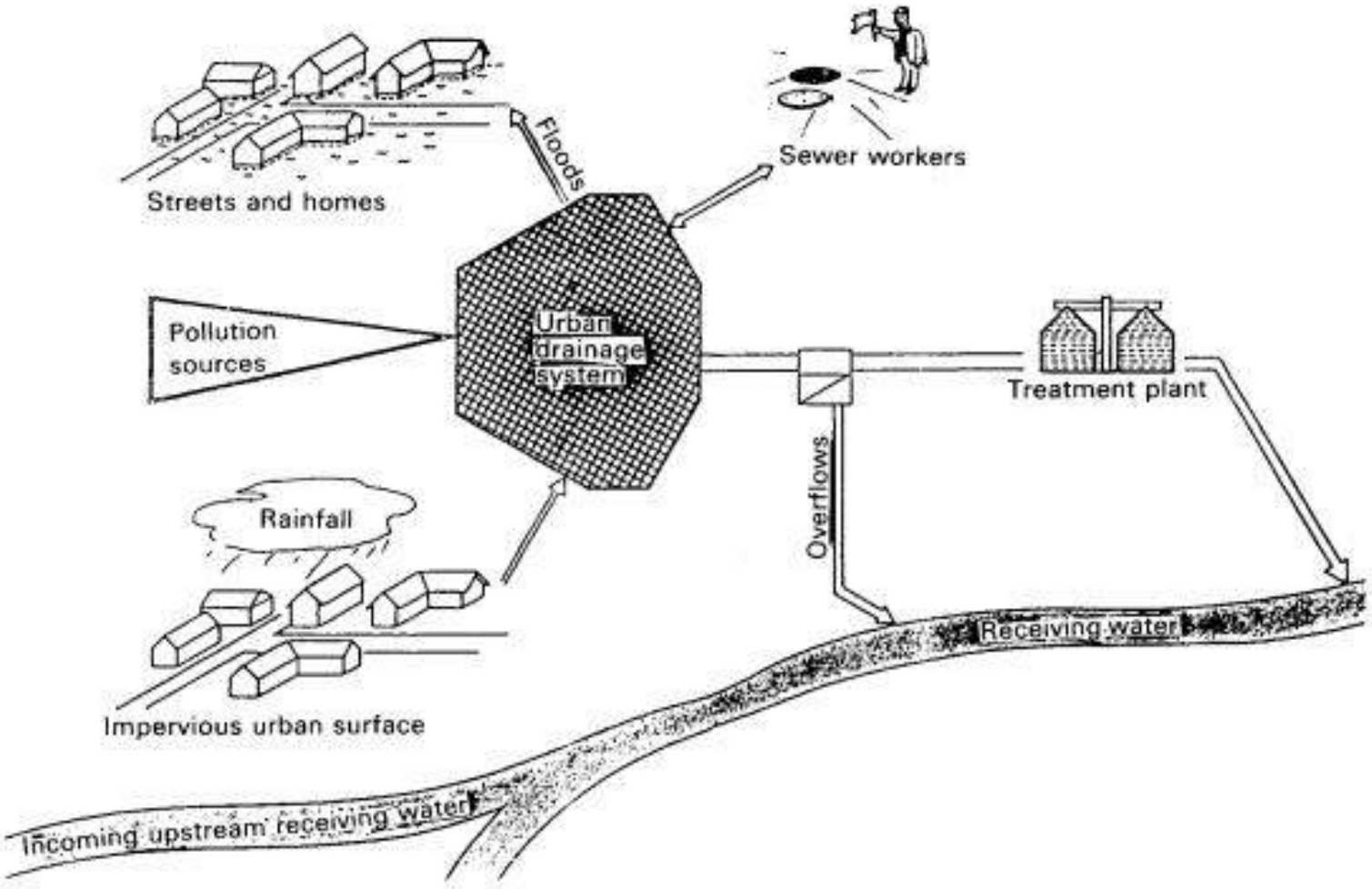
Urban Drainage Systems Considering the Urbanization Impacts

Dr. Shivangi Narayen Waghray
Asst. Professor,
Department of Urban and Regional Planning,
SPA, JNAFAU, Hyderabad.

