VISION CONSULTING ENGINEERS

Monitoring Framework

Taumārere Catchment
Nature-Based Solutions Feasibility Study

Prepared For:

Northland Regional Council

July 2025

Preface

The **Taumārere Hydrological Catchment**, encompassing the Upper Kawakawa River area, faces significant environmental challenges, including persistent flooding impacting communities and critical infrastructure, along with degraded water quality, erosion, and biodiversity loss. This comprehensive feasibility study was initiated to understand the opportunities and constraints for implementing **Nature-based Solutions (NbS)** and restoration to address these issues. This project was supported by funding from the **Ministry for the Environment's (MfE) NbS for Flood Mitigation Programme**. The project's overarching ambition is to provide a foundational blueprint to guide future restoration, with its process and outcomes having the potential for replication across Northland and wider Aotearoa New Zealand.

This study employs a multi-faceted and integrated approach, **combining advanced scientific analysis with deep community and cultural engagement**. It has systematically moved through phases involving extensive consultation with iwi, notably **Ngāti Hine**, and utilised **high-resolution GIS mapping** and **hydrological analysis** to identify and prioritise suitable NbS sites, alongside assessing **financial viability** and developing robust **monitoring frameworks**. This collaborative and data-driven methodology aims for solutions that are culturally aligned, **ecologically considered**, and **financially assessed**, ultimately aiming to reduce flood risk, improve water quality, enhance ecological health, and strengthen community resilience and cultural well-being.

This phase two report looks at the requirements of **funding streams**, like grants or the carbon market, in terms of monitoring and project validation. Establishing the **baseline conditions** and in turn understanding the **efficacy of NbS** interventions is a consideration for not only funding applications, but also for catchment planning and reporting outcomes to the public and stakeholders. The monitoring framework provided is specific to NbS used in the catchment. It outlines a scalable approach designed to complement ongoing monitoring, including **cultural indicators and NRC regional monitoring**, and that outlined in the Ngāti Hine environmental management plans.

Taumārere Catchment Nature-Based Solutions Feasibility Study
Monitoring Framework

First Edition

This report has been prepared by Vision Consulting Engineers Limited (VISION) based on the agreed scope of our engagement for this literature review. It is intended for the use of our Client, Northland Regional Council, and for broader dissemination to inform wider stakeholders and the public on the findings related to the Taumārere Hydrological Catchment and Nature-Based Solutions.

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Acknowledgements
Vision Consulting Engineers Ltd would like to thank the many people who have contributed to this Monitoring Framework document for the Taumārere Catchment Nature-Based Solutions Feasibility Study.

Our thanks especially go to:

- Ngāti Hine
- Ngāti Manu
- Ngāti Hine Forestry Trust
- Nga Tangariki O Ngāti Hine / Te Papa Pa Orooro
- Martin Jenkins
- Ministry for the Environment

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Executive Summary

This document outlines an **environmental monitoring framework to support Nature-based Solutions (NbS)** implementation in the **Taumārere Hydrological Catchment**. It is designed to help funders, mana whenua (customary authority), and local partners can **track the impact of restoration activities**—ecologically, hydrologically, and culturally. A suite of targeted NbS—such as riparian planting, wetland restoration, erosion control, floodplain reconnection, and intertidal habitat enhancement—has been identified to reduce flood risk, improve water quality, support biodiversity, and improve habitat for mahinga kai (food gathering) gathering.

The monitoring framework provides **SMART-aligned** guidance on what to measure, how to measure it, and when monitoring can be scaled back. Each NbS technique is supported by a one-page monitoring sheet in the Appendix, highlighting key indicators, suitable methods, and opportunities for community and kaitiaki (guardian) involvement. **Māori Cultural Indicators (MCI)** are woven throughout the framework, reflecting **Ngāti Hine values** and the importance of mauri (life force) in environmental assessment.

This framework **focuses on achievable methods and scalable tools** — outlining what can be delivered locally, tracked credibly, and reported transparently. It aligns with common funder expectations and provides a foundation for adaptive management, future funding bids, and long-term ecosystem recovery.

Key Themes and Findings

Hydrological Resilience

- NbS are mapped and monitored for their role in reducing flood peaks, supporting baseflows, and managing catchment hydrology through interventions like leaky barriers, floodplain reconnection, and wetland restoration.

Water Quality & Sediment Control

- Targeted monitoring and action address sediment, E. coli, and nutrient loads — tackling both legacy land use impacts and future risks. Tools include silt traps, riparian buffers, and erosion control techniques.

Biodiversity & Habitat Recovery

- NbS are designed to improve native species habitat, support aquatic macroinvertebrates, and rebuild ecological corridors — with monitoring focused on taonga species, canopy cover, and habitat structure.

Cultural Values & Mātauranga Māori

- Ngāti Hine-led values are embedded throughout: from the use of Māori Cultural Indicators (MCI) to data sovereignty, ahi kā (continuous occupation), and place-based knowledge guiding restoration design and monitoring.

Monitoring for Funding Confidence

- The framework uses SMART principles and funder-aligned metrics to deliver evidence of impact. This aims to give councils, communities, and funders the confidence to invest and adapt.

Community-Led Implementation

- The monitoring strategy supports local delivery — using citizen science tools, co-designed protocols, and equipment that match local capacity, funding levels, and long-term aspirations.

Strategic Alignment and Opportunity

The monitoring framework presented in this memo is aligned with both national policy direction and local strategic goals. Nature-based Solutions (NbS) directly respond to the environmental and cultural challenges outlined in the Taumārere catchment — including sedimentation, flood risk, habitat loss, and declining water quality — while advancing broader government objectives under the **National Policy Statement for Freshwater Management (NPS-FM 2020)** and **Te Mana o te Wai**.

This alignment creates an opportunity for investment. NbS interventions such as wetland restoration, riparian planting, and native afforestation are well-supported by national funding priorities that emphasise integrated catchment management, climate adaptation, biodiversity recovery, and mātauranga Māori (Māori knowledge systems).

The local momentum driven by Ngāti Hine, community restoration groups, and council partners provides a foundation for delivery. By combining policy alignment, cultural leadership, and monitoring tools, this framework positions the Taumārere catchment as a leading example of place-based, co-designed NbS in Aotearoa.

