2017-01 LRep
Status: Open
20 January, 2017

Prepared for:
Tonkin and Taylor Ltd

Background information: Whanganui Port Basin management assessment

1. Resource Consents: including consultant reports, Hearing Committee Decisions and monitoring requirements

1993 breach diversion

In an effort to reduce maintenance dredging costs, the then Port Company, Ocean Terminal Ltd, engaged Beca Carter Hollings and Ferner Ltd (Beca) in June 1992 to investigate breaching the Basin Wall at its eastern end and excavating a flow channel (the basin channel) across the Basin to the Wharves. The concept being to maintain ebb flow through the Basin and thus limit sedimentation during high sediment bearing flows. In addition, ebb flows along the wharves would encourage scour and reduce maintenance dredging.

Beca's report of September 1992 contained minimal flow velocity data/analysis and the description of river dynamics were based mainly upon their site inspection. Although not stated in the September report, rather in a later Statement of Evidence for the consent hearing by Mr Steel (Beca engineer), the report had relied upon the experience of Professor Raudkivi (Auckland University) for sediment transport viability and breach and channel dimensions. Professor Raudviki's report has not yet been located, and neither has his Evidence presented at the subsequent resource consent hearing on 19 March 1993.

In his evidence, Mr Steel made the following comments;
The major effect will be to provide a net outflow through the Basin within an excavated channel that will reduce dredging by 50%.

The 100 m wide breach can be expected to deliver some 10-15% of river flow through the Basin. Limiting the breach depth to 0.5 above CD will deflect sediment-laden river flow into the main river channel (i.e. prevent it crossing the breach and into the Basin), maintaining an erosion/deposition balance in the river similar to before.

Flood flow capacity of this section of the river will be slightly improved due to change in hydrology after the breaching. [unclear]

The proposed flow path will tend to scour along the wharves and maintain deep water in the berthing area; however, expansion of flow means that diversion channel's scour effectiveness is reduced the further up-basin deep water is required.

The expected net outflow from the Basin was predicted to reduce sedimentation opposite No 2 Wharf and across the basin entrance, with deepest water being near the wharf.

The greatest negative sedimentation effect was predicted to be in that area immediately upstream of the breach on the right bank (i.e. by the Wanganui Engineering Ltd. slipway/beach), with the bed expected to be raised some 100 to 150 mm, while on the downstream (river) side of the breach a small, potentially imperceptible, increase in bed level may also occur. Note Wanganui Engineering was later to become Q-West.

Mr Steel explained that the hydraulic assessment and impact predictions were based primarily of Professor Raudkivi's extensive experience in fluid mechanics and river siltation which allowed them a high degree of confidence. He noted that to quantify the hydraulic effects would require modelling and added that numerical or physical modelling would be expensive and could face scaling limitations, these constraints making use of the full scale (prototype) model appropriate.

Breach performance would be checked with periodic soundings taken over at least 2 and preferably 5 years. The sounded area should extend some 75 m above the Wanganui Engineering wharf/slipway and downstream to No 1 wharf, and should be made at 6 monthly intervals, preferably at the end of summer and the end of winter

Mr Steel's evidence also addressed the range of RMA effects; landscape, visual, water quality, ecology, economics, recreation, cult and heritage, as well as temporary construction and channel excavation effects.

Payne and Sewell Ltd outlined possible negative impacts on behalf of Wanganui Engineering: (1) if too higher proportion of the ebb flow is diverted, the channel between the Te Anau and the South Spit may silt and limit vessels using their slip, and (2) high flow flood conditions may transport silt upstream from the Basin through the breach and to the slipway.

The Hearing Committee subsequently granted coastal permit 913273 to divert part of the Whanganui River by breaching the harbour Basin wall over a length of 100 m and to a depth of CD +0.5 m with a 10 m riprap apron on the Basin side, for the purpose of reducing siltation and maintaining water depths for a term expiring on 30 June 1996. Three plans defining the location and depth of the breach and excavated channel as attached to the Decision are included here in Attachment 1. Furthermore, Figure 1 below has been prepared to show the proposed breach and channel as located upon 1998 and 2015 aerial photos.

In keeping with the Applicant's suggestion, monitoring conditions attached to the consent required contour surveys at quarterly intervals prior to breaching from 75 m upstream of Wanganui Engineering's slipway to downstream of No 1 berth at 0.5 m intervals and shall cover both the Harbour Basin and the main river channel. In addition, a transect survey be produced every 6 months which crossed the main channel as well as the Basin.

1996 continued breach diversion

Presumably, monitoring associated with the 1994 breach and diversion was to continue at least until the review in 3 yrs time (June 1996); however, we understand that monitoring ceased in January 1996 (after 2.5 yrs). We have yet to locate any monitoring data and we have seen no report, other evidence or consent decision as to the morphological or inferred hydrological effects of the breach: such material must have been produced to justify a cessation of monitoring and continuance of permit 913273 which expired on 30 June 1996.

1999 training wall

On 28 October 1999, a Hearing Committee granted coastal permit 100762 to erect and maintain a 150 m training wall. This wall extends from the south side of the breach and along the southern side of the diversion (basin) channel and was required as flood flows had realigned the channel across the Basin mud flats, thus bypassing the marina and wharves (See Figure 1). The Committee granted the consent for 35 yrs with 5 yearly reviews to assess actual effects on sedimentation patterns. A matter of concern to submitters was the impact of increased flow velocity against the wharf structure. However, the Decision stated that Professor Raudviki considered the training wall could increase current velocities against the wharves by up to 15%.

In terms of monitoring conditions, the Hearing Committee required that "the bathymetry of the port basin should be measured and chartered prior to establishment of the training wall and thereafter so the effect of the wall can be ascertained. Furthermore, water flow velocities in the Basin should be measured once the training wall is completed and thereafter to provide an ongoing comparison with the base line figures presented by Ocean Terminals at the Hearing".

The 2016 Baseline Study describes the training wall as being 350 m long, while the consent was for a 150 m long structure. Infact, the pile and tyre wall is 165 to 170 m long (measuring from the 2015 aerial photo), with an additional 200 m comprising rubble. Presumably the extension was to constrain the flow further toward the wharves; however, we have as yet no information about the extension.

Discussion

The 1994, 1996 (uncited), and 1999 resource consent decisions refer to technical information and monitoring data that we have not as yet seen. These materials should explain why certain management decisions were made and may be helpful in our various analyses of Basin and River dynamics associated with insertion and removal of the breach. We are particularly interested in obtaining a copy of Professor Raudkivi's 1992 report and 1993 evidence.

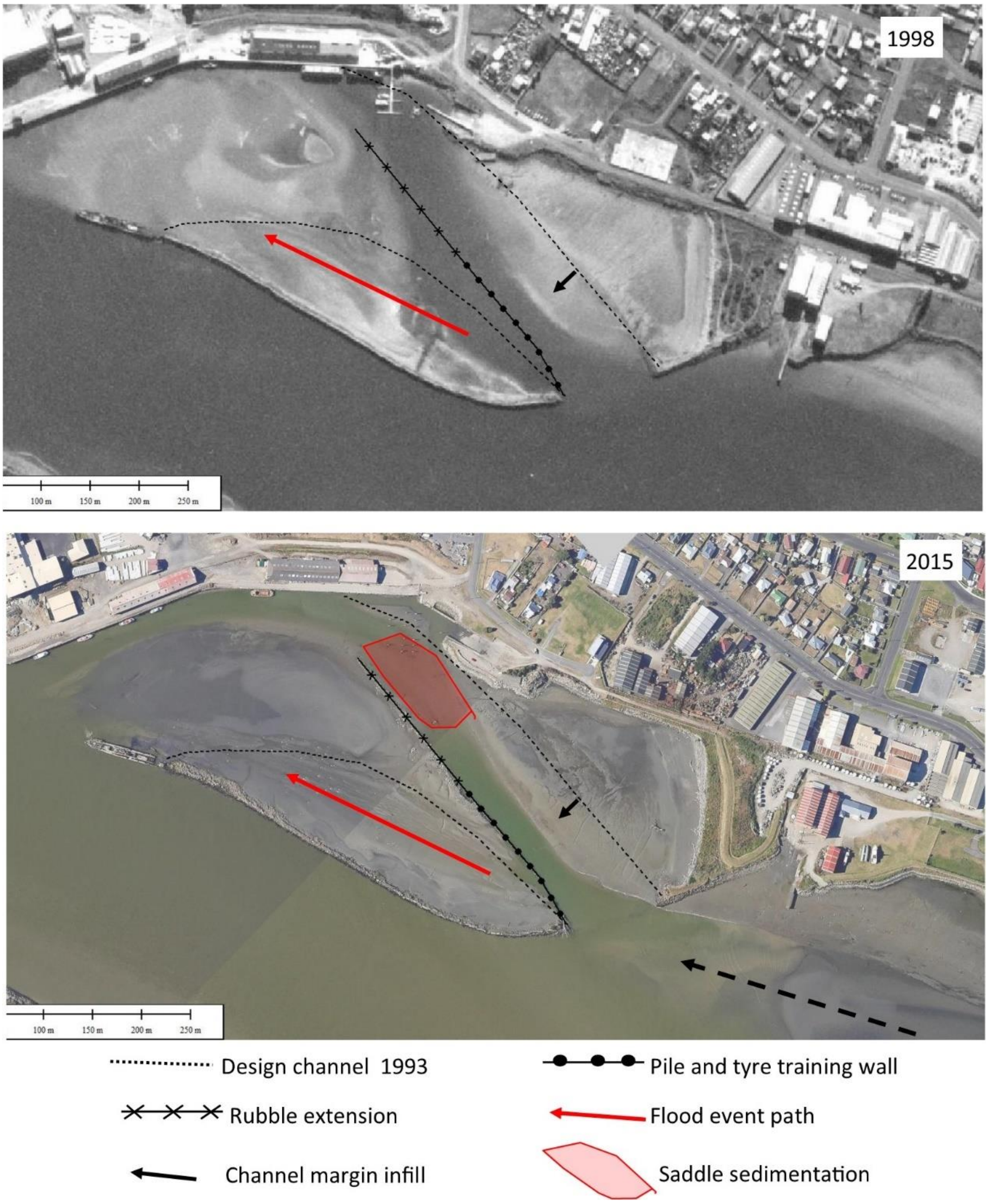


Figure 1 Design channel and training wall locations superimposed upon 1998 and 2015 aerial photos. The flood event (erosional) pathway is marked by the red arrow; this resulted in substantial erosion of the tidal flat and meandering of the channel depriving the wharves of breach-diversion flow. The pile and tyre training wall was constructed in 1999.

