

MONITORING REPORT
Technological and Environmental Management Network Ltd
February 25th 2002

DREDGING AND RECLAMATION PROGRAMME IN KINGSTON HARBOUR

The R1 bund preparation continued during the period covered by this report. First sector completed, material dredged from PB dredge site was still being pumped into the completed section of R1 from the Leonardo Da Vinci. Significant plume noted from the outlet weir in R1. Screen around outlet appears to be holding. (See Photographs)

The Christoforo Colombo dredged in the H1 and H2 areas at the following times:

16/01/2002 07:50 – 21/01/2002 11:35
21/01/2002 20:10 – 22/01/2002 02:05
22/01/2002 23:10 – 25/01/2002 15:30
25/01/2002 23:30 – 31/01/2002 13:55
05/02/2002 17:15 - 10/02/2002 08:30

The Christoforo was in the channel again between Wed. 20th and Friday 22nd February, but the exact times were not available in time to be included in this report.

Monitoring flights were carried out on February 11th and February 19th.
A water quality monitoring exercise was carried out on February 18th

The flight of February 11th suggested that the screen at R3 was not very effective at the time of the flight, however the “plume” noted in the attached photograph was in fact material on or near to the sea floor as the depth in the occluded area was generally less than 0.6 m. There is some drift of the plume toward the SW which will be further monitored. Water quality results for samples collected in this area on February 18th are discussed later in this report. Laboratory analysis results for the set of samples collected in December is now available, and the data is reviewed in this report.

WATER QUALITY MONITORING

1. December 13, 2001

This is a follow up of data presented in Monitoring report #3 dated 3rd January 2002

Methodology:

Monitoring of activities by sea. Water samples collected and field measurements made. Photographs taken.

Results:

Results of laboratory analysis are represented in Figure 1 and Table 1. TSS data were discussed in Report No. 3. [4]

**Table 1: Dredging and Reclamation in Kingston Harbour
Water Quality Sampling Sites -December 13, 2001**

Station ID	LOCATION	GPS N	GPS W	BOD	TURB	TSS	COD
1T	Offshore Discharge Pipe Outfall Hunts Bay	17°58.925	76°50.542	2	3	77.9	405.6
1B				2	3	114.7	351.0
2T	Near Causeway Bridge	17°58.684	76°50.786	2	1	71.8	473.3
2B				2	22	116.5	467.0
3T	Dredge Site	17°58.026	76°50.408	2	48	242.0	677.2
3B				2	0	94.4	720.9
4T	East of Dredge	17°58.026	76°50.158	2	1	435.7	452.4
4B				2	0	111.0	520.9

Biological Oxygen Demand (BOD), was <2 at all stations. COD was determined to be in the range 351 – 721 for all samples. The highest values were determined for the sample from the dredge site 3T and 3B, where COD was 677 and 721 respectively. Turbidity was determined to be in the range 0 – 48 NTU for all samples. The highest value for this parameter (128 NTU) was determined for station 3 in the dredge plume where TSS was determined to be 93.6 mg/l. Other high values were determined for 3T, where turbidity was 48 NTU compared to a TSS of 242 mg/l, and 3B where turbidity was 22 NTU, while TSS was 116 mg/l. At 1T and 1B turbidity was 3 NTU but TSS was 78 and 115 respectively. At 4T (1NTU), and 4B (0 NTU), TSS was 436 and 111 respectively.

2. **January 16, 2002**

This follows up on Monitoring report #4 dated 24th January 2001 and presents the results of laboratory analysis

STATION NO	DESCRIPTION	N COORD.	W COORD
1T	Plume in wake of vessel that traversed Channel	17° 58.216'	76° 49.590'
1M	"	"	"
1B	"	"	"
2T	In Wake of Dredge - H1	17° 56.638'	76° 51.299'
2M	"	"	"
2B	"	"	"
3T	Bustamante Beacon	17° 56.759'	76° 50.275'
3B	"	"	"
4	H1 Resampled	17° 56.695'	76° 51.303'

T - Denotes Surface Sample
B- Denotes Sample collected near the bottom

Results:

Results of analyses of samples collected on January 16th , as well as field data collected by Jan De Nul on the same occasion are presented in Table 3.

