केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report
on

AQUIFER MAPPING

Outer Plains of Kashmir Valley, Jammu &Kashmir

उत्तर पश्चिम हिमालय क्षेत्र, जम्मू

North Western Himalayan Region, Jammu

Central Ground Water Board
Ministry of Water Resources,
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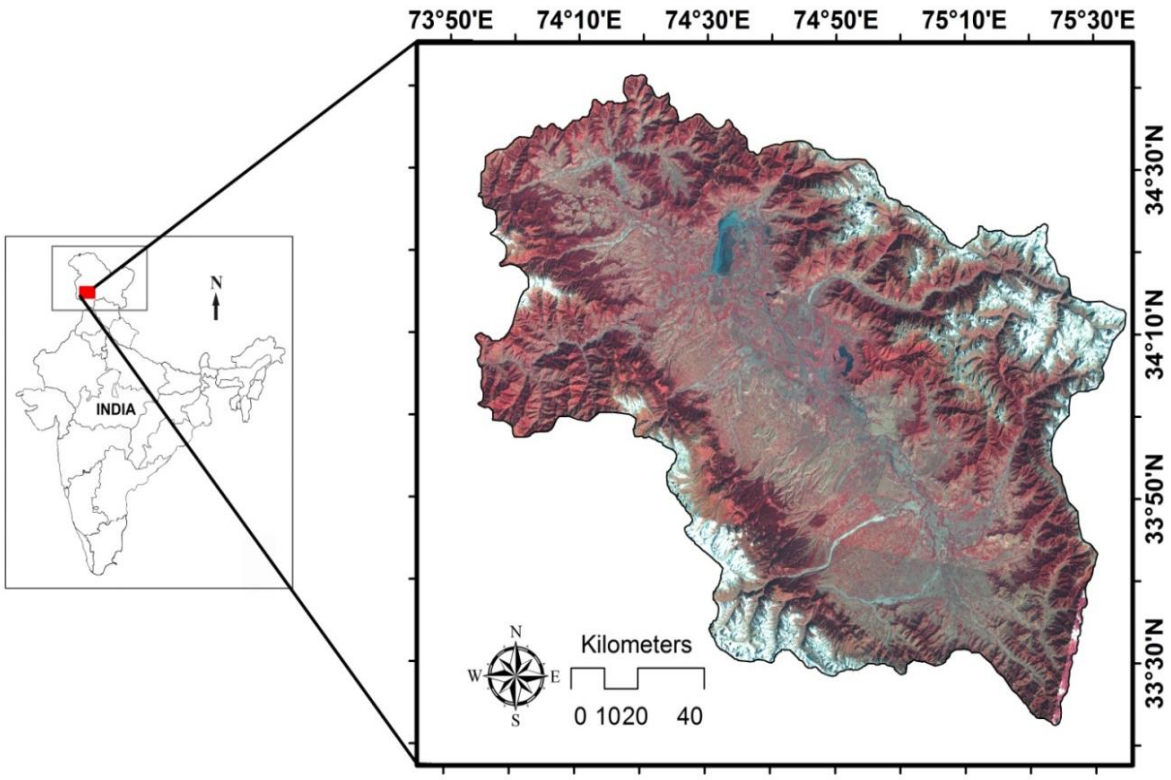
Report on

Aquifer Mapping & Management Plan

of

Kashmir Valley,J&K

(5200 sq.km)



North Western Himalayan Region
Jammu
March 2017

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North Western Himalayan Region
Jammu
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PREFACE

Aquifer mapping studies have been carried out in the Kashmir Valley, J&K State with an objective to identify and map the aquifers at micro level, quantify the availability of ground water resource and suggest Aquifer Management Plans to address the basic ground water related issues in the area. Aquifer Mapping study involves integration and analysis of multi-disciplinary scientific aspects including geological, hydrogeological, geophysical, hydrological and hydro-chemical. These studies help to characterize the quantity, quality and ground water movement in the aquifers and devise their optimal management plans. The representative area of the study was in the State of Jammu & Kashmir, forming valley part of Kashmir in the alluvial tract and spread over an area of 5,200 Sq. Km. The study area includes parts of the present day Anantnag, Pulwama, Badgam, Srinagar, Baramulla and Kupwara districts of the State.

The report on "Aquifer Mapping & Management Plan of Kashmir Valley of Kashmir Province, J&K" elaborates the outcome of the Aquifer Mapping Study, in particular, the vertical and lateral extent of the aquifer units, their characteristics and response of the aquifer units to different stress conditions and their redressal through appropriate management plans. Various water stress mitigation options by integrating technical and scientific measures are also recommended for sustainable ground water development and management in the area.

The untiring efforts put forth by a team of Scientists of North Western Himalayan Region, Jammu namely Shri Vinod Sharma, Shri K.P. Singh and Smt. Priya Kanwar, in bringing this report are duly appreciated, as this report would not have seen the light of the day without their hard work and dedication.

The report shall be of immense use for the planners and managers as well as academicians / researchers as a guide and reference volume in the field of Ground Water Resource Management.

Place: Jammu **(Dr. S. K. Jain)**
Date : **Regional Director**

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Last but not the least, the authors express their sincere thanks to every person, who directly or indirectly helped in carrying out this study and bringing out this report in presentable form.

REPORT ON
AQUIFER MAPPING & MANAGEMENT PLAN
OF
KASHMIR VALLEY, J&K (5200 sq.km)

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1 INTRODUCTION

The delineation of aquifers along with their extent and potential through ground water surveys, exploration and monitoring is an on-going activity of Central Ground Water Board. The entire country including the valley areas of Jammu & Kashmir has already been covered under Systematic Hydrogeological Surveys to generate basic hydrogeological data. Reappraisal Hydrogeological Surveys/ Ground Water Management Studies have been conducted to study the changes in the groundwater regime over a period of time. The hydrogeological map of the entire country was compiled on 1: 2,000,000 scale and was first published in 1984. Subsequently, it was revised and again published in 2002 based on the data collected by CGWB through ground water survey, investigation and exploration program supported by exploratory drilling, geophysical investigations and hydro chemical studies. Aquifer Atlas of Jammu & Kashmir was prepared on 1:250,000 scale in the year 2013.

In today's scenario, increasing population, rapid urbanization, industrial development and human interventions in the ecosystem pose a challenge for water resource managers. Any strategy for management of ground water resources on sustainable basis depends on proper understanding of the characteristics of the aquifer system. In view of the emergent challenges in the ground water sector in the country, an urgent need was felt for comprehensive and realistic information pertaining to various aspects of ground water resources available in different hydro-geological settings through a process of systematic data collection, compilation, data generation, analysis and synthesis.

In view of this the micro level aquifer mapping programme has been taken up by Central Ground Water Board (CGWB) during the XII Five Year Plan. Aquifer mapping is a multidisciplinary scientific process wherein a combination of geological, hydrogeological, geophysical, hydrological and water quality data are integrated to characterize the quantity, quality and movement of ground water in the aquifers. Under the **N**ational **Aqui**fer **M**anagement Programme (NAQUIM) North Western Himalayan Region had undertaken aquifer mapping of Kashmir Valley of Kashmir Province, Jammu & Kashmir.

Objectives

The objective of aquifer mapping is delineation of geometry of the underlying aquifer systems in horizontal as well as vertical domain and their characterization, estimating their yield potential and formulation of aquifer management plans to ensure water availability on sustainable basis.

Scope of the study

The scope of the present study is broadly within the framework of NAQUIM being implemented by CGWB. There are four major components of this activity viz.: (i) Data collection /compilation (ii) Data gap analysis (iii) Data generation, and (iv) Preparation of aquifer maps and management plan.

Data compilation included collection and wherever required procurement, of related maps from concerned Agencies, such as the Survey of India, Geological Survey of India, State Governments, etc., computerization and analyses of all acquired data, and preparation of a knowledge base.

Identification of Data Gap was included to ascertain the requirement for further data generation in respect of hydrogeological, geophysical, chemical, hydrological studies, etc.

Data generation included those pertaining to exploratory drilling and aquifer characteristics, sub-surface geophysics, chemical quality of ground water and geophysical survey. Generation of chemical quality data of ground water was accomplished by collection of water samples and their laboratory analyses for all major parameters and heavy metals. Sub-surface geophysical studies incorporated Vertical Electrical Sounding and borehole logging.

Based on integration of data generated from various studies of hydrogeology & geophysics, aquifers have been delineated and characterized in terms of quality and potential. Various maps have been prepared bringing out Characterization of Aquifers, which can be termed as Aquifer maps providing spatial variation (lateral & vertical), quality, water level and potential (quality & quantity). Finally, a suitable strategy for sustainable development and management of the aquifer in the area has been evolved based on the acquired data.

Approach and Methodology

The study involves collection of existing data from various sources including CGWB records, State Government agencies, available literature and other sources relevant for the purpose of aquifer mapping and management. Godwin Austin (1859) described the lithology, structure and fossil remains of the Karewa formation. Lydekkar (1878) postulated that the Karewas were deposited in a huge lake and divided the same into two series on the basis of lithology. Middlemiss (1911 and 1924) and Daineli (1922) gave an account of the structure and glacial history of the Kashmir valley respectively. De Terra and Patterson (1939) gave a comprehensive account of the stratigraphy, sedimentation, tectonics and climatology of the Karewa formation of Kashmir Valley. Wadia established the Pleistocene stratigraphy of the Kashmir Valley. During the recent years a number of geologists geophysicists, and geohydrologists of the Geological Survey of India and Oil and Natural Gas Commission have carried out short term as well as systematic geological, geohydrological and geophysical investigations in the Kashmir valley. Preliminary geohydrological survey

in Kashmir Valley is reported to have been carried out by B.P.C. Sinha, Geological Survey of India, but the report was not available for consultation.

The department of Geology and Mining was carrying out ground water exploration in Kashmir Valley since 1969. The Rajasthan Ground Water Board has constructed tubewells during the year 1970 to augment the depleting water supply. In 1973, in Kashmir Valley and CGWB started its Ground Water Exploration and drilled first tubewell at Satsukalan that falls in the current aquifer mapping area. Thereafter groundwater exploration and other field surveys were continue in the Kashmir Valley till 1989. From 1989 to 2005, CGWB has not taken up any activity in the valley due to Law and Order problem. Since 2005 ground water exploration started again and is being continued till date. After 2005, about 60 exploratory wells have been drilled in the valley. Some other baseline reports on the project area include Systematic Ground Water Investigation in a part of Kashmir Valley by U.P. Srivastava, 1970-71, report on Systematic Hydrogeological Studies carried out in Sindh Valley, Kashmir Province by A.Q. Mumtaz, 1987, Geohydrological Investigation of area covered by Exploratory Drilling in a part of Kashmir Valley, 1971-72 by S. K. Sharma, a brief technical resume on Achievements of Groundwater Investigation during the year 1975-76. Geological Survey of India, a note on Ground Water Exploration carried out in during 1988-89, Hydrogeology of Srinagar Distict, report on Hydrometerological Data Analysis of Kashmir Province (J & K) 2009-10 by Priya Kanwar. For quality testing collection of ground water samples from different sources was done. Water samples were also for analysis of pesticides. Even the quality analysis of the two lakes viz. Dal and Wular was done by CGWB in 2007-08. District Ground water Brochures of all the six districts (old) were prepared in 2011 and revised in 2014.

The data was compiled, analysed, examined, synthesized and interpreted from available sources. Since some of these sources had predominantly non-computerized data, all the data available and collected was converted into computer based GIS data sets, which were used to prepare various thematic layers. These layers were integrated to generate aquifer maps. Finally an attempt was made to formulate aquifer management plans.

STUDY AREA

Kashmir is known for its fascinating beauty, perfection beyond this world makes it a paradise. Shahjahan called it Paradise on earth as saying *"Agar Firdous Baroae Zameen Ast, Hami Astu Hami Astu Hami Ast".* Kashmir is one of the most picturesque states lies in northwest Himalaya. Geographically Kashmir is situated between 33° 30´ and 34° 45´ N latitudes and 74° and 75° 30´ E longitudes covering an area of 5200 sq. km. The Valley is unique oval shaped, at an average altitude of 1800 meter above mean sea level. It is surrounded by Great Himalayan Range in the northeast and the Pir Panjal Range in the southwest. (Figure 1).

The national highway NH-1A (Delhi-Srinagar) connects the area with the remaining parts of the country. The area forms the valley parts of Anantnag, Pulwama, Badgam, Srinagar, Baramulla and Kupwara Districts of Kashmir Province.

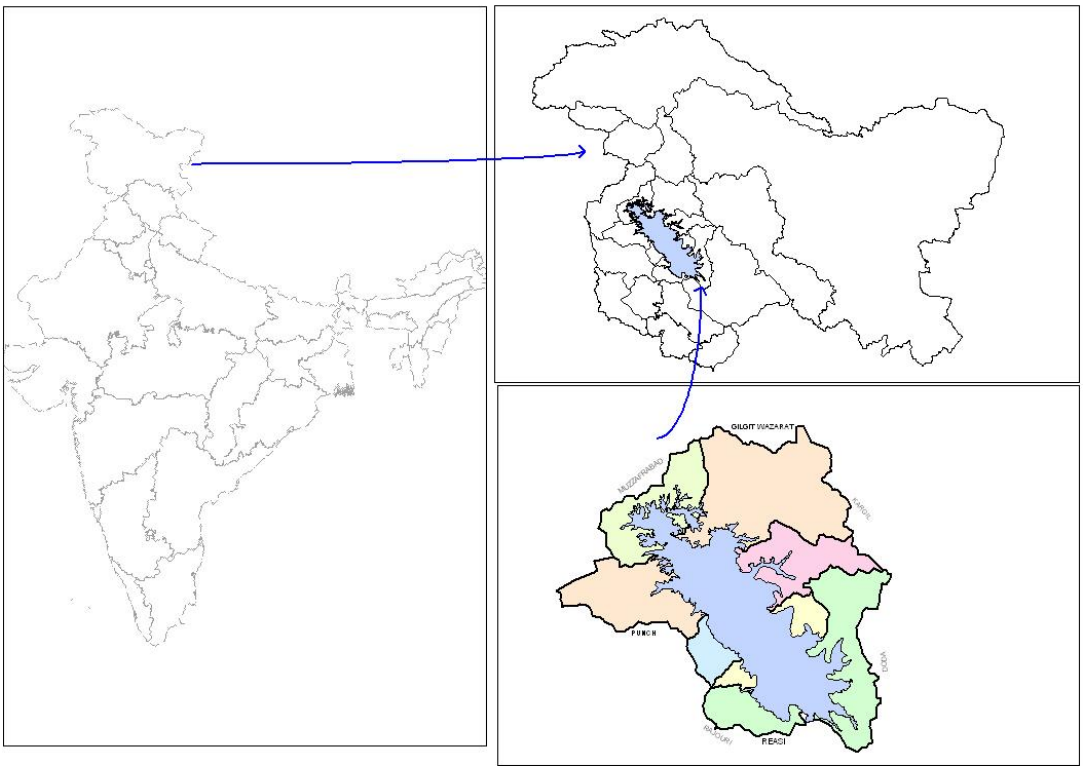


Figure 1. Location Map of Aquifer Mapping Area

Geology

The Kashmir 'Basin' is folded in a major Synclinorium. This synclinal basin preserves an excellent record of the four major glaciation periods, which are separated by the interglacial periods of humid and temperate climatic conditions. Thick deposition of terrigenous Karewa sediments occured here untill drained through a gorge near Baramulla. The Karewas sediments are about 1300 meter in thickness and spread throughout the Valley. These deposits are almost horizontal but tilted towards Pir-Panjal Range. The basement rock of Karewa sediments is Triassic limestone and Late Permian Panjal Trap. Kashmir Valley has a complete stratigraphic sequence of the geological formations of all ages from Archean to Recent that is given in Table 1.

There are several minor and also major faults/thrusts in the Kashmir 'Basin'. The most important thrusts are the Salkhala Thrust and Panjal Thrust that delimits the Kashmir 'Basin' in north and west respectively. A major lineament running along the Jhelum's course from Wular to SE is designated as the Jhelum Lineament. Two extensive lineaments trending NE-SW are identifiable and named as the Sopur (southbound Phoru and northbound Jhelum rivers) the collinear Badgam Lineament that follows course of the Sind River before its confluence with the Jhelum River.

Faults are uncommon within the Karewa sequence and when noticed they are gravity faults of very small magnitude, affecting only few beds. Some of the faults appear to be contemporaneous with the deposition

Table 1. The stratigraphic sequence of geological formation of Kashmir region (Wadia, 1982)

Age	Formation	Thickness (meters)	Lithology
Quaternary	Alluvium	5-30	Sand.
Plio-Pleistocene	Karewa Formation	1300-1800	Conglomerates, silt, clay sand and loess-paleosols
Jurassic	Wuyan Formation	300	Limestone and sandstone
Triassic	Khrew Formation	2000	Clay, shale, limestone, and conglomerate
Permian	Zewan Formation	400	Tuffs, shale, slate quartzite & basalt
Late Carboniferous	Panjal Volcanic Agglomerate Slates	2400	Shale, limestone and sandstone, andesitic and basaltic trapes. Agglomerate Slates and tuffs
Middle Carboniferous	Fenestella Shale	600	Shale, sandstone and conglomerate
Early Carboniferous	Syringothyris Limestone	300	Limestone, sandstone and conglomerate
Devonian	Muth Quartzite	900	Quartizites
Silurian		50	Slate, limestone and sandstone
Cambrian			Quartizite, slate, shale and sandstone
Early Cambrian	Dogra Slate	1525	Slate, limestone and shale
Pre-Cambrian	Salkhala Series		Quartzite, phyllites and shale etc.

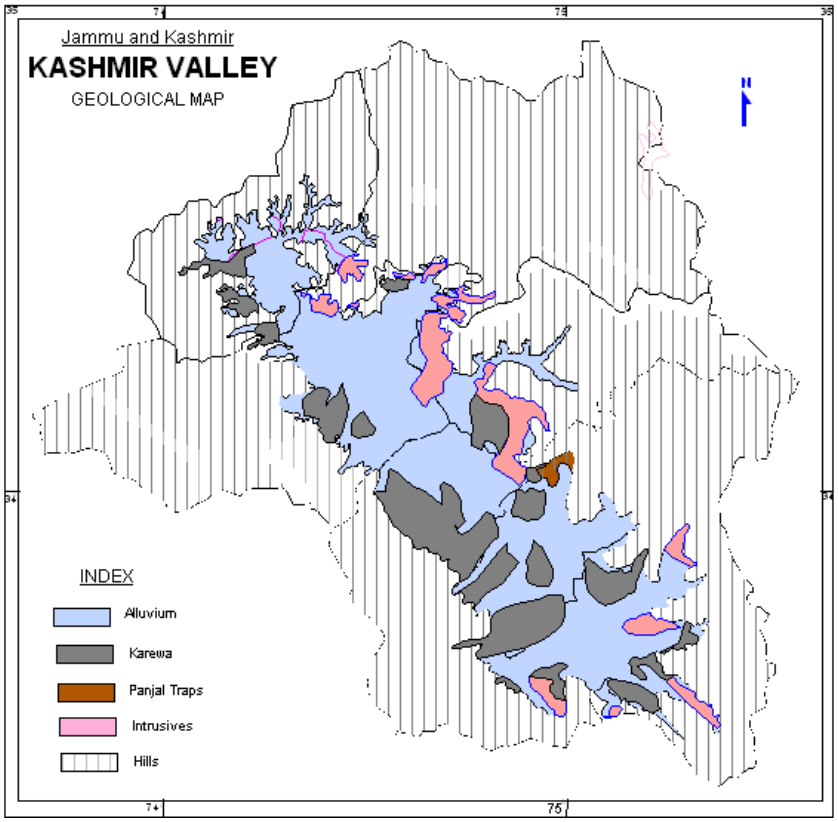


Figure 2: Geological Formations in Kashmir Valley

Climate

Kashmir Valley experiences Temperate-cum-Mediterranean type of climate, which is characterized by rainfall distribution mainly concentrated in winter, spring and then in autumn. Summer is the period of scarce or null rainfall. The precipitation in the valley is received in the form of snowfall as well as rains and average annual precipitation is 660 mm. Summer temperatures are not usually higher than 35°C, winter temperatures are not usually lower than -5°C. Definitely, seasons are clearly drawn: Winter is very cold, lasts from November to March. During these months strong winds bring snow and rain from the Mediterranean depressions. Summer is warm and dry; July and August are the warmest months. Autumn i.e September and October is almost cloudless, quite rainy, but never severe. Spring begins after 15th of March when rain falls heavily and days are sunny. Longest sunshine hours are in September, October and November.

In Kashmir province, weather conditions are different at different places. The causes of difference are:

A) Relief

Relief is the main factor. Lofty mountains like the Pir Panjal, the Zanskar and the Karakoram ranges check winds from blowing in. Thus, moisture is being stopped from entering the valley by the lofty mountains covering the west, north-western and northern part of the area.

B) Monsoon winds

The monsoon winds in summer cause rain in Jammu region. But these winds can cross the Pir Panjal range only when they are very strong. Because of this, there is no monsoon season in Kashmir valley and monsoon rains are nil. In winter winds from the Mediterranean cause snow and rain in the Valley of Kashmir.

C) Forests

Forests influence winds, rainfall and temperature. The moisture-laden wind causes rainfall in the forests on the hills making the temperature to fall in summer. Thus the climate of Pahalgam, Gulmarg etc. is comparatively milder than that of Srinagar or Sopore.

D) Altitude

Altitude is also a factor. So the climate of the valley of Kashmir is comparatively milder than that of the Outer Plain that lies on a very low altitude. The rainfall also varies as the altitude rises.

Physiography

The Kashmir Valley forms more or less a flat terrain bounded by the Pir Panjal range in the south-west and the Great Himalayan range in the north-east. The topography of the valley on the whole is gentle, but for the miniature plateaux constituted of the Karewas. Such plateaux are more frequent on the southwestern side. i.e. the Pir Panjal side, than on the north-eastern side. The Jhelum river flows in a north-westerly direction along the central portion of the valley and the Karewas in the neighbourhood of its course are concealed by the river deposits. The general elevation of the valley floor is about 1585 metres above the mean sea level. The elevation of these mounds is about 1620 m amsl. The general topographic slope in the northern part is towards the south, in the southern part is towards north while in the central part the master slope is towards west. This major synclinorium of Kashmir Basin has four anticlines and five small synclines giving rise to intermediate hillocks and valleys. Low lying areas, especially those around natural water bodies, are marshy. The general elevation contour map of the valley is shown in figure 3.

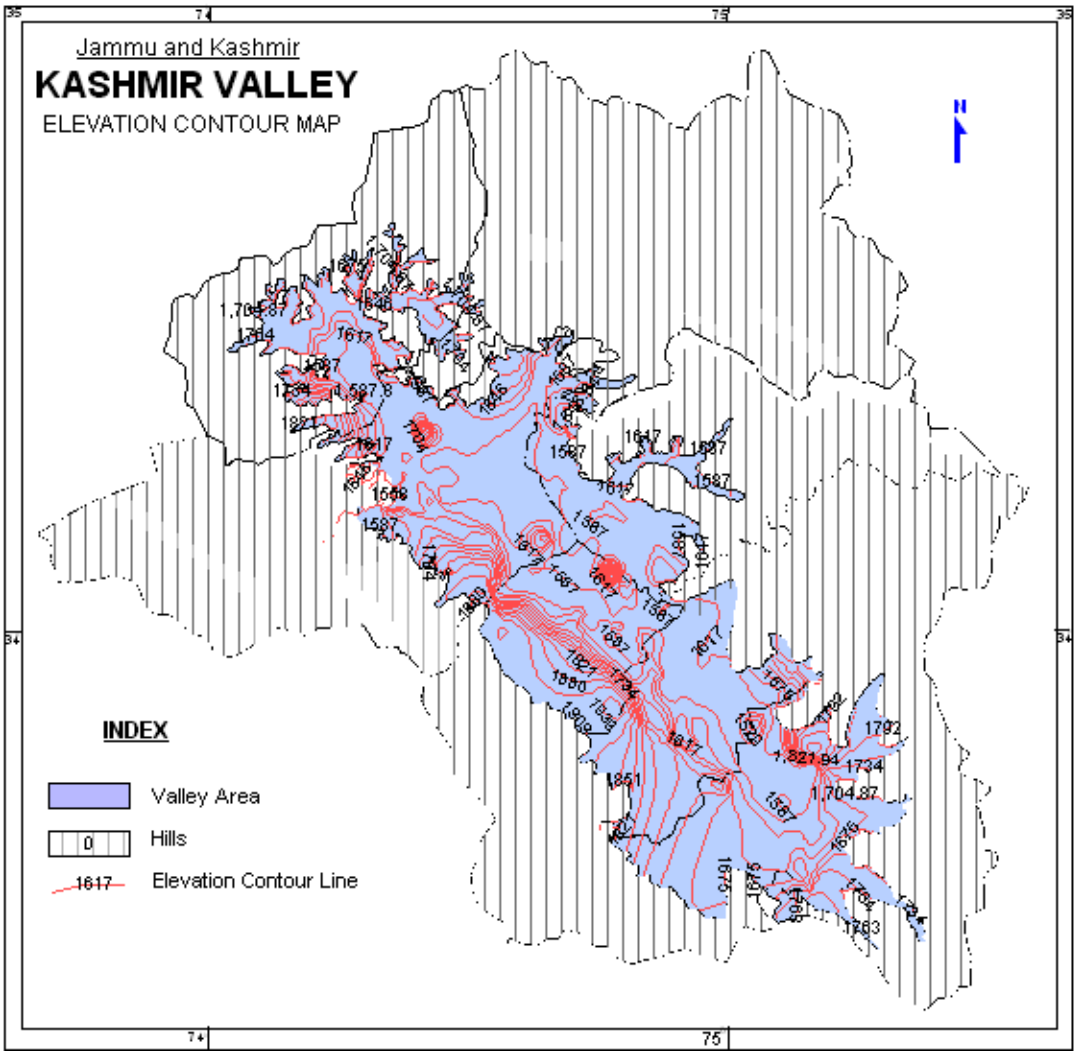


Figure 3: Elevation Contour Map of Kashmir Valley

Drainage

The province is drained mainly by the River Jhelum along with its tributaries which forms Sub-basin of Indus River. The River Jhelum originates from Triassic limestone as a spring at Verinag in Anantnag district, meanders over a distance of about 175 km., across the valley of Kashmir. It enters the Wular Lake near Sopore. The only outlet of the valley is Baramulla where the Jhelum flows out through a narrow gorge. The valley of Jhelum is longitudinal, around 135 km long and 32 km wide and 15520.3 sq. kms. in area and is about 1700m above mean sea level. There is a high wall of mountains around the valley. These rise to a height of 5500 m above sea level. Nullah Sind is the largest tributary of the River Jhelum, discharges itself into the Anchar Lake, which is a local base-level for this stream and later joins the Jhelum. Towards Pahalgam lies the Liddar Valley. Its length is 64 Kms. It has small glaciers, grassy meadows, huge rock walls and gorges in its upper mountains. The path to the holy Amarnath cave passes through this valley. The Kolohai and Sheshnag streams join at Pahalgam to form the Liddar River.

