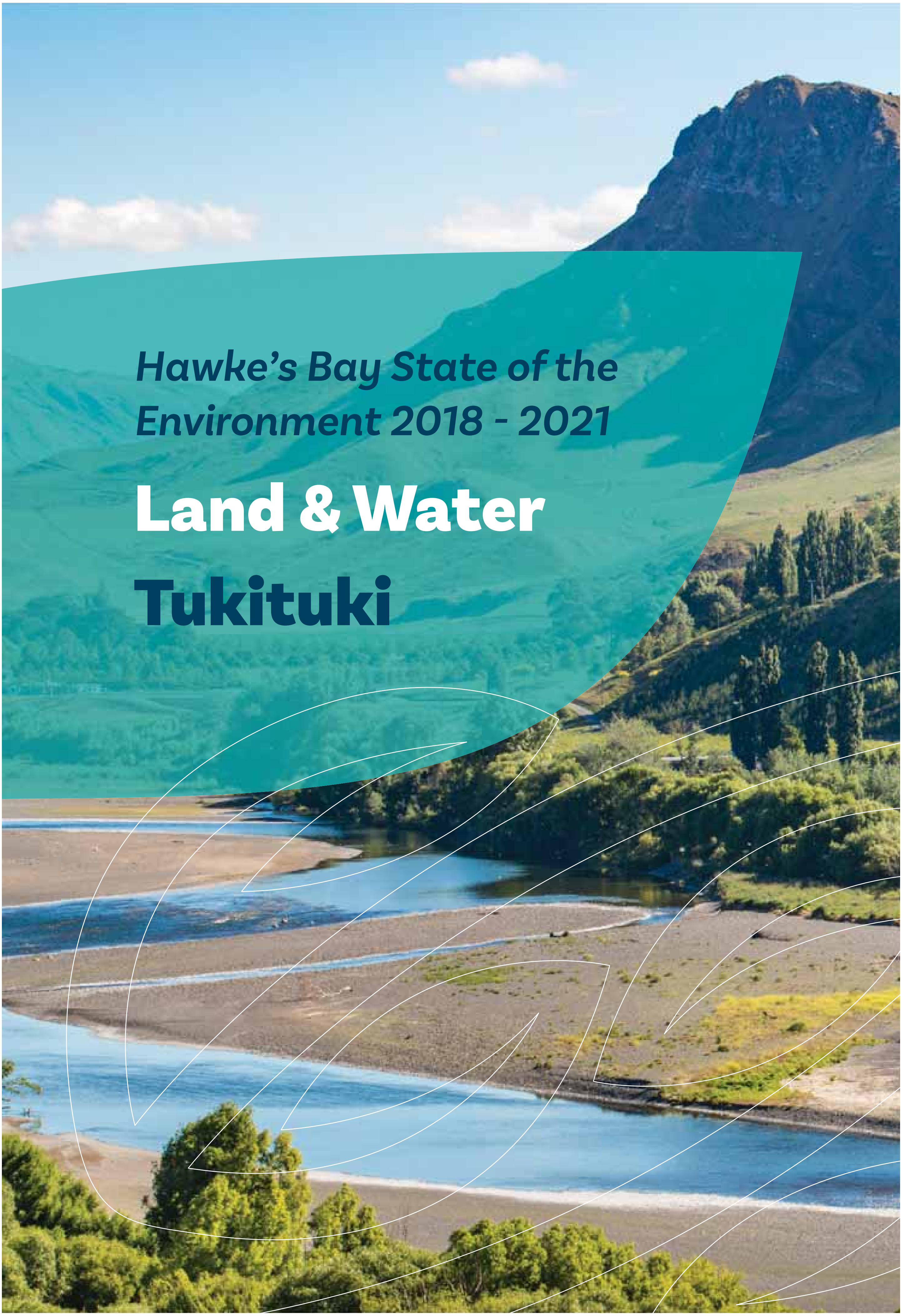
*Hawke's Bay State of the Environment 2018 - 2021*

# Land & Water

# Tukituki



# 19. Tukituki catchment

## Key points:

- Water scarcity is a pervasive feature of the Tukituki catchment. Freshwater was under particular pressure during autumn 2020. Climate patterns correlate with a reduction in river flows over the last three decades, and further climate change is expected to exacerbate this problem.
- Groundwater use in the Ruataniwha Plains is subject to limits that are expected to prevent further groundwater level declines. However, climate variability will drive interannual oscillations, and climate change may continue to affect future groundwater levels.
- Nitrogen is problematic in some Tukituki surface water and groundwater systems, including the Tukituki Estuary. Achieving nitrogen targets in all waterways will be a major challenge because some areas are 2-4 times over the target.
- Phosphorus and fine sediment problems in streams are linked to land erosion. These contaminants, along with poor riparian habitat, are likely to be driving the overall poor health of waterways.
- The Tukituki River is generally safe to swim in, except after heavy rain when more contaminants are washed into waterways.
- Potentially toxic algae can proliferate on the hard bottom of the Tukituki River over summer/autumn when flows are at their lowest.
- Actions that will help improve water quality and ecosystem health are riparian protection, wetland creation, and erosion control.

***The Tukituki catchment is one of the larger river catchments in Hawke's Bay, covering approximately 250,000 ha in 17 sub-catchments (Figure 19-1). The 117 km Tukituki River starts in the Ruahine Range and flows through Central Hawkes Bay, where it joins with the Waipawa River and continues past Te Mata Peak (Figure 19-2) before entering the coast at Haumoana. The Ruataniwha aquifer system lies beneath the Ruahine Ranges, where there are complex interactions between surface water and groundwater.***

The Tukituki River and aquifer systems within the catchment are highly valued for their contribution to surface waters, and for productive uses, such as providing water for farms and orchards throughout Central Hawke's Bay and to the eastern corner of the Heretaunga Plains. Most intensive land use is focused around the Ruataniwha Plains. Despite significant modifications to the landscape, the waterways in the Tukituki catchment have high fisheries and wildlife values. Lake Whatumā was recognised as one of 15 regionally outstanding water bodies, along with the mainstem of the Tukituki River between State Highway 50 and its estuary.

