PIEZOMETRIC STUDY OF GROUNDWATER IN THE DASA PROJECT AREA

ADRAR EMOLES PERMIT 3

INTERIM REPORT

October 2022

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REMINDER OF THE STUDY'S OBJECTIVES

In accordance with the technical offer of the contract, the Study initiated and to be carried out over a period of ten (10) months, within the perimeter of the DASA mining project has a double objective, namely:

- surface water monitoring;
- groundwater monitoring;
- water quality monitoring.

1. Surface water monitoring

This monitoring consists first of all of making an inventory of the various watercourses (or koris) that may affect the mining operations area in normal times or in periods of flooding and of monitoring their flows while evaluating their depths and sizes. It also consists of assessing the spread of these koris over the area of mining operations or in case of flooding.

Once these operations have been completed, flow measurements of the various watercourses will be carried out using the float or tracer method. The following equipment is required for these measurements:

- a graduated rod to measure depths taking into account many parameters;
- a tape measure for length and width measurements;
- a float or tracer to measure the flow velocity;
- a stopwatch.

Once all these parameters have been determined, the flow rate of each of the rivers will be calculated and consequently the quantities of water they can drain during the high and low water period. These measurements should be made several times on several streams in order to obtain an average.

2. Groundwater monitoring

This monitoring consists of plotting the piezometric surface of the aquifers before the mine opens and drawing up a hydrogeological baseline of the mining area. This monitoring should be carried out on several structures during the rainy and dry seasons.

This monitoring should allow:

- to confirm or deny whether or not the water table is being recharged;
- to confirm or deny whether the aquifers communicate with each other.

Measurements must be taken weekly at each structure and always at the same time and place. To this end, the measuring points of the various structures must be marked, the above-ground level must be measured, and the piezometric level must be determined.

Measurements from two periods will be superimposed to assess the influence of the rainy seasons on possible groundwater recharge.

In order to have a representative baseline, a large number of boreholes are required, hence the need to use all the water boreholes in the project area as well as some of the mining boreholes that are still accessible.

3. Water quality monitoring

As there are no permanent water bodies (ponds) in the mining project area, water quality monitoring can only be done through groundwater sampling. Several factors can influence water sampling, but the most important is the state of the water at the time of sampling.

For the purposes of the Study, in addition to the results obtained through the various hydrological and hydrogeological programmes, new piezometers, an inventory of existing wells and structures and a piezometric campaign on the identified water boreholes will be carried out.

The depth of groundwater fluctuates with seasonal variations in precipitation and can also be affected locally by withdrawals from the aquifer (a reservoir rock consisting of any porous or fissured geological formation containing groundwater and sufficiently permeable for water to circulate freely). Within the aquifer, a kind of equilibrium state is created that ensures that the range of seasonal fluctuations in water levels remains relatively constant from year to year. Under normal conditions, the volume of water entering the aquifer (mainly precipitation) is equal to the volume leaving it, so the reserve in place remains constant (the reserve is the volume of water in the aquifer). However, a significant increase in abstraction due to an increase in the number of wells, intensive pumping or a significant rainfall deficit (e.g. prolonged drought), can create a change in the state of equilibrium which will then result in a change in the reserve in place. Such a change will be reflected in the water levels in the form of a shift in the range of their seasonal fluctuations. It is in this context that the various aquifers in the study area are regularly monitored for water levels during certain periods of the year, in particular by means of a piezometric system. At the same time, water samples are taken to monitor water quality.

1. PRESENTATION OF THE STUDY AREA AND THE MINING PROJECT

1.1. Presentation of the study area

The geographical location of the Study Area in the Republic of Niger is shown in Figure 1 below. It is located in the north-central region of Niger, approximately 120km northwest of the town of Agadez (the region's capital) and 108km southeast of the town of Arlit. It can be reached by taking the RN 25 (Agadez-Arlit).

It is precisely located in the south-western part of the "Adrar Emoles 3" exploration permit, which has a total area of 121.2 km^2. Administratively speaking, the area is attached to the department of Tchirozérine.

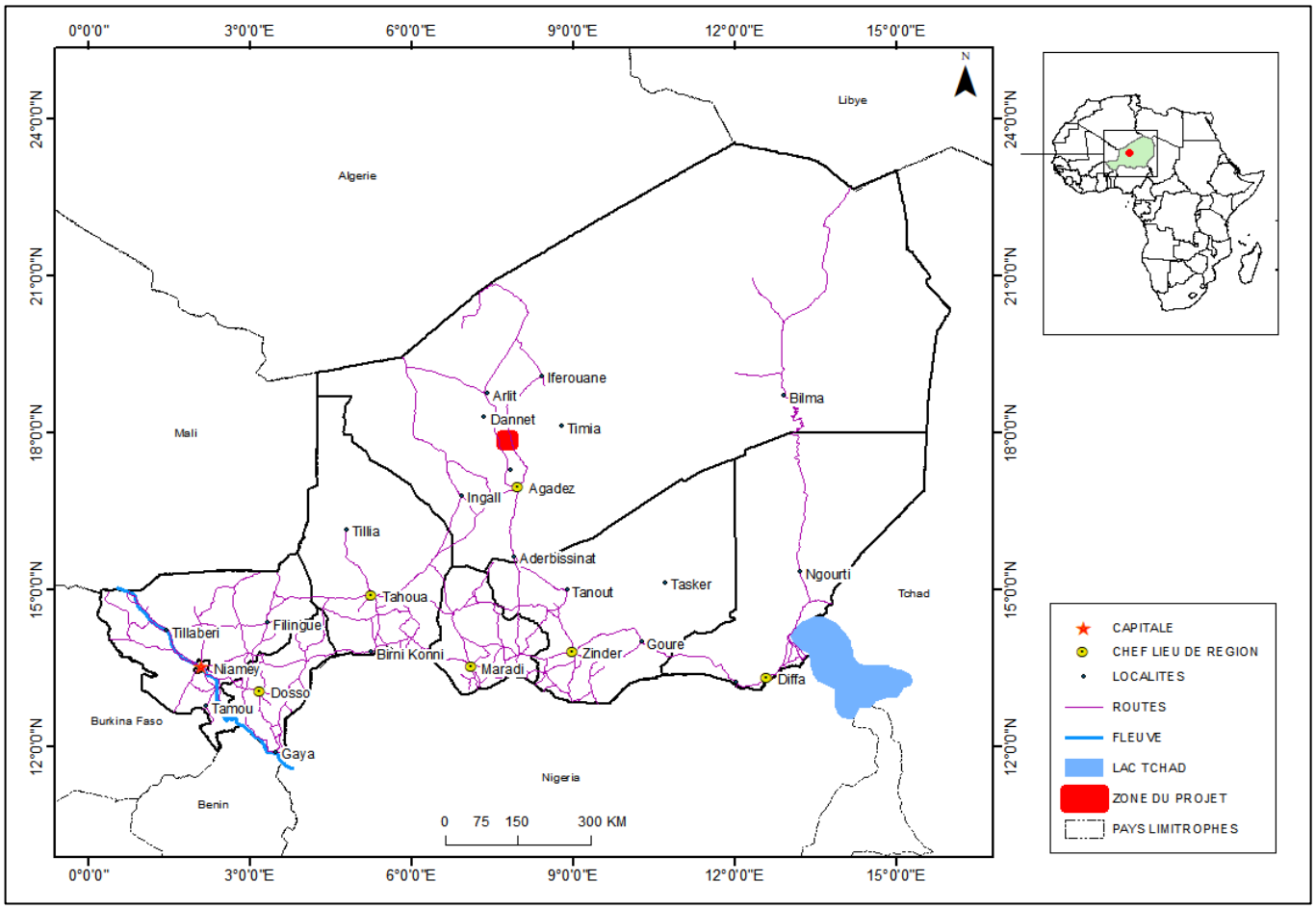

Figure 1 Geographical location of the study area

1.1.1. Vegetation

Woody vegetation is mainly concentrated in the kori bed. The main species encountered are:

- Acacia radiana;

- Balanites aegyptiaca ;
- Hyphaena thebaica ;
- Calotropis procera.

The herbaceous vegetation is cenchrus biflorus, afazaou, aloun mouz, adag etc.

1.1.2. The climate

The sub-desert tropical climate is very arid with:

- A very low level of rainfall, intense evaporation which exacerbates climatic drying (ETP 2,500 to 2,600 mm/year), very high insolation (3192.9 hours/year on average from 1967 to 1992).
- A brutal thermal gradient characterised by large thermal amplitudes (maxima 42°C and minima - 2°C) and a regularity of the dominant North/North-East winds (observations of wind higher than 25 km/h in Bilma for 160 days/year).

1.1.3. Rainfall

The climate of the project area is desert, with an average annual rainfall of 144 mm according to the ten (10) years' record (maximum available) obtained from the Meteorological Department for the Tchirozérine station (**Table 3, below**). It can be seen that seven (07) years out of ten (10) have recorded rainfall in excess of 100 mm and three (03) years out of ten (10) have recorded rainfall of less than 100 mm. The rainy season lasts about two three months, from July to September.

Table 1 Annual rainfall (mm) from 2011 to 2020

Year	Year to date
2011	89,2
2012	173,2
2013	48,8
2014	105,2
2015	271,6
2016	222,1
2017	158,5

2018	114,4
2019	174,6
2020	89

Source: National Meteorological Directorate

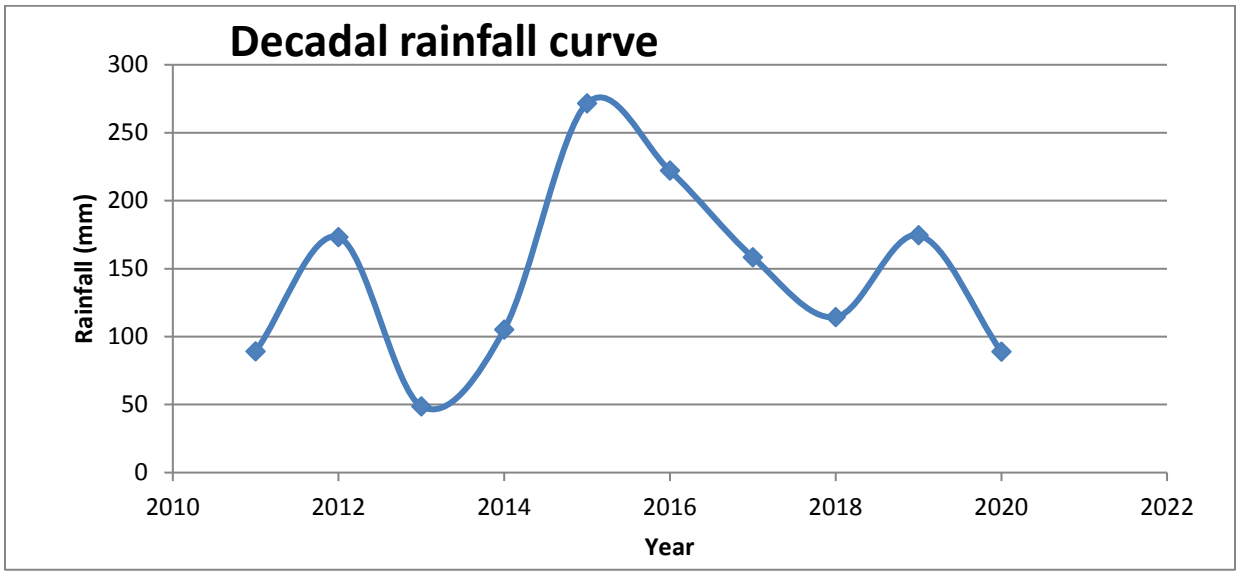

Figure 2 Ten-year rainfall curve

The average rainfall recorded in recent years in the area hardly exceeds 144 mm/year. However, it should be noted that they are unevenly distributed in time and space, especially with the phenomenon of climate change.

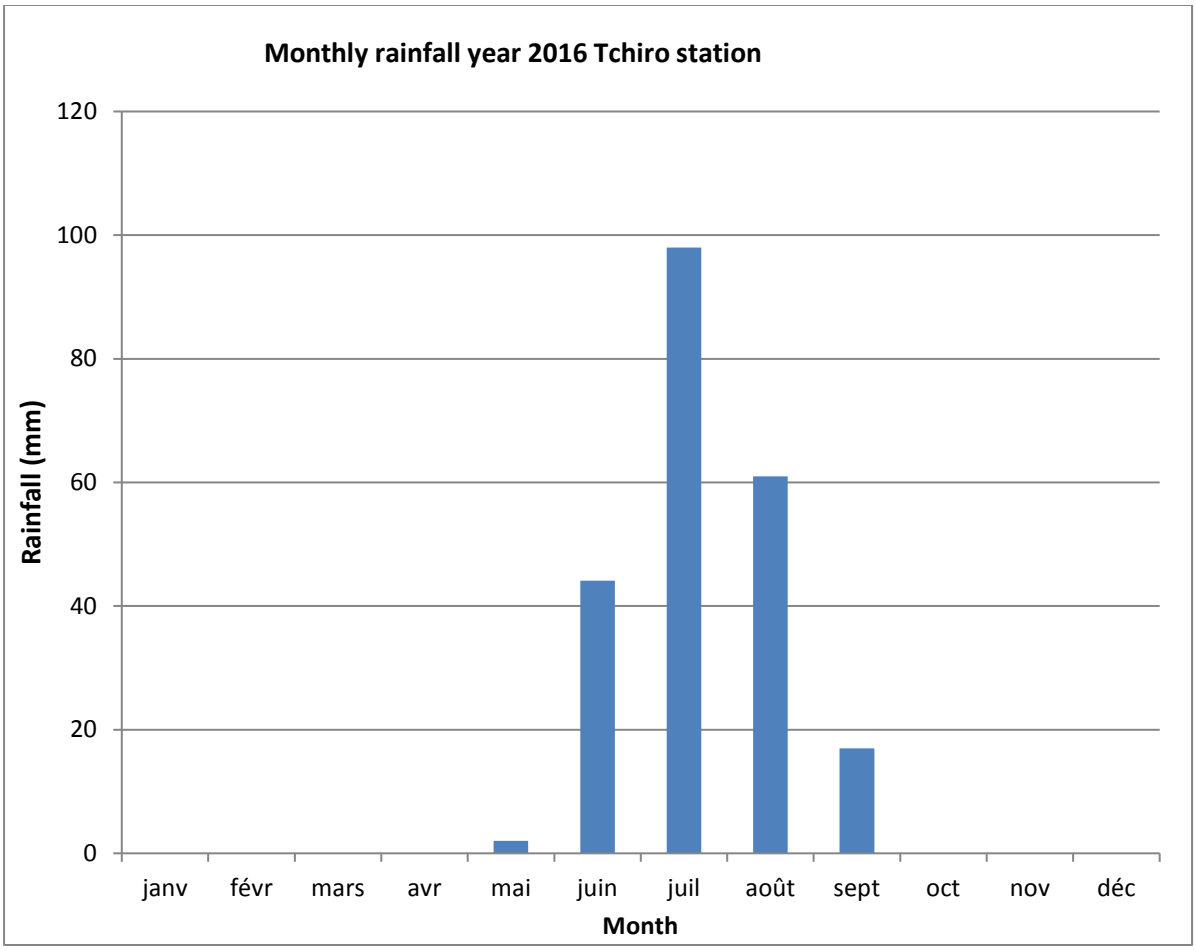

Figure 3 **Monthly rainfall for the year 2016**

Rainfall in the area hardly lasts 3 months with the maximum recorded between July and August with a maximum recorded in 2016.

1.1.4. The temperatures

The temperature variations in the area are summarised as follows:

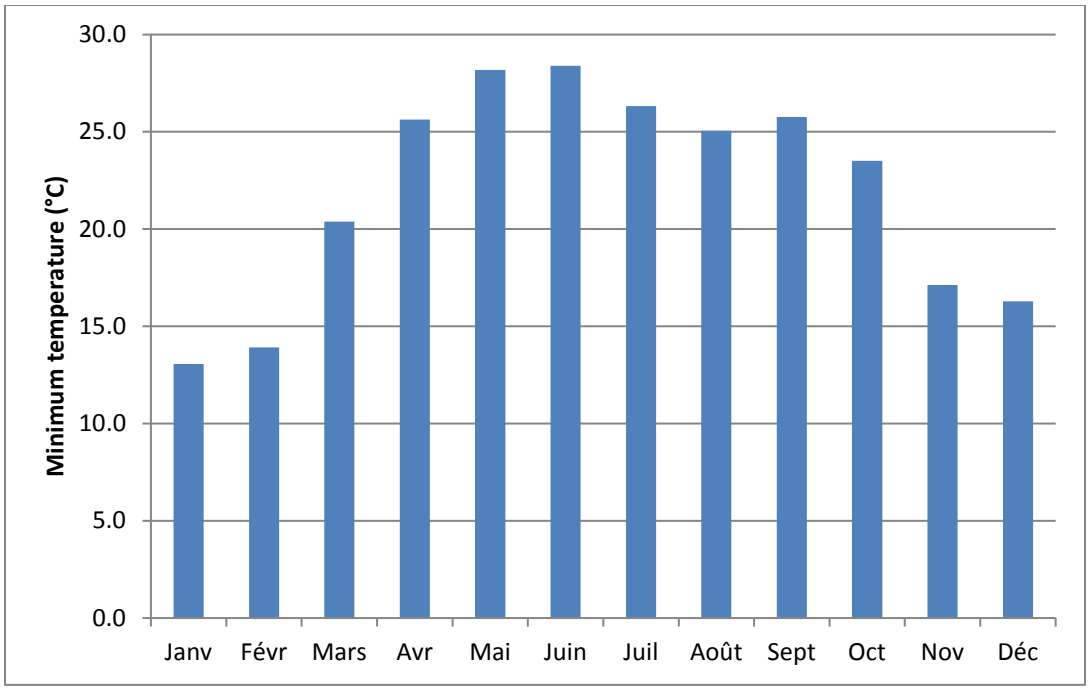

Figure 4 Low temperatures

They are usually recorded between October and March.

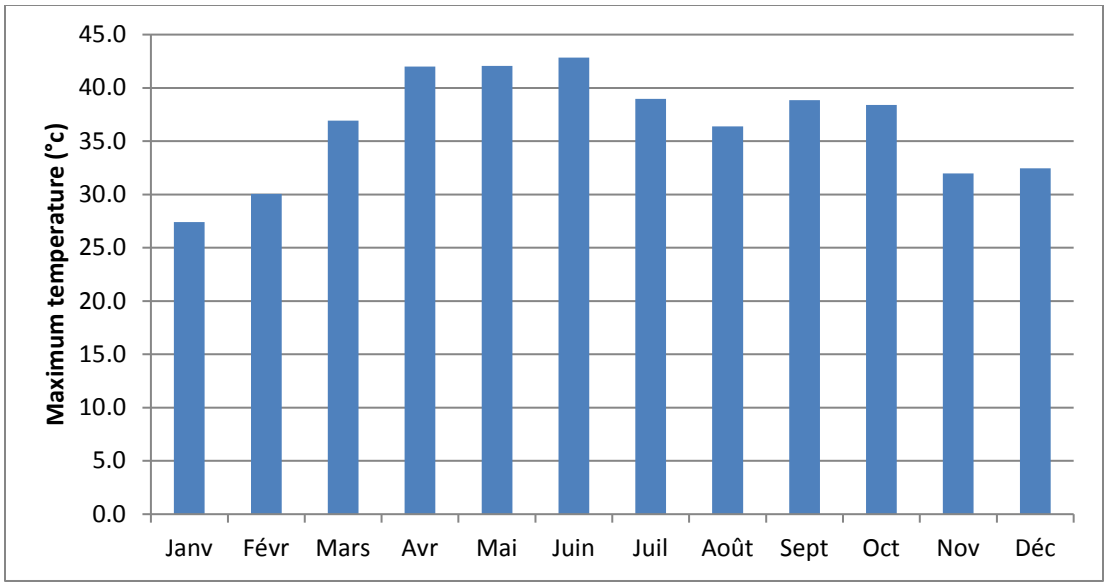

Figure 5 High temperatures

1.1.5. The winds

The study area is windy all year round. The preferential direction of these winds varies with the seasons. Measurements of wind strength and wind direction (wind rose) as a function of season are given in the figures below.

