MOANATAIARI SUBDIVISION, THAMES, SCOPING REPORT - HISTORICAL CONTAMINATION REVIEW

PREPARED FOR:
Environment Waikato

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Contaminated Site Investigation

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REPORT: MOANATAIARI SCOPING REPORT

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CONTAMINATED SITE INVESTIGATION

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0.0 Executive Summary

Purpose	A potential contamination issue was brought to the attention of Environment Waikato contaminated land staff with the publication of a Ministry for the Environment Report. This report stated that the Moanataiari subdivision in Thames had been reclaimed from the sea with mullock and mine tailings. CSI were engaged by Environment Waikato to investigate: ▪ The composition of the infill; and ▪ The potential risk to human health and the environment.
Current Site Status	Moanataiari is located on the northern outskirts of Thames. The subdivision is bounded to the north and west by a seawall, south by Burke Street and to the east by Queen Street. The subdivision currently consists of 212 residential properties, a school, a child care centre, an engineering firm and an electrical substation and depot. To the north is a beach. To the south east is a closed municipal landfill and industrial land with sea beyond. To the south east is industrial land with residential land beyond.
Historical Photo Review	**Aerial Photos** An aerial photo from 1940 shows that over two thirds of the land has been infilled from east to west. An aerial photo from 1985 shows landfilling and development as complete. **Oblique Photos** A 1965 photo shows the area within the seawall as being totally infilled except for two small areas in the north west and south west. Development has occurred westwards up to Moanataiari Street. Hummocky land north and adjacent to Burke Street appears to be 'waste'. Photos from 1967 and 1968 are very similar. A 1972 photo shows infilling as complete and development as far west as Centennial Drive. A 1986 photo shows development as complete except for one or two residential lots. **Photos** Photos from the decade 1860 document mining in the foothills behind Moanataiari and associated batteries on the coastal margin or on land only recently reclaimed. A photo from 1877 shows mullock or tailing piles on reclaimed land west of Tararu Road. A second photo from 1877 shows a battery in the Moanataiari Creek valley and a shute coming out of the battery and ending in the Moanataiari Creek. Photos from the decade 1890 clearly show mullock and tailing piles around the batteries and conveyors from the foothills ending on the foreshore. The photos also document a larger foreshore occupied by a large number of buildings. Photos from the decade 1900 show extensive reclamation north of the 'Burke Street wharf'. A undated photo which has the title 'Dredging for gold' shows the extent and type of reclamation within the seawalls.
Thames Coromandel District Council Review	**File** An internal memo states that the reclamation was extensively infilled with mullock or tailings. Minutes from the Thames Flood Protection Project in 1995 documents that the site was the towns rubbish dump from 1965 to 1970. **Library** The book titled 'The First 100 Years' by W Kelly states '*the considerable mullock tips from the Moanataiari Tunnel and battery waste were levelled to form the start of the present Moanataiari subdivision'*. **Other** Staff discovered the following: councils minutes from 1967 documenting the 'town rubbish dump' at Moanataiari Flats; correspondence from the main infilling contractor, Ken Verran, dated 1967, implying a reuse dump to the north of the Burke Street Wharf.

Continued on following page.

Environment Waikato Review	File A letter from the Chief Executive Officer of Thames Coromandel District Council dated 1997 outlines the development of the subdivision; built by Thames Coromandel District Council between 1950 and 1972; subdivision works completed in 1972; houses constructed in the early 1970's. Report An internal report by Dr Nick Kim titled *Trace Elements in Sediments of the Lower Coast of the Firth of Thames* dated May 2007 documents that sediment around the base of the seawall is highly enriched with mercury that the area could be listed as contaminated. Dr Kim states that the most likely source of these elevations is mine tailings. Other The consent application for the closed municipal landfill to the south of Burke Street documents elevations of mercury in sediment samples around the seawall above recommend guideline values.
Other Information Review	Online Newspapers An article from the Thames Star in 1888 documents the use of ash and mullock for footpath construction. Two articles from the Thames Star in the decade 1890 document a tip in Moanataiari and mullock and tailings on the Moanataiari foreshore. Historical Maps A map from 1910 shows the Thames coastline closely following the same path as Queen Street today.
Consultation	A 2005 paper from Mr. John Isdale, a Thames historian, stated that a huge amount of tailings and mullock was used as infill for Moanataiari. He also states that there was a refuse tip in the reclamation adjacent to Burke Street. The owner of the contracting company responsible for infilling in the 1960's, Verran Brother, recalls municipal waste being dumped in the infill. The surveyor who did the initial measurements and an engineer who designed the street both recall a rubbish dump.
Potential Hazard	Information clearly documents that mullock and mine tailings and municipal waste were used as reclamation fill for Moanataiari. The potential hazards sources associated with these activities are mainly considered to be heavy metals and hydrocarbons.
Risk Assessment	The potential hazard sources are considered to be heavy metals and hydrocarbons. The potential receptors within Moanataiari or immediately adjacent are considered to be: organisms within the ground; people or persons living, working or visiting; pets and other land based fauna; flora and the built environment; and the adjacent marine environment. Wider potential receptors are people or persons that have consumed impacted marine life. The risk to all receptors except the marine environment is based on qualitative data and therefore the risk is only perceived. The perceived risk to: ground (organisms that depend on) is high; residents is high east of Tararu Road and medium west of Tararu Road; child care children and staff is high; school children and staff is medium; maintenance workers is medium; tourists and recreational users is low; pets is medium; fauna and flora is low; and the built environment is low. The risk to the marine environment is based on qualitative date and is therefore an actual risk. The actual risk to the marine environment is high.
Recommendation	▪ That a strategy is developed in conjunction with Thames Coromandel District Council to address: notification of land owners and occupiers; quantification of high risks; and risk communication should any high risk be quantified. ▪ That all parcels of land are listed on the Selected Land Use; and ▪ That further investigations are undertaken on the other land parcels identified in this report as having possibly been impacted by hazardous substances.

1.0 INTRODUCTION

1.1 Gold was discovered in the Thames foothills in the 1860's with the most significant discoveries in the foothills immediately behind Moanataiari at the mouths of the Kuranui, Moanataiari and Waiotahi Streams. Gold bearing ore was more than likely brought to one of the seven stamper batteries[1] erected along this part of the Thames foreshore. Crushing the ore was performed by alternatively lifting and dropping a series of heavy iron stamps onto the ore. The crushed ore was then washed over amalgamating tables (covered with copper or Muntz[2] plates) to remove the gold. Amalgamating tables contain a thin film of mercury which traps gold or silver as a putty like amalgam. The amalgam was then heated in a furnace to remove the gold and mercury. A problem with this process was that it was only reasonably efficient at removing gold from high grade ore containing free gold and very inefficient where the gold was fine grade or mineralised. With fine gold approximately 50 percent of the gold or silver was lost in the tailings[3]. In the first few years the proportion of gold to rock was extremely high and there was very little waste. By 1871 most of the exceptionally rich patches of ore had been depleted and as such significant amounts of rock were required to produce a profit. This in turn resulted in increased volumes of mullock[4] and tailings. Even though the Moanataiari Mine was the third largest producer its main claim to fame was the Moanataiari Tunnel, an exceptionally long drive which for over 30 years served as the main artery of the goldfield with the most profitable different mines passing their ore into it and subsequently to one of the stamper batteries. The Ministry for the Environment's 2001 State of the Environment Report documents that the mullock and tailings waste were used to form the Moanataiari subdivision.

1.2 Contaminated Site Investigations was appointed by Environment Waikato to investigate:

- The composition of the infill used in Moanataiari; and
- The potential risk to human health and the environment from the fill material.

1.3 The aim of this report is to provide Environment Waikato with a Preliminary Site Investigation Report and risk assessment completed in general accordance with the Ministry for the Environment's *Contaminated Land Management Guidelines* identifying if any fill is a potential hazard source with a complete pathway to people and or flora and fauna. The information source to be used shall include but not be limited to:

- Thames Coromandel District Council files, Publications, Photographs and Maps;
- Environment Waikato Files, Publications, Photographs and Maps;
- Newspapers; and
- Consultation with people or persons with knowledge or experience of mine history and or this Thames reclamation.

1.4 Attention is drawn to the report conditions shown in Appendix L.

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[1] A stamper battery refers to the machinery which crushes ore by the alternate lifting and dropping of heavy iron stamps. In New Zealand the term also refers to the buildings which contained this machinery and other downstream processes involved in gold – amalgamation and smelting.

[2] 60 percent copper and 40 percent zinc alloy

[3] Tailings – finely crushed waste material containing quartz and heavy metals.

[4] Mullock – an old Cornish term used to describe waste rock.

2.0 STATUS

2.1 Identification

2.1.1 Moanataiari is a subdivision of Thames located on the foreshore. It is the last suburb when heading north along State Highway 25. The subdivision is sandwiched between the Thames foothills to the east and the Firth of Thames to the west. Refer Figure 1.

2.1.2 For the purpose of this report the term 'Moanataiari Subdivision' refers to the area of land which has been reclaimed from the Frith of Thames for residential accommodation, local amenities and industry. That is the land bounded to the north and west by Fergusson Drive with the seawall beyond, to the south by Burke Street and to the east by Queen Street (State Highway 25). Refer Figure 2.

2.2 Description

2.2.1 The Moanataiari Subdivision is comprised primarily of residential accommodation with a school, a child care centre and two industrial properties also present. In total there are 212 residential properties. Table 1 provides the number of residential properties on each street within the subdivision. For a full list of each individual's site details as of June 2010 refer to Appendix A.

Table 1: Street Name and Number of Residential Properties

STREET NAME - EAST TO WEST	NUMBER OF HOUSES
Fergusson Drive	16
Centennial Avenue	28
Moanataiari Street	21
Kuranui Street	25
Tararu Road	28
Owen Street	0
Queen Street	1
Fergusson Drive	22
STREET NAME - SOUTH TO NORTH	**NUMBER OF HOUSES**
Burke Street	11
Margaret Place	12
Haven Street	6
Coromandel Street	7
Ensor Street	24
Dickson Street	3
Fergusson Drive	8

2.2.2 The average section size is approximately 0.07 hectares. The majority of sections are rectangular in shape expect along the eastern side of Fergusson Drive where they are predominantly square and Margret Place and the western side of Ensor Street where they are irregular. The majority of sections run from east to west with the exception of the northern side of Fergusson Drive where they run north to south. The topography of all sections is predominantly flat with the exception of the sections along Queen Street and the south western side of Fergusson Drive which gently slope to the west.

2.2.3 The subdivision can be grouped into three areas based on when development occurred as noted by the average house age:

- East of Tararu Road – pre 1914;
- Tararu Road to Kuranui Street – 1950's to 1960's; and
- Kuranui west – 1970's.

2.2.4 Based on the average household number of 2.6[5] the number of people living in the Moanataiari Subdivision is estimated to be 572 persons. It is not known how many of these residents consume home grown produce including fruit. The current estimation from the 'Regional Waste and Contaminated Land Forum'[6] is that at least one in three New Zealand residential properties have a vegetable garden. However, as Moanataiari is located in the coastal growing margin the growing of produce may be difficult due to the influence of sea salt.

2.2.5 The 'Moanataiari School' is located on a large block of land bounded by Moanataiari Street to the east, Kuranui Road to the west, Burke Street to the south and Ensor Street to the north. The block of land is approximately 2 hectares in size. According to the Ministry for Education Review Report for Moanataiari School the roll in November 2009 was 81. The site is predominantly grassed. No vegetable gardens or fruit trees were observed. The topography of the site is flat however, at the perimeter the ground slopes down sharply by approximately one metre to the footpath.

2.2.6 The child care facility is the 'Thames Early Childhood Education Centre' which is located at 102 Tararu Street. The facility occupies land on the southern corner of Tararu Road and Haven Street. According to the Ministry for Education Review Report the roll in November 2009 was 63 children under the age of five. This report indicates that the facility is licensed to care for up to 45 preschool aged children at any one time of which 13 can be under 2 years of age. The facility occupies one building has several grassed play areas situated around the building. No vegetable gardens or fruit trees were observed. The site slopes gently to the west. Refer Figure 3.

2.2.7 The industrial company A & G Price occupy nearly all of the block of land bounded by Burke Street to the south, Tararu Road to the east, Haven Street to the North and Owen Street to the east. The 'Thames Early Childhood Education Centre' occupies the remainder of this block. Buildings are located along the length of Burke Street and in the south western and eastern corners. The reminder of the site is covered with asphalt or concrete. A residential house is located to the east of the child care centre on Haven Street and is surrounded by grass with a hedge along the southern and eastern boundaries. It is unknown if this house is occupied. Refer Figure 4.

[5] Statistics New Zealand 2006 Census.

[6] A forum established by regional council waste officers to share information on waste matters. This information was provided by a forum member, Michelle Begbie of Environment Waikato.

2.2.8 An electrical substation and depot occupy land on the western corner of Kuranui and Burke Street. A building is located in the centre of the site to the south with asphalt to the east and north and grass to the south and west. The electrical capacitors are located north of the building on asphalt hardstand. The depot is located further north. A building is present in the north western corner adjacent to Kuranui Road. This part of the site is covered with basecoarse metal. The entire site is flat. Refer Figure 5.

2.2.9 The seawall on the northern and western boundaries was upgraded in 1997 by making it higher and impermeable and by improving stormwater which had previously ponded behind the wall. The wall was made higher by erecting a timber parapet and waterproofed by lining with local clay. A pump station was built adjacent to the wall on the western side of Fergusson Drive with stormwater collected and pumped into the Firth. Kuranui Beach was also reshaped and a dune and swale built to the north of Fergusson Drive to divert stormwater.

2.2.10 The subdivision gently slopes to the west. No soil staining, unusual odour or vegetation stress was observed by CSI staff during a site walkover in June 2010.

2.3 Surrounding Environment

2.3.1 Beyond the western seawall is the Firth of Thames. In the south western corner are the historical remains of the 'Burke Street Wharf'.

2.3.2 Beyond the northern seawall is the Firth of Thames in the west and Kuranui Beach in the east. Further beyond Kuranui Beach is a reserve with State Highway 25 beyond and residential houses further beyond.

2.3.3 Beyond Queen Street, from north to south, are: residential properties; native reserve containing the Kuranui Battery remains, the Long Drive Mine and the Moanataiari Tunnel; a depot and quarry; Moanataiari Creek; native reserve containing Caledonian Mine, the Tookey Shaft, a mine museum, the Golden Mine, the Caledonian Battery remains and the Manakau Mine; and lastly Waiotahi Creek.

2.3.4 Beyond Burke Street, from west to east are: a stop bank reserve which ends opposite Kuranui Street; industrial land from Kuranui Street to Beach Street; A & G Price from Beach Street to Brown Street; and lastly reserve land between Brown Street and Queen Street. Beyond the stop bank is Waiotahi Creek. Further beyond is the old municipal landfill which occupies land from the Firth of Thames until Moanataiari Street, and industrial land from Moanataiari Street to Beach Street. Beyond A & G Price are residential properties.

2.3.5 Thames town centre is located approximately one kilometre to the south.

2.4 Thames Historical Overview

2.4.1 With the discovery of gold at the mouths of the Kuranui, Moanataiari and Waiotahi Streams the town of Grahamstown emerged on costal land immediately to the south of these streams. At the same time a kilometre to the south the town of Shortland was also emerging on coastal land as a result of mineral discoveries in the adjacent foothills. In 1874 the towns merged and Thames was born.

2.4.2 Many people migrated to Thames and at its gold rush peak it was arguably the largest city in New Zealand with an estimated 18,000 inhabitants. However, as the gold began to diminish at the turn of the century so did the number of inhabitants. By 1910 the population had shrunk to well under 10,000 inhabitants.

2.4.3 Thames is still the biggest town on the Coromandel. The population in the 2006 census was 6,756. This census also determined that the majority of residents work in tourism and locally owned businesses servicing the local farming community.

3.0 HISTORICAL PHOTO REVIEW

3.1 Aerial Photo Review

3.1.1 Reproductions of aerial photos are included in this report as SK01 (1944) and SK02 (1985) and are located in Appendix C.

3.1.2 The 1940 (SK01) reproduction shows the boundary of the Moanataiari subdivision as being very close to today's boundary. The Burke Street causeway and wharf and western sea wall are present in what appears to be the same location as today. The northern seawall appears to be in the same location as today but at Kuranui Bay the wall protrudes more to the north. The following roads are present: Queen Street (State Highway 25); Tararu Road; Coromandel Street; Haven Street; and Burke Street. Structures are present east of Tararu Road and South of Coromandel Street. No structures are present to the north east beyond Coromandel Road and west of Tararu Road. The dark patch to the west of Coromandel Road implies infilling has occurred up to two thirds along the seawall's length. The lighter patches within this dark patch to the north are more than likely non vegetated infill or possibly non contoured 'hummocky' fill. The lighter patches in the darker patch to the south could either be sea or non vegetated fill. The lighter patch between the seawall and the dark patch is more than likely seawater. Beyond the seawall to the south, immediately adjacent, is a small dark patch indicating infilling. Beyond is sea. Development is present beyond Burke Street. To the north Kuranui Bay is similar to today's outline. To the west are the foothills of Thames.

3.1.3 The 1985 (SK02) reproduction is vastly different to the 1940 reproduction. The land within the seawall has been completely infilled and developed. Development appears to be completed. All roads are present and all parcels of land appear to have been built on. The school is clearly visible. The surroundings environs are similar with the only real change infilling of the land to the south beyond the Burke Street causeway.

3.2 Oblique Aerial Photo Review

3.2.1 Reproductions of oblique aerial photos are included in this report as SK03 to SK05 and are located in Appendix D.

3.2.2 The 1965 (SK03) reproduction shows the area within the seawall as totally infilled except for patches of water in the north western corner and the south western corner. Residential infilling has occurred as far west as Moanataiari Street and a row north of Ensor Street and east of Moanataiari Street. However, Moanataiari Street is only constructed north of Ensor Street. The school block is bare grassed land with a structure in the north eastern corner. Magnification of this block shows that it is a rugby ground. The A&G Price Buildings north of Burke Street are prominent. All of the roads in this area have been sealed except for Burke Street west of Beach Road which appears to be a dirt causeway. The land west of development is predominantly vegetated with mangroves except for: bare soil south of Ensor Street and west of Moanataiari Street; hummocky land immediately to the south; and hummocky land adjacent to the causeway. This hummocky land appears to be recent infill. Patches of water may also be present. The land immediately beyond the causeway is Mangroves. The quarry to the east of Queen Street is beginning to be cut into the hill side.

3.2.3 The 1967 (SK04) reproduction is very similar to the 1965 reproduction. Residential development appears to be the same and the school is still bare. The major difference is that more vegetations and contouring has been undertaken west of Moanataiari Street. The only vegetation left is a rectangular strip of mangroves adjacent to the western seawall. This photo clearly shows the hummocky infill in the south western corner and a pocket of water between the hummocky land and the mangrove strip.

3.2.4 The 1968 (SK05) reproduction shows infilling complete except for in the north western corner and contouring complete except for in the south western corner. All undeveloped infill is bare land except for the uncontoured land which is vegetated. Roading has progressed, with Moanataiari Street, and Centennial Avenue completed and Ensor Street to the west beyond Centennial Avenue and Margret Place completed. Residential development still appears to be the same except one house has been built on Centennial Avenue. The surrounding environs are similar except infilling is occurring beyond the causeway.

3.2.5 The 1972 (SK06) reproduction shows that development has progressed. All roads appear to have been constructed with the exception of Burke Street and possibly the western side of Fergusson as it is not in this picture. Housing has advanced to the western side of Centennial Avenue. A number of buildings have been erected on the school block. The mangroves beyond Burke Street in the south have been cleared. The quarry to the east of Queen Street has well and truly been cut into the hillside.

3.2.6 The 1986 (SK07) reproduction shows that the development of the subdivision is complete and that nearly all residential lots have been built on. The rock seawall around the site is also complete and Kuranui Beach appears to have been 'cleaned'. Vegetation on residential lots to the east of Moanataiari Street has grown whereas to the west there is little to no vegetation. Reclamation to the south of Burke Street is extensive and the landfill is noticeable.

3.3 Photo Review

3.3.1 Reproductions of photos are included in this report as SK08 to SK22 and are located in Appendix E.

3.3.2 The 1868 (SK08) photo reproduction shows the Caledonian and Golden Crown mine at work. Note the Caledonian and Golden Crown mining operations were located to the south of Moanataiari Creek. This photo is considered to show more than one battery due to the size of the operation and the presence of three chimneys. The chimneys are more than likely associated with furnaces. The land is flat land and based on the date of the photo, these mines had only recently commenced operation, it is considered that this land would be 'natural' land and not reclaimed land.

3.3.3 The 1868 (SK09) photo reproduction shows the Moanataiari Creek mining site. Note the Moanataiari Creek operation was located at the mouth of Kuranui Stream. This photo is considered to be of two batteries as two chimneys are present some distance apart. This photo clearly shows the difference between the tidal flats and coastal land. At the centre of the photo is the Kuranui Stream which appears to be discharging waste product onto the mud flats.

3.3.4 The 1868 (SK11) photo reproduction also shows the Moanataiari Creek mining site. However, it appears to be to be further to the north. Note this is the area in which the Kuranui Battery was located. This photo also clearly shows the difference between the tidal flats and coastal land.

3.3.5 The 1877 (SK12) photo reproduction is titled Tararu Road. This photo appears to have been taken from Kuranui Beach looking south towards the Kuranui Battery. At least two chimneys are present in the foreground possibly indicating two batteries in this area. The Tararu Road is clearly visible on higher coastal land. Kuranui Beach and the Firth of Thames are visible. However, what is more noticeable is the large amount of mullock or tailings piles on the foreshore. The land directly behind these piles appears to be hummocky and possibly suggests further dump sites.

3.3.6 The 1877 (SK13) photo reproduction is titled Moanataiari Valley Settlement. Based on the chimney it appears that a battery was located within this settlement. The Moanataiari Stream is present in the foreground. In the centre of the photo is a shute which terminates on the creek bank. A conveyor is present from the battery to this shute. Another conveyor is present on the right and exits the photo which suggests that it terminates on the coast. A railway is also visible on the western side of the Moanataiari Creek bank.

3.3.7 The 1898 (SK14) photo reproduction is taken from the Burke Street causeway looking back to Thames foothills with Moanataiari Creek in the centre. The causeway has been constructed out of rock and soil. The sea is clearly visible adjacent to the causeway. The beach or reclaimed land appears to be deep and contoured upwards to the coast. In the background before the foothills are a number of buildings which are dwarfed by large mounds of mullock and or tailings.

3.3.8 The circa 1898 (SK15) photo reproduction is a close up of Moanataiari Creek and surrounds. The photo has been taken from the causeway as it is present in the foreground. This photo clearly shows the extent of the beach or reclaimed land behind a rock wall. Further back it appears, due to the chimney, that a battery is located on the left with a large mullock and or tailings dump beyond. Further behind it is noticeable that the foothills have been cleared of vegetation. To the left of centre, a conveyor is visible exiting the mouth of Moanataiari Creek then bifurcating at the foreshore to form an inverted 'v' with what looks like mining spoil in between. Further to the right are a number of buildings with the large mullock and or tailings dumps beyond and the foothills further beyond.

3.3.9 The 1909 (SK16) photo reproduction is titled 'Overlooking the Foundry' and as such the majority of the photo captures Grahamstown. However, in the far right infilling beyond Burke Street causeway is clearly evident and quite extensive.

3.3.10 The circa 1910 (SK17) photo reproduction is a panoramic photo of northern Thames. In the centre of the photo is Burke Street Wharf. Beyond the wharf infilling is clearly evident stretching some distance into and along the coastline.

3.3.11 A photo with no date (SK18) titled 'Moanataiari Battery' has the caption 'This is an early photo taken before much reclamation was done'. In the foreground is the battery which appears to be located on both natural and reclaimed land as the sea level in the left hand side of the photo is before the chimney and smelter. Directly behind the chimney is a house built on reclaimed land. Behind the battery is large pile of mullock and or tailing's. A conveyor can be seen emerging on the right side of the photo onto this pile. In the Firth of Thames are at least four lines which are considered to be rockwalls.

3.3.12 A photo with no date (SK19) titled 'A Very Early Picture' has the caption 'in the distance is the goods wharf and Moanataiari flume in centre'. This photo shows that extensive development has occurred along the foreshore. A conveyor is present in the centre of the photo and dumping is clearly visible in the Firth of Thames. Note the foothills are now some distance from the coast.

3.3.13 A photo with no date (SK20) shows two men in the foreground walking along Burke Street Wharf. In the background to the right is the Moanataiari battery with a conveyor on the foreshore disappearing back into the foothills at the mouth of Moanataiari Creek. In the background centre is a mine shaft surrounded by a number of buildings. Further to the right is another conveyor which appears to be discharging product onto the foreshore.

3.3.14 A photo with no date (SK21) titled 'View from Thames Wharf' shows in the far right, a large black object stretching from Waiotahi Creek to the northern side of the wharf. This object is considered to be a conveyer. On the foreshore to the right of this object there appears to be a pile of mullock and or tailings. The Thames – Hauraki pumphouse is located further beyond at the base of the foothills. To the south of the wharf are a number of buildings presumed to be part of A & G Price Limited. To the right of the building in the centre of the photo are large piles of black and grey mounds.

3.3.15 A photo with no date (SK22) titled 'Dredging for gold' shows a barge in the Firth of Thames. The barge is considered to be dredging tailings and mullock dumped in the Firth of Thames north of Burke Street Warf. The wharf is visible behind the barge with the A & G Price buildings shown in SK15 further beyond. Note the large pile of spoil in the foreground.

4.0 THAMES COROMANDEL DISTRICT COUNCIL REVIEW

4.1 File Review

4.1.1 Reproductions of extracts from Thames Coromandel District Council files are included in this report as DOC01 to DOC05 and are located in Appendix F.

4.1.2 An internal Memorandum to the Chief Executive Officer from the Deputy Chief Executive Officer dated 3 February 1997 (DOC01) contains the following relevant quotes:

- *The Moanataiari area is built on land originally reclaimed by the Thames Harbour Board*;
- *Prior to the 1920's development, the area was probably low-lying swampy land, which had been extensively infilled with mine mullock or tailings discharged from the batteries locally associated with gold mines in the area*;
- *The Borough Council inherited the title from the Harbour Board on amalgamation of the Council and Board in 1936*;
- *The Borough Council progressively laid out the area from the landward end as street and sections from about 1948 until 1972*;
- *There is no evidence of any formal regulatory process in the development. The Council apparently filled the land, employed a surveyor to lay out street and boundaries, and approved the final subdivision plan*; and
- *The reclaimed land has slumped almost one metre from its apparent finished height.*

4.1.3 A meeting of the Thames Flood Mitigation Project held on 1 December 1995 (DOC02) noted the following:

- The Thames Borough Council, through an Act of Parliament, had licences to fill a large area of the Firth. The boundaries of the Moanataiari were the stone walls, established as protection for the original Thames Wharf;
- The site was initially a rubbish dump/refuse depot and filling occurred between 1965/70. Refuse was first dumped west of Tararu Road, progressing south to the Waiotahi Stream outlet;
- Verran Brothers filled the site west of Moanataiari Road with quarry tailings; and
- The school site was built up an additional one metre.