Introduction

- Urban drainage systems are vital city infrastructure to collect and convey storm water and wastewater in urban areas.
- Despite development over the years, it remains a significant challenge to design an effective functioning drainage system.
  - frequency and magnitude of urban flooding
  - water quality problems also emerge as a result of urbanization
  - The variety and amount of pollutants in water bodies

Elements of Urban Drainage System

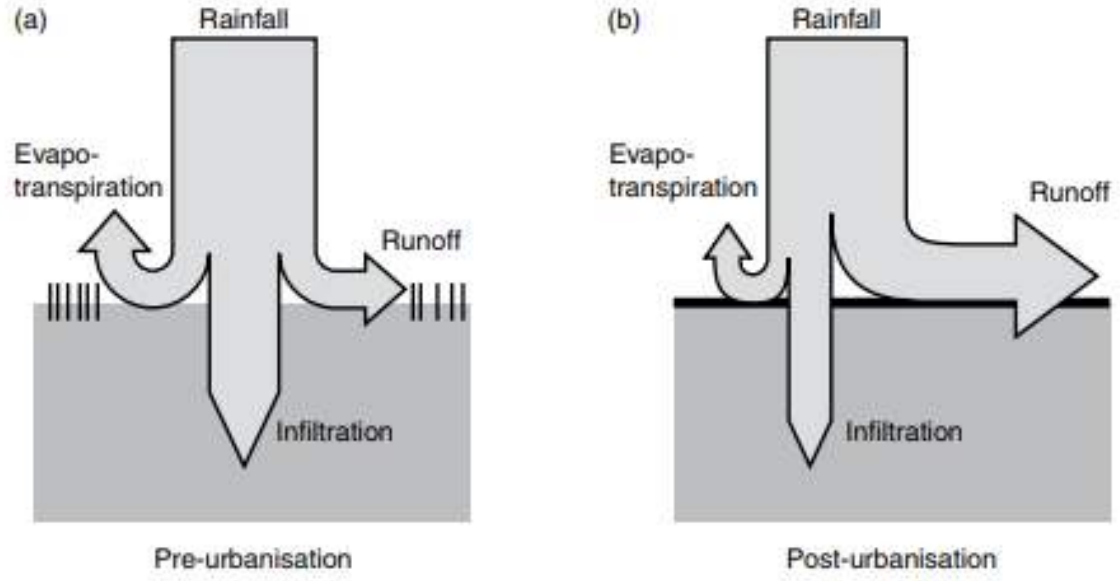


Types of Drainage

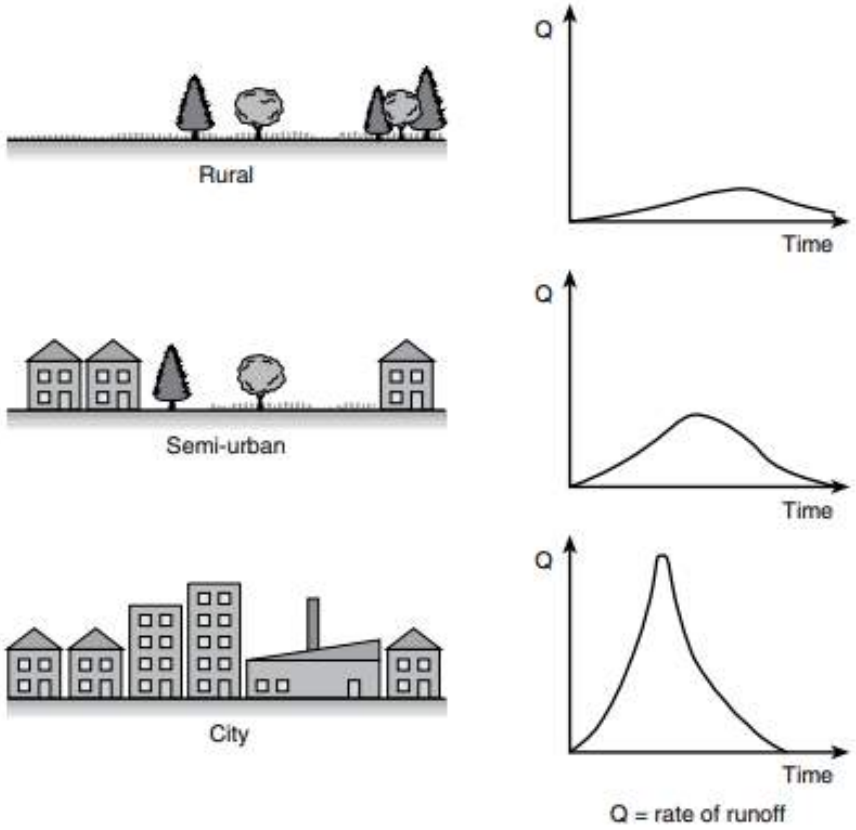
- Types of drainage.
  - The first type, wastewater from households.
  - The second type, storm water drainage from rainwater.

