Auckland
Regional Council
TE RAUHĪTANGA TAIAO

Regional Assessment of Areas Susceptible to Coastal Erosion

Volume 2: Appendices A - J

February TR 2009/009

Auckland Regional Council
Technical Report No. 009 February 2009
ISSN 1179-0504 (Print)
ISSN 1179-0512 (Online)
ISBN 978-1-877528-16-3

Contents

Appendix A: Consultants Brief

Our Ref: 19891.100
08 January 2004

Auckland Regional Council
Private Bag 92 012
Auckland

Proposal for Coastal Erosion Hazard Mapping

- **Rodney and Gulf Islands**
- **Auckland Isthmus - East Coast**
- **Auckland Isthmus - West Coast**

1.0 Introduction

Following your discussions with Richard Reinen-Hamill and in accordance with your request we are pleased to confirm the basis on which we will carry out coastal erosion hazard mapping of this area for you as our client.

2.0 Assumptions

- Regional Scale Assessment. Scale of 500 m to 2km.
- Ignore possible effect of coastal structures unless of regional scale.
- Desktop study approach using simple methodology, existing information and expert judgment.
- Site-specific refinement allowed (i.e. lines are guides).
- Lines to be refined subject to peer reviewed improved information.
- GIS/Mapping by ARC in house.
- No presentations/external meetings

3.0 Methodology

3.1 Background

1. Base plans established using aerial photographs (where available), LINZ cadastral and topographic information, including coastline string and geologic charts – largely completed by ARC in-house GIS team.
2. Delineate Shoreline Behaviour Units (beaches, cliffs, river mouths/barrier beaches). Identify representative areas for site inspections/verification.
3. Identify previous erosion hazard mapping results (lit review; University Theses, T&T JOBINFO, ARC Database).
4. Review findings - workshop.

3.2 Cliffs

1. Establish erosion risk area based on 100*R + h/tan(theta) + F, where R = regression rate, h = height of cliff, theta = threshold slope angle. Include allowance for large scale failures dependent upon geology.
2. Develop long term regression (R) matrix based on orientation, presence of elevated shore platform and shore platform width. Establish shore platform widths based on aerial photographs, hydrographic charts, NZMS maps. Note, for areas with extensive seawalls (i.e. Tamaki Drive), set R = 0.
3. Breakdown SBU into smaller sections based on the established matrix.
4. Establish threshold slope angle (theta) based on expert knowledge at representative sites (consider dual slope, composite slope, single slope).
5. Map translating existing shoreline at each shoreline segment within identified reach. Consider right-lining or smoothing.

3.3 Beaches/Spits

1. Erosion risk to be established from cumulative effect of: storm cut, fluctuation/trend and sea level rise based on Bruun Rule and a Factor of Safety. Check potential effect of headland retreat on SLR rate.
2. Establish storm cut from existing info at selected beach areas (i.e. Omaha, Browns Bay, Onetangi, Maraetai, EW study for Coromandel, etc), develop storm cut matrix based on exposure, fetch and orientation.
3. Spit/river mouth influence assessed by expert judgement.

4.0 Scope of Works

The scope of works and expected input is scheduled below:

1. Project set-up (1 people, 0.5 day)
2. GIS set-up (ARC, T&T review; 1 person, 0.5 day)
3. Background data collation/review (1 people, 2 weeks)
4. Refine methodology and have peer reviewed (1 people, 1 week)
5. Develop cliff/beach hazard areas (1 people, 2 weeks) – output: table of setbacks
6. Field verification: (2 people, 1 weeks). Boat hire, mileage, etc at cost
7. Draft report (1 person, 2 weeks)
8. Peer and ARC review (1 person, 2 days)
9. Assistance and review of GIS mapping/refinement (1 person, 2 days)
10. Final report (1 person, 1 weeks)
11. Meetings (1 person, 1 week)
12. Project management (1 person, 1 week)

5.0 Output

- Technical report outlining methodology and tabulated findings
- GIS mapped lines (By ARC)

Two hard copies of both the draft and final report and one electronic copy (PDF) will be provided.

Appendix B: Peer reviewer's comments

Peer Review of Auckland Regional Coastal Erosion Hazard Mapping

Comments on 2nd draft

Sections 1 – 3 outline the basic problem and set the scene in terms of materials, methods, and environment. I have no problem with these beyond editorial comments marked in the manuscript. Some of the tables in Section 3 could easily be moved to appendices without detracting from the report.

Section 4 – Assignment of GSI values to hard rock cliffs.

1. The GSI chart you have included (Figure 4-1) is quite limited in scope, and in particular does not include the high GSI values above 85. You do however, apply values up to 95, so it would be more sensible to include a complete chart that includes the "intact / massive" structure at least. The one in Wyllie and Mah, Rock Slope Engineering, for example is more complete.

2. Several examples are given of the assignment of GSI to various lithologies. The examples given are not complete, and are not related either to the GSI chart or the lithological groupings described in Section 3.4 (the greywackes are not mentioned at all at this stage). I would suggest that this section gets tightened up, with the examples used clearly related to the original geological discussion, and some indication on the GSI chart made of how each class was arrived at – ie. the estimates of structure and surface quality leading to the boxes chosen.

3. I'm also going to have problems later with some of the assignments to GSI that are completely different from the examples given here. I think you need to be rather more inclusive here and explain your rationale for either cutting a box down to a smaller range, or using GSI values that span across more than one box.

Section 5 – Beach erosion

No comment – looks fine to me.

Section 6 – Cliff erosion

1. In Section 6.1 where the cliff erosion hazard zone equation is given, the "+ 2.5" term added to the cliff height is not defined or supported at this point. You should at least refer to a later section (Section 6.3) when you say why this term is added, and in Section 6.3 there should be a clear statement of how this term is used to allow for the known error in your estimates of cliff height.

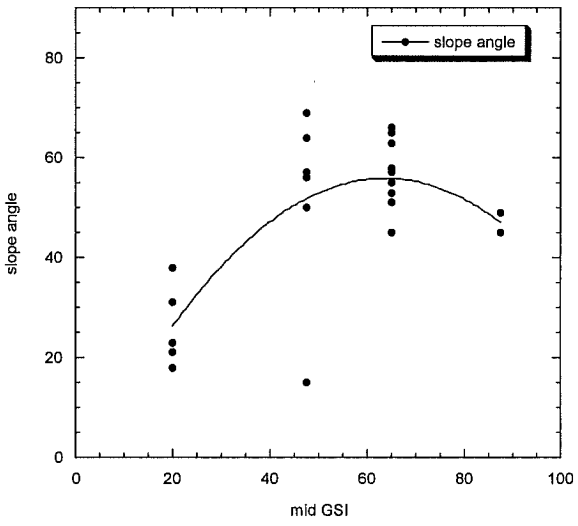
2. In Section 6.1.1 for the soft cliffs, I think there is still an error in the equation given, in that a "x" symbol has replaced a "+", and the bracket is misplaced. This seems to have been carried through into the calculations; for site 270 table 6.8 gives possible / unlikely distances of 33 / 43 m, while I calculate 56 / 67 m respectively. This needs to be checked thoroughly.

3. Section 6.2 determines characteristic slope angles for possible and unlikely hazard zones. Initially Figure 6.3 is drawn giving measured slope angle versus GSI:

a. This graph is divided into medium / strong, weak, very weak, and extremely weak rocks. There appears to be no reason for this division, though I assume it was an attempt to get better results from the scatterplot. Indeed, it seems contradictory to the aims of using the GSI to define the strength of the units – surely then the strength terms used should relate to GSI, which they don't. I assume they are an assessment of intact strength, but as such I don't see what relevance they have to deriving the graph. I suggest that this graph is replotted with all sites using the same symbol, and a single best-fit regression line put through the data. The –1sd and –2sd lines could be added, removing the need to repeat this graph in Figure 6-4.

b. The data for this graph should be presented somewhere – probably just adding a measured slope angle column into one of the tables. It is very difficult to retrieve the data on which this graph is based at present.

c. I find it confusing that at this stage all sorts of GSI values have appeared – many quite different from the ones originally defined in Section 4. I actually think that by using too many GSI groupings, and having numerous overlapping groups, you've probably made this graph more complex than it needs to be and thus obscured some vague relationships that may exist. By grouping the GSIs somewhat more coarsely (and from my best efforts at determining the slope angles from the data) I can start to perhaps see the makings of a trend (though it is not nice and simple). I don't suggest altering it at this stage, but this was an interesting sideline. However, these additional GSI values, and how they were assessed should be included in the discussion in Section 4.?



4. I like the inclusion of the standard deviations on the graph (Figure 6-4). You need to keep in mind that the location of the mid-point GSI values for plotting these lines is fairly arbitrary, especially where various overlapping GSI ranges have been used, so the exact shape of the lines on this graph should not be over-interpreted (see later).

5. The SLIDE analysis is an interesting approach, and sensible given the poor relationships determined directly for slope angle and GSI. I cannot reproduce the angles derived from the SLIDE analysis using the software I have (I get much lower slope angles), but that is probably my

problem, not yours, as the results do fit very well with the measured slopes (a quick confirmation of the results would not go amiss). One important piece of information you have not given though is the distubance factor, D, used to determine strength parameters from the GSI values. As the final results are very sensitive to this, it would be sensible to include it in the paragraph outlining the input data for the stability analysis.

6. Figure 6-5 is difficult to follow at present, but I assume in colour it is easier to read. I find the discussion following that justifies the choices of slope angles rather confusing, and it seems to make life more difficult than it needs to be:

    a. There is mention of "composite slopes ... loosely based on the average ...". These composites are not carefully defined, and seem from my reading to be based partly on the fact that the 1.5 MPa, 1.5 FoS line closely follows the –2sd line for part of the curve. As mentioned above, the –2sd line is very approximate, and I don't think the coincidence of the two lines over part of the curve should be interpreted as having terribly much significance at all.

    b. I don't see the justification for deriving "composite lines". Surely you could just use your SLIDE analysis results for 1.0 MPa as best estimates. They can easily be justified by:

        i. 1.0 MPa lines provide a lower bound to essentially all slopes, and are close to the –1sd line for FoS = 1 and –2sd line for FoS = 1.5;

        ii. 1.0 MPa is probably a reasonable estimate of siltstone strength by comparison with similar published results;

        iii. FoS = 1 provides a sensible lower level to consider for hazard analysis ("unlikely" hazard zone), and FoS = 1.5 fits with stability guidelines for slopes ("possible" hazard zone).

    c. This all seems a lot simpler, and easier to support, than deriving some composite. If sticking with the composite lines, there really needs to be an explanation and justification of how they were defined.

7. Table 6.4 defines the slope angles actually used for the hazard assessment for various GSI values. There are big overlaps in the GSI ranges – how were values assigned in these overlap zones? It would be much better if these were exclusive zones, but if overlaps are maintained, there should be some rules as to which value to choose. The same applies to Table 6.7 relating long-term retreat rates to GSI.

8. In Section 6.3 it should be explained that the 2.5 m addition in the height term in the hazard zone equation arises from known uncertainties in this measurement. Also, Section 6.6, page 105

discusses the uncertainty in cliff height measurements, and states that errors should be included in ultimate hazard width. As this has been done with the equation used, is this statement necessary?

9. Long-term retreat rates look good, and the GSI approach looks to be promising for this – though limited by amount of data available at this stage.

Sections 7 - 9

These look fine to me, except for some editorial comments.

Appendix C: Summary of relevant Tonkin & Taylor jobs

Job Number	North	East	Year of investigation	Weathered layer depth (m)	Depth is Estimated/ Greater than	Weathered layer Slope (deg)	Typical weathered layer slope (rad)	Cliff Height (m)	Cliff Slope (deg)	Cliff Slope (rads)	Composite slope from calc (degree)	Composite slope from profile (deg)	**Final Slope (degree)**	Geology	Rec Setback from Crest (m)	erosion rate (m/yr)	Comments	Street address	Suburb
12531.000	2676066	6475685	1994	2.40		58	0.454	12.0	51.5	0.899	43.70	35	**35**	avt	6			6 RIVERVIEW ROAD	PANMURE
15590.000	6472865	2675315	2001	2.40			0.454	4.0	30.0	0.524	27.48		**27**	avt	8			29 MATAROA RD	OTAHUHU
16619.000	6475823	2675659	1999	2.40			0.454	6.0	50.0	0.873	37.07		**37**	avt				LAGOON DRIVE	PANMURE
5890.000	2665773	6529758	1983	0.75	G		0.454			0.000	N.D			Kk	15 - 20	0.050	long term recession ~ 50mm/yr	FIDELIS AVENUE	
7305.000	6529000	2666400	1986	1.80			0.454	40.0	30.0	0.524	29.80		**30**	Kk	6		80m setback from toe recc. Onerahi Formation underlying weathered	FIDELIS AVE	ALGIES BAY
7436.000	6529154	2666400	1987	2.00	G		0.454			0.000	N.D			Kk				67 FIDELIS AVE	ALGIES BAY
5033.000	2638270	6484610	1981	2.40			0.454			0.000	N.D			Mtt	5		Maori Bay - andesite lavas		MURIWAI
1070.000	2667687	6499272	1965	3.50			0.454			0.000	N.D			Mwe				60 CLIFF ROAD	TORBAY
2588.000	2666912	6498138	1974	5.00	E		0.454	24.0	67.0	1.169	52.65		**53**	Mwe				913 BEACH RD	TORBAY
3572.000	6491855	2668160	1978	4.00	E		0.454	30.0	37.5	0.654	35.48	40	**40**	Mwe				39 BEACH ROAD	CASTOR BAY
7494.000	6498136	2666922	1986	4.00			0.454			0.000	N.D			Mwe		0.062	50-75mm/yr recession est.	913 BEACH RD	TORBAY
7909.000	2667742	6499164	1987	3.00		80	0.454	20.0	77.5	1.353	63.62	60	**60**	Mwe	8		suspected fault through property	74 CLIFF ROAD	TORBAY
12173.000	2667249	6498760	1994	4.00			0.454	15.0	35.0	0.611	32.10	37	**37**	Mwe				34 ROCK ISLE RD.	TORBAY
14302.000	2667705	6499238	1996	5.00	E		0.454	30.0		0.000	N.D			Mwe	10	0.100	0.1m/yr recession over last 24yrs	64 CLIFF RD	TORBAY
16144.000	2667431	6493965	1998	2.00	E		0.454	20.0	67.5	1.178	59.98		**60**	Mwe		0.150	Dip ~5` to NW. States published studies est cliff retreat ~0.15m/yr	51 VIEW ROAD	MAIRANGI BAY
16629.000	6513240	2662015	1991	5.85			0.454			0.000	N.D			Mwe	20-25		setback recc in 83 by BECA	483 HIBISCUS COAST HIGHWAY	
17155.000	6506371	2668705	1999	4.75			0.454	25.0	75.0	1.309	58.76	55	**55**	Mwe				77 TIRI RD	MANLY
19176.000	2667742	6499163	2001	4.00			0.454			0.000	N.D			Mwe	8			74 CLIFF RD	TORBAY
16940.000	6450485	2661591	1999				0.454		32.5	0.567	N.D		**32.5**	Pup				22 CRISP ROAD	
1062.000	6480591	2670732	1965	6.25	E		0.454			0.000	N.D			re				21 BURWOOD CRES	REMUERA
1106.000	6480342	2680372	1965	5.80	G		0.454	30.0		0.000	N.D			re				92 CLOVELLY RD	BUCKLANDS BEACH
1404.000	2670493	6486877	1967	7.00	G		0.454		67.0	1.169	0.00		**50**	re			Cliff is Waitemata sandstone/siltstone	28 SEACLIFFE AVE	BELMONT
1843.000			1970	4.90			0.454			0.000	N.D			re					
2047.000			1973	6.00	E		0.454			0.000	N.D			re	15		closely jointed/fractured/disturbed sand/siltstone.		
2059.000	2670445	6487004	1971	3.00	E	25	0.454	23.0		0.000	N.D			re					BELMONT
2252.000	2680480	6480150	1972	4.00			0.454			0.000	N.D			re	15			116 CLOVELLY RD	BUCKLANDS BEACH
2304.000	2670687	6486623	1973	4.00			0.454	14.0	20.0	0.349	21.43		**21**	re				68 SEACLIFFE AVE	BELMONT
2433.000	2664845	6483045	1973	6.00	G	90	0.454	9.0		0.000	N.D			re				X WAIRANGI RD	HERNE BAY
2510.000	6485350	2664869	1973	4.10	E		0.454			0.000	N.D			re				30 TIZARD RD	BIRKENHEAD
2632.000	6480544	2670689	1973	3.35			0.454			0.000	N.D			re				31 BURWOOD CRES	REMUERA
3168.000	6472617	2664614	1975	2.40			0.454			0.000	N.D			re				CAPE HORN RD	HILLSBOROUGH
3177.000	2670451	6486998	1975	6.00	G		0.454	13.0	60.0	1.047	38.50	35	**35**	re				10 SEACLIFFE AVE	DEVONPORT
3318.000	6485635	2668395	1976	3.50			0.454	17.0		0.000	N.D			re				15 NORWOOD RD.	BAYSWATER
3362.000	6480638	2669903	1976	4.60	G	35	0.454			0.000	N.D			re				9 ELAM ST.	PARNELL
3468.000	6475540	2684422	1976	4.00			0.454			0.000	N.D			re				109 PAH ROAD	HOWICK
3667.000	2661340	6486350	1977	6.00			0.454			0.000	N.D			re				18 VALKYRIA PLACE	
4331.000	6470076	2656604	1979	4.00			0.454	11.0	45.0	0.785	35.89		**36**	re	6		bank sloping into creek		LAINGHOLM
4442.000	2670023	6481918	1979	4.00			0.454			0.000	N.D			re	8			11 JUDGE ST	PARNELL
4490.000	2676740	6482300	1979	6.00			0.454			0.000	N.D			re				ACHILLES POINT	ST HELIERS
4520.000	2670780	6480575	1979	6.00		50	0.454	15.0	40.0	0.698	33.08	33	**33**	re	6-13			11A BURWOOD CRESCENT	REMUERA
4576.000	6485188	2665127	1979	7.00			0.454	20.0	67.0	1.169	45.19		**45**	re			2-3m soil mantle, 4-5m weathered zone		BIRKENHEAD

4605.000	2677360	6482137	1979	2.00			0.454	20.0		0.000	N.D			re			Waitemata sand/siltstones highly deformed faulted	719 RIDDELL ROAD	GLENDOWIE
4659.000	6478424	2681664	1980				0.454	35.0	55.0	0.960	55.00		**55**	re	10			285 BLEAKHOUSE RD	HOWICK
4849.000	2680524	6480024	1983	4.00	G		0.454	30.0		0.000	N.D			re	5			134 CLOVELLY RD	BUCKLANDS BEACH
5097.000	6481439	2670158	1981	4.00			0.454	10.0		0.000	N.D			re		0.075	cliff regression ~5-10cm/yr		PARNELL
5353.000	6470649	2658554	1981	4.00	D	35	0.454	35.0	70.0	1.222	60.90	63	**63**	re				19 OKEWA RD	TITIRANGI
5494.000	2669402	6488142	1982	5.00			0.454	10.0	62.5	1.091	37.88	45	**45**	re				43 CLIFTON RD	TAKAPUNA
5529.000	6486948	2661014	1983	2.00			0.454			0.000	N.D			re					BIRKENHEAD
5583.000	6484348	2668577	1982	3.00			0.454			0.000	N.D			re				91 STANLEY PT RD	DEVONPORT
5645.000	6473648	2667930	1985	2.00			0.454			0.000	N.D			re	12.5	0.050	long term recession est. at 5m/100yrs		HILLSBOROUGH
5940.000	6480638	2669903	1983	4.50	E	40	0.454	14.0	40.0	0.698	34.27	35	**35**	re	10			9 ELAM STREET	PARNELL
5962.000	6481443	2670243	1983	2.00			0.454			0.000	N.D			re				AWATEA ST AND CRESCENT RD	PARNELL
6100.000	2670603	6486758	1983	5.00		40	0.454	33.0	55.0	0.960	47.86	45	**45**	re	10	0.055	recession ~ 37-75mm/yr	50 SEACLIFFE AVE	DEVONPORT
6205.000	6485483	2666197	1985	5.00		35	0.454	20.0	37.5	0.654	33.87	25	**25**	re				102A QUEEN ST	NORTHCOTE
6501.000	2670493	6486877	1984	5.00	E		0.454	15.0	65.0	1.134	45.16	45	**45**	re				28 SEACLIFFE AVE	BELMONT
6736.000	6485755	2665903	1985	4.00			0.454	40.0		0.000	N.D			re				44 CLARENCE RD	NORTHCOTE
7101.000	6473758	2662424	1985	3.50			0.454			0.000	N.D			re				52 LEWIS ST	BLOCKHOUSE ABY
7204.000	2663261	6481734	1985	4.00			0.454	3.0	30.0	0.524	24.88	40	**40**	re				28 WESTMERE PARK AVE	WESTMERE
7347.000	6477680	2678995	1986	1.75			0.454			0.000	N.D			re				18 LILFORD PLACE	PAKURANGA
7967.000	2668593	6484333	1987	2.25		80	0.454	15.0	55.0	0.960	47.93	45	**45**	re	8			87 STANLEY PT ROAD	DEVONPORT
8009.000	2670136	6481879	1987	7.00	G		0.454	30.0	45.0	0.785	38.77	45	**45**	re	20	0.050	recession ~ 5cm/yr	138 ST STEPHENS AVE	PARNELL
10756.000	2676460	6482335	1989	7.00			0.454			0.000	N.D			re		0.050	recession estimated at 5m/100yrs. 25m to unweathered sandstone	51 CLIFF RD	ST HELIERS
11180.000	2670082	6487543	1991	4.00	G		0.454			0.000	N.D			re		0.030	recession ~ 2-4m/100yrs	4 ST LEONARDS RD	TAKAPUNA
11241.000	2660368	6473085	1991	4.00			0.454	50.0		0.000	N.D			re				36 CLIFF VIEW DR	GREENBAY
11399.000	6480163	2680459	1992	6.00	G		0.454			0.000	N.D			re				116 CLOVELLY RD	BUCKLANDS BEACH
11733.000	2669540	6487974	1992	6.00	E		0.454			0.000	N.D			re	6	0.020	recession estimated at 1-3m/100yrs	21A CLIFTON ROAD	TAKAPUNA
12018.000	6480487	2678158	1993	6.50			0.454			0.000	N.D			re				10 GLENDOWIE ROAD	GLENDOWIE
12291.000	2672448	6482230	1993	3.00	E		0.454	12.5	67.0	1.169	50.83		**51**	re				23 TAMAKI DRIVE	ORAKEI
12377.000	6482994	2665238	1994	5.25			0.454			0.000	N.D			re				75 SARSFIELD ST	HERNE BAY
12696.000	2677084	6482279	1994	7.00			0.454		25.0	0.436	0.00			re				27 WAITARA ROAD	ST HELIERS
13036.000	2670465	6486954	1994	5.75			0.454			0.000	N.D			re			interface dipped at ~20` towards cliff	16 SEACLIFFE RD	BELMONT
13410.000	2668687	6484444	1995	5.00			0.454	20.0		0.000	N.D			re	12			67 STANLEY POINT RD	DEVONPORT
13738.000	2684022	6476636	1995	5.50	E	60	0.454	30.0	85.0	1.484	65.90	60	**66**	re				5 COLLEEN CLOSE	HOWICK
13767.000	2680382	6480343	1995	5.25		55	0.454	25.0	55.0	0.960	45.47	40	**40**	re				2/92 CLOVELLY ROAD	BUCKLANDS BEACH
14014.000	2676689	6482435	1996	3.00			0.454			0.000	N.D			re			3m to weathered ECBF	29 SPRINGCOMBE RD	ST HELIERS
14041.000	6490189	2658663	1996	3.50			0.454	9.0		0.000	N.D			re	5		recession estimated at 2-3m/100yrs	113 FERRY RD	HERALD ISLAND
14371.000	6473558	2662985	1996	4.00			0.454		55.0	0.960	0.00		**48**	re			2.4m soft/firm clay overlying solid base	30 ROYAL VIKING WAY	LYNFIELD
14487.000	2684022	6476636	1996	4.50		60	0.454	35.0	70.0	1.222	59.85		**60**	re				3&5 COLLEEN COURT	HOWICK

14833.000	6484660	2669022	1995	5.00			0.454	40.0	40.5	0.707	37.98		**38**	re		0.040	Soil and Rock Consultants report. 3-5m/100yrs retreat given	28a Sta nley Point Road	Devonport.
15581.000	6473763	2667560	1997	4.00			0.454	35.0	50.0	0.873	45.65		**46**	re			Cliff is ECBF	87 FREDERICK ST	Hillsborough
15616.000	6485218	2665018	1997	1.50			0.454			0.000	N.D			re			Weathered material overlying ECBF silt	6 TIZARD RD	BIRKENHEAD
15844.000	2676520	6482450	1998	1.75			0.454			0.000	N.D			re			Interface dipping away from cliff face	61 CLIFF RD	ST HELIERS
16363.000	2668149	6485478	1998	5.50			0.454	17.0	52.5	0.916	40.22		**40**	re				12 MARINE TERRACE	BAYSWATER
16393.000	2677829	6481401	1998	2.00	E		0.454	20.0		0.000	N.D			re			Slip caused by heavy rain	483 RIDDELL ROAD	GLENDOWIE
16403.000	6475646	2684418	1998	4.00			0.454	35.0	37.5	0.654	35.76		**36**	re			Heavy rain caused slip of upper 4m (soils). 12m to unweathered. Photos!!	125 PAH ROAD	COCKLE BAY
16646.000	6479977	2680530	1999	5.50			0.454	38.0	77.5	1.353	64.06	55	**55**	re	12	0.045	3-6m/100yrs recession given	140 Clovelly Rd	Bucklands Beach
19015.000	2659410	6472275	2001	6.00			0.454	38.5		0.000	N.D			re			Bank slopes into sea. 18m high scarp.		GREEN BAY
19249.000	2660860	6487640	2001	4.00			0.454		45.0	0.785	0.00		**42**	re			sandstone/siltstone dips 30` SW (out of slope)	68 ROSECAMP ROAD	BIRKDALE
19295.000	2670571	6486781	2001	2.00	G		0.454			0.000	N.D			re				44 SEACLIFFE AVE	TAKAPUNA
20763.000	2670640	6486790	2003	5.00	G (Tauranga Group)	26.5	0.454		80.0	1.396	0.00		**60**	re		0.040	Fault zone to left of property (looking inland). 3-5m/100yrs regression estimated	48 SEACLIFFE AVE	TAKAPUNA
21586.000	2670502	6486974	2004	4.00		35	0.454	20.0	65.0	1.134	51.94	45	**45**	re		0.133	Erosion estimated at 6-10m in 60 years (possibly high as ECBF does not appear to extend into cliffs at the site)	12A SEACLIFFE AVE	BELMONT
1195.000	6479963	2678028	1966	2.50	G		0.454			0.000	N.D			ta				26 VISTA CRESCENT	GLENDOWIE
2638.000	6478334	2691045	1973	5.00			0.454			0.000	N.D			Tjw					OMANA
17120.000	6483370	2696115	1999	3.50		45	0.454	10.0	55.0	0.960	40.45	53	**53**	TJw		0.040	recession estimate to be 3-5m/100yrs in area - higher due to slips locally		
20148.000	2691807	6489491		10.00	E		0.454			0.000	N.D			Tjw			Soil is very stiff to hard residual greywacke from the Waipapa Group.	95A GREAT BARRIER ROAD	Waiheke Island
6154.000	6476933	2659949	1984				0.454	17.0	25.0	0.436	25.00		**25**	tp			rubble overlying highly organic soils	TONY SEGEDIN DR	AVONDALE
11249.000	6476239	2660525	1991				0.454			0.000	N.D			tp			Tauranga group bank. V. hard soils below 7.5m	72 DELTA AVE	NEW LYNN
12282.000	2677815	6458822	1997				0.454	3.6	28.0	0.489	28.00	33	**33**	tp		0.1 - 0.3	Cliff erosion rate varies. Slope analysis using soil properties indicates at 30 deg FOS is ~1.00	CARNOUSTIE DRIVE	WATTLE DOWNS
13361.000	2687570	6478088	1996	4.00			0.454	16.0	50.0	0.873	41.21	35	**35**	re			interface dipping 10` away from cliff	13 HAWKE CRESCENT	BEACHLANDS
18370.002	6460332	2679157	2004				0.454	10.0	47.0	0.820	47.00	43	**43**	tp				GLENROSS DR	MANUKAU
3481.000	6476294	2677874	1976				0.454	10.0	45.0	0.785	45.00	40	**40**	tpp			Steep bank above shore platform, covered by ~1m of water at high tide	119 FISHER PARADE	PAKURANGA
3593.000	6476336	2677868	1976				0.454	11.0	40.0	0.698	40.00		**40**	tpp				123 FISHER PDE	PAKURANGA
17622.000	6483856	2658613	1999				0.454	7.5	22.5	0.393	22.50	21	**21**	tpp			20m coastal margin given	WAIMANU BAY	TE ATATU
18518.000	6476157	2677873	2000				0.454			0.000	N.D			tpp			5m fill overlying Taurangas (to 24m) then	99 FISHER PARADE	PAKURANGA

21481.000	2659186	6487116	2004				0.454	12.0	24.0	0.419	24.00	24	**24**	tpp		0.140	Some seawalls in place substantually lowering	20 SCOTT ROAD	HOBSONVILLE

overall slope from calc based on recorded values of cliff/weathered layer height/slope
note: where weathered layer slope is not given 26degrees is assumed

overall slope from profile is measured off drawing from toe to ~horizontal ground above cliff
note: where no obvious distinction between cliff slope and weathered slope is shown weathered layer is drawn back at 26degrees.

Appendix D: Summary of shoreline characterization

REPORT

AUCKLAND REGIONAL COUNCIL

Regional assessment of areas susceptible to coastal erosion Appendix D: Summary of shoreline characterization

Report prepared for:

AUCKLAND REGIONAL COUNCIL

Report prepared by:

TONKIN & TAYLOR LTD

Distribution:

AUCKLAND REGIONAL COUNCIL	copies
TONKIN & TAYLOR LTD (FILE)	1 copy

April 2006

Job no: 19891.100

Table of contents

1 Introduction

This appendix provides a brief characterisation of the main shoreline areas of the region based on internal and external references.

1.1 Firth of Thames/Tamaki Straits

- Kingston Morrison. 1996. **Coastal Survey, South of Orere River Mouth to Omana Beach.** 1996. Prepared for Manukau City Council.
    - South of Orere River Mouth
        - Lithology of area comprises Tauranga Group alluvial deposits – moderately to poorly cemented muddy sandy gravels.
        - Intensely weathered south of Orere River mouth, prone to slumping/erosion
        - Long term erosion rate for this area is unlikely to exceed 1m/10yrs
        - Recent slumps protect cliff toe for a few years until washed away
        - No council infrastructure/property in the area which is in danger of being damaged
    - Waiti Bay
        - Underlain by hard Waipapa Group greywacke.
        - Several slips present close to Kawakawa Bay coast road.

1.1.1 Beachlands - Matingarahi

- Kingston Morrison. **Coastal Scoping Study Beachlands - Matingarahi.** 1993. Prepared for Manukau City Council.
    - Geology along this length of coastline consists of:
        - Basement Jurassic sandstones and mudstones – 'greywacke' (Waipapa Group). Form headlands/reefs/hard rock platforms at the coast
        - Waitemata group – west of Omana Beach. Form steep 10-20m high cliffs and wide, soft shore platforms around the coast.
        - Alluvial deposits. Older (Walton Subgroup – exposed in the Orere Point area) form near-vertical cliffs up to 40m high or more at the coast. Younger (Tauranga Group) is found in low-lying areas inland of beaches.
    - Summary table gives coastal process/physical features/lithology/etc info on 28 sections of coast between Beachlands and Matingarahi.
        - Ranges from low lying beaches to steep, 30m, sandy muddy gravel cliffs.
        - Generally static coastline. Some cliffs in erosion and some beaches in accretion.
        - Alluvial gravel terraces which make up Orere Point are eroding relatively quickly, particularly just south of the township. Weathered greywacke on parts of the Kawakawa Bay coast is eroding very gradually, while some areas are aggrading.
    - Waipapa Greywacke around Whakakaiwhara Point reaches 20-30m at 45°. 3 Other sections of Greywacke also slope at ~45°, sections at Taturau Bay and Tawhitokino

Beach reach 60° and a section at Tapapakanga slopes at 30°. **Average slope of Waipapa Cliffs is 47°.**

- **3 areas of Waitematas (ECBF) all slope at 60°**

1.1.2 Tamaki River – Kawakawa Bay

- Kingston Morrison. 1996. **Coastal Survey, South of Orere River Mouth to Omana Beach.** 1996. Prepared for Manukau City Council.
  - Kawakawa Bay
    - Foreshore is underlain by sandy alluvial deposits which form a low lying terrace <1m above MHWL
    - Broad, gently sloping inter-tidal beach backed by steeper, sandy upper beach in places.
  - Duders Beach (Umupuia) to Maraetai Beach
    - Underlain in part by alluvial/beach deposits composed of shell and sand, also by areas of hard greywacke.
    - In places low lying terrace <1m above MHWL exists.
    - On Duders beach, some erosion of the shore alluvial and beach deposits over the last 2 years – more than 1m in places.
    - North of Umupuia there is a shore platform of hard greywacke
    - Ohinerangi Beach is generally stable although there has been some foreshore erosion in the central part the beach.
  - Maraetai Beach to Te Pene Point
    - This length of coast is underlain by hard greywacke and has suffered little erosion.
    - Beach east of Te Pene Point appears to be accreting.
  - Te Pene Point to Omana Beach
    - Omana beach is presently accreting at each end but eroding in the centre.
    - Bank exists behind beach in some places – ranges from ~0-8m high.

1.1.3 Maraetai

- Tonkin & Taylor. 2000. **Maraetai Coastal Hazard Zone Assessment.** 2000. T&T. Job no. 17284. Report for ARC
  - Upper foreshore at Maraetai Beach is 25-30m wide at a slope of ~1:10. The beach sediment is course sand and shell.
  - The lower foreshore overlies an intertidal platform and slopes at ~6°. Only a small amount of the platform is visible at low tide.
  - Erosion processes along Maraetai Beach do not appear to be significant, probably due to sheltered hydraulic environment.
  - Aerial photos showed no evidence of shoreline retreat.
  - Beach profiles showed beach in dynamic equilibrium with area of erosion and accretion.

- Numerical model (SBEACH) used to assess the impacts of cross-shore sediment transport during storm events.
- Erosion hazard zone determined on the basis of volume of sediment moved as well as the horizontal shoreline change that occurred.
- Thought that the Bruun rule is not applicable at this site as the beach is comprised of two systems. A relatively course sediment beach "perched" on a finer, relatively flat seabed.
- Based on model results: short-mid term beach fluctuations can be expected in the order of $10m^3/m$, storm cut – 16m3/m, sea-level rise – $25m^3/m$. This gives a total of $51m^3/m$ equalling a shoreline change of ~5.5m
- Typical physical shoreline response model gives 8m of horizontal erosion during a storm at high tide. When sea-level rise is taken into account, this could be more like 40m.
- 1st zone represents potential for erosion during extreme storm event including sea-level rise to 2100 (0.49m)
- 2nd zone includes the backshore area affected dune retreat and rollover.

1.1.4 Cliffs around Cockle Bay

- BECA. 1996.**Cliff Top Failure at 5 Colleen Court**. Geotechnical report prepared by BECA.
  - Slip occurred after extended period of heavy rain
  - Shallow depth of topsoil/fill overlying weathered Waitemata soils.
  - Waitemata soils became less weathered and more sandy at depth.
  - Weathered Waitemata Group sandstones was encountered beneath soils at 4 - 5m
  - Slightly weathered to unweathered Waitemata Group sandstones with thin siltstone beds were encountered at approx 12.5m.
  - Groundwater was encountered at 2.45-3.75m below ground level
  - Cliff below property is over 35m high inc weathered soil profile.
  - Steep cliff faces are prone to weathering and frittering due to wetting and drying
  - Also subject to wave undercutting
  - Rockfalls up to 1-2m thick may therefore occur with recent rockfalls evident at the cliff base.
  - Experience indicates Auckland Harbour cliffs retreat by 3-5m/100yrs on average with higher rates in some areas
  - Upper soils also prone to slumping and failure
- Failure Risk: (from Engineering Quality Standards, Manukau CC, May 1995)
    - FS = 1.1: Risk of failure in any one year = 1:10
    - FS = 1.3: Risk of failure in any one year = 1:50
    - FS = 1.5: Risk of failure in any one year = 1:200
    - FS = 1.7: Risk of failure in any one year = 1:1000

1.2 Auckland General

1.2.1 Okahu Bay/Mission Bay/Kohimaramara/St Heliers

- Le Marquand, D.W. 1979. **Dynamics of some Waitemata Harbour Beaches.** Masters Thesis, University of Auckland.
    - Post glacial rise in sea-level caused inundation of an old river valley – resulting in the Waitemata Harbour.
    - Resulted in alternately exposed cliffs of the Waitemata formation and crescentic pocket beaches at the land-sea interface of old tributary valleys.
    - 50m wide wave cut platform at the base of most cliffs
    - Due to changes in fetch lengths and water depth during tides, higher waves may be expected at high tide.
    - Rainfall runoff is concentrated due to impermeable nature of much of the land cover in the area. When discharged from stormwater drains, water infiltrates raising water table levels or scours lowering the beach level in the vicinity.
    - These outer Waitemata Harbour beaches exhibit very similar characteristics in plan, profile and sediment.
    - Plan: Characterised by headlands and associated wave cut platforms at either end. Unaltered beaches tend to be in gentle arc. Removal of sediment in from of seawalls may have been in response to cutting across this arc.
    - Profile: Typically backshore, beachface and intertidal flat. Beachface 2.5-3.5m high, 15-20m wide inclined between 6 and 8 deg. 200-300m intertidal flat slopes at 0.5-1 deg before dropping into deeper water.
    - Sediments: Course sand in the backshore and beachface. Intertidal flat is characterised by thin layer of very fine potentially mobile sediments overlying more compact 'dry' layer less influenced by wave action.
- BECA, 2003. **Kohimarama Beach Seawall Protection Project – Coastal Engineering Report**. Report for Auckland City Council.
    - Four large stormwater discharges onto Kohimaramara Beach at present.
    - Site is underlain by Miocene Series Waitemata Group muddy sandstone and mudstone. These are exposed at either end.
    - Surface deposits onshore are Holocene Series undifferentiated alluvium.
    - Winds are predominantly from the W-SW, however strong winds (>20knots) also occur from the NE and E.
    - Largest waves were predicted by the wave modelling program STWAVE to be generated by N – NE winds. These had a significant wave height of ~0.6m.
    - Mean spring tidal range is approximated to Queens Wharf in the Waitemata Harbour at 2.7m.
    - Beach sediment is medium-course sand with D50 of 0.3-0.5mm with 30-40% shell fragments. Sediments become courser on the beach face (D50 = 1.0mm) and much finer (muddy-fine sand) further seaward.
- Tonkin & Taylor. 1994. **Okahu Bay to Glendowie Boat Club. Coastline stability assessment and foreshore management plan**. T&T Report 12560 for Auckland City Council.

- Report on 5.4km predominantly seawall from Okahu Bay to St Heliers Bay and 3.6km predominantly cliff area from St Heliers bay to the Glendowie boat club.
- Cliff area spilt into 4 structural regions
  - A: Glendowie Rd to south end of Karaka Bay.
  - B: All of Karaka Bay to west Tamaki Head. Volcanic Tuff mantles the northern end.
  - C: West Tamaki Head to the western side of Glover Park. ~60m high, sloping at 55-65deg. Volcanic tuff up to 29m thick overlies Waitematas.
  - D: Achilles Point to Ladies Bay. ~30m cliffs at 65 deg.
- Cliff retreat occurring by two mechanisms – Local Landslip (5-10m slab failures) and Fretting (30-50mm/yr).
- 16 areas given hazard ratings Low/Med/High

- City Design, 1996. **Eastern Bays Coastal Management Strategy**. Prepared for Auckland City Council
  - Lithology and erosion rates given along 11km from Mechanics Bay to the Glendowie Boat Club.
  - Cliffs and Bays beneath are mostly ECBF, some volcanic deposits from St Heliers and Orakei volcanoes.
  - Unweathered, sediments consist of grey, alternating mudstone and muddy sandstone.
  - Weathered, sediments turn grey or yellowish brown.
  - Headlands have generally formed where there is a predominance of Parnell Grits
  - According to Brodnax (1991), cliff toe protection along Tamaki Drive has not appeared to diminish the erosion rate. This would indicate removal of material at the base of the cliff has little effect on erosion rates in the short-term.
  - Erosion rates today appear to be primarily due to sub-aerial actions and weathering.
  - Erosion rates given as follows:
    - 106mm/yr – Takaparawha Point, Bastion Point
    - 121mm/yr – Pipimea Head
    - 43mm/yr - Gower Point
    - 58mm/yr – Cliff Road – Achillies Point
    - 84mm/yr – West Tamaki Point
    - 153mm/yr – South of Karaka Bay – Glendowie Rd
  - Large trees such as Pohutukawas tend to push their roots into cliff joins widening them and allowing water to run through. While the trees lend support while alive this is lost when they die.
  - Other erosional factors include chemical weathering on cliff faces (i.e salt weathering) and biological erosion particularly on shore platforms.
  - Winds recorded 1962 – 1983. SW then NE most common. N and NE winds have most potential to affect the Eastern Bays coastline.

- Fetch is limited to a max. of about 6.5km due to Rangitoto and other islands. Steep local waves therefore dominate the spectrum.
- Wave reflection off the Tamaki Drive seawall adds significantly to the erosive potential of these waves.
- Mean High Water Spring range is 2.74m.
- Long shore sediment transport appears to be from east to west until West Tamaki Point, then from North to South.
- Rainfall in Auckland averages 1264mm/yr.
- Stormwater outflows from Judges Bay to Glendowie Rd given. Outflows greater than 600m diameter pipe at: eastern Okahu Bay, eastern Mission Bay, western and central Kohimarama Bay, western and eastern St Heliers and 3 discharging at Glendowie Rd.
- Stormwater has increased with increasing urbanisation of the area and will probably continue to do so.
- Plan and cross-sections also available for most beaches

1.2.2 Karaka Bay

- Tonkin & Taylor Ltd. 1994.**Coastal Erosion, North End Of Karaka Bay.** Report for Auckland City Council.
  - Apparent littoral shift of shells and sand to the south resulting in severe erosion.
  - The wave cut, Waitemata shore platform Nth of the beach was covered with gravel and pebble sized siltstone/sandstone/Parnell grit particles.
  - Wave cut platform is 10-15m wide in front of the northern most property.

1.3 Waitemata Harbour

- Wells-Green, P.S. **Current, Wave and Sediment Transport – Upper Waitemata Harbour.** 1975. N.Z. Engineering, Vol. 30, No. 10
  - Soils samples taken from the upper harbour floor indicate 3 zones of material
    - Recent marine deposits – uniform fine sand
    - Pleistocene white deposit – course silt
    - Pleistocene green deposit – fine sand
  - Largest waves observed during study occurred during 10.3m/s E wind – H=0.49m, T=2.4s.
  - Larger waves may occur with stronger winds.
- Gregory, MR and Thompson, S. 1973. **Recent sediments of the Waitemata Harbour.** Report for the Auckland Harbour Board.
  - Contains summaries on sediment properties of 20 locations within the Waitemata and inner Hauraki Gulf.
- Brodnax, R.C. 1991. **Cliff erosion in the Waitemata Harbour and Hauraki Gulf.** Masters Thesis, University of Auckland.
  - Apart from areas of volcanics, lithologies of the study area are ECBF and Blockhouse Bay formation – both flysch Sequences. The 6 lithologic units are:

- Thick sandstones (Turbidite)
- Thin sandstone (Interturbidite)
- Siltstones (Interturbite)
- Parnell Grits
- Orakei Greensands
- North Head Volcanics

- 4 main types of erosion can be observed in the Waitemata Habour
  - Mechanical wave erosion (hydraulic action, corrosion, attrition)
  - Bioerosion
  - Sub-aerial erosion (mass movement)
  - Erosion resulting from weathering
- Along each of the 75 sections of cliffed coastline, erosion rates were determined every 100m using aerial photographs and a Zoom Transfer Scope. ZTS registers each image by shrinking/enlarging/stretching to match other images.
- Erosion rates in the harbour varied from 0.05m/yr – 0.35m/yr
  - Highest in open coastal environments (0.176m/yr)
  - Lowest where Hauraki Gulf islands provide significant shelter (0.1054m/yr)
  - Fairly high rates in the inner harbour (0.125m/yr)
- Areas of high erosion rate tend to be concentrated in the areas of interbedded sandstones and where the coastline is more exposed (ECBF and headlands)
- Areas of lowest erosion rates are reported for the Parnell Grit beds and sites that are in sheltered environments (Shoal Bay, Ngataringa Bay + other inner harbour sites)
- Areas protected by seawalls/reclamations do not appear to show a particularly low rate of erosion indicating removal of material from the cliff base has little effect.
- Figures derived from structures tend to be lower than those from aerial photos – due to structure measurements generally being take mid-slope while aerial measure the cliff top.
- Erosion rates varied depending on rock types, dip direction, structural class, bioerosion, shore platform, beach existence, vegetation type, fetch bearing, plan morphology, wave environment. – Summarised in table 'variation in cliff erosion.xls'
- Siltstone appears to be the weakest lithology therefore making it preferentially eroded.
- The most resistant lithologies are Parnell Grit and volcanic tuff. However, volcanic tuff had a reasonably fast erosion rate – perhaps due to its location at the harbour mouth – this implies rock type may not be the dominant control of erosion.
- Variables influencing erosion in order of significance were:
  - Groundwater: higher groundwater – low erosion
  - Beach presence: erosion rates were higher where beaches were present

- Wave environment: (non harbour): erosion rates lowest where shoreline wave sheltered by Inner Hauraki islands
- Platform width: erosion rates lower with wider platforms
- Aspect: Cliffs facing E and SE eroded fastest
- Strike direction: erosion rates are greatest where strike direction is parallel to the coastline
- Lithology: Erosion rates were lower where the lithology was Parnell Grit

1.3.1 Hobsonville

- Tonkin & Taylor. 2004.**Coastal Erosion and Slope Stability Investigation at 20 Scott Road, Hobsonville**. Unpublished report 21481 for Hazen and Jeanette Rota.
  - Report for lot 4 – DP 63801 included:
    - Engineering geological mapping of foreshore
    - Topographic survey
    - Drilling of 4 boreholes
    - Installation of 5 standpipe piezometers
  - Site is on Puketoka Formation of Tauranga Group
  - 20-50° coastal cliff up to 12m high slopes down to wide intertidal mudflat
  - Locally generated waves of up to 0.75m may occur during 15m/s southerly (CRESS).
  - Erosion calculated based on aerial photo comparisons over last 30 years.
    - Average rate is 0.14m/yr
    - Maximum rate is 0.27m/yr
  - Estimated that in the next 100yrs the shoreline and cliff top may regress between 15 and 30m
  - Building restriction line 30-55m from cliff edge suggested to provide buffer from area with instability risk.
  - **From profiles – overall slope ~ 24°**

1.3.2 Te Atatu Peninsula

- Tonkin & Taylor, 1999 and 2003. **Geotechnical Investigations for subdivisions at Waimanu Bay, Te Atatu Peninsula**. T&T report number 17622 and 18042.200
  - Bank slopes back at between 17 and 30° - averaging 20.5 ° to a height of between 6 and 9m
  - Subsurface material is Puketoka formation below about 1.5m.

1.4 Torbay – North Head

- Moon, V. 1983. **Report on Coastal Cliff Geology (Nth Shore Bays).** Report prepared for City of East Coast Bays.
  - Structural features of 8km of east coast bays cliffs examines qualitatively

- Total cliff length (Long Bay to Rahopara Point) is divided into 10 sections defined on the basis of topographic characteristics.
- Waitemata Flysch dominates, comprising almost the entire length of cliffs
- Several outcrops of tuffaceous Parnell Grit exist, specifically near Waiake and Campbells Bay beaches.
- Parnells Grit comprises of primarily volcanic clasts ranging from several mm to 10cm all contained within a muddy matrix
- Generally 2 types of soils
  - Those formed over flysch material
  - Those formed over tuffaceous grit
- 3 types of shore platforms
  - High energy environment in flysch: Most common. Long, low platform at low tide level, extending 30-40m from the cliff and ending abruptly.
  - Low energy environment in flysch: high level platform 2-3m above low tide level, generally only a few metres wide. More platforms between this and low tide platform described above.
  - In grit material: platform of irregular height approx starting 1-2m above low tide level, about 20m wide sloping down to low tide level.
- Summary of geology of sections given in 'East Coast Bays cliff geology' spreadsheet

1.4.1 Takapuna-Cheltenham

- Riley Consultants. 1997. **Cliff Stability Study: Takapuna to Cheltenham.** Unpublished report for North Shore City Council.
  - 4.5km between Takapuna Beach and Cheltenham Beach surveyed
  - 55 individual surveys completed – 25 cliff failures and 30 non
  - Information collected on: General condition of slope, Geological data and discontinuity data.
  - During desk study it was noted that 1995 and 96 winters were notable for poor cliff stability. This could be attributed to 530mm of rainfall during June, July and August instead of the usual 395.
  - Waitemata Group rocks are Miocene (9-20 Ma) turbidite deposits.
  - Composed of 3 main units along the North Shore Cliffs.
  - Poorly sorted sandstone beds (0.05 – 2.00m thick) with unconfined compressive strength >7MPa
  - Siltstone beds (0.01 – 1.00m thick) with strength ~2MPa
  - Andesitic breccia beds – Parnell Grit (4-10m thick) with strength ~12MPa
  - Generally flat-lying, dipping 3-5° to the east – however, mainly dipping to the west in the study area.
  - Overlying soil mantle consisting of very firm, yellow clayey soil.
  - Failure mechanisms were observed as follows:

- Joint Rock Block Fall: Blocks of sandstone and siltstone fall from cliff face due to loss of support, i.e. from underlying siltstone being more rapidly eroded. Most common form of erosion excluding siltstone frittering. Small – Moderate volumes involved in fall.
- Fault Plane Failure and Erosion: Clays that line the fault plane form very weak zones along the cliff face. Faults normal to the cliff are generally more stable although may wash out forming a narrow gully. Faults subparallel to the cliff face can act as a "pull away" zone depending on the faults dip and geometry of surrounding geology.
- Wedge Failure: Caused by two dominant discontinuities, which intersect forming a wedge shaped failure zone.
- Bedding Plane Failure: Caused by the discontinuity between beds. Failure may occur when rock beds dip out of the slope. Failures have the potential to include a very large volume of material but are fairly rare in occurrence.
- Failure of Folded/Disturbed Strata:
- Failure of Overburden: Cliff retreat leads to the oversteepening of mantle soils. Soils in the Waitemata Group generally fail along existing defects. Other failures that may occur include rotational failures and slow, continued soil creep. These failures are often initiated by soil saturation during and after heavy rainfall.

- Dip direction is very important to cliff stability. Unfavourable dips out of the slope will ultimately lead to more, large failures.
- Beds dipping vertically are often more resistant than those at horizontal angles.
- Thicker beds are often more resistant than thinner.
- Vegetation on the cliff top and face will generally stabilise soil and weathered rock.
- Groundwater may exasperate large failures due to build-ups of hydrostatic pressure.
- Water running over a slope, especially in a concentrated path such as from a stormwater drain, may accelerate erosion.
- Wave action at the base of cliff will undercut the slope. This leads to problems in overall slope stability. Wave action eroding the toe is much less effective in cliffed areas where there is a shore platform.
- Cliff survey results:
  - Cliff height: 3-36m, average: 16m
  - Lower slope angle: 25-90°, average: 68°
  - Upper slope (weathered zone) angle: 20-90°, average: 43°
  - Sandstone bed thickness: 0.05-2.0m, average: 0.3m
  - Siltstone bed thickness: 0.05-0.6m, average: 0.2m
- Relationships observed include:
  - Failures due to folded bedding occur in lower cliffs
  - Joint block falls occur in steeper, higher cliffs
  - Soil failures occur in higher cliffs

        - Fault related failures affect all cliff heights
        - Cliffs with lower slope angles tended to be wetter
        - Higher cliffs tended to be drier
        - Presence of absence of exposed shore platform appeared to have no relationship with failure mechanism or cliff height.
        - Boulders often appeared beneath steeper cliffs and shore platforms in from of shallower slopes.
    - Area divided into structural regions and given a hazard rating based on set criteria
    - Weathered zone thickness noted in some locations: 0.5-1.5m
    - From 49 profiles overall slope inc. weathered ~ 59°

- Paterson, R. 2002. **Engineering Geology and Coastal Cliff Erosion of Takapuna.** Masters Thesis, University of Auckland.
    - Study area includes 4km of cliffs from Takapuna Beach to Fort Takapuna
    - 20 detailed cross sections taken at intervals.
    - Area divided up into localities based on variation in geological units/geomorphic features
    - ECBF sandstone beds are highly weathered, extremely weak residual soil to weak rock. Beds are 0.1 – 2.0m thick
    - Thinner mudstone layers (<10cm) are interbedded. These layers are less resilient
    - Limonite is an iron oxide produced during weathering. Limonitic sandstones have been stained with limonite and are stronger than other sandstones. Typically found on shore platforms and up to just above the high water mark.
    - Parnell Grit outcrops at beach level on either side of Narrow Neck Beach. These outcrops form small reefs protruding across the beach and off shore. Material is moderately strong – strong.
    - Cliff height varies from ~5m high banks either side of Narrow Neck beach and at Takapuna Beach to steep (~70°) cliffs over 30m high. Average height is 16m.
    - Average slope angle of overlying soils is 43° and 68° for the cliff face (Roy, 1997).
    - Estimated erosion rates of geomorphic features shown in scanned table 5.1.
    - New fixed structure and theoretical rates of erosion (see scanned tables) show erosion rates to vary between 2m/100yrs for protected cliffs and 13m/100yrs for those undergoing rapid erosion or mass movement events.
    - An average retreat rate of 4-8m/100yrs seems appropriate for future planning guidelines.
    - Suggests a new ranking system for parameters effecting cliff stability
        - 1: Lithology and Properties – slaking, strength, RBIS
        - 2: Defects – bedding dip, lithological specific joint intensity, rock mass defect proximity
        - 3: Geomorphology and Erosion – mass movement, gradual erosion, features
    - Other conclusions:

- Susceptibility of a rock or soil to erode is influenced as much by the way it slakes as it is by strength.
- Frittering of mudstone fragments (formed by slaking) is the most widespread erosive process operating on cliffs, leading to block fall in the jointed sandstone beds.
- In most geomorphic domains lower dips correspond with higher cliffs.

1.4.2 Soft Flysch Cliffed Area

- Moon, V.G and Healy, T. 1994. **Mechanisms of Coastal Cliff Retreat and Hazard Zone Delineation in Soft Flysch Deposits.** JCR 10, 3.
    - Cliffs of the Waitemata and inner Hauraki Gulf: Beachlands – Pt Chev, Beach Haven – Nth of Orewa.
    - Cliffs throughout the Auckland area are very steep – generally 10-20° from vertical
    - Their height varies from 5 - 30m, typically ~ 20m
    - A bevelled zone in the upper soil mantle often exists as a result of past failures. This represents an equilibrium angle of stable configuration.
    - A broad, gently sloping shore platform 40-200m in width commonly exists at the cliff base. This shore platform ends in a bio-eroded sea-cliff (Healy, 1968)
    - Beaches in the area may be old valleys or simply thin veneer of sand over a shore-platform
    - 3 identifiable units of flysch material: Sandstone bed, thinner siltstone beds and Parnell Grit deposits. (Note mostly similar info to Riley report)
    - Dip is generally 3-5° to the east, but may reach up to 90°.
    - Two general strike directions can be recognised – approximately E and approx. NW
    - Soil overlying the flysch deposits is a very firm, yellow clayey soil.
    - Overlying Parnell Grit, the soil has a gritty texture and is a firm silty clay.
    - Given fault mechanisms same as Rileys report (probably originally from this paper).
    - Rates of cliff retreat from structure based measurements are given at 2-6m/100yrs
    - When delineating hazard zones Healy (1981) and Gibb and Aburn (1986) recommend 100 years as a convenient human time frame.
    - A total hazard zone of 23m is suggested: 10m rock failure, 6m soil failure, 7m SF.
- Moon, V.G and de Lange, W.P. 2003. **Estimating long-term cliff recession rates in soft Flysch Deposits, Waitemata Group, Auckland, New Zealand.** Coasts and Ports Australasian Conference. Paper No. 93.
    - Previous studies have demonstrated that for the Auckland region, the available historical record is too short to reliably estimate long-term cliff erosion rates.
    - In this paper cliff-erosion rates are assessed based on shore platform widths.
    - Assuming Waitemata platforms behave in a similar manner to those studied by Stephenson and Kirk at Kaikoura
        - The seaward margin of the platform is relatively stable

        - Max erosion exists 0.6-0.9m above MSL on the cliff face
        - Subaerial processes dominate the development of shore platforms and retreat of associated cliffs.
    - Shore platform survey carried out between Waiake Beach and Tipau Point
    - GPS system used for the surveys was checked against known locations and the RMS error for horizontal positions was thought to be <2m.
    - Platform widths varied between 10 and 103m, with a mean of 57.6m. (Widths less than ~30m were in Parnell Grit!!)
    - Taking 7200 years as the time taken for the shore platforms to develop (since stabilisation of sea-level at ~ current level, long-term cliff erosion rates range from 1.4 – 14.3mm/yr with a mean of 8mm/yr.
    - At the low end of cliff short-term estimates.
    - Nth section comprised of Parnell Grit has the narrowest shore platform and hence the lowest erosion rate of 1.4mm/yr
    - Flysch cliffs that appear relatively free of major discontinuities/faults also coincide with narrow sections of shore platform and lower (4-5mm/yr) erosion rates.
    - Areas regularly exposed to wave activity are relatively debris free, a build-up of debris greatly increases the stability of the slope.

1.4.3 Browns Bay

- Coastline Consultants. 2001**. Coastal Hazards and Management Browns Bay.** 2001. Report prepared for: ARC and North Shore City Council.
    - Beach is approx 800m long contained at both ends by cliff approximately 20m high and shore platform and reef extending from these cliffs.
    - Taiotea Stream discharges at southern end of cliff.
    - Beach width to low tide varies between 60-70m at the nth end to 120m at the south end.
    - High tide beach is very narrow – seawalls along almost entire length.
    - 10-15m berm at about 1:12 before flat, sandy intertidal platform sloping at ~1:40 (nth) to 1:55 (south).
    - Beach sediments are primarily fine-med sands.
    - Mean spring tidal range at Murrays Bay is 2.4m (2.7m at Auckland).
    - Wave modelling by BECA indicates NE winds with return period of 1 year can generate max wave heights of 2.5m and max periods of 6s.
    - Kench (2001) gave the seaward edge of the active beach system at Takapuna and Cheltenham as being 5m below CD.
    - Past information suggests Browns Bay was in dynamic equilibrium with no long-term movement.
    - Historical photographs indicate fluctuation in the vegetated zone of less than 6-8m.
    - Seawalls hold the beach forward of its natural position therefore removal could mean initial retreat of 10-12m.

- Assumes Bruun Rule holds at Browns Bay – sea level rise to 2100 could mean retreat of up to 10m

1.4.4 J.F. Kennedy Memorial Park

- Glassey et al. 2003. **Establishing a methodology for coastal cliff hazard mapping: an east coast bays, Auckland pilot study**. Coasts and Ports Australasian Conference. Paper No. 49
  - Three pilot areas identified as having different sets of cliff variables such as cliff-face aspect, height, angle, lithology, faults and joint spacing that influence cliff stability.
  - In Nth Shore City, development is setback from the coast by foreshore yard varying from 9 – 30m from MHWS.
  - Methodology used to determine Coastal landslide hazard zone (CLHZ) included:
    - Net long-term rate of sea-cliff retreat (R)
    - Extent likely to fail in sudden landslip (S)
    - Safety factor (F)
    - Hazard assessment period (T)
  - Previous sea-cliff retreat rate studies for North Shore City
    - Aerial surveys (Brodnax, 1991) 1940-87: 15.5mm/yr; 1953-87: 18.0mm/yr.
    - Cadastral surveys (Riley, 2001) 1920 – 1980: 75mm/yr.
    - Man-made structures (from 1926) range from 11.2mm/yr to 41.7mm/yr.
    - Geological Markers (Moon/Healy 1994) 6,500yrs: 19mm/yr.
    - Laser cliff face surveys (Gulyaev, 2001) 2001 – 2003: 15.6mm/yr.
  - Investigations by Riley (1999) of 44 sea-cliff profiles found that weathered layers unprotected by vegetation eventually slump back to about 26°.
    - Summary table of Nth Shore City sea-cliff variables determined from Riley cross sections (1999) scanned/extracted.
    - Weathered layer thickness in the 44 profiles ranged from 2.0 – 7.0m, averaging 4.2m.
    - Cliff Height: 21-29m
    - Cliff Slope: 55-75°
  - CLHZ values along North Shore sea-cliffs given as: least – 16m, average – 39m, high – 55m, most likely – 31m. All values from cliff toe.
  - CLHZ for 6 profiles in Kennedy Park range from 23 to 52m. Average is 38m.
  - Width is proportional to the degree of risk this century from natural hazards of coastal erosion and landslip.
  - Anticipate that correlation between each variable and overall composite relationship to coastal instability/recession can be modelled using the spatially-driven statistical probability Weights of Evidence technique (Atterberg et al. 1993, Bonham-Carter, 1997).
  - **Including weathered layer the average cliff height is 25m at 60°**

1.4.5 Murrays Bay to Campbells Bay

- Riley Consultants Ltd. 2001. **Erosion of Seacliffs between Murrays Bay and Campbells Bay.** 2001. Prepared for ARC.
    - Investigation of effects the encased trunk sewer may have on protecting sea cliffs from erosion.
    - Sewer runs shore parallel just out from cliff toe.
    - 11 cross sections examined on aerial photographs dating from 1963.
        - From 8 cross sections between Murrays Bay and Mairangi Bay beaches, erosion varied between 0 and 4m in 50 years.
        - From 3 cross sections between Mairangi Bay and Campbells bay beaches erosion varied between 0 and 4m in 50yrs
        - In locations where erosion was ~0m the was generally either a sloping, more resistant sandstone shelf or an accumulation of boulders landward of the sewer.
    - Previous Riley wave analysis for 18 and 26 knot NE winds give wave heights of 1.0 and 1.8m respectively.
    - Cross sections indicate:
        - Bedding dip ranges from horizontal to 5° back into cliff.
        - Cliff height ranges from 7-34m
        - Slope ranges from 65° - >90°
        - Depth of weathered layer ranges from 1 – 4m
    - Overall slope inc. weathered layer appears to be ~56°

1.5 Kawau Island – Long Bay

- Healy, T.R. 1967. **Shore platform morphology on the Whangaparaoa Peninsula, Auckland.**
    - Shore platforms, exposed at low tide, make up 75% of the Whangaparaoa Peninsula.
    - Platforms highly variable in both vertical and areal dimensions.
    - 6 major profile types given: Straight form, Curved form, Compound form, Complex form, High level bench form in massive sandstone and Stepped form.
    - Cause is a combination of subaerial aerial weathering and wave action in the intertidal and supertidal zones, controlled by the level of permanent rock saturation
    - The most important feature of subaerial weathering is the mechanical disintegration of mudstone by wetting and drying.

1.5.1 Orewa

- Robinson, M. 1985. **Morphodynamics of Orewa Beach July 1984 – July 1985.** Masters Thesis, University of Auckland.
    - Mean grain size of Orewa beach was 2.75 phi and in the estuary was 2.77 phi. (both ~ 0.16mm).

- 2.5km long beach facing NE
- Streams at both ends
- Orewa block is covered by East Coast and Pakari subgroups of Waitemata formation
- Longest fetch is from the ENE
- Wave data collected by buoy situated 800m off Orewa from Nov 84 to July 85
    - Largest wave recorded was 2.25m on 16th Feb, 1985 during 35km/hr wind
- 10 beach profiles exist – surveyed intermittently over study year.
    - Beach width above MHWS ranges from 13 to 70m (Although seawalls are in place along sections of beach).
    - MHWS to MLWS (foreshore) ranges from 100 to 300m
    - Change in m^3/m over year ranged from –86 m^3/m to +33m^3/m, however, larger fluctuations (up to –143m3/m over 2 weeks) did occur during the year.

1.6 Mangawhai – Tauwharanui

- NIWA. 2001.**Definition of the coastal marine area along the Rodney District coastline.** Report for Rodney District Council.
    - MHWS defines the Coastal Marine Zone under the RMA.
    - This report provides a level of MHWS around the Rodney District.
    - Auckland Vertical Datum – 1946 (AVD-46) used in report
    - On west coast MHWS ranges from 1.540m - 1.557m
    - On east coast MHWS ranges from 1.079m at Mangawhai to 1.307 at the mouth of the Weiti estuary on the Whangaporoa Peninsula.

1.6.1 Omaha

- Montgomery Watson. 1997. **Draft Comprehensive Coastal Management Plan – Omaha/Whangateau Harbour.** Prepared for Rodney District Council.
    - Whangateau Harbour is a shallow, tidal estuary, partially impounded by the Omaha Spit - a Holocene sand barrier.
    - Most hills/cliffs in the area are Waitemata rock, although To Point is a Basaltic flow.
    - Another 'things that need to be done' report!!
- Tonkin & Taylor. 1998. **Omaha Development Revised Coastal Hazard Assessment.** T&T job no. 15485. Unpublished report for Boffa Miskell.
    - No large sources of sediment supplying spit or estuary.
    - Both appear to be closely linked with sediment exchanges between dune/beach face and the ebb shoal.
    - Beach profile data available from 1965 – 1995.
        - Suggest southern end is fairly stable with trend of accretion.

        - Northern end also appear to be in accretion, however, it has been dramatically altered with the introduction of groynes + renourishment and trend may discontinue once equilibrium has been reached.
    - Results indicate max storm demand at southern end of beach during major storm may be ~100m3/m (~15m retreat).
    - Storm demand increases from south to north.
    - Erosion Risk Zone (ERZ) was determined. ~54m at mid-spit location (increasing to the north).
    - Coastal Management Zone also determined to include allowance for dune movement. Setback was up to 72m (inc. ERZ).

- BECA. 1976. **Omaha foreshore erosion investigation.** 1976. Report for Rodney County Council.
    - Geology of Omaha Bay outlined in figure.
    - Boreholes drilled offshore of Omaha Beach
        - 2 boreholes contain very similar sand to that on the present spit close to the seabed. This indicates the seabed has been eroding back in the bay to many thousands of years.
        - Drill-hole investigation also shows that node point governed by depth of wave influence (outer closure depth) is at approx 15m water depth.
    - Dredging occurred from 1942 to 1963**.**
    - Changes in spit orientation and hydraulic regime resulting from dredging now means that sediment transported in the ebb current is deposited much further from shore. This means that the sediment will take much longer to reach the beach which is being starved as a result.
    - The MHW mark fluctuated approx 20m either side of an average line from 1874 until the 1960's. The beach level then dropped considerably.

1.7 Hauraki Gulf Islands

1.7.1 Waiheke Island

- Gregory, C.R. 1979. **Aspects of the beach geomorphology of Waiheke Island.**. Masters Thesis, University of Auckland
    - Comparisons of different beaches sharing a common landward environment but dissimilar seaward environment and energy regime
    - Northern facing beaches are characterized by white, sandy beaches and rocky headlands and southern, by large muddy embayments.
    - Owhiti Beach
        - 740m long, NW facing, infinite fetch at 342 - 352°, foreshore slope ~ 3°, foreshore sediment size 2.33 phi
        - Stream at NE end of beach flows into lagoon behind beach ridge.
    - Onetangi
        - 1980m long, N facing, infinite fetch at 345 - 15°, foreshore slope ~ 3°, foreshore sediment size 1.90 phi (lower) to 1.52 phi (upper).

- Profile varied considerably during year.

- Sandy Bay
  - 130m long, NW facing, 93km fetch at 343 - 345°, foreshore slope ~ 4.5°, foreshore sediment size –0.55 to 2.78 phi
  - Relatively straight profile gradient. Upper foreshore includes cobbles up to 10cm in size.
- Oneroa
  - 1230m long, NE facing, 67km fetch at 30°, foreshore slope ~ 1.5°, foreshore sediment size 0.05 – 2.10 phi.
- Matiatia
  - W facing, foreshore slope ~ 8°, foreshore sediment size –3.17 phi (~9mm)
  - Some sand exposed just above low tide – appears to be thin veneer over gravel
- Surfdale
  - 860m long, SW facing, 13.3km fetch at 205°, foreshore slope = 8° (upper) and 0.2° (lower), foreshore sediment size ranged from –1.32 phi (mid) to 2.99 phi (upper).
  - Depositional sand flat behind beach, also extensive flat exposed at low tide.
  - Blackpool beach appears very similar.
- Kowhakarau
  - 400m long, S facing, 13.3km fetch at 230° (beach open to waves through 90° arc, foreshore slope = 8° (upper) and 2° (lower), foreshore sediment size ranged from –1.76 phi (mid) to 2.21 phi (lower).
  - Large cobbles found near low water.
- Omiha
  - 450m long, S facing, 7.2km fetch at 205°, foreshore slope = 8°, foreshore sediment size ranged from –7.32 phi (lower) to 0.53 phi (upper) – 2.76phi below low tide mark.
  - Sheltered from max fetch waves by reef. No backshore – water up to bank at high tide.
- Rocky Bay
  - 1720m long, SW facing, 14.7km fetch at 250°, foreshore slope = 7.5° (upper) and 0.3° (lower), foreshore sediment size ranged from –0.51 phi (mid) to 3.03 phi (lower).
  - Large sandy flat exposed at low tide. Sediment becomes finer further out.
- Otakawhe
  - 440m long, S facing, 11.8km fetch at 200°, foreshore slope = 8°, foreshore sediment size ranged from –3.07 phi (upper) to –0.21 phi (lower).
  - Beach is mainly pebbles, stream runs into the bay.
- Man O'War Bay

        - 730m long, E facing, 26.6km fetch at 80°, foreshore slope = 9° (upper) and 0.4° (lower), foreshore sediment size ranged from –2.80 phi (upper) to 2.72 phi (lower).
        - Max fetch through small gap in islands. Beach is backed by raised spit with mangrove swamp behind.
    - Cactus Bay
        - N facing, 10-20m stretch of course sand above high water merging into grassy area.
    - Omaru Bay
        - Long flats at low tide, Little/no beach at high tide.
        - Platforms below headlands at each end of the beach.
    - Hooks Beach
        - Beach is backed by cliffs in places. Large slips have occurred bringing material/vegetation to beach.
        - Extensive flats comprising of fine, silty sand material between headlands.
    - Beaches categorised 1 or 2
        - Category 1: Nth facing - Owhanake Bay to Thumb Point. Steep headlands with sandy beaches in between. More uniform sediment and slope up beach (1.5 - 5.5°). Beach material is thought to be derived from eroding surfaces in the hinterland.
        - Category 2: E, S, W facing - Rest of island. Less steep headlands and large, shallow embayments. More variety in beach sediments, steeper upper foreshore (7.5 – 9.0°) with low tide flat. Eroding bedrock cliffs or unconsolidated banks are a common feature.

- Tonkin & Taylor. 2002. **Onetangi Beach Coastal Hazard Management Strategy.** T&T job no. 18945**.** Unpublished report for ARC and ACC.
    - Shortcut to report in m**:**\19891.100\ARC Areas\2 – Hauraki Gulf Islands\
    - 1 in 50 yr storm cuts for Onetangi vary from 9.5-15m horizontal retreat.
    - Short term fluctuations are about 3m on average
    - Medium term fluctuations incorporating IPO and ENSO have been calculated at ~4m
    - Long term trends could not be accurately measured – appears to be zero based on limited info from historic aerial photographs.
    - On average long term shoreline retreat from sea level rise to 2050 is 7m and to 2100 is 18m.
    - Risk zones given as
        - Current Risk Zone: 16.3 – 21.5m
        - 2050 Risk Zone: 23.2 – 28.2m
        - 2100 Risk Zone
        - Coastal Management Zone: 34.9m – 39.8m

- Assessment of management options for Onetangi given as table using weighted and non-weighted scores.
- From contour map, slopes of cliffs at either end of Onetangi appear to range from ~2:1 to about 46°

- Tonkin & Taylor. 2004. **Eastern Huruhi Bay - Coastal Hazard Assessment.** &T. Report no. 20852. Report for ARC/ACC
  - Shortcut to report in m**:**\19891.100\ARC Areas\2 – Hauraki Gulf Islands\
  - Steep sided headlands and bays
  - Marine terrace approx 2m above MSL along section of coast.
  - Localised SW facing pocket beaches bounded by rock outcrops. These beaches are mostly inter-tidal with little/no high hide beach.
  - Beaches all comprise a moderate-thin layer of surface sediment overlying harder materials.
  - Peninsula is formed by massive to thin bedded sandstone and argillite (Waipapa Group).
  - Weathering is well developed and extends up to 30m in places.
  - Typically highly weathered rocks are found within the embayments and less weathered on the headlands.
  - Observations suggest regardless of degree of weathering, regression of cliff face is controlled by rock mass failure along unfavourably orientated defect sets.
  - Erosion hazard assessed for 100 year timeframe based on long term toe erosion rates, stable angle of repose and a safety buffer to include uncertainties and possible increases due to sea-level rise.
    - 3 levels of estimated retreat given:
      - Zone 1: less than 1m/100yrs
      - Zone 2: 1 – 5m/100yrs
      - Zone 3: 5 – 10m/100yrs
    - Buffer zone is taken as 10m

1.8 Papakanui – Whatipu

1.8.1 Muriwai

- ARC. 1994. **Muriwai Regional Park Draft Management Plan.**
  - Area behind Muriwai Beach consists of unconsolidated Holocene sand dunes.
  - Geology of the area behind Otakamiro Point and Maori Bay is predominantly Waitakere Group rocks capped by Pleistocene sandstones.
  - South of Otakamiro Point, rocks are capped by sandstones originating from ancient dunes and beaches.
  - Older rocks of the Waitakere Group were placed in the Nihotupu formation. They are well-bedded sandstones, siltstones and grits + a single 3m conglomerate bed.
  - Sections of basaltic andesite pillow lava occur in the upper part of this formation.

