

NZCPS 2010 guidance note

Policy 22: Sedimentation



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Policy 22 Sedimentation

- (1) Assess and monitor sedimentation levels and impacts on the coastal environment.
 - (2) Require that subdivision, use, or development will not result in a significant increase in sedimentation in the coastal marine area, or other coastal water.
 - (3) Control the impacts of vegetation removal on sedimentation including the impacts of harvesting plantation forestry.
 - (4) Reduce sediment loadings in runoff and in stormwater systems through controls on land use activities.
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Disclaimer: This guidance is intended as general guidance on implementing the New Zealand Coastal Policy Statement 2010 and has been written primarily for local government practitioners. It does not substitute for professional advice where and when that is needed and should not be taken as providing legal advice or the Crown's legal position. This guidance is not official government policy.

Overview of the policy

Policy 22 of the New Zealand Coastal Policy Statement 2010 (NZCPS 2010) addresses sedimentation in the coastal environment. It directs that sedimentation levels and impacts on the coastal environment should be assessed and monitored, and requires action for reducing sedimentation in the coastal marine area by controlling the impacts of land-based activities.

Policy 22 is one of three policies in the NZCPS 2010 that directly address water quality in the coastal environment.

- Policy 21: Enhancement of water quality.
- Policy 22: Sedimentation.
- Policy 23: Discharge of contaminants.

Therefore, this guidance note should be read alongside the guidance notes for Policies 21 and 23.¹ To avoid duplication, some information and guidance that is common to all three policies is only provided in the Policy 21 guidance note.

Readers of this NZCPS 2010 guidance note should also refer to the NZCPS 2010 Implementation Guidance Introductory Note,² which contains general information and guidance that is important for implementing all of the objectives and policies in the NZCPS 2010.

'Sedimentation' and 'sediment'

The Resource Management Act 1991 (RMA) distinguishes between the deposition of a substance (section 12) and the discharge of a contaminant (section 15). At various stages during the transportation, suspension and re-suspension of the solid mineral and organic matter of which sediment is comprised, sediment can be considered a substance (when deposited on the seabed) or a contaminant (when suspended in the water column).

While not explicitly stated in the NZCPS 2010, the most consistent interpretation is that the term 'sedimentation' refers to sediment that has settled on the bed of a river or the seabed and is therefore a substance according to the RMA definition (section 12), while the term 'sediment' refers to sediment that is suspended in the water column and is therefore a contaminant according to the RMA definition (section 15). This interpretation is also consistent with the 2007 Ministry for the Environment definition of 'sedimentation' as 'the accumulation of sediment'.

The distinction between these and the relevant statutory provisions and definitions are discussed more fully in the 'Resource Management Act 1991' section below.

¹ <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>

² Department of Conservation 2018: NZCPS 2010 implementation guidance introductory note. Department of Conservation, Wellington. 12 p. www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/introductory-note.pdf

Rationale

Erosion takes many forms and generates sediment particles across a wide range of sizes, from boulders and gravels to sand, silt and clay, depending on the substrate type and other erosion factors. Sediment and sediment transport are components of the natural functioning of rivers, and sediment transport along the coast is a natural process that forms and maintains coastal features, such as beaches and spits. However, excess sedimentation (accumulation of deposited sediment), particularly of fine sand, silt and clay particles, can be a significant environmental issue.

Human activities have increased both the rates and quantities of sediment arriving at the coast, causing significant adverse environmental effects. For instance, a study of sediment deposition rates over the past 1,000 years in the Pelorus Sound / Te Hoiere in Marlborough showed that sedimentation accumulation rates have increased ten-fold from 0.2–1.2 mm per year before European settlement to 1.8–4.6 mm per year since European settlement mainly due to forest clearance and land use change.³ This, in turn, has had significant coastal ecosystem effects and has contributed to a decline in benthic biodiversity.

In a recent study on anthropogenic threats to marine habitats, increased sediment rates as a result of changes in land use was assessed as being the second equal most threatening human activity to New Zealand's marine habitats – with climate change being the greatest threat and bottom trawling being second equal.⁴ Furthermore, sedimentation was the third highest ranked threat across all 62 identified marine habitats and was the highest ranked threat for five coastal habitats, including harbour intertidal mud and sand, subtidal mud, seagrass meadows, and kelp forest.

Excess sedimentation can adversely affect intertidal areas, estuaries, wetlands and coastal waters. Sediment accumulation has contributed to the expansion of mangroves in the estuaries of the Hauraki Gulf due to these plants taking advantage of the new habitat created.⁵ Landform modification (such as by earthworks and road development) and vegetation clearance for agriculture, forestry and urban development can increase the amount of sediment that is discharged into waterways

³ Handley, S.; Gibbs, M.; Swales, A.; Olsen, G.; Ovenden, R.; Bradley, A. 2017: A 1,000 year history of seabed change in Pelorus Sound/Te Hoiere Marlborough. Prepared for Marlborough District Council, Ministry of Primary Industries and the Marine Farming Association. National Institute of Water & Atmospheric Research Ltd, Nelson. 136 p.
www.marlborough.govt.nz/repository/libraries/id:1w1mps0ir17q9sgxanf9/hierarchy/Documents/Environment/Coastal/Historical%20Ecosystem%20Change%20List/A_1000_year_history_of_seabed_change_in_Pelorus_Sound_Te_Hoiere.pdf

⁴ MacDiarmid, A.; McKenzie, A.; Sturman, J.; Beaumont, J.; Mikaloff-Fletcher, S.; Dunne, J. 2012: Assessment of anthropogenic threats to New Zealand marine habitats. *New Zealand Aquatic Environment and Biodiversity Report No. 93*. Ministry of Agriculture and Forestry, Wellington. 255 p.
http://fs.fish.govt.nz/Doc/22981/AEBR_93.pdf.ashx

⁵ Swales, A.; Bentley Sr, S.J.; Lovelock, C.E. 2015: Mangrove-forest evolution in a sediment-rich estuarine system: opportunists or agents of geomorphic change? *Earth Surface Processes and Landforms* 40: 1672–1687.
<https://onlinelibrary.wiley.com/doi/abs/10.1002/esp.3759>

or directly into the sea, resulting in higher than natural sediment loadings in the coastal environment. Furthermore, land drainage and development has often resulted in the loss of wetlands and saltmarsh, which are natural sediment traps.

The adverse ecological effects of excess sediment, such as increased water turbidity and sediment accumulation on the seabed and foreshore, often occur in areas of the coastal environment where water quality and ecosystem health are already experiencing multiple stresses from other intensive activities within the same catchment, such as urban and industrial waste and stormwater discharges, and intensive commercial and recreational fishing and shellfish harvesting.

The rate at which sediment enters the coastal environment and is subsequently deposited at a particular location varies with the geology, vegetation cover, nature of the activities inland and/or within the coastal environment, and other factors, such as hydrological regimes and climate variability. Extreme daily rainfall events are predicted to become more frequent under climate change, particularly in western regions of New Zealand and in the south of the South Island, with a more than 20% increase in the 99th percentile of daily rainfall being predicted in these regions by 2090,⁶ which will potentially increase sedimentation rates in coastal waters.

The resuspension of sediment through activities in the coastal marine area, such as benthic trawling, dredging, dredge spoil disposal and seabed mining, may significantly increase sedimentation in coastal marine areas that are some distance from the activity causing the resuspension. Conversely, the removal of excess deposited sediment through dredging can be a form of remediation.

The way in which land is managed and used can significantly reduce soil erosion and thus the effects of excess sediment on marine and freshwater ecosystems in New Zealand.

Policy 22(1) directs that sedimentation levels and impacts in the coastal environment should be assessed and monitored. Knowledge about the linkages between activities and land use changes and the rate at which sediment enters and is deposited in the coastal environment will assist resource managers in sustainably managing the coastal environment. Such understanding will also help in the development and implementation of effective plans and policies in relation to the management and control of sedimentation in the coastal marine area or other coastal waters.

A number of technical studies have highlighted the potential significance of freshwater sediment inputs to estuaries.

- A 2009 study conducted by the National Institute of Water & Atmospheric Research (NIWA) summarised existing research at the time.⁷ One piece of

⁶ Ministry for the Environment 2018: Climate change projections for New Zealand: atmosphere projections based on simulations from the IPCC Fifth Assessment, 2nd Edition. Ministry for the Environment, Wellington. 131 p. <https://www.mfe.govt.nz/publications/climate-change/climate-change-projections-new-zealand>

⁷ Morrison, M.A.; Lowe, M.L.; Parsons, D.M.; Usmar, N.R.; McLeod, I.M. 2009: A review of land-based effects on coastal fisheries and supporting biodiversity in New Zealand. *New Zealand Aquatic Environment and*

research found that the recruitment of juveniles into the West Coast snapper fishery was likely to be affected by high sediment loadings in freshwater systems feeding into estuaries and impacting on the seagrass growing there through smothering and reduced growth as a result of the increased turbidity.

- A study of sedimentation in Te Awarua-o-Porirua Harbour in 2009 found that unless there was immediate human intervention to reduce the current average sedimentation rates, it was highly likely that both the Onepoto Arm and Pāuatahanui Inlet would change from tidal estuaries to brackish swamps. Monitoring and active management is continuing.⁸
- The Bay of Islands Project⁹ was the first coastal survey under the Ocean Survey 20/20 and identified changes in, and likely sources of, sediment inputs.
- The Kaipara Harbour sediment study 2018,¹⁰ which was undertaken on behalf of both the Northland Regional Council and Auckland Council, assessed the economic costs and environmental benefits of various scenarios to reduce catchment sediment loss. The analysis concluded that re-forestation of the catchments would reduce sediment loss by 68–88% at a mainly lost opportunity cost of \$225–331 million per annum. An alternative of stock exclusion by fencing and poplar planting on highly erodible slopes would reduce sediment loss by 41% at a cost of \$13 million per annum. The overall conclusion was that targeted mitigation could be cost effective.

Biodiversity Report No. 37. Ministry of Fisheries, Wellington. 100 p.
https://fs.fish.govt.nz/Doc/22003/AEBR_37.pdf.ashx

⁸ www.gw.govt.nz/porirua-harbour-and-catchment-programme/

⁹ <https://marinedata.niwa.co.nz/bay-of-islands-coastal-survey-project/>

¹⁰ Green, M.O.; Daigneault, A. 2018: Kaipara Harbour sediment mitigation study: summary. Report NRC1701-1 (minor revision). Streamlined Environmental, Hamilton. 64 p.
<http://www.knowledgeauckland.org.nz/assets/publications/Kaipara-Harbour-sediment-mitigation-study-Summary-Streamlined-Enviornment-Ltd-30-Jan-2018.pdf>

Suspended and deposited sediments can have a range of adverse effects on the coastal environment, the coastal marine area or other coastal waters.

- Indigenous biodiversity, natural habitats and ecosystems: Suspended sediments can damage fish gills and the filter-feeding apparatus of invertebrates, and can reduce water clarity, which can reduce the amount of light that can penetrate through the water and thus affect light-dependent species. Deposited sediments can smother benthic communities and habitats. Thus, together, these can reduce estuarine health and productivity, and alter the distribution of plants and animals.
- Aquaculture: The quality and yield of filter-feeding shellfish can be affected by suspended sediments and sediment can kill spat.
- Fisheries: These can be affected directly through increased turbidity and benthic smothering, eg adult cockles and flatfish, or indirectly by impacting on nursery habitats such as seagrass.
- Areas of coastal water of particular interest to tangata whenua: High water quality is an important issue for places of significance to iwi, and both suspended and deposited sediments can alter the distribution and abundance of traditional mahinga kai resources.
- Water quality: Suspended sediment can make the water murky and reduce visibility. It can also transport attached pollutants, heavy metals and other urban contaminants into coastal waters – for example, phosphate can adhere to the surface of soil particles. High concentrations of nitrogen and phosphorus can contribute to excessive plant growth, algal blooms and depletion of the amount of oxygen dissolved in the water,¹¹ while heavy metals and other urban contaminants can have toxic effects on aquatic life. Contaminant discharges are further examined in the Policy 23 guidance note.¹²
- Navigation safety and infrastructure: Sediment accumulation in harbours, marinas and ports can cause navigation problems and require dredging to maintain navigation safety. Sediment deposition can also block infrastructure, such as stormwater drainage systems, which may lead to flooding on land.

The NZCPS 2010 introduced Policy 22 as a new, specific policy on sedimentation. This policy provides explicit direction on assessing and monitoring sedimentation levels and controlling the impact of land use activities and development on sedimentation.

¹¹ Parliamentary Commissioner for the Environment 2012: Water quality in New Zealand: understanding the science. Parliamentary Commissioner for the Environment, Wellington.

<https://www.pce.parliament.nz/publications/water-quality-in-new-zealand-understanding-the-science>

¹² <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>

Related objectives, policies and provisions

This section covers the links between the various provisions of the NZCPS 2010, the Resource Management Act 1991 (RMA)¹³ and other national policy statements in terms of the management of sedimentation.