Urban Drainage – interfaces with public and environment

Urban Drainage – Effect of Urbanization on rate of rainfall



Effect of urbanisation



So the general effects of urbanization on drainage creates

- The need for wastewater treatment and
- Efficient rain water management

Urban drainage system

- Drainage systems are needed in developed urban areas because of the interaction between human activity and the natural water cycle.
- This interaction has two main forms:
  - The concept of water from the natural cycle to provide a water supply for human life, and
  - The covering of land with impermeable surfaces that divert rainwater away from the local natural system of drainage.

Urban drainage priorities

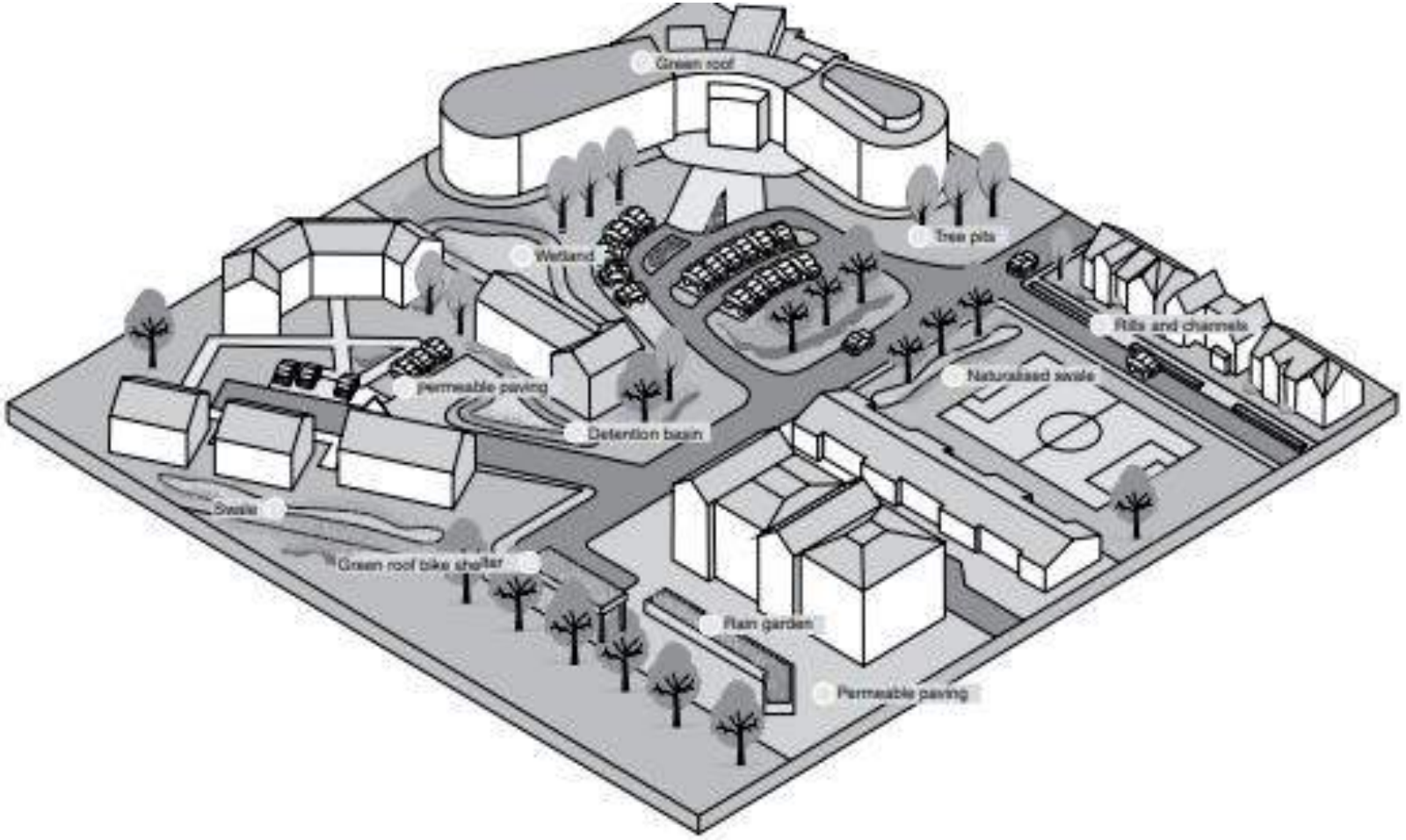
- Public health
- Minimize adverse impacts like urban flooding

