UNIVERSITI TEKNOLOGI MALAYSIA

BORANG PENGESAHAN
LAPORAN AKHIR PENYELIDIKAN

TAJUK PROJEK : **Investigation of the Hydraulic Characteristics for Portable Rubbish & Sediment Trap**

Saya **PROF. MADYA DR. NORHAN ABD. RAHMAN**
(HURUF BESAR)

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(PENYELIDIKAN PERANGKAP SAMPAH DAN SEDIMEN TERHADAP CIRI-CIRI HIDRAULIKNYA)

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Jabatan Hidraul dan Hidrologi
Fakulti Kejuruteraan Awam
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2008

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ABSTRACT

Rubbish trap is devises used to prevent large items polluting waterways. They are used in stormwater drains, urban wetlands, river and other locations. They generally collected larger items from the water, such as take away containers, leaves, bottles and plastic bags. The purpose of this research is to determine the efficiency of rubbish trap in terms of the trapping rubbish and water quality improvement as well as to evaluate the efficiency of perforated wall's rubbish traps and to compared with existing mesh type in terms of trapping litter or rubbish. A laboratory test are also conducted to study the rubbish traps characteristic in four difference types of scale rubbish modelling in various discharge and quantity of artificial rubbish collected. Data taken from laboratory test are energy loss and backwater flow. The study is based on rubbish trap at L52 and trash screen at L50 which is located at UTM campus and rubbish trap at Taman Universiti, Skudai. From the results obtained, rubbish trap at L52, L50 and Taman Universiti shows the effectiveness to trap rubbish and sediment where it can reduce the amount of suspended solids in water. However, the existing rubbish trap (mesh type) is more effective than new rubbish trap (perforated).

ABSTRAK

Perangkap sampah adalah alat yang digunakan untuk menahan bahan cemar yang bersaiz besar dan selalunya digunakan pada sistem saliran, sungai dan sebagainya. Biasanya, perangkap sampah akan menahan sampah yang bersaiz besar seperti daun kering, botol dan plastik. Kajian ini adalah bertujuan untuk mengkaji keberkesanan perangkap sampah dari aspek sampah yang terperangkap dan peningkatan kualiti air. Ia juga bertujuan mengkaji keberkesanan rekabentuk perangkap sampah baru (dinding berlubang atau '*perforated wall)*' dan membuat perbandingan dengan perangkap sampah lama (bentuk jejaring) berdasarkan kuantiti sampah yang tertahan. Kajian di makmal juga dilakukan bagi menguji 4 rekabentuk perangkap sampah dari aspek hidraulik apabila perangkap ini diuji pada kadar aliran air dan kuantiti sampah yang telah ditentukan. Keputusan daripada data ujikaji makmal dibandingkan dengan kajian sebelumnya berdasarkan parameter jarak air-balik dan kehilangan tenaga. Kajian ini dilakukan terhadap perangkap sampah di L52, perangkap sampah (trash screen) di L50 yang terletak dalam kampus UTM dan perangkap sampah di Taman Universiti, Skudai. Berdasarkan keputusan yang diperolehi, perangkap sampah menunjukkan keberkesanannya dalam memerangkap sampah dan sedimen dan dapat mengurangkan kandungan pepejal terampai dalam air. Walaubagaimanapun, perangkap sampah lama adalah lebih berkesan daripada perangkap sampah baru.

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ABBREVIATION

E	-	Energy loss
FKA	-	Fakulti Kejuruteraan Awam
GFRP	-	Glass Fibre Reinforced Polymer
Kg	-	Kilogram
m	-	Metre
m^3/s	-	Metre cubic per second
SS	-	Suspended solid
S_0	-	Channel slope
UTM	-	Universiti Teknologi Malaysia
Q	-	Flow
Δy	-	Changing depth between segments
Δx	-	Length of segment

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Portable Rubbish and Sediment Trap

Rubbish trap is devices used to prevent large items polluting waterways. They are used in stromwater drains, urban wetlands, river and other locations. They generally collected larger items from the water, such as take away containers, leaves, bottles and plastic bags.

Rubbish and sediment trap are provided at the downstream end of drains or open channel flow which discharge to rivers to reduce litter and sediment load. This trap must be properly studies so as to prevent any additional surcharge in the stormwater system in the event of partial or complete blockage or flooding which should be considered as backwater effect.

Potable trap are used primarily in streams where there is flowing water. Sedimentation traps function by providing an enlarged waterway area and reduce hydraulic gradient to reduce flow velocities and allow bedload sediment to be trapped and suspended sediments to settle out of suspension. The purpose of this research is to determine the efficiency of rubbish trap in terms of trapping rubbish and water quality improvement, to determine the efficiency of perforated wall's rubbish traps and to compared with existing mesh type in terms of trapping litter or rubbish.

1.2 Statement of Need

Rubbish is a waste type consisting of any tangible personal property which has been unlawfully scattered and or abandoned in a public place (usually outdoors). Rubbish is often caused by careless or accidental treatment of debris and waste as opposed to proper disposal. Careless garbage and rubbish left consciously. Rubbish can harm the environment. Rubbish can have many effects on the environment. It is extremely unsightly and uncollected rubbish can attract more. Animals may get trapped or poisoned with rubbish in their habitats. Rubbish can end up in rivers and canals, polluting the water supply. Vermin and disease are rife in places with high amounts of rubbish. Open containers such as paper cups or beverage cans can hold rainwater, providing breeding locations for mosquitoes which have been known to cause disease. It is also a road hazard and can occasionally contribute to accidents.

Coarse sediments transported from urban areas have a physical impact on the receiving aquatic environment by smothering aquatic habitats and silting waterways leading to a reduction in the waterway discharge capacity. Fine suspended particles carried by stromwater flows may not necessarily be considered to have significant physical impacts on the environment. However, they lead to elevated turbidity levels and it is generally understood that the highest concentrations of pollutants are attached to the finer fractions of suspended sediments in urban stromwater.

To overcome these problems, a portable rubbish and sediment trap made of Glass Fibre Reinforced Polymer (GFRP) composite that offer light weight, corrosion resistance and high strength to weight ratio are designed to capture trash, debris as well as sediment before it discharges to the receiving waterbodies or as part of an overall solution to ensure that treated stormwater flows meet industry standards as well as specified water quality objectives. Figure 1.1 illustrated the mesh type rubbish and sediment trap (first generation) whereas, Figure 1.2 show the perforated wall type rubbish and sediment traps (second generation) which is installed at L52, Universiti Teknologi Malaysia, Johor.

Figure 1.1: The mesh type rubbish and sediment trap

Figure 1.2: The perforated wall type rubbish and sediment traps

1.3 Objective of the Study

The objectives of the study are:

- To investigate the hydraulic parameter for the design of a potable rubbish and sediment trap in open channel flow.

1.4 Scope Of Works

The scope of work is given as follows:

- Analyze the rainfall intensity from the rain gauge located at meteorological station in UTM campus
- Laboratory testing at Hydraulic and Hydrology laboratory, FKA , UTM
  - To observe and collect data for the water hydraulic characteristics analysis (i.e. energy lost and back water)
- Fieldwork at L50 and L52, UTM Skudai Campus
- Fieldwork at housing area in Taman Universiti

1.4 Duration of the Project

The estimate project duration is 12 months, it started on February 2007 and completed on February 2008. At the moment, the project status up to February 2008 is 100% completed.

