knowledge of ecology and food gathering techniques; complex systems of kinship and territorial organisation; and a sophisticated set of religious beliefs, referred to by Traditional Owners in the Victoria catchment as the Dreaming. These Indigenous religious cosmologies provide a source of spiritual and emotional connection as well as guidance on identity, language, law, territorial boundaries and economic relationships (Rose, 2011; Strang, 1997; Williams, 1986). From an Indigenous perspective, ancestral powers are present in the landscape in an ongoing way, intimately connected to people, Country and culture. Mythological creators have imbued significance to places through creation, leaving evidence of their actions and presence through features in the landscape (Rose, 2011). Totemic figures can be animals or plants, take human-like or inanimate object form, or be sentient beings that have agency to act (Rose 2011; Peterson, 2013). Those powers must be considered in any action that takes place on Country.

Colonisation

European colonisation resulted in significant levels of violence towards Indigenous Peoples with consequent negative effects on the structure and function of existing Indigenous societies across the continent. Overt violence, armed defensiveness and avoidance were all evident in colonial relationships as hostilities occurred as a result of competition for land and water resources, colonial attitudes and cultural misunderstandings.

Following a number of visits by explorers earlier in the 1800s, pastoralism commenced seriously in the Victoria catchment in the 1880s, and the large and high-profile Victoria River Downs Station and the nearby Wave Hill Station were both established in 1883 (Lewis, 2012). Pastoral homesteads and outstations were sited close to permanent water and on the fertile plains and river valleys used by Indigenous Peoples for food and other resources (Lewis, 2012; McGrath, 1987). Indigenous attacks on colonial pastoral operations were made both in retaliation for past attacks by colonists and as a response to shortages of food and other resources. Major killings are recorded in both historical documentation and oral histories, and massacres and violent encounters in the early colonial period in the Victoria catchment have received some attention (Lewis, 2012; Rose, 2011; Ryan et al., 2018). The police station at Timber Creek was established in 1898 as one response to the serious situation. However, some police employees were involved in the violence, and there were further massacres in the twentieth century (Lewis, 2012). Figure 3-23 shows the locations of some key colonial massacre sites in the Victoria catchment.

To ensure their safety, Indigenous Peoples were obliged to move to cattle stations and mission settlements. The stations became places for enforced dependence and colonial influence in order to both control people and protect cattle (Hokari, 2011; Rose, 2011). Poor conditions on pastoral stations were ubiquitous, and at Wave Hill Station, the combination of pastoral exploitation and a desire to control their own lands led to the local Gurindji stockmen going on strike and walking off the property in 1966 (Hardy, 1968; Ward, 2016). The Wave Hill Walk-off and associated strike lasted 7 years and was a crucial part of the wider momentum for Indigenous rights and recognitions in the 1960s and early 1970s that led to the recognition of Aboriginal land rights through the ALRA. The formation or major expansion of the townships of Kalkarindji, Daguragu and Yarralin all date from this significant period of social change (Rose, 2011; Ward, 2016).

