An irrigation channel polluted by sewage discharge and solid waste dumping

Fostering symbiosis between Ecology, Community, and Urban Development

Water systems as the primary determinants of Eco-sensitive urbanism

Munawar Irfaan S | SPA New Delhi

- **Loss events**
- **Selection of catastrophes**
  Overall losses ≥ US$ 1,500m
- **Geophysical events**
  (Earthquake, tsunami, volcanic activity)
- **Meteorological events**
  (Tropical storm, extratropical storm, convective storm, local storm)
- **Hydrological events**
  (Flood, mass movement)
- **Climatological events**
  (Extreme temperature, drought, wildfire)

Farming activities relying on the water tank system

Economic functions

- Development of agronomy → Agriculture, Livestock
- Insurance against low rainfall periods
- Livestock uses → Grazing, Drinking
- Fishing
- Duck rearing
- Building raw materials → Bricks, Tiles, Pottery
- Social Forestry
- Tree crops
- Auctions → Trees, Grass, Fish
- Silt collection as fertilizer

Annual Float festival performed on Mariamman Temple ta

Socio-cultural functions

- Ensuring livelihood
- Domestic uses → Drinking water, Washing, Toilet, Bathing
- Leisure area
- Temple festival
- Conservation of traditional knowledge and culture

Water tank ecosystem

Ecological functions

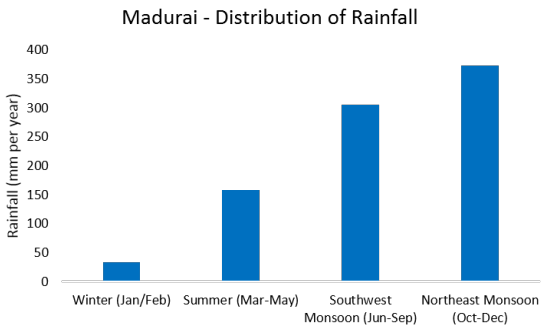
- Water conservation → Avoid erosion, Creation of organic layer of silt
- Soil conservation
- Protection and sustain of the surrounding area ecology → Provision of many habitats, Conversion of Biodiversity
- Flood control
- Recharge of groundwater
- Recharge of surface water of other water bodies → Well, Kulam, Oorani, Kuttai, Kanmois

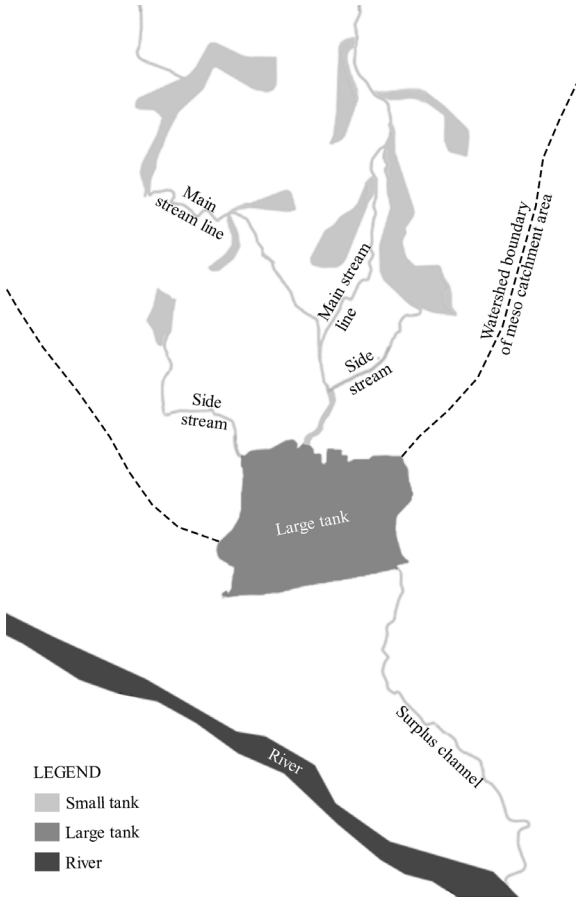
Temple tanks facilitating ground water percolation

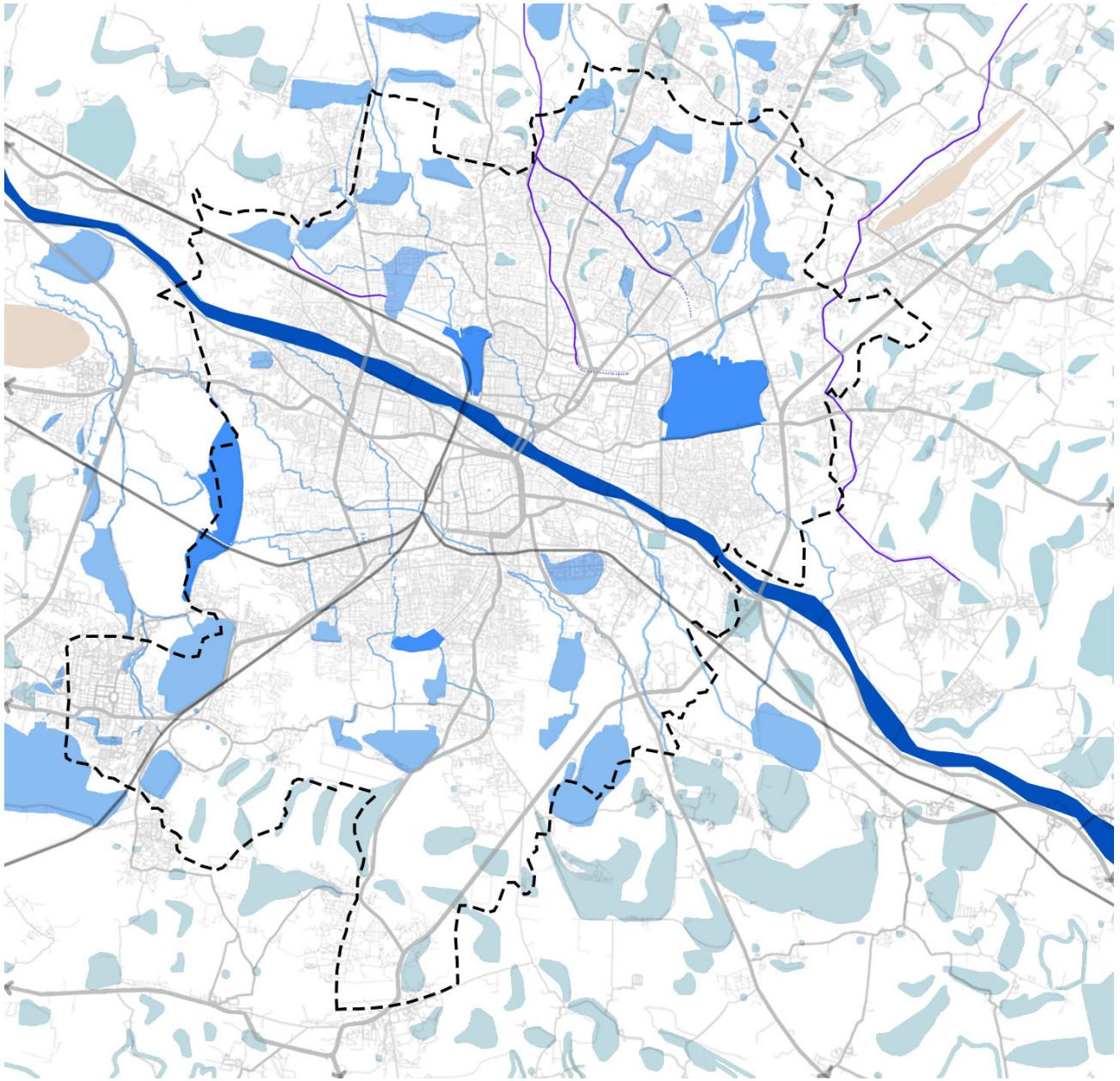
Chithirai festival performed on the bed of River Vaig

City study

Traditional water harvesting system well integrated with the ecological system

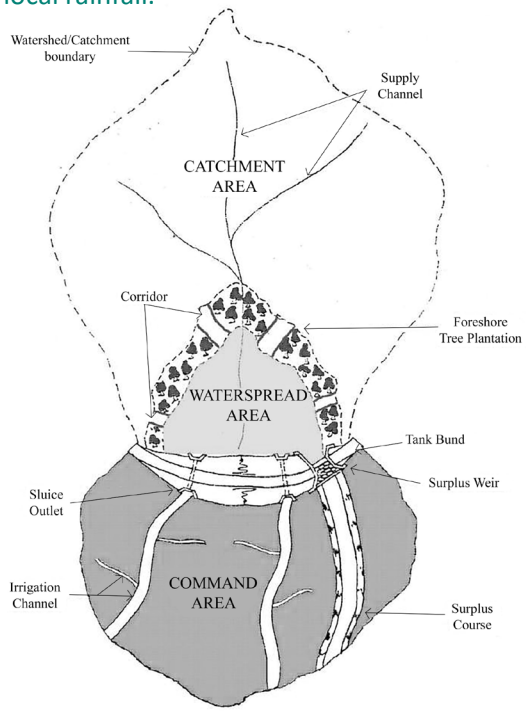






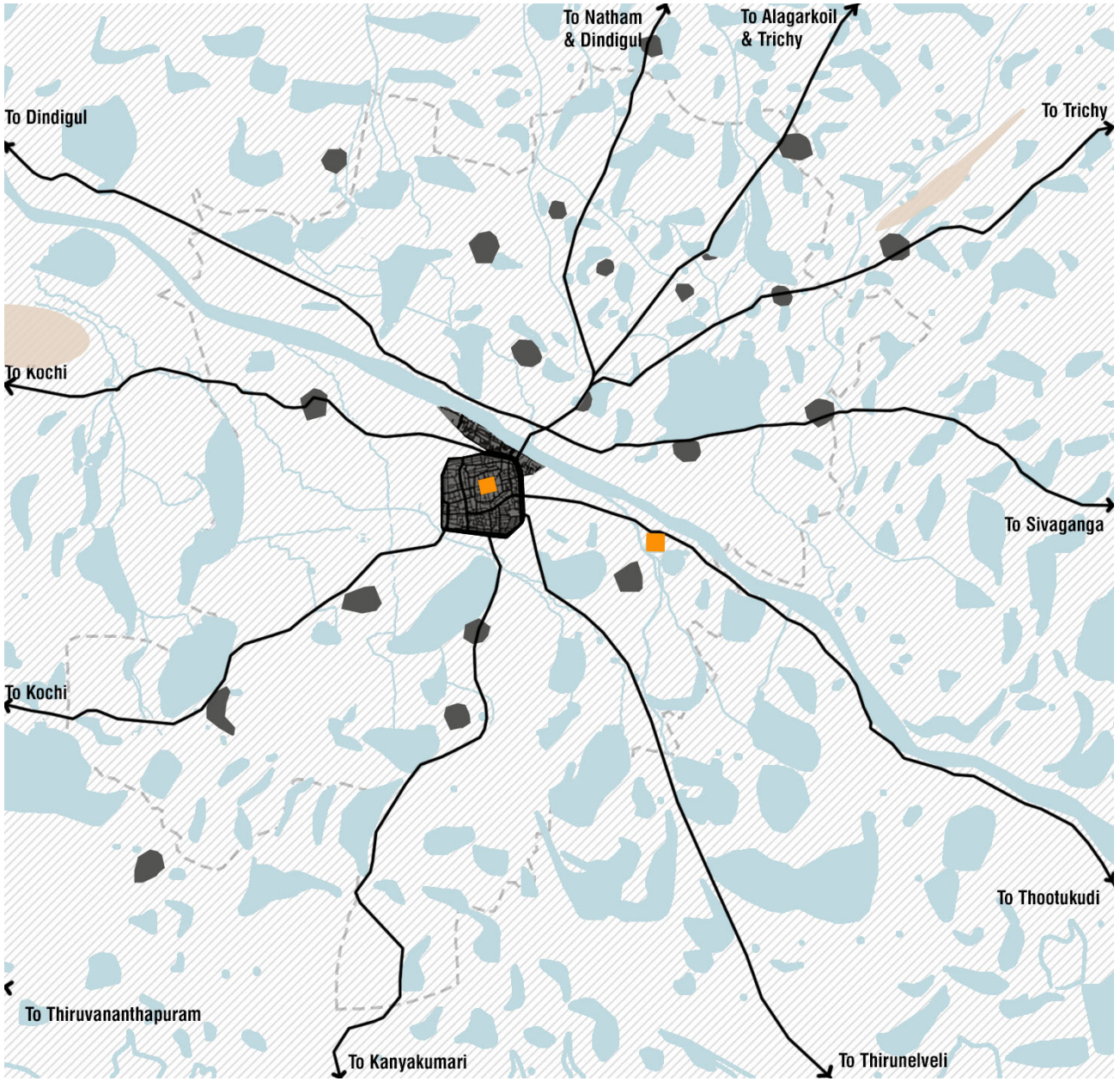
- Isolated tanks
- Small system tanks (fills every year)
- Large system tanks (fills once in 4 yrs)
- River
- Corporation limits
- Surplus channels
- Man-made branch channels
- Mountain

A subset of tanks, called system tanks, or 'eris' are connected to a network of other tanks and to the river through canals and thus are the beneficiaries of surplus non-local rainfall.



