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RESILIENT VILLAGE: FLOOD MITIGATION LANDSCAPE AT PERKAMPUNGAN SUNGAI ISAP, KUANTAN, PAHANG

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ABSTRACT

This project aims to create a resilient village where the residential area of Perkampungan Sungai Isap is a significant flood vulnerable area. The concept of a resilient village aims to enhance the performance of a system to maintain or recover functionality in the event of disruption or disturbance. Therefore, this project is proposed to create a green and sustainable design as strategies for adaptive flood landscape. The project, located in the East Coast State of Pahang in Kuantan, is among the high-risk areas for floods near the Kuantan River Basin. The developed area is about 610 hectares, while the abandoned area is about 90 hectares. Perkampungan Sungai Isap is a mixed development area located in a suburban area that consists of residential, commercial facilities and utilities.

Keywords: Flood mitigation, water catchment, recreational park, resilient
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- Major flood vulnerable area as it is located near Kuantan River Basin.
- Develop area about 610 hectares.
- Abandoned area about 90 hectares.

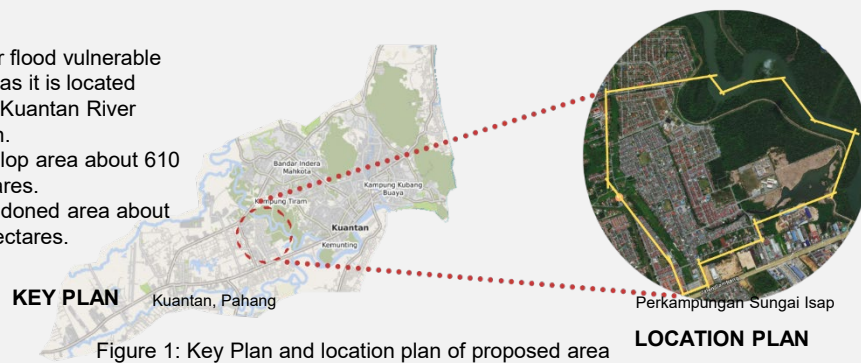


Figure 1: Key Plan and location plan of proposed area

INTRODUCTION

This project aims to create a green and sustainable design for adaptive flood landscape strategies to develop a resilient village. In addition, the project aims to cater the environmental issues such as flood-inducing rain during monsoon season, overflow from the river, excessive anthropogenic activities, and solid and waste pollution that leads to drainage problems.

Apart from that, the objective of a resilient village is to create a residential area that can function so that the people living and working in the area can survive no matter what stresses or shocks they encounter. Therefore, instead of just preventing and mitigating the loss of assets, the main goal of resilience is to enhance the performance of a system. Due to that, it can provide a safer environment for the community and wildlife and create a more prepared community. Thus, these objectives would help to achieve the aim:

- To improve water management through a Sustainable Urban Drainage System (SUDS).
- To adopt a nature-based solution for flood risk reduction.
- To develop sustainable waste management to promote the best practice of waste in the community.

LITERATURE REVIEW

Qualities of Resilient System

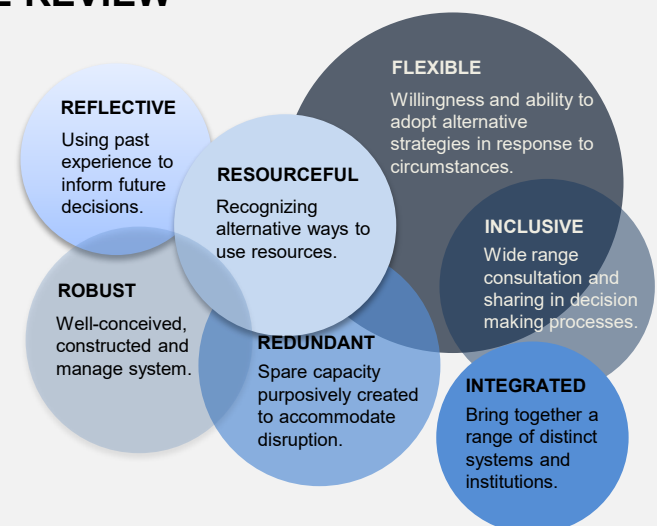


Figure 2: Qualities of Resilient System (Source: City Resilient Framework, The Rockefeller Foundation)

Sustainable Flood Management

1. Constructed Wetland

Constructed wetland is an artificial wetland to treat municipal or industrial wastewater or stormwater runoff. A constructed wetland can provide water quality improvement, flood storage and desynchronization of storm rainfall and surface runoff, cycling of nutrients and other materials, habitat for fish and wildlife, education and research, and aesthetic and landscape enhancement. Constructed wetland consists of two types which are surface flow and subsurface flow.

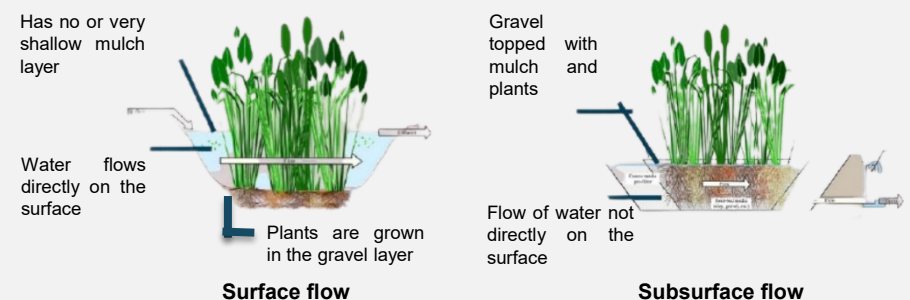


Figure 3: Cross section of constructed wetland

2. Water Collection

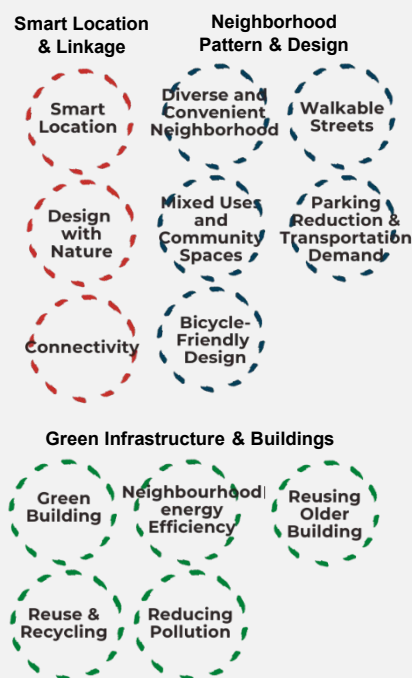
Water collection, also known as water harvesting, collects and stores rainwater from roofs, paved surfaces, and the landscape. The system of rainwater harvesting is to collect and store rainwater for reuse. They also slow down and reduce water runoff and provide a source of water. The collected water later can be reused for toilets, watering plants, and others. This approach is particularly valuable in areas that have a limited supply of water.