System responses we have identified suggests both Professor Raudkivi and Mr Steel under-estimated scour within the Basin as the channel proved to be particularly unstable and prone to meander, requiring subsequent structural control (Figure 1). The scour action appears to extend not much beyond the pile training wall (Figure 1 and also 2015 bathymetric chart contained in the 2016 Baseline Study) with maintenance dredging required beyond.

2. 2016 Baseline Study

The breach and associated structures are briefly described in Section 2.6 of the study, and the 1994 oblique aerial photo showing channel excavation is included here as Figure 2. Breach and channel dimensions and timing have been discussed in Section 2, as has the requirement for, and construction of, a training wall along the southern side of the channel in 1999.

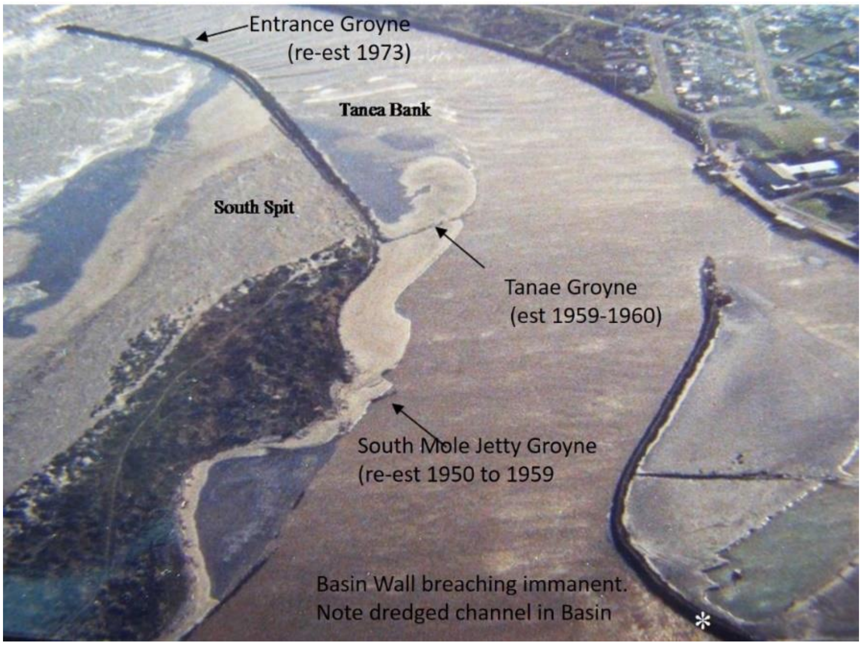


Figure 2 Excavation of the Basin Channel prior to breaching the wall.
Source 2016 Baseline Study, Figure 12.

The 2016 Baseline Study (Section 2. Analysis and Discussion) addressed morphological change in the vicinity of the breach based on (a) superimposed profiles (see Figure 3 below for section locations) which were derived from bathymetric data, as well as (b) aerial photography. However, the Baseline Study primarily addressed effects on the river side of the Basin Wall breach. Superimposed profiles for 1993, 2006 and 2015 at transects 5 (250 m upstream of the breach, transect 6 (just inside the breach), and transect 7 (within the Basin midway along number 3 wharf) are depicted below in Figure 4. In addition, some additional reported below will be drawn from the bathymetric charts shown in Appendix D of the Baseline Study

It should be noted that the 2016 Baseline Report was high level study (large scale/long-term/broad relationships), and an indepth investigation of high spatial and temporal resolution bathymetric data, some of which appears to exist for consent monitoring, may modify the indicated associations.

Figure 3 Section locations (red lines), numbers and names. Black lines locate river control structures. (source Figure 15, Baseline Study 2016). Blue line is transect sampled in Figure 5 to compare breach bed levels.

Section 5: Wreck (upstream of the breach)

The 2006 profile shows considerable erosion in the main river channel (between 100 to 150 m from measurement datum at the South Spit) and indicates a lesser, albeit well defined, northern channel (between 300 to 400 m) persists from 1993. This north channel is better defined here than at sections further upstream, and this may be associated with local strengthening of river flood flows through the breach immediately downstream. However, the 2015 profile shows shallowing of the north channel by up to 1 m, and this is further illustrated by the sediment body (lobe) evident in the bottom right of the 2015 aerial photo in Figure 1. Sequential aerial photos (not shown) show this sediment is migrating downstream and possibly beginning to affect the breach area. Monitoring is required to determine whether sediment enters the Basin or if the elevated base of the breach enables it to be deflected toward the main channel as predicted by Mr Steel.

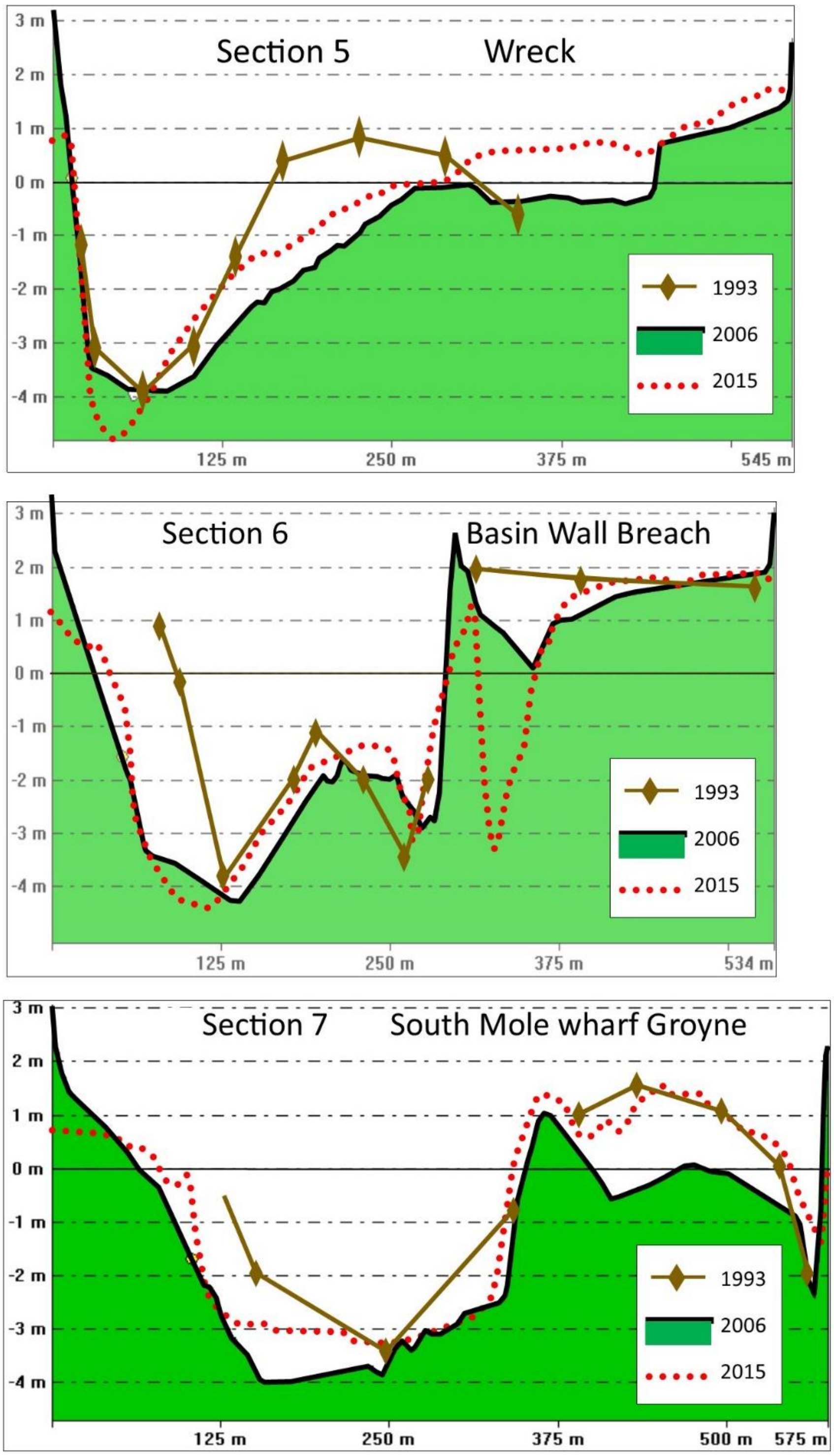


Figure 4 Section graphs for 1993 (pre-breach), 2006 and 2015 superimposed upon the 2006 profile. Note the constant scales in all graphs enable direct comparisons. Source 2016 Baseline Study, Figure 16, with the original graphs also including earlier data.

The wider extent of 2015 aerial photo and bathymetry (not shown) depict additional accumulations further upstream and these are migrating downstream indicating sediment input into the breach area is likely to continue into the future.

Section 6: Basin Wall immediately west of Breach

The profiles shown in Figure 4 depict substantial post-breach erosion against the South Spit. However, as described in the 2016 Baseline Report, this appears to be more likely a result of larger scale sediment supply variation than and effect of the breach. By contrast, on the western side of the main channel, i.e. the Basin Wall side, the well-defined pre-breach channel along the river side of the Basin Wall, referred to as “the basin wall channel”, had reduced in size in the 2006 and 2015 profiles. These changes are more likely related to the breach diverting flood flows through the Basin and thus reducing flow along the basin wall channel.