City study

Development trajectory Pre-colonial (till 1757)



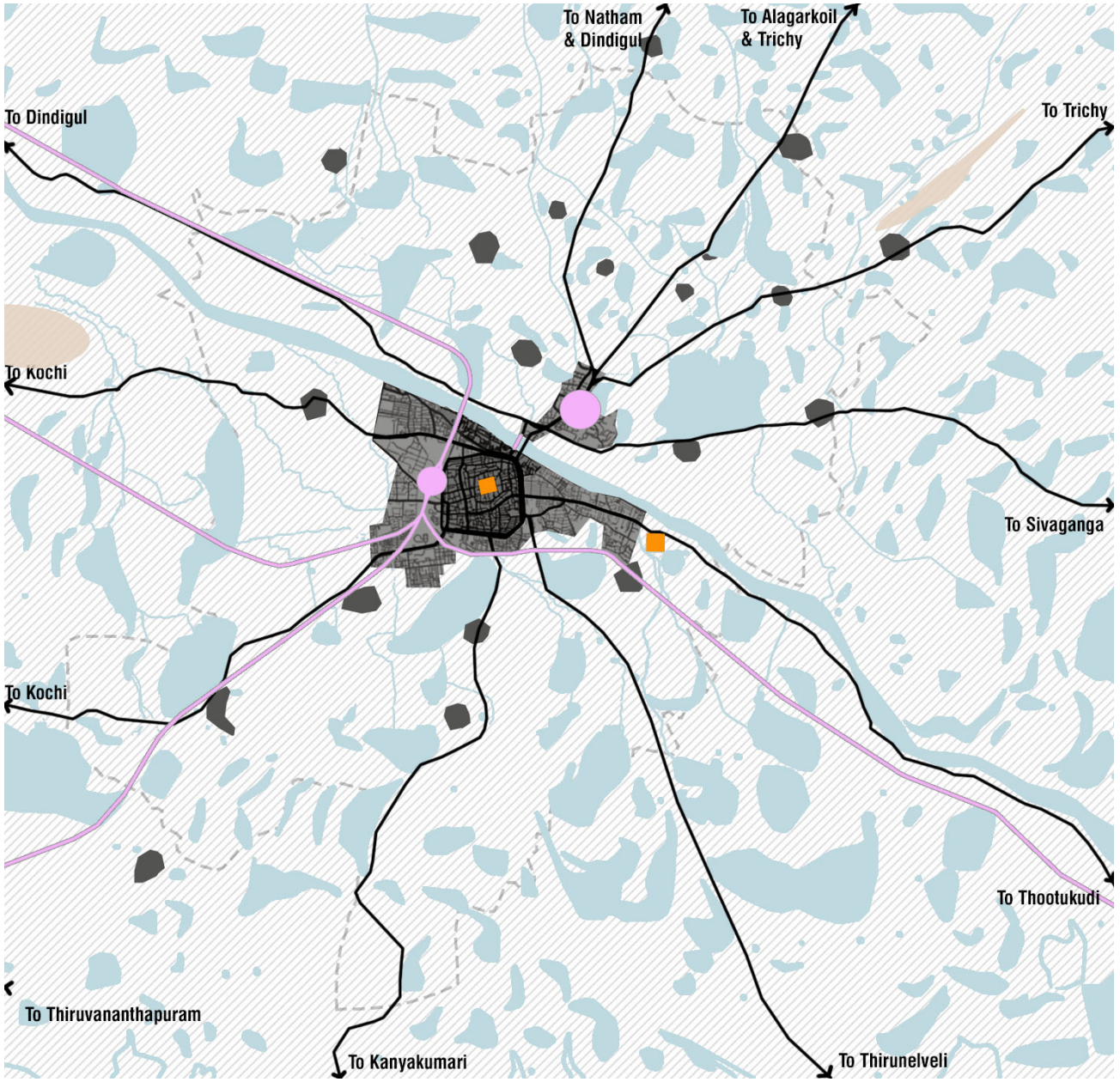
- Waterbodies
- Meenakshi amman temple & Vandiyur Mariamman theppakulam
- **Pre-colonial (till 1757)** Agro-based economy ensured eco-sensitive urbanization

- Madurai was majorly an agro-based economy and due to their deep-rooted social, economic and ecological values for the ecological system, development pattern was sensitive.
- Generally villages settled on steeper highlands with low ground water percolation and farmlands were located on low-lying lands which were fertile due to high ground water percolation.

Irrigation using rain water from the surplus

City study

Development trajectory Colonial (1757 – 1947)



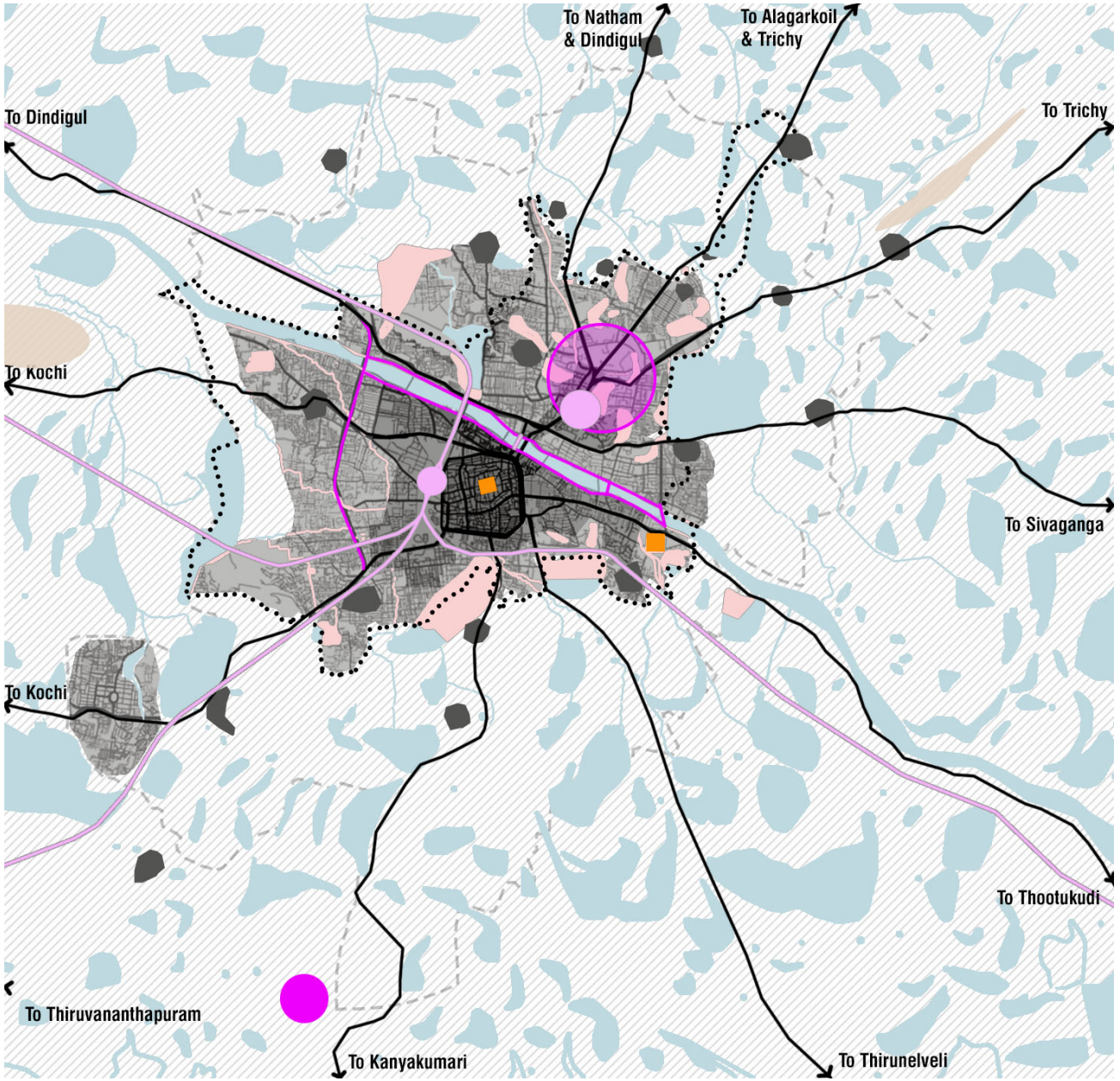
- Colonial infrastructure development
- Waterbodies
- Meenakshi amman temple & Vandiyur Mariamman theppakulam
- **Pre-colonial (till 1757)** Agro-based economy ensured eco-sensitive urbanization
- **Colonial (1757 to 1947)** City started growing north due to administrative district

- During the colonial time, with the introduction of railways and administrative centre, the city started growing on the north banks of Vaigai.
- Modern water system internalized the relationship between the local community and the water system thus making waterbodies readily available for


Dams and bore wells internalized the relationship with

City study

Development trajectory Post-colonial (1947 – 1992)



- Colonial infrastructure development
- Post-colonial infrastructure development
- Disappeared waterbodies
- Waterbodies
- Meenakshi amman temple & Vandiyur Mariamman theppakulam
- **Pre-colonial (till 1757)** Agro-based economy ensured eco-sensitive urbanization
- **Colonial (1757 to 1947)** City started growing north due to administrative district
- **Post-colonial (1947 to 1992)** Huge disappearance of waterbodies due to conversion into other land uses

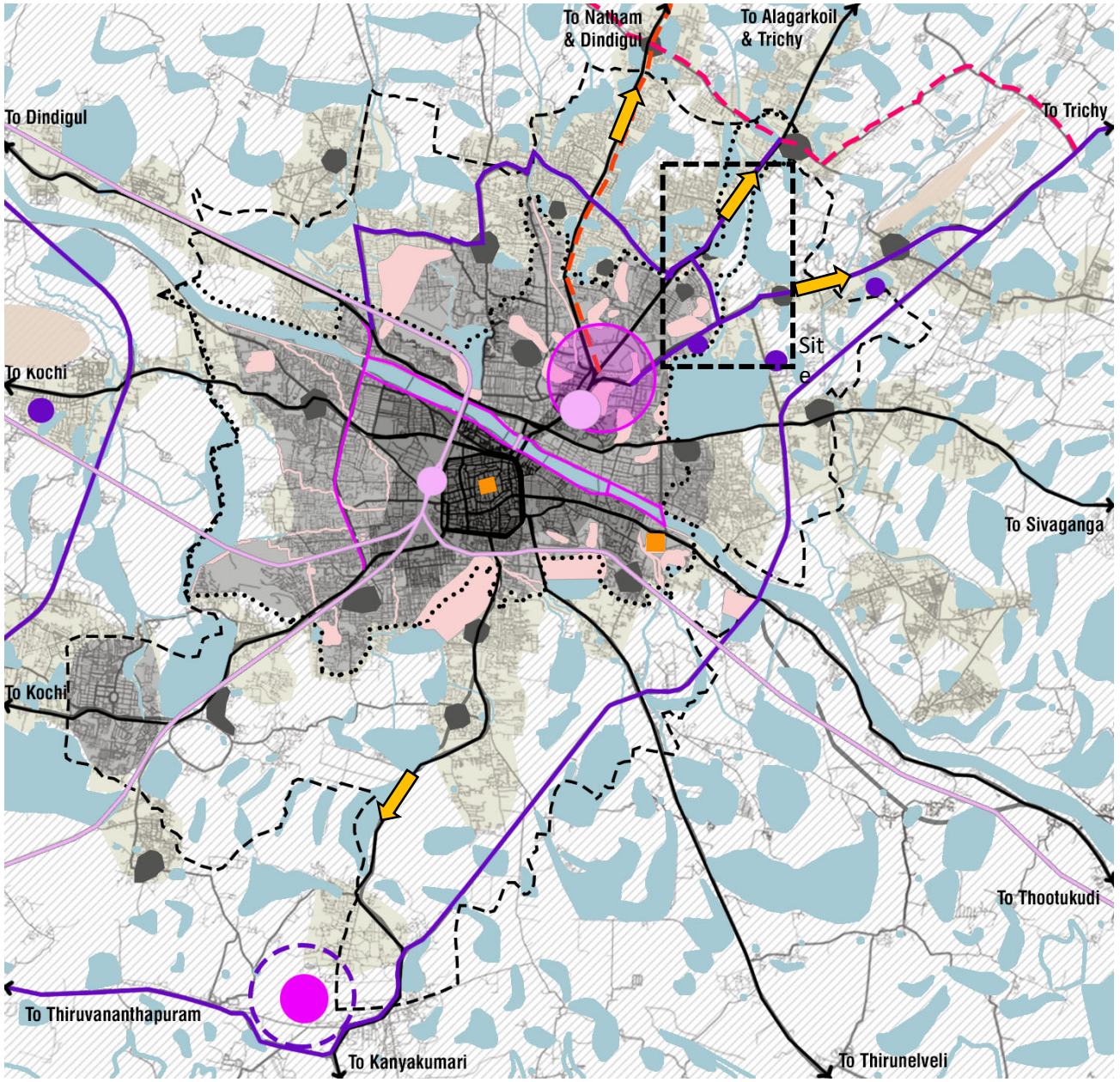
- During Post colonial period, with real estate driving the economy, the city was growing as a large monolithic urban agglomeration, converting the waterbodies on it's way into industrial, residential, institutional or transport infrastructures through systemic encroachment.

- This transformation is done through the reclassification of land use. This is quite visible from the comparison of the Masterplan 1992 and the proposed Masterplan 2021.


