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Investigating the subsoil saline and sweet water layers in Rudbar Region, Kerman Province

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Abstract

In this research, using the geophysical method, it was attempted to identify and study the different layers of the earth in terms of recognizing the boundary of salt and sweet water and engineering solutions to prevent the penetration of saline water into fresh water in the wells and also the method of exploitation The freshwater is enclosed between two layers of water in the Roudbar area of Kerman province. The results showed that the geophysical method in this region estimates the boundary of salt and sweet water interference with acceptable accuracy; therefore, it is possible to assess the geophysical results with acceptable information for groundwater studies. In order to study the hydrogeological characteristics of groundwater aquifers such as depth, aquifer thickness and determining the layers of fresh water and salinity and their boundary separation, a hydrologic survey was conducted in the city of Roudbar of Kerman province. Also, according to geophysical data, areas with high discharge potential in the study area are determined. Hydrological studies led to the determination of the complex aquifer status, the determination of the depth and thickness of the juice layer, the determination of the boundary of saline and sweet water, and the determination of suitable areas for drilling wells. By determining the surface of saline and deep saline water, a solution was needed to isolate the saline layer of the surface to prevent penetration into the deep water layer. The results showed that the maximum depth of drilling for the extraction of fresh water was determined.

Keywords: soluble water layer, special electric resistive method, Roudbar area

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INTRODUCTION

Due to the fact that Iran is located in a dry area, the country has a significant surface area covered with pasture lands. Also, the groundwater of most parts of it has high levels of salts. Given the natural economic and social conditions of the country, there is a strong need for drinking water and consumable in industry and agriculture. Since natural freshwater is not needed at all points and is really rare in some places, using the appropriate techniques, the identification of the boundaries of sweet and salty water, the type of table, and the quality and amount of salts in water, make a decision to make optimal use of sweet water and take measures to use saline water (Hojjat and Sakhi 2003).

Despite the abundance of water on our planet, the water at the surface of the earth is not scattered horizontally, and all societies do not have the same size. At some point, the water is so abundant that it creates a problem, and at a point so rare that every drop of that case unfortunately, in our country, water resources are also limited. Iranians have long been faced with the problem of water scarcity, especially fresh water, from ancient times, especially in arid central areas, in various ways, including the construction of numerous aqueducts and various water channels with this problem has been confronted and based on the many discoveries of the ancient Qanats and Persians, aqueducts have been created.

As a result of overtaking the sweet waters of the coast of the seas, the lakes, as well as around the deserts, saline marshes and the like, the state of balance between salty and sweet water, and saline waters advance to the sweet groundwater resources (Hojat and Ranjbar 2011).

In Iran, the presence of saline waters and the effects of its interactions with sweet waters in some coastal areas and desert regions have been reported. For example, aquifers in the coastal plains in the north and south of our country and the aquifers around the lakes and marshes in the length of about 3666 kilometers with saline water, and despite the observation of the effects of saltwater influx on most coast of the Caspian Sea, the Persian Gulf, Oman Sea, as well as some of the plains of Urmia Lake, unfortunately, so far, there have not been complete, serious and effective measures to control and prevent it.

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One of the problems of groundwater resources is the interpenetration of saline water, these juicy layers, in other words, the entry of saline water into the layers of the water-borne phenomenon, especially in coastal areas, islands and desert regions, and in general, the bottom is deeper, more important. Field studies show that due to the advent of saline water in coastal aquifers, three areas, including freshwater area, transitional area (and transitional area), can be detected. The mixing zone occurs due to the diffusion of hydrodynamic, in which the salt concentration from saline water to freshwater underground, in fact, this area is considered as a common interface between salt and sweet water, and its non-permanent changes are due to external influences such as tea and fashion, nutrition and pumping from wells, etc. (Shabani 2013)

In these areas, if the interference of saline water and fresh water in the wells is continued due to the conical uplift phenomenon, the water of the utilization facility will be more salty and will be useless for many uses, even if they are not taken from them, It is believed that the return of the common surface area between the saline water and its natural and artificial nutrition is costly and it takes a long time to absorb fresh water. This study is aimed at obtaining geophysical data and geo-electric data in determining the saline layer and the level of the aquifer, and thickness of the layer of fresh water and passion was carried out and the question is whether it can be determine the depth and the layers of water?

