COASTAL RESOURCES LIMITED

POST 150,000m^3 DISPOSAL

CHARACTERISATION

OF

SEABED CHANGES

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November 2015

FOR : Coastal Resources Limited
BY : Bioresearches Group Limited
23 March 2017

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1 INTRODUCTION

For many years Auckland regional stakeholders have relied upon use of the Auckland Explosives Dumping Ground, within a circle of four nautical miles radius centred on position 27 nautical miles east of Cuvier Island, for disposal of dredged marine sediments.

The Auckland Explosives Dumping Ground has presented significant difficulties for administration. It was originally established by the military after World War II as a safe deep-water site for disposal of ordnance and ammunition. Subsequently, due to the need for a disposal site for capital and maintenance dredged material in the Auckland region, the site was identified as a pragmatic solution given its historic use, the no-anchoring prohibition, the notion that covering explosives in sediments would be beneficial, and the assumption that the seafloor ecology was already likely to have been modified to some extent.

However, when New Zealand became party to the 1996 Protocol to the London Convention in 1998, new responsibilities including comprehensive marine disposal site assessments were imposed on the administration. These were enacted in New Zealand in 1999 through amendments to Part 21 of the Maritime Transport Act 1994, with more detailed regulations contained in Marine Protection Rule Part 180.

Unfortunately, since the Auckland Explosives Dumping Ground is in 500-1300m water depth, seafloor assessment and monitoring is both technically difficult and prohibitively expensive for individual stakeholders to undertake. Therefore a new location where monitoring would be more achievable was needed.

Coastal Resources Ltd has obtained approval for a new marine disposal site, the Outer Gulf Disposal Area (OGDA), in 135-140m water depth, 20km east of Great Barrier Island in the Exclusive Economic Zone. The permit states that; between 2 November 2012 and 2 November 2013 disposal of up to 15,000m^3 was permitted, between 3 November 2013 and 2 November 2014 disposal of up to 7,800m^3 was permitted, and between 3 November 2014 and 2 November 2015 disposal of up to 127,000m^3 was permitted. From 3 November 2015 the disposal of up to 50,000m^3 of dredged marine sediments at the site is permitted annually. On-going use of the site is dependent on monitoring that demonstrates to the Environmental Protection Authority (EPA) satisfaction that effects are within acceptable limits and contained within the defined site.

Clean marine sediment has been and is being disposed of by Coastal Resources Ltd under Maritime New Zealand (MNZ) Permit 568, now under EPA consent EEZ900012, at a site 20km east of Great Barrier Island. During the entire term of this Consent, the Consent Holder must undertake post-disposal monitoring of the Disposal Area and Monitoring Zone, in order to assess the extent of environmental impacts.

The post-disposal monitoring includes the following:

1. Accumulation of contaminants;
2. Sediment textural changes;
3. Bathymetric changes due to the accumulation and dispersal of dredge spoil; and
4. Changes in the biodiversity and quantity of benthic biota.

The MNZ Permit 568 prescribed that the monitoring be conducted following disposal volume triggers. The first trigger was when a cumulative total of 10,000m^3 of dredge spoil had been disposed of or on the two year anniversary of the first disposal, and then when a cumulative total of 50,000m^3 of dredge spoil has been disposed of or on the five year anniversary of the first disposal operation, and then after every 50,000m^3 of dredge spoil has been disposed thereafter.

This report assesses and characterises the changes on the seabed in and around the Outer Gulf Disposal Area following the disposal of 150,000m^3 of dredge spoil, under EPA consent EEZ900012. The monitoring includes assessment of the accumulation of contaminants, sediment textural changes and changes in the biodiversity and quantity of benthic biota. The sediment and benthic biota samples were collected on 23 November 2016.

2 SEDIMENT CHARACTERISTICS

2.1 Introduction

The sediment being disposed of at the OGDA has the potential to include contaminants. The levels of potential contaminants were determined before the sediment was dredged and taken to the disposal site. Disposal trials undertaken prior to MNZ Permit 568, undertook elutriation of the sediments from the disposal site after 4800m^3 of sediment were deposited in the area. These results showed that the contaminants present in the dredge spoil were not mobilised once within the disposal site. Therefore, it was predicted that any dispersal and concentration of contaminants will be due to the physical movement of the sediment clasts to which they are bound. This is most likely to occur due to sediment transport preferentially sorting fine sediment into a surficial layer. Based on the available data, it was predicted that most transport is likely to occur as the near-bed density flow erodes and transports surficial sediment close to the impact point on the seabed. The limited data collected during the trials indicates that this process diluted the contaminants.

2.2 Methods

To determine if contaminants are accumulating on the seabed, the particle size and chemistry of surficial sediments were monitored.

The EPA consent EEZ900012 requires analysis of sediments on axes throughout the Disposal Area with a minimum of thirteen sampling sites and a Control site included. Monitoring should also be undertaken at four sites midway between the sites on the boundary (i.e. the sites beyond the boundary should be in a NE, SE, SW and NW direction from the site centre) at a distance of 250m beyond the Disposal Area boundary. Thus sixteen sample sites within and around the disposal area were sampled and an additional three Control site samples were collected from 2500m south of the disposal centre site, as shown in Figure 2.1.

At each sampling site two 70mm diameter clear barrel cores were taken using a gravity corer with sufficient mass to achieve at least 10-15cm penetration. In addition to those sites required under the consent, eight single core samples were collected at the 100m N, S, 250m N, E, W, S and 375m N, S. On retrieval of the core barrels the bottom was sealed and the cores photographed with a label and scale to show layers.

From those sites required under the consent, the bottom cap was carefully removed and plunger inserted to push the sediment core up through the core barrel, removing the surface water and then carefully extruding the top 5cm of the sediment core. The top 5cm from both cores were combined, homogenised and 50g sub-sampled for grain size and remainder used for sediment chemistry. All samples were double bagged in clean zip lock plastic bags, with a waterproof label between the two bags.

The sediment was analysed for particle size by the University of Waikato using a Malvern Laser Sizer particle size analysis. The sediment was analysed for total recoverable metals

(Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc) in the total sediment fraction, and for Total Petroleum Hydrocarbons (TPH) by Hill Laboratories.

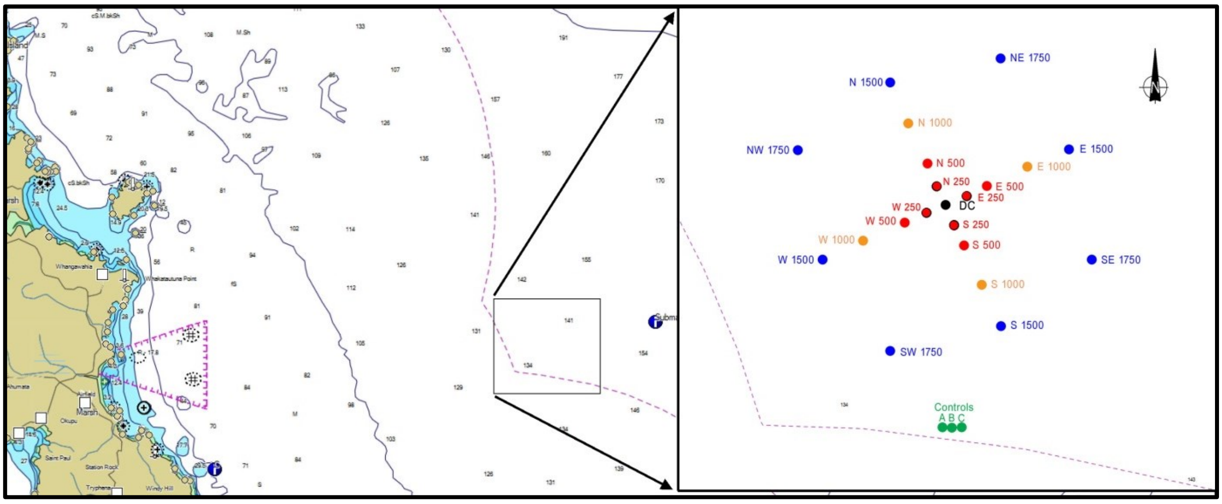

Figure 2.1 Seabed Sediment Quality Sampling Sites

2.3 Results

Photographs of the core barrels at each site are presented in Appendix 1. The depths of layers in the sediment are summarised in Table 2.1.

Sediment particle size results as received from the University of Waikato are attached in Appendix 3, and summarised in Table 2.2.

Sediment chemistry results as received from Hills Laboratories are attached in Appendix 5. Raw sediment quality data from all sites are presented and compared with sediment quality guidelines in Table 2.3.

Table 2.1 Sediment Core Depths (mm), Post 150,000m^3 Disposal

Site		Depth of Core A	Depth of Core B	Depth of Core Average	Depth of mixing A	Depth of mixing B	Depth of mixing Average	Comments
DC		263	280	**271.3**	263	280	**271.3**	No obvious mixed layer, sediment darker in colour, likely all disposal material, surface interface broken
100m	**N**	172		**171.7**	172		**171.7**	No obvious mixed layer, sediment darker in colour, some clay present, likely all disposal material, surface interface broken
	S	296		**296.3**	296		**296.3**	No obvious mixed layer, sediment darker in colour, likely all disposal material
250m	**N**	231		**230.9**	73		**73.2**	surface layer slightly darker and coarser, surface layer similar to 500m and beyond, unlikely disposal material
	E	224		**223.7**	195		**194.9**	surface layer slightly darker, mottled and coarser, surface layer likely disposal material, surface broken
	S	213		**213.2**	81		**80.9**	surface layer slightly darker and coarser, surface layer similar to 500m and beyond, unlikely disposal material
	W	232		**232.5**	158		**157.7**	surface layer slightly darker and mottled, surface layer may be disposal material
375m	**N**	210		**210.0**	83		**82.5**	surface layer slightly darker and coarser, surface layer similar to 500m and beyond, unlikely disposal material
	S	164		**164.0**	73		**72.9**	surface layer slightly darker and coarser, surface layer similar to 500m and beyond, unlikely disposal material
500m	**N**	179	175	**177.0**	70	75	**72.7**	surface layer slightly darker and coarser, unlikely disposal material
	E	176	181	**178.9**	60	73	**66.5**	surface layer slightly darker and coarser, unlikely disposal material
	S	173	199	**186.1**	62	69	**65.8**	surface layer slightly darker and coarser, unlikely disposal material
	W	186	204	**194.7**	58	73	**65.5**	surface layer slightly darker and coarser, unlikely disposal material
1000m	**N**	166	171	**168.7**	61	61	**61.2**	surface layer slightly darker, mottled and coarser, unlikely disposal material
	E	169	174	**171.8**	68	56	**62.4**	surface layer slightly darker, mottled and coarser, some open spaces, unlikely disposal material
	S	192	198	**194.9**	75	83	**78.8**	surface layer slightly darker, mottled and coarser, some open spaces, unlikely disposal material
	W	204	184	**193.9**	89	84	**86.8**	surface layer slightly darker and coarser, some open spaces, unlikely disposal material
1500m	**N**	178	155	**166.4**	76	66	**70.7**	surface layer slightly darker and coarser, unlikely disposal material
	E	171	173	**172.1**	70	73	**71.7**	surface layer slightly darker, mottled and coarser, unlikely disposal material
	S	208	208	**208.3**	80	73	**76.4**	surface layer slightly darker, mottled and coarser, some open spaces, unlikely disposal material
	W	208	163	**185.6**	108	63	**85.6**	surface layer slightly darker, mottled and coarser, unlikely disposal material
1750m	**NE**	165	176	**170.4**	52	71	**61.7**	surface layer slightly darker, and coarser, unlikely disposal material
	SE	211	176	**193.5**	74	70	**72.2**	surface layer slightly darker, mottled and coarser, some open spaces, unlikely disposal material
	SW	216	162	**189.2**	68	74	**71.2**	surface layer slightly darker, mottled and coarser, some open spaces, unlikely disposal material
	NW	158	208	**183.1**	64	68	**66.1**	surface layer mottled, some open spaces, unlikely disposal material
Control	**A**	178	194	**186.2**	78	75	**76.6**	surface layer slightly darker, mottled and coarser, no disposal material
	B	197	182	**189.4**	74	74	**73.7**	surface layer slightly darker, mottled and coarser, some open spaces, no disposal material
	C	190	197	**193.7**	66	65	**65.5**	surface layer slightly darker and coarser, no disposal material

Summary	Depth of Core Average	Depth of Core CL	Depth of mixing Average	Depth of mixing CL
DC	**271**	111.2	**271**	111.2
100m	**234**	791.7	**234**	791.7
250m	**225**	13.9	**127**	94.5
375m	**187**	292.4	**78**	61.2
500m	**184**	9.5	**68**	5.3
1000m	**182**	11.9	**72**	10.3
1500m	**183**	18.2	**76**	11.6
1750m	**184**	20.1	**68**	5.9
Control	**190**	8.5	**72**	5.6

Table 2.2 Surficial Sediment Particle Size, Post 150,000m³ Disposal

Grain size (mm)	Class	DC	500m N	500m E	500m S	500m W	1000m N	1000m E	1000m S	1000m W	1500m N	1500m E	1500m S	1500m W	1750m NE	1750m SE	1750m SW	1750m NW	Control A	Control B	Control C
		Percentage of total sample																			
> 3.35	Gravel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.35 - 2.00	Granules	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.00 - 1.18	Very Coarse Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.18 - 0.600	Coarse Sand	0.0	0.0	0.0	0.6	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
0.600 - 0.300	Medium Sand	1.1	4.0	2.4	6.4	6.0	5.5	5.7	4.2	4.4	5.0	6.2	5.3	3.5	4.8	4.8	3.9	4.0	5.4	0.7	5.6
0.300 - 0.150	Fine Sand	5.3	13.9	15.6	14.8	15.3	14.8	14.6	12.7	12.5	13.9	15.4	13.4	12.3	13.9	16.1	13.6	12.4	13.0	17.4	14.6
0.150 - 0.063	Very Fine Sand	11.3	18.4	18.8	19.5	18.5	18.1	17.0	16.9	17.1	17.8	18.7	15.6	16.6	18.3	17.2	16.9	16.8	14.5	22.1	14.8
0.063 - 0.0313	Coarse Silt	12.2	12.0	11.8	11.8	11.4	11.9	11.5	12.1	12.3	12.5	11.8	11.6	12.1	12.2	11.2	12.0	12.8	12.1	12.1	11.8
0.0313 - 0.0156	Medium Silt	13.1	12.3	12.5	11.0	11.1	11.8	12.0	12.5	12.4	11.7	11.5	12.7	12.6	12.0	11.9	12.7	12.8	13.2	11.8	12.8
0.0156 - 0.0078	Fine Silt	15.3	13.7	14.2	12.3	12.3	13.2	13.6	14.2	13.9	13.1	12.9	14.2	14.1	13.5	13.5	14.2	14.2	14.8	13.1	14.3
0.0078 - 0.0039	Very Fine Silt	15.6	12.1	12.3	11.1	11.3	11.7	12.0	12.8	12.7	12.0	11.2	12.6	13.0	12.0	11.9	12.5	12.4	12.9	11.1	12.4
< 0.0039	Clay	26.3	13.6	12.4	12.6	13.8	13.1	13.5	14.7	14.8	14.0	12.5	14.4	15.8	13.4	13.5	14.2	14.7	14.0	11.7	13.7
< 0.063	**Silt and Clay**	**82.4**	**63.8**	**63.2**	**58.8**	**59.9**	**61.6**	**62.6**	**66.2**	**66.0**	**63.3**	**59.8**	**65.6**	**67.6**	**63.1**	**62.0**	**65.6**	**66.8**	**66.9**	**59.8**	**64.9**
Mean Size		**0.012**	**0.027**	**0.028**	**0.033**	**0.031**	**0.030**	**0.029**	**0.025**	**0.025**	**0.028**	**0.032**	**0.026**	**0.024**	**0.028**	**0.029**	**0.026**	**0.025**	**0.026**	**0.031**	**0.028**
Grain size description		**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**	**sZ**

Table 2.3 Surficial Sediment Quality, Post 150,000m³ Disposal (Dry Weight)

Tests	units	Site DC	500m N	500m E	500m S	500m W	1000m N	1000m E	1000m S	1000m W	1500m N	1500m E	1500m S	1500m W	1750m NE	1750m SE	1750m SW	1750m NW	Control A	Control B	Control C	AC Green	AC Amber	AC Red	ANZECC ISQG Low	ANZECC ISQG High
Dry Matter	g/100g	34	48	49	50	60	50	49	49	52	48	51	49	52	48	50	48	48	49	49	50					
Total Sediment, Total Recoverable Metals																										
Arsenic	mg/kg dry wt	9.5	4.0	3.6	3.9	4.0	5.0	5.0	4.1	3.6	4.0	4.0	5.0	3.0	4.0	5.0	4.0	3.0	5.0	5.0	5.1				**20**	**70**
Cadmium		0.081	0.170	0.160	0.120	0.100	0.110	0.130	0.130	0.094	0.121	0.090	0.110	0.122	0.130	0.115	0.116	0.102	0.100	< 0.100	0.120	0.7	0.7 - 1.2	1.2	**1.5**	**10**
Chromium		22	22	21	21	22	20	23	23	20	20	20	23	20	22	23	22	17	22	24	25	52	52 - 80	80	**80**	**370**
Copper		29.0	5.5	5.1	5.0	5.0	8.4	4.9	5.0	5.2	4.7	4.2	4.7	5.6	4.7	4.6	4.9	4.4	5.0	4.8	5.1	19	19 - 34	34	**65**	**270**
Lead		26.0	4.4	4.2	4.1	4.2	4.2	4.4	4.4	4.0	3.9	3.8	4.1	5.2	4.1	4.2	4.2	3.6	4.4	4.5	4.8	30	30 - 50	50	**50**	**220**
Mercury		0.123	0.048	0.046	0.037	0.038	0.038	0.052	0.043	0.045	0.046	0.040	0.037	0.045	0.042	0.067	0.050	0.053	0.047	0.050	0.046				**0.15**	**1**
Nickel		10.0	16.3	15.1	14.4	16.1	14.8	15.8	16.2	14.4	15.0	14.3	15.8	16.0	15.7	15.4	15.6	13.9	17.1	16.3	17.2				**21**	**52**
Zinc		95	30	29	28	29	30	31	30	28	27	26	30	29	28	30	30	25	29	31	32	124	124 - 150	150	**200**	**410**
Total Sediment, Total Petroleum Hydrocarbons (TPH)																										
C7 - C9	mg/kg dry wt	< 19	< 14	< 30	< 30	< 11	< 14	< 13	< 14	< 13	< 14	< 13	< 14	< 13	< 14	< 13	< 14	< 14	< 14	< 13	< 13					
C10 - C14		< 40	< 30	< 60	< 60	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30					
C15 - C36		< 80	< 60	< 110	< 110	< 50	< 60	< 60	< 60	< 50	< 60	< 60	< 60	< 50	< 60	< 60	< 60	< 60	< 60	< 60	< 60					
Total TPH		< 140	< 100	< 190	< 190	< 80	< 100	< 90	< 100	< 90	< 100	< 90	< 100	< 90	< 100	< 90	< 100	< 100	< 100	< 90	< 100				**280#**	**550#**

Key: AC = Auckland Council, ANZECC ISQG = Australian and New Zealand Environment and Conservation Council Interim Sediment Quality Guideline, # from Simpson, *et al.* 2013.

2.4 Discussion

2.4.1 Cores

The disposed sediment is visually obvious in the cores from the disposal centre site and at 100m and the E and W 250m cores. The sediment is softer and darker allowing for greater penetration of the corer than at the more distant sites. The lack of a base layer at the disposal centre site and 100m sites prevents the determination of the thickness of disposed sediment layer on top of the original sea bed sediment. Additional single core samples were collect at the 250m compass points. These show that the layer of darker material, presumably disposal sediments, is present at the W and E cores ranging between 158mm and 195mm depth, with an average depth of 77mm at cores from N and S. The differences in core penetration depth and thickness and colour of mixing layer are graphically compared in Figure 2.2.

While there is what appears to be a mottled bioturbated surface layer in the cores from 500m and beyond in the disposal area, this is also present at the Control sites, indicating it is natural and not disposal related.

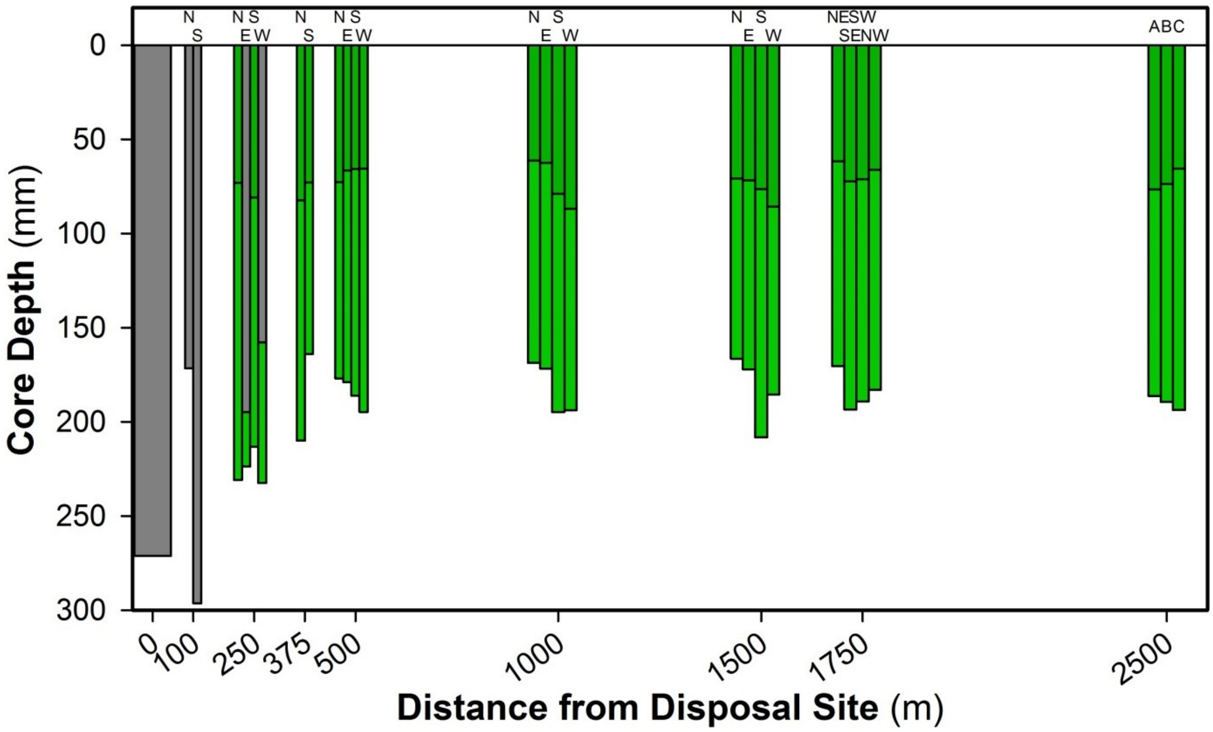

Figure 2.2 Changes in Depth of Cores and Thickness of Mixing Layers with Distance from Disposal Centre Site. (▇ = dark layer of sediment, ▇ indicates bioturbated sediment layer)

There is no evidence indicating that disposed sediment, once on the seabed is spreading far from its point of disposal. Sediments in the disposal area at and beyond 500m from the disposal centre site, and at the Control sites are of similar density as shown by the similar depths of core penetration. The zone of surface mixing is similar throughout the study sites with the exception of the disposal centre site, 100m and at W and E 250m. The east west elongation of the disposal mound is likely to be the result of the direction of barge approach

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and minor variations in the timing and location of discharge, rather than a spread of the material once it has reach the seabed.

There are statistically significant differences in depths of cores and thickness of the surface layer between the DC, 100m, 250m, 375m, 500m, 1000m, 1750m and the Control sites (Appendix 2). The depth of the core at the disposal centre site (DC), 100m and 250m cores were statistically significantly different from the other sites. The non parametric Kruskal-Wallis one way analysis of variance on ranks was conducted on the surface layer data as both the assumptions of equal variance and normality was not met. Statistical analysis of the median values of the thickness of the surface layer at each distance indicated a statistical difference; however none of the pairwise comparisons showed statistically significant differences.

2.4.2 Particle Size

Particle size at the disposal centre site was statistically finer (Figure 2.3, Appendix 4) than the other disposal area and the Control sites, as a result of the disposal of fine sediments. The disposal centre site had approximately 20% less sand (●), approximately 6% more silt (●) and 13% more clay (●) than the surrounding sites.

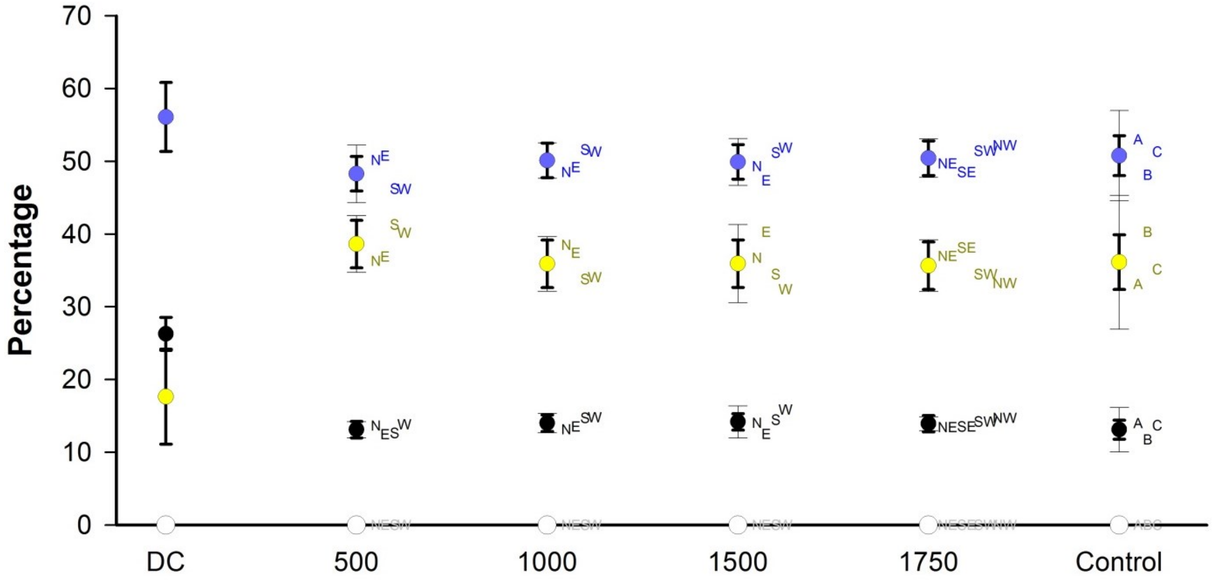

Figure 2.3 Particle Size Class Comparison With Distance From Disposal Centre Site (DC), After 150,000m³ Sediment Disposal. (○ Gravel, ● Sand, ● Silt, ● Clay, N, E, S, W = individual sites) (± 95% CI Ɪ and ± $HSI_{0.05}$ **Ɪ**)

Sediments at all sites were classified as sZ, slightly sandy Silt. All sites had sediments which were poorly sorted and strongly fine skewed, with the exception of the disposal centre site which was poorly sorted and strongly coarse skewed.

The lack of statistically significant differences between the Control site and 500m, 1000m, 1500m, and 1750m radius sample sites, indicates that sediment disposed of has not spread far from where it was deposited. Based on particle size data there was no evidence to suggest that disposal material has spread from the disposal centre site to the 500m sites or beyond.

The honest significant interval (HSI) error bar is a graphical representation of statistical difference (Andrews *et al*, 1980), if the error bars overlap there is no statistically significant difference, and if they do not overlap then there is a statistically significant difference between the two means.

2.4.3 Sediment Chemistry

2.4.3.1 Sediment Quality Criteria

The sediment data have been compared with the Australian and New Zealand Environment and Conservation Council (ANZECC) Interim Sediment Quality Guideline (ISQG) Low and ISQG-High values which have been derived from the effects range low (ERL) and median (ERM) described in US National Oceanic and Atmospheric Administration, NOAA (Long and Morgan, 1991) and updated in 1995 (Long *et al*, 1995). The above references present data to assess the potential for adverse biological effects occurring due to exposure of biota to toxicants in sediment. Two values are determined from the data for each chemical or chemical group. The ERL is the concentration at the low end (10^{th} percentile) of the range in which effects had been observed and the ERM is the concentration approximately midway (50^{th} percentile) in the range of reported values associated with biological effects. These values defined three ranges in chemical concentrations that were anticipated to be: (1) rarely (less than ERL), (2) occasionally (between ERL and ERM), or (3) frequently (greater than ERM) associated with biological effects.

There are few reliable data on sediment toxicity for either Australia or New Zealand samples from which independent sediment quality guidelines might be derived and without a financial impetus there is little likelihood that further data will be forthcoming in the immediate future. Because of this, and as has been done in many other countries, the sediment quality guidelines are based on the best available overseas data and have been refined on the basis of current knowledge of existing baseline concentrations as well as by using local effects data as they become available. Therefore, the values provided by ANZECC (2000) are presented as interim sediment quality guidelines.

The Auckland Council (AC) has adopted a number of amendments to the ANZECC ISQG-Low guidelines, when the values provided were considered inappropriate to the Auckland region. This is consistent with the ANZECC (2000) philosophy of developing trigger values appropriate to local conditions.

The ANZECC (2000) ISQG-Low values for copper and zinc are the same as the Hong Kong interim sediment quality values for dredge spoil disposal “ISQV” (Chapman *et al*. 1999). The Hong Kong data are based on local unpublished studies, which did not find toxic effects below these concentrations. The text accompanying the ANZECC (2000) guidelines asserts a high level of confidence in ER-L (Long *et al*. 1995) values for copper and zinc and the guidelines have used ER-L for other toxicants. There seems to be no justification for the substitution of ER-L values with ISQV values in the ANZECC (2000) guidelines, so ARC has adopted the ER-L values for copper and zinc.

A revision of the ANZECC sediment quality guidelines was published in 2013 (Simpson, *et al.* 2013). This largely confirmed the ANZECC ISQG values for metals but recommended changes for organic compounds, and proposed ISQG values for total petroleum hydrocarbons; these are included in Table 2.3.

The values provided by ANZECC (2000) and Auckland Regional Council are not standards but are presented as guidelines in evaluating sediment contaminant data for their potential effects on biota. These guideline values are presented in Table 2.3; the data have been colour coded for comparison and are discussed below.

2.4.3.2 Dry Matter

The percentage of dry matter in the sediments sampled from the sites, following 150,000m^3 of spoil disposal, shows that the disposal centre site had statistically significantly low percentage dry matter compared to the outer sample sites and the Control (Figure 2.4, Appendix 6).

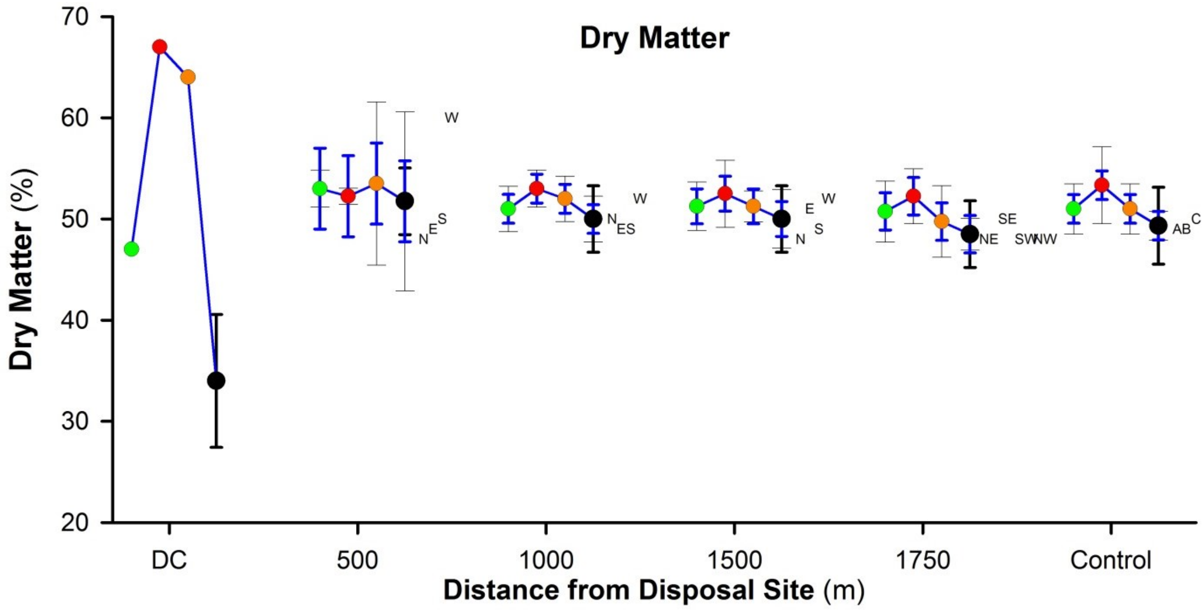

Figure 2.4 Comparison of Percent Dry Matter with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal (N, E, S, W = individual sites) (± 95% CI Ι and ± $HSI_{0.05}$ Ι) **and Over Time** (● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ Ι).

2.4.3.3 Metals

Arsenic

Concentrations of arsenic, following 150,000m^3 of spoil disposal, were all below the ANZECC ISQG low value of 20 mg/kg dry weight as shown in Table 2.3. The concentration of arsenic from the disposal centre site, following 150,000m^3 of spoil disposal, was higher but not statistically significantly than the concentrations recorded at the other sites. The average concentration of arsenic was slightly higher at the Control site than the disposal area sites excluding the disposal centre site.

The statistical tests (Appendix 6) indicate that the concentration of arsenic varies statistically significantly over time and between sites but the changes over time are different at different sites. Concentrations of arsenic have varied statistically significantly at the disposal centre site over time (Figure 2.5, Appendix 6). These changes are reflective of the variability in the quality characteristics of the source sediment disposed.

The average concentration of arsenic has decreased over time between the 10,000m^3 and 150,000m^3 samples from the 500m, 1000m, 1500m, 1750m and the Control sites. The decreases were statistically significant at the 500m, 1500m and 1750m sites but not the 1000m or the Control sites. While statistically significant the decreases over time at the distant sites do not indicate the spread of disposal material as this would have resulted in increases over time. The decreases in concentration of arsenic from the 500m to Control sites, based on the evidence to date, are considered to be the result of natural variations in the concentrations arsenic.

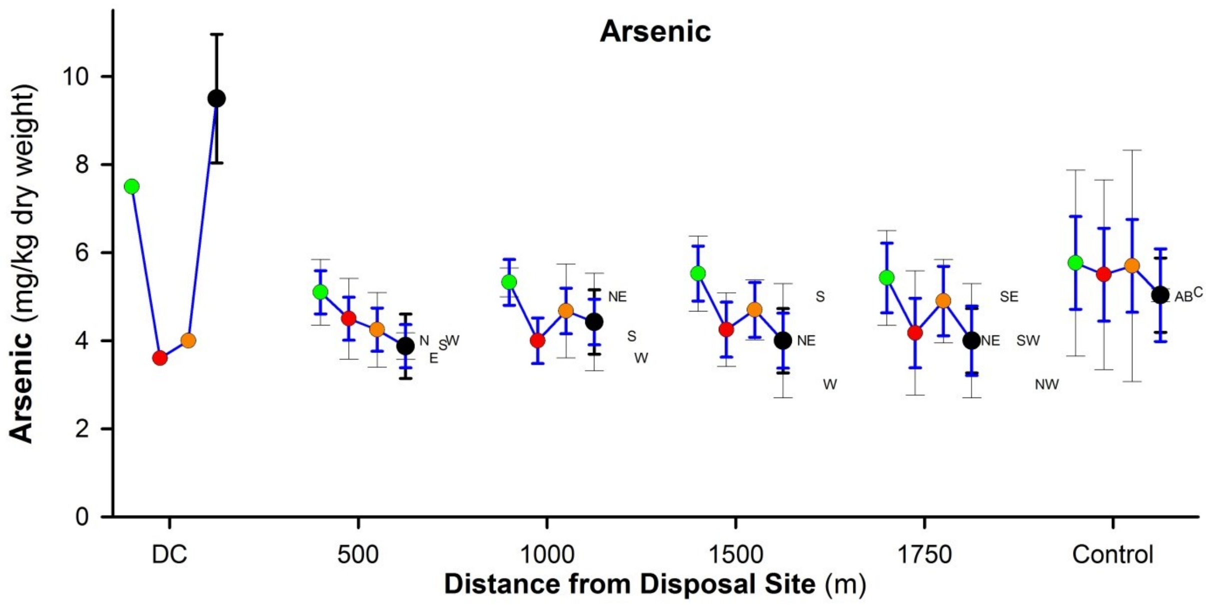

Figure 2.5 Comparison of Total Recoverable Arsenic with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time**
(● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I).

Bioresearches
A Babbage Company

Cadmium

Concentrations of cadmium, following 150,000m^3 of spoil disposal, were all well below the lowest guideline value, the AC Green trigger value of 0.7 mg/kg dry weight. The concentration recorded at the disposal centre site was approximately half the concentration recorded in the other sites in and around the disposal area; the differences were statistically significant (Figure 2.6, Appendix 6).

The statistical tests (Appendix 6) indicate that the concentration of chromium varies statistically significantly over time and between sites. Concentrations of cadmium have not varied statistically significantly at the disposal centre site over time (Appendix 6), nor have the other disposal area and Control site average concentrations. Figure 2.6 shows similar slight decreases in the concentration of cadmium over time at the 1000m, 1500m, 1750m and the Control sites. At the 500m sites the decreases in the concentration of cadmium followed a similar trend until the 150,000m^3 sample which showed a slight increase. The variability of the results as shown by the 95% CL error bars on Figure 2.6 indicate that the changes are most likely natural. The increased 150,000m^3 500m average cadmium concentration was the result of higher concentrations of cadmium at the N and E sites, however these are higher than recorded in the disposal material so the spread of disposal material is unlikely to be the cause of the increased concentrations.

The very small changes concentrations of cadmium recorded are all within the likely natural background variation in the concentration of cadmium. The decreased concentration of cadmium at the disposal centre site is the result of reduced cadmium in the source material.

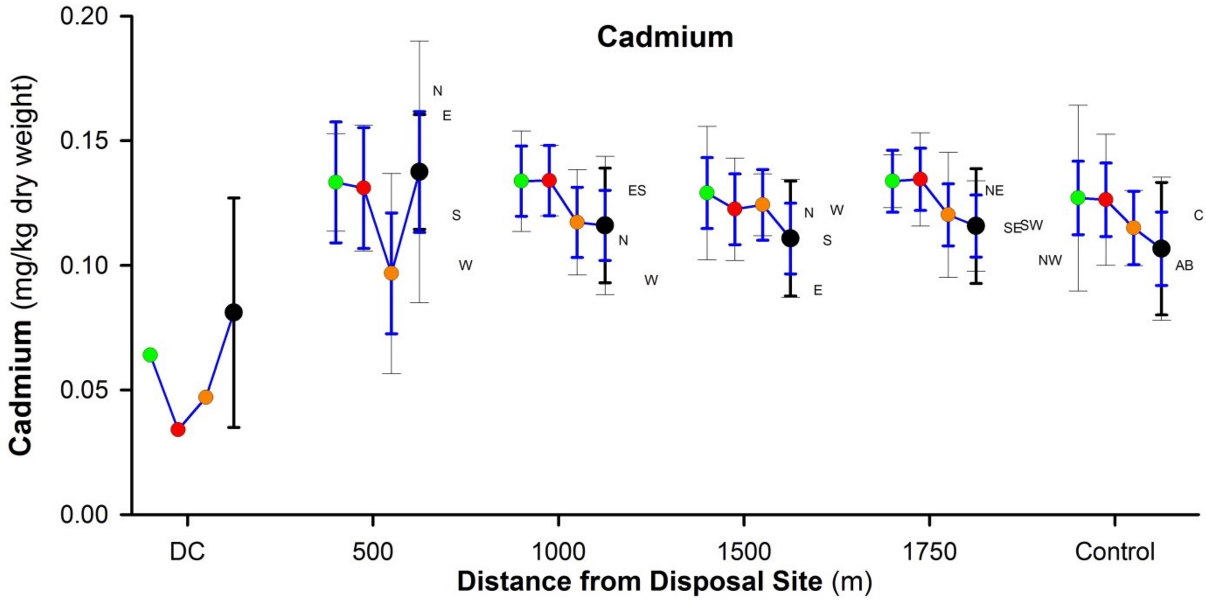

Figure 2.6 Comparison of Total Recoverable Cadmium with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time**
(● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I).

Bioresearches
A Babbage Company

Chromium

Concentrations of chromium, following 150,000m³ of spoil disposal, were all well below the lowest guideline value, the AC Green trigger value of 52 mg/kg dry weight as shown in Figure 2.7. The concentration of chromium recorded at all sites following the 150,000m³ of spoil disposal was similar, with the Control site recording the highest concentration. There were no statistically significant differences recorded between sites.

The statistical tests (Appendix 6) indicate that the concentration of chromium varies statistically significantly over time and between sites, but the changes over time are different at different sites. Concentrations of chromium have varied statistically significantly at the disposal centre site over time (Figure 2.7, Appendix 6). These changes are reflective of the changes in the quality of the sediment being disposed.