4.1.4 The following quote from an unknown source (DOC03) suggests that the settlement was capped with weathered rock and clay fill:

- *The Moanataiari subdivision was formed progressively from the turn of the century by indiscriminate dumping of mine tailings and mullock over extensive marine sediments followed by dredgings from the port. Finally, capping with a raft of weathered rock and clay fill sourced from the adjacent hills was constructed under controlled conditions in the mid to late 1960's. Limited available records indicate that filling was essentially complete by May 1968 and that settlement was monitored over the following 13 months.*

4.1.5 A report by Tonkin and Taylor tilted 'Moanataiari Subdivision Revised Remedial Proposals' dated 18 April 1997 (DOC04) included the excavation of three test pits in the south eastern corner of the subdivision on the grass verge of Burke Street or Fergusson Drive. All three test pits document a basecourse fill material to approximately 200 mm followed by fill mainly comprising silt and sand with timber branches in one test pit to approximately two metres. Underlying the fill is a dark grey clayey silt.

4.1.6 A letter report from a consulting engineer dated 5 June 1951 (DOC05) comments that fill can be obtained from the large spoil dumps on site. The quote from the report is as follows:

- *There is available in the large spoil 53,124 cu.yds and a further 2,200 in the smaller one; a total of 55,344 cu.yds.*

4.1.7 An article from the 'New Zealand Engineering' magazine dated June 1999 by John Duder of Tonkin and Taylor (DOC06) outlines a history of and the flood protection measures that have been undertaken at Moanataiari. In summary:

- Homes were built on land reclaimed in the 1960's. The area had been created with infill (largely spoil from the local gold diggings) dumped on top of compressible marine sediments. Over the following 30 years the land has been settling, to the point where some parts of the subdivision are now below sea level;
- The subdivision was protected from the sea by a 50 m long rockfill seawall which in severe storms provided inadequate protection – storm surge overtopped the wall easily;
- But the graver problem was the embankment's permeability – storm surge simply flowed through;
- Poor stormwater drainage contributed to the flooding. Run-off from the hills pooled against the seawall; and
- The solution included upgrading the seawall by making it higher and impermeable and improving stormwater. The wall was made higher by erecting a timber parapet. The wall was waterproofed by lining the inside with local clay. A pump station was also built and Kuranui Beach was reshaped and a dune added with a swale behind to divert stormwater.

4.2 Library Review

4.2.1. William A Kelly in the book 'Thames: The First 100 Years' documents that the Moanataiari battery waste was used to form the start of the subdivision. The quote from this book is as follows:

- *The battery, the last of the big ones, was later demolished. The considerable mullock tips from the Moanataiari Tunnel and battery waste were levelled to form the start of the present Moanataiari reclaimed subdivision.*

4.3 Other

4.3.1 The Manager of Environmental Services for the Thames Coromandel District Council Mr. Craig Birkett requested staff to undertake a search of the files to see if they could unearth any relevant information. The following information was obtained and extracts are included in this report as DOC07 to DOC11 and SK23:

- A letter from 1950 (DOC07) indicates that the soil in the area was very infertile, acidic, phosphorous and potassium deficient and almost devoid of humus;
- A letter from 1965 (DOC08) indicates that fill was to consist of mullock and small rock and landfill and that further clay filling was to become available from the Chan subdivision at Parawai;
- Information dated 1966 (DOC09) states that fill came from the quarry on the corner of Moanataiari Creek Road;
- There is reference to a town rubbish dump at Moanataiari Flat in Council Minutes dated 1967 (D0C10) - 4,115 cubic yards of filling were carted to the subdivision during July towards filling depressions and the rubbish dump;
- Council minutes from 1967 (DOC11) refer to a letter from Verran Brothers Ltd concerning at refuse depot in Burke Street. To quote this letter - *having undertaken to keep the refuse depot covered on the completion of the reclamation originally at a cost of £25 per week we wish to advise that it is virtually impossible to carry out work at this price.* To further quote *we would point out that the height of the tip face on the southern side of Burke Street is far too shallow*;
- Correspondence from Mrs Dot Pollock (ex Thames District Council Records Officer) documents that her husband can recall a rubbish dump on the northern side of Moanataiari and that it was one for quite some time. When he was a child he remembers being told off for playing in the reclamation as it was dangerous. He also remembers piles of mullock and holes filled with water. The area was called 'the coloured sands'. Mr. Pollock was born and breed in Thames; and
- A hand drawn map dated 1948 (SK23) from an unknown source documents an old battery site and mullock dumps south of Tararu Road.

5.0 ENVIRONMENT WAIKATO REVIEW

5.1 File Review

5.1.1 Reproductions of letters from Environment Waikato files are included in this report as DOC12 to DOC14 and are located in Appendix F.

5.1.2 A report titled 'Geotechnical Investigation Foreshore Reclamation Thames' by G Harris dated September 1991(refer Appendix I for a full copy of this report) identifies another reclamation area in Thames which could be impacted by hazardous substances. This reclaimed area is immediately south of Danby Field and is now residential. The report states that the area was reclaimed between 1969 and 1977 by filling with a mixture of inorganic spoil and some household rubbish which is estimated to be about 25%. As part of the geotechnical investigation six test pits were excavated across the site with refuse found in four test pits excavated along the western boundary. The report recommended two foundation options with one involving the removal of the refuse.

5.1.3 A letter from Mr. J N Duder, Tonkin and Taylor, dated November 1997 (DOC12) outlines Thames Coromandel District Council's intended flood protection measures for Moanataiari as follows:

- Raise the seawall to 4.0 metres; and
- Re-shape Kuranui Beach.

5.1.4 A letter from The Deputy Chief Executive Officer of Thames Coromandel District Council, dated 28 January 1997 (DOC13), summarises the development of the Moanataiari subdivision. The following are quotes from this letter:

- *The Moanataiari development was built by the Thames Borough Council between 1950 and 1972. The area on the sea wall boundary was built to a level in 1968, subdivision works were completed in 1970/71 and titles issued in 1972. The houses in the area were mainly constructed in the early years of the 1970's*; and
- *The 'land' was originally created by early miners spoil disposal, by the Thames Harbour Board in the early years of the century.*

5.1.5 A report by the Thames Community Board titled Capital Works Project Brief Moanataiari Subdivision Inundation Protection dated 25 February 1998 (DOC14) summarises the development of the Moanataiari subdivision as:

- The Moanataiari subdivision was developed in the 1960's by the then Thames Borough Council by filling out to an earlier rockfill bund formed in the 1920's as part of a proposed port development. Impermeable fill from the adjacent hillside was placed over marine sediments.

5.2 Report

5.2.1 A technical report titled *Trace Elements in Sediments of the Lower Eastern Coast of the Firth of Thames* by Dr Nick Kim dated May 2007[7] investigated which potential sources of: natural sulphide mineralisation; former mining operations; agricultural activities; and or urban inputs; could be casing sediment enrichment. The report was based on results from 11 sampling locations including one in Kuranui Bay approximately 10 metres north of the seawall and one by the Thames pipeline approximately 100 metres south of the closed municipal landfill. The key findings of this report in relations to these two sample locations are as follows:

- The highest concentrations of mercury were found at Kuranui Bay and the nearby pipeline sampling site in northern Thames;
- A possible natural source of mercury is the cinnabar (mercuric sulphide) deposit situated in the Kauaeranga Valley. However, the most likely source is mine tailings and other municipal or industrial fill that has been deposited in the immediate vicinity as part of historic land reclamation. In addition to mine tailings, the area of the hotspot is near a significant historic foundry and a coastal landfill; and
- There are two possibilities about the source of local mercury contamination. The tail of the reclamation as it may extend some distance beyond the seawall. Secondly, sediment in this immediate area of the Firth of Thames is likely to be receiving leachate from the base of the Moanataiari reclamation, as rainwater enter and flow through it.

5.2.2 Table 2 compares the metal concentrations from one surface sample and one deep sample in Kuranui Bay and by the Thames Pipeline to The Australian and New Zealand Environmental Conservation Councils Sediment Quality Guideline[8]. Samples were collected at the surface and at depth at both locations. Both samples are representative samples containing a number of sub samples. The Kuranui Bay surface sample comprised six subsamples with each containing a further five subsamples. The deep sample comprised four subsamples collected through the profile. The Thames Pipeline surface samples comprised three subsamples with each subsample containing a further five subsamples. The deep sample comprised two subsamples collected through the profile.

[7] A copy of this report is available from Environment Waikato. Quote DOC#1120743.

[8] New Zealand risk based derived sediment quality guidelines designed for the protection of aquatic organisms as required by the Ministry for the Environments Contaminated Site Management Guideline Two, *Hierarchy and Application in New Zealand of Environmental Guideline Values.*

Table 2: Average Metal Concentrations at Kuranui Bay and Thames Pipeline

SAMPLE	TRACE ELEMENT							
	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Kuranui Bay – surface	**42.5**	0.40	21.0	17.0	1.0	7.6	28.6	142
Kuranui Bay – deep	61.4	0.97	23.6	25.2	1.8	8.9	**44.5**	**263**
Thames Pipeline – surface	161.9	0.39	25.2	16.9	0.5	9.1	**116.6**	157
Thames Pipeline – deep	22.4	0.41	22.1	16.8	0.43	8.2	30.7	137.5
GUIDELINE	**TRACE ELEMENT**							
	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
ANZECC Low	20	1.5	80	65	0.15	21	50	200
ANZECC High	70	10	370	270	1.0	52	220	410

Notes

1. All concentrations in mg/kg and are on a dry weight basis;
2. ANZECC Low represents a concentration below which adverse effects are unlikely;
3. ANZECC High represents a concentration at which adverse effects are expected in half of the exposed population;
4. A highlighted box denotes above recommended ANZECC High; and
5. A bold result denotes above recommended ANZECC Low.

5.2.3 The results show:

- Arsenic is elevated at the surface above the ANZECC Low at Kuranui Bay;
- Arsenic is elevated at the surface above the ANZECC high at Thames Pipeline;
- Mercury is elevated at the surface and at depth above the ANZECC high at Kuranui Bay;
- Mercury is elevated at the surface and at depth above the ANZECC low at Thames Pipeline;
- Lead is elevated at the surface above the ANZECC low at Thames Pipeline; and
- Zinc is elevated at depth above the ANZECC low at Kuranui Bay.

5.2.4 The report highlighted that the sediment sampled at Kuranui Bay were enriched with metals in comparison to other sampling sites. This is documented in Table 3 which is taken directly from Dr Kim's report.

Table 3: Trace Element Concentrations Comparison in the Firth of Thames

ELEMENT	MEASURED CONCENTRATIONS				ENRICHMENT RATIO
	FOUR NON - KURANUI BAY SITES			KURANUI BAY	
	MEAN	CONFIDENCE LEVEL		Composite result	
		Lower	Upper		
Cadmium	0.035	0.010	0.60	0.34	9.7
Silver	0.067	0.030	0.100	0.30	4.5
Mercury	0.198	0	0.520	0.84	4.2
Zinc	53.1	28.9	77.3	199	3.7
Manganese	474	127	820	1480	3.1
Antinomy	0.26	0	0.64	0.81	3.1
Molybdenum	0.47	0	1.02	1.22	2.6
Lead	19.7	7.3	32.2	42.9	2.2
Caesium	0.74	0.48	0.99	1.2	1.6
Lithium	12.4	7.5	17.3	18.7	1.5
Tin	0.40	0.27	0.53	0.6	1.5
Boron	10.4	8.1	12.7	13.0	1.3

Note

1. All concentrations in mg/kg and are on a dry weight basis.

5.2.5 The report also commented on sediment samples collected from a resource consent application for the landfill south of Burke Street. Dr. Kim considered that the mercury concentrations in these samples were so enriched that they would meet a reasonable test of the Resource Management Acts definition of contaminated land. The sediment samples collected for this consent results are presented in detail in section 5.3.

5.3 Consent

5.3.1 Resource Consent was granted to Thames Coromandel District Council in February 2010 for the discharge of leachate into ground from the closed Thames landfill south of Burke Street: Authorisation number 116055 and file number 60 53 78A. As part of the application, Kingett Mitchell Ltd collected sediment samples at 16 locations around the coast of the Moanataiari reclamation - three in Kuranui Bay, four west of the landfill, six south of the landfill, and three southwest of the landfill. A number of samples recorded elevations of mercury well above the New Zealand Environmental Conservation Councils Sediment Quality Guideline High value for mercury.

5.3.2 Table 4 documents average mercury concentrations in sediment around the Moanataiari from the samples collected by Kingett Mitchell Ltd.

Table 4: Average Mercury Concentrations in Sediment Surrounding the Moanataiari Reclamation

SAMPLE	MERCURY
Kuranui Bay	2.53
West	1.56
South	0.60
Southwest	1.61
GUIDELINE	**MERCURY**
ANZECC High	1.0

Notes

1. All concentrations in mg/kg and are on a dry weight basis; and
2. ANZECC High represents a concentration at which adverse effects are expected in half of the exposed population.

5.3.3 The results show that mercury is elevated above the ANZECC high in all samples except south of the landfill.

6.0 OTHER INFORMATION SOURCES REVIEW

6.1 On-line Newspapers

6.1.1 Reproductions of On-line newspaper articles are included in this report as DOC16 to DOC18 and are located in Appendix G.

6.1.2 An article from the Thames Star dated 28 January 1881(DOC16) documents Council approval to allow mullock or ash to be used for the construction of footpaths to the south of Moanataiari.

6.1.3 An article from the Thames Star dated 8 December 1897 (DOC17) documents a tip in Moanataiari. To quote the article "*the Moanataiari culvert is finished and well inside the tip end now, and probably before long Mr Clark will be turning the tip more towards Tararu*".

6.1.4 Articles from the Thames Star dated 8 December 1899 (DOC18) document tailings on the foreshore, tailings adjacent to the Big Pump, reference to the Moanataiari Tip and reference to Judd's tailings. To quote the articles:

- *"It was decide to write to Mr Buckley, who applied some time back for permission to remove tailings from the foreshore, and inform him that part of the ground applied for belonged to the Railway Department*;"
- *"Mr Judd wrote applying for an allotment at the foot of the Big Pump flume from which to remove tailings;"* and
- *"I should strongly advise raising the silt works wall another 2ft from the wharf road to half way to the Moanataiari Tip. We shall have a big hole over beyond Judd's tailings plant to fill up*."

6.2 Historical Maps

6.2.1 Reproductions of maps are included in this report as SK24 and are located in Appendix H.

6.2.2 A map titled 'Plan of the Thames Goldfield NZ' dated 1910 (SK24) shows the original coastline pretty much in the same location as the present day Queen Street.

7.0 CONSULTATION

7.1 Mr. Vernon Pickett – Environment Waikato Coastal Scientist

7.1.1 Mr. Pickett explained the general current patterns in the Firth of Thames. He stated that basically the currents flow down along the western side of the Firth, swirl around the bottom and then heading north back up the eastern side. He also stated that an eddy was present in Kuranui Bay as the currents from the south swirl around the reclamation. This eddy could be transporting sediment from southern areas into Kuranui Bay.

7.2 Mr. John Isdale – Thames Historian

7.2.1 Mr. Isdale was requested by Environment Waikato in 2005 to complete a historical account of the Moanataiari reclamation. The following are considered to the key points from his report verbatim. A full copy of Mr. Isdale's paper can be found in Appendix J.

- *"From 1867, with the establishment of the Thames goldfield, the flattish areas around the mouths of the Kuranui, Moanataiari and Waiotahi Creeks became important as battery sites for this richest area of Thames;"*
- *"In the first few years the amount of gold to rock was extremely high particularly in this area;"*
- *"Gold era maps and photos and other illustrations of this time, clearly show an initial shoreline relatively unaltered from Maori times";*
- *"While some of the waste, mullock and tailings went back into the mine as back-fill, a huge amount ended up on the present day Moanataiari flat. Illustrations of this time show the batteries running tailings and waste straight out onto the mudflats;"*
- *"The Moanataiari tunnel being 'the main artery of the goldfield' servicing mines such as the Alburnia, Fame and Fortune and the Golden Age, adding to the total of fill being pumped out. The main dumping area ran north from the Burke Street wharf towards the Magazine wharf at the northern end of Kuranui Bay;"*
- *"Up until the late 1890's the main method of gold extraction on 'the Thames' was by Mercury amalgamation which was at best extracting only 65% of the gold and silver as ore. This created the rich resource of the Moanataiari sands that was exploited by H.H. Adams and Judd's;"*
- *"By the end of 1925 harbour dredging had created a large area of reclaimed land. This work continued until 1928 when the money ran out. It appears that the 'protective' breakwaters' which enhanced silting up were completed;"*

- *"The method adopted in the 1950 was to put the town dump on a low lying area on the seaward side of the existing built up area. When the rubbish fill had built up sufficiently it was covered, top soil brought in and roads and other services established to increase the built up area. As one dump site began to fill up the next dump site was prepared. The dump was moved several times repeating this continuous process, reclaiming more and more of the old harbour";*

- *"By 1959 the northern parts of Kuranui and Moanataiari Streets are in existence with the town dump between Burke and Ensor Streets. Kuranui Street was pushed through to join Burke Street by the early sixties with the dump on the present school site;"*

- *"A new dump further seaward but still north of Burke Street is in operation;"* and

- *"Over the period from 1950 to the end of the 20th Century, the methods and materials underwent considerable change. The bash, burn, bury of the fifties gave way to clean fill and finally and end of refuse being an integral part of the Thames foreshore reclamation process."*

7.2.2 Mr. Isdale in a follow up conversation thought that at least seven batteries were located in this area and that the batteries moved with the reclamation and changed their names. One battery was located on a property which is now clearly residential land: the northern corner of Dickson Street and Fergusson Drive. The 'dead giveaway' is that the land is raised in relation to the neighbouring sites.

7.3 Mr. Ken Verran – Owner Verran Brothers

7.3.1 Mr. Verran stated that his company had a contract with Thames Borough Council to infill the subdivision during the 1960's. He clearly recalls Moanataiari being used as the municipal landfill by council. In his opinion council saw an opportunity to use this area as a rubbish dump and they did. On rubbish day trucks would arrive at the face and dump their loads. This occurred for at least five years. However, he did not consider the amount of rubbish in the reclamation to be significant as Thames was a small town with a small amount of rubbish produced and the rubbish was dispersed over a large area.

7.3.2 Mr. Verran also believes an older council dump was located further east.

7.3.3 Mr Verran stated that his company owned and reclaimed another part of the Thames foreshore which council also used as a municipal dump site. The land was south of Danby Fields and is now occupied by a retirement village. He stated that council basically ordered them to take refuse when they were infilling it.

7.3.4 Mr. Verran further stated that the 'Goldfields Shopping Centre' was also built on rubbish. The site was owned by a Mr. G Harris a Hamilton real estate agent and he also accepted refuse from the council when the site was being infilled by Verran Brothers.

7.4 Mr. Barry Corp – Truck Driver

7.4.1 Mr. Crop was a truck driver who helped infill Moanataiari. Mr. Crop worked for Verran Brothers, the contractor who infilled Moanataiari from Moanataiari Street west.

7.4.2 Mr. Crop cannot recall any refuse being present in the areas he carted clay onto. The clay was sourced from council's quarry located directly behind Moanataiari.

7.4.3 Mr. Crop also stated that he brought a section on Centennial Drive and erected a house. Mr. Crop excavated the foundations, piles to one metre, and the service drains and cannot recall any refuse. He remembers rumours that an old boiler was buried in that area but he never found it. Mr. Crop was surprised that he did not find the boiler as the land to the south around A & G Price had been heavy industry.

7.4.4 Mr Crop grew up in Thames and recalls an old timber mill on the land which is now the Moanataiari school in the early 1950's.

7.5 Mr. Morrie Dunwoodie – Surveyor

7.5.1 Mr. Dunwoodie explained that he was engaged by Thames Borough Council to survey (determine the exact location) infrastructure and sections within the reclaimed land at Moanataiari.

7.5.2 Mr. Dunwoodie cannot recall any refuse being dumped in this area apart from minor amounts. To his knowledge the council never used this area as a tip site as 'Southland Wharf' was the official dump during the reclamation period. Mr. Dunwoodie stated that the reclamation was filled with clean fill from the quarry directly behind Moanataiari.

7.5.3 Mr. Dunwoodie also stated that most of the reclaimed land along the Thames foreshore was a dump at some point in time. A retirement village south of Danby's field was built on a dump site.

7.6 Mr. John Duder – Director, Tonkin and Taylor

7.6.1 Tonkin and Taylor were the engineering consultancy engaged by Thames District Council to proved improved flood protection measures for Moanataiari during the late 1990's. Mr. Duder was the chief engineer for the project.

7.6.2 Mr. Duder cannot recall any rubbish being unearthed during excavations works. However, he was not physically involved in the excavations. In his opinion the excavations works were pretty minor, foundations for the pump station on Fergusson Drive and the laying of pipes from the pump station to Kuranui Beach. The contractor was Brown and Sons with Mr. Bryce Louden the site manager. Mr. Duder does recall a layer of clay capping.

7.6.3 Mr. Duder stated that the same clay was used to line the seawall as 'testing' showed it to be pretty impregnable. The clay was sourced from the quarry behind Moanataiari.

7.7 Mr. Bryce Louden – Ex Brown and Sons Ltd Manager

7.7.1 Mr. Louden was on site when the excavations for the pump station and pipes were undertaken. Excavations were relatively shallow to about one metre. Mr. Louden does not recall any rubbish being excavated apart from some truck chassis' and steel in the Ensor Street area.

7.8 Mr. Max Bosselmann – Engineer

7.8.1 Mr. Bosselmann was an engineer contracted by Thames Borough Council in the late 1967 to provide compaction advice and roading design for the Moanataiari subdivision.

7.8.2 Mr. Bosselmann recalls a significant dump site to the north of Burke Street. He estimated that the dump covered at least two hectares in an 'L' shape. However, by the time his services had been engaged the dump had been closed for several years and had been covered so he does not know what type of rubbish was dumped.

8.0 POTENTIAL HAZARDS

8.1 Information Review

8.1.1 Table 5 documents information that is considered to confirm mine waste within the Moanataiari reclamation.

Table 5: Mine Waste Confirmation

SOURCE	MINE WASTE
Photos	▪ An early photo with no date of the 'Moanataiari Battery' clearly shows the original foreshore and the early stages of reclamation confined within seawalls. Piles of mullock and or tailings are visible. ▪ Photos from the decades of 1860 and 1870 also show mullock and or tailing piles around batteries on increased flat land which implies further reclamation. ▪ Moanataiari Valley photo from 1877 showing a conveyor belt into the creek. ▪ Photos from the decade of 1890 show huge piles of mullock and or tailings on the foreshore and conveyors emerging from the foothills and ending on the foreshore. The foreshore appears to have progressed west by some distance. ▪ A photo with no date but from a different angle shows the same situation but highlights the amount of reclamation that has occurred, nearly as far west as Kuranui Street. ▪ A photo with no date titled 'Dredging for Gold' shows a barge located within the Moanataiari seawall. The barge appears to be located some distance from the coast and Burke Street wharf.
Thames Coromandel District Council	▪ A Thames Coromandel District Council internal memo from 1997 on the Moanataiari Subdivision states that prior to 1920 infilled comprised mine mullock or tailings. ▪ A letter from the Chief Executive Officer of Thames Coromandel District Council dated 1997 states that the reclamation was formed from miners spoil. ▪ Letter report dated 1951 documenting that fill can be obtained from the large spoil dumps. ▪ A library book by William Kelly titled ;Thames: The First 100 Years' states '*the considerable mullock tips from the Moanataiari Tunnel and battery waste were levelled to form the start of the present Moanataiari reclaimed subdivision'* ▪ An article from Mr John Duder, Tonkin and Taylor, dated 1999 for the New Zealand Engineering Magazine states that the area had been created within infill (largely spoil from the local gold diggings) dumped on marine sediments.
Environment Waikato	▪ The report by Dr Nick Kim has the following quote from a Ministry for the Environment Report dated 2001: '*the Moanataiari reclamation was formed progressively form the turn of the century, initially by dumping mine tailings and mullock'*. ▪ The report by Dr Nick Kim documents that sediment samples collected in Kuranui Bay are enriched with metals. In addition, concentrations of mercury and arsenic are above recommend guideline values. ▪ Marine sediment sampling associated with the recourse consent application for the municipal landfill located to the south of Burke Street documents concentrations of mercury around the reclamation well in excess of recommend guideline values.
Anecdotal	▪ A Thames historian Mr. John Isdale states that a huge amount of mullock and tailings ended up on the present day Moanataiari flat. ▪ Mr. John Isdale stated that sometime around 1910 when the 'bonanza' was over all of the area behind the seawall was dredged for gold.
Other	▪ A map from 1910 clearly shows that coastline as being in the same place as today's Queen Street.

8.1.2 Table 6 documents the information that is considered to confirm the presence of municipal waste in the reclamation.

Table 6: Municipal Waste Confirmation

SOURCE	MUNICIPAL WASTE
Photos	▪ An aerial photo form 1940 shows patches of 'hummocky' land in the north east and in the west. Oblique photos from 1965 and 1967 show 'hummocky' land west of Ensor Street.
Thames Coromandel District Council	▪ Minutes from a flood protection meeting in 1995 state that the subdivision was initially a rubbish dump/refuse depot and filling occurred between 1965/70. Refuse was first dumped west of Tararu Road progressing south to Waiotahi Stream outlet. ▪ Council minutes from 1967 refer to a rubbish dump at Moanataiari Flats. ▪ Council minutes from 1967 tables a letter from Mr. Ken Verran which suggests a landfill north of Burke Street. ▪ Anecdotal information from a long time resident recalls a rubbish dump. ▪ A test pit excavated by Tonkin and Taylor documenting wood waste at approximately two metres.
Environment Waikato	▪ The report by Dr Nick Kim documents that sediment samples collected in Kuranui Bay are enriched with metals. Dr. Kim hypothesises that the enrichment is directly related to the mine tailings used in the reclamation. However, this enrichment may also be as a result of municipal waste. Dr. Kim was unaware that the reclamation received municipal waste.
Anecdotal	▪ Mr. John Isdale states that the site was the municipal dump. Rubbish was used to build up the area and that the dump was moved several times repeating the processes of filling. ▪ Mr Ken Verran the contractor responsible for infilling the reclamation in the 1960's stated that the reclamation was the local dump for at least five years. A rubbish truck would arrive on collection day and dump the load which he would then cover. ▪ Mr. Verran also believes that an older council tip was located further west. ▪ Mr. Max Bosselmann the engineer contracted by Council to develop the reclamation recalls a dump covering approximately two hectares.

8.2 Discussion

8.2.1 Mine Waste

8.2.1.1 The information clearly shows that mullock and mine tailings have been used as fill in the reclamation. However, a depth profile is unable to be ascertained. The best estimation is: land east of Tararu Road is entirely mine waste; land between Tararu and Kuranui Street is mostly mine waste; and the land west of Kuranui Road has mine waste as a base.

8.2.1.2 Based on the average age of homes east of Tararu Road, pre 1914, photos of early reclamation, this area is considered to be entirely composed of mine waste. The age of the houses also shows that this area predates Thames Borough Council development. A letter on file at Thames Coromandel District Council dated 1950 documents that the soil is infertile and almost devoid of humus. It is considered that this letter refers to this area.

