Retrofitting a decentralized system: the Waipatiki experience

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ABSTRACT

This paper summarises the process undertaken at the Waipatiki Beach Settlement, Hawke's Bay, to retrofit a decentralised wastewater system to an existing and expanding community previously serviced by poorly performing on-site wastewater systems. It summarises the community, problems faced and the system installed.

A number of lessons were learnt along the way and there is still finetuning of the system required. The experiences of the respective parties involved, being Hastings District Council, Hawke's Bay Regional Council, Innoflow Technologies and Glasson Potts Flower are reported.

INTRODUCTION

Waipatiki Beach is a small coastal settlement and popular surf/swim beach approximately 35 km north of Napier. The settlement is located on a small narrow alluvial old flood plain surrounded by relatively steep hills. The existing community is adjacent to the Waipatiki Stream and set back from the beach. Immediately surrounding land use is pastoral land on the gully flats and exotic and native forests on the steeper slopes (Figure 1).

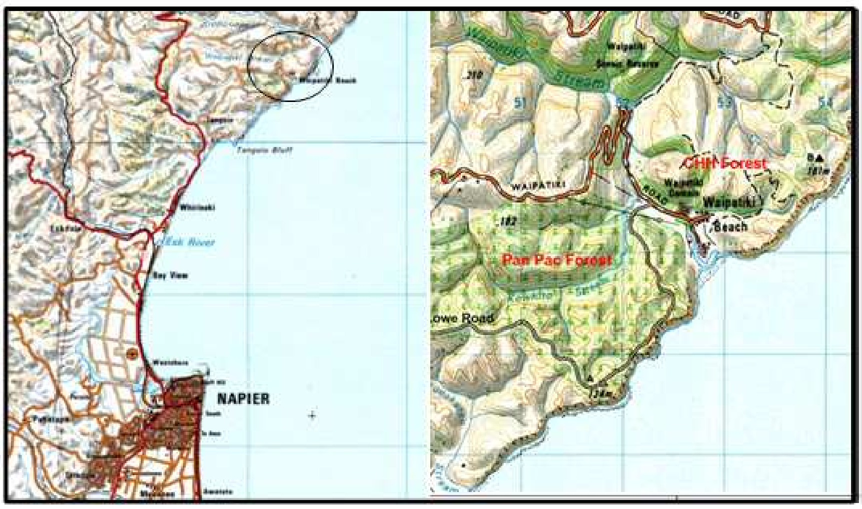

Figure 1. Waipatiki Beach location and topography.

The settlement comprised of approximately 42 households with a seasonal increase in population in the summer months. There are some fulltime residents, but the majority would be weekend or holiday occupied dwellings. All households relied on septic systems and various discharge systems for their wastewater disposal. A new subdivision adjacent to the existing community has been proposed for a number of years, which would potentially add 30 new residential lots to the community.

Historical recreational water quality monitoring of the Waipatiki Stream and a lagoon close to the beach undertaken by the Hastings District Council, found a link between degrading water quality and on-site wastewater treatment systems. The Waipatiki and Opoutama Coastal Catchment Water Quality Assessment (HBRC, 1997) indicated bacteriological water quality downstream of the settlement was significantly poorer then the upstream environment, and there was a seasonal trend showing deteriorating water quality. Figure 2 demonstrates the correlation between the recreational water quality in the Waipatiki Beach Lagoon 2001 and 2002 and rainfall in the area.