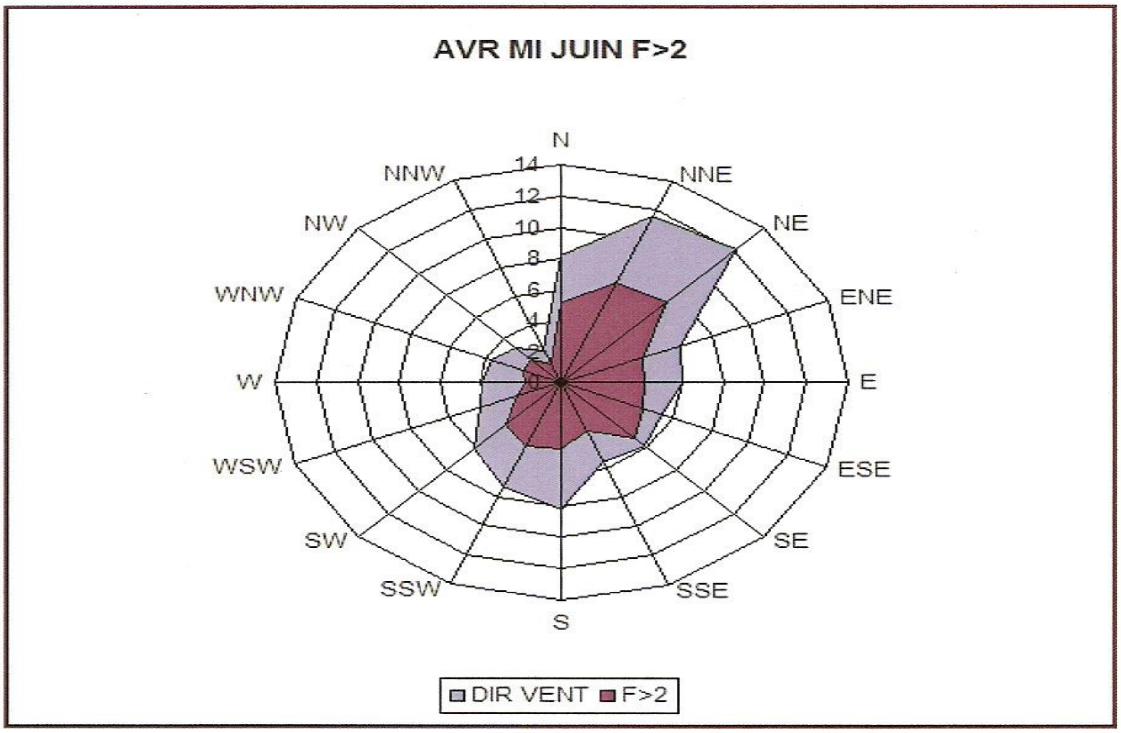

Figure 6 Wind rose in the dry season (April-June)

This figure shows winds above zero on the BEAUFORT scale (in blue) and those above 2 (9km/h) in purple. This wind rose also shows that the study area is located in an area with little wind. It can be seen that the dominant winds, which represent 12% of the winds, are from the north-east, followed by those from the north-north-east. These are the Harmattan winds.

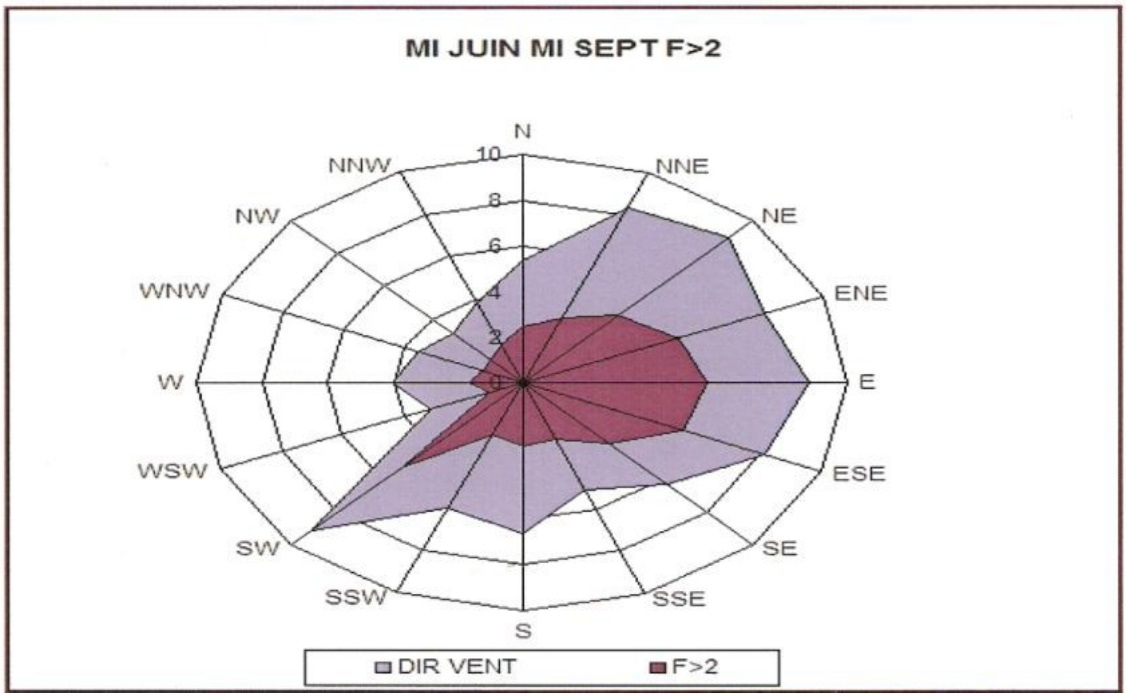

Figure 7 Wind rose in rainy season (June-September), *1Source: EIA, Immouraren 2008-AREV*

This second figure shows that the dominant winds during the rainy period are from the southwest and represent 9% of the winds. It can also be seen that 50% of the winds are above 9km/h with a maximum of 35km/h.

1.1.6. The hydrological cycle

The hydrological cycle (or water cycle) is a model representing the flows between the major reservoirs of liquid, solid or gaseous water on Earth: the oceans, the atmosphere, lakes, rivers, groundwater and glaciers. It corresponds to a continuous movement of water in the globe, the quantity in displacement being constant, it is in fact the distribution of this quantity during these displacements which is irregular.

The water cycle can be analysed schematically according to the following three elements:

- Precipitation.
- Surface runoff and subsurface runoff.
- Physical evaporation and evapotranspiration, which encompasses the processes of evaporation and transpiration by vegetation.

The 'engine' of this cycle is solar energy, which, by promoting the evaporation of water, drives all other exchanges.

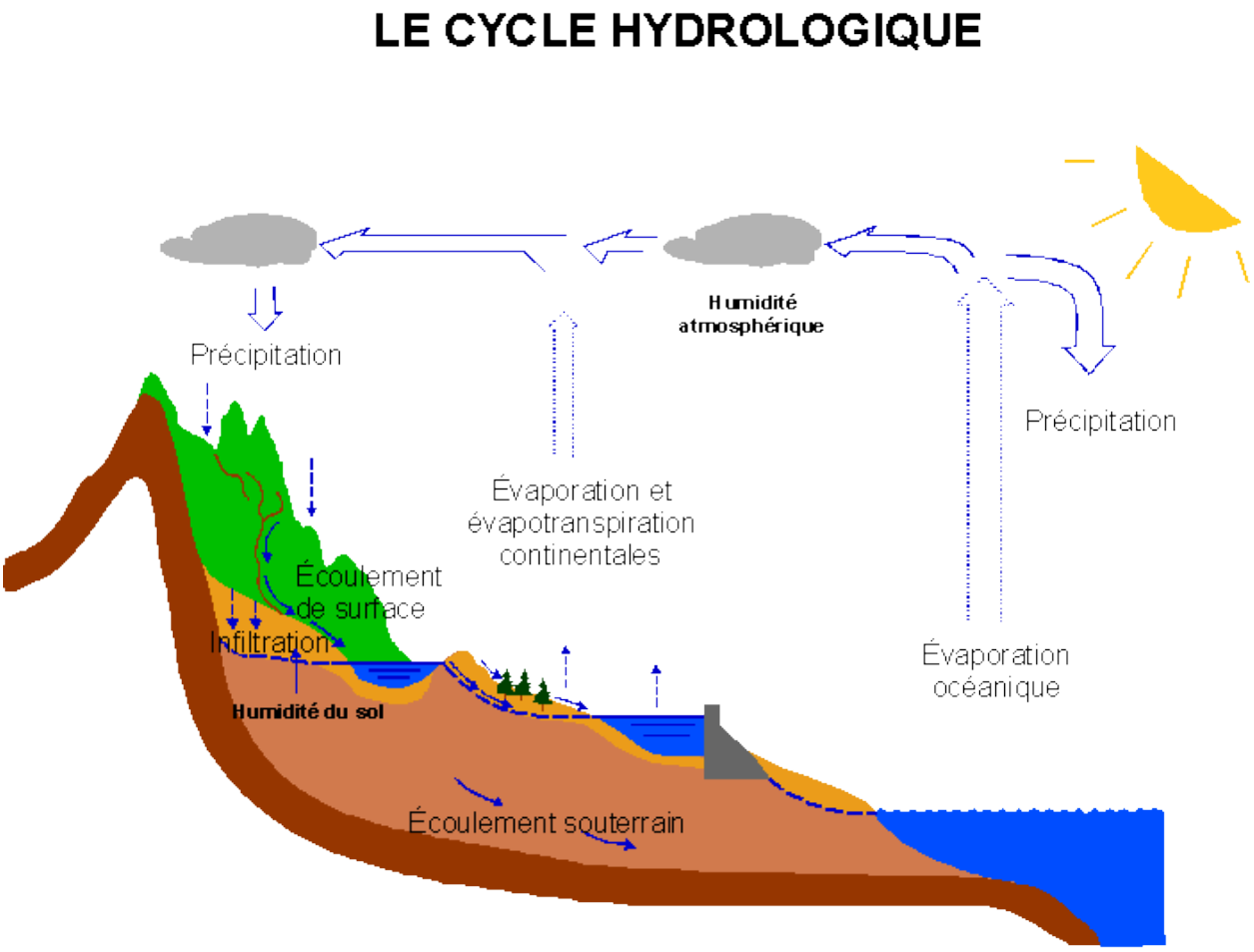

Figure 8 Illustration of the existing binders the different climatic parameters of the region

1.1.7. Local water framework

Surface water, although temporary, is an important reserve for at least four months of the year.

- Surface water

The waters of the region are generally made up of temporary streams known as koris and semi-permanent streams. The koris are seasonally flowing rivers that drain the western slopes of the Air and flow into the three major collectors of the region which are: Anou Zangarène, Anou Makarene and Irhazer Wan Agadez.

These three main rivers merge about 200 km west of the Air to form the Azawk, which is a powerful ancient river that flows into the Dallol Bosso.

The Téloua kori, which flows through the town of Agadez and is assumed to recharge the water table of the same name, the exploitation of which ensures the water supply of the town of Agadez.

- **Semi-permanent watercourses**

These watercourses are located in the Irhazer valleys and in the fracture zones of the Air Massif, the main ones being the Tchintaborak and Aderbissanat pools. In addition, there are the springs of Azelik, Toubak, Geleli and the thermal spring of Tafadek.

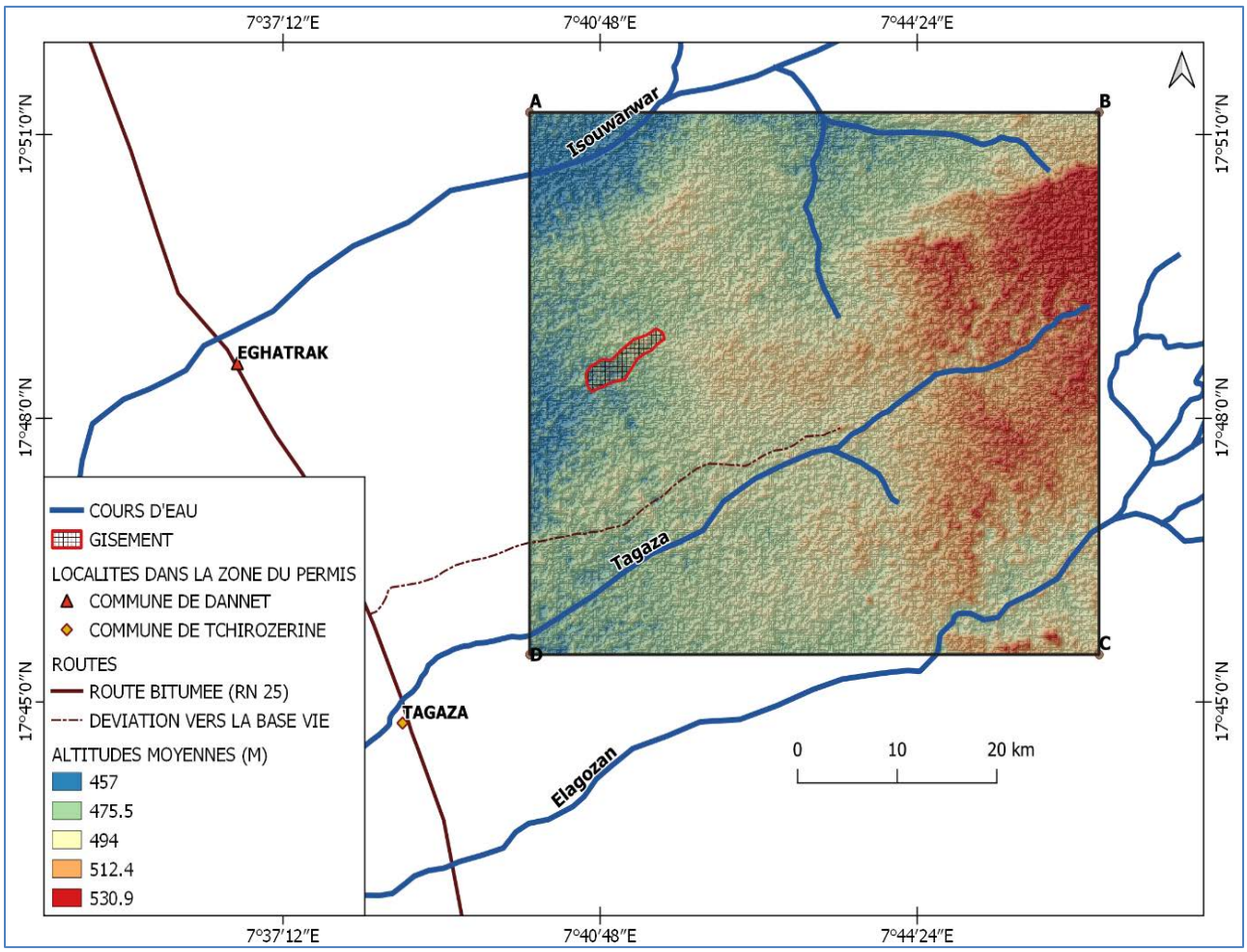

Figure 9 Map of the water system in the permit area

1.1.8. Local hydrogeological framework

The hydrogeology of the study area is characterised by a multi-layered aquifer system which includes the Guezouman, Tarat and Izégwandan aquifers in the eastern part of the In-Azaoua-Arlit fault. In the western part, these aquifers are surmounted by a permeable horizon which shelters the Tchirozérine and Téloua aquifers.

- **The Guezouman slick**

It is formed of white sandstone to fine to medium sandstone. The sandstone-clay alternation at the top of the Guezouman corresponds to a very low permeability level. The transmissivities are also low, between 1.8 x 10-4 and 1.5 x10-6 m²/s. This water table flows from an old supply zone in the south to an evaporation zone in the north at the edge of the water table, where it is free.

- **The Tarat tablecloth**

This nappe is made up of coarse sandstone, fine sandstone and micro conglomeratic sandstone mudstones, which are well individualised at all levels of the spreading, especially in the thickening zones where feldspars are more abundant. The transmissivities of this nappe are between 3.8x10-6 to 1x10-2m2/s and flow in a SSE - NNW direction.

- **The Izegwandan slick**

It is represented by arkosic, heterogranular sandstones mixed with lenses of very red argillite. With a low flow, its permeabilities are between 1.2 x 10-6 and 7.5 x 10-7 m/s. It has a SSE-NNW flow direction and low transmissivities (1.10-4 and 8.10-5m²/s).

- **The Chirozerin aquifer**

The sandstones of this nappe are coarse, poorly cemented, vacuolated, permeable and locally conglomeratic. Silicified wood can be found. The sandstones of Tchirozérine II are separated by an impermeable layer called Abinky located at the base of Tchirozérine II. The specific flow rates can vary considerably from 0.5 to 2 m3/h/m and up to 12 m3/h/m at SONICHAR (Rharous). Transmissivities are of the order of 2.10-3 m²/s and tend to increase towards the south (SONICHAR: T≈1.10-2 m/s).

- **The Teloua aquifer**

This water table is composed of arkosic sandstones with pebbles, fine, medium and coarse sandstones, analcimus sandstones and feldspathic clayey sandstones. It constitutes a multi-layered reservoir whose water can be captured within permeable sandstone lenses, the location and extent of which are not well known. This water table is practically not recharged, apart from a few infiltrations of water from the koris in the west of the Aïr (Téloua, Tchirozérine, Solomi, etc.) in favourable years. It is one of the best aquifers in the sector with a flow rate varying from 10 to 20m3 /h in the free parts and from 30 to 100m3/h in the captive parts, especially to the west of the flexure-fault. The static level of this water table varies from 30 to 80 m depending on whether it is free or confined. The transmissivities are different and are low in the parts where the water table is free. The power of this water table varies from 80 to 100 metres and flows from East to West. It is one of the most exploited aquifers in the region and is the main resource for supplying drinking water to the city of Agadez.

- **Alluvial aquifers**

These aquifers are present in the Aïr valley (kory) and provide a significant part of the region's water supply, especially in rural areas. These aquifers take the form of a succession of alluvial reservoirs separated by sills resting on the crystalline base. Their maximum thickness reaches 30 metres (Téloua basin in Agadez). These aquifers are sandy-gravelly, with silty or clayey lenses. The water is generally found at a depth of between 10 and 20 metres.

1.2. Presentation of the mining project

The "DASA" uranium deposit (25 km²) is located in the "Adrar Emoles 3" exploration permit held by the Canadian company Global Atomic Fuels Corporation. It was discovered after intensive exploration work carried out between 2010 and 2018. The deposit will be developed as an underground mine.

Hydrological and hydrogeological studies conducted by the company have provided a better understanding of the aquifers. The estimated water resources would be more than sufficient to cover the needs of the mine and ore processing facilities.

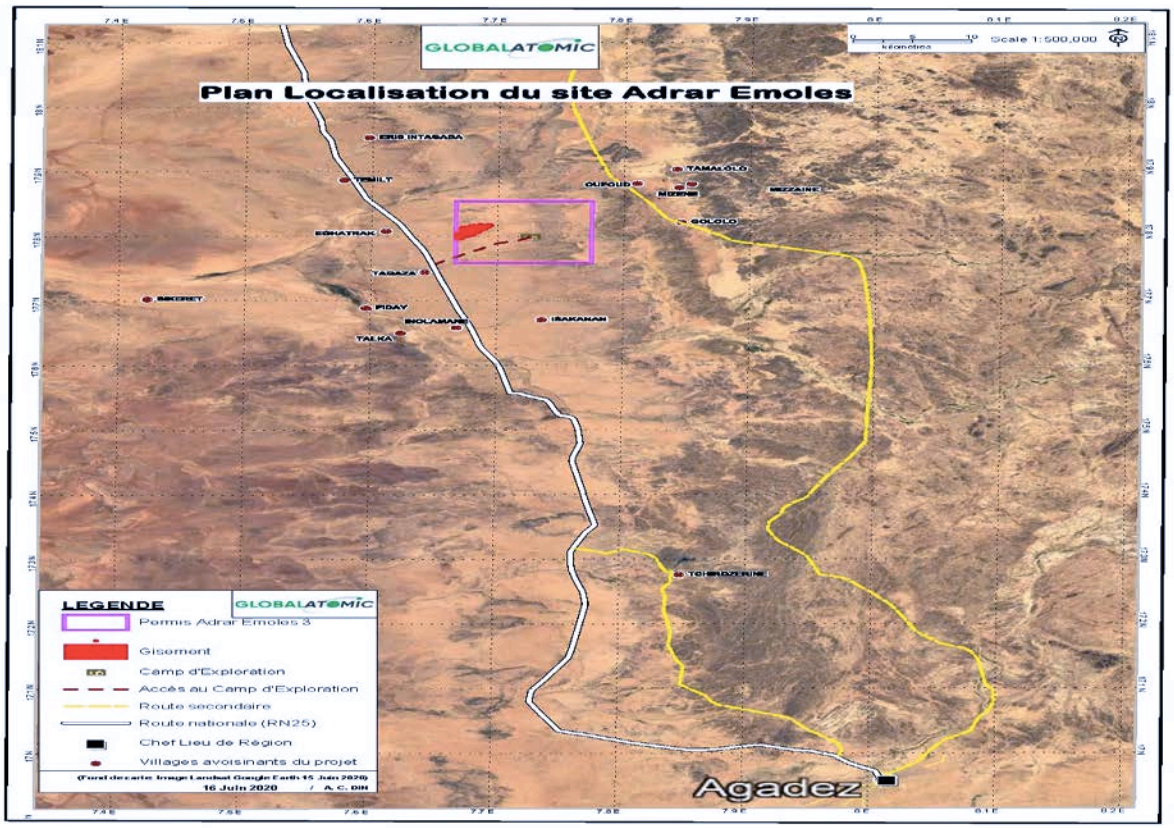

Figure 10 Geographical location of the project area

2. HYDRODYNAMIC CHARACTERISTICS OF THE AQUIFERS IN THE STUDY AREA

In order to better understand the flow regimes of the aquifers, piezometric data from the steady state period (non-pumping conditions) were used to determine the general trend of the piezometry on the one hand, and to study the potential lateral and vertical exchanges between the four aquifers on the other. The monitoring of water levels makes it possible to understand the effect of anthropogenic or natural modifications on the reserve in place, and therefore on the availability of the resource. Piezometric monitoring carried out between 2013, 2018, 2021 and 2022 has shown that fluctuations in water levels remain negligible (maximum 1.51m), which shows that there is not a great deal of abstraction in the sector and that rainwater does not affect the water table levels too much. These aquifers are considered to be fossilised but we believe that they are being recharged, albeit in small volumes. The data presented in the table below has been used to model these aquifers in order to determine their direction of flow as shown in Figure 12 below.

