MULTIDISCIPLINARY APPLIED RESEARCH AND INNOVATION
e-ISSN: 2773-4773

MARI

Vol. 5 No. 1 (2024) 110-118
https://publisher.uthm.edu.my/periodicals/index.php/mari

Sediment Transport Analysis at Pantai Perpat, Batu Pahat, Johor

Muhammad Syakir Danial Che Rahim, Muhammad Hidayat Azhari Abd Rahman, Nor Izzati Shafina Suhaimi, Nor Baizura Hamid*

Department of Civil Engineering, Centre for Diploma Studies,
Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

*Corresponding author: norbaizura@uthm.edu.my
DOI: https://doi.org/10.30880/mari.2024.05.01.017

Article Info

Received: 1 September 2023
Accepted: 10 December 2023
Available online: 31 January 2024

Keywords

Sediment, Deposition, Coastal, Zone, Tide

Abstract

Environmental problems are a big deal in coastal areas, especially those that are closely related to sedimentation The coastal system is an open system that receives input from a variety of sources, including river, terrestrial, and marine coastal erosion. This problem may be increasing the concentration of sediment and changing the quality of the water. The goal of this study was to evaluate the suspended sediment content, water quality, and influencing shoreline changes and sediment deposition in Pantai Perpat, Johor. The laboratory tests on water samples are pH and temperature, turbidity, and total suspended solids test while tests on sediment samples are sieve analysis, specific gravity, and moisture content test. The questionnaire was conducted through the medium of Google Forms, which is to find out the cause of sedimentation in the study area. First objective was achieved using a sieve analysis test. Results show that medium and low tide samples for zone 1, Zone 3, and Zone 4 are well-graded soil. The result for the specific gravity test was 2 for all zones except zone 2. The specific gravity of soils is in the range of 2.60 to about 2.80. For the moisture content testing result, high tide in zone 1 contains 28.86% compared to medium tide with a value of 105.02% and low tide with 123.75%. Then, for the water test, the pH result was 7, which is an alkaline state, with an average value of total suspended solids of 699 NTU and an average value of turbidity of 11400 mg/L. This shows that as the turbidity value increases, the total suspended solid (TSS) also increases. By 50 respondents, 56.7% said that the causes of increased sand deposition are affected by currents and waves; 28.4% said it was blown by coastal tides; and 14.9% said it was blown by monsoon winds and coastal winds. In conclusion, all the results obtained answered all the objectives, and this study was successful.

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 110-118

1. Introduction

Pantai Perpat is a coastal area where sediment transportation and deposition processes play a crucial role in shaping its morphology. Sediment comes from rock fragmentation. The breakdown occurs due to weathering that can take place physically, chemically, or biologically [1]. The formation of these sediments can disturb the balance of the environment and nature [2]. Waves and currents are the primary agents responsible for sediment transport along the beach. Sediments are transported parallel to the coastline during periods of high energy and deposited during low energy periods, resulting in the formation of sandbars and beaches [3]. However, sedimentation is also a significant concern for the area due to the high wave energy and shoreline exposure [4]. Understanding these processes is essential for effective coastal management and the protection of the Pantai Perpat environment.
This study aims to examine the issue of suspended sediment due to sedimentation in Pantai Perpat, Johor. This study needs the suspended sediment concentration level, and water quality based on the turbidity level and the pH value [5]. The study has three objectives: to determine the level of suspended sediment concentration through laboratory tests such as sieve analysis, specific gravity, and moisture content. In addition, the second objective is to determine the water quality in the study area. The water samples taken have been tested using total suspended solids (TSS) and turbidity tests, while to answer the third objective, a questionnaire has been conducted with the local community to identify the causes of sedimentation and changes occurring in the coastal area.

2. Methods

The workflow presented in the research methodology is necessary to achieve all the objectives of this study. Therefore, the work is carried out based on the flow chart shown in Fig 1.