The average concentration of chromium has fluctuated and ultimately decreased similarly over time between the 10,000m³ and 150,000m³ samples at the 500m, 1000m, 1500m, 1750m and the Control sites. The decreases at the 1500m and 1750m sites were statistically significant, although the very small changes concentrations of chromium recorded are all within the likely natural background variation in the concentration of chromium.

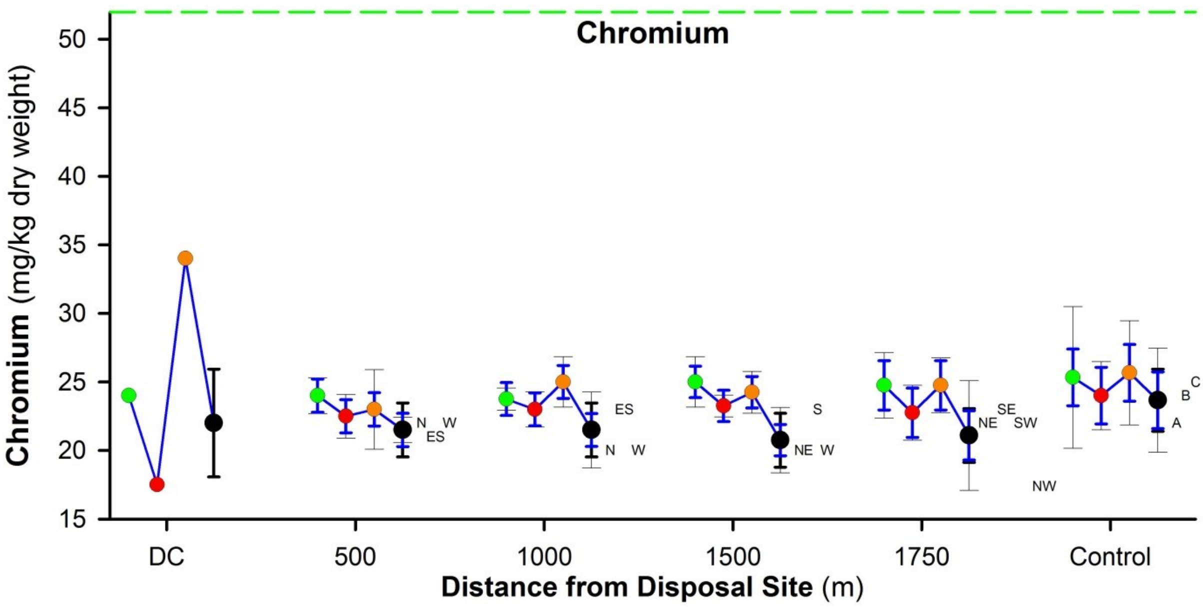

Figure 2.7 Comparison of Total Recoverable Chromium with Distance from Disposal Centre Site (DC), after 150,000m³ Sediment Disposal
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time**
(● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I). (- - - AC green guideline 52 mg/kg dry weight)

Copper

The concentrations of copper, following 150,000m³ of spoil disposal, were below the lowest guideline value, the AC green trigger of 19 mg/kg dry weight at all site except the disposal centre site, as shown in Figure 2.8. The concentration of copper at the disposal centre site was statistically significantly higher than at the other sites within and around the disposal area (Appendix 6). With the exception of the disposal centre site the concentration of copper at sites within and around the disposal area, were not statistically significantly different from the concentration of copper at the Control sites.

The statistical tests (Appendix 6) indicate that the concentration of copper varies statistically significantly over time and between sites but the changes over time are different at different sites. Concentrations of copper have varied statistically significantly at the disposal centre site over time (Figure 2.8, Appendix 6). These changes are reflective of the changes in the quality characteristics of the source sediment being disposed.

During each monitoring event the concentration of copper has generally decreased with distance from the disposal centre site. The differences between the average concentrations at each sampling distance within each volume sampling event are very small and not statistically significant. There is no consistent trend for increasing or decreasing concentration of copper over time at across all sites. Beyond the disposal centre site the differences in the concentration of copper between sample events and sample sites are very small and most likely within the natural background variation in the concentration of copper from the area. Hence the concentration of copper does not provide significant evidence of the spread of disposal material from the disposal centre site.

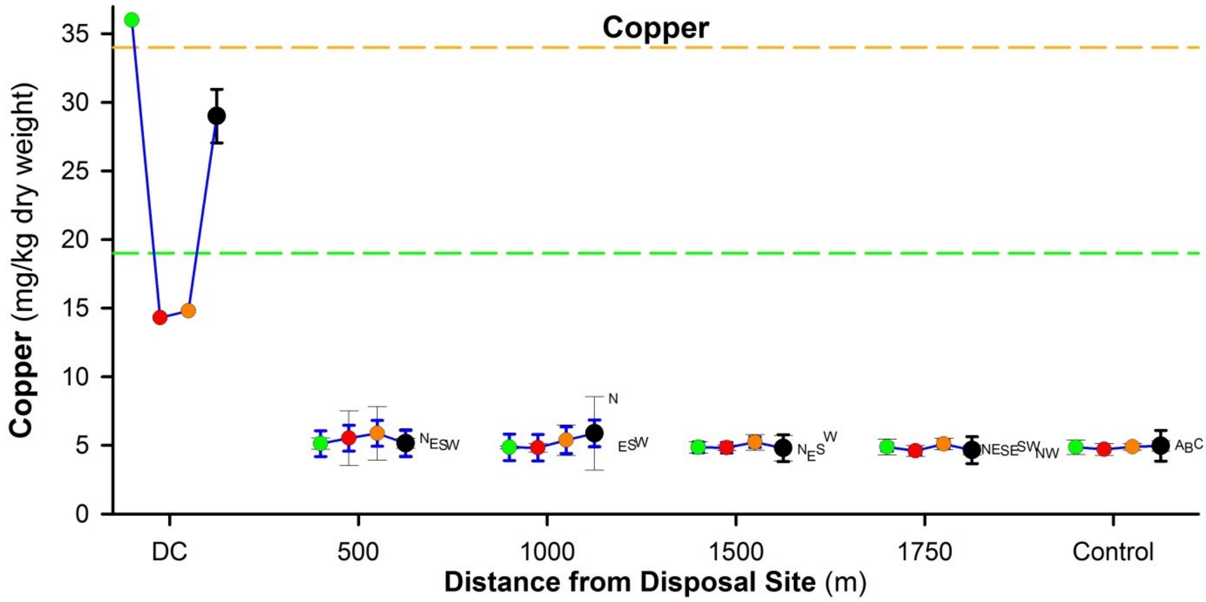

Figure 2.8 **Comparison of Total Recoverable Copper with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal** (N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time** (● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I). (- - - AC green guideline 19 mg/kg dry weight, - - - AC red guideline 34 mg/kg dry weight)

Lead

Concentrations of lead, following 150,000m^3 of spoil disposal, at all sites were below the lowest guideline value, the AC Green trigger value of 30 mg/kg dry weight. The concentration of lead at the disposal centre site was statistically significantly higher than the average concentrations at the other sites within and around the disposal area.

The statistical tests (Appendix 6) indicate that the concentration of lead varies statistically significantly over time and between sites but the changes over time are different at different sites. Concentrations of lead have varied statistically significantly at the disposal centre site over time (Figure 2.9, Appendix 6). These changes are reflective of the changes in the quality and characteristics of the source sediment being disposed.

The average concentration of lead has decreased over time between the 10,000m^3 and 150,000m^3 samples from the 500m, 1000m, 1500m, 1750m and Control sites. The decreases were only statistically significant at the 1750m sites. The decreases over time at the distant sites do not indicate the spread of disposal material as this would have resulted in increases over time. Therefore the changes recorded are considered to be natural variation.

There is no indication of lead rich sediment spreading from the disposal centre site.

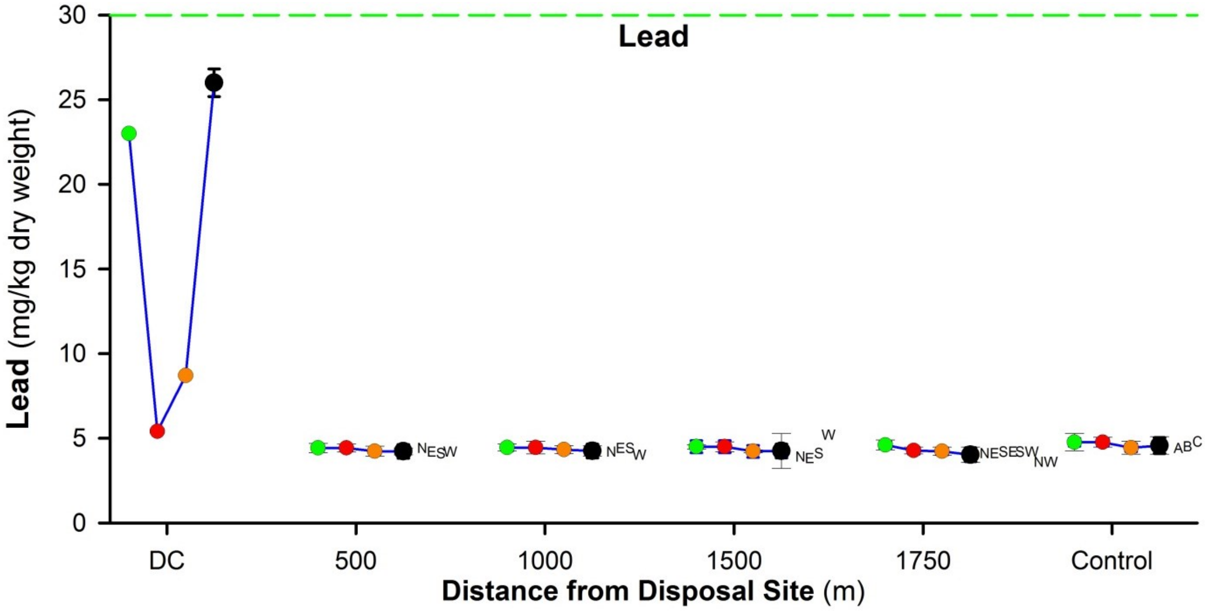

Figure 2.9 Comparison of Total Recoverable Lead with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time** (● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I). (- - - AC green guideline 30 mg/kg dry weight)

Mercury

The concentrations of mercury within the disposal area following 150,000m^3 of spoil disposal were all below the lowest guideline value, the ANZECC ISQG-Low guideline of 0.15 mg/kg dry weight, as shown in Figure 2.10. The concentration of mercury from the disposal centre site was statistically significantly higher than the other sites within and around the disposal area. With the exception of the disposal centre site the other sites within and around the disposal area were not statistically significantly different from the Control sites. There is no indication of mercury rich sediment spreading from the disposal centre site following the disposal of 150,000m^3 of spoil.

The statistical tests (Appendix 6) indicate that the concentration of mercury varies statistically significantly over time and between sites but the changes over time are different at different sites. Concentrations of mercury have varied statistically significantly at the disposal centre site over time (Figure 2.10, Appendix 6). These changes are reflective of the changes in quality and sources of the sediment being disposed. The average concentration of mercury has generally remained similar with minor fluctuations between the 10,000m^3 and 150,000m^3 samples at the 500m, 1000m, 1500m, 1750m sites. A statistically significant fluctuation in the concentration of mercury was record at the Control site during the 100,000m^3 survey, but there has not been any statistically significant change over time (Figure 2.10, Appendix 6).

The fluctuations in the concentration of mercury from in and around the disposal area were very small and likely within the natural variation in concentration from the area as indicated by the changes in the Control site. There is no indication of mercury rich sediment spreading from the disposal centre site.

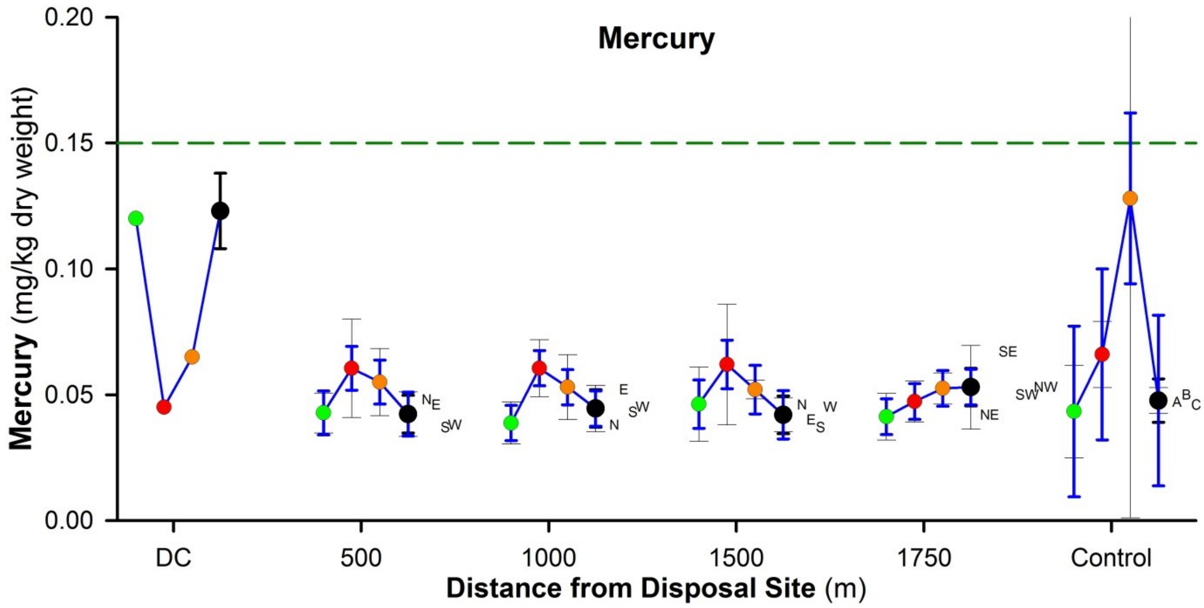

Figure 2.10 Comparison of Total Recoverable Mercury with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time** (● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I). (- - - ISQG-Low guideline 0.15 mg/kg dry weight)

Nickel

The concentrations of nickel, following 150,000m^3 of spoil disposal, at all sites were below the lowest guideline value, the ANZECC ISQG-Low guideline of 21 mg/kg dry weight as shown in Figure 2.11. The concentration of nickel from the disposal centre site was statistically significantly lower than the other sites within and around the disposal area. With the exception of the disposal centre site the average concentrations of nickel at other sites within and around the disposal area were not statistically significantly different from the concentrations of nickel at the Control sites. There is no indication of nickel rich sediment spreading from the disposal centre site.

The statistical tests (Appendix 6) indicate that the concentration of mercury varies statistically significantly over time and between sites but the changes over time are different at different sites. Concentrations of nickel have varied statistically significantly at the disposal centre site with an overall decrease over time (Figure 2.11, Appendix 6). These changes are reflective of the changes in quality and sources of the sediment being disposed.

The average concentration of nickel has fluctuated and ultimately increased similarly over time between the 10,000m^3 and 150,000m^3 samples at the 500m, 1000m, 1500m, 1750m and the Control sites. The increases at the 500m, 1000m, 1500m and the Control sites were statistically significant, although the very small changes in concentrations of nickel recorded are all within the likely natural background variation in the concentration of nickel as indicated by the changes at the Control site.

With the disposal centre site nickel concentrations, decreasing to bellow the Control site concentration, there is little likelihood that the increases, if real, in the nickel concentration from the disposal area sites are the result of the spread of disposal material.

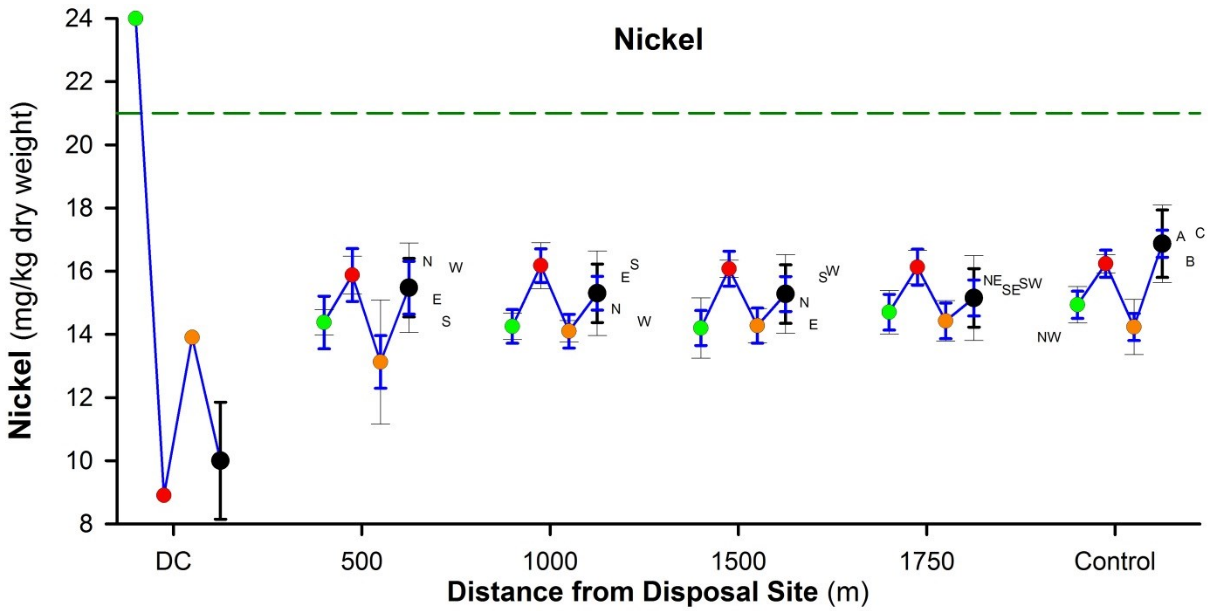

Figure 2.11 Comparison of Total Recoverable Nickel with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time** (● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I). (- - - ISQG-Low guideline 21 mg/kg dry weight)

Zinc

Concentrations of zinc, following 150,000m^3 of spoil disposal, at all sites were below the lowest guideline value, the AC Green trigger value of 124 mg/kg dry weight. The concentration of zinc at the disposal centre site was statistically significantly higher than the average concentrations recorded in the more distant samples including the Control sites (Figure 2.12, Appendix 6). There was no indication of zinc rich sediment spreading from the disposal centre site.

The statistical tests (Appendix 6) indicate that the concentration of zinc varies statistically significantly over time and between sites but the changes over time are different at different sites. Concentrations of zinc have varied statistically significantly at the disposal centre site over time (Figure 2.12, Appendix 6). These changes are reflective of the changes in the quality of the source sediment being disposed. The average concentration of zinc showed very small, but in some cases statistically significant fluctuations in concentration between the 10,000m^3, 50,000m^3, 100,000m^3 and 150,000m^3 samples at the 500m, 1000m, 1500m, 1750m and Control sites (Figure 2.12, Appendix 6). However the overall changes over time have not been statistically significant.

The very small changes are likely within the natural variation in concentration of zinc from the area and do not show any indication of spread of disposal material from the disposal centre site.

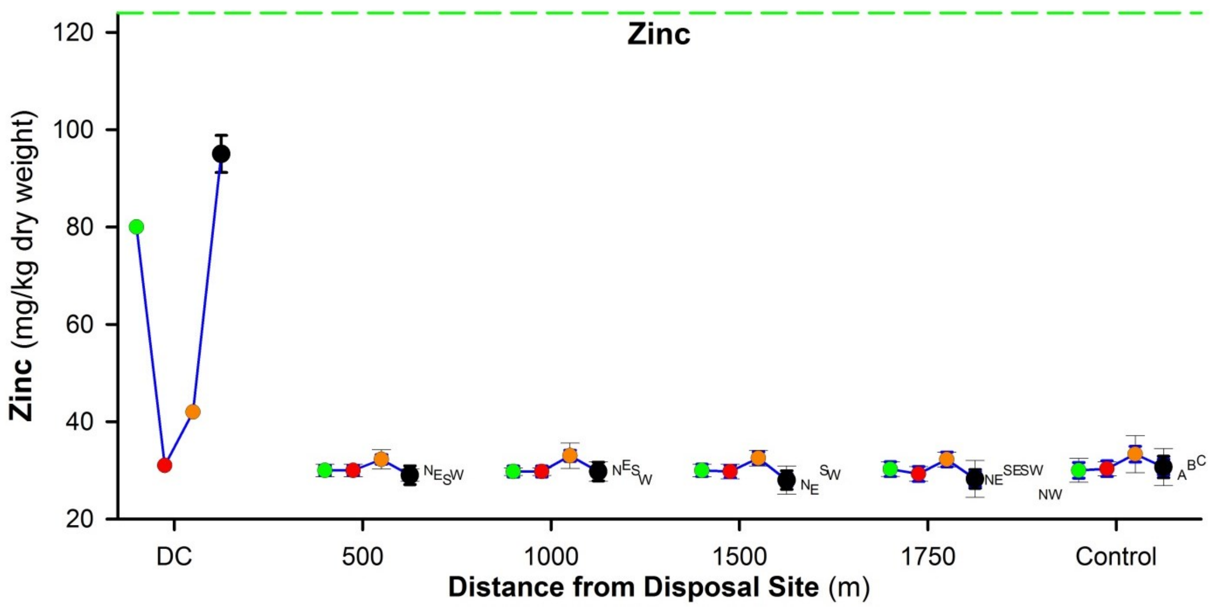

Figure 2.12 Comparison of Total Recoverable Zinc with Distance from Disposal Centre Site (DC), after 150,000m^3 Sediment Disposal.
(N, E, S, W = individual sites) (± 95% CI I and ± $HSI_{0.05}$ I) **and Over Time** (● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ I).

2.4.3.4 Total Petroleum Hydrocarbons

Proposed ISQG values for total petroleum hydrocarbons were presented in Simpson, *et al.* (2013).

All results were less than the detection limits, i.e. no Total Petroleum Hydrocarbons were detected in any of the samples. Therefore all concentrations of TPH, following 150,000m^3 of spoil disposal, at all sites were below the proposed ISQG low trigger value of 280 mg/kg dry weight. Nor is there any evidence of TPH rich sediment being deposited or spreading from the disposal centre site.

3 BENTHIC BIOTA

3.1 Methods

The MNZ Permit 568 and EPA consent EEZ900012 require monitoring of benthic biota at the Control site, the disposal centre site, and a minimum of four sampling sites equally spaced on the boundary of the Disposal Area.

Additional sample sites may be required if contaminants analysed in the sediments at the other sites are;

i. above ANZECC ISQG-Low levels or
ii. shown to be moving from the site, (i.e. if the difference in sediment chemistry between any one sampling site and the Control site is more than 50% of the difference between the Control and disposal area centre samples).

None of the additional sites (500N, 500E, 500S, 500W, 1000N, 1000E, 1000S, 1000W, 1750NE, 1750SE, 1750SW and 1750NW) sampled for sediment chemistry (Figure 2.1) showed significant contamination above the ANZECC ISQG-Low guidelines for the metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc) or TPH (Table 2.3).

The average concentration at the Control sites and the concentration at the disposal centre site are present in the Table 3.1 together with the 50% change trigger value and the differences in concentration between the test sites and the Control site.

The percentage dry matter and concentrations of cadmium, chromium and nickel were lower at the disposal centre site than the average concentration at the Control sites, thus higher concentrations of these parameters at the disposal area sites than the Control site are not the result of material moving from the disposal centre site, these are highlight in Table 3.1 as .

If the metal concentration of the disposal area site is less than at the Control site (a negative change) the change is not expected to result in adverse effects, these are highlighted in Table 3.1 as . While some of these negative changes may exceed the 50% change trigger they will not result in adverse effects to the biota as sediment quality is improved, i.e. lower in contaminants and below the guideline values.

Negative changes in the percentage dry matter indicate the sediment is less dense than at the Control site, none of the disposal area sites exceeded the 50% trigger levels. None of the disposal area sites with concentrations of copper, lead, mercury, nickel or zinc greater than at the Control sites, had concentrations that exceeded the 50% trigger levels.

Concentrations of percentage dry matter, cadmium, chromium exceeded the 50% change trigger values at some of the disposal area sites as indicated in Table 3.1 by red text. However these changes are either not related to disposal material and or beneficial to the environment, thus additional benthic biota sampling was not assessed as necessary.

All the results of the total petroleum hydrocarbons were less than detection, so no comparison could be made to define if the concentrations at the additional sites exceeded the average concentrations recorded at the Control sites by more than 50% of the difference between the disposal centre site and the average at the Control sites.

Table 3.1 Differences in Surficial Sediment Quality between the Control site and disposal area sites, Post 150,000m³ Disposal (Dry Weight)

Tests	Sites		50% change trigger	Sites															
	Control Average	DC		500m				1000m				1500m				1750m			
				N	E	S	W	N	E	S	W	N	E	S	W	NE	SE	SW	NW
Dry Matter	49.3	34.0	-7.7	-1.33	-0.33	0.67	10.67	0.67	-0.33	-0.33	2.67	-1.33	1.67	-0.33	2.67	-1.33	0.67	-1.33	-1.33
Total Sediment, Total Recoverable Metals																			
Arsenic	5.0	9.5	2.2	-1.0	-1.43	-1.13	-1.03	-0.03	-0.03	-0.93	-1.43	-1.03	-1.03	-0.03	-2.03	-1.03	-0.03	-1.03	-2.03
Cadmium	0.107	0.081	-0.013	0.06	0.05	0.01	-0.01	0.00	0.02	0.02	-0.01	0.01	-0.02	0.00	0.02	0.02	0.01	0.01	0.00
Chromium	23.7	22.0	-0.8	-1.67	-2.67	-2.67	-1.67	-3.67	-0.67	-0.67	-3.67	-3.67	-3.67	-0.67	-3.67	-1.67	-0.67	-1.67	-6.27
Copper	5.0	29.0	12.0	0.53	0.13	0.03	0.03	3.43	-0.07	0.03	0.23	-0.27	-0.77	-0.27	0.63	-0.27	-0.37	-0.07	-0.57
Lead	4.6	26.0	10.7	-0.17	-0.37	-0.47	-0.37	-0.37	-0.17	-0.17	-0.57	-0.67	-0.77	-0.47	0.63	-0.47	-0.37	-0.37	-0.97
Mercury	0.048	0.123	0.038	0.000	-0.002	-0.011	-0.010	-0.010	0.004	-0.005	-0.003	-0.002	-0.008	-0.011	-0.003	-0.006	0.019	0.002	0.005
Nickel	16.9	10.0	-3.4	-0.57	-1.77	-2.47	-0.77	-2.07	-1.07	-0.67	-2.47	-1.87	-2.57	-1.07	-0.87	-1.17	-1.47	-1.27	-2.97
Zinc	30.7	95.0	32.2	-0.67	-1.67	-2.67	-1.67	-0.67	0.33	-0.67	-2.67	-3.67	-4.67	-0.67	-1.67	-2.67	-0.67	-0.67	-5.67

As per the consent only the five sample sites (DC, 1500N, 1500E, 1500S, 1500W) within and around the disposal area, and the Control site, as shown in Figure 3.1, were required to be sampled, but additional samples were collected the 500N, 500E, 500S and 500W sites.

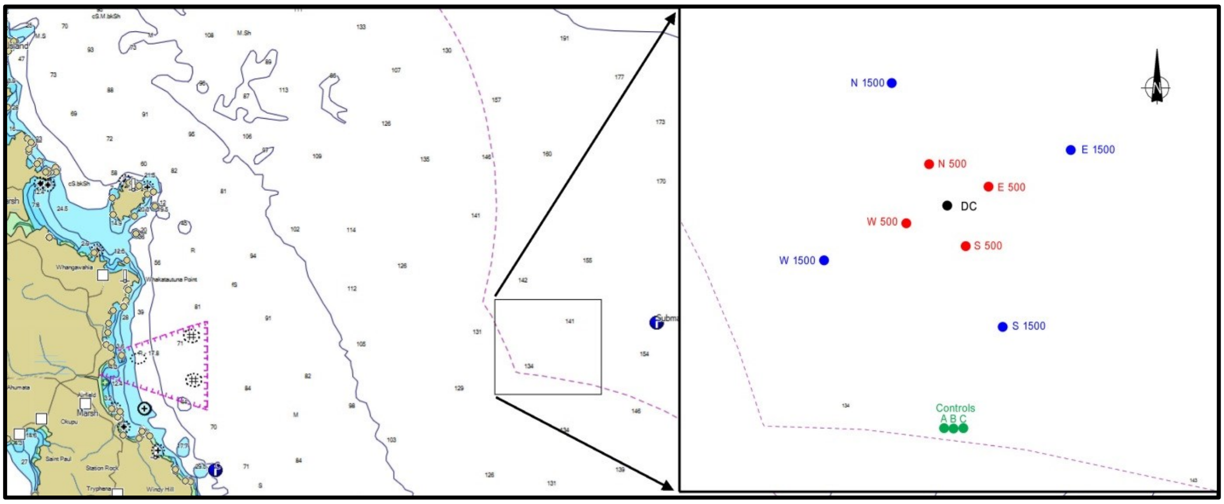

Figure 3.1 Seabed Benthic Biota Sampling Sites

Three replicate samples of two, 100mm diameter gravity core samples were collected from each site. The two cores were combined, labelled and then sieved as soon as practicable by washing each whole sample through 0.5mm mesh sieves with seawater. All samples were sieved within six hours of collection. The material retained on the sieves was transferred to a polyethylene ‘zip lock’-type bag, and preserved with a 10% glyoxal, 70% ethanol sea water solution, sealed, placed in a second polyethylene ‘zip lock’-type bag and packed into a labelled plastic container, for transportation to the laboratory.

Prior to sorting, the samples were rinsed with freshwater and placed in a white sorting tray. All organisms were picked out of the samples and placed in a labelled vial of 70% isopropyl alcohol solution prior to taxonomic identification and counting.

3.2 Results

Benthic biota results are summarised by calculation of numbers of taxa, numbers of individual organisms, and Shannon-Wiener diversity index for each replicate at each sampling station. The full results of the benthic biota sampling are presented in Appendix 7 and summarised in Table 3.2 along with previous results. It was not possible to distinguish between living and recently dead Foraminifera despite the use of Rose Bengal stain. Therefore only intact and uneroded animals were counted.

The summary statistics are compared graphically over time within sites and between sites following disposal of 150,000m^3 of spoil, in Figure 3.2, Figure 3.3 and Figure 3.4.

Shannon-Wiener Diversity Index measures the rarity and commonness of species in a community and is calculated using the following formula.

$$H = - \Sigma (p_i \ln p_i)$$

Here p_i is the proportion of total number of species made up of the i^{th} species.

Table 3.2 Total Numbers of Species and Animals - Summary Data

Station	Total Number of Species									
	Average per sample					Per site				
	Pre	10k	50k	100k	150k	Pre	10k	50k	100k	150k
	Jun 10	Aug 13	Apr 15	Aug 15	Nov 16	Jun 10	Aug 13	Apr 15	Aug 15	Nov 16
DC	**9.00**	**7.33**	**3.67**	**19.00**	**0.67**	**12**	**17**	**11**	**36**	**2**
500 N					19.00					37
500 E					14.00					27
500 S					16.33					31
500 W					10.33					18
Average					**14.92**					**28.3**
95% CL					5.85					12.7
1500 N	8.50	27.00	23.33	21.00	18.00	11	42	41	37	37
1500 E	9.50	15.67	21.00	15.67	19.00	15	34	40	28	37
1500 S	7.50	18.00	24.00	13.67	18.33	12	37	42	25	31
1500 W	11.00	13.33	18.00	16.70	15.33	16	27	34	29	27
Average	**9.13**	**18.50**	**21.58**	**16.76**	**17.67**	**13.5**	**35.0**	**39.3**	**29.8**	**33.0**
95% CL	2.38	9.51	4.32	4.93	2.56	3.8	10.0	5.7	8.2	7.8
Control	**6.56**	**18.33**	**22.67**	**19.67**	**19.33**	**22**	**35**	**37**	**38**	**35**

Station	Total Number of Animals									
	Average per sample					Per square metre				
	Pre	10k	50k	100k	150k	Pre	10k	50k	100k	150k
	Jun 10	Aug 13	Apr 15	Aug 15	Nov 16	Jun 10	Aug 13	Apr 15	Aug 15	Nov 16
DC	**58.5**	**14.7**	**70.3**	**297.0**	**0.7**	**15201**	**953**	**4478**	**18908**	**42**
500 N					120.0					7639
500 E					150.7					9592
500 S					161.7					10292
500 W					106.3					6769
Average					**134.7**					**8573.1**
95% CL					41.1					2617.5
1500 N	65.5	101.3	876.0	450.3	106.7	17020	6583	55768	28669	6791
1500 E	62.5	35.0	610.0	586.3	195.7	16240	2274	38834	37327	12457
1500 S	25.5	40.3	365.0	246.0	187.3	6626	2620	23237	15661	11926
1500 W	55.5	30.7	332.7	302.0	131.7	14421	1992	21178	19226	8382
Average	**52.3**	**51.8**	**545.9**	**396.2**	**155.3**	**13576.9**	**3367.2**	**34754.1**	**25220.8**	**9888.8**
95% CL	29.1	52.9	401.8	244.0	68.6	7574.3	3435.5	25578.3	15530.7	4368.6
Control	**12.7**	**40.7**	**347.3**	**353.0**	**159.0**	**3291**	**2642**	**22112**	**22473**	**10122**

Station	Shannon Wiener Diversity Index				
	Pre	10k	50k	100k	150k
	Jun 10	Aug 13	Apr 15	Aug 15	Nov 16
DC	**1.447**	**1.627**	**1.002**	**1.458**	**0.693**
500 N					1.501
500 E					1.066
500 S					1.208
500 W					1.375
Average					**1.288**
95% CL					0.303
1500 N	1.324	2.457	1.496	1.592	1.722
1500 E	1.252	2.293	1.105	1.203	1.594
1500 S	1.663	2.534	1.413	1.162	1.361
1500 W	1.650	2.074	1.308	1.461	1.383
Average	**1.472**	**2.339**	**1.330**	**1.354**	**1.515**
95% CL	0.341	0.324	0.269	0.328	0.276
Control	**1.644**	**2.432**	**1.401**	**1.357**	**1.791**

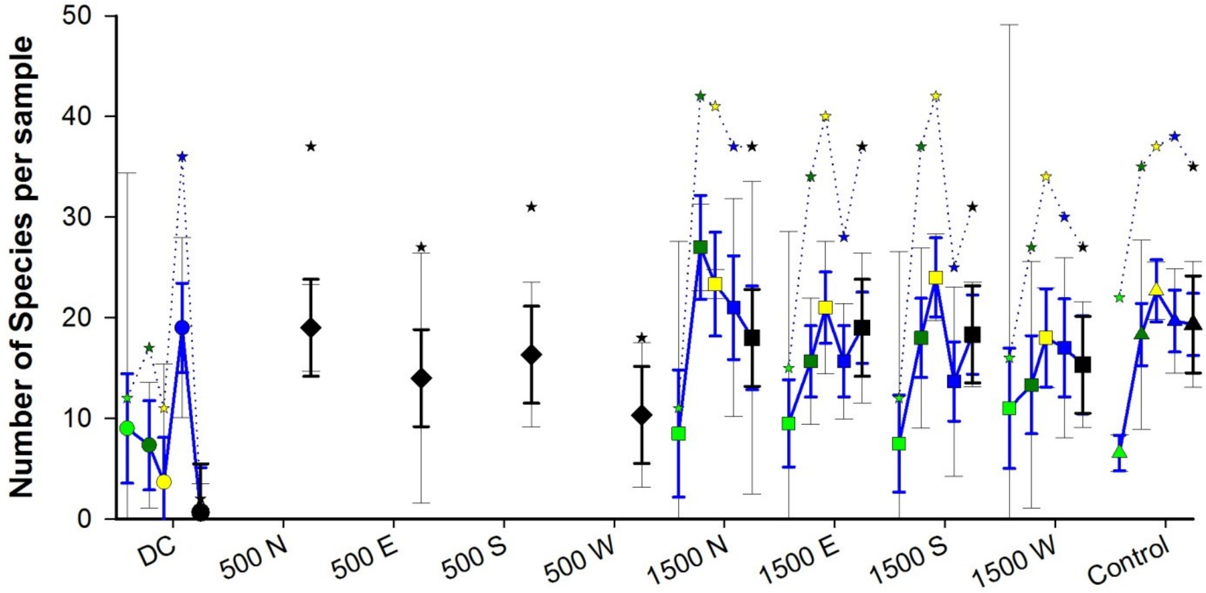

Figure 3.2 **Comparison of average Number of Species per sample after 150,000m³ Sediment Disposal** (± 95% CI and ± HSI$_{0.05}$) **and Over Time** (● pre, ● 10k, ● 50k, ● 100k, ● 150k, ± HSI$_{0.05}$), **total species per site** (★).

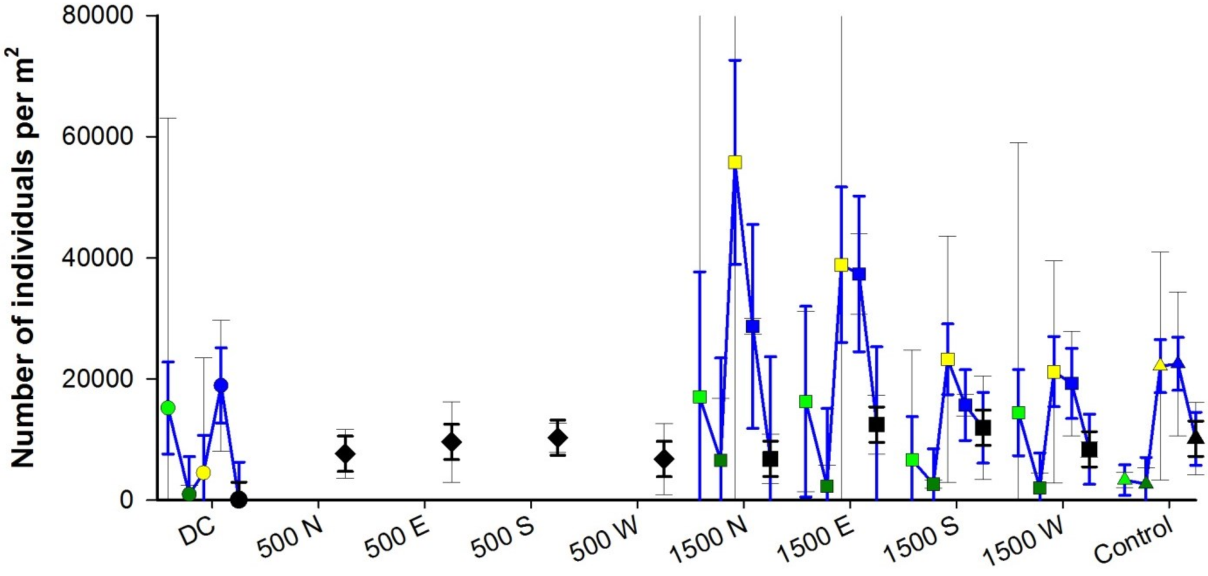

Figure 3.3 **Comparison of average Number of Individuals per m² after 150,000m³ Sediment Disposal** (± 95% CI and ± HSI$_{0.05}$) **and Over Time** (● pre, ● 10k, ● 50k, ● 100k, ● 150k, ± HSI$_{0.05}$).

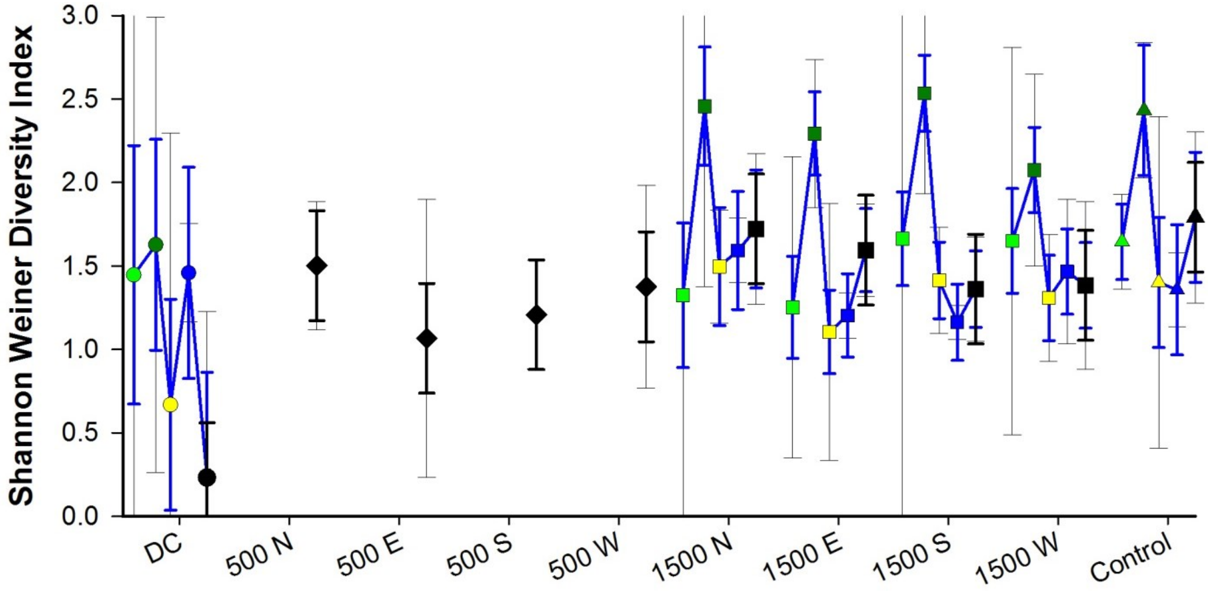

Figure 3.4 Comparison of average Shannon Weiner Diversity Index per sample after 150,000m³ Sediment Disposal (± 95% CI ⌶ and ± $HSI_{0.05}$ ⌶) **and Over Time** (● pre, ● 10k, ● 50k, ● 100k, ● 150k, ± $HSI_{0.05}$ ⌶).