Built encroachments of the waterbodies flooded during

City study

Development trajectory Upcoming projects/triggers of development



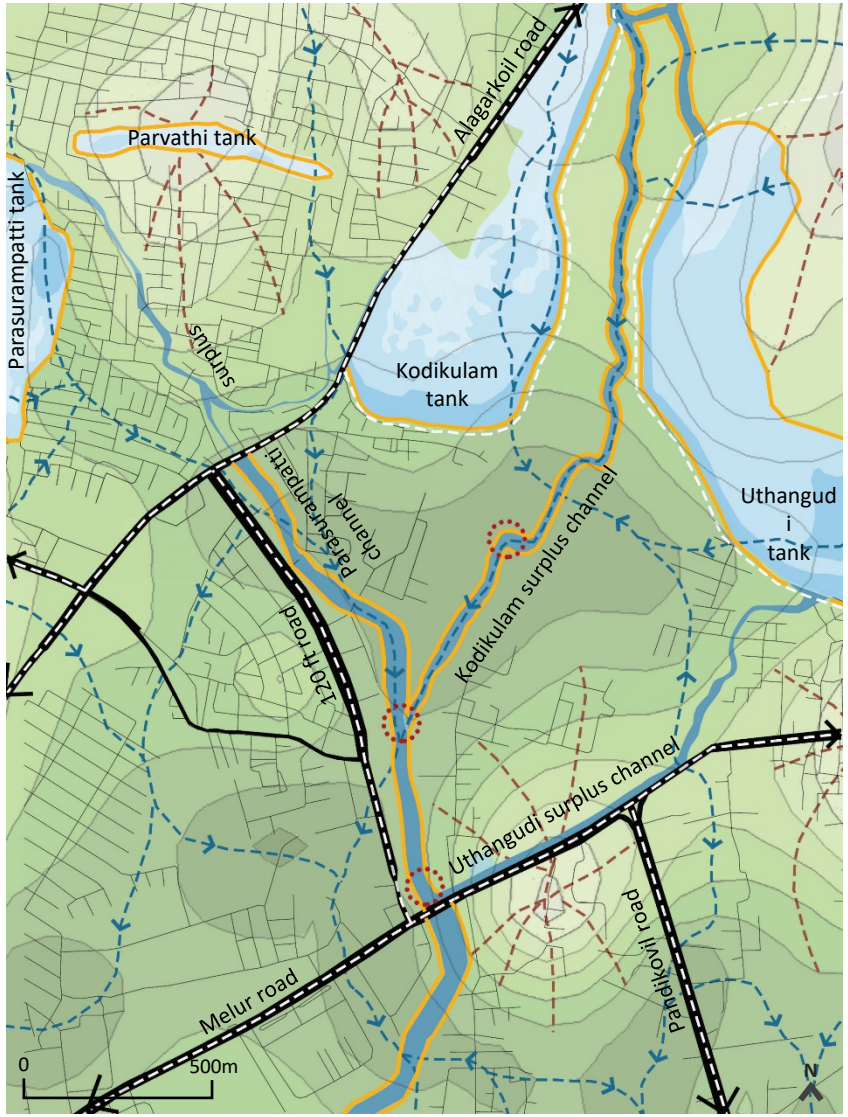
- Proposed ring road
- Proposed elevated corridor of National highway
- Urban growth directions
- Colonial infrastructure development
- Post-colonial infrastructure development
- Neo-liberal infrastructure development
- Disappeared waterbodies
- Waterbodies
- Meenakshi amman temple & Vandiyur Mariamman theppakulam
- **Pre-colonial (till 1757)** Agro-based economy ensured eco-sensitive urbanization
- **Colonial (1757 to 1947)** City started growing north due to administrative district
- **Post-colonial (1947 to 1992)** Huge disappearance of waterbodies due to conversion into other land uses
- **Neo-liberal (1992 to now)** Rapid transformation due to an ecologically insensitive development pattern


Encroachment of waterbodies by Govt. for new urban

- With new development projects lined up, ecological systems in Madurai's peripheries are under rapid transformation due to an ecologically insensitive development pattern.
- An increasing number of projects are being developed insensitive to the water system in order to satisfy short term political goals.

Area study

Ecological conditions



- Water extent – summer
- Water extent – monsoon
- Water extent – once in 50 yrs
- Waterbodies – surplus Channel (only in monsoon)
- Bunds (Embankments)
- Ridge lines
- Water flow lines
- Watershed divide
- Primary road
- Flood breach points in bunds

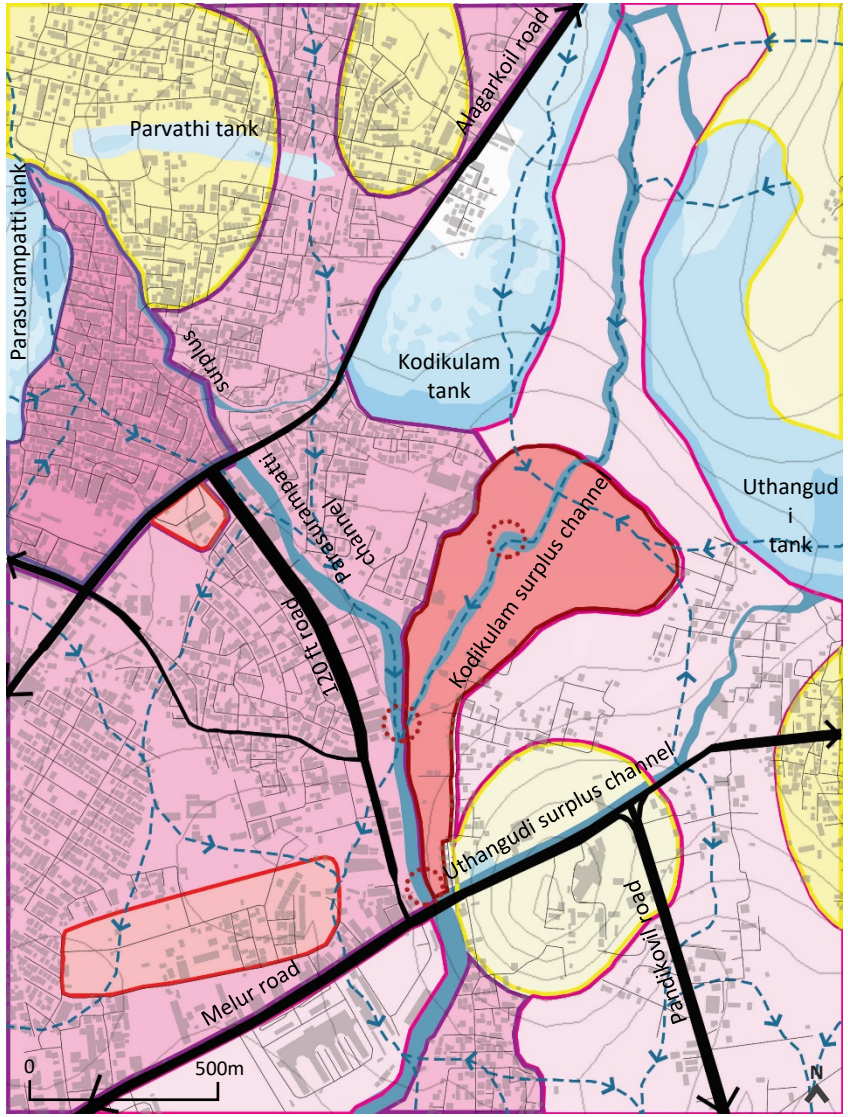
Contours at 1m interval

Low — High

Bund along the water channel

The site has a rich interconnected seasonally inundated system of irrigation water tanks connected by overflow channels whose edges are bunded as flood control measure. The major highways have modified the natural water flow such that they have divided the ecological system into separate micro-watersheds.

Ecological zones



- Water extent – summer
- Water extent – monsoon
- Water extent – once in 50 yrs
- Waterbodies – surplus Channel (only in monsoon)
- Ridge lines
- Water flow lines
- Primary road
- Flood breach points in bunds
- Flooding on low lying lands due to backflow from channels
- Flooding on lakes that were encroached
- Valley areas with high building density
- Valley areas with medium building density
- Valley areas with less building density
- Ridge areas with less and moderate building densities

Ecology under verge of loss

Based on overlapping the various layers of ecological conditions, Building densities, open space structure and the ecological issues, six major ecological zones with varying ecological roles were identified. These were further studied to understand the nuances at a more detailed scale.

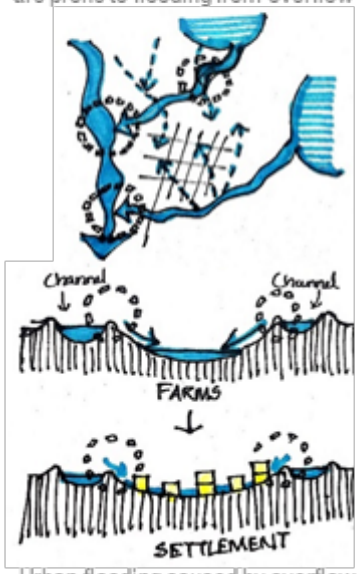
Area study

Ecological conditions

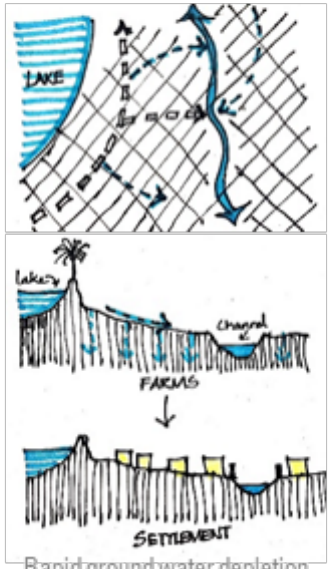
Building on low lying lands which are prone to flooding from overflow

Valley areas - low permeable ground cover streets blocking stream lines

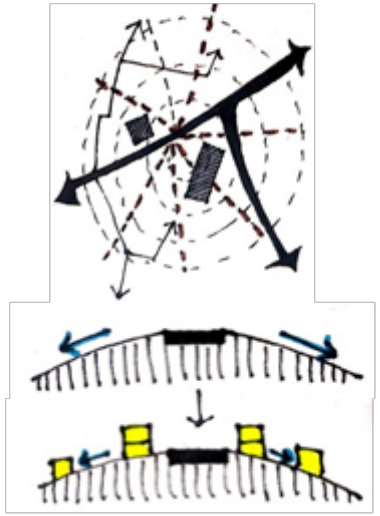
Ridge areas - less and moderate building densitie; less percolation



Urban flooding caused by overflow



Rapid ground water depletion



Ground water depletion

Inferences

- Lack of sensitivity in the development framework and regulations(building density, ground coverage, street layout) towards the ecological system has caused various socio-ecological issues(urban flooding, depletion and deterioration of ground water quality).

- Need to regulate the ratio of Building density vs available permeable ground cover with respect to local ecological conditions.
  - Low lying lands = No construction
  - Valley areas = Low building density
  - Ridge areas = Medium building density
  - Waterbodies = No construction

- Streets should be laid out such that they don't block the natural flow of water to ensure recharge of water bodies.

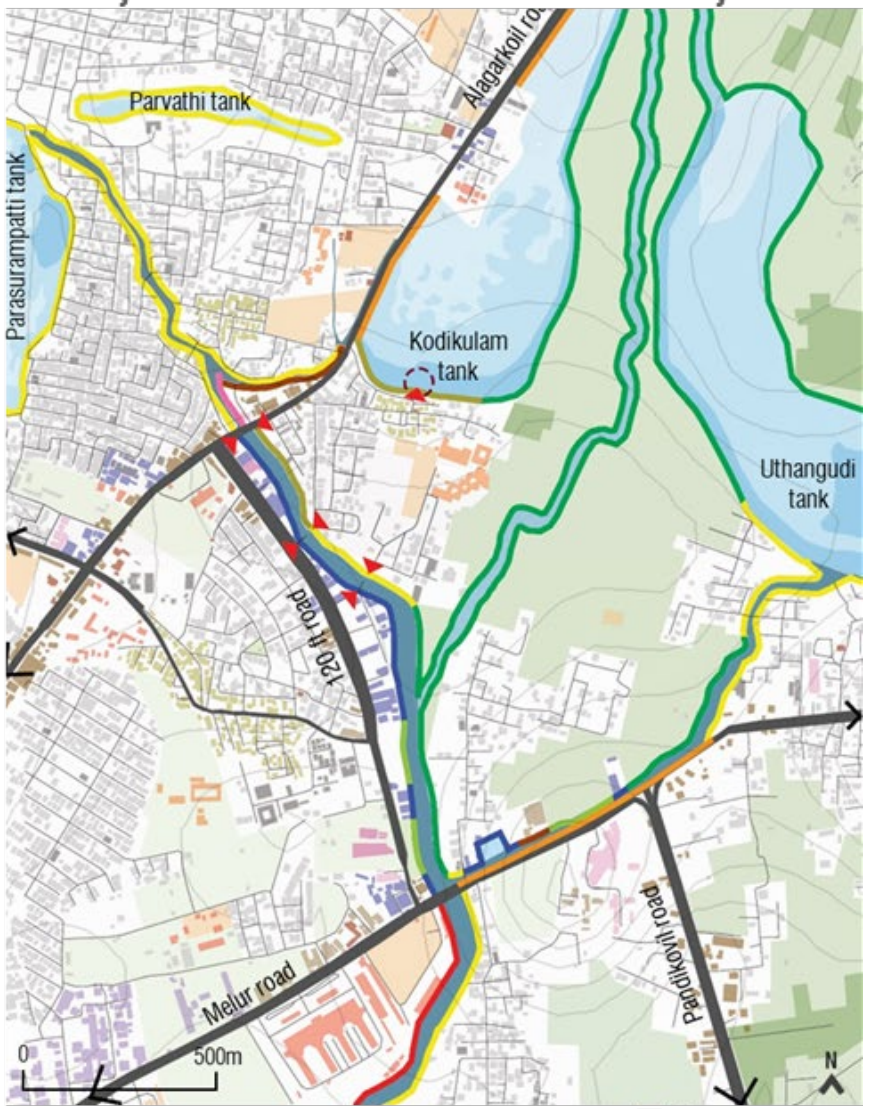
- Need to reserve open spaces within the urban built form to ensure ground water recharge.