- Today's drainage solutions also highlight the need and importance of urban water management, such as
  - Runoff quality,
  - Visual amenity,
  - Recreational value,
  - Ecological protection and
  - Multiple water uses.

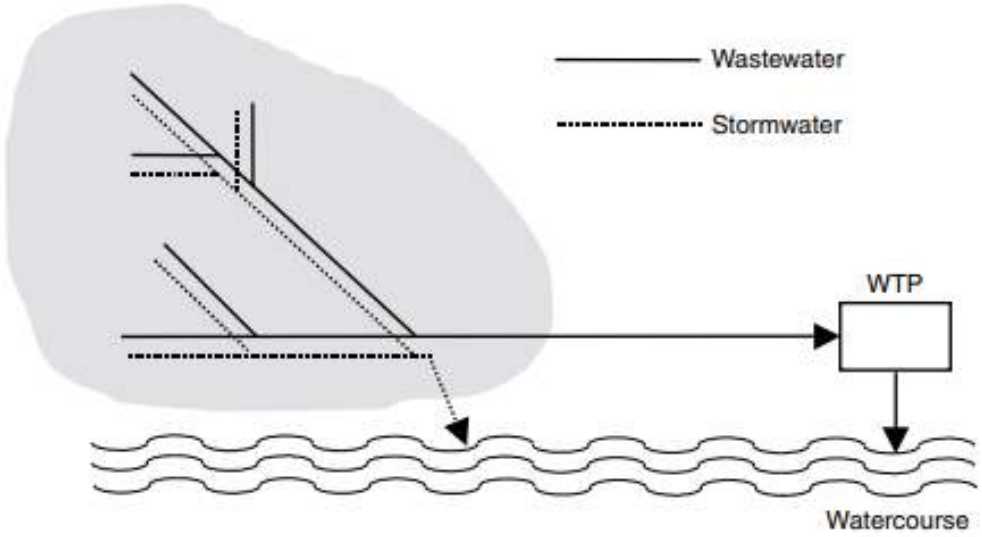
Types of Drainage system

- Combined system
- Separate system
- Partially separate system - “partially separate” systems, in which wastewater is mixed with some storm water, while the remaining storm water is conveyed by a separate pipe.
- Non pipe system