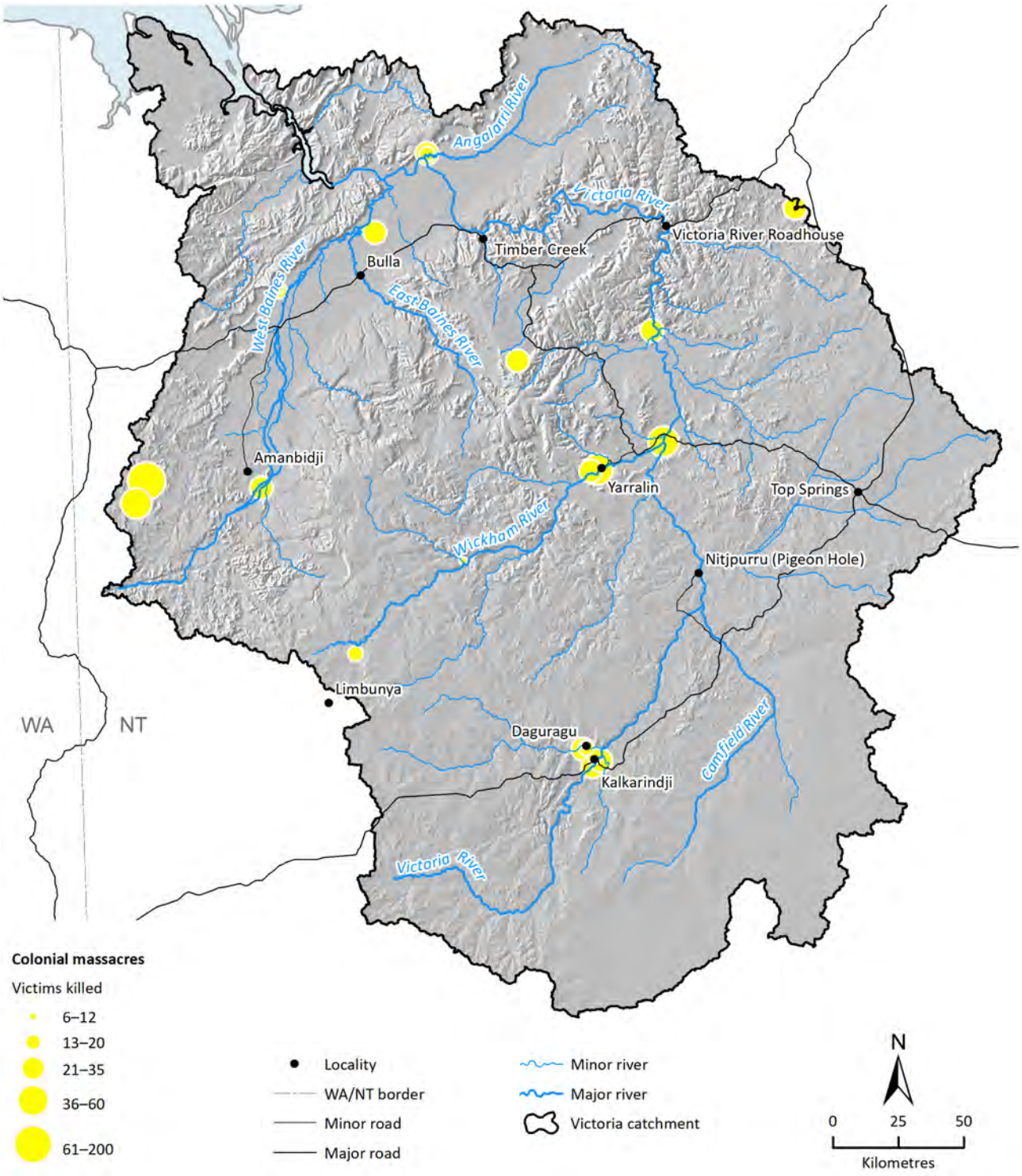

Figure 3-23 Colonial frontier massacres in the Victoria catchment

Source: Ryan et al. (2018, 2022).

3.4.3 Contemporary Indigenous ownership, management, residence and representation

Despite the pressures entailed by colonisation, Country remained crucial to Indigenous Peoples' lives, sustaining distinct individual and group identities as well as connections to past ancestors and future descendants. People are connected to places through a combination of genealogical, traditional and residential ties. Only some of these connections are formally recognised by the Australian state.

Traditional Ownership

Traditional Ownership of the Victoria catchment is complex and diverse, encompassing large language groups divisible into related groups and subgroups. Ownership patterns tend to follow natural landscape features, such as rivers and hills, as well as formal boundaries between ownership groups where these have been negotiated. In other places, the edges of group territories are less distinct, and there may be shared territory or overlapping claims. Information regarding the identification of potential owners and interest holders is provided by registered organisations such as the NLC, CLC and the Aboriginal Areas Protection Authority (AAPA). Key language group names used publicly include the Gurindji and Ngarinyman in the southern and central parts of the catchment, Ngaliwurru and Nungali in the Timber Creek area, and Miriuwung and Gajerrong groups in the west.

The ALRA provides a standardised form of inalienable collective freehold ownership across significant parts of the NT. The Act grants strong rights that are held and managed by Aboriginal Land Trusts that represent the Traditional Owners. Thirty-one per cent of the land tenure underlying the Victoria catchment is held under the land rights regime (Figure 3-24). However, over half of this overall holding comprises the Judbarra National Park, which is overlaid by a 99-year lease with the NT Government. The lease provides for joint management by Traditional Owners and the government and creates a very different public access regime than the stringent access permit system that operates on conventional land rights land. Consequently, Traditional Owners do not have the same direct control, unimpeded access, ability to exclude others, or amenity and privacy on national park ALRA land as they do on standard ALRA land.

Across the whole of Australia, the primary form of recognition for Indigenous Peoples' rights and interests is the Commonwealth *Native Title Act 1993*. In the NT, the native title system has primarily been used to secure rights for Traditional Owners in circumstances where the ALRA is not applicable. This is because native title does not provide a strong standard set of rights – rather, each native title determination outlines specific rights that were able to be determined (proven in court) in that particular case. A determination may only recognise very limited rights, such as access for specific cultural purposes under certain conditions, or it may encompass strong rights such as exclusive possession. This variability means that considerable caution should be used in interpreting a map showing substantial areas of determined native title, such as Figure 3-25. The areas may indicate constrained and specific rights to access and consultation, which is very different to the inalienable freehold granted under the ALRA.