Within the Basin, the 2015 profile shows the diversion channel immediately downstream of the breach is now over 3 m below Chart Datum. However, the 2006 profile shows it was still near the design depth of CD plus 0.5 m (see Breach Bathymetry section below). The right side of the channel had migrated into and across the design centreline by 1998 (Figure 1) with the 2006 and 2015 profiles indicating that this side of the channel is now relatively stable. There is little difference in pre-breach and present elevation across the tidal flat.

Section 7: Western end of Basin to mid No 3 Wharf

As occurs at Section 6, the left side of the Main Channel had moved significantly towards the South Spit. However, on the right hand side of the main channel at least 1 m of erosion had occurred by 2006, and this was essentially unchanged in 2015. This may be associated with the erosional adjustment to the onset of deposition at the adjacent upstream section (6). Note, deposition and erosion typically alternate along sediment transport pathways.

Within the Basin itself, the 2015 profile indicates a shallowing of about 1 m against No 3 Wharf, and 0.5 m of deepening on the tidal flat near the Basin Wall between 1993 and 2015. The latter change possibly relating to the flood event pathway marked in Figure 1. While the 2006 profile shows the same pattern, it is over 1 m deeper, indicating a slow response to the post-breach erosive flood events.

An alternative perspective of depth changes in the vicinity of the wharves is shown in Figure 5 which has been constructed from the bathymetric data presented in the 2016 Baseline Study. In particular, -1m CD contour has been plotted from (i) 1982 when the dredge WANGANUI was operating, from (ii) 1993, some 5 years after Ocean

Terminals had been operating the port and depicting the depths which initiated their decision to investigate an alternative flow regime, and (iii) from 2015 when the natural system, coupled with the associated port dredging regime, appears to have stabilized.

Breach bathymetry

The breach resource consent was to divert part of the Whanganui River by breaching the harbour basin wall over a length of 100 m and to a depth of CD +0.5 m with a 10 m riprap apron on the Basin side. Attachment 1, drawing 1, shows the channel invert was designed to decrease from 0.5m CD at the breach down to CD at the wharves.

Figure 5 shows bathymetries for 1993, 2006 and 2015 along the Basin channel, crossing the breach and extending 100 m upstream of the breach – this 200 m long transect has been marked blue in Figure 3.

The 4.8 m depth immediate upstream site of the breach as wall as depicted by the 1993 elevation line, was crucial to the Wanganui Engineering slipway operation.

These data do not show whether or not the 1994 breach was constructed at the design depth of 0.5 m CD, as the 2006 data is 12 years post event.

While the breach invert was about 1 m below design level in 2006, the channel across the Basin appears to be at design level suggesting subsidence may have affected the base of the breach following its opening. Upstream of the breach, the 2006 bed level has risen some 2.5 to 3.5 m.

The 2015 breach invert appears to be up to 1.5 m below design level and there are contrasting bed level changes on each side of the breach, with levels in the Basin eroding 2 to 3 m (close to the training wall) and up to 2 m of deposition occurring on the upstream side of the breach. The 2015 lines in Figure 5 show that the sediment accumulating on the upriver side is higher than the breach invert and beyond the graph range the bed level increases to 1m CD. Sediment may well enter the Basin unless the invert is raised.

Furthermore, the training wall is being placed under increasing strain due to channel scour possibly aided by slow encroachment of the right side of the channel. Inspection with a view to maintenance and strengthening should be carried out immediately and regularly thereafter.

Note, while the accuracy of the 2006 Basin data was queried in the 2016 Baseline report, we now think the effects of post breach floods (Figure 1) may have significantly affected the bathymetry and recovery/adjustment following construction of the training wall was particularly slow.

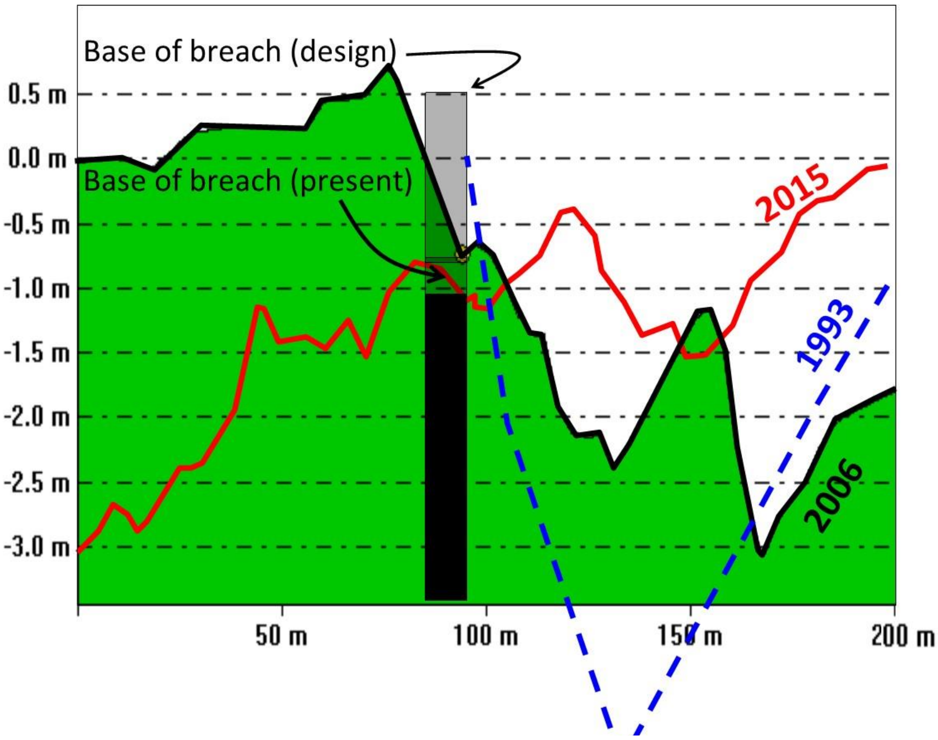


Figure 5 Bed level comparisons on each side of the breach (Basin on left, upstream on right). The breach is depicted by the black bar. Graph includes about 100 m of channel into the Basin (left) and about 100 m upstream of the breach (right). 1993 is pre-breach bed level and maximum depth was 4.8 m.

Dredging background

"Dredging volumes for the period 1951 to 1983 averaged 80,533 m^3/yr and ranged between 40,917 to 108,600 m^3/yr" (2016 Baseline Report, p57). The results of such a maintenance regime are evident in the 1982 Basin depth contours (see Figure 6).

"During the late 1980s, Port Company Ocean Terminals Ltd tried to further develop the port by leasing a suction dredge and spending nearly $1M improving bar and basin depths (WDC, 2004), but this was not economically sustainable" (2016 Baseline Report, p57).

The 1993 contour in Figure 6 shows reduced depths had occurred when the company breached the Basin Wall in 1994. Trevor Gibson (Section 4 below) considered much of the reduction had occurred by 1990.

"City Port Ltd took over the lease in 2004 and pursued a minimalist approach to dredging, allowing for only the depth required for existing shipping and boating, i.e. there is no Turning Basin. The dredge was a hydraulic excavator operating from a barge or directly from the wharves. The WDC (2004) report stated that having private companies operate the port had saved the community $6 m between 1988 and 2004. However, the matter of deferred maintenance remained contentious and the Wanganui District Council itself took over the lease in 2010" (2016 Baseline Report, p57). The 2015 contour (-1m CD) in Figure 6 indicates an overall reduction in depth has occurred during the lifetime of the breach.

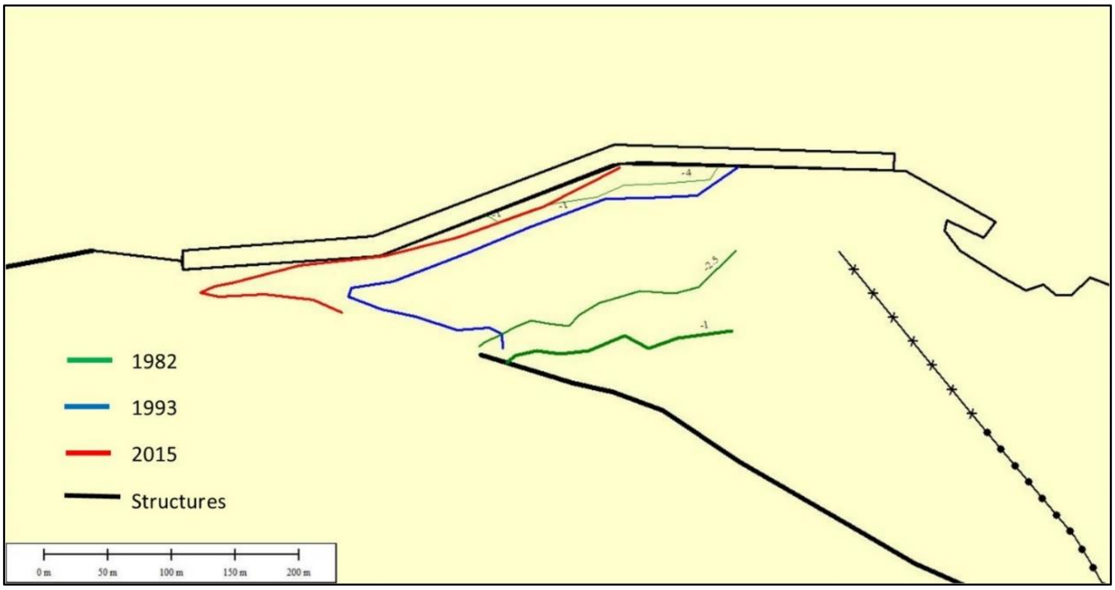


Figure 6 Plan view of Basin elevation change 1982 to 2015. Contour lines at -1m CD are shown for all samples, with -2.5m CD and -4m CD also depicted for 1982,

Discussion

The 2016 Baseline Study data suggested that the breach has, on the river side, had an erosive effect immediately upstream and depositional effect (within the river) immediately downstream (and erosive effect beyond that). However, upstream sediment supply input appears able to overwhelm these signals and monitoring is required to determine how an accumulation about to impact the breach will affect sedimentation patterns within the Basin.