1.5 Utilization of Human Resources

Table 1.1 shows the employment of human resources to complete the study on investigation of the hydraulic characteristics for potable rubbish and sediment trap.

Table 1.1: Utilization of human resources

Project Leader	Prof. Madya. Dr. Norhan bin Abd. Rahman
Researcher	Dr. Shukur Abu Hassan
Research Assistant	Mohd Kamarul Huda bin Samion
	Siti Rabe'ah binti Othman
	Ngien Su Kong
B. Eng Final Year Student	Mohd Khairi Azfa bin Abd Aziz
	Khairul Anuar bin Mohamad
	Sarizah binti Saipin
Technian	2 persons

1.6 Achievement on Project Objectives

The investigation on the hydraulic parameter for the design of a potable rubbish and sediment trap in open channel flow are conducted in laboratory as well as field sampling up to February 2008 is 100% achieved. The hydraulic parameters analyse such as backwater profile, flow (Q), energy loss, sediment rate, rainfall intensity.

1.7 Milestone Achievement

Table 1.2 shows the milestone achievement from year 2007 until the study complete on February 2008. According to the Table 1.2, the data collection in laboratory has been done between 2nd quarter and 3rd quarter on 2007 as well as data collection at site between 3rd and 4th quarter at 2007. The project will complete in the middle of February 2008.

Table 1.2: Milestone achievement for year 2007 to 2008

No.	Project Activities	Year 2007				Year 2008	
		Q1	Q2	Q3	Q4	Q1	Q2
1	Complete data collection (lab work)		◆				
2	Complete data collection (site work)			◆			
3	Documentation completed				◆		

Legend: ◆ Milestone

1.8 Utilization of Research Equipment

Table 1.3 depicted the equipment that use in the study. All the equipments available at Hydraulics and Hydrology Laboratory, Fakulti Kejuruteraan Awam, Universiti Teknologi Malaysia. Figure 1.3 illustrates the automatic flowmeter used in the study, while Figure 1.4 shows the physical open channel at study area during laboratory analysis where a small figure on the right shows the model of rubbish trap located. The open channel is 0.36m in height, 0.41m in width and 12m in length as shown in Figure 1.4.

Table 1.3: Research equipment used in laboratory

Parameter	Apparatus
Flow (Q)	Automatic Flowmeter (Area-velocity ISCO)
Water depth	Water Level Apparatus
Rainfall	Automatic raingauge
Research area (Lab work)	Physical open channel flow facilities

Figure 1.3: The automatic flowmeter (area-velocity ISCO)

