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भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

AQUIFER MAPPING AND MANAGEMENT PLAN

Nawanshahar District, Punjab

उत्तरी पश्चिम क्षेत्र, चंडीगढ़

North Western Region, Chandigarh

AQUIFER MAPPING

&

MANAGEMENT PLAN

NAWAN SHAHR DISTRICT

PUNJAB

Central Ground Water Board
Ministry of Water Resources, River Development and Ganga Rejuvenation
Government of India
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AQUIFER MAPPING AND GROUND WATER MANAGEMENT IN NAWAN SHAHR DISTRICT, PUNJAB
(1325 Sq.Km UNDER NAQUIFERUIM XII PLAN)

1.0 INTRODUCTION

There has been a paradigm shift from “groundwater development” to “groundwater management” in the past two decades in the country. An accurate and comprehensive micro-level picture of ground water through aquifer mapping in different hydrogeological settings would enable robust groundwater management plans in an appropriate scale. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. This would help achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural India, and many parts of urban India.

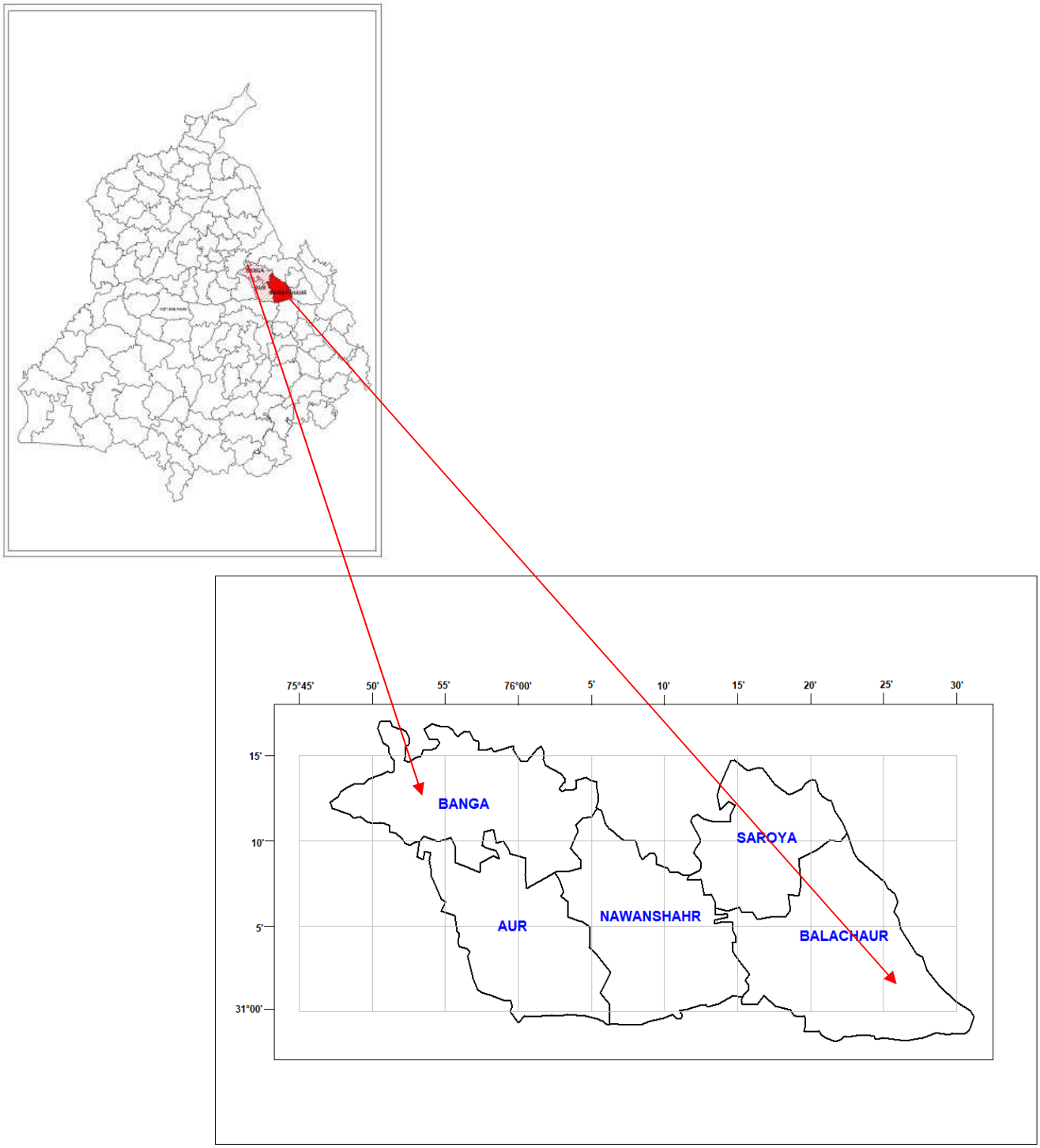
Central Ground Water Board (CGWB) implemented the Aquifer Mapping Programme in Punjab in four phases (**Fig. 1**) with the broad objective of preparing an Aquifer-wise management plan for the region. Various multi–disciplinary geo-scientific activities were undertaken in the study partly through in-house capacity of CGWB, DWRS, PSCTC and Private agencies for generation of additional micro-level hydrogeological data. This report primarily deals with Nawan Shahr district of Punjab State (**Fig. 1**), covered under Phase-IV.

Administratively the district has 2 tehsils namely Nawanshahr and Balachaur comprising five-development block.The blocks are Aur, Balachaur, Banga, Nawanshahr, Saroya. The area is bounded by Hoshiarpur district in the north, Siwalik Hills in the northeast, Sutlej River in the south, Kapurthala district in the northwest and Jalandhar in the west. Nawanshahr district was carved out of Hoshiarpur and Jalandhar districts of Punjab in November 7, 1995 on the auspicious occasion of birthday of Sh. Guru Nanak Dev Ji as the sixteenth district of Punjab State. The name of the district was changed to "Shahid Bhagat Singh Nagar", to conclude the Birth Centenary celebrations of the great martyr Sardar Bhagat Singh, on 27/09/2008.

Nawanshahr district, located in the eastern part of the Punjab State, forms a part of the Bist-Doab region. Geographically, it lies between North latitudes of 30°48′45″ and 31°16′15″ and East longitudes of 75°46′00″ and 76°26′30″ covering a geographical area of 1325 sq.km.

The population of the district Nawanshahr, as per 2011 Census is 6,14,362 persons.

Fig 1: Base Map of Nawan Shahr District



2. DATA COLLECTION AND GENERATION

2.1 Tube well Logs

The Lithologs of Exploratory Well/ Observation well/ Peizometer/ productive wells of CGWB, and private wells have been collected and those supported electrical logs have been validate for aquifer map preparation. The details are shown below

NAWAN SHAHR DISTRICT

Sl.No	Source of data	Depth Range (m)			
		< 100	100-200	200-300	>300
1	CGWB	0	0	0	8
2	WR&ED	0	0	0	0
3	PRIVATE	0	34	12	3
Total		**0**	**34**	**12**	**11**

2.2 Ground Water Quality

The ground water in the district is alkaline in nature with low to medium salinity. The chemical quality data from the shallow and deep aquifers indicate that all major cations (Ca, Mg, Na, K) and anions (CO3, HCO3, Cl, SO4) are within the permissible limits set by BIS, 1991. In the western part of the district, electrical conductivity is slightly higher than 700 microsiemens/cm. While, the maximum value of 940 microsiemens/cm is reported at village Rahon.

The ground water in the district is of Ca-Mg-HCO3 type imparting temporary hardness. Since all the physical and chemical parameters are below the permissible limit prescribed by BIS the ground water in the area is suitable for drinking purposes. The suitability of groundwater for irrigation purpose is calculated by SAR and RSC values which are below 10 and 2.0 respectively in the entire district. As per USSL diagram, ground water of the district falls in medium to high salinity hazard and low sodium hazard and hence it is suitable for irrigation in all types of soil.

The minor constituents such as iron, nitrate and fluoride, which are essential for plant and animal growth, are found below the permissible limit. Similarly the trace element arsenic is also found below the permissible limit.

2.3 SPATIAL DATA DISTRIBUTION

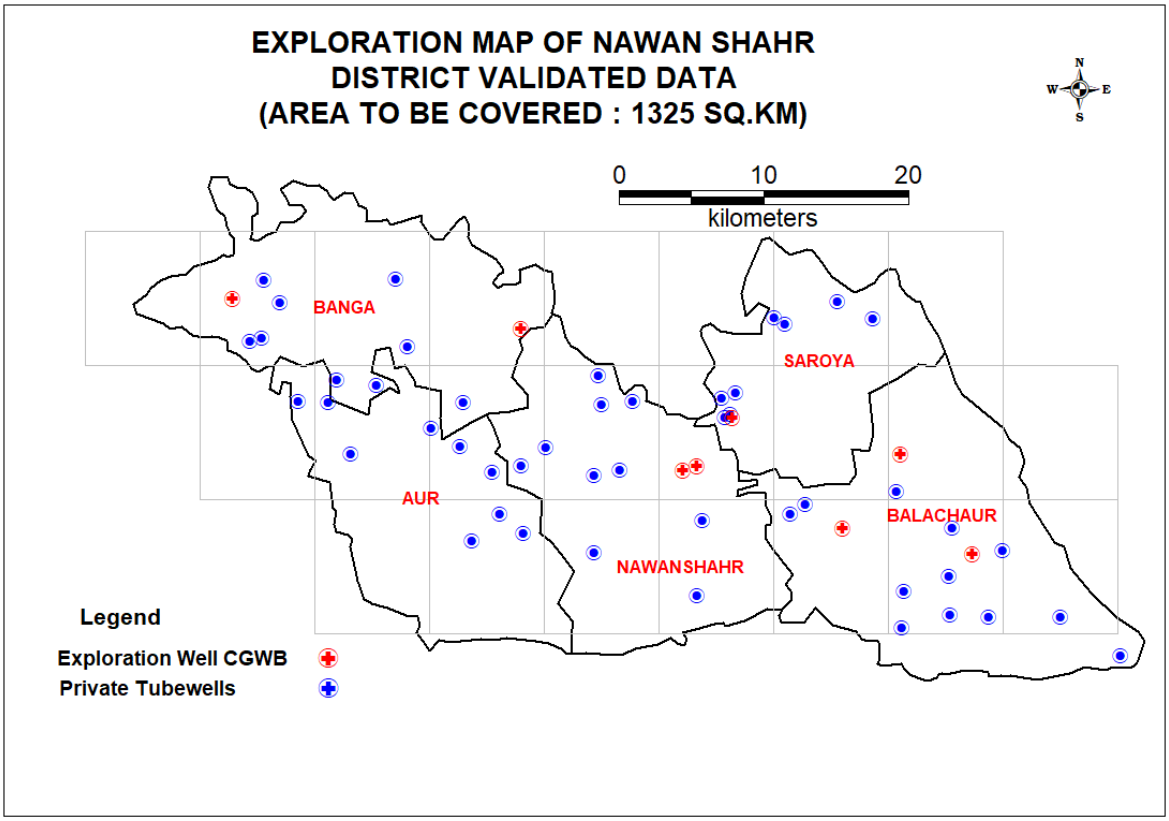
Data Distribution

The actual data of all the wells in the area are plotted on the map of 1:50000 scale with 5 min x 5 min grid (9km x 9km) and is shown in Fig: 2.The exploration data shows that majority of tube wells falls in the IInd Aquifer. After data validation, only selected the deepest well in each quadrant is plotted on the map of 1.50000 scale with 5 min x 5 min grid (9km x 9km) and is shown in Fig: II. The grids/ formations devoid of SH/PZ/EW are identified as data gaps and these are to be filled by data generation.

2.4 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

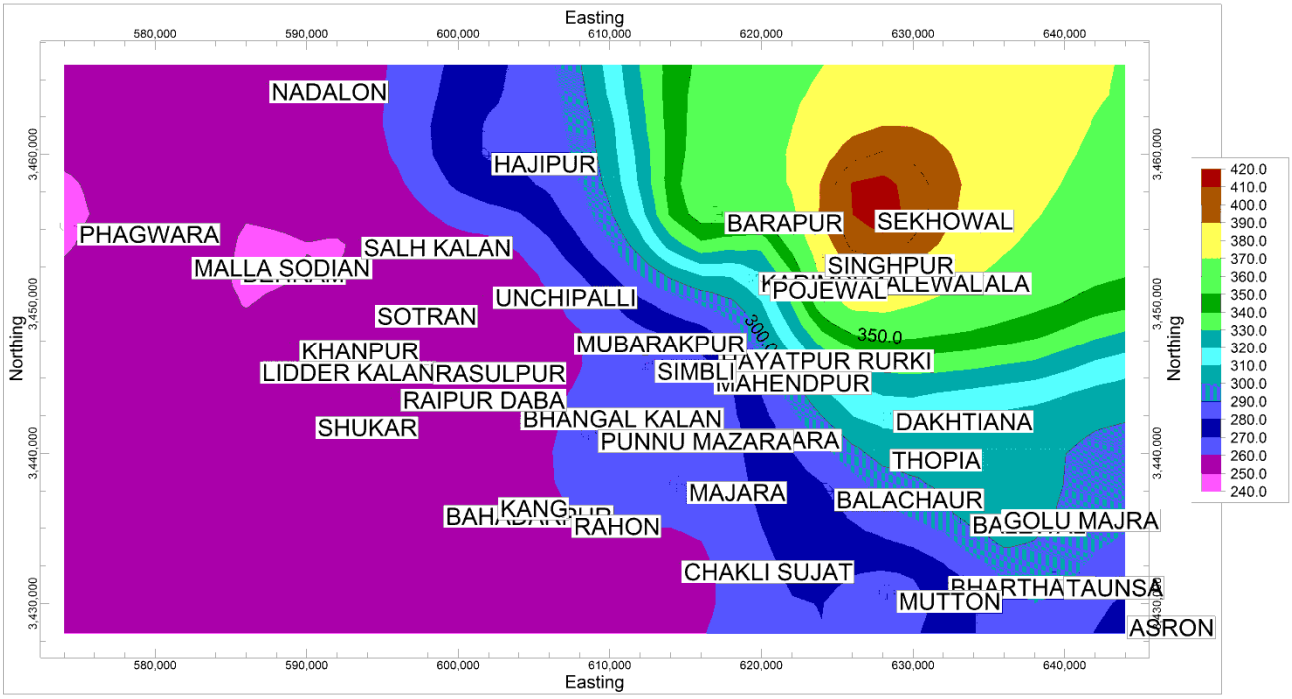
All the available data have been validated for consideration to generate aquifer map. The deepest well in each quadrant is selected and plotted on the map of 1.50000 scale with 5'X5'grid (9 x 9km) and is shown in Fig -3.