- Soils of Muriwai are derived from sand, except at Otakamiro Point where poorly drained soils called Awapuku clay loam are found.
- Establishment of Coastal Hazard Zone suggested in 1987 by Cato. Car park and Motor Camp occupy part of this zone.

1.8.2 Piha

- King, D.N.T. 2001. **Shoreline Change at Piha Beach, NZ.** Masters Thesis, University of Auckland.
  - Hinterland embayment formed mainly in volcanoclastic rocks and sediments (Waitakere Group).
  - The Waitakere ranges are comprised of Manakau Subgroup rocks.
  - Piha formation is at least 600m thick and geologically resilient over the short to medium term.
  - Overlain by Quaternary alluvium and dune sands.
  - 3-4m foredunes (although some reach 4-12m) extend the entire length of Piha Beach, interrupted only by 4 streams.
  - Net northerly longshore drift dominates sediment transport patters along this coast.
  - Northernmost section of Piha Beach exhibits a net rate of coastal accretion since 1940 of 1.0m/yr. Range was 0.8 – 1.1m/yr
  - Net rate of coastal accretion at Central Piha is 0.5m/yr since 1940.
  - Net rate of coastal accretion at South Piha has been 0.4m/yr since 1940.
  - Fluctuations have occurred in the last 60 years with some periods of erosion and some of far more rapid accretion.
  - Other shoreline change studies have been carried out at Anawhata to Sth Kaipara, Whatipu, Kaipara and Piha (see scanned table). Overall coast appears to be in progradtion.
- Tonkin & Taylor. 2004. **Re-alignment of Marawhara and Wekatahi Streams.** T&T job no. 19367.100. Report for Waitakere City Council**.**
  - Two streams drain small steep catchments and discharge into North Piha.
  - The deliver little material from the hinterland, but erode the dunes and return this sediment to the sea.
  - Historically, the streams channels have discharged separately at times, and joined together before discharging at other times.
  - Channels have meandered across a roughly 200-300m wide section of beach.
  - Shoreline change in their vicinity has fluctuated considerably since the 1940s.
    - An overall increase in beach volume from 1940 to 1980 was followed by a considerable decrease from 1980 to 2000.
    - WCC recorded erosion rates of up to 40cm/month near North Piha Road during 1999/2000 monitoring.

- Tonkin & Taylor. 1998. **Beach Profile database for Muriwai, Piha and Long Bay**. T&T job no.16254. Report for ARC.
    - Muriwai
        - Beach monitoring of 2 beach profiles initially undertaken in 1981.
        - Expanded to 4 sections in 1990.
        - Northern Muriwai is either dynamically stable or experiencing net accretion.
        - Closer to south Muriwai, significant erosion has occurred from 1981-1998, although the rate decreased from 1993 onwards.
    - Piha
        - Beach monitoring of 2 beach profiles, 1 north and 1 south, were initially undertaken in 1981.
        - Expanded to 5 sections (1 north and 4 south) in 1990.
        - Profiles indicate beach is generally dynamically stable with areas of accretion for the examined time period.
    - Long Bay
        - A beach monitoring profile at the south end of the beach has been monitored since 1982.
        - Profiles at the north end have been monitored since 1990.
        - The profiles indicate that the beach is dynamically stable with slight accretionary trend in the upper beach/dunes.

1.9 Manukau Harbour

- Menzies, M.B. and Duder, J.N. 1987. **Physical Study of Manukau Harbour, NZ.** 8th Australasian Conference on Coastal and Ocean Engineering.
    - Harbours and estuaries are considered ephemeral features that fill with sediment from upstream (by rivers/streams) and from the marine environment (by tidal circulation).
    - From 10,000 to 6,000 BP sea level rose by 120m. Manukau harbour is a resultant drowned river system.
    - Erosion most severe in cliffs comprising weak zones/layers, especially near high water mark and exposed to wave attack.
    - Sedimentary rocks along the northern boundary also susceptible due to intense faulting/folding and dipping out of the cliff.
    - Shoreline erosion most prevalent (possible exceeding 0.5m/yr) along the southern shoreline of the harbour inlet channel. High Cliffs + high wind/wave energy.
    - Long-term accretion predominates along the southern shoreline.
- Tonkin & Taylor. 1986. **Manukau Harbour Resources Study.** 1986. Report for Manukau Harbour Maritime Planning Authority.
    - 5 dominant sedimentary and 4 volcanic lithologies are present in the study area.
        - Waiheke Group – Very hard, finely bedded sandstones and siltstones (greywacke) form the basement rocks of the study area.

- Te Kuiti Group – Highly calcareous sandstone, siltstone and mudstone.
- Waitemata Group – Dark grey interbedded sandstone and siltstone. Located predominantly on the harbour's northern shores.
- Watakere Group – Shallow marine andesitic conglomerate and breccia; sandstone and siltstone with some lavas, pillow lavas and dykes.
- Kaihu Group – Fixed dune sands; terrace sediments (6-105+ m); shallow marine sandstone
- Bombay Basalts – Deeply weathered basalt; well eroded cones
- Franklin Basalts – Basalt; scoriaceous in part; coarse tuff
- Auckland Basalts – Basaltic scoria tuffs and ashes; lava flows.
- Kaihu/Tauranga Groups – Undifferentiated alluvium; fixed/drifting dune sands

o Shoreline erosion potential around the harbour:

- Whatipu – Progradation of up to 1km in the last 150 years has been documented although erosion and accretion episodes have occurred within this period.
- Paratutae to Fosters Bay – Shoreline cliffs of andesitic conglomerates and breccias up to 50m high. Generally stable but rock-falls occur where base of cliff has been undercut by wave action. A fairly short high water mark platform slopes at about 15-20°.
- Fosters Bay to Taumatarea Point – Mixed lithologies but mainly Waitakere and Waitemata rocks. The presence of more massive Cornwallis 'grit' beds and Waitakere Group units increases stability and results in less erosion than occurs in cliffs further east. Long, low gently sloping shore platforms between high and low tide are common in this area.
- Taumatarea Point to Hillsborough bay – Typically flysch of the Waitemata Group. Cliffs are up to about 20m high and near vertical. Estimates of erosion range from 0 to 0.03m/yr. Overburden slumping is associated with rock instability in this area, especially between Green Bay and Wattle Bay.
- Onehunga Wharf to Ihumatao – Variable shoreline geology comprising lavas, tuffs and ashes. Erosion has occurred in the low-lying dune-sands east of the Purification Works and in weakly consolidated Kaihu Group sediments within the inlet,
- Ihumatao to Karaka Point – Kaihu Group cliffs up to about 10m high dominate with small areas of other lithologies. Surveys of the Conifer Grove area indicate that prior to shore protection, it was eroding at about 0.33m/yr.
- Karaka Point to Clarks Beach – Recent partially-fixed sand dunes and terraces up to ~2m high occur in prograding areas near Seagrove and east of Ellets Beach. Kaihu Group cliffs up to about 10m high occur elsewhere.
- Waiuku Inlet (and Taihiki River) – Shoreline dominated by weakly consolidated Kaihu Group cliffs up to ~10m high, with areas of Waitakere Group rock and tuff and scoria also outcropping in cliffs up to ~15m. Cliffs fairly stable with retreat rates estimated to be generally less than 0.3m/yr.

        - Tokaroa Point to Grahams Beach – Generally similar to above but cliffs higher (up to 15m), slopes steeper and wave energy higher over the northern area.
        - Grahams beach to South Head – Kaihu Group cliffs in excess of 50m high occur near South Head fronted by small dunes in places. Erosion of this shoreline reaches up to 1m/yr in places,
    - Sensitive areas appear to be: Whatipu; Takanini – Karaka Point; Tokoroa Point – Grahams Beach; Grahams Beach – South Head.

- Manning, P.A. 1983. **Engineering geology of a section along the northern coast of the Manukau Harbour, Auckland.** Masters Thesis, University of Auckland.
    - Study area confined to Green Bay to Hillsborough Bay
    - Predominant lithologies of this study belong to or are derived from Waitemata Group
    - Rockmass - residual soil contact is generally slope parallel – independent of bedding
    - Range of rock and soil failure mechanisms given.

- Patel, J. 1997. **Engineering geology of coastal cliff stability along the northern Manukau Harbour.** Masters Thesis, University of Auckland.
    - Study area includes 7km of coastline from Hillsborough Bay to Blockhouse Bay
    - Highest elevation is 109m at Waikowhai and 104m at Hillsborough cemetery.
    - Beds dip eastward at 20° from Hillsborough Bay to Waikowhai Bay then westward at 14° from Waikowhai Bay to Blockhouse Bay
    - Slope movement processes:
        - Rock falls
        - Slab and block fall
        - Frittering
        - Slides – Rock block, small rock block, debris slides/earthslides, debris flows/earth flows
    - Area broken into 11 regions based on lithology, structure, etc.
    - Cliff retreat of 0.02 – 0.06m/yr is assumed for this study (following Moon and Healy, 1994).
    - Suggests (based on Moon and Healy, 1994) giving types of slope movement individual rates and summing based on particular features at each site.
    - Hazard zones delineated as follows:
        - High: recurrence interval <5 years.
        - Medium: recurrence interval >5 years.
        - Low: has not undergone movement in preceding 100 years.
        - Negligible: no evidence of past landslip activity and currently stable.

- Representative cross sections giving cliff heights/slopes for each region.
    - Cliff height ranges from 11 – 23m with mean of 16.1 m
    - Slope ranges from 50 - 72° with mean of 60°.

1.9.1 Onehunga Bay to Green Bay

- Auckland City Development Consultancy. **Manukau Harbour Coastal Reserves Study – Onehunga Bay to Green Bay, Geotechnical Assessment..**
    - Geology is Blockhouse Bay Formation, Waitemata Group rocks and weathered soils
    - Coast is dominated by hard rock shoreline with intertidal rock platform and steeply inclined marine cliff composed of Waitemata rocks.
    - Compressive strength of rocks other than Parnell Grit are 3-20MPa
    - Parnell Grit can exceed 100Mpa
    - The base of the cliff is typically 60-70°.
    - The upper cliff is typically weathered soil derivatives and less steep at 30-50°.
    - Heads of embayments were generally low lying terraces of Holocene alluvium – now mostly replaced by seawalls
    - Coastal processes occurring along the coastline include: mechanical wave erosion, bio-erosion of the rock platform, sub-aerial erosion and mass movement
    - Brodnax (1991) determined mean rates of cliff erosion since 1940 for the Waitemata clifflines in the Waitemata Harbour and Hauraki Gulf
        - 0.18m/yr in open coasts
        - 0.12m/yr in inner harbours
        - 0.14m/yr for lithotypes other than Parnell Grit
        - 0.07m/yr for Parnell Grit lithotype
    - Brodnax found that width of shore platform was not proportional to the rate of cliff retreat – where shore platform was less than 20m, higher wave energies at the cliff base promoted higher rates of cliff retreat during the 50yr study period.
    - Also found cliffs now protected by seawalls continue to retreat at the same rate as adjacent cliffs. This suggests marine actions may have little effect on cliff erosion.
    - Waitemata lithotypes along the Manukau coastline tend to be more volcanigenic and therefore resistant to erosion than ECBF

1.10 Hingaia Peninsula

- Tonkin & Taylor. 2002. **Hingaia development project – Coastal Hazard Assessment**. T&T. Report no. 20156. Report for Papakura District Council.
    - Study area extends from west of the Southern Motorway beside Pahurehure to west of the Southern Motorway beside Drury.
    - Cliffed shoreline up to 25m above MSL, typically 5-10m high.
    - Site underlain by Puketoka Formation of the Tauranga Group.
    - Deposits weather to depths of up to 10m.

- Erosion a function of weathering (wetting/drying), wind action, wave/tidal forces and biological activity.
- Also: Steep, unfavourable bedding planes in the area, concentrated storm water discharges, wind leverage on trees, continuous limonite bands.
- Primary mechanism appears to be weathering of fairly unconsolidated cliffs.
- Erosion rates from previous reports used – 0.33m/yr were recorded prior to construction of extensive coastal protection along Conifer Grove (T&T, 1986) and 0.1-0.25m/yr were identified along the Wattle Downs coast.
- Long term erosion within the study site, inferred from historic rates range from 0.05m/yr to 0.25m/yr. Most in the 0.05 and 0.1m/yr categories.
- Based on stable slope angle (2:1), long term retreat and a 5m buffer a line 10-40m wide is obtained. However, to maintain consistency with the esplanade reserve provisions of the RMA a min. width of 20m should be used.
- From 9 profiles, overall slope varies between 12 and 37° with an average of ~26°

1.11 Clarks Beach

- Tonkin & Taylor. 2004**. Clarks Beach – Coastal Erosion Management Guidelines.** Guidelines as a tool for property owners.
  - Report on 9.5km stretch of coastline between Waiuku River and Clarks Creek
  - Orientated WSW-ENE on southwestern shore of Manukau Harbour.
  - Predominant material forming the cliffs at Clarks Beach are weakly cemented andesitic breccias of the Waitakere Group. Prone to slow erosion resulting in steep cliffs.
  - Overlying the breccias are siltstones, mudstones and consolidated peats of Pleistocene Kaihu Group. These materials tend to soften on wetting and weather to soft clayey soils which are easily eroded (T&T, 1992).
  - Tides are semi-diurnal, with mean spring tidal range of 3.4m at Onehunga Wharf and mean neap tidal range of 2m.
  - Currents over the inter-tidal flats are driven by wind-generated waves. They are much slower than tidal currents flowing through the Waiuku Channel.
  - Winds are from SW 26% of the year, N to NE 24%, W 10%, calm 13%. Sustained winds over 15m/s occur infrequently (0.2%) generally from the SW.
  - Max fetch is 23km to the Nth, 17kkm from the NE. Protected from other directions.
  - In 30knot ENE wind, extreme waves of Hs 0.71m and Tz 2.8s were recorded.
  - Beaches consist of poorly to very poorly sorted medium to course sand. Sediment becomes finer with increasing water depth and distance offshore.
  - The beaches have few sediment sources – primarily cliff erosion and onshore transport from a large offshore sandbank.
  - ~100 properties over 2.5km stretch at Clarks Beach, FDC owns/manages 4.5km of coastline, Rural property at Seagrove (eastern) end, ~10 properties at Waiau Beach just south of Clarks.
  - Typical estuarine beach interspersed with cliffs.

- Wide inter-tidal flat, narrow sandy perched high-tide beach, backed by a low, steep bank 0.1-2.0m high.
- No beach at all in some places – inter-tidal flats extend up to bank/cliff.
- Several stormwater discharges across Clarks and Waiau beach.
- ARC Coastal Hazard Strategy identifies Clarks Beach as an eroded tidal lowland with a low level of development, low wave energy and medium-low potential for coastal hazard issues.
- FDC Shoreline Erosion Management Guidelines (1999) states that Clarks Beach has a low potential erosion hazard at present and a moderate threat in the future (sea-level rise).
- Based on information spanning 1942 – 2002 rates of shoreline change range from +0.0-0.2m/yr to –0.2m/yr. Most parts appear to be retreating at about 0.1m/yr.
- T&T (1997) identified that long-term coastline retreat is occurring along the majority of the cliff coasts along the Manukau Harbour due to a combination of weak soil profiles and hydraulic forces.
- Development at Clarks Beach has resulted in an increase in impervious surfaces causing higher stormwater discharges onto the beach.
- Some properties have been affected by storm surge in the past – large floods occurred in 1975 and 1998/99.

- ARC. 2003.**Assessment of erosion rates at Clarks Beach.** ARC Report.
  - Similar to above – include some photo comparisons if required.
  - States in general western end appears to be relatively stable with no strong evidence of sig. Erosion over last 50yrs.
  - Erosion appears to increase progressively east.
- Tonkin & Taylor. 1992. **Geotechnical study and assessment of sea frontage, Clarks Beach.** Report for Franklin District Council.
  - To assess overall risk of sea front cliff degradation risk factors have been mapped
  - Erosion potential (E) – potential for future or continued toe erosion
  - Steepness of slope (S) – generally related to top, uncemented part of slope
  - Geology (G) – favourable/unfavourable
  - Vegetation (V) – a measure of the effectiveness of vegetation in enhancing stability
  - Water (W) – influence of surface and groundwater on erosion and stability
  - Risk factors weighted as follows: E –30%, S – 25%, G – 20%, V – 10% W – 15%
  - Andesitic breccia 3.3m depth at No. 19 Torkar Road, overlain by silts
  - Setbacks from 0 – 25m recommended along Torkar Rd. Generally 5-10m.

1.11.1 Waiuku

- Betts, A. 1992. **Waiuku Cliff Erosion.** 1992. Report for Franklin District Council.
  - Area investigated was 150m of eroding shoreline to the northeast of Racecourse Road.
  - Cliffs are 6 – 7.5m high above intertidal foreshore

- Cliffs are almost vertical in some places and experiencing active erosion
- Erosion is being initiated at base of cliffs
- Based on site observations spring high tides extend 1.2 – 1.5m up cliff
- Cliff is fine-grained siltstone interbedded with coarser grained, weakly cemented sandstone.
- Weathered layer approx 1.5m deep.
- Inter-tidal foreshore is composed of fine-grained estuarine sediments.
- Max fetch is 2.5km to the north
- Estimates max wave height 0.3-0.4m
- Based on DOSLI info map erosion rates between 6 and 10m in last 50years (0.12 – 0.2m/yr).

1.11.2 Big Bay

- Betts, A. 1992. **Big Bay: Foreshore erosion.** Report for Franklin District Council.
  - Steep cliffs approx 15m high exist at western end from Mako Pt to Big Bay beach. Little sand in front but cliffs well vegetated – no significant erosion evident.
  - Central beach ~650m long with cliffs at either end.
  - Low 1.5 – 2.5m bank behind backshore at western end of beach. Low levels of sand on the backshore. Significant (??) amounts of erosion have occurred at this end
  - Up to 25m accretion at eastern end of beach
  - Stream discharging at very eastern end of beach. 10m accretion to the west of stream - apparently used to experience erosion
  - Further to the east 5-15m high cliffs to Kauri Point
  - Local residents state that nearshore tidal currents are in a net westerly direction.
  - Sand particles assumed to be similar to Grahams/Hudsons beaches: median ~0.4mm

1.11.3 Hudsons Beach/Grahams Beach

- Betts, A. 1992. **Hudsons Beach: Foreshore Erosion**Report for Franklin District Council.
- Betts, A. 1992. **Grahams Beach Erosion.** 1992. Report for Franklin District Council.
  - Consists of a broad, sandy, inter-tidal beach approximately 160m wide and a steep narrow backshore beach in some places
  - A low bank approx. 4.8-5.1m above CD backs the foreshore.
  - A stream discharges at the southern end of Grahams Beach
  - Fetch lengths are 11.5km from the N, 15.4km from the E and 9.6km from the SE.
  - Waves from the northerly quarter would be much more significant than from the easterly quarter.
  - It is thought that waves of up to 0.6m may reach Grahams Beach during winds exceeding 20 knots – probably from the N – NW.
  - Mean spring tidal range is 3m

- Beach history includes groyne and seawall construction, sand extraction, a wharf, concrete pipes in the foreshore and beach nourishment.
- Erosion is of greatest problem in the upper foreshore
- Sediment on the foreshore is medium to course sand with D50 of ~0.4mm.
- It is thought that at least 8m of erosion has occurred at the southern end of Hudsons Beach from 1930-1960 (when erosion protection works were undertaken). The average pre control works erosion rate was therefore ~0.25m/yr. This is consistent with rates at the southern end of Grahams Beach.

1.11.4 Huia Bay

- Coastal Consultants NZ, 2003. **Preliminary Report on the effects of operation of the upper and lower Huia dams on coastal processes and coastal morphology at Huia and Fosters Bay, Manukau Harbour.**
  - Huia Bay is the first estuarine sub-embayment inside Manukau Heads.
  - A wide intertidal flat extends 1–1.5km from the shoreline.
  - Assuming a spring high tide, southerly fetch length of 5.5-6.0km and wind duration of 6 hrs, wave hindcasting predicts waves of 0.57m may be generated during 30 knot winds.
  - Waves less than 0.2m can be expected for the majority of time.
  - Sediments in the Manukau Harbour are predominantly medium to fine sands, with muds in sheltered inlets and calcareous sands and gravels in channels.
  - In Huia Bay sediments are predominantly medium to fine sands with additions of silt. Isolated areas exhibit increasing percentage of mud.

1.12 Port Waikato – Awhitu

1.12.1 Awhitu Peninsula

- Macdonald, W.L. 1986. **Cliff Erosion and Coastal Processes on the West Coast of the Awhitu Peninsula.** Extracts of Masters Thesis – University of Auckland.
  - Manukau South Head is experiencing high erosion rates of 0.77m/yr (perhaps caused by focussing of wave energy as it refracts across Manukau Bar.
  - Cliff erosion is occurring at an average rate of 0.26m/yr along the northern 24km
  - The south is more stable and foredunes are prograding.
  - The Waikato River is not thought to be adding significant quantities of sediment at present.
  - Thinks sediment primarily sourced from cliffs. Cliffs on the western Awhitu Peninsula have angle between 35 and 45 deg.
  - Comprised of weakly consolidated Pleistocene sands. – No shore platform!
  - Sediment from these cliffs is making a significant contribution to the Whatipu and Waitakere Coasts
  - From Manakau South Head to Kariaotahi Gap cliffs are 50-100m high, unconsolidated sediments, base is exposed to wave attack on most tides.
  - From Kariaotahi to Thompson's Gap a foredune is present in from of cliffs decreasing in height towards the south.

- From Thompsons to the Waikato River Mouth there is a continuous series of Holocene dune ridges, widening southwards in from of cliffs.
- Bar at the Manukau Harbour entrance extends 9km seaward
- Winds: 26% SW, 24% N – NE. Winds over 20knots generally from SW**.**
- Waves most common from SW, ~2m, 10s
- Appears to be slight trend towards courser sediment further from the Waikato river mouth. Mean ~ 2.05mm, SD ~ 0.41, heavy min content ~ 67%, fines ~ 0.3%
- It is thought that most additions to the sediment budget in this area are from erosion of the coastal cliffs.

P:\19891\RRH050406.appendix D.V1.doc

Appendix E: Field investigation data

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
1	Waimangu Point	040615	1100	2713680	6464208	1,2	1		1.65	1	-29.85	-1.64	-1.34	Water level		
										2	0	-1.65	0	mid beach		
										3	24.12	1.32	1.62	bottom of slope		
										4	39.48	2.17	2.47	top of slope		
										5	42.99	2.34	2.64	back of beach		
										6	44.73	3.02	3.32	top of bank		
										7	60.23	3.02	3.32	edge of road		
2	Waihihi	040615	1200	2714697	6459935	3,4,5		Large gravel cobbles in intertidal. Steeper in the backshore with finer materials. Flat berm at the back of beach with low (0.1-0.2m) bank behind then flat grass.								
3	Firth of Thames Coast Road	040615	1230	2714206	6461719	6,7		Cliffs, hard grey rock outcrops, reefs on intertidal cobble/sand beach								
4	Waiti Bay	040615	1330	2706021	6471626	8,9	4	Shot at cliff to NW of beach. Rocks/headland at e	1.70	1	0	-1.7	0	Water Level		
										2	15.24	0.2	0.65			
										3	33.2	1.42	1.87	toe		
										4	34.33	2.93	4.63			
										5	40.18	8.99	10.69			
										6	40.04	15	16.7	Crest	65	15
5	Umupuia Beach	040615	1400	2694809	6475390	10	5	Mud/silt flat - shelly backshore. Low grass bank li	1.65	1	-57.23	-2.73	-1.08	Water Level		
										2	-6.14	-2.2	-0.55	Edge of intertidal flat		
										3	0	-1.65	0			
										4	11.6	-0.44	1.21	Top of Beach		
										5	16.79	1.28	2.93	Grass behind bank		
6	Maraitai	040615	1430	2692962	6477953	11,12,13	6		1.70	1	-17.25	-3.28	-1.58	Water edge		
										2	-7.95	-1.08	-0.63	Front of berm		
										3	0	-1.7	0	back of berm/edge of grass		
7	West of Sunkist Bay	040615	1500	2687243	6478106	14-16			1.65	1	0	-1.65	0	Edge of platform/waters edge		
										2	15.09	-0.28	1.37	Toe of Cliff		
										3	17.65	4.44	6.09	1/2 way up		
										4	21.31	9.64	11.29	Crest	58	10
8	Karioitahi Beach	040615	1600	2657131	6433679	17 - 20	8		1.65	1	-56.04	-2.15	-1.85	low water mark		
										2	0	-1.65	0	laser		
										3	48.47	1.63	1.93	base of foredune		
										4	57.57	4.48	4.78	crest of foredune		
										5	81.6	2.59	4.24	toe of cliff		
										6	107.04	22.88	24.53			
										7	170.91	62.5	64.15	crest of cliff	34	60
9	Howick Beach	040616	1100	2683436	6476981	22	9		1.70	1	-60.13	-3.94	-3.64	Water edge		
										2	0	-1.65	0	laser		
										3	35.92	-0.66	-0.36	edge of backshore		
										4	44.98	0.31	0.61	bottom of wall		
										5	45.6	1.19	1.49	top of wall		
10	Cliff Nth of Howick Beach	040616	1115	2683433	6477120	23,24			1.65	1	0	-1.65	0	Water edge		
										2	3.77	-0.76	0.89	outer edge of intertidal platform		
										3	60.33	-0.63	1.02	inner edge of intertidal platform		
										4	80.2	0.12	1.77	Toe of Cliff		
										5	87.6	7.73	9.38			
										6	91.99	17.2	18.85	Crest of cliff	55	17
11	Cockle Bay	040616	1200	2684268	6476063	25			1.65	1	-84.93	-3.47	-1.82	outer edge of intertidal platform		
										2	-37.58	-3.38	-1.73			
										3	-9.54	-2.91	-1.26	Front of backshore		
										4	0	-1.65	0	top of backshore		
										5	6.39	-0.93	0.72	grass crest		

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
12	Eastern Beach	040616	1230	2680849	6479482	26	12		1.65	1	-61	-3.45	-1.8	shore platform		
										2	-11.82	-2.85	-1.2	front of backshore		
										3	0	-1.65	0	mid beach		
										4	7.77	-0.66	0.99	back of backshore		
										5	10.38	0.05	1.7	top of bank		
13	Clovelly Road Cliffs	040616	1300	2680468	6480425	27			1.65	1	-48.95	-1.85	-0.2	Edge of platform/waters edge		
										2	0	-1.65	0	laser		
										3	32.16	-1.28	0.37	edge of mud		
										4	48.05	-0.29	1.36	Toe of Cliff		
										5	54.13	1.33	2.98			
										6	58.87	8.28	9.93			
										7	69.83	21.17	22.82	cliff crest/retaining wall	45	21
14	Bucklands Beach	040616	1330	2679758	6480312	28			1.70	1	0	-1.7	0	bottom of bach/waters edge		
										2	11.83	0.47	2.17			
										3	25.76	1.88	3.58	top of beach		
										4	26.67	2.39	4.09	top of bank/grass		
15	Karaka Bay Beach	040616	1430	2677753	6481857	29	15		1.65	1	0	-1.65	0	waters edge		
										2	10.24	-0.47	1.18			
										3	18.09	0.38	2.03	top of beach		
										4	22.25	0.85	2.5			
										5	26.09	1.94	3.59			
16	East of Achilles Point	040616	1500	2676934	6482404	30-33			1.70	1	0	-1.7	0	waters edge		
										2	18.13	-0.15	1.55	Toe of Cliff		
										3	28.56	10.39	12.09			
										4	32.22	15.31	17.01			
										5	49.78	34.41	36.11			
										6	63.56	56.31	58.01	crest of cliff	51	56
17	Waikowhai Bay	040616	1600	2664984	6472606	34,35		Cliff covered with fairly dense vegetation, therefore profile may contain inaccuracies.	1.65	1	0	-1.65	0	edge of mud/shore platform		
										2	29.77	-0.87	0.78	bottom of beach		
										3	43.9	0.47	2.12	Toe of Cliff		
										4	63.14	16.33	17.98			
										5	93.42	39.72	41.37	crest of cliff	38	39
18	West of Faulkner Bay	040616	1630	2665186	6472642	36-38			1.65	1	0	-1.65	0	edge of shore platform		
										2	26.16	-0.09	1.56	Toe of Cliff		
										3	34.65	2.01	3.66	change in slope		
										4	37.7	6.96	8.61	crest of cliff	31	7
19	West of Wattle Bay	040616	1700	2663460	6472538	39-46			1.65	1	-11.62	-2.42	-0.77	edge of water		
										2	0	-1.65	0	edge of platform		
										3	36.28	-0.83	0.82	Toe of Cliff		
										4	52.31	17.06	18.71			
										5	61.25	32.14	33.79	crest of cliff	53	33
20	Minnehaha Ave	040617	900	2669164	6489830	47-50		Very uneven, rough sloping platform	1.68	1	0	-1.68	0	Edge of platform/waters edge		
										2	42.81	-0.59	1.09	back of platform		
										3	47.51	-0.61	1.07	bottom of wall		
										4	80.27	1.69	3.37	bottom of slope		
										5	88.83	5.15	6.83	up bank		
										6	93.46	6.87	8.55		21	5
21	Winstones Cove	040617	945	2667351	6498825	51-55			1.68	1	0	-1.68	0	edge of platform		
										2	17.65	-0.71	0.97	toe of cliff		
										3	21.56	0.84	2.52			
										4	22.17	3.66	5.34			
										5	24.92	8.79	10.47	bottom of unweathered		
										6	29.29	13.85	15.53	crest of cliff	51	15
22	South of Long Bay	040617	1030	2667478	6499533	56,57		Very smooth, even platforms	1.68	1	0	-1.68	0	outer edge of intertidal platform		
										2	42.89	-0.44	1.24	inner edge of intertidal platform		
										3	47.6	1.18	2.86	toe of cliff		

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
										4	56.48	10.28	11.96			
										5	60.94	18.79	20.47			
										6	68.96	33.37	35.05			
										7	72.5	39.52	41.2	crest of cliff	57	38
23	East of Chelsea Bay	040617	1130	2664890	6485198	58,59			1.68	1	0	-1.68	0	waters edge		
										2	11.86	-0.85	0.83	edge of platform		
										3	19	1.21	2.89	toe of cliff		
										4	24.25	10.2	11.88			
										5	26.08	19.38	21.06	crest of cliff	69	18
24	Cornwallis Beach	040617	1400	2653069	6465725	60,61			1.65	1	-68.45	-4	-2.35	edge of water		
										2	-30.9	-3.34	-1.69			
										3	-9.19	-2.67	-1.02	edge of backshore		
										4	0	-1.65	0	back of beach		
										5	0.38	-0.99	0.66	top of bank		
										6	7.66	-1.05	0.6	grass		
24a	Huia Point Lookout	040617	1430			62-66										
25	Kaitarakhi Bay	040617	1500	2651327	6464784	67-71			1.65	1	0	-1.65	0	edge of platform/water		
										2	68.76	-0.78	0.87	Toe of cliff		
										3	81.48	9.54	11.19			
										4	88.4	23.1	24.75	Crest of Cliff	51	24
26	Arkles Bay	040618	1000	2666859	6505355	72,73			1.65	1	-23.05	-4.06	-2.41	water edge		
										2	-10.15	-2.28	-0.63			
										3	-0.48	-1.77	-0.12	top of beach		
										4	0	-1.65	0	top of bank		
										5	7.87	-1.4	0.25	road		
27	West of Little Manly	040618	1030	2667970	6505432	74,75			1.65	1	-12.69	-1.61	0.04	LT platform		
										2	0	-1.65	0	LT platform		
										3	4.32	-1.42	0.23	edge of HT platform		
										4	13.27	-0.82	0.83	Toe of cliff		
										5	16.42	4.33	5.98			
										6	18.23	10.55	12.2	Crest of Cliff	66	11
28	Matakatia Bay	040618	1100	2669044	6507032	76,77			1.65	1	-19.76	-4.21	-2.56	water edge		
										2	-9.14	-2.76	-1.11	Front of berm		
										3	-0.58	-2.1	-0.45	Back of berm		
										4	0	-1.65	0	Top of bank		
										5	7	-1.42	0.23	road		
29	Left of Okoromai Bay	040618	1200	2672078	6508193	78,79			1.65	1	0	-1.65	0	water edge		
										2	24.57	-0.79	0.86			
										3	31.96	0.34	1.99	Toe of cliff		
										4	38	10.24	11.89			
										5	42.61	22.55	24.2	Top of cliff	64	22
29a	Army Bay					80,81										
30	West of Fishermans Reserve	040618	1230	2670411	6509278	82,83			1.65	1	0	-1.65	0	Edge of platform		
										2	94.94	-0.28	1.37	Toe of cliff		
										3	107.13	12.38	14.03			
										4	108.21	23.89	25.54	bottom of weathered layer		
										5	108.91	26.56	28.21	Crest of cliff	63	27
31	Maori Bay	040620	1500	2637682	6484172	84-86			1.65	1	-20.23	-2.36	-0.71	Water edge		
										2	0	-1.65	0			
														top of beack/bottom of		
										3	12.65	-0.54	1.11	cobbles/boulders		
										4	19.62	1.12	2.77	Toe of cliff		
										5	31.03	7.74	9.39	Break in slope		
										6	41.7	15.33	16.98	Break in slope		
										7	68.78	30.6	32.25	Change of material		

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
										8	75.35	45.67	47.32			
										9	75.22	56.06	57.71	Crest of cliff	45	55
32	Pakiri	040621	1430	2665956	6549180	87-90			1.65	1	-29.72	-3.36	-1.71	edge of saturation		
										2	-8.39	-2.13	-0.48			
										3	0	-1.65	0			
										4	15.59	-0.47	1.18	toe of dune		
										5	20.84	0.59	2.24			
										6	24.85	2.24	3.89	crest of dune		
33	West of Goat Island	040621	1500	2671652	6546258	91-95	33	Hard, grey conglomerate type rock on Goat Island and high tide platform in from Goat. Hard, smooth grey rock on low tide platform. Softer, yellowey - brown material with outcrops of grey shore-platform material make up cliffs	1.65	1	-52.17	-1.99	-0.34	Platform		
										2	-3.39	-1.72	-0.07			
										3	0	-1.65	0	edge of sand		
										4	19.7	1.02	2.67	toe		
										5	28.3	11.46	13.11			
										6	31.45	17.92	19.57			
										7	43.83	33.05	34.7	crest	53	32
34	Jones Bay	040621	1530	2673690	6534282	96-98	34	Appears to flatten below water level - appears to be sandy. Maybe mixed sand/gravel beach	1.65	1	-17.61	-5.8	-4.15	edge of water		
										2	-7.84	-3.81	-2.16			
										3	-6.04	-3.02	-1.37			
										4	-5.77	-2.93	-1.28			
										5	-0.73	-2.48	-0.83	back of beach		
										6	0	-1.65	0	top of bank		
										7	12.18	-2.56	-0.91	road		
35	West of Anchor Bay	040621	1600	2674734	6535481	99-103	35		1.65	1	-52.77	-3.11	-1.46			
										2	0	-1.65	0			
										3	15.11	-0.03	1.62	HWM		
										4	18.77	0.12	1.77	toe of dune		
										5	26.56	1.86	3.51			
										6	32.84	5.75	7.4	crest of dune		
36	Christian Bay	040621	1615	2671488	6534115	104-106		Sand on western side, muddy on eastern. Also higher cliffs on western side								
37	Millon Bay	040621	1630	2668868	6533808	107-111	37a,37b	Very wide, flat intertidal mudflat. Material under mud layer is much harder, yellow/white clay type substance	1.65	1	-101.46	-3.08	-1.43	On mudflat		
										2	-38.42	-3.04	-1.39	On mudflat		
										3	-13.96	-2.69	-1.04	bottom of beach		
										4	0	-1.65	0	top of beach		
										5	2.97	-0.63	1.02	top of bank.		
38	Shelly Beach	040623	810	2633876	6513409	112-114	38	Muddy intertidal flats, occ. Patches of dark brown, fairly soft rock (weak mudstone?). Med slope shelly beach, low bank with cliffs 40-60m behind beach.	1.65	1	-65.5	-3.31	-1.66	waters edge		
										2	-39.9	-2.88	-1.23	Intertidal mud platform		
										3	-9.84	-2.46	-0.81	edge of beach		
										4	0	-1.65	0			
										5	7.34	-0.55	1.1	top of beach		
										6	8.62	-0.24	1.41	top of bank		
39	Sth of Shelly Beach	040623	830	2633634	6513101	115,116		Significant slumping evident	1.65	1	-59.43	-1.9	-0.25	Platform		
										2	-27.71	-1.91	-0.26	Platform		
										3	0	-1.65	0			
										4	9.42	-1.45	0.2	edge of loose rocks		
										5	22.38	-0.22	1.43	toe of cliff		
										6	25.28	3.66	5.31	change in slope		
										7	27.23	10.33	11.98	change in colour		
										8	27.93	14.58	16.23	crest of cliff	69	15
40	SW Kairpara - near Kaituna Creek	040623	915	2632474	6507287	117-119		Mudflats covered with dense mangroves Generally backed by definate cliff/bank								
41	End of Jordan Road	040623	945	2639619	6514540	120-122			1.65	1	-23.05	-3.07	-1.42	water		
										2	-13.8	-2.17	-0.52	Front of berm		
										3	-3.3	-2.11	-0.46	Back of berm		
										4	0	-1.65	0	Crest of stopbank		

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
										5	6.71	-2.37	-0.72	Paddock		
										6	17.87	-2.2	-0.55	Road		
41a	Top of Jordan Road	040623	1000			123,124										
42	Mouth of Hoteo River	040623	1030	2640248	6529623	125-127		Vast intertidal mudflats surrounding river								
43	Stables Landing	040623	1100	2636698	6538203	128-135	43	Some photos taken from road above Stables Landing	1.65	1	-24.15	-2.66	-1.01	Water		
								Trees on bank appear fairly stable		2	0	-1.65	0			
										3	16.49	-1.11	0.54	Toe of bank		
										4	21.4	-0.49	1.16	change in slope		
										5	25.5	1.7	3.35	change in slope		
										6	29.66	3.08	4.73	On bank	18	4
44	Journeys End	040623	1130	2624203	6541735	136-139	44		1.65	1	-95.91	-2.02	-0.37	Intertidal platform		
										2	-53.95	-2.24	-0.59			
										3	0	-1.65	0	Saturation Point		
										4	5.96	-1.01	0.64	HWM		
										5	9.11	-0.62	1.03	Toe of bank		
										6	11.93	0.82	2.47	Change in grade		
										7	13.95	1.44	3.09	Crest of bank	23	2
44a	Port Albert	040623	1200	2638960	6546750	140-144										
45	Snells Beach	040623	1300	2665670	6529737	145-147	45		1.65	1	-22.06	-2.62	-0.97	Waters Edge		
										2	-9.03	-2.36	-0.71	Change in slope		
										3	0	-1.65	0	Front of berm		
										4	4.94	-1.37	0.28	edge of vegetation		
										5	9.66	-0.94	0.71	base of bank		
										6	10.8	-0.73	0.92	top of bank		
45a	Algies Bay	040623	1330	2666925	6528225	148-151										
46	Martins Bay	040623	1400	2668628	6526378	152-155	46		1.65	1	-23.54	-2.54	-0.89	Waters edge		
										2	-9.82	-1.76	-0.11	front of berm		
										3	0	-1.65	0			
										4	8.06	-1.19	0.46	edge of vegetation		
										5	8.5	-0.93	0.72	toe of bank		
										6	11.78	-0.81	0.84			
										7	16.8	1.23	2.88	Crest of bank	15	2
47	South of Martins Bay	040623	1430	2668571	6525671	156-158			1.65	1	-6.72	-1.65	0	Waters edge		
										2	0	-1.65	0			
										3	13.08	-1.44	0.21	back of lower platform		
										4	15.59	-1.14	0.51	Front of higher platfrom		
										5	17.44	-0.93	0.72	extent of loose rocks		
										6	22.32	-0.52	1.13	Toe of cliff		
										7	41.42	21.88	23.53			
										8	68.23	53.61	55.26	Crest of cliff	50	54
47a	Sandspit	040623	1500	2665565	6532860	159-161										
48	Wenderholm Beach	040623	1530	2663901	6517362	162-164	48		1.65	1	-46.23	-3	-1.35	water edge		
										2	-17.08	-2.21	-0.56	change in grade		
										3	-8.75	-1.76	-0.11			
										4	0	-1.65	0			
										5	20.96	-0.64	1.01	Toe of dune/bank		
										6	25.94	0.67	2.32	Crest of dune/bank		
49	Sth of Wenderholm	040623	1545	2664001	6517053	165			1.65	1	0	-1.65	0	edge of platform		
										2	17.16	-1.67	-0.02	extent of rocks		
										3	32.6	0.55	2.2	toe of cliff		
										4	47.32	14.13	15.78	upper extent of veg.		
										5	62.6	34.01	35.66			
										6	79.72	60.36	62.01			
										7	84.11	76.03	77.68	crest of cliff	56	75
50	Waiwera - Wenderholm	040603		2664175	6516335			9 profiles total carried out - Max cliff height: 92.66m								

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
								Average Cliff Height: 61.67m						Average	58	93
51	West of Little Huia	040713	1400	2648742	6463249	166-172		Max cliff height: 112.7m above toe	1.65	1	-1.83	-2.34	-0.69	Water		
										2	0	-1.65	0	Edge of Platform		
										3	10.76	-1.02	0.63	Toe		
										4	17.93	8.42	10.07	Start of veg		
										5	19.29	12.31	13.96	In vegetation	57	13
52	Karekare	040713	1500	2641301	6467557	173-175		Cliffs at back of beach and at headlands On cliffs: outcrops of rock with veg/trees/shrubs intermittantly.	1.65	1	0	-1.65	0	On beach		
										2	98.19	0.67	2.32	toe		
										3	151.03	47.54	49.19			
										4	164.85	81.4	83.05			
										5	232.81	129.86	131.51			
										6	246.03	171.78	173.43	crest	49	171
53	Pt England NE	040713	1300	2677356	6478098	176-178		Most shore in this area is protected by armour. Trees on bank appear to be holding the shore further seaward than area without trees.	1.65	1	-23.73	-5.83	-4.18	water		
										2	-11.75	-4.85	-3.2	flat		
										3	-3.35	-3.82	-2.17			
										4	-1.01	-3.82	-2.17	toe		
										5	0	-1.65	0	Change in grade		
										6	2.32	-0.27	1.38	crest		
										7	5.05	-0.15	1.5	flat	31	4
54	Pt England SW	040713	1315	2677330	6478062	179-181			1.65	1	-14.42	-2.18	-0.53	water		
										2	0	-1.65	0			
										3	9.4	-0.83	0.82	toe		
										4	10.12	1.02	2.67	Start of veg		
										5	11.69	2.84	4.49	crest	58	4
55	Kiwi Esplanade (Mangere)	040713	1400	2667970	6472009	182-188		All very flat rock/reef with intermittant shelly beaches. Erosion protection (armour) fronts most shoreline in the area. Flat grass/road exist behind the shore	1.65	1	-24.04	-2.66	-1.01	water		
										2	-12.81	-2.33	-0.68	on rocks		
										3	-4.65	-1.97	-0.32	front of small beach		
										4	0	-1.65	0	edge of grass		
										5	7.76	-1.34	0.31	flat grass	3	
56	Norana Ave Reserve	040713	1415	2671682	6471476	189-194		Very wet on ground above bank. Bank appears to be being 'held' in position by trees. As they fall, large area of bank is ripped out too.	1.65	1	-9.37	-8.31	-6.66	water		
										2	-4.04	-8.14	-6.49	toe		
										3	-2.34	-4.17	-2.52	Change in grade		
										4	-1.07	-2.03	-0.38	Change in grade		
										5	0	-1.65	0	crest		
										6	7.69	-1.52	0.13	flat grass	58	6
57	Gibbons Road	040713	1500	2675485	6460261	195-196			1.65	1	-29.12	-2.34	-0.69	water		
										2	-11.96	-1.75	-0.1			
										3	0	-1.65	0			
										4	8.53	-0.98	0.67			
										5	10.43	-0.59	1.06	toe		
										6	11.22	0.66	2.31	Change in grade		
										7	12.94	2.77	4.42			
										8	15.26	5.63	7.28	crest	52	6
58	Weymouth Park	040713	1515	2675492	6460128	197-198		Rock (same as last profile) platform then narrow shelly beach (some black sand!!) ~15m wide. Then grass berm then gentle bank.	1.65	1	-45.75	-2.08	-0.43	water		
										2	-19.35	-1.89	-0.24			
										3	0	-1.65	0	edge of platform		
										4	10.82	-0.46	1.19			
										5	11.69	-0.16	1.49	on grass		
										6	25.54	0.84	2.49	toe		
										7	38.54	5	6.65			
										8	45.85	7.54	9.19	crest	18	7
59	Karaka Point (Clarks Beach)	040713	1615	2660266	6450023	199-202		Reasonably soft rock cliff and platform. Platform overlain in places by shelly sand. Rock appears to be conglomerate type with some red staining	1.65	1	-24.5	-2.95	-1.3	water		
										2	0	-1.65	0			
										3	10.16	-0.96	0.69	toe		
										4	12.63	-0.37	1.28	Change in grade		
										5	13.33	3.35	5	Weathered interface		

Number	Name	Date	Time	Easting	Northing	Photos	Sample	Notes:	Laser height (m)	Profile: Number	Horizontal	Vertical	Beach level	Notes	Average Cliff angle	Cliff Ht above toe
										6	14.6	4.35	6	crest	50	5
60	Medlands Beach	041210	930	2734507	6545325	203		Reflective high tide beach with flatter nearshore slope. 1-3rs growth on dune scarps in backshore indicating beach exposed to high energy events. Small new dune developing below old scarp. No evidence of long-term retreat.	1.65	1	-18.73	-3.6	-1.95	water		
										2	0	-1.65	0	top of berm		
										3	16.76	-1.27	0.38			
										4	35.53	-0.13	1.52	bot. of veg.		
										5	40.87	0.42	2.07	toe		
										6	45.5	2.19	3.84			
										7	48.68	4.01	5.66	crest		
										8	77.32	8.24	9.89	back-dune	12	
61	Sth Kaiarara Bay	041210	1030	2722775	6555684	204-207		Jointed rock on face - mod weathered. Bedding at approx 70 deg out of face. Evidence of recent slumps/rockfalls - trees falling onto rocky foreshore. High tide platform typically 3-5m wide accumulation of loose rocks on platform	1.65	1	-4.27	-1.72	-0.07	water		
										2	0	-1.65	0			
										3	10.77	-0.28	1.37	toe		
										4	13.16	1.29	2.94	bot. of veg.		
										5	16.7	5.2	6.85			
										6	21.04	10.8	12.45			
										7	24.94	15.54	17.19	veg obscuring slope	48	>16
62	Awana Beach	041210	1230	2733465	6551490	208-210		Small pocket beach on E coast of Gt Barrier. Reflective beach state. Similar material to Medlands. Steep scarp 1-3m high at back of beach - still mostly unvegetated (or 1-2yrs max)	1.65	1	-14.14	-3.47	-1.82	water		
										2	0	-1.65	0	top of berm		
										3	11.48	-0.86	0.79			
										4	20.03	0.19	1.84	toe		
										5	23.88	1.89	3.54	Start of veg		
										6	28.76	4.32	5.97			
										7	37.19	6.17	7.82			
										8	41.76	8.11	9.76	top of backdune	20	

Appendix F: Summary of regional beach properties

Table 4.1 Beaches of the Auckland Region and their properties

No.	Name	General Region	Material	Type	Section length (km)	Orientation	Exposure			Predominant max fetch length (km)	Nearshore max wave height (Hbmax) (m)	Wave Height Source	Closure depth (dl) (Hallermeier) (m)	Distance from MHWS to CD (M)	Distance from CD to dl (m)	Distance from MHWS to dl (m)	Ratio: MHWS-CD : MHWS-closure	SLR Retreat	Streams/ s/w controls
							From	To	Total										
1	Waimangu Point	1		ocean	3	58	320	150	190	45	1.51	NIWA Hind	2.6	120	170	290	0.41	32.17	Some small streams
2	Tawhitokino Beach	1		ocean	1.3	26	330	90	120	45	1.51	NIWA Hind	2.6		140	140	0.00	26.49	Some small streams
3	Kawakawa Bay	2		harbour	1.5??	28	340	50	70	6	0.65	NIWA Hind	1.1	370	290	660	0.56	127.47	small stream
4	Umupuia Beach	2		harbour	1.1	35	340	70	90	8	0.65	NIWA Hind	1.1	425	210	635	0.67	92.31	small stream
5	Maraetai Beach	2		harbour	0.9	17	325	70	105	6	0.65	NIWA Hind	1.1	120	270	390	0.31	118.68	small stream
6	Rocky Bay	8 (Waiheke I)	mud/sand	harbour	1	254	240	270	30	14	0.65	NIWA Hind	1.1	315	85	400	0.79	37.36	Some small streams
7	Man o' War Bay	8 (Waiheke I)	mud/sand	harbour	0.7	101	70	130	60	23	0.65	NIWA Hind	1.1	45	65	110	0.41	28.57	
8	Owhiti Bay	8 (Waiheke I)	mud/sand	ocean	0.7	315	300	0	60	33	2.89	NIWA Hind	5.1	180	175	355	0.51	17.30	
9	Onetangi Bay	8 (Waiheke I)	sand	ocean	1.6	13	335	45	70	∞	2.89	NIWA Hind	5.1	85	255	340	0.25	25.21	
10	Surfdale	8 (Waiheke I)	mud/sand	harbour	0.5	50	205	235	30	12	0.65	NIWA Hind	1.1	240	110	350	0.69	48.35	
11	Blackpool Beach	8 (Waiheke I)	sand	harbour	0.8	180	170	200	30	9	0.65	NIWA Hind	1.1	275	85	360	0.76	37.36	
12	Oneroa Beach	8 (Waiheke I)	sand	ocean	1.1	64	25	60	35	65	2.89	NIWA Hind	5.1	80	330	410	0.20	32.62	
13	Cockle Bay	2			0.45	45	0	100	100	14	1.2	Fetch Calc	2.1	850	745	1595	0.53	177.38	
14	Howick Beach	2			0.3	35	340	90	110	14	1.2	Fetch Calc	2.1	325	150	475	0.68	35.71	Seawall behind beach
15	Eastern Beach	2	sand	ocean	1.7	49	0	110	110	14	1.2	Fetch Calc	2.1	410	120	530	0.77	28.57	
16	Bucklands Beach	2	sand	harbour	1.2	250	180	320	140	1.5	0.53	NIWA Hind	0.9			30	0.00	0.00	Seawall behind beach
17	Karaka Bay	3			0.35	58	0	70	70	6.5	0.8	Fetch Calc	1.4	160	120	280	0.57	42.86	
18	Cheltenham Beach	5	sand	ocean	0.8	61	10	130	120	3.5	0.7	NIWA Hind	1.2	790	120	910	0.87	48.98	
19	Narrow Neck Beach	5	sand	ocean	0.4	41	0	80	80	3.5	0.7	NIWA Hind	1.2	250	135	385	0.65	55.10	
20	Takapuna Beach	5	sand	ocean	1.2	60	10	120	110	25	1.46	NIWA Hind	2.6	230	285	515	0.45	55.77	
21	Milford Beach	5	sand	ocean	0.8	51	10	110	100	55	1.46	NIWA Hind	2.6	250	235	485	0.52	45.99	small stream
22	Castor Bay	5	sand	ocean	0.2	111	80	140	60	6	0.9	Fetch Calc	1.6	130	180	310	0.42	57.14	
23	Campbells Bay	5	sand	ocean	0.5	57	0	120	120	55	1.46	NIWA Hind	2.6			155	0.00	0.00	
24	Mairangi Bay	5	sand	ocean	1	74	30	140	110	55	1.46	NIWA Hind	2.6			270	0.00	0.00	small stream
25	Browns Bay	5	sand	ocean	0.7	112	50	150	100	55	1.46	NIWA Hind	2.6	170	185	355	0.48	36.20	small stream
26	Waiake Beach	5	sand	ocean	0.4	127	110	150	40	11	1.1	Fetch Calc	1.9	120	180	300	0.40	46.75	
27	Long Bay	5	sand	ocean	1	69	10	140	130	55	1.21	NIWA Hind	2.1	70	165	235	0.30	38.96	
28	Dacre Beach	6		harbour	0.5	68	10	70	60	50	1.21	NIWA Hind	2.1	700	685	1385	0.51	161.75	
29	Arkles Bay	6		harbour	0.5	145	110	180	70	18	1.21	NIWA Hind	2.1	140	125	265	0.53	29.52	
30	Matakatia Bay	6		harbour	0.5	160	120	190	70	18	1.21	NIWA Hind	2.1	380	115	495	0.77	27.15	
31	Okoromai Bay	6		harbour	0.4	175	160	190	30	18	1.21	NIWA Hind	2.1	950	60	1010	0.94	14.17	
32	Te Haruhi Bay	6	sand	ocean	0.8	194	155	215	60	20	1.21	NIWA Hind	2.1	230	185	415	0.55	43.68	
33	Army Bay	6	Sand	ocean	0.6	350	290	20	90	20	1.56	NIWA Hind	2.7	90	225	315	0.29	41.21	Cliff/Bank behind
34	Big Manly/Tindalls Beach	6	sand	ocean	2	342	320	20	60	15	1.56	NIWA Hind	2.7	55	400	455	0.12	73.26	
35	Stanmore Bay	6	sand with intermittent rocks	ocean	1.4	32	340	50	70	80	1.56	NIWA Hind	2.7	110	340	450	0.24	62.27	
36	Red Beach	6	sand	ocean	0.7	64	15	120	105	80	1.56	NIWA Hind	2.7	150	455	605	0.25	83.33	
37	Orewa Beach	6	sand	ocean	3	71	35	140	105	80	1.56	NIWA Hind	2.7	100	530	630	0.16	97.07	river/estuary entrance/major S/W
38	Hatfields Beach	6		ocean	0.45	120	100	170	70	10	1.1	Cress	1.9	170	220	390	0.44	57.14	
39	Waiwera	6	sand/mud??		0.5	122	100	140	40	11	1.1	Cress	1.9	220	240	460	0.48	62.34	river/estuary entrance
40	Wenderholm Beach	6	sand	ocean	0.9	115	70	130	60	50	1.56	NIWA Hind	2.7	230	350	580	0.40	64.10	Puhoi River at northern end
41	Mahurangi Res Beach	6	sand	ocean	0.6	101	75	130	55	50	1.56	NIWA Hind	2.7	130	245	375	0.35	44.87	stream
42	Martins Bay	6	sand/mud		0.9	103	70	160	90	50	0.63	NIWA Hind	1.1	100	75	175	0.57	34.01	
43	Sandspit Beach	6		barrier/harbour	0.5	95	10	130	120	1	0.63	NIWA Hind	1.1	1015	540	1555	0.65	244.90	
44	Buckleton Beach	6		harbour	0.25	145	110	200	90	7	0.63	NIWA Hind	1.1	155	40	195	0.79	18.14	
45	Million Bay	6	Mud	harbour	1	180	160	195	35	6	0.63	NIWA Hind	1.1	630	35	665	0.95	15.87	Small stream
46	Christian Bay	7	Sand/mud	harbour	0.7	137	110	180	70	4	0.63	NIWA Hind	1.1	80	80	160	0.50	36.28	Small stream
47	Waikauri Bay	7		harbour	0.25	170	120	200	80	4	0.63	NIWA Hind	1.1			35	0.00	0.00	
48	Jones Bay	7	Gravel	harbour	0.4	150	115	210	95	3	0.63	NIWA Hind	1.1	30	60	90	0.33	27.21	
49	Tawharanui	7	Sand/gravel with intermittent rocks	ocean	2.5	35	10	90	80	∞	3.65	NIWA Hind	6.4			365	0.00	0.00	
50	Omaha	7	Sand	barrier	4	73	45	115	70	50	3.65	NIWA Hind	6.4	75	575	650	0.12	45.01	Harbour entrance at North end
51	Mangawhai - Pakiri	7	Sand	ocean/barrier	24	63	350	130	140	∞	6.2	NIWA Hind	10.9			650	0.00	0.00	Harbour entrance + streams
52	Whangaparapara	8 (Gt Barrier)	Sand/mud	harbour	0.8	180	175	185	10	25	1.56	NIWA Hind	2.7			290	0.00	0.00	Small stream
53	Okupu Bay	8 (Gt Barrier)	Sand		0.8	235	205	250	45	85	1.56	NIWA Hind	2.7			890	0.00	0.00	
54	Puriri Bay	8 (Gt Barrier)	Sand	harbour	0.8	225	210	245	35	85	1.56	NIWA Hind	2.7	190	180	370	0.51	32.97	
55	Rosalie Bay	8 (Gt Barrier)		harbour	0.4	235	220	280	60	85	1.56	NIWA Hind	2.7	220	175	395	0.56	32.05	
56	Medlands Beach	8 (Gt Barrier)	Sand	ocean	2.5	28	0	60	60	∞	6.38	NIWA Hind	11.2	100	325	425	0.24	14.55	Small Stream
57	Kaitoke/Palmers Beach	8 (Gt Barrier)	Sand	ocean	4	78	40	130	90	∞	6.38	NIWA Hind	11.2	215	640	855	0.25	28.66	Kaitoke Creek
58	Awana Beach	8 (Gt Barrier)	Sand	ocean	0.5	83	40	125	85	∞	6.38	NIWA Hind	11.2			875	0.00	0.00	Stream at north end
59	Whangapoua Beach	8 (Gt Barrier)	Sand	ocean/barrier	3.4	68	45	130	85	∞	6.38	NIWA Hind	11.2	75	750	825	0.09	33.59	Estuary entrance at south end
60	Papakanui Spit	10	Sand	barrier/spit	14	290	200	20	180	∞	7.5	NIWA Haz Guide	13.1	265	6700	6965	0.04	255.24	
61	Shelly Beach	9		harbour	0.5	110	30	150	120	7									Cliff/embankment behind beach
62	Muriwai Beach	10	Sand	ocean	39	245	170	310	140	∞	7.5	NIWA Haz Guide	13.1	380	1470	1850	0.21	56.00	Some small streams
63	O'Neill Bay	10	Sand	ocean	0.5	255	215	295	80	∞	7.5	NIWA Haz Guide	13.1						
64	Bethells Beach	10	Sand	ocean	1.4	248	190	295	105	∞	7.5	NIWA Haz Guide	13.1	235	1100	1335	0.18	41.90	Some small streams

65	Piha Beach	10	Sand	ocean	2.8	249	200	310	110	∞	7.5	NIWA Haz Guide	13.1	160	1060	1220	0.13	40.38	Some small streams
66	Karikari Beach	10	Sand	ocean	0.9	257	200	310	110	∞	7.5	NIWA Haz Guide	13.1	175	900	1075	0.16	34.29	Some small streams
67	Whatipu - Karikari Point	10	Sand	ocean/barrier	9	250	180	340	160	∞	7.5	NIWA Haz Guide	13.1	235	2650	2885	0.08	100.95	streams/swamps
68	Cornwallis Beach	11		harbour	1.5	90	50	150	100	22									
69	Glenbrook Beach	11		harbour	0.6	230	180	290	110	2.5									Beach with soft shore behind
70	Clarks Beach	11		harbour	5	350	280	60	140	22									
71	Grahams Beach	11		harbour	1.3	60	350	140	150	17									
72	Big Bay	11		harbour	1.3	20	310	80	130	16									
73	Orua Bay	11		harbour	1.5	0	310	50	100	14									
74	Wattle Bay	11		harbour	0.45	5	310	70	120	4									
75	South Head	12	Sand	Spit/ocean	10	270	180	60	240	∞	7.5	NIWA Haz Guide	13.1	170	4900	5070	0.03	186.67	
76	Awhitu Beach	12	Sand	ocean	16	247	170	330	160	∞	7.5	NIWA Haz Guide	13.1	110	2400	2510	0.04	91.43	Some small streams
77	Port Waikato Beach	12	Sand	ocean	6	247	170	330	160	∞	7.5	NIWA Haz Guide	13.1	110	2400	2510	0.04	91.43	

Appendix G: Summary of regional cliff properties

Table G-1. Components of cliff erosion hazard zones

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
1	11.0	2715189	6458279	2714718	6453043	2714025	6462609	15-25	TJw	20
2	1.5	2714207	6463271	2713782	6463854	2714025	6462609	15-25	TJw	20
3	1.4	2712266	6466399	2711773	6466882	2712768	6465944	15-25	TJw	10
4	4.5	2710687	6468592	2709184	6469421	2711773	6466882	Alluvium	eQa	25
5	9.1	2695103	6469865	2696069	6472281	2695760	6469888	Coastal	Q1b	2
6	1.4	2709120	6469888	2708563	6470017	2709184	6469421	25-40	TJw	20
7	0.5	2708338	6470080	2708200	6470241	2708563	6470017	25-40	TJw	10
8	3.2	2698207	6470454	2697235	6470882	2698848	6470638	Alluvium	Q1a	5
9	15.5	2675084	6470480	2675344	6472771	2675945	6471035	Alluvium	avt	5
10	1.0	2707956	6470638	2707528	6470653	2708200	6470241	25-40	TJw	20
11	3.4	2696810	6470748	2695760	6469888	2697235	6470882	40-55	TJw	15
12	11.0	2677795	6471015	2675945	6471035	2677063	6472188	60-85	avt	15
13	1.3	2698931	6471184	2698848	6470638	2699172	6471456	40-55	TJw	15
14	1.2	2699739	6471324	2699172	6471456	2700327	6471484	40-55	TJw	2
15	1.4	2706494	6471476	2706042	6471599	2706734	6471046	25-40	TJw	10
16	3.0	2705307	6471930	2704164	6471302	2706042	6471599	45-55	TJw	10
17	5.1	2701273	6472309	2700327	6471484	2701894	6470567	40-55	TJw	15
18	15.8	2685038	6472672	2683189	6474265	2685480	6473783	45-65	re	10
19	1.3	2696005	6472820	2695802	6473405	2696069	6472281	40-55	TJw	15
20	10.3	2688299	6473676	2686685	6474903	2687590	6475809	Alluvium	ta	3
21	2.1	2695414	6473903	2695882	6474637	2695802	6473405	Coastal	Q1b	2
22	28.2	2679735	6474041	2677063	6472188	2676144	6474835	Alluvium	tp	3
23	1.8	2685314	6474449	2685480	6473783	2685808	6474736	Alluvium	Q1a	5
24	7.9	2675470	6474865	2675545	6476070	2675344	6472771	60-85	avl	5
25	2.5	2684151	6474866	2684528	6475843	2683189	6474265	45-65	re	20
26	1.2	2686230	6475144	2685808	6474736	2686685	6474903	45-65	re	15
27	2.9	2676366	6475179	2676144	6474835	2676882	6475165	60-85	avt	3
28	1.2	2675811	6475521	2676262	6475726	2675545	6476070	60-85	avt	12
29	4.6	2697301	6475748	2695224	6475244	2695882	6474637	30-40	TJw	35
30	0.8	2687431	6476168	2687590	6475809	2687565	6476550	45-65	re	10
31	3.7	2677799	6476202	2676882	6475165	2678430	6477168	Alluvium	tpp	10
32	2.4	2676879	6476421	2676879	6477585	2676262	6475726	60-85	avt	4
33	1.1	2684256	6476661	2683733	6476848	2684185	6476165	55-75	re	35
34	22.1	2659324	6476724	2658150	6481280	2658856	6480462	Alluvium	tp	5
35	0.4	2687591	6476761	2687565	6476550	2687631	6476938	Alluvium	ta	2
36	2.4	2687568	6477107	2687631	6476938	2687431	6477608	Marina	hf	3
37	3.9	2679004	6477124	2678430	6477168	2679514	6478432	45-50	re	15
38	2.7	2693933	6477161	2693280	6478033	2694283	6475954	30-40	TJw	15
39	2.7	2682514	6477951	2681514	6478603	2683363	6477022	55-65	re	35
40	7.3	2707034	6478327	2705952	6475438	2706213	6480622	55-75	TJw	60
41	1.4	2679930	6478361	2679514	6478432	2680106	6478760	Marina	hf	3

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
42	5.6	2689002	6478384	2687431	6477608	2690962	6478440	30-40	re	15
43	4.5	2660623	6478674	2659620	6479916	2661507	6478334	Alluvium	tp	2
44	8.0	2677992	6479169	2678095	6480446	2676879	6477585	Alluvium	tpp	6
45	2.3	2661535	6479304	2661507	6478334	2662346	6479514	45-60	re	5
46	6.4	2672720	6479485	2671822	6480404	2672565	6480275	60-85	avl	10
47	8.8	2659269	6480262	2662346	6479514	2659620	6479916	Seawall	hf	3
48	1.3	2680460	6480343	2680315	6480900	2680723	6479785	55-75	re	35
49	1.8	2671263	6480424	2670572	6480468	2671603	6480574	50-65	re	20
50	0.7	2672303	6480439	2672565	6480275	2672065	6480652	Alluvium	tc	10
51	0.9	2670226	6480467	2669905	6480496	2670572	6480468	Alluvium	ta	5
52	0.6	2671825	6480838	2672065	6480652	2671730	6481112	60-85	avl	15
53	1.4	2678236	6481007	2678008	6481601	2678095	6480446	45-50	re	60
54	4.1	2661903	6481049	2661854	6479791	2662737	6481379	45-60	re	8
55	1.0	2679837	6481144	2679790	6480652	2679781	6481642	50-60	re	35
56	1.7	2670192	6481207	2670232	6481975	2669905	6480496	50-65	re	20
57	4.5	2662833	6481314	2662737	6481379	2663088	6481456	Alluvium	ta	5
58	0.7	2671581	6481374	2671730	6481112	2671369	6481604	60-85	Qva	0
59	2.0	2680132	6481842	2679781	6481642	2680315	6480900	30-45	re	35
60	1.8	2663622	6481972	2663088	6481456	2664219	6482097	55-75	re	10
61	8.0	2669943	6482004	2671603	6480574	2670232	6481975	Seawall	hf	3
62	2.1	2677053	6482329	2676343	6482041	2677818	6481792	45-50	re	60
63	6.5	2673424	6482390	2671360	6481640	2676343	6482041	Seawall	hf	2
64	1.4	2657017	6482890	2657045	6482238	2656392	6482977	Alluvium	tp	7
65	3.5	2658383	6482924	2658510	6484308	2658150	6481280	Alluvium	ta	8
66	8.7	2655974	6482941	2654751	6481782	2657045	6482238	Alluvium	re	3
67	2.7	2664749	6482986	2664219	6482097	2665577	6483496	55-70	re	15
68	15.5	2667817	6483119	2665577	6483496	2669949	6482217	Seawall	hf	3
69	3.3	2670521	6483897	2671880	6484174	2669312	6484504	Seawall	hf	3
70	3.8	2656835	6484106	2656392	6482977	2657636	6484996	35-45	re	10
71	8.7	2656629	6484188	2657131	6486243	2654751	6481782	35-45	re	23
72	2.1	2668508	6484377	2669312	6484504	2669210	6484758	45-60	re	20
73	0.9	2672196	6484414	2671926	6484714	2671880	6484174	60-90	avs	40
74	2.2	2666478	6484678	2666647	6485702	2666211	6485330	45-60	re	7
75	1.6	2657905	6484781	2657636	6484996	2658510	6484308	Alluvium	ta	5
76	3.2	2670051	6484926	2669210	6484758	2670156	6485476	Alluvium	ta	3
77	2.6	2668070	6485343	2668985	6485752	2668782	6486139	45-60	re	17
78	2.3	2665477	6485498	2666211	6485330	2664870	6485219	45-60	re	28
79	7.2	2661679	6485633	2664220	6485193	2660934	6487279	35-45	re	28
80	1.2	2664522	6485640	2664870	6485219	2664220	6485193	45-60	re	15
81	1.0	2671712	6485720	2671309	6486012	2671557	6485262	40-50	re	20
82	2.2	2669791	6485819	2670156	6485476	2668985	6485752	45-60	re	10
83	1.4	2656841	6486571	2657297	6486792	2657131	6486243	Marina	hf	3
84	0.9	2670815	6486613	2670558	6486990	2670998	6486233	40-50	re	28

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
85	6.1	2668699	6486826	2668782	6486139	2668292	6488300	45-60	re	7
86	4.0	2659170	6486952	2659374	6487771	2657565	6487457	Alluvium	tpp	12
87	0.8	2657349	6487145	2657565	6487457	2657297	6486792	35-45	re	10
88	11.0	2666661	6487242	2668292	6488300	2666647	6485702	Alluvium	ta	3
89	0.8	2670396	6487347	2670129	6487628	2670558	6486990	55-65	re	28
90	1.0	2669763	6487931	2669416	6488237	2670129	6487628	40-50	re	28
91	2.5	2660463	6488115	2660934	6487279	2660216	6488805	35-45	re	28
92	3.3	2656693	6488366	2657136	6489346	2657376	6488954	35-45	re	7
93	5.8	2659744	6488875	2657848	6488623	2659374	6487771	35-45	re	5
94	0.7	2657713	6488885	2657376	6488954	2657848	6488623	Alluvium	tpp	5
95	15.1	2661948	6489967	2660216	6488805	2659025	6491039	35-45	re	28
96	2.1	2653334	6490000	2653775	6490840	2654088	6490600	Alluvium	Pup	7
97	2.2	2668974	6490011	2668555	6490933	2668826	6489158	60-85	ava	5
98	7.8	2655986	6490512	2654088	6490600	2657136	6489346	35-45	Mwe	5
99	7.1	2655522	6491081	2656390	6492954	2653580	6492039	35-45	Mwe	28
100	10.9	2658788	6491195	2660979	6494701	2656336	6491915	35-45	Mwe	30
101	3.4	2652928	6491352	2653165	6492116	2653775	6490840	35-45	Mwe	7
102	4.0	2659678	6491444	2659025	6491039	2660428	6491777	Alluvium	Pup	10
103	0.3	2668263	6491649	2668269	6491784	2668220	6491528	40-55	Mwe	30
104	0.7	2660222	6492037	2660428	6491777	2660081	6492301	35-45	Mwe	20
105	2.5	2656513	6492312	2656336	6491915	2656390	6492954	Alluvium	Pup	10
106	2.2	2653348	6492639	2653580	6492039	2653165	6492116	Alluvium	Pup	7
107	1.9	2668015	6492776	2667989	6493432	2668481	6491971	40-55	re	32
108	3.7	2660379	6493353	2660081	6492301	2660979	6494701	Alluvium	Pup	15
109	0.5	2667591	6493997	2667467	6494205	2667689	6493774	55-75	Mwe	30
110	0.5	2667270	6495227	2667407	6495363	2667081	6495080	55-75	Mwe	25
111	1.5	2667060	6496025	2666792	6496678	2667407	6495363	55-75	Mwe	25
112	1.0	2667064	6497709	2667012	6498178	2667011	6497412	55-75	Mwe	25
113	1.6	2667335	6498777	2667869	6499129	2667056	6498434	40-55	Q1a	15
114	1.2	2667521	6499496	2667133	6499876	2667869	6499129	55-75	Mwe	25
115	5.1	2663133	6501369	2663160	6501739	2663742	6501391	Alluvium	Mwe	5
116	1.9	2666611	6501811	2666754	6502673	2666678	6500918	55-75	Mwe	25
117	4.3	2664586	6501823	2663742	6501391	2666018	6502808	55-75	Mwe	10
118	4.0	2664254	6502280	2665103	6502971	2663160	6501739	55-75	Mwe	25
119	1.0	2666413	6503000	2666018	6502808	2666754	6502673	55-75	Mwe	25
120	1.0	2664941	6503847	2664916	6504323	2664873	6503399	55-75	Mwe	25
121	1.2	2666334	6504661	2666627	6505093	2665823	6504459	55-75	Mwe	28
122	1.6	2667681	6505120	2668069	6505676	2667024	6505388	55-75	Mwe	28
123	8.0	2664214	6505619	2663134	6507385	2664916	6504323	55-75	Mwe	15
124	2.0	2668699	6506067	2668915	6506947	2668069	6505676	55-75	Mwe	28
125	5.4	2664163	6506336	2665823	6504459	2662823	6508325	55-75	Mwe	30
126	1.9	2671413	6506536	2671949	6507178	2670785	6506703	40-55	Mwe	25
127	0.8	2669584	6506915	2669937	6507085	2669311	6507075	55-75	Mwe	25

