Jurnal
Teknologi

Full Paper

SEWERAGE CATCHMENT STUDY FOR CLAN JETTIES, PENANG

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Article history
Received
27 April 2015
Received in revised form
15 June 2015
Accepted
1 July 2015

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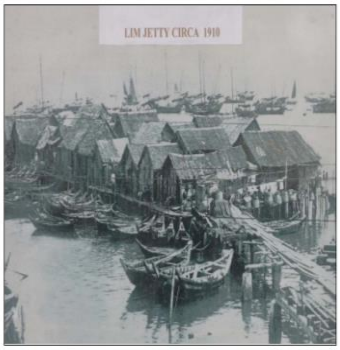
Graphical abstract



Abstract

The Water Pollution Study concluded that the most contaminated zone is the stretch where the fundamental channels meet the Clan Jetties shores. These are the channels along Lebuh Chulia, Gat Lebuh Armenian and Gat Lebuh Melayu. The organic loads, measured as far as BOD, COD, Oil & Grease, Suspended Solids are most noteworthy along this strip took after by the shoreline strip. The high E Coli concentrations along these 2 strips affirmed that there is fecal contamination most likely from the partially treated sewage being released from the unsewered premises nearby the Clan Jetties shore. This contamination is exacerbated by the direct sewage transfer into the ocean by the Clan jetties community because of the non-presence of any sewerage system at all. The usage of sewerage system must be provided as soon as possible and may be implemented in stages based on the budget and by doing in stages, the workability of the new system can be enhanced and redesigned in the subsequent stages. Since the houses are based on the ocean floor, the most suitable system to tap the sewage stream from the houses is the Vacuum Sewer System.

Keywords: Pollution, jetties, sewerage

Abstrak

Penyelidikan Pencemaran Air menyimpulkan bahawa zon yang tercemar ialah saluran asas Clan Jeti pantai. Saluran ini terletak di sepanjang Lebuh Chulia, Gat Lebuh Armenian dan Gat Lebuh Melayu. Bahan organik, diukur dengan BOD, COD, Minyak & Gris, pepejal terampai yang perlu diberi perhatian sepanjang jalur ini mengambil selepas jalur pantai. Kedua-dua jalur ini mengandungi E coli yang tertinggi dan membuktikan bahawa pencemaran bahan kumbahan kemungkinan besar disalurkan dari premis yang tidak mempunyai sistem pembentungan berdekatan pantai di Jeti Clan. Pencemaran ini diburukkan juga oleh penyaluran kumbahan terus ke dalam laut oleh masyarakat jeti Clan kerana tidak mempunyai sistem pembetungan yang sesuai. Penggunaan sistem pembetungan perlu disediakan sebaik yang mungkin dan perlu dilaksanakan secara berperingkat berdasarkan bajet. Dengan melakukan secara berperingkat, kebolehkerjaan sistem baru boleh dipertingkatkan dan direka semula pada peringkat seterusnya. Oleh sebab rumah adalah berdasarkan kepada dasar laut, sistem yang paling sesuai untuk menyalurkan kumbahan dari rumah adalah Sistem Pembetung Vacuum.

Kata kunci: Pencemaran, jeti , pembentungan

1.0 INTRODUCTION

The environmental health issue is a challenge for the government in order to create a pollution-free environment and preventing and controlling infectious diseases to the community. The pollution from sewage and solid waste contribute to the negative impact on the environment. Apart from the environment, humans residing in polluted areas will be

exposed to the infectious illnesses like Hepatitis A and E, cholera, dysentery, malaria and typhoid fever. Hepatitis E is a disease of developing countries with improper sewage disposal and unclean water supplies [1]. In addition, cholera and diarrhoeal diseases kill about two million children a year in low and medium- income countries.[2] Therefore, in the face of increasing demand for potable water supply to domestic and commercial needs, and the consciousness of the pollution potentials of improper sewage management to water bodies and the consequent spread of infectious diseases; the sanitary design, monitoring and maintenance of sewage facilities becomes imperative to prevent and control associated health problems.