Fig-3 Location of Exploratory Bore Holes



The topographic elevation values have been plotted to prepare the elevation contour map and is in fig 4.

Fig 4: Elevation Contour Map-Nawan Shahr District



The data is validated by selecting the deepest well in each quadrant with those supported electrical logs for preparation of aquifer map and is shown below

Table-2: Summery of Optimized Exploration Wells

Data Validated: The data is validated by selecting the deepest well in each quadrant with those supported electrical logs for preparation of aquifer map and is shown below;

S.NO.	BLOCK	TOPOSHEET/ QUADRANT	DEPTH RANGE (m)							
			LOCATION	<100	LOCATION	100-200	LOCATION	200-300	LOCATION	>300
1	Aur	3A1 53A/ 04			MEHRAMPUR	150				
2	Nawanshahr	3B 53A/ 04			RAHON	152.43				
3	Balachaur	3A1 53A/ 08			RURKI KHURD	153				
4	Aur	2A2 53A/ 04			KAMAM	153.96				
5	Banga	1C2 44M/ 16			SOTRAN	157				
6	Aur	2A3 53A/ 04			SAKOHPUR	157.6				
7	Nawanshahr	2B3 53A/ 04			JAFARPUR	158				
8	Banga	2C2 44M/ 16			KHAN KHANA	159				
9	Nawanshahr	2B1 53A/ 04			BHANGAL KALAN	160				
10	Aur	2A1 53A/ 04			RAIPUR DABA	160				
11	Aur	2C3 44M/ 16			SHUKAR	161.58				
12	Banga	1B3 44M/ 16			CHAK GURU	163				
13	Nawanshahr	2B2 53A/ 04			PUNNU MAZARA	163				
14	Banga	1C1 44M/ 16			SALH KALAN	163.1				
15	Aur	2B 44M/ 16			LIDDER KALAN	164				
16	Aur	3A2 53A/ 04			KANG	165				
17	Aur	3A3 53A/ 04			BAHADARPUR	171				
18	Nawanshahr	3C2 53A/ 04			CHAKLI SUJAT	172				
19	Balachaur	3A2 53A/ 08			GARHI KANUGOAN	172				

20	Banga	2C1 44M/ 16			KHANPUR	198.2				
21	Banga	1B2 44M/ 16					BEHRAM	200		
22	Balachaur	2B2 53A/ 08					THOPIA	200		
23	Balachaur	3B3 53A/ 08					JAMIATGARH	201		
24	Balachaur	3B2 53A/ 08					BHARTHALA	202		
25	Nawanshahr	3C1 53A/ 04					MAJARA	202.7		
26	Saroya	1A2 53A/ 08					MALEWAL	214.93		
27	Saroya	1A1 53A/ 08					KARIMPUR CHAHWALA	216.46		
28	Saroya	1A3 53A/ 08					POJEWAL	220		
29	Balachaur	1A 53B/ 09					ASRON	240		
30	Balachaur	3C1 53A/ 08					GOLU MAJRA	260.67		
31	Saroya	2C1 53A/ 04							MEHANDPUR	300
32	Balachaur	3C2 53A/ 08							TAUNSA	309.45
33	Nawanshahr	2C3 53A/ 04							BHAN MAJRA	355
34	Balachaur	3A3 53A/ 08							BALACHAUR	302
35	Banga	1A 53A/ 04							UNCHIPALLI	303.58
36	Banga	1B1 44M/ 16							MALLA SODIAN	304.95
37	Balachaur	2B1 53A/ 08							DAKHTIANA	310
38	Nawanshahr	2C2 53A/ 04							KISHANPURA	450
39	Balachaur	3B1 53A/ 08							BALEWAL	451.8

3. HYDROGEOLOGY

3.1 PREVIOUS WORK

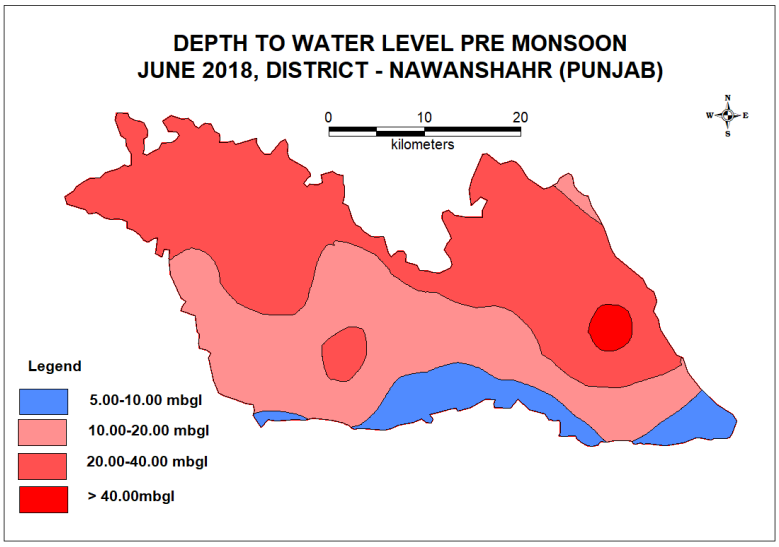
The Nawanshahr district is covered by Quaternary alluvial deposit except in the north-eastern part, where the Siwalik hills of Tertiary age are exposed. The aquifer in the alluvial tracts of Banga, Aur and Nawanshahr block comprises sand and silt with intercalation of little clay and kankar. In Kandi formation, covering large parts of Balachaur and Saroya blocks, boulders, gravel, pebbles and coarse sand with several layers of lenticular and fringing clay forms the main water bearing formation.

The Central Ground Water Board has drilled 8 exploratory wells and 5 Peizometers (3 Peizometers were drilled under HP-II Programme.) to delineate the aquifer geometry and quality of formation water. The wells drilled were in the depth range of 101-451 m bgl. Exploratory drilling revealed the presence of 5-7 aquifer groups within the depth range of 300 m in western part of the district. In the northeastern part, clay is predominant over sand formations and usually thick beds of clay are associated with boulders and pebbles. The average thickness of aquifer is 100m in the eastern and northern parts while it is of order of 150 m upto the total depth of 300 m bgl in the western part.

Groundwater occurs under both unconfined as wells as confined conditions. In Kandi area and top aquifer of alluvial tract that extends to a depth range of 50 to 60m bgl groundwater occurs under unconfined condition. But towards south, groundwater occurs under semi-confined to confined condition particularly below 50 m depth that is in hydraulic continuity with the kandi area. Precipitation is the principal source of replenishment of groundwater in kandi area.

In unconfined aquifer, the depth to water level varies from 8.8 to 29.7m during pre monsoon and 8.3 to 23.7m during post monsoon season. Deeper water levels are observed in the north eastern part of the district where Tertiary Siwalik hills are exposed. Since the depth to water level is more than 5 m bgl, the whole district is not prone to water logging condition.

In major part of the district, the water level ranges between 10 and 40 m while the water level in the western and southern part is within the depth range of 5 to 10 m bgl. Seasonal fluctuation shows that in general there is an overall rise in the water level except in the eastern part and few isolated patches. However, the long term trend of water level of 10 years shows that there is a decline in water level in major part of the area ranging from 0.25 to 0.86 m /year except a few isolated patches where the rise is at the rate of 0.06 m/year which is insignificant.



The water table elevation is highest in the north-eastern part (Kandi area) and lowest in the south-western part, which in turn reflects the topographic gradient. In the eastern part of the district, the Sutlej River is effluent in nature while moving to the plains it becomes influent in nature. This indicates that Sutlej river also has some roles on the occurrence of groundwater in the district. The groundwater flow direction is towards south and southwest along the hilly tract but the flow direction changes to west on the central and western part of the district.

The subsurface geology shows a marked difference between the north eastern Kandi belt and alluvial plain in the western part of the district. Hence the performance of aquifer and various aquifer parameters will also show variation. The shallow tubewells tapping 40 m of alluvial aquifer in Banga, Aur and Nawanshahr block shows more yield in the range of 1500-5700 lpm for drawdown of 4.6 and 5.6 m respectively while those in Kandi belt the yield is in the range of 708-1500 lpm for drawdown of 4.69-5.9 m respectively. Similarly the aquifer parameter also show vide variation from eastern to western part of the district. In the eastern part the hydraulic conductivity is 7 m/day and transmissivity is 645 m2/day. While in the western part the value of K & T are 53 m/day and 2940 m2/day respectively. Similarly the storage coefficient of the aquifer in southeastern part is 1.8*10-3 while it is of the order of 1.18*10-3 in the western part. The values of various aquifer parameters clearly indicates that

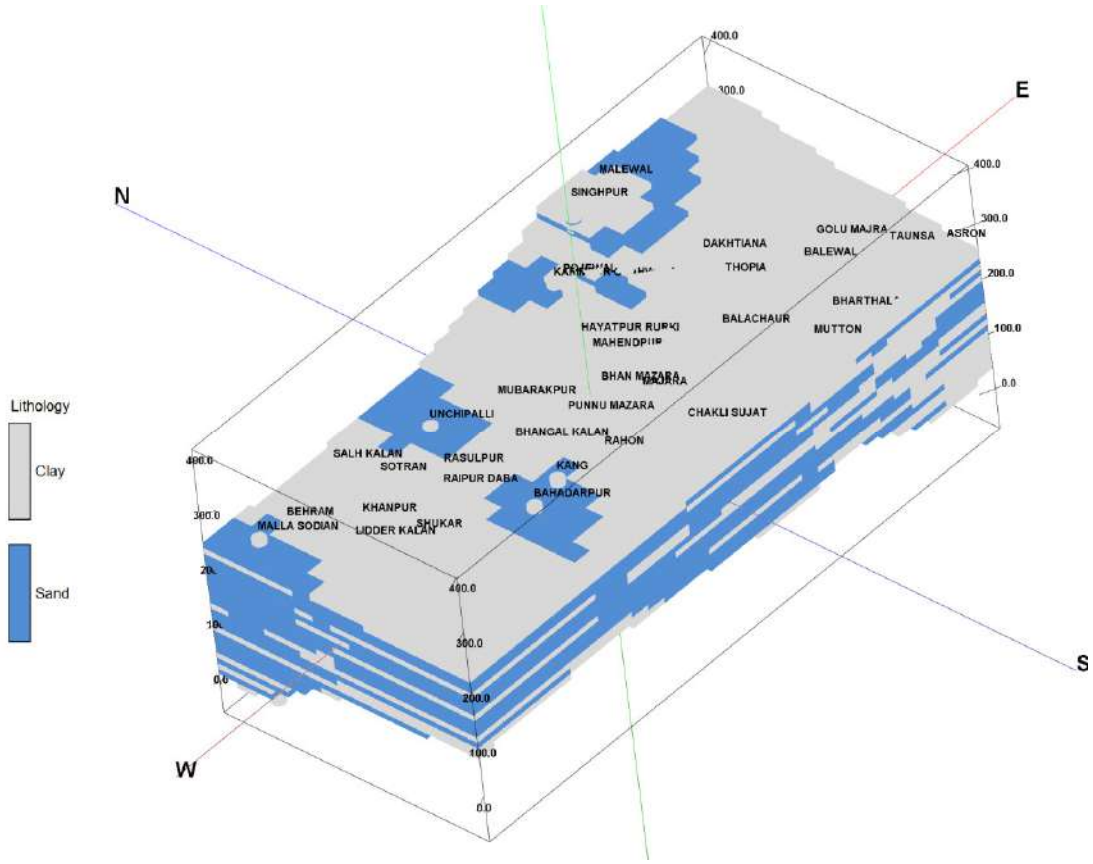
the aquifer in the western part of the district bear promising potential aquifer while the aquifer in the eastern part are intercalated by more clay layers.

North Western Region, CGWB has 7 ground water monitoring stations (2 dug wells and 5 Pzs) in Nawanshahr district.

3.2 Present NAQUIM study

To understand the sub surface lithology and its disposition, the lithological data of the optimized wells drilled by CGWB, PHED and Private Agencies is plotted using the RockWorks15 software and a lithological model has been prepared and is shown in fig. The 2D lithology map,3-D Strip logs and 3D lithological fence diagram has been prepared using the lithology model and are shown in fig 5,6,7 & 8 respectively.

Fig 5: 3-Dimension Lithological Model of Nawan Shahr District



To present a three dimensional regional picture of the sub-surface conditions in the two districts a fence diagram was prepared by synthesizing the various sub-surface sections. The fence diagram thus drawn reveals broad picture of disposition, inter relationship of granular zones, nature, geometry and extension of aquifers of the entire district. The aquifer group embodies a number of granular layers alternating with thick or thin clay lenses. Strip logs

showing lithologs of exploration wells and various block diagrams based on Lithology and Aquifer Group.

