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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

Hoshiarpur District, Punjab

उत्तरी पश्चिम क्षेत्र, चंडीगढ़

North Western Region, Chandigarh

AQUIFER MAPPING

&

MANAGEMENT PLAN

HOSHIARPUR 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 HOSHIARPUR DISTRICT, PUNJAB
(3331 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 Hoshiarpur district of Punjab State (**Fig. 1**), covered under Phase-IV.

Administratively the district has four tahsils, five sub-tehsils and ten blocks. The tehsils are Hoshiarpur, Dasuya, Garh Shankar and Mukerian.The blocks are Hoshiarpur-I, Hoshiarpur-II, Bhunga, Tanda, Dasuya, Garh Shankar, Mahipur, Mukerian, Talwara, Hazipur. The district is one of the second lowest densely populated districts of the state. Hoshiarpur district falls in the eastern part of the Punjab State and is bounded by North latitudes $30^0$58'30'' and $32^0$08'00''and East longitudes $75^0$28'00'' and $76^0$30'00''. It falls in parts of Survey of India Toposheets nos. 43P, 44M and 53A and covering an area of 3331 sq.km. The district is drained by the river Beas in the north and northwest and Satluj in the south. The district is well connected by roads and

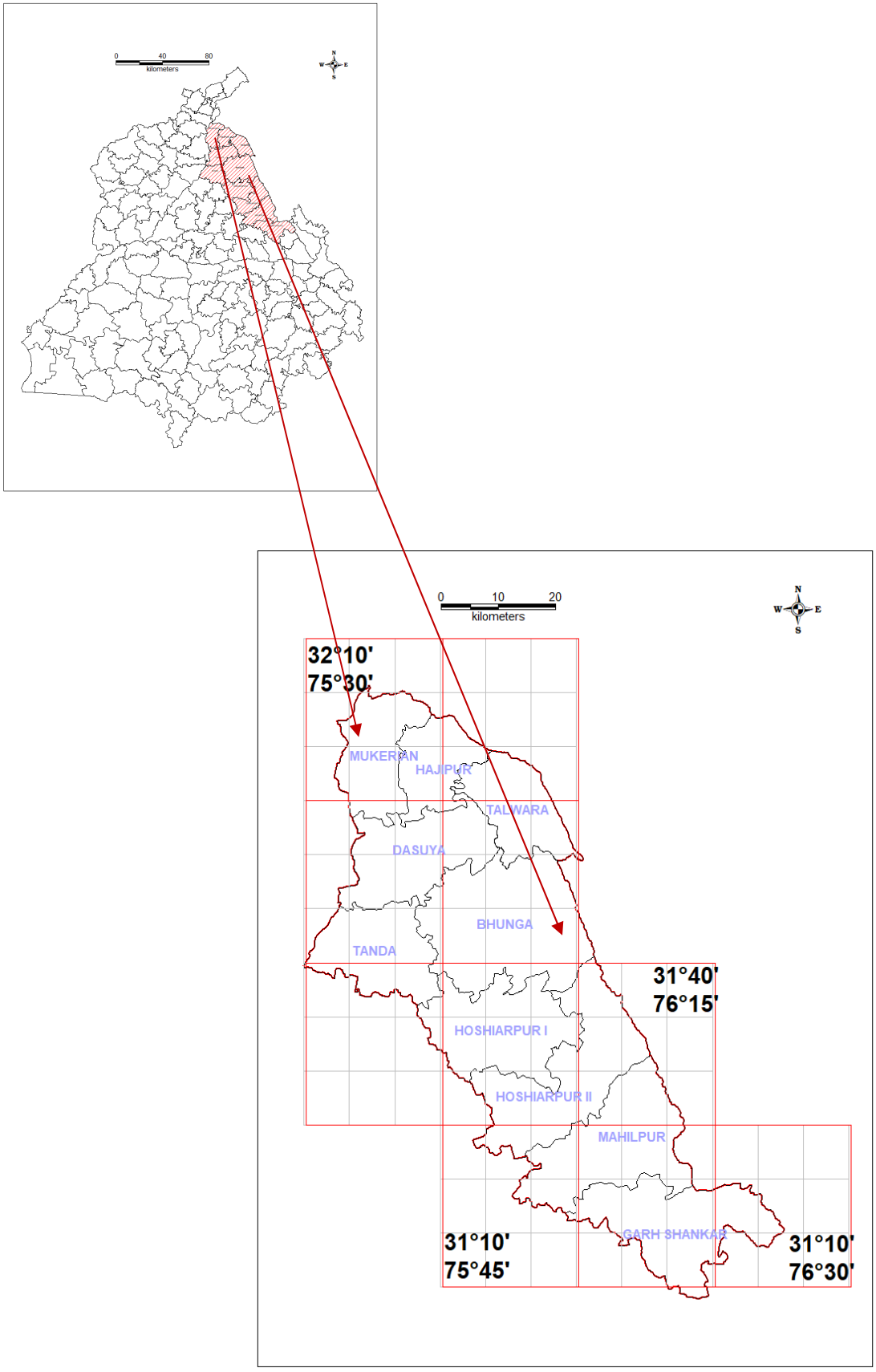
railways. It shares common boundaries with Kangra and Una districts of Himachal Pardesh in the north east, Jalandhar and Kapurthala districts (interspersed) in south-west and Gurdaspur district in the north-west.

At present, it has an area of 3331 Sq. Kms. and a population, as per 2011 Census is 15, 82,793 persons. Area wise Population as per 2011 Census is given in table-1.

Table-1: The population of Hoshiarpur district as per census 2011

Tehsil	Rural			Urban			Total population
	Male	Female	Total	Male	Female	Total	
Hoshiarpur	1,88,136	1,80,544	3,68,680	99,322	89,786	1,89,108	55,77,88
Dasuya	1,52,076	1,49,368	3,01,444	28,983	27,198	56,181	3,57,625
Garhshankar	1,53,456	1,48,840	3,02,296	14,677	13,632	28,309	3,30,605
Mukerian	1,38,583	1,36,966	2,75,549	31,688	29,538	61,226	3,36,775
Total	6,32,251	6,15,718	12,47,969	1,74,670	1,60,154	3,34,824	15,82,793

Fig 1: Base Map of Hoshiarpur 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

HOSHIARPUR DISTRICT

Sl.No	Source of data	Depth Range (m)			
		< 100	100-200	200-300	>300
1	CGWB	3	71	41	32
2	WR&ED	0	0	0	0
3	PRIVATE	0	0	0	0
Total		**3**	**71**	**41**	**32**

2.2 Ground Water Quality

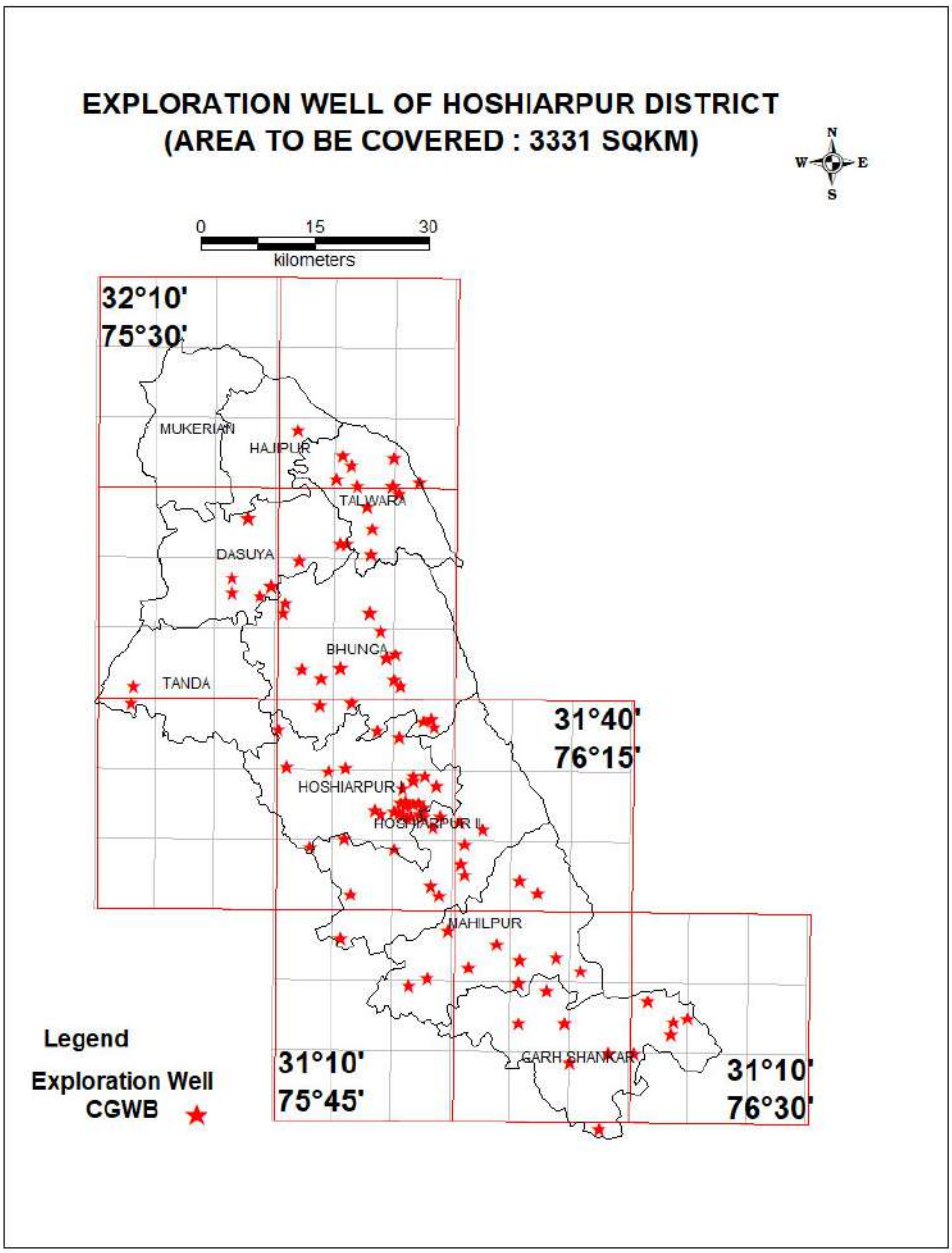
Data of chemical analysis of water samples from shallow aquifers indicates that ground water is slightly alkaline in nature (pH varies between 7.45 to 8.20). Salinity is low to medium (E.C. value ranges between 280 to 1050). All chemical parameters are well within the permissible limits for safe drinking waters set by Bureau of Indian Standards (BIS 1991, revised in 2007) except Iron which is high at two locations with a value of greater than 1.0 mg/l which is permissible limit and As greater than the permissible value of 0.01 mg/l also at two locations. Among anions, bicarbonate is the dominant ion and among cations Ca ion is dominant one. Hence ground water is calcium bicarbonate type. By and large, quality of ground water is suitable for drinking purposes. The suitability of ground water for irrigational uses is generally ascertained by considering salinity (EC), Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC). These parameters range from 280 to 1050 micro mhos/cm. At 25^0C 0.27 to 5.95 and - 1.2 to 1.68 mill equivalents respectively. Thus it can be concluded that ground water is suitable for irrigation on all types of soils. The US Salinity Laboratory classification of irrigation waters indicates that all ground waters fall under C_2S_1 class except for one sample each which fall under C1S1 and C3S2 class. These waters will cause neither salinity nor sodium hazards when used for irrigation purposes.

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.

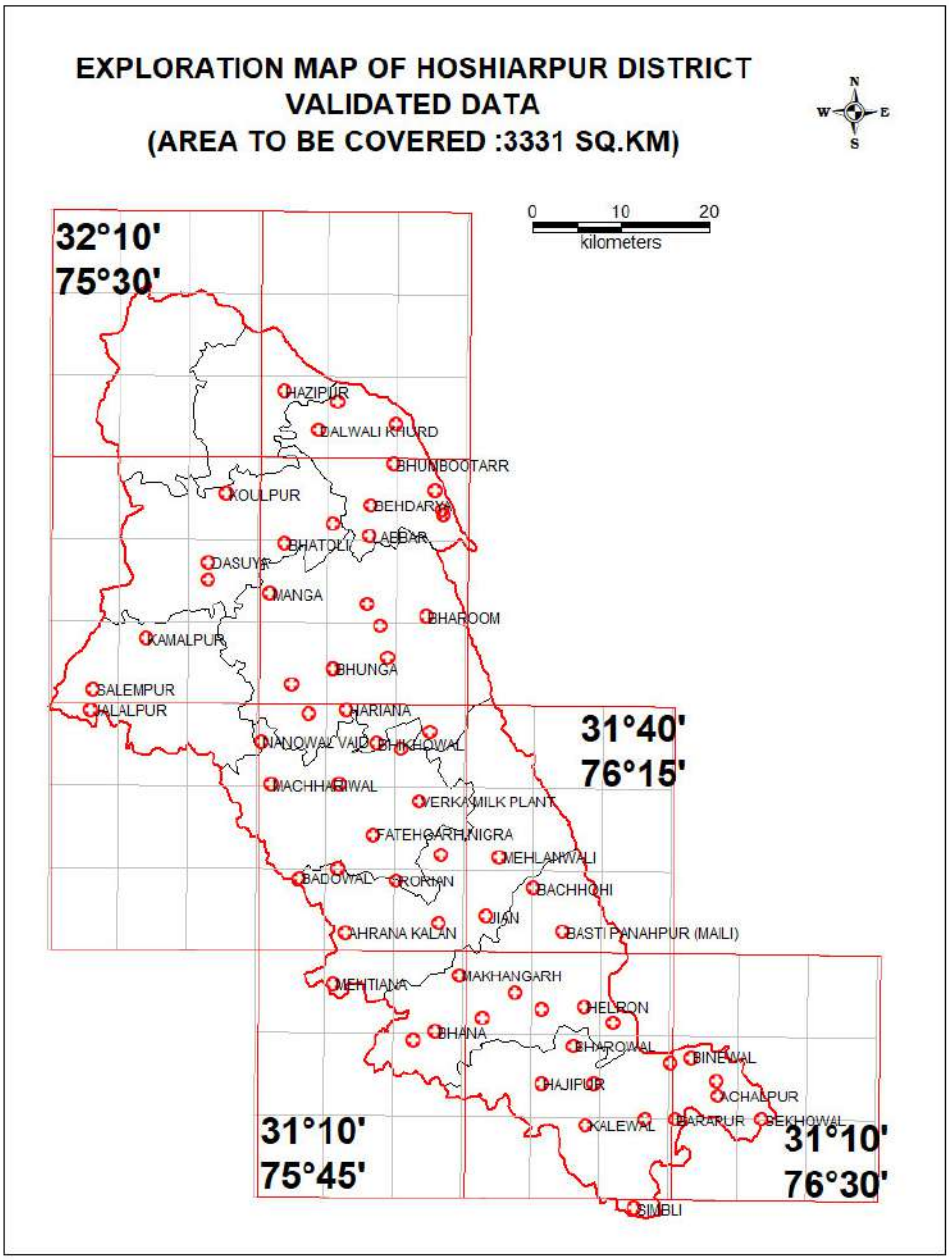
Fig-2 Location of Exploratory Bore Holes



2.4 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

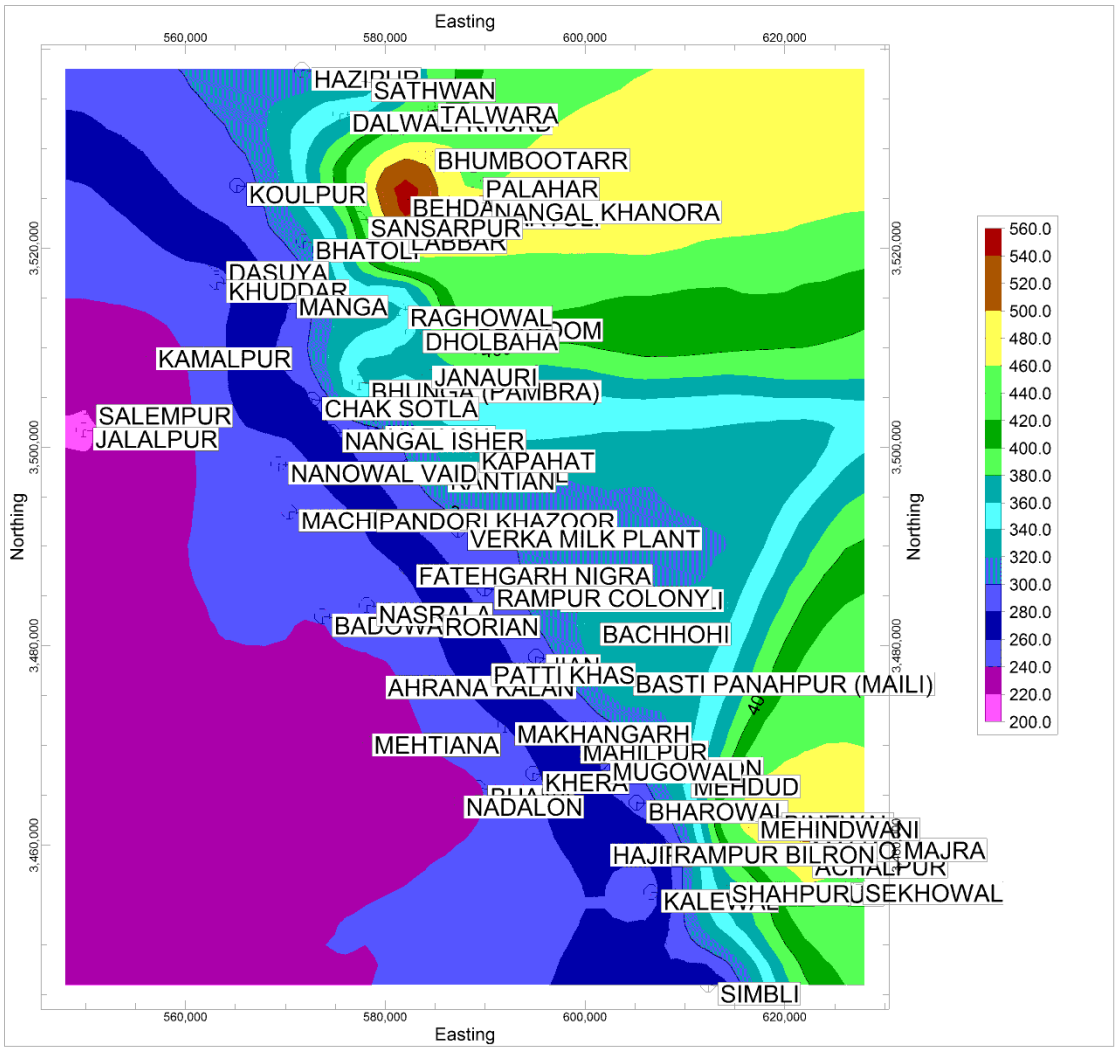
All the available data have been validated for consideration to generate aquifer map. The deepest well in each quadrant is selected and plotted on the map of 1.50000 scale with 5'X5'grid (9 x 9km) and is shown in Fig -3.