Figure 4: Rainwater harvesting adapted to the building and its surrounding.

Sustainable Neighbourhood Development

The LEED for Neighbourhood Development (LEED-ND) rating system, the dominant sustainable neighbourhood rating system in the US, is examined for its resilience potential concerning a wide range of future shocks and stresses (Mariko, 2016). LEED-ND suggests sustainable actions for resilience potential against future shocks. The sustainable action includes “Smart Location and Linkage”, which this category determines ‘where to build’. The second sustainable action is to determine ‘what to build,’ listed under the category “Neighbourhood Pattern and Design”. The last category is “Green Infrastructure and Buildings” as strategies on how to manage environmental impacts. These three sustainable actions are approaches to create a resilient neighbourhood.



METHODS

Checklist and Observation

The method of data collection is by preparing a checklist and conducting the observation. The site inventory and observation checklist are done by mapping the existing site condition and taking pictures of the site condition.

Site Inventory and Analysis

1. Site Context

There are four main residential areas consist of low-cost housing to medium-cost housing residences. The area has good accessibility with multiple entrances and the provision of public buses.

The Green areas have the potential to cater for flood issues with a great management system. However, low maintenance activities and excessive human activities lead to environmental problems.

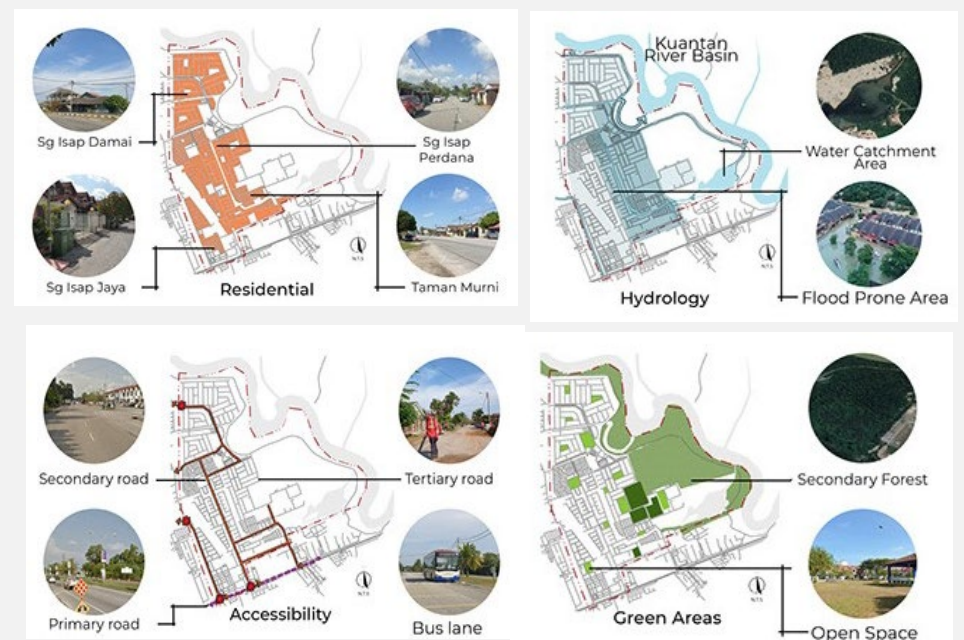


Figure 5: Analysis map site context (con't)

2. Circulation

The site location has four entrances that are the primary access for transportation. The main entrance located at Perkampungan Sungai Isap is the main access to public buses that connect all residential and commercial areas.

Potential to be a public square with various activities as it is connected to public buses routes.

The shortcut route disturbs the residential environment and leads to low access control.

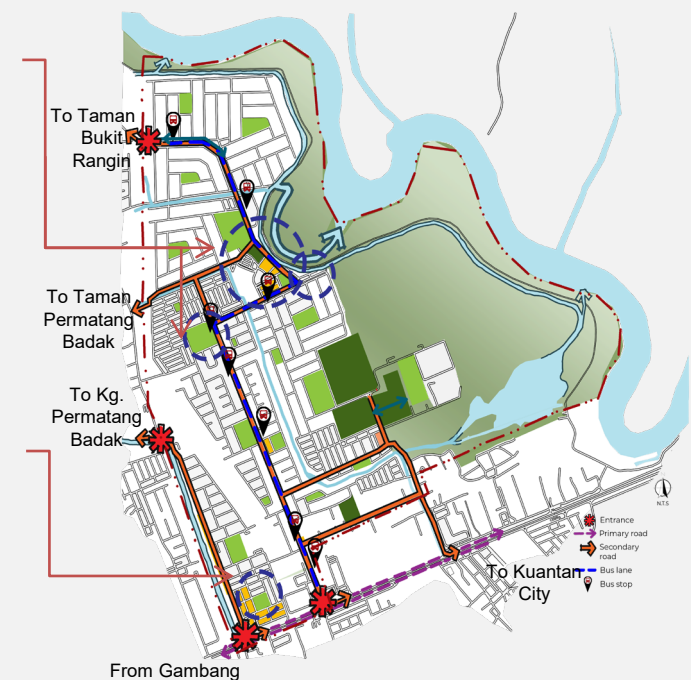


Figure 6: Analysis map for circulation

3. Solid and Void

Figure 6 shows the analysis maps on the solid and void. The solid map indicates the existing buildings that serve various functions such as residential, commercial, educational and community infrastructure. The void map shows the green areas and open spaces that have the potential for development.