Wastewaters entering a water body represent a heavy source of environmental pollution in Malaysian rivers. It affects both the water quality as well as the microbial and aquatic flora. With competing demands on limited water resources, awareness of the issues involved in water pollution, has led to considerable public debate about the environmental effects of effluents discharged into aquatic environments. Wastes containing high concentration of microbial nutrients would obviously promote an after-growth of significantly high coliform types and other microbial forms. Organic pollution is occasional discharge of raw sewage through storm water outlets. Waste effluents rich in decomposable organic matter, is the primary cause of organic pollution. Hence, this study will review the options of sewerage system for Clan Jetties and its pre-estimated cost as a basis of developing a proper sewerage system. It is aimed at providing the necessary impetus for a wholesome planning and become the catalyst for improvements of wastewater management in always evident and the pollution is made worse by land-based sources such as the Clan jetties. In order to achieve the above concept, Jabatan Perkhidmatan Pembentungan has recommended a comprehensive study to be conducted to outline the immediate needs, short term requirements and long term plans to be carried-out in Clan Jetties. A proper sewerage system is vital for the Clan Jetties as a part of the World Heritage Site because as Hugo [3] quoted: The sewer is the conscience of the city

2.0 LITERATURE REVIEW

2.1 History of Clan Jetties

Clan Jetties is located at Weld Quay, George Town area in Penang. Georgetown, the state capital of Penang has been named after Britain's King George III. It was founded on 11 August 1786 by Captain Francis Light, a trader from the British East India Company. Weld Quay was one of Penang Island's economic activities to which ships from all over the world came to trade. After the opening of the Suez Canal in1869, Penang was the first port of call east of the Indian subcontinent (Penang Economic Monthly January, 2010). Historically, the jetties were built by Chinese immigrants in the mid-19th century, when the British colonial masters actively encouraged Chinese to migrate to Malaya to fill the labour force [4]. The majority were coolies employed to unload goods in the port; others oversaw the production and sale of coal; and some ferried people and goods, particularly between the island and mainland [5]. When they arrived they did not have money to buy land and so decided to build their own villages, hence the jetties [6].

Prior to 1882, there were references that waterfront coolies lived in attap roofed, stilt houses immediately behind the original seafront [7]. This environment would gradually be incorporated into the construction of individual family homes as marriages occurred or wives joined husbands in Penang. When the jetties were established in the mid-19th century everybody who lived on the same jetty had the same surname because they all came from the same fishing village in China's Fujian Province [6]. In addition, towards the end of the 1960s, there were eight of them: Lim, Tan, Chew, Lee, Mixed, Yeoh, Peng Aun and Koay [5]

After Penang lost its free port status in 1974 the port became very quiet and the people who lived on the jetties had to find other ways to make a living. The demise of the Penang free port status also marked the breakdown of the communities' communal (clan) organization although there have been various attempts of reconstitution to maintain its survival (Chan, 1980). The decision to demolish the Koay jetty was precipitated in 2003 after a fire ravaged about fifty houses on the Noordin Street Ghaut, located right next to the jetty.[5] Penang Economic Monthly (January,2010) reported that currently, only six main Clan left under surname Lim,Tan,Chew,Lee,Yeoh and Mixed Clan which totalling about 200 households.

2.2 The Importance of Sewerage System in Clan Jetties as UNESCO World

During the 32nd session meeting, the Word Heritage Committee has inscribed new sites on UNESCO's World Heritage List with additional 19 cultural sites and eight natural sites to the List 2 and Georgetown and Malacca were included in the List on 8 July 2008.

Georgetown, Penang has been selected as the World Heritage Site Status. The outstanding universal value for Georgetown is the place as a historic colonial town on the Straits of Malacca which is formerly functioning as a trading port linking East and West. Due to European colonial powers for almost 500 years, the town developed successfully over a long span of time and even plan of Fort Cornwallis became the town planning from British colonial initiated.

Key conservation areas are divided into core areas and buffer area which are respectively 109.8 hectares bounded by the Straits of Malacca in the northeast,

Love Lane to the north-west and Gat Lebuh Melayu and Jalan Dr Lim Chwee Leong to the south-west and 150.04 hectares, bounded by the sea area around the harbour, Prangin Road to the south-west corner and Transfer Road to the north-west [8]. With George Town on the UNESCO World Heritage Site list, they are turning to tourism (Penang Economic Monthly January, 2010). In affordability to continuously recognize as the World Heritage Site, the Penang Investment Tourism Office must retain authenticity of the city while making it more tourist-friendly besides the state government stresses its cultural and ethnic diversity reflected in the language, costume, custom and cuisine and its historic links with the neighboring countries such as Singapore and Indonesia (OECD, 2011) [9].