NZCPS 2010

The implementation of Policy 22 of the NZCPS 2010 requires careful consideration of all of the NZCPS 2010 objectives and policies. The table below outlines the key objectives and policies in relation to sedimentation, as well as other provisions that are relevant.

Key related objectives and policies	Other related objectives	Other related policies
Objective 1 Policies 1, 4, 8, 11, 13, 14, 21 and 23	2, 3 and 6	2, 3, 5, 7, 10 and 16

Objective 1

Objective 1 seeks to safeguard the integrity, form, functioning and resilience of the coastal environment, and sustain its ecosystems by, inter alia, maintaining coastal water quality. Policy 22 relates directly to this objective because reducing the amount of sediment entering the coastal environment will help to maintain or enhance coastal water quality. Furthermore, ensuring that land use activities do not significantly increase sedimentation rates and putting controls in place that reduce sediment loadings in runoff and stormwater systems will help to maintain and enhance natural biological and physical processes in the coastal environment and to protect natural ecosystems such as shellfish beds.

Policy 1: Extent and characteristics of the coastal environment

Policy 1 recognises that the extent and characteristics of the coastal environment vary between regions and localities, as do the important issues and effects. In some places, the coastal environment will include erosion-prone land that contributes sediment directly to the coastal marine area rather than transporting it via a river – the Marlborough Sounds is such an example. Areas that are at risk from coastal hazards are part of the coastal environment and wave action on such areas can result in significant additional sediment. Therefore, a good understanding of the extent and characteristics of the coastal environment will be important for assessing and

¹³ <http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html>

monitoring sedimentation rates and impacts on the coastal environment, as required to give effect to Policy 22(1).

Policy 4: Integration

Policy 4 provides for the integrated management of both the natural and physical resources in the coastal environment, and any activities that affect that environment. It directs that particular consideration be given to situations where land use activities cause or are likely to cause sedimentation. Decisions that are made to implement Policy 22(4) to reduce sediment loadings and the related Policy 21 to enhance water quality that has deteriorated as a result of sediment will need to consider the controls that will be required on land uses in the upstream catchments. This, in turn, will require integrated and coordinated objectives and policies in regional policy statements and regional and district plans, and integrated methods in plans.

Policy 8: Aquaculture

Policy 8 recognises the significant existing and potential contribution of aquaculture to the social, economic and cultural wellbeing of people and communities. Policy 8(c) requires that development in the coastal environment does not reduce the water quality to a level that is unfit for aquaculture activities in areas that have been approved for that purpose. This could include areas that have been identified as being appropriate for marine farming but have yet to be developed for that purpose. Excess sedimentation can clog the gills of both shellfish and finfish, thereby constraining aquaculture in areas that have been zoned or otherwise identified for aquaculture in regional coastal plans.

Policy 11: Indigenous biological diversity (biodiversity)

Policy 11 seeks to protect New Zealand's indigenous biodiversity in the coastal environment. It directs that any activities that would have adverse effects on threatened species and rare or nationally significant ecosystems and habitats should be avoided (not allowed¹⁴). This relates directly to Policy 22, as increased suspended and deposited sediment in the coastal environment can degrade estuarine and inshore habitats and can alter the distribution of indigenous plants and animals and the habitats of migratory species. The effect of sedimentation on threatened species may be indirect, such as the smothering of important food sources (eg worms and cockles) or some other disruption to the food web.

¹⁴ *The Supreme Court in Environmental Defence Society Inc. v The New Zealand King Salmon Company Ltd* [2014] NZCS38 held that 'avoid' means 'not allow' or 'prevent the occurrence of' (paragraph 96).

Policy 13: Preservation of natural character

Policy 13 states that natural character includes matters such as natural elements, processes and patterns; biophysical, ecological, geological and geomorphological aspects; and the natural movement of water and sediment. Excessive sediment arising from land use or development may increase turbidity and alter landforms through deposition and thus may adversely affect the natural character of the coastal environment.

Policy 14: Restoration of natural character

Policy 14 promotes the restoration or rehabilitation of the natural character of the coastal environment including, where practicable, by imposing or reviewing restoration or rehabilitation resource consent conditions (Policy 14 (c)). Where the consent conditions for a continuing activity provide for a review or it is necessary to adopt a best practicable option to continue to operate under a discharge or coastal permit, activities that have resulted in excess sediment entering the coastal environment could be subject to revised consent conditions to restore degraded areas of the coastal environment.

Policy 21: Enhancement of water quality

Policy 21 seeks to improve the water quality in the coastal environment where it has deteriorated and is having a significant adverse effect on ecosystems, natural habitats or water-based recreational activities, or is restricting existing uses, such as aquaculture, shellfish gathering and cultural activities. This policy requires the identification of areas where coastal water quality has deteriorated to the extent that it is having a significant adverse effect, which will include coastal waters that have been affected by excess sediment. Policy 21 is given effect, in part, through Policy 22(4), which requires that sediment loadings in runoff and stormwater systems be reduced through controls on land use activities.

Policy 23: Discharge of contaminants

Policies 22 and 23 are closely related, as suspended sediment can be considered a 'contaminant' under the RMA (refer to the 'Resource Management Act 1991' section below). Although Policy 23 applies to the discharge of all types of contaminants, it particularly refers to the discharge of stormwater (Policy 23(4)), with Policy 23(4)(b) directing that a catchment-based approach should be taken to reduce sediment loadings in stormwater at source by placing controls on land use activities. Policy 22 directs that sediment loadings should be reduced and other land-based activities should be managed in a way that does not cause significant impacts on the coastal environment.

Resource Management Act 1991

Water quality plays an important role in enabling people and communities to provide for their social, economic and cultural wellbeing, and in safeguarding the life-supporting capacity of water and ecosystems. It may also affect the health and safety of people. Section 5 of the RMA requires that any adverse effects on the environment, such as suspended and deposited sediment, is avoided, remedied or mitigated.

Section 6 of the RMA sets out matters of national importance that all persons exercising powers and functions under the RMA are to recognise and provide for. Relevant matters of national importance in relation to Policy 22 include those listed under (a) the preservation of the natural character of the coastal environment and the protection of it from inappropriate subdivision use and development; and (c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.

Section 7 of the RMA lists matters that should be given particular regard when managing the use, development and protection of natural and physical resources. Matters of relevance to Policy 22 include those listed under (a) kaitiakitanga; (aa) the ethic of stewardship; (c) maintenance and enhancement of amenity values; (d) intrinsic values of ecosystems; and (f) maintenance and enhancement of the quality of the environment.

Under section 12(1)(d) of the RMA, no person ‘may deposit in on or under any foreshore or seabed any substance in manner that has or is likely to have an adverse effect on the foreshore or seabed’ unless expressly allowed by a rule on an operative or proposed regional coastal plan or a resource consent. Thus, ‘sedimentation’ – the deposition of sediment as a substance – falls under section 12.

Under section 15(1) of the RMA, no person may discharge any ‘contaminant into water’ (section 15(1)(a)) or ‘contaminant onto or into land in circumstances which may result in that contaminant ... entering water’ (section 15(1)(b)). A ‘contaminant’ is defined in section 2 as:

... any substance (including ... solids ...) that either by itself or in combination with the same, similar, or other substances, energy or heat -

- (a) When discharged into water changes or is likely to change the physical, chemical, or biological condition of water: ...

Solid mineral materials, such as rock and soil, and organic matter that comprises ‘sediment’ fit the RMA definition of ‘contaminant’ and thus sediment that is suspended in the water column falls under section 15.

Therefore, depending on the circumstances, sediment can be either a ‘substance’ (section 12) or a ‘contaminant’ (section 15)¹⁵.

¹⁵The Court of Appeal considered the discharge of a contaminant (section 15) and the deposit of a substance on a riverbed (section 13) in *Brook Valley Community Group Inc v The Brook Waimarama Sanctuary Trust* [2018] NZCA 573 [11 December 2018]. This case related to the aerial discharge of a toxin where the toxin ended up on dry land and riverbed and one of the questions was whether resource consents were required under both sections 13 and 15 for the exact same activity. The Court concluded that the exemption by

For details on other relevant RMA provisions that apply to the discharge of sediment as a contaminant, please see the 'Resource Management Act 1991' sections in the guidance notes for Policies 21 and 23.¹⁶

In relation to the requirement under Policy 22(1) for sedimentation levels and impacts to be assessed and monitored, section 35 of the RMA sets out the duties of each local authority to gather information, monitor and keep records.

- Section 35(2)(a) requires local authorities to monitor the state of the whole or part of the environment in the region or district to an extent that is appropriate for it to carry out its functions under the RMA. Policy 22(1) of the NZCPS 2010 requires the monitoring of sedimentation levels and impacts.
- Section 35(2)(b) requires every local authority to monitor the efficiency and effectiveness of policies, rules or other methods in its policy statement or plan. Sections 62, 67 and 75 of the RMA also require regional policy statements and regional and district plans to give effect to the NZCPS.
- Section 35(2)(d) requires local authorities to monitor the exercising of resource consents. Therefore, consents for activities identified under Policy 22(2), (3) and (4) of the NZCPS 2010 should also be subject to monitoring.

Other national-level instruments

National Policy Statement for Freshwater Management 2014 (amended 2017) (NPS-FM)¹⁷

The NPS-FM applies to all freshwater resources, including those within the coastal environment. The preamble to the NPS-FM cross-references the NZCPS 2010 and emphasises the need for an integrated and consistent approach so that freshwater management decisions consider downstream coastal water quality effects.

Since both suspended sediment and sediment that has settled in the coastal environment often results from the erosion of land inland, entering the coastal

regulation from section 15 for the discharge of a contaminant covered the deposit of a substance. The Court noted that a contaminant is a substance by definition and that the definition of discharge includes deposit. This case reinforces the conclusion that sediment can be the deposit of a substance and so dealt with under Policy 22 as sedimentation but can also be a discharge of a contaminant dealt with under Policy 23. It is the circumstances of the situation which will indicate which applies – and a consent to discharge sediment as a contaminant might be sufficient to cover the deposit of a sediment as a substance in some cases. Note this case was not about the coast.

¹⁶ www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/

¹⁷ Ministry for the Environment 2017: National Policy Statement for Freshwater Management 2014 (amended 2017). Ministry for the Environment, Wellington. 47 p. <https://www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2014-amended-2017>

environment via streams and rivers, there are strong connections between water quality in freshwater bodies and in the coastal environment, including the coastal marine area. Sediment that is transported to the coastal marine area via rivers and streams is sometimes referred to as ‘riverine inputs’.

The NPS-FM recognises Te Mana o te Wai (the integrated and holistic wellbeing of a freshwater body) as a matter of national significance and requires every regional council to recognise the interactions ki uta ki tai (from the mountains to the sea) between freshwater, land-associated ecosystems and the coastal environment.¹⁸

The NPS-FM includes a number of objectives and policies that relate to managing water quality within streams and rivers. Policy A1(a)(iii) of the NPS-FM is particularly relevant to Policy 22 of the NZCPS 2010 as it requires the setting of freshwater objectives and quality limits to provide for the NPS-FM objectives while having regard to, amongst other matters, the connection between freshwater bodies and coastal waters.

Objective C1 of the NPS-FM seeks to improve the integrated management of fresh water and the use and development of land in entire catchments, including interactions with the coastal environment. Policy C2(b) requires regional councils to change their regional policy statements to provide for integrated management of the effects of the use and development of land and fresh water on coastal waters.

Part CA of the NPS-FM presents the National Objectives Framework, which sets out descriptions of mandatory ecosystem, human health and other values that councils and communities should consider for the management of fresh water in their regions. In considering ecosystem health, the description requires management of the adverse effects of contaminants and high sediment levels.¹⁹ Although sediment attributes are not currently included in Appendix 2 of the NPS-FM, technical work is underway to develop these.²⁰ Policy CA2(c)(iii) provides that councils and communities can develop and include sediment attributes to set objectives and inform limits or through methods in planning documents.

The relationship between the NPS-FM and the NZCPS 2010 is discussed in more detail in the Policy 21 guidance note,²¹ while further information on the NPS-FM itself is available on the Ministry for the Environment website.²²

¹⁸ Policy C1(a).

¹⁹ Appendix 1: Compulsory national values.

²⁰ Hicks, D.M.; Greenwood, M.; Clapcott, J.; Davies-Colley, R.; Dymond, J.; Hughes, A.; Shankar, U.; Walter, K. 2016: Sediment attributes stage 1. Prepared for Ministry for the Environment. National Institute of Water & Atmospheric Research Ltd, Christchurch. 199 p.
http://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/Sediment_Attributes_Stage%201_0.pdf

²¹ <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>

²² www.mfe.govt.nz/publications/fresh-water/guide-national-policy-statement-freshwater-management-2014

Resource Management (National Environmental Standards for Plantation Forestry) Regulations 2017 (NES-PF)²³

Effective from 1 May 2018, the NES-PF establishes a nationally consistent set of regulations for managing the environmental effects of plantation forestry, particularly soil erosion and sediment control. Electronic maps included by reference identify four classes of erosion susceptibility for all land across New Zealand.²⁴ The erosion susceptibility category is one of the elements that determines the RMA activity status of forestry-related earthworks, roading, river crossings, quarrying, harvest and mechanical land clearance.