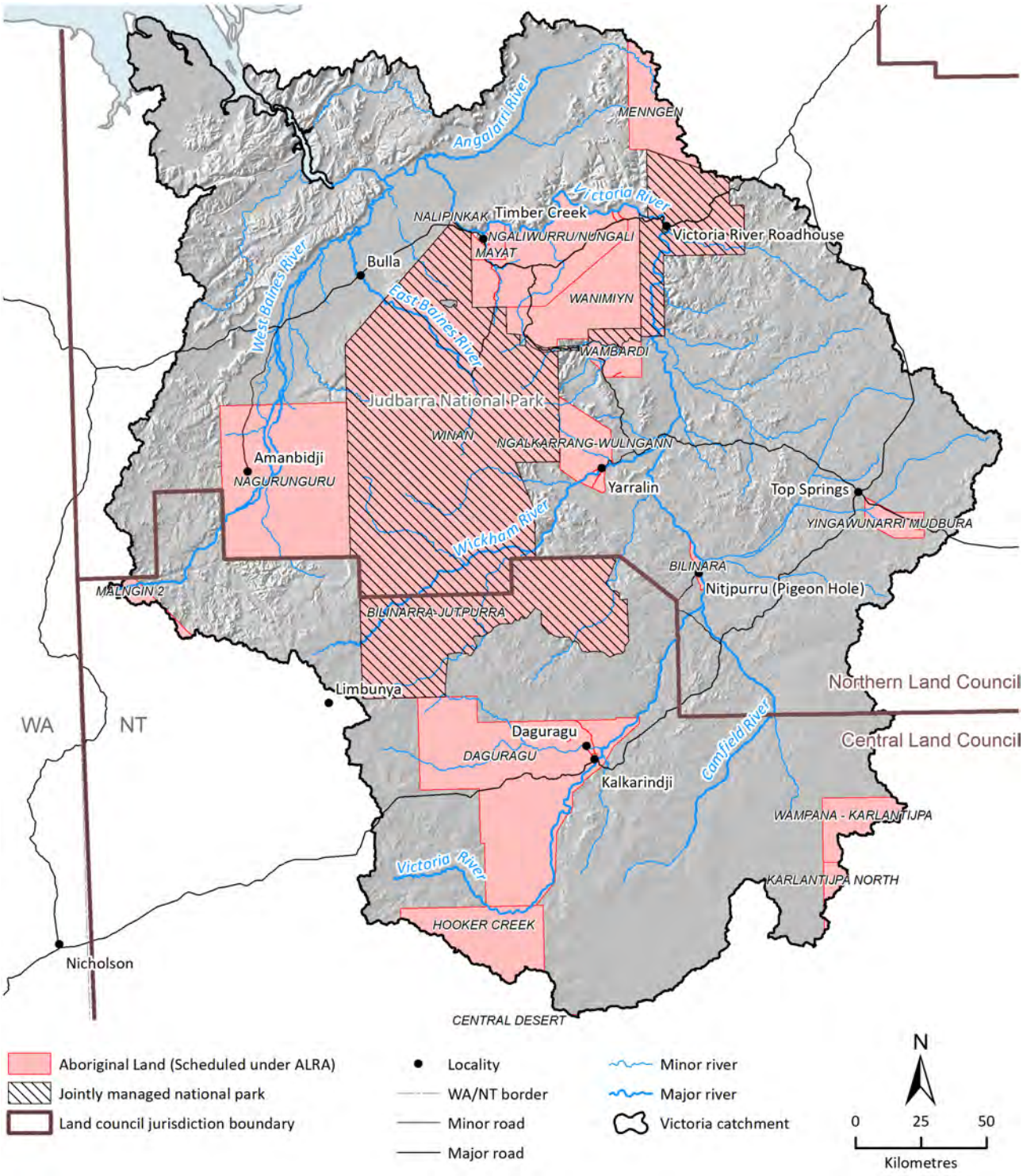

Figure 3-24 Aboriginal freehold land in the Victoria catchment as at November 2023

ILUA = Indigenous Land Use Agreement; ALRA = *Aboriginal Land Rights (Northern Territory) Act 1976* (Cth)