Fig 3: Validated Exploration Data of Hoshiarpur District



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

Fig 4: Elevation Contour Map-Hoshiarpur 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;

TOPOSHEET/ QUADRANT	DEPTH RANGE (m)								ELEVATION (mamsl)	SOURCE OF DATA
	LOCATION	<100	LOCATION	100-200	LOCATION	200-300	LOCATION	>300		
3A 44M/ 13	BHATOLI	99.1							300	Private
2C 44M/ 09	NANGAL KHANOURA	99.5							266	Private
3B1 44M/ 13			LABBER	111					518	Private
3B2 44M/ 13			RAGHOWAL	126.19					296	Private
2C1 44M/ 13			PALAHAR	133					441	Private
1A1 44M/ 15			NASRALA	153					266	Private
3C 44M/ 10			MACHHARIWAL	157					257	Private
2C1 44M/ 15			MAKHANGARH	158					280	Private
3A2 44M/ 14			DHADE FATEH SINGH	160					273	Private
1B2 53A/ 04			GARHSHANKAR BUS STAND	162					261	Private
2C 44M/ 10			NANOWAL VAID	162					262	Private
2A1 53A/ 03			MAHILPUR	165					296	Private
1A3 44M/ 15			AHRANA KALAN	170					255	Private
2A 44M/ 15			MEHTIANA	172.25					247	Private
3B1 53A/ 03			MEHDUD	174					380	Private
1A 44M/ 10			SALEMPUR	175					234	Private
2C2 44M/ 15			KHERA	176.78					272	Private

1A2 44M/ 13			SATHWAN	182					310	Private
1C 44M/ 14			BHAROOM	184					475	Private
2B2 44M/ 13			BEH RANGA	186					601	Private
1A2 53A/ 03			BACHHOHI	190					354	Private
1A3 44M/ 13			DALWALI KHURD	190					375	Private
3B 44M/ 15			NADALON	190					250	Private
3A1 44M/ 14			PANDORI KHAZOOR	190					282	Private
1B3 44M/ 14			PATIARI	190.54					359	Private
2B1 44M/ 13			BHUMBOOTARR	192					515	Private
1A2 44M/ 14			ABOWAL	193.54					290	Private
1A 53A/ 08			SEKHOWAL	195.12					447	Private
1A2 44M/ 15					BADOWAL	200			254	Private
1B 53A/ 03					BASTI PANAHPUR (MAILI)	200			366	Private
2B3 44M/ 13					BEHDARYA	200			665	Private
2C3 44M/ 13					KARTOLI	200			507	Private
1A3 44M/ 14					CHAK SOTLA	201			276	Private
3C3 44M/ 09					MANGA	201			281	Private
2C2 44M/ 14					MUSTFAPUR	201.2			375	Private
3B3 53A/ 03					RAMPUR BILRON	201.22			281	Private
1C2 44M/ 15					KUNDLA	204			319	Private
3C 44M/ 15					BHANA	205			257	Private
1B 44M/ 15					RORIAN	205.79			280	Private

2A2 53A/ 03					MUGOWAL	206			299	Private
3B2 53A/ 03					BHAROWAL	213			300	Private
1B 44M/ 10					KAMALPUR	220			233	Private
3C2 44M/ 14					BIRBAL NAGAR, STREET NO.3	222.56			311	Private
1C1 44M/ 15					MAL MAZARA	224			325	Private
2B2 44M/ 14					KANTIAN	226			332	Private
3C1 44M/ 14					VERKA MILK PLANT	232			316	Private
2A1 44M/ 14					NANGAL ISHER	246.95			283	Private
1B1 44M/ 14					DHOLBAHA	250			389	Private
3B3 44M/ 14					VARDHMAN SPINNING MILLS	254.5			289	Private
1C1 53A/ 04					SHAHPUR	261			242	Private
1B2 44M/ 14							JANAURI	304.8	389	Private
1C2 53A/ 04							BARAPUR	305	384	Private
1B1 53A/ 04							KALEWAL	365	256	Private
3A1 53A/ 07							MALKO MAJRA	378	506	Private
3C2 53A/ 03							MEHINDWANI	400	512	Private
2A2 44M/ 13							SANSARPUR(ARNIHALI)	405.5	375	Private
2C1 44M/ 14							KAPAHAT	430.19	364	Private
1C3 44M/ 15							PATTI KHAS	456.29	282	Private
1A1 44M/ 14							BHUNGA (PAMBRA)	458.11	555	Private

2A 44M/ 10							JALALPUR	460.5	231	Private
2A2 44M/ 14							HARIANA	505	306	Private
1A3 53A/ 03							JIAN	510	310	Private
3B1 44M/ 14							NALOYIAN	968	307	Private
1B3 53A/ 04	GARH SHANKAR	55							257	CGWB
1B 44M/ 13			TALWARA	137					380	CGWB
1A1 44M/ 13			HAZIPUR	181					296	CGWB
2C3 44M/ 14					KAPAHAT	223			365	CGWB
2C2 44M/ 13					NANGAL KHANORA	245			494	CGWB
3A2 53A/ 03					HAJIPUR	261			285	CGWB
3A1 53A/ 03					NALOIAN	295.35			285	CGWB
3C1 44M/ 09							DASUYA	301.45	266	CGWB
3C3 44M/ 14							RAMPUR COLONY	302.06	306	CGWB
3C2 44M/ 09							KHUDDAR	307.93	251	CGWB
1A1 53A/ 03							MEHLANWALI	309.3	330	CGWB
2B1 44M/ 14							BHIKHOWAL	311.66	310	CGWB
2C 53A/ 04							SIMBLI	351	262	CGWB
3C1 53A/ 03							BINEWAL	375	525	CGWB
3A3 53A/ 07							ACHALPUR	398	525	CGWB
3A2 53A/ 07							MALKOWAL	401.8	268	CGWB
2A1 44M/ 13							SANSARPUR	405.5	375	CGWB
2B 53A/ 03							HELRON	447.8	336	CGWB
3B2 44M/ 14							FATEHGARH NIGRA	459.33	282	CGWB

3. HYDROGEOLOGY

3.1 PREVIOUS WORK

Unconsolidated alluvial sediments lying south of Siwalik foothills mainly occupy the district. The alluvial sediments are classified as piedmont and fluvial deposits. The piedmont deposits lie along Siwalik Hills, which comprises boulders, pebbles, gravel, sand and clay. It is further divided into Kandi and Sirowal, which are contemporaneous, and merge imperceptibly with each other. The fluvial comprise of silt,sand, gravel and clay in association with Kankar. General Nature of sediments is given in table-2. Ground water is generally fresh at all levels. Ground water exploration was carried out at 48 sites which includes 11 piezometers . Detailed list of these exploratory boreholes is given in table-3. The boreholes at Patti Khas, Naloian, Jian, Hariana and Niala were abandoned due to insufficient thickness of aquifers. In the rest of the area, as well the ground water occurs under unconfined conditions in shallow aquifers and under semi-confined to confined condition in deeper aquifers. The drilling depth range from 126 to 460m bgl and constructed in the depth range of 103 to 374m. The yield of these wells ranges from 708 lpm to 2900 lpm with draw down of 5 to 12m. The wells constructed in the northwestern part of the district were high yielding wells than those constructed along the Siwalik foothills zone. Transmissivity of aquifers ranges from 634 to 4120 m2/day. The hydraulic conductivity value in the district varies from 2 to 29m/day. The value of storage coefficient worked out to be 58x10-2 to 1.8 x 10 -3.

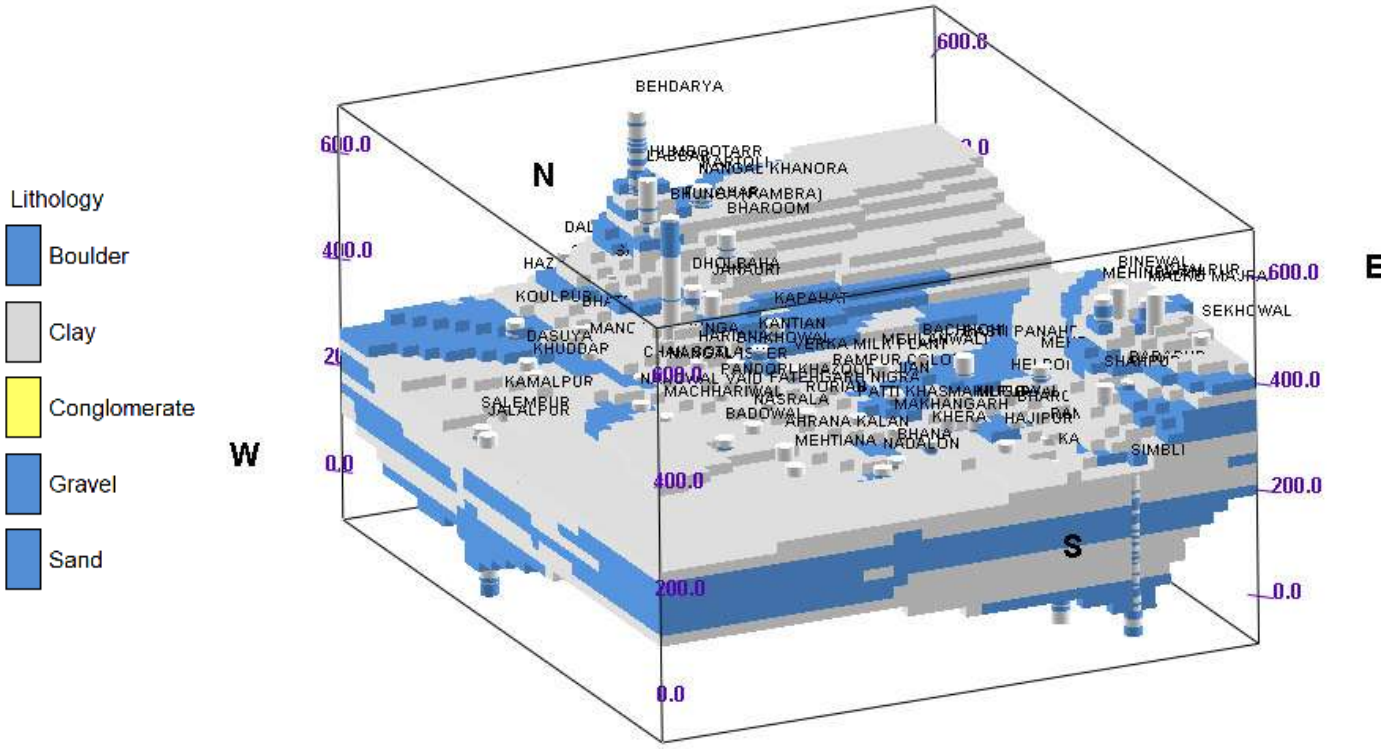
General nature of sediments

Aquifer Group	Depth Range (m bgl)	General Nature
I	0 to 55	Unconfined consisting of individual sand & clay layers
II	160 to 225	Semi-confined/ confined consisting of individual sand and clay layers.
III	380 to 425	Confined, consisting of thin sand layers alternating with thicker clay layer

3.2 Present NAQUIFERUIM 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 and 3D lithological fence diagram has been prepared using the lithology model and are shown in fig 5 & 6 respectively.

Fig 5: 3-Dimension Lithological Model of Hoshiarpur 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. Striplogs showing lithologs of exploration wells and various block diagrams based on Lithology and Aquifer Group .

Fig 7: 3 Dimension strip logs of Hoshiarpur District

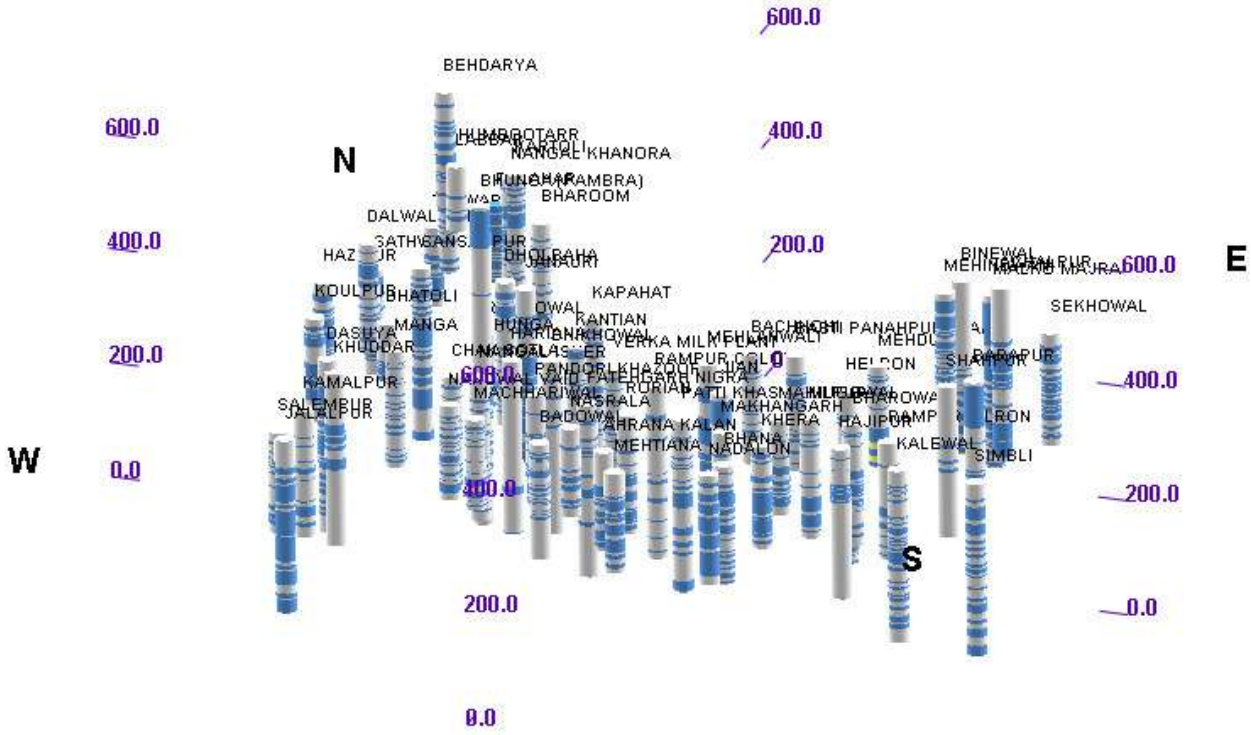
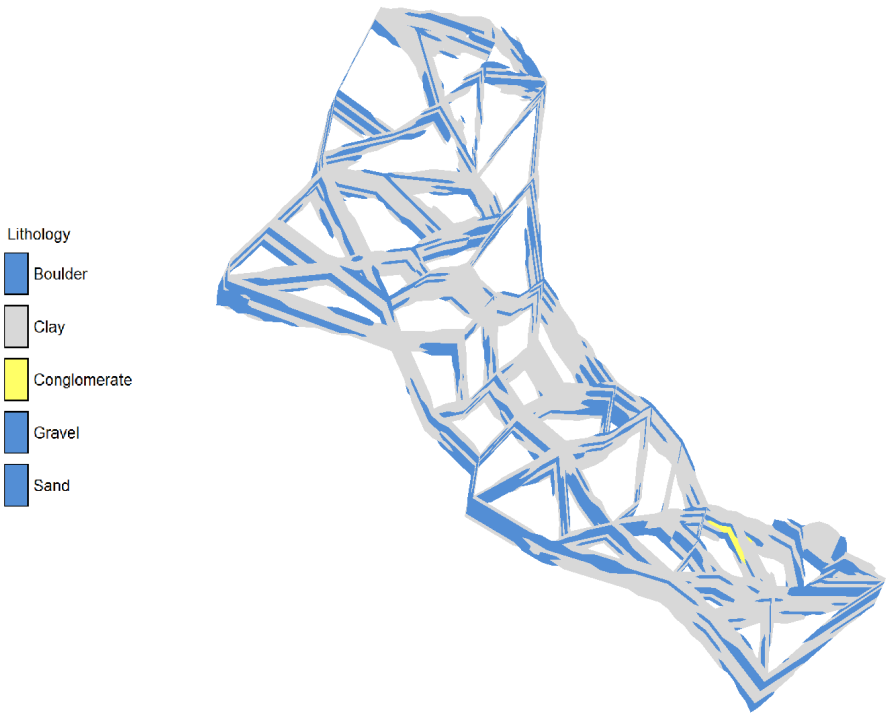


Fig 8: 3 Dimension Lithological Fence of Hoshiarpur District



3.3 Aquifer Geometry

Hoshiarpur District forms part of BIST Doab and 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 Hoshiarpur 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.