Table 2 Summary of piezometric measurements made on boreholes and some mining holes in 2018

HDI	X	Y	Pr (m)	Natural ground level (m)	Static level (m)	Piezometric level
DADH234	360900	1970250	37	487,95	33,8	454,15
DADH236	361000	1970250	39	486,90	35,6	451,30
DADH	360450	1969900			52,8	
DADH266	360550	1969950	82	483,50	64,85	418,65
DADH265	360550	1969900	70	480,90	62,2	418,70
DADH	360713	1970094			44,9	
DADH352B	360650	1969900			48,8	
DADH353	360550	1969800	40,32		44,7	
DADH197	360350	1969900	47,00	481,69	43,7	437,99
DADH190	360350	1969950	37,00	482,61	35,4	447,21
DADH176	360350	1970000	16,00	485,35	34,5	450,85
DADH149	360250	1970250	18,00	484,34	16,85	467,49
DADH193	360193	1970000	24,00	484,92	23	461,92
DADH333	360250	1970008	32,00	485,19	27,5	457,69
DADH216	360100	1970150	11,00	480,61	10,6	470,01
DADH184	360350	1970300	19,00	483,75	20,1	463,65
DADH162	360550	1970300	27,00	487,67	23,75	463,92
DADH298	360850	1970400	25,00	486,39	24,35	462,04
DADH297	360900	1970450	24,00	485,92	23,7	462,22
DADH295	361000	1970450	22,00	486,27	21,35	464,92
DADH294	361050	1970450	22,00	486,17	19,8	466,37
DADH292	361150	1970450	22,00	486,34	18,7	467,64
DADH279	361250	1970400	90,00	480,02	67,1	412,92

DADH105	360200	1970500	12	479,33	13,6	465,73
DADH220	359425	1969900	83,00	474,14	55,8	418,34
DADH222	359425	1969750	88,00	475,19	57,05	418,14
DADH362	359350	1969750	82,00		15,4	
DADH315	359587	1969768	92,00	477,00	59,05	417,95
DADH313	359785	1969750	58,00	479,34	58,36	420,98
ASDH030	359500	1968689	41	460,79	40,7	420,09
ASDH157	359250	1968550	60	460,79	39,63	421,16
ASDH089	359300	1968900	80	459,70	40,47	419,23
ASDH157	359300	1969050	24,00		40,6	
ASDH137	359300	1969100	115	460,14	41,12	419,02
ASDH300	359250	1969200	182	460,00	35,66	424,34
ASDH138B	359209	1969203	236	459,75	36,03	423,72
ASDH301	359150	1969200	156	458,82	37,59	421,23
ASDH287	359400	1969150	151	459,33	41,58	417,75
ASDH088	359400	1968900	77	460,61	41,27	419,34
ASDH179	359450	1968900	75	460,61	40,88	419,73
ASDH259	359446	1969102	128	460,70	41,36	419,34
ASDH285	359500	1969150	126	459,88	41,02	418,86
ASDH284	359550	1969150	121	460,22	42,67	417,55
ASDH308	360000	1969500	453	464,80	25,72	439,08
ASDH252	360350	1969400	350	466,70	44,5	422,20
ASDH277	360545	1969450	76	468,35	47,69	420,66
ASDH121	360500	1969450	60	466,70	45,76	420,94
ASDH348	359100	1969200	157,00	458,51	42,6	415,91
ASDH347	359100	1969150	170,00	458,46	42,05	416,41
ASDH481	359050	1969100	138	458,629	41,92	416,71
ASDH492	359050	1969150	143	458,842	42,45	416,39
ASDH493	359050	1969200	132	459,394	30,11	429,28
ASDH494	359000	1969200	137	459,511	44,38	415,13
ASDH491	359000	1969150	143	459,298	44,3	415,00
ASDH482	359000	1969100	140	458,908	37,92	420,99
ASDH371	359000	1969050	133	458,802	42,12	416,68
ASDH394	358950	1969050	124	458,549	42	416,55
ASDH393	358950	1969000	120	457,616	41,55	416,07
ASDH395	358900	1969050	109	457,862	34,5	423,36
ASDH490	358950	1969150	104	459,346	35,52	423,83
ASDH489	358900	1969150	95	458,967	43,2	415,77
ASDH381	359000	1968550	79	457,906	39,08	418,83
ASDH363	359050	1968700	83	457,886	39,45	418,44
ASDH362	359050	1968650	82	457,967	39,55	418,42

ASDH365	359050	1968800	93	458,425	39,88	418,55
ASDH366	359050	1968850	92	458,53	40,35	418,18
ASDH368	359050	1968950	115	458,328	40,78	417,55
ASDH370	359050	1969050	132	458,63	42,15	416,48
ASDH373	359000	1968950	105	458,085	40,68	417,41
ASDH374	359000	1968900	102	458,495	40,55	417,95
ASDH414	358850	1968850	113	455,345	39,45	415,90
ASDH264	360424	1969430	155	473,12	38,14	434,98
ASDH558	359863	1969302	690	469,75	35,38	434,37
ASDH559	360435	1969612	684,29	473,68	38,12	435,56
ASDH553	359444	1969395	737,6	470,36	37,89	432,47
ASDH575	360271	1969561	693,25	472,47	36,34	436,13
ASDH573	359837	1969350	750	469	37,76	431,24
DADH388	360550	1969740	700	482	40,11	441,89
ASDH580	360660	1969623	350	482	39,12	442,88

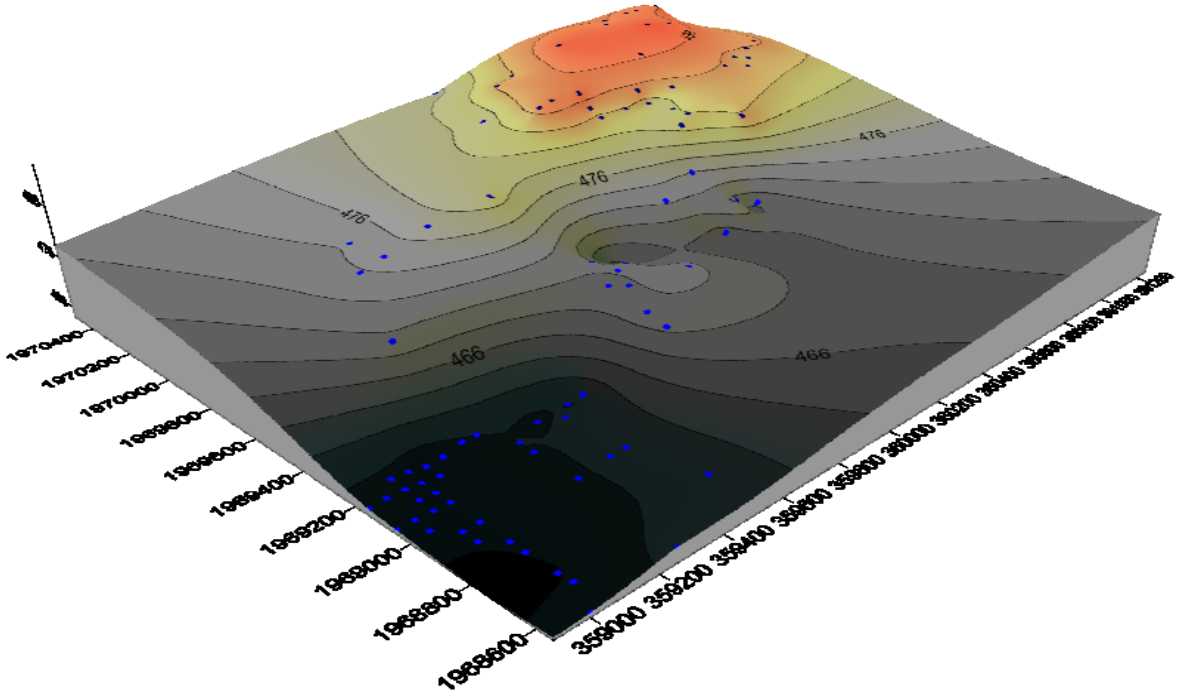

Figure 11 Piezometric map of the study area in 3D made in 2018

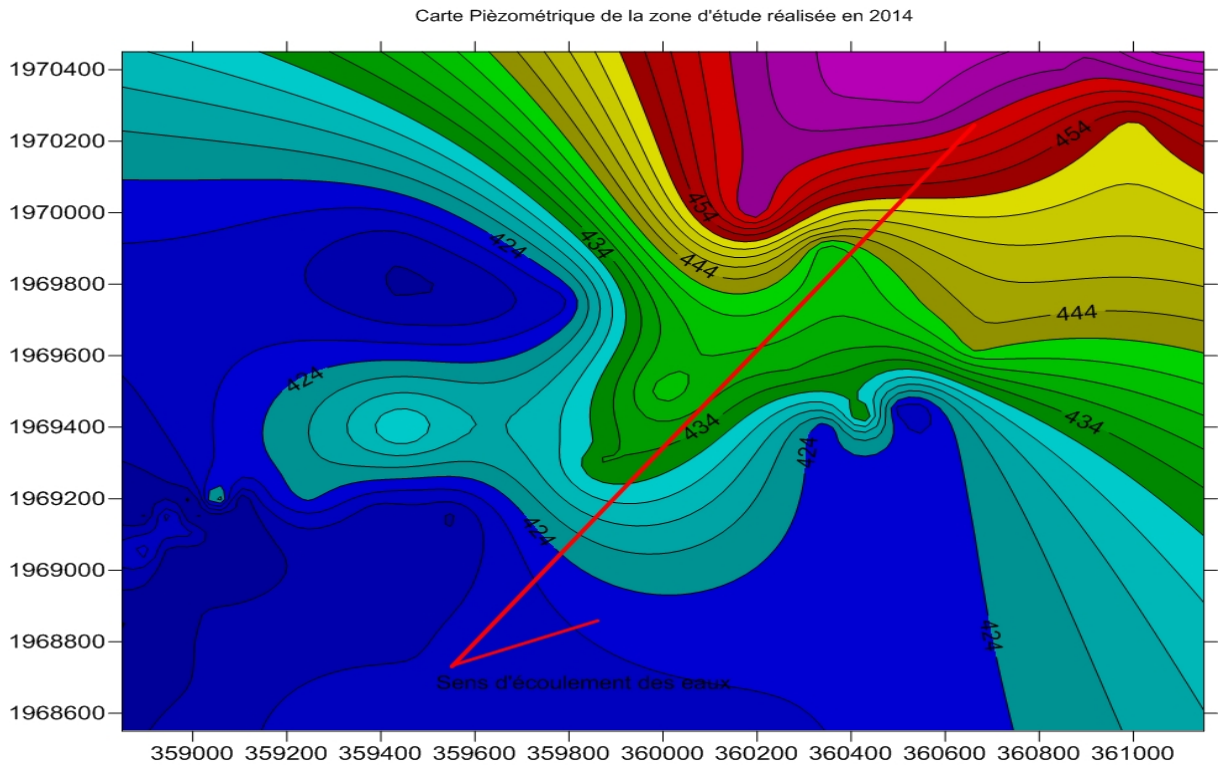

Figure 12 **Piezometric map of the study area**

These piezometric data allowed the direction of groundwater flow in the study area to be determined, which is from NE to SW. In addition to the direction of flow, the data recorded in 2021 and early 2022 showed that the piezometric levels of the various aquifers do not fluctuate sufficiently, which confirms the fossil nature of these aquifers and the absence of major water-consuming activities in the area. The hydrodynamic parameters of the aquifers calculated recently are summarised in the table below:

Table 3 Hydrodynamic characteristics of aquifers in the study area

Hydrodynamic characteristics of aquifers in the study area							
Reference	Aquifer types	Captured water	Depth (m)	Ns (m)	Q (m3/h)	TransmissivityT (m2/s)	Permeability K(m/s)
1	Chirezerin 2	Chirezerin 2	95	30 à 60	0,5	1.05.10-6	2.10-7
2	Teloua	Tchil and Teloua 1,2 and 3	180	40 à 55	15 à 25	2.10-4	5.10-6

3	Izégwandan	Izégwandan	231	30 à 45	2 à 3	3.10-5	1.4.10-6
4	Tarat	Tarat	330	25 à 40	>30	1.02.10-4	3.10-6
5	Guézouman	Guézouman	500				

3. RELATIONSHIP BETWEEN SURFACE WATER AND GROUNDWATER

The study area as a whole is not very hilly, which can facilitate exchanges between surface water and groundwater. All the alluvial groundwater along the koris is fed by the koris as shown in Figure 13 below.

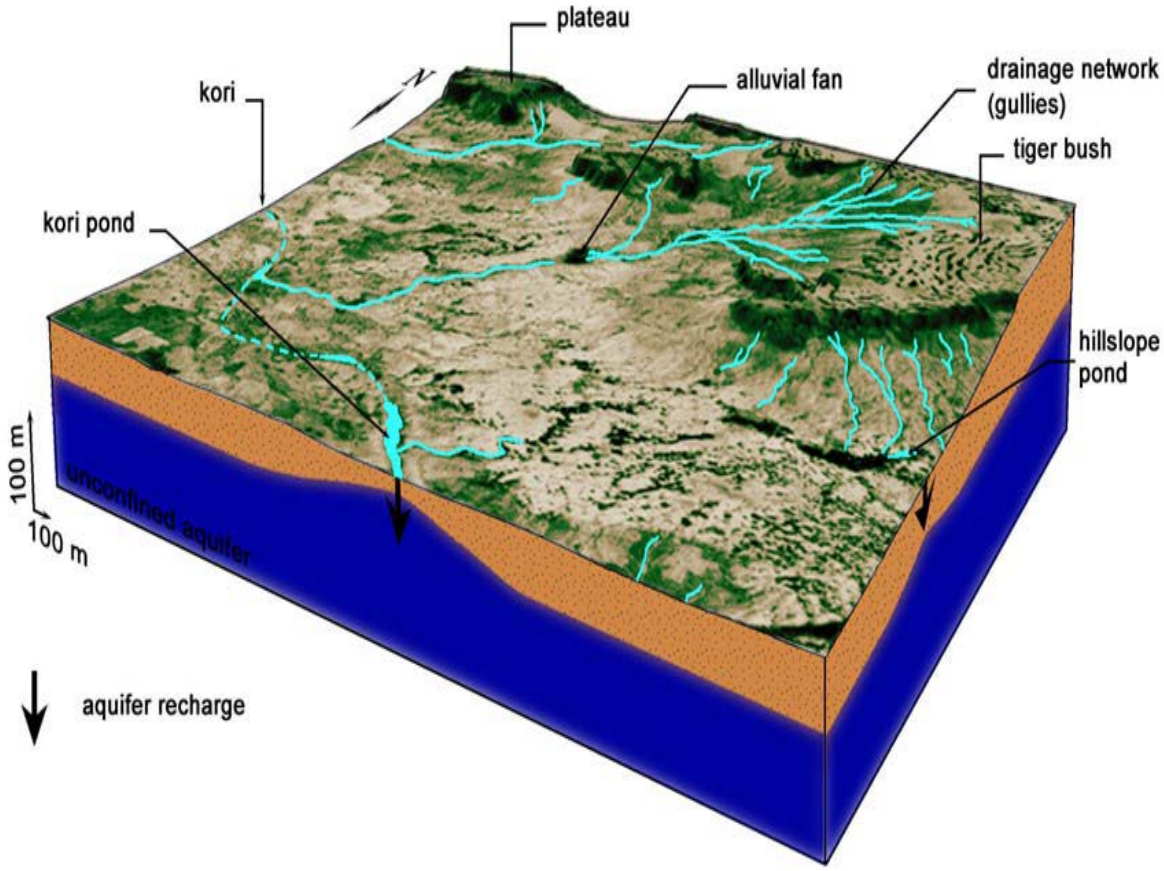

Figure 13 Hydrographic map showing the relationship between surface water and groundwater

In fact, the marked endoreism of the study area, especially in and around the uranium deposit, favours the maintenance of water resources in situ; increased recharge in the shallows, concentration of flows towards koris with well-marked beds and pools, support of certain water bodies by the overflow of the water table. Exchanges are irreversible because the alluvial aquifers receive water from the koris but, whatever the time of year, they never feed the koris. It should also be noted that these exchanges generally take place during the rainy season with the flow of the koris. On the other hand, the deep aquifers are considered as fossil aquifers and do not exchange with surface water in some places.

NB: It should be noted that exchanges between the different aquifers take place at the level of the Graben through faults or inclined exploration boreholes, as in the case of borehole HYDRO4. This borehole taps the Irhazer formation but, to our great surprise, it has the lowest dynamic level (29 m) observed during monitoring.

4. TYPES OF WATER USE

The types of water use in the study area fall into several categories. Water, a limited resource but essential to human life and activities, such as agriculture, industry and domestic activities (drinking water supply), as well as to the functioning of terrestrial ecosystems, owes its geopolitical dimension to the unequal distribution of resources according to region and to the transnational character of many rivers.

4.1. Use of surface water

Surface water is almost non-existent in the project area; there are no permanent or temporary springs apart from the koris, which have seasonal flows. They are used in the study area for drinking and watering livestock for a few days to a few months.

4.2. Groundwater use

The study area has significant groundwater resources that are not widely exploited. They are used in the following cases:

- **Small-scale irrigation**

Previously practised seasonally after the rainy season, we are now witnessing the development of market gardening exclusively from the groundwater of the alluvial aquifers, which are very accessible with few resources. The depths hardly exceed 10 to 20 m.

Nowadays, many projects are beginning to take an interest in these activities and are helping the local population with the construction of modern water points, such as the Global Atomic Corporation, which drilled a 180 m borehole in Elagozan for small-scale irrigation and drinking water supply. The International Organisation for Migration (IOM) has built a Mini AEP in Tagaza in the same framework, as well as Areva in Agatara.

- **Drinking water supply**

All the administrative villages in the study area are equipped with drinking water supply systems or modern water wells (modern or traditional wells). All these water points are supplied from groundwater.

- **Mining**

The two major mining companies in the area use groundwater for their operations.

5. PIEZOMETRIC MONITORING OF AQUIFERS

The main objective of piezometric monitoring is to observe fluctuations in the water table over time. It allows the identification of high and low water periods and thus the determination of the water table's beat.

The measurement campaign took place from September 2021 to August 2022 covering all seasons of the year. The piezometric network of the study area is made up of seven (07) boreholes transformed into piezometers for the occasion. These piezometers are distributed over the mine site and were set up with the main objective of monitoring the natural evolution of the water table. The parameter measured is the depth of water in the water table, which corresponds to the level naturally reached by the water in the piezometer.

The following table shows all the piezometric monitoring points carried out.

Table 4 Piezometric monitoring points

Work	**X**	**Y**	**Location in relation to the mine site**	**Monitoring period**	**Formation/ aquifer**
HYDRO 4	359976	1969222	On the website	September 2021 - August 2022	Tchirezerine 1
HYDRO 2	359987	1969340	On the website	September 2021 - August 2022	Irhazer
Piezometer	360008	1969087	On the website	September 2021 - August 2022	Teloua
ASDH-126 B	360045	1969257	On the website	September 2021 - August 2022	Teloua
ASDH-264	360425	1969430	On the website	September 2021 - August 2022	Teloua
GIHF4	365753	1973165	3km	September 2021 - August 2022	Tarat
GIHF2	365329	1972996	2.5km	September 2021 - August 2022	Izegwandan

5.1. Material and human resources

The implementation of the Study required the mobilisation of human and material resources as listed in the financial offer.

5.2. Measurement methodology

The measurements of the different piezometric levels must be carried out under conditions of stabilisation of the water table for the whole mapped area during the shortest possible period. The piezometric surface we measure is the upper limit of the water table. It is a hydrodynamic limit that is constantly fluctuating. This limit (piezometric surface) can rise or fall freely in the permeable hydrogeological formation. As it is very expensive to install them in the vicinity of the boreholes we want to study, we have carried out our measurements directly in the various works (boreholes) selected**.**

To take the measurement, the probe tip is inserted into the structure and once it reaches the surface of the water, the probe emits a sound and its indicator light comes on. The depth of the water level in the structure can then be read. Then the height of the coping (the elevation around the structure to protect it: in our study area it is usually a breeze block wall, a PVC pipe or a steel drill head) is measured to determine the actual water level in relation to the topographic surface. Then the water level in the structure is calculated. Finally, the name of the place or the number of the measuring well where the structure is located, the height of the coping and the piezometric level are recorded in a grid.

