MORPHUM ENVIRONMENTAL LTD

Engineers & Consultants

Preliminary Structure Plan Environmental Review

Maitahi & Bayview Development Private Plan Change Request

Document Status (Final)

Prepared for CCKV Maitai Dev Co LP and Bayview Nelson Ltd by Morphum Environmental Ltd

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Introduction

1.1 Scope

Morphum Environmental Ltd (Morphum) were engaged by CCKV Maitai Dev Co LP and Bayview Nelson Ltd to review information prepared in support of the proposed Private Plan Change Request (PPCR) to facilitate the development of land that is located primarily within the Matai River catchment (Kaka Stream). This review, including recommendations, aligns with both regulatory requirements and the long-term aspirations expressed for the development.

Specifically, we were engaged to provide guidance and recommendations in relation to stormwater management and ecological effects management.

Subsequent to an initial site meeting it was agreed to expand the scope of works to include works to delineate and assess existing waterways across the proposed development site. This includes;

- Map streams and overland flow paths (OLFP)
  - Uploading Lidar data from the client
  - Manually Adjusting the Digital Elevation Map (DEM) to allow for culverts and other stream crossings
  - Estimating stream and overland flow paths
  - Developing a 1m contour map to help visualise the terrain, including stream gullies and areas for future stormwater conveyance and treatment.
- Field verification
  - Site assessment to determine appropriate transition points to refine mapping.

Following an initial draft, a team meeting was held with Ecologist (Tonkin & Taylor), Infrastructure Engineer (Tonkin & Taylor), Landscape Architect (Rough & Milne) and Planner (Mark Lile) to discuss respective draft assessment reports and progression of PPCR documents. This provided useful clarification on matters relating to density and integration of three waters management with the environment which has been reflected in this final report. We have therefore updated this version to reflect the current intent for the development and the aspirations to support long term environmental improvements, including to the Kaka Stream and Maitai River environs.

1.2 Documents Reviewed

In undertaking the review, the following documents have been provided by the client and reviewed:

- Infrastructure and Flooding Report (Revised Draft). Prepared by Tonkin and Taylor. Dated 14 August 2020. Herein referred to as the Infrastructure report
- Ecological Opportunities and Constraints Assessment (DRAFT). Prepared by Tonkin and Taylor. Dated 12 August 2020. Herein referred to as the Ecological Opportunities and Constraints Assessment
- Structure Plan Drawing Set (Revision E). Prepared by Rough and Milne. Dated 6 August 2020
- Memorandum: Water quality survey of Kaka Stream. Prepared by Cawthron. Dated 20 August 2020.

1.3 Site Visits

Site visits were undertaken on 23rd September and 15th/16th October 2020. The first of these was to get an initial oversight of the drafted Structure Plan and understand the scope and scale of planned development. Following this it was agreed that further targeted assessment of waterways was required. This second field work was undertaken over 2 days to walk the site and make a visual assessment of the characteristics of streams, wetlands and overland flow paths. This did not include any formal ecological or geomorphological assessments but considered these aspects as they relate to potential development impacts and/or opportunities.

A team workshop was also held in Nelson on 23rd November 2020 to provide follow up from previous draft reporting and provide clarification on points raised in initial drafts. This session reflected a number of issues or questions raised by Morphum and demonstrated a clear intent to seek 'best practice' outcomes with regards to water management in particular. This revised report has been amended from the initial draft (dated 28th October 2020).

1.4 General Comments on the PPCR

In general terms, the proposed PPCR includes development of both the wide valley floor, as well as, slopes extending to (and over) the ridgeline on the west side and adjacent to the heavily forested terrain on the slopes of Kaka Hill to the east. The existing terrain and site context presents a number of clear constraints that have been reflected in the Structure Plan layout to avoid the risk of unachievable development yields and support an efficient consenting pathway. It is considered that if these constraints are not understood at the outset there is considerable risk to the PPCR in terms of delivery of the quality product that the applicants aspire to. In parallel, the site offers opportunities to integrate some of the biophysical conditions into the structure planning phase to demonstrate the ability to deliver a high profile example of urban development which is sympathetic to its environment and connects the community with a range of environmental and social benefits. This includes the potential to integrate water into the development through the adoption of water sensitive design principles which can mitigate the potential impacts from urbanisation whilst negating the existing degraded water quality impacts from current rural landuse.