3.3 Discussion

Site DC, had a very low diversity (0.7 species per replicate, 2 species in total) and a very low abundance (42 per m^2). This is lower than previously recorded from the disposal centre site however not unexpected as a result of the disposal of dredge spoil at the site. Only two individuals were found a mysid shrimp (21 per m^2) and a foraminifera *Pyrgo* sp. (21 per m^2).

Site 500 N, had a moderate to high diversity (19.0 species per replicate, 37 species in total) and a moderate to high abundance (7,639 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (5,029 per m^2). Of the other species present in much lower numbers the foraminifera, *Alabamina* sp. (531 per m^2), *Cibicidoides* sp. (488 per m^2), *Pyrgo* sp. (318 per m^2) and *Quinqueloculina suborbicularis* (149 per m^2) had significant contributions. Species from other taxonomic groups such as polychaete worms, nemerteans, molluscs, amphipods, isopods cumaceans, ostracods, tanaids and ophiuroid starfish were present but at very low numbers.

Site 500 E, had a moderate to high diversity (14.0 species per replicate, 27 species in total) and a moderate to high abundance (9,592 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (7,279 per m^2). Of the other species present in much lower numbers the foraminifera, *Alabamina* sp. (467 per m^2), *Cibicidoides* sp. (233 per m^2), *Pyrgo* sp. (552 per m^2) and *Quinqueloculina suborbicularis* (255 per m^2) had significant contributions. Species from other taxonomic groups such as polychaete worms, molluscs, amphipods, isopods and tanaids were present but at very low numbers.

Site 500 S, had a moderate to high diversity (16.3 species per replicate, 31 species in total) and a high abundance (10,292 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (7,257 per m^2). Of the other species present in much lower numbers the foraminifera, *Alabamina* sp. (1,082 per m^2), *Cibicidoides* sp. (594 per m^2), *Pyrgo* sp. (318 per m^2) and *Quinqueloculina suborbicularis* (127 per m^2) had significant contributions. Species from other taxonomic groups such as polychaete worms, sipunculid worms, amphipods, isopods, cumaceans, tanaids and ophiuroid starfish were present but at very low numbers.

Site 500 W, had a moderate diversity (10.3 species per replicate, 18 species in total) and a moderate abundance (6,769 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (4,032 per m^2). Of the other species present in much lower numbers the foraminifera, *Alabamina* sp. (891 per m^2), *Cibicidoides* sp. (785 per m^2), *Pyrgo* sp. (446 per m^2) and *Quinqueloculina suborbicularis* (127 per m^2) and the polychaete worm, *Lumbrinereis* sp. (127 per m^2) had significant contributions. Species from other taxonomic groups such as polychaete worms, isopods, cumaceans, mysids, ostracods and ophiuroid starfish were present but at very low numbers.

Site 1500 N, had a moderate to high diversity (18.0 species per replicate, 37 species in total) and a moderate abundance (6,791 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (3,629 per m^2), with significant contributions from *Cibicidoides* sp. (743 per m^2), *Alabamina* sp. (806 per m^2), *Pyrgo* sp. (361 per m^2) and *Quinqueloculina suborbicularis* (106 per m^2). Species from other taxonomic groups such as polychaete worms, sipunculid worms, amphipods, isopods, cumaceans, mysids, ostracods, ophiuroid starfish and a sponge were present but at very low numbers.

Site 1500 E, had a moderate to high diversity (19.0 species per replicate, 37 species in total) and a high abundance (12,457 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (6,133 per m^2), with significant contributions from *Cibicidoides* sp. (2,525 per m^2), *Alabamina* sp. (1,804 per m^2), *Pyrgo* sp. (615 per m^2) and *Quinqueloculina suborbicularis* (255 per m^2). Species from other taxonomic groups such as polychaete worms, amphipods, isopods, cumaceans, ophiuroid starfish and a sponge were present but at very low numbers.

Site 1500 S, had a moderate to high diversity (18.3 species per replicate, 31 species in total) and a high abundance (11,926 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (7,979 per m^2), with significant contributions from *Cibicidoides* sp. (997 per m^2), *Alabamina* sp. (700 per m^2), *Pyrgo* sp. (700 per m^2), *Quinqueloculina suborbicularis* (255 per m^2) and *Nummoloculina contraria* (191 per m^2). Species from other taxonomic groups such as polychaete worms, amphipods, ostracods and ophiuroid starfish were present but at very low numbers.

Site 1500 W, had a moderate diversity (15.3 species per replicate, 27 species in total) and a moderate abundance (8,382 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (5,411 per m^2), with significant contributions from *Cibicidoides* sp. (912 per m^2), *Alabamina* sp. (488 per m^2), *Pyrgo* sp. (531 per m^2), *Quinqueloculina suborbicularis* (233 per m^2), *Nummoloculina contraria* (127 per m^2) and *Triloculina insignis* (106 per m^2). Species from other taxonomic groups such as polychaete worms, amphipods, isopods, mysids, ostracods and a sponge were present but at very low numbers.

The Control site had a moderate diversity (19.3 species per replicate, 35 species in total) and a high abundance (10,122 per m^2). The biota was numerically dominated by the foraminifera, *Lenticulina* sp. (4,944 per m^2), with significant contributions from *Alabamina* sp.

(1,146 per m^2), *Pyrgo* sp. (1,316 per m^2), *Cibicidoides* sp. (594 per m^2), *Quinqueloculina suborbicularis* (615 per m^2), *Nummoloculina contraria* (127 per m^2) and *Triloculina insignis* (255 per m^2). Species from other taxonomic groups such as polychaete worms, sipunculid worms, molluscs, amphipods, isopods, cumaceans, mysids, ostracods, anemones, ophiuroid starfish and a sponge were present but at very low numbers.

Following the disposal of 50,000m^3 of sediment at the disposal centre site, the diversity and density of biota were predictably and statistically significantly depressed at the disposal centre site (DC) when compared to the disposal area boundary sites and the Control sites. However after the disposal of 100,000m^3 of sediment at the disposal centre site and with the relocation of the disposal centre site out to 150m east to obtain a sample, a similar pattern was not evident. Following disposal of 150,000m^3 of sediment at the disposal centre site, the diversity and density of biota at the disposal centre site were again predictably and statistically significantly depressed (Appendix 8). The 100,000m^3 sample indicates the depression of numbers of individuals and species was confined to a relatively small area.

The numbers of species and individuals increases with distance from the disposal centre site. The average numbers of species and individuals at the 500m and 1500m sites were not statistically significantly different from the Control Site, indicating little if any effect, beyond the immediate disposal centre site, as seen in the sediment chemistry data. The average diversity index increases with distance from the disposal centre site, with the disposal centre site statistically significantly lower compared with all the other sites and the average for the 500m sites statistically significantly lower than the Control site. The average diversity index for the 1500m sites was not statistically significantly different from the Control site.

There is no indication the disposal of sediment at the centre of the disposal area has adversely affected benthic biota beyond the disposal area boundary.

No exotic pest species were recorded in the post 150,000m^3 survey.

The majority of species are present at very low numbers which limits the statistical analysis, with the exception of foraminifera. When the average numbers of individuals of foraminifera are compared the numbers increase with distance from the disposal centre site. The average numbers of foraminifera are very similar between the 1500m sites and the Control site. However the most abundant species of foraminifera (*Lenticulina* sp.) is absent from the disposal centre site but decreases in abundance, by 16%, from the 500m sites to the Control site. Other than the absence of species from the disposal centre site the disposal sediment is not considered to have had an impact on any individual species recorded.

<u>Differences Over Time</u>

Due to differences in the methodologies and site locations the trial benthic biota data (University of Waikato, 2011) and the post-permitting benthic biota data are not directly comparable. The pre-disposal data have been adjusted to allow inclusion in the data set but any conclusions should be interpreted with some caution.

At the disposal centre site numbers of species, individuals and diversity index have declined statistically significantly following disposal as expected (Figure 3.2, Figure 3.3, Figure 3.4, Appendix 8).

At the Control site the numbers of species increased statistically significantly between the pre-disposal and 10,000m^3 post-disposal surveys. But the number of species post-disposal has not varied statistically significantly between consecutive surveys. This is likely the result of the different survey methods and locations between pre and post disposal. The number of individuals increased statistically significantly between the 10,000m^3 and 50,000m^3 post disposal surveys and is likely the result of the way in which the foraminifera were enumerated. The numbers between the 50,000m^3 and 100,000m^3 post disposal surveys did not change statistically significantly, however the numbers halved between the 100,000m^3 and 150,000m^3 post disposal surveys. The large increase in abundance between the 10,000m^3 and 50,000m^3 post disposal surveys resulted in a statistically significant decrease in the diversity index. There were no statistically significant differences between the 50,000m^3, 100,000m^3 and 150,000m^3 surveys.

At the 1500m sites the numbers of species increased between the pre and 10,000m^3 post surveys, again likely the result of the different survey methods and locations between pre and post disposal. The four post disposal surveys have shown little statistically significant variation within sites, at 1500N the numbers of species were statistically significantly lower in the 150,000m^3 survey compared to the 10,000m^3 survey. At 1500S the numbers of species were statistically significantly higher during the 50,000m^3 survey than the 100,000m^3 surveys, and in general followed the pattern of changes at the Control site.

At all the 1500m sites the numbers of individuals increased between the 10,000m^3 and 50,000m^3 surveys and like the Control site this is likely due to the way in which the foraminifera were enumerated. The numbers of individuals decreased statistically significantly between the 50,000m^3 and 100,000m^3 surveys at the 1500N site. This was the result of a 50% reduction in the numbers of the six most abundant foraminifera species (*Lenticulina* sp., *Elphidium* sp., *Cibicidoides* sp., *Alabamina* sp., *Pyrgo* sp. and *Quinqueloculina suborbicularis*). The cause of the reduction is unknown but there is no evidence it is related to sediment quality effects of disposed sediments. The numbers of individuals decreased at all 1500m sites between the 100,000m^3 and 150,000m^3 surveys as did the numbers at the Control site. Diversity index values vary at the 1500m sites varied in a similar way to the Control site indicating that any statistically significant differences are natural or related to minor variations in the sampling methods.

On comparison the two most recent sets of data (100,000m^3 Aug 2015 and 150,000m^3 Nov 2016) showed significantly less of all species in the 150,000m^3 samples at the disposal centre site, more polychaete worms, amphipods, ophiuroid starfish, but fewer molluscs, isopods and foraminifera, at the 1500m sites and more polychaete and sipunculid worms, mysid shrimps and sponges but fewer molluscs, amphipods, cumaceans, ostracods and foraminifera in the Control samples.

Species composition varies between the 100,000m^3 and 150,000m^3 samples with both numerically dominated by foraminifera; however a total of 35 taxa present in the 100,000m^3 samples were not found in the 150,000m^3 samples. These included 10 polychaete worm species (*Aglaophamus macroura*, *Ancistrosyllis* sp., *Armandia maculata*, *Boccardia* sp., *Glycinde trifida*, Paraonidae B, Polynoidae, Scalibregmatidae, Serpulidae and Trichobranchidae), Platyhelminthes, 6 species of gastropod (*Amalda novaezelandiae, Austrofusus glans, Microvoluta marginata, Solariella tryphenensis, Zeatrophon ambiguus,* undentified), a scaphopod, 4 amphipods (Atylidae, *Corophium* sp., Eusiridae and Phoxocephalidae E), the isopod (*Neastacilla fusiformis*), the crab (*Lyreidus tridentatus*), Cumacean B, Ostracod B, the anthozoa (*Sphenotrochus ralphae*), the echinoid (*Peronella hinemoae*), the ascidian (*Botryllus schlosseri*), a Salp and 4 species of foraminifera (unidentified Miliodida, *Astacolus* sp., *Nodosaria vertebralis*, *Planularia* sp. and unidentified flat sim otolith).

In addition 26 taxa were not recorded in the 100,000m^3 survey but were found in the 150,000m^3 survey, these included 15 species of polychaete worms (Ampharetidae, *Aonides* sp., Dorvilleidae, Flabelligeridae sp. A, Hesionidae, *Hyalinoecia* sp., *Laonice* sp., *Naineris* sp., Phyllodocidae, *Phylo* sp., Sabellidae, Sigalionidae, Spionidae, Spionidae sp B, Terebellidae), a sipunculid worm, 2 molluscs (*Uberella barrierensis, Cuspidaria willetti*), the amphipod (Haustoriidae), Mysid shrimps, the anthozoa (*Edwardsia* sp.), the holothurian (*Trochodota* sp.), and 4 species of foraminifera (*Ammodiscus* B, Cribrostomoides / Haplophragmoides, *Elphidium* sp B, *Planularia* sp.). Of these 26 taxa, 16 were recorded in the previous monitoring studies (Pre, 10,000m^3, 50,000m^3).

A total of 133 taxa groups have now been recorded, however the large majority of these species are present at very low numbers with none or only 1 or 2 individuals recorded per survey. This has resulted in apparent significant changes in species composition between surveys. There is no evidence to suggest the overall species composition changes between surveys are the result of any changes associated with the dredge spoil disposal.

Of the more abundant taxa present in both the 100,000m^3 and 150,000m^3 surveys the foraminifera at the disposal centre site showed decreased abundance as a result of the disposal of sediment. At the 1500m sites the 6 most abundant species of foraminifera showed an average 60% reduction in abundance, however a similar 49% reduction was observed at the Control site. Several less abundant species (*Nummoloculina contraria*, *Triloculina insignis*) showed increased abundance at the Control site but either were reduced at the 1500m sites or showed variable changes around the 1500m perimeter. However the reliability of these less abundant species is poor as they are based on changes of 3 or less individuals between surveys. No other individual taxa were present at sufficient density to show similar trends. However combined taxa groupings showed similar trends between the 1500m sites and the Control site.

Thus it is concluded that no effect as a result of the disposal activity has occurred at or beyond the 1500m disposal boundary following the disposal of 150,000m^3 of sediment.

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5 APPENDICES

Appendix 1 Sediment Gravity Core Photographs.