8.2.1.3 Historical photos clearly show a foreshore of mine waste to the west beyond what is now Kuranui Street. These photos also show buildings present up to approximately Kuranui Street. Therefore, as the land was considered flat enough for development it is most likely all mine waste. However, in this area houses were built in the decades of 1950 and 1960 so the mine waste may have been altered by the council.

8.2.1.4 A number of information sources indicate that mine waste is present at the base of the reclamation. The photo 'dredging for gold' implies that mullock and tailings is present over the entire subdivision. Information from Thames Coromandel District Council shows that mullock dumps were pushed over marine sediments to form the base of the reclamation.

8.2.1.5 Dr. Nick Kim hypothesis that the high mercury and metal enrichment in Kuranui Bay is directly related to mine tailing and that it could actually be the toe of the reclamation.

8.2.2 Municipal Dump

8.2.2.1 Information clearly shows that municipal waste was used as additional fill by the Thames Borough Council. However, it is unclear on the exact location and dates that infilling occurred. A Thames Borough Council memo documents that the council inherited the land in 1936 and that they commenced development around 1948. A historical summary from minutes for a flood protection meeting in 1995 documents that council under an Act of Parliament had licences to infill an area of the Firth and that rubbish was used from 1965 to 1970 commencing west of Tararu Road. Anecdotal information supports filling from 1965 to 1970 however, based on photos the location is very different. An aerial photograph from 1940 documents that infilling has yet to occur east of Tararu Road. An oblique photograph from 1965 shows that infilling is complete except for in the north eastern corner and patches in the south west.

8.2.2.2 Based on an oblique photo, Thames Coromandel District Council records, anecdotal information and a test pit excavated by Tonkin and Taylor in the south western corner of the reclamation it is safe to assume that municipal waste dumping occurred in the area bounded by: Moanataiari Street in the east; Ensor Street in the north; Burke Street in the south; and the seawall in the west.

8.2.2.3 Based on the information obtained it can only be assumed that waste of unknown composition was dumped between Tararu Road and Moanataiari Street. Articles from the Thames Star in the 1890's document a dump in Moanataiari. Also an article from the Thames Star in 1881 documents that mullock and ash was used in the construction of footpaths in Thames.

8.2.3 Clay Cap

8.2.3.1 Thames Coromandel District Council records show that clay was used to cap the reclamation with the majority sourced from the quarry behind Moanataiari upon which mines and batteries were located. However, as the properties east of Tararu Road predate Thames Borough Council subdivision works it is considered that they are unlikely to be capped with clay. The extent of clay cap is not known on the sites between Tararu Road and Kuranui Street as photos indicate that the pre-existing fill of mullock and tailings was extensive. Clay comprised the majority of fill from Kuranui Road west however, as municipal waste was dumped in this area the extent of the clay cap is not known. The Tonkin and Taylor test pits in the south western corner document a sand silt containing clay to about two metres.

9.0 CONTAMINATION ASSESSMENT

9.1 Introduction

9.1.1 The following section presents a contaminated land assessment for the 'Moanataiari Reclamation'. This is the area of land bounded to the north and west by Fergusson Drive with a seawall beyond, to the south by Burke Street and to the east by Queen Street (State Highway 25).

9.1.2 A 'contaminated land' risk assessment is the process of **estimating the potential impact** of a hazard substance on a specified receptor and usually involves the following four steps:

- Hazard source – identification of the contaminants of concern;
- Potential Receptors – define a receptor which maybe or possibly has been exposed to the hazard source. Receptors are usually humans but it may also include other organisms such as livestock and plants or inert objects such as utilities or buildings;
- Exposure Pathways – for a hazard source to pose a risk to a receptor a pathway of contact must exits to the hazard source. An exposed pathway consists of a transport mechanism or migratory pathway, a point of exposure and an exposure route. Human exposure routes are ingestion, consumption, dermal contact and inhalation; and
- Risk Characterisation – estimates the risk to the receptor using the classifications of low, medium or high. Low refers to no risk. Medium refers to tolerable or acceptable risk. High refers to a high likelihood of risk to receptors. However, the risk assessment for this report is based predominantly on qualitative data and therefore, the risk can only be taken as an **estimated** or **perceived** risk.

9.2 Hazard Sources

9.2.1 Mullock and Tailings

The composition of mullock and tailings is directly dependant on the ore and the process of mineral extraction used.

Mullock

9.2.1.1 The bedrock within this area is volcanic. A report by the Auckland Regional Council titled *Background Concentrations of Inorganic Elements in Soils from the Auckland Region* dated October 2001[9] documents elements which are elevated in volcanic soils and therefore considered to document potential elements in ore from the Thames Goldfields. These are: arsenic, barium, boron, cadmium, chromium, cobalt, copper, magnesium, manganese, nickel, phosphorous, vanadium and zinc.

[9] A copy of this report is available from Auckland Regional Council. Quote Technical Publication #153.

Mine Tailings

9.2.1.2 An Environment Waikato technical report by Mr. Sam McNally titled *Waikino Tailings Dam Detailed Site Investigation*[10] included sample results from mine tailings from the Victoria Battery in Waikino. This battery processed ore from a similar geological field however, they used cyanide for amalgamation. Therefore the results shown in Table 7 are considered to represent the tailings dumped at Moanataiari except for mercury. The samples were collected at the surface along the length of the tailings dam at approximately every 10 metres. The Results have been compared to residential guideline values in accordance with the Ministry for the Environment protocols.

Table 7: Waikino Sample Results Compared to Residential Guideline Values

SAMPLE NAME	ELEMENT					
	As	Cd	Pb	Ni	Se	Zn
MD1	2400	0.16	6700	66	23	140
MD2	2300	0.49	8600	53	23	330
MD3	2600	1.1	5800	49	34	740
MD4	2800	2	6600	55	39	1400
MD5	2600	0.92	6100	57	31	650
MD6	2600	7.4	8800	47	28	4900
MD7	3100	1.4	6900	68	41	1100
MD8	2000	1.5	9300	33	35	1100
MD9	2400	0.52	7700	62	37	340
MD10	1200	0.49	10000	28	<20	370
GUIDELINE						
NES	24	5	730			
CAN				50	1	200

Table Notes

1. All concentrations in mg/kg and are on a dry weight basis;
2. NES denotes proposed National Environmental Standard value and CAN denotes Canadian Guideline value;
3. Highlighted box denotes above recommended guideline value.

Results

Arsenic is elevated in all samples. The average arsenic concentration is elevated by a factor of 100. Cadmium is elevated in one sample marginally. Lead is elevated in all samples. The average concentration is elevated by a factor of 9.5 with the maximum elevated by a factor of 13. Nickel is elevated in six samples marginally. Selenium is elevated in all samples. The average concentration is elevated by a factor of 31 with the maximum elevate by a factor of 41. Zinc is elevated in nine samples. The maximum concentration is elevated by a factor of 24.

[10] A copy of this report is available from Environment Waikato. Quote DOC#1498933.

9.2.1.3 The process of amalgamation involved mercury. Sediment sampling shows elevated arsenic and mercury and sediment enrichment by a number of trace elements. Therefore, the reclamation is likely to contain elevated mercury.

9.2.2 Municipal Waste

9.2.2.1 The Ministry for the Environment *Solid Waste Environmental Report Card 2009*[11] defines municipal waste as any non hazardous solid waste from a combination of domestic, commercial or industrial sources. Anecdotal information implies that the waste was primarily from the domestic collection. A Gisborne District Council Waste Survey in 2006 shows that household waste does contain a small percentage of hazardous waste mainly comprising heavy metal or hydrocarbon based products. Therefore, it is considered that the reclamation is likely to contain mainly heavy metals and hydrocarbons.

9.2.2.2 The Ministry for the Environments *Landfill Guidelines*[12] documents that gas generation within landfills is dependent on the composition and age of the waste and typically gas generation is significantly reduced after 40 years. As the waste was buried nearly 40 years ago the likelihood of any gas production is considered to be low.

9.2.3 In summary, the hazard sources are considered to be:

- Heavy metals; and
- Hydrocarbons.

9.2.4 Table 8 shows some of the human health and environmental risks associated with the heavy metals most likely to be found in the reclamation. Note the elements of interest are also essential elements. For these elements the risks presented are possible at high exposures, but adverse health effects can also come about through deficiency.

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11 A copy of this report is available online from the Ministry for the Environment. Solid Waste Composition Environmental Report July Card 2009. http://www.mfe.govt.nz/environmental-reporting/report-cards/waste-composition/2009/waste-composition.pdf.

12 A copy of this report is available online from the Ministry for the Environment. Landfill Guidelines Towards Sustainable Waste Management in New Zealand, Centre for Advance Engineering University of Canterbury, Christchurch, New Zealand. http://www.mfe.govt.nz/withyou/funding/smf/results/4139_landfill.pdf.

Table 8: Human and Environmental Health Risks

ELEMENT	HUMAN HEALTH RISK		ENVIRONMENTAL
	ACUTE	CHRONIC	
Arsenic	Skin changes. Irritation of the stomach, intestines and lungs.	Uptake of significant amounts can intensify the chances of cancer development, especially the chances of development of skin cancer, lung cancer, liver cancer and lymphatic cancer.	Plants absorb arsenic fairly easily. Chances of alteration of genetic materials of fish.
Cadmium	Diarrhoea, stomach pains and severe vomiting.	Bone fracture. Reproductive failure and possibly even infertility. Damage to the central nervous system and immune system. Possibly DNA damage or cancer development.	Earthworms and other essential soil organisms are extremely susceptive to cadmium poisoning. They can die at very low concentrations and this has consequences for the soil structure. Animals eating or drinking cadmium sometimes get high blood-pressures, liver disease and nerve or brain damage.
Lead	Kidney damage.	Brain damage. Disruption of nervous systems. Declined fertility of men through sperm damage. Diminished learning abilities of children.	Health effects on shellfish can take place even when only very small concentrations of lead are present. Body functions of phytoplankton can be disturbed when lead interferes. Soil functions are disturbed by lead intervention.
Mercury	Allergic reactions, resulting in skin rashes, tiredness and headaches.	Disruption of the nervous system. Damage to brain functions. DNA damage and chromosomal damage. Negative reproductive effects, such as sperm damage, birth defects and miscarriages.	The effects that mercury has on animals are kidneys damage, stomach disruption, damage to intestines, reproductive failure and DNA alteration.
Nickel	Allergic reactions such as skin rashes.	Asthma and chronic bronchitis. Heart disorders.	Nickel is not known to accumulate in plants or animals.
Selenium	Skin rashes and swelling of the skin.	Brittle hair and deformed nails. Severe pains.	Bioaccumulative. Reproductive failure and birth defects.
Zinc		Excessive absorption of zinc suppresses copper and iron absorption.	Toxic to plants, invertebrates, and even vertebrate fish

9.3 Potential Receptors

9.3.1 The subdivision comprises 212 residential properties, one school, one child care centre and two industrial sites. The subdivision is also located adjacent to the coastal marine area and associated beach and park and historical mining sites. The built environment includes buildings, roads and utilities which all require maintenance and or servicing.

9.3.2 Therefore, potential receptors are considered to be:

- The ground and organisms within the ground;
- Residents,
- School and child care students and staff;
- Industrial site workers, maintenance workers, recreational users and tourists;
- Pets, other fauna and flora;
- The built environment – buildings, roads and services; and
- The Firth of Thames – sea, sediment and organisms and people or persons who consume affected shell fish and or fish from the Firth of Thames.

9.4 Exposure Pathways

9.4.1 The human health exposure pathways are:

- Ingestion;
- Inhalation; and
- Dermal absorption.

9.4.1.1 Ingestion is almost always the dominant exposure route typically accounting for more than 99% of any potential exposure from soil impacted with hazardous substances. An adult is estimated to ingest about 20 mg (0.02 g) of soil or dust per day from direct contact with the soil or dust, followed by transfer to the mouth or by eating food grown on a property that has been impacted by contaminants. A child is considered to ingest about 100 mg of soil or dust a day. A significant contextual factor to bear in mind is that the heavy metals also occur naturally. As such the intake of these elements through ingestion of ordinary uncontaminated food usually accounts for most (typically >95%) of a person's daily exposure. Another possible ingestion source is the consumption of marine organisms sourced from the Firth of Thames. However, the extent to which this pathway may operate depends on the fishing/gathering and consumption habits of potentially affected parties.

9.4.1.2 Inhalation is most commonly associated with indoor industrial settings. Outdoors inhalation usually accounts for less than 1% of potential exposure for a person living or working on a site. For this to occur the site must be predominantly unpaved and have extremely high concentrations present.

9.4.1.3 Dermal absorption is considered to be a negligible exposure pathway for metal contaminants as they are not significantly absorbed through the skin. For hydrocarbons, exposure has to be in high concentrations.

9.4.2 Therefore, the primary human health exposure pathways are considered to be:

- Ingestion of impacted soil or dust;
- Ingestion of any food sourced from the Moanataiari subdivision land;
- Ingestion of food sourced from the Firth of Thames either in close proximity to Moanataiari or biocumulative species; and
- Inhalation of any landfill gases or vapours.

9.4.3 The potential environmental exposure pathways are as follows:

- Ingestion of soil by pets as pets may indirectly ingest soil or dust whilst eating food placed on the ground or by eating grass;
- Various interactions undertaken by organisms that depend on soil (microbes, invertebrates and plants) which may be directly affected by any contamination in the immediate vicinity; and
- Various interactions undertaken by both marine invertebrates and fish which may be affected by any contamination associated with Moanataiari.

9.5 Risk Characterisation

9.5.1 Soil Assessment

9.5.1.1 Mullock and mine tailings form the base of the reclamation and most likely account for the entire fill east of Tararu Road based on the age of the houses (pre 1914). Historical photos also suggest that mine waste may account for most of the fill east of Kuranui Street. However, most of the houses were built in the decades of 1950 and 1960 so council may have capped this area with clay.

9.5.1.2 Clay fill overlays mine waste from Kuranui Road west. The majority of this clay was sourced from the quarry behind Moanataiari upon which mines and batteries were located. Municipal waste was used as additional fill west of Kuranui Road and it is possible that an earlier waste dump is located to the east of Kuranui Road.

9.5.1.3 Therefore, the perceived likelihood of risk to the ground and organisms that depend on the ground (microbes, invertebrates and plants) within Moanataiari is considered **high**.

9.5.2 Human Health – Residents

9.5.2.1 Properties east of Tararu Road are unlikely to be capped with clay. The extent of clay cap is not known on the sites between Tararu Road and Kuranui Street. Also municipal waste may be present in this area. Clay comprised the majority of fill from Kuranui Road west however: this clay was sourced from an ex mining site so associated contamination may be dispersed over the reclamation; and municipal waste was dumped in this area so the extent of the clay cap is not known.

9.5.2.2 The general consensus of the 'Regional Waste and Contaminated Land Officers Forum' is that one in three households is likely to have a vegetable garden. However, this number may be lower in Moanataiari due to a harsh coastal environment. People may consume fruit sourced from their property.

9.5.2.3 Residents may also undertake intrusive works on their land thereby potential exposing themselves to contaminants at depth or they may inadvertently deposit contaminants on the top soil. Produce may then be grown in this new soil or children may play on it.

9.5.2.4 Therefore, the perceived likelihood of risk to residents east of Tararu Road is considered **high** and west of Tararu Road **medium**.

9.5.3 Human Health – Child Care Children and Staff

9.5.3.1 The child care facility is located on land east of Tararu Road and unless altered or capped during development, mine waste is likely to be present at the surface. The age of the building suggests that the site may have been developed in the 1970's.

9.5.3.2 The building is surrounded by a number of play areas which are all grassed. As discussed in section 8.4 both adults and children will advertently ingest soil with children ingesting approximately five times as much.

9.5.3.3 Therefore, the perceived likelihood of risk to both adults and children at the child care centre is considered to be **high**.

9.5.4 Human Health – School Children and Staff

9.5.4.1 The school is located on land east of Kuranui Road and as such mine waste is considered to be at depth. The dumping of municipal waste in this area has not been substantiated.

9.5.4.2 Minutes from a flood protection meeting in 1995 document that the site was built up by a metre. This was noted by CSI staff during a site drive by. It is assumed that this material is clay sourced from the local quarry. However, as this quarry historically housed batteries and associated mine waste it is unknown if the capping contains any contaminants.

9.5.4.3 Therefore, the perceived likelihood of risk to both adults and children at the school is considered to be **medium**.

9.5.5 Human Health – Maintenance Workers

9.5.5.1 Maintenance workers undertaking any intrusive works may potentially expose themselves to mine waste and or hazardous substances associated with municipal waste dumping. However, the length of exposure is limited.

9.5.5.2 Therefore, the perceived likelihood of risk to maintenance workers is considered to be **medium**.

9.5.6 Human Health – Land Based Recreational Users and Tourists

9.5.6.1 The perceived likelihood of risk to recreational users and tourists is considered to be **low** due to the limited opportunity of exposure.

9.5.7 Pets and other Land Based Fauna

9.5.7.1 Both cats and dogs are known to eat grass as an emetic and dogs may inadvertently consume soil and or dust from food placed on the ground. Cats and dogs are carnivores and therefore they may accumulate heavy metals from other land based fauna that have inadvertently ingested heavy metals from impacted ground within Moanataiari.

9.5.7.2 Birds may eat fruit from trees which have absorbed metals from impacted ground or they may eat seeds coated with metals from sitting on impacted ground.

9.5.7.3 Therefore, the perceived likelihood of risk to pets and land based fauna is considered to be **medium**.

9.5.8 Flora

9.5.8.1 High concentrations or repeated exposure to heavy metals can result in phytotoxic effects on vegetation. However, based on observations by CSI during the dive-by, the flora within Moanataiari appears to be relatively healthy.

9.5.8.2 Therefore, the perceived likelihood of risk to flora is considered **low**.

9.5.9 The Built Environment

9.5.9.1 Hydrocarbons are considered to be corrosive to buildings, services and utilities when present in very high concentrations. Heavy metals are not considered corrosive.

9.5.9.2 Hydrocarbon may be present with the municipal waste either passively leaking from containers or contained within containers. However, as the waste was domestic the quantity is likely to be small and therefore, concentrations are likely to be low.

9.5.9.3 Therefore, the perceived likelihood of risk to the built environment is considered **low**.

9.5.10 The Marine Environment

9.5.10.1 Sediment samples at three out of four locations show elevations of mercury above the ANZECC High guideline value. Sediment samples west and south west show elevations of mercury above the ANZECC High. Concentrations above this value are considered to be at levels that are posing or are likely to pose significant adverse effects to aquatic organisms. Mercury is bioaccumulative which may result in effects on the entire marine community. However, the ANZECC guideline is not designed to protect against this type of risk therefore, non compliance does not provide any information about risks to wildlife, or people consuming seafood.

9.5.10.2 Sediment samples from Kuranui Bay show elevations of metals above background levels. Heavy metals are bioaccumulative.

9.5.10.3 Therefore, the risk to the marine environment is considered **high**.

9.5.11 Human Health – Seafood Consumption

9.5.11.1 Sediment samples from Kuranui Bay show elevations of mercury above ANZECC High and elevation of other metals above ANZECC Low. Sediment samples west and south west show elevations of mercury above the ANZECC High. At low tide these areas are exposed and as such shellfish may be gathered relatively easily.

9.5.11.2 As Thames is a coastal town fishing is probably a hobby/sport of many residents. Therefore, intertidal and or estuarine fish which feed in the areas adjacent to the Moanataiari reclamation may be consumed.

9.5.11.3 Therefore, the perceived likelihood of risk to human health from the consumption of impacted seafood is considered **medium**.

9.6 Risk Characterisation Summary

9.6.1 Table 9 provides a risk characterisation summary.

Table 9: Risk Characterisation Summary

HUMAN HEALTH				
ON SITE	SOURCE	PATHWAY	RECEPTOR	LIKELIHOOD OF RISK
Residents east of Kuranui	Present	Present	Present	High
Residents west of Kuranui	Present but at depth	Partially present	Present	Medium
Child Care	Present	Present	Partially present	High
School	Present but at depth	Partially present	Partially present	Medium
Maintenance Workers	Present but at depth	Partially present	Partially present	Medium
Recreation/Tourists	Present	Unlikely	Possible	Low
Ingestion of fish/shellfish	Not quantified	Possible	Possible	Medium
ENVIRONMENTAL				
Soil organisms	Present	Present	Present	High
Pets and Fauna	Present	Partially present	Present	Medium
Built Environment	Possibly present	Unlikely	Present	Low
Marine Environment	Present	Present	Possible	High

10.0 CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

10.1.1 Reclamation of the Moanataiari subdivision has occurred in two distinctive phases: one; during the gold rush; and two during council ownership and subsequent development.

10.1.2 When gold was discovered in the foothills behind Moanataiari the only available land for the associated processing was a slim coastal margin at the base of these foothills. To overcome this barrier mine waste was pushed into the Firth of Thames behind seawalls created for the Thames Goods Wharf. As more and more land was required, due to increased production and the influx of people and economic by-product of industry and commerce, more and more mine waste was dumped into the firth. By the end of the bonanza a foreshore of mine waste was present up to Kuranui Street with at least a thin layer overlaying the marine sediments beyond to the seawall; however in places, the waste was piled as high as the foreshore.

10.1.3 Thames Borough Council took ownership of the land in 1936 and commenced development in the early 1940's. The fill of choice for this reclamation period was clay sourced from the quarry behind Moanataiari. However, the council also used the reclamation as the local tip for at least five years. The tip face moved with the reclamation works of the time, east of Moanataiari Street and south of Ensor Street. However, municipal waste dumping may have occurred further east but this has unable to be substantiated. Another piece of unsubstantiated information shows mullock dumps present along the entire length of the northern seawall. These dumps may have been used by council to form the base of the reclamation.

10.1.4 It is also possible that uncontrolled dumping occurred between these two periods as the land was vacant and waste would have remained uncovered which would have contributed to it looking like a dumping ground.

10.1.5 Both mullock and tailings contain heavy metals associated with the host ore. However, heavy metals in tailings are more freely available as a result of the crushing and processing. In this area processing involved mercury. Municipal landfills contain a wide variety of chemicals; however, the main ones are considered to be heavy metals and hydrocarbons. Therefore, heavy metals and hydrocarbons may be present in the reclaimed ground which could affect the heath of any people or persons living, working or visiting the area, pets and other land based fauna, flora and the built environment within Moanataiari and the adjacent marine environment.

10.1.6 The risk to all receptors except the marine environment is based on the qualitative data collected and therefore is a perceived likelihood of risk. The risk to the marine environment is based on quantitative data collected.

PERCEIVED LOW RISK

The perceived likelihood of risk to tourists, recreational users, flora, and the built environment is low.

PERCEIVED MEDIUM RISK

The perceived likelihood of risk to residents west of Tararu Road, school children and staff; pets and other fauna, and maintenance workers is medium.

PERCEIVED HIGH RISK

The perceived likelihood of risk to residents east of Tararu Road and child care children and staff is high.

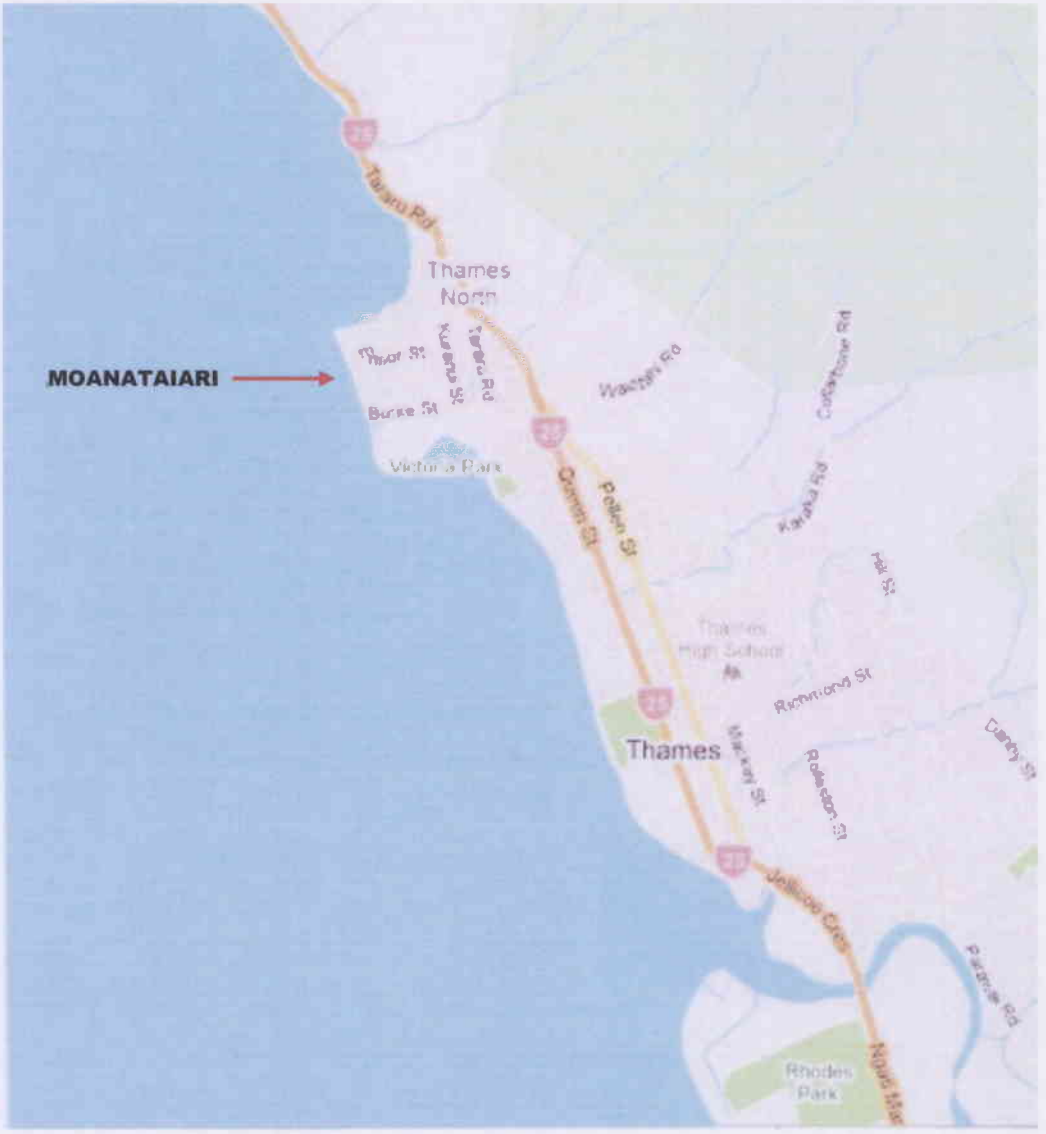
HIGH RISK

The risk to the marine environment is high.

10.2 Recommendations

10.2.1 The following is recommended:

- That a strategy is developed in conjunction with Thames Coromandel District Council to address:
    - notification of land owners and occupiers;
    - quantification of actual risks where a high likelihood of risks is suspected; and
    - risk communication should any high risk be quantified.
- That all parcels of land are listed on the Selected Land Use; and
- That further investigations are undertaken on the other land parcels identified in this report as having possibly been impacted by municipal refuse.