Key **constraints** identified include;

- Steep slopes, and related challenges with developing the indicative road linkage and building sites. From experience it is found that the development of steeply sloping sites is constrained primarily by the requirements for vested public roads. Based on maximum grades (and even with some leniency) the construction of primary and secondary roads can result in significant volumes of earthworks and major recontouring of the site due to the need for extended lengths to meet required grades. Such earthworks need to then be balanced with the scale of developable land (which may be impacted by severance from road frontage) and the typologies to support this. Since the draft report the alignment of the proposed main spine road up the western slope has been re-aligned to avoid any impact on the identified wetland area/kahikatea and to utilise the existing road grade. It is also noted that developable parcels within this zone will be difficult with an expectation of only scattered dwellings where grade allows. Therefore, the road is intended to provide access to the ridgeline lots rather than open up the steep slopes for maximum development yield.
- Overland flow paths and hydrology. The site follows a substantial valley with the main stem of the Kaka Stream in the middle (north – south) and multiple side gullies (west-east) extending to the ridgelines. Due to the soils and grade across the site many of these gullies are either ephemeral or intermittent and give the impression of minimal flow. It is, however, fundamental to understand the importance of preserving overland flows during large infrequent storm events which will generate large flows through these gullies. Development will therefore need to retain overland flow paths

(either as surface channels or within public space (roads)) to ensure no unintended flooding of properties. This will be resolved through design development in collaboration with roading engineers and urban designers.

- Existing streams. The Kaka Stream forms a spine through the site and is observed to be reasonably stable in its current state (upstream of woolshed) with a mix of open and forested reaches and diverse instream habitat. The stream channel is considered to be largely natural in the upper reaches (upstream of existing woolshed) with the downstream (below woolshed) reach having been historically realigned and modified to support drainage and farming of the lower terrace. This lower reach is considered to be degraded with extensive mud substrates, limited instream habitat and a tendency to dry out over the summer months. Changes in landcover (such as increased imperviousness) will substantially alter the hydrologic response to rainfall (especially frequent small events) with risk of instability and scour within the stream. Additionally, changes in water quality (including toxicants and physical characteristics) has the potential to adversely impact instream biota. These potential urban water impacts are therefore proposed to be mitigated through the use of stormwater treatment devices (such as constructed wetlands), capture and reuse of rainwater and the reinstatement of the relic channel alignment in the lower reaches allowing for expected post developed flow conditions and volumes whilst supporting ecosystem function.
- Local and regional flooding.
- Presence of potential wetland areas and the prohibited activity status of the NES-F for certain works within a wetland (s53). Two wetlands were identified during field works as requiring protection and have subsequently been included on maps for exclusion and protection. These have now been integrated into the Structure Plan.

2. Earthworks

2.1 Potential Effects

Earthworks will be a key consideration for the development of sloping land on either side of the main valley which is currently identified for residential lots. Earthworks modelling is not to be undertaken at this stage as detailed subdivision and engineering design will follow at a later phase, however, consideration to the challenges associated with the steep site has informed proposed densities etc. Slope needs to be considered with regard to the ability to implement public roads (that are able to be vested to council) with a realistic scale of earthworks. Due to maximum permissible road grades there is a need to construct longer roads on steep terrain to manage required vertical elevation changes resulting in large cut/fill requirements and difficulty achieving developable land along extended runs of road. This is further complicated by preferred building typologies whereby the creation of level building platforms can be difficult without substantial earth working and retaining structures. T&T have mapped the relative slopes across the site and highlighted areas with steep slopes. At present the structure plan shows only the indicative road connecting the valley floor with the ridgeline to the west.

2.2 Zoning and Lot Size Considerations

Proposed zoning of land and inferred lot sizes has been based on consideration of the full spectrum of biophysical constraints. This has resulted in reduced expectations of achievable yield on the steeper area with density to be focussed on the flat valley floor and more gentle lower slopes. Further design (supported by earthworks modelling) may include clusters of higher density dwellings in suitable locations at the expense of other areas deemed unfeasible/uneconomic to develop.

3. Ecology

3.1 Corridors

As drafted the spatial aspects of the PPCR identify an open space corridor extending along the length of Kaka Stream from the confluence with the Maitai River and the identified wetland areas, including in the headwaters (outside of the subject property). This proposed riparian corridor provides several ecological benefits including functional benefits to the Kaka Stream (e.g. shading and habitat provisions), as well as, providing linkages between important headwater wetland habitat and areas identified as high priority for protection downstream of Dennes hole (Leathwick, 2019).