Haphazard urban development on flood plains shrinking the catchent area of the

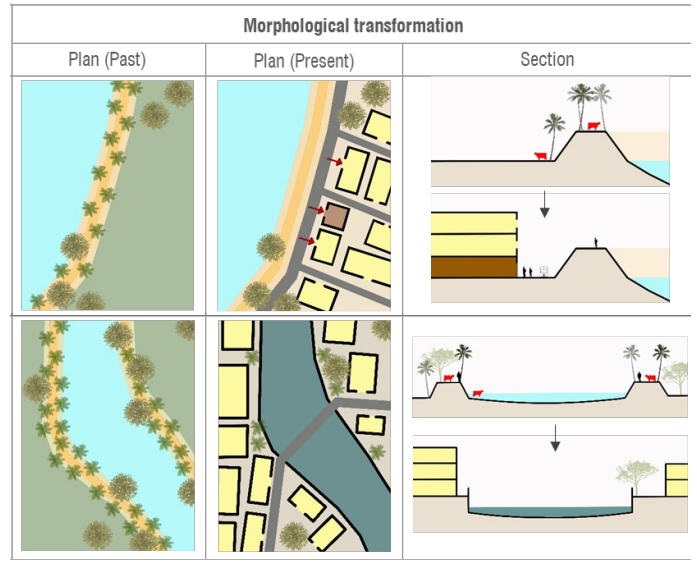
Accessibility – Stakeholder composition analysis

- Water extent – summer
- Water extent – monsoon
- Water extent – once in 50 yrs
- Waterbodies – surplus Channel (only in monsoon)
- Bunds (Walkable)
- Boundary wall (Not accessible)
- Primary road
- Pedestrian – cattle rearing routes
- Access points to water edge
- Visibility of water edge
- Disappeared waterbodies
- Bus stop
- Important transport nodes
- Indigenous community
- New community
- Outsiders (from other parts of city)
- Students

Water system – Built environment interface analysis



- Water extent – monsoon
- Water extent – once in 50 yrs
- Waterbodies – surplus Channel (only in monsoon)
- Primary road
- Access points to water edge
- Temple and ghats
- Water – Residential edge
- Water – Hospital edge
- Water – Mised use edge
- Water – Indigenous comm.
- Water – Godowns edge
- Water – Biodiversity edge
- Water – Open space edge
- Water – Road edge
- Water – Institutional edge
- Existing Farmlands
- Abandoned farmlands
- Campus greens
- Play ground
- Educational
- Car workshops + Godowns
- Independent house
- Apartments
- IT offices
- Hospital
- Institutional + Transport hub

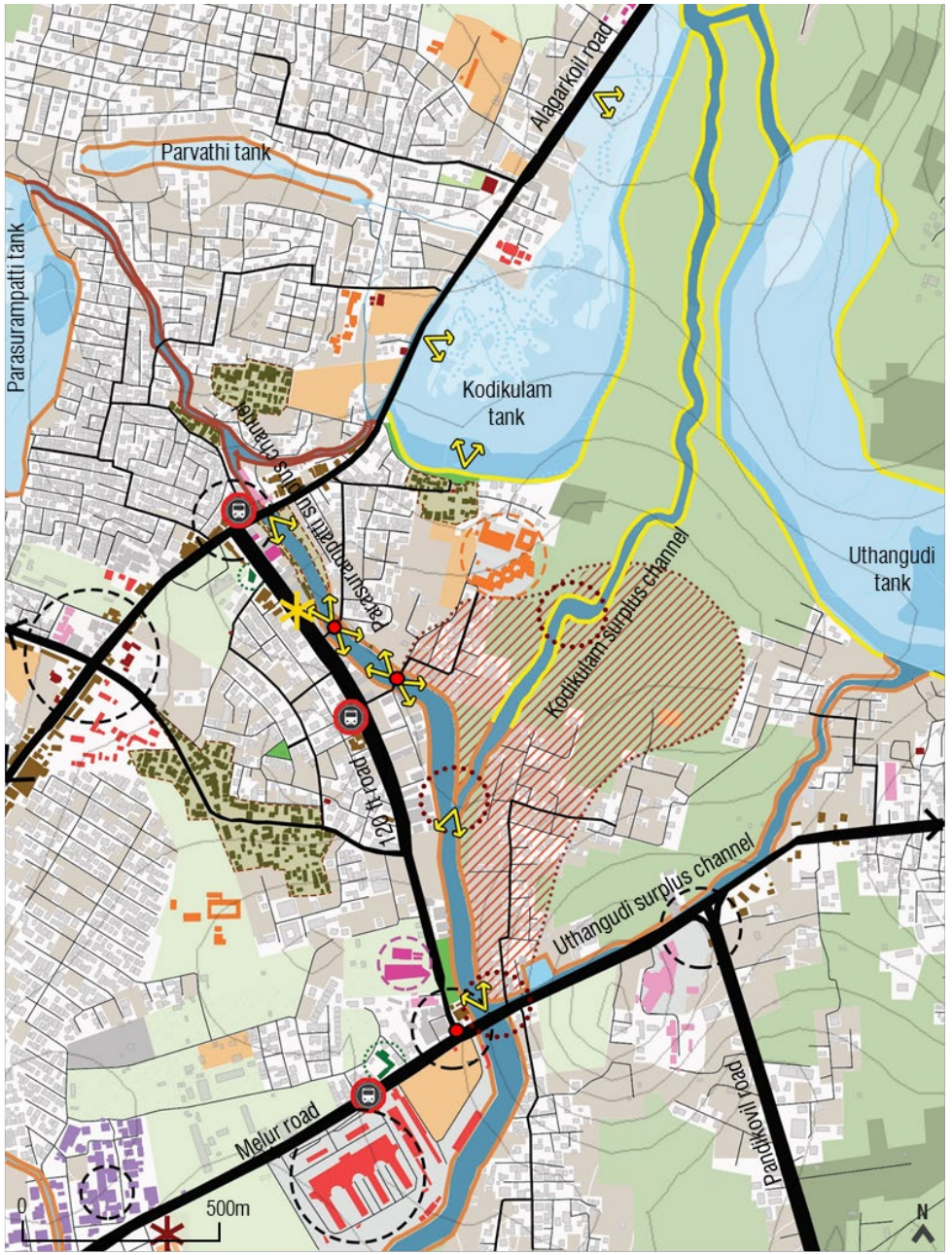


Inferences

- Loss of positive socio-spatial associations with water system along with lack of sensitivity in development framework and regulations towards treatment of water edge has led to it becoming backyard which in turn leads to negative spatial associations with water system.
- Water system to be made accessible to local community.
- Buildings should be oriented facing the water system.
- Everyday community functions should be present along the water system in order to create purpose.
- Land along the water system should be community-owned and open spaces in order to enhance social associations with the water system.
- Sustainable waste management plan needed in order to prevent damage to the water system.
- Top-down interventions through regulations and planning mechanisms along with strategies for enhancing the existing interdependencies through Govt. schemes needed.

Issue identification

ISSUES	STAKEHOLDERS
• Negative socio-spatial association with the ecological system due to worsening air quality, mismanagement of waste.	Residents, commercial workers and patients
• Urban edges along the water channel lack physical-visual accessibility leading to unused-misused and dead spaces along the water system.	Residents, passersby Residents(esp. Cattle rearers)
• Decreasing amount of permeable ground cover, concretisation of water edges, growth of harmful weeds and obstruction of water flow	Residents and non-resident workers
• This has lead to **urban flooding** and **ground water depletion** which has resulted in **loss of water-based livelihoods** and **biodiversity** while also affecting the **livability** of the area.	Residents, Farmers, Cattle rearers
• Poor living conditions of indigenous community and LIG due to gentrification	Farmers, Cattle rearers, Blue-collar workers
• Inaccessibility to water supply and sanitation for the income-poor population	
• Loss of biodiversity and climate change	Livestock, birds, flora, fauna, residents
• Poor last mile connectivity, road network and public transport	Students, Early/Middle adult residents, workers
• Lack of accessible public open spaces	Children, Early/Middle adult residents
• Lack of affordable schools within walkable distance	
• Lack of community purposes and market	Residents
• Lack of designated space for street vendors	Str. vendors, passersby

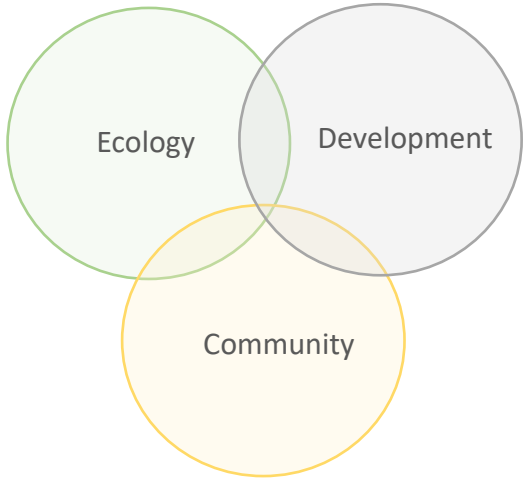


Sewage discharge and Solid waste dumping into waterbodies
Waterbodies carrying sewage from upstream neighbourhoods
Non-polluted yet silted waterbodies due to lack of maintenance
Boundary wall; inaccessible
Bund; accessible
Bund; accessible
View points of the water system
Flooded area
Flood breach points
Built mass
Vacant plots
Play ground
Campus greens
Farmlands
Abandoned farms

Farmers, Cattle rearers, Blue-collar workers
Water stressed areas
Abandoned farms containing Juliflora weed trees

Bus stop
Important nodes
Traffic congestion points
Primary road
Secondary road
Tertiary road
Available public open spaces
Morning market
Farmer's market
ISBT
Mixed use
IT hub
Educational
Industrial estate

Design Concept



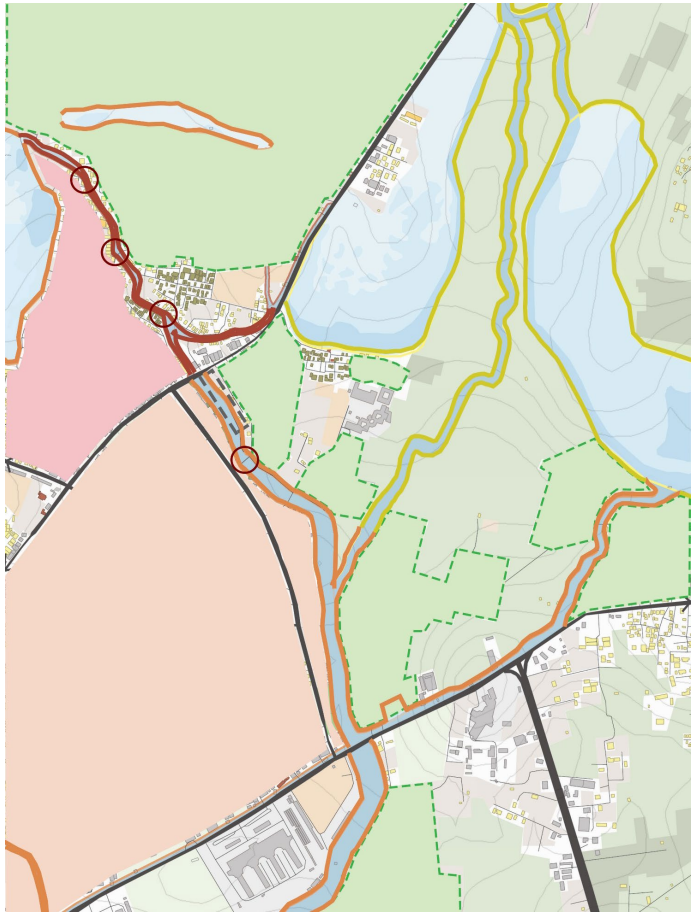
Vision

An ecologically sensitive neighbourhood which is also socially and economically sustainable, healthy, and climate change resilient where people's everyday lives revolve around symbiotic relationships with water.