The NES-PF provides that for afforestation, earthworks, forest quarrying, the operation of tree harvesting machinery, mechanical land preparation or replanting to be a permitted activity, it cannot occur within 30 m of the coastal marine area. Where the NES-PF provides for forestry operations as a restricted discretionary activity and there is the potential for that activity to release sediment, the effects on water quality in the coastal marine area is a matter to which discretion is restricted.

A rule in a plan may be more stringent than the NES-PF if it gives effect to Policy 11 (Indigenous biological diversity), Policy 13 (Preservation of natural character), Policy 15 (Natural features and landscape) and/or Policy 22 (Sedimentation) of the NZCPS 2010.²⁵

Draft National Regulation for stock exclusion from waterways 2017

During February to April 2017, as part of the consultation on proposed amendments to the NPS-FM, the Ministry for the Environment included a proposal to exclude dairy cattle and pigs from waterways and lakes by 1 July 2017, with the exclusion of other stock to be progressively included through to 2030. This proposal was to be implemented through a regulation under the RMA. Various practical difficulties were subsequently identified with respect to the effectiveness and methods for implementing and monitoring a national regulation of this type, particularly in terms of the determination at a national level of a suitable riparian buffer that would apply to all local situations. Stock exclusion from waterways remains a priority for national direction and as at November 2018 there is ongoing analysis of the various policy options.

Although the proposed national direction is focussed on reducing faecal contaminants in water, excluding stock from water bodies will also reduce the amount of sediment reaching them as a result of stock pugging and trampling of beds and banks.

²³ www.legislation.govt.nz/regulation/public/2017/0174/14.0/DLM7373517.html

²⁴ https://mpi_nes.cloud.eaglelegis.co.nz/NESPF/

²⁵ Regulation 6(1)(b) of the NES-PF.

Origins of the policy

The provisions relating to water quality in the NZCPS 1994 did not directly address the issue of sedimentation. In New Zealand's 10-yearly report on the state of the environment, Environment New Zealand 2007,²⁶ it was noted that while land cover was changing from pasture to more stabilising vegetation on erosion-prone hill country, soil erosion and subsequent sedimentation remained a national issue.

The Board of Inquiry that recommended the current NZCPS acknowledged that sedimentation appears to cause a number of problems in the coastal environment that are far-reaching, and consequently is seen as a considerable threat to intertidal waters, estuaries and wetlands. The Board concluded that sedimentation is an issue that needs to be directly addressed if the NZCPS is to effectively protect and improve the ecological health of marine areas. In particular, the Board wanted to see a strategic and targeted approach to the management of sediment, and for sedimentation levels to be monitored and action to be taken to minimise sediment from activities such as subdivision, use, development and vegetation removal.

For further information, refer to Volume 2 of the Board of Inquiry report.²⁷

²⁶ Ministry for the Environment 2007: Environment New Zealand 2007. Ministry for the Environment, Wellington. 460 p. <http://www.mfe.govt.nz/publications/environmental-reporting/environment-new-zealand-2007>

²⁷ Board of Inquiry 2009: Proposed New Zealand Coastal Policy Statement (2008). Board of Inquiry Report and Recommendations. Volume 2: Working papers. Pp. 284-286. <https://www.doc.govt.nz/globalassets/documents/getting-involved/consultations/closed-consultations/nzcps/nzcps-2008-board-of-inquiry-vol-2.pdf>

Implementing the policy

When implementing Policy 22, it is necessary to consider the entire NZCPS 2010 as well as the guidance provided here. Therefore, please also refer to the NZCPS 2010 Implementation Guidance Introductory Note,²⁸ which covers the matters that are relevant in giving effect to the NZCPS 2010.

Policy 22 directs the assessment, monitoring and management of sediment to avoid significant increases, and to control and reduce all sediment release from land-based activities. This approach will require information (eg on the source and quantity of sediment, and the effects sediment is having on the coastal environment) to enable the development of provisions in plans and conditions on resource consents where relevant. The policy also mandates particular attention to the impacts of sediment, with the expectation that this will improve the application of plan controls and other methods to address sediment release.

‘Sediment’ is not defined in the RMA but is defined in the NES-PF as:

... solid material that –

(a) is mineral or is mineral and organic; and

(b) is in suspension, is being transported, or has been moved from the site of origin by air, water, gravity, or ice, and has come to rest on the earth’s surface either above or below water.

The NES-PF also defines ‘sediment control measures’ as:

... structures or measures to slow or stop water with sediment in it, so that the sediment will drop out of suspension before the water from the site reaches a water body.

However, this definition only applies to sediment that is transported by water, whereas Policy 22 of the NZCPS 2010 is concerned with sediment irrespective of the transport mechanism. Thus, sediment control structures and measures could comprise ‘hard structures’, such as sediment detention ponds and/or ‘soft’ measures, such as the retention of riparian vegetation.

Policy 22 covers four policy areas.

- Assessing and monitoring sedimentation levels and impacts.
- Managing subdivision, use and development.
- Controlling vegetation removal.
- Reducing sediment loadings in runoff and stormwater systems.

Each of these policy areas is discussed below.

²⁸ www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/introductory-note.pdf

Assessing and monitoring sedimentation levels and impacts

In order to implement Policy 22, councils will need to gather a variety of information on sedimentation (sediment accumulation) rates and how sediment is affecting the coastal environment. This information will include:

- historical data, where available, to evaluate long-term changes and trends (such as situations where smothering of benthic communities, reduced water clarity and reduced fish stocks have been noted)
- the baseline/status of sediment accumulation rates and impacts of both suspended and deposited sediment in the coastal environment
- consideration of the sensitivity of the receiving environment, including an understanding of the hydrosystem type and its functioning (see the guidance note for Policy 21 (Enhancement of water quality) for further information)²⁹
- the identification of activities or circumstances that are giving or could give rise to increased sediment entering the coastal environment, and the main pathways by which this sediment is transported to the coast (eg via rivers/streams and stormwater systems, or directly discharging into the coastal marine area), noting the possible variability in both the potential effects of activities and the way in which different discharge pathways can alter these effects³⁰
- the identification of areas of major forestry and future vegetation clearance where particular land use management practices may be needed – although the NES-PF regulates forestry activities, in accordance with Regulation 6 of the NES-PF, councils may need to consider whether more stringent rules are required in plans to control sediment from forestry activities in sensitive environments
- the identification of areas of erosion-prone land (where stricter controls on vegetation removal, stocking types and riparian buffers may be appropriate); electronic maps included by reference in the NES-PF classify all land in New Zealand into four categories of erosion susceptibility.³¹

It will be difficult to assess the effects of both accumulated and suspended sediments in some areas because there will have been significant changes over time and the benthic species that are currently present will have adapted to sediment deposition

²⁹ <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>

³⁰ Identifying activities and pathways and understanding the effects that could arise can be complicated by a number of variables, including the availability of natural treatment systems and variability in management systems, such as seasonal variations and operator competency.

³¹ https://mpi_nes.cloud.eaglelegis.co.nz/NESPF/

rates or will be naturally more resilient. There may also be little information available on previous species composition and abundance aside from anecdotal accounts.

In some instances, it may be possible to compare the effects of sediment in an estuary where the catchment is largely production forestry or some other land use activity with a nearby estuary of a similar soil type where the catchment is substantially protected and managed for conservation purposes, as was done in a 2018 study of the Kaiteriteri, Otuwhero and Rākauroa / Torrent Bay Estuaries in Tasman District.³²

Establishing a baseline of current sediment levels in the coastal marine area and other waters in the coastal environment (including lagoons, streams and wetlands) requires measuring sedimentation rates, water quality (eg suspended sediments, turbidity, clarity) and the current biological and ecological state of the environment, and identifying commercial and non-commercial uses at risk (eg aquaculture). It could also be useful to include an assessment of historical data/surveys (where available) to help identify and evaluate long-term changes and trends.

Other critical information that is required includes the identification of:

- which activities are contributing to the sediment issue
- each activity's relative contribution to the issue
- the mechanisms of sediment creation and movement (ie direct or diffuse) in the water
- the timing of the input (eg historic, current and ongoing, seasonal, climate-dependent).

Various methods and approaches can be used to monitor sediment accumulation rates, including sediment cores, sediment plates, periodic bathymetric surveys and sediment source tracking. Turbidity monitoring can assess the levels of sediment in suspension.

One site-specific but relatively expensive tool that is available to assist with this process is sediment source tracking using stable isotopes (the Compound Specific Stable Isotope (CSSI) method). This method uses naturally occurring biomarkers to identify and apportion the sources of soil contributing to sediment within an estuary according to land use on a catchment scale. The method has been used in over 20 estuaries in New Zealand and tested in the Environment Court.

Useful efficiencies can be gained by working with land users, such as the forestry and agricultural sectors, as well as other parties (eg universities, research institutes and community groups) to define the information that needs to be collected and the

³² Davidson, R.J. 2018: Qualitative description of estuarine impacts in relation to sedimentation at three estuaries along the Abel Tasman coast. *Research, survey and monitoring report no. 882*. Prepared by Davidson Environmental Ltd for Sustainable Marahau Incorporated. 37 p. <https://tasmanbayguardians.org.nz/wp-content/uploads/2018/11/Estuary-impacts-Davidson-2018-2.pdf>

monitoring that is required. Where monitoring and research investigations have been undertaken over an extended period of time, integrating these datasets with future monitoring programmes can save time and ensure that comprehensive and coordinated baseline information is available.

An example of such collaboration is provided by the 2017 NIWA report ‘A 1,000 year history of seabed change in Pelorus/Te Hoiere, Marlborough’, which was co-funded by the Marlborough District Council, the Marine Farming Association Inc. and the Ministry for Primary Industries.³³

Once baselines have been established, the effectiveness of new control measures can be tested and understood. Monitoring sedimentation levels and associated impacts on the coastal environment (including any impacts on water quality, and biological and ecological health) will help identify areas that are subject to increased sedimentation rates, and determine the actual and potential adverse effects of sedimentation on the environment and its users.

Having established baselines, the ongoing monitoring of sedimentation rates and impacts on the coastal environment should become an integral part of a regional council’s state of the environment monitoring and reporting programmes.

For large-scale projects, predictive modelling may be useful for understanding the potential effects as part of the decision-making process. Examples of this type of work are included in the Resources section of this guidance note, under the heading ‘Sediment modelling’. However, sediment modelling can be prone to error and uncertainty, and so should be used with caution and only in combination with other avoidance and mitigation measures. Policy 3 (Precautionary approach) is particularly relevant in respect of modelling approaches. In a 2014 decision in relation to modelling in the water column, the Supreme Court quoted the opinions of experts to a Board of Inquiry that models ‘can never perfectly simulate what effects will transpire under real world conditions’ and ‘all models are wrong, but some models are useful’.³⁴

Assessing and monitoring sedimentation levels and impacts on the coastal environment will also help local authorities to determine which areas would be unsuitable for certain types of use or activities on land and in the coastal marine area, thus informing the implementation of Policy 22 as well as other NZCPS 2010 policies, such as Policy 7 (Strategic planning) and Policy 8 (Aquaculture). By adopting a

³³ Handley, S.; Gibbs, M.; Swales, A.; Olsen, G.; Ovenden, R.; Bradley, A. 2017: A 1,000 year history of seabed change in Pelorus Sound/Te Hoiere Marlborough. Prepared for Marlborough District Council, Ministry of Primary Industries and the Marine Farming Association. National Institute of Water & Atmospheric Research Ltd, Nelson. 136 p.

www.marlborough.govt.nz/repository/libraries/id:1w1mps0ir17q9sqxanf9/hierarchy/Documents/Environment/Coastal/Historical%20Ecosystem%20Change%20List/A_1000_year_history_of_seabed_change_in_Pelorus_Sound_Te_Hoiere.pdf

³⁴ *Sustain Our Sounds Incorporated v The New Zealand King Salmon Company Limited* [2014] NZSC 40 (paragraph 132). This case deals with the appropriateness of an adaptive management approach for dealing with the effects of discharges from proposed salmon farms on the water column. The Court accepted a staged adaptive management approach involving predictive modelling to determine feed levels, with an intensive monitoring programme to calibrate and validate the model and ensure compliance with conditions.

whole-of-catchment approach, local authorities can manage catchment activities to ensure that they do not cause adverse cumulative effects on the coastal environment (see Policy 7(2): Strategic planning). The links with other NZCPS 2010 policies, particularly Policies 4 (Integration) and 7, are described further in the next section on managing subdivision, use and development.