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
128	2.1	2666890	6507483	2666446	6507163	2667193	6506747	40-55	Mwe	25
129	14.1	2661511	6507487	2662823	6508325	2663134	6507385	25-45	Kk	10
130	1.8	2668794	6507588	2668418	6506975	2668680	6508438	40-55	Q1b	20
131	2.8	2670354	6507645	2670785	6506703	2669937	6507085	Marina	Mwe	3
132	2.0	2671972	6507890	2672153	6508739	2671949	6507178	55-75	Mwe	25
133	1.7	2672807	6508016	2673177	6507936	2672691	6508766	20-35	Mwe	28
134	3.2	2664581	6508283	2663503	6509181	2665747	6507203	55-75	Mwe	25
135	0.9	2668840	6508812	2668680	6508438	2669176	6508993	40-55	Mwe	26
136	1.0	2669652	6508888	2669176	6508993	2670000	6509218	55-75	Mwe	26
137	2.4	2671069	6509448	2670000	6509218	2672207	6509497	40-55	Mwe	26
138	7.0	2674911	6509758	2672824	6509653	2674130	6507792	20-35	Mwe	28
139	0.6	2663177	6509814	2662926	6509909	2663271	6509585	55-75	Mwe	15
140	10.7	2659807	6510196	2660628	6510776	2662926	6509909	25-45	Q1d	7
141	4.0	2661787	6510731	2662686	6510245	2660628	6510776	Alluvium	Q1d	3
142	1.1	2662147	6513056	2662141	6513588	2661791	6512740	55-75	Mwe	20
143	1.3	2662930	6513875	2663346	6514130	2662381	6514104	55-75	Mwp	30
144	1.7	2663485	6514789	2663479	6515536	2663346	6514130	40-55	Mwp	35
145	4.3	2662386	6516240	2660704	6516658	2663593	6516137	Alluvium	Q1a	10
146	1.5	2664149	6516517	2663870	6517152	2663736	6516225	55-75	Mwp	100
147	3.9	2662234	6516761	2663736	6516225	2660704	6516658	55-75	Mwp	30
148	7.3	2661493	6517954	2660784	6518728	2663965	6517928	Alluvium	Q1b	12
149	0.8	2664589	6517983	2664484	6518324	2664228	6517931	55-75	Mwp	25
150	6.4	2662289	6518427	2664228	6517931	2660784	6518728	55-75	Mwp	25
151	1.8	2665335	6519204	2664731	6519698	2664803	6518909	55-75	Mwp	20
152	2.3	2664161	6519293	2663759	6519757	2664576	6518947	Alluvium	Q1b	10
153	1.7	2664308	6519390	2664803	6518909	2663759	6519757	55-75	Mwp	15
154	0.3	2664713	6519856	2664725	6520014	2664731	6519698	40-55	Mwp	5
155	2.0	2665941	6520430	2666334	6521004	2665955	6521326	40-55	Mwp	35
156	2.6	2664324	6520964	2663948	6521699	2664725	6520014	40-55	Mwp	20
157	1.0	2666549	6521404	2666972	6521545	2666334	6521004	40-55	Mwp	20
158	3.7	2665003	6522462	2665998	6523528	2665407	6523795	40-55	Mwp	35
159	5.5	2667878	6523747	2668596	6526131	2666972	6521545	55-75	Mwp	45
160	22.6	2663249	6523816	2661956	6524945	2663948	6521699	40-55	Mwp	20
161	12.5	2666903	6524433	2665955	6521326	2665998	6523528	40-55	Mwp	12
162	5.0	2665583	6525601	2665407	6523795	2665401	6527426	40-55	Mwp	35
163	0.8	2668412	6527569	2668160	6527868	2668748	6527372	40-55	Mwp	10
164	3.7	2670008	6527686	2668748	6527372	2668882	6526847	55-75	Mwp	28
165	2.0	2667820	6528079	2667046	6528097	2668160	6527868	40-55	Mwp	28
166	21.1	2662190	6528131	2663594	6528874	2661956	6524945	40-55	Mwp	30
167	0.7	2666812	6528368	2666644	6528684	2667046	6528097	25-45	Kk	5
168	0.8	2666511	6529025	2666263	6529227	2666644	6528684	40-55	Kk	30
169	7.6	2664795	6529308	2665401	6527426	2663594	6528874	25-45	Kk	8
170	2.5	2665638	6529945	2665713	6531156	2666263	6529227	25-35	Kk	5

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
171	2.3	2666365	6531909	2665663	6532679	2665713	6531156	55-75	Mwp	25
172	1.5	2666661	6532497	2667160	6532521	2666268	6533056	55-75	Mwp	20
173	0.9	2665431	6532923	2665319	6532947	2665679	6533224	Alluvium	Q1a	3
174	1.3	2671238	6533140	2671136	6533734	2670860	6533220	40-55	Mwp	30
175	0.6	2670584	6533258	2670860	6533220	2670316	6533288	55-75	Mwp	30
176	3.3	2668902	6533332	2669859	6533316	2668960	6533736	55-75	Mwp	30
177	2.5	2667959	6533355	2668053	6533955	2667521	6532768	55-75	Mwp	25
178	1.0	2670086	6533544	2670316	6533288	2669859	6533316	55-75	Mwp	7
179	1.0	2672321	6533872	2672675	6533991	2671837	6534014	45-65	TJw	25
180	0.6	2673337	6534163	2673616	6534153	2673088	6534136	45-65	TJw	25
181	8.8	2677632	6534977	2675778	6535209	2673927	6534436	55-75	TJw	35
182	25.5	2665480	6535670	2666268	6533056	2665319	6532947	55-75	Mwp	17
183	0.9	2673316	6536684	2673037	6536889	2673561	6536370	20-40	Mwp	10
184	16.3	2669113	6536785	2666879	6539246	2670230	6540705	Coastal	TJw	3
185	2.1	2672342	6537561	2671390	6537348	2673037	6536889	40-55	Mwp	30
186	3.3	2667554	6540382	2667977	6541028	2666879	6539246	40-55	Mwp	20
187	2.5	2671520	6540595	2672067	6541173	2670788	6541133	65-85	Mvt	25
188	1.0	2671771	6541501	2671811	6541949	2672067	6541173	55-75	Mvt	40
189	8.9	2670109	6541824	2670788	6541133	2667977	6541028	55-75	TJw	18
190	1.5	2671771	6542619	2672345	6542983	2671811	6541949	55-75	Mwr	30
191	0.9	2672599	6543325	2672951	6543565	2672345	6542983	55-75	Mwr	30
192	2.6	2672666	6544301	2673359	6544294	2672951	6543565	55-75	TJw	25
193	2.2	2673822	6544527	2674082	6545124	2673359	6544294	55-75	TJw	25
194	3.1	2673458	6545855	2672225	6546432	2674082	6545124	55-75	TJw	30
195	5.5	2669953	6546951	2667590	6547790	2672225	6546432	55-75	Mwp	140
196	11.4	2703390	6478245	2705936	6475439	2704458	6479942	55-75	TJw	9
197	15.6	2705557	6482526	2704458	6479942	2706213	6480622	55-75	TJw	60
198	16.6	2702330	6483042	2702704	6487972	2701024	6483869	50-60	TJw	50
199	1.9	2694402	6483622	2694579	6483295	2694981	6483861	50-60	TJw	20
200	3.8	2701313	6484125	2701024	6483869	2700347	6484038	Alluvium	Q1a	10
201	18.1	2698469	6484967	2700347	6484038	2694579	6483295	50-60	TJw	35
202	3.2	2690973	6486377	2722529	6562572	2691135	6487554	50-60	TJw	25
203	8.9	2683429	6486796	2683745	6484690	2683745	6484690	45-65	Mwe	25
204	20.6	2693894	6486815	2694745	6485000	2690774	6485596	50-60	TJw	25
205	6.3	2687807	6486820	2689028	6486721	2687458	6488943	50-60	TJw	25
206	1.9	2689401	6487262	2689612	6488130	2689028	6486721	50-60	TJw	50
207	0.9	2690512	6487769	2690719	6487724	2690367	6488125	50-60	Q1a	25
208	3.8	2680291	6488447	2681179	6488303	2679755	6489953	45-50	Qva	35
209	31.1	2673605	6488794	2679755	6489953	2686643	6485416	65-85	Qva	5
210	0.9	2694692	6488858	2694487	6489146	2694991	6488549	55-75	TJw	40
211	8.8	2692615	6489234	2690393	6488820	2694558	6490642	55-75	TJw	33
212	11.2	2706567	6489526	2704849	6491958	2702943	6488454	55-75	TJw	70
213	1.3	2694545	6489531	2694381	6489957	2694487	6489146	55-75	TJw	30

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
214	0.8	2694601	6490253	2694558	6490642	2694381	6489957	55-75	TJw	55
215	10.5	2688527	6490310	2687458	6488943	2689813	6489639	55-75	TJw	35
216	11.1	2698828	6490803	2696732	6488367	2701980	6490677	55-75	TJw	35
217	10.2	2683246	6491228	2682505	6493962	2681180	6488310	55-75	Mcu	48
218	3.2	2679547	6491242	2679733	6490028	2680126	6492493	45-50	Mwe	35
219	1.6	2702360	6491609	2702300	6490965	2702576	6492251	55-75	TJw	45
220	1.8	2704164	6492392	2704316	6493119	2679733	6490028	55-75	TJw	45
221	4.5	2703905	6493140	2702576	6492251	2704316	6493119	55-75	TJw	70
222	5.6	2681490	6494246	2680126	6492493	2682494	6493963	55-75	TJw	35
223	7.9	2684452	6497178	2684105	6495095	2684108	6495098	50-75	TJW	25
224	3.4	2678944	6527356	2678800	6528859	2678773	6526301	55-75	TJW	80
225	35.3	2676902	6528811	2678773	6526301	2675913	6532336	50-60	TJw	80
226	5.9	2677779	6530888	2675918	6532329	2678800	6528859	40-55	Mwe	60
227	12.9	2733529	6537283	2737234	6536076	2734375	6539904	55-70	Mcu	50
228	0.8	2733931	6540278	2734282	6540230	2734092	6540591	55-70	Mcu	40
229	16.0	2729342	6540638	2733735	6541322	2729964	6545465	55-70	Mcu	60
230	17.1	2739210	6540821	2735675	6544876	2737234	6536076	55-70	Mcu	120
231	9.9	2726486	6545344	2729527	6546124	2726016	6548177	55-70	Mcu	50
232	1.3	2734471	6546174	2734175	6546444	2734288	6546011	55-70	Mcu	80
233	9.8	2724013	6547454	2725234	6548149	2721313	6549693	55-70	Mcu	80
234	3.9	2734099	6550345	2733604	6551292	2733188	6549225	55-70	Mcu	35
235	53.3	2722032	6552324	2721313	6549693	2718711	6559395	55-70	Mcu	45
236	2.5	2733933	6552753	2734056	6553620	2733625	6551815	55-70	Mcu	35
237	2.1	2734319	6554012	2734988	6553839	2734056	6553620	55-75	Jmt	40
238	9.1	2734843	6556197	2733019	6556753	2734988	6553839	55-75	Jmt	75
239	24.5	2697922	6556535	2698583	6550000	2698584	6550000	70-85	Qvh	180
240	7.4	2730718	6557983	2728834	6558528	2733019	6556753	55-70	Mcu	65
241	9.1	2726517	6558922	2728772	6559493	2728834	6558528	Coastal	Q1a	5
242	6.6	2719024	6561184	2718711	6559395	2721190	6560800	55-70	Mcu	70
243	9.5	2723162	6561374	2721190	6560800	2722731	6562631	55-70	Mcu	45
244	22.4	2728004	6564922	2726539	6569383	2728554	6561509	55-75	Jmt	65
245	17.5	2721482	6567486	2722731	6562631	2726539	6569383	55-75	Jmt	180
246	27.8	2644065	6546810	2639014	6546740	2643673	6551476	25-35	Om	15
247	10.1	2638901	6544478	2638968	6546536	2638967	6546534	25-35	Om	15
248	3.8	2636392	6543951	2635628	6542569	2637391	6545341	25-35	Kk	18
249	7.3	2634410	6542321	2633752	6541731	2635628	6542569	25-35	Kk	20
250	7.1	2627335	6542236	2625064	6542507	2629008	6541360	45-60	Mto	40
251	15.9	2631060	6540571	2629008	6541360	2633752	6541731	40-55	Mwb	30
252	28.5	2637710	6537726	2638505	6532343	2635734	6537281	25-35	Kk	8
253	13.8	2635180	6534838	2635734	6537281	2634479	6533403	40-55	Mwo	7
254	39.6	2623048	6534706	2629690	6534242	2625064	6542507	Coastal	Q1d	5
255	4.2	2631113	6532849	2632236	6531332	2629690	6534242	25-45	Mwl	20
256	5.2	2633816	6532315	2634479	6533403	2632236	6531332	25-45	Mwl	20

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
257	3.3	2621934	6528379	2621132	6529684	2622690	6526964	Coastal	eQd	60
258	18.6	2638404	6528165	2637514	6523936	2638505	6532343	Alluvium	Q1a	5
259	3.5	2623859	6525844	2622690	6526964	2624280	6524275	Coastal	eQd	15
260	14.9	2617641	6524292	2619476	6529612	2621132	6529684	Coastal	Q1d	5
261	3.4	2637223	6522813	2638068	6522071	2637514	6523936	25-45	Q1a	35
262	6.1	2625206	6522218	2624280	6524275	2626329	6520011	Coastal	Pad	45
263	6.5	2638858	6520598	2638384	6519165	2638068	6522071	Alluvium	Q1a	20
264	1.7	2638035	6518458	2638729	6518323	2638384	6519165	25-45	Q1a	20
265	1.0	2638872	6518125	2638419	6518167	2638729	6518323	Alluvium	Q1a	5
266	15.3	2628979	6516787	2626329	6520011	2633232	6514570	Alluvium	Q1a	5
267	5.8	2638971	6516637	2640280	6515299	2638419	6518167	Alluvium	Q1a	5
268	2.8	2640839	6514731	2641368	6515916	2640280	6515299	25-45	Mwc	20
269	1.2	2633739	6514325	2633232	6514570	2633873	6513767	Coastal	Pad	10
270	2.0	2632973	6512878	2633764	6513209	2632402	6512343	Coastal	Pad	10
271	21.6	2630767	6509135	2632402	6512343	2635173	6507824	Alluvium	Q1a	5
272	66.5	2639043	6507246	2635173	6507824	2641368	6515916	Alluvium	Q1a	3
273	2.3	2637736	6483726	2638070	6482813	2637443	6484555	65-85	Mtt	120
274	2.5	2637817	6481859	2638239	6480906	2638070	6482813	65-85	Mtt	120
275	2.5	2637938	6479817	2638512	6479104	2638239	6480906	70-85	Mtl	140
276	1.9	2638494	6478261	2638914	6477994	2638507	6478399	70-85	Q1d	55
277	7.9	2639868	6474864	2640374	6473092	2639395	6476888	80-95	Mtl	180
278	3.4	2672734	6473195	2673371	6472156	2671294	6472927	60-80	avl	4
279	6.4	2660329	6472877	2662576	6473457	2658733	6471155	55-75	re	35
280	4.4	2669417	6472733	2671294	6472927	2668183	6473680	Seawall	hf	4
281	8.4	2665034	6472625	2668183	6473680	2662576	6473457	55-75	re	35
282	7.0	2671806	6470539	2671029	6471083	2673371	6472156	Alluvium	Pup	6
283	5.2	2656744	6470451	2657069	6469934	2656617	6469346	55-75	re	30
284	3.9	2657961	6470381	2658733	6471155	2657069	6469934	55-75	re	35
285	20.3	2666126	6470071	2666640	6465234	2671029	6471083	60-85	avl (hf tp)	5
286	10.9	2654361	6469581	2656617	6469346	2653137	6465875	55-75	re	35
287	2.7	2640711	6469511	2641029	6468408	2640868	6470450	80-95	Mtw	180
288	1.8	2641123	6467782	2641433	6467389	2641029	6468408	65-85	Mtw	180
289	0.9	2641682	6466355	2641747	6465917	2641571	6466706	80-95	Mtp	60
290	1.1	2650203	6465719	2650343	6465266	2649794	6465760	Alluvium	Q1a	5
291	43.0	2673142	6465712	2675549	6460672	2671247	6464787	Alluvium	Pup	8
292	1.5	2667239	6464774	2667943	6464728	2666640	6465234	Alluvium	Pup	5
293	4.8	2651663	6464694	2652549	6464897	2650343	6465266	60-75	rc	35
294	11.7	2670744	6463848	2671247	6464787	2667943	6464728	Seawall	hf	5
295	3.7	2653134	6463404	2653362	6464041	2652549	6464897	65-80	Mtp	35
296	8.7	2647654	6462801	2649794	6465760	2644843	6460586	65-80	Mtp	140
297	0.6	2655283	6461460	2655103	6461599	2655506	6461255	Alluvium	Pup	10
298	1.9	2654482	6460904	2653729	6460366	2655103	6461599	Coastal	Pad	40
299	1.8	2650124	6460883	2649491	6461007	2650924	6460688	Coastal	eQd	40

Cliff id no.	Length (km)	Section Midpoint		Start of Section		End of Section		Geological Strength Index	Geological lithotype[1]	Cliff height (m)
		Easting	Northing	Easting	Northing	Easting	Northing			
300	2.3	2657324	6460877	2656243	6460769	2658098	6460243	Coastal	Pad	25
301	10.2	2678297	6460743	2677470	6459202	2675584	6459598	Alluvium	Pup	8
302	2.6	2648304	6460738	2647250	6460184	2649460	6461010	Coastal	Pad	200
303	1.1	2652269	6460669	2651742	6460539	2652619	6460455	Coastal	Pad	35
304	0.5	2675566	6460434	2675475	6460205	2675549	6460672	Alluvium	Pup	8
305	0.6	2675535	6459903	2675584	6459598	2675475	6460205	Alluvium	Pup	8
306	1.3	2647003	6459606	2646953	6459021	2647250	6460184	Coastal	Pad	140
307	1.6	2678016	6458727	2678346	6459085	2677470	6459202	Alluvium	Pup	10
308	126.4	2677361	6457160	2662651	6450675	2678346	6459085	Alluvium	Pup	10
309	5.0	2647362	6456635	2648398	6454500	2646953	6459021	Coastal	Pad	140
310	6.7	2649800	6451469	2650929	6448766	2648398	6454500	Coastal	Pad	140
311	11.1	2662506	6448647	2664590	6448649	2660453	6450270	Alluvium	Mwe	5
312	0.7	2664818	6448439	2665102	6448263	2664590	6448649	Alluvium	Pup	5
313	96.8	2660758	6446223	2658576	6458996	2662753	6445168	Alluvium	Pup	10
314	2.5	2662645	6446186	2662753	6445168	2662436	6447349	Alluvium	Pup	10
315	36.6	2666022	6446141	2662238	6447552	2665102	6448263	Alluvium	Pup	10
316	10.1	2652773	6444433	2654489	6440203	2650929	6448766	Coastal	Pad	140
317	6.1	2655632	6437422	2656752	6434739	2654489	6440203	Coastal	eQd	120

Appendix H: Description of physical setting

REPORT

AUCKLAND REGIONAL COUNCIL

Regional assessment of areas susceptible to coastal erosion Appendix H: Description of physical setting

Report prepared for:

AUCKLAND REGIONAL COUNCIL

Report prepared by:

TONKIN & TAYLOR LTD

Distribution:

AUCKLAND REGIONAL COUNCIL	2 copies
TONKIN & TAYLOR LTD (FILE)	1 copy

April 2006

Job no: 19891.100

Table of contents

Tables

Figures

Photographs

1 Physical setting

This section outlines the background information used in the assessment of the regional hazard assessment.

1.1 Topography

Topographic information is important to provide an indication of the height of coastal cliffs and, where possible the slope. For the beaches it provided information on beach slope and the dune crest elevation.

1.1.1 Cliff shores

Digital topographic data was obtained from Land Information New Zealand (LINZ). The LINZ database contains the digital data used to create the 1:50,000 topographical maps of New Zealand. The data is expressed in NZMG coordinates. Heights are expressed in metres above mean sea level (MSL). The planimetric (x,y) accuracy of the data is defined as "90% of well defined points are within ±22 m of their actual position" (LINZ, 2002). The vertical accuracy of the data is defined as "90% of well defined points are within ±5 m of their actual height and contour lines are within ±10 m of their actual position" (LINZ, 2002). Examples of topographic data used in this study are shown in Figure H 1-1.

From our examination of the cliff information, resolution of the topography of the cliff areas is not good, particularly at the toe of the cliff. The cliff toe is more likely to represent the Mean High Water Mark, rather than the physical base of the cliff. This will result in a wider cliff face and therefore flatter slopes based on the LINZ data than will be obtained from field measurements.

Future refinement of the topographic data will have a significant effect on the extent of the erosion hazard along the cliff shorelines. In particular use of LIDAR survey, that provides good quality level data even in tree covered cliff top areas which previously were difficult or dangerous to survey, will improve height and cliff slope data.

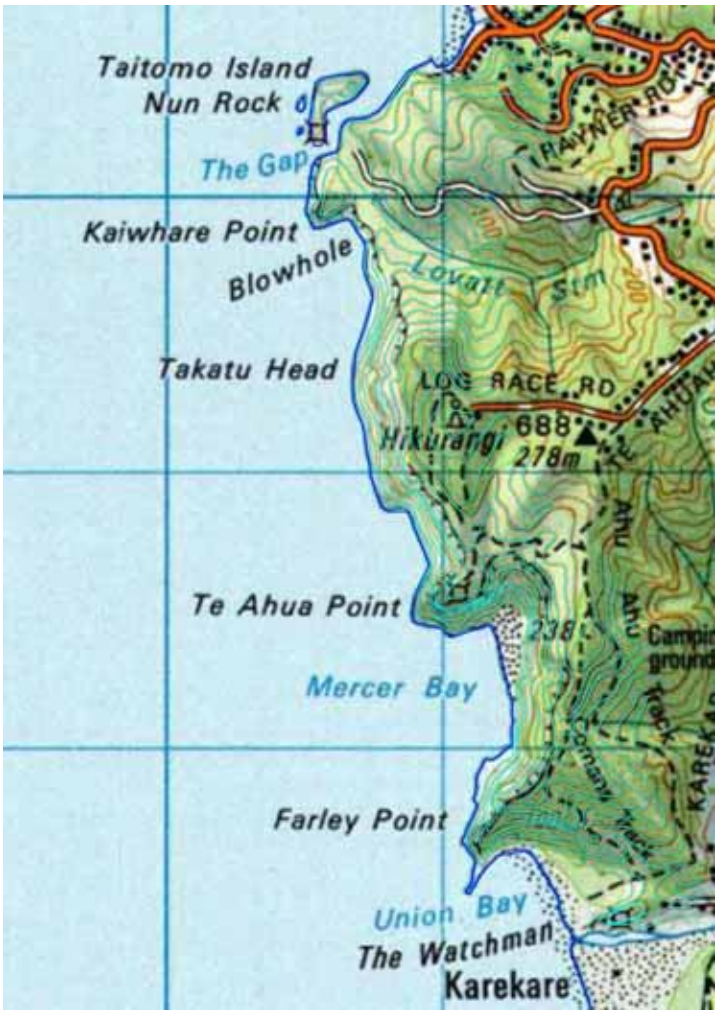


Figure H 1-1 Example of 20m topographic data from LINZ

1.1.2 Beaches

Beaches are comprised of unconsolidated alluvial and marine materials. These materials may include silts, sands, gravels and shells. Materials may be derived from:

- erosion of hinterland and adjacent shores
- inland erosion, with material being delivered to the coast via rivers and waterways
- organic materials, generally the remains of shellfish and other marine organisms
- other shorelines via longshore transport
- beach nourishment.

Beach form may vary considerably. Dominant influences beach shape may take include beach material and wave characteristics.

In general steep beaches are characterised by:

- coarse material
- low wave energy
- long period swell waves.

Flat Beaches are characterised by:

- fine material
- high wave energy
- steep, short period 'storm' waves.

Beach topography was obtained from beach profiles provided by ARC and previous reports. This provided information on the following beaches:

- Campbells' Bay
- Cheltenham
- Hatfields
- Long Bay
- Mangawhai-Pakiri
- Maraetai
- Milford
- Muriwai
- Omaha
- Onetangi
- Orere Point
- Orewa
- Piha
- Red Beach
- Takapuna.

Figure H 1-2 shows the beach areas around the Auckland region and identifies those areas with topographic or beach profile data. Table H 1-1 shows a summary of the beach profile information available from the ARC. The table includes the location, the profile reference number, the start and end date of data collection, the number of years and the number of survey records.

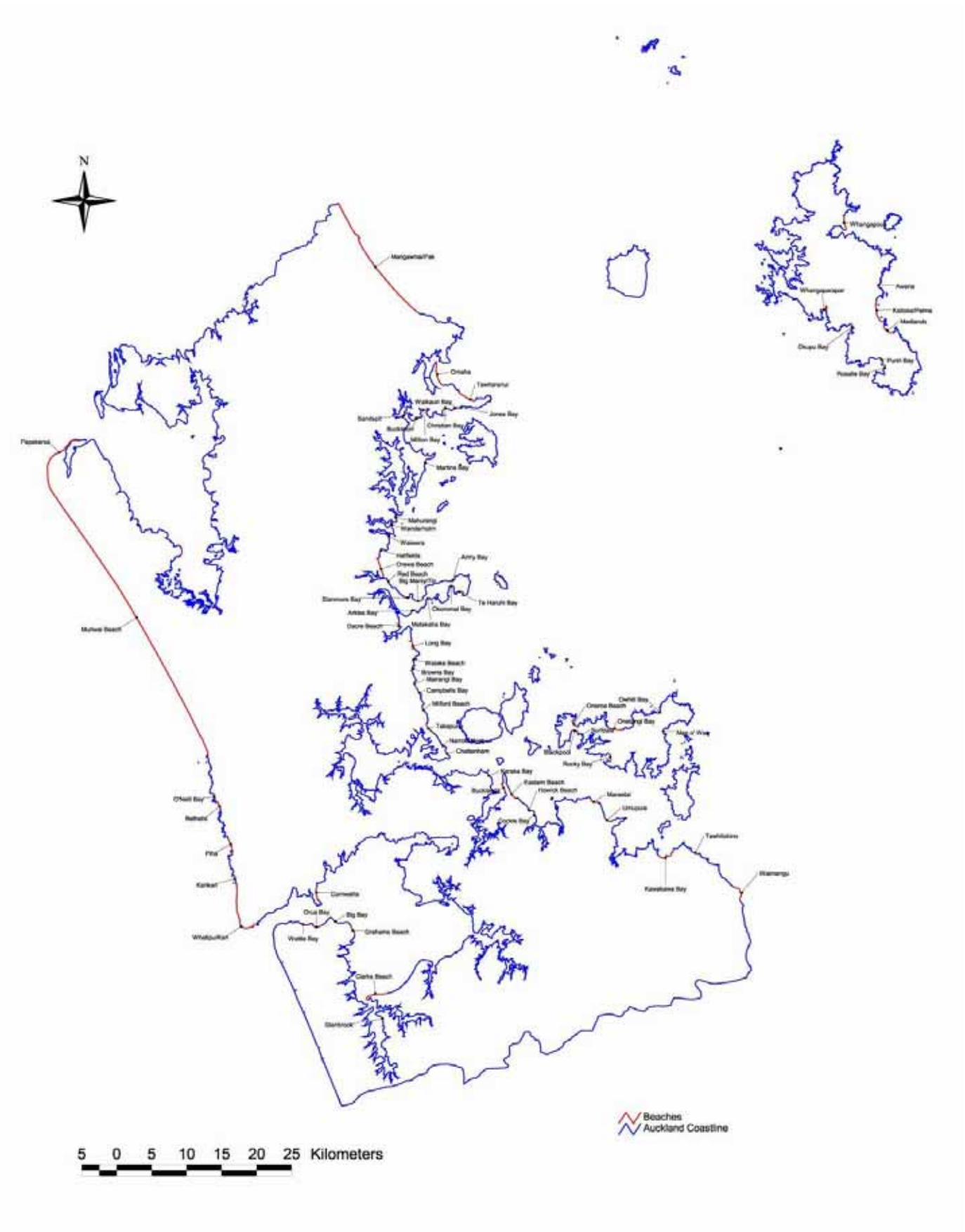


Figure H 1-2 Beach locations

Table H 1-1 Summary of available beach profile information from ARC

Beach	Profile	Data Range		No. Years	No. Records
		From	To		
Campbell's Bay	CB P1	29/06/1998	10/12/2004	6	75
	CB P2	19/10/1998	10/12/2004	6	50
Cheltenham	CHB P1	19/10/1998	10/12/2004	6	73
	CHB P2	30/11/1998	10/12/2004	6	73
	CHB P3	19/10/1998	10/12/2004	6	72
Hatfields	HB H1	01/09/1989	27/03/2002	13	35
	HB H2	01/09/1989	27/03/2002	13	35
Long Bay	LB P1	19/08/1982	12/11/2004	22	91
	LB P2	01/05/1990	10/12/2004	15	87
	LB P2A	11/06/2002	12/11/2004	2	39
	LB P3	21/05/2001	10/12/2004	4	53
	LB P4	21/05/2001	10/12/2004	4	50
Mangawhai - Pakiri	MP M1	11/01/1989	13/09/2004	16	39
	MP M2	11/01/1989	13/09/2004	16	38
	MP P1	07/09/1978	13/09/2004	26	62
	MP P2	15/03/1988	13/09/2004	17	53
	MP P3	14/08/1981	13/09/2004	23	57
	MP P4	12/09/1978	16/09/2004	26	60
	MP P5	17/10/1978	13/09/2004	26	62
	MP P6	17/10/1978	13/09/2004	26	61
	MP P7	24/10/1978	13/09/2004	26	81
	MP P8	24/10/1978	13/09/2004	26	54
	MP P9	11/01/1989	13/09/2004	16	43
	MP P2A	21/06/1990	13/09/2004	14	44
	MP P2B	08/03/1993	13/09/2004	12	36
Maraetai	MAB P1	25/06/1998	15/09/2004	6	14
	MAB P2	25/06/1998	15/09/2004	6	14
	MAB P3	20/10/1998	15/09/2004	6	13
	MAB P4	20/10/1998	15/09/2004	6	13
Milford	MB P1	29/06/1998	15/09/2004	6	15
	MB P2	29/06/1998	15/09/2004	6	15
	MB P3	29/06/1998	15/09/2004	6	15

Beach	Profile	Data Range		No. Years	No. Records
		From	To		
	MB P4	29/06/1998	15/09/2004	6	15
	MB P5	29/06/1998	15/09/2004	6	15
Muriwai	MU M3A	16/05/2000	23/11/2001	2	4
	MU M3B	16/05/2000	23/11/2001	2	4
	MU M3C	16/05/2000	22/05/2002	2	5
	MU M3D	16/05/2000	22/05/2002	2	5
	MU P1	01/04/1990	08/11/2004	15	27
	MU P2	01/04/1990	08/11/2004	15	27
	MU P3	27/02/1981	08/11/2004	24	35
	MU P4	01/04/1990	08/11/2004	15	27
Omaha	OM S2	01/02/1965	01/03/1995	30	37
	OM S3	02/02/1965	01/03/1995	30	55
	OM S4	01/08/1978	01/03/1995	17	18
	OM S5	02/02/1965	01/03/1995	30	56
	OM S6	02/02/1962	01/03/1995	33	54
	OM S7	02/02/1965	01/03/1995	30	51
Onetangi	ON S1	22/12/1998	17/12/2003	5	27
	ON S2	22/12/1998	17/12/2003	5	27
	ON S3	22/12/1998	17/12/2003	5	27
	ON S4	22/12/1998	17/12/2003	5	27
	ON S5	22/12/1998	17/12/2003	5	27
	ON S6	22/12/1998	17/12/2003	5	27
Orere Point	OP P1	25/06/1998	19/06/2001	3	7
	OP P2	25/06/1998	15/09/2004	6	13
Orewa	OW P02	22/01/1981	27/03/2002	21	38
	OW P03	05/03/1981	15/01/1994	13	34
	OW P04	28/07/1988	27/03/2002	14	33
	OW P06	28/07/1988	01/04/1998	10	28
	OW P07	28/07/1988	01/04/1998	10	25
	OW P08	28/07/1988	27/03/2002	14	28
	OW P10	28/07/1988	27/03/2002	14	27
	OW P11	28/07/1988	27/03/2002	14	23
	OW P14	15/01/1994	01/04/1998	4	22

Beach	Profile	Data Range		No. Years	No. Records
		From	To		
Piha	PB P1	01/04/1990	08/11/2004	15	25
	PB P2	15/03/1993	08/11/2004	12	20
	PB P3	15/03/1993	23/05/2003	10	17
	PB P4	16/02/1981	08/11/2004	24	33
	PB P5	15/03/1993	08/11/2004	12	20
Red Beach	RB R1	01/09/1989	27/03/2002	13	34
	RB R2	01/09/1989	27/03/2002	13	31
Takapuna	TB P1	30/06/1998	15/09/2004	6	14
	TB P2	19/10/1998	15/09/2004	6	14
	TB P3	30/06/1998	15/09/2004	6	15
Wattle Downs	WD P1	01/07/2001	01/04/2003	2	5
	WD P2	01/07/2001	20/05/2003	2	5
	WD P3	01/07/2001	01/04/2003	2	5
	WD P4	01/07/2001	01/04/2003	2	5
	WD P5	01/07/2001	01/04/2003	2	5
	WD P6	01/07/2001	01/04/2003	2	5

Shoreline trends were calculated at both the 1.8 m contour and at the 3 m contour, representing (approximately) Mean Sea Level and Mean High Water Springs, using BMAP, proprietary software developed by the US Army Corps of Engineers for analysing beach profiles (CERC, 1994). The resulting trend of erosion or accretion is shown in Table H 1-2 with the regression coefficient that shows the goodness of fit. Where the beach profile did not extend as high as 3 m the highest measurable contour was used. In the tables N.D. denotes those profiles where there was no beach due to the beach being lower than that level.

Table H 1-2 Regression trends from ARC beach profile

Beach	Profile	1.8m Contour Level			3m Contour Level		
		No. Records	Trend (m/yr)	r^2	No. Records	Trend (m/yr)	r^2
Campbell's Bay	CB P1	75	0.41	0.051	75	0.17	0.231
	CB P2	50	0.91	0.145	N.D.	N.D.	N.D.
Cheltenham	CHB P1	73	0.27	0.032	N.D.	N.D.	N.D.
	CHB P2	73	0.53	0.123	73	0.00	0.000
	CHB P3	72	0.31	0.043	N.D.	N.D.	N.D.
Hatfields	HB H1	35	-1.43	0.488	30	0.01	0.001
	HB H2	35	-0.24	0.101	21	-0.07	0.309
Long Bay	LB P1	91	-0.12	0.056	91	0.06	0.062
	LB P2	87	0.01	0.000	87	-0.05	0.029
	LB P2A	39	5.47	0.702	39	0.49	0.640
	LB P3	53	3.08	0.424	53	0.33	0.421
	LB P4	50	-6.45	0.591	50	1.70	0.791
Mangawhai - Pakiri	MP M1	39	-0.61	0.037	39	-0.17	0.025
	MP M2	38	-1.27	0.136	38	-0.96	0.215
	MP P1	62	-0.05	0.001	62	-0.31	0.032
	MP P2	53	-1.02	0.115	53	-0.86	0.143
	MP P3	57	-0.59	0.080	57	-0.70	0.211
	MP P4	60	-0.67	0.132	60	-0.32	0.048
	MP P5	62	-0.10	0.004	62	-0.14	0.012
	MP P6	61	-0.33	0.037	61	-0.33	0.065
	MP P7	81	0.51	0.107	81	0.39	0.123
	MP P8	54	0.17	0.009	54	-0.03	0.001
	MP P9	43	-0.39	0.027	43	-0.48	0.083
	MP P2A	44	-1.66	0.164	44	-1.47	0.302
	MP P2B	36	-0.88	0.069	36	-0.23	0.002
Maraetai	MAB P1	14	1.16	0.660	14***	-0.25***	0.211***
	MAB P2	14	1.25	0.673	14*	0.04*	0.012*
	MAB P3	13	0.29	0.074	13**	0.14**	0.516**
	MAB P4	13	-0.60	0.396	13	-0.06	0.061
Milford	MB P1	15	0.87	0.269	N.D.	N.D.	N.D.
	MB P2	15	0.33	0.047	N.D.	N.D.	N.D.
	MB P3	15	0.19	0.009	N.D.	N.D.	N.D.

Beach	Profile	1.8m Contour Level			3m Contour Level		
		No. Records	Trend (m/yr)	r^2	No. Records	Trend (m/yr)	r^2
	MB P4	15	-0.05	0.006	N.D.	N.D.	N.D.
	MB P5	15	0.22	0.042	N.D.	N.D.	N.D.
Muriwai	MU M3A	4	-14.84	0.958	4	-7.42	0.892
	MU M3B	4	-2.51	0.911	4	-4.24	0.852
	MU M3C	5	-3.67	0.862	5	-2.53	0.991
	MU M3D	5	-1.71	0.840	N.D.	N.D.	N.D.
	MU P1	27	0.26	0.029	27	0.39	0.167
	MU P2	27	0.26	0.017	27	0.20	0.040
	MU P3	35	-1.04	0.440	35	-1.17	0.684
	MU P4	27	-0.95	0.311	27	-0.96	0.441
Omaha	OM S2	37	-0.41	0.084	37	0.09	0.018
	OM S3	55	0.58	0.207	55	0.78	0.530
	OM S4	18	1.62	0.374	18	1.61	0.467
	OM S5	56	-0.34	0.069	57	0.11	0.012
	OM S6	54	0.57	0.185	57	1.09	0.479
	OM S7	51	2.90	0.726	51	3.07	0.860
Onetangi	ON S1	27	2.02	0.189	23	0.38	0.550
	ON S2	27	0.96	0.065	27	0.94	0.834
	ON S3	27	0.86	0.068	26	0.94	0.823
	ON S4	27	0.54	0.054	27	0.44	0.571
	ON S5	27	-0.36	0.018	26	0.75	0.656
	ON S6	27	0.12	0.002	21	0.74	0.280
Orere Point	OP P1	7	0.47	0.235	7	0.37	0.082
	OP P2	13	-0.82	0.456	13	-0.99	0.753
Orewa	OW P02	38	-0.35	0.053	N.D.	N.D.	N.D.
	OW P03	34	0.41	0.129	N.D.	N.D.	N.D.
	OW P04	33	0.63	0.287	26	0.48	0.276
	OW P06	28	0.93	0.341	24	0.42	0.092
	OW P07	25	0.96	0.508	25***	0.85***	0.606***
	OW P08	28	0.27	0.061	27***	0.21***	0.101***
	OW P10	27	0.01	0.000	21**	-0.17**	0.027**
	OW P11	23	0.03	0.001	16	0.06	0.010
	OW P14	22	-3.24	0.237	N.D.	N.D.	N.D.

Beach	Profile	1.8m Contour Level			3m Contour Level		
		No. Records	Trend (m/yr)	r^2	No. Records	Trend (m/yr)	r^2
Piha	PB P1	25	0.38	0.020	25	0.47	0.082
	PB P2	20	2.57	0.337	20	2.22	0.480
	PB P3	17	2.98	0.823	17	2.58	0.748
	PB P4	33	1.45	0.391	33	1.09	0.434
	PB P5	20	1.05	0.201	20	0.57	0.175
Red Beach	RB R1	34	0.01	0.000	21	0.37	0.670
	RB R2	31	0.03	0.002	N.D.	N.D.	N.D.
Takapuna	TB P1	14	-0.87	0.360	N.D.	N.D.	N.D.
	TB P2	14	0.12	0.006	14*	0.14*	0.264*
	TB P3	15	0.15	0.004	15***	0.32***	0.044***
Wattle Downs	WD P1	5	-5.40	0.818	5	-0.01	0.516
	WD P2	5	-0.38	0.135	5	0.00	1.000
	WD P3	5	-1.72	0.703	5***	-0.47***	0.916***
	WD P4	5	-2.04	0.724	5***	2.45***	0.652***
	WD P5	5	-1.35	0.888	5*	0.64*	0.423*
	WD P6	5	-0.25	0.299	5**	2.22**	0.699**

* 2.3m contour used instead of 3m

** 2.4m contour used instead of 3m

*** 2.5m contour used instead of 3m

Table H 1-3 shows the standard deviation of beach profile excursion at both +3m CD and +1.8 m CD together with the maximum extent of erosion that occurred at the 3 m contour before an accretion event took place. This table shows the typical range of excursion based on the measured data.

Table H 1-3 Standard deviation of beach profile excursions at + 1.8 m and +3.0 m Chart Datum

Beach	Profile	1.8 m Contour			3 m Contour			Max Extent Erosion
		1sd	2sd	3sd	1sd	2sd	3sd	
Campbell's Bay	CB P1	3.8	7.5	11.3	0.5	1.0	1.5	-2.4
	CB P2	4.5	9.0	13.6	N.D.	N.D.	N.D.	N.D.
Cheltenham	CHB P1	3.7	7.4	11.2	N.D.	N.D.	N.D.	N.D.
	CHB P2	2.5	5.0	7.5	0.9	1.7	2.6	-2.3
	CHB P3	2.6	5.3	7.9	N.D.	N.D.	N.D.	N.D.
Hatfields	HB H1	3.3	6.7	10.0	1.0	2.0	2.9	-2.4
	HB H2	2.3	4.6	6.9	0.5	1.1	1.6	-1.3
Long Bay	LB P1	3.0	6.0	9.0	0.5	1.0	1.5	-2.7
	LB P2	4.8	9.6	14.4	0.5	1.1	1.6	-2.2
	LB P2A	2.2	4.5	6.7	0.3	0.7	1.0	-0.9
	LB P3	2.9	5.7	8.6	0.5	1.0	1.4	-1.3
	LB P4	7.1	14.2	21.3	0.9	1.8	2.7	-2.8
Mangawhai - Pakiri	MP M1	12.0	23.9	35.9	3.2	6.3	9.5	-11.1
	MP M2	15.8	31.6	47.5	5.0	10.1	15.1	-20.7
	MP P1	15.7	31.4	47.1	12.5	24.9	37.4	-52.8
	MP P2	10.8	21.7	32.5	11.1	22.3	33.4	-31.8
	MP P3	11.4	22.8	34.2	7.8	15.5	23.3	-29.6
	MP P4	10.5	21.0	31.5	11.3	22.5	33.8	-29.9
	MP P5	10.3	20.6	31.0	9.8	19.6	29.4	-28.5
	MP P6	11.4	22.8	34.1	9.5	18.9	28.4	-24.2
	MP P7	9.2	18.4	27.7	6.7	13.4	20.1	-22.6
	MP P8	10.9	21.8	32.7	9.0	18.0	27.0	-24.0
	MP P9	10.3	20.5	30.8	6.8	13.6	20.4	-23.6
	MP P2A	12.3	24.6	36.9	5.9	11.8	17.7	-19.5
	MP P2B	12.3	24.7	37.0	20.4	40.8	61.2	-44.0
Maraetai	MAB P1	2.6	5.1	7.7	1.6***	3.1***	4.7***	-2.9***
	MAB P2	3.5	7.0	10.5	1.1*	2.1*	3.2*	-2.2*
	MAB P3	2.5	5.0	7.5	0.3**	0.6**	0.9**	-0.4**
	MAB P4	2.3	4.7	7.0	0.8	1.6	2.4	-1.3
Milford	MB P1	3.6	7.1	10.7	N.D.	N.D.	N.D.	N.D.
	MB P2	4.6	9.1	13.7	N.D.	N.D.	N.D.	N.D.
	MB P3	5.8	11.7	17.5	N.D.	N.D.	N.D.	N.D.
	MB P4	2.0	4.0	6.1	N.D.	N.D.	N.D.	N.D.
	MB P5	3.2	6.5	9.7	N.D.	N.D.	N.D.	N.D.
Muriwai	MU M3A	8.0	15.9	23.9	3.7	7.3	11.0	-8.1

Beach	Profile	1.8 m Contour			3 m Contour			Max Extent Erosion
		1sd	2sd	3sd	1sd	2sd	3sd	
	MU M3B	0.7	1.4	2.1	1.7	3.3	5.0	-6.0
	MU M3C	1.9	3.7	5.6	0.3	0.6	1.0	-4.8
	MU M3D	0.9	1.8	2.7	N.D.	N.D.	N.D.	N.D.
	MU P1	8.4	16.9	25.3	4.7	9.3	14.0	-11.9
	MU P2	12.6	25.1	37.7	5.3	10.6	16.0	-21.1
	MU P3	10.1	20.2	30.3	7.1	14.1	21.2	-24.0
	MU P4	8.2	16.5	24.7	5.4	10.8	16.2	-21.8
Omaha	OM S2	13.3	26.5	39.8	7.1	14.2	21.4	-16.8
	OM S3	11.3	22.5	33.8	10.7	21.5	32.2	-31.7
	OM S4	16.7	33.5	50.2	13.0	25.9	38.9	-26.8
	OM S5	11.1	22.1	33.2	12.9	25.8	38.7	-25.8
	OM S6	12.8	25.5	38.3	12.5	25.0	37.5	-27.4
	OM S7	17.2	34.3	51.5	13.0	26.0	39.0	-23.6
Onetangi	ON S1	10.8	21.6	32.5	0.8	1.5	2.3	-1.4
	ON S2	9.4	18.8	28.2	0.7	1.3	2.0	-1.2
	ON S3	7.8	15.6	23.3	1.1	2.1	3.2	-2.6
	ON S4	5.7	11.3	17.0	0.6	1.2	1.9	-1.8
	ON S5	6.1	12.2	18.3	1.2	2.4	3.5	-2.7
	ON S6	6.7	13.3	20.0	1.6	3.1	4.7	-4.7
Orere Point	OP P1	1.6	3.2	4.8	1.6	3.2	4.8	-2.2
	OP P2	3.0	6.0	9.0	2.4	4.9	7.3	-3.4
Orewa	OW P02	8.1	16.2	24.4	N.D.	N.D.	N.D.	N.D.
	OW P03	4.8	9.6	14.5	N.D.	N.D.	N.D.	N.D.
	OW P04	3.8	7.6	11.4	2.9	5.8	8.8	-8.2
	OW P06	4.7	9.3	14.0	2.0	4.0	6.0	-2.4
	OW P07	4.9	9.8	14.7	3.2***	6.4***	9.6***	-7.1***
	OW P08	5.5	11.0	16.5	2.9***	5.8***	8.7***	-4.8***
	OW P10	5.1	10.1	15.2	4.3**	8.6**	12.9**	-8.8**
	OW P11	5.0	10.0	15.1	2.3	4.5	6.8	-4.6
	OW P14	11.0	21.9	32.9	N.D.	N.D.	N.D.	N.D.
Piha	PB P1	13.4	26.8	40.2	6.8	13.6	20.3	-14.9
	PB P2	13.9	27.8	41.7	9.6	19.3	28.9	-35.2
	PB P3	8.7	17.3	26.0	6.9	13.8	20.7	-8.7
	PB P4	12.8	25.5	38.3	10.0	20.0	30.0	-26.1
	PB P5	8.4	16.8	25.2	5.6	11.2	16.8	-17.1
Red Beach	RB R1	3.3	6.7	10.0	1.1	2.2	3.3	-5.8
	RB R2	2.5	4.9	7.4	N.D.	N.D.	N.D.	N.D.
Takapuna	TB P1	3.1	6.3	9.4	N.D.	N.D.	N.D.	N.D.

Beach	Profile	1.8 m Contour			3 m Contour			Max Extent Erosion
		1sd	2sd	3sd	1sd	2sd	3sd	
	TB P2	4.9	9.8	14.7	0.9*	1.8*	2.7*	-1.4*
	TB P3	7.8	15.5	23.3	2.9***	5.8***	8.7***	-7.6***
Wattle Downs	WD P1	2.5	5.0	7.5	0.0	0.1	0.1	0.0
	WD P2	1.0	2.0	3.0	0.1	0.2	0.2	-0.2
	WD P3	1.1	2.1	3.2	0.2***	0.4***	0.6***	-0.6***
	WD P4	1.1	2.2	3.3	1.7***	3.4***	5.1***	-0.3***
	WD P5	0.6	1.2	1.7	0.6*	1.3*	1.9*	-0.5*
	WD P6	0.5	1.0	1.6	1.4**	2.7**	4.1**	-0.1**

* 2.3m contour used instead of 3m

** 2.4m contour used instead of 3m

*** 2.5m contour used instead of 3m

Additional information of beach slope and elevation above MHWS was obtained at 23 other sites not monitored by regulatory authorities during shoreline inspections carried out for this study. These sites included:

- Waimangu Point
- Umupuia Beach
- Karioitahi Beach
- Howick Beach
- Cockle Bay
- Bucklands Beach
- Karaka Bay Beach
- Cornwallis Beach
- Arkles Bay
- Matakatia Bay
- Jones Bay
- West of Anchor Bay
- Christian Bay
- Millon Bay
- Shelly Beach
- Martins Bay
- Wenderholm Beach
- Army Bay
- Sandspit
- Medlands Beach
- Awana Beach

The location of these sites is shown in Figure H 1-2. The measured beach profiles at these sites are shown in Figure H 1-3.

For those beaches with no data, expert judgement was applied based on a comparative assessment of beaches in close proximity or with a similar orientation.

1.2 Bathymetry

Bathymetric data provides information on the nearshore beach profile, the likely nearshore wave energy and the expected behaviour of beach system. It was also used to provide information to assist in establishing the long-term rate of shoreline retreat for cliff shores.

Bathymetry for the Auckland area was obtained from Land Information New Zealand (LINZ) hydrographic charts (refer Figure H 1-4 for an example). These digital charts were geo-referenced to ensure consistency and accuracy of measurements. The charts ranged in scale from 1:12,000 to 1:100,000.

Difference in tidal range and therefore local Chart Datum means that from chart to chart and even at different locations across a single chart, depths can vary compared to a set land-based level. For example chart datum at Auckland Port is given as 5.223 m below B.M. 98-21 (LINZ code DD1N), a bronze plaque set in concrete into the road at the entrance to Captain Cook Wharf. If Mean Sea-Level is assumed to be constant, Chart Datum at locations within the Auckland Region varies by more than 1.1m according to LINZ tidal predictions. The lowest datum is –0.51m (relative to Auckland) at Nagle Cove on Great Barrier Island and the highest is +0.66m at Onehunga on the Manukau Harbour.

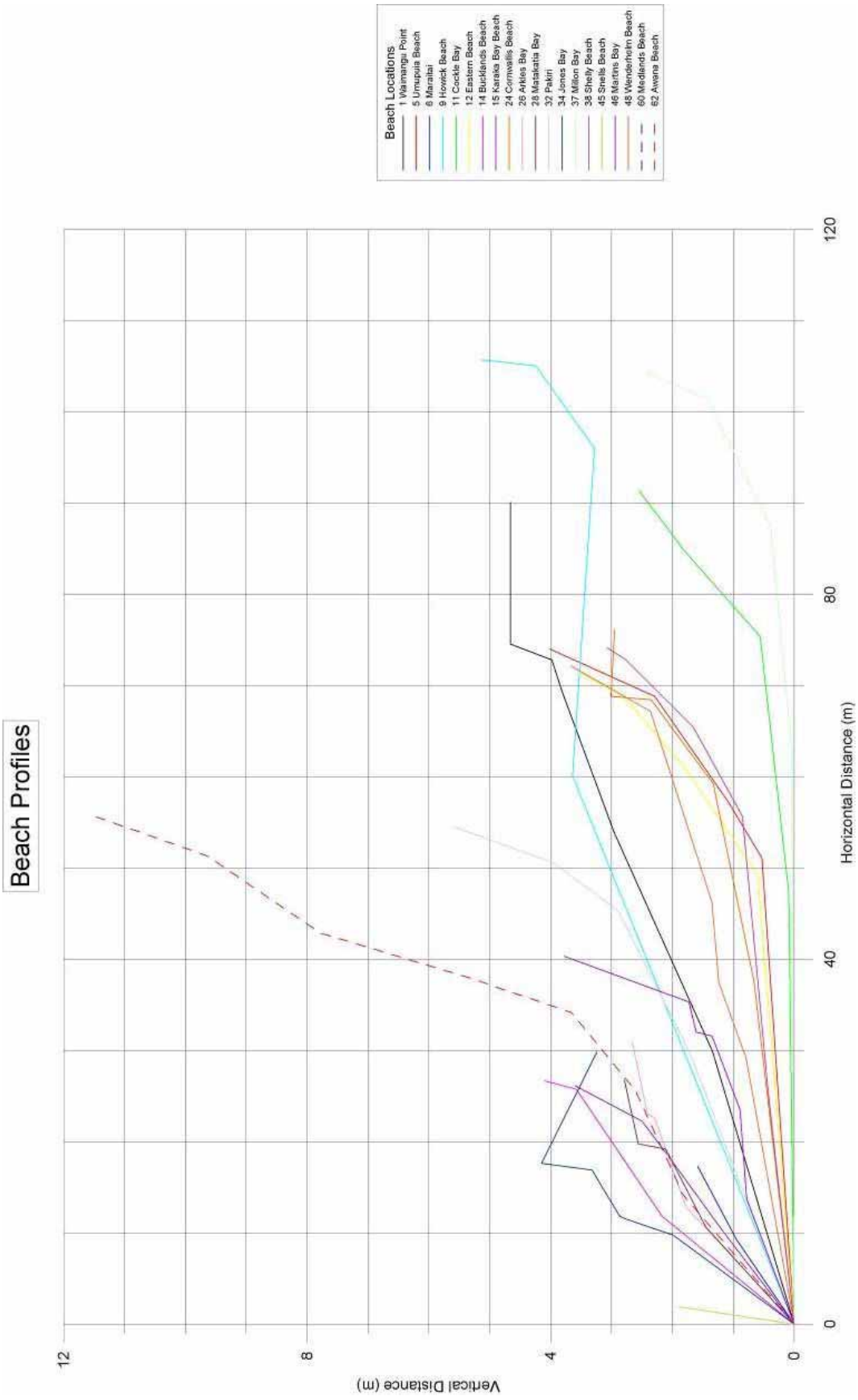


Figure H 1-3 Beach profiles

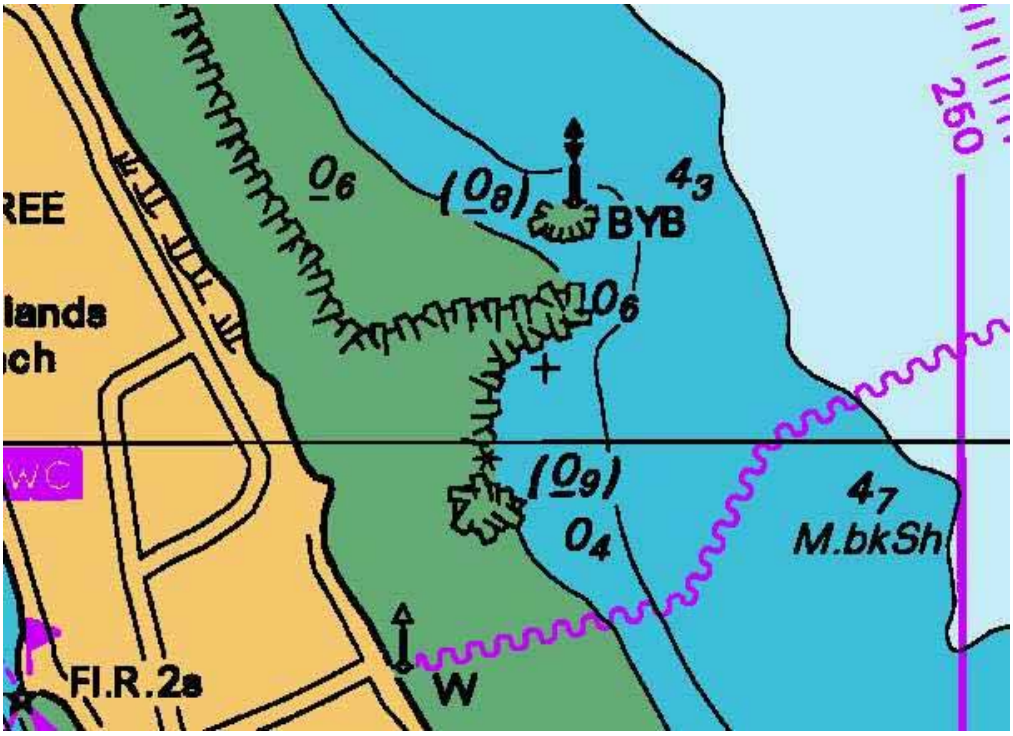


Figure H 1-4 Example of Bathymetric Information (from LINZ)

1.3 Geology

An understanding of the variations in geology was essential in the development of the erosion hazard assessment. Rock types vary in properties and this affects the rate of shoreline retreat as well as their stable angle of repose. However, this regional scale assessment is not of a sufficient scale to consider local features such as faulting and bedding that may locally control erosion processes.

From the Institute of Geological and Nuclear Sciences' (IGNS) 1:50,000 and 1:250,000 geological maps, the Auckland shoreline consists of 31 specific geological lithotypes. An example of this division is given in Figure H 1-5 where a section of east Kaipara Harbour shoreline is shown.

The geological maps show that Auckland geology can be summarised as consisting generally of old basement greywackes overlain by much younger predominantly marine sediments and sub-aerial and submarine volcanics, with some very young basaltic volcanics. Overall, the Auckland Coast can be categorised by seven dominant lithotypes:

- basement rocks
- volcanic rocks
- Waitemata Group rock
- displaced rock
- poorly consolidated alluvium and marine sediments
- fixed dune sands
- unconsolidated coastal sediments.

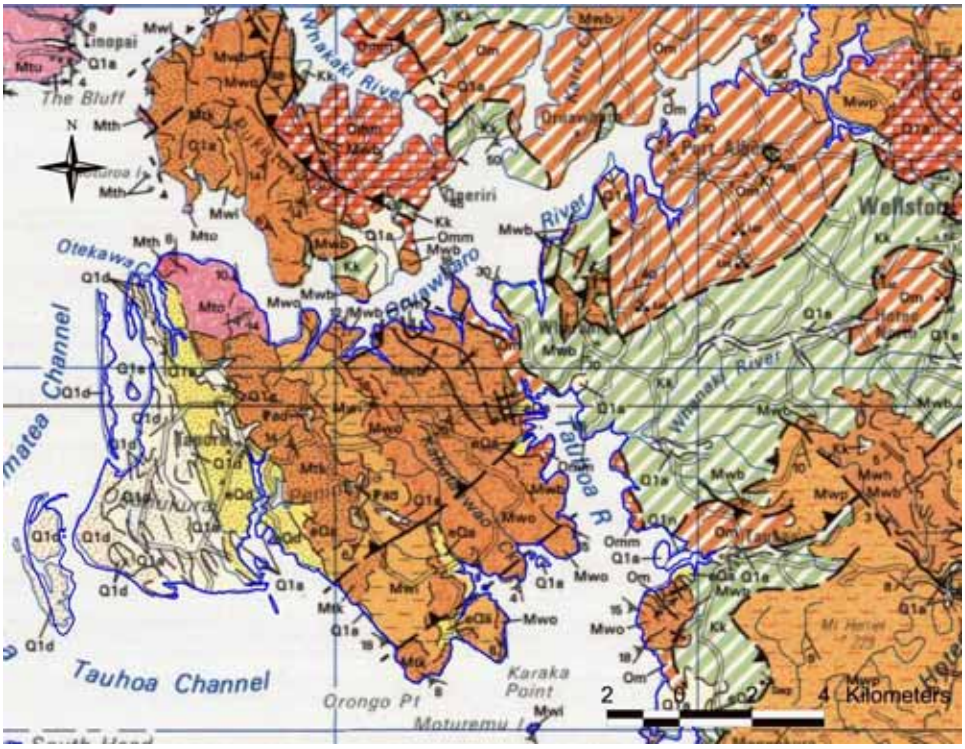


Figure H 1-5 Extract from geological maps showing variable conditions

The following sections, based on works by Applied Geology Associates (1980) and Edbrooke (2001), describe each of these dominant lithotypes.

1.3.1 Basement rocks

Basement rocks consist of Greywacke and Argillites formed during the Jurassic and Triassic periods (Photograph H 1). These rocks comprise strong hard (indurated) sandstone ("greywacke") inter-bedded fissile mudstone ("argillite). The rock mass is typically tightly jointed with numerous shattered and sheer zones. They are relatively resistant to erosion, but weather to soft clay at depths of up to 20m. These rocks outcrop at locations along Auckland's east coast including the Western Firth of Thames, Waiheke Island and Tawharanui Peninsula.

1.3.2 Volcanic rocks

Volcanic rocks of the Auckland Region have been produced during three distinct periods of volcanic activity.

- The Waitakere Ranges were formed during the Early Miocene by volcanoes off Auckland's West Coast (Photograph H 2). These ranges are comprised of lava flows, volcanic agglomerates and ash deposits. Although of similar age to the Waitemata Group rocks, these volcanic rocks are much more resistant to erosion and their topography is very steep.
- Volcanic Rocks of the South Auckland Volcanic Field formed between 600,000 and 1.6 million years BP. The field, centred at Pukekohe, consists of at least 97 volcanic centres. These centres are a mixture of small cones, explosion craters and lava sheets. Resulting basalt lava flows and tuff rings are deeply

weathered in places, although the extent varies considerably from location to location.

- The Auckland Volcanic Field began 140,000 years BP and has continued until present. The latest volcano, Rangitoto, has been dormant approximately 600 years ago. The field covers much of central Auckland and includes at least 48 eruption centres. These eruptions have produced scoria cones, tuff rings, ash deposits and basaltic lava flows. The volcanic basalt is very hard and predominantly unweathered. However, scoria is poorly consolidated and slumping frequently occurs when oversteepened. Tuff and volcanic ash are reasonably soft materials capable of slumping and reasonably prone to erosion.

1.3.3 Waitemata group rock

Waitemata group rocks were deposited in the early Miocene Period (between 16 and 24 million years ago). Sediment deposition in the Waitemata Basin produced inter-bedded sandstone and siltstone. These rocks are easily recognised around the central Auckland shoreline by their well-defined shore platforms and their distinctive erosion characteristics (Photograph H 3). The thinly bedded siltstone is much more susceptible to weathering and erodes back at a much faster rate than the more massively bedded sandstone. This tends to lead to differentially eroded cliffs prone to large block failures. Weathering occurs to a depth of 4 – 5m and residual soils are typically soft silty clays prone to failure when saturated. Oversteepening and failure of residual soils due to erosion of underlying rock is common around the Auckland Region.

While generally flat-lying to moderately dipping, the East Coast Bays Formation may be extremely disrupted where intruded by channel-type deposits of coarse volcaniclastic sand stone and grits (Parnell Grit) originated from the Waitakere Volcanoes. Pakiri Formation is dominated by 10-30 m thick bands of graded medium-to coarse grained sandstones alternating with thinner intervals of laminated siltstone and fine-grained sandstone (Photograph H 4).

1.3.4 Displaced rocks

These rocks, known as Northern Allochthon, originated to the north-east of Auckland where they were 'peeled' off the Pacific plate as it moved beneath New Zealand (Rait, 2000). Sheets of these rocks were then moved southward through a combination of tectonic thrust and gravity slip. These rocks now extend as far south as Silverdale and the Kaipara Flats. Rocks in these areas are of mixed sedimentary lithology. They include mudstone, sandstone, shale and limestone. They are typically soft, intensely sheared and closely fractured (Photograph H 5). All Allochthon sedimentary rock weathers rapidly to depths of about 10m. This weathered material is a soft to very soft, high plasticity clay. It generally has very low shear strength and is prone to failure, even on fairly gentle slopes.

1.3.5 Poorly consolidated alluvium and marine sediments

Poorly consolidated alluvium and coastal sediments occur predominantly around the three major Auckland harbours; Manukau, Waitemata and Kaipara. These deposits were sourced primarily from eroding Basement and Waitemata rocks with additional volcanic ash and organic material (Applied Geology Associates, 1980). They were formed by deposition of eroded material in estuarine environments during past sea level fluctuations. These materials are very weak and susceptible to failure, particularly when saturated or unconfined (Photograph H 6).

1.3.6 Fixed dune sands

Fixed dune sands exist in a variety of forms and exhibit a range of geological properties (Photograph H 7). The oldest coastal sand deposits were laid down along Auckland's west coast in the Late Pliocene and now form the Awhitu Peninsula and South Kaipara Barrier. These deposits have become moderately consolidated and now form coastal cliffs ranging in height to more than 200 m. Weathering over time has helped to stabilise these dunes with ferro-magnesium and iron oxide minerals binding sand particles. Younger dune and beach deposits overly these older forms. Due to their weakly consolidated form, these materials tend to have high rates of retreat.

1.3.7 Unconsolidated coastal sediments

These materials are constantly reworked and reshaped by winds, waves and currents. Generally referred to as beaches, these materials may be perched on more competent underlying structures or may exist to great depths. Sediments vary from region to region and range in size from fine silts and clays to large cobbles and boulders (Photograph H 8).

Typical sediment groupings are further discussed in Section 3.5. These materials have the ability to change form depending on climatic factors and are the only geological type that may recover from erosion

Photograph H 1 Waipapa Group rock

Photograph H 2 Waitakere Cliff

Photograph H 3 East Coast Bays formation, Castor Bay

Photograph H 4. Pakiri formation.

Photograph H 5 Whangai Formation, Northern Allochthon, Snells Beach

Photograph H 6 Tauranga Group materials

Photograph H 7 Awhitu fixed dune sands

Photograph H 8 Dunes at Bethells Beach

1.4 Sediments

Information on sediment properties such as grain size and mineralogy can assist in describing beach systems. Parameters that affect the size of sediment present on a shoreline include aspect, energy regime and shoreline type. The history of sediment transport to the coast and originating rock type determine sediment mineralogy. Sediments are generally relatively consistent throughout a particular region and thus can be broadly described by geographical location. Sediment characteristics were obtained both from existing information sources and by field investigation carried out for this study where an additional 20 beach sediment samples were collected during the present study.

Figure H 1-2shows the location of the beaches where site-specific information was obtained. Table H 1-4 shows the results of the sediment sample analysis and includes data from previous shoreline investigations (Klinac, 2002) and investigations carried out for this study.

1.4.1 Auckland West Coast

The Auckland West Coast includes the western Awhitu Peninsula, Waitakere Coast and South Kaipara Barrier. Sediments along this shoreline are not locally derived. They are generally thought to originate from mechanical breakdown of igneous rocks in the Taranaki region and then transported along the coast by strong longshore currents. It is also possible that these sediments may be derived from erosion of extensive ash deposits in the Central Volcanic Zone.

Table H 1-4 Beach sediment properties

Beach	Source	$d_{(15.9)}$ (mm)	$d_{(50)}$ (mm)	$d_{(84.1)}$ (mm)	Geometric Mean (mm)	Geometric SD
Arkles Bay	T&T	0.17	0.28	1.90	0.57	0.30
Browns Bay	Klinac	0.16	0.28	1.30	0.46	0.35
Campbells Bay	Klinac	0.30	0.41	0.91	0.52	0.57
Cheltenham Beach	Klinac	0.51	1.00	3.34	1.30	0.39
Devonport Beach	Klinac	0.61	1.68	6.47	1.99	0.31
Eastern Beach	T&T	0.30	0.71	3.00	0.95	0.32
Howick	T&T	0.28	0.36	0.53	0.38	0.73
Jones Bay	T&T	27.00	36.00	46.00	35.24	0.77
Journeys End	T&T	0.13	0.17	0.22	0.17	0.75
Karaka Bay	T&T	0.24	0.37	0.63	0.39	0.62
Karaka Bay	Klinac	0.38	2.17	6.53	1.58	0.24
Karioitahi	T&T	0.10	0.13	0.16	0.13	0.79
Kohimarama Beach	Klinac	0.38	2.17	6.53	1.58	0.24
Long Bay	Klinac	0.14	0.20	0.35	0.22	0.64
Maori Bay	T&T	0.11	0.15	0.18	0.14	0.78

Beach	Source	$d_{(15.9)}$ (mm)	$d_{(50)}$ (mm)	$d_{(84.1)}$ (mm)	Geometric Mean (mm)	Geometric SD
Maraitai	T&T	0.43	1.05	2.80	1.09	0.39
Martins Bay	T&T	0.14	0.18	0.23	0.18	0.78
Matakatia	T&T	0.25	0.79	5.75	1.20	0.21
Milford Beach	Klinac	0.16	0.27	1.57	0.50	0.32
Millon Bay	T&T	0.20	0.25	0.30	0.24	0.82
Mission Bay	Klinac	0.64	0.87	4.42	1.68	0.38
Okahu Bay	Klinac	0.43	1.30	6.05	1.61	0.27
Shelly Beach	T&T	0.26	0.70	4.90	1.13	0.23
Snells Beach	T&T	0.19	0.26	0.38	0.27	0.71
St Heliers Beach	Klinac	0.52	1.57	5.84	1.74	0.30
Takapuna Beach	Klinac	0.20	1.27	2.93	0.76	0.26
Torpedo Bay	Klinac	0.23	0.38	13.98	1.81	0.13
Umupuia	T&T	0.23	0.30	1.45	0.58	0.40
Waimangu Pt	T&T	10.40	11.40	12.50	11.40	0.91
Waiti Bay	T&T	0.22	1.35	5.20	1.07	0.21
Wenderholm	T&T	0.13	0.17	0.20	0.16	0.82
West of Anchor Bay	T&T	0.19	0.25	0.31	0.24	0.78
West of Goat Island	T&T	0.64	0.88	1.40	0.95	0.68

Sediments along the west coast tend to be well sorted and vary only slightly in size. Samples taken from Karioitahi Beach and Maori Bay indicate very fine material with a mean diameter of ~0.13mm. Sediments are comprised of a mixture of quartz, feldspar and mafic minerals, although the exact composition varies across and along the shoreline.

1.4.2 Outer Hauraki Gulf

Sediments of the Outer Hauraki Gulf tend to be clean, well sorted, fine to medium sands. Composition is fairly consistent, with feldspar being the primary material (55-76%), quartz materials making up 19-33% and mafic materials accounting for less than 2%. Size varies throughout the region with more exposed beaches such as Goat Island Beach having coarser sands of 0.23 to 0.43 mm and more sheltered regions around Omaha having finer sand of 0.13 to 0.22mm. These sandy sediments extend offshore to depths of 60m before being covered by a layer of mud. Schofield (1975) suggested that these highly feldspathic sands arrived in this area when the Waikato River flowed into the Firth of Thames during the last glaciation. At this time sea level was 60m lower than present levels. Thus, outer Hauraki Gulf sediments are derived predominantly from rock formations in the central North Island.

1.4.3 Inner Hauraki Gulf

Tidal flats are dominant in these much more sheltered regions of shoreline. Sand beaches still occur regularly, particularly in the north. However, these beaches tend to be perched on top of the flats. The beaches also consist either of finer sand than found on the outer Hauraki Gulf beaches or comprise predominantly of shell (calcium carbonate).

The mineral sands in these more protected areas are angular and a grey-tan colour. In general the mineralogy of these materials closely resembles the Waitemata Group rocks that dominate the adjacent hinterland (Schofield, 1970). It is therefore reasoned that the main sediment sources for these beaches include nearshore shellfish beds and erosion from local cliff and streamed catchments.

1.4.4 Western Firth of Thames

Further south, into the Firth of Thames, muds and clays tend to dominate offshore areas with extensive regions of intertidal mudflats also occurring. Overlying these finer bases, gravel and coarse shell beaches tend to dominate over sand. These sub-rounded gravels have average sizes of 100-200 mm and are derived from the local Greywacke rock.

1.4.5 Auckland harbours

The Auckland harbours consist of the Manukau, Waitemata and Kaipara. These harbours all exhibit similar properties with high and low energy regimes occurring depending on wave and/or currents. Sediment sizes are controlled according to the regimes with mud flats and low muddy sand beaches occurring in low energy areas and medium to coarse sands accumulating in higher energy zones. Gregory and Thompson (1973) conducted a study of recent sediments of the Waitemata Harbour and identified the following:

- Low energy: Consist of mangrove swamps, lagoons, tidal creeks and broad inter-tidal mudflats. Sediments are generally silts and clays less than 63 microns.
- High Energy: Clean, well sorted sands of varying shell content are typical of higher wave environments with less well sorted sandy sediments occurring in channels swept by tidal currents. Sediment collected from Shelly Beach inside the Kaipara Harbour had a mean grain size of 0.25mm.
- That there is a net accumulation of sediments within the harbour, eventually leading to infilling and greater expanses of inter-tidal mudflats.

These statements appear valid for all harbours although mineralogy differs depending on sediment derivation. The main sediment sources in all harbours are; tidal and wave driven flows contributing coastal materials (i.e. shells from adjacent shell fish beds), river systems delivering alluvial materials and erosion of the adjacent shoreline.

1.5 Wind

The National Institute of Water and Atmospheric Research (NIWA) maintains a number of weather stations throughout the Auckland Region. These stations measure and record a range of meteorological data including temperature, rainfall, atmospheric pressure and wind speed and direction. Wind measurements are made by an anemometer, typically situated 5 to 10m above ground level.

In general, winds on Auckland's West Coast are strong and predominantly from a northwest to south direction. However, strong winds (>20 knots) do occur periodically from all directions. Winds around the central and southern Auckland region are much lighter with most wind speeds being less than 10 knots. Predominant wind direction is still from a westerly quarter with almost all strong winds coming from this direction. The Eastern Auckland Region, including the northeast coast and Hauraki Gulf Islands, is subject to stronger winds more often than the central region. Although winds from the westerly quarter are still predominant, strong winds from the east and northeast are also frequent.