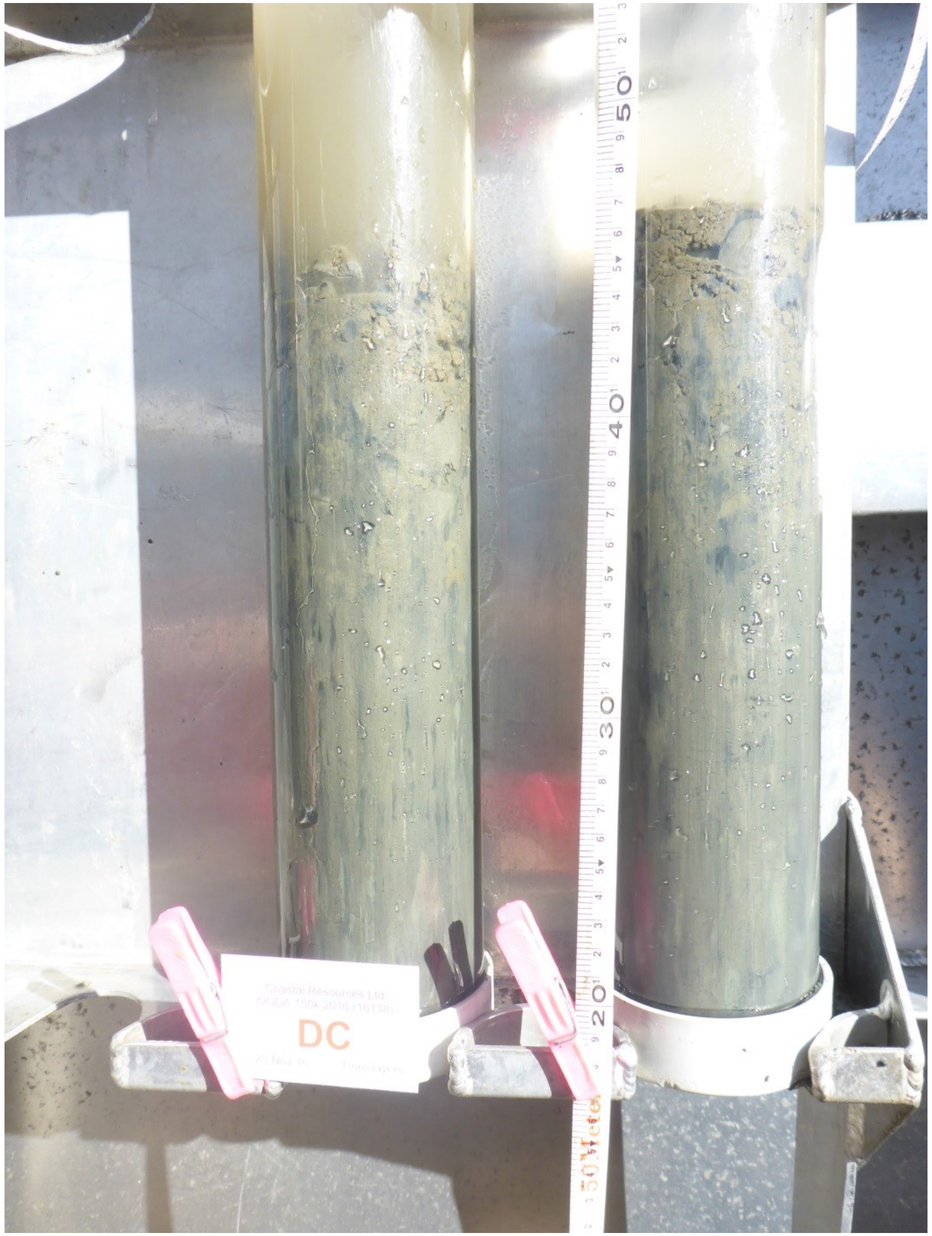


Figure 5.1 Sediment Gravity Cores – Disposal Centre Site, 23 November 2016

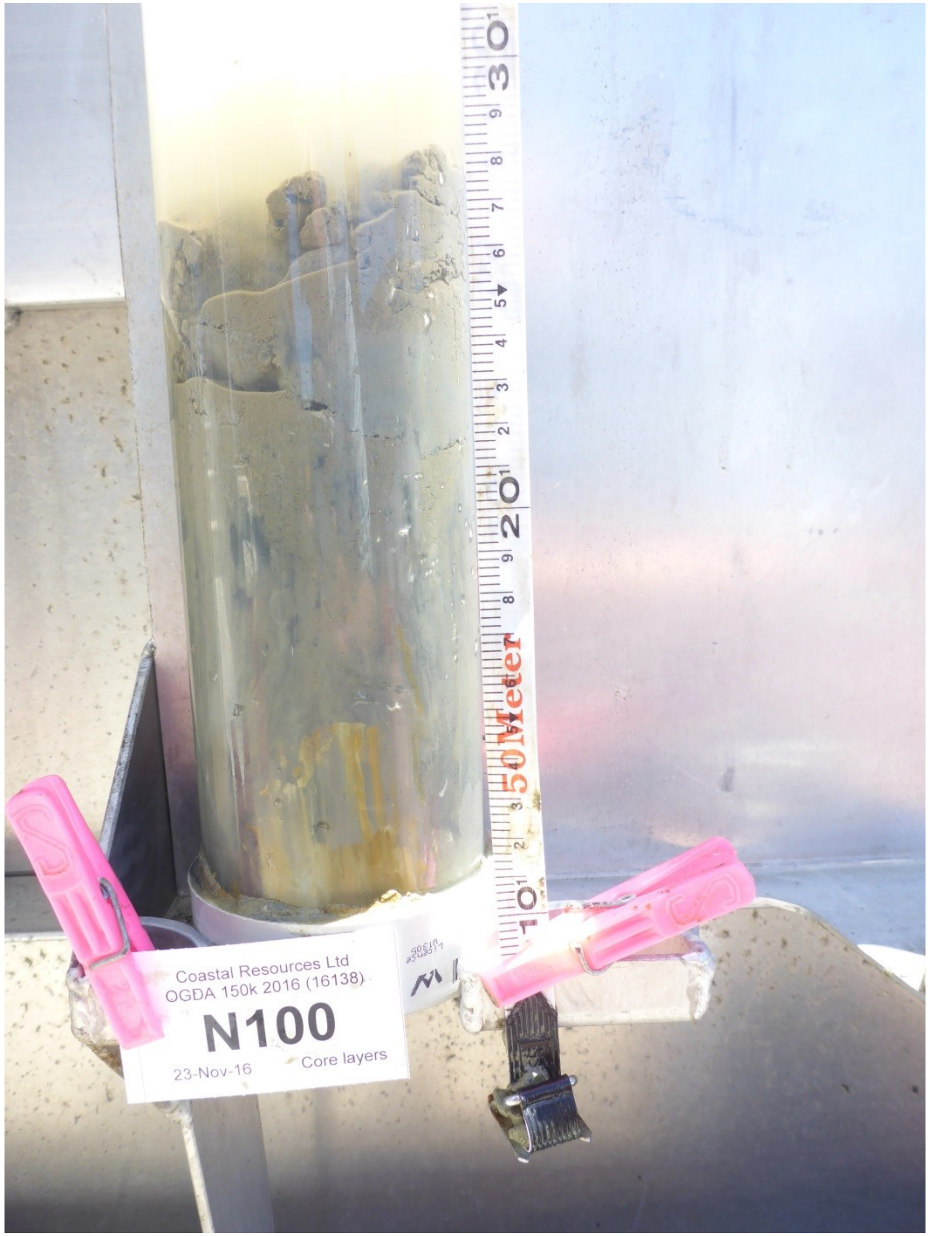


Figure 5.2 Sediment Gravity Cores – N 100, 23 November 2016

Figure 5.3 Sediment Gravity Cores – S 100, 23 November 2016

Figure 5.4 Sediment Gravity Cores – N 250, 23 November 2016

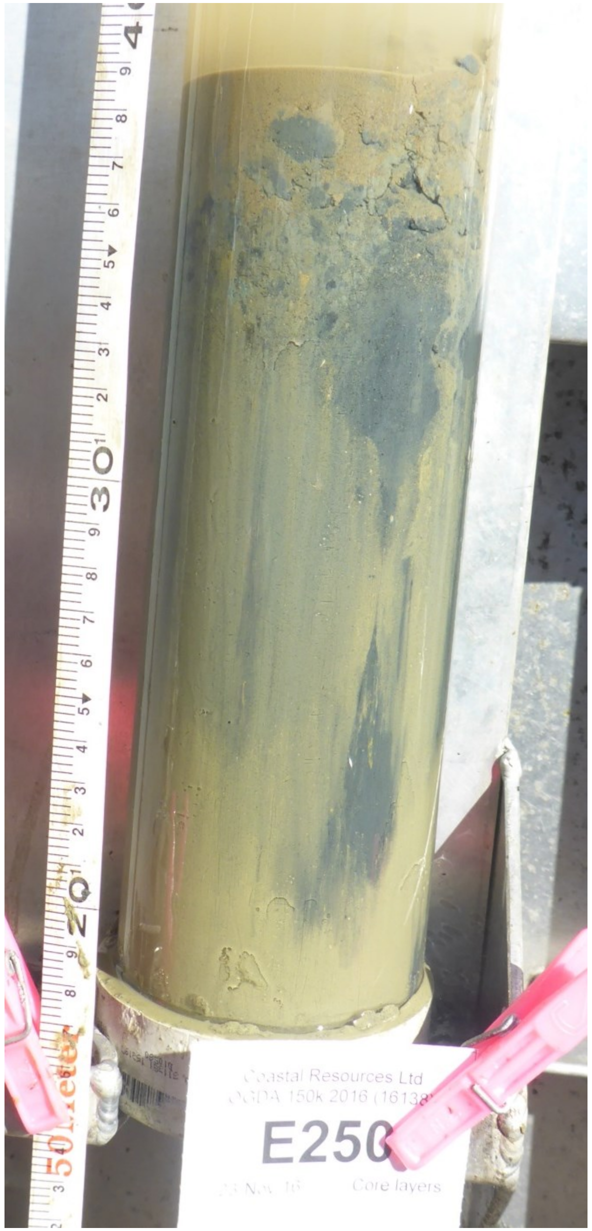


Figure 5.5 Sediment Gravity Cores – E 250, 23 November 2016

Figure 5.6 Sediment Gravity Cores – S 250, 23 November 2016

Figure 5.7 Sediment Gravity Cores – W 250, 23 November 2016

Figure 5.8 Sediment Gravity Cores – N 375, 23 November 2016

Figure 5.9 **Sediment Gravity Cores – S 375, 23 November 2016**

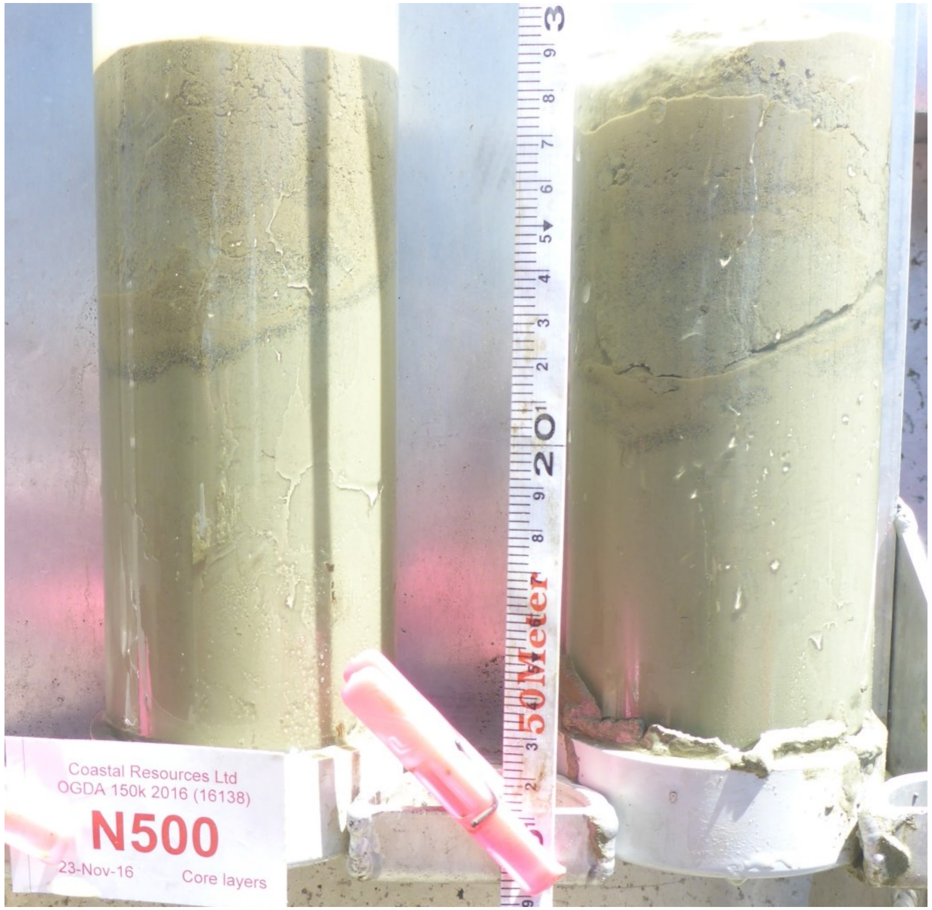


Figure 5.10 Sediment Gravity Cores – N 500, 23 November 2016

Figure 5.11 Sediment Gravity Cores – E 500, 23 November 2016

Figure 5.12 Sediment Gravity Cores – S 500, 23 November 2016

Bioresearches
A Babbage Company

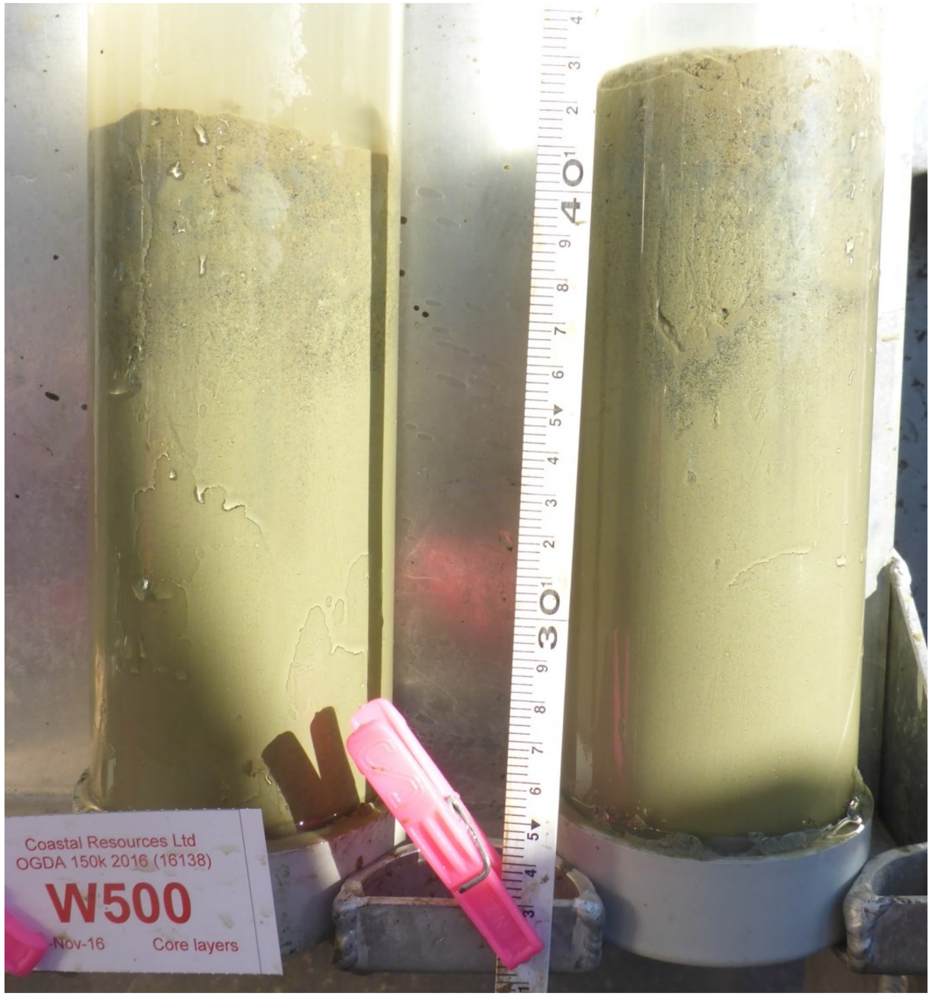


Figure 5.13 Sediment Gravity Cores – W 500, 23 November 2016

Figure 5.14 Sediment Gravity Cores – N 1000, 23 November 2016

Figure 5.15 Sediment Gravity Cores – E 1000, 23 November 2016

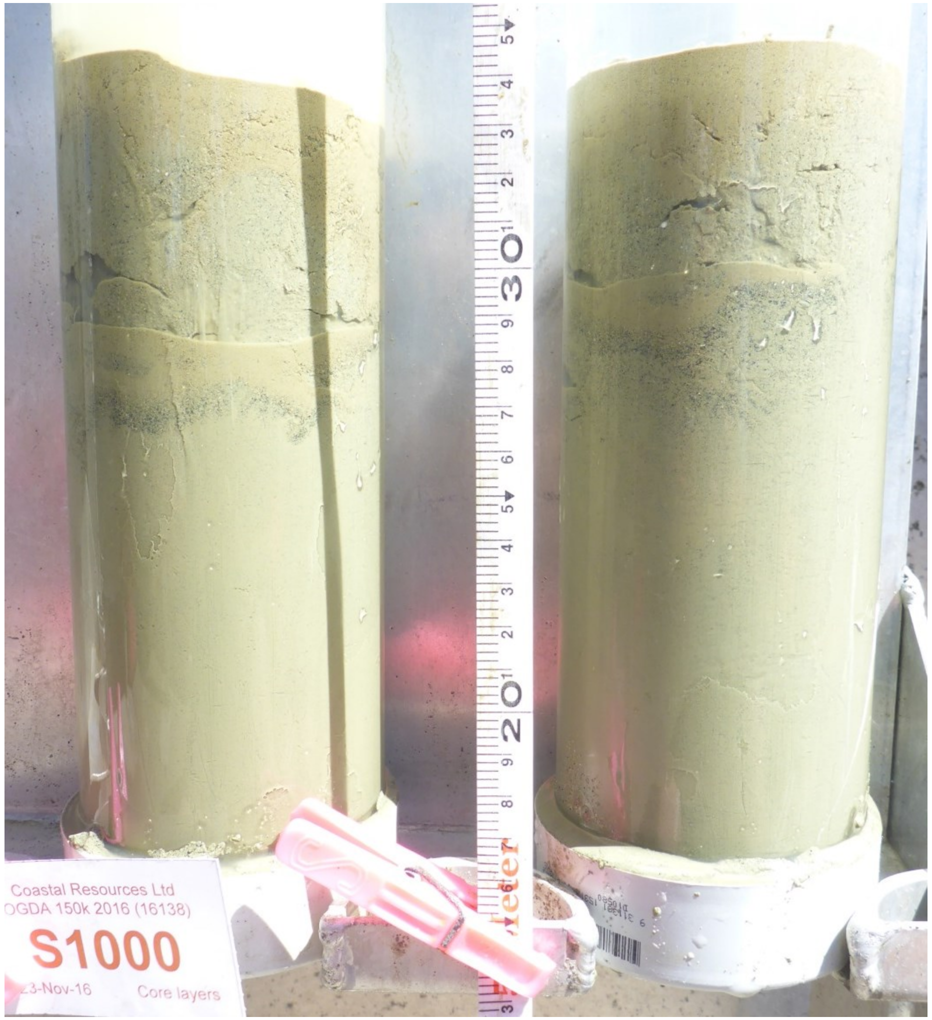


Figure 5.16 Sediment Gravity Cores – S 1000, 23 November 2016

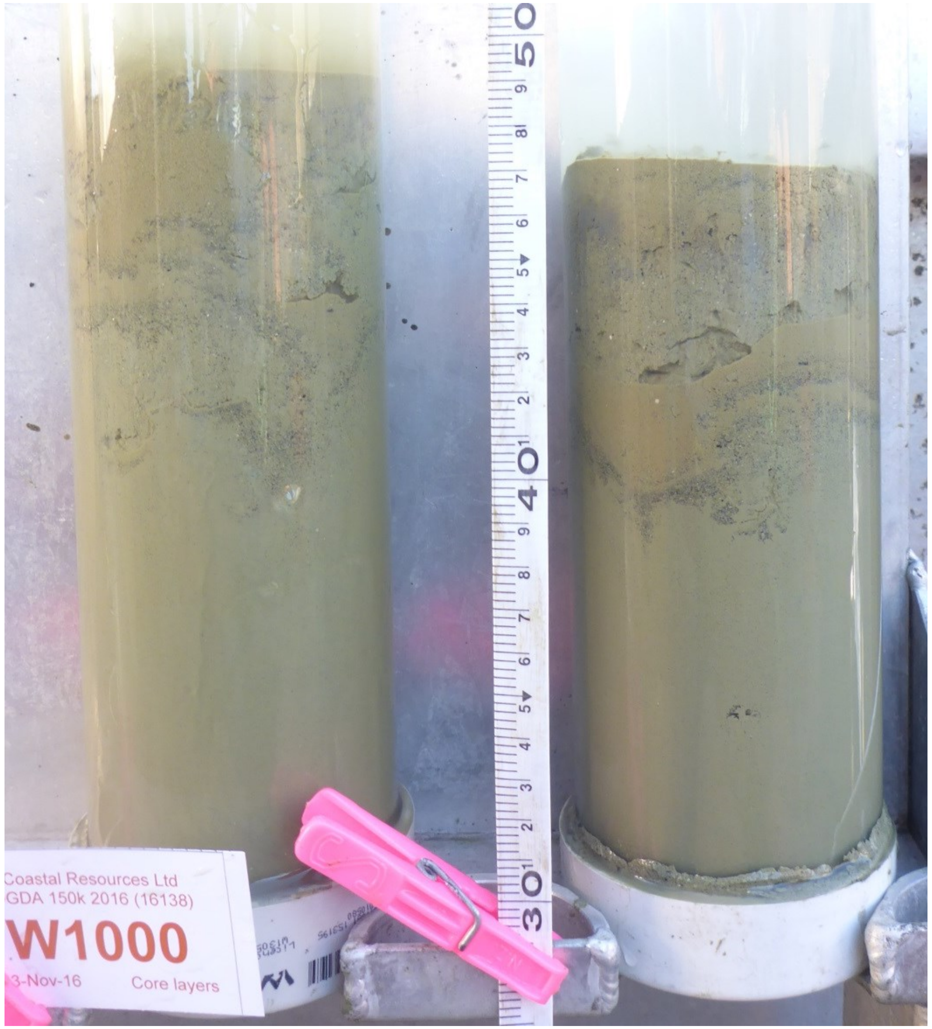


Figure 5.17 Sediment Gravity Cores – W 1000, 23 November 2016

Figure 5.18 Sediment Gravity Cores – N 1500, 23 November 2016

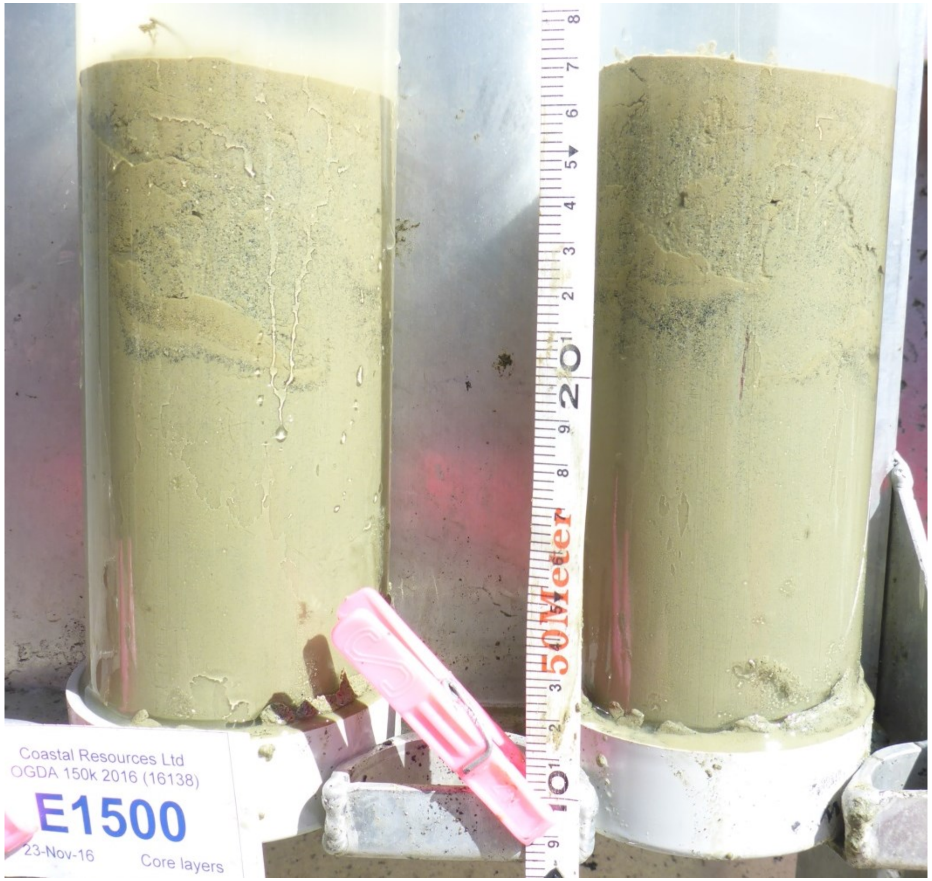


Figure 5.19 Sediment Gravity Cores – E 1500, 23 November 2016

Figure 5.20 Sediment Gravity Cores – S 1500, 23 November 2016

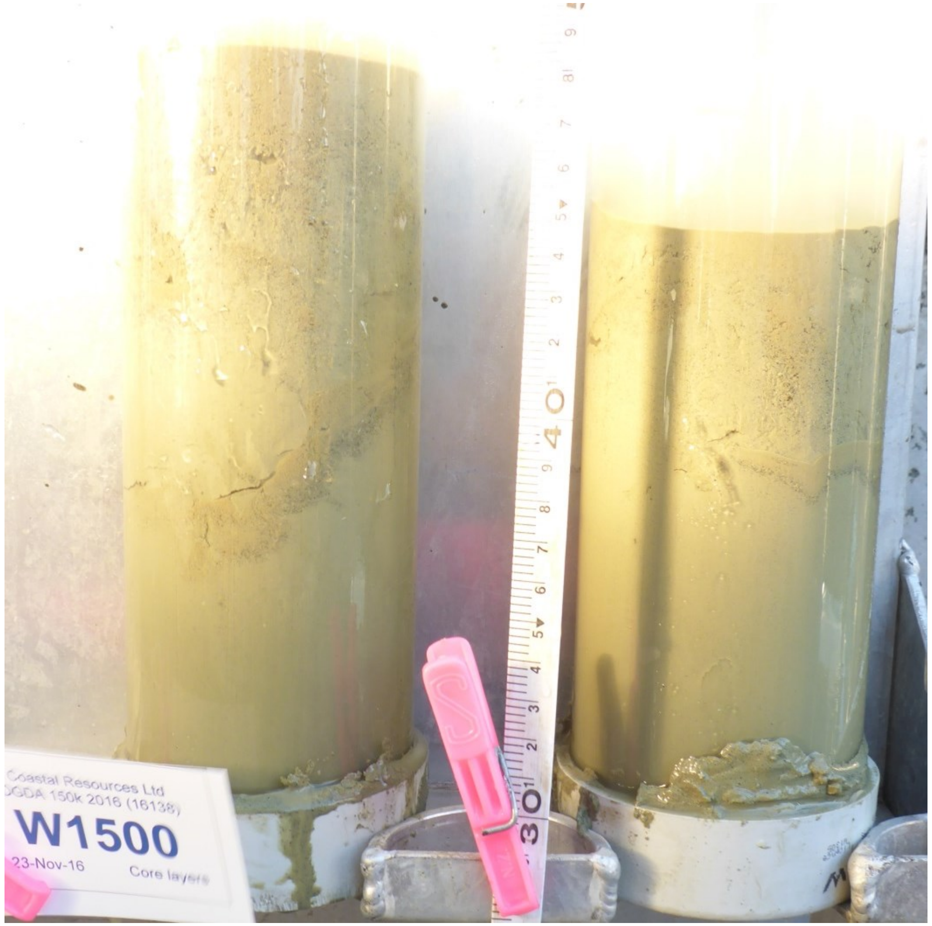


Figure 5.21 Sediment Gravity Cores – W 1500, 23 November 2016

Figure 5.22 Sediment Gravity Cores – NE 1750, 23 November 2016

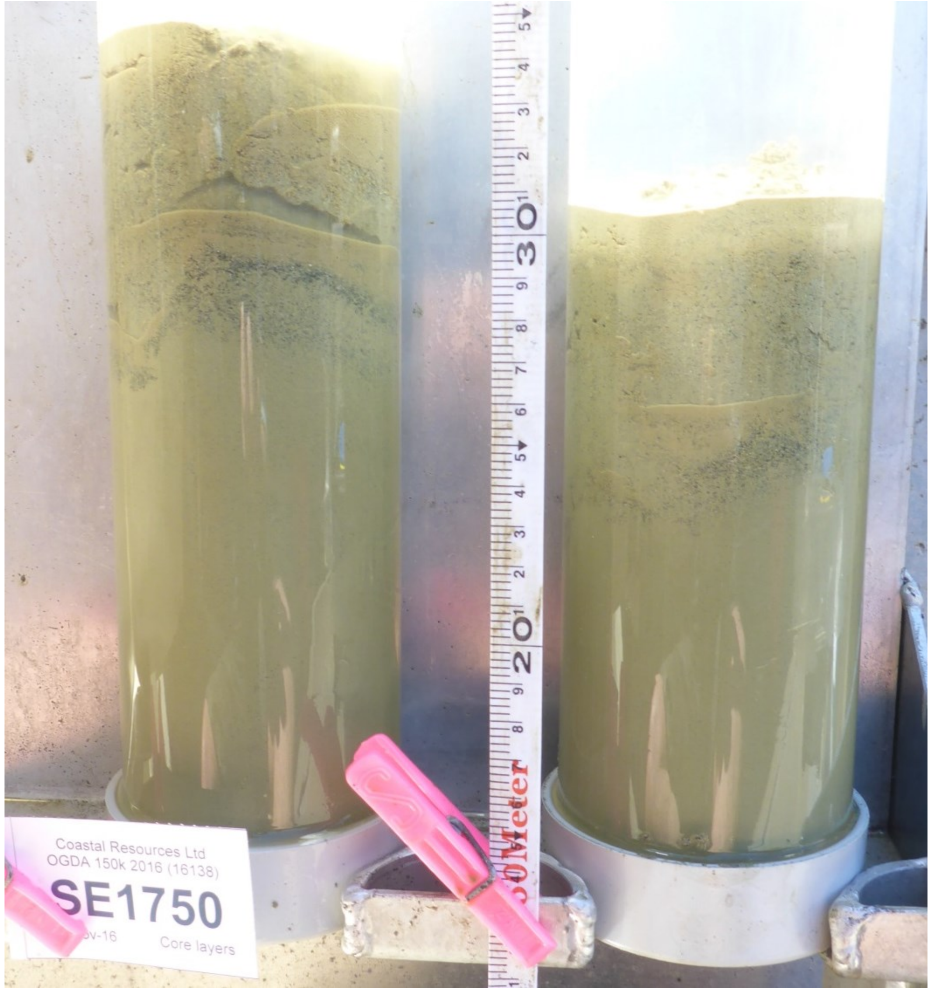


Figure 5.23 Sediment Gravity Cores – SE 1750, 23 November 2016

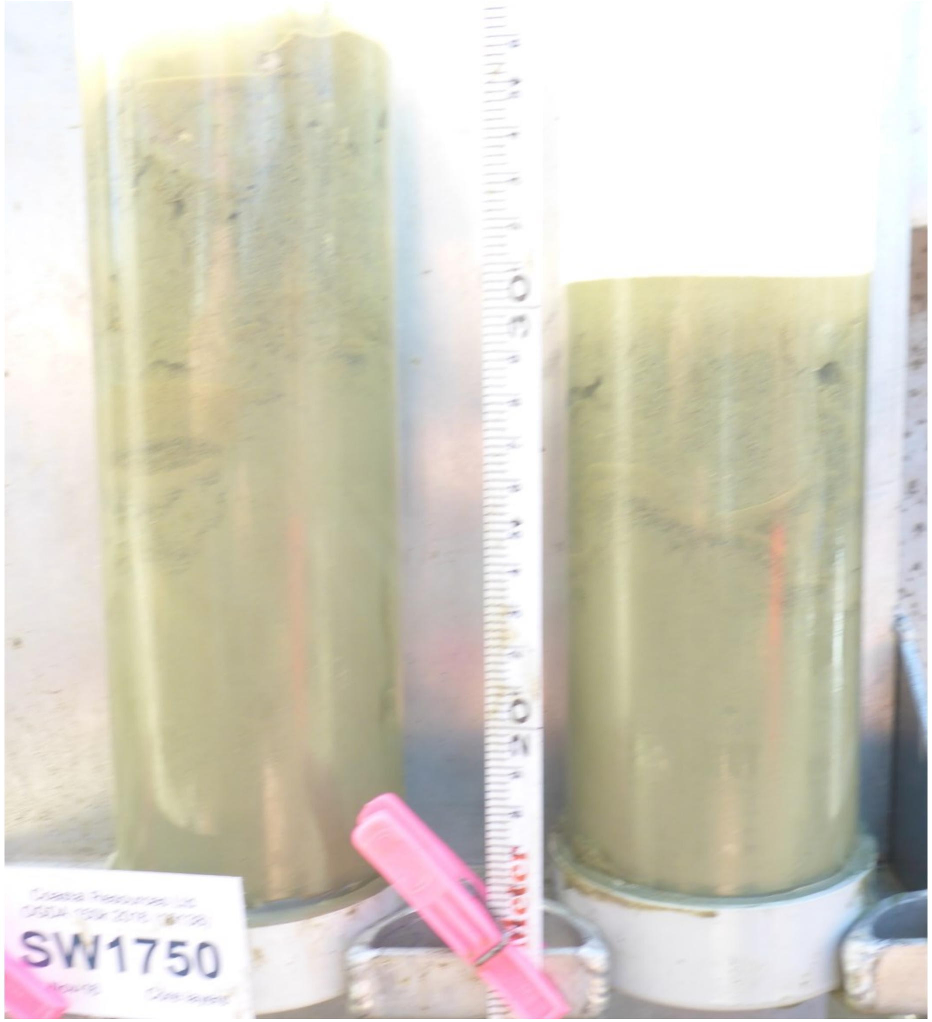


Figure 5.24 Sediment Gravity Cores – SW 1750, 23 November 2016

Figure 5.25 Sediment Gravity Cores – NW 1750, 23 November 2016

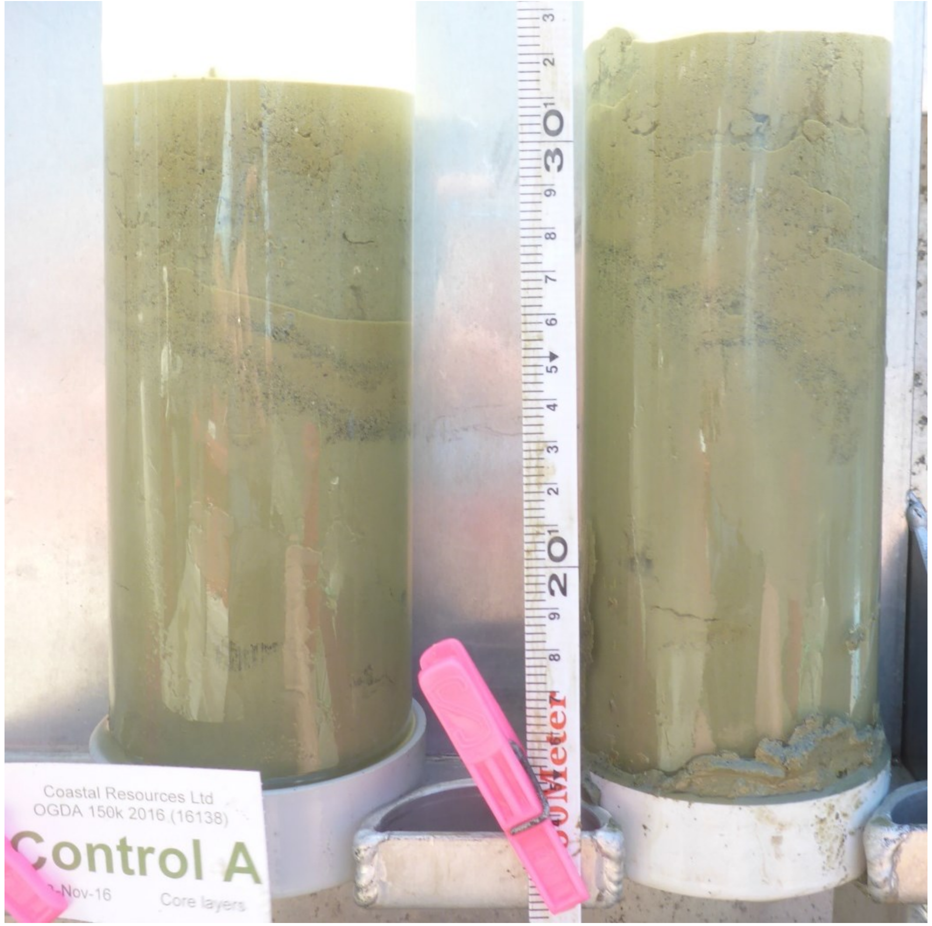


Figure 5.26 Sediment Gravity Cores - Control A, 23 November 2016

Figure 5.27 Sediment Gravity Cores - Control B, 23 November 2016

Figure 5.28 Sediment Gravity Cores - Control C, 23 November 2016

Appendix 2 Core Statistical Tests

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Core**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.053)
Equal Variance Test:	Failed	(P < 0.050)

Group Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
DC	2	0	271.250	12.374	8.750
100	2	0	233.989	88.116	62.307
250	4	0	225.078	8.761	4.381
375	2	0	186.984	32.550	23.016
500	8	0	184.184	11.345	4.011
1000	8	0	182.328	14.192	5.018
1500	8	0	183.089	21.743	7.687
1750	8	0	184.048	24.000	8.485
Control	6	0	189.785	8.134	3.321

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Between Groups	8	22799.223	2849.903	5.792	<0.001
Residual	39	19190.280	492.058		
Total	47	41989.503			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.994

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Distance**

Comparison	**Diff of Means**	**p**	**q**	**P**	**P<0.050**
DC vs. 1000	88.922	9	7.171	<0.001	Yes
DC vs. 1500	88.161	9	7.110	<0.001	Yes
DC vs. 1750	87.202	9	7.032	<0.001	Yes
DC vs. 500	87.066	9	7.021	<0.001	Yes
DC vs. 375	84.266	9	5.372	0.013	Yes
DC vs. Control	81.465	9	6.361	0.002	Yes
DC vs. 250	46.172	9	3.399	0.311	No
DC vs. 100	37.261	9	2.376	0.755	Do Not Test
100 vs. 1000	51.661	9	4.166	0.109	No
100 vs. 1500	50.900	9	4.105	0.119	Do Not Test
100 vs. 1750	49.941	9	4.027	0.134	Do Not Test
100 vs. 500	49.805	9	4.016	0.136	Do Not Test
100 vs. 375	47.005	9	2.997	0.476	Do Not Test
100 vs. Control	44.204	9	3.452	0.292	Do Not Test
100 vs. 250	8.911	9	0.656	1.000	Do Not Test
250 vs. 1000	42.750	9	4.451	0.069	Do Not Test
250 vs. 1500	41.989	9	4.371	0.079	Do Not Test
250 vs. 1750	41.029	9	4.272	0.092	Do Not Test
250 vs. 500	40.894	9	4.257	0.094	Do Not Test
250 vs. 375	38.094	9	2.804	0.564	Do Not Test
250 vs. Control	35.293	9	3.486	0.280	Do Not Test
Control vs. 1000	7.457	9	0.880	0.999	Do Not Test
Control vs. 1500	6.696	9	0.790	1.000	Do Not Test
Control vs. 1750	5.737	9	0.677	1.000	Do Not Test
Control vs. 500	5.601	9	0.661	1.000	Do Not Test
Control vs. 375	2.801	9	0.219	1.000	Do Not Test
375 vs. 1000	4.656	9	0.375	1.000	Do Not Test
375 vs. 1500	3.895	9	0.314	1.000	Do Not Test
375 vs. 1750	2.935	9	0.237	1.000	Do Not Test
375 vs. 500	2.800	9	0.226	1.000	Do Not Test
500 vs. 1000	1.856	9	0.237	1.000	Do Not Test
500 vs. 1500	1.095	9	0.140	1.000	Do Not Test
500 vs. 1750	0.136	9	0.0173	1.000	Do Not Test
1750 vs. 1000	1.720	9	0.219	1.000	Do Not Test
1750 vs. 1500	0.959	9	0.122	1.000	Do Not Test
1500 vs. 1000	0.761	9	0.0970	1.000	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Layer**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
DC	2	0	271.250	262.500	280.000
100	2	0	233.989	171.681	296.296
250	4	0	119.309	75.099	185.620
375	2	0	77.687	72.874	82.500
500	8	0	69.684	60.955	72.586
1000	8	0	71.476	61.202	83.921
1500	8	0	73.145	66.614	78.842
1750	8	0	69.419	65.254	73.231
Control	6	0	73.714	65.947	75.743

H = 19.293 with 8 degrees of freedom. (P = 0.013)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = 0.013)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

Multiple Comparisons versus Control Group (Dunn's Method) :

Comparison	Diff of Ranks	Q	P<0.05
DC vs Control	22.500	1.968	No
100 vs Control	22.000	1.925	Do Not Test
250 vs Control	13.500	1.494	Do Not Test
500 vs Control	8.500	1.124	Do Not Test
1750 vs Control	7.000	0.926	Do Not Test
375 vs Control	6.500	0.569	Do Not Test
1000 vs Control	1.750	0.231	Do Not Test
1500 vs Control	0.750	0.0992	Do Not Test

Note: The multiple comparisons on ranks do not include an adjustment for ties.

Appendix 3 Sediment Particle Size Results.

Control A

Analysis - Under

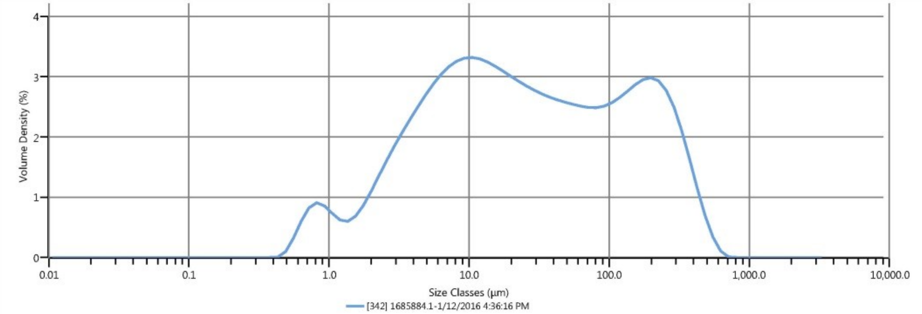
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.1
SOP File Name	Marine Sediment.msop
Lab Number	2016226/1

Measurement Details	
Analysis Date Time	1/12/2016 4:36:16 PM
Measurement Date Time	1/12/2016 4:36:16 PM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.56 %
Laser Obscuration	14.34 %

Result	
Concentration	0.0151 %
Span	9.638
Uniformity	2.782
Specific Surface Area	836.6 m^2/kg
D [3,2]	7.17 µm
D [4,3]	74.9 µm
Dv (10)	2.92 µm
Dv (50)	23.8 µm
Dv (90)	232 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.81	88.0	72.38	350	96.70	1410	100.00
0.0600	0.00	15.6	41.64	105	75.29	420	98.49	1680	100.00
0.120	0.00	31.0	54.85	125	78.28	500	99.51	2000	100.00
0.240	0.00	37.0	57.97	149	81.46	590	99.92	2380	100.00
0.490	0.03	44.0	60.95	177	84.73	710	100.00	2830	100.00
0.980	2.96	53.0	64.09	210	88.05	840	100.00	3360	100.00
2.00	6.36	63.0	66.94	250	91.36	1000	100.00		
3.90	13.96	74.0	69.56	300	94.50	1190	100.00		

Control B

Analysis - Under

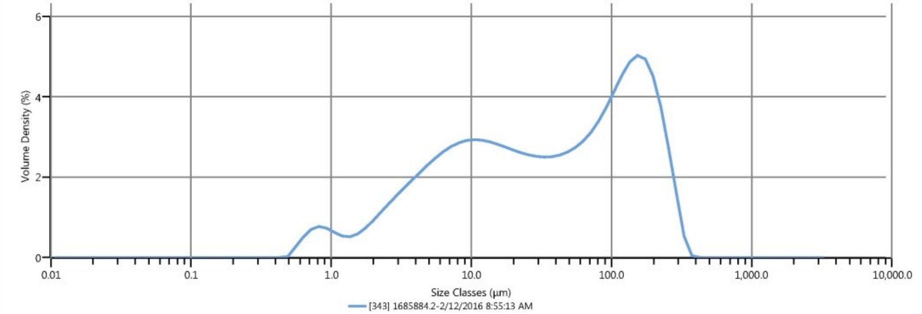
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.2
SOP File Name	Marine Sediment.msop
Lab Number	2016226/2

Measurement Details	
Analysis Date Time	2/12/2016 8:55:13 AM
Measurement Date Time	2/12/2016 8:55:13 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	1.24 %
Laser Obscuration	15.19 %

Result	
Concentration	0.0186 %
Span	5.264
Uniformity	1.664
Specific Surface Area	716.6 m^2/kg
D [3,2]	8.37 µm
D [4,3]	71.0 µm
Dv (10)	3.39 µm
Dv (50)	35.8 µm
Dv (90)	192 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	22.77	88.0	66.76	350	99.98	1410	100.00
0.0600	0.00	15.6	35.86	105	71.25	420	100.00	1680	100.00
0.120	0.00	31.0	47.67	125	76.27	500	100.00	2000	100.00
0.240	0.00	37.0	50.56	149	81.88	590	100.00	2380	100.00
0.490	0.00	44.0	53.42	177	87.52	710	100.00	2830	100.00
0.980	2.45	53.0	56.60	210	92.72	840	100.00	3360	100.00
2.00	5.35	63.0	59.76	250	96.75	1000	100.00		
3.90	11.70	74.0	62.94	300	99.28	1190	100.00		

Control C

Analysis - Under

Measurement Details

Operator Name	rodgers
Sample Name	1685884.3
SOP File Name	Marine Sediment.msop
Lab Number	2016226/3

Measurement Details

Analysis Date Time	2/12/2016 9:04:34 AM
Measurement Date Time	2/12/2016 9:04:34 AM
Result Source	Measurement

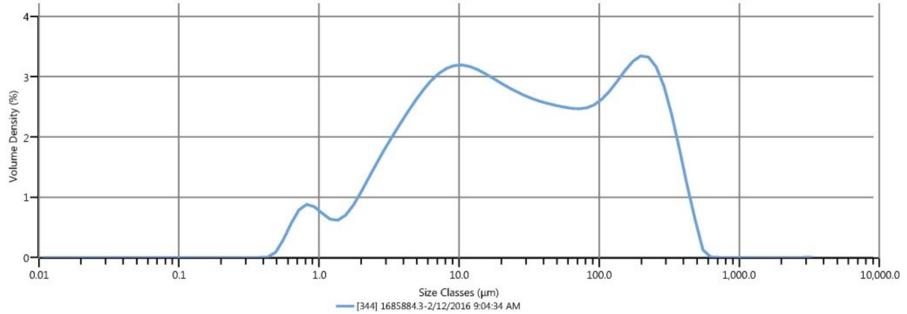
Analysis

Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.61 %
Laser Obscuration	13.64 %

Result

Concentration	0.0146 %
Span	9.133
Uniformity	2.654
Specific Surface Area	814.6 m²/kg
D [3,2]	7.37 µm
D [4,3]	78.2 µm
Dv (10)	2.96 µm
Dv (50)	26.0 µm
Dv (90)	241 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.08	88.0	70.31	350	96.85	1410	100.00
0.0600	0.00	15.6	40.34	105	73.27	420	98.80	1680	100.00
0.120	0.00	31.0	53.09	125	76.36	500	99.80	2000	100.00
0.240	0.00	37.0	56.12	149	79.74	590	100.00	2380	100.00
0.490	0.03	44.0	59.03	177	83.32	710	100.00	2830	100.00
0.980	2.84	53.0	62.10	210	87.03	840	100.00	3360	100.00
2.00	6.29	63.0	64.91	250	90.79	1000	100.00		
3.90	13.66	74.0	67.51	300	94.36	1190	100.00		

DC

Analysis - Under

Measurement Details

Operator Name	rodgers
Sample Name	1685884.4
SOP File Name	Marine Sediment.msop
Lab Number	2016226/4

Measurement Details

Analysis Date Time	2/12/2016 9:14:57 AM
Measurement Date Time	2/12/2016 9:14:57 AM
Result Source	Measurement

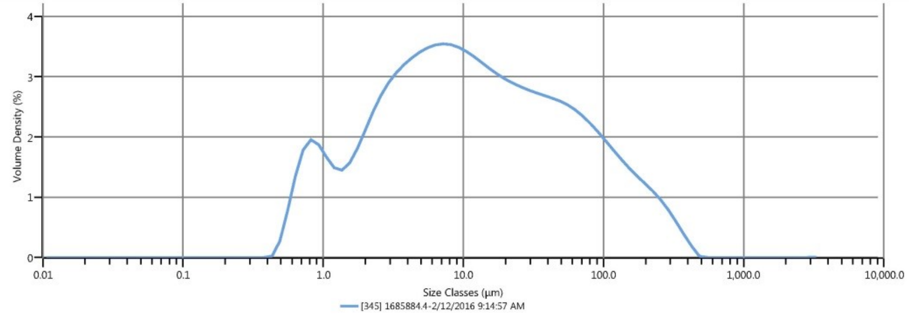
Analysis

Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.91 %
Laser Obscuration	13.60 %

Result

Concentration	0.0085 %
Span	9.517
Uniformity	2.949
Specific Surface Area	1449 m²/kg
D [3,2]	4.14 µm
D [4,3]	37.2 µm
Dv (10)	1.38 µm
Dv (50)	11.2 µm
Dv (90)	107 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	41.88	88.0	87.38	350	99.51	1410	100.00
0.0600	0.00	15.6	57.13	105	89.70	420	99.90	1680	100.00
0.120	0.00	31.0	70.21	125	91.78	500	100.00	2000	100.00
0.240	0.00	37.0	73.36	149	93.62	590	100.00	2380	100.00
0.490	0.10	44.0	76.37	177	95.21	710	100.00	2830	100.00
0.980	6.57	53.0	79.53	210	96.61	840	100.00	3360	100.00
2.00	14.20	63.0	82.36	250	97.83	1000	100.00		
3.90	26.28	74.0	84.86	300	98.87	1190	100.00		

500N

Analysis - Under

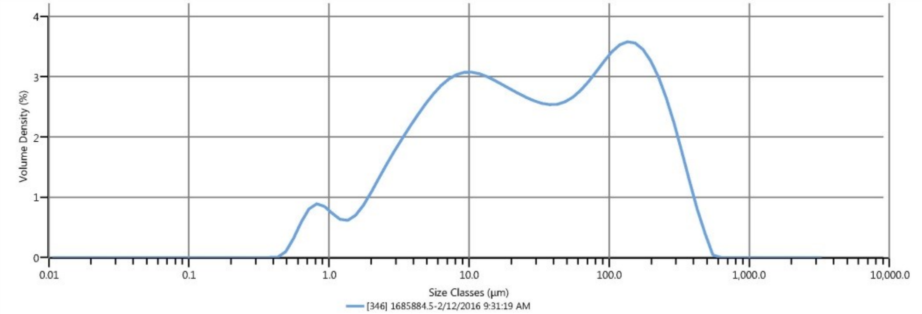
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.5
SOP File Name	Marine Sediment.msop
Lab Number	2016226/5

Measurement Details	
Analysis Date Time	2/12/2016 9:31:19 AM
Measurement Date Time	2/12/2016 9:31:19 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.58 %
Laser Obscuration	14.40 %

Result	
Concentration	0.0156 %
Span	7.472
Uniformity	2.274
Specific Surface Area	812.3 m²/kg
D [3,2]	7.39 μm
D [4,3]	73.1 μm
Dv (10)	2.96 μm
Dv (50)	28.0 μm
Dv (90)	212 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	25.72	88.0	70.24	350	97.90	1410	100.00
0.0600	0.00	15.6	39.45	105	74.07	420	99.26	1680	100.00
0.120	0.00	31.0	51.74	125	78.04	500	99.91	2000	100.00
0.240	0.00	37.0	54.69	149	82.14	590	100.00	2380	100.00
0.490	0.03	44.0	57.56	177	86.10	710	100.00	2830	100.00
0.980	2.90	53.0	60.69	210	89.81	840	100.00	3360	100.00
2.00	6.34	63.0	63.75	250	93.13	1000	100.00		
3.90	13.62	74.0	66.76	300	96.03	1190	100.00		

500E

Analysis - Under

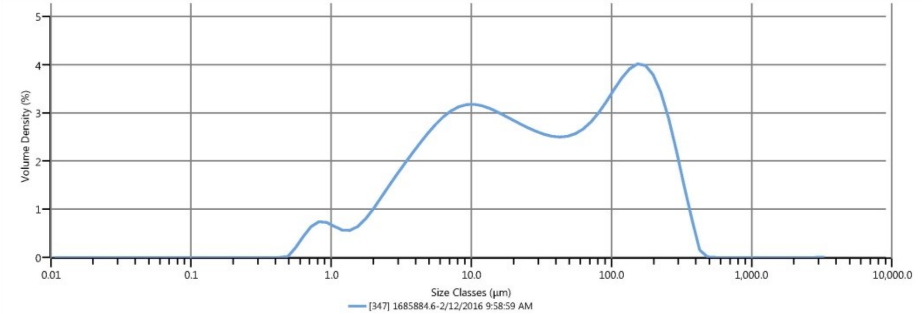
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.6
SOP File Name	Marine Sediment.msop
Lab Number	2016226/6

Measurement Details	
Analysis Date Time	2/12/2016 9:58:59 AM
Measurement Date Time	2/12/2016 9:58:59 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.68 %
Laser Obscuration	9.08 %

Result	
Concentration	0.0103 %
Span	7.017
Uniformity	2.134
Specific Surface Area	741.3 m²/kg
D [3,2]	8.09 μm
D [4,3]	70.8 μm
Dv (10)	3.25 μm
Dv (50)	28.6 μm
Dv (90)	204 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	24.73	88.0	69.44	350	99.21	1410	100.00
0.0600	0.00	15.6	38.91	105	73.28	420	99.95	1680	100.00
0.120	0.00	31.0	51.40	125	77.43	500	100.00	2000	100.00
0.240	0.00	37.0	54.33	149	81.94	590	100.00	2380	100.00
0.490	0.00	44.0	57.17	177	86.45	710	100.00	2830	100.00
0.980	2.26	53.0	60.22	210	90.76	840	100.00	3360	100.00
2.00	5.38	63.0	63.16	250	94.54	1000	100.00		
3.90	12.44	74.0	66.05	300	97.56	1190	100.00		

500S

Analysis - Under

Measurement Details

Operator Name rodgers
Sample Name 1685884.7
SOP File Name Marine Sediment.msop
Lab Number 2016226/7

Measurement Details

Analysis Date Time 2/12/2016 10:08:42 AM
Measurement Date Time 2/12/2016 10:08:42 AM
Result Source Measurement

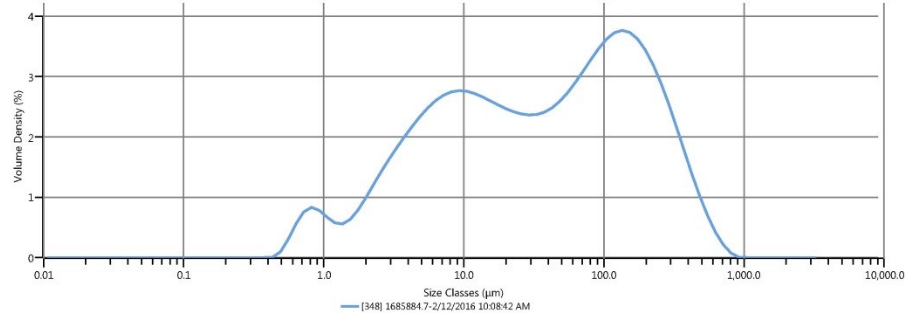
Analysis

Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.50 %
Laser Obscuration 14.15 %

Result

Concentration 0.0166 %
Span 6.595
Uniformity 2.083
Specific Surface Area 753.1 m²/kg
D [3,2] 7.97 µm
D [4,3] 90.2 µm
Dv (10) 3.17 µm
Dv (50) 37.8 µm
Dv (90) 252 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	23.68	88.0	65.64	350	95.32	1410	100.00
0.0600	0.00	15.6	35.97	105	69.71	420	97.30	1680	100.00
0.120	0.00	31.0	46.93	125	73.92	500	98.64	2000	100.00
0.240	0.00	37.0	49.68	149	78.23	590	99.43	2380	100.00
0.490	0.03	44.0	52.45	177	82.38	710	99.85	2830	100.00
0.980	2.73	53.0	55.59	210	86.27	840	99.99	3360	100.00
2.00	5.87	63.0	58.75	250	89.84	1000	100.00		
3.90	12.59	74.0	61.93	300	93.06	1190	100.00		

500W

Analysis - Under

Measurement Details

Operator Name rodgers
Sample Name 1685884.8
SOP File Name Marine Sediment.msop
Lab Number 2016226/8

Measurement Details

Analysis Date Time 2/12/2016 10:25:01 AM
Measurement Date Time 2/12/2016 10:25:01 AM
Result Source Measurement

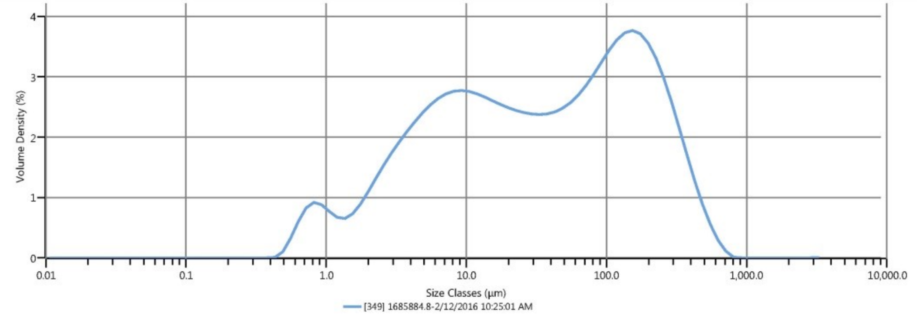
Analysis

Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.58 %
Laser Obscuration 13.44 %

Result

Concentration 0.0147 %
Span 7.085
Uniformity 2.222
Specific Surface Area 806.3 m²/kg
D [3,2] 7.44 µm
D [4,3] 86.7 µm
Dv (10) 2.89 µm
Dv (50) 34.2 µm
Dv (90) 245 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	25.09	88.0	66.24	350	95.93	1410	100.00
0.0600	0.00	15.6	37.41	105	70.07	420	97.83	1680	100.00
0.120	0.00	31.0	48.46	125	74.13	500	99.04	2000	100.00
0.240	0.00	37.0	51.20	149	78.41	590	99.69	2380	100.00
0.490	0.04	44.0	53.92	177	82.63	710	99.96	2830	100.00
0.980	3.00	53.0	56.93	210	86.66	840	100.00	3360	100.00
2.00	6.59	63.0	59.88	250	90.36	1000	100.00		
3.90	13.78	74.0	62.81	300	93.67	1190	100.00		

1000N

Analysis - Under

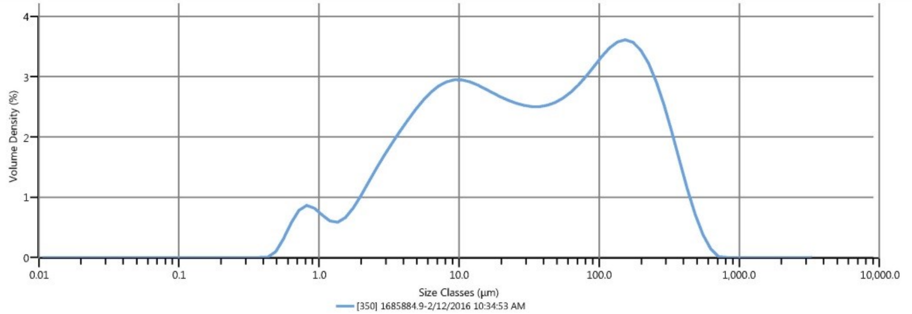
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.9
SOP File Name	Marine Sediment.msop
Lab Number	2016226/9

Measurement Details	
Analysis Date Time	2/12/2016 10:34:53 AM
Measurement Date Time	2/12/2016 10:34:53 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.54 %
Laser Obscuration	14.60 %

Result	
Concentration	0.0164 %
Span	7.340
Uniformity	2.258
Specific Surface Area	783.9 m²/kg
D [3,2]	7.65 μm
D [4,3]	81.7 μm
Dv (10)	3.06 μm
Dv (50)	31.6 μm
Dv (90)	235 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	24.74	88.0	67.92	350	96.63	1410	100.00
0.0600	0.00	15.6	37.89	105	71.65	420	98.41	1680	100.00
0.120	0.00	31.0	49.68	125	75.56	500	99.43	2000	100.00
0.240	0.00	37.0	52.57	149	79.67	590	99.89	2380	100.00
0.490	0.03	44.0	55.41	177	83.71	710	100.00	2830	100.00
0.980	2.82	53.0	58.53	210	87.60	840	100.00	3360	100.00
2.00	6.10	63.0	61.56	250	91.21	1000	100.00		
3.90	13.09	74.0	64.52	300	94.44	1190	100.00		

1000E

Analysis - Under

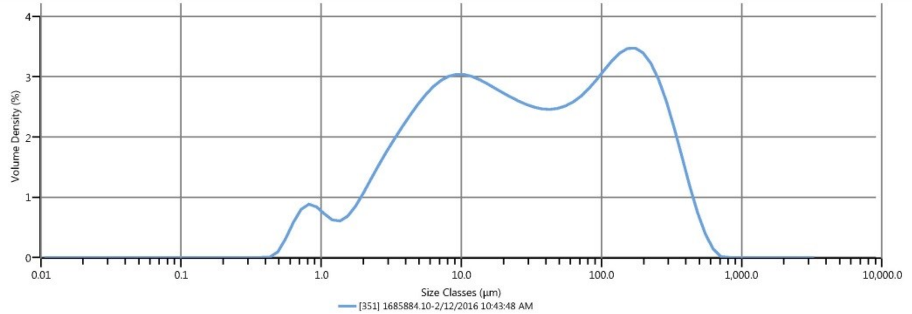
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.10
SOP File Name	Marine Sediment.msop
Lab Number	2016226/10

Measurement Details	
Analysis Date Time	2/12/2016 10:43:48 AM
Measurement Date Time	2/12/2016 10:43:48 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.55 %
Laser Obscuration	13.19 %

Result	
Concentration	0.0144 %
Span	8.119
Uniformity	2.466
Specific Surface Area	803.9 m²/kg
D [3,2]	7.46 μm
D [4,3]	81.1 μm
Dv (10)	2.98 μm
Dv (50)	29.0 μm
Dv (90)	238 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	25.54	88.0	68.57	350	96.50	1410	100.00
0.0600	0.00	15.6	39.10	105	72.04	420	98.35	1680	100.00
0.120	0.00	31.0	51.12	125	75.70	500	99.42	2000	100.00
0.240	0.00	37.0	53.99	149	79.60	590	99.89	2380	100.00
0.490	0.03	44.0	56.77	177	83.51	710	100.00	2830	100.00
0.980	2.87	53.0	59.78	210	87.34	840	100.00	3360	100.00
2.00	6.26	63.0	62.64	250	90.95	1000	100.00		
3.90	13.50	74.0	65.41	300	94.24	1190	100.00		

1000S

Analysis - Under

Measurement Details

Operator Name rodgers
Sample Name 1685884.11
SOP File Name Marine Sediment.msop
Lab Number 2016226/11

Measurement Details

Analysis Date Time 2/12/2016 10:53:02 AM
Measurement Date Time 2/12/2016 10:53:02 AM
Result Source Measurement

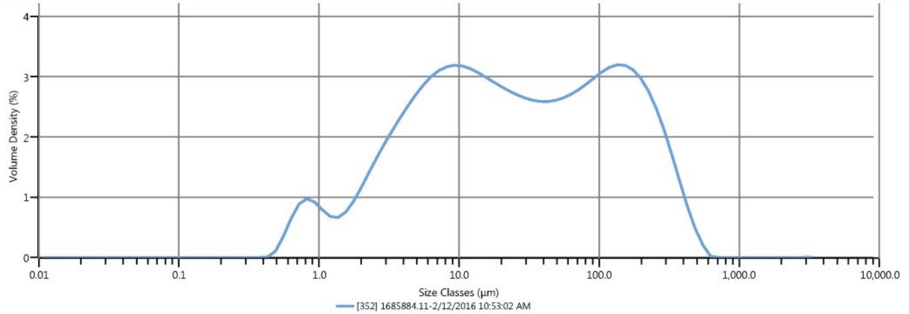
Analysis

Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.59 %
Laser Obscuration 14.01 %

Result

Concentration 0.0142 %
Span 8.456
Uniformity 2.530
Specific Surface Area 867.8 m²/kg
D [3,2] 6.91 µm
D [4,3] 70.5 µm
Dv (10) 2.77 µm
Dv (50) 24.5 µm
Dv (90) 210 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	27.42	88.0	72.37	350	97.62	1410	100.00
0.0600	0.00	15.6	41.59	105	75.85	420	99.01	1680	100.00
0.120	0.00	31.0	54.11	125	79.42	500	99.74	2000	100.00
0.240	0.00	37.0	57.12	149	83.08	590	100.00	2380	100.00
0.490	0.04	44.0	60.05	177	86.64	710	100.00	2830	100.00
0.980	3.19	53.0	63.21	210	90.01	840	100.00	3360	100.00
2.00	6.89	63.0	66.22	250	93.08	1000	100.00		
3.90	14.66	74.0	69.12	300	95.81	1190	100.00		

1000W

Analysis - Under

Measurement Details

Operator Name rodgers
Sample Name 1685884.12
SOP File Name Marine Sediment.msop
Lab Number 2016226/12

Measurement Details

Analysis Date Time 2/12/2016 11:01:55 AM
Measurement Date Time 2/12/2016 11:01:55 AM
Result Source Measurement

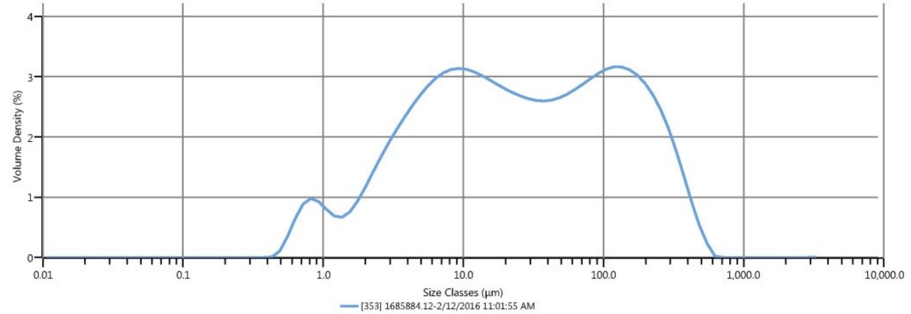
Analysis

Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.63 %
Laser Obscuration 12.91 %