The strategic opportunity now lies in **moving from feasibility to delivery** — securing targeted funding, activating site-level implementation, and building long-term co-governance structures that uphold Indigenous rights, ecological outcomes, and community wellbeing.

1 Introduction

1.1 The Purpose of this Memo

This report sets out an environmental monitoring framework to support the planning, funding, and delivery of Nature-based Solutions (NbS) in the **Taumārere (Upper Kawakawa) Catchment**.

A suite of targeted NbS — including erosion control, riparian planting, wetland restoration, leaky barriers, silt traps, and floodplain reconnection — has been recommended to address key catchment pressures and build long-term resilience (NRC, 2022).

Key catchment pressures targeted by these NbS:

- **Flooding & flow instability**
- **Sediment & erosion**
- **Water quality decline**
- **Loss of mahinga kai**

This framework provides clear, actionable guidance on what to monitor, which methods to use, and when monitoring can be scaled back. To meet the expectations of funders and, so that restoration efforts are:

- Technically credible.
- Aligned with funder and carbon market requirements (MfE, 2023).
- Culturally grounded in Ngāti Hine values and mātauranga Māori (Ngāti Hine, 2022a).
- Designed for local delivery by councils, kaitiaki, and community groups.

The focus of this framework is to outline monitoring approaches that are scalable and aligned with local capacity, so results can be used by funders and applied confidently to adapt and grow NbS projects over time (WWF-NZ, 2022).

1.2 Objectives and Key Outcomes

The main objectives of this monitoring framework at the feasibility stage are to:

- Set out monitoring requirements for each recommended NbS in the catchment.
- Combine Ngāti Hine's own Māori Cultural Indicators (MCI) with technical measures to provide a holistic view of catchment health.
- Support local delivery by recommending accessible tools suited for local application.
- Provide a basis for adaptive management, linking monitoring results to project adjustments and defining when monitoring can be scaled back.
- Align monitoring actions with funding needs, by applying the SMART framework, which helps confirm that indicators are (Milne, 2021):
  - **S – Specific:** Clearly linked to each NbS goal (e.g., erosion rates for slope stabilisation).
  - **M – Measurable:** Collected using repeatable, consistent methods.
  - **A – Achievable:** Realistic for local budgets, skills and available tools.
  - **R – Relevant:** Aligned with funding priorities and reporting requirements.
  - **T – Time-bound:** Includes a clear timeframe for measurement and a defined point when monitoring can be reduced or stopped.

This framework is intended to evolve as projects move from feasibility to delivery. It provides a flexible starting point that can be refined with local experience, co-design with mana whenua, and future funding opportunities.

1.3 How to Use This Document

This memo is a practical planning guide for councils, funding partners, community groups, and kaitiaki involved in planning and delivering NbS in the Taumārere catchment.

Use it to:

- Identify what to monitor for each NbS technique.
- Select practical tools and methods suited to local budgets and skills.
- Align monitoring activities with funder and carbon market requirements.
- Draw upon Ngāti Hine cultural indicators and scientific data for a comprehensive assessment.
- Decide when monitoring can be reduced or stopped, based on clear exit criteria.

2 Monitoring Requirements for Funding

A review of over **30 funding sources** confirmed that most restoration and community grants allow applicants to define their own monitoring measures, provided they clearly demonstrate project impact. Only carbon market schemes (e.g., NZ Emissions Trading Scheme, VCS, ACR) require strict, verified monitoring for carbon stock estimation and trading (MfE, 2023). All other funding streams expect monitoring to match the project's stated objectives — for example, a wetland grant will expect water level, water quality and habitat condition tracking, but not carbon stock data.

This framework uses SMART monitoring principles outlined in **Section 1.2** to support funding applications. This approach provides funders with confidence that results are verifiable and that investments are achieving measurable outcomes.

Section 4 presents monitoring recommendations for each NbS type, linking them directly to these principles and typical funding expectations.

2.1 Carbon Market Verification

Carbon credit trading is an **alternative revenue stream** for large-scale native planting and ecosystem restoration — but it requires a high level of monitoring rigour to verify carbon sequestration claims.

Key carbon trading schemes relevant to Aotearoa New Zealand include:

- **NZ Emissions Trading Scheme (NZ ETS)** — national, regulated scheme.
- **VERRA's Verified Carbon Standard (VCS)** — global voluntary market.
- **American Carbon Registry (ACR)** — international voluntary market.

Verification requirements typically include:

- Establish a **certified baseline carbon stock** before restoration (e.g., vegetation plots, soil cores).
- Measure **annual or periodic carbon gains** (e.g., plot sampling, growth models, remote sensing).

- Undergo independent **third-party audits** to verify data and prevent double-counting or leakage (carbon loss elsewhere).
- Follow **scheme-specific protocols** for permanence and reporting.

Although this level of monitoring is more stringent than for general restoration grants, the potential financial return for communities and landowners is a consideration, especially for large-scale forest regeneration. Most NbS projects aiming to trade carbon must design monitoring to meet these standards from the outset, use SMART-aligned indicators (e.g., *total aboveground biomass per hectare*) and support data being traceable and verifiable.

3 Current Monitoring Snapshot

This section provides a short overview of the main monitoring already happening in the Taumārere (Upper Kawakawa) catchment. These activities create a **baseline** for understanding catchment health — but they are broad in scope and not designed to measure the local, site-specific effects of each NbS recommended as part of this project.

3.1 NRC Monitoring

Northland Regional Council (NRC) delivers core catchment monitoring that underpins local water management and reporting (NRC, 2022).

- **State of Environment (SoE) Water Quality:**
  - Monthly sampling at sites including Stringers Road (Waiharakeke Stream) for turbidity, nutrients (N & P), E. coli, visual clarity and dissolved oxygen.
  - Results benchmarked against the **NRC Water Quality Index (WQI)** and national guidelines (NPS-FM). For example, the latest report card for Waiharakeke shows some parameters repeatedly exceed regional standards, showing persistent runoff and land use impacts.
  - **Over 30 parameters** have been monitored at Stringers Road since 2004, including pH, conductivity, temperature, heavy metals, and bacterial indicators. Sampling occurs approximately monthly, with a relatively consistent long-term record.
  - **Data gaps are minimal** for most key parameters, though some variables (e.g., metals or visual clarity) have shorter or more sporadic records, which may limit trend detection.
- **Hydrometric Monitoring:**
  - Streamflow and water level recorded at key stations down to hourly intervals: Otiria Stream, Waiharekeke Stream, and Tirohanga Stream.
  - Data supports flood forecasting, hydrological modelling, and flow trend analysis.
  - Two long-term rain gauges are located in the catchment, and several more regionally.
- **Ecological Monitoring:**
  - Macrophyte and periphyton surveys at selected sites to indicate nutrient enrichment and habitat health; however, the frequency is uncertain due to lack of information.