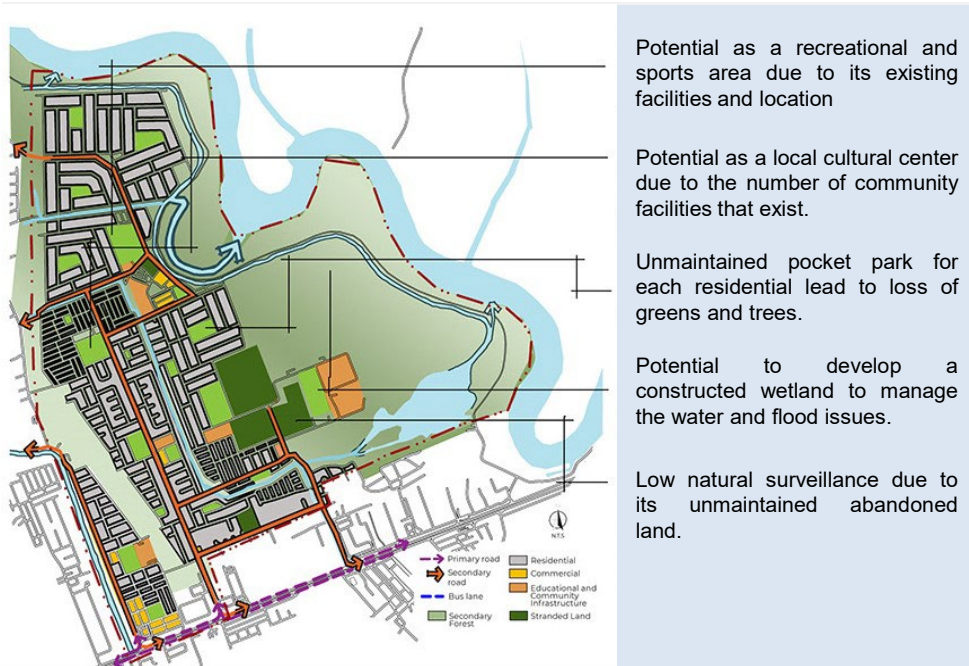


Figure 7: Analysis map for solid and void

5. Flood Prone Area

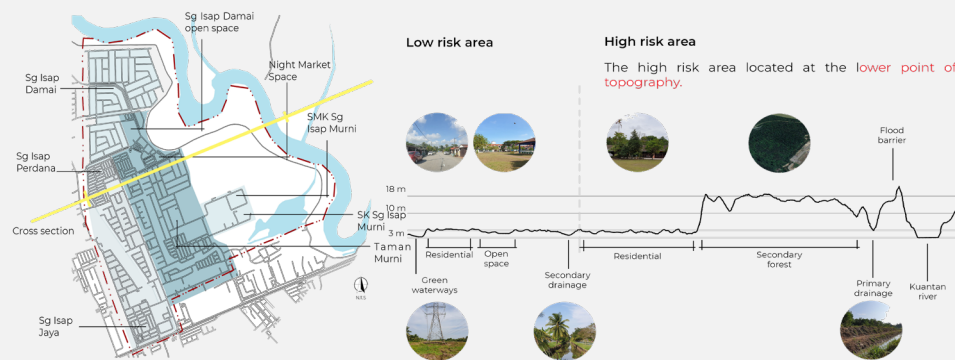


Figure 8: Analysis map for flood prone area

The presence of open space, natural drainage, and green waterways has the potential to slow down the excess water and acts as a water collection area through ecological and sustainable approaches

7. Hydrology

Figure 9 shows the existing drainage system and the affected activities towards the drainage.

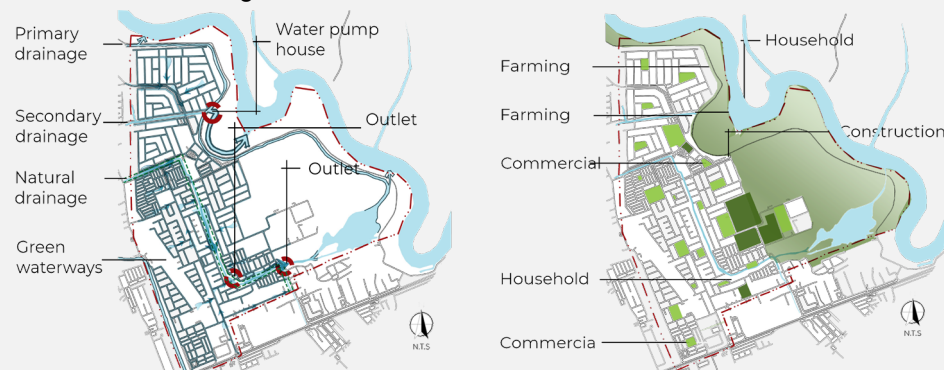


Figure 9: Inventory map for drainage system and activities

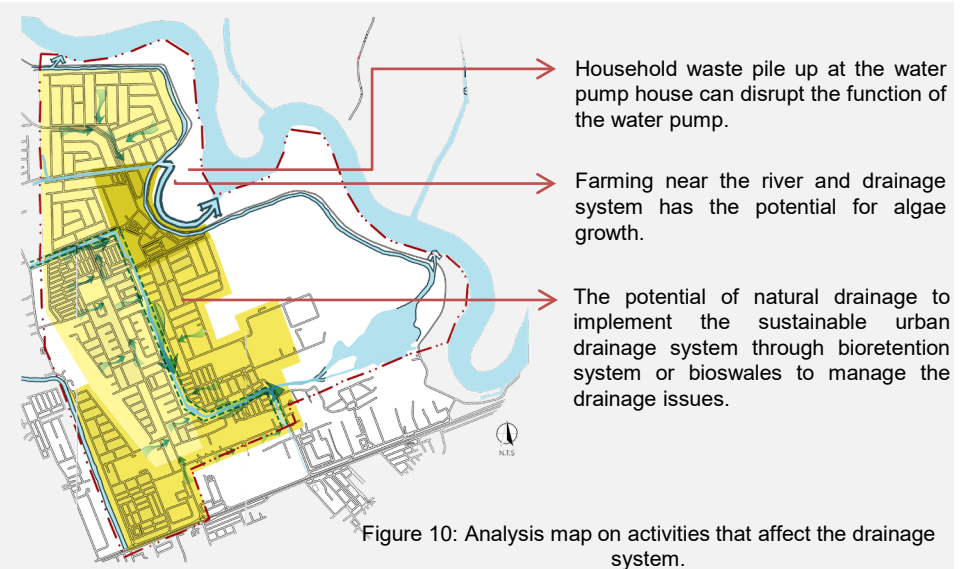


Figure 10: Analysis map on activities that affect the drainage system.

SITE SYNTHESIS

Figure 11 is the synthesis map to show a brief on the design strategies proposed at the site selection. The synthesis is the results of the analysis on the potential and constraints on the site. The synthesis is categorised into three main ideas: the sustainable urban drainage System, sustainable neighbourhood, and sustainable waste management.

1. SUSTAINABLE NEIGHBORHOOD

- 1 Reshaping open green spaces
- 2 Enhancing street landscaping
- 3 Enhancing neighborhood security and visibility
- 4 Develop good connectivity and linkage to a variety of land uses

2. SUSTAINABLE URBAN DRAINAGE SYSTEM

- 1 Potential to develop a bioretention system
- 2 To develop a constructed wetland to create a flood adaptive landscape
- 3 Implement rainwater harvesting from roofs to be reuse for household

3. SUSTAINABLE WASTE MANAGEMENT

- 1 Potential to create a composting center at community farming area
- 2 To develop a waste collection center to promote 4R practice