2.3 Existing Sewerage Treatment Plants in Penang Island

Indah Water Consortium is the national sewerage company of Malaysia which is owned by the Ministry of Finance. The vision of IWK is to develop and maintain an efficient and up-to-date sewerage system for all Malaysians. The Federal Government in 1994 acknowledged the company to take over sewerage services nationwide which was used to be the responsibility of local Councils. As the Clan Jetties is located in George Town, the study will focus on the Jelutong Sewage Treatment Plan.

3.0 METHODOLOGY

Regularly visit the site to collect, collate, identify, record the data needed for the study. Data collection is the first of the three technical steps in developing a sewerage master plan. As of any type of technical study or research, the amount and quality of data determines the quality and reliability of the output, and subsequently the relevant and appropriateness of the decision or planning made. Therefore, has put up a framework to gather sewerage related data and information from various sources to compile a complete database, which will support the analyses and development of the master plan. Data collection is divided into three categories, i.e. data gathering and acquisition, literature review and field works. Primary data collection for sewerage infrastructure works will be carried out by means of site investigation. This exercise requires an understanding of sewerage assets and their potential location in relation to a given development. Secondary data ranging from sewerage treatment plant location, capacity, process and plants current performance levels will be secured from various government agencies and especially from Indah Water Consortium. Sewerage infrastructure data obtained from various sources subject to process and checked against collected field information as a result this study will create comprehensive information pertaining to sewerage infrastructure. The collected information on the sewerage infrastructures will be subject to exploration of current levels of quantities and qualitative analysis.

Data gathering involves acquiring, collating, and cleaning up existing information and data from various sources. These information and data will be formatted and arranged to form an integrated database for ease of use and reference in later stages of the study. Gap and discrepancies between these data will be identified and rectified accordingly. Additional data required to bridge gap or solve discrepancy will be obtained via further data collection or fieldworks.

Basic catchment morphology information is required for the study. This information is crucial in identifying and further describes the nature and characteristic of the study area. Information such as District Boundaries, Road Alignments, Satellite Images, and Cadastral Street play a significant role in better understanding of the study area. Base Map Relevant plans have and will be purchased from PEGIS to establish the reference for the base map for the catchment study. Most of the area lies in the mud flat below the highest tide level and has not been demarcated in State Survey record. Platform levels will also be needed for sewer computations. Initial investigation indicated that the houses in the study area have been issued TOL by the state but the lot boundaries have not been digitised into the base map.

Topography data were obtained from several sources. First a group of fundamental sources will be explored, namely topographical maps from Jabatan Ukur dan Pemetaan Malaysia (JUPEM). Geographical Information System (GIS) were used to store and manage all geo- spatial data acquired in this study. It is understood the Client is already operating and managing a GIS database. Hence, structure the new database to complement and integrate with the existing one. Instead of duplicating information, this study will supplement additional information currently incomplete in the existing database especially on sewerage assets.

4.0 RESULTS AND DISCUSSION

The data collected from the water sampling which collected from the site, laboratory results will be analyzed and discussed.

Table 1 Results at Sampling Points 1

PARAMETERS		Storm Water 1	Storm Water 1A	Marine Water 1B	Marine Water 1C	Marine Water 1D
*TEMPERATURE, °C		28	28	28	28	28
pH VALUE		6.5	4.6	7.5	8.1	8.1
B.O.D.(5 DAYS @ 20°C)	/mg/L	410	2790	10	4	2
C.O.D	/mg/L	778	5824	438	398	478
AMMONICAL NITROGEN,	/mg/L	24.7	45.3	N.D(<0.3)	4.4	N.D(<0.3)
NITRATE NITROGEN,mg/l	/mg/L	0.6	5.2	1.0	1.1	0.6
SUSPENDED SOLIDS,mg/l	/mg/L	376	2734	159	216	166
OIL & GREASE, mg/l	/mg/L	16	214	2	1	1
PHOSPHORUS, mg/l	/mg/L	17.4	40.8	2.9	0.2	1.3
E.COLI COUNT	/100ml	$2.1x10^{6}$	$4.3x10^{5}$	$1.5x10^{3}$	40.0	90.0
DISSOLVED OXYGEN	mg/L	N.D(<0.01)	0.04	4.15	6.70	6.30

