ACTION RESEARCH PROJECT

PROMOTION OF INTEGRATED WATER RESOURCE MANAGEMENT IN PERI-URBAN IN DELHI NCR

In

Garhi Harsaru, Gurgaon

Supported by

Prepared by

TARU Leading Edge, New Delhi

In partnership of

DECEMBER 2015

जल संरक्षण

जल में बसते है प्राण,
उसकी बचत करना है हमारा काम,
उसको बेकार करना है बुरी बात,,
उसको बचाना है हमारा काम,
जब पानी की पडेगी कमी,
चिल्लाएगा हर व्यक्ति पानी,
ना जाने दुनिया को क्या हो रहा,
उनको क्या पता जल बेकार हो रहा,
फिर तरसना पडेगा बूंद के लिए,
याद आ जाएगी नानी,
फिर मांगोगे पानी,
क्योंकि है जल ही प्राणों का रक्षक।

Source: *Recited duirng Expempore Competition by a school student*

Table of Contents

EXECUTIVE SUMMARY **6**

Section 1. INTRODUCTION **10**

Section 2. ACTION RESEARCH **16**

2.1 IMPORTANCE OF THE STUDY 16

2.2 ACTION RESEARCH PLAN 16

2.3 SCOPING EXERCISE 17

2.4 LITERATURE REVIEW 18

2.5 SELECTION OF LOCAL PARTNER 19

2.6 TECHNICAL ADVISORY COMMITTEE (TAC) 20

2.7 RESOURCE MAPPING 20

2.8 COMMUNITY CONSULTATION AND AWARENESS ACTIVITIES 21

2.9 PRIMARY DATA COLLECTION 22

Section 3. FINDINGS/ANALYSIS **26**

3.1 OCCUPATIONAL PROFILE 26

3.2 SOURCE OF WATER SUPPLY 26

3.3 WATER SUPPLY SERVICE LEVEL 29

3.4 WATER STORAGE 30

3.5 WATER QUALITY 31

3.6 SANITATION STATUS 36

3.7 SOLID AND LIQUID WASTE MANAGEMENT 36

3.8 TREATMENT AT HH LEVEL 38

3.9 AGRICULTURE 39

3.10 WATER STATUS IN SCHOOLS/ANGANWADIS 40

Section 4. SOLUTION MAPPING **42**

4.1 SOLUTION MAPPING PROCESS 42

4.2 INTEGRATED SOLUTIONS FOR GARHI HARSARU 43

Section 5. CONCLUSIONS, RECOMMENDATIONS & WAY FORWARD **45**

5.1 CONCLUSIONS 45

5.2 WAY FORWARD 49

5.3 INDICATIVE WATER INVESTMENT PLAN 49

5.3 INDICATIVE INSTITUIONAL AND ADVOCACY STRATEGY 51

ANNEXURES 53

List of Figures

Figure 2. 1: Map Showing HH Data Collected in Village Garhi Harsaru 24

Figure 3. 1: Primary Occupation of the Head of the Household (N = 607) 26
Figure 3. 2: Main Source of Drinking Water for HHs (N = 607) 27
Figure 3. 3: Depth of Borewell and Adequacy of water from Borewell (N = 370) 28
Figure 3. 4: Frequency of water from the Govt. PWS in summers (N = 206) 29
Figure 3. 5: Frequency of water from the Govt. PWS for the rest of the year (N = 206) 30
Figure 3. 6: Average Capacity of Overhead Tanks in Litres (N = 607) 31
Figure 3. 7: Water Quality for PWS (N = 206) 32
Figure 3. 8: Water Quality for Borewell (N = 370) 32
Figure 3. 9: Solid Waste Management Facility within the HHs (N = 607) 36
Figure 3. 10: Liquid Waste Management Facility (N = 607) 37
Figure 3. 11: HHs segregating waste at home (N = 607) 37
Figure 3. 12: Waste Management program (N = 607) 38
Figure 3. 13: HHs treating Water (N = 607) 38
Figure 3. 14: When will your village start facing water shortages (N = 591) 39
Figure 3. 15: Presence Of Agriculture Land With Average Land Holding 39
Figure 3. 16: Source of Irrigation and Irrigation System (N = 58) 40
Figure 3. 17: Map showing Schools/Anganwadis data coverage 40

List of Tables

Table 3. 1: HHs who increased the depth of borewell in last 10 years (N = 370) 28
Table 3. 2: Type of Storage Structure (N = 607) 30

Abbreviations

BCM	Billion Cubic Meter
COI	Census of India
FGD	Focus Group Discussion
Ft	Feet
GP	Gram Panchayat
GPS	Global Positioning System
GWP	Global Water Partnership
GWT	Ground Water Table
HHs	Households
IWP	India Water Partnership
IWRM	Integrated Water Resource Management
MCM	Million Cubic Meter
NCR	National Capital Region
PHC	Public Health Center
PHED	Public Health and Engineering Department
PRI	Panchayati Raj Institutions
PWS	Piped Water Supply
SLWM	Solid and Liquid Waste Management
Sq. kms	Square Kilometers
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
UA	Urban Agglomeration

EXECUTIVE SUMMARY

Delhi NCR is a water scarce region, largely dependent on groundwater and surface water resources located outside the region. Average annual rainfall in NCR generally varies from 500 mm to 850 mm. It is estimated that on an average, NCR receives about 22542 MCM/year of rainfall; about 75% is received during the monsoon season. The expanding peri-urban areas experience issues in terms of infrastructure and physical underdevelopment. Water stress is one of the major problems faced in these areas. Rising population, increasing per capita water demands for domestic uses, environmental sanitation, increasing municipal & industrial uses, environmental management services, compounded by dwindling local sources of water and increasing inability of peri-urban water utilities all compound the problem.

Integrated Water Resources Management (IWRM) is a solution to the water problems with improved water governance and management. IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM approach considers participatory and inclusive principles with knowledge frameworks which helps the development of the action research plan. A pilot initiative was launched in this regard implemented by TARU and supported by IWP/GWP with a 'hypothesis that Integrated Water Resource Management is one of the best approaches to ensure safe and sustainable water even in rural setting'. One of the methodologies used were action research to test it which is used to solve an immediate problem to improve the way they address issues and solve problems.

The first step as part of the action research was the identification of appropriate water stressed peri-urban area. The scoping exercise was carried out in eight villages Abhaypur, Khedla, Chandu, Ghamroj, Hariyaheda, Mahchana, Basunda and Garhi Harsaru situated in the outskirts of Gurgaon. Each of these villages was visited by the project team, the criteria considered for Scoping included intensity of water scarcity/water stress and water quality, level of urbanization and inclination towards / peri-urban characteristics (based on changing land-use, occupational diversification), declining dependence on agriculture, rapidly growing population. This information was collected through discussions with the Community, Stakeholders and one on one interview with households. Based on the information collected from secondary and primary sources the **village of Garhi Harsaru in Gurgaon was selected.** Garhi Harsaru has seen a rapid influx of people /migrant population and associated urbanization and changing lifestyle.

Once the village was selected to develop an implementation plan, TARU partnered with S.M Seghal Foundation. The partnership ensured that action plan, ground situation was assessed through surveys, resource mapping and focused group discussions in an effective manner. To further strengthen the approach and the implementation aspect a Technical Advisory Committee was formed with eminent members from IRC and Sehgal to review the project.

One of the key steps of the action research study was resource mapping at Garhi Harsaru. Resource mapping aimed to identify the number and type of water resources in the village and mapping the geographical location of the source using GPS. Resource mapping exercise was undertaken by the TARU team on the field/village area through participatory observation method which included transect walks and visual documentation to gain insights of the ground situation in the village.

Resource Mapping resulted in identifying the drinking water and agricultural water resources, the water source type and the physical mapping of the source. It was observed that the core of the village/old areas had access to piped water supply from a public water source which is chlorinated before supply. There is

no other water treatment facility in the village. In addition to these, there are 23 existing source/delivery point/stand points.[1]

Consultation meetings were organized in the village, with the panchayat members (Sarpanch and others), Educational Institutions (School Principal and teachers) to understand their views on the water related issues. In addition to the consultations, primary data collection were collected through one on one interviews with all key stakeholders, group discussions and triangulations, Household, school and anganwadi surveys.

Groundwater is the only source of usable, fresh water in the village especially when domestic, agricultural, and industrial water needs can only be met by using the water beneath the ground. Over-extraction of groundwater has resulted in lowering of the water table due to pumping out more water than it can be replenished. 60 percent of the population relies on individual borewells. About 33% of the village population has access to public water supply and the rest on handpumps and tubewells.

70% of the households depend on borewells with depths varying from 100 to 200 feet, though residents find the quantity of water still inadequate. A very small percentage of households use handpump as a water source. There is no metering system for the PWS and no charges are incurred by the residents using public water supply, which is available free of cost to the people in the village. Adopting metered water supply systems are the best way to ensure judicious use of water.

Based on the survey and discussions, it was found that groundwater tables are lowering. Lower water table means water has to be pumped farther to reach the surface, using more energy can be cost prohibitive in the long run and is not a sustainable or viable option. Rapidly increasing population (at the rate of 39.25%)[2] has also stressed the existing water resources further caused lowering of the groundwater tables.

Moreover there is no focus on surface or rainwater management. With climatic variation looming large, there is severe threat to ground water resources if the increasing population continues to extract groundwater in unregulated manner.

Lowering of groundwater table has affected the quality of water. Excessive pumping causes saltwater to move inland and upward and has resulted in saltwater contamination of the water supply. Water quality assessment was conducted by an accredited laboratory. Around 13 samples were collected from various location considering individual households, agricultural and public water supply sources. High levels of Hardness and TDS have also been reported at many places. The water quality test reports indicate, fecal contamination at few places indicating the need for treatment.

The water supply through the public water system is intermittent and when provided, the supply is for just an hour, in the morning and in some cases in the morning and evening. Inadequate and inefficient systems PWS has caused people to depend on individual borewells. In the survey, about 60% of the households mentioned that they use individual borewells.

45% of the HHs surveyed[3] who practice agriculture is dependent on groundwater sources. Those who do not rely on the public water sources tend to over-use the water during the period of water availability.

[1] NRWDP
[2] COI, 2011
[3] Primary survey

Solid waste from the households is being dumped in the open areas; there is no system of collection, and proper disposal. No system for segregation of SWM or Liquid Waste Management was found. No system of management of water and wastewater has been functioning properly in the village resulting in poor service levels, wastage and depleting water resources. There is no system of metering or monitoring of the water supply, absence of which has led to wastage of water.

Water conservation programs/campaigns are not carried out at the HH/ community level. Moreover, people are not aware (nor experience) of water shortage issues / quality issues and hence do not practice any water conservation/water treatment measures. But they are aware of the future water shortage[4].

The action research exercise was built on the hypothesis that integrated water resource management is one of the best approaches to ensure safe and sustainable water in the village. The study recommends the following to address the water issues for the village within this framework. Augmenting Groundwater by Constructing Roof top Rainwater harvesting structures, Recharging of Groundwater, Reuse of Water Improving Water Quality through filtration and disinfection at HH level.

Improving Service Delivery by extending the coverage and increasing the efficiency to two times a day and aiming for 24x7 in the future. Meters should be installed at the consumer end for effective monitoring of amount of water used which shall help plug water wastage. Reducing Water Wastage by improvements to the agriculture practices that can help reduce the over extraction of groundwater sources, which include shifting to better practices/behavior, Shifting to better irrigation methods such as drip irrigation, Change to less water intensive crops, No irrigation during heavy winds.

Awareness campaigns should be conducted regularly to highlight the importance of water conservation and reducing water wastage. Integrated plan for solid and waste management to be developed - Zero waste SWM Model should be used to address the solid and liquid waste problems in the village as part of the integrated solution.

In order to ensure that the recommendations are implemented, a well-defined institutional structure is required with clear roles and responsibilities to lead the processes in a sustainable. Formulating a Water and Sanitation Committee to address the water and Sanitation related issues, etc.

For sustainable development, building partnerships with different stakeholders is essential. One of the key stakeholders to be involved is the community. Awareness campaigns should be conducted regularly to highlight the importance of water conservation, reducing wastage. These can be done at the community level, school level, HH level using different mediums such as shows, street plays, competitions, consultations etc. Importance of segregation of the solid waste at source needs to be highlighted at the community and HH level through awareness campaigns, street plays etc.

Also the village needs centralized liquid waste management system. Groundwater and surface water are connected. When groundwater is overused, the lakes, streams, and rivers connected to groundwater can also have their supply diminished. The options of using surface water for drinking or agricultural purposes should be considered. The existing sources of surface water near the village should be explored as an alternate source.

Currently there is no system of reusing the wastewater in the village. Options of reusing the water after treatment, for gardening or agricultural purposes has neither been explored nor been encouraged in the village. Currently there is no system of water treatment in the village. Though the actual water wastage

[4] Based on the household survey and group discussions

has not been quantified, it is estimated that around 30% unaccounted water in water supply systems. Considering this, system of reuse and recycle should be explored, encouraged and implemented in the village.

Competition for water use continues to increase and drinking water supply can no longer be separated from agricultural and industrial use. Integrated water resource management needs to address the water issues in entirety.

The next steps would include development of Water Investment Plan. The main aim of the Water Investment Plan is to provide a comprehensive framework for sustainable development and management of the water resources, as well as to highlight the main areas that the investment will be directed, in which an effective legal and institutional framework for its implementation will be put in place. The plan will include a water security plan, water safety plan and a solid and liquid waste management plan.

Water Security Plan refers to the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.

Water Safety Plan ensures the safety and acceptability of a drinking-water and the Solid & Liquid Management Plan is about redesigning this resource flow so that most of what is generated as waste can be reused as raw material for further production. This resource flow is more sustainable and will take us closer to ‘zero waste’.

Section 1. INTRODUCTION

1.1 BACKGROUND

We live in a world of growing interdependence. The impact of economic, financial, and natural crises spread faster than ever before, and affects more people. When one part of an economy collapses, it can trigger a chain reaction across the globe. Water security is influenced by all of these global challenges. The financial crisis has constrained capital investment in increasing water security in many countries. Changing weather patterns have caused catastrophic floods and droughts. The lives lost, damage done to homes and businesses and direct economic losses from these water-related disasters have had a negative impact on employment, social services, and infrastructure.

World's oceans cover about three fourth of the earth surface. However the fresh water constitutes only 2.7 % of the Earth's total water. Out of which 75.2 % are locked up in glaciers and ice caps[5]. India is endowed with a rich and vast diversity of water resources. India has seasonal rainfall with high temporal and spatial variability. 50 % of precipitation in a year falls in just 15 days and over 90 percent of rivers flow in just four months (www.india-reports.com). Only 4% of the world's fresh water share is present in India for supporting 16% of the world's population. India receives about 4000 km^3 of precipitation annually distributed over 100-120 days, but this rainfall is non-uniformly over India. Almost all the irrigation is dependent on rainfall in India. The other source of fresh water is ground water which is beneath the Earth's surface between the cracks and spaces in soil, sand and rock. Ground water is an important source of water in India. It is the major source of drinking water in both urban and rural India and also an important source for irrigation. It accounts for about 80% of domestic water requirement and more that 45% of the total irrigation requirement in the country[6]. The natural recharge of ground water also occurs through precipitation.

Social values have been changed thus impacting the water management. The ground water is continuously being pumped from lower levels, beyond the capacity of the rainfall to recharge it. The ground water is also getting contaminated due to industrialization and urbanization and it is due to the human interferences that the ground water is getting degraded and depleted. Although water is a renewable source, but it is not always available where and when it is needed which makes its consumption limited. This situation is further exaggerated with growing population, rising standards of living, changing land use, urbanization, increasing economic activity and climate change. Recognizing this, it becomes important to implement the principals of Integrated Water Resource Management (IWRM) to address threats from growing population and economy which increases the demand of water. This interdependence calls for integration in the natural system as well as human system.

Safe drinking water, sanitation and good hygiene are fundamental to health, survival, growth and development. However, these basic necessities are still a luxury for many of the world's poor people. Health and hygiene is largely dependent on adequate availability of drinking water and proper sanitation and its access is a fundamental human right and essential to life, health and dignity. Consumption of unsafe drinking water, improper disposal of human excreta, improper environmental sanitation and lack of personal and food hygiene are the major causes of human diseases in developing countries such as India.