Although this provides a foundation for understanding catchment-wide trends, it does not measure the outcomes of small-scale, site-specific interventions. Most NbS, such as riparian plantings, wetland restorations, or leaky barriers, are implemented at a local scale—where benefits may not show up in regional datasets. Without fine-scale monitoring, it is difficult to demonstrate how individual actions are contributing to broader catchment health (NIWA, 2022). This indicates the need for a complementary approach: one that pairs council datasets with targeted, on-the-ground assessments tied directly to specific activities or sites.

3.2 Ngāti Hine & Community Monitoring

Alongside council-led monitoring, Ngāti Hine, kaitiaki, community groups, and local schools play an important role in generating **localised, culturally grounded environmental data** (Ngāti Hine, 2022). These efforts are typically small in scale but high in relevance for tracking the progress of specific restoration actions.

- **SHMAK & Visual Stream Assessments:**
  - Macroinvertebrate sampling, clarity checks, habitat assessment.
  - Used at accessible sites with low-cost kits and volunteer training.
- **Mahinga Kai & Taonga Species Observation:**
  - Local knowledge and seasonal checks for tuna (eels), īnanga (whitebait), kōura, wetland birds including duck hunting, plant and habitat health and productivity.
  - Oral narratives shared at hui and wānanga.
- **Volunteer Activities:**
  - Plant survival counts on restoration projects, repeat photo points, simple water tests (e.g., pH, salinity, etc).
- **Drone-Based Habitat Checks:**
  - Drones are now more accessible and play a role in local monitoring.
  - Drones can be flown to target floods and floodplain behaviour, or to capture photos of riparian margins, erosion points, along with habitat monitoring.

These community-led methods build local ownership and embed mātauranga Māori and place-based perspectives into catchment care. However, the data they produce is often general in scope and not explicitly structured around measuring the effectiveness of individual NbS techniques. Providing support for these efforts with simple, goal-specific monitoring tools can contribute to delivering both funder confidence and culturally relevant outcomes (WWF-NZ, 2022).

3.3 Monitoring Constraints & Challenges

Monitoring in the catchment must account for real-world constraints:

- Large areas of **commercial forestry** and steep hillslopes can limit physical access to sites.
- **Productive grazing** and mixed landownership mean permissions and relationships are key to securing monitoring locations.
- Heavy rainfall and **flood-prone areas** demand simple, robust tools that can be used quickly and withstand damage.
- Community and iwi capacity is a resource but not unlimited — monitoring plans should be **low-cost** and complement rather than duplicate NRC's core work.

3.4 Gaps & Opportunity

Together, NRC and community monitoring provide a solid foundation — but gaps remain for tracking the **real-world performance of specific NbS,** including:

- Measuring **local effects** (e.g., erosion reduction at a stabilised slope or nutrient retention in a restored wetland or silt trap).

- Linking physical changes (shade, sediment capture, flow slowing) to improvements in water quality or habitat.
- Demonstrating sustained impact over time for funding renewals or carbon verification.
- Embedding **Māori Cultural Indicators (MCI)** as a core component of the monitoring framework.

The Monitoring Framework in Section 4 fills these gaps by setting out clear, practical monitoring actions, tools, and exit criteria for each NbS — aiming to give partners and funders confidence that local actions are delivering measurable environmental and cultural results.

4 NbS Monitoring Framework

This section outlines the structure and intent of the proposed environmental monitoring framework (Table 1) for each recommended NbS in the Taumārere catchment.

Purpose of this framework:

- **To demonstrate that site-specific monitoring is feasible** and aligns with typical funder expectations (MfE, 2023).
- **To provide a SMART-aligned structure** for what will be tracked — complemented by clear tools and indicators described in the Appendix.
- **To complement, not duplicate, existing council and community monitoring** by focusing on filling localised data gaps and tracking direct NbS outcomes.
- **To highlight how Ngāti Hine values and mātauranga** are woven into assessment design — confirming cultural and ecological outcomes are considered together (Ngāti Hine, 2022) with equal weight.
- **To support monitoring that is achievable for local capacity**, while providing verifiable evidence to support adaptive planning, funding renewals, and long-term project outcomes (WWF-NZ, 2022).

Key points:

- Detailed monitoring protocols (e.g. frequency, site selection, calibration) will be **co-designed** during the implementation phase, guided by the framework structure and info sheets. This should incorporate specialised or targeted monitoring protocols main publicly available for most regional habitat types (DOC, Whitebait Connection (etc) guidance).
- Recommended methods include **simple and cost-effective tools**, such as SHMAK kits, photo points, turbidity tubes, and drone imagery — many of which are already familiar to community groups.
- **Māori Cultural Indicators (MCI)** appear alongside ecological indicators for each NbS type, reflecting the Ngāti Hine Environmental Management Plan (Ngāti Hine, 2022) and principles of kaitiakitanga (guardianship) and intergenerational knowledge.

What's in the Appendix — Each NbS info sheet includes:

- **Purpose** — what the NbS aims to achieve in this catchment.
- **What to monitor** — key baseline and change indicators.
- **Recommended methods & tools** — options suited to local delivery.
- **Citizen & kaitiaki role** — what can be community-led.
- **Ecological & Cultural Indicators** — combined to show outcomes.
- **Exit criteria** — when to reduce or conclude monitoring for that intervention.