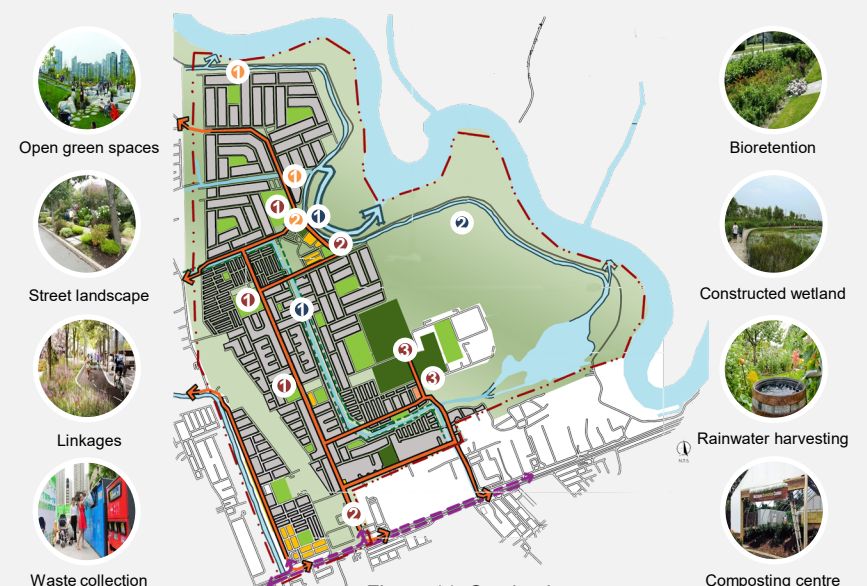


Figure 11: Synthesis map

DESIGN DEVELOPMENT

DESIGN CONCEPT

The design concept for this project is Eco-Sponge Village. This design concept refers to the absorption of valuable information related to the function of the village through ecological and sustainable approaches as a system to strengthen resilience. The design concept can be achieved by implementing sustainable flood management, creating a zero-waste village, and creating a vibrant, sustainable, and efficiently connected neighbourhood.

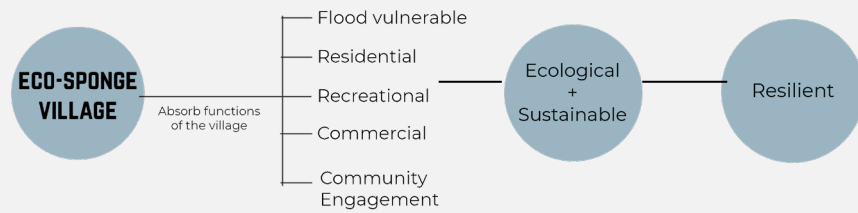


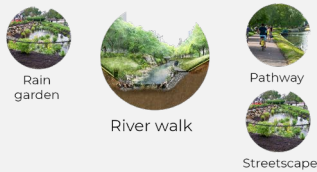
Figure 12: Related Eco-Sponge Village concept

DESIGN STRATEGIES AND IDEAS

SUSTAINABLE FLOOD MANAGEMENT

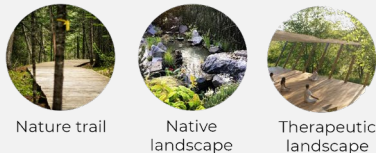
Bio-retention system

A landscape basin used to slow and treat on-site stormwater runoff.



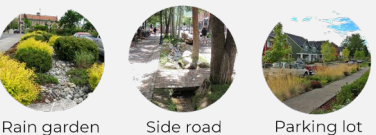
Nature Park

Act as a buffer and catchment basin and for recreational and therapeutic buffer.



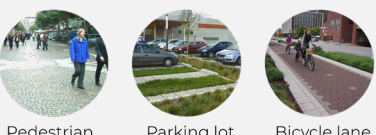
Bio-swales

Storm water runoff conveyance systems that provide an alternative to storm sewers. They can absorb low flows.



Permeable surfaces

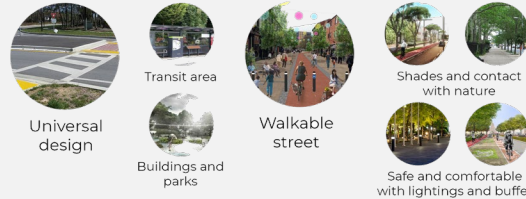
Allow water to percolate into the soil to filter out pollutants and recharge the water table.



SUSTAINABLE NEIGHBOURHOOD

Neighbourhood pattern and design

Encourages strategies like walkable streets, high quality public spaces, community participation and reduced dependence on automobiles.



Community spaces



Multipurpose park

Smart location and linkage

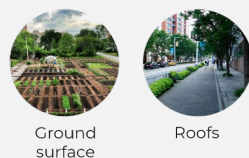
Selecting good location for development and facilitating connections to the surrounding



GREEN INFRASTRUCTURE

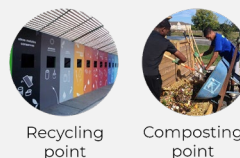
Rainwater harvesting

A collection and efficient storage of rainwater from different basement areas.



Sustainable waste management

To reduce the amount of natural resources consumed.



SPACE PROGRAMMING

Figure 13 is the design development derived from design strategies and ideas. The design ideas aim to cater the flood management issues to achieve the concept of resilience. The design spaces and activities are developed according to the site characteristics, potential, and constraints representing Eco-Sponge Village through ecological and sustainable approaches.

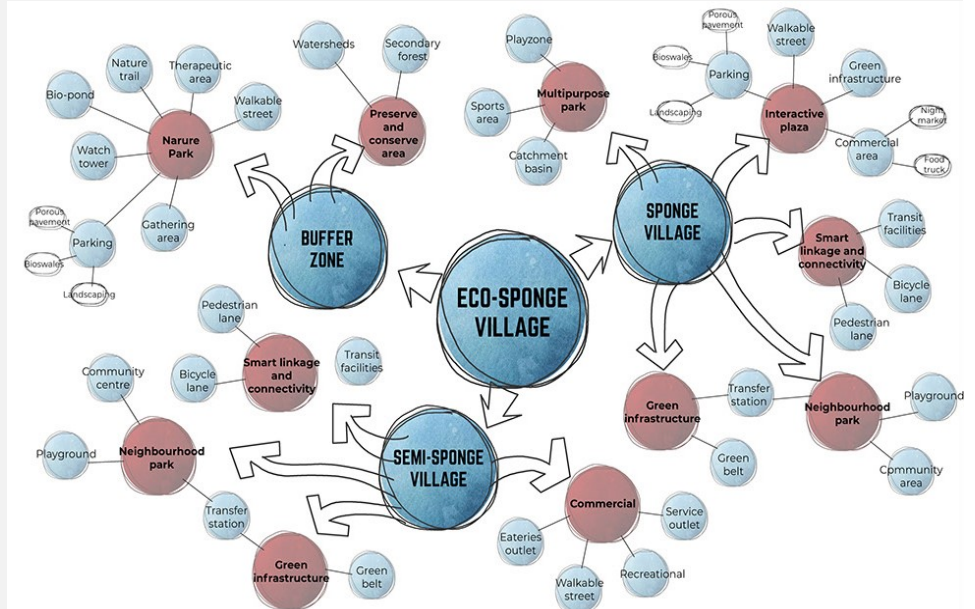


Figure 13: Space programming

SITE RELATED FUNCTIONAL DIAGRAMS

The functional diagram is divided into three categories which are zoning, circulation, and green corridor.