Managing subdivision, use and development

Using the planning hierarchy to manage sedimentation rates

Policy 22 directs that the impacts of vegetation removal on sedimentation be controlled and that sediment loadings in runoff and stormwater be reduced through controls on land use activities. It also requires that subdivision, use and development activities do not result in a significant increase in sedimentation. In these situations, land disturbance practices may generate accelerated soil loss and sediment movement into rivers, streams and drains, which will be transported into the coastal environment and remain in suspension or deposited over the foreshore and seabed.

Regional policy statements, regional plans and district plans are required to give effect to the NZCPS 2010.³⁵ The effective management of sediment through planning instruments requires an integrated and strategic catchment approach, preferably using the planning hierarchy of the RMA. This is particularly necessary where turbidity and sediment accumulation issues in the coastal marine area have resulted from land uses inland of the coastal environment.

Policy 4 of the NZCPS 2010 (Integration) requires councils to provide for the integrated management of natural and physical resources in the coastal environment, and activities that affect the coastal environment. It requires particular consideration of the effects of both suspended and deposited sediment on marine ecosystems and water quality from land use activities (Policy 4(c)(iv)). Policy 7(2) requires that the resources and values that are under threat or at significant risk from adverse cumulative effects be identified and, where practicable, that thresholds are set or acceptable limits to change are specified. Giving effect to these two policies in relation to reducing the amount of sediment entering the coastal environment is likely to require consideration of activities inland of the coastal environment.

Section 62(3) of the RMA requires that a regional policy statement gives effect to the NZCPS 2010, while section 67(3)(b) requires that a regional plan (and not just the regional coastal plan) also gives effect to the NZCPS 2010.

Integrated planning documents comprising regional policy statements, regional coastal plans, regional land and water plans, and (for unitary authorities) district plans can be an effective way of achieving and demonstrating the necessary integration. Examples include the Horizons Regional Council 'One Plan' (operative

³⁵ Sections 62(3), 67(3) and 75(3) of the RMA.

December 2014)³⁶ and the Proposed Marlborough Environment Plan (notified June 2016).³⁷

The regional policy statement must state the significant resource management issues for the region.³⁸ Where the adverse effect of sediment is a significant issue in the coastal environment, the sediment sources and resulting issues for water bodies and the coastal marine area should be identified in the regional policy statement. This then leads logically into the inclusion of appropriate objectives and policies in regional policy statements, regional coastal plans, and regional and district plans. Without this top-down approach, regional and district plans may not adequately guide the management of sediment through lower-order policies, methods and rules. This is particularly important where the contributors to sediment problems are diffuse and controls on land use may be necessary.

Regional and territorial authorities have different functions under sections 30 and 31 of the RMA, whereas unitary authorities are required to meet the requirements of both sections. Councils with regional council responsibilities under section 30 have the functions of controlling the use of land for the purposes of soil conservation, and maintaining and enhancing water quality (including coastal water), as well as controlling the discharge of contaminants, such as sediment, into the water. Under section 31, territorial authorities have the function of controlling any actual or potential effects of the development, use and protection of land.

Regional plans, regional coastal plans and district plans

Regional plans, including regional coastal plans, may contain policies for controlling sediment arising from land use activities that are designed to guide the implementation of objectives at the regional level to address the identified issues. Regional plans may also contain freshwater objectives to implement the NPS-FM through quantitative or qualitative sediment attributes and/or limits, having regard to the connection between freshwater bodies and coastal waters when setting any such limits.³⁹ District plans can also have controls on earthworks and vegetation clearance that contribute to minimising sedimentation from widespread, small-scale activities.⁴⁰

³⁶ www.horizons.govt.nz/Publications-Feedback/One-Plan

³⁷ www.marlborough.govt.nz/your-council/resource-management-policy-and-plans/proposed-marlborough-environment-plan

³⁸ Resource Management Act 1991, section 61(1)(a).

³⁹ NPS-FM Policy CA2(b)(ii) states that ‘... every regional council, through discussions with communities, including tangata whenua, ... in developing freshwater objectives for all freshwater management units: ... may include any other ... values that the regional council considers appropriate (... having regard to local and regional circumstances) ...’; and Policy A1(a)(iii) requires that when setting freshwater objectives for all freshwater management units, regard must at least be given to the connections between freshwater bodies and coastal waters.

⁴⁰ Section 31 of the RMA.

Policies and rules that aim to manage an activity's sediment contribution to fresh and coastal waters need to be clear, refer to measurable limits or standards wherever possible, and address point source versus diffuse inputs of sediment appropriately.

Policy 7(2) (Strategic planning) directs local authorities, where practicable, to set thresholds in their plans, including zones, standards or targets, or to specify acceptable limits to change to assist in determining when activities that cause adverse cumulative effects are to be avoided. However, while it is possible to set limits for sediment accumulation, this can be a complex and difficult process that needs to be carefully thought through. Where receiving environments have been identified as being particularly sensitive, limits for sediment accumulation should be considered. Having set such limits, they should then be used as a mechanism to drive whole-catchment management initiatives to reduce effects.

The presence of a marine reserve, identification of appropriate places for aquaculture activities or identification of part of the coastal marine area as an area of outstanding natural character may all require more stringent measures to limit sediment inputs and the effects of sedimentation (refer to Policy 5 (Land or water managed or held under other Acts), Policy 8 (Aquaculture) and Policy 13 (Preservation of natural character)).

Methods

Methods in plans can be regulatory (rules) or non-regulatory (eg education, incentives, support for community initiatives). Non-regulatory methods are discussed in the 'Education/voluntary and non-regulatory measures' section below.

Policy 22(2) requires that the use and development of land will not result in a significant increase in sedimentation in the coastal marine area or other coastal waters. These activities do not have to occur within the coastal environment to be subject to Policy 22.

The interpretation of 'significant' depends on the context of the situation, including the sensitivity of the receiving waters and the types of activities occurring in coastal waters. For instance, in respect of marine reserves and other marine protected areas, Policy 5 (Land and water administered under other Acts) requires that significant adverse effects (such as turbidity and sediment deposition) be avoided (ie not allowed). Similarly, where part of the coastal marine area has been identified as an area of outstanding or high natural character, consideration needs to be given to whether the ecological or other values that have led to that assessment require more stringent sediment controls.

Policy 22 is closely linked to Policy 4 (Integration), which directs that the integrated management of activities that affect the coastal environment be provided for, with particular consideration of situations where land use activities affect, or are likely to affect, water quality in the coastal environment and marine ecosystems through increasing sedimentation. Policy 4 requires the coordinated management of activities and working collaboratively. Accordingly, regional councils and territorial authorities should share information on the management of land use activities that have the

potential to result in significant sediment loadings entering waterways. Adopting a collaborative, problem-solving approach is important. The integrated implementation of Policy 22 and the NPS-FM is also necessary. It is important that regional and district responsibilities are integrated and aligned, and ideally do not result in duplication of the necessary consents.

Policy 22 is also closely linked to Policy 7 (Strategic planning), which directs local authorities to consider where, how and when to provide for future residential, rural residential, settlement, urban development and other activities in the coastal environment at a regional and district level when preparing regional policy statements and plans.

Regulatory methods – plan rules

Rules should be targeted, specific and proportional to the activities that contribute to sedimentation. Different land uses will have different proportional contributions over different geographical and temporal scales. For instance, in the Marlborough Sounds, forestry activity is the main source of sediment.⁴¹

Rules can be used to address both direct and diffuse sediment impacts from land uses or activities. They may refer to management or farm plans, codes of practice, good management practices (eg the primary sector industry-agreed Good Management Practices relating to water quality for the Canterbury region,⁴² which are applicable nationwide) or other best practicable options to reduce the effects that are covered by them. Rule frameworks should recognise the sensitivity of particular receiving environments and their vulnerability to the effects of certain activities. Permitted activity status may be appropriate in relation to some activities, such as small-scale vegetation removal, where they are certain, unambiguous and only apply to activities that will not have adverse effects. To be effective, permitted activity rules work best if they are supported by monitoring and education on good practice.

Provisions could also be included in regional or district plans to control or manage land use activities or their effects to help reduce sediment loadings in runoff and stormwater systems. Development standards in plan rules can set minimum requirements for the management of sediment loss from development sites. Restricting the area of land within a catchment area that can be disturbed or have vegetation cleared within a given period of time may assist in reducing runoff, while controlling the amount of new urban development within a catchment can reduce the generation of stormwater and subsequent sedimentation in the coastal environment.

⁴¹Handley, S.; Gibbs, M.; Swales, A.; Olsen, G.; Ovenden, R.; Bradley, A. 2017: A 1,000 year history of seabed change in Pelorus Sound/Te Hoiere Marlborough. Prepared for Marlborough District Council, Ministry of Primary Industries and the Marine Farming Association. National Institute of Water & Atmospheric Research Ltd, Nelson. 136 p.
www.marlborough.govt.nz/repository/libraries/id:1w1mps0ir17q9sgxanf9/hierarchy/Documents/Environment/Coastal/Scientific%20Investigations%20List/A_1000_year_history_of_seabed_change_in_Pelorus_Sound_Te_Hoiere.pdf

⁴²http://files.ecan.govt.nz/public/pc5/MGM_Technical_Reports/Industry_Agreed_Good_Management_Practices_MGM_2015.pdf

Activity in the beds of rivers for flood protection or other works can generate and resuspend sediment. Under section 13 of the RMA, activity in the beds of rivers and lakes can only be undertaken if allowed by a rule in a regional plan or on the granting of a resource consent. Depending on the scale and nature of the works, the effects of sedimentation on the water body and in the coastal environment should be considered when drafting rules for instream works and assessing consent applications.

District plans are required to give effect to the NZCPS 2010 under section 75(3) of the RMA. Primarily, territorial authority functions in relation to sedimentation issues in the coastal environment will occur in the development and implementation of objectives, policies and rules in district plans to identify appropriate and inappropriate areas for particular land use activities and forms of subdivision, use and development when giving effect to Policy 4 (Integration) and Policy 7 (Strategic planning) of the NZCPS 2010.

Scope of plan rules and standards

Plan rules typically categorise land use activities that are likely to generate sediment into vegetation clearance (usually differentiating between indigenous and non-indigenous), soil disturbance/cultivation and earthworks/excavation. Plantation forestry planting and harvest are often also included as a further category. The nature and scale of the activity, slope of the land, and soil type and the extent to which it is prone to erosion are the most commonly used criteria for determining the activity status – permitted, controlled, restricted discretionary, discretionary or prohibited.

For permitted activities, typical plan standards that are common to all vegetation clearance, soil disturbance/cultivation, excavation/earthworks and forestry land use activities may include:

- setbacks from rivers, wetlands and sources of potable and stock water
- maximum slope angle for mechanical operations
- area of land to be cleared in any specified period or at any one time (cultivation, harvest)
- depth of disturbance (cultivation) or volume of excavation (earthworks)
- extent of conspicuous change in the colour, visual clarity or reflectance of adjacent waters after reasonable mixing
- restoration of vegetative cover by a specified time
- timing of works to minimise the adverse effects of sediment in suspension and accumulating on the bed, eg avoiding work during the whitebait or fish spawning season.

For controlled and restricted discretionary activities, matters over which control may be reserved or discretion restricted may include the:

- timing, location and duration of the activity
- area and volume of works

- methods of stabilising soil disturbance
- methods of minimising erosion
- methods of retaining sediment
- methods of managing stormwater runoff
- preparation of a management plan that includes the proposed erosion and sediment control measures – the relevant plan standards should specify the details to be included in such management plans; schedules in the NES-PF set out the information to be included in a forestry earthworks management plan and in a quarry erosion and sediment control management plan,⁴³ which may be applicable to earthworks and quarrying for activities other than forestry
- monitoring requirements and, where appropriate, adaptive management.⁴⁴

Controlling vegetation removal

The removal of vegetation exposes soil and can result in soil erosion and sediment runoff. In New Zealand, deforestation⁴⁵ and catchment development has resulted in land erosion and the accelerated infilling of estuaries with sediments.⁴⁶

Policy 22(3) directs that the impacts of vegetation removal on sedimentation, including the impacts of harvesting plantation forestry, are controlled. Poor land management practices in agricultural and forest areas can result in significant amounts of sediment entering water in the coastal environment.

Managing the various activities associated with plantation forestry that are likely to produce sediment (earthworks, quarrying, harvesting and mechanical land preparation) to mitigate sediment runoff is addressed in the NES-PF. These controls apply nationally unless a more stringent rule is required in a plan to address a matter listed under Regulation 6, including to give effect to Policy 11 (Indigenous biological

⁴³ Regulation 27 of the NES-PF states that a forestry earthworks management plan is required for all forestry earthworks that involve more than 500 m³ of soil disturbance in any 3-month period. Schedule 3 of the NES-PF sets out the matters that must be addressed in the plan, including water runoff measures and sediment control measures. Schedule 4 of the NES-PF sets out the specifications for a forestry quarry erosion and sediment management plan.

