Drainage Improvement Work For High Density Development: Case Study of Kampung Tersusun, Juru

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ABSTRACT: Rapid development in the Study Area, Kampung Tersusun into 90% well developed residential area and lack of drainage improvement works has increased frequency of flash flood in most part of the Study area wherever it rains heavily for duration more than two hours. The incident of flash flood has caused extensive damage to property and interruption to everyday activities in the Study area. This phenomenan are considerable concerned to the local government, Majlis Perbandaran Seberang Perai (MPSP), which has appointed River Engineering and Urban Drainage Research Centre (REDAC), Universiti Sains Malaysia to carry out a feasibility study on flood mitigation and drainage improvement in the Study area. The proposed flood mitigation and drainage improvement measures have been formulated which include the upgrading of inter allotment drain, construction of trunk drains and monsoon drains, construction of pumping stations which is intergated with gross pollutant trap and sediment basin as well as installation of backflow prevention gates.

Key words: Flooding; flood mitigation; drainage improvement; storage facility; pumping.

1 INTRODUCTION

The Study area Kampung Tersusun, Juru covers an area of 2.9 ha, which is situated in Mukim 13, Seberang Perai Tengah as depicted in Figure 1. The Study area is subjected to the effect of tidal influence and is liable to occurrence of the flooding or inundation when the high intensity storms occur and coincide with the high spring tide. This situation becomes worse with the existing low platform level of the Study area.

Frequent flooding in the Study area has been a long-standing issue, which is of considerable concern to the local government, Majlis Perbandaran Seberang Perai (MPSP). Consequently, River Engineering and Urban Drainage Research Centre (REDAC), Universiti Sains Malaysia has been appointed by MPSP to carry out a feasibility study on flood mitigation and drainage improvement in Kampung Tersusun, Juru.

2 BACKGROUND OF STUDY AREA

2.1 Study area

Generally, the Study area can be concluded as a residential area with 90% is well developed into housing lots and surrounded by several housing estates.

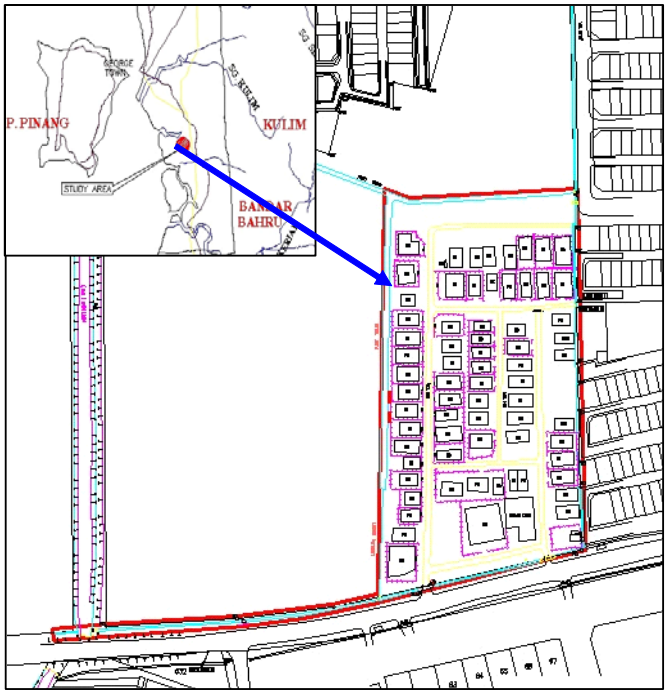

Figure 1. Location of the Study area, Kampung Tersusun. (MPSP, 2004).

The Study area is located adjacent to Parit No.5. Consequently, it is the main waterway that caters

and conveys runoff from the Study area to the neighboring river, Sungai Juru. However, these customary sequent of runoff conveyance will be blocked during high tide season of Sungai Juru, which has caused the occurrence of flooding or inundation. This phenomenon will become worse during occurrence of high intensity storms in the Study area.

The existing drainage facilities in the Study area consist of open drains either lined or unlined, trunk drains, inter allotment drains and peripheral drains. As a result of undersized local internal drains, low platform level in the Study area, the rapid development of its surrounding areas and lack of improvement for the existing drainage system, flash floods occur in most parts of the Study area whenever it rains heavily for duration more than two hours.