Extreme winds affect all areas in the Auckland region. Intense low-pressure systems that travel along the 'roaring forties' latitudes generate extreme winds from the SW to NW on Auckland's West Coast. The occurrence of sub-tropical and mid-latitude depressions to the northeast of New Zealand can produce winds of up to 80 knots (41m/s) on Auckland's East Coast. The New Zealand Standard (AS/NZ 1170.2:2002), gives the 100 year design 3-second wind speed in the Auckland Region at 41m/s (Table H 1-5). These extreme wind speeds were converted to design duration wind speeds and used in areas of limited data to calculate maximum wave heights.

Table H 1-5 3 second wind gusts (from AS/NZS 1170.2:2002)

Velocity (return period)	**3 second gusts for Region A6 (Includes Auckland) (m/s)[1]**
V_5	32
V_{10}	34
V_{20}	37
V_{50}	39
V_{100}	41

Note: The calculated value are rounded to the nearest 1m/s

1.6 Wave Regime

New Zealand's exposed position means it is an area of intense sea and swell activity. It is subject to large swells generated in the Tasman Sea and Southern Ocean, local seas derived from strong 'roaring forties' winds and cyclonic waves produced by extra-tropical storms. A 20 year, mean significant wave height has been developed by NIWA based on wave hindcasting from the global Wind Atmospheric Model (WAM) and is presented in Figure H 1-6. This figure provides a general impression of the variation in wave height around New Zealand.

The Auckland Shoreline is subject to three different wave regimes; West Coast, East Coast and harbour and estuarine environments.

1.6.1 West Coast

Auckland's West Coast is exposed to short period wind waves from the south to the northwest and longer period swell waves, generally derived from intense low-pressure systems passing beneath Tasmania. NIWA's 20-year wave climate describes the west coast wave climate as being high energy, with a mean significant wave height of 2-3m and period of 6-8 seconds. The upper-limit significant wave height, derived from wind hindcasts (MfE, 2004), is given as 7.5m. This wave height is likely to not represent the most extreme wave heights as the WAM model typically under predicts extreme wave heights.

Information collected from the Maui Oil Platform off the South Taranaki shoreline between 1977 and 1981 indicate significant waves of greater than 4m occur more than 10% of the time. The highest significant wave height recorded was 10.5m and the highest individual wave, 19.5m. These heights are more likely to represent extreme storm conditions in deep water off Auckland's west coast.

1.6.2 East Coast

The East Coast of the Auckland Region is much more sheltered from the prevailing winds and swell than the west coast. However, locally generated seas and extra-tropical cyclone swells occur from the north to southeast. These systems, while infrequent, can be very intense and may generate waves well in excess of typical conditions.

NIWA classifies this region of shoreline as being a 'low-energy lee shore' environment. Based on NIWA's wave hindcast model, the 20-year mean wave height ranges from 1-2m with and period of 5-7 seconds. The upper-limit significant wave height from the hindcast is given as 6.5m (Gorman et al, 2003). Similarly to the west coast, this height is not representative of extreme conditions, but represents a reasonable storm event.

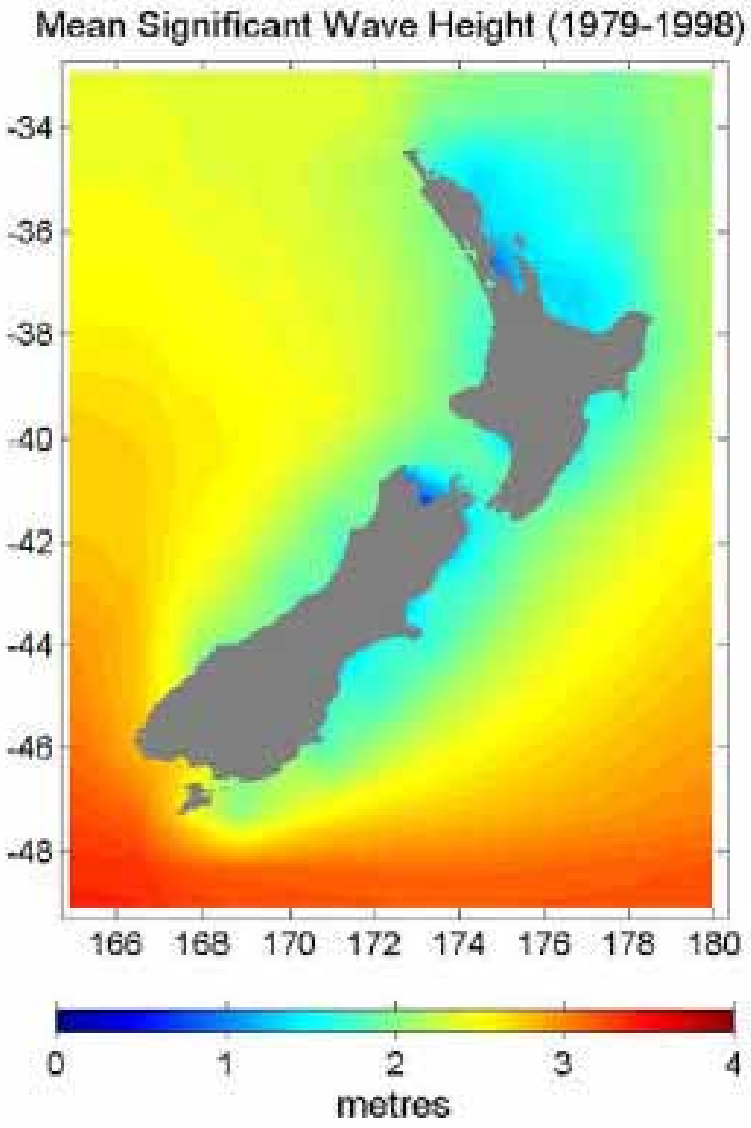


Figure H 1-6 New Zealand mean significant wave heights, 1979 – 1998.

Source MfE, 2004

Reliable wave data has been collected from buoys situated in the Mokohinau Islands, Mangawhai Heads and at Tiritiri Island. Based on the Tiritiri Island data, Murphy (1997) concluded that the mean deepwater significant wave height (H_s) for the inner Hauraki Gulf is 0.78 m with a mean period of 3.16 seconds. The largest waves appear to approach from the northeast to east.

Wave data from the Mokohinau Islands gives a maximum significant wave height of 7.16m. A significant wave height of 5.35m was recorded at the Mangawhai Buoy and 3.33 m at Tiritiri Island during Cyclone Drena in February, 1997.

Actual near-shore wave heights at east coast locations are likely to be significantly smaller than the buoy readings due to energy losses during wave refraction, diffraction and shoaling.

1.6.3 Harbour and estuarine shoreline

Almost all waves inside these sheltered environments are generated by local winds blowing within the harbours themselves. Due to this, the distance over which wind can blow limits wave height. These waves are termed to be distance or 'fetch' limited. Due to the shallow nature of most harbours within the Auckland Region, tides greatly influence maximum wave heights obtainable. During low tide, vast expanses of mudflats are exposed and effective fetch is significantly reduced. Typically wave heights will be either depth, fetch or duration limited, or be affected by a combination of these three factors. At the shoreline, wave heights are typically affected by water depth, with the wave height at the shore typically not exceeding 0.6 times the water depth. Site specific assessment by a qualified and experienced coastal expert is required to quantify nearshore wave heights for design or assessment purposes.

1.7 Water levels

Water levels around the Auckland Region include phenomena that are both cyclic and event derived. Astronomical tides that result from the influence of the sun and moon on the earth are cyclic and constant while the effects of storm surge, climate cycles and nearshore processes are variable and change from year to year. The components of the water level affecting the nearshore are presented in Figure H 1-7.

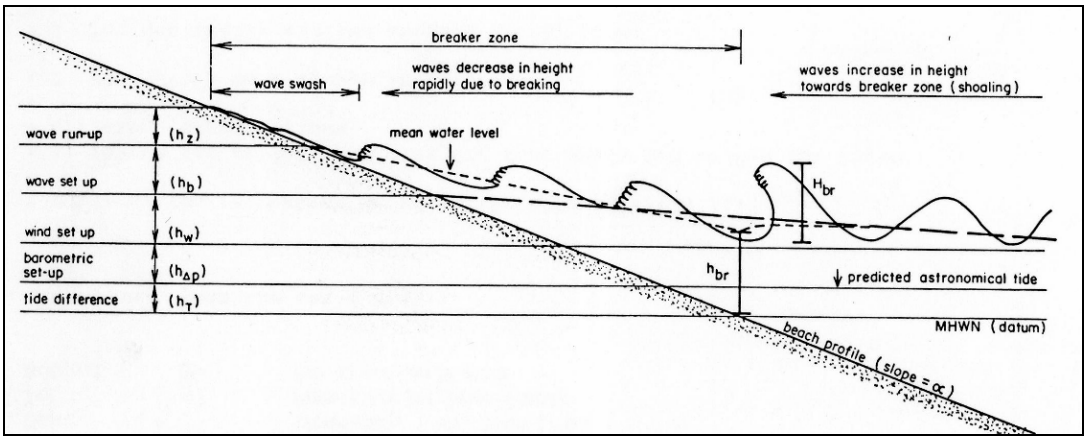


Figure H 1-7 Water level components contributing to storm surge and coastal inundation. Source: Frisbey and Goldberg, 1981

1.7.1 Tides

Astronomical tides on the New Zealand's west coast follow a semi-diurnal pattern and are generally in the meso-tidal range. Tides on the New Zealand's east coast are also meso-tidal and semi-diurnal, but are more significantly influenced by monthly lunar (perogean-appogean) than bimonthly solar (spring-neap) cycles. Table H 1-6 gives astronomical tide information for sites relating to Auckland's east and west coast. These levels are not the traditional "nautical" levels; rather they represent levels more characteristic of actual tidal levels. This is achieved by the inclusion of the lunar N_2 tidal constituent. By inclusion of this extra constituent, the MHWS levels are elevated from the "nautical" levels. They therefore represent a more "pragmatic" upper tide level that is exceeded by 10 to 12% of high tides. A range of

organizations have used these base measurements to model tidal levels around the Auckland Region with varying degrees of accuracy.

Table H 1-6 Astronomical tide variability within the Auckland Region (LINZ, 2004)

Standard Port	MHWS	MHWN	MLWN	MLWS	Spring Range	Neap Range	MSL
Auckland	3.31	2.75	0.88	0.32	2.99	1.87	1.82
Marsden Pt	2.8	2.4	0.91	0.43	2.37	1.49	1.62
Onehunga	4.22	3.53	1.35	0.62	3.6	2.18	2.42
Taranaki	3.59	2.89	1.06	0.36	3.23	1.83	1.98

Note: Table includes the N2 tidal constituent

1.7.2 Storm surge

Storm surge results from the combination of barometric set-up from low atmospheric pressure and wind stress from winds blowing onshore or up-harbour that super elevates the water level above the predicted tide. Water levels elevated under storm surge conditions not only pose an inundations hazard, but also allow larger waves to advance further into the backshore increasing the potential for erosion and damage.

Previous studies of storm surge around the New Zealand shoreline have concluded that storm surge appears to have an upper limit of approximately 1.0 m (Hay, 1991; Heath, 1979; Bell et. al, 2000), with a level of 0.9 m likely to represent a 100-year type surge event.

1.8 Currents

A range of driving mechanisms generates currents. These include temperature variations, tidal effects, wind and waves. Some currents are of very low velocity and have no noticeable influence on coastal change, while others, such as tidal flows in and out of estuaries and harbours, are primary drivers of morphological alterations.

On the Auckland shoreline, persistent regional currents exist on both the east and west coasts. However, these currents are weak and generally not the dominant longshore current close to shore. Of more significance are wind and wave driven nearshore currents. These may act in a longshore or cross-shore direction. These currents are capable of transporting significant quantities of sediments. Volumes transported vary depending on energy regimes, shoreline morphology and sediment properties and availability.

Rising and falling tides will often generate longshore tidal streams. These streams generally have relatively slow velocities and often only add to the competency of other currents to transport sediment. Tidal currents have much more significance in harbour and estuarine environments. Currents moving through narrow channels and entranceways such as at the Manukau Heads, can obtain velocities of up to 3.6 knots. This is easily sufficient to entrain and transport sediment.

1.9 Shoreline change

Throughout Auckland's history the position of its shoreline has altered considerably. This has been related to historic sea-level fluctuations, tectonic movements, natural coastal erosion and accretion and human induced modifications. Shoreline position is generally specified as being equal to the Mean High Water-Spring (MHWS) line.

During the past 2 million years the globe has experienced a series of temperature fluctuations. These have a typical oscillation of 20,000 to 40,000 years. During these fluctuations, sea-level varied by up to 150m. Our current water level is relatively high and during the last cooler period (ice-age), when sea-level was considerably lower, the Auckland coast lay considerably further offshore than present. Sea level rose rapidly from 10,000 to around 6,500 B.P. Over the last 6,500 years sea-level has been relatively stable (+/- 2 m) and the current coastal morphology and much of our beach and spit systems became established.

New Zealand lies on an active, convergent plate boundary. To the east of Auckland, the Pacific Plate is subducting beneath the Indo-Australian Plate. This has led to increased volcanism in the Auckland area and historic land and shoreline movements. However, Auckland is currently one of New Zealand's least tectonically active regions and although many areas of New Zealand are currently experiencing continual long-term vertical movement, Auckland is relatively static.

Natural shoreline accretion and erosion is a function of local energy regime and sediment supply. Energy regime heavily influences the shape a beach will take. This means that over time material may be added or removed from the visible beach temporarily altering shoreline position. Changes to the sediment supply of an area offset the sediment budget and lead to more permanent changes in shoreline position.

Human activities along the shoreline, which may alter shoreline position, include, reclamations, sediment removal, sediment entrapment, shoreline protection structures and beach nourishment. These activities are carried out for a variety of reasons and almost always result in a change to existing morphological processes.

Overall, long-term, horizontal shoreline movement is occurring at almost all coastal locations. Coastal cliffs are in a constant state of weathering, erosion and therefore retreat. While the direction of shoreline movement, shoreward or landward, may be qualitatively assessed, quantifying this change is very difficult.

A significant number of previous reports have evaluated shoreline change at specific locations using a range of assessment techniques, including short-term site specific measurement (beach and cliff profiling), aerial photographic assessment (often with un-rectified images), comparison of cadastral boundary surveys, examination of coastal tree position and expert judgement. Significant errors can occur with all these methods and caution must be applied when evaluating rates of change.

Improvements in accuracy and spatial coverage of data collection techniques (such as LIDAR) and increasing length of record for beach profile measurements will improve the levels of accuracy of shoreline change measurements.

1.10 Climate change

Climatic impacts have the potential to affect both short-term and long-term coastal processes and trends, potentially resulting in increased erosion. The following sections outline the various relevant climatic effects.

1.10.1 Sea level

Sea level variations occur both due to existing climatic cycles (such as El Nino/La Nina and the Inter-decadal Pacific Oscillation) as well as from ongoing longer-term trends associated with global warming.

Analysis of annual mean sea levels recorded at the Port of Auckland since 1899 (Figure H 1-8) indicate a linear rise of 1.3 mm/yr. Mean sea levels have a recorded inter-annual variation of ±150 mm and Inter-decadal variation between 100 and 150 mm (Bell et al., 2000).

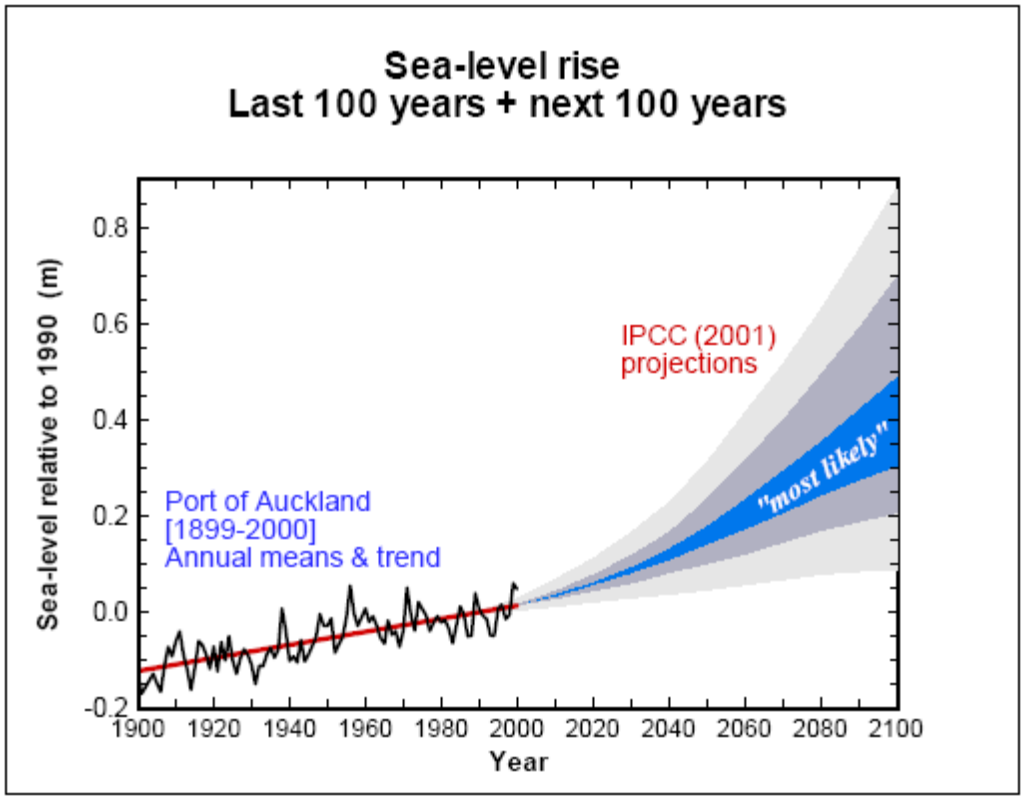


Figure H 1-8 Historic sea-level rise at the Port of Auckland and predicted future trends. Source: MfE, 2004

Sea Level Rise (SLR) estimates due to global warming have been taken from the latest findings of the Intergovernmental Panel on Climate Change (IPCC). According to the IPCC climate has changed over the past century. Global mean surface air temperature has increased between 0.3 to 0.6 °C and global sea level has risen between 0.10 m to 0.25 m (IPCC, 2001).

During the next century the IPCC predict best estimates of global mean surface temperature and global sea level change relative to 1990, are an increase of approximately 2 °C and 0.50 m respectively by the year 2100 (IPCC, 2001). Interim sea level rise to 2050 has been estimated to be 0.20 m.

1.10.2 Rainfall

Rainfall is a direct contributor to coastal change through stream and river processes, stormwater discharge and by its effect on cliff edge erosion. The frequency of cliff erosion problems, such as slumps and slips increases significantly during periods of heavy rainfall.

Predicted climate change effects to 2080 (MfE, 2004) include:

- Possibility of slightly lower mean rainfalls along the east coast and slightly higher mean rainfalls on the west coast.
- Heavier and/or more frequent extreme rainfalls, especially where mean rainfall increases are predicted.

1.10.3 El Niño Southern Oscillation

The El Niño-Southern Oscillation (ENSO) represents an irregular, but coherent set of fluctuations across the Pacific and Indian Oceans. The extremes of ENSO are known as El Niño and La Niña. The fluctuation between these two extremes result in changes in weather patterns that can affect coastal processes. It is known that ENSO operates at 5 to 8 year periods and has influenced coastal hazards.

Table H 1-7 outlines the changes to the physical system that affects coastal processes and coastal hazards in as a result of El Niño and La Niña.

Table H 1-7 Relative ENSO effects affecting northern New Zealand

Factor	El Niño	La Niña
Air Temperature	Decreased	Increased
Atmospheric Pressure	SE to NW gradient	NW to SE gradient
Wind Direction	More south-westerly	More north-westerly to north-easterly
Storm Frequency (Also affects extreme rainfall)	Reduced extratropical cyclone frequency	More extratropical cyclone activity
Sea Surface Temperature	Decreased	Increased
Sea Level	Drops	Rises
Wave Climate	Reduced sea component in the east. Increased sea component in the west	Increased sea component in the east. Reduced sea component in the west.
Wave Steepness	Reduced in the east. Increased in the west.	Increased in the east. Reduced in the west.
Coastal Response	Tendency to accrete on the east coast and erode on the west	Tendency to erode on the east coast and accrete on the west.

Adapted from de Lange (2001)

1.10.4 Inter Pacific Oscillation

The Inter Pacific Oscillation (IPO) is a climate cycle that affects the frequency and intensity of ENSO extremes. De Lange (2001) indicated based on historic data that IPO cycles behave in an oscillatory nature and appear to have a frequency of 20 to 25 years. IPO influences are likely to lead to a cumulative effect for coastal impacts, particularly erosion and accretion. The last IPO shift was in 1976 where El Niño conditions were pre-dominant leading to a period of less energy and suppressed sea level rise indicating that the shoreline had a tendency to accrete. The expected responses from IPO are summarised in Table H 1-8.

Table H 1-8 Relative IPO effects influencing northern New Zealand

Factor	Negative IPO	Positive IPO
ENSO	Normal to more La Nina activity	Increased El Nino activity
Precipitation	Increased	Decreased
Storm Frequency (Also affects extreme rainfall)	More extratropical storms	Fewer extratropical storms
Sea Level	Rapid initial rise	Steady to dropping
Wave Climate	Higher energy in the east, lower in the west	Lower energy in the east, higher in the west
Coastal Response	Increased erosion on the east coast, more stability or accretion in the west	Stability or accretion on the east coast, increased erosion in the west.

These effects are similar to ENSO response in Table 2.5 except they are for a longer duration (de Lange, 2001)

Based on historic trends a period of more persistent La Niña climatic conditions are expected in the near future. If the IPO cycle becomes negative increased coastal erosion of the East Coast is expected.

P:\19891\Appendix H. Description of physical setting.doc

Appendix I: Heli-survey DVDs

Appendix J: Analysis of beach profile changes

- **Campbell's Bay (CB)**
- **Cheltenham Beach (CHB)**
- **Hatfields Beach (HB)**
- **Long Bay Beach (LB)**
- **Mangawhai Pakiri (MP)**
- **Maraetai Beach (MAB)**
- **Milford Beach (MB)**
- **Muriwai Beach (MU)**
- **Omaha Beach (OB)**
- **Onetangi Beach (ON)**
- **Orere Point (OP)**
- **Orewa Beach (OW)**
- **Piha Beach (PB)**
- **Red Beach (RB)**
- **Takapuna Beach (TB)**
- **Wattle Downs (WD)**

CB P1 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	29/06/1998	0.704	16.41	0	0
P1	19/10/1998	0.656	12.58	-3.83	-3.83
P1	30/11/1998	0.637	12.05	-0.53	-4.36
P1	14/12/1998	0.689	15.12	3.07	-1.29
P1	28/01/1999	0.814	23.07	7.95	6.66
P1	18/03/1999	0.715	15.93	-7.14	-0.48
P1	15/04/1999	0.882	28.29	12.36	11.88
P1	27/05/1999	0.758	20.38	-7.91	3.97
P1	30/06/1999	0.898	24.09	3.71	7.68
P1	29/07/1999	0.736	19.19	-4.9	2.78
P1	26/08/1999	0.739	19.17	-0.02	2.76
P1	27/09/1999	0.711	17.78	-1.39	1.37
P1	26/10/1999	0.721	16.97	-0.81	0.56
P1	23/11/1999	0.662	12.9	-4.07	-3.51
P1	21/12/1999	0.758	18.31	5.41	1.9
P1	19/01/2000	0.662	14.09	-4.22	-2.32
P1	28/02/2000	0.685	18.55	4.46	2.14
P1	3/04/2000	0.717	17.62	-0.93	1.21
P1	19/05/2000	0.642	12.82	-4.8	-3.59
P1	19/06/2000	1.202	17.24	4.42	0.83
P1	20/07/2000	0.371	12.66	-4.58	-3.75
P1	16/08/2000	0.419	17.41	4.75	1
P1	14/09/2000	0.402	15.86	-1.55	-0.55
P1	13/10/2000	0.474	19.77	3.91	3.36
P1	23/11/2000	0.409	16.89	-2.88	0.48
P1	13/12/2000	0.4	15.65	-1.24	-0.76
P1	15/01/2001	0.523	21.95	6.3	5.54
P1	23/01/2001	0.479	21.32	-0.63	4.91
P1	22/02/2001	0.488	19	-2.32	2.59
P1	21/03/2001	0.504	19.87	0.87	3.46
P1	24/04/2001	0.481	19.82	-0.05	3.41
P1	22/05/2001	0.37	13.44	-6.38	-2.97
P1	19/06/2001	1.19	22.43	8.99	6.02
P1	18/07/2001	0.521	26.16	3.73	9.75
P1	20/08/2001	0.591	25.34	-0.82	8.93
P1	18/09/2001	0.455	21.41	-3.93	5
P1	16/10/2001	0.487	19.68	-1.73	3.27
P1	12/12/2001	1.243	20.61	0.93	4.2
P1	30/01/2002	0.521	17.51	-3.1	1.1
P1	26/02/2002	0.504	17.66	0.15	1.25
P1	26/02/2002	0.521	22.28	4.62	5.87
P1	28/03/2002	0.521	22.28	0	5.87
P1	30/04/2002	0.509	20.16	-2.12	3.75
P1	15/05/2002	0.474	19.7	-0.46	3.29
P1	21/06/2002	0.537	19.09	-0.61	2.68
P1	1/07/2002	0.459	22.45	3.36	6.04
P1	23/07/2002	0.425	17.5	-4.95	1.09
P1	21/08/2002	0.511	22.64	5.14	6.23
P1	6/09/2002	0.544	22.44	-0.2	6.03
P1	21/10/2002	0.576	22.85	0.41	6.44
P1	19/11/2002	0.532	20.34	-2.51	3.93
P1	3/12/2002	0.69	24.51	4.17	8.1
P1	30/01/2003	0.499	19.28	-5.23	2.87
P1	2/04/2003	0.588	24.41	5.13	8
P1	16/04/2003	0.668	22.37	-2.04	5.96
P1	27/05/2003	0.617	21.94	-0.43	5.53
P1	12/06/2003	0.598	18.61	-3.33	2.2
P1	15/07/2003	0.618	18.18	-0.43	1.77
P1	13/08/2003	0.659	20.51	2.33	4.1
P1	29/09/2003	0.64	20.75	0.24	4.34
P1	13/10/2003	0.601	17.46	-3.29	1.05
P1	25/11/2003	0.564	18.92	1.46	2.51
P1	8/12/2003	0.564	18.58	-0.34	2.17
P1	21/01/2004	0.593	19.35	0.77	2.94
P1	17/02/2004	0.589	20.11	0.76	3.7
P1	22/03/2004	0.517	18.03	-2.08	1.62
P1	20/04/2004	0.551	20.49	2.46	4.08
P1	5/05/2004	0.593	21.77	1.28	5.36
P1	30/06/2004	0.633	19.75	-2.02	3.34
P1	16/07/2004	0.578	20.17	0.42	3.76
P1	2/08/2004	0.574	19.27	-0.9	2.86
P1	1/09/2004	0.56	18.9	-0.37	2.49
P1	13/10/2004	0.523	16.25	-2.65	-0.16
P1	12/11/2004	0.504	16.95	0.7	0.54
P1	10/12/2004	0.472	17.32	0.37	0.91

Descriptive Statistics	
Mean	0.012297297
Standard Error	0.43665254
Median	-0.4
Mode	-0.43
Standard Deviation	3.756227176
Sample Variance	14.1092426
Kurtosis	0.851245352
Skewness	0.606997983
Range	20.27
Minimum	-7.91
Maximum	12.36
Sum	0.91
Count	74
Confidence Level(95.0%)	0.870247847

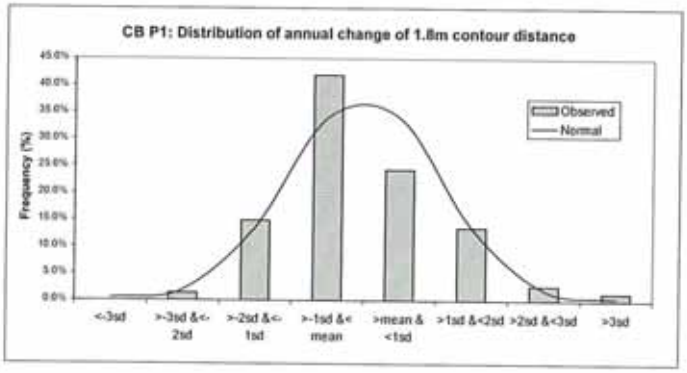
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.224804347
R Square	0.050536994
Adjusted R Square	0.037350008
Standard Error	3.202726896
Observations	74

	Coefficients	*'andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-39.13741969	21.45788	-1.82392	0.072314	-81.9129	3.638055	-81.9129	3.638055
X Variable 1	0.001128151	0.000576	1.957636	0.054149	-2.1E-05	0.002277	-2.1E-05	0.002277

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-11.3			0	0.0%	0.5%
>-3sd &<-2sd	-11.3	to	-7.5	1	1.4%	2.0%
>-2sd &<-1sd	-7.5	to	-3.7	11	14.9%	13.5%
>-1sd &< mean	-3.74	to	0.01	31	41.9%	34.0%
>mean & <1sd	0.01	to	3.77	18	24.3%	34.0%
>1sd &<2sd	3.77	to	7.52	10	13.5%	13.5%
>2sd &<3sd	7.52	to	11.28	2	2.7%	2.0%
>3sd	11.28			1	1.4%	0.5%
				74		



CB P1 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	29/06/1998	7.69	6.81	0	0
P1	19/10/1998	7.513	6.99	0.18	0.18
P1	30/11/1998	7.172	6.64	-0.35	-0.17
P1	14/12/1998	7.71	6.81	0.17	0
P1	28/01/1999	7.687	6.9	0.09	0.09
P1	18/03/1999	7.571	6.78	-0.12	-0.03
P1	15/04/1999	7.551	6.77	-0.01	-0.04
P1	27/05/1999	7.735	6.75	-0.02	-0.06
P1	30/06/1999	7.954	6.74	-0.01	-0.07
P1	29/07/1999	6.322	6.82	0.08	0.01
P1	26/08/1999	7.394	6.56	-0.26	-0.25
P1	27/09/1999	7.39	6.83	0.27	0.02
P1	26/10/1999	7.44	6.66	-0.17	-0.15
P1	23/11/1999	7.416	6.83	0.17	0.02
P1	21/12/1999	7.715	6.77	-0.06	-0.04
P1	18/01/2000	7.514	6.64	-0.13	-0.17
P1	28/02/2000	7.38	6.59	-0.05	-0.22
P1	3/04/2000	7.66	6.94	0.35	0.13
P1	19/05/2000	7.204	6.55	-0.39	-0.26
P1	19/06/2000	14.636	6.94	0.39	0.13
P1	20/07/2000	3.412	6.8	-0.14	-0.01
P1	16/08/2000	3.235	6.73	-0.07	-0.08
P1	14/09/2000	3.111	6.63	-0.1	-0.18
P1	13/10/2000	3.249	6.87	0.24	0.06
P1	23/11/2000	3.021	6.77	-0.1	-0.04
P1	13/12/2000	3.176	6.94	0.17	0.13
P1	15/01/2001	3.405	6.93	-0.01	0.12
P1	23/01/2001	2.912	6.93	0	0.12
P1	22/02/2001	3.641	7.01	0.08	0.2
P1	21/03/2001	3.456	6.78	-0.23	-0.03
P1	24/04/2001	3.505	6.78	0	-0.03
P1	22/05/2001	3.357	6.7	-0.08	-0.11
P1	19/06/2001	13.745	6.78	0.08	-0.03
P1	18/07/2001	3.51	6.97	0.19	0.16
P1	20/08/2001	3.079	6.71	-0.26	-0.1
P1	19/09/2001	3.392	6.82	0.11	0.01
P1	16/10/2001	3.576	6.95	0.13	0.14
P1	12/12/2001	13.197	6.94	-0.01	0.13
P1	30/01/2002	3.552	6.96	0.02	0.15
P1	26/02/2002	3.312	6.78	-0.18	-0.03
P1	28/02/2002	3.358	6.85	0.07	0.04
P1	26/03/2002	3.358	6.85	0	0.04
P1	30/04/2002	3.031	6.82	-0.03	0.01
P1	15/05/2002	2.886	6.73	-0.09	-0.08
P1	21/06/2002	2.946	8.06	1.33	1.25
P1	1/07/2002	3.142	6.99	-1.07	0.18
P1	23/07/2002	3.323	6.69	-0.3	-0.12
P1	21/08/2002	3.313	6.88	0.19	0.07
P1	6/09/2002	3.41	6.92	0.04	0.11
P1	21/10/2002	3.521	6.86	-0.06	0.05
P1	19/11/2002	3.552	6.94	0.08	0.13
P1	3/12/2002	3.537	7.09	0.15	0.28
P1	30/01/2003	3.162	6.87	-0.22	0.06
P1	2/04/2003	3.307	6.85	-0.02	0.04
P1	16/04/2003	3.409	6.91	0.06	0.1
P1	27/05/2003	3.402	8.47	1.56	1.66
P1	12/06/2003	3.494	8.29	-0.18	1.48
P1	15/07/2003	3.729	9.08	0.79	2.27
P1	13/08/2003	3.906	9.35	0.27	2.54
P1	29/09/2003	3.547	8.73	-0.62	1.92
P1	13/10/2003	3.754	8.49	-0.24	1.68
P1	25/11/2003	3.295	7.83	-0.66	1.02
P1	8/12/2003	3.575	7.71	-0.12	0.9
P1	21/01/2004	3.578	7.4	-0.31	0.59
P1	17/02/2004	3.265	6.91	-0.49	0.1
P1	22/03/2004	3.512	7.35	0.44	0.54
P1	20/04/2004	3.291	7.04	-0.31	0.23
P1	5/05/2004	3.469	6.93	-0.11	0.12
P1	30/06/2004	4.079	9.19	2.26	2.38
P1	16/07/2004	3.603	7.04	-2.15	0.23
P1	2/08/2004	3.469	6.93	-0.11	0.12
P1	1/09/2004	3.464	7.12	0.19	0.31
P1	13/10/2004	3.62	7.03	-0.09	0.22
P1	12/11/2004	3.64	6.84	-0.19	0.03
P1	10/12/2004	3.718	6.97	0.13	0.16

Descriptive Statistics	
Mean	0.002162162
Standard Error	0.059153685
Median	-0.015
Mode	0.08
Standard Deviation	0.508859241
Sample Variance	0.258837727
Kurtosis	9.900721764
Skewness	0.667827241
Range	4.41
Minimum	-2.15
Maximum	2.26
Sum	0.16
Count	74
Confidence Level(95.0%)	0.117893204

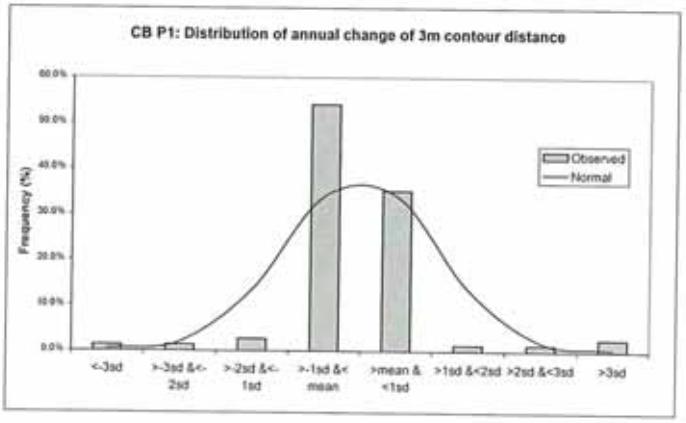
SUMMARY OUTPUT

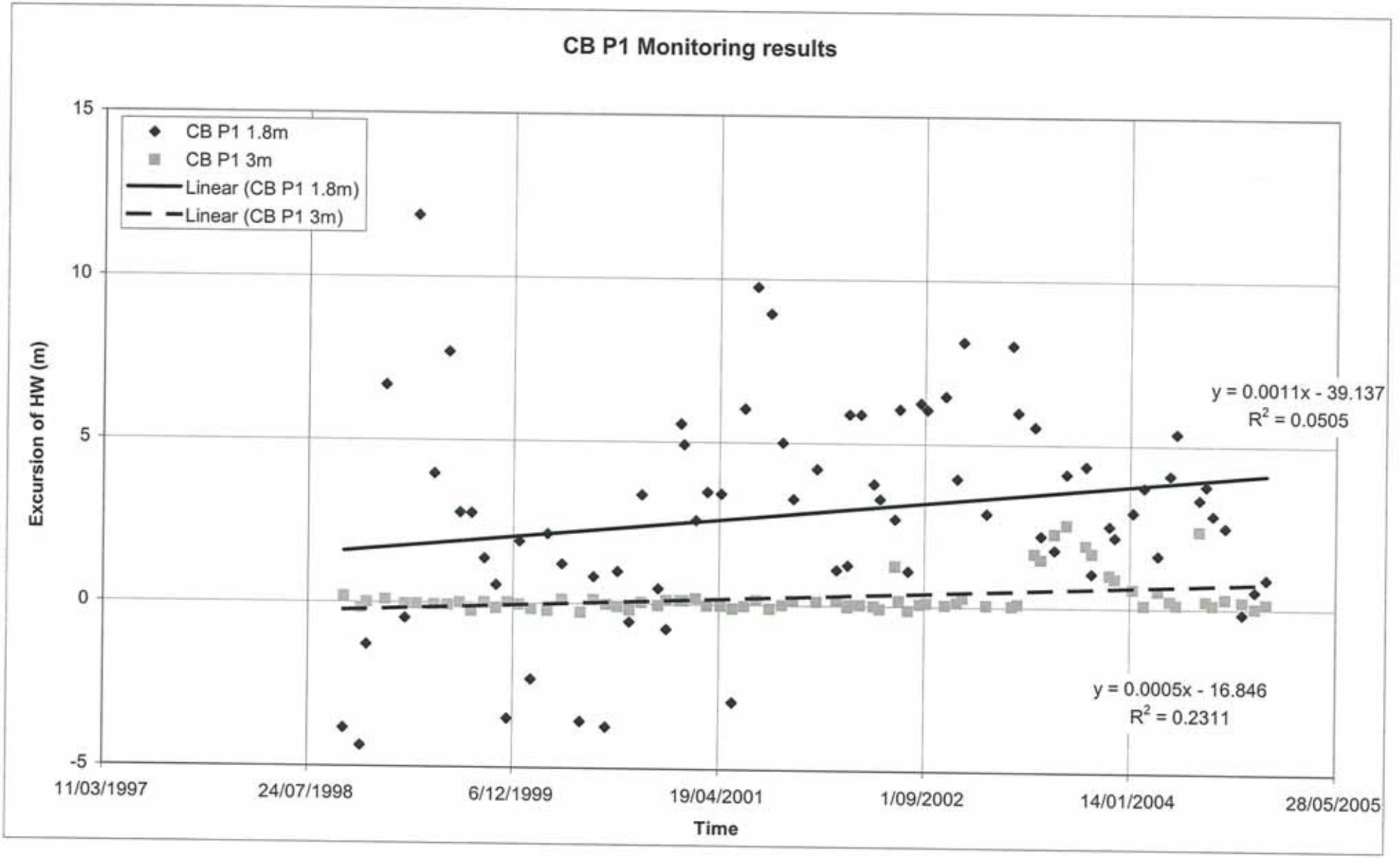
Regression Statistics	
Multiple R	0.480743105
R Square	0.231113933
Adjusted R Square	0.220434959
Standard Error	0.549385666
Observations	74

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-16.84578712	3.680817	-4.57684	1.93E-05	-24.1834	-9.50822	-24.1834	-9.50822
X Variable 1	0.000459876	9.89E-05	4.652092	1.46E-05	0.000263	0.000657	0.000263	0.000657

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-1.5			1	1.4%	0.5%
>-3sd &<-2sd	-1.5	to	-1.0	1	1.4%	2.0%
>-2sd &<-1sd	-1.0	to	-0.5	2	2.7%	13.5%
>-1sd &< mean	-0.51	to	0.00	40	54.1%	34.0%
>mean & <1sd	0.00	to	0.51	26	35.1%	34.0%
>1sd &<2sd	0.51	to	1.02	1	1.4%	13.5%
>2sd &<3sd	1.02	to	1.53	1	1.4%	2.0%
>3sd	1.53			2	2.7%	0.5%
				74		




CB P1 Monitoring results
CB P1 1.8m
CB P1 3m
Linear (CB P1 1.8m)
Linear (CB P1 3m)
y = 0.0011x - 39.137
R² = 0.0505
y = 0.0005x - 16.846
R² = 0.2311
Excursion of HW (m)
15
10
5
0
-5
11/03/1997
24/07/1998
6/12/1999
19/04/2001
1/09/2002
14/01/2004
28/05/2005
Time

CB P2 TOTAL REPORT

Profile Volume Report

Contour Level: **1.8 m** *Seawall. Profiles do not reach 3m. 1.8m contour only.*

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	19/10/1998	1.702	6.12	0.00	0.00
P2	30/11/1998	0.928	2.33	-3.79	-3.79
P2	14/12/1998	1.617	5.36	3.03	-0.76
P2	28/01/1999	5.662	14.35	8.99	8.23
P2	18/03/1999	2.909	8.56	-5.79	2.44
P2	15/04/1999	3.107	19.09	10.53	12.97
P2	27/05/1999	3.713	11.64	-7.45	5.52
P2	30/06/1999	8.088	18.94	7.30	12.82
P2	29/07/1999	7.663	14.24	-4.70	8.12
P2	26/08/1999	8.154	15.63	1.39	9.51
P2	27/09/1999	8.448	17.85	2.22	11.73
P2	26/10/1999	8.527	15.93	-1.92	9.81
P2	23/11/1999	6.333	10.67	-5.26	4.55
P2	21/12/1999	6.81	13.08	2.41	6.96
P2	19/01/2000	6.856	13.51	0.43	7.39
P2	28/02/2000	6.805	16.04	2.53	9.92
P2	3/04/2000	6.919	14.94	-1.10	8.82
P2	19/05/2000	3.973	8.97	-5.97	2.85
P2	19/06/2000	4.85	12.57	3.60	6.45
P2	20/07/2000	0.823	3.43	-9.14	-2.69
P2	16/08/2000	1.182	6.08	2.65	-0.04
P2	14/09/2000	3.758	9.35	3.27	3.23
P2	13/10/2000	3.931	11.03	1.68	4.91
P2	23/11/2000	3.709	9.87	-1.16	3.75
P2	13/12/2000	3.432	10.61	0.74	4.49
P2	23/01/2001	6.489	15.97	5.36	9.85
P2	22/02/2001	5.934	13.17	-2.80	7.05
P2	21/03/2001	7.165	15.31	2.14	9.19
P2	24/04/2001	2.33	7.64	-7.67	1.52
P2	22/05/2001	1.195	5.05	-2.59	-1.07
P2	19/06/2001	1.089	6.28	1.23	0.16
P2	18/07/2001	3.477	13.01	6.73	6.89
P2	20/08/2001	5.225	15.12	2.11	9.00
P2	19/09/2001	2.148	9.31	-5.81	3.19
P2	16/10/2001	1.97	7.66	-1.65	1.54
P2	15/11/2001	3.528	12.33	4.67	6.21
P2	12/12/2001	6.676	16.7	4.37	10.58
P2	30/01/2002	7.879	14.88	-1.82	8.76
P2	26/02/2002	7.132	13.79	-1.09	7.67
P2	28/03/2002	7.395	16.67	2.88	10.55
P2	22/03/2004	8.098	18.04	1.37	11.92
P2	20/04/2004	8.83	16.93	-1.11	10.81
P2	5/05/2004	7.953	16	-0.93	9.88
P2	30/06/2004	9.595	17.91	1.91	11.79
P2	16/07/2004	8.565	15.96	-1.95	9.84
P2	2/08/2004	9.832	18.41	2.45	12.29
P2	1/09/2004	7.849	14.34	-4.07	8.22
P2	13/10/2004	7.188	11.93	-2.41	5.81
P2	12/11/2004	8.645	20.96	9.03	14.84
P2	10/12/2004	7.425	15.8	-5.16	9.68

Descriptive Statistics	
Mean	0.19765102
Standard Error	0.645569709
Median	0.74
Mode	#N/A
Standard Deviation	4.518967963
Sample Variance	20.42125221
Kurtosis	-0.265318291
Skewness	0.118622308
Range	19.67
Minimum	-9.14
Maximum	10.53
Sum	9.68
Count	49
Confidence Level(95.0%)	1.298004136

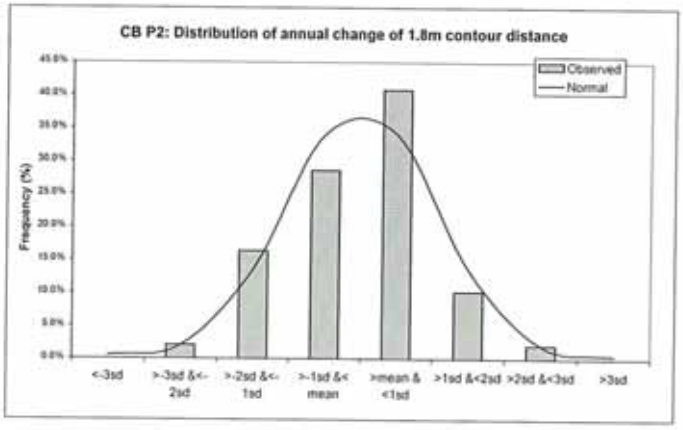
SUMMARY OUTPUT

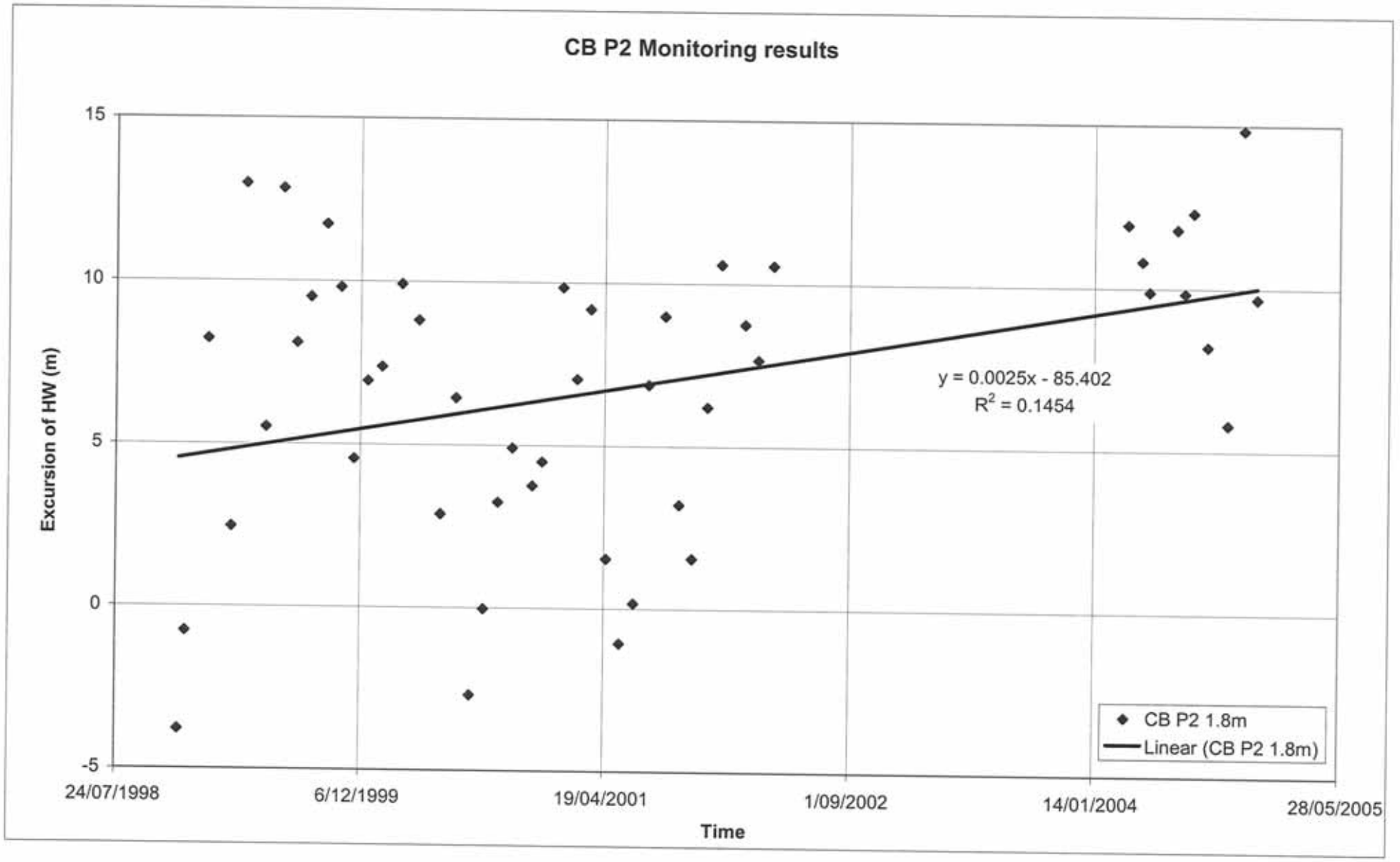
Regression Statistics	
Multiple R	0.381325566
R Square	0.145409187
Adjusted R Square	0.127226404
Standard Error	4.115169526
Observations	49

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-85.40218841	32.6108	-2.618831	0.011839	-151.0066	-19.79778	-151.0066	-19.79778
X Variable 1	0.00248928	0.00058	2.827911	0.006864	0.000718	0.00426	0.000718	0.00426

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-13.4			0	0.0%	0.5%
>-3sd &<-2sd	-13.4	to	-8.8	1	2.0%	2.0%
>-2sd &<-1sd	-8.8	to	-4.3	8	16.3%	13.5%
>-1sd &< mean	-4.32	to	0.20	14	28.6%	34.0%
>mean & <1sd	0.20	to	4.72	20	40.8%	34.0%
>1sd &<2sd	4.72	to	9.24	5	10.2%	13.5%
>2sd &<3sd	9.24	to	13.75	1	2.0%	2.0%
>3sd	13.75			0	0.0%	0.5%
				49		




CB P2 Monitoring results
15
10
5
0
-5
Excursion of HW (m)
y = 0.0025x - 85.402
R2 = 0.1454
CB P2 1.8m
Linear (CB P2 1.8m)
24/07/1998
6/12/1999
19/04/2001
1/09/2002
14/01/2004
28/05/2005
Time

CHB P1 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m** *Seawall. Profiles do not reach 3m. 1.8m contour only.*

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	19/10/1998	0.138	0.36	0	0
P1	30/11/1998	0.116	0.27	-0.09	-0.09
P1	14/12/1998	0.072	0.12	-0.15	-0.24
P1	28/01/1999	0.061	0.2	0.08	-0.16
P1	18/03/1999	0.066	0.22	0.02	-0.14
P1	15/04/1999	0.016	0.05	-0.17	-0.31
P1	27/05/1999	0.103	0.25	0.2	-0.11
P1	30/06/1999	0.018	0.06	-0.19	-0.3
P1	29/07/1999	0.035	0.12	0.06	-0.24
P1	26/08/1999	0.03	0.1	-0.02	-0.26
P1	27/09/1999	0.232	5.17	5.07	4.81
P1	26/10/1999	0.148	4.88	-0.29	4.52
P1	23/11/1999	0.263	4.48	-0.4	4.12
P1	21/12/1999	0.314	4.95	0.47	4.59
P1	19/01/2000	0.228	3.42	-1.53	3.06
P1	28/02/2000	0.16	1.38	-2.04	1.02
P1	3/04/2000	0.22	2.24	0.86	1.88
P1	19/05/2000	0.156	1.07	-1.17	0.71
P1	19/06/2000	0.307	2.17	1.1	1.81
P1	20/07/2000	0.089	0.15	-2.02	-0.21
P1	16/08/2000	0.089	0.15	0	-0.21
P1	14/09/2000	0.114	0.8	0.65	0.44
P1	13/10/2000	0.079	0.52	-0.28	0.16
P1	23/11/2000	0.095	0.67	0.15	0.31
P1	13/12/2000	0.097	1.21	0.54	0.85
P1	23/01/2001	0.092	0.42	-0.79	0.06
P1	22/02/2001	0.079	0.93	0.51	0.57
P1	21/03/2001	0.037	0.55	-0.38	0.19
P1	24/04/2001	0.09	1.36	0.81	1
P1	22/05/2001	0.111	1.05	-0.31	0.69
P1	19/06/2001	0.032	0.25	-0.8	-0.11
P1	18/07/2001	0.082	0.34	0.09	-0.02
P1	20/08/2001	0.09	0.15	-0.19	-0.21
P1	19/09/2001	0.09	0.15	0	-0.21
P1	16/10/2001	0.066	0.53	0.38	0.17
P1	15/11/2001	0.091	0.32	-0.21	-0.04
P1	12/12/2001	0.037	0.46	0.14	0.1
P1	30/01/2002	0.029	0.1	-0.36	-0.26
P1	26/02/2002	0.084	0.14	0.04	-0.22
P1	28/03/2002	0.072	8.61	8.47	8.25
P1	30/04/2002	0.095	0.85	-7.76	0.49
P1	13/05/2002	0.232	12.15	11.3	11.79
P1	1/07/2002	0.091	0.35	-11.8	-0.01
P1	23/07/2002	0.106	0.73	0.38	0.37
P1	21/08/2002	0.218	3.14	2.41	2.78
P1	6/09/2002	0.136	1.85	-1.29	1.49
P1	21/10/2002	0.121	1.13	-0.72	0.77
P1	19/11/2002	0.145	1.29	0.16	0.93
P1	3/12/2002	0.11	1.65	0.36	1.29
P1	30/01/2003	0.121	2.66	1.01	2.3
P1	4/03/2003	0.108	1.03	-1.63	0.67
P1	2/04/2003	0.186	1.66	0.63	1.3
P1	16/04/2003	0.153	2.18	0.52	1.82
P1	27/05/2003	0.093	0.52	-1.66	0.16
P1	12/06/2003	0.09	1.75	1.23	1.39
P1	15/07/2003	0.06	0.2	-1.55	-0.16
P1	13/08/2003	0.136	1.04	0.84	0.68
P1	29/09/2003	0.112	1.29	0.25	0.93
P1	13/10/2003	0.157	11.77	10.48	11.41
P1	25/11/2003	0.046	0.74	-11.03	0.38
P1	8/12/2003	0.208	2.71	1.97	2.35
P1	21/01/2004	0.262	3.2	0.49	2.84
P1	17/02/2004	0.134	2.15	-1.05	1.79
P1	22/03/2004	0.133	2.09	-0.06	1.73
P1	20/04/2004	0.135	1.47	-0.62	1.11
P1	5/05/2004	0.098	0.62	-0.85	0.26
P1	30/06/2004	0.24	3.33	2.71	2.97
P1	16/07/2004	0.136	1.24	-2.09	0.88
P1	2/08/2004	0.232	12.68	11.44	12.32
P1	1/09/2004	0.267	0.9	-11.78	0.54
P1	13/10/2004	0.148	0.5	-0.4	0.14
P1	12/11/2004	0.106	0.55	0.05	0.19
P1	10/12/2004	0.125	0.41	-0.14	0.05

Descriptive Statistics

Mean	0.000694444
Standard Error	0.438324601
Median	0
Mode	0
Standard Deviation	3.719307571
Sample Variance	13.83324881
Kurtosis	5.564936484
Skewness	-0.073363092
Range	23.24
Minimum	-11.8
Maximum	11.44
Sum	0.05
Count	72
Confidence Level(95.0%)	0.873994862

SUMMARY OUTPUT

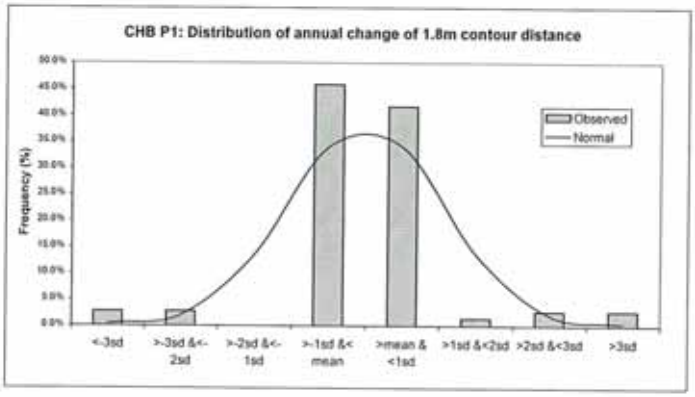
Regression Statistics

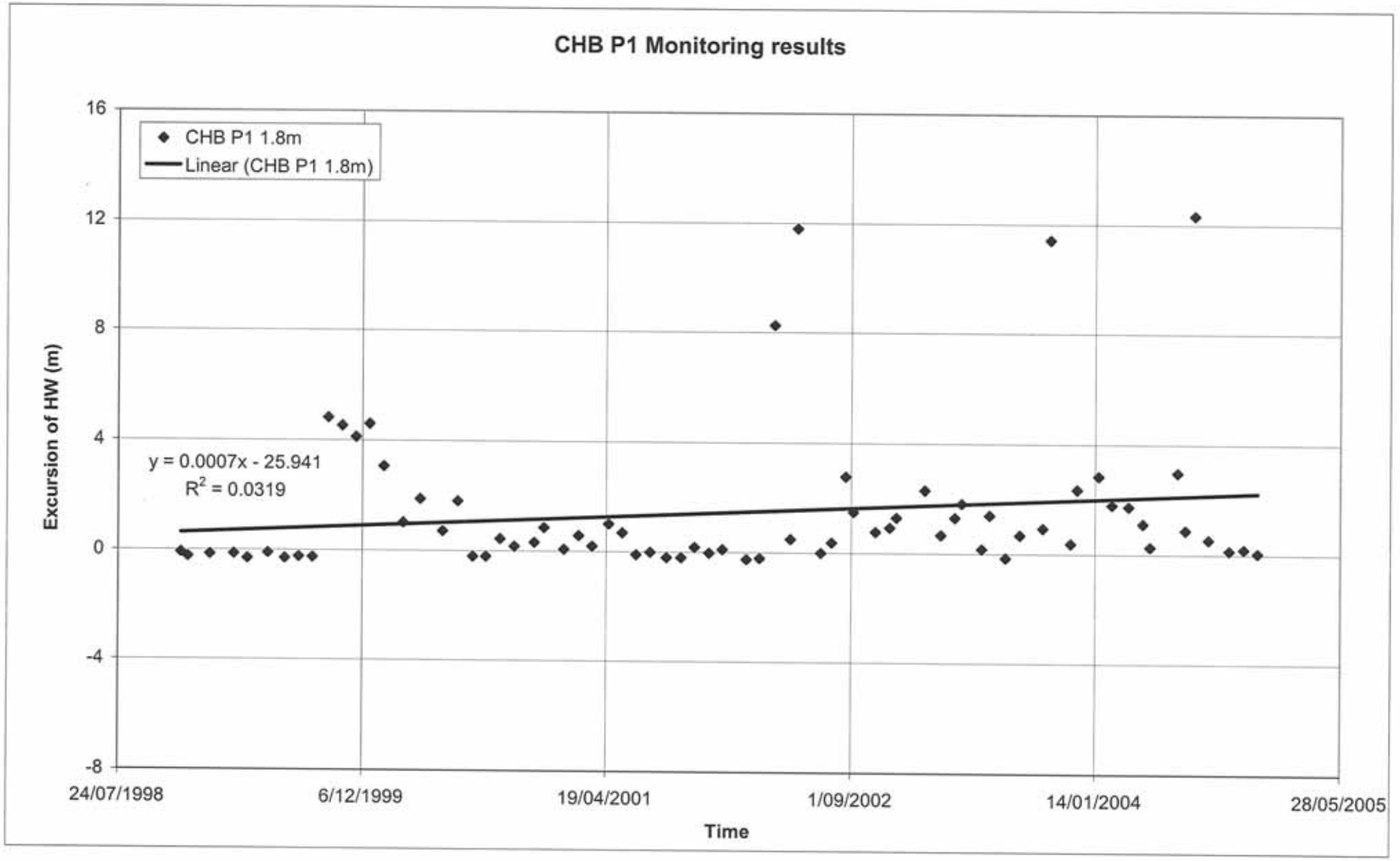
Multiple R	0.178735044
R Square	0.031946216
Adjusted R Square	0.018116876
Standard Error	2.631430239
Observations	72

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-25.94093023	18.02007	-1.439557931	0.15445	-61.8808	9.998931	-61.8808	9.998931
X Variable 1	0.000735112	0.000484	1.519878909	0.133046	-0.00023	0.0017	-0.00023	0.0017

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-11.2			2	2.8%	0.5%
>-3sd &<-2sd	-11.2	to	-7.4	2	2.8%	2.0%
>-2sd &<-1sd	-7.4	to	-3.7	0	0.0%	13.5%
>-1sd &< mean	-3.72	to	0.00	33	45.8%	34.0%
>mean & <1sd	0.00	to	3.72	30	41.7%	34.0%
>1sd &<2sd	3.72	to	7.44	1	1.4%	13.5%
>2sd &<3sd	7.44	to	11.16	2	2.8%	2.0%
>3sd	11.16			2	2.8%	0.5%
				72		




CHB P1 Monitoring results
CHB P1 1.8m
Linear (CHB P1 1.8m)
y = 0.0007x - 25.941
R2 = 0.0319
Excursion of HW (m)
16
12
8
4
0
-4
-8
24/07/1998
6/12/1999
19/04/2001
1/09/2002
14/01/2004
28/05/2005
Time

CHB P2 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	30/11/1998	5.736	7.14	0	0
P2	14/12/1998	6.481	8.43	1.29	1.29
P2	28/01/1999	6.445	8.38	-0.05	1.24
P2	18/03/1999	7.947	18.56	10.18	11.42
P2	15/04/1999	7.499	17.65	-0.91	10.51
P2	27/05/1999	8.934	18.91	1.26	11.77
P2	30/06/1999	9.138	17.64	-1.27	10.5
P2	29/07/1999	7.618	13.32	-4.32	6.18
P2	26/08/1999	9.938	17.57	4.25	10.43
P2	27/09/1999	10.381	17.88	0.31	10.74
P2	26/10/1999	10.121	17.91	0.03	10.77
P2	23/11/1999	9.789	15.95	-1.96	8.81
P2	21/12/1999	9.753	17.41	1.46	10.27
P2	19/01/2000	11.33	18.24	0.83	11.1
P2	28/02/2000	9.436	17.47	-0.77	10.33
P2	3/04/2000	10.162	19.4	1.93	12.26
P2	19/05/2000	8.111	13.17	-6.23	6.03
P2	19/06/2000	10.085	17.1	3.93	9.96
P2	20/07/2000	7.836	11.87	-5.23	4.73
P2	16/08/2000	7.665	15.39	3.52	8.25
P2	14/09/2000	9.21	15.9	0.51	8.76
P2	13/10/2000	10.415	17.99	2.09	10.85
P2	23/11/2000	10.483	15.55	-2.44	8.41
P2	13/12/2000	9.556	16.95	1.4	9.81
P2	23/01/2001	10.229	18.38	1.43	11.24
P2	22/02/2001	10.871	18.14	-0.24	11
P2	21/03/2001	10.718	18.1	-0.04	10.96
P2	24/04/2001	10.034	16.52	-1.58	9.38
P2	22/05/2001	6.666	9.4	-7.12	2.26
P2	19/06/2001	7.598	10.75	1.35	3.61
P2	18/07/2001	7.454	13.61	2.86	6.47
P2	20/08/2001	8.441	15.88	2.27	8.74
P2	19/09/2001	8.224	16.3	0.42	9.16
P2	16/10/2001	9.862	18.06	1.76	10.92
P2	15/11/2001	8.663	16.72	-1.34	9.58
P2	12/12/2001	9.266	17.63	0.91	10.49
P2	30/01/2002	11.265	19.42	1.79	12.28
P2	26/02/2002	9.936	18.78	-0.64	11.64
P2	28/03/2002	9.78	18.21	-0.57	11.07
P2	30/04/2002	10.305	17.96	-0.25	10.82
P2	13/05/2002	10.009	18.12	0.16	10.98
P2	21/06/2002	8.327	13.88	-4.24	6.74
P2	1/07/2002	8.811	14.52	0.64	7.38
P2	23/07/2002	7.628	12.18	-2.34	5.04
P2	21/08/2002	8.027	14.04	1.86	6.9
P2	6/09/2002	8.153	13.54	-0.5	6.4
P2	21/10/2002	8.144	16.18	2.64	9.04
P2	19/11/2002	9.051	18.86	2.68	11.72
P2	3/12/2002	8.453	18.88	0.02	11.74
P2	30/01/2003	8.715	15.56	-3.32	8.42
P2	4/03/2003	9.249	17.56	2	10.42
P2	2/04/2003	8.474	17.61	0.05	10.47
P2	16/04/2003	7.538	16.18	-1.43	9.04
P2	27/05/2003	9.861	17.1	0.92	9.96
P2	12/06/2003	8.685	16.79	-0.31	9.65
P2	15/07/2003	10.011	18.79	2	11.65
P2	13/08/2003	10.668	19.09	0.3	11.95
P2	29/09/2003	10.342	18.4	-0.69	11.26
P2	13/10/2003	10.919	18.23	-0.17	11.09
P2	25/11/2003	10.184	19.36	1.13	12.22
P2	8/12/2003	9.651	18.38	-0.98	11.24
P2	21/01/2004	10.812	19.9	1.52	12.76
P2	17/02/2004	9.044	19.29	-0.61	12.15
P2	22/03/2004	8.351	16.23	-3.06	9.09
P2	20/04/2004	9.994	18.42	2.19	11.28
P2	5/05/2004	9.809	18.08	-0.34	10.94
P2	30/06/2004	9.154	16.99	-1.09	9.85
P2	16/07/2004	9.615	17.83	0.84	10.69
P2	2/08/2004	9.929	18.57	0.74	11.43
P2	1/09/2004	10.537	19.2	0.63	12.06
P2	13/10/2004	10.148	18.34	-0.86	11.2
P2	12/11/2004	11.2	20.16	1.82	13.02
P2	10/12/2004	9.005	16.83	-3.33	9.69

Descriptive Statistics	
Mean	0.134583333
Standard Error	0.294793364
Median	0.23
Mode	#N/A
Standard Deviation	2.501404641
Sample Variance	6.257025176
Kurtosis	3.761602287
Skewness	0.151448323
Range	17.3
Minimum	-7.12
Maximum	10.18
Sum	9.69
Count	72
Confidence Level(95.0%)	0.587801563

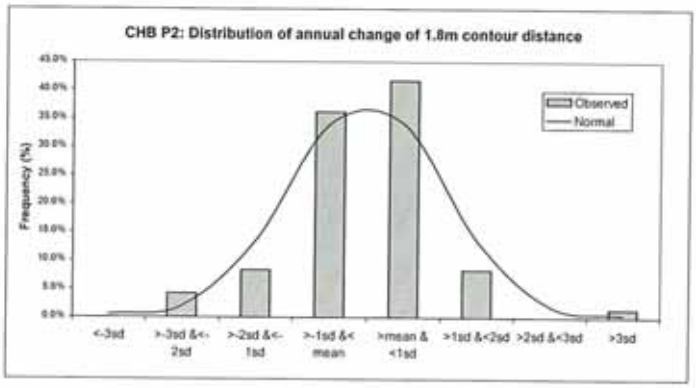
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.351145847
R Square	0.123303406
Adjusted R Square	0.110779169
Standard Error	2.446290156
Observations	72

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-44.1265882	17.1267	-2.578479209	0.012092	-78.2847	-9.96849	-78.2847	-9.96849
X Variable 1	0.00144167	0.000459	3.137703458	0.002492	0.000525	0.002358	0.000525	0.002358

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-7.4			0	0.0%	0.5%
>-3sd &<-2sd	-7.4	to	-4.9	3	4.2%	2.0%
>-2sd &<-1sd	-4.9	to	-2.4	6	8.3%	13.5%
>-1sd &< mean	-2.37	to	0.13	26	36.1%	34.0%
>mean & <1sd	0.13	to	2.64	30	41.7%	34.0%
>1sd &<2sd	2.64	to	5.14	6	8.3%	13.5%
>2sd &<3sd	5.14	to	7.64	0	0.0%	2.0%
>3sd	7.64			1	1.4%	0.5%
				72		



CHB P2 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	30/11/1998	0.133	3.46	0	0
P2	14/12/1998	0.231	3.4	-0.06	-0.06
P2	28/01/1999	0.185	3.19	-0.21	-0.27
P2	18/03/1999	0.178	3.09	-0.1	-0.37
P2	15/04/1999	0.117	2.22	-0.87	-1.24
P2	27/05/1999	0.18	3.32	1.1	-0.14
P2	30/06/1999	0.152	2.63	-0.69	-0.83
P2	29/07/1999	0.152	2.63	0	-0.83
P2	26/08/1999	0.162	2.81	0.18	-0.65
P2	27/09/1999	0.179	3.1	0.29	-0.36
P2	26/10/1999	0.172	2.98	-0.12	-0.48
P2	23/11/1999	0.154	2.66	-0.32	-0.8
P2	21/12/1999	0.122	2.38	-0.28	-1.08
P2	19/01/2000	0.197	3.32	0.94	-0.14
P2	28/02/2000	0.178	2.84	-0.48	-0.62
P2	3/04/2000	0.08	1.37	-1.47	-2.09
P2	19/05/2000	0.086	1.48	0.11	-1.98
P2	19/06/2000	0.198	3.14	1.66	-0.32
P2	20/07/2000	0.132	2.28	-0.86	-1.18
P2	16/08/2000	0.122	1.81	-0.47	-1.65
P2	14/09/2000	0.119	1.76	-0.05	-1.7
P2	13/10/2000	0.205	2.78	1.02	-0.68
P2	23/11/2000	0.254	3.36	0.58	-0.1
P2	13/12/2000	0.174	2.51	-0.85	-0.95
P2	23/01/2001	0.099	1.2	-1.31	-2.26
P2	22/02/2001	0.211	2.73	1.53	-0.73
P2	21/03/2001	0.211	2.73	0	-0.73
P2	24/04/2001	0.279	3.19	0.46	-0.27
P2	22/05/2001	0.152	3.36	0.17	-0.1
P2	19/06/2001	0.227	3.12	-0.24	-0.34
P2	18/07/2001	0.214	2.91	-0.21	-0.55
P2	20/08/2001	0.144	2.02	-0.89	-1.44
P2	19/09/2001	0.146	2.05	0.03	-1.41
P2	16/10/2001	0.251	3.37	1.32	-0.09
P2	15/11/2001	0.162	2.3	-1.07	-1.16
P2	12/12/2001	0.131	1.81	-0.49	-1.65
P2	30/01/2002	0.293	3.4	1.59	-0.06
P2	26/02/2002	0.211	3.01	-0.39	-0.45
P2	28/03/2002	0.089	1.14	-1.87	-2.32
P2	30/04/2002	0.201	2.93	1.79	-0.53
P2	13/05/2002	0.117	1.59	-1.34	-1.87
P2	21/06/2002	0.095	1.06	-0.53	-2.4
P2	1/07/2002	0.231	2.75	1.69	-0.71
P2	23/07/2002	0.125	1.72	-1.03	-1.74
P2	21/08/2002	0.162	2.32	0.6	-1.14
P2	6/09/2002	0.233	2.98	0.66	-0.48
P2	21/10/2002	0.129	2.08	-0.9	-1.38
P2	19/11/2002	0.157	2.35	0.27	-1.11
P2	3/12/2002	0.228	3.31	0.96	-0.15
P2	30/01/2003	0.228	3.17	-0.14	-0.29
P2	4/03/2003	0.21	3.13	-0.04	-0.33
P2	2/04/2003	0.254	3.26	0.13	-0.2
P2	16/04/2003	0.158	2.2	-1.06	-1.26
P2	27/05/2003	0.217	3.21	1.01	-0.25
P2	12/06/2003	0.157	2.35	-0.86	-1.11
P2	15/07/2003	0.201	2.8	0.45	-0.66
P2	13/08/2003	0.248	3.36	0.56	-0.1
P2	29/09/2003	0.173	2.4	-0.96	-1.06
P2	13/10/2003	0.28	3.43	1.03	-0.03
P2	25/11/2003	0.265	3.13	-0.3	-0.33
P2	8/12/2003	0.109	1.9	-1.23	-1.56
P2	21/01/2004	0.26	3.57	1.67	0.11
P2	17/02/2004	0.149	2.41	-1.16	-1.05
P2	22/03/2004	0.18	2.89	0.48	-0.57
P2	20/04/2004	0.225	3.35	0.46	-0.11
P2	5/05/2004	0.112	1.96	-1.39	-1.5
P2	30/06/2004	0.144	2.14	0.18	-1.32
P2	16/07/2004	0.144	2.33	0.19	-1.13
P2	2/08/2004	0.127	2.05	-0.28	-1.41
P2	1/09/2004	0.177	2.63	0.58	-0.83
P2	13/10/2004	0.189	3.05	0.42	-0.41
P2	12/11/2004	0.19	3.49	0.44	0.03
P2	10/12/2004	0.18	2.68	-0.81	-0.78

Descriptive Statistics	
Mean	-0.010833333
Standard Error	0.102056466
Median	-0.045
Mode	-0.21
Standard Deviation	0.865977832
Sample Variance	0.749917606
Kurtosis	-0.509638294
Skewness	0.199891599
Range	3.66
Minimum	-1.87
Maximum	1.79
Sum	-0.78
Count	72
Confidence Level(95.0%)	0.203494914