Result

Concentration 0.0130 %
Span 8.372
Uniformity 2.504
Specific Surface Area 868.4 m²/kg
D [3,2] 6.91 µm
D [4,3] 71.2 µm
Dv (10) 2.76 µm
Dv (50) 25.0 µm
Dv (90) 212 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	27.42	88.0	72.33	350	97.44	1410	100.00
0.0600	0.00	15.6	41.36	105	75.88	420	98.92	1680	100.00
0.120	0.00	31.0	53.72	125	79.47	500	99.71	2000	100.00
0.240	0.00	37.0	56.73	149	83.09	590	100.00	2380	100.00
0.490	0.04	44.0	59.67	177	86.55	710	100.00	2830	100.00
0.980	3.20	53.0	62.89	210	89.82	840	100.00	3360	100.00
2.00	6.92	63.0	65.99	250	92.84	1000	100.00		
3.90	14.75	74.0	68.97	300	95.58	1190	100.00		

1500N

Analysis - Under

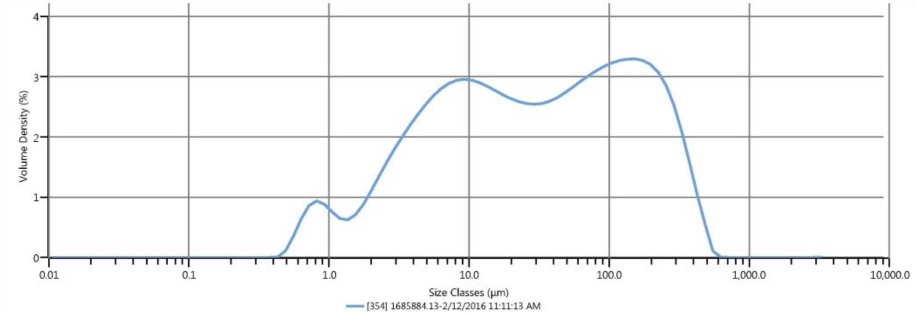
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.13
SOP File Name	Marine Sediment.msop
Lab Number	2016226/13

Measurement Details	
Analysis Date Time	2/12/2016 11:11:13 AM
Measurement Date Time	2/12/2016 11:11:13 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.60 %
Laser Obscuration	15.32 %

Result	
Concentration	0.0164 %
Span	7.609
Uniformity	2.273
Specific Surface Area	830.8 m^2/kg
D [3,2]	7.22 μm
D [4,3]	76.7 μm
Dv (10)	2.87 μm
Dv (50)	29.5 μm
Dv (90)	227 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	25.98	88.0	69.94	350	97.24	1410	100.00
0.0600	0.00	15.6	39.10	105	73.63	420	98.96	1680	100.00
0.120	0.00	31.0	50.82	125	77.34	500	99.83	2000	100.00
0.240	0.00	37.0	53.79	149	81.11	590	100.00	2380	100.00
0.490	0.04	44.0	56.75	177	84.80	710	100.00	2830	100.00
0.980	3.11	53.0	60.07	210	88.40	840	100.00	3360	100.00
2.00	6.62	63.0	63.31	250	91.85	1000	100.00		
3.90	14.02	74.0	66.44	300	95.05	1190	100.00		

1500E

Analysis - Under

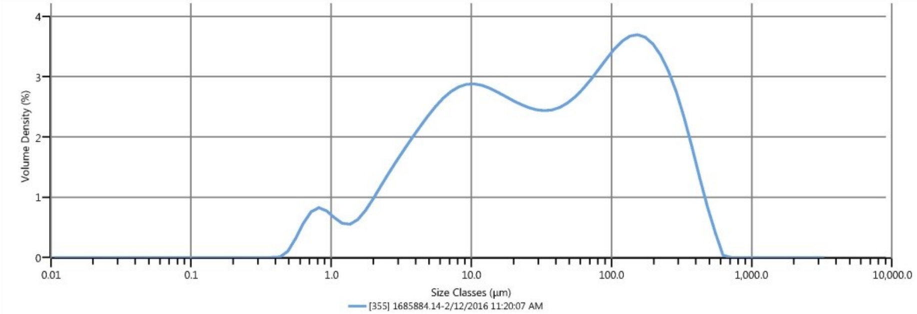
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.14
SOP File Name	Marine Sediment.msop
Lab Number	2016226/14

Measurement Details	
Analysis Date Time	2/12/2016 11:20:07 AM
Measurement Date Time	2/12/2016 11:20:07 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.53 %
Laser Obscuration	20.87 %

Result	
Concentration	0.0253 %
Span	6.890
Uniformity	2.117
Specific Surface Area	755.6 m^2/kg
D [3,2]	7.94 μm
D [4,3]	85.6 μm
Dv (10)	3.19 μm
Dv (50)	35.2 μm
Dv (90)	246 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	23.63	88.0	66.34	350	96.26	1410	100.00
0.0600	0.00	15.6	36.49	105	70.22	420	98.29	1680	100.00
0.120	0.00	31.0	47.99	125	74.25	500	99.49	2000	100.00
0.240	0.00	37.0	50.81	149	78.47	590	100.00	2380	100.00
0.490	0.04	44.0	53.60	177	82.61	710	100.00	2830	100.00
0.980	2.74	53.0	56.71	210	86.60	840	100.00	3360	100.00
2.00	5.84	63.0	59.78	250	90.36	1000	100.00		
3.90	12.45	74.0	62.82	300	93.83	1190	100.00		

1500S

Analysis - Under

Measurement Details

Operator Name rodgers
Sample Name 1685884.15
SOP File Name Marine Sediment.msop
Lab Number 2016226/15

Measurement Details

Analysis Date Time 2/12/2016 11:28:56 AM
Measurement Date Time 2/12/2016 11:28:56 AM
Result Source Measurement

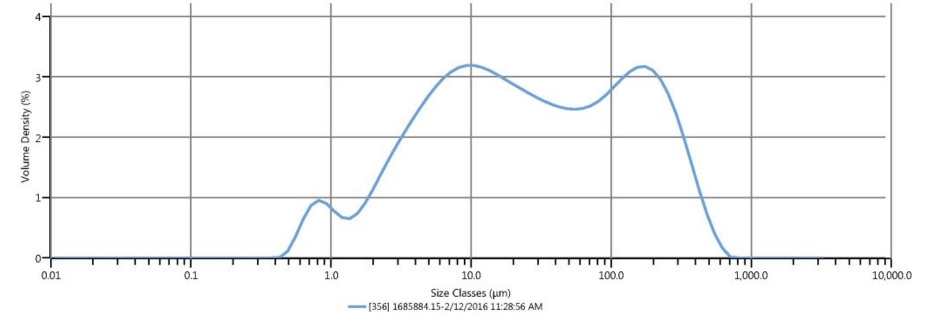
Analysis

Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.57 %
Laser Obscuration 16.58 %

Result

Concentration 0.0173 %
Span 9.175
Uniformity 2.724
Specific Surface Area 855.9 m²/kg
D [3,2] 7.01 µm
D [4,3] 76.2 µm
Dv (10) 2.81 µm
Dv (50) 24.8 µm
Dv (90) 230 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	27.04	88.0	71.13	350	96.67	1410	100.00
0.0600	0.00	15.6	41.28	105	74.30	420	98.40	1680	100.00
0.120	0.00	31.0	53.94	125	77.62	500	99.41	2000	100.00
0.240	0.00	37.0	56.93	149	81.17	590	99.88	2380	100.00
0.490	0.04	44.0	59.78	177	84.73	710	100.00	2830	100.00
0.980	3.13	53.0	62.79	210	88.23	840	100.00	3360	100.00
2.00	6.76	63.0	65.57	250	91.54	1000	100.00		
3.90	14.42	74.0	68.20	300	94.58	1190	100.00		

1500W

Analysis - Under

Measurement Details

Operator Name rodgers
Sample Name 1685884.16
SOP File Name Marine Sediment.msop
Lab Number 2016226/16

Measurement Details

Analysis Date Time 2/12/2016 11:38:49 AM
Measurement Date Time 2/12/2016 11:38:49 AM
Result Source Measurement

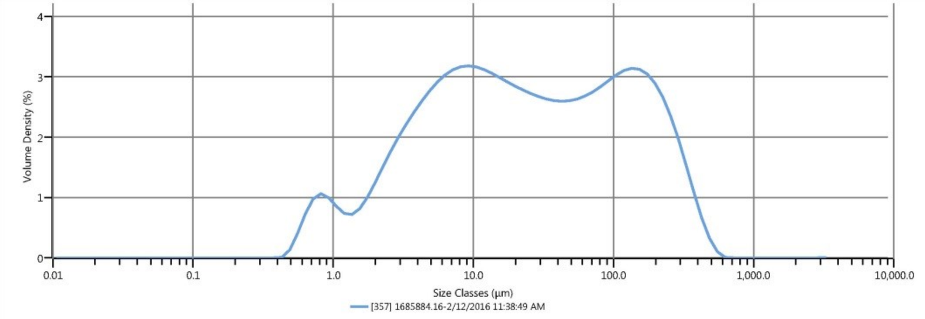
Analysis

Particle Name Marine Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.61 %
Laser Obscuration 16.84 %

Result

Concentration 0.0164 %
Span 8.654
Uniformity 2.568
Specific Surface Area 923.8 m²/kg
D [3,2] 6.49 µm
D [4,3] 66.3 µm
Dv (10) 2.57 µm
Dv (50) 22.7 µm
Dv (90) 199 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	28.82	88.0	73.71	350	98.17	1410	100.00
0.0600	0.00	15.6	42.95	105	77.14	420	99.33	1680	100.00
0.120	0.00	31.0	55.51	125	80.65	500	99.86	2000	100.00
0.240	0.00	37.0	58.55	149	84.25	590	100.00	2380	100.00
0.490	0.05	44.0	61.49	177	87.73	710	100.00	2830	100.00
0.980	3.53	53.0	64.65	210	91.01	840	100.00	3360	100.00
2.00	7.54	63.0	67.64	250	93.97	1000	100.00		
3.90	15.81	74.0	70.51	300	96.53	1190	100.00		

1750NE

Analysis - Under

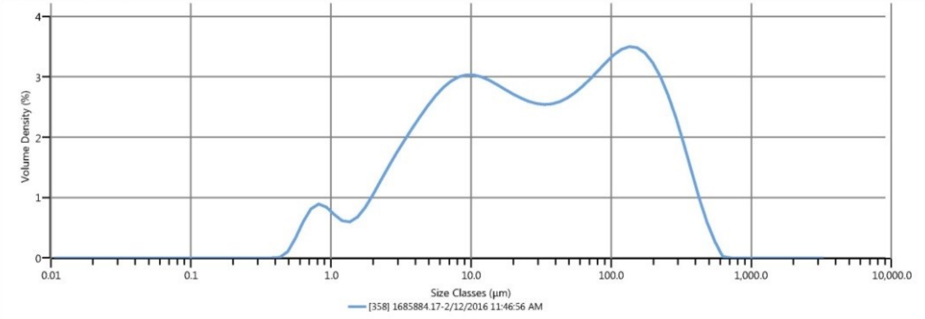
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.17
SOP File Name	Marine Sediment.msop
Lab Number	2016226/17

Measurement Details	
Analysis Date Time	2/12/2016 11:46:56 AM
Measurement Date Time	2/12/2016 11:46:56 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.56 %
Laser Obscuration	15.41 %

Result	
Concentration	0.0170 %
Span	7.446
Uniformity	2.271
Specific Surface Area	805.4 m^2/kg
D [3,2]	7.45 μm
D [4,3]	76.5 μm
Dv (10)	2.99 μm
Dv (50)	29.4 μm
Dv (90)	222 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	25.37	88.0	69.66	350	97.23	1410	100.00
0.0600	0.00	15.6	38.89	105	73.46	420	98.80	1680	100.00
0.120	0.00	31.0	50.89	125	77.36	500	99.66	2000	100.00
0.240	0.00	37.0	53.83	149	81.38	590	100.00	2380	100.00
0.490	0.04	44.0	56.73	177	85.25	710	100.00	2830	100.00
0.980	2.93	53.0	59.95	210	88.92	840	100.00	3360	100.00
2.00	6.28	63.0	63.08	250	92.26	1000	100.00		
3.90	13.42	74.0	66.16	300	95.24	1190	100.00		

1750SE

Analysis - Under

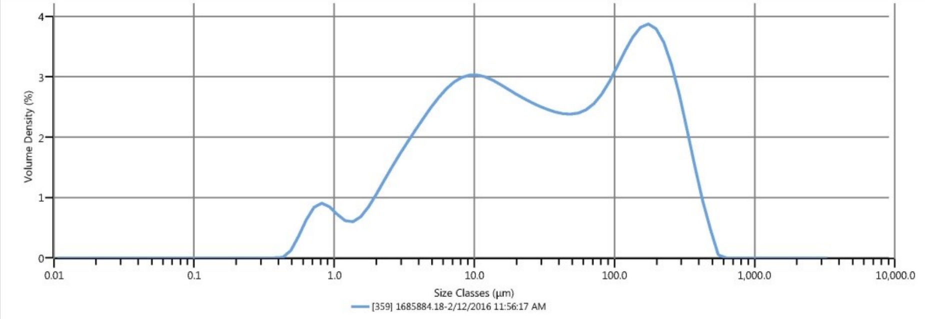
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.18
SOP File Name	Marine Sediment.msop
Lab Number	2016226/18

Measurement Details	
Analysis Date Time	2/12/2016 11:56:17 AM
Measurement Date Time	2/12/2016 11:56:17 AM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.54 %
Laser Obscuration	22.42 %

Result	
Concentration	0.0257 %
Span	7.715
Uniformity	2.353
Specific Surface Area	812.4 m^2/kg
D [3,2]	7.39 μm
D [4,3]	79.4 μm
Dv (10)	2.97 μm
Dv (50)	29.6 μm
Dv (90)	231 μm

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	25.32	88.0	67.65	350	97.50	1410	100.00
0.0600	0.00	15.6	38.84	105	71.13	420	99.12	1680	100.00
0.120	0.00	31.0	50.78	125	74.93	500	99.90	2000	100.00
0.240	0.00	37.0	53.61	149	79.15	590	100.00	2380	100.00
0.490	0.05	44.0	56.32	177	83.48	710	100.00	2830	100.00
0.980	3.04	53.0	59.22	210	87.76	840	100.00	3360	100.00
2.00	6.40	63.0	61.95	250	91.74	1000	100.00		
3.90	13.47	74.0	64.59	300	95.24	1190	100.00		

1750SW

Analysis - Under

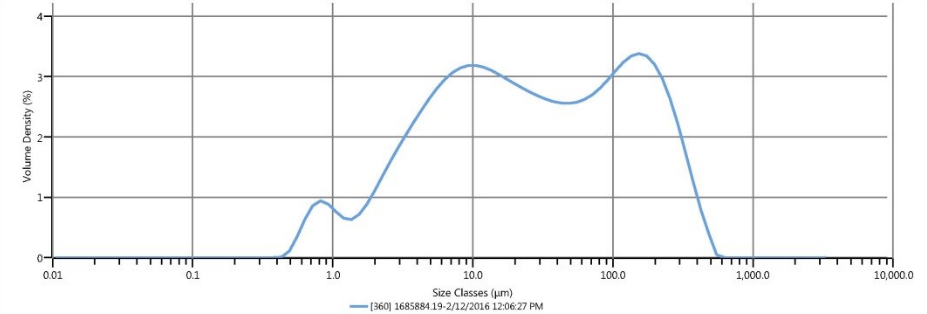
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.19
SOP File Name	Marine Sediment.msop
Lab Number	2016226/19

Measurement Details	
Analysis Date Time	2/12/2016 12:06:27 PM
Measurement Date Time	2/12/2016 12:06:27 PM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.57 %
Laser Obscuration	17.12 %

Result	
Concentration	0.0181 %
Span	8.238
Uniformity	2.461
Specific Surface Area	847.1 m^2/kg
D [3,2]	7.08 µm
D [4,3]	71.1 µm
Dv (10)	2.85 µm
Dv (50)	25.3 µm
Dv (90)	211 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	26.68	88.0	71.53	350	97.92	1410	100.00
0.0600	0.00	15.6	40.90	105	74.99	420	99.27	1680	100.00
0.120	0.00	31.0	53.60	125	78.63	500	99.91	2000	100.00
0.240	0.00	37.0	56.62	149	82.47	590	100.00	2380	100.00
0.490	0.04	44.0	59.53	177	86.25	710	100.00	2830	100.00
0.980	3.10	53.0	62.63	210	89.88	840	100.00	3360	100.00
2.00	6.65	63.0	65.56	250	93.19	1000	100.00		
3.90	14.16	74.0	68.36	300	96.07	1190	100.00		

1750NW

Analysis - Under

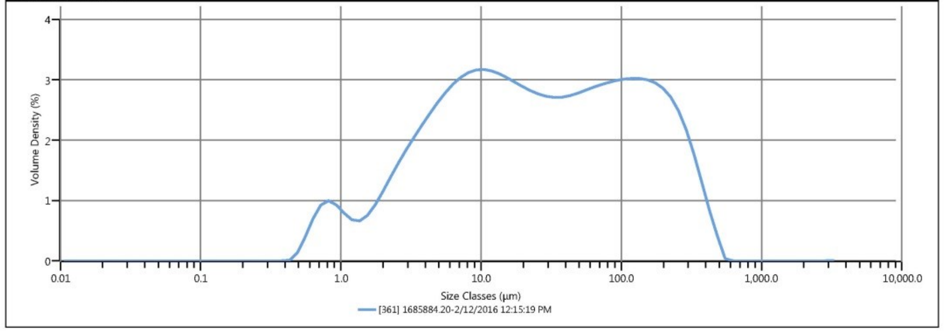
Measurement Details	
Operator Name	rodgers
Sample Name	1685884.20
SOP File Name	Marine Sediment.msop
Lab Number	2016226/20

Measurement Details	
Analysis Date Time	2/12/2016 12:15:19 PM
Measurement Date Time	2/12/2016 12:15:19 PM
Result Source	Measurement

Analysis	
Particle Name	Marine Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.60 %
Laser Obscuration	23.34 %

Result	
Concentration	0.0249 %
Span	8.309
Uniformity	2.443
Specific Surface Area	878.2 m^2/kg
D [3,2]	6.83 µm
D [4,3]	69.1 µm
Dv (10)	2.74 µm
Dv (50)	24.7 µm
Dv (90)	208 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	27.11	88.0	73.22	350	97.83	1410	100.00
0.0600	0.00	15.6	41.28	105	76.67	420	99.24	1680	100.00
0.120	0.00	31.0	54.04	125	80.11	500	99.91	2000	100.00
0.240	0.00	37.0	57.16	149	83.57	590	100.00	2380	100.00
0.490	0.05	44.0	60.25	177	86.92	710	100.00	2830	100.00
0.980	3.35	53.0	63.62	210	90.15	840	100.00	3360	100.00
2.00	7.05	63.0	66.82	250	93.19	1000	100.00		
3.90	14.67	74.0	69.87	300	95.96	1190	100.00		

Appendix 4 Particle Size Statistical Tests

One Way Analysis of Variance

Dependent Variable: **Gravel**

Normality Test (Shapiro-Wilk)	Failed	(P < 0.050)
Equal Variance Test:	Passed	(P = 1.000)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	0.000	0.000	0.000
500	4	0	0.000	0.000	0.000
1000	4	0	0.000	0.000	0.000
1500	4	0	0.000	0.000	0.000
1750	4	0	0.000	0.000	0.000
Control	3	0	0.000	0.000	0.000

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.000	0.000	1.000	1.000
Residual	14	0.000	0.000		
Total	18	0.000			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 1.000).

Power of performed test with alpha = 0.050: 1.000

One Way Analysis of Variance

Dependent Variable: **Sand**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.214)
Equal Variance Test:	Passed	(P = 0.465)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	17.640	0.000	0.000
500	4	0	38.615	2.446	1.223
1000	4	0	35.898	2.356	1.178
1500	4	0	35.925	3.365	1.683
1750	4	0	35.648	2.231	1.116
Control	3	0	36.130	3.701	2.137

Source of Variation	DF	SS	MS	F	P
Between Groups	4	360.418	90.104	11.373	<0.001
Residual	14	110.915	7.922		
Total	18	471.333			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.997

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Sand**

Comparison	Diff of Means	p	q	P	P<0.050
500 vs. DC	20.975	6	9.426	<0.001	Yes
500 vs. 1750	2.968	6	2.109	0.675	No
500 vs. 1000	2.718	6	1.931	0.746	Do Not Test
500 vs. 1500	2.690	6	1.911	0.753	Do Not Test
500 vs. Control	2.485	6	1.635	0.850	Do Not Test
Control vs. DC	18.490	6	8.045	<0.001	Yes
Control vs. 1750	0.483	6	0.317	1.000	Do Not Test
Control vs. 1000	0.233	6	0.153	1.000	Do Not Test
Control vs. 1500	0.205	6	0.135	1.000	Do Not Test
1500 vs. DC	18.285	6	8.217	<0.001	Yes
1500 vs. 1750	0.278	6	0.197	1.000	Do Not Test
1500 vs. 1000	0.0275	6	0.0195	1.000	Do Not Test
1000 vs. DC	18.257	6	8.205	<0.001	Yes
1000 vs. 1750	0.250	6	0.178	1.000	Do Not Test
1750 vs. DC	18.007	6	8.093	<0.001	Yes

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

One Way Analysis of Variance

Dependent Variable: **Silt**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.074)
Equal Variance Test:	Passed	(P = 0.161)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	56.080	0.000	0.000
500	4	0	48.278	2.492	1.246
1000	4	0	50.103	1.529	0.764
1500	4	0	49.900	2.022	1.011
1750	4	0	50.423	1.663	0.831
Control	3	0	50.763	2.496	1.441

Source of Variation	DF	SS	MS	F	P
Between Groups	4	50.873	12.718	3.036	0.054
Residual	14	58.650	4.189		
Total	18	109.523			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.054).

Power of performed test with alpha = 0.050: 0.458

The power of the performed test (0.458) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

One Way Analysis of Variance

Dependent Variable: **Clay**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.683)
Equal Variance Test:	Passed	(P = 0.619)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	26.280	0.000	0.000
500	4	0	13.108	0.690	0.345
1000	4	0	14.000	0.832	0.416
1500	4	0	14.175	1.382	0.691
1750	4	0	13.930	0.598	0.299
Control	3	0	13.107	1.227	0.709

Source of Variation	DF	SS	MS	F	P
Between Groups	4	154.441	38.610	40.573	<0.001
Residual	14	13.323	0.952		
Total	18	167.763			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Clay**

Comparison	Diff of Means	p	q	P	P<0.050
DC vs. Control	13.173	6	16.539	<0.001	Yes
DC vs. 500	13.173	6	17.080	<0.001	Yes
DC vs. 1750	12.350	6	16.014	<0.001	Yes
DC vs. 1000	12.280	6	15.923	<0.001	Yes
DC vs. 1500	12.105	6	15.696	<0.001	Yes
1500 vs. Control	1.068	6	2.028	0.708	No
1500 vs. 500	1.068	6	2.189	0.642	Do Not Test
1500 vs. 1750	0.245	6	0.502	0.999	Do Not Test
1500 vs. 1000	0.175	6	0.359	1.000	Do Not Test
1000 vs. Control	0.893	6	1.696	0.830	Do Not Test
1000 vs. 500	0.893	6	1.830	0.784	Do Not Test
1000 vs. 1750	0.0700	6	0.144	1.000	Do Not Test
1750 vs. Control	0.823	6	1.563	0.871	Do Not Test
1750 vs. 500	0.822	6	1.686	0.833	Do Not Test
500 vs. Control	0.000833	6	0.00158	1.000	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Appendix 5 Sediment Chemistry Results.

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Bioresearches	**Lab No:**	1685884 SPv2
Contact:	S West	**Date Received:**	24-Nov-2016
	C/- Bioresearches	**Date Reported:**	22-Dec-2016 **(Amended)**
	PO Box 2828	**Quote No:**	
	Auckland 1140	**Order No:**	16138
		Client Reference:	Coastal Resources Limited - 150 K Disposal Area Sediments
		Submitted By:	S West

Sample Type: Sediment

Sample Name:		Control A 23-Nov-2016 2:15 pm	Control B 23-Nov-2016 2:00 pm	Control C 23-Nov-2016 1:45 pm	DC 23-Nov-2016 8:45 am	N500 23-Nov-2016 9:30 am
Lab Number:		1685884.1	1685884.2	1685884.3	1685884.4	1685884.5
Individual Tests						
Dry Matter	g/100g as rcvd	49	49	50	34	48
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	5	5	5.1	9.5	4
Total Recoverable Cadmium	mg/kg dry wt	0.10	< 0.10	0.12	0.081	0.17
Total Recoverable Chromium	mg/kg dry wt	22	24	25	22	22
Total Recoverable Copper	mg/kg dry wt	5.0	4.8	5.1	29	5.5
Total Recoverable Lead	mg/kg dry wt	4.4	4.5	4.8	26	4.4
Total Recoverable Mercury	mg/kg dry wt	0.047	0.050	0.046	0.123	0.048
Total Recoverable Nickel	mg/kg dry wt	17.1	16.3	17.2	10.0	16.3
Total Recoverable Zinc	mg/kg dry wt	29	31	32	95	30
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 14	< 13	< 13	< 19	< 14
C10 - C14	mg/kg dry wt	< 30	< 30	< 30	< 40	< 30
C15 - C36	mg/kg dry wt	< 60	< 60	< 60	< 80	< 60
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 100	< 90	< 100	< 140	< 100

Sample Name:		E500 23-Nov-2016 12:00 pm	S500 23-Nov-2016 12:15 pm	W500 23-Nov-2016 8:30 am	N1000 23-Nov-2016 9:45 am	E1000 23-Nov-2016 11:45 am
Lab Number:		1685884.6	1685884.7	1685884.8	1685884.9	1685884.10
Individual Tests						
Dry Matter	g/100g as rcvd	49	50	60	50	49
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	3.6	3.9	4.0	5	5
Total Recoverable Cadmium	mg/kg dry wt	0.16	0.12	0.10	0.11	0.13
Total Recoverable Chromium	mg/kg dry wt	21	21	22	20	23
Total Recoverable Copper	mg/kg dry wt	5.1	5.0	5.0	8.4	4.9
Total Recoverable Lead	mg/kg dry wt	4.2	4.1	4.2	4.2	4.4
Total Recoverable Mercury	mg/kg dry wt	0.046	0.037	0.038	0.038	0.052
Total Recoverable Nickel	mg/kg dry wt	15.1	14.4	16.1	14.8	15.8
Total Recoverable Zinc	mg/kg dry wt	29	28	29	30	31

Sample Type: Sediment						
Sample Name:		E500 23-Nov-2016 12:00 pm	S500 23-Nov-2016 12:15 pm	W500 23-Nov-2016 8:30 am	N1000 23-Nov-2016 9:45 am	E1000 23-Nov-2016 11:45 am
Lab Number:		1685884.6	1685884.7	1685884.8	1685884.9	1685884.10
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 30	< 30	< 11	< 14	< 13
C10 - C14	mg/kg dry wt	< 60	< 60	< 30	< 30	< 30
C15 - C36	mg/kg dry wt	< 110	< 110	< 50	< 60	< 60
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 190	< 190	< 80	< 100	< 90

Sample Name:		S1000 23-Nov-2016 12:30 pm	W1000 23-Nov-2016 8:15 am	N1500 23-Nov-2016 10:00 am	E1500 23-Nov-2016 11:00 am	S1500 23-Nov-2016 12:45 pm
Lab Number:		1685884.11	1685884.12	1685884.13	1685884.14	1685884.15
Individual Tests						
Dry Matter	g/100g as rcvd	49	52	48	51	49
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	4.1	3.6	4	4	5
Total Recoverable Cadmium	mg/kg dry wt	0.13	0.094	0.121	0.090	0.11
Total Recoverable Chromium	mg/kg dry wt	23	20	20	20	23
Total Recoverable Copper	mg/kg dry wt	5.0	5.2	4.7	4.2	4.7
Total Recoverable Lead	mg/kg dry wt	4.4	4.0	3.9	3.8	4.1
Total Recoverable Mercury	mg/kg dry wt	0.043	0.045	0.046	0.040	0.037
Total Recoverable Nickel	mg/kg dry wt	16.2	14.4	15.0	14.3	15.8
Total Recoverable Zinc	mg/kg dry wt	30	28	27	26	30
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 14	< 13	< 14	< 13	< 14
C10 - C14	mg/kg dry wt	< 30	< 30	< 30	< 30	< 30
C15 - C36	mg/kg dry wt	< 60	< 50	< 60	< 60	< 60
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 100	< 90	< 100	< 90	< 100

Sample Name:		W1500 23-Nov-2016 7:30 am	NE1750 23-Nov-2016 10:45 am	SE1750 23-Nov-2016 1:30 pm	SW1750 23-Nov-2016 2:30 pm	NW1750 23-Nov-2016 2:45 pm
Lab Number:		1685884.16	1685884.17	1685884.18	1685884.19	1685884.20
Individual Tests						
Dry Matter	g/100g as rcvd	52	48	50	48	48
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	3	4	5	4	3
Total Recoverable Cadmium	mg/kg dry wt	0.122	0.130	0.115	0.116	0.102
Total Recoverable Chromium	mg/kg dry wt	20	22	23	22	17.4
Total Recoverable Copper	mg/kg dry wt	5.6	4.7	4.6	4.9	4.4
Total Recoverable Lead	mg/kg dry wt	5.2	4.1	4.2	4.2	3.6
Total Recoverable Mercury	mg/kg dry wt	0.045	0.042	0.067	0.050	0.053
Total Recoverable Nickel	mg/kg dry wt	16.0	15.7	15.4	15.6	13.9
Total Recoverable Zinc	mg/kg dry wt	29	28	30	30	25
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 13	< 14	< 13	< 14	< 14
C10 - C14	mg/kg dry wt	< 30	< 30	< 30	< 30	< 30
C15 - C36	mg/kg dry wt	< 50	< 60	< 60	< 60	< 60
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 90	< 100	< 90	< 100	< 100

Analyst's Comments

Amended Report: This report replaces an earlier report issued on 05 Dec 2016 at 12:17 pm
Reason for amendment: Following a client query [QOWQ 64060], the mercury analysis was repeated on sample 1685884.20. It was found that spot contamination had elevated the initial result and the repeated result is now reported.

Appendix No.1 - Particle size Report -1685884

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-20
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, trace level.	0.010 - 0.4 mg/kg dry wt	1-20
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	1-20
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-20
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-20
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-20

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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Ara Heron BSc (Tech)
Client Services Manager - Environmental

Appendix 6 Sediment Chemistry Statistical Tests

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Dry**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
DC	1	0	34.000	34.000	34.000
500	4	0	49.500	48.250	57.500
1000	4	0	49.500	49.000	51.500
1500	4	0	50	48.250	51.750
1750	4	0	48.000	48.000	49.500
Control	3	0	49.000	49.000	50

H = 5.949 with 5 degrees of freedom. (P = 0.311)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.311)

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Dry**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)
Equal Variance Test: Passed (P = 0.817)

Source of Variation	DF	SS	MS	F	P
Volume	3	548.336	182.779	37.142	<0.001
Site	5	54.033	10.807	2.196	0.067
Volume x Site	15	619.233	41.282	8.389	<0.001
Residual	56	275.583	4.921		
Total	79	1137.888	14.404		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 0.386
Power of performed test with alpha = 0.0500: for Volume x Site : 1.000

Least square means for **Volume** :

Group	Mean
10	50.667
50	55.056
100	53.583
150	47.264

Std Err of LS Mean = 0.565

Least square means for **Site** :

Group	Mean	SEM
DC	53.000	1.109
500	52.625	0.555
1000	51.500	0.555
1500	51.250	0.555
1750	50.312	0.555
Control	51.167	0.640

Least square means for **Volume x Site** :

Group	Mean	SEM
10 x DC	47.000	2.218
10 x 500	53.000	1.109
10 x 1000	51.000	1.109
10 x 1500	51.250	1.109
10 x 1750	50.750	1.109
10 x Control	51.000	1.281
50 x DC	67.000	2.218
50 x 500	52.250	1.109
50 x 1000	53.000	1.109
50 x 1500	52.500	1.109
50 x 1750	52.250	1.109
50 x Control	53.333	1.281
100 x DC	64.000	2.218
100 x 500	53.500	1.109
100 x 1000	52.000	1.109
100 x 1500	51.250	1.109
100 x 1750	49.750	1.109
100 x Control	51.000	1.281
150 x DC	34.000	2.218
150 x 500	51.750	1.109
150 x 1000	50	1.109
150 x 1500	50	1.109
150 x 1750	48.500	1.109
150 x Control	49.333	1.281

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
500 vs. DC	6.000	2.419	0.248	No
1500 vs. DC	4.250	1.714	0.742	No
1000 vs. DC	4.000	1.613	0.788	No
Control vs. DC	4.000	1.562	0.796	No
1750 vs. DC	3.750	1.512	0.800	No
500 vs. 1750	2.250	1.434	0.819	No
500 vs. 1000	2.000	1.275	0.877	No
500 vs. Control	2.000	1.180	0.892	No
500 vs. 1500	1.750	1.116	0.889	No
1500 vs. 1750	0.500	0.319	1.000	No
1500 vs. 1000	0.250	0.159	1.000	No
1000 vs. 1750	0.250	0.159	1.000	No
1500 vs. Control	0.250	0.148	0.998	No
Control vs. 1750	0.250	0.148	0.986	No
1000 vs. Control	0.000	0.000	1.000	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	14.750	5.947	<0.001	Yes
DC vs. 500	14.750	5.947	<0.001	Yes
DC vs. 1500	14.500	5.846	<0.001	Yes
DC vs. 1000	14.000	5.645	<0.001	Yes
DC vs. Control	13.667	5.335	<0.001	Yes
Control vs. 1750	1.083	0.639	0.999	No
Control vs. 500	1.083	0.639	0.999	No
Control vs. 1500	0.833	0.492	1.000	No
1000 vs. 1750	0.750	0.478	0.999	No
1000 vs. 500	0.750	0.478	0.998	No
1000 vs. 1500	0.500	0.319	0.999	No
Control vs. 1000	0.333	0.197	0.999	No
1500 vs. 1750	0.250	0.159	0.998	No
1500 vs. 500	0.250	0.159	0.984	No
500 vs. 1750	0.000	0.000	1.000	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	14.250	5.745	<0.001	Yes
DC vs. 1500	12.750	5.141	<0.001	Yes
DC vs. Control	13.000	5.075	<0.001	Yes
DC vs. 1000	12.000	4.838	<0.001	Yes
DC vs. 500	10.500	4.234	<0.001	Yes
500 vs. 1750	3.750	2.391	0.185	No
500 vs. Control	2.500	1.476	0.758	No
1000 vs. 1750	2.250	1.434	0.745	No
500 vs. 1500	2.250	1.434	0.698	No
1500 vs. 1750	1.500	0.956	0.920	No
500 vs. 1000	1.500	0.956	0.878	No
Control vs. 1750	1.250	0.738	0.917	No
1000 vs. Control	1.000	0.590	0.913	No
1000 vs. 1500	0.750	0.478	0.866	No
1500 vs. Control	0.250	0.148	0.883	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
500 vs. DC	17.750	7.157	<0.001	Yes
1500 vs. DC	16.000	6.451	<0.001	Yes
1000 vs. DC	16.000	6.451	<0.001	Yes
Control vs. DC	15.333	5.986	<0.001	Yes
1750 vs. DC	14.500	5.846	<0.001	Yes
500 vs. 1750	3.250	2.072	0.355	No
500 vs. Control	2.417	1.426	0.790	No
500 vs. 1000	1.750	1.116	0.919	No
500 vs. 1500	1.750	1.116	0.889	No
1500 vs. 1750	1.500	0.956	0.920	No
1000 vs. 1750	1.500	0.956	0.878	No
Control vs. 1750	0.833	0.492	0.980	No
1500 vs. Control	0.667	0.393	0.972	No
1000 vs. Control	0.667	0.393	0.907	No
1500 vs. 1000	0.000	0.000	1.000	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	33.000	10.519	<0.001	Yes
100 vs. 150	30.000	9.563	<0.001	Yes
50 vs. 10	20.000	6.375	<0.001	Yes
100 vs. 10	17.000	5.419	<0.001	Yes
10 vs. 150	13.000	4.144	<0.001	Yes
50 vs. 100	3.000	0.956	0.343	No

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	1.750	1.116	0.848	No
100 vs. 50	1.250	0.797	0.939	No
10 vs. 150	1.250	0.797	0.894	No
10 vs. 50	0.750	0.478	0.951	No
100 vs. 10	0.500	0.319	0.938	No
50 vs. 150	0.500	0.319	0.751	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	3.000	1.913	0.314	No
50 vs. 10	2.000	1.275	0.688	No
100 vs. 150	2.000	1.275	0.606	No
50 vs. 100	1.000	0.638	0.894	No
100 vs. 10	1.000	0.638	0.776	No
10 vs. 150	1.000	0.638	0.526	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	2.500	1.594	0.525	No
50 vs. 100	1.250	0.797	0.939	No
50 vs. 10	1.250	0.797	0.894	No
10 vs. 150	1.250	0.797	0.814	No
100 vs. 150	1.250	0.797	0.674	No
10 vs. 100	0.000	0.000	1.000	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	3.750	2.391	0.115	No
50 vs. 100	2.500	1.594	0.462	No
10 vs. 150	2.250	1.434	0.495	No
50 vs. 10	1.500	0.956	0.716	No
100 vs. 150	1.250	0.797	0.674	No
10 vs. 100	1.000	0.638	0.526	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	4.000	2.208	0.174	No
50 vs. 100	2.333	1.288	0.678	No
50 vs. 10	2.333	1.288	0.596	No
10 vs. 150	1.667	0.920	0.740	No
100 vs. 150	1.667	0.920	0.592	No
10 vs. 100	0.000	0.000	1.000	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Arsenic**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
DC	1	0	9.500	9.500	9.500
500	4	0	3.950	3.675	4.000
1000	4	0	4.550	3.725	5.000
1500	4	0	4.000	3.250	4.750
1750	4	0	4.000	3.250	4.750
Control	3	0	5.000	5.000	5.100

H = 9.348 with 5 degrees of freedom. (P = 0.096)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.096)

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Arsenic**
Normality Test (Shapiro-Wilk) Passed (P = 0.194)
Equal Variance Test: Failed (P < 0.050)

Source of Variation	DF	SS	MS	F	P
Volume	3	17.645	5.882	15.133	<0.001
Site	5	16.952	3.390	8.723	<0.001
Volume x Site	15	27.112	1.807	4.650	<0.001
Residual	56	21.766	0.389		
Total	79	81.360	1.030		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 0.999
Power of performed test with alpha = 0.0500: for Volume x Site : 0.998

Least square means for **Volume** :

Group	Mean
10	5.774
50	4.337
100	4.704
150	5.139

Std Err of LS Mean = 0.159

Least square means for **Site** :

Group	Mean	SEM
DC	6.150	0.312
500	4.431	0.156
1000	4.606	0.156
1500	4.619	0.156
1750	4.625	0.156
Control	5.500	0.180

Least square means for **Volume x Site** :

Group	Mean	SEM
10 x DC	7.500	0.623
10 x 500	5.100	0.312
10 x 1000	5.325	0.312
10 x 1500	5.525	0.312
10 x 1750	5.425	0.312
10 x Control	5.767	0.360
50 x DC	3.600	0.623
50 x 500	4.500	0.312
50 x 1000	4.000	0.312
50 x 1500	4.250	0.312
50 x 1750	4.175	0.312
50 x Control	5.500	0.360
100 x DC	4.000	0.623
100 x 500	4.250	0.312
100 x 1000	4.675	0.312
100 x 1500	4.700	0.312
100 x 1750	4.900	0.312
100 x Control	5.700	0.360
150 x DC	9.500	0.623
150 x 500	3.875	0.312
150 x 1000	4.425	0.312
150 x 1500	4.000	0.312
150 x 1750	4.000	0.312
150 x Control	5.033	0.360

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 500	2.400	3.443	0.016	Yes
DC vs. 1000	2.175	3.120	0.039	Yes
DC vs. 1750	2.075	2.977	0.054	No
DC vs. 1500	1.975	2.833	0.074	No
DC vs. Control	1.733	2.408	0.194	No
Control vs. 500	0.667	1.400	0.839	No
1500 vs. 500	0.425	0.964	0.976	No
Control vs. 1000	0.442	0.928	0.971	No
1750 vs. 500	0.325	0.737	0.987	No
Control vs. 1750	0.342	0.718	0.979	No
1000 vs. 500	0.225	0.510	0.991	No
Control vs. 1500	0.242	0.508	0.978	No
1500 vs. 1000	0.200	0.454	0.958	No
1500 vs. 1750	0.1000	0.227	0.968	No
1750 vs. 1000	0.100	0.227	0.821	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 1000	1.500	3.150	0.039	Yes
Control vs. 1750	1.325	2.783	0.098	No
Control vs. DC	1.900	2.639	0.131	No
Control vs. 1500	1.250	2.625	0.126	No
Control vs. 500	1.000	2.100	0.363	No
500 vs. DC	0.900	1.291	0.895	No
500 vs. 1000	0.500	1.134	0.935	No
1500 vs. DC	0.650	0.933	0.970	No
1750 vs. DC	0.575	0.825	0.976	No
500 vs. 1750	0.325	0.737	0.976	No
1000 vs. DC	0.400	0.574	0.985	No
1500 vs. 1000	0.250	0.567	0.967	No
500 vs. 1500	0.250	0.567	0.922	No
1750 vs. 1000	0.175	0.397	0.906	No
1500 vs. 1750	0.0750	0.170	0.866	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 500	1.450	3.045	0.052	No
Control vs. DC	1.700	2.361	0.265	No
Control vs. 1000	1.025	2.153	0.376	No
Control vs. 1500	1.000	2.100	0.389	No
Control vs. 1750	0.800	1.680	0.680	No
1750 vs. 500	0.650	1.474	0.794	No
1750 vs. DC	0.900	1.291	0.869	No
1500 vs. 500	0.450	1.021	0.950	No
1500 vs. DC	0.700	1.004	0.932	No
1000 vs. DC	0.675	0.968	0.915	No
1000 vs. 500	0.425	0.964	0.874	No
1750 vs. 1000	0.225	0.510	0.977	No
1750 vs. 1500	0.200	0.454	0.958	No
500 vs. DC	0.250	0.359	0.922	No
1500 vs. 1000	0.0250	0.0567	0.955	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 500	5.625	8.070	<0.001	Yes
DC vs. 1500	5.500	7.891	<0.001	Yes
DC vs. 1750	5.500	7.891	<0.001	Yes
DC vs. 1000	5.075	7.281	<0.001	Yes
DC vs. Control	4.467	6.205	<0.001	Yes
Control vs. 500	1.158	2.433	0.168	No
Control vs. 1500	1.033	2.170	0.269	No
Control vs. 1750	1.033	2.170	0.243	No
Control vs. 1000	0.608	1.278	0.802	No
1000 vs. 500	0.550	1.248	0.770	No
1000 vs. 1500	0.425	0.964	0.874	No
1000 vs. 1750	0.425	0.964	0.809	No
1750 vs. 500	0.125	0.284	0.989	No
1500 vs. 500	0.125	0.284	0.951	No
1750 vs. 1500	0.000	0.000	1.000	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 50	5.900	6.692	<0.001	Yes
150 vs. 100	5.500	6.238	<0.001	Yes
10 vs. 50	3.900	4.423	<0.001	Yes
10 vs. 100	3.500	3.970	<0.001	Yes
150 vs. 10	2.000	2.268	0.054	No
100 vs. 50	0.400	0.454	0.652	No

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	1.225	2.779	0.044	Yes
10 vs. 100	0.850	1.928	0.262	No
50 vs. 150	0.625	1.418	0.506	No
10 vs. 50	0.600	1.361	0.447	No
100 vs. 150	0.375	0.851	0.638	No
50 vs. 100	0.250	0.567	0.573	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 50	1.325	3.006	0.024	Yes
10 vs. 150	0.900	2.042	0.209	No
100 vs. 50	0.675	1.531	0.431	No
10 vs. 100	0.650	1.474	0.377	No
150 vs. 50	0.425	0.964	0.563	No
100 vs. 150	0.250	0.567	0.573	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	1.525	3.459	0.006	Yes
10 vs. 50	1.275	2.892	0.027	Yes
10 vs. 100	0.825	1.871	0.241	No
100 vs. 150	0.700	1.588	0.314	No
100 vs. 50	0.450	1.021	0.526	No
50 vs. 150	0.250	0.567	0.573	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	1.425	3.232	0.012	Yes
10 vs. 50	1.250	2.836	0.031	Yes
100 vs. 150	0.900	2.042	0.171	No
100 vs. 50	0.725	1.645	0.285	No
10 vs. 100	0.525	1.191	0.420	No
50 vs. 150	0.175	0.397	0.693	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	0.733	1.441	0.637	No
100 vs. 150	0.667	1.310	0.663	No
50 vs. 150	0.467	0.917	0.836	No
10 vs. 50	0.267	0.524	0.937	No
100 vs. 50	0.200	0.393	0.908	No
10 vs. 100	0.0667	0.131	0.896	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Cadmium**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.880)
Equal Variance Test:	Failed	(P < 0.050)

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
DC	1	0	0.0810	0.0810	0.0810
500	4	0	0.140	0.105	0.168
1000	4	0	0.120	0.0980	0.130
1500	4	0	0.115	0.0950	0.122
1750	4	0	0.116	0.105	0.127
Control	3	0	0.1000	0.1000	0.120

H = 5.086 with 5 degrees of freedom. (P = 0.405)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.405)

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Cadmium**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.588)
Equal Variance Test:	Failed	(P < 0.050)

Source of Variation	DF	SS	MS	F	P
Volume	3	0.00221	0.000736	3.062	0.035
Site	5	0.0176	0.00351	14.612	<0.001
Volume x Site	15	0.00566	0.000377	1.570	0.113
Residual	56	0.0135	0.000240		
Total	79	0.0404	0.000511		

The difference in the mean values among the different levels of Volume is greater than would be expected by chance after allowing for effects of differences in Site. There is a statistically significant difference (P = 0.035). To isolate which group(s) differ from the others use a multiple comparison procedure.

