Regional Gravel Management Report

Report No R06/1

Report prepared in part by MWH New Zealand Limited for Environment Canterbury

January 2006

Environment Canterbury
Your regional council

Acknowledgement: Environment Canterbury would like to knowledge the contributions to this report from MWH New Zealand Ltd, specifically Sections 12, 13, 14, 25 & 26 - Tamsin Page, Rebecca Joblin, Terry Day, Bob Hall, Sections 16, 17, 18, 20 - Neil Sutherland, Rob Connell, Section 19 - Martin Single, Project Manager - Peter Gribbin, Project Director - Tom Burkitt, Technical Director - Brian Kouvelis

Report No. R06/1
ISBN 1-86937-582-3

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Executive summary

The Regional Gravel Management Report (report) provides the basis for Environment Canterbury (ECan) to decide on a way forward for the future management of fluvial gravel extraction in Canterbury. This report has been developed by ECan staff with input from consultants MWH New Zealand Ltd (MWH). It is proposed that the results of public consultation will be incorporated into this report and that the final report to ECan Councillors (June 30th 2006) will include recommendations for a future management approach to fluvial gravel extraction in Canterbury.

The report includes:

- background information on fluvial gravel processes;
- a discussion of the relationship between the flood control functions of ECan and gravel extraction;
- a summary of past and present management approaches in Canterbury,;
- the concerns with the current management approach;
- the general environmental and physical effects of gravel extraction;
- an investigation into demand and supply of fluvial gravels in Canterbury; and
- options for future gravel management.

The report also addresses fluvial gravel as a limited resource, looking at historical volumes of extraction and demand and then the potential future supply of gravel from fluvial and coastal sources. The report then addresses the two key alternatives to the current fluvial active river channel extraction: land-based and fluvial out of channel extraction. The report also provides an assessment of the effectiveness of current river monitoring programmes to manage gravel before identifying possible future management options.

This report shows that in the past, in many areas, gravel extraction for commercial use and maintenance of flood capacity have been complementary, but lowered bed levels are now causing concern to river engineering staff at ECan who need to ensure the stability of flood control structures such as stopbanks. The report proposes that identifying design bed levels for flood control structures will provide an indicator for management of volumes of gravel extracted at specific sites.

The chapter on effects of fluvial and coastal extraction provides a picture of the common and potential effects associated with gravel extraction and makes some recommendations towards best practice approaches. The report does not propose that these recommendations become consent conditions.

ECan began keeping a record of fluvial gravel extraction volumes in the early 1990's and records show a 3 to 6-fold increase from that time, from approximately 500,000m^3 to 1 million cubic metres extracted annually to 3,000,000m^3 in 2004. The report acknowledges that while the gravel "returns" provided by consent holders may not always be reliable, they more accurately reflect the actual volumes extracted than consented volumes.

The key rivers for gravel extraction in Canterbury are the Opihi River and tributaries, the lower Waimakariri River, the Ashburton River and tributaries, the Pareora River and the Ashley River.

Demand for gravel in Canterbury is expected to increase from 2,843,000m^3 in 2005 to 6,137,000m^3 in year 2015. About 60% of current extraction is for roading, with about 30% for concrete and other construction activities. Major influences on demand are localised economic and population growth, the travel distance (proximity) from a specific extraction site to the end use of the gravel and, to a lesser extent, the quality of the gravel. The report identifies a number of areas where road construction, subdivision, irrigation schemes and other projects are likely to influence local demand for gravel in the future.

Technical investigations were carried out based on information available for 17 key rivers (identified as priority 1 for gravel extraction) to assess the amount of gravel moving through the river systems and to identify a potential “sustainable supply”. A further 20 rivers (priority 2 rivers) were also assessed at a less in-depth level, for an estimate of the sustainable supply of gravel. A summary of the sustainable supply information from these river reports[1] is included in this report. Collectively, these provide a reasonable regional picture of gravel supply from rivers. This report estimates that the regional net sustainable annual supply of fluvial gravel is about 750,000m^3. This does not include any accumulated deposits that are not moving through the river systems.

The expected demand for gravel in 2006 (about 3,000,000m^3) exceeds the estimated average annual fluvial supply rate by some 2,300,000m^3. Some of this (about 750,000m^3) is likely to be met by land-based extraction and a small proportion by coastal extraction. In the short-term, the rest of the demand will be met by mining of fluvial channels, where a surplus of about 4,600,000m^3 has been identified, either as aggradation or desired increase in flood capacity. In the longer term, the fluvial sustainable supply is significantly less than the demand, so to avoid ongoing degradation of riverbeds, a significant proportion of gravel extraction will need to move out of the rivers.

Land-based (e.g. pits and quarries) and fluvial out of channel (e.g. old oxbows) gravel extraction have been identified as the two primary alternatives to fluvial gravel extraction. Both fluvial gravel and land-based extraction will be needed, but more will progressively have to come from land-based sources, these alternatives are therefore the most likely sources for excess demand. A discussion is provided on these alternatives and their general pros and cons compared to fluvial extraction and the planning framework in relation activities on land. The report identifies that the role of ECan in managing gravel extraction from land-based sources is limited and largely relates to any potential affects the activity may have on ground water quality. A map of the unconfined aquifers in Canterbury is provided to show where land-based gravel extraction could come under Chapter 4, Water Quality, of the Proposed Natural Resources Regional Plan.

Current cross section surveying programmes, which form the basis for fluvial gravel supply information, have also been assessed. The report identifies that objectives for gravel resource management are not considered in the existing surveying or environmental monitoring programmes, but should be. It is noted that existing data will not necessarily answer management questions for the gravel resource.

Assessment of the current cross section monitoring programme indicates that, this monitoring, is sufficient to show aggradation and degradation trends and, is satisfactory for the purpose of managing for flood protection, but recommends that increased monitoring be carried out at specific sites to manage for commercial gravel extraction. Future monitoring is recommended for 5 rivers which currently have no monitoring and for 7 rivers which need improved monitoring programmes. The recommended key assessment criteria to be used in determining a monitoring regime for a particular river have been identified as follows:

- sensitivity of river;
- extraction pressure (demand);
- flood risk;
- presence of infrastructure;
- bed and bank stability;
- ecological sensitivity.

To improve monitoring of extracted volumes the report lists, among other things, a resource allocation process based on previous years’ returns and consistency in requesting gravel returns. The report recommends that a gravel management and monitoring framework be developed in the Canterbury region.

The report concludes that the accuracy, extent and focus of information, provided by the current monitoring programmes, is insufficient to ensure that over-extraction does not occur.

[1] See the list of Associated Reports for a full list of Priority 1 and 2 River Reports under References.

Management options consistent with the tools provided for, under the RMA, are discussed, from permitted through to prohibited activities for managing fluvial gravel extraction. Cost recovery options are also explored. Criteria for a desirable management approach have been identified and an indicative assessment of these against the management options has been provided in table format and brief discussion. This shows that the permit option to gravel management is the only option that could meet all of the nine criteria listed. A summary of the current approaches used by regional councils throughout New Zealand is included.

The report suggests that managing demand though the use of “end use controls” could increase the efficiency and effectiveness for managing a limited resource.

Recommendations for a future management approach have intentionally not been included at this stage. Public consultation will help to develop recommendations for the final report to ECan councillors at the end of this financial year (30 June 2006).

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Chapter 1 Introduction - Gravel in Canterbury

1. The Need For a Regional Gravel Management Report

This report focuses on gravel extraction from within the active channel (in-channel) of the river bed, and only briefly addresses gravel extraction from land-based and riparian (out of channel) sources. The report was initiated as a result of evidence of adverse effects of gravel extraction in South Canterbury rivers and a concern from Environment Canterbury (ECan) staff and gravel extractors that the current consenting process for gravel extraction is not working.

In October 2004 ECan staff became aware of adverse environmental effects of in-channel gravel extraction on river bank stability in local areas in southern rivers. An investigation was carried out to assess the cause and the likely extent of the effects. It was determined that the adverse effects were caused by the cumulative effects of extraction in those rivers, and although the effects were only observed at accessible local sites, it was probable that they were also occurring at less accessible sites.

Engineering staff providing advice on consent applications found that their information was insufficient in many South Canterbury rivers to assure ECan consent staff that the volumes of gravel applied for would not have an adverse effect on flood protection works. The consents team then let applicant know that they could only process the application by either seeking further information, which the applicant would have to provide, or by public notification of the application. Because this was the first time the consents staff were faced with the situation for gravel extraction applications, they also resolved to offer applicants the option to put their consent on hold and therefore keep them in the queue until a process was developed to deal with this issue. This process is discussed further in the ECan management approach Chapter 3 (section 5), and is still on going at the time of writing this report.

ECan staff recognised that although this was a South Canterbury problem, potentially it would become an issue throughout the region and that a new approach to gravel management was therefore needed for the whole Canterbury region. ECan Councillors agreed and funding was provided for this Regional Gravel Management Report to provide a basis for identifying a new management approach. The key objectives of this report are to:

- quantify present demands;
- determine future demands;
- identify environmental effects of gravel extraction;
- investigate how other regional councils are managing gravel;
- assess current gravel monitoring programmes and their effectiveness;
- identify effect of extraction on flood control and other infrastructural assets;
- provide gravel management budgets for Priority 1 rivers, and for the coastal areas;
- identify alternative extractions options;
- recommend a process for monitoring extracted volumes of gravel;
- investigate funding options for on going management; and
- investigate management options and provide a recommendation for future management approach.

During the drafting of this report, it became clear that the short timeframe was insufficient to provide for public input into any recommendations for a future management approach. Staff proposed to ECan Councillors that the report be completed within the original timeframe, but without recommendations, and that public consultation on management options be carried out from February 2006 to May 2006 to be incorporated into any recommendations for a new management approach. Recommendations to ECan Councillors should be presented at the end of the financial year June 30, 2006.

2. Gravel in Natural Systems

The term gravel, used in a geological context, is sediment that has a size that falls within a particular range in a classification system or scale. Several different classification systems exist, however the most commonly used is the Udden-Wentworth scale. This defines gravel as sediment particles between 2mm and 64mm. Sediments above 64mm are described as cobbles and boulders. Although sediment from the gravel size class is removed from riverbeds during extraction, other material both larger and smaller may be removed also. This material is commonly referred to as gravel, shingle, metal, aggregate or sand. For the purpose of this report, gravel refers to all sediment removed from a river.

River sediments are derived from the erosion of parent rocks in the river catchment area and from erosion of the river channel itself. The supply of gravel entering a river system from its catchment area is highly dependant on the geomorphic and geologic setting. The setting of many of Canterbury's rivers with their headwaters in the Southern Alps or adjacent foothills is one of high tectonic uplift coupled with high rainfall. This combination controls basin sediment yields and results in relatively high rates of sediment delivery to rivers. The bulk of the Southern Alps and their foothills consist of highly folded and shattered 'greywacke' rock. Greywacke is a slightly metamorphosed sandstone and mudstone with structural characteristics (joints and fractures) that make it susceptible to being broken up by water action.

River sediments are also derived from the erosion of riverbanks themselves and through the process of riverbed incision. Multiple advances of valley glaciers in the South Island over the last several million years have resulted in glacial outwash fans extending as plains from the mountains to the sea. Most Canterbury rivers now flow across these outwash fans with old glacial sediment contributing to river sediment load as river banks erode. At the time of the end of the last glacial advance (about 14,000 years ago) sea level was around 120m lower than present. As sea level rose to modern levels the coast has retreated, causing rivers to steepen as they near the sea. This steepening of riverbed gradients through the outwash gravels also contributes sediment load to the system.

Rivers transport gravels when water velocities reach levels that are sufficient to entrain large sized sediments. The distance transported depends on water velocity and particle size. Sediment is often deposited where the riverbed changes grade, for example, where it emerges onto plains from a gorge. As the grade of a river flattens out and its velocity decreases, finer and finer material is deposited. Floods play an important role in the transportation of gravel as they provide water velocities high enough to transport sediment that has been deposited as channel bars and on floodplains or in abandoned braid channels. Floods also erode sediment from riverbanks. The amount of gravel transported in a river is therefore significantly coupled to the frequency and magnitude of river flood events. This dependence on flood frequency means that the length of residence time of gravels away from the main river channel may be significant.

Where rivers have flood control measures such as stopbanking, the pattern of normal deposition of sediments is altered. In a natural river system, gravel is deposited over the floodplain, but on rivers with stopbanks, deposition is restricted to the artificial confines of the training works.

Gravel is delivered to the coast as the river reaches the sea. The grade of material that nourishes the beaches and shoreface of the open coast of Canterbury is primarily that sediment moved as bedload through rivers. Generally the finer silts and clays delivered by rivers are carried offshore and play little role in shoreline dynamics. Gravel that reaches the coast may become stored in gravel barriers adjacent to river mouths and eventually distributed alongshore by wave-induced currents.

Chapter 2 Gravel Extraction for Flood Control Purposes

3. The Role of Gravel Extraction

A key function of regional councils is to develop and maintain flood protection and erosion control works, using the provisions of the Soil Conservation and Rivers Control Act of 1941. Gravel extraction is an important tool for the management of aggrading rivers (with rising riverbeds). Riverbed gravels can be removed to maintain or increase flood capacity, correct undesirable river alignments, reduce bank erosion, and prevent course change onto the adjoining floodplain. A managed gravel extraction regime can reduce river management costs, and improve flood control effectiveness. On the other hand, excessive gravel extraction, or extraction from degrading rivers (with falling beds), can pose an undermining threat to flood protection and erosion control works.

The input, movement, and deposition of gravel in riverbeds is episodic, and is affected by factors such as catchment erosive potential, channel and bank condition, and flood size and frequency. The correct management of gravel extraction can therefore be difficult, requiring an ongoing monitoring and review programme, and the ability to target gravel extraction in terms of location, quantity, and timing.

In aggrading rivers, bed degrade can be induced if the rate of extraction exceeds the rate of natural supply. This degrade may occur in a local area where access for extraction purposes has been easiest, or over a longer length of river where extraction rates have consistently exceeded rates of natural supply. Extraction-induced degrade will occur more quickly in stable or naturally degrading rivers.

Although bed aggrade (particularly in the upper reaches) can be sudden, and relate to an extreme flood or earthquake event, degrade is generally a gradual process which occurs over many years, and can occur naturally even in the absence of gravel extraction. A degrade trend can be very difficult to identify without riverbed level comparisons (cross section networks) using accurate survey systems and a consistent datum.
Bed degrade can significantly increase the risk of undermining of flood protection infrastructure such as tree or rock armour bank protection and stopbanks. Excessive bed degrade will increase river scheme maintenance and flood damage restoration costs. Although degrade increases river channel flood capacity, it can reduce the effective flood protection standard of stopbanked river systems. The reason for this apparent contradiction is that bank and berm erosion increases, and stopbanks become more vulnerable to undermining and breach during flood.

Where extraction can be properly managed, an opportunity may exist in some rivers to increase the river flood capacity. The induced-riverbed degrade would have to be consistent to ensure an equitable flood protection standard over the scheme length.
A decision to increase the scheme flood capacity in this way would need to give due regard to the effect on riverbank stability, flood protection and community infrastructure, and long-term river regime. Environmental, ecological, and cultural issues would also need to be addressed, and a resource consent would probably be needed for the diversion of floodwaters.

4. Design Bed Levels

Design bed levels can be adopted for flood protection schemes, to meet the objective of maintaining design flood capacity, whilst ensuring flood protection and erosion control works are not threatened by excessive degrade.

Riverbed levels for flood protection schemes throughout New Zealand have traditionally been monitored by cross section networks extending the length of the schemes, and sometimes beyond into the catchment headwaters. Many of these networks were originally established in the 1950's, and have been resurveyed at regular frequencies (say 5 to 10 yearly) over the intervening period.

These networks consist of a series of cross sections at relatively uniform spacings (say 0.5 to 1.0 kilometres) extending across the river channel (more or less at right angles to the flow direction) between permanent benchmarks. The benchmarks levels have been accurately surveyed to a consistent datum, so the cross section lines and relative levels can be accurately reproduced.

The cross section networks have a dual role, i.e. assisting with management of gravel extraction, and enabling the checking of flood capacity. As it is difficult to interpret riverbed changes using cross section plots alone, mean bed levels (i.e. the average bed level between bench marks or river banks) are generally used to quantify aggrade or degrade trends between surveys.

Knowing the distance between cross sections, and assuming a uniform gradient and linear change in channel width between cross sections, the differences in mean bed level can be used to estimate changes in bed volume between surveys. The volume changes for a given section of river can be related to the gravel extraction returns over the same period to estimate natural rates of average gravel supply or loss. This information can in turn be used as a tool for allocation of gravel extraction volumes.

Gravel extraction can also be regulated by relating current mean bed levels to the design bed levels adopted at particular cross sections. If the current bed level was higher than the design bed level, then lowering by gravel extraction would be considered. If the current bed level was lower than the design bed level, then gravel extraction would cease.

Design bed levels have been determined using hydraulic computer models for the Ashley, Waimakariri, North Ashburton, Orari, Waihi, Opihi, Tengawai, and Pareora Rivers. Design bed levels need to be calculated for the remaining Canterbury rivers with flood protection infrastructure.

In some rivers, there may be a design envelope at each cross section, between a maximum level set by flood capacity requirements, and a minimum level set by bank stability requirements. These design envelopes would have to be developed as appropriate for particular rivers, taking account of factors such as the need to cope with extra gravel input in major floods, and the possibility of increasing design flood capacity by extraction induced degrade. At this stage more work is required to define appropriate design envelopes.

Chapter 3 Current Management Regime

5. Approaches to Gravel Management in Canterbury Region

5.1 Pre-Resource Management Act 1991 (RMA)

Prior to the Resource Management Act 1991, fluvial gravel extraction was managed by the Catchment Board Engineers in carrying out their functions under the Soil Conservation and Rivers Control Act 1941. People wishing to extract gravel would contact the local Catchment Board Engineer, who would give them written or verbal permission (permit), if the engineer was satisfied that the location and volume were appropriate. The Engineer would use their knowledge of the area, and some times carry out a site visit, to decide whether the location and volume of gravel requested were appropriate. The engineer would direct extractors to other sites when necessary, and consider potential effects of extraction on flood protection works and the environment, using information provided by the Department of Conservation when available. In the North Canterbury Catchment Board area, management of gravel extraction took less that 10% of the Engineers' time and was funded by the general rate.

5.2 Post RMA up to 1995

The Resource Management Act 1991 (RMA) introduced many new considerations especially in relation to adverse environmental effects for the regional council (and others) to consider in managing natural resources. Section 13 of the RMA provides for activities in the beds of rivers, lakes and streams to be the statutory responsibility of regional councils. Section 13 states that no person may excavate or disturb the bed unless the activity is allowed by a rule in a regional plan, proposed plan, or by a resource consent.

The Canterbury Transitional Regional Plan 1991 (TRP) includes the Catchment Board Bylaws requiring that all gravel extraction under section 13 of the RMA be a discretionary activity. Because gravel extraction from beds of rivers is a discretionary activity, even if a farmer just wants a trailer load of gravel to maintain farm tracks, a consent must be sought from ECan.

At ECan, the change over to the RMA process did not happen overnight. In South Canterbury, until the mid 1990's, Kevin McFall, a Timaru based Compliance Monitoring Officer, would write up a permit form when someone telephoned or called into the office, which would advise the volumes and location of material sought. Once a week (on a Wednesday), a list of these permits would be sent to the Christchurch Office for approval by the Resource Officers Committee (ROC). This system ceased in 1995, and a predominantly short-term duration consent system was adopted.

5.3 Post RMA – from 1995

At this time, ECan started requiring contractors to apply for resource consents to extract gravel from the beds of rivers. As required under the RMA, ECan asked applicants to assess the effects of their activity on people and the environment, and submit this information to ECan for assessment. If ECan determined that the adverse effects on the environment and people were minor, the consent was granted, often with mitigation measures attached as conditions of consent.

Managing rivers for flood control was a key function of ECan carried over from the Catchment Boards. Gravel extraction from riverbeds was encouraged as a key method of increasing and maintaining flood capacity. To facilitate this, ECan developed a standard application form for applicants to fill out. The form provides guidance on the information required for the activity. Information required includes details of the location and volume to be taken, and the effects of gravel excavation on: erosion and flooding; structures; riverbed plants and animals including nesting birds; cumulative effects on riverbed levels; effects of gravel excavation on amenity values; and people and communities. However the information provided by applicants was often minimal, including statements such as “no adverse effects”, although no information was provided to justify this statement.

ECan recognised that the activity for gravel extraction from beds of rivers differs from most other activities, in that there can be adverse effects on people and the environment if the gravel is not excavated. This resulted in there being several consequences unique to processing of gravel consents, in that applicants were not often asked to provide information normally sought for other activities, e.g. provide more information than “no adverse effects”. Instead ECan sought this information internally, and attached it to the consent application. This role was (and still is) carried out by the ECan River Engineering Section, who provide comment on flood risk (gravel availability), erosion capacity, and cumulative effects issues.

River dynamics and changing environmental conditions can make extraction sites unsuitable, to counter this and ensure supply, applicants began to apply for larger volumes, large reaches of river(s) and longer consent terms. Information for long term, and larger volumes, took longer to provide and processing timeframes had to be extended. There was some concern at ECan that information available would not be sufficient for long term consents, and that the application process timeframe was too long for applicants. An internal discussion document highlighted the need for quick application processing to ensure applicants could meet gravel supply contracts, and short term consent periods to provide for changing river conditions. Engineering staff felt that a quick consent or permit process would better suit the needs of the applicant, as well as ECan in managing extraction for flood control purposes, and would enable specific site selection and short durations. However this approach was never adopted.

Through the consent process gravel resources were often over allocated. Over allocation was due to a number of factors:

1. a reach could be allocated to more that one consent holder;
2. the changing volume of gravel available in any specific reach of a river;
3. the need for consent holders to secure supply for bidding on contracts to supply gravel (ECan staff were aware that although more than one consent holder would tender for a gravel supply contact, only one would win the contract, meaning the others would often not exercise their gravel consent);
4. there was a widely held belief that there was surplus gravel in many rivers, and uncertainty over actual volumes that would be extracted was not a concern; and
5. additionally existing consent holders operating in the same location as an applicant seeking consent were not considered affected parties, and written approvals were never sought from them (and still are not).

To mitigate against adverse affects on people and the environment, all consents issued to extract gravel from rivers within the Canterbury region are subject to various conditions, depending on the volume of gravel extracted and the location of extraction. Such conditions might include references to the following:

- Operate only in specified areas;
- Volumes extracted shall not exceed specified limit or timeframes;
- Notify Environment Canterbury of commencement of extraction;
- Prior to commencing excavation, a copy of the consent shall be given to all persons undertaking activities authorised by the consent;
- Vehicles and machinery operating in the river bed to be clearly labelled with the operator’s name;
- Gravel, sand and natural material shall not be excavated within [as specified] metres of the banks of the river or any flood protection works;
- No excavation within [as specified] metres of any structures, including fords, bridges, pylons;
- Excavation shall not exceed a depth of [as specified] metre(s) below the natural riverbed prior to excavation; and a level of 300 millimetres above the level of the flowing water adjacent to the active work site;

- No stockpiling in the river bed or berm, or stockpiling at specified location, for certain volume and time;
- No vegetation removed from river banks or berm;
- Gravel, sand and other natural material shall not be excavated from river channels containing flowing water (shall be [as specified] metres from flowing water);
- Vehicles and machinery shall not enter river channels containing flowing water;
- If it is necessary to cross river channels containing flowing water to access work sites, then temporary culverts shall be installed. These shall not prevent the passage of fish;
- Excavation shall not occur within 100 metres of nesting birds;
- No storage of fuel or refuelling of vehicles and machinery shall be allowed on the bed of a river;
- Works shall not be carried out on weekends or public holidays and works shall only occur between specified hours;
- Within 7 days of completion or cessation of working a site, all deposits [excluding stockpiles] shall be levelled to the natural bed level, the excavation area shall be reshaped and formed to a state consistent with the surrounding natural river bed and any temporary culverts shall be removed;
- Excavation shall cease three months prior to the expiry of the consent;
- Where the consent shall be exercised by any person other than the consent holder, Environment Canterbury requires specific information on that person and for that person to receive guidance on consent conditions from the consent holder;
- The Environment Canterbury shall be notified within seven working days after the completion of excavation;
- The consent holder shall measure the total quantity of material excavated each month and submit this information to Environment Canterbury quarterly;
- Where access to the site is over stopbanks, access shall be via existing access points. The consent holder shall ensure that the stopbank access is maintained with at least 200mm of gravel on top of the crest;
- Review claus;
- Lapsing provisio;

among others.

Gravel extraction consent applicants were still not required to provide technical information on the cumulative adverse effects of their activity. There was still a reliance on ECan River Engineering staff with local knowledge for local effects information. As described above, this suited the purpose at the time; to encourage extraction, reduce costs on extractors, and increase river capacities for flood flows.

However as consented volumes increased, adverse effects were noted at localised sites, and available gravel supplies became uncertain. The information available to ECan engineers or supplied by applicants for the consent process, became inadequate. Although ECan had monitoring data from bed-level surveys, carried out to monitor bed levels in relation to flood protection structures and river flood capacity, this data had not been interpreted for identifying where gravel was available for extraction. This is further discussed under Chapter 8 Monitoring for Gravel Management.

5.3.1 May 2004 – Proposed Natural Resource Regional Plan

In July 2004, ECan notified Variation 1 to the Proposed Regional Resources Regional Plan (Proposed NRRP). This introduced Chapter 6, which includes rules for activities in the beds of rivers. When the Proposed NRRP becomes operative, in its current form, gravel extraction takes under $50m^3$ and $100m^3$ (up to $300m^3$ per year) will be a permitted activity (this varies for specific rivers, refer Chapter 6, Proposed NRRP for details). Gravel extraction over the permitted amount will remain discretionary.

Because both an operative and proposed regional plan must be considered when processing a consent application, the TRP and Proposed NRRP must both be considered. Case law dictates that, in this situation, the rule with the stronger conditions apply for an activity described in section 13 of the RMA. This means that permitted activity rules in Chapter 6 covering the same matters as the TRP will not have effect until the TRP is withdrawn.

However the policy provisions in the Proposed NRRP can give guidance in setting conditions on consents under the TRP's discretionary activity requirements.

5.4 Post October 2004

Since October 2004 ECan's management approach to gravel extraction has changed. ECan staff first became aware of potential cumulative adverse effects occurring from over-extraction in South Canterbury rivers in October 2004. This coincided with a significant increase on consent applications for large volumes and long durations of gravel consents, in combination with seeing physical signs of bed degradation in the Waihi, Pareora and Opihi Rivers.

River Engineering staff then commissioned reports to estimate stopbank freeboard. When these showed that there were some potential issues, the River Engineering Section advised the Consents Section that they were concerned about potential cumulative adverse effects, given the information in the reports, the consent volumes and long durations being sought by applicants.

The Consents Section then advised the applicants, for rivers showing signs of adverse effects, of the following options, depending on locations, volumes and durations sought:

(1) provide information to show that the findings of the reports ECan had commissioned are incorrect, and that more gravel can be taken without adverse effect; or
(2) provide a cumulative effects assessment to show that the cumulative effects of the proposed take on the environment and people are minor and *de minimis* respectively; or
(3) the application is notified due to uncertainty of adverse effects (and in the River Rating Districts the River Engineering Section may be a potentially affected party); or
(4) discuss with the River Engineering Section alternative gravel sources.

Since October 2004, no applicants have chosen to provide cumulative effects information that may allow a long term consent to be issued, due to potential costs and uncertainty of approval, preferring to remain on hold, and wait for ECan or someone else to gather the information. Because so many consents were put on hold, an "interim approach" was put in place to allow limited and controlled gravel extraction, while more information was sought by ECan and investigations for a new management approach were undertaken (i.e. this report). The interim approach provides for limited volume, and duration gravel extraction, which limits the extent of any adverse effects and reduces the consent period to provide flexibility to adapt to any new requirements.

The interim approach, first adopted in October 2004 for rivers showing the signs of over extraction, was developed in consultation with consent applicants and has varied in volumes and consent term as new information on the river applied for has come to hand. At the time of writing this report the interim approach provides for consented volumes to be limited to $<5,000m^3$, for a duration of three months, with a local inspection, for all rivers showing signs of over extraction. Many contractors seeking consents for large volumes and/or long terms have used the short term small volume consents of this interim approach to enable their work to continue.

5.5 Concerns with past and current approaches

Key issues that are a concern in the Canterbury region under the current and past approaches to gravel management.

5.5.1 Length of time to process a consent:

On application for a gravel extraction consent, if all the necessary information is available, either held by ECan or provided by the applicant, a consent usually takes less than one month to process. If an application is put on hold while further information is sought, the process can take a lot longer. If a consent is notified it will also take longer. Because the standard time for a contractor to make a bid for a gravel supply contract is 6 weeks an application that is put on hold, or notified, can take to too long for a the tender process.

5.5.2 Over allocation of resource

The management approach taken by ECan pre October 2004 was not based around measured sustainable limits. Gravel was often viewed as a limitless resource. As discussed above “over allocation” of consented volumes of gravel was considered acceptable management of gravel resources when supplies were considered limitless. Over allocation, on paper, enabled gravel extractors to secure supply before bidding on a tender, avoiding the risk of not getting a consent in time to supply the tender. Because this approach requires an estimation and usually an over estimation on the contractors part, it has been the case in the past that gravel volumes under each consent are not fully utilised. Now that gravel is becoming a more scarce resource and demand has grown, consent holders are more likely to extract to the limit of their consent. This means that over allocation may result in over extraction. Over extraction leads to adverse effects and is inconsistent with the sustainable management requirement of the RMA and the objectives of the Proposed NRRP.

5.5.3 Adverse effects

This interim approach is not suitable in the long term, as it does not ensure that adverse effects of over extraction will not occur, or that current extraction will not exacerbate current over-extraction issues.

5.5.4 Robustness of information on effects of extraction and gravel available

The bed level monitoring programme is general rate funded and has been reduced over time due to pressure on the general rate. The monitoring program is limited both spatially (the number and extent of monitoring sites) and temporally (how often each site is monitored), hindering ECan’s ability to manage gravel extraction volumes, and help make decisions on consent applications. Until recently there had been no work done to interpret this data as there was no budget to reassign in-house expertise or employ external consultants to undertake such analysis.

Where cross-section information is available, reliable and up-to-date, it provides an approximate estimate of changes in gravel volumes for a river, or river reach. However, between cross-sections, volume estimates rely on interpolation. The overall determination of gravel availability is based on an understanding of catchment and river behaviour, river cross section information, and extraction records.

While ECan, and the previous Catchment Boards, have collected data since the 1950’s, little analysis was carried out on this prior to 2004, other than for the Waimakariri River. The main reasons for this were lack of resources and no perceived need. The deficiencies of this gravel management approach became apparent in 2004, and consultants were engaged to analyses existing data on selected rivers, so that staff were in a better position to provide advice on consent applications. For selected rivers some work has been carried out to establish design bed levels and ensure flood protection works are not adversely effected through over extraction.

See Chapter 8 for more information on the current monitoring programme and recommendations for improvement.

5.5.5 Cost of collecting and updating information on gravel in rivers

The issue here is who pays. The current cross-section data collection costs approximately $170,000 per year and if primarily funded from general rates, because of the flood hazard management benefits to the wider regional community. Interpreting this data for the purpose of managing for gravel extraction is not budgeted for, and in the past may only have been carried out in respect to specific consent applications. With the surge in demand for gravel, extraction volumes will be pushed closer to the sustainable limits and more information is needed on gravel availability and sustainable volumes/supply. To this end ECan has funded this RGMR report and associated river reports[2] from the general rate. This information will help improve gravel management for the region, but the extent to which more intensive cross

[2] See the list of Associated Reports for a full list of Priority 1 and 2 River Reports under References.

section monitoring that is likely to be needed, and river reports on available supplies, should be funded by general rate needs further consideration. The primary beneficiaries are:

1. rating districts with flood protection schemes
2. gravel extractors
3. the community though having access to fluvial gravels and better understanding of environmental impacts.

5.5.6 Cost of additional monitoring:

Additional monitoring of the existing cross-section network would involve, additional surveys, recording, analysis, reporting, advice and preparation costs, none of which is presently budgeted for.

5.5.7 Information from consent monitoring

Because of the large number of consents to monitor and the limited resources available, general information and observation from monitoring gravel extraction consent sites are not fed back into any kind of gravel management system. Monitoring volumes of gravel extracted is also time consuming (counting trucks etc) and consent holders prefer to supply returns rather than be charged for ECan staff carrying out monitoring of volumes. However, information supplied by contractors on extracted volumes may not be very reliable, as it is not audited and has not been collected on a regular basis.

5.5.8 Lack of cumulative effects information

The cumulative effects of gravel extraction takes are a real concern because of a number of factors not addressed by the current approach. Since October 2004, consent applicants who have requested large volumes or long-duration gravel consents have been asked to provide an assessment of the cumulative environmental effects of their proposed activity. To date, no contractor has provided this information. The only cumulative effects information available to ECan engineering staff, is that contained in the cross-section surveys and gravel returns. This information is limited spatially and temporally. Without cumulative effects assessments, the Consents Section may not be able to ascertain whether the adverse effects on the environment are minor, and process the consent application.

Chapter 4 Effects of Fluvial and Coastal Extraction

6. Introduction

The effects of gravel extraction are wide-ranging, some positive and some negative, and very much dependant on the conduct of the extractor at the site. Although this report largely focuses on the environmental effects of gravel extraction and changing bed levels for flood capacity and protection of flood control structures, it is acknowledged that recreational activities are also influenced by gravel extraction. Recreation is restricted at gravel extraction sites by noise and safety concerns, e.g. no picnicking or swimming. Where extraction occurs in flowing water the water, become dirty from disturbed sediment deterring swimmers and detracting from amenity values of the river. Extraction can also change the riverbed area either improving or deteriorating the areas for recreational activities. The more knowledge about the site and any recreational uses, the more opportunity for gravel extractors to mitigate any adverse effects or avoid the specific site entirely.

7. Ecological effects of fluvial gravel extraction

The ecological effects of gravel abstraction activities can be wide ranging, depending upon the mining method and the environment being mined. Gravel can be mined intensively from confined areas, or extensively over large areas, and over short or long timeframes. It can also be taken anywhere from the ‘wet’ flowing channel, from dry or ‘wet’ pits on the river fairway, from ‘skimming’ or ‘scalping’ the fairway, or through to excavating higher floodplain areas inundated only on extreme floods. These features greatly affect the extent of ecological effects that might accrue or need to be managed in different situations.

Previous compilations of the effects of gravel abstraction generally relate to impacts on features such as channel geometry, bed elevation and gradient, substrate composition, stability, instream roughness and complexity elements, depth, velocity, turbidity, sediment transport, discharge, and temperature. However, combinations of these can give rise to wide ranging ecological effects.

In the USA, the National Marine Fisheries Service (US NMFS) 2005 has produced a gravel abstraction policy, primarily for the protection of anadromous salmonid fish (salmon and trout) and list thirteen broad classes of ‘effects’. However, the limitation of this policy is that it fails to consider effects upon other ecological components, such as native fish, invertebrate production, aquatic plant and algal growth, and terrestrial flora and fauna (such as birds, reptiles and insects) living on adjacent dry river fairways. Other ecological effects of gravel abstraction can also relate to dispersal of noxious or locally endemic flora and fauna, and biosecurity issues arising from transfer of machinery and gravel between catchments. Therefore, while the US NMFS policy is a useful starting point for compilation of potential adverse effects of gravel abstraction, the list of potential effects in a New Zealand or Canterbury context may be somewhat greater.

Effects (that may be either positive or negative) can therefore be considered under the following headings:

1. Bed degradation

- change in river gradient (velocity)
- decreased bed stability (decreased biological productivity)
- more confined channels

Increased bed degradation generally leads to an overall reduction in ecological productiveness of systems.

2. Increased fine sediment loads, decreased clarity, and sedimentation.
   - turbid plumes affect aesthetics, fish migration, feeding ability,
   - suspended sediment – abrasive and irritant to gills and surfaces of fish and invertebrates
   - fine sediments infill interstitial spaces as a loss of cover, habitat and flood refuge, and spawning suitability for aquatic biota
   - fine sediments deposit on hard surfaces – reduce food production on exposed cobble/gravel surfaces, encourage less desirable algal species to develop
   - fine sediments get trapped within weed and algae – this decreases the food value of them, their aesthetic ‘look’, and shades their production
   - fine sediments bury organic material such as deciduous leaf fall, leading to sediments becoming anoxic and/or toxic
   - fine sediments infill and cover over spawning sites and trout/salmon redds (nests)
   - increased prominence of fine sediments infill and change the sediment composition (character) of lagoons, estuaries and beaches

Overall, the fine sediments (sand, silt etc.) are ecologically the least desirable sediment size classes in rivers and their increased prevalence in the water column, surface of the riverbed, and within the sediments generate a range of adverse effects that degrade aquatic communities and recreational activities and aesthetics. Generally ‘wet’ gravel abstraction cannot avoid selectively extracting the larger sediments and depositing the finer sediments to some degree.

3. Change in channel morphology
   - changes optimum habitat availability
     i. channel depth, velocity, and width
     ii. number of braids or habitat complexity
     iii. migration pathways
     iv. inhibited tributary access pathways (channels)
     v. removal of low flow channel elements
     vi. removal of stable stream elements that act as sources of recolonisation of stream biota
     vii. recreational elements e.g. fishing holes, swimming holes etc.

Overall, changes in channel morphology that arise from gravel abstraction change the natural or status quo river morphology. In general, the changes in channel morphology can greatly affect optimal habitat for a wide range of flora and fauna and activities. They are generally viewed as frequently detrimental changes to ecological values unless specific (sensitive) features are identified and ‘engineered’ into the activities.

4. Removal or disturbance of ecologically important ‘roughness’ elements
   - loss of important stable rock clusters and boulders that act as ‘regugia’ and ‘recolonisation’ sources for plants and animals
   - loss of stable woody debris (logs, stumps, snags) as productive habitat and food production ‘hot spots’
   - preferential removal of certain gravel size classes (boulders or gravels) changes ‘nature’ and suitability of river

Overall, certain ‘roughness elements’ can easily be destroyed if not identified and/or maintained. These provide a disproportionate amount of the ecologically important habitat, production and refugia in rivers.

5. Riparian Zone features
   - destruction of overhanging, shading, or habitat forming vegetation
   - stranding of vegetation features away from river channel such that they receive insufficient moisture
   - isolation of river channels away from important riparian elements (trees, groynes, etc.)
   - loss of shade, terrestrial food sources,

Riparian vegetation features can provide important habitat features that are required to sustain productive ecological communities through provision of shade, habitat stability, and terrestrial food and energy inputs.

6. Direct destruction from heavy equipment operation

- excavation of spawning and nursery redds, lampreys, etc
- compaction and disturbance from roading access
- noise and activity displacement of nesting biota

Operation of heavy equipment can have localised adverse effects on terrestrial and aquatic communities if conducted in reaches where important ecological functions take place (i.e. nesting of rare birds or spawning of fish).

7. Discharges from equipment and refuelling

- discharges of fuel, hydraulic oil, etc

There is the potential for toxic discharges (primarily hydrocarbons) from operation and refuelling of heavy equipment in riverbeds.

8. Reduction in groundwater elevations

- decrease in river surface flow
- decrease in number of productive blind spring channels and other stable (productive) habitat
- subsurface flow at high points
- increase in duration of no flow where flow is intermittent
- dewatering of shallow groundwater fed streams and wetlands alongside one or both sides of rivers
- drying out of riparian vegetation.

Gravel excavation can potentially have a wide range of effects on subsurface flow patterns and groundwater elevations in riverbeds through either changed permeability or changing preferential flowpaths. Shallow groundwater flow needs to be considered as much as surface water flows.

9. Structures and access

- bridges, culverts, causeways, roading, etc. associated with gravel abstraction activities affect different habitat elements (side channels, stable blind channels etc.)
- increased access for other (recreational) vehicles, etc.

10. Change disturbance regimes

- reduce (or increase) ability of floods to change channel courses.
- functional increase in disturbance frequency can prevent adequate recovery cycles for lifecycles of biota to be completed.
- disturb features that slow recovery (dry main channels in seasonally dry streams)

11. Timing relative to:

- bird nesting
- fish migration
- peak angling, whitebaiting
- peak recreational use times

12. Providing habitat/encouraging undesirable pests

- predators (mustelids, cats etc.)
- Canada Geese, Black Backed Gulls

13. Biosecurity risk

- spread of invasive organisms, terrestrial plants, aquatic weeds, nuisance and invasive algae (Didymo, Phormidium etc.), pest fish etc.