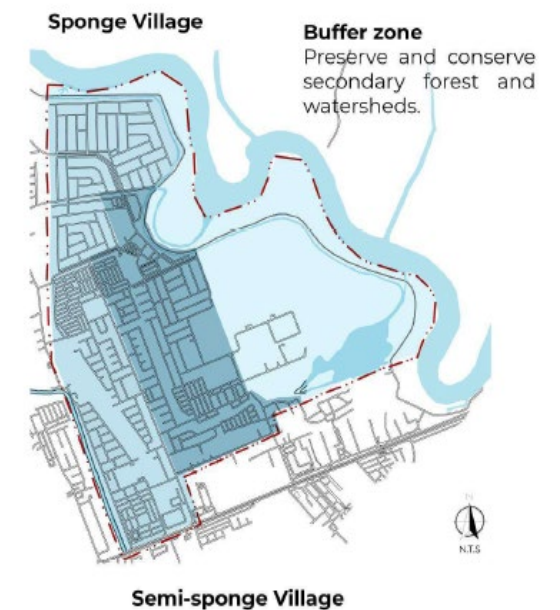
The zoning shows the major proposed spaces which are developed according to the site character towards the flood issues.

The circulation shows the proposed access to enhance linkages and easy access.

The green corridor is to enhance the functionality and aesthetical value through greenery and landscape.

ZONING

The zoning are decided based on the risk of the area to flood.



CIRCULATION

Secondary entrance
Retain the entrance as they connect directly towards Semi-sponge village.

Smart linkage
Bicycle lane and transit lane connect with the design area and greenbelt attract users to stop by the area.



Main entrance
Located at central spine of the village that connect with primary road as well as both sponge village and semi-sponge village..

Proposed bus transit
Create easy access towards proposed Nature Park and educational area.

GREEN CORRIDOR

Green waterways
Electrical line act as green waterways that collect surface water.



Natural corridor
Natural corridor is a preserved area that act as buffer between Kuantan River Basin and develop area.

Street planting
Enhancement of street planting promotes walkable street, improve scenic beauty and identity and provide direction.

Riparian corridor
Riparian corridor as storm water management, slow down, filter and purify the water before discharge to the main river.

CONCEPTUAL PLAN

Figure 15 below is the conceptual plan, resulting from the merging layers of the functional diagram. The plan indicates the details of the spaces and sub-spaces as well as the activities related to the site. The concept of Eco-Sponge Village is reflected in the proposed spaces and activities.

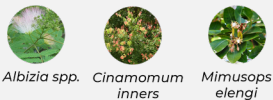


Figure 15: Conceptual diagram

PLANTING CONCEPT

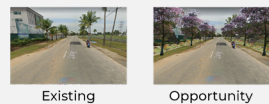
FLOWERING AND FRAGRANCE PLANTS

-to proposed plant species that can absorb stormwater and easy to maintained.
- provide shades and reduce temperature



FORMAL PLANTING AND LUSH CROWN

- tree canopy reduces, soak up and slow stormwater by intercepting precipitation in their leaves and branches.
- provide cooling shade that enhance the pedestrian experience.



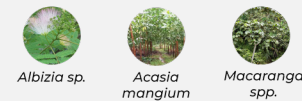
RIPARIAN SPECIES

- A vegetated, mulched, or xeriscape channels
- slow down, infiltrate, and filter the stormwater
- well suited to be created along linear streets and parking lots which can enhance the visual aesthetic.



NATIVE SPECIES

-introduce and expose native species at nature park to visitors.
- act as buffer



RAIN GARDEN

- rain garden proposed at bio-retention system
- act as riparian buffer
- vegetated basin functions to collect, absorb and filter water runoff from rooftops, pavement and streets.

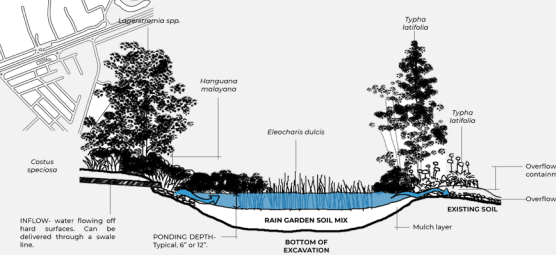


Figure 16 shows the proposed planting concept at Eco-Sponge Village for visual enhancement and functionality toward community and environment.

The proposed planting concept reflected the Eco-Sponge concept to improve flood management as well as to serve the community.

Proposed new plants as well as remained the native and significant species to sustain the identity of the place.

Figure 16: Planting concept



Green Parking



The green parking with porous pavement and bioswale with rain garden collect, absorb and purify the stormwater runoff and reduce stagnant water on the surface.

Catchment Basin



Multipurpose park serves function such as a catchment basin to collect water during the flood. Variety plant species like Ficus tree, Tabebuia spp. and Delonix regia help absorb the water as well as create green and vibrant environment.

Stream Walk



A bio-retention system as leisure area with a walkway next to the river known as a stream walk. A lush greenery provide shades with riparian species act as filter to purify the stormwater runoff.

Multipurpose Park



Multipurpose park provides various activities include kids playzone and sports activities such as football, badminton, tennis and basketball.