The Dudganga, Shaliganga, Ramshu, Nishar, Rambiar, Bring and Arpal are some of the important tributaries of the Jhelum. Liddar and Vishav rivers join the river Jehlum near Kakapur. Both Shaliganga and Dudhganga rivers meet each other near the southern fringe of Damodar Karewas and finally flow northwards till they meet the Jehlum spill-channel near Barzul. During their high water stage, the flood waters of the Jehlum and Dudganga are channelled through spill channel to Batmalu Nambal. The tributaries of the Jehlum River described above are fed either by springs or by glacial melt-waters

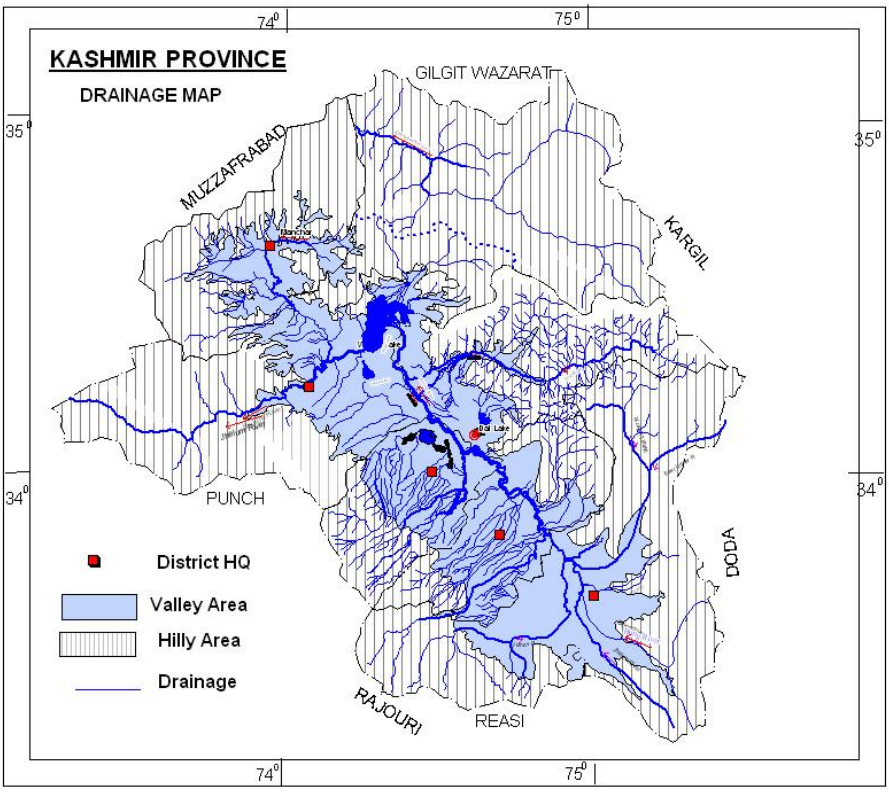


Figure 4: Drainage Map of Kashmir Valley

There are also some small valleys in this region viz., on the north of Baramulla is Lolab valley which is 6 kms long and 4.4 kms wide.

The surface of the valley is plain and abounds with springs and lakes.

Evaluation of the drainage map (Figure 3) reveals that the catchment is consequent in nature mainly due to the original slope of the land surface. The flow of the direction of tributaries joining the main stream is controlled by structural features. Majority of the lower order streams are found to be in sequent in nature joining the higher order main stream at higher angles and lacking structural and geological controls. The tributaries have spread irregularly in all directions and join the main stream at all angles.

Soil

Soil in Kashmir Valley can be broadly classified into two classes:

1) Hapludalfs: Soils developed on high table Karewa lands and
2) Ochraqualfs: Soils developed on valleys on recent alluvial formations

Hapludalfs: These are developed on Karewa deposits and found on Karewas tops and uplands with a slope variation of 1-3%. These soils are severely eroded soils resulting into formations of gullies and ravines. These are very deep soils, well drained with moderate to low permeability. These soils have been tentatively classified as Hapludalfs that are medium to fine textured soils and the surface texture varies from clay loam to silty clay loam. The colour of these soils varies from yellowish brown to dark brown. These are mostly used for cultivation of fruits, wheat, maize and pulses.

Ochraqualfs: These soils are classified as Ochraqualfs. These soils are found on plain to mid- uplands topography with slope variations of 1-3%. They are developed in broad valleys plains. These are very deep soils but the water table in encountered at shallow depths and as such water logging conditions prevail. These are moderately fine textured soils with clay loam as the predominant surface texture. These are slightly eroded soils and are brown to dark – yellowish brown in colour. These soils have moderate to impede drainage with moderately to low permeability. These soils are used for cultivation of paddy, sarsoan and at places wheat.

Agriculture

Kashmir's economy is centred on agriculture, horticulture and tourism. Traditionally the staple crop of the valley is rice, which formed the chief food of the people. In addition, Indian corn, wheat, barley and oats are also grown. Given its temperate climate, it is suited for crops like asparagus, artichoke, seakale, broad beans, scarletrunners, beetroot, cauliflower and cabbage. Fruit trees are common in the valley, and the cultivated orchards yields pears, apples, peaches, and cherries. The chief trees are deodar, firs and pines, chenar or plane, maple, birch and walnut, apple, cherry.

Cropping Pattern

The data of cropping pattern of Kasmir Valley during 2012-13 is given in table 2.

Table 2: Crops Irrigated in Kashmir Valley in hactares

District	Rice	Maize	Wheat	Barley	Other Cereals, Pulses & millets	Other food crops	other non food crops	Total area irrigated under all crops
Kashmir Valley	140361	17087	1	852	2948	39859	61532	262741

Digest of Statistics 2013-14

Irrigation

Irrigation in Kashmir Valley is done through canals/Kuhls, lift irrigation, leer system, tubewells and dugwells etc.

Canals form the most important system of irrigation in the broad valley of Kashmir where the soil is soft and canals can be easily dug. Since historical times there was not a piece of land, not a region and not a forest in Kashmir where the king did not excavate a canal. Some of these ancient canals were the Kakapur canal, the Karla canal, the Chakdar canal, the Avantipur canal, the Shahkul canal (of Safapur), Lachham Kuhl or Zainaganga, Lall Kuhl or Pohri canal, Shah Kuhl on Martanda canal and Mar Canal. The Shah Kuhl was taken out on the left bank of the Lidder River and ran along the face of the limestone cliffs above Martanda. Here it split into four distributing channels, and finally fell over the edge of the plateau into the Jhelum valley at Anantnag. Some of these canals are still important sources of irrigation, but in most cases they have narrowed down. Before the Mar Canal was constructed, the surplus waters of the Dal Lake used to flow into the Jhelum River at Habba Kadal. This junction was extended up to Shadipura.

Moreover, the Jhelum and its tributaries are fed by snowmelt water and never dry. They supply water to the canals throughout the year. About 284.42 Th ha of land in Kashmir are irrigated by canals.

Being a hilly state, the problem of irrigation is complicated in many areas. At higher altitudes the main source of water is *naga* or lift irrigation. The formation of the valley is such that irrigation is easy and in ordinary years abundant. If there is normal snowfall in the winter and the great mountains are well covered, the water supply for rice is sufficient. On both sides of the Jhelum, the valley rises in bold terraces, and water passes quickly from one village to another in years of good snow. In earlier times, at convenient points on the mountain, weirs or protecting snags were erected, and the water was taken into main channels which pass into small networks of ducts and eventually empty themselves in the Jhelum. Lower down in the valley, where the streams flow gently, dams were erected.

Wherever water is available at the depth of one or two meters, it is drawn out by leer system and then supplied to the fields directly. At present about 6000 such wells are working in the valley.

The total area of the valley is irrigated by different types of irrigation sources. The source wise net irrigated area of Kashmir Valley in 2013-14 is given in table 3.

Table 3: Source-wise (Type) of Irrigation & Net Irrigated Area in Kashmir Valley

Type of Irrigation	**Net Irrigation Area (sq.km)**
Canal Irrigation	1793
Tube wells and wells Irrigation	44.69
Wells Irrigation	53.84
Other sources	22.71
Total	**1914.54**

Digest of Statistics 2013-14

Landuse

The data of land use of Kasmir Valley during 2013-14 is given in table 3. The district wise land use and land cover map of Kashmir Valley is available on official website of nrsc site but a composite map of landuse landcover map is not available. The available map is shown in figure 4.

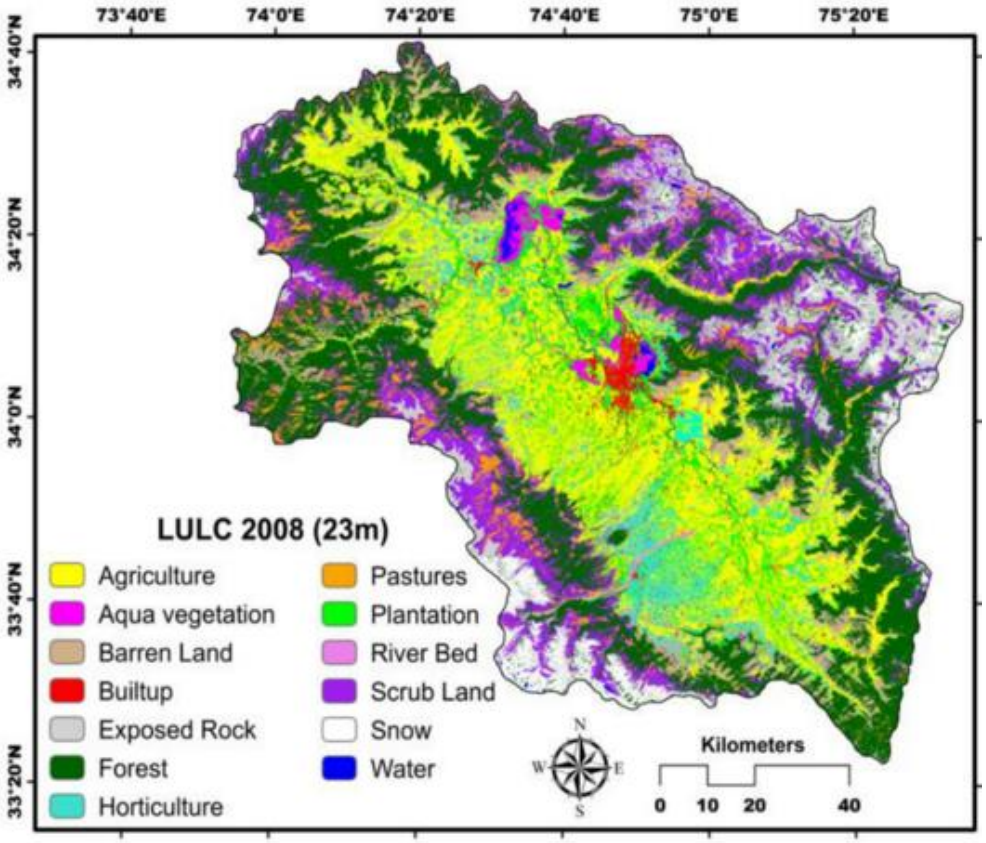


Figure 5: Land use Land cover map of Kashmir Valley

The major land use/land cover classes such as built up land (11.3%), agriculture (34.3%), plantation (2.24%), forest land (0.009%), scrub land (10%), pasture (6.27%), wastelands (6.55%) and water bodies and marshy land (0.97%) were identified in the study area. The area with water bodies is good for groundwater recharge. About 76.46% of the catchment area, covered by plantation, agriculture, forest, scrub land and water bodies is favourable for groundwater potential.

Table 4: Land use and land cover data of Kashmir Valley

In ha.

District	Total Area according to Village Papers	Area Under Forest	Land put to non-agricultural uses	Barren & Uncultivable Land	Marshy & Water logged Land	Land under still water	Social Forestry	Permanent Pastures & other Grazing lands	Land under Miscell. Tree Crops not included in area sown	Culturable Waste land	Fallow land other fallows than current	Current Fallows	Net Area Sown
Kashmir Valley	556643	5241	53859	30820	355	5065	1880	34915	10633	36493	9226	36112	331044

Digest of Statistics 2013-14

Water Conservation

"Kashmir Valley is essentially a flood plain of the river Jhelum and its tributaries, rivulets, streams and canals," All the valley lakes and the vast associated swamps played an important role in maintaining the uniformity of flows in the river Jhelum. In the past, during the peak summers, whenever the river would flow high, these lakes and swamps used to act as places for storage of excessive water and thereby prevented large areas of the valley from floods."

Kashmir Valley encloses about 104 tanks/ ponds/ lakes including 36 marshy areas. The total area mapped under this category was 195.67 sq.km. Many of these traditional ponds and tanks have been erased to house commercial complexes and parks. Un-organised planning and political instability in the Kashmir region has also played its part in transforming the towns into unplanned ones.

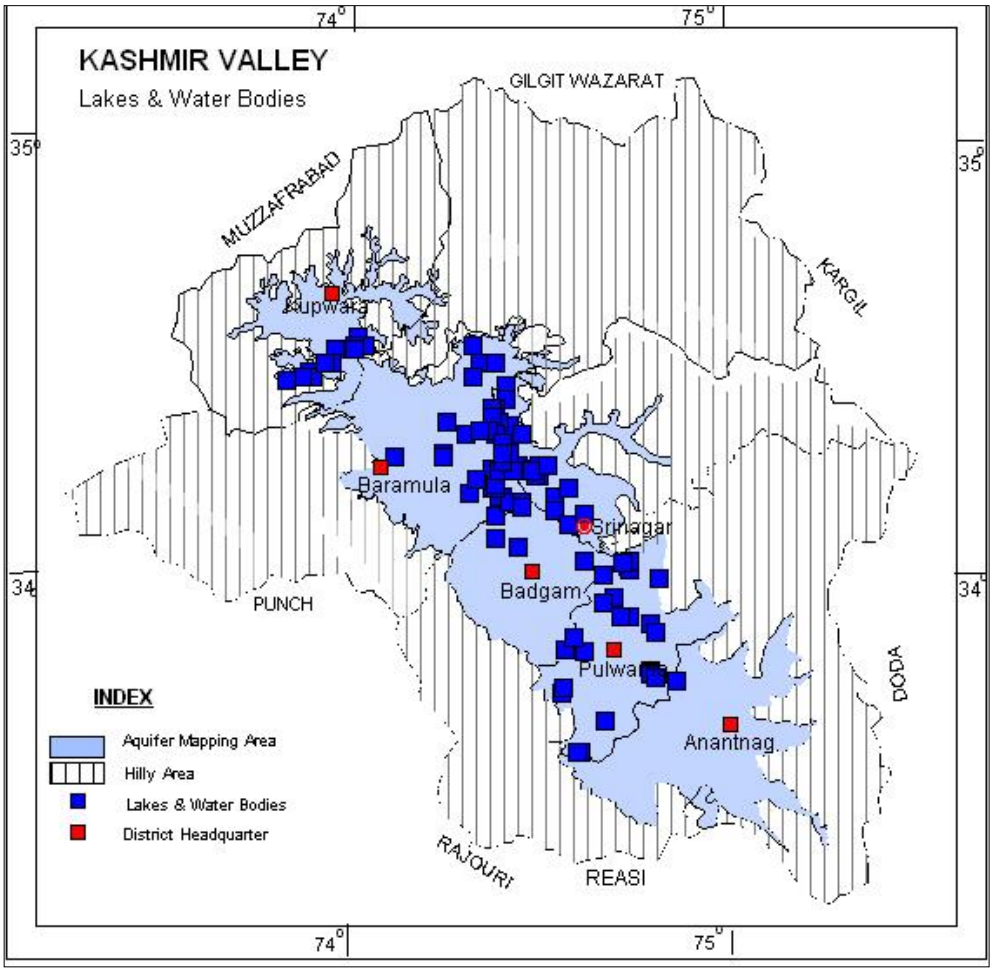


Figure 6: Lakes and Water Bodies in Kasmir Valley

Ground Water Recharge and Discharge

Recharge to the groundwater occurring in Karewas and alluvium is affected through rainfall, melting of snow and lake waters. Spring seepages from within the Karewas and the sub-surface flow of the Jhelum River are sources of discharge of groundwater.

Lower Karewa sediments covering the slopes of Pir Panjal Range along western fringe of Kashmir Valley are a dipping sequence of coarse clastic material interbedded with fine "aquicludes". Such beds in their close proximity to hills are better suited to recharge. River flowing parallel to the fringe of western mountains are mostly fed by base flow discharge in the form of springs.

Discharge of ground water occurs both by natural and artificial ways. Natural discharge is through spring flow and sub surface ground water flow to effluent system. Heavy withdrawal of groundwater from dugwells and tubewells for domestic,

irrigational and allied uses also contribute to the artificial discharge.

Data Availability

The compiled data were plotted on 1:50000 scale map and an analysis of data gap was carried out. The summarized table presenting the data requirement, data availability and data gap analysis is presented in table 5.

Table 5: Data Requirement, Data Availability and Data Gap Analysis

S. No.	Items	Data Requirement	Data Availability	Data Gap
1.	Rainfall Data	Meterological Stations spread over the project area	District-wise Rainfall Data	No Data Gap
2.	Soil	Soil map and Soil Infiltration Rate	Not Available on any Scale	Soil Infiltration Rate across study area
3.	Land use	Latest Land Use pattern	Land use data of 2002-03	Latest data required in GIS Platform
4.	Geomorphology	Digitized Geomorphological map	Downloaded from NRSC, ISRO, Hydrabad.	To obtain digitised Geomorphological map
5.	Geophysics	Geophyiscal data in each Quadrant	87 VES	117 VES
6.	Exploration Data	EW in each Quadrant with Aquifer Parameters	140 EW's	Deep EW's especially **(Annexure I)**
7.	Aquifer Parameters	Aquifer parameters for all the quadrants	Only 30% wells	
8.	Recharge Parameters	Recharge parameters for different soil and aquifer types based on field studies	Recharge parameters given in Resources Estimation	
9.	Discharge Parameters / Draft Data	Discharge parameters for different GW abstraction structures	Discharge parameters given in Resources Estimation	
10.	Geology	All the maps on 1:50,000 Scale. Hard and digitized copies.	Hard copies of only few geological maps	Soft copies of entire study area

2 DATA COLLECTION AND GENERATION

Data on various attributes of Aquifer Mapping has been generated based on the data availability and data gap analysis discussed in previous section. The data generated and data collected from various state government departments is summarized in table 6.

Table 6. Data Generated and Data Collected for Aquifer Mapping Area

S. No.	Items	Data Generated	Data Collected
1	Rainfall Data		2 metereological stations
2	Geophysical data	Carried out 26 VES at 13 sites, 131 E-logging	Geophysical data is not available with any other department in the State.
3	GW Exploration	Construction of 14 EW and 6 OW. Carried out Pumping Tests for determination of Aquifer parameters	Tubewell details of about 180 wells collected from State Government Departments (PHE and I & FC)
4	GW Regime Monitoring	Established 52 key stations. Total 80 monitoring Stations in the aquifer mapping area	Monitoring data not available with any other Department
5	GW Quality Monitoring	Water samples were collected from 81 dugwells, 53 tubewells and more than 100 springs 26 pesticide samples were collected	Chemical data not available with any other Department

Rainfall

Most of the winter precipitation is in the form of snowfall and the summer precipitation is in the form of rainfall. All of the villages located at higher altitudes receive snowfall during winter season. The central and low lying areas experience less precipitation as compared to higher reaches. Rainfall is deficient in the valley portion where annual rainfall is about 300 to 650 mm and in hilly area the rainfall is about 300 to 1300 mm. The monthly mean of 98 year's rainfall data is available at national data centre of IMD Pune is plotted in figure 7 and found that the valley receives maximum rainfall in the month of March viz. 101.1 mm and minimum rainfall in the month of November viz. 19.7 mm. The annual mean rainfall of 98 years at Srinagar is 676.2 mm. There are five monitoring stations of IMD in Kashmir Valley. The mean monthly rainfall data and number of rainy days for all 5 stations is collected from the website of Regional Meterological Station, Srinagar and given in Annexure II.

Monthly mean monthly rainfall based upon 1901-2000 data

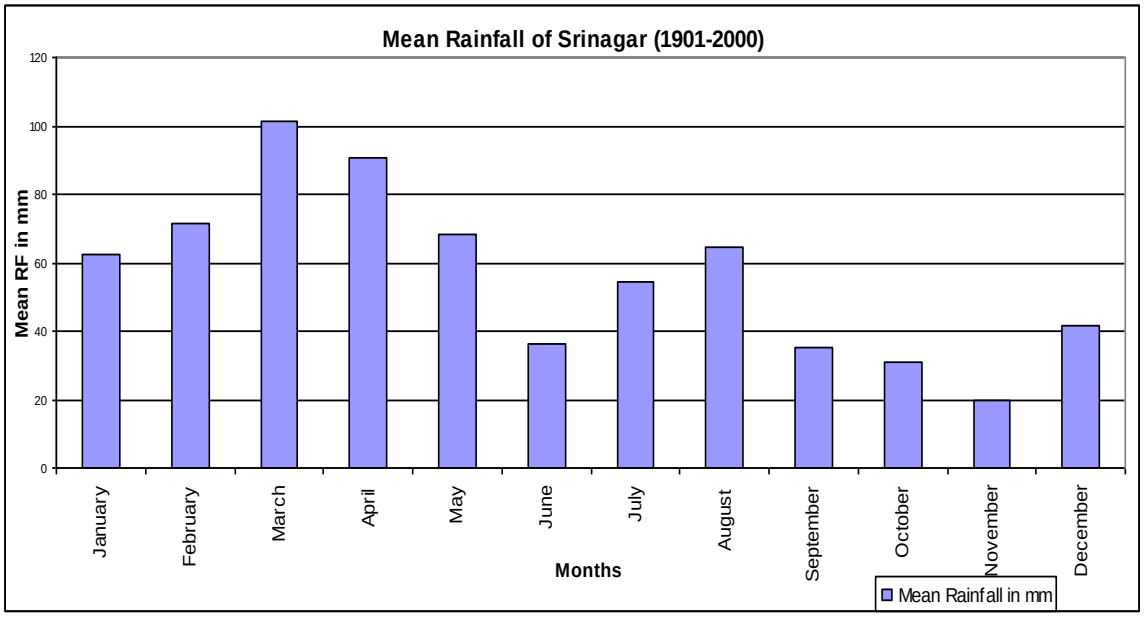


Figure 7: Monthwise Mean Rainfall of Srinagar (1901-2000)

Table 7: Monthwise Mean Rainfall of Srinagar (1901-2000)

Station	Month	Period	No. of years	Mean Rainfall in mm
Srinagar	January	1901-2000	98	62.2
Srinagar	February	1901-2000	98	71.4
Srinagar	March	1901-2000	98	101.1
Srinagar	April	1901-2000	98	90.7
Srinagar	May	1901-2000	98	68.2
Srinagar	June	1901-2000	98	36.3
Srinagar	July	1901-2000	98	54.3
Srinagar	August	1901-2000	98	64.6
Srinagar	September	1901-2000	98	35.4
Srinagar	October	1901-2000	98	30.9
Srinagar	November	1901-2000	98	19.7
Srinagar	December	1901-2000	98	41.4

Source: ndc@imdpune.gov.in

Water Level Monitoring

The open dugwells are located in alluvium/Karewa sediments. The dugwells located in alluvium have higher yields than those located in Karewa sediments. These open wells used for monitoring are losing their identity and also being closed due to piped water supply by State Government Department. In the central and lower part of the valley very few dugwells exist. At the onset of the aquifer mapping in 2012, 28 monitoring wells existed in Kashmir Valley for water level measurement. Inventory of 52 wells was done during field survey of the aquifer mapping area. A total of 80 monitoring wells were therefore monitored to study the impact of various development related activities on the ground water regime. Locations of monitoring

wells are shown in figure 8.

