Notes on lowland indigenous forest remnants on the alluvial flood-plains of the Waihou-Piako Zone, Waikato

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June 2016

Introduction

Recent analyses of regional-scale priorities for the conservation of indigenous-dominated terrestrial ecosystems of the Waikato Region have highlighted significant losses of formerly extensive forest ecosystems, particularly in the lowlands (Leathwick 2016a). This is particularly marked for the indigenous-dominated ecosystems of the Waihou-Piako Zone (Map 1), in which podocarp-dominated forests formerly occurred across more than 100,000 ha on alluvial and peat soils of the Hauraki Plains; these have now been reduced to around 1% of their former extent (Leathwick 2016b).

This report describes the results of a brief inspection of a selection of the larger surviving remnants of these forests, focussing on remnants dominated either by kahikatea (WF2 of Singers unpublished) or totara (WF8 of Singers unpublished). In particular, it assesses (i) the degree to which these remnants meet criteria 9 and 10 for determining the significance of indigenous biodiversity under the proposed regional policy statement (Waikato Regional Council 2016), and (ii) their potential to respond to active conservation management actions designed to protect and enhance their ability to represent the biodiversity values of the historic forests of the Hauraki Plains.

Background and methods

The extensive alluvial surfaces of the Hauraki Plains were originally built up by the Waikato River when it flowed through the Hinuera Gap and discharged into the Firth of Thames; with the Waikato River now flowing through the Hamilton basin and discharging into the Tasman Sea at Port Waikato, the plains now drained by smaller rivers arising on the surrounding hills, including the Kaimai Range and Mamaku Plateau to the east and south, and the lower elevation hills in the west that extend from Te Tapui northwards along the Hapuakohe Range. These include the Waihou River (eastern), the Waitoa River (central), the Piako River (western), and the Waitakaruru River (northeastern).

Historically, the Hauraki Plains most likely supported a mix of podocarp-dominant forests and raised bogs dominated by restiad rushes (Singers unpublished); in forested sites, kahikatea would have been dominant on less well drained sites but totara would have been locally prominent on better drained soils. The vast majority of this former forest cover has now been cleared, with only small remnants surviving, mostly on the flood plains of the largers rivers and streams. Although many of the former wetlands have also been converted to pasture, an extensive wetland, the Kopuatai Peat Dome, remains largely intact; other smaller areas of wetland survive throughout the Zone, often in proximity to water courses.

All remnants asssessed in this report were initially identified in the Regional Council's satellite imagery-based BIOVEG2 layer as consisting of 'Indigenous Forest'; their expected ecosystem composition was subsequently determined by overlaying their locations onto the potential ecosystems layer of Singers (unpublished). Forest patches located less than 100 m apart were

aggregated together to form a single site; for each site its spatial extent, degree of fragmentation, predicted potential composition, and average rank from the analyses of Leathwick (2016b) were calculated using standard GIS analyses.

Nineteen patches or (clusters of patches) whose combined area exceeded 5 ha (Map 1) were then visited for a road-side inspection, during which checking was also carried out along the routes driven to assess whether other extensive landscape patches had missed detection. Two more diffuse aggregations of sites (Nos. 11 & 12), located in the lower Waihou catchment between Paeroa and Ngatea, were also visited. While these were much more widely dispersed than the other sites, including them allowed assessment of the suitability of criteria used for selecting the main group of sites.

Notes were taken for each site describing the accuracy of its mapping, including correspondence between its actual composition and that predicted by the potential ecosystem layer, and its general condition including the intactness of its canopy, its degree of fencing, and the presence of any obvious issues with exotic weeds. A specific assessment was also made of the degree to which each remnant met Criteria 9 and 10 of the Regional Council's 'Criteria for determining significance of indigenous biodiversity', i.e.,

9. It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because:
   • its structure, composition, and ecological processes are largely intact; and
   • if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its ecological sustainability over time.
10. It is an area of indigenous vegetation or habitat that forms part of an ecological sequence, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.

Statistics presented for each stand include its total area of indigenous-dominated forest, the number of individual forest patches that it contains, and its edge ratio. The latter statistic was calculated by dividing the actual perimeter, by the minimum perimeter that could contain the same area of forest, i.e., a circle; values close to one indicate a very compact shape, while the values greater than two generally indicate elongated or other complex shapes; a square would have an edge ratio of 1.13.

Results

Visits to the sites described in this report (detailed below) indicate that despite very heavy clearance of the kahikatea and totara forests that were once widespread on the Hauraki Plains, there are significant opportunities to protect and restore representative examples of these ecosystems.

Choosing which sites represent the best opportunities for biodiversity conservation depends on the selection criteria used. If the choice was to be made based on size alone, then the most significant opportunities are found along the Waitoa River at Ngarua between Kereone Road and State Highway 27 (Site 5), on the Piako River near Tahuna (Site 16), and at the end of Mangawhero Road (Site 14). The first two of these sites contain riverine forests that are dominated by kahikatea on poorly drained river terrances, with totara-dominant forest on better drained terraces; the third site, located on poorly drained soils adjacent to the Kopuatai peat dome is dominated by kahikatea alone.

Map 1. Locations of seventeen indigenous, alluvial floodplain forest remnants on the Hauraki Plains. Numbers indicate the broad location of each remnant, and link to site numbers used in the detailed descriptions provided below.

If representation and site diversity are also taken into account, as in Criteria 9 and 10 of the Regional Council significance criteria, then the Ngarua stand (Site 5) is important for its inclusion of small areas of riverine wetland, a feature that it shares with the nearby site downstream at Woods Road (Site 6); there are similar opportunities to jointly manage forests and riverine wetlands at Kerepehi (Site 10). Overall representation of the historic regional forest cover would be improved by inclusion of the forest remnants occurring at and to the north of Waharoa (Sites 2 & 3), and that contain the most extensive non-riparian stands on moderately to well drained soils; although these are mostly dominated by kahikatea, at least one stand (near Jagger Road) contains significant amounts of rimu and totara.

Feasibility is also an important consideration when selecting sites for biodiversity management, and this can be strongly influenced by land tenure. Forest stands at Waharoa (Site 2), Woods Road (6), Kerepehi (10), and Mangawhero (14) are all located (at least partially) on publically owned land or have a significant owner commitment to active management of biodiversity values (Wallace Corporation at Woods Road). One of the larger Waharoa stands is reserve land administered by the Matamata Piako District Council, the Kerepehi site is partially located on land owned by the Waikato Regional Council, and the Mangawhero site is public conservation land managed by the Department of Conservation.

Finally, if geographic spread is considered, then it is probably important to include at least one site on the Waihou River on the eastern side of the Hauraki Plains, in addition to sites on the Waitoa and Piako Rivers. Of the three sites on the Waihou River, the Tirohia stand (Site 10) provides representation of kahikatea forest, and the Totara Springs stand (Site 1) representation of totara forest. The first of these smaller, but arguably provides greater opportunities for expansion and for linking with small wetland fragments. However, the Totara Springs site would provide an opportunity for conservation education if management activities could be linked to use of this site by educational groups. Similarly, inclusion of the Waitakaruru stand (Site 13) would provide representation on the northeast fringes of the Hauraki Plains.

Management requirements

Management requirements are likely to be closely similar for many of these forest stands. The majority of them are fragmented, and although generally fenced, often have very abrupt transitions from forest to open pasture. This makes them susceptible to loss of the micro-climate typical of forest, and which is required if species typical of forest interiors are to thrive; it also makes them susceptible to weed invasion, and increases their accessibility by introduced mammalian predators. Mitigation of impacts on micro-climate would be best achieved by establishing marginal plantings of shrub and small tree species selected for their natural occurrence in such environments, e.g., mahoe, pigeonwood, lancewood, titoki, cabbage-tree, etc.. In the longer term, consideration should also be given to the natural successions that would occur in these small stands. Where required, shade tolerant species such as tawa, titoki, and perhaps miro may require artificial introduction, given that seed sources for these species are likely to be found only at considerable distances.

Most of these sites will also require active control of currently established exotic weed species, as well as ongoing surveillance to detect any new incursions. The larger of these sites would also benefit from predator control to encourage growth in the populations of native vertebrates, principally birds and lizards, but possibly also bats. However, given the small sizes of these stands, integrated management across a number of adjacent stands is more likely to reap benefits at landscape-scales. Given the proximity of urban settlements to some of these sites (e.g., Wharoa and

Waitoa), education programmes may be required to raise awareness of the threats posed by domestic cats.

Methodological issues

One of the challenges for effective biodiversity conservation in highly modified landscapes such as the Hauraki Plains is efficiently finding sites with the greatest potential to represent the historic ecosystem pattern. In this project, three elements were combined to facilitate this process. First, an analysis of historic versus current ecosystem patterns was used to identify the relative degree of loss of different indigenous-dominated ecosystems. Second, spatial prioritisation of surviving indigenous-dominated fragments was used to identify best options for representation. Third, results from these first two components were used to identify high-ranked surviving primary (clusters of) fragments of two of the most diminished forest ecosystems. A number of these were then visited and assessed from the roadside to determine their broad composition, degree of fencing, and any significant weed issues. The information gathered was then combined with GIS-based description of the patch size, shape, proximity to other patches, and tenure, to assess the broad potential of each patch to represent the historic ecosystem cover.

In general terms, this approach worked well both for assessing the significance of different stands under the Regional Council's significance criteria 9 and 10, and for identifying sites with greatest potential for active conservation management aimed at improving representation of the former forests of the Hauraki Plains. Actual choices for conservation management would presumably be finalised after consideration of a range of factors including the ability of the different stands to fully represent the historic ecosystem pattern, their size and shape, and operational considerations such as tenure, the interests of private land owners, and proximity to population centres where an interest might be fostered in community involvement in hands on conservation.

The approach used here would also seem to have potential for application in other parts of the Waikato Region, or in fact in other lowland parts of New Zealand that have retained only a small proportion of their historic ecosystem pattern. Flexibility will be required, however, in applying the results, in particular because of the automated routine used for grouping together adjacent remnants. This step was necessitated by the impracticality of dealing individually with a very large number of small fragments, which are frequently clustered in ways that would require joint management for success. Aggregating fragments spaced less than 100 m apart worked reasonably well here, although at times it produced breaks between stands separated by slightly greater distances, for example, in the riverine forest fragments that are relatively continuously distributed along the middle reaches of the Piako and Waitoa Rivers.

In these settings, management actions should be planned not just for individual sites as described below, but also with a view to managing groups of related sites that are close enough together to benefit from joint management, e.g., sites 5 and 6 on the Waitoa River and sites 16 and 17 on the Piako River near Tahuna, with both pairs of sites likely to benefit from joint management. Similar considerations apply at Waharoa, where remnants just outside the aggregation distance should be considered for concurrent management with sites 2 and 3.

It is difficult to identify any alternative approach that would work to more effectively identify groups of related remnants for management. Inclusion in the field survey phase of two more diffuse aggregates of small fragments at Wilson Road (Site 11) and east of Ngatea (Site 12), neither of which could be considered strong long-term prospects for conservation, suggests that using a larger

aggregation distance will not automatically improve the site selection process. A better approach would be to retain the 100 m aggregation distance used here, but to also add qualitative consideration of other adjacent fragments during the field survey and management planning phases.