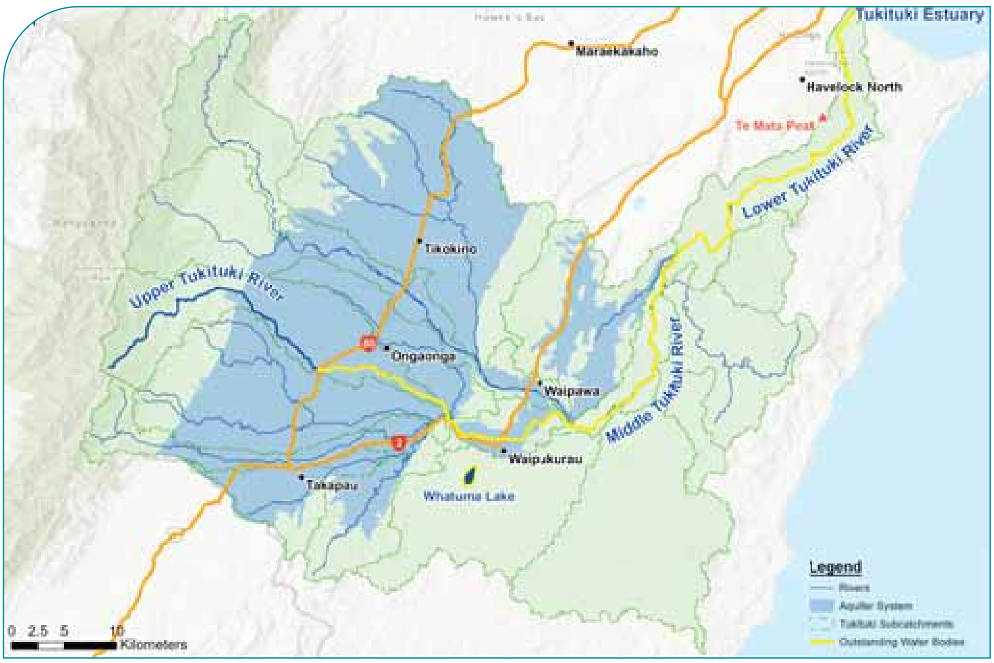



*Figure 19 1. The Tukituki catchment.*

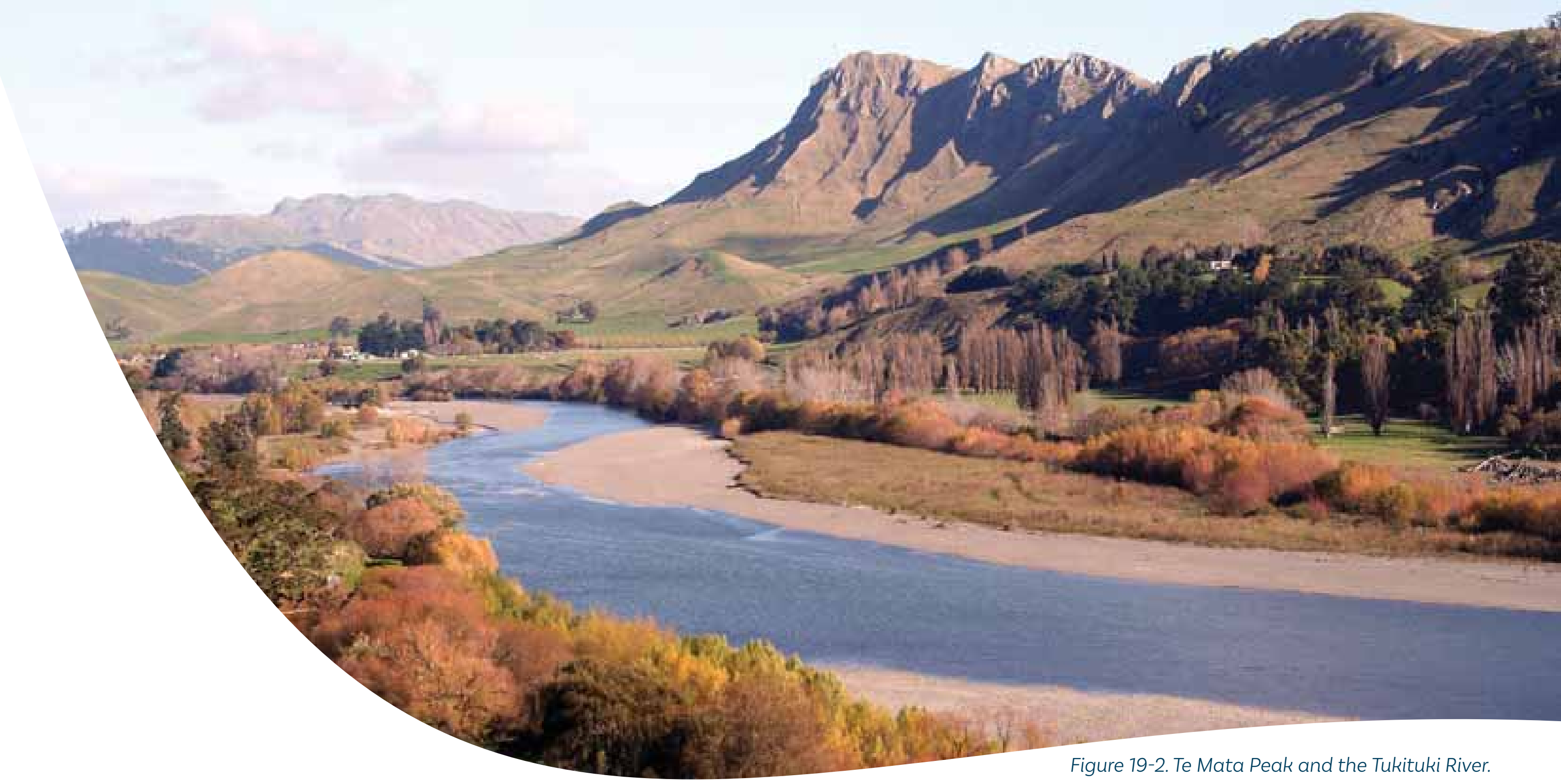


*Figure 19-2. Te Mata Peak and the Tukituki River.*

## Land cover

***The Tukituki catchment has changed considerably since human arrival, and only about 10% of the catchment is covered with indigenous vegetation (Figure 19-3).***

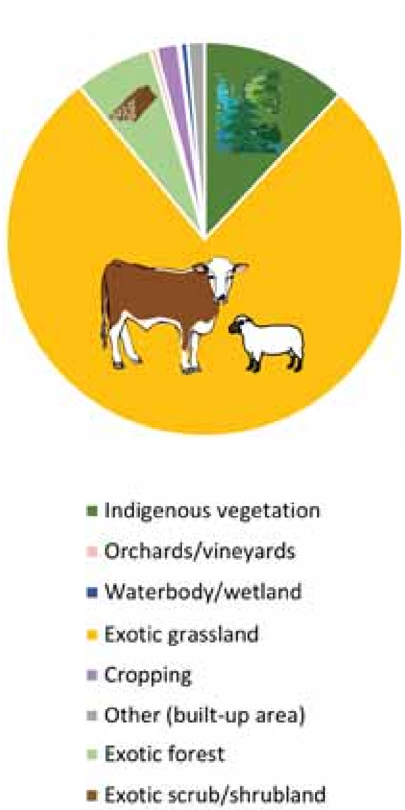



*Figure 19-3. Land cover in the Tukituki catchment. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.*

Over three-quarters of the Tukituki catchment is hill country and is used for extensive sheep and beef farming. The Ruataniwha Plains contain large areas of well-drained and productive land that support more intensive farming practices. Most of the dairying and more intensive sheep and farming occurs on the Ruataniwha Plains above the Ruataniwha aquifer. There were negligible changes in land cover between 2001 and 2018 (Figure 19-4).

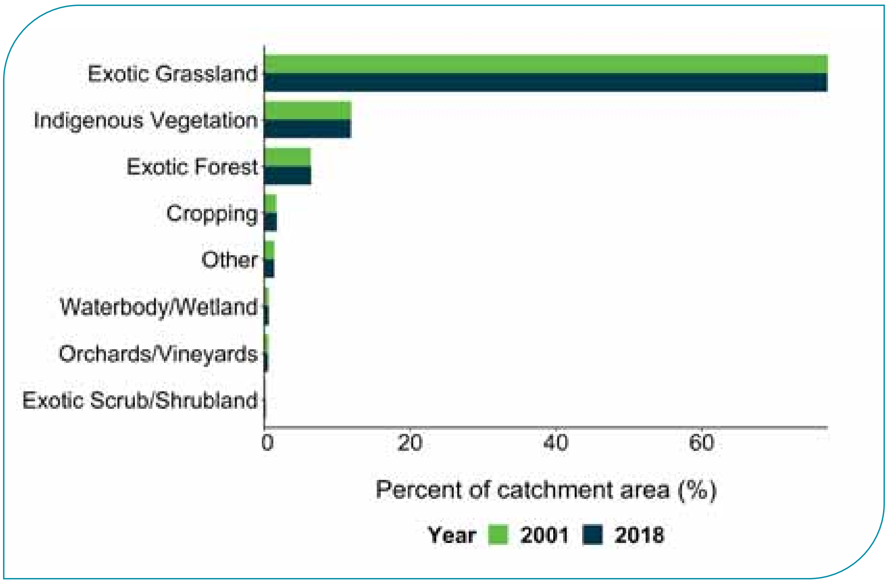



*Figure 19-4. Land cover change in the Tukituki catchment (250,705ha) between 2001 and 2018. The 'other' category includes built-up areas (settlements, urban parkland, and transport infrastructure) and bare surfaces such as bare soil, gravel, and rock.*

## Climate

***Rainfall patterns vary throughout the Tukituki catchment. On average, rainfall exceeds 2000mm per year in the western ranges, while less than 1000mm falls each year on the Ruataniwha Plains. Droughts and water scarcity are an ongoing problem, and the last three years have been exceptionally dry, with rainfall well below normal for most seasons since autumn 2019 (Figure 19-5).***

Normally, the Ruahine Range captures much of the rainfall that comes to the area through the prevailing westerly flow, but during the storm in early September 2018, the plains saw rainfall return periods of 10-50 years, compared to just 3 years in the ranges. The 2019-20 and 2020-21 droughts also did not spare the ranges, as the whole Tukituki catchment was similarly affected (Figure 19-5).

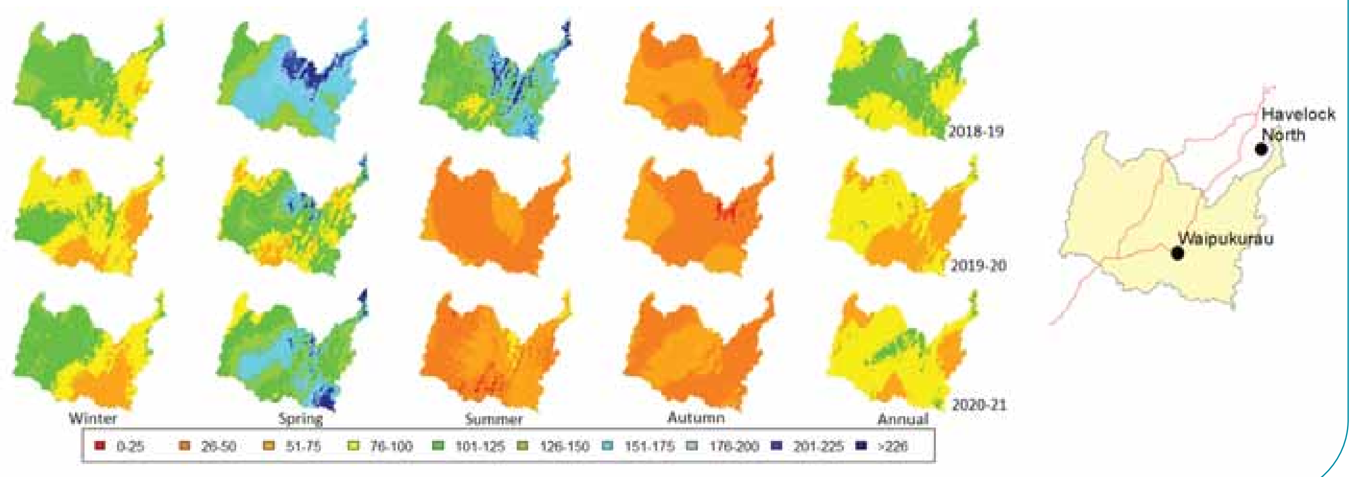



*Figure 19-5. Seasonal and annual rainfall for 2018-2021, shown as a percentage of the long-term average.*

Summer rainfall in the ranges has decreased over the last 30 years. Climate change projections suggest this will continue in the ranges, and the western parts of this catchment will see some of the region's greatest declines (5-10%) in annual rainfall by the end of the century. The eastern areas may at least see an increase in summer rain but will not escape a decline in annual rainfall.