Fig 6: 3 Dimension strip logs of Nawan Shahr District

Fig 7: 3 Dimension Lithological Fence of Nawan Shahr District

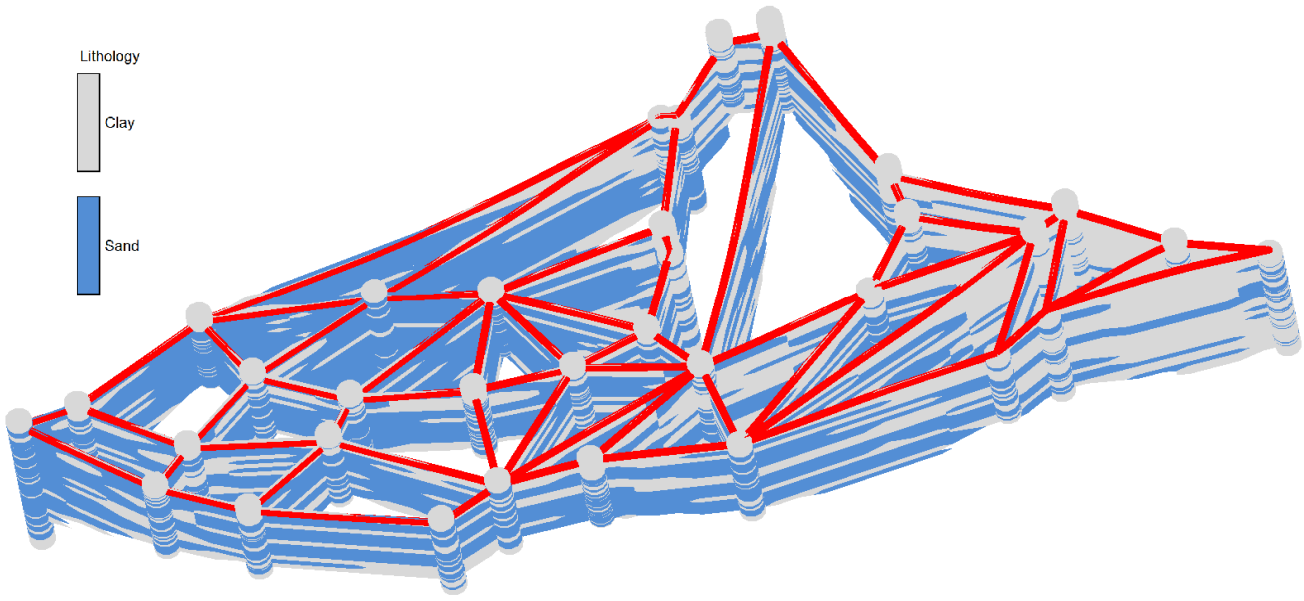
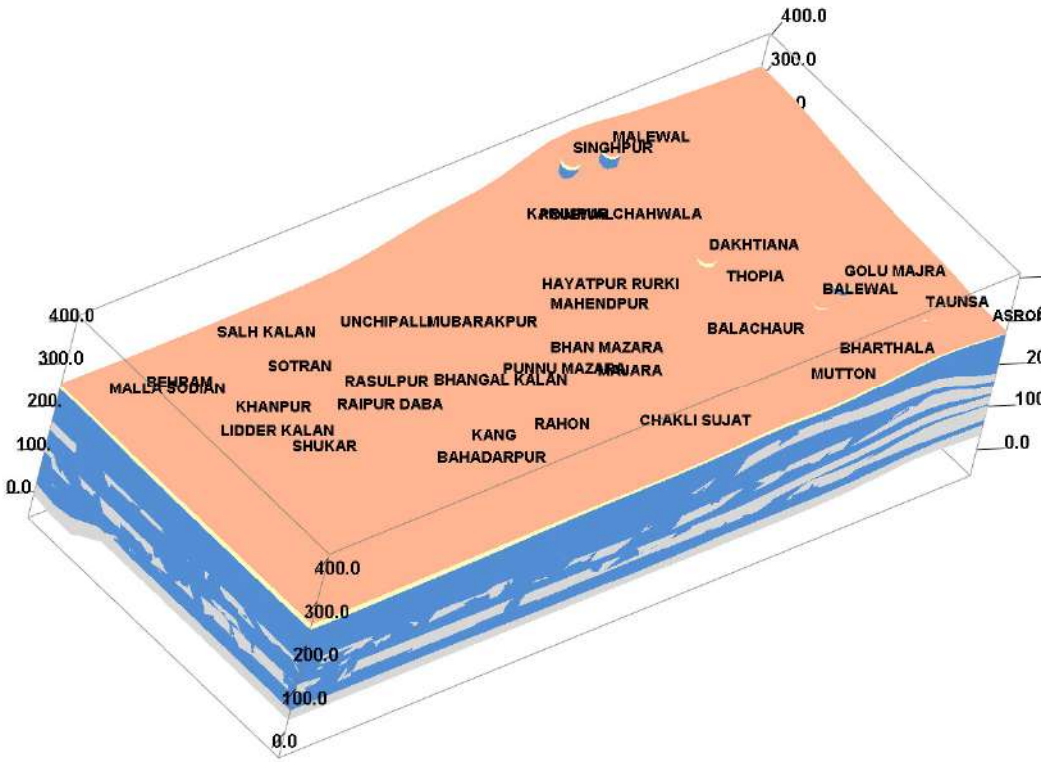


Fig 8: 3-Dimension Aquifer model - Nawan Shahr District

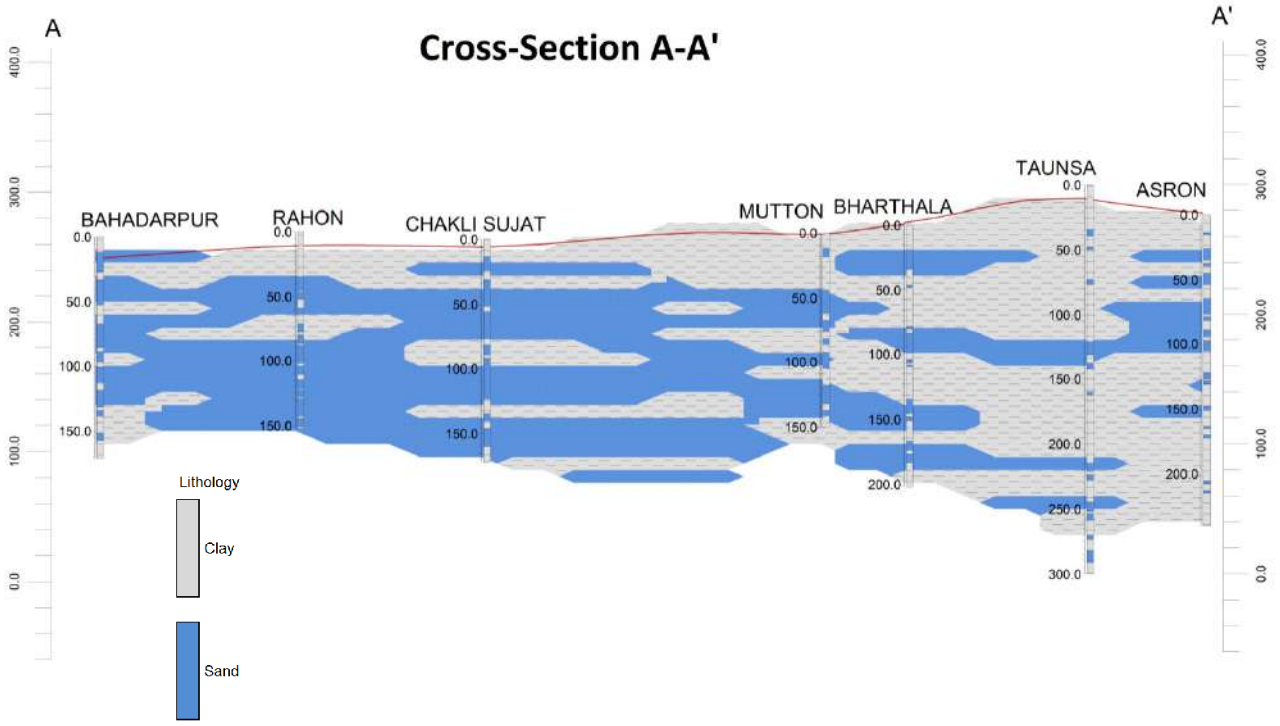


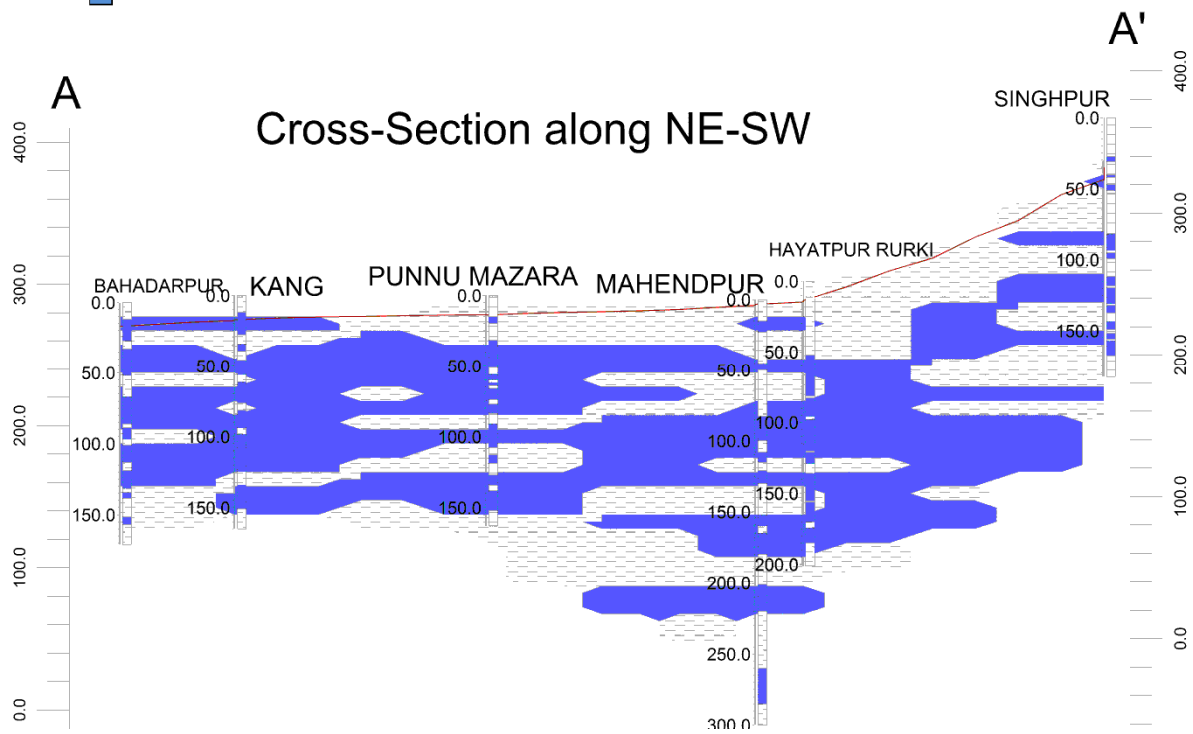
3.3 Aquifer Geometry

Nawan Shahr District is underlain by formations of Quaternary age comprising of alluvium deposits and Siwalik deposits comprised of boulders, cobbles, pebbles mixed with clay and sand; therefore it belongs to a multiple aquifer system up to 300m depth with alternate bands of medium to coarse sand and clay. To know the broad picture of the aquifer disposition, inter-relationship of granular zones, nature, geometry and extension of aquifers in the Nawan Shahr district, the aquifer grouping has been done using the sub-surface lithology and a three-dimensional aquifer model has been prepared. The 2D aquifer map was also prepared using the aquifer model. The aquifer grouping is done and given in Table. The first aquifer is water table aquifer and extends all over the area. The aquifer is mainly composed of medium to coarse grained sand.

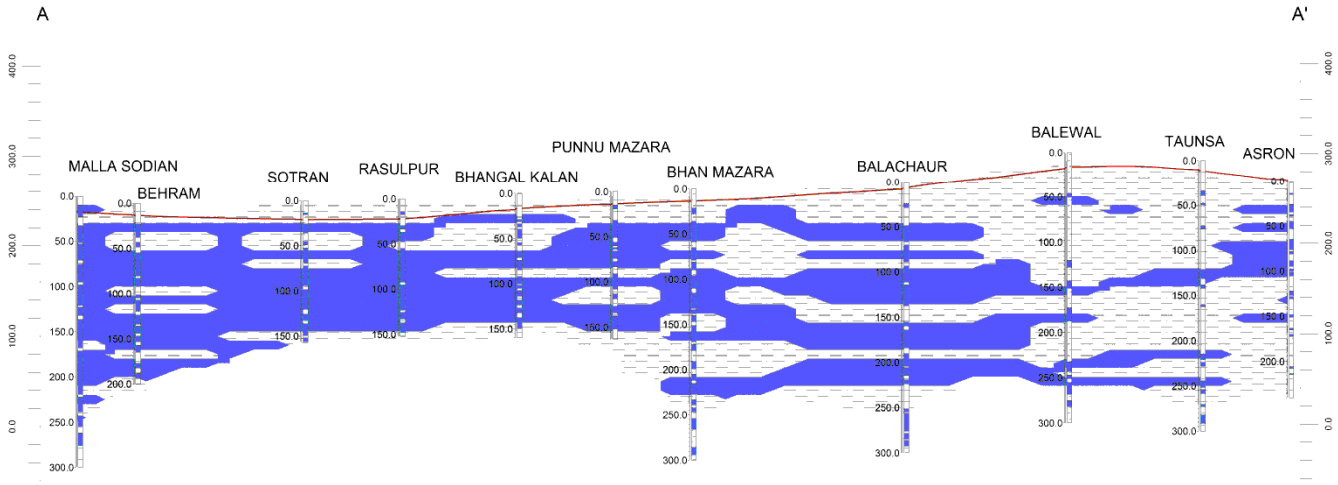
2 dimensional cross- section are prepaired for the Nawanshahr district and shown in fibure-10

Fig 10: Cross sections of Aquifer Map of Nawan Shahr District





Cross-Section along NW-SE



4. GROUND WATER RESOURCES

Ground water resource estimation of the area have been carried out by taking Dynamic and In-storage resources of unconfined aquifer and confined aquifers present up to 300m depth. The assessment of Dynamic and in storage Ground Water Resources of the study area have been carried out jointly by CGWB, Water Resources & Environment Directorate, Department of Irrigation, on the basis of Groundwater Estimation Committee (GEC) (1997) methodology based on data available and as per the revised methodology for the year 2013.