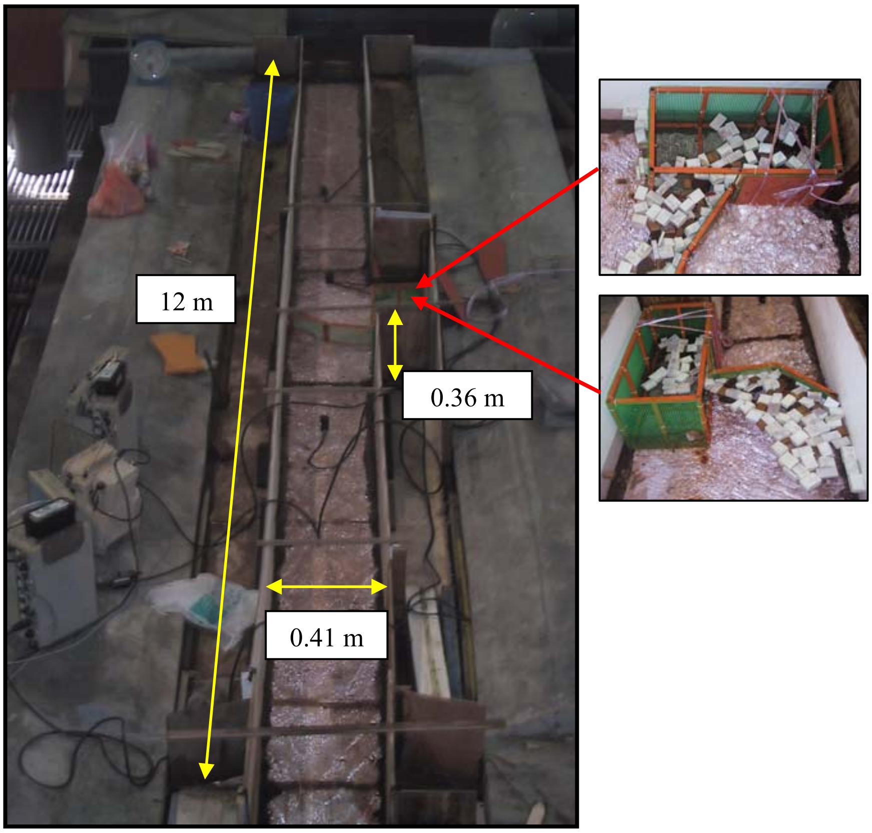


Figure 1.4: Research area during laboratory analysis

1.9 Timing Performance of the Research

Table 1.4: Timing performance of the research for year 2007

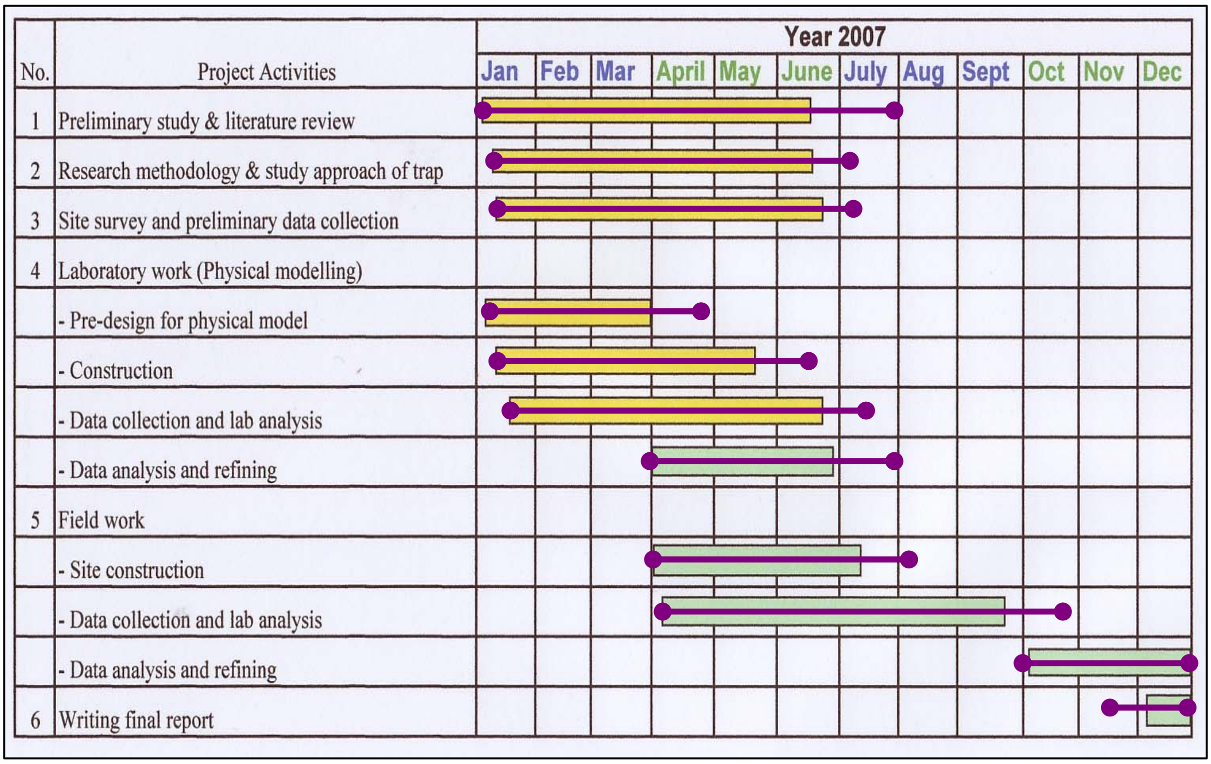


Table 1.5: Timing performance of the research for year 2008

No.	Project Activities	Year 2008		
		Jan	Feb	Mar
1	Preliminary study & literature review			
2	Research methodology & study approach of trap			
3	Site survey and preliminary data collection			
4	Laboratory work (Physical modelling)			
	- Pre-design for physical model			
	- Construction			
	- Data collection and lab analysis			
	- Data analysis and refining			
5	Field work			
	- Site construction			
	- Data collection and lab analysis			
	- Data analysis and refining			
6	Writing final report			

Legend:

Current progress

Planning progress

CHAPTER 2: MATERIALS AND METHODS

2.1 Site Description

The site took part for this research is located at L50, L52 and housing areas in Taman Universiti, Johor. Two rubbish traps were installed, one at block L50 and the other at block L52 of Universiti Teknologi Malaysia (UTM), Skudai. Both blocks have a cafeteria which made them suitable for the study. On the other hand, a rubbish trap was also installed at Jalan Kemajuan 10, Taman Universiti, Skudai. This allowed for the monitoring and study of rubbish traps in housing areas. The same methodology was applied for this area to study the effectiveness of rubbish trap. Figure 2.1 shows the plan view of the Glass Fibre Reinforced Polymer (GFRP) rubbish trap installed in the study areas.

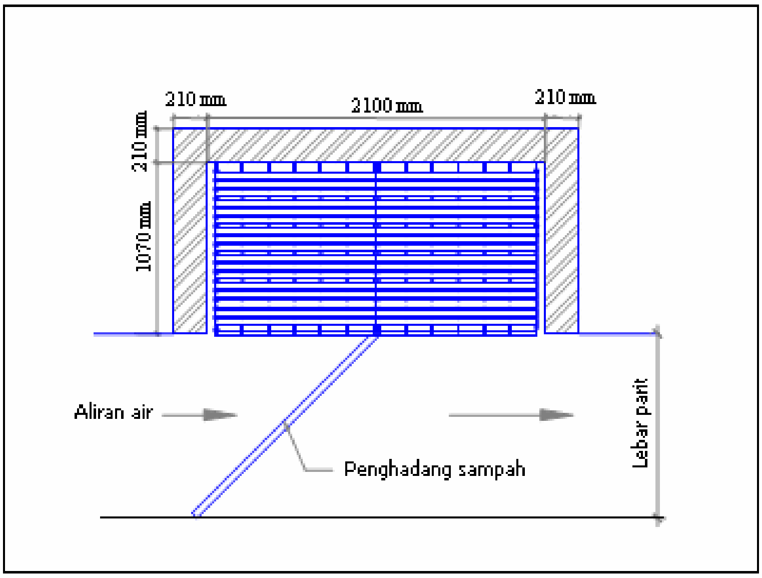


Figure 2.1: Plan View of the Glass Fibre Reinforced Polymer (GFRP) Rubbish Trap

2.2 Operation of the System

Up to January 2008, there are two types of rubbish trap established; Generation 1 is Mesh Type Rubbish Trap; Generation 2 is Perforated Type Rubbish Trap. However, the form of rubbish trap methods is similar. The different between both generations are their wall where the first generation more to mesh wall where the rubbish easily came out during high flow and the efficiency of the trap in terms of rubbish collected are low. To overcome the problem, the second generation are intended with the perforated wall where the rubbish remains in its cage during high flow.

The rubbish trap is designed to operate manually by applying a hydraulic principle to trap the rubbish and sediment instead of using mechanical or electrical system. The collected rubbish then cleared by maintenance workers periodically. The rubbish that flow through the channel will be details by a trash screen and collected in main structure of the rubbish trap. Trash screen made of grating where it allows the water flow through it to prevent channel from clogging.

The designed rubbish trap has several main components such as main wall, trash screen, rubbish trap shutter, and main structure handle as shown in Figure 2.2 and 2.3.

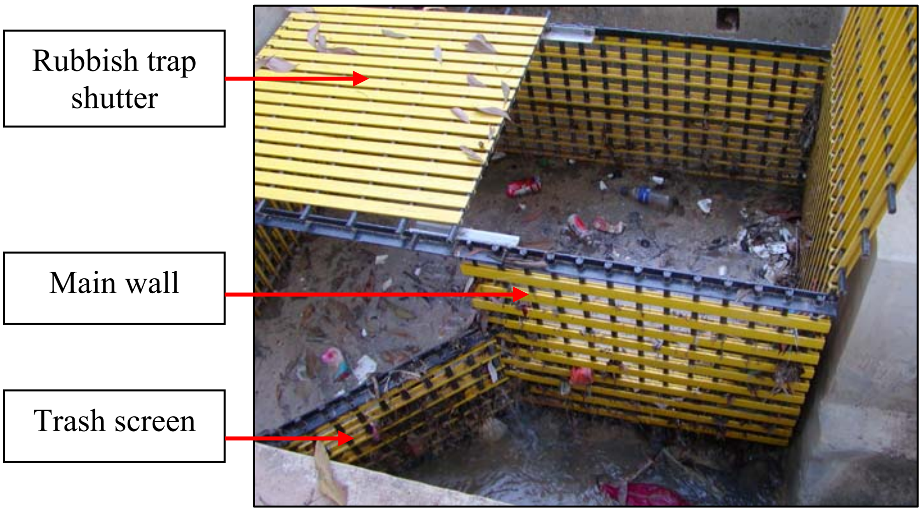


Figure 2.2: Component of Mesh Type Rubbish Trap

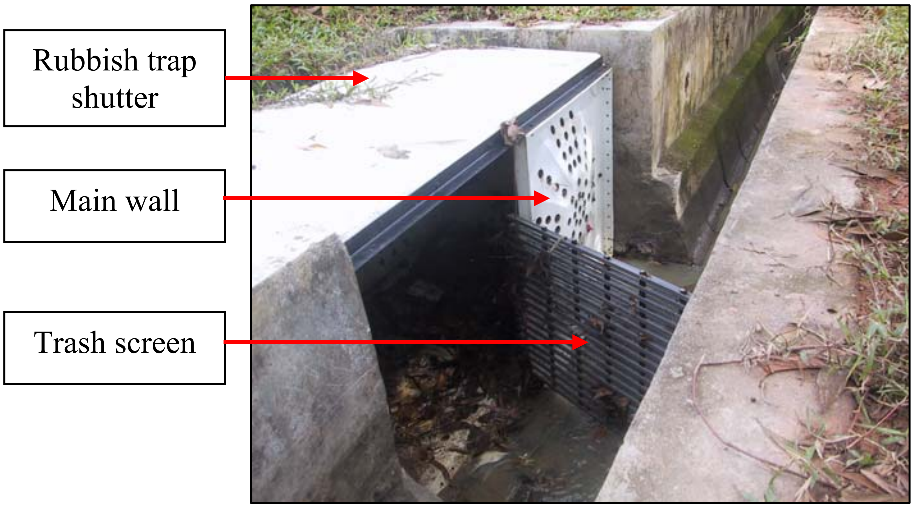


Figure 2.3: Component of Perforated Type Rubbish Trap

2.3 Sampling Procedure

On each of the sampling period calculation of backwater, continuous weighing of rubbish, water sampling and suspended solid were taken from each of three sites at block L50, L52 and housing area in Taman Universiti. Rainfall data were obtained from the meteorological station located in UTM, Skudai campus. The sampling procedures included field readings and laboratory analysis.

