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Infrastructure Cook Islands

Rarotonga and Aitutaki Landfills

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April 2018

This report has been prepared following an assignment by Adrian Mitchell and Brett Way in March 2018. This report should be used in conjunction with other reports and information and does not necessarily reflect the views of Local Government New Zealand or the Ministry of Foreign Affairs and Trade.

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Contents

Introduction

This report includes a number of recommended actions, which are considered necessary to achieve the following:

- Practical, achievable and sustainable minimisation of the environmental impact of ongoing landfill and septage treatment operations in the Cook Islands context.
- Optimisation of landfill capacity at the Rarotonga Landfill and thus maximum deferment of capital investment in future waste disposal facilities.
- A return of the Aitutaki Landfill to a condition such that the asset value is recovered and future operational practice serves to ensure asset protection.
- A brief discussion of future residual waste disposal in the Cook Islands.

While the intent of the review was to focus primarily on landfill management, this report also addresses operation of the septage treatment plants and, to a limited extent, waste diversion and residential waste collection. The rationale for the inclusion of septage treatment and waste collection is:

- Staff at both Aitutaki and Rarotonga facilities are responsible for both landfill and septage treatment operations. Staff operational practices, training and succession planning should logically incorporate both landfill and septage treatment.
- Both Rarotonga and Aitutaki waste facilities incorporate domestic rubbish and recycling reception and processing.
- ICI is currently considering changes to its' household rubbish and recycling collection systems on Rarotonga.
- Practical and cost effective diversion of waste from landfill will prolong the asset life.
- Discussion with ICI staff.

Landfills – Asset condition and current practice

Rarotonga Landfill

The original landfill operating processes, specified in the Maunsell Ltd Management Plan, have been progressively abandoned or significantly amended. There are a number of understandable reasons for this including complexity of operation, damage to infrastructure, changes to available operating plant, financial restraints, staff changes and training.

With rehabilitation works, the adoption of suitable operating practices, and the use of suitable plant, the life of the Rarotonga landfill can be extended well beyond the 2020 completion date anticipated in the original Maunsell design. This would defer the need for capital expenditure for replacement waste disposal facilities.

Rehabilitation work will not necessarily require significant "off-island" expenditure, but will require commitment of staff and plant time, purchase of some materials, sourcing of clay cover (neighbour quarry overburden is ideal), and some technical supervision during rehabilitation. Rehabilitation works are described further below.

Landfill liner

It can be assumed that the integrity of the liner, originally constructed and now for the most part buried, has retained its' integrity. Liner exposed along the eastern (quarry) side of the landfill shows deterioration, however this is likely due to exposure of this section to the elements and repairs can be carried out during rehabilitation works.

Lining on the southern (old quarry face) side has not been extended as fill has progressed beyond the height of the original liner. Due to the height of rubbish already placed over this area, and the original liner acting to capture leachate migrating at the rock /fill interface, it appears practical instead to place a drainage medium between compacted rubbish and the rock face to facilitate leachate flow to the lined section below.

Landfilling progression, intermediate cover and stormwater control

The intent of the original progressive filling of the landfill was to minimise contamination of rainwater within the landfill footprint staged filling and the use of intermediate cover.

Currently the whole of the landfill footprint is effectively exposed rubbish resulting in all rainfall within this footprint becoming contaminated (leachate). This contaminated water is then passing through the rubbish to the underlying leachate collection system or passing over the surface of the rubbish to discharge into what was originally the clean stormwater retention pond. It is estimated that the peak flow of leachate thus generated approaches 12 litres per second as opposed to the design flow of 1 litre per second (Maunsell).

A retrofitted 100mm PVC pipe has been installed in the storm water pond to direct this contaminated water towards the septage receiving point and thus into the primary septage treatment pond.

Leachate collection, recirculation and treatment system

The designed leachate system was intended to:

- Minimise the active landfill area and thus the volume of leachate produced (design flow of 1 litre per second)
- Capture the leachate and direct to the leachate pump station
- From the leachate pump station, pump 80% of this leachate back through the landfill via a distribution field to encourage rapid decomposition of buried refuse (resulting in optimum landfill space usage)
- Pump 20 per cent of the leachate to the secondary septage pond
- Avoid leachate escaping the site to clean water collection systems

As noted earlier the whole of the landfill footprint is effectively active, and the leachate volumes produced are considerable with some flow bypassing the leachate pump station directly to the primary septage pond.