Warming temperatures are evident across the area, particularly a rise in minimum temperatures towards the hill country to the west of the plains. The Gwavas site has seen a decline in annual frost days, an increase in days over 25°C, and an expansion of the growing season. This pattern is likely to continue, along with the observed increase in potential evapotranspiration. The Tukituki catchment, particularly western parts, may suffer the most in Hawke's Bay from water scarcity under climate change forecasts.

## Groundwater quantity

***The main groundwater resources in the Tukituki catchment include the Ruataniwha Plains aquifer system, Ōtāne and Papanui aquifer system, and lower Tukituki River, which is part of the Heretaunga Plains aquifer system (Figure 19-6). Few wells are found outside of these areas, which suggests that groundwater systems in this catchment are limited to mainly alluvial deposits.***

Excluding the wells in the lower Tukituki catchment, the largest and most productive groundwater resource is beneath the Ruataniwha Plains. Sediments from the Ruahine Ranges together with tephra from the Taupo Volcanic Zone have formed both confined and unconfined aquifers that support the flow of streams and rivers, and provide water for irrigation.

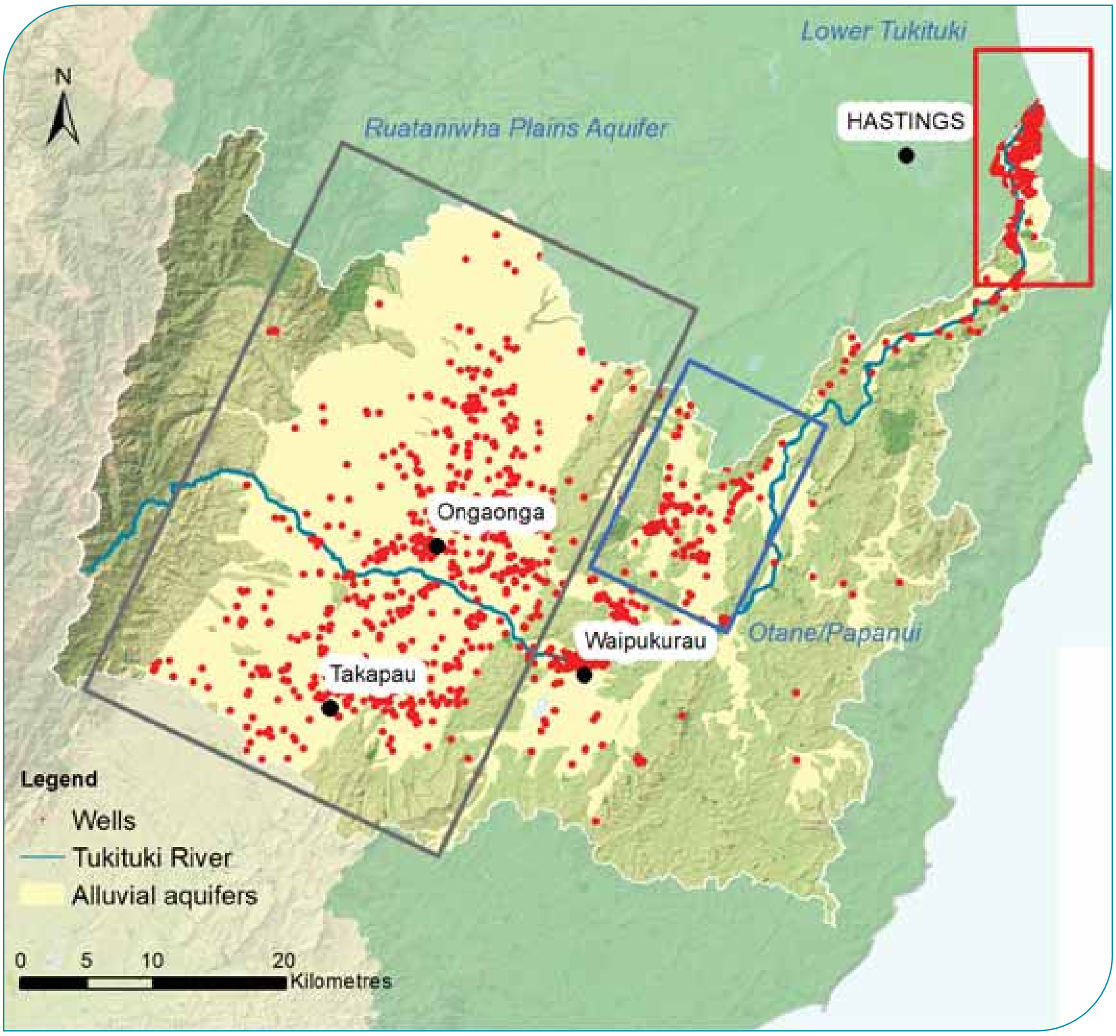



*Figure 19-6. Location of wells and alluvial aquifers within the Tukituki catchment..*

# Groundwater use

***The total volume of groundwater used by resource consent holders provides an indication of how much pumping pressure exists on the groundwater systems in this catchment. On the Ruataniwha Plains, all the consented groundwater volume has been metered since 2016. This means we have an accurate indication of actual groundwater used over the last five years.***

Between 2016 and 2021, the volume of groundwater used on the Ruataniwha Plains ranged from 15 to 25 gigalitres per year, making the Ruataniwha Plains aquifer system the second most productive groundwater resource in the region. This is approximately a third of the volume used in the Heretaunga Plains and double the volume used by all other groundwater takes in Hawke's Bay.

Since 2016, metered groundwater consents in the Ruataniwha Plains used a monthly average of about 27,500 m$^3$ per consent, and when combined about 16.3 gigalitres per year. Although the total volume used is smaller than on the Heretaunga Plains, the average monthly use per consent is much larger. This reflects the larger areas irrigated under each consent in the Ruataniwha Plains compared with consents on the Heretaunga Plains.

On the Ruataniwha Plains, groundwater is mainly used between December and April for agricultural purposes such as irrigation (Figure 19-7). This means there is more demand for groundwater during the summer and autumn than during other times of the year.

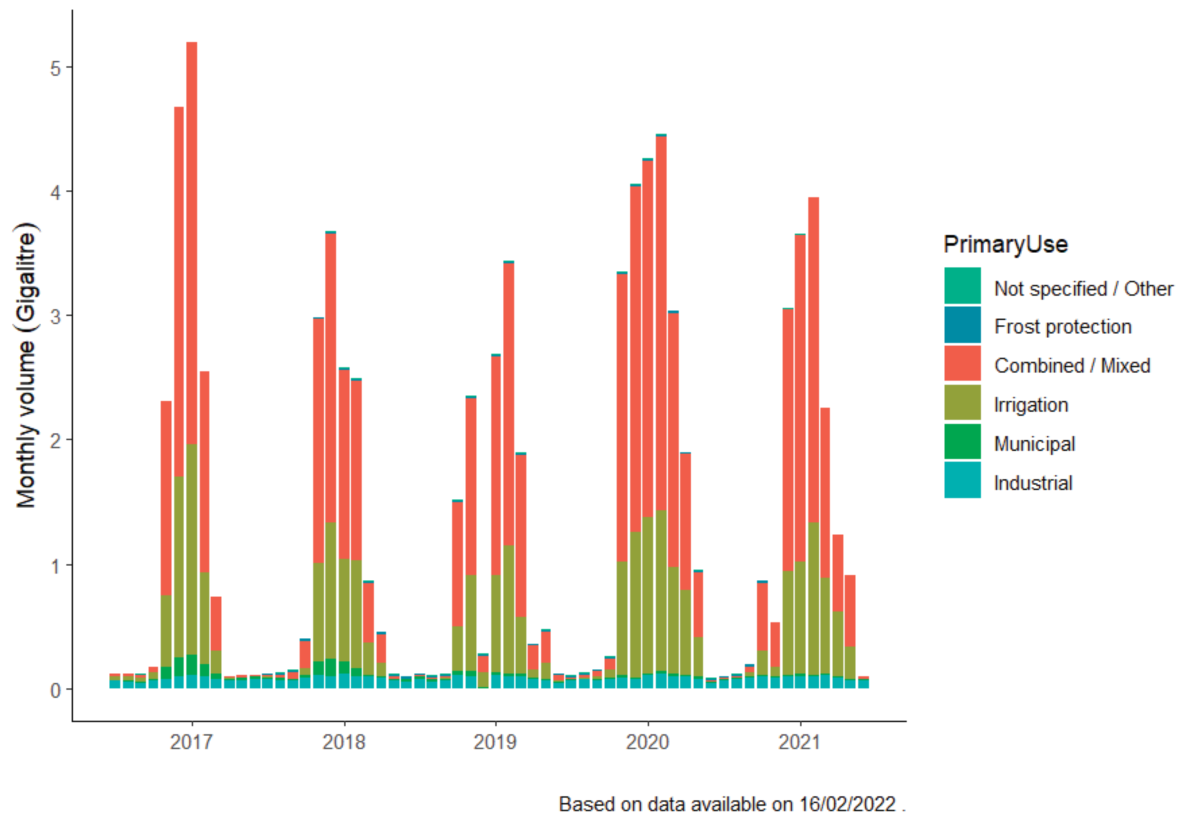



*Figure 19-7. Metered groundwater use in the Ruataniwha Plains between July 2017-June 2021.*

# Impacts of groundwater pumping

***The most commonly observed impact of groundwater pumping is a lowering of groundwater levels. This impact is more pronounced in the Ruataniwha aquifer system compared to other groundwater resources in the region. Aquifers in the Ruataniwha Plains tend to have relatively low transmissivity and storage properties and are pumped at relatively higher rates. This results in deeper and more localised drawdown impacts than those observed in the Heretaunga Plains.***