Table 1: Proposed draft Monitoring Framework

NbS Technique	NbS Purpose	Monitoring (Baseline & Change Detection)	Rationale / Description	Monitoring (Long-Term Impact Assessment)	Māori Cultural Indicators (MCI)	SMART Exit Criteria (When Can Monitoring Stop?)
Forest & Native Vegetation Restoration	Restore indigenous forest to stabilise slopes, reduce erosion and surface runoff, increase biodiversity, sequester carbon, and revive ngahere mauri and rongoā.	Canopy closure (%), biodiversity surveys, pest control rates, stream sediment or flow checks	Restores native forest, slows runoff, improves baseflows, supports ecosystem resilience	Native bird returns (e.g., ruru), kōura in streams, soil moisture stability, downstream awa habitat change	Return of rongoā species, bird calls, activity in ngahere	≥80% canopy closure, active seedling recruitment, pest reduction, stream sediment stable, kaitiaki confirm ngahere mauri restored
Erosion Control & Steep Slope Stabilisation	Reduce sediment from slips and erosion-prone land, stabilise steep slopes, and protect downstream water quality and habitats.	Landslide records, slope vegetation cover, erosion scars, stream sediment loading, cross check with rainfall & flow	Reduces hillslope failure, sediment yield, and flash runoff	Slope stability during storm seasons, sediment trend improvements in adjacent streams	Visible whenua mauri, reduced land loss across whenua	Slopes stable for 2–3 wet seasons/ big events, vegetation cover healthy, erosion minimal, kaitiaki confirm whenua resilience
Leaky Barriers	Slow runoff, trap sediment, reduce peak flows, and enhance microhabitat and small stream connectivity.	Streamflow lag (flow/ level gauges), sediment build-up, barrier condition, water turbidity	Attenuates storm peaks, traps silt, and buffers flood energy	Tuna sightings in pools, peak flow reductions, sediment stability	Tuna return, stories of small stream mauri revival	Barrier intact, peak flow reduction evident, sediment accumulation upstream, taonga species use confirmed by kaitiaki
Silt Traps	Capture fine sediment before it enters waterways to protect water clarity, aquatic life, and mahinga kai.	Sediment accumulation in trap, downstream turbidity, overflow condition	Reduces smothering of in-stream habitat and maintains visual water quality	Macroinvertebrate rebound, clearer water post-storm	Whānau observe clarity, taonga species return, sediment visibly reduced	Trap emptied before full, downstream turbidity low, cultural clarity confirmed
Riparian Planting	Stabilise streambanks, reduce erosion, shade and filter water, and restore ecological corridors.	Bank erosion, canopy cover, macroinvertebrates, stream temperature	Filters runoff, cools streams, reduces sediment, connects habitats	Native fish sightings, shaded channels, stable invertebrate communities	Return of manu, tuna movement, ruru at dusk, stream use by whanua	≥70% canopy cover, bank erosion reduced, water cooler, taonga species and cultural use visible

NbS Technique	NbS Purpose	Monitoring (Baseline & Change Detection)	Rationale / Description	Monitoring (Long-Term Impact Assessment)	Māori Cultural Indicators (MCI)	SMART Exit Criteria (When Can Monitoring Stop?)
Floodplain Connection & Restoration	Reconnect streams to their floodplains, restore natural water storage, and support habitat diversity and mahinga kai.	Inundation frequency, flood extent, floodplain vegetation, fish/invertebrate use	Reduces downstream flood peaks, spreads flows, supports repo function	Taonga fish present post-flood (e.g., kōura, tuna), wetland vegetation thriving	Repo used for kai and resources, stories of restored floodplain function, species of pūrākau (stories of whakapapa and myth)	Floodplain safely inundated each season, taonga species use confirmed, wetland mauri stable
Wetland Restoration	Restore wetlands to store water, support biodiversity, trap nutrients, and revive cultural harvest and birdlife.	Wetland extent, native cover, groundwater level (borehole and pressure/ level logger), water quality buffering	Increases water retention, filters runoff, supports habitat diversity	Vegetation health and diversity, key species (koura, mudfish, tuna) return, harakeke health/ use, clean outflows	Repo used for weaving, kai, and wānanga, species return noted by whānau	Wetland stable in size, water clean, species use confirmed by kaitiaki
Intertidal Wetland Restoration (Īnanga Focus)	Restore estuarine and tidal fringe habitats to support īnanga (whitebait) spawning, estuarine fish recruitment, and wetland bird species.	Spawning habitat condition (vegetation fringe), salinity buffering, fry/egg presence, bird use	Improves connectivity between tidal and freshwater zones, supports īnanga lifecycle, protects key mahinga kai	Annual egg surveys, bird presence counts, salinity patterns through tidal season	Īnanga fry sightings, repo stories revitalised, tamariki involved in kai gathering and monitoring	Spawning edge vegetation stable, īnanga lifecycle confirmed each season, harvest confirmed sustainable by iwi
Catchment Management	Track broad-scale patterns in water quality, erosion, and land use to support integrated planning and adaptive action.	Erosion hotspots, land use changes, NRC WQ & flow nodes, tributary SHMAK	Informs cumulative risk, tracks restoration benefit, helps inform priorities	Soil quality trends, stormwater response, community rainfall records	Healthy puna and repo, confirm mauri health seasonally	No new erosion expansion, key WQ sites improved, land use aligns with whakapapa decisions, reduced flooding.

Note: Monitoring indicators and approaches are based on methods outlined in DOC (2025), MfE (2023), NIWA (2022, 2025), NRC (2022b), WWF-NZ (2022), and Ngāti Hine (2022). See Appendix for full reference list

4.1 Monitoring Framework Table

Table 1 summarises the monitoring framework developed for the suite of NbS techniques proposed in this project. For each intervention, it identifies:

- **Monitoring requirements** for baseline establishment and change detection
- **Ecological rationale** and long-term performance indicators
- **Māori Cultural Indicators (MCI)** drawn from Ngāti Hine values and narratives
- **SMART exit criteria** that signal when monitoring may be scaled back or concluded

4.2 Indicative Monitoring Equipment & Cost Summary

To support the practical delivery of this monitoring framework, Table 3 provides an indicative list of typical field equipment and estimated cost ranges for each Nature-based Solution (NbS). Costs are indicative only and should be refined during detailed Monitoring & Evaluation planning in Phase 2, in partnership with NRC, Ngāti Hine, and local community groups. Many items can be shared between sites or sourced through existing council resources to keep costs realistic and efficient.

Costs are approximate retail or community supplier rates for small to mid-scale monitoring. Many tools (e.g., SHMAK kits, drones) can be shared across sites or borrowed through council partnerships to reduce total outlay.