2.2 Meteorology and Hydrology

The climatic characteristic of the Study area is tropical with generally high humidity with uniformly high temperature and rainfall throughout the year. The temperature is about 27.5 ^{o}C. The average maximum temperature is 32.2 °C and the average minimum 23.3°C.

The mean annual rainfall is approximately 267 cm, which is evenly distributed throughout the year. There are two wet periods during the year, which occur between April to May and September to November, when the Intertropical Convergence Zone passes over the area. Dry period occurs from December to March, whilst a transitional period of moderate rains occurs from June to August. The distributions of the monthly and mean annual rainfall for the Study area which is adopted from the nearest rainfall station in the Study area is situated in Permatang Rawa are given in Figure 2.

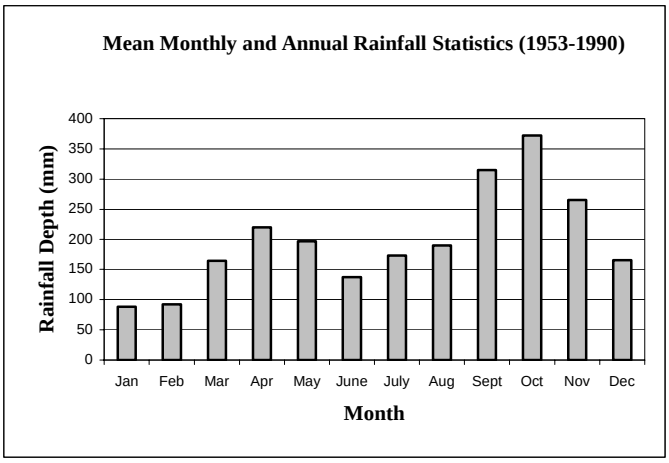

Figure 2. Average mean monthly and annual rainfall statistics for Permatang Rawa Station (1953 – 1990). (Source: Hydrological Data, Rainfall Records 1986-1990, DID 1991)

3 FLOOD CONDITION

Flooding in Kampung Tersusun has caused inconvenience to local community instead of damage to property. A site observation has been done on 6th of October 2003. During the site observation, the whole Study area was flooded with an average depth of three to four inches Figure 3. This recent flood was caused by a continuous and high intensity rainfall event, which occurred from 2nd to 6th of October. The total rainfall depth of 356 mm was recorded in Sungai Juru Rainfall Station for the storm duration from 2nd to 5th of October. It is categorized as a 50 to 100-year ARI (Average Recurrence Interval) storm event.

Figure 3. Flood condition in the Study area. (MPSP, 2004)

During the site observation, some inadequacy and ineffectiveness of existing drainage system have been identified. Figure 4 shows the main access road in Kampung Tersusun, Juru was submerged by floodwater. All the existing drains do not have adequate capacity to convey that amount of stormwater. Furthermore, there have no proper roadside drains to serve the stormwater from premises and road. Some residents' premises in the Study area were relieved from flood by constructing flood-proofing structures as given in Figure 5.

4 EXISTING DRAINAGE SYSTEM

The conveyance system of the Study area consists of open drains either lined or unlined, which are peripheral drains, inter allotment drains and trunk drains. The peripheral drains in the Study area are located between the housing lots, which play the main role to discharge sullage wastewater from the lots. Each of the peripheral drain is connected to the inter allotment drains that cater the stormwater from catchment area and convey the sullage wastewater discharge. Then, the discharge is served by trunk

drains, which are located at the site boundary, surrounding the Study area. There are two discharge outlet points from the Study area to the receiving waterbody, Parit No. 5, which are the natural waterway at the North and trunk drain along Jalan Juru at the South convey the discharge to Parit No. 5 and flow into Sungai Juru.

Figure 4. Main access road in the Study area was flooded. (MPSP, 2004)

Figure 5. Flood proofing at house entrance. (MPSP, 2004)

Few site visits, interviews with local communities, internal drainage inventories and drain capacity computation have been carried out in order to evaluate the existing drainage system. Through these assessments, the problems that contribute to the flooding in the Study area have been identified and can be summarized as follows:-

(i) Inter allotment drains in the Study area have insufficient capacity to convey higher stormwater discharge since the drainage system was constructed decade ago. In the other word, the inter allotment drains are undersized.