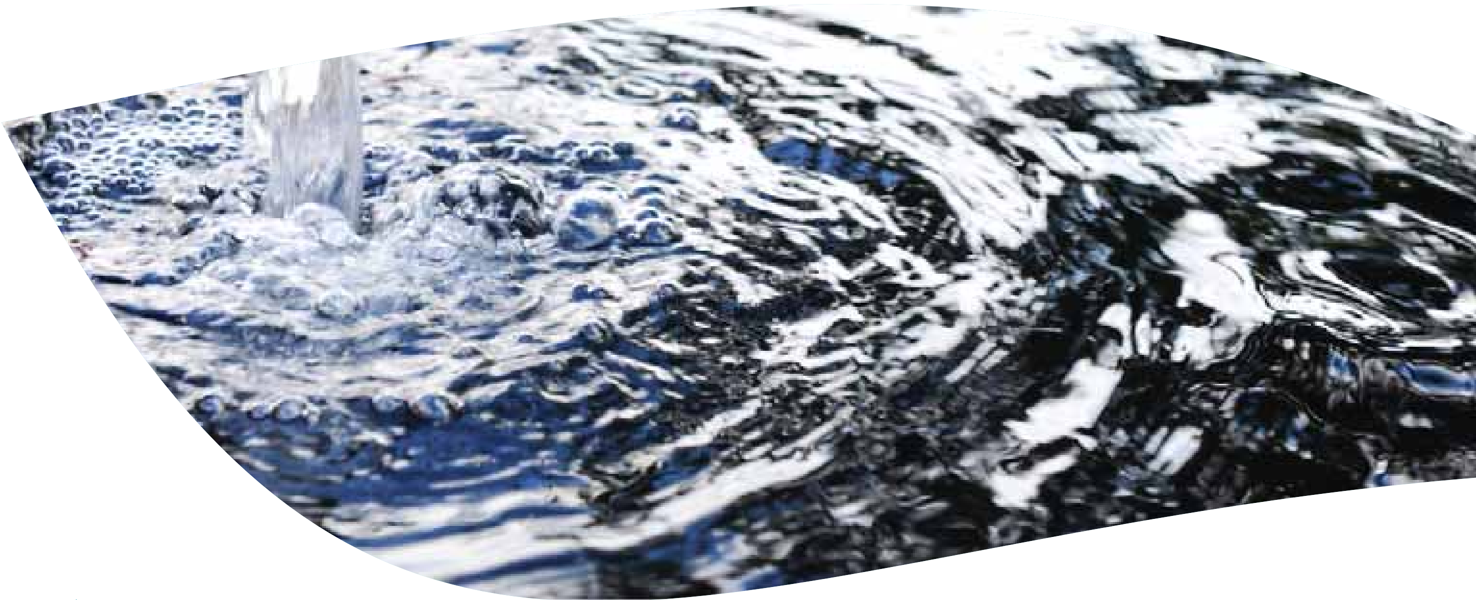
In the Ruataniwha Plains, the volume and number of groundwater takes has been increasing for decades, and therefore groundwater levels have declined. The largest impacts occur over summer and autumn when groundwater use is at its peak. Table 19-1 shows the average rate of groundwater level change for monitoring wells in the Ruataniwha Plains.

*Table 19-1. Rate of change in monthly groundwater levels in the Ruataniwha Plains (m/year)* [1].

| | July | August | September | October | November | December | January | February | March | April | May | June |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean rate of change (m/yr)** | -0.18 | -0.14 | -0.11 | -0.10 | -0.10 | -0.12 | -0.26 | -0.31 | -0.31 | -0.31 | -0.28 | -0.20 |

Lower groundwater levels over time can increase pumping costs and impact water availability by drawing groundwater below pump intakes. In the Ruataniwha Plains, most wells are drilled deep enough to cope with these changes. However, in some areas such as Ongaonga and Tikokino, the pump systems are not always installed deep enough, or cannot access the full well depth. In these locations, particularly during late summer and early autumn, a decline in groundwater levels can cause water supply issues.

In the Tukituki catchment, an allocation limit has been set to manage groundwater resources. By limiting groundwater use, the RRMP seeks to balance the environmental effects of groundwater pumping with its benefits. The HBRC website has further information on the rules and policies implemented to manage groundwater use (https://www.hbrc.govt.nz/services/policy-and-planning/plan-changes/).



[1] As calculated using Sen's slope method for wells with statistically significant trends. Based on each well's full monitoring period.

# Climate impacts on groundwater

***Superimposed on the effects of groundwater pumping are the impacts caused by climatic conditions. Along with increasing the demand for groundwater use, extended periods of dry weather exacerbate declining water levels by reducing aquifer recharge (the amount of water making its way into the aquifer).***

During the autumn of 2019-2020, groundwater levels were below normal with many sites experiencing their lowest ever monthly observations (Figure 19-8). These extreme levels followed consecutive months of below normal rainfall and record high metered groundwater use.

Drought conditions prevailed over summer and autumn of 2020-21, resulting in further high groundwater use and below normal groundwater levels. In contrast, groundwater levels during the summer of 2018-2019 were near normal with some sites experiencing their highest ever summer groundwater levels. This followed a period of above normal rainfall and relatively low metered groundwater use.

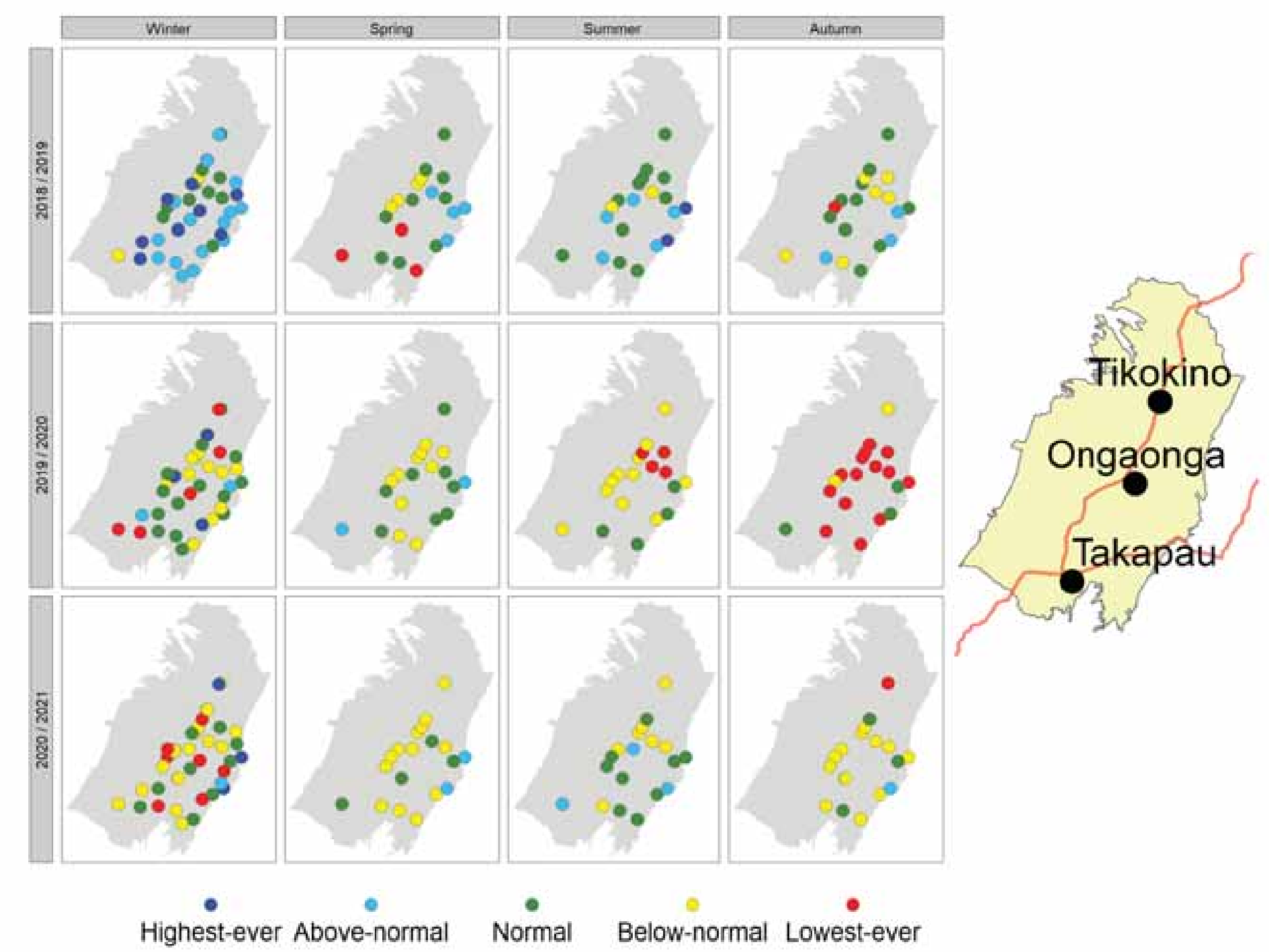



*Figure 19-8. Seasonal groundwater level conditions in the Ruataniwha Plains between 2018-2021. Categories are: Below normal = 0-25th percentile, Normal = 25-75th percentile, Above normal = 75-100th percentile. Wells with fewer than 10 years of records are excluded from the analysis..*

## Groundwater quality

***Within the Tukituki catchment there are two main groundwater systems, the extensive Ruataniwha Plains, and the Papanui Basin. Reduced conditions (low oxygen) in the Papanui Basin and southern Ruataniwha Plains result in naturally elevated iron, manganese, and arsenic concentrations that exceed drinking-water standards at certain locations. This is the natural state of the groundwater.***

Exceedance of nitrate ($NO_3$-N) concentrations tend to occur in oxygenated groundwater systems of the central Ruataniwha Plains. The land use in these areas are typically sheep and beef farming, orchard, vineyard or other perennial crop, short-rotation cropland, and dairy cattle farming (Figure 19-9). The concentration of $NO_3$-N in groundwater is concerning in relation to the potential influence these levels may have on surface water quality and aquatic ecosystems. Groundwater-surface water interaction of the unconfined groundwater system and spring fed surface water systems could influence water quality in these areas.