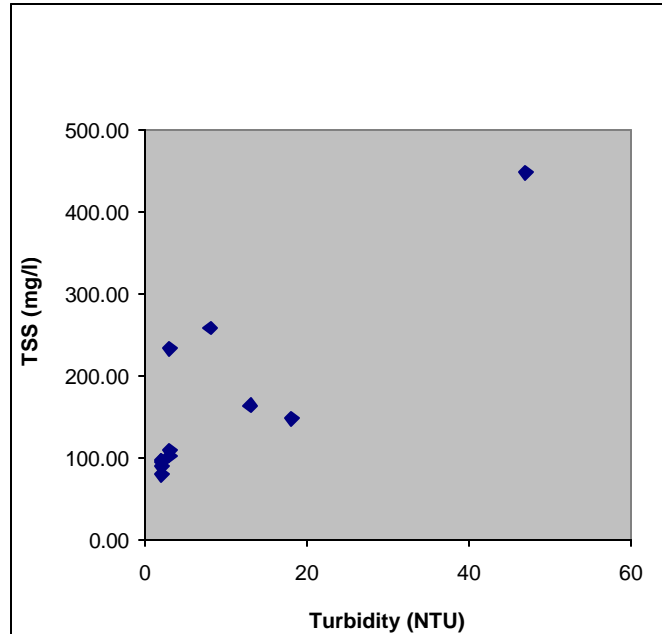
Table 3: Lab results and field data of samples collected January 16, 2002

STATION NO	TIME	DEPTH (M)	LAB. RESULTS		FIELD DATA
			TURBIDITY (NTU)	TSS (mg/l)	TSS (mg/l)
1T	1215		47	448.20	50
1M			2	95.50	100
1B		13.00	18	147.30	180
2T	1335		2	88.70	100
2M			3	109.00	100
2B		9.50	13	163.30	300
3T	1352		2	78.50	5
3B		4.50	3	232.30	5
4T	1415		2	95.30	5
4M			3	101.50	5
4B		12.00	8	257.50	50

T - Denotes Surface Sample
M - Denotes sample collected at mid depth
B - Denotes Sample collected near the bottom

TSS/Turbidity correlation for samples collected on this day, was particularly weak as indicated in Figure 2.

Figure 2: TSS vs. Turbidity – January 16, 2002



TSS in propeller plume of vessel was determined from field measurements to be in the range 0-180mg/l. The highest reading was recorded at the bottom of the water column, while the lowest reading was recorded at 6m below the surface. Laboratory analysis however had the value at 448 mg/l, the highest value found on this day. These results however are suspect and are being rechecked by the laboratory..

Please see report #4 dated 24th January 2001 for an analysis of the field data collected.

3. January 24, 2002 & Jan 21 – Feb 3, 2002

The following data made available by Jan De Nul is also reviewed:

- Hunts Bay Turbidity Profiles - January 24, 2002
- Turbidity from the fixed monitors at Middle Ground, Angel, and Bustamante beacons for the period January 21 to February 3, 2002

The attached map (Figure 3) identifies both the fixed sites operated by Jan de Nul.

Hunts Bay Turbidity Profiles January 24, 2002 [2]

Data collected by Jan De Nul on 24/01/02 (Table 1) indicated a range of TSS at four sites in Hunts Bay of 20 to 500 mg/l. The highest levels were found closest to the berm (Sites 1, and 2). At site 1 the range was from 50 mg/l at the surface to 500 mg/l near the bottom while at site 2 a level of 50NTU at the surface, and 300NTU near the bottom was indicated. At site 3 (centre of the lagoon) the range measured was 100 NTU in a thin layer at the surface. Just below this the level was 20 mg/l throughout the water column, increasing to 100 mg/l near the bottom.