Weekly monitoring of the 7 points was carried out to control the variation of the groundwater level in the study area.

Monitoring of a river was also carried out by measuring a few hills along the river.

6. SUMMARY OF RESULTS

6.1. Monitoring of water levels

Monitoring water level fluctuations firstly allows us to assess whether there is a decrease in water reserves. Past data are used to assess whether the observed water levels correspond to a usual or abnormal variation. Under natural flow conditions, water level fluctuations are negligible. However, when levels are influenced by intermittent pumping, such as seasonal pumping (e.g. in agriculture), these variations can be significant. In addition, variations in rainfall can also cause water levels to vary. Monitoring of water levels therefore makes it possible to understand the effect of anthropogenic or natural modifications on the reserve in place, and therefore on the availability of the resource. In addition, this monitoring will make it possible to define various future projects: definition of alert coasts in the event of drought, development of a hydrogeological model.

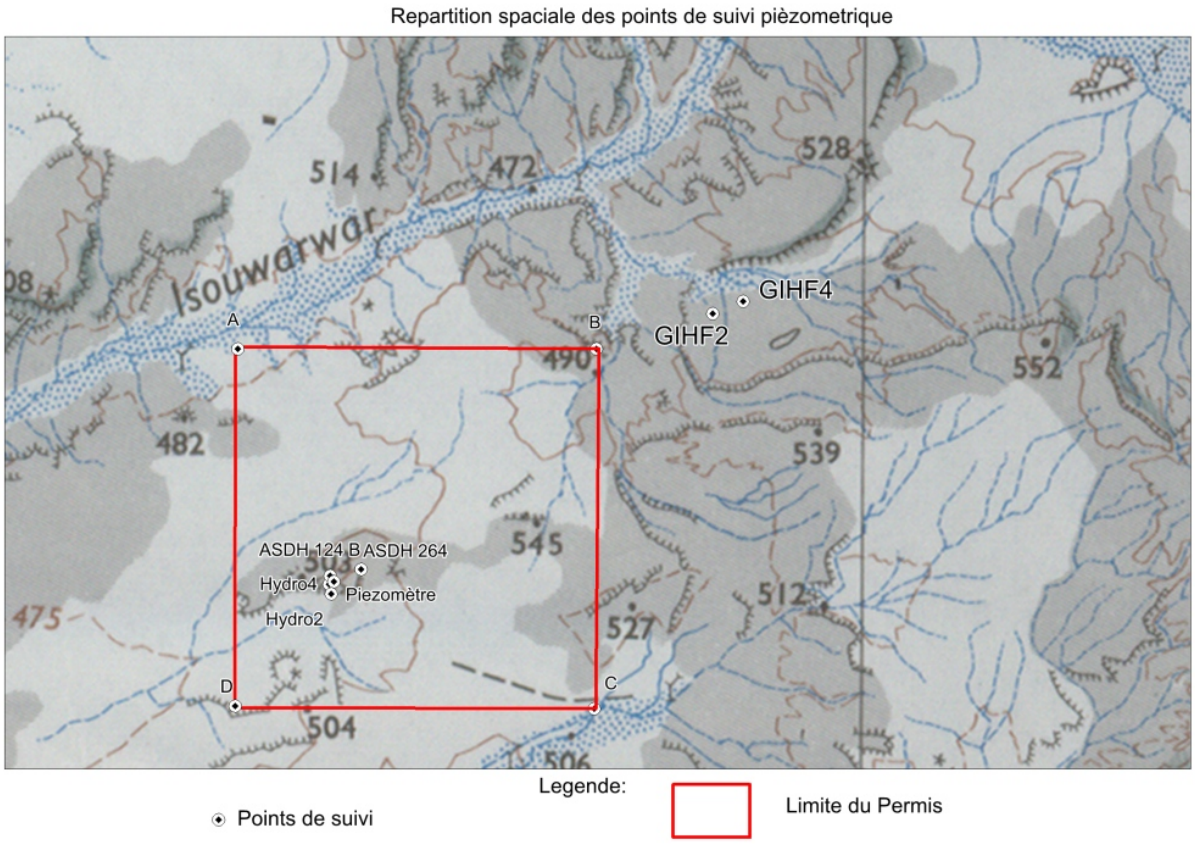

Figure 14 Map of spatial distribution of monitoring points

6.2. Monitoring of water levels in the Chirozerin 2 aquifer

This water table is not very productive in our sector, with a flow rate varying from 1 to 4 m3/h (Hydro4), but it is of capital importance for us because part of the mineralization is found in this formation. Knowledge of the fluctuation of this water table is essential for the project. A reconnaissance borehole was drilled on this water table in 2020. It was

transformed into a piezometer and monitored for a few months (12 months). The diagram below shows the fluctuation of this aquifer.

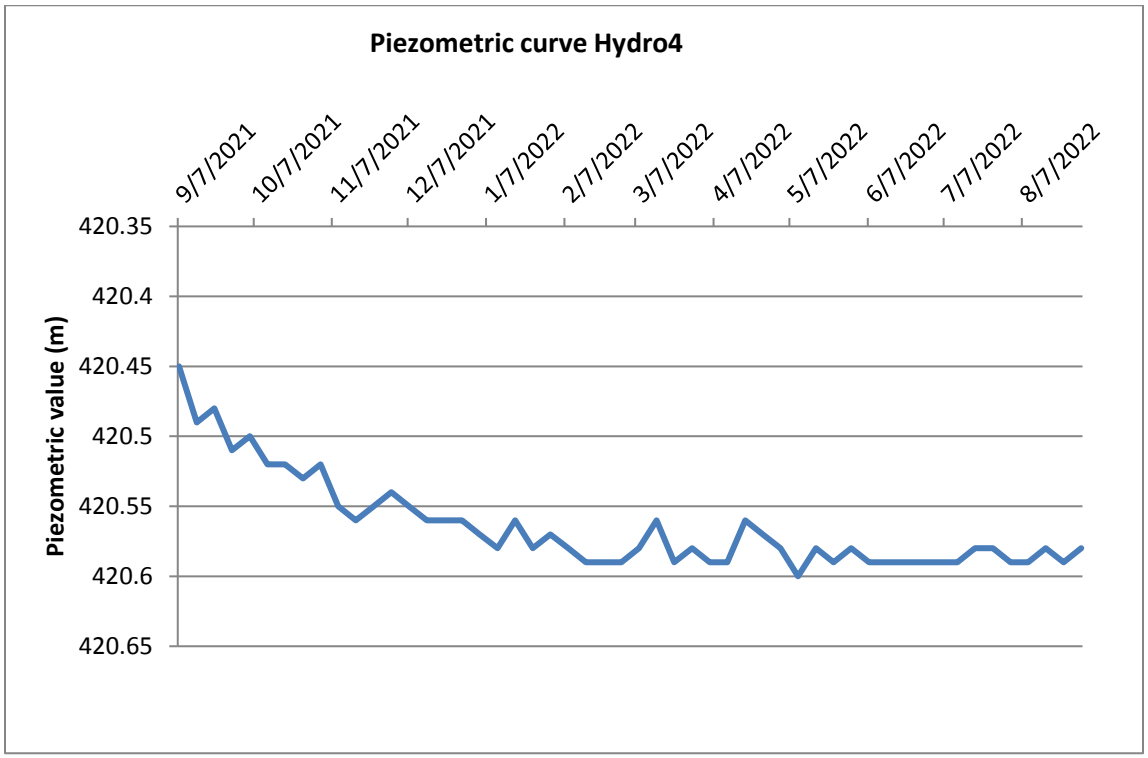

Figure 15 Water level monitoring curve in the Chirozerin 2 aquifer

The water table rises successively from September to April, then falls slightly between April and May, and then rises again because this is the period of high water in rivers and aquifers. However, there is little fluctuation (**0.15** m) throughout the year, so this water table is not recharged very much and we can therefore conclude that its natural level is not disturbed.

6.3. The Izegwandane water table

This aquifer is not very productive in the study area with a flow rate of $3m^3$ /h and a drawdown of more than 160 m. It is not of great interest from a hydrogeological point of view in this sector due to the very important clay alternations in this aquifer. The curve below gives us an overview of the groundwater level during the period of the measurements.

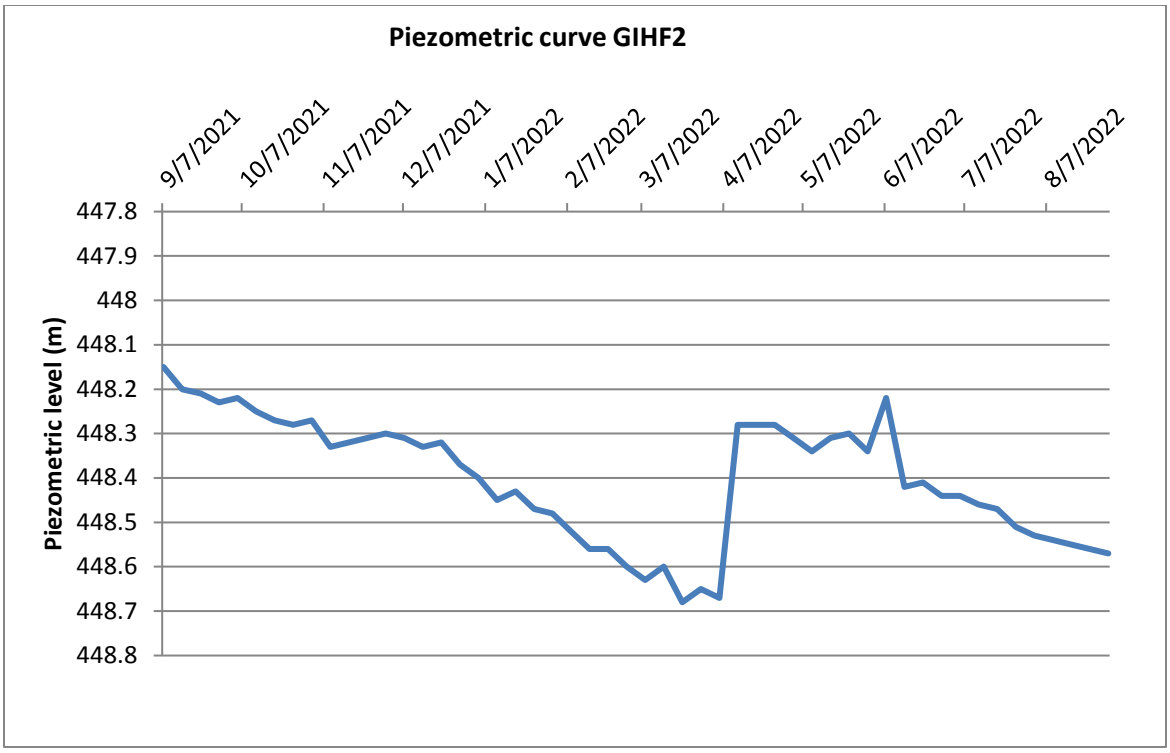

Figure 16 Water level monitoring curve in the Izégwandane aquifer

From September to the end of March, the water table rises before starting to fall from April until July. This water table follows the normal evolution of aquifers. During the period of high water the level rises and then falls again during the period of low water, from April to June. After the month of June the curve resumes its upward trend following the evolution of rainfall. However, it should be noted that the variation in piezometric levels (0.46 m in one year only) is significant.

6.4. The Teloua aquifer

The Teloua aquifer is the best exploited and best known aquifer in the area. It supplies the entire town of Agadez and almost all the villages along the Agadez-Arilt road. It is a very productive water table with a flow rate varying from 10 to 50 m3/h and from 20 to 100 m3/h depending on whether one is to the east or west of the Arlit fault flexure. In the study area, three boreholes tap this water table, two of which are in operation and one of which is considered to be a piezometer for monitoring variations in the level of this water table.

The flow rates of these boreholes vary from 10 to 30 m^3 /h, which confirms the thesis found in the literature that the flow rates vary according to the position in relation to the fault flexure. The piezometric measurements carried out at the level of this water table give us enough information as shown in the figures below:

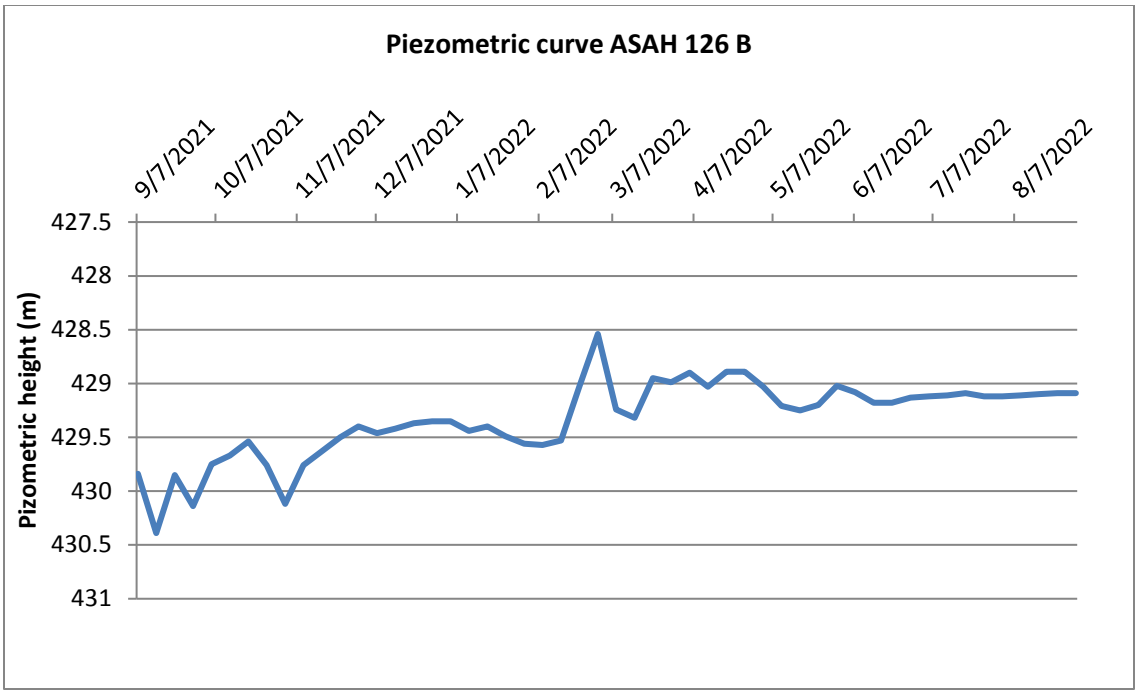

Figure 17 Monitoring curve of water levels in the Teloua aquifer.

If we analyse the following curve, we can see that the level only goes down throughout the recording period, which corresponds to the high water period. In principle, the level should rise during this period, but given the pumping for the drilling work, this is not the case. However, from April onwards, the water level rises slightly until the end of the study. We believe that the piezometric level of this borehole is disturbed by the pumping for the exploration works. A piezometric amplitude of 1.51 m was measured on this structure and the fluctuation is enormous.

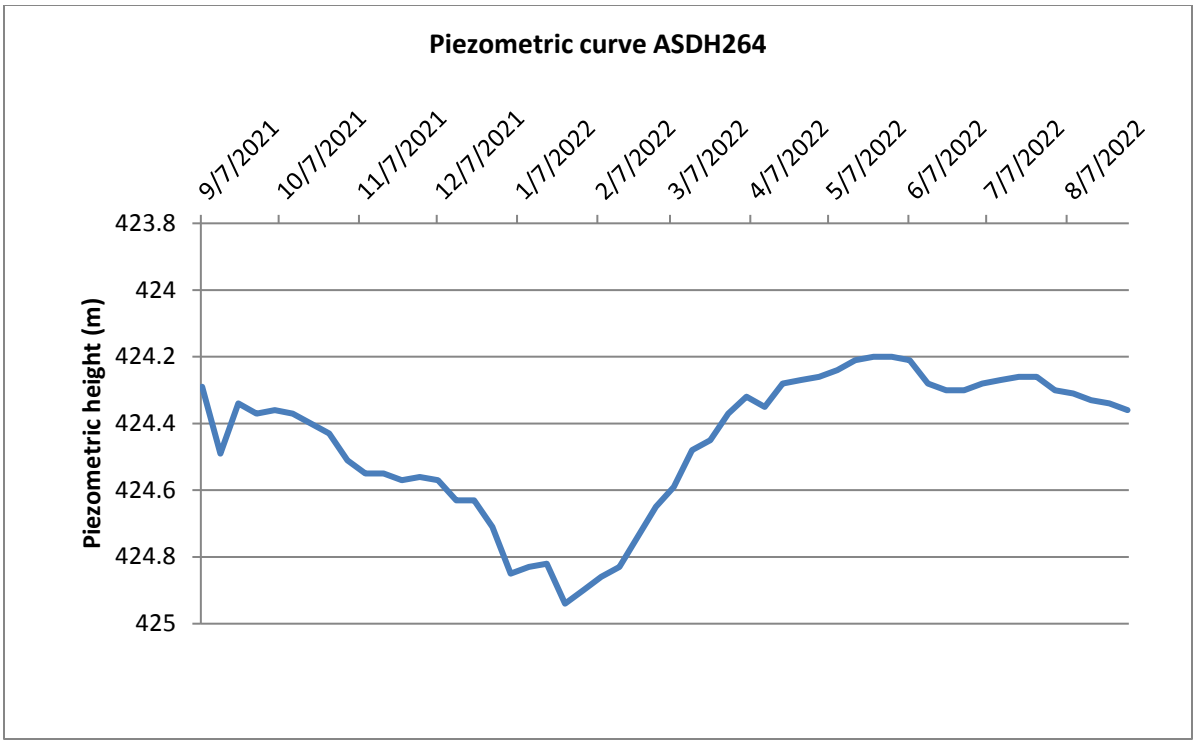

Figure 18 Monitoring curve of water levels in the Teloua aquifer.

We can see here that the water level rises from September to February, which corresponds to the high water period. The variation observed during this period is **0.73 m which is** enormous for one year of monitoring. On the other hand, from March onwards, the water level decreased, which is quite normal as it is a low water period until June. Then the water table starts to rise after the first rains recorded in the area and this until the end of the study. It can be concluded that the water table of the Teloua in the area is recharged during the rainy season.

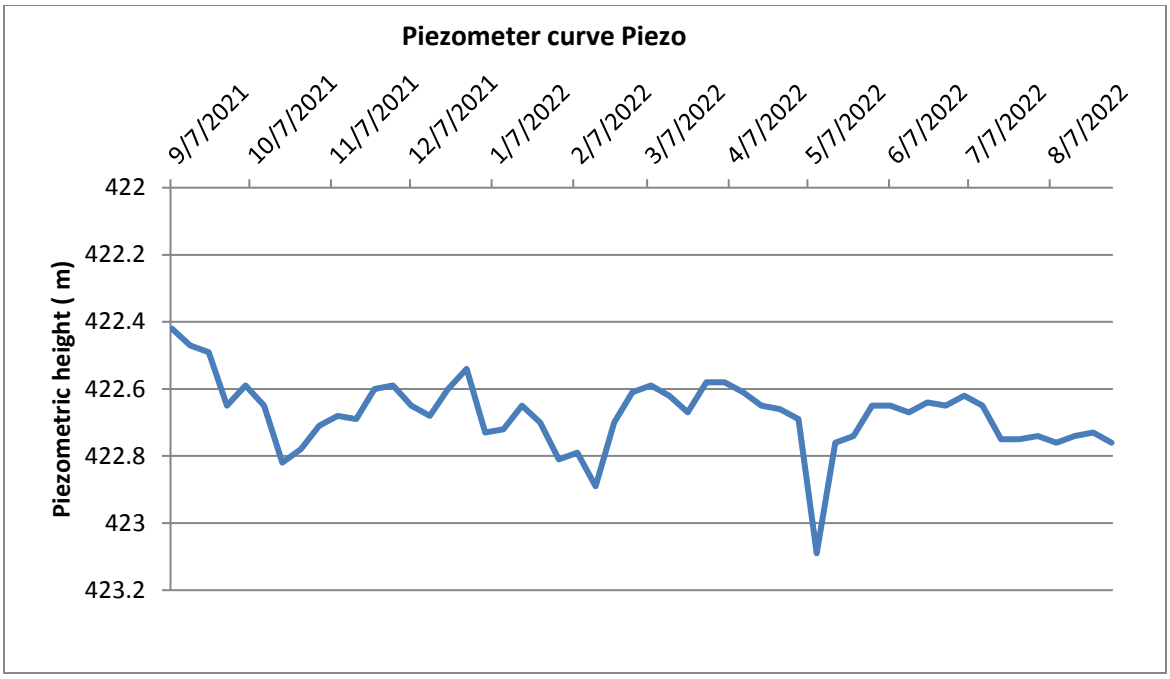

Figure 19 Monitoring curve of water levels in the Teloua aquifer on a piezometer

We can see here that the water level rises from September to February, which corresponds to the high water period. The variation observed during this period is **0.62 m which is** enormous for one year of monitoring.