Table 2: Indicative Monitoring Equipment Costs

Equipment / Tool	Purpose	Typical Use Across NbS	Approx. Cost (NZD)
SHMAK Kit	Community water quality & macroinvertebrate surveys	Riparian Planting, Silt Traps, Floodplain, Wetlands, Catchment Nodes	\$800–\$1700 per kit
Fixed Photo Point Markers	Visual tracking of changes	All NbS sites	\$20–\$50 per marker
Digital Camera or Smartphone	Capturing repeat site photos	All NbS sites	Often owned; if needed, \$0–\$500
Canopy Densiometer or App (*e.g. Canopeo*)	Measure canopy cover	Forest & Native Vegetation, Riparian Planting	\$50–\$150 (app)
Temperature Water Pressure/ Level Loggers	Stream/wetland water temperature	Riparian Planting, Wetland Restoration, Floodplain Connection	\$100–\$1000 each
Erosion Pins	Slope stability tracking	Erosion Control, Steep Slopes	\$20–\$50 per pin
Drone (shared or contracted)	Aerial habitat mapping, floodplain coverage	Riparian Planting, Wetlands, Floodplain Connection	\$1,500–\$3,500 (one-off or hire)
Sweep Nets / Fry Traps	Fish fry or īnanga checks (trained users)	Intertidal Wetland, Floodplain Pools	\$50–\$150
Piezometer Pipe + Tape	Groundwater level tracking (optional)	Wetland Restoration	\$200–\$400 per piezometer
Notebook / Story Log / Audio Recording	Kaitiaki & community cultural observations	All NbS sites	\$10–\$50 per site

Note: Equipment guidance adapted from DOC (2025), MfE (2023), NIWA (2022, 2025), NRC (2022b), WWF-NZ (2022), and Ngāti Hine (2022). Final selection and costing should be tailored to project scale and delivery team.

5 Funding Alignment & Next Steps

This section outlines how the proposed monitoring framework aligns with funder expectations and practical community delivery, and it sets out actions for progressing to detailed monitoring plans and funding applications.

5.1 Funding Alignment

- **Integrated monitoring**: Each NbS monitoring activity is designed to produce credible evidence for funders, carbon schemes, and local reporting. Baseline conditions, site-specific change tracking, and SMART exit criteria demonstrate clear measurable outcomes (MfE, 2023; WWF-NZ, 2022).
- **Carbon market compatibility**: For forest and large-scale planting projects, carbon stock monitoring aligns with NZ ETS, VERRA, and ACR requirements, providing a pathway to long-term revenue streams.
- **Flexible monitoring scope**: Simple, cost-effective tools (e.g., SHMAK kits, photopoints, drones) match the scale and budget typical of community and regional restoration grants (NIWA, 2025).
- **Fundable priorities**: The framework supports key funder themes such as biodiversity recovery, water quality improvement, flood resilience, cultural restoration, and community co-benefits (DOC, 2025; Ngāti Hine, 2022).

5.2 Community Engagement & Capacity

- **Local leadership**: Citizen science and iwi-led monitoring are central to delivery, building ownership and local skills.
- **Training and support**: Funding applications will include provisions for training kaitiaki, volunteers, and schools in monitoring techniques.
- **Shared reporting**: Monitoring outputs will be designed for easy use in community storytelling, iwi reporting, and compliance reporting for funders.

5.3 Māori Cultural Indicators & Indigenous Data Sovereignty

- **Embedded cultural values**: Māori Cultural Indicators (MCI) are woven throughout the monitoring framework, reflecting Ngāti Hine values for mauri, whakapapa, taonga species, and ahi kā (Ngāti Hine, 2022).
- **Co-design and co-governance**: Monitoring protocols will be refined with mana whenua to ensure cultural integrity, relevance, and long-term stewardship.
- **Data sovereignty**: Ngāti Hine will maintain control over cultural data, with clear agreements for sharing and reporting, ensuring that mātauranga and community narratives are respected and protected (Kukutai, 2015).

5.4 Immediate Next Steps

- Identify funding streams that best match the catchment's NbS priorities, including carbon schemes and restoration grants.
- Formalise partnerships with Ngāti Hine and local community groups for co-designing site-specific Monitoring & Evaluation Plans.
- Prioritise "quick win" sites for initial low-cost monitoring (e.g., riparian planting, silt traps) to build early momentum and community engagement.
- Develop costed proposals for Phase 2 funding applications, covering training, simple tools, and longer-term ecohydrological monitoring.

6 Conclusion

This monitoring framework provides a locally-focused, culturally grounded starting point for tracking the outcomes of **Nature-based Solutions in the Taumārere (Upper Kawakawa) Hydrological Catchment**.

By combining clear baseline indicators, site-specific monitoring actions, accessible tools, Māori Cultural Indicators (MCI), and SMART exit criteria, the framework aims to confirm that restoration projects are:

- Technically robust and credible
- Aligned with funder and carbon market requirements
- Achievable with local capacity and community involvement
- Responsive to Ngāti Hine values, mātauranga and aspirations

The next phase will build on this foundation by **co-designing detailed Monitoring & Evaluation Plans with Ngāti Hine, community groups, and funding partners**. This will help confirm that monitoring stays adaptable and able to demonstrate **benefits for ecosystems, whānau, and funders**.

Through this integrated approach, the project will **support catchment stewardship, funding resilience, and uphold the long-term mauri of the Taumārere Catchment** and those that call it home.

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Appendix: NbS Types and Monitoring.