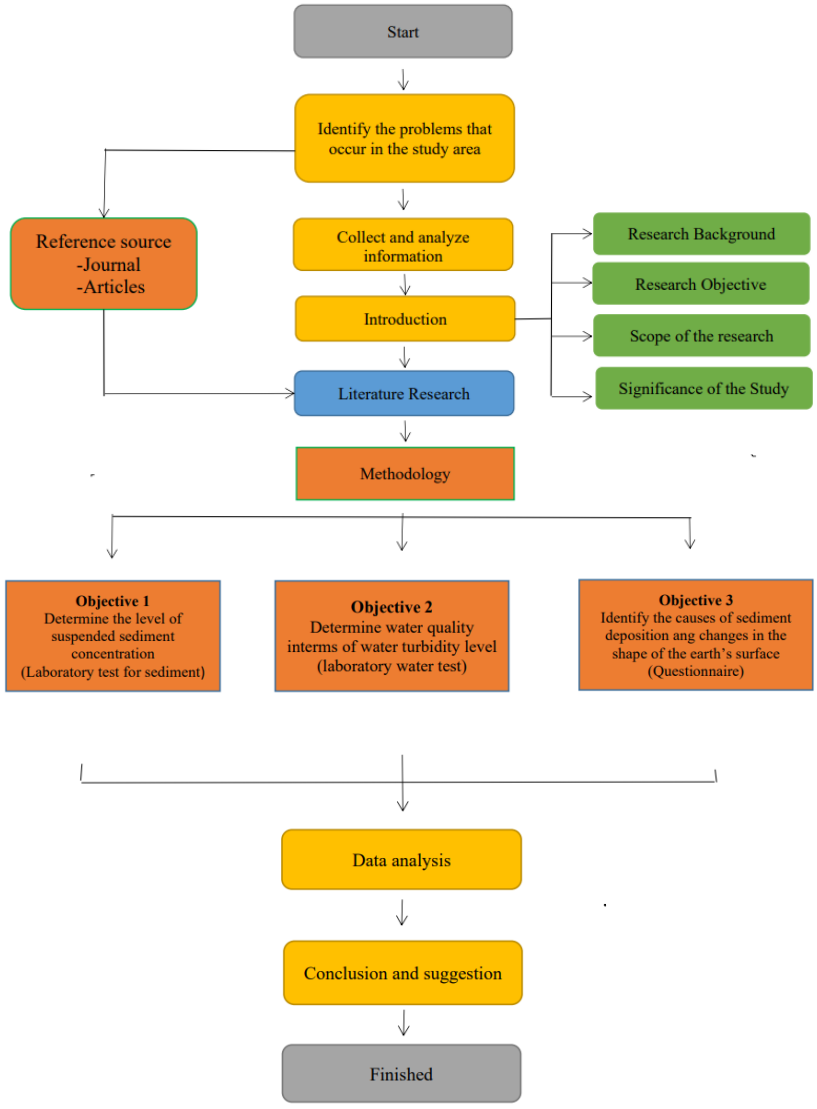


Fig. 1 *Flowchart of the study*

2.1. Sampling collection

Fig. 2 shows Pantai Perpat, Johor, from Google Earth. Here, water samples and sediment samples are taken to conduct the tests that have been carried out. All water and sediment samples were taken from four different zones named Zone 1, Zone 2, Zone 3 And Zone 4 with the distance between each zone being 200m long.

Fig.2 *Location of sample collection at Pantai Perpat*

For sediment sampling, it is taken from three different types of tidal water, namely high tide (HT), medium tide (MT), and low tide (LT). High tide is the area with the furthest tidal range represented as H1, H2, H3 and H4; medium tide is the area with the normal tidal range represented as M1, M2, M3 and M4; and low tide is the area with the nearest tidal range represent as L1, L2, L3 and L4.

2.2. Laboratory Test for Sediment Sample

There are three tests for the sediment sample that was conducted: sieve analysis, specific gravity, and moisture content.

2.2.1. Sieve Analysis Test

The most popular method of particle size analysis for material determination is through sieve analysis. Through this method, the particles will be separated into sieves of different sizes. Particle size distributions are typically specified using a list of size ranges that cover nearly all sizes available in the sample.

Fig. 3 shows the equipment used during sieve analysis testing in the Geotechnical Engineering Laboratory. This test is to determine the particle size distribution of sediment sample A total of 150 g of sediment sample was used to determine the grain size of the soil. The arranged stack of sieves was started with the largest mesh opening at the top and the smallest at the bottom. The sample was poured into the top sieve, and the plate was covered to prevent dust and particle loss while shaking. A mechanical sieve shaker was used for about 10 minutes, and then the sieves were weighed one by one without losing any materials to get an accurate result and value.