Regarding the history of the study of saline water and sweet water by geophysical method, it should be noted that examples of these studies elsewhere in the world are as follows:

Aboqua and Benel (2012) in northern Wales study the combination of electro-catastrophes and hydro chemical to assess the interactions between the lower spit table and the upper sweet aquarium aquifer (Obikoya 2012).

By Beatrix and Grygio in 2018, the study of high-resolution high-resistivity tomography (ERT) was done to determine the spatial dimensions of freshwater lenses in the coastal watersheds (freshwater stored in the Ravenna coastal hills and the effects of their buffer on groundwater) The use of the electrical restive method has been used to detect the freshwater layer from the coastal resilient layer (Greggio et al. 2018).

By Liu and Hu and Zhang in 2018 performed a study which determined the quantitative blockage of the water flow in the lagoon subterranean horizon using a special electrical resistivity method performed by the Wenner method and examined the layer of waterless and replaced it as refining Sewage water is blocked. Underground wetlands (SSW CWs) are widely used as passive around the world as a subsurface sewage treatment system (environmental wastewater treatment) due to the advantages of high efficiency, low cost and significant value of sewage it flows through the empty space inside the bed (Liu et al. 2018).

A study was done by Kumar and Priego in India in 2015 which investigating the influence of saline water on the coastal aquifers of the Parijer River basin, Kerala using hydro chemical methods and special electrical resistivity methods with the dotted line method for determining the surface of freshwater layer and replacement of saline water coastal is due to the excessive removal of surface water, which is by combining data from water chemical parameters.

The fifth example by Mohammad and Wahabala in the field of water and sewage detection and management in Egypt, the Kharga Uasis region, was conducted in 2016 using a special electric resistive method and an ecological geological survey (Anil Kumar et al. 2015).

BACKGROUND OF INTERNAL INVESTIGATION

The records of some saline and sweet water studies by geophysical methods in Iran are as follows:

The research of Gholinezhad and Kourosh (2019) was carried out by means of a method to investigate and detect saline water layers in a part of the Golshin village area of Sari city.

The second example is Ansari and Ghiyathi's research (2017) about the application of geophysical methods to investigate the salinity of groundwater, which in this method used non-indigenous and saline materials in the water and soil environment in Tehran.

Abbasi et al. (2012) had done a study by investigating the expansion of saline and sweet ground underground using two-dimensional electrical tomography with 159 specific resistance cadres in the region of Gonbad and East of Inceh Bouron. The results of two-dimensional inversion of catheter data showed that saline water is in contrast to the normal state on fresh water.

METHODOLOGY

The present study is a combination of geophysical craft worker and scientific analytical method. The practical range of special strength for earth materials is about 0.01 to 100,000 ohm. The stone grains and the amount of fluid between the seeds are effective in this particular resistance. For the processing and modeling of the specific resistance data, the software "IPI2win" and "RES2dinv" have been used. Determining the position of the catheters and profiles on the geological map of the area by GEOPLANNER software and specially designed special resistance maps.

INTRODUCTION OF THE STUDY AREA

Roudbar is one of the districts of Kerman province. It is located in the southwest of the province and is part of the Jasmoryan basin. It is from the north by Bam and Anbarabad from the east, with Sistan and Baluchestan province, from the south by the treasure trove and from the west by Kahnouj. Its distance from the center of the province is 333 km and Jiroft is 85 km and the last distance from the provincial capital is 500 km. The area of this city is 13200 square kilometers and its catchment area is 29904 hectares and its center is Roudbar. The population of this city in 2016 was 12,841.

Geomorphology of the Region

The study area and the basin of the Rudbar-Jiroft plain are 230 km south of the city of Kerman. Geomorphologically, this region has two levels of geomorphology of the Concha and Playa.

Roudbar-Jiroft plain has a slope of less than 5% with the dominant vegetation community of Kohr and Ghaz, and its geological formation is often Quaternary. The total slope of this basin is from north to south, and the annual rainfall is about 170 mm. There are several seasonal and permanent rivers in the catchment area, the most important of which is the Halil River, located on the upstream and downstream of the plain. Roudbar and especially due to its proximity to the central desert, the studied area has underground saline waters compared to other parts of Jiroft plain.