The occurrence of potential aquifers (productive granular zones) upto 300 m depth has been demarcated on basis of aquifer wise subsurface mapping. The total saturated thickness of granular zones was derived from the exploratory borehole data of a particular block. The granular zones occurring below the zone of water level fluctuation up to the first confining layer has been considered as static unconfined zone. The ground water resource of this zone has been calculated considering 12% specific yield of the formation. The specific yield value for the unconfined aquifer has been taken as 60% of 0.12 which comes as 0.072 whereas for the confined aquifer, the Storativity value has been considered. Since the specific yield is likely to reduce with increase in depth due to compaction of overlying sediments.

Hence, the major data elements considered in this estimation are thickness of granular zones, specific yield, Storativity and area of fresh water. It has been observed that in some of the blocks sufficient data on probable occurrence of granular zones was not available. In those cases, the existing exploratory data of adjoining block/district has been either extrapolated or interpolated to derive such parameters required for estimation. This assessment of total groundwater resources has been computed based on the available data with CGWB Water Resources & Environment Directorate, Department of Agriculture, and Punjab Water Resource Management & Development Corporation, Punjab

4.1 Unconfined aquifers

Dynamic Resources

As per Groundwater Resources Estimation 2013, the ground water development in 2 blocks has exceeded the available recharge, thus 2 blocks **Aur,** and **Banga** have been categorized as **over exploited** except **Nawan Shahr** which is **Critical** and 2 **blocks** falls in **Safe Category**. Stage of ground water development in the Nawan Shahr district has been assessed to be **107%**.

Table 4: Dynamic Ground Water Resource & Development Potential (as on 31.03.2013)

Assessment Unit/ Block	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Provision for domestic, and industrial requirement supply to 2025	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development (%)
AUR	**14598**	23787	200	23988	223	-9412	164
BALACHAUR	**15886**	9249	381	9629	412	6225	61
BANGA	**10150**	13772	294	14067	328	-3950	139
NAWAN SHAHR	**23561**	21591	443	22034	494	1476	94
SAROYA	**2837**	1592	139	1731	155	1091	61
Total (ham)	**67033**	**69991**	**1457**	**71448**	**1612**	**-4570**	**107**

In Storage Ground Water Resources

As per revised guidelines recommended by the Central Level Expert Group on ground water resources assessment, the resources are separately considered as dynamic and in-storage unconfined. In case of alluvial area, the in-storage resources of unconfined aquifer have been computed based on specific yield of the aquifer as detailed below:

In-storage Ground Water resources (unconfined Aquifer) = Thickness of the aquifer (granular/productive zone) below the zone of water level fluctuation down to the bottom layer of unconfined aquifer x Sp. Yield of the aquifer x Areal extent of the aquifer

4.2 Confined Aquifer

The availability of ground water resources in confined aquifer have two components: Storage under pressure (using Storativity concept) and Storage under desaturated (gravity drainage) condition (using Specific Yield concept) (source: Assessment of Ground Water Resources; A Review of International Practices, 2014) and

is shown in Fig 11. However, since ground water withdrawals from confined aquifer are known to have serious environmental degradation effects, the preliminary assessment of ground water resources in confined aquifer is restricted to the estimation of ground water storage under pressure conditions only but here the storage under de-saturation is also computed.

Storativity Concept:

ii)	In-storage Ground Water resources (within the Peizometer)	=	Thickness of the water column in Peizometer of particular confined aquifer up to the top layer of same confined aquifer	×	Storativity of the confined aquifer	×	Areal extent of the confined aquifer group

Specific Yield Concept:

ii)	In-storage Ground Water resources (within the aquifer thickness)	=	Thickness of the confined aquifer (granular/ productive zone) down to the bottom layer of confined aquifer or exploitable depth of 300 m	×	Sp. Yield of the aquifer	×	Areal extent of the confined aquifer group

Preliminary assessment of the ground water resources in confined aquifer does not imply that the assessed resource is available for exploitation. The objective of this exercise is to have an overview of the ground water regime in the particular confined aquifer. It should be kept in mind that any significant ground water withdrawal from confined aquifer may invoke serious environmental degradation problem. Therefore, in case the preliminary assessment reveals that ground water is being withdrawn in significant quantity for any confined aquifer, that particular aquifer should be identified for detailed assessment using numerical modeling approach.

Total Availability of Ground Water Resources = Dynamic Resources + In-storage Resources.

Fig 11: Concept for Resource Estimation in Unconfined and Confined Aquifer System

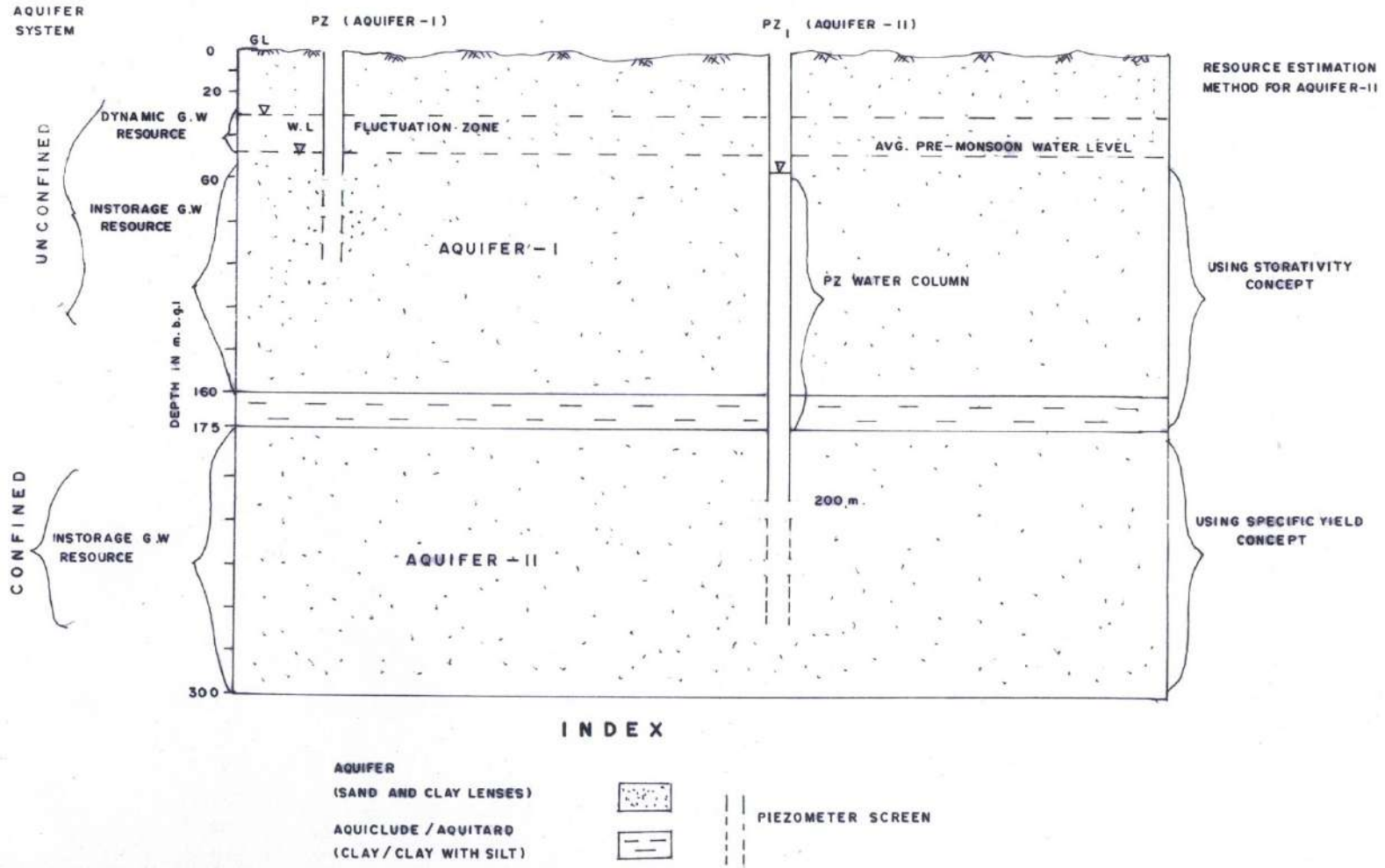


Table 5: BLOCK WISE INSTORAGE GROUND WATER RESOURCES IN UNCONFINED AQUIFER -I

Annexure II A-1 (for unconfined aquifer, alluvial area)													
GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF NAWAN SHAHR DISTRICT (2013)													
BLOCK WISE INSTORAGE GROUND WATER RESOURCES IN UNCONFINED AQUIFER –I													
Sr. No.	Name of Assessment Unit	Areal extent (sq.km)				Average Pre-monsoon Water Level (m bgl)	Depth to bottom of Aquifer Group I (m bgl)	Total Thickness of formation below Pre-monsoon Water Level (m) (9-8)	Thickness of the Granular Zone in AQUIFER GROUP-I below Pre-monsoon WL (m)	Average Specific Yield	In-Storage Ground Water Resources [(6)*(11)*(12)*] FRESH (mcm)	Dynamic Ground water Resources (2013) AQUIFER-I	Total Ground Water Resource
		Total Geographical Area	Assessment Area										
			Total	Fresh Water	Brackish/ Saline Water								
1	2	3	4	5	6	7	8	9	10	11	12		
1	AUR	218.5	218.5	218.5	0	18	107	89	58	0.072	912	146	1058
2	BALACHAUR	378.5	378.5	378.5	0	12	119	107	44	0.072	1199	159	1358
3	BANGA	232.4	232.4	232.4	0	20	110	90	68	0.072	1138	102	1239
4	NAWAN SHAHR	330.2	330.2	330.2	0	13	110	97	57	0.072	1355	236	1591
5	SAROYA	165.8	165.8	165.8	0	14	115	101	46	0.072	549	28	577
Dist.Total (mcm)		1325.40	1325.4	1325.4		0					5154	670	5824
Dist.Total (bcm)											5.15	0.67	5.82

Table 6: BLOCK WISE INSTORAGE GROUND WATER RESOURCES - CONFINED (AQUIFER II)

BLOCK WISE INSTORAGE GROUND WATER RESOURCES – CONFINED (AQUIFER II)															
Sr. No.	Name of Assessment Unit	Areal extent (sq.km)			Top Aquifer II (m bgl)	Depth to bottom of Aquifer II (m bgl)	Piezometric Head (m bgl)	Thickness of piezo-metric level(m bgl)	Total Thickness of confined aquifer down to explored depth (m) (9-8)	Thickness of the Granular Zone in confined aquifer down to explored depth (m)	Average Specific Yield	Average value of Storativity	In-Storage Ground Water Resources (ham) (Specific yield concept) [(5)*(11)*(12)]	In-Storage Ground Water Resources (Storativity concept) [(5)*(9)*(13)]	Total in-Storage Ground Water Resources (ham) (14+15)
		Total Geographical Area	Assessment Area												
			Total	Fresh Water											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	AUR	218.5	218.5	218.5	107	164	15	149	57	29	0.072	0.00128	456	41.67	498
2	BALACHAUR	378.5	378.5	378.5	119	202	15	187	83	37	0.072	0.00128	1008	90.60	1099
3	BANGA	232.4	232.4	232.4	110	205	15	190	95	62	0.072	0.00157	1037	69.32	1107
4	NAWAN SHAHR	330.2	330.2	330.2	110	201	15	186	91	40	0.072	0.00128	951	78.61	1030
5	SAROYA	165.8	165.8	165.8	115	203	15	188	88	44	0.072	0.00157	525	48.94	574
Dist.Total (mcm)													3978	329.15	4307
Dist.Total (bcm)													3.98	0.33	4.31

Table 7: BLOCK WISE INSTORAGE GROUND WATER RESOURCES - CONFINED (AQUIFER III)

Sr. No.	Name of Assessment Unit	Areal extent (sq.km)			Depth to Top Aquifer III (m bgl)	Depth to bottom of Aquifer III (m bgl)	Thickness of piezo-metric level(m bgl)	Total Thickness of confined aquifer down to explored depth (m) (9-8)	Thickness of the Granular Zone in confined aquifer down to explored depth (m)	Average Specific Yield	Average value of Storativity	In-Storage Ground Water Resources (Specific yield concept) [(5)*(10)*(11)]	In-Storage Ground Water Resources (Storativity concept) [(5)*(8)*(12)]	Total in-Storage Ground Water Resources (mcm) (13+14)
		Total Geographical Area	Assessment Area											
			Total	Fresh Water										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	AUR	218.5	218.5	218.5	200	300	170	100	43	0.072	0.000237	676	8.8	685
2	BALACHAUR	378.5	378.5	378.5	202	300	154	98	36	0.072	0.000237	981	13.8	995
3	BANGA	232.4	232.4	232.4	205	300	175	95	43	0.072	0.000237	720	9.6	729
4	NAWAN SHAHR	330.2	330.2	330.2	201	300	171	99	43	0.072	0.000237	1022	13.4	1036
5	SAROYA	165.8	165.8	165.8	203	300	155	97	43	0.072	0.000237	513	6.1	519
Dist.Total (mcm)												3913	52	3964
Dist.Total (bcm)												3.91	0.05	3.96

Table 8: BLOCK WISE TOTAL AVAILABLE GROUND WATER RESOURCES IN AQUIFERS UP TO 300m DEPTH

AVAILABILITY OF TOTAL FRESH GROUNDWATER RESOURCES IN NAWAN SHAHR DISTRICT UPTO 300 METRE DEPTH								
Sl.No	**BLOCK**	*Dynamic Groundwater Resources (2013) AQUIFER-I*	*In-storage Groundwater Resources AQUIFER-I*	**Groundwater Resources AQUIFER-I [(3)+(4)]**	**In-storage Groundwater Resources AQUIFER-II**	**In-storage Groundwater Resources AQUIFER-III**	**Total Availabilty of Groundwater Resources [(5)+(6)+(7)]**	
							mcm	**ham**
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1	**AUR**	146	*912.46*	1058	685	684	2428	242806
2	**BALACHAUR**	159	*1199.09*	1358	995	995	3348	334772
3	**BANGA**	102	*1137.83*	1239	729	728	2697	269664
4	**NAWAN SHAHR**	236	*1355.14*	1591	1036	1034	3661	366070
5	**SAROYA**	28	*549.13*	577	519	519	1616	161631
Dist.Total (ham)		**67033**					***0***	**1374943**
Dist.Total (mcm)		**670**	***5154***	***5824***	**3964**	**3961**	**13749**	

5. GROUND WATER RELATED ISSUES

Nawan Shahr is famous for its paddy cultivation and is also known as 'Rice Bowl' of Punjab. The quality of ground water in the district is potable for both the drinking and irrigation purposes therefore, the ground water is constantly being pumped for the irrigation due to its easy access through tube wells and they are the main source of irrigation.