<table>
<tr><td colspan="6">Forest & Native Vegetation Restoration
Purpose: Restore indigenous forest cover to stabilise slopes, reduce surface runoff and erosion, boost biodiversity, sequester carbon, and re-establish cultural connections through ngahere mauri and rongoā resources.</td></tr>
<tr><td colspan="6" align="center">What to monitor</td></tr>
<tr><td colspan="2" align="center">Ecological</td><td colspan="2" align="center">Hydrological</td><td colspan="2" align="center">Cultural</td></tr>
<tr><td colspan="2">• Planted area and canopy closure (%)
• Native species diversity and seedling regeneration
• Pest and weed presence (e.g., possum, pine, gorse)
• Signs of bird and invertebrate return (e.g., ruru, wētā)</td><td colspan="2">• Soil moisture trends under restored canopy (simple probes or manual by touch)
• Surface runoff reduction (visual checks post-rainfall or flow comparison with unrestored sites)
• Stream sediment movement in adjacent gullies or tributaries
• Baseflow support in downslope spring-fed streams or seeps</td><td colspan="2">• Kaitiaki observations of mauri return (birdsong, ngahere use)
• Rongoā species re-emergence (e.g., kawakawa, harakeke, horopito)
• Use of ngahere areas for wānanga or harvest</td></tr>
<tr><td colspan="6" align="center">Methods & Tools</td></tr>
<tr><td colspan="3">• Fixed plots and photo points (drone optional)
• Plot survival counts (1-year, 3-year survival)
• Bird counts (5-minute DOC protocol)
• Pest trap line results
• Flow gauge of level sensor loggers</td><td colspan="3">• Simple soil moisture readers or rain-event logbooks
• Visual sediment checks at nearby waterways
• Kaitiaki interviews, harvest logs, or wānanga storytelling</td></tr>
<tr><td colspan="6" align="center">Citizen Science & Community Involvement
High — community and school groups can contribute to photo monitoring, plot checks, pest trap maintenance, and bird surveys. Soil moisture probes and visual hydrology checks can be introduced with basic training.</td></tr>
<tr><td colspan="6" align="center">SMART Exit Criteria</td></tr>
<tr><td colspan="3">• ≥80% canopy closure
• Seedling recruitment evident under canopy
• Pest levels under control (trapping or signs)
• Visual reduction in surface runoff or gully erosion post-rainfall</td><td colspan="3">• Soil moisture levels consistent through dry periods
• Kaitiaki confirm that ngahere mauri has returned and rongoā use is re-established</td></tr>
</table>

<table>
<tr><td colspan="6">Erosion Control & Steep Slope Stabilisation

Purpose: Reduce soil loss, stabilise steep slopes, and protect downstream streams from sedimentation. Supports whenua resilience and the protection of wāhi tapu through revegetation and land care.</td></tr>
<tr><th colspan="6">What to monitor</th></tr>
<tr><th colspan="2">Ecological</th><th colspan="2">Hydrological</th><th colspan="2">Cultural</th></tr>
<tr><td colspan="2">• Vegetation cover and establishment on slopes
• Bare soil or exposed slip scars
• Presence of pioneer/native stabilisers (e.g., toetoe, kākābeak)</td><td colspan="2">• Evidence of slope runoff during rain events
• Sediment movement or deposition at base of slope or in receiving streams
• Stream turbidity or clarity post-rainfall
• Rain-event response time (visual or sensor where feasible)</td><td colspan="2">• Kaitiaki observations of whenua mauri (e.g., no visible land scarring, healthy ngahere)
• Cultural landscape protection — no loss of wāhi tapu or access tracks
• Whānau recollection of past slips replaced by vegetation and healing land</td></tr>
<tr><th colspan="6">Methods & Tools</th></tr>
<tr><td colspan="3">• Fixed slope photo points (pre/post rain seasons)
• Erosion pins (optional for quantification)
• Turbidity tube or SHMAK clarity at base stream points
• Manual rainfall log or sensor (if installed)</td><td colspan="3">• Kaitiaki-led visual checks of sensitive sites
• Wānanga-based interviews about landscape changes or healing
• Use of mapping or storytelling to track slope recovery over time</td></tr>
<tr><td colspan="6" align="center">Citizen Science & Community Involvement
Medium — visual slope checks and photo points are ideal for local volunteers. Turbidity tubes and rainfall logs can be introduced easily. Kaitiaki-led cultural tracking enhances long-term connection and awareness.</td></tr>
<tr><th colspan="6">SMART Exit Criteria</th></tr>
<tr><td colspan="3">• Slopes visibly stable across at least two wet seasons
• Ground cover well established with minimal bare patches
• Reduced sediment in baseflow after storms
• No new slips or erosion scarring during seasonal checks</td><td colspan="3">• Kaitiaki confirm landscape mauri has recovered
• No further degradation of wāhi tapu
• Community narratives acknowledge land recovery and slope healing</td></tr>
</table>

Leaky Barriers

Purpose: Slow runoff, trap sediment, reduce peak flows, and enhance small aquatic habitats. Leaky barriers also help restore mauri through tangible, site-specific interventions that can be built and maintained with local involvement.

What to monitor

Ecological	Hydrological	Cultural
• Condition of barrier structure (logs, branches, brush bundles) • Sediment accumulation behind the barrier • Aquatic habitat use (e.g., tuna or kōura observed in pools)	• Change in hydrograph timing (delayed or extended flow during/after storms) • Reduction in peak flow energy downstream • Visual evidence of ponding or flow spreading	• Tuna presence and return to pool habitats • Kaitiaki observations of mauri restoration • Local narratives of site safety and customary value (e.g., wānanga location, restored peace after floods)

Methods & Tools

Field Methods	Community Tools
• Post-storm inspections and photographs • Sediment depth checks (e.g., pole ruler) • Spot velocity or flow comparison upstream/downstream (optional) • Drone flyover (optional)	• Visual logbooks after storms • Storytelling or oral history capture • Community sightings of tuna or flood behaviour • Repeat photo point

Citizen Science & Community Involvement

High — Easy-to-monitor sites with high visibility. Volunteers and kaitiaki can take repeat photos, measure sediment depth, observe tuna habitat use, and document cultural feedback through kōrero and story logs. The physical presence of these structures often sparks local engagement.

SMART Exit Criteria

- Barriers structurally intact after multiple high-rainfall events
- Sediment builds up consistently behind barrier (e.g., 30%–50% fill)
- Visual or basic flow logging confirms delayed runoff or dampened flood peaks
- Tuna or kōura are regularly seen in pools by community members
- Cultural indicators confirm site value: wānanga held, stories shared, mauri acknowledged by kaitiaki