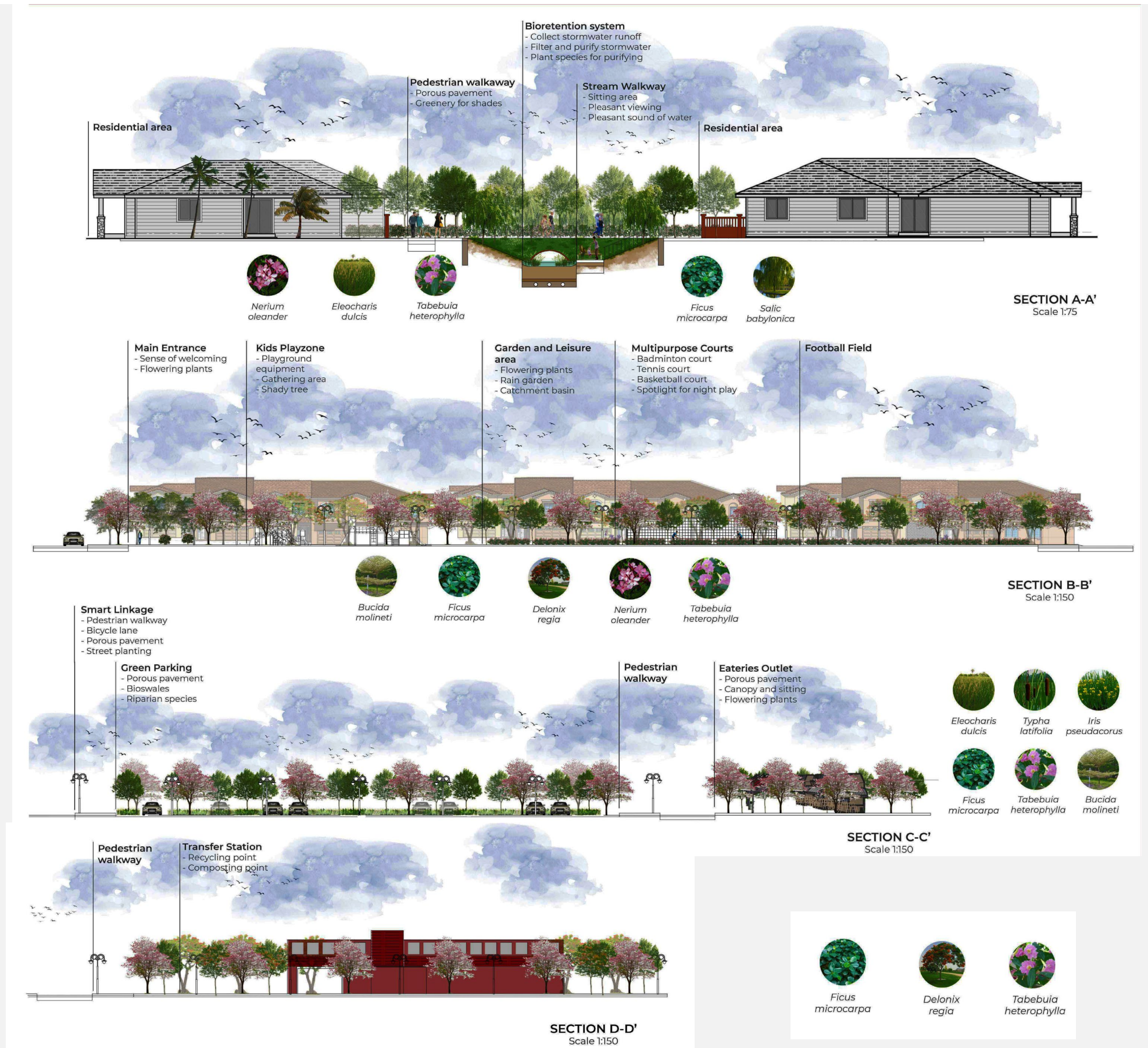
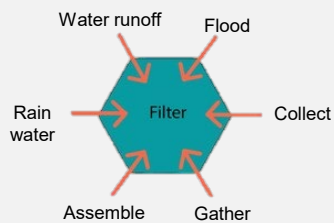


Figure 18: Sectional Elevation

DETAIL DEVELOPMENT

INTRODUCTION

Hive Park is a residential park located in Sponge Village in Perkampungan Sungai Isap. This park functions to serve the community and fulfil the village's objectives to create a resilient village through ecological and sustainable approaches to cater to the flood issues. Hive Park becomes the centre of the catchment basin where it collects runoff water and flood.



The design concept inclines the entire park to create a container for water.

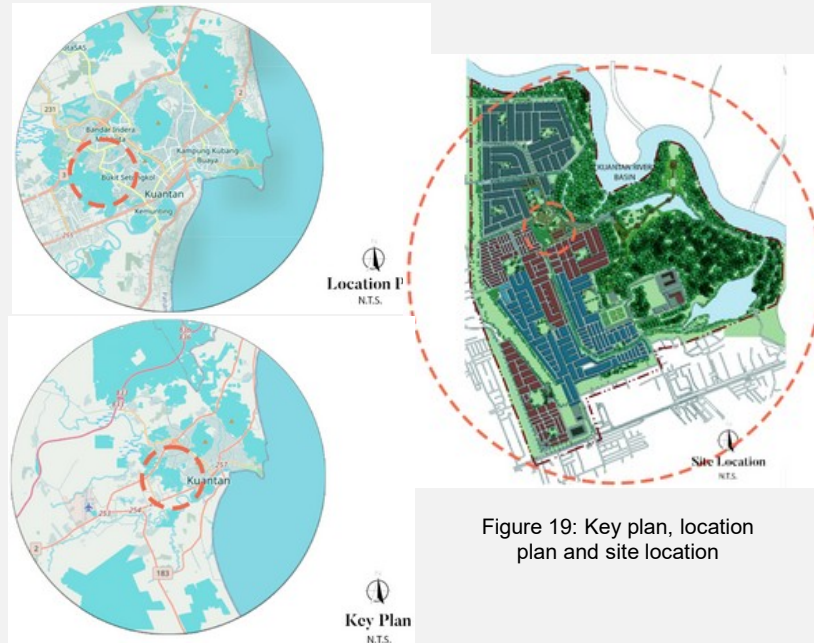



Figure 19: Key plan, location plan and site location

AIM

To **mitigate the flood issues** and revive the residential park through resilient landscaping.

OBJECTIVES

 To **integrate the park as a water treatment system** through green infrastructure.

 To **adapt the concept of live with water** by making the park a catchment basin.

 To **propose various outdoor public spaces** to serve the community.