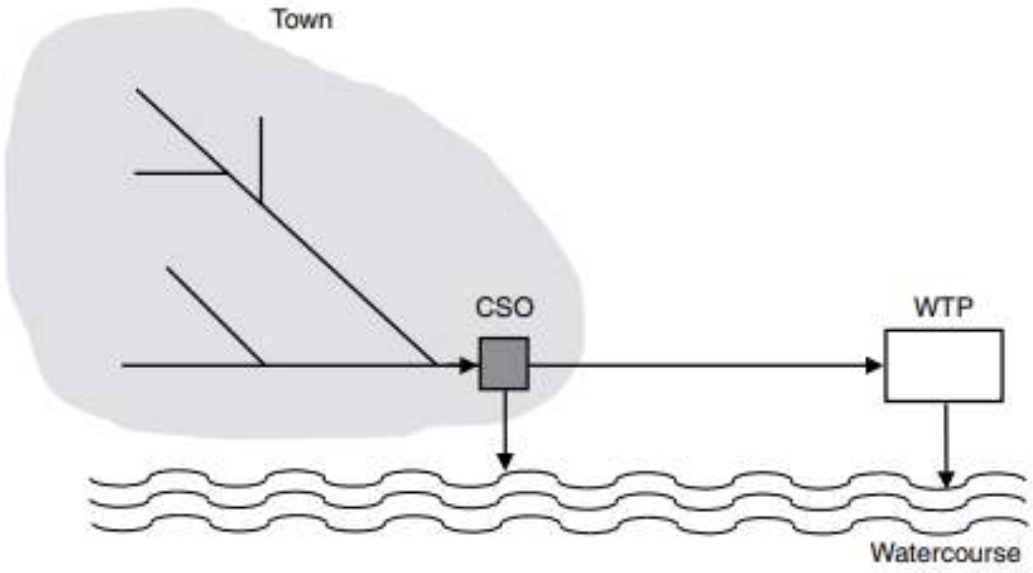
Non – Pipe Drainage System



Separate Drainage system



Combined Drainage system



Challenges to Conventional Drainage Systems

- Conventional drainage systems are designed to collect and transport water runoff from urban areas via sewer networks and water treatment facilities to nearby receiving water bodies.
- Manage water volume in order to avoid urban flooding in city areas.
- Conventional drainage system there is limited concern for water quality issues and even less for its amenity and recreational values.
- Negative impacts on urban environments

Techniques Sustainable urban drainage

- Permeable pavement;
- Semi permeable pavement;
- Detention and retention reservoirs;
- Infiltration trenches;
- Infiltration gullies;
- Infiltration wells;
- Micro reservoirs;
- Rooftop reservoirs;
- Green roofing;
- Underground reservoirs; and,
- Grassed strips.

Advantages localized sustainable drainage techniques

- According to Nascimento (1996), the advantages in the use of this type of techniques are:
  - Reduction or even elimination of the local micro drainage network;
  - It avoids reconstruction of the downstream network in the case of saturation;
  - Reduction of risks of flooding;
  - Reduction in pollution of surface waters;
  - Recharging of underground waters;
  - Good integration with the urban area.

Sustainable Urban Drainage System (SUDS)

- The most popular SUDS techniques applied nowadays include
  - Filter and infiltration trenches,
  - Permeable surfaces,
  - Water storage,
  - Water harvesting,
  - Detention basins,
  - Wetlands and ponds.

Urban Drainage System in India

- Urban storm water drainage systems have got priority in India only after drinking water supply and sewerage.
- Due to fast pace of urbanization and migration of people from rural areas to urban areas in quest of livelihood and better education, there has been immense pressure on urban infrastructure, worsening the problem of urban drainage systems in India.

Indian scenario

- Urbanisation along with recent trends in climate change is also causing the rise in incidences of acute water logging, urban flooding and related adverse economic and health impacts.
- In recent years, frequency of urban flooding has increased and the issue is getting more pronounced day-by-day due to its enormous socio-environmental hazards leading to disruption in urban life.