The 2015 bathymetry indicates the breach invert is now 1 to 1.5 m beneath design level (0.5 m CD). The elevation of the approaching upriver sediment wave is greater than the present invert level and this situation may well structural raising to ensure sediment diverts along the outside of the Basing Wall and into the main channel.

Within the Basin itself, post breach surface levels across the tidal flats appear to have stabilised close to pre-breach levels. However, during the intervening period, flood flows across the flats caused substantial channel realignment (meandering) and surface erosion (Figure 1 upper and 4). A training wall now constrains the western side of the channel; this limits but does not eliminate flood scour of the flats closer to the Basin Wall (see Figure 1 lower). The training wall's effect on channel depths seems to be most pronounced along the 170 m pile section with sedimentation occurring thereafter and a saddle before the deeper water (dredged) along the bethages. Note that the saddle is marked in Figure 1 and clearly evident in the 2015 bathymetric chart in the Baseline Report; it indicates effective channel scour along the wharves may be limited.

The effective dredging of the Turning Basin carried out by the WANGANUI prior to dissolution of the harbour Board had been significantly reduced by the time of the 1993 survey, and possibly earlier according to Mr Gibson (Section 3). The 2015 survey indicates additional depth reduction along the berthages; however, a more thorough analysis of available data would be required to validate/quantify this snapshot result.

3. Additional information

Materials from Trevor Gibson

Mr Gibson was employed with Wanganui Harbour Board between 1958-88 as Pilot Staff, Dredge Master, and Port Captain)

Mr Gibson has summarized dredging from 1878 to 1988 in his article of 19 May 1992 (copy is attached as Attachment 2) including his diagram showing the changing "mud line" at low tide. In addition, we spoke with Mr Gibson on 9-12-2008 and 12-1-2017.

Points of interest from the interviews and article include the following:

- The grab dredge WANGANUI served the port between 1950 and 1988 when the new Port Company Ocean Terminals considered it surplus and sold it.
- The WANGANUI was ideally suited for Basin mud (85% liquid), compared with a suction dredge.
- The WANGANUI maintained a depth of 3 m below MLWS within the 122 m Turning Circle (marked on his diagram), and removed over 1,500,000 m^3 of sediment.
- Three quarters of the WANGANUI's dredging in the Basin occurred within the circle and ¼ at the mouth of the Basin which tended to shoal after floods.
- By the time of the flood in 1990, depths had already reduced with fishing vessels settling on the bottom at low water.
- Turning Circle dredging also resulted in elevation on the adjacent flats lowering some 1.5 to 2 m due to earthflow. His evidence of this being concrete the gap between concrete capping of the Basin Wall Surface, poured onto the surface mud in the early 1960s, and the later subsiding mud level.

- The turning circle depth increased in later years as vessels increased in size.
- He recalled that the turning circle lost 1 m in depth in one flood during the 1970s.

Sediment data

Ministry of Works

As noted in the 2016 Baseline Report, suspended sediment measurements carried out by the Ministry of Works between 1956 and 1967 derived a rating curve for Paetawa which gives an annual (total) sediment discharge of 486 t/km^2 (Tonkin and Taylor, 1978). Assuming a bulk density of 2 tonnes/m^3, this equates to 1.7 x 106 m^3 sediment discharged annually into the Tasman sea.

Sir Alexander Gibb and Partners

Sediment information on suspended solids is contained in Gibb, 1962, p14 and 19, and is reproduced here as Attachment 3(i)

Geotest Services

Particle size analysis from 1992 is reproduced below in Attachment 3(ii)

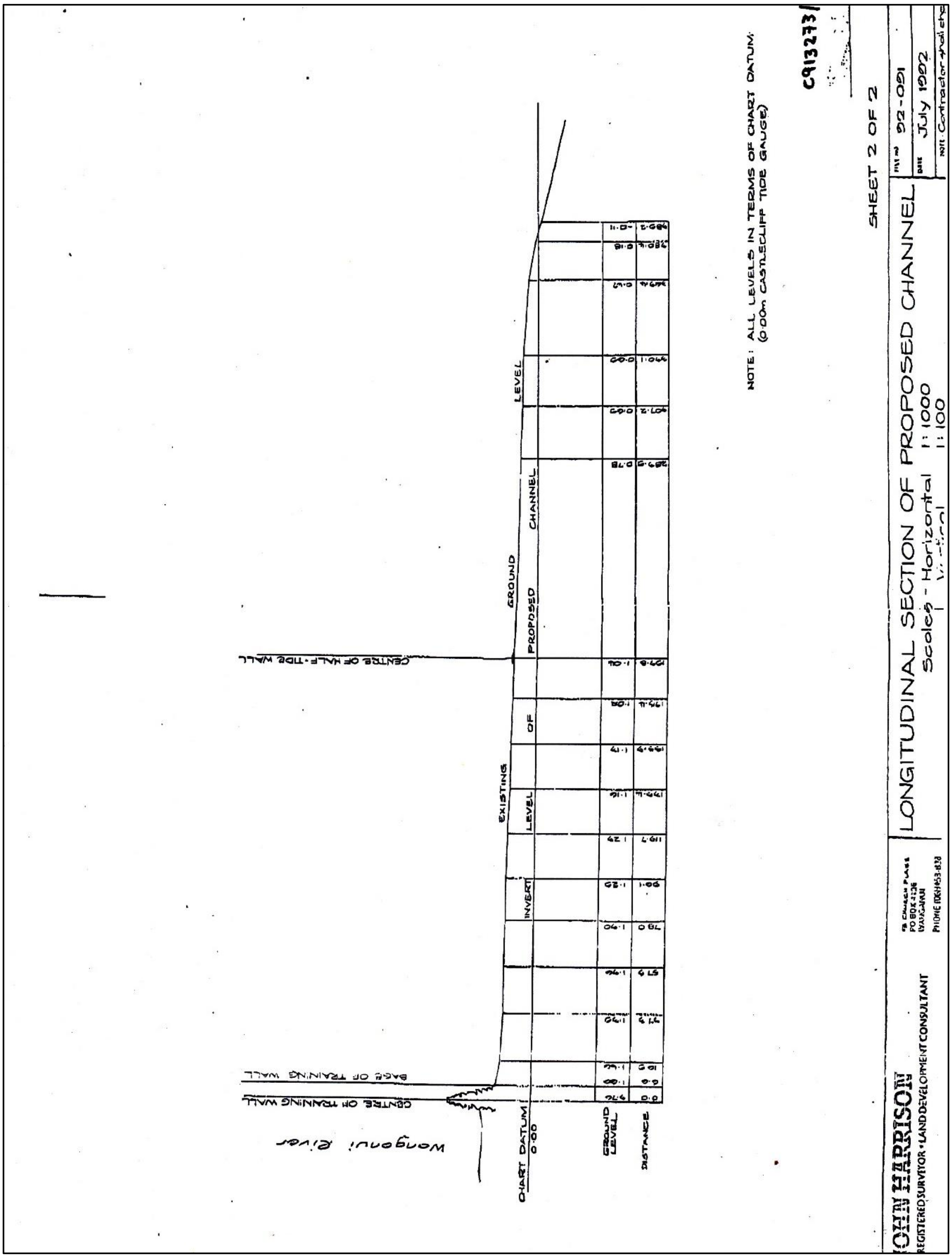
Envirolab Services

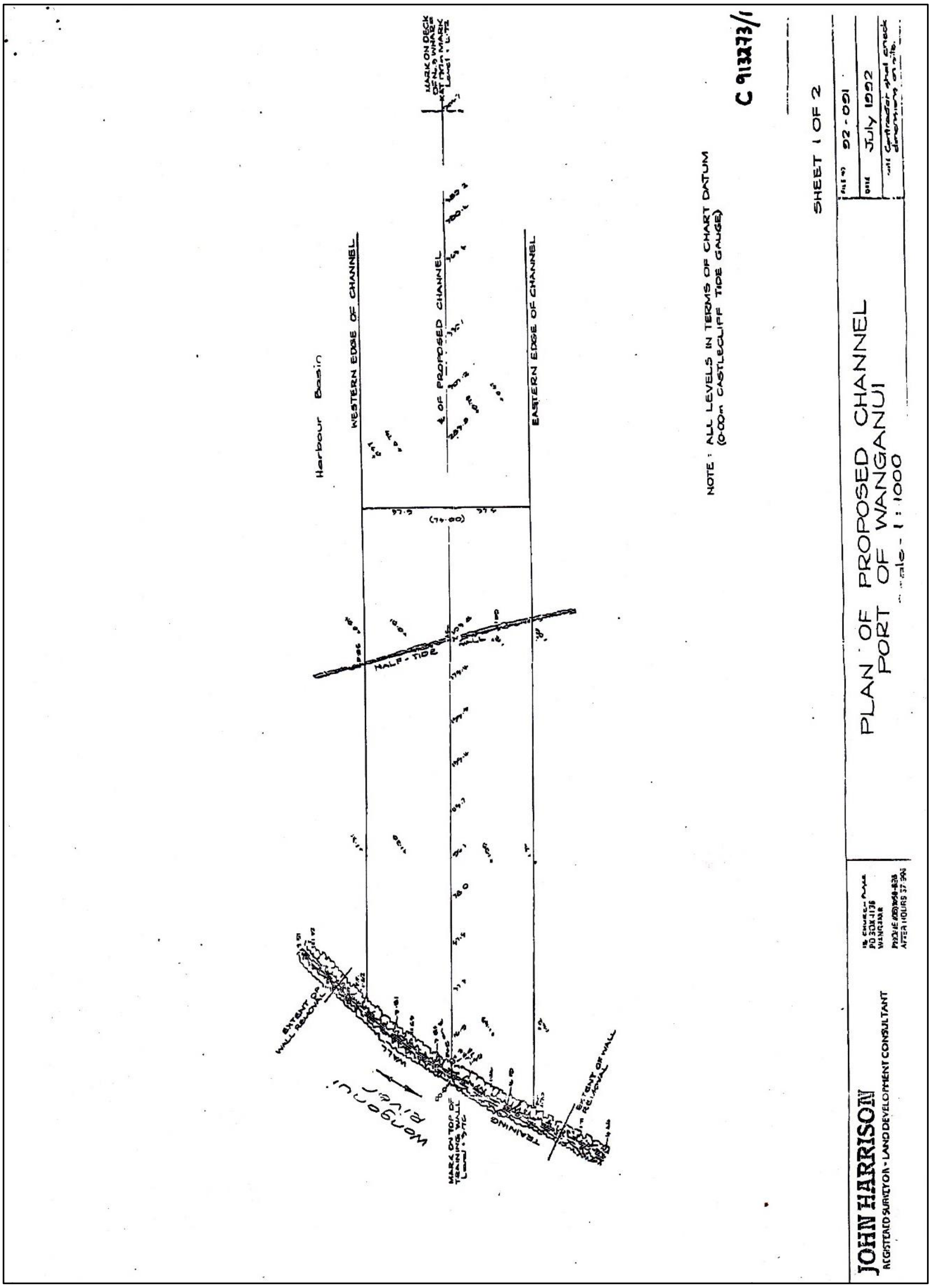
Chrome analysis from 1993 is reproduced below as Attachment 3(iii)