[5] http://wrmin.nic.in/

[6] http://www.iisc.ernet.in/currsci/sep102005/794.pdf.

Water Resource Situation across the country:

- 17.4% households are slums
- 43.3% of households don't have drinking water source within the household premises

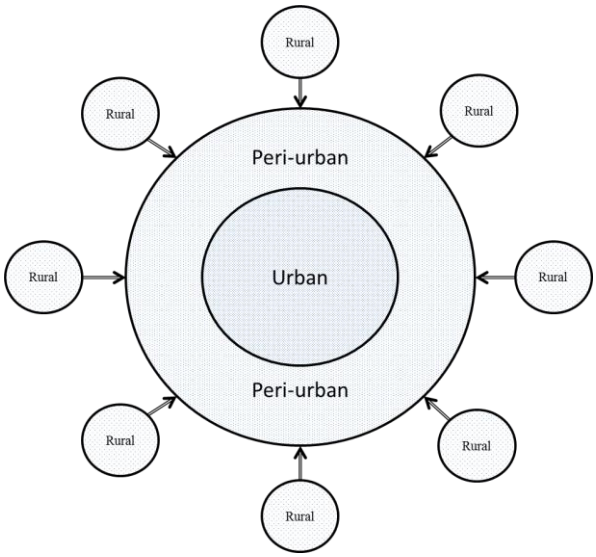
Water Situation across NCR of Delhi:

- 14.6% of urban households are slums (U)[7]
- Out of 27 Groundwater assessed units, 74% (20 in no.) are over exploited and 19 percent are semi-critical[8]

Increasing population and rapid economic growth in India has created strong pressure to convert agriculture land to industrial and residential and these areas having land use change are described as 'peri-urban'.

Peri-urban areas (also called urban space, outskirts or the hinterland) are defined by the structure resulting from the process of peri-urbanisation. It can be described as the landscape interface between town and country, or also as the rural—urban transition zone where urban and rural uses mix and often clash.

As the cities grow and expand, peri-urban areas become the part of the cities and more villages become peri-urban areas. This creates several problems in terms of infrastructure development and delivery resulting into huge pressure on natural resources. Out of the 4041 statutory slums in India, it has reported that 2543 (63 percent)[9] towns have peri-urban setting around them which accounts for 1.08 slum blocks in 2543 towns compromising 137.49 lakh households' populations in the country. Peri-urban areas are not just geographically distinct, but are also socially distinct.



"Today's Peri-urban is tomorrow's big cities. Therefore we have to catch them young & groom them before it is too late"[10]

[7] COI, 2011

[8] http://wrmin.nic.in/

[9] COI, 2011

[10] Periurban Area: A Review of Problems and Resolutions, IJERT, Vol. 4 Issue 09, September-2015

It has been estimated that Asia's peri-urban populations will increase by approximately 200 million over the next 25 years, accounting for 40 percent of urban population growth[11]. The situation is worst in India. As indicated in the COI, the area for urban uses has increased from 38,504 sq kms in 1961 to 64,026 sq kms in 1991 with decadal growth rate from 8.72 per cent during 1961-71 to 20.54 per cent during 1971-81 to 21.81 per cent in 1981-91[12]. The population has also grown nearly two and half times in last 50 years but urban population have grown nearly five times. In 2001 total 306.9 million Indian were living in 3700 towns and cities spread across the country. In 2011 total 377 Million or 31% population was living in urban areas[13]. This urban population is expanding on the expense rural areas which are getting transformed into urban areas. Transformation being a lengthy process develops hybrid population having both rural and urban characteristics referred to as peri-urban. This growth is adding pressure on resources and infrastructure, which is mostly old and was designed for a much lower population, and resource and infrastructure shortages are causing major bottlenecks to growth. Thus there is a lag between the demand increase and infrastructure building to meet those demands.

Inhabitants of these peri-urban areas are exposed to deteriorating quality of life stimulated by deforestation, water depletion, non-existent mechanisms of sewage disposal and pollution. These areas often lie outside the legal jurisdiction of the city and sometimes even outside the legal jurisdiction of any local body. They are situated near or within the larger metropolitan region and are not even provided by many of the basic services except electricity. These areas lack piped water supply and sanitation facilities. So they obtain water from other resources such as ponds, tubewells etc. and the water is not treated; and for sanitation, they build their own septic tanks or surface drains that empty into local streams. No municipal services are provided for solid and liquid waste which lies along roadsides. This leads to not only deterioration of local landscape but causes serious health hazards.

According to the GOI, the areas are considered urban based upon two criteria. One is administrative criteria that is, all statutory towns and urban local bodies are considered as urban and the other is demographic and economic criteria that is settlements with a population exceeding 5,000 persons, with a population density of 450 persons per sq km and with three-fourths of the male workforce in nonagricultural activity, are considered urban. But only the statutory towns are given municipal status and the rest are governed by rural local bodies and in rural areas services such as water supply, sanitation etc. are not given. But as they lie near or within the metropolitan region, they have urban lifestyle.

Urban population in Gurgaon has grown exponentially since the expansion of BPO/IT/ITES. There has been a large influx of population largely from Delhi and surrounding states of Uttar Pradesh, Punjab and Rajasthan. This migration in the city has led to rapid urbanization and further growth of urban outgrowths in continuation of the municipal boundaries of the city popularly known as peri-urban settlements. The total population of Gurgaon UA was 228820 in 2001, which was 62% of the total urban population of the district. The figure below represents the growth of urban population in Gurgaon.

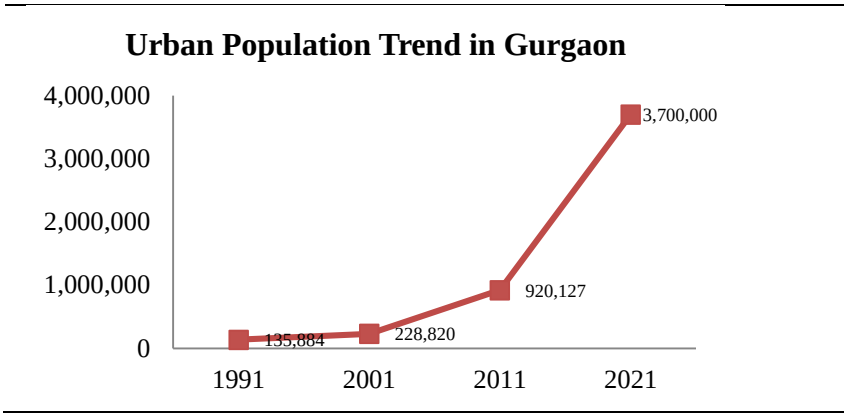
Around one-third of the population in India is already residing in urban areas and increasing and thus the role and importance of peri-urban areas is also increasing. Water, Sanitation and SLWM are the few of the basic amenities that need to be planned for these areas. This highlights the need to not understand the process and dynamics of urbanization but identify and map the transformation to accommodate the growth. Integrated Water Resource Management (IWRM) is one of the key tools to address the water

[11] http://www.eastwestcenter.org/

[12] http://www.indiaenvironmentportal.org.in/files/peri%20urban.pdf

[13] Peri urban Area: A Review of Problems and Resolutions, IJERT, Vol. 4 Issue 09, September-2015

issue which is interactive, community based and specific to local area requirements and promotes sustainable water use.



1.2 INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

Water is often an overlooked element in sustainable development but is very critical for life. To find long lasting solutions to all the water problems, a new water governance and management paradigm is required which is termed as IWRM. The word IWRM has different definitions for different scientists and researchers. But all the definitions clearly indicate that IWRM is an approach to water management that seeks to integrate physical as well as human systems.

The most commonly used definition was cited by Global Water Partnership (GWP): **Integrated Water Resources Management (IWRM)** ***is a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems***[14].

The goals of integrated water management is to ensure access to water and sanitation infrastructure and services; management of rainwater, waste water, storm water drainage and runoff pollution; control water borne diseases and reduce the risk of water related hazards. Conventional water management strategies were equipped to meet the demands earlier, but are not able to manage the population stress now days. Thus there is a need to adopt the policies under IWRM.

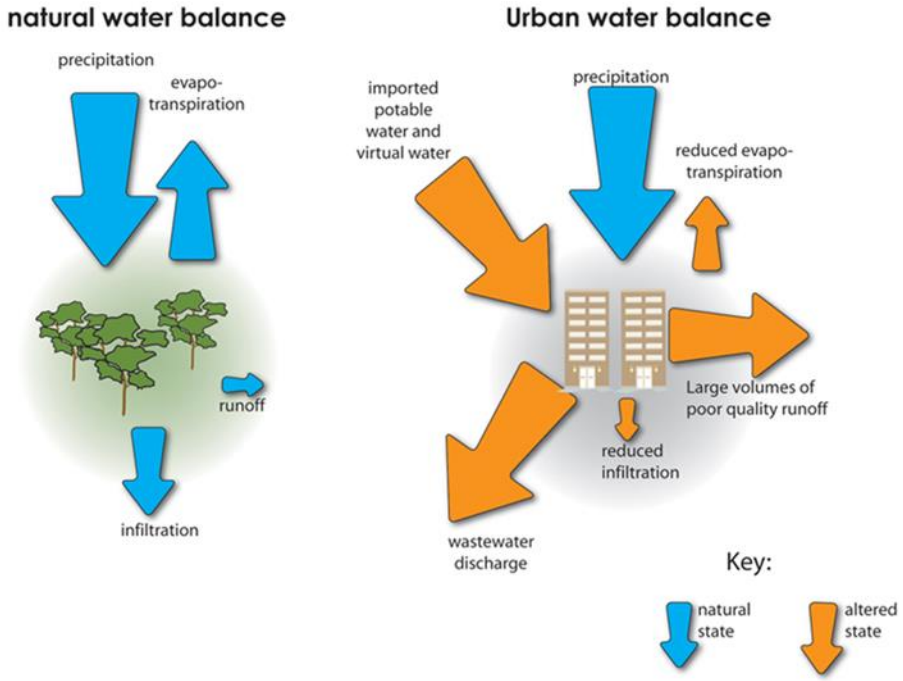
IWRM is based on the three principles: social equity, economic efficiency and environmental sustainability. It integrates all the resources to be together and incorporates both social and environmental considerations directly into policy and decision making in water policies. IWRM is a multi-sectoral approach in assessing and managing all the developmental issues that includes securing food production in irrigated agriculture, better management of water quality thus reducing health risks, assists disaster preparedness, water management of shared basins and assists appropriate planning of water use with better resilience. IWRM mainly focuses on more coordinated decision making across different sectors of water cycle and at different scales and works to achieve mainly three key objectives[15]:

- **efficiency to make water resources go as far as possible**

[14] http://www.gwp.org/
[15] http://www.sswm.info/category/concept/iwrm

- **equity, in the allocation of water across different social and economic groups**
- **Environmental sustainability, to protect the water resources base and associated ecosystems.**

The growing population and economy has altered the natural water balance. The altered water balance or the urban water balance which is similar to the peri-urban has reduced infiltration and increased runoff, thus affecting the ground water recharge. This alteration needs immediate action across all components of water cycle. The difference between the natural and the peri-urban water cycle has been presented below. In this context the role of IWRM is crucial and imperative, as it has a holistic approach towards the management of water resources and addressed all aspects of the water cycle.



Source: http://www.engineeringnaturesway.co.uk/

Thus, with increasing water stress level especially in regions exposed to variance in rainfall, climate change, and population pressure, Integrated Water Resource Management becomes a prerequisite to ensure for sustainable water supply. Many models have been demonstrated on IWRM looks at surface water, ground water, rainwater and recycled water; however, innovations are needed to make it more efficient and effective. Possibilities lie in integrating this with water quality, sanitation and climate initiative as well as energy efficient technologies; along with creating synergies with local knowledge, capacity, local institutions; and community.

1.3 STUDY OBJECTIVES

The main objective of the study is to promote Integrated Water Resource Management in Peri-urban setting in NCR using participatory, subsidiarity and inclusive principles within partnership and knowledge frameworks.

Other objectives include:

- To develop IWRM Action Research in peri-urban area of National Capital Region of Delhi

- To develop innovative IWRM plan, supported by advocacy strategy for policy and funding support

The Initiative

As indicated, with increasing water stress level especially in NCR exposed to variance in rainfall, climate change, and population pressure, the need for Integrated Water Resource Management is increasingly realized for sustainable water supply. Contextualizing this, TARU Leading Edge partnered with IWP for IWRM Action Research in peri-urban area of National Capital Region of Delhi with objectives to develop innovative IWRM plan, supported by advocacy strategy for policy and funding support. A pilot initiative was launched in this regard implemented by TARU and supported by IWP/GWP with a 'hypothesis Integrated Water Resource Management is one of the best approaches to ensure safe and sustainable water in the village'. One of the methodologies used were action research which is used to solve an immediate problem to improve the way they address issues and solve problems.

The initiative planned to be owned by local community and institutions for improved sustainability of the project inputs. The action research geared to showcase innovative methods of data collection, community engagement process and planning by involving a community researcher, schools, local knowledge practicners and local leaders. This was in sync with GWP's three goals:

Section 2. ACTION RESEARCH

2.1 IMPORTANCE OF THE STUDY

Delhi NCR is a water scarce region, largely dependent on groundwater and surface water resources located outside the region. The constant increasing population and consequent rising demand due to urbanisation alters the water cycle to a large extent and pose serious challenges for the availability of water. Average annual rainfall in NCR generally varies from 500 mm to 850 mm. It is estimated that on an average, NCR receives about 22542 MCM/year of rainfall; about 75% is received during the monsoon season (July-September). A part of rainfall infiltrates into the ground and recharges aquifers another part of rain water is lost to interception by vegetation, soil moisture and evaporation. The major challenge lies in utilising this runoff in small catchments of NCR, and the remaining rainwater runs off to natural drains or rivers.

Ground water is major source of water in NCR which is used for all irrigation, domestic and industrial uses. The stage of groundwater development in NCR (ratio of annual draft to net ground water availability) in 2009 was about 103%, as compared to 61% for India as a whole[16]. This shows that there is an imbalance between the net annual recharge and withdrawal in NCR indicating very clearly that groundwater withdrawal significantly exceeds the rate of aquifer recharge. For this reason it is important to understand the present water resources situation of the region and develop an integrated water resources model which accounts all the components of water cycle.

The expanding peri-urban areas create and experiences several problems in terms of infrastructure resulting in inheritance of physical underdevelopment. Water stress is one of the major features of the peri-urban areas being experienced by India now days. The exponential growth in water demands owing to rising population, increasing per capita water demands for domestic uses, environmental sanitation, municipal & industrial uses, environmental management services, compounded by dwindling local sources of water and increasing inability of peri-urban water utilities to improve the water supply infrastructure and undertake necessary institutional reforms have precipitated this crisis. Reducing per capita supplies and reliability, huge water wastages, growing inequity in access to water and inefficient pricing of water across different classes are some of the problems. Growing deprivation of the urban poor to water for basic survival needs is a rude shock presented by the crisis.

2.2 ACTION RESEARCH PLAN

Integrated Water Resource Management is an ***Action Research Project which also focuses on means and methods to improve approach of the study and associated stakeholders, along with problem identification and mapping solutions.***

Developing the action research involves identification of the area, studying previous literature, understanding the previous work undertaken. In order to implement the action plan, in ground situation needs to be assessed through surveys and focused group discussions and would require the knowledge and expertise of a local agency. The overall methodology to develop action research plan is divided into four phases as presented below:

[16] CGWB

The action research focuses on providing knowledge and technical support in planning, organizing and preparing a framework to address the issues of water scarcity, quality through a demonstrable action plan for integrated water resource management. The recommendations of the action research plan were to substantiate with advocacy and institutional strategy.