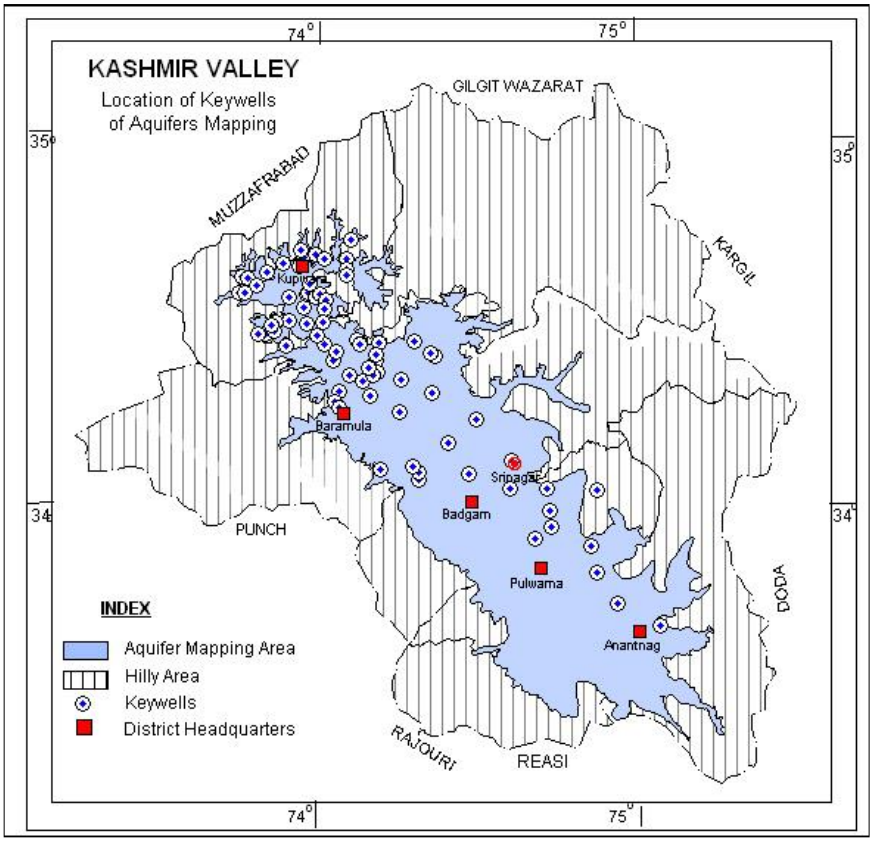


Figure 8: Location Map of Keywells fixed during Aquifer Mapping

Water Level Scenario

The water level scenario of Kashmir Valley is quite different from general perception, in that the pre monsoon deeper water levels are observed in the month of November, because winter rains and snowfall recharges the ground water and shallowest water levels are observed during May. The ground water levels in November 2014, in the south-eastern part of Kashmir Valley are the deepest viz. more than 10 m bgl (figure 9). These deeper levels are observed in small patches in the valley portions of Baramulla and Kupwara Districts on the central and easten parts respectively. Shallowest water levels from 0 to 2 m bgl are observed in the central and south-western parts of the valley. In Baramulla and Kupwara Districts and the north-eastern part of Badgam District the water level ranges between 2 to 5 m bgl.

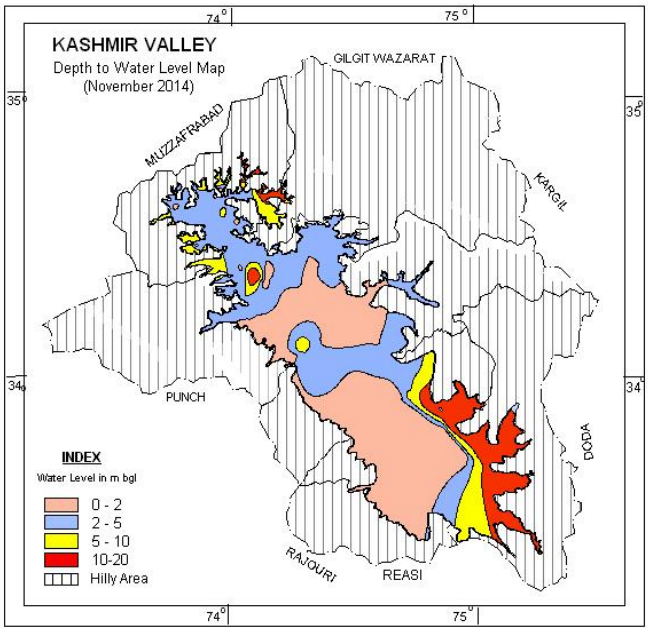


Figure 9: Depth to Water Leval Map of Kashmir Valley (November 2014)

Water Table

Contours of water table and flow direction for November 2014 are shown in figure 9. Ground water moves in the direction of maximum hydraulic gradient i.e. perpendicular to water table contour. It is observed that there is variation in the rate of movement of ground water from the hills to the north -west. The form and disposition of water table contours in the valley roughly follows the surface topography. Near Hamrey the ground water mound of 1896 m elevation is probably the area of local recharge. A 1579 m water table contour indicates that ground water flows north-eastward from Anantnag upto Srinagar and south-westward from Kupwara and Baramulla towards Jhelum River. The Marshy lands are expected to be underlain by clay pans and fed by ground water.

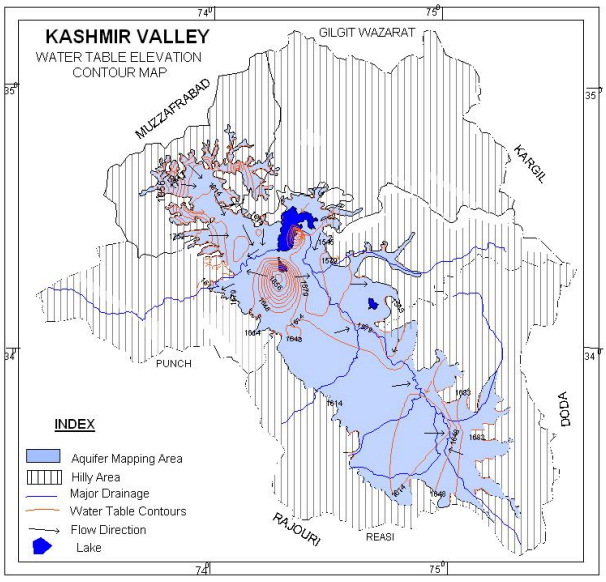


Figure 10: Water Table Elevation Contour Map (November 2014)

Water Quality

The quality of ground water was interpreted by the results of water samples collected from the dugwells and tubewells of Kashmir Valley. Water samples were collected for the analysis of pesticides being used in the agriculture fields. None of the samples were found to have pesticide contents in it. In general the water quality is fresh and potable. The dugwell sample reflects the quality of shallow aquifers and the samples collected from the tubewells are considered to be of deeper aquifers. Thus for the purpose of aquifer mapping the results of 53 samples collected from tubewells are discussed below. The basic chemical parameters determined for evaluating the groundwater quality of Kashmir Valley are pH, EC, CO_3, HCO_3, Cl, NO_3, $S0_4$, F, Ca, Mg, TH, Na, K, TDS, Alkalinity and Fe. All the parameters are well within the safe limits as prescribed by BIS for drinking water except for Iron in some tubewells. The results of chemical analysis are given in Annexure-IV & V.

Electrical Conductivity in the area varies from 160 µS/cm at 25˚C at Trehgam, district Kupwara to 1760 µS/cm at 25˚C at Sopore, Baramulla. The water quality distribution maps for EC is shown in figure 10 which reveals that the EC between 0 and 250 µS/cm at 25˚C is observed in the north-eastern end of the valley along with two other patches in the central parts in Pulwama and Badgam Districts. Highest EC is observed only in a single patch in Baramulla District, otherwise it ranges between 250 and 750 µS/cm at 25˚C.

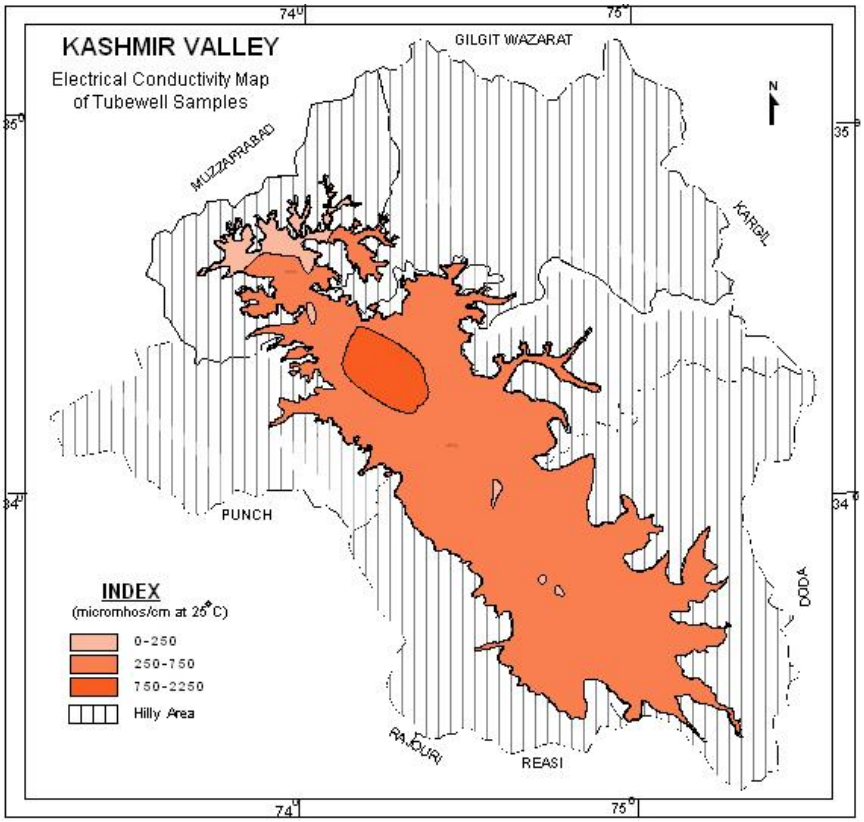


Figure 11: Electrical Conductivity Map of Tubewells in Aquifer Mapping Area

Nitrate concentrations over the permissible limits of 45 mg/l as set by BIS are observed only in two tubewells of 55 mg/l at Satsoo in Pulwama District and 124 mg/l

at Magam in Kupwara District. The higher concentration of Nitrate is accounted to the localized anthropogenic pollution.

The geological formation in Kashmir Valley is responsible for the presence of Iron in the ground water samples. The Iron concentration more than 1 mg/l was observed in 13 samples from all the districts of Kashmir Valley except Anantnag District. The iron concentrations in the ground water samples range from 0.6 mg/l at Thaman, Pulwama District and Wayun in Srinagar District to 25 mg/l at Parigam Jagir, Pulwama District.

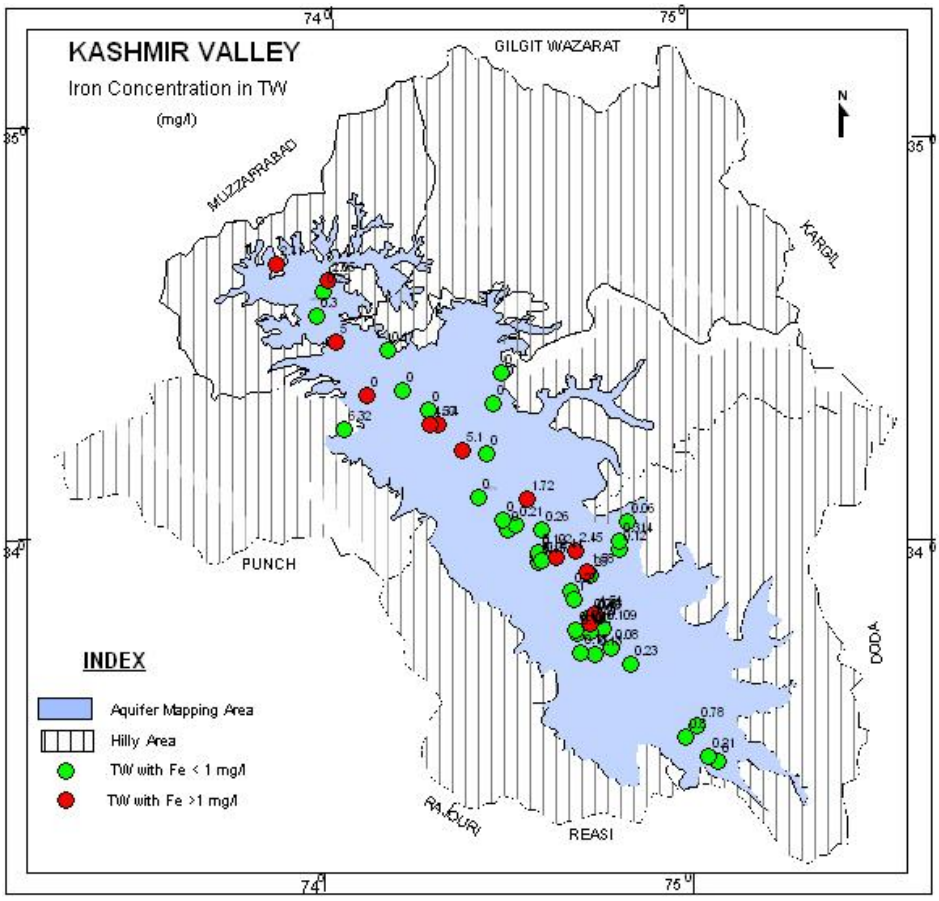


Figure 12: Point Map of Iron Concentration in Tubewells of Aquifer Mapping Area

Geophysics

Resistivity Surveys

Geophysical studies carried out in the Kashmir Valley area includes VES and need based Borehole Electrical Loggings. As per the Data Gap Analysis carried out upto March-2016, the geophysical data available is 26 VES at 13 sites and data gap i.e. required VES are 117.

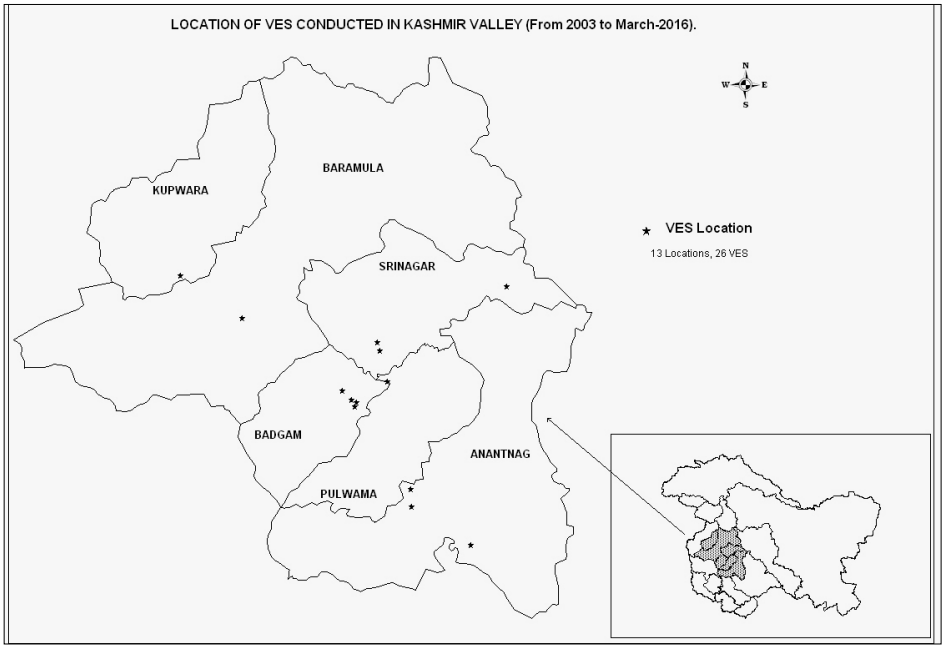


Figure 13: Locations of VES Sites in Aquifer Mapping Area

Borehole Geophysical Logging

A total of 206 electrical loggings have been done in the tubewells drilled in Kashmir Valley. The data interpreted from the electrical logs reveals that there are prominent granular horizons of interglaciation period in the valley but these horizons occur at different depth in different parts. In the electrical logs of some districts of the valley, it has been found that the there is a thick layer of clay beyond 105 to 120 m bgl, as in Deva, Dussoo, Green Colony, to the explored depth of 200 m bgl. The analysis of 23 Electrical logs of the boreholes drilled in Srinagar District reveals that there are prominent aquifer zones in the depth range of 30 – 35, 60 - 70 and 110 - 120 m bgl. The boulder bed is also encountered in the depth range of around 120 – 130 m bgl like at Iqbal Park, Tulip Garden. The boreholes wherever gassy aquifers have been encountered, there is an abrupt change in the SP and / or N16" Resistivity values in that very depth range like at Goshbug, Trikulbal, Sopore and Saidpora Zainger. In some of the exploratory boreholes, the SP has shown the erratic /shaking behavior due to the presence of gas. In resistivity parameters, sudden high /low variations were observed, in down-log, with no repeatability in up-log, in some cases. Even in some of the cases, the probe could not go inside the borehole due to the gas buoyancy.

The reason for erratic behavior /non-repeatable response needs more analysis and study.

Table 8: Details of Electrical Loggings Conducted in Kashmir Valley

S. No.	District	No. of Loggings	Logging Meterage	Deepest log at	Depth in m bgl.
1.	Anantnag	08	1007.50	Vessu	247.00
2.	Baramulla	56	9537.90	Gundi Jehangir	442.50
3.	Budgam	32	5820.90	Charar-e-Sharif	387.00
4.	Kupwara	27	6195.50	Didikut II EW	402.50
5.	Pulwama	23	4054.50	Pampore	390.00
6.	Srinagar	60	7423.50	Karan Nagar,	355.00
	TOTAL	**206**	**34039.8**		

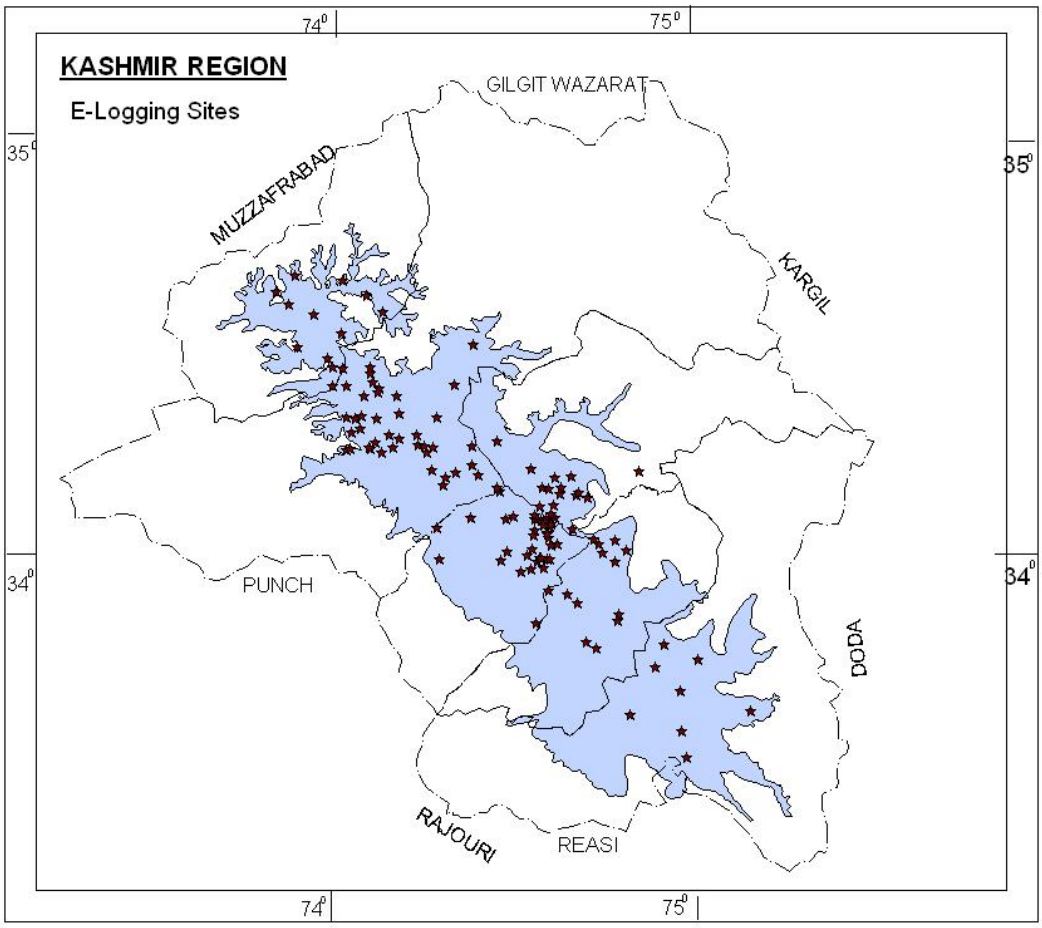


Figure 14: Location Map of Electrically Logged Tubewells in Aquifer Mapping Area

The 3 D lithological model prepared by Rockworks software by using the data of possible saturated granular zones deciphered during electrical logging of tubewells drilled by CGWB and State Government departments depicts that there are artesian wells in the central longitudinal section of the Kashmir Valley. The electrical loggings have deciphered the occurrence of saturated granular zones at shallower depths on the south-eastern end of valley as compared to the north-western part which corroborates with the lithological 3 D model of the area.

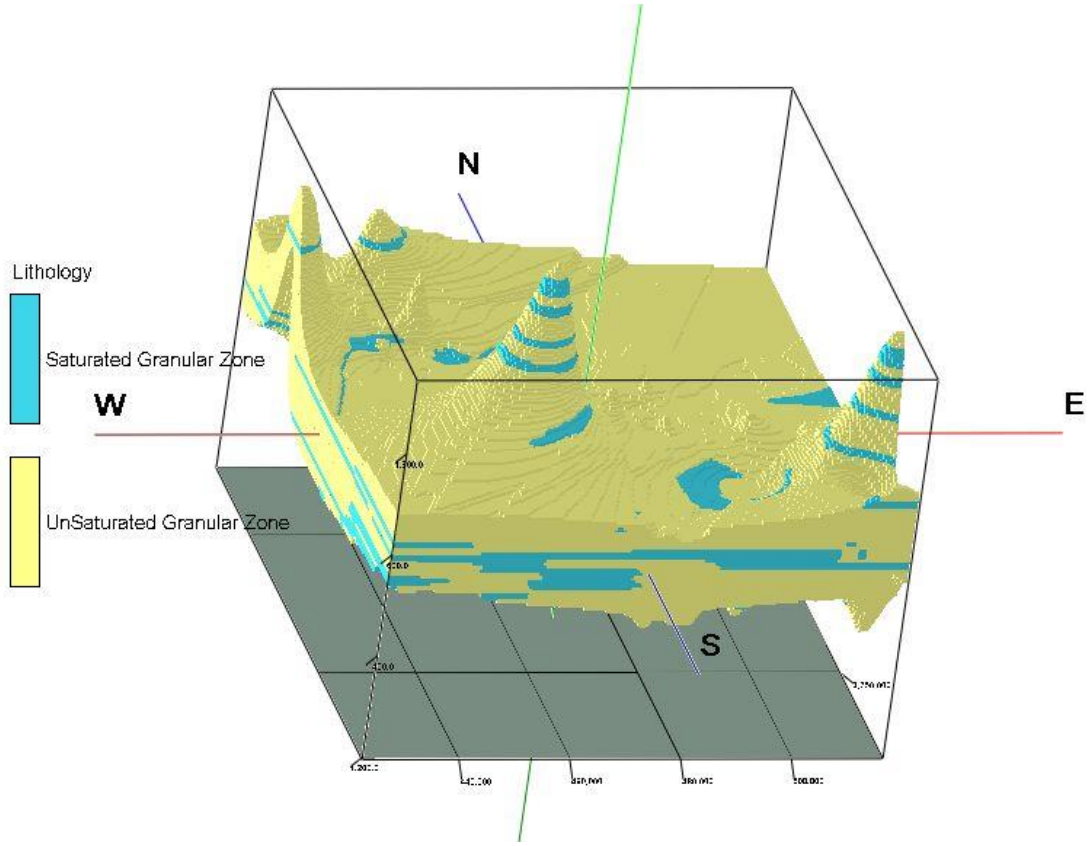
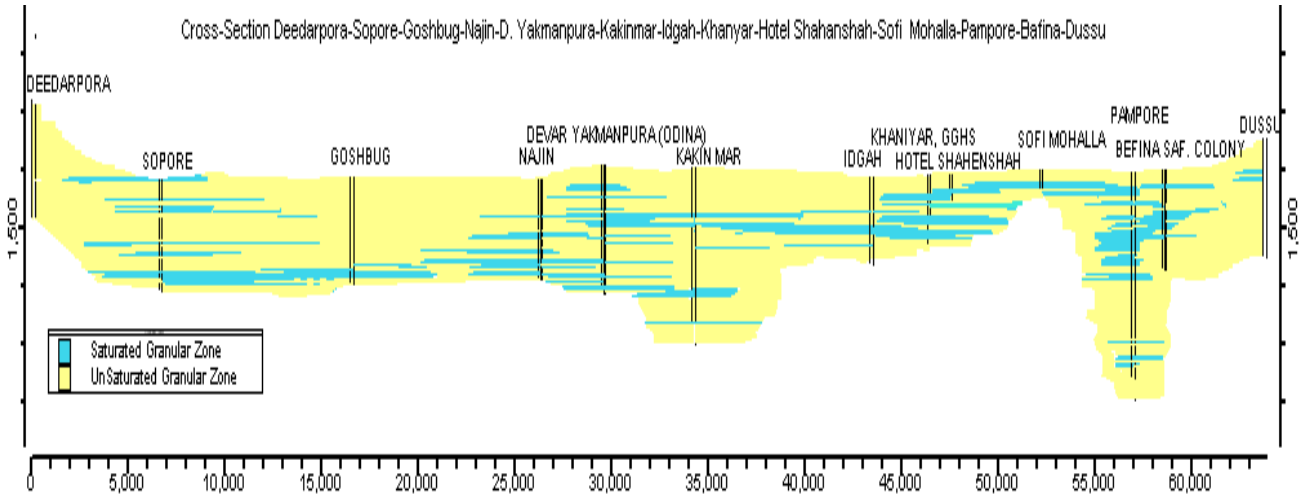


Figure 15: 3 D Model deciphered from Electical Loggings in Kashmir Valley

The electric cross section drawn in the north-west to south- east direction along Deedarpora-Sopore-Goshbug-Najin-Dever Yakmanpora-Kakinmar-Idgah-Khanyar-Hotel Shahenshah-Sofi Mohalla-Pampore -Baffina and Dussu reveals that at Sopore, Najin, Dever Yakmanpora Khanyar and Pampore there are multiple layers of granular sediments that are saturated with water. At Deedarpora a very thin zone of about 1.5 m thickness is encountered. The last saturated granular zone encountered at Sopore seems to continue in the western direction upto Kakinmar. This is the only zone encountered at Goshbug at depth of 153 m bgl and is under high pressure and proved to be flowing well. Pampore is the deepest well in this section drilled down to a depth of 390 m bgl. At Sopore, Dever Yakmanpura and Khanyar the first saturated granular zone is encountered at very shallow depth of about 25 m bgl which towards west is encountered at a depth of 35 m bgl at Hotel Shahenshah, Sofi Mohalla and Pampore and extends further at Baffina and Dussu.