Table 2 Results at Sampling Points 2

PARAMETERS		Storm Water 2	Storm Water 2A	Marine Water 2B	Marine Water 2C	Marine Water 2D
*TEMPERATURE, °C		28	28	28	28	28
pH VALUE		7.0	6.6	7.6	7.8	8.1
B.O.D.(5 DAYS @ 20°C)	/mg/L	831	474	29	1	4
C.O.D	/mg/L	3013	1546	577	458	438
AMMONICAL NITROGEN,	/mg/L	254.2	49.5	N.D(<0.3)	2.7	N.D(<0.3)
NITRATE NITROGEN,mg/l	/mg/L	0.8	1.0	1.3	1.1	0.7
SUSPENDED SOLIDS,mg/l	/mg/L	1926	1134	804	161	120
OIL & GREASE, mg/l	/mg/L	242	422	2	2	2
PHOSPHORUS, mg/l	/mg/L	40.2	11.6	1.2	0.7	0.2
E.COLI COUNT	/100ml	2.3x10^5	9.0x10^4	4.0x10^2	N.D(<30.0)	40.0
DISSOLVED OXYGEN	mg/L	N.D(<0.01)	N.D(<0.01)	4.98	5.68	6.77

Table 3 Results at Sampling Points 3

PARAMETERS		Storm Water 3	Storm Water 3A	Marine Water 3B	Marine Water 3C	Marine Water 3D
*TEMPERATURE, °C		28	28	28	28	28
pH VALUE		6.8	6.8	7.2	7.8	8.0
B.O.D.(5 DAYS @ 20°C)	/mg/L	72	76	17	4	2
C.O.D	/mg/L	249	105	338	557	478
AMMONICAL NITROGEN,	/mg/L	18.3	28.6	N.D(<0.3)	N.D(<0.3)	N.D(<0.3)
NITRATE NITROGEN,mg/l	/mg/L	0.4	1.4	0.5	0.8	1.0
SUSPENDED SOLIDS,mg/l	/mg/L	30	32	493	153	40
OIL & GREASE, mg/l	/mg/L	10	4	1	2	2
PHOSPHORUS, mg/l	/mg/L	2.7	2.7	N.D(<0.2)	0.2	0.2
E.COLI COUNT	/100ml	4.3x10^5	9.3x10^5	3.9x10^3	90.0	40.0
DISSOLVED OXYGEN	mg/L	N.D(<0.01)	0.05	N.D(<0.01)	5.19	6.23

Table 4 Results at Sampling Points 4

PARAMETERS		Storm Water 4	Storm Water 4A	Marine Water 4B	Marine Water 4C	Marine Water 4D
*TEMPERATURE, °C		28	28	28	28	28
pH VALUE		6.8	6.3	7.8	8.1	8.2
B.O.D.(5 DAYS @ 20°C)	/mg/L	58	540	5	2	2
C.O.D	/mg/L	103	1497	438	418	358
AMMONICAL NITROGEN,	/mg/L	25.8	29.1	4.4	N.D(<0.3)	N.D(<0.3)
NITRATE NITROGEN,mg/l	/mg/L	0.3	1.0	1.4	0.9	1.0
SUSPENDED SOLIDS,mg/l	/mg/L	24	1272	208	52	56
OIL & GREASE, mg/l	/mg/L	8	524	44	N.D(<1)	1
PHOSPHORUS, mg/l	/mg/L	1.4	27.7	0.2	0.2	0.2
E.COLI COUNT	/100ml	1.5x10^6	9.3x10^5	90.0	40.0	40.0
DISSOLVED OXYGEN	mg/L	0.01	N.D(<0.01)	4.80	6.27	6.94

Table 5 National Water Quality Standards for Malaysia (NWQSM)

Parameter	I	II	III	IV	V
BOD	<1	1-3	3-6	6-12	>12
COD	<10	10-25	25-50	50-100	>100
NH3N	<0.1	0.1-0.3	0.3-0.9	0.9-2.7	>2.7
DO	<7	5-7	3-5	1-3	<1
pH	>7	6-7	5-6	<5	>5
SS	<25	25-50	50-150	150-300	>300
WQI	>92.7	76.5-92.7	51.9-76.5	31.0-51.9	<31.0

Table 1 shows the results obtained at sampling points 1, Table 2 at at sampling points 1, Table 3 at sampling points 3 and Table 4 at sampling points 4. It can be clearly seen from these 4 tables the variation of results obtained at different points. On the other hand, Table 5 shows the National Water Quality Standards for Malaysia (NWQSM). Figure 1 summarized the results of measured BOD, COD, oil and grease, suspended solids and nitrate nitrogen

In order to assess the existing water quality, baseline water monitoring will be carried out and the results will be compared with the Environmental Quality Act 1974 (EQA), National Water Quality Standards for Malaysia (NWQSM) and the water quality status will be rated from Malaysia Water Quality Index (WQI).