2.3 SCOPING EXERCISE

Scoping to identify potential sites/finalize the study area *for research and the key issues for in-depth investigation and research using available resources.*

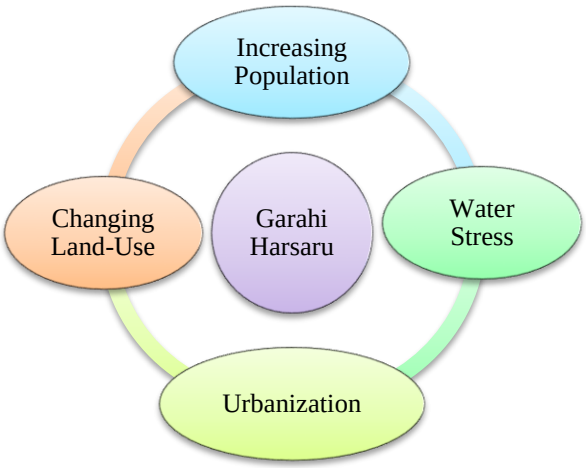
The first step as part of the action research was the identification of appropriate water stressed peri-urban area. The scoping exercise was conducted was carried out in eight villages. Scoping criteria to delineate the study area included

- **Intensity of water scarcity/ Water stress and water quality**
- **Level of urbanization and inclination towards / peri-urban characteristics (based on changing land-use, occupational diversification)**
- **Declining dependence on agriculture**
- **Rapidly growing population**

The villages considered for the study included Abhaypur, Khedla, Chandu, Ghamroj, Hariyaheda, Mahchana, Basunda and Garhi Harsaru situated in the outskirts Gurgaon. Each of these villages was visited by TARU team and information was collected through discussions with:

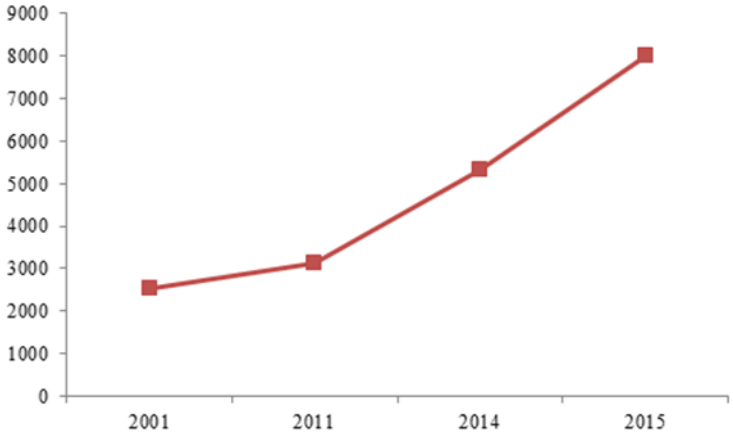
- **Community**
- **Stakeholders**
- **One on one interviews**

Based on the information collected from secondary and primary sources the **village of Garhi Harsaru in Gurgaon was selected. Garhi Harsaru** has seen a rapid influx of people /migrant population and associated urbanization and changing lifestyle.



Garhi Harsaru's population has been increased from 3140 persons in 2011 to 8000 persons in 2015 at a rate of 39.25 percent. Increasing population, higher densities, and urbanization has resulted in changing land-use as agricultural land gave way to other activities. Proximity to the urban area and associated economic activities has aided the population growth.

Population Trend in Garhi Harsaru



Source: GOI (2011), MDWS (2014), Primary Research (2015)

2.4 LITERATURE REVIEW

Literature review aimed to identify current strands of peri-urban research, especially as they relate to the NCR. This involved studying of previous works done in the field of water management, water issues studies in the peri-urban areas etc.

Secondary data was collected from government and other agencies and institutions to capture the population growth, level of urbanization, usage of water, water levels, and administrative information.

This information was used to understand and correlate the rapid urbanization and the associated implication on water sources.

As part of the literature review, past studies were studied. One of them was the scoping study report for Gurgaon done by MDI on Water security in peri-urban South Asia, adapting to climate change and urbanization – Water Security in Peri-Urban South Asia. The study was designed as an exploratory study to understand peri-urban water security in a context of climate change and looked at processes shape the water security of peri-urban. Residents, how are these effects further aggravated by the impacts of climate change and variability. Vulnerability groups etc.

Central Ground Water Authority have been warning that Gurgaon's water table has been declining at a rate of about two meters (six feet) every year since 2006. Haryana draws 2.72 billion cubic meters of water whereas the annual availability is 2.64 bcm within NCR. It is predicted by the scientists that the city will have no water left by 2017 and this will also have serious implications for the residents of peri-urban Gurgaon, since their remaining water resources would also be under severe threat. The digging of bore wells was barred in Gurgaon in 2001. But, in the past three decades, 35,000 bore wells have come up, of which only 9,780 are registered[17].

There is a wide variety of ways in which urbanization and climate variability shape the water security of peri-urban residents. The uncertainty associated with water supply caused by climatic variability is further aggravated by the processes of urbanization. The issue is not only that of water scarcity, but also of excess. Further, water insecurity is experienced differently by different groups of people depending upon social relations as well as their location in village networks and power structures that allocate resources, goods and services. Adaptation responses also vary and are shaped by a mix of technological and institutional factors.

As part of the paper on water scarcity and adaptation in peri-urban Gurgaon, India: emerging socio-technical regimes for sustainable water use[18]. The process of changing land use has placed great stress on the village's groundwater resources. The large number of farm-houses competes for the village's groundwater as the owners of these farm-houses are able to suck deep into the aquifers, using costly, high powered submersible pump-sets that local residents cannot afford.

Based on earlier work and understanding the sensitivity and criticality of the water issues in peri-urban areas, it was felt that the problem needs to be addressed through an integrated approach. Integrated Water Resource Management shall be a coordinated effort for development and management of water.

2.5 SELECTION OF LOCAL PARTNER

For the effective implementation of the program, TARU partnered with S.M Seghal Foundation which provided:

- **Technical Assistance in the project**
- **Implementation Support**
- **Guidance and Review of project outputs**

[17] Water Security in India: Hope, Despair, and the Challenges of Human Development; Vandana Asthana, A. C. Shukla

[18] Vishal Narain, PhD, Associate Professor, School of Public Policy and Governance, MDI

Seghal Foundation is an emerging knowledge leader on rural development issues in India, the foundation engages in participatory research, impact assessment, interactive dialogue, and community media to take informed actions and achieve sustainable results. Sehgal Foundation's approach to ensuring water security in rural India is to build the capacities of villagers and local leaders to manage community-led water projects, and to teach them the importance of hygiene and sanitation practices in growing healthier communities, and how to effectively advocate and campaign for safe drinking water.

2.6 TECHNICAL ADVISORY COMMITTEE (TAC)

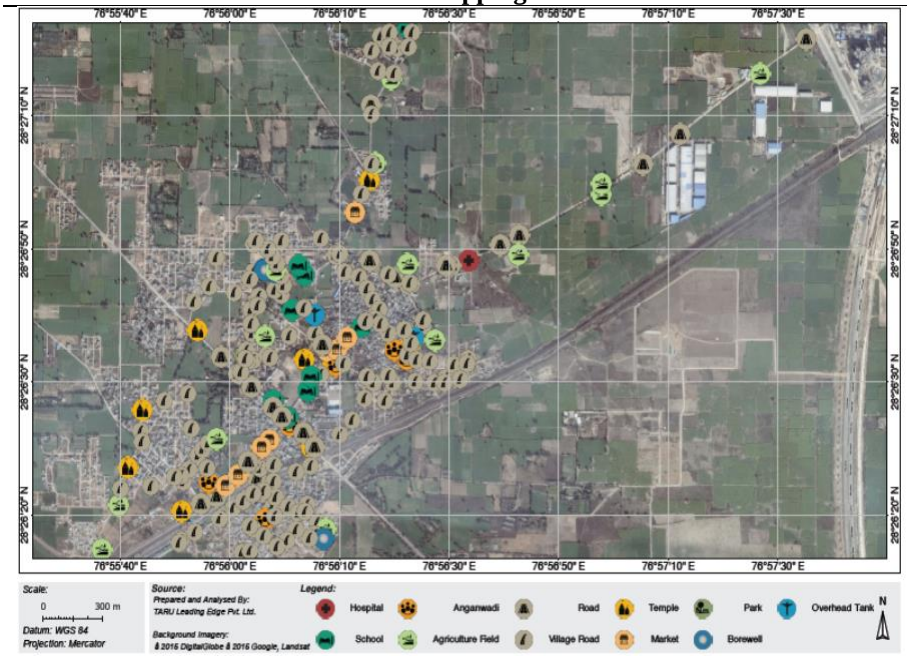
A Technical Advisory Committee was formed for guidance, recommendations and advises to TARU in the successful implementation of the project and meeting the project objectives. The Technical Advisory Committee has experts in the field of water resources from different organizations that includes experts from IRC, S. M. Sehgal Foundation (SMSF), IWP and others. In addition to providing guidance during the study, helping in developing the road map, the technical committee also played a proactive role in ensuring the quality of work and documentation.

2.7 RESOURCE MAPPING

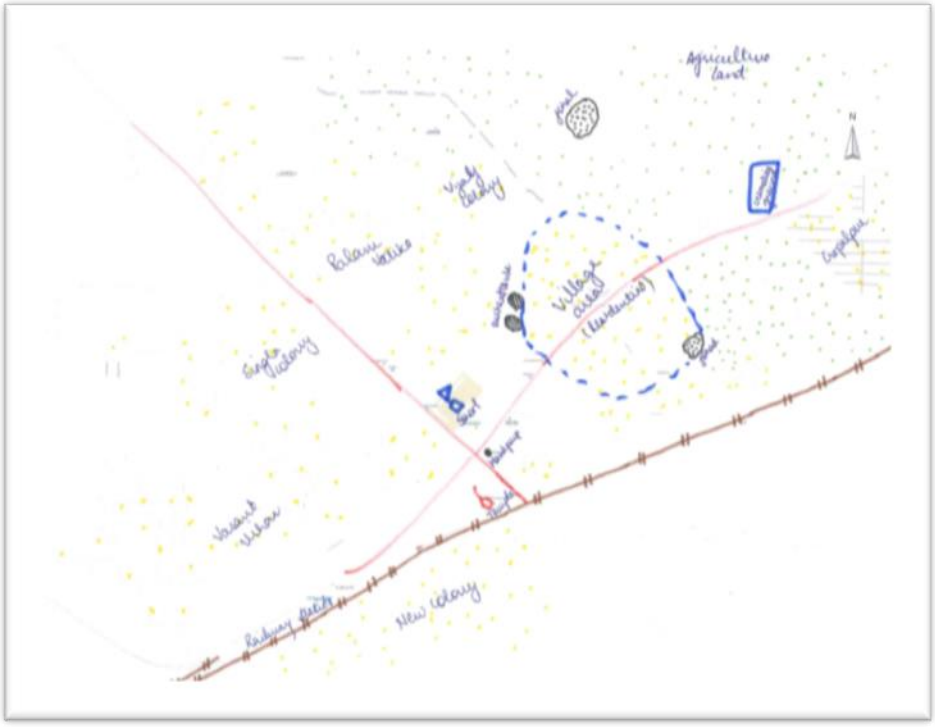
Resource Mapping involved the mapping of the various water sources in the village area, which are the water source to the households /agriculture etc. Resource mapping was done using GPS. It was done through P**articipatory Observation including transact walks and visual documentation** to gain insights of the ground situation in the village.

Participatory observation involves establishing a rapport within a community and learning to act in such a way as to blend into the community so that its members will act naturally. It is done using transect walks that covers location and distribution of resources, features, landscape and main land uses along a given transect.

GPS Resource Mapping in Garhi Harsaru



Resource Mapping with Community



The village is demarcated in two portions- the *lal dora* area which is the actual/old village area and the other part is the colonies which have been being constructed on the periphery and agricultural land that characterizes it as peri-urban.

The village is completely dependent on groundwater for its water usage for all purposes. Even the government Public Water Supply (PWS) is dependent on groundwater.

The core of the village/ old areas has access to piped water supply from a treated water source. In addition there are 23 existing source/delivery point/stand points.[19] The village has a total of 18 tubewells; out of which 10 are owned by group of farmers while 8 by individual farmers[20].

2.8 COMMUNITY CONSULTATION AND AWARENESS ACTIVITIES

Consultation meetings in the village were organized with the panchayat members and School Principal and Teachers to understand the water related issues. These interactions formed the base for developing awareness programs. Awareness programs were formulated and conducted in the village.

A drawing competition cum awareness program was organized in the Senior Secondary Government School with students from class 6th to 8th. Approximately 160 students participated in the competition.

[19] NRWDP
[20] Ministry of Water Resources,

The theme for the drawing competition was water conservation. The Sarpanch and other PRI members along with the principal of the school presented the winners of the drawing competition with prizes.

A presentation on Water Conservation was done in the School to make students aware about the importance of water and conservation measures

Assessment of the water quality using the Water Testing Kit was carried out in the Senior Secondary Government School. The demonstrated water quality testing kit enabled the students to understand the quality of water, and whether the drinking water consumed by them was potable.

2.9 PRIMARY DATA COLLECTION

- Interview with all key stakeholders: In addition to the surveys, information on community water sources, availability and services was gathered through Key Stakeholder Interviews at various levels.
    - GP level: One interview with Panchayat Pradhan and other PRI members
    - Key interviews with govt. officials

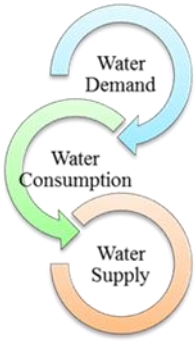
- Group Discussions and Triangulations: In order to triangulate the findings of the sample survey, interviews, and focus group discussions were conducted at village level.
    - Focused Group Discussions with Community members
    - Focused Group Discussions with Farmers
- Household, school and anganwadi surveys: Pre-coded questionnaires capturing the proxy indicators for measuring water availability, demand and supply components were administered.

The following parameters were used to define water status and proxy indicators were developed through the survey questionnaires to capture these parameters:

- Source of water for drinking and other purposes in the household
- Water Quality

- Water Storage
- Complaint Redressal System for water problems
- Health & Hygiene
- Solid and Liquid Waste Disposal in the village
- Agricultural Uses

The assessment revolved around three broad parameters i.e. Water Demand, Water Consumption and Water Supply which are interlinked and formed the basis of the assumptions and the analysis.

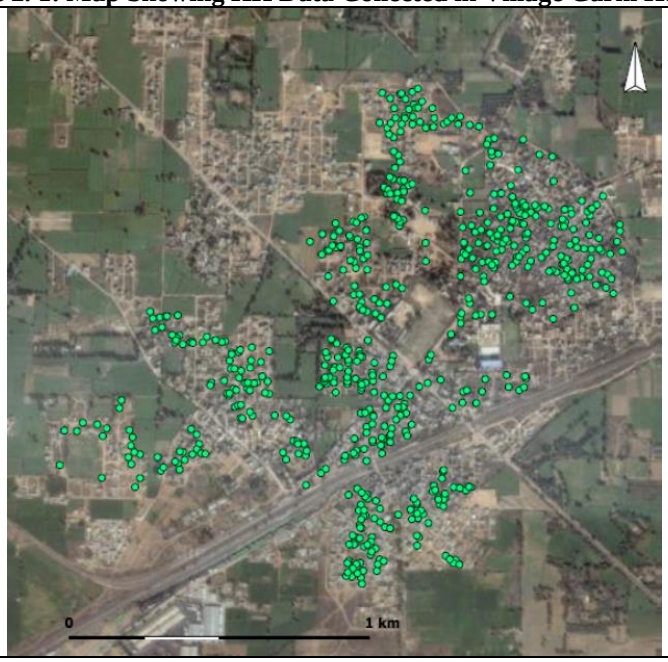


The qualitative study was in the form of FGD's and discussions; and quantitative assessment was done using primary as well as secondary data. The following scope/areas were considered in developing the questionnaires for the study.

Profile of Village, HH, Schools, Aganwadi, PHC	• Profile of the village (social-economic status etc.) • HH, Schools, and Anganwadi (in terms number of students, building and facilities, water conservation, waste water treatment etc.)
Access and usage of facilities	• Assess the usage and access of all the water systems in the village • Usage and access of Sanitation facilities • Solid and liquid waste management facilities
Service & Technical Issues	• Water table level • Capturing the service levels (piped water supply, ground water resources such as handpumps, wells, tanker supply) • Technological issues of infrastructure availability, etc. • Issues of inclusiveness • Adequacy of infrastructure facilities for both availability and treatment (Overhead tanks at HH level and community level; water treatment plant which is technically feasible and socially and economically viable) • Water quality
Institutional and Program Issues	• Policies and programs including highlighting roles and responsibilities of existing institutions and group • Initiatives/projects undergoing in the village
Monitoring and Regulation	• Monitoring system within and outside to assess the functioning and performance of the water and sanitation program • Water supply and demands
Behaviour Issues	• Assessing the awareness level and behaviour issues related to water availability and usage • Hygiene practices

The study was conducted at 607 Households, 15 School/Anganwadis, 6 FGDs (Community and farmers) and Key Interviews with PRI members, PHED, village and block level officials. The sample was proportionality distributed as per the village population.