SPACE PROGRAMMING

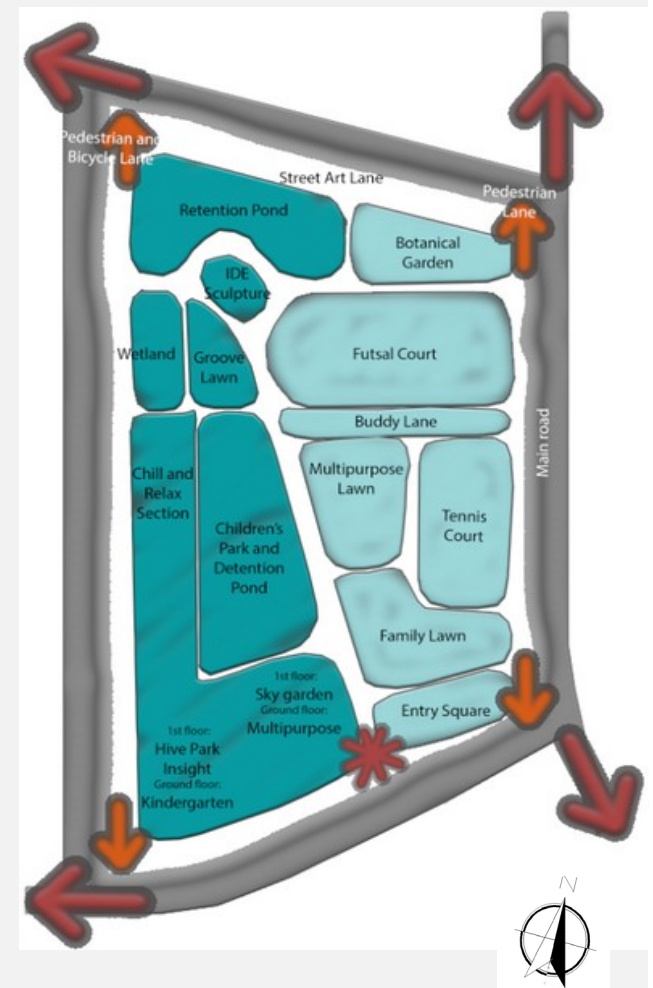


Figure 20: Space Programming

BUBBLE DIAGRAM

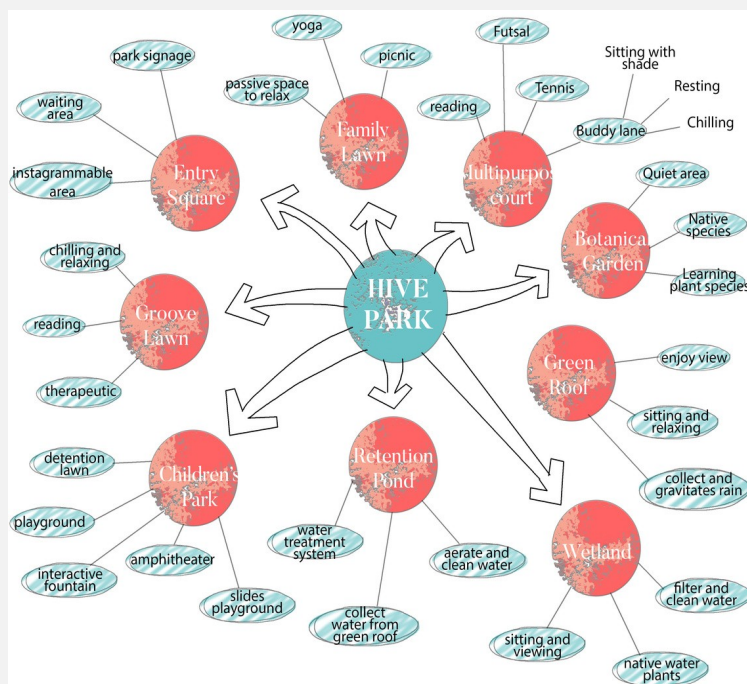


Figure 21: Bubble Diagram

DETAIL DEVELOPMENT PLAN

Figure 22 shows the proposed detailed development plan known as Hive Park which its special function is the water treatment system apart to serve the community with recreational activities.

The water treatment system area consists of the Green Roof, the Wetland, and the Retention Pond. The green roof is a building that inclines 3 degrees towards the wetland.

The green roof collects rainwater and flows towards the wetland, filtered by the wetland species before entering the retention pond. Hive Park serves the community with sports and recreational areas such as futsal and tennis court, Sky Garden, lawn, and botanical garden for passive activities.

Interactive Digital Water Curtain is another significant attraction that visitors can engage with its unique features.



The water collection area where the rainwater and water runoff are collected from the green roof, wetland, and the surrounding area.



SKY GARDEN and CHILL AND RELAX SECTION function to collect rainwater that will flow slowly through the grass with gravel pavement before being channeled to the wetland.



The GROOVE LAWN has a wetland area consists of plant species that function to filter the rainwater and water runoff from the green roof before discharge towards the retention pond.



A sunken CHILDREN'S PARK serves as a detention area for excess water runoff during flood besides various playground equipment provided.

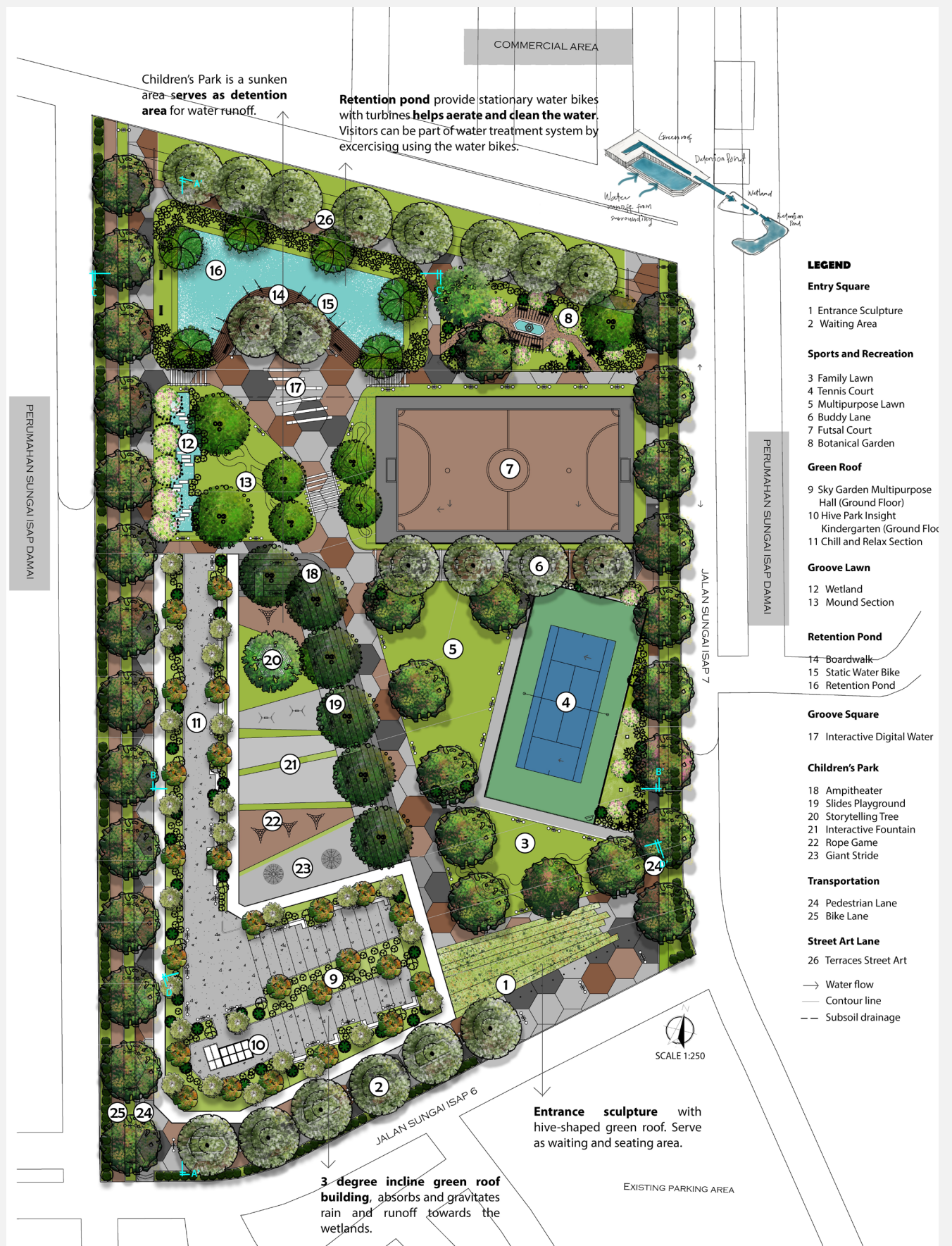
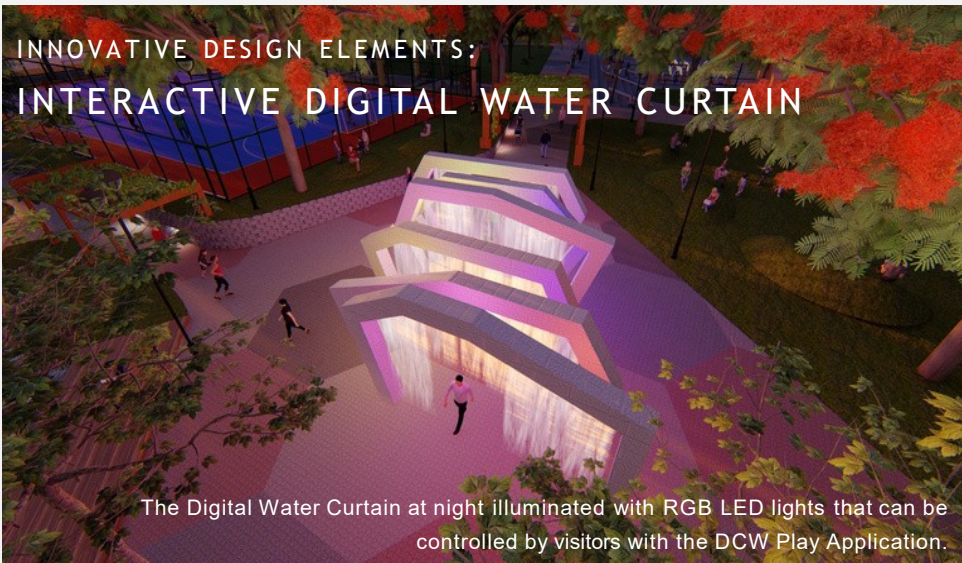