The Ecological Opportunities and Constraints Assessment recommends that the Significant Ecological Area (SNA) on the upper eastern boundary of the valley should be connected into the Kaka Hill Tributary corridor. In addition to this, it is also recommended that the kanuka vegetation identified (which adjoins the SNA) should also be connected to the Kaka Hill Tributary corridor. It is recommended that a corridor of appropriate width (~ 30 – 50 m) is covenanted along the northern boundary of the site between the Kaka Stream corridor and the identified kanuka vegetation and SNA. Given this area is currently proposed as rural zoning this should have no impact on anticipated lot yields.

Morphum support the inclusion of these potentially important ecological corridors to facilitate uninterrupted movement by a range of species. It is noted that the upper vegetated slopes on the eastern Kaka Hill will not be developed providing further protected terrestrial at the head of drainage catchments. This will support biodiversity outcomes in addition to maintaining natural rainfall runoff from these headwaters.

3.2 Stream and Wetland Mapping

In addition to the main channel of the Kaka Stream there are various additional watercourses within the subject site, including: artificial watercourses, modified watercourses, intermittent streams, ephemeral streams and overland flow paths (OLFPs).

These streams were mapped in GIS and field verified to determine transition points and potential priority reaches. This field work is an initial step to support the following;

- Understanding of the extent of artificial and ephemeral channels within the subject site, and thus an understanding of the extent of streamworks activities that may be considered permitted.
- Enable the anticipated extent of reclamation of permanent and intermittent streams, (as defined by the NRMP), if any, to be understood and communicated.
- Provide confidence that the positive actions available to enhance the Kaka Stream are more than sufficient to offset any anticipated adverse effects from the loss of permanent and intermittent streams (if any).

Mapping was undertaken by creating an OLFP data set from the Digital Elevation Model (DEM) derived from the available LiDAR. This data was then field validated to apply appropriate classifications from the NRMP and RMA.

The Ecological Opportunities and Constraints Assessment identifies the loss and clearance of wetland habitat as a constraint. An area of wetland was identified on the western side of the valley (where proposed road alignment was originally located) but a full assessment was not undertaken. The National Environmental Standards for Freshwater (NES-F) that became operative, in part, on the 3rd September 2020 makes earthworks and diversion and drainage within a natural wetland a prohibited activity (section 53) where not having a separate activity status under sections 38 to 51, including for 'specified

infrastructure'. Based on this, changes have been made to the road alignment and the existing wetland identified for protection and restoration.

3.3 Enhancement Actions

Several opportunities for ecological enhancement are outlined within the Ecological Opportunities and Constraints Assessment including:

- Terrestrial and wetland habitat enhancement though restoration planting,
- Riparian and stream habitat enhancement though restoration planting,
- Animal and plant pest control, stock exclusion, and enhancement,
- Mitigation and provision of native fish passage,
- Realignment of the lower Kaka Stream and associated ecological enhancements,
- Linkage of ecological features,
- Protection of ecological habitats though covenants (or similar).

All of these opportunities are supported. Various means to provide confidence in the desired, proposed, and anticipated outcomes should be integrated into proposed provisions of the PPCR.

3.3.1 Expected Outcomes vs Offsets Actions

It is recommended that the PPCR clearly signal that the anticipated enhancement actions may be utilised as offset or compensation actions to address residual adverse effects, that may exist, at later resource consent application stages.

However, it is noted that offsets should be protected for a period at least as long as the impact; in the case of stream reclamation, that is in perpetuity. This can create a tension when subdivision and streamworks consents are not applied for concurrently and the proposed 'protection' mechanism for a streamworks offset is to vest the enhancement area to council (i.e. the vesting may not be possible without the subdivision and the offset may not be appropriate without a level of protection applied). Furthermore, if a covenant is applied to protect the offset, this can become a barrier to vesting land to council in the later subdivision stages.

3.3.2 Realigned Channel Design

The Ecological Opportunities and Constraints Assessment identifies that the anticipated realignment of the lower Kaka Stream provides an opportunity to improve ecological values and recommends that natural channel design guidelines are utilised. This shall be integrated with requirements to accommodate peak flows and protect adjacent development areas from potential flooding.

Therefore, the channel shall be designed to integrate hydraulic function with ecological habitat values to improve the existing conditions observed in the current realigned channel which extends across the lower terrace downstream of the woolshed.

Ecological outcomes should include:

- A low flow channel for fish passage and temporal habitat availability.
- Diversity in hydrological conditions (runs, pools, riffles) where appropriate.
- Diversity and availability of habitat (shaded margins, woody debris etc).

The intent to integrate ecological values into the re-aligned channel will be a key part of the design including variability, design for low flow (with defined meandering channel) and long term enhancements including planting, habitat features and inclusion of pools as appropriate. It is further

noted that flood capacity can be at least partially accommodated in esplanade reserve landscaped areas in addition to the channel itself.