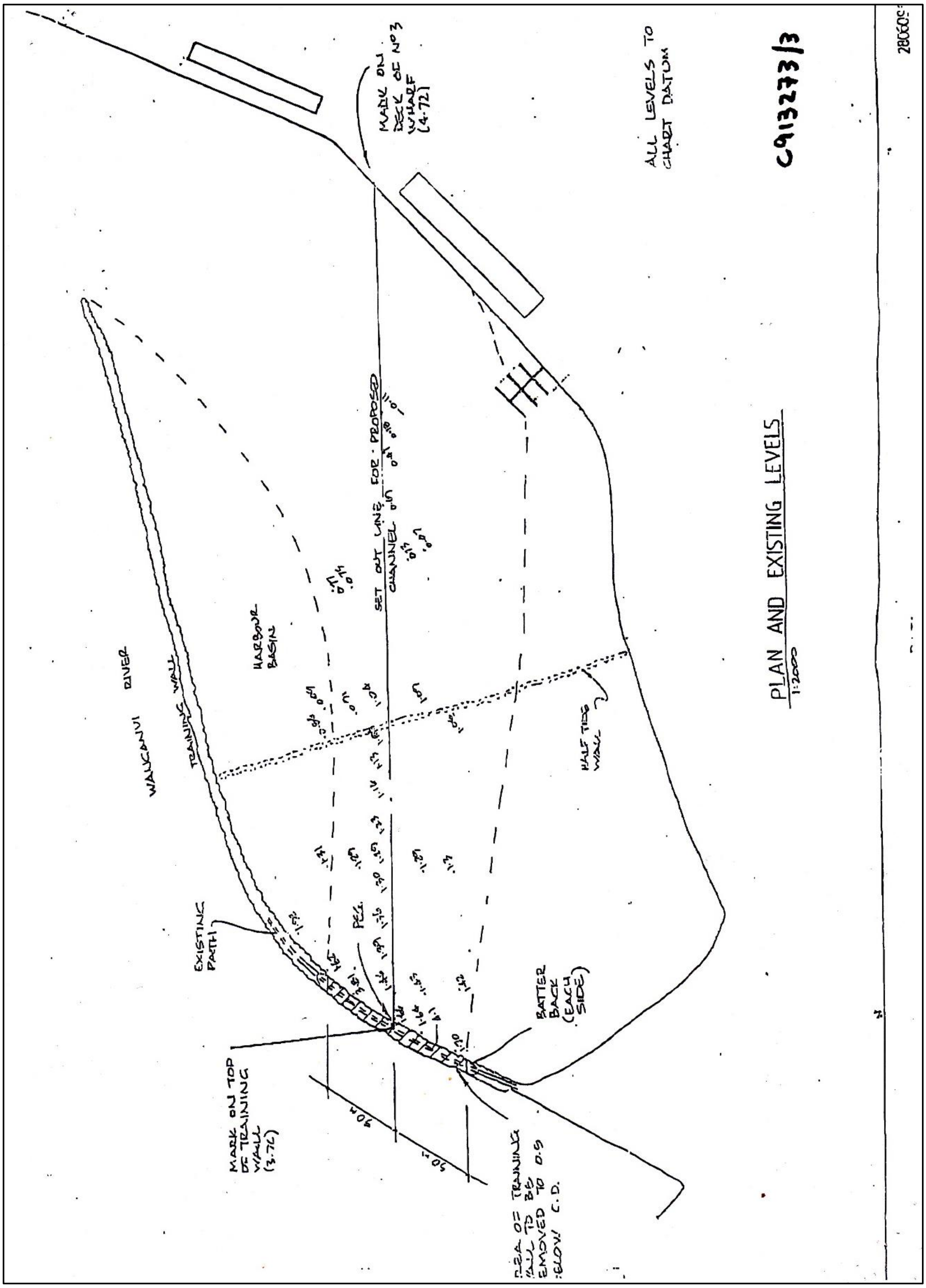
Environmental Laboratory Services

Suspended solids and Turbidity tests from 1994 are reproduced below as Attachment 3(iv)

Attachment 1 **Drawings C913273/1-3 attached to the Hearing Committee Decision of 11 May 1993 for Coastal Permit 913273**




PLAN OF PROPOSED CHANNEL
PORT OF WANGANUI
SHEET 1 OF 2
92-091
July 1992
C 913273/1
NOTE : ALL LEVELS IN TERMS OF CHART DATUM
(0-00m CASTLECLIFF TIDE GAUGE)
Harbour Basin
WESTERN EDGE OF CHANNEL
EASTERN EDGE OF CHANNEL
HALF - TIDE
TRAINING WALL
Wanganui River
JOHN HARRISON
REGISTERED SURVEYOR - LAND DEVELOPMENT CONSULTANT


PLAN AND EXISTING LEVELS
1:2000
C913273/3
ALL LEVELS TO CHART DATUM
MARK ON DECK OF No3 WHARF (4.72)
HARBOUR BASIN
TRAINING WALL
SET OUT LINE FOR PROPOSED CHANNEL
HALF TIDE WALL
EXISTING PATH
BATTER BACK (EACH SIDE)
MARK ON TOP OF TRAINING WALL (3.76)

Attachment 2 T. H. Gibson's 1992 article

HISTORY OF DREDGING THE PORT OF WANGANUI

1878/1919

Various methods were used during this time the main being a bucket type dredge mounted on a barge and discharging into hopper punts which were unloaded by bottom opening doors after being towed into the run of the river, thousands of cubic yards were disposed of in this manner.

1919/1945

The Kaione a T.S. Suction hopper dredge 830 grt was purchased by the Wanganui Harbour Board and entered service at Wanganui for 28 years, her pumping arrangement was 2 pumps with impellers 5 feet x 11 inches turning at 160/185 rpm driven by a 250 ihp compound engine, but if necessary could be coupled to the main engines making 500 ihp available to each pump through 17 inch suctions.

On commencing dredging operations in the harbour basin the mud line at MLWS was from the bow of the Te Anau to number 7 bollard number 3 wharf, after 26 years of dredging the mud line was still the same position never gaining never losing, she would pump all day and never get a full load of mud, yet out on the Bar she could load 1000 tons in 35/40 minutes the pumping of fluid mud is uneconomic as the ratio is at the best of times 85% water 15% solids on sand it reverses 85% solids 15% water.

1945/1950

During this time of no resident dredge the basin was kept open by the use of other dredges from other Ports, the MAUI a bucket hopper dredge 557 grt from Westport, MAWHERA a twin screw suction and bucket hopper dredge 658, grt, the suction never used in Wanganui, and the TE WHAKA 324 grt a grab hopper dredge from Lyttleton, also the Tug KAHANUI which was twin screw 237 grt was moored at number 2 wharf and the engines run to create scouring on the outgoing tide, the MAWHERA was from Greymouth, but ended her time at Westport when Greymouth closed to commercial shipping.

1950/1988

With the arrival of the grab dredge WANGANUI 252.50 grt the harbour basin was continually dredged over these years maintaining a 3 metre turning circle of 122 metre radius of number 2 bollard number 3 wharf, the berths to a depth of 5 metres mlws except the fishing berth which was 3 metres mlws, removing in the excess of 1,500,000 m^3 over these years, prior to the establishment of the Marina, dredging of 21000 cubic metres took place before any piles could be driven, this area was dredged to a depth of 3 metres mlws.

Dredging on the Bar was first undertaken by the KAIONE in the mid 30's then in the late 70's by the Timaru dredge W H ORBELL 3110 grt, then the Grab/suction dredge NGAMOTU 923 grt of New Plymouth in the mid 80's.

With the dissolution of the Wanganui Harbour Board in June 1988 dredging ceased, and the Dredge Wanganui disposed of as the Port Company that was formed did not require her.

SUMMARY

Siltation at the Basin entrance has always been a problem, and with no dredging and very little shipping movements, siltation took over at a faster rate than normal. Christmas 1988 the Port Company chartered the NGAMOTU to dredge the Bar and Basin, suction on the Bar, and grabbing in the basin, at a later date they used the suction in the basin and in doing so undone all the work that was done by the grab because the over board discharge was putting it all back as the mud was so fluid. The only sure way of dredging the basin is by physically removing the spoil by grab or bucket dredging, this also removes any debris that accumulates, e.g. logs rope tyres etc that are always present. One way that the basin siltation could be reduced drastically would be to construct a groyne 30 metres long in a 250° true from the bow of the TE ANAU, this would deflect the river flow away from number 1 wharf which happens now. And this in turn creates a settling pond which causes shoaling.