14. Stockpiling of aggregate, or retention of pits in riverbeds may directly or indirectly affect all of the above.

Many of the potential effects listed above are currently considered when drafting consent conditions, but difficulties frequently arise in drafting workable, effective conditions to address all of these issues. Some of the major issues above are typically dealt with by avoidance, for instance, conditions that require work to avoid flowing water. Some of these issues are discussed further in the Recommended Best Practice section 10 of this report.

There are a number of actions that gravel extractors can take for positive effects or to mitigate adverse effects, however reports from the US NMFS and Otago Regional Council[3] (ORC), warn that, justifications that gravel abstraction works are environmentally positive are problematical because they inevitably are composed of a wide range of both positive and negative effects and it is unrealistic to expect or prove an overall net environmental gain from such works (only a lessening of adverse effect).

[3] Draft Gravel Management Strategy for the Otago Region

8. Effects on Community infrastructure and flood protection structures

Community infrastructure such as road and rail bridges, and water supply or irrigation intake structures, can be threatened by river bed aggrade or degrade.

In the case of excessive aggrade, bridge waterway capacities would reduce, road approaches would close more often by flooding, and abutments could be more vulnerable to erosion. In the case of water supply or irrigation intakes, aggrade could also cause gravel blockage and increase the risk of flood damage.

In the case of excessive degrade, bridge abutments could be undermined, and pile exposure above bed level could increase, with a resultant increase in the risk of undermining due to scour, or damage during earthquake. Degrade could also reduce headwater levels at irrigation or water supply intakes, and reduce intake flow capacity. Further degrade could undermine intake structure foundations, and cause damage or failure during flood. Other assets within river channels and at risk from degrade include power pylons.

The security of riverside community infrastructure is then reliant on riverbed levels being maintained within an appropriate operating range. Where possible operating ranges for each structure should be obtained from the infrastructure owners or operators.

Currently minimum bed levels are linked to gravel extraction consents for the Waimakariri River Old Highway Bridge and Ashburton River SH1 Bridges. Also degrade at the Pareora River SH1 Bridge is understood to be a concern for Transit NZ, as pile embedment is inadequate to cope with design flood scour depths.

Transit New Zealand, OnTrack, and individual District Councils, have been approached to determine which bridges and other structures are currently at risk from excessive river aggrade or degrade, and to determine appropriate maximum and minimum bed levels. This information should be integrated into riverbed level monitoring programmes, gravel allocation policies, and individual consent conditions as it becomes available.

9. Effects of fluvial extraction on coastal processes and groundwater quality

Sediment supply to the Canterbury coast is derived from numerous sources such as, but not exclusively, rivers, eroding cliffs, eroding beaches themselves and longshore transport from other parts of the coast. Generally speaking mixed sand and gravel beaches make up most of the Canterbury coastline, apart from the beaches of central and southern Pegasus Bay and some of the bay head beaches of Banks Peninsula, where medium to fine sands predominate.

Whether a beach is stable, accretionary or erosional, is dependant on the balance between the quantity of beach sediment entering the coastal system (for example from rivers or cliff erosion) and the quantity of material lost from the system (for example wind-blow into dunes, entrapment in lagoons or estuaries, or abrasion). If the input of sediment to the coast remains the same as the losses, then the coast should remain stable. If losses exceed inputs then the coast will erode. Any reduction in the supply of sediment to the coast could cause a change in this balance, either initiating erosion or exacerbating erosion on an already erosional coast.

9.1 Effects of Direct Coastal Extraction

The reports presented as part of the Regional Gravel Management Report (appendices U,V and W) on the potential annual supply of gravel for the region for the coast, address primarily the question of how much gravel can be sustainably extracted directly from the coastal zone. The extraction of gravels or sands directly from the beach or coastal nearshore zone has the potential for upsetting the coastal sediment budget by starving the coast downdrift of an extraction site of sediment. Direct extraction may also reduce the volume and height of a beach at the location of the take and increase the risk of flooding to coastal hinterland during coastal storm events. Extraction in one particular area of a beach will create a weak point in the beach that may become more vulnerable to coastal erosion processes.

9.2 Effects of river extraction on coastal processes

Gravel supply to the coast and the potential impacts of the reduction in river bedload reaching the coast and the impact that may have on coastal erosion rates has not been addressed in any great detail in this report. Primarily this was due to time and budgetary constraints and could not, unfortunately, be included in the consultants brief. It is obviously a very important consideration and intuitively is a fairly straightforward consideration. If the bedload contribution from a river is important compared with other sediment sources such as eroding cliffs, then any reduction in supply has the potential to increase the rate of erosion. Therefore, gravel extraction from the beds of rivers may decrease the supply of bedload delivered to the coastal system, upset the sediment budget and potentially result in increased erosion rates. Reduction in river bedload delivery to the coast may be offset by accelerated erosion of beaches and/or cliffs as they take up the deficit of material not supplied by river bedload input.

The effects of fluvial extraction on coastal stability may not be immediately obvious. It may take some time, possibly years or even decades, for any bedload deficit to the coast to manifest itself by way of a change in erosion rates. Lag effects propagating down the river and the buffering effect by gravel storage in river mouth barrier/spit complexes would cause such a time lag (Hicks and Todd 2003).

The difficulty arises when trying to quantify the potential impacts of gravel extraction on coastal erosion. Generally this must be done using a sediment budgeting approach but unfortunately, quantities of the various components which go into constructing coastal sediment budgets are still not known to any certainty. River bedload estimates to the coast for many of the regions rivers are still quite uncertain and vary widely amongst researchers. The question of losses of sediment to abrasion is still something of an unknown as is the rate of long-shore sediment transport. The question of the relative importance of a particular rivers bedload supply to the coast in terms of the overall sediment supply (including rivers and eroding cliffs as well as eroding beaches) is important but is dependent on accurate bedload estimates. The relative importance of river bedload supply to the coast can vary depending on the relative contribution of other sediment sources such as cliff erosion. For example, Duncan and Hicks (2001) estimate that river inputs contribute around 72% of beach sized material to the coastal system between the Rakaia River and the Lake Ellesmere/Te Waihora outlet. In comparison, the river input of sediment to the stretch of coast between the Ashburton River and the Rakaia River is approximately 10% of the total input.

Another largely unknown process is how rivers may recover some of their bedload downstream of, for example, an extraction site i.e. does the loss of gravels through extraction fully propagate downstream or does the river recover some of these losses from its channel. Some good research has been undertaken trying to quantify potential effects of river bedload reduction to the coast on erosion rates (Hicks 1998, Duncan and Hicks 2001, Hicks and Todd 2003) but is still reliant on using information that may contain many uncertainties.

What is clear however is that whatever the amount of reduction in bedload reaching the coast, any reduction increases the sediment deficit to an already eroding coast or may begin the start of a deficit on a stable coast. Small amounts of extraction may not have a significant effect but we don't know what a "small" amount constitutes.

9.3 Critical Issues

Critical issues include:

1. The type of coastline and relative importance of river contributions of gravel:
    a. The Waimakariri River (and others such as the Ashley which feed into Pegasus Bay) is essentially a closed system with gravel deposition ceasing about 3 km from the coast; hence there should be little or no effect of river gravel extraction on the coast. The sandy beaches nourished by these rivers are stable to accretionary which indicates the sand fraction reaching the coast is sufficient to maintain the stability of the Southern Pegasus Bay shoreline.
    b. Canterbury Bight rivers (e.g. Ashburton, Orari, Opihi) often directly input gravel to the coast, which is eroding. This must accelerate coastline erosion, but the critical issue is the relative importance of the river gravels to the coastal budget. It is important to recognise that these rivers are 'small' river in that the coarse fraction nourishing beaches from rivers, and the regional long-shore drift, is insufficient to maintain either the river mouth or the adjacent coast against long-term erosion by the sea. Duncan and Hicks 2001 looked at the effects of a potential decrease in 30% in river bedload from the Ashburton, Rakaia and Rangitata Rivers due to damming and found that the relative supply of river gravels compared to the supply from the eroding beaches and cliffs was an important consideration in the impact on any potential increase in coastal erosion. For example they found that a reduction in river bedload from the Rangitata River (which contributes approximately 40-50% of the total sediment supply to the adjacent coast) could increase erosion of the adjacent coastal cliffs from a current 0.4 metres per year to 0.5 metres per year, an increase of 10cm of erosion per year. Reduction in bedload reaching the coast due to gravel extraction from smaller rivers in South Canterbury such as the Pareora and Makikihi, although not contributing large amounts of gravel to the coastal system, may have localised erosion effects on the nearby coastline as extraction of any amount, particularly close to the coast, will contribute to the sediment deficit. This has been pointed out in the Coastal Reports, Appendices U,V and W. Recommendations have been made to further investigate some of these localised effects.

c. Hudson 2000 did some detailed work on this for the River Engineering Section on the Ashburton River for stopbank gravel extraction. Building on a lot of good coastal geomorphology research (e.g. Kirk 1991; Flatman 1997) it was concluded that with lower reach river degradation induced by river re-grading to a new coastline position, and with some by-passing of gravel continuing from upstream (particularly if extraction ceases in the SH1 reach), coastal impacts of gravel extraction in Blands Reach would be no more than minor.

d. Other rivers (e.g. Clarence, Hapuka) have significant deltas indicating large bedload inputs relative to coastal energetics. Project Aqua investigations on the effects of reduction of bedload from the Waitaki dams are not clear cut; but work by Hicks and Todd 2003 has assessed the potential effects of a 50% reduction in bedload supply down the Waitaki at increasing erosion of the Waitaki Fan cliffs by a further 0.5 metres per year. In non dam situations (or with foothill dams with significant upper plains sediment contributions), it is likely that relatively low volumes of gravel extraction from the active channel are unlikely to have significant effects (but "relatively low volumes" still require further definition).

2. Where river gravel is extracted:

   a. Skimming of exposed gravel bars essentially cuts of the conveyor belt of gravel going to the coast.

   b. Off channel excavations (e.g. in the floodplain-bermlands) does not effect gravel by-passing (e.g. gravel starved beaches in the Mataura River are rebuilding after the shift to off channel gravel sources - Hudson 2006).

9.4 Effects of Fluvial Extraction on Groundwater Quality

If gravel extraction occurs from the bed of a river above a shallow, unconfined aquifer, there will be a reduction in the depth of gravel above that aquifer. With a reduction in gravel depth between the bed of the river and the underlying aquifer, the potential exists for leakage from the river into the shallow groundwater system. Although this recharge of groundwater from rivers occurs naturally in some parts of Canterbury, gravel extraction may increase the losses. This will reduce downstream river flows and potentially increase groundwater levels. Leakage of river flow into the groundwater may also result in any contamination within the river flow to filter downwards into the groundwater system.

10. Recommended Best Practice

10.1 Best practice guidelines for fluvial gravel extraction

In carrying out gravel extraction, a variety of measures can be taken to mitigate or improve the river environment for flora, fauna, structure protection and amenity values. Many of these can be undertaken outside of the regulatory framework of consents.

The RMA requires that gravel extraction from rivers should be carried out in such a manner as to minimise adverse environmental effects. From a best practice point of view, maximising flood protection benefit is a significant additional opportunity in many cases. Opportunities are also available for habitat creation or restoration or improvement of recreational aspects of rivers.

Best practice for gravel extraction can differ considerably depending on the location involved. A number of different aspects are discussed below.

10.1.1 Flood protection benefit

From the flood protection perspective, the following key requirements should be satisfied;

- where available, the most recent survey and design bed levels should be used to guide assessment of available gravel;
- there should be no unauthorised excavation or vegetation removal (grass, scrubs, or trees) on the river berm or banks;
- access tracks should be aligned to minimise vegetation removal and the risk of berm or bank erosion during flood;
- there should be no unauthorised gravel or reject material stockpiling on the berm (between the stopbank and river bank) or in the channel fairway (between river banks);
- stockpiles should be sited, shaped, and sized to eliminate any potential increase in bank, berm, or stopbank erosion risk or reduction in flood capacity;
- access ramp construction over stopbanks requires authorisation, and should not increase stopbank erosion risk;
- stopbanks should not be used for gravel extraction access without authorisation;
- gravel extraction should not be carried out too close to the river bank or any erosion protection structures;
- mobile processing plant should only be sited within the channel fairway or berm area if flood capacity is not compromised, and erosion risk to river banks or stopbanks is not increased;
- otherwise mobile processing plant should be sited on the landward side of stopbanks, and outside flood overflow paths and ponding areas;
- selective removal of the coarse or fine components of the natural river bed gravel material should generally be discouraged, as it can destabilise the natural river regime;
- gravel should be excavated, and reject gravel material should be replaced in the river bed, in such a way as to retain the natural channel form;
- in degrading rivers, consideration should be given to encouraging natural erosion of problem beaches rather than gravel extraction;
- gravel extraction should generally not be undertaken below water level, and should not lower the mean bed level below specified design bed levels. There may be specific exceptions to this where potential channel alignment changes are not a concern;
- gravel extraction pilot channels or cuts should duplicate the natural channel form, and be aligned so as bank erosion risk is not increased.

10.1.2 Dry bed/fairway

Issues to consider include:

Skimming

- Timing/distance from birds
- Distance to structures
- Maintaining contours and low flow channel shapes
- Amenity issues

Wet pits

- Siting of extraction to allow adequate separation of extraction from flowing water (including groundwater) to minimise effects on in-stream clarity.
- Positive/negative impacts on recreational use, e.g. swimming holes, fish habitat.

Dry pits

- Level out or shape to avoid river gouging and improve amenity values.

10.1.3 Seasonally dry channels

In areas where there is no surface flow at the time of abstraction of gravel, the dominant low flow channel should be avoided and left intact. The reason for this is that it will have a layer of desiccated algae along its length that will re-hydrate and rapidly become a viable and productive ecological unit within approximately 2 weeks of recommenced flow, compared to 8-10 weeks for a new channel in virgin (disturbed) gravel. This is important in intermittently flowing reaches as it affects the viability of these systems to commence and complete seasonal lifecycles for fish, invertebrates (and as food for riverbed birds) in what can be a relatively short period of available time to seasonally achieve or complete these ecological processes.

10.1.4 Flowing waters

The effects on in-stream life and amenity values suggest that extraction in flowing water should be avoided where possible.

10.1.5 Lagoons

Prevent excessive sediment contamination. Excavate when the tide is out. Investigate to select most appropriate areas, monitor effects and change monitoring practices as required to mitigate effects.

10.1.6 End uses of gravel

Consider the risks of pest transfer. Alternative extraction locations may have lesser risks. Mitigation may include cleaning equipment between rivers and cleaning transportation equipment which enters the river beds.

10.1.7 Degrading river channels

Where a riverbed is naturally degrading, gravel extraction may speed up this process. Bed levels play a significant role in river processes (velocity and gravel movement), and thus in managing effects upon natural environments, structures and amenity values. The extent of the cumulative effects of gravel extraction on each river and on the coast is poorly understood. As acknowledged above (sections 7-9), changing bed levels can have both beneficial and detrimental effects. As an initial indicator, the effects on structures of changing the bed level can provide an indication for where gravel extraction may or may not be appropriate. Where possible, operating ranges for nearby structures should be considered as part of assessing any volumes available for extraction.

10.1.8 Extraction outside of rivers

Land-based excavation outside of the main river channels is discussed in Chapter 7. Best practice guidance has not been developed for this report in these areas, but some relevant comments are included in Chapter 7.

Note: Best practice guidance has not been developed for this report for coastal extraction.

10.2 Environmental effects and the regulation of fluvial gravel extraction

The local environment (e.g. flora, fauna, structures, proximity of people etc) as well as the wider environment (e.g. gravel supply and transport) play a major role in how much impact a particular volume of gravel extracted will have. A variety of potential effects are discussed or listed in the sections 6 through 9 above.

Many of the potentially significant local impacts are addressed in resource consent conditions as discussed under section 5.3 (Post RMA – From 1995) above.

While there is a wide range of potential effects, many of the effects of gravel extraction are difficult to differentiate from natural processes and thus regulate and manage effectively. Because of the perception of gravel as a relatively low value resource and the perception that the effects of extraction are generally minor, the resources directed to ensuring these effects are minor tend to be relatively limited. However, the cumulative effects of long-term, large-scale gravel extraction may be causing significant effects that are difficult to detect, manage or regulate.

It can be very difficult to attribute some of the potential adverse effects of gravel extraction to specific activities. For instance, erosion as a result of flooding tends to be episodic and may be removed in time and/or location from some of the causes. It may be exacerbated by a general bed degradation caused or enhanced by gravel extraction, but in many cases, may not be directly attributable to an activity such as an immediately adjacent gravel extraction operation. At a more general level, potentially adverse cumulative effects such as erosion of the coast may be exacerbated by *any* fluvial gravel extraction, but any erosion identified would be virtually impossible to attribute directly to any specific act or acts.

For instance, for ECan to demonstrate sufficient evidence of environmental effect to effectively use the consent condition review clause (section 5.3) to control consents may be very difficult, costly and time-consuming. Because of the time lag involved in activity and effect, it may also be too late to prevent significant adverse effects from occurring.

General bed degradation, identified by repeatable cross-section survey or similar method, may be the only reliable indicator currently available to warn of the increasing risk of some of these effects (in advance of the effects themselves occurring).

Chapter 5 Gravel as a Resource

11. Historical Quantities

11.1 Historic Gravel Extraction from Canterbury Rivers

Gravel extraction from Canterbury river beds (fluvial gravel extraction) has been undertaken for many years. The main uses include the construction and maintenance of roads, building materials (e.g. concrete production) and bulk fill for stopbanking and landscaping. Gravels are a key resource for a wide variety of end uses.

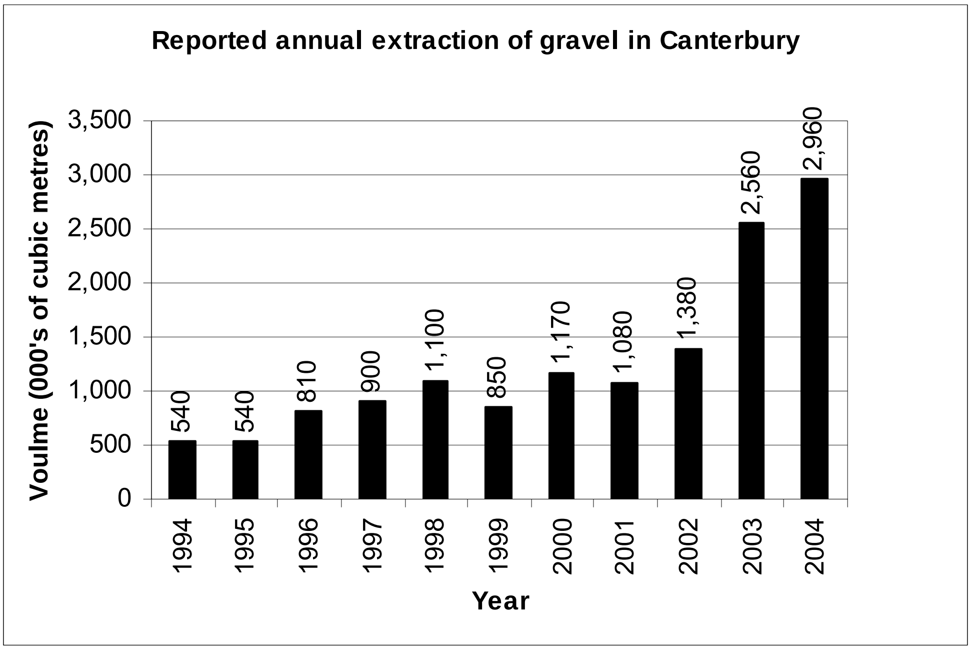
In the 1990's, around 500,000 to 1 million cubic metres of gravel was extracted from Canterbury rivers annually. This rate has increased substantially to nearly 3 million cubic metres in 2004.

River beds often provide an easily accessible supply of gravel. Although gravels are resourced from pits in some areas in Canterbury, access, cost and regulatory hurdles mean that river beds are often favoured by extractors. Extraction from rivers has played a key role in reducing flood risk in Canterbury, as discussed in Chapter 2 Gravel Extraction for Flood Control Purposes.

ECan has kept a database of fluvial gravel extraction volumes since the early 1990's, by requesting consent holders to provide information of how much gravel they had taken (gravel returns). Gravel returns provide a more accurate figure of what is being extracted than consented volumes because consent holders often do not extract the full volume allowed under their consent.

The quantities of gravel reported via resource consent gravel returns in the period 1994-2004 are summarised in Figure 1 below. While the gravel returns requested have largely been completed, these quantities, which rely on a variety of estimation methods and a degree of trust, cannot easily be verified.

Figure 1: Historic extraction rates from Canterbury Rivers



Major extractions have tended to be close to major population centres and not necessarily in the rivers or sections of river with the greatest supply rates.

The major sources of gravel have been (1990-2005):

- The Opihi River and tributaries (33%, 25% in the lower Opihi below Pleasant Point)
- The lower Waimakariri River (26%, 24% within 6km of SH1)
- The Ashburton River and tributaries (6%)
- The Pareora River (5%)
- The Ashley River (4%)

Reported extraction from the Opihi River exceeded reported extraction from the Waimakariri River for the first time in 2002. In 2003 and 2004, extraction from the Opihi River, at more than 1 million cubic metres per year, was greater than twice the extraction from the Waimakariri.

Records of gravel extraction in earlier periods were summarised by Williman and Smart (1987). Their summaries have been assumed to be representative of extraction from the 1960's to the 1980's where other records are not available. Records are available on some rivers, for instance, the Waimakariri has a comprehensive history of extraction since 1960[4], however for many rivers, the available data is less reliable or less well documented. Estimates of annual gravel extraction volumes taken from some key rivers are summarised in Table 1 below.

The 1960's figures tend to be higher than those in the period from 1970 to 1994. They include substantial amounts used for construction of the Christchurch Northern Motorway and stopbanks on some of the major river schemes. Returns from 1990 to 2004 tend to show substantial increases over the period, particularly on the Opihi. The total fluvial gravel extraction for Canterbury shows a six-fold increase between 1995 and 2004. The regional demand for gravel, section 12, includes details of the recent changes in aggregate production for the region and its end use.

Table 1. Average annual gravel extraction volumes (cubic metres/year) from key rivers

<table>
<tr><th>River</th><th>1960's</th><th>1970's</th><th>1980's</th><th>1990-1994</th><th>1995-1999</th><th>2000-2004</th></tr>
<tr><td>Waimakariri</td><td>414,000</td><td>228,000</td><td>191,000</td><td>197,000</td><td>307,000</td><td>394,000</td></tr>
<tr><td>Opihi and tributaries</td><td colspan="3">67,000</td><td>98,000</td><td>174,000</td><td>610,000</td></tr>
<tr><td>Ashburton</td><td colspan="2">84,000</td><td>60,000</td><td>42,000</td><td>65,000</td><td>82,000</td></tr>
<tr><td>Ashley</td><td colspan="3">70-80,000</td><td>≈25,000</td><td>46,000</td><td>61,000</td></tr>
</table>

[4] Prior to 1960, the rate of extraction is understood to be generally much less than the above rates (due to lower rates of road building and other economic activity and the resources and methods available). In the early to mid 1900's, when Catchment Boards and their predecessors were actively pursuing control on the courses of rivers, diversion cuts and channel confinement were probably more significant to the rivers than gravel extraction.

12. Regional demand for gravel

The principal uses of aggregate are the construction and maintenance of roads, and in the manufacture of concrete and concrete products for the building industry. Lesser uses are rock for reclamation, railway ballast maintenance, drainage material, bulk fill, farm tracks, erosion and flood protection. The principal end users of aggregate, the roading and construction industries, are the primary drivers of aggregate demand on both a national and regional basis and the level of this demand is therefore dependent upon the level of activity within these industries. The level of activity within these industries is, in turn, highly dependent on the current state of the economy.

"The demand for aggregates is a function of the level of activity of the construction industry, which is in turn dependent on the economy." [5]

Thus, aggregate demand is highly variable and cyclical, and inherently difficult to predict, as it is essentially a reactive process that responds to changes in the economic climate as these filter through via the primary consumers of aggregate.

There is very limited specific information available regarding projected future gravel demand, and even gravel extractors themselves find it difficult to project future demand, aside from basing rough estimates on historic records. Similarly, projections relating to future economic growth are limited – generally looking only two to three years ahead and only very broadly quantified. The only projections for factors that may impact on gravel demand that extend further than this, are population projections, which extend for up to 20 years.

Therefore, estimating future gravel demand in Canterbury requires consideration of a range of different factors, including:

- historic regional aggregate production and river gravel extraction returns;
- past and projected regional economic trends;
- past and projected regional population change; regional roading expenditure forecasts;
- extractor questionnaire responses; and
- rough industry aggregate consumption measures (e.g. annual per capita aggregate consumption).

When considered together, these provide indications of potential future trends that are likely to impact on gravel demand, and from which a rough estimate of future demand can be made.

Each of these factors is discussed within the following Sections. An estimate of annual gravel demand in Canterbury over the next ten years is then set out at Section 13.8. Section 14 contains a discussion of factors that influence local demand, and gives an indication of the areas where demand could be expected to be concentrated over the next ten years.

13. Projected Regional Demand

13.1 Industry Questionnaire

In order to obtain feedback from gravel extractors on issues related to gravel extraction, gravel demand, end uses of gravel, and existing gravel consent monitoring systems, a questionnaire was prepared and sent to gravel extraction consent holders.

A copy of the questionnaire is attached at Appendix A.

The questionnaire was sent to all consent holders with a total annual consented extraction volume of more than 5000 cubic metres (m^3). This was a total of 70 extractors, based on

[5] www.minerals.co.nz

data provided by ECan showing all gravel consent holders as at September 2005. For the purposes of recording responses, extractors were grouped on the basis of the total annual volume for which they have consent to extract, as follows –

a. >100,000 m^3/yr
b. 50,000m^3 to 100,000 m^3/yr
c. 20,000m^3 to 50,000 m^3/yr
d. 5,000m^3 to 20,000 m^3/yr

There were 7 extractors in group (a); 9 in group (b); 13 in group (c); and 41 in group (d).

Despite several ‘rounds’ of follow-up calls to recipients, only 31 of the 70 questionnaires were returned, giving a response rate of 44%. Although this level of response was disappointing, the feedback received was useful, and responses were received from extractors within all of the representative size groups. It is possible that this relatively low rate of response may improve as the relationship between ECan and extractors matures. To assist this, it has been recommended in the “Monitoring for Gravel Management” report that a Gravel Users Group be established to improve and facilitate exchange between ECan and gravel extractors.

Feedback received was collated and analysed, and in most cases the resulting data converted to percentages. The results are referred to at relevant sections within this report. Specific feedback and respondent names have not been included with this report, to ensure that information that may be commercially sensitive is protected.

13.2 Regional Aggregate Production & Gravel Extraction Returns

13.2.1 Regional Aggregate Production

Records of industrial mineral production in New Zealand were sourced from Crown Minerals, Ministry of Economic Development[6]. This data shows annual production of minerals on a national and regional basis. Historic records are extensive, however due to organisational and data collection process changes, the most consistent and comparable records are those for 1998 to 2004.

The data is broken down to show totals for metals, non-metals (including aggregate), and coal. The non-metals figures include land-based, coastal, and river-based sources and are based on an annual industry survey to obtain operators’ annual production figures.

Where operators extract under a Crown Minerals licence, they are obliged to submit returns to Crown Minerals, and these can be audited. There are only a small number of operators with Crown Minerals licences, and therefore there are some potential limitations in the accuracy of the data, as it is dependent upon the rate of response and the accuracy of the records provided (Kazianis 2005). In addition, the survey process focuses primarily on the larger operators, and therefore on a regional scale may potentially under-represent total production as smaller operators are not always surveyed.

Within the non-metals category, data is further broken into separate commodities, including the following –

- Building and dimension stone
- Rock for reclamation and protection
- Rock, sand, and gravel for building
- Rock, sand and gravel for roading
- Rock, sand, gravel and clay for fill
- Recycled material

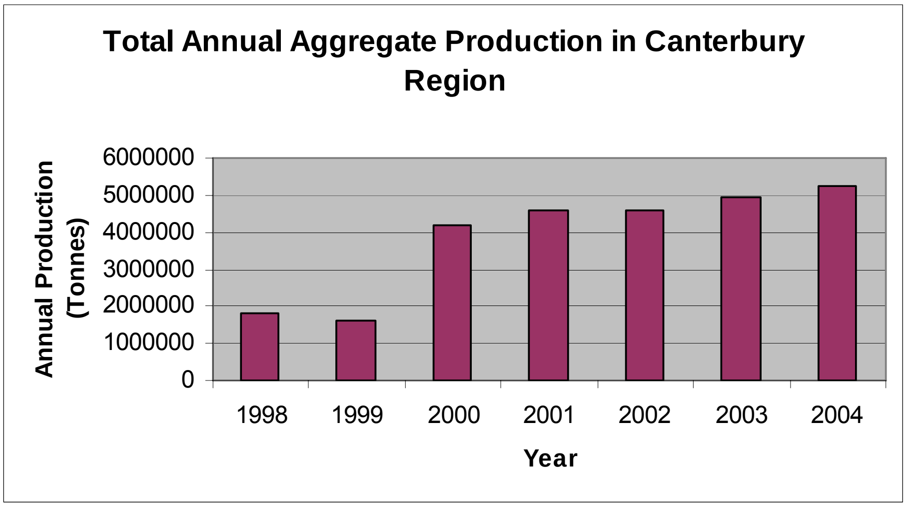
[6] www.crownminerals.govt.nz

- Sand for industry

Assuming that these commodities are generally indicative of aggregate production, the data shows a significant increase in demand over the past five years (1999 to 2004). Over the 7 years 1998 to 2004, regional production increased by 189% from 1.8 million tonne (Mt) in 1998 to 5.2Mt in 2004. (Refer Figure 2)

Although the average annual increase over the period 1998 to 2004 is approximately 29%, this figure is primarily a consequence of the significant increase that occurred between 1999 and 2000, when production increased by 158% from 1.6Mt to 4.1Mt. It is unclear what this spike in production is due to, however since then, production has increased at a much more even average annual rate of 6%. This rate of increase is more consistent with the national average annual increase over the full period 1998 to 2004 of 7%, and is considered likely to be more reflective of what could be expected into the future in Canterbury.

Figure 2[7]



13.2.2 Gravel Extraction Returns

As a condition of river gravel extraction consents, ECan requires all extractors to file quarterly returns showing the volume of gravel extracted over that quarter. These returns provide a record of the annual amount of gravel extracted from Canterbury rivers, and when considered over time can give an indication of the changes in demand for river gravel. Although in some parts of the region records are available for longer, data for all parts of the region are only available from 1993 onwards.

It is important to note that the accuracy of these records may be limited due to several factors. Firstly, the accuracy of the records is entirely dependent on extractors providing full and accurate return figures. Secondly, although all extractors are required to show their returns in m^3, the basis upon which extractors calculate their returns varies, and can include truck movements, aggregate sales, and loader buckets. And thirdly, returns for 2003, 2004 and the first half of 2005 were not collected until August 2005. Given this time lapse, it is possible that extractors may not have retained accurate records for these years, and therefore may have given rough estimates.

Figure 3 below shows the gravel return figures for 1993 to 2004. This data shows an increase in the annual amount of gravel extracted from Canterbury rivers from about 470,000m^3 in 1993 to about 2,960,000m^3 in 2004. Prior to 2000, there was a peak in 1998, followed by a marked decline in 1999, and then a rebound to just over 1998 levels. The graph also clearly shows that the rate of annual increase in extraction has increased significantly in the last three years over that which occurred prior to 2002. This increase is

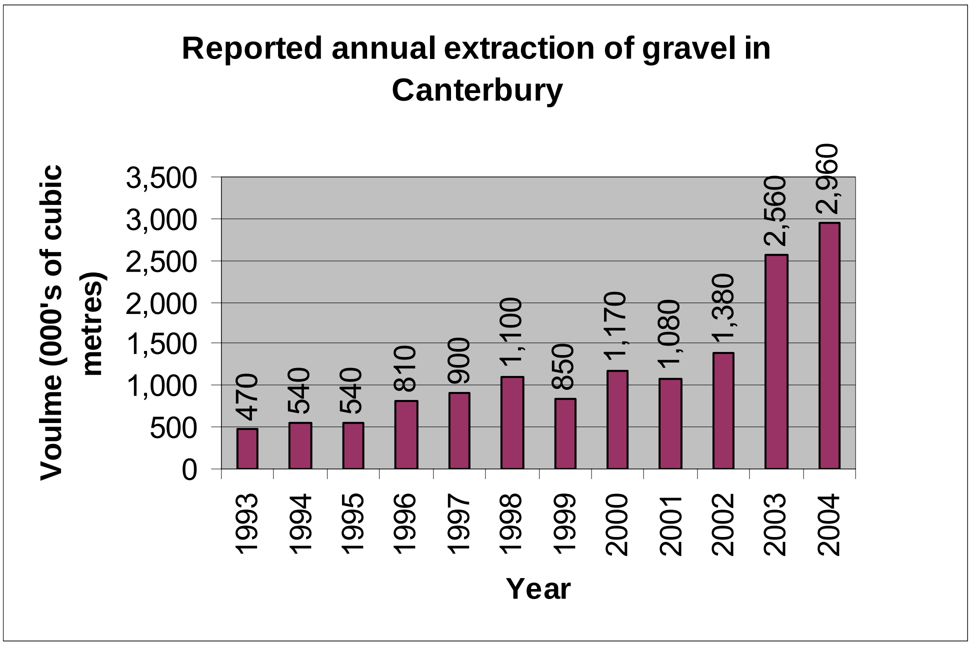
[7] www.crownminerals.govt.nz

consistent with the strong economic climate and performance within the construction sector over the past 3-4 years.

On a year to year basis, the percentage change in the volume extracted ranged from –23% to +85%. This indicates that gravel demand can vary significantly from year to year. However, when considered over the 11-year period, there has been an average annual increase of 21%.

When the total regional aggregate production figures are compared with the gravel extraction returns data for the same time period (1998 to 2004), the two data sets provide a similar picture of significant average annual growth of 29% and 23% respectively. Over the past four to five years (2000 to 2004) however, the rate of increase has been much stronger for gravel extraction returns (30%) than for total regional aggregate production (6%). The reason for this is highly uncertain given the inherent limitations of both sets of data. Therefore, aside from identifying general trends over relatively long periods, it is very difficult to draw any certain conclusions from comparing these data sets.

Figure 3[8]



13.3 End Use – The Key Drivers of Demand

The two principal drivers of aggregate demand are the roading and construction industries, which respectively represent around 60% and 20-30% of annual aggregate demand in Canterbury[9]. This is illustrated in the annual aggregate production figures for Canterbury from 1998 to 2004[10] (Figure 4), and the end use data obtained through the Extractor Questionnaire[11] (Figure 5). This demand-share split appears to be relatively consistent, with limited variation in the respective percentages shown in the aggregate production data for each year over the period 1998 to 2004. This annual data is attached at Appendix B.

As the biggest user of aggregate, the roading industry is the main driver of gravel demand. New road construction can have a significant impact on gravel demand, given that the construction of each 1km of standard two-lane highway consumes over 4000t (approximately

[8] Data received from ECan gravel returns database as at 8th December 2005. Data has been rounded to the nearest 1000m^3.
[9] www.crownminerals.govt.nz, NZ Industrial Mineral Production 2000-2004.
[10] www.crownminerals.govt.nz, NZ Industrial Mineral Production 2000-2004.
[11] MWH Gravel Extractor Questionnaire, 2005 – Appendix A.

2000m^3[12]) of aggregate.[13] However, on-going maintenance of local roads and state highways is the area the generates the greatest demand for aggregate, as is shown in the projected expenditure figures in the National Land Transport Programme and Transit's ten-year forecast discussed below.

Two of the key indicators of the projected level of activity in the roading sector are the National Land Transport Programme (NLTP) and Transit New Zealand's ten-year Year State Highway Forecast. Both of these forecasts are produced annually and give an indication of future funding for land transport on a regional basis.

Although these documents contribute useful information upon which estimates of future gravel demand may partly be based, it is important to note that the funding allocations and projections within them can be subject to quite considerable change.

Figure 4: Regional Aggregate Production – End Use

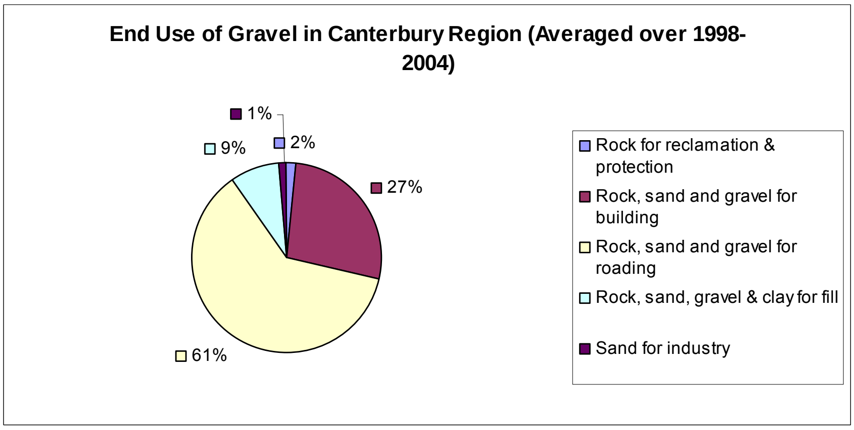
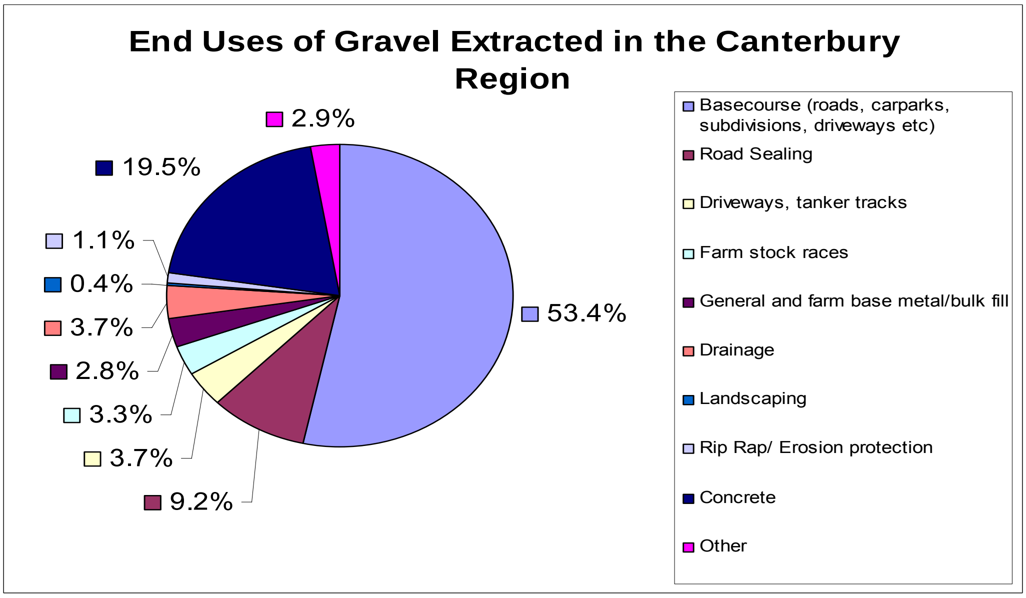


Figure 5: Gravel Extraction Questionnaire End Use Figures



[12] An accurate conversion from tonnes to m^3 is dependent upon the density of the particular material. In relation to aggregate, this can range from about 1.8 tonnes to 2.5 tonnes per m^3. In this document, all conversions are based on a conversion rate of 2 tonne/m^3.
[13] www.aqa.org.nz

13.3.1 National Land Transport Programme

The NLTP is set each year by Land Transport NZ (LTNZ) (previously Transfund). The programme outlines the annual funding for New Zealand's land transport system, and is the mechanism through which LTNZ allocates funds to approved organisations for land transport infrastructure and services. The NLTP includes nationally distributed funds and regionally distributed funds, and each region receives a combined annual allocation. Funding is allocated to a number of different land transport activity classes, including local road and state highway maintenance, and local road and state highway construction.

There has been a slight decrease in the total amount allocated to Canterbury for 2005/2006 from the previous year's allocation. The allocated portions that impact most on gravel demand are road construction (local roads and state highways) and road maintenance (local roads and state highways). For the 2005/2006 year, construction funding has decreased 22% from the 2004/2005 year to $21.92 million, while maintenance funding has increased 8% to $58.34 million.