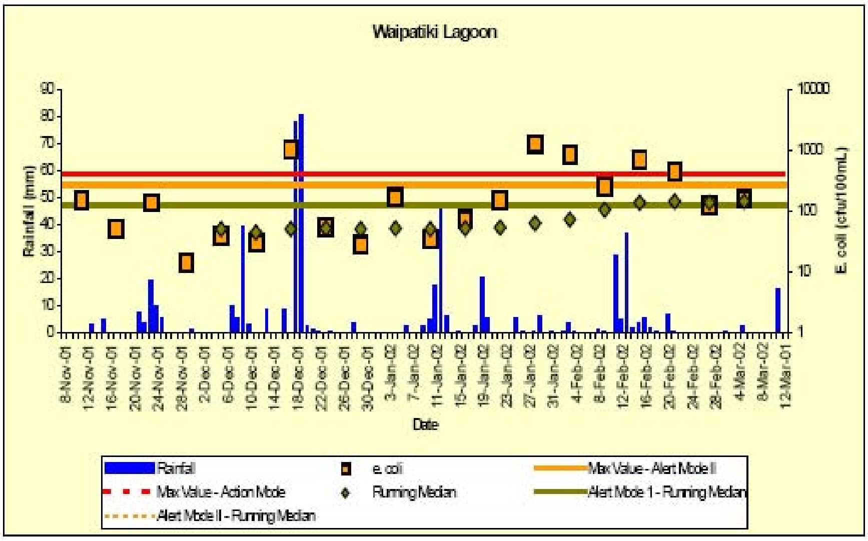

Figure 2. Water quality data Waipatiki Lagoon 2001-2002 (HBRC, 2002).

The HBRC 2002 report suggested the most likely cause of this pollution was infiltration from the on-site wastewater treatment systems. Contamination in the summer months often exceeded safe water quality guidelines for recreational use and as a result the lagoon was regularly closed for swimming.

Despite an initial reluctance to accept that existing on-site systems were responsible, extensive monitoring and an increasing awareness of potential adverse effects, the community acknowledged poor water quality was likely to be a result of existing on-site systems. The current effects and the potential for increased development in the area resulted in Waipatiki Beach residents and the Hastings District Council (HDC) considering alternative methods of wastewater treatment and disposal.

THE DECISION TO UPGRADE

Water quality monitoring provided a clear picture that on-site systems were having a detrimental effect. Consequently the HDC felt it would be irresponsible to allow the approval of the proposed subdivision until a communal wastewater treatment system had been provided for. To address the poor water quality monitoring results and the potential development, the HDC and Hawke's Bay Regional Council (HBRC) engaged in community consultation.

Initial consultation showed strong support to address poor water quality, with the logical answer being a reticulated sewer and common treatment plant. While the majority of the community were supportive, some were less supportive because of ways in which funding was proposed, in particular residents having to pay for the upgrade. Some residents were retirees, had low incomes or were absentee owners.

SCHEME FUNDING

Following much debate and community consultation, an agreement was reached on how a community scheme could be funded. A summary of the funding approach is shown in Figure 3.

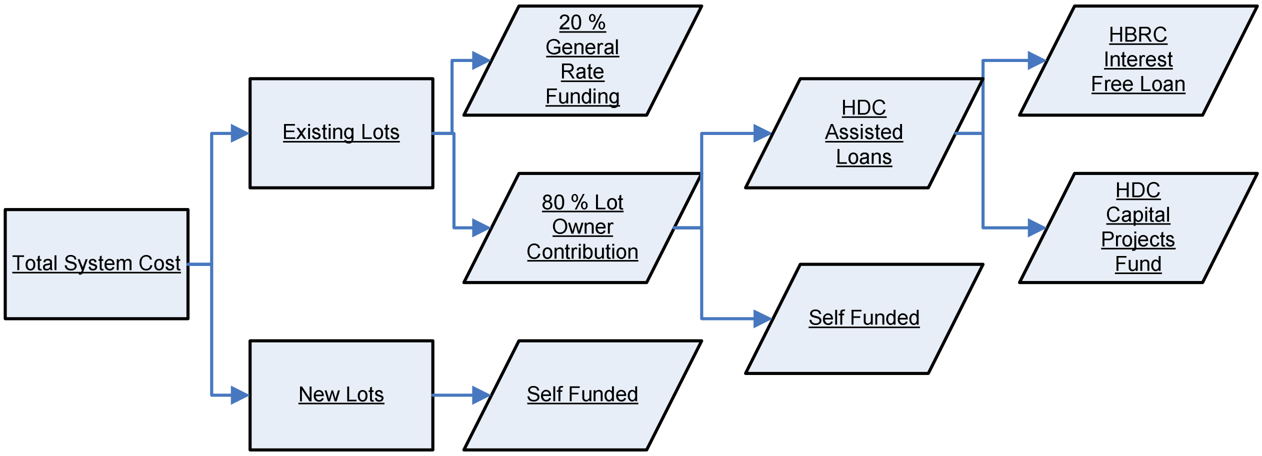

Figure 3. Funding approach.