The Environmental Quality Act of 1974 and other environmental laws are administered by the Division of Environment of the Ministry of Science, Technology, and Environment. Discharge of untreated sewage has contaminated the nation's water; the most heavily polluted areas are along the west coast. Malaysia's water pollution problem also extends to its rivers, of which 40% are polluted. The nation has 580 cubic km of water with 76% used for farming and 13% used for industrial activity. Malaysia's cities produce an average of 1.5 million tons of solid waste per year.

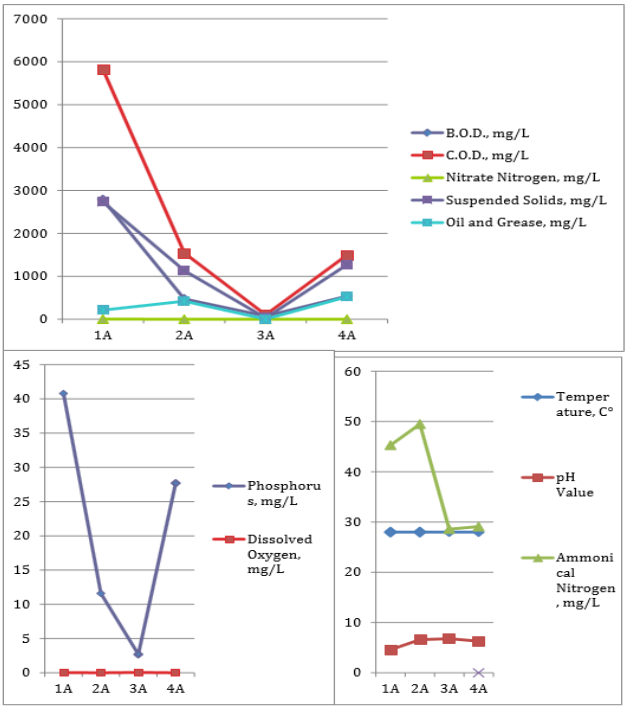


Figure 1 Measured BOD, COD, oil & grease, suspended solids and nitrate nitrogen

5.0 CONCLUSION

It can be concluded that most polluted area is the stretch, which the main drains are leading into Clan Jetties shores. These are the drains along Lebuh Chulia, Gat Lebuh Armenian, and Gat Lebuh Melayu. The organic loads, measured in terms of BOD, COD, Oil & Grease and Suspended Solids are highest along this strip followed by the shoreline strip. The high E Coli concentrations along these 2 strips confirmed that there is faecal contamination most probably from the partially treated sewage emanated from the septic tanks from premises adjacent to the Clan Jetties shore. This pollution is made worse by the sewage direct disposal into the sea by the Clan jetties community due to the non-existence of any sewerage system whatsoever.

The implementation of sewerage system must be provided as soon as possible and may be implemented in phases based on the budget and by doing in phases, the workability of the new system can be improved and upgraded in the subsequent phases. Since the houses are built on the ocean floor, one suitable system to tap the sewage flow from the houses is the vacuum sewer system.

A vacuum sewer system uses the differential pressure between atmospheric pressure and a partial vacuum maintained in the piping network and vacuum station collection vessel. This differential pressure allows a central vacuum station to collect the wastewater of several thousand individual homes, depending on terrain and the local situation. Vacuum sewers take advantage of available natural slope in the terrain and are most economical in flat sandy soils with high ground water.

Vacuum technology is based on differential air pressure. Rotary vane vacuum pumps generate an operation pressure of -0.4 to -0.6 bar at the vacuum station, which is also the only element of the vacuum sewerage system that must be supplied with electricity. Interface valves that are installed inside the collection chambers work pneumatically. Any sewage flows by means of gravity into each house's collection sump. After a certain fill level inside this sump is reached, the interface valve will open. The impulse to open the valve is usually transferred by a pneumatically (pneumatic pressure created by fill level) controlled controller unit. No electricity is needed to open or close the valve. The according energy is provided by the vacuum itself. While the valve is open, the resulting differential pressure between atmosphere and vacuum becomes the driving force and transports the wastewater towards the vacuum station. Besides these collection chambers, no other manholes, neither for changes in direction, nor for inspection or connection of branch lines, are necessary. High flow velocities keep the system free of any blockages or sedimentation.

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