The leachate pump station is not operating according to design (due to a combination of complexity of design and failures of pumps and automated pump switches). Following rainfall, leachate entering the leachate pump station was travelling through the overflow pipe of the pump station and surcharging through the overflow manhole cover, over ground and into the septage receiving area.

The design recirculation of 80 per cent leachate back through the landfill and the direction of the remaining leachate to the secondary septage pond is not taking place. *Note that recirculation under current practices is unnecessary, but may be beneficial once intermediate and final cover is in place*

Compaction

Effective compaction is essential to extend the life of the landfill as much as possible and defer the capital expenditure of a replacement waste disposal facility.

Given the nature of rubbish received at this site, target compaction rates for the Rarotonga Landfill may achieve a density of up to 800kg per cubic metre of waste deposited. Thus, an annual volume of 1800 tonnes (as estimated in Tonkin + Taylor report) would utilise 2250 cubic metres of landfill space (ignoring space consumed by cover material).

Given the current mix of baled and loosely placed rubbish at the site, it is not possible to determine actual current density, however an educated guess would suggest that overall density achieved is closer to 400kg per cubic metre resulting in an annual consumption of 4000 cubic metres of landfill capacity.

With the rider that assumed densities are estimates rather than accurate measures, effective compaction can then be seen to offer roughly a 40 per cent extension of the remaining landfill life. At an estimated $100 per tonne capital cost of landfill space (Tonkin + Taylor report), each additional year of landfill life achieved through greater compaction densities offers a theoretical potential capex deferment of $180,000.

Actual available landfill life cannot be accurately determined until rehabilitation works have been completed. Following rehabilitation a site topographical survey will accurately determine the remaining fill area and this, coupled with density testing, will provide an accurate forecast of the remaining landfill life.

A rough estimate would suggest that with effective compaction, at least a further 10 years of landfill life can be achieved.

Given the estimated capex savings achieved for every year the life of the landfill is extended, the 11-year period needed to find and commission the current landfill, and anticipated difficulties in establishing a replacement landfill or alternative waste disposal system, the rehabilitation of the site and establishment of a new operating regime is strongly recommended.

Compaction methodology

The original Maunsell Management Plan specified a 7.5 tonne towed “Wedge Foot” Roller to compact rubbish although this system appears to have been abandoned at an early stage (probably due to the “clogging” of the roller feet, and the need for a dozer to tow the roller being difficult to justify given the relatively small volume of rubbish received).

The current compaction methodology is the use of a baler at the waste reception area (baler also used to bale recycled plastics), the transport of the bales by bobcat or loader to the landfill (100 to 150m distant), and the placing/stacking of these bales. In addition to the baled rubbish, some material is delivered directly to the landfill.

This bale system (still used in some landfills today) appears logical given the presence of the recycling baler on site, the nature of waste received at the site, and the relatively small volumes of waste received. However, the use of balers for landfilling is only effective if bales can be progressively placed in even layers, and voids between the bales are kept to the absolute minimum.

An alternative method of compaction would be a smaller purpose built landfill compactor (eg CAT 816F). Such a compactor could be used to both compact existing waste in the landfill and achieve optimum compaction for the remainder of the landfill life. Landfill compactors are designed to achieve maximum compaction, are fitted with push blades for the moving and placing of waste, are robust and therefore less prone to breakdown or excessive maintenance costs.

While the capital cost of a dedicated landfill compactor may appear excessive at first glance, the savings available through deferment of landfill replacement capex must be considered. A second hand unit at significantly lower purchase price should be considered, given the low operating hours needed at the site.

In summary, both a well operated baled waste landfill, or a landfill using a dedicated landfill compactor will extend the landfill life well beyond what is currently likely. A dedicated landfill compactor will achieve greater overall compaction than a bale system, however requires investment which may be difficult to justify, given the small volume of waste received.

Tyres

A number of tyres were visible within the landfill. Tyres are unique in landfill operation in that their shape allows them to migrate to the surface of the landfill over time. Tyres can appear at the finished landfill surface years after the date of original landfilling.

Tyres received at Rarotonga landfill should be stockpiled until sufficient are accumulated for cutting into segments (some tyres already cut at the wall/tread interface were observed on site suggesting that appropriate machinery to cut tyres exists on Rarotonga).

It is unlikely that a market for recycling tyres can be found.