No Ministry of Health funding was obtained for the installation of a the sewer. Existing lot owners have had to contribute 80 % of the scheme costs, with the remaining 20 % funded from general rates. The proposed development had to self fund their contribution, and subdivision approval (S224 certificate) was with-held until their contribution was received.

WHAT SYSTEM

The community consultation process highlighted potential reticulation, treatment and discharge options. It was clear that a discharge to land system was the desired disposal option. A range of treatment technologies were discussed. The preference was to use a gravity main reticulation system, with oxidation pond treatment, followed by spray irrigation into adjacent pine plantation.

It was also important that the recommended system could handle the large variations in flow that are associated with a seasonally variant population. The system also had to allow for the growth of the community.

At this stage Glasson Potts Fowler (GPF) were engaged to assist with the implementation of the project. The GPF brief was simple and consisted of site selection, tendering and consent application.

A staged approach was also put forward to allow for future community expansion, in addition to the proposed subdivision. The initial stage (Stage 1) was to provide for the existing 42 houses and proposed 30 house subdivision, plus a common ablution facility. Stage 2 was to allow for at some stage in the future the connection of a further 96 residential lots.

SITE SELECTION

Site selection consisted of two parts; a location for the treatment plant and a location for the land application area. The citing of a treatment plant created some difficulty as the valley floor consisted of the community, was narrow and/or was part of a flood plain. The surrounding hills were steep. This limited the choice for locating large facilities, especially ponds. Also consideration had to be given to odours, in particular kadiabatic drainage down the valley.

The land application area also had considerable constraints; the valley floors potentially being flooded, steep hill slopes, mixed and varying age pine trees, public access constraints and land ownership.

A series of site investigation were carried out to categorise available sites, including soil profile assessment and hydraulic property determination. This assessment concluded with a preferred site being recommended.

TENDER

HDC had a Design, Build and Operate preference for the installation and commissioning of the system. This created some interesting aspects for tender document preparation, as it had to run in parallel to the resource consent process. There was also the desire to have the system commissioned prior to the 2005 summer. Because of the potential for changes within design and contracts, a staged tender and not a lump sum tender was sought. The stages consisted of:

Phase 1: Designing Sewerage Reticulation Including Pumping Station and Rising Main
Phase 2: Designing Oxidation Pond Sewage Treatment Plant
Phase 3: Designing Effluent Irrigation Disposal Field
Phase 4: Construction of Sewage Reticulation Including Pumping Station and Rising Main
Phase 5: Construction of Oxidation Pond Sewage Treatment Plant
Phase 6: Installation of Effluent Irrigation Disposal Field
Phase 7: Operation of the Sewage Reticulation, Treatment Plant, and Effluent Irrigation Disposal Field for 5 Years

At total of four tenders were received. A weighted evaluation matrix was utilised to identify the most suitable option for the site. One non-conforming tender was also received. This was an Innoflow system which did not utilise oxidation ponds. Despite being a non-conforming tender, the Innoflow system ranked highly in the evaluation process. As community involvement was critical in the overall process, the Innoflow proposal was taken back to the community and they were able to compare the system merits with those of the oxidation pond system initially proposed. Agreement was reached and Innoflow were awarded the contract. The accepted system is described in more detail below.

RESOURCE CONSENT

The resource consent process was run in parallel with the tender process. HBRC requirements were for resource consents for a discharge to land and a discharge to air. A land use consent was also required for the treatment plant.

Both consents were processed on a non-notified basis, with immediate land owners being the only approvals required. The location of proposed site was far enough away from the community and there had been extensive consultation about the scheme to warrant a non-notified process.

TREATMENT SYSTEM

Reticulation system

The collection and reticulation network proposed by Innoflow consisted of replacing all existing septic tanks with new on-lot interceptor tanks equipped with screened pump vaults, and a small diameter variable grade effluent sewer. Each on-lot tank contains a small submersible turbine pump that delivers screened septic effluent to the decentralised wastewater treatment plant located approximately 1 km up the valley.

Treatment plant

The treatment plant consists of a recirculation tank, an AdvanTex® textile packed bed reactor and a treated effluent storage tank. Treated effluent is then pumped to the land application area. A summary of this system installed can be seen in Figure 4 while Table 1 summarises the design parameters for the major treatment components.