NORTH

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	FIGURE ONE
	MOANATAIARI LOCATION

NORTH

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	FIGURE TWO
	MOANATAIARI

NORTH

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	FIGURE THREE
	CHILD CARE CENTRE

NORTH

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	FIGURE FOUR
	A & G PRICE

NORTH

CSI Contaminated Site Investigations 80 Cook Street Hamilton	MOANATAIARI
	FIGURE FIVE
	ELECTRICAL SUBSTATION

APPENDIX A

INDIVIDUAL SITE DETAILS

ADDRESS	VRN	LEGAL DESCRIPTION	AREA ha
		BEACH STREET	
210	04870/190/00	24 ML KAUAERANGA LOT 1 DPS 735 LOT 1 DPS 77596 LOT 2 DPS 735 LOT 2 DPS 77596 LOT 3 DPS 735 LOT 3 DPS 77596 LOT 4 DPS 77596	1.28
		BURKE STREET	
405	04920/436/00	LOT 2 DPS 63709	0.0452
403	04920/436/01	LOT 1 DPS 63709	0.0501
401	04920/434/00	LOT 1 DPS 75613	0.4168
203	04920/378/00	LOT 44 DPS 11540	0.0733
201	04920/377/00	LOT 18 DPS 11540	0.0658
111	04920/327/00	LOT 17 DPS 11540	0.0607
109	04920/326/00	LOT 42 DPS 15691	0.0607
107	04920/325/00	LOT 41 DPS 15691	0.0607
105	04920/324/00	LOT 40 DPS 15691	0.0607
103	04920/323/01B	Flat 1 Cport 1 DP 378314 LOT 39 DPS 15691	
		TARARU ROAD	
101 A	04920/437/00	LOT 2 DP 33502	0.0218
101	04920/438/00	LOT 2 DPS 40387	0.0984
105 B	04920/439/00C	Flat 3 DPS 50805 LOT 5 DP 33502 LOT 6 DP 33502	
105 A	04920/439/00D	Flat 4 DPS 50805 LOT 5 DP 33502 LOT 6 DP 33502	
108	04870/189/00	LOT 2 DPS 74559	0.124
109	04920/440/00	LOT 1 DP 34906	0.1161
110	04870/177/00	LOT 18 KAUAERANGA NO 23 LOT 19 KAUAERANGA NO 23	0.0291
111	04920/441/00	LOT 2 DPS 2556	0.0835
112	04870/176/01	LOT 20 DP 7330	0.0619
113	04920/442/00	LOT 1 DP 34797	0.0835
114	04920/480/00	LOT 1 DPS 64408	0.105
115 B	04920/443/00B	Flat 2 DPS 36656 Pt 28A ML KAUAERANGA	
116	04920/479/00	LOT 1 DPS 6422	0.0835
117	04920/445/00	Pt LOT 1 DP 33184	0.0834
118	04920/478/00	LOT 2 DPS 14227	0.1389
119	04920/446/00	LOT 2 DP 33184	0.0842
120 B	04920/477/00B	Flat 2 DPS 15812 LOT 1 DPS 14227	
122	04920/475/02	LOT 1 DPS 7720	0.1884
201	04920/447/00	LOT 7 DPS 601	0.0736
203	04920/448/00	LOT 8 DPS 601	0.0746
205	04920/449/00	LOT 9 DPS 601	0.0741
207	04920/450/00	LOT 10 DPS 601	0.0736
209	04920/451/00	LOT 11 DPS 601	0.0731
211	04920/452/00	LOT 12 DPS 601	0.0711
		HAVEN STREET	
103	04870/179/00	23NO15 ML KAUAERANGA 23NO16 ML KAUAERANGA 23NO17 ML KAUAERANGA	0.0455
105	04870/180/00	23NO14 ML KAUAERANGA LOT 1 DP 7330	0.0344
107	04870/181/00	23NO13 ML KAUAERANGA LOT 2 DP 7330	0.0334
109	04870/182/01	LOT 1 DPS 57431	0.0456
111	04870/183/00	23NO10 ML KAUAERANGA LOT 4 DP 7330	0.0433
113	04870/184/00	Pt 23NO6 ML KAUAERANGA Pt 23NO6 ML KAUAERANGA Pt 23NO7 ML KAUAERANGA Pt 23NO7 ML KAUAERANGA Pt 23NO8 ML KAUAERANGA Pt 23NO8 ML KAUAERANGA Pt 23NO9 ML KAUAERANGA Pt 23NO9 ML KAUAERANGA Pt LOT 5 DP 7330	0.0675

ADDRESS	VRN	LEGAL DESCRIPTION	AREA ha
		COROMANDEL STREET	
101	04920/480/01	LOT 2 DPS 64408	0.05
103	04920/480/02	LOT 3 DPS 64408	0.05
105	04920/480/03	LOT 4 DPS 64408	0.04
106	04870/182/00	LOT 3 DP 7330	0.02
107	04920/480/04	LOT 5 DPS 64408	0.044
		QUEEN STREET	
1101	04920/482/00	LOT 3 DP 37090 SEC 2 Blk IV SO THAMES	0.0804
		FERGUSSON DRIVE	
101	04920/453/00	LOT 15 DPS 2098	0.0779
103	04920/454/00	LOT 14 DPS 2098	0.0842
105	04920/455/00	LOT 13 DPS 2098	0.0739
107	04920/456/00	LOT 12 DPS 2098	0.0739
109	04920/457/00	LOT 11 DPS 2098	0.0739
111	04920/458/00	LOT 10 DPS 2098	0.0739
113	04920/459/00	LOT 9 DPS 2098	0.0739
115	04920/460/00	LOT 8 DPS 2098	0.0739
117	04920/471/00	LOT 7 DPS 2098	0.0898
123	04920/287/00A	Flat 1 DPS 32312 LOT 3 DPS 2098	
117 B	04920/286/00B	Flat 2 DPS 28551 LOT 2 DPS 2098	
119	04920/285/00	LOT 1 DPS 2098	0.0718
125	04920/288/00	LOT 4 DPS 2098	0.0766
127	04920/289/00	LOT 5 DPS 2098	0.0764
203	04920/292/00	LOT 1 DPS 68635 LOT 25 DPS 2098	0.079
205	04920/293/00	LOT 26 DPS 2098	0.0759
207	04920/294/00	LOT 27 DPS 2098	0.0759
209	04920/295/00	LOT 28 DPS 2098	0.0759
301	04920/297/00	LOT 2 DPS 6308	0.0809
303	04920/298/00	LOT 1 DPS 6308	0.0809
305	04920/299/00	LOT 1 DPS 8945	0.0658
401	04920/302/00	LOT 2 DPS 11541	0.0683
403	04920/303/00	LOT 1 DPS 11541	0.0683
405 B	04920/304/02	Flat 2 DP 360465 LOT 1 DPS 15688	
407 B	04920/305/00B	Flat B DPS 21178 LOT 2 DPS 15688	
409	04920/306/00	LOT 3 DPS 15688	0.0607
411 A	04920/307/00	LOT 1 DPS 86179	0.0275
411 B	04920/307/01	LOT 2 DPS 86179	0.0331
413	04920/308/00	LOT 5 DPS 15688	0.0607
415 B	04920/309/00B	Flat B Grge DPS 22489 LOT 6 DPS 15688	
417	04920/310/00	LOT 7 DPS 15688	0.0607
419	04920/311/00	LOT 12 DPS 15689	0.0607
421	04920/312/00	LOT 13 DPS 15689	0.0607
423 A	04920/313/00	LOT 1 DPS 85641	0.0278
423 B	04920/313/01	LOT 2 DPS 85641	0.0328
425	04920/314/00	LOT 15 DPS 15689	0.0607

ADDRESS	VRN	LEGAL DESCRIPTION	AREA ha
		FERGUSSON DRIVE	
427	04920/315/00	LOT 22 DPS 15690	0.0607
429	04920/316/00	LOT 23 DPS 15690	0.0607
431	04920/317/00	LOT 24 DPS 15690	0.0607
433	04920/318/00	LOT 25 DPS 15690	0.0607
435	04920/319/00	LOT 26 DPS 15690	0.0607
437	04920/320/00	LOT 36 DPS 15691	0.0607
439	04920/321/00	LOT 37 DPS 15691	0.0632
441	04920/322/00	LOT 38 DPS 15691	0.0771
		KURANUI STREET	
101	04920/402/00	LOT 13 DPS 601 LOT 62 DPS 2098 LOT 63 DPS 2098 LOT 64 DPS 2098 LOT 65 DPS 2098 LOT 66 DPS 2098 LOT 71 DPS 2098 LOT 72 DPS 2098 LOT 73 DPS 2098 LOT 74 DPS 2098 LOT 75 DPS 2098 LOT 76 DPS 2098 LOT 77 DPS 2098 LOT 78 DPS 2098	1.9766
110	04920/433/00	LOT 1 DPS 2556	0.0837
114	04920/431/00	28A ML KAUAERANGA	0.1067
116	04920/430/00	Pt LOT 1 DP 33184	0.0832
200	04920/428/00	LOT 1 DPS 601	
202	04920/427/00	LOT 2 DPS 601	0.0746
204	04920/426/00	LOT 3 DPS 601	0.0741
205	04920/408/00	LOT 38 DPS 2098	0.0774
206	04920/425/00	LOT 4 DPS 601	0.0736
207	04920/409/00	LOT 37 DPS 2098	0.0774
208	04920/424/00	LOT 5 DPS 601	0.0731
209	04920/410/00	LOT 36 DPS 2098	0.0774
211	04920/411/00	LOT 35 DPS 2098	0.0819
213	04920/412/00	LOT 34 DPS 2098	0.0936
300	04920/421/00	LOT 23 DPS 2098	0.0855
301	04920/413/00	LOT 33 DPS 2098	0.0878
302	04920/420/00	LOT 22 DPS 2098	0.0739
303	04920/414/00	LOT 32 DPS 2098	0.0885
304	04920/419/00	LOT 21 DPS 2098	0.0739
306	04920/418/00	LOT 20 DPS 2098	0.0739
307	04920/291/00	LOT 2 DPS 68635	0.0743
308	04920/417/00	LOT 19 DPS 2098	0.0739
310	04920/416/01	LOT 18 DPS 2098	0.0739
312	04920/416/00	LOT 17 DPS 2098	0.0739
314	04920/290/00	LOT 6 DPS 2098	0.0683
		DICKSON STREET	
100	04920/423/00	LOT 6 DPS 601	0.0711
103	04920/422/00	LOT 16 DPS 2098	0.0784
		MOANATAIARI STREET	
103	04920/379/00	LOT 43 DPS 11540	0.0658
105	04920/380/00	LOT 42 DPS 11540	0.0658
107	04920/381/00	LOT 41 DPS 11540	0.0658
109	04920/382/00	LOT 40 DPS 11540	0.0655
111	04920/383/00	LOT 39 DPS 11539	0.0663
113	04920/384/00	LOT 38 DPS 11539	0.0716
115	04920/385/00	LOT 37 DPS 11539	0.0754

ADDRESS	VRN	LEGAL DESCRIPTION	AREA ha
		MOANATAIARI STREET	
200	04920/401/00	LOT 44 DPS 2098	0.0751
202	04920/400/00	LOT 43 DPS 2098	0.0764
203	04920/390/00	LOT 7 DPS 6308	0.0809
204	04920/399/00	LOT 42 DPS 2098	0.0759
205	04920/391/00	LOT 6 DPS 6308	0.0809
206	04920/398/00	LOT 41 DPS 2098	0.0756
207	04920/392/00	LOT 2 DPS 30104	0.0602
208	04920/397/00	LOT 40 DPS 2098	0.1042
209	04920/393/00	LOT 4 DPS 6308	0.0885
210	04920/396/00	LOT 39 DPS 2098	0.0913
211	04920/394/00	LOT 3 DPS 6308	0.0809
212	04920/395/00	LOT 29 DPS 2098 LOT 30 DPS 2098	0.0816
		CENTENNIAL AVENUE	
102	04920/376/00	LOT 19 DPS 11540	0.0658
103	04920/328/00	LOT 16 DPS 11540	0.0607
104	04920/375/00	LOT 20 DPS 11540	0.0673
105	04920/329/00	LOT 15 DPS 11540	0.0607
106	04920/374/00	LOT 21 DPS 11540	0.0713
108	04920/373/00	LOT 22 DPS 11540	0.0736
109	04920/341/00	LOT 12 DPS 11539	0.0607
110	04920/372/00	LOT 23 DPS 11539	0.0741
111	04920/342/00	LOT 11 DPS 11539	0.0607
112	04920/371/00	LOT 24 DPS 11539	0.0779
113	04920/343/00	LOT 10 DPS 11539	0.0607
114	04920/370/00	LOT 25 DPS 11539	0.0774
115 B	04920/344/00B	Flat 2 DPS 32306 LOT 9 DPS 11539	
116	04920/369/00	LOT 26 DPS 11539	0.0658
117	04920/345/00	LOT 8 DPS 11539	0.0622
118	04920/368/00	LOT 27 DPS 11539	0.0675
201	04920/359/00	LOT 7 DPS 11539	0.068
202	04920/366/00	LOT 29 DPS 11541	0.0683
203	04920/360/00	LOT 6 DPS 11541	0.0683
204	04920/365/00	LOT 30 DPS 11541	0.0683
205	04920/361/00	LOT 5 DPS 11541	0.0683
206	04920/364/00	LOT 1 DPS 30104	0.0942
207	04920/362/00	LOT 4 DPS 11541	0.0683
208	04920/363/00	LOT 32 DPS 11541	0.0731
209	04920/301/00	LOT 3 DPS 11541	0.0701
210	04920/300/00	LOT 33 DPS 11541	0.0696
		ENSOR STREET	
103	04920/429/00	LOT 2 DP 33184	0.0842
200	04920/407/00	LOT 49 DPS 2098	0.0766
202	04920/406/00	LOT 48 DPS 2098	0.0774
204	04920/405/00	LOT 47 DPS 2098	0.0774
206	04920/404/00	LOT 46 DPS 2098	0.0774
208	04920/403/00	LOT 45 DPS 2098	0.0774
300	04920/389/00	LOT 8 DPS 6308	0.0825

ADDRESS	VRN	LEGAL DESCRIPTION	AREA ha
		ENSOR STREET	
301	04920/387/00	LOT 35 DPS 11539	0.0675
302	04920/367/00	LOT 28 DPS 11539	0.0696
303	04920/388/00	LOT 34 DPS 11539	0.0688
402	04920/358/00	LOT 21 DPS 15689	0.0607
403 B	04920/346/00B	Flat 2 DPS 26102 LOT 32 DPS 15690	
404 B	04920/357/00A	Flat 1 Grge 1 DPS 34941 LOT 20 DPS 15689	
406	04920/347/00	LOT 31 DPS 15690	0.0668
406	04920/356/00	LOT 11 DPS 15688	0.0678
407	04920/348/00	LOT 30 DPS 15690	0.0782
408	04920/355/00	LOT 10 DPS 15688	0.0612
409	04920/349/00	LOT 16 DPS 15689	0.0701
411	04920/350/00	LOT 17 DPS 15689	0.0607
413 B	04920/351/00B	Flat B DPS 21615 LOT 18 DPS 15689	
415	04920/352/00	LOT 19 DPS 15689	0.0607
417	04920/353/00	LOT 8 DPS 15688	0.0677
419	04920/354/00	LOT 9 DPS 15688	0.0607
		MARGARET PLACE	
102 A	04920/340/00A	Flat A Cport C DPS 22241 LOT 35 DPS 15690	
103	04920/331/00	LOT 43 DPS 15691	0.064
104	04920/339/00	LOT 34 DPS 15690	0.063
105 A	04920/332/00	LOT 1 DPS 68753	0.0302
105 B	04920/332/01	LOT 2 DPS 68753	0.0353
106	04920/338/00	LOT 33 DPS 15690	0.0635
107	04920/333/00	LOT 45 DPS 15691	0.085
108	04920/337/00	LOT 29 DPS 15690	0.0658
109	04920/334/00	LOT 46 DPS 15691	0.068
111	04920/335/00	LOT 27 DPS 15690	0.0647
115	04920/336/00	LOT 28 DPS 15690	0.0632

APPENDIX B

AERIAL PHOTOS

NORTH

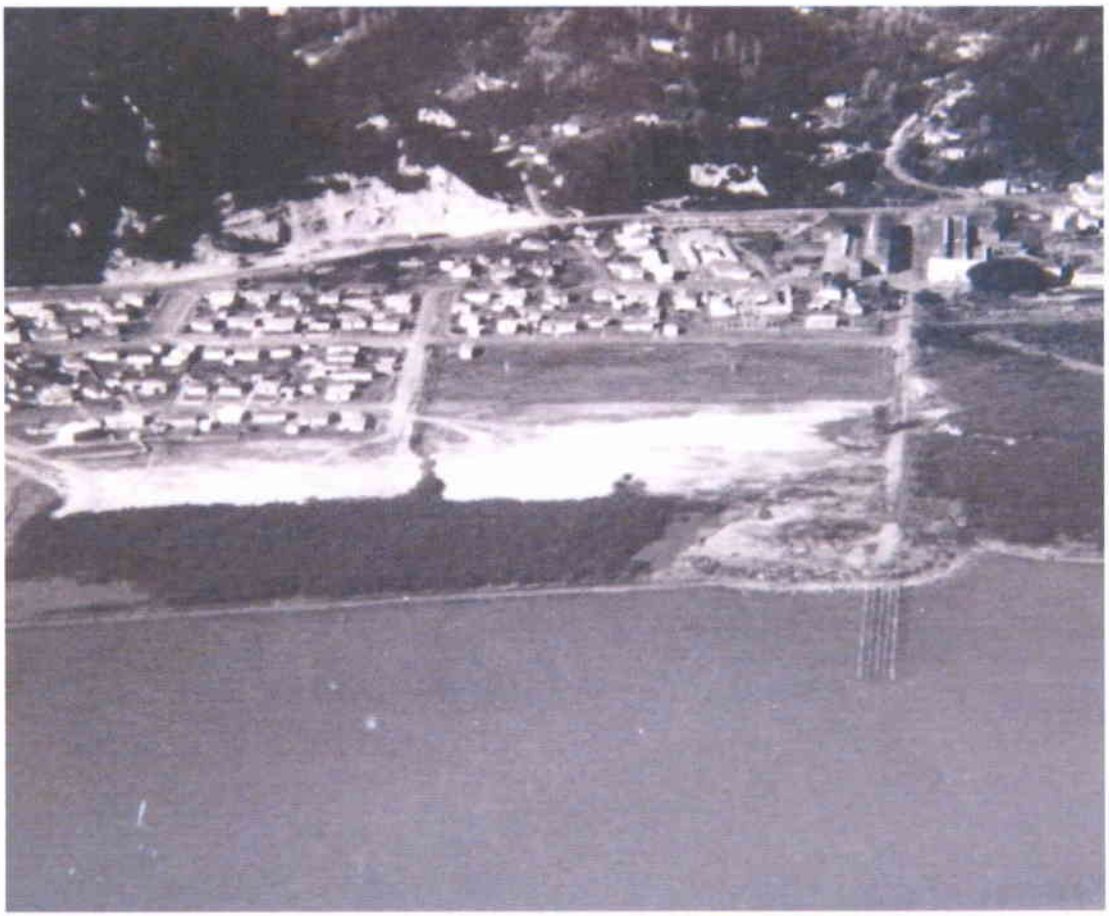
CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK01
	1940

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK02
	1985

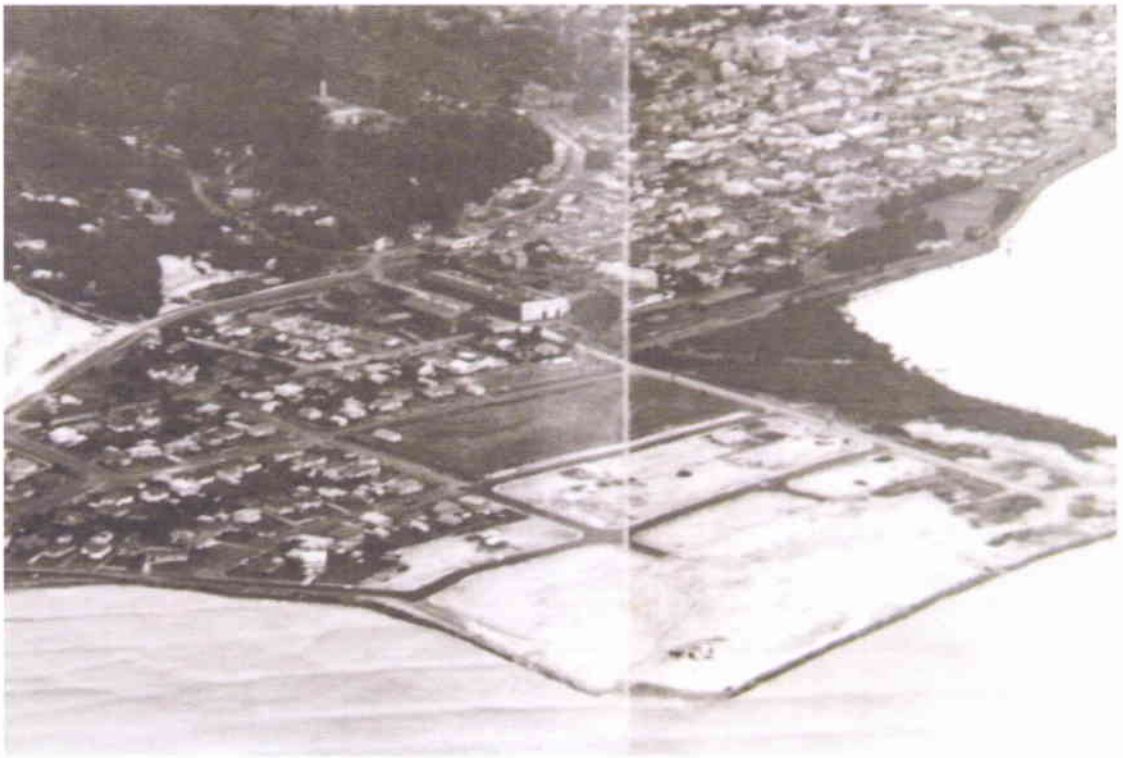
APPENDIX C

OBLIQUE AERIAL PHOTOS

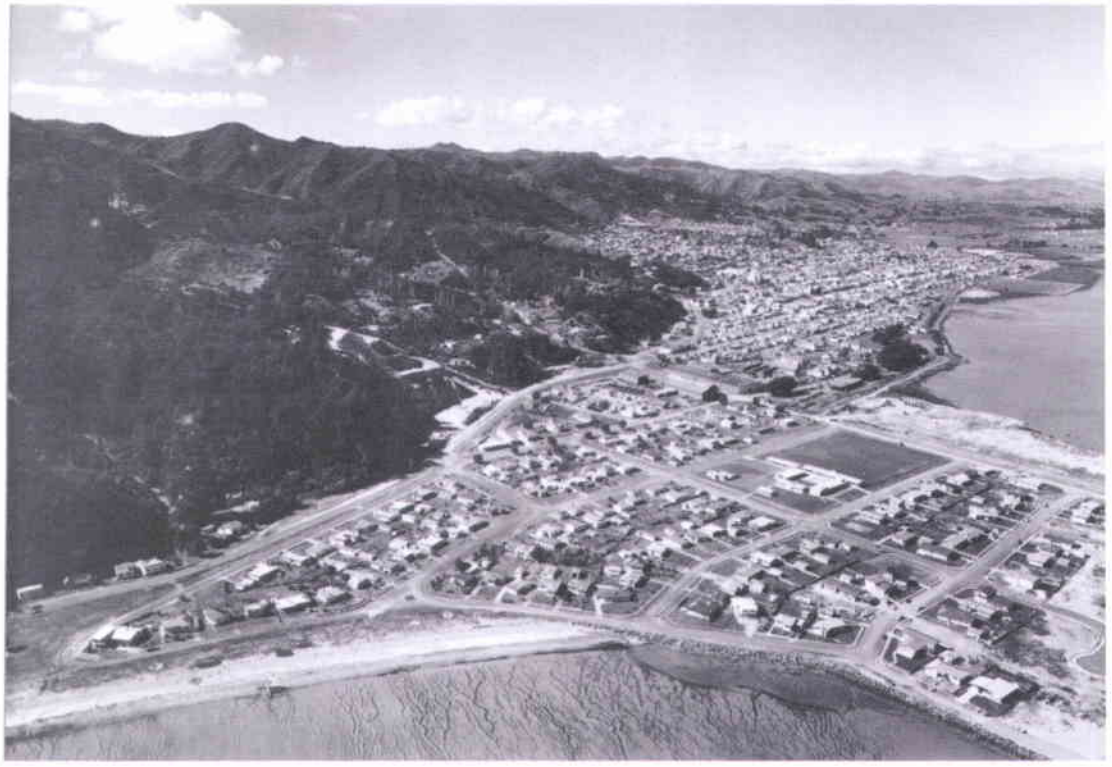
CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK03
	1965