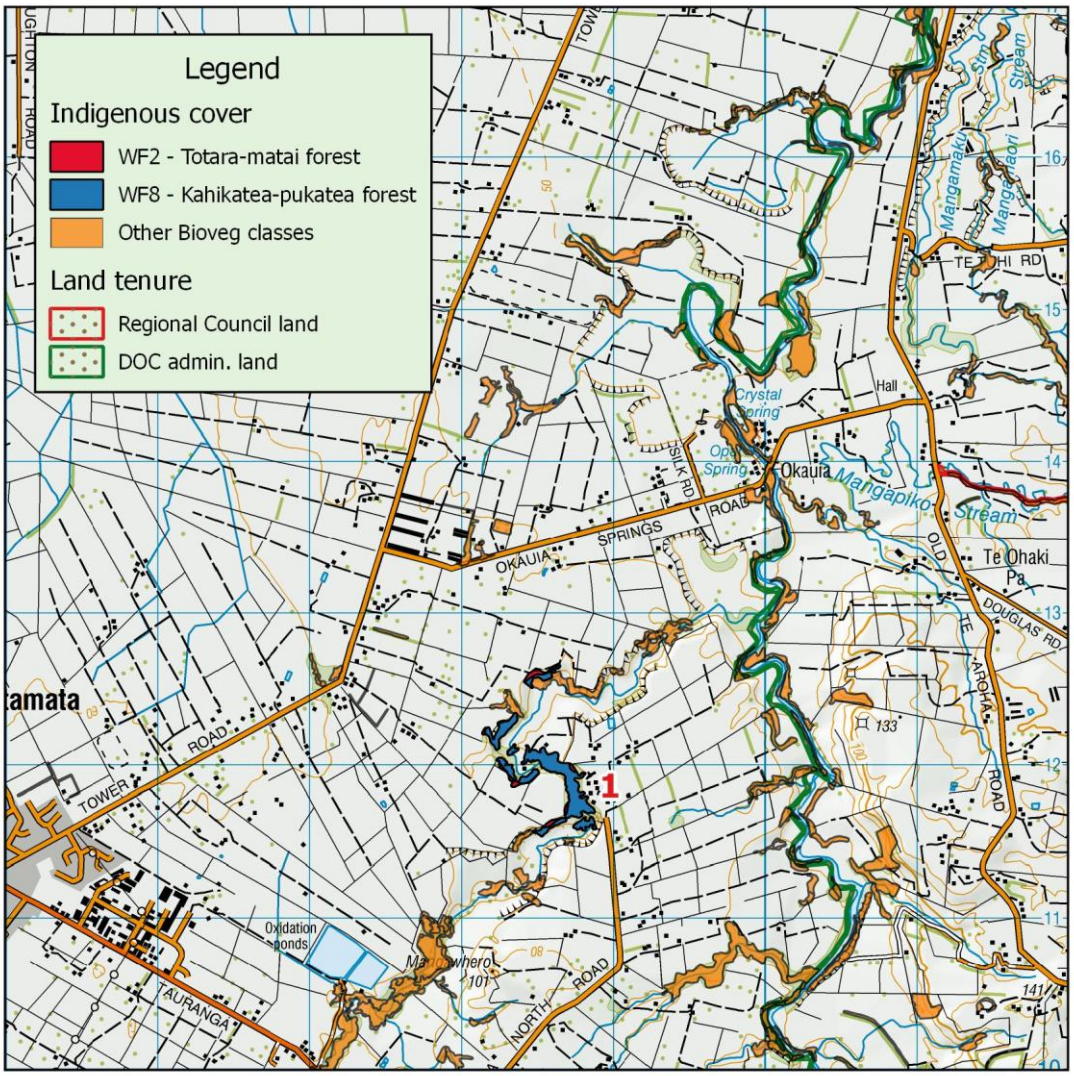
Reliability of the input data

Results from the field inspection highlighted the challenges inherent in accurate reconstruction of the potential ecosystem pattern, particularly in lowlands that have been subject to extensive clearance. In this study, it was evident that assumptions about the distributions of totara-dominant versus kahikatea-dominant forest with respect to soils of differing drainage on the Hauraki Plains were well founded, with the first dominating forests on well drained sites, and the second dominating on heavier, less well drained soils. However, the ability of the potential ecosystem layer to accurately capture fine-scale differences in drainage and therefore the composition of forest remnants was less successful. This resulted in a number of discrepancies between the predicted and actual ecosystem pattern in the small remnants described here.

Alternatively, it should be noted that some of these discrepancies where totara is dominant rather than kahikatea as predicted in the potential ecosystem layer, may reflect the marginally greater ability of totara as a pioneer species. That is, some of the totara stands, which are clearly of a relatively young age, may be an early successional stage that over time will be gradually replaced by the somewhat more shade tolerant kahikatea.

This challenge of using broad-scale data at finer scales indicates a strong need for more detailed field inspection of the high value sites identified here, prior to any final decisions being made to implement management. Conversely, it is possible that some high value sites on the Hauraki Plains may have been overlooked in this process because of inadequacies in the input data. As a consequence, failure to mention any particular site should not be interpreted as indicating that it contains no biodiversity of value – only that other sites have even high values, with these sites therefore offering the greatest potential for future conservation management, based on current information.

Site One – Totara Springs

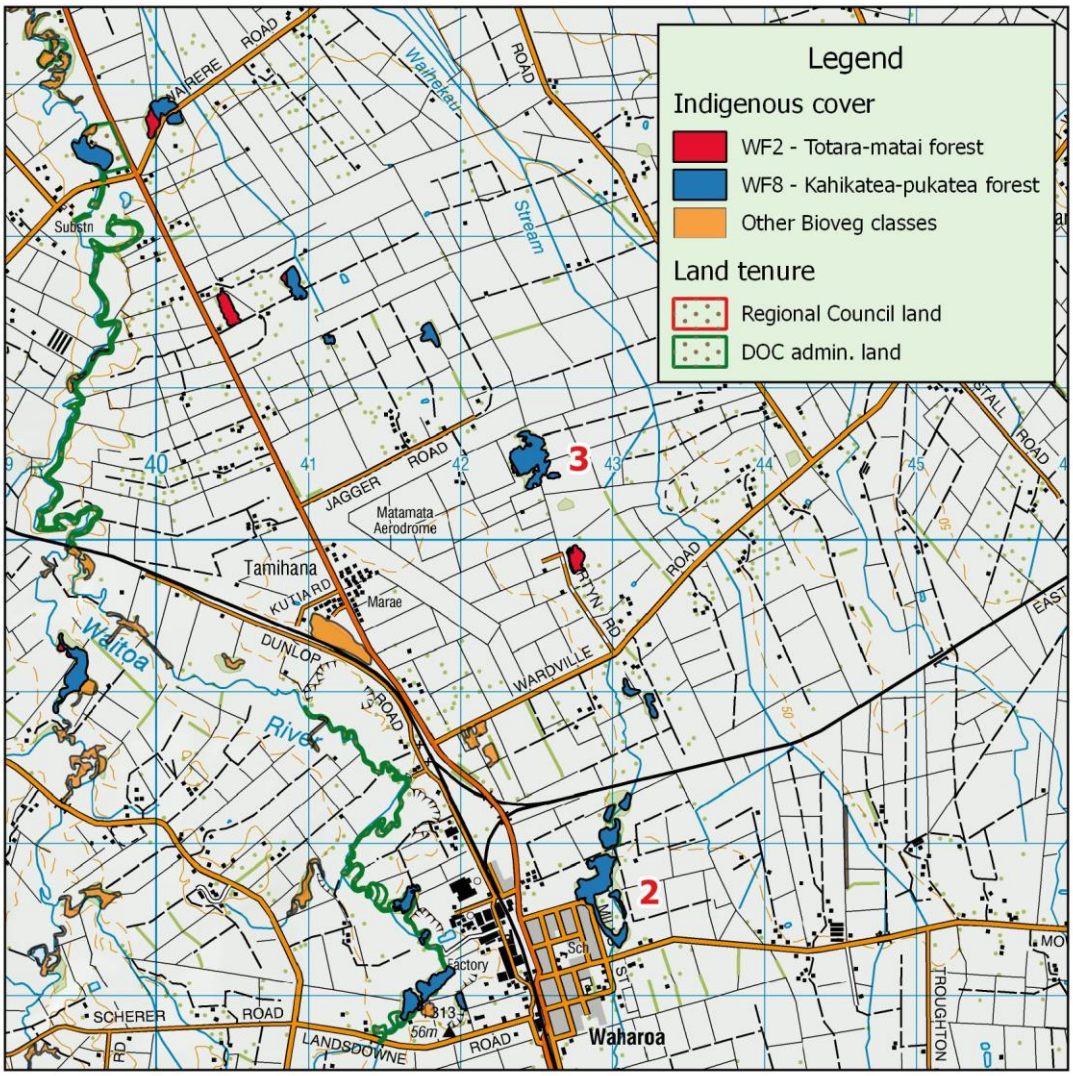


Total extent: 11.2 ha Number of patches: 19 Edge ratio: 4.6

This site is located approximately 4km east of Matamata and contains indigenous forest remnants distributed along terraces and terrace edges adjacent to the Mangawhero Stream, a tributary of the Waihou River. Although mapped in the potential ecosystem layer as WF8 kahikatea-pukatea forest, totara is strongly dominant, reflecting the well-drained soils. The forest remnants form a backdrop to a residential camp facility that is widely used for school and community events.

This remnant is both highly fragmented and convoluted in shape making it highly susceptible to edge effects; these are exacerbated by it being spread along both sides of the Mangawhero Stream. It was not possible to ascertain the state of the understorey or its degree of protection from grazing. The site lies within several hundred metres of other indigenous-dominated patches along the Mangawhero valley, most of which are dominated by kanuka, although with some totara.

Sites 2 & 3 – Waharoa



Site 2:	Total extent:	8.9 ha	Number of patches:	6	Edge ratio:	3.6
Site 3:	Total extent:	5.7 ha	Number of patches:	5	Edge ratio:	2.4

This site, which is located on the northern outskirts of Waharoa, contains 11 forest remnants of varying size, distributed along an arc stretching north approximately six km from Waharoa to the northwest, and together totalling nearly 15 ha in extent; another outlier to the north straddles Wairere Road just to the east of SH27. All of the remnants contain kahikatea-dominant forest, although with occasional rimu and totara, particularly in the stand immediately south of Jagger Road; this contrasts, with the potential ecosystems layer, which identifies three of these stands as being likely to be dominated by totara.

The southern-most of these remnants, the Waharoa Bush Reserve (Photo 1), is located on the outskirts of Waharoa township and is administered by the Matamata-Piako District Council. The stand is well fenced and is partially buffered by adjacent unfenced remnants of forest and woodland in intensively managed pasture. It has signifcant issues with weeds, including ivy, privet species, and chinese fan palm.