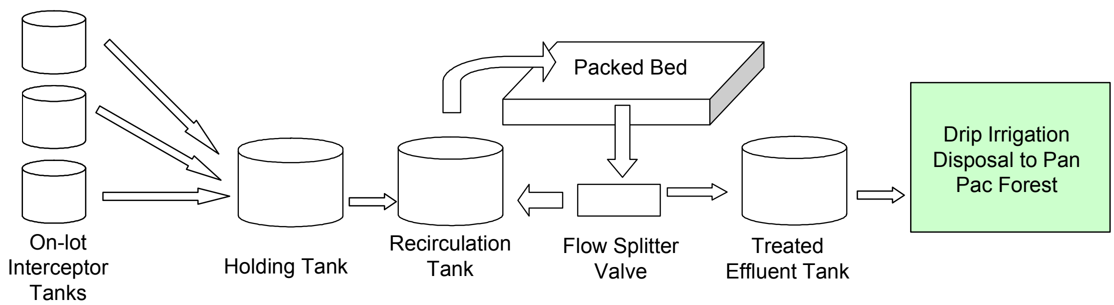

Figure 4. Sewage collection and treatment process.

Table 1. Sewage collection and treatment summary – Stage 1.

Parameter	Value
Total Design Flow - Stage 1	76 m^3/day
Interceptor Tank Volume[4]	4.5-6.0 m^3 each
Recirculation Tank Volume	69 m^3 (3 x 23 m^3)
Textile Packed Bed Area	60 m^2 (AX600)
Treated Effluent Tank Volume	69 m^3 (3 x 23 m^3)

Benefits of this system compared to the conforming tenders were that it has a small footprint, could be located in a flood plain, potential for low odours and could be expanded as the community grew and new development occurs. There was also the potential due to the design of the system to cater for the large seasonal variations in flow as a result of the holiday nature of the location.

Land application area

This variation in flow also had an effect on the calculations undertaken in order to provide loading rates for the system and the land application area. A peak summer flow (1 month) of 76 m^3/d and winter/normal season flow (11 month) of 15.2 m^3/d was used. Based on a design nitrogen loading rate of 20 g/m^3, a total annual nitrogen loading of 149 kg-N/year was calculated.

When applied at a design hydraulic loading rate of 5 mm/day, an area of 1.52 ha is needed for Stage 1, resulting in a nitrogen loading rate of 98 kg-N/ha/year. Provision has been made to increase the area to in excess of 3.43 ha to allow for future development while maintaining the same loading rates (note the HDC has allowed 4 ha of total land area for future effluent disposal).

The land application area has been incorporated into a 12 ha stand of *pinus radiata* owned by a neighbouring forestry company (Pan Pac Forestry Products Limited). Only 4 ha has been designated for use at any one time, with additional room for crop rotation and shut down to provide for tree management. The discharge method uses surface laid pressure compensating drip emitters. Other details of the land application area are provided in Table 2 below.

Table 2. Land application details for the Waipatiki Beach site.

Parameter	Value
Total Area	12 ha (including reserve)
Area used daily	1.52 ha – Stage 1; 4 ha – Stage 2
Area with irrigation	6 sector field (2,533 m^2 each)
Soil Infiltration Rate	10-38 mm/hr
Slope	<25°
Soil Type	Black silt or fine sandy loam over lying a pale yellow brown sandy clay to depths over 1 m
Daily application	5mm/day peak
Peak daily flow	76 m^3 / day - Stage 1; 172 m^3 / day - Stage 2
Nitrogen Loading	150 (kg/N/ha/year)

[4] Individual on-lot interceptor tank volumes apply to up to 4 bedroom dwellings, and volumes are operating volumes. A maximum of 24 hours emergency storage is also provided above operating levels.

PROBLEMS ENCOUNTERED

A range of issues have been encountered with this project.

Funding and community participation – this was a major component, as many residents did not want to contribute to a system they only benefited from for several weeks of the year. It was also important to actively involve the community and keep them informed. Once key representatives were identified the process was made a lot easier.

Community reticulation – the gravity reticulation proposed by the HDC in their initial specifications created some problems. This included some interceptor tanks being below the road and small drains within the community requiring deeper gravity mains. These was overcome with the use of a pressurised sewer.