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 110-118

(a) **(b)**

Fig. 3 *Sieve analysis test. (a) weighing the empty sieve, (b) Mechanical sieve shaker*

2.2.2. Specific Gravity Test

The specific gravity (Gs) of a material is the ratio of the mass of a unit volume of soil solids at a specific temperature to the mass of an equal volume of gas-free distilled water at the same temperature. This test is used to calculate the density of the soil solids at the field area.

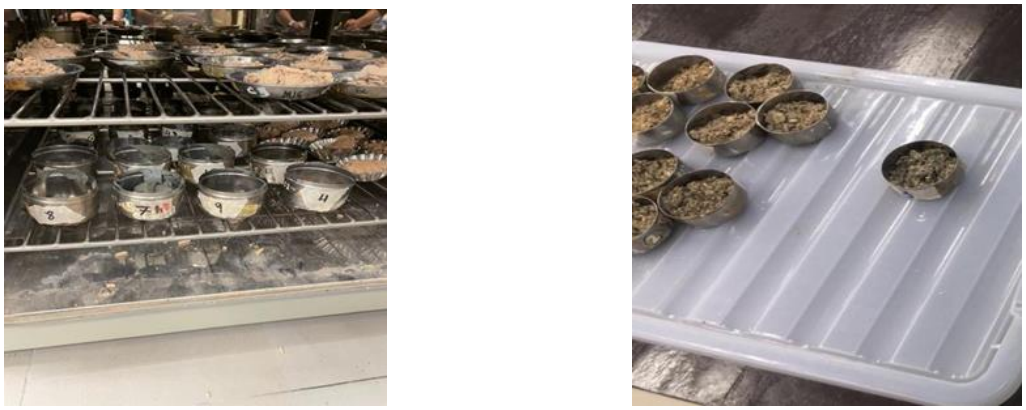
Fig. 4 shows the equipment used during specific gravity testing in the Geotechnical Engineering Laboratory. These tests are to determine the composition of binary mixtures of pure chemicals. The volumetric flasks with stoppers were weighed, then 10 g of soil sample was added, and which passed the British Standard 2 mm sieve. After that, distilled water is added to a volumetric flask, and the vacuum pump is switched on. The air needs to be removed, and then the distilled water is added to fill the flask and let it for an hour. The volumetric flask was wiped out before weighing it to get an accurate value. Take out the soil and water from the flask. After that, add distilled water to the same volumetric flask as the sample used and let it sit for 1 hour in the vacuum pump to make sure that the test was held correctly.

(a) **(b)**

Fig. 4 *Specific gravity test. (a) Vacuum pump, (b) Distilled water with sample in a volumetric flask*

2.2.3. Moisture Content Test

The moisture content of the sediment was determined by quantifying the amount of water present in the soil samples collected from different zones of the coastal region at Pantai Perpat. Fig.5 (a) and (b) show the equipment that has been used to calculate and complete the finding of the moisture content. These tests are contained in the pore spaces of soil to the solid mass of particles in that material, expressed as a percentage. Three moisture containers were used for one sample. At the end of the experiment, the value obtained was divided by three. Samples in moisture containers were weighed and placed in an oven at a specific temperature, typically between 105°C and 110°C. Usually, it is dried for 24 hours until it is completely dry before being weighed again to obtain accurate results.



(a) **(b)**

Fig. 5 *Moisture content test. (a) Sample placed in the soil drying oven (105°C and 110°C), (b) Sample placed in the moisture can container*

2.3. Laboratory Test for Water Quality

There are four tests for the water sample that was conducted: total suspended solid, turbidity, pH and temperature tests.

2.3.1. Total Suspended Solid Test

The total suspended solids (TSS) test was conducted to measure the concentration of suspended solids in water. The analysis involved the use of filter paper as the method to determine the content of suspended solids.

Fig. 6 shows the equipment used during suspended sediment testing in the Environmental Engineering Laboratory. These tests are for determining how to achieve reproducibility and comparability of results and require close attention to procedural details, especially filter characteristics and time and temperature of drying. A 100 ml water sample was tested to determine the level of turbidity. Filter paper is used to filter the suspended material, which is then dried and weighed. The data obtained will be compared with each sample to find out the level of turbidity for each sample.