The conclusion is the same as for Figure 18.

By combining the three piezometric curves of the boreholes tapping the Teloua aquifer, we obtain the figure below.

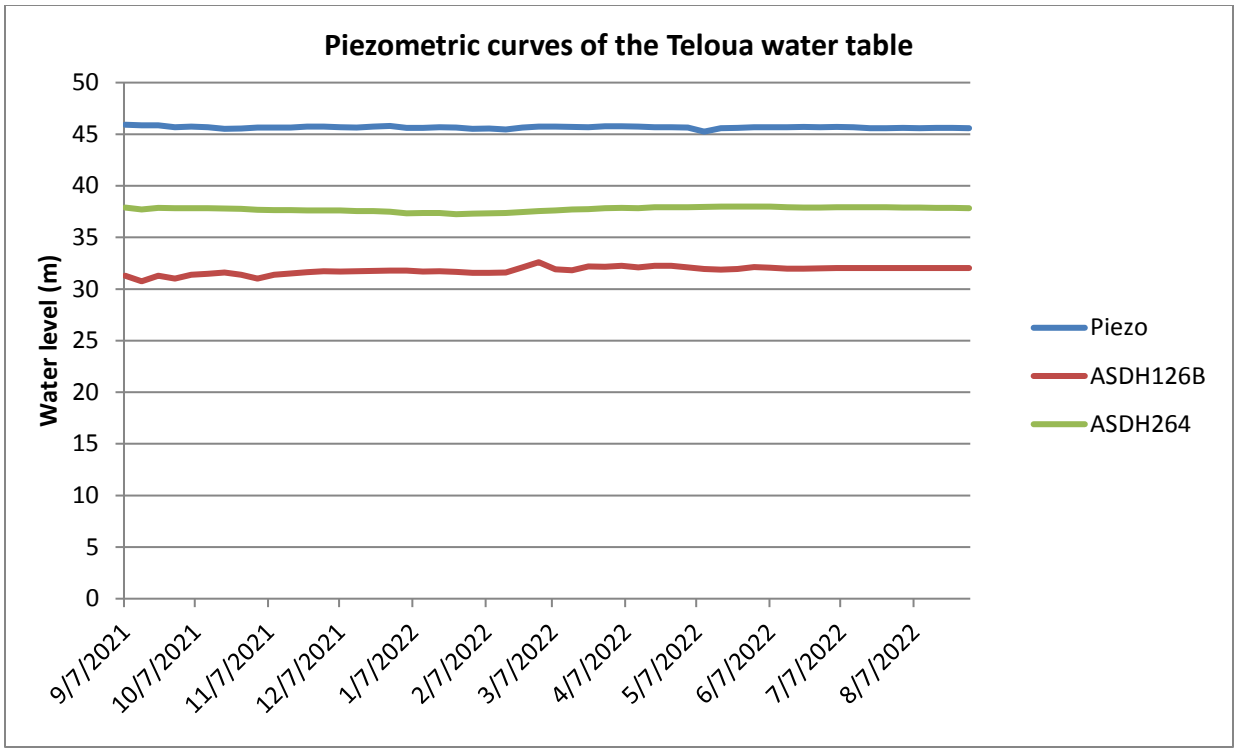

Figure 20 Piezometric curves of the Teloua water table

The first constant that can be drawn from this graph is that the Teloua water table has a piezometric level that varies from 31 to 46 m in the Graben area, whatever the time of year.

6.5. The Tarat aquifer

The Tarat aquifer is of great importance in the region because of its water resources. Its exploitation ensures the supply of water to urban areas and industrial units.

This water table is very productive with a flow rate varying from 20 to 50 m^3 /h and from 40 to 100 m^3 /h depending on the sector. In the study area, a borehole tapping this water table has been drilled and the pumping tests carried out gave a flow rate of 27 m^3 /h. The curve below shows the variation of the water table during the recording period.

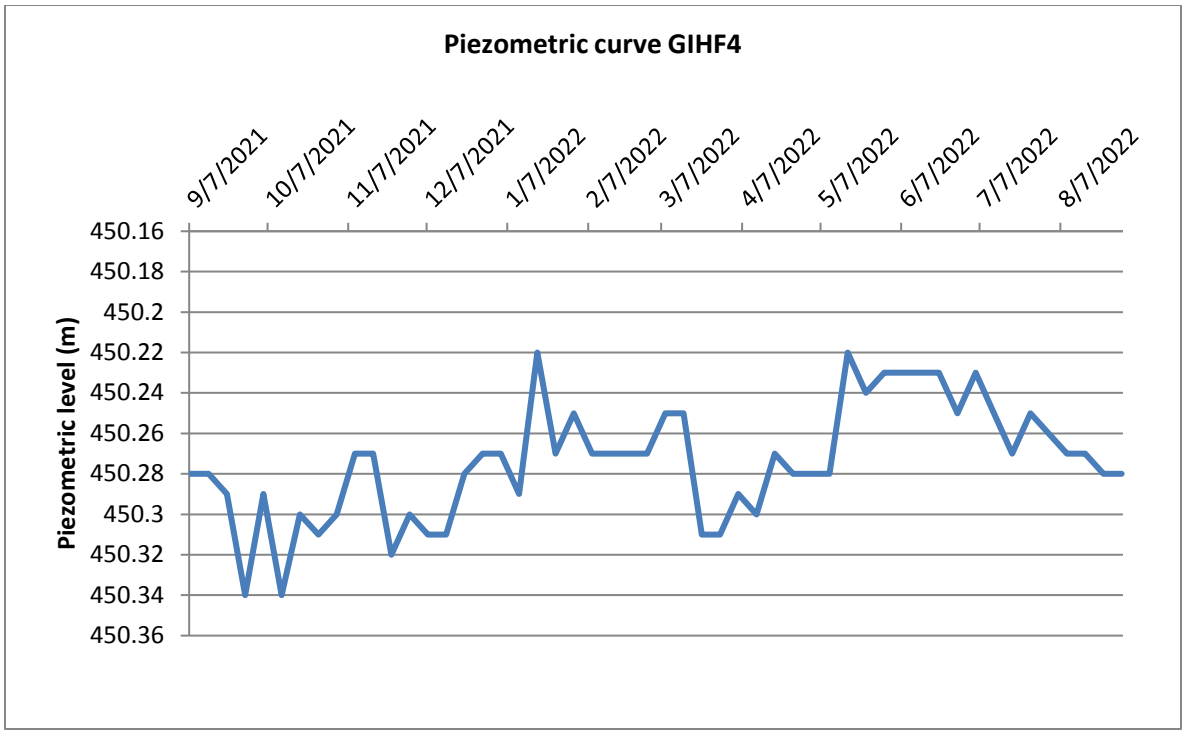

Figure 21 Water level monitoring curve in the Tarat aquifer

The observation of this curve shows us that the water level shows a particular pattern, which is proof of a certain disturbance of the water in this well.

6.6. The formation of the Irhazer

This formation only exists in the study area at the Graben. It consists solely of clay and is therefore of no importance from a hydrogeological point of view. However, it may be of interest in the context of water management in the mine. For this purpose, a borehole (HYDRO 2: 265 m deep) was drilled in this formation to follow the water flowing from the argillites. The dynamic level in this borehole is the lowest of all (29 m) during the monitoring period as shown in the figure below.

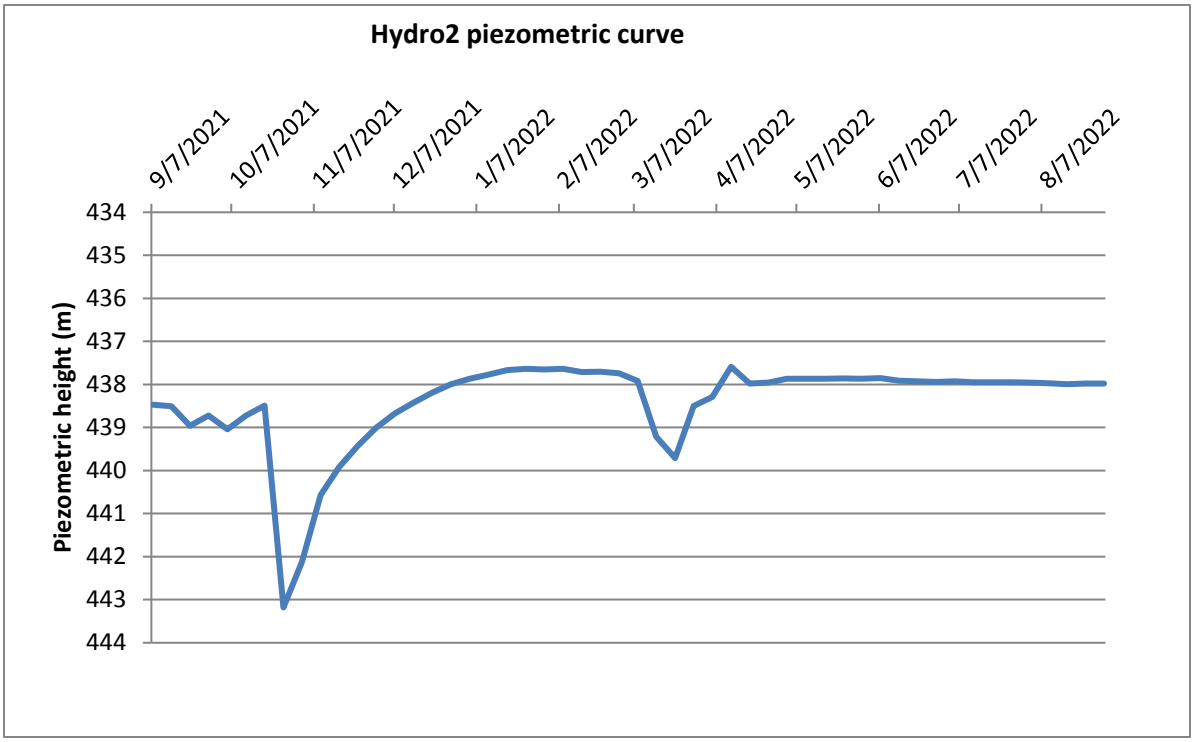

Figure 22 **Water level monitoring curve in the Irhazer formation**

We note that the water level fell by 4.96 m during October before starting to rise again in January. We believe that the presence of water in this structure is due in part to the various faults that exist in the Graben and the communication between the water table through these faults and the unsealed mine holes. It should be noted that the presence of water in this formation through both events can be an obstacle that must be taken into account during mining. All this was confirmed by a water level monitoring that we carried out in the Graben of some of the mining holes, the results of which are presented below.

6.7. Piezometric monitoring work prior to the Study

In 2018 four mining holes were cleaned up to monitor water levels. These holes cross several aquifers and the results of the monitoring are given in the following tables.

- ***The ASDH 553 survey***

This borehole is located in the Graben.

Table 5

Date	ID - HOLE	Pr (m)	Z (m)	Ns (m)	Hs (m)	Cp (M)
25/06/2018	ASDH553	737,6	470,36	12,68	0,3	457,38
26/06/2018	ASDH553	737,6	470,36	12,68	0,3	457,38
27/06/2018	ASDH553	737,6	470,36	12,67	0,3	457,39

28/06/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
29/06/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
30/06/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
01/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
02/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
03/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
04/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
05/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
06/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
07/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
08/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
09/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
10/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
11/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
12/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
13/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
14/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
15/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
16/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
17/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
18/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
19/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
20/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
21/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
22/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
23/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39
24/07/2018	ASDH553	737,6	470,36	12,67	0,3	457,39

- ***The ASDH 558 survey***

This borehole is located in the Graben.

Table 6

Date	ID - HOLE	Pr (m)	Z (m)	Ns (m)	Hs (m)	Cp (M)
25/06/2018	ASDH558	690	469,75	34,43	0,7	434,62
26/06/2018	ASDH558	690	469,75	34,43	0,7	434,62
27/06/2018	ASDH558	690	469,75	34,42	0,7	434,63
28/06/2018	ASDH558	690	469,75	34,43	0,7	434,62
29/06/2018	ASDH558	690	469,75	34,43	0,7	434,62
30/06/2018	ASDH558	690	469,75	34,43	0,7	434,62

01/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
02/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
03/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
04/07/2018	ASDH558	690	469,75	34,43	0,7	434,62
05/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
06/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
07/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
08/07/2018	ASDH558	690	469,75	34,43	0,7	434,62
09/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
10/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
11/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
12/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
13/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
14/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
15/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
16/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
17/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
18/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
19/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
20/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
21/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
22/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
23/07/2018	ASDH558	690	469,75	34,42	0,7	434,63
24/07/2018	ASDH558	690	469,75	34,42	0,7	434,63

- ***The ASDH559 survey***

This borehole is also located in the Graben.

Table 7

Date	ID - HOLE	Pr (m)	Z (m)	Ns (m)	Hs (m)	Cp (M)
25/06/2018	ASDH559	684,29	473,68	23,29	0,5	449,89
26/06/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
27/06/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
28/06/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
29/06/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
30/06/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
01/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
02/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
03/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
04/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90

05/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
06/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
07/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
08/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
09/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
10/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
11/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
12/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
13/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
14/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
15/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
16/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
17/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
18/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
19/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
20/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
21/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
22/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
23/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90
24/07/2018	ASDH559	684,29	473,68	23,28	0,5	449,90

The graph below gives us an overview of the evolution of the water levels during the two months of monitoring.

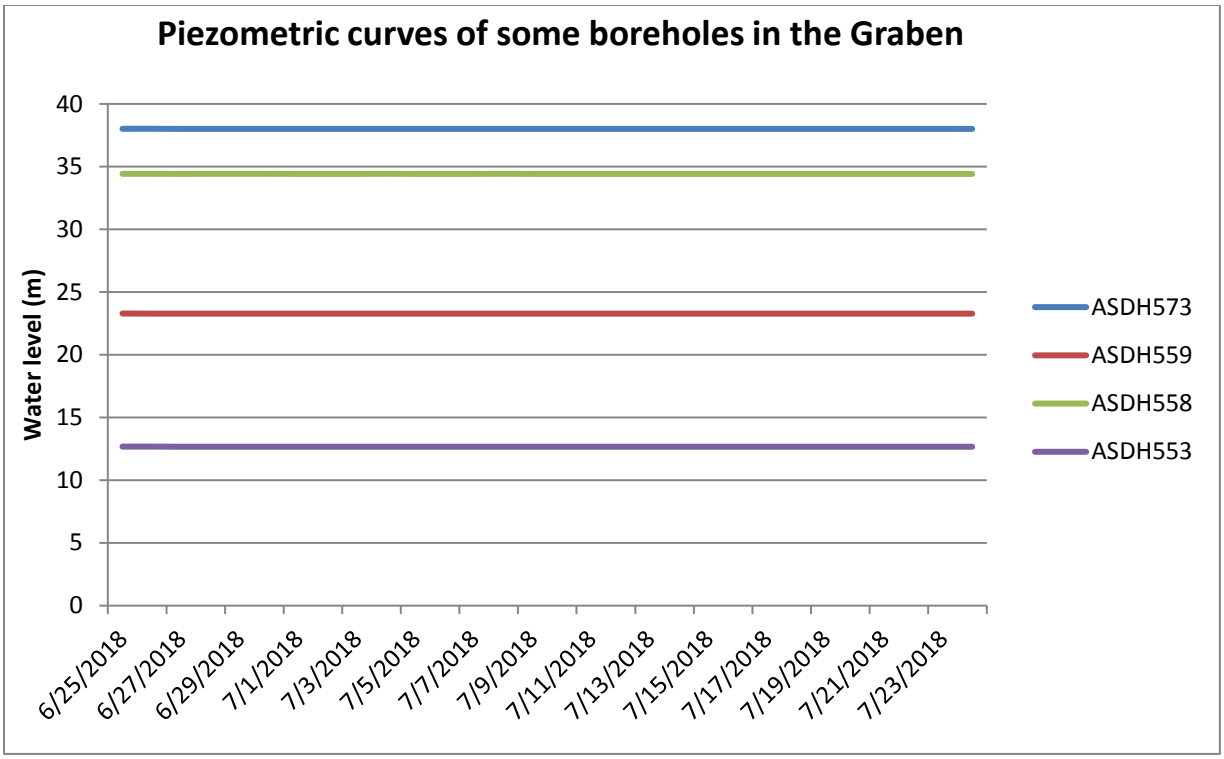

Figure 23 Piezometer curves for selected boreholes in the Graben

We can see that the four curves are almost horizontal, so no variation in water level has been observed during this period, whereas normally we should see a rise in water levels as we are in a high water or rainy season. However, these measurements show that water can rise to within 20 m of the surface in this area.

7. INTERPRETATION OF RESULTS

7.1. Calculation of the hydraulic gradient

By comparison between the experimental device of the Darcy laboratory (Castany, 1998) and the field, the hydraulic gradient is the difference in piezometric level between two points on the surface, per unit of length, measured along a flow line (direction of groundwater flow). The hydraulic gradient, I, can be compared to the slope of the piezometric surface (Castany, 1998).

In practice, the hydraulic gradient is calculated in the field, using piezometric levels measured in two observation structures, aligned on a streamline,

The hydraulic gradient can also be assessed from observation wells. In this case, the depth of water in the different wells is measured, the difference in water level, AH, between two neighbouring wells is calculated and the result is divided by the distance between them.

In application to our study area for the HYDRO 4 boreholes and the piezometers which are on the same streamline and 100 m apart; on 12 August and 11 November for example, the hydraulic gradient is:

12 August 2005	**11 November 2005**
i = (1109.19 m - 1095.12 m) / 300 m	i = 1109.61 m - 1095.05 m) / 300 m
= 0, 047	= 0, 048

These two values of the gradient for the extreme periods show us that even over time the groundwater regime in the basin is constant. This suggests a uniform groundwater recharge and identical groundwater circulation in the Tem Mersoi basin.

7.2. Hydrochemistry of groundwater

The availability of the water resource takes into account its quantity as well as its quality. Its quality is determined by its chemical composition. Water in its journey through nature undergoes several processes that affect its chemical composition and therefore its quality (Tremblay et al 2014). Water that is unfit for human consumption can cause diseases commonly known as waterborne diseases. This is why, in addition to quantitative monitoring, piezometers are monitored from the point of view of quality, even if the monitoring is not regular over time. In addition to the analysis of the dynamics of the evolution of the piezometric levels, a brief overview of the hydrochemistry of the water was made. To do this, the chemical parameters of the water in the piezometers at the time of our visit were analysed; then Piper and Scöeller diagrams were drawn up to highlight the mineralisation and the different hydrochemical facies of the water in the piezometers. The aim is to highlight the quality of the water. Our work, which also aims

to determine the physico-chemical parameters of the groundwater in the study area, the sampling methods and materials used are presented as follows:

7.3. Data

Two types of data were used. These were field data (carried out in April 2018) and data collected from the DGRE (Directorate General for Water Resources). As the time spent on fieldwork did not allow for water sampling from boreholes, we limited ourselves to sampling and analysis of piezometer water. For this purpose, the analysis concerned physico-chemical parameters (pH, temperature, turbidity, conductivity, total alkalimetric titre) and major ions such as calciums, magnesium, sodium, chloride, carbonates, sulphates and nitrates.

7.4. Materials and methods in groundwater hydrochemistry

Plastic bottles of 1.5 litres were used to collect the water and a cooler was used to store and pack the samples for analysis.

7.5. Choice of sampling points

Sampling is the procedure of taking a representative quantity of water from a river, lake or well.

The choice of sampling points should meet several criteria. These points must be representative of the water table or river bed, based on the following parameters:

- characterisation of the watercourse;
- the search for a possible source of groundwater contamination (domestic waste and chemical deposits);
- the use of the water point by the surrounding population for various activities (agriculture, washing clothes, cooking, drinking, etc.).

The water was collected from 10 boreholes, 6 of which were in the exploration permit and 4 in the surrounding area, using a 1.7 Kw solar-powered submersible pump mobilised for the purpose and packaged in plastic bottles. Sampling was carried out in the borehole piezometers that were accessible. In situ and laboratory measurements were made using the electrochemical method for physical parameters with the WTW pH 3210 SET 1&3 and the 355IR turbidimeter. 47 For major ions, the spectrophotometric method was applied with DR 3900 (for nitrates, sulphates), by photometry for sodium and potassium with the AFP 100 flame spectrophotometer. Calcium, magnesium, and chlorides were determined by complexometric titration with NF T90-016; NF T90-003, NF T90-017.

7.6. Methods of sample collection

According to Moll (2005), there are several types of samples: the point sample; the periodic sample; the composite sample (weighted or unweighted) and the integrated sample.