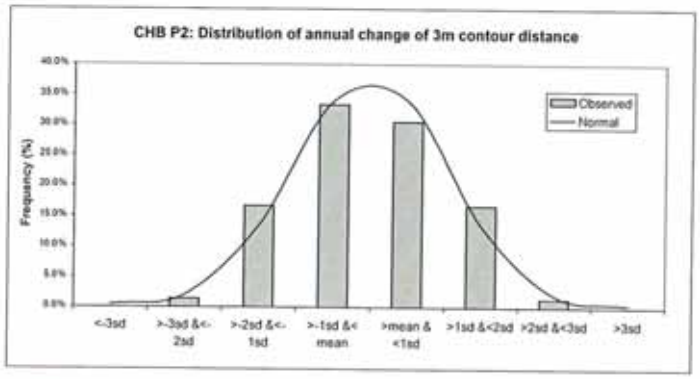
SUMMARY OUTPUT

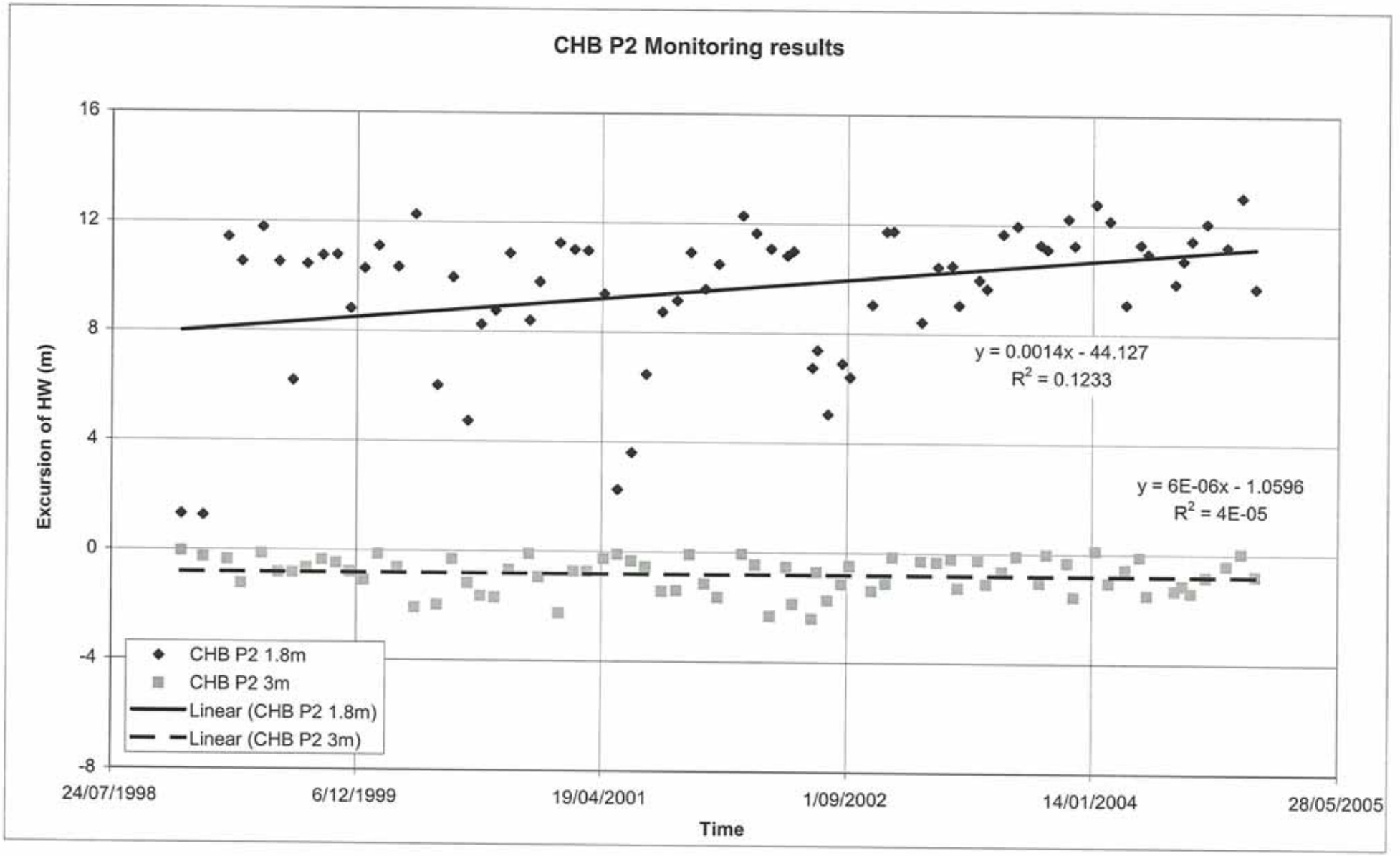
Regression Statistics	
Multiple R	0.006108806
R Square	3.73151E-05
Adjusted R Square	-0.014247866
Standard Error	0.642603141
Observations	72

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0*	*Upper 95.0%*
Intercept	-1.0596261	4.498923	-0.235528824	0.814486	-10.0324	7.913186	-10.0324	7.913186
X Variable 1	6.16862E-06	0.000121	0.05110922	0.959384	-0.00023	0.000247	-0.00023	0.000247

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-2.6			0	0.0%	0.5%
>-3sd &<-2sd	-2.6	to	-1.7	1	1.4%	2.0%
>-2sd &<-1sd	-1.7	to	-0.9	12	16.7%	13.5%
>-1sd &< mean	-0.88	to	-0.01	24	33.3%	34.0%
>mean & <1sd	-0.01	to	0.86	22	30.6%	34.0%
>1sd &<2sd	0.86	to	1.72	12	16.7%	13.5%
>2sd &<3sd	1.72	to	2.59	1	1.4%	2.0%
>3sd	2.59			0	0.0%	0.5%
				72		




CHB P2 Monitoring results
16
12
8
4
0
-4
-8
Excursion of HW (m)
y = 0.0014x - 44.127
R2 = 0.1233
y = 6E-06x - 1.0596
R2 = 4E-05
CHB P2 1.8m
CHB P2 3m
Linear (CHB P2 1.8m)
Linear (CHB P2 3m)
24/07/1998
6/12/1999
19/04/2001
1/09/2002
14/01/2004
28/05/2005
Time

CHB P3 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m** *Seawall: Profiles do not reach 3m, 1.8m contour only*

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P3	19/10/1998	1.266	5.84	0	0
P3	30/11/1998	0.719	1.82	-4.02	-4.02
P3	14/12/1998	0.536	2.52	0.7	-3.32
P3	28/01/1999	0.166	2.55	0.03	-3.29
P3	18/03/1999	0.008	0.43	-2.12	-5.41
P3	15/04/1999	0.021	9.64	9.21	3.8
P3	27/05/1999	0.209	10.61	0.97	4.77
P3	30/06/1999	0.634	10.69	0.08	4.85
P3	29/07/1999	0.823	7.49	-3.2	1.65
P3	26/08/1999	1.196	10.34	2.85	4.5
P3	27/09/1999	1.449	9.82	-0.52	3.98
P3	28/10/1999	1.451	9.45	-0.37	3.61
P3	23/11/1999	1.308	8.67	-0.78	2.83
P3	21/12/1999	1.392	9.46	0.79	3.62
P3	19/01/2000	0.475	3.64	-5.82	-2.2
P3	28/02/2000	1.29	6.66	3.02	0.82
P3	3/04/2000	1.13	6.97	0.31	1.13
P3	19/05/2000	1.373	6.75	-0.22	0.91
P3	19/06/2000	2.119	9.29	2.54	3.45
P3	20/07/2000	1.399	4.99	-4.3	-0.85
P3	16/08/2000	1.145	5.02	0.03	-0.82
P3	14/09/2000	1.545	7.73	2.71	1.89
P3	13/10/2000	1.589	8.1	0.37	2.26
P3	23/11/2000	1.695	8.21	0.11	2.37
P3	13/12/2000	2.206	9.54	1.33	3.7
P3	23/01/2001	1.945	10.24	0.7	4.4
P3	22/02/2001	2.158	10.17	-0.07	4.33
P3	21/03/2001	2.058	10.37	0.2	4.53
P3	24/04/2001	1.502	7.19	-3.18	1.35
P3	22/05/2001	0.81	3.31	-3.88	-2.53
P3	19/06/2001	0.56	2.51	-0.8	-3.33
P3	18/07/2001	0.691	2.95	0.44	-2.89
P3	20/08/2001	0.815	9.22	6.27	3.38
P3	19/09/2001	0.513	2.68	-6.54	-3.16
P3	18/10/2001	0.521	8.81	6.13	2.97
P3	15/11/2001	0.904	9.08	0.27	3.24
P3	12/12/2001	1.027	9.76	0.68	3.92
P3	30/01/2002	1.553	10.53	0.77	4.69
P3	26/02/2002	0.649	9.4	-1.13	3.56
P3	28/03/2002	1.451	10.23	0.83	4.39
P3	30/04/2002	1.349	10.51	0.28	4.67
P3	13/05/2002	1.246	10.52	0.01	4.68
P3	1/07/2002	1.082	7.25	-3.27	1.41
P3	23/07/2002	0.715	4.5	-2.75	-1.34
P3	5/09/2002	0.701	4.42	-0.08	-1.42
P3	21/10/2002	0.604	4.2	-0.22	-1.64
P3	19/11/2002	0.772	4.91	0.71	-0.93
P3	3/12/2002	0.656	4.93	0.02	-0.91
P3	30/01/2003	0.943	7.73	2.8	1.89
P3	4/03/2003	0.8	5.63	-2.1	-0.21
P3	2/04/2003	0.795	7.96	2.33	2.12
P3	16/04/2003	0.727	6.38	-1.6	0.52
P3	27/05/2003	1.228	7.5	1.14	1.66
P3	12/06/2003	0.383	6.49	-1.01	0.65
P3	15/07/2003	1.109	9.03	2.54	3.19
P3	13/08/2003	0.91	8.96	0.93	4.12
P3	29/09/2003	1.932	10.42	0.46	4.58
P3	13/10/2003	1.514	8.95	-1.47	3.11
P3	25/11/2003	1.213	6.49	-2.46	0.65
P3	8/12/2003	1.524	9.5	3.01	3.66
P3	21/01/2004	1.736	8.2	-1.3	2.36
P3	17/02/2004	1.632	8.26	0.06	2.42
P3	22/03/2004	1.532	8.9	0.64	3.06
P3	20/04/2004	1.422	8.73	-0.17	2.89
P3	5/05/2004	1.412	7.41	-1.32	1.57
P3	30/06/2004	1.552	9.57	2.16	3.73
P3	16/07/2004	1.522	8.93	-0.64	3.09
P3	2/08/2004	1.851	9.78	0.85	3.94
P3	1/09/2004	0.936	5.03	-4.75	-0.81
P3	13/10/2004	1.993	10.09	5.06	4.25
P3	12/11/2004	2.125	10.01	-0.08	4.17
P3	10/12/2004	1.618	6.93	-3.08	1.09

Descriptive Statistics	
Mean	0.015352113
Standard Error	0.313068402
Median	0.06
Mode	-0.22
Standard Deviation	2.637961243
Sample Variance	6.958839517
Kurtosis	2.056087312
Skewness	0.451566439
Range	15.75
Minimum	-6.54
Maximum	9.21
Sum	1.09
Count	71
Confidence Level(95.0%)	0.624394728

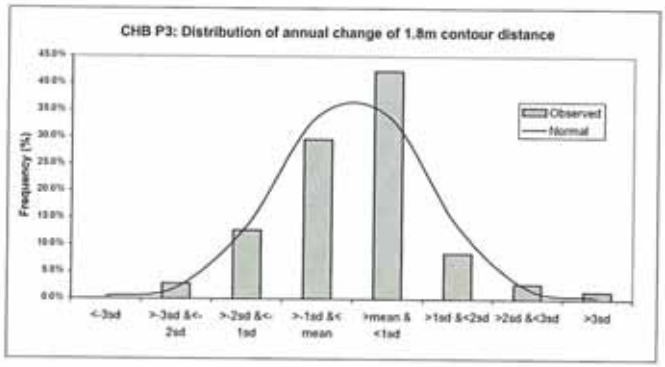
SUMMARY OUTPUT

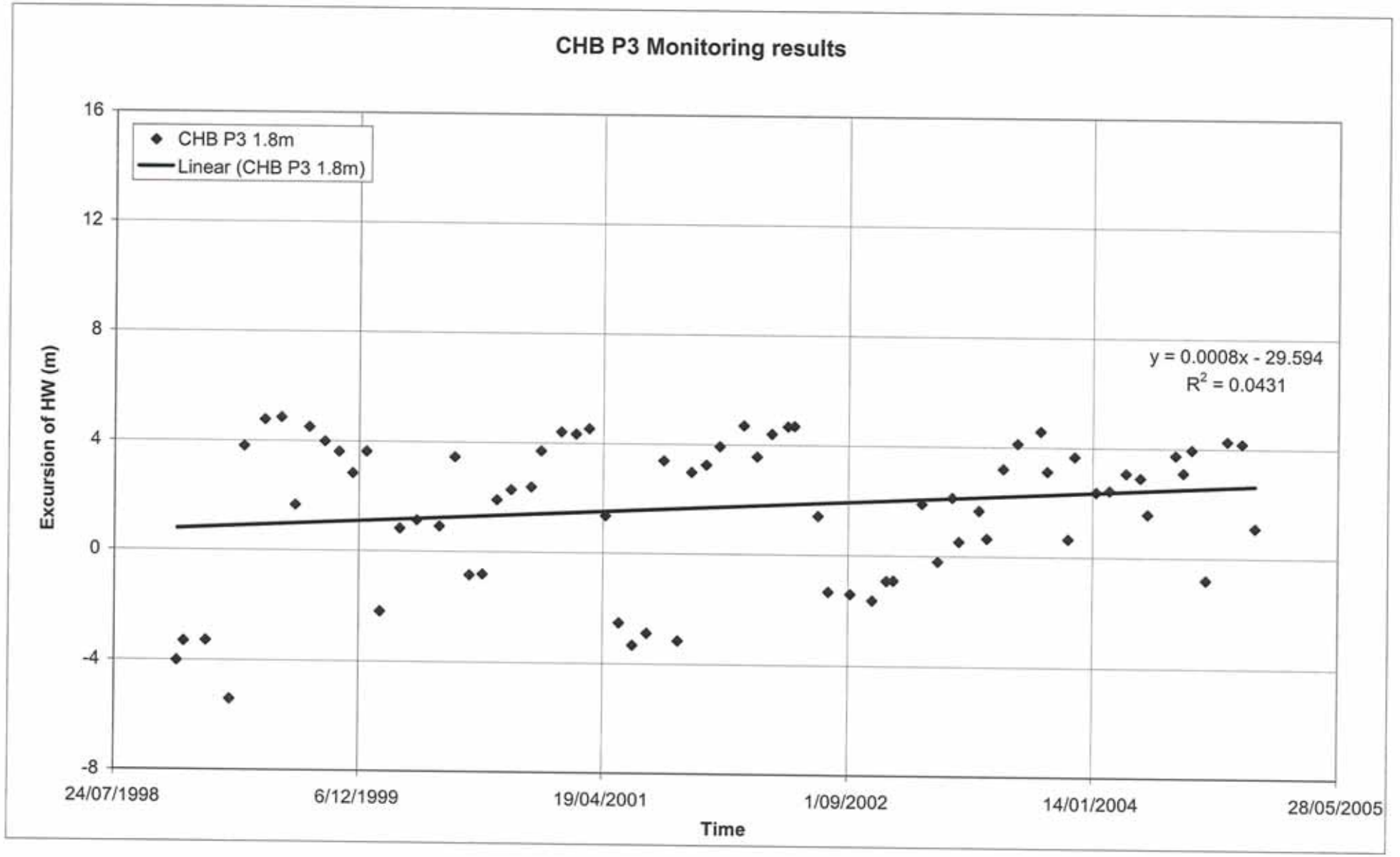
Regression Statistics	
Multiple R	0.207642249
R Square	0.043115304
Adjusted R Square	0.02924741
Standard Error	2.590504701
Observations	71

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-29.59375394	17.76536	-1.66675008	0.100098	-65.0147	5.827217	-65.0147	5.827217
X Variable 1	0.000840361	0.000477	1.763236088	0.082268	-0.00011	0.001791	-0.00011	0.001791

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-7.9			0	0.0%	0.5%
>-3sd &<-2sd	-7.9	to	-5.3	2	2.8%	2.0%
>-2sd &<-1sd	-5.3	to	-2.6	9	12.7%	13.5%
>-1sd &< mean	-2.62	to	0.02	21	29.6%	34.0%
>mean & <1sd	0.02	to	2.65	30	42.3%	34.0%
>1sd &<2sd	2.65	to	5.29	6	8.5%	13.5%
>2sd &<3sd	5.29	to	7.93	2	2.8%	2.0%
>3sd	7.93			1	1.4%	0.5%
				71		




CHB P3 Monitoring results
CHB P3 1.8m
Linear (CHB P3 1.8m)
y = 0.0008x - 29.594
R2 = 0.0431
Excursion of HW (m)
16
12
8
4
0
-4
-8
24/07/1998
6/12/1999
19/04/2001
1/09/2002
14/01/2004
28/05/2005
Time

HB H1 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
H1	1/09/1989	13.28	23	0	0
H1	20/02/1990	16.051	27.3	4.3	4.3
H1	23/05/1990	1.66	28.27	0.97	5.27
H1	5/11/1990	9.405	25.36	-2.91	2.36
H1	1/02/1991	24.938	25.75	0.39	2.75
H1	11/04/1991	0.833	35.56	9.81	12.56
H1	1/07/1991	2.693	35.83	0.27	12.83
H1	18/11/1991	0.511	36.82	0.99	13.82
H1	11/02/1992	27.8	35	-1.82	12
H1	16/03/1992	12.15	35	0	12
H1	13/05/1992	11.9	33.33	-1.67	10.33
H1	12/08/1992	11.188	31.97	-1.36	8.97
H1	13/11/1992	29.421	31.43	-0.54	8.43
H1	25/03/1993	26.636	29.94	-1.49	6.94
H1	3/08/1993	28.97	31	1.06	8
H1	1/10/1993	26.791	27.64	-3.36	4.64
H1	15/01/1994	30.526	28.1	0.46	5.1
H1	1/04/1994	17.584	37.03	8.93	14.03
H1	1/06/1994	34.294	37.08	0.05	14.08
H1	1/07/1994	4.122	33	-4.08	10
H1	1/07/1994	15.757	38.25	5.25	15.25
H1	1/01/1995	19.132	35.76	-2.49	12.76
H1	1/04/1995	16.733	32.26	-3.5	9.26
H1	1/06/1995	16.828	29.7	-2.56	6.7
H1	1/09/1995	15.448	28.86	-0.84	5.86
H1	1/02/1996	23.304	26.91	-1.95	3.91
H1	1/11/1996	13.774	26.49	-0.42	3.49
H1	1/07/1997	9.099	19.88	-6.61	-3.12
H1	1/10/1997	8.253	18.3	-1.58	-4.7
H1	1/01/1998	17.878	18.82	0.52	-4.18
H1	1/04/1998	8.943	20.73	1.91	-2.27
H1	1/11/1998	5.73	16.94	-3.79	-6.06
H1	19/06/2001	26.305	18.56	1.62	-4.44
H1	18/09/2001	25.303	18.28	-0.28	-4.72
H1	27/03/2002	25.378	18.06	-0.22	-4.94

Descriptive Statistics	
Mean	-0.145294118
Standard Error	0.573148921
Median	-0.35
Mode	#N/A
Standard Deviation	3.342003766
Sample Variance	11.1689893
Kurtosis	2.659873415
Skewness	1.275072766
Range	16.42
Minimum	-6.61
Maximum	9.81
Sum	-4.94
Count	34
Confidence Level(95.0%)	1.166081172

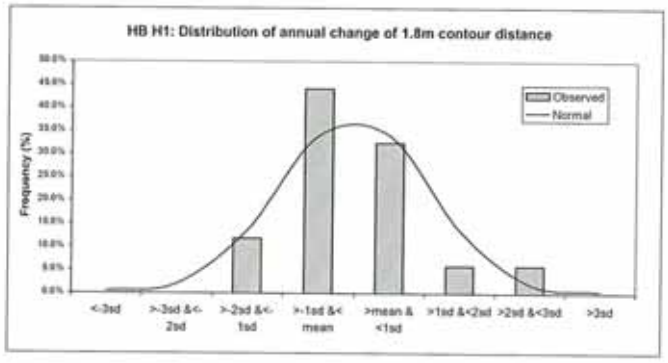
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.698731514
R Square	0.488225728
Adjusted R Square	0.472232762
Standard Error	4.805333122
Observations	34

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	140.8510174	24.4886	5.751696851	2.23E-06	90.96941	190.7326	90.96941	190.7326
X Variable 1	-0.003907317	0.000707	-5.525175729	4.31E-06	-0.00535	-0.00247	-0.00535	-0.00247

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-10.2			0	0.0%	0.5%
>-3sd &<-2sd	-10.2	to	-6.8	0	0.0%	2.0%
>-2sd &<-1sd	-6.8	to	-3.5	4	11.8%	13.5%
>-1sd &< mean	-3.49	to	-0.15	15	44.1%	34.0%
>mean & <1sd	-0.15	to	3.20	11	32.4%	34.0%
>1sd &<2sd	3.20	to	6.54	2	5.9%	13.5%
>2sd &<3sd	6.54	to	9.88	2	5.9%	2.0%
>3sd	9.88			0	0.0%	0.5%
				34		



HB H1 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)	Max Extent Erosion (m)
H1	1/09/1989	2.012	13.85	0	0	
H1	20/02/1990	2.615	14.78	0.93	0.93	
H1	5/11/1990	0.7	12.8	-1.98	-1.05	
H1	1/02/1991	4.294	12.97	0.17	-0.88	
H1	11/02/1992	4.485	13.48	0.51	-0.37	
H1	16/03/1992	0.835	13.48	0	-0.37	
H1	13/05/1992	0.835	13.48	0	-0.37	
H1	12/08/1992	0.737	15.07	1.59	1.22	
H1	13/11/1992	4.54	14.83	-0.24	0.98	
H1	25/03/1993	3.508	13.36	-1.45	-0.47	
H1	3/08/1993	4.841	13.12	-0.26	-0.73	
H1	1/10/1993	4.016	12.63	-0.49	-1.22	-2.44
H1	15/01/1994	6.07	14.27	1.64	0.42	
H1	1/04/1994	1.669	14.77	0.5	0.92	
H1	1/06/1994	6.691	14.77	0	0.92	
H1	1/07/1994	1.188	15.58	0.81	1.73	
H1	1/01/1995	1.831	15.88	0.3	2.03	
H1	1/04/1995	1.395	13.93	-1.95	0.08	
H1	1/06/1995	1.82	14.37	0.44	0.52	
H1	1/09/1995	1.299	14.16	-0.21	0.31	
H1	1/02/1996	4.374	14.52	0.36	0.67	
H1	1/11/1996	1.695	15.83	1.31	1.98	
H1	1/07/1997	1.634	13.7	-2.13	-0.15	
H1	1/10/1997	1.676	13.78	0.08	-0.07	
H1	1/01/1998	4.8	13.41	-0.37	-0.44	
H1	1/04/1998	1.592	13.37	-0.04	-0.48	
H1	1/11/1998	1.294	12.87	-0.5	-0.98	-0.91
H1	19/06/2001	7.426	14.2	1.33	0.35	
H1	18/09/2001	6.715	13.76	-0.44	-0.09	
H1	27/03/2002	6.713	14.11	0.35	0.26	

Descriptive Statistics

Mean	0.008965517
Standard Error	0.181184781
Median	0
Mode	0
Standard Deviation	0.975709796
Sample Variance	0.952009606
Kurtosis	0.390473348
Skewness	-0.586153189
Range	3.77
Minimum	-2.13
Maximum	1.64
Sum	0.26
Count	29
Confidence Level(95.0%)	0.371140574

SUMMARY OUTPUT

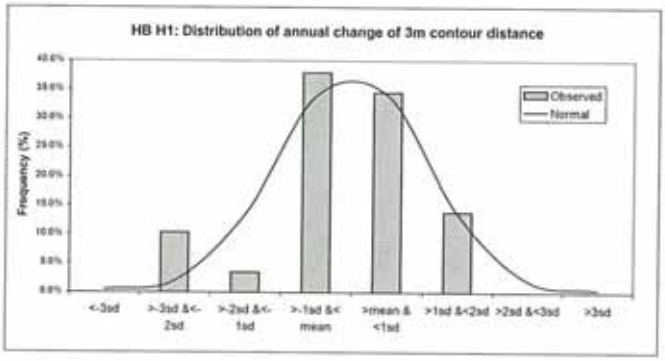
Regression Statistics

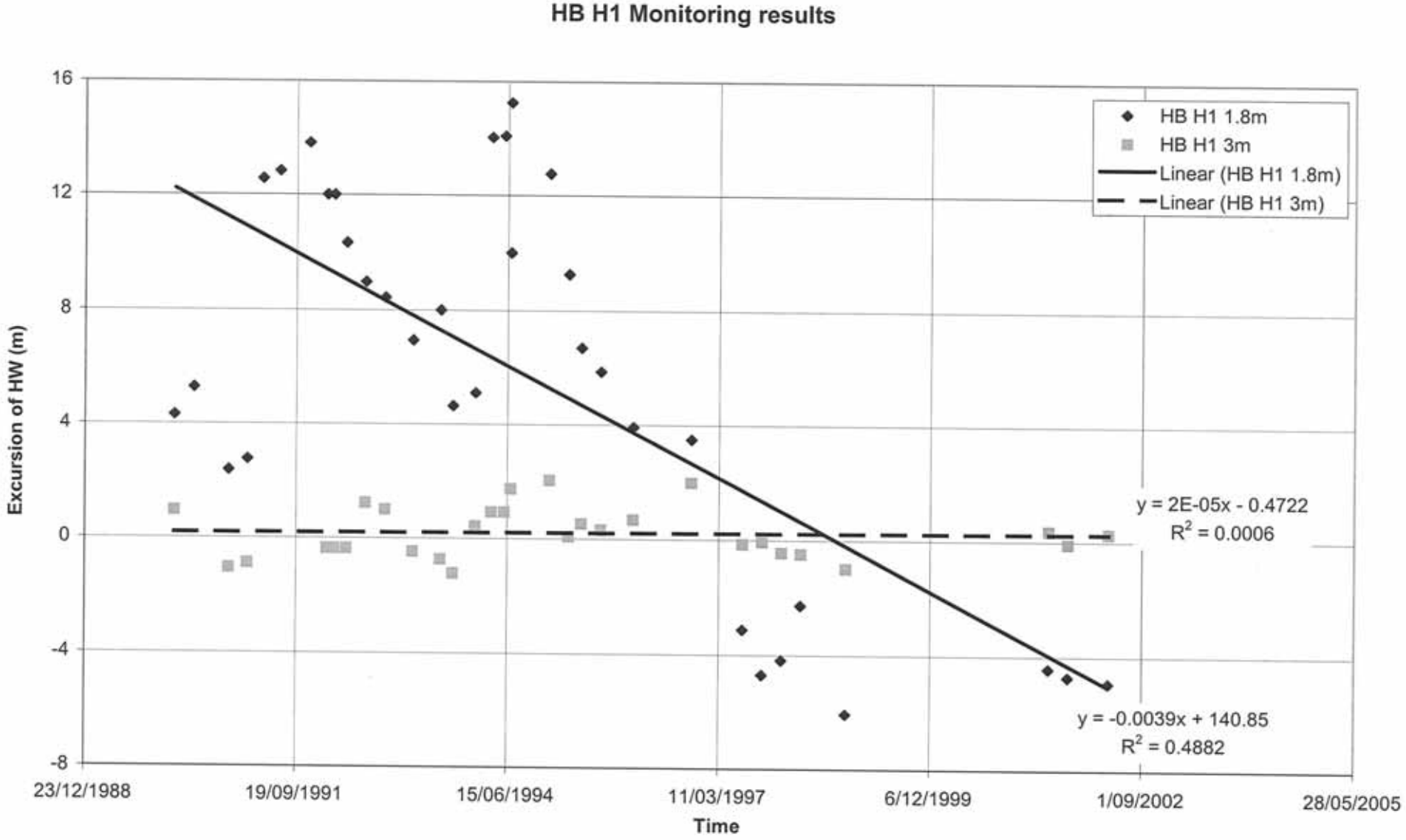
Multiple R	0.025344402
R Square	0.000642339
Adjusted R Square	-0.036370908
Standard Error	0.993977684
Observations	29

	Coefficients	andard Err	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	Upper 95.0%
Intercept	-0.472209018	5.066228	-0.093207218	0.926427	-10.8672	9.922825	-10.8672	9.922825
X Variable 1	1.91745E-05	0.000146	0.131735694	0.89617	-0.00028	0.000318	-0.00028	0.000318

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-2.9			0	0.0%	0.5%
>-3sd &<-2sd	-2.9	to	-1.9	3	10.3%	2.0%
>-2sd &<-1sd	-1.9	to	-1.0	1	3.4%	13.5%
>-1sd &< mean	-0.97	to	0.01	11	37.9%	34.0%
>mean & <1sd	0.01	to	0.98	10	34.5%	34.0%
>1sd &<2sd	0.98	to	1.96	4	13.8%	13.5%
>2sd &<3sd	1.96	to	2.94	0	0.0%	2.0%
>3sd	2.94			0	0.0%	0.5%
				29		




HB H1 Monitoring results
HB H1 1.8m
HB H1 3m
Linear (HB H1 1.8m)
Linear (HB H1 3m)
y = 2E-05x - 0.4722
R2 = 0.0006
y = -0.0039x + 140.85
R2 = 0.4882
Excursion of HW (m)
16
12
8
4
0
-4
-8
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

HB H2 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
H2	1/09/1989	11.195	10	0	0
H2	20/02/1990	0.503	9.53	-0.47	-0.47
H2	23/05/1990	1.083	10.7	1.17	0.7
H2	5/11/1990	0.025	8.5	-2.2	-1.5
H2	1/02/1991	3.357	8.89	0.39	-1.11
H2	11/04/1991	3.587	9.41	0.52	-0.59
H2	1/07/1991	1.059	11.62	2.21	1.62
H2	18/11/1991	1.378	13.88	2.26	3.88
H2	11/02/1992	2.139	11.54	-2.34	1.54
H2	16/03/1992	1.447	11.54	0	1.54
H2	13/05/1992	3.989	12.71	1.17	2.71
H2	12/08/1992	1.103	11.3	-1.41	1.3
H2	13/11/1992	2.525	11.5	0.2	1.5
H2	25/03/1993	2.908	15.33	3.83	5.33
H2	3/08/1993	9.129	12.26	-3.07	2.26
H2	1/10/1993	9.88	7.65	-4.61	-2.35
H2	15/01/1994	9.436	9.55	1.9	-0.45
H2	1/04/1994	6.99	14.53	4.98	4.53
H2	1/06/1994	11.124	14.55	0.02	4.55
H2	1/07/1994	7.689	16	1.45	6
H2	1/07/1994	1.859	11.02	-4.98	1.02
H2	1/01/1995	2.743	13.52	2.5	3.52
H2	1/04/1995	5.061	13.06	-0.46	3.06
H2	1/06/1995	2.411	14.26	1.2	4.26
H2	1/09/1995	5.219	12.91	-1.35	2.91
H2	1/02/1996	8.965	13.9	0.99	3.9
H2	1/11/1996	1.57	10.9	-3	0.9
H2	1/07/1997	5.227	8.94	-1.96	-1.06
H2	1/10/1997	4.415	8.53	-0.41	-1.47
H2	1/01/1998	4.402	7.16	-1.37	-2.84
H2	1/04/1998	5.108	10.63	3.47	0.63
H2	1/11/1998	5.9	8.61	-2.02	-1.39
H2	19/06/2001	8.048	6.92	-1.69	-3.08
H2	18/09/2001	8.353	8.08	1.16	-1.92
H2	27/03/2002	9.167	9.15	1.07	-0.85

Descriptive Statistics	
Mean	-0.025
Standard Error	0.39313817
Median	0.11
Mode	#N/A
Standard Deviation	2.292369754
Sample Variance	5.254959091
Kurtosis	-0.097658415
Skewness	-0.10246286
Range	9.96
Minimum	-4.98
Maximum	4.98
Sum	-0.85
Count	34
Confidence Level(95.0%)	0.799646254

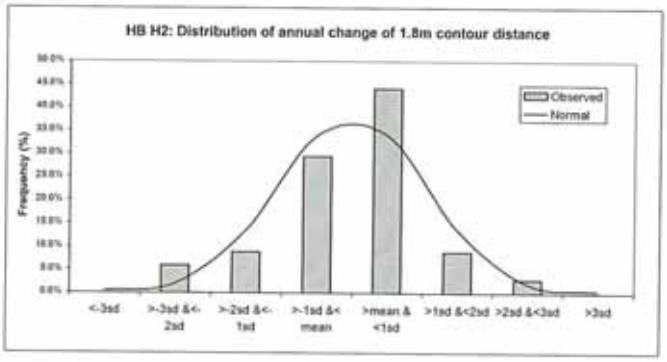
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.318025197
R Square	0.101140026
Adjusted R Square	0.073050652
Standard Error	2.393436245
Observations	34

	Coefficients	*andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	24.26636601	12.19728	1.989492837	0.055251	-0.57862	49.11136	-0.57862	49.11136
X Variable 1	-0.000668377	0.000352	-1.897538072	0.066811	-0.00139	4.91E-05	-0.00139	4.91E-05

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-6.9			0	0.0%	0.5%
>-3sd &<-2sd	-6.9	to	-4.6	2	5.9%	2.0%
>-2sd &<-1sd	-4.6	to	-2.3	3	8.8%	13.5%
>-1sd &< mean	-2.32	to	-0.03	10	29.4%	34.0%
>mean & <1sd	-0.03	to	2.27	15	44.1%	34.0%
>1sd &<2sd	2.27	to	4.56	3	8.8%	13.5%
>2sd &<3sd	4.56	to	6.85	1	2.9%	2.0%
>3sd	6.85			0	0.0%	0.5%
				34		



HB H2 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)	Max Extent Erosion (m)
H2	1/09/1989	4.54	3.99	0	0	
H2	1/02/1991	0.199	4.02	0.03	0.03	
H2	11/04/1991	0.225	3	-1.02	-0.99	
H2	13/05/1992	0.249	3.46	0.46	-0.53	
H2	3/08/1993	2.031	2.73	-0.73	-1.26	
H2	1/10/1993	4.227	3.78	1.05	-0.21	
H2	15/01/1994	2.828	3.49	-0.29	-0.5	
H2	1/04/1994	1.418	3.36	-0.13	-0.63	-0.42
H2	1/06/1994	3.77	3.37	0.01	-0.62	
H2	1/07/1994	1.308	3.18	-0.19	-0.81	
H2	1/04/1995	0.22	3.45	0.27	-0.54	
H2	1/09/1995	0.589	3.52	0.07	-0.47	
H2	1/02/1996	1.467	4.04	0.52	0.05	
H2	1/07/1997	1.16	2.78	-1.26	-1.21	
H2	1/10/1997	1.159	2.71	-0.07	-1.28	-1.33
H2	1/01/1998	1.183	2.75	0.04	-1.24	
H2	1/04/1998	1.3	2.88	0.13	-1.11	
H2	1/11/1998	1.782	3.3	0.42	-0.69	
H2	19/06/2001	3.232	2.82	-0.48	-1.17	
H2	18/09/2001	3.296	2.85	0.03	-1.14	
H2	27/03/2002	3.185	2.8	-0.05	-1.19	

Descriptive Statistics

Mean	-0.0595
Standard Error	0.118367125
Median	0.02
Mode	#N/A
Standard Deviation	0.529353876
Sample Variance	0.280215526
Kurtosis	0.998347646
Skewness	-0.452806769
Range	2.31
Minimum	-1.26
Maximum	1.05
Sum	-1.19
Count	20
Confidence Level(95.0%)	0.247745317

SUMMARY OUTPUT

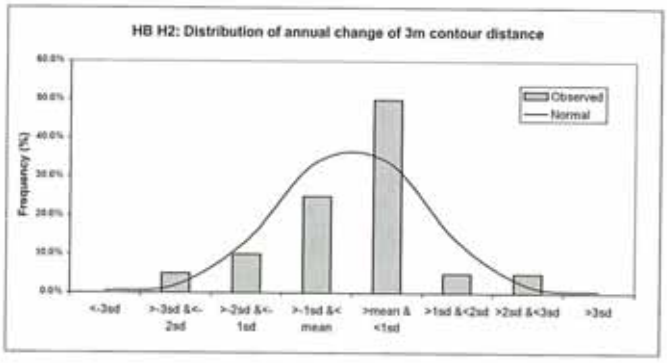
Regression Statistics

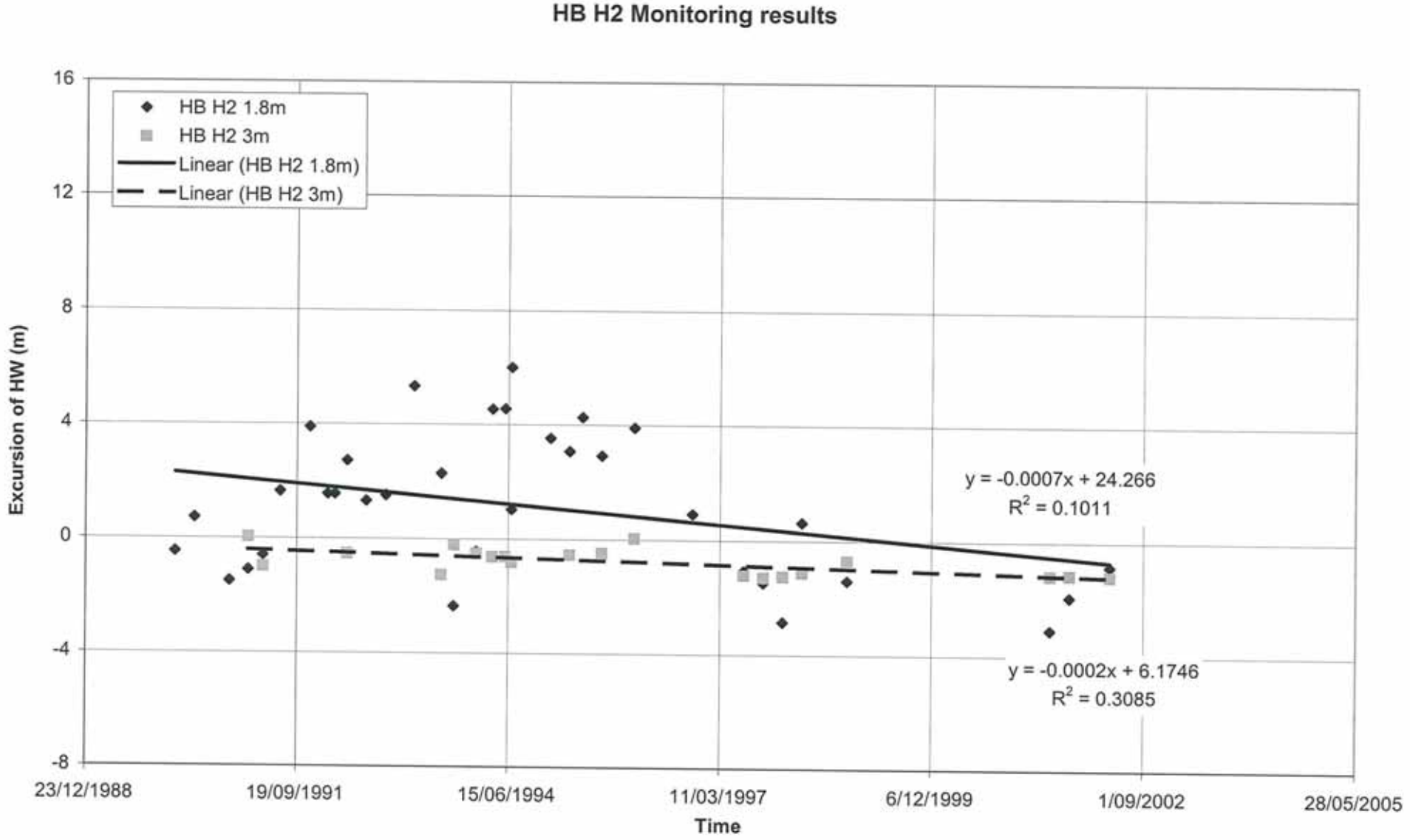
Multiple R	0.555459064
R Square	0.308534771
Adjusted R Square	0.270120036
Standard Error	0.366723265
Observations	20

	Coefficients	andard Err	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	pper 95.0%
Intercept	6.174648448	2.453769	2.516394022	0.02156	1.019468	11.32983	1.019468	11.32983
X Variable 1	-0.000198001	6.99E-05	-2.834021478	0.011003	-0.00034	-5.1E-05	-0.00034	-5.1E-05

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-1.6			0	0.0%	0.5%
>-3sd &<-2sd	-1.6	to	-1.1	1	5.0%	2.0%
>-2sd &<-1sd	-1.1	to	-0.6	2	10.0%	13.5%
>-1sd &< mean	-0.59	to	-0.06	5	25.0%	34.0%
>mean & <1sd	-0.06	to	0.47	10	50.0%	34.0%
>1sd &<2sd	0.47	to	1.00	1	5.0%	13.5%
>2sd &<3sd	1.00	to	1.53	1	5.0%	2.0%
>3sd	1.53			0	0.0%	0.5%
				20		




HB H2 Monitoring results
HB H2 1.8m
HB H2 3m
Linear (HB H2 1.8m)
Linear (HB H2 3m)
y = -0.0007x + 24.266
R2 = 0.1011
y = -0.0002x + 6.1746
R2 = 0.3085
Excursion of HW (m)
16
12
8
4
0
-4
-8
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

LB P1 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	19/08/1982	38.025	18.66	0	0
P1	14/10/1982	38.011	20	1.34	1.34
P1	27/01/1983	38.269	25.82	5.82	7.16
P1	11/08/1983	39.449	26.02	0.2	7.36
P1	20/03/1984	39.842	21.93	-4.09	3.27
P1	4/03/1988	40.859	20.35	-1.58	1.69
P1	18/03/1988	39.811	17.82	-2.53	-0.84
P1	1/05/1990	21.298	20.77	2.95	2.11
P1	1/09/1990	21.362	21.08	0.31	2.42
P1	1/03/1991	21.94	31.92	10.84	13.26
P1	1/09/1991	23.135	24.22	-7.7	5.56
P1	1/03/1992	24.819	33.74	9.52	15.08
P1	1/03/1993	26.047	24.24	-9.5	5.58
P1	1/10/1993	25.951	20.26	-3.98	1.6
P1	1/04/1994	28.48	22.88	2.62	4.22
P1	6/10/1994	27.061	24.81	1.93	6.15
P1	1/04/1995	29.777	27.49	2.68	8.83
P1	22/05/1997	26.943	23.26	-4.23	4.6
P1	16/10/1997	17.062	21.34	-1.92	2.68
P1	9/04/1998	17.94	26.73	5.39	8.07
P1	14/10/1998	17.362	21.62	-5.11	2.96
P1	30/11/1998	12.993	16.86	-4.76	-1.8
P1	14/12/1998	13.609	18.14	1.28	-0.52
P1	28/01/1999	14.272	20.56	2.42	1.9
P1	18/03/1999	20.576	24.63	4.07	5.97
P1	5/04/1999	13.945	20.2	-4.43	1.54
P1	27/05/1999	15.302	21.64	1.44	2.98
P1	30/06/1999	15.871	21.63	-0.01	2.97
P1	29/07/1999	13.749	19.43	-2.2	0.77
P1	26/08/1999	13.985	20.64	1.21	1.98
P1	27/09/1999	14.897	20.79	0.15	2.13
P1	26/10/1999	14.679	21.32	0.53	2.66
P1	23/11/1999	15.128	20	-1.32	1.34
P1	21/12/1999	15.123	20.3	0.3	1.64
P1	19/01/2000	15.161	22.68	2.38	4.02
P1	28/02/2000	14.581	21.25	-1.43	2.59
P1	3/04/2000	14.779	22.38	1.13	3.72
P1	19/05/2000	14.387	19.77	-2.61	1.11
P1	19/06/2000	14.947	19.72	-0.05	1.06
P1	20/07/2000	11.586	15.84	-3.88	-2.82
P1	16/08/2000	11.965	17.97	2.13	-0.69
P1	14/09/2000	13.446	18.93	0.96	0.27
P1	13/10/2000	13.522	18.91	-0.02	0.25
P1	23/11/2000	12.578	19.83	0.92	1.17
P1	13/12/2000	14.25	21.83	2	3.17
P1	23/01/2001	13.949	24.26	2.43	5.6
P1	22/02/2001	12.517	21.36	-2.9	2.7
P1	23/03/2001	15.44	24.28	2.92	5.62
P1	24/04/2001	13.066	20.12	-4.16	1.46
P1	22/05/2001	13.954	19.25	-0.87	0.59
P1	19/06/2001	13.26	18.97	-0.28	0.31
P1	18/07/2001	14.104	20.42	1.45	1.76
P1	20/08/2001	14.648	22.7	2.28	4.04
P1	18/09/2001	13.959	21.79	-0.91	3.13
P1	17/10/2001	14.414	23.5	1.71	4.84
P1	15/11/2001	14.488	21.27	-2.23	2.61
P1	12/12/2001	14.844	22.54	1.27	3.88
P1	30/01/2002	14.73	22.1	-0.44	3.44
P1	26/02/2002	14.898	22.64	0.54	3.98
P1	28/03/2002	14.914	21.92	-0.72	3.26
P1	30/04/2002	15.129	20.94	-0.98	2.28
P1	13/05/2002	14.707	21.51	0.57	2.85
P1	11/06/2002	15.133	20.92	-0.59	2.26
P1	23/07/2002	14.601	19.09	-1.83	0.43
P1	21/08/2002	14.826	20.16	1.07	1.5
P1	6/09/2002	14.865	19.84	-0.32	1.18
P1	21/10/2002	15.739	21.79	1.95	3.13
P1	19/11/2002	15.646	22.22	0.43	3.56
P1	3/12/2002	16.252	23.3	1.08	4.64
P1	30/01/2003	15.129	20.31	-2.99	1.65
P1	28/02/2003	14.379	19.81	-0.5	1.15
P1	2/04/2003	14.875	20.32	0.51	1.66
P1	16/04/2003	15.136	20.85	0.53	2.19
P1	27/05/2003	15.45	20.08	-0.77	1.42
P1	12/06/2003	14.305	18.98	-1.1	0.32
P1	15/07/2003	15.736	24.64	5.66	5.98
P1	13/08/2003	16.526	21.1	-3.54	2.44
P1	29/09/2003	16.366	21.42	0.32	2.76
P1	13/10/2003	17.005	22.53	1.11	3.87
P1	25/11/2003	16.169	22.16	-0.37	3.5
P1	8/12/2003	15.981	21.02	-0.24	3.26
P1	17/02/2004	18.215	24.99	3.07	6.33
P1	22/03/2004	18.385	22.46	-2.53	3.8
P1	20/04/2004	19.781	22.78	0.32	4.12
P1	5/05/2004	20.496	22.84	0.06	4.18
P1	30/06/2004	19.833	22.98	0.14	4.32
P1	16/07/2004	18.875	21.76	-1.22	3.1
P1	2/08/2004	19.852	23.29	1.53	4.63
P1	1/09/2004	20.225	22.28	-1.01	3.62
P1	13/10/2004	18.963	22.49	0.21	3.83
P1	12/11/2004	19.996	22.79	0.3	4.13

Descriptive Statistics

Mean	0.045888889
Standard Error	0.317127317
Median	0.205
Mode	0.53
Standard Deviation	3.00853389
Sample Variance	9.051276167
Kurtosis	2.896194928
Skewness	0.288882815
Range	20.34
Minimum	-9.5
Maximum	10.84
Sum	4.13
Count	90
Confidence Level(95.0%)	0.630124882

SUMMARY OUTPUT

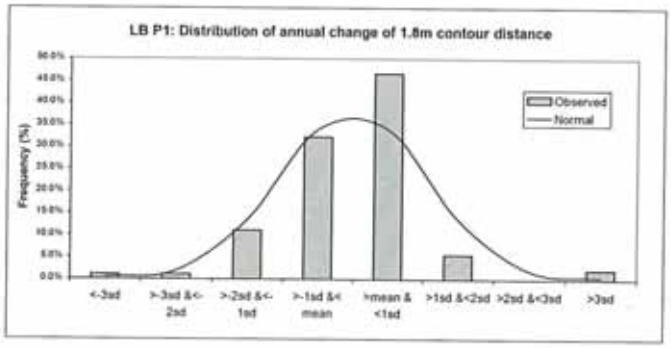
Regression Statistics

Multiple R	0.236656299
R Square	0.056006204
Adjusted R Square	0.045279002
Standard Error	2.803263162
Observations	90

	Coefficients	*andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	15.21266507	5.294577	2.87329206	0.005091	4.690998	25.73473	4.690998	25.73473
X Variable 1	-0.000332114	0.000145	-2.284940179	0.024721	-0.00062	-4.3E-05	-0.00062	-4.3E-05

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-9.0			1	1.1%	0.5%
>-3sd &<-2sd	-9.0	to	-6.0	1	1.1%	2.0%
>-2sd &<-1sd	-6.0	to	-3.0	10	11.1%	13.5%
>-1sd &< mean	-2.96	to	0.05	29	32.2%	34.0%
>mean & <1sd	0.05	to	3.05	42	46.7%	34.0%
>1sd &<2sd	3.05	to	6.06	5	5.6%	13.5%
>2sd &<3sd	6.06	to	9.07	0	0.0%	2.0%
>3sd	9.07			2	2.2%	0.5%
				90		



LB P1 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	19/08/1982	16.575	5.16	0.00	0.00
P1	14/10/1982	14.809	4.16	-1.00	-1.00
P1	27/01/1983	16.537	5.16	1.00	0.00
P1	11/08/1983	16.794	5.46	0.30	0.30
P1	20/03/1984	17.592	5.73	0.27	0.57
P1	4/03/1988	18.545	6.42	0.69	1.26
P1	18/03/1988	18.303	6.83	0.41	1.67
P1	1/05/1990	5.629	7.85	1.02	2.69
P1	1/09/1990	5.123	8.51	0.66	3.35
P1	1/03/1991	5.066	8.75	0.24	3.59
P1	1/09/1991	6.348	9.57	0.82	4.41
P1	1/03/1992	6.522	10.03	0.46	4.87
P1	1/03/1993	7.237	10.78	0.75	5.62
P1	1/10/1993	8.243	11.33	0.55	6.17
P1	1/04/1994	9.961	11.33	0.00	6.17
P1	8/10/1994	8.393	11.57	0.24	6.41
P1	1/04/1995	10.337	12.05	0.48	6.89
P1	22/05/1997	8.087	12.07	0.02	6.91
P1	16/10/1997	3.732	10.76	-1.31	5.60
P1	9/04/1998	3.746	10.4	-0.36	5.24
P1	14/10/1998	3.286	11.58	1.18	6.42
P1	30/11/1998	3.167	8.92	-2.66	3.76
P1	14/12/1998	3.311	8.87	-0.05	3.71
P1	28/01/1999	3.106	8.89	0.02	3.73
P1	18/03/1999	5.129	8.39	-0.50	3.23
P1	5/04/1999	2.515	8.65	0.26	3.49
P1	27/05/1999	2.873	8.83	0.18	3.67
P1	30/06/1999	2.74	8.82	-0.01	3.66
P1	29/07/1999	2.259	8.52	-0.30	3.36
P1	26/08/1999	2.349	8.31	-0.21	3.15
P1	27/09/1999	2.716	8.74	0.43	3.58
P1	26/10/1999	2.623	8.63	-0.11	3.47
P1	23/11/1999	2.875	8.78	0.15	3.62
P1	21/12/1999	2.872	8.82	0.04	3.66
P1	19/01/2000	2.613	8.45	-0.37	3.29
P1	28/02/2000	2.606	8.71	0.26	3.55
P1	3/04/2000	2.408	8.64	-0.07	3.48
P1	19/05/2000	2.742	8.62	-0.02	3.46
P1	19/06/2000	3.02	9.02	0.40	3.86
P1	20/07/2000	2.745	7.83	-1.19	2.67
P1	16/08/2000	2.903	7.73	-0.10	2.57
P1	14/09/2000	2.762	7.66	-0.07	2.50
P1	13/10/2000	2.607	7.63	-0.03	2.47
P1	23/11/2000	2.523	7.39	-0.24	2.23
P1	13/12/2000	2.703	7.63	0.24	2.47
P1	23/01/2001	2.714	7.54	-0.09	2.38
P1	22/02/2001	2.59	7.35	-0.19	2.19
P1	23/03/2001	2.749	7.55	0.20	2.39
P1	24/04/2001	2.861	7.6	0.05	2.44
P1	22/05/2001	2.96	7.54	-0.06	2.38
P1	19/06/2001	2.732	7.37	-0.17	2.21
P1	18/07/2001	2.979	7.58	0.21	2.42
P1	20/08/2001	2.768	7.74	0.16	2.58
P1	19/09/2001	2.896	7.47	-0.27	2.31
P1	17/10/2001	3.052	7.77	0.30	2.61
P1	15/11/2001	2.692	7.73	-0.04	2.57
P1	12/12/2001	2.718	7.96	0.23	2.80
P1	30/01/2002	2.803	7.63	-0.33	2.47
P1	26/02/2002	2.925	7.63	0.00	2.47
P1	28/03/2002	2.754	7.48	-0.15	2.32
P1	30/04/2002	2.855	7.67	0.19	2.51
P1	13/05/2002	2.628	7.68	0.01	2.52
P1	11/06/2002	2.825	7.66	-0.02	2.50
P1	23/07/2002	3.04	8.2	0.54	3.04
P1	21/08/2002	2.977	8.24	0.04	3.08
P1	6/09/2002	2.973	8.25	0.01	3.09
P1	21/10/2002	3.016	8.77	0.52	3.61
P1	19/11/2002	2.984	8.72	-0.05	3.56
P1	3/12/2002	3.056	8.44	-0.28	3.28
P1	30/01/2003	3.01	8.37	-0.07	3.21
P1	28/02/2003	2.806	8.41	0.04	3.25
P1	2/04/2003	2.855	8.53	0.12	3.37
P1	16/04/2003	3.047	8.09	-0.44	2.93
P1	27/05/2003	2.815	8.51	0.42	3.35
P1	12/06/2003	2.786	8.04	-0.47	2.88
P1	15/07/2003	2.893	9.01	0.97	3.85
P1	13/08/2003	3.04	8.93	-0.08	3.77
P1	29/09/2003	3.034	8.72	-0.21	3.56
P1	13/10/2003	3.08	8.83	0.11	3.67
P1	25/11/2003	2.825	8.69	-0.14	3.53
P1	8/12/2003	3.108	8.87	0.18	3.71
P1	17/02/2004	3.969	8.64	-0.23	3.48
P1	22/03/2004	4.102	8.98	0.34	3.82
P1	20/04/2004	4.307	9.34	0.36	4.18
P1	5/05/2004	4.59	9.68	0.34	4.52
P1	30/06/2004	4.14	9.1	-0.58	3.94
P1	16/07/2004	4.319	9.26	0.16	4.10
P1	2/08/2004	4.22	9.47	0.21	4.31
P1	1/09/2004	4.587	9.53	0.06	4.37
P1	13/10/2004	4.017	9.06	-0.47	3.90
P1	12/11/2004	4.386	9.54	0.78	4.68

Descriptive Statistics

Mean	0.052
Standard Error	0.054294292
Median	0.04
Mode	0.24
Standard Deviation	0.515080682
Sample Variance	0.265308315
Kurtosis	8.385005589
Skewness	-1.710839748
Range	3.84
Minimum	-2.66
Maximum	1.18
Sum	4.68
Count	90
Confidence Level(95.0%)	0.107881544

SUMMARY OUTPUT

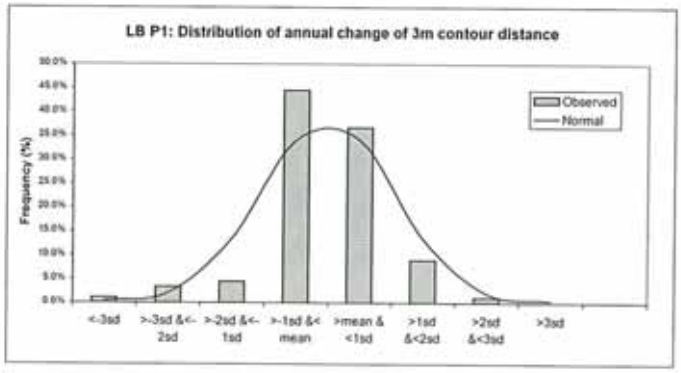
Regression Statistics

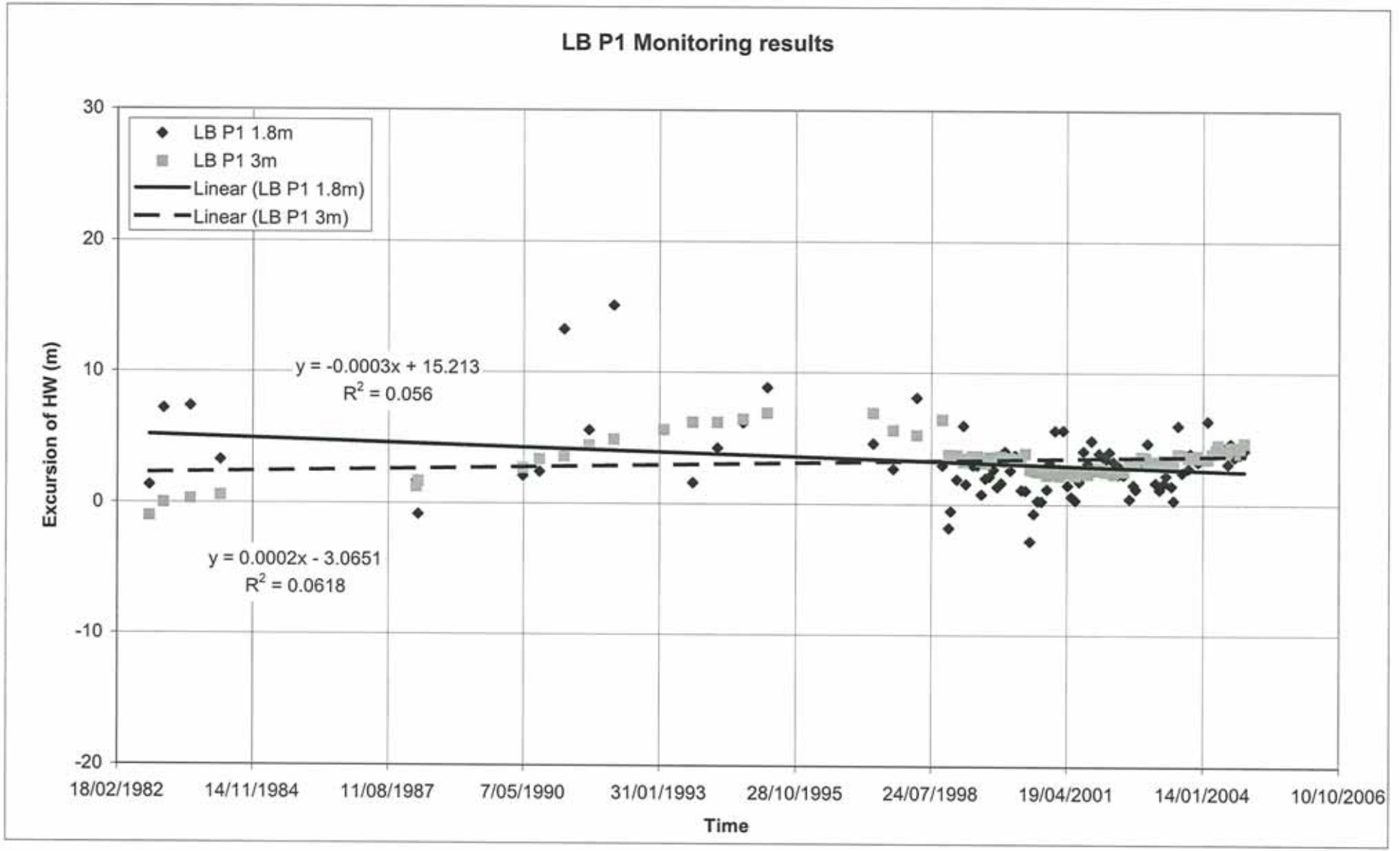
Multiple R	0.248614109
R Square	0.061808975
Adjusted R Square	0.051147714
Standard Error	1.312636092
Observations	90

	Coefficients	tandard Er	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	Upper 95.0%
Intercept	-3.065073552	2.66967	-1.14811	0.254035	-8.37048	2.240338	-8.37048	2.240338
X Variable 1	0.000178465	7.33E-05	2.407806	0.018137	3.08E-05	0.000322	3.08E-05	0.000322

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-1.5			1	1.1%	0.5%
>-3sd &<-2sd	-1.5	to	-1.0	3	3.3%	2.0%
>-2sd &<-1sd	-1.0	to	-0.5	4	4.4%	13.5%
>-1sd &< mean	-0.46	to	0.05	40	44.4%	34.0%
>mean & <1sd	0.05	to	0.57	33	36.7%	34.0%
>1sd &<2sd	0.57	to	1.08	8	8.9%	13.5%
>2sd &<3sd	1.08	to	1.60	1	1.1%	2.0%
>3sd	1.60			0	0.0%	0.5%
				90		




LB P1 Monitoring results
LB P1 1.8m
LB P1 3m
Linear (LB P1 1.8m)
Linear (LB P1 3m)
y = -0.0003x + 15.213
R2 = 0.056
y = 0.0002x - 3.0651
R2 = 0.0618
Excursion of HW (m)
30
20
10
0
-10
-20
18/02/1982
14/11/1984
11/08/1987
7/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
Time

LB P2 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	1/05/1990	24.957	20.85	0.00	0.00
P2	1/09/1990	25.723	22.51	1.66	1.66
P2	1/03/1991	27.265	34.26	11.75	13.41
P2	1/09/1991	25.224	25.63	-8.63	4.78
P2	1/03/1992	26.831	43.13	17.50	22.28
P2	1/10/1992	28.637	27.88	-15.25	7.03
P2	1/03/1993	31.191	28.22	0.34	7.37
P2	1/10/1993	32.338	25.29	-2.93	4.44
P2	1/04/1994	31.396	31.91	6.62	11.06
P2	6/10/1994	34.633	26.64	-5.27	5.79
P2	6/04/1995	35.436	32.79	6.15	11.94
P2	22/05/1997	29.641	20.49	-12.30	-0.36
P2	16/10/1997	40.217	25.52	5.03	4.67
P2	9/04/1998	38.179	29	3.48	8.15
P2	14/10/1998	36.348	19.84	-9.16	-1.01
P2	30/11/1998	35.276	18.9	-0.94	-1.95
P2	14/12/1998	34.953	20.74	1.84	-0.11
P2	28/01/1999	33.883	18.63	-2.11	-2.22
P2	18/03/1999	35.833	20.3	1.67	-0.55
P2	15/04/1999	34.849	20.03	-0.27	-0.82
P2	27/05/1999	33.587	18.62	-1.41	-2.23
P2	30/06/1999	35.787	19.82	1.20	-1.03
P2	29/07/1999	33.097	17.73	-2.09	-3.12
P2	26/08/1999	32.793	18.28	0.55	-2.57
P2	27/09/1999	35.974	21.16	2.88	0.31
P2	26/10/1999	34.719	20	-1.16	-0.85
P2	23/11/1999	34.954	20.51	0.51	-0.34
P2	21/12/1999	31.292	16.08	-4.43	-4.77
P2	19/01/2000	35.735	24.04	7.96	3.19
P2	28/02/2000	34.686	24.36	0.32	3.51
P2	3/04/2000	35.567	27.15	2.79	6.30
P2	19/05/2000	35.598	23.09	-4.06	2.24
P2	19/06/2000	34.588	23.1	0.01	2.25
P2	20/07/2000	31.119	17.87	-5.23	-2.98
P2	16/08/2000	30.937	17.44	-0.43	-3.41
P2	14/09/2000	30.417	16.78	-0.66	-4.07
P2	13/10/2000	30.15	15.96	-0.82	-4.89
P2	23/11/2000	31.279	19.5	3.54	-1.35
P2	13/12/2000	31.864	20.11	0.61	-0.74
P2	23/01/2001	32.377	20.37	0.26	-0.48
P2	22/02/2001	28.993	17.48	-2.89	-3.37
P2	21/03/2001	32.896	21.4	3.92	0.55
P2	24/04/2001	31.847	21.04	-0.36	0.19
P2	22/05/2001	30.051	18	-3.04	-2.85
P2	19/06/2001	30.035	17.63	-0.37	-3.22
P2	18/07/2001	29.321	18.63	1.00	-2.22
P2	20/08/2001	30.55	21.18	2.55	0.33
P2	19/09/2001	30.182	20.85	-0.33	0.00
P2	17/10/2001	29.321	18.63	-2.22	-2.22
P2	15/11/2001	30	19.95	1.32	-0.90
P2	12/12/2001	30.272	20.6	0.65	-0.25
P2	30/01/2002	31.972	21.06	0.46	0.21
P2	26/02/2002	32.502	23.28	2.22	2.43
P2	28/03/2002	31.738	21.97	-1.31	1.12
P2	30/04/2002	33.081	21.74	-0.23	0.89
P2	13/05/2002	31.979	21.97	0.23	1.12
P2	11/06/2002	36.354	26.99	5.02	6.14
P2	23/07/2002	31.045	18.71	-8.28	-2.14
P2	21/08/2002	29.779	19.31	0.60	-1.54
P2	6/09/2002	32.657	22.33	3.02	1.48
P2	21/10/2002	32.841	23.61	1.28	2.76
P2	19/11/2002	31.891	24.3	0.69	3.45
P2	10/12/2002	30.728	22.02	-2.28	1.17
P2	30/01/2003	33.831	28.2	6.18	7.35
P2	28/02/2003	34.346	24.44	-3.76	3.59
P2	2/04/2003	33.961	23.56	-0.88	2.71
P2	16/04/2003	32.718	21.84	-1.72	0.99
P2	27/05/2003	31.655	20.36	-1.48	-0.49
P2	12/06/2003	33.359	21.22	0.86	0.37
P2	15/07/2003	110.378	22.73	1.51	1.88
P2	13/08/2003	109.148	20.36	-2.37	-0.49
P2	13/10/2003	111.214	23.47	3.11	2.62
P2	25/11/2003	115.087	27.24	3.77	6.39
P2	8/12/2003	110.875	24.75	-2.49	3.90
P2	21/01/2004	115.901	32.48	7.73	11.63
P2	17/02/2004	120.21	33.7	1.22	12.85
P2	22/03/2004	113.573	31.62	-2.08	10.77
P2	29/03/2004	114.039	32.13	0.51	11.28
P2	20/04/2004	116.192	27.92	-4.21	7.07
P2	5/05/2004	110.883	25.48	-2.44	4.63
P2	30/06/2004	118.174	36.08	10.60	15.23
P2	16/07/2004	115.498	36.48	0.40	15.63
P2	2/08/2004	115.437	36.52	0.04	15.67
P2	1/09/2004	113.385	34.59	-1.93	13.74
P2	13/10/2004	116.718	35.44	0.85	14.59
P2	12/11/2004	116.355	42.62	7.18	21.77
P2	10/12/2004	115.848	31.51	-11.11	10.66

Descriptive Statistics	
Mean	0.123953488
Standard Error	0.518593839
Median	0.29
Mode	0.51
Standard Deviation	4.809241417
Sample Variance	23.12680301
Kurtosis	2.912724471
Skewness	0.06797334
Range	32.75
Minimum	-15.25
Maximum	17.5
Sum	10.66
Count	86
Confidence Level(95.0%)	1.031104108

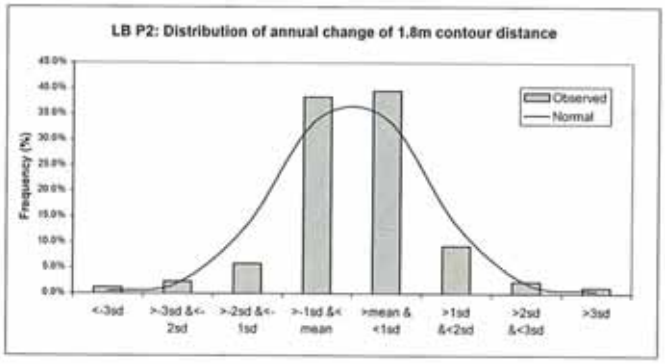
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.006104527
R Square	3.72652E-05
Adjusted R Square	-0.011867053
Standard Error	6.067370967
Observations	86

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	2.147557404	19.40338	0.11068	0.912134	-36.4382	40.73331	-36.4382	40.73331
X Variable 1	2.94808E-05	0.000527	0.05595	0.955515	-0.00102	0.001077	-0.00102	0.001077

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-14.3			1	1.2%	0.5%
>-3sd &<-2sd	-14.3	to	-9.5	2	2.3%	2.0%
>-2sd &<-1sd	-9.5	to	-4.7	5	5.8%	13.5%
>-1sd &< mean	-4.69	to	0.12	33	38.4%	34.0%
>mean & <1sd	0.12	to	4.93	34	39.5%	34.0%
>1sd &<2sd	4.93	to	9.74	8	9.3%	13.5%
>2sd &<3sd	9.74	to	14.55	2	2.3%	2.0%
>3sd	14.55			1	1.2%	0.5%
				86		



LB P2 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	1/05/1990	9.742	7.46	0.00	0.00
P2	1/09/1990	9.84	8.76	1.30	1.30
P2	1/03/1991	9.986	9.29	0.53	1.83
P2	1/09/1991	8.184	9.85	0.56	2.39
P2	1/03/1992	8.621	10.65	0.80	3.19
P2	1/10/1992	9.975	11.16	0.51	3.70
P2	1/03/1993	11.227	11.51	0.35	4.05
P2	1/10/1993	12.197	12.14	0.63	4.68
P2	1/04/1994	11.188	11.13	-1.01	3.67
P2	6/10/1994	14.263	12.49	1.36	5.03
P2	6/04/1995	13.973	13.04	0.55	5.58
P2	22/05/1997	12.338	12.88	-0.16	5.42
P2	16/10/1997	18.842	13.37	0.49	5.91
P2	9/04/1998	17.243	13.09	-0.28	5.63
P2	14/10/1998	17.697	13.51	0.42	6.05
P2	30/11/1998	18.397	12.75	-0.76	5.29
P2	14/12/1998	17.142	12.37	-0.38	4.91
P2	28/01/1999	16.887	12.23	-0.14	4.77
P2	18/03/1999	18.385	12.42	0.19	4.96
P2	15/04/1999	17.18	12	-0.42	4.54
P2	27/05/1999	16.507	11.76	-0.24	4.30
P2	30/06/1999	17.624	12.72	0.96	5.26
P2	29/07/1999	16.353	12.15	-0.57	4.69
P2	26/08/1999	16.38	11.78	-0.37	4.32
P2	27/09/1999	18.11	12.36	0.58	4.90
P2	26/10/1999	17.591	11.66	-0.70	4.20
P2	23/11/1999	17.307	11.4	-0.26	3.94
P2	21/12/1999	15.673	11.97	0.57	4.51
P2	19/01/2000	17.36	11.55	-0.42	4.09
P2	28/02/2000	15.958	12.03	0.48	4.57
P2	3/04/2000	16.577	11.8	-0.23	4.34
P2	19/05/2000	16.798	11.76	-0.04	4.30
P2	19/06/2000	15.991	11.77	0.01	4.31
P2	20/07/2000	15.757	10.55	-1.22	3.09
P2	16/08/2000	15.681	10.89	0.34	3.43
P2	14/09/2000	15.715	10.63	-0.26	3.17
P2	13/10/2000	15.338	10.59	-0.04	3.13
P2	23/11/2000	15.566	10.55	-0.04	3.09
P2	13/12/2000	15.387	10.57	0.02	3.11
P2	23/01/2001	15.137	10.43	-0.14	2.97
P2	22/02/2001	13.905	10.07	-0.36	2.61
P2	21/03/2001	15.28	10.71	0.64	3.25
P2	24/04/2001	14.426	10.62	-0.09	3.16
P2	22/05/2001	14.772	10.28	-0.34	2.82
P2	19/06/2001	15.081	10.06	-0.22	2.60
P2	18/07/2001	14.128	10.46	0.40	3.00
P2	20/08/2001	14.358	9.9	-0.56	2.44
P2	19/09/2001	14.392	9.93	0.03	2.47
P2	17/10/2001	14.128	10.46	0.53	3.00
P2	15/11/2001	13.918	9.92	-0.54	2.46
P2	12/12/2001	13.739	10.16	0.24	2.70
P2	30/01/2002	14.606	10.08	-0.08	2.62
P2	26/02/2002	14.363	10.73	0.65	3.27
P2	28/03/2002	14.287	10.45	-0.28	2.99
P2	30/04/2002	15.023	10.5	0.05	3.04
P2	13/05/2002	14.066	10	-0.50	2.54
P2	11/06/2002	14.695	11.4	1.40	3.94
P2	23/07/2002	14.497	9.69	-1.71	2.23
P2	21/08/2002	14.184	9.24	-0.45	1.78
P2	6/09/2002	14.949	10.13	0.89	2.67
P2	21/10/2002	14.894	10.34	0.21	2.88
P2	19/11/2002	14.085	10.32	-0.02	2.86
P2	10/12/2002	13.429	9.98	-0.34	2.52
P2	30/01/2003	14.939	10.27	0.29	2.81
P2	28/02/2003	14.663	10.63	0.36	3.17
P2	2/04/2003	15.051	10.48	-0.15	3.02
P2	16/04/2003	14.537	10.26	-0.22	2.80
P2	27/05/2003	13.983	10.2	-0.06	2.74
P2	12/06/2003	15.331	10.52	0.32	3.06
P2	15/07/2003	63.573	10.58	0.06	3.12
P2	13/08/2003	63.351	10.53	-0.05	3.07
P2	13/10/2003	63.852	10.78	0.25	3.32
P2	25/11/2003	67.177	10.78	0.00	3.32
P2	8/12/2003	63.402	10.51	-0.27	3.05
P2	21/01/2004	65.941	11.3	0.79	3.84
P2	17/02/2004	68.204	11.32	0.02	3.86
P2	22/03/2004	65.265	10.91	-0.41	3.45
P2	29/03/2004	65.505	10.97	0.06	3.51
P2	20/04/2004	65.79	10.94	-0.03	3.48
P2	5/05/2004	62.878	10.84	-0.10	3.38
P2	30/06/2004	67.181	11.55	0.71	4.09
P2	16/07/2004	64.142	11.76	0.21	4.30
P2	2/08/2004	65.118	10.82	-0.94	3.36
P2	1/09/2004	64.012	11.1	0.28	3.64
P2	13/10/2004	66.51	11.77	0.67	4.31
P2	12/11/2004	66.629	11.94	0.17	4.48
P2	10/12/2004	65.323	11.84	-0.10	4.38