Figure 2. 1: Map Showing HH Data Collected in Village Garhi Harsaru



Information on different residential areas in the village was gathered based on their location and approximate number of households. A village street map was drawn about the habitation pattern based on the knowledge from the local people as shown below. Representative households were chosen from each residential area, ensuring at the same time that these households represented the socio-economic composition of the village.

Target Respondents

For the household surveys, the respondent was an adult household member, preferably a woman. In schools and anganwadis, the principal/head master and the anganwadi worker were target respondents, respectively.

i. Study Tools for HH Survey & Research Protocol

For household surveys, pre-coded close-ended questionnaires capturing the proxy indicators for water availability, demand and supply, solid waste management and other issues faced by the village were administered. All HH interviews were taken after prior consent from the Households.

For focus group discussions and in-depth interview, semi-structured discussion guidelines were prepared. The focused group discussions considered people from the community, the local leaders as well as farmers and was carried out in the village.

The household questionnaires were translated from English to Hindi. The study instruments were pre-tested before the actual survey was administered.

Key Indicators for assessment: To plan an Integrated Resource Water Management system for the area, both source and system sustainability components were to be considered. Through quantitative and qualitative methods, following indicators were used to develop the questionnaires for the study.

- Identifying availability and demand of water for drinking and irrigation purposes
- Identify different Storm water interventions that would augment the existing water supply sources
- Testing the economic and institutional viability of leakage and introducing reduction measures
- Wastewater treatment system which is technically feasible and socially and economically viable
- Socio-economic viability of metering and volumetric pricing of water
- Identification of factors affecting urban hydrology and surface and groundwater interactions
  Studying the key physical, chemical and biological parameters to be monitored for ascertaining water quality

Number & Training of Field Staff

In order to cover the study sample, five investigators and one supervisor were selected. Besides this, one field coordinator was selected from the village to supervise the survey. The field coordinator was familiar with the area and facilitated the survey of the households.

The investigators and supervisor were given half-day training in Delhi by the core team. The training for investigators included:

- Quick refresher training on good interviewing techniques
- Survey protocol and behavior
- Objectives of the survey
- Sample methodology
- Training on the use of tablets, probing recording open ended responses (whenever required) and skipping patterns, mock interviews to familiarize them with asking questions and recording responses.

The supervisors were trained on their specific role in this study, which included selection of households based on background characteristics, arranging team logistics, how to monitor, adherence to established processes – sampling and survey; field level data collection; reporting periodicity and progress on survey. The training also focused on the importance of maintaining the confidentiality of respondents' answers and any comments made. The completed questionnaires were secured and viewed only by firm contracted to conduct the study.

ii. Data collection

Quantitative data were collected using tablets to ensure accuracy and to save time. Structured questionnaires were pre-loaded into each tablet using an application that allowed for geo-tagging, time stamping and to photographically record the interview. This form of data collection saved time and reduced errors while entering data, as compared with the paper-pen survey method. For FGDs and key informant interviews, notes and logs were maintained to analyse key patterns in the responses.

iii. Data Quality Monitoring and Analysis

Since data were collected in near real time and were accessible via a dashboard, data could be easily checked to ensure consistency and how the survey was progressing. Team members from the study agency were present in the field to check quality of data being collected and logistics. Quantitative data were analysed using advanced excel tools. Besides this, the survey was also monitored (location and number) on real time basis so that there are no gaps in the process.

Section 3. FINDINGS/ANALYSIS

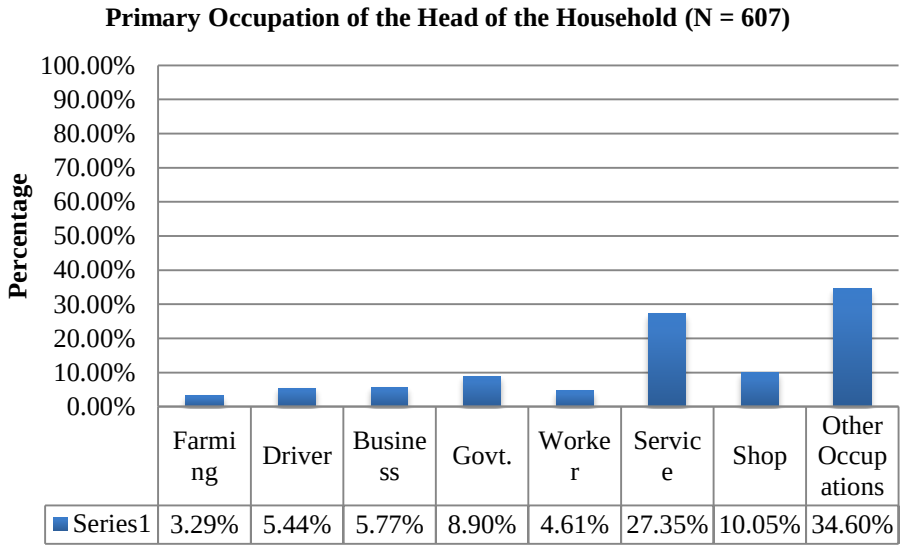
3.1 OCCUPATIONAL PROFILE

Only 3.29 percent of the Households, practice farming as their primary occupation. A significant 27.35 percent of the households are involved in the service sector and about 34.60 percent are involved in other occupations.

This could be attributed to proximity of the village to the metropolitan city of Gurgaon. This has also resulted in high land prices. People tend to sell their agriculture land and work in the service sector in the nearby industries. The village has a railway station which connects the village area to the main Gurgaon city, which facilitates the outward movement of people seeking employment outside the village.

Rapid Urbanization
Changing land -use and dynamics, expected to further change with the upcoming expressway

Figure 3. 1: Primary Occupation of the Head of the Household (N = 607)



3.2 SOURCE OF WATER SUPPLY

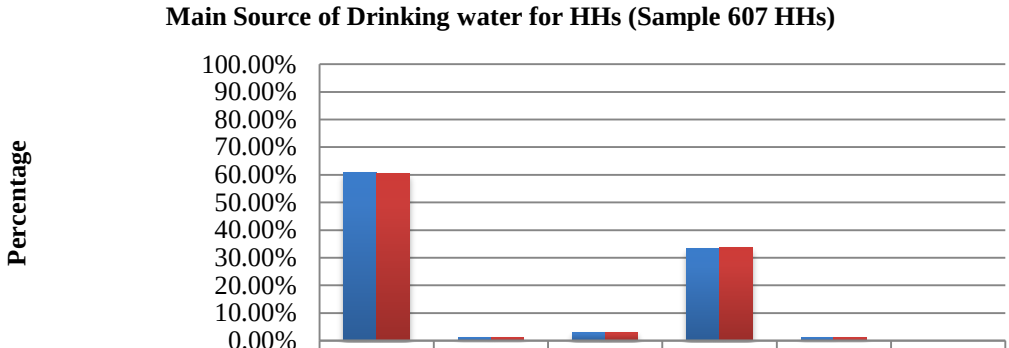
TYPES OF WATER SUPPLY SOURCE

The source of drinking water was studied in the village. More than 61% of HHs use borewells for drinking and other purposes. In most cases the source of water supply for domestic and other purposes is the same. *Handpumps have started yielding saline water since groundwater table has gone down.*
3 ponds are there in the village, but only one is in shape. Others are at verge of extinction as the inflow channel and pond area is either encroached or filled up. The pond in shape is

Overdependence on Groundwater
Majority of the population is using groundwater for drinking purposes which is depleting rapidly. For example borewells need to be bored again every 5 years, not just the depth and also the location needs to be changed. Also the village has no availability of surface water and ponds as well as no rainwater harvesting mechanism which also increases the pressure of groundwater

collecting waste water also. Thus it also has lost its purpose. Field visits and primary research indicated that the village is heavily dependent on groundwater and though people do accept the overly dependence on groundwater resources and the resulting GWT but are yet to embrace harvesting measures.

Figure 3. 2: Main Source of Drinking Water for HHs (N = 607)



	Borewell	Handpump	Other Sources	HH Piped Water Supply	Tubewell	Tanker
Drinking Water	60.79%	1.32%	3.13%	33.44%	1.32%	0.00%
Other Domestic Purposes	60.46%	1.32%	3.13%	33.77%	1.15%	0.16%

Note: Other sources may refer to canal supply or public stand posts

Tubewells and borewells are quite similar functionally, tubewells tend to deeper and have galvanized casing while borewells.

PUBLIC WATER SUPPLY

It was found that only 33 percent (206 HHs) have PWS at the household level. The government PWS system is supplied though borewells, which are at a depth of 250 feet. The whole system is connected to dedicated electricity feeder system and managed by PHED. Bleaching powder is being used in the underground tank for purification of water but not on regular basis. The overhead tank is filled twice and the water supply is available in morning and afternoon.

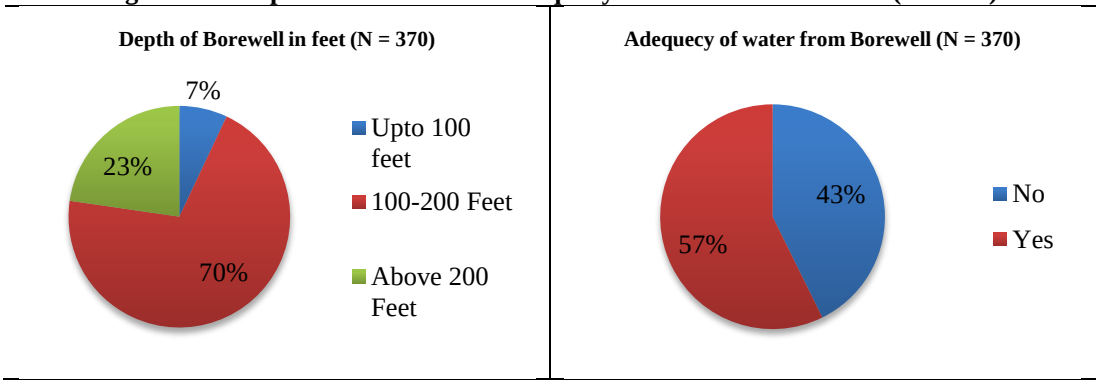
Of the sample surveyed, a significant **66 percent of the HHs** doesn't have access to PWS. The pipelines are not available in their areas. This could be due to high installation charges for the pipeline, since OHT are located far away. Moreover, Panchayat is not been operational in peripheral areas.

Government Piped Water Supply System in the Village

BOREWELL

Almost 60 percent (370 HHs) of the households use water from the borewell for drinking and other purposes. In the survey, 70 percent of the households have borewell with depth above 200 feet while only 7 percent of the households have a borewell with depth up to 100 feet and the water is still not adequate for the people. More than half of the HHs informed that they water from borewell is not adequate for them.

Figure 3. 3: Depth of Borewell and Adequacy of water from Borewell (N = 370)



About 22 percent of the HHs has dug their borewell to a greater depth in the last years; however significant 78 percent households have not dug their borewell since installation.

Table 3. 1: HHs who increased the depth of borewell in last 10 years (N = 370)

No. of Times	Percentage
Once	4.86%
Twice	16.22%
More than 3 times	1.08%
Not done	77.84%

Case Study

Dharamveer, age 60 lives in *lal dora* area in Garhi Harsaru with his family. They are living in this village since ages. 15 years ago, Dharmveer was elected as the sarpanch and served the community for their betterment. He owns approximately 5 acres of land in which he practices farming. His sons also help him in farming. Currently he owns a tubewell for irrigation which is at a distance of 2 kms from his agricultural land. 15 years ago, the tubewell in his land become dysfunctional due to salinity. He has to dig another tubewell at 150 feet for farming which is now 2 kms away. The issue of salinity was not enough; the water table is also decreasing exponentially as informed by him. The tubewell which was dug at 150 feet has to be rebored again 5 years ago at 220 feet. Apart from the declining GWT and deteriorating water quality (particularly in terms of salinity), they are facing another problem of water logging in their lane due to clogged drains. The water logging acts as a carrier for many water and vector borne diseases within the vicinity. The declining GWT & quality; and water logging issues are big concerns not only for Dharamveer but also for many in the village.

3.3 WATER SUPPLY SERVICE LEVEL

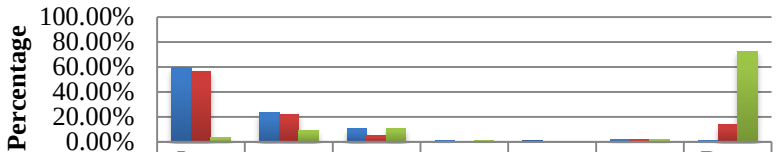
PIPED WATER SUPPLY

About 73 percent of the respondents surveyed said that they receive the water from the public water supply only in the morning. About 56-58 percent people said that they receive water for less than 1 hour in the morning and afternoon. However, about 2 percent mentioned that receive water for 6 hours. This is could be due to the presence of electric pump (*tullu* pump) at household level which draws more water. As seen from the graphs below, there is not marked difference in the hours of supply in summer and winter.

Inefficient Service Levels

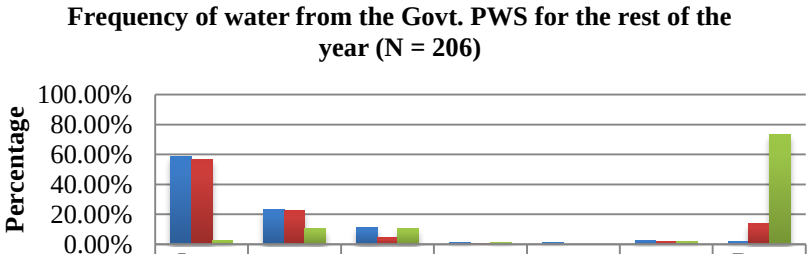
PWS is available only in limited areas and supply only for a few hours in a day. Due to the non-availability of the continuous water supply, storage structures are constructed at the household level which not only increases the individual's expenditure but also incurs huge loss of water. With decreasing ground water table, the quality of water decreases. It was found that at some places the issues of salinity have aroused. Although the community perception towards the quality of water is good. But the water quality analysis depicts the presence of faecal contamination.

Figure 3. 4: Frequency of water from the Govt. PWS in summers (N = 206)



	Less than 1 hour	1 hour	2 hours	3 hours	5 hours	6 hours	Does not Come
Morning	59.71%	23.30%	10.68%	1.46%	0.97%	2.43%	1.46%
Afternoon	56.80%	22.33%	4.85%	0.49%	0.00%	1.94%	13.59%
Evening	3.40%	9.22%	11.17%	1.46%	0.00%	1.94%	72.82%

Figure 3. 5: Frequency of water from the Govt. PWS for the rest of the year (N = 206)



	Less than 1 hour	1 hour	2 hours	3 hours	5 hours	6 hours	Does not Come
Morning	58.74%	23.30%	11.17%	1.46%	0.97%	2.43%	1.94%
Afternoon	56.80%	22.33%	4.37%	0.49%	0.00%	1.94%	14.08%
Evening	2.43%	10.68%	10.19%	1.46%	0.00%	1.94%	73.30%

3.4 WATER STORAGE

TYPE OF STORAGE

Many factors decide the water availability in the area besides the GWT. Electricity is one of them which are a problem in the village. The individual borewell as well as PWS borewell are connected to pumps to pull water to the overhead storage tanks (59% of the HHs have pump connected to PWS); hence power supply is a must since HHs are lifting the water directly from the pipeline. Also the PWS is not available all times of the day. To combat the non-availability of water at all times, people tends to store water. 90 percent of the households have overhead tanks. A very small percentage of HHs has both overhead tank as well as underground tanks.