Fig 9: 3-Dimension Aquifer model - Hoshiarpur District

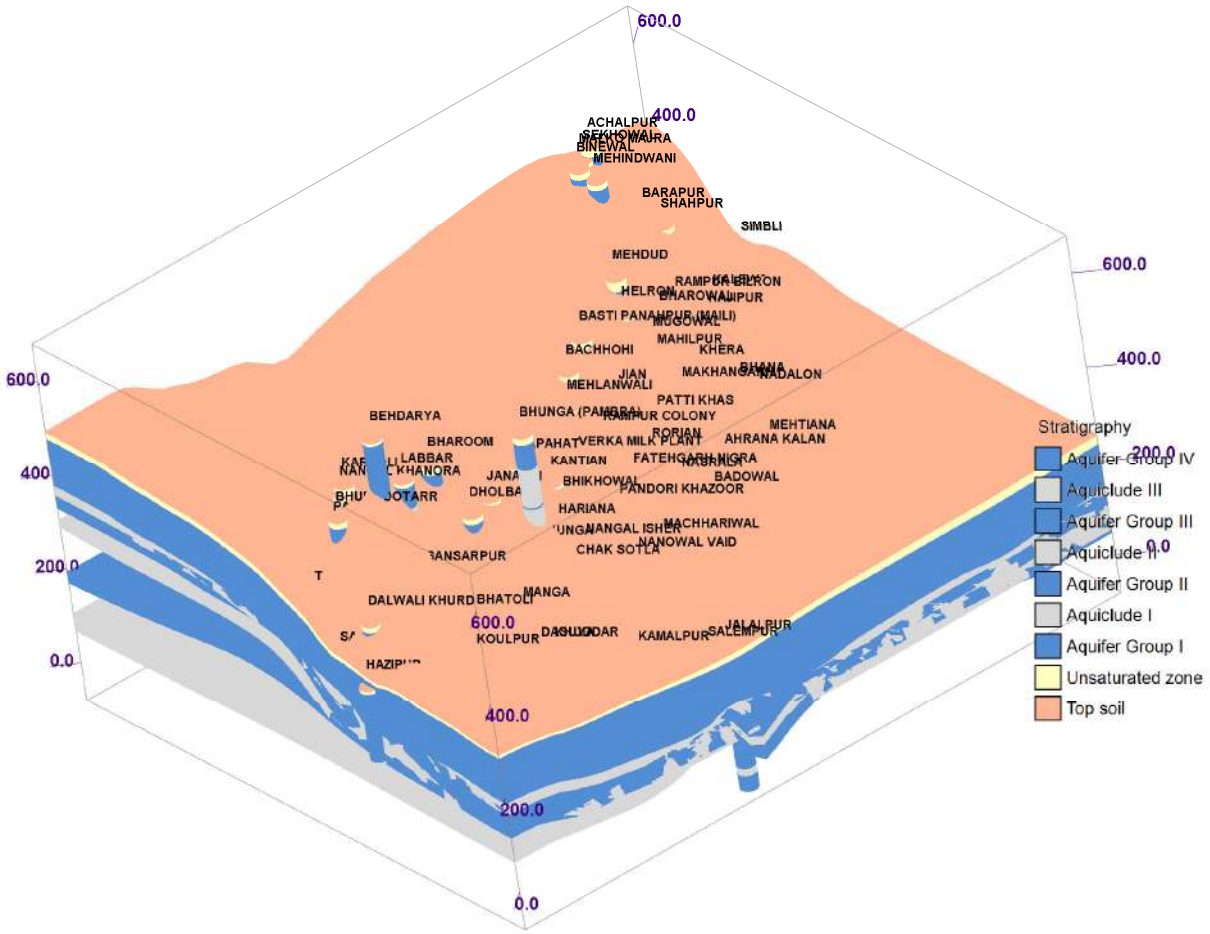
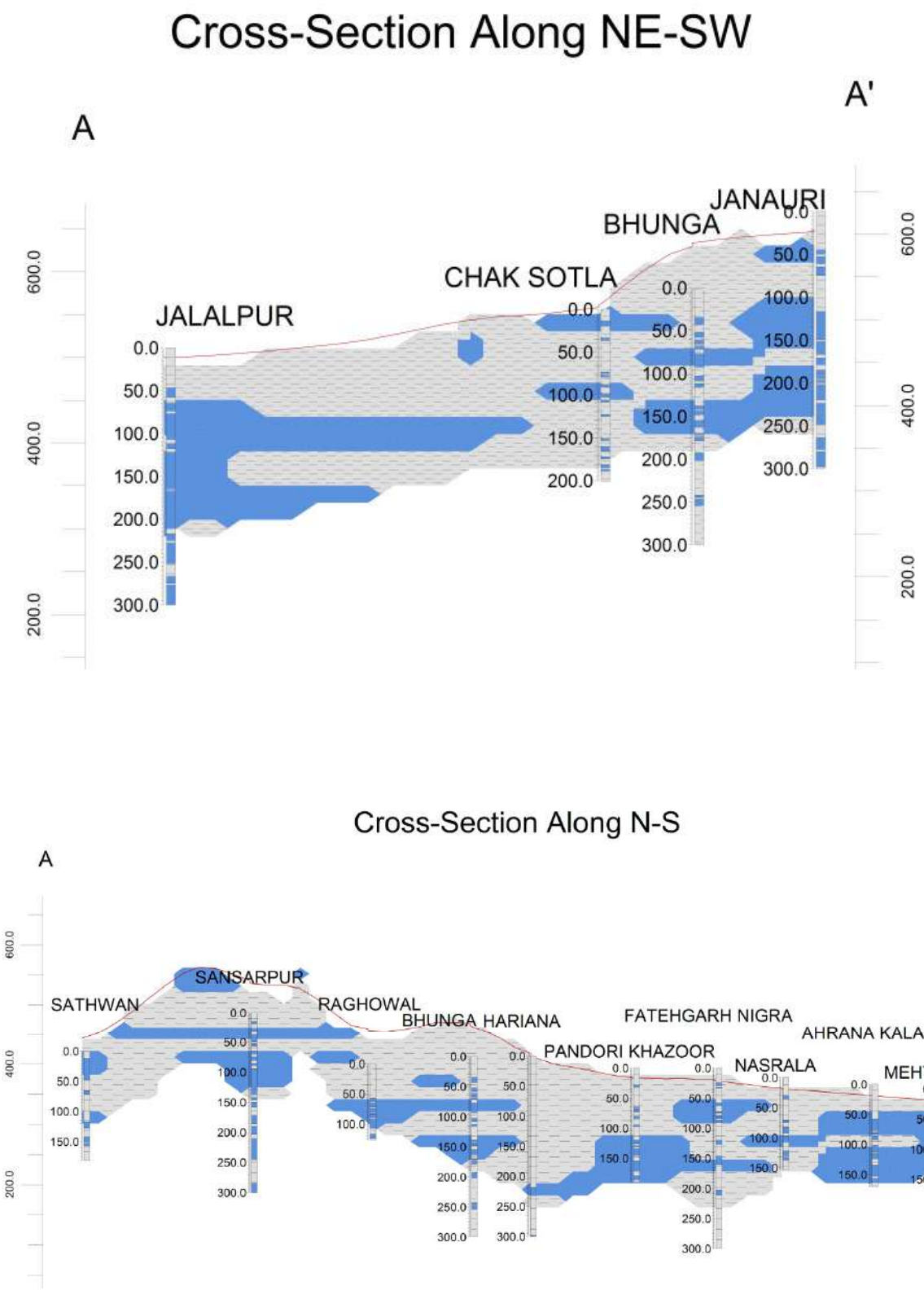
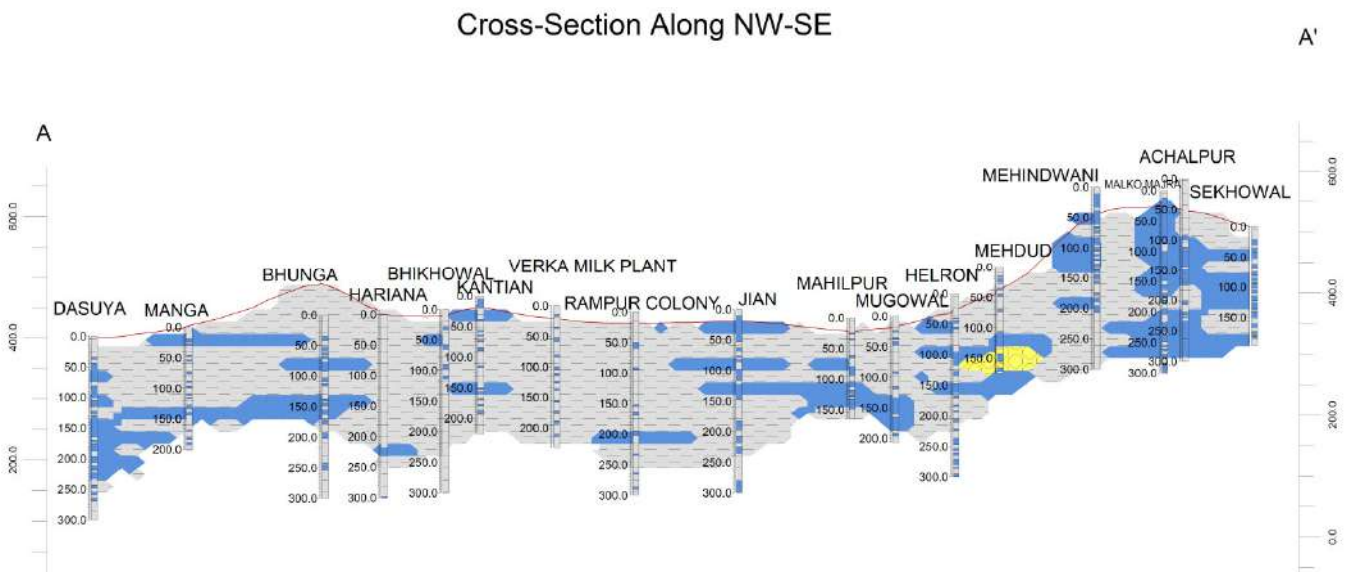


Fig 10: Cross sections of Aquifer Map of Hoshiarpur District





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 3 blocks has exceeded the available recharge, thus 4 blocks **Dasuya, Garhshankar Hoshiarpur-I** and **Tanda** have been categorized as **over exploited** except **Mukerian** which is **Semi- Critical**. Stage of ground water development in the Hoshiarpur district has been assessed to be **99%**.

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 (%)
BHUNGA	**10259**	6198	300	6498	351	3710	63
DASUYA	**12816**	14055	385	14440	450	-1688	113
GARHSAHNKAR	**13128**	14012	944	14956	1014	-1898	114
HAZIPUR	**8289**	5654	183	5838	215	2420	70
HOSHIARPUR-1	**9862**	10724	1139	11863	1270	-2132	120
HOSHIARPUR-II	**8971**	5208	493	5701	548	3215	64
MAHILPUR	**7032**	5051	156	5206	182	1799	70
MUKERIAN	**9163**	7790	416	8205	483	890	90
TALWARA	**1945**	1212	140	1352	164	569	70
TANDA	**9640**	15936	246	16182	288	-6584	168
Total (ham)	**91106**	**85840**	**4403**	**90242**	**4966**	**301**	**99**

Instorage 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 modelling approach.

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

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

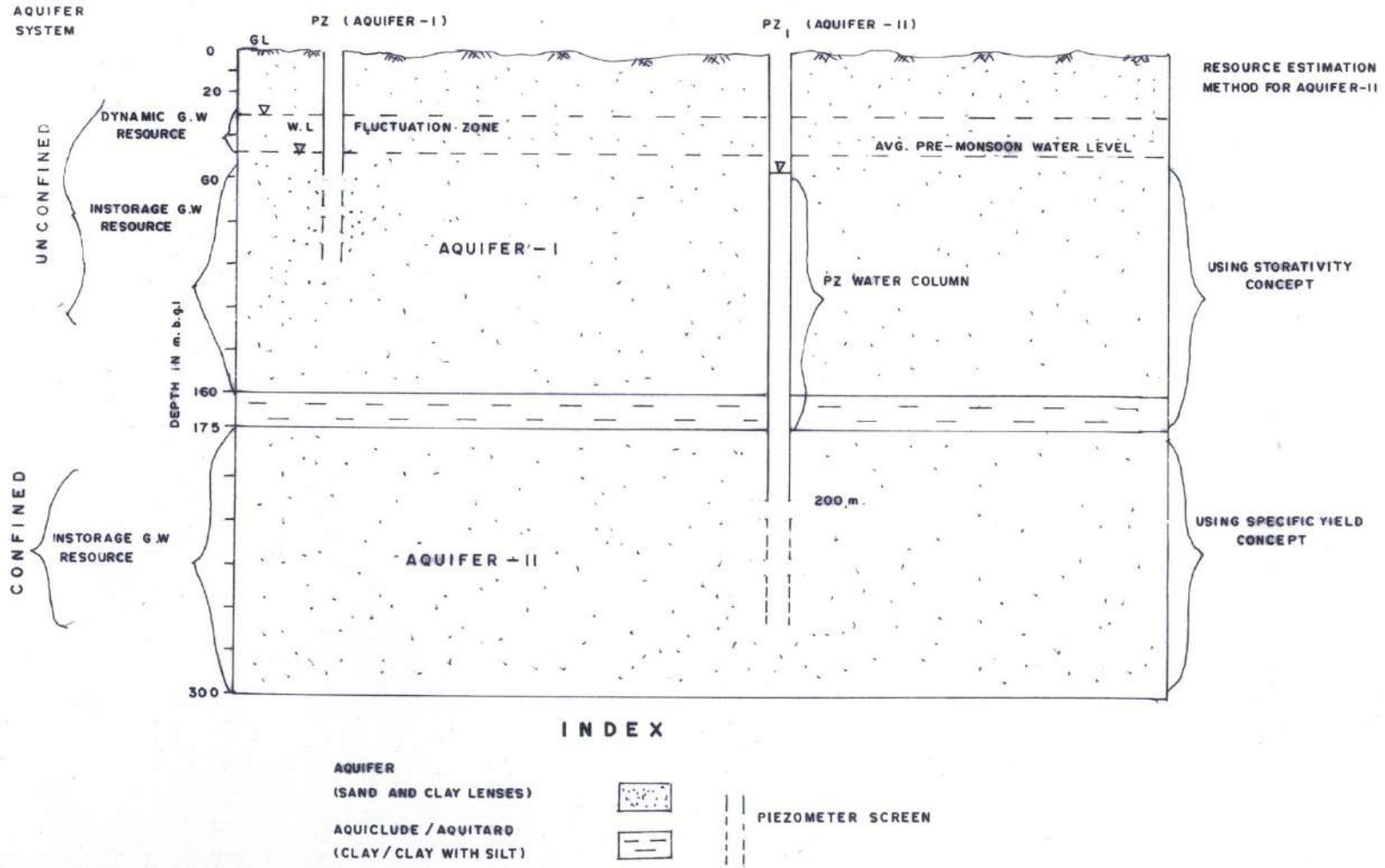


Table 5: BLOCK WISE INSTORAGE GROUND WATER RESOURCES IN UNCONFINED AQUIFER -I

Annexure II A-1 (for unconfined aquifer, alluvial area)													
GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF HOSHIARPUR 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	BHUNGA	549.1	549.1	549.1	0	15	131	116	79	0.072	3123	*102.59*	3226
2	DASUYA	374.5	374.5	374.5	0	6	111	105	58	0.072	1564	*128.16*	1692
3	GARHSAHNKAR	412.1	412.1	412.1	0	18	104	86	65	0.072	1929	*131.28*	2060
4	HAZIPUR	125.9	125.9	125.9	0	8	111	103	50	0.072	453	*82.88*	536
5	HOSHIARPUR-1	311.2	311.2	311.2	0	21	156	135	60	0.072	1344	*98.61*	1443
6	HOSHIARPUR-II	462.6	462.6	462.6	0	21	90	69	65	0.072	2165	*89.71*	2255
7	MAHILPUR	379.9	379.9	379.9	0	23	150	127	64	0.072	1751	*70.31*	1821
8	MUKERIAN	256	256	256	0	6	143	137	62	0.072	1143	*91.63*	1234
9	TALWARA	226.4	226.4	226.4	0	15	160	145	87	0.072	1418	*19.45*	1438
10	TANDA	233.7	233.7	233.7	0	12	147	135	75	0.072	1262	*96.40*	1358
Dist.Total (mcm)		**3331.4**	**3331.4**	**3331.4**	**0**						**16152**	**911**	**17063**
Dist.Total (bcm)											**16.15**		17.06

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)	Piezo-metric 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	BHUNGA	549.1	549.1	549.1	137	202	47	155	65	28	0.072	0.00128	1107	108.94	1216
2	DASUYA	374.5	374.5	374.5	112	155	7	148	43	38	0.072	0.00128	1025	70.95	1096
3	GARHSAHNKAR	412.1	412.1	412.1	130	180	36	144	50	40	0.072	0.00157	1187	93.17	1280
4	HAZIPUR	125.9	125.9	125.9	120	181	8	173	61	40	0.072	0.00128	363	27.88	390
5	HOSHIARPUR-1	311.2	311.2	311.2	124	185	34	151	61	19	0.072	0.00157	426	73.78	499
6	HOSHIARPUR-II	462.6	462.6	462.6	129	195	26	169	66	22	0.072	0.00157	733	122.74	856
7	MAHILPUR	379.9	379.9	379.9	107	194	25	169	87	32	0.072	0.00157	875	100.80	976
8	MUKERIAN	256	256	256	112	155	7	148	43	38	0.072	0.00128	700	48.50	749
9	TALWARA	226.4	226.4	226.4	122	189	28	161	67	17	0.072	0.00128	277	46.66	324
10	TANDA	233.7	233.7	233.7	107	175	33	142	68	19	0.072	0.00068	320	22.57	342
Dist.Total (mcm)		**3331.4**	**3331.4**	**3331.4**	**0**								**7012**	**715.97**	**7728**
Dist.Total (bcm)													**70.12**	**7.16**	**77.28**

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	BHUNGA	549.1	549.1	549.1	225	300	201.8	75	28	0.072	0.000237	1107	26.3	1133
2	DASUYA	374.5	374.5	374.5	204	300	180.8	96	15	0.072	0.000237	404	16.0	421
3	GARHSAHNKAR	412.1	412.1	412.1	196	300	172.8	104	44	0.072	0.000237	1306	16.9	1322
4	HAZIPUR	125.9	125.9	125.9	208	300	184.8	92	21	0.072	0.000237	190	5.5	196
5	HOSHIARPUR-1	311.2	311.2	311.2	203	300	179.8	97	28	0.072	0.000237	627	13.3	641
6	HOSHIARPUR-II	462.6	462.6	462.6	235	300	211.8	65	14	0.072	0.000237	466	23.2	490
7	MAHILPUR	379.9	379.9	379.9	215	300	191.8	85	40	0.072	0.000237	1094	17.3	1111
8	MUKERIAN	256	256	256	204	300	180.8	96	15	0.072	0.000237	276	11.0	287
9	TALWARA	226.4	226.4	226.4	208	300	184.8	92	21	0.072	0.000237	342	9.9	352
10	TANDA	233.7	233.7	233.7	203	300	179.8	97	28	0.072	0.000237	471	10.0	481
Dist.Total (mcm)		**3331.4**	**3331.4**	**3331.4**	**0**							**6285**	**149**	**6434**
Dist.Total (bcm)												**6.29**	**0.15**	**6.43**

The Average Peizometer head value for Confined Aquifer-III is 23.20m.bgl

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

AVAILABILITY OF TOTAL FRESH GROUNDWATER RESOURCES IN HOSHIARPUR 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	BHUNGA	*102.59*	*3123.28*	3226	1216	1133	5575	557505
2	DASUYA	*128.16*	*1563.91*	1692	1096	421	3208	320816
3	GARHSAHNKAR	*131.28*	*1928.63*	2060	1280	1322	4662	466233
4	HAZIPUR	*82.88*	*453.24*	536	390	196	1122	112247
5	HOSHIARPUR-1	*98.61*	*1344.38*	1443	499	641	2583	258313
6	HOSHIARPUR-II	*89.71*	*2164.97*	2255	856	490	3600	359970
7	MAHILPUR	*70.31*	*1750.58*	1821	976	1111	3908	390836
8	MUKERIAN	*91.63*	*1142.78*	1234	749	287	2271	227078
9	TALWARA	*19.45*	*1418.17*	1438	324	352	2114	211362
10	TANDA	*96.40*	*1261.98*	1358	342	481	2182	218175
Dist.Total (ham)		***91106***	***1615192***	***10725765***	***772803***	***643436***	***12142004***	1214200416
Dist.Total (mcm)		**911**	***16152***	**17063**	**7728**	**6434**	**31225**	**3122533.5**

5. GROUND WATER RELATED ISSUES

Hoshiarpur 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.