Site ID	Description	TSS Range in NTU
1	Just off shore berm (approx 200m from Causeway bridge)	50 – 500
2	Just off shore berm Near Water Box	50 – 300
3	Closer to centre of lagoon	20 – 100
4	Near Causeway Bridge	20 – 50

Turbidity From The Fixed Monitors At Middle Ground, Angel, and Bustamante Beacons For The Period January 21, To February 3, 2002 [3]

The trend continues where the turbidity values at all fixed monitor sites reduce subsequent to cleaning. However at Middle Ground beacon even though there was reduction in values after cleaning on January 22, TSS remained relatively high (50 – 300 mg/l) up to January 25, while turbidity remains low (0 – 20 mg/l) at Bustamante and Angel beacons for the same period. After January 25, and up to the next cleaning on January 29, readings increase, particularly at Bustamante (20 – 300 mg/l), and Middle Ground (50 – 500 mg/l). At Angel beacon a temporary increase to around 80 mg/l is recorded in the nighttime of January 26. The range returns to 50 g/l before cleaning on January 29. After cleaning, all readings get lower. Middle Ground remains at around 50 until a sharp increase to over 700 mg/l and upwards from February 1 to 3. The pattern is similar in data from the monitors at Angel and at Bustamante beacons, though less pronounced at the latter.

4. **January 28, 2002**

Methodology:

Samples were collected on January 28 for laboratory analysis and field measurements of TSS were also made at the following sites(Table 5):

- Dredge Plume east of Burial Ground Beacon
- Dredge Plume at Burial Ground Beacon

Samples were taken at three depths denoted T (Surface), M (Mid way the water column), B (0.5m form the bottom).

Table 5 : Dredging and Reclamation in Kingston Harbour Water Quality Sampling Sites January 28, 2002			
STATION NO	DESCRIPTION	N COORD.	W COORD
1T	Dredge Plume east of Burial Ground	17° 57.652'	76° 50.809'
1TA	"	"	"
1B	"	"	"
1BA	"	"	"
2T	Dredge Plume at Burial Ground	17° 57.678'	76° 50.872'
2B	"	"	"
2BA	"	"	"
T - Denotes Surface Sample B- Denotes Sample collected near the bottom			

Results:

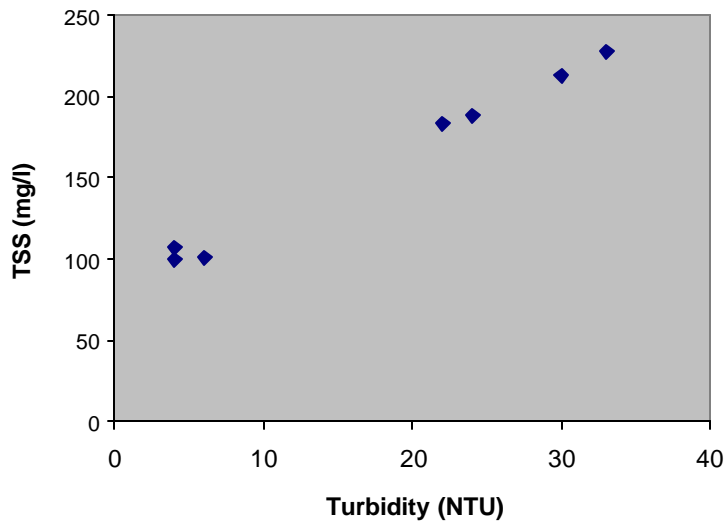
Results of analyses of samples collected on January 28th , as well as field data collected by Jan De Nul on the same occasion are presented in Table 6.