2.3.1 Field Sampling

Rubbish and sediment trapped by the rubbish traps were taken out, dried and weighed at the end of each day to ascertain the amount. Graphs were plotted to show the relationships between the amount of rubbish and rainfall. For the assessment of suspended solids, water samples were taken at a point before and after the rubbish traps once every seven days for four consecutive weeks. Suspended solid tests were performed to determine the amount of suspended solids and the results are compared with both Standard A and Standard B of Environmental Quality Act 1974. The trapped rubbish was also weighed at the same time as the water samples were taken. This was conducted to observe the relationship between amount of rubbish and the suspended solid water quality parameter.

2.3.2 Laboratory Analysis

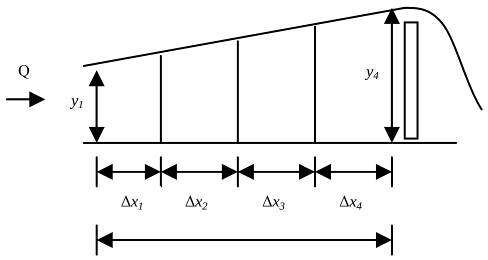
Analysis was conducted in the Environmental Laboratory, Faculty of Civil Engineering for suspended solids (SS). A small amount of samples was taken out after moderate shaking and filtered using a 0.45 μm filter. Before the filtering process began the filter was weighed and the result noted. The filters were then taken and placed in the oven for one hour at 105˚C to dry the contents of the filter out, and then weighed again. The results after the drying process were compared with the results of the initial weighing and the result noted as the total suspended solids content of the water.

Testing for energy loss and backwater effect were also performed for different flow rates at the Hydraulics and Hydrology Laboratory, Faculty of Civil Engineering, UTM. Figure 2.4 shows the energy loss and backwater were conducted during the period of study. The laboratory testing was done using a prototype open channel specially built to study the rubbish trap model.

Figure 2.4: Energy loss and backwater analysis were performed at the laboratory

2.4 Data Analysis

Calculation of backwater was performed using the Numerical Integration method, as shown in Figure 2.5 and also the Direct-Step method. Parameters such as velocity, water depth, channel width and water surface width were needed for the calculations. The channel is assumed to be trapezoidal in cross-section so all calculations were based on the trapezoidal channel formula. The velocity was measured using a current-meter whereas water depth, channel width and water surface width were measured using a measurement tape. The slope of the channel was determined through fixing two points along the channel, measuring the height of the points as well as the distance between them and then using the Pythagoras theory to calculate the slope. For the Numerical Integration method, the length of backwater was divided into several segments and the distance for each segments were determined by using Equation 1.



$$\Delta x = \frac{\Delta y}{S_o}\left[\frac{1-\left(\frac{y_c}{\bar{y}}\right)^3}{1-\left(\frac{K_o}{\bar{K}}\right)^2}\right] \qquad \textbf{(1)}$$

Figure 2.5: Numerical Integration Method

where:
Δx = length of segment
Δy = changing depth between segment
$\bar{y}$ = average depth for each segment = $\frac{1}{2}(y_i+y_{i+1})$
S_0 = channel slope, y_c = critical flow = $(q^2/g)^{1/3}$
$K_o = AR^{2/3}/n = Q/(S_o)^{1/2}$
$\bar{K} = \bar{A}\bar{R}^{2/3}/n$

The Direct-Step method was used for the rubbish trap installed at Jalan Kemajuan 10, Taman Universiti, Skudai. The calculation for backwater is the same as in Equation 1. The calculation for energy loss is shown in Equation 2.

$$E = d\cos\theta + \frac{Q^2}{2gd^2B^2} \qquad \textbf{(2)}$$

where d = water level (m), θ = angle between bottom surface and the datum (^{o}), Q = flow rate, g = gravity acceleration (9.81m/s^2), B = width of channel (m). The laboratory tests were performed using four different models, each under three different flow rates. The different models are modifications of the original rubbish trap model. The first model is the original model. In the second model, only the arm of the rubbish trap was modified to become solid instead of mesh. In the third model, only the wall was modified to become solid. The fourth model applied a perforated wall instead of a mesh wall.

CHAPTER 3: RESULTS AND DISCUSSION

3.1 Amount of Rubbish and Sediment

According to Sarizah (2006), Figure 3.1 and 3.2 shows the amount of rubbish collected during a ten-day period by the trash screen and mesh wall rubbish trap installed at block L52 and L50 respectively. From both figures, the graph curve for amount of rubbish trapped increases whenever there is rainfall recorded. This shows that rain influences the amount of rubbish trapped. It seems that the rubbish traps work better when there is higher velocity flows in the channel. The highest recorded amount of trapped rubbish recorded is 40kg/day and 18kg/day for block L52 and L50 respectively and the rubbish is made up of food waste, plastic containers, bottles, cans, leaves, twigs and grass clippings. Both trash screen and mesh rubbish traps show 100% efficiency in trapping rubbish; no overflow bringing rubbish with it occurred over the arm of the rubbish traps.

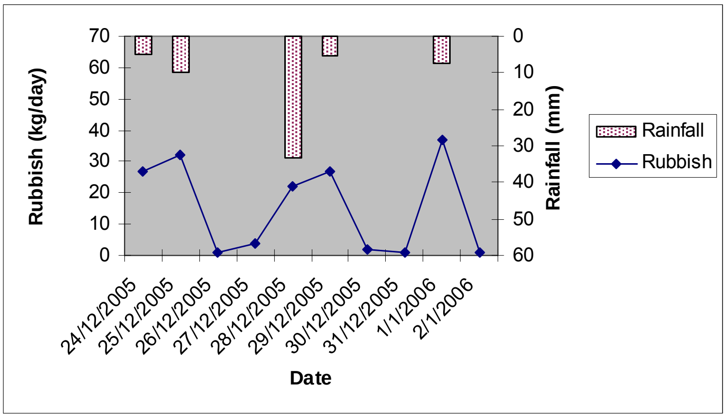


Figure 3.1: Rubbish vs rainfall graph, L52

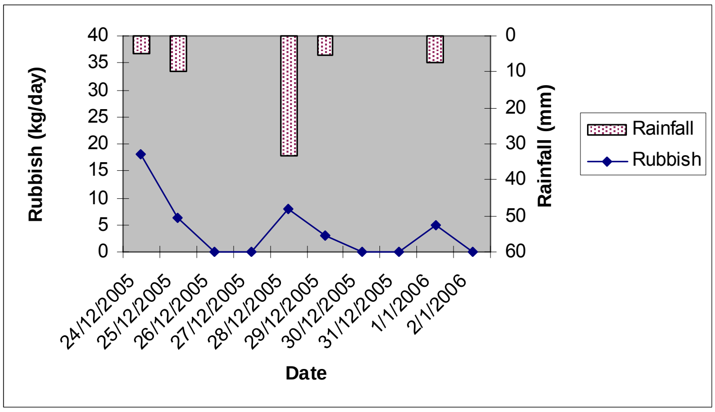


Figure 3.2: Rubbish vs rainfall graph, L50

Measurement for the amount of both rubbish and sediment was done over a period of one month at the rubbish trap installed at Jalan Kemajuan 10, Taman Universiti, Skudai from 13/01/06 until 31/1/06. Two measurements were taken and the results plotted as shown in Figure 3.3 and 3.4 (Siti Rabe'ah, 2006).