The amount of funding allocated under the programme can change as the year goes on, as additional projects receive funding approval.

A ten-year financial forecast is also included in the NLTP. This includes annual forecasts of the regionally distributed proportion of funding on a region by region basis. This proportion of allocation is based on population projections for each region. Over the period from 2005/2006 to 2013/2014, Canterbury's allocation of regionally distributed funds is forecast to steadily increase at an average annual rate of 2.5%, while a drop in funding is forecast at the end of the ten-year period from 2013 to 2015.

13.3.2 Transit Ten-Year State Highway Forecast

Transit New Zealand also produces a ten-year State Highway Forecast on an annual basis. This sets out Transit's long-term projections for state highway improvements and maintenance and is broadly based on the NLTP ten-year financial forecast for state highway expenditure. Table 2 below is reproduced from Transit's ten-year forecast (Table C1) and shows forecasts of expenditure on state highway maintenance and improvements for the Canterbury region.

This forecast indicates an expected increase in expenditure from $48.5 million in 2005/2006 to $102.5 million in 2014/2015. The rate of increase in expenditure is fairly steady over the first five years, increasing at an average annual rate of just over 7%. However, expenditure is expected to increase considerably over the period 2010 to 2012, before dropping back in 2013 and decreasing at a gradual rate over the following two years.

Table 2: Canterbury Region Forecasts of Expenditure on State Highway Maintenance and Improvements[14]

	05/06 ($M)	06/07 ($M)	07/08 ($M)	08/09 ($M)	09/10 ($M)	10/11 ($M)	11/12 ($M)	12/13 ($M)	13/14 ($M)	14/15 ($M)	Total ($M)
Maintenance											
Structural	17.2	17.9	19.3	20.2	21.1	22.0	23.0	24.0	25.0	26.2	215.7
Corridor	7.3	7.6	8.2	8.6	9.0	9.4	9.8	10.2	10.7	11.1	91.9
Professional Services	3.6	3.7	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	44.9
Property Management	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.1	9.3
Preventive Maintenance	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	2.7
Emergency Works	1.1	1.5	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	19.3
Sub-total	30.2	31.7	34.4	35.9	37.5	39.2	40.9	42.7	44.6	46.6	383.9
Improvements											
Minor Safety Projects	2.2	2.3	2.5	2.6	2.8	2.9	3.0	3.1	3.3	3.4	28.1
Committed Projects	4.2	0.0	0.0	0.0	-	-	-	-	-	-	4.2
New Projects	6.3	10.1	11.8	11.9	15.7	33.7	60.4	54.4	48.1	44.5	297.0
Property Purchase	5.6	5.8	6.0	6.3	6.5	6.7	7.0	7.3	7.5	7.8	66.4
Walking & Cycling	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Sub-total	18.3	18.4	20.4	20.9	25.0	43.4	70.5	64.9	59.0	55.9	396.7
Total	**48.5**	**50.1**	**54.8**	**56.8**	**62.5**	**82.6**	**111.4**	**107.6**	**103.6**	**102.5**	**780.5**

The marked increase over 2010 to 2012 is expected to be due to a number of relatively large projects in the Christchurch area that are forecast for construction over this period. These include:

- SH73 Christchurch Southern Motorway extension (begin 2009/2010)
- 4-Laning Sawyers Arms Rd to Memorial Ave (begin 2009/2010)
- 4-Laning Yaldhurst Rd to Waterloo Rd (being 2011/2012)
- 4-Laning Memorial Ave to Yaldhurst Rd (begin 2011/2012)

Additional demand in the Christchurch area is also indicated by figures associated with the Greater Christchurch Urban Development Strategy, which predicts that $2 billion will need to be spent on the roads around the Greater Christchurch area by 2021.[15]

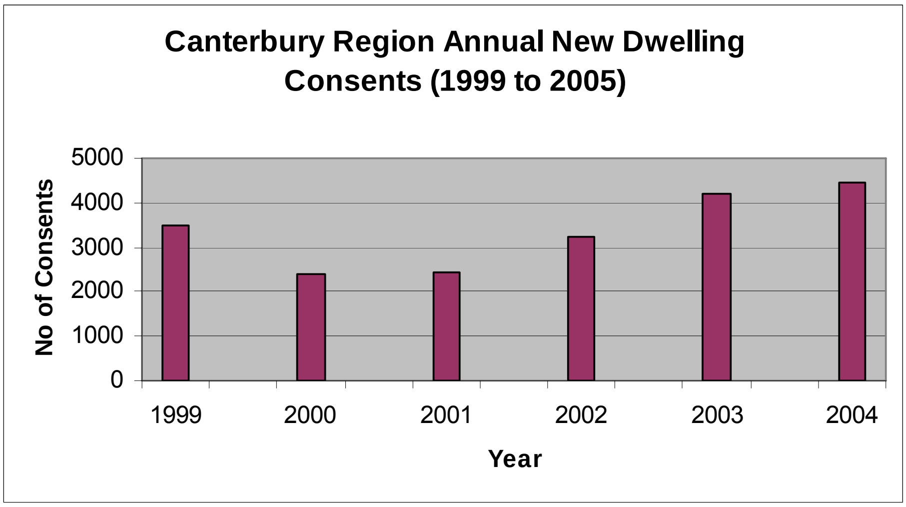
Based on the current NLTP and Transit's ten-year forecast, it is anticipated that demand for gravel from the roading sector in Canterbury is likely to increase over the next ten years at a relatively gradual rate. There is likely to be a peak in demand around the Christchurch area over the period 2010 to 2012, however, over the full ten-year period the average annual increase in demand throughout the region is likely to be between 5% and 10%.

13.3.3 Building Consents

Another key area of demand is the construction industry. Historical data is available for the annual number of new dwelling consents issued regionally for the period 1999 to 2005.[16] The data for Canterbury is shown in Figure 6 below. It is important to note that the data for 2005 only covers the period January to August. To provide an annualised figure for 2005 this has been multiplied by 0.33, however the discussion below only addresses the period 1999 to 2004. In addition, the new dwelling consents only represent part of the construction sector activity, which also includes non-residential construction. Unfortunately regional data for non-residential consents was not readily available.

[14] Transit New Zealand.
[15] Greater Christchurch Urban Development Strategy.
[16] Statistics New Zealand

Figure 6



These data show a drop in house construction around 2000, followed by a strong period of growth from 2001 to 2004, with an average annual increase over that period of almost 5%. This period of strong growth is consistent with the “building boom” that has been occurring over the past few years. The data indicates a sharp drop in 2005, which may be due to the introduction of changes to the Building Act in April 2005, and/or to the start of a slow down in the construction industry, which has been suggested within the media over recent weeks (November 2005). On a year to year basis for the period from 1999 to 2004, there have been considerable fluctuations in the number of consents issued, with the annual percentage change ranging from a decrease of 24%, to an increase of 2%, to an increase of 32.5%. This indicates that there can be considerable variation within the residential construction sector from year to year. However, when considered over the full period 1999 to 2004, there has been an average annual increase of 4%.

Based on these building consent figures, and recognising that they represent only the residential portion of the construction sector, it is anticipated that demand for gravel from the construction sector in Canterbury is likely to increase over the next ten years at an average annual rate of around 4% to 5%.

13.4 Economic Activity

As outlined above, the primary drivers of aggregate demand are the roading and construction industries, which make up between 80 and 90% of total aggregate consumption. The level of activity within these industries is strongly linked to the status of the economy – generally, where there is strong economic growth, there is commensurate growth in construction, and investment in infrastructure and roads. This then filters through to the raw materials market, including aggregate.

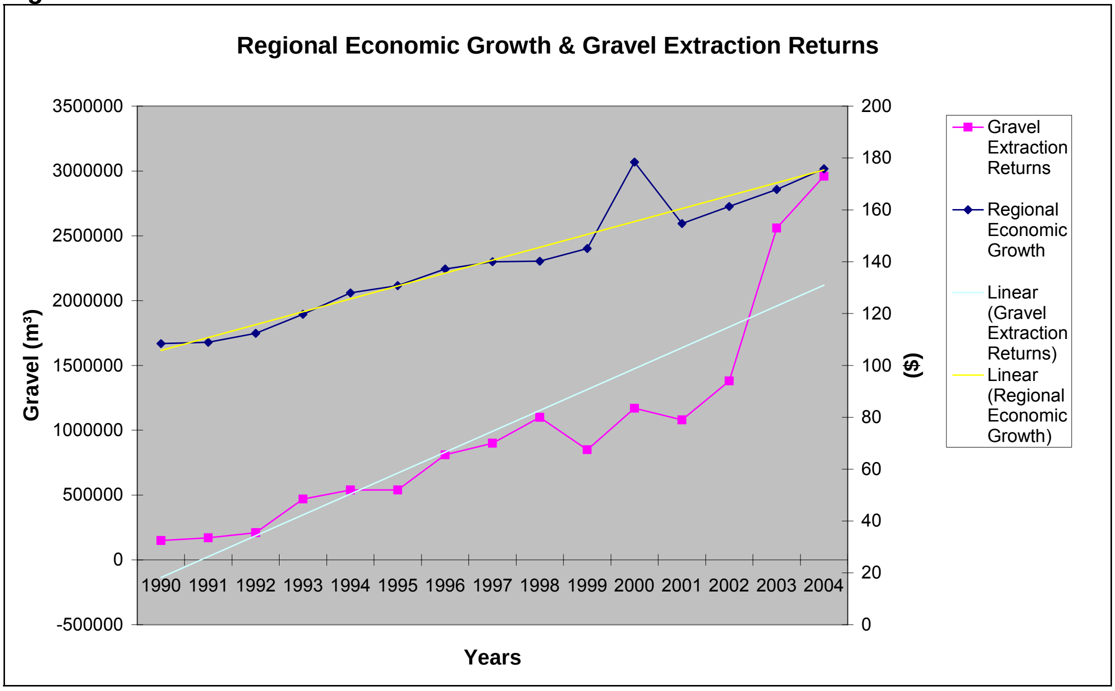
Data for Canterbury economic growth over the period 1990 to 2005 indicates an average annual increase of about 5%. Steady growth at just below average levels occurred over the early 1990’s, followed by a slight slow-down through the mid to late 1990’s, and then a sharp peak in 1999/2000. This was followed by a drop in 2001, and a return to more average levels of growth through to 2005.

When the national economy is considered over the same period, it follows a similar trend of steady growth, with a dip in 1998 (likely to be associated with the Asian economic downturn), followed by continued steady growth. The exception to this consistency in trends is the regional peak in 2000, which is not reflected in the national data.

When regional economic data is compared to the regional river gravel extraction returns, the results indicate that there is a greater degree of variability and oscillation in the gravel extraction data on a year to year basis than the economic data (see Figure 7). Given the dominance of two particular sectors on gravel demand (roading and construction), gravel extraction and aggregate production figures are expected to be highly sensitive to short term fluctuations in the level of activity within these two industries. This makes gravel demand a relatively reactive function, and therefore results in considerable variability in gravel demand on a year to year basis. In comparison, regional economic growth data takes account of all industries, and is therefore influenced by a greater range of factors that when combined, can result in a dilution of their respective influence on the overall regional figures. Therefore, fluctuations in overall growth are generally likely to be lesser in scale and frequency than fluctuations in the gravel extraction data. Given this, it is considered that general regional economic data is not sufficiently sensitive to be used as the only or principal tool in gravel demand projections for gravel management purposes. Subsets of data that reflect the roading and construction industries are likely to provide a more accurate basis for gravel demand projections.

The linear trend lines in Figure 7 indicate that in very broad terms, regional economic activity and gravel extraction rates follow a similar increasing trend. However, over the past ten years (1994 to 2004), the demand for gravel appears to have increased at a significantly higher rate than the rate of regional economic growth, with an average annual increase of 22% and 3.5% respectively.

Figure 7[17]



On a national scale, there has been an average annual increase in total aggregate production of 7% over the period 1998 to 2004. This is greater than the average annual increase of 4% in the national GDP, however it is closer to the national construction sector GDP, which increased at an average annual rate of approximately 8% over the same period. This suggests that the latter represents a better indicator of gravel demand.

The steady growth in the Canterbury economy of the past few years is, however, expected to slow in the near term. Current forecasts indicate that the South Island economy is cooling, with the annual rate of economic growth forecast to fall from 3.8% to 3.2%[18]. Although this cooling trend is expected to continue for a few years, economic growth is still predicted, but at a slower rate than the past few years. In the Canterbury region, there has most recently been a decline in economic growth, with growth of 2.2% (quarter for quarter) in quarter 1 of

[17] Gravel Extraction Returns data supplied by Environment Canterbury; Regional Economic data sourced from National Bank New Zealand.
[18] Mainland Monitor, The Press, Christchurch, October 12th 2005.

this year, giving way to a 0.4% drop in quarter 2. This has been primarily attributed to the Canterbury economy's exposure to manufacturing and tourism, which are particularly vulnerable to recent high exchange rates and increased oil costs.[19] House sales growth in the Canterbury region was also flat over the last quarter and signs are that the market is cooling, as is the rate of increase in house prices.

Based on the information above, although regional economic activity data can provide an indication of broad trends, it is generally not sufficiently sensitive to provide a good indicator of likely changes in gravel demand. A more useful indication of gravel demand is likely to be found in the more specific patterns of activity within the roading and construction sectors, which have a direct and determinative impact on gravel demand.

13.5 Population

One of the key factors influencing the level of economic activity in a region is population growth. A growing population tends to generate increased construction activity, investment in infrastructure, and a general increase in the level of economic activity. Given that the state of the economy impacts on the level of activity in the roading and construction industries, which in turn are the key drivers of aggregate demand, regional population trends are a factor that should be considered in estimating future demand for gravel resources. In addition, when annual aggregate production figures are considered on a region by region basis, there appears to be a strong link between aggregate production and population, with the Auckland and Waikato regions showing by far the highest level of aggregate production. It is likely that the high Waikato figures are strongly influenced by demand from Auckland, which is increasingly sourcing aggregate from northern Waikato as increasing pressure is placed on the remaining aggregate sources within the Auckland region.

Past, present, and projected population data for the Canterbury region has been obtained from Statistics NZ[20]. This includes the 1996 and 2001 census data, and estimated and projected population figures based on the 2001 census. The Canterbury population has increased by 45,900 over the past 9 years, from 480,400 in 1996 to an estimated 526,300 in 2005. This is projected to increase by another 17,300 over the next 6 years, and then by another 15,000 in the following five years to 2016. By 2026 the Canterbury population is projected to reach 584,400. These figures indicate that although the population of the region is expected to continue to grow, this will be at a slower rate than that of the past decade, as shown in Table 3. This trend is also reflected in the NLTP and Transit's latest ten year State Highway Forecast.

Table 3: Canterbury Population Change 1996 to 2026

Period	Change		
	Number	Percentage Increase	Average Annual Rate of Change
1996 to 2005	45,900	9.5%	1%
2005 to 2016	32,300	6%	0.6%
2016 to 2026	25,800	4.6%	0.5%

A broad measure of national aggregate demand that is used by industry bodies is a per capita measure that has been calculated on the basis of current population data and annual aggregate production figures. This gives a rough measure of approximately 6t (approximately $3m^3$[21]) of aggregate per person per year[22]. However, when Canterbury population figures are compared with total regional aggregate production figures, they indicate that 6t/pers/yr is a conservative measure, and that in fact, aggregate production over the past five years indicates that demand is now closer to 9t/pers/yr, and over that period has increased at an average annual rate of 0.4t (approximately $0.20m^3$) per person.

[19] Mainland Monitor, The Press, Christchurch, October 12th 2005.
[20] www.stats.govt.nz
[21] An accurate conversion from tonnes to m^3 is dependent upon the density of the particular material. In relation to aggregate, this can range from about 1.8 $tonnes^3$ to 2.5 $tonnes^3$ per m^3. In this document, all conversions are based on a conversion rate of 2 $tonne/m^3$.
[22] www.minerals.co.nz

Applying this rate of demand to available projected population numbers indicates that annual demand for gravel in Canterbury may increase from 5,748,660t (approximately 2,874,330m^3) in 2006 to 8,323,140t (approximately 4,161,570m^3) in 2016. This is a total increase of 2,574,480t (approximately 1,287,240m^3) or approximately 45%, at an average annual rate of 4.5%.

13.6 Industry Projections

In the Gravel Extraction Questionnaire, extractors were requested to provide demand projection figures for their organisation if they were available. Of the 31 responses received however, only 12 extractors provided an indication of projected future demand. In considering the responses received, it has been assumed that the future demand from extractors that currently hold consents to extract more than 50,000m^3 per year will have the greatest impact on future demand generally. Responses were received from six of these extractors and five provided an indication of projected future demand. Two of these respondents use gravel for specific purposes that change little from year to year, and therefore their projected future demand will be consistent with their historic demand. The other three extractors projected their gravel demand over the next ten years to increase at just over 1% per year; at between 5-10% per year; and at roughly 10% per year respectively. The latter two represent the two largest gravel extractors to respond to the questionnaire, and they indicated that although they do not have specific projection figures, their projections are roughly based on historic increases in demand. This projected increase in demand of between 5% and 10% is consistent with the average annual increase in aggregate demand shown by the regional aggregate production figures for the past five years (2000 to 2004) of 6%.

13.7 Out of Region Demand

Gravel extractors were also asked to indicate in the Gravel Extraction Questionnaire where the gravel they extracted was used – locally, regionally, or outside the Canterbury region. The overwhelming majority of responses indicated that gravel is used locally, with only one or two cases of aggregate being used regionally. In only one instance was it indicated that aggregate is used outside the Canterbury region. However, it is assumed that in some instances, where gravel is extracted within Canterbury but close to regional boundaries, the gravel may be used for end uses that in fact lie outside Canterbury, as proximity is a far more significant driver for where gravel is sourced than the presence of a regional boundary. It has been assumed that in these instances, extractors have probably indicated that the gravel is used locally.

Aggregate is a relatively low value commodity, and therefore transportation costs make up a significant proportion of the cost of production and supply. This means that unless supply in a particular region is so limited that it pushes the price of aggregate to such a level that the influence of transportation costs is significantly reduced, out of region demand is likely to continue to be limited to areas adjoining regional council boundaries.

13.8 Conclusion

When all of the factors discussed above are taken into consideration, it is estimated that the demand for aggregate in Canterbury over the next ten years is likely to increase at a similar average annual rate to that of the past ten years. On a year to year basis, the level of demand may fluctuate quite considerably, and a predicted slow-down in the regional economy (including the roading and construction sectors) in the next few years is likely to result in a commensurate decrease in aggregate demand. Given the variability in year to year aggregate demand, it is impossible to accurately quantify what the specific annual demand will be. However, when averaged over the ten-year period, it is possible to estimate the annual demand for aggregate based on an average annual increase.

This estimate is however, based on a range of different data sets, each of which has inherent potential limitations, either in terms of the extent and accuracy of the data itself, or in terms of the sensitivity of that data for the purposes of projecting regional aggregate demand. Therefore, the estimate is based on trends indicated by these different data. In addition, this estimate is for regional demand for aggregate generally, rather than specifically for river-sourced aggregate. In order to provide an accurate projection of future demand for river-based aggregate, a much greater degree of accuracy in gravel extraction returns data and land-based extraction data would be required.

Historic records for total regional aggregate production and for river based gravel extraction returns indicate that over the past ten years, regional aggregate demand has increased at an average annual rate in the order of 20% to 25%. On the basis of historic growth in demand, gravel extractors predict demand to increase by between 5% and 10% per year. Economic forecasts and population projections indicate continuing growth in the Canterbury region, however at a slower rate than has occurred over the past five to ten years.

Using population data and regional annual aggregate production figures, an annual per capita measure can be estimated. Over the past five years (2000 to 2004), aggregate demand has averaged about 9t/pers/yr (approximately 4.5m^3/pers/yr), and has increased at an average annual rate of 0.4t/pers/yr (approximately 0.20m^3/pers/yr). Applying this to projected population figures for the next ten years indicates an average annual increase in gravel demand of 4.5%.

Consideration of projected regional roading expenditure indicates an average annual increase in gravel demand from this sector of between 5% and 10%, and analysis of past residential building consent numbers indicates an average annual increase in demand from the construction sector of between 4% and 5%.

Based on all of these factors, an average annual increase in regional aggregate demand of 8% has been estimated for the next ten years. A similar annual rate of increase could be expected beyond ten years, however given all of the factors that influence gravel demand, it is unrealistic to quantify annual demand beyond ten years. Using total regional aggregate production figures for 2004, an average annual increase of 8% equates to a demand for 12,272,815t (approximately 6,136,422m^3) of aggregate in Canterbury by 2015. Assuming this annual rate of increase, the estimated annual amount of gravel required in Canterbury from 2005 to 2015 are set out in Table 4 below, and shown in Figure 8.

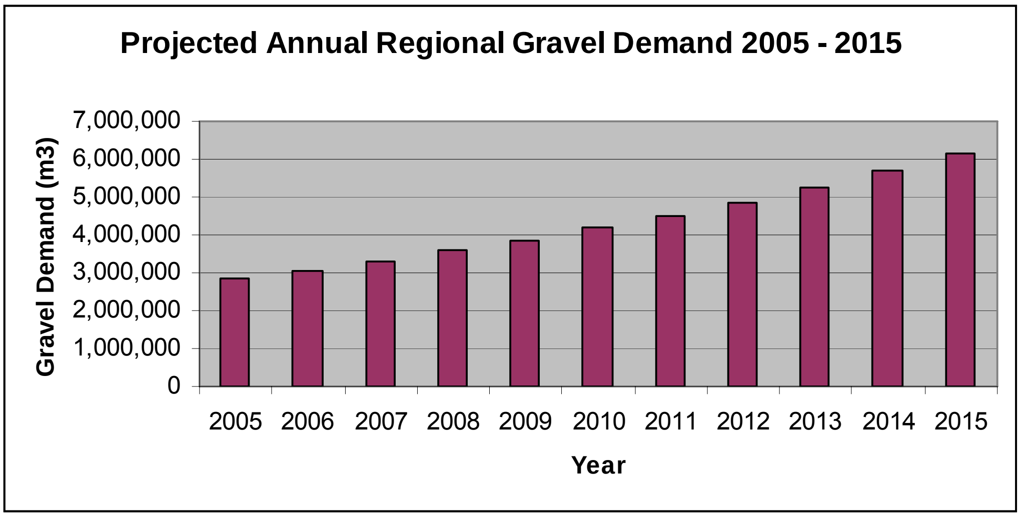
Table 4: Projected Annual Regional Gravel Demand 2005 to 2015[23]

Year	Gravel Demand (m^3) [24]	Gravel Demand (t)
2005	2,843,000	5,685,000
2006	3,070,000	6,139,000
2007	3,316,000	6,631,000
2008	3,581,000	7,161,000
2009	3,867,000	7,734,000
2010	4,177,000	8,353,000
2011	4,511,000	9,021,000
2012	4,872,000	9,743,000
2013	5,261,000	10,522,000
2014	5,682,000	11,364,000
2015	6,137,000	12,273,000

[23] These figures have been rounded to the nearest 1000t or 1000m^3

[24] An accurate conversion from tonnes to m^3 is dependent upon the density of the particular material. In relation to aggregate, this can range from about 1.8 tonnes to 2.5 tonnes per m^3. In this document, all conversions are based on a conversion rate of 2 tonne/m^3.

Figure 8


Projected Annual Regional Gravel Demand 2005 - 2015
Gravel Demand (m3)
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year

14. Influences on Local Demand

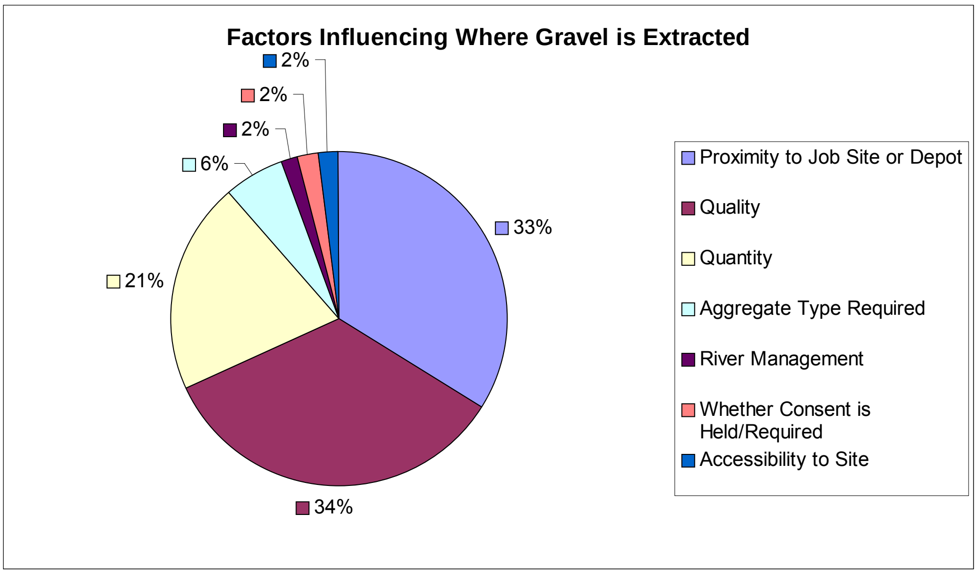
14.1 Factors Influencing Choice of Supply

As part of the Gravel Extraction Questionnaire, gravel extractors were asked to indicate the key factors that influence where they seek to source their gravel. The responses received indicate that the principal influences are:

1. Proximity
2. Quality
3. Quantity

Each of these factors is discussed below. In addition to these, the accessibility to a site, whether a consent is held or not, and river management works made up the remaining drivers behind gravel extraction locations. A breakdown of this feedback is shown in Figure 9 below.

Figure 9[25]



14.1.1 Proximity

Gravel is a relatively low value commodity, and economic margins for production are relatively small. Given this, transport costs are a major factor in the economics of supply. Given this, rivers and land-based aggregate sources close to population centres tend to be the focus for demand. Even distances of only a few kilometres can be determinative, as illustrated in the Christchurch area, where a number of extractors prefer to extract aggregate from land-based pits close to the city than from the Waimakariri River (Fenwick, G; McKerchar, A; Glova, G; 2003).

In the Gravel Extraction Questionnaire extractors were asked to indicate the average cost per kilometre to transport aggregate. The costs indicated ranged from $0.25/m^3/km to $1.00/m^3/km, with an average of $0.63/m^3/km.

Therefore the proximity of a gravel source to the demand site or processing plant is a key factor in influencing locations and quantities of abstractions.

[25] MWH Gravel Extraction Questionnaire responses, 2005 – Appendix A.

14.1.2 Gravel Quality

Different end uses require different qualities of gravel. Gravel quality can be expressed in a number of different ways; particulate size, amount of fines and hardness or strength of the material. The choice of river for gravel extraction is determined by appropriateness of the material for its end use and the amount of additional processing, such as screening and crushing, needed to produce the quality of material required. Further processing requires additional cost that is balanced out against the other influences when consideration is given to the desired location for extraction.

There is an increasing trend of quality specification amongst end users, particularly in roading applications where standards of durability and aggregate size are often applied.

14.1.3 Gravel Quantity

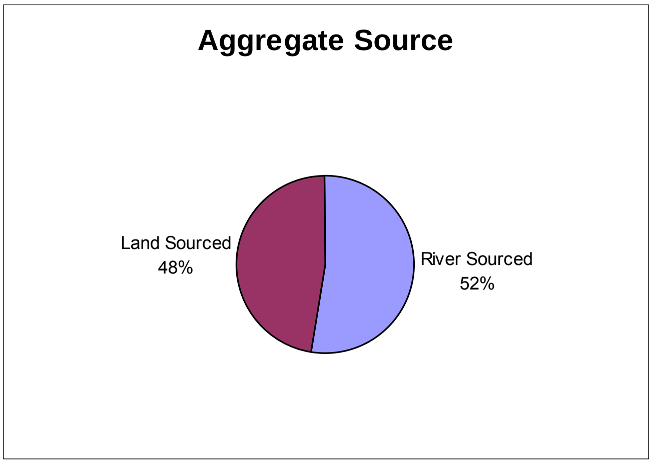
Extractors are limited under their consents to the amount of material that can be extracted from any one location. If the demand for gravel in an area outweighs the consented supply in the nearest suitable river system the extractor may be forced to source material from a different location. This may result in added costs due to the increased travel distance, and potentially, if mobile processing plant is being used, the costs of relocating this plant. Essentially, there are greater efficiencies available if an extractor is able to extract all of the quantity of material required from one source rather than numerous scattered sources.

14.2 Land-Based Sources

Although they have not been considered specifically in this report, it is important to recognise that regional demands for aggregate are met through both river-based and land-based sources, and that changes in the management of one of those resources will impact on the demand pressures on the other. In addition, given the influence of proximity and ease of access on where local aggregate demand will fall, the presence of a nearby land-based source of similar quality aggregate will often impact directly on a particular river by alleviating the demand for gravel from the river.

In order to obtain a rough indication of the extent of land-based extraction in Canterbury, extractors were asked in the Gravel Extraction Questionnaire to indicate the total volume of gravel they extract each year from rivers within Canterbury, and the total volume that they extract from land-based sources. Analysis of the responses received shows that the source of Canterbury's aggregate resources is reasonably evenly split between land-based (48%) and river-based (52%), as shown in Figure 10 below.

Figure 10: Source of Aggregate in Canterbury



It is important to note however, that there may be some distortion in the data obtained from the Extractor Questionnaire. This is because responses were not received from several of the larger operators whose volumes may have had a significant influence on the results, and because land-based extractors who do not hold river gravel extraction consents were not included in the questionnaire.

In terms of the RMA, ECan's direct responsibilities include management of rivers and riverbeds (and thus gravel within riverbeds), but does not extend to the extraction of material from land unless that impacts on air quality, water, or soil conservation. This responsibility lies primarily with city and district councils.

However, discussions with staff from the various district councils during research for this report indicate that generally, district councils do not currently have a good grasp on the number of operating quarries or gravel pits in their districts, or the volume of material being sourced from them. In addition, there can be quite considerable differences in the management of quarrying activities in terms of how they are addressed in District Plans. Where District Plans apply a more restrictive activity status on quarrying activities (e.g. discretionary, non-complying), this may have a considerable impact on the extent to which local aggregate demand falls on local rivers.

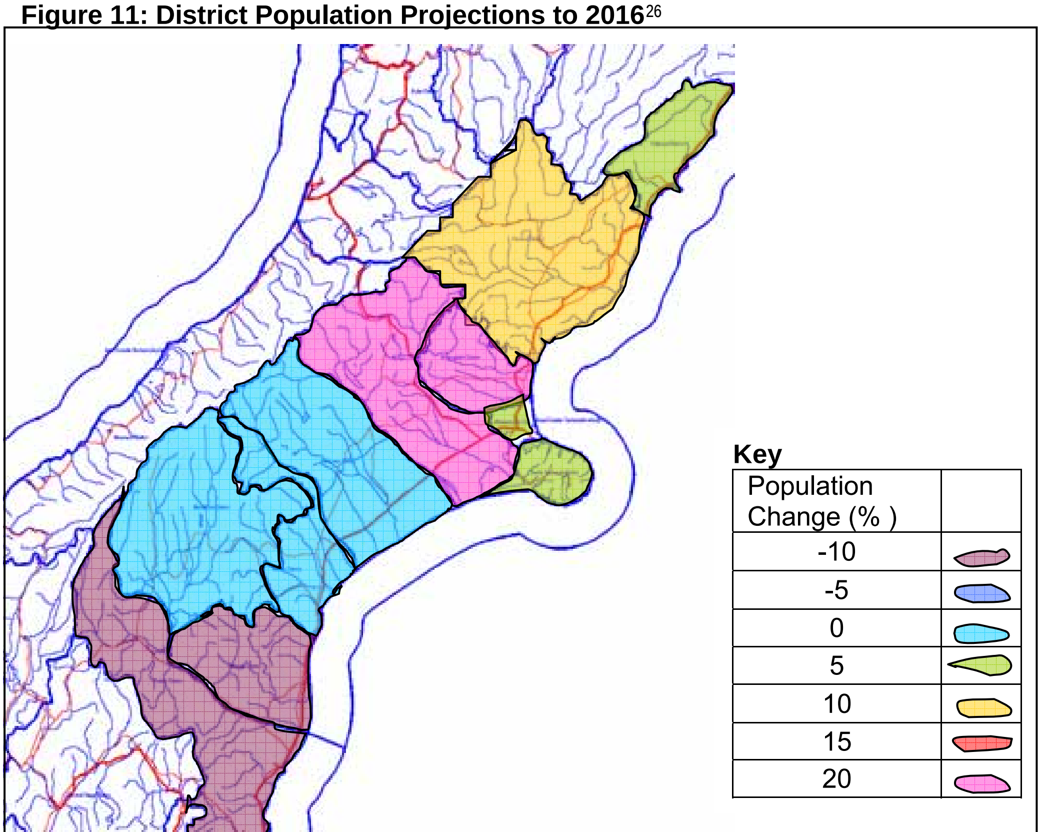
It is important that these factors are recognised and taken into account when making changes to the river gravel management framework, and that on-going consultation and liaison with district councils in this regard is established and maintained.

14.3 District and Urban Population Growth

As discussed in Section 13.5 above, one of the factors that influence the general trend of demand for gravel is population growth. Population growth generally goes hand in hand with economic growth, and concentrations of population generate on-going demand for construction, roads, and investment in infrastructure. Therefore, population is closely linked to the key drivers of aggregate demand – the roading and construction industries.

When population growth is considered on a more magnified scale, such as on a district by district basis, it can provide an indication of the areas where growth, and therefore gravel demand, is most likely to occur. The following map (Figure 11) represents the Canterbury Region using colour coding to show a percentage change in the population across the region. The data used for the map was sourced from Statistics New Zealand, and estimates population change for each district out until 2016.

Figure 11: District Population Projections to 2016[26]



[26] www.stats.govt.nz

This map indicates that population growth for the South Canterbury districts of Waitaki and Waimate is expected to decrease by more than 5% over the period to 2016. Population in the Mackenzie, Timaru and Ashburton Districts are predicted to stagnate, while Banks Peninsula, Christchurch and Kaikoura districts will have an approximate 5% increase in population. The areas of greatest growth will be the Hurunui District with a 10% growth rate and Selwyn and Waimakariri Districts, where a 20% growth rate is predicted.

Where significant population growth occurs, this will in turn produce an increased demand for housing and infrastructure, thereby increasing demand for gravel in the area. Conversely, a decline in the population can be expected to be followed by a weakening in the construction industry, and less local government revenue available for infrastructure investment. This decrease then filters through as a reduction in the demand for gravel.

Townships and urban centres generally provide for a concentrated gravel demand. They are usually concentrated areas of building construction and road maintenance. Concrete used within the construction industry, and aggregate used for constructing, sealing, and maintaining roads, carparks and driveways make up over 80% of the aggregate use in Canterbury[27]. Given this, townships contribute to a large percentage of the demand for gravel within Canterbury.

As populations grow, our towns expand and more people live further away from their places of work, shops and schools. If traffic volumes in the greater Christchurch area reach the projected 40-50% increase by 2021[28] there will be a significant increase in the demand for maintenance of existing roads and the development of new roads. The Greater Christchurch Development Strategy Group has predicted that $2 billion will need to be spent on the roads around the Greater Christchurch area by 2021.[29] This is significantly more than the $780 million forecast by Transit for expenditure on state highways in the whole of the Canterbury Region over the next ten years.

Based on the population growth patterns shown in the map above, it is expected that increases in gravel demand in Canterbury over the next ten-years will be concentrated within the Waimakariri, Selwyn, and Hurunui Districts, and the Christchurch City area.

14.4 Sub-Regional Influences

14.4.1 Localised Growth

Analysis of end-use information indicates that the main influences on demand for gravel are promoted by growth and construction within urban areas, development of the road network to accommodate growth, maintenance of the existing road network, and to a lesser but recently increasing extent, construction and development associated with dairy conversions. These influences, along with known point sources of demand have been mapped on three maps showing North, Central and South Canterbury. Discussions have been held with staff from all district and city councils within the region to assist in this process. Each of these maps are set out below, along with a discussion of the influences predicted to affect each section of the region.

This information, combined with the currently consented potential demand discussed below, provides an overview of the region with direction as to areas of potential development and particular gravel demand “hot spots”, that are anticipated to potentially influence local gravel demand.

14.4.2 Currently Consented Potential Demand

In addition, existing gravel extraction consents have been analysed to provide a summary “snapshot in time” of the already consented potential demand for river gravel in Canterbury over the next ten years. All consents currently granted by ECan, excluding applications that

[27] MWH Gravel Extraction Questionnaire, 2005
[28] www.greaterchristchurch.org.nz
[29] Greater Christchurch Urban Development Strategy.

have been lodged but not yet granted and consents that expire prior to 1st July 2006 (an arbitrary date) were collated. All of the maximum annual volumes under each consent in place for a particular catchment were then totalled for each year. These annual figures clearly decrease over time as consents expire. Although this indicates a decrease in demand, which is contradictory to expectations of an on-going increase in demand, this is because they assume no further consents will be issued. Clearly this is unrealistic, however the figures indicate the potential existing demand as at the current time, and are also useful in illustrating an indicator of local demand, showing which catchments are likely to continue to receive at least a base level of demand.

This information shows that region-wide, 3.2 Mm^3 have been consented for extraction in 2006. This figure reduces to about half by 2010, and then to 365,000m^3 by 2016. [30] To give a better indication of where this base level demand is likely to fall, this consents information has been broken down into river catchments and grouped into four sub-regions (North Canterbury, Christchurch Area, Mid Canterbury, and South Canterbury). This information has been incorporated into the following discussions relating to the 3 sub-regions (the Christchurch Area data has been incorporated into the Mid-Canterbury discussion).

14.4.3 North Canterbury

For the purpose of this project the North Canterbury sub-region stretches from the Clarence River in the north to the Waipara River in the south. This area includes two districts - the Hurunui and the Kaikoura. Population projections for these districts over the next ten years suggest that the Hurunui District will have a 10% population growth rate while the Kaikoura District will have a 5% increase.

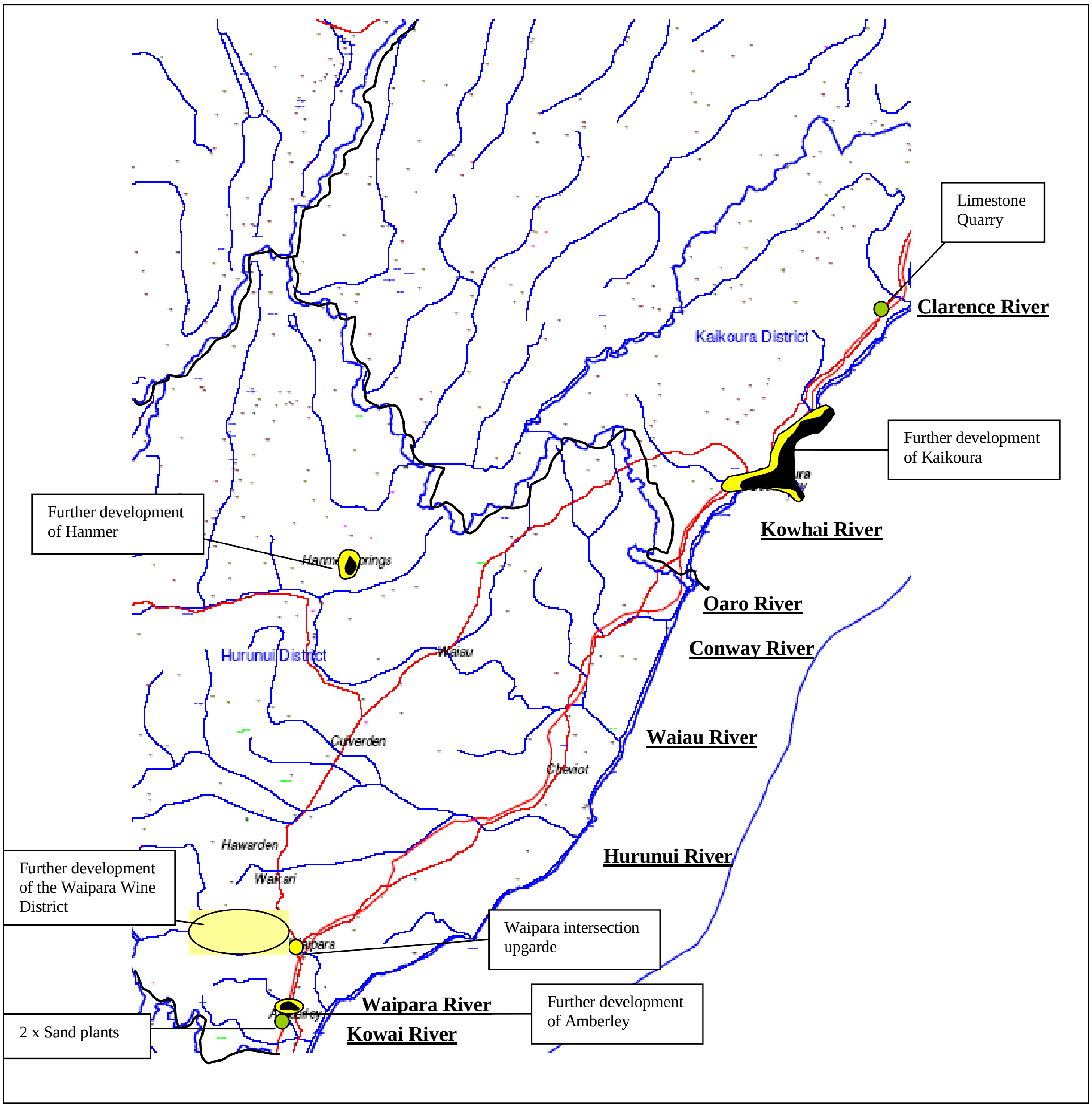
There is current potential for development around all the townships in the Hurunui District with the exception of Hanmer Springs were the majority of the land zoned for urban development under the district plan has already been developed. Discussions with the District Planner for Hurunui suggest that there may be a plan change put forward for Hanmer Springs in 2 years time to allow for further development, and with the current popularity of the settlement it is likely that any new areas for development will be utilised quickly. Another area where the Council is currently considering rezoning land for further urban development is Amberley. Under the current proposal there would be potential for a further 250 houses to be established.