Photo 1. Looking east from the embankment on SH27 where it crosses the Hamilton–Tauranga railway line, just north of Waharoa. The Waharoa Bush Reserve is located on the right, while several smaller stands in the centre and left are located in intensively-managed pasture.

The remaining forest stands are all located on private land, and are mostly well fenced. Those north of Wardville Road are surround by horticultural land, so are under little threat from grazing by stock. The largest and most diverse of these is located just south of Jagger Road (Photo 2); while it is dominated by kahikatea, it also contains rimu and totara. A local resident I spoke to recalled hearing kiwi calling from within this stand when growing up at the marae in the 1950s. Other stands further north (e.g., Photo 3) are smaller, and are almost completely dominated by kahikatea.

Photo 2. The large remnant of kahikatea forest approximately 300 m southeast of the eastern end of Jagger Road, Waharoa. The more distant stand on the far right is located at the end of Martyn Road.

Perhaps the most important feature of these forest remnants is their location on extensive, older alluvial soils, which contrasts with the more recent soils of the riparian sites occupied by most other forest remnants on the Hauraki Plains. While they are relatively widely spread across the landscape, they arguably provide the best surviving representation of the forests that would have once been widespread on the more poorly drained alluvial soils of the Hauraki Plains. The two largest patches are extensive enough to contain some core habitat, i.e., more than 50 m from a margin. Some

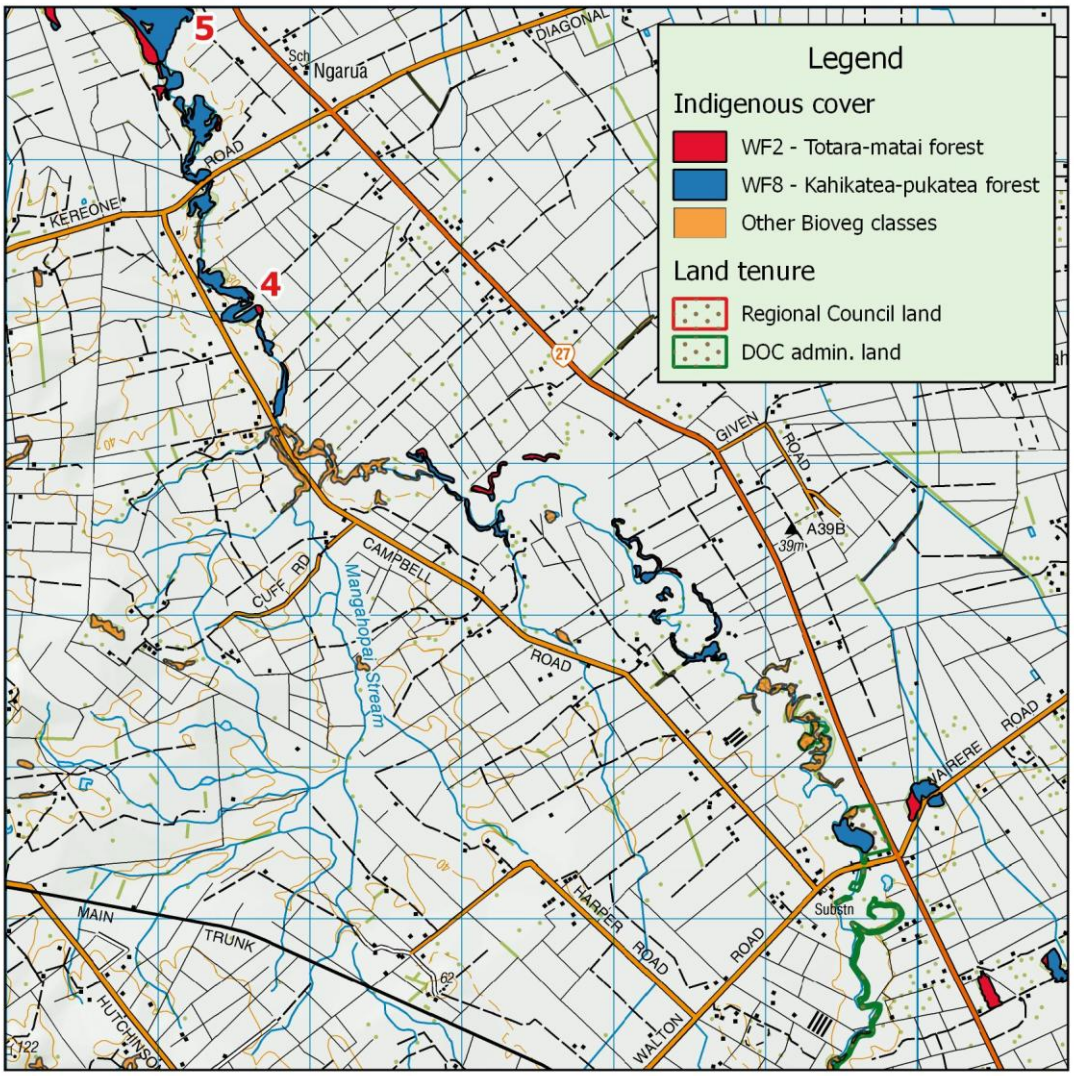
compensation for their fragmented nature could be achieved by managing them in a coordinated fashion, allowing for movement between stands of more mobile species that would respond positively to predator management, e.g., tui. This could possibly be extended to include a moderate-sized stand of riparian kahikatea forest on the Waitoa River, just downstream of the Walton Road.

These stands collectively meet at least two of the Regional Council's criteria for signficance, including Criteria 4 ('an ecosystem that is under-represented (20% or less of its known or likely original extent remaining)') and Criteria 7 ('large relative to other examples in the Waikato Region'). They also meet Criteria 9 within the limitations of their size, i.e., their structure and composition are largely intact, and if given adequate protection, including remedial actions to remove weeds, they are likely to have reasonable prospects for long-term sustainability, at least of the plant species that they support. This is likely to also extend to include smaller, more mobile species (e.g., forest birds) that are capable of using these stands in conjunction with other lowland remnants (including those dominated by introduced plant species. Longer distance links would probably occur with the more extensive forests of the Kaimai Range located approximately nine km to the east and those on Maungakawa and Te Tapui approximately 12 km to the south west.

By contrast, these stands fail to meet RPS Significance Criteria 10 ('sites that form part of an ecological sequence'), given that they have now almost completely lost their connections with the wetlands and riparian forests with which they once together occupied this landscape.

Photo 3. Forest remnant on Wairere Road, approximately 0.5 km from its junction with SH27.

Site 4 – Waitoa River – Campbell Road



Total extent: 7.4 ha Number of patches: 8 Edge ratio: 4.0

Site 4 contains a series of narrow riparian forest stands along the upper Waitoa River immediately upstream of Kereone Road. Although the majority of these stands are mapped as having a potential composition dominated by kahikatea, they are generally dominated by totara, which mostly forms narrow strips of forest growing on steep terrace edges adjacent to the river (Photo 4). Small patches of kahikatea occur locally on poorly drained lower-level river terraces, the largest of which are located adjacent to Campbell Road approximately 500 m from its junction with Kereone Road (Photo 5), and immediately downstream of Walton Road. A number of totara patches growing along this section of the Waitoa River are wrongly mapped in BIOVEG2 as 'manuka and/or kanuka', particularly adjacent to the junction of Cuff and Campbell Roads, and further upstream towards Walton Road.

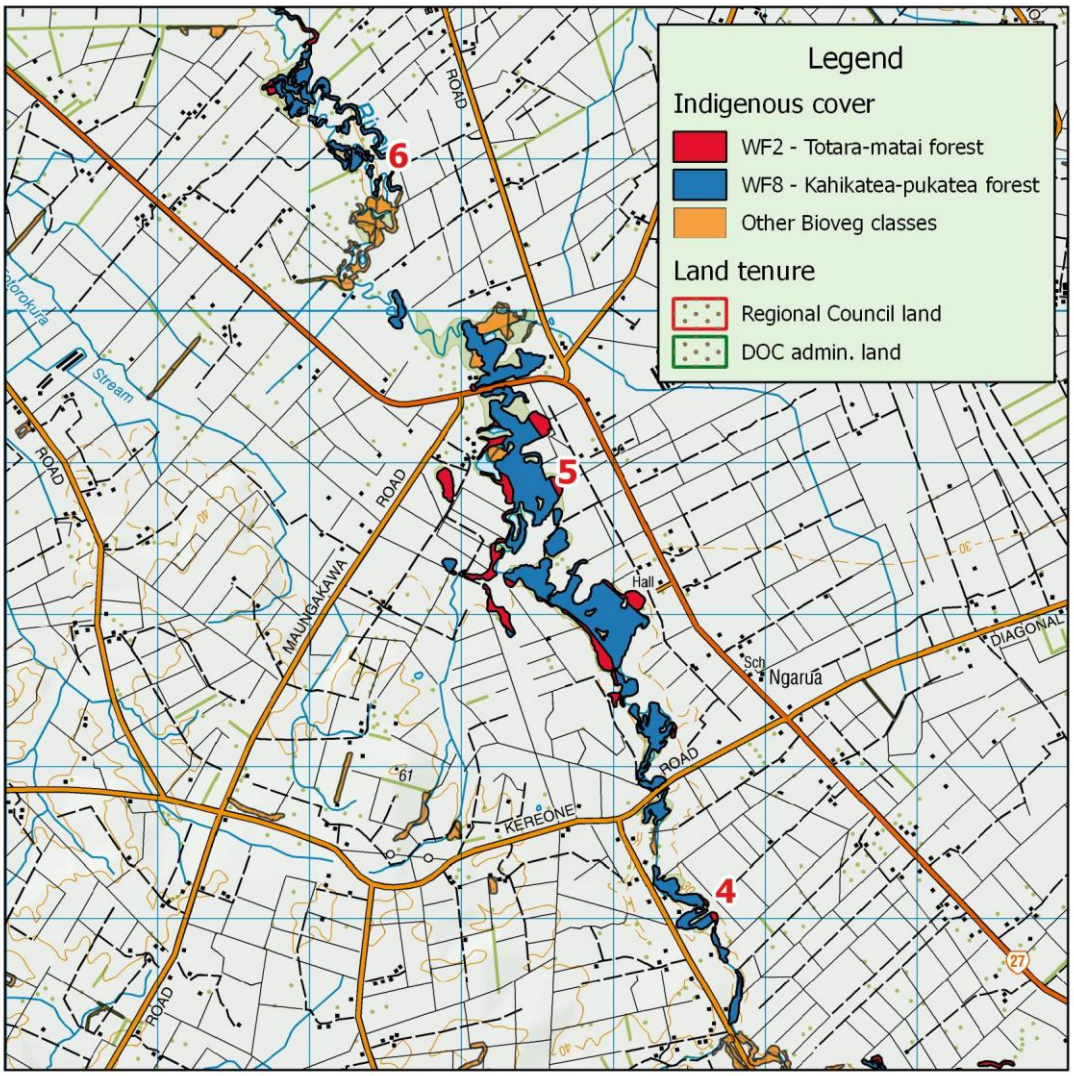
Overall, the restoration potential of this site is only moderate, owing to its highly convoluted shape, and strong edge effects; a number of trees occur within intensively managed pasture (Photo 4). While it provides some representation of WF2 totara-matai forest, which is now regionally rare (Criteria 4), its small size and significant edge effects result in much of it being highly susceptible to weed invasion, and this will threaten its long-term viability, particularly with respect to its

compositional integrity (Criteria 9). On the other hand, it meets some aspects of Criteria 10 ('forms part of an ecological sequence') through its representation of sites with floodplain sequences (forests and wetland on soils of differing drainage status) and processes (regular inundation).