This will lead to its major ground water issue which is deepening of ground water level as the recharge of the groundwater through rainfall and other sources are less than the overall extraction.

5.1 GROUND WATER IRRIGATION SCENARIO

As per the data available from minor irrigation census 2006-07, the number of shallow and deep, tube wells, lined, unlined water distribution system, land holdings of wells are given in Table 9, 10 and 11

Fig 10: Irrigation tube wells as per depth.

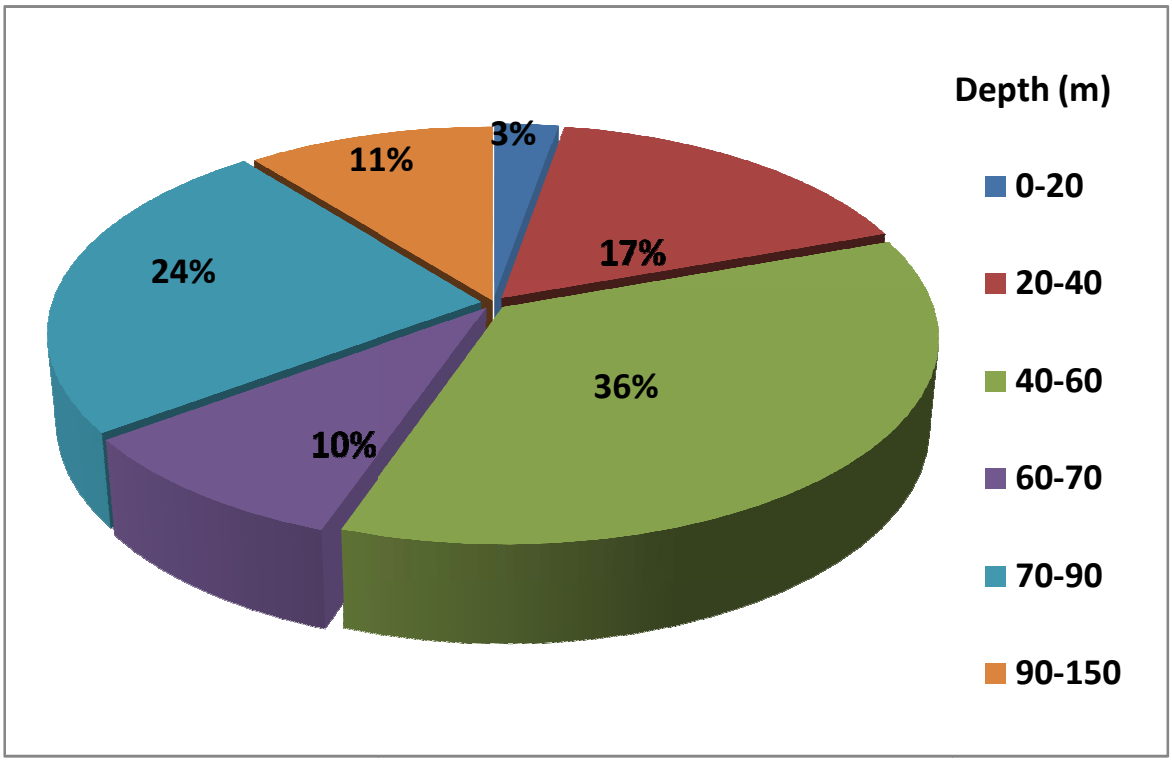


Table 9-Distribution of Tube wells According to Owner's holding Size

No. of shallow tube wells by size class of individual owner							
Sr.no	district	Marginal (0-1 ha)	Small (1-2 ha)	Semi-Medium (2-4 ha)	Medium (4-10ha)	Big (>=10 ha)	Total
1	**Nawan Shahr**	**1452**	**3596**	**6098**	**4677**	**1212**	**17035**

Table10 -Distribution of Shallow Tube wells According to Depth of tube well

No. by the depth of shallow Tube well							
Sr.no	district	(0-20 mts)	(20-40 mts)	(40-60 mts)	(60-70 mts)	(>70 mts)	Total
1	**Nawan Shahr**	**719**	**4406**	**9410**	**2503**	**9241**	**26279**

Table11- Type of Ground water distribution device

Open Water Channel		
Lined/pucca	**Unlined/kutcha**	Total
628	**25663**	26291

6. AQUIFER MANAGEMENT PLAN

A summery outline of the artificial recharge plan for the entire district of each OE block is given at the beginning in tabular forms. This is followed by the salient features of each block along with the detailed structure-wise recharge plan and cost estimates. Details of the block wise type of suitable recharge structures and volume of water assured for annual recharge for each block in rural area, urban area and artificial recharge in agricultural farm are given in table and design of recharge structures are annexed at annexure I, II. More than 5 meter Mean decadal water level with falling trend is considered for block wise artificial recharge calculation.

Another focus has been given to minimize the gross draft by enhancing ground water use efficiency in irrigation system after replacing the water distribution system from unlined/kutcha channel to Under Ground Pipeline System in the whole district.

6.1 SCOPE OF IMPLEMENTATION

This plan is focusing on the technical aspects of the ground water recharge through various means so that various implementing agencies may get the appropriate technical guidelines. The existing/ongoing schemes of the Central or State Govt. like MANERGA, IWSP, PMKSY (Prime Minister Krishi Sinchai Yojna), NABARD funded schemes, Urban Development schemes, departmentally funded projects etc. may be benefitted from the recharge plan by incorporating the input in the operational guidelines/ design and for locating the specific sites.

Agriculture University, Engineering Collages, Academic and Research Institution and NGO may also take up the pilot or demonstrative projects in the blocks suitable to them to plan at local level as per local conditions.

6.2 POTENTIAL OF ENHANCING THE GROUND WATER USE EFFICIENCY

The micro level transformation in the ground water management have vast impact potential to counter extensive ground water depletion faced by the state of Punjab, particularly in overexploited blocks. There are around 26203 tubewells operated by farmers for irrigation through unlined/Kutcha (97.61%) open channel system in Nawanshahar district where water from the tube-well is discharge to the agricultural field. In this process huge quantity of ground water is wasted in soil moisture and evaporation losses.

Dynamic ground water resources (2011) indicate that Gross ground water draft for irrigation in Nawanshahar district is estimated at 699.90 MCM. It is expected that around 19.90 % of over draft can be brought down by switching over to underground/surface pipeline based distribution from the prevailing unlined open channels. Thereby gross draft will be reduced to the tune of 583.86 MCM assuming there is no crop diversification by the farmers.

The benefit will lead to saving of precious ground water resources in overexploited blocks of Nawanshahar Districts. The measure if implemented will bring down the ground water overdraft from 107% to 82 %. The category of the blocks will also improve drastically resulting in

boosting of agriculture and industrial development otherwise not sustainable in majority of the blocks in the state.

The tube wells also consume enormous electricity which is subsidized and government incurs significant revenue on this account. The measures therefore will result in saving of energy and money. Pollution impact will be reduced whenever diesel engines are used by the farmers. The environmental and ecological condition in the irrigated land will improve. Unwanted weed growth will also be controlled inside the farm land. This will also be useful in the waterlogged/ shallow water table areas as the seepage losses in these areas also aggravate the water logging. Government should make/launch a mission mode program for installing the underground pipe lines instead of having kutcha channel in the entire Punjab. Heavy ground water overdraft can be reduced by these efforts. This will ensure more crop per drop.

6.3 Water Saving Potential from Crop Diversification-Change Paddy to Maize/Pulses:

As the requirement of water for paddy is much high therefore by changing paddy to maize/Pulses will help in saving of water. For estimating the water saving by crop diversification it is assumed that one mcm of water will be saved in case of maize or pulses planted in one sq km of land. In case of pulses even higher amount of ground water can be saved

Table 12: Scope of Quantitative Impact on Stage of Development after applying various management strategies

Block	Net Ground Water Availability (mcm)	Total Draft (mcm)	Present Stage of draft (SOD) (%) per 2013	Reduction in draft by different water saving method				SOD afterwards (%)	Change of paddy cultivation area (% of existing)
				Replace water courses by UG Pipes (mcm)	Adopt Artificial recharge (mcm)	Change Paddy to Maize (mcm)	Total (mcm) (2+3+ 4)		
			1	2	3	4	5		
AUR	145.98	239.88	164	60.0	2.47	32	94.12	98.47	21.70
BALACHAUR	158.86	96.29	61	0.0	0.00	0	0	61	Not required
BANGA	101.50	140.67	139	35.2	3.02	1	38.4	97.83	1
NAWAN SHAHR	235.61	220.34	94	0.0	3.42	0	3.42	90.18	Not required
SAROYA	28.37	17.31	61	0.0	0.00	0	0	61	Not required
Total	670	714	107	95.2	8.91	33	136	82	22.70

7. BLOCK WISE AQUIFER MAPS AND MANAGEMENT PLAN

(I) AUR BLOCK (218.50 SQ KM)

1. Salient Information

Population (2011)	Rural- 91,283 Urban- 4063 Total- 95,346
Rainfall 2014 (Nawan Shahr District)	Average annual rainfall -924 mm
Average Annual Rainfall (Aur block)	700 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops-Sugarcane, Potatoes, Pulses, Net Area Sown- 199.95sq.km Total Irrigated Area-399.90sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Aur block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (58 m) is very prominent in terms of thickness and geographic extent. Aquifer II (29 m) & III (43 m) are less in thickness. Block is categorized as **Over Exploited** as per Ground Water Assessment 2013.

Ground water Extraction: Information regarding the abstraction from deeper Aquifer is available, but there are drinking water supplies from tube wells tapping combined aquifer and very few tube-wells are available for which resources can be assessed separately.

Water level Behavior (2015): Pre Monsoon-*~14.00-14.23 (mbgl) & Post Monsoon-~14.35-14.30 (mbgl)*

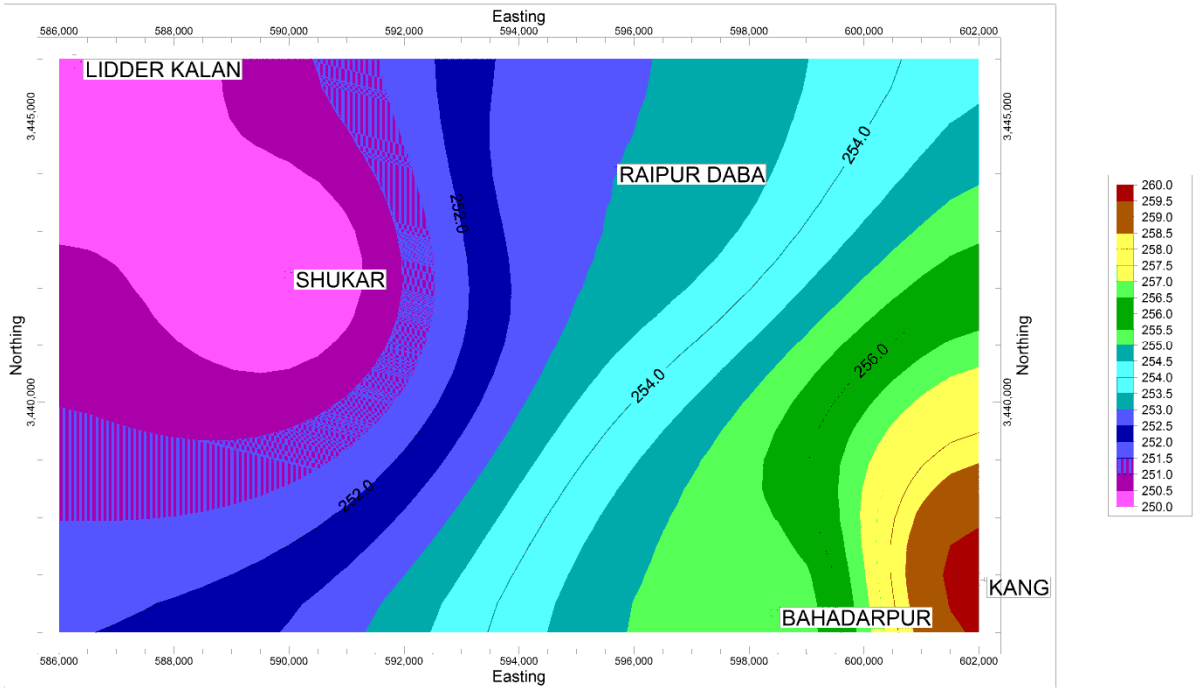
Aquifer Disposition: Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (18-107m)	Quaternary Alluvial deposits	Unconfined	58	4100	0.072	$1.18*10^{-3}$
Aquifer-II (107-164m)		Unconfined to Confined	29	-	0.072	0.00128
Aquifer-III (200-300m)		Unconfined to Confined	43	-	0.072	0.000237