Objectives

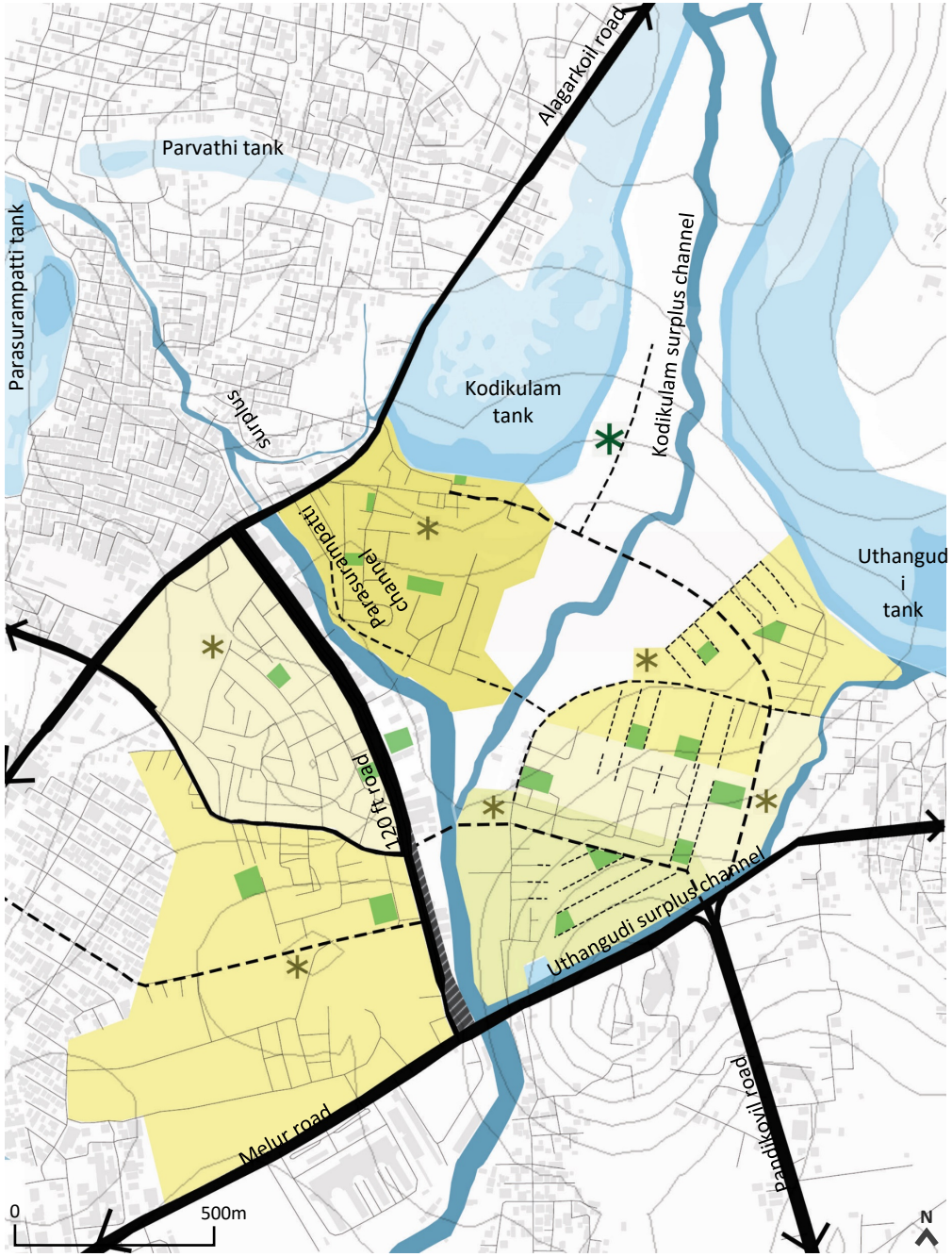
1. To strengthen the ecological system & give back to nature.
2. To foster the development of an ecology-determined urban form.
3. To create and enhance interdependencies between the local community and the ecological system.
4. To ensure environmentally sustainable urban development.

Design intervention - Integrating Sustainable waste management into urban form

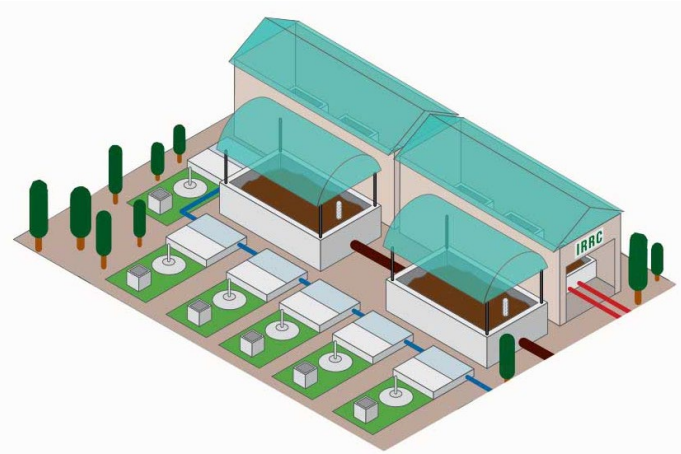


Existing waste management system

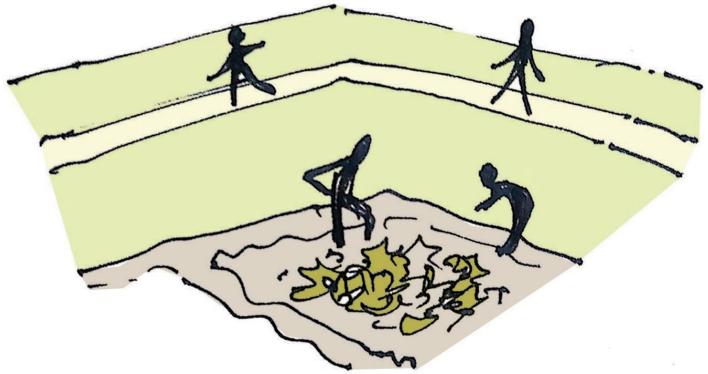
- Solid waste dumping spots
- Highly polluted water bodies
- Moderately polluted water bodies
- Repairable condition water bodies
- Areas discharging sewage into channels
- Areas with Municipal Underground drainage
- Areas with septic tanks and negligible discharge into channels



Integrated waste processing centre

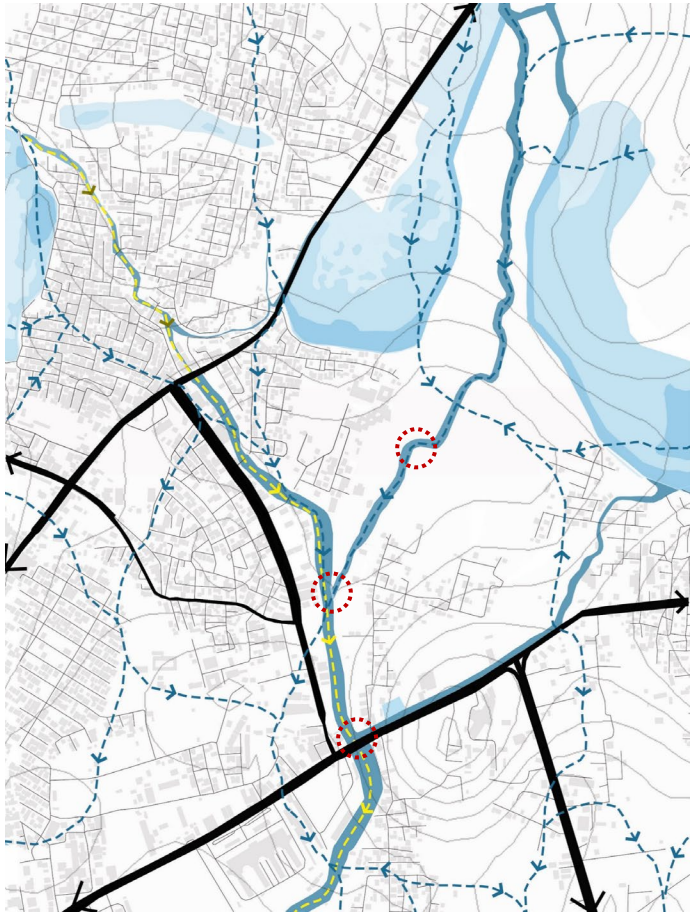


Community-level Compost parks



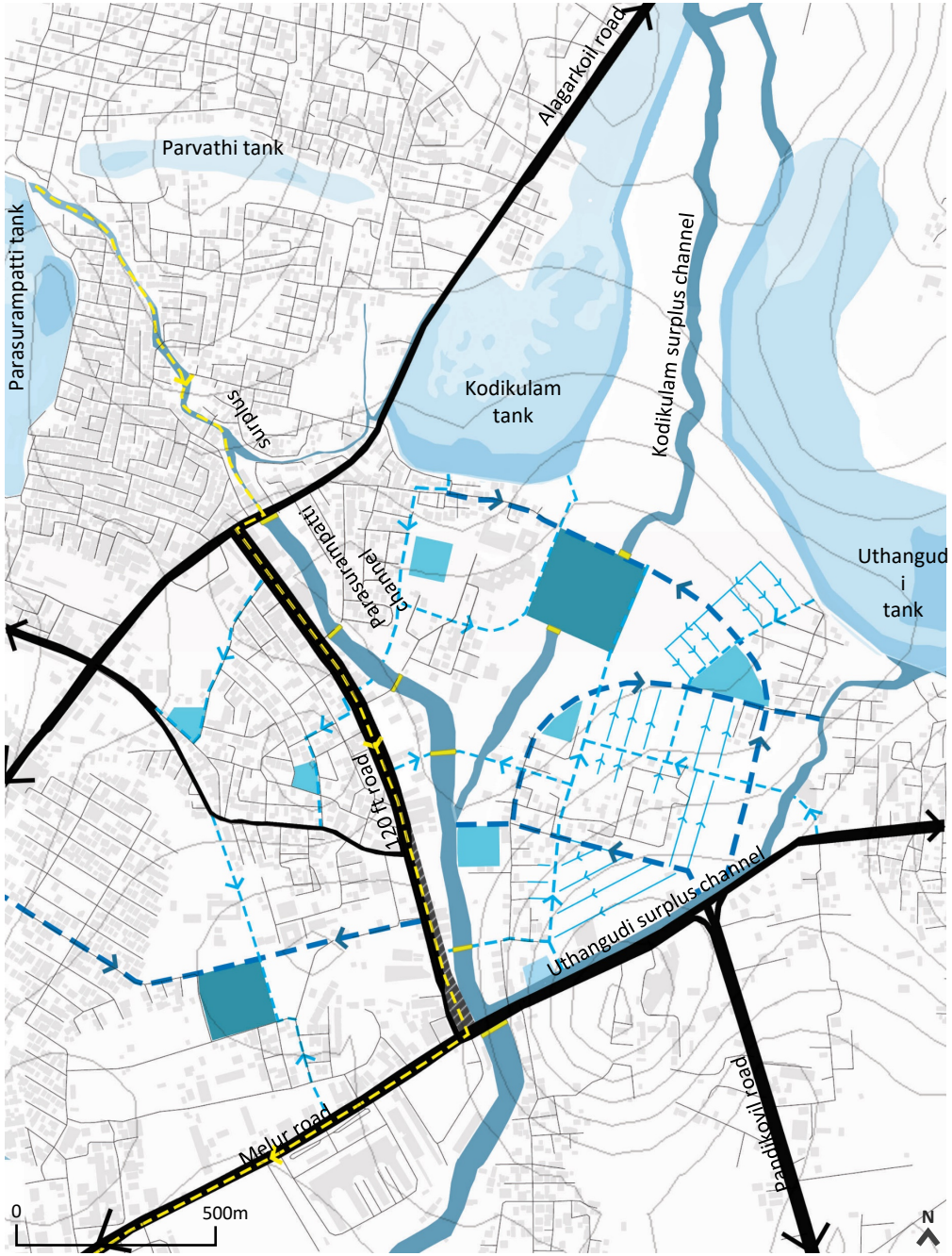
Agricultural and Animal husbandry waste processing centre

Design intervention - Integrating Sustainable water management into urban form

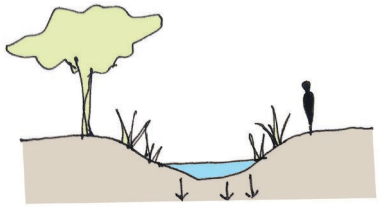


Existing Water management system

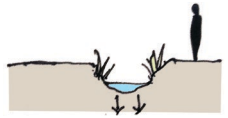
- Natural water flow
- Sewage water flow
- Arterial roads
- Flood breach points in bunds
- Water extent – summer
- Water extent – monsoon
- Water extent – once in 50 yrs
- Waterbodies – surplus Channel (only in monsoon)



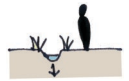
- Primary Bio swale



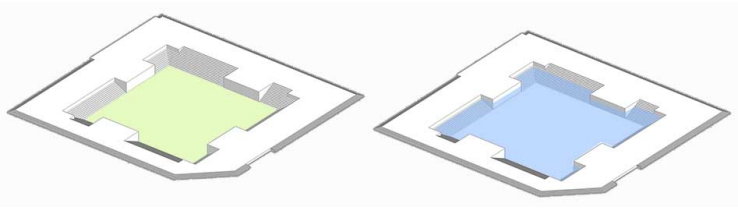
- Secondary Bio swale



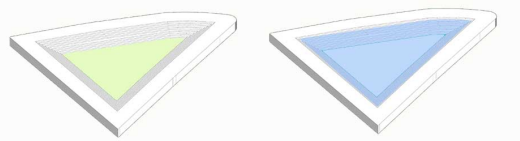
- Tertiary Bio swale



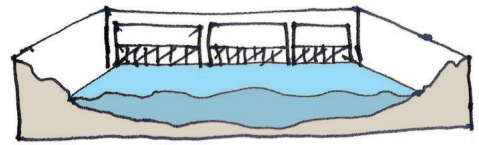
- Neighbourhood level water harvesting tank