(a) **(b)**

Fig. 6 *Total suspended solid test. (a) Filtration test and (b) Sealed vacuum container*

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 110-118

2.3.2. Turbidity Test

A turbidity test was performed to measure the cloudiness or haziness of water samples, indicating the presence of dispersed and suspended solids. A turbidity meter was used to determine the turbidity levels in the water samples. These instruments measure the amount of light scattered by suspended particles in a water sample at a specific angle. The turbidity readings obtained are expressed in Nephelometric Turbidity Units (NTU). Turbidity testing was run in the Environmental Engineering Laboratory. These tests are to determine the level of turbidity and water safety, which is the main source of the population for daily activities. The water sample will be put into a small bowl that has been prepared before being put into the turbidity testing device. Each sample was repeated three times to obtain an average value.

2.3.3. pH & Temperature Test

The pH and temperature tests were conducted to assess the acidity, alkalinity, and temperature of the water samples. The portable in-situ test was used to measure the temperature, while a pH meter was utilized to analyze the pH value of the water samples. All four water samples are examined using these two devices, and the data obtained can be recorded in a very short time.

2.4. Questionnaire

2.4.1. Google Form

A Google form was created to answer the third objective of the research work in Pantai Perpat. By getting as many as 63 respondents who are residents in the area, several questions have been asked in the Google form related to the sediment transport problem in the coastal areas.

3. Results and Discussion

3.1. Result of Sediment Test

The results for the sieve analysis test, specific gravity, and moisture content were stated in **Appendix A**.

3.1.1. Sieve Analysis Test

According to Table 1 (Appendix A), all the high tides for each zone were eligible for the sieve analysis test. It is because the maximum aperture size available at the laboratory is only 5mm. The high tide, medium tide, and low tide at Zone 2 only contain clamshells bigger than 5 mm, so it is not necessary for them to proceed with the test. Based on the Cu value we managed to collect all the samples for each zone and tide shows well-graded soil as shown in Fig. 7, which has a value greater than 4 for gravel and 6 for sand.

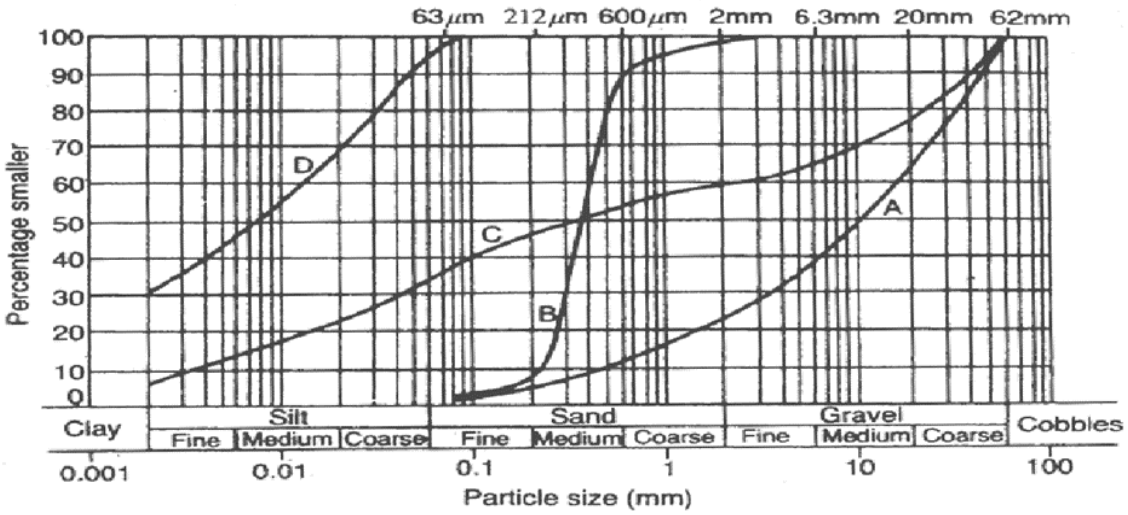


Fig. 7 *Particle Size Distribution Curve*

3.1.2. Specific Gravity Test

According to Table 2 (Appendix A), the specific gravity value for high tide zones 1, 2, 3, and 4 is illegible. This may happen because the sample only contains clamshells. The specific gravity value for the sample of Zone 1 of the medium tide area is 4.13 kg/ m^3 while the low tide area is 2.13kg/ m^3. Zone 2 with the sample that only contains clamshells for high, medium, and low tide The test cannot be continued because the sample for Zone 2 was not required as per the standard that has been set by the British Standard. Medium tide for Zone 3 and Zone 4, with values of 2.35 kg/ m^3 and 2.34 kg/ m^3, respectively. Results for low tide for Zone 3 and Zone 4 are 2.49 kg/ m^3 and 2.60 kg/ m^3.