The flood of 1990 did contribute to siltation in the basin but the depths had already decreased prior to that date as the local fishing vessels were settling on the bottom at low water. And the

-3-

basin entrance was restricted in width with a build up off the corner of N^{o}: 1 and N^{o}: 2 wharves

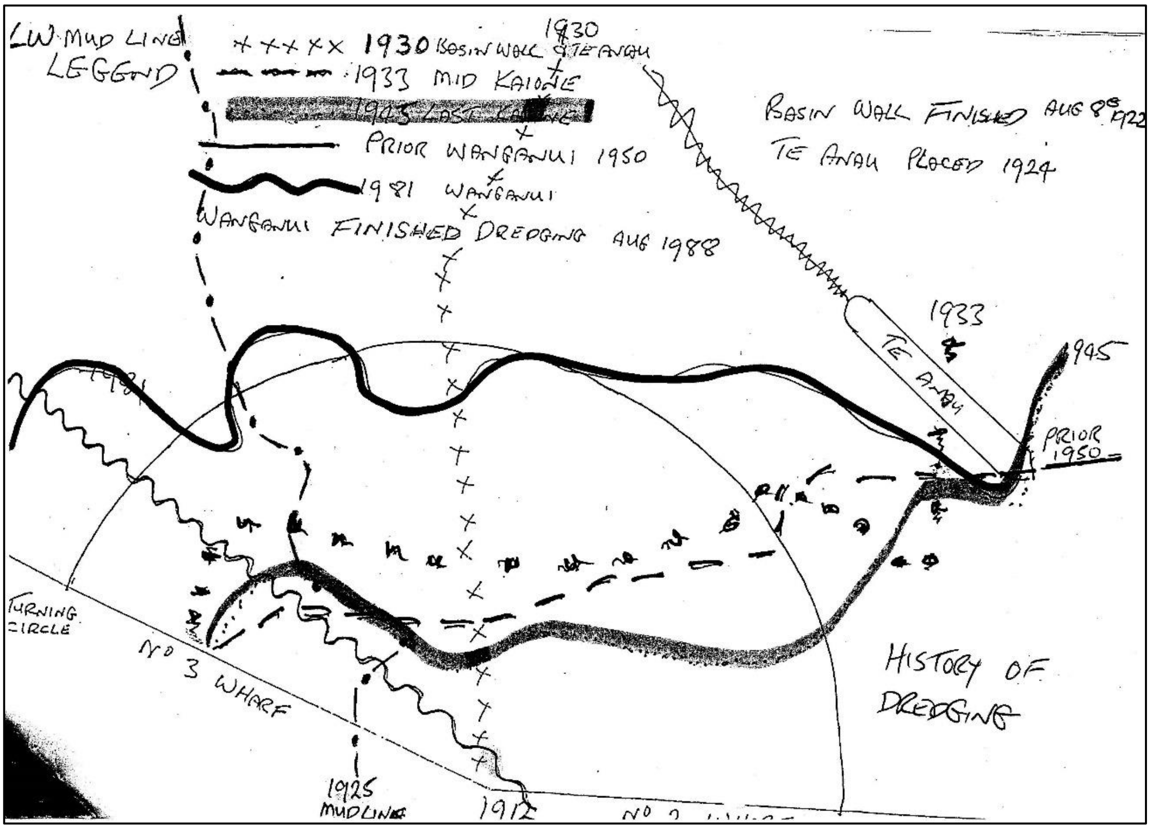
During the Dredge Wanganui's tenure the mud level at low water was lowered by 1½ metres to 2 metres in the surrounding mud flats. When the basin wall was built up and concreted in the early 60's the mud line was up to the concrete, the wall running across the basin was level with the mud flats as the stone was used on the basin wall repairs.

Just recently the Dredge Tasman Bay 323 grt which is a grab dredge worked for about 2 months, but was not used to her full capacity and what she did achieve will be wasted as there is nothing to maintain it.

Any future dredging would have to be of a **CAPITAL** nature as the current situation is past maintenance dredging unless a major development takes place or a dredge is purchased to work full time as the Dredge Wanganui did and showed what could be achieved using the right equipment. The present depths in the basin entrance and basin proper are the worst for 40 years.

This article by T H Gibson (Wanganui Harbour Board 1958-1988) Pilot staff, Dredgemaster and Port Captain.

19 May 1992



Attachment 3 Additional water quality data

7.02 Recent Sediment Measurements

Silt samples were taken with the salinity measurements of 29th September 1959 and the results are shown in Table VI.V. On that occasion samples taken from the salt water wedge underlying the fresh water were noticeably less silty.

On another occasion the river has been seen running at about 40,000 cusecs, a uniform brown muddy stream. A thick cover of silt 40 feet vertically up the river bank has also been noted in many locations as left by the 173,000 cusecs flood of February 1958.

TABLE VI.V

SOLIDS IN SUSPENSION

29th September, 1959

Sample No.	*Solids p.p.m.**	*Sample No.*	*Solids p.p.m.*	*Sample No.*	*Solids p.p.m.*
1	630	27	530	53	200
2	800	28	600	54	100
3	870	29	580	55	120
4	1,020	30	290	56	80
5	1,220	31	290	57	140
6	850	32	420	58	120
7	630	33	470	59	140
8	660	34	450	60	100
9	1,360	35	220	61	120
10	790	36	310	62	100
11	860	37	240	63	80
12	570	38	310	64	160
13	650	39	340	65	60
14	670	40	Number not used	66	80
15	510	41	270	67	20
16	530	42	290	68	20
17	760	43	340	69	40
18	860	44	420	70	20
19	1,060	45	600	71	40
20	970	46	140	72	60
21	600	47	220	73	60
22	580	48	170	74	20
23	Broken in transit	49	120	75	120
24	590	50	90	76	340
25	520	51	150	77	40
26	550	52	210	78	40
				79	120

* Parts per million

NOTE.—Sediment samples were taken with salinity samples and were numbered in chronological order. *See* Plates Nos. VI.20 and VI.22 for details of sample positions, river flows and tide.

The Wanganui City Engineer has made recent measurements of silt load as follows:—

Date		*Gms. of silt/500 cc. of surface water*
1940 flood, 175,000 cusecs	.. ..	4·54 (1 : 110 by wt.)
1958 flood, 173,000 cusecs.	Mid-river	2·2 (1 : 230 by wt.)
1958 flood, 173,000 cusecs.	Edge river	3·3 (1 : 150 by wt.)

The mass movement of sand down the coast from the north is covered in the geological section.

Sub-section 5·09 deals with the siltation resulting from the interaction of density currents and sediment load.

 the flood of May, 1926, resulted in the deposition of 24,000 cu. yd. of silt in the Basin

ii. Particle size analysis: Basin 1992 GEOTEST services Ltd

PARTICLE-SIZE DISTRIBUTION

GEOTEST SERVICES LIMITED

JOB NAME Port Wanganui

JOB No. 2806095

DATE 23 July 1992

LOCATION 30 metres from Main Rock Wall on line

BORE / TEST PIT No. -

SAMPLE No. 1 DEPTH (m) -

SAMPLE DESCRIPTION Dark greenish grey, mottled black, fine to medium SANDY SILT, some clay, trace organics; saturated, moderately plastic, organic odour

SAMPLE TYPE Disturbed HISTORY Natural

TESTED BY R. Twyman

CHECKED BY D. Botica

TEST STANDARD ASTM D422-63

FINAL SUMMARY

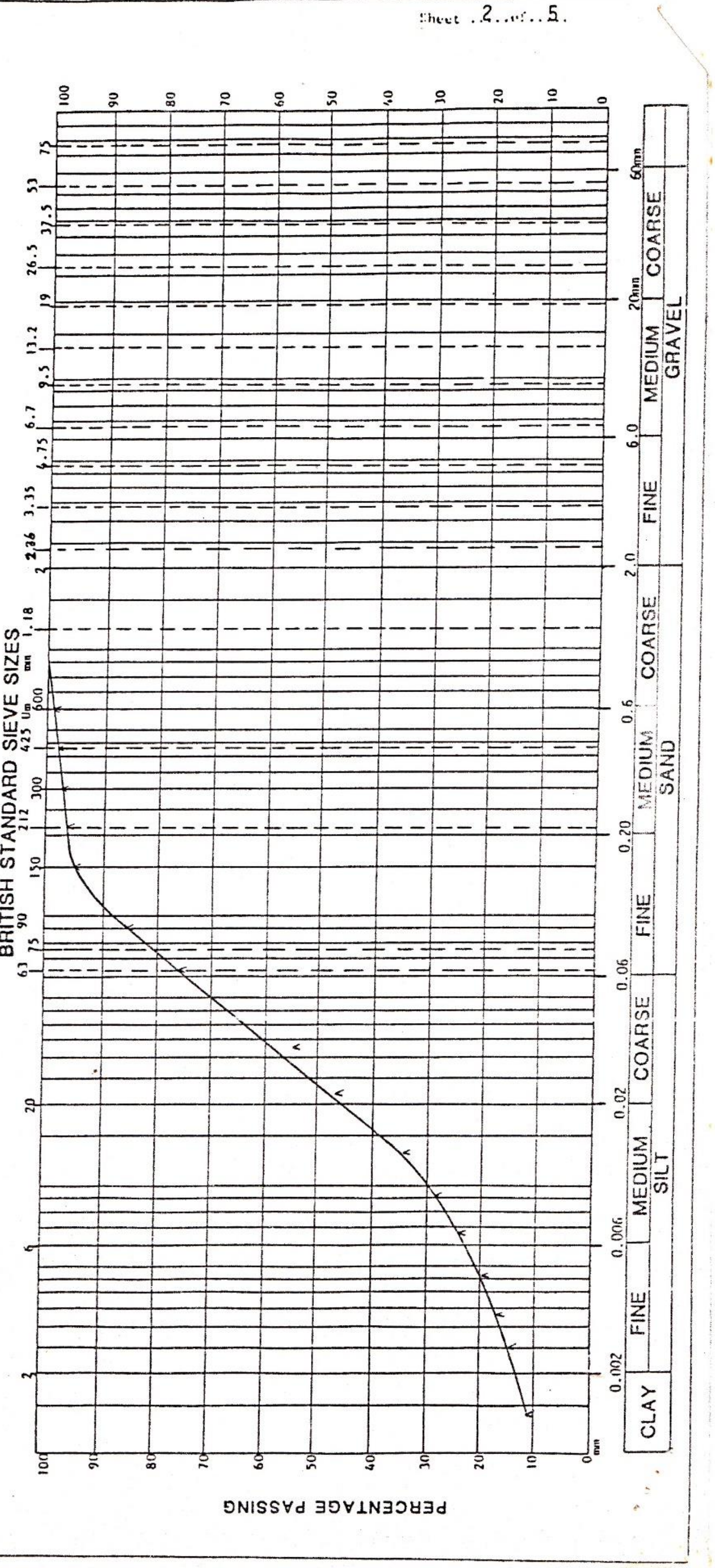
% GRAVEL	0
% SAND	25
% SILT	63
% CLAY	12

TELARC

THIS LABORATORY IS REGISTERED BY THE TESTING LABORATORY REGISTRATION COUNCIL OF NEW ZEALAND. THE TESTS REPORTED HEREIN HAVE BEEN PERFORMED IN ACCORDANCE WITH ITS TERMS OF REGISTRATION. THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL.