A thorough study of a river or well in a watershed requires multiple samples, according to a predetermined grid (Tardat - Henry, 1992).

Samples were taken in March 2022 from ten (10) different water points. The samples were taken in plastic bottles previously washed with soap and distilled water and rinsed with the water to be analysed. They were kept in a cooler and sent for analysis to the laboratory of the Agadez regional water authority. As spot samples do not provide absolute information on the variability of water (Tardat - Henry, 1992), our samples were composed and weighted in 12 hours to obtain a single sample. The constant volume samples taken at 6, 12 and 18 hours (i.e. at 6-hour intervals) are mixed.

Once the weighted composite samples had been taken, they were subjected in situ to temperature measurement using a precision thermometer, conductivity measurement using a conductivity meter and pH measurement using a pH meter. The temperatures obtained are close to the atmospheric temperature, with an average of 35°C. The other parameters such as colour, calcium and total hardness, salinity, major cations and anions and silica were measured in the laboratory.

7.7. Laboratory analysis of samples

To assess the physico-chemical quality of the water in the study area, chemical analyses were carried out on 10 water samples from the boreholes. The elements analysed at the laboratory of the Regional Directorate of Hydraulics and Sanitation of Agadez are the following: HCO3, SO4, Cl, NO3, Na, K, Ca, Mg, pH and Electrical Conductivity. The results of these physico-chemical analyses allowed the potability of these waters to be assessed in accordance with the acceptable standards of the World Health Organisation (WHO). The information obtained from the analyses of these parameters is described below and the critical values are reported on a case-by-case basis. ***Electrical Conductivity (EC) -*** there is a relationship between the dissolved salt content of water and the resistance it offers to the passage of electric current.

Electrical conductivity is measured in micro Siemens per centimetre (µS/cm). Conductivity measured at 25°C is a good measure of the material in solution, but is not proportional to the mass of the elements dissolved in the water. For example, pure demineralised water has a very low conductivity, whereas seawater has a conductivity of around 30,000µS/cm. Drinking water quality is defined as follows:

- from 50 to 400µS/cm: excellent quality;
- of 400 0 750 µS/cm: good quality;
- 750 to 1500 µS/cm: poor quality but usable;
- Above 1500µS/cm: excessive mineralisation.

The electrical conductivity measurements carried out 'in situ' on 10 groundwater points provided a preliminary characterisation of the chemical quality of the groundwater, the

level of which varies from 20 to 46 metres. The measurements can be broken down as follows: - water points with EC below 500 = 82.14%; - water points with EC above 500 = 17.86%.

7.8. Presentation of results

The table below gives the different values of the physico-chemical parameters measured on the boreholes of the study area.

Table 8 Physico-chemical parameters analysed

Parameters analysed in April 2022												
Sample Work	**pH**	**T (°C)**	**Conductivity (µs/cm)**	**Ca++**	**K**	**HCO3-**	**Cl**	**$SO4^{2-}$**	**NO3-**	**NO2**	**Fe**	**F-**
Drilling Camp Global Atomic	9,1	29,6	470	136	0,3	215	0	1	25,52	0	0	0,35
Drilling Camp Foraco	8,95	37,5	444	0	0,5	205	0	1	19,45	0,0033	0	0,2
Drilling and tanking	8,3	36	370	4	0,3	65	0	10	17,69	0	0	0,29
HYDRO 4 borehole	8,66	38,92	528	148	0	190	0	74	17,69	0	0	1,17
HYDRO 5 borehole	8,44	41,9	446	0	0,5	170	0	150	14,74	0,0033	0,01	1,52
Borehole Piezometer	8,69	40,22	622	2	1,3	140	0,05	150	13,42	0	0,02	1,51
Borehole No. 7	7,64	36,9	374	22	3	210	0	1	19,1	0,0033	0	0,15
Drilling GIHF2	8,64	37,82	650	123	0,9	420	0,07	130	11,4	0	0	11,9
Agatara borehole	8,17	38,2	352	4	0,2	190	0	13	10,78	0	0	0,39
Tagaza borehole	8,5	38,3	253	12	1,2	165	0	0	25,08	0	0	0,18
WHO Standard	**6,5-9,5**		**200 à 1100**	**100 mg/l**	**12 mg/l**	**400 mg/l**	**250 mg/l**	**400 mg/l**	**50 mg/l**	**0.3 mg/l**	**0.3 mg/l**	**1.5 mg/l**

- The conductivity

The electrical conductivity measurements carried out on ten samples spread over the study area also made it possible to assess the mineralization of the water. The measured values vary from 252 to 650 µS/cm and 84% of the water samples have values below 200 µS/cm. The chemical analysis results show that about 100% of the water samples have

EC (groundwater) values below 750 uS/cm. This means that the quality of the water analysed is good, as shown in the curve below:

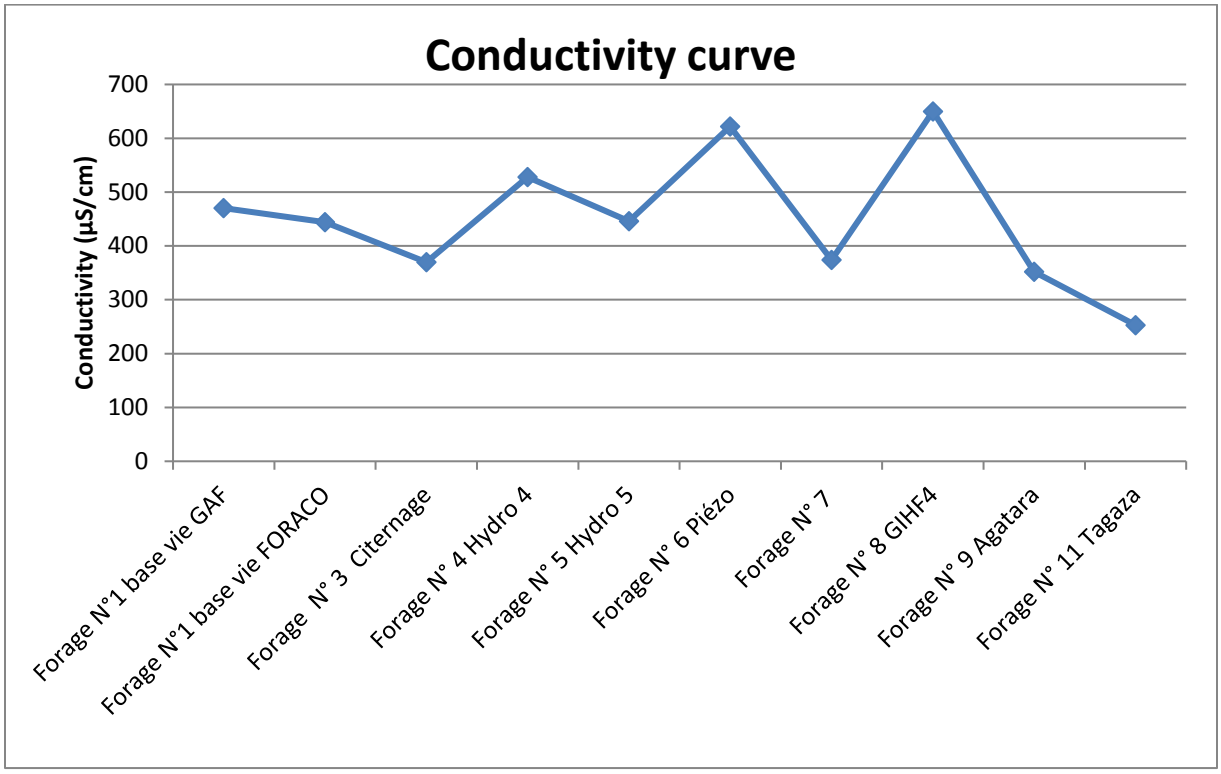

Figure 24 Conductivity curve

- The pH

The determination of the pH consists of a measurement of the concentration of H+ ions in water. Its value conditions a large number of physico-chemical equilibria. In groundwater, the pH depends on the geological nature of the reservoir, with more acidic pH values and less in the basement areas or in sandstone. The pH value is at the origin of most of the problems attributable to water in the pipes, in particular too high an acidity favours the corrosion of metal pipes. The pH value also affects the taste. Values between 7.5 and 9.2 can be considered an acceptable range. Most of the water in the study area is basic, except for the water from borehole 7, which is located outside the permit area and has a value of 7.64, as shown in the curve below.

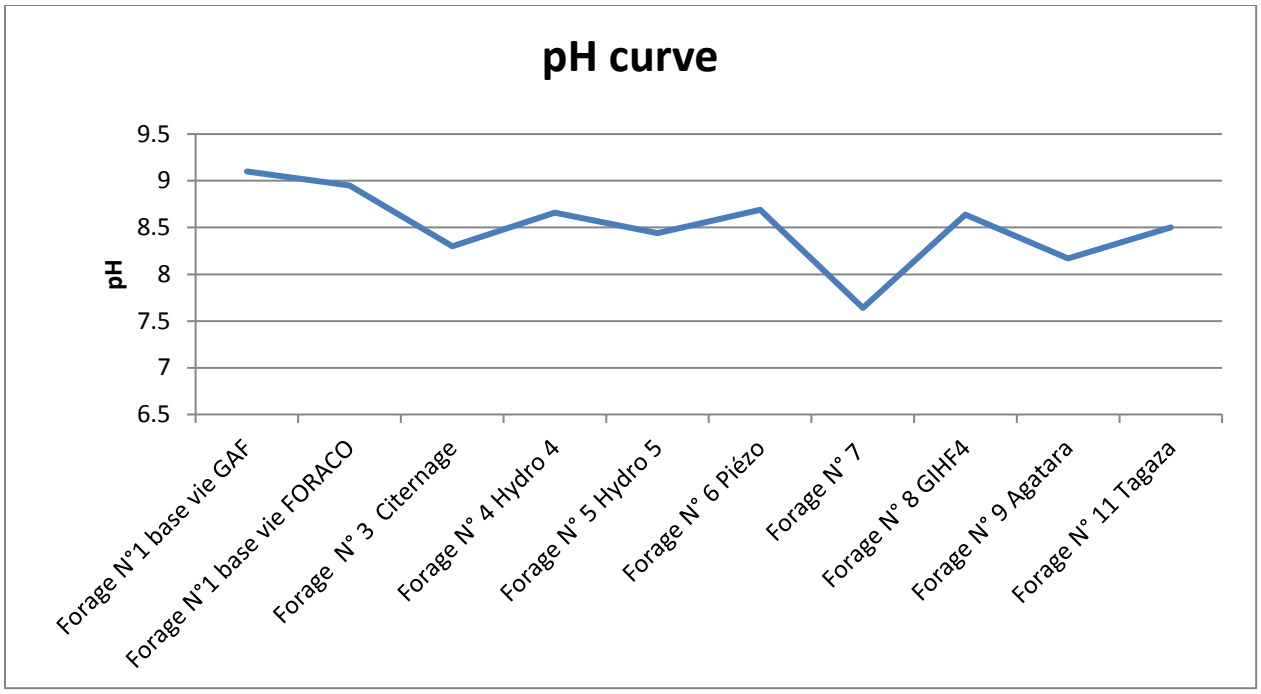

***Figure 25* pH curve**

- Calcium

The calcium content is directly related to the nature of the geological formations crossed. The content can vary from 1 to 150mg/l. It is mainly found in the form of bicarbonates. For the WHO, the permissible levels vary from 75 to 200 mg/l. The human body needs 0.7 to 2 g of calcium per day. In the 10 water samples analysed, the calcium values vary from 1 to 148 mg/l as shown in the curve below:

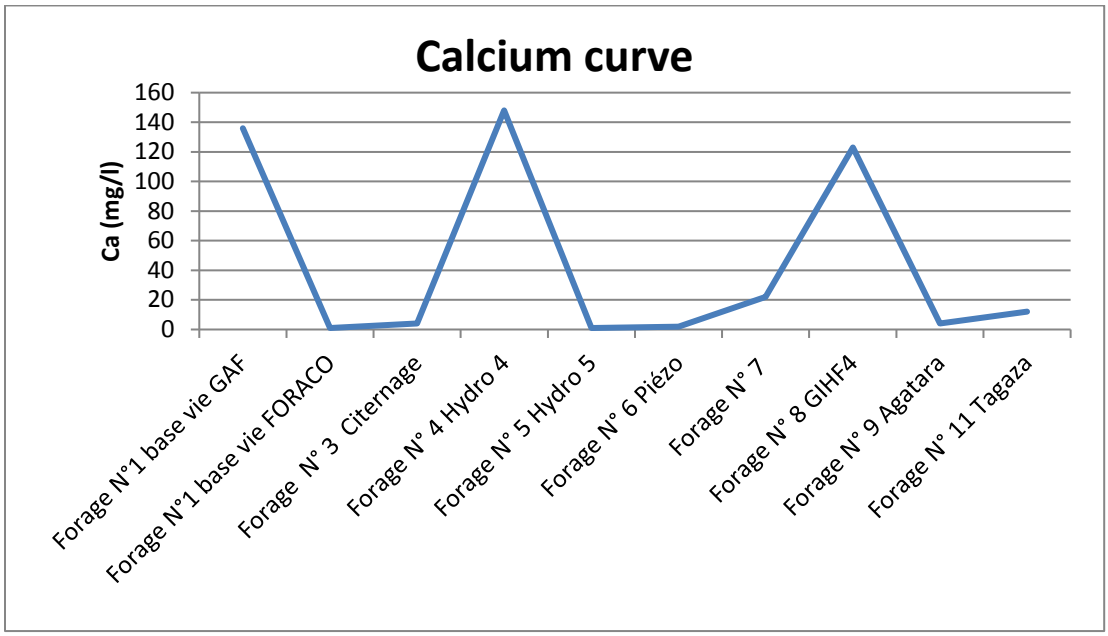

Figure 26 Calcium curve

- Magnesium

Magnesium has the same origin as calcium. It contributes to the hardness of water without being the essential element. The various regulations give acceptable limits of between 50 and 150 mg/l. Magnesium is of great biological importance in the constitution of bones. At high concentrations it gives water a bitter taste and leaves traces in food cooking vessels that are more visible and unpleasant than those of calcium. Magnesium values could not be obtained due to lack of reagent.

- Sodium

It is one of the major constituents of the earth's crust, and the solubility of sodium salts is very high. It is present in all waters. A high level has no major disadvantage, apart from a laxative effect in very high concentrations. However, these waters are not suitable for people with vascular or kidney problems. Good quality water can contain up to 200 mg/l of sodium, but the desirable level should not exceed 10 mg/l. The values could not be obtained due to lack of reagent.

- Potassium

Potassium is a normal element in water, but its concentration is much lower than that of sodium. Although as abundant as sodium and highly soluble, potassium salts remain adsorbed in the soil. Despite a purgative action above 1000mg/l, this cation is considered to have no physiological effect on humans. The taste perception threshold is around 340mg/l.

- Bicarbonates

The concentration of bicarbonates and carbonates in water is essentially a function of equilibrium conditions involving CO2 content, temperature and water mineralisation. In a natural environment, alkalinity expressed as HCO3 varies from 25 to 250mg/l and can reach 350mg/l. There are no precise standards for alkalinity; however, if the water is aggressive, it can attack the pipes. In the study area, the 10 water samples analysed have values between 65 and 420 mg/l.

- Sulphates

Natural compounds in water, they are related to the major cations: calcium, potassium, and sodium. They come mainly from the formations through which the water has passed. The sulphate content of water does not exceed one gram per litre. International standards set the maximum permissible level at 400mg/l. Higher levels have no effect, but can cause diarrhoeal problems in children. The sulphate values of the 10 water samples analysed range from 0 to 150 mg/l and are well below the WHO standards.

- Chlorides

Chlorides exist in all waters in highly variable concentrations, the origin of which may be percolation through saline soils or industrial waste. The taste threshold of chlorides varies

greatly from one individual to another, and according to the composition of the water. Extreme values of 100 to 700 mg/l are quoted, but the average detectable level is 400 mg/l. International standards set the maximum permissible level at 600 mg/l. Slightly higher values are not harmful, but water with a high chloride content is laxative. In the study area, the 10 water samples analysed show very low or even zero values with a maximum value of 0.07mg/l

- Nitrates

The nitrates found naturally in water come from rain (for a small part) and from the leaching of surface soil. As soon as the content exceeds 50mg/l, human activity is undoubtedly involved. Nitrates can harm infants, but they are not dangerous for children or adults. International standards set the maximum level at 50mg/l. Of the 10 nitrate measurements taken, none exceeded the WHO standard.

- Nitrites

The presence of nitrites in water in its natural state is extremely rare, and if they are present it is always necessary to carry out a bacteriological control. In fact, their presence is often due to the bacterial oxidation of ammonia. Up to 0.1mg/l can be tolerated. In the study area, the 10 water samples analysed have very low nitrite values between 0 and 0.003 mg/l.

- Iron

Iron comes from the leaching of geological formations. It is an essential element of the human diet. Potability limits are based on aesthetic effects, on the taste threshold, on household effects (linen and containers) and on the inconvenience it causes to the network if it is found in too large a quantity. The limits imposed for human consumption are 0.3 mg/l. The total iron values of the 10 water samples analysed are between 0 and 0.02 mg/l.

Table 9 Physico-chemical parameters analysed

Analysis results second campaign September 2022												
Sample name	**pH**	**T (°C)**	**Conductivity (µS/cm)**	**Sulphate (SO2-4)**	**Bicarbonate (HCO3-)**	**Total chloride**	**Fluorides (F-)**	**Nitarates (NO3-)**	**Nitrites (NO2-)**	**Potassuim (K+)**	**Total iron**	**Calcuim (Ca 2+)**
WHO standards	**6,5-9,5**	**-**	**200 à 1100**	**400 mg/l**	**400 mg/l**	**250 mg/l**	**1.5 mg/l**	**50 mg/l**	**0.3 mg/l**	**12 mg/l**	**0.3 mg/l**	**100 mg/l**
Elogazan	9,2	26	435	8	165	0,12	0,24	14,52	0,0066	0,4	0,01	128
Agatara	8,8	26,1	394	10	170	0,12	0,08	9,86	0,0033	0,6	0,00	6
Tagaza	8,5	25,7	415	1	15	0,10	0,04	14,04	0,0033	3,3	0,01	20
GAF Life Base	9	25,8	511	0,00	205	0,09	0,08	15,93	0,0033	0,4	0	133
FORACO	8,9	27	491	0,00	200	0,09	0,06	14,21	0,00	0,1	0	0,00
HYDRO 5	9,5	26,6	771	128	0,00	0,01	1,90	9,02	0,00	0,40	0,01	2
GIHF2	9,4	25,8	1283	132	270	0,17	7,9	6,03	0,017	1,3	0,06	142
HYDRO 4	9,2	25,4	685	94	165	0,09	0,6	9,28	0,017	1,4	0,03	2
Citing	8,8	24,6	425	2	165	0,15	0,13	12,14	0,0033	0,5	0	2

We can see that it is always in the same structures that we find fluoride levels exceeding the normal (GIHF2, HYDRO 5) as in the April 2022 analysis, so these structures must be monitored regularly for this element.

7.9. Interpretation of results

The method used was based firstly on a comparative analysis of the physical parameters of the water in the piezometers at their date of completion, some in 2013 and others in 2020. Piper and Schöeller diagrams were then drawn up to highlight the mineralization of the water and the various related facies in order to better understand the quality of the water. The DIAGRAMS software was used to produce the diagrams. The ionic balance was calculated beforehand to check the reliability of the analyses. The reliability limit of the analyses considered was based on the work of Ouandaogo, (2008) who used BI = 10% in the case where the water had a high ionic load. In this case, an electrical conductivity of 672 µs/cm was observed in one piezometer (GIHF2). This shows a high mineralization of the water at this location. Hence the consideration of the 10% reliability limit. Thus the ion balance is calculated with the following relationship: BI (%) = (Σ $cations$ - Σ $anions$)

(Σ $cations$ + Σ $anion$)

où $les\ concentrations\ sont\ exprimées\ en\ meq/l$

7.9.1. Comparative analysis of the situation in April 2022 and 2022 of the physico-chemical parameters

- Physical parameters

Only the physical parameters were compared. The curves obtained from the analysis results of the ten works give an overview of this comparative study. The analysis results are in Annexes 2, 3 and 4 of the report.