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK04
	1967



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK05
	1968

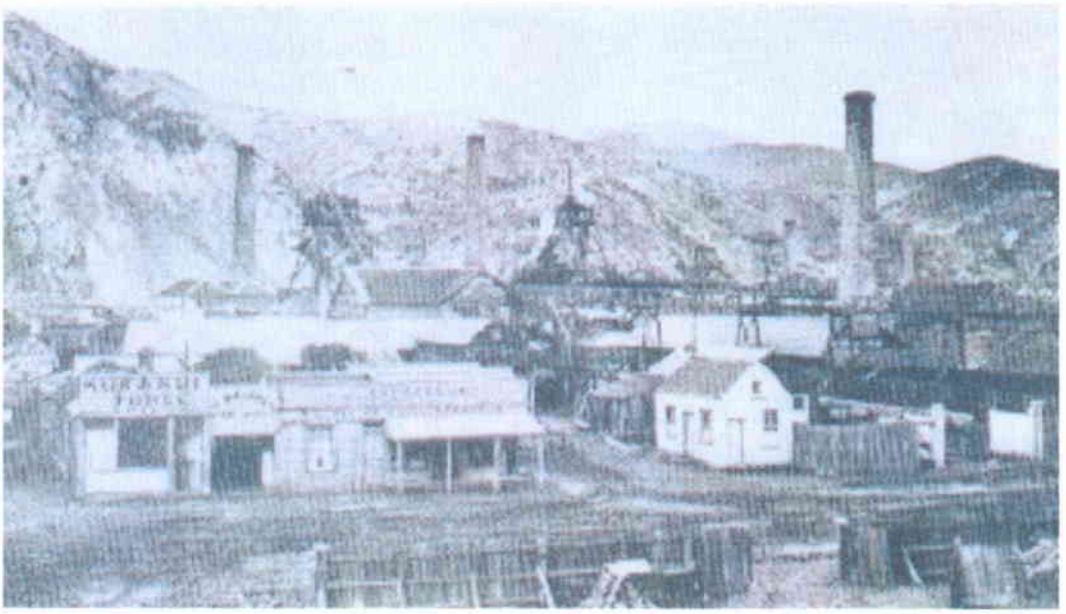


CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK06
	1972

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK07
	1983

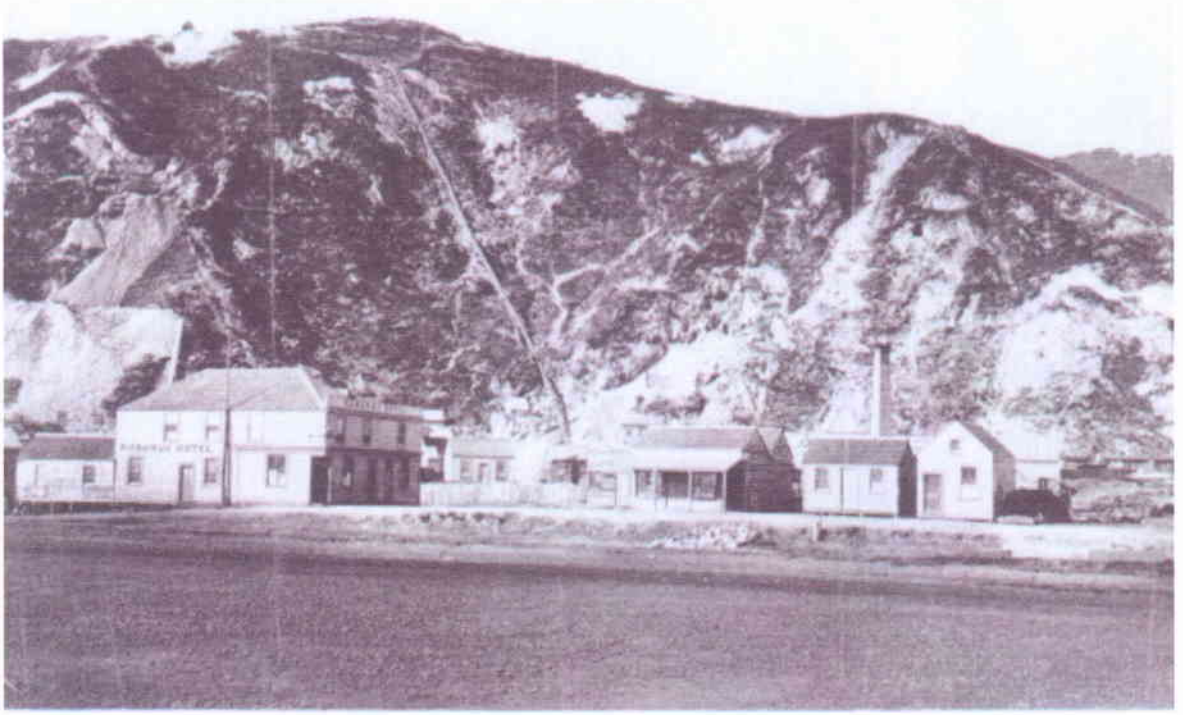
APPENDIX D

HISTORICAL PHOTOS



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK08
	1868

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK09
	1868



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK10
	1868

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK11
	1877

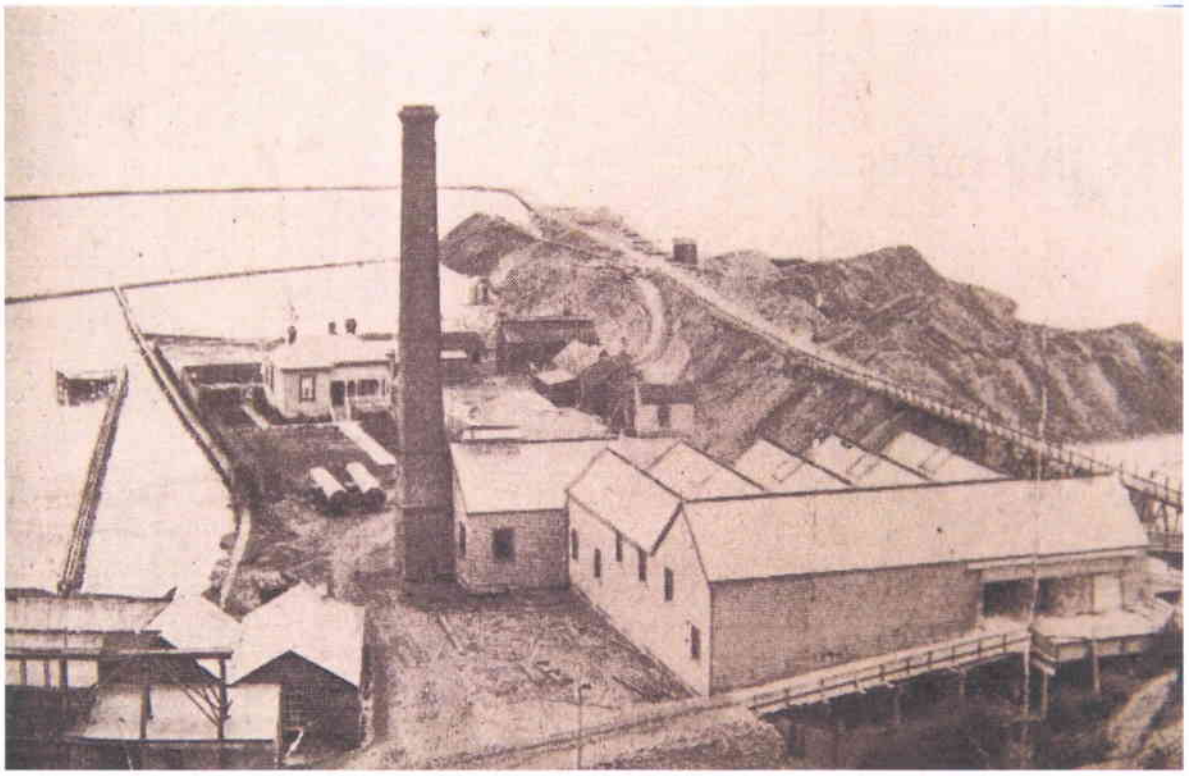
CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK12
	1877

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK13
	1898

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK14
	1898

CSI Contaminated Site Investigations 80 Cook Street Hamilton	MOANATAIARI
	SK15
	1909

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK16
	1910



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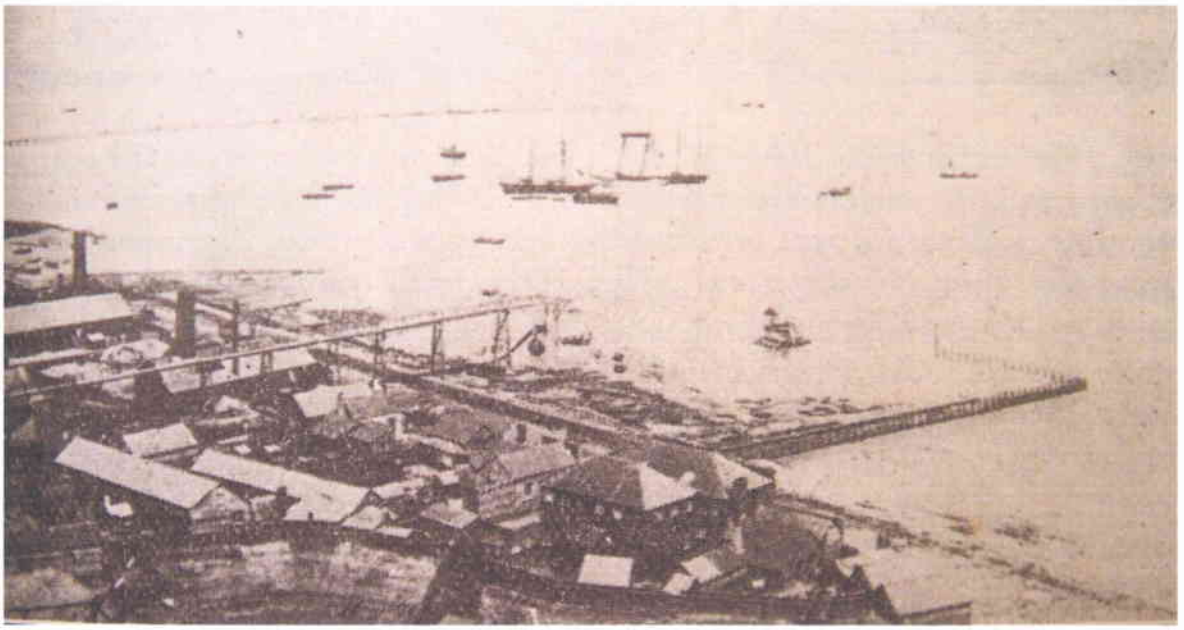
	SK17
	NO DATE



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK18
	NO DATE

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK19
	NO DATE

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK20
	NO DATE

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK21
	NO DATE

APPENDIX E

THAMES COROMANDEL DISTRICT COUNCIL INFORMATION

FILE COPY

INTERNAL MEMORANDUM

3 February 1997

35.40.78.03

CONFIDENTIAL

TO: CEO

FROM: John Farquhar

SUBJECT: MOANATAIARI SUBDIVISION

It is appropriate that I record for you the results to date of my investigations into appropriate levels of flood protection for the Moanataiari.

You gave me responsibility for this project in mid-November 1996. On 10 January 1997 the area was inundated, 33 houses flooded, from the effects of storm waves generated, I believe, by Cyclone Drena in its movement down New Zealand's west coast. The wave event is, so far as any witnesses have observed, unprecedented. There are no wave records for the Firth of Thames.

While this event was particularly unfortunate from every perspective, it has concentrated resources and effort on the project, and provided new evidence of the hazard this coastal subdivision is exposed to.

Background

The Moanataiari area is built on land originally reclaimed by the Thames Harbour Board as part of its rather grandiose harbour developments of 1929. See plan A attached which shows the Harbour Board's development proposals. Prior to the 1920's development, the area was probably low-lying swampy coastal land, which had been extensively filled with mine mullock or tailings discharged from the batteries locally associated with gold mines in the area. The 1929 plan shows the remains of an earlier sea wall probably about the alignment of Centennial Ave.

The coastal defences for the Moanataiari area are based on the 1929 rock walls.

The Development Process

A search of the old Thames Borough records shows that the Borough Council

1. Inherited the title from the Harbour Board on the amalgamation of the Council and Board in 1936.

2. Progressively laid out the area from the landward end as streets and sections from about 1948 until 1972.

3. Overall engineering development was based on a scheme prepared by Engineering Consultant, B.W. Hamilton, in 1951. (Attached - Doc 2.)

4. Various engineers and overseers exercised some oversight of the works during the period of the development. In the later stages (identified by the Borough as Moanataiari No. 2 subdivision) when the block west of Centennial Drive was developed, various engineers - Max Bosselman, J T Turoa, B Poff, were involved. I have interviewed Max Bosselman on his involvement. He recalls very limited involvement - some work on services design is all he recollects or can locate in his records. Evidence of involvement appears in Document 3.

The engineering reports all focus on the filling of the tidal swamp, and the construction of services.

There is no indication in any of the records that any of the engineers were asked to or offered any information on the adequacy of the protection offered by the existing sea wall, or on the risk the sea posed the development. Mr Hamilton's initial report gives some cursory attention to extra costs related to 40 sections facing the waterfront and "stonewalling to street F", but this does not appear to be followed up anywhere, or supported by any design or design standard. At the time the No. 2 development was being promoted by the Borough, the Hauraki Catchment Board reminded the Council of the need for care with levels and security. This advice followed an enquiry by the Town Clerk regarding the Borough's special legislation for reclamation authority for about 200 acres between the Kauaeranga River and Moanataiari and may not have specifically registered as relating to the on-going and committed development of Moanataiari.

5. There is no evidence of any formal regulatory process in the development. The Council apparently filled the land, employed a surveyor to lay out streets and boundaries, and approved the final subdivision plan. I have found no evidence of any subdivision standards actually existing at the time, or of any regulatory overview of the total scheme.

While this may be not inconsistent with some small borough practices of the time, the development overview process falls short of the standard established by the immediate neighbour, Thames County Council, which was at the time concerned with the development of Pauanui, Whangamata areas.

6. The manner in which the land was filled was probably consistent with other marine area filling projects carried out around the country at the time. The file identifies projects done in a similar fashion in Nelson and in Invercargill. (Doc 4 identifies approach).

On the Moanataiari project the reclaimed land has dumped almost 1m from its apparent finished height in 1969, in the northwest corner.

The consequence of this is that the land, which was comfortably above the level of highest spring tides, is now up to 150 mm below the highest spring tides. Se handwritten memo, apparently from Borough Engineer Turoa, 1969 - Doc 5.

While the land is not sinking at any measurable rate today we do not know if that is because it is securely stable, or whether it has simply reached a cautious equilibrium which could be upset by other relatively minor natural events. Certainly our drilling under the northwest corner reveals nothing which gives us any security at this stage, although proper conclusions about this area will not be available until the geotechnicians have completed their analysis.

The method of construction of the land surface, on reflection, gives a clue as to why this situation has occurred in this area. Eye witnesses at the time of the construction describe how the surface mud was rolled back by bulldozers towards the northwest corner of the reclamation and simply pushed in waves over the existing wall as the filling was consolidated towards that corner.

This action would surcharge this corner with marine mud, and must have trapped a considerable wave of unconsolidated mud and water inside the wall. By its nature this would, I expect, give this particular area quite different settlement characteristics from the rest of the area.

Conclusions:

I would stress that these are very personal conclusions and reflect a fairly negative view of the process.

1. **The Borough Council did not subject its own development to any regulatory examination.**

   Even a fairly ordinary internal/independent review would have asked some questions which should have improved the standard of work done, which would have resulted in the traps in the filling and consolidation process and the risk relating to the sea wall.

2. The Borough Council did not employ adequately qualified and experienced advisers with responsibility to overview the whole process.

   Engineering oversight was sporadic at best. No overall construction standards appear to have been set, and no precautionary investigation undertaken.

3. I believe an independent technical review would establish that the slumping in the northwest corner can be directly attributed to the construction technique, and would have been avoided if proper professional advice had been sought and taken.

4. I believe that such a review would establish that the Borough was negligent in not applying the Hauraki Catchment Board's advice (Doc 6.) about heights of reclamation, berm widths and reserve areas.

The Board's letter contains a perhaps oblique reference to the need for coastal defences, which should have warned Borough staff to look carefully in this area.

In my opinion the weaknesses in the original process and the lack of cautious professional engineering standards or consideration applied to the Moanataiari subdivision leaves Council rather more exposed than is desirable to some special liability to those landowners.

.....
J.M. Farquhar
DEPUTY CHIEF EXECUTIVE

Attach:

Harbour Board's development
Scheme prepared by Engineering Consultant, B W Hamilton
Document 3 - Evidence of Involvement
Document 4 - Identifies approach
Document 5 - Handwritten Memo by Borough Engineer Turoa
Document 6 - HCB advice

NOTES OF A MEETING HELD 1 DECEMBER 1995 RELATIVE TO THE THAMES FLOOD MITIGATION PROJECT

PRESENT: Colin Brokenshire, Andrew Lilburn (Thames Community Board Members), Joel Robinson, Peter Ireland, Bain Cross, Heather Knight (Council staff), Jim Dahm (Environment Waikato), Barry Murch

The meeting reviewed the history of the Moanatairi development.

The Thames Borough Council, through an Act of Parliament, had licences to fill a large area of the Firth. The boundaries of the Moanatairi site were the stone walls, established as protection for the original Thames Wharf. The Borough Council subsequently strengthened and raised these walls (1980) in the belief that by adding rock, settlement would occur more quickly.

The site was initially a rubbish dump / refuse depot and filling occurred between 1965/70. Refuse was first dumped west of Tararu Road, progressing south to the Waiotahi (?) stream outlet.

Verrans filled the site west of Moanatairi Road with quarry tailings, and as filling took place, a wave of mud was pushed out to the north-west corner. No compaction or pre-loading estimates were taken, and the depth of the mud base was not established, although it is considered the depth was approximately 4 m.

Tararu Road was used as the level datum (check with Colin Hovell / Howard Selwood).

Soon after the area was relatively level, subdivision of the land occurred, roads were constructed, sections sold, and houses erected. The school site was built up an additional 1 m above the levels.

Max Bosselmann designed the stormwater system over most of the subdivision, the Borough did the west boundary.

Barry Murch was the Borough Building Inspector at the time, and promoted that house foundations should be of a raft design, rather than pile construction.

In 1981 a report was done on the sea wall and Council promoted a beach proposal in front of the western sea wall in its planning documents.

Frank Millington completed a survey in 1982, using seven points on the centre line of Burke Street, which identified settlement of the land of approximately 5 cm.

A further survey in 1987 established that the southern boundary had sunk 50 cm and extended out 75 mm.

Prior to 1979 no flooding of the area occurred as a result of sea water breaching the sea wall. The 1979 flood event was created by

Since 1979 sea water breaching the wall has been a contributing factor to flood events.

Problems were also reported by the Tararu Store and Kurunui Street areas, including sewerage problems.

Although awareness of the settlement of sewerage and stormwater reticulation were acknowledged (possibly due to the pipes being laid at too flat a grade) there was a lack of awareness of building settlement. It was considered that there were no greater problems in this area, comparative to other areas of Thames. But it was recognised that the north-west corner was of specific concern.

Jim Dahm advised that Environment Waikato are currently gathering information on sea walls and some direction on this is included in the Coastal Plan. Environment Waikato have experienced similar situations in other areas and some case law exists (Wainui Beach, Nokau).

Environment Waikato's approach is to involve all affected parties to reach an amicable agreement. Although off-site relocation is optimum, all extenuating factors need to be borne in mind (ie buyer/seller situation), including development (ie climate change, sea level rise, estuarine situation, environmental effects, etc).

Member Brokenshire noted some residents of Moanatairi were organising a petition requesting information on Council's actions in addressing the problem. He requested that a press statement be released advising that a committee had been established to review the problems, and that when further information was available a public meeting would be held with affected residents.

A copy of the Flood Management plan was requested to be made available to Community Board Members.

Environment Waikato are currently undertaking a detailed study of land protection around the district in order to provide a modelling strategy. (This report is due February/March 1996). Discussions will be held with the District Council on specific issues that affected the TCDC district.

Mr Dahm asked that the Thames Community Board give consideration to allocating funding toward a joint study 1996/97 on various aspects of sea land interactions/effects (to be addressed with the Thames Community Board Business Plan process).

Actions identified:

- levels to be established (funding provision provided TCB 1995/96)
- letter to residents (history, committee formed, what looking at, difficulties in getting info and deciding level of protection)
- seek representative from affected residents to sit on committee
- further information to be gathered from Frank and Max

Next Meeting — February.
Insurance professional (CD) to be contacted and attend next meeting of this committee to advise on where insurance companies are coming from - their perspective.

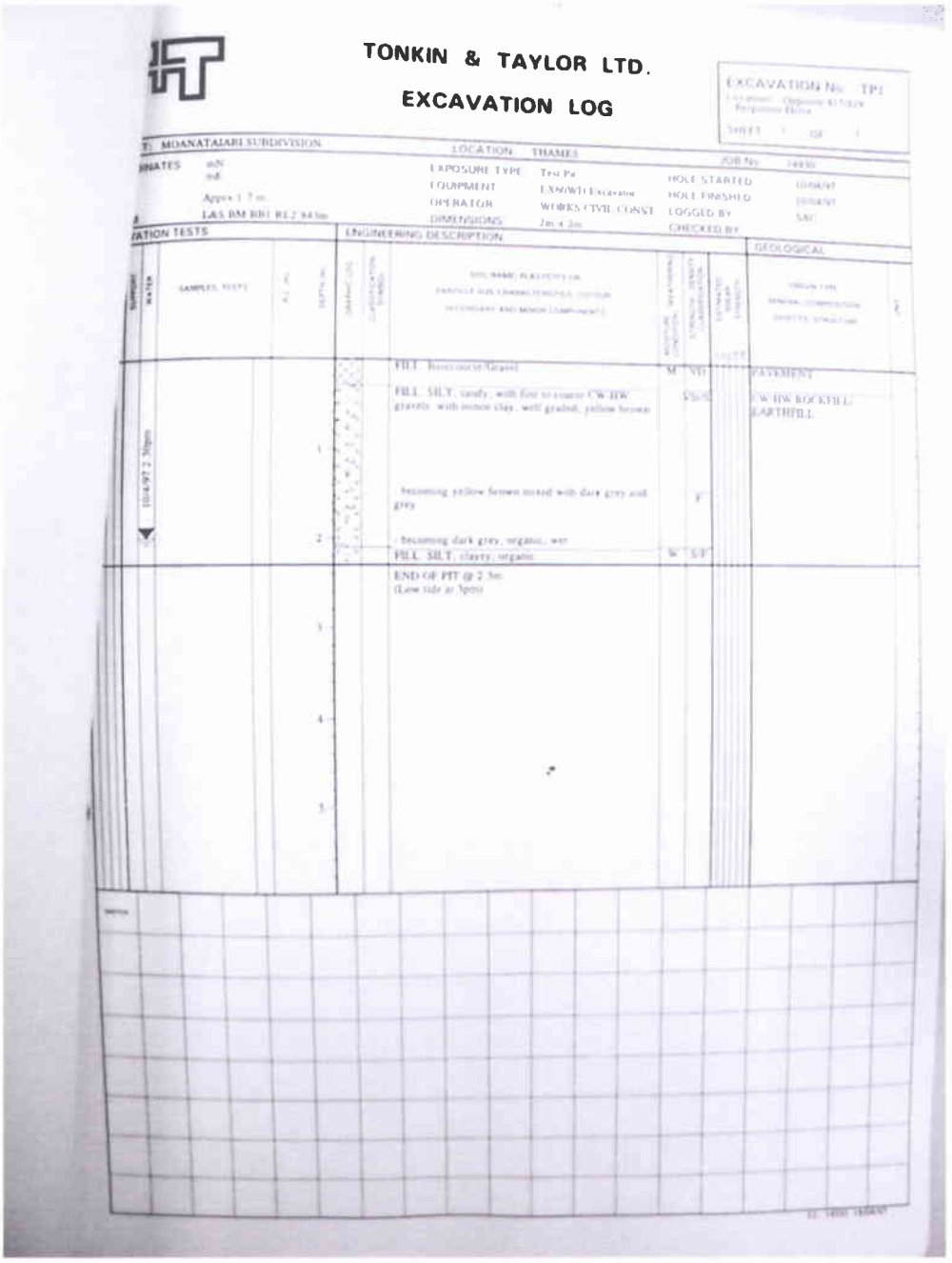
5. Geotechnical Considerations

The Moanataiari subdivision was formed progressively from the turn of the century by indiscriminate dumping of mine tailings and mullock over extensive marine sediments followed by dredgings from the port (Photo 1). Finally, capping with a raft of weathered rock and clay fill sourced from the adjacent hills was constructed under controlled conditions in the mid to late 1960s. Limited available records indicate that filling was essentially complete by May 1968 and that settlements were monitored over the following 13 months. Housing construction was generally underway in the period 1973-1977.

There is a lack of settlement observations over the past 30 years, and no as-built confirmation of road design levels. However, recent survey records over 3 years show a uniform settlement of 16 mm/year at the seaward edge of the subdivision along Fergusson Drive. A 1997 inspection of some seventy houses, including many constructed of settlement-sensitive unreinforced masonry or plaster finishing, showed no widespread adverse effects of settlement. Results of the geotechnical investigations were used to assess ongoing settlement, stability of the raised seawall embankment, the potential for significant seepage under high tide/surge conditions and liquefaction potential under seismic conditions.

A staged borehole and test pit investigation in early 1997 included cone penetrometer testing to some 30 m depth. The earthfill raft of stiff silts and clays was generally 1.5 to 2 m thick overlying soft to firm dredgings and marine sediments, including continuous sand layers. In-situ strength and standard penetration testing was complemented by laboratory consolidation tests on thin-walled tube samples. Monitoring of standpipe groundwater levels indicated little tidal influence and relatively low in-situ mass permeabilities of the earthfill raft and underlying sediments.

Settlement analyses and a review of the historical data suggests that the majority of settlement associated with subdivisional development is likely to have occurred within the 5 year period before housing construction. The present rate of surveyed settlement suggests some secondary compression, although the rafting effects are expected to minimise differential effects, as they have over the past 25 years. Allowance has been made for settlement in the final seawall embankment crest details. The stability of the raised and widened embankment was analysed using Bishop's method and the SLOPE/W software, and the minimum design factor of safety of 1.4 was achieved for both low and



TONKIN & TAYLOR LTD.

EXCAVATION LOG

EXCAVATION No. TP1

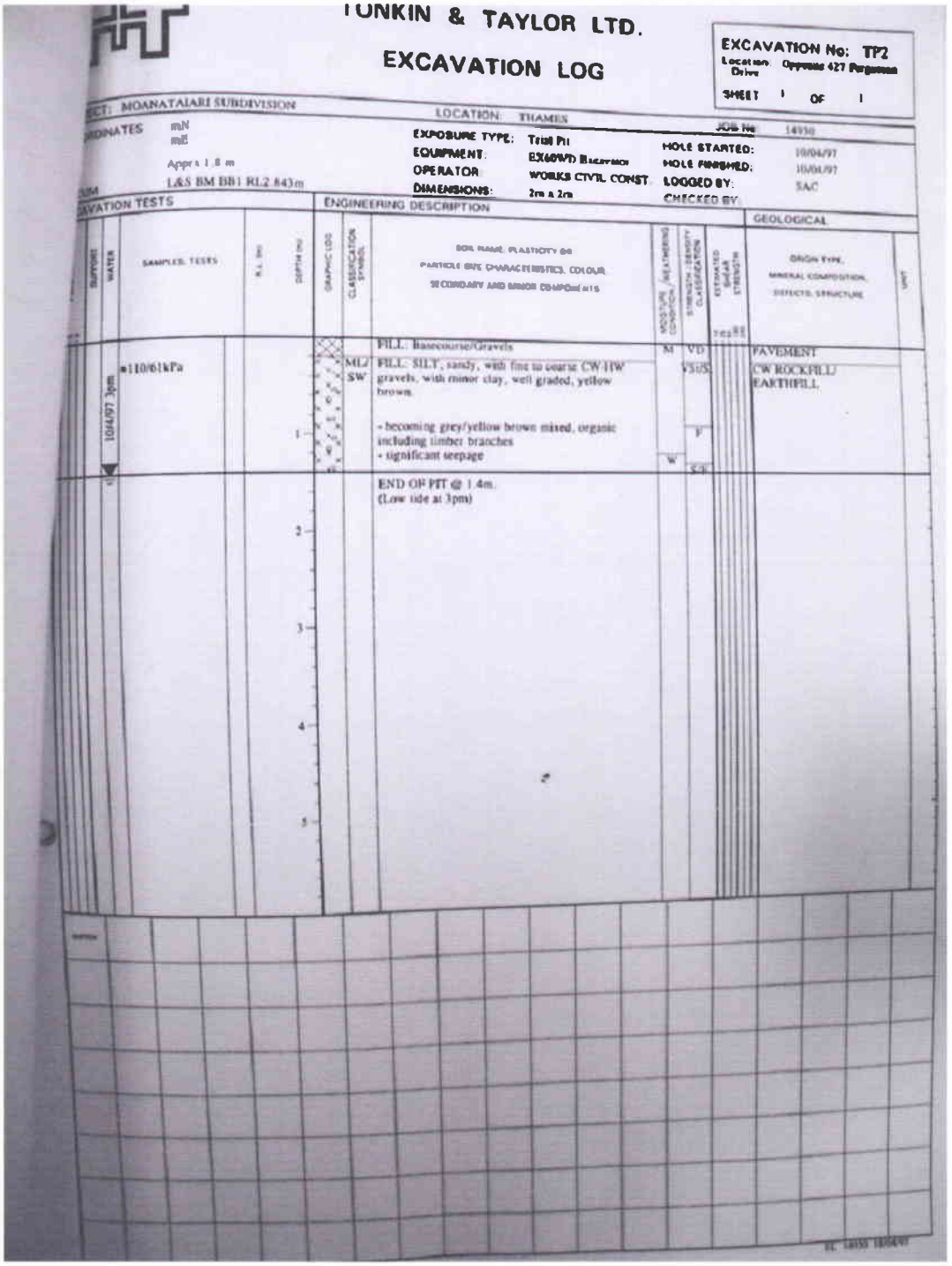
SHEET 1 OF 1

T: MOANATAIARI SUBDIVISION — LOCATION THAMES — JOB No. [illegible]

NATES	mN mE	EXPOSURE TYPE	Test Pit	HOLE STARTED	[illegible]
	Approx 1.7 m	EQUIPMENT	EX60WD Excavator	HOLE FINISHED	[illegible]
	L&S BM BR1 RL2.843m	OPERATOR	WORKS CIVIL CONST	LOGGED BY	SAC
		DIMENSIONS	2m x 3m	CHECKED BY	

ATION TESTS				ENGINEERING DESCRIPTION				GEOLOGICAL
SUPPORT	WATER	SAMPLES, TESTS	A.C. (%)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, DESIGN SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	WEATHERING	STRENGTH, DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH	ORIGIN TYPE, GENERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
							FILL: Reinforcement/Gravel	M	VD		PAVEMENT	
	10/4/97 2.30pm			1			FILL: SILT, sandy, with fine to coarse CW-HW gravels, with minor clay, well graded, yellow brown		VS/S		CW HW ROCKFILL, EARTHFILL	
							becoming yellow brown mixed with dark grey and grey		F			
				2			becoming dark grey, organic, wet					
							FILL: SILT, clayey, organic	W	S/F			
							END OF PIT @ 2.5m (Low tide at 3pm)					
				3								
				4								
				5								

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC04
	TONKIN AND TAYLOR



TONKIN & TAYLOR LTD.