- Community level water harvesting tank



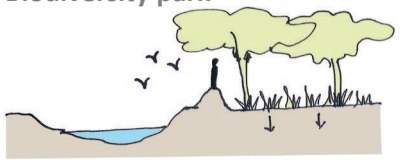
- Bridge filters for Removing solid waste



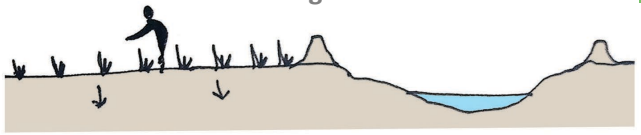
- Alternate Underground pipe for carrying sewage

Design intervention – Enhancing the functioning of the ecological system

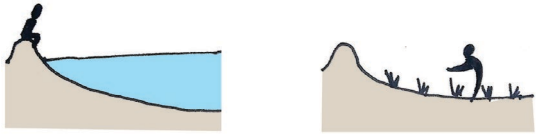
Biodiversity park



Reserved land for Farming



Demarcating part of the lake for farming during dry season

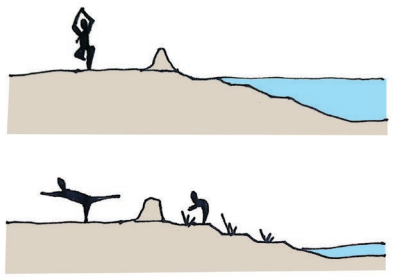


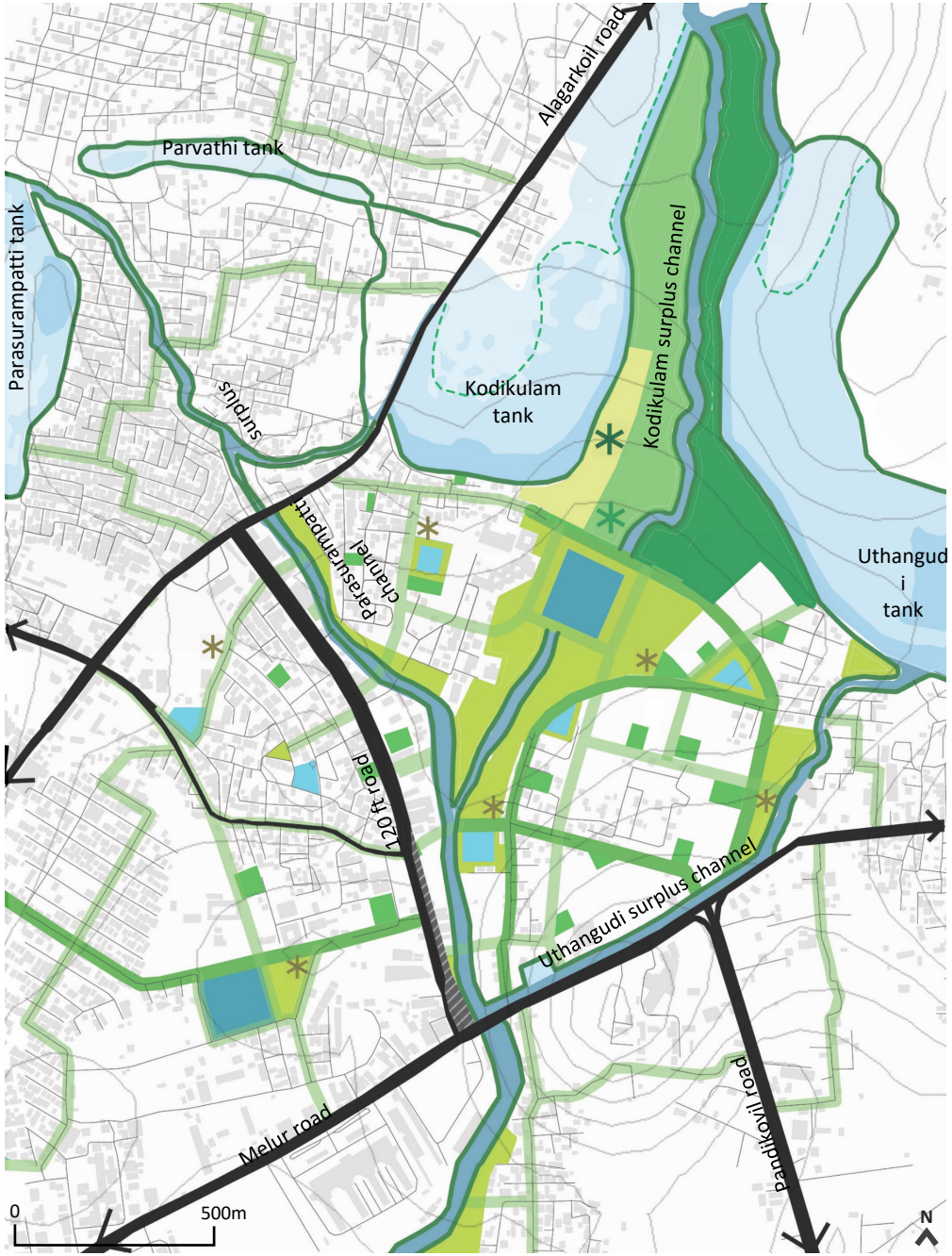
Co-operative housing for Farmers and Cattle rearers

Proposed Agricultural waste processing centre

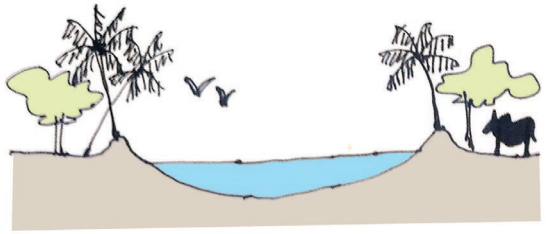
Proposed Skill Development centre

Reserved land for public and productive open spaces

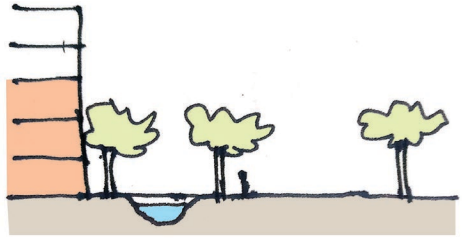




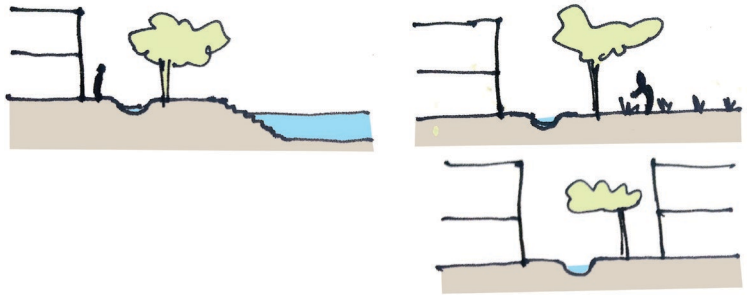
City-level Blue-green ecological corridor



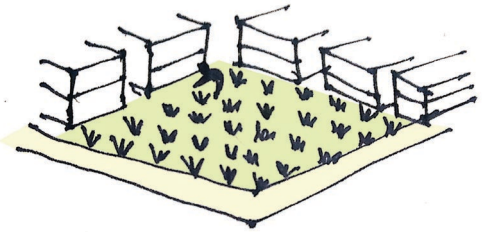
Primary Green Corridor along Primary Bio swale



Secondary Green Corridor along Secondary Bio swale

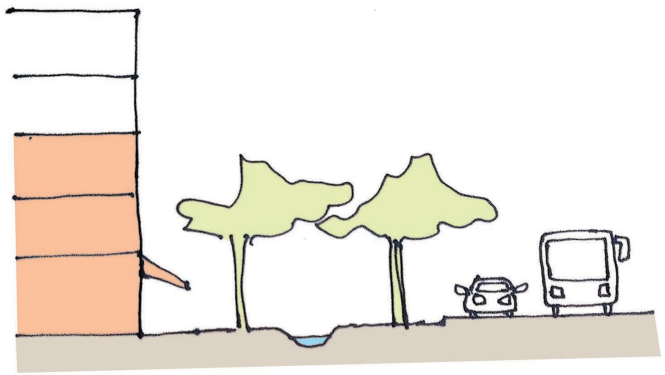


Compost parks doubling up as Urban Farms and Recharge areas

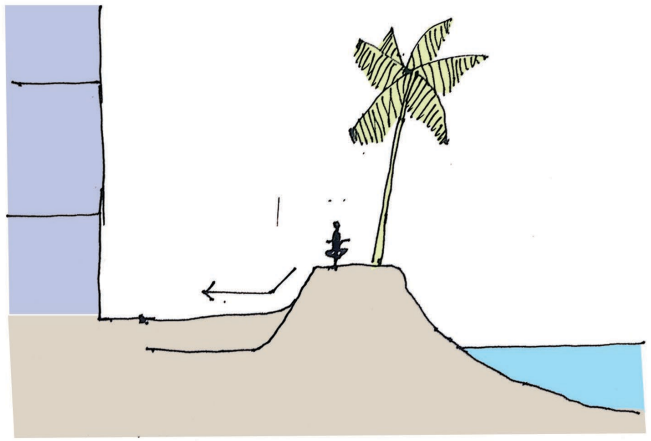


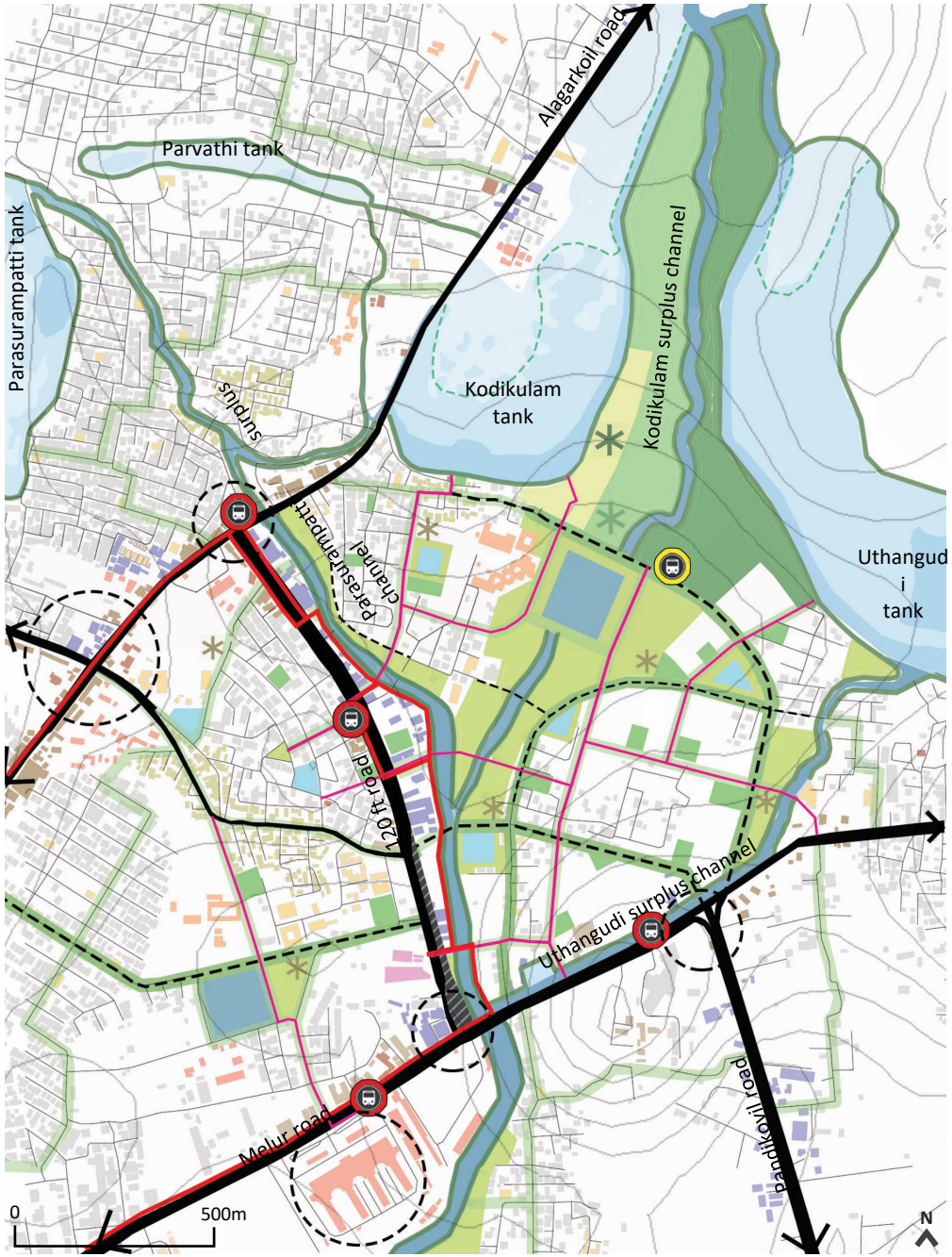
Design intervention – Integrating movement system with the Ecological system

