International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.01, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

# Impact of Underground Structures on Flow of Groundwater – A Review

**Somank kumar[1] ,Raj kumar Soni[2]**

*[1,2]Final Year, Dept. of Civil Engineering*

*IIMT college of engineering, Greater Noida, (UP) , (India)*

## ABSTRACT

Property economics favors the vertical development of cities but flow of groundwater can be affected by the use of underground space in them. This review article presents the state of the art regarding the impact of disturbances caused by underground structures (tunnels, basements of buildings, deep foundations, etc.) on the groundwater flow in urban aquifers. The structures built in the underground levels of urban areas are presented and organized in terms of their impact on flow: obstacle to the flow or disturbance of the groundwater budget of the flow system

This paper gives an account of a study review performed for the underground structures and foundation (pile raft) of buildings.

In paper, the impact of the building foundations and structures on the groundwater regime was studied using hypothetical flow and transport models. The paper uses a three-dimensional hypothetical model to investigate the change of groundwater flow. It is assumed that groundwater flow is in a steady state before urbanization and achieves another steady state after urbanization when deep foundations of high-rise buildings are added.

The water levels and groundwater discharge from the two steady-state models with and without foundation blocks are compared. The groundwater level and flow are modified to various degrees, depending on the foundations percentage and the distribution pattern of the buildings and underground structures.

***KEYWORD:- Barrier effect, Foundation, Tunnels, Piles, Urban Groundwater flow, Underground constructions.***

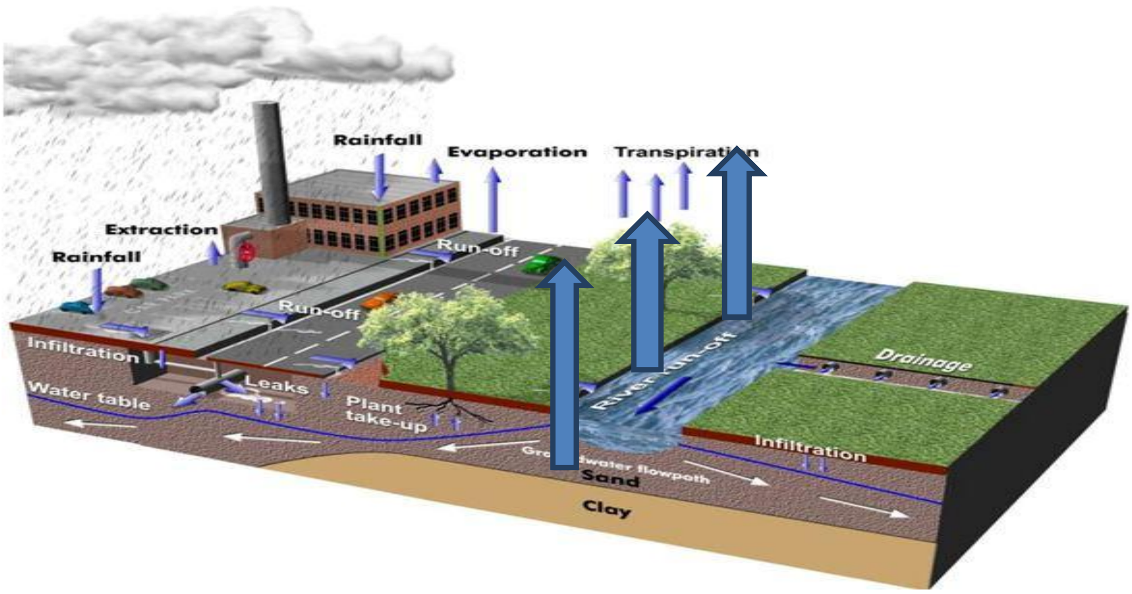
## I.INTRODUCTION

Half of the world's population now lives in cities. The phenomenon of urbanization is such that this proportion will reach almost 70% by 2050, so there will need a large space of ground.

This results in a lack of coordination and planning in the exploitation of this space, illustrated by conflicts over use, and which can be detrimental to the different systems of the underground environment. When a linear underground structure is constructed in the ground where the groundwater level is extremely close to the surface, it blocks the flow of groundwater.

Soil layering and the effect of ground water tables are mainly ignored the protection of natural spaces remains a major challenge in the effort to limit horizontal urban sprawl.Meanwhile the cities spread and demand for city center sites roseleading to higher buildings with deeper basements and foundations.Tunnels for transport and other services were also built.