Table 6: Dredging and Reclamation in Kingston Harbour Water Quality Sampling Sites - January 28, 2002					
STATION NO	TIME	DEPTH (M)	LAB. RESULTS		FIELD DATA*
			TURBIDITY (NTU)	TSS (mg/l)	TSS (mg/l)
1T	1004	15	4	106.8	50 - 150
1TA			4	99.9	
1B			22	183.3	150 - 250
1BA			24	188.3	
2T	1020	14	6	100.7	100 - 200
2B			33	227.4	
2BA			30	212.9	200 - 300
T - Denotes Surface Sample B- Denotes Sample collected near the bottom					

Field measurements (Table 6) indicate a range of 50 – 300 mg/l for TSS in field profiles taken in the dredge plume in the vicinity of Burial Ground beacon. In general the lower values were found near the surface. The levels recorded here was in a similar range of TSS to that determined by field measurement on Jan 16, which indicated a range of 100 – 300 mg/l (Table 7). The levels taken in the prop plume of a ZIM container vessel are included for comparison.

Table 7: Comparison of Prop Plume (PP) to Dredge Plume (DP)			
PP JAN 16	DP JAN 16	DP1 JAN 28	DP2 JAN 28
0-180mg/l	100 - 300	50 – 250	100 - 300
DP1 Dredge Plume - East of Busatamante Beacon			
DP2 Dredge Plume - Busatamante Beacon			

Figure 4: TSS vs Turbidity - January 28



Conclusions/Environmental Impact:

- TSS associated with the dredging appears to be around twice that associated with propeller wake from typical shipping traffic.
- Sites closest to the berm in Hunts Bay appear to be more affected by TSS. Away from the berm the problem is considerably less. More intensive monitoring could be carried out to determine if this increase is due to material shedding from the berm.
- Though fouling of the sensors for the fixed monitors is an obvious contributor the high readings, there it would appear that impact at Middle Ground continues to be greater than at Angel, and Bustamante beacons as was observed in the previous Monitoring Report.
- The sediment forming the TSS does not appear to have any measurable BOD though COD is high(See Fig 1) This is in agreement with background values from the EIA, and is quite likely due to oil residues which were determined to be present in sediment analysed for the EIA.

Follow Up:

- More intensive monitoring of WQ in Hunts Bay near the berm
- Aerial observation of plumes backed up with ground truthing
- Monitoring of dump sites R3 and R1
- Monitoring of Rackhams Cay dredging

5. February 18th, 2002**Background:**

The sampling exercise carried out on February 18, was intended to provide measurement of TSS (total suspended solids)/ turbidity in the vicinity of Hunts Bay where filling was in progress. In addition it was hoped that correlation between turbidity and TSS could be strengthened. Preliminary analytical results from the laboratory indicate a weak correlation between TSS and Turbidity data collected in December. Salt water interference was suspected.

Methodology:

Monitoring on February 18 was carried out from a skiff "Viceroy HB" - skipper Vincent Clarke, to enable observation of the silt screen near Fort Augusta, as well as sampling in shallow areas. Four sites were sampled in the vicinity of Fort Augusta (Figure 5), in order to assess the effectiveness of the silt screen. Sampling was also carried out in the main fishing area in Hunts Bay to assess the impact of filling activities in the Bay. These sites were identified as Stations 1 – 6 (see Table 8).

**Table 8: Dredging And Reclamation In Kingston Harbour
Water Quality Sampling Sites - February 18, 2002**

STATION NO	DESCRIPTION	N COORD.	W COORD
1T	At screen (on landward side)	17° 58.105	76° 50.723
1TA	Duplicate of 1T		
2T	Just North East of Screen	17° 58.129	76° 50.692
2TA	Duplicate of 2T		
3T	Further North East	17° 58.132	76° 50.629
3TA	Duplicate of 3T		
3B	.5m from Bottom at Station 3		
3BA	Duplicate of 3B		
4T	North East of Station 3	17° 58.161	76° 50.444
4TA	Duplicate of 4B		
5T	Angel Beacon	17° 57.177	76° 49.546
5TA	Duplicate of 5T		
6T	Hunts Bay (Midway Between Rio Cobre Mouth and Causeway)	17° 58.673	76° 51.005
6TA	Duplicate of 6T		
T - Denotes Surface Sample			
B - Denotes Sample collected near the bottom			

Samples were collected in duplicate at all stations, and, with the exception of Station 3 where a bottom sample was taken sampling was at the surface. The sampling exercise on February 18, was carried out between 1025 and 1140. It was observed that there was some sediment in the pipe cock of the sampler while dispensing the first of the duplicate samples taken at 3B. This sample visibly had more sediment than the duplicate 3BA.