3.1.3. Moisture Content Test

According to Table 3 (Appendix A), high tide in Zone 1 contains 28.86% of the moisture content compared to medium tide with a value of 105.02% and low tide with 123.75%, respectively. The moisture content value that is more than 100% shown that particle distribution of the soil is clay. The type of soil clay will contain more water than usual soil. This made the suspended solid value increase and outright made this to success the objective to determine the level of suspended sediment concentration.

3.2. Result for Water Quality

3.2.1. Total Suspended Solid Test

Table 4 (Appendix A) shows that Zone 1 has the highest value of average total suspended solids compared to other zones, with a value of 11400 mg/L. The highest value of total suspended solids will contribute to the highest turbidity value.

3.2.2. Turbidity Test

Table 5 (Appendix A) shows that Zone 1 has the highest average turbidity value (699 NTU) compared to Zone 2, Zone 3, and Zone 4. Water samples that have a high average turbidity value indicate a high suspended solids content, and vice versa.

3.2.3. pH & Temperature Test

Table 6 (Appendix A) shows that all the water samples are in an alkaline state because they exceeded the pH value of 7. Water that exceeds the pH value of 7 is suitable for daily use, such as bathing and drinking, because it is not harmful to health. These results show that the sample water from Pantai Perpat has a high concentration of hydrogen ions (H^+). The highest concentration of hydrogen ions (H^+), the lowest chance for marine life to stay alive longer. The best for marine life is between 6.5 to 9.0.

3.3. Questionnaire

Results from the Google Form show a total of 50 respondents are permanent residents, and 50% or more of them are aware of the problems that occur in Pantai Perpat, Johor, especially about changes in the coastal zone.

The result shown in Fig. 8 explains the factors of deposition occurring in the study area. More than 50% of respondents agreed that the cause of increased sedimentation is affected by waves and currents; however, less than 10% of respondents agreed that the sedimentation problem at Pantai Perpat is due to the type and size of sand. Other factors that cause sediment depositions are Coastal orientation, Monamoon wind, Beach tides, Coastal plant and Beach and slope which are in the range of 13% to 28% answered by the respondents.

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 110-118

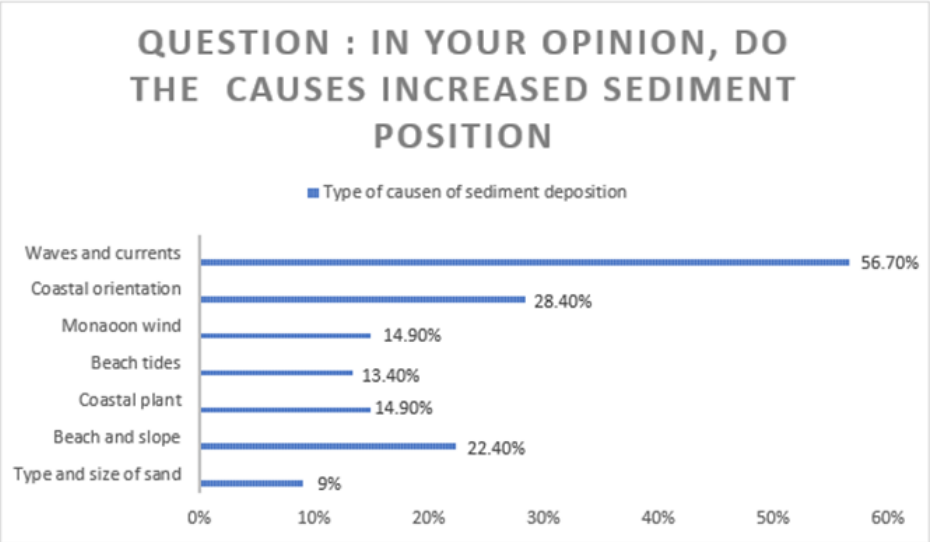


Fig. 8 *Bar chart of types that cause sediment deposition.*

4. Conclusion

The conclusion that can be drawn is that the three objectives were successfully achieved. The first objective was achieved by doing the sieve analysis test, specific gravity, and moisture content test. The second objective was achieved by doing the TSS test, turbidity test, pH, and temperature test. The third objective was achieved by the data collected from the questionnaire. Based on the data achieved, it will be proposed to the authorities for coastal preservation at Pantai Perpat.