A significant user of gravel in the Hurunui District is viticulture. The wineries in the Waipara Valley are continuing to develop at a steady rate. In conjunction with the development of this area, the Waipara Junction will be upgraded in the coming years which is likely to produce a short term increase in local demand for gravel.

The Kaikoura township is the only significant township within the Kaikoura District. Discussions with the Kaikoura District Council revealed that the township is developing at a rate of 90 new sections a year and is expected to do so for the next few years. Kaikoura is becoming a popular holiday destination and the development of the township may not be truly reflected in the population growth statistics, which do not reflect the number of second homes and holiday accommodation being established in the township. Given this, the Council expects that the township will double in size, if not population, over the long term.

[30] In some cases, consents allow a maximum annual volume that may be extracted, but that volume may be extracted from a number of different sites. In some cases, the consent specifies a maximum annual amount for each of those sites, and together these add up to the total annual volume that may be extracted under that consent. In other cases, the consent may allow an annual volume to be extracted, but this volume may be made up of smaller extractions from a number of different sites. Where this occurs, and all sites are within the same catchment, the total annual volume consented was allocated to that catchment. However, in a few cases, the sites are in different catchments. In these particular instances, the amount that could potentially be extracted under the consent in each catchment for each year has been included. This will result in a double up of these amounts. However, given that this scenario only occurred in a few consents and generally referred to small volumes, the impact of this will be minimal.

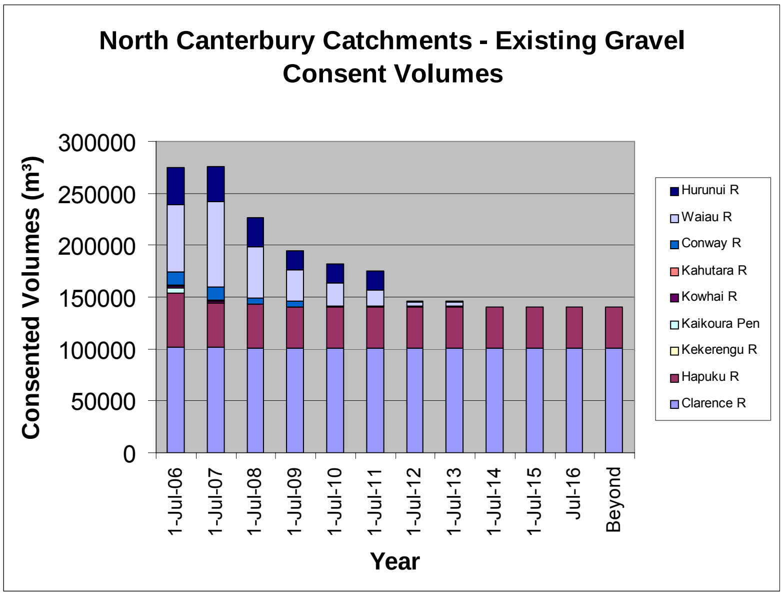
Map 1: North Canterbury



14.4.3.1 Existing Consented Volume

In North Canterbury, approximately 180,000m^3 is consented in 2006, reducing to about half by 2011, but then remaining constant at around 140,000m^3 per year through to 2016 and beyond. The bulk of this allocation is within the Clarence and Hapuku rivers, where annual volumes of approximately 100,000m^3 and 40,000m^3 respectively may be extracted under existing consents for the next ten years. Other rivers included in the North Canterbury grouping are the Hurunui, Waiau, Conway, Kahutara, Kowhai, Kekerengu, and the Kaikoura Peninsula.

Figure 12: Consented Volumes – North Canterbury



14.4.4 Mid Canterbury

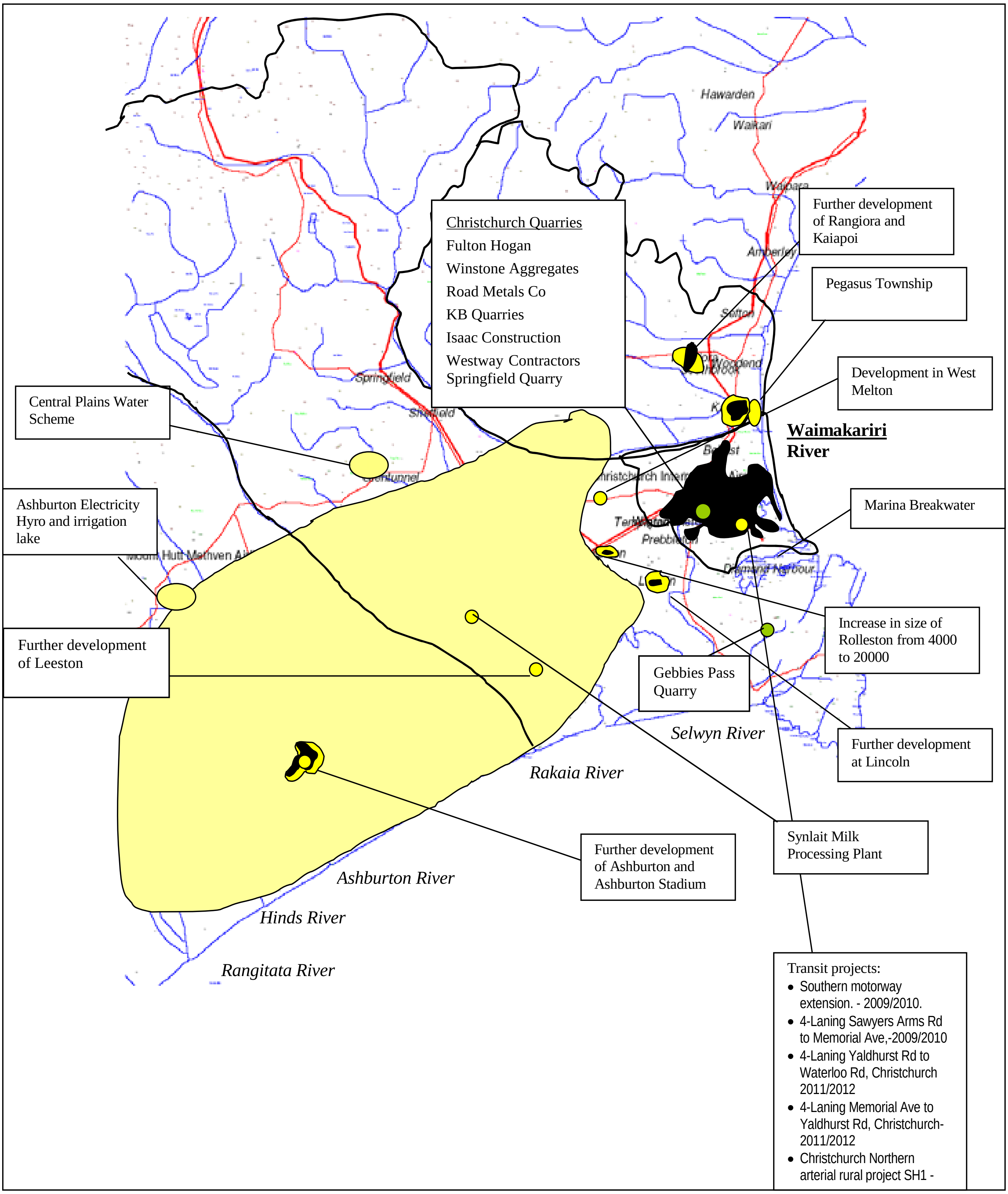
For the purposes of this project, the Mid Canterbury sub-region stretches from the Rangitata River in the South to the Waipara River in the North. As discussed in Section 3.3 above, this area has the greatest potential for growth within the Canterbury Region.

The Ashburton District is predicted to have a population growth rate of 1.5% over the next ten years. From discussion with the Ashburton District Council there seems to be a strong trend toward development within the district. There are a number of large urban developments being proposed, along with a significant number of dairy conversions and at least one proposal for an irrigation storage lake. The Mid Canterbury map (see Map 2 below) shows the expansion of Ashburton as a result of a proposed structure plan with a potential for 300 – 400 new houses. In addition to this, 120ha of rural land is proposed for development into industrial blocks. According to the Ashburton District Planner, dairy conversions within the district have slowed in the last year. However, these are driven by the price Fonterra is willing to pay, and if the company wins another overseas contract requiring additional milk supply, Fonterra would be in the position to provide the incentives to drive further conversions. Indications within the Dairy industry are that a 2.5 – 3% increase in dairy growth within Canterbury is expected over the coming years. This indicates that demand for gravel for farm stock races and concrete for dairy sheds is likely to continue, although with only moderate growth.

The potential for dairy conversions is also restricted by the availability of water for irrigation. Water is becoming a scarce resource in the Canterbury region and this has prompted farmers to look at alternative water sources for irrigation. A number of potential combined water storage, irrigation and hydro schemes are currently being considered in the Canterbury region, with at least two proposals within the Mid Canterbury sub-region.

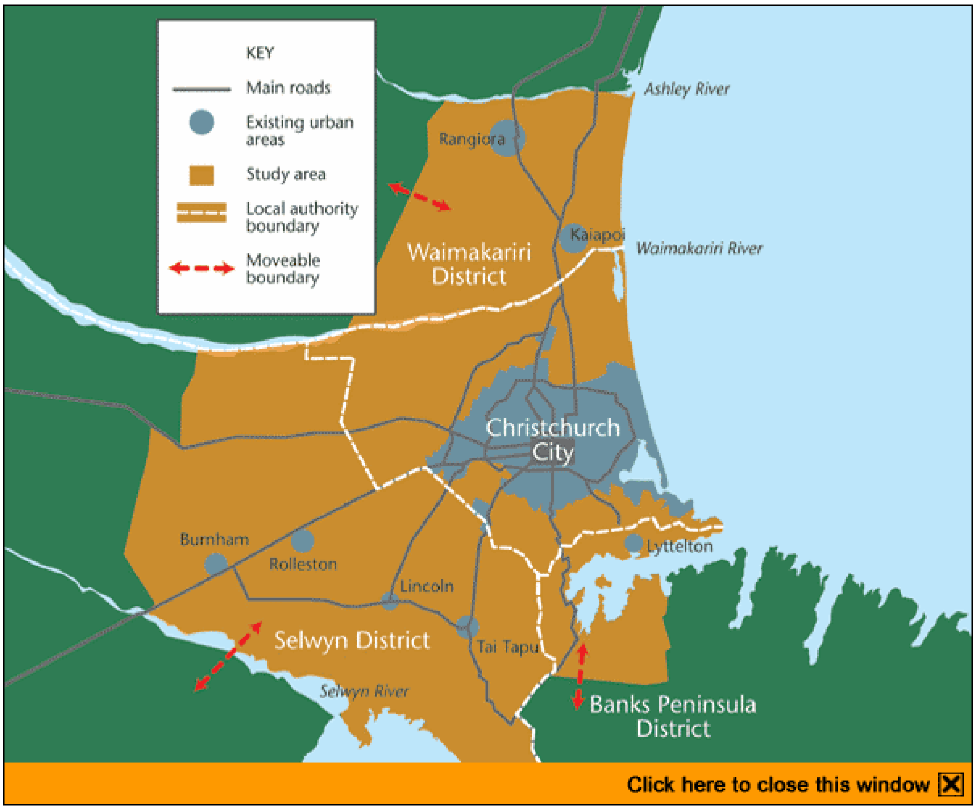
The likelihood of these schemes proceeding, and the final form that they may take is very dependent upon the Resource Management Act process, and therefore difficult to predict. However, the schemes being considered are currently proposed for construction roughly within the next five years. In the event that they go ahead, these may create a short-term peak in gravel demand, particularly for concrete that may be required for irrigation races and other infrastructure.

Map 2: Mid Canterbury



It is clear from the population data and indications of district development, that there will be a concentration of growth over the next ten-year period in the greater Christchurch area. Over the past decade, the population of greater Christchurch has grown by 1.2% per year. That equates to 13 more people calling Christchurch their home each day, or four new households being set up[31]. The population predictions used in this study show a move away from development within Christchurch City out toward the surrounding districts of Selwyn and Waimakariri.

Figure 13: Greater Christchurch[32]



This trend is supported by the research carried out in the initial stages of the Greater Christchurch Urban Development Strategy. The strategy is in its early stages but the indication from 63% of the 3200 submitters on the strategy, is that it is preferred to concentrate development within Christchurch City and other larger towns in surrounding districts, rather than allow for sprawling development. If this theme is continued through into the strategy then there will be less potential for development with the Christchurch City boundaries pushing the development into surrounding townships like Rolleston, Kaiapoi and Rangiora within the Selwyn and Waimakariri Districts. Information provided by the Greater Christchurch Strategy group indicates that an additional 33,590[33] dwellings will be required by 2021. A typical new house in New Zealand contains about 250t[34] (approximately 125m^3) of aggregate, resulting in 8,397,500t (approximately 4,198,750m^3) of aggregate being required by 2021 for housing in greater Christchurch alone.

Discussions with the Selwyn District Council reflected the predictions made in the Greater Christchurch Urban Development Strategy and the trend toward population growth in the District. Selwyn has one of the fastest growing populations in the country. The township of Rolleston has a current population of 4000, and once the land zoned for urban development is utilised, it is predicted the township will swell to the size of Rangiora (20,000).

[31] www.greaterchristchurch.org.nz
[32] www.greaterchristchurch.org.nz
[33] www.greaterchristchurch.org.nz
[34] www.minerals.co.nz

There have been approximately 2 new houses a day constructed in Rolleston for the last two to three years according to the District Council, so it is likely that the uptake of the currently undeveloped land will be swift. In addition to Rolleston there is also spare capacity for residential development at Lincoln which is developing quickly at present but is estimated to slow in a couple of years time unless a plan change releases further rural land for urban development. Indications from the Council are that available land at Leeston will take two to three years to fill in. Like the Ashburton District, the rural parts of the Selwyn district are also under pressure for water resources.

The Central Plans irrigation scheme could have significant implications for the District both with dairy conversion and the potential for rural villages such as Coalgate and Whitecliffs to become lake settlements in the future. The construction of the Synlait Milk processing plant between Rakaia and Dunsandel will provide a demand for gravel in 2006 and 2007 as the 200 million litre capacity plant is constructed. It is likely that this will also have implications for Dunsandel, as the demand for housing will increase with the influence of staff to the proposed plant.

The major influences on gravel demand within Christchurch City will continue to be the construction of homes and businesses, and road re-constructions and improvements. The general development of the city is rapid with just under 100ha of land being developed every year within the Council boundaries. An ageing population is also creating more single person households, fuelling the demand for dwellings ahead of population growth.

According to the Greater Christchurch Urban Development Strategy, Christchurch City has experienced rapid housing expansion to the north and south-west in recent years. New development in these outer suburbs is increasing traffic congestion on key roads in and out of the city. Following the spread of housing outwards, businesses are leaving the inner city and suburban malls are expanding, creating mini city hubs around the suburbs. The City Council is aware of a number of large retail proposals currently being planned around the city.

In addition, Transit New Zealand’s ten year State Highway Forecast (see Section 13.3.2) lists a number of large scale construction projects, expected to be constructed during the period 2009 – 2015. These projects are shown on the Mid Canterbury map (Map 2 above).

In comparison with the Christchurch City Council, the nearby Banks Peninsula District anticipates only minor scale future development. Subdivisions generally range in size from 2 to 12 lots, and only rarely contribute new sections of road to the District network. There is however considerable potential for development in and around the Diamond Harbour area where the council owns 38ha of urban zoned land that they envisage will be developed at some stage in the future. In addition, a relatively large subdivision is currently proposed for Black Point, located between Charteris Bay and Diamond Harbour on the south side of Lyttelton Harbour. However this development is yet to go through the consent process. The only other significant development the Council is currently aware of is construction of the marina breakwater, which will see the development of a number of apartments along the marina.

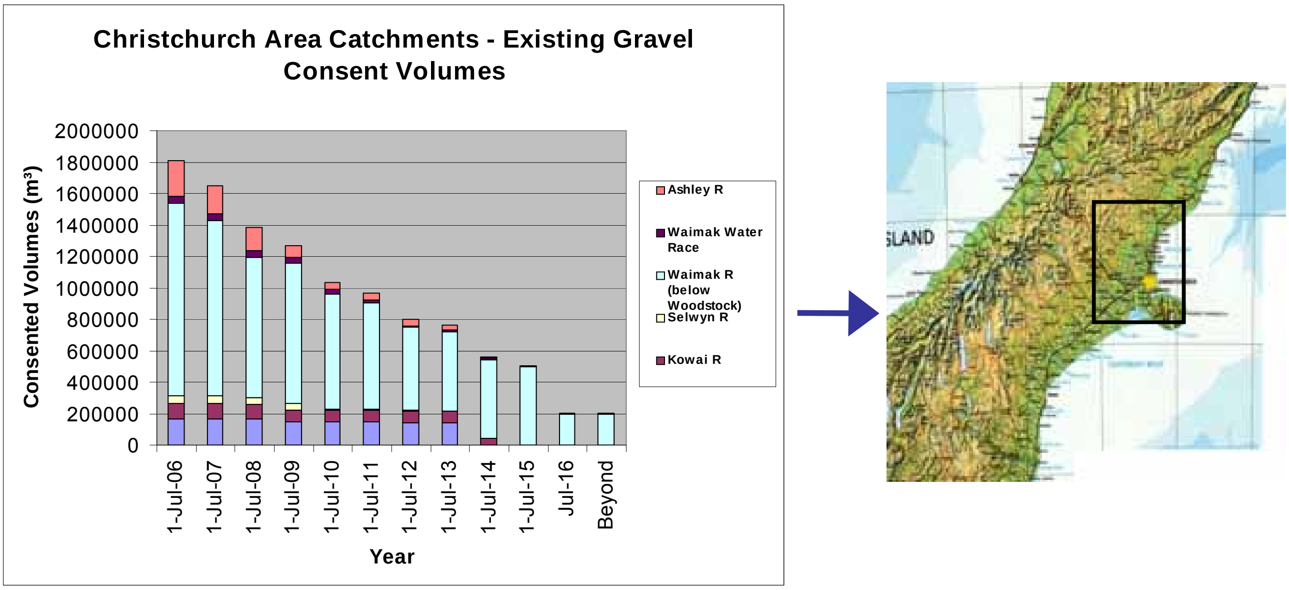
According to the Greater Christchurch Urban Development Strategy, the rapid growth of Waimakariri District, and expansion of Rangiora, Kaiapoi and Woodend looks set to continue. This is reflected in the population predictions for the District, which indicate an increase of nearly 18% over the next ten year period. Under the District Plan, Rangiora is currently the principal area identified for potential growth, however the Council is considering rezoning areas of land around Kaiapoi for urban development. The most significant proposed new development in the District is the proposed Pegasus Bay Township. This is a planned town for 5000 residents centred around a lake and commercial area adjacent to Pegasus Bay Beach near Woodend. With just over 1700 house sites and 295 commercial and business sites, the 340ha town represents the largest available consented residential land development in New Zealand. At present, developers anticipate that the town will be

developed in stages, beginning within the next couple of years. However, specific predictions about when the bulk of the town's development will occur are unavailable.
If development of the township occurs in specific stages, this is likely to dilute the demand for gravel that the town's construction will create. However, if the bulk of the infrastructure construction and building occurs at once, this is likely to create a peak in local gravel demand in the area.

14.4.4.1 Existing Consented Volume

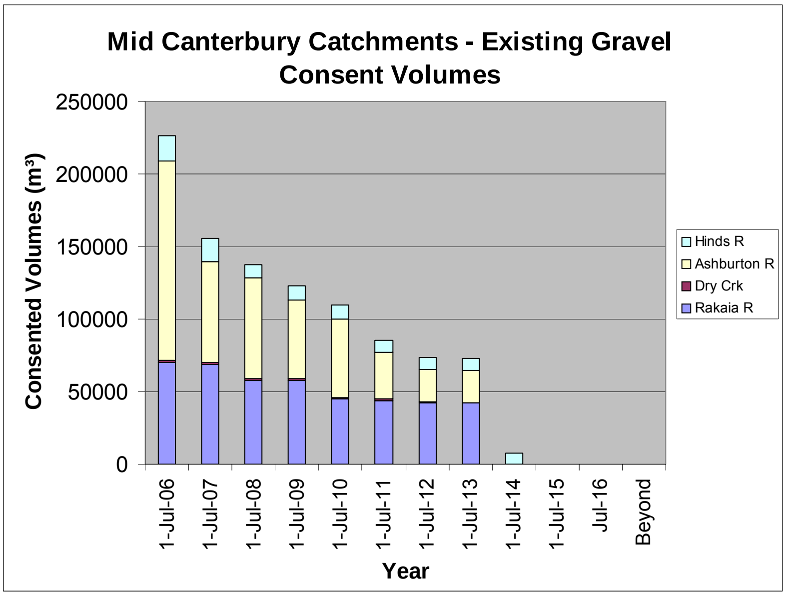
The most significant proportion of the total regional currently consented volume of gravel falls within the river catchments grouped into the Christchurch Area. These catchments include the Waipara, Ashley, Kowai, Waimakariri, and Selwyn rivers. In this area, 1.8 Mm^3 is consented in 2006, reducing to approximately half this level by 2011. From 2016, this volume decreases again to 200,000m^3. The majority of this is from the Waimakariri River.

Figure 14: Consented Volumes – Christchurch Area



The Mid Canterbury area, which includes the Rakaia, Ashburton, and Hinds rivers and Dry Creek, has the least amount of current allocation, with 226,000m^3 consented in 2006. This amount decreases quite dramatically during 2007, and then steadily until 2014, from when no extraction is currently consented. The greatest reduction in consented extraction occurs in the Ashburton River, where consented volumes reduce from about 140,000m^3 in 2006, to about half this in 2007.

Figure 15: Consented Volumes – Mid Canterbury



14.4.5 South Canterbury

Within and bordering the South Canterbury sub-region there are 6 significant townships. Oamaru, Waimate, Timaru and Temuka are located on the coastal plain while Tekapo and Twizel are located in the 67Basin. While it is expected that the coastal plain townships will continue to produce a steady demand for gravel, the future population and economic projections for South Canterbury suggest that gravel demand in this part of Canterbury will decrease over the next ten year period. Discussions with the District Planners support this, with indications that although there is land zoned for urban development around each of these townships, they do not envisage that there will be a rapid uptake of this land.

Conversely, the Tekapo and Twizel townships are expected to grow significantly. The Mackenzie District, within which they are located, only shows a 0.8% increase in population over the next ten year period, however this population data is based on the properties within which people normally reside[35]. It is assumed that the development around the central lakes will consist largely of second homes and holiday accommodation. The population data in this area will therefore not give a true reflection of the growth occurring in the Mackenzie District. A comment from one gravel extraction consent holder operating out of the area was:

> "*Mackenzie area development in building & irrigation is high. All concrete for Tekapo comes from Fairlie/Timaru area. One development alone in Tekapo is 5,000m^3 concrete. I would forecast shingle requirements at 2-3 times our resource consent capacity*"

In addition to this anecdotal evidence, discussions with the Mackenzie District Council have revealed that there have been 441 new properties developed in the district in the last 2 years. Based on the NZ Minerals Industry Association estimate of roughly 250t of aggregate per house, this equates to a demand for 110,250t (approximately 55,125m^3) of aggregate. The Mackenzie District planning team do not foresee a change in this rate of development over the coming years.

The Mackenzie District Plan has permissive rules within the rural zone which make obtaining consent for development within the district relatively easy when compared to other parts of New Zealand. This, combined with the release of leasehold land currently under tenure review may result in further potential for development. Data on the cost of properties within

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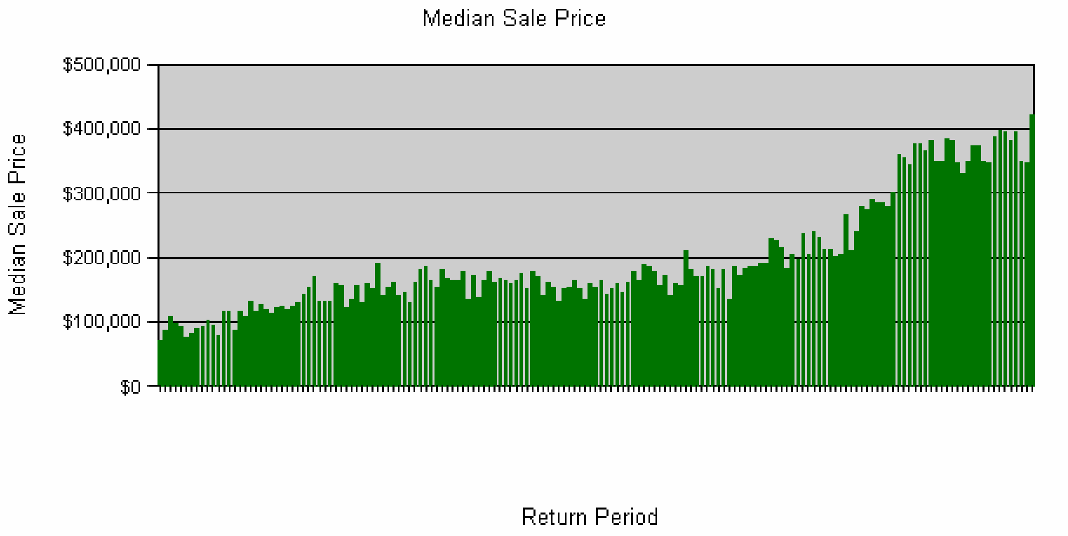
[35] The population data is based on the 2001 census data and census data is based on number of people ordinarily resident in a particular place.

the Mackenzie District Lakes area since 1992 shows a steady increase in demand for this type of property (Figure 16), which is not expected to decline significantly.

Figure 16: Property Prices Mackenzie District Lakes area[36]



The South Canterbury sub-region has a number of projects that may create an additional demand for aggregate. The most southern of these is centred on the Waitaki River, where the Waitaki Catchment Water Allocation Plan has recently been released. The full implications of the Plan for development, particularly hydro and irrigation based developments, are not yet fully known. However, Meridian Energy have indicated that consideration is being given to a potential hydropower development on the lower Waitaki, that is likely to incorporate an irrigation scheme element. Any such development is likely to create a demand for gravel both in terms of construction, and in terms of consequential changes in land use to viticulture and/or dairying. On a smaller scale the Kakahu irrigation scheme is about to be completed south of Geraldine and may also result in dairy conversions and farm development.

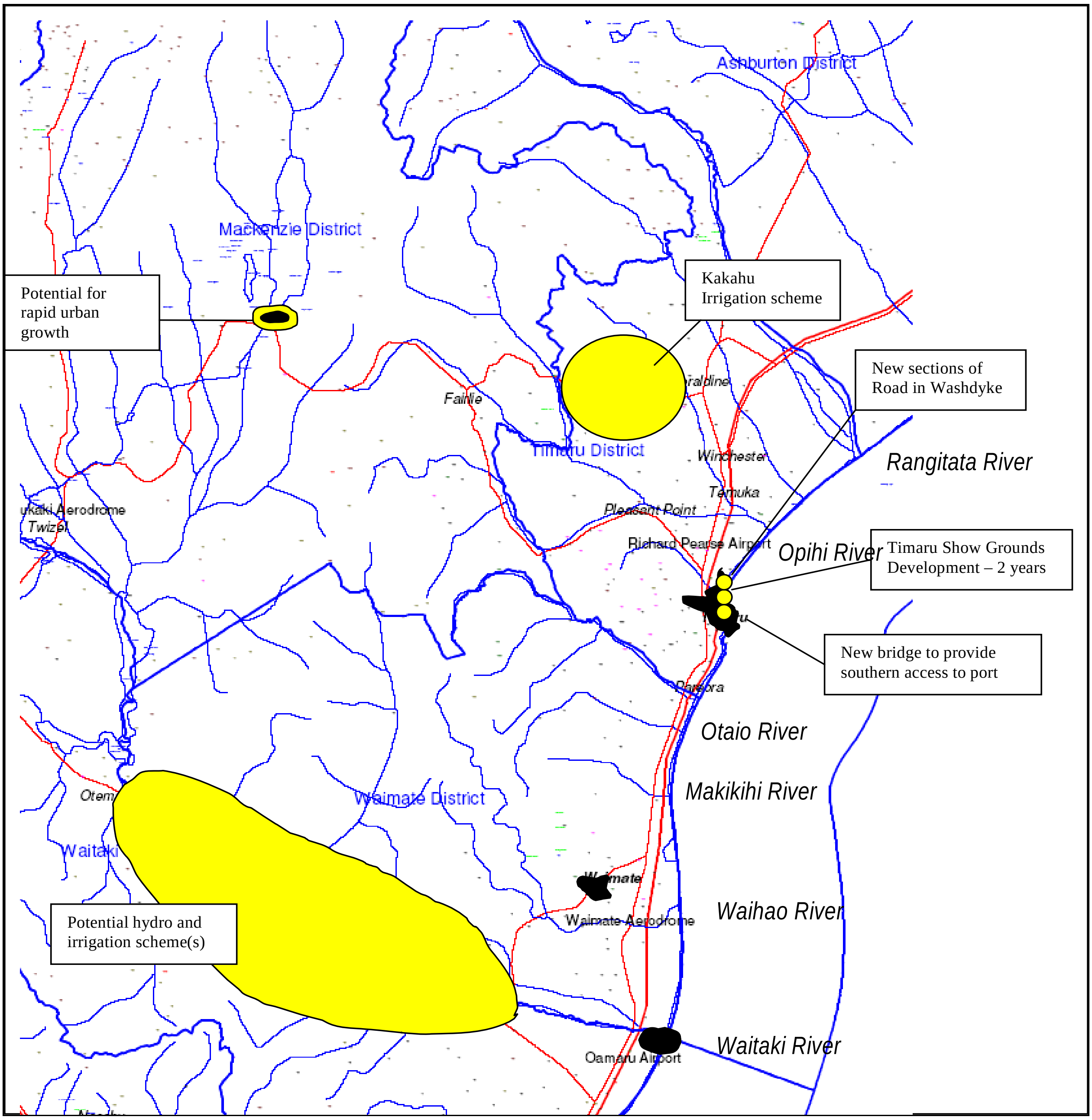
Other large construction projects within the South Canterbury region over the next ten years include development of the Timaru showgrounds site for commercial buildings, and the potential for an additional building to be constructed at the Fonterra Clandeboye site. The showgrounds site is likely to commence construction in 2 years time, while the Clandeboye development will probably occur toward the end of the ten-year projection period. Developments at Clandeboye have a greater demand for gravel than standard industrial development as the factory is located on a floodplain and the ground level under the buildings need to be built up with gravel before construction can commence.

The Timaru District Council is also planning the construction of a new bridge into the Port from the township and two new sections of road within the Washdyke industrial area.

It is unlikely that any of the potential developments within South Canterbury will have a significant impact on the gravel extraction rates for Canterbury as a whole. The effects of these demand sources are more likely to influence localised river systems at the time of construction.

[36] www.reinz.co.nz

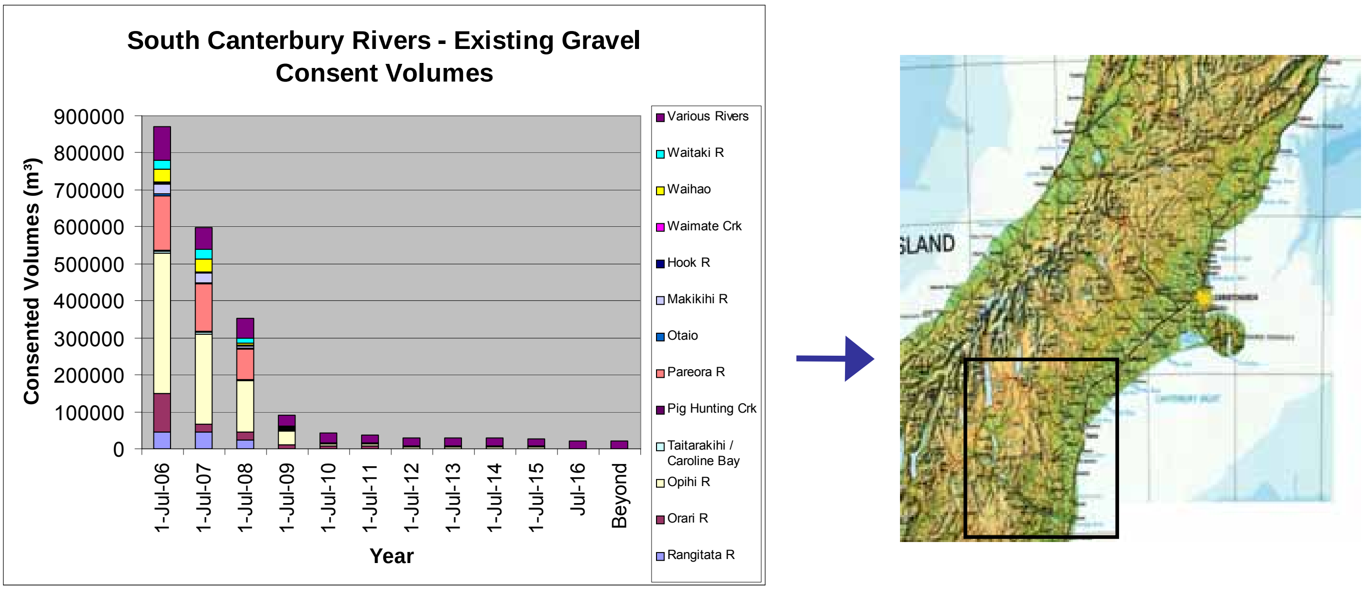
Map 3: South Canterbury



14.4.5.1 Existing Consented Volume

In South Canterbury, the currently consented volume of gravel decreases quickly from approximately 870,000m^3 in 2006, to less than half this amount by 2008, and then to less than 50,000m^3 per year beyond 2010. The majority of consented extraction in this area is in the Opihi River, but also included are the Rangitata, Orari, Pareora, Otaio, Makikihi, Waihao, and Waitaki rivers, Pig Hunting and Waimate Creeks, Taitarakihi/Caroline Bay, and a number of other smaller rivers and tributaries.

Figure 17: Consented Volumes – South Canterbury



14.5 Conclusion

The key factors considered to influence local demand for aggregate are localised economic and population growth; the proximity of aggregate sources to the area; and the quality of the aggregate. Based on district population projection figures, and indications of likely developments within particular districts, it is anticipated that the key areas where gravel demand is likely to occur over the next ten years are as follows:

1. Greater Christchurch, including parts of the Waimakariri and Selwyn districts (Rolleston, Rangiora, and Pegasus Bay Town).
2. North Canterbury, particularly parts of the Hurunui District.
3. Localised areas with holiday / resort type developmental potential, including Kaikoura, Hanmer Springs, and Mackenzie District lakes area.
4. Rural parts of Canterbury where potential water storage and irrigation schemes may result in land use changes and intensification, including the central Canterbury Plains between the Waimakariri and Rakaia Rivers; the Waitaki River valley; the Mackenzie basin.

Chapter 6 Sustainable Gravel Supply from Rivers and Coast

15. Introduction

To better understand how the demand for gravel in Canterbury, relates to the actual volumes available in river beds, ECan commissioned river reports to interpret bed level survey data and gravel return information for a total of 37 (priority 1 and priority 2) rivers in the region. Priority 2 rivers were included to give a better base of information from which to extrapolate a regional picture of gravel supply. This information was then used to provide an estimate of sustainable supply, i.e. how much gravel moves through the river system on an annual basis. Priority 1 rivers were identified by ECan engineering and consents staff as those rivers with the most demand for gravel, with potential supply of gravel or with signs of over-extraction. The methodology behind the river reports on priority 1 rivers, produced by MWH NZ Limited, is described below, the methodology used in the river reports produced by EMA Limited, is similar and described within their reports. The summary of supply information from all 17 river reports[37] has been brought into this chapter and is provided below for the annual supply of gravel for priority 1 rivers.

[37] See the list of Associated Reports for a full list of priority 1 and 2 reports under References.

16. Methodology behind each (new) river report

16.1 Rivers with Bed Monitoring

The sustainable annual gravel supply in the rivers where sufficient riverbed monitoring surveys were available was done on a conservation of volume basis over the surveyed river reach. Rivers analysed in this way were the Ashley, Hinds, Temuka, Waihao, Otaio and Kowhai.