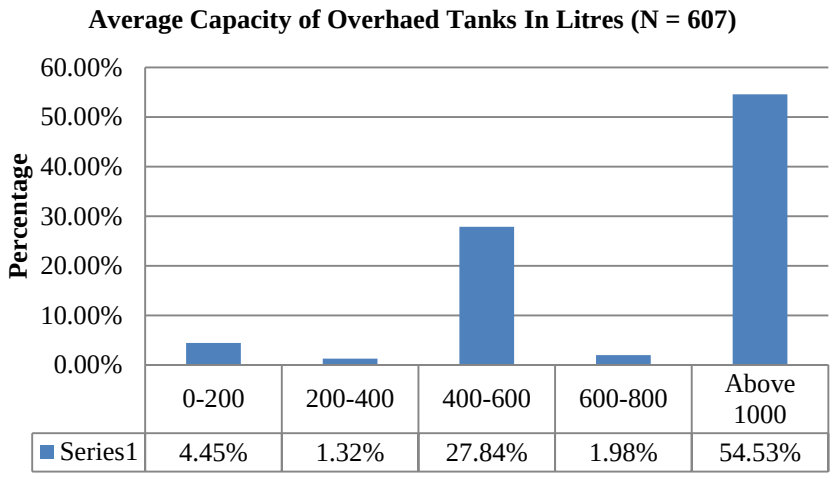
Table 3. 2: Type of Storage Structure (N = 607)

Type of Storage Structure	Percentage
Overhead	90.12%
Overhead & Underground	0.16%
Underground	3.95%
Other	5.77%

CAPACITY OF STORAGE

The capacities of overhead tanks in the households are presented below. It has been found that the more than half (54.33 percent) of the households have overhead tanks with a capacity above 1000 litres.

Figure 3. 6: Average Capacity of Overhead Tanks in Litres (N = 607)



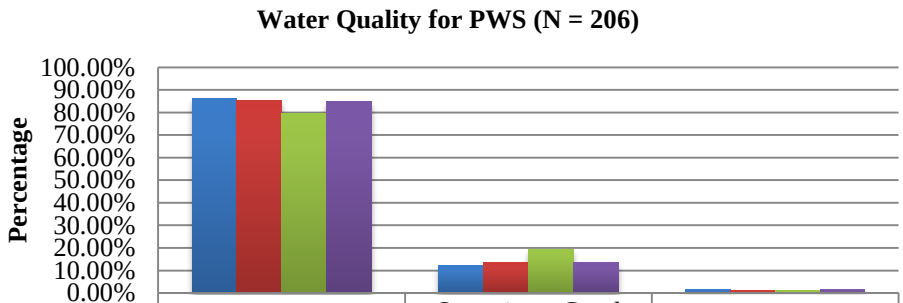
Besides these household storage tanks, the village has several community water tanks as depicted in the picture below. These have the public water supply or the nearby tubewells as the source of water supply.

3.5 WATER QUALITY

WATER QUALITY FOR PWS

Majority of the respondents said that the color, taste, smell and pressure were always good. Only a very small percent of respondents (1 percent) were not satisfied with water quality and said that the color, taste, smell and pressure were always bad.

Figure 3. 7: Water Quality for PWS (N = 206)

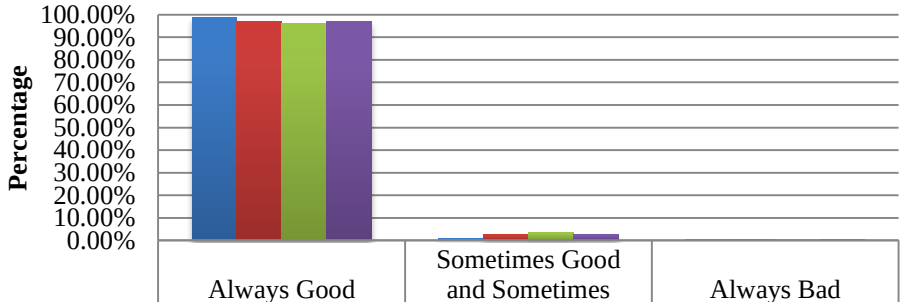


	Always Good	Sometimes Good and Sometimes Bad	Always Bad
Color	86.41%	12.14%	1.46%
Taste	85.44%	13.59%	0.97%
Smell	79.61%	19.42%	0.97%
Pressure	84.95%	13.59%	1.46%

WATER QUALITY FOR BOREWELL

Almost all respondents said that the water from their borewell was always good.

Figure 3. 8: Water Quality for Borewell (N = 370)



	Always Good	Sometimes Good and Sometimes Bad	Always Bad
Color	98.65%	1.08%	0.27%
Taste	97.03%	2.70%	0.27%
Smell	95.95%	3.78%	0.27%
Pressure	97.03%	2.70%	0.27%

Case Study

One of the hamlets **Gopalpur** in Garhi Harsaru is considered to be the most saline zone of the village. The hamlet has saline groundwater which is bitter in taste. The groundwater is highly saline that it becomes difficult for even the birds and animals to drink. The water for drinking and other domestic purposes is fetched via pipelines from the *lal dora* area as there are no borewells or tubewells. Besides this, water is also drawn from a canal supplied by government due to its extreme salinity conditions. Farmers in this hamlet mostly grow rain fed crops. There is a myth in this hamlet i.e. the place is blessed from God Ram that only one rain is sufficient to cater all the agriculture needs within that area

WATER QUALITY ASSESSMENT

To understand the quality of the water in the village, 12 water samples are collected from different places in the village. The samples from the villages were selected on the basis so that all the sources and point of the village can be mapped. The water was collected from school, anganwadis, borewell in colonies, government overhead tank and households connecting overhead tank as depicted (locations mentioned below). The below samples were tested by Quality Lab, Gurgaon which is an ISO 9001:2008 certified. The method used for testing was IS 3025.

Deteriorating water quality

Increasing salinity and instances of biological contamination

	Indicators	**Range**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
General	Appearance	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Turbid	Clear	Clear	Clear
Bacteria	Faecal Coliform per 100ml	10	21	Nil	Nil	Nil	03	Nil	03	07	17	Nil	Nil	Nil
	E.Coli per 100ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Faecal Streptococci per 100ml	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	02	Nil	Nil	Nil
Chemical	pH	6.5-8.5	8.16	7.27	8.32	8.15	7.70	7.80	7.72	7.79	7.68	7.92	7.68	7.99
	Total Dissolved Solids mg/l	500	355	4608	404	746	641	1541	422	428	417	362	423	281
	Turbidity in NTU	05	1.0	1.0	1.0	1.0	1.2	1.0	1.1	1.0	42.4	1.0	1.0	0.50
	M. Alkalinity as CaCO3	200	230	209	225	188	198.5	439	225	226	234	241	192	188
	P. Alkalinity as CaCO3	N.S	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Total Hardness as CaCO3	300	244	3079	241	602	559	963	258	252	333	286	331	299
	Residual Free Chlorine	0.20	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Chlorides as Cl	250	109	2546	122.5	401	321	604	151	153	101	47	101.3	61.2
	Iron as Fe	0.30	0.01	0.01	0.01	0.01	0.16	0.01	0.01	0.01	2.6	0.01	0.01	0.01
	Arsenic as As	0.05	Nil	0.01	Nil	Nil	Nil	Nil	Nil	Nil	0.03	Nil	Nil	Nil
	Fluorides as F	1.0	1.09	0.73	0.55	0.30	0.42	0.52	0.67	0.71	0.80	0.35	0.54	0.12
	Nitrates as NO3	45	0.51	60.8	8.4	2.29	9.2	31.3	9.4	9.60	30.4	34	42.5	14.8

Cases of fecal contamination were observed in the water samples collected from public hand pump, Anganwadi and overhead tank and from household near overhead tank. The source of water for the overhead tank is a nearby borewell. Fecal contamination was observed in one of the community water tank.

Analysis of Water Quality		
No.	**Source**	**Result**
1	From Anganwadi (Submersible water in the temple)	Needs disinfection
2	From submersible in agriculture land (Jagga Singh)	Agric Tube-well should not be used - Nitrates, TDS, Hardness
3	HH sample (PWS) from last house	Ok
4	Gopalpur School- PWS	Ok
5	HH Gopalpur- borewell	Ok
6	Public Water Tank- Roadside borewell	Alkalinity and Hardness on higher side - water can be consumed but if there is a better source, people should not use for drinking and cooking
7	Overhead tank borewell	Needs disinfection
8	HH near overhead tank	Needs cleaning and disinfection
9	Public hand pump- main chowk	Needs disinfection
10	Sr. Sec Govt School	Ok
11	Vasant Vihar HH borewell	Ok
12	New colony borewell	Ok

3.6 SANITATION STATUS

TOILET ACCESS & USAGE

In this study access refers to having a physical structure of a toilet/latrine (on observation by enumerators) at the time of the survey. Results of the household survey suggest that 98 percent have access to toilets. Access to a sanitation facility does not necessarily translate into regular usage. In this study usage was calculated at a person level that is the extent to which members of a household use toilet irrespective of access and toilet usage in this village is found to be almost 100 percent.

It has also been observed that only 4 out of 607 mentioned that there exists any monitoring system of sanitation in the village which is on usage of toilets.

Disposal of Child feces

Appropriate method of child feces disposal is important to separate excreta from human contact and in containing household environmental contamination. Among the surveyed households, information on child excreta disposal was collected for 140 children below four years of age. In terms of method of disposal of child feces, 92 percent dispose their child feces in toilet and 5 percent in drains.

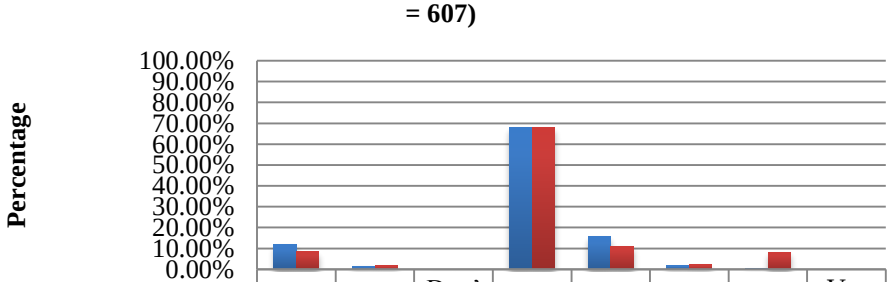
3.7 SOLID AND LIQUID WASTE MANAGEMENT

The survey gathered information on the type of disposal systems that the sample households had access to for managing solid and liquid waste. Also water stagnation on streets creates breeding ground for flies and mosquitoes leading to water and vector borne diseases.

Lack of proper Solid & Liquid Waste Management contaminating village water resources

Majority of the respondents dump their biodegradable (68.04 percent) and non-biodegradable (67.71 percent) waste in dustbins which is ultimately thrown in the open fields. A very less proportion of households (1.48 percent) dispose bio-degradable waste in a safe manner. Safe disposal of bio-degradable waste includes disposing solid waste in an identified place, composting, burying, re-using in the garden having GP collect the waste and feeding to cattle

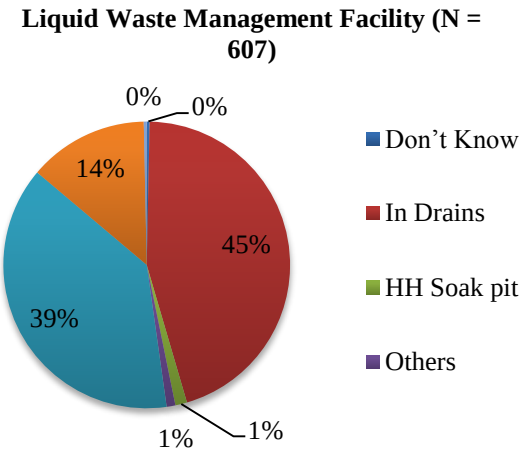
Figure 3. 9: Solid Waste Management Facility within the HHs (N = 607)



	Burn	Compost	Don't Know	Dustbin	Dumping Area	No facility	Others	Vermi-compost
Biodegradable	11.86%	1.48%	0.16%	68.04%	15.65%	1.98%	0.66%	0.16%
Non-Biodegradable	8.57%	1.81%	0.16%	67.71%	11.20%	2.31%	8.24%	0.00%

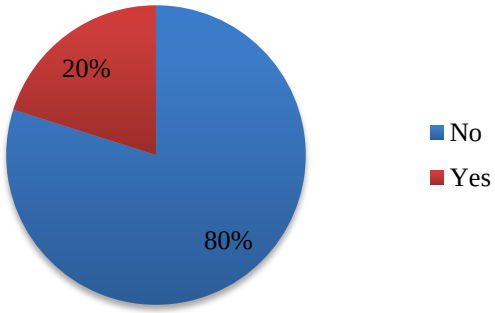
As far as liquid waste (waste water from either the kitchen or bathing area) is concerned, 45 percent of the households reported safe disposal of liquid waste[21] while 14 percent mentioned that the liquid waste goes on the streets causing serious health issues as well as bad odour and environment.

Figure 3. 10: Liquid Waste Management Facility (N = 607)



The awareness level of waste segregation at home is very less in the village. Only 20 percent mentioned that they segregate waste at home.

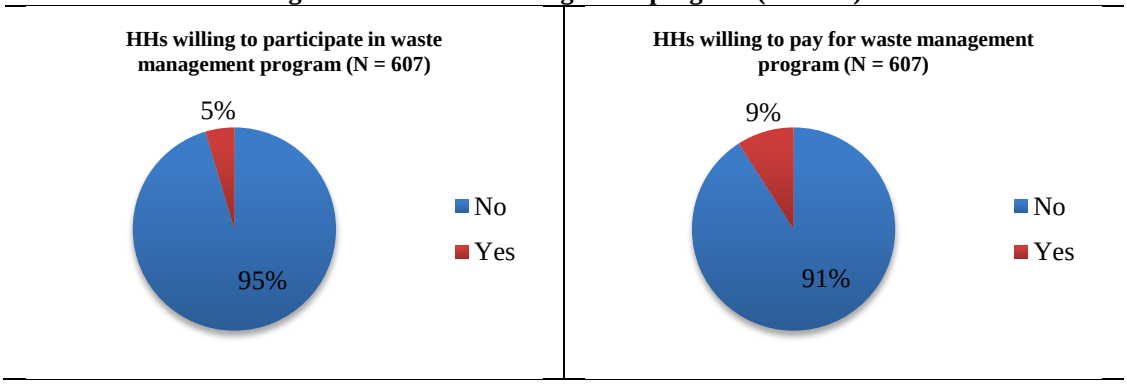
Figure 3. 11: HHs segregating waste at home (N = 607)



Only 5 percent of the respondents mentioned that they are willing to participate in waste management program and amongst that only 9 percent out of them are willing to pay for waste management program. On an average, people are willing to pay Rs. 100 ranging from Rs. 50 to Rs. 300.

[21] Safe disposal of liquid waste includes disposal in to a soak pit , drain or kitchen garden

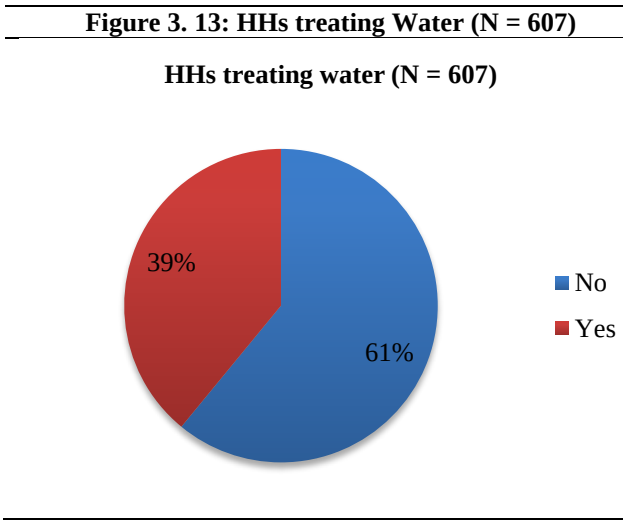
Figure 3. 12: Waste Management program (N = 607)



3.8 TREATMENT AT HH LEVEL

It was found that more than half of the population (61 percent) does not treat their water before drinking and about 39 percent of the households treat their water before drinking.