Indian scenario

- Some of the notable cases of flooding which caused devastating impact on economic loss as well the loss of lives are urban flooding in
  - Hyderabad (2001 and 2012),
  - Delhi (2002, 2003, 2009, 2010 and 2011),
  - Chennai (2004 and 2015),
  - Mumbai (2005, 2008 and 2009),
  - Kolkata (1978 and 2007),
  - Surat (2006),
  - Jamshedpur (2008),
  - Guwahati (2010), Jaipur (2012),
  - Jammu & Kashmir (2014) and
  - Kerala (2018).
- To address this issue of urban flooding - GoI, Ministry of Housing and Urban Affairs has introduced a manual on storm water management, May 2019.

Indian scenario contd…

- The frequent urban flooding due to flawed and non-existent storm water management in our cities during the monsoon highlights our inability to recognize the rainwater as a precious resource.
- It's a great irony that on one hand our cities are complaining of rapidly depleting water table and on the other, we are letting the rainwater get washed away into drains and sewers.
- In turn, also adding increased pressure over the drainage/sewerage network.
- Historically the cities have always had natural storm water outlets culminating into either local watersheds, rivers.
- Water tends to find its way naturally towards the lower points of the topography. Not too back in history the Baolis and stepped wells were common feature of cities designed to redirect storm water into the Ground water.

Indian scenario contd…

- However human intervention has taken it all away. The traditional system has taken a backseat due to unplanned development.
- Lakes and ponds no more exist in cities. In the beginning of 1960, Bengaluru had 262 lakes. Now, only 10 of them hold water. In 2001, when the collector of Ahmedabad listed the waterbodies in the city following a high court order, he found that 65 of the 137 listed lakes were encroached.
- Cities are also replacing the permeable land with impervious surfaces. The problem gets aggravated by the fact that drains do not have sufficient slope to draw water from surface water and channelize it.

Indian scenario contd…

- By the 1860s, Bengaluru had evolved an intricate system of harvesting rainwater. Laid out in 1866 by then commissioner of the city, Lewing Bentham Bowring, these drains carried rainwater to outlying tanks.
- Modern Bengaluru discounted this security and is now grappling with severe water shortage.
- Chennai, which has traditionally depended on temple tanks, or kulams, for harvesting rain. There are 39 kulams in Chennai, each spanning 0.4-2.8 hectares (ha). The kulams also act as flood-control devices.
- Lately, the natural course of storm-water drains, leading to these kulams, has been changed due to unplanned settlement near the catchment areas.
- The drains now flow directly to the sea without filling the tanks.

Indian scenario contd…

- Storm-water channels also formed an integral part of the forts and palaces of desert cities of Rajasthan.
- Jaigarh fort in Jaipur is a classic example of this. The fort has three underground sumps, which stored runoff rainwater drained from the Aravallis through well-designed channels. The fort still uses the stored rainwater during peak water scarcity periods in summer.
- Urban flooding is absolutely preventable. All that we need to do is to let Storm water find its right of way.

- Storm water management has two aspects-
  - Qualitative and Quantitative.
  - The learned Engineers in our municipal corporations are already taking care of the **quantitative aspect to some extent.**

Quantitative aspect

- Keep surface imperviousness under 50%, check Surface run off.
- Promote Green roof over buildings.
- Rainwater harvesting on individual plots is already mandatory in many cities. Its build quality and maintenance is of paramount importance.
- The municipal bodies need to urgently chalk out a methodology for Quality check.
- Develop stringent building codes.
- Permeable pavements, grass channels etc are some of the doable things that can be adopted at the community level.