The Jiroft plain is in terms of geo-morphology of the downstream region (Graben), which is located on the north, west, and east by altitudes, in which three morphological units can be identified in this area:

A) Highlands: These areas are in the Jabal Barz mountain range, which is part of Urumieh's daughter's zone, with a peak of 3486 meters above sea level and along the north-west-south-east of the northeast and northern shores of Jiroft.

METHOD WHICH WAS USED IN THIS RESEARCH

The method that was used in this study is Shulomberger's method, because in this research, a large depth should be investigated and the basis of this method is based on the transfer of electric current to the ground and the measurement of the potential difference created between the two points to obtain a specific depth resistance lots of terrain is designed.

The instrument used in this research is a high-resolution, high-injection, high-resolution geoelectric device.

In this research, extraction water was studied from deep wells that were of good quality for a long time and the causes of electrical conduction rise (EC). The best option for solving the suspected rise in probability of saline water and its replacement with fresh water was geo-electric exploration in the vicinity of these wells and adjacent land. Simultaneously, the information of the geological pillar and the technical structure of these wells and the qualitative analysis of the sample of their extracted water were analyzed. The results were obtained and its matching with data and data (VES) from geoelectric data indicated by the vertical winding method showed that the direct interaction of saline and sweet water table is not occurring and higher than expected electrical conductivity is rooted in continuous harvesting is more than groundwater table capacity and non-compliance with wells, but in today's conditions, due to the poor nutrition of aquifers and the growing trend of their evacuation, the likelihood of this occurrence is far from expected.

FINDINGS

Investigation of Electrical Resistance of Catalyzed Points

According to **Fig. 1**, the resistors obtained by the geoelectric device showed that the first point at 16 meters north of the old well and the second point at a distance of 120 meters west of it, had a fresh water layer with more thickness and porosity and drainage than the There are other points, which will further examine the porosity and discharge characteristics of the layers of these two points.

1. The results of electrical resistance of the earth's layers at the first point are as follows:

The first point (at a distance of 16 meters north of the well) is located at 637245

3070369

From the surface of the ground to a depth of 4 m, the surface is dry, and from 4 m to 40 m deep, the semi-hard layer of soil and compact gravel is located at a depth of 40 meters to a depth of 70 meters, a layer of gravel and clay with a very low drainage and plenty of salts And from a depth of 70 meters to 125 meters, the middle and coarse sandy layer with water (asteroid layer) can be seen from 125 meters to 140 meters of sand and medium clay layer (semi-saline alluvium layer), and there is 140 meters from the flower layer the clay layer of saline water and saltiness has high levels of salts.

By studying watersheds, for mountains overlooking the area and catacombs, the total slope of the area was determined. In the study area, the total area of the groundwater layer flow from west and North West to east and south-east of the study area was studied.

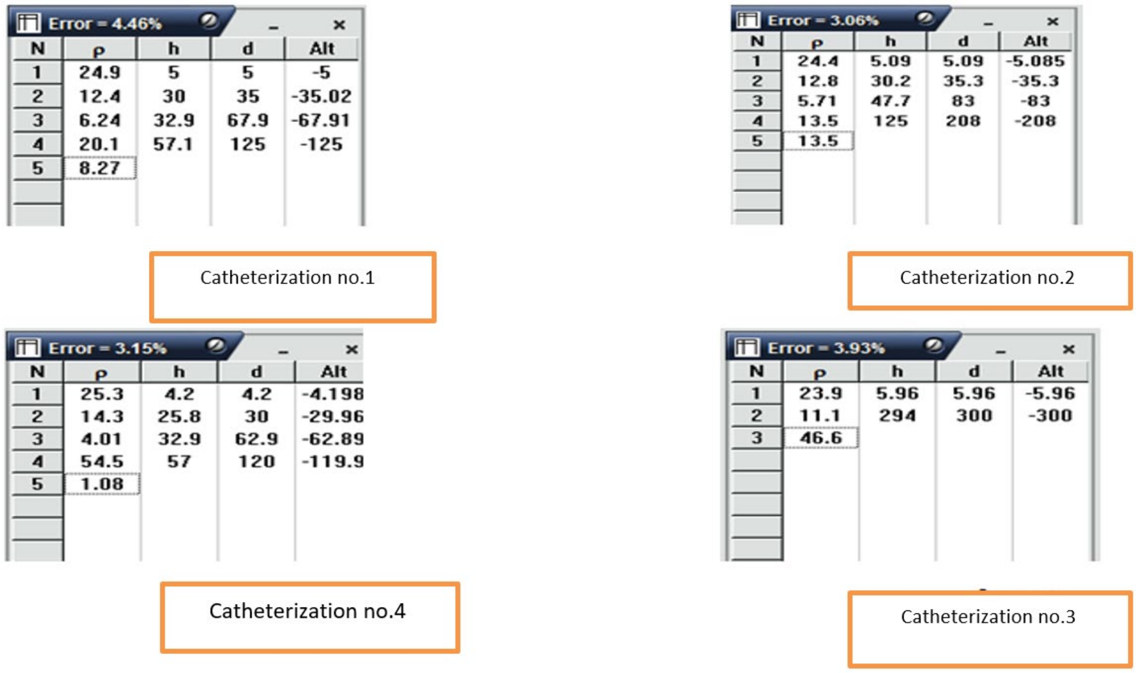
The height of the site is 380 m above sea level.