<table>
<tr><td colspan="6">Silt Traps

Purpose: Capture fine sediment from surface runoff before it reaches streams, improving water clarity, reducing bed smothering, and enhancing mahinga kai habitat. These small-scale interventions are effective at the paddock or drain level and align with kaitiakitanga by protecting wai māori and life downstream.</td></tr>
<tr><th colspan="6">What to monitor</th></tr>
<tr><th colspan="2">Ecological</th><th colspan="2">Hydrological</th><th colspan="2">Cultural</th></tr>
<tr><td colspan="2">• Sediment accumulation in trap basin
• Downstream macroinvertebrate presence (optional SHMAK)
• Vegetation health within and around trap</td><td colspan="2">• Water clarity downstream during/after storm events
• Trap overflow or bypass activity
• Sediment delivery reduction to streams (visual or turbidity trend)</td><td colspan="2">• Observations of clearer wai by kaitiaki or whānau
• Return of kai species to nearby stream reaches (e.g., kōura, īnanga)
• Mahinga kai beds no longer visibly smothered or degraded</td></tr>
<tr><th colspan="6">Methods & Tools</th></tr>
<tr><td colspan="3">Field Methods
• Measure sediment depth with a pole or ruler
• Visual checks after rain for overflow points or erosion
• Optional turbidity tube or SHMAK clarity test downstream
• Check for vegetation clogging or damage</td><td colspan="3">Community Tools
• Repeat photo points pre- and post-rainfall
• Simple turbidity tube readings
• Visual tracking of flow bypassing trap
• Story logbooks or feedback forms for cultural observations</td></tr>
<tr><td colspan="6">Citizen Science & Community Involvement
High — Easy to access and monitor. Community members, school groups, and kaitiaki can conduct depth checks, water clarity readings, and capture visual or oral records of how well the trap is working. These activities build local knowledge and support adaptive trap management.</td></tr>
<tr><th colspan="6">SMART Exit Criteria</th></tr>
<tr><td colspan="6">• Sediment consistently captured (e.g., fills to 50–70% capacity before clean-out)
• Overflow is rare and does not cause visible erosion
• Downstream clarity stable across seasons
• Cultural confirmation that wai is clearer and kai species are more abundant
• Maintenance routine established and handed to local group or landowner</td></tr>
</table>

<table>
<tr><td colspan="3">Riparian Planting

Purpose: Stabilise streambanks, filter surface runoff, reduce stream temperatures, and reconnect ecological corridors for fish, insects, and birds. Riparian zones also carry deep cultural importance, supporting mauri, taonga species, and rongoā gathering along the margins of awa.</td></tr>
<tr><th colspan="3">What to monitor</th></tr>
<tr><th>Ecological</th><th>Hydrological</th><th>Cultural</th></tr>
<tr><td>• Canopy cover across riparian margin (%)
• Native plant survival and growth rates
• Macroinvertebrate diversity using SHMAK</td><td>• Bank erosion extent (via photo points)
• Stream temperature (manual or logger)
• Width of planted buffer vs. runoff source areas</td><td>• Return of taonga species (e.g., tuna, ruru, kawau)
• Use of riparian areas for wānanga, harakeke/kawakawa gathering
• Community or kaitiaki confirmation of restored mauri (e.g., birdsong, clean water, visible life)</td></tr>
<tr><th colspan="3">Methods & Tools</th></tr>
<tr><td colspan="2">Field Methods
• Fixed photo points on banks
• Canopy densiometer or smartphone apps for shade levels
• SHMAK kits to assess water quality and stream life
• Water temperature loggers (where budget allows)
• Vegetation transects or plots for plant tracking</td><td>Community Tools
• Repeat photos from marked posts
• Visual checks for plant growth and bank condition
• SHMAK sessions with trained volunteers
• Story collection and observation forms for MCI (e.g., sightings, mauri feedback)</td></tr>
<tr><td colspan="3" align="center">Citizen Science & Community Involvement
High — Riparian zones are easily accessible for schools, community groups, and whānau. Photo points, water temperature strips, SHMAK assessments, and taonga sightings all offer meaningful ways to track change. These spaces are also ideal for community planting days, educational sessions, and storytelling.</td></tr>
<tr><th colspan="3">SMART Exit Criteria</th></tr>
<tr><td colspan="3">• ≥70% canopy closure in planted zones
• Streambank visibly stable, no active erosion at photo points
• Temperature reduction (trend or evidence of shading)
• SHMAK scores show healthy aquatic bugs (e.g., high EPT richness)
• Confirmed presence of taonga species and community-reported mauri revival
• Plantings self-sustaining with minimal weeding or replanting needed</td></tr>
</table>

<table>
<tr><td colspan="6">Floodplain Connection & Restoration

Purpose: Reconnect rivers with their natural floodplains to reduce downstream flood peaks, enhance flood storage, and restore seasonal wetland and riparian habitats. These areas hold cultural significance as mahinga kai and ecological transition zones.</td></tr>
<tr><th colspan="6">What to monitor</th></tr>
<tr><th colspan="2">Ecological</th><th colspan="2">Hydrological</th><th colspan="2">Cultural</th></tr>
<tr><td colspan="2">• Floodplain vegetation health and diversity
• Presence of fish and invertebrates in seasonal pools
• Bird sightings and breeding evidence in reconnected areas</td><td colspan="2">• Frequency and extent of overbank inundation (photo/drone)
• Duration of standing water after flood events
• Flow timing and attenuation compared to upstream gauge
•</td><td colspan="2">• Revival of customary harvests (e.g., tuna, kōura, watercress)
• Signs of repo (wetland) use by whānau
• Oral histories, names, or stories reactivated through site use
• Observations of mauri returning to landscape (via wānanga or interviews)</td></tr>
<tr><th colspan="6">Methods & Tools</th></tr>
<tr><td colspan="3">Field Methods
• Photo points across floodplain
• Drone flights post-storm to map flood spread
• Dip-net surveys in seasonal pools
• Vegetation surveys (quadrats or fixed transects)
• Flow logger or comparison with upstream rainfall/discharge</td><td colspan="3">Community Tools
• Visual flood maps drawn by locals after large events
• Repeat site photos showing water extent
• SHMAK checks in pools for clarity, invertebrates
• Story-sharing on repo revival and mahinga kai sightings</td></tr>
<tr><td colspan="6" align="center">Citizen Science & Community Involvement
Medium to High — Community groups can easily photograph flood events, track changes in vegetation, and assist in pool sampling. Drone support or trained contractors may assist with mapping. Ideal for whānau engagement through food gathering, site visits, and seasonal storytelling.</td></tr>
<tr><th colspan="6">SMART Exit Criteria</th></tr>
<tr><td colspan="6">• Floodplain receives regular overbank flow without damage
• Native wetland and riparian vegetation is established and spreading
• Pools support fish/invertebrates during seasonal visits
• Community and kaitiaki confirm cultural values restored (kai, stories, visible mauri)
• Evidence of reduced downstream flood peaks or spread timing confirmed over 2–3 major events</td></tr>
</table>