Data source: NT Government

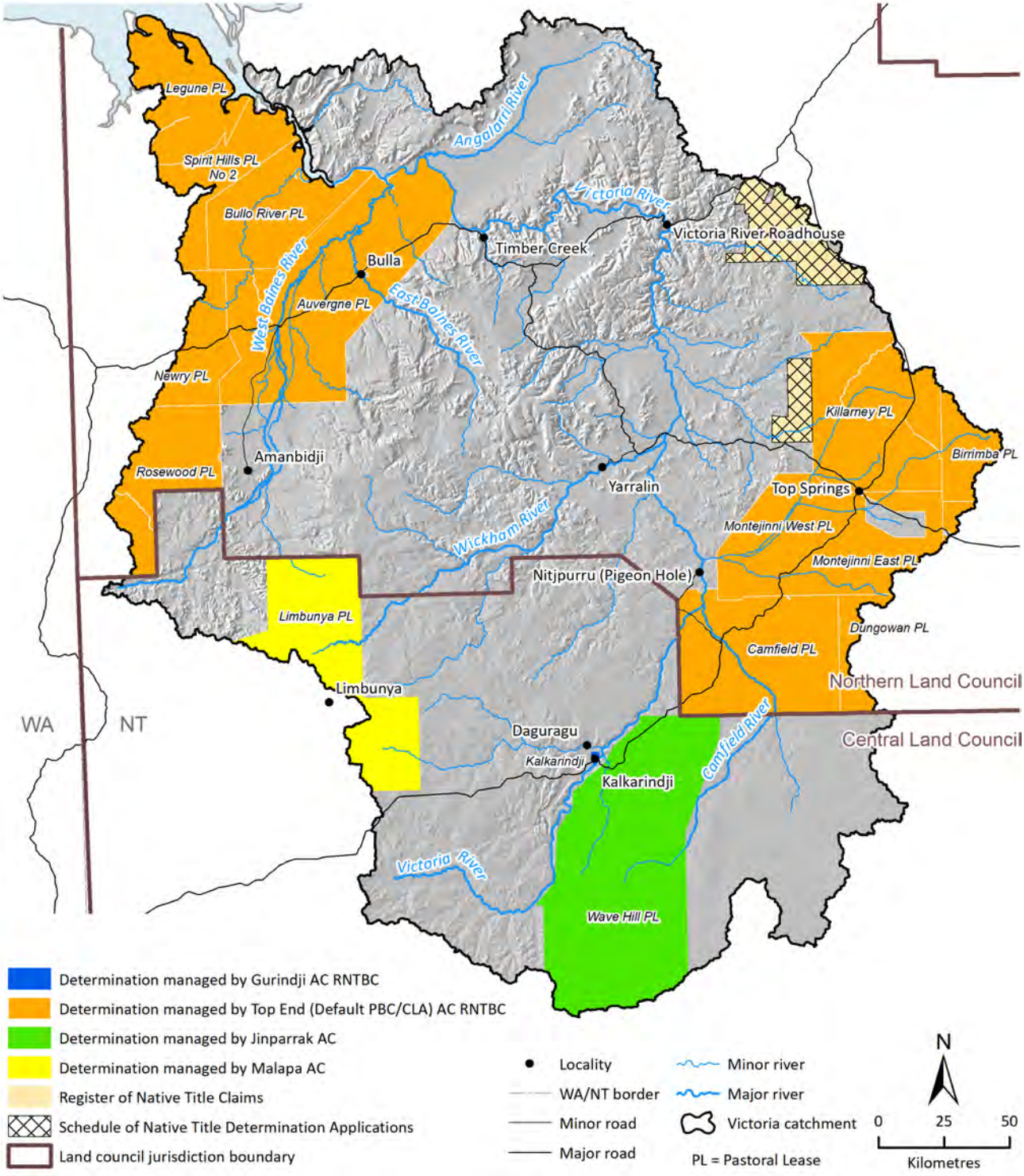

Figure 3-25 Native title claims and determinations in the Victoria catchment as at November 2023

Data source: National Native Title Tribunal

Native title in the Victoria catchment demonstrates this pattern. Approximately 34% of the catchment is covered by determinations that native title exists in all or part (generally the large majority) of the determination area, and a further 1.6% is under current claim. But the determination areas are aligned with and named after existing pastoral lease boundaries, and the determinations themselves provide limited access rights onto leases held and operated by generally large-scale pastoral and agricultural companies. In addition, native title holders in the NLC jurisdiction are not represented by locally based Registered Native Title Bodies Corporate (RNTBCs), often known as Prescribed Bodies Corporate (PBCs). Rather, they are all represented by a small and operationally limited shell entity based at the NLC in Darwin known as the Top End (Default PBC/CLA) Aboriginal Corporation RNTBC (Figure 3-25). As a result, native title holders in much of the Victoria catchment do not have locally distinctive representative or operational capacity comparable to land trusts under the ALRA. The native title system also allows for voluntary registered agreements between native title claimants or holders and other interested parties for the use and management of land and resources. These are known as Indigenous Land Use Agreements (ILUA). Further information on these in the Victoria catchment is provided in Barber et al. (2024).

The specific implementation of the ALRA and native title regimes in the Victoria catchment means that Traditional Owners in the area experience five primary states of tenure over large areas of the wider landscape beyond towns and communities. In order from the greatest amount of legal recognition, ownership, and control to the least, they are:

1. Collective freehold, primarily through the ALRA or other freehold mechanisms
2. Collective freehold through the ALRA overlaid by a 99-year lease to the NT Government for a national park
3. Limited, native title–based access rights for specific purposes to pastoral leases held by non-Indigenous people and corporations (often large pastoral and agricultural companies)
4. Crown lease for defence training purposes with an Indigenous Land Use Agreement over the lease
5. Pastoral leases and other holdings held by non-Indigenous people without current native title determinations or other forms of Indigenous recognition (notably Victoria River Downs, Humbert River, Delamere, Riveren and Waterloo stations).

This variety of possible tenures means that the location of any proposed development is highly consequential in determining how Traditional Owners are positioned with respect to that development. They may have substantial control through the ALRA, have only limited rights to consultation under native title, or have no recognised substantial Indigenous-specific tenure and property rights.

Indigenous population and residence

Indigenous Peoples comprise 74.68% of the total estimated Victoria catchment population of approximately 1600 people (Table 3-3). This includes people who are Traditional Owners as well as residents who identify as Indigenous but have their origins elsewhere. Many Traditional Owners may primarily reside outside the traditional lands to which they have formal ties. These patterns of

residence and dispersal reflect a combination of historical involuntary relocation, voluntary movement to seek jobs and other opportunities, and kinship and family links.