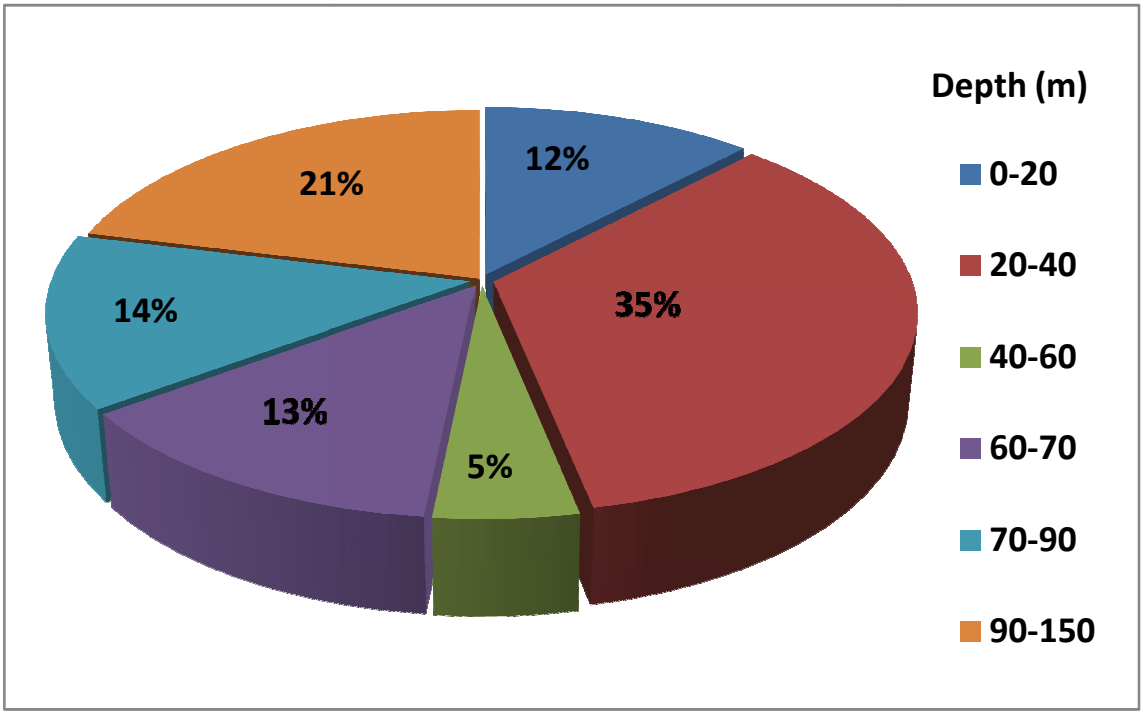


Table 9-Distribution of Tube wells According to Owner's holding Size

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	**Hoshiarpur**	**4090**	**7485**	**13818**	**10702**	**1675**	**37770**

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	**Hoshiarpur**	**7033**	**20239**	**2783**	**7715**	**0**	**37770**

Table11- Type of Ground water distribution device

Open Water Channel		
Lined/pucca	**Unlined/kutcha**	Total
15106	**37156**	52262

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 58442 tubewells operated by farmers for irrigation through unlined/Kutcha (63.57%) open channel system in Hoshiarpur 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 Hoshiarpur district is estimated at 902.40 MCM. It is expected that around 10.34 % 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 807.79 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 Hoshiarpur Districts. The measure if implemented will bring down the ground water overdraft from 99% to 88.66 %. 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 crops 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	Ground Water lability mcm)	l 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		
BHUNGA	102.59	61.98	63	16.2	0.00	0.0	16.2	48	Not required
DASUYA	128.16	140.55	113	36.1	5.09	0.0	41.2	81	Not required
GARHSAHNKAR	131.28	140.12	114	37.4	4.84	0.0	42.2	82	Not required
HAZIPUR	82.88	56.54	70	14.6	2.75	0.0	17.3	50	Not required
HOSHIARPUR-1	98.61	107.24	120	29.7	0.00	0.0	29.7	90	Not required
HOSHIARPUR-II	89.71	52.08	64	14.3	0.00	0.0	14.3	48	Not required
MAHILPUR	70.31	50.51	70	12.3	0.00	0.0	12.3	57	Not required
MUKERIAN	91.63	77.90	90	20.5	0.00	0.0	20.5	67	Not required
TALWARA	19.45	12.12	70	3.4	0.00	0.0	3.4	52	Not required
TANDA	96.40	159.36	168	40.5	3.62	21.3	65.4	100	16
Total	911	858.40	99	225.6	16.30	21.3	241.9	73	16

7. BLOCK WISE AQUIFER MAPS AND MANAGEMENT PLAN

(I) BHUNGA BLOCK (549.10 SQ KM)

1. Salient Information

Population (2011)	Rural-1,38,051 Urban-0 Total-1,38,051
Rainfall 2014 (Hoshiarpur District)	Average annual rainfall -938 mm
Average Annual Rainfall (Bhunga block)	943 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops-Sugarcane, Potatoes, Pulses, Net Area Sown- 238.92 sq.km Total Irrigated Area-238.92 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 available in the Bhunga block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (79 m) is very prominent in terms of thickness and geographic extent. Aquifer II (28 m) & III (28 m) are less in thickness. Block is categorized as **Safe** 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-*~13.60-21.00 (mbgl)* &Post Monsoon-*~12.38-19.85 (mbgl)*

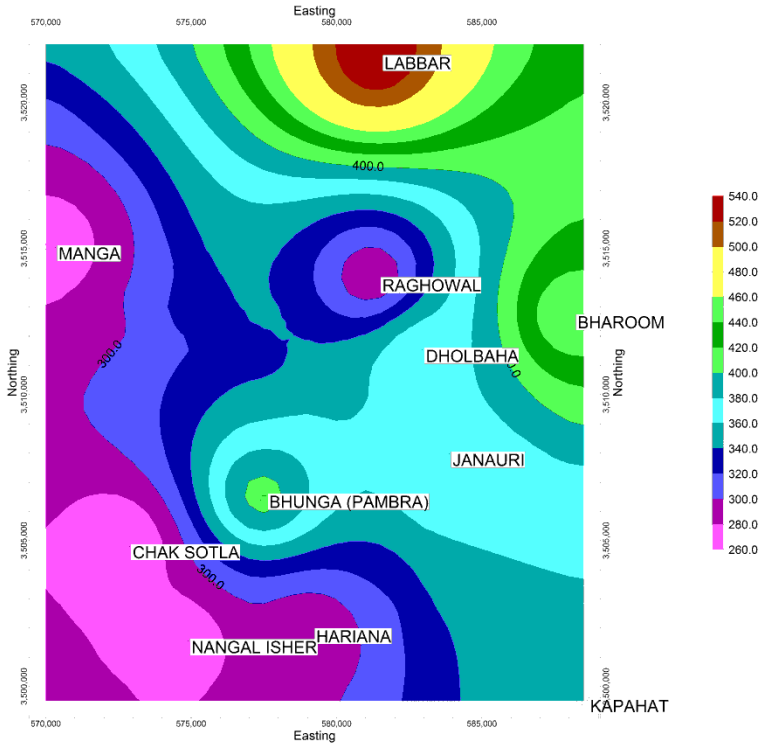
Aquifer Disposition: Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (15-131m)	Quaternary Alluvial deposits	Unconfined	79	130-2248	0.072	$1.57*10^{-3}$ to $6.8*10^{-4}$
Aquifer-II (137-202m)		Unconfined to Confined	28	-	NA	-
Aquifer-III (225-300m)		Unconfined to Confined	28	-	NA	-

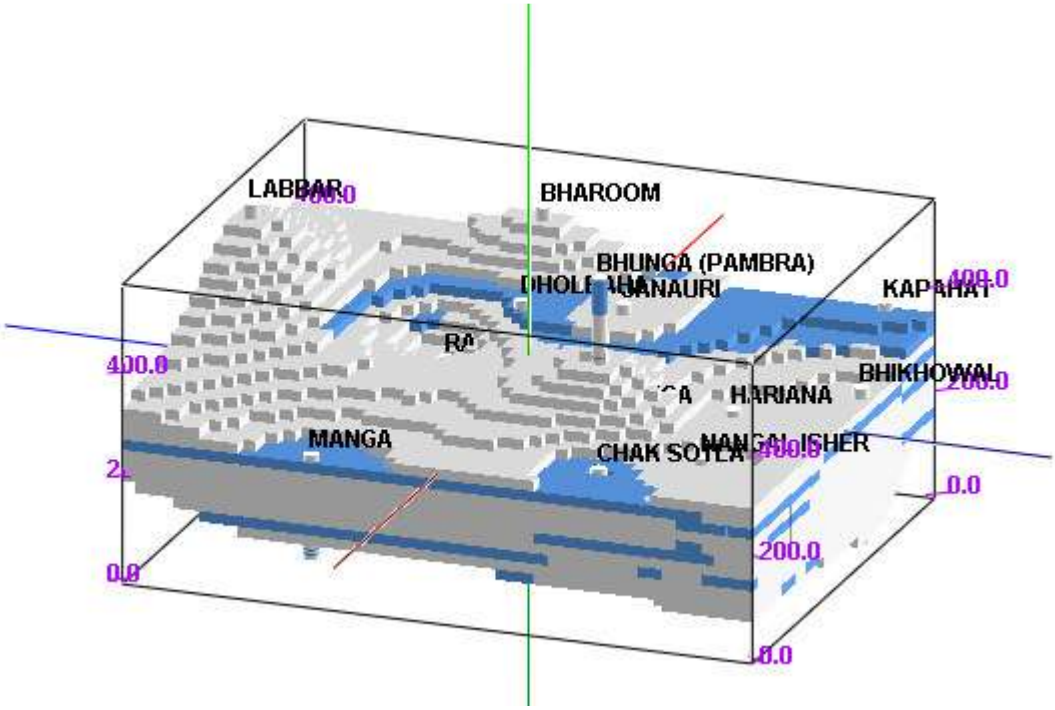
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

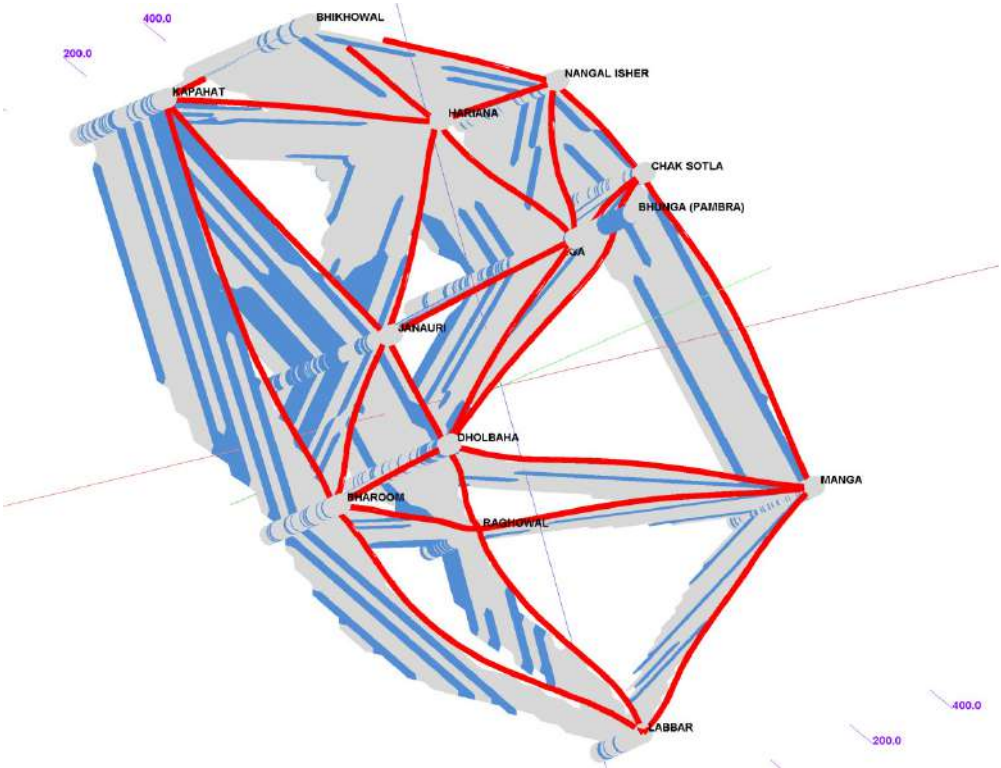
Elevation Contour Map- Bhunga Block



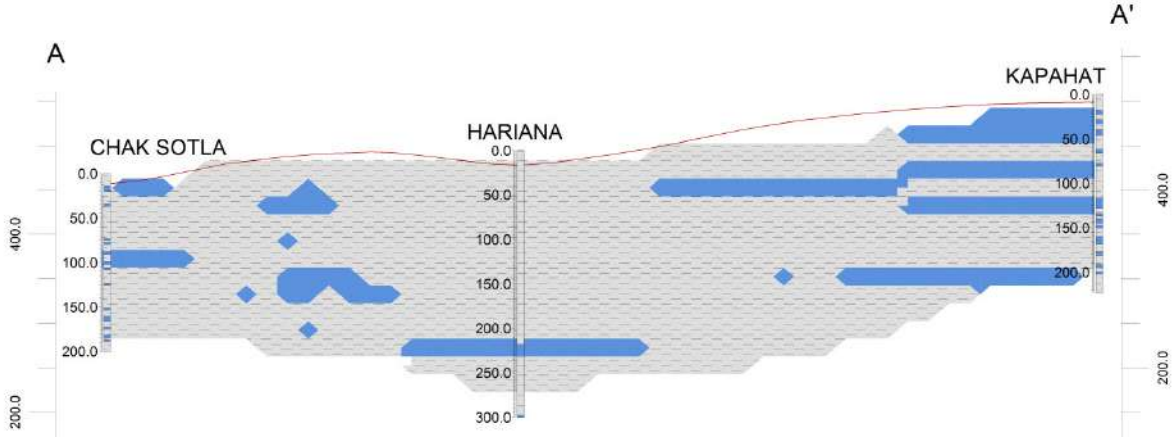
3D Lithology model



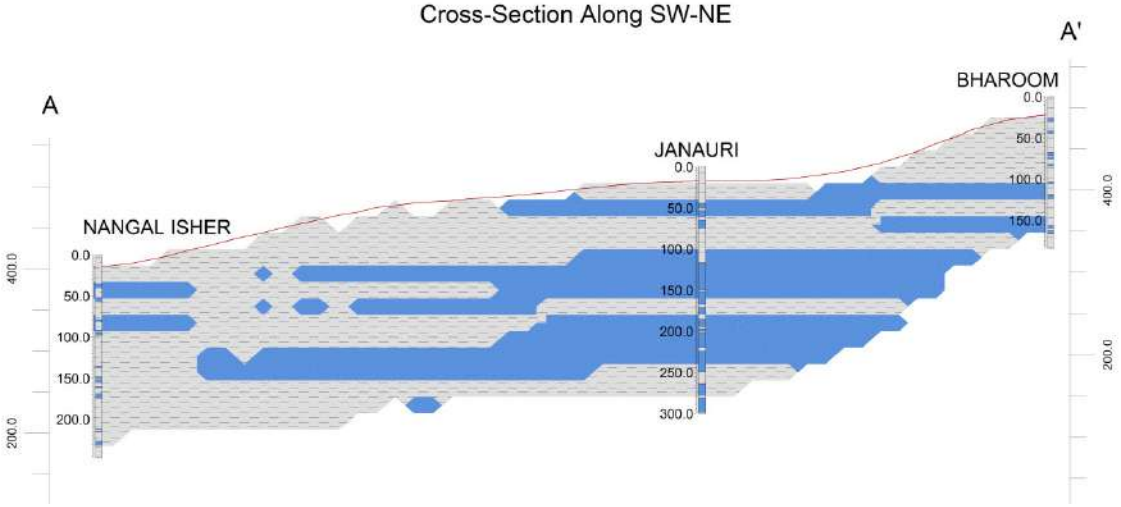
3D Lithology Fence



Cross-Section Along NW-SE



Cross-Section Along SW-NE



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

Aquifer wise Water Resource available (mcm)	Dynamic Aquifer I	102.59
	In-storage Aquifer I	3123.28
	Dynamic Aquifer II	-
	In-storage Aquifer II	1216
	Dynamic Aquifer III	-
	In-storage Aquifer III	1133
	Total	5575
Ground Water Extraction (in mcm)	Irrigation	61.98
	Domestic & Industrial	3.00
Provision for domestic & Industrial requirement upto 2025 (in mcm)		3.51
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 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 is not required in the block

4. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 16.20 mcm volume of water wastage
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	-

(II) DASUYA BLOCK (374.50 SQ KM)