Recommended rehabilitation of Rarotonga Landfill

The following actions are recommended:

- Establish the location and levels of landfill liner edge along the northern and western edge by survey based on Maunsell Ltd. "As built" drawings or through potholing.
- Using an excavator (ideally over 25 tonne), remove all existing rubbish currently above the original northern, western and eastern liner levels from a strip approximately 20mW along landfill perimeter until liner edge exposed (using care to minimise damage to liner).
- Removed rubbish to be temporarily placed in centre of landfill footprint
- Compact exposed rubbish along 20m wide perimeter (using landfill compactor if purchased)
- Place and compact excavated rubbish along the 20mw perimeter in lifts (eg 300mm) to form final profile (I.e. the placed and compacted rubbish forms the designed finished fill gradient). Tests may be carried out at intervals to determine compaction densities achieved.
- As the rubbish is placed and compacted to achieve final gradients around the perimeter, place and compact the final 600mm clay cap in lifts sufficient to achieve optimum density. Clay compaction is typically achieved by roller on horizontal lifts, with final slope finished by excavator "clean-up" bucket. Note that selected clay overburden from adjacent quarry would be suitable for the cap.
- Level and compact remainder of rubbish in landfill within the area bounded by completed side slopes.
- Trench within compacted rubbish and install leachate re-circulation field as per original Maunsell drawings, connect to recirculation pipe, repair break in leachate circulation pipe and test. Note that connection between pipe at south/eastern side of the landfill, to start of recirculation field, is to be surface laid.
- Create internal access road to tipping face using quarry materials (eg crusher run or quarry forkings subject to best price) or mix of crushed glass and quarry material.
- Reinstate stormwater retention pond at western side of landfill and form perimeter stormwater drains to discharge into retention pond. Note that simple silt traps will be required until grass is established.

- Grass all completed slopes as soon as possible.
- Following grass strike, line surface drains with geotextile and rip rap (selected rock) to prevent erosion, monitor and remove temporary silt traps.
- When comfortable that stormwater retention pond is receiving only clean surface water renew connection to existing drain discharging to lined stream diversion drain. Note that repairs are needed to the invert of the stream diversion.
- Ensure pump in leachate pump station is working (replace with spare pump on site if necessary).
- Rod or flush leachate collection drain via rodding point (if suitable equipment exists on island).
- Clean up site and repair fence

Note that the above actions are necessarily brief "heading" descriptions only, with supplementary action required during rehabilitation (eg areas of intermediate cover and detailed stormwater controls within site, grade and placement of recirculation field)

Operations following rehabilitation

Once rehabilitation is complete:

<u>If using a dedicated landfill compactor</u>

- Restrict active tipping area to minimal area possible (estimated at 6m x 5m) such that the depth of fill placed, when spread over the tipping area, does not exceed 500mm per day and compact using repeated passes of compactor until no further compaction visible.
- Place intermediate cover over all remaining areas and grass to minimise contamination of rainwater and reduce leachate flows.
- Direct all tipping or self-un-loading (compactor trucks) directly to tipping face. Define tip face by daily placement of signs. *Note that depending on tip face access and surface conditions achievable, it may be feasible to direct utility vehicles and non-tipping trucks direct to tip face to limit transfer of rubbish from domestic waste receiving bay.*
- Transfer waste from domestic receiving bay to tip face by truck.
- As leachate flows reduce, periodically inspect inflow to leachate pump station to determine if manual operation (switch on/switch off) is sufficient at peak flows.
- As leachate flows approach design volumes (1l/s) the recirculation of leachate through the landfill will be beneficial in accelerating decomposition (and thus creating further landfill capacity through settlement). At this point, activate recirculation of leachate back through the landfill.
- As leachate becomes more concentrated (due to recirculation), discharge to the primary septage pond may negatively affect the bacterial and algal digestion of septage. If this occurs, residual leachate discharge from the pumping station should be directed to the secondary treatment pond (as per original Maunsell management plan)