Photo 4. Scattered riparian totara scatted across pasture alongside Campbell Road. Note the Chinese privet in the foreground.

Photo 5. A Riparian stand at the northern end of Campbell Road, with totara on terrace edges closest to the camera, and taller kahikatea forest in the background on a lower terrace.

Site 5 – Waitoa River at Ngarua (Kereone Road)



Total extent: 71.0 ha Number of patches: 37 Edge ratio: 7.6

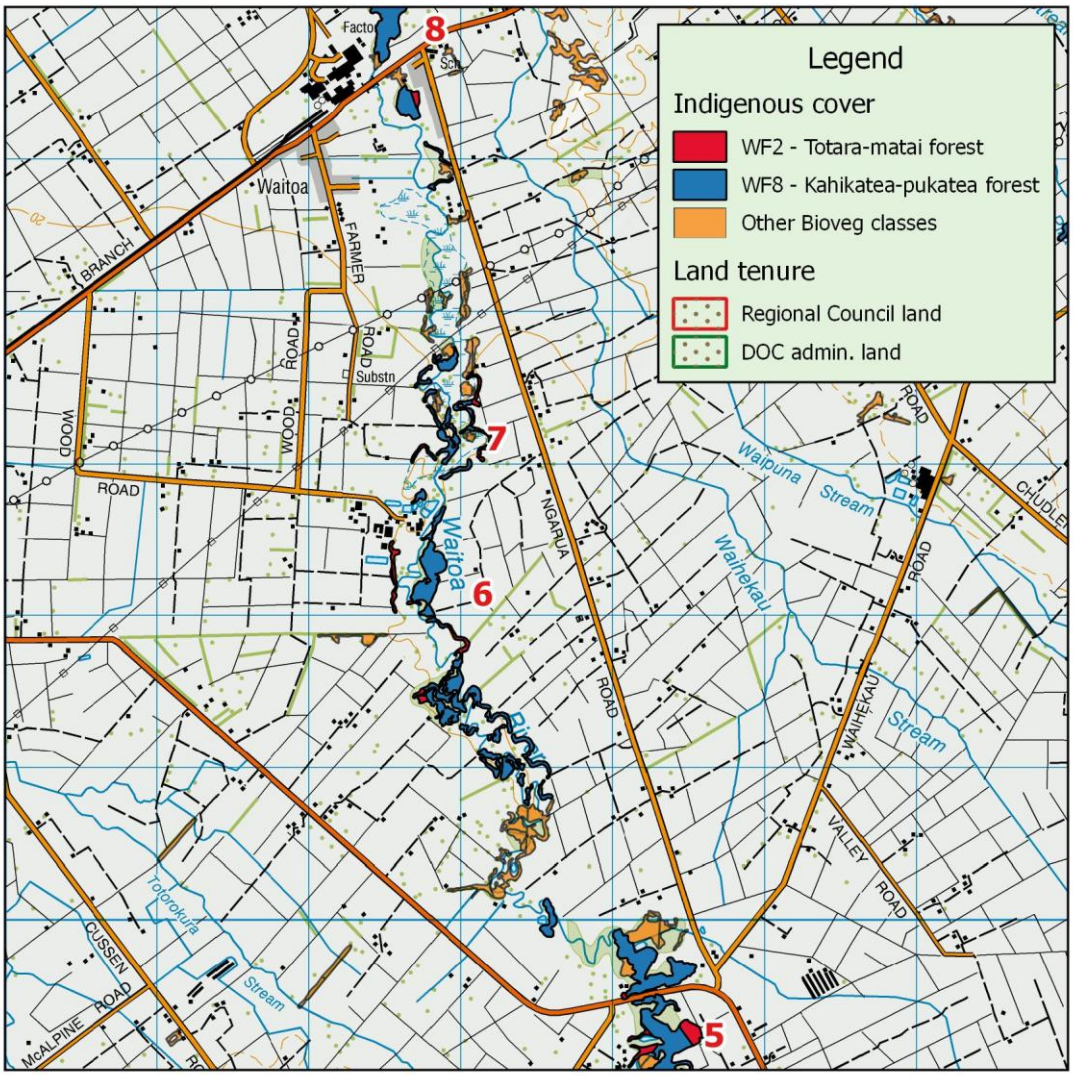
This is the most extensive forest remnant surviving on the Hauraki Plains, containing kahikatea and totara-dominant forest growing along both sides of the Waitoa River from Kereone Road to just downstream of SH27 (Photo 6). In contrast to the mapped potential ecosystem pattern, totara is generally dominant on the well-drained terrace edges and levees, while kahikatea is dominant on the heavier soils that occur both on flood-prone lower river terraces and the adjacent slightly higher elevation terrace country; satellite imagery indicates the presence of several small areas of wetland. Most of the forest appears well fenced, and willows have been planted extensively around the margins; scattered emergent willow and poplar were also visible in more open parts of the interior.

This remnant clearly meets a number of the Regional Council's significance criteria, including Criteria 4 ('an ecosystem that is under-represented'), Criteria 6 ('wetland habitat'), Criteria 9 (healthy, representative and sustainable), and Criteria 10 ('an ecological sequence'). More specifically, its size and relatively compact shape, coupled with its diversity of landforms and vegetation, make it arguably one of the better prospects for the long-term representation of WF2 and WF8 on the Hauraki Plains. Its value is further enhanced by its representation of the flood plain processes and

dynamics that would have once been a feature of the Plains. Its value could be improved significantly by indigenous plantings to improve protection of the edges, to restore some of the smaller pasture enclaves within the forest stands, and to improve connectivity across the more fragmented central part of the stand.

Photo 6. A mixed stand of totara at the northern end of Maungakawa Road – note the scattered taller kahikatea standing above the totara canopy left of centre.

Site 6 – Waitoa River at Wood Road (Wallace Corporation)



Total extent: 19.7 ha Number of patches: 6 Edge ratio: 9.2

The next forest remnant downstream on the Waitoa River is located adjacent to and upstream of the Wallace Corporation factory at the end of Wood Road. Its upstream parts consist mostly of fringing totara growing on terrace edges, sometimes at some distance from the river, and with scattered to dense patches of kahikatea occurring locally on the lower flood plain; this includes a section at the upstream (southern) end of the remnant which is currently mapped as 'manuka and/or kanuka'. Much of this part of the remnant is unfenced, with areas of developed pasture intermingled with forest. A much more extensive patch of kahikatea forest occurs further downstream on the eastern bank of the Waitoa River immediately opposite the Wallace Corporation factory.

As well as meeting Criteria 4 ('an ecosystem that is under-represented'), this remnant, and particularly its northern parts is valuable for the size of its kahikatea stands, its inclusion of wetland habitat (Criteria 6), and its resulting representation of floodplain processes typical of the Hauraki Plains (Criteria 10). Together these features make it a strong prospect for as a sustainable site for biodiversity protection in the long-term (Criteria 9), particularly in its downstream half. A relatively fragmented section of forest along the convoluted river channel in the middle parts of this site

would benefit from restoration planting designed to increase the indigenous cover, and to increase the ratio of core to edge habitat.

Site 7 – Waitoa River at Farmer Road

See map for site 6.

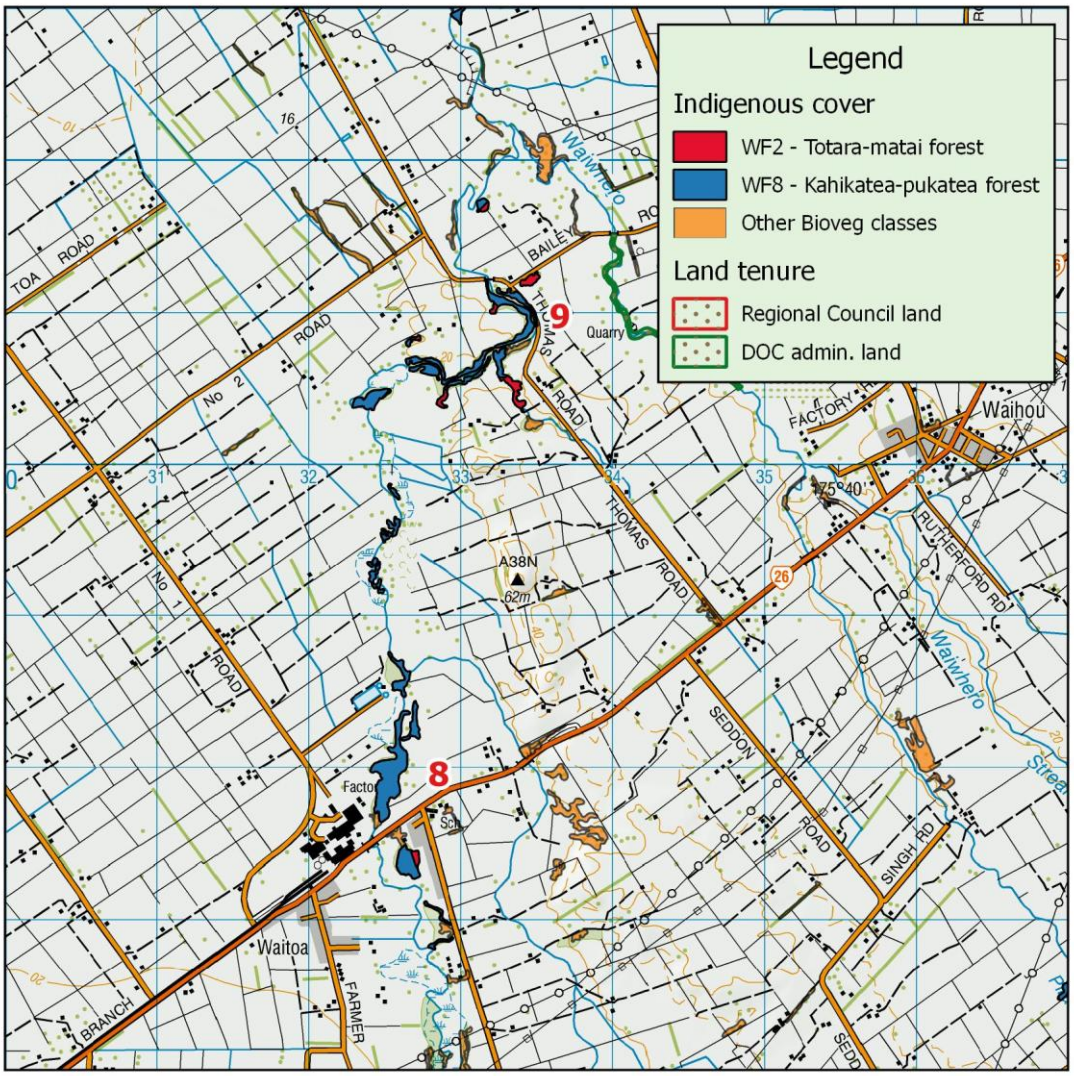
Total extent: 7.0 ha Number of patches: 7 Edge ratio: 7.4

This relatively small remnant consists of a highly convoluted set of small riverine totara and kahikatea fragments scattered along the Waitoa River immediately downstream of the previous site but upstream of SH26. Totara dominates stands on the terrace edges and kahikatea is dominant in a few small patches of low stature forest on the Waitoa River flood plain (Photo 7). Exotic trees appear to be scattered throughout the remnant.