1. Salient Information

Population (2011)	Rural-120128 Urban-- Total-120128
Rainfall 2014 (Hoshiarpur District)	Average annual rainfall -938mm
Average Annual Rainfall (Dasuya block)	908 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops-Sugarcane, Potatoes, Pulses, Net Area Sown- 221.72 sq.km Total Irrigated Area-223.62 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 Dasuya 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 (38m) is less in terms of thickness and geographic extent & Aquifer III (15m) data is limited for resources. 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 2.64-*8.39 (mbgl) (mbgl) &*Post Monsoon-*~3.0-9.00(mbgl) (mbgl)*

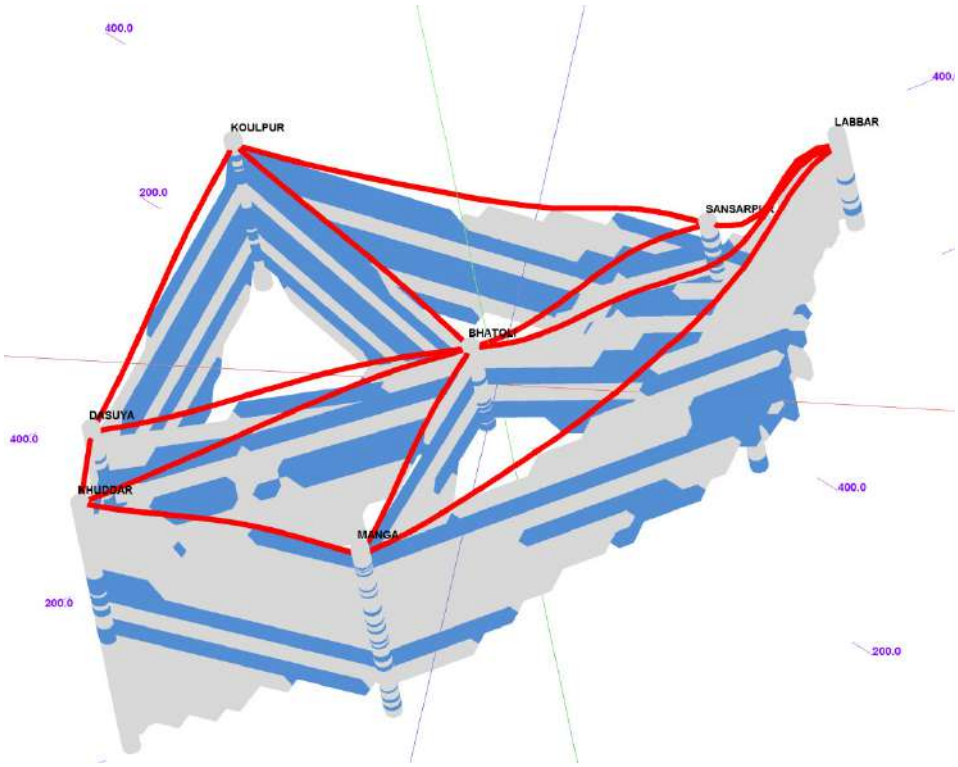
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (6-111m)	Quaternary Alluvial deposits	Unconfined	58	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (112-200m)		Unconfined to Confined	38	-	NA	0.00128
Aquifer-III (204-300m)		Unconfined to Confined	15	-	NA	0.000237

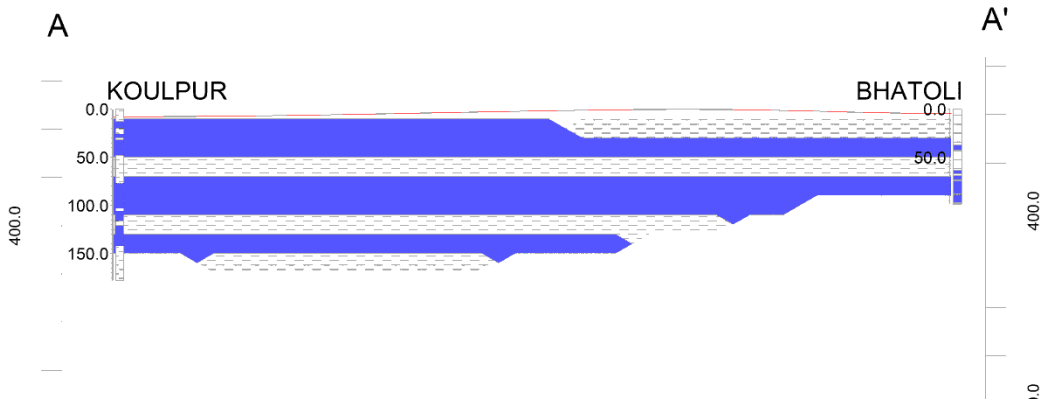
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

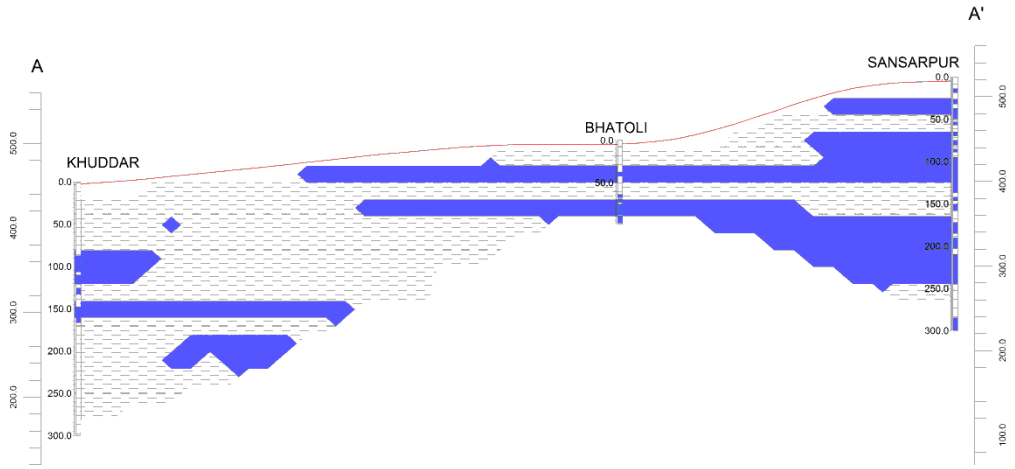
3D Lithology Fence



Cross-Section Along NW-SE



Cross-Section Along SW-NE



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

Aquifer wise Water Resource available (mcm)	Dynamic Aquifer I	*128.16*
	In-storage Aquifer I	*1563.91*
	Dynamic Aquifer II	1096
	In-storage Aquifer II	1096
	Dynamic Aquifer III	-
	In-storage Aquifer III	421
	Total	3208
Ground Water Extraction (in mcm)	Irrigation	140.55
	Domestic & Industrial	3.85
Provision for domestic & Industrial		4.50

requirement in 2025 (mcm)	
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 (6 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 5.09 mcm volume of water

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 41.21 mcm volume of water wastage
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) GARHSHANKAR BLOCK (412.10 SQ KM)

1. Salient Information

Population (2011)	Rural-169580 Urban- - Total-169580
Rainfall 2014 (Hoshiarpur District)	Average annual rainfall -938mm
Average Annual Rainfall (Gharshankar block)	806 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops- Sugarcane, Potatoes, Pulses, Net Area Sown- 225.77sq.km Total Irrigated Area - 227.69 sq.km

Water Bodies & Canal Irrigation

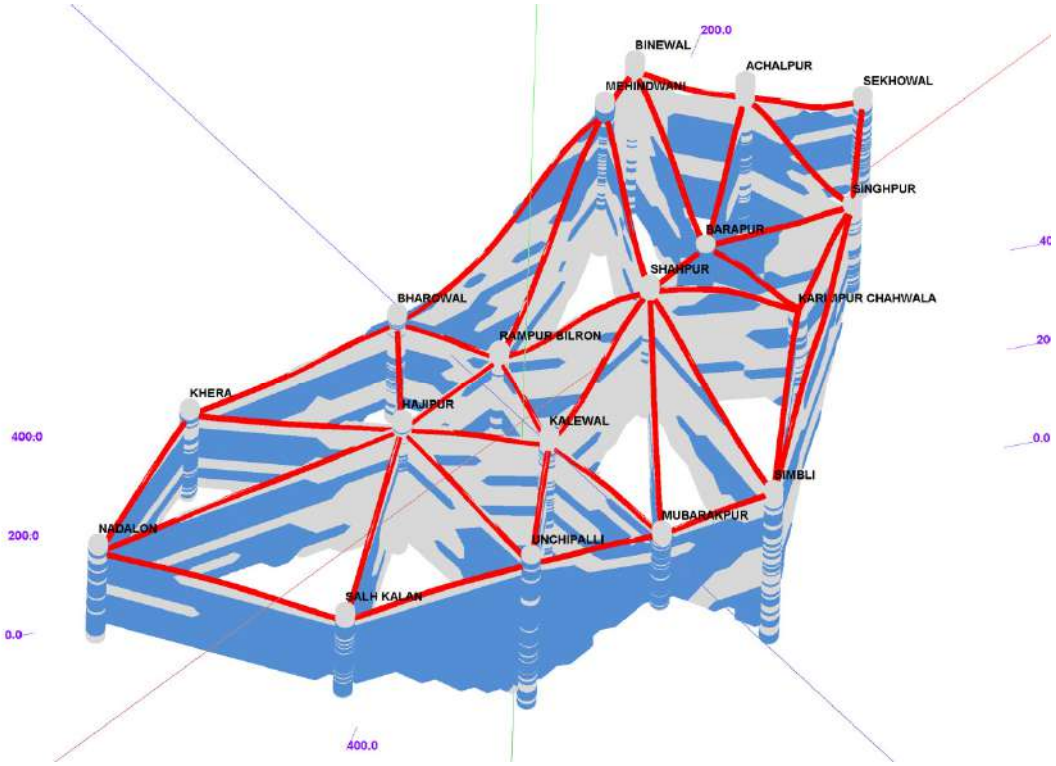
Water bodies available in the villages for storm water and untreated waste water of villagers, that can be used for irrigation after treatment. The canal irrigation is also available in the Garhshankar block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (65 m) is very prominent in terms of thickness and geographic extent. Aquifer II (50m) & III (44 m) are less in thickness. Block is categorized as **Over-Exploited** as per Ground Water assessment 2013.

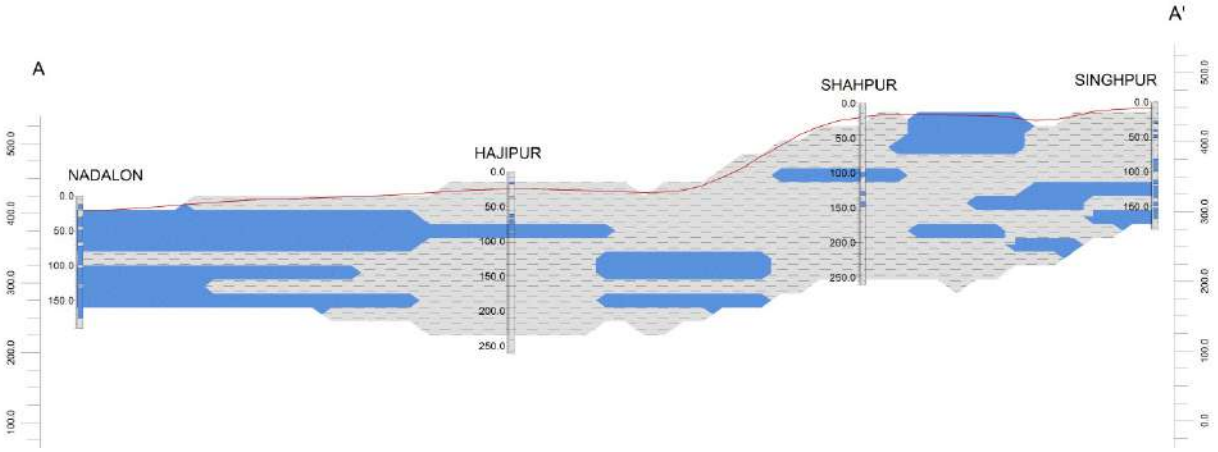
Ground water Extraction: Information regarding the abstraction from Aquifer III is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

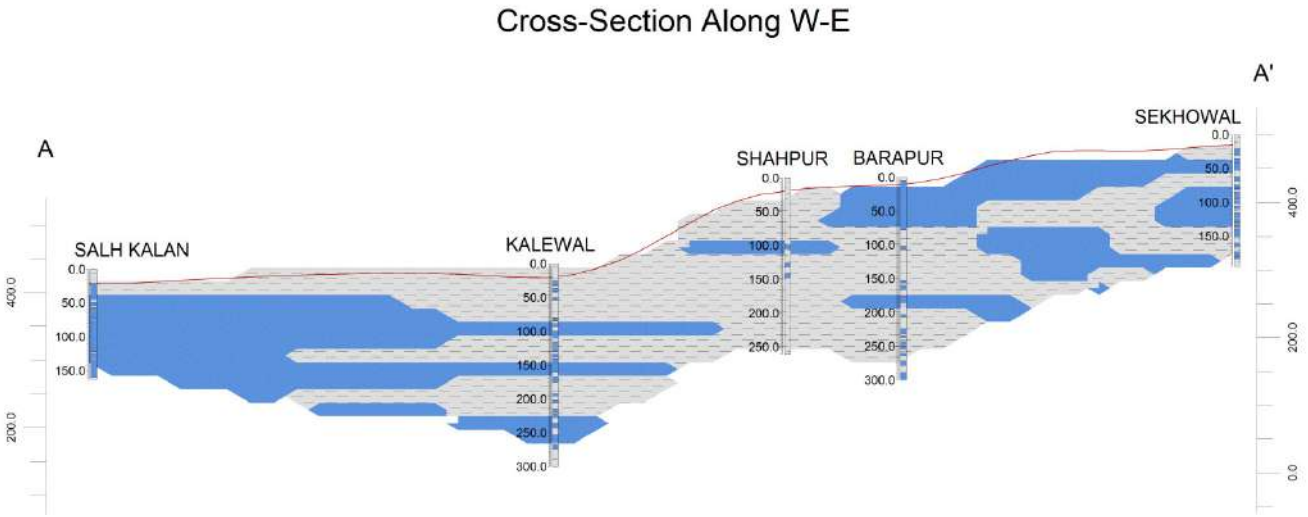
Water level Behavior (2015): Pre Monsoon *22.00-23.00 (mbgl) (mbgl)* & Post Monsoon-~*23.00-4.00 (mbgl) (mbgl)+6*

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 (6-104m)	Quaternary Alluvial deposits	Unconfined	65	*1450-7190*	0.072	2.00*10-2
Aquifer-II (130-200m)		Unconfined to Confined	50	-	NA	0.00157
Aquifer-III (200-300m)		Unconfined to Confined	44	-	NA	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	*131.28*
	In-storage Aquifer I	*1928.63*
	Dynamic Aquifer II	-
	In-storage Aquifer II	1280
	Dynamic Aquifer III	-
	In-storage Aquifer III	1322
	Total	4662
Ground Water Extraction (in	Irrigation	140.12
	Domestic & Industrial	9.44

mcm)		
Provision for domestic & Industrial requirement up to 2025 (mcm)		10.12
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 (18 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits will save 4.84 mcm volume of water

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 37.4 mcm volume of water wastage
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	-

(IV) HAZIPUR BLOCK (125.90 SQ KM)

1. **Salient Information**

Population (2011) Rural- 79144
Urban- 6091
Total-85235

Rainfall 2014 (Hoshiarpur District) Average annual rainfall -938 mm

Average Annual Rainfall (Hazipur block) 1005 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops- Sugarcane, Potatoes, Pulses,
Net Area Sown- 105.79 sq.km
Total Irrigated Area- 106.85 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 Hazipur block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (50 m) is very prominent in terms of thickness and geographic extent. Aquifer II (40 m) is less in thickness & Aquifer III is (21m) 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 *8.35— 13.38 (mbgl)* &Post Monsoon- *~ 8.02—11.80 (mbgl)*

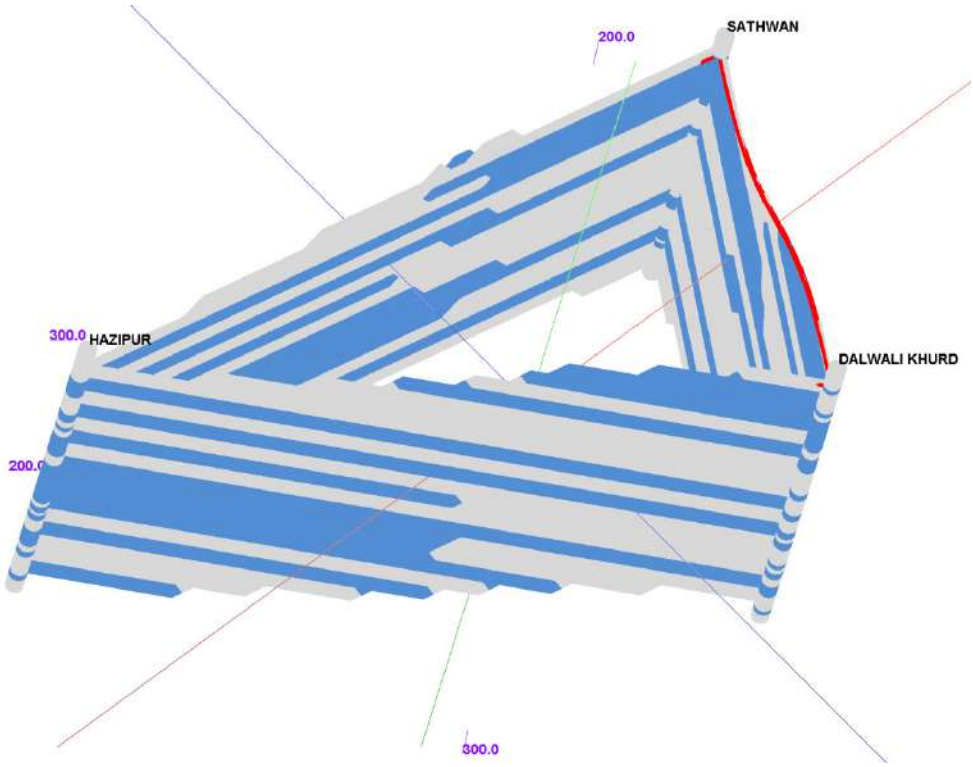
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (8-111m)	Quaternary Alluvial deposits	Unconfined	50	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (120-181m)		Unconfined to Confined	40	-	NA	0.00128
Aquifer-III (208-300m)		Unconfined to Confined	21	-	NA	0.000237

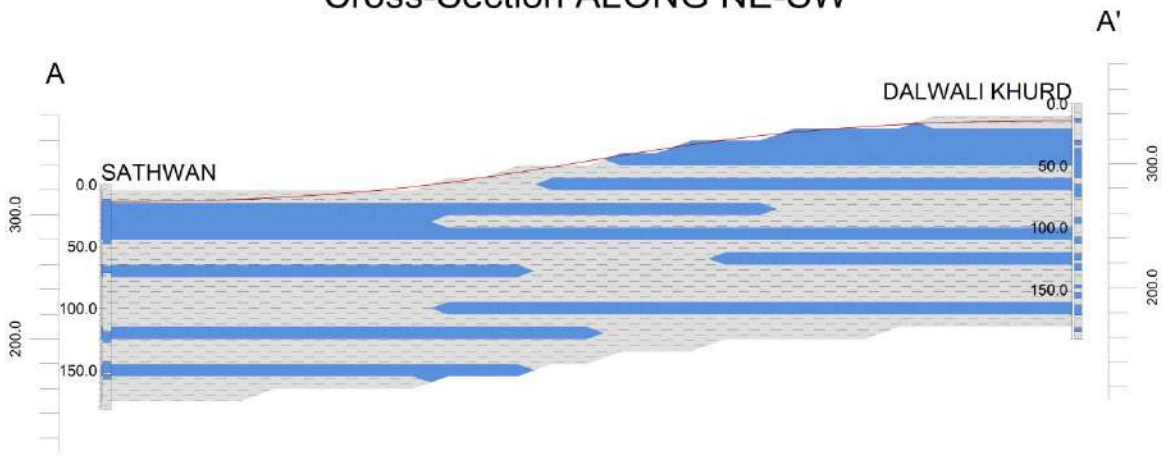
Aquifer comprises of freshwater only and the main aquifer material is sand.