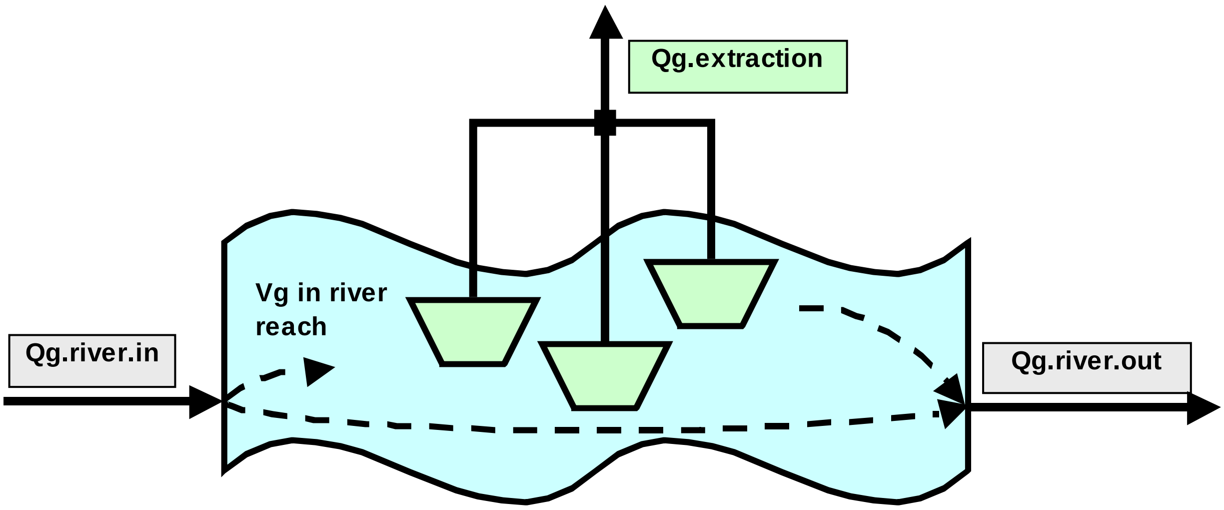
In essence, gravel entering the reach either leaves or remains in the reach. In mathematical terms for a given reach of river (refer also to accompanying Figure 18 below):

$$\frac{\Delta V_g}{\Delta t} = Q_{g.river.in} - Q_{g.river.out} - Q_{g.extraction} \qquad \textit{(Eqn. 1)}$$

where:

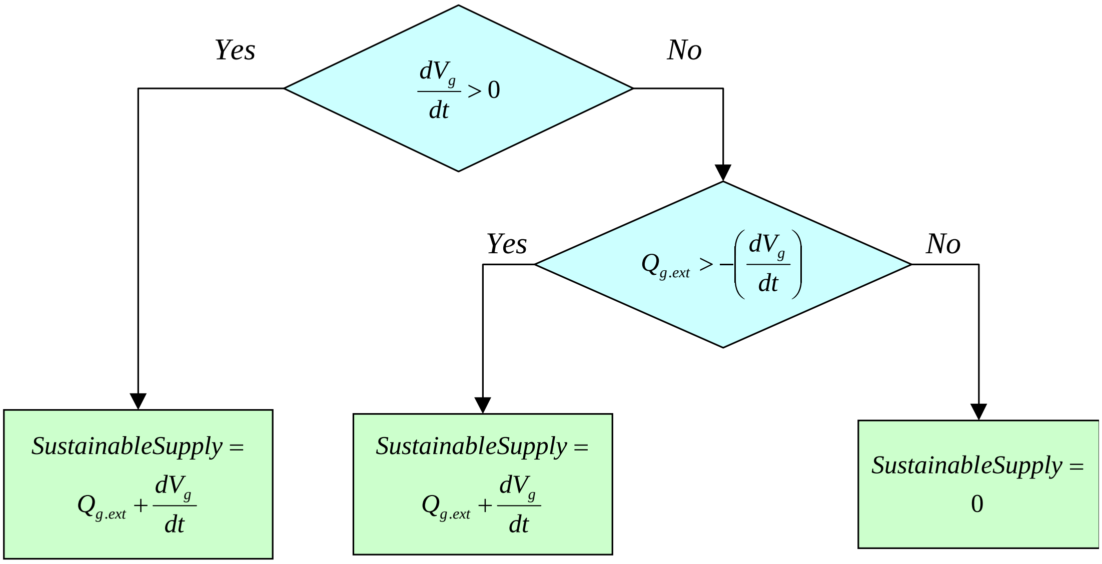
ΔV_g	=	Change in volume of gravel (m^3). This is known from riverbed surveys
Δt	=	Time elapsed (y). This is known from riverbed surveys
$Q_{g.river.in}$	=	Volume flow rate of gravel into river reach from upstream, side tributaries or bank erosion (m^3/y). This is estimated using catchment erosion rates.
$Q_{g.extraction}$	=	Volume rate of gravel extracted from river reach (m^3/y). This is derived from gravel returns using the years that best match the riverbed monitoring data.
$Q_{g.river.out}$	=	Volume flow rate of gravel out of river reach by downstream transport (m^3/y). This is the unknown in the equation and is solved for.

Figure 18: Schematic Representation of Change in Gravel Volumes



With the indicative gravel volume balance established a judgement follows to determine the sustainable supply. For these estimates the sustainable supply is the amount of gravel that can be removed from the river reach without degrading the bed. Therefore, the sustainable supply is calculated as shown in the flow diagram of Figure 19.

Figure 19: Logic Diagram for Calculating Sustainable Gravel Supply



16.2 Rivers without Bed Monitoring

Of the Priority 1 rivers the Waipara, Rangitata, Te Moana and Makikihi Rivers had insufficient or no bed monitoring data, thus ruling out a conservation of volume approach to estimating the sustainable gravel yield. The Priority 2 rivers all fall into this category as well.

For all of these rivers the estimates of the sustainable gravel yield have been made using of similar rivers on the based on location, underlying geology and catchment similarities as the starting point. The sustainable gravel yield of the similar river was then modified to reflect differences in catchment area, river channel slope and relative suspended sediment yields (as indicated by the NIWA Chart “Sediment from New Zealand Rivers” Hicks, D.M. and Shankar U., 2003).

Each river sustainable gravel yield estimated by this process subject has the detail of the assumptions described in the relevant river report.

17. Annual Sustainable Supply of Gravel in Priority 1 Rivers

Table 5 summarises the estimated sustainable gravel yields from the Priority 1 Rivers.

Table 5: Priority 1 Rivers – Gravel Yields

	River	Estimated Sustainable Gravel Yield (m^3/yr)
1	Ashley	3,600
2	Hinds	1,000
3	Kowhai	19,000
4	Makikihi	0
5	Otaio	0
6	Rangitata	30,000
7	Te Moana*	2,000
8	Temuka	0
9	Waihao	13,000
10	Waipara	2,000
11	Pareora	0
12	Waihi	2,300
13	Orari	35,000
14	Opihi	0
15	Tengawai	0
16	Ashburton	75,000
17	Waimakariri	250,000
	Total	**432,900**

* Excludes contribution from Kakahu River
Note: river reports were produced for rivers 1 –10 by MWH NZ Limited and for rivers 11-17 by EMA Limited[38].

[38] See the list of Associated Reports for a full list of Priority 1 and 2 River Reports under References.

18. Annual Sustainable Supply of Gravel in Priority 2 Rivers

Table 6 summarises the estimated sustainable gravel yields from the Priority 2 Rivers.

Table 6: Priority 2 Rivers – Gravel Yields

River	Estimated Sustainable Gravel Yield (m^3/yr)
Clarence	21,000
Oaro	2,500
Conway	7,000
Waiau	158,000
Hurunui	15,000
Pahau	3,000
Kowai	600
Selwyn	1,800
Waianawaniwa	200
Rakaia	85,000
Kakahu	2,000
Twizel	2,000
Lower Waitaki	300
Hakataramea	10,800
Penticotico	800
Elephant Hill	800
Kurow	800
Otiake	1,100
Otekaieke	1,700
Maerewhenua	3,800
Total	**318,200**

Note: Priority 2 river report produced by MWH NZ Limited[39]

[39] See the list of Associated Reports for a full list of Priority 1 and 2 River Reports under References.

19. Annual Sustainable Supply of Gravel to Coast

19.1.1 Waitaki River to Timaru (South Canterbury Coast)[40]

Analysis of the beach survey monitoring data shows that the South Canterbury Coast is eroding between the Waitaki River and Patiti Point. There is a surplus in the gravel budget at South Beach. However approximately 86% of the gravel and sand supplied to the beach system is lost through abrasion.

Gravel extraction at Makikihi and other areas of the coast between the Waitaki River and Patiti Point add to the overall deficit, but extraction at the existing small quantities does not appear to contribute significantly to natural erosion processes. However, all extraction from the rivers supplying gravel to this coast contribute to the deficit at the coast in the vicinity of the river outlet. Therefore, extraction from these rivers should be considered in determining a comprehensive gravel budget for the area to assess the extent of the effect at the coast.

Substantial losses from the system due to abrasion may be an indication that river and coastal gravel extraction is a minor effect, limited to the vicinity close to the river mouth. Coastal sites or river sites near the river mouth may not have a sustainable source of gravel for extraction on an annual basis, but may at times have a surplus of gravel for extraction depending on temporal variability of flooding for gravel supply. Therefore, consistent extraction at a consent limit may be unsustainable in the long term.

Extraction rates at South Beach of up to 10,000 to 12,000m^3/yr appear to be sustainable, while extraction may mitigate against infilling of the dredged harbour channel.

Further analysis of the beach monitoring surveys is required to analyse volumetric changes to the beach system over time, and to correlate actual coastal extraction and river extraction near the river mouth against changes to the beach profiles close to the extraction site.

Further assessment of the beach profile data for South Beach is also necessary to determine the changes along this stretch of coast in light of the development of the artificial beach in front of the harbour breakwater. Management of the build up of sediment may indicate that there may be a greater amount of gravel available for extraction at South Beach than is currently taken.

19.1.2 Timaru to Banks Peninsula (Canterbury Bight)[41]

Looking at the Canterbury Bight coastal system as a whole, it is nearly in a gravel budget balance. However this view obscures the findings that much of the coast is eroding, and therefore in budget deficit. At times there is a surplus of supply of sand and gravel at the coast near the Rangitata and Rakaia Rivers.

This material is delivered to the coast during floods, and is distributed along the coast by southerly storm and swell waves. Therefore the sediment does not result in long term accretion to the coast near the rivers.

The only area that exhibits net accretion in the long term is Birdlings Flat. The actual amount of material building up in this area is unknown, but is thought to be a relatively small volume.

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[40] Oamaru to Timaru Coastal Report (2006) by Martin Single MWH NZ Ltd, Report No: R06/14, Environment Canterbury

[41] Pegasus Bay Coastal Report (2006) by Martin Single MWH NZ Ltd, Report No: R06/15, Environment Canterbury

Further study of the changes to the beach profiles in this area is required to determine if there is a sufficient surplus of gravel that could be taken from the coast. However, it is likely that there is a high level of uncertainty as to the long-term nature of gravel build-up due to the variability of sediment supply from the rivers and cliff erosion.

It is recommended that the volumes of gravel change for each profile site be examined to determine an accurate gravel budget balance for sections of the coast, noting that erosion and retreat of the cliffs behind the mixed sand and gravel beach continue to contribute to the beach gravel budget.

19.1.3 Pegasus Bay[42]

The Pegasus Bay coast is characterised by sand beaches except for the northern section between about Leithfield and Teviotdale. The gravel component of the beaches is mixed with sand and is not a significant proportion of the active beach that extends offshore. Although the southern section of the bay is stable to prograding, the northern part of the bay is stable to eroding, and has inundation and erosion problems at Amberley Beach. Mitigation of these hazards has required nourishment of the beaches with sand and gravel deposited at the limit of wave run-up. Therefore, it is concluded that gravel extraction would not be sustainable for Pegasus Bay.

In addition, there is little quantitative information about the supply of gravel to the coast from the Ashley, Kowai and Waipara Rivers. Studies by MWH for the overall gravel resources study indicate that the Ashley may contribute no gravel to the coast at present. It is also possible that extraction of gravel from the Waipara River has an adverse effect on the coastal gravel budget in the Amberley Beach area. Further analysis of the beach profile monitoring surveys, and gravel extraction from the Waipara and Kowai Rivers is required to determine the significance of extraction from the rivers for management of coastal hazards at Amberley Beach.

19.1.4 Coastal Gravel Supply

A summary of the total gravel supplies for the coastal cells is limited due to the significant uncertainties as to gravel supply from the rivers and abrasion of gravel on the beaches. There is a significant spatial distribution of long term gravel build up, showing that any build up is limited to the down drift ends of the coastal cells. These are South Beach in Timaru, and Birdlings Flat. Gravel accumulations occur near the Waitaki, Rangitata, Ashburton and Rakaia River mouths. However these are likely to be of short-term duration and are resident only until wave action distributes the gravel along the shore.

Table 7 shows a rough estimate of the annual total gravel budgets for each of the coastal cells. Only the South Canterbury Cell has a total budget surplus. This budget surplus is expressed on the coast by progradation of the beach between Patiti Point and the Port of Timaru breakwater. There is no significant contemporary accretion at Birdlings Flat in the Canterbury Bight cell, and there is erosion of the beaches at Amberley, indicating a deficit in the gravel budget of the Pegasus Bay cell.

Table 7 Gravel Budget for the Canterbury Coastal Cells Investigated (m^3/yr).

	Inputs	Extraction	Unknown Outputs	Budget Balance
South Canterbury	488,500	6,600	422,300	52,000
Canterbury Bight	666,400	0	658,600 to 671,400	-5,000 to +7,800
Pegasus Bay	20,600	0	31,600	-11,000

[42] Timaru and Banks Peninsula Coastal Report (2006) by Martin Single MWH NZ Ltd, Report No: R06/16, Environment Canterbury

Unknown outputs in the gravel budget include losses due to abrasion of gravel to fine sand that is then lost from the beach, losses alongshore from South Canterbury to the Port of Timaru dredged channel, losses offshore usually near river mouths due to floods carrying coarse sediment onto the nearshore seabed.

The coast from the Waitaki River to Teviotdale can be considered generally to be in gravel deficit, and/or eroding by landward movement of the shoreline except for South Beach, Birdlings Flat and the sand coast between the Avon Heathcote Estuary and Leithfield Beach, which are stable or accreting.

Extraction of gravel from the rivers which supply gravel to the coast adds to the total budget deficit, but may not add significantly to existing erosion rates due to the significant amount of material lost by abrasion as the gravel is transported in the swash zone and along the shore by wave action.

It is recommended that further study of the gravel budget investigate smaller segments of the shoreline (related to beach profile monitoring sites for example) to determine site-specific effects.

20. Regional Annual Sustainable Supply of Gravel

The sum of the estimated annual sustainable river gravel supply in the Canterbury region is:

Priority 1 Rivers	432,900m^3/yr
Priority 2 Rivers	318,200m^3/yr
Total estimate	**751,000 m^3/yr**

The sum of the estimated annual sustainable coastal gravel supply in the Canterbury region is:

South Canterbury	12,000m^3/yr
Canterbury Bight	0m^3/yr
Pegasus Bay	0m^3/yr

21. Summary of river reports

Available information on thirty-seven rivers in Canterbury has been analysed to estimate the average net gravel supply, and, where possible, approximate aggradation and degradation trends and volumes. For seventeen rivers (the more significant gravel extraction rivers), river reports have been developed which detail the history and available information. Twenty other rivers with limited information, have also been assessed for sustainable supplies and briefly discussed, allowing a regional picture of sustainable fluvial gravel supplies to be established. The thirty-seven rivers include the majority of the main rivers in the region, adding up to a total catchment area of 28,000km^2, or 2/3rds of the Canterbury Region. The notable exclusions are: the upper Waitaki, Banks Peninsula, and lowland streams. The excluded areas tend to be either of limited commercial use or have little or no gravel supply.

For the 12 rivers where sufficient survey information is available (refer Table 9), estimates of net supply rates have been made by calculating the difference in volume between surveys and allowing for the gravel estimated to be taken over the period, generally from the "gravel returns" collected as part of the consent process. In addition, estimates of average annual bedload supply and throughput (gravel and sand that passes through the system to the coast) have been made for some rivers.

For rivers with no survey information, estimates of annual sustainable supply rates have been inferred by comparison with rivers with similar characteristics, allowing as far as practicable for differences in catchment area, geology and river bed slope. Significant assumptions (see methodology section 16) have had to be made about the proportion of gravel that might typically be washed out to sea. These estimates are likely to be less accurate than those with survey information.

The combined estimated supply rate for these 37 rivers is about 751,000 cubic metres per year (m^3/yr). For comparison, typical reported extraction rates on these rivers totalled about 740,000 m^3/yr in the 1990's. This increased to around 2.6 million m^3/yr in 2003/2004. The consented volume for these rivers for 2006 is about 4 million m^3. The estimates for the 37 rivers are summarised in Table 9 over page.

Some perspective on the figures may be provided by the thought that, on a large river such as the Rakaia, an excavation 100mm deep by 1km wide by 10km long would yield 1 million cubic metres.

The estimated sustainable supply from coastal areas is only a fraction of the estimated sustainable river supply, at 12,000 m^3/yr in the South Canterbury area and negligible amounts in the Canterbury Bight. A net negative supply of gravel is estimated on average for the Pegasus Bay area. Extraction from rivers contributes to coastal sediment deficits in many areas but may or may not be significant in comparison to natural abrasion losses due to wave action.

The rivers with significant sustainable gravel supplies are not necessarily those that have traditionally had large extraction volumes, with the exception of the Waimakariri (see Table 8):

Table 8: Major sources of net gravel supply

River	Catchment area (km^2)	Estimated net sustainable annual supply rate (cubic metres per year)	Estimated surplus or aggradation at last survey[1]	Average annual extraction rate (typically 1990-2003)
Waimakariri	3564	250,000	2,400,000	320,000
Waiau	3334	158,000		19,000
Rakaia	3105	85,000		16,800
Ashburton	1520	75,000	320,000	40,000

[1] Returns indicate surpluses are generally likely to have reduced since last survey

A number of rivers, including the Temuka, Tengawai, Pareora, Otaio and Makikihi have been shown to have degraded over time in excess of the known gravel extraction, so have been assessed as having no net sustainable supply. The assessment for the Opihi River also indicated this, but returns received recently suggest there may be a small net annual supply. In 18 of the 37 rivers, long term extraction rates (1990-2003) exceed the estimated sustainable supply rates. Extraction in 2003/2004 was higher than the long term rate in 10 of these 18 rivers.

In 28 of the 37 rivers, currently consented extraction volumes for 2006 exceeds the estimated supply rates, however, some of these include aggraded areas where it may be desirable to remove gravel at a faster rate than the supply (to lower the bed level and reduce the flood risk). While many extractors work with river engineers to identify preferred extraction sites for flood capacity purposes, there is no clear mechanism to ensure that gravel extraction locations are compatible with flood management objectives.

21.1 Demand summary

Current levels of demand (2.5 to 3 million cubic metres per year) are several times higher than in the 1990's. Demand appears to be strongly related to the prevailing strength of the Canterbury economy and, in particular, roading demands. Future demand is anticipated to continue at an average of around 4-5% per year, but is likely to be highly variable from year to year.

21.2 Current demand and existing gravel availability

Gravel supply appears to be greater than the demand in the following areas/rivers:

- Kaikoura area
- Waiau River
- Rakaia River
- Rangitata River
- Orari River
- Mid Waimakariri River
- North Branch Ashburton River above Thompsons Track

Gravel supply and demand are reasonably well balanced in the following areas:

- Hurunui River
- Upper Ashley River
- North Branch Ashburton River to Thompsons Track
- Hinds River
- Upper Opihi River
- Otaio River
- Lower Waitaki area

Gravel demand exceeds the estimated supply and surplus (above design bed levels) in the following areas:

- Waipara River
- Kowai River
- Lower Ashley River
- Lower Waimakariri River
- Selwyn River
- South Branch Ashburton River
- Main Stem Ashburton River
- South Canterbury from the Waihi River to the Pareora River
- Makikihi River
- Waihao River

The Lower Waimakariri River and the Main Stem Ashburton River have had bed level controls for a number of years. These have limited the quantities taken and the adverse effects, particularly in relation to vulnerable bridges. The same controls are not generally in place on the other rivers listed.

Net coastal supply is very limited and extraction has generally been similar to the net supply rate.

The generalisations above hide local variations (e.g. concentration of extraction at accessible locations) and do not take into account the differences in quality or grading that different end uses may require.

However, the river reports highlight that gravel extraction on some rivers has been unsustainable, particularly in the Pareora to Temuka and Christchurch to Amberley areas.

21.2.1 Medium term demand (next few years)

The projected demand is anticipated to use up surplus gravel resources in the relatively near future in the following areas:

- Mid Waimakariri River
- Rangitata River
- Orari River
- Upper Opihi River
- Otaio River

21.3 Long term demand

The long term demand for gravel may be far in excess of the sustainable supply from rivers and the coast. Because transport cost is a significant factor in preferred gravel extraction locations, the demand is generally likely to continue to be concentrated mainly on the rivers that have already had significant extraction pressure, but may also spread to nearby areas. Over the longer term, given projections in population growth and known major projects, extraction pressure may extend to:

- Hurunui River
- Upper Ashley River
- Hinds River
- Rakaia River

In summary, gravel extraction in several major rivers in Canterbury has been ongoing at an unsustainable rate and has increased sharply in the last few years. The demand for gravel, particularly from or near these rivers, is anticipated to continue to increase in the future. There is a clear need for the gravel resource to be managed on a more sustainable basis.

Table 9 Summary of river report estimates and gravel returns

River / *Tributary*	Catchment area[1] (km^2)	Estimated net sustainable annual supply rate[2]	Surplus or aggradation at last survey [3]	Method[4]	Average annual reported extraction rate (typically 1990-2003)	Recent annual reported extraction rate (2003/2004)	Consented annual extraction rate (2006)
Clarence	1758	21000		inferred	350	0	103500
Kowhai (Kaikoura)	90	19000	330000	surveyed	0	0	1500
Oaro	51	2500		inferred	100	0	0
Conway	503	7000		inferred	23350	0	13000
Waiau	3334	158000		inferred	19020	16100	99500
Hurunui	2297	15000		inferred	4430	12000	26000
-Pahau	360	3000		inferred	280	1000	8300
Waipara	737	2000		inferred	14900	26750	170700
Kowai	217	600		inferred	7690	4960	130900
Ashley	1340	3600	345000	surveyed	52300	45560	231550
Waimakariri	3564	250000	2400000	surveyed	320000	513100	1703000
Selwyn	633	1800		inferred	19150	30200	48400
-Waianiwaniwa	122	200		inferred	0	0	0
Rakaia	3105	85000		inferred	16770	27210	70300
Ashburton	1520	75000	320000	surveyed	40000	91430	177900
Hinds	350	1000	112000	surveyed	1900	1200	17300
Rangitata	1773	30000		inferred	6600	17300	146000
Orari	520	35000	727000	surveyed	23500	41200	145650
Opihi (main river)	1190	0	170000	surveyed	107000	1194200	472050
-Temuka	100	0	0	surveyed	3650	3600	19500
--Waihi	175	2300	0	surveyed	8400	15600	16000
--Te Moana	146	2000		inferred	9100	3800	31500
--Kakahu	149	2000		inferred	60	0	0
-Tengawai	640	0		surveyed	10600	14300	31500
Pareora	540	0	99000	surveyed	22600	241100	202500
Otaio	140	0	42000	surveyed	2920	0	5500
Makikihi	107	0		inferred	9530	95300	30000
Waihao	580	13000	32500	surveyed	8660	92300	39000
Lower Waitaki (main river below Kurow)	301	300		inferred	510	60400	3500
-Hakataramea	899	10800		inferred	3160	100	3750
-Penticotico	51	800		inferred	440	0	0
-Elephant Hill Stream	58	800		inferred	2050	400	5000
-Kurow	47	800		inferred	2630	3000	5200
-Otiake	61	1100		inferred	310	0	10000
-Otekaieke	116	1700		inferred	1010	0	0
-Maraewhenua	290	3800		inferred	420	0	0
Upper Waitaki							
-Twizel	300	2000		inferred	520	300	3000
Subtotal of region covered by river reports	**28164**	**751100**	**4577500**		**743910**	**2552410**	**3971500**
Upper Waitaki (excl Twizel)	9834						
Rest of region	4202						
Canterbury region	42200						

[1] Where tributaries are shown, the main catchment area is in addition to the tributary area
[2] Zero rates indicate net long term degradation over and above extraction. Units are cubic metres per year.
[3] Returns indicate surpluses are generally likely to have reduced since last survey. Units are cubic metres.
[4] Method of calculation of sustainable supply rates is either based on survey and return information or inferred by comparison with other catchments. In general, the surveyed estimates are likely to be more accurate.

Chapter 7 Land-Based and Out of Channel Gravel Extraction as Alternatives to In River Channel Fluvial Gravel Extraction

22. The Need for Alternatives

Survey information shows that the source of gravel to meet current demands is split approximately equally between land-based gravel extraction and extraction of fluvial gravels from the channels of river beds (in channel) (see section 14.2). Section 21 indicates that the sustainable supply of fluvial gravel from rivers will be insufficient to meet projected demand over the next ten years.

As an alternative to fluvial gravel extraction, extraction primarily from land-based sources appears to be the most likely source for increased demand. However land-based gravel extraction is not a primary function of regional councils. These alternatives are considered in this report in recognition that a change in fluvial gravel management could result in increased land-based extraction, section 23 provides discussion of the role of ECan for the activity of gravel extraction on land and a look at the pros and cons of land-based extraction compared to river-based fluvial extraction from the ECan perspective.

Sections 23 and 24 look at the pros and cons of land-based and out of channel gravel extraction.

23. Land-based Gravel Extraction

23.1 Formation of land-based gravels in Canterbury

Over the last several million years, multiple advances of valley glaciers in the South Island have resulted in glacial outwash fans extending as plains from the mountains to the sea. The Canterbury Plains, formed from such alluvial gravels, extend eastwards as successive layers and contain within them Canterbury's valuable groundwater resource. In many areas, rainwater is the main source of groundwater recharge, percolating through the gravels and into aquifer systems. In other areas significant recharge occurs as seepage from alpine and foothill rivers.

The river valleys, flat lands and Canterbury plains are made from porous gravel sediments that allow water from rain and rivers to filter down to form aquifers. These unconfined or semi-confined aquifers provide the principle source of groundwater throughout the region. While the gravels of the plains and river valleys provide a potential source of gravel for extraction, potentially significant adverse effects on groundwater could occur as a result. It is the role of the regional council to ensure that the ground water source is protected from pollution and managed sustainably.

23.2 Land-based gravel extraction

Land extraction of gravel is usually carried out in pits or quarries. In Canterbury, land-based extraction is as common as river extraction with similar volumes of gravel extracted annually (see Land-Based Sources section 14.2). The general pros and cons of land-based gravel extraction compared with fluvial, in channel, gravel extraction are listed below.

23.2.1 Pros and Cons

Pros

Land-based gravel extraction:

- may not have the same adverse environmental effects as extraction from river beds on flora and fauna;
- is not dependent on large volumes of gravel are being transported by the river;
- means that site remediation can provide new recreation areas and/or provide habitat for flora and fauna.

Cons

Land-based gravel extraction:

- site remediation may be expensive for the consent holder;
- the cost of purchasing land can be expensive;
- a consent from the district/city council and the regional council may be required ;
- notification of consent application is costly and there may be significant issues for adjacent landowners, such as lowering of groundwater levels, traffic etc;
- material suitable for backfilling pits may not be available in sufficient quantities;
- there is a risk of contamination to groundwater from contaminants spilt on site;
- sites that are not remediated, can turn into unsightly waste dump areas and lead to groundwater contamination;
- if land-based extraction became the most dependable source in Canterbury it may lead to reduced volumes being taken from those rivers where it is necessary to maintain flood capacity;
- is a finite resource at each site.

As with extraction from riverbeds, land-based extraction cons also include:

- the risk of spread of pest plants seeds from the extraction site to gravel destinations;
- increased transportation costs where available sites may not be close to where gravel is needed;
- a possible monopoly situation where only limited sites are available;

- access to the site needing to be negotiated with land owner;
- the risk of contaminating water from contaminants spilt on site.

Although land-based extraction can be a viable alternative to extraction from river beds, there may be limited sites where it can be carried out within Canterbury. Land-based extraction is likely to require more than one consent and possibly notification. Other considerations include private land ownership and potentially expensive remediation consent conditions.

23.3 Land-based gravel extraction under the RMA

Under the RMA, any activity is allowed on land unless it is restricted by a rule in a regional or district plan. This is quite different from fluvial gravel extraction because no one may undertake an activity that disturbs the bed of a river, unless they have a resource consent or it is authorised by a rule in a regional plan.

23.4 Land-based gravel extraction under the TRP

The Canterbury Transitional Regional Plan (TRP) does not address the activity of land-based gravel extraction directly, however Section 10 of the Underground Water Bylaw provides for the protection of groundwater quality. Section 10.2 of the Underground Water Bylaw requires a resource consent from the regional council for any matter or thing on the ground that may detrimentally affect (directly or indirectly) the quality of underground water.

Therefore, although no resource consent is required under the TRP for the activity of gravel extraction on land, a resource consent may be required for effects associated with the activity.

23.5 Land-based gravel extraction under the Proposed NRRP

The Proposed NRRP must be taken into account when looking at land-based gravel extraction. Again, as under the TRP, the main area of concern for the regional council is the effect on water quality of excavation of gravel or subsequent use of the pit or quarry. The adverse effects on groundwater quality in the Canterbury Region is currently a discretionary activity under the Transitional Regional Plan and under the Proposed NRRP Chapter 6 (the relationship between operative and proposed regional plans is discussed in Chapter 3 of this report). This means that the policy and conditions in the Proposed NRRP have to be considered when setting conditions on a resource consent where a consent is required.

Table 10: Example of rules that may apply to these activities in the Water Quality Chapter

Relevant rules		Main concern addressed by rule
Rule WQL5 – Discharge of stormwater containing contaminants into or onto land	permitted activity	Storm water contamination
Rule WQL40 – Excavation of land over an unconfined or semi-confined aquifer	restricted discretionary activity	Locations of confined/unconfined or semi-confined aquifers that could get contaminated
Rule WQL41 – Deposition of more than 20 cubic metres of material into excavated land	controlled activity	Deposition of materials such as replacing or putting back gravel that could cause contamination
Rule WQL43 – Use including storage in an above ground storage container of a specified hazardous substance	permitted activity	Use and storage of hazardous substances on the land
Rule WQL44 – Use including storage, of a specified hazardous substance	controlled activity	Storage of hazardous substances that could leak/spill and contaminate groundwater such as fuel tankers on extraction sites
Rule WQL55 – Use of land for	discretionary activity	Manage existing activities within the

mineral extraction, use a of a specified hazardous substance or the discharge of storm water in Zone 1A, Zone 1B or Zone 1C of the Christchurch Groundwater Recharge Zone		Christchurch Groundwater Recharge Zone to protect the source of Christchurch's drinking water
Rule WQL63 – Use of land for mineral extraction, or the use, including storage of a specified hazardous substance in Zone 1 excluding Zone 1A Zone 1B of Zone 1C of the Christchurch Groundwater Recharge Zone	prohibited activity	To protect the source of drinking water to Christchurch City, no new quarries beyond defined area are allowed and extraction is a prohibited activity outside of Zone 1C of the Christchurch Groundwater Recharge Zone

Land-based gravel extraction activities may trigger one or more of these rules listed above. Where the activity of gravel extraction or associated activities are referred to in a rule, a resource consent may be required to ensure management of adverse effects. Each of these rules has specific conditions that must be met.

Map 4 below, is an indicative map[43] showing approximate areas in the region where pit, quarry or other land-based gravel extraction may trigger a rule in the Proposed NRRP.

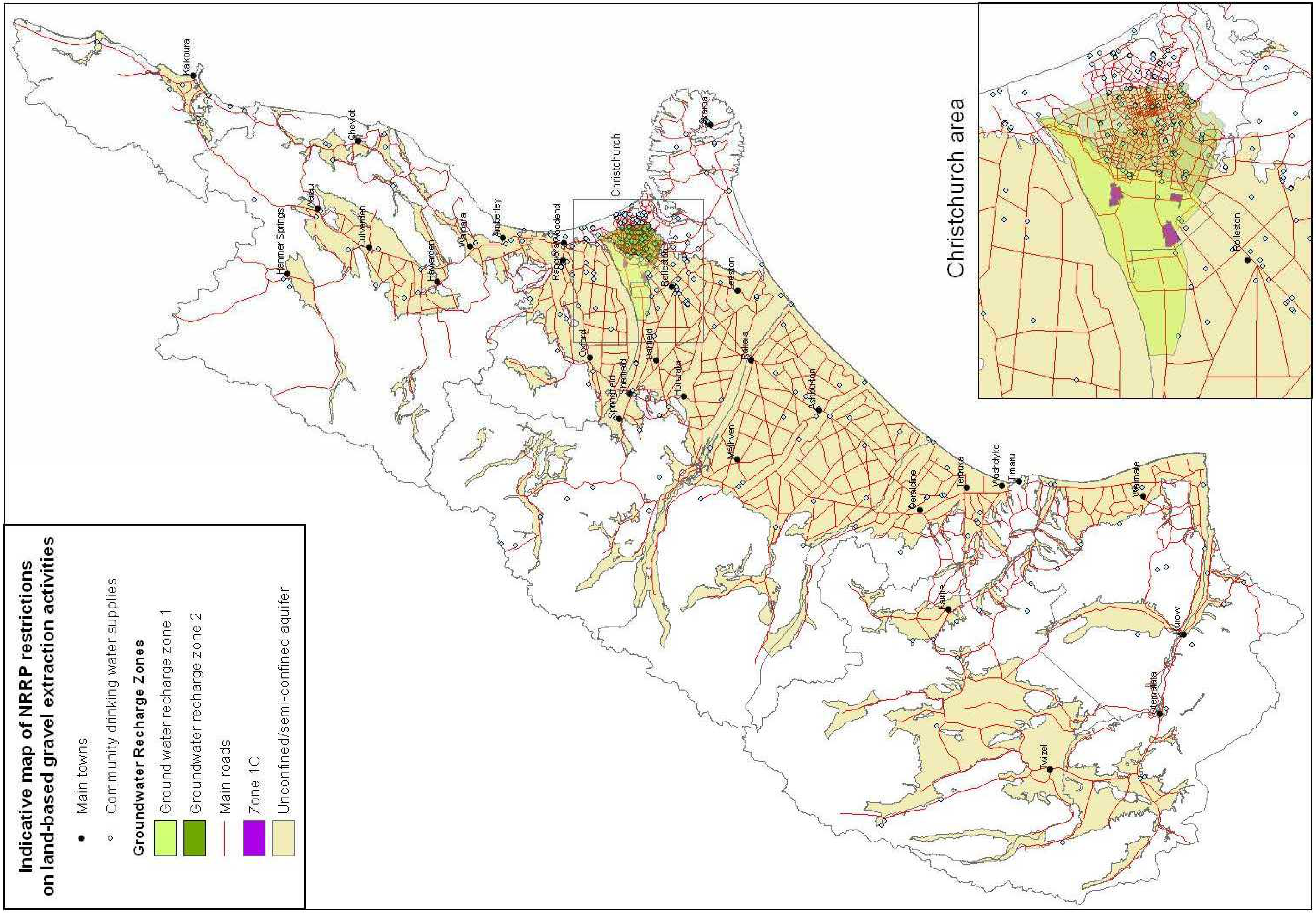
23.6 District Plans

Whether a resource consent is required from the regional council (ECan) or not, a resource consent may also be required from the local Territorial Authority. This is because district plans also influence how, when and where land-based extraction can occur. The main concerns commonly addressed in these plans are: noise, dust, traffic effects, visual detraction and site remediation. For example, Christchurch City Council has restricted current dry land extraction to a specific zone in recognition of these effects (Christchurch City Plan 2005). Depending on how close the proposed site is to a residential area there may also be a number of affected parties and the resource consent may need to be notified.

The significant difference between gravel extraction from land and from river beds is that in riverbeds, lack of gravel extraction can have significant adverse effects on the regional councils functions in maintaining flood carrying capacity, whereas there are no significant adverse effects from not extracting gravel from land.

[43] Note the map is indicative only and limited to show the parts of the Canterbury Plains where there is sufficient information.

Map 4: Example of areas where land-based gravel extraction may trigger a rule in the Proposed NRRP



24. Out of Channel Gravel Extraction

Out-of-channel gravel extraction is carried out on riparian land, largely between the riverbanks and the active channel. In most cases these areas are considered riverbed under section 13 of the RMA, in areas that are considered land, the planning framework as described in section 23 above, on land-based extraction applies.

Out of Channel extraction consists of the excavation of gravel to form pits or depressions. These pits can be shaped and contoured to replicate natural channel forms, and provide ecological restoration benefits. Out-of-channel extraction also provides an opportunity to relieve extraction pressure on degrading rivers.

Riparian land is generally part of the natural floodplain, and is typically overlain with old river channels and flood overflow paths. Riparian land will often provide better quality gravel than geologically older alluvial sites located further inland. Where the natural floodplain has been modified by stopbank construction, out-of-channel extraction would occur within the riparian margin between the riverbank and stopbank.

Out-of-channel extraction is an alternative to in-channel extraction, where environmental and ecological effects may be unacceptable, and to land-based extraction, which can have problems associated with noise, dust, and visual disturbance.

In the case of rivers with an inadequate supply of gravel from the catchment or tributaries, such as the Mataura and Oreti Rivers in Southland, in-channel gravel extraction has been restricted because of significant riverbed degrade.

Out-of-channel extraction from alluvial floodplain areas adjacent to the river has been developed as a means of satisfying gravel demand, whilst enhancing environmental and ecological values. Out-of-channel extraction typically involves the artificial formation of oxbow lakes and backwaters.

Natural backwaters are abandoned river channels, which remain open to the river at the downstream end, but have been blocked by gravel bars at the upstream end. These gravel bars prevent inflow other than seepage or flood overflow.

Oxbow lakes are deep pools of still water within an abandoned river meander loop, and are supplied with water from groundwater, flood overflows, and tributary streams. The upstream and downstream ends of the oxbows are often swampy depressions, which may have small channel connections to the river.

Backwaters can provide wading bird and fish spawning habitat. Oxbow lakes often have riparian vegetation, as well as provide waterfowl and fish habitat. To achieve the potential ecological and environmental benefits from formation of backwaters and oxbow lakes by gravel extraction, the excavation and removal of gravel must be carefully managed, and incorporate appropriate mitigation measures.

These mitigation measures would typically include mimicking the natural river channel plan form and cross-section shape, construction of bunds to control fine sediment release, appropriate disposal of waste vegetation and silt material, and retention of existing or planting of new riparian vegetation.

Obvious constraints to out-of-channel extraction include land ownership, cost in comparison to more traditional land (pit) based gravel extraction methods, and potential threat to flood protection infrastructure and adjoining land from river bank erosion and course change.

The majority of riparian land within the Canterbury Region is privately owned, and land purchase for out-of-channel extraction would have to be negotiated with land owners. Also specialised techniques would be required for the construction and remediation of backwaters and oxbow lakes.

Out-of-channel extraction should not be carried out in such a way as to increase the risk of bank erosion or course change during flood, or to increase the risk of failure of flood protection infrastructure such as riparian planting and stopbanks.

As a general principle, out-of-channel extraction should not be carried out where there is a narrow berm margin between the stopbank and river edge. Where there is a wide berm margin, out-of-channel extraction may be an option, provided any increased risk of damage to stopbanks and adjoining property is minimised.

Given these constraints, out-of-channel extraction is likely to be attractive in specific locations only. In the absence of a regional assessment, opportunities for out-of-channel extraction would need to be identified at the initiative of individual contractors.

Chapter 8 Monitoring for Gravel Management

25. Introduction to Monitoring

Sustainable management of natural and physical resources requires the development of clear and measurable objectives; an understanding of the resource and the issues associated with it; and an adaptive management framework that can respond to increasing levels of knowledge about the resource, and enables integration with management of associated resources. A key component of such a system is monitoring – monitoring of the state and use of the resource itself, but also of the effectiveness of the system and tools of management. The importance of monitoring to sustainable resource management is reflected in the requirements of the Resource Management Act 1991 (RMA) (sections 35 and 67), which places specific monitoring responsibilities on local authorities [see Section 26.4].

This section of the Canterbury Regional Gravel Management Report undertakes an assessment of ECan's current monitoring programmes associated with gravel management, and makes recommendations for a region-wide gravel monitoring regime. The assessment of existing monitoring focuses on the current river bed cross-section survey programme, and on current methods of monitoring the volume of gravel extracted from Canterbury rivers.

The results of this assessment indicate that current monitoring is limited in its effectiveness in terms of sustainable gravel management, and there are significant gaps in ECan's understanding of the state of the gravel resource regionally. In order to achieve more sustainable gravel management, a more cohesive and comprehensive gravel management framework needs to be developed, and existing monitoring processes require review and improvement.

25.1 Consultation With Other Regional Councils

As part of the process of assessing current monitoring programmes and making recommendations for improvements, consideration has been given to what effective and appropriate monitoring programmes might involve. In doing this, a number of other regional councils were consulted to identify the systems utilised in other regions, and to seek feedback on the effectiveness or otherwise of those systems. Discussions were held with staff of Otago Regional Council (ORC)[44] and Hawkes Bay Regional Council (HBRC)[45], and with past staff of Greater Wellington Regional Council (GWRC)[46]. Summaries of these discussions are attached at Appendix C. Relevant regional plans and policies of these councils, and of Horizons Regional Council (HRC) and Environment Bay of Plenty (EBOP) were also researched. Although the systems currently in place in these other councils may not necessarily represent the optimal for sustainable gravel management, the monitoring undertaken appears to incorporate and address gravel management objectives to a greater and more effective extent than currently occurs in Canterbury.

25.2 Current Monitoring

25.3 Bed Level Cross Section Surveys

25.3.1 The Current System

Monitoring of riverbed levels is currently undertaken via periodic surveys of a network of cross sections that have been established on many Canterbury rivers. The frequency of cross section survey records varies considerably between rivers, however records in some

[44] Steven Swabey, Manager Natural Hazards, Otago Regional Council
[45] Vince Byrne, Hawkes Bay Regional Council
[46] Peter Holden, MWH Christchurch

instances extend back as far as the 1930s. In other instances, no cross section surveys have been undertaken at all.

The cross section survey programme is currently funded out of the Investigations and Monitoring Directorate, managed by staff in the Land and Coastal Resources section, but where and when surveying is undertaken is determined by the Engineering, Land and Coastal, and River and Hazards section. The River and Hazards section is responsible for natural hazard management and planning, including flood risk management. Given this, the rationale behind when and where cross section surveys are undertaken is based primarily on flood risk management objectives.