2. The results of the electrical resistance of the earth's layers at the second point are as follows:

The second point is located at a distance of 120 meters west of the well with 637131 bays.

3070391

From the surface of the earth to a depth of 5 meters, the surface soil is dry, from 5 meters to a depth of 35



N	ρ	h	d	Alt
1	24.9	5	5	-5
2	12.4	30	35	-35.02
3	6.24	32.9	67.9	-67.91
4	20.1	57.1	125	-125
5	8.27			

Error = 4.46% — Catheterization no.1

N	ρ	h	d	Alt
1	24.4	5.09	5.09	-5.085
2	12.8	30.2	35.3	-35.3
3	5.71	47.7	83	-83
4	13.5	125	208	-208
5	13.5			

Error = 3.06% — Catheterization no.2

N	ρ	h	d	Alt
1	25.3	4.2	4.2	-4.198
2	14.3	25.8	30	-29.96
3	4.01	32.9	62.9	-62.89
4	54.5	57	120	-119.9
5	1.08			

Error = 3.15% — Catheterization no.4

N	ρ	h	d	Alt
1	23.9	5.96	5.96	-5.96
2	11.1	294	300	-300
3	46.6			

Error = 3.93% — Catheterization no.3

Fig. 1. Specific resistivity tables for catheterization

Table 1. Specifications for the first point layers at a distance of 16 meters north of the well

	Layer resistance (in ohms m)	Layer sex	Layer thickness (in m(
1	24	Surface Soil	From ground to depth of 4 meters
2	12	The pebble and fine sandstone layer and the freshwater flow	From a depth of 4 meters to 40 meters
3	6	Clay layer and salty water	From depths of 40 to 70 meters deep
4	20	Medium and coarse sandy layer with fresh water (sweet supersaturated layer)	From 70 to 125 yards
5	8	Smooth layer with moderate water and water (deep water salinity layer)	From 125 yards to 140 meters
6	8	The salt and saline water has a high level of salts	From 140 yards later

Table 2. Specifications for the second point layers at a distance of 120 meters west of the well

	Layer resistance (in ohms m)	Layer sex	Layer thickness (in m(
1	24	Surface Soil	From ground to depth of 5 meters
2	12	Smooth and clay layer	From a depth of 5 meters to 35 meters
3	5	Layer mixture of clay and salt water	From depths of 35 to 83 meters
4	13.5	The clay layer and the fine sand with medium drainage (medium alluvium layer)	From 83 to 108 yards
5	7	The salt and saline water has a high level of salts	From a depth of 108 meters

meters, the soil layer is a mixture of clay and moist soil, and from 35 meters to a depth of 83 meters a layer of mixture of clay and saline water is located from a depth of 83 meters to 108 meters of clay and water Low soluble salts can be seen from 108 m below the clay layer and fine sand with a medium discharge and high salts. The height of the site is 397 m above sea level.