Figure 16: Cross Section deciphered from Electical Loggings in Kashmir Valley



GROUND WATER EXPLORATION IN AQUIFER MAPPING AREA

In the year 1973, ground water exploration commenced in Kashmir Valley by deploying direct Rotary rig at Satsukalan site, now in Badgam district, to explore Karewa Formation. Exploration continued up to the year 1989 only in the Kashmir region & after that all the activities of the CGWB were suspended due to law & order problem. During this period i.e. from 1973 to 1989, 85 EW were constructed in the valley After the improvement in the law & order the exploration activities were once again taken up in the year 2006 by deploying DTH & Rotary rigs & 60 EW were constructed till date (as on March-2016). This includes 21 EW constructed through outsourcing under the accelerated exploration programme.

Table 9 : District wise Exploratory wells in Kashmir Valley

S.No	Name of the District	Total Geographical area	Total Valley area	No. Of Tube wells		Total	Density of the wells
		Sq.Kms	Sq.Kms	Ist Phase (1973-1989)	IInd Phase (2006-till date)		Well/sq.kms.
1	Anantnag	3984	900	10	7	17	1/70
2	Budgam	1371	850	17	8	26	1/40
3	Baramulla	4558	1100	21	17	38	1/30
4	Kupwara	2379	600	18	7	25	1/20
5	Pulwama	1398	1050	11	11	22	1/150
6	Srinagar	2228	500	8	10	18	1/50
				85	**60**	**145**	

STATE GOVERNMENT WELLS

Strata Charts, water level data, their discharges, assembly details were collected for 200 tubewells from Public Health Engineering and Irrigation and Flood Control Departments.

DATA INTERPRETATION, INTEGRATION AND AQUFIER MAPPING

Data of 298 wells drilled was used that includes 112 tubewells drilled by CGWB and 186 by state agency to decipher the lithology beneath by preparing model fence and cross sections with the help of Rockworks Software. The locations of the tubewells used in preparation of aquifer maps, cross sections etc. are shown below in figure 30 and Annexure VI.

As there is no Ground Water Department in Jammu and Kashmir and no other department is working in this field except for making ground water abstraction structures and extracting huge amount of water, the data of Central Ground Water Board was the only reliable source. However, strata charts of tubewells constructed by private agencies for State Government were used in the preparation of 3 D Aquifer Maps.

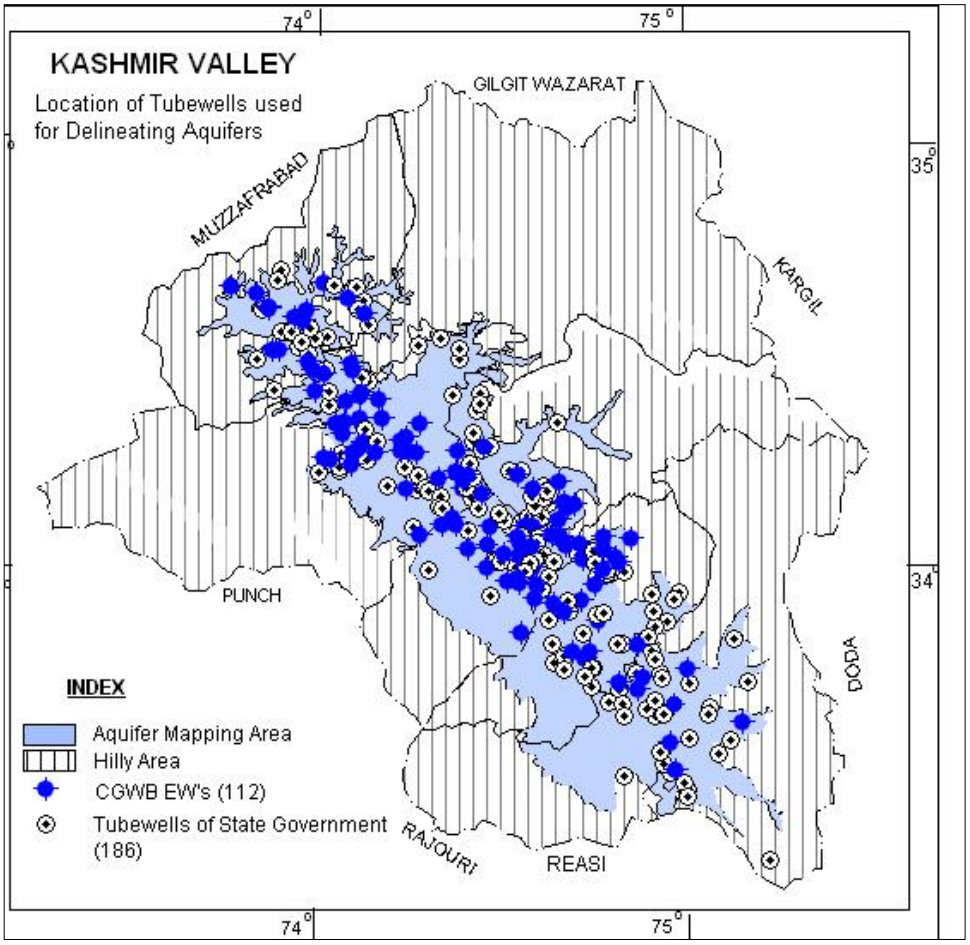


Figure 17: Location Map of Exploratory & Production Tubewells in Aquifer Mapping Area

Nature of Aquifer Available

Kashmir Valley is a synclinal basin, which preserves an excellent record of the alternate glacial and interglacial periods. This resulted in a thick deposition of sediments that occupy nearly half of the area of it.

The principal ground water reservoir is formed by fine to coarse sand, gravel, boulder, pebbles present in the alluvium. This formation represents the flood plain of river Jhelum and its tributaries, deposited during sub recent to recent times. The depth to water level in alluvium ranges between ground level to 3 m b. g. l. The ground water is mostly associated with methane gas. The aquifers are usually of fine granular matter mixed with silt. Their behavior is also irregular both vertically as well as horizontally. Because of the fine nature of these sediments, modest quantities of sub-surface water could be found both under unconfined as well as confined conditions.

The belt along the fringes of mountain ranges encircling the valley continues along its margin and depression. The fringe areas of the valley are covered by scree and talus material derived from the hill slopes of surrounding ranges. The sediments are of heterogeneous nature ranging from boulder, cobbles, pebbles, gravels before merging into valley fill of fine-grained sediments. This belt may constitute a good groundwater reservoir due to the barrier provided by fine sediments of clay and silt disposed at various depths both vertically and laterally (towards the main valley) besides providing favourable conditions to recharge the aquifers at deeper levels.

The most prominent geological formation of Kashmir province is Karewa sediments. These are fluvioglacial sediments deposited under lacustrine environment, during plio-pleistocene times. These are divisible into two stages viz Upper Karewa and Lower Karewa, separated by a hiatus.

The lower Karewa sediments comprise bluish, grey clay, silt and sand greyish, interspersed with gravel. The formation has stopper dips and is very thick. At places lignite seams are met with. The ground water is found under both confined as well as unconfined conditions. In the phreatic aquifers it occurs under confined to semi-confined conditions. The water table conforms to the topography of the area. The sub-surface water is usually mixed with methane gas.

The Upper Karewa sediments are found in the form of mounds, high and dry table lands and terraces. This lacustrine facies comprise the pale yellow laminated marls and silts with medium to coarse-grained calc grits and varved clays. Perched water bodies are encountered in these sediments. The deeper aquifers mostly tapped by tube wells are under confined conditions, invariably the flowing conditions.

Panjal Volcanics, Triassic limestone and Cambrio-silurian rocks are also met with, at certain places. These rocks are consolidated and constitute mountain boundaries all around Kashmir valley. The ground water occurs in fissures, cracks, joints, faults and weathered rock which are interconnected and form groundwater reservoirs. The groundwater occurs both under water table conditions as well as sub-artesian conditions. Groundwater in this formation has been successfully exploited and the results are very much promising. Some springs with moderate to good discharges emanate from this formation at favourable points, in different places of the valley viz. Awantipora and Cheshmashahi etc. At favourable places this sub-surfaces water moves in pervious zones of Karewas at favourable points, a portion of which is retained as ground water and places some water gushes out in the form of springs at the foot of Karewa sediments.

Congenial spots for groundwater exploitation do exist in the area. So far, the studies reveal that fair to modest discharges from the tube wells can be achieved and the formations possessing groundwater are confined and unconfined in character.

Table 10 & 11 summarizes the aquifer properties, its yield potential, quality and rig suitable for drilling.

Table 10: Aquifer Type, its Quality

Belt	Prominent Lithology	Characterstics of Aquifer	Suitability of Drilling Rig	Suitability for Drinking /Irrigation	Remarks
Alluvium	Sandy clay, medium to coarse sand, conglomerate, gravels.	high permeability, mostly confined with occasional flowing	Rotary	Yes	High artesian pressure, Fe & Marshy Gases in isolated pockets
Karewa Sediments Upper	Loamy silt and marl facie; with 2nd glacial bed at the base.	Low permeability, High yielding tubewells and springs.	Rotary	Yes	Fe & Marshy Gases
Karewa Sediments Lower	Alternate Sand & clay. medium to coarse sand and Ist glacial boulder bed	Moderately high permeability. yield fair to good.; confined to flowing conditions;	Rotary	Yes	Silt, Fe & Marshy Gases
Limestone	Ash grey to pale yellow coloured limestone jointed and cavernous.	secondary porosity. High yielding springs e.g. at Achhabal, Mattan, Verinag, Nagbal etc.	DTX with ODEX	Yes	-
Limestone shales and Traps	Zewan lime-stone Panjal Traps & Shales	Some high yielding tubewells	DTX with ODEX	Yes	-

Aquifer Characteristics

Table 11: Aquifer characteristics including its thickness, depth to water level

Belt	Explored Depth (m bgl)	Maximum depth drilled range (mbgl)	Static Water Level range	Yield Potential range (lpm)	Remarks
Kashmir Valley	**37-450**	**450 m Gund –i-Jehangir (Baramulla)**	**2.5 m agl to 33 m bgl (Charsoo, - Warsun Gujran)**	**30 - 4164**	**High artesian pressure, Fe & Marshy Gases in isolated pockets**

Lithological Disposition and Aquifer Disposition

The valley, constitute the low lying, flat and continuous area of the valley, which is overlain by 'Alluvium'. The Karewa sediments represent bulk of the area of the valley is depicted by elevated flat topped table lands and terraces in the central, north and north-western part of the valley. In southern part, aquifers are thinner, erratic but mostly are composed of fine grained material viz. coarse elastic material namely pebbles cobbles and boulders. In the north and north-western part slopes are seen over a vast expanse. At the central, eastern and western parts the water bearing granular zones occurs at the ground levels resulting in water logged conditions.

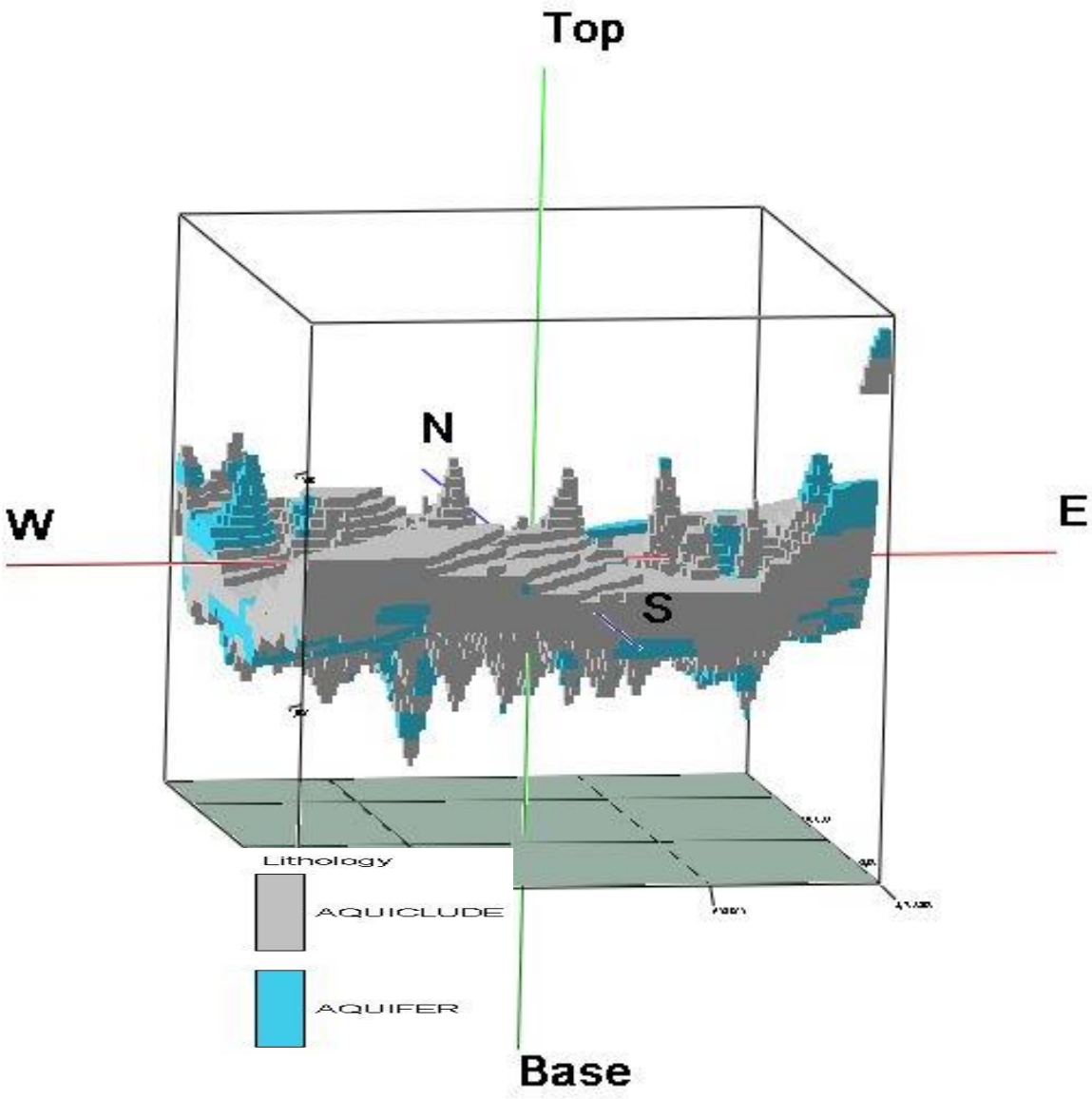


Figure 18: 3 D Model Depicting Aquifer Disposition in Kashmir Valley.

The fence drawn by joining the lithologs of Kashmir Valley parallel to its long axis (figure 18) reveals that the behaviour of the aquifers is not uniform, these are highly erratic both laterally and vertically. The water bearing formations by and large comprise fine granular material. Irregular, multi layered aquifers are seen throughout the fence. In the south-eastern part the aquifer is almost at ground level which is not seen in any other part of the valley. Thick aquiclude seems to confine the aquifer in the central part of the fence and this part is devoid of very deep aquifers. In the north western part of the valley, aquifers occur at deeper levels, rather more than two aquifers are observed in this part of the valley.

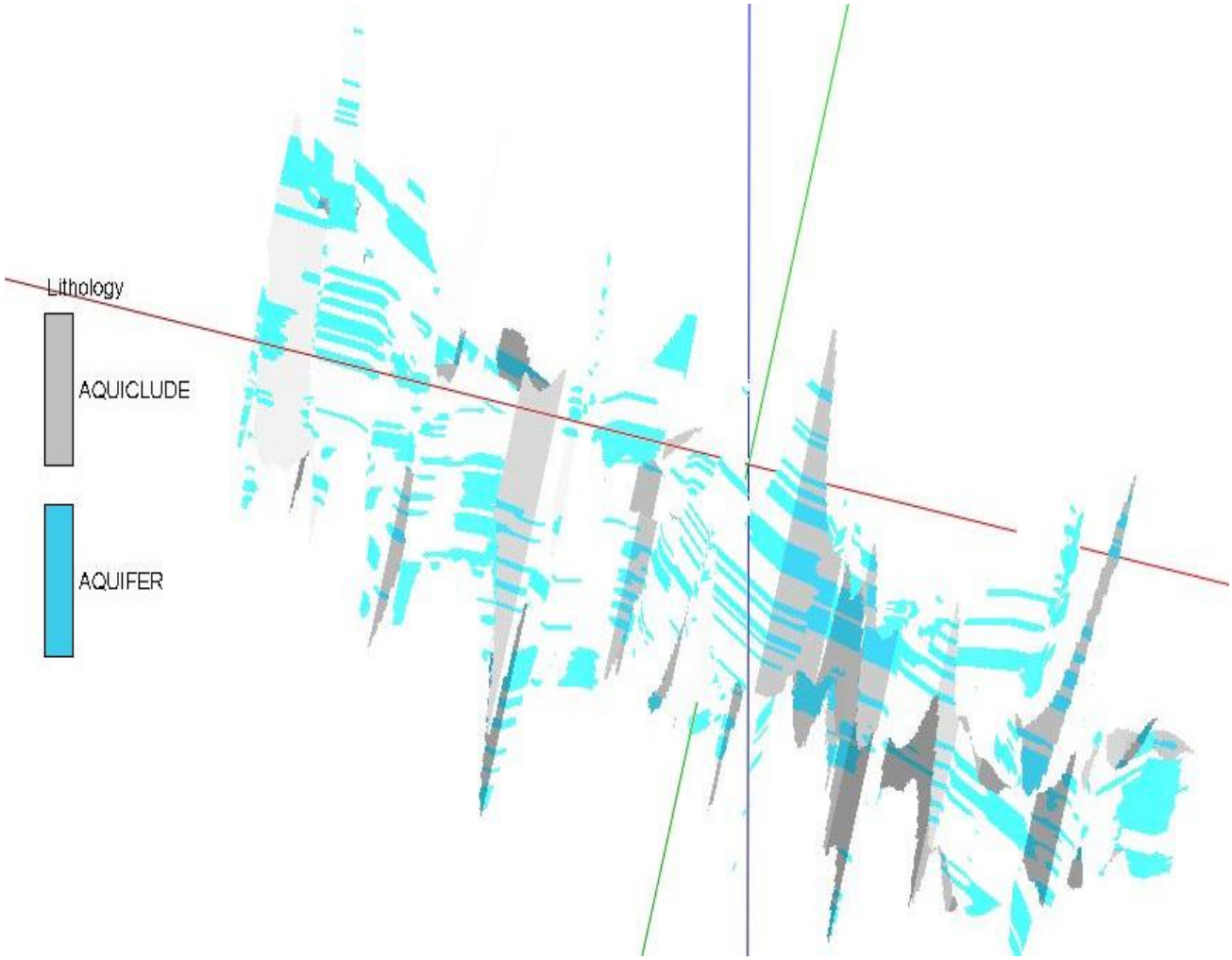


Figure 19: 3 D Fence Depicting Aquifer Disposition in Kashmir Valley.

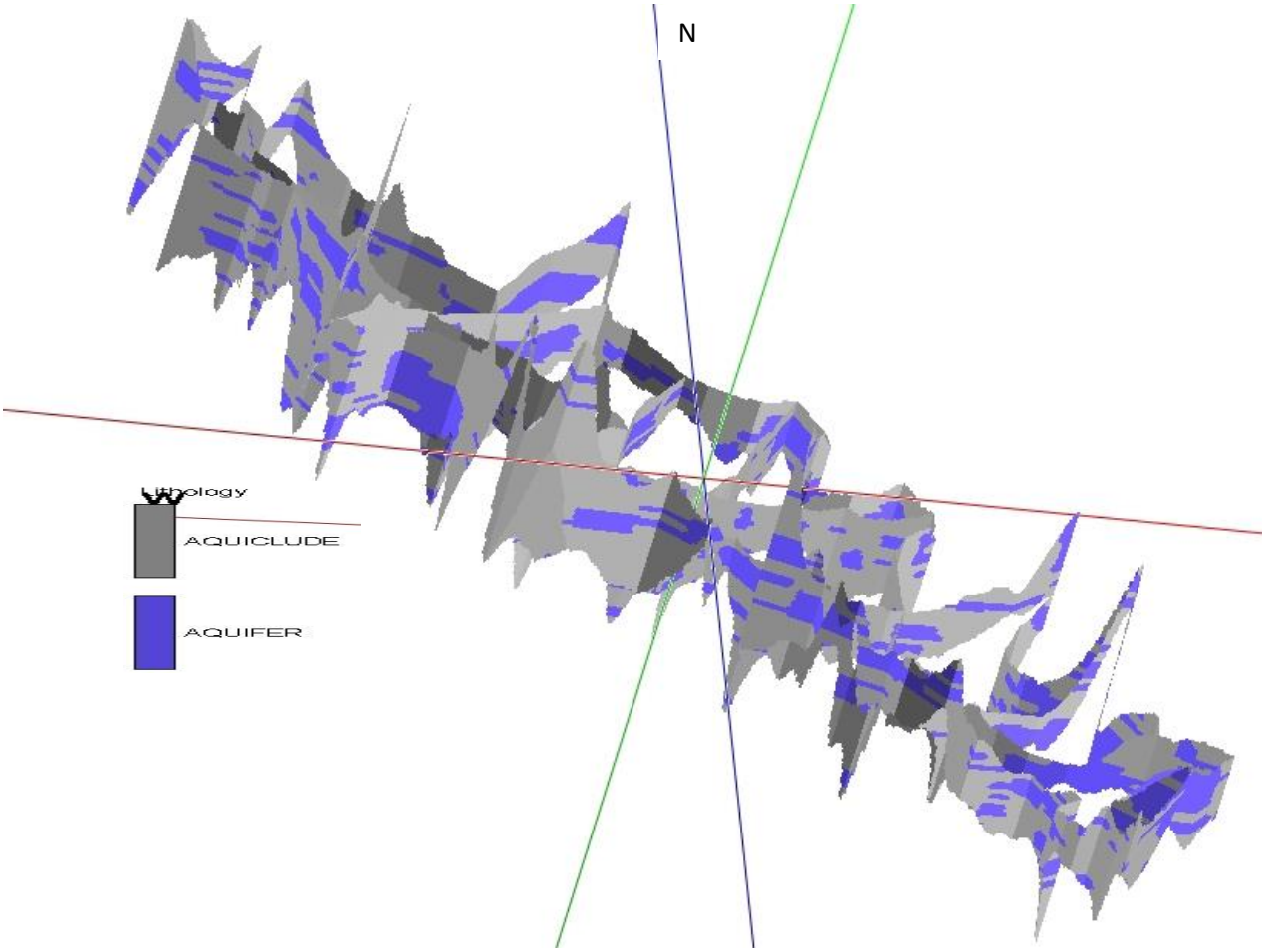


Figure 20: 3 D Fence Depicting Aquifer Disposition in Kashmir Valley.