Urban subsoil is now recognized as a space rich in resources available water, available space, geomaterials and geothermal heat, which play a vital role in ensuring sustainable land development but for which regulations remain wanting. Barrier effect is defined as the increase in head loss along flow lines caused by the reduction in conductance associated with an underground construction.




**(fig.no.1 – soil layer and ground structures)**

## II. IMPACT OF UNDERGROUND STRUCTURES ON THE GROUNDWATER.

The aim of the study was to quantify the cumulative impact of underground structures on the flow of urban groundwater.

A methodology to assess the actual and the potential state of the groundwater flow in an urban area is proposed. The results show that underground structures fragment groundwater flow systems leading to a modification of the aquifer regime. Structures with drainage systems are shown to have a major impact on flow systems. The comparison between the actual state and the potential state of urban groundwater flow shows that the underground structures have fragmented the flow systems The results show that underground structures fragment groundwater flow systems leading to a modification of the aquifer regime. Structures with drainage systems are shown to have a major impact on flow systems. The comparison between the actual state and the potential state of urban groundwater flow shows that the underground structures have fragmented the flow systems.

## III.THE IMPACT OF THE BUILDING FOUNDATIONS ON THE GROUNDWATER

In paper, the impact of the building foundations on the groundwater regime was studied using hypothetical flow and transport models. The paper uses a three-dimensional hypothetical model to investigate the change of groundwater flow

system as a result of distributed foundation blocks in urban areas. The urban area is considered as a bimodal system: the original porous media with high hydraulic conductivity and the deep foundation blocks with low hydraulic conductivity. The effective hydraulic conductivity was first calculated for different realizations and the results show that the effective hydraulic conductivity can be reduced significantly. Then a hypothetical numerical model based on FEFLOW is set up to study the change of hydraulic head, groundwater discharge, and seepage to the ground surface after foundations are added. The study focuses on the modification of the groundwater system by deep foundations in the long term. It is assumed that groundwater flow is in a steady state before urbanization and achieves another steady state after urbanization when deep foundations of high-rise buildings are added. The water levels and groundwater discharge from the two steady-state models with and without foundation blocks are compared. The groundwater level and flow are modified to various degrees, depending on the foundations percentage and the distribution pattern of the buildings. When the foundations percentage is high and the building foundations are aggregated, the hydraulic head is raised significantly and the originally one-dimensional groundwater flow field becomes complicated.

- **The following conclusions were drawn from the study:**

(1) Underground structures involving pumping/reinjection rates caused a fragmentation of urban flow systems. Consequently, the urban groundwater regime had been modified and an inversion of the interaction between the groundwater and the river was observed. This regime modification can lead to an influx of polluted water from the river to the groundwater

(2) Regarding water table elevation, the cumulative effect of underground structures was a global drawdown. This drawdown was caused by pumping devices (i.e. pumping wells and structures with drainage systems).

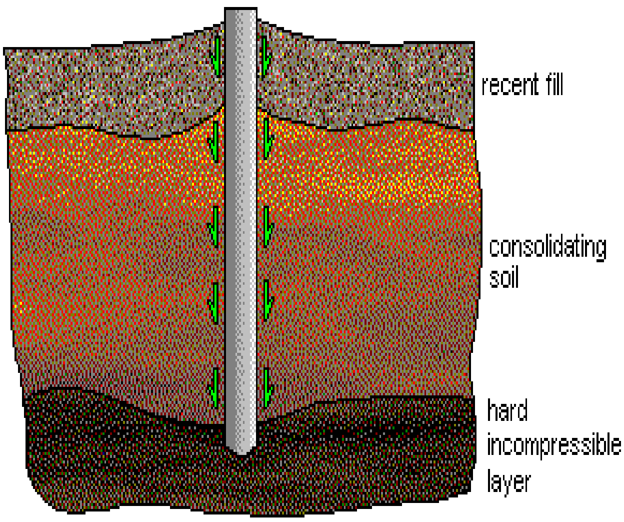
(3) Because of the small hydraulic gradient of the area studied, the impact of impervious structures was negligible. On the other hand, the influence of structures with drainage systems was emphasized. These underground structures have a major influence on urban flow systems.

(4) Transient simulation demonstrated the temporal stability of flow system structure for this case. Thus the relevance of the steady state approach for the quantitative depiction of flow systems was demonstrated. The stability of flow systems was considered an asset regarding underground planning.