EXAMINING THE RESULTS OF CATHETERIZED POINTS

The researcher's method for determining the saline and sweet water layer and providing fresh water extraction methods has been that with the studies and geophysical field studies and the characteristics of the described catfights, it was found that there is a juvenile layer around the well and the solvent layer the low point 1 is extended. Point number 1 is located 16 meters north of the current well with the above conventions. The second is another point at 120 meters west of the current well with the coordinates.

The flow of water with salts and surface salinization in the first impression (16 meters north of the old well) lies at a depth of 20 meters to 70 meters, and the flow between the layer of its fresh water is at depths of 70 to 125 meters, and its deep water layer between the depths of 125 meters to 140 meters, the water of this layer has a moderate amount of fluid in the stream.

Then point 2 is located at a distance of 120 meters from the west of the well. The sandy layer has a moderate thickness and a fine and medium aggregate. From a depth of 15 meters to 35 meters, it is a layer of sand and clay and from a depth of 35 meters to The depth of 83 meters of its salt water layer is located at a

Table 3. Statistical indexes of chemical parameters of groundwater underground water samples in the southern Roudbar plain (mg / l)

Parameter	EC	TDS	Ca	Mg	Na	K	HCO3	Cl	SO4	As	NO3	PO4
Old well	10800	7243	783	235	932	31	787	1798	2844	0.6	144	-
New correction well	1450	721	31	10.7	115	4.2	313	65	87	0.3	75	-

(Under Detection Limit)

Table 4. Statistical Indexes of Chemical Parameters of Several Water Wells in the Range of Wells in the South Roodbar Plain (mg / L)

Parameter	EC	TDS	Ca	Mg	Na	K	HCO3	Cl	SO4	As	NO3	PO4
Well 1	6037	3320	387	125	465	16	384	867	1412	0.4	55	-
Well 2	7159	5123	445	103.2	698	15	492	990	1796	0.16	76	-
Well 3	7654	4765	462	112	687	17	477	988	1711	0.34	74	-
Well 4	10323	7365	756	176	985	26	645	1432	2432	0.44	143	-
Well 5	9875	7123	744	166	956	23	622	1396	2248	0.38	135	-

(Under Detection Limit)

Table 5. Statistical Indexes of Chemical Parameters of Groundwater Samples in Jiroft Plain, in mg / L (Reference 46)

Parameter	EC	TDS	Ca	Mg	Na	K	HCO3	Cl	SO4	As	NO3	PO4
Average account	1296.2	809.03	83	27.64	173.9	3.28	203.5	163.9	291.68	0.039	12.42	UDL*
Standard deviation	1163.2	699.5	90.11	26.94	171.9	2.69	90.48	236.8	378.03	0.035	12.68	-
max	5260	3101	436	103.2	752.1	14.04	494.1	1008	1795.2	0.16	54.71	-
min	356	228	10	3.6	18.4	1.17	103.7	14.2	28.8	0.02	1.73	-
The range of changes	4904	2873	426	99.6	733.7	12.87	390.4	994	1766.4	0.158	52.98	-

(Under Detection Limit)

depth of 83 meters to a depth of about 108 meters in the salty water layer and saline layer is 108 meters later.

The rest of the study area is suitable due to the presence of silty clay loamy layers that are wide in depth; the flow of fresh water is suitable as a weak drain with a low thickness or no sweet water.

Due to the fact that the sweet juice layer at the point 1 is coarser and the intensity of the freshwater flow and consequently its proper discharge rate is higher, the drilling offer was given at point 1.

By studying the location of well drilling and matching its position on the maps of the concentration of sodium, calcium, magnesium, salinity, hardness, the wells are located in the southern plain of Roudbar and the location of the most inaccurate location according to the maps of the concentration of salts it is also close to the Jasmourian wetland. Due to its position, its underground water quality is not good and the thickness of its saline water surface is more than other parts of the region.

RESULTS

Study of the Results of Hydrogeochemical Studies of the Region

The characteristics of the old well have been such that the depth of the well is 65 meters, which has been investigated by the geoelectric device and the observations made that this site has a layer of saline and semi-deep saline water from 20 meters to 70 meters depth and this reason for the old well water is high salt content and is unusable for agricultural crops and most garden products. Water quality and parameters related to hydrogeochemical analysis of water in old wells and wells have been investigated. Old and new wells analysis of anions and cations is presented in **Table 3**.