(ii) The design of existing drainage system is improper, where the roadside drains are not provided (Figure 6).

(iii) Trunk drains and natural waterways in the Study area have poor flow capacity due to tidal and low-lying topographical condition.

(iv) Drainage system is not regularly maintained (Figure 7).

(v) Indiscriminate littering and dumping are easily seen. Consequently, drains are clogged by rubbish and debris (Figure 8).

(vi) Sedimentation and siltation problem occurred in the trunk drains (Figure 9).

(vii) There is neither on-site retention/detention storage nor hydraulic structures such as pump house, provided in the Study area, which can reduce the flood conditions.

Figure 6. Flooding occurs after a few minutes raining due to roadside drains are not provided. (MPSP, 2004)

Figure 7. Lack of Maintenance. (MPSP, 2004)

Figure 8. Indiscriminate Littering and Dumping in Trunk Drains. (MPSP, 2004)

Figure 9 Sedimentation in Trunk Drain. (MPSP, 2004)

5 FLOOD MITIGATION PLAN

For alleviating flood woes in the Study are, a proper flood mitigation plan have been proposed based on the Study and site observations conducted. The planning and detail design are compliance to "Urban Stormwater Management Manual for Malaysia" or MSMA (JPS, 2000).

Three main stages of flood mitigation measures have been proposed in tackling the flood problems, which are upgrading of the inter allotment drainage system, construction of monsoon drains and installation of pumping station. Besides these measures, others hydraulic components such as culverts, gross pollutant trap and flood control gate are also proposed in the Study area as illustrated in Figure 10.

Locations of existing inter allotment drains in the Study area will be retained. However, the alignment of the existing internal drains will be realigned and the capacity will be upgraded with new cast concrete drains due to insufficiency of the existing drains to cater and convey discharge for both minor and major storm events. Figure 11 shows typical cross section of proposed inter allotment drains.

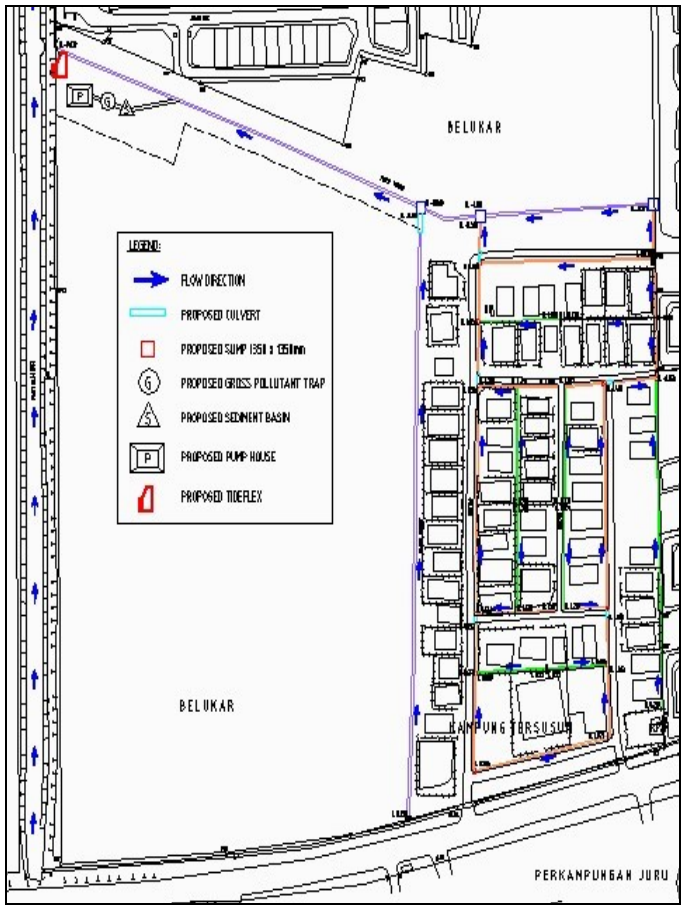

Figure 10. Proposed flood mitigation plan. (MPSP, 2004)

Besides realignment and upgrading of the existing inter allotment drains, trunk drains are proposed in the Study, which consists of concrete lined drain (Figure 12). The trunk drains act as the main drains to cater runoff from road and convey discharge from the inter allotment drains. Trunk drains also function to link and connect all the inter allotment drains in the Study area to the proposed monsoon drain along the Jalan Juru.