Samples were analysed by Poly-Diagnostics Centre in accordance with Standard Methods for the Analysis of Water and Waste Water. TSS was determined by filtration of a known sample volume through a dried, pre weighed filter. After filtration, the filter was dried and re-weighed. TSS in mg/l is obtained through a determination of the weight difference of the filter before and after filtration. As a precaution against salt water interference, filters were rinsed with warm distilled water after filtration of the sample. This precaution was employed in analysing the set of samples collected on February 18.

Results and Observations:

At the time of our visit, it was noted that the screen was in place, but had been damaged. The damage was immediately reported to allow prompt repairing of the screen. Damage to the screen was noted on the section closer to the Causeway (See Photographs). The section towards Fort Augusta was observed to be intact (See Photographs).

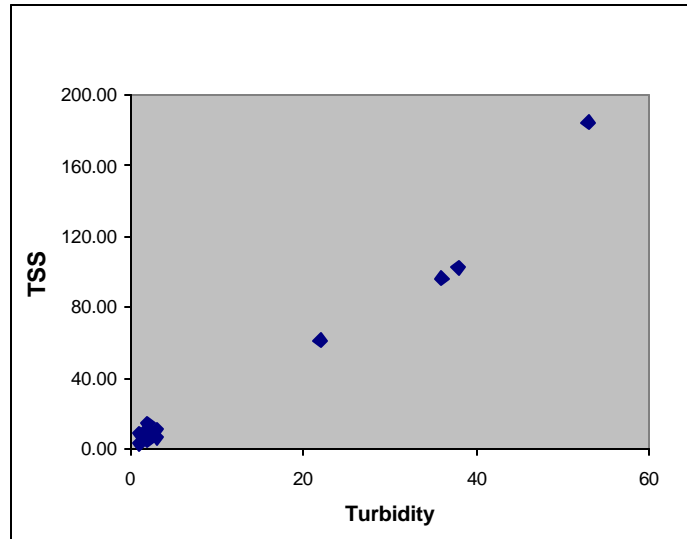
Results of analyses of samples collected on February 18, as well as field data collected by Jan De Nul on the same occasion are presented in Table 9.

Table 9: Lab results and field data of samples collected Feb 18, 2002

			LAB. RESULTS		FIELD DATA*
STATION NO	TIME	DEPTH (M)	TURBIDITY (NTU)	TSS (mg/l)	TSS (mg/l)
1T	1025	<0.5	38	102.60	200-300
1TA			36	96.60	
2T	1037		2	14.60	20-40
2TA			3	11.40	
3T	1040		2	9.60	20-30
3TA			2	11.20	
3B		1.5	53	184.30	30-40
3BA			22	61.60	
4T	1056	1.5	2	10.00	10
4TA			1	9.00	
5T	1116	3.0	1	3.40	5
5TA			2	5.20	
6T	1138	4.0	2	7.20	10
6TA			3	6.60	
T - Denotes Surface Sample					
B- Denotes Sample collected near the bottom					

Turbidity at all stations monitored on February 18, was determined to be in the range 1 – 53 NTU. This corresponded to a TSS range of 3.4mg/l – 184.3 mg/l. With the exception of Station 3 bottom samples, there was good agreement between the duplicate samples taken. Field data by Jan De Nul indicated a range of 5 – 300mg/l for all stations. Correlation between TSS and Turbidity for February 18 was very good (Figure 6). compared to that observed for data collected on January 28 (Figure 4). TSS/Turbidity correlation for samples collected on January 16, was particularly weak (Figure 2).