The programme of monitoring is founded on the basis of historic rotations, however this is then refined through a prioritisation process required due to the limitations imposed by increasing resource constraints. This process identifies priority rivers or sections of rivers for surveying based on topical issues and points of concern (or the "squeaky wheel" approach). [1] Justin Cope (2005).

Underlying the cross section surveys are design bed levels that have historically been established for flood management purposes. These are based on the design flood-carrying capacity of rivers, taking account of bed widths, riverbed character (braided/meandering or channelised), and flood control structure capacity (stop-bank heights etc). In most instances these design bed levels have not changed in many years despite potentially significant changes to these contributing factors. Moreover, in some instances (in South Canterbury at least), minimum bed levels were not established as the original scheme design intended the bed to degrade over time to increase flood carrying capacity. However whether or not the extent to which this was intended has been specified, is not clear and therefore there is a danger that present mean bed level estimates may not match earlier design expectations. [47] Bob Hall (2005).

25.3.2 Limitations of Current System

Although the current bed level monitoring programme may suffice for river management purposes, if it is to be used for gravel resource management, there are a number of limitations that need to be addressed. These include –

- Drivers behind existing monitoring come primarily from flood risk management and do not sufficiently incorporate gravel resource management purposes.
- Data sets are incomplete and for some rivers non-existent.
- Extent of data is inconsistent across the region.
- Does not appear to be a particularly cohesive systematic approach to riverbed monitoring.
- Surveys not always exactly replicated.
- The design of the existing monitoring programme in relation to particular rivers does not sufficiently take account of relevant factors that influence and inform the determination of the need for monitoring for gravel management purposes.

Consideration of the existing data indicates that records are erratic and there does not appear to have been a systematic approach to undertaking the cross section surveys. Surveys have generally been undertaken infrequently; and there is significant variation between rivers in the frequency of surveys (ranging roughly between 5 and 35 years) and the reasoning behind this is not clear. There is inconsistency in the number of cross sections surveyed on each monitoring occasion; and there appears to have been minimal analysis and interpretation of the resulting data.

Discussions with staff from both the Land and Coastal Resources and River Engineering sections indicate that the cross section survey records have historically been under-utilised, with analysis limited to flood modelling and/or river engineering design purposes. In addition, although the programme has been operating for many years, over time it has undergone a

[47] Pers comm, Bob Hall, RJ Hall Consulting Ltd, Timaru

number of changes, primarily due to resourcing limitations resulting in elements of the programme being suspended.

The bed level survey programme is currently managed by a member of the Land and Coastal Resources section. However, the data collected is not used by this section and does not in practice relate directly to the core work of this section. The rationale for this situation appears to be historical, and may no longer be appropriate. It could also potentially lead to a fragmented approach to management of the programme.

Limitations in the comparability of historic data also becomes increasingly apparent as surveying technology improves, producing increasingly accurate data that can highlight a lack of reliability in historic data collected using much earlier methods and technology.

Central to the limitations of the existing programme is the underlying purpose or objective of the monitoring. Historically, the monitoring has been driven by flood risk management purposes, and has incorporated gravel management only as an adjunct to those purposes and as a tool for river management purposes. The drivers of the programme have not specifically incorporated gravel resource management purposes as a resource management issue in its own right. The design bed levels against which cross section surveys are assessed are set for flood management purposes (i.e., based on design bed levels associated with flood carrying capacity of river channel and stop-banks etc), and the objectives of gravel resource management (and to some extent, river engineering) have generally not been integrated into the design bed levels upon which the programme is based. This means that for the purposes of gravel management, there are likely to be gaps within the monitoring data, and existing data will not necessarily answer management questions for the gravel resource.

25.3.3 The Existing Cross-Section Network

ECan records of cross-section surveys have been tabulated for all of the rivers addressed in this investigation (Priority 1 rivers and Priority 2 rivers) in order to provide a summary "snapshot" of the current cross-section monitoring network. This is shown in Table 11 below.

Table 11 shows that under the current network, there are a large number of rivers with little or no bed level monitoring occurring on them (primarily Priority 2 rivers). When this information is considered alongside annual gravel extraction data, existing gravel consents, and sustainable gravel supply estimates for respective rivers[48], it is possible to identify key rivers of concern where bed level monitoring is currently inadequate. This also provides a useful tool for prioritising improvements to specific river monitoring regimes.

Table 11: Canterbury River Cross-Section Network and Monitoring Frequency[49]

River	First Survey	Last Survey	Total no. of surveys	Average survey frequency (yrs)	No. of cross sections	Average no. of cross sections surveyed	Average distance between cross sections (m)	Upstream distance of cross sections (km)
Ashburton								
- Main	1937	2002	10	7	28	15	750	20
- North Br	1948	2002	17	3	53	24	757	37
- South Br	1937	2002	8	9	26	17	913	44
Pareora	1949	1999	4	17	27	26	588	16
Opihi	1953	2004	10	6	40	25	650	26
- Upper	1952	1998	5	12	14	8	1418	65
Orari	1949	1995	7	8	64	45	732	37
Waihi	1962	2004	8	5	48	24	493	31
Waimakariri	1960	2004	8	6	63	60	913	56
Ashley	1960	2001	7	10	25	13	840	21

[48] Section 13 Projected Regional Demand for existing consented volumes and MWH NZ Ltd *River Reports 2006*
[49] Based on mean bed level data provided by ECan September 2005.

Temuka	1953	2001	6	10	15	11	438	8
Hinds - Main - Upper - South	1937 1967 1969	2001 2003 2002	6 5 4	13 9 11	32 15 5	24 13 5	932 790 820	29 41 45
Otaio	1984	2002	2	18	32	32	730	23
Waihao	1966	2001	6	7	35	21	404	14
Kowhai (Kaikoura)	1987	2002	3	8	25	25	436	11
Rangitata								
Makikihi								
Te Moana								
Waipara								
Pahau								
Kowai		1977		30	7			
Selwyn		1999		10	10			
Rakaia		1988		40	25			
Kakahu								
Clarence								
Conway								
Waiau								
Hurunui		1989		30				
Waitaki								
Hakataramea								
Twizel								
Oaro								
Waianiwaniwa								
Kurow Creek								
Otiake								
Otekaieke								
Maerewhenua								
Penticotico								
Elephant Hill Strm								

Rivers that require urgent development of monitoring programmes include:

- Rangitata
- Makikihi
- Te Moana
- Waipara
- Clarence

Currently, no cross-section monitoring occurs on any of these rivers. However, gravel extraction is occurring in all of them, and in each case the estimated annual sustainable gravel supply is less than the average annual gravel extraction, or in the case of the Rangitata, Waipara and Clarence, is less than the amount that is currently consented for extraction. In the case of the Makikihi, the sustainable gravel supply estimate indicates that there is currently no sustainable supply.

Rivers that require urgent improvement (e.g. increased frequency and/or cross-sections) to the current cross-section monitoring include:

- Rakaia
- Selwyn
- Kowai
- Pareora

- Otaio
- Hinds
- Temuka

Although there are currently cross-section networks on all of these rivers, the frequency of monitoring should be increased. The frequency of monitoring on the Rakaia is currently 40 years. Given that there is a reasonably small “buffer” between the estimated annual sustainable supply of gravel and the annual amount that is consented for extraction over the next 8 years, the frequency of monitoring on this river should be increased. On both the Selwyn and the Kowai the annual amount that is currently consented for extraction far exceeds the estimated annual sustainable supply, posing a potential risk of over extraction. Therefore the respective monitoring frequencies of 10 years and 30 years should be increased. The frequency of monitoring on the Pareora (17 years) should be increased as the rate of extraction on this river currently exceeds that of replenishment and gravel supply is unsustainable (Hudson, H.R. 2005. Pareora River Report). Estimates indicate that there is no sustainable supply of gravel in either the Otaio or the Temuka, and very limited sustainable supply in the Hinds (1000m^3/yr). Given this, the current average monitoring frequency of 18, 10 and 9-13 years respectively should be increased.

The specific details of the monitoring required on these rivers have not been identified at this stage. One of the key recommendations of this report is that a regional monitoring framework be developed, along with a consistent set of assessment criteria that can then be applied to each river for the purposes of reviewing and developing individual river monitoring regimes (see Section 26.1). Therefore, to recommend specific monitoring details for these particular rivers at this stage would be putting “the cart before the horse”, and would simply continue an ad hoc approach to monitoring that is not based on a consistent and comprehensive region wide framework, supported by appropriate and integrated management objectives. However, this does not preclude use of the list of rivers above and Table 11 to prioritise the focus of immediate and short-term action to undertake interim improvements in the bed level monitoring on these rivers.

25.3.4 Benefits of Current System

A monitoring system involving regular bed level surveys is a key tool in the monitoring of the state of the gravel resource, the impacts of current gravel extraction rates, and in providing information for river engineering and flood risk management purposes. Bed level survey data can be used to calculate changes in mean bed levels and the volume of gravel stored in the river channel through time. This can show whether a river bed is trending toward aggradation or degradation. Furthermore, when river bed gravel volume changes are compared with gravel extraction records, the influence of gravel extraction on observed trends in bed levels can be determined.

Therefore, notwithstanding the gaps and limitations inherent within the current bed level monitoring programme and resulting data, some (albeit limited) data may be better than no data at all. Existing data provides a starting point from which to review and refine bed level monitoring in order to incorporate gravel resource management and other related purposes.

In addition, where it is available the existing data provides a broad overview of historic trends in terms of bed level changes. When analysed, this data can give an indication of trends across a particular reach, and a catchment as a whole, showing whether over time, the bed is aggrading or degrading.

On this basis, the data can provide ECan with a basis for prioritising rivers in terms of the need for improved management with respect to gravel extraction and/or river engineering. Although the assessment in this report indicates that the development of a comprehensive region-wide gravel management and monitoring framework is required, a process of prioritisation on the basis of analysis of existing information should provide the impetus to focus resources in the short term in the areas that need it most.

25.4 Consent Compliance Monitoring

There are currently a range of "standard" conditions that are generally attached to gravel extraction consents. These conditions address a wide range of potential effects of gravel extraction, and include conditions relating to –

- the maximum allowable depth of excavation
- preventing extraction within 300mm of water level
- the specific location from which extraction may occur
- notification to ECan before and after excavation
- minimum distance of excavation to river banks and flood protection works
- limitations on stockpiling on the riverbed
- access impacts on stopbanks
- restricting work within flowing water
- avoidance of impacts on nesting birds
- fuel storage and re-fuelling
- site recontouring upon completion

Indications from River Engineering and Compliance and Enforcement section staff are that most of these "standard" gravel extraction consent conditions are reasonably effective, and can be readily and practicably monitored. An exception to this is the standard condition preventing extraction within 300mm of water level. Although one of the aims of this condition is to provide a buffer, and to maintain preferred riverbed levels, in some instances this is not achieved. Specifically, where the condition applies to long-term consents within a river that is in a degrading cycle, and where minimum bed levels are not specified, it does not necessarily prevent extraction continuing even when the bed is degrading. This is because extractors may excavate to within 300mm of water level, and then a fresh event may re-contour the bed and realign the flow channel.

Subsequently, extractors may return and extract once again to within 300mm of water level, and be in full compliance with their consent. This may occur frequently over the term of a consent. Where a river is in a degrading cycle, this can lead to exacerbation of this degradation. Given this, it is recommended that the use of this condition be reviewed.

Almost all gravel extraction consents also contain a condition that prescribes the maximum annual volume of gravel that may be extracted under the consent. The following assessment has focused on the effectiveness of existing systems for monitoring compliance with these maximum annual volume conditions. The existing monitoring process contains a number of limitations in this regard, and these are discussed in the following sections.

25.4.1 The Current System

At present, almost all consents issued by ECan for the extraction of gravel from riverbeds contain a condition or conditions that prescribe the maximum annual volume of gravel that may be extracted under the consent and/or from a particular site. Also included is a condition requiring extractors to maintain a record of the volume of gravel extracted under the consent, and to provide quarterly "gravel returns" to ECan indicating the volume extracted over the preceding quarter. Typically, this returns condition is worded as follows –

> *The consent holder shall measure the total quantity of gravel; sand and other natural material excavated each month to within an accuracy of 10 percent and shall record this measurement. The Canterbury Regional Council will send the consent holder a "Gravel Excavation Return" form for completion at the end of each quarter. This form shall be submitted to the Canterbury Regional Council by the 20th of January, April, July and October each year.*

This condition is clear in its requirement that the consent holder measure and retain records of monthly quantities of gravel extracted. However, submission of the return form appears to be contingent upon this form being sent to the consent holder by ECan.

There are some variations to this condition on some consents. In some instances, the requirement that the consent holder record monthly volumes is contingent upon ECan requesting that this be done –

> *"When requested by the Canterbury Regional Council, the total quantity of gravel…"*

And in some cases, the requirement that the Gravel Excavation Return form be submitted is not contingent upon this form being sent to the consent holder by ECan –

> "*…shall be measured…and recorded on the Canterbury Regional Council's "Gravel Excavation Return" form.*"

In assessing compliance with consent conditions, the Compliance and Enforcement team cross-check gravel excavation returns against the maximum volumes permitted by the resource consent. Gravel excavation return records also provide an indication of the total volume of gravel being extracted from each river catchment each year, although given the limitations of the returns process (refer Section 25.4.2 below), this may not be an accurate indication.

Prior to introduction of the RMA, the extent to which the North Canterbury and South Canterbury Catchment Boards collected gravel extraction returns varied, and following the introduction of the RMA, it took a couple of years for a consistent region-wide system to be established. Therefore, although gravel extraction records are available for some catchments prior to 1993, region wide records are only available from 1993 onwards.

Broadly, ECan's approach to consent compliance monitoring is as follows:

- The frequency of consent monitoring varies according to the type of activity authorised by the consent, the conditions of the consent, and the level of historic compliance by the consent holder.
- If there is full compliance, the frequency of monitoring decreases.
- It is Council's policy to recover all actual and reasonable costs of compliance monitoring of resource consents.

25.4.2 Limitations of Current System

The key limitation of the existing gravel returns system is that it is dependent on the accuracy and honesty of the records provided by consent holders. It is very difficult to audit these records, and on-the-ground monitoring to provide a cross-check requires considerable resources. This means that although the gravel returns records can provide a general estimate of the volume of material extracted from particular catchments, the accuracy of these records will always be inherently uncertain, and therefore so will the impacts of extraction.

Another concern with the existing system lies in the inconsistency in the wording of consent conditions relating to gravel returns. The varying wording is discussed above in Section 2.2.1. In order to ensure that the obligation to measure and maintain records of gravel extracted and to submit quarterly returns is clear, it is important that the wording of this standard condition is consistent, and does not suggest that any obligation is contingent upon prior action by ECan.

There are also inherent limitations in the gravel returns data due to a lack of a consistent requirement regarding the basis upon which extractors calculate their returns. At present, returns could be based on a range of factors, including truck tallies, loader buckets, or post-processing sales.

25.4.3 Benefits of Current System

Despite its limitations, the existing system provides data that can give a rough estimate of volumes being extracted. When this is combined with the general trends indicated by the bed level monitoring data, river managers are able to get a very general picture of whether there is a surplus or deficit in the gravel budget for particular catchments. However, for effective and sustainable management of the gravel resource, a greater level of accuracy is required. This is key information in the gravel resource equation and it is impossible to effectively manage a resource without a good understanding of what is there and what is being removed, and the impacts this is having on the river system.

25.5 Key Limitations of Current Monitoring Programmes

The accuracy, extent and focus of information provided by existing monitoring programmes is insufficient to ensure that over-extraction does not occur, and to ensure that managers of the resource have a sufficient level of information to be able to respond to gravel extraction related impacts quickly and appropriately. Current programmes cannot provide adequate data for sustainable management of the river gravel resource for the following key reasons –

- Underlying purpose and objective - sustainable gravel management objectives and purposes are not specifically incorporated into the drivers underlying the current monitoring programmes, which have principally been driven by flood risk management purposes.
- Incomplete data - existing data, both in terms of gravel extraction volumes and bed level monitoring contains many gaps, making it inherently uncertain and potentially inaccurate.
- Regionally inconsistent - monitoring has not been consistent in either frequency or extent across the region.
- Unclear rationale behind reasoning for when and where of bed level monitoring - gives rise to disparate data, and in some instances no data at all.
- Lack of resources – limited funding constrains existing monitoring programmes and this is causative of many of the limitations listed above.

26. Recommended Improvements/Changes

"*The effective regulation and monitoring of gravel excavation activities through the systematic collection of measurements of the trends in bed levels, gravel deposition and excavation rate data over time is essential for setting maximum and minimum excavation rates.*"[50]

26.1 Bed Level Monitoring

To ensure that bed level monitoring provides information that is relevant and appropriate to gravel resource management, the existing monitoring programme needs to be reviewed and updated, and sensitised to the needs of gravel management. Central to this is the development of specific objectives and policies for gravel resource management [see section 26.4.2 below] that will then provide the purpose and drivers for the monitoring programme.

However, it is important that an integrated approach is taken to the review and development of this programme. It needs to recognise and take account of the interrelationship between gravel resource management, river ecology, river engineering and flood risk management, and the relative importance of each of those factors in a particular river or river reach. The objectives of all of these issues will need to be considered, and in order to ensure the most efficient use of information and resources, it needs to address all three management objectives wherever they are relevant and applicable.

To this end, it is recommended that a region-wide framework for assessing the bed level monitoring requirements of rivers is developed. This framework needs to establish all of the factors to be taken into account (or the assessment criteria) in determining the monitoring regime for a particular river, as this will differ from river to river. This assessment will then give direction to the frequency of surveys; the number of cross sections to be surveyed; the required accuracy and precision of the measurements; and the underlying design bed levels (which may vary within and between rivers depending on the sensitivity of infrastructure present, and the capacity of flood control works).

It is important that the assessment criteria include all key factors that impact on flood risk management, river engineering, and sustainable gravel resource management, and that the assessment criteria are applied consistently across the region. This type of approach will ensure a systematic basis to the development of monitoring requirements that are tailored to the level of detail and accuracy required for each particular river. From a gravel resource management perspective, it is also important that this framework is applied to all rivers with the potential for gravel extraction. Its application should not be limited to only those rivers where gravel extraction has traditionally occurred, or where river engineering or flood risk management have historically been an issue.

The following are recommended as key assessment criteria to be used in determining the necessary monitoring regime for a particular river or section of river. It is important to note that this list is not exhaustive, and is intended as a guideline starting point only.

- Sensitivity of the reach – takes account of trends in riverbed changes shown by existing bed level monitoring data and/or completed assessments of natural sediment supply. A sensitive reach is one where bed levels and volumes appear to be degrading rapidly or falling below design levels, or where a lack of aggradation is evident. This may be due to natural processes or potential over extraction.
- Extraction pressure – takes account of past, present and projected rates of gravel extraction. Close attention should be paid to reaches where large volumes of material have or are being extracted, or where demand is increasing rapidly.
- Flood risk – takes account of the level of flood risk posed within the reach – give consideration to whether design bed levels can be changed due to changes in flood risk rating.

[50] Environment Bay of Plenty Regional River Gravel Management Plan

- Presence of infrastructure – identify presence of all sensitive infrastructure such as bridges, water intakes, pylons etc.
- Bed and bank stability – takes account of existing problems associated with bed and/or bank stability, and potential problems that may arise through flow path changes consequent upon extraction activities.
- Ecological sensitivity – identify any ecological sensitivities such as native fish or salmonid spawning sites; bird nesting areas; significant indigenous fauna and habitat.

Once this framework is established, the monitoring regime for each river should be reviewed. Given that it is unlikely that the resources to undertake a region-wide review of all rivers at once will be available, a process of prioritisation should be undertaken to determine the starting point, and then an on-going timetable of reviews. This process should take account of the status of current cross-section monitoring (see Section 25.3.3), estimates of sustainable gravel supply[51], understanding of impacts, and current and consented future extraction for each river.

There needs to be capacity within the resulting monitoring framework for review of the framework itself and the assessment criteria, to ensure a system that is responsive to change. However, given the highly dynamic nature of the environments being monitored, it is most important that the framework allows for adaptive management in terms of the specific river monitoring regimes. There must be sufficient flexibility within the system to allow review of these regimes in response to information obtained through improved monitoring, in response to improved understanding of particular river systems, in response to changes in management objectives within particular rivers, and following unforeseen events such as floods.

The particular aspects of the monitoring regime established for a particular river can then be carried through to gravel extraction consents granted within that particular river system, and where necessary, conditions implemented that are directly relevant to those monitoring parameters. For example, where design bed levels are established for a particular river reach in relation to a bridge or other structure, consent conditions will be able to specifically link gravel extraction to those levels. Similarly, where a particular reach requires a high frequency of bed level survey due to the extent of gravel extraction occurring, requirements for regular bed level surveys may be able to be incorporated as a condition of consent.

Consideration should also be given to out-sourcing the bed level survey work if this will result in cost efficiencies without compromising accuracy requirements. Often one of the benefits of out-sourcing is that it can lead to improvements in cost efficiency, and can initiate the development of innovative processes and solutions that improve on the existing approach.

At present ECan uses XSECT as a tool for analysis of bed level monitoring data. Examples of systems used by other regional councils include 'Ricoda' (GWRC) and 'XSECT' (ORC and HBRC). However, ECan undertakes very little interpretation of the data. It is recommended that existing data analysis is improved and extended to include interpretation relevant to gravel resource management, and to include mechanisms that ensure feedback loops to appropriate management objectives.

26.2 Monitoring of Extracted Volumes

Although there are inherent limitations in the existing gravel extraction returns system, there are limited alternative methods for monitoring volumes of gravel extracted that will not require a significant increase in the scale and intensity of monitoring. Similar systems are used by other regional councils, and Canterbury gravel extractors have indicated that they consider the existing system of quarterly returns to be an efficient and suitable level of requirement.[52]

[51] See Section 17 & 18 for supply summary reports and refer to associated River Reports by MWH & EMA listed under References.
[52] MWH Gravel Extraction Questionnaire, 2005 – Appendix A.

However, for effective and sustainable management of the gravel resource, a greater level of accuracy is required. This is key information in the gravel resource equation and it is impossible to effectively manage a resource without a good understanding of what is there and what is being removed and the impacts of doing so. Standard consent conditions presently require extractors to measure material extracted to within 10% accuracy. Although the more accurate the better, this level of accuracy is probably appropriate. However it is very difficult to determine whether or not this is being achieved.

There are a number of potential improvements to the gravel extraction returns process that may improve the effectiveness of the system and the accuracy of the resulting records. It is recommended that the existing system of monitoring the volumes extracted be reviewed, and all or at least some of the following improvements incorporated.

Resource allocation process based on previous years' returns.
One of the key limitations of the existing returns process is that it relies on extractors to provide an accurate record of all material extracted. The only effective way to audit this is to undertake a detailed audit of the consent holder's business records, if they are available!

As it is difficult to audit the accuracy of the returns, and given that consents specify maximum extraction volumes, extractors may in some instances be inclined to under-report the actual volumes extracted to ensure compliance with volume conditions. This results in distorted and potentially inaccurate gravel extraction data, and thereby limits its effectiveness as a tool in monitoring the status of the gravel resource.

Other regional councils (HBRC, ORC, GWRC) have gravel resource allocation systems that are based on short term (1 to 5 year) consents, and utilise historic gravel extraction records as a guide for gravel allocation under consent renewals.

This system provides a disincentive for extractors to under-report quantities in their returns, as one of the primary tools used in the allocation of annual gravel volumes for renewals of existing consents is the previous years' returns figures for that particular extractor (assuming the sustainable extraction limit for that river can continue to provide this). Therefore, if an extractor is under-reporting in their returns, this lesser volume will carry through to their subsequent years' allocation.

The flip side of this might be that extractors over-report in their returns where actual extraction volumes are less than consented volumes, to ensure the same or similar allocation in following years. However, a system of charging for each cubic metre extracted counteracts this potential over-reporting. [See Section 26.5 for further discussion of financial instruments].

Consistency of measurement
The conditions under existing consents requiring the measurement of the quantity of gravel extracted do not specify the measure for expressing that quantity, or the basis for calculating that quantity. The basis upon which extractors calculate their returns varies, and can include truck movements, aggregate sales, and loader buckets. These different bases for calculating returns can lead to inconsistencies and potential inaccuracies in the records.

In addition, the key factor to be measured for sustainable gravel management purposes is the quantity of all material actually removed from the river. Measurements of volumes post-processing, or based on sales will not necessarily capture the total volume of material removed. Therefore, to ensure that all extraction returns are calculated on a consistent basis, consent conditions should specify the measure (e.g. m^3) to be reported, and the factors upon which calculation of extracted volumes may be based. This should clarify whether what is required is "bank cubic metres" (i.e. pre extraction), or "bulk cubic metres" (i.e. post extraction), and if the latter, a consistent basis for calculation should be specified. It will be important to undertake consultation with extractors in establishing these requirements to ensure that they are practical and achievable.

Consistency of onus for submission of returns
At present there is some variation in the wording of the condition relating to the submission of returns. Under some consents, the measuring of the quantity of gravel extracted is subject to this being required by ECan, e.g. "*when requested by the Canterbury Regional Council…*", and under others, the submission of quarterly returns is effectively contingent upon ECan sending out extraction returns. Although in practice this may be an effective management tool that potentially reduces the need for reminder notices and delays, the consent condition should place the onus on the consent holder to provide the returns regardless of whether ECan sends forms out or not. This would potentially avoid the gaps in returns collection that have occurred in the past when internal changes and resourcing problems have led to a lapse in the proactive seeking of returns by ECan. In addition, the requirement that the consent holder maintain a record of monthly volumes of gravel extracted should not be contingent on the request of ECan to do so.

Physical separation of extractors
Where there are suspicions that the volume of gravel extracted is being under-reported, compliance staff may be able to confirm this by undertaking a compliance visit to the extraction site to measure the size of the excavation. However, where more than one extractor is operating within the same extraction area, it can be difficult to differentiate between the extraction activities of each of the extractors. And in some cases this may be exacerbated by uncooperative operators who simply "point the finger" at the other operator(s) extracting from within the same area. Therefore, wherever practicable, extractors should be directed to extract at separate sites so that on-the-ground compliance monitoring may provide a better cross-check to gravel returns.

Before and after photographs
Some regional councils require the provision of before and after photographs of the extraction area (ORC, West Coast Regional Council). Provided that clear and relevant photographs are used, and that these are submitted within the specified time before and after extraction activities, these can also provide useful additional information. In particular, photographs are useful for assessing the general environmental state of a particular site both before and after extraction. Where small volumes are extracted, they can provide an additional means to very roughly (potentially +/- 50%) cross-check gravel returns figures, however for larger volumes photographs are less useful for quantifying or cross checking volumes of gravel extracted.

26.3 Other Monitoring

In addition to the improvements and developments recommended in the preceding sections, it is also recommended that the following be incorporated into an improved monitoring regime:

- Regular aerial photographs of all major rivers and rivers with high extraction rates. These provide a very useful illustrative overview of a particular river system, and can give valuable supplementary information about the riverbed between cross-sections. Aerial photographs are a useful support tool to other monitoring data, and help to remind users that a particular reach is part of a working system.
- Increased on-the-ground site monitoring to 'ground truth' trends identified by monitoring data and to encourage accurate reporting of extraction volumes.
- Increased input to the specific locations for extraction prior to the exercise of consents. This enables a greater level of refinement in determining the specific location of extraction, which is particularly important in rivers and reaches where extraction pressure is increasing and/or in rivers where degradation is occurring or infrastructure needs protecting. The dynamic nature of river environments means that unpredictable changes can occur in short timeframes. If significant changes have occurred since the granting of the consent, this input immediately prior to extraction beginning ensures that extraction occurs from the locations most appropriate at the time of extraction, rather than slavish compliance with originally submitted plans when this may have become inappropriate. At present, ECan has a reasonable level of input where river schemes are

in place, however in other areas this input is limited, and is exacerbated by extractors not always notifying ECan prior to exercising their consents.

- Investigate the possibility of ultimately incorporating monitoring of effects on aquatic ecosystems.

26.3.1 Gravel Quality

In developing a gravel resource management framework, consideration may be given to adopting a "best end use" policy, whereby the proposed end use of gravel is taken into account in the allocation process to ensure efficient use of the resource. If this is the case, an understanding of the character and quality of gravel at particular sites, and ultimately across the region, will be required. Developing this understanding will require a process of investigating and sampling the material within particular rivers and within different reaches of those rivers. This is because there is a natural process of sorting that occurs as material moves through the river system that will impact on the nature of material at different points along the river.

It is also important to recognise that significant levels of extraction of a particular size or type of material concentrated within a particular river reach or system can also potentially have downstream impacts in terms of ecological values (e.g. changes in substrate materials) and natural river processes (e.g. changes in effectiveness of natural armouring processes). These processes are inherently complex, and a full understanding of them will require relatively in-depth research and investigation. However, these factors need to be kept in mind, and ultimately, as resources allow, need to be investigated and understood, particularly if a greater level of management input to where extraction for particular material is proposed to occur.

26.3.2 Alternative Methods/Technologies

26.3.2.1 Riverbed Morphology

Improvements in the technology available for measuring changes in river bed gravel volumes and transportation rates are being developed. NIWA has been involved in experimenting with remote-sensing technologies for estimating gravel transport rates in large braided rivers (Hicks, M; Westaway, R: Lane, S 2003). This has led to the development of the "morphological method", which uses measurements of changes in the shape of the river channel over time to estimate average rates of movement of bed material. To do this, repeat surveys are carried out along a riverbed at relevant times, such as before and after a flood. A comparison of the surveys allows an estimate of the volume of material that has been eroded and deposited. The average distance that the bed load moves is then estimated – the "step length". This method depends however on very accurate surveys of the riverbed. This is where remote sensing technology offers an alternative to time-consuming measurements of many river cross sections. Remote sensing technology produces high-resolution digital elevation models (DEMs) of the riverbed from which annual bedload transport can be estimated. There are several alternative methods available for undertaking the measurements required to create the DEMs, including digital photogrammetry (digitising high-resolution aerial photographs), aerial laser scanning (remotely sensing the shape of the riverbed from an aircraft – see below), and within channels containing water, echo-sounders and GPS and/or calibration of water colour on aerial photos with actual water depth measurements.

LIDAR (light detection and ranging) surveys are another method for surveying riverbeds. These produce a three-dimensional model of the riverbed and can improve the precision of assessing gravel dynamics. Environment Bay of Plenty (EBOP) have recently commissioned a trial LIDAR survey on four rivers within its region. The survey will be repeated in around 3 to 5 years.[53].

ECan have utilised LIDAR surveys to assist with flood plain modelling, specifically the Waimakariri and Ashley flood plains, and coastal erosion surveys, particularly in areas where

[53] Environment Bay of Plenty Gravel Management Guidelines

cliffs pre-dominate the coastline, making traditional surveys difficult. Currently, the cost of LIDAR surveys mean that for gravel and river management purposes, they are likely to be feasible only for the very large rivers such as the Waimakariri. LIDAR surveys are also less practical for smaller or more entrenched rivers, where a significant proportion of the riverbed is underwater, as the survey does not penetrate water. Where the bed is under water, the survey needs to be supplemented by depth surveys taken from a boat.

Costs for LIDAR survey can range from around $150/km^2 to at least $600/km^2, depending on the area surveyed – the larger the area surveyed, the lower the per km^2 cost (Oliver, T; 2005). LIDAR surveys provide useful information for a wide range of management purposes and therefore additional cost efficiencies can be achieved in areas where there are multiple agencies with an interest in the information obtained, as the cost of the survey can be shared. E.g. district councils, regional councils, different sections within those councils, and central government agencies.

LIDAR surveys are not as accurate as traditional GPS cross section surveys, which achieve accuracy of about +/- 50mm. The LIDAR specification states accuracy of +/- 150mm, although over clear open ground LIDAR can achieve accuracy of about +/- 70mm (Oliver, T; 2005). However, the key benefit of LIDAR surveys is the significant volume of additional information that is provided. Traditional cross-section surveys only provide data for the specific cross sections surveyed. Information between cross-sections has to be interpolated from the survey data. Although this can provide general trend information, it can not always provide accurate information about specific sections of the riverbed, particularly in rivers where cross-sections are a considerable distance apart (e.g. 1-2km). LIDAR surveys provide data for every 2-3m, so a much fuller picture is given. This would be particularly useful for identifying specific sections of rivers that are aggrading and degrading, in order to better direct localised gravel extraction.

26.3.2.2 Gravel Extraction Volumes

Implementation of on-site methods of monitoring extraction volumes is another method by which the accuracy of gravel returns can be audited. An example of such a method is proposed by ORC, which is proposing to implement a truck movement monitor system. This process consists of a seismic monitor that is installed at specific gravel extraction access points. The monitor is able to distinguish between large and small vehicle movements, and thus record the number of trucks. Generally the size of trucks used by a particular operator will be known, and therefore the monitored truck movements can in turn be used to estimate the quantity of gravel extracted. The ORC requires extractors to advise them prior to exercising their resource consent, and the council usually has a good idea of how long extraction will take place, so are able to readily install the monitor for the period of extraction. Clearly the monitor is most effective where access to an extraction site is only used by the extractor being monitored.

26.3.3 Industry Consultation

Specific legislative requirements aside, it is vitally important that relevant and effective consultation is undertaken with affected parties during the development and implementation of changes in the way that gravel resources are managed. Key to this is developing open and accessible lines of communication between the regional council and resource users. Therefore, it is recommended that ECan work with the gravel extraction industry to establish a Gravel User Group(s) with representatives from the industry (including large, medium and small sized operators) and ECan. This would provide a forum for discussing current issues relating to the gravel resource, introducing and receiving feedback on proposed management changes, and enhancing the relationship between the regulator and the user.

Establishment of such a forum will be important during development of changes in the way gravel resources are managed and monitored, but will also provide a way of maintaining an on-going dialogue once new systems and processes are established. A similar group was established by GWRC in the Wairarapa as a means of discussing topical issues and obtaining direct feedback in relation to compliance reporting, annual charges, allocation rates and rationale, potential and current consent conditions etc. In addition, to keep the wider industry informed of proposed changes to the gravel management framework and of the outcomes of the gravel user group meetings, a number of "gravel forums" are held throughout the year.

These discussions would benefit from an ECan commitment to a level of service policy that would be a standing item when the group meets (see Section 26.4.3).

26.4 Monitoring the Management Framework

26.4.1 RMA Monitoring Requirements

A key component of sustainable resource management is monitoring of resources, the environment, and the effectiveness of management frameworks in achieving specified objectives and policies. Monitoring is about checking that what was set out to be achieved is being achieved, and about having sufficient information available upon which sound resource management decisions can be made.[54] This is reflected in the requirements of the Resource Management Act 1991 (RMA), which places specific monitoring responsibilities on local authorities.

Section 35(2) of the RMA places a duty on regional councils to monitor the state of the regional environment; the effectiveness of any regional policy statement or plans; and compliance with resource consents exercised within their regions.

Specifically, s.35(2) states –

(2) Every local authority shall monitor –

- *(a) the state of the whole or any part of the environment of its region or district to the extent that is appropriate to enable the local authority to effectively carry out its functions under this Act; and*
- *(b) the efficiency and effectiveness of policies, rules, or other methods in its policy statement or its plan; and*
- *(c) the exercise of any functions, powers, or duties delegated or transferred by it; and*
- *(d) the exercise of the resource consents that have effect in its region or district, as the case may be; and*
- *(e) in the case of a regional council, the exercise of a recognised customary activity in its region, including any controls imposed under Schedule 12 on that activity, -*

and take appropriate action (having regard to the methods available to it under this Act) where this is shown to be necessary.

Section 67(2)(e) of the RMA also provides for the inclusion in regional plans of "*the procedures for monitoring the efficiency and effectiveness of the policies and methods*" set out within the plan.

These sections of the RMA clearly indicate that although monitoring the utilisation and state of a particular resource is important, sustainable resource management also requires an iterative system of monitoring and review of the management system itself.

Section 1.3.2 of Chapter 1 of the Proposed Canterbury Natural Resources Regional Plan (PNRRP) sets out the procedures that ECan will use to review and monitor the effectiveness of the PNRRP as a means of achieving its objectives and policies. These include –

- *(a) develop a strategy that includes indicators to assess the effectiveness of the Proposed NRRP;*
- *(b) record complaints about non-compliance;*
- *(c) monitor compliance with rules, including consent conditions and standards and terms;*

[54] Quality Planning Monitoring and Reporting One Stop-Shop, www.qp.org.nz/monitoring/index.php

(d) *monitor the environment and especially the environmental results anticipated listed in the Proposed NRRP, and compare what has occurred with what was predicted.*

Chapter 6 – Beds and Margins of Lakes and Rivers of the PNRRP contains provisions related to gravel extraction from rivers. At Section 6.10 the general procedures, in addition to Section 1.3.2 of Chapter 1, to be used in Chapter 6 to monitor the achievement of anticipated environmental results, and the efficiency and effectiveness of the chapter's policies and methods are set out. This includes the following monitoring methods listed in relation to the excavation and extraction of bed material:

- Consents database
- Enforcement database
- Compliance database
- Liaison with district councils, network utility operators, and land owners over the extent of the erosion or undermining of structures, which is verified by objective data
- Liaison with DoC and Fish & Game over extent of change to significant indigenous flora or fauna; that can be verified by objective monitoring data
- Information received from people contacting ECan to comply with the conditions of Rule BLR3

The location of this monitoring is identified as "*sites of activity throughout the region*".

Similar approaches to monitoring plan effectiveness have been adopted by other regional councils and offer ECan possible directions.

Environment Southland – Regional Fresh Water Plan
This plan identifies a combination of monitoring achievement of anticipated environmental outcomes with monitoring of key State of the Environment (SOE) indicators. The former is a method of assessing the effectiveness of the plan based on the fact that:

- *the objectives identify what the Plan is seeking to achieve*
- *the policies set out the approach and philosophy the Council wishes to adopt for achieving those objectives;*
- *the methods (Rules and non-regulatory methods) set out how activities need to be managed to achieve the objectives given Council's preferred approach and philosophy;*
- *the outcomes are the results expected from adopting the objectives, policies, and methods.*[55]

On this basis, if the expected environmental outcomes are being achieved, this indicates that the objectives and policies within the plan are effective.

Measuring achievement of environmental outcomes overlaps with monitoring required for SOE reporting. SOE monitoring includes monitoring of key environmental indicators, which are often key indicators related to environmental outcomes. Therefore, SOE monitoring can also be a key indicator for whether the plan is effective and the most suitable mechanism for achieving the stated environmental outcomes.

Horizons Regional Council – Regional Plan for Beds of Rivers and Lakes and Associated Activities
Monitoring of the effectiveness of the plan as a means of achieving its objectives and policies is based on information obtained through the Regional Monitoring Strategy. This strategy includes a comprehensive framework of Monitoring Programmes undertaken to provide information for SOE reporting and regional resource management reporting.

Monitoring for regional resource management reporting includes:

[55] Environment Southland, Regional Fresh Water Plan

- ***Consents Issued** including numbers of consent applications made for each type of activity regulated by the Plan.*
- ***Incidents** information relating to incidents can provide indications of adverse effects of resource use, the natural character, habitat, and ecosystems in the beds of rivers and lakes.*
- ***Compliance Monitoring** in relation to individual consents … Where appropriate individual consent monitoring programmes will be designed and implemented in conjunction with the consent holder.*
- ***Compliance Audits** of all self-monitoring carried out by resource consent holders.*
- ***Enforcement** records and information relating to the Regional Council's response to non-compliance with consents issued under the Plan, or non-compliance with the permitted rules of the Plan.*

SOE monitoring includes:

- *Fluvial Systems*
- *Water Resources*
- *Natural Hazards*

Hawkes Bay Regional Council – Proposed Regional Resource Management Plan, February 2005.
The HBRC has a Regional Monitoring Strategy made up of three key components –

(a) **State of the Environment monitoring** – monitors key environmental indicators to enable understanding of the Region's resources and trends in the quality and quantity of those resources. SOE Monitoring programmes set out in the Plan include river cross section monitoring.
(b) **Compliance monitoring** –monitors the extent to which resource users are complying with the provisions of the regional plan and requirements of resource consents.
(c) **Effects based monitoring** –uses a combination of SOE monitoring and Compliance monitoring to ascertain the effects of individual and groups of activities on the region's resources.

All three of these elements contribute towards monitoring the effectiveness of the regional plan.