Indigenous communities in the Victoria catchment include Daguragu, Nitjpurru (Pigeon Hole), Yarralin, Bulla and Amanbidji. Substantial numbers of people also live at the towns of Kalkarindji and Timber Creek. Indigenous communities face a range of social and demographic challenges, including significant unemployment, poor health and housing, water insecurity and structural impediments to economic participation, including remoteness and social and family units under high levels of stress. As two responses to these circumstances, participants in the Assessment sought economic and social conditions that would enable more of their people, particularly young people, to be employed and for the capacity to engage in formal planning processes on their own traditional lands.

Indigenous governance and representation

Indigenous organisational and political structure within the Victoria catchment is diverse. The NLC and the CLC are the major regional Indigenous representative organisations for the Victoria catchment. They represent and act for Traditional Owners with respect to access, participation, partnership and ownership. Local groups in the area are represented through a range of Indigenous corporations and entities, including Aboriginal Land Trusts and Aboriginal corporations. However, as noted above, native title representation is limited. Traditional Owners and their corporations varied significantly in their existing capacity, resourcing, partnerships and ability to participate in natural resource management decision making.

3.4.4 Culture, people and Country

Traditional Owners in the Victoria catchment are strongly connected to their Country and to one another. Cultural responsibilities to protect and sustain Country and kinship connections with others are key drivers of belief and action. Participants in the Assessment highlighted important underlying assumptions and roles that include:

- the assumption of Traditional Ownership of land and water resources
- the need for formal external recognition of, and engagement with, that ownership and its associated responsibilities
- the role of local histories in establishing Traditional Owners' connections and authority
- the ongoing role of religious and spiritual beliefs
- the knowledge and practices that sustain group and language boundaries and identities
- the importance of hunting, foraging and fishing activity to Indigenous Peoples' cultures
- inter-generational obligations to both ancestors and descendants to care for Country
- regional responsibilities to near neighbours and downstream groups to maintain the integrity of the Country and related Indigenous Knowledge and practices
- the significance of environmental and cultural heritage and its protection.

Alongside native title and land rights, a key mechanism for protecting Country is the Northern Territory *Aboriginal Sacred Sites Act* 1989 (NT). The AAPA is established under this Act as an independent statutory authority that assists with recording, registering and protecting sacred

sites. With respect to environmental protection and management, Indigenous cultural and natural resource management programs, often known as Indigenous rangers, can play a very significant role. Culture, people, and Country, and the connections between those concepts, are fundamental to Indigenous Peoples' responses to development.

3.4.5 Contemporary Indigenous water values

In general terms, Indigenous water values emphasise securing sufficient water of good quality to maintain healthy landscapes, remote community health and livelihoods, and to support Indigenous needs. Those needs can be defined in multiple ways. From an economic perspective, they encompass such activities as art and cultural production, hunting and gathering, tourism and recreation, and ownership and participation in larger-scale economic enterprises such as pastoralism and agriculture. All of these needs depend on natural resources, which highlights the importance of securing and maintaining good-quality water supplies.

Data from the Assessment clearly demonstrate the fundamental significance of water for Traditional Owners in the Victoria catchment. Water is essential for community life, health and practical hygiene, sustaining a healthy Country, religious symbolism and ancestral connection. Statements about the importance of water from participants in the Assessment are consistent with broader statements that outline significant Indigenous water rights, values and interests, both in Australia (NAILSMA, 2008, 2009) and internationally (United Nations, 2023; World Water Council, 2003).

Traditional Owners experience very high variability in the presence and absence of water in the landscape. The country can be extremely dry at the end of the dry season, while flooding incidents in 2022, 2023 and 2024 across the Victoria catchment had a significant impact on a number of major towns and communities. Daguragu, Kalkarindji, Nitjpurru (Pigeon Hole) and Timber Creek were all seriously affected by major floods that required residents to emergency evacuate and/or residentially relocate for significant periods. These experiences have heightened awareness of water, climate change, community infrastructure and regional development issues.

Water is extremely important to Traditional Owners in the Victoria catchment for cultural, ecological, and practical reasons. Key issues and ongoing goals for water include:

- ensuring there is enough water of sufficient quality to maintain healthy landscapes (environmental flows) and sustain cultural resources and practices
- having access to all water sites
- maintaining adequate and good-quality supplies of water for human consumption and recreation in communities
- monitoring and reporting of water uses
- development impacts on water quality
- deriving benefits from water development and water use
- securing sufficient water reserves for current and future economic activity.

3.4.6 Responses to water and irrigation development

In the Victoria catchment, Traditional Owner responses to water and irrigation development are interpreted through perceptions of past and current development within and beyond the catchment, and through observations of ongoing environmental and seasonal changes. Participants' responses to water development and extraction included considerations of impacts on water quality, streamflow, water-dependent ecosystems, community water access, and human cultural practices and recreation. Large instream dams were strongly resisted. In general, larger-scale water and agricultural development were seen as incompatible with Traditional Owner values and ways of living. Concerns about water development encompassed concerns about the cumulative impacts from other industries, particularly mining.

Traditional Owners' assessments of the relative risks and benefits associated with development proposals were significantly affected by their awareness of their position as long-term custodians, marginalised socio-economic status, limited understanding of non-Indigenous water governance and development approval regimes, and knowledge of negative ongoing impacts of development projects elsewhere. Some data on preferences for particular kinds of water development were gathered. The general order of preference, from most to least favourable, was:

1. flood harvesting to supply smaller, offstream storages
2. bore and groundwater extraction
3. smaller instream dams constructed inside tributaries or branches
4. large instream dams in major river channels.