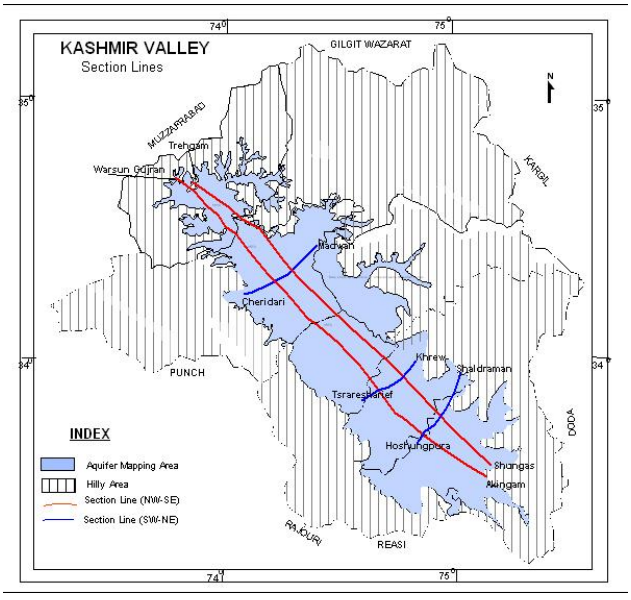


Figure 21: Map Showing Cross Section Lines

The cross section is drawn along the oval shape of the valley from NW to SE direction, covering Kupwara to Anantnag Districts. The section is drawn between Trehgam-Nagrimalpura-Arampora-Gungbug-Latishot-Bomai-Gund-i-Jehangir-Sonburn-S.Sumbal -Idgah-Panthachowk-Chanduhara-Lariyar-Dumhal Hanjipora-Shungas. Most of these wells are drilled in Quaternary alluvium deposits, except for the wells at, Pantha Chowk and Dumhal Hanjipora drilled in Panjal Traps and Idgah and Shungas drilled on Karewa mounds respectively. Correlation of aquifers is difficult especially from Trehgam to Nagrimalpura. In this section the continuity of aquifer can be established in the tubewells drilled in Quaternary alluvium at Bomai, Gund-i-Jehangir and Sonburn tubewells for the first aquifer only. Depth to water level at Nagrimalpura stands at 19.75 m bgl showing water table conditions. On the other hand flowing conditions are observed at Trehgam, Latishot, Gund-i-Jehangir, Panthachowk and Dumhal Hanjipora in the section. The deepest well of 450 m drilled in Kashmir valley viz. Gund-i-Jehangir, falls in this section has multiple aquifer layers separated by clay horizons and found to encounter glacial boulder pebble bed at a depth of 200.0 m bgl. Other tubewells having more than one aquifer in this section are Trehgam, Bomai and Sonburn. Rest of the tubewells has one or 2 aquifer layers. The aquifer layers are separated by clay lenses locally. The clay content increases in the south east direction towards Shungas which is located at a higher elevation. Gas was found at Sonburn and Gund-i-Jehangir in this section.

The cross section is drawn along the oval shape of the valley from NW to SE direction, between Warsun Gujran- Salkoot -Giripora -Karalpora Magam- Chotipora -Panditpura-Watergam -Lisser -Chinard Sangrama –Tapper -Malikpora Sumbal -Wanigam –Pattan -Sikh Basti Ganipora -Shibpur –Kakinmmar –Sharifabad -Danderpora Naroo-Satsukalan –Lalgaon –Qazipora Hayatpora- Badrivan –Armulla Tantraypura –Reshipora –Gopbal Kawaki Bazar -Madwan-Dialgam and Akingam. Tubewell at Warsun Gujran and Tapper are drilled through Panjal Traps in this section. Traps here are underlain by Karewa sediments at Warsun Gujran. The potential boulders bed at Salkoot is continuing up to Giripura at a shallower depth. Similarly, good continuity of boulder bed is observed between Panditpura and Chotipura but thereafter geometry does not correlate. From Tapper to Wanigam facies change from boulder to fine sand is observed. The boulder bed here comprises boulders and gravels of Panjal Traps and quartzite. The continuation of boulder bed is also observed from Pattan to Ganipura and Shibpur. Thick pile of Karewa sediments is encountered at Pattan Kakinmar and Sharifabad abundance of silt here results in low yield. Single aquifer is encountered at Sharifabad and Dangerpura Naroo. Locally separated multiple aquifers are obtained at Satsukalan, Banderpora and Gopbal Kawaki Bazar. Thick clay layer extending from Tapper towards Wanigam acts as confining layer and results in flowing conditions in these wells. In this section, flowing conditions are observed also at Waripura Magam, Panditpura, Kakinmar, Lalgaon, Badrivan and Banderpora. Isolated Karewa mound that yields a copious amount of ground water is drilled at Dialgam and Akingam.

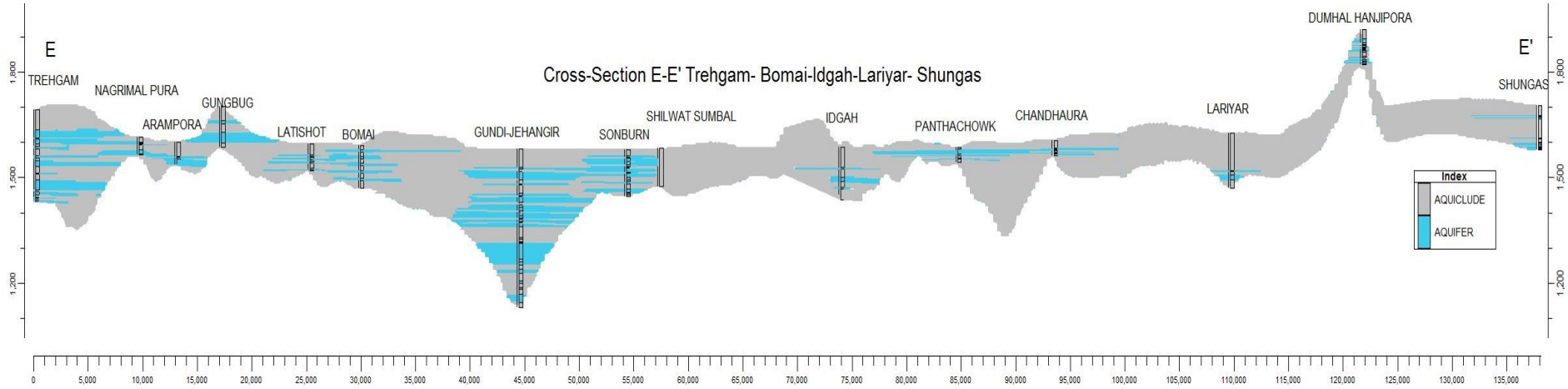


Figure 22: Cross section between Trehgam-Gungbug-Latishot-Bomai-Sonburn-Idgah-Lariyar-Shungas.

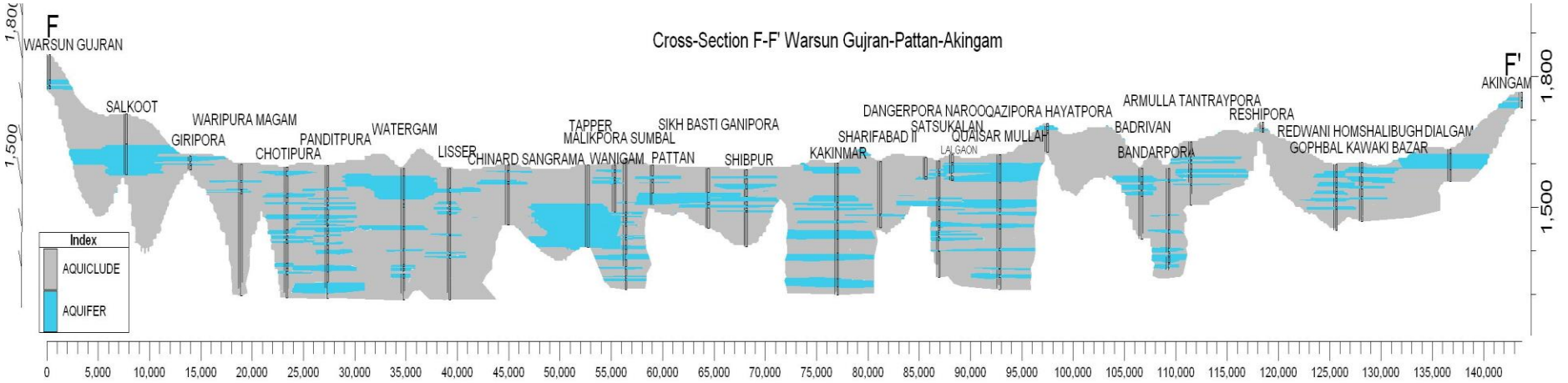


Figure 23: Cross Section from Warsun Gujran- Magam-Lisser–Pattan–Kakinmmar–Lalgaon–Reshipora -Dialgam - Akingam.

The cross section is drawn along Cheridari- Wadura – Naugam – Haigam – Haigam Trumbgund – Gund I Jehangir and Madwan of Baramulla District across the oval shape of valley. Numerous granular zones separated by clay horizons are encountered throughout this section. Except for the two ends viz. Cheridari and Madwan and Singhpura that lies on high Karewa mound, all the wells of the section are flowing as well as contains gas. At Wadura the granular zone encountered below 1460 m elevation is under artesian pressure. At Naugam this bed is encountered at a depth of 1430 m elevation. At Haigam and Haigam Trumbgund the aquifer material comprises fine to medium sand occurring within clay horizon. At Haigam Trumbgund the boulders are encountered at a depth of 159 m bgl, which further continues at Gund-i-Jehangir at a depth of 200 m bgl. The tubewell drilled at Madwan is drilled in alluvium underlain by Karewa formation and the granular material comprising fine to medium sand was encountered within clay formation.

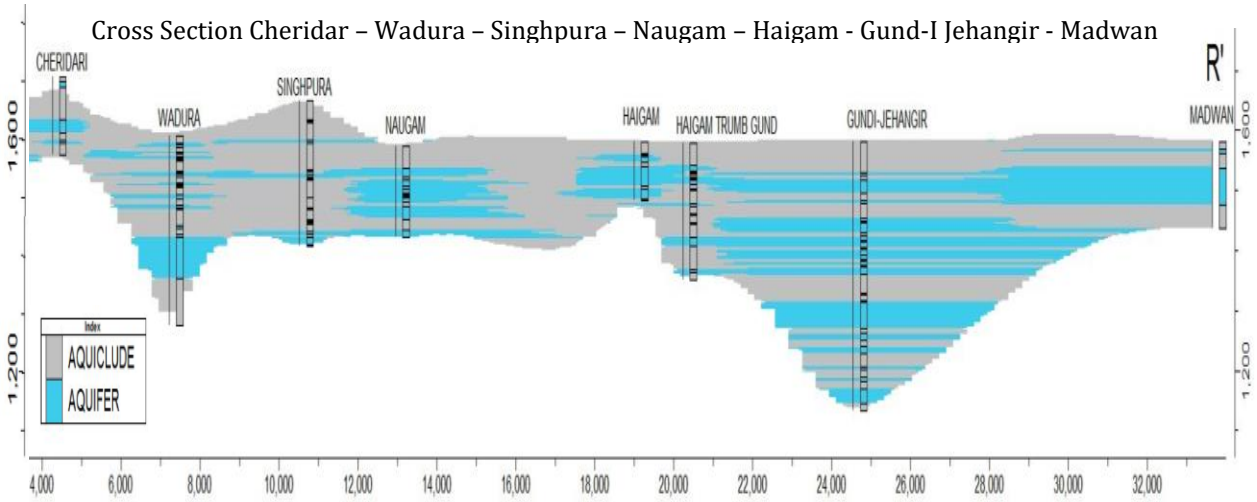


Figure 24: Cross Section between Cheridari- Wadura – Naugam – Haigam – Haigam Trumbgund – Gund I Jehangir and Madwan

The cross section is drawn along Tsaresharief- Qazipora Hayatpora - New Karewa Lukbawan – Ratnipura – Lethpora - Konibal and Khrew. The top clay layer is persistant throughout the section, which is thicker at Niu-Karewa but thins out at Ratnipora. Tsaresharief tubewell is drilled through thick pile of Karewa sediments at a height of 1950 m elevation yielded discharge of 355 lpm with a drawdown of 32 m. Multiple granular zones separated by clay horizons are encountered here. A deeper granular layer seems to continue at Qazipura Hayatpura. At Ratnipura the first aquifer encountered is comprised of sand and boulders. Here very boulder bed is encountered at a depth of 40.0 m bgl that seems to be conspicuously missing in both the directions. Numerous thin granular zones with intervening thick clays have been encountered at New Karewa borehole but the lateral extension of an individual zone appears to be limited. Lethpura and Konibal are underlain by Karewa formation rich in argillaceous material with subordinate silt and sand. The tubewell at Lukbawan and Khrew encountered scree materal comprising angular boulders of limestone alternating with silty clay. At Konibal flowing conditions were observed.

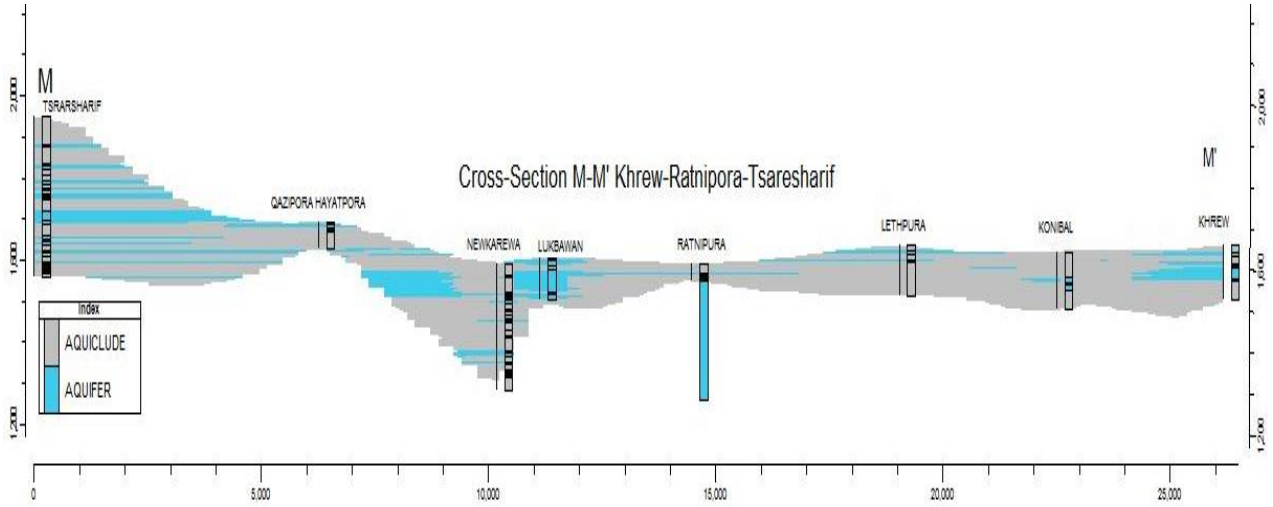


Figure 25:Cross Section between Tsaresharief- Qazipora Hayatpora - New Karewa Lukbawan – Ratnipura – Lethpora - Konibal and Khrew

The cross section is drawn between Shaldaraman- Bajwani Tral- Soimo- Achan Ashtanpura, Lasdenew, Niklora- Reshipora and Hoshangpura. Shaldraman and Bajwani Tral were drilled through Panjal Traps, whereas Achan Ashtanpura, Niklora, Reshipora and Hoshangpura were drilled through Karewa sediments. Multiple aquifers are encountered at Bajwani Tral, Soimo and Hoshangpura. Achan Ashtanpura, Lasdenew and Niklora were low yielding as very thin aquifer layers were encountered. Reshipora is the only flowing well in this section.

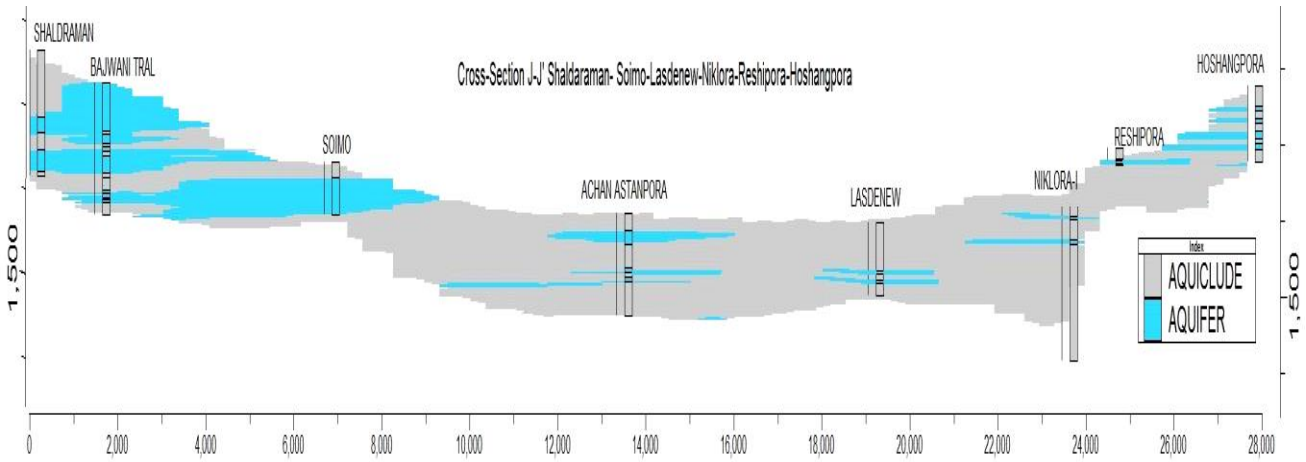


Figure 26: Cross Section between Shaldaraman- Bajwani Tral- Soimo- Achan Ashtanpura, Lasdenew, Niklora- Reshipora Hoshangpura

Aquifer Conditions

Artesian Conditions

The artesian wells are seen throughout the valley of Kashmir, especially concentrated in central part of the oval shaped valley parallel to its long axis on either sides of Jhelum River. The piezometeric level is observed between 2 m agl and 12 m bgl. In Anantnag District almost all the wells drilled below 25 m by CGWB shows flowing conditions except for Kuchhipura. The exploratory tubewells drilled by CGWB at Chandisuma I and II, Mamun, Lachhipura, Didikut III, Koyil III, Marhama etc. were some of the sites where construction could not be completed due to high artesian pressure.

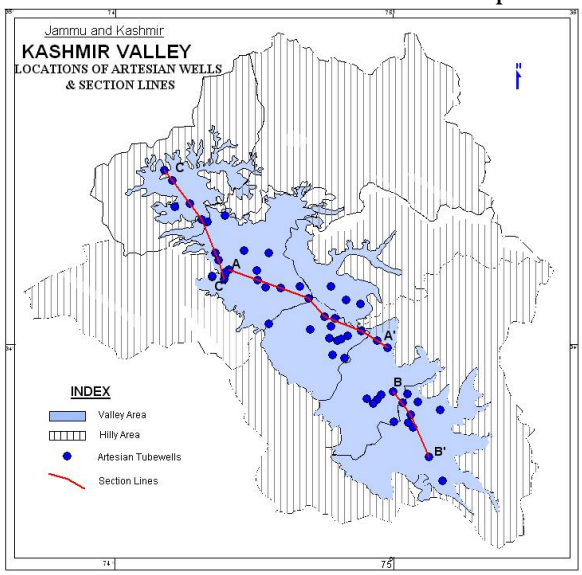


Figure 27 : Map showing location of Artesian Wells & Section Lines

The section drawn along NW-SE direction in the central part of the valley between Kanispora -Tapper -Trikulbal -Tokenwaripora –Palapora – Panthachowk - Deva and Konibal tubewells. Except for tubewell drilled at Panthchowk in Panjal Traps, in all other wells the aquifer is overlain by thick aquiclude which results in the development of piezometeric head causing flowing conditions in the tubewells. The boulder bed encountered at Tapper is extending in both the directions and pierced at Kanispura in west and Trikulbal in the east. The second aquifer zone encountered at Tokenwaripura is extending to Palapura and thins out towards Panthachowk. Similarly aquifer encountered at Deva seems to extent up to Konibal.

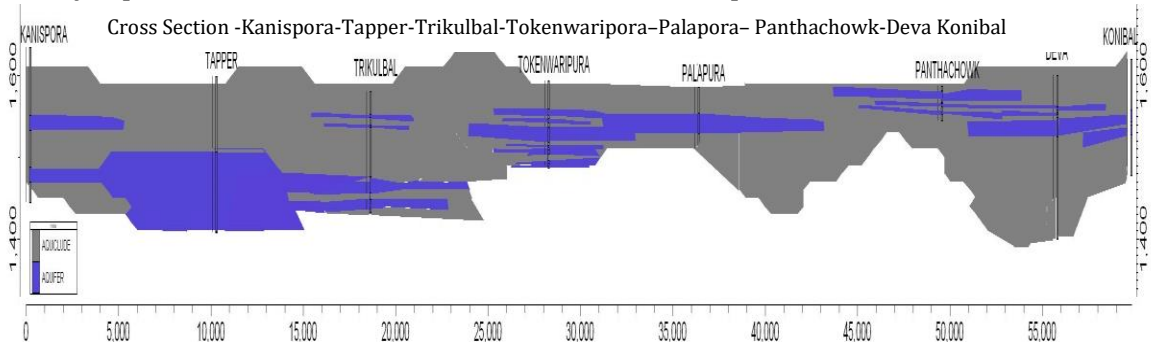


Figure 28: Cross Section between Kanispora-Tapper-Trikulbal-Tokenwaripora–Palapora–Panthachowk-Deva and Konibal

The section drawn along NW-SE direction in the lower part of the valley viz. Anantnag District between Renzipora -Mamun and Vessu reveals that multiple aquifers separated by aquicludes are encountered at all the three wells. The tubewell drilled at Vessu is the deepest well of 300 m bgl in this part of the valley. At Mamun site, the construction of well could not be completed due to high artesian pressure.

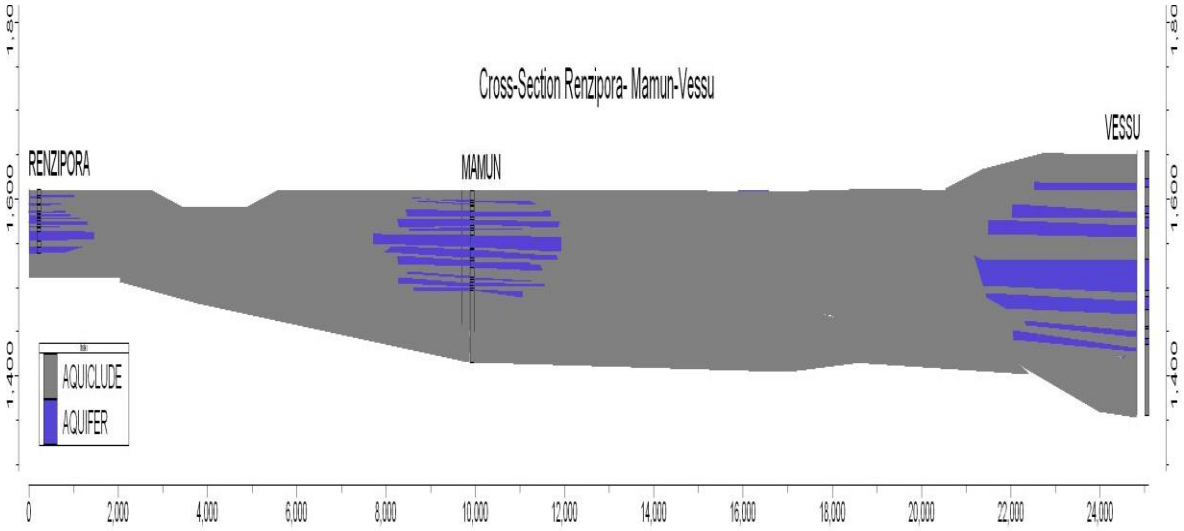


Figure 29: Cross Section between Renzipora -Mamun and Vessu

The cross section drawn along N-S direction in the top part of the valley viz. Kupwara and lower part of Baramulla Districts between Trehgam-Didikut-Waripora Magam-Langate-Rihoma-Nadihal and Wadura tubewells reveals that except for Waripura Magam and Langate having only two aquifers separated by clay horizons, all other locations comprise of multiple aquifer layers separated by aquicludes. At Didikut the first water bearing zone is encountered at a depth of 262 m bgl and the aquiclude above this zone has created high artesian pressure, and thus this well was abondoned. At Wadura the water bearing zone was encountered below 1460 m elevation.

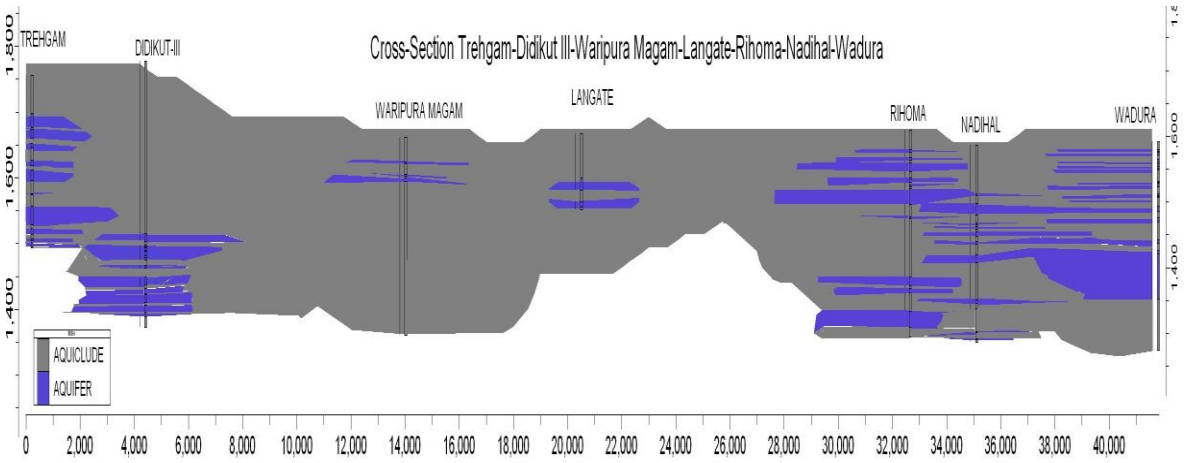


Figure 30: Cross Section between Trehgam-Didikut-Waripora Magam-Langate-Rihoma-Nadihal – Wadura

Gassy Aquifers

In the Karewa sediments, gas shows were encountered at shallow depth containing 50% to 95% methane. The target area, therefore, has to be pre-Karewa sequences, which need to be studied for hydrocarbon occurrences. In the central part of oval shaped Kashmir Syncline, gas viz. Methane was found while drilling of tubewells. It imparts an un-acceptable odour to the water and sometimes creates artesian pressure too. The exploratory drilling at Lalu I was abandoned due to pressure of gas. It is observed that the aquifer on the eastern bank of Jhelum River is argillaceous in nature and devoid of gas whereas that on the western bank is calcareous and full of gas. The sediments in this part comprise buff coloured clay, varved with decomposed vegetable matter, greenish silt and blackish sand. The gas dies out, on exposing to the air. About 30 tubewells were identified to have gas.