Primary streets along primary green corridors

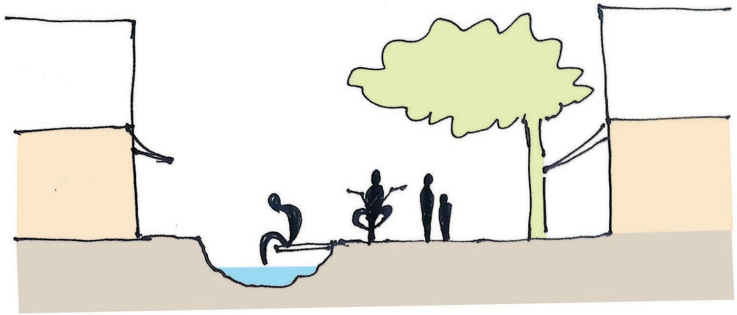


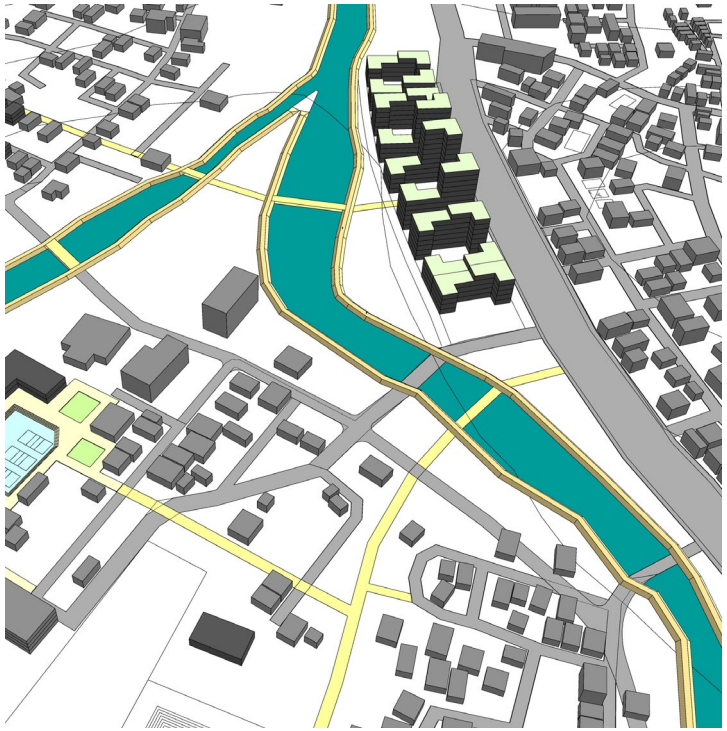
NMT track along water channel





Pedestrian & Cycle movement corridor along Secondary green corridors





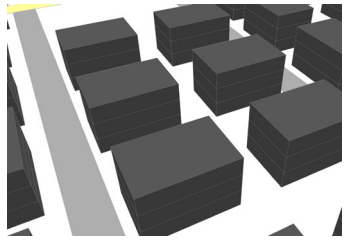
Design intervention – Fostering Adaptive urban growth through water-sensitive development

Framework

Medium dense residential areas (Ridge areas)

Existing **FSI**: **2**
Proposed FSI: **2.5**
Existing **Ground coverage**:**90%**
Prop. Ground coverage: **75%**

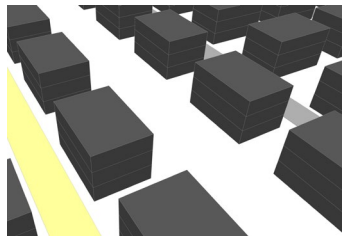
Open ground to be fully permeable for **percolation**



Low dense residential areas (Valley areas)

Existing **FSI**: **2**
Proposed FSI: **3**
Existing **Ground coverage**:**90%**
Prop. Ground coverage: **50%**

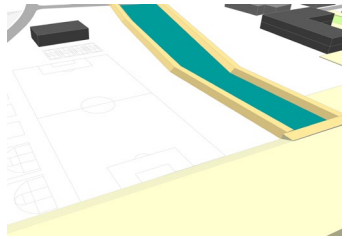
Open ground to be fully permeable for **percolation**



No construction areas (Low-lying flat lands)

Existing **FSI**: **2**
Proposed FSI: **0**
Existing **Ground coverage**:**90%**
Prop. Ground coverage: **0%**

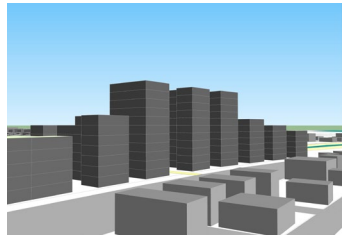
Open ground to be fully permeable for **percolation**

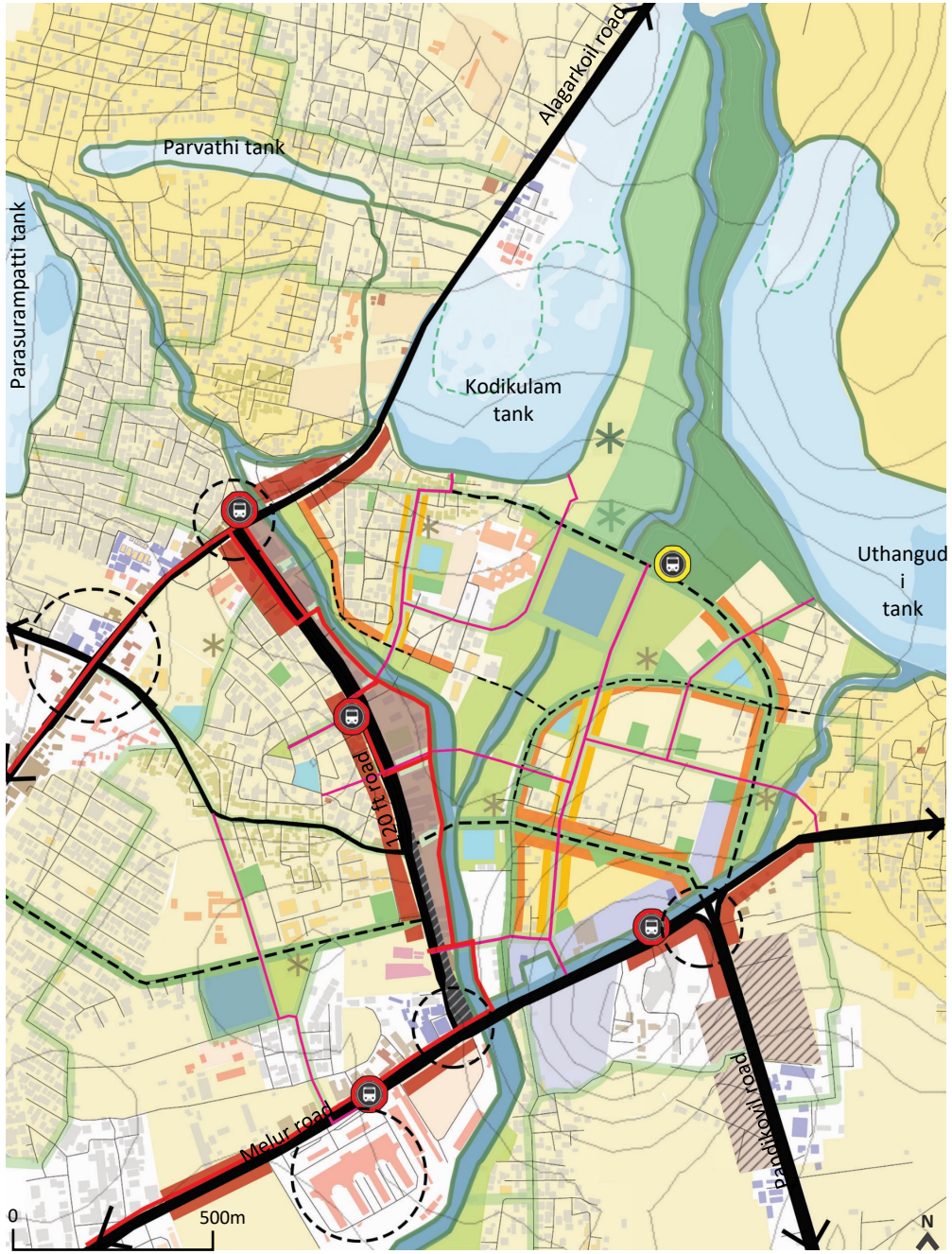


High dense work areas (Arterial road, Ridge areas)

Existing **FSI**: **3**
Proposed FSI: **3.5**
Existing **Ground coverage**:**50%**
Prop. Ground coverage: 4**0%**

Open ground to be fully permeable for **percolation**

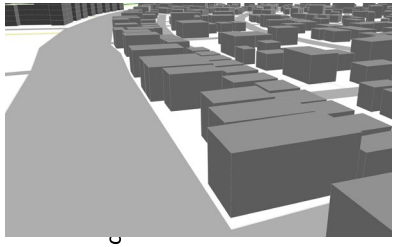




High dense commercial areas (Arterial road, Ridge areas)

Existing **FSI**: **2**
Proposed FSI: **2.5**
Existing **Ground coverage**:**90%**
Prop. Ground coverage: **90%**

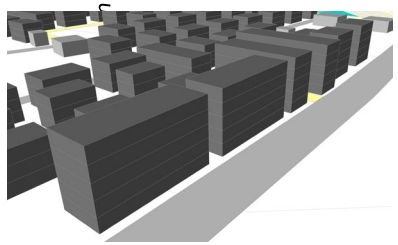
Open ground to be fully permeable for **percolation**



Medium dense mixed use functions (Prim. green corridors)

Existing **FSI**: **2**
Proposed FSI: **2.5**
Existing **Ground coverage**:**90%**
Prop. Ground coverage: **75%**

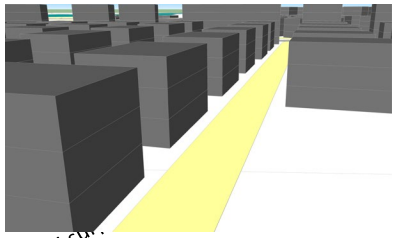
Open ground to be fully permeable for **percolation**



Low dense community-level mixed use functions (Secondary green corridors)

Existing **FSI**: **2**
Proposed FSI: **2.75**
Existing **Ground coverage**:**90%**
Prop. Ground coverage: **60%**

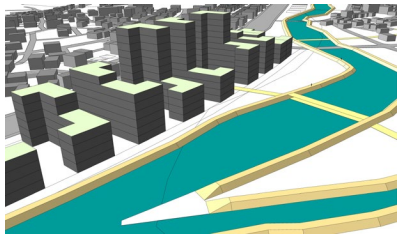
Open ground to be fully permeable for **percolation**



High dense work areas on Relocated Godown areas

Existing **FSI**: **3**
Proposed FSI: **3.5**
Existing **Ground coverage**:**50%**
Prop. Ground coverage: 4**0%**

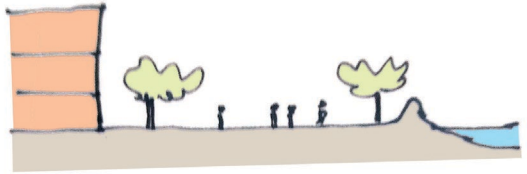
Open ground to be fully permeable for **percolation**



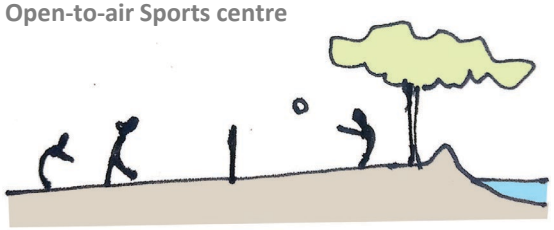
Relocated Godowns and Car workshops

Design intervention – Enhancing and Creating socio-spatial associations through place-making along the water system