APPROVED SIGNATORY

Sheet 2 of 5



PARTICLE-SIZE DISTRIBUTION

GEOTEST SERVICES LIMITED

JOB NAME Port Wanganui

DATE 23 July 1992

JOB No. 2806096

LOCATION 30 metres from 1/2 tide wall Heading 163.0 metres East.

BORE / TEST PIT No. -

SAMPLE No. 2 DEPTH (m) -

SAMPLE DESCRIPTION Dark greenish grey,mottled black,fine to medium SANDY SILT,some clay,trace organics;saturated,moderately plastic,organic odour

SAMPLE TYPE Disturbed

HISTORY Natural

TESTED BY R.Twyman

CHECKED BY D.Botica

TEST STANDARD ASTM D422-63

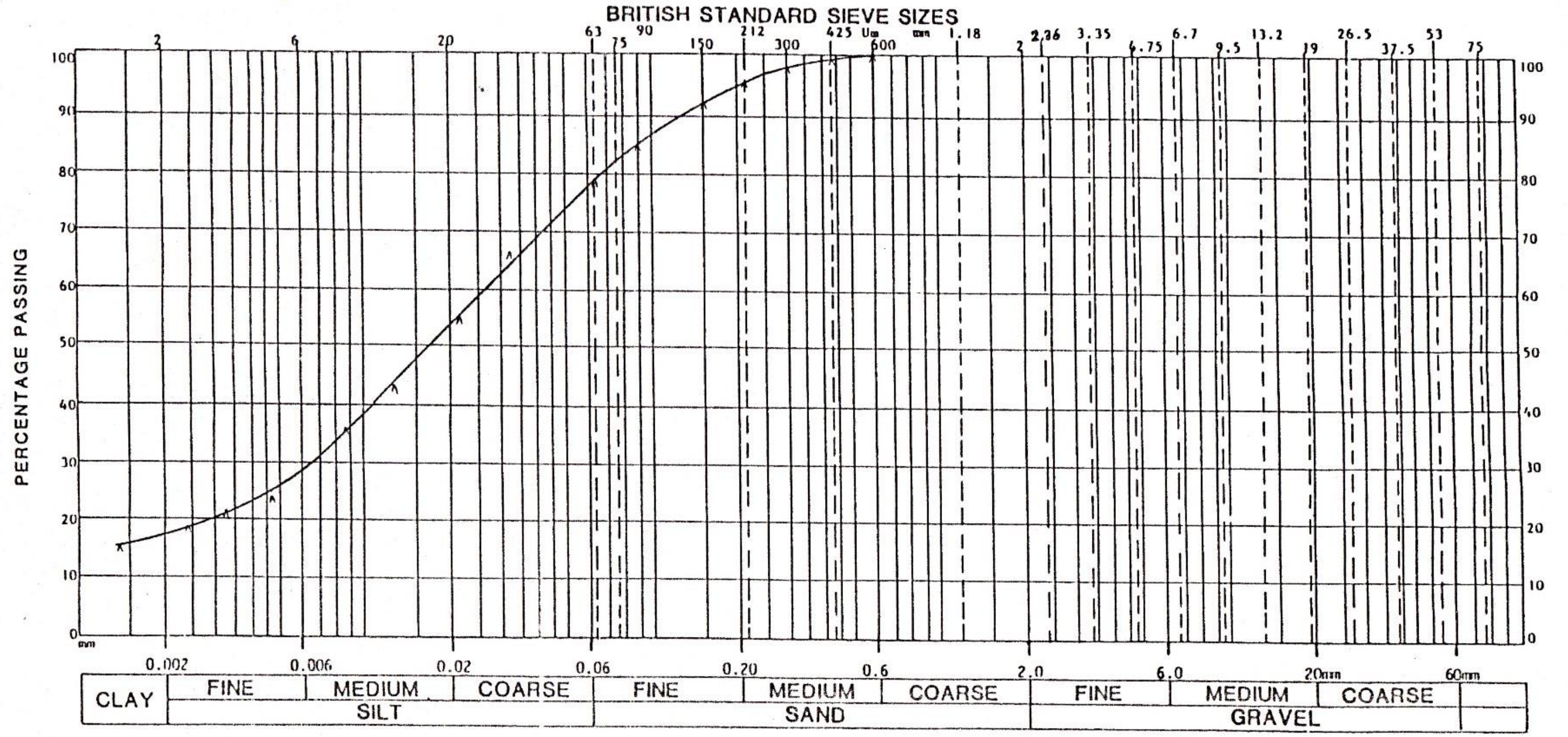
TELARC

THIS LABORATORY IS REGISTERED BY THE TESTING LABORATORY REGISTRATION COUNCIL OF NEW ZEALAND. THE TESTS REPORTED HEREIN HAVE BEEN PERFORMED IN ACCORDANCE WITH ITS TERMS OF REGISTRATION. THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL.

APPROVED SIGNATORY ....

FINAL SUMMARY

% GRAVEL	0
% SAND	22
% SILT	61
% CLAY	17



Sheet ..?..of....

PARTICLE-SIZE DISTRIBUTION

Report No; 263L;1

GEOTEST SERVICES LIMITED

JOB NAME Port Wanganui **DATE** 24.7.92

JOB No. 2806096 **LOCATION** On line off end of marina 283.9m

BORE / TEST PIT No. - **SAMPLE No.** 3 **DEPTH (m)** -

SAMPLE DESCRIPTION Dark greenish grey, mottled black, SILT-fine to medium SAND, minor clay, minor shells, trace organics; saturated, moderately plastic, strong organic odour; shell fragments; +4mm 10.8% of total.

SAMPLE TYPE Disturbed **HISTORY** Natural **TESTED BY** R. Twyman

CHECKED BY M. Weston

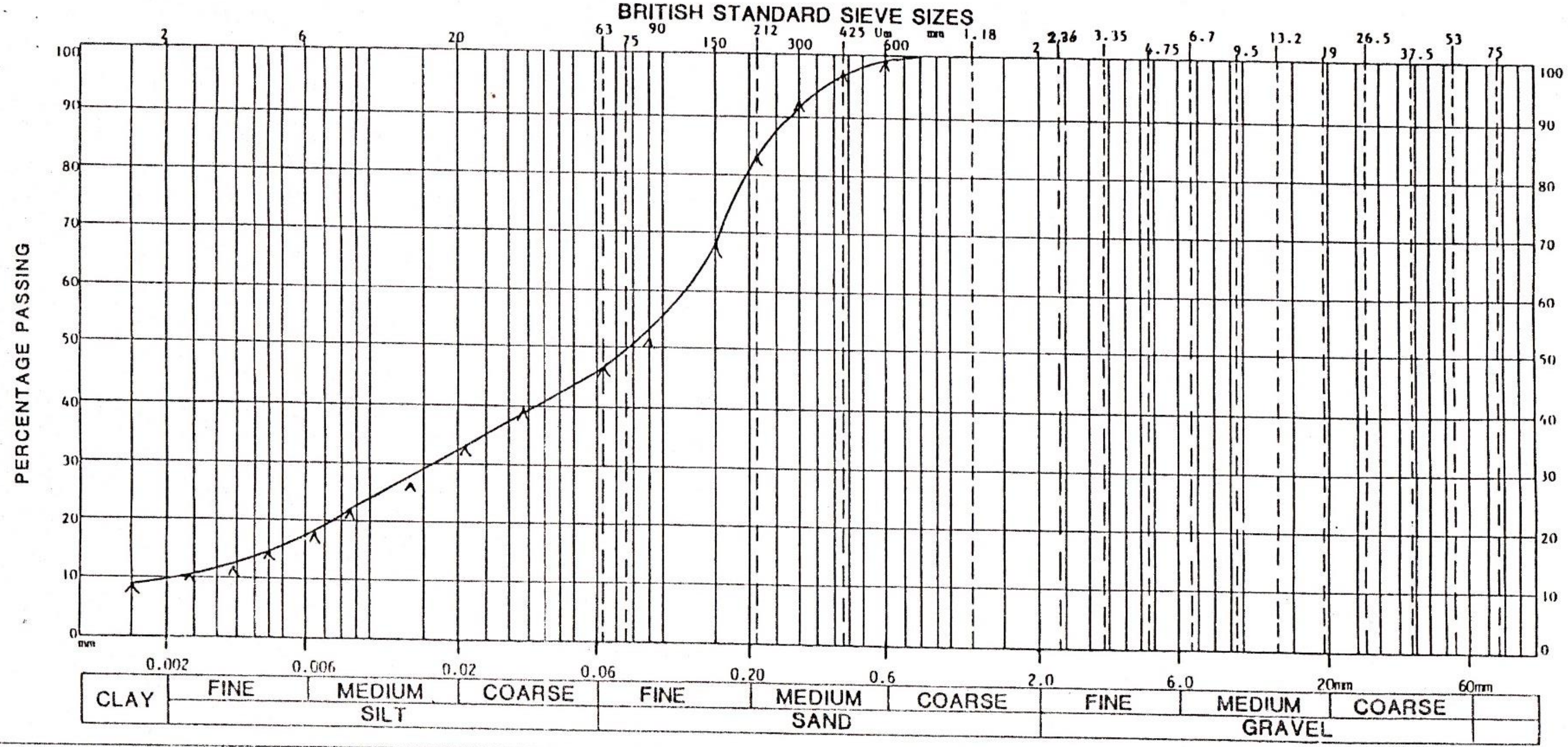
TEST STANDARD ASTM D422-63

Shell fragment fraction not included in grading curve.