Proposals for specific sites may or may not align with the order of preference above, and new information may alter the above order at both local and regional scales. How water infrastructure affects flood risk might also be a factor in the Victoria catchment.

Traditional Owners wish to own and control their own developments. With respect to major water and irrigation development undertaken by others, key criteria for evaluation include:

- early and further formal consultations with Traditional Owners and affected groups about options, environmental assessments and potential impacts and preferences
- development that specifically addresses Indigenous needs (e.g. education, amenity, access to sites, community and outstation water supply, and recreational opportunities)
- appropriate cultural heritage surveys of likely areas of impact
- agreements that support Traditional Owner employment and other benefits, and continuous consultation and assessment during development, construction and operation
- support for Traditional Owner roles in development that enable influence over water planning, wider catchment management and enterprise development.

3.4.7 Indigenous interests in water planning

Water planning is understood to be one way of managing water development risk, but water planning also has particular challenges. In the NT, significant progress in one element has been achieved through the Strategic Aboriginal Water Reserves (SAWRs) (NT Government, 2017). This

policy provides scope for further Indigenous recognition by creating reserved water allocations for Indigenous development purposes in water allocation plans. However, only a small area in the far east of the Victoria catchment is currently included in a water control district with an associated water plan. Elsewhere there are no districts or water plans through which such a reserve could be created.

The Assessment highlights that formalisation and specification of Indigenous water values and water planning issues in the context of both water planning and catchment management regimes is needed. This requires:

- creating the planning and regulatory structures that enable water planning and management
- formal scoping discussions at local and catchment scales about how best to support Traditional Owner involvement
- refining Traditional Owner governance rights, roles and responsibilities in water planning
- resourcing Traditional Owner involvement in water planning, including formal training and water literacy programs
- allocating Indigenous-specific water for development purposes, which may include options for leasing water rights, and remote community and outstation water access and supply
- further specifying the impacts of water planning on current and potential future native title rights and on cultural heritage
- coordinating water planning processes with land, catchment and development planning
- addressing continuing Indigenous water research needs and information priorities.

These suggested steps rely on Traditional Owners having relevant information for their decision making and having sufficient time to undertake their consultations at local and catchment scales.

3.4.8 Indigenous development objectives

Indigenous Peoples have a strong desire to be understood as development partners and investors in their own right, and they have their own independent development objectives. This stance informs their responses to development proposals outlined by others. As a group, Indigenous Peoples are socially and economically disadvantaged while also being custodians of ancient landscapes. They therefore seek to balance short- to medium-term social and economic needs with long-term cultural, historical and religious responsibilities to ancestral lands. Past forums have outlined Indigenous development agendas (NAILSMA, 2012, 2013) that are consistent with the perspectives from Traditional Owners in the Assessment. These agendas are informed by two primary goals:

- greater ownership of, and/or management control over, traditional land and waters
- sustainable retention and/or resettlement of Indigenous Peoples on their Country.

These goals are interrelated because retention and/or resettlement relies on employment and income generation, and most business opportunities identified by Traditional Owners depend on land and natural resources: pastoralism, conservation services, ecotourism, agriculture, aquaculture and marine harvesting. Each group in the Victoria catchment has multiple responsibilities and management roles, but differences in geography, accessibility, residence,

assets, governance and/or skills mean that some Traditional Owners are more easily able to sustain multiple business activities; others will achieve greater success by focusing on a single activity.

With respect to Indigenous objectives and development planning, five primary interrelated development goals are identified:

- greater recognition of Traditional Ownership of water and/or management control over water
- ensuring water supply for human consumption and recreation in communities and outstations
- improved information flow and empowerment for Indigenous decision makers
- protection and strengthening of regional and catchment governance in line with customary connections
- development of new Country-based businesses and industries.

Three Country-based industries were the most commonly raised by participants in the interviews as a focus for their own future business aspirations: agriculture, Indigenous cultural and natural resource management, and tourism. Traditional Owners in the Victoria catchment possess valuable natural, historical and cultural assets and represent a significant potential labour force, but they collectively lack skills in business development and implementation. Partnerships can address this gap, but opportunities for business to understand and invest in Traditional Owners and their lands in the Victoria catchment are currently limited.

Indigenous development objectives and Indigenous development partnerships are best progressed through locally specific group- and community-based planning and prioritisation processes that are nested in a system of regional coordination. Such planning and coordination can greatly increase the success of business development and of the opportunities for Indigenous employment, retention and resettlement that arise from them. Beyond business conditions, health and community services and infrastructure will be vital to attracting and retaining a skilled labour force. The work undertaken here shows that Traditional Owners in the Victoria catchment strongly wish to participate in sustainable economic activity. They can also act as a substantial enabler of appropriate development but need to be engaged early and continuously in defining development pathways and options.