The project provides an opportunity to demonstrate how the potentially competing objectives of flood conveyance and ecological habitat can be integrated into a functional and positive outcome. This could take the form of plan provisions (objectives, standards, or directions in the Schedule of specific rules) or the inclusion of typical drawings (cross section and long section) demonstrating the minimum stormwater requirements integrated with ecological outcomes.

3.3.3 Demonstrating Adverse Effects can be Appropriately Managed

The draft Ecological Opportunities and Constraints Assessment identified that up to 36.2 ha of common or abundant indigenous vegetation and 12 ha of exotic vegetation with indigenous fauna habitat values could be impacted as part of the development. The Ecological Opportunities and Constraints Assessments highlights that future developments in these zones will need to consider the ecological impacts of removing vegetation and necessary mitigation, offset or compensation actions will need to be taken to ensure developments do not result in a net loss of ecological value.

Any work that threatens to displace or injure indigenous fauna will need to be planned and undertaken in accordance with relevant regulations and authority sought.

It is concluded that based on preliminary assessments and the final structure plan, it is expected that there will be sufficient space available for mitigation, offset or compensation within the site.

With respect to freshwater values the Ecological Opportunities and Constraints Assessment notes that the lower reach of Kaka Stream has been artificially modified with an intent to realign the stream on the western side of the lower terrace which aligns with the inferred natural stream position prior to land drainage for farming. This realignment will enable a more natural character to be achieved than currently exists with opportunities to enhance the existing habitat values, connectivity and ecological function. Any further mitigation or offsetting that may be required as part of future development is highly likely to be able to be provided within the subject site (based on stream classification mapping and understanding of proposed development).

The site includes areas of wetland that are considered to meet the definition of wetlands under the NPS-FM. These will be protected through the development through excluding disturbance (including modified hydrology) and through restoration planting where appropriate. These wetlands have been broadly identified as part of the PPCR but shall be further delineated and classified as part of subsequent development design.

3.3.4 Mechanisms to Achieve Anticipated Outcomes

Various means to provide confidence in the desired, proposed, and anticipated outcomes are available through the PPCR provisions. These means include, matters of discretions, standards, objectives and policies, and rules. How such mechanisms are proposed will depend on the level of confidence in the outcome required, as well as, the level of flexibility required at later resource consent stages.

Utilising the available mechanisms, it is recommended that at a minimum:

- The vesting and/or protection of the riparian and ecological corridors is signalled,
- The areas requiring active enhancement (pest control and planting) are clearly identified along with the responsibilities, timing, and standards for enhancement,
- Wetlands within the structure plan area are mapped and classified,

- Demonstrate that the ecological and stormwater objectives can be integrated with the development,
- Clearly signal that the anticipated enhancement actions may be utilised as offset or compensation actions to address residual adverse effects.

4. Stormwater

Evaluation of the stormwater aspects of the proposed structure plan zonings and plan change has been undertaken with consideration of objectives and policies within the Nelson Resource Management Plan (NRMP). Whilst it is noted that the NRMP is limited with regards to clear and definitive requirements, it clearly outlines the intent to manage stormwater in a manner consistent with community values, the Resource Management Act and the NPS-Freshwater Management.

- **DO1.1.6 water management** Make policy decisions on water management having regard to the provisions of resource management plans such as eel management and iwi environmental management plans that promote the sustainable use of water and associated resources.
- **DO14.3.2 drainage, water and utilities** Subdivision and development should provide for:
    a. The disposal of stormwater in a manner which maintains or enhances the quality of surface and ground water, and avoids inundation of any land, and
- **DO18.1.4 water quantity (NPS – Freshwater Management 2014)** When considering an application for a discharge, the consent authority must have regard to the following matters:
    a. The extent to which the change would adversely affect safeguarding the life supporting capacity of freshwater and of any associated ecosystem and
    b. The extent to which it is feasible and dependable that any adverse effect on the life supporting capacity of freshwater and of any associated ecosystem resulting from the change would be avoided.
- **DO19.1 highest practicable water quality** All surface water bodies contain the highest practicable water quality
- **DO19.1.7 effect of land use activities on surface water bodies** To control land use activities which have potential to adversely affect surface water quality and to encourage land use activities that minimise and filter contaminants entering water bodies.
- **DO19.1.8 stormwater discharges** The level of contaminants in point source stormwater discharges to water bodies will be avoided or remedied.
- **DO19.1.10 new development** Maintain existing water quality by requiring use of techniques to limit both nonpoint discharges and control point source stormwater discharges caused by land disturbing activities such as forestry, subdivisions and land development, increased impervious surfaces, and commercial and industrial activities.
- **DO19.1.12 Water Quality (NPS – Freshwater Management 2014)** When considering any application for a discharge, the consent authority must have regard to the following matters:
    c. The extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water; and
    d. The extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with freshwater, resulting from the discharge would be avoided; and
    e. The extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their secondary contact with fresh water; and
    f. The extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their secondary contact with freshwater resulting from the discharge would be avoided.
- **DO20.1 integrated water management** A management approach that integrates the expertise of relevant statutory authorities and mana whenua iwi and other stakeholders in the community