The Regional Resource Management Plan (RRMP) contains limits for $NO_3$-N in Tukituki surface waters to protect biodiversity and amenity values. These have been set at far lower values than the groundwater limits which are based on human health. However, groundwater that is hydraulically connected to surface waters may provide pathways for nutrient discharge through groundwater seeps and springs. Within both the Ruataniwha Plains and Papanui Basin, groundwater and surface water are hydraulically connected.

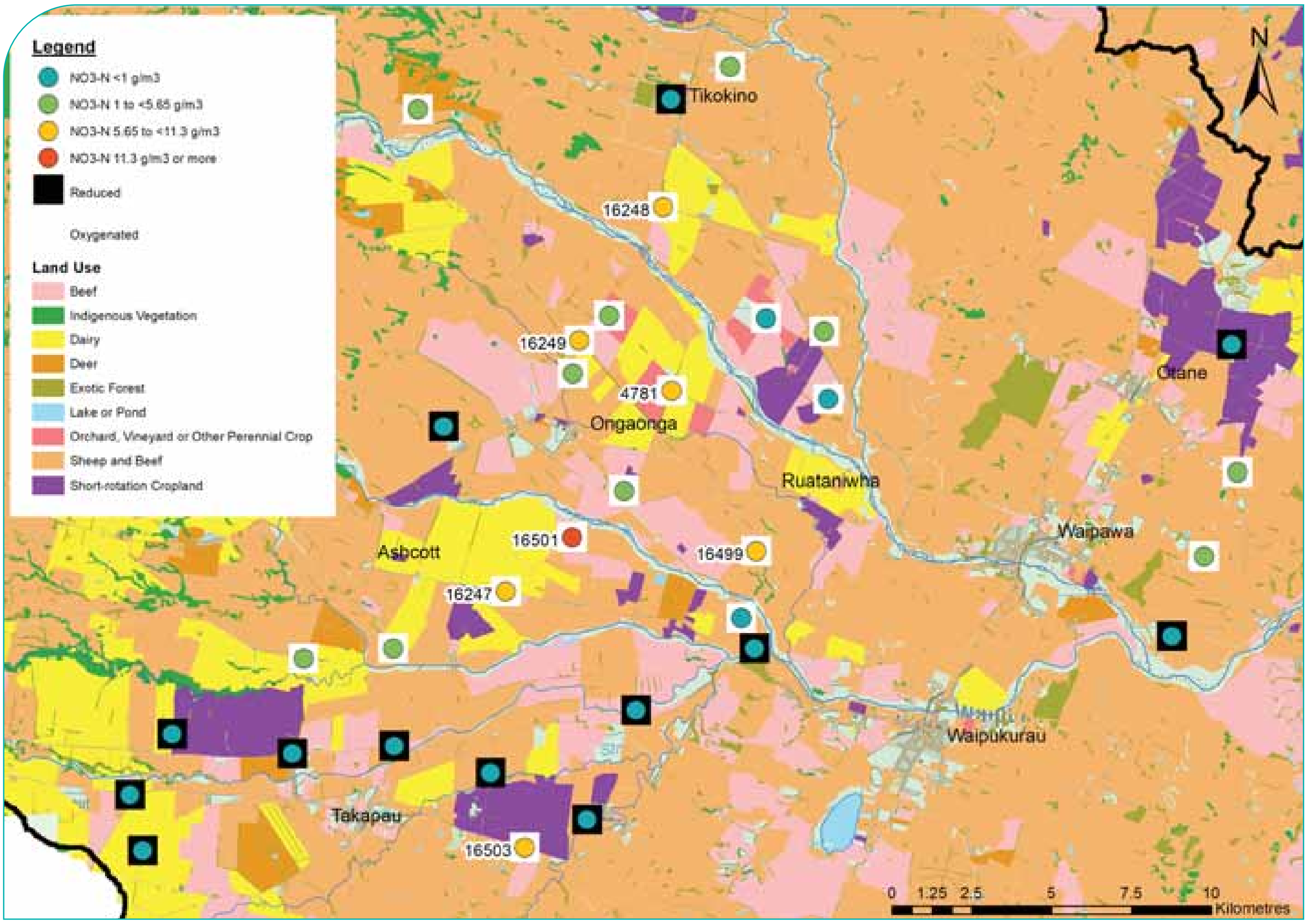


Figure 19-9 Nitrate-nitrogen in groundwater, along with redox status and land use.

Another nutrient of concern is dissolved reactive phosphorous (DRP), which particularly becomes an issue where groundwater conditions are reduced such as in the lower southern portion of the Ruataniwha Plains and within the Kaikora arm of the Papanui Basin (Figure 19-10). In reduced groundwater environments, phosphate remains in solution as DRP. However, it is likely that only a small component of DRP in these areas is due to natural conditions. The bulk of problematic DRP is likely from human activities. Again, groundwater hydraulically connected to surface waters could provide nutrients by seeps and springs, potentially impacting aquatic ecosystems.

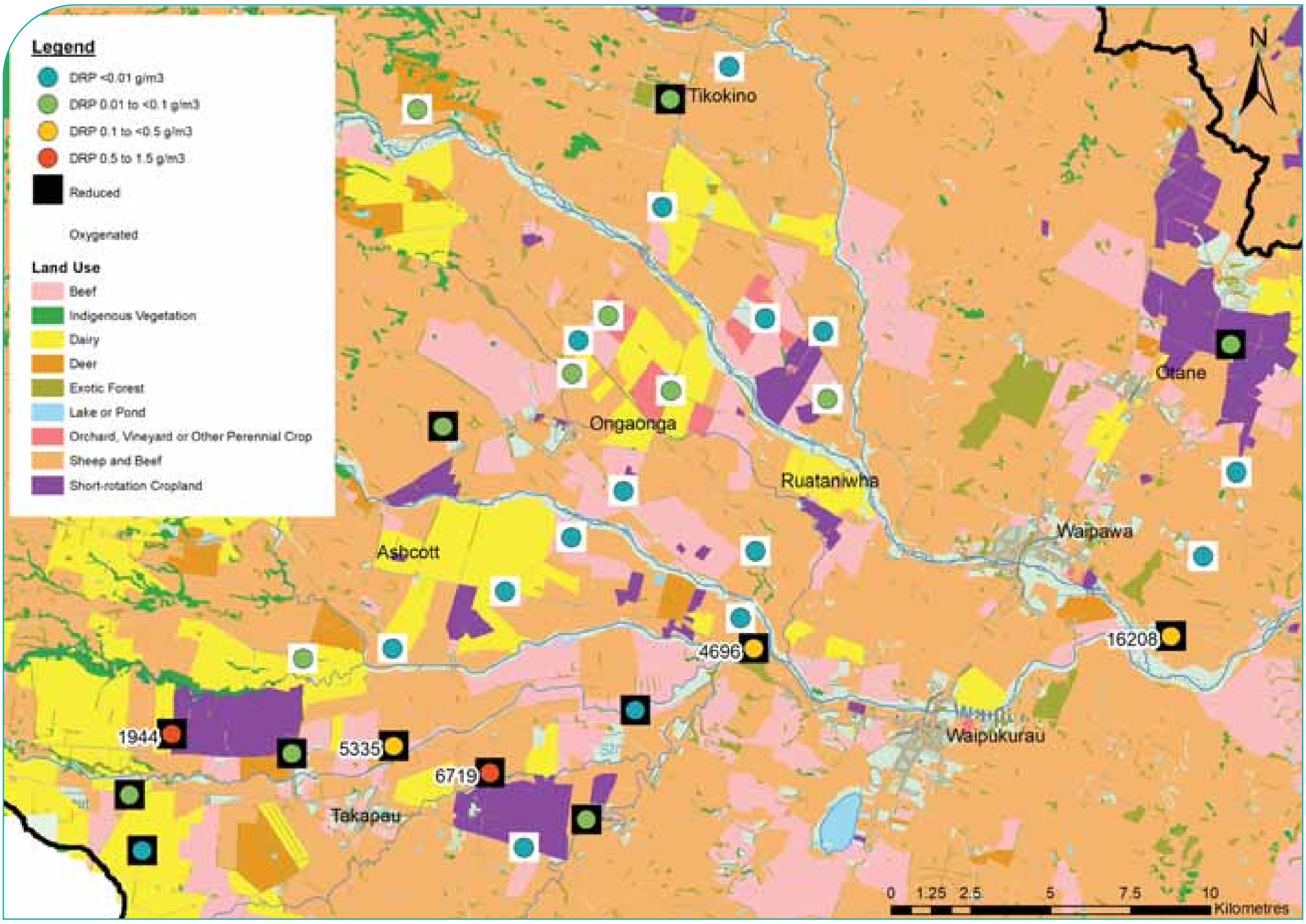
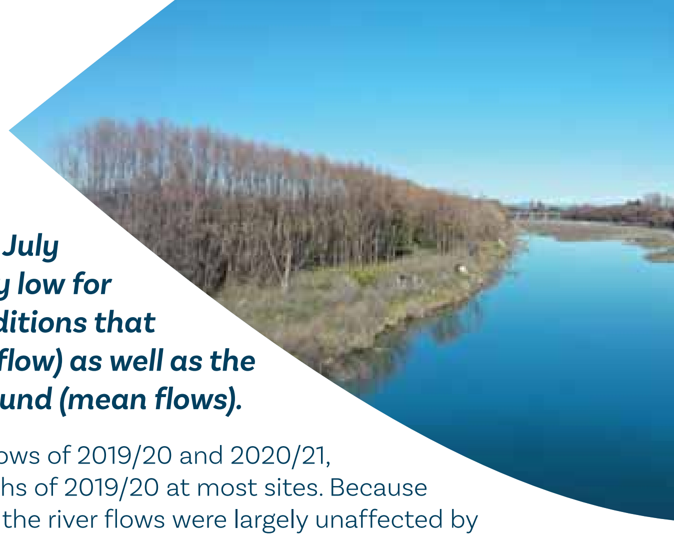