Otago Regional Council – Regional Plan Water
Monitoring is undertaken via a Regional Monitoring Strategy, implemented in detail through the Annual Plan. The monitoring strategy may include the following techniques:

1. Analysis of feedback, compliments, complaints received and responses to complaints.
4. Requiring self-monitoring of consents, where necessary, and the provision of the collected information to the Otago Regional Council for audit.
5. Compliance audit monitoring, at appropriate intervals, to ensure the conditions on resource consents are being adhered to.
6. Maintaining a database of resource consents issued.
7. Commission research, as necessary, to provide additional information on the environment of water bodies.
8. Where appropriate, develop and implement joint initiatives with other local authorities, government departments, Kai Tahu, water user groups, land care groups and other agencies to monitor key aspects of Otago's water body environment.

26.4.2 Management Objectives and Policies

Gravel extraction in Canterbury is addressed in Chapter 6 – Beds and Margins of Lakes and Rivers of the PNRRP. However, although the objectives and policies within this chapter address some of the potential effects of river gravel extraction, there is little specific policy guidance in terms of sustainably managing the gravel resource (i.e., ensuring extraction does not exceed natural replenishment), or in terms of balancing the related management goals of flood risk management, river engineering and river asset management, and the extraction and use of gravel.

Sustainable management of the gravel resource requires the development of specified objectives and policies. These not only form the drivers of the management process, but also provide a focus for associated monitoring.

Examples of objectives and policies specific to river gravel management adopted by other Regional Councils include the following:

Horizons Regional Council - Regional Plan for Beds of Rivers and Lakes and Associated Activities:

> *"**Policy 4: Management of fluvial gravel extraction***
> *To ensure gravel extraction in river reaches does not exceed natural rates of replenishment, except where extraction is necessary to decrease the risk of flooding or potential damage to essential structures, while ensuring that any adverse environmental effects are avoided, remedied or mitigated."*

Policy 4 of the Horizons plan includes Schedule 2, which is a table setting out maximum annual total combined volumes of fluvial gravel available for extraction for specified rivers. These rates are set annually for 1st July to 30th June in year following. Explanation states that Schedule 2 represents approximate annual rates of extraction that are considered to be sustainable. These rates will guide the Council in making decisions on gravel extraction consent applications for the rivers and streams listed. Where applicants present information that clearly establishes that sustainable rates of extraction are higher or lower than set out in the Schedule, decision makers will also have regard to this.

Hawkes Bay Regional Council - Proposed Regional Resource Management Plan (February 2005)

> *"**Issue:** The risk of an imbalance between the natural supply of river gravel and the rate at which gravel is extracted."*
>
> *"**Objective 28:***
> *The avoidance of any gravel extraction at a rate which exceeds the rate of natural supply, except in areas where there are stored reserves which may be removed in a controlled manner such that flood protection and river control assets are not compromised."*
> *"**Objective 29:***
> *The facilitation of gravel extraction from areas where it is desirable to extract excess gravel for river management purposes and the minimisation of flood risk, or to maintain or protect the functional integrity of existing structures, whilst ensuring than any adverse effects of gravel extraction activities are avoided, remedied or mitigated."*
> *"**Policy 51:***
> *To assess the availability of river bed gravel by:*
> *(a) Defining both annual and long-term extraction rates for the regional gravel resource for each river bed within the Region where major extraction takes place.*
>
> *These rates will be based on regular monitoring of the rate of extraction, and an assessment of the river design profile, supply of gravel to the coast, and supply of gravel from upstream sources (including land use activities).*
> *(b) Ensuring that as far as practicable, long-term gravel extraction is undertaken at a level consistent with maintaining the rivers close to their design profiles, while maintaining compatibility with other resource management and environmental values."*
> *"**Policy 52:***
> *To allocate gravel from river beds in Hawke's Bay generally on an annual basis, in accordance with the following approach:*

(a) Determining by 15 April each year the likely demand for river bed gravel. Gravel extractors will be contacted at the beginning of March each year, and required to provide notice of their requirements for gravel by 15 April. Requests for gravel allocation will be required to specify the proposed end use of the gravel.
(b) Carrying out an assessment and allocation process between 15 April and 30 June each year, in accordance with Policy 51.
(c) Notifying gravel extractors of their annual allocation by 1 July each year."

The explanation to Policy 52 clarifies the approach to be taken to the allocation of gravel within the region. This will be done on an annual basis, based on extractors' requirements, resource availability as determined in accordance with Policy 51, the proposed end use of the gravel, and an assessment of the effects of extraction. It also states that Council will determine the appropriate location for sourcing the gravel, especially where demand in a particular location exceeds supply and alternative locations are required.

Policy 54 of the Hawkes Bay Plan sets out the decision-making criteria for gravel allocation. This includes, but is not limited to:

> *"(e) The avoidance of any adverse effects on flood control assets or river protection works;*
> *(f) The avoidance of any activity that would cause flood control measures or river protection works to be required;*
> *(h) The end uses of the gravel, in order that high quality gravel is allocated to uses which require such gravel;"*
>
> "***Policy 55:***
> *To integrate the management of gravel extraction with river control works by:*
> *(a) Encouraging gravel extraction where there is the potential to minimise flooding or the risk of damage to protection works or essential structures;*
> *(b) Undertaking specific works to control erosion and encourage gravel movement where appropriate."*

This policy recognises the positive influence that the managed extraction of gravel can have on minimising flood risk and assisting with the overall management of the river.

Otago Regional Council – Regional Plan Water

> "***Policy 8.6.4***
> *To ensure that any extraction of bed material from the bed of any lake or river is within the sustainable yield of the lake or river system.*

26.4.3 Recommendations

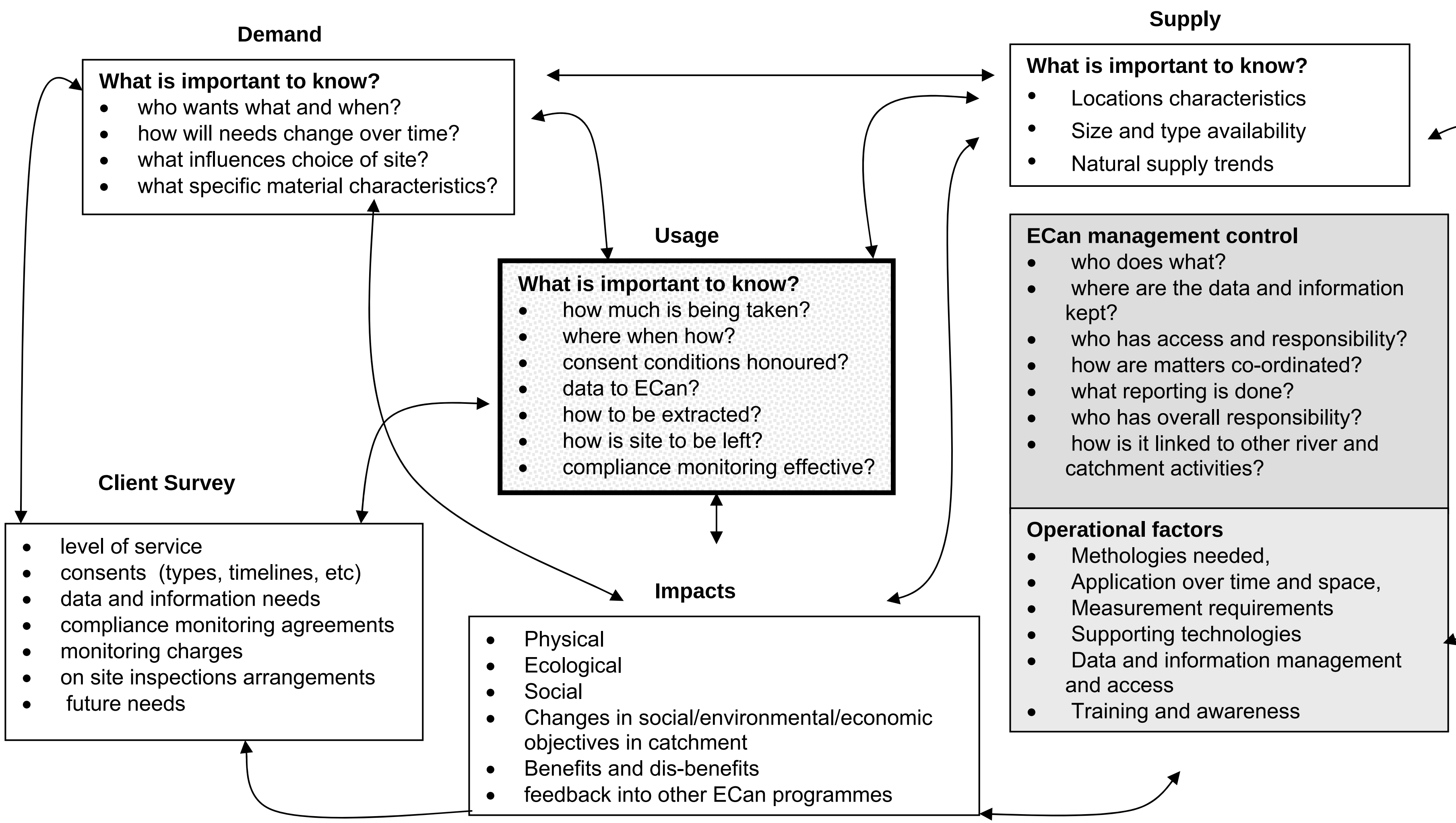
Successful resource management requires a strategic and systemic management approach that is driven by clear purposes and objectives, and which is based on a management and monitoring framework that provides sufficient and appropriate information upon which sound resource management decisions can be made. In addition, that system needs to be sufficiently adaptive as to be able to respond to changes in the level of understanding of the resource, and the identification of new issues and influences.

In terms of gravel resource management, this currently appears to be lacking in Canterbury. Current management and monitoring of gravel extraction has operated essentially as an adjunct to river and flood risk management. Alluvial gravel is an important natural resource used by communities to provide for their current and on-going social, economic, and cultural wellbeing. Therefore, the river gravel resource needs to be managed as a resource in its own right, although within a system that recognises and takes account of the interconnectedness of the key objectives behind river engineering, flood risk management, and sustainable utilisation of the gravel resource.

To this end, it is recommended that a gravel management and monitoring framework be developed for the Canterbury region. Given the gaps in existing data and the level of understanding of the resource, the dynamic nature of the resource itself, the potential impacts of un or poorly managed extractions, and its geographic spread throughout the region, this framework needs to be flexible in both space (over the whole region) and time (as knowledge levels improve and/or needs shift). The framework should also incorporate a “client survey” element, being a proactive commitment by the regional council to set and ensure appropriate levels of service (for consents, surveys, site visits, feedback, etc). This recognises the importance of on-going discussion and co-operation between resource managers and resource users. The following diagram (Figure 20) provides an illustration of such a management framework, showing the various factors and interactions that need to be taken into account.

Figure 20: Management Framework Diagram

Monitoring Elements of the RGM Strategy



26.5 Resourcing the Monitoring

To improve the current monitoring programmes and to implement a region wide monitoring regime to better achieve sustainable management of the gravel resource will require a significant increase in the financial resources available for this purpose. One method that may be utilised to assist in meeting these increased costs is to implement a system of charging that adequately meets the reasonable costs of monitoring gravel extraction consents and monitoring the state of the resource to ensure that the continued extraction of gravel does not result in significant adverse environmental effects due to over-extraction.

There are several mechanisms under the RMA by which this may be implemented.

26.5.1 Administrative Charges

Section 36(1) of the RMA provides that local authorities may fix administrative charges for particular purposes, including:

> *(b) Charges payable by applicants for resource consents, for the carrying out by the local authority of its functions in relation to the receiving, processing, and granting of resource consents…*
>
> *(c) Charges payable by holders of resource consents, for the carrying out by the local authority of its functions in relation to the administration, monitoring, and supervision of resource consents…, and for the carrying out of its resource management functions under section 35.*

The process that must be followed in relation to fixing administrative charges under s.36 is outlined in subsections (2) to (4) as follows:

> *(2) Charges may be fixed under subsection (1) only –*
> - *(a) in the manner set out in section 150 of the Local Government Act 2002; and*
> - *(b) after using the special consultative procedure set out in section 83 of the Local Government Act 2002; and*
> - *(c) in accordance with subsection (4).*
>
> *(3) Where a charge fixed in accordance with subsection (1) is, in any particular case, inadequate to enable a local authority to recover its actual and reasonable costs in respect of the matter concerned, the local authority may require the person who is liable to pay the charge, to also pay an additional charge to the local authority.*
>
> *(4) When fixing charges referred to in this section, a local authority shall have regard to the following criteria:*
> - *(a) The sole purpose of a charge is to recover the reasonable costs incurred by the local authority in respect of the activity to which the charge relates:*
> - *(b) A particular person or persons should only be required to pay a charge –*
>   - *(i) To the extent that the benefit of the local authority's actions to which the charge relates is obtained by those persons as distinct from the community of the local authority as a whole; or*
>   - *(ii) Where the need for the local authority's actions to which the charge relates is occasioned by the actions of those persons; or*
>   - *(iii) In a case where the charge is in respect of the local authority's monitoring functions under section 35(2)(a) (which relates to monitoring the state of the whole or part of the environment), to the extent that the monitoring relates to the likely effects on the environment of those persons' activities, or to the extent that the likely benefit to those persons of the monitoring exceeds the likely benefit of the monitoring to the community of the local authority as a whole, -*
>
>   *and the local authority may fix different charges for different costs it incurs in the performance of its various functions, powers, and duties under this Act –*

(c) In relation to different areas or different classes of applicant, consent holder, …; or
(d) Where any activity undertaken by the persons liable to pay any charge reduces the cost to the local authority of carrying out any of its functions, powers, and duties.

Clearly, should charges related to gravel extraction be fixed in accordance with s.36, these would need to be established in accordance with the procedure set out in the Local Government Act 2002.

Regional Councils that have utilised s.36 in relation to gravel resource management include ORC and HBRC. ORC charges an "inspection and management fee" of $0.60/m^3. This fee is charged in accordance with s.36 of the RMA and the LGA 2002. Extractors are required to pay this fee at the same time as submitting 6 monthly gravel extraction returns. The requirement for the fee is noted on the consent as follows –

> *Note: The consent holder must pay an inspection and management fee to the Consent Authority. The fee is set by the Consent Authority under Section 36 of the Resource Management Act 1991 and the Local Government Act 2002.*

26.5.2 Financial Contributions

Financial contributions may be imposed in accordance with s.108 of the RMA. The term financial contribution is defined in subsection 108(9) as a contribution of money, land, works or services. Where a resource consent for an activity is granted under a plan, the consent authority may impose a condition requiring that a financial contribution be made for purposes that are specified in the plan (s.108(1)(a)).

Section 108(9) and Clause 5 of Part 1 of the Second Schedule of the RMA require that the plan specify the following –

- the circumstances when contributions may be imposed;
- the purposes for which contributions may be required and used; and
- the maximum amount of any contribution.

Section 108(10) of the RMA provides that a condition requiring a financial contribution may only be imposed in accordance with the purposes specified in the plan, and if the level of contribution is determined in the manner described in the plan.

Given this, the utilisation of financial contributions requires specific provisions within the relevant regional plan. Under the PNRRP, Section 6.11 of Chapter 6 addresses financial contributions. The specific purpose for which financial contributions will be used in relation to activities covered by Chapter 6 is where an activity will –

> *(a) disturb, remove, damage, or destroy any plant or part of any plant (whether exotic or indigenous) or the habitats of any such plants or of animals in, on, or under the bed of any lake or river.*
> *(b) have an adverse effect on flood carrying capacity.*

Given this, if financial contributions were to be applied in relation to all gravel extraction consents, a variation to the PNRRP would be required, as the existing provisions will not capture all gravel extraction activities. As the PNRRP is still a proposed plan and is unlikely to become operative for several years, it is worth considering the provisions of the Transitional Regional Plan (TRP) in this regard. The TRP incorporates a number of provisions from the previous South Canterbury and North Canterbury Catchment Board bylaws.

Included is the following provision which applies to gravel extraction, and gives rise to the requirement for a resource consent to extract gravel under the TRP –

> *No person shall without the written license of the Board remove shingle sand or other material from any watercourse under the control of the Board and any such license may be revocable at the will of the Board or on breach of conditions thereof or otherwise and may be given subject to payment or royalties or other consideration and may be subject to such conditions as the Board things fit to impose.*

Several other regional councils utilise the financial contribution provisions of the RMA in relation to gravel extraction consents.

Horizons Regional Council
Horizons Regional Council has included the following policy in its Regional Plan for Beds of Rivers and Lakes and Associated Activities, -

> ***Policy 7: Use and circumstances for financial contributions***
> *To use financial contributions as a condition of a resource consent, where appropriate, for mitigating or offsetting adverse effects arising as a consequence of, or in association with, the activity for which the consent is granted for:*
> *a. maintaining, restoring or enhancing flood protection or erosion control works; and/or*
> *b. maintaining or enhancing public access to and along the margins of rivers and lakes.*

The plan states that financial contributions may be imposed on any consent granted for an activity under the plan, and sets out the circumstances, purpose and maximum amount of any financial contribution including the following –

> ***Maintenance, restoration or enhancement of flood protection or erosion control works***
> ***Circumstances:*** *Where the activity for which consent is granted will cause or contribute to adverse effects on flood protection or erosion control works.*
> ***Purposes:*** *To mitigate or offset the adverse effects of the activity by protecting, restoring or enhancing the river bed, bank and/or flood protection or erosion control works, including (without limitation) maintenance and planting of vegetation, sediment replenishment, flood protection or erosion protection works, and including contribution to such measures elsewhere in the general locality.*
> ***Maximum amount:*** *For gravel extraction a maximum amount of $3.00 (excluding GST) per cubic metre of gravel extracted to avoid, remedy or mitigate the adverse effects of extraction on the flood control or erosion control works. The maximum amount payable per cubic metre of gravel extracted will be set each year in the Annual Plan.*
> *For other activities, full actual costs to undertake works to a standard sufficient to fully mitigate the adverse effects of the activity on the flood control or erosion control works.*

The plan then sets out assessment criteria for determining whether or not to impose a financial contribution condition, and the type and amount of contribution. These assessment criteria state that "*the "maximum amounts" indicated are intended as an upper limit. The actual amount of particular contributions will vary depending on the circumstances and the application of the criteria*".

In addition to the plan provisions relating to financial contributions, the plan includes the "*payment of administrative charges*" as one of the factors to which its discretion is restricted under Rule 15. Rule 15 provides for the extraction of more than $50m^3$ of gravel as a restricted discretionary activity.

Also included are -

> *l. the carrying out of measurements, samples, analysis, surveys, investigations or inspections at the consent holder's expense;*
> *m. the provision of information to the Regional Council at specified times;*

Hawkes Bay Regional Council
The HBRC charges a consent processing fee of $20 for applications to extract up to 50m^3 per year, and $80 for applications to extract 50m^3 or more. In addition, the council charges a State of the Environment Monitoring charge and a Compliance/Allocation charge under s.36 of the RMA, and a Financial Contribution in accordance with s.108 of the RMA. These charges are based on the volume of gravel extracted, the source of the gravel, and the quality of the gravel. These charges are set out in the Proposed Regional Resource Management Plan as follows –

	State of Environment Monitoring Charge (S35 of RMA)	Compliance/ Allocation Charge (S36 of RMA)	Financial Contribution (S108 of RMA)	Total
Upper Tukituki catchment	No charge	$0.20	No charge	$0.20
Inferior grade	$0.17	No charge	$0.03	$0.20
All other	$0.17	$0.40	$0.03	$0.60

The HBRC plan only refers to the use of financial contributions in relation to gravel extraction consents, and sets out the circumstances, purpose and amount of financial contributions as follows -

> ***Circumstances***
> *The HBRC will only use financial contributions as a resource management tool in relation to resource consents granted for river bed gravel extraction.*
> ***Purposes***
> *The purposes for which financial contributions will be sought from river bed gravel extractors are as follows:*
> *(a) Construction of, or maintenance of, roads, fences and gates that are used or will be used to access the gravel extraction site;*
> *(b) Stop bank restoration or enhancement to offset the effects of gravel extraction on flooding;*
> *(c) Strengthening or restoration of affected flood control or river stabilisation works;*
> *(d) Replanting of vegetation removed, destroyed or damaged by gravel extractors accessing gravel extraction sites, or by the gravel extraction process;*
> *(e) Downstream planting of riparian margins to offset erosion caused or exacerbated by gravel extraction.*
> ***Level of contribution***
> *The level of contribution will be determined in the following manner:*
> - *The total annual cost of the works and services to be funded by the contributions (as determined in each year's annual plan prepared pursuant to the Local Government Act 1974) divided by the total annual estimated volume of river bed gravel extraction, thereby giving rise to a uniform financial contribution per cubic metre of gravel extracted.*
> - *The final actual financial contributions sought will fairly and reasonably reflect the degree of adverse effects arising as a result of river bed gravel extraction.*

26.5.3 Recommendation

Given the need for considerable improvements in existing monitoring processes for gravel resource management, a significant increase in the resources available for monitoring will be required. Therefore, it is recommended that ECan further investigate the options available to it to utilise administrative charges and financial contribution conditions in relation to gravel extraction consents. Given that gravel is a valuable commodity, consideration should be given to moving away from public funding of gravel resource monitoring, to a system of user funding.

Chapter 9 Management Options for Fluvial, In Channel, Gravel Extraction

27. Management options

There are a number of ways that regional councils can approach the management of fluvial gravel resources. Listed below are the options and assessment criteria against which each option has been assessed. This assessment and the outcomes will form the basis for consultation with the community to identify which approach ECan will take for the future management of fluvial gravel resources.

Gravel extraction in river beds in the Canterbury region is currently managed as a discretionary activity under both the Transitional Regional Plan and the Proposed NRRP Chapter 6 with the stronger conditions from each applying (as discussed in the Current Management Regime Chapter 3).

27.1 Management Options for Regional Rules

The following options reflect the hierarchy of regulation (rules) that can be used, ranging from having no rules, through the most permissive rule (permitted) to the most restrictive (prohibited). Each rule option presents different advantages and disadvantages for managing fluvial gravel extraction, with some (e.g. prohibited), not being a useful option by itself. All the rule options are provisions that can only be given effect to through a regional plan.

Rule Options

1. No regional rules
2. Permitted activity rule
3. Controlled activity rule
4. Restricted discretionary activity rule
5. Discretionary activity rule
6. Non Complying activity rule
7. Prohibited activity rule

27.1.1 No regional rule

If there is no operative regional rule or proposed regional rule that allows activities in the beds of rivers, then under Section 13 RMA, a resource consent is required for any fluvial gravel extraction within the bed of a river, even small amounts. Section 77C of the RMA states, that where a resource consent is required under Section 13 it shall be treated as a discretionary activity.

If ECan were to adopt this approach, the existing rules relating to gravel extraction in the Proposed NRRP Chapter 6 would have to be withdrawn. It is unlikely that this would happen as ECan has specifically prepared Chapter 6 of the Proposed NRRP, which includes permitted activity rules, to better manage activities that Section 13 RMA regulates.

27.1.2 Permitted Activity

A permitted activity rule allows gravel extraction to be carried out without the need for a resource consent. A permitted activity is essentially a mechanism to authorise those activities where any adverse effects are likely to be insignificant.

Conditions included in a permitted rule can limit volumes extracted, manage adverse effects and require that notice of the activity be provided to the regional council. Generally only small volumes are permitted, often restricted to specific areas or times of the year. To ensure that activities under a permitted activity rule are complied with, some form of monitoring would be required, however it is not possible to charge compliance monitoring costs for a permitted activity in the same way as for a consented activity. Usually, the only monitoring of permitted activity effects is picked up though State of Environment monitoring, and funded through the general rate. Although it is not possible to charge for compliance monitoring of permitted activities under the RMA, the RMA may allow for these costs to be recovered through the use of charges under section 150 and 83 of the Local Government Act 2002. However, the more complex the conditions, the more they need to be monitored and, the more the purpose of having a permitted activity is being defeated. This can indicate that the activity (or scale of the activity) may not really be suitable as a permitted activity. Permitted activity rules are unsuitable for situations where it is not possible to specify conditions that would address all possible effects in all situations.

Because river control works are a function of the regional council under the Soil Conservation and Rivers Control Act 1941, consent applications for gravel extraction as a flood management tool would generally be granted, provided any adverse effects can be appropriately addressed. An alternative to consents could be to rely on a permitted activity rule (no consent needed) with conditions to facilitate river control works, including gravel extraction. This is an option that Environment Bay of Plenty has adopted.

The Proposed NRRP includes a permitted activity rule (BLR3) for the extraction of small volumes of gravel, with consents being required for larger volumes. If it was decided to have a permitted activity rule different from the one in the Proposed NRRP Chapter 6 (e.g. for all gravel extraction), a variation would need to be made to include this into the Proposed NRRP.

As in the Proposed NRRP a permitted rule for small volumes can work well when combined with a discretionary activity, or another more restrictive rule.

27.1.3 Controlled activity

An application for a consent defined as a controlled activity must be granted provided it complies with any standards, terms and conditions specified in the plan. Any conditions placed on the consent are restricted to matters specified for control in the plan. Having to list conditions and/or matters for control in the plan can reduce the flexibility of the consenting authority to address the issues relevant to each specific consent application. Not only could this lead to the activity having to comply with conditions in the rule that are not relevant to the specific extraction site, but there is also a risk that unforeseen effects outside those of matters provided for may arise. If ECan discovers adverse effects not addressed by the controlled activity rule, then the council may face a plan change process and the consent holder a consent review. Controlled activity rules therefore are unsuitable for situations where it is not possible to foresee all possible effects that need to be controlled.

In order to adopt the option of a controlled rule for gravel extraction there would need to be a variation to the Proposed NRRP as it does not contain such a rule.

27.1.4 Restricted Discretionary activity

A restricted discretionary rule means the regional council can only consider those effects of the activity in relation to the matters it has restricted its discretion to listed in the rule, and conditions placed on the consent are similarly restricted. This can provide clarity and certainty to an applicant as to how a consent will be processed. However, in terms of gravel management, trying to capture the relevant matters for each river in the region could lead to a very long and complex list of matters. There is also a risk to the regional council that a matter that was not specified may turn out to be crucial in addressing adverse effects of some kind. ECan would need to notify a plan change to remedy this.

If ECan adopted a restricted discretionary rule option, there would need to be a variation to the Proposed NRRP as it does not contain such a rule.

27.1.5 Discretionary activity

A discretionary rule in a regional plan gives the regional council discretion to consider the effects of the activity and if satisfied, to grant an application subject to the relevant conditions. Because each river or river reach can be very different, a discretionary rule gives flexibility to address issues relevant to each location without the need for very long list of matters in the rule. If not enough information is available for council to grant a consent and/or the effects of the extraction activity are likely to be more than minor, then the consent may be declined or notified. To date, notification of a gravel extraction application usually results in the applicant withdrawing their application to avoid possible high costs of consultation and hearings.

Once a consent is granted, if significant adverse effects become evident, then ECan may initiate a consent review and/or enforcement processes unless an agreement can be reached which would avoid such adverse effects. Unlike for a controlled or restricted discretionary activity this would not necessitate a plan change, as ECan could consider the new matter and request any relevant information when considering new consent applications and setting condition on new consents.

As the Proposed NRRP already provides a discretionary rule for gravel extraction, no variation to the Proposed NRRP would be needed, unless it is to make all gravel extraction a discretionary activity by withdrawing the proposed permitted activity rule.

27.1.6 Non Complying activity

A resource consent cannot be granted for a non-complying activity unless the adverse effects on the environment are minor or granting the consent will not be contrary to the objectives and policies of the regional plan. Generally non-complying activities are those that may have unacceptable adverse effects or not provided for by the plan. In setting conditions on a consent for a non-complying activity, a regional council can place any conditions it deems are relevant.

To order to adopt a non-complying rule option, there would need to be a variation to the Proposed NRRP

27.1.7 Prohibited activity

Because gravel volumes are subject to change through natural processes and extraction is often required to maintain flood capacity in a river, prohibiting the activity on a region wide basis would not be appropriate. However, it is possible that a prohibited rule could ensure that gravel is not extracted from specified locations. For example, where gravel extraction posed a high risk to certain structures or values, and where gravel accumulation would not pose a risk to these structures or values. However, those values could more simply be protected by conditions on any consent granted, or through declining a resource consent, as provided for in the Proposed NRRP.

In order to adopt a prohibited activity rule option, there would need to be a variation to the Proposed NRRP. By itself, a prohibited rule would not address fluvial gravel management issues.

27.2 Provision of charges and financial contributions of consented activities

As discussed in section 26.5 Resourcing the Monitoring, charges to recover the reasonable costs incurred by the consenting authority can be made to consent applicants and consent holders as provided for under Section 36 of the RMA. Provision for financial contributions must be addressed within the regional plan itself as specified in Section 108 of the RMA, before it can be included as a condition on a resource consent. In the case of controlled and restricted activity rules, financial contributions must be specified within the rule itself. Chapter 6 of the Proposed NRRP includes a the provision of financial contributions and the assessment matters for deciding whether or not they would be imposed under the discretionary rule (there is no controlled or restricted activity rules in Chapter 6).

27.3 Management Options for Consents

There are a variety of approaches to using the management options above via a rule(s) in a Regional Plan. Most common is the discretionary activity rule or a combination of permitted and discretionary activity rules.

To manage gravel extraction under a consented activity process (usually discretionary, see Table 13), there are three main approaches adopted by regional councils:

- individual consents held by private consent holders;
- consents for gravel extraction for flood control management held by Rating Districts or regional council (small global consents), and individual consents outside these areas.;
- catchment or region wide (global consents) held by a regional council.

27.3.1 Individual consents

The most common management approach for gravel extraction is where a consent is applied for by the individual/company that will extract the resource and they ensure the conditions of the consent are not breached.

27.3.2 River Rating District (flood scheme area) consents

In Canterbury, consents for gravel extraction for flood management purposes are applied for by River Rating Districts and, when granted, they can be transferred to ECan or managed on behalf of the rating district by ECan. These consents can be for part of or all of the river bed area within the river rating district. River Rating District consents are also termed “global consents” because of the large consent areas and the fact that contractors are often given permission by the consent holder to operate under their global consent, ECan engineering team hold or manage six such consents. River rating district consents are similar to the larger “global consents” held by a number of regional councils, as discussed below (section 27.2.3).

27.3.3 “Global Consents” held by regional councils

The term “global consent” is most commonly used where a consent is applied for over a large area such as over all or part of a catchment or region. At least three regional councils manage the majority of fluvial gravel extraction by holding global consents (see Table 14). Applications are normally notified and require a hearing commissioner, as a neutral party, to process the application. One regional council said that their latest global consent cost in the tens of thousands of dollars to process. However, in the long term this can be cheaper than many individual consents.

By holding a global consent, the regional council is able to manage gravel extraction for a whole river rather than just on a consent application-by-application basis for specific sites. Holding the consent also gives the regional council more control over how much and when gravel is extracted and provides a quicker and easier process for contractors seeking to extract gravel. For those contractors given permission to extract under the global consent, no consent application process is required. Holding a global consent does not prevent someone else from applying for a consent in the same location. However, the applicant would have to demonstrate that there is gravel available for extraction and address issues relating to the existing global consent holder. A consent application for gravel extraction where a global consent is already held may have to be notified.

Global consents held by regional councils can help management for gravel extraction purposes and for flood control purposes.

Permission to extract gravel under global consents

Permission for gravel extraction under a global consent would be very similar to the permit system used by the former catchment boards. Where a global consent for gravel extraction is held by the regional council or managed by the regional council on behalf of a rating district, a permission process can be used to enable others to extract gravel under that consent.

Permission is commonly given in the form of a permit. A permit process enables the consent holder (regional council) to ensure that the permit holder will meet the conditions of the global consent plus any other conditions the consent holder wished to impose, e.g., location of extraction site, volume of gravel to be extracted and timeframe for extraction. However, the **consent holder is ultimately responsible** if the conditions of the consent are breached and can be prosecuted or liable for remediation if the extraction causes unauthorised adverse effects.

Because there is no consent process involved in issuing a permit, a permit can be issued in a matter of hours, if all the information is available or in a matter of days, if a site visit is required.

Charges/cost recovery under the permit approach
Any charges incurred by the global consent holder (regional council) such as consent application costs and monitoring charges can be recovered under the permit approach by charging a permit application fee and/or extraction (per cubic metre) charges. Any such charges should be set under the provisions of the Local Government Act 2002. Because the number of permits issued can vary in any given year, where the total recovery charges collected are more than required they can be refunded. Charges for permits and permit holders can be set each year as part of the annual plan process thus allowing for public input. Charges under a permit system are likely to be passed on to the permit applicant/holder from the consent holder, and will therefore reflect the costs to the consent holder, see section 26.5. Resourcing the Monitoring for more discussion of charges.

Per cubic metre charges are common in other regions under global consents (see section 26.5.1 and Table 14). In Canterbury, there has been no cost recovery from permit holders
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extracting gravel under the River Rating Districts consents.

27.4 Criteria for Assessing Options

To enable assessment of the relative merits of each of the regional plan and consent options, the following criteria have been developed. Their relative importance has not been evaluated and they are in no particular order.

27.4.1 Sustainable management and sustainable supply

The aim is to be able to manage the resource sustainably over the long term such that gravel extraction does not exceed the rate of replenishment, and flood management design bed levels are met. “Sustainable volumes” of extraction are different for each river and there may be local existing areas of accumulation, which can be extracted above the “sustainable supply[56]” without adverse effects on design bed levels (see Sustainable Gravel Supply, Chapter 6 and Design Bed Levels section 4). It may also be that part of the same river is naturally degrading, losing more gravel than is being supplied. In this case, it may be prudent to retain accumulated reserves, where these do not pose a flood hazard, to slow the bed lowering process and provide more time to ensure that flood protection management can deal with a lowering bed. To truly manage for sustainability will require the ability to ensure that only sustainable volumes of available gravel are extracted.

27.4.2 Processing time

In general, the shorter the time needed to prepare and process a consent or permit application the lower the cost. This relates to both the time it takes for the applicant to get the information together to lodge an application and the time it takes for ECan to process the application. A short application time provides certainty for resource users needing to secure a supply in order to bid on a contract. Because of the information required by ECan to manage the gravel resource, application processing time is closely tied to the information made available to ECan by the applicant.

[56] note “sustainable volume” of gravel for extraction is different from “sustainable supply” (discussed in Chapter 6), and should be based on the available volume of gravel at the location in question, including sustainable supply and accumulated gravels.

27.4.3 Ability to recover costs for monitoring/investigations

In Canterbury, the costs of monitoring consents is a set recovery charge to consent holders. Monitoring of consent conditions is recovered from consent holders, however, bed level surveys are mostly funded by the general rate. Bed level surveys are usually only carried out in rating districts and a percentage of the cost is paid for by those districts. State of environment monitoring is not currently carried out specifically to investigate effects of extraction but rather as part of the state of the environment reporting, and charged to general rate.

To achieve sustainable management of the gravel resource, more investigation work and regular bed level monitoring will need to be carried out as recommended in section 26. Information available to the regional council from this work will assist in providing information for gravel extraction and the consent process. The cost of this work could either be funded from the general rate or split between the general rate and a charge to consent applicants, or it could be fully recovered from consent applicants.

If this information is not available, then applicants would have to provide it as part of the consent application process. This could mean that the first few applicants bear the full cost of providing information on the gravel resource that assists with processing other consents later on.

27.4.4 Ability to monitor volumes of gravel available for extraction

Regular monitoring to assess gravel movement enables better judgments to be made as to what sustainable volumes of gravel are in a particular river. This enables management of gravel extraction to be based on annual sustainable volumes. Knowing what is extracted and from where, is important for maintaining an up-to-date database of:

- what volumes of gravel need extraction to maintain flood capacity;
- what is available for extraction or should not be taken so as to maintain minimum bed levels.

As demand starts to approach the estimated available gravel volume, a more detailed assessment of gravel availability needs to be carried out. The underlying requirements for this work are:

- establishment of design bed levels, including minimum bed levels at key sites;
- surveyed cross section networks, where each cross section is truly representative of the adjacent reach;
- a frequency of surveying that captures significant changes to river bed level, and long-term aggrade or degrade trends;
- extraction records on a reach by reach basis, based on a consistent means of measurement.

Analysis is carried out as an iterative process, so that the assessment of available gravel volume improves over time.

The Monitoring for Gravel Management, Chapter 8 of this report, makes a number of recommendations to improve our current monitoring programmes.

27.4.5 Ability to compare allocation with volumes taken

One of the difficulties with the current individual consent approach is that volumes consented are not the same as the volumes taken. “Gravel returns” (i.e., consent holder records of extracted volumes) are one way to seek this information. However, if the information is not received until some time after the gravel is taken, and because there is no way of knowing whether consented volumes will be taken in any future period, then the returns are of limited use. What is needed is a system that better allows ECan to know what the running total of actual gravel extraction is, on a, monthly or quarterly basis. Potentially this system would enable ECan to know what gravel is currently available, and what is actually going to be extracted by current consent or permit holders. This should also prevent tying up a resource that is allocated to, but not being extracted by, consent holders.

27.4.6 Ability to manage for flood control

The primary reason for ECan wanting to ensure gravel extraction from rivers is to maintain flood capacity. Although lowering bed levels can increase flood capacity, too much lowering can destabilise structures such as stop banks and groynes designed to protect surrounding land from floodwaters.

27.4.7 Ability to manage to protect or improve ecological values

Conditions on resource consents provide for mitigation of environmental effects. The opportunity to provide for environmental enhancement, although not a requirement under the RMA can be considered as a criteria for a new management approach to provide an opportunity for ecological enhancement in conjunction with the gravel extraction.

27.5 Assessment of Rules and Management Options

Table 12 over page provides an indicative assessment of the regional rule options for each activity type, if they were used in isolation (the only rule used) against the above criteria.

Table 13, provides an indicative assessment of each management option (a mix of rules and global consent approach) against the above criteria. The assessment is briefly discussed below the table.

Note: Both tables 12 and 13 are indicative only, it is hoped that they will stimulate debate on these options and the reasons for and against, in order to provide a robust recommendation to ECan Councillors in June 2006.

Table 12: Regional Rule Options vs. Assessment Criteria

Criteria → / Option ↓	Sustainable management/ sustainable volumes[57]	Short application time	Cheap application cost	Ability to recover costs	Ability to monitor volumes taken	Ability to match allocation with volumes taken	Ability to manage for flood control	Ability to manage for ecological values	Total Yes/No
Permitted Activity	no	N/A	N/A	no	no	no	In part	no	0/8
Restricted Discretionary activity	In part	Yes/No Depends on quality of information	no	yes	no	no	yes	yes	5/3 or 3/5
Discretionary activity	yes	Yes/No Depends on quality of information	no	yes	no	no	yes	yes	5/3 or 4/4
Controlled activity	In part	Yes/No Depends on quality of information	no	yes	no	no	yes	yes	5/3 or 3/5
Non-Complying activity	In part	Yes/No Depends on quality of information	no	yes	no	no	yes	yes	5/3 or 3/5
Prohibited Activity	no	N/A	N/A	no	no	no	no	no	0/8

[57] note “sustainable volume” of gravel for extraction is different from “sustainable supply” (discussed in Chapter 6), and should be based on the available volume of gravel at the location in question, including sustainable supply and accumulated gravels.

Table 13: Management Options vs. Assessment Criteria

Criteria → Option ↓	Sustainable management/ sustainable volumes	Short application time	Cheap application cost	Ability to recover costs	Ability to monitor volumes taken	Ability to match allocation with volumes taken	Ability to manage for flood control	Ability to manage for ecological values	Total Yes/No
COMBINATION OF DISCRETIONARY & PERMITTED ACTIVITY WITH INDIVIDUAL CONSENTS	yes	In part	In part	yes	In part	In part	yes	yes	8/0 or 4/4
GLOBAL CONSENT WITH **NO** 'PERMIT' SYSTEM	no	no	no	In part	yes	yes	yes	yes	5/3 or 4/4
GLOBAL CONSENT WITH 'PERMIT' SYSTEM	yes	Yes/no	Yes/no	yes	yes	yes	yes	yes	8/0 or 6/2
COMBINATION OF GLOBAL CONSENT WITH 'PERMIT' SYSTEM AND INDIVIDUAL CONSENTS	yes	In part	In part	yes	In part	In part	yes	yes	8/0 or 4/4

27.5.1 Management options vs. assessment criteria

Table 13 provides a indicative assessment of possible management options against the assessment criteria identified in section 27.4. The pros and cons of these options will be explored through public consultation before an approach is recommended to ECan Council.

Combination of discretionary & permitted activity with individual consents
Discretionary and permitted have been included in Table 13 as a likely rule combination, based on the assessment in Table 12 and, because they are the most common rule combination for gravel extraction, see Table 14, also this combination is consistent with the Proposed NRRP.