The difference in the mean values among the different levels of Site is greater than would be expected by chance after allowing for effects of differences in Volume. There is a statistically significant difference (P = <0.001). To isolate which group(s) differ from the others use a multiple comparison procedure.

The effect of different levels of Volume does not depend on what level of Site is present. There is not a statistically significant interaction between Volume and Site. (P = 0.113)

Power of performed test with alpha = 0.0500: for Volume : 0.493
Power of performed test with alpha = 0.0500: for Site : 1.000
Power of performed test with alpha = 0.0500: for Volume x Site : 0.311

Least square means for **Volume :**

Group	Mean
10	0.120
50	0.114
100	0.103
150	0.111

Std Err of LS Mean = 0.00395

Least square means for **Site** :

Group	Mean	SEM
DC	0.0565	0.00775
500	0.125	0.00388
1000	0.125	0.00388
1500	0.122	0.00388
1750	0.126	0.00388
Control	0.119	0.00448

Least square means for **Volume x Site** :

Group	Mean	SEM
10 x DC	0.0640	0.0155
10 x 500	0.133	0.00775
10 x 1000	0.134	0.00775
10 x 1500	0.129	0.00775
10 x 1750	0.134	0.00775
10 x Control	0.127	0.00895
50 x DC	0.0340	0.0155
50 x 500	0.131	0.00775
50 x 1000	0.134	0.00775
50 x 1500	0.123	0.00775
50 x 1750	0.134	0.00775
50 x Control	0.126	0.00895
100 x DC	0.0470	0.0155
100 x 500	0.0967	0.00775
100 x 1000	0.117	0.00775
100 x 1500	0.124	0.00775
100 x 1750	0.120	0.00775
100 x Control	0.115	0.00895
150 x DC	0.0810	0.0155
150 x 500	0.137	0.00775
150 x 1000	0.116	0.00775
150 x 1500	0.111	0.00775
150 x 1750	0.116	0.00775
150 x Control	0.107	0.00895

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Volume**

Comparison	Diff of Means	t	P	P<0.050
10 vs. 100	0.0167	2.993	0.024	Yes
50 vs. 100	0.0103	1.846	0.305	No
10 vs. 150	0.00885	1.585	0.396	No
150 vs. 100	0.00786	1.408	0.417	No
10 vs. 50	0.00640	1.147	0.447	No
50 vs. 150	0.00244	0.438	0.663	No

Comparisons for factor: **Site**

Comparison	Diff of Means	t	P	P<0.050
1750 vs. DC	0.0696	8.027	<0.001	Yes
1000 vs. DC	0.0688	7.933	<0.001	Yes
500 vs. DC	0.0681	7.861	<0.001	Yes
1500 vs. DC	0.0651	7.515	<0.001	Yes
Control vs. DC	0.0623	6.955	<0.001	Yes
1750 vs. Control	0.00731	1.235	0.919	No
1000 vs. Control	0.00650	1.098	0.946	No
500 vs. Control	0.00587	0.992	0.957	No
1750 vs. 1500	0.00444	0.810	0.978	No
1000 vs. 1500	0.00362	0.661	0.986	No
500 vs. 1500	0.00300	0.547	0.988	No
1500 vs. Control	0.00288	0.486	0.981	No
1750 vs. 500	0.00144	0.262	0.991	No
1750 vs. 1000	0.000812	0.148	0.986	No
1000 vs. 500	0.000625	0.114	0.910	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Chromium**
Normality Test (Shapiro-Wilk) Passed (P = 0.488)
Equal Variance Test: Passed (P = 0.744)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	22.000	0.000	0.000
500	4	0	21.500	0.577	0.289
1000	4	0	21.500	1.732	0.866
1500	4	0	20.750	1.500	0.750
1750	4	0	21.100	2.511	1.256
Control	3	0	23.667	1.528	0.882

Source of Variation	DF	SS	MS	F	P
Between Groups	4	16.935	4.234	1.469	0.264
Residual	14	40.337	2.881		
Total	18	57.272			

The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.264).

Power of performed test with alpha = 0.050: 0.128

The power of the performed test (0.128) is below the desired power of 0.800.
Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Chromium**
Normality Test (Shapiro-Wilk) Passed (P = 0.153)
Equal Variance Test: Passed (P = 0.438)

Source of Variation	DF	SS	MS	F	P
Volume	3	193.327	64.442	35.670	<0.001
Site	5	29.823	5.965	3.302	0.011
Volume x Site	15	128.466	8.564	4.741	<0.001
Residual	56	101.170	1.807		
Total	79	402.590	5.096		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 0.699
Power of performed test with alpha = 0.0500: for Volume x Site : 0.999

Least square means for **Volume** :

Group	Mean
10	24.472
50	22.167
100	26.111
150	21.753

Std Err of LS Mean = 0.342

Least square means for **Site** :

Group	Mean	SEM
DC	24.375	0.672
500	22.750	0.336
1000	23.312	0.336
1500	23.312	0.336
1750	23.337	0.336
Control	24.667	0.388

Least square means for **Volume x Site** :

Group	Mean	SEM
10 x DC	24.000	1.344
10 x 500	24.000	0.672
10 x 1000	23.750	0.672
10 x 1500	25.000	0.672
10 x 1750	24.750	0.672
10 x Control	25.333	0.776
50 x DC	17.500	1.344
50 x 500	22.500	0.672
50 x 1000	23.000	0.672
50 x 1500	23.250	0.672
50 x 1750	22.750	0.672
50 x Control	24.000	0.776
100 x DC	34.000	1.344
100 x 500	23.000	0.672
100 x 1000	25.000	0.672
100 x 1500	24.250	0.672
100 x 1750	24.750	0.672
100 x Control	25.667	0.776
150 x DC	22.000	1.344
150 x 500	21.500	0.672
150 x 1000	21.500	0.672
150 x 1500	20.750	0.672
150 x 1750	21.100	0.672
150 x Control	23.667	0.776

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Volume**

Comparison	Diff of Means	t	P	P<0.050
100 vs. 150	4.358	9.006	<0.001	Yes
100 vs. 50	3.944	8.151	<0.001	Yes
10 vs. 150	2.719	5.619	<0.001	Yes
10 vs. 50	2.306	4.764	<0.001	Yes
100 vs. 10	1.639	3.387	0.003	Yes
50 vs. 150	0.414	0.855	0.396	No

Comparisons for factor: **Site**

Comparison	Diff of Means	t	P	P<0.050
Control vs. 500	1.917	3.734	0.007	Yes
Control vs. 1500	1.354	2.638	0.141	No
Control vs. 1000	1.354	2.638	0.131	No
Control vs. 1750	1.329	2.590	0.137	No
DC vs. 500	1.625	2.163	0.323	No
DC vs. 1500	1.063	1.414	0.831	No
DC vs. 1000	1.063	1.414	0.798	No
DC vs. 1750	1.038	1.381	0.781	No
1750 vs. 500	0.588	1.236	0.827	No
1000 vs. 500	0.563	1.184	0.810	No
1500 vs. 500	0.563	1.184	0.749	No
Control vs. DC	0.292	0.376	0.993	No
1750 vs. 1000	0.0250	0.0526	1.000	No
1750 vs. 1500	0.0250	0.0526	0.998	No
1000 vs. 1500	0.000	0.000	1.000	No

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 1000	1.583	1.542	0.873	No
1500 vs. 1000	1.250	1.315	0.951	No
Control vs. 500	1.333	1.299	0.944	No
1750 vs. 1000	1.000	1.052	0.985	No
1500 vs. 500	1.000	1.052	0.979	No
Control vs. DC	1.333	0.859	0.993	No
1750 vs. 500	0.750	0.789	0.994	No
1500 vs. DC	1.000	0.665	0.997	No
Control vs. 1750	0.583	0.568	0.997	No
1750 vs. DC	0.750	0.499	0.997	No
Control vs. 1500	0.333	0.325	0.999	No
1500 vs. 1750	0.250	0.263	0.998	No
500 vs. 1000	0.250	0.263	0.991	No
DC vs. 1000	0.250	0.166	0.983	No
DC vs. 500	0.000	0.000	1.000	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
Control vs. DC	6.500	4.188	0.002	Yes
1500 vs. DC	5.750	3.826	0.005	Yes
1000 vs. DC	5.500	3.660	0.007	Yes
1750 vs. DC	5.250	3.494	0.011	Yes
500 vs. DC	5.000	3.327	0.017	Yes
Control vs. 500	1.500	1.461	0.802	No
Control vs. 1750	1.250	1.218	0.903	No
Control vs. 1000	1.000	0.974	0.961	No
1500 vs. 500	0.750	0.789	0.981	No
Control vs. 1500	0.750	0.731	0.977	No
1000 vs. 500	0.500	0.526	0.990	No
1500 vs. 1750	0.500	0.526	0.975	No
1000 vs. 1750	0.250	0.263	0.991	No
1750 vs. 500	0.250	0.263	0.957	No
1500 vs. 1000	0.250	0.263	0.793	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 500	11.000	7.320	<0.001	Yes
DC vs. 1500	9.750	6.488	<0.001	Yes
DC vs. 1750	9.250	6.155	<0.001	Yes
DC vs. 1000	9.000	5.989	<0.001	Yes
DC vs. Control	8.333	5.369	<0.001	Yes
Control vs. 500	2.667	2.598	0.113	No
1000 vs. 500	2.000	2.104	0.307	No
1750 vs. 500	1.750	1.841	0.445	No
Control vs. 1500	1.417	1.380	0.736	No
1500 vs. 500	1.250	1.315	0.725	No
Control vs. 1750	0.917	0.893	0.905	No
1000 vs. 1500	0.750	0.789	0.897	No
Control vs. 1000	0.667	0.649	0.889	No
1750 vs. 1500	0.500	0.526	0.841	No
1000 vs. 1750	0.250	0.263	0.793	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 1500	2.917	2.841	0.090	No
Control vs. 1750	2.567	2.500	0.195	No
Control vs. 1000	2.167	2.111	0.406	No
Control vs. 500	2.167	2.111	0.382	No
Control vs. DC	1.667	1.074	0.976	No
DC vs. 1500	1.250	0.832	0.995	No
1000 vs. 1500	0.750	0.789	0.994	No
500 vs. 1500	0.750	0.789	0.989	No
DC vs. 1750	0.900	0.599	0.996	No
1000 vs. 1750	0.400	0.421	0.999	No
500 vs. 1750	0.400	0.421	0.996	No
1750 vs. 1500	0.350	0.368	0.993	No
DC vs. 500	0.500	0.333	0.983	No
DC vs. 1000	0.500	0.333	0.933	No
500 vs. 1000	0.000	0.000	1.000	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 50	16.500	8.680	<0.001	Yes
100 vs. 150	12.000	6.313	<0.001	Yes
100 vs. 10	10	5.261	<0.001	Yes
10 vs. 50	6.500	3.420	0.004	Yes
150 vs. 50	4.500	2.367	0.042	Yes
10 vs. 150	2.000	1.052	0.297	No

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	2.500	2.630	0.064	No
100 vs. 150	1.500	1.578	0.473	No
10 vs. 50	1.500	1.578	0.401	No
50 vs. 150	1.000	1.052	0.653	No
10 vs. 100	1.000	1.052	0.506	No
100 vs. 50	0.500	0.526	0.601	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	3.500	3.683	0.003	Yes
10 vs. 150	2.250	2.367	0.102	No
100 vs. 50	2.000	2.104	0.150	No
50 vs. 150	1.500	1.578	0.319	No
100 vs. 10	1.250	1.315	0.350	No
10 vs. 50	0.750	0.789	0.433	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	4.250	4.472	<0.001	Yes
100 vs. 150	3.500	3.683	0.003	Yes
50 vs. 150	2.500	2.630	0.043	Yes
10 vs. 50	1.750	1.841	0.198	No
100 vs. 50	1.000	1.052	0.506	No
10 vs. 100	0.750	0.789	0.433	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	3.650	3.840	0.002	Yes
100 vs. 150	3.650	3.840	0.002	Yes
10 vs. 50	2.000	2.104	0.150	No
100 vs. 50	2.000	2.104	0.115	No
50 vs. 150	1.650	1.736	0.168	No
10 vs. 100	0.000	0.000	1.000	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	2.000	1.822	0.368	No
100 vs. 50	1.667	1.519	0.514	No
10 vs. 150	1.667	1.519	0.439	No
10 vs. 50	1.333	1.215	0.543	No
100 vs. 10	0.333	0.304	0.944	No
50 vs. 150	0.333	0.304	0.762	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Copper**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
DC	1	0	29.000	29.000	29.000
500	4	0	5.050	5.000	5.400
1000	4	0	5.100	4.925	7.600
1500	4	0	4.700	4.325	5.375
1750	4	0	4.650	4.450	4.850
Control	3	0	5.000	4.800	5.100

H = 10.198 with 5 degrees of freedom. (P = 0.070)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.070)

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Copper**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)
Equal Variance Test: Passed (P = 0.870)

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Volume	3	140.316	46.772	116.406	<0.001
Site	5	1300.267	260.053	647.220	<0.001
Volume x Site	15	337.788	22.519	56.046	<0.001
Residual	56	22.501	0.402		
Total	79	1675.322	21.207		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 1.000
Power of performed test with alpha = 0.0500: for Volume x Site : 1.000

Least square means for **Volume** :

Group	**Mean**
10	10.094
50	6.462
100	6.879
150	9.074

Std Err of LS Mean = 0.161

Least square means for **Site** :

Group	**Mean**	**SEM**
DC	23.525	0.317
500	5.419	0.158
1000	5.231	0.158
1500	4.925	0.158
1750	4.806	0.158
Control	4.858	0.183

Least square means for **Volume x Site :**

Group	**Mean**	**SEM**
10 x DC	36.000	0.634
10 x 500	5.125	0.317
10 x 1000	4.850	0.317
10 x 1500	4.850	0.317
10 x 1750	4.875	0.317
10 x Control	4.867	0.366
50 x DC	14.300	0.634
50 x 500	5.525	0.317
50 x 1000	4.825	0.317
50 x 1500	4.825	0.317
50 x 1750	4.600	0.317
50 x Control	4.700	0.366
100 x DC	14.800	0.634
100 x 500	5.875	0.317
100 x 1000	5.375	0.317
100 x 1500	5.225	0.317
100 x 1750	5.100	0.317
100 x Control	4.900	0.366
150 x DC	29.000	0.634
150 x 500	5.150	0.317
150 x 1000	5.875	0.317
150 x 1500	4.800	0.317
150 x 1750	4.650	0.317
150 x Control	4.967	0.366

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1000	31.150	43.954	<0.001	Yes
DC vs. 1500	31.150	43.954	<0.001	Yes
DC vs. 1750	31.125	43.919	<0.001	Yes
DC vs. 500	30.875	43.566	<0.001	Yes
DC vs. Control	31.133	42.535	<0.001	Yes
500 vs. 1500	0.275	0.614	1.000	No
500 vs. 1000	0.275	0.614	0.999	No
500 vs. 1750	0.250	0.558	0.999	No
500 vs. Control	0.258	0.534	0.998	No
1750 vs. 1500	0.0250	0.0558	1.000	No
1750 vs. 1000	0.0250	0.0558	1.000	No
Control vs. 1500	0.0167	0.0344	1.000	No
Control vs. 1000	0.0167	0.0344	1.000	No
1750 vs. Control	0.00833	0.0172	1.000	No
1000 vs. 1500	0.000	0.000	1.000	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	9.700	13.687	<0.001	Yes
DC vs. 1500	9.475	13.370	<0.001	Yes
DC vs. 1000	9.475	13.370	<0.001	Yes
DC vs. Control	9.600	13.116	<0.001	Yes
DC vs. 500	8.775	12.382	<0.001	Yes
500 vs. 1750	0.925	2.064	0.360	No
500 vs. Control	0.825	1.704	0.588	No
500 vs. 1500	0.700	1.562	0.653	No
500 vs. 1000	0.700	1.562	0.604	No
1000 vs. 1750	0.225	0.502	0.997	No
1500 vs. 1750	0.225	0.502	0.992	No
1000 vs. Control	0.125	0.258	0.998	No
1500 vs. Control	0.125	0.258	0.992	No
Control vs. 1750	0.100	0.207	0.973	No
1000 vs. 1500	0.000	0.000	1.000	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	9.700	13.687	<0.001	Yes
DC vs. Control	9.900	13.526	<0.001	Yes
DC vs. 1500	9.575	13.511	<0.001	Yes
DC vs. 1000	9.425	13.299	<0.001	Yes
DC vs. 500	8.925	12.594	<0.001	Yes
500 vs. Control	0.975	2.014	0.394	No
500 vs. 1750	0.775	1.729	0.569	No
500 vs. 1500	0.650	1.450	0.734	No
500 vs. 1000	0.500	1.116	0.889	No
1000 vs. Control	0.475	0.981	0.910	No
1500 vs. Control	0.325	0.671	0.970	No
1000 vs. 1750	0.275	0.614	0.956	No
1750 vs. Control	0.200	0.413	0.968	No
1000 vs. 1500	0.150	0.335	0.932	No
1500 vs. 1750	0.125	0.279	0.781	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	24.350	34.359	<0.001	Yes
DC vs. 1500	24.200	34.147	<0.001	Yes
DC vs. 500	23.850	33.653	<0.001	Yes
DC vs. Control	24.033	32.835	<0.001	Yes
DC vs. 1000	23.125	32.630	<0.001	Yes
1000 vs. 1750	1.225	2.733	0.081	No
1000 vs. 1500	1.075	2.398	0.165	No
1000 vs. Control	0.908	1.876	0.420	No
1000 vs. 500	0.725	1.618	0.562	No
500 vs. 1750	0.500	1.116	0.848	No
500 vs. 1500	0.350	0.781	0.944	No
Control vs. 1750	0.317	0.654	0.945	No
500 vs. Control	0.183	0.379	0.975	No
Control vs. 1500	0.167	0.344	0.928	No
1500 vs. 1750	0.150	0.335	0.739	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 50	21.700	24.207	<0.001	Yes
10 vs. 100	21.200	23.649	<0.001	Yes
150 vs. 50	14.700	16.398	<0.001	Yes
150 vs. 100	14.200	15.840	<0.001	Yes
10 vs. 150	7.000	7.809	<0.001	Yes
100 vs. 50	0.500	0.558	0.579	No

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 10	0.750	1.673	0.468	No
100 vs. 150	0.725	1.618	0.446	No
50 vs. 10	0.400	0.892	0.848	No
50 vs. 150	0.375	0.837	0.791	No
100 vs. 50	0.350	0.781	0.684	No
150 vs. 10	0.0250	0.0558	0.956	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 50	1.050	2.343	0.129	No
150 vs. 10	1.025	2.287	0.123	No
100 vs. 50	0.550	1.227	0.639	No
100 vs. 10	0.525	1.171	0.572	No
150 vs. 100	0.500	1.116	0.466	No
10 vs. 50	0.0250	0.0558	0.956	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	0.425	0.948	0.923	No
100 vs. 50	0.400	0.892	0.905	No
100 vs. 10	0.375	0.837	0.876	No
10 vs. 150	0.0500	0.112	0.999	No
10 vs. 50	0.0250	0.0558	0.998	No
50 vs. 150	0.0250	0.0558	0.956	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 50	0.500	1.116	0.848	No
100 vs. 150	0.450	1.004	0.854	No
10 vs. 50	0.275	0.614	0.956	No
10 vs. 150	0.225	0.502	0.944	No
100 vs. 10	0.225	0.502	0.854	No
150 vs. 50	0.0500	0.112	0.912	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 50	0.267	0.515	0.996	No
100 vs. 50	0.200	0.386	0.998	No
10 vs. 50	0.167	0.322	0.996	No
150 vs. 10	0.1000	0.193	0.996	No
150 vs. 100	0.0667	0.129	0.990	No
100 vs. 10	0.0333	0.0644	0.949	No

One Way Analysis of Variance between Sites after 150,000m^3Disposal.

Dependent Variable: **Lead**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
DC	1	0	26.000	26.000	26.000
500	4	0	4.200	4.125	4.350
1000	4	0	4.300	4.050	4.400
1500	4	0	4.000	3.825	4.925
1750	4	0	4.150	3.725	4.200
Control	3	0	4.500	4.400	4.800

H = 8.542 with 5 degrees of freedom. (P = 0.129)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference (P = 0.129)

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Lead**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)
Equal Variance Test: Passed (P = 0.671)

Source of Variation	DF	SS	MS	F	P
Volume	3	133.745	44.582	893.497	<0.001
Site	5	494.142	98.828	1980.695	<0.001
Volume x Site	15	299.923	19.995	400.732	<0.001
Residual	56	2.794	0.0499		
Total	79	812.860	10.289		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 1.000
Power of performed test with alpha = 0.0500: for Volume x Site : 1.000

Least square means for **Volume** :

Group	Mean
10	7.624
50	4.636
100	5.022
150	7.886

Std Err of LS Mean = 0.0569

Least square means for **Site** :

Group	Mean	SEM
DC	15.775	0.112
500	4.325	0.0558
1000	4.369	0.0558
1500	4.369	0.0558
1750	4.281	0.0558
Control	4.633	0.0645

Least square means for **Volume x Site :**

Group	Mean	SEM
10 x DC	23.000	0.223
10 x 500	4.425	0.112
10 x 1000	4.450	0.112
10 x 1500	4.500	0.112
10 x 1750	4.600	0.112
10 x Control	4.767	0.129
50 x DC	5.400	0.223
50 x 500	4.425	0.112
50 x 1000	4.450	0.112
50 x 1500	4.500	0.112
50 x 1750	4.275	0.112
50 x Control	4.767	0.129
100 x DC	8.700	0.223
100 x 500	4.225	0.112
100 x 1000	4.325	0.112
100 x 1500	4.225	0.112
100 x 1750	4.225	0.112
100 x Control	4.433	0.129
150 x DC	26.000	0.223
150 x 500	4.225	0.112
150 x 1000	4.250	0.112
150 x 1500	4.250	0.112
150 x 1750	4.025	0.112
150 x Control	4.567	0.129

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 500	18.575	74.378	<0.001	Yes
DC vs. 1000	18.550	74.277	<0.001	Yes
DC vs. 1500	18.500	74.077	<0.001	Yes
DC vs. 1750	18.400	73.677	<0.001	Yes
DC vs. Control	18.233	70.691	<0.001	Yes
Control vs. 500	0.342	2.003	0.402	No
Control vs. 1000	0.317	1.856	0.473	No
Control vs. 1500	0.267	1.563	0.652	No
1750 vs. 500	0.175	1.108	0.892	No
Control vs. 1750	0.167	0.977	0.912	No
1750 vs. 1000	0.150	0.950	0.881	No
1750 vs. 1500	0.1000	0.633	0.951	No
1500 vs. 500	0.0750	0.475	0.952	No
1500 vs. 1000	0.0500	0.317	0.939	No
1000 vs. 500	0.0250	0.158	0.875	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	1.125	4.505	<0.001	Yes
DC vs. 500	0.975	3.904	0.004	Yes
DC vs. 1000	0.950	3.804	0.005	Yes
DC vs. 1500	0.900	3.604	0.008	Yes
Control vs. 1750	0.492	2.882	0.060	No
DC vs. Control	0.633	2.455	0.159	No
Control vs. 500	0.342	2.003	0.370	No
Control vs. 1000	0.317	1.856	0.434	No
Control vs. 1500	0.267	1.563	0.603	No
1500 vs. 1750	0.225	1.425	0.648	No
1000 vs. 1750	0.175	1.108	0.796	No
500 vs. 1750	0.150	0.950	0.817	No
1500 vs. 500	0.0750	0.475	0.952	No
1500 vs. 1000	0.0500	0.317	0.939	No
1000 vs. 500	0.0250	0.158	0.875	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	4.475	17.919	<0.001	Yes
DC vs. 500	4.475	17.919	<0.001	Yes
DC vs. 1500	4.475	17.919	<0.001	Yes
DC vs. 1000	4.375	17.518	<0.001	Yes
DC vs. Control	4.267	16.542	<0.001	Yes
Control vs. 1750	0.208	1.221	0.924	No
Control vs. 500	0.208	1.221	0.902	No
Control vs. 1500	0.208	1.221	0.873	No
Control vs. 1000	0.108	0.635	0.995	No
1000 vs. 1750	0.100	0.633	0.989	No
1000 vs. 500	0.100	0.633	0.977	No
1000 vs. 1500	0.1000	0.633	0.951	No
1500 vs. 1750	0.000	0.000	1.000	No
1500 vs. 500	0.000	0.000	1.000	No
500 vs. 1750	0.000	0.000	1.000	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	21.975	87.992	<0.001	Yes
DC vs. 500	21.775	87.191	<0.001	Yes
DC vs. 1000	21.750	87.091	<0.001	Yes
DC vs. 1500	21.750	87.091	<0.001	Yes
DC vs. Control	21.433	83.098	<0.001	Yes
Control vs. 1750	0.542	3.175	0.024	Yes
Control vs. 500	0.342	2.003	0.370	No
Control vs. 1000	0.317	1.856	0.434	No
Control vs. 1500	0.317	1.856	0.392	No
1500 vs. 1750	0.225	1.425	0.648	No
1000 vs. 1750	0.225	1.425	0.581	No
500 vs. 1750	0.200	1.266	0.612	No
1500 vs. 500	0.0250	0.158	0.998	No
1000 vs. 500	0.0250	0.158	0.984	No
1500 vs. 1000	0.000	0.000	1.000	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 50	20.600	65.211	<0.001	Yes
10 vs. 50	17.600	55.714	<0.001	Yes
150 vs. 100	17.300	54.764	<0.001	Yes
10 vs. 100	14.300	45.268	<0.001	Yes
100 vs. 50	3.300	10.446	<0.001	Yes
150 vs. 10	3.000	9.497	<0.001	Yes

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	0.200	1.266	0.758	No
10 vs. 100	0.200	1.266	0.694	No
50 vs. 150	0.200	1.266	0.612	No
50 vs. 100	0.200	1.266	0.508	No
10 vs. 50	0.000	0.000	1.000	No
100 vs. 150	0.000	0.000	1.000	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	0.200	1.266	0.758	No
10 vs. 150	0.200	1.266	0.694	No
50 vs. 100	0.125	0.791	0.896	No
10 vs. 100	0.125	0.791	0.817	No
100 vs. 150	0.0750	0.475	0.868	No
50 vs. 10	0.000	0.000	1.000	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 100	0.275	1.741	0.421	No
10 vs. 100	0.275	1.741	0.366	No
50 vs. 150	0.250	1.583	0.398	No
10 vs. 150	0.250	1.583	0.316	No
150 vs. 100	0.0250	0.158	0.984	No
50 vs. 10	0.000	0.000	1.000	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	0.575	3.640	0.004	Yes
10 vs. 100	0.375	2.374	0.101	No
10 vs. 50	0.325	2.058	0.166	No
50 vs. 150	0.250	1.583	0.316	No
100 vs. 150	0.200	1.266	0.377	No
50 vs. 100	0.0500	0.317	0.753	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 100	0.333	1.828	0.365	No
50 vs. 100	0.333	1.828	0.315	No
10 vs. 150	0.200	1.097	0.728	No
50 vs. 150	0.200	1.097	0.623	No
150 vs. 100	0.133	0.731	0.717	No
10 vs. 50	0.000	0.000	1.000	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Mercury**
Normality Test (Shapiro-Wilk) Passed (P = 0.875)
Equal Variance Test: Passed (P = 0.581)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	0.123	0.000	0.000
500	4	0	0.0422	0.00556	0.00278
1000	4	0	0.0445	0.00580	0.00290
1500	4	0	0.0420	0.00424	0.00212
1750	4	0	0.0530	0.0104	0.00521
Control	3	0	0.0477	0.00208	0.00120

Source of Variation	DF	SS	MS	F	P
Between Groups	4	0.00600	0.00150	36.033	<0.001
Residual	14	0.000582	0.0000416		
Total	18	0.00658			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Distance**

Comparison	Diff of Means	p	q	P	P<0.050
DC vs. 1500	0.0810	6	15.885	<0.001	Yes
DC vs. 500	0.0808	6	15.836	<0.001	Yes
DC vs. 1000	0.0785	6	15.395	<0.001	Yes
DC vs. Control	0.0753	6	14.305	<0.001	Yes
DC vs. 1750	0.0700	6	13.728	<0.001	Yes
1750 vs. 1500	0.0110	6	3.411	0.217	No
1750 vs. 500	0.0108	6	3.333	0.236	Do Not Test
1750 vs. 1000	0.00850	6	2.636	0.461	Do Not Test
1750 vs. Control	0.00533	6	1.531	0.880	Do Not Test
Control vs. 1500	0.00567	6	1.627	0.852	Do Not Test
Control vs. 500	0.00542	6	1.555	0.874	Do Not Test
Control vs. 1000	0.00317	6	0.909	0.985	Do Not Test
1000 vs. 1500	0.00250	6	0.775	0.993	Do Not Test
1000 vs. 500	0.00225	6	0.698	0.996	Do Not Test
500 vs. 1500	0.000250	6	0.0775	1.000	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Mercury**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)
Equal Variance Test: Failed (P < 0.050)

Source of Variation	DF	SS	MS	F	P
Volume	3	0.00138	0.000461	3.103	0.034
Site	5	0.00950	0.00190	12.787	<0.001
Volume x Site	15	0.0175	0.00116	7.833	<0.001
Residual	56	0.00832	0.000149		
Total	79	0.0395	0.000501		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 0.502
Power of performed test with alpha = 0.0500: for Site : 1.000
Power of performed test with alpha = 0.0500: for Volume x Site : 1.000

Least square means for **Volume** :

Group	Mean
10	0.0554
50	0.0569
100	0.0676
150	0.0587

Std Err of LS Mean = 0.00310

Least square means for **Site :**

Group	Mean	SEM
DC	0.0882	0.00609
500	0.0501	0.00305
1000	0.0492	0.00305
1500	0.0506	0.00305
1750	0.0485	0.00305
Control	0.0712	0.00352

Least square means for **Volume x Site :**

Group	Mean	SEM
10 x DC	0.120	0.0122
10 x 500	0.0427	0.00609
10 x 1000	0.0387	0.00609
10 x 1500	0.0462	0.00609
10 x 1750	0.0412	0.00609
10 x Control	0.0433	0.00704
50 x DC	0.0450	0.0122
50 x 500	0.0605	0.00609
50 x 1000	0.0605	0.00609
50 x 1500	0.0620	0.00609
50 x 1750	0.0472	0.00609
50 x Control	0.0660	0.00704
100 x DC	0.0650	0.0122
100 x 500	0.0550	0.00609
100 x 1000	0.0530	0.00609
100 x 1500	0.0520	0.00609
100 x 1750	0.0525	0.00609
100 x Control	0.128	0.00704
150 x DC	0.123	0.0122
150 x 500	0.0422	0.00609
150 x 1000	0.0445	0.00609
150 x 1500	0.0420	0.00609
150 x 1750	0.0530	0.00609
150 x Control	0.0477	0.00704

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1000	0.0812	5.962	<0.001	Yes
DC vs. 1750	0.0787	5.779	<0.001	Yes
DC vs. 500	0.0772	5.669	<0.001	Yes
DC vs. Control	0.0767	5.447	<0.001	Yes
DC vs. 1500	0.0737	5.412	<0.001	Yes
1500 vs. 1000	0.00750	0.870	0.993	No
1500 vs. 1750	0.00500	0.580	0.999	No
Control vs. 1000	0.00458	0.492	1.000	No
500 vs. 1000	0.00400	0.464	0.999	No
1500 vs. 500	0.00350	0.406	0.999	No
1500 vs. Control	0.00292	0.313	0.999	No
1750 vs. 1000	0.00250	0.290	0.997	No
Control vs. 1750	0.00208	0.224	0.995	No
500 vs. 1750	0.00150	0.174	0.981	No
Control vs. 500	0.000583	0.0627	0.950	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 1750	0.0188	2.014	0.528	No
1500 vs. 1750	0.0147	1.711	0.743	No
1000 vs. 1750	0.0132	1.537	0.836	No
500 vs. 1750	0.0132	1.537	0.812	No
Control vs. DC	0.0210	1.492	0.813	No
1500 vs. DC	0.0170	1.247	0.914	No
1000 vs. DC	0.0155	1.137	0.934	No
500 vs. DC	0.0155	1.137	0.910	No
Control vs. 500	0.00550	0.591	0.997	No
Control vs. 1000	0.00550	0.591	0.992	No
Control vs. 1500	0.00400	0.430	0.996	No
1500 vs. 1000	0.00150	0.174	1.000	No
1500 vs. 500	0.00150	0.174	0.997	No
1750 vs. DC	0.00225	0.165	0.983	No
500 vs. 1000	0.000	0.000	1.000	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 1500	0.0760	8.164	<0.001	Yes
Control vs. 1750	0.0755	8.110	<0.001	Yes
Control vs. 1000	0.0750	8.056	<0.001	Yes
Control vs. 500	0.0730	7.842	<0.001	Yes
Control vs. DC	0.0630	4.476	<0.001	Yes
DC vs. 1500	0.0130	0.954	0.985	No
DC vs. 1750	0.0125	0.917	0.983	No
DC vs. 1000	0.0120	0.881	0.979	No
DC vs. 500	0.01000	0.734	0.988	No
500 vs. 1500	0.00300	0.348	1.000	No
500 vs. 1750	0.00250	0.290	0.999	No
500 vs. 1000	0.00200	0.232	0.999	No
1000 vs. 1500	0.001000	0.116	0.999	No
1000 vs. 1750	0.000500	0.0580	0.998	No
1750 vs. 1500	0.000500	0.0580	0.954	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1500	0.0810	5.944	<0.001	Yes
DC vs. 500	0.0807	5.925	<0.001	Yes
DC vs. 1000	0.0785	5.760	<0.001	Yes
DC vs. Control	0.0753	5.352	<0.001	Yes
DC vs. 1750	0.0700	5.137	<0.001	Yes
1750 vs. 1500	0.0110	1.276	0.902	No
1750 vs. 500	0.0108	1.247	0.890	No
1750 vs. 1000	0.00850	0.986	0.959	No
Control vs. 1500	0.00567	0.609	0.996	No
Control vs. 500	0.00542	0.582	0.993	No
1750 vs. Control	0.00533	0.573	0.985	No
Control vs. 1000	0.00317	0.340	0.995	No
1000 vs. 1500	0.00250	0.290	0.988	No
1000 vs. 500	0.00225	0.261	0.958	No
500 vs. 1500	0.000250	0.0290	0.977	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 50	0.0780	4.525	<0.001	Yes
10 vs. 50	0.0750	4.351	<0.001	Yes
150 vs. 100	0.0580	3.365	0.006	Yes
10 vs. 100	0.0550	3.191	0.007	Yes
100 vs. 50	0.0200	1.160	0.439	No
150 vs. 10	0.00300	0.174	0.862	No

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	0.0182	2.117	0.211	No
50 vs. 10	0.0177	2.059	0.202	No
100 vs. 150	0.0128	1.479	0.465	No
100 vs. 10	0.0123	1.421	0.409	No
50 vs. 100	0.00550	0.638	0.775	No
10 vs. 150	0.000500	0.0580	0.954	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 10	0.0217	2.524	0.084	No
50 vs. 150	0.0160	1.856	0.299	No
100 vs. 10	0.0142	1.653	0.355	No
100 vs. 150	0.00850	0.986	0.697	No
50 vs. 100	0.00750	0.870	0.625	No
150 vs. 10	0.00575	0.667	0.507	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 150	0.0200	2.321	0.136	No
50 vs. 10	0.0158	1.827	0.315	No
50 vs. 100	0.01000	1.160	0.685	No
100 vs. 150	0.01000	1.160	0.580	No
100 vs. 10	0.00575	0.667	0.757	No
10 vs. 150	0.00425	0.493	0.624	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 10	0.0118	1.363	0.692	No
100 vs. 10	0.0113	1.305	0.666	No
50 vs. 10	0.00600	0.696	0.932	No
150 vs. 50	0.00575	0.667	0.880	No
100 vs. 50	0.00525	0.609	0.793	No
150 vs. 100	0.000500	0.0580	0.954	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 10	0.0847	8.507	<0.001	Yes
100 vs. 150	0.0803	8.072	<0.001	Yes
100 vs. 50	0.0620	6.230	<0.001	Yes
50 vs. 10	0.0227	2.278	0.078	No
50 vs. 150	0.0183	1.842	0.136	No
150 vs. 10	0.00433	0.435	0.665	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Nickel**
Normality Test (Shapiro-Wilk) Passed (P = 0.086)
Equal Variance Test: Passed (P = 0.920)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	10	0.000	0.000
500	4	0	15.475	0.888	0.444
1000	4	0	15.300	0.841	0.420
1500	4	0	15.275	0.780	0.390
1750	4	0	15.150	0.843	0.421
Control	3	0	16.867	0.493	0.285