Compared to other forest fragments along the Waitoa River, this collection of small forest stands is a relatively poor prospect for the sustainable long-term representation of the forests of the Hauraki Plains. This reflects its high degree of fragmentation and its convoluted shape, which would necessitate extensive planting for remediation, along with removal of exotic elements, including large exotic trees.

Photo 7. Low stature forest of totara and kahikatea growing on a terrace edge above the Waitoa River just upstream from SH 26. Note the tall introduced conifer at left.

Site 8 – Waitoa River at Waitoa (Dairy Factory)



Total extent: 9.0 ha Number of patches: 4 Edge ratio: 3.4

This remnant is located on the western bank of the Waitoa River immediately to the northeast of the Waitoa Dairy Factory. It consists of a relatively compact shaped patched of dense, reasonably tall kahikatea forest, with lower stature forest in the north; it is more open along its eastern (river) margin. Satellite imagery indicates that the western boundary is well fenced, while the Waitoa River provides a natural boundary along its eastern margin. A smaller (2.4 ha) patch of kahikatea forest occurs approximately 200 m to the south, upstream of SH 26.

This stand, while not as large as some of the other remnants on the Waitoa River, offers good prospects for the sustainable representation of the former extensive kahikatea forests (WF8) of the Hauraki Plains (Criteria 9). This is enhanced by its compact shape, its freedom from grazing impacts, and its potential for expansion through restoration plantings both along the eastern margin adjacent to the river, and in the northeast.

Site 9 – Waitoa River at Thomas Road

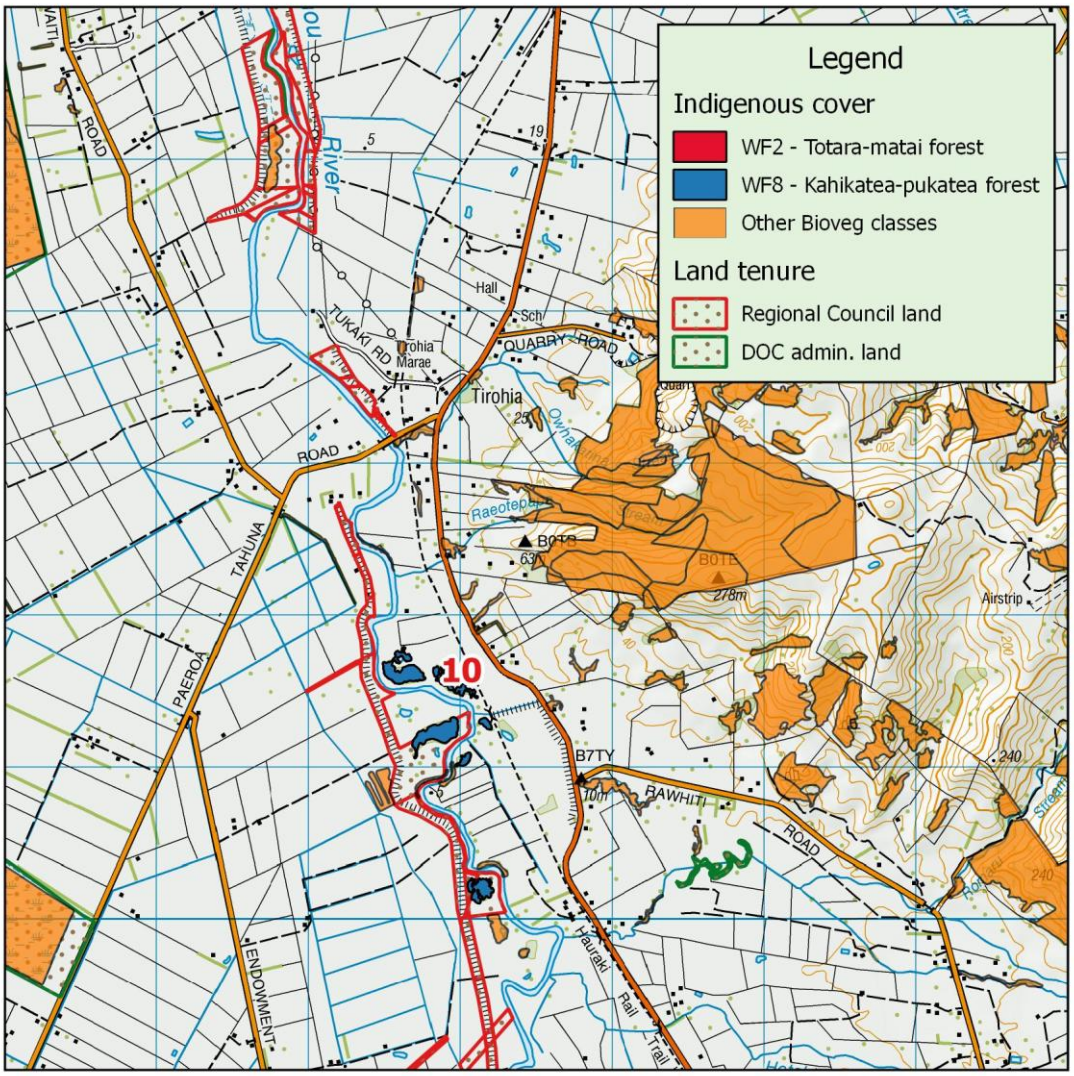
See map for site 8

Total extent: 10.4 ha Number of patches: 14 Edge ratio: 7.1

This remnant is located along the Waitoa River adjacent to Thomas Road approximately 3 km north of Waitoa. It consists of a mostly narrow marginal strip of totara and kanuka with occasional kahikatea, growing along the terrace edges above the Waitoa River; one more compact patch of kahikatea in the south is visible on satellite imagery, but not from the road. The remnant is only partially fenced and contains a wide variety of exotic tree species, including eucalypts, oaks, willows and pines.

It would be difficult to argue that this site meets either Criteria 9 or 10 of the Regional Council's significance criteria, given its convoluted shape, high degree of fragmentation, and mixed indigenous/exotic composition. However, its conservation value could be significantly improved through weed control, fencing and restoration planting to provide greater linkages between the various patches.

Site 10 – Waihou River at Tirohia



Total extent: 4.3 ha Number of patches: 3 Edge ratio: 3.7

The site is located on the floodplain of the the Waihou River approximately 2 km upstream (south) of where it is crossed by the Paeroa-Tahuna Road. It lies closely adjacent to the Hauraki Rail Trail, and is visible both from the Rail Trail and from SH26, just north of its junction with Rawhiti Road (Photo 8).

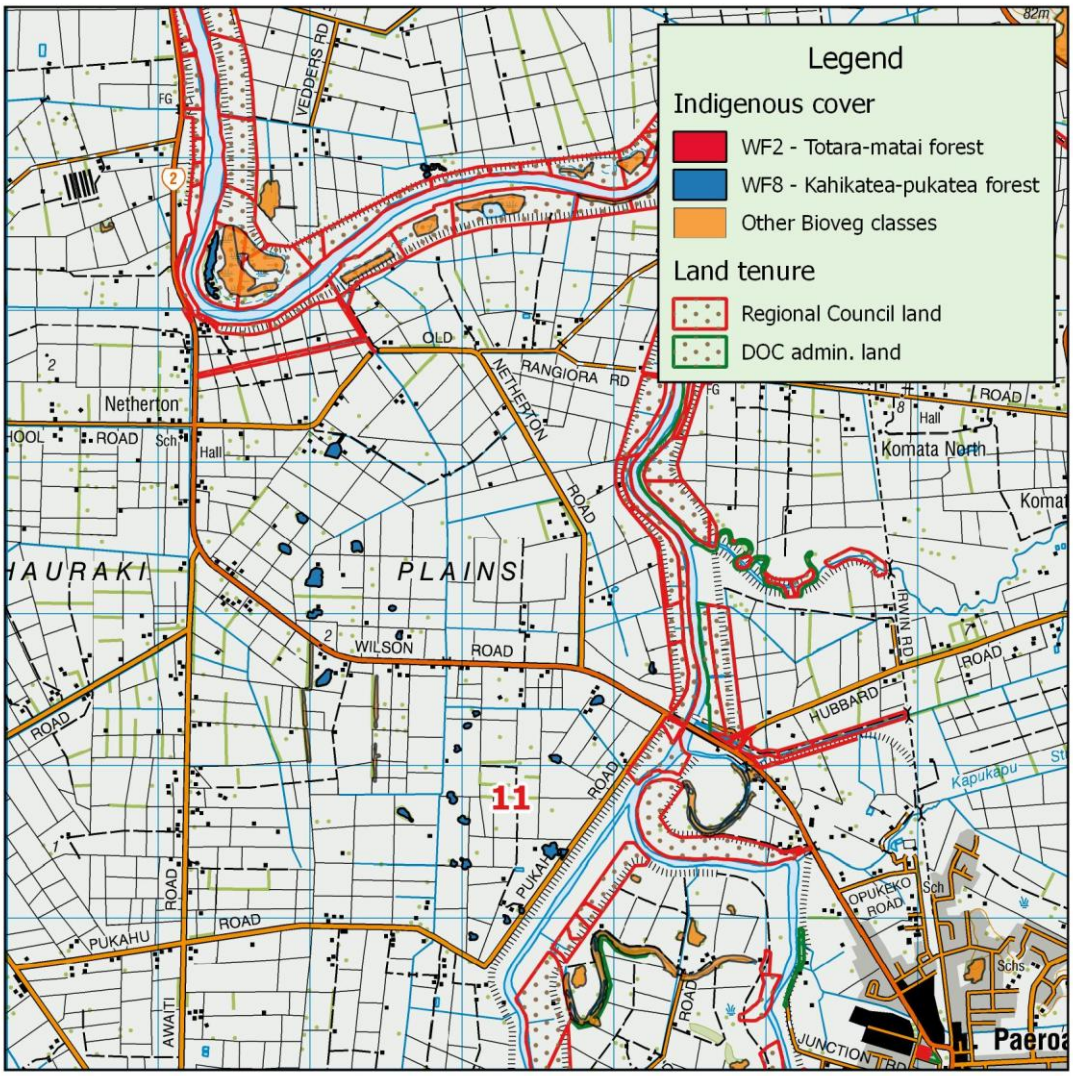
The site contains two remnants of tall kahikatea-dominant forest, each of approximately 2 ha, and growing on opposite sides of the Waihou River; several smaller areas of scattered kahikatea individuals, open woodland, and locally dense forest provide some connection between these two main stands. A smaller stand of kahikatea forest (c. 1.5 ha) lies approximately 1 km upstream. Cabbage trees are prominent around the forest edges. Satellite imagery indicates the presence of wetlands fringing two small ponds adjacent to the largest kahikatea patch, located on the flood-prone lower terrace between the stop-bank and the river on the western side of the Waihou River; one of these is on Regional Council land and the second is most likely on private land.