IJARSE
ISSN: 2319-8354

**(fig. no. 2 - foundation of buildings )**

**(fig. no.3 underground structure)**

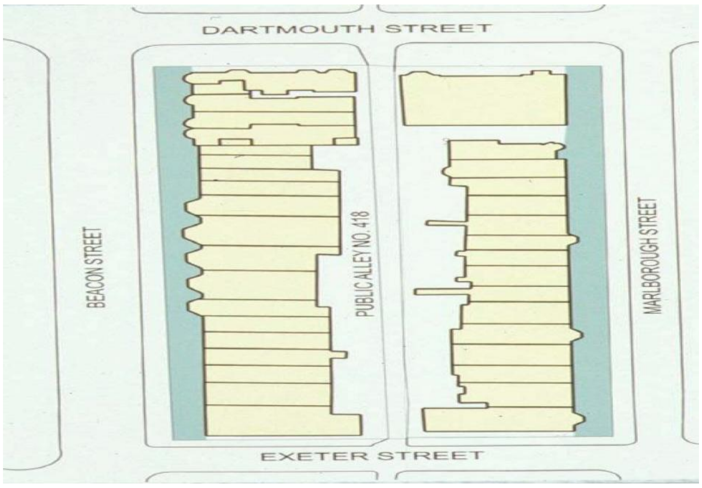


**(fig. no. – 4 pile raft foundation)**

**(fig. no. 5- underground tunnel)**

## IV.What Causes the Groundwater to be Lowered?

From an engineering or hydrogeology point of view, it is obvious that over the widespread area,
The lowering of groundwater levels is being caused by the leaking of groundwater into man-made
Below ground structures, such as pipes, tunnels and basements. Of course in the summer months when the weather is dry, the trees and evaporation can take substantial
Amounts of water out of the ground.Of all the man-made structures in the ground, only the water pipes that bring fresh water to homes and businesses are under pressure and capable of being a *source* of water to the ground.
Tunnels, basements and all other underground spaces have the same potential when they
are at levels lower than groundwater. Further complicating the problem is the fact that precipitation has very little access to enter the ground and reach the groundwater table.maximum rain water is run off in river or sewer pipe due to the lack of precipitation so that the level of ground water doesn't get rise the main factor upon which the precipitation depends are surfaces of ground and water resting time . An observation from above a typical block of houses in Back Bay is shown in Figure to illustrate just how little of the annual rainfall on the block can actually get into the ground.




**(Fig. no. 6- Plan of Typical Block of Back Bay showing Limited Area Available for Precipitation Infiltration )**

## V.RISING THE LEVEL OF WATER TABLE WHEN FLOW IS OBSTRUCTED BY TUNNEL

The paper investigates the steady state rise of groundwater table on the upstream of a shallow tunnel due to the obstruction of groundwater flow in the direction normal to the tunnel axis.

When a tunnel is constructed below water table or intersecting the water table, the existence of tunnel forces the groundwater to circumvent it by locally increasing the length of flow path and corresponding flow velocity. The required energy loss is provided by the locally increased hydraulic gradient in the length of influence. The increased hydraulic gradient in turn causes a moderate rise of water table in the upstream side. The magnitude of rise of groundwater table was investigated by 2D finite element steady state flow model around a cylindrical tunnel located at a depth (d) below groundwater table. The hydraulic gradient of water table was assumed to have a uniform initial gradient in the direction perpendicular to the tunnel axis. A graphical plot of depth of tunnel crest below initial water table in the x-axis and steady-state water table rise in the upstream in y-axis is used to analyses the results. The magnitude of rise of water table depends on the size of tunnel, depth of tunnel below water table and the hydraulic gradient. It is a time dependent process. Water table rises after construction of tunnel and reaches its maximum value

corresponding to steady state condition. This paper proposes a simple analytical method to predict the water table rise due to the construction of tunnel and the magnitude depends on the size of tunnel very much. For typical values of hydraulic gradient (0.5%-5%) the predicted water table rise is of the order of 1-10% of the size of tunnel. It shows the effect of presence of tunnel in water table rise is very much.

## VI.MODELING OFGROUNDWATER DUE TO SUBSURFACE BARRIER

Simple contour modeling has been applied to help interpret data on groundwater levels The BWSC uses the data to producegroundwater level contours which visually ‘point out’ depressions in the groundwater table.These are drawn using simple contouring program that applies free-field without regard to thethickness of the fill stratum, its interconnection to the outwash stratum, or basements ofbuildings, tunnels or other barriers to subsurface flow. Although not a fully accuraterepresentation, the BWSC contours do serve a very useful purpose of directing attention to pipesand drains in the vicinity of the depressions. When isolated mounds appear, these often indicatewater main leaks and trigger similar investigations. In the future, more accurate modeling willlikely be undertaken as research effort, primarily to assess the usefulness and affect of certainrecharge efforts or the installation of new barriers in the fill stratum. It is now being considered that additional barriers may be necessary in some instances tointerrupt groundwater flow toward withdrawals that can not be reasonably accessed or where it

will not be possible to specifically identify the exact cause of groundwater lowering. In suchinstances, it might be more practical to install subsurface flow barriers to block the drawdown, orto totally contain an area to make the groundwater stay around the area of concern.