- Conductivity

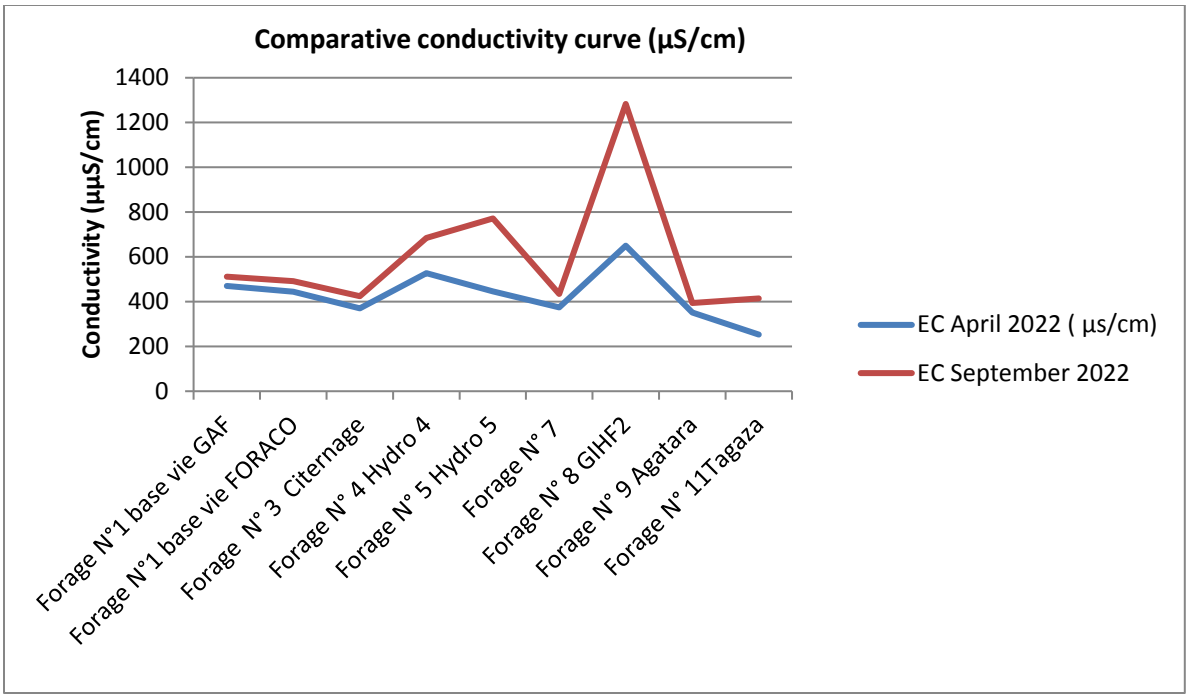

Figure 27 In situ conductivity curves

The curves above show the situations for the months of April and September 2022. It can be seen that the conductivities are higher in September than in April, which is quite normal as this month corresponds to a period of rising waters and therefore of mineral substance transport.

- The temperature

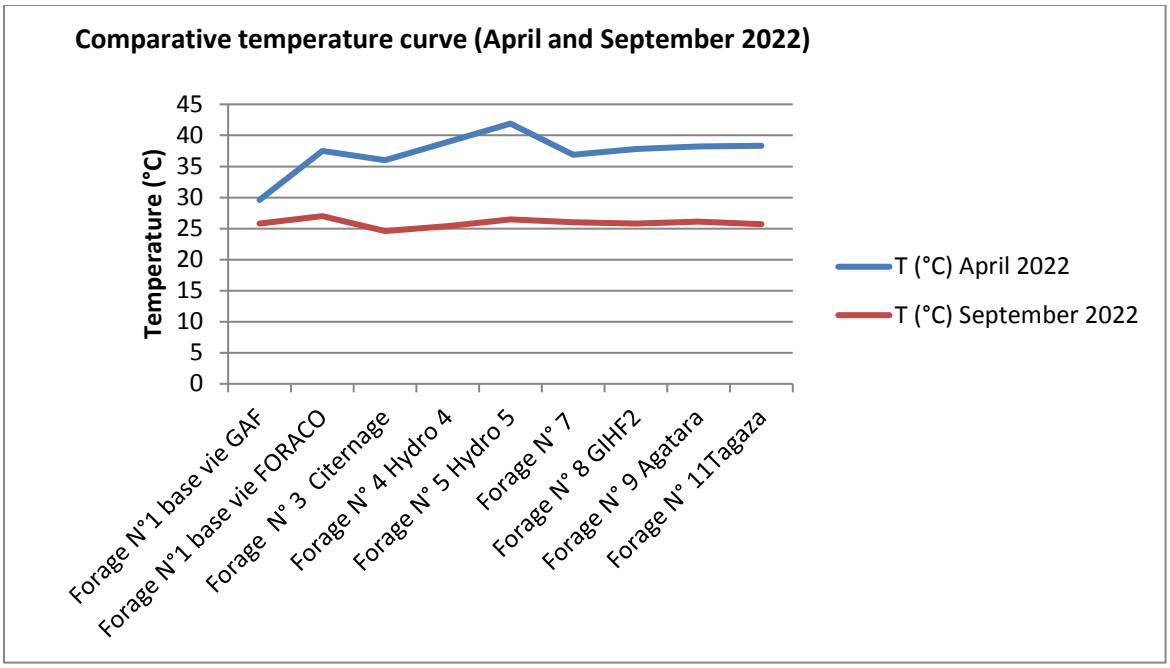

Figure 28 In situ temperature curves

These curves show that temperatures are higher in April than in September, which confirms the thesis that the temperatures of the subterranean evolve in most cases in function of the ambient temperature.

- The pH

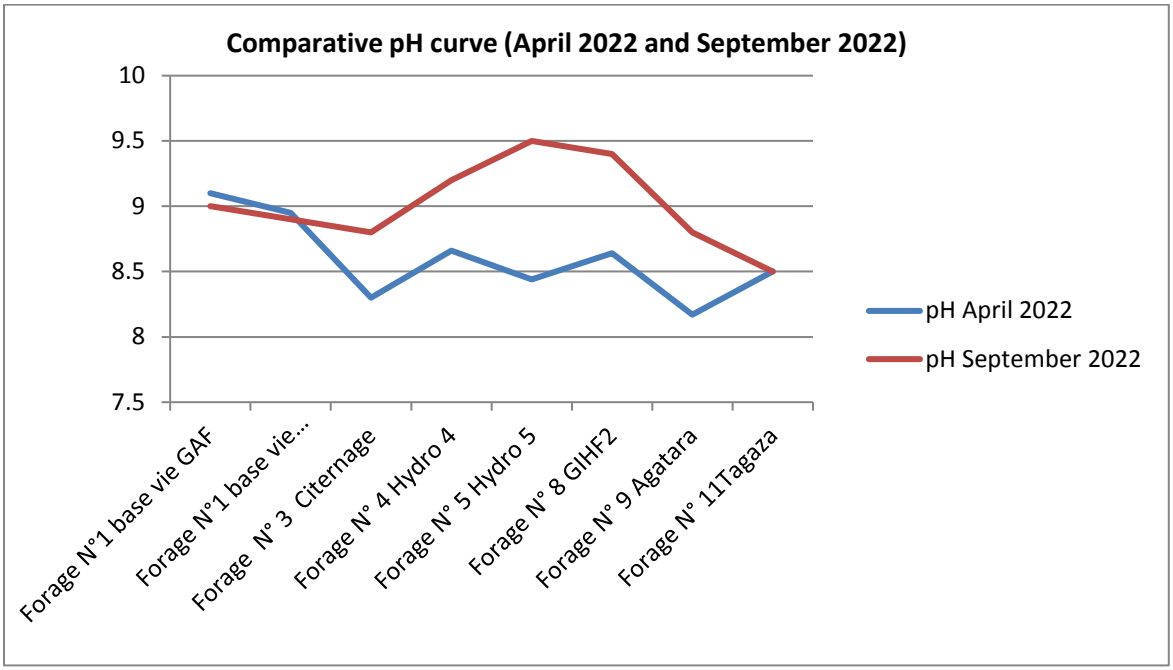

Figure 29 In situ pH curve

In the same way as conductivity, pH changes with the period of rising water.

- Major ions

Major ions include negatively charged anions and positively charged cations. It is the major ions that contribute to the mineralisation of water (Kagamaté, 2006).

Cations: consisting of positively charged ions are represented by Na, Mg, K and Fe ions. Among the most abundant cations are the Ca ions. The waters of all the piezometers have their Ca higher than the other cations. The second most abundant element is Mg which is often exceeded by Na. The least abundant element is K. This gives the order of abundance: Ca2+>Mg2+>Na+>K+ or Ca2+> Na+> Mg2+>K+.

Anions: consisting of negatively charged ions are represented by ions such as

HCO3- , NO3- , Cl- , SO4-2 . The HCO3- are largely dominant and allow the order to be established: HCO3- >NO3- >Cl- >SO-2 4 or HCO3- > Cl- > NO3- >SO-2 4.

- Hydrochemical Facies

Piper and Schöeller diagrams were developed to characterise the hydrochemical facies of the piezometer water. The DIAGRAMMES software was used.

- Piper diagram

The Piper diagram consists of two triangles and a diamond. Each triangle represents a cationic or anionic facies. The rhombus summarises the overall facies of the water analysed. At the end of our analysis, two facies families emerge. These are the family of calcic and magnesian bicarbonates and the family of calcic bicarbonates, as shown in the figure below:

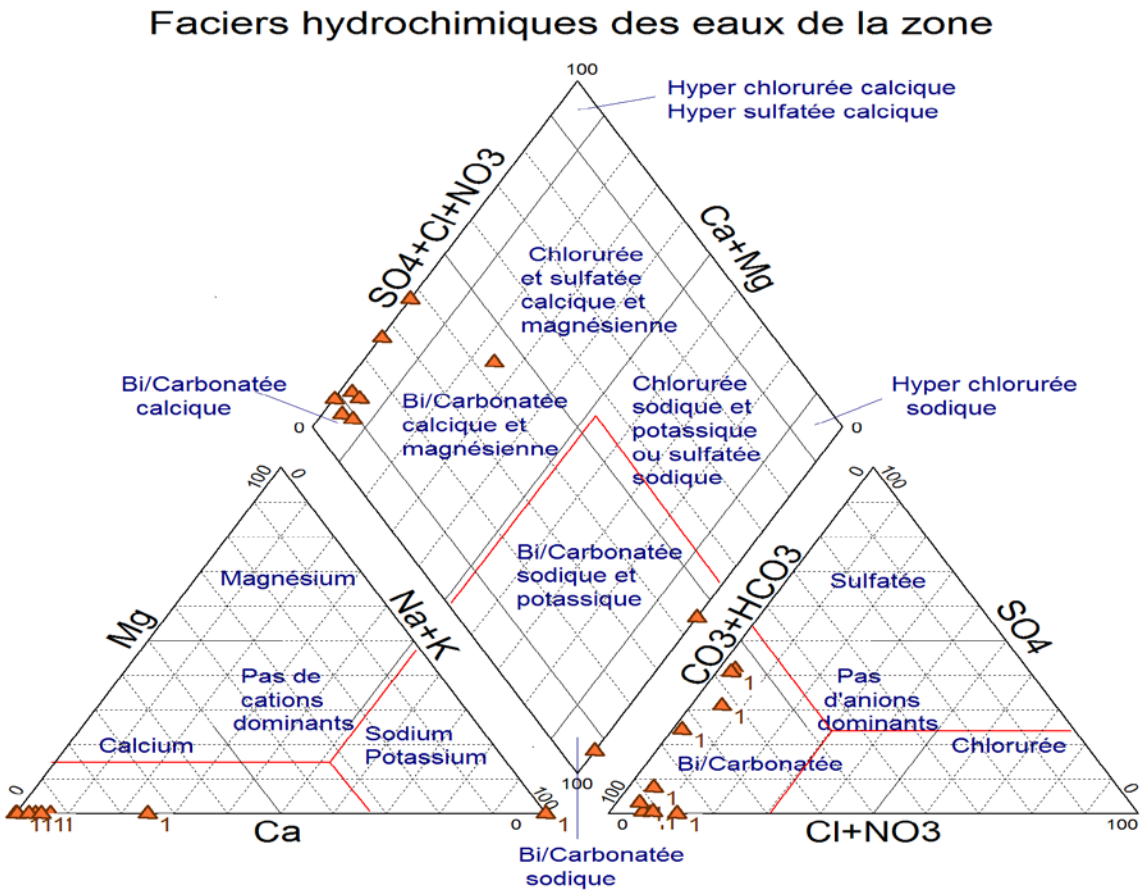

Figure 30 Hydro-chemical facies of the waters in the area

The waters of the study area are calcic bicarbonate and sodium bicarbonate.

8. MONITORING OF SURFACE WATER FLOWS

A range of equipment was used to ensure the smooth running of the study, including (in addition to the logistics) 1 ETREX child GPS for taking coordinates, 1 stopwatch, 1 tape measure, 1 graduated ruler, 1 float, 1 station stake and 1 record sheet.

8.1. Methods

There are several methods of measuring stream flow, the choice of which will depend on the objectives sought, the accuracy and the equipment available. In this study, the float method was used because it allows both low and high flows to be measured with moderate accuracy. The equipment required to apply the method is: a float, a station stake, a tape measure, a record sheet, a stopwatch and a ruler.

- Principle of the method

First, place a stake as the first station, take the coordinates of each station, measure the width of the stream, measure a length of 10 m, place a second stake (second station), measure the depths of the stream along each station, the average is the depth, stand in the middle of the stream and set the stopwatch to start and throw the float at the same time from station 1 to station 2 to stop the stopwatch and float, the time recorded is the time from station 1 to station 2. The operation can be repeated many times depending on the number of stations defined and the objectives to be reached, in this case about ten stations have been made.

- Measured parameters

The parameters measured are: length (L), width (l), time (chrono), depth.

- The length (L) or distance (d) is equal to the average of the measured lengths;
- The width (l) is equal to the average of the measured widths;
- The time (t) is equal to the average time ;
- The depth or height is equal to the average of the measured heights.
- The average speed: Vmean (m/s) = dmean (m) / Tmean (s)
- The average cross-section: Smoyen (m^2) : lmoyen (m) x Hmoyen (m)
- **The flow rate: Q (m^3 /s) = Vmean (m/s) x Smmean (m^3)**

8.2. Results obtained

Results of the measurements made

The tables below summarise the measurements made on the kori located to the south-east of the base and the kori of Aborak located 4 km north-east of the Exploration Camp.

Table 10 Measurements taken on 15/06/2022 on the Aborak kori

15/06/2022	Stopwatch (seconds)	Launch time	Time of visit	Length (m)	Water height (m)	Width (m)	Contact details		
							X	Y	Z
1st station	16	18h 30'	18h 31'	10	0,3	9,08	364325	1972530	529
2nd Station	17	18h 33'	18h 34'	10	0,3	10	364328	1972554	523
3rd station	12	18h 42'	18h 43'	10	0,4	9,5	364333	1972504	523
4th station	20	18h 50'	18h 51	10	0,3	11,4	364330	1972518	520
5th station	15	18h 57'	16h 58'	10	0,3	8,2	364332	1972537	496
6th station	22	19h 04'	19h 05'	10	0,2	11	364320	1972531	500
7th station	15	19h 10'	19h 11'	10	0,2	14,3	364314	1972543	479

The Aborak kori has a flow rate of : **Qmean= 1.787 m3/S; Qmean = 6433.2 m3/h.**

Table 11 Measurements taken on 14/09/2021 on the kori south-east of the Exploration Camp

14/09/021	Stopwatch (seconds)	Launch time	Time of visit	Length (m)	Water height (m)	Width (m)	Contact details		
							X	Y	Z
1st Station	27	15h 28'	15h 28'	10	0,3	27,8	365764	1968610	499
2nd station	21	15h 50'	15h 51'	10	0,4	14,1	365786	1968614	492
3rd station	18	16h 03'	16h 03'	10	0,03	15,3	365792	1968617	493
4th station	23	16h 10'	16h 11	10	0,25	17	365804	1968621	504
5th station	24	16h 24'	16h 25'	10	0,25	14	365612	1968624	491

This kori located at a flow rate of : **Qaverage= 1.898 m3/S; Qaverage = 6832.8 m3/h.**

9. CONCLUSION

The implementation of this study on the groundwater in the DASA mining project area allows the following conclusions to be drawn.

9.1. Evolution of the piezometers since their installation

The variations observed vary from one piezometer to another. Some piezometers show a decreasing trend while others show an increase in water levels over time, probably due to climatic conditions.

9.2. Hydrodynamic parameters

The analysis of the hydrodynamic parameters of the aquifers has shown the uneven distribution of transmissivity in the different geological formations. It is generally low. Nearly half of the boreholes in the study area have a transmissivity **of** less than **10^{-5} m2/s**, while all the boreholes tapping the Teloua and Tarat aquifers have a transmissivity of more than **10^{-4} m2/s** (in the sandstone).

9.3. Flow measurements

According to the Study, good flow rates from boreholes do not depend on great depths or great thicknesses but on the aquifer formation.

Finally, the sketch on the water quality of the piezometers indicates that physical parameters such as turbidity has increased while hardness has decreased (situation in 2020 compared to 2022). Electrical conductivity has decreased in some piezometers and increased in others. The reasons for this evolution could not be highlighted due to insufficient data. As these chemical parameters can change following a change in the environment, a comparative analysis of the chemical analysis results for 2020 and 2022 was only carried out. In addition, two hydrofacies were identified: calcium bicarbonates and sodium bicarbonates. Despite the results obtained, the lack of data was a major limitation. Not all piezometers have good continuity in the piezometric data records and have many gaps. The insufficient number of piezometers was also a limitation for this work. One of the initial objectives, which was to draw up a piezometric map, was therefore not achieved. The water level data in the boreholes, which could have complemented the piezometer data, was also insufficient. The lack of data on chemistry was also a major limitation.

10. RECOMMENDATION

- The densification of the piezometric network or the number of piezometers in the study area is insufficient. As the main purpose of a piezometer network is to monitor and improve knowledge of groundwater, the piezometer network must be densified by the installation of new piezometers.

- Improve the monitoring of piezometers in order to increase the quality and reliability of data. Some of the piezometers we have used have failed and are partly clogged (case of GIHF4). It will also be important to equip the piezometers with recorders in order to automate monitoring and increase their number for better monitoring.

- Increase protection of piezometers: some piezometers are subject to vandalism (GHIF1 and GIHF4). It would be advisable to build fences with a grid to increase the security of the piezometers.

- Carry out an in-depth study on the impact of climate change on groundwater. Indeed, this study highlighted the increase in piezometric levels in all the piezometers with amplitudes ranging from 0.15m to 1.51 or even more (5.59 m HYDRO 2, a borehole that is not supposed to contain water because it captures the Irhazer formation). It would be important to investigate further in order to find the real causes and to check whether the return of favourable climatic conditions is not the main factor, and especially the play of faults in the Graben area or the inter-connections between the aquifers in the Graben. It should also be noted that the presence of unformed exploration boreholes may play an important role in the upwelling of water in the Graben.