*Figure 19-10. Dissolved reactive phosphorus (DRP) in groundwater, along with redox status and overlying land use*



## Surface water flows

***Flows in the Tukituki River were relatively normal between July 2018 and June 2019 (Figure 19-11). However, flows were very low for the next two years, when compared against low-flow conditions that are typically observed in summer and autumn (7-day low flow) as well as the average conditions that are generally observed all year round (mean flows).***

Extensive bans on surface water takes were in place during the low flows of 2019/20 and 2020/21, with the ban lasting more than three weeks during the summer months of 2019/20 at most sites. Because abstraction was banned during the periods with extremely low flows, the river flows were largely unaffected by surface water takes at those times. Long-term records show the annual low flow has been decreasing in both the Tukituki and Waipawa Rivers over the last 30 years (Figure 19-12).

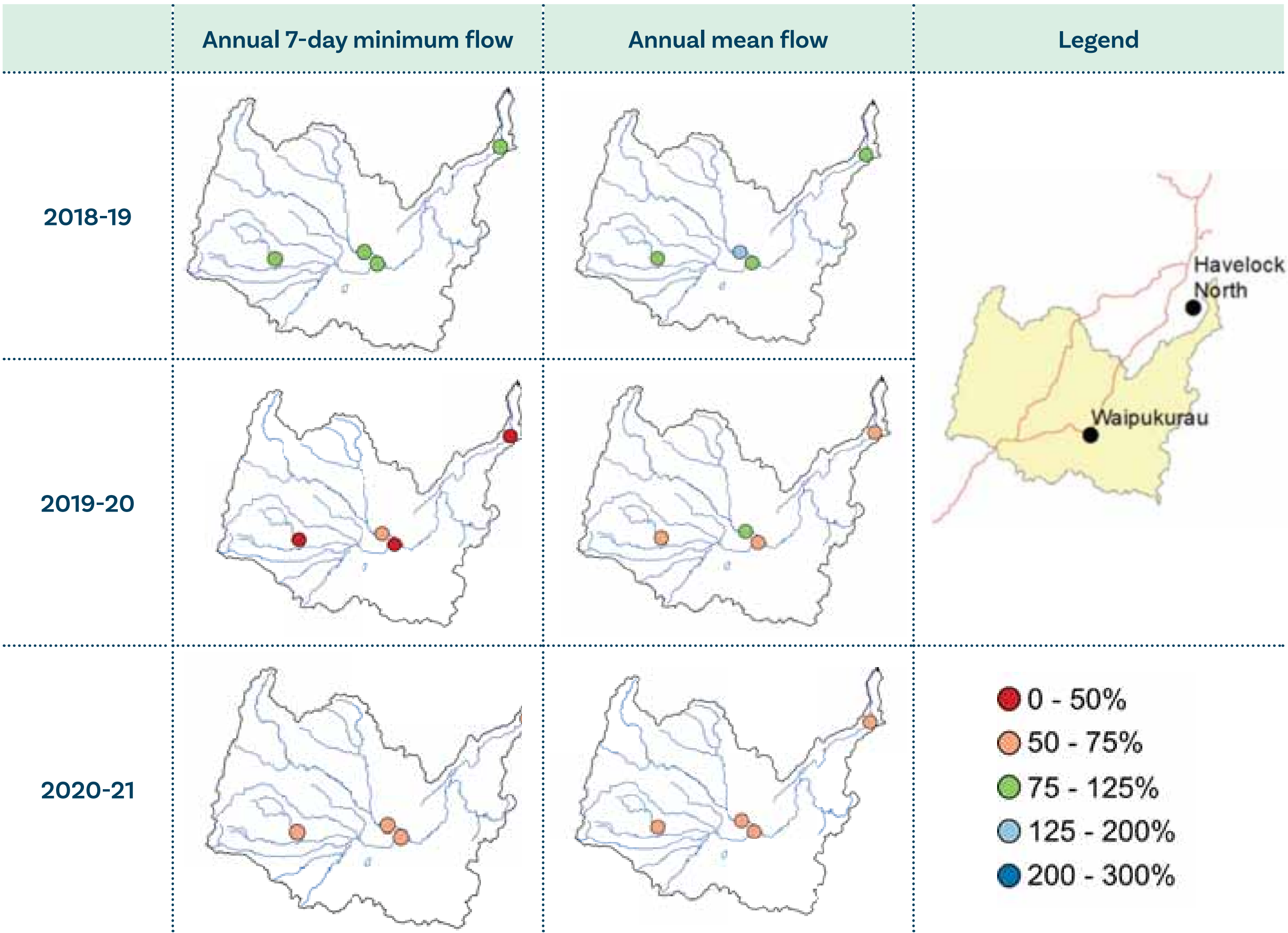



*Figure 19-11. River flows as a percentage of the long-term average.*

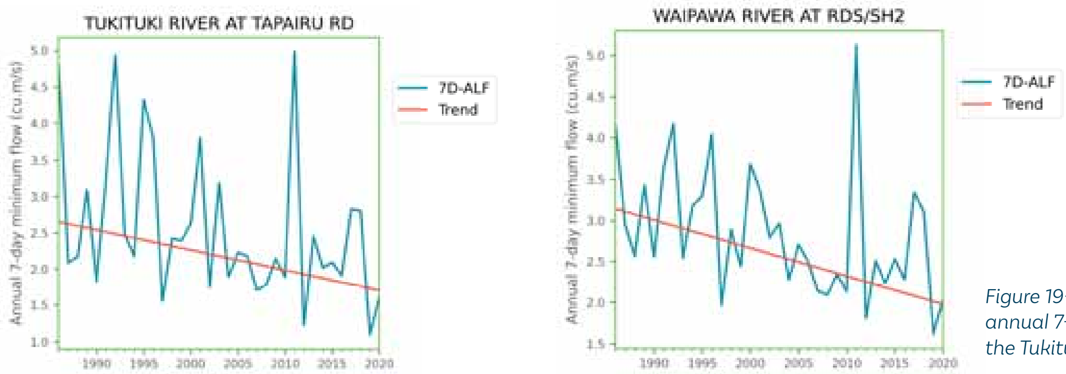



*Figure 19-12. Long-term trends in annual 7-day low flows for two sites in the Tukituki catchment.*

# River water quality

***The fact that most of the dairying and more intensive sheep and beef farming in the region occurs over the Ruataniwha aquifer, means that activities with a high risk of nitrogen loss are concentrated in a landscape that is vulnerable to nitrogen leaching. As such, the highest nitrogen concentrations in Hawke's Bay occur in streams draining the Ruataniwha Plains.***