⁴⁴An adaptive management approach is appropriate provided that ‘there will be good baseline information about the receiving environment; the conditions provide for effective monitoring of adverse effects using appropriate indicators; thresholds are set to trigger remedial action before the effects become overly damaging; and effects that might arise can be remedied before they become irreversible’ (*Sustain Our Sounds Incorporated v The New Zealand King Salmon Company Limited* [2014] NZSC 40: paragraph 133).

⁴⁵ Here, ‘deforestation’ means the conversion of land by removal of vegetation rather than the usual cycle of forestry harvesting and replanting.

⁴⁶ Parliamentary Commissioner for the Environment 2015: Chapter 7 Estuaries. Pp. 17–18 in: Managing water quality. Examining the 2014 National Policy Statement. Parliamentary Commissioner for the Environment, Wellington. <https://www.pce.parliament.nz/publications/managing-water-quality-examining-the-2014-national-policy-statement>

diversity), Policy 13 (Preservation of natural character), Policy 15 (Natural features and natural landscapes) and Policy 22 (Sedimentation) of the NZCPS 2010.

Appropriate controls can usefully be imposed to avoid and mitigate sediment leaving areas that have been exposed by vegetation removal. However, each land use activity will have different characteristics and effects, so controls may need to be fine-tuned for particular land uses and land management practices. Examples of controls that could be used include:

- limiting the area of vegetation that may be cleared (eg x m² per year, particularly on erosion-prone land)
- limiting the time of year that such works can be carried out to avoid soil disturbance during the wetter months
- enhancing and maintaining existing riparian vegetation zones (these can minimise bank erosion, filter runoff and trap sediment)
- planting new riparian margins (plant root systems stabilise banks and take up nutrients from runoff)
- minimising soil disturbance and sediment generation from the activity (eg associated with harvesting plantation forestry)
- installing sediment fencing or barriers to capture sediment from the runoff
- installing sediment detention ponds or other treatment devices
- replanting exposed, steep slopes (to stabilise the soil).

Reducing sediment loadings in runoff and stormwater systems

Policy 22(4) promotes reducing sediment loadings in runoff and stormwater systems by placing controls on land use activities.

Land is often particularly vulnerable to erosion during and immediately after subdivision development and building construction, and significant amounts of sediment can enter waterways either directly or indirectly via stormwater systems.

Development often results in more impermeable surfaces. Stormwater (which would have previously soaked into the ground and been filtered before reaching the coast) is channelled into drainage systems, entraining and carrying sediments and other contaminants into coastal waters.

Appropriate controls may need to be imposed on relevant land use activities in order to manage and reduce sediment loadings in runoff and stormwater systems both during and after development and construction works. Reducing sediment loadings in runoff and stormwater systems requires planning, education, inspection and maintenance. The precautionary approach of Policy 3 is also applicable, with climate projections suggesting more frequent and extreme rainfall events in the future.

Some examples of practical steps to reduce sediment loadings in runoff and stormwater systems include:

- using vegetation to contain runoff and sediment generated from construction sites (eg planting a vegetated margin between waterways and earthworks or rural agricultural activity) – this also provides the opportunity for environmental enhancement measures, such as those outlined in the Policy 14 guidance note⁴⁷
- using sediment retention methods, such as sediment runoff collection, filter fabrics (which retain sediment particles above a certain size and allow water to pass through), hay bales, silt fences (filter fabric stretched across support poles), sediment ponds (used to retain or detain runoff to allow excessive sediment to settle out during construction) and artificial wetlands
- limiting the footprint of the disturbed area
- staging works to reduce the potential for erosion and sedimentation at any one time
- containing entranceways (eg using metal aggregate) to prevent sediment from being carried off-site by vehicle tyres – for some activities, such as drill pad construction, a geotextile fabric layer can be used to separate the metal aggregate from the original ground surface, allowing the entire working area to be covered in metal aggregate and restored effectively without any vehicular soil disturbance.

The Policy 23 guidance note includes further information on management approaches for stormwater discharges.

The cumulative effect of sediment discharges from multiple sites can have a significant impact on the coastal environment, so a precautionary approach should be adopted when the effects on the coastal environment are uncertain, unknown or little understood but potentially significantly adverse (Policy 3(1) in the NZCPS 2010).

Appropriate management is required to prevent significant adverse effects on coastal waters, particularly shallow, sheltered estuaries and harbours, marine protected areas, or areas that have been identified as having outstanding or high natural character or significant ecological values. In these situations, an integrated, catchment-based approach can be very useful, with regional councils and territorial authorities working with landowners to manage land use and reduce runoff into coastal waters.

Resource consent decision-making

Policy 22(2) requires that subdivision, use or development will not result in a significant increase in sedimentation in the coastal marine area or other coastal waters.

To give effect to Policy 22(2) and where a resource consent is required under section 15 of the RMA (Discharge), consent conditions can require the consent holder to

⁴⁷ <https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/coastal-management/guidance/policy-14.pdf>

employ methods to prevent any sediment generated by land use activities from entering the coastal environment, and may require the inspection and maintenance of sediment controls.

For any consents involving direct discharges to the coastal marine area, or disturbance to the seabed or foreshore,⁴⁸ consent conditions can require monitoring to be carried out to assess the impacts of any sedimentation, including effects on biological and ecological health. This information can then contribute to the overall monitoring of sedimentation levels and impacts, as required by Policy 22(1).

Sediment management in relation to large-scale activities will generally require appropriate modelling of sediment yields over a range of conditions, including climatic events, to gauge the significance of any potential increase in sediment into the coastal environment. For example, for the Transmission Gully Road of National Significance Project, modelling was necessary to determine the likely load of sediment that would enter the Pāuatahanui Inlet so that appropriate conditions could be imposed.

For controlled and restricted discretionary activities, the matters over which the relevant regional plan has reserved control or restricted discretion will determine the scope and nature of any conditions of consent.

For discretionary and non-complying activities, conditions could also specify the following requirements in addition to the matters listed under the sections entitled 'Scope of plan rules and standards', 'Vegetation removal' and 'sediment loadings in runoff and stormwater' above, depending on the scale of the works and sensitivity of the location to sedimentation.

- Water quality turbidity and clarity standards and sediment deposition limits that are not be exceeded at specified monitoring sites in receiving waters, including coastal waters.
- The preparation by a suitably qualified and experienced person(s) of an erosion and sediment control management plan to be certified by the regional council, which demonstrates how the consent holder intends to ensure that the water quality limits specified in the conditions are not exceeded. The management plan may include an adaptive management approach with trigger and response mechanisms should sedimentation thresholds set below the compliance limits be exceeded.⁴⁹
- Monitoring requirements, including sites in the catchment and coastal receiving environment, monitoring methods, baselines, and reporting.
- The staging and sequencing of earthworks.
- Erosion and sediment control devices and their maintenance during construction activities and subsequent decommissioning.

⁴⁸ Section 12 of the RMA.

⁴⁹ The assessment factors that should be considered and circumstances under which an adaptive management approach is appropriate are set out in the Supreme Court decision *Sustain Our Sounds v New Zealand King Salmon Company Limited* [2014] NZSC 40.

- Identification of project staff roles and responsibilities, and the qualifications, experience and training requirements for staff.
- Processes for dealing with incidents that result in the uncontrolled release of sediments.

Activities within the coastal marine area that are likely to release sediment

Some activities within the coastal marine area can generate sediment plumes from the resuspension of sediment in the water column, such as dredging for port activities, the dumping of dredge spoil, benthic trawling and offshore mining. The dumping of dredged material and the subsequent movement of that material by coastal processes may also cause increased sediment turbidity in the water column and the possible redeposition of sediment in the coastal marine area some distance from the dumping grounds. These potential effects were considered by the Environment Court in approving a set of conditions that were agreed between the applicant, Port Otago Ltd and appellants, including iwi and commercial fishers, for the dredging and disposal of up to 7.2 million m³ of seabed material from the Otago Harbour.⁵⁰

The adaptive management conditions set by the Court included environmental and response limits for turbidity at defined locations and the management actions that would be required should these response limits be exceeded. The conditions also required comprehensive monitoring and reporting of the sediment plume and the characteristics of the dredged material, aquatic communities, bathymetry, and changes in tidal height and current. The conditions required that communication with local hapū and iwi was facilitated through a Manawhenua Consultative Group, the formation of a Project Consultative Group with representation from port users, and community and conservation organisations, and that technical oversight of all monitoring and reporting was provided by a Technical Group of representatives from rūnanga, statutory organisations, the applicant, the regional council and the local fishing industry.

Education and voluntary / non-regulatory measures

The effective implementation of Policy 22 will also require a strong focus on the education of the community, land owners and contractors – for example, informing contractors about the impact that earthworks associated with land development, roading, farms and forestry can have on water, habitats, wildlife and fisheries in the coastal environment. Most regional councils have produced guidelines for earthworks, or rely on other examples by reference (refer to the ‘Resources’ section of this guidance note). Other non-regulatory tools, such as accords and memoranda of understanding between councils and resource users, can also encourage

⁵⁰ *East Otago Taiapure Management Committee & ors v Otago Regional Council* [3013] NZEnvC 126.

improvements in the management of activities that have the potential to increase the amount of sediment reaching the coastal environment.

The Community Environment Fund⁵¹ and the Sustainable Farming Fund⁵² support landcare groups and farming-related projects, including the management of soil erosion. National-level monitoring information on freshwater quality helps to target soil conservation and sustainable land management to catchments where the water quality has been degraded. Regional councils work with farmers and community groups on initiatives to target erosion-prone land in their regions to reduce sediment runoff.⁵³

Sector groups such as Dairy NZ have produced internet tools to assist landowners in planning, planting and fencing riparian margins.⁵⁴

Non-regulatory methods are essentially 'voluntary' and are usually associated with permitted activities. These can be encouraged, incentivised and/or funded through plan methods, and are most successful if they are linked to funding through local government long-term planning (LTP) processes under the Local Government Act 2002. An example of a non-regulatory sediment control method is the Manawatu-Whanganui region's Sustainable Land Use Initiative (SLUI).

Strategies can be partnerships with industry, iwi, DOC or other groups in the management of water and land. Often these strategies employ riparian fencing and planting to reduce sediment inputs and stabilise bank erosion. Hillside erosion planting, retirement and restoration are also encouraged through farm management plans.

Land uses that do not require vegetation clearance, such as retaining or planting mānuka for honey production, can be promoted through education and by raising the awareness of landowners about the economic benefits of 'non-traditional' land uses.

Regional councils and the New Zealand Transport Agency (NZTA) use codes of practice to manage activities for flood management and erosion control, and may produce non-regulatory guidance for sediment-generating activities (refer to the 'Resources' section of this guidance note for examples).

Preserving and restoring wetlands and providing new wetlands is a good way to improve water quality. Wetlands work in a similar way to riparian strips – they trap sediment and their plants take up nutrients. They can also be useful measures of the effects of subdivision, use and development, vegetation removal, and runoff and stormwater discharges. However, if wetlands receive large amounts of sediment, they may themselves be altered and degraded. Therefore, care needs to be taken that wetlands (particularly natural wetlands) are managed appropriately.

⁵¹ <http://www.mfe.govt.nz/more/funding/community-environment-fund>

⁵² <https://www.mpi.govt.nz/funding-and-programmes/sustainable-food-and-fibre-futures/>

⁵³ See the 'Resources' section of this guidance note for examples.

⁵⁴ <https://www.dairynz.co.nz/environment/waterways/>

Planting riparian margins to trap sediment and nutrients, and stabilise banks can be encouraged by providing community initiatives such as landcare groups with incentives, education or support.

Fencing off streams and coastal margins to prevent stock from damaging stream banks or causing pugging within the waterway can also control sedimentation and can be achieved through a combination of non-regulatory and regulatory methods.

Remediation measures may also include dredging specifically to remove accumulated terrestrial sediment. For example, the long-term specific sediment yield from the 220-km² upper Whangarei Harbour catchment has been estimated as 138 ± 28 t/km²/yr (totalling 30,400 ± 6,040 t/yr) over the 50-year period from 1962 to 2012 based on sedimentation data.⁵⁵ There is currently a consent permitting the removal of 20,000 m³ per year from the Hātea River to maintain safe navigation, which is also likely to have reduced the impact of sediment elsewhere in the harbour.

Integrated catchment management plans

[Please also refer to the section entitled ‘Implementation – integrated management’ in the Policy 21 guidance note.⁵⁶]

Both the NZCPS 2010 and the NPS-FM encourage local authorities to take an integrated catchment management approach when developing values, objectives and limits for a region or in a specific catchment (usually in response to specific issues). Such an approach may involve classifying the waterways, identifying their values and setting catchment-specific limits.