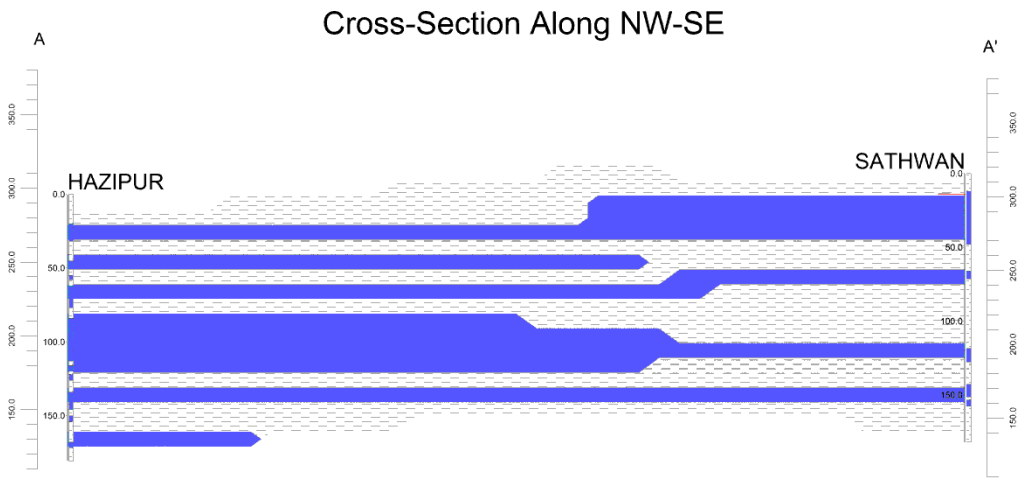
The non-aquifer material comprise of clay.

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	*82.88*
	In-storage Aquifer I	*453.24*
	Dynamic Aquifer II	-
	In-storage Aquifer II	390
	Dynamic Aquifer III	-
	In-storage Aquifer III	196
	Total	1122
Ground Water Extraction (in mcm)	Irrigation	56.54
	Domestic & Industrial	1.83
Provision for domestic & Industrial requirement 2025 (in mcm)		2.15
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 (8 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing

	pits will save 2.75 mcm volume of water

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 14.6 mcm volume of water wastage
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) HOSHIARPUR-I BLOCK (311.20 SQ KM)

1. Salient Information

Population (2011) Rural-153417
Urban- -
Total-153417

Rainfall 2014 (Hoshiarpur District) Average annual rainfall -699 mm

Average Annual Rainfall (Hoshiarpur -I block) 883 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops- Sugarcane, Potatoes, Pulses,
Net Area Sown- 254.59sq.km
Total Irrigated Area- 254.59 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 Hoshiarpur-I block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (60 m) and are very prominent in terms of thickness and geographic extent. Aquifer II (19 m) and Aquifer III is (28 m) is less in thickness. Block is categorized as **Over Exploited** 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)

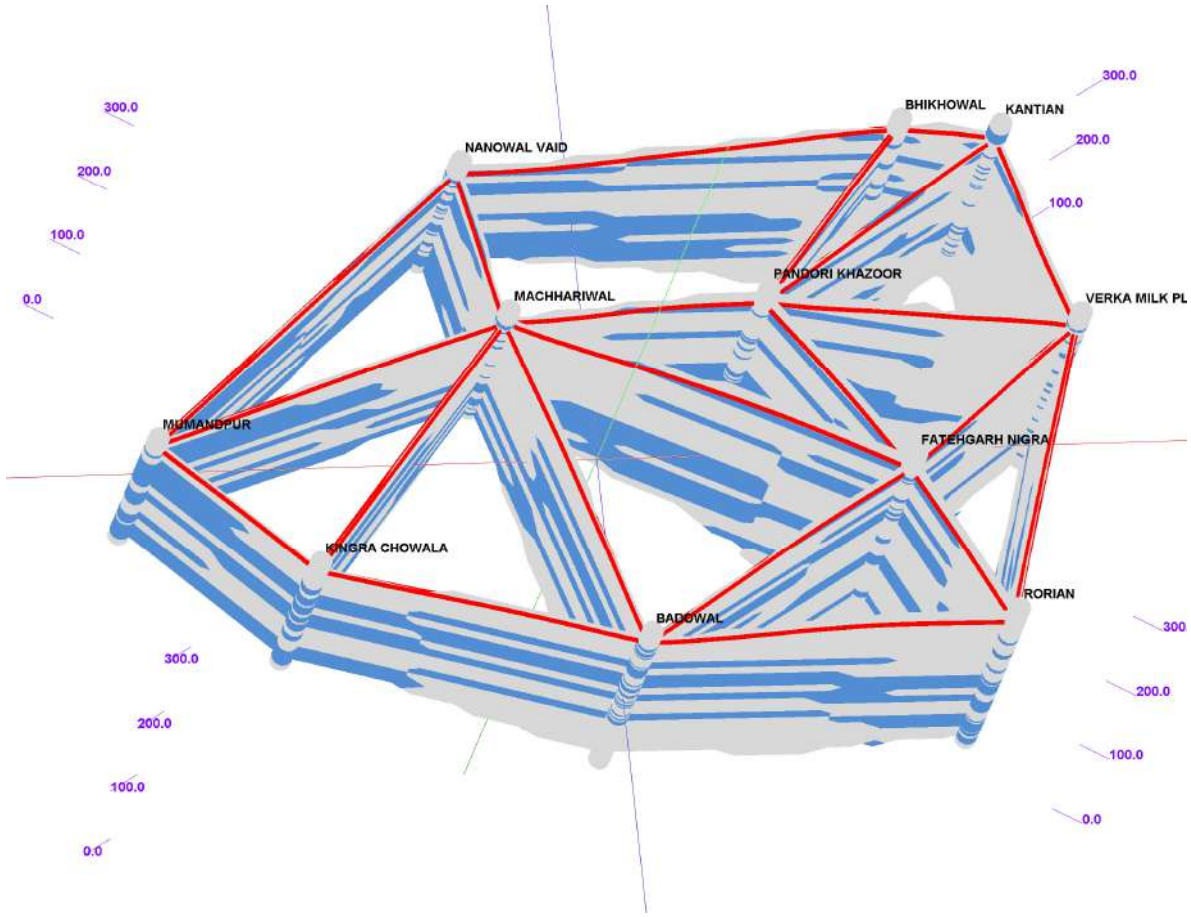
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (21-156m)	Quaternary Alluvial deposits	Unconfined	60	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (110-190m)		Unconfined to Confined	19	-	NA	0.00128
Aquifer-III (203-300m)		Unconfined to Confined	28	-	NA	0.000237

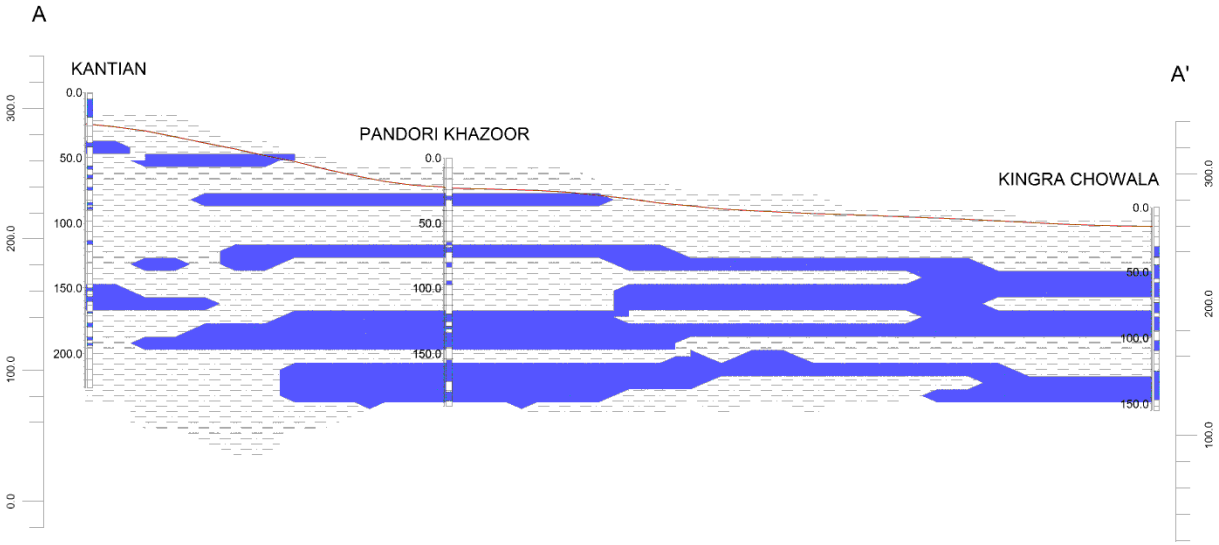
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

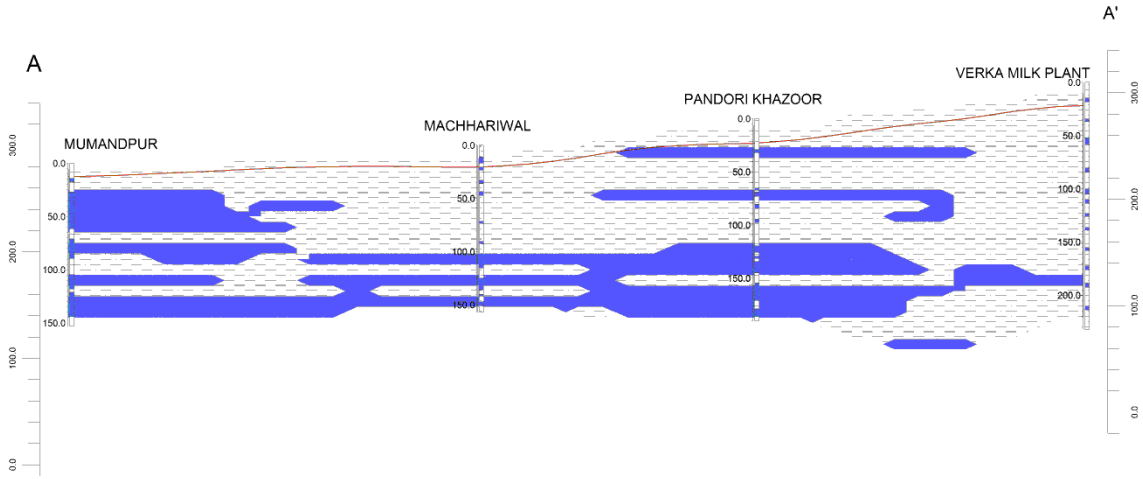
3D Lithology Fence



Cross-Section Along NE-SW



Cross-Section Along W-E



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

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*98.61*
	In-storage Aquifer I	*1344.38*
	Dynamic Aquifer II	-
	In-storage Aquifer II	499
	Dynamic Aquifer III	-
	In-storage Aquifer III	641
	Total	2583
Ground Water Extraction (in mcm)	Irrigation	107.24
	Domestic & Industrial	11.39
Provision for domestic & Industrial requirement up to 2025 (in mcm)		12.70
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 (21 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 29.7 mcm volume of water wastage
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	-

(VI) HOSHIARPUR -II BLOCK (462.60 SQ KM)

1. Salient Information

Population (2011) Rural-150830
Urban- 7304
Total-158134

Rainfall 2014 (Hoshiarpur District) Average annual rainfall -938 mm

Average Annual Rainfall (Hoshiarpur-II block) 883 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops- Sugarcane, Potatoes, Pulses,
Net Area Sown- 265.23sq.km
Total Irrigated Area- 265.23sq.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 Hoshiarpur block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (65 m) is very prominent in terms of thickness and geographic extent. Aquifer II (22 m) is very prominent in terms of thickness & Aquifer III is (14 m) 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 *3.95-34.20 (mbgl)* &Post Monsoon- *~ 3.85-34.96 (mbgl)*

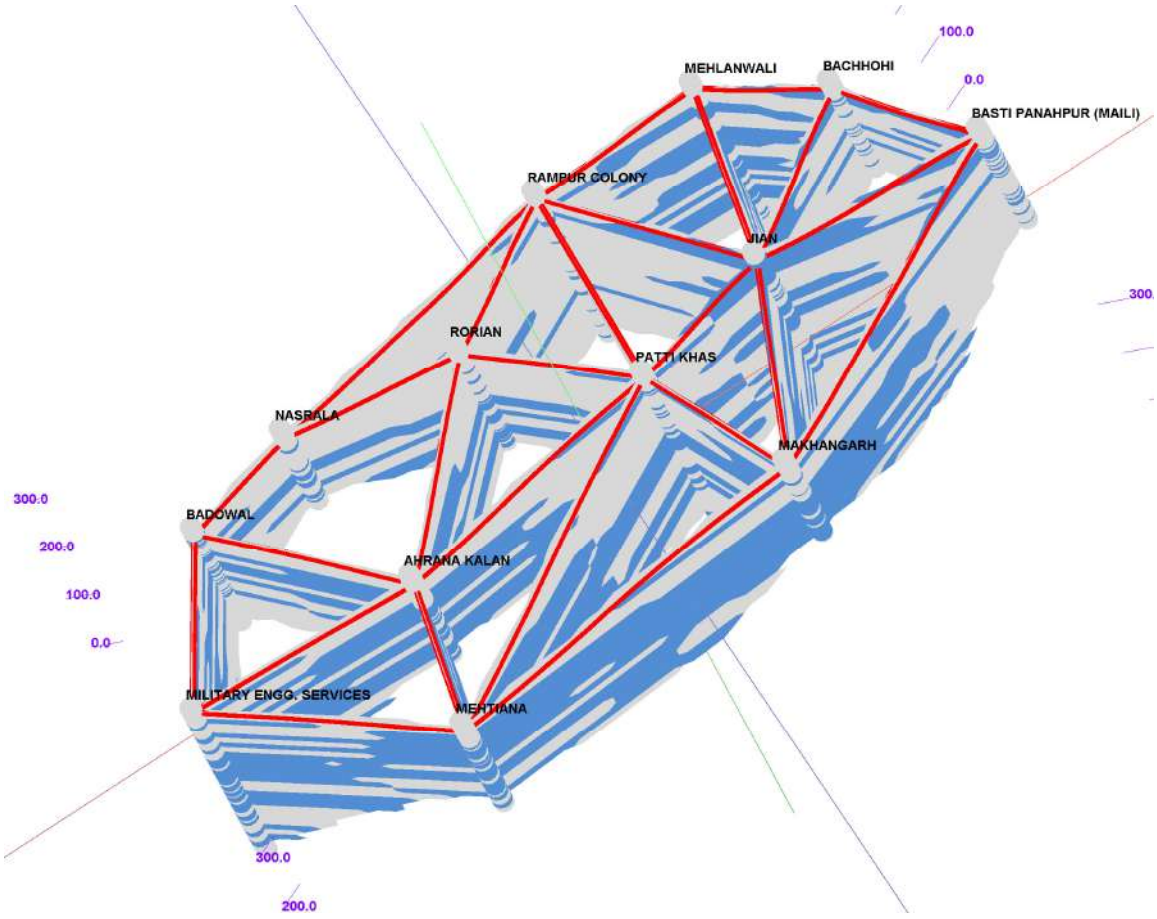
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (21-90m)	Quaternary Alluvial deposits	Unconfined	65	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (129-195m)		Unconfined to Confined	22	-	NA	0.00128
Aquifer-III (235-300m)		Unconfined to Confined	14	-	NA	0.000237