This stand meets both Criteria 9 (healthy, representative and sustainable), and Criteria 10 (‘an ecological sequence’) of the Regional Council’s significance criteria. The two larger stands of

kahikatea are both compact in shape, and are large enough to provide good long-term prospects for sustaining their existing values, subject to appropriate management. They have also retained their dynamic connections with the river system and surviving remnants of its associated wetlands. Broader landscape connctions are available with a 150 ha patch of secondary hill-country forest one km to the northeast, and the extensive Kopuatai wetland which is one km to the west. The two southern-most large kahikatea stands on the western side of the Waihou River are located on Waikato Regional Council land, simplifying expansion of indgenous cover by restoration planting if this were deemed a priority. Extending restoration actions to reconnect the forest with adjacent wetlands on private land would further enhance the value of this site. Public appreciation of this site could be fostered by linking it with the adjacent cycleway.

Photo 8. Kahikatea forest remnants on the Waihou River floodplain at Tirohia, looking west from SH26 just north of its junction with Rawhiti Road. The stand on the left is located on Waikato Regional Council land on the west bank of the Waihou River, while forest in the centre and to the right are located on the east bank of the Waihou River. The Hauraki Rail Trail runs along the old railway line which is located just beyond the drain running left to right beyond the foreground pasture.

Site 11 – Waihou kahikatea remnants (Wilson Road)



Total extent: 8.0 ha Number of patches: 20 Edge ratio: 5.4

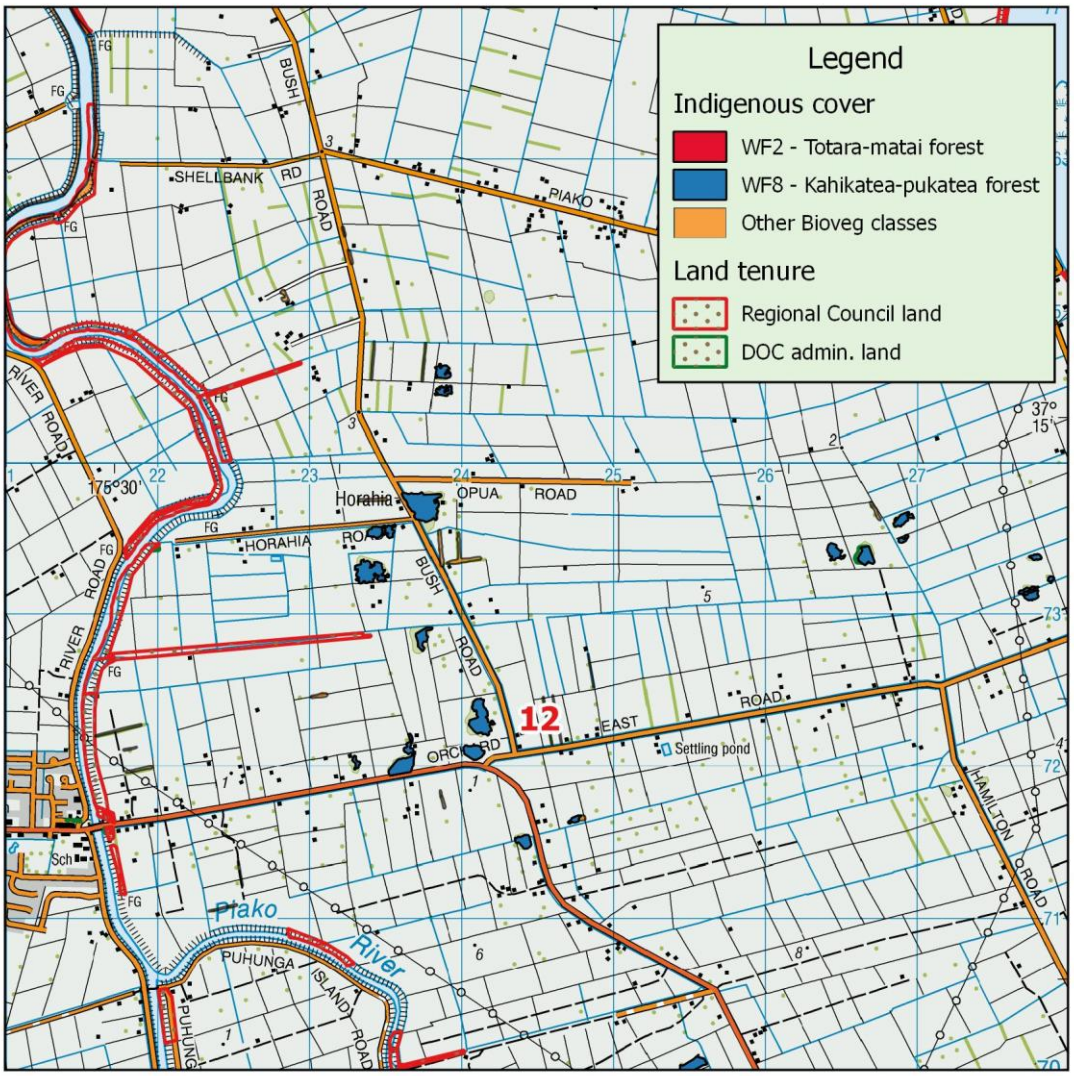
This diffuse cluster of small remnants is located on the western flood plain of the lower Waihou River approximately 5 km northwest of Paeroa. All of the remnants are of limited extent and the majority are unfenced (Photos 9 & 10). They would appear to offer limited prospects for restoration, given the likely expense of fencing, which would ideally be supported by restoration planting to increase both the size and connectivity of the individual patches.

For this reason, these stands are unlikely to meet either Criteria 9 (healthy, representative and sustainable) or Criteria 10 (‘an ecological sequence’) of the Regional Council’s significance criteria.

Photo 9. A small kahikatea remnant adjacent to Pukahu Road.

Photo 10. Looking north from Wilson Road towards three small kahikatea remnants; note isolated trees on the right.

Site 12 – Piako kahikatea remnants (Ngatea east)

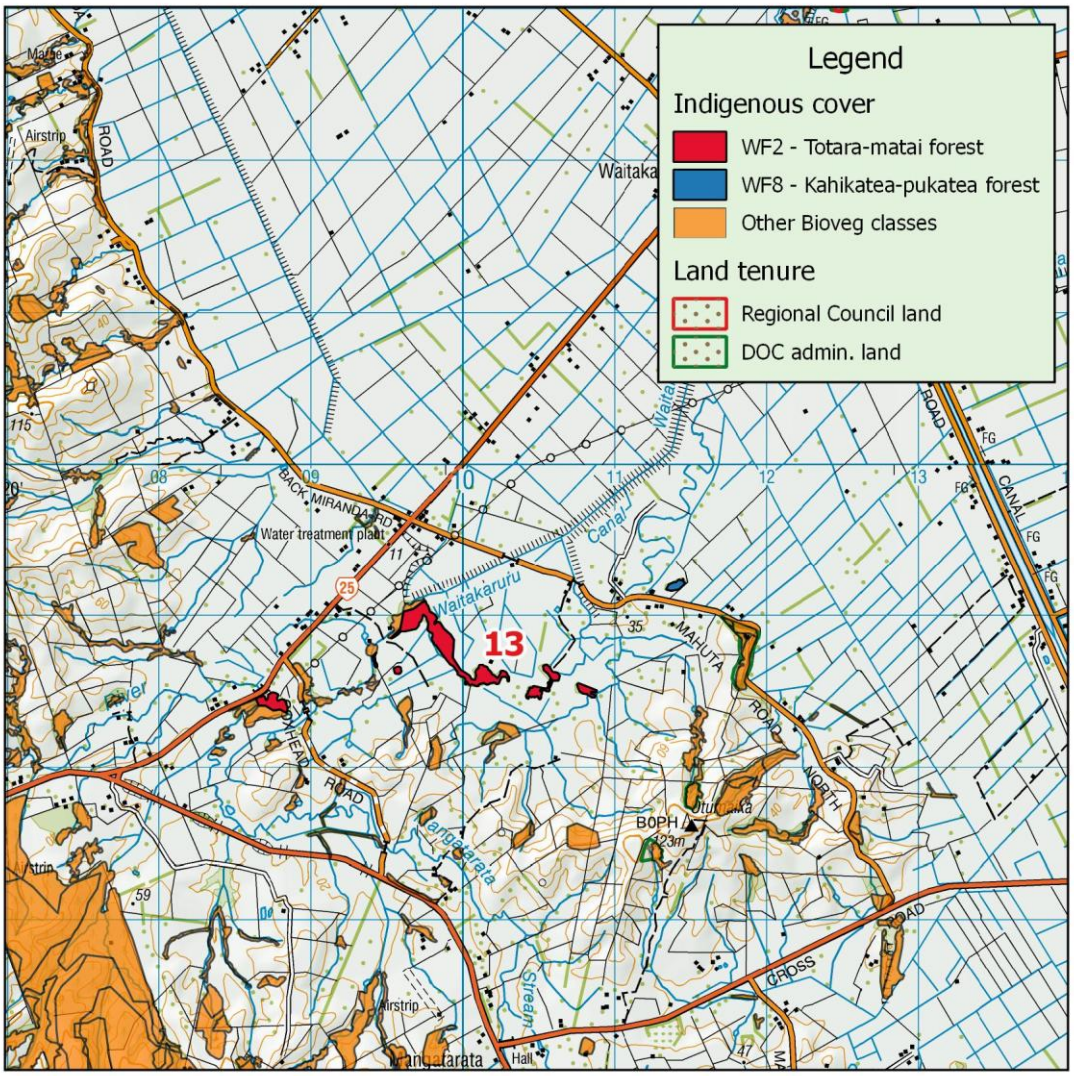


Total extent: 14.1 ha Number of patches: 10 Edge ratio: 5.4

This collection of small forest remnants is located on the flood plain of the Piako River 2-3 km east of Ngatea, mostly north of East Road. Most of these stands contain small stature kahikatea, with a few titoki and cabbage trees (Photo 11). Many of these remnants are unfenced and subject to modification through grazing and trampling by domestic stock. As with the previous set of remnants adjacent to Wilson Road, these stands are unlikely to meet either Criteria 9 (healthy, representative and sustainable) or Criteria 10 ('an ecological sequence') of the Regional Council's significance criteria. However, they offer marginally better options for restoration, given their closer proximity to each other than the Wilson Road stands.

Photo 11. A mixed stand of kahikatea and titoki with marginal cabbage trees adjacent to Horahia Road.