Source of Variation	DF	SS	MS	F	P
Between Groups	4	35.650	8.913	13.970	<0.001
Residual	14	8.932	0.638		
Total	18	44.582			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Distance**

Comparison	Diff of Means	p	q	P	P<0.050
Control vs. DC	6.867	6	10.529	<0.001	Yes
Control vs. 1750	1.717	6	3.980	0.113	No
Control vs. 1500	1.592	6	3.690	0.159	Do Not Test
Control vs. 1000	1.567	6	3.632	0.170	Do Not Test
Control vs. 500	1.392	6	3.226	0.264	Do Not Test
500 vs. DC	5.475	6	8.670	<0.001	Yes
500 vs. 1750	0.325	6	0.814	0.991	Do Not Test
500 vs. 1500	0.200	6	0.501	0.999	Do Not Test
500 vs. 1000	0.175	6	0.438	1.000	Do Not Test
1000 vs. DC	5.300	6	8.393	<0.001	Yes
1000 vs. 1750	0.150	6	0.376	1.000	Do Not Test
1000 vs. 1500	0.0250	6	0.0626	1.000	Do Not Test
1500 vs. DC	5.275	6	8.354	<0.001	Yes
1500 vs. 1750	0.125	6	0.313	1.000	Do Not Test
1750 vs. DC	5.150	6	8.156	<0.001	Yes

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Nickel**

Normality Test (Shapiro-Wilk)	Failed	(P < 0.050)
Equal Variance Test:	Passed	(P = 0.271)

Source of Variation	**DF**	**SS**	**MS**	**F**	**P**
Volume	3	34.328	11.443	34.860	<0.001
Site	5	7.949	1.590	4.843	<0.001
Volume x Site	15	169.068	11.271	34.338	<0.001
Residual	56	18.382	0.328		
Total	79	226.972	2.873		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 0.925
Power of performed test with alpha = 0.0500: for Volume x Site : 1.000

Least square means for **Volume :**

Group	**Mean**
10	16.076
50	14.897
100	14.010
150	14.678

Std Err of LS Mean = 0.146

Least square means for **Site :**

Group	**Mean**	**SEM**
DC	14.200	0.286
500	14.712	0.143
1000	14.956	0.143
1500	14.956	0.143
1750	15.100	0.143
Control	15.567	0.165

Least square means for **Volume x Site :**

Group	**Mean**	**SEM**
10 x DC	24.000	0.573
10 x 500	14.375	0.286
10 x 1000	14.250	0.286
10 x 1500	14.200	0.286
10 x 1750	14.700	0.286
10 x Control	14.933	0.331
50 x DC	8.900	0.573
50 x 500	15.875	0.286
50 x 1000	16.175	0.286
50 x 1500	16.075	0.286
50 x 1750	16.125	0.286
50 x Control	16.233	0.331
100 x DC	13.900	0.573
100 x 500	13.125	0.286
100 x 1000	14.100	0.286
100 x 1500	14.275	0.286
100 x 1750	14.425	0.286
100 x Control	14.233	0.331
150 x DC	10.000	0.573
150 x 500	15.475	0.286
150 x 1000	15.300	0.286
150 x 1500	15.275	0.286
150 x 1750	15.150	0.286
150 x Control	16.867	0.331

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	**Diff of Means**	**t**	**P**	**P<0.05**
DC vs. 1500	9.800	15.299	<0.001	Yes
DC vs. 1000	9.750	15.221	<0.001	Yes
DC vs. 500	9.625	15.026	<0.001	Yes
DC vs. 1750	9.300	14.519	<0.001	Yes
DC vs. Control	9.067	13.705	<0.001	Yes
Control vs. 1500	0.733	1.676	0.649	No
Control vs. 1000	0.683	1.562	0.696	No
Control vs. 500	0.558	1.276	0.844	No
1750 vs. 1500	0.500	1.234	0.828	No
1750 vs. 1000	0.450	1.111	0.850	No
1750 vs. 500	0.325	0.802	0.938	No
Control vs. 1750	0.233	0.533	0.973	No
500 vs. 1500	0.175	0.432	0.963	No
500 vs. 1000	0.125	0.309	0.942	No
1000 vs. 1500	0.0500	0.123	0.902	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
1000 vs. DC	7.275	11.357	<0.001	Yes
1750 vs. DC	7.225	11.279	<0.001	Yes
1500 vs. DC	7.175	11.201	<0.001	Yes
Control vs. DC	7.333	11.085	<0.001	Yes
500 vs. DC	6.975	10.889	<0.001	Yes
Control vs. 500	0.358	0.819	0.995	No
1000 vs. 500	0.300	0.741	0.996	No
1750 vs. 500	0.250	0.617	0.998	No
1500 vs. 500	0.200	0.494	0.999	No
Control vs. 1500	0.158	0.362	1.000	No
Control vs. 1750	0.108	0.248	1.000	No
1000 vs. 1500	0.100	0.247	0.999	No
Control vs. 1000	0.0583	0.133	0.999	No
1750 vs. 1500	0.0500	0.123	0.990	No
1000 vs. 1750	0.0500	0.123	0.902	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
1750 vs. 500	1.300	3.209	0.033	Yes
1500 vs. 500	1.150	2.839	0.085	No
Control vs. 500	1.108	2.533	0.169	No
1000 vs. 500	0.975	2.407	0.210	No
DC vs. 500	0.775	1.210	0.945	No
1750 vs. DC	0.525	0.820	0.995	No
1750 vs. 1000	0.325	0.802	0.993	No
1500 vs. DC	0.375	0.585	0.999	No
Control vs. DC	0.333	0.504	0.999	No
1750 vs. Control	0.192	0.438	0.999	No
1500 vs. 1000	0.175	0.432	0.996	No
1750 vs. 1500	0.150	0.370	0.993	No
1000 vs. DC	0.200	0.312	0.985	No
Control vs. 1000	0.133	0.305	0.943	No
1500 vs. Control	0.0417	0.0952	0.924	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
Control vs. DC	6.867	10.380	<0.001	Yes
500 vs. DC	5.475	8.547	<0.001	Yes
1000 vs. DC	5.300	8.274	<0.001	Yes
1500 vs. DC	5.275	8.235	<0.001	Yes
1750 vs. DC	5.150	8.040	<0.001	Yes
Control vs. 1750	1.717	3.923	0.002	Yes
Control vs. 1500	1.592	3.637	0.005	Yes
Control vs. 1000	1.567	3.580	0.006	Yes
Control vs. 500	1.392	3.180	0.017	Yes
500 vs. 1750	0.325	0.802	0.964	No
500 vs. 1500	0.200	0.494	0.992	No
500 vs. 1000	0.175	0.432	0.988	No
1000 vs. 1750	0.150	0.370	0.976	No
1500 vs. 1750	0.125	0.309	0.942	No
1000 vs. 1500	0.0250	0.0617	0.951	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 50	15.100	18.636	<0.001	Yes
10 vs. 150	14.000	17.279	<0.001	Yes
10 vs. 100	10.100	12.465	<0.001	Yes
100 vs. 50	5.000	6.171	<0.001	Yes
100 vs. 150	3.900	4.813	<0.001	Yes
150 vs. 50	1.100	1.358	0.180	No

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 100	2.750	6.788	<0.001	Yes
150 vs. 100	2.350	5.801	<0.001	Yes
50 vs. 10	1.500	3.703	0.002	Yes
10 vs. 100	1.250	3.086	0.009	Yes
150 vs. 10	1.100	2.715	0.018	Yes
50 vs. 150	0.400	0.987	0.328	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 100	2.075	5.122	<0.001	Yes
50 vs. 10	1.925	4.752	<0.001	Yes
150 vs. 100	1.200	2.962	0.018	Yes
150 vs. 10	1.050	2.592	0.036	Yes
50 vs. 150	0.875	2.160	0.069	No
10 vs. 100	0.150	0.370	0.713	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 10	1.875	4.628	<0.001	Yes
50 vs. 100	1.800	4.443	<0.001	Yes
150 vs. 10	1.075	2.654	0.041	Yes
150 vs. 100	1.000	2.468	0.049	Yes
50 vs. 150	0.800	1.975	0.104	No
100 vs. 10	0.0750	0.185	0.854	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 100	1.700	4.196	<0.001	Yes
50 vs. 10	1.425	3.517	0.004	Yes
50 vs. 150	0.975	2.407	0.075	No
150 vs. 100	0.725	1.790	0.219	No
150 vs. 10	0.450	1.111	0.469	No
10 vs. 100	0.275	0.679	0.500	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 100	2.633	5.629	<0.001	Yes
50 vs. 100	2.000	4.275	<0.001	Yes
150 vs. 10	1.933	4.133	<0.001	Yes
50 vs. 10	1.300	2.779	0.022	Yes
10 vs. 100	0.700	1.496	0.261	No
150 vs. 50	0.633	1.354	0.181	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Zinc**
Normality Test (Shapiro-Wilk) Passed (P = 0.373)
Equal Variance Test: Passed (P = 0.350)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	1	0	95.000	0.000	0.000
500	4	0	29.000	0.816	0.408
1000	4	0	29.750	1.258	0.629
1500	4	0	28.000	1.826	0.913
1750	4	0	28.250	2.363	1.181
Control	3	0	30.667	1.528	0.882

Source of Variation	DF	SS	MS	F	P
Between Groups	4	4148.383	1037.096	380.419	<0.001
Residual	14	38.167	2.726		
Total	18	4186.550			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **Distance**

Comparison	Diff of Means	p	q	P	P<0.050
DC vs. 1500	67.000	6	51.328	<0.001	Yes
DC vs. 1750	66.750	6	51.137	<0.001	Yes
DC vs. 500	66.000	6	50.562	<0.001	Yes
DC vs. 1000	65.250	6	49.988	<0.001	Yes
DC vs. Control	64.333	6	47.720	<0.001	Yes
Control vs. 1500	2.667	6	2.991	0.334	No
Control vs. 1750	2.417	6	2.710	0.432	Do Not Test
Control vs. 500	1.667	6	1.869	0.769	Do Not Test
Control vs. 1000	0.917	6	1.028	0.975	Do Not Test
1000 vs. 1500	1.750	6	2.120	0.671	Do Not Test
1000 vs. 1750	1.500	6	1.817	0.788	Do Not Test
1000 vs. 500	0.750	6	0.908	0.986	Do Not Test
500 vs. 1500	1.000	6	1.211	0.951	Do Not Test
500 vs. 1750	0.750	6	0.908	0.986	Do Not Test
1750 vs. 1500	0.250	6	0.303	1.000	Do Not Test

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Zinc**
Normality Test (Shapiro-Wilk) Passed (P = 0.155)
Equal Variance Test: Passed (P = 0.335)

Source of Variation	DF	SS	MS	F	P
Volume	3	939.669	313.223	219.943	<0.001
Site	5	3812.571	762.514	535.433	<0.001
Volume x Site	15	2801.579	186.772	131.150	<0.001
Residual	56	79.750	1.424		
Total	79	6817.800	86.301		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of Site is present. There is a statistically significant interaction between Volume and Site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for Site : 1.000
Power of performed test with alpha = 0.0500: for Volume x Site : 1.000

Least square means for **Volume** :

Group	Mean
10	38.333
50	30.014
100	34.222
150	40.111

Std Err of LS Mean = 0.304

Least square means for **Site :**

Group	Mean	SEM
DC	62.000	0.597
500	30.313	0.298
1000	30.563	0.298
1500	30.063	0.298
1750	30.000	0.298
Control	31.083	0.344

Least square means for **Volume x Site :**

Group	Mean	SEM
10 x DC	80.000	1.193
10 x 500	30.000	0.597
10 x 1000	29.750	0.597
10 x 1500	30.000	0.597
10 x 1750	30.250	0.597
10 x Control	30.000	0.689
50 x DC	31.000	1.193
50 x 500	30.000	0.597
50 x 1000	29.750	0.597
50 x 1500	29.750	0.597
50 x 1750	29.250	0.597
50 x Control	30.333	0.689
100 x DC	42.000	1.193
100 x 500	32.250	0.597
100 x 1000	33.000	0.597
100 x 1500	32.500	0.597
100 x 1750	32.250	0.597
100 x Control	33.333	0.689
150 x DC	95.000	1.193
150 x 500	29.000	0.597
150 x 1000	29.750	0.597
150 x 1500	28.000	0.597
150 x 1750	28.250	0.597
150 x Control	30.667	0.689

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Site within 10**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1000	50.250	37.663	<0.001	Yes
DC vs. 1500	50.000	37.475	<0.001	Yes
DC vs. 500	50.00	37.475	<0.001	Yes
DC vs. 1750	49.750	37.288	<0.001	Yes
DC vs. Control	50.000	36.285	<0.001	Yes
1750 vs. 1000	0.500	0.593	1.000	No
500 vs. 1000	0.250	0.296	1.000	No
1500 vs. 1000	0.250	0.296	1.000	No
1750 vs. 1500	0.250	0.296	1.000	No
1750 vs. 500	0.250	0.296	1.000	No
Control vs. 1000	0.250	0.274	1.000	No
1750 vs. Control	0.250	0.274	0.998	No
500 vs. 1500	0.000	0.000	1.000	No
500 vs. Control	0.000	0.000	1.000	No
Control vs. 1500	0.000	0.000	1.000	No

Comparisons for factor: **Site within 50**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	1.750	1.312	0.961	No
Control vs. 1750	1.083	1.189	0.978	No
DC vs. 1500	1.250	0.937	0.997	No
DC vs. 1000	1.250	0.937	0.995	No
500 vs. 1750	0.750	0.889	0.995	No
DC vs. 500	1.000	0.750	0.998	No
Control vs. 1000	0.583	0.640	0.999	No
Control vs. 1500	0.583	0.640	0.997	No
1000 vs. 1750	0.500	0.593	0.997	No
1500 vs. 1750	0.500	0.593	0.992	No
DC vs. Control	0.667	0.484	0.993	No
Control vs. 500	0.333	0.366	0.993	No
500 vs. 1000	0.250	0.296	0.988	No
500 vs. 1500	0.250	0.296	0.946	No
1000 vs. 1500	0.000	0.000	1.000	No

Comparisons for factor: **Site within 100**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1750	9.750	7.308	<0.001	Yes
DC vs. 500	9.750	7.308	<0.001	Yes
DC vs. 1500	9.500	7.120	<0.001	Yes
DC vs. 1000	9.000	6.746	<0.001	Yes
DC vs. Control	8.667	6.289	<0.001	Yes
Control vs. 1750	1.083	1.189	0.935	No
Control vs. 500	1.083	1.189	0.915	No
Control vs. 1500	0.833	0.914	0.973	No
1000 vs. 1750	0.750	0.889	0.964	No
1000 vs. 500	0.750	0.889	0.942	No
1000 vs. 1500	0.500	0.593	0.983	No
Control vs. 1000	0.333	0.366	0.993	No
1500 vs. 1750	0.250	0.296	0.988	No
1500 vs. 500	0.250	0.296	0.946	No
500 vs. 1750	0.000	0.000	1.000	No

Comparisons for factor: **Site within 150**

Comparison	Diff of Means	t	P	P<0.05
DC vs. 1500	67.000	50.217	<0.001	Yes
DC vs. 1750	66.750	50.029	<0.001	Yes
DC vs. 500	66.000	49.467	<0.001	Yes
DC vs. 1000	65.250	48.905	<0.001	Yes
DC vs. Control	64.333	46.687	<0.001	Yes
Control vs. 1500	2.667	2.926	0.048	Yes
Control vs. 1750	2.417	2.651	0.090	No
1000 vs. 1500	1.750	2.074	0.295	No
Control vs. 500	1.667	1.829	0.411	No
1000 vs. 1750	1.500	1.778	0.397	No
500 vs. 1500	1.000	1.185	0.748	No
Control vs. 1000	0.917	1.006	0.785	No
500 vs. 1750	0.750	0.889	0.759	No
1000 vs. 500	0.750	0.889	0.613	No
1750 vs. 1500	0.250	0.296	0.768	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
150 vs. 50	64.000	37.922	<0.001	Yes
150 vs. 100	53.000	31.404	<0.001	Yes
10 vs. 50	49.000	29.034	<0.001	Yes
10 vs. 100	38.000	22.516	<0.001	Yes
150 vs. 10	15.000	8.888	<0.001	Yes
100 vs. 50	11.000	6.518	<0.001	Yes

Comparisons for factor: **Volume within 500**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	3.250	3.851	0.002	Yes
100 vs. 50	2.250	2.666	0.049	Yes
100 vs. 10	2.250	2.666	0.039	Yes
10 vs. 150	1.000	1.185	0.563	No
50 vs. 150	1.000	1.185	0.424	No
10 vs. 50	0.000	0.000	1.000	No

Comparisons for factor: **Volume within 1000**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	3.250	3.851	0.002	Yes
100 vs. 10	3.250	3.851	0.002	Yes
100 vs. 50	3.250	3.851	0.001	Yes
50 vs. 150	0.000	0.000	1.000	No
50 vs. 10	0.000	0.000	1.000	No
10 vs. 150	0.000	0.000	1.000	No

Comparisons for factor: **Volume within 1500**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	4.500	5.333	<0.001	Yes
100 vs. 50	2.750	3.259	0.009	Yes
100 vs. 10	2.500	2.963	0.018	Yes
10 vs. 150	2.000	2.370	0.062	No
50 vs. 150	1.750	2.074	0.084	No
10 vs. 50	0.250	0.296	0.768	No

Comparisons for factor: **Volume within 1750**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	4.000	4.740	<0.001	Yes
100 vs. 50	3.000	3.555	0.004	Yes
100 vs. 10	2.000	2.370	0.082	No
10 vs. 150	2.000	2.370	0.062	No
50 vs. 150	1.000	1.185	0.424	No
10 vs. 50	1.000	1.185	0.241	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 10	3.333	3.421	0.007	Yes
100 vs. 50	3.000	3.079	0.016	Yes
100 vs. 150	2.667	2.737	0.033	Yes
150 vs. 10	0.667	0.684	0.872	No
150 vs. 50	0.333	0.342	0.929	No
50 vs. 10	0.333	0.342	0.734	No

Appendix 7 Raw Benthic Biota Data.

Table 5.1 Benthic Biota Monitoring Data 23 November 2016 following 150,000m^3 Spoil Disposal (numbers per two 100mm diameter cores, numbers per square metre)

Taxa	DC				500m															
					N				E				S				W			
	A	B	C	Ave/m^2	A	B	C	Ave/m^2	A	B	C	Ave/m^2	A	B	C	Ave/m^2	A	B	C	Ave/m^2
PHYLUM ANNELIDA																				
CLASS POLYCHAETA																				
Ampharetidae													1			21				
Aonides sp.																				
Aricidea sp.							1	21	1			21								
Capitellidae																				
Cirratulidae					1			21		2		42		2		42				
Dorvilleidae																				
Flabelligeridae A						1		21		1		21			1	21	1			21
Hesionidae															4	85				
Heteromastus filiformis						1	1	42												
Hyalinoecia sp.							1	21							1	21		1		21
Laonice sp.							1	21												
Lumbrinereis sp.					1		1	42						1	1	42	1	4	1	127
Marphysa sp.							1	21												
Maldanidae					1			21	1	1		42	2	2		85				
Naineris sp.													1			21				
Orbinia sp.																				
Paraonidae					1			21		1		21								
Phyllodocidae																				
Phylo sp.																				
Prionospio sp.					1	2		64						1		21				
Rhamphobrachium sp.																				
Sabellidae										2		42								
Sigalionidae						1		21												
Spionidae						1	1	42												
Spionidae B											1	21								
Syllidae						1		21						1		21				
Sphaerosyllis sp.					1		1	42		3		64		1	1	42	1	1	1	64
Terebellidae													1			21				
Unident. - damaged pieces																				
PHYLUM NEMERTEA																				
Nemertian						1		21												
PHYLUM SIPUNCULA																				
CLASS SIPUNCULIDEA																				
Sipunculid worm A															1	21				
Sipunculid worm B																				
PHYLUM MOLLUSCA																				
CLASS GASTROPODA																				
Uberella barrierensis																				
CLASS BIVALVIA																				
Cuspidaria willetti																				
Nucula hartvigiana						1		21		2		42								
Nucula nitidula										1		21								
Unident. mussel spat										1		21								
PHYLUM ARTHROPODA																				
CLASS CRUSTACEA																				
ORDER AMPHIPODA																				
Ampeliscidae																				
Amphilochidae					1			21												
Caprella sp.															2	42				
Haustoriidae							1	21												
Liljeborgia sp.																				
Lysianassidae						1		21	1			21			1	21				
Phoxocephalidae A					3			64					1			21				
Phoxocephalidae D					2		1	64	1			21								
Urothoidae									1			21								
Unident. Amphipod species																				
ORDER ISOPODA																				
Asellota									2			42		1	1	42				
Munna sp.					1		1	42					1			21				
Paranthura flagellata						1		21		1		21		1		21		2		42
ORDER CUMACEA																				
Cumacean A						1		21						1		21		1		21
ORDER MYSIDACEA																				
Mysid			1	21															1	21
ORDER OSTRACODA																				
Ostracod A							1	21										1		21
Ostracod C																				
Ostracod E																				
ORDER TANAIDACEA																				
Tanaidacea spp						1		21	1			21			1	21				
PHYLUM COELENTERATA																				
CLASS ANTHOZOA																				
Edwardsia sp.																				
PHYLUM ECHINODERMATA																				
CLASS OPHIUROIDEA																				
Amphiura sp.							1	21					1	1		42			2	42
CLASS HOLOTHUROOIDEA																				
Trochodota sp.					1	1		42		1		21						1		21

Taxa	DC				500m															
					N				E				S				W			
	A	B	C	Ave/m²	A	B	C	Ave/m²	A	B	C	Ave/m²	A	B	C	Ave/m²	A	B	C	Ave/m²
PHYLUM PORIFERA																				
CLASS DEMOSPONGIAE																				
Unident. sponge - sandy, flask-shaped																				
PHYLUM FORAMINIFERA																				
CLASS FORAMINIFERA																				
ORDER LITUOLIDA																				
Ammodiscus sp. A										1		21			1	21				
Ammodiscus sp. B																				
Cribrostomoides / Haplophragmoides																				
ORDER MILIODIDA																				
Nummoloculina contraria					4	1		106	2	1	1	85		1	3	85			2	42
Pyrgo spp			1	21	6	5	4	318	18	3	5	552	4	6	5	318	5	7	9	446
Quinqueloculina suborbicularis					5	2		149	4	5	3	255	1	3	2	127		4	2	127
Triloculina insignis						3		64	4	1	2	149	1	1	1	64			1	21
ORDER LAGENIDA																				
Lenticulina spp					80	102	55	5029	144	89	110	7279	120	114	108	7257	52	94	44	4032
ORDER ROTALIIDA																				
Calcarina sp.																				
Cibicidoides sp. 1					8	4	11	488	6	3	2	233	17	3	8	594	11	16	10	785
Alabamina					8	9	8	531	13	5	4	467	27	7	17	1082	10	17	15	891
Elphidium sp. A																				
Elphidium sp. B											1	21		1		21			1	21
Planularia sp.					2	1	1	85												
Unident. Foram - dome shaped																				
Unident. Foram - spine like																				
Unident. Foram - flat sim otolith																				
Total Number Of Species/Taxa	**0**	**0**	**2**	**2**	**18**	**21**	**18**	**37**	**14**	**19**	**9**	**27**	**13**	**18**	**18**	**31**	**7**	**12**	**12**	**18**
Total Number Of Individuals	**0**	**0**	**2**	**42**	**127**	**141**	**92**	**7639**	**199**	**124**	**129**	**9592**	**178**	**148**	**159**	**10292**	**81**	**149**	**89**	**6769**
Shannon- Wiener	**0.00**	**0.00**	**0.69**	**0.69**	**1.58**	**1.32**	**1.60**	**1.61**	**1.14**	**1.36**	**0.70**	**1.16**	**1.14**	**1.12**	**1.36**	**1.30**	**1.15**	**1.34**	**1.63**	**1.44**

Taxa	1500m																Control			
	N				E				S				W							
	A	B	C	Ave/m²	A	B	C	Ave/m²	A	B	C	Ave/m²	A	B	C	Ave/m²	A	B	C	Ave/m²
PHYLUM ANNELIDA																				
CLASS POLYCHAETA																				
Ampharetidae	1			21																
Aonides sp.																	1			21
Aricidea sp.		1		21						1		21	1			21				
Capitellidae			1	21						1		21					1			21
Cirratulidae	1			21	1			21		1		21			1	21				
Dorvilleidae							1	21												
Flabelligeridae A	1			21		1	1	42		1		21								
Hesionidae																		1		21
Heteromastus filiformis																				
Hyalinoecia sp.	1	2		64	1			21			1	21					1	2	3	127
Laonice sp.																				
Lumbrinereis sp.	2			42	1	2	2	106		5	1	127							3	64
Marphysa sp.	3			64					1	1		42	1		1	42		1		21
Maldanidae			1	21					3			64	1		1	42	4	3		149
Naineris sp.						1		21												
Orbinia sp.																		1	1	42
Paraonidae		1		21			1	21												
Phyllodocidae					1			21	1	1		42								
Phylo sp.														1		21				
Prionospio sp.		2		42					1			21	2			42				
Rhamphobrachium sp.										3		64								
Sabellidae																				
Sigalionidae		1		21	1			21									1			21
Spionidae	1	1		42		1	1	42	3	1	1	106		1	1	42	2	1		64
Spionidae B	1			21																
Syllidae																	1			21
Sphaerosyllis sp.		2		42	3			64					1	1		42				
Terebellidae																				
Unident. - damaged pieces					1			21					1			21				
PHYLUM NEMERTEA																				
Nemertian									1			21								
PHYLUM SIPUNCULA																				
CLASS SIPUNCULIDEA																				
Sipunculid worm A	2			42																
Sipunculid worm B																		1		21
PHYLUM MOLLUSCA																				
CLASS GASTROPODA																				
Uberella barrierensis														1		21				
CLASS BIVALVIA																				
Cuspidaria willetti							1	21												
Nucula hartvigiana																			1	21
Nucula nitidula																				
Unident. mussel spat																				

Taxa	1500m																Control			
	N				E				S				W							
	A	B	C	Ave/m^2	A	B	C	Ave/m^2	A	B	C	Ave/m^2	A	B	C	Ave/m^2	A	B	C	Ave/m^2
PHYLUM ARTHROPODA																				
CLASS CRUSTACEA																				
ORDER AMPHIPODA																				
Ampeliscidae	1			21		1		21												
Amphilochidae													1			21				
Caprella sp.																				
Haustoriidae		1		21					1			21								
Liljeborgia sp.						1		21	1		1	42								
Lysianassidae							2	42												
Phoxocephalidae A		1		21			1	21	1			21								
Phoxocephalidae D						2	1	64	1			21	1			21	2	1		64
Urothoidae																				
Unident. Amphipod species							1	21						1		21	2		1	64
ORDER ISOPODA																				
Asellota							1	21									1			21
Munna sp.					1			21							1	21			1	21
Paranthura flagellata	2		1	64															1	21
ORDER CUMACEA																				
Cumacean A	1	1		42			1	21									1			21
ORDER MYSIDACEA																				
Mysid			1	21										1		21			1	21
ORDER OSTRACODA																				
Ostracod A			1	21					1		1	42	1	1		42				
Ostracod C																		1		21
Ostracod E						1		21												
ORDER TANAIDACEA																				
Tanaidacea spp																				
PHYLUM COELENTERATA																				
CLASS ANTHOZOA																				
Edwardsia sp.																		1		21
PHYLUM ECHINODERMATA																				
CLASS OPHIUROIDEA																				
Amphiura sp.	1			21		2		42		1	1	42					1		1	42
CLASS HOLOTHUROOIDEA																				
Trochodota sp.			2	42		1		21	2	2	1	106								
PHYLUM PORIFERA																				
CLASS DEMOSPONGIAE																				
Unident. sponge - sandy, flask-shaped	1			21			1	21						1		21	2		1	64
PHYLUM FORAMINIFERA																				
CLASS FORAMINIFERA																				
ORDER LITUOLIDA																				
Ammodiscus A		1		21			1	21			1	21	1			21	1		1	42
Ammodiscus B	1			21							1	21								
Cribrostomoides / Haplophragmoides									1			21					1		1	42
ORDER MILIODIDA																				
Nummoloculina contraria		3		64		2	1	64	3	4	2	191	1	3	2	127	2	4		127
Pyrgo spp	7	5	5	361	6	13	10	615	11	18	4	700	9	9	7	531	37	20	5	1316
Quinqueloculina suborbicularis	3	2		106	8	2	2	255	4	7	1	255	6	1	4	233	16	8	5	615
Triloculina insignis	1	1		42	1			21	2	2	1	106	1	3	1	106	6		6	255
ORDER LAGENIDA																				
Lenticulina spp	65	67	39	3629	87	81	121	6133	149	137	90	7979	74	91	90	5411	75	92	66	4944
ORDER ROTALIIDA																				
Calcarina sp.																				
Cibicidoides sp. 1	7	21	7	743	74	23	22	2525	27	7	13	997	14	5	24	912	15	11	2	594
Alabamina	15	6	17	806	36	26	23	1804	14	13	6	700	10	7	6	488	21	15	18	1146
Elphidium sp. A	1	1	2	85	1	1	1	64							2	42			1	21
Elphidium sp. B					2	1		64		2		42	1			21		1		21
Planularia sp.	3	1		85		2	2	85												
Unident. Foram - dome shaped																				
Unident. Foram - spine like																				
Unident. Foram - flat sim otolith																				
Total Number Of Species/Taxa	**23**	**20**	**11**	**37**	**16**	**19**	**22**	**37**	**20**	**19**	**16**	**31**	**18**	**15**	**13**	**27**	**22**	**17**	**19**	**35**
Total Number Of Individuals	**122**	**121**	**77**	**6791**	**225**	**164**	**198**	**12457**	**228**	**208**	**126**	**11926**	**127**	**127**	**141**	**8382**	**194**	**164**	**119**	**10122**
Shannon- Wiener	**1.91**	**1.71**	**1.55**	**1.91**	**1.56**	**1.72**	**1.51**	**1.70**	**1.41**	**1.45**	**1.22**	**1.45**	**1.61**	**1.23**	**1.30**	**1.47**	**2.02**	**1.63**	**1.73**	**1.93**

Appendix 8 Benthic Biota Statistical Tests Data.

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Species**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.520)
Equal Variance Test:	Passed	(P = 0.232)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	3	0	0.667	1.155	0.667
500 N	3	0	19.000	1.732	1.000
500 E	3	0	14.000	5.000	2.887
500 S	3	0	16.333	2.887	1.667
500 W	3	0	10.333	2.887	1.667
1500 N	3	0	18.000	6.245	3.606
1500 E	3	0	19.000	3.000	1.732
1500 S	3	0	18.333	2.082	1.202
1500 W	3	0	15.333	2.517	1.453
Control	3	0	19.333	2.517	1.453

Source of Variation	DF	SS	MS	F	P
Between Groups	9	902.967	100.330	9.039	<0.001
Residual	20	222.000	11.100		
Total	29	1124.967			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **site**

Comparison	Diff of Means	p	q	P	P<0.050
Control vs. DC	18.667	10	9.704	<0.001	Yes
Control vs. 500 W	9.000	10	4.679	0.080	No
Control vs. 500 E	5.333	10	2.773	0.633	Do Not Test
Control vs. 1500 W	4.000	10	2.080	0.889	Do Not Test
Control vs. 500 S	3.000	10	1.560	0.979	Do Not Test
Control vs. 1500 N	1.333	10	0.693	1.000	Do Not Test
Control vs. 1500 S	1.000	10	0.520	1.000	Do Not Test
Control vs. 500 N	0.333	10	0.173	1.000	Do Not Test
Control vs. 1500 E	0.333	10	0.173	1.000	Do Not Test
1500 E vs. DC	18.333	10	9.531	<0.001	Yes
1500 E vs. 500 W	8.667	10	4.506	0.101	Do Not Test
1500 E vs. 500 E	5.000	10	2.599	0.706	Do Not Test
1500 E vs. 1500 W	3.667	10	1.906	0.929	Do Not Test
1500 E vs. 500 S	2.667	10	1.386	0.990	Do Not Test
1500 E vs. 1500 N	1.000	10	0.520	1.000	Do Not Test
1500 E vs. 1500 S	0.667	10	0.347	1.000	Do Not Test
1500 E vs. 500 N	0.000	10	0.000	1.000	Do Not Test
500 N vs. DC	18.333	10	9.531	<0.001	Yes
500 N vs. 500 W	8.667	10	4.506	0.101	Do Not Test
500 N vs. 500 E	5.000	10	2.599	0.706	Do Not Test
500 N vs. 1500 W	3.667	10	1.906	0.929	Do Not Test
500 N vs. 500 S	2.667	10	1.386	0.990	Do Not Test
500 N vs. 1500 N	1.000	10	0.520	1.000	Do Not Test
500 N vs. 1500 S	0.667	10	0.347	1.000	Do Not Test
1500 S vs. DC	17.667	10	9.184	<0.001	Yes
1500 S vs. 500 W	8.000	10	4.159	0.158	Do Not Test
1500 S vs. 500 E	4.333	10	2.253	0.837	Do Not Test
1500 S vs. 1500 W	3.000	10	1.560	0.979	Do Not Test
1500 S vs. 500 S	2.000	10	1.040	0.999	Do Not Test
1500 S vs. 1500 N	0.333	10	0.173	1.000	Do Not Test
1500 N vs. DC	17.333	10	9.011	<0.001	Yes
1500 N vs. 500 W	7.667	10	3.986	0.195	Do Not Test
1500 N vs. 500 E	4.000	10	2.080	0.889	Do Not Test
1500 N vs. 1500 W	2.667	10	1.386	0.990	Do Not Test
1500 N vs. 500 S	1.667	10	0.866	1.000	Do Not Test
500 S vs. DC	15.667	10	8.145	<0.001	Yes
500 S vs. 500 W	6.000	10	3.119	0.484	Do Not Test
500 S vs. 500 E	2.333	10	1.213	0.996	Do Not Test
500 S vs. 1500 W	1.000	10	0.520	1.000	Do Not Test
1500 W vs. DC	14.667	10	7.625	0.001	Yes
1500 W vs. 500 W	5.000	10	2.599	0.706	Do Not Test
1500 W vs. 500 E	1.333	10	0.693	1.000	Do Not Test
500 E vs. DC	13.333	10	6.932	0.003	Yes
500 E vs. 500 W	3.667	10	1.906	0.929	Do Not Test
500 W vs. DC	9.667	10	5.025	0.049	Yes

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Species**

Normality Test (Shapiro-Wilk)	Passed	(P = 0.484)
Equal Variance Test:	Passed	(P = 0.876)

Source of Variation	DF	SS	MS	F	P
Volume	4	941.542	235.385	25.411	<0.001
site	5	1081.998	216.400	23.361	<0.001
Volume x site	20	1227.223	61.361	6.624	<0.001
Residual	61	565.056	9.263		
Total	90	4414.418	49.049		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of site is present. There is a statistically significant interaction between Volume and site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for site : 1.000
Power of performed test with alpha = 0.0500: for Volume x site : 1.000

Least square means for **Volume :**

Group	Mean	SEM
Pre	8.676	0.820
10	16.611	0.717
50	18.778	0.717
100	17.667	0.717
150	15.111	0.717

Least square means for **Site :**

Group	Mean	SEM
DC	7.933	0.824
1500 N	19.567	0.824
1500 E	16.167	0.824
1500 S	16.300	0.824
1500 W	14.933	0.824
Control	17.311	0.732

Least square means for **Volume x Site** :

Group	Mean	SEM
Pre x DC	9.000	2.152
Pre x 1500 N	8.500	2.152
Pre x 1500 E	9.500	2.152
Pre x 1500 S	7.500	2.152
Pre x 1500 W	11.000	2.152
Pre x Control	6.556	1.015
10 x DC	7.333	1.757
10 x 1500 N	27.000	1.757
10 x 1500 E	15.667	1.757
10 x 1500 S	18.000	1.757
10 x 1500 W	13.333	1.757
10 x Control	18.333	1.757
50 x DC	3.667	1.757
50 x 1500 N	23.333	1.757
50 x 1500 E	21.000	1.757
50 x 1500 S	24.000	1.757
50 x 1500 W	18.000	1.757
50 x Control	22.667	1.757
100 x DC	19.000	1.757
100 x 1500 N	21.000	1.757
100 x 1500 E	15.667	1.757
100 x 1500 S	13.667	1.757
100 x 1500 W	17.000	1.757
100 x Control	19.667	1.757
150 x DC	0.667	1.757
150 x 1500 N	18.000	1.757
150 x 1500 E	19.000	1.757
150 x 1500 S	18.333	1.757
150 x 1500 W	15.333	1.757
150 x Control	19.333	1.757

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Volume**

Comparison	Diff of Means	t	P	P<0.050
50 vs. Pre	10.102	9.274	<0.001	Yes
100 vs. Pre	8.991	8.254	<0.001	Yes
10 vs. Pre	7.935	7.285	<0.001	Yes
150 vs. Pre	6.435	5.908	<0.001	Yes
50 vs. 150	3.667	3.614	0.004	Yes
100 vs. 150	2.556	2.519	0.070	No
50 vs. 10	2.167	2.136	0.139	No
10 vs. 150	1.500	1.479	0.374	No
50 vs. 100	1.111	1.095	0.478	No
100 vs. 10	1.056	1.040	0.302	No

Comparisons for factor: **site**

Comparison	Diff of Means	t	P	P<0.050
1500 N vs. DC	11.633	9.981	<0.001	Yes
Control vs. DC	9.378	8.509	<0.001	Yes
1500 S vs. DC	8.367	7.178	<0.001	Yes
1500 E vs. DC	8.233	7.064	<0.001	Yes
1500 W vs. DC	7.000	6.006	<0.001	Yes
1500 N vs. 1500 W	4.633	3.975	0.002	Yes
1500 N vs. 1500 E	3.400	2.917	0.044	Yes
1500 N vs. 1500 S	3.267	2.803	0.053	No
Control vs. 1500 W	2.378	2.158	0.220	No
1500 N vs. Control	2.256	2.047	0.241	No
1500 S vs. 1500 W	1.367	1.173	0.756	No
1500 E vs. 1500 W	1.233	1.058	0.752	No
Control vs. 1500 E	1.144	1.038	0.662	No
Control vs. 1500 S	1.011	0.917	0.594	No
1500 S vs. 1500 E	0.133	0.114	0.909	No

Comparisons for factor: **site within 0**

Comparison	Diff of Means	t	P	P<0.05
1500 W vs. Control	4.444	1.868	0.644	No
1500 E vs. Control	2.944	1.238	0.969	No
1500 W vs. 1500 S	3.500	1.150	0.978	No
DC vs. Control	2.444	1.027	0.988	No
1500 W vs. 1500 N	2.500	0.821	0.997	No
1500 N vs. Control	1.944	0.817	0.995	No
1500 E vs. 1500 S	2.000	0.657	0.998	No
1500 W vs. DC	2.000	0.657	0.997	No
DC vs. 1500 S	1.500	0.493	0.999	No
1500 W vs. 1500 E	1.500	0.493	0.997	No
1500 S vs. Control	0.944	0.397	0.997	No
1500 N vs. 1500 S	1.000	0.329	0.996	No
1500 E vs. 1500 N	1.000	0.329	0.983	No
DC vs. 1500 N	0.500	0.164	0.983	No
1500 E vs. DC	0.500	0.164	0.870	No

Comparisons for factor: **site within 10**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. DC	19.667	7.914	<0.001	Yes
1500 N vs. 1500 W	13.667	5.500	<0.001	Yes
1500 N vs. 1500 E	11.333	4.561	<0.001	Yes
Control vs. DC	11.000	4.426	<0.001	Yes
1500 S vs. DC	10.667	4.292	<0.001	Yes
1500 N vs. 1500 S	9.000	3.622	0.006	Yes
1500 N vs. Control	8.667	3.488	0.008	Yes
1500 E vs. DC	8.333	3.353	0.011	Yes
1500 W vs. DC	6.000	2.414	0.124	No
Control vs. 1500 W	5.000	2.012	0.259	No
1500 S vs. 1500 W	4.667	1.878	0.286	No
Control vs. 1500 E	2.667	1.073	0.742	No
1500 S vs. 1500 E	2.333	0.939	0.727	No
1500 E vs. 1500 W	2.333	0.939	0.579	No
Control vs. 1500 S	0.333	0.134	0.894	No

Comparisons for factor: **site within 50**

Comparison	Diff of Means	t	P	P<0.05
1500 S vs. DC	20.333	8.182	<0.001	Yes
1500 N vs. DC	19.667	7.914	<0.001	Yes
Control vs. DC	19.000	7.646	<0.001	Yes
1500 E vs. DC	17.333	6.975	<0.001	Yes
1500 W vs. DC	14.333	5.768	<0.001	Yes
1500 S vs. 1500 W	6.000	2.414	0.173	No
1500 N vs. 1500 W	5.333	2.146	0.280	No
Control vs. 1500 W	4.667	1.878	0.417	No
1500 E vs. 1500 W	3.000	1.207	0.842	No
1500 S vs. 1500 E	3.000	1.207	0.795	No
1500 N vs. 1500 E	2.333	0.939	0.885	No
Control vs. 1500 E	1.667	0.671	0.940	No
1500 S vs. Control	1.333	0.537	0.933	No
1500 S vs. 1500 N	0.667	0.268	0.956	No
1500 N vs. Control	0.667	0.268	0.789	No