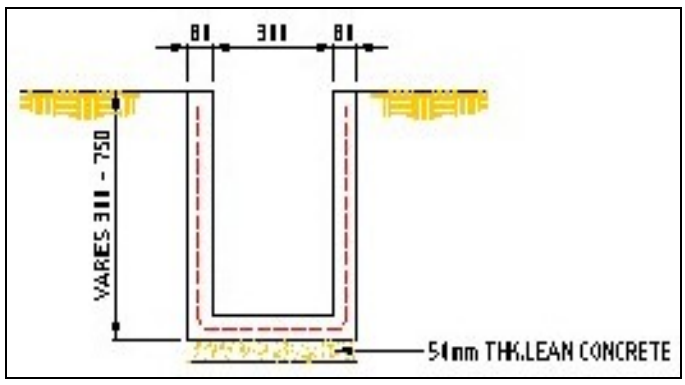

Figure 11. Cross section of proposed inter allotment drains. (MPSP, 2004)

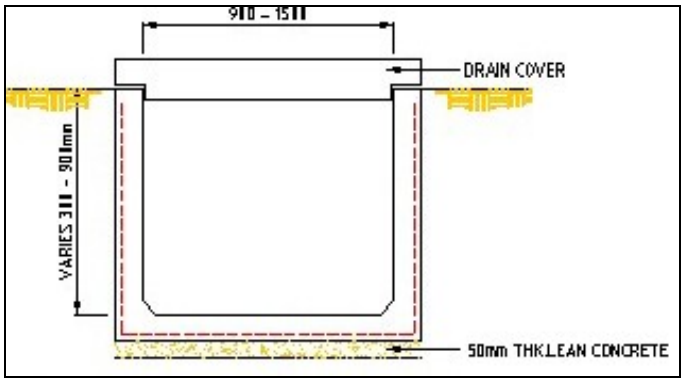

Figure 12. Cross section of proposed trunk drains. (MPSP, 2004)

Monsoon drains are designed to function as storage facilities to attenuate the flood peak. With the provision of the monsoon drains, the Study area will have adequate storage to detain stormwater and release then gradually without causing any substantial flood events in both Study area and the downstream catchments. It is highly recommended that the monsoon drains should be located at downstream end of the drainage system before entering the pump station. Therefore, the existing trunk drains and natural waterways, which are located at the downstream of the drainage system, will be upgraded to monsoon drains. The proposed monsoon drains are precast reinforced U shape drain as shows Figure 13.

The runoff is then conveyed to Parit No.5 and controlled by a pump station. Neither on-site detention nor retention storages are not feasible in the Study area due to lack of available open space. The proposed pump station is incorporated with gross pollutant and sediment basin to screen inflow of submersible pump. Tideflex® Check Valve (Figure 14) is recommended to be installed at the outlet discharge point from the pump station to ensure that there is no occurrence of backflow in the drainage system due to tidal effect.

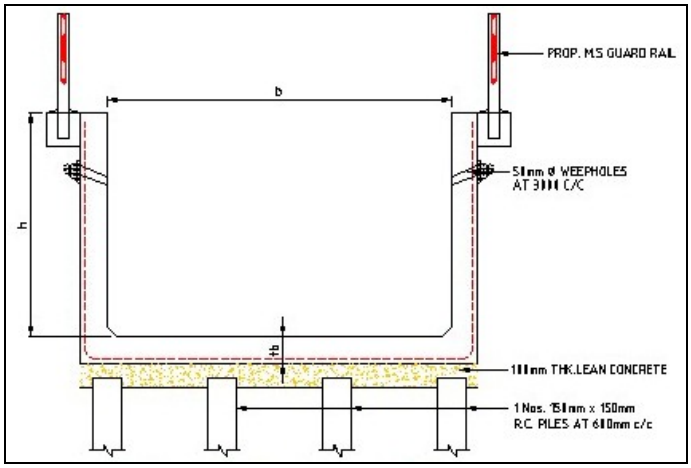

Figure 13. Cross section of proposed monsoon drains. (MPSP, 2004)