Stormwater intrusion – flow monitoring post commissioning has indicated there is a significant stormwater intrusion problem (Figure 5). The correlation between rainfall and effluent discharge volumes indicates that infiltration is related to direct connection of stormwater into the sewer and not a result of groundwater ingress. The extra flow has had little effect on the performance of the treatment plant other than the activation of high level alarms. The system post interceptor tanks is completely sealed, indicating intrusion is occurring between the interceptor tanks and the houses, possibly from down pipes being directed into what were once soak pits. No investigation work has yet been carried out as yet.

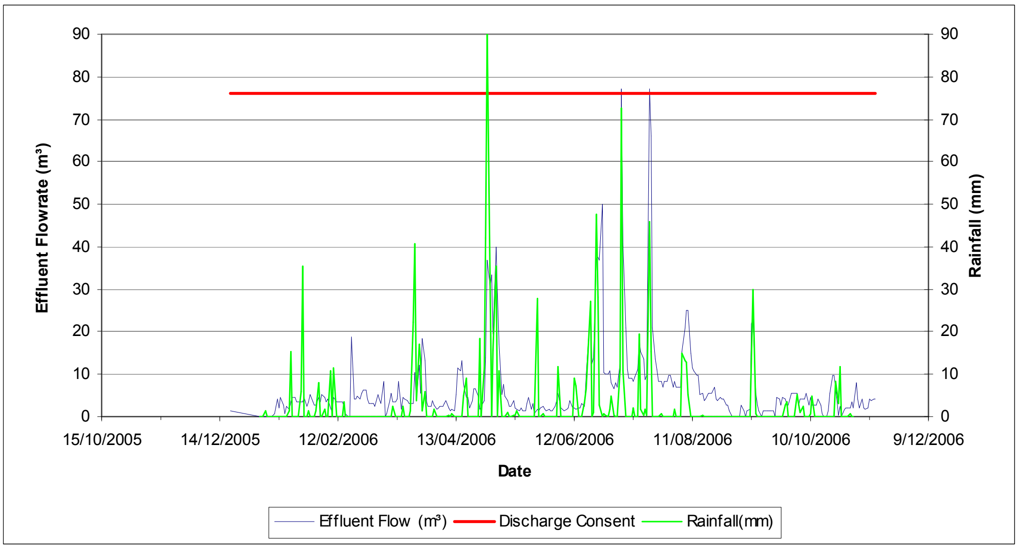

Figure 5. Relationship between effluent flow and rainfall at Waipatiki Beach.

Effluent quality – resource consent conditions require periodic sampling of the wastewater leaving the treatment plant. Analysis undertaken indicates that the system is not performing to its consented level for nitrogen and phosphorus removal. Table 3 shows the predicted values of the system compared against 2 samples taken over 2006.

Table 3. Wastewater analyses from the Waipatiki Beach wastewater treatment plant.

	Expected[5]	28/2/06[6]	16/10/06	23/02/07
Biochemical Oxygen Demand (BOD) g/m^3	<30	2	2	8.5
Total Suspended Solids (TSS) g/m^3	<30	3	2	7
Nitrogen – Nitrate mg/L	<20	58	26.7	64
Nitrogen – Total Kjeldahl mg/L	N/A	2	4	4
Total Nitrogen (TN) g/m^3	<20	60	31	68
Total Phosphorus (TP) g/m^3	<7	8.72	4.72	N/A
Faecal Coliforms cfu/100ml	<10000	4100	760	130

All parameters are well within the expected values except nitrogen. While a high degree of nitrification is being achieved, there is little denitrification. This is potentially a result of the earlier samples being taken during the start up phase of the treatment plant and during low inflow conditions.

It should be noted that the treatment plant was not set up to achieve denitrification. However, it does appear to be being achieved some degree of denitrification as the total nitrogen concentration discharged is lower than that expected for influent.

WHAT HAS BEEN LEARNT

HDC

The initial aim has been achieved; being an improvement to the environment at Waipatiki by installing a community wastewater treatment scheme.

Consultation was successful as a result of involving members of the local Marae and making an effort to keep the residents up to date with progress on the scheme. Consultation also extended to having a good relationship with land owners, both over which reticulation passes and also the discharge areas (Pan Pac). Pan Pac have been extremely cooperative and a willing participant, despite the system potentially being an inconvenience at certain times of the plantation rotation.