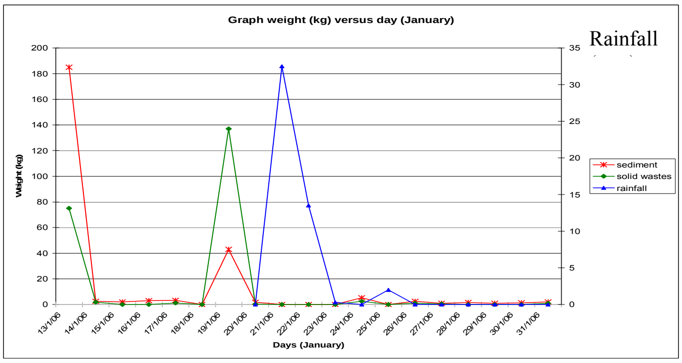


Figure 3.3: January data, Taman Universiti

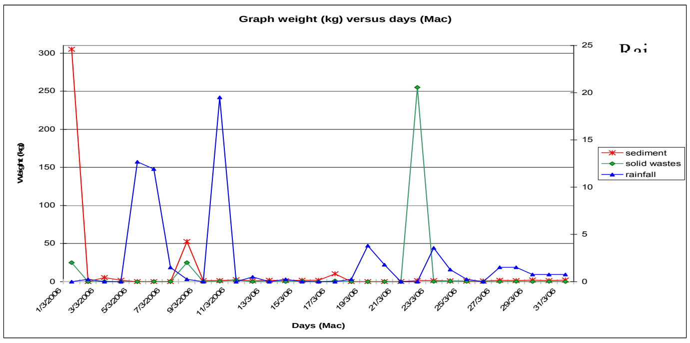


Figure 3.4: March data, Taman Universiti

In Figure 3.3, the amount of rubbish and sediment recorded at the start of the measurement, on the 13th January 2006, is very high because the rubbish trap was not cleaned and maintained since the end of the previous year. The second measurement shown in Figure 3.4 also faced the same scenario where on the first day of measurement, a large amount of sediment and rubbish was recorded. The graph curve for trapped sediment is frequently higher than the graph curve for trapped rubbish in both figures. This is because there will be accumulation of sediment day after day even when there is little or no rubbish present in the channel flows. Notable amount of rubbish trapped occurred on the 19th January 2006 and 22nd March 2006 with 137kg/day and 255kg/day recorded respectively. Normally, these situations occurred after heavy rainfall.

Research done by Mohd Khairi (2007), Figure 3.5 shows the amount of rubbish collected during a two-week period by the perforated wall rubbish trap, which replaced the mesh wall rubbish trap at block L52 for that period. The graph curve for amount of rubbish trapped increased when rainfall occurred. The highest amount of trapped rubbish recorded for the perforated wall rubbish trap is 98kg/day. It was observed that overflow over the arm of the perforated wall rubbish trap will occur during heavy rainfall and some rubbish will escape with the overflow.

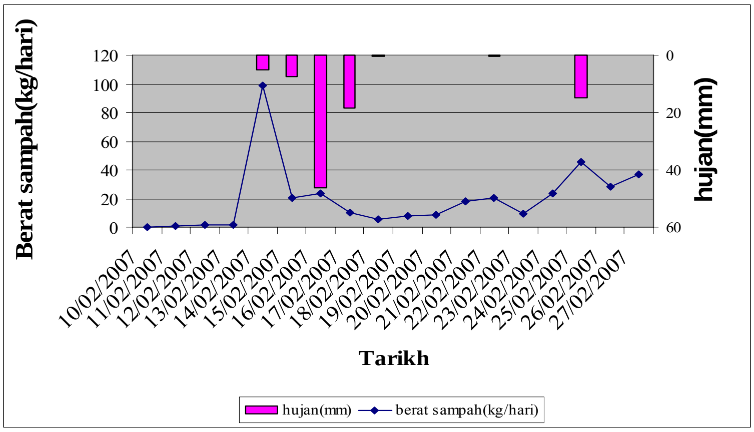


Figure 3.5: Perforated wall performance, L52

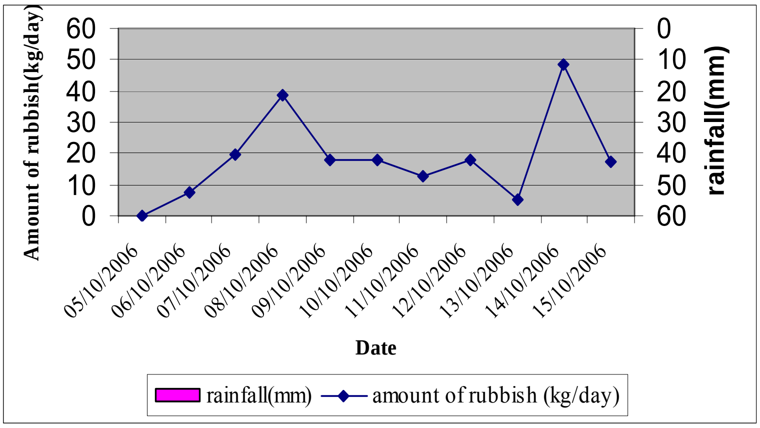


Figure 3.6: Dry period performance, L52

Figure 3.6 (Mohd Khairi, 2007) shows the amount of rubbish collected by the mesh wall rubbish trap at block L52 during a long dry period of two weeks. The graph shows that rubbish was still collected by the rubbish trap. This is because the cafeteria at block L52 was operating during that period. An average of 18.48kg/day of rubbish was retained by the rubbish trap during that period.

Research done by Khairul Anuar (2007), Figure 3.7 shows the amount of rubbish collected for one month period by the perforated wall rubbish trap at block L52. The graph curve for amount of rubbish trapped increased when rainfall occurred. The highest amount of trapped rubbish recorded for the perforated wall rubbish trap is 63kg/day. It was observed that overflow over the arm of the perforated wall rubbish trap will occur during heavy rainfall and some rubbish will escape with the overflow. Meanwhile, Table 3.8 shows the amount of sediment collected for one month from 19/08/07 to 17/09/09. Average sediment collected per day was 2.1 kg/day while minimum sediment recorded everyday during the experiment period was 0.5 kg/day. However, heavy rainfall does not influence sedimentation as the sediment will be carried away by rainwater before it can settle.