Comparisons for factor: **site within 100**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. 1500 S	7.333	2.951	0.065	No
Control vs. 1500 S	6.000	2.414	0.233	No
DC vs. 1500 S	5.333	2.146	0.378	No
1500 N vs. 1500 E	5.333	2.146	0.355	No
Control vs. 1500 E	4.000	1.610	0.731	No
1500 N vs. 1500 W	4.000	1.610	0.697	No
1500 W vs. 1500 S	3.333	1.341	0.841	No
DC vs. 1500 E	3.333	1.341	0.805	No
Control vs. 1500 W	2.667	1.073	0.907	No
DC vs. 1500 W	2.000	0.805	0.963	No
1500 E vs. 1500 S	2.000	0.805	0.937	No
1500 N vs. DC	2.000	0.805	0.890	No
1500 W vs. 1500 E	1.333	0.537	0.933	No
1500 N vs. Control	1.333	0.537	0.835	No
Control vs. DC	0.667	0.268	0.789	No

Comparisons for factor: **site within 150**

Comparison	Diff of Means	t	P	P<0.05
Control vs. DC	18.667	7.512	<0.001	Yes
1500 E vs. DC	18.333	7.377	<0.001	Yes
1500 S vs. DC	17.667	7.109	<0.001	Yes
1500 N vs. DC	17.333	6.975	<0.001	Yes
1500 W vs. DC	14.667	5.902	<0.001	Yes
Control vs. 1500 W	4.000	1.610	0.697	No
1500 E vs. 1500 W	3.667	1.475	0.756	No
1500 S vs. 1500 W	3.000	1.207	0.879	No
1500 N vs. 1500 W	2.667	1.073	0.907	No
Control vs. 1500 N	1.333	0.537	0.995	No
Control vs. 1500 S	1.000	0.402	0.997	No
1500 E vs. 1500 N	1.000	0.402	0.991	No
1500 E vs. 1500 S	0.667	0.268	0.991	No
Control vs. 1500 E	0.333	0.134	0.989	No
1500 S vs. 1500 N	0.333	0.134	0.894	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	18.333	7.377	<0.001	Yes
100 vs. 50	15.333	6.170	<0.001	Yes
100 vs. 10	11.667	4.695	<0.001	Yes
100 vs. Pre	10.000	3.599	0.004	Yes
Pre vs. 150	8.333	2.999	0.023	Yes
10 vs. 150	6.667	2.683	0.046	Yes
Pre vs. 50	5.333	1.920	0.218	No
10 vs. 50	3.667	1.475	0.375	No
50 vs. 150	3.000	1.207	0.410	No
Pre vs. 10	1.667	0.600	0.551	No

Comparisons for factor: **Volume within 1500 N**

Comparison	Diff of Means	t	P	P<0.05
10 vs. Pre	18.500	6.659	<0.001	Yes
50 vs. Pre	14.833	5.339	<0.001	Yes
100 vs. Pre	12.500	4.499	<0.001	Yes
10 vs. 150	9.000	3.622	0.004	Yes
150 vs. Pre	9.500	3.419	0.007	Yes
10 vs. 100	6.000	2.414	0.090	No
50 vs. 150	5.333	2.146	0.136	No
10 vs. 50	3.667	1.475	0.375	No
100 vs. 150	3.000	1.207	0.410	No
50 vs. 100	2.333	0.939	0.351	No

Comparisons for factor: **Volume within 1500 E**

Comparison	Diff of Means	t	P	P<0.05
50 vs. Pre	11.500	4.139	0.001	Yes
150 vs. Pre	9.500	3.419	0.010	Yes
10 vs. Pre	6.167	2.220	0.217	No
100 vs. Pre	6.167	2.220	0.193	No
50 vs. 100	5.333	2.146	0.197	No
50 vs. 10	5.333	2.146	0.167	No
150 vs. 100	3.333	1.341	0.558	No
150 vs. 10	3.333	1.341	0.458	No
50 vs. 150	2.000	0.805	0.668	No
10 vs. 100	7.105E-015	2.859E-015	1.000	No

Comparisons for factor: **Volume within 1500 S**

Comparison	Diff of Means	t	P	P<0.05
50 vs. Pre	16.500	5.939	<0.001	Yes
50 vs. 100	10.333	4.158	<0.001	Yes
150 vs. Pre	10.833	3.899	0.002	Yes
10 vs. Pre	10.500	3.779	0.003	Yes
50 vs. 10	6.000	2.414	0.107	No
50 vs. 150	5.667	2.280	0.124	No
100 vs. Pre	6.167	2.220	0.115	No
150 vs. 100	4.667	1.878	0.183	No
10 vs. 100	4.333	1.744	0.165	No
150 vs. 10	0.333	0.134	0.894	No

Comparisons for factor: **Volume within 1500 W**

Comparison	Diff of Means	t	P	P<0.05
50 vs. Pre	7.000	2.519	0.135	No
100 vs. Pre	6.000	2.160	0.273	No
50 vs. 10	4.667	1.878	0.417	No
150 vs. Pre	4.333	1.560	0.604	No
100 vs. 10	3.667	1.475	0.610	No
50 vs. 150	2.667	1.073	0.816	No
10 vs. Pre	2.333	0.840	0.874	No
150 vs. 10	2.000	0.805	0.809	No
100 vs. 150	1.667	0.671	0.755	No
50 vs. 100	1.000	0.402	0.689	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
50 vs. Pre	16.111	7.940	<0.001	Yes
100 vs. Pre	13.111	6.462	<0.001	Yes
150 vs. Pre	12.778	6.297	<0.001	Yes
10 vs. Pre	11.778	5.805	<0.001	Yes
50 vs. 10	4.333	1.744	0.418	No
50 vs. 150	3.333	1.341	0.640	No
50 vs. 100	3.000	1.207	0.652	No
100 vs. 10	1.333	0.537	0.933	No
150 vs. 10	1.000	0.402	0.903	No
100 vs. 150	0.333	0.134	0.894	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Individual per m^2**
Normality Test (Shapiro-Wilk) Passed (P = 0.917)
Equal Variance Test: Passed (P = 0.829)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	3	0	42.441	73.511	42.441
500 N	3	0	7639.437	1606.756	927.661
500 E	3	0	9591.738	2669.505	1541.239
500 S	3	0	10292.020	966.181	557.825
500 W	3	0	6769.390	2366.080	1366.057
1500 N	3	0	6790.611	1635.919	944.498
1500 E	3	0	12456.527	1945.947	1123.493
1500 S	3	0	11926.010	3440.889	1986.598
1500 W	3	0	8382.160	514.574	297.089
Control	3	0	10122.254	2403.187	1387.481

Source of Variation	DF	SS	MS	F	P
Between Groups	9	337592592.158	37510288.018	9.242	<0.001
Residual	20	81175830.436	4058791.522		
Total	29	418768422.594			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **site**

Comparison	Diff of Means	p	q	P	P<0.050
1500 E vs. DC	12414.086	10	10.673	<0.001	Yes
1500 E vs. 500 W	5687.137	10	4.889	0.059	No
1500 E vs. 1500 N	5665.916	10	4.871	0.061	Do Not Test
1500 E vs. 500 N	4817.090	10	4.141	0.161	Do Not Test
1500 E vs. 1500 W	4074.367	10	3.503	0.336	Do Not Test
1500 E vs. 500 E	2864.789	10	2.463	0.761	Do Not Test
1500 E vs. Control	2334.272	10	2.007	0.907	Do Not Test
1500 E vs. 500 S	2164.507	10	1.861	0.938	Do Not Test
1500 E vs. 1500 S	530.516	10	0.456	1.000	Do Not Test
1500 S vs. DC	11883.569	10	10.217	<0.001	Yes
1500 S vs. 500 W	5156.620	10	4.433	0.111	Do Not Test
1500 S vs. 1500 N	5135.399	10	4.415	0.114	Do Not Test
1500 S vs. 500 N	4286.573	10	3.685	0.277	Do Not Test
1500 S vs. 1500 W	3543.850	10	3.047	0.514	Do Not Test
1500 S vs. 500 E	2334.272	10	2.007	0.907	Do Not Test
1500 S vs. Control	1803.756	10	1.551	0.979	Do Not Test
1500 S vs. 500 S	1633.991	10	1.405	0.989	Do Not Test
500 S vs. DC	10249.578	10	8.812	<0.001	Yes
500 S vs. 500 W	3522.629	10	3.029	0.522	Do Not Test
500 S vs. 1500 N	3501.409	10	3.010	0.530	Do Not Test
500 S vs. 500 N	2652.582	10	2.281	0.827	Do Not Test
500 S vs. 1500 W	1909.859	10	1.642	0.971	Do Not Test
500 S vs. 500 E	700.282	10	0.602	1.000	Do Not Test
500 S vs. Control	169.765	10	0.146	1.000	Do Not Test
Control vs. DC	10079.813	10	8.666	<0.001	Yes
Control vs. 500 W	3352.864	10	2.883	0.585	Do Not Test
Control vs. 1500 N	3331.643	10	2.864	0.593	Do Not Test
Control vs. 500 N	2482.817	10	2.135	0.873	Do Not Test
Control vs. 1500 W	1740.094	10	1.496	0.984	Do Not Test
Control vs. 500 E	530.516	10	0.456	1.000	Do Not Test
500 E vs. DC	9549.297	10	8.210	<0.001	Yes
500 E vs. 500 W	2822.348	10	2.426	0.775	Do Not Test
500 E vs. 1500 N	2801.127	10	2.408	0.782	Do Not Test
500 E vs. 500 N	1952.301	10	1.678	0.966	Do Not Test
500 E vs. 1500 W	1209.578	10	1.040	0.999	Do Not Test
1500 W vs. DC	8339.719	10	7.170	0.002	Yes
1500 W vs. 500 W	1612.770	10	1.387	0.990	Do Not Test
1500 W vs. 1500 N	1591.549	10	1.368	0.991	Do Not Test
1500 W vs. 500 N	742.723	10	0.639	1.000	Do Not Test
500 N vs. DC	7596.996	10	6.531	0.005	Yes
500 N vs. 500 W	870.047	10	0.748	1.000	Do Not Test
500 N vs. 1500 N	848.826	10	0.730	1.000	Do Not Test
1500 N vs. DC	6748.170	10	5.802	0.016	Yes
1500 N vs. 500 W	21.221	10	0.0182	1.000	Do Not Test
500 W vs. DC	6726.949	10	5.783	0.016	Yes

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Individual per m^2**
Normality Test (Shapiro-Wilk) Failed (P < 0.050)
Equal Variance Test: Failed (P < 0.050)

Source of Variation	DF	SS	MS	F	P
Volume	4	7809169102.451	1952292275.613	41.839	<0.001
site	5	2425696358.103	485139271.621	10.397	<0.001
Volume x site	20	3770875105.434	188543755.272	4.041	<0.001
Residual	61	2846412247.877	46662495.867		
Total	90	17831787360.217	198130970.669		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of site is present. There is a statistically significant interaction between Volume and site. (P = <0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for site : 1.000
Power of performed test with alpha = 0.0500: for Volume x site : 0.998

Least square means for **Volume** :

Group	Mean	SEM
Pre	12133.309	1839.693
10	2843.857	1610.081
50	27601.004	1610.081
100	23714.087	1610.081
150	8286.667	1610.081

Least square means for **site** :

Group	Mean	SEM
DC	7916.259	1849.842
1500 N	22966.037	1849.842
1500 E	21426.283	1849.842
1500 S	12013.925	1849.842
1500 W	13044.209	1849.842
Control	12127.996	1641.967

Least square means for **Volume x site** :

Group	Mean	SEM
Pre x DC	15200.921	4830.243
Pre x 1500 N	17019.835	4830.243
Pre x 1500 E	16240.300	4830.243
Pre x 1500 S	6626.043	4830.243
Pre x 1500 W	14421.387	4830.243
Pre x Control	3291.368	2276.998
10 x DC	952.764	3943.877
10 x 1500 N	6582.735	3943.877
10 x 1500 E	2273.642	3943.877
10 x 1500 S	2620.102	3943.877
10 x 1500 W	1992.144	3943.877
10 x Control	2641.756	3943.877
50 x DC	4477.559	3943.877
50 x 1500 N	55767.892	3943.877
50 x 1500 E	38833.806	3943.877
50 x 1500 S	23236.622	3943.877
50 x 1500 W	21178.218	3943.877
50 x Control	22111.927	3943.877
100 x DC	18907.607	3943.877
100 x 1500 N	28669.110	3943.877
100 x 1500 E	37327.139	3943.877
100 x 1500 S	15660.846	3943.877
100 x 1500 W	19247.138	3943.877
100 x Control	22472.678	3943.877
150 x DC	42.441	3943.877
150 x 1500 N	6790.611	3943.877
150 x 1500 E	12456.527	3943.877
150 x 1500 S	11926.010	3943.877
150 x 1500 W	8382.160	3943.877
150 x Control	10122.254	3943.877

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Volume**

Comparison	Diff of Means	t	P	P<0.050
50 vs. 10	24757.147	10.873	<0.001	Yes
100 vs. 10	20870.229	9.166	<0.001	Yes
50 vs. 150	19314.337	8.482	<0.001	Yes
100 vs. 150	15427.419	6.775	<0.001	Yes
50 vs. Pre	15467.695	6.327	<0.001	Yes
100 vs. Pre	11580.778	4.737	<0.001	Yes
Pre vs. 10	9289.452	3.800	0.001	Yes
150 vs. 10	5442.810	2.390	0.059	No
50 vs. 100	3886.917	1.707	0.177	No
Pre vs. 150	3846.641	1.573	0.121	No

Comparisons for factor: **site**

Comparison	Diff of Means	t	P	P<0.050
1500 N vs. DC	15049.778	5.753	<0.001	Yes
1500 E vs. DC	13510.024	5.164	<0.001	Yes
1500 N vs. Control	10838.040	4.382	<0.001	Yes
1500 N vs. 1500 S	10952.112	4.186	0.001	Yes
1500 N vs. 1500 W	9921.827	3.793	0.004	Yes
1500 E vs. Control	9298.286	3.759	0.004	Yes
1500 E vs. 1500 S	9412.358	3.598	0.006	Yes
1500 E vs. 1500 W	8382.074	3.204	0.017	Yes
1500 W vs. DC	5127.951	1.960	0.325	No
Control vs. DC	4211.738	1.703	0.446	No
1500 S vs. DC	4097.666	1.566	0.480	No
1500 N vs. 1500 E	1539.754	0.589	0.962	No
1500 W vs. 1500 S	1030.285	0.394	0.972	No
1500 W vs. Control	916.213	0.370	0.917	No
Control vs. 1500 S	114.072	0.0461	0.963	No

Comparisons for factor: **site within 0**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. Control	13728.467	2.571	0.173	No
1500 E vs. Control	12948.933	2.425	0.228	No
DC vs. Control	11909.554	2.230	0.322	No
1500 W vs. Control	11130.019	2.084	0.397	No
1500 N vs. 1500 S	10393.792	1.522	0.793	No
1500 E vs. 1500 S	9614.258	1.407	0.834	No
DC vs. 1500 S	8574.879	1.255	0.886	No
1500 W vs. 1500 S	7795.344	1.141	0.908	No
1500 S vs. Control	3334.675	0.624	0.995	No
1500 N vs. 1500 W	2598.448	0.380	0.999	No
1500 E vs. 1500 W	1818.914	0.266	1.000	No
1500 N vs. DC	1818.914	0.266	0.998	No
1500 E vs. DC	1039.379	0.152	0.998	No
DC vs. 1500 W	779.534	0.114	0.992	No
1500 N vs. 1500 E	779.534	0.114	0.910	No

Comparisons for factor: **site within 10**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. DC	5629.971	1.009	0.997	No
1500 N vs. 1500 W	4590.592	0.823	0.999	No
1500 N vs. 1500 E	4309.093	0.773	1.000	No
1500 N vs. 1500 S	3962.633	0.710	1.000	No
1500 N vs. Control	3940.980	0.707	0.999	No
Control vs. DC	1688.991	0.303	1.000	No
1500 S vs. DC	1667.338	0.299	1.000	No
1500 E vs. DC	1320.878	0.237	1.000	No
1500 W vs. DC	1039.379	0.186	1.000	No
Control vs. 1500 W	649.612	0.116	1.000	No
1500 S vs. 1500 W	627.958	0.113	1.000	No
Control vs. 1500 E	368.113	0.0660	1.000	No
1500 S vs. 1500 E	346.460	0.0621	1.000	No
1500 E vs. 1500 W	281.499	0.0505	0.998	No
Control vs. 1500 S	21.654	0.00388	0.997	No

Comparisons for factor: **site within 50**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. DC	51290.333	9.196	<0.001	Yes
1500 N vs. 1500 W	34589.674	6.202	<0.001	Yes
1500 E vs. DC	34356.247	6.160	<0.001	Yes
1500 N vs. Control	33655.965	6.034	<0.001	Yes
1500 N vs. 1500 S	32531.270	5.833	<0.001	Yes
1500 S vs. DC	18759.063	3.363	0.013	Yes
1500 E vs. 1500 W	17655.588	3.166	0.022	Yes
Control vs. DC	17634.368	3.162	0.019	Yes
1500 N vs. 1500 E	16934.086	3.036	0.024	Yes
1500 E vs. Control	16721.879	2.998	0.023	Yes
1500 W vs. DC	16700.659	2.994	0.020	Yes
1500 E vs. 1500 S	15597.184	2.796	0.027	Yes
1500 S vs. 1500 W	2058.404	0.369	0.976	No
1500 S vs. Control	1124.695	0.202	0.975	No
Control vs. 1500 W	933.709	0.167	0.868	No

Comparisons for factor: **site within 100**

Comparison	Diff of Means	t	P	P<0.05
1500 E vs. 1500 S	21666.293	3.885	0.004	Yes
1500 E vs. DC	18419.532	3.302	0.022	Yes
1500 E vs. 1500 W	18080.002	3.242	0.025	Yes
1500 E vs. Control	14854.461	2.663	0.112	No
1500 N vs. 1500 S	13008.264	2.332	0.226	No
1500 N vs. DC	9761.503	1.750	0.589	No
1500 N vs. 1500 W	9421.973	1.689	0.598	No
1500 E vs. 1500 N	8658.029	1.552	0.659	No
Control vs. 1500 S	6811.832	1.221	0.835	No
1500 N vs. Control	6196.432	1.111	0.850	No
1500 W vs. 1500 S	3586.291	0.643	0.975	No
Control vs. DC	3565.071	0.639	0.949	No
DC vs. 1500 S	3246.761	0.582	0.916	No
Control vs. 1500 W	3225.540	0.578	0.811	No
1500 W vs. DC	339.531	0.0609	0.952	No

Comparisons for factor: **site within 150**

Comparison	Diff of Means	t	P	P<0.05
1500 E vs. DC	12414.086	2.226	0.364	No
1500 S vs. DC	11883.569	2.131	0.411	No
Control vs. DC	10079.813	1.807	0.640	No
1500 W vs. DC	8339.719	1.495	0.836	No
1500 N vs. DC	6748.170	1.210	0.944	No
1500 E vs. 1500 N	5665.916	1.016	0.977	No
1500 S vs. 1500 N	5135.400	0.921	0.982	No
1500 E vs. 1500 W	4074.367	0.731	0.994	No
1500 S vs. 1500 W	3543.850	0.635	0.995	No
Control vs. 1500 N	3331.644	0.597	0.992	No
1500 E vs. Control	2334.273	0.419	0.996	No
1500 S vs. Control	1803.756	0.323	0.996	No
Control vs. 1500 W	1740.094	0.312	0.985	No
1500 W vs. 1500 N	1591.549	0.285	0.950	No
1500 E vs. 1500 S	530.516	0.0951	0.925	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
100 vs. 150	18865.166	3.382	0.013	Yes
100 vs. 10	17954.843	3.219	0.018	Yes
100 vs. 50	14430.048	2.587	0.093	No
Pre vs. 150	15158.480	2.431	0.120	No
Pre vs. 10	14248.157	2.285	0.145	No
Pre vs. 50	10723.362	1.720	0.378	No
50 vs. 150	4435.118	0.795	0.894	No
50 vs. 10	3524.795	0.632	0.896	No
100 vs. Pre	3706.686	0.594	0.801	No
10 vs. 150	910.323	0.163	0.871	No

Comparisons for factor: **Volume within 1500 N**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 10	49185.157	8.819	<0.001	Yes
50 vs. 150	48977.281	8.781	<0.001	Yes
50 vs. Pre	38748.057	6.214	<0.001	Yes
50 vs. 100	27098.782	4.859	<0.001	Yes
100 vs. 10	22086.375	3.960	0.001	Yes
100 vs. 150	21878.500	3.923	0.001	Yes
100 vs. Pre	11649.276	1.868	0.241	No
Pre vs. 10	10437.100	1.674	0.269	No
Pre vs. 150	10229.224	1.640	0.201	No
150 vs. 10	207.876	0.0373	0.970	No

Comparisons for factor: **Volume within 1500 E**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 10	36560.164	6.555	<0.001	Yes
100 vs. 10	35053.497	6.285	<0.001	Yes
50 vs. 150	26377.279	4.729	<0.001	Yes
100 vs. 150	24870.612	4.459	<0.001	Yes
50 vs. Pre	22593.506	3.623	0.004	Yes
100 vs. Pre	21086.839	3.382	0.006	Yes
Pre vs. 10	13966.658	2.240	0.110	No
150 vs. 10	10182.885	1.826	0.203	No
Pre vs. 150	3783.773	0.607	0.794	No
50 vs. 100	1506.667	0.270	0.788	No

Comparisons for factor: **Volume within 1500 S**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 10	20616.520	3.696	0.005	Yes
50 vs. Pre	16610.579	2.664	0.085	No
100 vs. 10	13040.745	2.338	0.168	No
50 vs. 150	11310.611	2.028	0.286	No
150 vs. 10	9305.909	1.668	0.470	No
100 vs. Pre	9034.804	1.449	0.563	No
50 vs. 100	7575.775	1.358	0.547	No
150 vs. Pre	5299.968	0.850	0.783	No
100 vs. 150	3734.836	0.670	0.756	No
Pre vs. 10	4005.941	0.642	0.523	No

Comparisons for factor: **Volume within 1500 W**

Comparison	Diff of Means	t	P	P<0.05
50 vs. 10	19186.074	3.440	0.011	Yes
100 vs. 10	17254.994	3.094	0.027	Yes
50 vs. 150	12796.057	2.294	0.185	No
Pre vs. 10	12429.243	1.993	0.305	No
100 vs. 150	10864.977	1.948	0.292	No
150 vs. 10	6390.017	1.146	0.773	No
50 vs. Pre	6756.831	1.084	0.735	No
Pre vs. 150	6039.226	0.968	0.708	No
100 vs. Pre	4825.751	0.774	0.689	No
50 vs. 100	1931.080	0.346	0.730	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
100 vs. Pre	19181.310	4.212	<0.001	Yes
50 vs. Pre	18820.559	4.133	<0.001	Yes
100 vs. 10	19830.922	3.556	0.006	Yes
50 vs. 10	19470.171	3.491	0.006	Yes
100 vs. 150	12350.424	2.214	0.170	No
50 vs. 150	11989.672	2.150	0.166	No
150 vs. Pre	6830.887	1.500	0.450	No
150 vs. 10	7480.499	1.341	0.458	No
Pre vs. 10	649.612	0.143	0.987	No
100 vs. 50	360.751	0.0647	0.949	No

One Way Analysis of Variance between Sites after 150,000m^3 Disposal.

Dependent Variable: **Shannon Wiener Diversity Index**

Normality Test (Shapiro-Wilk) Passed (P = 0.758)

Equal Variance Test: Passed (P = 0.092)

Group Name	N	Missing	Mean	Std Dev	SEM
DC	3	0	0.231	0.400	0.231
500 N	3	0	1.501	0.154	0.0891
500 E	3	0	1.066	0.335	0.193
500 S	3	0	1.208	0.130	0.0751
500 W	3	0	1.375	0.244	0.141
1500 N	3	0	1.722	0.182	0.105
1500 E	3	0	1.594	0.111	0.0643
1500 S	3	0	1.361	0.126	0.0730
1500 W	3	0	1.383	0.202	0.116
Control	3	0	1.791	0.207	0.119

Source of Variation	DF	SS	MS	F	P
Between Groups	9	5.288	0.588	11.352	<0.001
Residual	20	1.035	0.0518		
Total	29	6.323			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

All Pairwise Multiple Comparison Procedures (Tukey Test):

Comparisons for factor: **site**

Comparison	Diff of Means	p	q	P	P<0.050
Control vs. DC	1.560	10	11.878	<0.001	Yes
Control vs. 500 E	0.725	10	5.519	0.024	Yes
Control vs. 500 S	0.584	10	4.443	0.109	No
Control vs. 1500 S	0.430	10	3.276	0.420	Do Not Test
Control vs. 500 W	0.417	10	3.172	0.462	Do Not Test
Control vs. 1500 W	0.408	10	3.105	0.490	Do Not Test
Control vs. 500 N	0.290	10	2.207	0.851	Do Not Test
Control vs. 1500 E	0.197	10	1.501	0.983	Do Not Test
Control vs. 1500 N	0.0698	10	0.531	1.000	Do Not Test
1500 N vs. DC	1.490	10	11.347	<0.001	Yes
1500 N vs. 500 E	0.655	10	4.988	0.052	No
1500 N vs. 500 S	0.514	10	3.911	0.214	Do Not Test
1500 N vs. 1500 S	0.361	10	2.745	0.644	Do Not Test
1500 N vs. 500 W	0.347	10	2.641	0.689	Do Not Test
1500 N vs. 1500 W	0.338	10	2.574	0.717	Do Not Test
1500 N vs. 500 N	0.220	10	1.676	0.967	Do Not Test
1500 N vs. 1500 E	0.127	10	0.970	0.999	Do Not Test
1500 E vs. DC	1.363	10	10.378	<0.001	Yes
1500 E vs. 500 E	0.528	10	4.018	0.188	Do Not Test
1500 E vs. 500 S	0.386	10	2.942	0.559	Do Not Test
1500 E vs. 1500 S	0.233	10	1.775	0.953	Do Not Test
1500 E vs. 500 W	0.220	10	1.671	0.967	Do Not Test
1500 E vs. 1500 W	0.211	10	1.604	0.975	Do Not Test
1500 E vs. 500 N	0.0928	10	0.707	1.000	Do Not Test
500 N vs. DC	1.270	10	9.671	<0.001	Yes
500 N vs. 500 E	0.435	10	3.312	0.406	Do Not Test
500 N vs. 500 S	0.294	10	2.235	0.843	Do Not Test
500 N vs. 1500 S	0.140	10	1.069	0.999	Do Not Test
500 N vs. 500 W	0.127	10	0.965	0.999	Do Not Test
500 N vs. 1500 W	0.118	10	0.898	1.000	Do Not Test
1500 W vs. DC	1.152	10	8.773	<0.001	Yes
1500 W vs. 500 E	0.317	10	2.414	0.780	Do Not Test
1500 W vs. 500 S	0.176	10	1.337	0.992	Do Not Test
1500 W vs. 1500 S	0.0225	10	0.171	1.000	Do Not Test
1500 W vs. 500 W	0.00880	10	0.0670	1.000	Do Not Test
500 W vs. DC	1.144	10	8.706	<0.001	Yes
500 W vs. 500 E	0.308	10	2.347	0.804	Do Not Test
500 W vs. 500 S	0.167	10	1.270	0.995	Do Not Test
500 W vs. 1500 S	0.0137	10	0.104	1.000	Do Not Test
1500 S vs. DC	1.130	10	8.602	<0.001	Yes
1500 S vs. 500 E	0.295	10	2.243	0.840	Do Not Test
1500 S vs. 500 S	0.153	10	1.166	0.997	Do Not Test
500 S vs. DC	0.977	10	7.436	0.001	Yes
500 S vs. 500 E	0.141	10	1.076	0.998	Do Not Test
500 E vs. DC	0.835	10	6.359	0.007	Yes

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Two Way Analysis of Variance between Sites and Disposal Volumes.

Dependent Variable: **Shannon Wiener Diversity Index**

Normality Test (Shapiro-Wilk)	Failed	(P < 0.050)
Equal Variance Test:	Failed	(P < 0.050)

Source of Variation	DF	SS	MS	F	P
Volume	4	11.628	2.907	36.039	<0.001
site	5	3.988	0.798	9.888	<0.001
Volume x site	20	4.374	0.219	2.711	0.001
Residual	61	4.920	0.0807		
Total	90	25.437	0.283		

Main effects cannot be properly interpreted if significant interaction is determined. This is because the size of a factor's effect depends upon the level of the other factor.

The effect of different levels of Volume depends on what level of site is present. There is a statistically significant interaction between Volume and site. (P = 0.001)

Power of performed test with alpha = 0.0500: for Volume : 1.000
Power of performed test with alpha = 0.0500: for site : 1.000
Power of performed test with alpha = 0.0500: for Volume x site : 0.915

Least square means for **Volume :**

Group	Mean	SEM
Pre	1.497	0.0765
10	2.236	0.0669
50	1.232	0.0669
100	1.373	0.0669
150	1.347	0.0669

Least square means for **site :**

Group	Mean	SEM
DC	1.086	0.0769
1500 N	1.718	0.0769
1500 E	1.489	0.0769
1500 S	1.626	0.0769
1500 W	1.576	0.0769
Control	1.725	0.0683

Least square means for **Volume x site :**

Group	Mean	SEM
Pre x DC	1.447	0.201
Pre x 1500 N	1.324	0.201
Pre x 1500 E	1.252	0.201
Pre x 1500 S	1.663	0.201
Pre x 1500 W	1.650	0.201
Pre x Control	1.644	0.0947
10 x DC	1.627	0.164
10 x 1500 N	2.457	0.164
10 x 1500 E	2.293	0.164
10 x 1500 S	2.534	0.164
10 x 1500 W	2.074	0.164
10 x Control	2.432	0.164
50 x DC	0.668	0.164
50 x 1500 N	1.496	0.164
50 x 1500 E	1.105	0.164
50 x 1500 S	1.413	0.164
50 x 1500 W	1.308	0.164
50 x Control	1.401	0.164
100 x DC	1.458	0.164
100 x 1500 N	1.592	0.164
100 x 1500 E	1.203	0.164
100 x 1500 S	1.162	0.164
100 x 1500 W	1.466	0.164
100 x Control	1.357	0.164
150 x DC	0.231	0.164
150 x 1500 N	1.722	0.164
150 x 1500 E	1.594	0.164
150 x 1500 S	1.361	0.164
150 x 1500 W	1.383	0.164
150 x Control	1.791	0.164

All Pairwise Multiple Comparison Procedures (Holm-Sidak method):
Overall significance level = 0.05

Comparisons for factor: **Volume**

Comparison	Diff of Means	t	P	P<0.050
10 vs. 50	1.004	10.608	<0.001	Yes
10 vs. 150	0.889	9.390	<0.001	Yes
10 vs. 100	0.863	9.116	<0.001	Yes
10 vs. Pre	0.739	7.274	<0.001	Yes
Pre vs. 50	0.265	2.606	0.067	No
100 vs. 50	0.141	1.492	0.532	No
Pre vs. 150	0.150	1.471	0.469	No
150 vs. 50	0.115	1.218	0.540	No
Pre vs. 100	0.124	1.216	0.405	No
100 vs. 150	0.0259	0.274	0.785	No

Comparisons for factor: **site**

Comparison	Diff of Means	t	P	P<0.050
Control vs. DC	0.639	6.214	<0.001	Yes
1500 N vs. DC	0.632	5.811	<0.001	Yes
1500 S vs. DC	0.540	4.968	<0.001	Yes
1500 W vs. DC	0.490	4.506	<0.001	Yes
1500 E vs. DC	0.403	3.708	0.005	Yes
Control vs. 1500 E	0.236	2.292	0.226	No
1500 N vs. 1500 E	0.229	2.103	0.305	No
Control vs. 1500 W	0.149	1.448	0.734	No
1500 N vs. 1500 W	0.142	1.305	0.784	No
1500 S vs. 1500 E	0.137	1.260	0.761	No
Control vs. 1500 S	0.0987	0.960	0.876	No
1500 N vs. 1500 S	0.0916	0.843	0.873	No
1500 W vs. 1500 E	0.0868	0.798	0.813	No
1500 S vs. 1500 W	0.0503	0.462	0.874	No
Control vs. 1500 N	0.00704	0.0684	0.946	No

Comparisons for factor: **site within 0**

Comparison	Diff of Means	t	P	P<0.05
Control vs. 1500 E	0.392	1.767	0.724	No
1500 S vs. 1500 E	0.411	1.446	0.903	No
Control vs. 1500 N	0.320	1.441	0.887	No
1500 W vs. 1500 E	0.398	1.400	0.888	No
1500 S vs. 1500 N	0.338	1.191	0.950	No
1500 W vs. 1500 N	0.325	1.146	0.948	No
Control vs. DC	0.198	0.891	0.986	No
1500 S vs. DC	0.216	0.761	0.992	No
1500 W vs. DC	0.203	0.715	0.989	No
DC vs. 1500 E	0.195	0.685	0.984	No
DC vs. 1500 N	0.122	0.431	0.996	No
1500 N vs. 1500 E	0.0722	0.254	0.998	No
1500 S vs. Control	0.0183	0.0825	1.000	No
1500 S vs. 1500 W	0.0129	0.0454	0.999	No
1500 W vs. Control	0.00543	0.0244	0.981	No

Comparisons for factor: **site within 10**

Comparison	Diff of Means	t	P	P<0.05
1500 S vs. DC	0.907	3.911	0.003	Yes
1500 N vs. DC	0.830	3.580	0.010	Yes
Control vs. DC	0.806	3.474	0.012	Yes
1500 E vs. DC	0.666	2.874	0.065	No
1500 S vs. 1500 W	0.460	1.982	0.444	No
1500 W vs. DC	0.447	1.929	0.452	No
1500 N vs. 1500 W	0.383	1.650	0.628	No
Control vs. 1500 W	0.358	1.545	0.664	No
1500 S vs. 1500 E	0.240	1.037	0.921	No
1500 E vs. 1500 W	0.219	0.945	0.924	No
1500 N vs. 1500 E	0.164	0.705	0.963	No
Control vs. 1500 E	0.139	0.600	0.959	No
1500 S vs. Control	0.101	0.437	0.962	No
1500 S vs. 1500 N	0.0769	0.331	0.933	No
1500 N vs. Control	0.0245	0.106	0.916	No

Comparisons for factor: **site within 50**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. DC	0.828	3.570	0.010	Yes
1500 S vs. DC	0.745	3.212	0.029	Yes
Control vs. DC	0.733	3.159	0.032	Yes
1500 W vs. DC	0.640	2.759	0.088	No
1500 E vs. DC	0.437	1.883	0.520	No
1500 N vs. 1500 E	0.391	1.687	0.638	No
1500 S vs. 1500 E	0.308	1.329	0.848	No
Control vs. 1500 E	0.296	1.276	0.843	No
1500 W vs. 1500 E	0.203	0.876	0.967	No
1500 N vs. 1500 W	0.188	0.811	0.962	No
1500 S vs. 1500 W	0.105	0.453	0.995	No
1500 N vs. Control	0.0953	0.411	0.990	No
Control vs. 1500 W	0.0927	0.400	0.970	No
1500 N vs. 1500 S	0.0829	0.358	0.923	No
1500 S vs. Control	0.0124	0.0535	0.958	No

Comparisons for factor: **site within 100**

Comparison	Diff of Means	t	P	P<0.05
1500 N vs. 1500 S	0.430	1.854	0.655	No
1500 N vs. 1500 E	0.389	1.677	0.766	No
1500 W vs. 1500 S	0.304	1.310	0.941	No
DC vs. 1500 S	0.296	1.277	0.938	No
1500 W vs. 1500 E	0.263	1.133	0.964	No
DC vs. 1500 E	0.255	1.100	0.960	No
1500 N vs. Control	0.235	1.012	0.967	No
Control vs. 1500 S	0.195	0.842	0.984	No
Control vs. 1500 E	0.154	0.665	0.993	No
1500 N vs. DC	0.134	0.577	0.993	No
1500 N vs. 1500 W	0.126	0.544	0.988	No
1500 W vs. Control	0.109	0.468	0.983	No
DC vs. Control	0.101	0.435	0.962	No
1500 E vs. 1500 S	0.0409	0.177	0.981	No
1500 W vs. DC	0.00767	0.0331	0.974	No

Comparisons for factor: **site within 150**

Comparison	Diff of Means	t	P	P<0.05
Control vs. DC	1.560	6.728	<0.001	Yes
1500 N vs. DC	1.491	6.428	<0.001	Yes
1500 E vs. DC	1.363	5.878	<0.001	Yes
1500 W vs. DC	1.152	4.970	<0.001	Yes
1500 S vs. DC	1.130	4.873	<0.001	Yes
Control vs. 1500 S	0.430	1.856	0.507	No
Control vs. 1500 W	0.408	1.759	0.544	No
1500 N vs. 1500 S	0.361	1.555	0.657	No
1500 N vs. 1500 W	0.338	1.458	0.679	No
1500 E vs. 1500 S	0.233	1.005	0.900	No
1500 E vs. 1500 W	0.211	0.908	0.899	No
Control vs. 1500 E	0.197	0.850	0.869	No
1500 N vs. 1500 E	0.127	0.550	0.928	No
Control vs. 1500 N	0.0697	0.301	0.945	No
1500 W vs. 1500 S	0.0225	0.0970	0.923	No

Comparisons for factor: **Volume within DC**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 150	1.396	6.018	<0.001	Yes
100 vs. 150	1.227	5.291	<0.001	Yes
Pre vs. 150	1.216	4.689	<0.001	Yes
10 vs. 50	0.958	4.133	<0.001	Yes
100 vs. 50	0.790	3.406	0.007	Yes
Pre vs. 50	0.778	3.003	0.019	Yes
50 vs. 150	0.437	1.885	0.233	No
10 vs. 100	0.169	0.727	0.851	No
10 vs. Pre	0.180	0.694	0.740	No
100 vs. Pre	0.0115	0.0442	0.965	No

Comparisons for factor: **Volume within 1500 N**

Comparison	Diff of Means	t	P	P<0.05
10 vs. Pre	1.132	4.368	<0.001	Yes
10 vs. 50	0.961	4.143	<0.001	Yes
10 vs. 100	0.865	3.729	0.003	Yes
10 vs. 150	0.735	3.170	0.017	Yes
150 vs. Pre	0.397	1.532	0.568	No
100 vs. Pre	0.268	1.032	0.839	No
150 vs. 50	0.226	0.973	0.804	No
50 vs. Pre	0.172	0.662	0.883	No
150 vs. 100	0.130	0.559	0.822	No
100 vs. 50	0.0959	0.414	0.681	No

Comparisons for factor: **Volume within 1500 E**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 50	1.188	5.124	<0.001	Yes
10 vs. 100	1.090	4.701	<0.001	Yes
10 vs. Pre	1.041	4.015	0.001	Yes
10 vs. 150	0.699	3.014	0.026	Yes
150 vs. 50	0.489	2.110	0.212	No
150 vs. 100	0.391	1.687	0.399	No
150 vs. Pre	0.342	1.319	0.574	No
Pre vs. 50	0.147	0.568	0.922	No
100 vs. 50	0.0981	0.423	0.893	No
Pre vs. 100	0.0491	0.189	0.850	No

Comparisons for factor: **Volume within 1500 S**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 100	1.372	5.915	<0.001	Yes
10 vs. 150	1.173	5.057	<0.001	Yes
10 vs. 50	1.120	4.832	<0.001	Yes
10 vs. Pre	0.871	3.359	0.009	Yes
Pre vs. 100	0.501	1.931	0.302	No
Pre vs. 150	0.302	1.164	0.761	No
50 vs. 100	0.251	1.083	0.736	No
Pre vs. 50	0.250	0.963	0.712	No
150 vs. 100	0.199	0.858	0.633	No
50 vs. 150	0.0521	0.225	0.823	No

Comparisons for factor: **Volume within 1500 W**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 50	0.766	3.304	0.016	Yes
10 vs. 150	0.691	2.978	0.037	Yes
10 vs. 100	0.608	2.623	0.085	No
10 vs. Pre	0.424	1.636	0.547	No
Pre vs. 50	0.342	1.318	0.722	No
Pre vs. 150	0.266	1.027	0.842	No
Pre vs. 100	0.184	0.710	0.927	No
100 vs. 50	0.158	0.680	0.874	No
100 vs. 150	0.0823	0.355	0.924	No
150 vs. 50	0.0755	0.326	0.746	No

Comparisons for factor: **Volume within Control**

Comparison	Diff of Means	t	P	P<0.05
10 vs. 100	1.075	4.636	<0.001	Yes
10 vs. 50	1.032	4.448	<0.001	Yes
10 vs. Pre	0.788	4.161	<0.001	Yes
10 vs. 150	0.641	2.764	0.052	No
150 vs. 100	0.434	1.872	0.336	No
150 vs. 50	0.391	1.685	0.400	No
Pre vs. 100	0.287	1.517	0.439	No
Pre vs. 50	0.244	1.287	0.494	No
150 vs. Pre	0.147	0.776	0.687	No
50 vs. 100	0.0435	0.188	0.852	No