One aspect of consultation that could have been better was the decision on the location of the treatment plant. Originally it was intended to construct the treatment plant close to the community, where the effluent from at least some of the properties could flow by gravity flow. This caused some outrage due to their perception of the visual aesthetics. Based on community preference the treatment plant was moved, however this preference may have been bias by those that 'shout loudest'. This decision ultimately added extra costs to the project.

The project was "design, build, operate". Insufficient time was allowed between the design and build portions to allow for the resource consenting process. This didn't have a major impact on the final outcome of the project, but potentially could have. In future it may be

[5] Values taken from GPF 2004 'Waipatiki Beach Sewage Discharge to Land and Discharge to Air -Resource Consent Application and Assessment of Environmental Effects'
[6] Sample taken only two weeks after commissioning with very few houses connected.

beneficial base the design more around the consent, rather than having to juggle the consent to meet a particular design. This would provide far greater certainty with the design.

HBRC

Not all community residents acknowledged their systems were having no effect. One existing lot owner upgraded there own system to a secondary treatment standard. This is likely to have worked in favour of the move to a reticulated system as lot owners could not use the excuse that they had already invested in better treatment systems. Addressing community upgrades before individuals invest themselves is beneficial to community consensus on upgrades.

HBRC was already in consultation with HDC about reticulation when the developer submitted the subdivision consent. This created an opportunity and also strengthened Council's case for reticulation of the whole community. The assistance of a third party can be a beneficial driver to convince the community for the need to upgrade.

The developer was encouraged to make a submission to the annual plan, requesting HBRC contribute towards the cost of reticulating the whole community, including the new subdivision. Council agreed to this in the way of an interest free loan. It would have been easier to get community buy in if this amount was more. Possibly the community should have been more active in the annual plan process.

The resource consent has requirements for monitoring the discharge, including daily meter readings and quarterly sample analysis. The flow of this information back to HBRC has not been adequate to date. Refinement of the consent requirement is needed.

Innoflow

Community involvement throughout the project is essential; as it can be vital and can make for smooth sailing especially when work is required on private properties.

Communication with the client and clients engineer was also very important, enabling any changes to be quickly discussed and agreed with in a timely manner.

The approach of Innoflow and HDC was to let the community decide the location of the treatment plant. The flexibility of the small diameter effluent sewer and packed bed reactor treatment plant meant that numerous options were available to the community.

Consideration of stormwater infiltration is essential when retrofitting into an existing community. Whilst systems are designed for watertightness and tested before completion, it is very difficult to discount infiltration within the older gravity pipes upstream of the new connections. In future, we suggest that more emphasis be placed on examining stormwater ingress and Councils allow sufficient funds to test or install equipment to readily detect infiltration problems.

GPF

Community involvement at an early stage has been critical to the successful installation of a reticulated sewer at Waipatiki. The consultation should also extend to the project team at large, including the design engineers and project management consultants. This enables all parties to be aware of outstanding issues and saves on duplication of work.

The development and management of design, build and operate contracts/tenders can be difficult to manage when the community and design outcomes are not known at an early stage. While ultimately a successful system was developed, uncertainly with design parameters made it difficult to evaluate tenders, especially the management component. This also created some uncertainty for the resource consent process.

It is essential that the 'project team' work closely together from planning to design and installation. This relationship helps to avoid confusion when there are changes in design parameters, which can lead to debates regarding fees and responsibilities.

SUMMARY

The experience of the parties involved during the wastewater upgrade at Waipatiki Beach underlined the importance of consultation at all stages of the process. Consultation was seen as an important step in obtaining the community's needs and views about the proposed upgrade, as well as obtaining access for installation and discharge over private lands and to insure that all parties are working together towards a common goal.

The experience also demonstrated that all communities are unique in their needs for a wastewater system. It was important for Waipatiki Beach that the installed system was able to function under varying flows and well as provide an opportunity for the community's population to grow. These needs also had to be reflected in the resource consent conditions and agreements with council.

While the process of fine tunning the wastewater treatment and consent process is still ongoing we are confident that the system will meet the needs of the Waipatiki Beach community now and in the future

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