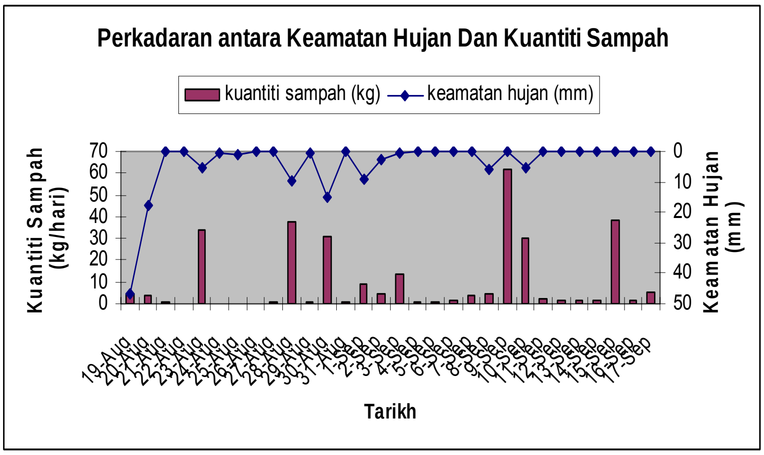


Figure 3.7: Rubbish trap performance for one month, L52

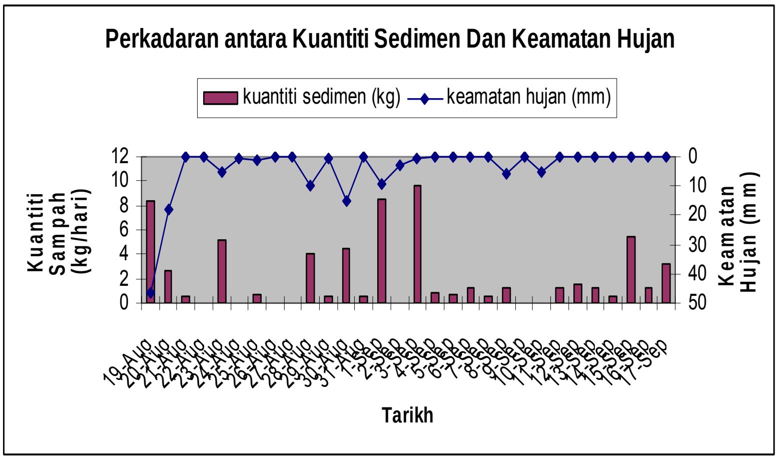


Figure 3.8: Relationship between sediment collected and rainfall for one month, L52

3.2 Flow Observation

The flow data was obtained through area and flow method in open channel at research area for 30 days. Quantity of sediment and rubbish collected was observed to made relationship between these parameters. The highest flow recorded was $54m/s^3$ and the quantity of sediment and rubbish trapped was 8.4kg/day and 4.4kg/day respectively. While, the lowest flow recorded was $1.0m/s^3$ and the amount of sediment and rubbish collected was 0.6kg/day each. These data shows that the higher flow influence the amount of sediment and rubbish trapped in the perforated wall rubbish trap. Figure 3.9 shows the relationship between flow and quantity of rubbish collected from 19/08/07 to 17/09/07, while Figure 3.10 shows the relationship between flow and quantity of sediment collected along the study period.

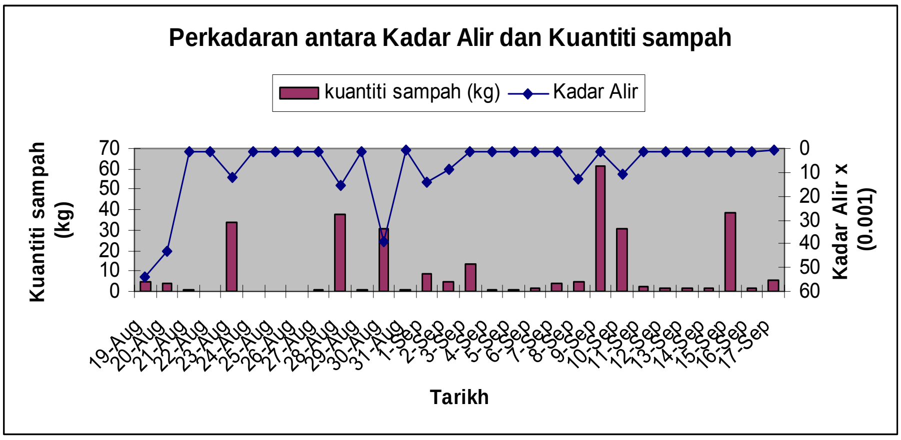


Figure 3.9: Relationship between flow and quantity of rubbish collected

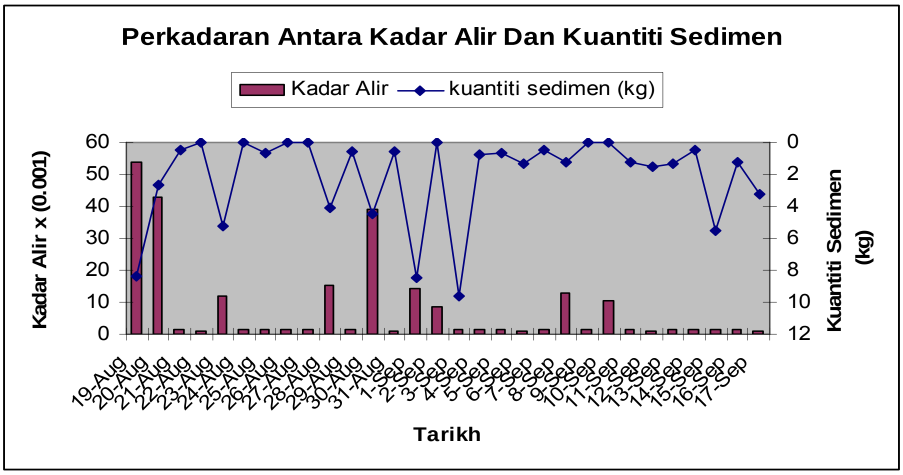


Figure 3.10: Relationship between flow and quantity of sediment collected along the study period

3.3 Suspended Solids Assessment

Table 3.1: Percentage of removal for suspended solids

	Rubbish Trap at L52			Rubbish Trap at L50		
Sample	**Date**	**Rubbish (Kg)**	**Removal of SS (%)**	**Date**	**Rubbish (Kg)**	**Removal of SS (%)**
1	7/1/2006	67	33.3	9/9/2005	No data	53.6
2	14/1/2006	81	45.8	28/12/2005	No data	92.3
3	28/1/2006	90	51	11/1/2006	10	66.7
4	3/2/2006	82	47	2/2/2006	5	41.3

Water samples are taken from both block L52 and block L50 on the dates as shown in Table 3.1 (Sarizah, 2006) and tested for suspended solids. From the results displayed in Table 3.1, it can be seen that there is a relationship between the amount of rubbish trapped and the percentage of suspended solids removed. The higher the amount of rubbish collected in the rubbish traps, the higher the percentage of removal of suspended solids.

Figure 3.11 and Figure 3.12 (Sarizah, 2006) shows the level of suspended solids before and after the rubbish traps for block L52 and L50 respectively with reference to both Standard A and Standard B of Environmental Quality Act 1974 as illustrate in Appendix A. Figure 3.11 shows that the outflow from the rubbish trap installed at block L52 achieved the requirement of Standard B and nearly achieved the requirement for Standard A. Figure 3.12 shows that the outflow from the rubbish trap installed at block L50 did not achieve either the requirement for Standard A or Standard B. This is because of an exceptionally high reading for suspended solids on the 2nd February 2006.