4.1 Protection of the Kaka Stream

It is noted that the main stem of the Kaka Stream is proposed to be protected via a designated linear reserve extending along its full length. This includes the lower reach which is proposed to be realigned. The width of this riparian reserve was initially defined with a constant width (40m) to follow the general stream alignment (i.e. does not vary for all meanders). This includes sections which are currently well forested (mix of indigenous and exotic) and others which are in open pasture with limited protection from stock. The stream is understood to support continuous baseflow in the upper reaches with supporting reports and discussions indicating that the lower reaches do run dry over summer. At the time of inspection the stream was flowing freely over its full length with considerable base flow (estimated at 10-20L/s).

Stormwater from the development areas will discharge into the Kaka Stream and ultimately into the Maitai River. It has therefore been recognised that the management of stormwater will be critical to provide appropriate protection for the existing Kaka Stream and downstream waterways. This will comprise a mix of offline wetlands integrated into the riparian corridor co-located on flood plain alongside the restored stream. These wetlands shall be designed to receive and treat the first flush of stormwater from roads, roofs and hardstands to manage contaminants (heavy metals and nutrients), sediments, temperature and other biophysical parameters.

It is noted that the current stream (upstream of woolshed) appears stable and displays fairly typical characteristics of a natural undeveloped stream. This includes longitudinal variability, flood benches and stable meanders without evidence of significant slumping or scour except where stock access has created disturbance. The lower reach (downstream of woolshed) appears to have historically been realigned to facilitate 'drainage' of the flat land for farming purposes. This has resulted in an artificially straightened channel without habitat diversity and/or flow variability. Water appeared clear and non-turbid with a gravel substrate (upstream of existing stock yards).

Cawthron have been engaged to undertake monthly water quality sampling in two locations, being upstream of the confluence with the Maitai River and towards the top of the catchment upstream of any proposed development. The first of these sampling events was in November 2020 with a subsequent sampling event in December. These initial results identify water quality impacts indicative of the current rural landuse including elevated E. coli and suspended sediment. Nitrate and Ammonia toxicity were not sampled levels which exceeded NPS-FM national bottom line values (band B), potentially due to comparatively low stocking rates. It is noted that E. coli was worse at the downstream sampling site and all parameters were higher in the November sampling which was undertaken following periods of rain. Sampling is proposed to continue at a monthly interval through 2021 which will hopefully capture a wider range of flow and antecedent climate conditions.

In response to the risk of increased instream scour as a result of urbanisation, all stormwater shall be managed to reduce the ongoing risks of scour, slumping and sediment transport.

We understand that the client intends that the PPCR and eventual development needs to regard the main stem of the Kaka Stream as a 'receiving environment' and provide pre-treatment of stormwater inflows consistent with good management practice. This would be achieved through the implementation of Water Sensitive Design/Low Impact Design (as referenced in the Land Design Manual) to manage frequent flows (through retention) and water quality. This is independent of peak flow attenuation which is focussed on avoidance of flooding rather than environmental outcomes.

4.2 Water Quality

The water quality of runoff from development prior to discharge into the Kaka Stream has been considered at the structure plan stage given the requirement to consider strategically where to position mitigation measures such as stormwater treatment wetlands/raingardens etc.

Water quality treatment shall be provided prior to discharge to natural waterways by routing a proportion of stormwater runoff through treatment devices which are optimally located in positions where flows are able to be conveyed under gravity. Decisions around whether this is achieved through multiple smaller distributed devices or a lesser number of larger consolidated devices will consider costs (both CAPEX and OPEX), functionality, resilience and the potential to connect the community with water and celebrate the natural asset of the site. It is suggested that a smaller number of larger devices will offer the greatest benefit for the Maitahi development, particularly given the linear Kaka Stream corridor through the site and the reasonably well spaced side catchments which are expected to remain (hydrologically) in the developed scenario.