Figure 22: Detail Development Plan



INTERACTIVE DIGITAL WATER CURTAIN

A computer-controlled water plotter that displays graphics, patterns, and texts onto cascading water, by switching fast acting valves on and off that allow people to interact simultaneously with the water curtain.

Features

Sensors

- Detect the approach of people, so that the water curtain can open to let people pass through.
- Activate customized content.
- Display a pre-programmed water game.



Smartphones/ Tablets

- Allow people to interact simultaneously with the water curtain.
- Draw or send text onto a digital water curtain. Display with your tablets/ smartphones using specific apps.



Digital Water Curtain Play Apps

- Has different operating options customized for users.
- Send images, drawing, and texting.
- Control sound and colour.



Figure 23: Elevation of Interactive Digital Water Curtain

HOW IT WORKS ?



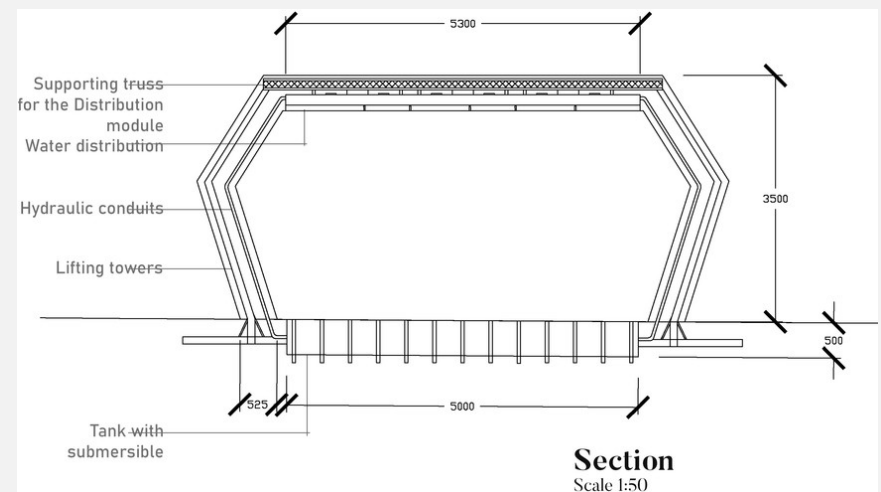
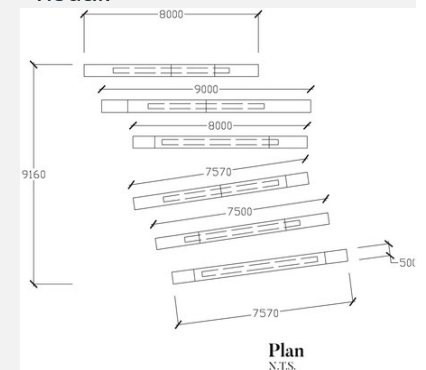
The water falls into the bottom tank, from which it is pumped back up.

The resulting droplets create falling images

The top of the digital water printer has a large number of holes.

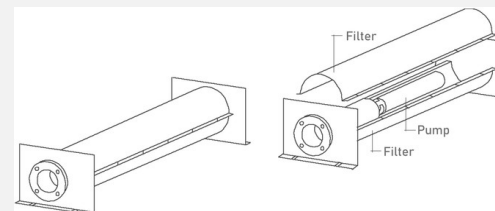
CONCEPT

The injection of HIVE shape with various lengths, heights, and width of the hexagon to enhance the visual.



Hydraulic Conduits

Pipes are necessary to connect the pump and water distribution modules.



There is a supply and a return conduit, to avoid excessive pressure in the manifold when all the valves are closed.

Water Distribution Modules

A stainless steel manifold with a square section in which 32 orifices have been drilled per linear meter.

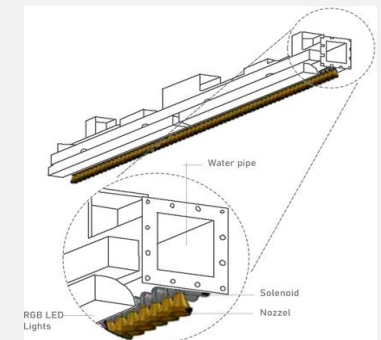


Figure 24 : Construction Details

SOFTSCAPE PLAN

Figures 25 and 26 show the plant selection for the Hive Park with 14 plant species. The plant selection consists of riparian species, lush greenery, fragrance, and flowering plants. The main purpose of the plants is to improve the water treatment system.



Figure 25 : Softscape plan

Figure 26 : Planting schedule and palette

CONCLUSION

The concept of resilience is an excellent approach to managing a disturbance of a place's existing system. This project aims to create a residential and a community that can function and adapt to disaster. The integration of ecological and sustainable approaches are the initiatives for flood mitigation that can help achieve resilience. The development of a sustainable neighbourhood, sustainable flood management, and green infrastructure are the strategies to serve the community with various activities and facilities while preserving and enhancing the environment with good functionality.

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