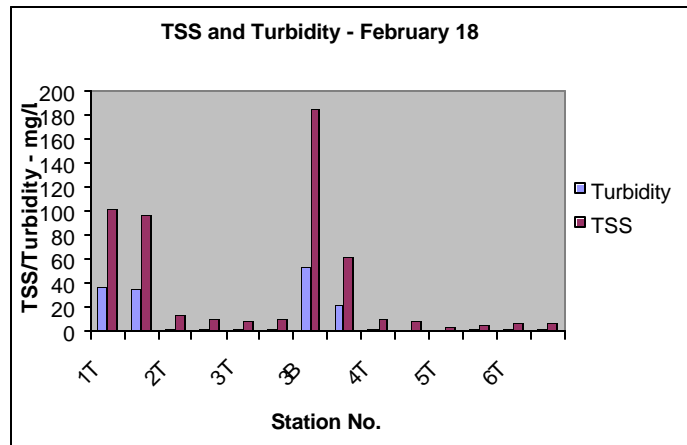
Figure 6: Relationship between Turbidity and TSS values from samples collected on Feb 18, 2002



For samples collected on February 18, the highest value (184.3mg/l) was determined for Station 3 in the first of the duplicates taken at the bottom (3B). the other duplicate however had a value of 61.6mg/l. The corresponding value by Jan De Nul was 30 – 40mg/l. The highest value in surface water (102.6 and 96.6mg/l) was determined for samples from Station 1 (landward side of screen).

In general, TSS was lower on the seaward side of the screen with the exception of the sample taken at 3B (Figure 7). With the exception of the outlier value the range of TSS on the seaward side of the screen was 9.0 – 14.6mg/l. The lowest value was determined for the sample taken at the furthest point from the screen, while the highest value was determined for the sample taken just outside the screen. Values determined from field measurements carried out by Jan De Nul, were generally greater than values determined by laboratory analysis.

Figure 7: TSS and Turbidity values – Feb 18, 2002



At Angel beacon, TSS was determined to be 3.4 and 5.2mg/l for the duplicate samples. Field measurement indicated a level of 5mg/l at this site. At station 6 (Hunts Bay), TSS was determined to be 7.2, and 6.6mg/l in duplicate samples.

Conclusion/Environmental Impact:

Based on sampling carried out on February 18, the following may be concluded with regard to environmental impact:

- The screens deployed in the vicinity of Fort Augusta appeared to be having a mitigating effect on the release of sediment to areas beyond R3. The relatively quiescent conditions in R3 would also be expected to promote settling out of sediment. This would explain the reduction in sediment that was observed north of R3 despite damage observed to the screen.
- At the time of sampling water quality at Angel beacon showed no measurable impact that could be associated with dredging activities. TSS level was well below the draft ambient standard of 10mg/l.
- Water quality at the Hunts Bay site was within the draft TSS standard.
- The excellent correlation between TSS and Turbidity suggests that determination of the latter is sufficient to monitor impact of the dredging. Turbidity measurements can be more readily determined and can be used to determine the criteria parameter TSS.

Recommendations/Follow Up:

- It is recommended that future monitoring involve analysis to determine turbidity, so that TSS be derived from the plot presented in this report (Figure 6).
- The screens should be monitored closely and repaired as needed.

REFERENCES

1. Results of Monitoring Turbidity in Kingston Harbour on 28/01/01, Jan De Nul, 2/2/02.
2. Results of Monitoring Turbidity in Hunts Bay Lagoon on 24/01/02, Jan De Nul, 24/01/02.
3. Turbidity Graphs Weeks 4 and 5, Jan De Nul, 08/02/02.
4. Kingston Transshipment Port Expansion Monitoring Report No. 2, Date of Trip: December 13, 2001 TEMN and January 24, 2002.