Descriptive Statistics	
Mean	0.050930233
Standard Error	0.05835821
Median	-0.01
Mode	-0.42
Standard Deviation	0.541191774
Sample Variance	0.292888536
Kurtosis	0.995615934
Skewness	-0.10145622
Range	3.11
Minimum	-1.71
Maximum	1.4
Sum	4.38
Count	86
Confidence Level(95.0%)	0.116031826

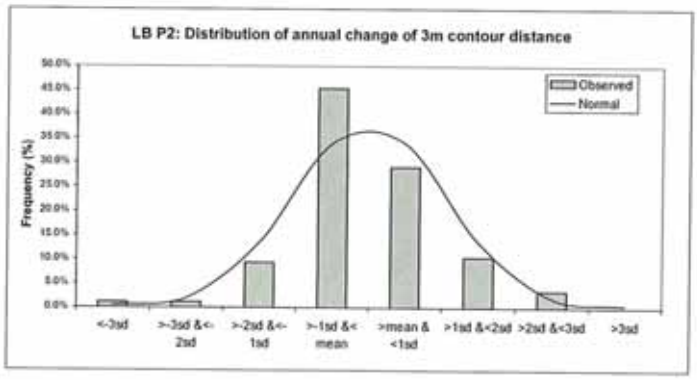
SUMMARY OUTPUT

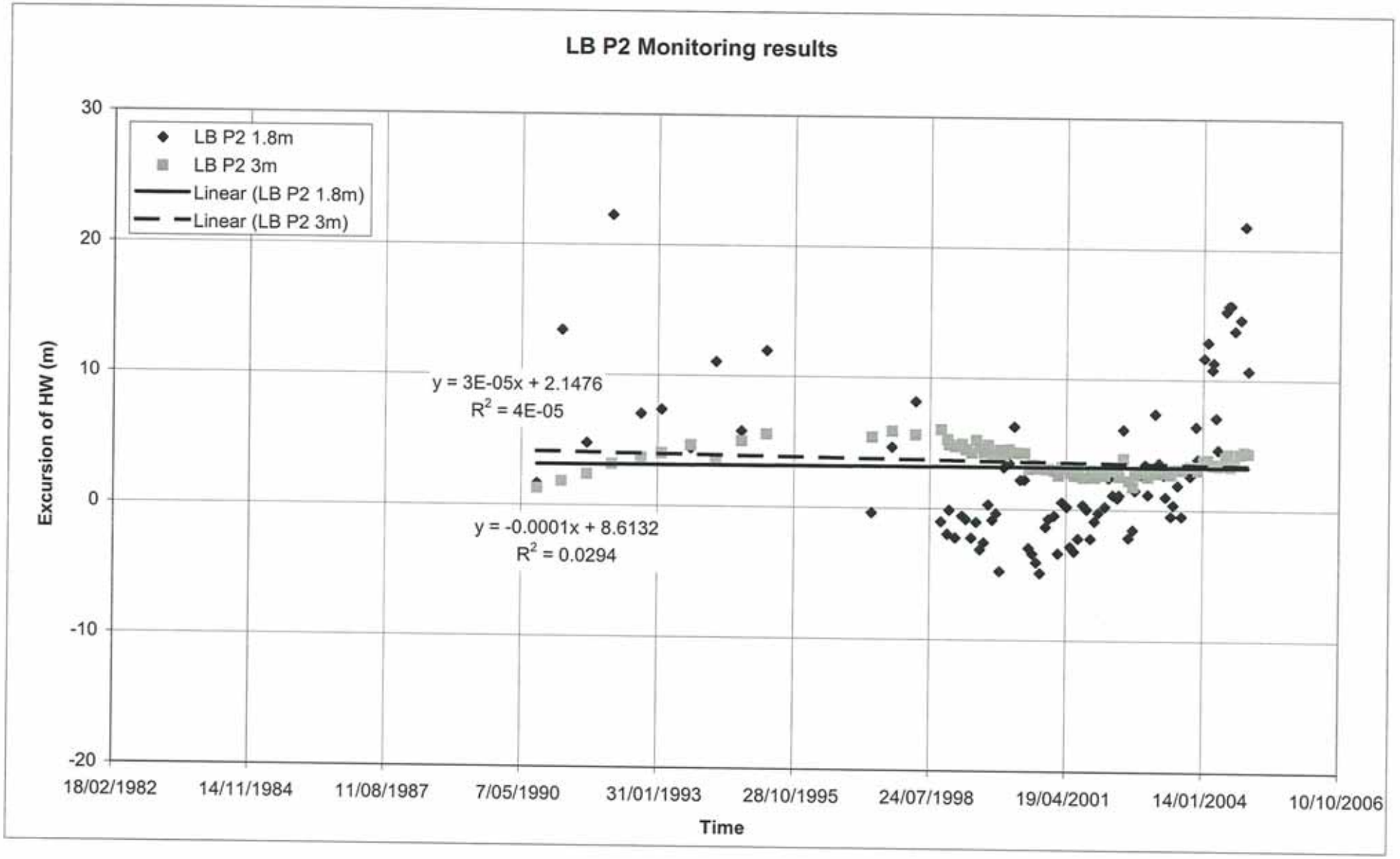
Regression Statistics	
Multiple R	0.171550535
R Square	0.029429586
Adjusted R Square	0.017875176
Standard Error	0.981816187
Observations	86

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	8.613159273	3.139836	2.743186	0.007436	2.369249	14.85707	2.369249	14.85707
X Variable 1	-0.000136078	8.53E-05	-1.595946	0.114256	-0.000306	3.35E-05	-0.000306	3.35E-05

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-1.6			1	1.2%	0.5%
>-3sd &<-2sd	-1.6	to	-1.0	1	1.2%	2.0%
>-2sd &<-1sd	-1.0	to	-0.5	8	9.3%	13.5%
>-1sd &< mean	-0.49	to	0.05	39	45.3%	34.0%
>mean & <1sd	0.05	to	0.59	25	29.1%	34.0%
>1sd &<2sd	0.59	to	1.13	9	10.5%	13.5%
>2sd &<3sd	1.13	to	1.67	3	3.5%	2.0%
>3sd	1.67			0	0.0%	0.5%
				86		




LB P2 Monitoring results
LB P2 1.8m
LB P2 3m
Linear (LB P2 1.8m)
Linear (LB P2 3m)
y = 3E-05x + 2.1476
R2 = 4E-05
y = -0.0001x + 8.6132
R2 = 0.0294
Excursion of HW (m)
30
20
10
0
-10
-20
18/02/1982
14/11/1984
11/08/1987
7/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
Time

LB P2A TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2A	11/06/2002	36.032	24.1	0.00	0.00
P2A	12/06/2002	34.631	23.4	-0.70	-0.70
P2A	21/06/2002	35.14	22.55	-0.85	-1.55
P2A	23/07/2002	35.381	21.71	-0.84	-2.39
P2A	21/08/2002	36.852	24.06	2.35	-0.04
P2A	6/09/2002	35.753	23.1	-0.96	-1.00
P2A	21/10/2002	34.887	26.01	2.91	1.91
P2A	2/11/2002	35.495	26.34	0.33	2.24
P2A	19/11/2002	35.505	27.21	0.87	3.11
P2A	3/12/2002	35.249	27.81	0.60	3.71
P2A	30/01/2003	35.189	25.71	-2.10	1.61
P2A	28/02/2003	35.725	24.25	-1.46	0.15
P2A	1/03/2003	36.258	25.44	1.19	1.34
P2A	2/04/2003	34.163	24.47	-0.97	0.37
P2A	5/04/2003	32.119	22.32	-2.15	-1.78
P2A	16/04/2003	34.616	23.24	0.92	-0.86
P2A	3/05/2003	35.606	23.45	0.21	-0.65
P2A	27/05/2003	35.222	22.98	-0.47	-1.12
P2A	12/06/2003	35.472	23.27	0.29	-0.83
P2A	15/07/2003	36.143	24.1	0.83	0.00
P2A	13/08/2003	35.92	23.78	-0.32	-0.32
P2A	29/09/2003	36.918	25.51	1.73	1.41
P2A	13/10/2003	37.012	25.23	-0.28	1.13
P2A	25/11/2003	35.362	24.1	-1.13	0.00
P2A	8/12/2003	37.319	26.25	2.15	2.15
P2A	21/01/2004	41.338	33.34	7.09	9.24
P2A	17/02/2004	37.547	30.27	-3.07	6.17
P2A	22/03/2004	37.526	30.46	0.19	6.36
P2A	20/04/2004	38.065	30.51	0.05	6.41
P2A	5/05/2004	39.287	30.92	0.41	6.82
P2A	30/05/2004	39.354	35.3	4.38	11.20
P2A	28/06/2004	38.21	33.93	-1.37	9.83
P2A	30/06/2004	39.477	34.94	1.01	10.84
P2A	16/07/2004	38.837	35.18	0.24	11.08
P2A	26/07/2004	37.811	29.82	-5.36	5.72
P2A	2/08/2004	38.41	35.2	5.38	11.10
P2A	1/09/2004	40.039	36.42	1.22	12.32
P2A	13/10/2004	39.302	36.78	0.36	12.68
P2A	12/11/2004	39.274	35	-1.78	10.90

Descriptive Statistics	
Mean	0.286842105
Standard Error	0.36166520?
Median	0.225
Mode	#N/A
Standard Deviation	2.229454066
Sample Variance	4.970465434
Kurtosis	2.453395831
Skewness	0.718461981
Range	12.45
Minimum	-5.36
Maximum	7.09
Sum	10.9
Count	38
Confidence Level(95.0%)	0.732802602

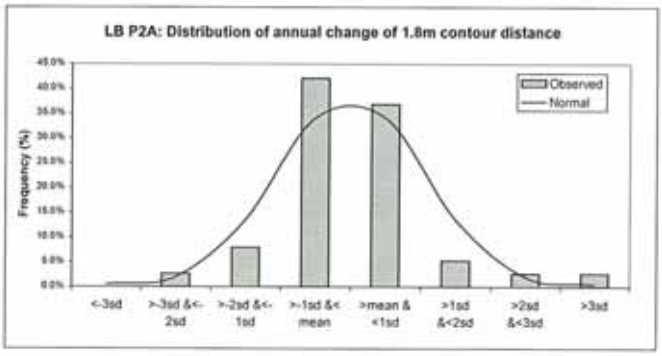
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.837801671
R Square	0.70191164
Adjusted R Square	0.693631407
Standard Error	2.662969559
Observations	38

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-563.6628116	61.61841	-9.14764	6.35E-11	-688.631	-438.695	-688.631	-438.695
X Variable 1	0.014985226	0.001628	9.207039	5.38E-11	0.011684	0.018286	0.011684	0.018286

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-6.4			0	0.0%	0.5%
>-3sd &<-2sd	-6.4	to	-4.2	1	2.6%	2.0%
>-2sd &<-1sd	-4.2	to	-1.9	3	7.9%	13.5%
>-1sd &< mean	-1.94	to	0.29	16	42.1%	34.0%
>mean & <1sd	0.29	to	2.52	14	36.8%	34.0%
>1sd &<2sd	2.52	to	4.75	2	5.3%	13.5%
>2sd &<3sd	4.75	to	6.98	1	2.6%	2.0%
>3sd	6.98			1	2.6%	0.5%
				38		



LB P2A TOTAL REPORT

Profile Volume Report

Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2A	11/06/2002	16.284	12.04	0.00	0.00
P2A	12/06/2002	15.307	11.7	-0.34	-0.34
P2A	21/06/2002	15.739	11.92	0.22	-0.12
P2A	23/07/2002	16.069	12.13	0.21	0.09
P2A	21/08/2002	16.528	12.4	0.27	0.36
P2A	6/09/2002	16.009	12.26	-0.14	0.22
P2A	21/10/2002	15.383	11.99	-0.27	-0.05
P2A	2/11/2002	15.682	12.02	0.03	-0.02
P2A	19/11/2002	15.513	12.02	0.00	-0.02
P2A	3/12/2002	15.342	11.92	-0.10	-0.12
P2A	30/01/2003	15.462	12.05	0.13	0.01
P2A	28/02/2003	15.681	12.09	0.04	0.05
P2A	1/03/2003	15.951	12.25	0.16	0.21
P2A	2/04/2003	14.861	11.9	-0.35	-0.14
P2A	5/04/2003	14.327	11.45	-0.45	-0.59
P2A	16/04/2003	15.198	11.99	0.54	-0.05
P2A	3/05/2003	15.203	12.16	0.17	0.12
P2A	27/05/2003	15.448	12.21	0.05	0.17
P2A	12/06/2003	15.428	12.13	-0.08	0.09
P2A	15/07/2003	15.937	12.56	0.43	0.52
P2A	13/08/2003	15.856	12.46	-0.10	0.42
P2A	29/09/2003	16.138	12.68	0.22	0.64
P2A	13/10/2003	16.37	12.54	-0.14	0.50
P2A	25/11/2003	15.533	12.24	-0.30	0.20
P2A	8/12/2003	15.86	12.73	0.49	0.69
P2A	21/01/2004	16.785	13.26	0.53	1.22
P2A	17/02/2004	16.063	12.46	-0.80	0.42
P2A	22/03/2004	15.627	12.73	0.27	0.69
P2A	20/04/2004	15.822	12.81	0.08	0.77
P2A	5/05/2004	16.528	13.15	0.34	1.11
P2A	30/05/2004	16.126	12.94	-0.21	0.90
P2A	28/06/2004	16.089	13	0.06	0.96
P2A	30/06/2004	16.567	12.76	-0.24	0.72
P2A	16/07/2004	16.483	12.73	-0.03	0.69
P2A	26/07/2004	16.223	12.92	0.19	0.88
P2A	2/08/2004	16.164	12.66	-0.26	0.62
P2A	1/09/2004	17.073	13.45	0.79	1.41
P2A	13/10/2004	16.541	12.79	-0.66	0.75
P2A	12/11/2004	15.959	12.58	-0.21	0.54

Descriptive Statistics	
Mean	0.014210526
Standard Error	0.05398571
Median	0.035
Mode	0.27
Standard Deviation	0.332790264
Sample Variance	0.11074936
Kurtosis	0.307351359
Skewness	-0.098661307
Range	1.59
Minimum	-0.8
Maximum	0.79
Sum	0.54
Count	38
Confidence Level(95.0%)	0.109385331

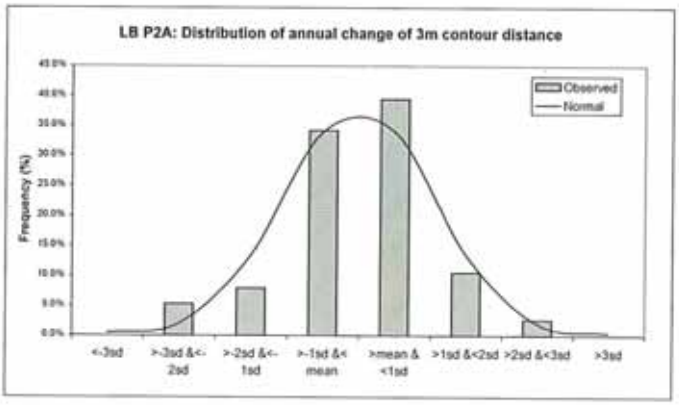
SUMMARY OUTPUT

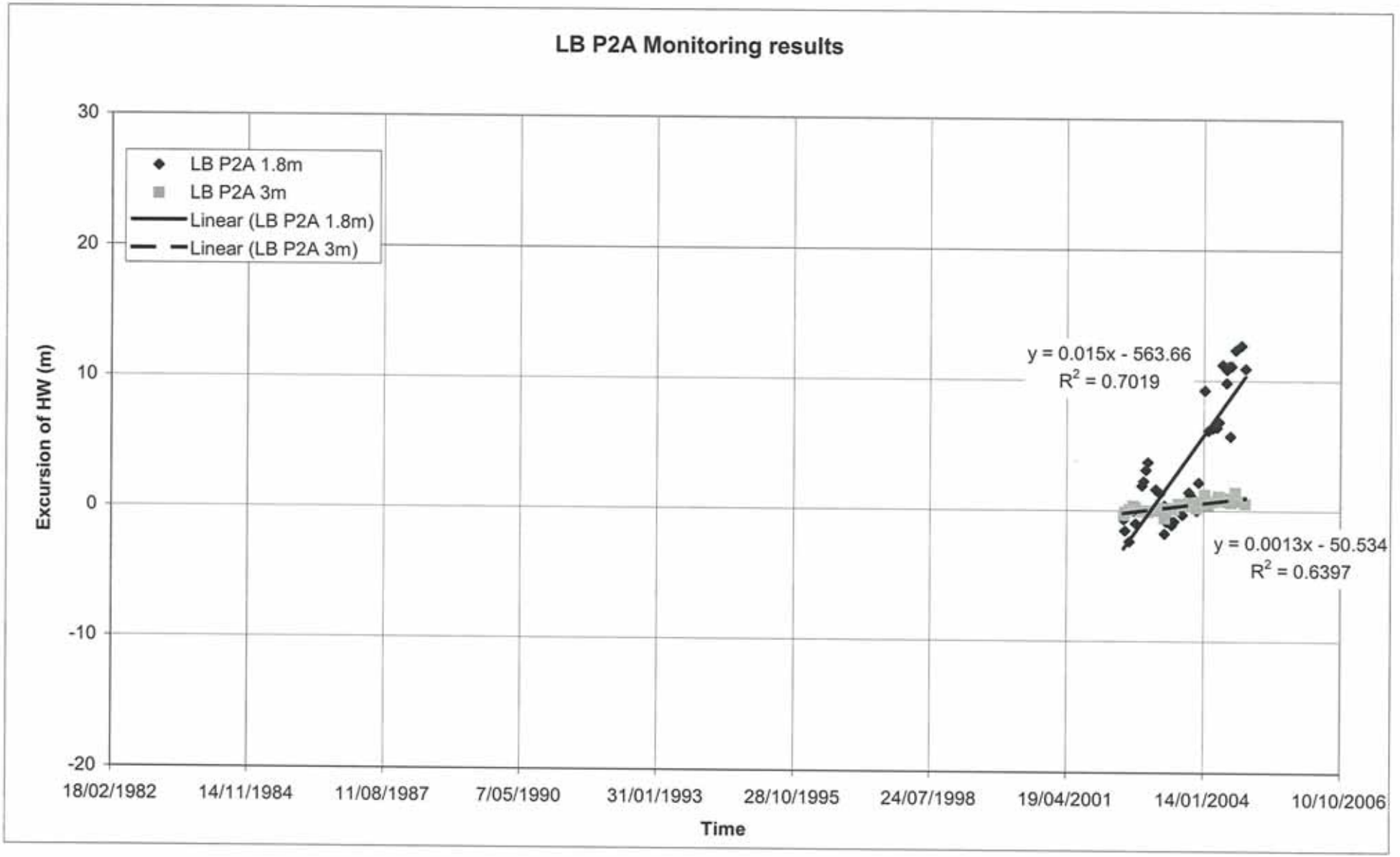
Regression Statistics	
Multiple R	0.799809255
R Square	0.639694844
Adjusted R Square	0.629686367
Standard Error	0.275242581
Observations	38

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-50.53358838	6.368834	-7.93451	2.03E-09	-63.4502	-37.617	-63.4502	-37.617
X Variable 1	0.001344916	0.000168	7.994705	1.7E-09	0.001004	0.001686	0.001004	0.001686

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-1.0			0	0.0%	0.5%
>-3sd &<-2sd	-1.0	to	-0.7	2	5.3%	2.0%
>-2sd &<-1sd	-0.7	to	-0.3	3	7.9%	13.5%
>-1sd &< mean	-0.32	to	0.01	13	34.2%	34.0%
>mean & <1sd	0.01	to	0.35	15	39.5%	34.0%
>1sd &<2sd	0.35	to	0.68	4	10.5%	13.5%
>2sd &<3sd	0.68	to	1.01	1	2.6%	2.0%
>3sd	1.01			0	0.0%	0.5%
				38		




LB P2A Monitoring results
LB P2A 1.8m
LB P2A 3m
Linear (LB P2A 1.8m)
Linear (LB P2A 3m)
y = 0.015x - 563.66
R2 = 0.7019
y = 0.0013x - 50.534
R2 = 0.6397
Excursion of HW (m)
30
20
10
0
-10
-20
18/02/1982
14/11/1984
11/08/1987
7/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
Time

LB P3 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P3	21/05/2001	47.341	28.76	0.00	0.00
P3	19/06/2001	47.313	28.08	-0.68	-0.68
P3	18/07/2001	17.512	29.82	1.74	1.06
P3	20/08/2001	49.257	32.43	2.61	3.67
P3	19/09/2001	49.718	33.55	1.12	4.79
P3	17/10/2001	50.284	35.53	1.98	6.77
P3	15/11/2001	52.105	33.3	-2.23	4.54
P3	12/12/2001	52.616	32.21	-1.09	3.45
P3	30/01/2002	51.353	30.59	-1.62	1.83
P3	26/02/2002	50.368	30.5	-0.09	1.74
P3	28/03/2002	50.677	31.03	0.53	2.27
P3	30/04/2002	53.754	33.42	2.39	4.66
P3	13/05/2002	54.901	34.47	1.05	5.71
P3	11/06/2002	51.865	35.94	1.47	7.18
P3	23/07/2002	49.866	30.38	-5.56	1.62
P3	21/08/2002	18.871	32.42	2.04	3.66
P3	6/09/2002	19.762	32.95	0.53	4.19
P3	18/10/2002	20.252	37	4.05	8.24
P3	21/10/2002	20.563	36.34	-0.66	7.58
P3	2/11/2002	18.525	34.98	-1.36	6.22
P3	18/11/2002	20.826	37.28	2.30	8.52
P3	3/12/2002	20.109	37.35	0.07	8.59
P3	7/12/2002	17.586	35	-2.35	6.24
P3	30/01/2003	20.558	32.52	-2.48	3.76
P3	28/02/2003	20.352	33.5	0.98	4.74
P3	1/03/2003	19.925	32.64	-0.86	3.88
P3	2/04/2003	18.88	28.5	-4.14	-0.26
P3	5/04/2003	22.196	37.25	8.75	8.49
P3	16/04/2003	21.08	33.38	-3.87	4.62
P3	3/05/2003	22.506	33.77	0.39	5.01
P3	27/05/2003	21.112	31.96	-1.81	3.20
P3	12/06/2003	19.379	31.39	-0.57	2.63
P3	15/07/2003	19.545	31.97	0.58	3.21
P3	13/08/2003	20.954	32.75	0.78	3.99
P3	29/09/2003	20.322	32.57	-0.18	3.81
P3	13/10/2003	20.945	32.71	0.14	3.95
P3	25/11/2003	20.745	34.07	1.36	5.31
P3	8/12/2003	21.074	33.15	-0.92	4.39
P3	21/01/2004	22.068	35.35	2.20	6.59
P3	17/02/2004	21.528	36.13	0.78	7.37
P3	22/03/2004	21.809	34.9	-1.23	6.14
P3	20/04/2004	21.002	36.8	1.90	8.04
P3	5/05/2004	21.588	36.98	0.18	8.22
P3	30/05/2004	22.973	42.55	5.57	13.79
P3	28/06/2004	27.771	50	7.45	21.24
P3	30/06/2004	23.033	45.75	-4.25	16.99
P3	16/07/2004	23.125	45.62	-0.13	16.86
P3	26/07/2004	21.996	43.62	-2.00	14.86
P3	2/08/2004	22.171	46.75	3.13	17.99
P3	1/09/2004	22.242	42.26	-4.49	13.50
P3	13/10/2004	21.453	36.63	-5.63	7.87
P3	12/11/2004	22.391	39.76	3.13	11.00
P3	10/12/2004	22.255	37.64	-2.12	8.88

Descriptive Statistics

Mean	0.170769231
Standard Error	0.39606024
Median	0.16
Mode	0.53
Standard Deviation	2.856031009
Sample Variance	8.156913122
Kurtosis	1.286299472
Skewness	0.474857246
Range	14.38
Minimum	-5.63
Maximum	8.75
Sum	8.88
Count	52
Confidence Level(95.0%)	0.795123498

SUMMARY OUTPUT

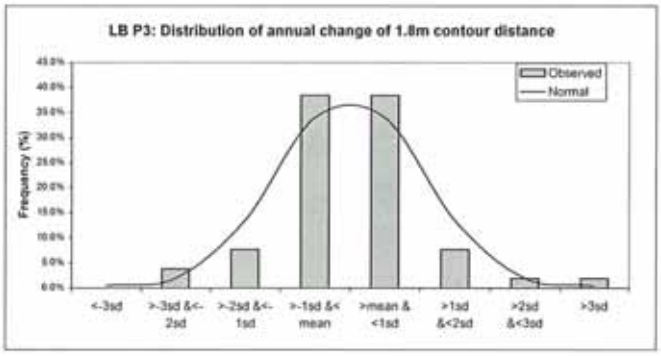
Regression Statistics

Multiple R	0.651422174
R Square	0.424350849
Adjusted R Square	0.412837866
Standard Error	3.606929299
Observations	52

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-311.3473117	52.36881	-5.94528	2.66E-07	-416.533	-206.161	-416.533	-206.161
X Variable 1	0.008426825	0.001388	6.071117	1.7E-07	0.00564	0.011217	0.00564	0.011217

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-8.4			0	0.0%	0.5%
>-3sd &<-2sd	-8.4	to	-5.5	2	3.8%	2.0%
>-2sd &<-1sd	-5.5	to	-2.7	4	7.7%	13.5%
>-1sd &< mean	-2.69	to	0.17	20	38.5%	34.0%
>mean & <1sd	0.17	to	3.03	20	38.5%	34.0%
>1sd &<2sd	3.03	to	5.88	4	7.7%	13.5%
>2sd &<3sd	5.88	to	8.74	1	1.9%	2.0%
>3sd	8.74			1	1.9%	0.5%
				52		



LB P3 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P3	21/05/2001	20.759	18.1	0.00	0.00
P3	19/06/2001	20.908	18.52	0.42	0.42
P3	18/07/2001	5.764	18.79	0.27	0.69
P3	20/08/2001	21.05	19.45	0.66	1.35
P3	19/09/2001	21.614	18.95	-0.50	0.85
P3	17/10/2001	21.582	18.8	-0.15	0.70
P3	15/11/2001	22.805	19.41	0.61	1.31
P3	12/12/2001	23.222	19.92	0.51	1.82
P3	30/01/2002	22.714	19.27	-0.65	1.17
P3	26/02/2002	21.775	19.27	0.00	1.17
P3	28/03/2002	22.092	19.68	0.41	1.58
P3	30/04/2002	23.554	19.92	0.24	1.82
P3	13/05/2002	23.948	20.32	0.40	2.22
P3	11/06/2002	21.902	19.76	-0.56	1.66
P3	23/07/2002	21.608	19.11	-0.65	1.01
P3	21/08/2002	5.603	19.68	0.57	1.58
P3	6/09/2002	5.813	19.86	0.18	1.76
P3	19/10/2002	5.578	19.89	0.03	1.79
P3	21/10/2002	5.942	20.06	0.17	1.96
P3	2/11/2002	5.162	19.58	-0.48	1.48
P3	19/11/2002	5.924	19.97	0.39	1.87
P3	3/12/2002	5.441	19.81	-0.16	1.71
P3	7/12/2002	4.763	19.78	-0.03	1.68
P3	30/01/2003	5.991	20.07	0.29	1.97
P3	28/02/2003	5.997	20.04	-0.03	1.94
P3	1/03/2003	5.939	19.86	-0.18	1.76
P3	2/04/2003	5.686	19.85	-0.01	1.75
P3	5/04/2003	6.413	20.36	0.51	2.26
P3	16/04/2003	6.131	20.2	-0.16	2.10
P3	3/05/2003	6.677	20.46	0.26	2.36
P3	27/05/2003	6.104	19.99	-0.47	1.89
P3	12/06/2003	5.501	19.66	-0.33	1.56
P3	15/07/2003	5.429	19.65	-0.01	1.55
P3	13/08/2003	5.857	19.9	0.25	1.80
P3	29/09/2003	5.712	19.85	-0.05	1.75
P3	13/10/2003	5.821	20.21	0.36	2.11
P3	25/11/2003	5.45	19.84	-0.37	1.74
P3	8/12/2003	5.725	20.2	0.36	2.10
P3	21/01/2004	6.2	20.79	0.59	2.69
P3	17/02/2004	5.951	20.11	-0.68	2.01
P3	22/03/2004	5.827	20.03	-0.08	1.93
P3	20/04/2004	5.773	19.91	-0.12	1.81
P3	5/05/2004	5.764	20.41	0.50	2.31
P3	30/05/2004	6.011	20	-0.41	1.90
P3	28/06/2004	6.957	21.59	1.59	3.49
P3	30/06/2004	6.202	20.3	-1.29	2.20
P3	16/07/2004	6.047	20.63	0.33	2.53
P3	26/07/2004	5.791	19.76	-0.87	1.66
P3	2/08/2004	5.753	20	0.24	1.90
P3	1/09/2004	5.894	20.24	0.24	2.14
P3	13/10/2004	5.694	20.02	-0.22	1.92
P3	12/11/2004	5.622	19.94	-0.08	1.84
P3	10/12/2004	5.693	19.74	-0.20	1.64

Descriptive Statistics	
Mean	0.031538462
Standard Error	0.066300304
Median	-0.005
Mode	-0.65
Standard Deviation	0.478098294
Sample Variance	0.228577979
Kurtosis	1.651868016
Skewness	0.066638596
Range	2.88
Minimum	-1.29
Maximum	1.59
Sum	1.64
Count	52
Confidence Level(95.0%)	0.133103313

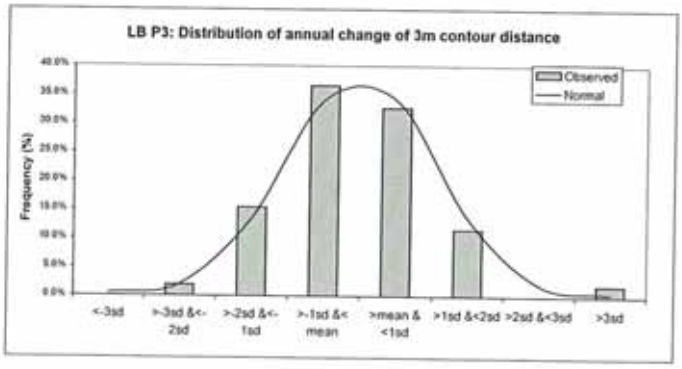
SUMMARY OUTPUT

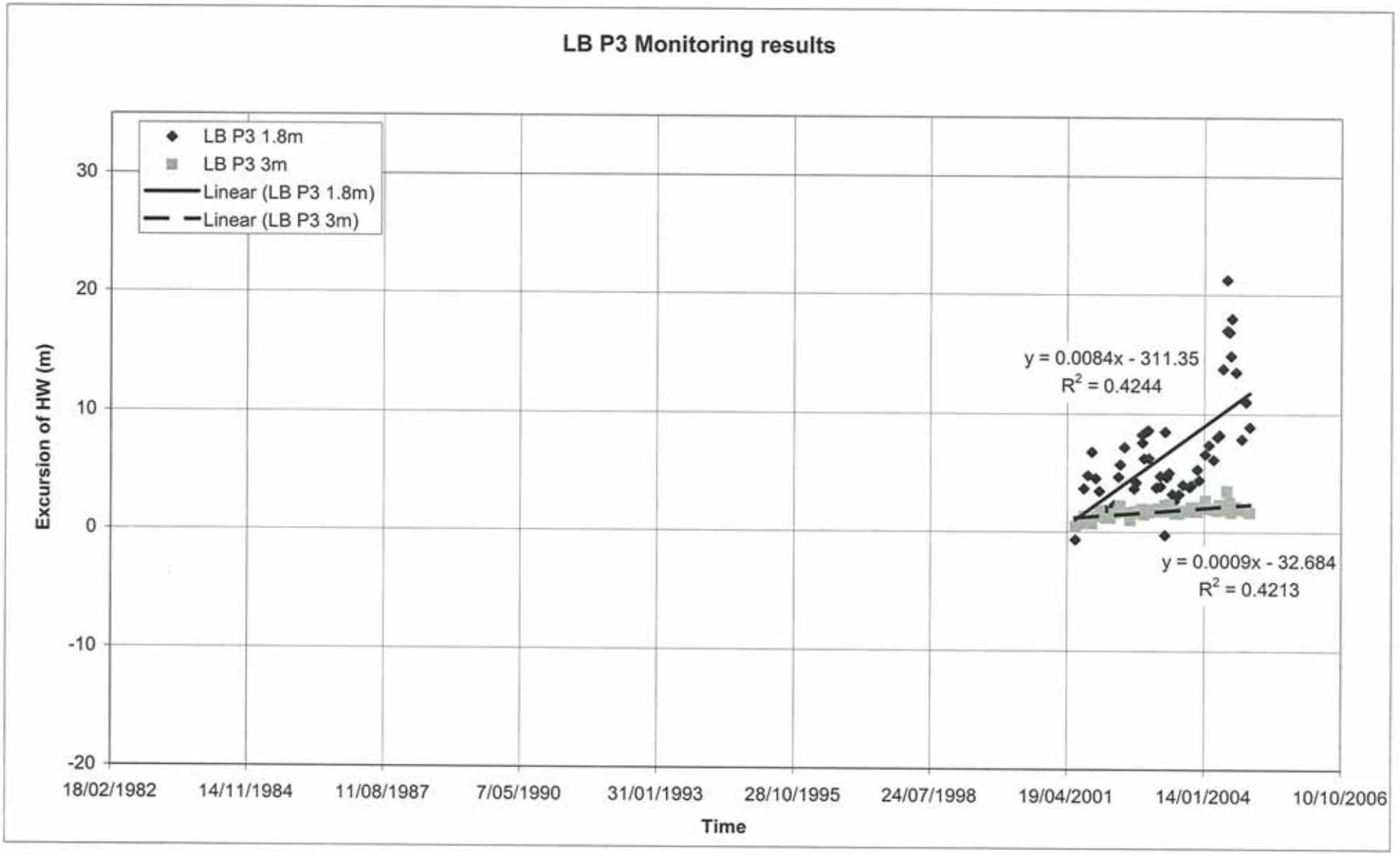
Regression Statistics	
Multiple R	0.649074835
R Square	0.421298142
Adjusted R Square	0.409724105
Standard Error	0.393381318
Observations	52

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-32.68404027	5.711482	-5.72251	5.89E-07	-44.1559	-21.2122	-44.1559	-21.2122
X Variable 1	0.000913517	0.000151	6.033264	1.94E-07	0.000609	0.001218	0.000609	0.001218

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-1.4			0	0.0%	0.5%
>-3sd &<-2sd	-1.4	to	-0.9	1	1.9%	2.0%
>-2sd &<-1sd	-0.9	to	-0.4	8	15.4%	13.5%
>-1sd &< mean	-0.45	to	0.03	19	36.5%	34.0%
>mean & <1sd	0.03	to	0.51	17	32.7%	34.0%
>1sd &<2sd	0.51	to	0.99	6	11.5%	13.5%
>2sd &<3sd	0.99	to	1.47	0	0.0%	2.0%
>3sd	1.47			1	1.9%	0.5%
				52		




LB P3 Monitoring results
LB P3 1.8m
LB P3 3m
Linear (LB P3 1.8m)
Linear (LB P3 3m)
y = 0.0084x - 311.35
R2 = 0.4244
y = 0.0009x - 32.684
R2 = 0.4213
Excursion of HW (m)
30
20
10
0
-10
-20
18/02/1982
14/11/1984
11/08/1987
7/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
Time

LB P4 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P4	21/05/2001	49.688	53	0.00	0.00
P4	19/06/2001	15.94	54	1.00	1.00
P4	18/07/2001	15.044	47.59	-6.41	-5.41
P4	20/08/2001	20.402	58.02	10.43	5.02
P4	19/09/2001	18.176	58.88	0.86	5.88
P4	17/10/2001	19.612	64.91	6.03	11.91
P4	15/11/2001	25.059	67.45	2.54	14.45
P4	12/12/2001	20.153	61.03	-6.42	8.03
P4	30/01/2002	20.201	62	0.97	9.00
P4	26/02/2002	17.415	52.99	-9.01	-0.01
P4	28/03/2002	17.233	52.65	-0.34	-0.35
P4	30/04/2002	21.871	60.04	7.39	7.04
P4	13/05/2002	20.456	59.56	-0.48	6.56
P4	11/06/2002	19.549	58	-1.56	5.00
P4	23/07/2002	21.135	53.27	-4.73	0.27
P4	21/08/2002	19.737	54.01	0.74	1.01
P4	10/09/2002	20.763	58.97	4.96	5.97
P4	21/10/2002	19.591	53.01	-5.96	0.01
P4	19/11/2002	19.503	52.2	-0.81	-0.80
P4	3/12/2002	20.876	56.41	4.21	3.41
P4	7/12/2002	19.135	53	-3.41	0.00
P4	30/01/2003	19.854	50.92	-2.08	-2.08
P4	28/02/2003	18.59	48.9	-2.02	-4.10
P4	2/04/2003	20.409	50.93	2.03	-2.07
P4	5/04/2003	21.709	56.21	5.28	3.21
P4	16/04/2003	21.409	49.36	-6.85	-3.64
P4	3/05/2003	21.552	51.64	2.28	-1.36
P4	27/05/2003	20.347	51.21	-0.43	-1.79
P4	12/06/2003	20.244	51.31	0.10	-1.69
P4	15/07/2003	19.445	48.76	-2.55	-4.24
P4	13/08/2003	21.056	51.32	2.56	-1.68
P4	29/09/2003	19.067	46.38	-4.94	-6.62
P4	13/10/2003	18.926	45.32	-1.06	-7.68
P4	25/11/2003	19.989	43.9	-1.42	-9.10
P4	8/12/2003	18.738	42.68	-1.22	-10.32
P4	21/01/2004	19.037	43.01	0.33	-9.99
P4	17/02/2004	19.042	41.8	-1.21	-11.20
P4	22/03/2004	19.72	41.72	-0.08	-11.28
P4	20/04/2004	19.736	41.89	0.17	-11.11
P4	5/05/2004	20.131	43.61	1.72	-9.39
P4	30/05/2004	18.809	41.35	-2.26	-11.65
P4	28/06/2004	20.831	68.54	27.19	15.54
P4	30/06/2004	17.093	38.89	-29.65	-14.11
P4	16/07/2004	20.582	45.12	6.23	-7.88
P4	26/07/2004	15.54	34.11	-11.01	-18.89
P4	2/08/2004	17.425	35.97	1.86	-17.03
P4	1/09/2004	15.611	35.25	-0.72	-17.75
P4	13/10/2004	16.531	37.57	2.32	-15.43
P4	12/11/2004	17.139	38.95	1.38	-14.05
P4	10/12/2004	16.606	37.45	-1.50	-15.55

Descriptive Statistics	
Mean	-0.317346939
Standard Error	1.01429455
Median	-0.34
Mode	#N/A
Standard Deviation	7.100061847
Sample Variance	50.41087823
Kurtosis	9.446978849
Skewness	-0.284464475
Range	56.84
Minimum	-29.65
Maximum	27.19
Sum	-15.55
Count	49
Confidence Level(95.0%)	2.039374681

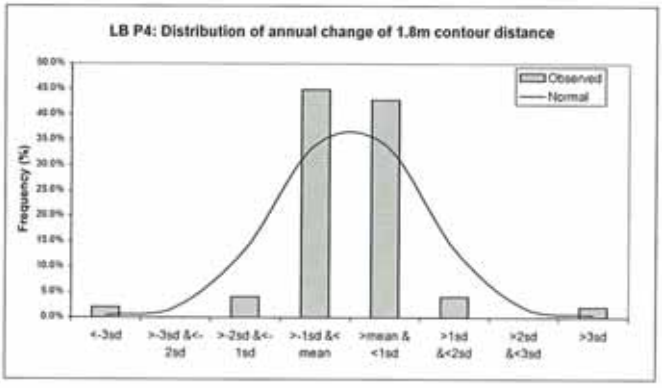
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.76899882
R Square	0.591359185
Adjusted R Square	0.5826647
Standard Error	5.544433946
Observations	49

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	664.0129667	80.87681	8.210178	1.24E-10	501.31	826.716	501.31	826.716
X Variable 1	-0.017678885	0.002144	-8.24715	1.09E-10	-0.02199	-0.01337	-0.02199	-0.01337

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-21.6			1	2.0%	0.5%
>-3sd &<-2sd	-21.6	to	-14.5	0	0.0%	2.0%
>-2sd &<-1sd	-14.5	to	-7.4	2	4.1%	13.5%
>-1sd &< mean	-7.42	to	-0.32	22	44.9%	34.0%
>mean & <1sd	-0.32	to	6.78	21	42.9%	34.0%
>1sd &<2sd	6.78	to	13.88	2	4.1%	13.5%
>2sd &<3ad	13.88	to	20.98	0	0.0%	2.0%
>3sd	20.98			1	2.0%	0.5%
				49		



LB P4 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P4	21/05/2001	13.138	25.74	0.00	0.00
P4	19/06/2001	0.564	26.38	0.64	0.64
P4	18/07/2001	2.247	26.23	-0.15	0.49
P4	20/08/2001	2.232	26.57	0.34	0.83
P4	19/09/2001	2.341	26.48	-0.09	0.74
P4	17/10/2001	2.256	26.08	-0.40	0.34
P4	15/11/2001	2.03	26.44	0.36	0.70
P4	12/12/2001	1.917	25.93	-0.51	0.19
P4	30/01/2002	2.198	25.98	0.05	0.24
P4	26/02/2002	2.008	25.75	-0.23	0.01
P4	28/03/2002	2.309	26.61	0.86	0.87
P4	30/04/2002	2.495	27.66	1.05	1.92
P4	13/05/2002	2.323	26.95	-0.71	1.21
P4	11/06/2002	2.617	26.87	-0.08	1.13
P4	23/07/2002	2.836	27.15	0.28	1.41
P4	21/08/2002	2.565	27.01	-0.14	1.27
P4	10/09/2002	2.629	26.93	-0.08	1.19
P4	21/10/2002	2.517	26.84	-0.09	1.10
P4	19/11/2002	2.419	26.8	-0.04	1.06
P4	3/12/2002	2.623	27.56	0.76	1.82
P4	7/12/2002	2.706	27.19	-0.37	1.45
P4	30/01/2003	2.676	27.09	-0.10	1.35
P4	28/02/2003	2.567	27.13	0.04	1.39
P4	2/04/2003	2.465	29.39	2.26	3.65
P4	5/04/2003	2.605	29.59	0.20	3.85
P4	16/04/2003	2.603	29.53	-0.06	3.79
P4	3/05/2003	2.599	26.76	-2.77	1.02
P4	27/05/2003	2.815	30.17	3.41	4.43
P4	12/06/2003	2.454	30	-0.17	4.26
P4	15/07/2003	2.854	29.66	-0.34	3.92
P4	13/08/2003	2.991	30.21	0.55	4.47
P4	29/09/2003	2.843	30.38	0.17	4.64
P4	13/10/2003	2.792	30.97	0.59	5.23
P4	25/11/2003	3.361	31.37	0.40	5.63
P4	8/12/2003	2.799	30.89	-0.48	5.15
P4	21/01/2004	2.954	29.94	-0.95	4.20
P4	17/02/2004	3.119	30.93	0.99	5.19
P4	22/03/2004	3.188	30.99	0.06	5.25
P4	20/04/2004	2.973	31.01	0.02	5.27
P4	5/05/2004	3.503	30.57	-0.44	4.83
P4	30/05/2004	3.037	30.76	0.19	5.02
P4	28/06/2004	2.659	30.54	-0.22	4.80
P4	30/06/2004	2.641	30.3	-0.24	4.56
P4	16/07/2004	3.523	32.16	1.86	6.42
P4	26/07/2004	2.788	30.85	-1.31	5.11
P4	2/08/2004	3.058	30.23	-0.62	4.49
P4	1/09/2004	3.034	29.66	-0.57	3.92
P4	13/10/2004	2.841	30.28	0.62	4.54
P4	12/11/2004	3.049	30.24	-0.04	4.50
P4	10/12/2004	2.829	30.35	0.11	4.61

Descriptive Statistics	
Mean	0.094081633
Standard Error	0.127261822
Median	-0.04
Mode	-0.09
Standard Deviation	0.890832753
Sample Variance	0.793582993
Kurtosis	5.375906985
Skewness	0.78134615
Range	6.18
Minimum	-2.77
Maximum	3.41
Sum	4.61
Count	49
Confidence Level(95.0%)	0.255876892

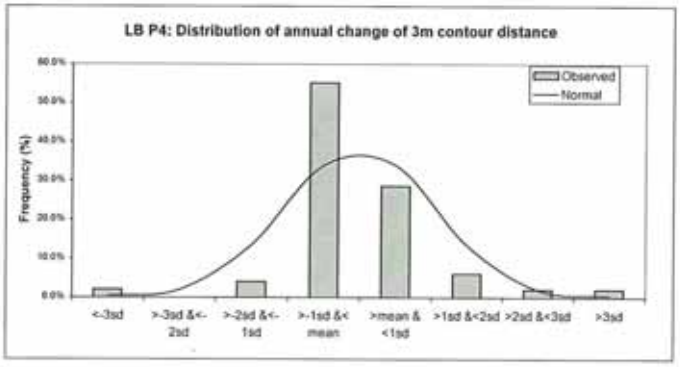
SUMMARY OUTPUT

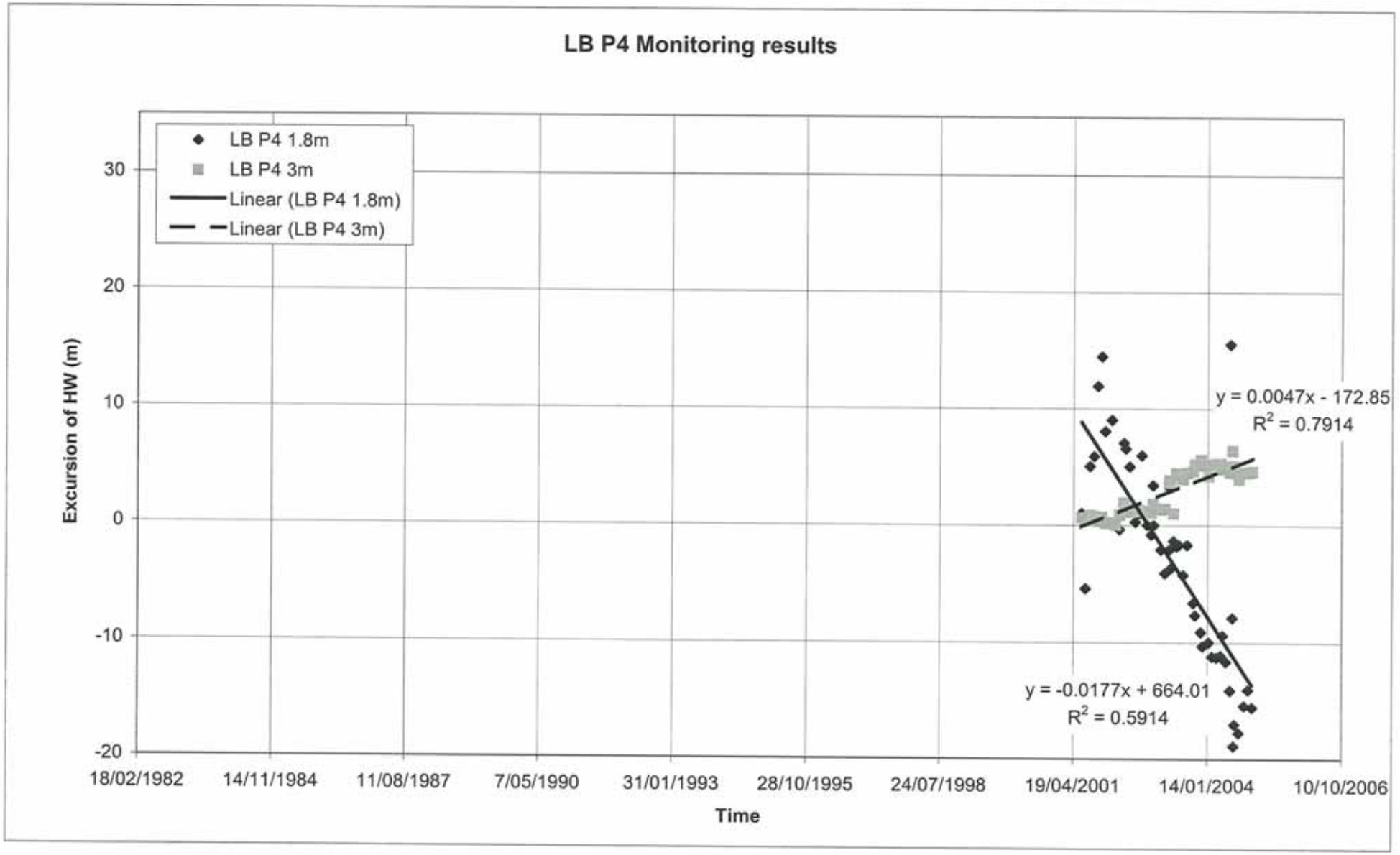
Regression Statistics	
Multiple R	0.889620085
R Square	0.791423895
Adjusted R Square	0.786986106
Standard Error	0.902485336
Observations	49

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-172.8545175	13.16458	-13.1303	2.45E-17	-199.338	-146.371	-199.338	-146.371
X Variable 1	0.004659672	0.000349	13.3543	1.3E-17	0.003958	0.005362	0.003958	0.005362

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-2.6			1	2.0%	0.5%
>-3sd &<-2sd	-2.6	to	-1.7	0	0.0%	2.0%
>-2sd &<-1sd	-1.7	to	-0.8	2	4.1%	13.5%
>-1sd &< mean	-0.80	to	0.09	27	55.1%	34.0%
>mean & <1sd	0.09	to	0.98	14	28.6%	34.0%
>1sd &<2sd	0.98	to	1.88	3	6.1%	13.5%
>2sd &<3sd	1.88	to	2.77	1	2.0%	2.0%
>3sd	2.77			1	2.0%	0.5%
				49		




LB P4 Monitoring results
LB P4 1.8m
LB P4 3m
Linear (LB P4 1.8m)
Linear (LB P4 3m)
y = 0.0047x - 172.85
R² = 0.7914
y = -0.0177x + 664.01
R² = 0.5914
Excursion of HW (m)
30
20
10
0
-10
-20
18/02/1982
14/11/1984
11/08/1987
7/05/1990
31/01/1993
28/10/1995
24/07/1998
19/04/2001
14/01/2004
10/10/2006
Time

MP M1 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
M1	11/01/1989	171.651	60.92	0	0
M1	3/07/1989	163.795	53.14	-7.78	-7.78
M1	9/01/1990	164.123	67.16	14.02	6.24
M1	21/06/1990	162.757	60.86	-6.3	-0.06
M1	14/01/1991	179.797	83.88	23.02	22.96
M1	11/07/1991	167.525	64.15	-19.73	3.23
M1	5/10/1993	177.479	76.37	12.22	15.45
M1	24/02/1994	194.349	80.42	4.05	19.5
M1	2/08/1994	195.948	78.35	-2.07	17.43
M1	16/10/1994	201.556	82.87	4.52	21.95
M1	1/01/1995	188.931	86.27	3.4	25.35
M1	15/03/1995	204.82	97.31	11.04	36.39
M1	22/09/1995	195.887	106.3	8.99	45.38
M1	6/03/1996	196.877	77.12	-29.18	16.2
M1	18/03/1996	192.13	75.49	-1.63	14.57
M1	2/04/1996	183.316	69.02	-6.47	8.1
M1	1/07/1996	195.493	67.7	-1.32	6.78
M1	5/08/1996	181.307	60.43	-7.27	-0.49
M1	23/10/1996	184.385	66.77	6.34	5.85
M1	7/02/1997	181.666	57.71	-9.06	-3.21
M1	19/03/1997	176.54	61.42	3.71	0.5
M1	8/05/1997	40.442	66.86	5.44	5.94
M1	21/04/1998	53.334	75.08	8.22	14.16
M1	4/07/1998	49.733	63.35	-11.73	2.43
M1	15/10/1998	33.477	51.47	-11.88	-9.45
M1	2/12/1998	148.056	50.31	-1.16	-10.61
M1	28/04/1999	54.436	50.45	0.14	-10.47
M1	5/10/1999	162.212	82.07	31.62	21.15
M1	17/04/2000	162.585	63.99	-18.08	3.07
M1	17/07/2000	148.183	51.5	-12.49	-9.42
M1	26/10/2000	58.369	58.57	7.07	-2.35
M1	7/05/2001	159.779	57.59	-0.98	-3.33
M1	15/10/2001	67.123	60.98	3.39	0.06
M1	2/05/2002	67.351	61.29	0.31	0.37
M1	9/09/2002	70.779	67.82	6.53	6.9
M1	30/05/2003	177.649	72.06	4.24	11.14
M1	9/10/2003	68.733	60.71	-11.35	-0.21
M1	6/04/2004	188.037	81.16	20.45	20.24
M1	13/09/2004	81.731	73.93	-7.23	13.01

Descriptive Statistics

Mean	0.342368421
Standard Error	1.938835328
Median	0.225
Mode	#N/A
Standard Deviation	11.95178364
Sample Variance	142.8451321
Kurtosis	0.819795439
Skewness	0.132048269
Range	60.8
Minimum	-29.18
Maximum	31.62
Sum	13.01
Count	38
Confidence Level(95.0%)	3.928449693

SUMMARY OUTPUT

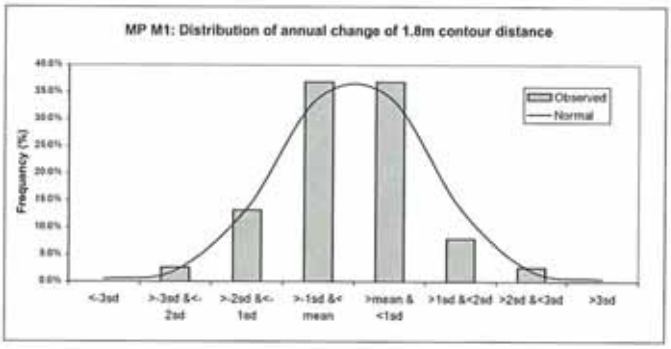
Regression Statistics

Multiple R	0.192452502
R Square	0.037037966
Adjusted R Square	0.01028902
Standard Error	12.75854125
Observations	38

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	67.49474042	50.53613	1.335574019	0.190072	-34.9971	169.9866	-34.9971	169.9866
X Variable 1	-0.001668168	0.001418	-1.176712128	0.247033	-0.00454	0.001207	-0.00454	0.001207

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-35.5			0	0.0%	0.5%
>-3sd &<-2sd	-35.5	to	-23.6	1	2.6%	2.0%
>-2sd &<-1sd	-23.6	to	-11.6	5	13.2%	13.5%
>-1sd &< mean	-11.61	to	0.34	14	36.8%	34.0%
>mean & <1sd	0.34	to	12.29	14	36.8%	34.0%
>1sd &<2sd	12.29	to	24.25	3	7.9%	13.5%
>2sd &<3sd	24.25	to	36.20	1	2.6%	2.0%
>3sd	36.20			0	0.0%	0.5%
				38		



MP M1 TOTAL REPORT
Profile Volume Report
Contour Level: **3 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
M1	11/01/1989	108.068	45.71	0	0
M1	3/07/1989	107.671	42.33	-3.38	-3.38
M1	9/01/1990	101.95	38.97	-3.36	-6.74
M1	21/06/1990	101.908	39.28	0.31	-6.43
M1	14/01/1991	104.543	40.04	0.76	-5.67
M1	11/07/1991	106.063	41.3	1.26	-4.41
M1	5/10/1993	110.577	43.4	2.1	-2.31
M1	24/02/1994	117.499	49.14	5.74	3.43
M1	2/08/1994	119.908	48.97	-0.17	3.26
M1	16/10/1994	121.425	48.07	-0.9	2.36
M1	1/01/1995	111.854	45.85	-2.22	0.14
M1	15/03/1995	114.545	46.58	0.73	0.87
M1	22/09/1995	117.443	48.56	1.98	2.85
M1	6/03/1996	120.348	50.32	1.76	4.61
M1	18/03/1996	117.13	47.18	-3.14	1.47
M1	2/04/1996	117.078	45.51	-1.67	-0.2
M1	1/07/1996	123.892	49.88	4.37	4.17
M1	5/08/1996	119.449	44.04	-5.84	-1.67
M1	23/10/1996	119.259	45.63	1.59	-0.08
M1	7/02/1997	119.44	45.38	-0.25	-0.33
M1	19/03/1997	115.608	42.56	-2.82	-3.15
M1	8/05/1997	13.841	43.7	1.14	-2.01
M1	21/04/1998	14.945	45.16	1.46	-0.55
M1	4/07/1998	21.163	45.85	0.69	0.14
M1	15/10/1998	15.28	39.74	-6.11	-5.97
M1	2/12/1998	98.28	34.79	-4.95	-10.92
M1	28/04/1999	26.836	34.74	-0.05	-10.97
M1	5/10/1999	100.797	38.51	3.77	-7.2
M1	17/04/2000	99.741	40.07	1.56	-5.64
M1	17/07/2000	96.713	35.94	-4.13	-9.77
M1	26/10/2000	26.545	34.95	-0.99	-10.76
M1	7/05/2001	101.01	40.36	5.41	-5.35
M1	15/10/2001	29.643	40.47	0.11	-5.24
M1	2/05/2002	30.041	41.3	0.83	-4.41
M1	9/09/2002	30.771	41.47	0.17	-4.24
M1	30/05/2003	108.683	46.12	4.65	0.41
M1	9/10/2003	33.338	40.66	-5.46	-5.05
M1	6/04/2004	110.46	46.59	5.93	0.88
M1	13/09/2004	36.036	45.19	-1.4	-0.52

Descriptive Statistics	
Mean	-0.013684211
Standard Error	0.513697779
Median	0.24
Mode	#N/A
Standard Deviation	3.166945784
Sample Variance	10.02764552
Kurtosis	-0.392897028
Skewness	-0.075759561
Range	12.04
Minimum	-6.11
Maximum	5.93
Sum	-0.52
Count	38
Confidence Level(95.0%)	1.040849553

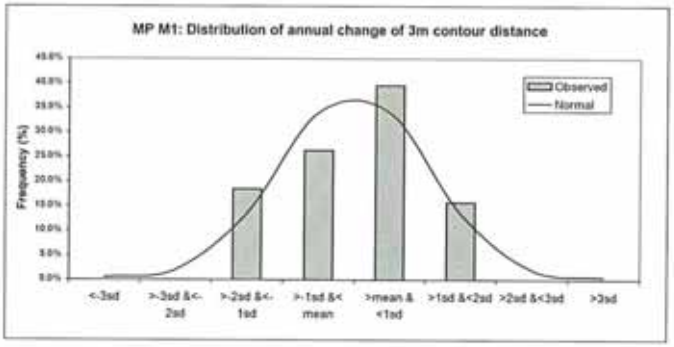
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.158860364
R Square	0.025236615
Adjusted R Square	-0.001840145
Standard Error	4.308735486
Observations	38

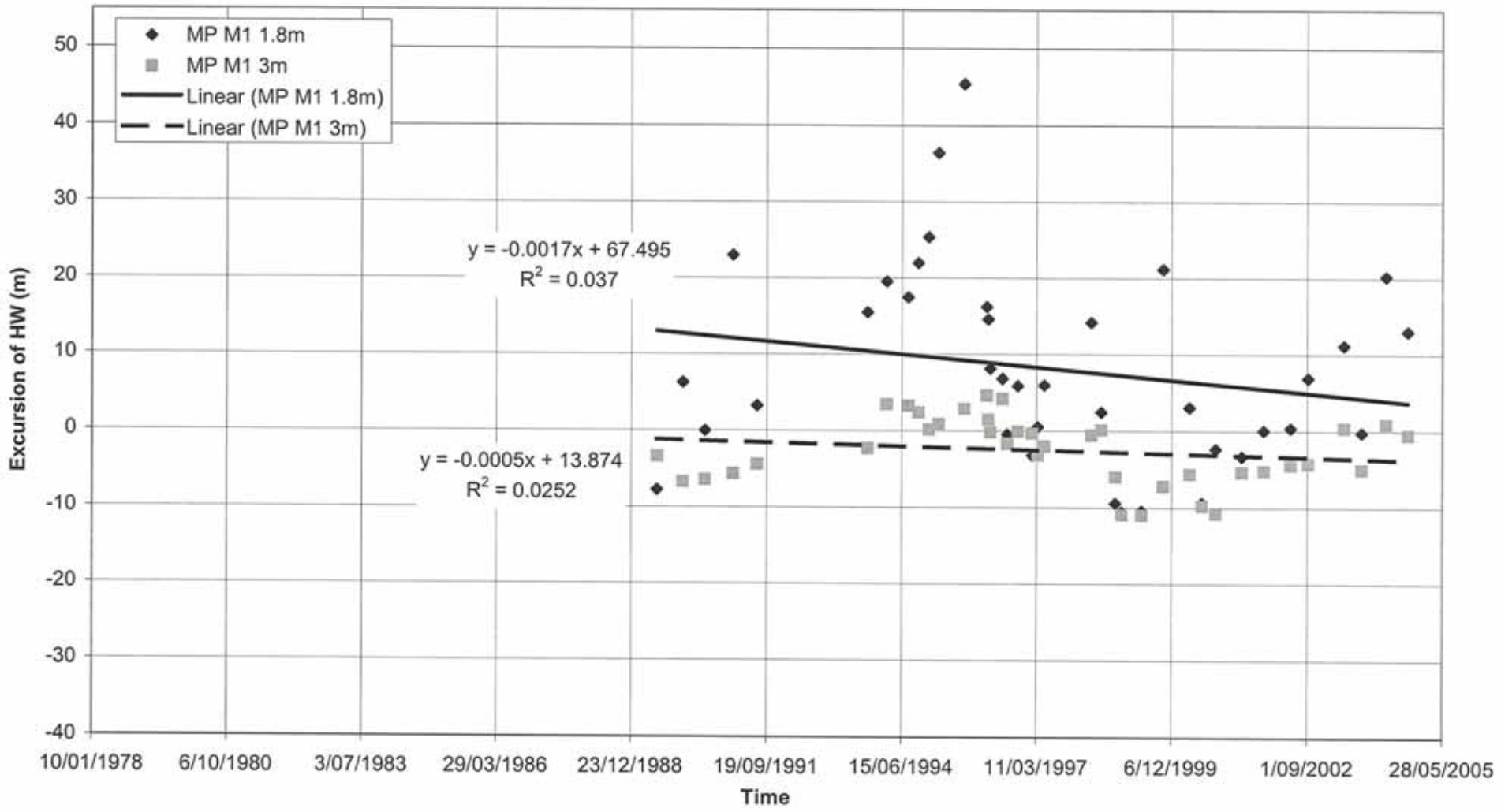
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	13.67364313	17.06675	0.812916613	0.42161	-20.7391	48.48677	-20.7391	48.48677
X Variable 1	-0.000462206	0.000479	-0.965422021	0.340774	-0.00143	0.000509	-0.00143	0.000509

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-9.5			0	0.0%	0.5%
>-3sd &<-2sd	-9.5	to	-6.3	0	0.0%	2.0%
>-2sd &<-1sd	-6.3	to	-3.2	7	18.4%	13.5%
>-1sd &< mean	-3.18	to	-0.01	10	26.3%	34.0%
>mean & <1sd	-0.01	to	3.15	15	39.5%	34.0%
>1sd &<2sd	3.15	to	6.32	6	15.8%	13.5%
>2sd &<3sd	6.32	to	9.49	0	0.0%	2.0%
>3sd	9.49			0	0.0%	0.5%
				38		



MP M1 Monitoring results



MP M2 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
M2	11/01/1989	75.725	43.99	0	0
M2	3/07/1989	80.784	44.32	0.33	0.33
M2	9/01/1990	59.535	41.45	-2.87	-2.54
M2	21/06/1990	59.651	40.3	-1.15	-3.69
M2	14/01/1991	106.07	85.76	45.46	41.77
M2	11/07/1991	84.032	56.98	-28.78	12.99
M2	15/10/1993	111.882	59.85	2.87	15.86
M2	24/02/1994	111.528	60.69	0.84	16.7
M2	2/08/1994	108.079	55.93	-4.76	11.94
M2	1/01/1995	116.726	52.86	-3.07	8.87
M2	15/03/1995	114.011	50.72	-2.14	6.73
M2	22/09/1995	122.884	64.99	14.27	21
M2	6/03/1996	121.309	62.71	-2.28	18.72
M2	18/03/1996	128.326	73.98	11.27	29.99
M2	2/04/1996	124.509	64.73	-9.25	20.74
M2	1/07/1996	118.006	55.82	-8.91	11.83
M2	5/08/1996	105.081	49.33	-6.49	5.34
M2	23/10/1996	109.279	54.62	5.29	10.63
M2	7/02/1997	109.645	50.05	-4.57	6.06
M2	19/03/1997	99.793	44.89	-5.16	0.9
M2	30/09/1997	118.384	50.95	6.06	6.96
M2	21/04/1998	129.14	59.18	8.23	15.19
M2	4/07/1998	117.568	54.33	-4.85	10.34
M2	15/10/1998	104.401	43.91	-10.42	-0.08
M2	2/12/1998	97.428	44.6	0.69	0.61
M2	28/04/1999	88.345	35.72	-8.88	-8.27
M2	5/10/1999	106.825	84.33	48.61	40.34
M2	17/04/2000	96.4	48.62	-35.71	4.63
M2	17/07/2000	68.894	34.68	-13.94	-9.31
M2	26/10/2000	65.327	36.71	2.03	-7.28
M2	7/05/2001	42.479	18.29	-18.42	-25.7
M2	15/10/2001	58.022	36.05	17.76	-7.94
M2	2/05/2002	55.019	31.67	-4.38	-12.32
M2	9/09/2002	85.746	42.14	10.47	-1.85
M2	3/05/2003	54.787	34.91	-7.23	-9.08
M2	9/10/2003	52.865	35.9	0.99	-8.09
M2	6/04/2004	73.228	56.97	21.07	12.98
M2	13/09/2004	73.979	53.42	-3.55	9.43

Descriptive Statistics	
Mean	0.254864865
Standard Error	2.601103561
Median	-2.28
Mode	#N/A
Standard Deviation	15.82186028
Sample Variance	250.3323701
Kurtosis	3.323783351
Skewness	1.040536495
Range	84.32
Minimum	-35.71
Maximum	48.61
Sum	9.43
Count	37
Confidence Level(95.0%)	5.275275581

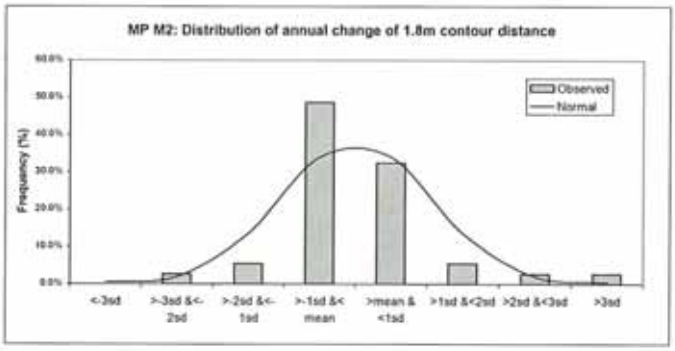
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.36831036
R Square	0.135652521
Adjusted R Square	0.110956879
Standard Error	13.2221554
Observations	37

	Coefficients	*andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	130.2526122	52.79801	2.466998338	0.018694	23.06681	237.4384	23.06681	237.4384
X Variable 1	-0.003468288	0.00148	-2.343709456	0.0249	-0.00647	-0.00046	-0.00647	-0.00046

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-47.2			0	0.0%	0.5%
>-3sd &<-2sd	-47.2	to	-31.4	1	2.7%	2.0%
>-2sd &<-1sd	-31.4	to	-15.6	2	5.4%	13.5%
>-1sd &< mean	-15.57	to	0.25	18	48.6%	34.0%
>mean & <1sd	0.25	to	16.08	12	32.4%	34.0%
>1sd &<2sd	16.08	to	31.90	2	5.4%	13.5%
>2sd &<3sd	31.90	to	47.72	1	2.7%	2.0%
>3sd	47.72			1	2.7%	0.5%
				37		



MP M2 TOTAL REPORT
Profile Volume Report
Contour Level: **3 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
M2	11/01/1989	35.218	26.03	0	0
M2	3/07/1989	37.246	26.45	3.42	3.42
M2	9/01/1990	20.983	17.88	-10.57	-7.15
M2	21/06/1990	22.989	21.85	3.97	-3.18
M2	14/01/1991	24.649	21.95	0.1	-3.08
M2	11/07/1991	32.536	29	7.05	3.97
M2	15/10/1993	54.051	34.46	5.48	9.43
M2	24/02/1994	52.209	37.54	3.08	12.51
M2	2/08/1994	58.662	33.11	-4.43	8.08
M2	1/01/1995	63.48	35.27	2.16	10.24
M2	15/03/1995	64.215	34.42	-0.85	9.39
M2	22/09/1995	63.376	37.14	2.72	12.11
M2	6/03/1996	63.18	35.59	-1.55	10.56
M2	18/03/1996	65.508	37.06	1.47	12.03
M2	2/04/1996	63.954	37.32	0.26	12.29
M2	1/07/1996	61.952	35.02	-2.3	9.99
M2	5/08/1996	60.216	27.4	-7.62	2.37
M2	23/10/1996	59.959	28.77	1.37	3.74
M2	7/02/1997	61.026	31.08	2.31	6.05
M2	19/03/1997	56.485	27.77	-3.31	2.74
M2	30/09/1997	66.031	33.58	5.81	8.55
M2	21/04/1998	68.005	42.54	8.96	17.51
M2	4/07/1998	66.446	33.76	-8.78	8.73
M2	15/10/1998	62.312	27.73	-6.03	2.7
M2	2/12/1998	56.249	25.68	-2.05	0.65
M2	28/04/1999	54.087	22.48	-3.2	-2.55
M2	5/10/1999	52.587	23.88	1.4	-1.15
M2	17/04/2000	51.478	29.77	5.89	4.74
M2	17/07/2000	37.765	17.4	-12.37	-7.63
M2	26/10/2000	36.044	15.53	-1.87	-9.5
M2	7/05/2001	27.889	9.04	-6.49	-15.99
M2	15/10/2001	25.735	15.98	6.94	-9.05
M2	2/05/2002	26.198	16.42	0.44	-8.61
M2	9/09/2002	27.371	15.82	-0.6	-9.21
M2	3/05/2003	24.656	16.25	0.43	-8.78
M2	9/10/2003	22.972	14.93	-1.32	-10.1
M2	6/04/2004	27.097	21.07	6.14	-3.96
M2	13/09/2004	26.26	21.16	0.09	-3.87

Descriptive Statistics	
Mean	-0.104594595
Standard Error	0.827421153
Median	0.26
Mode	#N/A
Standard Deviation	5.033006388
Sample Variance	25.3311533
Kurtosis	0.030836551
Skewness	-0.508550431
Range	21.33
Minimum	-12.37
Maximum	8.96
Sum	-3.87
Count	37
Confidence Level(95.0%)	1.678085668