<table>
<tr><td colspan="6">Wetland Restoration

Purpose: Restore or enhance wetlands to hold water, filter nutrients, recharge baseflows, and support culturally important biodiversity. Wetlands (repo) also act as natural flood buffers and are essential mahinga kai sites for species like tuna, kōura, wātakirihi, and harakeke.</td></tr>
<tr><th colspan="6">What to monitor</th></tr>
<tr><th colspan="2">Ecological</th><th colspan="2">Hydrological</th><th colspan="2">Cultural</th></tr>
<tr><td colspan="2">• Wetland area and vegetation health
• Native plant cover (e.g., sedges, harakeke)
• Presence of wetland birds, tuna, kōura, and aquatic plants</td><td colspan="2">• Groundwater or soil moisture levels (optional piezometer)
• Surface water retention duration after rain events
• Inflow/outflow quality (turbidity, nutrients)
• Evidence of baseflow contribution to nearby streams
•</td><td colspan="2">• Return of taonga species (e.g., tuna, kōura, harakeke, wātakirihi)
• Use of repo for cultural practices (weaving, rongoā, kai collection)
• Kaitiaki observations of mauri and repo vitality (e.g., bird song, healthy wai)
• Oral histories or stories re-emerging about the site</td></tr>
<tr><th colspan="6">Methods & Tools</th></tr>
<tr><td colspan="3">Field Methods
• Vegetation quadrats or visual plant surveys
• Fauna presence surveys (waders, tuna, kōura traps)
• Basic water quality tests (grab samples, SHMAK)
• Piezometer readings if installed
• Aerial or drone photos to map seasonal wetland extent</td><td colspan="3">Community Tools
• Repeat photos of wetland margin growth
• Turbidity tubes for outflow clarity
• Story logs from whānau using the repo
• Wānanga-based records of harvest or cultural observation</td></tr>
<tr><td colspan="6" align="center">Citizen Science & Community Involvement
High — Wetlands are highly accessible for community monitoring. Local groups can contribute to water sampling, vegetation checks, and photo documentation. Cultural monitoring can be integrated through harvest stories and whānau-led site visits.</td></tr>
<tr><th colspan="6">SMART Exit Criteria</th></tr>
<tr><td colspan="6">• Wetland area stable or increasing (no further drainage or degradation)
• Vegetation dominated by healthy native species (≥70% cover)
• Cleaner outflow water (improved turbidity and clarity after storms)
• Regular sightings or harvest of taonga species
• Kaitiaki confirm repo mauri has returned and cultural use is re-established</td></tr>
</table>

Intertidal Wetland Restoration (Īnanga Focus)

Purpose: Restore tidal wetland edges, estuarine fringes, and lowland stream mouths to support īnanga spawning, other native fish species, and wetland birdlife. These zones are key for life-cycle completion of īnanga (whitebait) and hold cultural significance for kai gathering and storytelling.

What to monitor

Ecological	Hydrological	Cultural
• Spawning habitat condition (presence of dense grasses or rushes) • Egg or fry presence during peak spawning season • Bird activity (e.g., kawau, pūkeko, wading birds)	• Tidal inundation frequency and salinity range • Edge stability and sediment accumulation/loss • Water level fluctuation at spawning margins	• Confirmation of īnanga lifecycle events (spawning, fry return) • Mahinga kai activity at restored sites (e.g., whitebaiting) • Revival of place-based stories or tamariki-led exploration and learning • Kaitiaki assessment of repo condition and safe access

Methods & Tools

Field Methods	Community Tools
• Visual spawning edge checks (seasonal) • Sweep netting or egg mats for īnanga (trained volunteers or ecologists) • Salinity spot meter or strips • Drone or GPS mapping of edge extent and changes • Bird count tallies using simple 5-minute protocols	• Photo series during spring tides • Community-led bird observations • Interviews or wānanga for mahinga kai recollection • Tamariki mapping or storytelling exercises

Citizen Science & Community Involvement

Medium–High — While fish surveys may need expert input or training, much of the monitoring can be community-led through bird counts, seasonal visual checks, story collection, and tamariki engagement. Repeat visits during spring tides build strong place-based knowledge.

SMART Exit Criteria

- Spawning vegetation maintained or expanded across key sites
- Īnanga eggs or fry consistently observed for 2+ years
- Shoreline stable and accessible without erosion or grazing impact
- Cultural use confirmed (whitebaiting, wānanga, tamariki involvement)
- Kaitiaki confirm mauri restored and site is active for mahinga kai

Catchment Management		
Purpose: Track overall catchment condition to support integrated land and water management. Provides context for site-level NbS monitoring and helps identify emerging pressures or improvement trends across the Taumārere catchment.		
What to monitor		
Ecological	**Hydrological**	**Cultural**
• Erosion hotspots and land cover changes (e.g., forest loss, pasture expansion) • Macroinvertebrate health at key tributaries (e.g., SHMAK scores) • Signs of pest species or degraded habitats	• Streamflow trends at hydrometric stations (baseflow, peak flow shifts) • Sediment and nutrient loads at key WQ sites • Rainfall variability across sub-catchments •	• Kaitiaki observations of catchment mauri and change over time • Local tohu (seasonal signs) used to guide land and water use • Wānanga feedback on place-based stories, puna health, or cumulative impact
Methods & Tools		
Field Methods • NRC streamflow and WQ data (Stringers Rd, tributary nodes) • Drone or satellite imagery to track land-use change • SHMAK at community monitoring sites • Fixed photo points at erosion-prone zones	**Community Tools** • Community rainfall logbooks • Local erosion maps or "hotspot diaries" • Storytelling sessions or seasonal catchment walks • Tamariki-led land use sketches and change observation	
Citizen Science & Community Involvement **High —** Many aspects of catchment monitoring are suited to local groups. SHMAK, drone flights, erosion logs, photo points, and seasonal storytelling can all be supported by schools, iwi, and volunteer networks. NRC data adds the technical backbone.		
SMART Exit Criteria		
• No new erosion hotspots observed over 3+ wet seasons • Key WQ indicators (e.g., turbidity, nitrate) show stable or improving trends • Streamflow variability reflects natural range (not extreme flashiness) • Whānau and kaitiaki confirm catchment mauri is stable or improving • Catchment-level indicators support long-term integrated management		