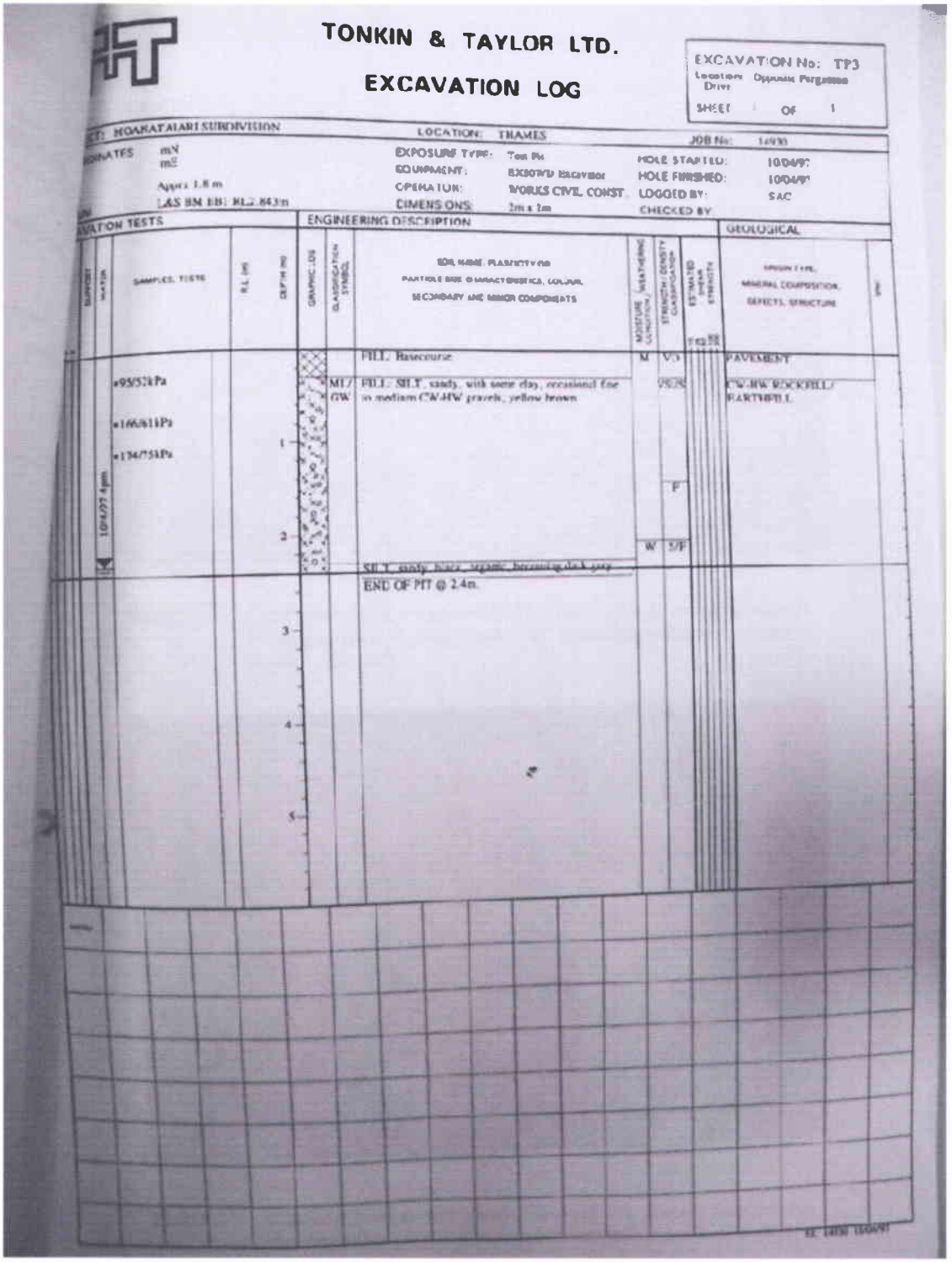
EXCAVATION LOG

EXCAVATION No: TP2
Location: Opposite 427 Ferguson Drive
SHEET 1 OF 1

ECT: MOANATAIARI SUBDIVISION
LOCATION: THAMES
JOB No: 14930
ORDINATES mN mE
Appx 1.8 m
L&S BM BB1 RL2.843m
EXPOSURE TYPE: Test Pit
EQUIPMENT: EX60WD Excavator
OPERATOR: WORKS CIVIL CONST
DIMENSIONS: 2m x 2m
HOLE STARTED: 10/04/97
HOLE FINISHED: 10/04/97
LOGGED BY: SAC
CHECKED BY:

EXCAVATION TESTS					ENGINEERING DESCRIPTION				GEOLOGICAL
SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG / CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ORIGIN, MINERAL COMPOSITION, DEFECTS, STRUCTURE
	10/4/97 3pm	=110/61kPa		1		FILL: Basecourse/Gravels	M	VD	PAVEMENT
					ML/SW	FILL: SILT, sandy, with fine to coarse CW-HW gravels, with minor clay, well graded, yellow brown.		VS/S	CW ROCKFILL EARTHFILL
						+ becoming grey/yellow brown mixed, organic including timber branches + significant seepage	W		
				2		END OF PIT @ 1.4m. (Low tide at 3pm)			
				3					
				4					
				5					

EL: 14930 10/04/97



TONKIN & TAYLOR LTD.

EXCAVATION LOG

EXCAVATION No: TP3
Location: Opposite Pergamon Drive
SHEET 1 OF 1

...CT: HOAKATAIARI SUBDIVISION	LOCATION: THAMES		JOB No: 14930
...DINATES: mN / mE	EXPOSURE TYPE: Test Pit	HOLE STARTED:	10/04/97
Approx 1.8 m	EQUIPMENT: EX50WD Excavator	HOLE FINISHED:	10/04/97
L&S BM EB: RL2.843m	OPERATOR: WORKS CIVIL CONST.	LOGGED BY:	SAC
	DIMENSIONS: 2m x 2m	CHECKED BY:	

...VATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL
SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE, CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE
							FILL: Basecourse	M	VD		PAVEMENT
		•95/52kPa				MI / GW	FILL: SILT, sandy, with some clay, occasional fine to medium CW-HW gravels, yellow brown		VS/S		CW-HW ROCKFILL/ EARTHFILL
		•166/61kPa									
		•134/75kPa		1							
	10/4/97 4pm								F		
				2				W	S/F		
							SILT, sandy, black, organic, becoming dark grey				
							END OF PIT @ 2.4m.				
				3							
				4							
				5							

EE 14930 10/04/97

Mt. Albert,
Auckland, S.W.2.
5th June 1951.

203B

Town Clerk,
Thames Borough Council,
Thames.

Dear Sir,

Foreshore Sub-division.

I have to report that in accordance with your instructions in your 203 of 10th November 1950, I have carried out a stadia survey of the whole of the Moanataiari flats area, prepared a contour plan and a scheme for roading the area together with a sewerage system and water reticulation.

The scheme has been based on the principal of a gravity system of sewerage, and sufficient fill being used to allow cover on the sewers, and at the same time to have sufficient grade on the roads to permit of storm water run off. Where the State Highway Dept. intend to divert the main Tararu Rd. the road and number of sections available are still indefinite until we receive the final plans of the deviation, but I have kept my estimate of the number of sections on the low side.

For the purpose of allowing of progressive development of the area I am dividing the estimate into stages to show what would be sound present day development, a second stage and the final stage. I should like to point out that previous estimates were based on the plan prepared by the State Housing Dept. and on drawing my plans I found that their plan was not accurate. I find that the total area is approximately 52 acres (not including Burke St. or Tararu Rd.) of which 14½ acres would be taken up by roads and a further 9½ acres have already been sold or leased. So that the area at present available for housing sections is approximately 28 acres. This would give 140 fifth acre sections plus a further 5 sections when the Keelin lease expires and 10 more when the Mill lease is terminated. In addition there are the 12 sections already sold and a further 6 would be available if the present owners on the Tararu Rd. frontage should decide to halve their sections. This would bring the total number of rateable sections to 183.

Of the 140 new sections 90 would be available in the first stage at an estimated cost of £252 each, the cost of developing the second stage totalling 109 sections would be £28 each, and to develop the full 140 sections the cost would be £[illegible] each.

In order to arrive at a progressive development plan I had cross sections of the whole area drawn at 50 ft. and at 25 ft. intervals and from these have obtained an accurate measurement of the amount of cutting available and the fill required to various stages.

There is available in the large spoil dump 53,124 cu.yds. and a further 2,220 in the smaller one; a total of 55,344 cu.yds. of fill to half way between Ponds D and E 52,605 cu.yds. of spoil are required. As it is not possible at this stage to estimate the degree of consolidation that there would be in this filling as a result of machine compaction an estimation of this amount must be "gross" only. An allowance of 10% would show a deficit of 5,000 cu.yds.. This can be allowed for by a slight adjustment of final levels.

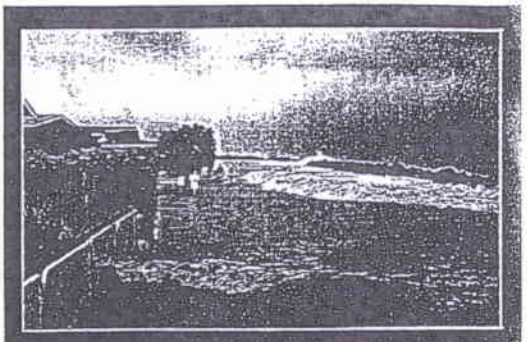
To complete the filling to Ponds E we would require 96,225 cu. yds. which would mean that 40,000 cu.yds would have to be carted in from one of the neighbouring spoil dumps. A further 80,000 cu.yds. would be required to complete the filling to the [illegible] Breakwater. As you will see this is approximately 80,000 cu.yds. greater than my original estimate based on the State Housing Dept's plan. As the actual area is 9 acres greater than that shown and the average depth over this section would be about 6 ft. this [illegible] quite closely.

An estimate of cost of development is given in Appendix A and a plan in Appendix B. Costs are based on present day prices.

The sewerage scheme consists of a 12" main sewer leading to the farther side of Kuranui Bay and passing under the main Tararu Road with about 3 ft of cover. The total cost of this main

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC05
	LETTER

Periodic flood damage, ground settlement, a sensitive coastline, and the withdrawal of insurance cover set the stage for a somewhat unusual environmental engineering project recently completed in the Firth of Thames.



Flood Protection

January 1997 did not start well for residents of the exposed Moanataiari subdivision in the Firth of Thames. The year's first cyclone had left a trail of devastation. Storm waves breaking over the protective sea wall embankment had flooded homes, turned roads into canals and gardens into sewage ponds. But the *really* depressing part was the deja vu. It mirrored a similar inundation 18 months earlier, which explained the insurance companies' reluctance to reinstate cover.

Moanataiari – everyone agreed – needed better flood protection. So the Thames Coromandel District Council appointed environmental engineering consultancy Tonkin & Taylor to investigate the problem and devise a solution. Finding one proved more of a challenge than initially envisaged. The subdivision's flood problems were compounded by unusual factors, and required a custom-designed solution.

For a start, the homes were built on land reclaimed in the 1960s. The area had been created with infill (largely spoil from the local gold diggings) dumped on top of compressible marine sediments. Over the following 30 years the land has been settling, to the point where some parts of the subdivision are now below highest sea level.

The subdivision was protected from the sea by a 550 m long rockfill seawall which in severe storms proved inadequate: after marching across the length of the Firth, waves and surge overtopped the wall easily. But a graver problem was the embankment's permeability: heavy surge simply flowed through the rockfill and quickly gave many residents a waterfront property.

Poor stormwater drainage contributed to the flooding. Run-off from the hills behind the subdivision pooled against the sea wall. Drainage pipes had been fitted in the embankment, but leaking flap valves often contributed backflow of water to the landward side of the wall. The pooled water caused havoc with the sewerage system, with predictable results.

Thames Coromandel District Council wanted a solution to address both the sea flooding and rainfall ponding, one capable of handling the "one-in-50 year" tempests. The budget was set at $1.6 million.

At that budget, removing and replacing the sea wall with a more substantial structure was not feasible. Besides, such a step could leave the subdivision vulnerable to the sea during construction of the project.

Reducing Environmental Impact

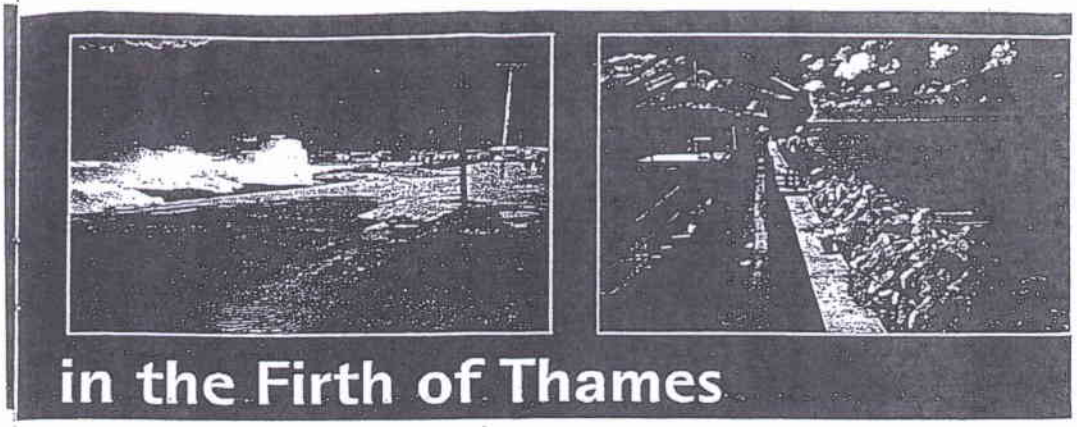
To minimise the impact of construction on the environment and the residents, the project was designed to re-use materials as far as possible. With the ready cooperation of the contractors, Fred Brown and Son Ltd, this included:

- Reuse of excavated roading material as a transition filter layer to improve the sea wall's sealing
- Use of local clay fill in preference to synthetic liners or sheet piling
- Minimisation of dumping by incorporation the majority of excavated spoil in non-critical embankments or landscaping
- Careful control of pollutants, particularly oil and fuels, including prevention of road soiling during movement of fill materials.

The solution

Essentially, the inundation problem was solved by upgrading the existing sea wall and making it impermeable. It has been raised 300 mm – to 3.5 m above the local mean sea level (the design level used for most stopbanks in the Hauraki Plains area). Additional pipes have been fitted to supplement the wall's existing gravity drainage system – and have been equipped with flap or rubber Tideflex valves. The subdivision's stormwater

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC06
	MR. JOHN DUDER



in the Firth of Thames

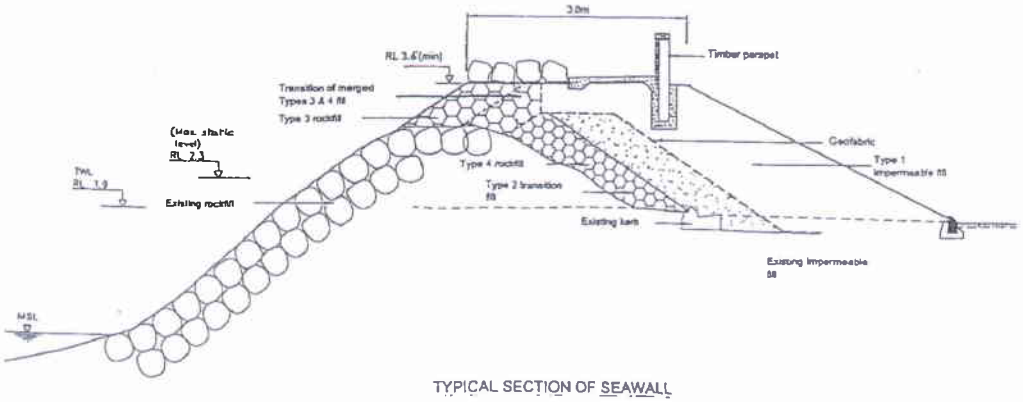
system has also been upgraded. It now features a pump station to handle catchment rainfall when it exceeds the capacity of the gravity drainage system – particularly at high tide.

Waterproofing the wall was achieved by compacting a 1.5 m thick blanket of impermeable, local clay on the *inside* rather than the outside face of the wall, and carefully bonding it to the underlying subdivision fill of similar material (see diagram). The clay blanket has been covered with topsoil and sown with grass to inhibit erosion and enhance the wall's aesthetic appeal.

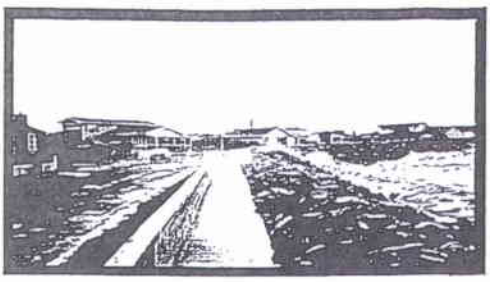
As an added precaution against wave run-up overtopping the seawall, a 600 mm heavy timber parapet wall has been erected. It is set into a new, concrete-paved walkway on the crest of the seawall (the walkway will ultimately form part of an extended coastal walkway being planned by the District Council). Any wave splash that does blow over the wall and its parapet and fall on to the road below, is now channelled to the pump stat It's fitted with two 670 litres/second axial flow pumps that are activated automatically.

Beach

Addressing the flooding problem also extended to the Kuranui Beach immediately north of the sea wall. A low-lying beach, it proved little impediment to waves and surge during severe storms. Making it a greater obstacle to such waves entailed a "natural" solution. The beach itself had rapidly aggraded due to the groyne effect of the subdivision and previous reclamations.



TYPICAL SECTION OF SEAWALL



Taking advantage of the surplus material (shell and sand) created by aggradation – and the available space – the project team was able to reshape the beach and build up a dune at the beach head to absorb the main wave uprush more effectively.

In addition, a graded swale was excavated behind the dune to divert local stormwater (and any seawater that *did* overtop the lune) to a slightly more sheltered outlet channel at the north end of the beach. Stormwater drainage previously channelled to beach outlets now exits into this swale drain, through upwelling manholes fitted with flapgates or Tideflex rubber valves.

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Consents

The beach is a popular spot for walkers and roosting birds, and key environmental considerations for the project focused mainly on minimising encroachment on the coastal marine area. By avoiding the migration season, the project minimised disruption to the prolific bird life.

RMA procedures required application for a number of land use consents, including the source of impermeable fill for the sea wall, modifications to the beach and reserve, and a building consent for the pump station.

Particular emphasis was laid on developing a memorandum of understanding with the tangata whenua, and on obtaining consent from all property owners affected by drainage works. Consent applications were accompanied by an Assessment of Environmental Effects and followed extensive public consultation by the District Council.

The outcomes

Following their acceptance of the improved standard of protection provided by the works, insurance companies are once again making cover available to Moanatiari residents.

The benefits and positive effects of the project are evident in the improvements to the social environment and quality of life for the households in the subdivision. Improved protection has been achieved without degradation of the natural environment – either along the sea wall or on Kuranui beach. Recreational use of the reserve has been enhanced by the coastal walkway along the sea wall.

Of particular relevance to continued environmental sustainability is the establishment of an Operations and Maintenance Manual for the District Council to administer the subdivision protection works.

Strong northwest winds during the storm of Saturday 17 March produced a high spring tide and waves well above predicted levels at Thames. Moanatiari subdivision residents were quick to acknowledge that they would have been flooded without the sea wall.

John Duder *is a director of Tonkin & Taylor Ltd*

DEPARTMENT of AGRICULTURE,

P.O. Box 61,

THAMES.

June 9th., 1950.

The Town Clerk,
Thames Borough Council,
P.O. Box 400,
THAMES.

Dear Sir,

Foreshore Subdivision.

In reply to your letter No. 203 of May 3rd., I wish to advise that soil samples were taken on the "Moanataiari Flat" representative of the area subdivided for housing.

Results of analysis indicate that the area is very infertile, a condition which can be rectified however, by fairly substantial applications of lime and fertiliser.

The soil is extremely acid and one to two tons of lime per acre would be necessary to rectify this fault.

The area is also deficient in phosphorous and potassium and an application of at least 4 cwt. of Super-phosphate and 1 cwt. of Muriate of Potash per acre would be necessary to correct these deficiencies.

The soil is of course almost devoid of humus so that the addition of any organic matter such as compost would be beneficial. The digging in of a crop such as blue lupins would be helpful.

Yours faithfully,

(Sgd.) G.L. Banfield,
INSTRUCTOR IN AGRICULTURE.

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC07
	LETTER

Borough of Thames

Telephones 405 & 406

PLEASE ADDRESS ALL COMMUNICATIONS TO THE TOWN CLERK AND QUOTE THIS No.

Office of the Town Clerk,
P.O. Box 400,
Thames, N.Z.

26 March 1965

Mr L.W. Cobb,
Upper Grey Street,
THAMES.

Dear Sir,

Moanataiari Flat Reclamation

I am pleased to advise that my Council has accepted your tender dated 16 March 1965 for the supply and delivery of up to 15,000 cubic yards of filling to the Moanataiari Flat reclamation.

The tender was accepted on the basis of your letter dated 16 March 1965 at the tendered price of £1,675 for 15,000 cubic yards of filling consisting of mullock and small rock, and on the basis of an estimated 8,000 cubic yards being available from the present Borough tip head and that if further quantities in excess of this are available from the Council's tip head, the above price will be reduced by the figure of 6d per cubic yard of the quantity so available.

The position is that further clay filling will become available in the near future from the Chan subdivision at Parawai. This filling will be carted by Messrs McMahon & Son Limited, and it is desired that the mullock filling be deposited before the spoil available from the Chan subdivision.. It would be appreciated if you would confer with Mr Doug McMahon regarding the urgency of your delivering the 15,000 cubic yards of filling, and with the Works Supervisor (Mr J.A. Hays) regarding the placing of the filling.

Formal contract documents will be drawn up at this office, and I should be pleased if you would sign these documents before commencing the contract.

Yours faithfully,

Certified Correct Copy

TOWN CLERK

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC08
	LETTER

THAMES BOROUGH COUNCIL

Sealed Tenders endorsed "Moanataiari Flat" will be received until noon on Tuesday 6 December 1966 for the supply and delivery of approximately 80,000 cubic yards of filling to the Moanataiari Flat reclamation. The Council's quarry at the corner of the State Highwa and Moanataiari Road is available for obtaining the spoil. Further details may be obtained from the Council's office or from the Council's Consulting Engineer, Mr M.L.K. Bosselmann. Lowest or any tender not necessarily accepted.

F.C. Tuck, TOWN CLERK

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC09
	ADDITIONAL INFORMATION

Worship the Mayor
d Councillors,
MES.

tlemen,

I have the honour to present the following report for
e month of July 1967.

The month of July was reasonably fine but wet ground
nditions held up earthworks on Moanataiari Flat.

The various works started or completed in the borough are
ted herewith.

Harbour Foreshore Development : Moanataiari Flat

(a) Earthworks

4,115 cubic yards of filling were carted to the subdivision
ring July towards filling depressions and the rubbish dump.

Filling is now complete as far as subdivision No. 1 is
ncerned and house building will commence during August.

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC10
	COUNCIL MINUTES

"Having undertaken to keep the refuse depot covered on the completion of the reclamation originally at a cost of £25 ($50) per week we wish to advise that it is virtually impossib to carry out this work at the agreed upon price.

On the 16th May we received a letter from the Borough Inspector, Mr B. Murch, following a discussion which we had with him on the matter of filling and bulldozing the dump. Approximately 100 yds of filling and 3 hours bulldozing would make up the $50 weekly allowance but it was agreed that this would only be a basis to work on and would vary according to conditions. We would point out that the height of the tip face on the South side of Burke Street is far too shallow and is requiring much more filling and bulldozing than was anticipated. It has also got to a stage where disorderly dumping by the general public during the week and at weekends has added somewhat to the problem.

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC11
	DOT POLLOCK

APPENDIX F

ENVIRONMENT WAIKATO INFORMATION

82 0692

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S Fowlds

Waikato Regional Council
Mail Ref: 97/5073
Referred to: J Dahm.
REC'D 14 NOV 1997
Copy to: O. Passau
Instructions:
MAIL

Our Ref: 14930
12 November 1997

Environment Waikato
P O Box 4010
HAMILTON EAST

Attention: Mr Scott Fowlds

Dear Scott

THAMES COROMANDEL DISTRICT COUNCIL
MOANATAIARI SUBDIVISION PROTECTION

We refer to the series of meetings with TCDC and yourselves earlier this year, and enclose a copy of our letter of July 9th, and a set of Drawings to keep you informed of the final proposals. These confirm the final proposals for:

- raising the existing rockfill wall crest to 4.0 m (or 4.1 m on the northern face) on the landwide side and water proofing with impermeable fill
- providing pumped drainage for the lower part of the subdivision while maintaining existing gravity systems with non-... mechanisms
- excluding upland inflows by road lumps, diverting flow to Burke St drain or Kuranui beach
- re-shaping Kuranui beach and reserve to effect gravity drainage by way of a swale to the orth end of the beach

We note your previous advice that no resource consent would be required from Environment Waikato for the proposed works, as they will not impart any on the coastal marine zone, and the Kuranui beach regrading is a permissible activity.