3.5 Legal and policy environment

Proponents must be aware of a range of legal, policy and regulatory requirements and approvals when contemplating land and water developments within the Victoria catchment. As part of their due diligence process, proponents must be prepared to secure appropriate land tenure and authorisations to take water and to obtain the necessary approvals well in advance of commencing construction and operation of a development. This section describes the overarching Australian legal context and summarises the key issues and related legal, regulatory and approval considerations that apply to water-related developments in the Victoria catchment. Detailed information is available in the companion technical reports on water planning arrangements

(Vanderbyl, 2024) and regulatory requirements for land and water development (Speed and Vanderbyl, 2024).

3.5.1 Australian legal and policy context

Australia is a federal constitutional monarchy consisting of six states and two territories. The Victoria catchment is wholly located within the NT, as shown in Figure 3-26.

There are three levels of government: the Australian Government, state and territory governments, and local governments. The Australian Government has powers under the EPBC Act relating to matters of national environmental significance (including those arising from the World Heritage Convention, the Ramsar Convention on Wetlands of International Importance, and the Convention on Biological Diversity) and powers relating to the native title rights of Indigenous Peoples.

Generally, the NT Government is responsible for land, water and environmental policy and laws. However, the NT is an administrative territory established by the Australian Government and as such the Australian Parliament retains a right of veto over all NT laws.

Land use planning is also the responsibility of the NT Government, which administers the NT Planning Scheme.

3.5.2 Key legal and regulatory requirements

Land tenure and native title

Proponents will need to secure appropriate tenure over the land of the proposed development site. Consideration should be given as to whether land tenure can be granted or transferred to the developer (or converted to a more suitable form of tenure) and whether any approvals will be required beyond those held by the current owner or lessee of the land.

If the land is not freehold, which is the case for most of the Victoria catchment, native title requirements are likely to apply. In that case, the proponent will need to check if a native title determination has been made (or is underway) for the land, who the relevant parties are and whether the proposed development is consistent with the rights of native title holders. The proponent will then need to negotiate with the relevant Indigenous Peoples for the area prior to undertaking development activities.

Most of the land in the Victoria catchment is held as either Aboriginal freehold land or pastoral leases. If the proposed development is on Aboriginal freehold land, the proponent will need to obtain the consent of the Traditional Owners and approval from the relevant Aboriginal Land Council. If the proposed development is on pastoral lease land, the proponent will require approval for non-pastoral uses from the Pastoral Land Board.