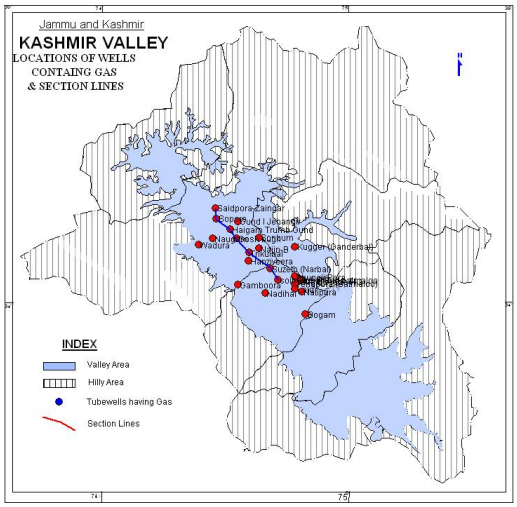


Figure 31: Map showing location of Wells containing Gas & Section Line

The section is drawn along NW –SE direction between Saidpura Zaingar – Sopore – Haigam Trumbgund – Goshbug – Trikulbal – Suzeth and Soibug. All these wells are drilled through Quaternary alluvium underlain by Karewa sediments. These wells lie in the centre of the bowl (shape of Kashmir Valley). The top of the entire section is occupied by clay horizon. The wells drilled at Sopore and Trikulbal are under flowing conditions. Except for Suzeth all the wells in this section were drilled more than 150 m bgl. Multiple granular zones separated by clay horizons occur at Saidpura Zaingar, Sopore, Haigam Trumbgund and Soibug. Granular zones at deeper levels seems to continue from Saidpura Zaingar to Sopore to Haigam Trumbgund to Goshbug and Trikulbal

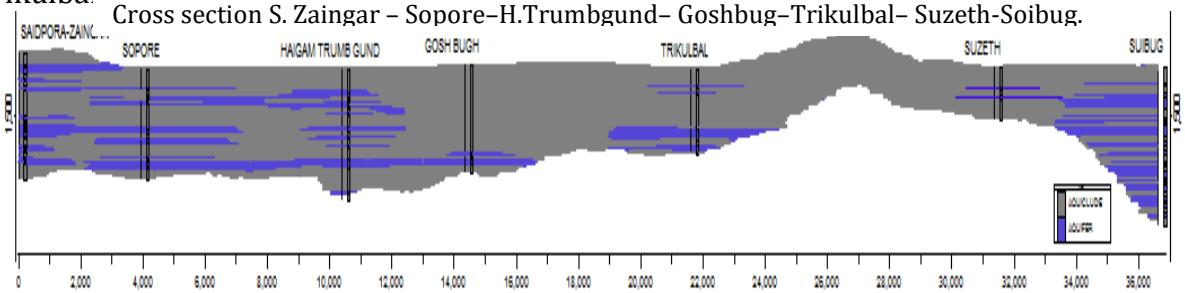


Figure 32: Cross Section between Saidpora Zaingar – Sopore–HaigamTrumbgund– Goshbug–Trikulbal– Suzeth-Soibug

Aquifers with excessive Iron

The ground water in the tubewlls contains iron concentration above maximum permissible limit of 1 mg/l as prescribed by Bureau of Indian Standards for drinking purposes. About 35 such wells are identified and located on a map and section drawn by joining the strata charts of these wells. This iron content is geogenic. The significant clay content in the Karewa sediments especially reddish clay contributes the iron content in ground water.

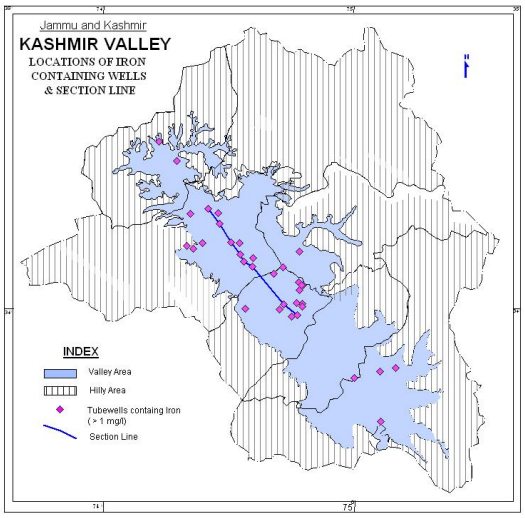


Figure 33 : Map showing location of Wells containing Iron>1 mg/l & Section Line

The section is drawn along NW –SE direction between Badar Payeen- Sopore- Ranji Hamray- Pahlalen- Pattan- Hanziveera and District Police Line Budgam. Satsukalan. The tubewells here are drilled through alluvium that is underlain by Karewa sediments are associated with gas. Pahlalen lies in Karewa sediments comprising silt, sand and gravel. Pattan lies on the contact of alluvium with Karewa sediments. Indications of gas were met here at a depth of 24.38 m bgl. Sopore, Ranji Hamray, Hanziveera are under artesian pressure and show flowing conditions. Pattan is underlain by the Karewas sediments which comprise clay, sandy clay, sands of various grades with occasional gravel and pebbles.

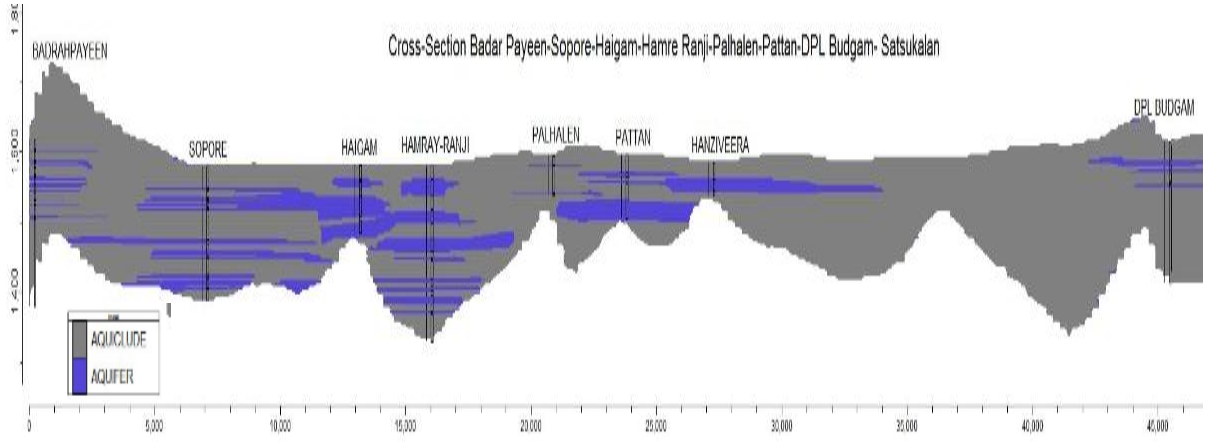


Figure 34: Cross Section between Badar Payeen- Sopore- Ranji Hamray- Pahlalen- Pattan- Hanziveera- District Police Line Budgam and Satsukalan

Silty Aquifers

Karewa sediments comprise heterogenous admixture of silt, sand and boulders especially lower Karewa. While tapping an aquifer in lower Karewa sediments filling of assembly by silt is a common phenomenon. Such wells cannot be cleared /developed even after long hours of pumping.

GROUND WATER RESOURCES

The quantitative estimation of various inputs to ground water resources and their temporal variation in space and time is imperative for a planned management and development of ground water resources. The resources in the surveyed area are computed on the basis of methodology recommended by the Ground Water Estimation Committee of Ministry of Water Resources, Govt. of India, 1997.

The entire aquifer mapping area, falls under command area and has been covered under ground water resource assessment. The estimation of ground water resource in the surveyed area is taken as on March 2013.

Methodology adopted

The primary source of recharge of groundwater in Kashmir Valley is snow melt and winter precipitation (snowfall and rainfall). Therefore rainfall infiltration method has been used for estimating the resources. Rainfall recharge factor or Infiltration factor is a recharge parameter that indicates a quantum of water recharged to the groundwater system in relation to the rainfall. It is a function of rate of infiltration and ability of the system to accept the infiltrated water. The infiltration factor can be expressed as follows

IF = (Qi/Qa) X SY,
Where,
IF = Infiltration Factor
Qi = Quantum of water infiltrated over the test period in m
Qa = Quantum of water applied in m
SY = Specific Yield

Recharge of ground water involves several components and the rainfall being the major one. The other components are return irrigation flow from surface water and ground water.

Rainfall infiltration factor for Kandi & Sirowal formations is taken as 20%. The Return Flow Factor for recharge from surface water irrigation has been taken as 15-25 % for non-paddy crops and 50-60 % for paddy crops. In case of ground water irrigation, the return flow factor has been taken as 15-25 % for non-paddy crops. Canal seepage factor, for lined and unlined canals, has been taken as per GEC' 97 norms. The recharge from other sources i.e. ponds and lakes have also been estimated based on the spread area of the water bodies. The areas of ponds of Kandi belts of Jammu and Kathua Districts have been taken from the study carried out by NIH.

DYNAMIC GROUND WATER RESOURCES (As on March 2013)

As per the replenishable recharge and Ground water draft of Kashmir Valley the net 253238 ham is still available for future development (as on March 2013). The overall stage of ground water development is 24.4 %, falls under safe category. The details are given in table 12.

Table 12: Dynamic Ground Water Resources of Kashmir Valley as on March 2013

Assessm-ent Unit	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for All uses	Provision for domestic & industrial requirement supply to 2025	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
Kashmir Valley in ham	**281376**	**28137.6**	**253238**	**61338.6**	**63065.7**	**355270**	**24.4**
mcm	**2813.76**	**281.376**	**2532.38**	**613.386**	**630.657**	**3552.7**	**24.2217**

Total Resources

The assessment of total availability of ground water resources encompasses two components namely Dynamic Resources and In-storage resources. The In-storage resources include In-storage unconfined and In-storage confined resources. For unconfined aquifer, In-storage resources are computed based on specific yield of the aquifer and of confined aquifer they are based on storativity of confined aquifer.

The In-storage resources of unconfined aquifer were calculated as per above norms and summarized in table 13.

Table 13: In-Storage Ground Water Resources of Unconfined Aquifer of Kashmir Valley

Name of Assessment Unit	Type of formation	Average Pre-monsoon Water Level(m)	Depth to Bottom of Unconfined Aquifer (mbgl)	Total Thickness of formation below Pre-monsoon Water Level (m)	Thickness of Granular Zone below Pre-monsoon WL(m)	Average Specific Yield (%)	In Storage Ground water Resources (ham)
Kashmir Valley	Alluvium & Karewa	9.15	09 to 25	1 to 15	32 to 70	16	77.90909

The In-storage resources of confined aquifer were calculated as per above norms and summarized in table 14.

Table 14: In-Storage Ground Water Resources of Confined Aquifer of Kashmir Valley

Name of Assessment Unit	**Type of formation**	**Depth to Bottom of Unconfined Aquifer (mbgl)**	**Average Explored depth (mbgl)**	**Total thickness of Confined aquifer down (m)**	**Thickness of Granular zones in confined aquifer down to explored depth (m)**	**Average Value of Storativity**	**In Storage Fresh Ground water Resouces (ham)**
Kashmir Balley	Alluvium and Karewa	9 to 25	125-193	110 to 181	30 to 70	0.000562	14909.61

The total ground Water availability of Kashmir Valley is calculated by adding up the dynamic and In-storage resources and the total ground water resources are 3692558.94 ham or 3692.55 bcm.

Table 15: Availability of Total Ground Water Resources in Kashmir Valley
(as on March 2013)

Name of Assessment Unit	**Net Ground Water Availability (Dynamic Ground Water Resources (As on 31st March 2013)**	**Fresh In-Storage Ground Water Resources**		**Total Fresh In-Storage Ground Water Resources**	**Total Avalability of Ground Water Resources [(3)+(4)] ham**
2	3	confined	Unconfined	4	5
Kashmir Valley	2532.38	148.96	3689877.6	3690026.56	3692558.94

ISSUES

Open Dug Wells losing their Utility

The large number of dug wells (open wells and most of them belong to the village community) that were the source of water in the area, have lost their utility with the coming up of piped water supply. These dug wells are either being filled up with garbage or they are being covered up with RCC slabs to avoid falling of children and animals in them.

Uneven Distribution of Aquifers

The groundwater conditions are very erratic in the valley. The behavior of water bearing formation in the valley in the central part comprising low lying alluvium is inconsistent and erratic. It shows variation within short distances.

High Iron content in ground water

The results of chemical analysis of ground water samples indicate the presence of iron in it. The source of this iron is geogenic.

Artesian Conditions

The often occurring thick confining layer or sometimes gas exerts pressure on aquifers and thus flowing conditions are encounterd with the piezometeric heads raised upto 2-3 m above ground level. The ground water coming out of these free flow wells is lost through natural drainages

Figure 35: Free Flowing Well at Trikulbal, Baramulla District.

Catchments of Spring

There are a large number of springs in the vallay as well as on its fringes on all the sides. Some of these springs have either disappeared or their discharges have been

reduced to a considerable amount due to encroachments/ alterations in their catchment areas.

Untapped Spring

The available spring sources are not tapped to their full extent.

High silt content in ground water

The tubewells drilled especially in lower Karewa sediments yield considerable amount of greyish silt in ground water. Such ground water did not clear up even after development with air compressor for a reasonable period.

Presence of Gas in wells

The basal Triassic limestones and the depositional history of Karewa lacustarine sediments alongwith the presence of fossil fuel as peat, lignite and marshy conditions support the occurrence of gas in Kashmir Valley. This gas is encountered during drilling of tubewells and sometimes imparts bad odour to the ground water and make it unfit for drinking.

Figure 36: Gas Bubbles on the surface of water in a tubewell

Ignorance of Kuhls

Disuse and non maintenance of Kuhls, the ancient system of irrigation canals from surface drainage from springs or divesion channels from river/stream, are posing pressure on ground water reservoirs as the tubewells being drilled to meet the irrigation needs.

Large number of Ponds and water bodies

There are a large number of ponds/tanks and other water bodies in the study area. In earlier days water from these ponds was being used for washing, bathing and even drinking at places. These ponds also acted as recharge structures. With the coming up of piped water supply these ponds have been put to dis-use and have even been encroached upon, and their inlets have been disturbed. Some ponds are being filled up by tubewells installed near them which are putting stress on aquifers.

Wetlands and Marshy areas

The Kashmir Valley is dotted with wetlands, which play an enormous role in maintaining the hydrological regimes of the entire valley. By virtue of natural functioning, these wetlands play an important role in water quality improvement, sediment control, oxygen production, nutrient recycling, flood control, aquifers recharging, ground water discharge and stabilization of local climatic conditions. Encroachment of the peripheral area and also due to plantation within these areas has significantly affected their existence.

Land Transformation/ Shrinking of Lakes

The Kashmir Valley has over a thousand small and large water bodies, which are the backbone of both its ecology and its economy. According to the State Water Mission, water bodies in Kashmir are the worst victims of human interference and rapid urbanisation. Massive erosion in the catchment area is resulting in silting up of these lakes, thereby converting water areas into landmasses. Some water bodies have disappeared due to natural causes like glacial action and low precipitation. The famous Dal Lake, which was described by Abul Fazal as thee 'delight of the world', has shrunk from 24 sq km to 10 sq km. The Anchar and the Gilsar lakes are now vanished.

Land Fill sites/Solid waste Disposal Sites

The land fill/solid waste disposal sites are being decided unscientifically, resulting leaching of pollutants and contaminating the aquifer.

Silting Up of Rivers

The rivers are getting silted at an alarming rate. The liquid and solid wastes of the entire valley also go in them.

Unscientific Development of Ground Water

No scientific guideline is followed by the Government as well as private agencies in proper selection of sites for construction of tubewells. The tube wells belonging to irrigation as well as drinking water supply departments are being pumped continuously for more than the recommended hours with greater drawdowns. With no scientific ground water department in J&K State the aquifer parameters are never

estimated in these wells nor is the capacity of pumps taken care off, leading to stress on the aquifers.

MANAGEMENT PLAN

Management Options - Demand Side

- **Harnessing the Auto Flow Wells**

  Huge amount of ground water is lost through the free flow artesian wells. The ground water emerging through these free flow tubewells can be channelised and utilized for irrigating the fields or supplying to the water scarce areas.

- **Conjunctive Use**

  Overall Valley of Kashmir possesses good groundwater potential, the distribution of which is not ubiquitous. Southern area possesses good groundwater potential. The Central portion has fair to moderate groundwater potential, while Northern and Western parts of the Valley have poor to good prospects of groundwater development, due to erratic and uncertain hydrogeological conditions present in these areas. For an efficient and sustainable agriculture in surface water deficient areas, surface water as well as groundwater can be harnessed conjunctively in a manner to have more or less drought proof water management system.

- **Revive the Irrigation Kuhls**

  The ancient Kashmiri system of "Kuhls" gravity irrigation should be revived.

- **Land Transformation**

  Land transformation is significant and this expansion is haphazard and without planning it has given rise to drainage failure, conversion of marshy areas into agriculture or built up etc.

- **Irrigation Statagies**

  Drought proofing can be achieved by promoting the use of drip & sprinkler irrigation system, with proper infrastructural support and government subsidies.

- **Solid Waste Disposal/Land fill site**

  Such site should be decided in consultation of Central Ground Water Board, so that the quality of ground water does not get affected.

In industrial areas Effluent Treatment Plants of sufficient capacities must be installed and their working and waste disposal should be strictly monitored to protect the aquifer/water body from pollution.

- **Capacity Building**

  People should be made aware of water management practices, modern agricultural and irrigation techniques, changing climate etc.

Management Options - Supply Side

- **Uneven distribution of Aquifers**

  The inconsistency in the lateral and vertical extent of aquifers creates excess water availability in one area and scarcity in the other. The excess water should be supplied to water scarece areas.

- **Silty Formation.**

  In many wells silt pumping occurs. In order to mitigate this problem, it is necessary to design the well assembly properly after carrying out the mechanical analysis of granular material and judicious selection of screens and pea gravel. It would be beneficial to use screens, with suitable openings (preferably 0.5 to 0.75 mm), to match the fine size of ground water bearing formation.

- **Gas in ground water**

  The ground water especially the central part “bowl” is associated with gas. The tubewells located in Karewa formation in districts of Budgam Baramulla and Srinagar yield gassy water. The gas bearing horizons or marsh gas pockets width will have to be sealed or exhausted of gas before the water can be made potable. This needs proper and careful designing of tubewells.

- **Geogenic Iron in ground water**

  Some of these wells had higher iron content than maximum permissible limit of 1 mg/l (BIS for drinking water) falling in parts of Baramulla, Srinagar, Badgam, Pulwama and Anantnag Districts. Testing water sample and possibilities of treating the water for making it potable be ascertained.

- **Scientific Approach for Exploration/Production**

  Costruction of tubewells should be done on systematic and scientific lines. Scientifically specified distance should be maintained between tubewells to avoid interference of the wells.

- **Estimation of Aquifer parameters**

  Proper pump tests needs to be carried out to arrive at the correct groundwater aquifer parameters of the tubewells and installation of the pumps of appropriate capacity.

  The wells should be given proper recuperation time and the capacity of pumps should be adhered to the recommended safe discharge.

- **Over Pumping/ Overdraft from Aquifer Ground Water**

  Over pumping from tubewells has to be stopped at all, as it is likely to damage not only the tubewell but also the surrounding groundwater bearing formation. Overdraft from groundwater reservoir has to be avoided which may otherwise lead to disastrous consequences for future development of sub-surface water.

- **Reclamation of water bodies and wetlands**

  The water bodies and wetlands should be protected and conserved and they should be restored to their original boundaries.

- **Sand Mining should be banned**

Recommendations

As it has been established that there is sufficient, exploitable, ground water resource available both in quantity and quality, it is recommended that:

- Artificial recharge is recommended only for those locations where water levels are deep and the aquifer has the potential to recharge.

- Tubewells should be constructed scientifically viz. suitable sites, distance between them, identifying aquifer parameters, recommended discharge and drawdown, recuperation time etc. should be strictly adhered to.

- Geophysical logging is recommended for deciphering the exact the potential zones and to have an idea about the high gas bearing zones.

- Tubewell assemblies should be shrouded with a thick gravel pack, so as to avoid pumping of sand and silt, or either stainless or low carbon galvanized screens, should be used, after carrying out the proper grain size analysis, of the aquifer to be tapped, and determining the appropriate size of the screen opening, which can form a natural gravel pack, around the assembly.

- Since the depth to water levels in valley portions are within 5 m bgl the ground water development is required to be given a fillip by funding agencies through

State Government, providing soft loans on liberal terms for construction of shallow tube wells, dug wells, hand pumps etc. The tapping the shallow aquifers will also minimize the chances of getting comparatively higher Iron content which is regular problem in the Karewa sediments.

- Since there are data gaps in monitoring of depth to water levels, it is recommended to install piezometers to observe behavioral changes of water levels over a long period of time in order to know the trends.

- It has been observed that, the basic data of bore holes/tubewells, has not been suitably prepared, preserved and maintained. However, necessary infrastructure may be created to build a data bank which will in turn help the workers and planners, in future prospecting and management of this precious resource.

- At suitably identified locations, along the Sindh River, Collector Wells/ Percolation Wells/ Ranney Wells may be constructed, which can provide a large volume of filtered water to augment the drinking water supplies of Srinagar city.

- Iron removal plants should be installed to minimize its presence for water supply.

- The original condition and boundaries of water bodies, lakes and Kuhls should be reclaimed.

- Sites for waste disposal should be decided in consultation with CGWB and ETP's should be constructed and maintained in working condition to avoid pollution of surface water bodies/ aquifers.

- Overpumping/Overdrawal from aquifer should not be allowed in any case.