Another reason for the over-wellness of the well in addition to the depth of the well and drilling in the salt water layer is close to the Jasmourian wetland and central Iran, so that the wells that are located on the northwest and west of the old well Solubles are less than this well. In **Table 4**, wells 1 through 3 are located in the northwest and west of the well.

In **Table 5**, the indexes and analysis of the chemical parameters of the groundwater samples of Jiroft plain, expressed in mg / l, show a significant difference with the study area, due to the location of the Roudbar Plain at the end of the Jiroft plain and more proximity to the Javzourian saline wetland and especially the central desert. In the table below, the chemical standard of agricultural water quality is based on the industrial Research Institute of Iran to determine the characteristics of each parameter in comparison with the parameters of this table.

Provide Solutions

With the suggestion of the researcher, a well at the point 1 was located at a distance of 16 meters north of the current well with the above coordinates to a depth of 120 meters. In order to prevent the mixing of saline water with a lower layer of water, two suggestions were made by the researcher:

A. The first suggestion is that the well should be drilled up to a depth of 70 meters with a 22-inch drill bit (at least 55 cm high), and the tube is placed 20 or 22 inches or inches inside the well, and then continue to drill with the drill 16 The inlay was then subjected to a depth of 120 meters. Then, by placing a 14-inch pipe that had a lattice depth of 120 meters to 70 meters, and from the 70 meters to the surface of the pipe, the 14-inch bezel was placed. Then, two pipe walls were made from a depth of 70 meters to the surface of the earth bentonite

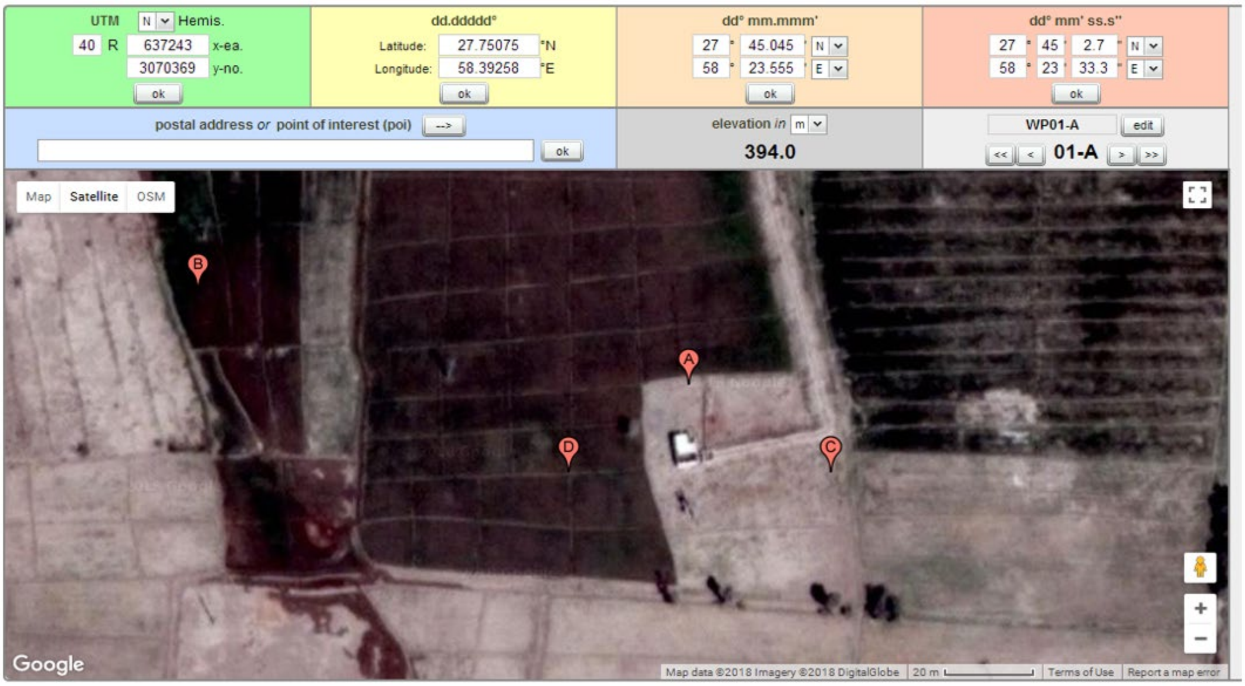


Fig. 2. Well-site mapping and location of electrical assemblies and conversion of GPS units

soil and concrete or cement were injected in a mixture for insulation, and the ends of the tubes it was connected by a metal funnel connected to the casing to prevent deep water penetration.