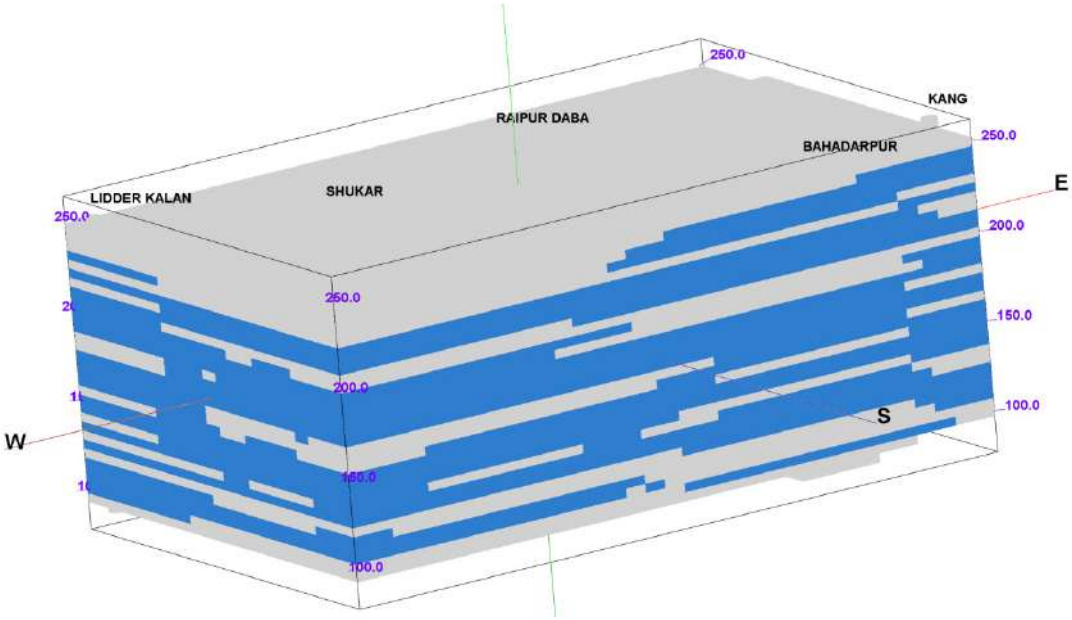
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

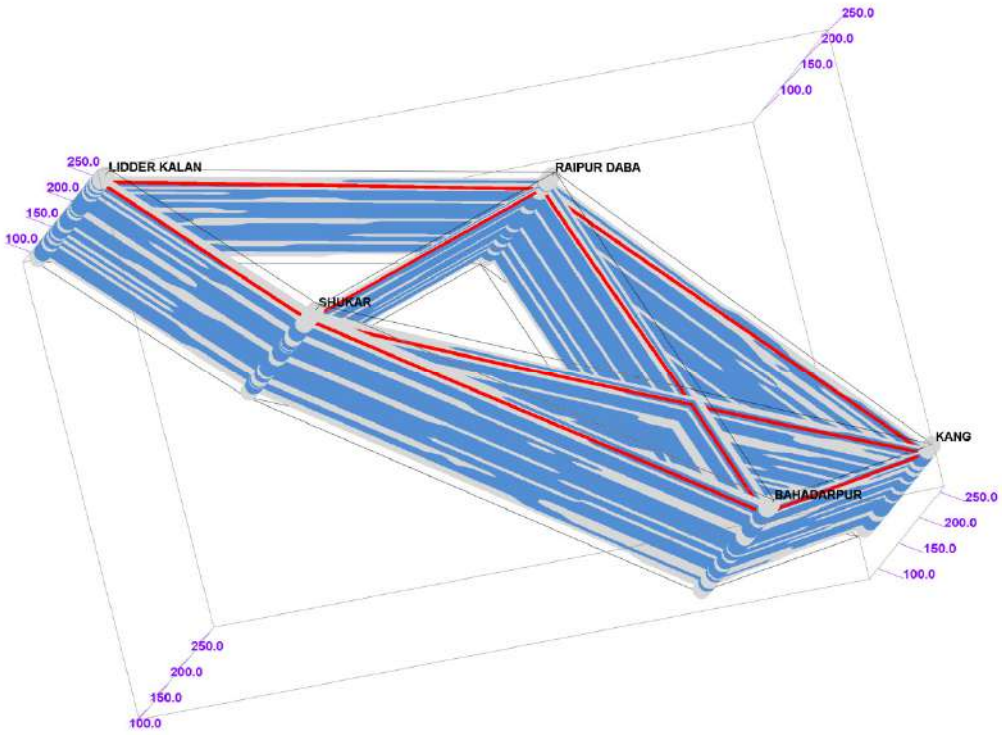
Elevation Contour Map- Aur Block



3D Lithology model



3D Lithology Fence



Cross-Section Along NW-SE

2. Ground Water Resource, Extraction, Contamination and Other Issues

Aquifer wise Water Resource available (mcm)	Dynamic Aquifer I	146
	In-storage Aquifer I	912.46
	Dynamic Aquifer II	-
	In-storage Aquifer II	685
	Dynamic Aquifer III	-
	In-storage Aquifer III	684
	Total	2428
Ground Water Extraction (in mcm)	Irrigation	237.87
	Domestic & Industrial	2.00
Provision for domestic & Industrial requirement upto 2025 (in mcm)		2.23
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

3. Ground Water Resource Enhancement

Aquifer wise space available for	Volume of unsaturated zone upto the average

recharge and proposed interventions	depth to water level (18 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 2.47 mcm volume of water

4. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 60.00 mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 21.70 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by maize/soyabean is 32 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

(II) BALACHAUR BLOCK (378.50 SQ KM)

1. Salient Information

Population (2011)	Rural- 92590 Urban--7589 Total-100179
Rainfall 2014 (Nawan Shahr District)	Average annual rainfall -924mm
Average Annual Rainfall (Balachaur block)	869 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops-Sugarcane, Potatoes, Pulses, Net Area Sown- 194.77 sq.km Total Irrigated Area-380.54 sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation available in the Balachaur block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (44 m), is very prominent in terms of thickness and geographic extent. Aquifer II (37m) is less in terms of thickness and geographic extent & Aquifer III (36m) data is less then Aquifer-I for resources. Block is categorized as **Safe** as per Ground Water assessment 2013.

Ground water Extraction: Information regarding the abstraction from Aquifer III is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon 15.00-33.00 (mbgl) &Post Monsoon-~16.0-31.80 (mbgl)

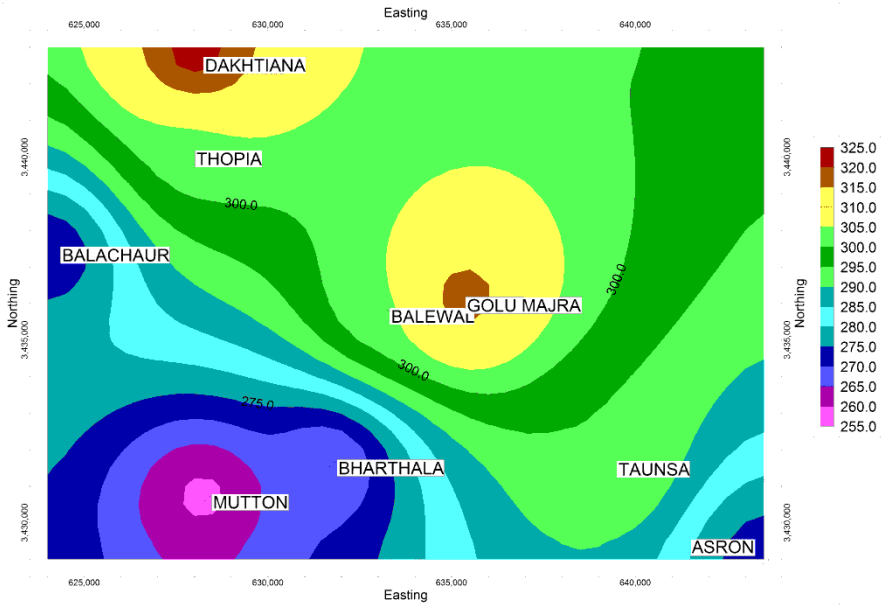
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (12-119m)	Quaternary Alluvial deposits	Unconfined	44	*4120*	0.072	$1.8*10^{-3}$
Aquifer-II (119-202m)		Unconfined to Confined	37	-	0.072	0.00128
Aquifer-III (202-300m)		Unconfined to Confined	36	-	0.072	0.000237

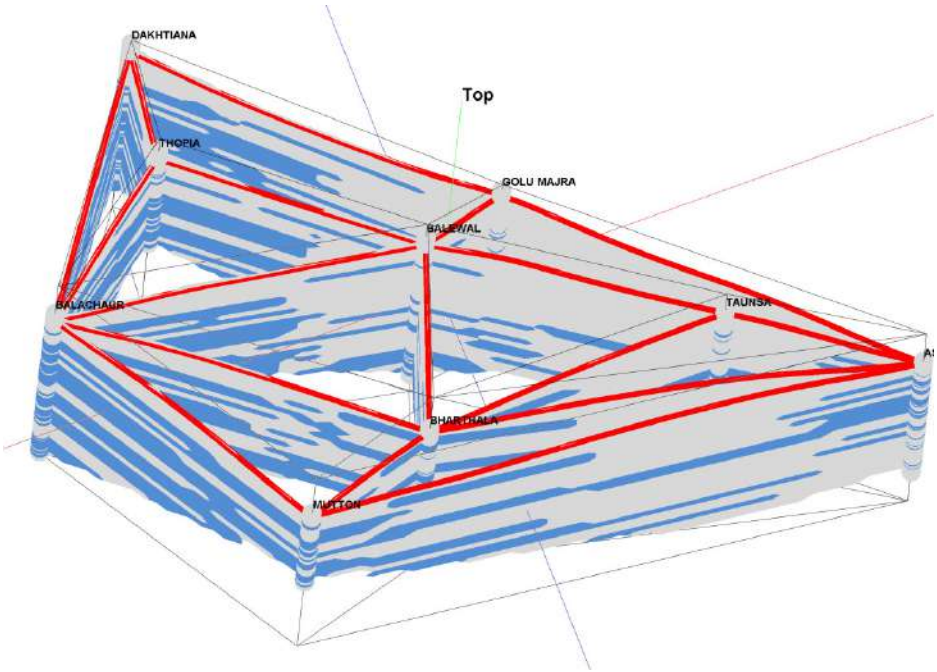
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

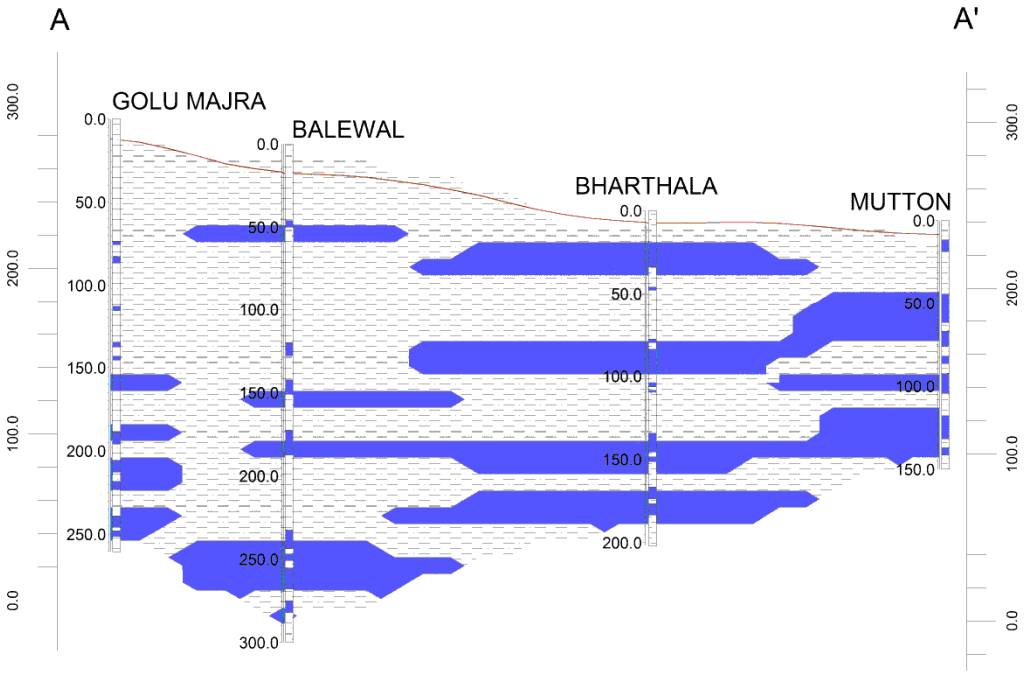
Elevation Contour Map- Balachaur Block

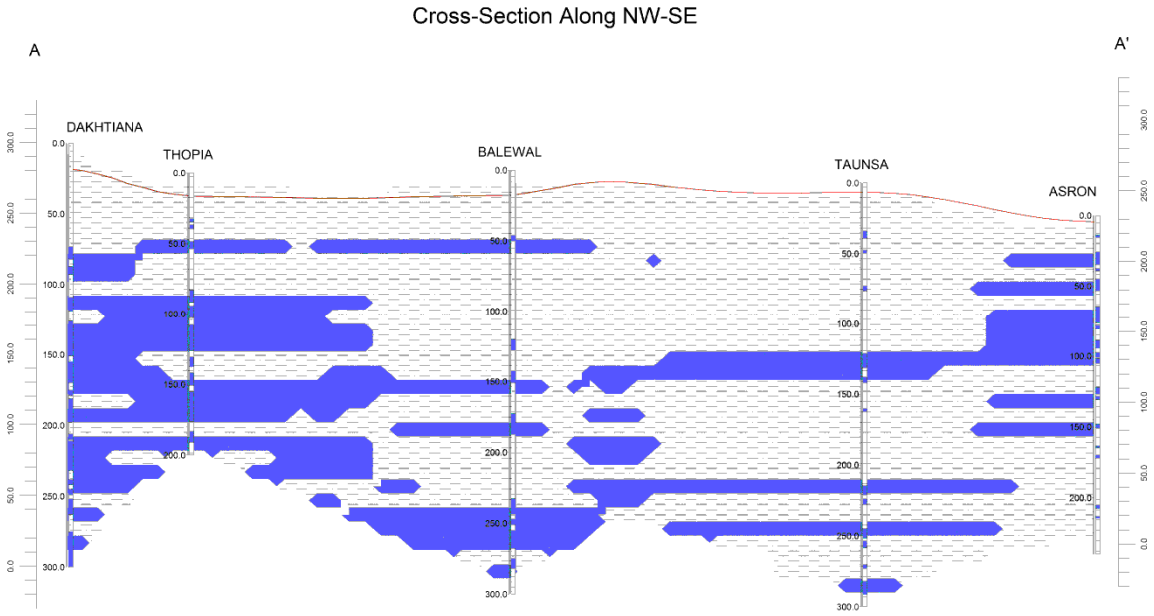


3D Lithology Fence



Cross-Section Along NE-SW





3. Ground Water Resource, Extraction, Contamination and Other Issues

Aquifer wise Water Resource available (mcm)	Dynamic Aquifer I	*159*
	In-storage Aquifer I	*1199*
	Dynamic Aquifer II	-
	In-storage Aquifer II	995
	Dynamic Aquifer III	-
	In-storage Aquifer III	995
	Total	3348
Ground Water Extraction (in mcm)	Irrigation	92.49
	Domestic & Industrial	3.81
Provision for domestic & Industrial requirement in 2025 (mcm)		4.12
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		declining water level trend

4. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (12 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting is not required.