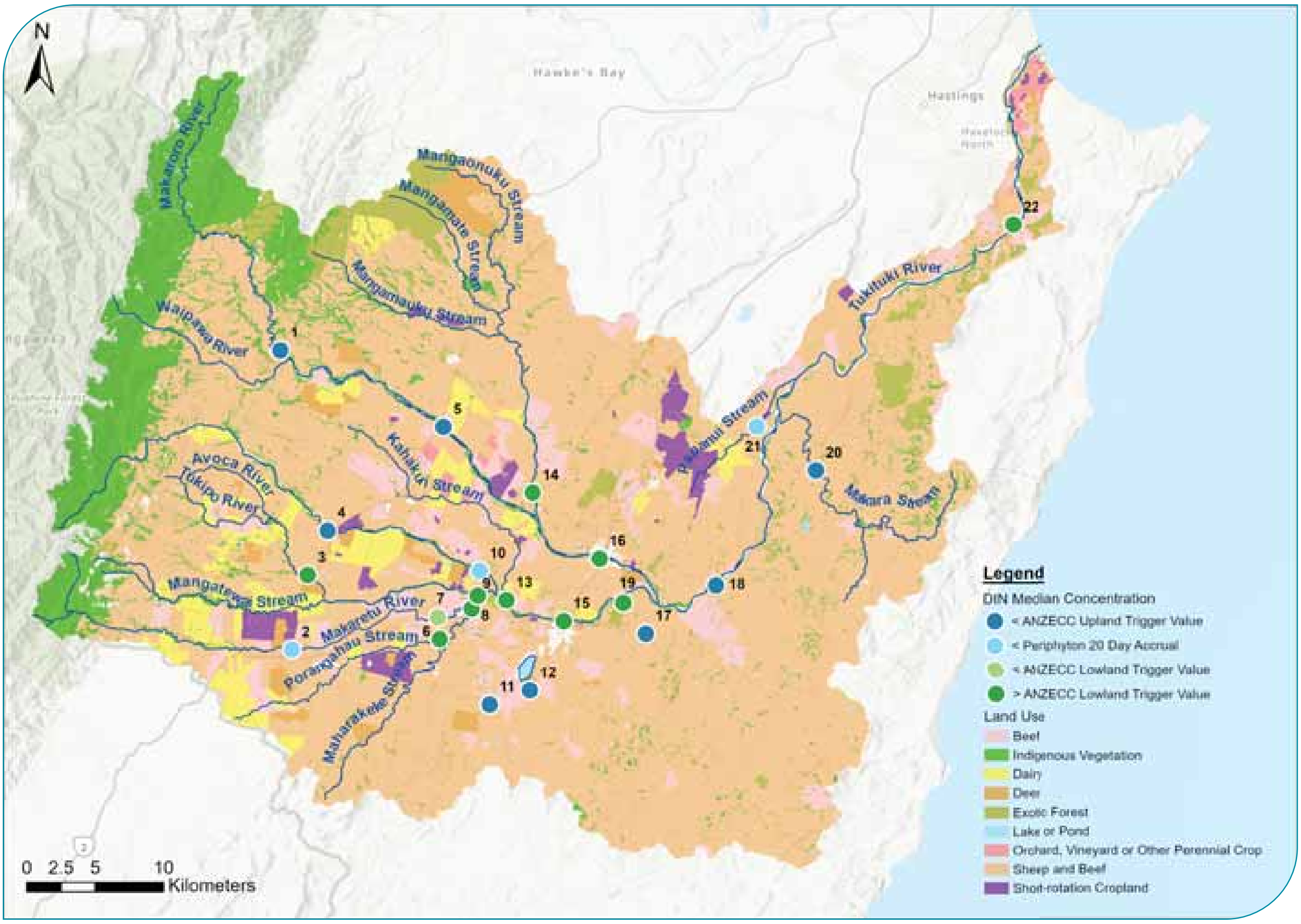



*Figure 19-13. Median dissolved inorganic nitrogen (DIN) concentrations in the Tukituki catchment relative to ANZECC upland and lowland (2000) or Biggs (2000) periphyton trigger values. 1: Makaroro River at Burnt Bridge, 2: Makaretu Stream at SH50, 3: Tukipo River at SH50, 4: Tukituki River at Ashcott Bridge SH50, 5: Waipawa River at SH50, 6: Porangahau Stream u/s Maharakeke , 7: Makaretu Stream at Speedy Rd , 8: Maharakeke Stream at SH2, 9: Tukipo River u/s Makaretu , 10: Tukituki River at Waipuk Onga Rd, 11: Ngahape Stream at Arlington Rd, 12: Kioreau Stream at Porangahau Rd, 13: Kahahakuri Stream u/s Tukituki , 14: Mangaonuku Stream at Waipawa Tikokino Rd, 15: Tukituki River at Waipukurau, 16: Waipawa River at SH2, 17: Mangamahaki Stream at Tamumu , 18: Mangatarata Stream at Mangatarata Rd, 19: Tukituki River at Tapairu Rd, 20: Makara Stream at St Lawrence Rd, 21: Papanui Stream at Middle Rd, 22: Tukituki River at Red Bridge.*

Macroinvertebrate community index (MCI) scores suggest overall stream health is impaired at more than 80% of the monitored river sites in the Tukituki catchment, and only two sub-catchments passed their respective Tukituki Plan MCI targets (Figure 19-14). Phosphorus levels are also a widespread problem, with only four sub-catchments passing the Tukituki Plan targets, and phosphorus levels considered moderately or highly elevated at more than 80% of sites.

No sub-catchments passed their Tukituki Plan water clarity targets, despite many sites being classed in A, B or C (good to average) bands under the NPS-FM grading system. Potential toxic effects from nitrogen are not being observed, but six of the 17 sub-catchments failed the Tukituki Plan dissolved inorganic nitrogen (DIN) target. DIN relates to increased algal growth from nitrogen enrichment, which are experienced at lower concentrations than the toxicity effects.

Both the winter and summer *Escherichia coli (E. coli)* targets were passed in just six sub-catchments although, as with many other variables, more targets were reached according to the NPS-FM bands (Figure 19-15). In other words, many of the Tukituki Plan targets appear quite ambitious when compared to the NPS-FM framework. This apparent discrepancy reflects the overall community objective of 'good' ecosystem health for waterways in the Tukituki catchment, which broadly equates to the B band in the NPS-FM framework.

However, water quality issues in the Tukituki catchment are not new phenomena and nitrogen concentrations appear to have been higher than the current Tukituki Plan targets since at least the late 1970s (Figure 19-16). The nitrogen targets are ambitious for areas with highly productive farming, and may not be achievable alongside conventional, high-intensity farming without substantial mitigations. Constructed wetlands may be one option to use alongside farm management improvements, because they are proven to effectively reduce nitrogen.


*Figure 19-14. Freshwater compliance with Tukituki Plan Targets. DRP = dissolved reactive phosphorus. DIN = dissolved inorganic nitrogen. MCI = macroinvertebrate community index. Grading is based on the latest five years of available data. Seventeen sub-catchments were assessed for plan compliance, but the results from one monitoring site (Makara Stream at St Lawrence Road) is used as a proxy for three sub-catchments (Makara, Mangarara, and Hawea) due to limited site access.*

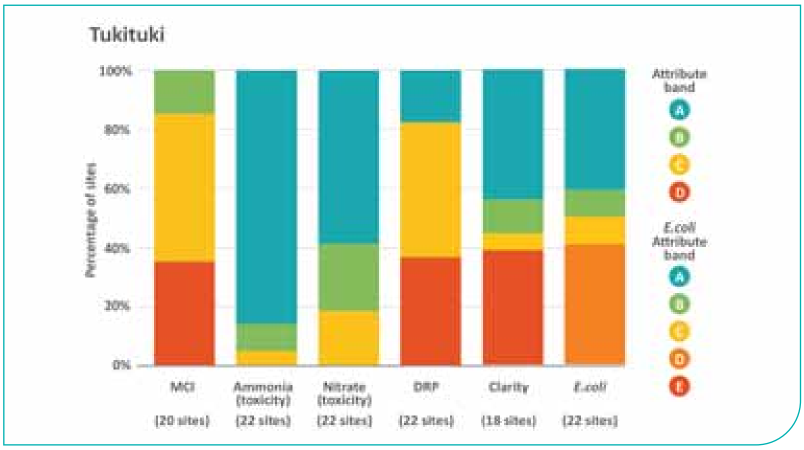



*Figure 19-15. Bands (A = Good, D/E = Poor) in the National Policy Statement for Freshwater Management (NPS-FM) for river attributes in the Tukituki catchment. DRP = dissolved reactive phosphorus. MCI = macroinvertebrate community index. Grading based on latest five years of available data.*

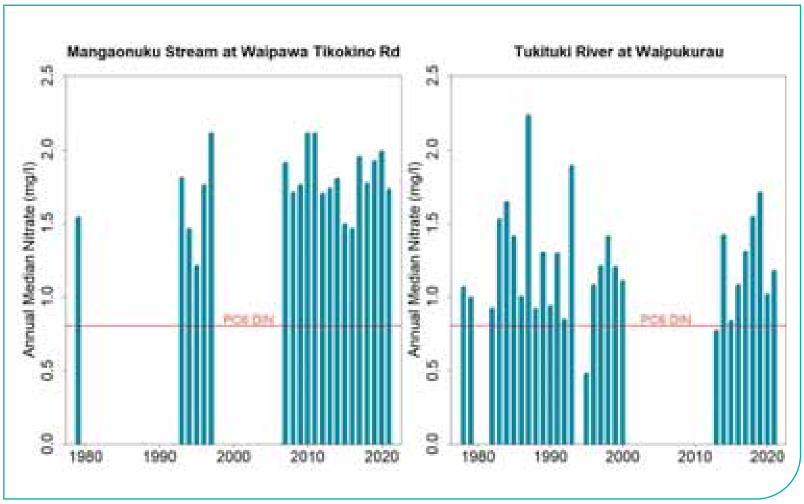



*Figure 19-16. Historical river sampling shows that waterways in the Tukituki catchment have had nitrogen levels above the current plan targets since at least the late 1970s. The red line marks the Tukituki Plan DIN limit of 0.8mg/l, but note these data are nitrate-nitrogen only. DIN also includes nitrite-nitrogen and ammoniacal-nitrogen, so the instream DIN values would be higher than the nitrate values shown here.*

# Whatumā Lake water quality

***Whatumā Lake (Figure 19-17) is a regionally outstanding waterbody and a focus for HBRC's environmental enhancement funding.***

The inflow and outflow of Whatumā Lake has had exceptionally high phosphorus levels since monitoring began in 2018. However, overall flow volume is low, which means the Mangataratara sub-catchment, which contains Whatumā, is not a major source of phosphorus into the Tukituki River. Nevertheless, high phosphorus concentrations may pose a risk to the lake's health, and potential phosphorus sources in the catchment need to be investigated.

Despite water quality issues, NIWA observed a high abundance of native submerged aquatic vegetation during surveys in 2016, and the area is known to support high biodiversity values, especially birdlife (Figure 19-18). Water level management, water quality, and pest plants and animals remain a long-term challenge. HBRC has begun engaging with Ti Tiriti partners, landowners, and other stakeholders to implement a subsidised work programme targeting biodiversity enhancement and water quality improvements.

*Figure 19-17 Whatumā Lake. Photos by Peter Scott, Above Hawke's Bay.*

*Figure 19-18. Whatumā is a hotspot for matuku, or Australasian Bittern (photo by John Cheyne)*

# Constructed wetlands

***Landscapes dominated by intensive primary production typically lose more nitrogen than is sometimes appropriate for healthy freshwater and coastal ecosystems. Good management practice, prudent fertiliser use, and rigorous stock management does significantly help reduce the amount of nitrogen that is leached, but the nitrogen requirement for plentiful pasture and crop growth means a productive farm will inevitably leach some nitrogen.***

If the landscape is dominated by nitrogen leaching land uses, the waterways flowing through it will typically have elevated nitrogen levels compared to reference conditions, unless other mitigations are in place. Pastoral farming covers almost 80% of the Tukituki catchment, with only 12% remaining in indigenous vegetation. This makes the 0.8mg/L DIN target ambitious, especially for waterways on the Ruataniwha Plains, where most of the intensive pastoral farming operations such as dairy and beef cattle are located.