Implementing an integrated management approach is especially valuable for achieving best outcomes and efficient processes.

Whaingaroa Harbour Care’s initiative to restore a harbour and a fishery⁵⁷ is one example of what can be achieved when councils and community groups work together. Since 1985, the Whaingaroa Harbour Care group, assisted by Waikato Regional Council, has worked in collaboration with the relevant landowners to improve stormwater runoff and to fence and extensively plant intertidal margins, resulting in reduced sediment loading and a healthier coastal environment. Other examples of similar best practice can be found in the ‘Our Estuaries’ hub,⁵⁸ which is an interactive database to which groups and individuals are encouraged to send in

⁵⁵ Swales, A.; Gibbs, M.; Pritchard, M.; Budd, R.; Olsen, G.; Ovenden, R.; Costley, K.; Hermanspahn, N.; Griffiths, R. 2013: Whangarei Harbour sedimentation. Sediment accumulation rates and present-day sediment sources. NIWA Client Report HAM2013-143 prepared for Northland Regional Council. 104 p.

⁵⁶ <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>

⁵⁷ www.harbourcare.co.nz/

⁵⁸ <https://www.doc.govt.nz/estuaries>

details of their estuary enhancement and restoration projects to share their knowledge and experiences.

In the same way that regulatory rules can specify management plans, codes of practice or good management practices, these can also be included as non-regulatory methods in a plan.

Despite the initiatives described above, sediment in waterways is still a large-scale issue. Codes of practice and technical guidelines do not cover all land uses and activities that have the potential to accelerate erosion and sediment movement to waterways, and are not always effective in controlling sediment transport during storm events when most sediment is moved.

Related and ongoing work

Primary industry-led initiatives

Land and environment planning toolkit

<http://beeflambnz.com/lep/>

Developed by Beef and Lamb New Zealand, the Land and Environment Planning Toolkit includes workbooks and guidelines for farm planning over three levels of increasing complexity. It includes modules on topics such as ways to keep stock out of water, erosion and sediment management, and nutrient management.

Industry-agreed good management practices relating to water quality

http://files.ecan.govt.nz/public/pc5/MGM_Technical_Reports/Industry_Agreed_Good_Management_Practices_MGM_2015.pdf

These good management practices were developed through a collaborative initiative between Environment Canterbury, Crown Research Institutes and primary sector organisations, and can be applied at a national level.

Regional Council-led initiatives

Horizons sustainable land use initiative

www.horizons.govt.nz/managing-natural-resources/land

This programme addresses accelerated erosion in highly erodible hill country.

Taranaki sustainable land management programme

www.trc.govt.nz/assets/Documents/Guidelines/Land-infosheets/LM60-Stress.pdf

This programme uses a variety of non-regulatory initiatives to improve land management throughout the region, demonstrating success in addressing hill country erosion.

Resources

Examples of plan provisions

Auckland Unitary Plan

http://unitaryplan.aucklandcouncil.govt.nz/pages/plan/Book.aspx?exhibit=AucklandUnitaryPlan_Print

Sections E11 and E12 of the Auckland Unitary Plan provide objectives, policies and rules for land disturbance at regional and district levels, while section E15 addresses vegetation management.

Regional Policy Statement for Northland

<https://www.nrc.govt.nz/Your-Council/Council-Projects/New-Regional-Policy-Statement/>

Objective 3.1 of the Regional Policy Statement for Northland adopts an integrated catchment management approach, while objective 3.2 includes reducing sedimentation rates in the region's estuaries and harbours as a particular focus. This regional policy statement became operative, in part, in May 2016.

Horizons One Plan

www.horizons.govt.nz/Publications-Feedback/One-Plan

This consolidated regional policy statement, regional plan and regional coastal plan for the Manawatu and Whanganui region, which became operative in December 2014, identifies accelerated erosion from human activity as one of the 'big four' regional issues. Objective 4.1 of the regional policy statement and section 13.1 of the regional plan set out an integrated set of objectives, policies and methods to address the issue, including working closely with individual land owners.

Sediment modelling

Auckland

- Haddadchi, A.; Hicks, M. 2016: Models for estimating sediment yields in the Waikato-Auckland-Northland region: a comparison. *Auckland Council Technical Report 2016/036*. Prepared for Auckland Council by the National Institute of Water & Atmospheric Research Ltd. 46 p.
www.mfe.govt.nz/publications/fresh-water/models-estimating-sediment-yields-waikato-auckland-northland-region

The authors of this study developed an improved version of the existing empirical sediment yield model that is used by the Waikato District Council, Auckland Council and Northland Regional Council and compares its performance against four different sediment yield models.

Pritchard, M.; Reeve, G.; Swales, S. 2009: Modelling storm-load sediment deposition thresholds for potential ecological effects in Okura Estuary / Karepiro Bay: model development and calibration. *Auckland Regional Council Technical Report TR2010/024*. 39 p.

<http://www.knowledgeauckland.org.nz/assets/publications/TR2010-024-Modelling-storm-load-sediment-Okura-Estuary-Karepiro-Bay-model-and-calibration.pdf>

Okura Holdings v Auckland Council [2018] NZEnvC 87.

[www.nzlii.org/cgi-](http://www.nzlii.org/cgi-bin/disp.pl/nz/cases/NZEnvC/2018/87.html?stem=0&synonyms=0&query=okura)

[bin/disp.pl/nz/cases/NZEnvC/2018/87.html?stem=0&synonyms=0&query=okura](http://www.nzlii.org/cgi-bin/disp.pl/nz/cases/NZEnvC/2018/87.html?stem=0&synonyms=0&query=okura)

This Environment Court decision concerns appeals against the rural/urban boundary in the Auckland Unitary Plan in relation to 130 ha of land in the catchment of the Okura Estuary north of Auckland. The appellants were seeking various zonings primarily to provide for future residential development. The Long Bay – Okura Marine Reserve is on the coastal edge of the site. One of the many matters considered in the appeal was in relation to sediment from the earthworks that would be required to develop the land for residential purposes. The appellants had undertaken sediment load modelling for the construction phase using the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model, which included coastal dispersion modelling. The decision evaluated the modelling and the effects of the additional sediment on the estuary, which already receives high sediment loads from other land use activities in the catchment. The appeals were dismissed for reasons other than sediment discharges.

- Stroud, M. 2003: Modelling long-term daily sediment loads to the Mahurangi Estuary. *Auckland Regional Council Technical Report 2008/018*. Prepared for Auckland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 23 p.
www.aucklandcity.govt.nz/council/documents/technicalpublications/TR2008_018%20-%20Modelling%20Long-term%20Daily%20Sediment%20Loads%20to%20the%20Mahurangi%20Estuary.pdf
- Final report and decision of the Board of Inquiry into the Ara Tuhono Puhoi to Wellsford Road of National Significance, September 2014.

Construction of the Ara Tuhono Puhoi to Wellsford Road required the excavation of 8 million m³ of fill and the placing of 6.2 million m³ of fill, with the balance to be placed in spoil dumps over a total construction area of approximately 189 ha. The road alignment traverses the catchments of the Puhoi Estuary and the Mahurangi Harbour. The final report and decision outline the sediment yield modelling that was undertaken for the project. This modelling was used to determine background sediment loads and the

additional sediment loads that would occur over the construction phase under 5- and 10-year construction periods, with indicative design erosion and sediment control measures in place as per the proposed conditions of consent. Daily sediment yields were also modelled under 2-, 10- and 50-year rainfall events, and the percentage increase in annual sediment loads for each catchment was calculated. The environmental effects of the sediment load during the construction phase was then assessed. The conditions imposed on the consent were intended to ensure that the modelled sediment yields were not exceeded.

- Kaipara Harbour sediment mitigation studies:
 - Green, M.O.; Daigneault, A. 2018: Kaipara Harbour sediment mitigation study: summary. *Report NRC1701-1* (minor revision). Streamlined Environmental, Hamilton. 64 p.
www.knowledgeauckland.org.nz/assets/publications/Kaipara-Harbour-sediment-mitigation-study-Summary-Streamlined-Enviornmental-Ltd-30-Jan-2018.pdf
 - Gibbs, M.; Olsen, G.; Swales, A.; He, S. 2012: Kaipara Harbour sediment tracing: sediment dispersion across the harbour. Prepared for the Ingegrated Harbour Management Group by the National Institute of Water & Atmospheric Research Ltd. 58 p.
www.kaiparaharbour.net.nz/Content/Publications/Gibbsetal2012KaiparaHarbourSedimentTracingFinal.pdf
 - Freshwater and estuaries update.
www.niwa.co.nz/freshwater-and-estuaries/freshwater-and-estuaries-update/freshwater-update-63-november-2014/modelling-the-impacts-of-mitigation

Wellington

- Transmission Gully roading project.

The Transmission Gully roading project is a very large-scale earthworks project for a 27-km-long highway that requires 6.3 million m³ of excavation with cut batters of up to 80 m and fill depths of up to 60 m. Most of the land area on which construction activity is occurring drains to the shallow, tidal Pāuatahanui Inlet and the Onepoto Arm of Te Awarua-o-Porirua Harbour. The resource consent applications and notices of requirement were considered by a Board of Inquiry that was appointed by the Environmental Protection Authority, and the final report and decision were issued in June 2012. The Board of Inquiry considered the management of sediment to be ‘a particularly important issue, if not the most important’.⁵⁹

⁵⁹ Paragraph 305 of the decision.

The decision provides an overview summary of expert opinion for modelling baseline sediment yields and managing the sediment production from large-scale earthworks in catchments that drain into important coastal estuaries and wetlands. The modelling included both catchment-derived sediment and the settlement of sediment (sedimentation) in the inlet and harbour.

- Fountain, B.; Milton, N.; Hansford, J. 2011: Transmission Gully project: assessment of hydrology and stormwater effects. *Technical Report 14*. Prepared for the New Zealand Transport Agency and Porirua City Council. 90 p.
www.nzta.govt.nz/assets/projects/transmission-gully-application/docs/technical-report-14.pdf
This report includes sedimentation modelling of the yields from the catchment.
- Keating, A.; Holland-Kearins, N.; Fountain, B.; Conland, N. 2011: Transmission Gully project: assessment of water quality effects. *Technical Report 15*. Prepared for the New Zealand Transport Agency. 198 p.
www.nzta.govt.nz/projects/transmission-gully-application/docs/technical-report-15.pdf
This report includes sedimentation modelling for the contributing streams and harbour receiving environments.
- www.epa.govt.nz/Resource-management/previous/tg/Pages/Final-report-and-decision.aspx
This is the final report and conditions that were appended to the decision of the Board of Inquiry. The discussion on sediment modelling and the sedimentation effects of the proposal can be found on pages 88-102 of the decision.
- Green, M.; Stevens, L.; Oliver, M.D. 2014: Te Awarua-o-Porirua Harbour and catchment sediment modelling: development and application of the CLUES and Source-to-Sink models. Greater Wellington Regional Council, Wellington. 57 p.
www.gw.govt.nz/assets/council-publications/Te-Awarua-o-Porirua-Harbour-and-catchment-sediment-modelling-report.pdf

Other regions

- Tauranga: There are many examples from Tauranga, including scenario planning.
www.boprc.govt.nz/our-region-and-environment/coast/tauranga-moana/harbour-issues/sedimentation/
- Catchment modelling of sediment loads to estuaries.
www.niwa.co.nz/freshwater-and-estuaries/freshwater-and-estuaries-update/freshwater-update-55-october-2012/catchment-modelling-of-sediment-loads

Erosion and sediment control guidelines – examples

Bay of Plenty Regional Council

- Bay of Plenty Regional Council 2010: Erosion and sediment control guidelines for land disturbing activities. *Guideline 2010/01*. Bay of Plenty Regional Council, Whakatane.
www.boprc.govt.nz/media/29555/Guideline-100624-ErosionandSedimentControl.pdf

Environment Canterbury

- Environment Canterbury 2007: Erosion and sediment control guideline 2007: a better way of managing earthworks and the environment. *Report No. R06/23*. Environment Canterbury, Christchurch. 226 p.
<http://files.ecan.govt.nz/public/lyttelton/ECan%202007%20Erosion%20and%20Sediment%20Control%20Guideline.pdf>

Greater Wellington Regional Council

- Greater Wellington Regional Council 2002: Erosion and sediment control guidelines for the Wellington region. Greater Wellington Regional Council, Wellington. 115 p.
www.gw.govt.nz/assets/Resource-Consents/Erosion-and-sediment-control-guidelines-2002.PDF

Auckland Council

- Leersnyder, H.; Bunting, K.; Parsonson, M.; Stewart, C. 2016: Erosion and sediment control guide for land disturbing activities in the Auckland region. *Auckland Council Guideline Document GD2016/005*. Prepared by Beca Ltd and SouthernSkies Environmental for Auckland Council. 301 p.
<http://content.aucklanddesignmanual.co.nz/project-type/infrastructure/technical-guidance/Documents/GD05%20Erosion%20and%20Sediment%20Control.pdf>
- Calculating sediment yield.
www.aucklanddesignmanual.co.nz/project-type/infrastructure/technical-guidance/erosionsedimentcontrol/guidance/erosionsedimentcontrolinauckland/erosionandsedimentationintheaucklandregion/calculatingsedimentyield

New Zealand Transport Agency

- New Zealand Transport Agency 2014: Erosion and sediment control guidelines for state highway infrastructure: construction stormwater management. New Zealand Transport Agency, Wellington. 181 p.
www.nzta.govt.nz/assets/resources/erosion-sediment-control/docs/erosion-and-sediment-control-guidelines.pdf

Waikato Regional Council

- Waikato Regional Council 2009: Erosion and sediment control: guidelines for soil disturbing activities. *Environment Waikato Technical Report No. 2009/02*. Environment Waikato, Hamilton. 137 p.
www.waikatoregion.govt.nz/assets/WRC/Services/publications/technical-reports/2009/TR0902.pdf

Reports, websites and additional information

Please see the equivalent section in the Policy 21 guidance note.⁶⁰ Additional resources of relevance to sedimentation are listed below.