Consolidated water quality treatment is therefore likely to correlate with existing connections with the Kaka Stream where current tributaries or overland flow paths enter. This provides the opportunity to co-locate a series of wetlands along the riparian corridor which can be integrated with community amenity such as walkways, parks or community gardens. Devices such as wetlands can be well suited to be located within flood prone land with adequate protection from excessive inundation and scour. Consideration must also be given to access for maintenance and any operational requirements for ultimate asset managers (assumed to be vested to NCC).

It is recommended that the structure plan identify these optimal locations based on conceptual sizing which reflects the expected development typology in catchments. This could have implications for the demarcation of the proposed riparian corridor whereby it may widen at proposed wetland locations and narrow in other locations as appropriate. The intent to pre treat stormwater and protect the existing and potential ecological values of Kaka Stream (in addition to the Maitai River) should be strongly promoted through the structure planning process, and so incorporated into the Schedule of associated rules.

4.3 Fish Passage for Online Attenuation

Flood mitigation is proposed to attenuate post development peak flows to ensure no worsening of flood flows in the lower Maitai River which could increase downstream flooding through Nelson. Options around online (on the main Kaka Stream) detention are proposed. This would typically involve the construction of areas subject to infrequent inundation triggered by a throttle which could comprise a culvert/pipe sized to pass a pre-determined flowrate. This enables the stream flows to pass under normal conditions with detention only occurring during infrequent large events (usually greater than 10% AEP). This approach is supported assuming appropriate design to respond to increased velocities during peak events, adequate flood storage without impacts on other infrastructure and appropriate design of any impoundment structures (which may trigger dam design requirements depending on dimensions). The preferred location of flood attenuation areas should be specified at the structure planning stage given the limitations this will place on development and the efficiencies with using infrastructure such as road crossings as embankments. As mentioned above, stormwater wetlands can be located in areas identifies for infrequent flood inundation.

Provision of fish passage through any online structures will be required. This can readily be achieved by ensuring that the design of culverts/pipes consider fish passage under 'normal' conditions which could

include greater embedded depth to retain a channel bed throughout. The integration of fish passage into the structure plan should be clearly communicated in the structure plan given the quality of upstream habitat and connection to the coast via the Maitai River.

4.4 Erosion Susceptibility / Mitigation of Channel Forming Flows

Based on a high-level assessment of the Kaka Stream and side tributaries it is concluded that under current landuse, the channel is stable with little sign of active scour or erosion. The stream appears to support a stable channel which displays sinuosity through gentle meanders, point bars, lateral flood benches and stable overhangs. Whilst a detailed geomorphological assessment was not undertaken, substrates appear to comprise a mix of well bound alluvial sediments through the mid reaches with bedrock and large boulders in upstream reaches. The lower reach (extending from the woolshed to river confluence) appears to be finer sediments (silts) with excessive deposition likely a result of elevated sediments from stock and increased deposition due to flat grade.

Current flowrates within the stream are considered likely to be modified due to the historical clearance of original forest cover for pasture. Whilst this will have increased overland flow and reduced evapotranspiration, these appear to have not substantially contributed to instream scour or mass slumping. It is suggested that substantive unmitigated changes to flow rates and volumes following development could change the current steady state with an expectation of worsening localised erosion. The scale and severity of this would require a more detailed geomorphological assessment as a part of subdivision and engineering design, and so be addressed within the resource consent processes that will follow.

Erosion susceptibility is typically mitigated through retention of post developed stormwater flows. Retention requires a portion of flows to kept out of the stormwater network to reduce the risks associated with flashy flows in regular small events. This can be achieved through optimising infiltration (either on lot or as part of sub-catchment scale stormwater devices) or capturing rainwater for reuse (through lot scale rainwater tanks connected to internal non potable reuse). Given the observed baseflows present in the Kaka Stream from upstream of the proposed development area it is suggested that infiltration (to recharge baseflow through the developed portion) is less critical with the use of rainwater tanks sized appropriately likely to provide the best way to manage the change in imperviousness from development. These tanks (when plumbed into toilets/laundry) will reduce the size of consolidated water quality treatment devices which will also mitigate erosion risks from modified hydrology.

4.5 Baseflow Effects

Stream baseflow can be impacted through the development of catchments which reduce the proportion of permeable landcover and increase stormwater runoff that would otherwise infiltrate into shallow soils and slowly release into streams as baseflow during dry spells between rainfall events. This is important for the ecological function of streams to retain habitat during inter event periods and sustain pools etc.