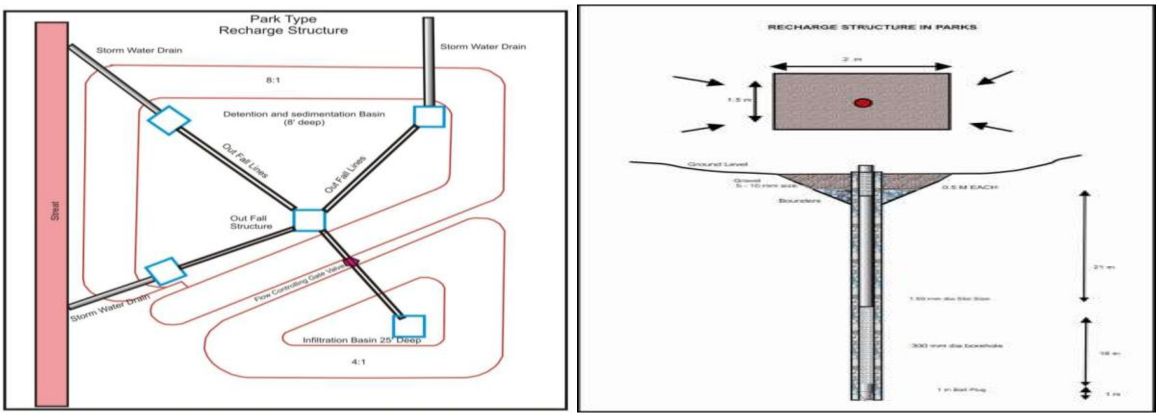
## VII.RECHARGING TO RISE AND PRESERVE GROUNDWATER LEVEL

The application of recharge systems to permit direct infiltration of precipitation into the ground
has been done for decades , but only in a few isolated areas.
Recharge systems that use sidewalk or rooftop precipitation run the risk of becoming cloggedwith time as fine particulate matter and soil particles are carried into the system. Some periodic
maintenance is therefore needed to continue the efficient operation of the recharge gallery. Such
maintenance would at a minimum have to clean the inlet basin (where water should first bedirected to permit settling out of “grit”. The annual removal of grit and organic matter willgreatly prolong the effective life of a given recharge installation, and the lack of maintenancewill shorten the system’s life (to as little as 5 to 10 years)From both a geotechnical and a water resources standpoint it isimportant to attempt to predict the rate at which the levels over theLondon Basin will change in the future and the final levels that willbe attained.

### 7.1Park Type Structures

- Parks of residential colonies and institutional areas of urban agglomerate can be fruitfully utilized for recharge to ground water.
- Rainwater from the catchment of park as well as surrounding area is diverted towards the park which is excavated in a basin type depression to accommodate the rainwater from the elevated surrounding area.
- The water is recharged through recharge shaft/ recharge wells or recharge pit depending upon the hydrogeological conditions and depth of unconfined aquifer.

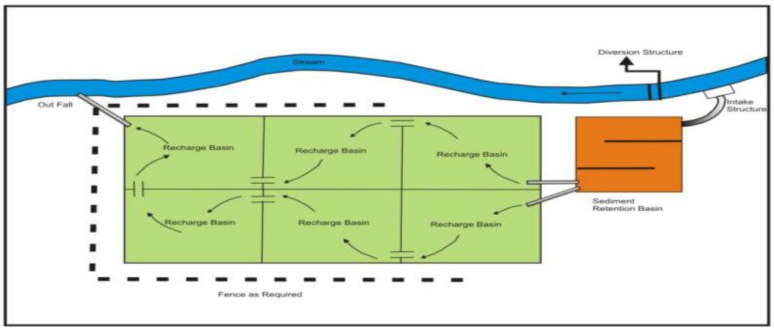
- Park type structure is used as rain water harvesting and recharge structure during monsoon and play ground in other seasons.
- Depth of excavation of park is such that the slope is in the ratio of 8:1 in the collector basin and 4:1 in the recharge basin.