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) is not required
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean **is not** required in the block
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

(III) BANGA BLOCK (232.40 SQ KM)

1. Salient Information

Population (2011)	Rural-131719 Urban- 5046 Total-136765
Rainfall 2014 (Nawan Shahr District)	Average annual rainfall -938mm
Average Annual Rainfall (Banga block)	701 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops- Sugarcane, Potatoes, Pulses, Net Area Sown- 230.10 sq.km Total Irrigated Area – 460.20 sq.km

Water Bodies & Canal Irrigation

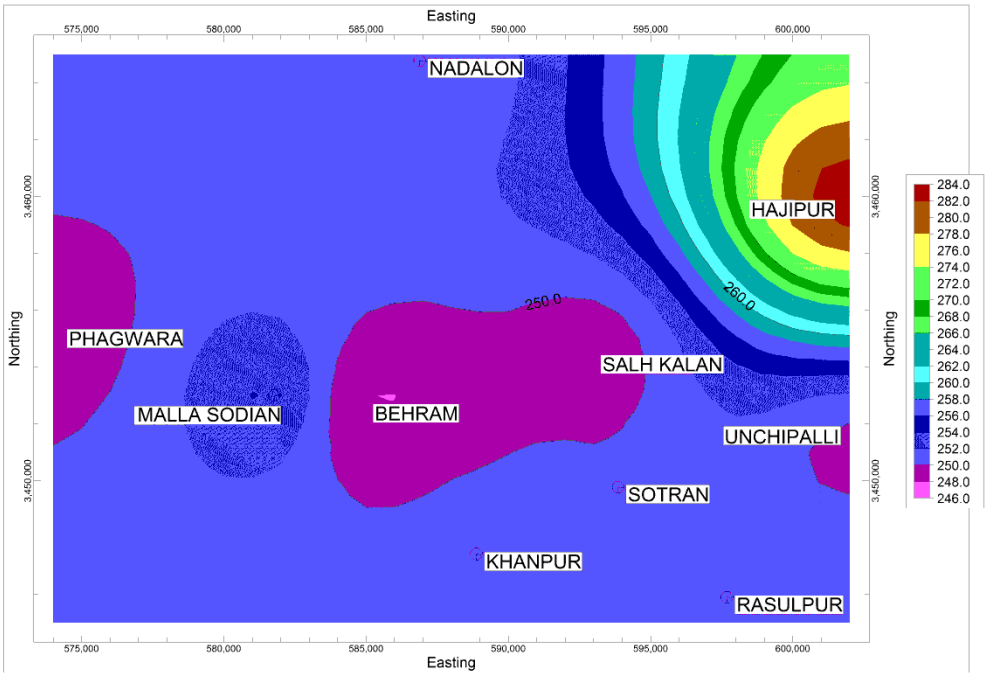
Water bodies available in the villages for storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is also available in the Banga block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (68 m) is very prominent in terms of thickness and geographic extent. Aquifer II (62m) & III (43 m) are less in thickness as compared to Aquifer-I. Block is categorized as **Over-Exploited** as per Ground Water assessment 2013.

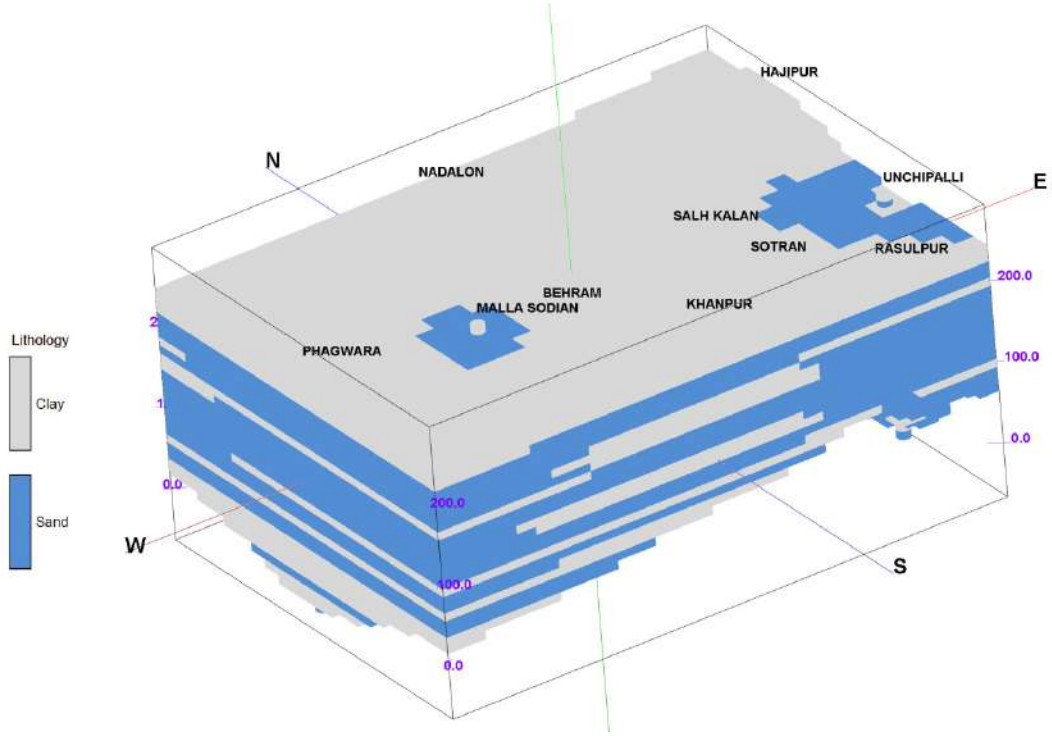
Ground water Extraction: Information regarding the abstraction from Aquifer III is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon 15.00-33.00 (mbgl) & Post Monsoon- ~16.00-31.70 (mbgl)

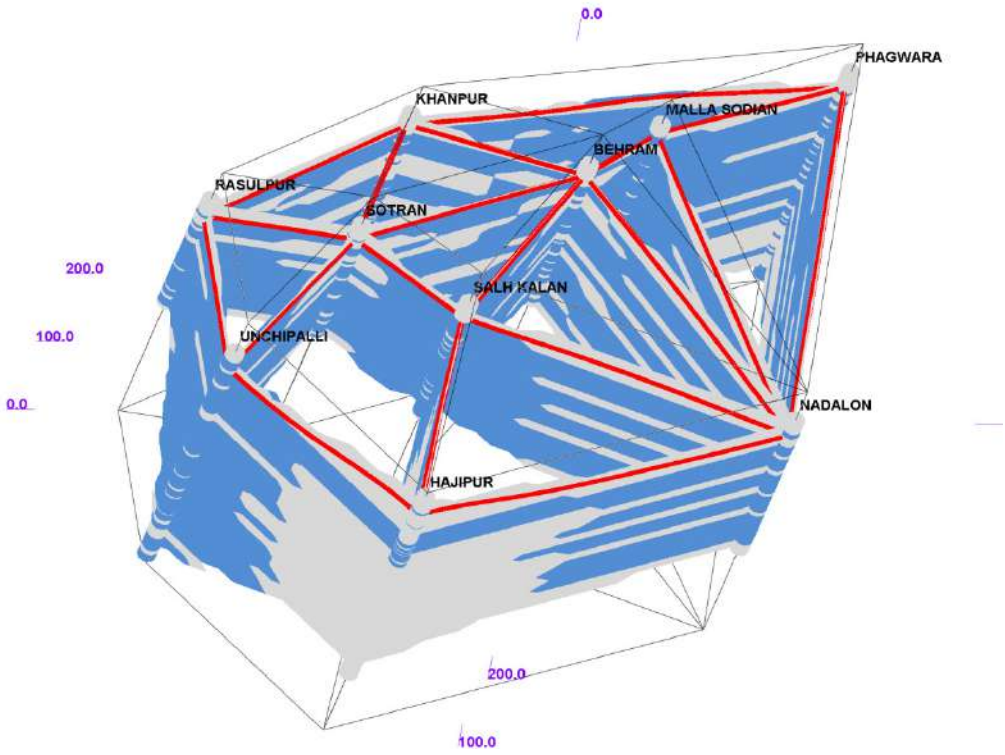
Elevation Contour Map- Banga Block



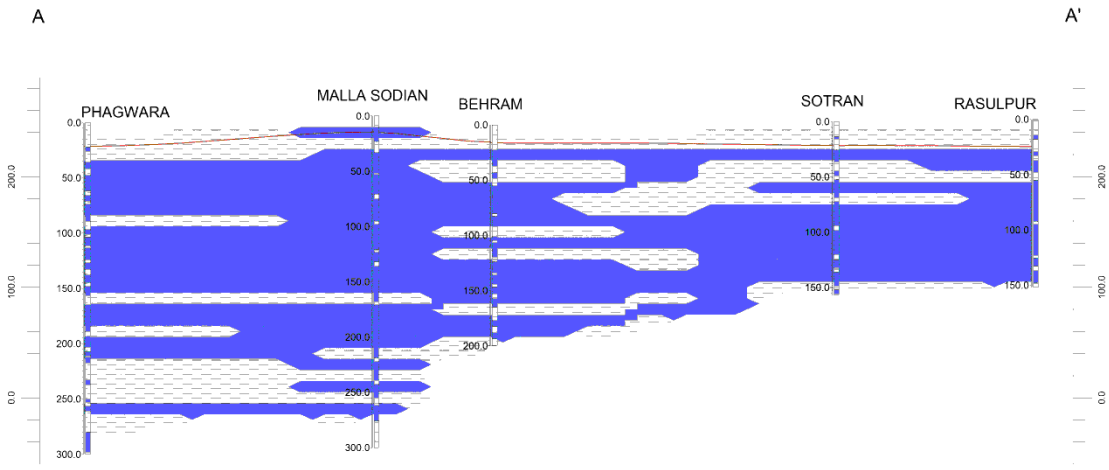
3D Lithology Model



3D Lithology Fence



Cross-Section Along NW-SE



2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (20-1110m)	Quaternary Alluvial deposits	Unconfined	68	*4120*	0.072	1.8*10-3
Aquifer-II (110-205m)		Unconfined to Confined	62	-	0.072	0.00128
Aquifer-III (205-300m)		Unconfined to Confined	43	-	0.072	0.000237

Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

3. Ground Water Resource, Extraction, Contamination and Other Issues

Aquifer wise Water Resource available (mcm)	Dynamic Aquifer I	*102*
	In-storage Aquifer I	*1138*
	Dynamic Aquifer II	-
	In-storage Aquifer II	729
	Dynamic Aquifer III	-
	In-storage Aquifer III	728
	Total	2697
Ground Water Extraction (in mcm)	Irrigation	137.72
	Domestic & Industrial	2.94
Provision for domestic & Industrial requirement up to 2025 (mcm)		3.28
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		declining water level trend

4. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (20 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 3.02 mcm volume of water

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 35.2 mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 1 % of the total area needs to change the crop from paddy to maize/soyabean Anticipated volume of water to be saved by maize/soyabean is1 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

(IV) NAWAN SHAHR BLOCK (330.20 SQ KM)

1. Salient Information

Population (2011) Rural- 104348
Urban- 4481
Total-108829

Rainfall 2014 (Nawan Shahr District) Average annual rainfall -924 mm

Average Annual Rainfall (Nawanshahr block) 828 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops- Sugarcane, Potatoes, Pulses,
Net Area Sown- 232.06 sq.km
Total Irrigated Area- 464.12 sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for the storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is also available in the Nawanshahr block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (57 m) is very prominent in terms of thickness and geographic extent. Aquifer II (40 m) & Aquifer III is (43m) is less in thickness as compared to Aquifer-II. Block is categorized as **Critical** as per Ground Water assessment 2013.