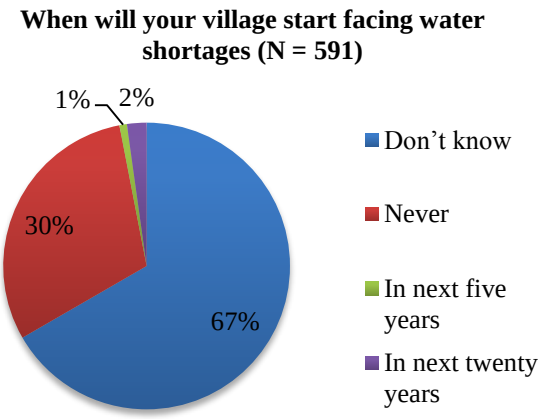
Figure 3. 13: HHs treating Water (N = 607)



Out of the 39 percent HHs who treat the water before drinking, 70 percent (165 HHs) use aquaguards; 25 percent filter water using cloth and 5 percent boil their water before drinking.

97 percent of the HHS mentioned that they did not feel any water scarcity and a small percentage (1 percent) felt that they might face water shortages in near future (5 years). About 2 percent said water shortage is envisaged only in the next 20 years. The reasons for possible water shortage in future according to the respondents were excessive wastage of water as well as the increasing population resulting in higher usage

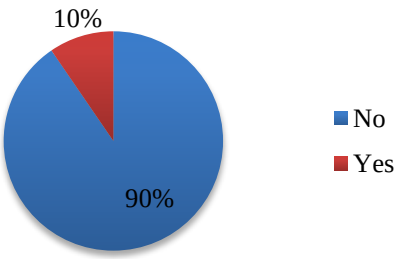
Figure 3. 14: When will your village start facing water shortages (N = 591)



3.9 AGRICULTURE

In Garhi Harsaru, only 3 percent of the people have agriculture as their main occupation (primary research). It was found that only 10 percent of the respondents have land for agriculture.. The land size varies from 1 acre to 10 acres. Mostly the respondents (68.97 percent) have a land holding of 1-2 acres. A small percent about 2% have a landholding of 9-10 acres.

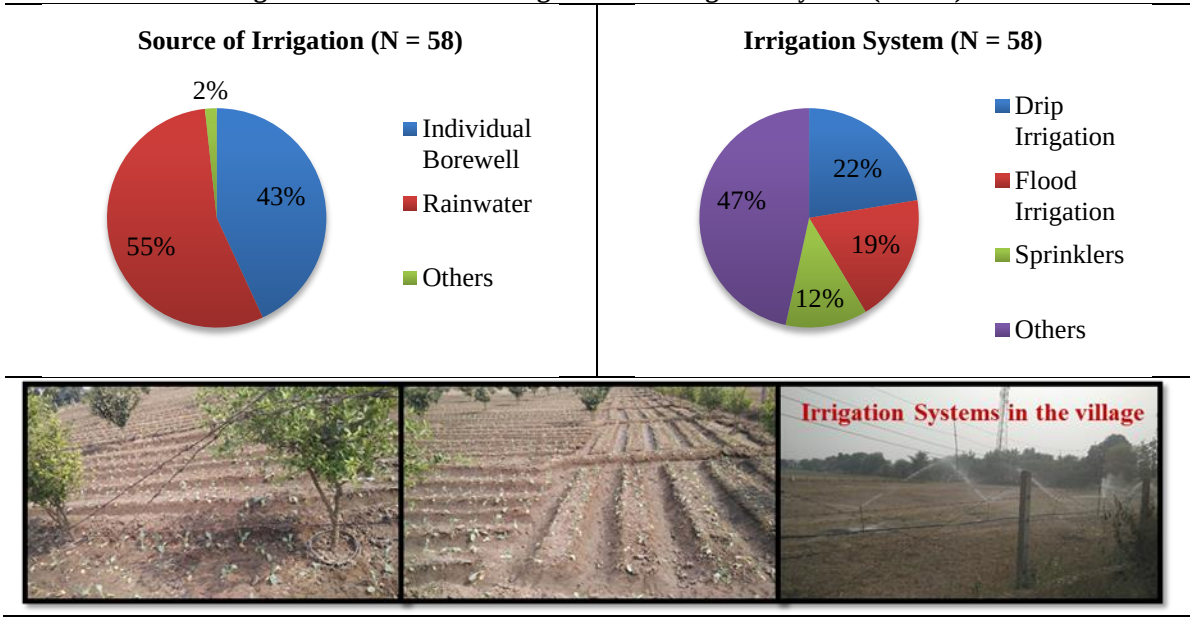
Figure 3. 15: Presence Of Agriculture Land With Average Land Holding



Area holding in Acres (N = 58)	
Land Area in Acres	**Percentage**
1-2	68.97%
3-4	20.69%
5-6	3.45%
7-8	5.17%
9-10	1.72%

More than half of the respondents (55%) are dependent on rainfall for agriculture. The type of irrigation system varies depends on the source as well as the on the type of crop grown in the village. Only 22 percent respondents said that they use drip irrigation and about 12% use sprinklers. Usually the kharif crops are rainfed while rabi crops and vegetables are grown using water from the tubewell. Kharif crops include gwar, bajra, jowar and corn and; rabi crops include mustard, wheat and vegetables such as cauliflower, cabbage, brinjal, spinach, carrot etc.

Figure 3. 16: Source of Irrigation and Irrigation System (N = 58)



Water has become unsuitable for drinking or agricultural purposes due to increasing salinity. This has caused the intake of water from far off locations to meet their agricultural needs. Digging of borewells is not legally permitted, however it was found that it was being abundantly done in the village using corrupt practices.

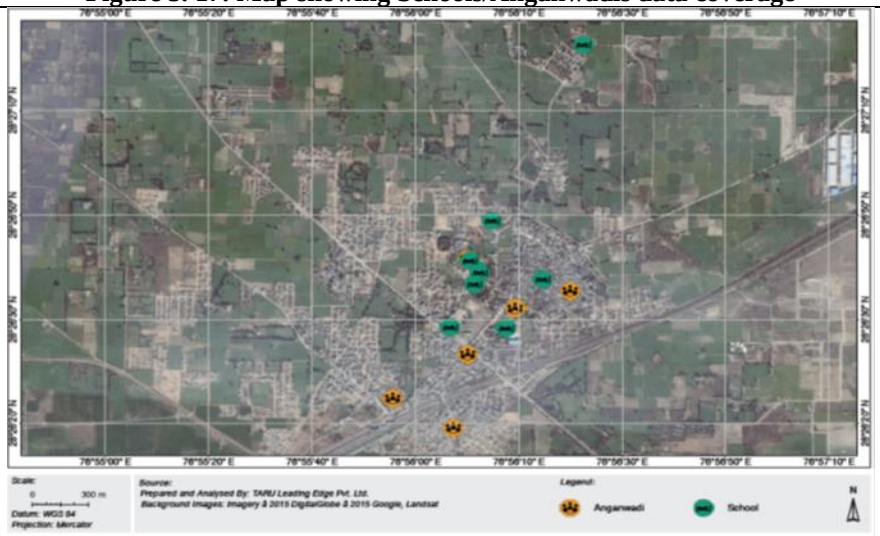
Salinity

Lowering the groundwater table has resulted in increasing salinity.

3.10 WATER STATUS IN SCHOOLS/ANGANWADIS

The village has institutions (government and private both) including 7 anganwadis and 8 schools. 8 schools include 5 primary schools, a secondary school and 2 senior secondary schools.

Figure 3. 17: Map showing Schools/Anganwadis data coverage



The observations of the water status of the schools and anganwadis are described below. It was found that the institution located in the *lal dora* area have PWS while others have individual borewells and the quality of water was found to be always good for both the sources. Out of 15, only 5 institutions treat their water before drinking.

Indicators	School	Anganwadi
Water amenities and Service		
Source of drinking water	3 borewell and 5 with Govt. PWS	1 with Govt. PWS and rest with borewell
Source of water for other purposes	Same as drinking water	Same as drinking water
Type of Storage Structure	Mostly overhead tanks	Mostly with other small containers
Capacity of Storage Structure	Average 2000 liters	With capacity ranging from 15-60 liters
Status of leakage from taps and storage tanks	No leakage	No leakage
Water quality for drinking purposes • Color • Taste • Smell • Pressure	 • Always Good • Always Good • Always Good • Always Good	 • Always Good • Always Good • Always Good • Always Good
Treatment of water	Treated in 50 percent of the schools-Installed aquaguards (all private schools)	Treated in only 1 anganwadi
Sanitation		
Presence of toilet	7 out of 8 have toilets (Only Government Girls Primary School do not have a toilet)	Only 4 have toilets
Handwashing facility	7 out of 8 have handwashing facility (Only Government Girls Primary School do not have handwashing facility)	Only 1 have handwashing facility
SLWM		
Disposal of bio-degradable waste	4 have dustbin, 2 with dumping area and 1 with compost pit (Only 1 school was observed with no facility)	No facility
Disposal of non-bio degradable waste	4 have dustbin, 2 with dumping area and 1 with compost pit (Only 1 school was observed with no facility)	No facility

Section 4. SOLUTION MAPPING

One of the key components of the action research an integrated solution mapping based on the problems identified. The solutions for an integrated approach were a combination of conventional knowledge as well as modernized technical expertise.

4.1 SOLUTION MAPPING PROCESS

Solutions were mapped in consultation with the community to work out the best implementable, practical solution. A community meeting was organized on 26th November 2015 in the village to discuss the problems and possible solutions. The meeting involved school children, community members, panchayat members, representatives from TARU, Seghal Foundation and IWP. The agenda included:

- sharing the findings from the primary research survey/ water quality assessment
- extempore competition among school children
- promoting adaptive solutions (e.g. bio-sand filter)
- discussion on solutions for management of water resources

Findings discussed with community

The problems identified during our study and as felt by the community included

- Over dependence on groundwater
- Deteriorating Water Quality
- Salinity related issues
- Lack of systems for liquid and solid waste management

Extempore Competition

To raise awareness about water conservation, an extempore competition on 'Water Conservation" was conducted for the school children who spoke on the importance of water conservation and measures of water conservation. 8 school children participated from 3 different schools in the village. The winners of the competition were gifted bio-sand filters.

Promoting Adaptive Solution

To address the water quality issues and to encourage the use of safe water in the village, the team also tried to promote adaptive to understand the response towards improved water security and safety. In this context, the Bio-sand filter developed by Sehgal Foundation (by Lalit Sharma and Sourabh Sood) was showcased to community. Eight bio-sand filters were donated in the village by IWP and TARU. Bio-sand filters were given to the winners of the extempore competition and 5 filters were installed in the anganwadis of the village.

Solution mapping with the community

Based on the sharing of the primary survey and water quality assessment, the community was consulted to seek solutions on the problems of water scarcity, depleting ground water levels and other issues faced by the community

- Community realized the over-dependence and over-use of groundwater and suggested that the wastages if plugged can help in the groundwater recharge.
- Community members also acknowledge the need of adopting water conservation measures
- Identified the need of proper liquid waste management through channelizing the water or other suitable measures

4.2 INTEGRATED SOLUTIONS FOR GARHI HARSARU

Indicator	Identified Problem	Solutions Explored
Groundwater	• Increasing population pressure on groundwater resources and declining GWT • No surface water provisions	• Groundwater Recharging: Rooftop rain water harvesting is an option for collecting and storing the rainwater from roof top runoff, which otherwise flows into the drainage. Water falling on the roof top is tapped for storage and ground water recharge purpose. This structure can be built up on any buildings such as panchayat ghar, temples, schools or other community centers. This will serve as demonstration of technology so that people can also adapt at household level. There are 3 defunct wells present in the village. • Usage of Johad: It was suggested that the johad in the village can also be used for rainwater harvesting after cleaning. This water can be used for agricultural purposes as well as for animals. This will also recharge ground water. In dry season, this johad can be filled using a nearby canal.
Service Delivery	• PWS in some parts of the village • Non-availability of water for 24 hours • No ownership of PWS with panchayat and community	• Community managed water supply system • Water availability through the day (24 X 7)
Water Quality	• Increasing salinity issues • Degrading drinking water quality	• Drinking Water: To address the water quality issues, Community Managed Water Purification System (RO) can be a good option to improve the living conditions. As majority of the people drink water without treating, these systems can a good and cheap way to address the water quality issues. This system can be installed at any community place and is a good way to provide affordable safe water to poor urban communities at a very nominal prize. • Use of Bio-sand filter can also be considered for HH water treatment. It removes biological contaminants and suspended solid particles from water and makes it suitable for drinking.
Solid Waste	• No solid waste disposal system and management	• Zero Waste based SLWM Model was discussed and found appropriate in the community meeting. The model can be used to address the solid waste problems in the village. This model systematically collects &

		transports the segregated solid waste with dedicated service delivery team and is completely community and Gram Panchayat ownership to execute, manage, monitor, and evaluate proposed SWM system. Importance of segregation of the solid waste at source needs to be highlighted at the community and HH level through awareness campaigns, street plays etc.
Liquid Waste	• No liquid waste disposal system and management	• Decentralized Waste Water Treatment System (DEWAT) can be considered to address this issue. In the DEWATS process waste water from households flows through the septic tank, anaerobic reaction chambers, planted gravel filter bed and finally through the polishing pond of DEWATS. It is an independent natural process of cleaning waste water and brings in back to a reusable state. • Individual Soak pits can be constructed at household level for liquid waste. (Only where space is available; if space is not available, another alterative will be looked upon).
Institutional Setup	• No ownership with panchayat • Lack of partnership among different stakeholders • No awareness programs • No monitoring and regulations	• Community and household level interventions and different awareness programs need to be conducted in the village on different issues. • Messaging on judicious use of water and proper practices of solid waste disposal would be helpful and communications and sensitization regarding this be planned at various levels. • Awareness on health issues pertaining to solid and liquid waste • Awareness about the management of drinking water schemes and role of governance • Training programs for masons on the technology to be used for the construction of toilet pits: It was found that the technology used for construction of toilet pit in the village was not appropriate. So training for masons can be useful. • Formation of committees at different levels on different aspects

Section 5. CONCLUSIONS, RECOMMENDATIONS & WAY FORWARD

5.1 CONCLUSIONS

CONCERNS ON GROUND WATER RESOURCES

Groundwater is the only source of usable, fresh water in the village especially when domestic, agricultural, and industrial water needs can only be met by using the water beneath the ground. Over-extraction of groundwater has resulted in:

- **Lowering of the Water Table**
  Groundwater depletion is primarily caused by sustained groundwater pumping, and pumping out more water than it can be replenished. Excessive pumping has lowered the groundwater table. Groundwater is the only source of water in the village. More than half of the population (60 percent) has individual borewells in their households while rests have access to public water supply (33%). Two-third of the population doesn't have access to government PWS and are dependent on individual borewells. 70% of the households depend on borewells with depths varying from 100 to 200 feet, though residents find the quantity of water still inadequate. A very small percentage of households use handpump as a water source

- **Lack of Metering System for PWS**
  There is no metering system for the PWS and no charges are incurred by the residents using public water supply, which is available free of cost to the people in the village. This also results in wastage of water and excessive use.

- **Increased Costs**
  As the water table has lowered, the water must be pumped farther to reach the surface, using more energy. In some cases, using such a well can be cost prohibitive. Low water table has resulted in some of the existing hand pumps being dysfunctional, since handpumps can generally pump water from at higher groundwater levels.

- **Population Increase**
  Rapidly growing population at a rate of 39.25 percent (3140 persons in 2011 to 8000 persons in 2015) has increased the stress on the existing water resources. Almost half of the population (48 percent) have migrated and have settled in the village only since less than 10 years. People are mostly increasingly employed in the service sector (27%) and other occupations such as labour, security etc. (35%). Agriculture is not the main occupation of the people in this village, only about 3% are into farming.

- No focus on surface or rainwater management. With climatic variation looming large, there is severe threat to ground water resources if the increasing population continues to extract groundwater in unregulated manner.

To address the depleting groundwater issues it is recommended to have:

- **Rainwater harvesting / Recharge of Groundwater**

Groundwater system relies on the amount of recharge by rainfall and is directly related to the water balance. Low rainfall necessitates the need for undertaking other measures of recharging the groundwater. Constructing Roof top Rainwater harvesting at household level and construction of ponds/johads for rainwater harvesting at the community level can help address the groundwater levels.