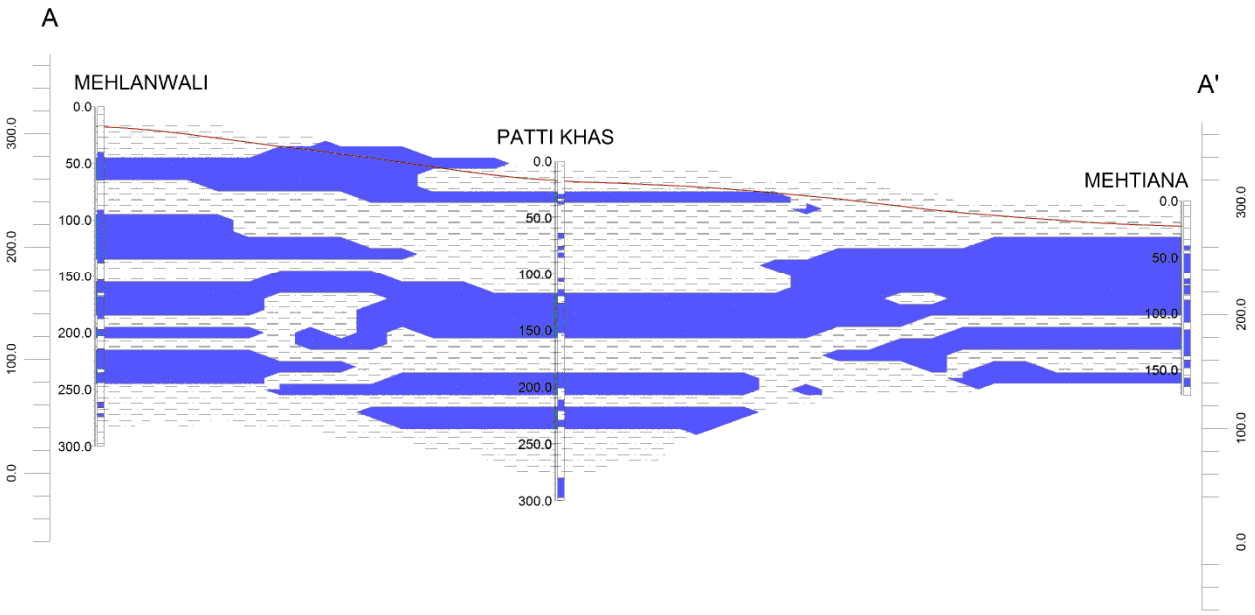
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

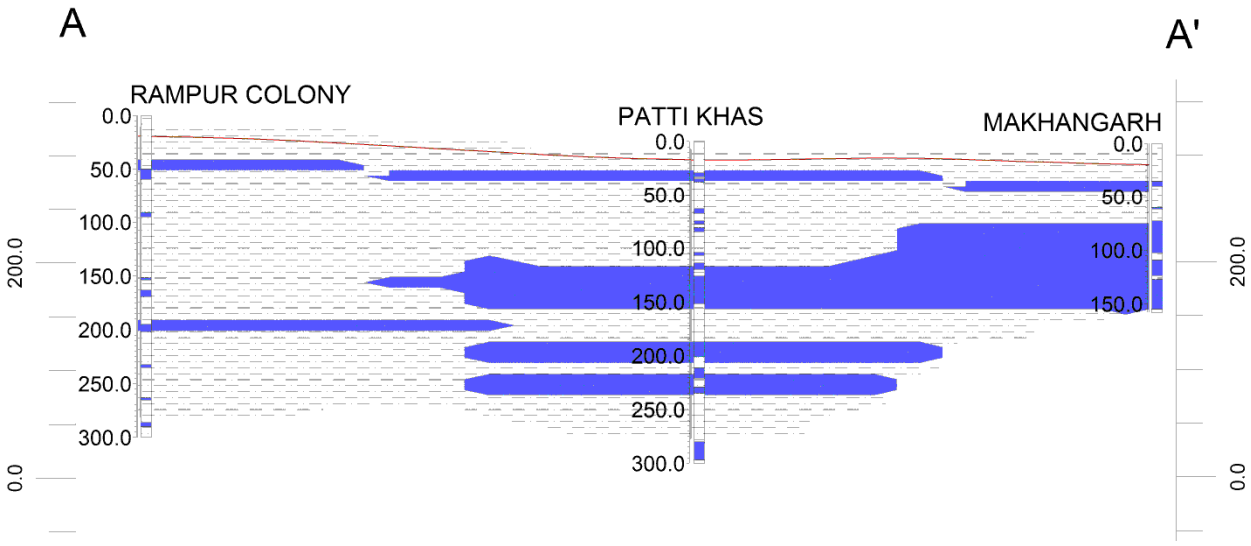
3D Lithology Fence

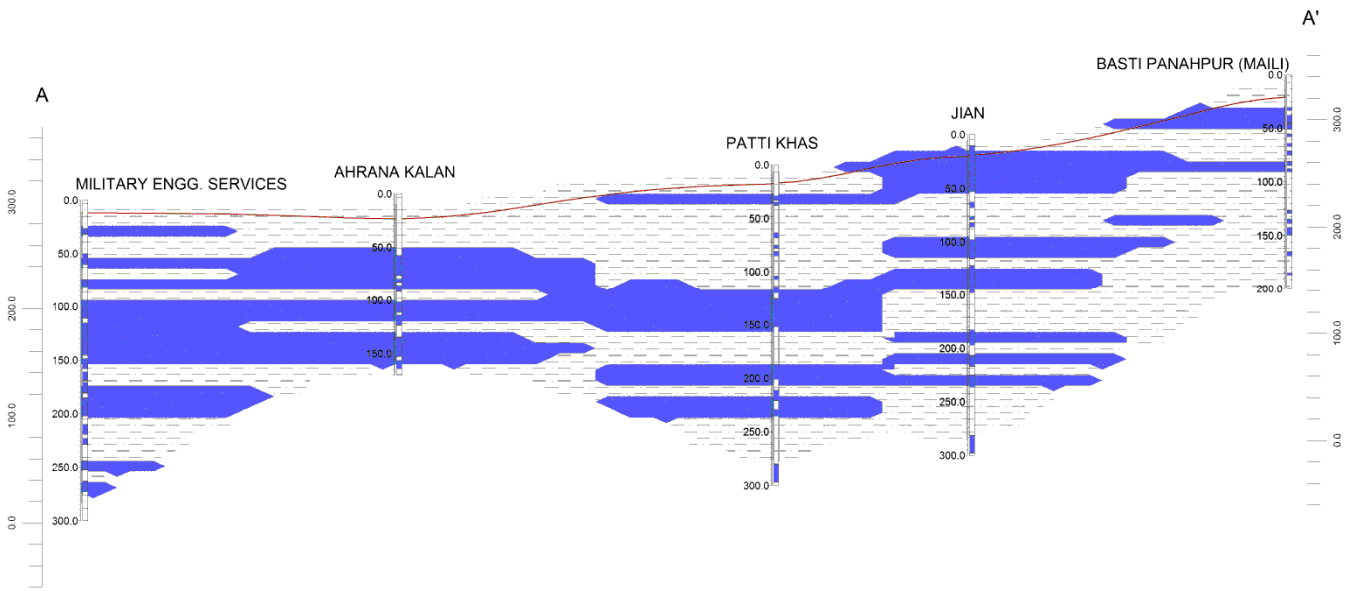


Cross-Section Along NE-SW



Cross-Section ALONG N-S





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

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*89.71*
	In-storage Aquifer I	*2164.97*
	Dynamic Aquifer II	-
	In-storage Aquifer II	856
	Dynamic Aquifer III	-
	In-storage Aquifer III	490
	Total	3600
Ground Water Extraction (in mcm)	Irrigation	52.08
	Domestic & Industrial	4.93
Provision for domestic & Industrial requirement up to 2025 (in mcm)		5.48
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 (21m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing

	pits .

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 14.3 mcm volume of water wastage
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	-

(VII) MAHILPUR BLOCK (236.50 SQ KM)

1. Salient Information

Population (2011) Rural- 132816
Urban- -
Total- 132816

Rainfall 2014 (Hoshiarpur District) Average annual rainfall - 938 mm

Average Annual Rainfall (Mahilpur-II block) 800 mm

Agriculture and Irrigation Major Crops- Rice, Wheat
Other crops- Sugarcane, Potatoes, Pulses,
Net Area Sown- 191.81 sq.km
Total Irrigated Area- 191.81 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 Mahilpur block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (64 m) is very prominent in terms of thickness and geographic extent. Aquifer II (32 m) is less in thickness & Aquifer III is (14 m) 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 11.26-34.00 (mbgl) & Post Monsoon- ~ 11.26-35.00 (mbgl)

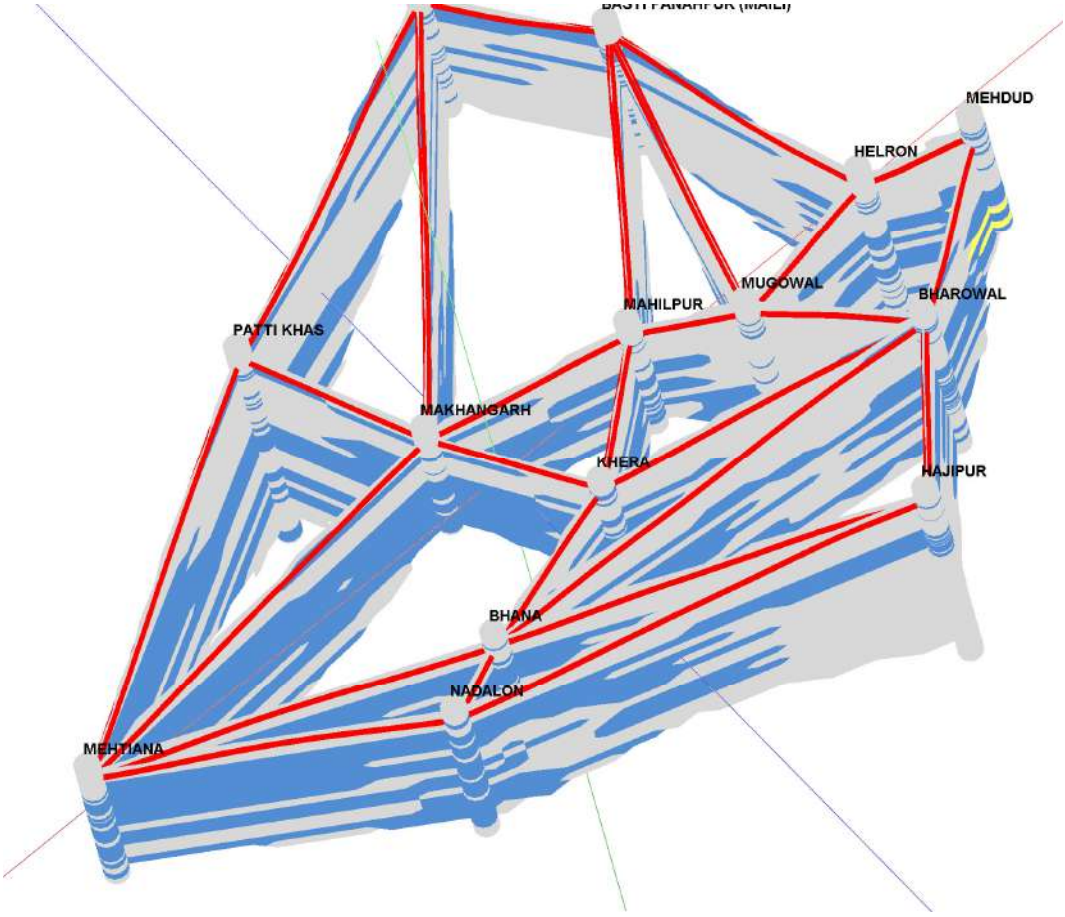
2. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (23-150m)	Quaternary Alluvial deposits	Unconfined	64	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (107-194m)		Unconfined to Confined	32	-	NA	0.00128
Aquifer-III (235-300m)		Unconfined to Confined	14	-	NA	0.000237

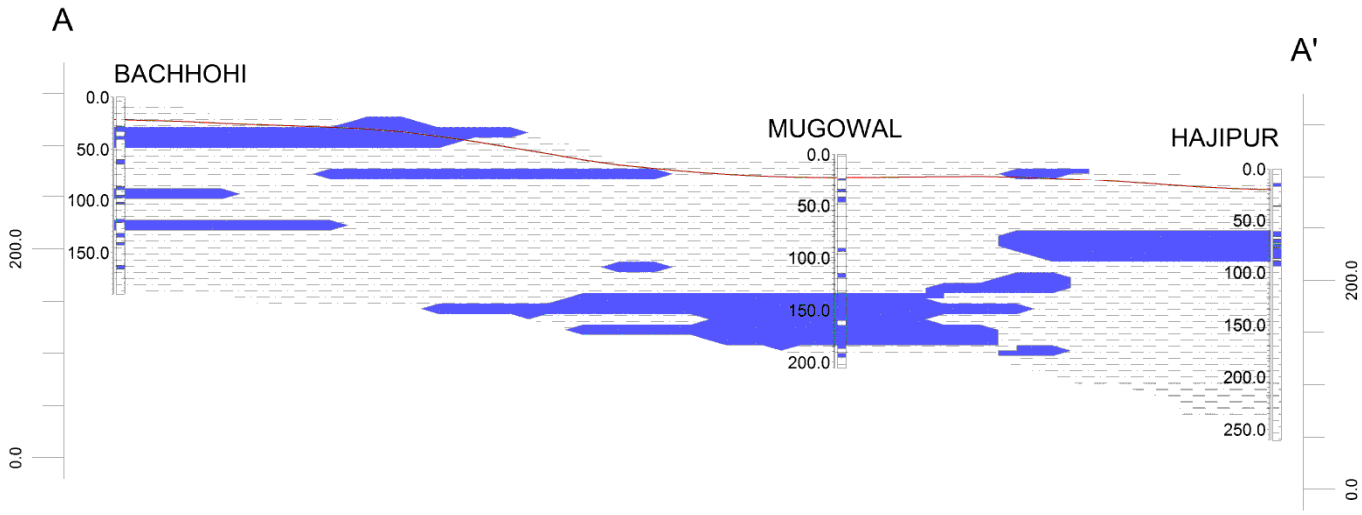
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

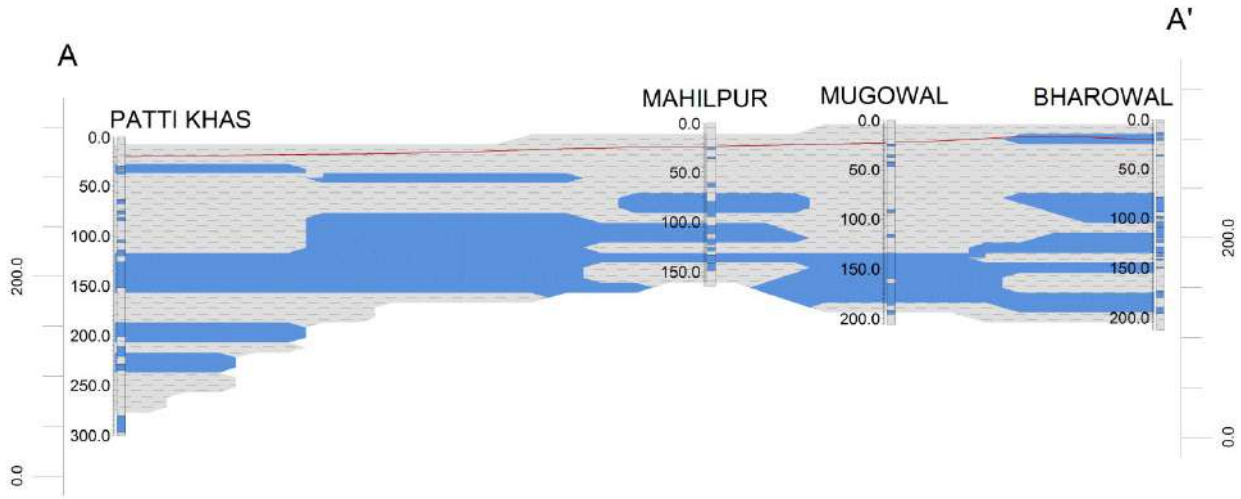
3D Lithology Fence



Cross-Section ALONG N-S



Cross-Section Along NW-SE



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

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*70.31*
	In-storage Aquifer I	*1750.58*
	Dynamic Aquifer II	-
	In-storage Aquifer II	976
	Dynamic Aquifer III	-
	In-storage Aquifer III	1111
	Total	3908
Ground Water Extraction (in mcm)	Irrigation	50.51
	Domestic & Industrial	1.56
Provision for domestic & Industrial requirement up to 2025 (in mcm)		1.82
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 (23m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 12.3 mcm volume of water wastage
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	-

VIII) TALWARA BLOCK (226.40 SQ KM)

1. Salient Information

Population (2011)	Rural-75883 Urban- 25207 Total-101090
Rainfall 2014 (Hoshiarpur District)	Average annual rainfall -938 mm
Average Annual Rainfall (Talwara block)	993 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops- Sugarcane, Potatoes, Pulses, Net Area Sown- 75.71 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 Talwara block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (62 m) is very prominent in terms of thickness and geographic extent. Aquifer II (17 m) is less in thickness & Aquifer III is (21m) Block is categorized as Safe as per Ground Water assessment 2013.