If continuing with use of baler

- Adjacent to the rock face, create a new landfill "floor" for the placing of bales. Floor to be at a constant grade to facilitate the even and progressive placing of bales.
- Commencing at the eastern end of the rock face, place bales in regular ranks (lines), "stepping" the ranks to allow for variations in the rock face alignment such that a single even rank is eventually created running the length of the landfill floor (east to west).
- As bales are placed against rock face, fill any voids between rock face and adjacent bale with crushed glass (or similar free draining material).
- Allow sufficient space adjacent to the new front rank of placed bales for an access road for the vehicle used to transport bales (eg bobcat or loader).
- Cover the remainder of the site with intermediate cover and grass so that rainwater can be directed to clean water (and reduce leachate flows).
- As a new rank is completed along the total length of the landfill floor, remove adjacent intermediate cover to form new access road for the next rank.
- Commence next layer ("lift") of bales along the rock face (stepping as above) once sufficient bales have been placed to create a stable platform for the bale transport vehicle.
- As leachate flows reduce, periodically inspect inflow to leachate pump station to determine if manual operation (switch on/switch off) is sufficient at peak flows.
- As leachate flows approach design volumes (1l/s) the recirculation of leachate through the landfill will be beneficial in accelerating decomposition (and thus creating further landfill capacity through settlement). At this point, activate recirculation of leachate back through the landfill.
- As leachate becomes more concentrated (due to recirculation), discharge to the primary septage pond may negatively affect the bacterial and algal digestion of septage. If this occurs, residual leachate discharge from the pumping station should be directed to the secondary treatment pond (as per original Maunsell management plan).

Waste receiving area and conveyor sorting of recycling

The current waste receiving area is adequate for purpose. Repairs were being carried out on the waste receiving bay at the time of visit. This bay appears to drain to the north/west corner. A grated manhole capable of being cleaned by suction truck should be installed at this point to prevent run-off of contaminated liquids to natural ground.

The planned purchase by ICI of a conveyor to provide a more efficient and safer method of sorting recycling should greatly improve the sorting of recycling. The placement and layout of the conveyor should allow for the following:

Feeding the conveyor – this will depend to an extent on how the material is delivered to the waste receiving area (eg partially sorted, loose, or some contained in plastic bags). Assuming the conveyor will be fed by loader or backhoe; options may include a hopper with “gate” control by first operator on the sorting line, or shute with gradient adjustment by first operator to control volume flow.

Layout and Sorting - If recycling anticipated to present with some contained in plastic bags assume the first operator will be tasked with breaking open bags and removing bags to waste receptacle.

The current use of fadges (sacks) to contain sorted materials is appropriate to the size of the operation and the frames used for the fadges can be easily placed adjacent to the conveyor for sorting staff to place the different materials in.

Typically, the end of the conveyor will feed direct to a waste/non-recyclable receptacle; however the nature of the material received will determine whether this is appropriate. If little waste element is received the conveyor may discharge that element of the recycling with the highest volume to minimise handling.

Health and safety

For ergonomic reasons it is probably preferable to have sorting staff “throw” materials to receptacles on the opposite side of the conveyor. This limits the need for the staff to deviate far from the ideal 90-degree elbow bend when sorting and avoid the rotation of upper body.

The height above ground level of the conveyor will be determined by the height of the adjacent receiving receptacles but should not be lower than that required to maintain the 90-degree elbow bend of sorters. If necessary, a platform can be provided for staff (with appropriate barrier to prevent falls).

Health and Safety – further to the ideal height of conveyor mentioned above, care should be taken to avoid potential for entanglement with the conveyor belt or drive. Shielding may be necessary. The use of pierce proof gloves is recommended for staff on sorting line.

Capture of contaminants – recycling materials may contain food or liquids and the belt and floor area will need washing down at intervals. Consideration should be given to a concrete floor beneath the sorting area, draining to a grated manhole capable of being emptied as required by suction truck (as done with baling unit).

It appears that most staff have received tetanus shots.

All staff working at the landfill and septage plant should be tested for Hepatitis B immunity. Staff without immunity should be offered the choice of vaccination or transfer to other duties.

Aitutaki Landfill

The main consideration for the Aitutaki Landfill is the repair to and future protection of exposed landfill liner. Due to the very low volume of waste received at this site, the majority of the surface area of the liner constructed in 2006 is exposed to the elements.

Landfill liner

Areas of the liner have been damaged during cyclone events. It is recommended that repairs to the liner be undertaken as soon as possible and measures put in place to prevent future damage.

Ideally, liner repairs should be carried out by specialist contractors, although it is noted that this will involve significant cost.

Once repairs are completed it is recommended that those areas of exposed liner are protected from UV damage and damage caused by high winds or debris from high winds.

Protection could take the form of a protective layer, the simplest being a layer of soil grassed to prevent erosion should this be achievable. Alternatively, a sacrificial layer of PE weighted down by tyres, with tyres linked and anchored to points around the perimeter.