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ANNEXURE I

Data Gap Ground Water Exploration and Aquifer Parameters in Kashmir Valley

Kashmir valley –5200 Sq.Km.								
S.No.	**District**	**formation**	**Toposheet no.**	**Quadrant no**	**total no . of well exist**	**aquifer parameters**		**Total no of sites porposed**
						available no. of T values	**available no. of S values**	
1.	Kupwara	Karewas	43J/2	B3	1	*	1	1
2.	Kupwara	Karewas		C3	2	*	*	1
3.	Kupwara	Karewas	43J/3	A1	nil	*	*	1
4.	Kupwara	Karewas		B1	1	*	*	1
5.	Kupwara	Karewas		B2	1	*	*	1
6.	Kupwara/Baramulla	Karewas		B3	1	*	*	1
7.	Kupwara	Karewas		C1	3	*	*	1
8.	Kupwara	Karewas		C2	4	*	*	1
9.	Kupwara/Baramulla	Karewas		C3	nil	*	*	1
10.		Karewas	43J/6					
11	Kupwara/muzaffarabad	Karewas		A2	nil	*	*	1
12	Kupwara	Karewas		A3	1	*	*	1
13	Kupwara	Karewas		B2	nil	*	*	1
14	Kupwara	Karewas		B3	1	*	*	1
15	Kupwara/Baramulla	Karewas		C3	nil	*	*	1
16	Kupwara	Karewas	43J/7	A1	4	*	*	1
17	Kupwara/Baramulla	Karewas		A2	3	1	*	1
18	Kupwara/Baramulla	Karewas		A3	nil	*	*	1
19	Kupwara/Baramulla	Karewas		B1	nil	*	*	1
20	Baramulla	Karewas		B2	5	1	*	1
21	Baramulla/Kupwara	Karewas		C1	1	*	*	1
22	Baramulla	Karewas		C2	nil	*	*	1
23	Baramulla	Karewas	43J/8	A2	nil	*	*	1
24	Baramulla	Karewas		B2	nil	*	*	1
25	Baramulla	Karewas		C2	nil	*	*	1
26	Baramulla/Badgam	Karewas		C3	nil	*	*	1
27	Baramulla	Karewas	43J/11	A1	nil	*	*	1
28	Baramulla	Karewas		A2	nil	*	*	1
29	Baramulla	Karewas		A3	1	*	*	1
30	Baramulla	Karewas		B1	nil	*	*	1
31	Baramulla/Srinagar	Karewas		B2	nil	*	*	1
32	Baramulla/Srinagar	Karewas		B3	nil	*	*	1
33	Baramulla	Karewas		C1	nil	*	*	1
34	Baramulla/Srinagar	Karewas		C2	nil	*	*	1
35	Baramulla/Srinagar	Karewas		C3	nil	*	*	1
36	Baramulla	Karewas	43J/12	A1	6	2	*	1
37	Baramulla/Badgam	Karewas		A2	3	*	*	1
38	Baramulla/Badgam	Karewas		A3	2	*	*	1
39	Baramulla/Srinagar	Karewas		B1	4	1	*	1
40	Badgam	Karewas		B3	1	*	*	1

S.No.	District	formation	Toposheet no.	Quadrant no	total no . of well exist	aquifer parameters		Total no of sites porposed
						available no. of T values	available no. of S values	
41	Baramulla/Srinagar/ Badgam	Karewas		C1	1	1	*	1
42	Baramulla/Srinagar	Karewas		C2	1	1	*	1
43.		Karewas		C3	5	1	*	1
44	Baramulla	Karewas	43J/15	A2	nil	*	*	1
45	Srinagar	Karewas		A3	nil	*	*	1
46	Srinagar	Karewas		B3	nil	*	*	1
47	Srinagar	Karewas		C3	nil	*	*	1
48	Srinagar/Badgam	Karewas	43J/16	A2	1	*	*	1
49	Srinagar/Badgam	Karewas		A3	8	5	*	1
50	Srinagar	Karewas		B1	nil	*	*	1
51	Srinagar	Karewas		C1	nil	*	*	1
52	Srinagar/Pulwama	Karewas		C2	nil	*	*	1
53	Pulwama	Karewas	43O/1	A1		*	*	1
54	Pulwama/Anantnag	Karewas		A2	1	*	*	1
55	Pulwama/Anantnag	Karewas		A3	5	*	*	1
56	Pulwama/Anantnag	Karewas		B1	nil	*	*	1
57	Pulwama/Anantnag	Karewas		B2	1	*	*	1
58	Pulwama/Anantnag	Karewas		C1	nil	*	*	1
59	Pulwama/Anantnag	Karewas		C2	nil	*	*	1
60	Anantnag	Karewas		C3	nil	*	*	1
61	Pulwama/Anantnag	Karewas	43K/14	A1	nil	*	*	1
62	Pulwama/Anantnag	Karewas		A2	nil	*	*	1
63	Pulwama/Anantnag	Karewas		B1	nil	*	*	1
64	Pulwama/Anantnag	Karewas		B2	nil	*	*	1
65	Anantnag	Karewas		B3	nil	*	*	1
66	Pulwama/Anantnag	Karewas		C1	1	*	*	1
67	Anantnag	Karewas		C2	nil	*	*	1
68	Anantnag	Karewas		C3	nil	*	*	1
69	Anantnag	Karewas	43O/2	A1	nil	*	*	1
70	Anantnag	Karewas		A2	1	1	*	1
71	Anantnag	Karewas		B1	2	*	*	1
72	Anantnag/Doda	Karewas		B3	nil	*	*	1
73	Anantnag	Karewas		C1	nil	*	*	1
74	Anantnag	Karewas		C2	1	*	*	1
75	Anantnag/Doda	Karewas		C3	nil	*	*	1
76	Anantnag	Karewas	43O/5	A1	nil	*	*	1
77	Anantnag	Karewas		A2	nil	*	*	1
78	Anantnag	Karewas		A3	nil	*	*	1
79.	Anantnag	Karewas		B3	nil	*	*	1

S.No.	District	Formation	Toposheet no.	Quadrant no	total no . of well exist	aquifer parameters		Total no. of sites porposed
						available no. of T values	available no. of S values	
80	Anantnag	Karewas	43O/6	A1	1	*	*	1
81	Anantnag	Karewas		A2	nil	*	*	1
82	Anantnag	Karewas		A3	nil	*	*	1
83	Anantnag	Karewas		B3	nil	*	*	1
84	Badgam	Karewas	43K/9	A1	NIL	*	*	1
85	Badgam	Karewas		B1	NIL	*	*	1
86	Badgam	Karewas		B2	NIL	*	*	1
87	Badgam	Karewas		C2	NIL	*	*	1
88	Badgam/Pulwama	Karewas		C3	NIL	*	*	1
89	Pulwama/Badgam	Karewas	43K/13	A1	2	1	*	1
90	Pulwama/Badgam	Karewas		A2	1	*	*	1
91	Pulwama	Karewas		A3	nil	*	*	1
92	Pulwama/Badgam	Karewas		B1	1	1	*	1
93	Pulwama	Karewas		B3	nil	*	*	1
94	Pulwama	Karewas		C1	2	*	*	1
95	Pulwama	Karewas		C2	4	*	*	1
96	Pulwama/Anantnag	Karewas		C3	2	*	*	1

ANNEXURE II

Mean Rainfall at IMD Stations of Kashmir Valley

Month	Srinagar		Qazigund		Gulmarg		Kupwara		Pahalgam		Kokernag	
	1971-2000		1971-2000		1971-2000		1977-2000		1978-2000		1978-2000	
	Mean RF in mm	No. of Rainy Days	Mean RF in mm	No. of Rainy Days	Mean RF in mm	No. of Rainy Days	Mean RF in mm	No. of Rainy Days	Mean RF in mm	No. of Rainy Days	Mean RF in mm	No. of Rainy Days
Jan	49.6	4.9	140.5	8	158.8	8.6	87.1	7.8	98.6	8.2	83.8	5.7
Feb	72.3	5.7	183.6	8.7	223.9	10.4	126.8	8.9	142.1	8.9	121.2	7.3
Mar	115.6	8.3	205.5	9.8	255.8	12.7	240.7	12.4	217.9	11.9	172.2	9.8
Apr	85.4	6.5	130.4	7.8	173.7	11	156.5	9.7	145.3	10	109.4	7.9
May	71.7	6.1	112.5	7.9	149.5	10.8	102.7	8.6	128.6	9.8	119.5	8.7
Jun	43.7	3.9	69.2	4.8	98	8.1	59.1	4.7	89.2	8.2	78.3	5.3
Jul	59.6	5	107.6	6.8	114.8	10.2	87.4	6.3	109.7	9.3	99.6	7.3
Aug	71.8	5.3	100	5.9	104.4	8.8	74.9	5.4	102.4	9	83.5	5.8
Sep	26.6	2.5	56.4	3.5	58	5.2	31.7	2.6	77.8	6.4	45.3	3.9
Oct	31.2	2	45.9	3	52.6	3.5	49.6	3.7	57.8	4.4	44.3	3.1
Nov	28.3	2	49.9	2.6	52.8	3.2	52	3.5	48.4	3.4	46.8	2.4
Dec	47.8	3.5	90.3	4.9			67.9	4.6	83.2	5.3	66.4	4.2
Annual	703.6	55.6	1291.9	73.7	1442.3		1136.5	78.3	1301	94.8	1070.4	71.7

ANNEXURE III

Results of Pesticides Analysis of water Samples collected from Kashmir Valley

S.No	Location	α-HCH	β-HCH	γ- HCH	δ-HCH	Total HCH	4,4'-DDT	2,4'-DDE	4,4'-DDE	4,4'-DDD	Total DDT	Chlorpyrifos	Aldrin
		<----------Pesticide Residues in µg/l-----(											
1.	Verinag	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2.	Sankarp[ora	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3.	Anantnag	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4.	Zirapora	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5.	Parampur (silk nursery)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
6.	Sumbala	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
7.	Gatabal	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
8.	Makhdhomyari	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
9.	Baramulla City	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
10.	Gandarbal	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11.	Nehru park	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
12.	Lal chowk	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
13.	Verinag	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
14.	Dhogun Ladi	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15.	Anantnag City	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
16.	Sangam	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
17.	Pumpura	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
18.	safapur	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
19.	Hajjan	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
20.	Dongli tang	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
21.	Mugbag	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
22.	Rampur	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
23.	Parampora	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
24.	Lal chowk	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
25.	MES	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
26.	Mirgund	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

ANNEXURE IV

Results of Chemical Analysis of water samples collected from Dugwells during Aquifer Mapping Field Work in Kashmir Valley

S. No.	District	Location	Latitude	Longitude	Date of collection	Temp °C	pH	Sp Cond ms/cm 25°C	CO3	HCO3	Alkali-nity	Cl	SO4	NO3	F	Ca	Mg	Na	K	TH	TDS	Fe
1	Kupwara	Aagam	34.40	74.18	02.06.14		8.1	730		348	285	60.35	2.32	46	0.57	34.07	53.06	38.86	16.80		305	0.53
2		Amargad			17.08.12	12	7.8	340	Nil	110		46.20	5.70	0.19	0.30	42.10	9.73	11.50	0.60		145	0.00
3	Budgam	Aripanthan village	34.06	74.58	15.09.11	14	8.2	670	Nil	232		55.00	15.00	61	0.20	76.00	11.00	35.00	18.00	235		0.09
4	Kupwara	Authoora	34.34	74.61	29.05.14		8.0	320		171	140	28.40	29.25	0.0	0.03	16.03	16.88	44.23	3.43		110	0.76
5	Kupwara	Bramri	34.47	74.28	31.05.14		7.9	770		153	125	120.70	136.76	24	0.05	102.2	10.85	69.35	4.82		300	0.25
6	Kupwara	Chakigam	34.47	74.31	31.05.14		7.6	470		287	235	24.85	0.90	0.0	0.07	66.13	15.68	17.88	1.76		230	0.62
7	Kupwara	Charkut	34.54	74.33	01.06.14		7.3	350		226	185	17.75	7.79	6	0.07	42.08	13.27	25.74	5.60		160	0.34
8		Checkrajpora	34.04	75.05	17.08.12	15	7.9	480	Nil	275		14.00	10.00	12	0.18	80.00	12.00	7.00	1.00		250	0.00
9	Kupwara	Chunjmul	34.39	74.18	02.06.14		7.8	340		140	115	42.60	0.00	1.	0.03	34.07	10.85	19.97	0.98		130	0.20
10	Kupwara	Dangarpora	34.34	74.46	28.05.14		7.4	720		311	255	92.30	34.60	0.7	0.06	62.12	34.97	55.05	1.63		300	0.23
11	Kupwara	Dardpora	34.51	74.11	01.06.14		7.4	200		136	111	14.20	0.00	4	0.04	32.06	9.65	6.22	1.28		120	0.04
12	Kupwara	Dardsund	34.50	74.12	01.06.14		7.5	300		159	130	28.40	13.39	1	0.07	38.08	13.27	15.63	0.75		150	0.07
13	Kupwara	Dolipura	34.46	74.16	30.05.13	20	7.7	430	ND	214	175	14.20	11.21	8.38	0.08	70.14	1.22	14.20	2.00	180	266.6	0.00
14	Kupwara	Duham	34.49	74.15	01.06.14		8.0	360		226	185	14.20	6.34	4	0.11	52.10	13.27	7.49	10.79		185	3.23
15	Kupwara	Dusilpora	34.19	74.73	28.05.14		7.9	630		171	140	78.10	51.52	41	0.01	30.06	31.36	58.88	2.93		205	0.34
16	Kupwara	Gangbug	34.52	74.38	01.06.14		7.7	160		98	80	10.65	25.18	0.3	0.09	28.06	10.85	2.73	0.60		115	0.71
17	Budgam	Gariend Khurd	34.03	74.68	01.07.11	19	7.6	320	Nil	165		27.00	Tr	4.3	0.12	32.00	16.00	12.00	2.40	145		1.31
18	Kupwara	Hadipora (maidanmo halla)	34.29	74.39	29.05.14		7.9	460		220	180	42.60	79.06	0.0	0.01	60.12	28.94	23.24	1.45		270	0.53
19	Kupwara	Hampoora	34.36	74.33	29.05.14		7.1	570		262	215	74.55	0.93		0.04	64.13	16.88	39.92	3.35		230	1.03
20	Kupwara	Handwara (Almustafa colony)	34.40	74.28	29.05.13	19	7.6	600	ND	220	180	39.05	45.21	15.88	0.10	68.14	14.59	28.50	2.30	230	372	0.00
21	Kupwara	Heewan	34.18	74.48	29.05.14		7.3	660		323	265	49.70	5.74	42	0.21	96.19	19.30	23.17	3.93		320	0.34
22	Kupwara	Imbrahim colony	34.30	74.47	28.05.14		7.9	400		183	150	24.85	57.93	1	0.08	34.07	34.97	6.87	1.11		230	0.62

S. No.	District	Location	Latitude	Longitude	Date of collection	Temp °C	pH	Sp Cond ms/cm 25°C	CO3	HCO3	Alkali-nity	Cl	SO4	NO3	F	Ca	Mg	Na	K	TH	TDS	Fe
23		Kaishtha			16.07.12	13	7.8	240	Nil	115		10.70	Tr	5.2	0.34	34.00	7.30	8.00	0.40		115	0.00
24	Kupwara	Kandikhas	34.46	74.33	31.05.14		7.9	380		226	185	17.75	30.21	2	0.09	52.10	16.88	17.71	3.76		200	0.58
25	Kupwara	Kawari village	34.47	74.28	31.05.14		8.0	350		146	120	49.70	0.42	2	0.02	38.08	12.06	16.52	8.73		145	0.65
26		Khanpoora			17.08.12	13	8.2	380	Nil	232		21.30	Tr	0.78	Tr	60.00	12.16	8.90	0.60		200	0.00
27	Kupwara	Krinipora	34.57	74.26	01.06.14		7.3	350		244	200	28.40	10.76	4	0.16	54.11	16.88	22.48	0.77		205	0.82
28		Kukroosa			17.08.12	13	8.1	380	Nil	226		21.30	4.30	4.52	0.50	52.10	14.60	13.80	2.60		190	0.00
29		Kupwara			16.08.12	12	8.1	710	Nil	287		67.50	Tr	Nil	0.14	96.00	18.20	2.10	9.80		315	0.15
30	Kupwara	Lassipora	34.51	74.38	01.06.14		7.7	170		128	105	7.10	5.66	0.2	0.09	28.06	10.85	2.60	0.50		115	0.49
31	Kupwara	Lolipura	34.36	74.56	28.05.14		7.5	1780		110	90	443.75	128.78	32	0.07	164.33	51.86	113.01	3.48		625	0.49
32	Kupwara	Madhwan	34.33	74.62	28.05.14		7.4	380		195	160	24.85	20.30	6	0.11	40.08	16.88	8.66	25.31		170	2.23
33	Kupwara	Markundal	34.25	74.61	28.05.14		7.4	490		298	244	21.30	1.00	0.0	0.03	44.09	31.36	15.32	1.23		240	0.16
34	Kupwara	Mazbugh	34.28	74.43	28.05.14		7.9	890		305	250	117.15	95.72	2	0.01	38.08	42.21	92.76	34.86		270	0.74
35	Kupwara	Mirmohalla katyanwalli	34.54	74.38	01.06.14		7.4	170		92	75	10.65	29.13	0.5	0.34	26.05	12.06	2.72	0.57		115	0.77
36	Kupwara	Munji	34.36	74.47	28.05.14		8.0	450		195	160	49.70	53.17	0.3	0.01	26.05	31.36	40.70	1.70		195	0.72
37	Kupwara	Muslina bad	34.29	74.45	29.05.14		7.8	360		134	110	21.30	37.72	48	0.13	40.08	19.30	16.28	2.30		180	0.23
38	Baramulla	Nooripura	34.11	74.61	27.05.13	18	7.4	2100	ND	622	510	188.15	1071.92	30.43	0.25	114.23	41.34	362.5	525.0	455	1302	0.00
39	Kupwara	Palpoora	34.34	74.36	29.05.14		7.4	230		140	115	14.20	16.29	0.2	0.01	32.06	12.06	8.46	2.94		130	0.33
40	Kupwara	Radbugha	34.46	74.30	31.05.14		7.8	710		134	110	142.00	116.10	2	0.15	50.10	39.80	62.86	4.91		290	0.58
41	Baramulla	Ranji	34.22	74.50	27.05.13	16	7.4	910	ND	415	340	71.00	ND	18.1	ND	102.2	23.10	43.50	5.70	350	564	0.00
42	Kupwara	Reshipoora	34.32	74.35	29.05.14		8.1	240		165	135	7.10	23.19	0.0	0.11	26.05	18.09	13.06	0.82		140	0.67
43	Kupwara	Saidpoora	34.32	74.46	28.05.14		7.9	330		171	140	28.40	27.68	1	0.01	44.09	19.30	8.57	0.81		190	0.85
44		Sharehama	34.35	74.23	28.08.12	12	7.8	560	Nil	317		35.50	Tr	34.7	0.21	94.20	10.90	22.50	0.50		290	0.10
45	Kupwara	Shatgam	34.38	74.17	02.06.14		7.6	360		189	155	31.95	36.10	8	0.20	40.08	25.33	17.95	0.44		205	1.25
46	Budgam	Soibugh (Hanjik Poora)	34.07	74.71	10.09.11	17	7.4	1920	Nil	616		277.00	35.00	99	0.20	244.0	39.00	112.0	1.40	770		0.09
47	Kupwara	Taratpura	34.47	74.12	01.06.14		7.8	260		165	135	7.10	2.63	3	0.12	20.04	21.71	4.71	0.18		140	0.72
48	Kupwara	Trich	34.44	74.33	31.05.14		8.0	280		165	135	17.75	32.06	0.0	0.07	36.07	19.30	9.17	2.84		170	0.27

S. No.	District	Location	Latitude	Longitude	Date of collection	Temp °C	pH	Sp Cond ms/cm 25°C	CO3	HCO3	Alkali-nity	Cl	SO4	NO3	F	Ca	Mg	Na	K	TH	TDS	Fe
49	Kupwara	Tujar	34.37	74.41	28.05.14		7.5	480		354	290	14.20	0.00	0.0	0.01	78.16	22.91	7.97	1.01		290	0.56
50	Kupwara	Uplona	34.21	74.53	29.05.14		7.8	820		189	155	85.20	136.24	47	0.11	60.12	36.18	58.69	21.47		300	0.36
51	Kupwara	Urwan (Warwan)	33.93	74.89	27.05.14		7.7	260		171	140	14.20	0.00	0.0	0.35	24.05	18.09	8.42	2.31		135	0.43
52	Kupwara	Wadder payeen	34.38	74.15	02.06.14		7.7	410		287	235	10.65	21.15	6	0.32	26.05	26.53	46.65	1.01		175	0.87
53	Kupwara	Wadipora	34.41	74.23	02.06.14		7.6	660		128	105	78.10	118.55	48	0.11	66.13	33.77	32.95	0.67		305	1.02
54	Kupwara	Yamrad	34.39	74.19	02.06.14		7.7	510		201	165	35.50	0.00	95	0.01	56.11	22.91	23.74	1.03		235	0.45
55	Kupwara	Zand Faran	34.25	74.37	29.05.14		7.8	460		195	160	35.50	3.86	34	0.07	42.08	25.33	13.68	1.47		210	0.23
56	Kupwara	Zengli	34.55	74.27	01.06.14		7.2	280		153	125	14.20	0.00	0.0	0.09	40.08	0.00	18.14	0.64		100	0.78
57	Budgam	Aripanthan	34.06	74.58	30.05.14	Nm	7.79	1250		354	290	124	107	**4.9**	**0.38**	124	21	**26.52**	**100.3**	395	77	3.1
58	Budgam	Badran	34.08	74.58	30.05.14	Nm	7.75	250		98	80	28	4	0.0	0.07	30	10	3.8	0.8	115	155	0.23
59	Baramulla	Binner	34.23	74.36	29.05.14	Nm	7.58	410		232	190	32		0.0	0.01	50	18	13.6	2.97	200	254	0.15
60	Baramulla	Bomai	34.36	74.42	28.05.14	Nm	7.7	560		226	185	64	41			38	29	46.4	1.46	215	347	0.04
61	Kupwara	Chowgal	34.41	74.32	31.05.14	Nm	7.4	560		390	320	7	4	0.0	0.09	52	41	15.1	0.85	300	347	16.08
62	Kupwara	Dolipora	34.47	74.16	31.05.14	Nm	7.52	430		146	120	46	42	5	0.66	46	19	17.8	1.06	195	267	0.76
63	Kupwara	Drugmulla	34.49	74.29	31.05.14	Nm	7.98	370		226	185	21		7	0.04	52	17	8.6	1.07	200	229	0.04
64	Pulwama	Gandhasi bhat	33.86	75.04	26.05.14	Nm	7.43	350		201	165	11	9	7	0.4	54	12	3.9	2.46	185	217	0.47
65	Kupwara	Gulgam	34.54	74.22	31.05.14	Nm	7.33	1060		360	295	107	87	49	0.19	104	28	67.5	42.39	375	657	0.38
66	Kupwara	Guse	34.54	74.28	31.05.14	Nm	8.1	270		159	130	14		0.0	0.05	22	18	7.4	0.24	130	167	10.86
67	Kupwara	Khanpora	34.44	74.27	31.05.14	Nm	7.78	500		268	220	43	16	2	0.06	88	12	12.8	0.66	270	310	0.7
68	Kupwara	Kupwara	34.53	74.26	31.05.14	Nm	7.98	950		226	185	174	8	16	0.18	30	35	106.0	0.9	220	589	0.31
69	Kupwara	Magam	34.46	74.23	31.05.14	Nm	7.97	740		201	165	89	27	75	0.1	64	34	35.6	0.79	300	459	0.04
70	Baramulla	Mirgund Silk Centre	34.14	74.65	31.05.14	Nm	7.57	750		464	380	28	26	2	0.29	48	40	69.0	11.69	285	465	0.04
71	Srinagar	Rainawari	34.10	74.82	27.05.14	Nm	7.4	550		305	250	7	50	7	0.52	64	23	21.2	14.39	255	341	0.23
72	Anantnag	Rambarpora	33.74	75.22	26.05.14	Nm	7.53	410		122	100	53	0	48	0.11	46	19	8.3	0.6	195	254	1.09

S. No.	District	Location	Latitude	Longitude	Date of collection	Temp °C	pH	Sp Cond ms/cm 25°C	CO3	HCO3	Alkali-nity	Cl	SO4	NO3	F	Ca	Mg	Na	K	TH	TDS	Fe
73	Srinagar	Regal chowk	34.04	74.82	27.05.14	Nm	7.65	660		372	305	50	16	1	0.15	38	41	56.7	3.52	265	409	0.07
74	Pulwama	Sambura	33.96	74.93	27.05.14	Nm	7.8	300		128	105	25	12	1	0.03	36	10	10.8	0.29	130	186	0.29
75	Baramulla	Sangrama	34.24	74.45	29.05.14	Nm	7.53	640		329	270	39		28	0.15	92	18	17.6	3	305	397	0.45
76	Baramulla	Sopore Model Town	34.31	74.44	28.05.14	Nm	7.5	590		317	260	50	0	7	0.25	74	16	35.3	7.48	250	366	0.72
77	Pulwama	Tral	33.91	75.03	26.05.14	Nm	7.3	480		195	160	18	65	6	0.17	64	21	5.7	0.74	245	298	1.09
78	Kupwara	Trehgam	34.52	74.18	31.05.14	Nm	7.8	670		366	300	60		1	0.17	78	28	32.9	1.44	310	415	0.04
79	Baramulla	Waripora	34.09	74.56	30.05.14	Nm	7.96	200		116	95	18	36	1	0.07	6	33	3.6	0.64	150	124	0.04
80	Baramulla	Handipora (Zambodzpora)	34.22	74.36	29.05.14	Nm	7.85	450		195	160	60	8	0.20	0.14	30	21	41.9	1.83	160	279	0.45
81	Pulwama	Zewan	34.04	74.92	27.05.14	Nm	8.09	690		390	320	43	0	6	0.27	86	25	26.1	3.89	320	428	1.43

ANNEXURE V

Results of Chemical Analysis of water samples collected from Tubewells during Aquifer Mapping Field Work in Kashmir Valley