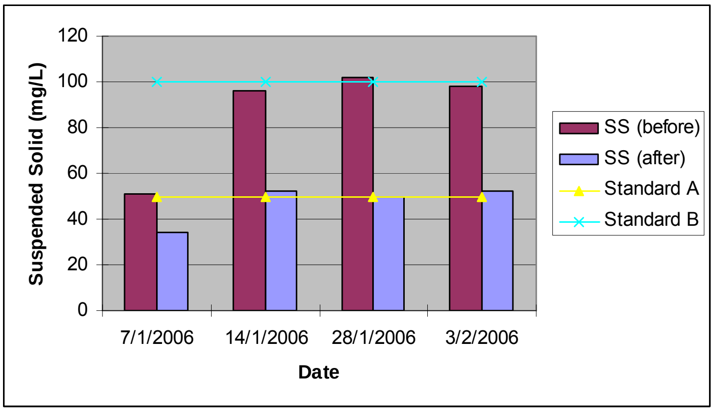


Figure 3.11: Suspended solid reduction at L52

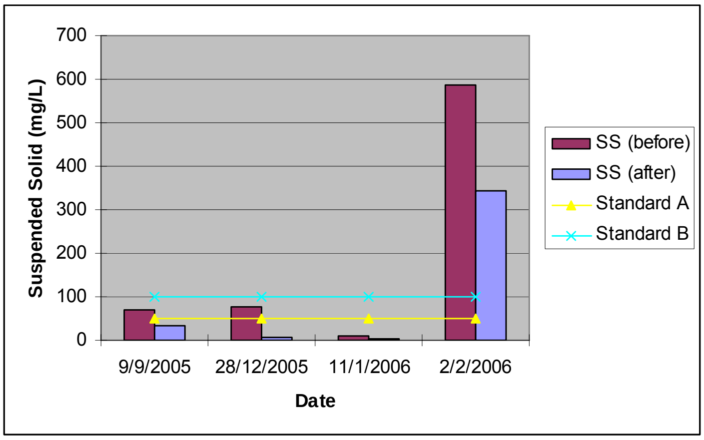


Figure 3.12: Suspended solid reduction at L50

3.4 Hydraulic Characteristics

3.4.1 Field Measurement

Two locations were selected for the field measurement of backwater length, block L52 and Jalan Kemajuan 10, Taman Universiti, Skudai. For block L52, the length of backwater was determined using Numerical Integration method. The results are shown in Table 3.2 (Sarizah, 2006).

Table 3.2: Calculated backwater results (Block L52)

Sample	Date	Rain	Rubbish (Kg)	Flow rate	Backwater
1	7/1/2006	yes	67	2.59×10^{-2}	10.5
2	14/1/2006	no	81	3.20×10^{-3}	11.0
3	28/1/2006	no	90	2.89×10^{-3}	12.0
4	3/2/2006	no	82	3.13×10^{-3}	11.5

It can be seen from Table 3.2 that as the amount of rubbish trapped increase, the length of backwater also increase. This is likely due to trapped rubbish impeding the flow of water in the channel, thus causing backwater flows. Table 3.3 (Siti Rabe'ah, 2006) shows the comparison between measured and calculated length of backwater at Jalan Kemajuan 10, Taman Universiti, Skudai. The results show that there are differences between measured and calculated backwater length. This could be due to several reasons such as error while determining the normal depth, y_0, and blockage by water pipes and vegetation during measurement. The Numerical Integration method gives the longest length for majority of the samples as it is more precise.

Table 3.3: Backwater result comparison (Jalan Kemajuan 10, Taman Universiti, Skudai)

Sample	Date	Rain	Backwater Length (m)		
			Field Observation	Numerical Integration	Direct-Step Method
1	12/1/2006	Yes	160.0	214.7	189.9
2	18/1/2006	Yes	85.0	74.3	60.4
3	21/1/2006	Yes	120.0	158.4	104.2
4	10/2/2006	Yes	68.0	93.6	56.0

3.4.2 Laboratory Testing

Figures 3.13 to 3.15 (Mohd Khairi, 2007) shows the laboratory test results for four different flow rates under three flow conditions, 0.0797m^3/s, 0.1323m^3/s and 0.1896m^3/s. In Figure 3.13 to Figure 3.15, the energy losses experienced by the different models are plotted. The plots show that rubbish trap with solid arm experienced the highest energy loss among the different models. However, no energy loss was recorded for flow condition where Q = 0.1896m^3/s as shown in Figure 3.15. The explanation could be from the observation that no rubbish was retained during high flow.

In Figure 3.16 to Figure 3.18 (Mohd Khairi, 2007), the length of backwater measured are plotted. The plots show that the length of backwater measured range from zero to 2.6m. The rubbish trap with solid arm experienced the least backwater effect.