Your confirmation of the above would be appreciated now that the design concepts are finalised.

JD. Please confirm/coordinate with Res. Use for response. O.P.

Yours sincerely
TONKIN & TAYLOR LTD

J N Duder

- Discussed with Murr Wood
→ Revised drawings T&T
→ letter 5/1/98
JD.

JND:MP
J:\14930\JND1211.LTR

Experience
The New Zealand Way
ISO 9001

CSI Contaminated Site Investigations 80 Cook Street Hamilton	MOANATAIARI
	DOC12
	Mr. JOHN DUDER

82 06 7

ET MANAGEMENT GROUP

THAMES COROMANDEL DISTRICT COUNCIL

J Dahm.
97/0228O

If Calling Please Ask For:

Mr Farquhar

Please Quote Ref:

35.40.78.03

28 January, 1997

Environment Waikato
P O Box 4010
HAMILTON

Attention : Jim Dahm

Dear Mr Dahm

THAMES : MOANATAIARI FLOODING

Thank you for accepting Graeme Lawrence's invitation to join our Moanataiari coastal defence project team. The team meets first on Wednesday 5 February 1997 from 8.30 am.

The Moanataiari development was built by the Thames Borough Council between 1950 and 1972. The area on the sea wall boundary was built to level in 1968, subdivision works were completed in 1970/71 and titles issued in 1972. The houses in the area were constructed mainly during the early years of the 1970's.

The 'land' was originally created by early miners spoil disposal, by the Thames Harbour Board in the early years of the century, and in doing a rather grandiose harbour development in 1929. The Thames Harbour Board plan attached demonstrates the early history.

The District Plan extract shows the built area. The north western corner of Fergusson Drive coincides with the north western corner of the "full height rubble wall", and Burke Street is the road leading to the 1929 wharf.

As far as I can ascertain no records exist of any land engineering work - heights, geotech, coastal erosion patters, etc. for this development.

The sea wall was examined by the District Councils engineers in 1980 - copy of the Engineers report of the time is attached. His cheapest option was adopted by the Council and the wall has been maintained by Council to a standard consistent with his suggestions since 1980.

CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC13
	DEPUTY CEO LETTER

CAPITAL WORKS
PROJECT BRIEF

OANATAIARI SUBDIVISION INUNDATION PROTECTION

PURPOSE

To implement works to provide a measure of protection against tidal storm surge inundation and storm rainfall runoff to lower lying parts of the subdivision.

PROPOSAL

1 The project involves:

- the extension and upgrading of the existing rock seawall protection to the coastal edge of Moanataiari subdivision road works.
- the installation of a stormwater pump station and associated pipework.
- the installation of stormwater systems and road flood humps within the Moanataiari subdivision.
- the formation of a swale drain and bund formation to the Kuranui Bay dune reserve.

.2 The design criteria for the works is 1/50 year protection against sea inundation and from catchment runoff from discrete non-concurrent events (ie concurrent 1/50 tidal and rain events would have a much lower probability).

.3 Principal features of the project are:

- raising of existing rockfill seawall and waterproofing by addition of impermeable fill on landward side along Fergusson Drive.
- upgrading of drainage conduits from Ensor Street and Margaret Place.
- provision of 1.34 m ^{3}/s pumping capacity in new pumpstation.
- provision of flood humps on approach roads to exclude upper catchment runoff.
- reshaping of Kuranui beach dunes and of beach reserve to provide drainage for both wave uprush and local runoff to outfall at north end of Kuranui beach.

3. REQUIREMENT

3.1 General Information

The Moanataiari subdivision was developed in the 1960's by the then Thames Borough Council by filling out to an earlier rockfill bund formed in the 1920's as part of a proposed port development. Impermeable fill from the adjacent hillside was placed over marine sediments. Initial settlement of underlying sediments was made up by addition of fill. Most settlement would then have occurred within five years

APPENDIX G

OTHER INFORMATION

WORKS COMMITTEE'S REPORT.

The above Committee reported as follows :—

Your Committee have the honor to report that the footpath on the west side of Pollen street, from Grey street to Cochrane street, requires raising in many places, and recommend that the Foreman of Works be directed to make up the lowest places with mullock or ashes, at as early a date as possible, and that he receive orders to gradually bring the whole length of this side walk up to its permanent level. The Committee find that by an expenditure of £15 the Beach Road, from Cochrane street to Pahau street hard, can be rendered fit for cart traffic, and advise this work to be authorised, as it will greatly accommodate the residents in this locality. The culverts reported by the Foreman of Works as being rotten on the Tararu Road, the Committee have directed that new ones be prepared, and when that road is opened for the reception of the water-mains now in process of being laid down, they be laid in position. This will save opening the same

CSI Contaminated Site Investigations 80 Cook Street Hamilton	MOANATAIARI
	DOC16
	THAMES STAR 1888

approved.

KOPU WHARF.—The Harbor Master (Captain T. C. Bayldon) reported as follows on the harbor and foreshore works in hand:—"During November work has been confined to general repairs. Shortland Wharf repairs were continued on to that stage so that the wharf was safe for traffic. I then shifted the plant and men to the Goods Wharf, where it was necessary to draw the stumps of two broken piles and drive and re-fasten new ones. When this was finished I sent the plant and men out to Kopu to get on with the repairs there. I hope to have the Kopu Wharf open for traffic again at the end of this week. When the wharf was opened up to start repairs I found it, that is the outer tee, in an awfully bad and decayed state, the stringers decayed, planking bad, and the front set of wharf piles so bad that it was impossible to repair the wharf with them. As a ground work I have driven five new wharf piles and two new fender piles, new headstock, stringers, braces, and planking, and taken the opportunity to bring the outer end up level, as it had sank considerably years ago. I have as far as possible estimated the damage done by the s.s. Kia Ora separately, and attach a detail voucher of the cost to the portion she damaged. As soon as the work at Kopu is finished I shall shift the plant back to Shortland and finish that job, as several piles there have to be drawn and driven again in a line so as to form a uniform face to the wharf. I am afraid this will not be completed before Christmas, but I hope to have it done before the January meeting. The only other work I have in hand at present is tarring and sanding the footpath of the Goods Wharf. I may mention that the Moanataiari culvert is finished and well inside the tip end now, and probably before long Mr Clark will be turning the tip more towards Tararu. The Goods Wharf as usual at this time of the year re-

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	DOC17
	THAMES STAR 1897

Foreshore.—It was decided to write to Mr Buckley, who applied some time back for permission to remove tailings from the foreshore, and inform him that part of the ground applied for belonged to the Railway Department, and therefore his offer could not be accepted.

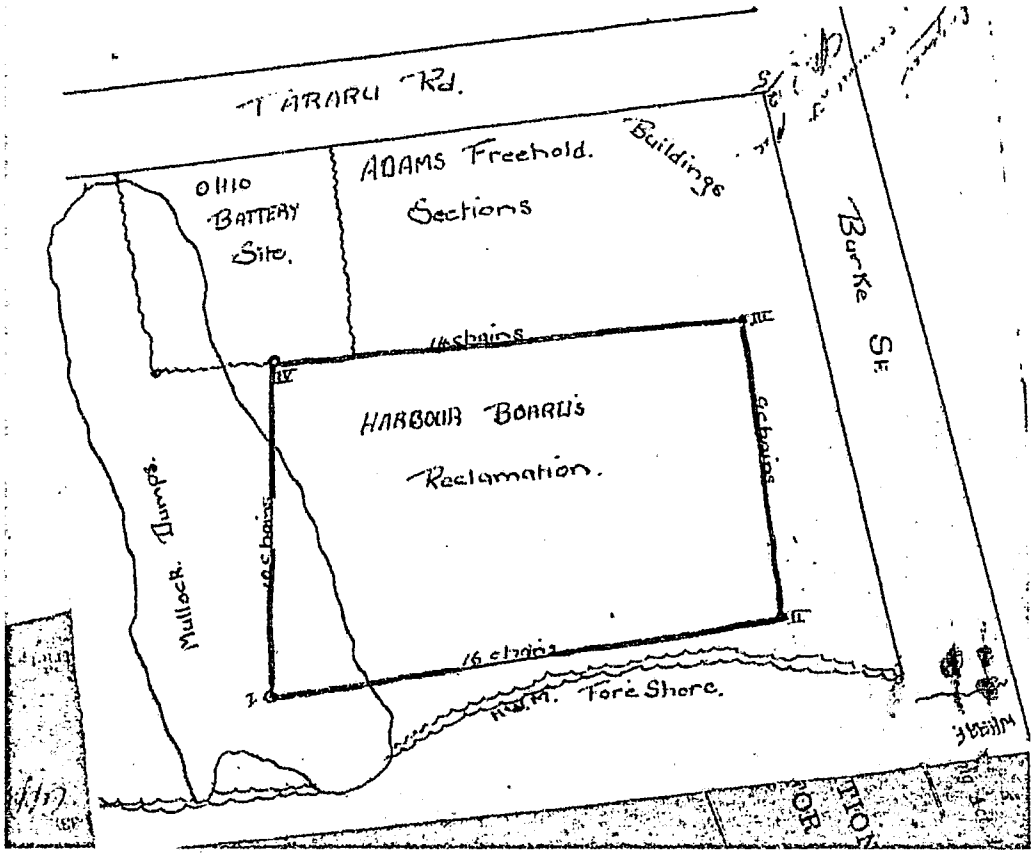
Tailings.—Mr Judd wrote applying for an allotment at the foot of the Big Pump flume from which to remove tailings, and offered £5 per annum for the same.—On the motion of Mr Gillespie, the offer was accepted, and the size of the allotment left for the Chairman to decide.

Report.—The Harbormaster reported as follows:—"During March work done was repairing the outside of the wharf office and giving it a coat of paint, which it badly needed, and scraping the barnacles off the piles, braces, and whalings under the wharf. I am glad to say that so far very litte sign of decay or worm shows upon the underneath structure, and I feel certain that if this work is done every six months the wharf will last many years longer than it would if it is neglected. I also had to spend a couple of days blocking up the outlet at the foot of the Waiotahi aqueduct so as to raise the water level, to help fill up the ground, and also to get cleaner water through the wall for scouring the gutter alongside the wharf. Now that the Golden Age battery is working the water is thicker than for some time past, and I am anxious to get as little silt as possible down the gutter. If it were not that without this scour the gutter would fill up rapidly, I should strongly advise raising the silt works wall another 2ft from the wharf road to half way to the Moanataiari tip; but as in a short time we shall have a big hole over beyond Judd's tailing plant to fill up, I think this can rest for awhile. To-day I find a pile gone in Curtis' Wharf, [illegible]

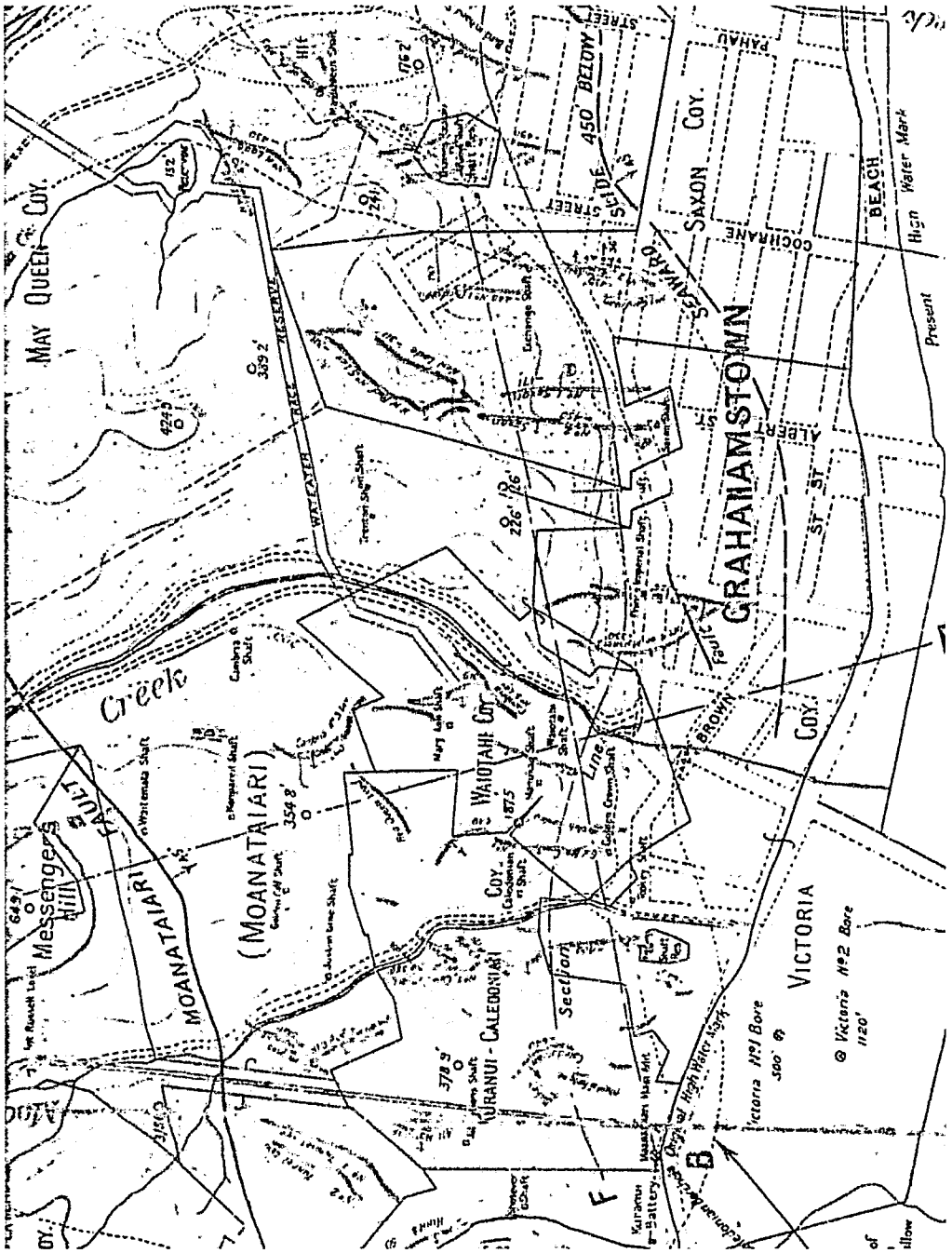
CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	DOC18
	THAMES STAR 1899

APPENDIX H

HISTORICAL MAPS



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK22
	1948 HAND DRAWN



CSI **Contaminated Site Investigations** **80 Cook Street** **Hamilton**	MOANATAIARI
	SK23
	1910 GOLD FIELDS

APPENDIX I

GEOTECHNICAL REPORT FOR MR. G HARRIS

GEOTECHNICAL INVESTIGATION
FORESHORE RECLAMATION
THAMES
for Mr G Harris

Project: 10/80117
Date: September 1991

GEOTECHNICAL INVESTIGATION
FORESHORE RECLAMATION
THAMES
for Mr G Harris

Project: 10/80117
Date: September 1991

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1. INTRODUCTION

Barrett Fuller and Partners Limited (BFP) were commissioned by Mr G Harris to carry out a geotechnical investigation for a proposed residential development on reclaimed land to the west of the existing railway station and immediately to the south of Danby Field. The reclaimed area was previously known as "Verran's Reclamation".

The objectives of the investigation were to assess the suitability of the site for the proposed development and to provide appropriate geotechnical recommendations. In particular, the following matters have been assessed:

- o settlement, both to date and predicted and its effect on buildings and services
- o suitable foundation systems for the proposed buildings
- o earthquake effects on the development

2. SCOPE OF INVESTIGATIONS

2.1 General

Discussions were held with Thames Coromandel District Council (TCDC) staff, who kindly supplied copies of all relevant information held by TCDC both related to the subject site and to the Goldfield's shopping centre development a few hundred metres to the north. Mr M Dunwoodie, a local surveyor, supplied all precise survey information (still ongoing) held by his company.

2.2 Field Work

Six test pits (TP1 to TP6) were excavated by hydraulic digger at the locations shown on the attached site plan, Figure 1. Where appropriate, strength testing was carried out by Pilcon hand shear vane or Scala Penetrometer (depending on

material type) although because of the variable nature of the materials the bulk of the observations were visual. An approximately 3m deep open channel drain had recently been excavated at the south-western end of the site and this provided excellent exposures of all materials. Two scala penetrometer probes (SP1 and SP2) were carried out in the base of this drain at the locations shown on the site plan.

The results of all field strength tests are included on the test pit logs which are presented in the Appendix.

3. BACKGROUND

3.1 Site History

The site was reclaimed from the sea between 1969 and 1977 by filling with a mixture of inorganic spoil and some household rubbish. Mr K Verran reported (KRTA report 1984) that about 75% of the fill was inorganic spoil derived from building demolition, excavations and quarry strippings from Verran Bros' own quarry. The fill was advanced across the tidal mudflats and mangroves by end-tipping.

3.2 Desk Study

Two reports on the subject property and two reports on the Goldfield's development were thoroughly perused:

A. Subject Property

1. Verran Bros Reclamation, Thames - KRTA (November 1984) Reference P 2470.
2. Reclamation of Part of Thames Harbour - Chambers, Adcock and Rudd (March 1979).

B. Goldfield's Site

3. Foreshore Reclamation, Thames (G Harris) - Murray-North Partners (November 1981) Reference A 5932.

4. Foodstuffs (Auckland) Ltd, Proposed Thames Shopping Centre - Tonkin & Taylor (November 1989) Reference 8859.

4. SITE DESCRIPTION

4.1 Surface Features

The property is a near level, generally grassed area with a perimeter sea wall. The construction of the sea wall was reported on relatively favourably by Mr Jim Dahm (WORKS Consultancy) in his report to the TCDC of 26 May 1989. A brief inspection of the wall during the period of the current investigation indicated that it appears to be in sound condition.

A timber container operation is being carried out on the southern metalled part of the property.

4.2 Geological Setting

Existing geological information indicates that the site is underlain by undifferentiated alluvium and estuarine and coastal deposits. This was confirmed by observation of materials exposed in the trial pits.

5. RESULTS OF INVESTIGATIONS

5.1 Ground Conditions

Observation of the test pits and analysis of Dutch Cone penetrometer soundings

and logs of the two boreholes put down by KRTA indicates that the site can effectively be considered as two parts, eastern and western. The eastern part of the site appears to be underlain by minimal (if any) domestic refuse and the near surface materials may be summarised as in Table 1.

TABLE 1

Summary of Ground Conditions - Eastern Part of Site

LAYER	MATERIAL TYPE	DESCRIPTION	DEPTH TO TOP OF LAYER (m)	THICKNESS OF LAYER (m)
1	Fill (Competent)	Stiff silty clay/ clayey silt with gravel	0	1.2 - 1.5
2	Marine Mud	Soft blue clay	1.2 - 1.5	1.0 - 1.3
3	Marine Mud/ Alluvium	Dense dark grey silty sand with shell fragments	2.2 - 2.8	1.5 - 2.0?
4	Alluvium	Interbedded and inter-mixed sand, with soft clay/silt	3.7 - 4.8	7m +

The reclamation fill beneath the western part of the site contains variable amounts of domestic refuse at depths below about 1m. The refuse is generally confined in a silty clay /clayey silt matrix and is less than 1m thick although some voids are present within the refuse. The organic content of the refuse appears low (probably less than 25%) as expected of material that has been placed at shallow depth (aerobic conditions) for at least 14 years. A summary of materials underlying the western half of the site is presented in Table 2.

TABLE 2

Summary of Ground Conditions - Western Half of Site

LAYER	MATERIAL TYPE	DESCRIPTION	DEPTH TO TOP OF LAYER (m)	THICKNESS OF LAYER (m)
1	Fill (Competent)	Stiff silty clay/ clayey silt with gravel	0	0.8 - 1.3
2	Fill (Containing refuse)	Domestic refuse within silty clay/clayey silt matrix	0.8 - 1.3	0.8 - 1.4
3	Marine Mud	Soft blue clay	1.6 - 2.7	0.5 - 0.8
4	Marine Mud/ Alluvium	Dense dark grey silty sand with shell fragments	2.1 - 3.5	1.5 - 2.0?
5	Alluvium	Interbedded and inter-mixed sand with thick layers of soft shelly clay	3.6 - 5.5	7m +

The inferred boundary between the two portions of the site (based on current plus all previous information) is shown on Figure 1. It should be viewed as tentative at this stage.

KRTA, in their report, indicated that the western portion of the site is underlain by sandy shelly clay between 4.5m and 11.5m depth while the eastern portion is underlain by shelly sand between these depths. They reasoned that the more permeable sandy zone (eastern part) consolidated much more rapidly under the reclamation filling than the clayey zone (western part) and that the bulk of the settlement expected to occur beneath the eastern portion of the site had

already generally occurred, while ongoing settlement of the western part could be expected for a further 15 to 20 years. The latest settlement data (described in Section 5.3) and our analyses largely confirm this hypothesis.

5.2 Groundwater

Groundwater appears to vary between about 1.0 and 1.5m beneath existing ground level, and to depend on tide level with maximum water level appearing to lag about 45 minutes behind high tide.

5.3 Settlement Monitoring

Settlement monitoring of various survey marks (locations shown on Figure 1) has been carried out by Mr Dunwoodie from 1979 to the present day. Although some of the original marks have been lost, reasonable records exist from April 1984 to August 1991. Figure 2 plots settlement with time for I.T's 2,4,6,9 and 10 and Pegs A and B. It indicates approximately 6mm/year continuing settlement at I.T.6 (eastern part of the site) and typically 40mm/year at the survey marks within the western part of the site. There is evidence, however, that the settlement rate is slowing in both areas.

6. PROPOSED DEVELOPMENT

The proposal is to construct a multi-unit residential development. At this stage, the intention is to have single level dwellings with concrete slab base and brick veneer (or similar) cladding.

7. GEOTECHNICAL CONSIDERATIONS

7.1 Foundations

7.1.1 Eastern Part of Site

The latest investigations and analysis of settlement data indicate that this part of the site has minimal domestic refuse and that currently, settlements due to the reclamation fill are of the order of 6mm/year. It is, however, expected that further settlement of between 50 and 100mm may be expected over the next 8 to 12 years-this figure allows for on-going settlement due to the reclamation fill and for settlement due to lightweight dwellings. Although this settlement is likely to be relatively uniform (i.e. non-differential) it is considered that the most appropriate foundation system will be a "semi-raft" probably comprising three longitudinal reinforced concrete beams with three transverse beams (similar to strip footings) supporting a slab. Such a "semi-raft" will be sufficiently stiff to level out the unavoidable localised differential settlements (while limiting applied load to less than about 8 kPa) and should adequately support a brick veneer construction.

If the estimated settlement was considered excessive, it would be possible to place a preloading (say 3 or 4m high) to accelerate settlement and minimise the settlement expected beneath a dwelling (following removal of preload) to less than about 30mm. Such a preload would need to be in place for at least 3 months.

7.1.2 Western Part of the Site

These and previous investigations indicate that this part of the site is underlain (between about 1.0m and 2.0m) by domestic refuse in a silty matrix, and between about 4.5m and 11.5m depth by clayey material. Although the refuse has been in place for about 14 years, it is likely that some further decomposition will occur and also that movement of water through the refuse zone will cause

internal erosion or piping. These processes will cause settlement, both differential and total and their magnitudes and rates are difficult to predict. Accordingly, it is considered that special foundation treatment will be necessary for dwellings in this part of the site. Two options for foundation treatment are considered feasible as follows:

A. PILED FOUNDATIONS

With this option, piles would be either driven or drilled to the dense sand layer encountered between 2.1m and 3.5m beneath existing ground level. Graphical plots of the Dutch Cone penetrometer probes carried out by KRTA are presented in Appendix II. They indicate this layer to be between 1.5m and 2m thick and to have cone resistances up to 8.2 MPa, and accordingly it is considered to be a suitable founding layer for the relatively light loads expected. Settlement of the compressible soil layers beneath the dense sand will still occur, however, but is expected to be reasonably uniform. This is discussed in more detail later in this section.

B. EXCAVATION AND REPLACEMENT OF REFUSE FILL

With this option, the fill containing refuse would be excavated (to a typical depth of less than 2.5m) and replaced by suitable compacted granular material. Again, however, settlement will continue but it is expected to be relatively uniform and the "semi-raft" foundations proposed in Section 7.1.1 are considered appropriate. Because of the greater settlements expected in this part of the site, it is likely that the "semi-raft" will need stiffer longitudinal beams to support a brick veneer dwelling without distress than in the eastern part of the site.

Calculations based on the Dutch Cone probes (Appendix II) indicate that between 300 and 400mm total settlement could have been expected since

completion of the reclamation and that, based on the single oedometer test carried out by KRTA, this settlement will be complete in about 40 years from completion in 1977. Extrapolation of the settlement data indicates that between about 300 and 500mm of settlement has already occurred since the reclamation was completed. The coefficients of consolidation (C_v) obtained from the KRTA data indicate that the consolidation process is approximately 60% complete, but that between 150 and 250mm of further settlement can be expected in the next 15 to 20 years - this makes no allowance for settlement due to decomposition or internal erosion of the refuse.

Even the piled foundations of Option A would be expected to settle by the amount described above although such settlement would be expected to be relatively uniform across a particular house site. Because of the magnitude of the settlement, however, it is likely that flexible light-weight construction (i.e. timber floor and lightweight cladding) will be the most appropriate and most readily able to be relevelled by jacking against the piles if required.

SUMMARY

Either piled foundations or excavation and replacement of the refuse and adoption of a "semi-raft" foundation are considered feasible. With both options, however, 150 to 250mm of settlement is expected. Accordingly, the piled foundation option is not considered suitable to support a brick veneer dwelling without distress and so lightweight construction is recommended. As described for the eastern part of the site, preloading could be used to accelerate consolidation and significantly reduce the magnitude of settlement.

7.2 Services

The TCDC has expressed some concern about the effect of ground settlement on services such as sewers and water supply lines. In the eastern part of the

site, further relatively uniform settlements of between 50 and 100mm are expected beneath house foundations and it should be a reasonably simple matter to design suitable flexible jointed conduits. In the western part, further settlements of between 150mm and 250mm can be expected, again relatively uniform, but design of services should take this into account. Construction of sewers both as shallow and at as steep a gradients as possible should ensure that such settlements can be tolerated. To minimise potential for differential settlement beneath services in the western part of the site, trenches should be excavated to the base of the refuse and to minimise costs, where possible, all services should be placed in one trench.

The expected settlements will necessitate periodic topping up of access roads, but this is not expected to pose particular problems.

7.3 Potential for Generation of Landfill Gas

Recent studies (e.g. "Municipal Refuse Disposal - Palos Verdes Kinetic Model") indicate that minimal landfill gas (methane + CO_2) is produced after about 7 years after placement. As this refuse was placed at least 14 years ago and the refuse thickness is small (less than 1m), it is concluded that there is now virtually no potential for production of gas, and accordingly no explosion hazard to residents.

7.4 Liquefaction

It is concluded (from available information) that the sandy materials beneath the water table are susceptible to liquefaction, or to large strains causing settlement during ground shaking caused by a moderate to strong earthquake. However, the rafting effect of the competent fill will mitigate these effects and tend to minimise damaging differential settlements.