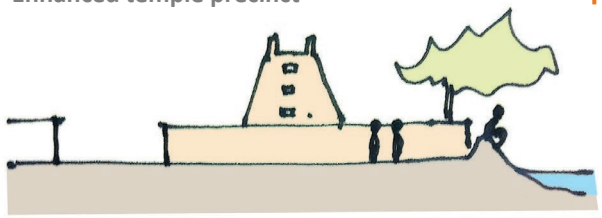
Social infrastructure



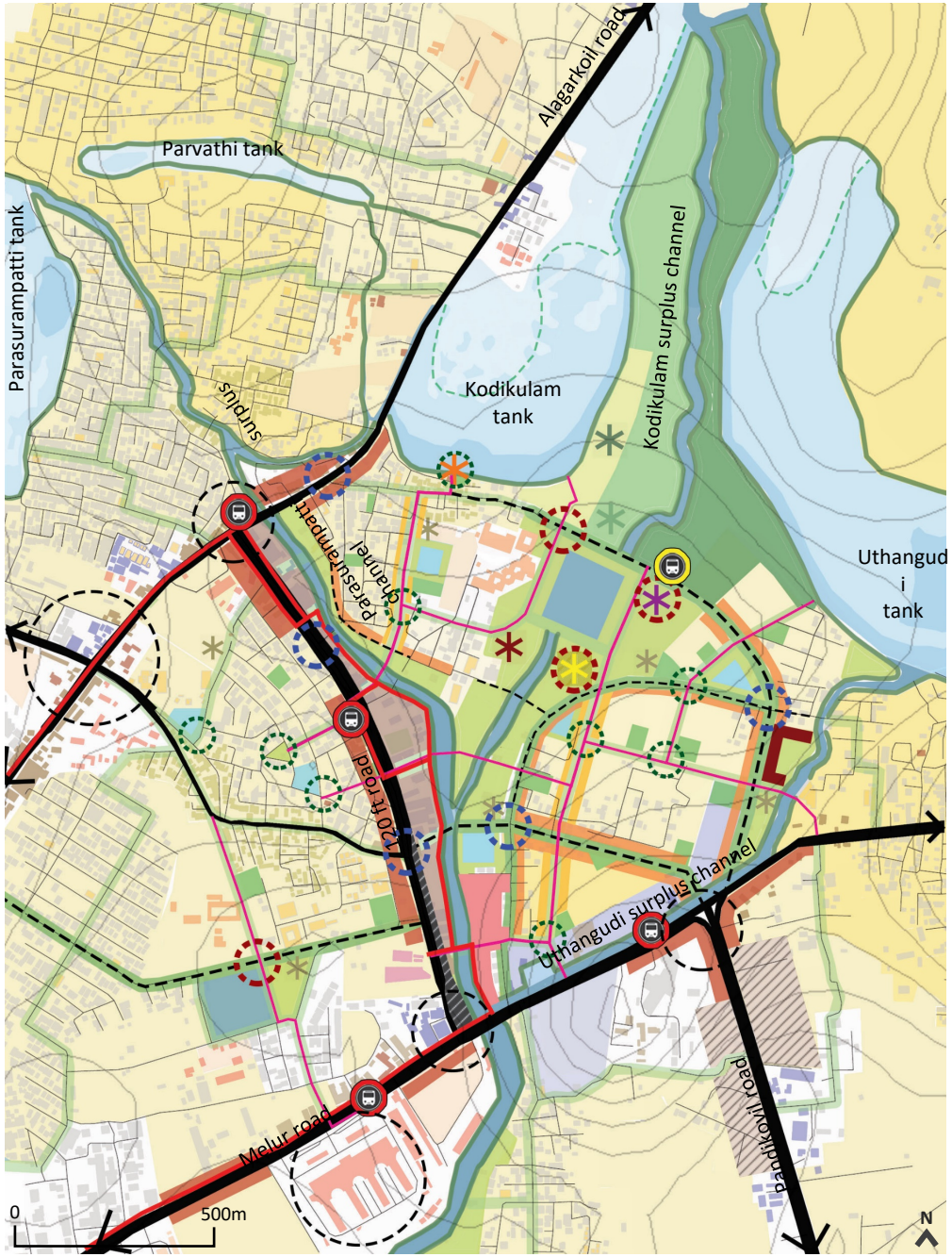
Open-to-air Sports centre



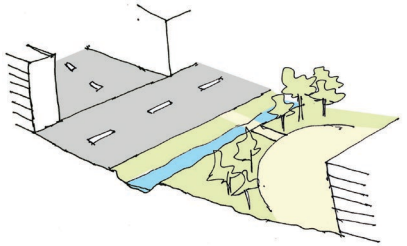
Enhanced temple precinct



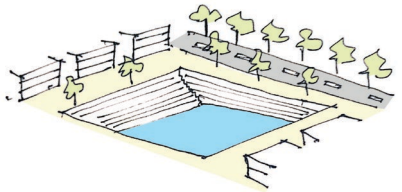
Farmer's market + Dairy market



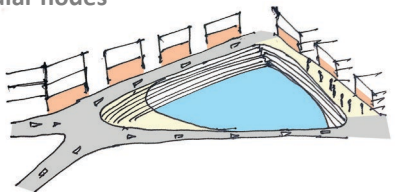
City level nodes



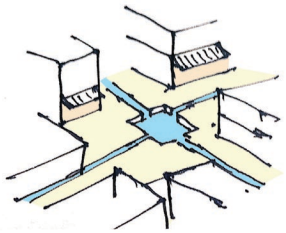
Neighbourhood level node



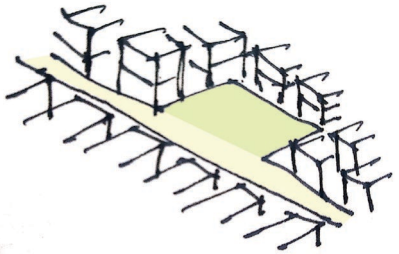
Neighbourhood level vehicular nodes



Inter-community level nodes

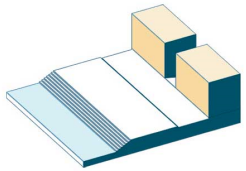


Community level nodes

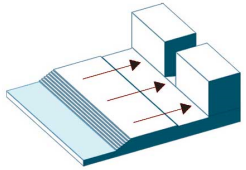


Proposed Guidelines for development

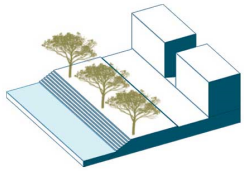
Treatment of water edge



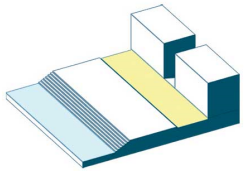
Active everyday functions to be placed along the edge of the water bodies to enhance associations with it.



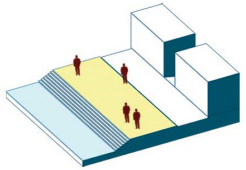
Direct accessibility, unobstructed view and building orientation facing the waterbodies to be ensured.



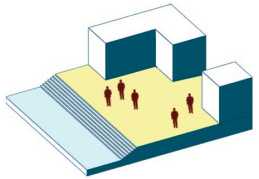
Urban forestry to be fostered along the edge of waterbodies to ensure continuity of biodiversity.



The waterbodies are to be integrated with the larger movement system especially public transport & NMT.

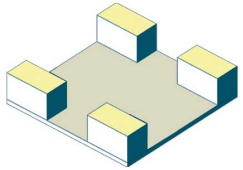


Public spaces along the edge of waterbodies to prevent privatisation of water edge, enhance associations.

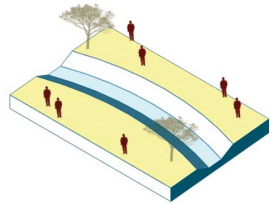


Land along water edge to be reserved for creation of economic, socio-cultural and recreational functions.

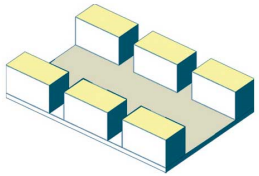
Density of development



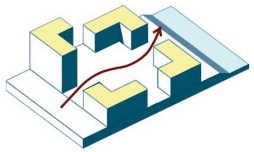
Low density residential development in the valley areas in order to ensure ground water percolation.



No development in the low-lying lands along the edge of waterbodies to prevent flooding..

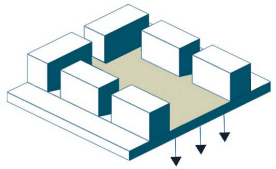


Medium density residential development in the ridge areas since they have lower percolation comparatively.

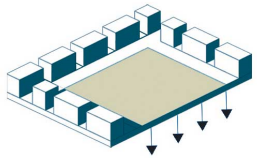


High density work areas along urban edge to have low ground coverage for ground water recharge.

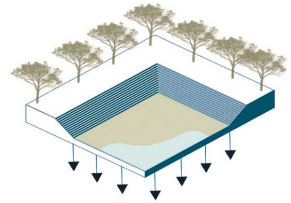
Open space design



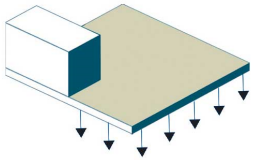
Clustering of residential buildings for creation of central open space for community pupose and recharge



Creation of compost parks in regular intervals to act as ground water recharge and urban farming areas.

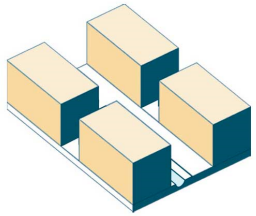


Bed of waterbodies should be completely permeable for recharge when wet and marginal farming when dry.

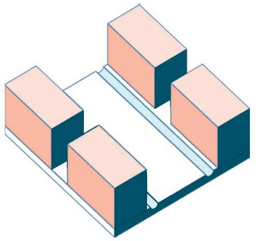


Open ground in the residential plots are to be fully permeable to ensure ground water recharge.

Building use along street edges



Community functions along pedestrian movement corridors for eyes on street, to enhance ped. experience.



Commercial/ mixed use and no setbacks along primary movement corridors due to high real estate demand.

Ecology as an integral part of the Urban experience

- Existing residential
- Proposed residential
- Existing School
- Proposed School
- Proposed Market
- Proposed Community facilities
- Proposed Integrated Waste processing centres
- Proposed Agriculture-related facilities
- Proposed mixed use-Neighbourhood level
- Proposed mixed use-Community level
- Proposed Mixed use work places
- Proposed Commercial- City level

- Pink Trumpet Tree, Gulmohar tree
- Golden shower tree
- Neem, Peepal, Mango trees
- Coconut palm tree
- Existing trees
- Mango trees
- Small trees

1. In Nodes as Landmarks
2. Thick canopy in Biodiversity park
3. Coconut plantations
4. Palm trees strengthening Bunds
5. Along Park-Channel edge
6. Along Work area-Channel-NMT edge
7. Along Work area-park-Channel-NMT
8. Along Small ponds proposed
9. Double line along Vehicular movement
10. Single line along Pedestrian movement


Public square – During Monsoon season
SCHOOL
LIBRARY


Canal edge – During Monsoon season
CAFE


Public square – During Dry season
SCHOOL
LIBRARY

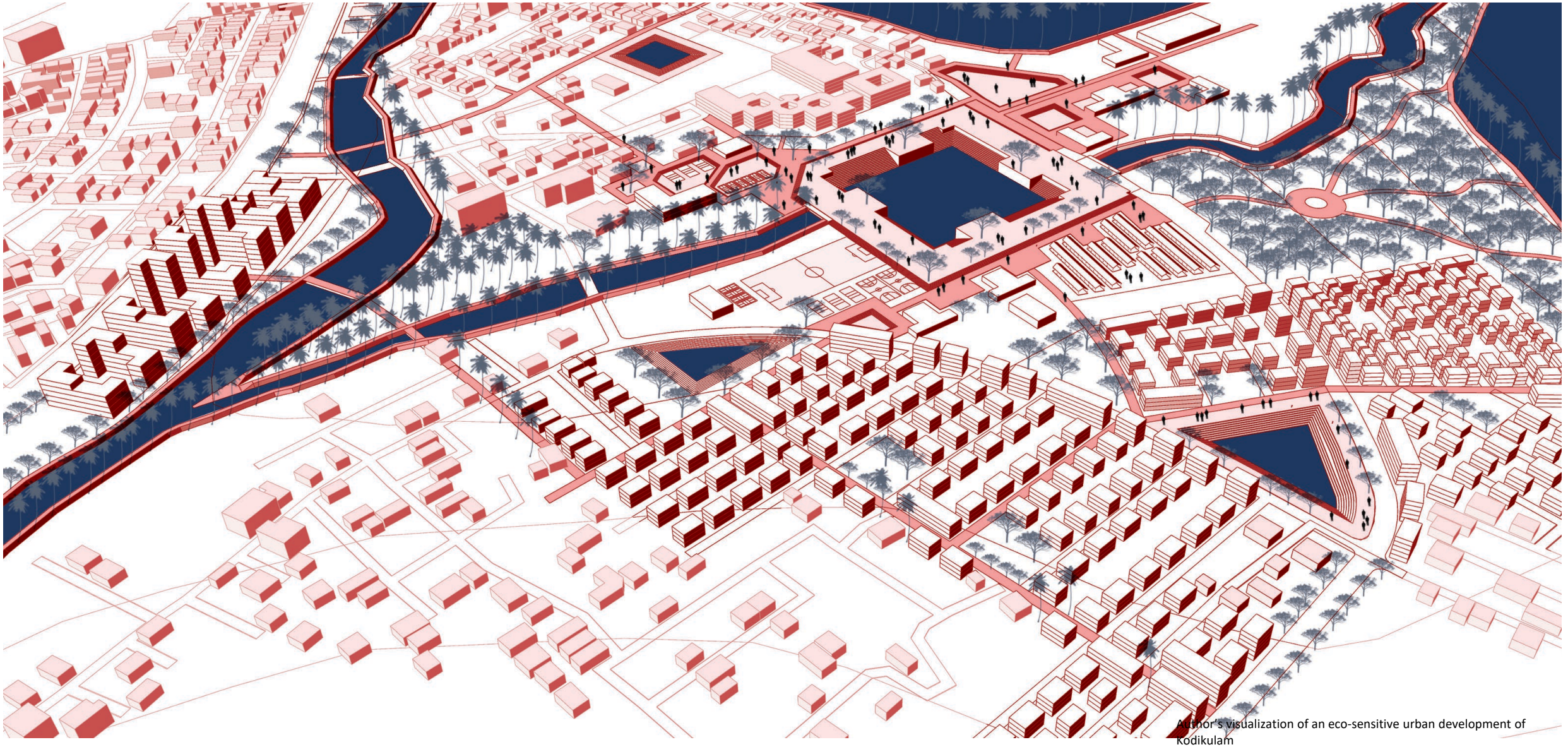

Canal edge – During Dry season
CAFE

Way forward!

While the bottom-up moves focus towards community-driven strengthening **Community – Ecology Symbiosis**, the top-down moves foster Eco-sensitive urban transformations by tackling speculative real estate development pressures and ensure that urban growth is fostered adaptively such that both the Ecology's needs as well as the Community's needs are met.

Environmentally, economically and socially interdependent communities with the ecological system whose everyday lives revolve around **sustainable waste management, water-based livelihoods, movement system** integrated with water system are the way to go about!

People from the local Indigenous communities actively engaging with the tank on a



Author's visualization of an eco-sensitive urban development of Kodikulam

Thank you