The volume and nature of waste received at this site does not warrant the use of dedicated compaction plant. Periodic placing and track rolling of waste using an excavator is appropriate.

As landfilling progresses, soils used to create the access route to the floor of the landfill should be progressively removed to preserve landfill capacity.

Currently the entire surface area of the landfill is exposed refuse. Consideration should be given to placing new waste arriving at the site along one side of the landfill sloping upwards to the centre of the landfill. Placing of intermediate cover and grass will then allow 50% of rainfall to be captured and pumped to adjacent ground, without the need for treatment in septage ponds.

Tyres

Whole tyres appear to have been kept out of the Aitutaki Landfill, which is appropriate given that untreated tyres pose problems in landfill operation.

Should it be impractical to otherwise dispose of accumulated tyres, tyres received at the landfill should be stockpiled until sufficient are accumulated for cutting onto segments at least cost and then landfilled.

Asbestos

Asbestos has been stockpiled and covered with polyethylene sheeting at various locations around the site. We understood this stockpiling to be due to concerns regarding the safe handling and disposal of the material.

Failure of the polyethylene coverings has led to asbestos being exposed to the elements, creating the potential for escape of asbestos fibres.

All asbestos on the site should be disposed of in the landfill at the earliest opportunity to minimise the risk of exposure and a protocol established for any further asbestos identified in incoming loads.

Reference to safe asbestos handling and disposal on the worksafe.govt.nz website may be informative, however the following minimum practices should be adopted when dealing with the existing material:

- Personnel undertaking asbestos disposal should wear appropriate face masks, gloves, and ideally, disposable hooded overalls.
- Excavate waste in the landfill to a depth of 1m and of sufficient area to accommodate asbestos material.
- Using a hose set on mist spray (as opposed to high pressure) thoroughly wet down all materials before and during handling.
- Using an excavator with clean-up bucket load asbestos onto tipping truck for transport to disposal area (excavator and truck driver not to exit vehicles during operation).
- Over-excavate area where asbestos has been stockpiled to ensure all material is removed.
- At the disposal point, use excavator to spread tipped asbestos over the excavated area to minimise height taking care not break asbestos sheet unnecessarily (use hoses to keep area well dampened).
- Wash down truck and excavator, ideally so that wash down water enters excavated area.
- Cover asbestos with excavated rubbish and seal with layer of soil to achieve a final cover of 1m depth.
- Remove and double bag protective clothes and masks worn by handlers and dispose of to landfill.
- Cover areas where asbestos has been removed with soil, smooth out and sow grass.
- Record date and location where material is placed in landfill (photographs is sufficient).

Scrap metal

The adopted practice at Aitutaki for diversion of scrap metals delivered by customers appears to be to allow customers to select and place scrap at the designated area. This has resulted in fairly significant contamination of diverted scrap metals, which may compromise the ability to successfully recover and ship this material for recycling.

It is recommended that customers unloading scrap metal area allowed to do so only under supervision of landfill staff, if necessary at the recycling processing area with later transport to scrap storage area by landfill staff.

Septage treatment plants

Overview

The Septage Treatment facilities at both Rarotonga and Aitutaki commissioned in 2006 were designed to meet "best practice". As a result, they incorporate relatively sophisticated operating systems that require the following:

- A sound technical understanding of the various elements of the system;
- Periodic testing and process calibration/adjustments to optimise effective treatment of septage;
- Compliance with extensive maintenance and monitoring schedules;
- Inspections and reporting to Environmental and Health authorities;
- Timely response to system failures or unique events; and
- Holding of a variety of replacement parts and regular (mainly offshore) servicing of pumps.

A comprehensive Management Plan exists for both facilities prepared by Maunsell Limited (consultants).

An apparent shortage of technical skills and the relative isolation of the islands has understandably resulted in the plants not having been operated and maintained in accordance with the original Management Plan with variations made to operational practices, to allow continuing operation.

For the most part, it appears that changes in operational practices adopted have not resulted in the failure of the plant to treat septage effectively while minimising adverse environmental effects. No significant odours (an indicator of effective treatment failure) were detectable at either site during inspections).

A review of both Rarotonga and Aitutaki Septage facilities in 2014 by Fraser Thomas (Consultants) did indicate that the designed effluent irrigation fields of both sites were of insufficient length. It appears practical to extend the irrigation fields at both sites at relatively low cost in accordance with the Fraser Thomas report.