Similar ground conditions are expected to exist beneath the bulk of the low-lying Thames land and no special precautions are taken for residential buildings. As the likelihood of a moderate to large earthquake is statistically relatively low, it is considered that protective measures against liquefaction for the lightweight residential development proposed on this site are not justified. That is, the proposed development has no greater requirement for protection than similar construction on low-lying land elsewhere in Thames.

8. FURTHER WORK REQUIRED

To confirm the findings of this report and to better delineate the eastern and western parts of the site, it is recommended that the following work be carried out:

1. On-going survey of existing settlement marks on a 3 monthly basis.

2. Installation and three-monthly survey of a further 8 settlement marks in the north-eastern corner of the site.

3. Machine drilling of three further boreholes to at least 15m to confirm ground conditions beneath the site and provide more detailed correlation with the Dutch Cone probe results.

9. CONCLUSIONS AND RECOMMENDATIONS

From the investigations carried out, it is concluded that the site is suitable for the proposed multiple-unit residential development. The eastern part of the site is expected to settle a further 50 to 100mm and "semi-raft" foundations are suggested. The western part is expected to settle a further 150 to 250mm in the next 15 to 20 years and two foundation options are presented for this area

to avoid the effects of differential settlement due to decomposition and internal erosion of the near surface refuse. The final choice of option will be made on the basis of economics. Settlements may be considerably accelerated by the use of preloading if desired.

It is likely that initially during development, specific investigation and design will be required for each unit. However, as the data base is built up and the site is better defined (in conjunction with on-going and increased settlement monitoring) specific investigation for each unit is unlikely to be required.

It is expected that site services can be designed to tolerate the expected settlements.

10. LIMITATION

Recommendations and opinions contained in this report are based on data from site observation, test pits carried out by BFP and from previous geotechnical information on the subject site and neighbouring properties. Inferences about the nature and continuity of ground conditions are made but cannot be guaranteed.

It is recommended that it would be in the interest of all parties that BFP be retained to inspect excavations and monitor settlement data to provide a comparison with assumed conditions. In any event, BFP should be notified if conditions differ from those described in this report.

Yours faithfully,
BARRETT, FULLER & PARTNERS LIMITED

G A LONEY
SENIOR ENGINEER

FIGURES

Figure 1 - Site Plan

Figure 2 - Settlement Data

A B C D

RICHMOND STREET

SS 18
RL 2.423

WILLOUGHBY STREET

NORTH

QUEEN STREET

INFERRED BOUNDARY BETWEEN EASTERN AND WESTERN PARTS OF THE SITE

THAMES BRANCH RAILWAY

NOKENOKE STREAM

TEST PIT 6

C 1

SP 1

SP 2

BOAT HARD STAND

BOAT RAMP

C 4

IT 6

TEST PIT 5

IT 10

C 5

DANBY FIELD

C 2

IT 2

IT 4

C 6

IT 9

PEG A

C 3

TEST PIT 1

TEST PIT 2

TEST PIT 3

TEST PIT 4

KAUAERANGA RIVER

PEG B

FIRTH OF THAMES

LEGEND

C 3 DUTCH CONE PENETROMETER TESTS 1984

TEST PIT 1 EXCAVATOR TEST PIT

SP 1 SCALA PENETROMETER TEST

IT 1 SETTLEMENT MARKER

⊗ RECOMMENDED FURTHER SETTLEMENT MARKERS

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BARRETT, FULLER & PARTNERS LTD

GRAHAM HARRIS
THAMES FORESHORE

SITE PLAN FIGURE 1

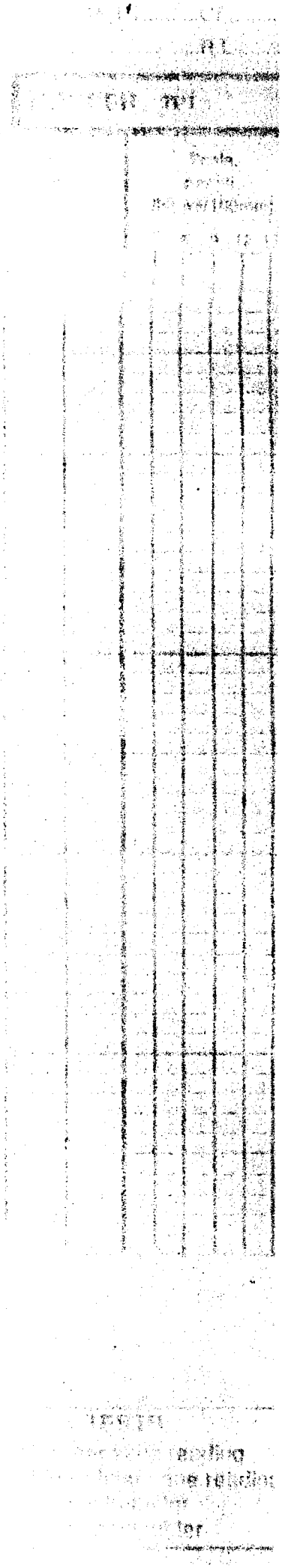
SCALE	1:1250
DATE	SEPT 91
DESIGN	—
DRAWN	JGM
APPVD	GAL

No	REVISION	BY	APPVD	DATE
	RECORD OF ISSUE			

JOB No	ORIGINAL SIZE	SHEET No.	REVISION No
10/80117	A3	1 of 1	—

APPENDIX I

Test Pit Logs and Scala Penetrometer Probes



TESTPIT LOG

JOB No. 10/80117 SHEET 1 OF

PROJECT THAMES FORESHORE LOCATION THAMES R.L.

CLIENT Mr Graham Harris

METHOD OF BORING EXCAVATOR

NUMBER TP1

Depth (m)	G.W.L. Samples	Geological description	Graphic log	FIELD DESCRIPTION (colour, structure, weathering, grain size, strength, water content, plasticity)	Vane shear strength (kPa) 50 100	Scala penetr. (blows/mm) 3 6 9 12
				Brown with grey; medium gravelly SILT with some ash lenses; wet, slightly plastic, firm, dense.		
1.0	▽20.8.91	Reclamation Fill		Light brown; silty CLAY with ignimbrite cobbles; wet, stiff, slightly-moderately plastic Rubbish in above matrix; metal, plastic bags, janola bottles. Water infiltration		
2.0						
3.0		Marine Mud		Dark blue; CLAY; wet, soft, highly plastic	□	
				Dark blue; SANDY SILT with shell fragments, wet, dense.		
4.0				E.O.P. @ 35m		
5.0						

Date started 20.08.91

Date finished 20.08.91

Logged by GAL

Checked by JGM

NOTES:

BARRETT, FULLER & PARTNERS LTD

SAMPLES

- Small disturbed sample
- Large disturbed sample
- 'Undisturbed' tube sample

TESTS

- □ Peak shear vane reading
- x Residual shear vane read
- ● Scala penetrometer
- PP- Pocket penetrometer

TESTPIT LOG

JOB No. 10/80117 SHEET 1 OF 1

PROJECT THAMES FORESHORE LOCATION THAMES R.L.

CLIENT Mr Graham Harris

METHOD OF BORING Excavator

NUMBER TP2

Depth (m)	G.W.L./Samples	Geological description	Graphic log	FIELD DESCRIPTION (colour, structure, weathering, grain size, strength, water content, plasticity)	Vane shear strength (kPa) 50 100	Scala. penetr. (blows/100mm) 3 6 9 12 15
				Brown with grey; silty CLAY with medium gravel; wet, firm-stiff, non plastic		
1.0	▽20.8.91	Reclamation Fill		Grey; clayey SILT, wet, firm, non plastic		
				Plastic bags, tin cans, metal, rubber etc in above matrix.		
2.0				Water infiltration		
				Voids within fill		
3.0		Marine Mud		Dark blue; CLAY; wet, soft, highly plastic.		
				Dark blue; SANDY SILT with shell fragments; wet, dense.		
4.0				E.O.P. 4.0m		
5.0						

Date started 20.08.91

Date finished 20.08.91

Logged by GAI

Checked by JGM

NOTES:

BARRETT, FULLER & PARTNERS LTD

SAMPLES

- Small disturbed sample
- Large disturbed sample
- 'Undisturbed' tube sample

TESTS

- □ Peak shear vane reading
- x Residual shear vane reading
- ● Scala penetrometer
- PP Pocket penetrometer

TESTPIT LOG

JOB No. 10/80117 SHEET 1 OF 1

PROJECT THAMES FORESHORE LOCATION THAMES R.L.

CLIENT Mr Graham Harris

METHOD OF BORING Excavator

NUMBER TP3

Depth (m)	G.W.L./Samples	Geological description	Graphic log	FIELD DESCRIPTION (colour, structure, weathering, grain size, strength, water content, plasticity)	Vane shear strength (kPa) 50 100	Scala. penetr. (blows/100mm) 3 6 9 12 15
0.0	▽20.8.91	Reclamation Fill		Yellowish brown; clayey SILT with rare cobbles; wet, firm, moderately plastic		
1.0						
2.0				Grey; Clayey SILT; wet., firm, non plastic. Rubbish articles in above matrix		
3.0		Marine Mud		Dark blue; CLAY; wet, soft, highly plastic		
				Dark blue; Sandy SILT with shell fragments; wet, dense.		
4.0				E.O.P. @ 3.75m		
5.0						

Date started 20.08.91

Date finished 20.08.91

Logged by GAL

Checked by JGM

NOTES:

BARRETT, FULLER & PARTNERS LTD

SAMPLES

- Small disturbed sample
- Large disturbed sample
- 'Undisturbed' tube sample

TESTS

- □ Peak shear vane reading
- x Residual shear vane reading
- ● Scala penetrometer
- PP- Pocket penetrometer

TESTPIT LOG

JOB No. 10/80117 SHEET 1 OF 1

PROJECT THAMES FORESHORE LOCATION THAMES R.L.

CLIENT Mr Graham Harris

METHOD OF BORING Excavator

NUMBER TP4

Depth (m)	G.W.L./Samples	Geological description	Graphic log	FIELD DESCRIPTION (colour, structure, weathering, grain size, strength, water content, plasticity)	Vane shear strength (kPa) 50 100	Scala. penetr. (blows/100mm) 3 6 9 12 15
0		Reclamation Fill		Yellowish brown; silty CLAY, with rare gravel; wet, firm-stiff, slightly plastic		
	▽20.8.91			Grey; clayey SILT; wet, firm, non plastic. Rubbish articles in above matrix (steel + plastic bags). 0.5m Ø log. electric cables		
2.0		Marine Mud		Dark blue; CLAY; wet, soft, highly plastic.		
3.0				Dark blue; Sandy SILT with shell fragments; Wet, dense. E.O.P. at 3m.		

Date started 20.8.91

Date finished 20.8.91

Logged by GAL

Checked by JGM

NOTES:

BARRETT, FULLER & PARTNERS LTD

SAMPLES

- Small disturbed sample
- Large disturbed sample
- 'Undisturbed' tube sample

TESTS

- □ Peak shear vane reading
- x Residual shear vane reading
- ● Scala penetrometer
- PP Pocket penetrometer

TESTPIT LOG

JOB No. 10/80117 SHEET 1 OF 1

PROJECT THAMES FORESHORE LOCATION THAMES R.L

CLIENT Mr. Graham Harris

METHOD OF BORING Excavator

NUMBER TP5

Depth (m)	G.W.L./Samples	Geological description	Graphic log	FIELD DESCRIPTION (colour, structure, weathering, grain size, strength, water content, plasticity)	Vane shear strength (kPa) 50 100	Scala. penetr. (blows/100) 3 6 9 12 15
				Light grey, clayey SILT; with rare fine gravel, wet, stiff, moderately plastic		
1.0		Reclamation Fill		Grey; clayey SILT; wet firm, slightly plastic. Rubbish articles in above matrix. (rags, rare plastic bags)		
2.0	20.8.91	Marine Mud		Dark blue; CLAY, wet, soft, highly plastic		
3.0				Dark grey; Silty SAND with shell fragments; wet, dense, non plastic.		
				E.O.P. at 3.1m		
4.0						
5.0						

Date started 20.8.91

Date finished 20.8.91

Logged by GAL

Checked by JGM

NOTES:

BARRETT, FULLER & PARTNERS LTD

SAMPLES

- Small disturbed sample
- Large disturbed sample
- 'Undisturbed' tube sample

TESTS

- □ Peak shear vane reading
- x Residual shear vane reading
- ● Scala penetrometer
- PP Pocket penetrometer

TESTPIT LOG

JOB No. 10/80117 SHEET 1 OF 1

PROJECT THAMES FORESHORE LOCATION THAMES

CLIENT Mr Graham Harris R.L.

METHOD OF BORING Excavator

NUMBER TP6

Depth (m)	G.W.L./Samples	Geological description	Graphic log	FIELD DESCRIPTION (colour, structure, weathering, grain size, strength, water content, plasticity)	Vane shear strength (kPa) 50 100	Scala. penetr. (blows/100mm) 3 6 9 12 15
0		Reclamation Fill		Yellowish brown; silty CLAY with some fine gravels; wet, stiff, slightly plastic.		
	20.8.91	Marine Mud		Dark blue; CLAY; wet, soft, highly plastic.		
3.0				Dark grey; silty SAND with shell fragments; wet, dense, non plastic.		
				E.O.P. @ 3.0m		

Date started 20.8.91

Date finished 20.8.91

Logged by GAI.

Checked by JGM

NOTES:

BARRETT, FULLER & PARTNERS LTD

SAMPLES

- Small disturbed sample
- Large disturbed sample
- 'Undisturbed' tube sample

TESTS

- Peak shear vane reading
- x Residual shear vane reading
- Scala penetrometer
- PP Pocket penetrometer

APPENDIX J

MR. JOHN ISDALES REPORT

Borough financial weakness included the number of non-rateable mining right sections, often in the hilly areas of town. Their pressing need was for income, including rates. The solution was to expand the reclaimed area around the silted up 1920's Harbour. As they had legal control of this tidal area, they could create flat rateable land for sale here, in the face of soaring land prices.

5. Post 1950 reclamation

The method adopted in the 1950 was to put the town dump (which the town had to have) on a low lying area on the seaward side of the existing built up area. When the rubbish fill had built up sufficiently it was covered, top soil brought in and roads and other services established to increase the built up area. As one dump site began to fill up the next dump site was prepared. The dump was moved several times repeating this continuous process, reclaiming more and more of the old harbour.

By1952 Dixon and Ensor streets where extended sea ward from Tararu Rd. By 1959 the northern parts of Kuranui and Moanataiari streets are in existence with the town dump between Burke and Ensor Sts and work was in progress building up the southern side of the wharf. Kuranui Street was pushed through to join Burke St by the early sixties with the dump on the present school site. 1967 sees the Moanataiari School ground to the west of Kuranui Street, built well above the surrounding reclaimed areas general elevation... The dump which had been on the other side of the school grounds, on what will later become the extension of Moanataiari Street to intersect Burke St, has just been capped. A new dump further seaward but still north of Burke St is in operation. Apart from a small triangular lagoon at the NW corner all the area which will become the contempory Flat is mangrove forest or reclaimed land. Just ten years later in 1977 all the present day streets are in existence just in time with the demise of the Borough of Thames.

Over the period from 1950 to the end of the 20th Century, the methods and materials of reclamation underwent considerable change. The bash, burn, bury of the fifties, gave way to clean fill and finally an end of refuse being an integral part of the Thames foreshore reclamation process. While some use of mullock for reclamation on "the Thames" was recorded in the 1900's, this material was no longer available in quantity by 1950. Materials used for back-filling refuse, included over-burden from local quarrying operations, slip material from the local area, and building site and road construction waste. The later was used much to the dismay of the new school on their playground drainage up grade in the late 80's. Removal of road metal and tar seal from "clean fill" took a good deal of time and effort but did contribute to school funds. What was consistent was the progressive systematic reclamation of the Flat. These dumps where predominantly on the Northern side of Burke St, it was not until the use of them as a means of assisting reclamation was abandoned in the 1980's that a dump was established south of Burke St. It is evident with over 700 acres of proposed reclamation and the under 300 completed, that considerable reclamation south of Burke Street was at least considered at one time.

John Isdale 2008

3 Post WWI harbour work

In 1919 (Isdale, A notes on the Thames Chamber of Commerce), The Thames wharf, which had once easily berthed the Rotomahana drawing 3m, is now so shallow that the Wakatere drawing nearly a metre less is berthing only with great difficulty. On p16 from a report of 30th April 1919; "The Thames foreshore offers magnificent facilities for reclamation" "Burke Street wharf is an instance of the wonderful power of nature building new land" '.....it was silting up badly.' On p17 the silting up of the mouth of the Waihou between Kopu and Opani point from 1879 to 1919 is given as over 2m approximately 3,500,000 m3. With this in mind it was hoped the build up in the vicinity of the present Moanataiari Flat would be less and schemes for a harbour for Thames centred on this location. All of the variations for a harbour here included provision for extensive reclamation.

The beginning of 1925 saw the start of work on a harbour improvement. By the end of 1925 the harbour dredging had created a large area of reclaimed land (Thames Chamber of Commerce notes p35) In 1925 H.H. Adams is recorded (H.H.Adams, notes p225) as leasing reclaimed land next to the Burke St wharf from the Harbour Board. This work continued till the end of 1928 when the money ran out. The scale of the operation can be judged by the expectation that to finish the job the final 1000m of dredging would have only taken another 10 months producing 26,000 m3 of fill. It appears that the "protective" breakwaters which enhanced silting up were completed. This silting had been anticipated/ warned about as ongoing dredging from levies on harbour activity were a feature of some of the planning. The failure of the harbour improvements directly contributed to the success of the later reclamation. The harbour break waters provided not only a protected area to in-fill, but the silting problems added to the mining debris provided a base on which work could begin. The harbour dredging operations also contributed fill to this area. . A 1949 photo in Hays 1968 p187 clearly shows the extensive semi tidal and reclaimed land available for this to begin

4 The situation of Thames post WWII

In 1947 with the return of the town management to an elected Borough Council, Thames looked forward. The war years had seen the population of Thames at its lowest ebb and with the return of the troops from the Second World War, the need for more land for housing was obvious. The constraints on the Borough were both physical and financial.

The Borough area was less than two kilometres wide, from the shore to its eastern boundary in the surrounding hills, and cut off from the flats to the south, by the Kauaeranga River its southern boundary. However, as shown in the 1942 US Army Service map, they had control of a stretch of foreshore out from high water mark, approximately 1.5 kilometres wide. This ran from the mouth of the Kauaeranga River to the vicinity of Rocky Point, north of Tararu.

2 The gold field era

From 1867, with the establishment of the Thames goldfield, the flattish areas around the mouths of the Kuranui, Moanataiari and Waiotahi creeks became important as battery sites for this the richest area on "the Thames". In the first few years the amount of gold to rock was extremely high particularly in this area, e.g. in 1871 the Caledonian mine, near the mouth of the Moanataiari Creek, had ore that was over 35% gold! Gold era maps and photos and other illustrations of this time, clearly show an initial shoreline relatively unaltered from Maori times.

After 1871, the year of peak production, the picture changes with the exhaustion of the first great "bonanzas". Hundreds of thousands of tonnes of rock was mined to extract generally profitable, but no longer world class, amounts of gold and silver. While some of the waste, "mullock" (un-mineralised quartz and rock) and tailings (treated quartz ore) went back into the mine as back-fill, a huge amount ended up on the present-day Moanataiari flat. Illustrations of this later time show the batteries running their tailings and waste straight out onto the mudflats. "Thames: the first 100 years" (1967) sees the start of reclamation as the sludge carried in the flumes from the Moanataiari and Waiotahi. Figures from Downey (1935) show 272,230 tons of quartz alone from these two mines. The Moanataiari tunnel being "the main artery of the goldfield" (Isdale, A. ,1967, p55) servicing mines such as the Alburnia 63,638 tons of quartz, Fame and Fortune 12,001 tons and the Golden Age 1,395 tons, adding to the total amount of fill being pumped out. The main dumping area ran north from the Burke Street (Goods) wharf towards the Magazine wharf at the northern end of Kuranui Bay.

Up until the late 1890's the main method of gold extraction on "the Thames" was by mercury amalgamation which was at best extracting only 65% of the gold and silver in the ore. This created the rich resource of the Moanataiari sands that was exploited by H.H. Adams and Judd's the former recorded as having won around 4,500 ounces from his dredging operations (ref Hauraki Prospectors Association). The exploits of the Thames foreshore Dredging Co are documented in the New Zealand Gazette from registration on the 16th of May 1908 to 1914. At this stage the area of built up "reclaimed" land seems to have been about 400m x 400m with the Victoria no 2 bore site in the middle. In some illustrations and accounts this area includes a lagoon.

The Moanataiari Flat reclamation

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#1358460

John Isdale 2008

A Historic overview of the Moanataiari Flat reclamation

1. Pre gold rush geographical features
2. The gold field era
3. Post WWI harbour work
4. The situation of Thames post WWII
5. Post 1950 reclamation

COPY FOR YOUR INFORMATION

1. Pre gold rush geographical features

The genesis of the present reclamation can be seen in the local Geography. Besides the massive sedimentary in-filling of the Hauraki graben from rivers, such as the Piako and prehistoric Waikato, flowing from the south, the contributions of streams from the hills around Thames were minor but still significant. For the Moanataiari area, not only the creek of the same name but the adjoining Kuranui and Waiotahi streams, bought material from the eastern hills to build up the area immediately west of the Seaward fault and shore line. Less obviously, creeks such as the Tararu to the north, the Hape to the south and even in pre-historic times the Kauaeranga River, have helped build up alluvial material in the Moanataiari area. The depth of sediment under the Moanataiari Flat is well over 300m as shown by the Victoria Number 2 bore which at its terminal depth of 1,120 ft, was hitting "marine boulders" (AMI) not bedrock.

The mud bank, which "dries out" shown on the 1867 Heaphy map, does not tell the whole story. The sea in this area was not just shallow from all the natural deposition but also had some solidity. The sand bar referred to in the story of Te Apurangi and the contemporary reef in front of the Tararu School site; illustrate that significant features of material other than the predominant mud brought by the larger rivers existed. These low, with elevations of less than one metre, more solid features were easily overlooked.

In the story of the Moanataiari Flat another significant geological feature is the Premier larva flow. This forms the hilly land immediately adjacent to the Moanataiari Flat. The flow came from the prehistoric Waiokaraka volcano situated offshore from the stream of the same name in Grahamstown. Hydrothermally altered, the Premier flow provided the quartz reefs which contained over 80% of gold on "the Thames". This area of the field was notable for the amount of "Free Gold" in the gold bearing quartz reefs that was easy to extract. Other areas of the field were plagued with contaminants, such as telluride up the Tararu, which made extraction harder.

The Moanataiari Flat has not been without problems including subsidence of reclaimed land, arguably not given enough time to settle. Considerable expense and effort has also been put in to protecting the area from flooding, a perennial problem on "The Thames". Built up by a combination of human and natural action it remains one of the largest flat housing areas within the old town boundaries. The various human reclamation actions of mine waste dumping, harbour work, and the decade's long borough scheme were all enhanced by natural action. This can be seen not just in the Moanataiari Flat but also in adjoining Kuranui Bay. In the opening years of "the Thames" the North Islands first passenger rail way followed what is now Tararu Road with the sea on one side at Kuranui Bay. Today only at the Magazine reserve area at the Northern end of the Bay is this now true. The bay which once ran North South now sweeps round against the Moanataiari Flat to give a wide sandy beach heading west. The continuing battle to keep a flood water escape open at the Northern end is an indication of the continued build up of sand. This sand is driven South by tide and wave action and is trapped by the man made earth works of the Moanataiari Flat to create the ever expanding beach front of today's Kuranui bay.

John Isdale

20 August 2008

APPENDIX K

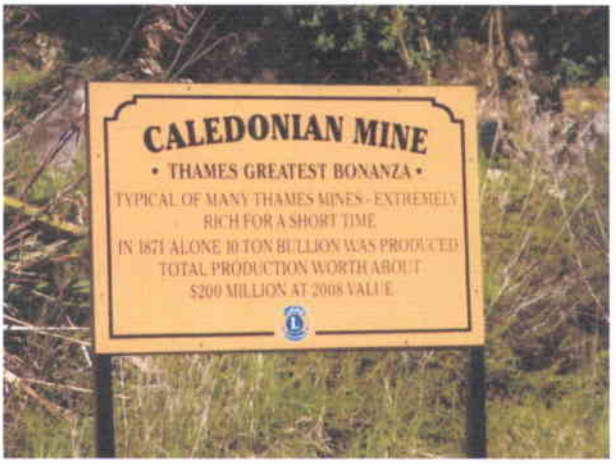
SITE WALKOVER PHOTOS

KURANUI BATTERY SITE

KURANUI BATTERY AND SHOTOVER MINE

LONG DRIVE

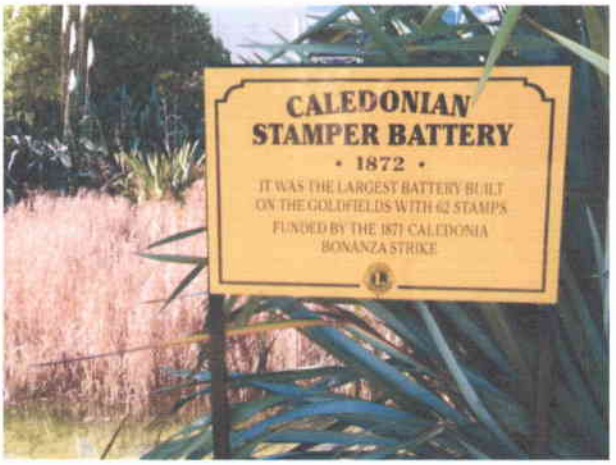
MOANATAIARI TUNNEL



CALEDONIAN MINE

TOOKEY SHAFT

GOLDEN CROWN MINE AND MUSEUM



CALEDONIAN BATTERY

MANUKAU MINE

ASSUMED BATTERY SITE

SCHOOL

MOANATAIARI SUBDIVISION

APPENDIX L

REPORT CONDITIONS

This report is prepared solely for the benefit of Environment Waikato and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise.

This report refers, with the limitations stated, to the conditions of the Moanataiari subdivision at the time of the investigation. No warranty is given as to the possibility of future changes in the condition of the site.

This report is based on information provided by Thames Coromandel District Council, a review of Environment Waikato Files, publications and maps, other historical publications, maps and newspapers and anecdotal information. Some of the opinions are based on unconfirmed data and information and are presented as the best that can be obtained without further extensive research and the collection of extensive soil samples within the subdivision and sediment samples from the adjacent Firth of Thames. Therefore, the findings detailed in this report reflect our best assessment.

This report is prepared and written for the proposed uses stated in the report and should not be used in a different context without reference to CSI. In time approved practices or amended legislation may necessitate a re-assessment.

The report is limited to those aspects of land contamination specifically reported on and is necessarily restricted and no liability is accepted for any other aspects especially concerning gradual or sudden pollution incidents. The opinions expressed cannot be absolute due to the limitations of time and resources imposed by the agreed brief and the possibility of unrecorded previous use and abuse of the site and adjacent sites. The report concentrates on the site as defined in the report and provides an opinion on surrounding sites. If migrating pollution or contaminants (past or present) exists further research will be required before the effects can be better determined.