Acknowledgement

This research was funded by Tier 1 Grant Vot Q396 provided by the Universiti Tun Hussein Onn Malaysia (UTHM). The authors would like to thank the Centre for Diploma Studies (CeDS), Universiti Tun Hussein Onn Malaysia for their support.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design, data collection, draft manuscript, draft manuscript preparation:*** *Muhammad Syakir Danial Che Rahim, Muhammad Hidayat Azhari Abd Rahman, Nor Izzati Shafina Suhaimi, Nor Baizura Hamid. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] Sharmeen, S., & Willgoose, G. R. (2006) The interaction between armouring and particle weathering for eroding landscapes, *Earth Surface Processes and Landforms, The Journal of the British Geomorphological Research Group, 31(10),* 1195-1210.

[2] Junaidi, E., & Tarigan, S. D. (2011) Pengaruh hutan dalam pengaturan tata air dan proses sedimentasi Daerah Aliran Sungai (DAS): Studi Kasus di DAS Cisadane, *Jurnal Penelitian Hutan dan Konservasi Alam, 8(2),* 155-176.

[3] Tătui, F. (2016) The correlative behavior of sandbars and shoreline along Sulina–Sf. Gheorghe beaches (Danube Delta Coast), *Revista de Geomorfologie, 18(1),* 19-31.

[4] Sarma, K. G. S. (2015) Siltation and coastal erosion at shoreline harbours, *Procedia Engineering, 116,* 12-19.

[5] Adityas, Y., Ahmad, M., Khamim, M., Sofi, K., & Riady, S. R. (2021) Water quality monitoring system with parameter of pH, temperature, turbidity, and salinity based on internet of things, *JISA (Jurnal Informatika dan Sains), 4(2),* 138-143.

Appendix A

Table 1 *Sieve Analysis Test*

Location Parameter	ZONE 1			ZONE 2			ZONE 3			ZONE 4		
	H	M	L	H	M	L	H	M	L	H	M	L
d_{10} (mm)		0.15	0.10					0.19	0.13		0.13	0.79
d_{30} (mm)		0.35	0.25					0.37	0.30		0.28	0.90
d_{60} (mm)	NIL	1.2	0.76		NIL		NIL	1.10	0.79	NIL	0.82	1.70
Coefficient of uniformity, Cu		8	7.60					5.79	6.08		6.31	2.15
Coefficient of curvature, Cc		0.68	0.82					0.66	0.88		0.74	0.60

Table 2 *Specific Gravity Test*

Location Parameter	ZONE 1			ZONE 2			ZONE 3			ZONE 4		
	H	M	L	H	M	L	H	M	L	H	M	L
Specific Gravity, Gs	Nil	4.13	2.14		Nil		Nil	2.35	2.49	Nil	2.34	2.60

Table 3 *Moisture Content Test*

Location Parameter	ZONE 1			ZONE 2			ZONE 3			ZONE 4		
	H	M	L	H	M	L	H	M	L	H	M	L
Moisture Content (%)	28.86	105.02	123.75	12.50	71.62	26.92	16.93	148.34	88.36	11.74	150.30	151.04

Table 4 *Total Suspended Solid Test*

Location Parameter	ZONE 1	ZONE 2	ZONE 3	ZONE 4
Average total Suspended Solids, (mg/L)	11400.00	11233.33	10933.33	11000.00

Table 5 *Turbidity Test*

Location Parameter	ZONE 1	ZONE 2	ZONE 3	ZONE 4
Average Turbidity Value (NTU)	699	112.4	48.1	52.8

Table 6 *pH and Temperature Test*

Sample no.	1	2	3	4
Volume (mL)	100	100	100	100
Temperature (^oC)	24.5	24.5	24.5	24.5
pH Value	7.44	7.68	7.74	7.80