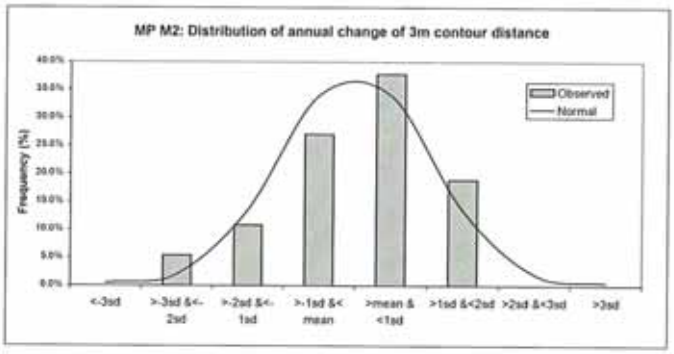
SUMMARY OUTPUT

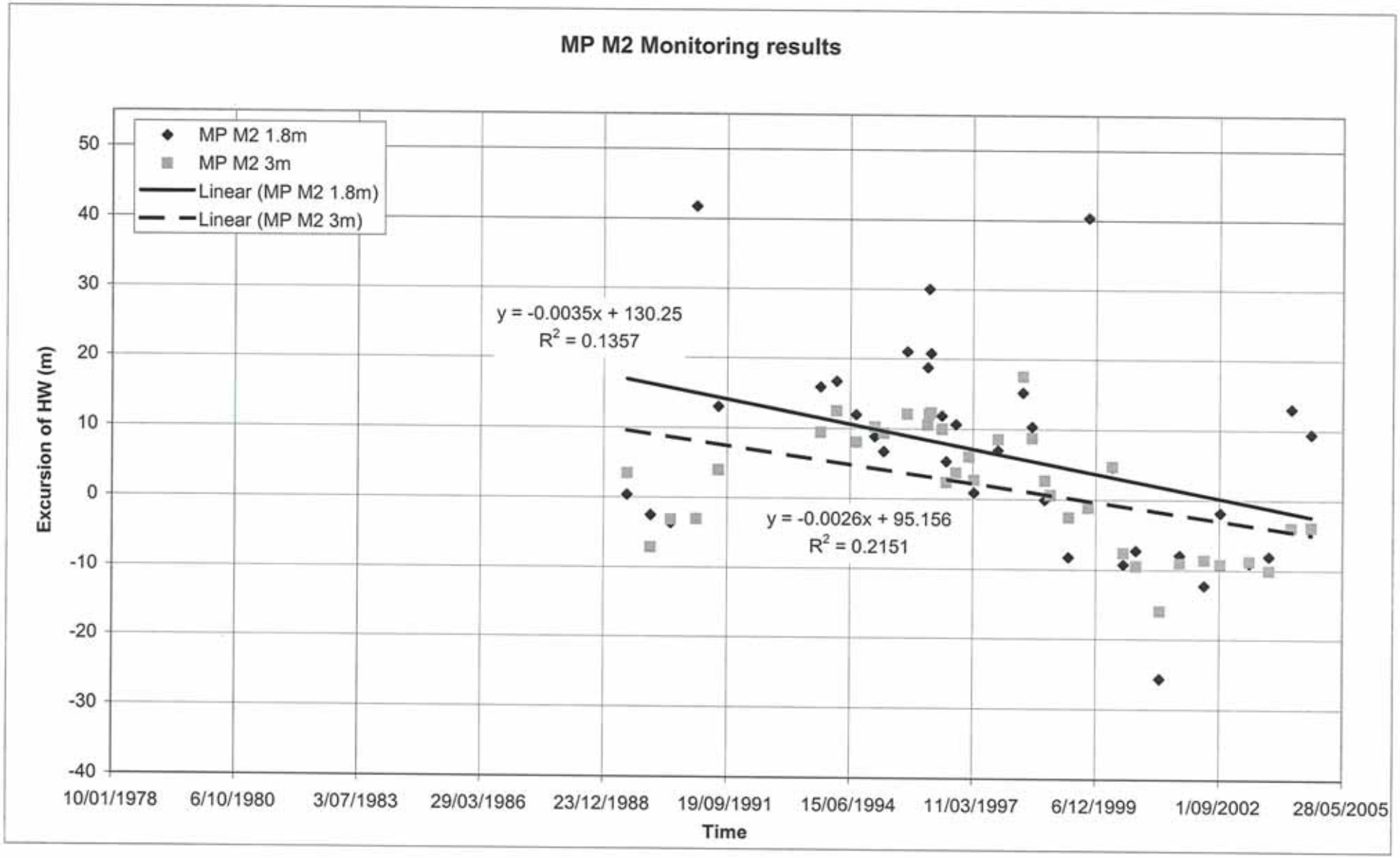
Regression Statistics	
Multiple R	0.463807176
R Square	0.215117096
Adjusted R Square	0.192691871
Standard Error	7.551811882
Observations	37

	Coefficients	*andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	95.15594247	30.1555	3.155509005	0.003287	33.93695	156.3749	33.93695	156.3749
X Variable 1	-0.002617757	0.000845	-3.097198577	0.003836	-0.00433	-0.0009	-0.00433	-0.0009

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-15.2			0	0.0%	0.5%
>-3sd &<-2sd	-15.2	to	-10.2	2	5.4%	2.0%
>-2sd &<-1sd	-10.2	to	-5.1	4	10.8%	13.5%
>-1sd &< mean	-5.14	to	-0.10	10	27.0%	34.0%
>mean & <1sd	-0.10	to	4.93	14	37.8%	34.0%
>1sd &<2sd	4.93	to	9.96	7	18.9%	13.5%
>2sd &<3sd	9.96	to	14.99	0	0.0%	2.0%
>3sd	14.99			0	0.0%	0.5%
				37		




MP M2 Monitoring results
MP M2 1.8m
MP M2 3m
Linear (MP M2 1.8m)
Linear (MP M2 3m)
y = -0.0035x + 130.25
R2 = 0.1357
y = -0.0026x + 95.156
R2 = 0.2151
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P1 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	7/09/1978	7072.339	76.01	0.00	0.00
P1	14/12/1978	347.642	86.88	10.87	10.87
P1	24/03/1979	7007.681	94.85	7.97	18.84
P1	14/08/1981	345.708	92.02	-2.83	16.01
P1	16/09/1982	2768.61	72.49	-19.53	-3.52
P1	28/01/1983	364.629	96.93	24.44	20.92
P1	20/10/1983	7519.635	106.6	9.67	30.59
P1	19/03/1984	7421.023	85.86	-20.74	9.85
P1	15/03/1988	319.082	70.76	-15.10	-5.25
P1	11/01/1989	148.681	78.7	7.94	2.69
P1	3/07/1989	150.994	81.49	2.79	5.48
P1	15/09/1989	106.688	56.36	-25.13	-19.65
P1	9/01/1990	120.145	73.95	17.59	-2.06
P1	21/06/1990	154.313	91.39	17.44	15.38
P1	15/09/1990	8124.612	93.29	1.90	17.28
P1	14/01/1991	185.495	113.68	20.39	37.67
P1	15/03/1991	342.501	102.77	-10.91	26.76
P1	11/07/1991	164.497	106.7	3.93	30.69
P1	15/09/1991	325.947	95.8	-10.90	19.79
P1	15/03/1992	349.102	121.77	25.97	45.76
P1	6/11/1992	674.38	84.9	-36.87	8.89
P1	6/03/1993	704.085	97.85	12.95	21.84
P1	15/10/1993	688.344	74.53	-23.32	-1.48
P1	24/02/1994	629.402	87.79	13.26	11.78
P1	15/03/1994	663.435	79.9	-7.89	3.89
P1	2/09/1994	148.421	96.9	17.00	20.89
P1	16/10/1994	158.919	103.05	6.15	27.04
P1	15/03/1995	156.471	96.41	-6.64	20.40
P1	21/07/1995	152.214	87.86	-8.55	11.85
P1	10/10/1995	162.639	91.01	3.15	15.00
P1	7/12/1995	162.661	96.58	5.57	20.57
P1	16/02/1996	155.149	85.2	-11.38	9.19
P1	6/03/1996	205.235	89.44	4.24	13.43
P1	18/03/1996	220.55	109.46	20.02	33.45
P1	2/04/1996	159.159	92.74	-16.72	16.73
P1	1/07/1996	213.046	84.81	-7.93	8.80
P1	5/08/1996	195.174	81.57	-3.24	5.56
P1	23/10/1996	172.143	106.77	25.20	30.76
P1	6/11/1996	367.224	106.06	-0.71	30.05
P1	10/01/1997	156.087	84.63	-21.43	8.62
P1	7/02/1997	224.865	77.57	-7.06	1.56
P1	19/03/1997	218.296	78.94	1.37	2.93
P1	8/05/1997	146.669	85.8	6.86	9.79
P1	30/09/1997	157.825	82.83	-2.97	6.82
P1	21/04/1998	186.048	110.24	27.41	34.23
P1	4/07/1998	181.378	99.16	-11.08	23.15
P1	15/10/1998	164.172	96.1	-3.06	20.09
P1	2/12/1998	157.714	87.1	-9.00	11.09
P1	28/04/1999	143.692	76.59	-10.51	0.58
P1	5/10/1999	164.49	115.13	38.54	39.12
P1	17/04/2000	167.609	103.14	-11.99	27.13
P1	18/07/2000	113.648	63.02	-40.12	-12.99
P1	26/10/2000	143.66	80.59	17.57	4.58
P1	7/05/2001	148.868	81.38	0.79	5.37
P1	7/05/2001	140.956	78.38	-3.00	2.37
P1	15/10/2001	295.432	72.26	-6.12	-3.75
P1	2/05/2002	143.445	90.32	18.06	14.31
P1	9/09/2002	129.277	78.49	-11.83	2.48
P1	30/05/2003	141.642	83.49	5.00	7.48
P1	9/10/2003	143.564	92.15	8.66	16.14
P1	6/04/2004	148.177	99.3	7.15	23.29
P1	13/09/2004	134.88	92.4	-6.90	16.39

Descriptive Statistics

Mean	0.268688525
Standard Error	2.011611192
Median	0.79
Mode	#N/A
Standard Deviation	15.71118566
Sample Variance	246.8413549
Kurtosis	0.127541418
Skewness	-0.10652812
Range	78.66
Minimum	-40.12
Maximum	38.54
Sum	16.39
Count	61
Confidence Level(95.0%)	4.02382018

SUMMARY OUTPUT

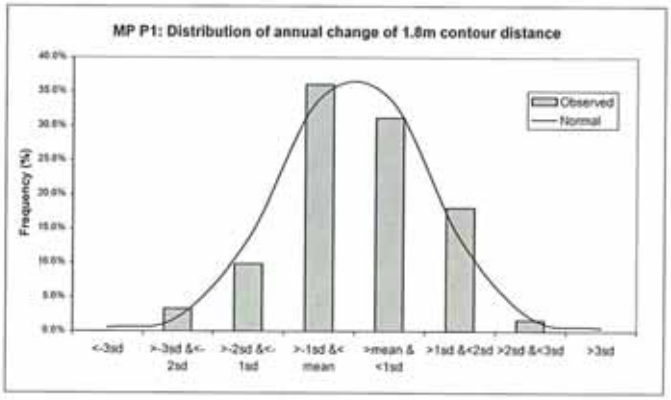
Regression Statistics

Multiple R	0.024669767
R Square	0.000608597
Adjusted R Square	-0.01633024
Standard Error	13.01542852
Observations	61

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	18.77614274	25.81158	0.727431	0.469839	-32.8728	70.42506	-32.8728	70.42506
X Variable 1	-0.000141123	0.000745	-0.18955	0.850313	-0.00163	0.001349	-0.00163	0.001349

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-46.9			0	0.0%	0.5%
>-3sd &<-2sd	-46.9	to	-31.2	2	3.3%	2.0%
>-2sd &<-1sd	-31.2	to	-15.4	6	9.8%	13.5%
>-1sd &< mean	-15.44	to	0.27	22	36.1%	34.0%
>mean & <1sd	0.27	to	15.98	19	31.1%	34.0%
>1sd &<2sd	15.98	to	31.69	11	18.0%	13.5%
>2sd &<3sd	31.69	to	47.40	1	1.6%	2.0%
>3sd	47.40			0	0.0%	0.5%
				61		



MP P1 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P1	7/09/1978	6475.704	53.14	0	0
P1	14/12/1978	256.826	53.68	0.54	0.54
P1	24/03/1979	6395.61	58.93	5.25	5.79
P1	14/08/1981	258.777	56.69	-2.24	3.55
P1	16/09/1982	2398.831	56.37	-0.32	3.23
P1	28/01/1983	258.603	50.88	-5.49	-2.26
P1	20/10/1983	6858.73	72.88	22	19.74
P1	19/03/1984	6784.086	75.69	2.81	22.55
P1	15/03/1988	245.7	51.55	-24.14	-1.59
P1	11/01/1989	93.585	53.68	2.13	0.54
P1	3/07/1989	92.537	55.07	1.39	1.93
P1	15/09/1989	71.164	41.35	-13.72	-11.79
P1	9/01/1990	69.761	41.71	0.36	-11.43
P1	21/06/1990	76.84	77.3	35.59	24.16
P1	15/09/1990	7432.006	51.9	-25.4	-1.24
P1	14/01/1991	80.139	100.06	48.16	46.92
P1	15/03/1991	229.229	89.55	-10.51	36.41
P1	11/07/1991	82.582	57.75	-31.8	4.61
P1	15/09/1991	232.304	56.17	-1.58	3.03
P1	15/03/1992	229.896	47.24	-8.93	-5.9
P1	6/11/1992	530.385	53.5	6.26	0.36
P1	8/03/1993	548.387	58.25	4.75	5.11
P1	15/10/1993	545.1	49.04	-9.21	-4.1
P1	24/02/1994	495.591	55	5.96	1.86
P1	15/03/1994	521.018	51.59	-3.41	-1.55
P1	2/08/1994	84.616	53.53	1.94	0.39
P1	16/10/1994	82.243	47.06	-6.47	-6.08
P1	15/03/1995	84.385	55.59	8.53	2.45
P1	21/07/1995	89.071	57.52	1.93	4.38
P1	10/10/1995	93.198	56.66	-0.86	3.52
P1	7/12/1995	91.449	60	3.34	6.86
P1	16/02/1996	89.984	56.81	-3.19	3.67
P1	6/03/1996	130.75	59.49	2.68	6.35
P1	18/03/1996	132.982	63.83	4.34	10.69
P1	2/04/1996	90.733	59.47	-4.36	6.33
P1	1/07/1996	140.205	59.23	-0.24	6.09
P1	5/08/1996	131.73	51.74	-7.49	-1.4
P1	23/10/1996	88.299	51.98	0.24	-1.16
P1	6/11/1996	264.168	58.72	6.74	5.58
P1	10/01/1997	90.017	58.77	0.05	5.63
P1	7/02/1997	155.38	55.61	-3.16	2.47
P1	19/03/1997	150.845	52.3	-3.31	-0.84
P1	8/05/1997	85.952	53.6	1.3	0.46
P1	30/09/1997	94.904	59.97	6.37	6.83
P1	21/04/1998	91.213	85.9	25.93	32.76
P1	4/07/1998	101.972	72.71	-13.19	19.57
P1	15/10/1998	95.063	59.38	-13.33	6.24
P1	2/12/1998	95.357	57.76	-1.62	4.62
P1	28/04/1999	89.56	52.48	-5.28	-0.66
P1	5/10/1999	91.492	68.09	15.61	14.95
P1	17/04/2000	89.322	65.36	-2.73	12.22
P1	18/07/2000	73.467	42.81	-22.55	-10.33
P1	26/10/2000	78.534	44.17	1.36	-8.97
P1	7/05/2001	90.649	52.4	8.23	-0.74
P1	7/05/2001	87.292	50.74	-1.66	-2.4
P1	15/10/2001	221.464	50.34	-0.4	-2.8
P1	2/05/2002	79.398	53.73	3.39	0.59
P1	9/09/2002	76.449	48.74	-4.99	-4.4
P1	30/05/2003	81.042	53.92	5.18	0.78
P1	9/10/2003	80.076	52.02	-1.9	-1.12
P1	6/04/2004	72.255	46.28	-5.74	-6.86
P1	13/09/2004	72.88	48.71	2.43	-4.43

Descriptive Statistics	
Mean	-0.072622951
Standard Error	1.594891739
Median	-0.24
Mode	#N/A
Standard Deviation	12.45494064
Sample Variance	155.1255463
Kurtosis	4.459663881
Skewness	0.962872755
Range	79.96
Minimum	-31.8
Maximum	48.16
Sum	-4.43
Count	61
Confidence Level(95.0%)	3.189657377

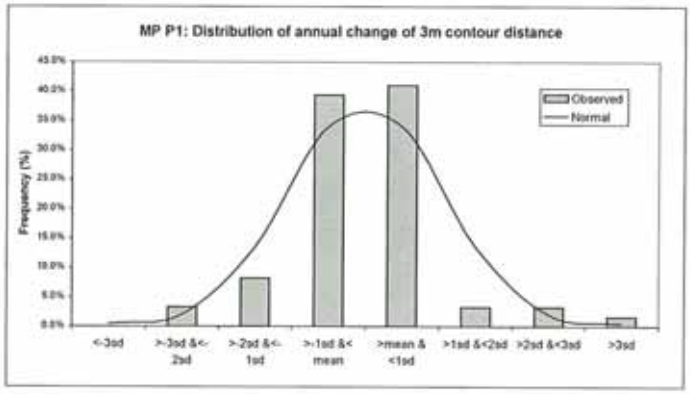
SUMMARY OUTPUT

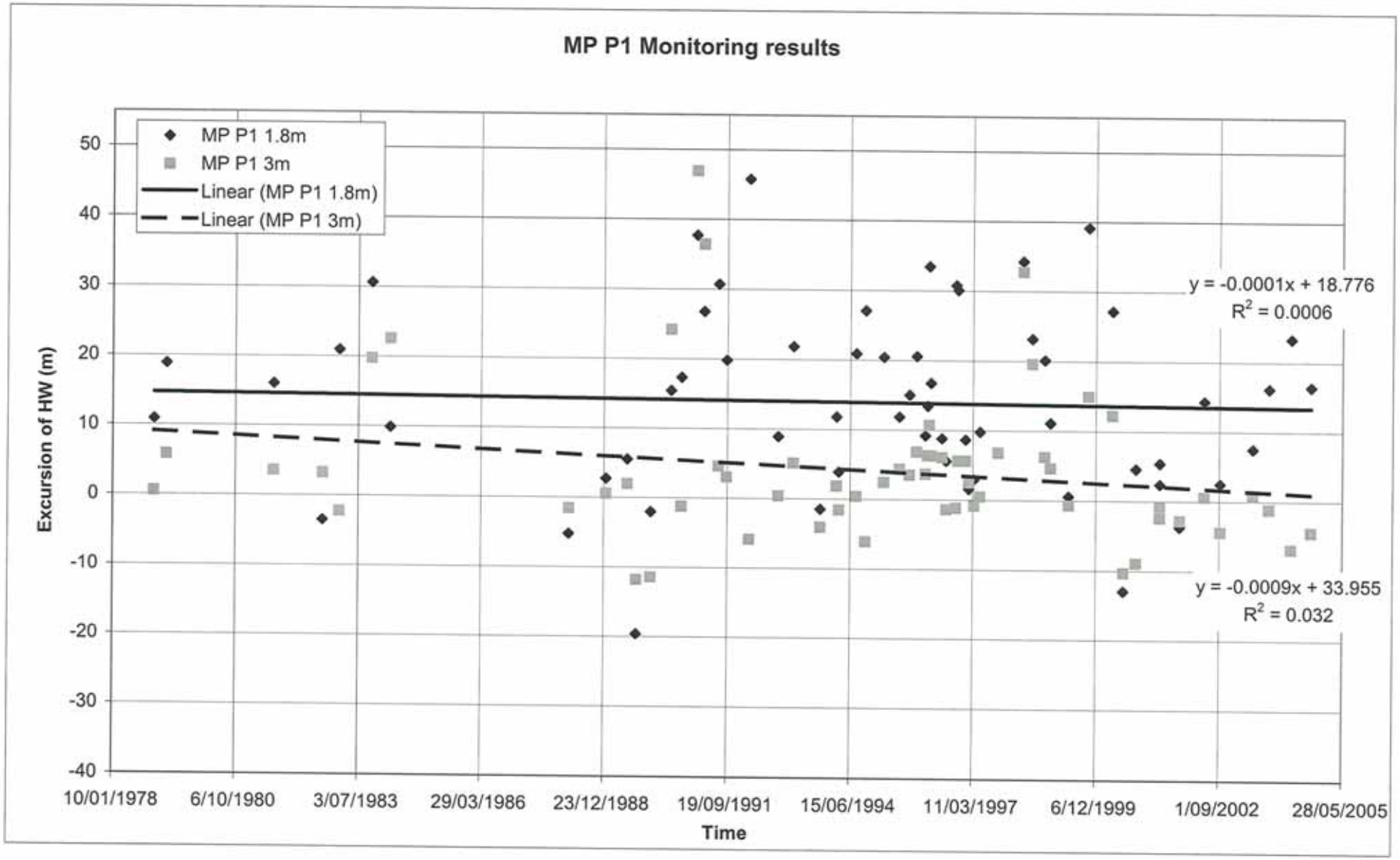
Regression Statistics	
Multiple R	0.178997274
R Square	0.032040024
Adjusted R Square	0.015633923
Standard Error	10.78540835
Observations	61

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	33.95476065	21.38911	1.587478644	0.11775	-8.844801	76.75432	-8.844801	76.75432
X Variable 1	-0.00086218	0.000617	-1.397473996	0.167504	-0.002097	0.000372	-0.002097	0.000372

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-37.4			0	0.0%	0.5%
>-3sd &<-2sd	-37.4	to	-25.0	2	3.3%	2.0%
>-2sd &<-1sd	-25.0	to	-12.5	5	8.2%	13.5%
>-1sd &< mean	-12.53	to	-0.07	24	39.3%	34.0%
>mean & <1sd	-0.07	to	12.38	25	41.0%	34.0%
>1sd &<2sd	12.38	to	24.84	2	3.3%	13.5%
>2sd &<3sd	24.84	to	37.29	2	3.3%	2.0%
>3sd	37.29			1	1.6%	0.5%
				61		




MP P1 Monitoring results
MP P1 1.8m
MP P1 3m
Linear (MP P1 1.8m)
Linear (MP P1 3m)
y = -0.0001x + 18.776
R2 = 0.0006
y = -0.0009x + 33.955
R2 = 0.032
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P2 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	15/03/1988	130.677	67.95	0.00	0.00
P2	11/01/1989	190.927	49.05	-18.90	-18.90
P2	3/07/1989	204.422	56.83	7.78	-11.12
P2	15/09/1989	188.336	49.63	-7.2	-18.32
P2	9/01/1990	208.533	59.18	9.55	-8.77
P2	21/06/1990	199.766	56.28	-2.90	-11.67
P2	15/09/1990	194.143	48.75	-7.53	-19.20
P2	14/01/1991	239.706	80.2	31.45	12.25
P2	15/03/1991	239.164	82.78	2.58	14.83
P2	11/07/1991	254.281	85.5	2.72	17.55
P2	15/09/1991	230.344	81.56	-3.94	13.61
P2	15/03/1992	256.742	93.83	12.27	25.88
P2	6/11/1992	183.151	102.29	8.46	34.34
P2	8/03/1993	250.008	80.08	-22.21	12.13
P2	15/10/1993	238.047	71.8	-8.28	3.85
P2	24/02/1994	236.689	69.74	-2.06	1.79
P2	15/03/1994	254.474	86.04	16.30	18.09
P2	2/08/1994	192.41	66.95	-19.09	-1.00
P2	16/10/1994	186.708	74.81	7.86	6.86
P2	15/03/1995	201.483	69.95	-4.86	2.00
P2	21/07/1995	186.021	60.24	-9.71	-7.71
P2	10/10/1995	190.605	65.6	5.36	-2.35
P2	7/12/1995	193.859	66.08	0.48	-1.87
P2	16/02/1996	203.852	65.45	-0.63	-2.50
P2	6/03/1996	196.76	64.1	-1.35	-3.85
P2	18/03/1996	199.107	64.09	-0.01	-3.86
P2	2/04/1996	199.878	66.55	2.46	-1.40
P2	1/07/1996	244.986	62.57	-3.98	-5.38
P2	5/08/1996	231.689	58.3	-4.27	-9.65
P2	23/10/1996	215.805	73.4	15.10	5.45
P2	6/11/1996	171.372	62.71	-10.69	-5.24
P2	10/01/1997	203.495	69.25	6.54	1.30
P2	7/02/1997	191.844	55.36	-13.89	-12.59
P2	19/03/1997	194.535	58.86	3.50	-9.09
P2	8/05/1997	210.074	70.1	11.24	2.15
P2	30/09/1997	240.187	53.78	-16.32	-14.17
P2	21/04/1998	214.06	67.02	13.24	-0.93
P2	4/07/1998	209.797	64.09	-2.93	-3.86
P2	15/10/1998	198.313	53.68	-10.41	-14.27
P2	2/12/1998	196.187	54.88	1.20	-13.07
P2	28/04/1999	203.833	61.49	6.61	-6.46
P2	5/10/1999	254.484	76	14.51	8.05
P2	17/04/2000	199.814	59.91	-16.09	-8.04
P2	17/07/2000	518.204	47.94	-11.97	-20.01
P2	26/10/2000	43.205	53.27	5.33	-14.68
P2	7/05/2001	34.831	41.92	-11.35	-26.03
P2	15/10/2001	46.03	55.7	13.78	-12.25
P2	2/05/2002	42.163	46.56	-9.14	-21.39
P2	9/09/2002	45.501	50.9	4.34	-17.05
P2	30/05/2003	177.57	54.71	3.81	-13.24
P2	9/10/2003	179.001	55.13	0.42	-12.82
P2	6/04/2004	208.534	71.65	16.52	3.70
P2	13/09/2004	195.872	69.22	-2.43	1.27

Descriptive Statistics	
Mean	0.024423077
Standard Error	1.502872122
Median	0.205
Mode	#N/A
Standard Deviation	10.837365
Sample Variance	117.4484801
Kurtosis	0.204798779
Skewness	0.2071406
Range	53.66
Minimum	-22.21
Maximum	31.45
Sum	1.27
Count	52
Confidence Level(95.0%)	3.017139359

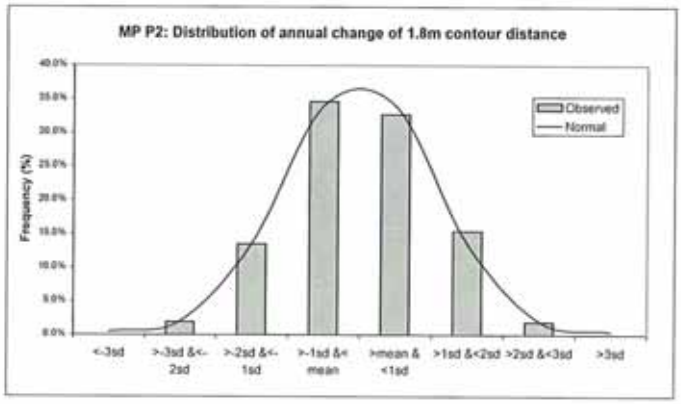
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.338456923
R Square	0.114554442
Adjusted R Square	0.096845531
Standard Error	11.87014219
Observations	52

	Coefficients	*andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	94.83665483	38.59042	2.457518	0.017501	17.32548	172.3478	17.32548	172.3478
X Variable 1	-0.002783928	0.001095	-2.54337	0.014118	-0.00498	-0.00059	-0.00498	-0.00059

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-32.5			0	0.0%	0.5%
>-3sd &<-2sd	-32.5	to	-21.7	1	1.9%	2.0%
>-2sd &<-1sd	-21.7	to	-10.8	7	13.5%	13.5%
>-1sd &< mean	-10.81	to	0.02	18	34.6%	34.0%
>mean & <1sd	0.02	to	10.86	17	32.7%	34.0%
>1sd &<2sd	10.86	to	21.70	8	15.4%	13.5%
>2sd &<3sd	21.70	to	32.54	1	1.9%	2.0%
>3sd	32.54			0	0.0%	0.5%
				52		



MP P2 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P2	15/03/1988	74.259	40.11	0.00	0.00
P2	11/01/1989	141.704	35.53	-4.58	-4.58
P2	3/07/1989	146.553	41.29	5.76	1.18
P2	15/09/1989	136.217	37.4	-3.89	-2.71
P2	9/01/1990	143.125	49.67	12.27	9.56
P2	21/06/1990	142.226	40.85	-8.82	0.74
P2	15/09/1990	143.233	36.1	-4.75	-4.01
P2	14/01/1991	149.731	70.06	33.96	29.95
P2	15/03/1991	151.307	64.26	-5.80	24.15
P2	11/07/1991	163.715	53.93	-10.33	13.82
P2	15/09/1991	153.613	48.62	-5.31	8.51
P2	15/03/1992	156.174	75.25	26.63	35.14
P2	6/11/1992	112.884	46.31	-28.94	6.20
P2	8/03/1993	163.236	61.89	15.58	21.78
P2	15/10/1993	164.914	46.4	-15.49	6.29
P2	24/02/1994	167.287	48.15	1.75	8.04
P2	15/03/1994	165.225	78.7	30.55	38.59
P2	2/08/1994	131.273	46.9	-31.80	6.79
P2	16/10/1994	123.653	46.95	0.05	6.84
P2	15/03/1995	135.244	48.71	1.76	8.60
P2	21/07/1995	131.729	43.28	-5.43	3.17
P2	10/10/1995	131.353	43.95	0.67	3.84
P2	7/12/1995	133.618	45.59	1.64	5.48
P2	16/02/1996	139.401	48.47	2.88	8.36
P2	6/03/1996	138.994	47.33	-1.14	7.22
P2	18/03/1996	137.144	47.84	0.51	7.73
P2	2/04/1996	137.571	47.9	0.06	7.79
P2	1/07/1996	177.734	49.31	1.41	9.20
P2	5/08/1996	170.965	43.79	-5.52	3.68
P2	23/10/1996	141.316	50.88	7.09	10.77
P2	8/11/1996	116.101	45.3	-5.58	5.19
P2	10/01/1997	139.224	48.18	2.88	8.07
P2	7/02/1997	138.767	44.56	-3.62	4.45
P2	19/03/1997	138.033	45.05	0.49	4.94
P2	8/05/1997	142.387	51.45	6.40	11.34
P2	30/09/1997	181.23	45.43	-6.02	5.32
P2	21/04/1998	148.292	53.09	7.66	12.98
P2	4/07/1998	149.436	47.84	-5.25	7.73
P2	15/10/1998	146.591	42.89	-4.95	2.78
P2	2/12/1998	145.108	42.25	-0.64	2.14
P2	28/04/1999	147.464	45.85	3.60	5.74
P2	5/10/1999	176.916	44.61	-1.24	4.50
P2	17/04/2000	142.906	45.39	0.78	5.28
P2	17/07/2000	430.424	34.7	-10.69	-5.41
P2	26/10/2000	18.018	32.95	-1.75	-7.16
P2	7/05/2001	18.206	33.38	0.43	-6.73
P2	15/10/2001	19.183	37.27	3.89	-2.84
P2	2/05/2002	20.924	37.45	0.18	-2.66
P2	9/09/2002	21.427	38.43	0.98	-1.68
P2	30/05/2003	130.219	38.98	0.55	-1.13
P2	9/10/2003	127.72	36.9	-2.08	-3.21
P2	6/04/2004	135.002	48.21	11.31	8.10
P2	13/09/2004	131.837	41.23	-6.98	1.12

Descriptive Statistics

Mean	0.021538462
Standard Error	1.543537576
Median	0.12
Mode	#N/A
Standard Deviation	11.13060775
Sample Variance	123.890429
Kurtosis	3.471393817
Skewness	0.436866705
Range	65.76
Minimum	-31.8
Maximum	33.96
Sum	1.12
Count	52
Confidence Level(95.0%)	3.098778602

SUMMARY OUTPUT

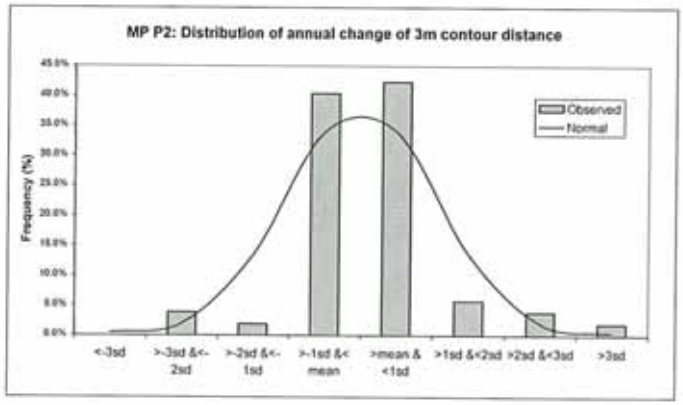
Regression Statistics

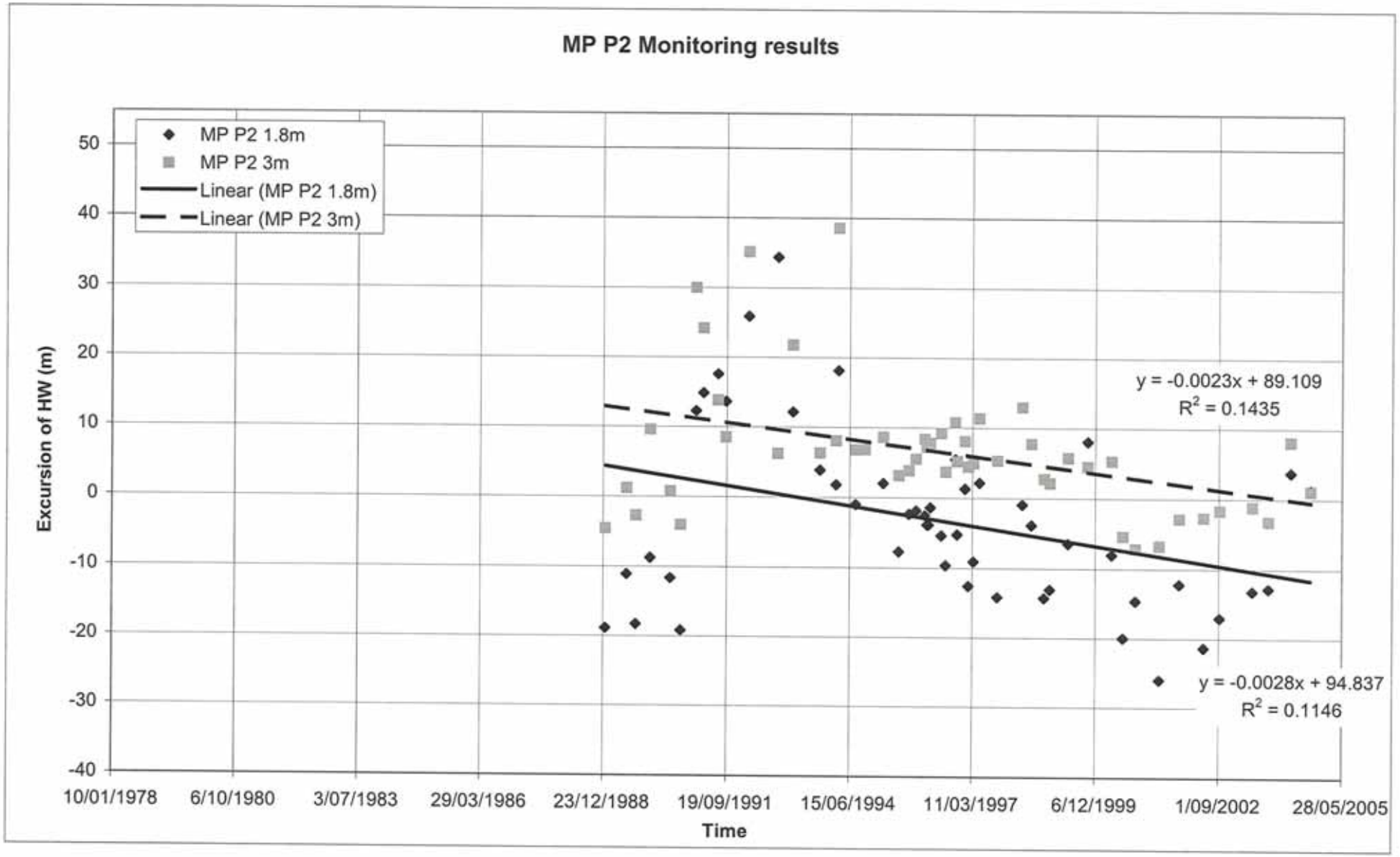
Multiple R	0.378795759
R Square	0.143486227
Adjusted R Square	0.126355952
Standard Error	8.78163825
Observations	52

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	89.10912267	28.54954	3.12121	0.00299	31.76566	146.4526	31.76566	146.4526
X Variable 1	-0.002343638	0.00081	-2.89416	0.00562	-0.00397	-0.00072	-0.00397	-0.00072

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-33.4			0	0.0%	0.5%
>-3sd &<-2sd	-33.4	to	-22.2	2	3.8%	2.0%
>-2sd &<-1sd	-22.2	to	-11.1	1	1.9%	13.5%
>-1sd &< mean	-11.11	to	0.02	21	40.4%	34.0%
>mean & <1sd	0.02	to	11.15	22	42.3%	34.0%
>1sd &<2sd	11.15	to	22.28	3	5.8%	13.5%
>2sd &<3sd	22.28	to	33.41	2	3.8%	2.0%
>3sd	33.41			1	1.9%	0.5%
				52		




MP P2 Monitoring results
MP P2 1.8m
MP P2 3m
Linear (MP P2 1.8m)
Linear (MP P2 3m)
y = -0.0023x + 89.109
R² = 0.1435
y = -0.0028x + 94.837
R² = 0.1146
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P3 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Dif (m)
P3	14/08/1981	154.753	75.27	0.00	0.00
P3	16/09/1982	381.612	70.79	-4.48	-4.48
P3	20/10/1983	181.489	79.79	9.00	4.52
P3	19/03/1984	192.569	83.31	3.52	8.04
P3	15/03/1988	217.975	71.64	-11.67	-3.63
P3	11/01/1989	199.336	65.21	-6.43	-10.06
P3	3/07/1989	209.021	69.36	4.15	-5.91
P3	15/09/1989	188.295	58.69	-10.67	-16.58
P3	9/01/1990	199.888	64.33	5.64	-10.94
P3	21/06/1990	211.596	74.56	10.23	-0.71
P3	15/09/1990	220.837	69.71	-4.85	-5.56
P3	14/01/1991	238.681	88.05	18.34	12.78
P3	15/03/1991	233.869	73.89	-14.16	-1.38
P3	11/07/1991	195.533	67.43	-6.46	-7.84
P3	15/09/1991	214.936	69.67	2.24	-5.60
P3	15/03/1992	244.397	90	20.33	14.73
P3	6/11/1992	231.533	94.82	4.82	19.55
P3	8/03/1993	232.846	75.4	-19.42	0.13
P3	15/10/1993	229.021	67.56	-7.84	-7.71
P3	24/02/1994	237.707	78.73	11.17	3.46
P3	15/03/1994	247.627	88.62	9.89	13.35
P3	2/08/1994	240.347	78.34	-10.28	3.07
P3	16/10/1994	246.326	88.2	9.86	12.93
P3	15/03/1995	254.998	83.08	-5.12	7.81
P3	21/07/1995	242.741	69.79	-13.29	-5.48
P3	10/10/1995	241.967	73.41	3.62	-1.86
P3	7/12/1995	247.56	77.55	4.14	2.28
P3	16/02/1996	255.453	78.07	0.52	2.80
P3	6/03/1996	246.21	71.98	-6.09	-3.29
P3	18/03/1996	249.289	74.61	2.63	-0.66
P3	2/04/1996	252.843	75.91	1.30	0.64
P3	1/07/1996	276.324	71.03	-4.88	-4.24
P3	5/08/1996	236.629	66.04	-4.99	-9.23
P3	23/10/1996	246.046	73.23	7.19	-2.04
P3	6/11/1996	229.679	59.97	-13.26	-15.30
P3	10/01/1997	227.927	63.63	3.66	-11.64
P3	7/02/1997	228.701	63.31	-0.32	-11.96
P3	19/03/1997	222.858	63.31	0.00	-11.96
P3	8/05/1997	104.178	65.1	1.79	-10.17
P3	30/09/1997	94.531	55.26	-9.84	-20.01
P3	21/04/1998	111.16	72.67	17.41	-2.60
P3	4/07/1998	95.793	58.11	-14.56	-17.16
P3	15/10/1998	102.563	87.46	29.35	12.19
P3	2/12/1998	94.025	68.42	-19.04	-6.85
P3	28/04/1999	87.529	64.26	-4.16	-11.01
P3	5/10/1999	90.448	75.71	11.45	0.44
P3	17/04/2000	85.412	62.62	-13.09	-12.65
P3	17/07/2000	156.979	50.14	-12.48	-25.13
P3	26/10/2000	61.575	61.52	11.38	-13.75
P3	7/05/2001	54.776	47.81	-13.71	-27.46
P3	15/10/2001	75.784	62.11	14.30	-13.16
P3	2/05/2002	78.701	60.89	-1.22	-14.38
P3	9/09/2002	73.263	55.76	-5.13	-19.51
P3	30/05/2003	94.683	67.36	11.60	-7.91
P3	9/10/2003	91.714	63.9	-3.46	-11.37
P3	6/04/2004	232.667	93.62	29.72	18.35
P3	13/09/2004	103.052	78.18	-15.44	2.91

Descriptive Statistics

Mean	0.051964286
Standard Error	1.525483326
Median	-0.16
Mode	#N/A
Standard Deviation	11.41567191
Sample Variance	130.3175652
Kurtosis	0.019649789
Skewness	0.527714784
Range	49.14
Minimum	-19.42
Maximum	29.72
Sum	2.91
Count	56
Confidence Level(95.0%)	3.05713615

SUMMARY OUTPUT

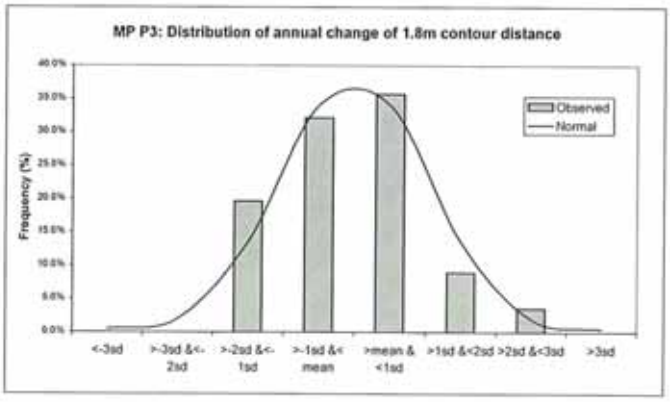
Regression Statistics

Multiple R	0.283001404
R Square	0.080089795
Adjusted R Square	0.063054421
Standard Error	10.14860132
Observations	56

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	51.94357365	25.89589	2.005862	0.049892	0.025402	103.8617	0.025402	103.8617
X Variable 1	-0.001605803	0.000741	-2.16827	0.034563	-0.00309	-0.00012	-0.00309	-0.00012

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-34.2			0	0.0%	0.5%
>-3sd &<-2sd	-34.2	to	-22.8	0	0.0%	2.0%
>-2sd &<-1sd	-22.8	to	-11.4	11	19.6%	13.5%
>-1sd &< mean	-11.36	to	0.05	18	32.1%	34.0%
>mean & <1sd	0.05	to	11.47	20	35.7%	34.0%
>1sd &<2sd	11.47	to	22.88	5	8.9%	13.5%
>2sd &<3sd	22.88	to	34.30	2	3.6%	2.0%
>3sd	34.30			0	0.0%	0.5%
				56		



MP P3 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P3	14/08/1981	77.595	51.79	0.00	0.00
P3	16/09/1982	261.128	50.1	-1.69	-1.69
P3	20/10/1983	100.912	48.22	-1.88	-3.57
P3	19/03/1984	103.21	72.22	24	20.43
P3	15/03/1988	144.436	56.19	-16.03	4.40
P3	11/01/1989	133.837	51.82	-4.37	0.03
P3	3/07/1989	140.288	53.7	1.88	1.91
P3	15/09/1989	128.226	48.16	-5.54	-3.63
P3	9/01/1990	131.62	56.21	8.05	4.42
P3	21/06/1990	136.105	58.73	2.52	6.94
P3	15/09/1990	147.376	54.05	-4.68	2.26
P3	14/01/1991	141.844	78.93	24.88	27.14
P3	15/03/1991	151.152	64.9	-14.03	13.11
P3	11/07/1991	129.406	49.37	-15.53	-2.42
P3	15/09/1991	144.863	49.7	0.33	-2.09
P3	15/03/1992	149.067	64.55	14.85	12.76
P3	6/11/1992	151.373	52.63	-11.92	0.84
P3	8/03/1993	152.254	57.27	4.64	5.48
P3	15/10/1993	155.779	50.44	-6.83	-1.35
P3	24/02/1994	157.626	55.36	4.92	3.57
P3	15/03/1994	157.601	54.47	-0.89	2.68
P3	2/08/1994	161.142	55.87	1.40	4.08
P3	16/10/1994	159.256	55.05	-0.82	3.26
P3	15/03/1995	167.554	63.06	8.01	11.27
P3	21/07/1995	168.694	54.91	-8.15	3.12
P3	10/10/1995	165.381	55.06	0.15	3.27
P3	7/12/1995	167.702	56.64	1.58	4.85
P3	16/02/1996	169.38	60.5	3.86	8.71
P3	6/03/1996	169.04	58.2	-2.30	6.41
P3	18/03/1996	168.991	58.61	0.41	6.82
P3	2/04/1996	170.297	59.92	1.31	8.13
P3	1/07/1996	194.12	59.82	-0.10	8.03
P3	5/09/1996	166.154	52.61	-7.21	0.82
P3	23/10/1996	166.887	54.67	2.06	2.88
P3	6/11/1996	163.591	50	-4.67	-1.79
P3	10/01/1997	161.46	49.22	-0.78	-2.57
P3	7/02/1997	161.258	51.04	1.82	-0.75
P3	19/03/1997	154.71	49.06	-1.98	-2.73
P3	8/05/1997	61.005	48.17	-0.89	-3.62
P3	30/09/1997	60.82	46.93	-1.24	-4.86
P3	21/04/1998	61.598	56.16	9.23	4.37
P3	4/07/1998	60.911	46.26	-9.90	-5.53
P3	15/10/1998	56.692	51.37	5.11	-0.42
P3	2/12/1998	52.961	47.4	-3.97	-4.39
P3	28/04/1999	49.598	46.79	-0.61	-5.00
P3	5/10/1999	44.774	46.58	-0.21	-5.21
P3	17/04/2000	47.174	48.1	1.52	-3.69
P3	17/07/2000	109.812	35.76	-12.34	-16.03
P3	26/10/2000	29.783	34.06	-1.70	-17.73
P3	7/05/2001	30.842	36.05	1.99	-15.74
P3	15/10/2001	37.43	44.5	8.45	-7.29
P3	2/05/2002	41.128	46.61	2.11	-5.18
P3	9/09/2002	39.871	44.34	-2.27	-7.45
P3	30/05/2003	49.733	50.75	6.41	-1.04
P3	9/10/2003	49.027	50.05	-0.70	-1.74
P3	6/04/2004	138.408	55.2	5.15	3.41
P3	13/09/2004	49.648	49.44	-5.76	-2.35

Descriptive Statistics

Mean	-0.041964286
Standard Error	1.037260547
Median	-0.41
Mode	-0.89
Standard Deviation	7.762147177
Sample Variance	60.2509288
Kurtosis	2.531534322
Skewness	0.76807068
Range	40.91
Minimum	-16.03
Maximum	24.88
Sum	-2.35
Count	56
Confidence Level(95.0%)	2.078716077

SUMMARY OUTPUT

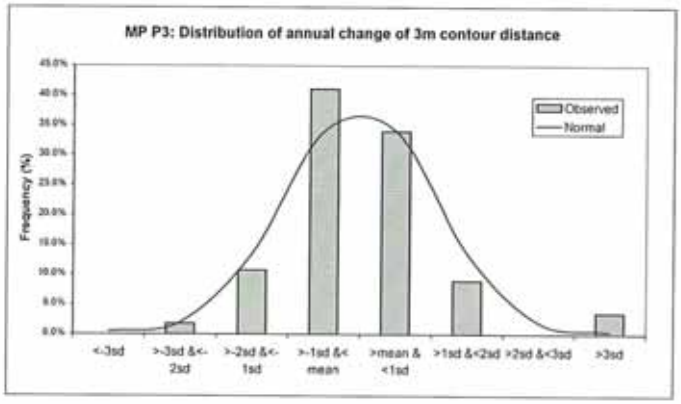
Regression Statistics

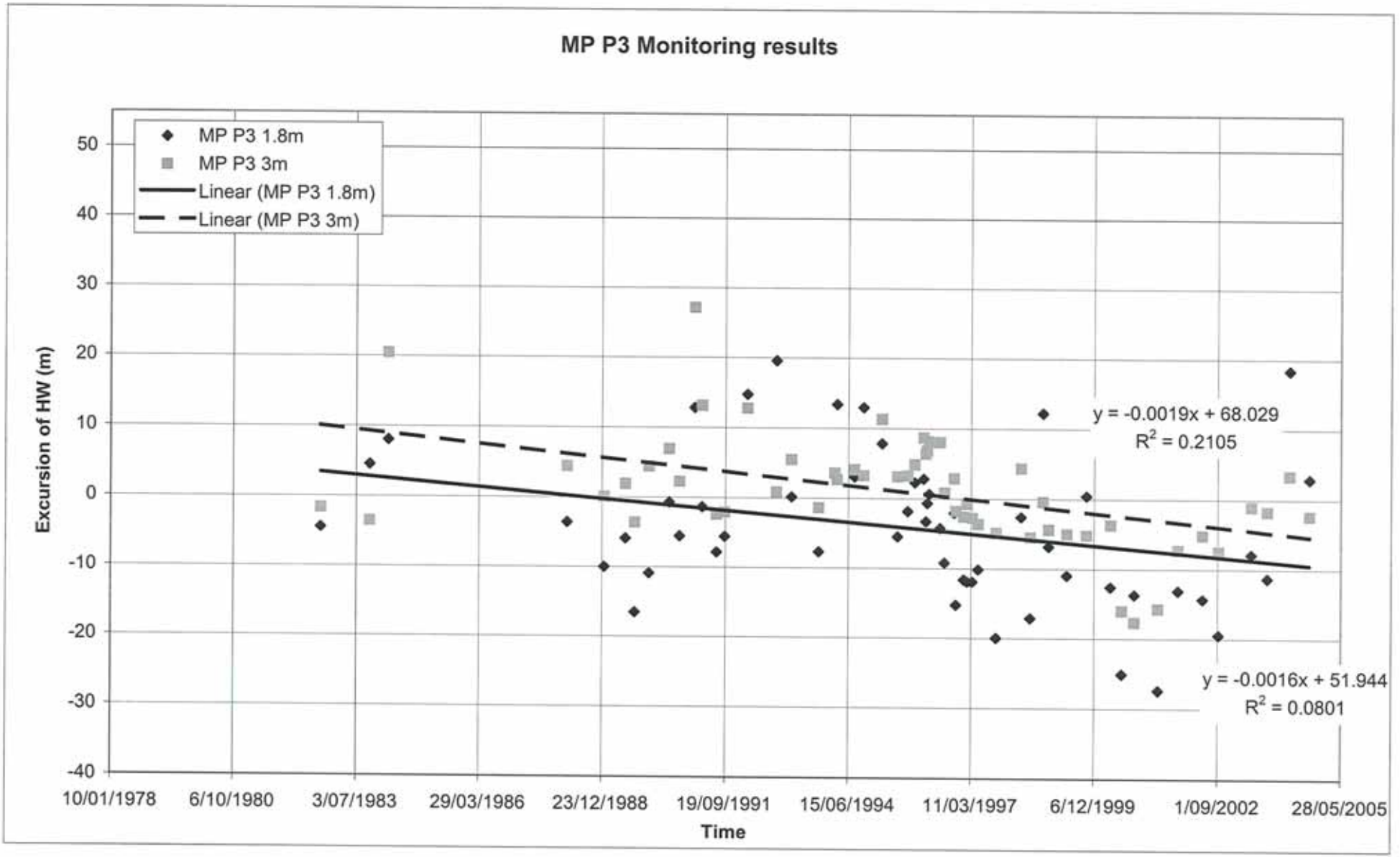
Multiple R	0.45884082
R Square	0.210534898
Adjusted R Square	0.195915174
Standard Error	6.932549366
Observations	56

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	68.02864481	17.68958	3.84569	0.000319	32.56314	103.4942	32.56314	103.4942
X Variable 1	-0.001919812	0.000506	-3.79483	0.000376	-0.00293	-0.00091	-0.00293	-0.00091

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-23.3			0	0.0%	0.5%
>-3sd &<-2sd	-23.3	to	-15.6	1	1.8%	2.0%
>-2sd &<-1sd	-15.6	to	-7.8	6	10.7%	13.5%
>-1sd &< mean	-7.80	to	-0.04	23	41.1%	34.0%
>mean & <1sd	-0.04	to	7.72	19	33.9%	34.0%
>1sd &<2sd	7.72	to	15.48	5	8.9%	13.5%
>2sd &<3sd	15.48	to	23.24	0	0.0%	2.0%
>3sd	23.24			2	3.6%	0.5%
				56		




MP P3 Monitoring results
MP P3 1.8m
MP P3 3m
Linear (MP P3 1.8m)
Linear (MP P3 3m)
y = -0.0019x + 68.029
R² = 0.2105
y = -0.0016x + 51.944
R² = 0.0801
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P4 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P4	12/09/1978	2295.368	150.88	0.00	0.00
P4	14/12/1978	964.657	164.71	13.83	13.83
P4	24/03/1979	1478.113	168.32	3.61	17.44
P4	14/08/1981	962.661	170.62	2.3	19.74
P4	16/09/1982	959.006	161.96	-8.66	11.08
P4	28/01/1983	243.782	171.63	9.67	20.75
P4	20/10/1983	989.324	165.59	-6.04	14.71
P4	19/03/1984	158.987	168.05	2.46	17.17
P4	15/03/1988	476.4	154.54	-13.51	3.66
P4	11/01/1989	139.161	139.89	-14.65	-10.99
P4	3/07/1989	181.542	160.7	20.81	9.82
P4	15/09/1989	148.974	143.6	-17.10	-7.28
P4	9/01/1990	153.563	155.4	11.80	4.52
P4	21/06/1990	172.709	165.35	9.95	14.47
P4	15/09/1990	1117.686	155.9	-9.45	5.02
P4	14/01/1991	201.15	177.05	21.15	26.17
P4	15/03/1991	1198.305	184.38	7.33	33.50
P4	11/07/1991	201.719	175.5	-8.88	24.62
P4	15/09/1991	1179.338	173.74	-1.76	22.86
P4	15/03/1992	1191.267	181.85	8.11	30.97
P4	6/11/1992	316.378	188.73	6.88	37.85
P4	8/03/1993	189.463	175.73	-13.00	24.85
P4	15/10/1993	256.659	154.49	-21.24	3.61
P4	24/02/1994	282.737	170.6	16.11	19.72
P4	15/03/1994	199.87	184.1	13.50	33.22
P4	2/08/1994	193.665	173.61	-10.49	22.73
P4	16/10/1994	189.859	166.52	-7.09	15.64
P4	15/03/1995	208.368	181.2	14.68	30.32
P4	21/07/1995	181.966	154.87	-26.33	3.99
P4	10/10/1995	188.843	158.55	3.68	7.67
P4	7/12/1995	191.459	160.95	2.40	10.07
P4	16/02/1996	189.708	161.31	0.36	10.43
P4	6/03/1996	185.523	158.82	-2.49	7.94
P4	18/03/1996	198.981	169.04	10.22	18.16
P4	2/04/1996	199.174	166.74	-2.30	15.86
P4	1/07/1996	188.154	156.31	-10.43	5.43
P4	5/08/1996	170.582	149.58	-6.73	-1.30
P4	23/10/1996	182.715	156.74	7.16	5.86
P4	6/11/1996	171.633	158.5	1.76	7.62
P4	10/01/1997	171.361	151.37	-7.13	0.49
P4	7/02/1997	173.727	150.7	-0.67	-0.18
P4	19/03/1997	171.123	150.96	0.26	0.08
P4	8/05/1997	187.078	158.65	7.69	7.77
P4	30/09/1997	182.525	152.18	-6.47	1.30
P4	21/04/1998	205.951	164.95	12.77	14.07
P4	4/07/1998	184.725	155.54	-9.41	4.66
P4	15/10/1998	197.692	149.98	-5.56	-0.90
P4	2/12/1998	176.724	157.24	7.26	6.36
P4	5/10/1999	186.894	155.35	-1.89	4.47
P4	17/04/2000	167.629	145.82	-9.53	-5.06
P4	12/07/2000	152.549	147.86	2.04	-3.02
P4	26/10/2000	178.618	156.13	8.27	5.25
P4	7/05/2001	142.304	142.48	-13.65	-8.40
P4	15/10/2001	153.491	149.33	6.85	-1.55
P4	2/05/2002	140.978	142.04	-7.29	-8.84
P4	9/09/2002	141.72	150.09	8.05	-0.79
P4	30/05/2003	135.567	152.38	2.29	1.50
P4	9/10/2003	217.804	165.79	13.41	14.91
P4	6/04/2004	212.729	169.03	3.24	18.15
P4	16/09/2004	377.977	156.91	-12.12	6.03

Descriptive Statistics	
Mean	0.10220339
Standard Error	1.366425776
Median	1.76
Mode	#N/A
Standard Deviation	10.49571556
Sample Variance	110.1600451
Kurtosis	-0.449843021
Skewness	-0.171962701
Range	47.48
Minimum	-26.33
Maximum	21.15
Sum	6.03
Count	59
Confidence Level(95.0%)	2.735196322

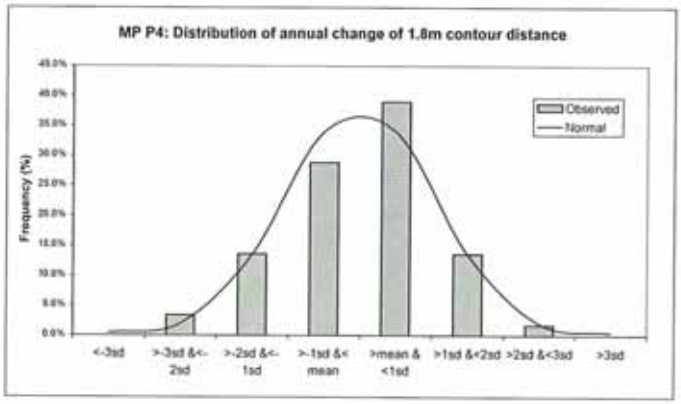
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.363336305
R Square	0.132013271
Adjusted R Square	0.116785433
Standard Error	10.72511423
Observations	59

	Coefficients	*andard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	73.61134131	21.54603	3.416468	0.001176	30.46613	116.7565	30.46613	116.7565
X Variable 1	-0.001833521	0.000623	-2.94435	0.004677	-0.00308	-0.00059	-0.00308	-0.00059

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-31.4			0	0.0%	0.5%
>-3sd &<-2sd	-31.4	to	-20.9	2	3.4%	2.0%
>-2sd &<-1sd	-20.9	to	-10.4	8	13.6%	13.5%
>-1sd &< mean	-10.39	to	0.10	17	28.8%	34.0%
>mean & <1sd	0.10	to	10.60	23	39.0%	34.0%
>1sd &<2sd	10.60	to	21.09	8	13.6%	13.5%
>2sd &<3sd	21.09	to	31.59	1	1.7%	2.0%
>3sd	31.59			0	0.0%	0.5%
				59		



MP P4 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P4	12/09/1978	2012.579	130.38	0.00	0.00
P4	14/12/1978	771.904	156.94	26.56	26.56
P4	24/03/1979	1244.279	145.5	-11.44	15.12
P4	14/08/1981	777.184	138.44	-7.06	8.06
P4	16/09/1982	776.592	140.16	1.72	9.78
P4	28/01/1983	145.7	157.48	17.32	27.10
P4	20/10/1983	805.383	137.99	-19.49	7.61
P4	19/03/1984	87.808	156.18	18.19	25.80
P4	15/03/1988	364.054	138.53	-17.65	8.15
P4	11/01/1989	98.586	134.52	-4.01	4.14
P4	3/07/1989	122.386	144.1	9.58	13.72
P4	15/09/1989	104.839	135.16	-8.94	4.78
P4	9/01/1990	97.667	144.69	9.53	14.31
P4	21/06/1990	108.909	146.85	2.16	16.47
P4	15/09/1990	941.976	139.12	-7.73	8.74
P4	14/01/1991	117.723	168.8	29.68	38.42
P4	15/03/1991	987.147	165.72	-3.08	35.34
P4	11/07/1991	122.542	154.9	-10.82	24.52
P4	15/09/1991	987.081	152.09	-2.81	21.71
P4	15/03/1992	982.378	157	4.91	26.62
P4	6/11/1992	217.707	147.84	-9.16	17.46
P4	8/03/1993	116.823	151.04	3.20	20.66
P4	15/10/1993	185.562	137.74	-13.30	7.36
P4	24/02/1994	196.876	148.85	11.11	18.47
P4	15/03/1994	119.195	176.33	27.48	45.95
P4	2/08/1994	128.274	146.4	-29.93	16.02
P4	16/10/1994	125.761	148.01	1.61	17.63
P4	15/03/1995	130.345	147.97	-0.04	17.59
P4	21/07/1995	127.379	142.09	-5.88	11.71
P4	10/10/1995	129.795	145.31	3.22	14.93
P4	7/12/1995	131.114	144.44	-0.87	14.06
P4	16/02/1996	129.106	143.15	-1.29	12.77
P4	6/03/1996	127.534	143.85	0.70	13.47
P4	18/03/1996	127.817	145.68	1.81	15.28
P4	2/04/1996	130.4	147.94	2.28	17.56
P4	1/07/1996	130.5	145.94	-2.00	15.56
P4	5/08/1996	121.593	137.72	-8.22	7.34
P4	23/10/1996	122.011	145.33	7.61	14.95
P4	6/11/1996	119.249	137.34	-7.99	6.96
P4	10/01/1997	121.058	138.51	1.17	8.13
P4	7/02/1997	123.608	139.41	0.90	9.03
P4	19/03/1997	118.069	136.58	-2.83	6.20
P4	8/05/1997	125.718	144.24	7.66	13.86
P4	30/09/1997	127.769	140.18	-4.06	9.80
P4	21/04/1998	136.778	152.73	12.55	22.35
P4	4/07/1998	127.94	141	-11.73	10.62
P4	15/10/1998	143.87	137.28	-3.72	6.90
P4	2/12/1998	121.775	138.41	1.13	8.03
P4	5/10/1999	130.769	133.88	-4.53	3.50
P4	17/04/2000	119.265	135.99	2.11	5.61
P4	12/07/2000	106.067	131.79	-4.20	1.41
P4	26/10/2000	118.65	146.19	14.40	15.81
P4	7/05/2001	98.196	132.47	-13.72	2.09
P4	15/10/2001	101.38	137.73	5.26	7.35
P4	2/05/2002	96.632	132.95	-4.78	2.57
P4	9/09/2002	89.298	140.42	7.47	10.04
P4	30/05/2003	84.679	138.39	-2.03	8.01
P4	9/10/2003	138.969	157.4	19.01	27.02
P4	6/04/2004	131.344	158.52	1.12	28.14
P4	16/09/2004	276.915	145.92	-12.60	15.54

Descriptive Statistics

Mean	0.263389831
Standard Error	1.465860188
Median	-0.04
Mode	#N/A
Standard Deviation	11.25948575
Sample Variance	126.7760193
Kurtosis	0.960592257
Skewness	0.406689819
Range	59.61
Minimum	-29.93
Maximum	29.68
Sum	15.54
Count	59
Confidence Level(95.0%)	2.934235769

SUMMARY OUTPUT

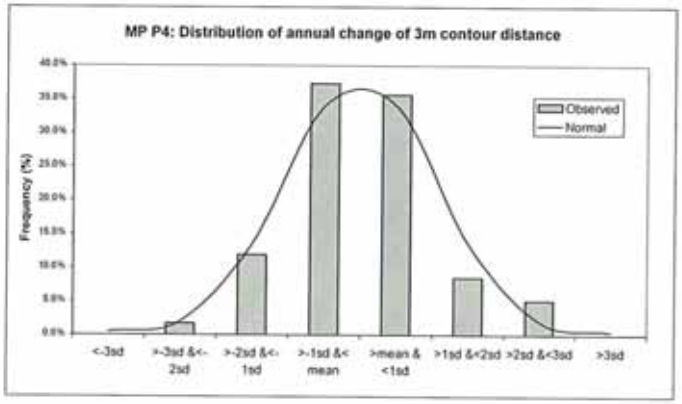
Regression Statistics

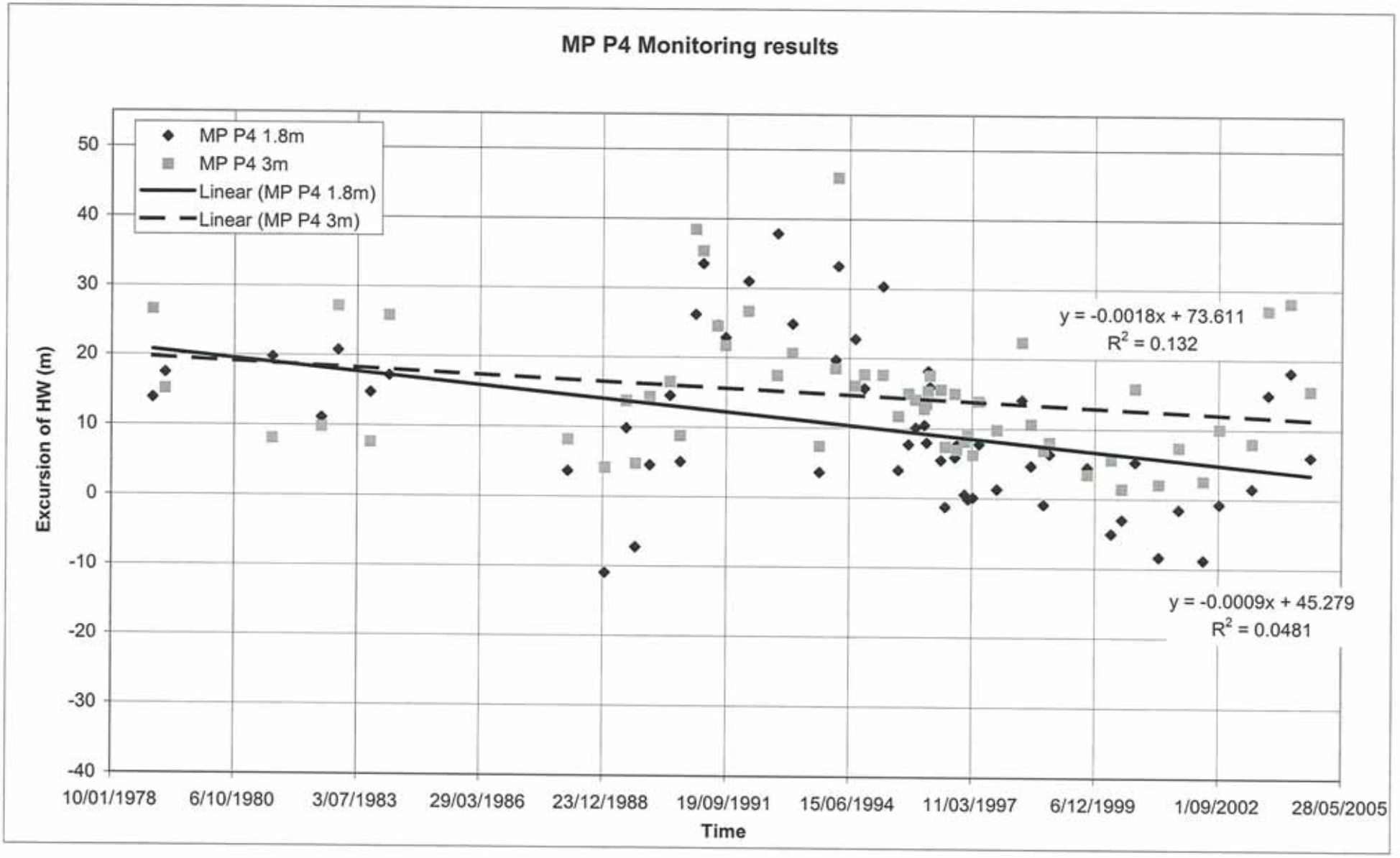
Multiple R	0.219387793
R Square	0.048131004
Adjusted R Square	0.031431548
Standard Error	8.997833688
Observations	59

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	45.27897862	18.07604	2.504916	0.015131	9.082311	81.47565	9.082311	81.47565
X Variable 1	-0.000886939	0.000522	-1.6977	0.095018	-0.00193	0.000159	-0.00193	0.000159

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-33.5			0	0.0%	0.5%
>-3sd &<-2sd	-33.5	to	-22.3	1	1.7%	2.0%
>-2sd &<-1sd	-22.3	to	-11.0	7	11.9%	13.5%
>-1sd &< mean	-11.00	to	0.26	22	37.3%	34.0%
>mean & <1sd	0.26	to	11.52	21	35.6%	34.0%
>1sd &<2sd	11.52	to	22.78	5	8.5%	13.5%
>2sd &<3sd	22.78	to	34.04	3	5.1%	2.0%
>3sd	34.04			0	0.0%	0.5%
				59		




MP P4 Monitoring results
MP P4 1.8m
MP P4 3m
Linear (MP P4 1.8m)
Linear (MP P4 3m)
y = -0.0018x + 73.611
R² = 0.132
y = -0.0009x + 45.279
R² = 0.0481
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P5 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P5	17/10/1978	5413.428	69.87	0.00	0.00
P5	14/12/1978	324.222	79.67	9.80	9.80
P5	24/03/1979	6636.86	71.6	-8.07	1.73
P5	14/08/1981	306.728	77.64	6.04	7.77
P5	16/09/1982	1584.111	88.11	10.47	18.24
P5	28/01/1983	330.522	97.55	9.44	27.68
P5	20/10/1983	4883.411	84.97	-12.58	15.10
P5	19/03/1984	5881.336	92.53	7.56	22.66
P5	15/03/1988	3525.21	82.74	-9.79	12.87
P5	11/01/1989	203.714	74.1	-8.64	4.23
P5	3/07/1989	217.197	81.91	7.81	12.04
P5	15/09/1989	184.816	68.79	-13.12	-1.08
P5	9/01/1990	211.545	82.24	13.45	12.37
P5	21/06/1990	212.651	82.98	0.74	13.11
P5	15/09/1990	2241.807	92.45	9.47	22.58
P5	14/01/1991	253.957	103.32	10.87	33.45
P5	15/03/1991	1015.183	96.45	-6.87	26.58
P5	11/07/1991	230.28	93.95	-2.50	24.08
P5	15/09/1991	353.366	96.33	2.38	26.46
P5	15/03/1992	351.143	94.35	-1.98	24.48
P5	6/11/1992	354.173	117.49	23.14	47.62
P5	8/03/1993	344.565	90.33	-27.16	20.46
P5	15/10/1993	337.027	88.27	-2.06	18.40
P5	24/02/1994	347.367	92.74	4.47	22.87
P5	15/03/1994	360.074	104.4	11.66	34.53
P5	2/08/1994	341.21	91.95	-12.45	22.08
P5	16/10/1994	354.739	94.01	2.06	24.14
P5	15/03/1995	357.168	98.67	4.66	28.80
P5	21/07/1995	346.934	90.76	-7.91	20.89
P5	10/10/1995	357.56	94.57	3.81	24.70
P5	7/12/1995	357.65	94.38	-0.19	24.51
P5	16/02/1996	363.824	93.38	-1.00	23.51
P5	6/03/1996	260.839	87.71	-5.67	17.84
P5	18/03/1996	268.028	93.92	6.21	24.05
P5	2/04/1996	264.494	90.01	-3.91	20.14
P5	1/07/1996	260.103	81.07	-8.94	11.20
P5	5/08/1996	235.573	75.81	-5.26	5.94
P5	23/10/1996	225.072	97.81	22.00	27.94
P5	6/11/1996	361.941	82.8	-15.01	12.93
P5	10/01/1997	237.282	86.32	3.52	16.45
P5	7/02/1997	233.407	80.24	-6.08	10.37
P5	19/03/1997	219.656	80.24	0.00	10.37
P5	8/05/1997	356.657	81.68	1.44	11.81
P5	30/09/1997	158.308	75.99	-5.69	6.12
P5	21/04/1998	161.88	91.2	15.21	21.33
P5	4/07/1998	168.718	85.62	-5.58	15.75
P5	15/10/1998	152.931	74.79	-10.84	4.91
P5	2/12/1998	128.033	69.74	-5.04	-0.13
P5	28/04/1999	143.448	76.97	7.23	7.10
P5	5/10/1999	157.549	90.15	13.18	20.28
P5	17/04/2000	157.193	83.57	-6.58	13.70
P5	13/07/2000	122.141	71.84	-11.73	1.97
P5	17/07/2000	114.929	70.93	-0.91	1.06
P5	26/10/2000	131.74	80.64	9.71	10.77
P5	7/05/2001	117.217	67.64	-13.00	-2.23
P5	15/10/2001	134.684	84.97	17.33	15.10
P5	2/05/2002	124.383	72.39	-12.58	2.52
P5	9/09/2002	154.82	83.46	11.07	13.59
P5	30/05/2003	146.535	81.73	-1.73	11.86
P5	9/10/2003	157.243	82.35	0.62	12.48
P5	6/04/2004	173.362	105.3	22.95	35.43
P5	13/09/2004	172.244	97.12	-8.18	27.25