Note: This report is based on observations of both plants within a limited time in March 2018. Conditions, particularly in Rarotonga, may be different in higher visitor loading between April and September or before Christmas when locals apparently often empty septic tanks prior to arrival of family visiting from overseas. There was anecdotal evidence of some odour at these times.

Rarotonga septage treatment

- Abandonment of automated pumping systems and adoption of a full manual operation.
- Very high leachate flows from landfill to septage ponds via leachate pump station, estimated at 11-12 l/s as opposed to design flow of 1 l/s. (discussed in previous landfill section).
- Current practice is to turn the effluent irrigation field pumps on at time of significant rain (during, or after work hours).
- Unclear at if alternating dual pump systems used (ensures back up pump always available).
- Septage receiving pit not discharging to outlet at primary tank centre (probably due to design not allowing for local nature of septage received).
- New 100mm PVC pipe installed discharging septage from pit direct to pond surface at point adjacent. (In theory, this new discharge point leads to uneven migration of sludge throughout primary pond affecting optimal performance and increases pond surface grass growth).
- Water supply to septage receiving area not working resulting in no wash down of area or of delivery vehicles possible.
- Leachate from adjacent landfill is discharging directly to primary septage pond (refer to discussion under landfill operation)
- Pond surface pumps and spray operation (algal zone) not working and pipes disconnected. Note that this system is for use mainly in response to visible changes in algae layer (eg scum or sludge at surface), which may not have occurred.
- Floating grass mat over 50 per cent+ of primary pond compromising algal effectiveness. Regular use of pond dinghy and rake, or floating boom dragged across surface at intervals, may be sufficient to rectify. Note that septage delivery to surface at side of the primary pond rather than to the centre at depth will encourage grass growth.
- Effluent disposal system to northern side of ponds disconnected.
- Effluent disposal system (main disposal field) to South of ponds unable to be inspected due to dense growth. A risk here that effluent may be able to migrate via surface water run-off to stream. Note Fraser Thomas recommendation to extend irrigation field.
- Sand filter prior to effluent discharge has been bypassed, possibly due to difficulty in backflushing sand filter leading to clogging or no local agent to service filter.

Recommended actions – Rarotonga septage treatment:

- Reduce leachate inflows from landfill
- Continue with current manual operation (may consider re-introduction of some basic automated systems following changes)
- Re-establish water supply to septage receiving area.
- Consider extending retrofitted septage discharge pipe (currently discharging to the edge of the primary pond) along the pond floor to the centre of the pond. This could be

undertaken following next de-sludging. (The septage receiving pit would then act as a sump to allow gravels to settle out and be removed to landfill by suction truck as required)

- Service Sand Filter and re-plumb to re-establish effluent flow through filter and enable back washing of filter.
- Remove growth cover from effluent irrigation field, inspect, repair as necessary, and consider extending effluent irrigation field (will require inspection of effluent irrigation field in operation and ability of area to accept larger field).
- Undertake regular removal of floating growth from primary treatment pond using rakes or booms.
- Regularly check sludge depth (purchase simple sludge depth gauge?)
- Consider recovery or purchase of pond de-sludging pump as per original Maunsell proposal for ease of de-sludging procedure (avoids use of other equipment which may damage pond)

Aitutaki septage treatment

- Abandonment of automated pumping systems and adoption of full manual operation.
- Telemetry alert system not operating
- Septage receiving pit not discharging to outlet at primary tank centre (likely due to blockage as in Rarotonga). New pipe installed discharging septage from pit direct to pond surface at point adjacent to receiving point (leads to uneven migration of sludge).
- Water supply to septage receiving area not working meaning no wash down of area or of delivery tanker possible.
- At least one of two mixing and spray operation pumps (algal zone) not working with one intake rose missing. Note that this system is for use mainly in response to visible changes in algae layer (eg scum or sludge at surface) which may not have occurred.
- Floating grass mat over 20 per cent of primary pond compromising algal effectiveness. Note primary pond being dewatered prior to desludging at time of visit.
- Effluent disposal system on access road side of ponds disconnected.
- Effluent disposal system (main disposal field) has had spray nozzles removed probably due to clogging (see sand filter below) with effluent discharging through nozzle holes in pipe.
- A break in effluent pipe due to fire damage not repaired reducing discharge zone by 50 per cent and allowing high volume discharge at pipe break. Note Fraser Thomas recommendation to extend irrigation field.
- Sand filter is used prior to effluent discharge however clean water in backflush tank has been replaced (re-plumbed) with effluent water due to failure in water supply.
- Sand filter servicing (sand replacement or servicing by agent probably not undertaken).