**(Fig. no. 7- park type structure)**

### 7.2Basin Spreading Recharge

- Water is recharged by releasing it into basins formed by excavation or by the construction of containment dikes or small dams of dimensions varying from few meters to several hundred meters.
- The most common system consists of individual basins fed by pumped water from nearby surface water sources.
- Silt-free water avoids the problem of sealing basins during flooding.
- Basins require periodic scraping of the bottom surface when dry to preserve a percolation surface.
- Basins, because of their general feasibility and ease of maintenance, are the most favored method of artificial recharge from the surface.
- Gradients of major feeder ditches should be sufficient to carry suspended material through the system since deposition of fine-grained material clogs soil surface openings.
- The primary purpose of water spreading is to extend the time and the area over which water is recharged.

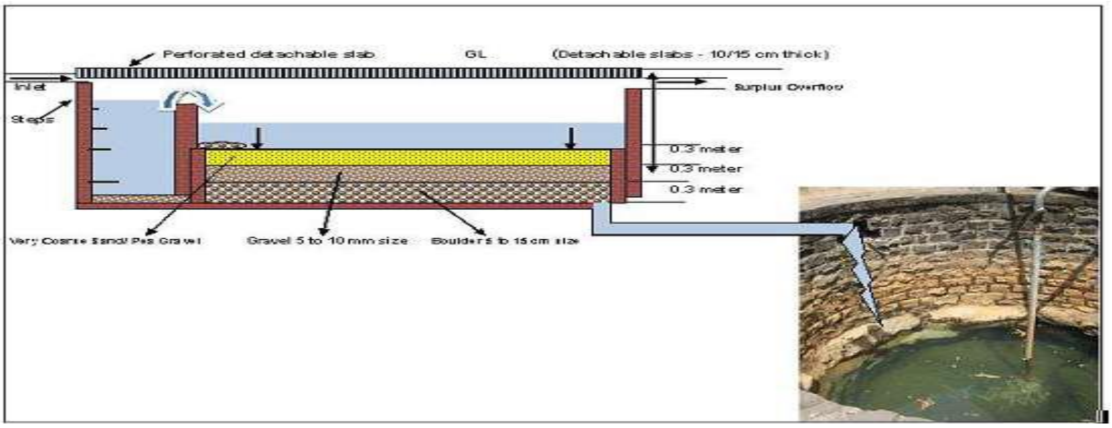



**(fig. no.8- Basin Spreading Recharge)**

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.01, February 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

### 7.3Dug Well Recharge

Dug wells are used to artificially recharge the groundwater. Generally, water level of dug wells depletes during the non-monsoon period generally in summer. Sometime the dug wells even dried up. These dug wells can be used for recharging groundwater easily .The water from various sources can be collected through a distribution system and can be discharged at the dug wells.




**(Fig. no.9- Dug Well Recharge)**

## VIII.RESULTS

Based on the above journals referred, it was concluded that underground structures reduces the area of aquifer section and affect the flow of ground water , thereby causing a reduction in effective transmissivity, leading to a rise in the water table up gradient and a lowering down gradient. Rising water levels may flood basements, promote soil salinization, affect flora by rotting the roots of plants , reduction of the bearing capacity of shallow foundations, expansion of heavily compacted fills under the foundation structures, settlements of poorly compacted fills upon wetting, increase in loads on retraining systems or basement walls of buildings. The lowering of heads on the down gradient side can cause seawater intrusion in coastal aquifers, ground subsidence and, the drying of wells and spring.

- To maximize storage(long-term & seasonal)
- Water quality improvement through dilution
- Preventing saline-water intrusion & land subsidence
- Reducing reduction volumes from river flow
- Controlling effects of climate change
- Maintaining declining ground water levels

## IX.ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to HOD of civil dept. Mrs. TabassumAbassi for her support and cooperation as well as Mr. Satish sir who gave me the golden opportunity to prepare a review paper on "Impact of underground structures on flow of groundwater " I am grateful to all of those with whom I have had the pleasure to work during this and other related projects. Each of the members of my team has provided me extensive personal and professional guidance and taught me a great deal about both scientific research and life in general.

## REFRENCES

[1.] Book :- Engineering Hydrology by ksubramanya
[2.] Book:- Soil Mechanics and Foundations by B.C. Punmia, **Ashok Kumar Jain &** Arun Kumar Jain
[3.] http://nptel.ac.in/courses/Groundwater Management/module.html
[4.] https://www.journals.elsevier.com/tunnelling-and-underground-space-technology