.

- **Reuse of Water**
  Encourage the reuse of water for non-potable purposes after treatment. This can be done at the community and household level.

WATER QUALITY CONCERNS

- **Salinity Issues**
  Lowering of groundwater table has affected the quality of water. Excessive pumping causes saltwater to move inland and upward and has resulted in saltwater contamination of the water supply.
- **Quality and Contamination Issues**
  Cases of fecal contamination have also been observed in a few places. High levels Hardness and TDS have also been reported.

To address the water quality issues,

- **Filtration & Disinfection measures should be adopted**
  The water quality at the consumer end should be improved considering simple filtration practices at home. **Since c**ases of faecal contamination have been reported, it is recommended that the water to be used for drinking purposes should be only after proper disinfection at the HH level for individual and public water supply systems.

ISSUES IN SERVICE DELIVERY

- **Inadequate Service Levels**
  The water supply through the public water system is highly inadequate and does not cater to the entire village. Only 33% of the households are covered by the public water system. The PWS is also dependent on groundwater.
- **Inefficient Service Levels**
  The water supply through the public water system is intermittent and when provided, the supply is for just an hour, in the morning and in some cases in the morning and evening.

In order to improve the service levels and the efficiency

- **Coverage**
  The water supply should be extended to the peripheral areas of the village ensuring equitable supply of water to all areas. Options of changing to a surface water source should also be explored as Gurgaon canal is passing from nearby.
- **Efficiency**
  The water supply through the public water system is intermittent and erratic. The PWS should ideally aim to provide water to all areas atleast two times in day and in future

build towards a 24X7 supply. The possibilities of the expansion to other areas and regular supply need to be discussed and the challenges in the same should be addressed.

WATER WASTAGE

- **Dependence on individual water sources**

Inadequate and inefficient systems PWS has caused people to depend on individual borewells (60%).

- **Excessive water use for agricultural purposes**

Among the households which mentioned that they are into agriculture, 45% of them mentioned they are dependent on groundwater sources. Intermittent supply of water supply has caused over-use of water during the period water is available.

Inadequate services levels forcing people to store more water which is often wasted given the culture practice to use to fresh water every time.

Some of the aspects which can help address the water wastage issues can include:

The improvements to the agriculture practices can help reduce the over extraction of groundwater sources, which include

- Shifting to better practices/ behavior
- Shifting to better irrigation methods such as drip irrigation
- Change to less water intensive crops
- No irrigation during heavy winds
- Awareness campaigns should be conducted regularly to highlight the importance of water conservation and reducing water wastage at the HH and community level.

- The options of using surface water for drinking or agricultural purposes should be considered. The existing sources of surface water near the village should be explored as an alternate source. Gurgaon Canal which is passes nearby is an option which can be explored.

- Options of reusing the water after treatment, for gardening or agricultural purposes has neither been explored nor been encouraged in the village. System of reuse and recycle should be explored, encouraged and implemented in the village.

SOLID AND LIQUID WASTE MANGEMENT CONCERNS

- No system for collection and disposal of SWM
- Solid waste from the households is being dumped in the open areas; there is no system of collection, and proper disposal.
- No system for segregation of SWM
- The concept of segregation and waste management is not understood by most of the households. Only about 20% of the respondents mentioned that they practice waste segregation at home.
- No system for Liquid Waste Management

- To manage the liquid waste, open drains are laid down only in *lal dora* area which are connected to Johad[22]. Only about 45% of the respondents have access to the open drains. In rest of the area, water is let out on the streets in the open, causing a major health concern.
- Lack of solid and liquid waste management adversely impacting the water resources in village. Though it (the waste water) can be potentially be reused

In order to address the above issues of SLWM the following are suggested

Integrated plan for solid and waste management to be developed

Zero waste SWM Model should be used to address the solid waste problems in the village. This model systematically collects & transports the segregated solid waste with dedicated service delivery team and is completely community and Gram Panchayat ownership to execute, manage, monitor, and evaluate proposed SWM system.

Alternate Sources of Water

Alternative water sources such as gray water which is untreated wastewater that does not include water from the toilet but generally includes water from bathroom sinks, showers, bathtubs, clothes washers, and laundry sinks- and storm water-water from rainfall can be explored and viewed as resources to supplement scarce water supplies rather than as waste discharged. Gray water can serve a range of non-potable uses, including irrigation, toilet flushing, washing, and cooling, although treatment may be needed.

LACK OF INSTITUIONAL MECHANISMS

- Absence of Institutional Mechanisms
- No system of management of water and wastewater has been functioning properly in the village resulting poor service levels, wastage and depleting water resources.
- Lack of Monitoring systems
- There is no system of metering or monitoring of the water supply, absence of which has led to wastage of water.

In order to ensure that all the above mentioned concerns and recommendations are met with, a well-defined institutional structure is required with clear roles and responsibilities to lead the processes in a sustainable manner. The setup should also involve formation of different committees with community participation so that the user has the ownership of their sources. Formulating a Water and Sanitation Committee to address the water and Sanitation related issues is one of the examples.

[22] A johad (Hindi: जोहड) is a rainwater storage tank, that collects and stores water throughout the year, to be used for the purpose of drinking by humans and cattle.

LACK OF AWARENESS

- Water conservation programs/campaigns are not carried out at the HH/ community level. Moreover, people are not aware (nor experience) of water shortage issues / quality issues and hence do not practice any water conservation/water treatment measures. But they are aware of the future water shortage.
- Lack of awareness at the HH/ Community Level on solid and liquid waste management practices and also unwilling to participate in the same.
- **Community Participation**
  For sustainable development, building partnerships with different stakeholders is essential. One of the key stakeholders to be involved is the community.
- **Awareness campaigns**
  Awareness campaigns should be conducted regularly to highlight the importance of water conservation, reducing wastage. These can be done at the community level, school level, HH level using different mediums such as shows, street plays, competitions, consultations etc.

  Importance of segregation of the solid waste at source needs to be highlighted at the community and HH level through awareness campaigns, street plays etc. Also the village needs centralized liquid waste management system.

5.2 WAY FORWARD

Competition for water use continues to increase and drinking water supply can no longer be separated from agricultural and industrial use. Integrated water resource management needs to address the water issues in entirety. The key takeaways from the project revolve around:

A. Planning for water resources
B. Institutional Mechanisms for Implementation
C. Community Mobilization and practices

The next steps would include development of:

- **Water Investment Plan that includes**
  - **Water Security Plan**
  - **Water Safety Plan**
  - **Solid & Liquid Management Plan**
- **Institutional and Advocacy Strategy**

The indicative plan is presented below. The detailed plan will be developed as part of the next phase initiative

5.3 INDICATIVE WATER INVESTMENT PLAN

The main aim of the Water Investment Plan is to provide a comprehensive framework for sustainable development and management of the water resources, as well as to highlight the main areas that the investment will be directed, in which an effective legal and institutional framework

for its implementation will be put in place. The Water Investment Plan has the following overall objectives:

- **securing water supply,**
- **developing new water resources that will enhance the water allowances per capital,**
- **providing access to improved water supply, and**
- **expanding the wastewater services and coverage all over the area**
- **Promoting metered supply, enhancing the energy efficiency and expanding the coverage of the services.**

In specific, it will promote developing a ***water security plan*** encompassing water safety is a holistic and participatory planning approach to address source sustainability, O&M issues, make provision for system replacement and expansion and water quality issues (Water Safety Plan).

Water security refers to the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability[23].

The main aim of a **Water Security Plan** (WSP) is to ensure that:

1. The surface and ground water resource is conserved, protected, enhanced and managed to ensure that the quantity of drinking water is sufficient to meet the demands of the population. This includes measuring water availability and metering its supply, constructing rainwater harvesting and groundwater recharge structures and instituting mechanisms
2. The water supply service is managed efficiently and sustainability with clear operational, maintenance and management procedures.
3. The quality of drinking water conforms to acceptable standards through the implementation of a series of preventive measures at the basin, source, system and household level (Water Safety Plan).

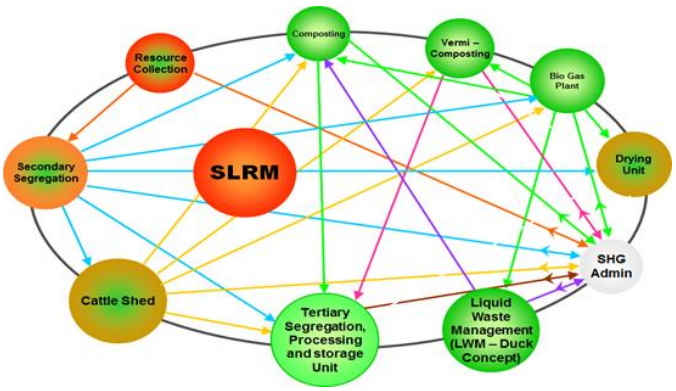
Along with, it also includes the **Water Safety Plan** (WSP) to consistently ensure the safety and ***acceptability of a drinking-water.*** This is done by eliminating/ minimizing potential risk of contamination in raw water sources, water treatment plants, catchment, distribution network, storage, collection and handling water safety plan which should be aimed at assuring the safety of drinking-water, including:

- preventing pollution of source waters;
- selective water harvesting;
- controlled storage;
- treatment prior to distribution;
- protection during distribution; and
- Safe storage within the home and, in some circumstances, treatment at the point of use.

[23] Un-Water 2013

The critical plan component will also include the proposed approach of the initiative will be to implement '**Zero Waste Model'** based on integrated **Solid & Liquid Resource Management (SLRM) methods**[24] that goes beyond managing generated waste to preventing waste generation. Our current linear resource flow uses huge amounts of raw materials and generates huge amounts of waste. This will lead our society to resource depletion. SLRM is about redesigning this resource flow so that most of what is generated as waste can be reused as raw material for further production. This resource flow is more sustainable and will take us closer to 'zero waste'. In other words, "*Zero Waste is a goal that is both pragmatic and visionary, to guide people to emulate sustainable natural cycles, where all discarded materials are resources for others to use. Zero Waste means designing and managing products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them. Implementing Zero Waste will eliminate all discharges to land, water, or air that may be a threat to planetary, human, animal or plant health.*

The SRLM[25] is an interlinking & interconnecting web model and its interlinking categories are described below and are also presented in the figure. In this interlinking figure, the output of one unit is an input of one or more other units which is shown by arrows. For example, vegetable waste from the secondary segregation unit goes to the cattle shed while cow dung from the cattle shed goes to the composting, vermicomposting and drying units.



5.3 INDICATIVE INSTITUIONAL AND ADVOCACY STRATEGY

The plan will focus on setting up/strengthening the institutions for improved management of water resources and supply systems that will include strengthening village water committees, their training, and developing planning, monitoring and implementation systems. Along with this, holistic advocacy strategy for all relevant stakeholders will also be adopted to achieve comprehensive change – such as the improvement of water supply, improve water resources involve coordinated advocacy work at regional and local levels. Advocacy has been alternatively seen as a means of seeking changes in government policies, to changing attitudes, power relations, social relations, and institutional functioning. Its goal can be to promote a cause, by

[24] IGS Concept

promoting citizen participation. Access to water, sanitation and a hygienic environment implies the need to envision advocacy as part of a social change process and acknowledges that to do effective advocacy requires work and change across a variety of arenas or dimensions. The Drinking Water Advocacy and Communication Strategy Framework focuses on critical behaviors related to drinking water at household and community level. They are to

- **Families ensure safe storage and handling of drinking water**
- **Communities demand establishment of representative and functional committees for drinking water supply from PRIs/PHED at GP level**

Recommendations from the School Children

Household

- Use of bucket and mug instead of tubs and shower
- Close taps during brushing and shaving
- Cleaning of utensils using bucket instead of running taps
- Use of bottle filled with sand in the flush tanks
- Roof top Rainwater harvesting at household level
- No irrigation during heavy winds

Community

- Construction of ponds/johads for rainwater harvesting
- Repair taps and pipes at public areas such as parks, schools, hospitals etc. so that there is no leakage
- Awareness programs of water harvesting
- Grow more and more plants

ANNEXURES

Annex 1: Visual Snapshots of the Village

Some other pictures
https://www.dropbox.com/s/zv25j9d2kdzcxbl/Photographs_IWRM%20Project_Garhi%20Harsaru_TARU.rar?dl=0

Annex 2: Questionnaires

Household Questionnaire

Name of the Enumerator …….....
Date of Survey……

1. Informed Consent
    a. Yes
    b. No

A. DEMOGRAPHIC PROFILE

2. Respondent's Name: _____
3. S/o or w/o _____
4. Mobile No. _____

5. Family Members Details

Age Group & Gender	**Number**
Elderly male [60 and above yrs]	
Elderly female [60 and above yrs]	
Adult male [18-59 yrs]	
Adult female [18-59 yrs]	
Boy [4-17 yrs]	
Girl [4-17 years]	
Children aged below 4 years	
Total	**00**

6. Does your household have BPL Card? (Choose a single response)
    a. Yes
    b. No
    c. Don't Know

7. For how long (in years) have you been living in this village?
    _____

8. What is primary source of occupation of the head of the household?
    a. Agriculture/Farming
    b. Government Job
    c. Industrial Worker
    d. Small Shop
    e. Business
    f. Driver
    g. Service
    h. Others

B. WATER SUPPLY

B.1 SOURCE OF WATER

9. What is the main source of drinking water for your household? (Single Choice)

a. Government Piped Water Supply
b. Hand pump
c. Individual Borewell with power pump
d. Water Tankers/ Vendors
e. Tubewell/Dug wells
f. Packaged Water bottles
g. Other Sources_____

10. What is the main source of water for other purposes (cattle, washing, etc.)? (single answer)
    a. Government Piped Water Supply
    b. Public Hand pump
    c. Individual Borewell with power pump
    d. Water Tankers/ Vendors
    e. Tubewell/Dug wells
    f. Other Sources_____

11. If option other that a. in q9 & 10, Have you ever tried to have a GOVERNMENT PIPED WATER SUPPLY connection?
    a. Yes
    b. No

12. If no in q11, what are the reasons?
    a. Can't afford due to high installation charges
    b. Cannot afford due to high tariff charged
    c. Not allowed
    d. It is not reliable
    e. No distribution in the area
    f. No Pressure/ technically not possible
    g. Lengthy process getting one
    h. Because nobody in my locality has a water connection
    i. Do not feel the need
    j. Others

B.2 <u>FOR HOUSEHOLD CONNECTION (only for option a. in q9 & 10)</u>

13. What is the frequency of water from the HH connection?

	Morning • Less than 1 hour • 1 hour • 2 hours • 3 • 5 • 6 • Does not come	**Afternoon** • Less than 1 hour • 1 hour • 2 hours • 3 • 5 • 6 • Does not come	**Evening** • Less than 1 hour • 1 hour • 2 hours • 3 • 5 • 6 • Does not come
In Summers			
For the rest of the year			

14. Do you use an electric pump to get water from connection (**Observation only**- tulu pump)?
    a. Yes
    b. No

15. What type of water tariff do you pay now?
    a. No Tariff
    b. Fixed
    c. Salary to the operator
    d. Others.

16. If option other than a. in q15, How much do you pay for water supply per month?
    Rs. _____

B.3 <u>FOR HANDPUMP (only for option b. in q9&10)</u>

17. How far is the handpump from your house?
    a. Within the household
    b. Less than 100 m
    c. 100-300 m
    d. 300-500 m
    e. More than 500 m

18. What is the average time taken for collection of water in a day?
    a. Upto 1/2hr
    b. ½ - 1 hr
    c. 1 – 2 hr
    d. More than 2 hr

19. What is the number of households catered by the handpump?
    --- Nos

20. What are the key difficulties in general do they face in collecting water? (Multiple choice)
    a. Do not face any problem
    b. Distance
    c. Time consuming/Waiting in Que
    d. Absenteeism in school
    e. Unhygienic surroundings
    f. Water logging around stand post
    g. Small fights/brawls in collecting water
    h. Any other

21. Is the water adequate?
    a. Yes
    b. No

.