Recommended actions – Aitutaki septage treatment

- Re-establish water supply to septage receiving area and back wash reservoir.
- Service Sand Filter and re-plumb to re-establish effluent flow through filter and back wash operation
- Repair and extend effluent irrigation field as per Fraser Thomas recommendation.
- Undertake regular removal of floating growth from primary treatment pond using rakes or floating booms.
- Regularly check sludge depth (purchase simple sludge depth gauge?)
- Consider purchase of pond de-sludging pump as per original Maunsell proposal for ease of de-sludging procedure (avoids use of other equipment which may damage pond)

Staff training and standard operating procedures

Following rehabilitation of both Rarotonga and Aitutaki Landfills and the adoption of changes to operational practice, training of staff should be undertaken to ensure the following:

- Operational procedures are clearly understood and likely to be followed;
- The asset value of the landfills and septage plants are both protected and optimised (to avoid further rehabilitation works and extend the potential asset life as long as practicable);
- The health and safety of staff; and
- Succession planning and business continuity capability.

The possibility of bringing Cook Island operational staff to New Zealand to undertake training and gain practical experience was considered, however we believe that may not add value given the difference in practices between New Zealand and Cook Island and the relatively unique scale and nature of the Cook Island operations.

Alternatively, it is suggested that a new landfill and septage Operational Management Plan be developed for both sites, including standard operating procedures (SOP's) for the various elements of operations, and this plan forms the basis of a training regime for staff.

In this way, SOP's can then become training "units", with the number of units reflecting the areas of responsibility of staff.

Development of the Operational Management Plan could be undertaken by either consultants or LGNZ representatives with practical "hands on" experience.

Development of training materials (eg power point, certificates) could be undertaken again by either consultants or LGNZ practitioners, with support from ICI.

Actual training could be provided by New Zealand local authority practitioners, if available or funded.

Future waste disposal in the Cook Islands (and possibly other Pacific Island states)

Landfilling as a solution to dealing with waste is being progressively abandoned in many developed and developing countries around the world. The European Commission has adopted the policy of the gradual limitation of the landfilling of municipal solid waste (MSW) in the EU to 10 per cent of MSW by 2030.

In Rarotonga, 11 years were needed to undertake the necessary consultation, selection of a suitable site, gaining of legislative permissions, and design and construction of a new landfill, which at the time of commissioning appeared to have a design life (thankfully conservative) of around 14 years.

Discussion with ICI staff and others suggests that establishing a replacement landfill will be extremely challenging, if possible at all.

While waste minimisation should take priority in addressing the universal challenge of dealing with waste, effective and environmentally sound residual disposal will remain a critical element of waste management for many years to come.

There are number of alternative residual waste disposal methodologies available which have been briefly addressed in the Tonkin + Taylor report. All of these pose significant cost and scale challenges in the Cook Island context, a situation which is likely to mirror that of other Pacific Island states.

It would appear logical therefore, that an off-island residual waste solution should be investigated that avoids these cost and scale challenges while addressing bio-security issues inherent in the cross border transfer of waste (note that cross border transport of municipal solid waste to waste to energy plants does take place in other parts of the world.

For this reason I would suggest that ICI (possibly in consultation with other pacific islands) investigate the longer term possibility of shipping waste to an off-shore, large scale, waste to energy (incineration) facility.

Work has recently commenced in Kwinana, Western Australia on a $400million waste to energy plant capable of receiving 400,000 tonnes of waste annually and generating 40MW of energy. This plant will be commissioned in 2021. A similar plant is proposed for Westport in New Zealand, although this plant is still in the planning stage.

Typically, waste received by these types of plants is compacted and baled near the source of the waste, including the wrapping of the bales in several layers of impervious plastic sheets, ready for transport to the plant.

Lastly, we do understand that there has been some interest expressed in the Cook Islands about a local waste incinerator as a replacement for the current landfill. We would advise a very cautious approach be taken in pursuing this for the following reasons:

- The volume of waste generated would probably be insufficient for the operation of a plant capable of meeting acceptable emission standards.
- In the unlikely event that acceptable emission standards would be achievable, the expense would likely be prohibitive.
- An incinerator on Rarotonga would typically generate approximately 20 per cent of the feedstock in “ash”, which would still require disposal.