S. No.	District	Location	Latitude	Longitude	Temp °C	pH	Sp Cond ms/cm 25°C	CO3	HCO3	Alkalinity	Cl	SO4	NO3	F	Ca	Mg	Na	K	TH	TDS	Fe
1	Sopian	Ahagam	33.79	74.90	17.5	8.0	300	ND	122	100	10.7	5.8	12.0	0.1	34.1	9.7	2.2	0.7	125	156	0.13
2	Pulwama	Belo Dardgund	33.83	74.86	18	8.1	380	ND	220	180	10.7	1.1	1.4	0.2	46.1	15.8	7.4	0.9	180	198	0.14
3	Pulwama	Bonoura	33.84	74.88	17	7.9	340	ND	177	145	3.6	2.9	17.0	0.6	50.1	8.5	2.8	0.5	160	177	0.18
4	Pulwama	Chandhara	33.98	74.95	17	8.4	470	42	238	265	10.7	ND	3.3	0.6	50.1	19.5	33.2	1.0	205	244	0.12
5	Kupwara	Charkut Lolab	34.47	74.28	13	8.2	410	Nil	244		7.1	Tr	7.8	0.6	34.0	28.0	8.7	0.9	170	200	0.29
6	Sopian	Chitragam	33.77	74.98	17	8.2	420	ND	214	175	7.1	43.9	5.8	0.1	62.1	14.6	8.8	1.0	215	218	0.23
7	Budgam	Chopanmohalla-i	33.96	74.77	17.4	7.4	250	ND	153	125	10.7	2.5	4.1	0.1	42.1	8.5	2.7	0.0	140	130	0.15
8	Anantnag	Dardkot	33.59	75.17	20	7.6	430	0	275	225	10.7	6.5	3.5	0.2	66.1	19.5	2.1	0.0	245	215	0.00
9	Pulwama	Drusso	33.86	74.90	18	8.0	250	ND	110	90	10.7	19.5	12.0	0.1	32.1	10.9	3.9	1.2	125	130	0.13
10	Budgam	Durbal	34.08	74.74	15	8.1	490	Nil	299		14.0	20.0	8.0	0.7	32.0	21.0	59.0	1.0	165	200	1.72
11	Pulwama	Farm Bonura	33.84	74.89	18	7.9	310	ND	195	160	10.7	2.3	1.9	0.1	46.1	12.2	5.8	1.0	165	161	1.51
12	Budgam	Godsathu	33.97	74.77	16	7.8	180	Nil	104		9.0	Tr	5.3	Tr	24.0	8.0	4.3	0.6	93	210	0.00
13	Budgam	Humhuma	34.02	74.78	16	7.7	230	Nil	128		7.1	Tr	4.4	0.2	36.0	4.8	4.0	1.2	150	110	0.26
14	Pulwama	Konibal	34.00	74.95	18	8.2	510	36	238	255	14.2	-0.1	1.6	0.7	34.1	25.5	38.9	1.3	190	265	0.31
15	Anantnag	Kurigam	33.60	75.16	17	7.6	440	0	275	225	10.7	2.8	1.5	0.3	70.1	14.6	4.2	0.0	235	220	0.21
16	Budgam	Lakripoora	34.02	74.70	15	7.9	300	Nil	171		7.1	16.0	4.0	Tr	46.0	4.8	3.8	0.5	135	190	0.00
17	Budgam	Naru Dangarpora	33.98	74.77	17.8	7.3	320	ND	226	185	7.1	2.9	2.1	0.0	56.1	12.2	4.0	0.8	190	166	0.10
18	Pulwama	Nayara Tahab	33.84	74.92	17.4	8.1	310	ND	159	130	7.1	2.4	17.0	0.1	46.1	8.5	2.5	0.6	150	161	0.11
19	Pulwama	Old Bandzowa	33.83	74.89	18	7.8	230	ND	122	100	3.6	2.0	13.0	0.1	26.1	10.9	3.0	0.8	110	120	0.20
20	Pulwama	Old Pulwama	33.86	74.90	17.4	8.0	370	ND	189	155	3.6	6.4	13.0	0.1	52.1	8.5	5.0	1.0	165	192	1.51
21	Budgam	Palar	34.03	74.72	18	8.5	470	18	262		12.0	6.0	9.0	0.2	78.0	11.0	7.0	1.3	240	180	0.21
22	Budgam	Panzan	33.96	74.78	17.2	8.1	390	ND	189	155	7.1	ND	3.4	0.1	62.1	1.2	2.9	0.5	160	203	0.07
23	Pulwama	Parigam Jagir	33.94	74.88	17.6	8.3	570	36	281	290	17.8	22.3	21.0	0.3	72.1	26.8	29.2	1.3	290	296	25.0
24	Pulwama	Parigam Old	33.94	74.88	17.5	8.3	530	30	293	290	7.1	1.8	16.0	0.5	60.1	28.0	24.5	1.2	260	276	1.58
25	Budgam	Qazipora	33.91	74.84	15	8.5	440	Nil	250		11.0	6.0	8.5	0.2	82.0	4.8	4.7	0.6	225		0.27
26	Pulwama	Reshiwani	33.86	74.89	18	8.1	380	ND	122	100	24.9	2.7	13.0	0.0	54.1	0.0	5.6	0.8	135	198	0.15
27	Budgam	Sharifabad	34.04	74.69	15	7.7	630	Nil	384		28.0	12.0	11.0	0.4	48.0	51.0	21.0	1.0	330		0.00
28	Pulwama	Sidko	33.80	74.93	18.6	8.2	220	ND	128	105	3.6	-0.5	6.0	0.1	30.1	8.5	1.7	0.5	110	114	0.08

S. No.	District	Location	Latitude	Longitude	Temp °C	pH	Sp Cond ms/cm 25°C	CO3	HCO3	Alkalinity	Cl	SO4	NO3	F	Ca	Mg	Na	K	TH	TDS	Fe
29	Anantnag	Sopat	33.63	75.10	18	7.6	700	0	287	235	42.6	8.5	36.0	0.3	76.2	32.8	3.4	0.4	325	350	0.80
30	Pulwama	Sutsoo	33.98	74.85	18	8.4	610	42	226	255	14.2	ND	55.0	0.1	56.1	28.0	27.3	2.3	255	317	2.45
31	Pulwama	Thaman	33.86	74.89	18	7.7	450	ND	195	160	14.2	-0.5	23.0	0.0	62.1	7.3	5.3	1.2	185	234	0.06
32	Pulwama	Tiken Batpora	33.83	74.85	17.7	7.9	390	ND	201	165	10.7	0.6	16.0	0.1	60.1	7.3	5.2	1.7	180	203	0.13
33	Sopian	Uzranpathri	33.79	74.86	17.4	8.1	380	ND	189	155	7.1	ND	18.0	0.1	48.1	12.2	**3.4**	**1.0**	170	198	0.18
34	Anantnag	Vassu	33.65	75.13	26	7.7	440	0	134	110	7.1	16.2	15.0	0.6	24.0	6.1	29.0	0.7	85	220	0.78
35	Budgam	Wathura	33.97	74.81	17.5	8.2	450	24	195	200	17.8	84.5	6.8	0.1	64.1	8.5	9.9	1.6	295	234	2.41
36	Srinagar	Wuyun	34.04	74.97	14	7.8	370	Nil	274		7.1	Tr	8.7	0.2	50.0	21.0	15.0	0.7		210	0.06
37	Pulwama	Zadoora	33.89	74.85	17	8.3	580	ND	403	330	7.1	9.2	17.0	0.2	84.2	21.9	28.3	1.4	300	302	1.00
38	Baramulla	Ajas Bandipora	34.316	74.68		7.52	417	0	220		21	31.68	8.6	0.23	66	15	7.6	0.5	225		0
39	Baramulla	Chewa Safapora	34.26	74.67		7.05	290	0	153		7	25.89	1.8	0.02	44	10	5.2	1.7	150		0
40	Baramulla	Sopore	34.28	74.46		7.28	1760	0	1092		46	7.67	1.26	0.12	132	96	112	8.4	725		0
41	Baramulla	Shippora	34.08	74.63		7.05	430	0	275		7.1	23.09	2	0.33	61	22	7.7	1	245		0
42	Baramulla	Goshbug	34.21	74.54		7.4	1360	0	897		21	0.01	2.14	0.36	130	61	68	4.7	575		5.4
43	Baramulla	Dewar Yakmanpora	34.16	74.65		7.38	436	0	299		11	5.75	4	0.36	36	16	51	1	155		0
44	Baramulla	Renji Hamrey	34.22	74.52		7.42	1116	0	653		39	13.01	0.13	nd	96	51	71	2.9	450		4.37
45	Baramulla	Nagaon Tragpora	34.275	74.37		7.2	627	0	415		14	22.7	0.82	0.1	68	4.4	90	1.3	187		0
46	Baramulla	Khanpora	34.21	74.33		7.5	445	0	201		39	472	26	0.5	47	24	30	1.1	219		6.32
47	Baramulla	Haigam Trumgund	34.24	74.51		7.6	1055	0	763		25	49.1	11	0.09	110	64	80	2.8	540		0
48	Baramulla	Trikulbal	34.169	74.59		7.65	620	0	397		21	1.61	nd	0.25	54	18	68	1.4	210		5.1
49	Kupwara	Bomai	34.36	74.43		7.42	670	0	256		85	16	27	0.18	64	26	4.7	3.5	265		0.17
50	Kupwara	Drugmulla	34.489	74.29		7.73	200	0	128		7.1	Tr	4.8	0.13	34	3.6	7.8	1.2	100		2.05
51	Kupwara	Magam	34.422	74.26		8.05	730	0	177		96	12	124	0.25	98	21	28	2.3	330		0.30
52	Kupwara	Trehgam	34.520	74.17		8.85	160	0	49		21	Tr	3.4	0.11	14	2.4	16	6.2	45		2.41
53	Kupwara	Langyt	34.375	74.30		8.25	230	0	122		18	Tr	7.6	0.25	26	7.3	14	1.4	95		5.00

ANNEXURE VI

Tubewell Details used for Aquifer Mapping in Kashmir Valley

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
A.G. OFFICE	74.80	34.07	1590	48.76
ACHAN ASTANPORA	75.08	33.85	1611	135.00
ACHHABAL	74.41	34.27	1586	148.00
AHAN	74.67	34.25	1580	96.92
AIRFIELD CIVIL ENCLAVE	74.77	34.01	1643	145.00
AKINGAM	75.23	33.65	1764	36.00
ALOOSA GHAT	74.54	34.43	1616	140.21
ARMULLA TANTRAYPORA	74.94	33.81	1650	145.00
BABAGUND	74.71	33.95	1836	158.00
BADAMPUR	74.69	34.23	1612	88.00
BADIBHERA	74.39	34.53	1737	78.63
BADRAHPAYEEN	74.42	34.33	1620	241.00
BADRIVAN	74.90	33.84	1590	163.00
BADWANI B	75.16	33.58	1748	100.00
BAFINA	74.93	34.03	1598	251.00
BAGAT KANIPORE	74.83	34.03	1589	91.44
BALHAMA	74.94	34.03	1601	92.05
BANDARPORA	74.93	33.83	1590	251.00
BANIMULLA CHANDERGHEE	75.01	33.61	1782	152.40
BATMALOO	74.79	34.08	1506	50.59
BATTAN ZANTRANG	75.03	34.06	1973	136.00
BB CANT	74.85	34.06	1610	36.00
BEL GARDEN	74.80	34.08	1591	357.20
BEMINA	74.77	34.06	1582	202.00
BIJHBEHARA	75.10	33.79	1601	40.00
BOGAM	74.82	33.96	1607	30.78
BOMAI	74.43	34.36	1590	121.00
BONPORA RAJPORA	74.17	34.40	1731	145.72
BOTAKADAL	74.82	34.13	1596	167.67
BUDGAM	74.71	34.02	1657	151.00
CHAK THUNE	74.91	34.04	1605	150.00
CHAL KHARGAM	74.54	34.15	1686	135.00
CHANDHAURA	74.95	33.99	1605	41.40
CHANDISOME	74.39	34.22	1596	71.50
CHARSOO	75.05	33.85	1510	43.50
CHATTABAL	74.79	34.09	1588	121.61
CHATTARGAN	74.84	33.99	1660	88.38
CHECI-WANGUND	75.14	33.62	1730	168.00
CHERIDARI	74.36	34.19	1690	130.00
CHESHMA SHAHI	74.87	34.09	1670	117.04
CHEWA	74.65	34.08	1593	72.00
CHEWA SAFAPORA	74.67	34.26	1603	129.84
CHINARD SANGRAMA	74.45	34.24	1597	137.20
CHIRKOOT	74.28	34.47	1602	121.92

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
CHIROKOT	74.33	34.54	1663	174.50
CHOGAL	74.63	34.40	1591	155.41
CHOTIPURA	74.30	34.39	1593	300.00
CHOWGAM	75.12	33.62	1677	86.87
CITH	74.79	34.01	1660	147.24
DADCHAK RASCHAK	74.23	34.57	1901	147.00
DADIWAR	74.39	34.51	1735	220.00
DANGERPORA NAROO	74.76	33.99	1615	50.29
DANGIWACHA	74.35	34.31	1604	86.25
DARPORA	74.42	34.51	1740	92.96
DEEDARPORA	74.41	34.33	1885	255.00
DELINA	74.42	34.24	1603	123.74
DEVA	74.94	34.01	1600	200.00
DEVSAR	75.10	33.63	1669	71.00
DIALGAM	75.16	33.68	1634	74.70
DIDIKUT-I	74.20	34.50	1713	403.50
DIDIKUT-III	74.20	34.49	1714	405.00
DIVISPORA	74.24	34.45	1623	65.24
DIWAR	74.65	34.15	1717	59.91
DPL BUDGAM	74.72	34.02	1615	201.00
DRUGMULLA	74.29	34.49	1685	83.00
DRUSSU	74.94	33.82	1653	36.58
DUMHAL HANJIPORA	75.17	33.81	1920	98.00
DUSSOO	74.97	34.00	1620	206.00
FAIRVIEW GUPKAR	74.84	34.07	1607	127.10
FIRE BRIGADE HQ	74.80	34.07	1587	122.83
FLOOD COLONY	74.38	34.21	1590	57.51
GADURAH	74.77	34.18	1595	80.00
GAMBOORA	74.55	34.06	1648	274.47
GIRIPORA	74.23	34.45	1620	33.52
GOGOO WAWOSA	74.79	34.00	1637	146.50
GOLF COURSE	74.83	34.08	1586	113.38
GOPHBAL KAWAKI BAZAR	75.09	33.72	1604	137.00
GOSH BUGH	74.54	34.22	1587	190.00
GREEN COLONY WAYUN	74.97	34.04	1610	200.60
GRENDWAN AISHMAQUAM	75.27	33.87	1808	187.00
GUDSUTH	74.75	33.98	1648	57.00
GULAB BAGH UJROO	74.34	34.31	1613	120.00
GULGAM	74.22	34.55	1700	188.00
GULSHANPORA SASPADI	75.08	33.96	1783	182.50
GUNDBAL ANDROOSA	74.98	33.99	1628	140.00
GUNDBUL	75.01	34.01	1588	251.00
GUNDI-JEHANGIR	74.55	34.28	1582	450.00
GUNDMACHER	74.41	34.49	1725	62.50
GUNGBUG	74.33	34.44	1702	115.82
HABAK, HC	74.84	34.14	1603	120.00
HAIGAM	74.51	34.24	1582	98.00

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
HAIGAM TRUMB GUND	74.52	34.25	1580	228.00
HAMPORA	74.29	34.41	1597	39.93
HAMRAY-RANJI	74.52	34.22	1580	250.00
HANZIVEERA	74.59	34.14	1585	47.59
HARI PARIGOM	75.07	33.87	1607	149.35
HAYATPURA	74.42	34.48	1732	299.00
HAYATPURA I	74.86	33.93	1682	277.00
HAZOORIBAGH	74.81	34.07	1591	132.75
HAZRATBAL	74.84	34.13	1592	126.46
HENGIPORA	75.35	33.45	2299	146.40
HOSHANGPORA	74.98	33.75	1778	100.58
HOTEL SHAHENSHAH	74.83	34.08	1592	50.00
HUMHAMA	74.78	34.02	1588	200.00
IDGAH	74.79	34.10	1586	150.00
ILLAHIBAGH	74.81	34.15	1592	172.00
IQBAL PARK	74.81	34.08	1585	201.00
ISLAMIA COLLEGE	74.81	34.10	1590	43.28
JAKLI	74.79	34.00	1585	178.00
JANBAZPUR	74.36	34.22	1588	86.59
JAWAHAR NAGAR	74.82	34.06	1587	128.94
JNV LOLAB	74.35	34.54	1711	121.00
KAKINMAR	74.70	34.05	1602	303.71
KANISPORA	74.41	34.23	1634	188.97
KARALPURA	74.81	34.00	1590	79.00
KARANNAGAR	74.81	34.07	1580	357.00
KEWAL PATI	74.92	33.88	1620	76.50
KHAGMALPORA	74.56	34.00	1940	232.00
KHANABAL	75.13	33.74	1600	37.18
KHANDAPORA	75.01	33.86	1599	100.58
KHANIYAR G.H.S.S	74.82	34.09	1591	123.00
KHANPURA	74.33	34.21	1589	159.09
KHANYAR	74.82	34.08	1591	122.83
KHARBATPORA	74.95	33.92	1594	146.00
KHONMOH	74.97	34.06	1625	90.00
KHREW	75.00	34.02	1635	132.62
KINIHAMA	74.85	34.02	1588	106.68
KONGAM DARA	74.59	34.12	1598	137.77
KONIBAL	74.98	33.99	1619	141.40
KUGGER	74.78	34.19	1585	56.03
KUNIBAL	74.98	34.00	1619	116.73
KURHAMA	74.71	34.24	1610	83.82
KURIGAM	75.15	33.60	1700	180.00
LACHHIPURA	74.21	34.41	1605	303.00
LAJOORA	74.96	33.90	1608	146.34
LALGAON	74.78	33.97	1621	60.00
LALU-II	74.78	34.05	1582	170.62
LANGATE	74.31	34.38	1604	115.82

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
LANGET	74.31	34.37	1604	291.00
LARIYAR	75.09	33.89	1626	155.00
LASDENEW	75.04	33.81	1598	95.11
LATISHOT	74.39	34.39	1595	75.00
LETHPURA	74.95	33.97	1635	123.00
LISSER	74.41	34.28	1590	302.00
LOWER JHELUM HP COLONY	74.35	34.21	1560	67.39
LUKBAWAN	74.89	33.92	1603	100.88
M.E.S BARAMULLA	74.35	34.20	1587	177.43
MADWAN	74.62	34.33	1582	144.17
MAIDANPORA BARIPORA	74.40	34.54	1733	73.17
MALANGAM	74.59	34.44	1715	173.00
MALDAIR	74.94	33.78	1723	118.00
MALIKABAD BADWANI	75.16	33.57	1799	137.00
MALIKPORA SUMBAL	74.53	34.18	1598	108.10
MALSOOMA SHEERI	74.31	34.18	1593	60.04
MAMAT	74.70	34.00	1700	252.00
MAMUN	75.06	33.79	1610	195.00
MANGWALPORA	74.33	34.38	1592	70.10
MANIGAM	74.86	34.28	1704	39.62
MARHAMA	75.09	33.83	1630	176.00
MEDICAL COLLEGE, SGR	74.80	34.07	1586	149.62
MEHJOORABAD MITRIGAM	74.85	33.86	1726	135.00
MIRGUND	74.66	34.14	1585	79.25
MOMIN ABAD	74.79	34.07	1587	125.05
MUSKHUD DEVSAR	75.10	33.65	1649	116.00
NADIHAL	74.37	34.25	1587	301.00
NADIHAL-I	74.66	34.03	1627	116.73
NAGRIMAL PURA	74.26	34.48	1616	50.57
NAJIN-B	74.63	34.18	1583	182.00
NATIPURA	74.81	34.04	1587	117.34
NAUGAM	74.45	34.22	1575	154.00
NAUGAM TRAGPORA	74.38	34.28	1623	254.00
NEELIPORA	74.25	34.45	1622	39.62
NEW SECRETRIAT	74.80	34.07	1592	119.70
NEWKAREWA	74.88	33.92	1590	306.00
NIHALPURA	74.52	34.15	1684	406.00
NIKLORA-I	75.01	33.78	1620	204.19
NISHAT GARDEN	74.88	34.12	1589	200.00
NOWDAL	75.08	33.92	1646	42.34
NUTNUS	74.31	34.44	1590	109.72
ODINA	74.58	34.16	1582	223.00
ODINA ASTANPORA	74.65	34.16	1607	93.00
OMPURA-II	74.74	34.03	1604	302.00
PALAPURA	74.75	34.08	1585	74.06
PALHALEN	74.54	34.18	1596	57.15
PAMPORE	74.92	34.02	1593	300.00

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
PANDITPURA	74.33	34.37	1595	303.47
PANTHACHOWK	74.88	34.04	1587	42.65
PARIGAM	74.88	33.94	1592	35.05
PATTAN	74.56	34.16	1597	91.44
PATUSHAHI DC	74.64	34.42	1595	150.00
POHAL BREN	74.89	34.11	1620	70.00
POHRU	74.42	34.27	1582	89.91
POKHRIBAL	74.82	34.11	1604	95.09
PUSSAL	74.97	33.92	1590	80.31
QAZIPORA HAYATPORA	74.84	33.90	1692	64.31
QUAISAR MULLAH	74.81	33.94	1620	308.00
RAJPORA	74.85	33.82	1793	45.00
RAKH SHILWATH	74.67	34.17	1586	86.89
RAMPURA	74.92	34.04	1605	300.00
RANGRETH	74.80	34.01	1593	66.14
RANJI	74.51	34.22	1583	264.00
RASOO	74.79	34.08	1603	200.04
RATNIPURA	74.92	33.94	1590	41.00
RAWALPURA	74.34	34.34	1605	122.00
RAZAQPORA SAGIPORA	74.41	34.37	1592	92.70
REDWANI HOMSHALIBUGH	75.06	33.74	1599	151.00
RENZIPORA	75.00	33.86	1611	72.24
RESHIPORA	75.00	33.77	1696	23.00
RIHOMA	74.36	34.27	1609	315.00
SADERBAL	74.83	34.14	1589	153.51
SAIDAKADAL	74.83	34.10	1597	128.93
SAIDPORA-ZAINGAR	74.46	34.32	1610	223.00
SALKOOT	74.18	34.49	1715	140.00
SANAT NAGAR	74.80	34.03	1592	115.00
SARNAL	75.17	33.79	1598	99.05
SATRI MAIDAN	75.21	33.74	1715	66.44
SATSUKALAN	74.77	33.98	1606	265.75
SEMTHOM	75.10	33.80	1620	143.29
SHALDRAMAN	75.14	33.96	1824	164.14
SHARIFABAD	74.74	34.09	1590	60.04
SHARIFABAD II	74.73	34.02	1605	152.20
SHELAL	74.28	34.43	1636	140.20
SHERPATHRI	74.75	34.19	1587	62.17
SHIBPUR	74.63	34.10	1587	177.78
SHILWAT SUMBAL	74.66	34.20	1583	107.32
SHIPPORA	74.63	34.08	1594	179.00
SHIRPURA	75.05	33.77	1610	164.84
SHOAL	75.09	33.75	1599	42.00
SHUNGAS	75.29	33.71	1706	127.71
SHUNGLIPORA	74.78	34.09	2100	109.06
SIKH BASTI GANIPORA	74.60	34.12	1589	137.20
SILK FACTORY, SGR	74.81	34.05	1587	60.96

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
SINGHPURA	74.42	34.21	1650	242.00
SM HOSPITAL, SGR	74.80	34.14	1597	163.00
SOIMO	75.11	33.90	1677	68.59
SONBURN	74.63	34.22	1580	134.50
SONSOMIL BANDZOO	74.88	33.84	1735	45.72
SOPORE	74.46	34.28	1580	193.00
SRTC PAMPORE	74.91	34.03	1608	152.00
SUDURKOOT PAYEEN	74.68	34.33	1694	150.87
SUFI MOHALLA	74.87	34.06	1600	37.34
SUIBUG	74.71	34.08	1585	277.00
SUZETH	74.68	34.12	1584	92.96
TAHAB	74.94	33.84	1662	237.00
TAKIA SULTAN	74.95	34.01	1596	83.82
TAKIPORA	74.43	34.47	1724	145.50
TAPPER	74.51	34.20	1598	189.89
TELBAL	74.87	34.16	1604	104.00
TENGPURA	74.78	34.06	1586	120.09
TIJJAR	74.39	34.38	1595	147.00
TOKENWARIPURA	74.69	34.14	1593	106.00
TREHGAM	74.18	34.52	1693	262.00
TRIGAM SHADIPORA	74.66	34.18	1585	247.00
TRIKULBAL	74.59	34.17	1580	147.50
TROPOSCATTER CENTER, SGR	74.80	34.07	1594	161.21
TSRARSHARIF	74.78	33.88	1950	390.00
TULIP GARDEN	74.90	34.12	1585	176.00
TULSIBAGH	74.80	34.06	1592	46.72
TURKPURA	74.21	34.34	1885	123.15
TURTAKCHALOO HOMSHALIBUG	75.01	33.74	1657	140.00
UPPER ATHWAJAN	74.87	34.06	1586	76.00
UPPER ISHBER	74.88	34.13	1600	69.00
UTIKU	74.60	34.08	1594	301.00
UZRAM PATHRI	74.88	33.81	1779	38.10
VAIL NAGBAL	75.30	33.79	1980	177.69
VESSU	75.13	33.67	1655	300.29
WADAPURA	74.23	34.41	1632	302.50
WADURA	74.39	34.20	1592	317.00
WANIGAM	74.54	34.17	1610	298.00
WANPOH	75.11	33.73	1580	42.67
WARIPURA MAGAM	74.27	34.42	1599	301.28
WARSUN GUJRAN	74.12	34.54	1850	80.00
WATERGAM	74.38	34.32	1590	302.00
WATHURA	74.82	33.97	1600	26.60
WOSSAN	74.53	34.08	1854	28.95
WUSHKUR	74.35	34.20	1600	45.72
YAKMANPURA	74.65	34.16	1606	223.00

BORE	LONGITUDE	LATITUDE	ELEVATION	TOTAL DEPTH
YARBUGH	74.68	34.30	1607	122.00
YARIPORA	75.02	33.72	1662	125.00
ZADIBAL	74.81	34.12	1602	108.20
ZAGSUNDERI	74.31	34.34	1660	222.00
ZAINAKOTE	74.73	34.11	1582	67.66
ZAKURA	74.83	34.16	1595	100.00
ZANGAM	74.56	34.15	1599	109.72
ZAZNA	74.69	34.23	1585	79.55
ZEWAN	74.92	34.05	1608	214.00
ARAMPORA	74.29	34.46	1600	64.01
CHITRAGAM	74.93	33.80	1705	106.68
BAZIPORA AJAS	74.69	34.32	1590	176.78
FARAST HAR	74.47	34.16	1662	152.40
BAGH-I-MAHTAB	74.81	34.02	1594	120.00
MANDAKPAL	75.02	34.00	1683	109.73
USHKURA	74.36	34.20	1615	47.24
USHKARA HILLTOP	74.38	34.21	1626	150.00
KOTHIAR	75.26	33.68	1706	152.40
GOPALPORA	75.21	33.72	1700	158.50
BAJWANI TRAL	75.13	33.95	1782	173.74
NASEEM BAGH	74.84	34.15	1603	124.97