APPROVED SIGNATORY ....

FINAL SUMMARY

% GRAVEL	0
% SAND	53
% SILT	39
% CLAY	8



Sheet ..4....5.

PARTICLE-SIZE DISTRIBUTION

GEOTEST SERVICES LIMITED.

Ph 3776 565, 132 Vincent St, Auckland, PO Box 5585, Auckland

JOB NAME Port Wanganui **DATE** 23 July 1992

JOB No. 2806096 **LOCATION** Off end of Marina 20 metres south of wall.

BORE / TEST PIT No. - **SAMPLE No.** 4 **DEPTH (m)** -

SAMPLE DESCRIPTION Dark greenish gey,mottled black,fine to medium SANDY SILT,some clay,trace organics;saturated,moderately plastic,organic odour

SAMPLE TYPE Disturbed **HISTORY** Natural **TESTED BY** R.Twyman

CHECKED BY D.Botica

TEST STANDARD ASTM D422-63

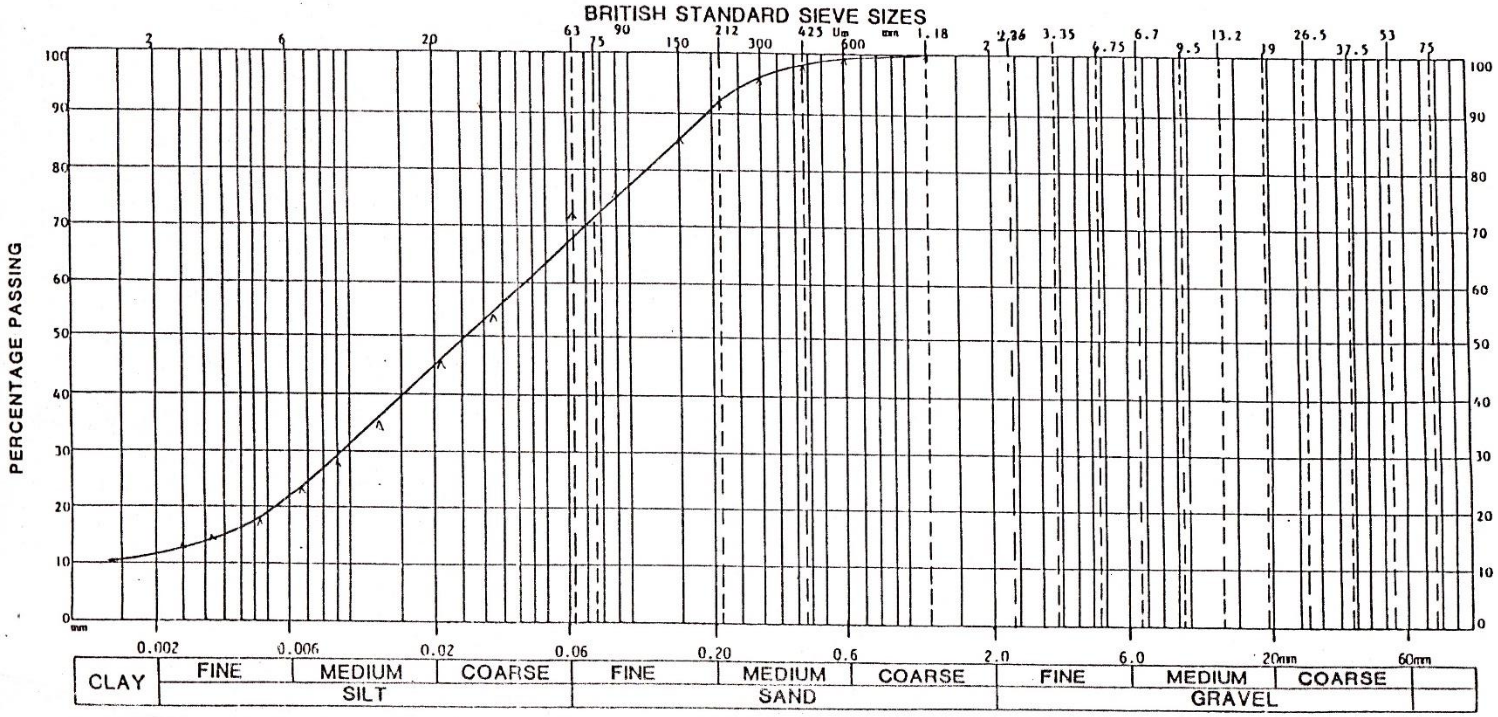
TELARC

THIS LABORATORY IS REGISTERED BY THE TESTING LABORATORY REGISTRATION COUNCIL OF NEW ZEALAND THE TESTS REPORTED HEREIN HAVE BEEN PERFORMED IN ACCORDANCE WITH ITS TERMS OF REGISTRATION. THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL

APPROVED SIGNATORY ....

FINAL SUMMARY.

% GRAVEL	0
% SAND	33
% SILT	55
% CLAY	12



Sheet ..5..of..5..

iii. Chrome size analysis: Basin 1993 ENVIROLAB services Ltd

ENVIROLAB

Our ref: 2806096

10 March 1993

Beca Carter Hollings & Ferner Ltd
P.O.Box 3942
Wellington

Attention: Mr. P.Steel

Report 93:036

Dear Sir

WANGANUI TANNERY SEDIMENT - CHROME ANALYSIS

Listed below are the results from the three samples submitted on the 1 March 1993 which were labelled: 1 at surface, 2 at 300mm and 3 at 450mm. The samples have been relabelled 93:036A to 93:036C in the same sequence.

Analyses	Unit	93:036A	93:036B	93:036C
Chrome (on dry basis)	mg/Kg	0.40	0.40	0.47
Total Solids	%	64.0	59.5	58.7

Yours Faithfully
ENVIROLAB SERVICES LTD

D.J.Knox
Laboratory Supervisor.

1 of 1

(iv) Suspended solids and turbidity tests: Basin 1994
Environmental Lab Services

06-3552262 CITY ENTERPRISES PN 409 P01 06 12 '94 11:11

PALMERSTON NORTH CITY COUNCIL

Private Bag11034
The Square
Palmerston North
NEW ZEALAND

Telephone 0-6-356 8199
Facsimile 0-6-355 2262

Environmental Laboratory Services
A Section of City Enterprises

Mu:cov

File Ref. 4310-2

Our Laboratory Number 94/2526,2527,2529 &2530.

December 6, 1994

Mr. John Blaikie,
Manager/Harbour Master,
Ocean Terminals,
Port of Wanganui.

Dear Sir

Please find following the test results for the samples taken from the Whanganui River on Friday, December 2, 1994.

Suspended solids and turbidity tests were per *Standard Methods for the Examination of Water and Wastewater* (18th ed.) 1992, Sections 2540D and 2130B respectively. Clarity measurements are vertical black disc depth readings (averaged) taken visually without use of a periscope.
All samples were at a nominal distance of 15 metres from the bank with the exception of controls. Sampling at a 5 metre distance was curtailed to preserve boat safety in the prevailing current towards the bank. Control samples were taken some 300m offshore to represent mid-stream conditions. Accurate site locations and site identifications were recorded by your staff.

A. SURFACE SAMPLES BEFORE DREDGING

Sample	Lab. code	Clarity(m)	Turbidity(NTU)	Susp.solids(g/m^3)
Control	94/2526/1	1.47	1.6	59
Site 1	94/2526/2	1.20	2.1	64
Site 3	94/2526/3	1.05	1.9	65
Site 4	94/2526/4	1.20	2.5	65
Site 6	94/2526/5	1.28	2.1	60
Site 8	94/2526/6	1.33	1.8	58

B. SURFACE SAMPLES AFTER DREDGING

Sample	Lab. code	Clarity(m)	Turbidity(NTU)	Susp.solids(g/m^3)
Control	94/2527/1	1.16	3.2	64
Site 1	94/2527/2	0.24	11.5	151
Site 3	94/2527/3	0.24	18.5	106
Site 4	94/2527/4	0.20	8.2	85
Site 6	94/2527/5	0.36	17.5	108
Site 8	94/2527/6	0.47	9.9	97

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C. 3 METRE SAMPLES BEFORE DREDGING

Sample	Lab. code	Turbidity(NTU)	Susp. solids(g/m^3)
Control	94/2529/1	2.6	65
Site 1	94/2529/2	2.7	62
Site 3	94/2529/3	2.8	67
Site 4	94/2529/4	2.5	68
Site 6	94/2529/5	2.3	62
Site 8	94/2529/6	2.0	73

D. 3 METRE SAMPLES AFTER DREDGING

Control	94/2530/1	6	79
Site 1	94/2530/2	27	157
Site 3	94/2530/3	14	108
Site 4	94/2530/4	20	126
Site 6	94/2530/5	12	104
Site 8	94/2530/6	15	118

If you require further details with regard to the above results, please contact me at the above address.

Yours faithfully,

J. Anderson

J.A. Anderson
Head of Environmental Laboratory Services

Roger Shand
Coastal Scientist