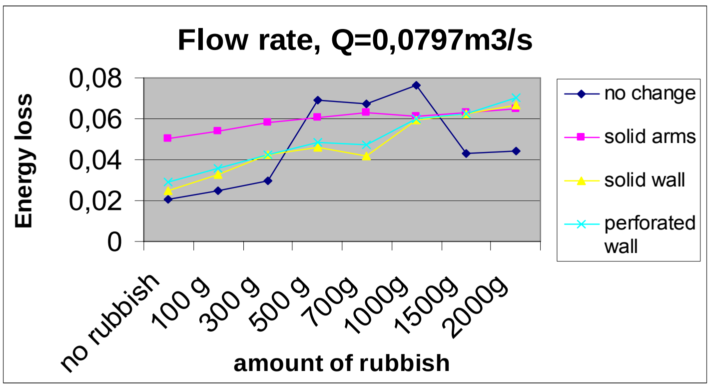


Figure 3.13: Energy Loss in Q = 0.0797m^3/s

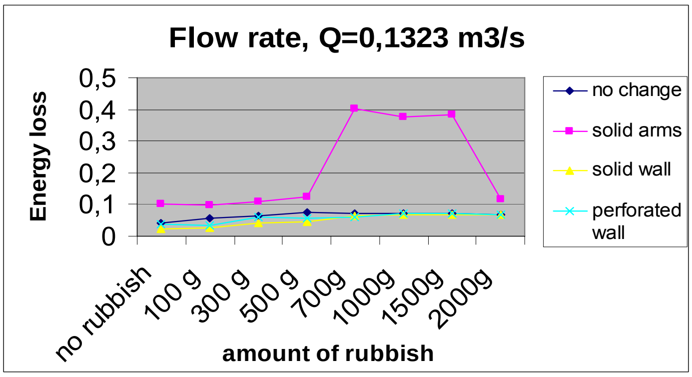


Figure 3.14: Energy Loss in Q = 0.1323m^3/s

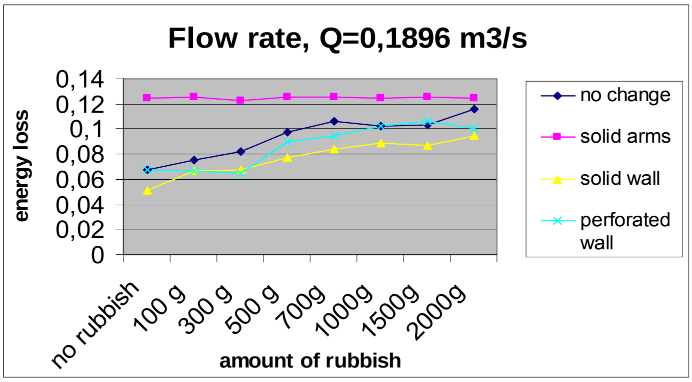


Figure 3.15: Energy Loss in Q = 0.1896m^3/s

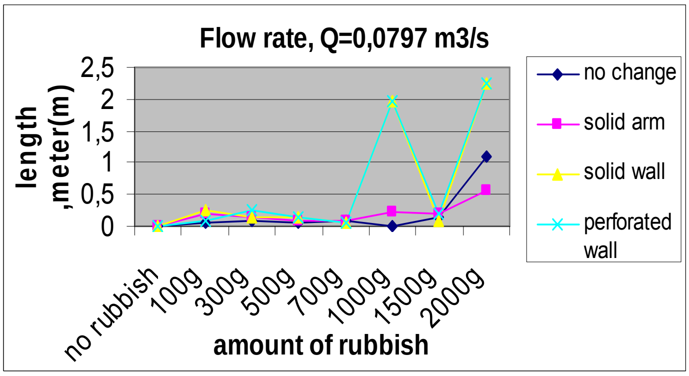


Figure 3.16: Backwater in Q = 0.0797m^3/s

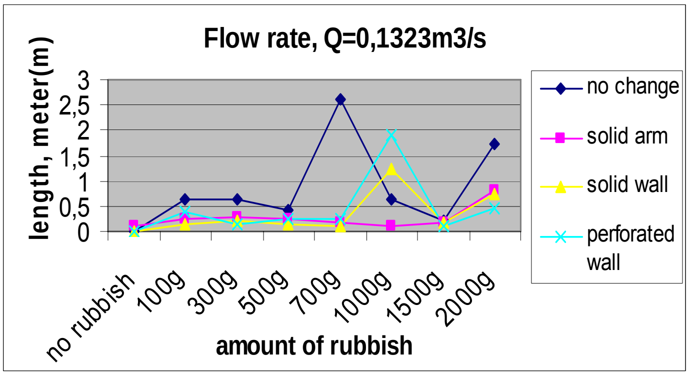


Figure 3.17: Backwater in Q = 0.1323m^3/s

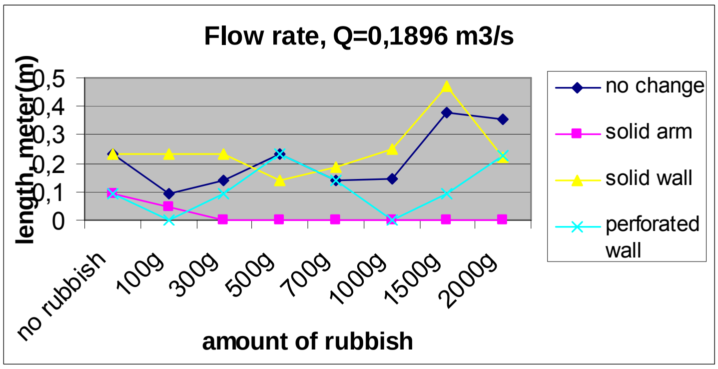


Figure 3.18: Backwater in Q = 0.1896m^3/s

CHAPTER 4: CONCLUSION

Rainfall plays an important part in the operation of rubbish traps. Increased rainfall will increase the amount of rubbish and sediment trapped in the rubbish traps. The highest recorded amount of rubbish trapped during this research is 255kg/day from the rubbish trap installed at Jalan Kemajuan 10, Taman Universiti, Skudai. The amount of rubbish trapped in turn will affect the removal of suspended solids as well as the length of backwater. Higher amount of trapped rubbish will result in higher percentage of suspended solids removal. By solely using rubbish traps installed along channels, suspended solids in water ranging from rain water to wastewater from canteens and cafeterias can be treated up to Standard B of the Environmental Quality Act 1974. Higher amount of trapped rubbish will also result in longer backwater lengths. Therefore, regular cleaning and maintenance is compulsory for optimal performance of rubbish traps. Mesh wall rubbish traps have 100% efficiency compared to perforated wall rubbish traps which is not effective during high flows. Table 4.1 shows the comparison between mesh wall & perforated wall rubbish traps. From the results, a mesh wall rubbish trap with solid arm gives the best performance. It experiences the highest energy loss and lowest backwater effect among the models compared.

Table 4.1: Comparison between mesh wall & perforated wall rubbish traps

Characteristic	Mesh Wall Rubbish Trap	Perforated Wall Rubbish Trap
Resistance to high flow rate	Moderate	Good
Effectiveness in trapping rubbish	100% provided maintenance is done daily	100% provided no overflow occurs

CHAPTER 5: REFERENCES

Allison, R., Chiew, F., and McMahon, T, 1997, Stormwater Gross Pollutants, Industry Report: Cooperative Research Centre for Catchment Hydrology, 1997

Manual Saliran Mesra Alam Malaysia (MASMA), 2000, Chapter 34, Jabatan Perparitan dan Saliran Malaysia.

Mohd Khairi, A. A., 2007, Kajian Terhadap Keberkesanan Penggunaan Perangkap Sampah Di Dalam Saluran Terbuka Di UTM, Skudai, Johor Bahru, Universiti Teknologi Malaysia : Tesis Sarjana Muda

Sarizah, S., 2006, Kajian Terhadap Penggunaan Perangkap Sampah Dalam Sistem Saliran Terbuka, Universiti Teknologi Malaysia : Tesis Sarjana Muda

Siti Rabe'ah, O., 2006, Keberkesanan Perangkap Sampah Dan Sedimen Bagi Air Larian Permukaan Dalam Saluran Terbuka, Universiti Teknologi Malaysia, Tesis Sarjana Muda

P.M. Dr. Norhan Abdul Rahman, Dr. Shukur Abu Hassan, Siti Rabe'ah Othman and Ngien Su Kong. Study of Effectiveness for Rubbish Traps In Open Channel Flow. National Seminar in Civil Engineering Research (SEPKA), UTM, Skudai, Johor, December 2007.

APPENDIX A

Akta Kualiti Alam Sekeliling 1974

Peraturan-peraturan Kualiti Alam Sekeliling (Kumbahan dan Effluen-effluen Perindustrian) 1978

[Peraturan 8 (1), 8 (2), 8 (3)]

Parameter	Unit	Kelas A	Kelas B
Suhu	^oC	40	40
Nilai pH	-	6.0-9.0	5.5-9.0
BOD_5 pada 20^oC	mg/l	20	50
COD	mg/l	50	100
Pepejal Terampai (SS)	mg/l	50	100
Raksa	mg/l	0.005	0.05
Kadmium	mg/l	0.01	0.02
Kromium Heksavalensi	mg/l	0.05	0.05
Arsenium	mg/l	0.05	0.10
Sianid	mg/l	0.05	0.10
Plumbum	mg/l	0.10	0.50
Kromium Trivalensi	mg/l	0.20	1.0
Tembaga	mg/l	0.20	1.0
Mangan	mg/l	0.20	1.0
Nikel	mg/l	0.20	1.0
Timah	mg/l	0.20	1.0
Zink	mg/l	1.0	1.0
Boron	mg/l	1.0	4.0
Besi (Fe)	mg/l	1.0	5.0
Fenol	mg/l	0.001	1.0
Klorin Bebas	mg/l	1.0	2.0
Sulfid	mg/l	0.50	0.50
Minyak dan Gris	mg/l	Tidak boleh dikesan	10.0