Observation of waterways across the site identified complexity with hydrology whereby many tributaries transitioned from above to below ground flow with an expectation that all tributary streams will be dry for prolonged periods and classified as ephemeral under the NCC NRMP. This reflects the site soils which appear to be dominated by fractured rock and colluvium with deposits of free draining material in side gullies. Large catchment areas will remain above the development extent (particularly on east side) which will be undeveloped and retain event flows. These flows (including subsurface and surface flow) will be conveyed in pipe network where side gullies are not maintained as open channels. As

mentioned earlier, the upper reaches of the Kaka Stream were observed to retain persistent baseflow which is expected to remain across the full year.

It is therefore suggested that the widespread use of infiltration to support baseflow will not be as important as other sites due to the expectation that baseflows within the main stream will be sustained from flows beyond the extent of development. This simplifies the engineering design given the risks associated with concentrated infiltration on steep slopes and the complications with creating soakage systems on private lots without impacting on downslope properties.

4.6 Conveyance Channel Design

From observation, it appears that the main stem of Kaka Stream has substantial capacity upstream of the woolshed given that it is set within a formed gully incised below adjacent terraces where development is expected to be concentrated. Below the woolshed, the stream is considered to be modified and is currently comprised of a shallow channel interspersed with multiple other smaller intermittent channels and overland flow paths across the flat flood plain.

The structure plan proposes to re-align this lower reach (from near the existing woolshed) and construct it as a constructed channel with capacity to convey the post developed 1% AEP event. This references the Tasman channel design guidelines which specify how to design a low flow channel within a larger channel form with flood benches and stable batters. It will be important to ensure that this channel is resilient across the range of flow events whilst still enabling it to form a resilient ecological corridor between the confluence with the Maitai River to the upper Kaka Stream reach. This will be designed in parallel with the design of any integrated flood detention, backwater impacts from the Maitai River and protection of any development in the lower terrace need to be factored into hydraulic design assumptions.

4.7 Overland Flow Paths

Inferred overland flow paths (OLFP) were initially mapped based on topography. Estimates were then made of where streams could be expected based on contributing catchment areas. These were then verified on site based on visual observations of flow (or evidence of). This exercise confirmed that many inferred streams displayed no evidence of flow (including ephemeral, intermittent or perennial) and would be regarded as 'land'. Other tributaries had reaches with flow in at the time of inspection but a likelihood that flow would not persist over summer and would not meet the NRMP definition of intermittent (contains pools of at least 150 mm depth and 2 m^2 area between months of February to April).

Regardless of stream classification, it will be important that development enables OLFP's to be sustained without impacts on private or public property. This will need to include provision for blockages at the top of development areas to enable flows to pass from the upper undeveloped slopes through the urbanised areas to the main Kaka Stream corridor at the base. These OLFP's need to be formally identified and marked and should ideally be on public land rather than through private properties. This could be a mix of road corridors (with consideration of risks related to depth and velocity) and interconnecting greenways.

OLFP's are an essential design consideration.

5. Plan Provisions/Principles

In addition to the existing district and regional plan provisions, various means to provide confidence in the desired, proposed, and anticipated outcomes are available within the PPCR. These means include, matters of discretions, standards, objectives and policies, and rules. How such mechanisms are proposed will depend on the level of confidence in the outcome required, as well as, the level of flexibility required at later resource consent stages.

Based on our understanding of the site and development intent the following 18 Principles were developed alongside Tonkin and Taylor and the wider team. These suggested principles could be adopted as the basis for more quantitative Plan Provisions (including rules) which would potentially define the means by which development will progress in a manner which reflects the intent to protect the existing environmental values as a key metric.

1) Align with the objectives and intent of the NPS-FM and NES 2020 which include mandatory provisions around stream/wetland effects avoidance and application of the effects management hierarchy.

2) Co-design with nature an integrated and regenerative approach to urban development.

a) Use nature-based or green infrastructure engineering solutions where possible to mimic or work with processes found in the natural environment. Retain, restore and enhance existing elements of the natural drainage system, and integrate these elements into the urban landscape.

3) Address pressures on waterbodies close to source by implementing Water Sensitive Design (WSD) principles in the planning through to the implementation stages

[note: Principles 1-3 are taken from the Urban Water Principles published by MfE in 2019 which were intended to provide a consistent suite of development Principles to be adopted across the country.

4) Mimic predevelopment hydrology through retention and detention. Predevelopment channel forming flows in Kaka Stream to be managed to reduce risk of scour and sediment mobilisation.