B.4 <u>FOR Borewell with power pump (only for option c. in q9 &10)</u>

22. What is the depth of the borewell in feet?
    _____

23. If borewell with power pump in the question, in the last 10 years, did you increase the depth of your borewell?
    a. Once
    b. Twice
    c. More than 3 times
    d. Not done

24. For options other than d. in q23, How many feet did you dig down recently?
    a. 12-24 feet
    b. 24-36 feet
    c. More than 36 feet

25. Is the water adequate?
    a. Yes
    b. No

B.5 <u>FOR PRIVATE TANKERS/VENDORS USERS (for all)</u>

26. Have you ever purchased water from a private vendor or tanker for domestic use (excluding marriages and other functions)?
    a. Yes
    b. No

<u>If yes in q26, than ask q 27-30</u>

27. How many times you have purchased the water from a private vendor or tanker for domestic use in last three months?

_____ (Number)

28. What is the cost of one tanker?
    _____ (Number)

29. Is it convenient to buy tankers?
    a. Yes
    b. No

30. What is your opinion on water quality of the water from the tankers?

	Color	**Taste**	**Smell**
Always Good			
Sometimes Good and Sometimes Bad			
Always Bad			

B.6 <u>WATER STORAGE (for all)</u>

31. What kind of storage structure do you have? (multiple)

Storage	**Total Capacity (in litres)**

Overhead tanks	
Underground storage	
Others	

32. In case of storage tanks, how often you clean?
    a. Daily
    b. Weekly
    c. Monthly
    d. As necessary
    e. Others

B.7 WATER QUALITY

33. What is the status of the water quality for drinking purpose?

	Color	Taste	Smell	Pressure
Always Good				
Sometimes Good and sometimes bad				
Always Bad				

34. Do you treat water?
    a. Yes
    b. No

35. If yes in q34, How do you treat water to make it potable?
    a. Boiling
    b. Filtering by cloth
    c. Aquaguard and other gadgets (non- electric)
    d. Others

B.8 WATER COMPLAINT REDRESSAL (Only for GOVERNMENT PIPED WATER SUPPLY- If option a in q9&10)

36. Are you aware of any '**Helpline numbers for Water Supply related queries**'?
    a. Yes
    b. No

37. If yes, have you ever lodged a complaint regarding water supply?
    a. Yes
    b. No

38. With whom did you lodge the complaint?
    a. Panchayat
    b. Water Department /Office
    c. Others

39. What is the nature of complaint?
    a. Inadequate water supply

b. Timing of water supply
c. No sufficient pressure
d. Inappropriate billing
e. Impurities in water
f. Bursting of water and/or sewage lines
g. Others (Specify)_____.

40. What is average time taken to solve the problem?
1) Within a day
2) Within 3 Days
3) Within a week
4) Within two weeks
5) Within 1 month
6) More than 1 month (Specify) _____.
7) Never

B.9 WATER CONSERVATION

41. Are you aware of any water shortages in your village?
a. Yes
b. No

42. If yes in q41, what according to you is the cause of shortage?
_____

43. If no in q41, How long do you think your village will start facing water shortages?
a. In next 5 years
b. in next 20 years
c. Never
d. DK

44. What according to you would cause this shortage? _____

45. Have you ever noticed any propaganda on water conservation?
a. Yes
b. No

46. Do you do anything to conserve water?
a. Yes
b. No

47. If yes, what do you do to conserve water?
Specify _____

C. SANITATION – General information

48. Does your household have a functional latrine?
a. Yes
b. No

49. Do men/males in your household use a toilet?

a. Always
b. Sometimes
c. Never (Open)

49.a. Do women/females in your household use toilets?
a. Always
b. Sometimes
c. Never (Open)

50. If YES in q48, what type of latrine do you have (Observation also)?
a. Flush/pour to piped sewer system
b. Flush/pour to septic tank
c. Flush /pour to circular cemented pit/firma gol wala
d. Flush pour to single leach pit
e. Flush pour to double leach pit
f. Others
g. Don't Know

51. How much did you spend in building the latrine?
a. Specify Rs. _____
b. DK

52. How much did you spend on its maintenance monthly?
a. Specify Rs. _____ (Include cost of emptying septic tank, other maintenance, etc.)
b. DK

D. HEALTH and HYGIENE INFORMATION

Linked to q5 only

53. How do you dispose feces of child below 4 years? {Choose a single response)
a. In toilet/child uses toilet
b. Buried
c. Thrown in drain Dumped/open
d. Other

54. When do you wash your hands? (Multiple)
a. Before or after cooking
b. Before eating
c. After eating
d. After defecation
e. After cleaning child feaces
f. Others

55. Can you show me the place where you usually wash your hands {observation only} Observe the material available for hand washing (Choose a single response)
1. Water only
2. Water and Soap/detergent
3. Water and Mud
4. Water and Ash

5. Other

56. Do you have any knowledge of water borne diseases?
    a. YES
    b. NO

57. Has anyone in your family members had fallen ill in the last six months and by which disease? (Typhoid, Gastroenteritis, Diarrhea etc.)
    a. Typhoid
        i. Yes
        ii. No
    b. Fever
        i. Yes
        ii. No
    c. Dengue
        i. Yes
        ii. No
    d. Diarrhea
        i. Yes
        ii. No
    e. Cholera/pelia/jaundice
        i. Yes
        ii. No
    f. Skin allergy
        i. Yes
        ii. No
    g. No health issues/illness

58. Where do you generally go for the treatment?
    a. Primary health Centre
    b. Anganwadi
    c. Private clinics/Hospitals
    d. Govt. hospital
    e. Others (Specify) _____

59. What is the average household medical expenditure in last six months?
    Rs _____.

E. Waste Management Infrastructure

60. Type of waste management facility household has (Single Choice):
    Solid Waste (Biodegradable- vegetable peels, agriculture waste)
    a. Burnt
    b. Dust-bins
    c. Compost pit
    d. Vermin-compost pit
    e. Bio-gas toilet
    f. HH bio-gas
    g. Nearby pit
    h. Recycling facility
    i. No facility

j. Others
k. DK

61. Type of waste management facility household has (Single Choice):

Solid Waste (Non-Biodegradable- plastic, metal, tyre, glass, polythene, paper)

a. Burnt
b. Dust-bins
c. Compost pit
d. Vermin-compost pit
e. Bio-gas toilet
f. HH bio-gas
g. Nearby pit
h. Recycling facility
i. No facility
j. Others/Kabadiwala
k. DK

62. Type of liquid waste management facility household from kitchen and bath area has (Single Choice):

Liquid Waste

a. Connect to Sewer
b. Connected to closed/open drain/underground drain
c. HH Soak pit
d. Community soak pits
e. Nearby water body/johad
f. Kitchen Garden
g. On to the road
h. Other
i. DK

F. Waste Management System

63. Type of waste management system/services household has/or access to
a. Collection system by GP/SHGs/Others
b. Collection by Kabadiwala/Rag-pickers
c. Safai Karamchari
d. Recycling services
e. Others
f. No system/services
g. DK

64. Do you segregate waste at home?
a. Yes
b. No

65. Are you willing to participate in waste management program?
a. Yes
b. No

66. Are you willing to pay for waste management services?
a. Yes, how much _____
b. No

67. Is there any system for monitoring of sanitation in your village/ward?
    a. Yes
    b. No

68. If yes, what is monitored in the village/ward? multiple responses possible
    a. Open Defecation
    b. Toilet access by all
    c. Toilet usage by all
    d. Solid Waste Management
    e. Liquid Waste Management
    f. School & Anganwadi Sanitation
    g. Hygiene Behavior
    h. Village/Ward Cleanliness
    i. None
    j. Other
    k. DK

69. Are you aware about the sanitation program being implemented by Govt?
    a. Yes (name the program_____)
    b. No

G. AGRICULTURE (for farming community)

70. Do you have land for agriculture?
    a. Yes
    b. No

If yes in q70 than q 71-74

71. How much area? (in acres)
    …….

72. What is the main source of irrigation for your land?
    a. Rainwater
    b. Individual Borewell/Tubewell
    c. Canal/Rivers
    d. Community Wells
    e. Others…….

73. If tubewell, what is the depth in feet?
    _____

74. Which one of the irrigation system you have installed?
    a. Flood irrigation
    b. Drip irrigation
    c. Sprinkler
    d. Others

- **Photograph - 2 pics**
- **GPS coordinates**

School/Anganwadi Questionnaire

School/Anganwadi Name ……
Name of the Enumerator …….....
Date of Survey……

1. Informed Consent
    a. Yes
    b. No

I. SCHOOL PROFILE DATA

2. Respondent's Name……
3. Mobile No. _____

4. School Type
    a. Anganwadi
    b. Primary
    c. Secondary
    d. Senior Secondary

5. School/Anganwadi members Details

	Number
School Teachers/AWW	
Students- Boys	
Students- Girls	
Other Staff	
Total	

II. WATER AMENITIES AND SERVICE DATA

6. What is the main source of drinking water for your school/anganwadi? (Single Choice)
    a. Government Piped Water Supply
    b. Public Hand pump
    c. Individual Borewell with power pump
    d. Water Tankers/ Vendors

e. Tubewell/Dug wells
f. Packaged Water bottles
g. Other Sources_____

7. What is the main source of water for other purposes (washing, etc.)? (single answer)
   a. Government Piped Water Supply
   b. Public Hand pump
   c. Individual Borewell with power pump
   d. Water Tankers/ Vendors
   e. Tubewell/Dug wells
   f. Other Sources_____

8. What kind of storage structure do you have? (multiple)

Storage	**Total Capacity (in litres)**
Overhead tanks	
Underground storage	
Others	

9. If overhead tanks, how often you clean them?
   a. Daily
   b. Weekly
   c. Monthly
   d. As necessary
   e. Others
   f. DK

10. Do you observe any leakage from the taps or water storage tanks?
    a. Yes
    b. No

11. If yes, have you complained to correct the leakage?
    a. Yes
    b. No

12. What is the status of the water quality for drinking purpose?

	Color	**Taste**	**Smell**	**Pressure**
Always good				
Sometimes good and sometimes bad				
Sometimes Bad				

13. Is the water treated before supply for drinking purposes?
    a. Yes
    b. No

14. If yes in q13, How do you treat water to make it potable?

a. Boiling
b. Filtering by cloth
c. Aquaguard and other gadgets (non- electric)
d. Others

15. Does this Anganwadi/School have a toilet {observation only}?
    a. Yes, functional
    b. Under construction
    c. Broken/choked/incomplete
    d. Under lock & key
    e. No toilet

16. Does have school/anganwadi have water supply and hand washing facility?
    a. Yes
    b. No

17. Is the toilet being used?
    a. Staff_____ Yes No
    b. Boys_____ Yes No
    c. Girls_____ Yes No

18. Type of waste management facility anganwadi/school has (Single Choice):

Solid Waste (Biodegradable- vegetable peels, agriculture waste)

a. Burnt
b. Dust-bins
c. Compost pit
d. Vermin-compost pit
e. Bio-gas toilet
f. HH bio-gas
g. Nearby pit
h. Recycling facility
i. No facility
j. Others
k. DK

19. Type of waste management facility school/Anganwadi has (Single Choice):

Solid Waste (Non-Biodegradable- plastic, metal, tyre, glass, paper)

a. Burnt
b. Dust-bins
c. Compost pit
d. Vermin-compost pit
e. Bio-gas toilet
f. HH bio-gas
g. Nearby pit
h. Recycling facility
i. No facility
j. Others /Kabadiwala
k. DK

- **Photograph**
- **GPS coordinates**

Observation Tool- Resource Mapping (Tab Based)

1. School
2. Anganwadi
3. Hospitals/Dispensary/PHE
4. Public Toilet
5. Agriculture Land
6. Park
7. Main Road
8. Internal village road
9. Market
10. Temple/Mosque/Church/Gurudwara
11. Water resources
    a. Streams
    b. Tubewell
    c. Government Piped water line
    d. Borewell
    e. Well
    f. Drainage ponds
    g. Overhead tanks

If options b. d. e., in point 11

1. Name of the Farmer: _____
2. Is your submersible/tubewell caters to only your land?
    a. Yes
    b. No
3. What is the total land area it caters? _____

GPS

Checklist for Focus Group Discussion/Panchayat with Community Members

1. Date: ……
2. Facilitator Name (s): ……
3. Location: ……
4. No. of Participants ……
5. Basic information about the village/hamlet/RA with respect to:
    a. Population
    ……..
    b. Number of Households_____
    c. Caste/community groups ……

d. Economic Base ……..
   - Agriculture
   - Service
   - Industry
   - Other

- **Water Source & Supply**
  a. What are the main sources of water in your village?
  b. Is source for drinking water and water for other purposes same in your village?
  c. Is there any metering system in the village for government piped water supply?
  d. What is the water tariff for the government piped? If there is no tariff for the government piped water supply, why do all households don't have this connection? What are the reasons?
  e. Are there any government water sources in the village? Who are all who use water from these resources?
  f. Are private tankers used in your village? When are the tankers basically used?

- **Ground water**
  a. What is the average depth of ground water in your village?
  b. How long do you dig your borewell?
  c. How deep do you dug?
- **Water Storage**
  a. Are there any community water tanks in the village?
  b. What is there purpose?
  c. If available, is there any water operator for these community water storage tanks?
  d. What and how do you pay him?

- **Water availability & quality**
  a. Is the ground water adequate in the village?
  b. What is the status of the water quality in your village?

- **Health aspects**
  a. What are the common health issues in your village?
  b. Where do people in your village go for treatment?

- **Sanitation and Hygiene issues; hygienic practices, customs to obtain water, advantages and disadvantages perceived in relation to these practices**
  a. Does everybody in your village have toilets?
  b. What is the percentage of open defecation in your village/
  c. What is the common technology being used in the village for seweage disposal?

- **Waste water treatment and disposal**
  - What is the system of waste water disposal (grey water) in your village?
  - Is there any mechanism of solid waste disposal in your village? If yes, what is it?

- **Industrial area – water intensive, waste water treatment, source of water**
  - Are there any industries within your village or nearby?
  - What are the types of industry?
- **Grievance redressal; Consumer complaints, where do they go? How a complaint is solved?** services issues?

- If water shortages occur in your village, what are the oppurtunities to tackle the situation?
- Willingness of community and panchayat for active participation
- Gathering local wisdom to tackle the situation and start a dialogue for future?
- What is the awareness and preparedness for climate change?

Checklist for Focus Group Discussion with Farmers

1. Date: ……
2. Facilitator Name (s): ……
3. Location: ……
4. No. of Participants ……
5. Basic information about the village/hamlet/RA with respect to:
    a. Population
    ……..
    b. Number of Households_____
    c. Caste/community groups ……

1. Since How long have you been faming in the village?
2. What is the average land in acres with each farmer in your village?
3. What are the major crops you grow in your area and what are the irrigation patterns?

Season	Crops	Irrigation pattern
Khariff		
Rabi		
Others (Vegetables etc.)		

4. What is the average depth of tubewell in your farms?
    - Does every farm have individual tubewells or one tubewell caters to more land?
    - In last 10 years, have you dug your tubewell deep?
    - If yes, how many times have you dug?
    - How deep have you dug?
5. What is the quality of the water?
6. What is the mechanism to deal with weeds and pesticides? (Use of pesticides)
    - What kind of pesticides do you use oftenly?
7. How the cost of water from the tubewell accounted? (electricity & water meter charges)
8. Are there any government subsidies for farming? What are these?
9. Are all members of your family are involved in agriculture?
10. Is Agriculture/farming your only source of income? If not what are the other occupations in the village?

Checklist for Water Providers/PRI

1. Date: ……
2. Facilitator Name (s): ……
3. Location: ……
4. Participant and their Designation

Name	Designation	Phone No.

5. How many tubewells are there for this supply for PWS?

6. If, piped water supply, is the supply available for the entire village? Or how much %age are benefitted

7. What is the frequency of water supply?

8. If daily, how many hours?

9. Electricity?

10. What is the regulation mechanism for the water users?

11. Is water meter installed in each and every household? What is the pricing mechanism?

12. What is the process of operation and maintenance of this piped water supply?

13. Do you receive any complaints from individual users?
    a. If yes, what is the frequency and types of complaints?
    b. How do you handle these issues?

14. Are there any water schemes available in the village to ensure quantity and quality of water?
a. If yes, what are they? How do you ensure quality of water?