Descriptive Statistics

Mean	0.446721311
Standard Error	1.321237285
Median	-0.19
Mode	-12.58
Standard Deviation	10.31919308
Sample Variance	106.4857457
Kurtosis	-0.080648416
Skewness	0.136486131
Range	50.3
Minimum	-27.16
Maximum	23.14
Sum	27.25
Count	61
Confidence Level(95.0%)	2.642867205

SUMMARY OUTPUT

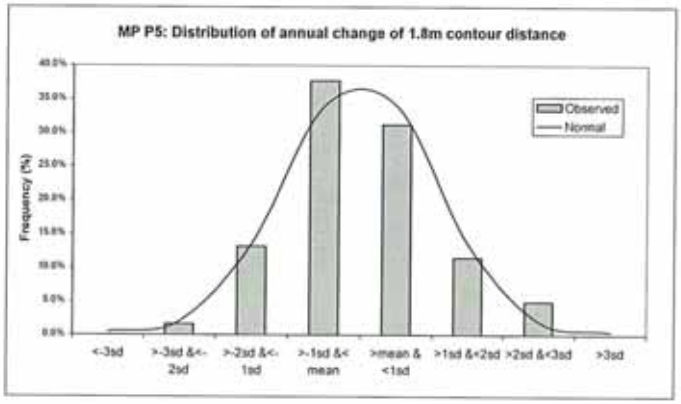
Regression Statistics

Multiple R	0.059638751
R Square	0.003556781
Adjusted R Square	-0.013332087
Standard Error	10.16961762
Observations	61

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	25.88740185	20.2099	1.280927	0.205232	-14.5526	66.32736	-14.5526	66.32736
X Variable 1	-0.000267559	0.000583	-0.45891	0.647984	-0.00143	0.000899	-0.00143	0.000899

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-30.5			0	0.0%	0.5%
>-3sd &<-2sd	-30.5	to	-20.2	1	1.6%	2.0%
>-2sd &<-1sd	-20.2	to	-9.9	8	13.1%	13.5%
>-1sd &< mean	-9.87	to	0.45	23	37.7%	34.0%
>mean & <1sd	0.45	to	10.77	19	31.1%	34.0%
>1sd &<2sd	10.77	to	21.09	7	11.5%	13.5%
>2sd &<3sd	21.09	to	31.40	3	4.9%	2.0%
>3sd	31.40			0	0.0%	0.5%
				61		



MP P5 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P5	17/10/1978	5060.585	52.94	0.00	0.00
P5	14/12/1978	235.535	68.14	15.20	15.20
P5	24/03/1979	6172.858	57.45	-10.69	4.51
P5	14/08/1981	227.051	57.08	-0.37	4.14
P5	16/09/1982	1359.927	63.18	6.10	10.24
P5	28/01/1983	223.219	89.56	26.38	36.62
P5	20/10/1983	4485.689	61.09	-28.47	8.15
P5	19/03/1984	5422.375	83.4	22.31	30.46
P5	15/03/1988	3185.591	61.05	-22.35	8.11
P5	11/01/1989	138.214	63.92	2.87	10.98
P5	3/07/1989	144.366	68.31	4.39	15.37
P5	15/09/1989	125.412	58.37	-9.94	5.43
P5	9/01/1990	134.151	74.73	16.36	21.79
P5	21/06/1990	137.429	71.06	-3.67	18.12
P5	15/09/1990	1974.201	66.99	-4.07	14.05
P5	14/01/1991	151.834	94.81	27.82	41.87
P5	15/03/1991	825.808	84.16	-10.65	31.22
P5	11/07/1991	143.402	76.44	-7.72	23.50
P5	15/09/1991	245.591	82.5	6.06	29.56
P5	15/03/1992	244.651	81.54	-0.96	28.60
P5	6/11/1992	245.671	69.49	-12.05	16.55
P5	8/03/1993	248.75	72.46	2.97	19.52
P5	15/10/1993	243.778	66.34	-6.12	13.40
P5	24/02/1994	248.788	72.29	5.95	19.35
P5	15/03/1994	246.028	70.88	-1.41	17.94
P5	2/08/1994	244.696	71.06	0.18	18.12
P5	16/10/1994	254.807	74.23	3.17	21.29
P5	15/03/1995	252.485	73.84	-0.39	20.90
P5	21/07/1995	250.909	72.35	-1.49	19.41
P5	10/10/1995	255.486	74.68	2.33	21.74
P5	7/12/1995	257.169	74.06	-0.62	21.12
P5	16/02/1996	259.78	76.37	2.31	23.43
P5	6/03/1996	174.778	74.42	-1.95	21.48
P5	18/03/1996	174.815	74.56	0.14	21.62
P5	2/04/1996	176.07	75.4	0.84	22.46
P5	1/07/1996	179.424	74.12	-1.28	21.18
P5	5/08/1996	183.182	64.34	-9.78	11.40
P5	23/10/1996	145.321	65.2	0.86	12.26
P5	6/11/1996	269.053	67.52	2.32	14.58
P5	10/01/1997	157.72	71.08	3.56	18.14
P5	7/02/1997	157.734	70.03	-1.05	17.09
P5	19/03/1997	146.846	63.78	-6.25	10.84
P5	8/05/1997	263.543	68.92	5.14	15.98
P5	30/09/1997	103.575	67.82	-1.10	14.88
P5	21/04/1998	92.241	69.91	2.09	16.97
P5	4/07/1998	103.948	70.6	0.69	17.66
P5	15/10/1998	97.628	65.3	-5.30	12.36
P5	2/12/1998	80.682	57.68	-7.62	4.74
P5	28/04/1999	89.154	64.91	7.23	11.97
P5	5/10/1999	86.567	68.29	3.38	15.35
P5	17/04/2000	94.255	73.29	5.00	20.35
P5	13/07/2000	74.958	57.41	-15.88	4.47
P5	17/07/2000	69.565	56.99	-0.42	4.05
P5	26/10/2000	71.891	71.16	14.17	18.22
P5	7/05/2001	72.905	58.01	-13.15	5.07
P5	15/10/2001	71.89	64.99	6.98	12.05
P5	2/05/2002	75.593	60.01	-4.98	7.07
P5	9/09/2002	92.97	70.2	10.19	17.26
P5	30/05/2003	87.398	67.28	-2.92	14.34
P5	9/10/2003	94.898	67.57	0.29	14.63
P5	6/04/2004	89.549	71.96	4.39	19.02
P5	13/09/2004	95.684	70.51	-1.45	17.57

Descriptive Statistics

Mean	0.288032787
Standard Error	1.252745266
Median	0.14
Mode	4.39
Standard Deviation	9.784253305
Sample Variance	95.73161273
Kurtosis	2.030883287
Skewness	0.210027093
Range	56.29
Minimum	-28.47
Maximum	27.82
Sum	17.57
Count	61
Confidence Level(95.0%)	2.505862812

SUMMARY OUTPUT

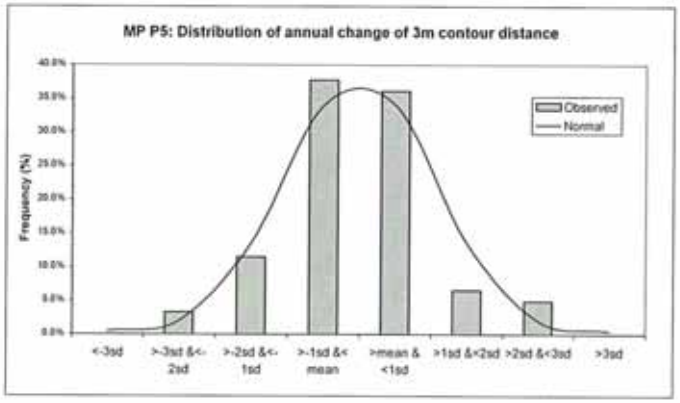
Regression Statistics

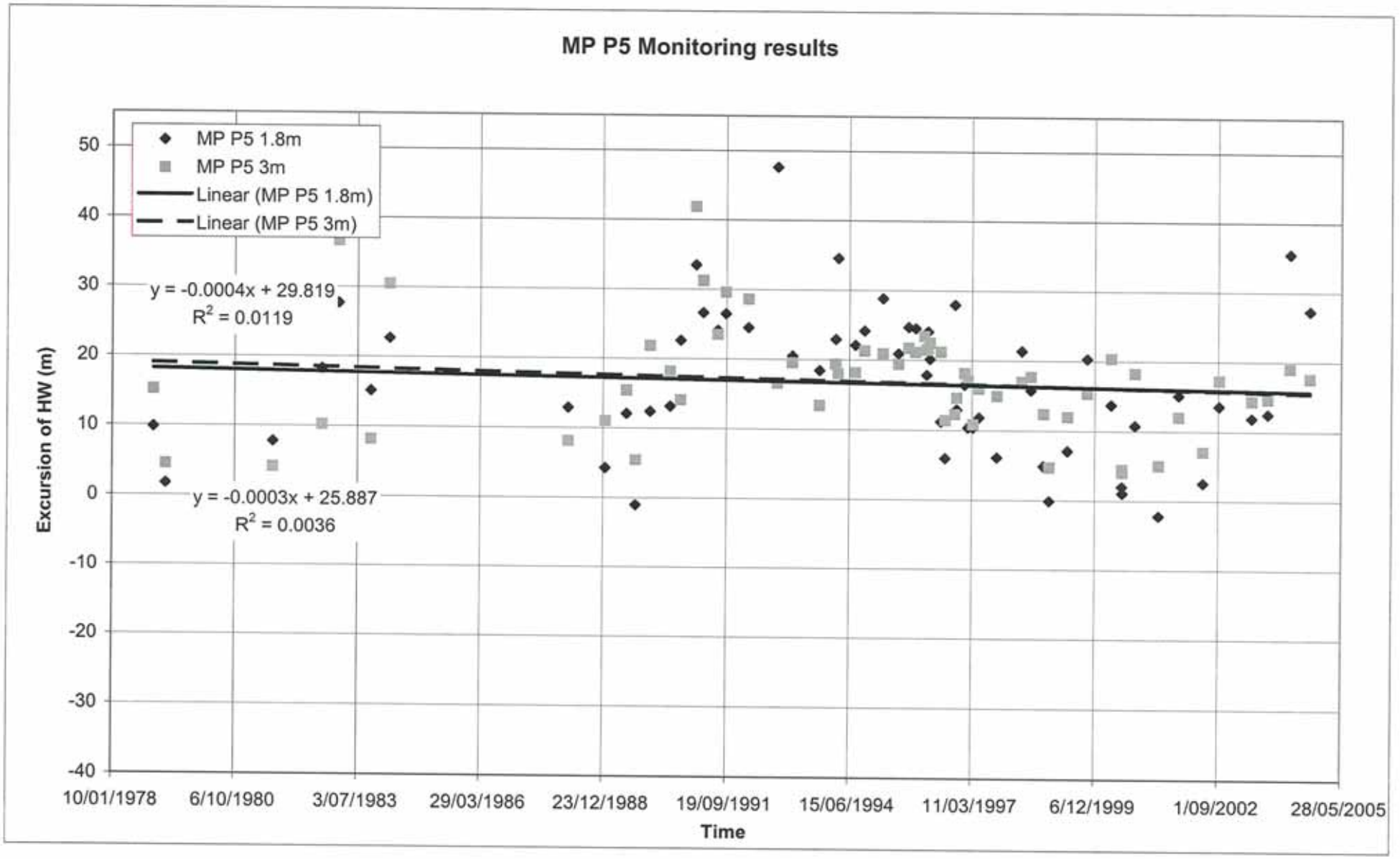
Multiple R	0.109077573
R Square	0.011897917
Adjusted R Square	-0.004849576
Standard Error	7.779301363
Observations	61

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	29.81898797	15.45967	1.928825	0.058568	-1.11576	60.75374	-1.11576	60.75374
X Variable 1	-0.000375913	0.000446	-0.84287	0.402705	-0.00127	0.000517	-0.00127	0.000517

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-29.1			0	0.0%	0.5%
>-3sd &<-2sd	-29.1	to	-19.3	2	3.3%	2.0%
>-2sd &<-1sd	-19.3	to	-9.5	7	11.5%	13.5%
>-1sd &< mean	-9.50	to	0.29	23	37.7%	34.0%
>mean & <1sd	0.29	to	10.07	22	36.1%	34.0%
>1sd &<2sd	10.07	to	19.86	4	6.6%	13.5%
>2sd &<3sd	19.86	to	29.64	3	4.9%	2.0%
>3sd	29.64			0	0.0%	0.5%
				61		




MP P5 Monitoring results
MP P5 1.8m
MP P5 3m
Linear (MP P5 1.8m)
Linear (MP P5 3m)
y = -0.0004x + 29.819
R² = 0.0119
y = -0.0003x + 25.887
R² = 0.0036
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P6 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P6	17/10/1978	2729.791	56.85	0.00	0.00
P6	24/03/1979	521.836	54.7	-2.15	-2.15
P6	14/08/1981	262.085	53.2	-1.50	-3.65
P6	16/09/1982	782.552	63.11	9.91	6.26
P6	28/01/1983	422.863	69.31	6.20	12.46
P6	20/10/1983	430.672	65.46	-3.85	8.61
P6	19/04/1984	214.459	63.71	-1.75	6.86
P6	15/03/1988	262.913	54.09	-9.62	-2.76
P6	11/01/1989	94.701	61.16	7.07	4.31
P6	3/07/1989	87.179	61.96	0.80	5.11
P6	15/09/1989	70.692	51.72	-10.24	-5.13
P6	9/01/1990	87.539	58.3	6.58	1.45
P6	21/06/1990	86.723	59.43	1.13	2.58
P6	15/09/1990	273.702	49.98	-9.45	-6.87
P6	14/01/1991	120.107	73.35	23.37	16.50
P6	15/03/1991	322.775	77.29	3.94	20.44
P6	11/07/1991	106.992	71.41	-5.88	14.56
P6	15/09/1991	296.759	59.16	-12.25	2.31
P6	15/03/1992	323.458	87.8	28.64	30.95
P6	6/11/1992	312.323	89.4	1.60	32.55
P6	8/03/1993	310.261	67.05	-22.35	10.20
P6	15/10/1993	306.619	64.73	-2.32	7.88
P6	24/02/1994	314.492	68.42	3.69	11.57
P6	15/03/1994	325.589	74.34	5.92	17.49
P6	2/08/1994	103.891	63.51	-10.83	6.66
P6	16/10/1994	103.665	72.76	9.25	15.91
P6	15/03/1995	113.892	69.34	-3.42	12.49
P6	21/07/1995	152.042	64.22	-5.12	7.37
P6	10/10/1995	154.041	58.27	-5.95	1.42
P6	7/12/1995	159.067	63.58	5.31	6.73
P6	16/02/1996	108.575	70.03	6.45	13.18
P6	6/03/1996	105.178	64.37	-5.66	7.52
P6	18/03/1996	115.45	71.26	6.89	14.41
P6	2/04/1996	112.498	70.5	-0.76	13.65
P6	1/07/1996	108.773	61.73	-8.77	4.88
P6	5/08/1996	92.153	55.76	-5.97	-1.09
P6	23/10/1996	114.336	76.41	20.65	19.56
P6	6/11/1996	101.317	62.96	-13.45	6.11
P6	10/01/1997	99.621	61.38	-1.58	4.53
P6	7/02/1997	98.898	60.01	-1.37	3.16
P6	19/03/1997	98.929	64.52	4.51	7.67
P6	8/05/1997	106.132	64.18	-0.34	7.33
P6	30/09/1997	82.375	47.38	-16.80	-9.47
P6	21/04/1998	99.898	61.16	13.78	4.31
P6	4/07/1998	107.082	66.19	5.03	9.34
P6	15/10/1998	80.244	48.45	-17.74	-8.40
P6	2/12/1998	92.372	60.66	12.21	3.81
P6	28/04/1999	80.195	43.99	-16.67	-12.86
P6	28/04/1999	87.983	57.78	13.79	0.93
P6	5/10/1999	94.22	60.33	2.55	3.48
P6	17/04/2000	314.022	68.88	6.55	10.03
P6	17/07/2000	77.236	37.61	-29.27	-19.24
P6	26/10/2000	103.245	48.24	10.63	-8.61
P6	8/05/2001	90.145	45.18	-3.06	-11.67
P6	15/10/2001	120.973	57.87	12.69	1.02
P6	2/05/2002	231.071	42.92	-14.95	-13.93
P6	9/09/2002	101.797	55.58	12.66	-1.27
P6	30/05/2003	109.249	57.47	1.89	0.62
P6	9/10/2003	130.745	60.09	2.62	3.24
P6	6/04/2004	285.052	76.51	16.42	19.66
P6	13/09/2004	89.283	53.82	-22.69	-3.03

Descriptive Statistics

Mean	-0.0505
Standard Error	1.468509534
Median	0.23
Mode	#N/A
Standard Deviation	11.37502593
Sample Variance	129.391215
Kurtosis	0.290488229
Skewness	-0.108648382
Range	57.91
Minimum	-29.27
Maximum	28.64
Sum	-3.03
Count	60
Confidence Level(95.0%)	2.938483881

SUMMARY OUTPUT

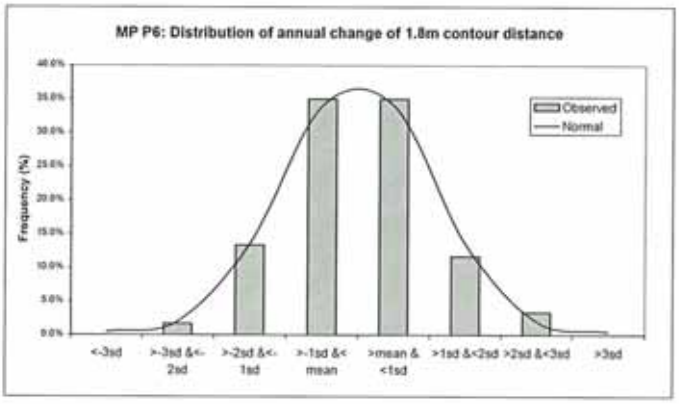
Regression Statistics

Multiple R	0.192163794
R Square	0.036926924
Adjusted R Square	0.020322216
Standard Error	9.895903084
Observations	60

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	36.40231112	20.97368	1.735619	0.087942	-5.58103	78.38565	-5.58103	78.38565
X Variable 1	-0.000900195	0.000604	-1.49127	0.14131	-0.00211	0.000308	-0.00211	0.000308

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-34.2			0	0.0%	0.5%
>-3sd &<-2sd	-34.2	to	-22.8	1	1.7%	2.0%
>-2sd &<-1sd	-22.8	to	-11.4	8	13.3%	13.5%
>-1sd &< mean	-11.43	to	-0.05	21	35.0%	34.0%
>mean & <1sd	-0.05	to	11.32	21	35.0%	34.0%
>1sd &<2sd	11.32	to	22.70	7	11.7%	13.5%
>2sd &<3sd	22.70	to	34.07	2	3.3%	2.0%
>3sd	34.07			0	0.0%	0.5%
				60		



MP P6 TOTAL REPORT
Profile Volume Report
Contour Level: **3 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P6	17/10/1978	2529.959	34.4	0.00	0.00
P6	24/03/1979	440.25	39.92	5.52	5.52
P6	14/08/1981	206.222	40.26	0.34	5.86
P6	16/09/1982	666.952	44.88	4.62	10.48
P6	28/01/1983	334.077	59.37	14.49	24.97
P6	20/10/1983	351.107	43.02	-16.35	8.62
P6	19/04/1984	152.239	51.79	8.77	17.39
P6	15/03/1988	207.448	34.68	-17.11	0.28
P6	11/01/1989	50.61	50.91	16.23	16.51
P6	3/07/1989	48.064	44.8	-6.11	10.40
P6	15/09/1989	39.147	39.5	-5.30	5.10
P6	9/01/1990	45.462	50.81	11.31	16.41
P6	21/06/1990	45.891	47.52	-3.29	13.12
P6	15/09/1990	220.997	37.95	-9.57	3.55
P6	14/01/1991	59.841	65.68	27.73	31.28
P6	15/03/1991	238.459	64.01	-1.67	29.61
P6	11/07/1991	53.652	53.96	-10.05	19.56
P6	15/09/1991	231.075	49.74	-4.22	15.34
P6	15/03/1992	230.964	64.67	14.93	30.27
P6	6/11/1992	237.475	49.07	-15.60	14.67
P6	8/03/1993	238.832	50.68	1.61	16.28
P6	15/10/1993	237.448	46.01	-4.67	11.61
P6	24/02/1994	243.605	50.6	4.59	16.20
P6	15/03/1994	244.094	49.88	-0.72	15.48
P6	2/08/1994	60.314	48.36	-1.52	13.96
P6	16/10/1994	61.105	47.83	-0.53	13.43
P6	15/03/1995	63.975	52.21	4.38	17.81
P6	21/07/1995	104.605	43.83	-8.38	9.43
P6	10/10/1995	105.914	46.97	3.14	12.57
P6	7/12/1995	106.113	49.43	2.46	15.03
P6	16/02/1996	59.969	48.55	-0.88	14.15
P6	6/03/1996	60.473	49.44	0.89	15.04
P6	18/03/1996	60.106	49.29	-0.15	14.89
P6	2/04/1996	61.799	51.27	1.98	16.87
P6	1/07/1996	63.834	53.24	1.97	18.84
P6	5/08/1996	55.62	44.43	-8.81	10.03
P6	23/10/1996	58.396	47.81	3.38	13.41
P6	6/11/1996	58.461	47.34	-0.47	12.94
P6	10/01/1997	58.246	47.07	-0.27	12.67
P6	7/02/1997	57.891	47.47	0.40	13.07
P6	19/03/1997	52.799	44.48	-2.99	10.08
P6	8/05/1997	59.51	53.78	9.30	19.38
P6	30/09/1997	53.635	41.6	-12.18	7.20
P6	21/04/1998	58.168	47.18	5.58	12.78
P6	4/07/1998	62.898	48.35	1.17	13.95
P6	15/10/1998	51.78	37.39	-10.96	2.99
P6	2/12/1998	56.201	42.17	4.78	7.77
P6	28/04/1999	56.1	38.33	-3.84	3.93
P6	28/04/1999	56.505	38.83	0.50	4.43
P6	5/10/1999	54.49	41.66	2.83	7.26
P6	17/04/2000	243.987	51.99	10.33	17.59
P6	17/07/2000	53.33	27.81	-24.18	-6.59
P6	26/10/2000	65.556	38.47	10.66	4.07
P6	8/05/2001	57.7	33.29	-5.18	-1.11
P6	15/10/2001	71.575	49.03	15.74	14.63
P6	2/05/2002	184.319	35	-14.03	0.60
P6	9/09/2002	58.005	34.61	-0.39	0.21
P6	30/05/2003	68.386	38.35	3.74	3.95
P6	9/10/2003	77.8	52.24	13.89	17.84
P6	6/04/2004	204.921	51.11	-1.13	16.71
P6	13/09/2004	54.89	34.41	-16.70	0.01

Descriptive Statistics

Mean	0.000166667
Standard Error	1.220537288
Median	0.095
Mode	#N/A
Standard Deviation	9.454241178
Sample Variance	89.38267624
Kurtosis	0.731089278
Skewness	0.059211441
Range	51.91
Minimum	-24.18
Maximum	27.73
Sum	0.01
Count	60
Confidence Level(95.0%)	2.442292041

SUMMARY OUTPUT

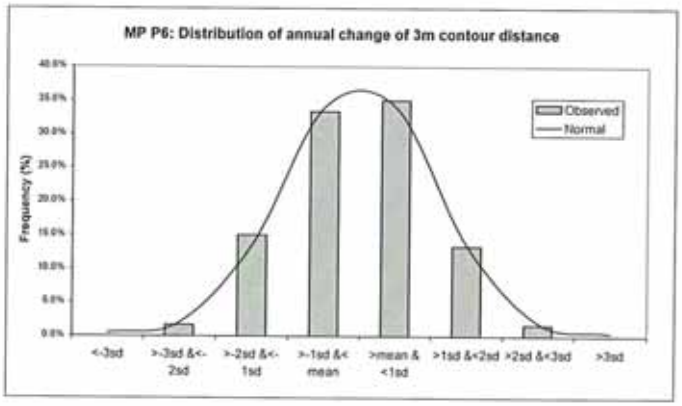
Regression Statistics

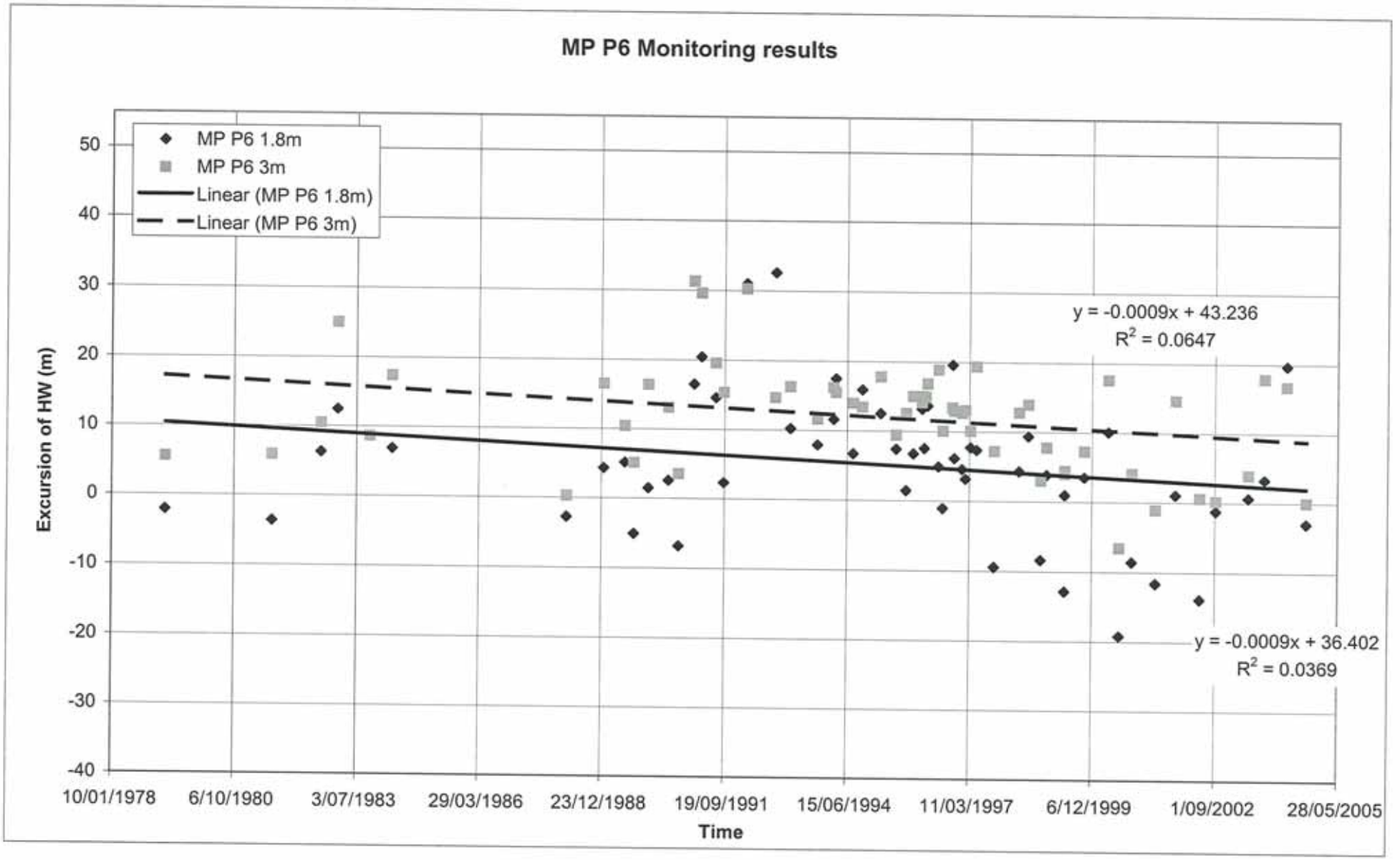
Multiple R	0.254350653
R Square	0.064694255
Adjusted R Square	0.048568293
Standard Error	7.370415422
Observations	60

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	43.23564208	15.62108	2.767775	0.007563	11.96667	74.50461	11.96667	74.50461
X Variable 1	-0.000900507	0.00045	-2.00295	0.049864	-0.0018	-5.5E-07	-0.0018	-5.5E-07

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-28.4			0	0.0%	0.5%
>-3sd &<-2sd	-28.4	to	-18.9	1	1.7%	2.0%
>-2sd &<-1sd	-18.9	to	-9.5	9	15.0%	13.5%
>-1sd &< mean	-9.45	to	0.00	20	33.3%	34.0%
>mean & <1sd	0.00	to	9.45	21	35.0%	34.0%
>1sd &<2sd	9.45	to	18.91	8	13.3%	13.5%
>2sd &<3sd	18.91	to	28.36	1	1.7%	2.0%
>3sd	28.36			0	0.0%	0.5%
				60		




MP P6 Monitoring results
MP P6 1.8m
MP P6 3m
Linear (MP P6 1.8m)
Linear (MP P6 3m)
y = -0.0009x + 43.236
R² = 0.0647
y = -0.0009x + 36.402
R² = 0.0369
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P7 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P7	24/10/1978	1213.405	74.2	0.00	0.00
P7	14/12/1978	390.663	73.52	-0.68	-0.68
P7	24/03/1979	377.315	74.92	1.40	0.72
P7	14/08/1981	568.211	67.27	-7.65	-6.93
P7	16/09/1982	378.208	73.09	5.82	-1.11
P7	28/01/1983	396.955	89.38	16.29	15.18
P7	20/10/1983	396.283	80.06	-9.32	5.86
P7	19/03/1984	146.423	74.63	-5.43	0.43
P7	13/11/1984	103.53	72.26	-2.37	-1.94
P7	6/12/1984	400.769	70.41	-1.85	-3.79
P7	26/01/1985	104.188	76.54	6.13	2.34
P7	9/04/1985	94.653	73.81	-2.73	-0.39
P7	11/06/1985	84.632	66.56	-7.25	-7.64
P7	3/07/1985	80.737	66.67	0.11	-7.53
P7	13/08/1985	78.495	65.96	-0.71	-8.24
P7	30/08/1985	85.91	67.89	1.93	-6.31
P7	4/09/1985	83.147	66.58	-1.31	-7.62
P7	17/09/1985	81.819	67.87	1.29	-6.33
P7	20/09/1985	80.407	63.12	-4.75	-11.08
P7	29/09/1985	79.909	62.74	-0.38	-11.46
P7	1/10/1985	82.767	65.02	2.28	-9.18
P7	28/10/1985	79.368	63.68	-1.34	-10.52
P7	28/11/1985	79.596	64.12	0.44	-10.08
P7	14/12/1985	89.193	70.68	6.56	-3.52
P7	16/01/1986	101.899	77.97	7.29	3.77
P7	10/06/1986	93.954	72.77	-5.20	-1.43
P7	3/12/1986	406.823	78.39	5.62	4.19
P7	13/12/1986	95.889	78.37	-0.02	4.17
P7	15/03/1988	382.113	75.64	-2.73	1.44
P7	11/01/1989	97.577	67.68	-7.96	-6.52
P7	3/07/1989	109.481	71.74	4.06	-2.46
P7	15/09/1989	97.502	67.3	-4.44	-6.90
P7	9/01/1990	108.005	76.82	9.52	2.62
P7	21/06/1990	105.917	75.83	-0.99	1.63
P7	15/09/1990	404.978	71	-4.83	-3.20
P7	14/01/1991	147	95.77	24.77	21.57
P7	9/03/1991	427.37	86.95	-8.82	12.75
P7	11/07/1991	125.588	87.85	0.90	13.65
P7	15/09/1991	415.648	82.2	-5.65	8.00
P7	15/03/1992	433.959	103.01	20.81	28.81
P7	6/11/1992	422.452	117	13.99	42.80
P7	8/03/1993	434.488	89.46	-27.54	15.26
P7	15/10/1993	418.941	79.57	-9.89	5.37
P7	24/02/1994	431.674	88.53	8.96	14.33
P7	15/03/1994	442.281	99.66	11.13	25.46
P7	2/08/1994	129.655	83.13	-16.53	8.93
P7	16/10/1994	147.781	95.44	12.31	21.24
P7	15/03/1995	141.265	85.89	-9.55	11.69
P7	21/07/1995	123.296	76.61	-9.28	2.41
P7	10/10/1995	128.604	77.74	1.13	3.54
P7	7/12/1995	132.092	82.01	4.27	7.81
P7	16/02/1996	133.099	84.16	2.15	9.96
P7	8/03/1996	130.647	81.31	-2.85	7.11
P7	18/03/1996	147.483	92.97	11.66	18.77
P7	2/04/1996	149.259	93.61	0.64	19.41
P7	1/07/1996	138.466	82.26	-11.35	8.06
P7	5/08/1996	118.683	73.93	-8.33	-0.27
P7	23/10/1996	138.47	95.95	22.02	21.75
P7	6/11/1996	2531.719	86.87	-9.08	12.67
P7	10/01/1997	131.723	81.08	-5.79	6.88
P7	7/02/1997	126.702	76.53	-4.55	2.33
P7	19/03/1997	135.683	85.28	8.75	11.08
P7	8/05/1997	81.105	82.99	-2.29	8.79
P7	30/09/1997	69.907	74.86	-8.13	0.66
P7	21/04/1998	72.112	76.25	1.39	2.05
P7	4/07/1998	127.804	76.07	-0.18	1.87
P7	5/10/1998	137.749	78.81	0.74	2.61
P7	2/12/1998	130.943	77.67	0.86	3.47
P7	28/04/1999	123.66	72.87	-4.80	-1.33
P7	5/10/1999	270.272	89.43	16.56	15.23
P7	17/04/2000	268.829	79.74	-9.69	5.54
P7	18/07/2000	390.31	64.29	-15.45	-9.91
P7	26/10/2000	87.16	68.56	4.27	-5.64
P7	7/05/2001	94.733	70.93	2.37	-3.27
P7	15/10/2001	105.643	75.9	4.97	1.70
P7	2/05/2002	97.85	71.26	-4.64	-2.94
P7	9/09/2002	103.513	75.67	4.41	1.47
P7	30/05/2003	118.949	83.94	8.27	9.74
P7	9/10/2003	105.853	69.38	-14.56	-4.82
P7	6/04/2004	135.293	92.19	22.81	17.99
P7	13/09/2004	125.952	85.4	-6.79	11.20

Descriptive Statistics

Mean	0.14
Standard Error	1.030927074
Median	-0.28
Mode	-2.73
Standard Deviation	9.220892074
Sample Variance	85.02485063
Kurtosis	1.009598989
Skewness	0.353665877
Range	52.31
Minimum	-27.54
Maximum	24.77
Sum	11.2
Count	80
Confidence Level(95.0%)	2.052010746

SUMMARY OUTPUT

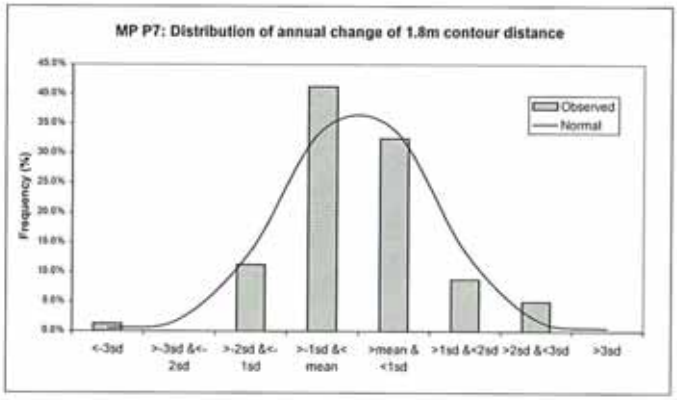
Regression Statistics

Multiple R	0.327386157
R Square	0.107181696
Adjusted R Square	0.095735307
Standard Error	9.765348606
Observations	80

	Coefficients	*'andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-43.11408616	15.44858	-2.79081	0.006607	-73.8699	-12.3583	-73.8699	-12.3583
X Variable 1	0.001397302	0.000457	3.060033	0.003034	0.000488	0.002306	0.000488	0.002306

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-27.5			1	1.3%	0.5%
>-3sd &<-2sd	-27.5	to	-18.3	0	0.0%	2.0%
>-2sd &<-1sd	-18.3	to	-9.1	9	11.3%	13.5%
>-1sd &< mean	-9.08	to	0.14	33	41.3%	34.0%
>mean & <1sd	0.14	to	9.36	26	32.5%	34.0%
>1sd &<2sd	9.36	to	18.58	7	8.8%	13.5%
>2sd &<3sd	18.58	to	27.80	4	5.0%	2.0%
>3sd	27.80			0	0.0%	0.5%
				80		



MP P7 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P7	24/10/1978	1065.974	55.24	0.00	0.00
P7	14/12/1978	310.64	59.61	4.37	4.37
P7	24/03/1979	294.675	62.81	3.20	7.57
P7	14/08/1981	474.567	53.07	-9.74	-2.17
P7	16/09/1982	297.745	57.98	4.91	2.74
P7	28/01/1983	297.436	78.63	20.65	23.39
P7	20/10/1983	306.189	73.45	-5.18	18.21
P7	19/03/1984	92.479	60.27	-13.18	5.03
P7	13/11/1984	57.386	64.4	4.13	9.16
P7	6/12/1984	322.684	59.99	-4.41	4.75
P7	26/01/1985	58.195	60.8	0.81	5.56
P7	9/04/1985	56.808	57.29	-3.51	2.05
P7	11/06/1985	48.1	55.12	-2.17	-0.12
P7	3/07/1985	45.282	51.32	-3.80	-3.92
P7	13/08/1985	44.383	51.84	0.52	-3.40
P7	30/08/1985	48.811	54.69	2.85	-0.55
P7	4/09/1985	47.485	53.66	-1.03	-1.58
P7	17/09/1985	46.537	53.12	-0.54	-2.12
P7	20/09/1985	46.519	53.48	0.36	-1.76
P7	29/09/1985	45.856	53.21	-0.27	-2.03
P7	1/10/1985	46.362	54.13	0.92	-1.11
P7	28/10/1985	45.452	52.01	-2.12	-3.23
P7	28/11/1985	44.754	54.13	2.12	-1.11
P7	14/12/1985	48.074	56.59	2.46	1.35
P7	16/01/1986	52.729	57.06	0.47	1.82
P7	10/06/1986	51.319	59.11	2.05	3.87
P7	3/12/1986	323.322	51.37	-7.74	-3.87
P7	13/12/1986	48.081	51.37	0.00	-3.87
P7	15/03/1988	304.756	55.54	4.17	0.30
P7	11/01/1989	57.699	58.57	3.03	3.33
P7	3/07/1989	65.022	61.76	3.19	6.52
P7	15/09/1989	57.962	57.98	-3.78	2.74
P7	9/01/1990	56.292	69.49	11.51	14.25
P7	21/06/1990	58.854	62.53	-6.96	7.29
P7	15/09/1990	326.311	59.75	-2.78	4.51
P7	14/01/1991	72.539	86.66	26.91	31.42
P7	9/03/1991	327.478	79.63	-7.03	24.39
P7	11/07/1991	64.409	67.1	-12.53	11.86
P7	15/09/1991	328.068	66.67	-0.43	11.43
P7	15/03/1992	330.12	69.72	3.05	14.48
P7	6/11/1992	331.07	64.72	-5.00	9.48
P7	8/03/1993	336.762	72.28	7.56	17.04
P7	15/10/1993	336.134	60.87	-11.41	5.63
P7	24/02/1994	340.761	66.12	5.25	10.88
P7	15/03/1994	341.063	65.67	-0.45	10.43
P7	2/08/1994	77.246	65.8	0.13	10.56
P7	16/10/1994	81.056	68.49	2.69	13.25
P7	15/03/1995	82.334	70.83	2.34	15.59
P7	21/07/1995	77.515	61.7	-9.13	6.46
P7	10/10/1995	78.063	65.87	4.17	10.63
P7	7/12/1995	79.08	65.85	-0.02	10.61
P7	16/02/1996	78.012	66.79	0.94	11.55
P7	6/03/1996	77.103	66.21	-0.58	10.97
P7	18/03/1996	77.813	84.23	18.02	28.99
P7	2/04/1996	79.934	71.43	-12.80	16.19
P7	1/07/1996	82.333	70.32	-1.11	15.08
P7	5/08/1996	73.102	61.6	-8.72	6.36
P7	23/10/1996	75.055	63.66	2.06	8.42
P7	6/11/1996	2325.655	64.51	0.85	9.27
P7	10/01/1997	78.902	67.25	2.74	12.01
P7	7/02/1997	77.343	64.96	-2.29	9.72
P7	19/03/1997	76.685	67.92	2.96	12.68
P7	8/05/1997	40.691	70.75	2.83	15.51
P7	30/09/1997	37.567	64.34	-6.41	9.10
P7	21/04/1998	38.338	65.78	1.44	10.54
P7	4/07/1998	80.016	63.53	-2.25	8.29
P7	5/10/1998	88.474	65.6	2.07	10.36
P7	2/12/1998	82.229	63.53	-2.07	8.29
P7	28/04/1999	79.975	60.74	-2.79	5.50
P7	5/10/1999	192.586	65.12	4.38	9.88
P7	17/04/2000	198.18	67.51	2.39	12.27
P7	18/07/2000	320.182	53.96	-13.55	-1.28
P7	26/10/2000	51.769	54.47	0.51	-0.77
P7	7/05/2001	57.292	59.4	4.93	4.16
P7	15/10/2001	61.353	62.09	2.69	6.85
P7	2/05/2002	59.922	59.99	-2.10	4.75
P7	9/09/2002	60.365	63.68	3.69	8.44
P7	30/05/2003	71.701	65.68	2.00	10.44
P7	9/10/2003	68.674	60.74	-4.94	5.50
P7	6/04/2004	74.876	71.09	10.35	15.85
P7	13/09/2004	74.505	65.89	-5.20	10.65

Descriptive Statistics	
Mean	0.133125
Standard Error	0.749788021
Median	0.49
Mode	4.17
Standard Deviation	6.706307931
Sample Variance	44.97456606
Kurtosis	3.665329897
Skewness	0.946677123
Range	40.46
Minimum	-13.55
Maximum	26.91
Sum	10.65
Count	80
Confidence Level(95.0%)	1.492416984

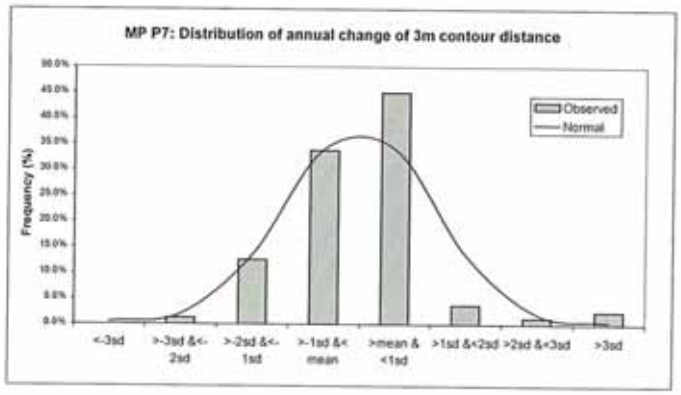
SUMMARY OUTPUT

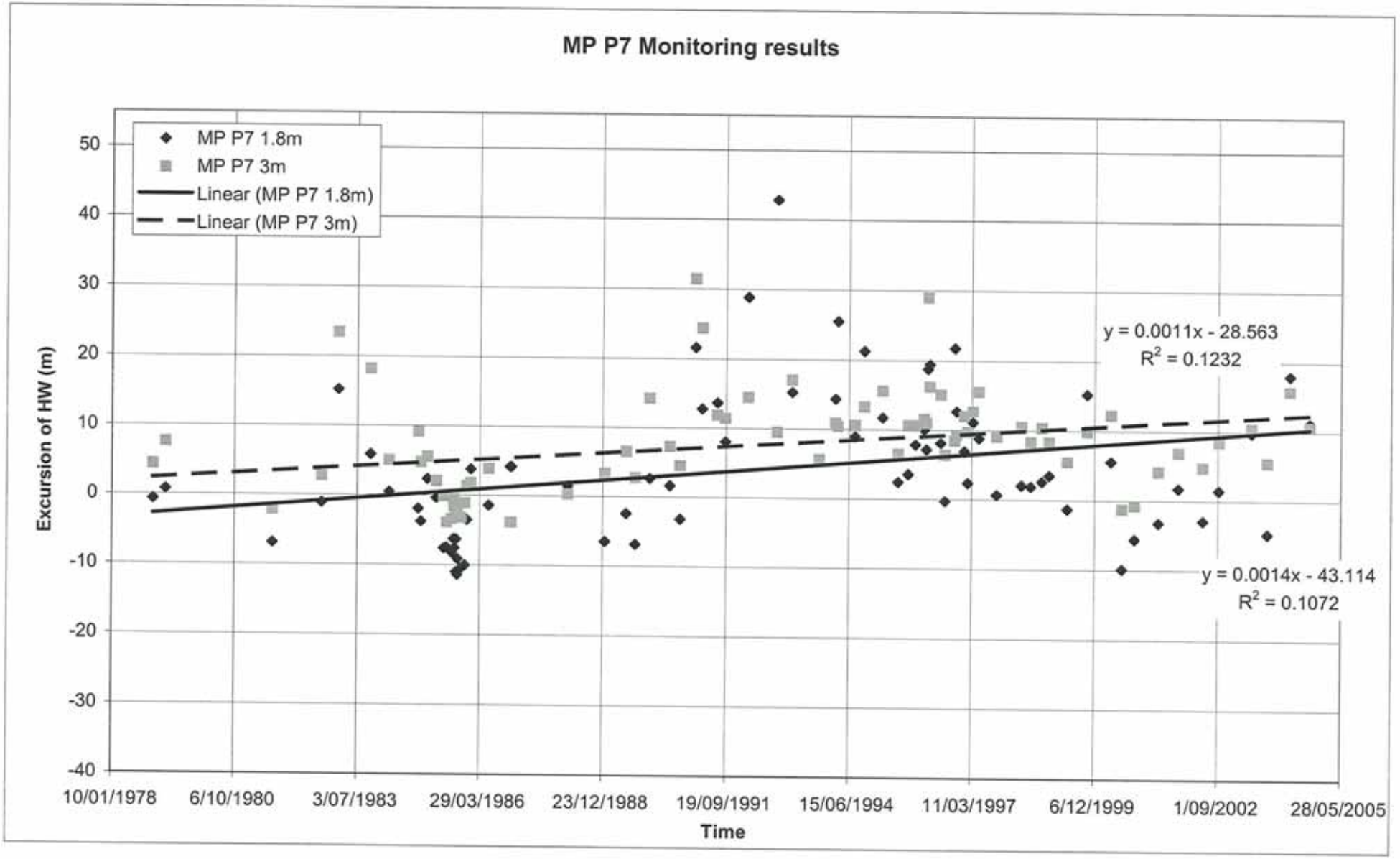
Regression Statistics	
Multiple R	0.350980135
R Square	0.123187055
Adjusted R Square	0.111945863
Standard Error	6.921916633
Observations	80

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-26.56299031	10.95033	-2.60841	0.010898	-50.3634	-6.76255	-50.3634	-6.76255
X Variable 1	0.001071468	0.000324	3.310369	0.001413	0.000427	0.001716	0.000427	0.001716

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-20.0			0	0.0%	0.5%
>-3sd &<-2sd	-20.0	to	-13.3	1	1.3%	2.0%
>-2sd &<-1sd	-13.3	to	-6.6	10	12.5%	13.5%
>-1sd &< mean	-6.57	to	0.13	27	33.8%	34.0%
>mean & <1sd	0.13	to	6.84	36	45.0%	34.0%
>1sd &<2sd	6.84	to	13.55	3	3.8%	13.5%
>2sd &<3sd	13.55	to	20.25	1	1.3%	2.0%
>3sd	20.25			2	2.5%	0.5%
				80		




MP P7 Monitoring results
MP P7 1.8m
MP P7 3m
Linear (MP P7 1.8m)
Linear (MP P7 3m)
y = 0.0011x - 28.563
R2 = 0.1232
y = 0.0014x - 43.114
R2 = 0.1072
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P8 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu.m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P8	24/10/1978	939.02	57.82	0.00	0.00
P8	21/11/1978	200.228	60.82	3.00	3.00
P8	24/03/1979	192.96	52.84	-7.98	-4.98
P8	14/08/1981	308.163	51.91	-0.93	-5.91
P8	16/09/1982	346.424	67.83	15.92	10.01
P8	26/01/1983	225.843	75.37	7.54	17.55
P8	20/10/1983	293.285	55.22	-20.15	-2.60
P8	19/03/1984	324.069	66.86	11.64	9.04
P8	15/03/1988	294.438	62.54	-4.32	4.72
P8	15/09/1990	306.274	59.72	-2.82	1.90
P8	15/03/1991	235.306	70.05	10.33	12.23
P8	15/09/1991	220.445	80.62	10.57	22.80
P8	15/03/1992	247.117	88.53	7.91	30.71
P8	6/11/1992	231.946	101.49	12.96	43.67
P8	8/03/1993	241.553	77.86	-23.63	20.04
P8	15/10/1993	241.086	74.52	-3.34	16.70
P8	24/02/1994	248.312	79.18	4.66	21.36
P8	15/03/1994	250.17	78.11	-1.07	20.29
P8	2/08/1994	247.861	72.71	-5.40	14.89
P8	18/10/1994	254.483	74.32	1.61	16.50
P8	15/03/1995	269.441	87.51	13.19	29.69
P8	21/07/1995	249.479	67.79	-19.72	9.97
P8	10/10/1995	257.68	71.36	3.57	13.54
P8	7/12/1995	266.504	78.27	6.91	20.45
P8	16/02/1996	263.324	75.91	-2.36	18.09
P8	6/03/1996	260.166	81.42	5.51	23.60
P8	18/03/1996	269.785	85.64	4.22	27.82
P8	2/04/1996	262.566	81.37	-4.27	23.55
P8	1/07/1996	250.851	66.64	-14.73	8.82
P8	5/08/1996	231.609	58.39	-8.25	0.57
P8	23/10/1996	252.352	75.27	16.88	17.45
P8	6/11/1996	241.66	67.14	-8.13	9.32
P8	10/01/1997	244.098	66.6	-0.54	8.78
P8	7/02/1997	240.64	59.66	-6.94	1.84
P8	19/03/1997	244.622	65.33	5.67	7.51
P8	8/05/1997	194.306	71.58	6.25	13.76
P8	30/09/1997	252.051	65.78	-5.80	7.96
P8	21/04/1998	250.882	78.65	12.87	20.83
P8	4/07/1998	258.752	69.94	-8.71	12.12
P8	15/10/1998	249.139	63.27	-6.67	5.45
P8	2/12/1998	237.92	56.45	-6.82	-1.37
P8	28/04/1999	242.607	56.73	0.28	-1.09
P8	5/10/1999	265.375	70.56	13.83	12.74
P8	17/04/2000	348.849	61.84	-8.72	4.02
P8	17/07/2000	217.456	52.43	-9.41	-5.39
P8	26/10/2000	220.277	61.79	9.36	3.97
P8	7/05/2001	217.399	52.63	-9.16	-5.19
P8	15/10/2001	219.28	57.22	4.59	-0.60
P8	2/05/2002	214.93	54.45	-2.77	-3.37
P8	9/09/2002	232.736	66.02	11.57	8.20
P8	30/05/2003	240.175	67.01	0.99	9.19
P8	9/10/2003	246.524	67.85	0.84	10.03
P8	6/04/2004	251.891	99.01	31.16	41.19
P8	13/09/2004	251.085	72.95	-26.06	15.13

Descriptive Statistics	
Mean	0.285471698
Standard Error	1.497429282
Median	0.28
Mode	#N/A
Standard Deviation	10.90144972
Sample Variance	118.841606
Kurtosis	0.608942417
Skewness	-0.070109121
Range	57.22
Minimum	-26.06
Maximum	31.16
Sum	15.13
Count	53
Confidence Level(95.0%)	3.004809648

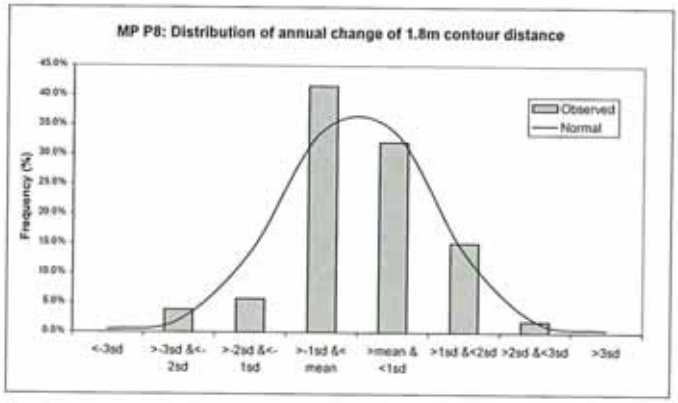
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.093795272
R Square	0.008797553
Adjusted R Square	-0.010637789
Standard Error	11.32260833
Observations	53

	Coefficients	*tandard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	-4.160268323	23.63603	-0.17601	0.86098	-51.6115	43.29101	-51.6115	43.29101
X Variable 1	0.000456379	0.000678	0.672798	0.504113	-0.00091	0.001818	-0.00091	0.001818

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-32.4			0	0.0%	0.5%
>-3sd &<-2sd	-32.4	to	-21.5	2	3.8%	2.0%
>-2sd &<-1sd	-21.5	to	-10.6	3	5.7%	13.5%
>-1sd &< mean	-10.62	to	0.29	22	41.5%	34.0%
>mean & <1sd	0.29	to	11.19	17	32.1%	34.0%
>1sd &<2sd	11.19	to	22.09	8	15.1%	13.5%
>2sd &<3sd	22.09	to	32.99	1	1.9%	2.0%
>3sd	32.99			0	0.0%	0.5%
				53		



MP P8 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P8	24/10/1978	825.877	36.6	0.00	0.00
P8	21/11/1978	135.531	47.06	10.46	10.46
P8	24/03/1979	138.203	39.75	-7.31	3.15
P8	14/08/1981	238.476	37.32	-2.43	0.72
P8	16/09/1982	256.785	44	6.68	7.40
P8	28/01/1983	142.468	66.51	22.51	29.91
P8	20/10/1983	221.023	42.53	-23.98	5.93
P8	19/03/1984	236.735	48.85	6.32	12.25
P8	15/03/1988	221.017	40.17	-8.68	3.57
P8	15/09/1990	231.685	43.57	3.40	6.97
P8	15/03/1991	153.892	65.72	22.15	29.12
P8	15/09/1991	153.639	42.92	-22.80	6.32
P8	15/03/1992	155.799	68.84	25.92	32.24
P8	6/11/1992	160.584	47.32	-21.52	10.72
P8	8/03/1993	163.48	53.53	6.21	16.93
P8	15/10/1993	167.835	49.84	-3.69	13.24
P8	24/02/1994	170.721	51.25	1.41	14.65
P8	15/03/1994	170.466	51.56	0.31	14.96
P8	2/08/1994	174.235	52.09	0.53	15.49
P8	16/10/1994	179.463	53.69	1.60	17.09
P8	15/03/1995	183.55	54.99	1.30	18.39
P8	21/07/1995	179.767	50.26	-4.73	13.66
P8	10/10/1995	182.173	53.87	3.61	17.27
P8	7/12/1995	183.8	56.25	2.38	19.65
P8	16/02/1996	184.109	52.15	-4.10	15.55
P8	6/03/1996	182.014	52.54	0.39	15.94
P8	18/03/1996	181.739	52.36	-0.18	15.76
P8	2/04/1996	181.411	55.15	2.79	18.55
P8	1/07/1996	180.231	50.06	-5.09	13.46
P8	5/08/1996	170.835	43.33	-6.73	6.73
P8	23/10/1996	172.522	46.25	2.92	9.65
P8	6/11/1996	173.559	47.71	1.46	11.11
P8	10/01/1997	175.839	49.17	1.46	12.57
P8	7/02/1997	176.507	47.95	-1.22	11.35
P8	19/03/1997	173.967	50.49	2.54	13.89
P8	8/05/1997	127.398	55.78	5.29	19.18
P8	30/09/1997	181.013	52.54	-3.24	15.94
P8	21/04/1998	172.621	47.96	-4.58	11.36
P8	4/07/1998	184.848	53.72	5.76	17.12
P8	15/10/1998	180.675	50.47	-3.25	13.87
P8	2/12/1998	178.566	43.55	-6.92	6.95
P8	28/04/1999	181.113	46.94	3.39	10.34
P8	5/10/1999	189.425	51.26	4.32	14.66
P8	17/04/2000	267.652	51.04	-0.22	14.44
P8	17/07/2000	163.49	39.13	-11.91	2.53
P8	26/10/2000	155.495	33.8	-5.33	-2.80
P8	7/05/2001	161.346	41.8	8.00	5.20
P8	15/10/2001	161.172	40.98	-0.82	4.38
P8	2/05/2002	158.015	40.99	0.01	4.39
P8	9/09/2002	167.263	43.36	2.37	6.76
P8	30/05/2003	172.92	47.71	4.35	11.11
P8	9/10/2003	176.812	49.52	1.81	12.92
P8	6/04/2004	170.144	48.86	-0.66	12.26
P8	13/09/2004	177.325	49.73	0.87	13.13

Descriptive Statistics	
Mean	0.247735849
Standard Error	1.238287028
Median	0.87
Mode	1.46
Standard Deviation	9.014865638
Sample Variance	81.26780247
Kurtosis	2.777047012
Skewness	0.001738232
Range	49.9
Minimum	-23.98
Maximum	25.92
Sum	13.13
Count	53
Confidence Level(95.0%)	2.484803025

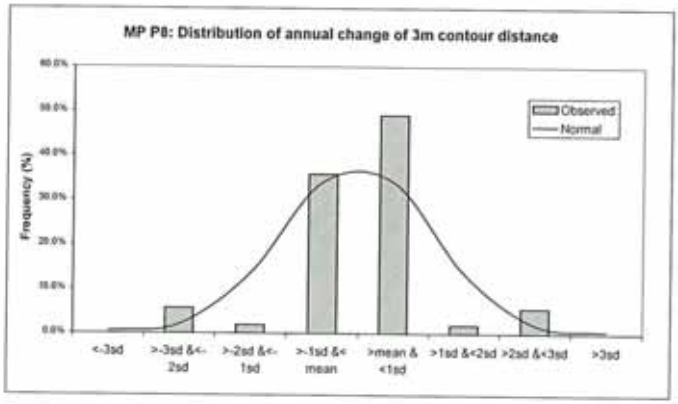
SUMMARY OUTPUT

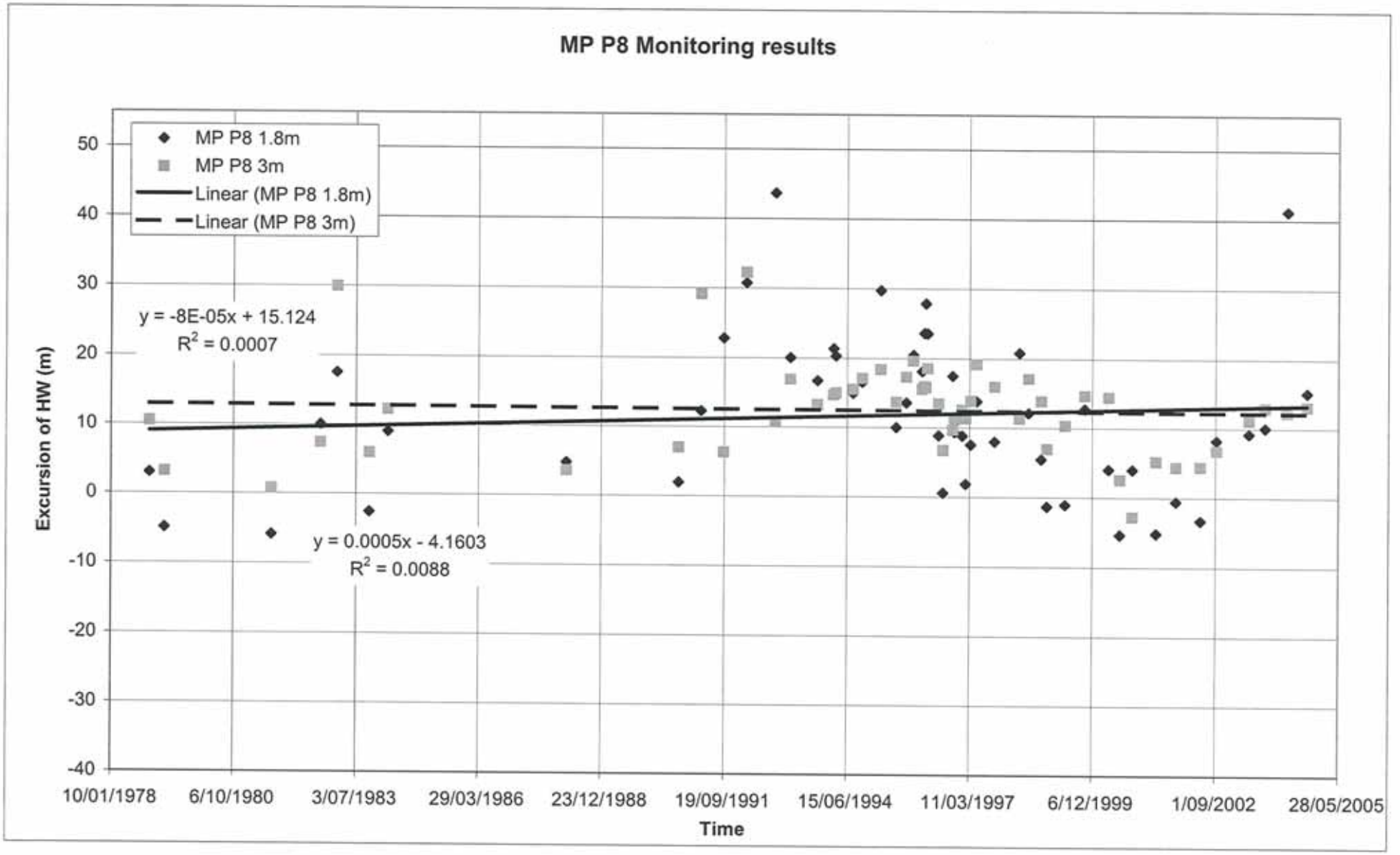
Regression Statistics	
Multiple R	0.026554245
R Square	0.000705128
Adjusted R Square	-0.018888889
Standard Error	6.836767244
Observations	53

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	15.1239767	14.2718	1.05971	0.29427	-13.5278	43.77579	-13.5278	43.77579
X Variable 1	-7.76993E-05	0.00041	-0.1897	0.850296	-0.0009	0.000745	-0.0009	0.000745

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-26.8			0	0.0%	0.5%
>-3sd &<-2sd	-26.8	to	-17.8	3	5.7%	2.0%
>-2sd &<-1sd	-17.8	to	-8.8	1	1.9%	13.5%
>-1sd &< mean	-8.77	to	0.25	19	35.8%	34.0%
>mean & <1sd	0.25	to	9.26	26	49.1%	34.0%
>1sd &<2sd	9.26	to	18.28	1	1.9%	13.5%
>2sd &<3sd	18.28	to	27.29	3	5.7%	2.0%
>3sd	27.29			0	0.0%	0.5%
				53		




MP P8 Monitoring results
MP P8 1.8m
MP P8 3m
Linear (MP P8 1.8m)
Linear (MP P8 3m)
y = -8E-05x + 15.124
R2 = 0.0007
y = 0.0005x - 4.1603
R2 = 0.0088
Excursion of HW (m)
50
40
30
20
10
0
-10
-20
-30
-40
10/01/1978
6/10/1980
3/07/1983
29/03/1986
23/12/1988
19/09/1991
15/06/1994
11/03/1997
6/12/1999
1/09/2002
28/05/2005
Time

MP P9 TOTAL REPORT
Profile Volume Report
Contour Level: **1.8 m**

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P9	11/01/1989	138.452	57.45	0.00	0.00
P9	3/07/1989	129.306	46.95	-10.50	-10.50
P9	15/09/1989	120.015	45.15	-1.80	-12.30
P9	9/01/1990	124.14	55.81	10.66	-1.64
P9	21/06/1990	125.149	52.17	-3.64	-5.28
P9	14/01/1991	165.389	73.03	20.86	15.58
P9	11/07/1991	152.532	76.16	3.13	18.71
P9	2/08/1994	115.105	61.05	-15.11	3.60
P9	18/10/1994	111.917	58.98	-2.07	1.53
P9	15/03/1995	126.413	71.6	12.62	14.15
P9	21/07/1995	110.819	57.61	-13.99	0.16
P9	10/10/1995	116.619	60.92	3.31	3.47
P9	7/12/1995	120.276	66.83	5.91	9.38
P9	16/02/1996	122.489	64.68	-2.15	7.23
P9	6/03/1996	117.616	63.6	-1.08	6.15
P9	18/03/1996	128.27	77.2	13.60	19.75
P9	2/04/1996	125.743	67.57	-9.63	10.12
P9	1/07/1996	123.591	58.8	-8.77	1.35
P9	5/08/1996	103.159	49.8	-9.00	-7.65
P9	23/10/1996	118.829	70.72	20.92	13.27
P9	6/11/1996	113.233	61	-9.72	3.55
P9	10/01/1997	117.53	61.92	0.92	4.47
P9	7/02/1997	111.357	52.04	-9.88	-5.41
P9	19/03/1997	116.401	58.22	6.18	0.77
P9	8/05/1997	130.952	69.78	11.56	12.33
P9	30/09/1997	115.178	52.17	-17.61	-5.28
P9	21/04/1998	126.609	63.87	11.70	6.42
P9	4/07/1998	116.945	58	-5.87	0.55
P9	15/10/1998	117.175	55.91	-2.09	-1.54
P9	2/12/1998	120.885	54.83	-1.08	-2.62
P9	28/04/1999	132.915	59.22	4.39	1.77
P9	5/10/1999	133.494	59.88	0.66	2.43
P9	17/04/2000	454.293	59.41	-0.47	1.96
P9	17/07/2000	75.331	36.5	-22.91	-20.95
P9	26/10/2000	65.182	43.7	7.20	-13.75
P9	7/05/2001	66.018	43.51	-0.19	-13.94
P9	15/10/2001	78.395	47.32	3.81	-10.13
P9	2/05/2002	85.646	50.8	3.48	-6.65
P9	9/09/2002	83.357	54.85	4.05	-2.60
P9	30/05/2003	90.149	55.3	0.45	-2.15
P9	9/10/2003	86.96	53.34	-1.96	-4.11
P9	6/04/2004	109.015	74.44	21.10	16.99
P9	13/09/2004	96.799	60.79	-13.65	3.34

Descriptive Statistics	
Mean	0.07952381
Standard Error	1.584732982
Median	-0.33
Mode	#N/A
Standard Deviation	10.27024353
Sample Variance	105.4779022
Kurtosis	-0.077943217
Skewness	0.112572263
Range	44.01
Minimum	-22.91
Maximum	21.1
Sum	3.34
Count	42
Confidence Level(95.0%)	3.200434943

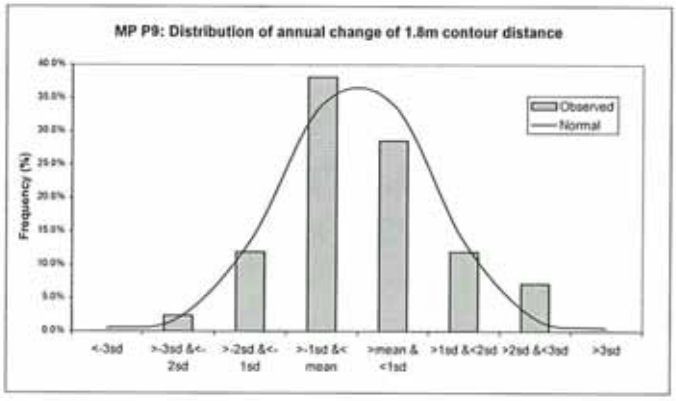
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.165079182
R Square	0.027251136
Adjusted R Square	0.002932415
Standard Error	9.30062506
Observations	42

	Coefficients	tandard Err	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	pper 95.0%
Intercept	39.02221857	35.71029	1.092744	0.281044	-33.1509	111.1954	-33.1509	111.1954
X Variable 1	-0.001061496	0.001003	-1.05858	0.296144	-0.00309	0.000965	-0.00309	0.000965

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-30.7			0	0.0%	0.5%
>-3sd &<-2sd	-30.7	to	-20.5	1	2.4%	2.0%
>-2sd &<-1sd	-20.5	to	-10.2	5	11.9%	13.5%
>-1sd &< mean	-10.19	to	0.08	16	38.1%	34.0%
>mean & <1sd	0.08	to	10.35	12	28.6%	34.0%
>1sd &<2sd	10.35	to	20.62	5	11.9%	13.5%
>2sd &<3sd	20.62	to	30.89	3	7.1%	2.0%
>3sd	30.89			0	0.0%	0.5%
				42		



MP P9 TOTAL REPORT
Profile Volume Report
Contour Level: 3 m

Profile	Date	Vol (cu m/m)	Distance (m)	Difference (m)	Cum. Diff (m)
P9	11/01/1989	90.005	42.83	0.00	0.00
P9	3/07/1989	90.011	39.42	-3.41	-3.41
P9	15/08/1989	83.091	36.96	-2.46	-5.87
P9	9/01/1990	78.159	32.03	-4.93	-10.8
P9	21/06/1990	82.292	39.92	7.89	-2.91
P9	14/01/1991	93.64	65.3	25.38	22.47
P9	11/07/1991	89.394	47	-18.30	4.17
P9	2/08/1994	70.749	43.33	-3.67	0.50
P9	16/10/1994	69.342	43.43	0.10	0.60
P9	15/03/1995	71.34	45.45	2.02	2.62
P9	21/07/1995	69.847	41.89	-3.56	-0.94
P9	10/10/1995	69.873	44.53	2.64	1.70
P9	7/12/1995	70.857	45.49	0.96	2.66
P9	16/02/1996	72.34	44.82	-0.67	1.99
P9	6/03/1996	69.991	44.56	-0.26	1.73
P9	18/03/1996	71.621	45.43	0.87	2.60
P9	2/04/1996	73.295	48.8	3.37	5.97
P9	1/07/1996	77.327	48.12	-0.68	5.29
P9	5/08/1996	67.494	38.84	-9.28	-3.99
P9	23/10/1996	69.632	41.1	2.26	-1.73
P9	6/11/1996	69.263	42.44	1.34	-0.39
P9	10/01/1997	71.705	44.57	2.13	1.74
P9	7/02/1997	72.238	42.08	-2.49	-0.75
P9	19/03/1997	71.962	43.97	1.89	1.14
P9	8/05/1997	75.924	49.31	5.34	6.48
P9	30/09/1997	75.452	42.71	-6.60	-0.12
P9	21/04/1998	76.446	48.07	5.36	5.24
P9	4/07/1998	74.361	42.87	-5.20	0.04
P9	15/10/1998	75.62	43.15	0.28	0.32
P9	2/12/1998	79.022	43.84	0.69	1.01
P9	28/04/1999	85.504	48.96	5.12	6.13
P9	5/10/1999	86.418	46.8	-2.16	3.97
P9	17/04/2000	365.394	46.58	-0.22	3.75
P9	17/07/2000	54.08	28.38	-18.20	-14.45
P9	26/10/2000	36.307	25.33	-3.05	-17.50
P9	7/05/2001	39.293	31.96	6.63	-10.87
P9	15/10/2001	45.707	35.52	3.56	-7.31
P9	2/05/2002	49.458	38.02	2.50	-4.81
P9	9/09/2002	47.125	36.11	-1.91	-6.72
P9	30/05/2003	52.844	38.47	2.36	-4.36
P9	9/10/2003	50.412	36.7	-1.77	-6.13
P9	6/04/2004	55.585	44.01	7.31	1.18
P9	13/09/2004	54.381	39.53	-4.48	-3.30

Descriptive Statistics	
Mean	-0.078571429
Standard Error	1.04769187
Median	0.19
Mode	#N/A
Standard Deviation	6.789819341
Sample Variance	46.10164069
Kurtosis	5.554606536
Skewness	0.390132865
Range	43.68
Minimum	-18.3
Maximum	25.38
Sum	-3.3
Count	42
Confidence Level(95.0%)	2.115857819

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.287708372
R Square	0.082776107
Adjusted R Square	0.05984551
Standard Error	6.356813459
Observations	42

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	45.7665201	24.40735	1.875931	0.067976	-3.54256	95.1156	-3.54256	95.1156
X Variable 1	-0.001302173	0.000685	-1.89998	0.064664	-0.00269	8.3E-05	-0.00269	8.3E-05

FREQUENCY ANALYSIS

				Observed Number	Observed Frequency	Normal Frequency
<-3sd	-20.4			0	0.0%	0.5%
>-3sd &<-2sd	-20.4	to	-13.7	2	4.8%	2.0%
>-2sd &<-1sd	-13.7	to	-6.9	1	2.4%	13.5%
>-1sd &< mean	-6.87	to	-0.08	17	40.5%	34.0%
>mean & <1sd	-0.08	to	6.71	19	45.2%	34.0%
>1sd &<2sd	6.71	to	13.50	2	4.8%	13.5%
>2sd &<3sd	13.50	to	20.29	0	0.0%	2.0%
>3sd	20.29			1	2.4%	0.5%
				42