Quantitative aspect

- The urban dense pockets must have a silt free storm water drainage system that is finally connected to some watershed.
  - (A case in the point is that of the city of Gurgaon where the connection of city level storm water drainage network to Najafgarh drain is yet to happen and currently the Badshahpur jheel is the only watershed available to the city. Hugely insufficient this causes massive urban flooding in the old Gurgaon areas and Palam Vihar, every year. This 140 Crore project to connect city level network to Najafgarh drain was sanctioned only in 2014 by the Government. Another project taken by HUDA in 2013, to build 46 KM long box type drain connecting Badshahpur jheel to NH-8 found mixed responses.)
- It is always better not to build very long drains, instead have local catchment areas in the form of lakes or ponds, however utmost care is needed in maintenance of these water bodies lest they become infested with dirt & silt.

Qualitative aspect

- Storm-water is a major source of pollution for all types of water bodies.
- Soil compaction caused by site grading and the expanse of impervious surfaces such as roads & parking lots, produce runoff that contains sediment & other contaminants, including atmospheric deposition, pesticides, fertilizers, vehicle fluid leaks and mechanical waste.
- Increased storm-water runoff can overload pipes and sewers damaging water quality.
- The idea behind Storm-water management practices is to ensure removal of about 80% of the average annual post development total suspended solids load based on existing monitoring reports.

Qualitative aspect

- Following are some management practices for removal of TSS (Total Suspended solids) from storm-water runoff-
  - Infiltration Basin
  - Infiltration Trench
  - Vegetated Filter Strip
  - Grass Swell
  - Porous pavement
  - Open Grid pavement
  - Sand filter Infiltration Basin
  - Water quality inlet with sand filter
  - Oil/ Grit separator
  - Extended detention dry pond
  - Wet pond
  - Constructed storm-water wetlands
- Each of above are capable of removing 60-90% of TSS depending on build quality, and are known as Best Management Practices in Storm-water quality control.

Factors responsible for present status of poor SUDS in India

- The natural drainage systems in most of the cities are in danger and the problem of flooding is worsening with time due to non-availability of properly engineered storm water drainage infrastructures.
- The problems are worsened due to encroachment and rampant dumping of garbage & solid waste in the drains on one hand and absence of preventive maintenance on the other hand.
- Most of the underground drainage facilities within core clusters of these mega cities are usually century old.
- The existing storm water collection network in these cities is mainly designed to serve as a combined system for sewage as well as storm water runoff.
- The coverage of storm water drainage network stands about 20% of road network and its allied catchments as per the report on Indian Urban Infrastructure and Services (March 2011), published by the erstwhile Ministry of Urban Development (MoUD) which is too inadequate to cater the storm water disposal in the present indian city scenario.

Benefits - SUDS

- Benefits of sustainable drainage systems
  - Slow down surface water run-off to help reduce the chances of flooding
  - Reduce the risk of sewer flooding during heavy rain
  - Recharge groundwater to help prevent drought
  - Provide valuable habitats in built-up areas
  - Create green spaces for people in urban areas

Way - forward

- Looking at various drainage systems and techniques we can say that localized area specific techniques can address the issue of sustainable urban drainage.
- A holistic approach is desirable where both localized techniques along with storm water drains are used.

GoI Manual on SWD

- In view of above factors GoI introduced manual on SWD with following objectives.
  - Identification and marking of probable drainage zones, direction of gradients and selection of disposal points.
  - Preparation of topographical layout of collection and conveyance.
  - Identification of locations for pumping stations
  - Strategy for rainwater storage and its recharge to ground water
  - Strategy for prevention of solid waste and C & D waste into storm water ways.
  - Strategy for arresting pollutants with urban runoff from entering into water bodies
  - Conserving the aesthetic, public safety and other social concerns of recreational open space and landscape to preserve the ecological nature of water ways;
  - Identification of existing storm water drains / drainage corridors including age-old drainage conduits for rehabilitation;
  - Non-structural measures should be studied and components designed accordingly to provide relief during occurrence of disasters due to flooding.
  - Frame a Road Map for Urban Storm Water Best Management Practices (BMP).
  - Preparation of strategy for protection of urban areas from flooding
  - Strategy for sustainable operation & maintenance of storm water systems
  - Holistic approach to local area planning including aspects of sustainability, consistency and responsive to community values.

Thank you