Department of Conservation

- ‘Our Estuaries hub’
www.doc.govt.nz/estuaries

This hub includes three interactive maps.

- Restoring estuaries.
www.doc.govt.nz/nature/habitats/estuaries/restoring-estuaries-map/

This interactive map shows where work to restore the health of estuaries is ongoing throughout New Zealand. It contains information about each estuary care group, links to strategic plans, revegetation guidance, council initiatives and opportunities for people to get involved.

- Monitoring estuaries.
www.doc.govt.nz/nature/habitats/estuaries/monitoring-estuaries-map/

This interactive map links to monitoring information collected by councils, government agencies, iwi and community organisations, and individuals for over 150 estuaries throughout New Zealand.

⁶⁰ <https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/policy-statement-and-guidance/>

- Experiencing estuaries.

www.doc.govt.nz/nature/habitats/estuaries/experiencing-estuaries-map/

This interactive map provides information on the walks that are available alongside and through estuaries, and the birdlife and other features of those estuaries.

Additional pages in the ‘Our Estuaries’ hub have practical featured projects that the public can get involved with and maps with datasets showing temporal changes in the extent of seagrass and mangroves (both of which are affected by sedimentation).

- Todd, M.; Kettles, H.; Graeme, C.; Sawyer, J.; McEwan, A.; Adams, L. 2016: Estuarine systems in the lower North Island/Te Ika-a-Māui: ranking of significance, current status and future management options. Department of Conservation, Wellington. 400 p.
www.doc.govt.nz/about-us/science-publications/conservation-publications/land-and-freshwater/estuaries/estuarine-systems-in-the-lower-north-island-te-ika-a-maui/

This document assesses the current state (as at 2016) of 48 estuarine sites from the mouth of the Manawatu River on the west coast to the mouth of the Waimata River on the eastern Wairarapa coast. The report presents a ranking system to guide decision-making about priorities for the ongoing management of these estuaries. Each distinct site is presented as a stand-alone chapter. Being essentially qualitative, the report is intended to act as a resource for further conversations about these estuarine ecosystems and their future management, noting that most are currently actively managed by agencies assisted by coastal restoration and catchment management groups.

- Hadfield, M.; O’Callaghan, J.; Pritchard, M.; Stevens, C. 2018: Regions of freshwater influence (RoFI) and the implications for sediment deposition in the Hauraki Gulf. *NIWA Client Report No: WLG2012-29*. Prepared for the Department of Conservation by the National Institute of Water & Atmospheric Research Ltd. 29 p.
www.doc.govt.nz/globalassets/documents/conservation/estuaries/hauraki-sedimentation-report.pdf

This was a pilot study that modelled the transport of sediment from the 20 largest river flows into the Hauraki Gulf, and the subsequent deposition, resuspension and movement of that sediment through the coastal marine area. The model was validated by monitoring. The report highlights the role of wave resuspension in sediment transport within the Gulf.

Ministry for the Environment

- Hicks, D.M.; Greenwood, M.; Clapcott, J.; Davies-Colley, R.; Dymond, J.; Hughes, A.; Shankar, U.; Walter, K. 2017: Sediment attributes Stage 1. *NIWA Client Report No: CHC2016-058*. Prepared for the Ministry for the

Environment by the National Institute of Water & Atmospheric Research Ltd. 199 p.

www.mfe.govt.nz/publications/fresh-water/sediment-attributes-stage-1

Davies-Colley, R.; Hicks, M.; Hughes, A.; Clapcott, J.; Kelly, D.; Wagenhoff, A. 2015: Fine sediment effects on freshwaters, and the relationship of environmental stage to sediment load: a literature review. *NIWA Client Report No: HAM2015-104*. Prepared for the Ministry for the Environment by the National Institute of Water & Atmospheric Research Ltd. 105 p.

<https://www.mfe.govt.nz/publications/fresh-water/fresh-water-report-2017/references>

These reports are two of several that were commissioned by the Ministry for the Environment to assist with developing attributes for sediment for the NPS-FE. Although they are specific to freshwater aspects, they contain information that is relevant to sediment in the estuarine and coastal environment.

- Townsend, M.; Lohrer, D. 2015: ANZECC guidance for estuary sedimentation. *NIWA Client Report No: HAM2015-096*. Prepared for the Ministry for the Environment by the National Institute of Water & Atmospheric Research Ltd. 45 p.

www.mfe.govt.nz/publications/fresh-water/anzecc-guidance-estuary-sedimentation

This report recommends guidelines for sedimentation in estuaries.

‘Sedimentation’ is defined as the thickness of sediment accumulation over a given period of time, recognising that there will typically be periods of scouring and deposition over any given time period. The report recommends ‘a Default Guideline Value of 2 mm of sediment accumulation per year above the natural annual sedimentation rate for the estuary, or part of the estuary, at hand’. The ‘natural sedimentation rate’ is defined as the rate of sedimentation under native-forested catchment. The report notes that a default guideline value alone will not be sufficient for managing sediment effects in estuaries but ‘may provide benefit as a foundation for a broader framework that includes other elements related to sediment stress, such as suspended sediment concentration (SSC), bed sediment particle size distribution (for mud content), and the areal extent of muddy sediment in an estuary’. The report assesses methods of measuring sedimentation across a range of spatial and temporal scales, and recommends a combination of methods.

- MacDiarmid, A.; Boschen, R.; Bowden, D.; Clark, M.; Hadfield, M.; Lamarche, G.; Nodder, S.; Pinkerton, M.; Thompson, D. 2014: Environmental risk assessment of discharges of sediment during prospecting and exploration for seabed minerals. *NIWA Client Report No: WLG2013-66*. Prepared for the Ministry for the Environment by the National Institute of Water & Atmospheric Research Ltd. 53 p.

www.mfe.govt.nz/publications/marine/environmental-risk-assessment-discharges-sediment-during-prospecting-and

This report provides ratings for all aspects of risk to the environment from the discharge of sediments associated with prospecting and exploration for

seabed minerals in the New Zealand Exclusive Economic Zone. The methodology may be applicable to mining and dredging in inshore waters.

- Ministry for the Environment 2017: National Policy Statement for Freshwater Management 2014 (amended 2017). Ministry for the Environment, Wellington. 47 p.

www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2014-amended-2017

A guide to the National Policy Statement for Freshwater Management 2014 (as amended 2017).

www.mfe.govt.nz/publications/fresh-water/guide-national-policy-statement-freshwater-management-2014

- About the National Environmental Standards for Plantation Forestry. www.mfe.govt.nz/land/national-environmental-standards-plantation-forestry/about-standards

Ministry for Primary Industries

- Suspended sediment and sedimentation. <https://www.fisheries.govt.nz/fisheriesnz/>

This link to the MPI website provides an overview of the effects of sediment on coastal fisheries and ecosystems, and contains links to relevant New Zealand research papers and reports, including those listed below.

- A review of land-based effects on coastal fisheries and supporting biodiversity in New Zealand. <https://www.fisheries.govt.nz/fisheriesnz/>

Section 11 of this report contains several relevant resources in addition to those listed in this guidance note.

- MacDiarmid, A.; McKenzie, A.; Sturman, J.; Beaumont, J.; Mikaloff-Fletcher, S.; Dunne, J. 2012: Assessment of anthropogenic threats to New Zealand marine habitats. *New Zealand Aquatic Environment and Biodiversity report No. 93*. National Institute of Water & Atmospheric Research Ltd, Wellington. 255 p. <http://healthyharbour.org.nz/wp-content/uploads/2016/08/McDiarmid-2012-Anthropogenic-threats.pdf>

This assessment identified 62 marine habitats in New Zealand's territorial sea and 200 nautical mile exclusive economic zone. For each habitat, the report ranks 65 potential threats arising from human activities and assesses the vulnerability of the habitat to each threat. The assessment uses a combination of published research, unpublished data and expert knowledge.

National Institute of Water & Atmospheric Research (NIWA)

- Predicting long-term sedimentation and heavy metal accumulation in estuaries.

www.niwa.co.nz/our-science/coasts/research-projects/predicting-sedimentation-and-heavy-metal-accumulation-in-estuaries-on-the-planning-timescale

The Urban Stormwater Contaminant (USC) model can be used to predict the long-term accumulation of sediment and heavy metals in estuaries. It can look 50–100 years ahead, allowing planners to evaluate the risks of different land use and management scenarios. The USC also tracks sediments from their source to the sea, enabling coastal managers to pinpoint problem areas and assess mitigation options. The work was funded by the Auckland Regional Council, Transit New Zealand, North Shore City Council, Waitakere City Council, Rodney District Council, and the Foundation for Research, Science and Technology.

- Catchment to estuary sediment deposition tool.

www.niwa.co.nz/freshwater/management-tools/sediment-tools/catchment-to-estuary-sediment-deposition-tool

- Suspended-sediment yield estimator.

www.niwa.co.nz/freshwater/management-tools/sediment-tools/suspended-sediment-yield-estimator

This tool was developed by NIWA in collaboration with Landcare Research.

- Compound Specific Stable Isotope tracing of sediment sources – tools to manage a sticky problem in New Zealand’s freshwaters and estuaries.

www.niwa.co.nz/freshwater-and-estuaries/freshwater-and-estuaries-update/freshwater-update-74-august-2017/compound-specific-stable-isotope

A relatively new tool that involves stable isotope tracing has been used to identify sediment sources in various estuaries around New Zealand. This article describes the method and gives some case study examples: Waitangi River catchment, Northland (2014), Whangarei Harbour (2013), New River Estuary (2014) and Jacobs River Estuary (2014).

The method has also been used for Waituna Lagoon.

- McDowell, R.W.; Norris, M.; Cox, N. 2013: Waituna sediment fingerprinting study. Prepared for Environment Southland. 34 p.
www.waituna.org.nz/repository/libraries/id:1ytnyjmap17q9s20wg7s/hierarchy/Waituna%20resources/Catchment%20management/2013%2010%20McDowell%20Waituna%20Sediment%20Fingerprinting%20Study.pdf

Parliamentary Commissioner for the Environment

- Parliamentary Commissioner for the Environment 2012: Water quality in New Zealand: understanding the science. Parliamentary Commissioner for the Environment, Wellington. 93 p.

www.pce.parliament.nz/publications/water-quality-in-new-zealand-understanding-the-science/

Written primarily for a non-technical audience, this report discusses the effects of pathogens, sediment and nutrients mostly on freshwater quality but it also includes estuaries.

Quality Planning

- Managing earthworks.

<http://qualityplanning.org.nz/index.php/node/735>

This link provides a useful discussion of the respective roles and responsibilities of regional councils and territorial authorities for the management of earthworks under the RMA.

Northland Regional Council

- Estuarine monitoring programme.

The Northland Regional Council runs an estuarine monitoring programme, as do many other councils, to help assess the health of its estuaries and monitor change over time. The programme also aims to identify the impact of human activities on these systems, assess the effectiveness of rules contained in the regional plans and promote awareness of environmental issues that affect estuarine health. The Council currently monitors sedimentation in five Northland estuaries: Whangarei Harbour, Kerikeri Inlet, Ruakaka Estuary, Whangaroa Harbour and Kaipara Harbour.

The Council also carries out a coastal sediment monitoring programme, which involves monitoring sediment metal concentrations and the physical characteristics of sediments every 2 years at 16 sub-tidal sites in the Whangarei Harbour and the Bay of Islands. The Council has also investigated sources of sediment in the Mangonui Harbour and Waitangi Estuary.

There is a permanent water quality platform in the Kaipara Harbour that continuously monitors a number of water quality parameters, including turbidity. The Council also deploys continuous water quality monitoring buoys in the Whangarei Harbour and Waitangi Estuary four times per year (every quarter) for 1 month, which also monitor a number of water quality parameters, including turbidity.