B. The second suggestion is that the well should be drilled up to a depth of 120 meters with a 22-inch drill bit (at least 55 cm high), and the intubation process should be such that the tube is 20 inches or 22 inches to a depth of 120 meters inside the well. The wall is 70 meters deep and 70 to 120 meters deep and 70 to 120 meters high. Then, by laying a 14 “or 16” inch pipe that has a lattice depth of 120 meters to 70 meters, it should be latched from the depth of 70-120 meters to allow fresh water to enter. The pipe was crimped and laid out from the 70 meters to the surface of the earth without a lattice, and the term “Salt water into wells to be called to this work in isolation drilling wells to say.

Thereafter, two tubes (with lattice) were poured from a depth of 120 meters from the bottom of the well to a depth of 70 meters of coarse gravel, and from a depth of 70 meters to the surface of the earth (a tubing without a lattice), soil bentonite and concrete or cement as a mixture to insulate the injection The ends of the wall pipes were sealed by a metal bundle attached to the wall of the pipe to prevent the penetration of deep saline water. At the back of the outer wall, if there is a gap and the pipe is not absorbed, it should be from the bottom of the well to 70 meters the gravel is spilled and injected from a depth of 70 meters to the surface of concrete, or a mixture of cement and bentonite, the maximum depth of drilling should be 120 meters.

DISCUSSION AND CONCLUSION

Considering that the saline layer began to surface at a depth of 20 meters and continued to a depth of 70 meters, the most important work in this study was to determine the saline layer from sweet and to detect flowers and deep salty water, and to determine the thickness of the layers and to propose to isolate the water layer Seductive saltiness with new engineering solutions.

Due to the fact that the second suggestion in terms of insulation of the pipework for the non-penetration of saline water, the surface layer to the middle layer of the fresh water is better, a second proposal for insulating and intubating was introduced and completed.

Using the specific strength resistance method and the depth of contact with the saline layer and saline water layer, as well as the surface of the freshwater tap water and the boundary of the salt and sweet water layer, it was also characterized by the depth of contact with the water layer and saline the deep below the freshwater layer is also known to indicate a maximum depth of drilling (120 meters) to avoid entering the deep salt water layer.

After digging the above well with the specifications and type of drilling, and observing the technical principles of laminar and double-conductor intubation with insulation, these results were obtained that not only the discharge of the well has reached more than 30 liters per second (previous reservoir drainage of 8 liters in S), but its salinity from the previous wells dropped from 10,800 to 1,450.

By performing this strategy and by insulating the wall of the well, it prevented the penetration of surface and semi-deep saline waters (from 20 meters to 70 meters depth of saline layer that was detected) to a less soluble juice layer (low and low water layer solubility was detected from 70 meters to 120 meters.

With this, the obtained and pumped water is suitable for the cultivation of horticultural and crop products, which, of course, is due to the cultivation of this agricultural wellbeing, which is more crops and the cultivation of crops with EC less than 4000 is a good success in correcting this agricultural wells were done.

Therefore, with regard to the above, arrangements should be made in the region as follows:

A. Regarding the increase in the water salinity level of wells, due to water extraction with a high discharge of superficial layers, this procedure should be adjusted and the depth of the saline wells should be controlled by isolation of the saline water layer, and also in order to prevent the penetration of lower saline water in wells that have been over-digging in the deep saline layer, they can be reduced by injection of other cements or other new methods, and the amount of wells that have not yet been washed has been reduced.

B. Alternate wells with depth and discharge (water harvesting) are less to be excavated at designated locations, enough distance to adjacent wells should be observed and for all wells, regular monthly sampling of water and measurement of electrical conductivity should be considered to constant concentration and degree of salinity of water.

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