Site 13 – Waitakaruru kahikatea remnant



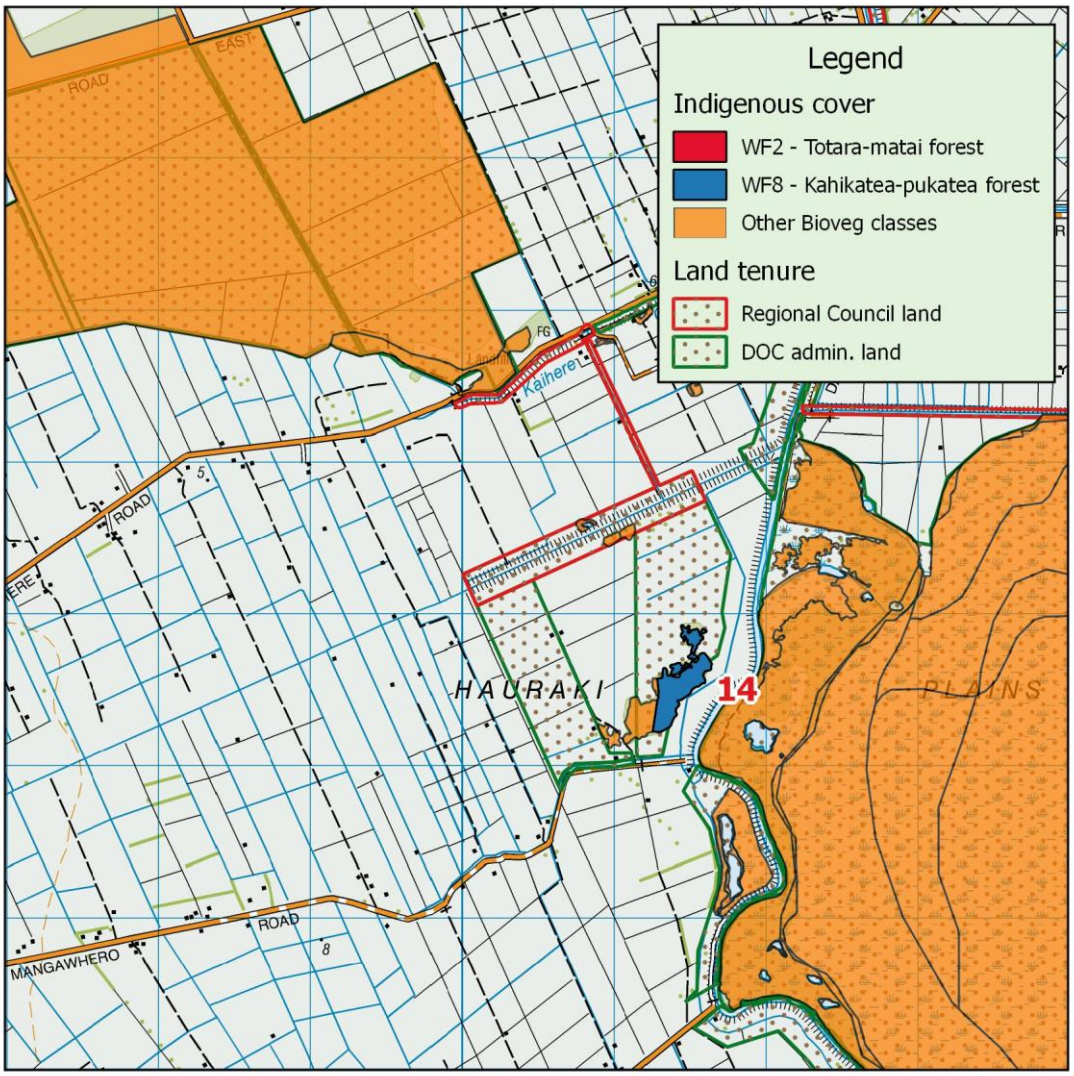
Total extent: 7.5 ha Number of patches: 1 Edge ratio: 2.9

This elongated forest remnant of 7.5 ha is located adjacent to the upper end of the Waitakaruru Canal. Although mapped in the potential ecosystem layer as totara-matai forest, inspection from the road indicates that it is dominated by tall kahikatea with some cabbage trees around the margins.

Given its relatively large size, this remnant meets Criteria 9 (healthy, representative and sustainable) of the Regional Council's significance criteria, provided that it is adequately managed to exclude stock and control any invasive weeds. Restoration planting could be used to expand the width of the stand in its narrower parts, i.e., around the middle section. The stand has relatively low connectivity with other native-dominated sites within the broader landscape, although several small fragments occur further upstream along the Waitakaruru River.

Photo 12. The elongated stand of tall kahikatea at Waitakaruru, as viewed from Mahuta Road North.

Site 14 – Piako kahikatea remnant – Mangawhero Road



Total extent: 15.8 ha Number of patches: 3 Edge ratio: 3.8

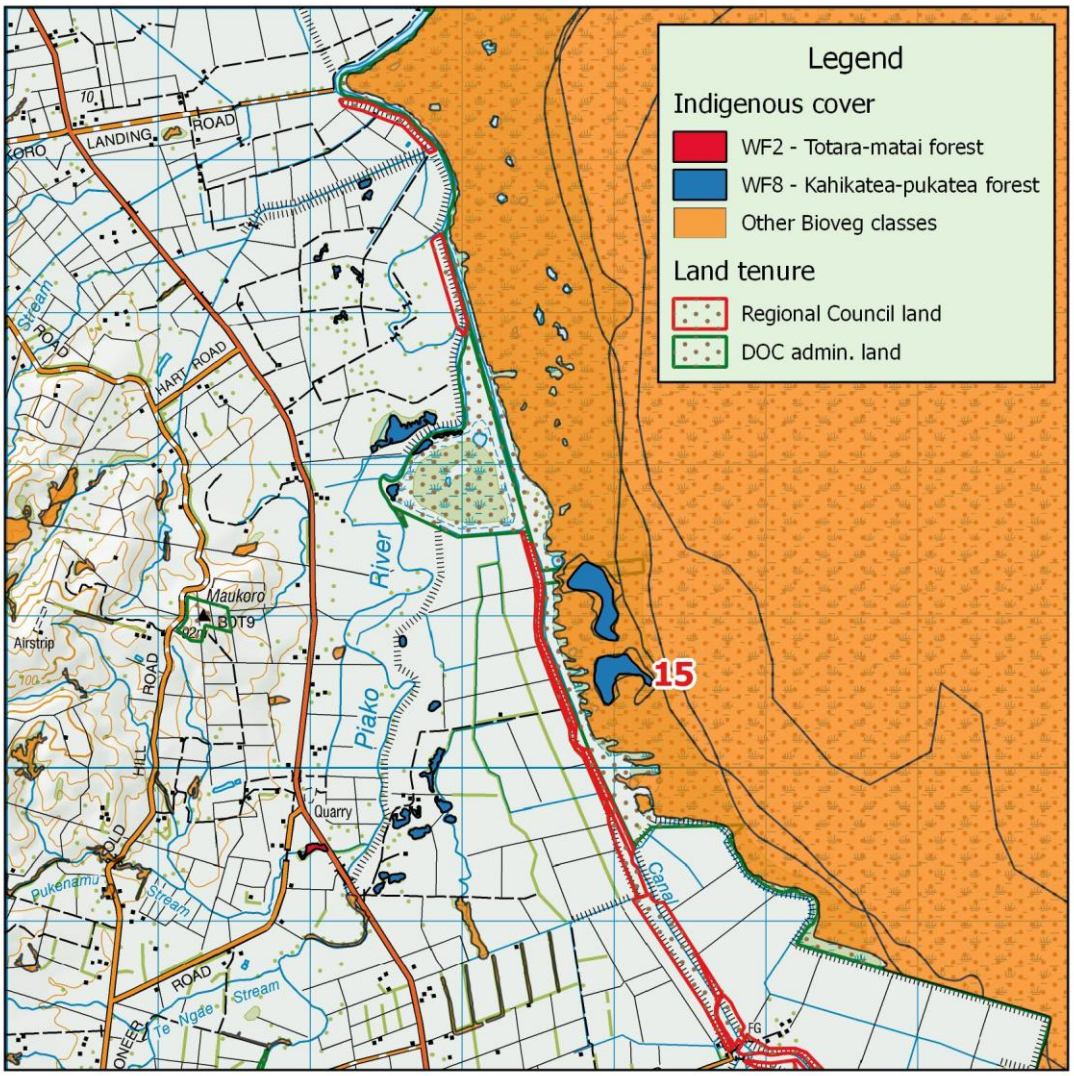
This remnant of kahikatea forest is located predominantly on Department of Conservation land just west of the Kopuatai Peat Dome and at the eastern end of Mangawhero Road. Although its western end is mapped as wetland in the potential ecosystem layer, the entire indigenous-dominated area of the remnants that is mapped above is identified in the BIOVEG2 layer as 'Indigenous forest'; it consists of tall kahikatea forest, the majority of which is fenced. Chinese privet forms dense thickets along that part of the margin that is visible from the road (Photo 13).

Given its size and relatively compact shape, this remnant meets Criteria 9 (healthy, representative and sustainable) of the Regional Council's criteria for significance, i.e., it is likely to provide good options for the long term representation of the kahikatea forests that were once extensive on the Hauraki Plains. Given its proximity to both the Piako River and the extensive Kopuatai wetland, it arguably also meets Criteria 10, i.e. it is part of an ecological sequence that is not common in the Waikato Region. Most of the stand is mapped as occurring on land administered by the Department of Conservation, and this would facilitate the implementation of restoration activities if this were

deemed a priority. Weed control would clearly be required, but there would also be the potential to expand this remnant through restoration planting.

Photo 13. Tall kahikatea forest at the end of Mangawhero Road.