5) Pass first flush of all site generated stormwater through constructed vegetated treatment devices prior to discharge to Kaka Stream, existing wetlands or Maitai River. First flush to be based on treating 80-85% of mean annual volume or stormwater resulting from 3-month ARI rainfall event.

6) Map areas with high infiltration capacity and factor in design to optimise groundwater recharge and baseflow where possible as part of water sensitive design strategy.

7) Provide and protect overland flow paths through road design and other dedicated pathways to pass peak flows from upper slopes safely.

8) Retain and protect the upper reach of Kaka Stream (above woolshed) through continuous riparian corridor (Blue-Green Spine). Corridor to reflect natural topography and be delineated to support;

a) Channel meanders and flood benches

b) Robust riparian vegetation

c) Peak flood capacity

d) Ecosystem function and habitat

e) Integrated stormwater wetlands

f) Public access via well designed walking/cycling paths (no roads except at crossing points)

9) Where practical, co-locate stormwater treatment wetlands within Kaka Stream Blue-Green Spine to protect mainstream, increase urban ecology, connect the community with water and provide high quality amenity.

10) Identify and delineate development areas able to drain to Blue-Green Spine or other dedicated stormwater treatment areas not able to be captured in these to self-manage through on lot management of water quality/quantity.

11) Where feasible, integrate peak flood controls within Blue-Green Spine whilst ensuring that Eco-System function (including fish passage) is preserved, stormwater wetlands are protected, and the health and safety of community and visitors are protected.

12) Provide for the realignment of the lower portion of the Kaka Stream where this provides for improved ecological outcomes, provides for more efficient urban form and demonstrates adherence with best practice channel design guidelines.

13) Identify, protect and enhance all remaining natural wetlands.

14) Protect and enhance the Kaka Stream and its tributaries, including;

a) Minimising stream loss,

b) Identifying springs/seeps and protect these including the flow paths to the nearest streams,

c) Providing for flood flows (1:100yr) within the stream including its riparian margins.

15) Provide for ecological linkages with other areas with ecological values (water and land based) inside and neighbouring the plan area.

16) Manage earthworks and compaction outside of proposed residential areas to minimise changes to the hydrologic response of flows directly or indirectly discharging into the Kaka stream and its tributaries

17) Conserve and reuse water resources.

a) Drinking water, wastewater and stormwater are each valuable resources and we should reduce their consumption and/or production and maximise their reuse. This includes increasing water-use efficiency by reducing potable water demand and maximising the use of greywater and stormwater.

18) Ensuring climate change is considered during all stages of the process

6. Recommendations

The following recommendations outline the recommended steps to progress the development to attain its aspirations around ecological values and sustainable management of water to protect the important receiving waters. Timeframes for these actions will vary as the development advances through consenting and design phases. These recommendations are therefore provided at this stage to inform project planning rather than to support the PPCR in isolation.

6.1 Additional Assessments

1. Develop an integrated stormwater management strategy to inform conceptual device sizing. Strategy should include the following;
   - Modelling of pre/post developed water and contaminant balance
   - Development of overall strategy to capture and treat stormwater through a mix of on lot and consolidated devices
   - Conceptual sizing of devices (such as wetlands) based on documented assumptions with contributing catchments and spatial constraints within Kaka Stream corridor
2. Develop provisional road hierarchy and public network to test feasibility and cost implications,
3. Map existing natural wetland extents and develop strategy to protect through development,
4. Develop site wide restoration strategy which includes area to be enhanced as part of the landscape design, as well as, those proposed to form offsets for potential adverse impacts in other parts due to unavoidable development requirements,
5. Provide schematic and illustrative drawings of the re-aligned lower stream channel to demonstrate the integration of ecological and conveyance function,
6. Quantify final areas of anticipated indigenous vegetation and habitat loss through development and demonstrate how the adverse effects are to be mitigated and/or offset, preferably within the subject site.

6.2 Spatial Plan Amendments

Spatial mapping which will form the basis for the PPCR (including structure plan and Schedule) should include refined allocation of spaces to include provision for stormwater management and associated open spaces. This should include;

1. Allowance for consolidated stormwater treatment wetlands where tributaries join main Kaka Stream
2. Key over land flow paths to enable safe passage of flows from existing side gullies through potential development areas
3. Linked public green spaces connecting OLFP's where supported through urban design
4. Location of hydraulic controls for flooding (embankments/culverts) and extent of ponding during peak events

   Include a linkage between the Kaka Hill Tributary Corridor and identified kanuka vegetation and SNA.

7. References

Leathwick, J. (2019). Indigenous Biodiversity Rankings for the Nelson Region. Report prepared for the Nelson City Council.