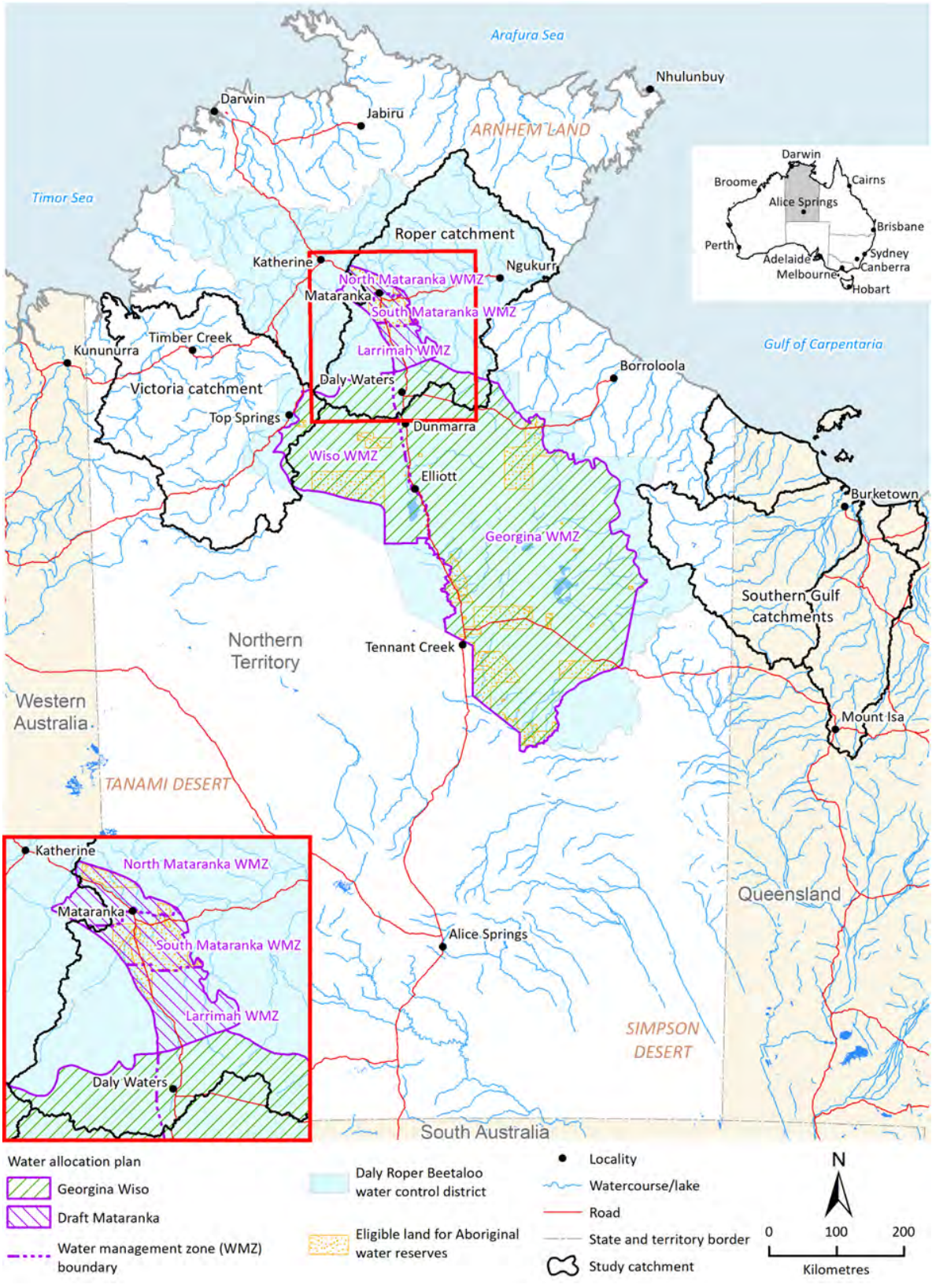

Figure 3-26 The Victoria catchment and neighbouring water plans and water control districts

Authority to take water

Proponents will generally need to obtain a water licence under the Northern Territory *Water Act 1992* to take any surface water or groundwater that may be required to construct and operate the development.

A water licence may be purchased and transferred from an existing licence holder subject to requirements or constraints relating to water trading and the purpose of the water use. Alternatively, it may be possible to seek the grant of a new water licence from unallocated water reserves. Such provisions are contained in the Georgina Wiso Water Allocation Plan, which partly intersects the Victoria catchment (Figure 3-26). Where a water allocation plan applies to a water source, then licences must only be granted consistent with the sustainable yield for the relevant water resource and in accordance with the volumes allocated to different beneficial uses. In the absence of a water allocation plan, which is the case for most of the Victoria catchment, the NT Water Allocation Planning Framework provides general rules for allocation of the available water. This framework establishes 'contingent allocation rules' that require a minimum amount of flow be set aside for environmental and other public purposes.

The NT legally requires that the allocation of water for Aboriginal use is part of water planning. The Strategic Aboriginal Water Reserve (SAWR) became statute in the NT in 2019. The SAWR is 'water allocated in a WAP [water allocation plan] for Aboriginal economic development in respect of eligible land' (Section 4(1), *Water Act 1992*). At its maximum, the SAWR can be no more than 30% in an area with more than 30% of eligible Aboriginal land (Godden et al., 2020). An Aboriginal Water Reserve can only exist where there is eligible land at the time of the WAP.

Planning requirements

Proponents will need to ensure that their development will be consistent with local and territory planning requirements. This usually involves a formal application and assessment process.

A single planning scheme applies across the NT, under which a proposed development may be categorised as: (i) permitted, (ii) merit assessable, (iii) impact assessable, or (iv) prohibited. NT Government websites provide detailed checklists and criteria for helping a proponent determine the category applicable to their particular development proposal. A development permit will be required for developments categorised as merit assessable and impact assessable. In addition, the NT Planning Commission may prepare a significant development report to be considered in the assessment of the development permit where a proponent's development is over a certain investment threshold.

Environmental approvals

Proponents will need to obtain approvals for certain activities that have a potential environmental impact, including any building or construction activities.

A proponent may require federal environmental approval under the EPBC Act if their development has the potential to affect matters of national environmental significance. Federal environmental impact assessment requirements can be met through the NT Government's assessment process, allowing for a more streamlined assessment process. However, the ultimate decision under the EPBC Act remains with the Australian Minister for the Environment and Water.

Under NT law, a proponent will require environmental approval for any actions that will have a significant impact on the environment or that are captured under a 'referral trigger'. Where required, the NT Environment Protection Authority will conduct an environmental impact assessment. Such processes can take significant time to complete.

Cultural heritage

Proponents will need to identify potential cultural heritage sites and/or objects (including Indigenous cultural heritage sites and/or objects) if a proposed development will affect cultural heritage.

The proponent will need to undertake searches of the NT Heritage Register and the NT Aboriginal Areas Protection Authority register of sacred sites.

National heritage values will also need to be considered through any environmental impact assessment process under the EPBC Act. A cultural heritage management plan is advisable (and may be required) for significant developments.

Works in a watercourse

Proponents will need approval to undertake any developments that involve activities within a watercourse.

In the NT, a proponent will require a permit under the *Water Act 1992* to interfere with a watercourse (e.g. extraction of materials, construction within a waterway, or diversion of a watercourse).

Clearing vegetation

In the NT, clearing of native vegetation is a controlled activity and generally requires a permit. This applies to both freehold land (including Aboriginal freehold land) and pastoral leases. For clearing on pastoral land, permit applications are determined by the Pastoral Land Board. For freehold land, applications are assessed under the Northern Territory *Planning Act 1999* and must be lodged with the Department of Infrastructure, Planning and Logistics. Exemptions apply for routine maintenance and day-to-day management activities. Therefore, a proponent will require a permit to clear native vegetation for construction or farming or other agricultural activities.

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