Ground water Extraction: Information regarding the abstraction from Aquifer III is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon *5.01— 16.30 (mbgl)* &Post Monsoon- *~ 4.99—15.70 (mbgl)*

2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

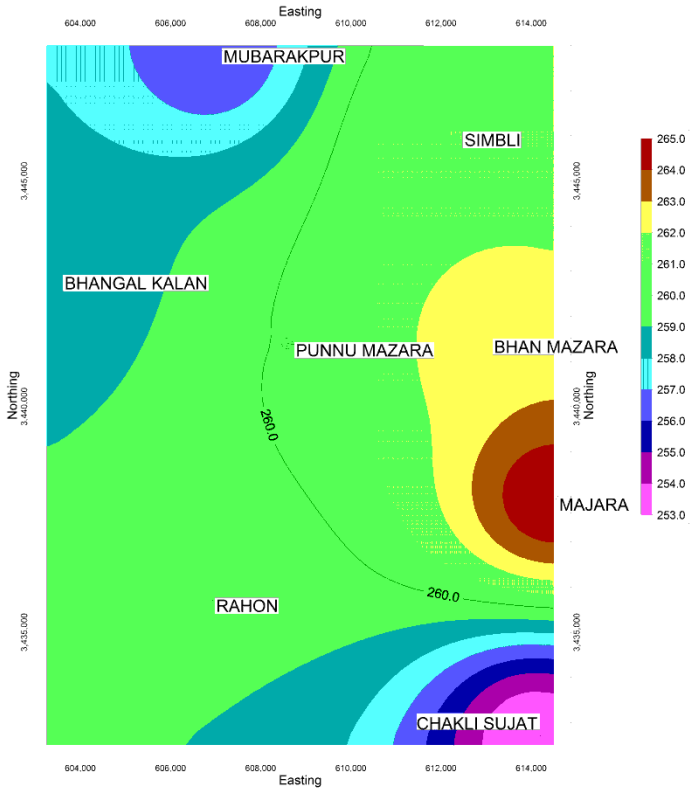
Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (13-110m)	Quaternary Alluvial	Unconfined	57	*1767-4100*	0.072	1.8*10-3
Aquifer-II (110-201m)		Unconfined to Confined	40	-	0.072	0.00128

Aquifer-III (201-300m)		Unconfined to Confined	43	-	0.072	0.000237

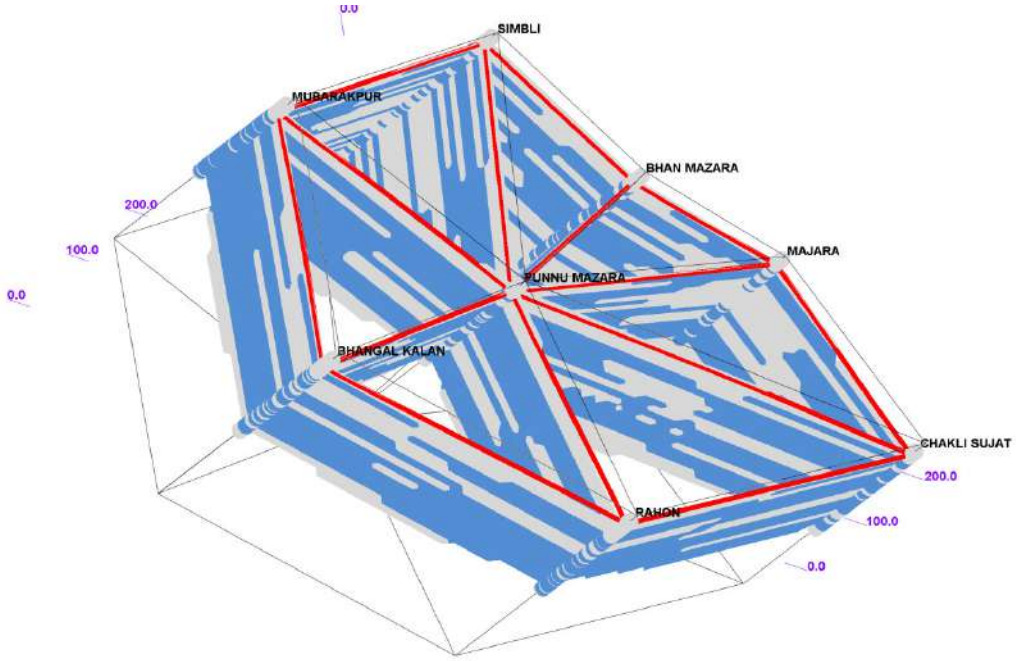
Aquifer comprises of freshwater only and the main aquifer material is sand.

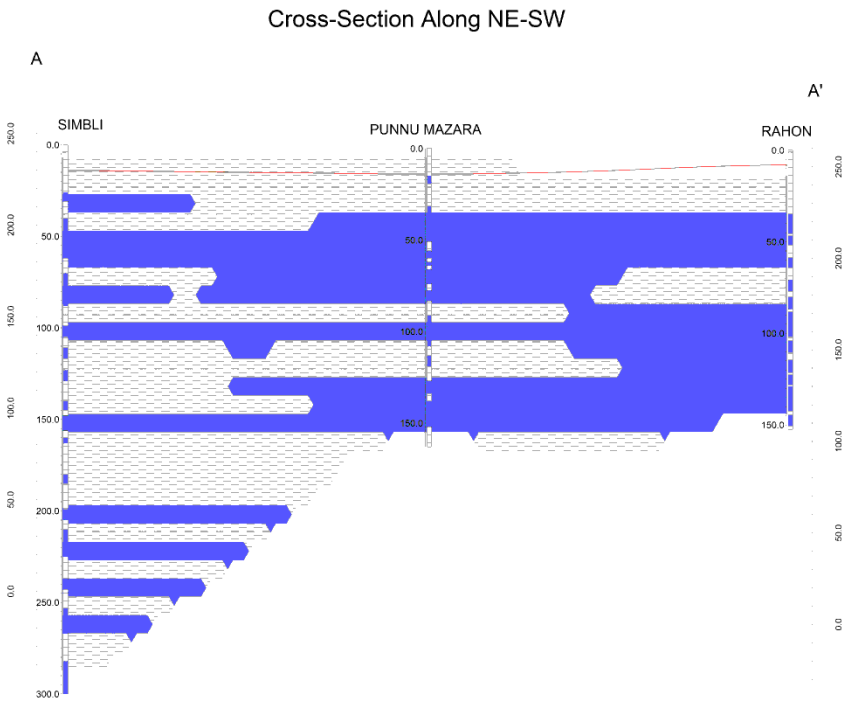
The non-aquifer material comprise of clay.

Elevation Contour Map- Nawanshahr Block



3D Lithology Fence





3. Ground Water Resource, Extraction, Contamination and Other Issues

Aquifer wise Water Resource available (mcm)	Dynamic Aquifer I	*236*
	In-storage Aquifer I	*1355*
	Dynamic Aquifer II	-
	In-storage Aquifer II	1591
	Dynamic Aquifer III	-
	In-storage Aquifer III	1036
	Total	3661
Ground Water Extraction (in mcm)	Irrigation	215.91
	Domestic & Industrial	4.43
Provision for domestic & Industrial requirement 2025 (in mcm)		4.94
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

4. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (13 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 3.42 mcm volume of water

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) is not required
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean **is not** required in the block
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

(V) SAROYA (165.80 SQ KM)

1. Salient Information

Population (2011) Rural-66954
Urban- -
Total-66954

Rainfall 2014 (Nawan Shahr District) Average annual rainfall -924 mm

Average Annual Rainfall (Nawan Shahr -I block) 870 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops- Sugarcane, Potatoes, Pulses,
Net Area Sown- 109.22 sq.km
Total Irrigated Area- 218.44 sq.km

Water Bodies & Canal Irrigation

Water bodies available in the villages for storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is available in the Saroya block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. All the Aquifer I (46 m) and are very prominent in terms of thickness and geographic extent, Aquifer II (44 m) and Aquifer III is (43 m). Block is categorized as **Safe** as per Ground Water assessment 2013.

Ground water Extraction: Information regarding the abstraction from Aquifer II & III is limited, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

Water level Behavior (2015): Pre Monsoon 12.05-23.40 (mbgl) & Post Monsoon-~ 12.07-23.80 (mbgl)

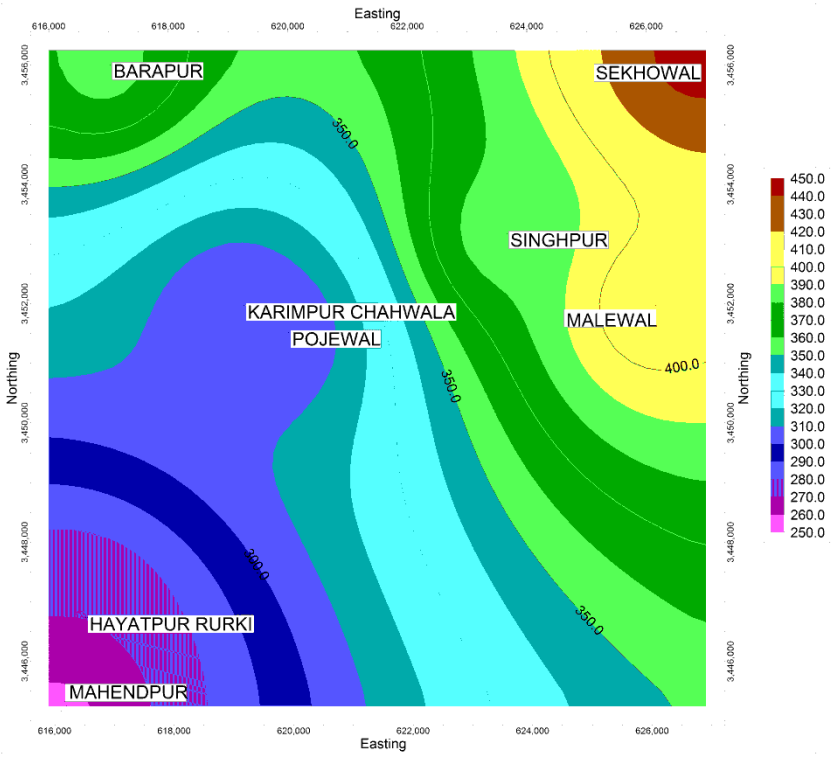
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (14-115m)	Quaternary Alluvial deposits	Unconfined	46	*4120*	0.072	1.18*10-3
Aquifer-II (115-203m)		Unconfined to Confined	44	-	0.072	0.00128
Aquifer-III (203-300m)		Unconfined to Confined	43	-	0.072	0.000237

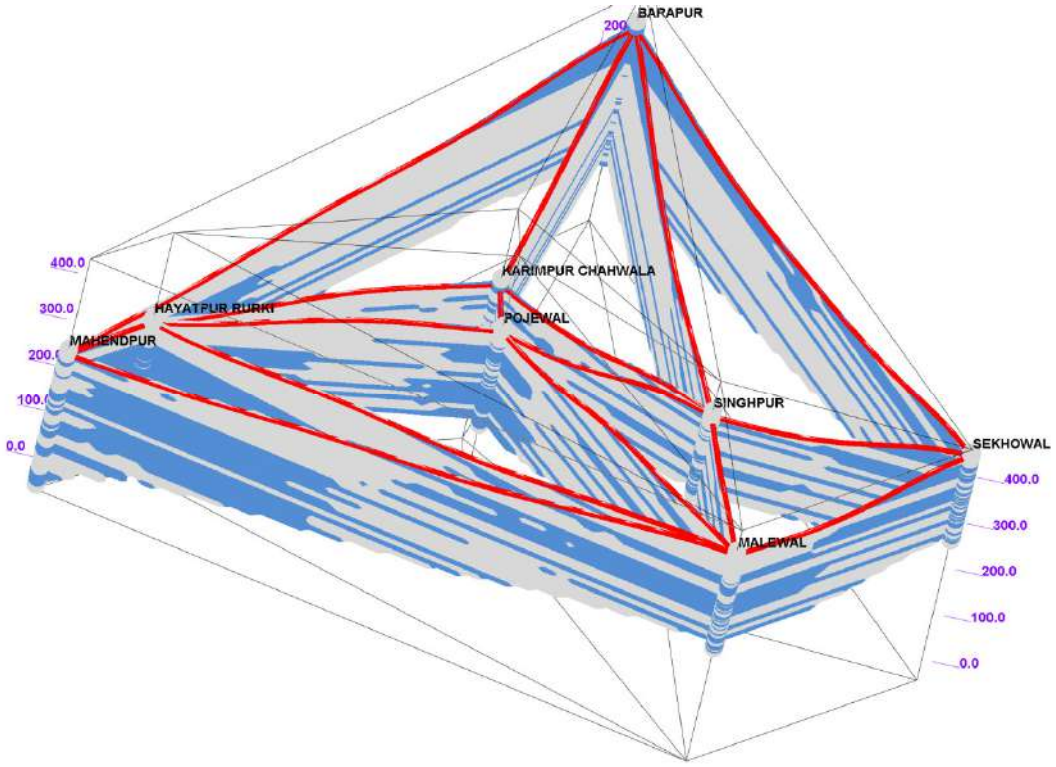
Aquifer comprises of freshwater only and the main aquifer material is sand.

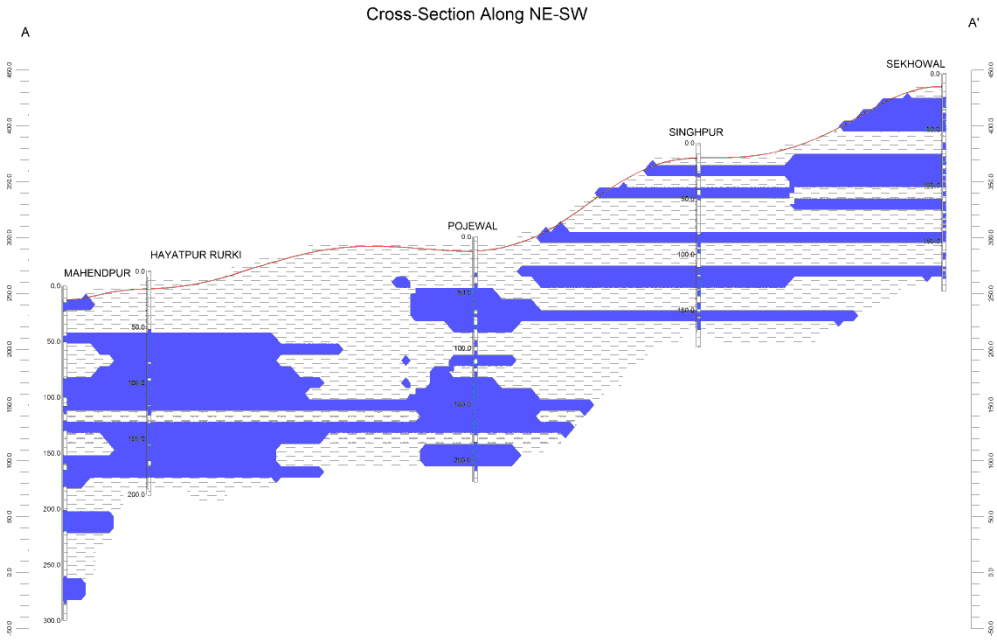
The non-aquifer material comprise of clay.

Elevation Contour Map- Saroya Block



3D Lithology Fence





3. Ground Water Resource, Extraction, Contamination and Other Issues

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*28*
	In-storage Aquifer I	*549*
	Dynamic Aquifer II	-
	In-storage Aquifer II	577
	Dynamic Aquifer III	-
	In-storage Aquifer III	519
	Total	1616
Ground Water Extraction (in mcm)	Irrigation	15.92
	Domestic & Industrial	1.39
Provision for domestic & Industrial requirement up to 2025 (in mcm)		1.55
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

4. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (14 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge is not required

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) is not rquired
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean **is not** required in the block
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-