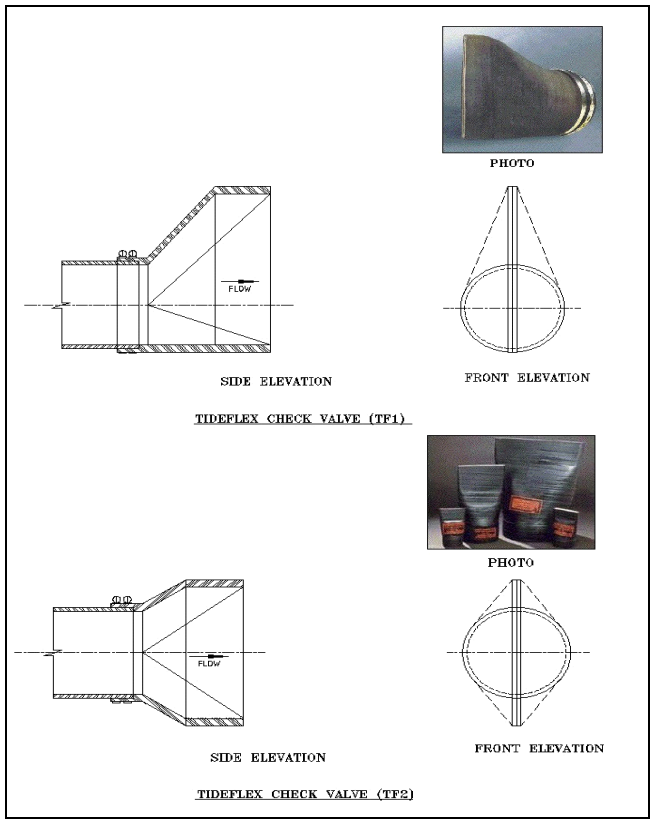

Figure 14 Tideflex® check valve. (MPSP, 2004)

Besides, it is essential to conduct a proper design and planning on the undeveloped catchment surrounding the Study area so that the discharge from the catchment can be controlled 'at source'. For examples, construction of suitable Best Management Practices (BMPs) components such as on site detention (OSD) storage component to control discharge from the catchment. As a result, it will minimize the impacts of urbanization from the new developed area to the existing developed area in the Study area. The design method of the OSD should be as recommended in Chapter 19, Volume 7, MSMA, 2000, which the flow discharge from the catchment area should be control with Permissible Site Discharge (PSD) and Site Storage Requirement (SSR). Fig.15 shows a few examples of OSD storage facilities that are highly recommended to be applied in the undeveloped catchment for further development.

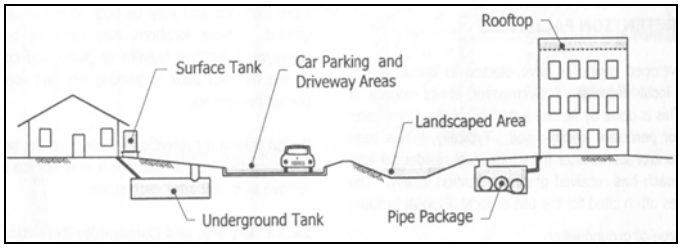

Figure 15. Typical OSD Storage Facilities. (JPS, 2000)

6 CONCLUSIONS

For alleviating flash flood woes in the Study area, pumping solution intercoprate with monsoon drains as storage component are the most acceptable and favourable solution here due to the lack of provision of open space and low lying platform. Even though the conventional storm drainage approach which adopt the rapid disposal, localised, reactive and mono-functional drainage concepts solution has encounted some shortcomings, the drainage upgrading and pumping has relief the stress of flooding in the study area. However construction of OSD should be the primary selection for others undeveloped area, which area located surounding the Study area as a long term flood mitigation solution.

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Tideflex® Check Valve (web page) http://www.redvalve.com/tideflex.html (accessed 5/11/2003 8.30 a.m.)