- Swales, A.; Gibbs, M.; Hewitt, J.; Hailes, S.; Griffiths, R.; Olsen, G.; Ovenden, R.; Wadhwa, S. 2012: Sediment sources and accumulation rates in the Bay of Islands and implications for macro-benthic fauna, mangrove and saltmarsh habitats. *NIWA Client Report: HAM2012-048*. Prepared for Northland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 132 p.

www.nrc.govt.nz/media/10600/sedimentsourcesandaccumulationratesinthebailandimplicationsswales2012.pdf

- Swales, A.; Gibbs, M.; Olsen, G.; Ovenden, R. 2015: Historical changes in sources of catchment sediment accumulating in Whangarei Harbour. *NIWA Client Report HAM2015-037*. Prepared for Northland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 39 p.
www.nrc.govt.nz/media/9459/historicalchangesinsourcesofcatchmentsedimentaccumulatinginwhangareiharbour.pdf
- Swales, A.; Gibbs, M.; Pritchard, M.; Budd, R.; Olsen, G.; Ovenden, R.; Costley, K.; Hermanspahn, N.; Griffiths, R. 2013: Whangarei Harbour sedimentation: sediment accumulation rates and present-day sediment sources. *NIWA Client Report HAM2013-143*. Prepared for Northland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 104 p.
www.nrc.govt.nz/media/11335/whangareiharboursedimentationreportpart1.pdf

Auckland Council

- Auckland Council has been undertaking a regional estuary monitoring programme since 2001, which monitors sedimentation in 14 estuaries: Whangateau Harbour, Mahurangi Estuary, Puhoi Estuary, Waiwera Estuary, Orewa Estuary, Okura Estuary, Waitemata Harbour, Whau Estuary, Tamaki Estuary, Mangere Inlet, Waikopua Estuary, Mangemangeroa Estuary, Turanga Estuary and Manukau Harbour.
- Mahurangi Action Plan: a strategic plan for the catchment 2010–2030.
www.mahurangi.org.nz/Action-Plan/PDF/Mahurangi-Action-Plan.pdf
This catchment-based restoration project is focused on protecting the long-term health of the Mahurangi Harbour. It was launched as a proactive response to increasing sedimentation in the harbour and has included sediment source mapping to identify the sources of catchment soil contributing to sediment deposition in the harbour.
- Reeve, G.; Swales, A.; Reed, J. 2008: Kaipara Harbour sediments: information review. *Auckland Regional Council Document Type 2009/055*. Prepared for the Auckland Regional Council and Northland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 36 p.
www.aucklandcity.govt.nz/council/documents/technicalpublications/TR2009_055%20-%20Kaipara%20Harbour%20Sediments%20Information%20Review.pdf
- Green, M.O.; Daigneault, A. 2018: Kaipara Harbour sediment mitigation study: summary. *Report NRC1701-1* (minor revision). Streamlined Environmental, Hamilton. 64 p.
www.knowledgeauckland.org.nz/assets/publications/Kaipara-Harbour-sediment-mitigation-study-Summary-Streamlined-Environmental-Ltd-30-Jan-2018.pdf

This report provides an assessment of the economic costs and environmental benefits of a range of scenarios to reduce catchment sediment loss, and was prepared jointly for the Northland Regional Council and the Auckland Council.

- Gibbs, M.; Hewitt, J. 2004: Effects of sedimentation on macrofaunal communities: a synthesis of research studies for ARC. *Technical Publication 264*. Prepared for Auckland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 48 p.
www.aucklandcity.govt.nz/council/documents/technicalpublications/TP264_Sed_eff_macrofauna.pdf
- State of Our Gulf report.
www.aucklandcouncil.govt.nz/about-auckland-council/how-auckland-council-works/harbour-forums/Pages/hauraki-gulf-forum.aspx
- Hart, G.; Scott, K. 2014: Hotoe River catchment: environment and socio-economic review. *Auckland Council Technical Report TR2014/021*. Prepared for Auckland Council by Landcare Research. 103 p.
<http://www.knowledgeauckland.org.nz/assets/publications/TR2014-021-Hotoe-River-catchment-environment-and-socio-economic-report.pdf>

Waikato Regional Council

- The Waikato Regional Council has been undertaking a regional estuary monitoring programme since 2001, which monitors sedimentation in three estuaries: southern Firth of Thames, Tairua Harbour and Whaingaroa (Raglan) Harbour.
- Sedimentation in estuaries factsheet.
www.waikatoregion.govt.nz/assets/PageFiles/41458-coastal-factsheets/4797_CFS2016_Sedimentation%20in%20Estuaries_MR.pdf

The Waikato Regional Council has published numerous monitoring reports and factsheets on the effects of sediment, and has also supported various community initiatives, such as the Whaingaroa Harbour Care Group. This particular factsheet provides a summary of council publications that are relevant to coastal sedimentation including the following.

- Coastal sedimentation: what we know and the information gaps. *Waikato Regional Council Technical Report 2008/12*.
- Mangrove-habitat expansion in the southern Firth of Thames: sedimentation processes and coastal-hazards mitigation. *Waikato Regional Council Technical Report, 2008/13*.
- Whaingaroa (Raglan) Harbour: sedimentation and the effects of historical catchment landcover changes. *Waikato Regional Council Technical Report 2005/36*.
- Hughes, A. 2015: Waikato River suspended sediment: loads, sources, and sinks. Information to inform economic modelling for the Healthy Rivers Wai

Ora Project. *NIWA Client Report No: HAM2015-059*. National Institute of Water & Atmospheric Research Ltd, Hamilton. 26 p.

www.waikatoregion.govt.nz/assets/PageFiles/37532/11%20-%20FINAL_NIWA_Waikato%20River%20Suspended%20Sediments%20-%20loads%20sources%20and%20sinks.pdf

Bay of Plenty Regional Council

- The Bay of Plenty Regional Council has been undertaking a regional estuary monitoring programme since 2001.
- Tauranga Harbour sediment study: assessment of predictions for management. (May 2010)

<https://cdn.boprc.govt.nz/media/374301/boprc-thfs6-sedimentation-web.pdf>

This report assesses sedimentation risks to the Turanga Harbour and prioritises the ecological sensitivity within sub-catchments. This knowledge will assist in adapting and prioritising management rules and practices for the catchment and harbour, providing a full understanding of the likely sedimentation that will result from the expected changes in land use and the anticipated effects of climate change to 2051.

Gisborne District Council

- Marden, M. 2011: Sedimentation history of Waipaoa catchment. *Envirolink project 1015-GSDC95*. Produced for Gisborne District Council by Landcare Research. 48 p.

<https://www.envirolink.govt.nz/envirolink-reports/index.htm>

This report is a literature review of pre- and post-human erosion and sedimentation rates in the Waipaoa catchment.

Hawke's Bay Regional Council

- The Hawke's Bay Regional Council has been undertaking a regional estuary monitoring programme since 2001.

Horizons Regional Council

- Horizons Regional Council has been undertaking a regional estuary monitoring programme since 2001.
- Gillespie, P. 2007: Potential effects of high sediment loads on the marine environment of the East Coast of the North Island, East Cape – Hawke Bay: a review of existing information. *Cawthron Report No. 1389*. Prepared for Gisborne District Council by Cawthron Institute. 9 p.

<http://envirolink.govt.nz/assets/Envirolink/334-GSDC45-Sediment-effects-on-marine-environment-E-Coast-NI.pdf>

Greater Wellington Regional Council

- The Greater Wellington Regional Council has been undertaking a regional estuary monitoring programme since 2001.
- Porirua Harbour and catchment programme.

www.gw.govt.nz/porirua-harbour-and-catchment-programme/

Sustainable Marahau Incorporated

- Davidson, R.J. 2018: Qualitative description of estuarine impacts in relation to sedimentation at three estuaries along the Abel Tasman coast. Prepared for Sustainable Marahau Incorporated by Davidson Environmental Ltd. 37 p. <https://tasmanbayguardians.org.nz/wp-content/uploads/2018/11/Estuary-impacts-Davidson-2018-2.pdf>

Sustainable Marahau Incorporated is a group of residents of Marahau and Sandy Bay in the Tasman District adjacent to the Abel Tasman National Park. Following concerns about the effects of sediment arising from a large rainfall event as a result of Cyclone Gita on 20 February 2018, this group commissioned a study comparing the estuarine impacts associated with the movement of sediment at three selected estuaries, all of which have Separation Point geology and are on the Abel Tasman coast: the Kaiteriteri Estuary catchment, which is dominated by pine forest in various stages of growth; the Otuwhero Estuary catchment, which was at the time dominated by partially logged pine plantation, unlogged plantation and early regeneration growth; and the Torrent Bay Estuary catchment, much of which lies within the national park and is dominated by mature native forest. The study concluded that the two estuaries with modified catchments are being ecologically degraded. The unmodified Torrent Bay Estuary showed little sign of the Cyclone Gita rainfall event, whereas the modified estuaries experienced considerable deposits of fine sediment, particularly the logged Otuwhero Estuary.

Marlborough District Council

- Coastal reports and special investigations.

The Marlborough District Council developed a coastal monitoring strategy in 2012 and has undertaken numerous ecological, habitat and sediment health studies of estuaries in Marlborough.

Barrett, H.; Anderson, T.J.; Morrisey, D. 2017: Effects of sediment deposition on the New Zealand cockle, *Austrovenus stutchburyi*. NIWA Client Report No:

2017214NE. Prepared for Marlborough District Council by the National Institute of Water & Atmospheric Research Ltd. 25 p.

www.envirolink.govt.nz/assets/Envirolink/1734-MLDC126-Effects-of-sediment-deposition-on-the-New-Zealand-cockle-Austrovenus-stutchburyi.pdf

- Historical ecosystem change.

www.marlborough.govt.nz/environment/coastal/historical-ecosystem-change

The Marlborough District Council has also commissioned NIWA to undertake studies on historic seabed change in the Pelorus Sound / Te Hoiere and the Queen Charlotte Sound / Tōtaranui to determine the sources of eroded soils and their relative contributions to sediment deposition, as well as how sedimentary contributions have changed by source over the recent past (1,000 years).

- Ulrich, S.C. 2015: Mitigating fine sediment from forestry in coastal waters of the Marlborough Sounds. *Marlborough District Council Technical Report No: 15-009*. Marlborough District Council, Blenheim. 53 p.

<http://envirolink.govt.nz/assets/Envirolink/1626-MLDC110-Mitigating-Fine-Sediment-from-Forestry-in-Coastal-Waters-of-the-Marlborough-Sounds.pdf>

Christchurch City Council

- The Christchurch City Council and the Avon-Heathcote Estuary Ihutai Trust have been undertaking intertidal mudflat monitoring in the Estuary of the Avon and Heathcote Rivers/Ihutai since 2007.

West Coast Regional Council

- The West Coast Regional Council has been undertaking a regional estuary monitoring programme since 2001.

Otago Regional Council

- The Otago Regional Council has been undertaking a regional estuary monitoring programme since 2001.
- Sediment in water factsheet.

http://archive.orc.govt.nz/Documents/Publications/Farming%20and%20Land%20Management/02_Sediment%20Guide%20Sheet%20WEB.pdf?epslanguage=en-NZ

This factsheet sets out the relevant rules in the regional water plan (operative February 2016) in relation to sediment control and provides examples of good practice.

Southland Regional Council

- Southland Regional Council has been undertaking a regional estuary monitoring programme since 2001.
 - Gibbs, M.; Olsen, G.; Stewart, M. 2014: New River Estuary sediment sources tracking pilot study. *NIWA Client Report No: HAM2014-002*. Prepared for Southland Regional Council by the National Institute of Water & Atmospheric Research Ltd. 39 p.
www.es.govt.nz/Document%20Library/Research%20and%20reports/Estuarine%20reports/New%20River%20Estuary%20sediment%20tracking%20pilot%20study.pdf
 - Gibbs, M.; Olsen, G.; Stewart, M. 2014: Jacobs River Estuary sediment sources assessment. *NIWA Client Report No: DNZ13201*. Prepared for Dairy New Zealand by the National Institute of Water & Atmospheric Research Ltd. 33 p.

Glossary of terms and definitions

NZCPS 2010 glossary

No relevant definitions.

Other definitions

Sedimentation The accumulation of sediment, where sediment is defined as particles or clumps of particles of sand, clay, silt, or plant or animal matter carried in the water (Environment New Zealand 2007; Ministry for the Environment 2007: 422).⁶¹

Sediment

Solid material that-

- (a) is mineral or is mineral and organic; and
- (b) is in suspension, is being transported, or has been moved from the site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below water.

(Resource Management (National Environmental Standards for Plantation Forestry) Regulations 2017)⁶²

⁶¹ <http://www.mfe.govt.nz/publications/environmental-reporting/environment-new-zealand-2007>

⁶² <http://www.legislation.govt.nz/regulation/public/2017/0174/latest/whole.html>