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

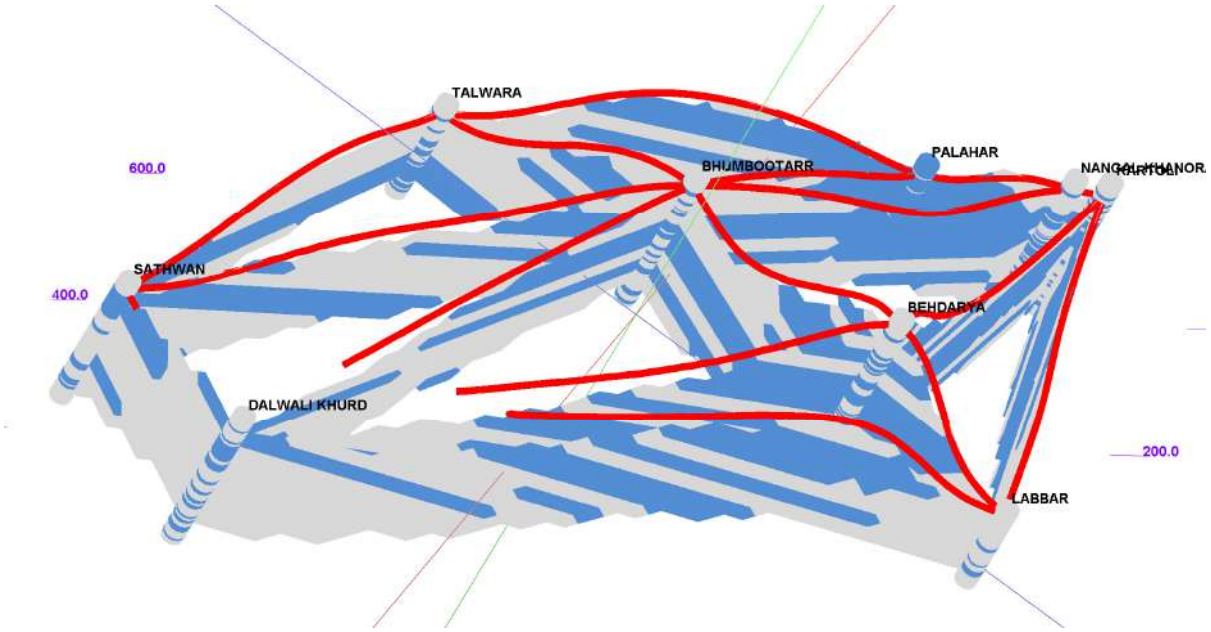
Water level Behavior (2015): Pre Monsoon 12.07-16.94 (mbgl)& Post Monsoon-~ 5.73-15.27(mbgl)

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

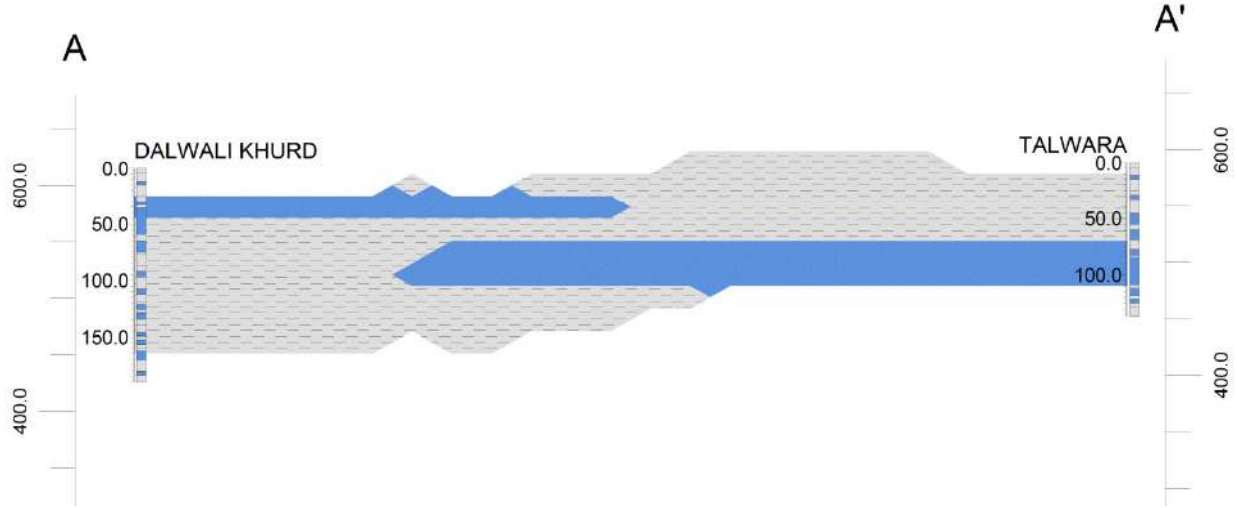
Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (6-143m)	Quaternary Alluvial deposits	Unconfined	62	*1450-7190*	12	$2.00*10^{-2}$
Aquifer-II (122-189m)		Unconfined to Confined	17	-	NA	0.00128
Aquifer-III (208-300m)		Unconfined to Confined	21	-	NA	0.00237

Aquifer comprises of freshwater only and the main aquifer material is sand. The non-aquifer material comprise of clay.

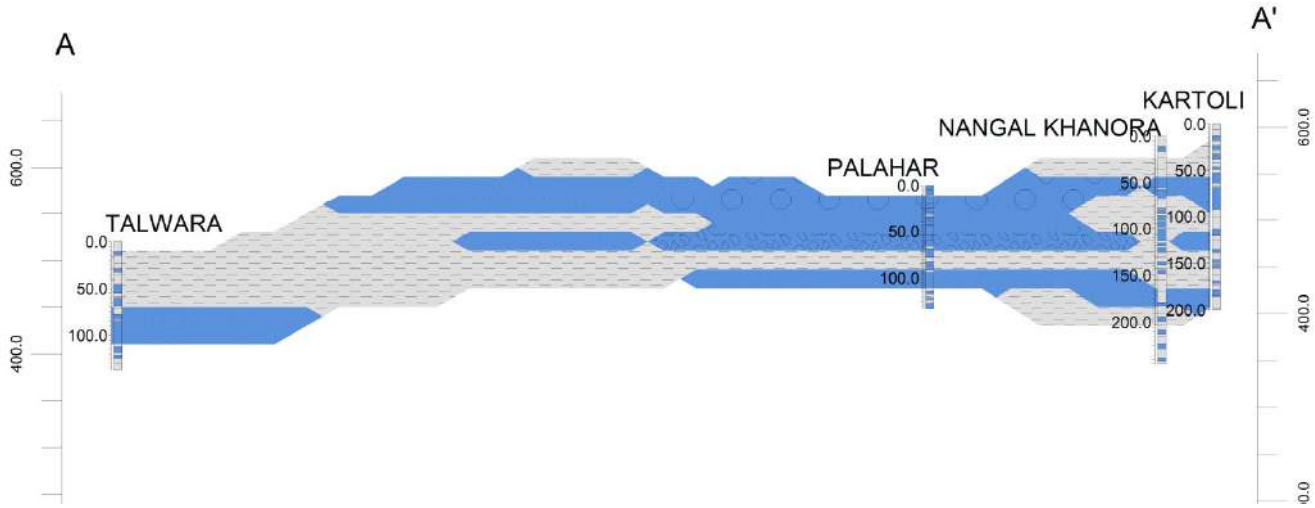
3D Lithology Fence



Cross-Section Along W-E



Cross-Section ALONG NW-SE



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

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*19.45*
	In-storage Aquifer I	*1418.17*
	Dynamic Aquifer II	-
	In-storage Aquifer II	324
	Dynamic Aquifer III	-
	In-storage Aquifer III	352
	Total	2114
Ground Water Extraction (in mcm)	Irrigation	12.12
	Domestic & Industrial	1.40
Provision for domestic & Industrial requirement up to 2025 (in mcm)		1.64
Chemical Quality of ground water & contamination		Potable for drinking and irrigation
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 (15m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits

5. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 3.4 mcm volume of water wastage
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	-

(IX) TANDA BLOCK (233.70 SQ KM)

1. Salient Information

Population (2011)	Rural-112263 Urban- Total-112263
Rainfall 2014 (Hoshiarpur District)	Average annual rainfall -699 mm
Average Annual Rainfall (Tanda block)	866 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops- Sugarcane, Potatoes, Pulses, Net Area Sown- 199.14 sq.km Total Irrigated Area- 200.77 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 Tanda block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (75 m) and are very prominent in terms of thickness and geographic extent. Aquifer II (19 m) and Aquifer III is (28 m) is less in thickness. Block is categorized as **Over Exploited** 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.

Water level Behavior (2015): Pre Monsoon 4.20-20.15 (m bgl) & Post Monsoon-~ 5.20-19.70 (m bgl)

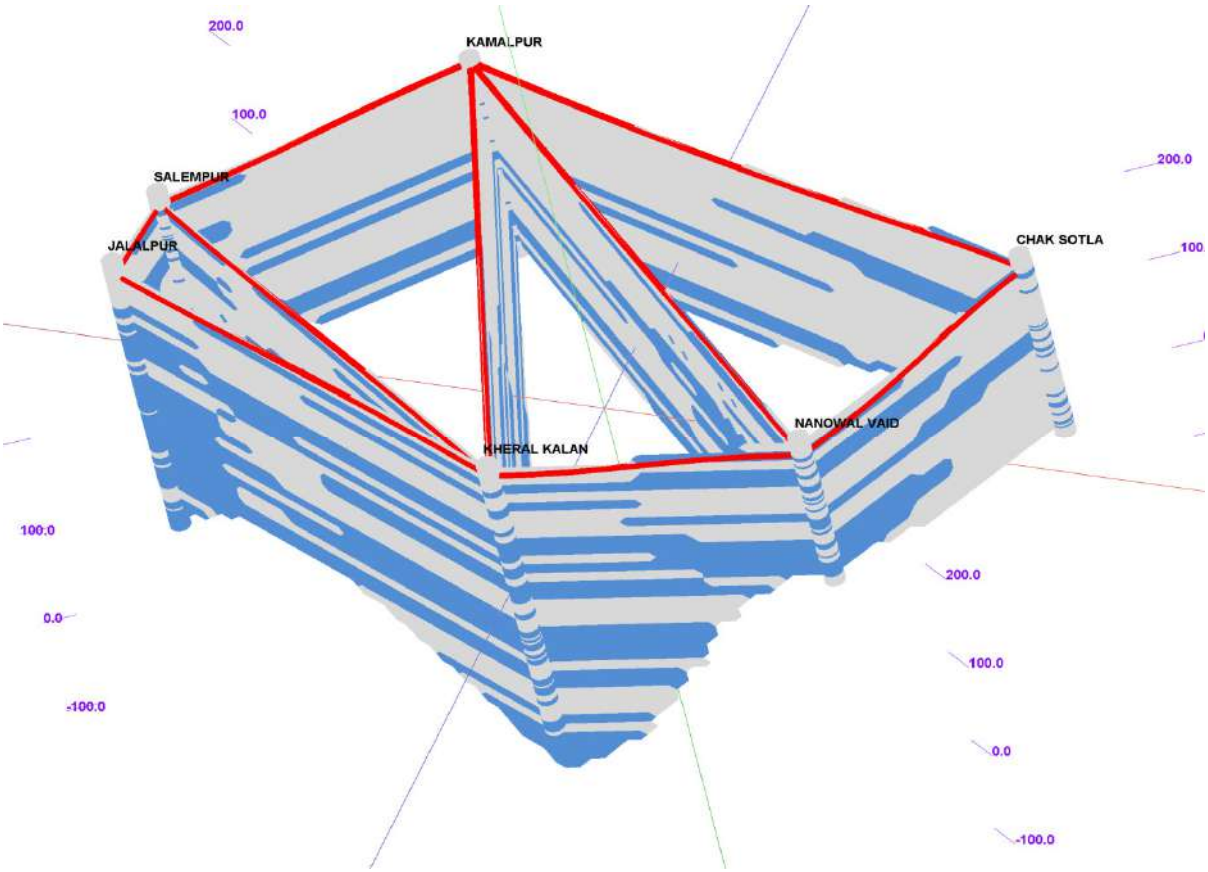
6. **Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

Aquifer	Geology	Type of Aquifer	Thickness of Granular Zones (m)	Transmissivity (m^2/day)	Specific Yield %	Storativity
Aquifer-I (12-147m)	Quaternary Alluvial deposits	Unconfined	75	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (107-175m)		Unconfined to Confined	19	-	NA	0.00128
Aquifer-III (203-300m)		Unconfined to Confined	28	-	NA	0.000237

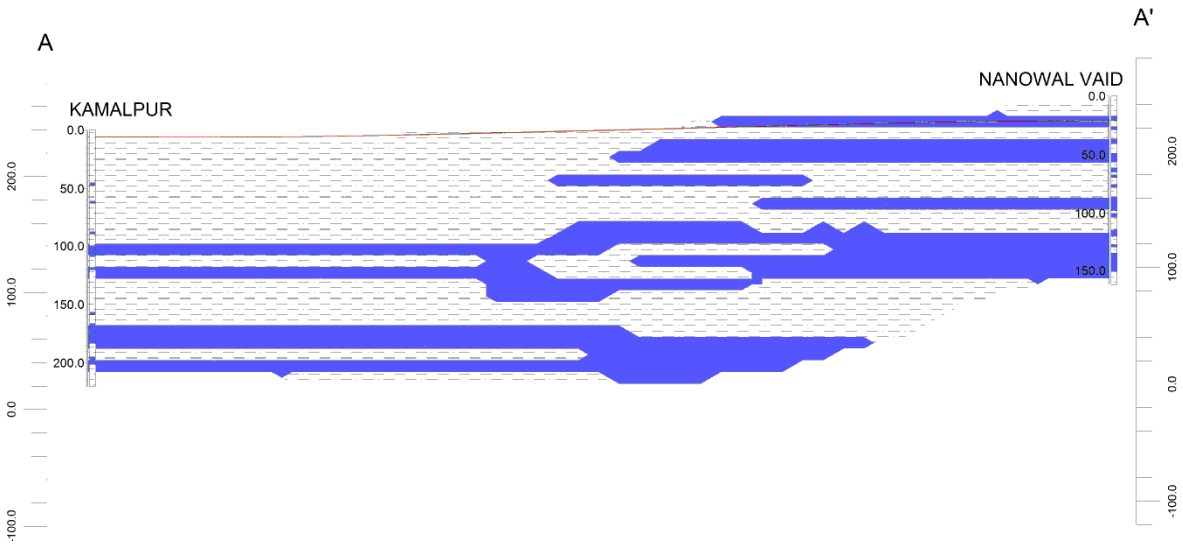
Aquifer comprises of freshwater only and the main aquifer material is sand.

The non-aquifer material comprise of clay.

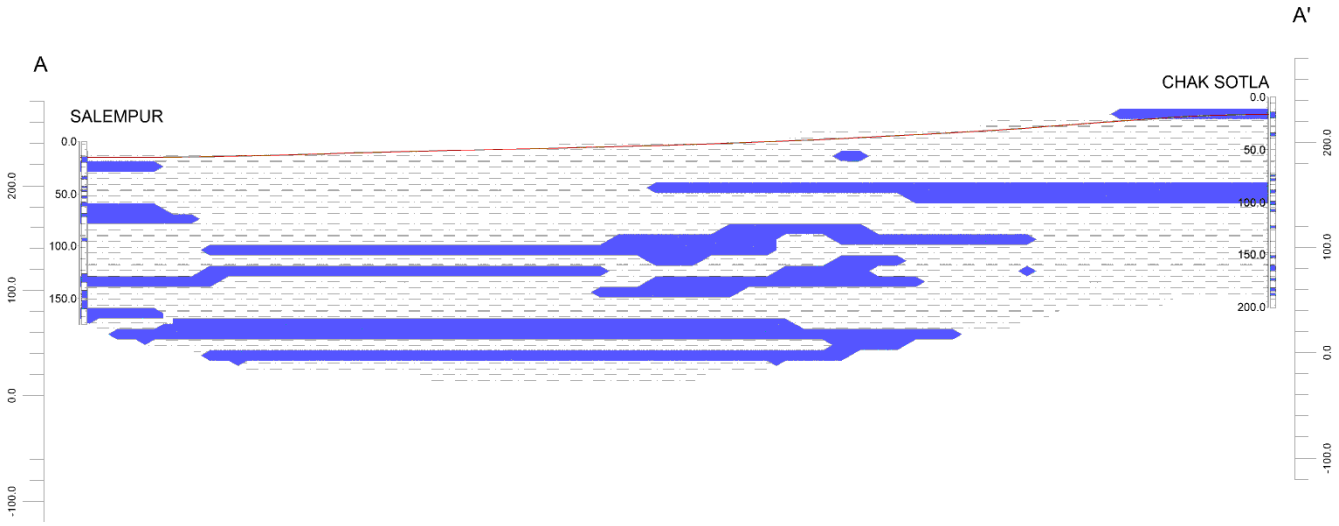
3D Lithology Fence



Cross-Section ALONG NW-SE



Cross-Section along W-E



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

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*96.40*
	In-storage Aquifer I	*1261.98*
	Dynamic Aquifer II	-
	In-storage Aquifer II	342
	Dynamic Aquifer III	-
	In-storage Aquifer III	481
	Total	2182
Ground Water Extraction (in mcm)	Irrigation	159.36
	Domestic & Industrial	2.46
Provision for domestic & Industrial requirement up to 2025 (in mcm)		2.88
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

8. 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, Farm recharge by constructing pits

9. Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 40.5 mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 16 % 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 21.30 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-

(X) MUKERIAN BLOCK (256 SQ KM)

2. Salient Information

Population (2011)	Rural-118897 Urban- Total-118897
Rainfall 2014 (Hoshiarpur District)	Average annual rainfall -699 mm
Average Annual Rainfall (Mukerian block)	994 mm
Agriculture and Irrigation	Major Crops- Rice, Wheat Other crops- Sugarcane, Potatoes, Pulses, Net Area Sown- 207.93 sq.km Total Irrigated Area- 209.37 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 Mukerian block.

Ground Water Resource Availability: Ground Water Resources available in the different group of aquifers. Aquifer I (75 m) and are very prominent in terms of thickness and geographic extent. Aquifer II (19 m) and Aquifer III is (28 m) is less in thickness. Block is categorized as **Semi Critical** 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.

Water level Behavior (2015): Pre Monsoon 2.50-7.18 (mbgl) &

Post Monsoon-~ 3.24-5.60 (mbgl)

10. **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 (12-147m)	Quaternary Alluvial deposits	Unconfined	75	*1450-7190*	0.072	$2.00*10^{-2}$
Aquifer-II (107-175m)		Unconfined to Confined	19	-	NA	0.00128
Aquifer-III (203-300m)		Unconfined to Confined	28	-	NA	0.000237

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

The non-aquifer material comprise of clay.

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

Aquifer wise Water Resource available (in mcm)	Dynamic Aquifer I	*91.63*
	In-storage Aquifer I	*1142.78*
	Dynamic Aquifer II	-
	In-storage Aquifer II	749
	Dynamic Aquifer III	-
	In-storage Aquifer III	287
	Total	2271
Ground Water Extraction (in mcm)	Irrigation	77.90
	Domestic & Industrial	4.16
Provision for domestic & Industrial requirement up to 2025 (in mcm)		4.83
Chemical Quality of ground water & contamination		Suitable for drinking and irrigation purposes
Other issues		Declining water level trend

12. Ground Water Resource Enhancement

Aquifer wise space available for recharge and proposed interventions	Volume of unsaturated zone upto the average depth to water level (6 m).
Other interventions proposed	Artificial Recharge, Roof top Rainwater Harvesting, Farm recharge by constructing pits

13.Demand Side Interventions

Advanced Irrigation Practices	Lining of underground pipelines (Kutcha channel) will save 40.5 mcm volume of water wastage
Change in cropping pattern	Proposed change in cropping pattern from Paddy to maize/soyabean 16 % 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 21.30 mcm
Alternate water sources	Tanks, ponds and canals
Regulation and Control	-
Other interventions proposed, if any	-