Site 15 – Kopuatai kahikatea remnant



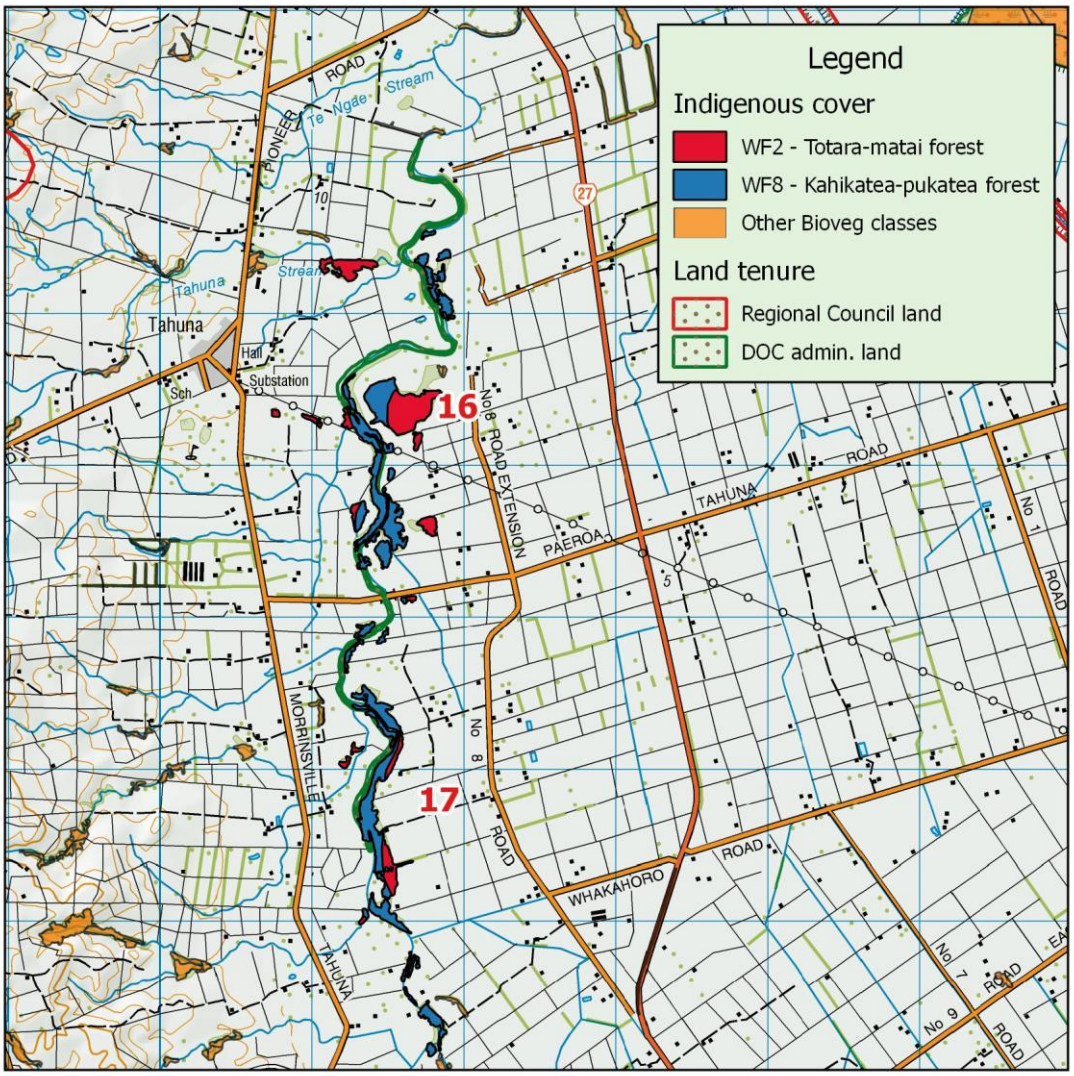
Total extent: 5.4 ha Number of patches: 2 Edge ratio: 2.2

These two small stands, located on the western edge of the Kopuatai Peat Dome, were difficult to view, with no roads in their immediate vicinity. Viewed from SH 27, they appear to consist of low to moderate stature kahikatea (Photo 14), surrounded by tall manuka and willows growing over restiad wetland. As a consequence, their relatively small size is offset by the high degree of buffering provided by their relatively natural surrounds, resulting in them meeting both Criteria 9 and 10 of the Regional Council's significance criteria. Any requirements for management, apart from willow control, are likely to be relatively modest.

Several small remnants of kahikatea forest occur approximately 1.5 km away on the eastern side of the Piako River, although they are relatively fragmented, and surrounded by pasture.

Photo 14. The two stands that are the focus of this site are located in shadow in the medium distance. The closer stand to the right is located in pasture, approximately 1.5 km from the main stands.

Site 16 – Piako kahikatea remnant – Tahuna (No. 8 Road Extension)



Total extent: 24.9 ha Number of patches: 21 Edge ratio: 5.7

This remnant, which is located on the Piako River near No. 8 Road Extension and north of the Paeroa-Tahuna Road, is one of the largest surviving podocarp forest remnants left on the Hauraki Plains. It contains both totara-dominant stands on well-drained sites along the terrace edges and kahikatea-dominant forest on the more poorly drained terraces further back from the river, including in the large stand closest to the north end of the No.8 Road Extension (Photo 15); this contrasts with the mapping in the potential ecosystems layer, which predicts dominance of totara in the eastern half of this stand.

Given its size, this is arguably one of the strongest prospects for sustainable representation of the totara- and kahikatea-dominant forests that were once widespread on the Hauraki Plains. The large single stand between No. 8 Road and the river is probably of the most original surviving examples of the kahikatea-dominant forests that were once extensive on the Hauraki Plains, and its compact shape makes it a strong candidate for long term sustainability. Its overall integrity and functioning

could perhaps be strengthened further by restoration of linkages with the totara-dominant riverine forests; a second smaller stand of kahikatea, located west of the Piako River, would also benefit from planting to reconnect it with the riparian totara forests; other smaller stands of kahikatea are generally well connected. Overall, given both the size, shape and condition of this site, and its connections with the Piako River, it clearly meets both Criteria 9 and 10 of the Regional Council's significance criteria.

Photo 15. Scattered kahikatea and totara (foreground) with an extensive kahikatea remnant in the background – No. 8 Road Extension.

Site 17 – Piako kahikatea remnant – Tahuna (south)

See map for Site 16.

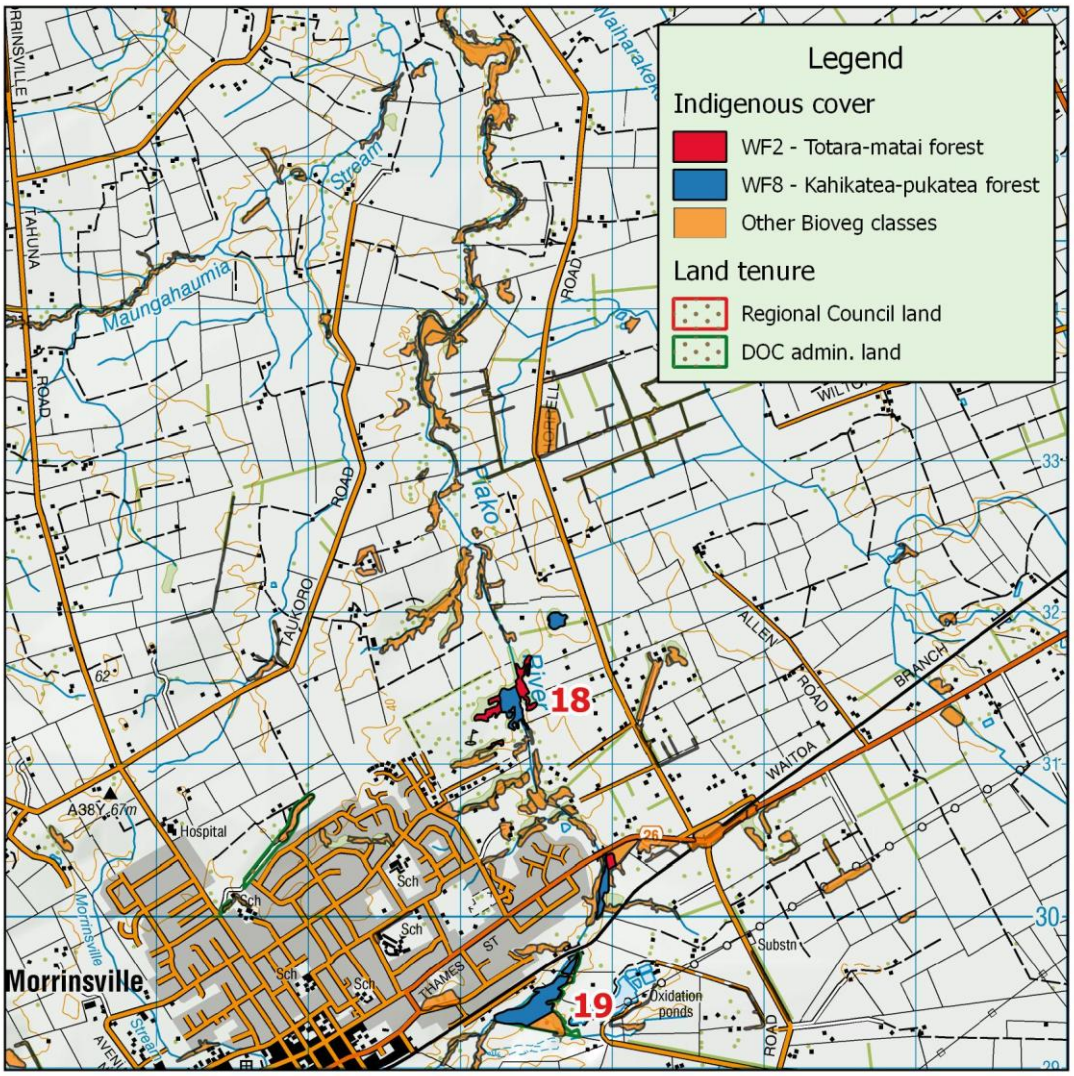
Total extent: 14.9 ha Number of patches: 9 Edge ratio: 5.2

This site is located along the banks of the Piako River, just upstream of the previous site (16) and south of the Paeroa-Tahuna Road. It contains riparian forests, mostly dominated by totara on well-drained levee sites, but with some kahikatea and small areas of wetland on more poorly drained terrace sites back from the river (Photo 16). Inspection from the road, indicates that it is mostly well fenced.

While this site is similar in composition to the previous site, it is less diverse, containing a lower proportion of kahikatea, and its elongated shape makes it more susceptible to edge effects. However, it still provides a good option for the representation of riparian podocarp forests, including sequences from well drained levee sites back into more poorly drained kahikatea forest and wetlands; it meets both Criteria 9 and 10 of the Regional Council's significance criteria.

Photo 16. Remnants stands of totara along the upper Piako, viewed from No. 8 Road.

Sites 18 – Morrinsville Golf Course & Site 19 Morrinsville East



Site 18:	Total extent:	5.7 ha	Number of patches:	5	Edge ratio:	3.9
Site 19:	Total extent:	6.4 ha	Number of patches:	2	Edge ratio:	2.1

The first of these two sites is located adjacent to the Piako River at the eastern end of the Morrinsville Golf Club on the outskirts of Morrinsville. While it is not easily viewable from the road, satellite imagery indicates that it is similar in composition to other riparian stands along the Piako River. Its small size and relatively convoluted shape make it a less attractive prospect for conservation purposes than some of other sites described above.

The second of these sites is located on the south-east bank of the Piako River on the outskirts of Morrinsville. The riparian parts of this stand (viewable from Piako Park Lane) are dominated by kanuka of relatively low stature. However, satellite imagery indicates that the forest growing further back from the river contains a mix of kanuka and totara, possibly with some kahikatea, and several clumps of tall exotic trees. While this stand has potential for restoration, its current composition results in it only marginally meeting either Criteria 9 or 10 of the Regional Council's significance criteria.

Acknowledgements

Topographic data used to produce all maps in this report was sourced from the LINZ Data Service http://www.linz.govt.nz/land/maps/topographic-maps and licensed by LINZ for re-use under the Creative Commons Attribution 3.0 New Zealand licence

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