Wetlands are particularly efficient at removing nitrogen from waterways. In warm places like Hawke's Bay, wetlands will remove 25-50% of nitrate if their cumulative area is 1-5% of the receiving catchment. In an attempt to get closer to nitrogen targets in the Tukituki catchment, HBRC collaborated with the White family, the Tukipo Catchment Care Group, Fonterra, and NIWA to build a 1.6ha wetland (Figure 19-19). Monitoring led by NIWA will precisely measure how much nitrogen and other contaminants are removed by the wetland.

This is part of a national research programme that includes five other constructed wetland sites around New Zealand. The intention is to better quantify both the environmental benefits and costs of constructed wetlands, so that a strategic network of wetlands can be considered for water quality improvements, biodiversity, and flood control benefits. Funding by Fonterra is being used to identify the most suitable sites for constructed wetlands in the Tukituki catchment, both on publicly and privately owned land. Catchment modelling will help quantify whether wetlands can reduce nitrogen substantially at a large scale.

*Figure 19-19. Wetlands are described as Earth's kidneys and can help remove nitrogen that leaches from productive farms. The White family (top right) offered up a less productive area of their farm (top left) for wetland construction (middle). This 1.6ha wetland (bottom) is part of a national trial being run by NIWA to precisely measure how much nitrogen is removed by constructed wetlands.*

# Estuary water quality

***Elevated nitrogen flows out to the coast, and manifests as high nitrogen levels in Hawke's Bay estuarine waters, which are well above the national median for similar systems (Figure 19-20). The mouth of the Tukituki Estuary is highly mobile and can vary between an opening to the sea larger than 120m, to being functionally closed during periods of low flows. It is during periods of river mouth closure that the risk of high nutrient concentrations is the greatest, although problematic algal blooms are not a consistent feature of this estuary.***

The Tukituki Estuary is a river-dominated estuary, and so does not tend to accumulate sediments like many other regional estuaries. Within the mainstem, gravels dominate the estuary floor (Figure 19-22). This is a highly abrasive environment that is not suitable for animals that live in sandier estuaries. The more depositional backwaters of the Tukituki do have high levels of fine sediments, but these can be too muddy for some of the sensitive species to survive here.

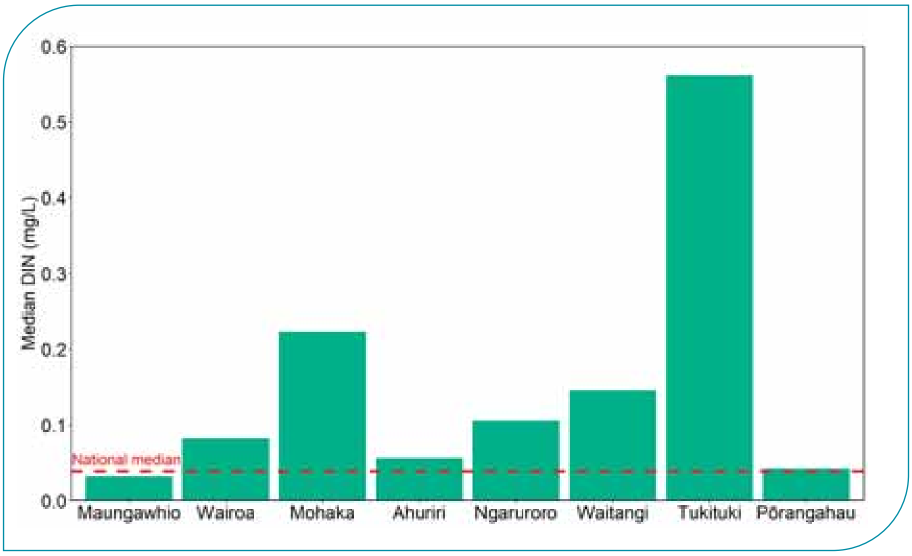



*Figure 19-20. Median dissolved inorganic nitrogen (DIN) levels for Hawke's Bay estuaries from Nov 2016 to June 2021. The dotted line is the national median for similar systems.*


*Figure 19-21. The proportion of mud in Tukituki Estuary. Greater than 25% (yellow and orange) indicates sediment stress and likely loss of some sensitive species. Greater than 60% (red) indicates a high level of sediment stress.*

## Coastal water quality

***Suspended sediment, turbidity, dissolved oxygen, and phosphorus levels in the Tukituki coastal waters are within the ranges observed in other New Zealand open coast sites (Figure 19 22).***

Although still within the levels observed nationally at coastal sites, Haumoana has elevated dissolved inorganic nitrogen levels. Nearby river systems and wastewater treatment plant outfalls contribute an estimated 64% of the nitrogen at that site.

High nutrient concentrations on the coast can lead to increased productivity in the form of phytoplankton (small algae) growth. Algal growth at Haumoana is higher than at other open coast sites nationally. To date, increased productivity has not had adverse effects on the system.

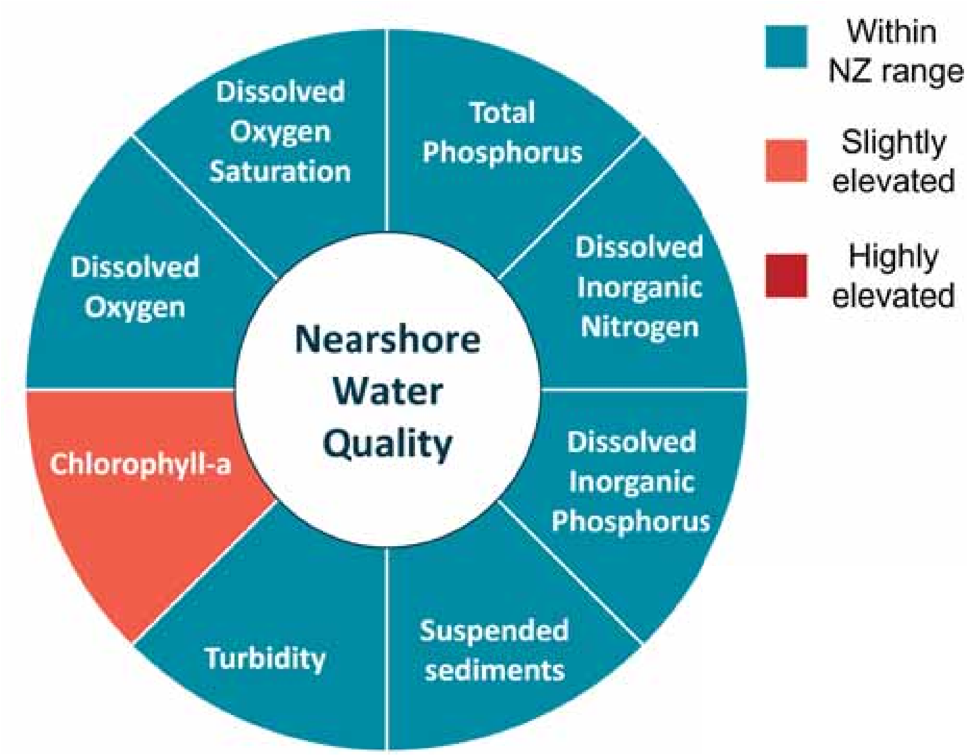



*Figure 19-22. Coastal water quality indicators for the Tukituki catchment, compared to other coastal sites around New Zealand.*

## Recreational water quality

***The Tukituki River has a number of swimming areas, and in general these areas have water quality that is suitable for swimming. Water quality guidelines can sometimes be exceeded after rain, but the river was suitable for swimming 96% of the time it was monitored over the last five years (Figure 19-23).***

Although water quality in the Tukituki River is generally suitable for contact recreation, the site at SH2 at Waipukurau has shown a deteriorating trend over the last 19 years. This site is also graded 'poor' for primary recreation under the NPS-FM, while Walker Road and Black Bridge recreational sites are graded B (good) and C (average) respectively.

The Tukituki River is a hotspot for Phormidium cyanobacteria during warmer months. Irrespective of water quality, river users need to be aware of this potentially toxic algae, which can be attractive to dogs who may become sick or die after ingesting only small amounts.


*Figure 19-23. Swimming suitability metrics for marine, estuarine, and freshwater sites in the Tukituki catchment.*

## Water quality problems: what are we doing?

**The Tukituki catchment was the first in Hawke's Bay to have a resource management plan change that sets specific targets for improved water quality and ecosystem health. HBRC is working with landowners and communities in the Tukituki catchment to manage water quality issues. The objectives of the Tukituki Plan are to improve water quality and reverse the decline in biodiversity and other natural values.**

**Stock exclusion rules are already in force in the Tukituki, and the operational freshwater plan means the Tukituki is the first catchment in Hawke's Bay to have mandatory stock exclusion and farm environmental planning rules in place. In time, stock exclusion will help reduce faecal contamination, although it is uncertain whether existing rules will be sufficient to meet ambitious national swimmability targets.**

**Reducing hill country erosion and associated sediment loads will require concerted efforts over a large scale, and it may take decades to begin to see an instream response. Widespread riparian protection and planting will assist in improving water quality and biodiversity outcomes.**

[2] For more information see www.hbrc.govt.nz and search #phormidium.