The assessment indicates that this management option would provide for 4 out of 8 of the assessment criteria and could meet in-part for a further 4 assessment criteria. The in-part comment for application time and cost criteria relates to the cost to consent applicants and holders. The in-part comment in relation to monitoring and allocation volumes relates to the fact that monitoring of volumes taken and matching these with allocation would be possible for consented extraction but would be very difficult for permitted volumes; therefore under this rule combination it would only be possible to achieve this in part.

Global consent with no 'permit' system
As indicated in Table 13, this management option would not achieve all the assessment criteria. It does not provide for the application time and cost criteria as there is likely to be an initial long consent application period and associated high costs, as discussed in section 27.3.3. However, once the consent is granted the

only further costs would be those involved in meeting the consent conditions and to extract the gravel. Ability to recover costs, other than from the general rate or rating district would be limited to extracted gravel that the regional council could on sell from stock piles. The regional council (or contractor working for the regional council) would be the only one able to extract gravel under this consent approach. Because of the costs involved, the fact that gravel is a crown resource, and the regional council is only able to recover reasonable costs (section 150 LGA) it is unlikely that extraction would occur other than for flood control purposes. In order for a regional council to go down this track they would have to ensure that they had the resources, including equipment, to ensure gravel is extracted for flood control purposes. Because of this focus on gravel extraction for flood control purposes, this management option, would not provide for the use of the fluvial gravel resource for the economic wellbeing of people and communities, to achieve sustainable management.

Global consent with 'permit' system
Table 13 indicates that this is the only management approach which can meet all the assessment criteria. Resource consent conditions can be met by ECan as the consent holder or passed on to the permit holder. Permission to extract under a global consent can be given in a matter of hours. Although there are initial time and cost restraints in applying for a global consent (see section 27,3,3), the permit system is comparatively cheap. Costs to the permit applicant and holder, if charged, are likely to reflect cost to ECan of the consent application and managing the consent, but will be spread over a large number of permit applications and permit holders. As stated in the LGA, any charges or fees, "must not provide for the local authority to recover more than the reasonable costs incurred by the local authority for the matter for which the fee is charged". In issuing permits the regional council can keep a record of extracted volumes and can encourage extraction for flood control purposes.

Combination of global consent with 'permit' system and individual consents
To some extent this already happens in the Canterbury region, where consents for gravel extraction are held or managed by ECan for gravel extraction in Rating Districts, for flood control purposes. It would be possible to expand this approach, to increase the number of consents held by ECan in specific areas, such are areas of high gravel demand, and then continue with individual consents outside these areas. It is possible to apply for an individual consent where a global consent is held as discussed in section 27.3.3, although this should be unnecessary where a global consent is held.

28. What Regional Councils are doing

Table 14: Summary of regional management approaches

REGION	MANAGEMENT APPROACH	APPLICATION PROCESSING TIME	CONSENT PERIOD	APPROXIMATE REGIONAL ANNUAL VOLUMES CONSENTED SINCE YEAR 2000	COSTS TO APPLICANT/ CONSENT HOLDER	PROCESS USED TO SET CHARGES	REASONS FOR MANAGEMENT APPROACH
Northland	Discretionary activity Increasing number of global consents held by NRC				No charges		

Region	**Management approach**	**Application Processing time**	**Consent period**	**Approximate regional annual volumes consented since year 2000**	**Costs to applicant/ consent holder**	**Process used to set charges**	**Reasons for management approach**
Bay of Plenty	Permitted rule for small volumes and RC river management. Discretionary activity.	20 days, but usually takes several weeks to months to obtain all info required	2 to 10 years	100,000 (very close to)	Monitoring fee of $0.90c/m^3$ Consent processing costs $1,000-$30,000 (if notified Fish and Game/DOC/Tangata whenua issues)	Monitoring fee based on costs of survey, analysis, reporting and compliance – covers around 65% of that cost.	Extraction carefully determined by river reach to benefit and manage flood flows. Carefully managed on degraded rivers to restore the environment.
Waikato				200,000m3 sand plus small volume of gravel			
Hawkes Bay	Discretionary activity		1 year	Total approx $500,000m^3$/yr	$80 (consent) $\$0.60m^3$ (monitoring)		Limited resources in favoured areas. Consented volumes based on last years gravel returns. All applications processed at beginning of year.
Manawatu – Wanganui	Discretionary activity 2 global consents in rating districts	Consents: 1-2 months Permits under RC Consent: hours	Consents 5 to 10 years Global consents 20 years with 5 yr reviews. Permits short term as required	$929,000 m^3$/yr (Approximately 60% from berm locations the rest river channels).	Consents $1,000 – $\$1,500 + \$0.20m^3$ levy on consented volumes Extra charge $\$2.00m^3$ (specified zone) Permits application free + $\$0.20m^3$ levy (extra levy $\$0.50m^3$ on one global consent given to Trust)	Consent application S36(1)(b)RMA. $\$0.20m^3$ levy S36 Extra levy through S108(2) RMA	Extra levy of 0.50 cents condition of one global consent to go to trust for habitat improvement.

REGION	MANAGEMENT APPROACH	APPLICATION PROCESSING TIME	CONSENT PERIOD	APPROXIMATE REGIONAL ANNUAL VOLUMES CONSENTED SINCE YEAR 2000	COSTS TO APPLICANT/ CONSENT HOLDER	PROCESS USED TO SET CHARGES	REASONS FOR MANAGEMENT APPROACH
Wellington	Global consent (Wairarapa catchment)	Permits: ?	Varies <1yr	Total 400,000m^3/yr	$75 min (permit) $1/$m^3$ (royalty) $0.08 m^3 (licensing)		
Tasman	Global consent (each river) for all river maintenance work including up to 40,000m3 of gravel extraction any where in the region. Consents and Authorisations issued under global consent.	Consent/Authorisations: Week-month.	Global consent until June 2011 Consent/ authorisation 3-6 months	Global total volume 40,000m^3/yr Authorisations 500 -3000m^3	Application fee approx $300 Admin, monitoring and supervision charge: 2.50m^3$ to 5m^3$	Section 36 RMA Council resolution in Annual Plan	Some local accumulations. Overall available gravel declining. This year's sustainable supply is 20,000 for the whole region, but this volume is likely to decline. Plan to add rivers and lakes section to Regional Plan
Marlborough	Global consent (each river)	Permits: one day			Permit free 0.55m^3$ (royalty) or 2m^3$ (from council stockpiles)		
West Coast	Discretionary activity Global consents for popular sites held by WRC				Permits in RC consent areas $50 up to 250$m^3$ and 20cents/m^3 thereafter. Concession charges apply in other areas.		
Canterbury	Discretionary activity. 6 Global consents in rating districts. Proposed permitted rule for small volumes	Consents: weeks Permits: hours- weeks	Consents 3 Months to 10 years Permits short term as required	3,500,000m3/yr	Consents $1,125. Permits free	Consent application charge S36(1)(b)RMA Consent monitoring charge S36(1)(c)RMA.	Lack of information on effects. High volumes available. Encourage extraction to manage flood flows.

REGION	MANAGEMENT APPROACH	APPLICATION PROCESSING TIME	CONSENT PERIOD	APPROXIMATE REGIONAL ANNUAL VOLUMES CONSENTED SINCE YEAR 2000	COSTS TO APPLICANT/ CONSENT HOLDER	PROCESS USED TO SET CHARGES	REASONS FOR MANAGEMENT APPROACH
Otago	Discretionary activity Permitted activity rule of $20m^3$ per month, with conditions. Proposed global consents for certain rivers (with permit system).	Consents: Weeks	Consents, 1 to 10 years, depending on supply and river activity	1,300,000 m^3/yr consented 320,000 m^3/yr extracted	60 cents/m^3 Consents deposit - $250; Total Consent charge varies	Consent application charge S36(1)(b)RMA Cubic metre consent monitoring charge S36(1)(c)RMA based on gravel return information.	Sustainability questions in certain rivers. High volumes available in some rivers. No gravel available in other rivers. Extraction used to align channel and provide capacity in some rivers. Some lack of compliance from extractors.
Southland	Discretionary activity	Consents: 5 days-2 months	Consents 3 Months to 10 years Permits short term as required	1,018,00m3/yr	Non-notified $60 - $600 (consent) $0.50/$m^3$ extracted and returned (monitoring)	Application Charge and Monitoring Charge S36	Lack of information on effects. Over extraction. Needs of community met Potential future issues with flood flow level of service

28.1.1 Summary of regional council approaches

Table 13 shows that the standard individual discretionary approach is declining in favour of global consents and a permit based approach. Of the 12 regional councils listed, 7 have a permit approach, at least within some rating districts, with Marlborough operating fully under a global consent for all rivers.

Time frames vary for consent periods from a month to ten years, although Horizons Regional Council holds two global consents for twenty years and Hawkes Bay Regional Council manages all their consents on an annual basis. Permits a all short term and issued on an as required basis.

Northland Regional Council is the only regional council not to charge for gravel extraction management, however the available supply of fluvial gravel in the region is low. Other regional councils charge a consent application fee or permit fee and 9 of the 12 regional councils listed, include a per cubic metre charge

Some of the regional councils who have a discretionary activity rule approach to gravel extraction said that they are being very careful about how much gravel they allocate, how long for, and where its extracted from. Staff of other regional councils have also said that with reducing volumes they are finding it harder to successfully manage the gravel sustainably through an individual consent-by-consent process. Others said they were looking to increase the number of global consents held by the Regional Council. Regional Councils with global consents said they are very happy with this management approach and plan on replacing the consent when it finishes. Staff from these regional councils have said that they are able to respond quickly to requests for gravel under a global consent, and to provide clear and precise instructions on how much, where and when gravel can be taken, and what conditions contractors have to meet. They also said that per cubic meter charging of permit holders, to recover costs, is also successful.

29. Management options - managing demand

There are a variety of gravel types and each type has different qualities, see section 14.1.2. These qualities can make some gravels unsuitable for different uses. High quality gravels are those gravels that are sought after for specific end uses. Although some contractors choose gravel type depending on end use, often, high quality gravels are also used for things where lower quality gravel could have been use.

In recognition of the high demand for fluvial gravels and the limited sustainable supplies the idea of managing demand is examined. With reducing volumes of alluvial gravels available the issue of managing these resources efficiently to ensure they last as long as possible has arisen. This idea of a “best end use” policy was raised in section 23.3.1. The implications of this as a management tool are briefly discussed below.

Because high quality gravels are more sought after than lower quality a extra, or increased, charge to extractors for high quality gravels in limited supply areas could help with managing demand. However charged would only be possible under the provisions of the RMA if, there was an actual increase in costs to the regional council in managing these gravels.

The Regional Council role in managing demand for gravel via a “best end use” policy is debatable. Section 5 and 7 of the RMA provide consideration of future generations, efficient use and finite characteristics of a natural resource. However a regional council has no powers to ensure the gravel resource is used for a specific purpose. A regional council can place many controls over the extraction of fluvial gravels, but once the gravel is extracted the regional council has no control over what it is used for.

Addressing the issues of efficient use and providing for future generations would more easily be provided for, by an industry driven initiative, such as best practise guidelines.

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Hinds River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/4, Environment Canterbury
Kowhai River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/5, Environment Canterbury
Makikihi River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/6, Environment Canterbury
Otaio River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/7, Environment Canterbury
Rangitata River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/8, Environment Canterbury
Te Moana River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/9, Environment Canterbury
Temuka River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/10, Environment Canterbury
Waihao River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/11, Environment Canterbury
Waipara River Report (2006)	by Neil Sutherland MWH NZ Ltd, Report No: R06/12, Environment Canterbury
Pareora River Report (2005)	by Dr Henry Hudson EMA Ltd, Report No: U05/30, Environment Canterbury
Waihi River Report (2005)	by Dr Henry Hudson EMA Ltd, Report No: U05/32, Environment Canterbury
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Waimakariri River Report (2005)	by Dr Henry Hudson EMA Ltd, Report No: U05/15, Environment Canterbury
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Oamaru to Timaru Coastal Report (2006)	by Martin Single MWH NZ Ltd, Report No: R06/14, Environment Canterbury
Pegasus Bay Coastal Report (2006)	by Martin Single MWH NZ Ltd, Report No: R06/15, Environment Canterbury
Timaru and Banks Peninsula Coastal Report (2006)	by Martin Single MWH NZ Ltd, Report No: R06/16, Environment Canterbury

Appendix A

CANTERBURY REGION GRAVEL EXTRACTION QUESTIONNAIRE

PART A

Name of Organisation: ______________________________

Address: ______________________________

Name and position of person completing questionnaire: ______________________________

____

Phone: ______________ **Email:** ______________________________

Gravel Extraction Consent number(s): ______________________________

____

(Please attach separate sheet if additional space is required)

PART B

1. Future Demand

(a) Does your organisation have projection figures for its future aggregate demand within Canterbury, or for future aggregate demand within the Canterbury region generally?

Yes No

(b) If yes, please indicate below what those figures are, for what projection timeframe (e.g. 2, 5, 10 years), and where relevant, for what use/end product (please also specify whether these figures are for your organisation, or for the region/district generally).

For example:	xyz m^3	to 2007	for concrete
	xyz m^3	to 2010	for roading

If no, please provide any comments you may have related to aggregate demand in your area or in the region over the next 10 years.

____

____

____

(c) In identifying future resources to meet your company's demand, what are the main factors that you take into account, e.g. aggregate quality, quantity, river reaches known to be aggrading, proximity to infrastructure etc?

____

____

____

2. Distance to source

(a) What is the average distance between where you extract gravel and your nearest depot / base within the Canterbury region? ______________ km

(b) What is the average cost per kilometre to transport aggregate? ______________

3. End Use

(a) Please indicate below the end use(s) of the gravel that you extract within the Canterbury region, the annual volume of gravel you supply for each end use, and where that end use occurs, i.e. local (within your district), elsewhere in the Canterbury region, or outside the region (specify where).

End Use	**Annual Volume (m^3)** **If you are unsure please provide a best estimate**	**Where Used (local, regional, out of region)**
Basecourse for roads, carparks, subdivisions, driveways etc		
Road sealing		
Driveways, tanker tracks		
Farm stock races		
General and farm base metal / bulk fill		
Drainage (no fines)		
Landscaping		
Rip rap, erosion protection		
Gabion rock		
Concrete		
Other (please specify)		

(b) Do you undertake any of the following activities?

- Screening
- Crushing

If so, to what size(s) / grade(s)? ____________________

- Concrete production

If so, how much per year do you produce in the Canterbury region? ____________________

(c) Do you purchase gravel from other Canterbury extractors?

- Yes
- No

If yes, how much? ____________________(m^3 per year)

(d) What criteria do you apply to determining the quality of the material that you extract, e.g. composition, particle size, amount of fines, hardness etc?

____

____

(e) How does the quality of the gravel you extract or have identified for potential future extraction affect suitable end use, e.g. screening/crushing, additional processing needs; proportion of unsuitable material; applicable standards, etc?

____

____

4. Aggregate Sources

(a) How much aggregate do you extract annually from river sources within Canterbury?

________________ (m^3 per year)

(b) For your Canterbury operations, do you extract or utilise aggregate from sources other than rivers, i.e. land-based sources?

✎ Yes ____
Please specify the type of material e.g. quarried rock, sand or alluvial gravels

✎ No

(c) If yes, on average how much do you extract / use per year?

________________(m^3/year)

(d) Please indicate where the alternative aggregate is sourced from (either a place name, or the distance from your local operational base).

____

(e) Is the alternative aggregate used for the same / similar end use(s) as that indicated above for river aggregate?

✎ Yes ✎ No

(f) If no, please specify the end use(s) and respective annual volumes (m^3).

End Use	Annual Volume (m^3) If you are unsure please provide a best estimate	Where Used (local, regional, out of region)

(g) If yes, does the alternative aggregate require any additional screening / processing in order to be used for the same / similar end use(s)?

____

____

5. Monitoring

The conditions of your gravel extraction consent(s) require that, on request, you provide ECan with quarterly returns of the volume of gravel extracted, in cubic meters. The accuracy and effectiveness of this monitoring relies on extractors using consistent methods in calculating their returns.

(a) What basis do you presently use for calculating your gravel returns?
For example: sales; truck movements; weight; screening volume; or some other basis (please specify).

____

(b) Do you consider that the process of monitoring the actual volume of gravel extracted under each consent could be undertaken more efficiently than the present quarterly returns process?
If so, how?

____

____

____

6. Additional Information

____

____

____

____

____

If additional paper is required, please attach.

Appendix B

Figure A2.1: 1998

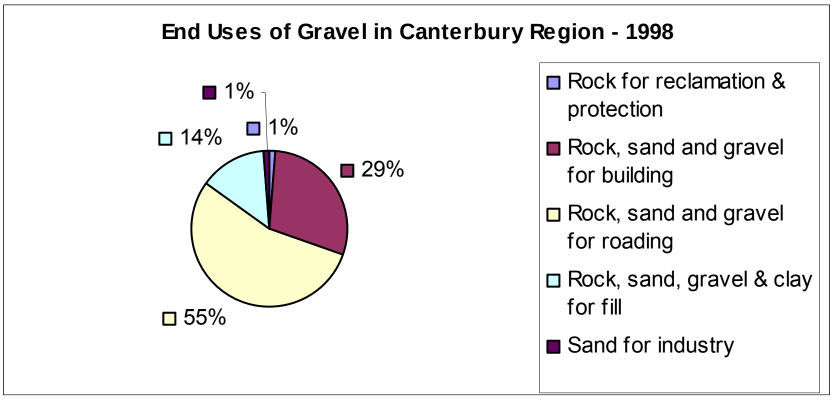


Figure A2.2: 1999

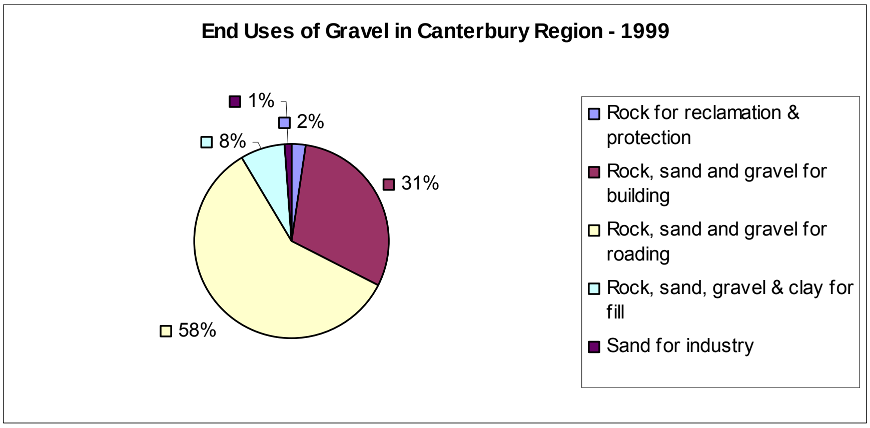


Figure A2.3: 2000

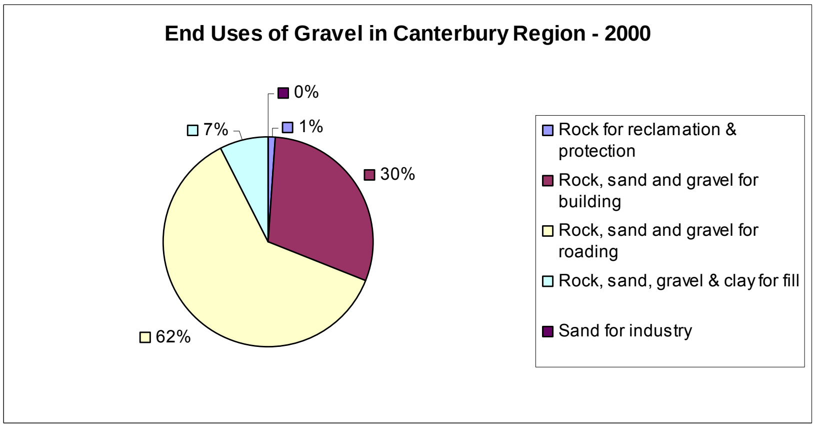


Figure A2.4: 2001

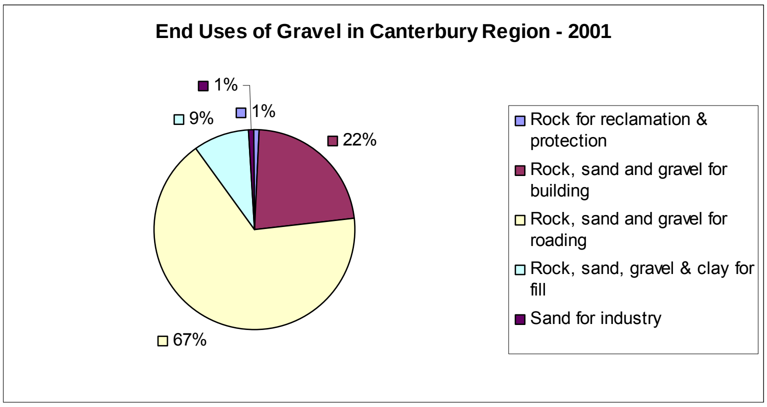


Figure A2.5: 2002

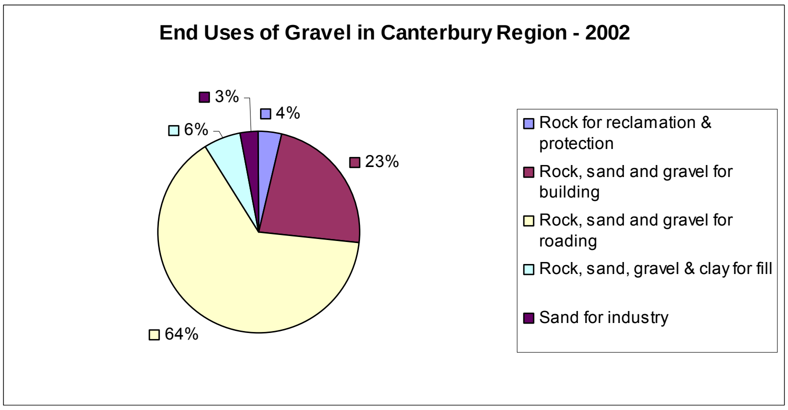


Figure A2.6: 2003

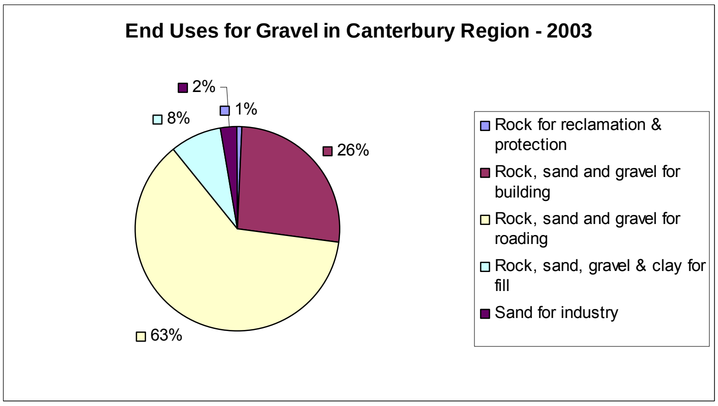
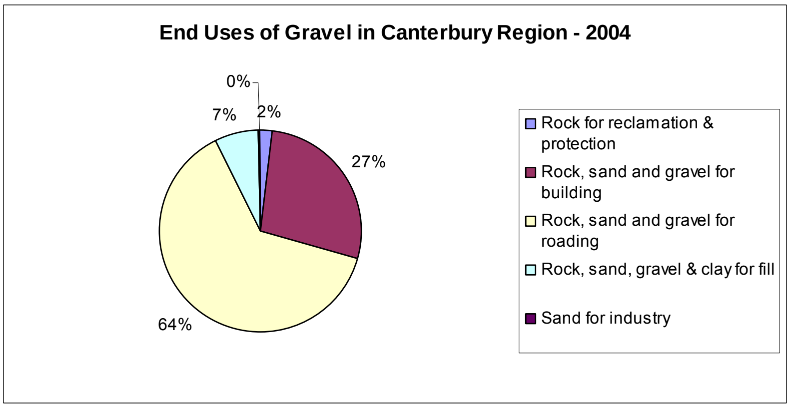


Figure A2.7: 2004



Appendix C

Hawkes Bay Regional Council

10th November 2005

Discussion with Vince Byrne, Hawkes Bay Regional Council - responsible for managing and monitoring gravel allocation.

Existing system has been in place for a number of years.

Monitoring methods:

- Cross section surveys. Undertaken on 3 yearly basis. Survey work contracted out. Design bed levels have been established.
- Statutory declaration (gravel return) from extractors on monthly basis (only enforced on 2 to 3 mthly basis) of amount of gravel extracted.
- Aerial photos. Undertaken on an annual basis.
- On-site monitoring. Frequency depends on who it is – newcomers more frequent; less reliable contractors up to weekly; established and reliable contractors less frequently.

Cross sections:
Have considerable historic data.
Does not know what basis is used for the design bed levels.
Spacing of cross sections varies – 200m, 300m , 500m.
Information provided by cross section surveys is very useful. Gives a good picture of trends across a particular reach, and a catchment as a whole.
Doesn't think more detailed/focussed surveys are required - some extractors complain that there may be spots of aggradation within a restricted reach, and argue that the surveys aren't reflecting the situation accurately enough. But if take that chainage as a whole, will find that overall, is degradation – these spots of aggradation are reservoirs. Would only take from these if they are causing a bank stability problem or similar.

Have same issue with statutory declarations/gravel returns as in Canterbury, in that are not always accurate, and extractors not always honest.

However, the gravel consenting/allocation process is very much based on previous years – Vince uses previous years' returns to determine how much gravel extractors are allocated. Therefore, if extractors submit a lower amount in their declaration than they actually took, they will only be allocated that sort of amount the following year.

Smaller operators are directed to separate sites to make site monitoring easier. This is difficult when more than one operator per site, as difficult to determine who is taking what.

Fees and charges:

<u>Consent processing:</u>
Fee for receiving, processing and deciding on non-notified land use consent applications to extract gravel are:

0-50m3 - $20
50m3 and over - $80

Compliance monitoring and administration charges, and financial contributions:
Compliance monitoring and administration charges and financial contributions are based on the volume of gravel extracted, the source of the gravel and the quality of the gravel. The categories include:

- Inferior grade material (as determined by the staff of the Hawke's Bay Regional Council)
- Material extracted from above the confluence of the Tukipo and Manga-o-nuku River tributaries of the Tukituki and Waipawa Rivers (Upper Tukituki catchment)
- All other material

The financial contribution is established in the Regional River Bed Gravel Extraction Plan under Section 108 of the Resource Management Act.

Gravel Extraction Charges based on $ per cubic metre extracted per annum

	State of Environment Monitoring Charge (S35 of RMA)	Compliance/ Allocation Charge (S36 of RMA)	Financial Contribution (S108 of RMA)	Total
Upper Tukituki catchment	No charge	$0.20	No charge	$0.20
Inferior grade	$0.17	No charge	$0.03	$0.20
All other	$0.17	$0.40	$0.03	$0.60

Resource consent charges for gravel extraction are due and payable monthly on the same day as statutory declarations/gravel returns. After completion of the financial year ended 30 June 2004 the actual costs incurred in relation to the monitoring and compliance allocation for gravel extraction and actual quantities of gravel extracted will be compared to the budgeted costs and estimated levels of extraction. Any under or over recoveries will be recovered from or refunded to gravel extractors after 30 June 2004.

Goes partially toward the cross section surveys, but not all, as this information is useful to a number of council sections, so the cost is shared. All expenses associated with managing the gravel allocation system are met, and in some years (last few years) a refund is paid.

Allocation process:
Extractors apply for a consent on an annual basis. There are currently roughly 150 consents. Is a restricted discretionary activity.

Based on cross section survey data, gravel returns and aerial photos, annual allocation limits are set for key rivers. Annually in April, extractors are required to submit an application for a gravel allocation. They indicate how much they want, location preference, end use etc. HBRC then allocates the gravel. Generally this is based on historical returns. This tends to mean that newcomers will generally get relatively small allocation.

The issue of an allocation is in fact a resource consent. These have a term of 1 year. A blanket issue of resource consents is made on 1st July.

Extractors are required to notify HBRC before they begin extracting. Vince meets them on the river and indicates where he wants them to extract and how much.
The nature of the consents varies. E.g., one extractor has a consent for a 7km stretch of a river. They have the access pretty much tied up, so difficult for others to get in. They also get pretty much all the allocation for that stretch. Allocation is made on a volume per cross-section length basis. E.g., over a 7km stretch are 20 odd cross-sections. Allocation is made for a certain amount per cross section length. This may change each year.

HBRC has a "best end use" policy, and end use is taken into account when allocating gravel.

An appraisal is undertaken half way through the year. Where problem aggradation areas have arisen, or there's been a flood event, etc, additional allocation may be made. Has never had to reduce an allocation through this process – would be very difficult!

General

Hold meetings with resource user group.
There are some issues over level playing field, and fact that some extractors have to travel further afield to the southern area where there is a gravel surplus. HBRC have discussed with users in the past, option of requiring all extractors to take a certain proportion of their allocation from the southern sources (e.g. 10-15%), and that it is the first 10-15% that must be taken from there, not the last. However, extractors were not supportive of this approach and at this stage it has not been pursued.

Some have also indicated that they would like longer consents, e.g. 3-5 years. However, HBRC don't see any additional benefit in this as would still be able to review the consent on an annual basis and restrict the amount of gravel that may be taken.

MWH

FILE NOTE

DATE 14 November 2005
JOB No. Z1236600

PROJECT ECan Gravel Management	FOR INFORMATION OF
SUBJECT Consent and Monitoring systems	FOR ACTION BY

THIS NOTE RECORDS:

☐ MEETING
☒ PHONE CONVERSATION ☒ WITH
☐ THOUGHT/IDEA ☐ ABOUT
☐

☐ CLIENT
☐ CONTRACTOR
☐ SUPPLIER
☒ ORC

BETWEEN Tamsin Page
AND Steven Swabey
TIME 10.00

DETAIL:

Discussion with Steven Swabey, Manager Natural Hazards, Otago Regional Council.

ORC allows extraction of 30m3/month as a permitted activity. This excludes gravel extraction for large scale construction activity.

Extractors apply for a land use consent to extract gravel. The application is for a specific volume, for a specific location on a river. Applicants are required to indicate the upper and lower bounds of the location. They also specify the method of extraction proposed.

Applications are circulated to 3 groups for input – Science (hydrology and ecology impacts), river engineering (river management, structures etc), and natural hazards (flood risk management).

Terms granted are usually between 1 and 5 years. Occasionally for 10 years, however this would have to be on a river with plenty of gravel and limited pressure in terms of demand.

The volume that may be extracted under the consent is a per year volume.

Condition of consent specifies that extractors must consult with ORC (engineering section) before exercising the consent. Through this, ORC has input into determining where, when and how much gravel is extracted. Although consents do not specify that ORC shall determine this, extractors generally follow this procedure, and the shorter term consents encourage this sort of cooperation. Extractors contact ORC before exercising the consent and ORC engineer meets on-site to discuss where, when, how much and method of extraction. This also ensures that ORC engineers are getting out on site frequently and so have a good grasp of the state of the river and gravel resource at all times.

ORC try to keep extractors in separate extraction locations as this makes site monitoring simpler. To do this, reaches are often broken up into quite short sections.

An "inspection fee" of 60 cents/m3 is charged. This is paid at the same time as returns are sent in. This used to be a royalty under the old catchment board system. No longer called this, and is now charged under s 36 of the RMA and the Local Govt Act 2002.

Until 2 years ago, very little monitoring undertaken and very little knowledge regarding the volume of gravel available in rivers. However, monitoring has increased, and 3 or 4 river reports are now produced each year

INITIALS

summarising gravel inputs and outputs etc to give an indication of sustainable extraction rates. Generally political will within Council is to be stringent in management of the resource, and at least two rivers in the region have been closed to extraction.

1. Internal processes of compliance monitoring

Provision of gravel returns by extractors – this is a condition on all consents. Historically varied between 3mthly, 6 mthly and 12 mthly. All new consents now standardised to 6 mthly. Returns are **required even if it is a nil return**.

Cheque for the inspection fee to be sent in with the returns.

If no return received, a letter is sent. If still no return, enforcement action initiated.

ORC cross check the volume on returns, consented volume, and $ amount sent in with returns.

Have implemented a gravel monitoring database, which is an integration of the consents system with the accounting system. The accounting department enters information from the gravel returns/inspection fee, and the system automatically sends a letter if –
- there is no return
- the gravel volume and $ don't match
- the gravel volume and consent volume limit don't match

2. On-site compliance monitoring

Compliance officers visit on site regularly.

In addition, are about to implement a truck movement monitor system. Is a seismic monitor that will be installed at gravel extraction access points. This can distinguish between large and small vehicles, and testing is going to determine whether can refine this to distinguishing between small trucks, big trucks, utes, and diggers, which will give even better info. If not, can assume two large vehicle movements over the extraction period will be the digger coming and going, and then other large vehicles will be trucks. Generally, each extractor has a separate access, as this tends to be negotiated with landowners, and therefore can usually be sure is only the one extractor passing through that access point. In addition, as extractors required to contact ORC before exercising, generally know where and when and about how long will be working there, so can easily install the monitor for the extraction period. Also, as know which operator is using the site, can generally find out what size trucks they use. This is going to give an additional set of information to check against returns.

Since the improvements in and tightening up of the monitoring processes and more consent enforcement, there has been a dramatic increase in the number of returns and associated inspection fees being submitted.

The inspection fees collected are split 50/50 between compliance monitoring section (for on-site and returns processing/monitoring) and natural hazards section who report on the state of the resource. The increased fees they are receiving as a result of improvements in the system will allow better, more accurate reporting and monitoring, and therefore a better understanding of the resource and the ability to make more certain allocations.

3. Cross-section surveys

On average, these are done every 5 years. They are analysed using XSECT (a system developed by Hawkes Bay RC). It relies on the same extent of survey each time, so need to ensure are located appropriately.
Also have an internal spreadsheet for tracking the horizontal and vertical positioning of the river bank. Based on these systems can get a general picture of whether the river is aggrading, degrading or remaining stable.

In addition, on-site monitoring of the rivers is undertaken to ground-truth. In some rivers, they also look at flows and ecology. E.g. Kawerau – special fish and so are working with DoC to look at impacts of gravel extraction.
Sometimes will do sediment transport modelling – 1 dimensional model to estimate the sediment transport rate through a particular reach.

They produce 3 or 4 river reports per year which summarises the status of the resource and recommends that extraction continue, that extraction is restricted in some way, or that extration cease. This is then endorsed or otherwise by Council, and forms the basis for policy making. The river reports take a broad geomorphological approach. It is important that gravel is analysed very broadly and understood in the context of the whole catchment and the long time frame of geomorphological change. They look at how the gravel gets into the river system, land use and land uses changes within the catchment, changes in hydrology, historical gravel extraction, engineering works and structures within the river and how these all impact on the gravel resource.

Have aerial photos. Last flown for all the rivers in 1997. Next due this year/next year. Some intermediate periods for some rivers.

Wellington/Wairarapa Gravel Allocation/Consenting Procedures

Peter Holden (MWH NZ Ltd, ex Greater Wellington Regional Council)

Most river based gravel extraction in the Wellington Region is undertaken in the Wairarapa. A small quantity is extracted from the Hutt River on the Wellington side of the region, however this is a limited amount and is strictly for river management purposes only.

Monitoring:

Gravel monitoring for River management/ and gravel extraction purposes was done in the form of cross section monitoring. All rivers of importance for these purposes had a network of cross sections established on them.

These cross sections would be surveyed and the results analysed using 'Ricoda' (a NIWA derived cross section programme) to determine changes in volume, from the last surveys. From analysing the change in volume over time sustainable extraction volumes could be deduced.

Due to limited time and money it is not possible to survey all rivers every year. A meeting was held each year therefore between staff of Consents Management and Operations (river engineers) to determine the programme of surveying for the coming year.

Which rivers to survey was determined by examining a number of factors including:

- **Extensiveness of Extraction in the Reach.**
  For example, reaches where large volumes of material are being removed would receive close attention, as would areas where demand is rapidly increasing due to increased activity in the area. **Catchments in this category would be surveyed annually.**

- **Sensitivity of the Reach.**
  A sensitive reach is one where bed levels/volumes seem to be degrading rapidly or falling below design levels, or a lack of aggradation is evident. This may be due to natural processes or potential over extraction. **Sensitive areas would typically be surveyed annually and in one particular case where a road bridge was threatened every six months.**

- **Presence of Bridges or Sensitive Infrastructure (i.e. water intakes) in the Reach.**
  It was important to ensure that extraction in the area did not cause bridges or any other infrastructure to be undermined. **Bridges were typically surveyed annually.**

- **Revolving Programme.**
  Medium risk rivers were surveyed on a rotating basis depending on when they were last surveyed. **Depending on the reach and presence of the above factors rivers of medium to low risk were typically surveyed every 2-8 years.**

Consent Process:

There were two types of consent that were granted in the Wairarapa. Annual renewals and one off consents.

Annual Renewals:
Annual renewals were consents that were applied for by contractors on an annual basis to allow them to extract gravel at a variety of rivers and sites throughout the year. The volumes applied for were based on what the contractors felt they may use over the coming year, but were more or less based on what they had used in the previous year.

Approximately 80% of gravel consents processed during the year were done so through this process. The annual renewal process gave the contractors a source of gravel that they could utilise throughout the year without having to repeatedly apply for consents, hence reducing delays if they have an urgent job to fulfil (such is the nature of the industry). The process also gives all contractors a chance to get a slice of the allocation.

A cut off date for these applications was set each year (normally 2 months before their old consents were due to expire). Once the deadline had been reached officers reports would be written on a catchment by catchment basis allowing consents to be processed in bulk. The reports would address the big issues as well as pick up on any specific adverse effects in certain areas which needed to be mitigated.

No more than approximately 60% of the total allocation would be allocated during the annual renewal process. This is so that no one extractor could tie up the whole resource, and allow available allocation for one off jobs applied for during the year.

Volumes allocated during this renewal process were also compared to volumes stated in their returns. Hence if a contractor was applying for a much larger volume than their returns suggested they were using then they would be allocated a reduced amount accordingly. By allocating gravel in this fashion a more honest approach to the volume stated in returns was seen.

Consents were applied for on a pro-forma style application form. The form was 'tick the box' style where contractors were required to tick a variety of potential effects from their operation. If an adverse effect was identified there would be room available to elaborate how they might mitigate this effect. The application form also included a map for them to hi-light the areas they wished to extract from making compliance easier to undertake.

One-off Consents
The remaining gravel would be available to allocate to contractors who would apply for one off jobs in a particular area or those who may have used up their original allocation and wished to apply for more should it be available.

Costs.

The contractors needed to pay an initial application fee. This was one of two set fees based on whether the extraction was deemed to be large or small. The fee was based on the average time taken to process a gravel application of that size, hence they received a refund if processing was reasonably straight forward or they were required to pay more if there were complicating factors leading to longer than usual processing times.

A gravel inspection fee was charged at a later date to cover the cost of the compliance officer carrying out an inspection of the extraction site and reporting back to the contractor.

A gravel/river management fee of $0.50/m^3 was charged based on the amount of gravel allocated. This fee not only paid for the cost of the cross section surveys and analysis to be undertaken it also tended to make the contractors more careful on what volume of gravel they applied for. This is so they did not end up paying for gravel they were not likely to use.

In areas where it was critical for the gravel to be removed as a matter of flood/river management purposes then the fee was removed to encourage contractors to extract from these areas.

Gravel User Groups

A gravel user group made up of contractors from the large and small operators in the industry was formed to discuss issues to do with gravel extraction and to get direct feed back from the industry in regards to a number of matters. These matters included compliance reporting, annual charges, allocation rational, fairness, potential and current consent conditions etc.

To keep the wider industry informed of any changes to way gravel was being managed and of the outcomes of the gravel user group meetings, a number of "gravel forums" were held throughout the year.

Note:
The above system was changed in 2003 to a licence based system operated directly by the Operations Department of the Regional Council. One consent was issued to the Operations Department for all the gravel in the Wairarapa. Contractors would then apply for licences similar to the consent process above.

The above change was undertaken to achieve the following advantages:

- Marry gravel extraction more with river management benefits,
- Free up more of the Consents Officer's time to be able to process more consents and to undertake a greater amount of compliance inspections.
- To reduce the approval time for contractors who often require gravel at short notice.