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- Water and agriculture & poverty in the Niger basin (J.c. Clanet, A.Ogilvie)
- report: The availability of water in the Niger River: issues and prospects for hydro-agricultural development: the case of Niger);
- Project: Support project for the "Kandadji" programme for the regeneration of ecosystems and development of the Niger Valley (P_KRESMIN)
- Doctoral thesis by Aissata Boubacar Hassane: **SUPERFICIAL AND DEEP AQUIFERS AND URBAN POLLUTION IN AFRICA :**
- Doctoral thesis by Maman Sani BABAYE: Evaluation of groundwater resources in the Dargol basin (Liptako - Niger) 2012
- Niger Water Master Plan 2011
- PANGIRE Niger 2017 - 2030

APPENDICES

Appendix 1: Piezometric monitoring data

Appendix 2: Water analysis results 2022

Appendix 3: Field photos

Appendix 1: Data from the 2021 - 2022 piezometric monitoring

Table 5 Data from piezometric monitoring of borehole HYDRO 2

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Cp (M)
07/09/2021	Hydro2	265	468	28,72	0,81	438,47
14/09/2021	Hydro2	265	468	28,68	0,81	438,51
21/09/2021	Hydro2	265	468	28,23	0,81	438,96
28/09/2021	Hydro2	265	468	28,47	0,81	438,72
05/10/2021	Hydro2	265	468	28,15	0,81	439,04
12/10/2021	Hydro2	265	468	28,47	0,81	438,72
19/10/2021	Hydro2	265	468	28,7	0,81	438,49
26/10/2021	Hydro2	265	468	24,01	0,81	443,18
02/11/2021	Hydro2	265	468	25,07	0,81	442,12
09/11/2021	Hydro2	265	468	26,62	0,81	440,57
16/11/2021	Hydro2	265	468	27,27	0,81	439,92
23/11/2021	Hydro2	265	468	27,77	0,81	439,42
30/11/2021	Hydro2	265	468	28,19	0,81	439
07/12/2021	Hydro2	265	468	28,52	0,81	438,67
14/12/2021	Hydro2	265	468	28,77	0,81	438,42
21/12/2021	Hydro2	265	468	29	0,81	438,19
28/12/2021	Hydro2	265	468	29,2	0,81	437,99
04/01/2022	Hydro2	265	468	29,32	0,81	437,87
11/01/2022	Hydro2	265	468	29,42	0,81	437,77
18/01/2022	Hydro2	265	468	29,52	0,81	437,67
25/01/2022	Hydro2	265	468	29,55	0,81	437,64
01/02/2022	Hydro2	265	468	29,54	0,81	437,65
08/02/2022	Hydro2	265	468	29,55	0,81	437,64

15/02/2022	Hydro2	265	468	29,48	0,81	437,71
22/02/2022	Hydro2	265	468	29,49	0,81	437,7
01/03/2022	Hydro2	265	468	29,45	0,81	437,74
08/03/2022	Hydro2	265	468	29,27	0,81	437,92
15/03/2022	Hydro2	265	468	27,98	0,81	439,21
22/03/2022	Hydro2	265	468	27,48	0,81	439,71
29/03/2022	Hydro2	265	468	28,69	0,81	438,5
05/04/2022	Hydro2	265	468	28,9	0,81	438,29
12/04/2022	Hydro2	265	468	29,6	0,81	437,59
19/04/2022	Hydro2	265	468	29,21	0,81	437,98
26/04/2022	Hydro2	265	468	29,23	0,81	437,96
03/05/2022	Hydro2	265	468	29,32	0,81	437,87
10/05/2022	Hydro2	265	468	29,32	0,81	437,87
17/05/2022	Hydro2	265	468	29,32	0,81	437,87
24/05/2022	Hydro2	265	468	29,33	0,81	437,86
31/05/2022	Hydro2	265	468	29,32	0,81	437,87
07/06/2022	Hydro2	265	468	29,34	0,81	437,85
14/06/2022	Hydro2	265	468	29,28	0,81	437,91
21/06/2022	Hydro2	265	468	29,26	0,81	437,93
28/06/2022	Hydro2	265	468	29,25	0,81	437,94
05/07/2022	Hydro2	265	468	29,26	0,81	437,93
12/07/2022	Hydro2	265	468	29,24	0,81	437,95
19/07/2022	Hydro2	265	468	29,24	0,81	437,95
26/07/2022	Hydro2	265	468	29,24	0,81	437,95
02/08/2022	Hydro2	265	468	29,23	0,81	437,96

09/08/2022	Hydro2	265	468	29,22	0,81	437,97
16/08/2022	Hydro2	265	468	29,2	0,81	437,99
23/08/2022	Hydro2	265	468	29,21	0,81	437,98
30/08/2022	Hydro2	265	468	29,21	0,81	437,98

Table 6 Data from piezometric monitoring of the Hydro 4 borehole

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Cp (M)
07/09/2021	Hydro4	81	466	44,81	0,74	420,45
14/09/2021	Hydro4	81	466	44,77	0,74	420,49
21/09/2021	Hydro4	81	466	44,78	0,74	420,48
28/09/2021	Hydro4	81	466	44,75	0,74	420,51
05/10/2021	Hydro4	81	466	44,76	0,74	420,5
12/10/2021	Hydro4	81	466	44,74	0,74	420,52
19/10/2021	Hydro4	81	466	44,74	0,74	420,52
26/10/2021	Hydro4	81	466	44,73	0,74	420,53
02/11/2021	Hydro4	81	466	44,74	0,74	420,52
09/11/2021	Hydro4	81	466	44,71	0,74	420,55
16/11/2021	Hydro4	81	466	44,7	0,74	420,56
23/11/2021	Hydro4	81	466	44,71	0,74	420,55
30/11/2021	Hydro4	81	466	44,72	0,74	420,54
07/12/2021	Hydro4	81	466	44,71	0,74	420,55
14/12/2021	Hydro4	81	466	44,7	0,74	420,56
21/12/2021	Hydro4	81	466	44,7	0,74	420,56
28/12/2021	Hydro4	81	466	44,7	0,74	420,56
04/01/2022	Hydro4	81	466	44,69	0,74	420,57
11/01/2022	Hydro4	81	466	44,68	0,74	420,58
18/01/2022	Hydro4	81	466	44,7	0,74	420,56
25/01/2022	Hydro4	81	466	44,68	0,74	420,58
01/02/2022	Hydro4	81	466	44,69	0,74	420,57
08/02/2022	Hydro4	81	466	44,68	0,74	420,58
15/02/2022	Hydro4	81	466	44,67	0,74	420,59
22/02/2022	Hydro4	81	466	44,67	0,74	420,59
01/03/2022	Hydro4	81	466	44,67	0,74	420,59
08/03/2022	Hydro4	81	466	44,68	0,74	420,58
15/03/2022	Hydro4	81	466	44,7	0,74	420,56
22/03/2022	Hydro4	81	466	44,67	0,74	420,59
29/03/2022	Hydro4	81	466	44,68	0,74	420,58

05/04/2022	Hydro4	81	466	44,67	0,74	420,59
12/04/2022	Hydro4	81	466	44,67	0,74	420,59
19/04/2022	Hydro4	81	466	44,7	0,74	420,56
26/04/2022	Hydro4	81	466	44,69	0,74	420,57
03/05/2022	Hydro4	81	466	44,68	0,74	420,58
10/05/2022	Hydro4	81	466	44,66	0,74	420,6
17/05/2022	Hydro4	81	466	44,68	0,74	420,58
24/05/2022	Hydro4	81	466	44,67	0,74	420,59
31/05/2022	Hydro4	81	466	44,68	0,74	420,58
07/06/2022	Hydro4	81	466	44,67	0,74	420,59
14/06/2022	Hydro4	81	466	44,67	0,74	420,59
21/06/2022	Hydro4	81	466	44,67	0,74	420,59
28/06/2022	Hydro4	81	466	44,67	0,74	420,59
05/07/2022	Hydro4	81	466	44,67	0,74	420,59
12/07/2022	Hydro4	81	466	44,67	0,74	420,59
19/07/2022	Hydro4	81	466	44,68	0,74	420,58
26/07/2022	Hydro4	81	466	44,68	0,74	420,58
02/08/2022	Hydro4	81	466	44,67	0,74	420,59
09/08/2022	Hydro4	81	466	44,67	0,74	420,59
16/08/2022	Hydro4	81	466	44,68	0,74	420,58
23/08/2022	Hydro4	81	466	44,67	0,74	420,59
30/08/2022	Hydro4	81	466	44,68	0,74	420,58

Table 7 Piezometric monitoring data from the Piezo borehole

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Pièzo
07/09/2021	Piezo	205	469	45,92	0,66	422,42
14/09/2021	Piezo	205	469	45,87	0,66	422,47
21/09/2021	Piezo	205	469	45,85	0,66	422,49
28/09/2021	Piezo	205	469	45,69	0,66	422,65
05/10/2021	Piezo	205	469	45,75	0,66	422,59
12/10/2021	Piezo	205	469	45,69	0,66	422,65
19/10/2021	Piezo	205	469	45,52	0,66	422,82
26/10/2021	Piezo	205	469	45,56	0,66	422,78
02/11/2021	Piezo	205	469	45,63	0,66	422,71

09/11/2021	Piezo	205	469	45,66	0,66	422,68
16/11/2021	Piezo	205	469	45,65	0,66	422,69
23/11/2021	Piezo	205	469	45,74	0,66	422,6
30/11/2021	Piezo	205	469	45,75	0,66	422,59
07/12/2021	Piezo	205	469	45,69	0,66	422,65
14/12/2021	Piezo	205	469	45,66	0,66	422,68
21/12/2021	Piezo	205	469	45,74	0,66	422,6
28/12/2021	Piezo	205	469	45,8	0,66	422,54
04/01/2022	Piezo	205	469	45,61	0,66	422,73
11/01/2022	Piezo	205	469	45,62	0,66	422,72
18/01/2022	Piezo	205	469	45,69	0,66	422,65
25/01/2022	Piezo	205	469	45,64	0,66	422,7
01/02/2022	Piezo	205	469	45,53	0,66	422,81
08/02/2022	Piezo	205	469	45,55	0,66	422,79
15/02/2022	Piezo	205	469	45,45	0,66	422,89
22/02/2022	Piezo	205	469	45,64	0,66	422,7
01/03/2022	Piezo	205	469	45,73	0,66	422,61
08/03/2022	Piezo	205	469	45,75	0,66	422,59
15/03/2022	Piezo	205	469	45,72	0,66	422,62
22/03/2022	Piezo	205	469	45,67	0,66	422,67
29/03/2022	Piezo	205	469	45,76	0,66	422,58
05/04/2022	Piezo	205	469	45,76	0,66	422,58
12/04/2022	Piezo	205	469	45,73	0,66	422,61
19/04/2022	Piezo	205	469	45,69	0,66	422,65
26/04/2022	Piezo	205	469	45,68	0,66	422,66

03/05/2022	Piezo	205	469	45,65	0,66	422,69
10/05/2022	Piezo	205	469	45,25	0,66	423,09
17/05/2022	Piezo	205	469	45,58	0,66	422,76
24/05/2022	Piezo	205	469	45,6	0,66	422,74
31/05/2022	Piezo	205	469	45,69	0,66	422,65
07/06/2022	Piezo	205	469	45,69	0,66	422,65
14/06/2022	Piezo	205	469	45,67	0,66	422,67
21/06/2022	Piezo	205	469	45,7	0,66	422,64
28/06/2022	Piezo	205	469	45,69	0,66	422,65
05/07/2022	Piezo	205	469	45,72	0,66	422,62
12/07/2022	Piezo	205	469	45,69	0,66	422,65
19/07/2022	Piezo	205	469	45,59	0,66	422,75
26/07/2022	Piezo	205	469	45,59	0,66	422,75
02/08/2022	Piezo	205	469	45,6	0,66	422,74
09/08/2022	Piezo	205	469	45,58	0,66	422,76
16/08/2022	Piezo	205	469	45,6	0,66	422,74
23/08/2022	Piezo	205	469	45,61	0,66	422,73
30/08/2022	Piezo	205	469	45,58	0,66	422,76

Table 8 Piezometric monitoring data for borehole ASDH126B

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Cp (m)
07/09/2021	ASDH126B	164	462	31,3	0,86	429,84
14/09/2021	ASDH126B	164	462	30,75	0,86	430,39
21/09/2021	ASDH126B	164	462	31,29	0,86	429,85
28/09/2021	ASDH126B	164	462	31	0,86	430,14

05/10/2021	ASDH126B	164	462	31,39	0,86	429,75
12/10/2021	ASDH126B	164	462	31,47	0,86	429,67
19/10/2021	ASDH126B	164	462	31,6	0,86	429,54
26/10/2021	ASDH126B	164	462	31,38	0,86	429,76
02/11/2021	ASDH126B	164	462	31,02	0,86	430,12
09/11/2021	ASDH126B	164	462	31,38	0,86	429,76
16/11/2021	ASDH126B	164	462	31,51	0,86	429,63
23/11/2021	ASDH126B	164	462	31,64	0,86	429,5
30/11/2021	ASDH126B	164	462	31,74	0,86	429,4
07/12/2021	ASDH126B	164	462	31,68	0,86	429,46
14/12/2021	ASDH126B	164	462	31,72	0,86	429,42
21/12/2021	ASDH126B	164	462	31,77	0,86	429,37
28/12/2021	ASDH126B	164	462	31,79	0,86	429,35
04/01/2022	ASDH126B	164	462	31,79	0,86	429,35
11/01/2022	ASDH126B	164	462	31,7	0,86	429,44
18/01/2022	ASDH126B	164	462	31,74	0,86	429,4
25/01/2022	ASDH126B	164	462	31,65	0,86	429,49
01/02/2022	ASDH126B	164	462	31,58	0,86	429,56
08/02/2022	ASDH126B	164	462	31,57	0,86	429,57
15/02/2022	ASDH126B	164	462	31,61	0,86	429,53
22/02/2022	ASDH126B	164	462	32,11	0,86	429,03
01/03/2022	ASDH126B	164	462	32,6	0,86	428,54
08/03/2022	ASDH126B	164	462	31,9	0,86	429,24

15/03/2022	ASDH126B	164	462	31,82	0,86	429,32
22/03/2022	ASDH126B	164	462	32,19	0,86	428,95
29/03/2022	ASDH126B	164	462	32,15	0,86	428,99
05/04/2022	ASDH126B	164	462	32,24	0,86	428,9
12/04/2022	ASDH126B	164	462	32,11	0,86	429,03
19/04/2022	ASDH126B	164	462	32,25	0,86	428,89
26/04/2022	ASDH126B	164	462	32,25	0,86	428,89
03/05/2022	ASDH126B	164	462	32,11	0,86	429,03
10/05/2022	ASDH126B	164	462	31,93	0,86	429,21
17/05/2022	ASDH126B	164	462	31,89	0,86	429,25
24/05/2022	ASDH126B	164	462	31,94	0,86	429,2
31/05/2022	ASDH126B	164	462	32,12	0,86	429,02
07/06/2022	ASDH126B	164	462	32,06	0,86	429,08
14/06/2022	ASDH126B	164	462	31,96	0,86	429,18
21/06/2022	ASDH126B	164	462	31,96	0,86	429,18
28/06/2022	ASDH126B	164	462	32,01	0,86	429,13
05/07/2022	ASDH126B	164	462	32,02	0,86	429,12
12/07/2022	ASDH126B	164	462	32,03	0,86	429,11
19/07/2022	ASDH126B	164	462	32,05	0,86	429,09
26/07/2022	ASDH126B	164	462	32,02	0,86	429,12
02/08/2022	ASDH126B	164	462	32,02	0,86	429,12
09/08/2022	ASDH126B	164	462	32,03	0,86	429,11
16/08/2022	ASDH126B	164	462	32,04	0,86	429,1

23/08/2022	ASDH126B	164	462	32,05	0,86	429,09
30/08/2022	ASDH126B	164	462	32,05	0,86	429,09

Table 9 Data from piezometric monitoring of borehole ASDH264

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Cp (M)
07/09/2021	ASDH264	182	463	37,9	0,81	424,29
14/09/2021	ASDH264	182	463	37,7	0,81	424,49
21/09/2021	ASDH264	182	463	37,85	0,81	424,34
28/09/2021	ASDH264	182	463	37,82	0,81	424,37
05/10/2021	ASDH264	182	463	37,83	0,81	424,36
12/10/2021	ASDH264	182	463	37,82	0,81	424,37
19/10/2021	ASDH264	182	463	37,79	0,81	424,4
26/10/2021	ASDH264	182	463	37,76	0,81	424,43
02/11/2021	ASDH264	182	463	37,68	0,81	424,51
09/11/2021	ASDH264	182	463	37,64	0,81	424,55
16/11/2021	ASDH264	182	463	37,64	0,81	424,55
23/11/2021	ASDH264	182	463	37,62	0,81	424,57
30/11/2021	ASDH264	182	463	37,63	0,81	424,56
07/12/2021	ASDH264	182	463	37,62	0,81	424,57
14/12/2021	ASDH264	182	463	37,56	0,81	424,63
21/12/2021	ASDH264	182	463	37,56	0,81	424,63
28/12/2021	ASDH264	182	463	37,48	0,81	424,71
04/01/2022	ASDH264	182	463	37,34	0,81	424,85
11/01/2022	ASDH264	182	463	37,36	0,81	424,83

18/01/2022	ASDH264	182	463	37,37	0,81	424,82
25/01/2022	ASDH264	182	463	37,25	0,81	424,94
01/02/2022	ASDH264	182	463	37,29	0,81	424,9
08/02/2022	ASDH264	182	463	37,33	0,81	424,86
15/02/2022	ASDH264	182	463	37,36	0,81	424,83
22/02/2022	ASDH264	182	463	37,45	0,81	424,74
01/03/2022	ASDH264	182	463	37,54	0,81	424,65
08/03/2022	ASDH264	182	463	37,6	0,81	424,59
15/03/2022	ASDH264	182	463	37,71	0,81	424,48
22/03/2022	ASDH264	182	463	37,74	0,81	424,45
29/03/2022	ASDH264	182	463	37,82	0,81	424,37
05/04/2022	ASDH264	182	463	37,87	0,81	424,32
12/04/2022	ASDH264	182	463	37,84	0,81	424,35
19/04/2022	ASDH264	182	463	37,91	0,81	424,28
26/04/2022	ASDH264	182	463	37,92	0,81	424,27
03/05/2022	ASDH264	182	463	37,93	0,81	424,26
10/05/2022	ASDH264	182	463	37,95	0,81	424,24
17/05/2022	ASDH264	182	463	37,98	0,81	424,21
24/05/2022	ASDH264	182	463	37,99	0,81	424,2
31/05/2022	ASDH264	182	463	37,99	0,81	424,2
07/06/2022	ASDH264	182	463	37,98	0,81	424,21
14/06/2022	ASDH264	182	463	37,91	0,81	424,28
21/06/2022	ASDH264	182	463	37,89	0,81	424,3

28/06/2022	ASDH264	182	463	37,89	0,81	424,3
05/07/2022	ASDH264	182	463	37,91	0,81	424,28
12/07/2022	ASDH264	182	463	37,92	0,81	424,27
19/07/2022	ASDH264	182	463	37,93	0,81	424,26
26/07/2022	ASDH264	182	463	37,93	0,81	424,26
02/08/2022	ASDH264	182	463	37,89	0,81	424,3
09/08/2022	ASDH264	182	463	37,88	0,81	424,31
16/08/2022	ASDH264	182	463	37,86	0,81	424,33
23/08/2022	ASDH264	182	463	37,85	0,81	424,34
30/08/2022	ASDH264	182	463	37,83	0,81	424,36

Table 10 Data from piezometric monitoring of borehole GIHF2

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Cp (m)
07/09/2021	GIHF2	231	480	31,3	0,55	448,15
14/09/2021	GIHF2	231	480	31,25	0,55	448,2
21/09/2021	GIHF2	231	480	31,24	0,55	448,21
28/09/2021	GIHF2	231	480	31,22	0,55	448,23
05/10/2021	GIHF2	231	480	31,23	0,55	448,22
12/10/2021	GIHF2	231	480	31,2	0,55	448,25
19/10/2021	GIHF2	231	480	31,18	0,55	448,27
26/10/2021	GIHF2	231	480	31,17	0,55	448,28
02/11/2021	GIHF2	231	480	31,18	0,55	448,27
09/11/2021	GIHF2	231	480	31,12	0,55	448,33
16/11/2021	GIHF2	231	480	31,13	0,55	448,32

23/11/2021	GIHF2	231	480	31,14	0,55	448,31
30/11/2021	GIHF2	231	480	31,15	0,55	448,3
07/12/2021	GIHF2	231	480	31,14	0,55	448,31
14/12/2021	GIHF2	231	480	31,12	0,55	448,33
21/12/2021	GIHF2	231	480	31,13	0,55	448,32
28/12/2021	GIHF2	231	480	31,08	0,55	448,37
04/01/2022	GIHF2	231	480	31,05	0,55	448,4
11/01/2022	GIHF2	231	480	31	0,55	448,45
18/01/2022	GIHF2	231	480	31,02	0,55	448,43
25/01/2022	GIHF2	231	480	30,98	0,55	448,47
01/02/2022	GIHF2	231	480	30,97	0,55	448,48
08/02/2022	GIHF2	231	480	30,93	0,55	448,52
15/02/2022	GIHF2	231	480	30,89	0,55	448,56
22/02/2022	GIHF2	231	480	30,89	0,55	448,56
01/03/2022	GIHF2	231	480	30,85	0,55	448,6
08/03/2022	GIHF2	231	480	30,82	0,55	448,63
15/03/2022	GIHF2	231	480	30,85	0,55	448,6
22/03/2022	GIHF2	231	480	30,77	0,55	448,68
29/03/2022	GIHF2	231	480	30,8	0,55	448,65
05/04/2022	GIHF2	231	480	30,78	0,55	448,67
12/04/2022	GIHF2	231	480	31,17	0,55	448,28
19/04/2022	GIHF2	231	480	31,17	0,55	448,28
26/04/2022	GIHF2	231	480	31,17	0,55	448,28

03/05/2022	GIHF2	231	480	31,14	0,55	448,31
10/05/2022	GIHF2	231	480	31,11	0,55	448,34
17/05/2022	GIHF2	231	480	31,14	0,55	448,31
24/05/2022	GIHF2	231	480	31,15	0,55	448,3
31/05/2022	GIHF2	231	480	31,11	0,55	448,34
07/06/2022	GIHF2	231	480	31,23	0,55	448,22
14/06/2022	GIHF2	231	480	31,03	0,55	448,42
21/06/2022	GIHF2	231	480	31,04	0,55	448,41
28/06/2022	GIHF2	231	480	31,01	0,55	448,44
05/07/2022	GIHF2	231	480	31,01	0,55	448,44
12/07/2022	GIHF2	231	480	30,99	0,55	448,46
19/07/2022	GIHF2	231	480	30,98	0,55	448,47
26/07/2022	GIHF2	231	480	30,94	0,55	448,51
02/08/2022	GIHF2	231	480	30,92	0,55	448,53
09/08/2022	GIHF2	231	480	30,91	0,55	448,54
16/08/2022	GIHF2	231	480	30,9	0,55	448,55
23/08/2022	GIHF2	231	480	30,89	0,55	448,56
30/08/2022	GIHF2	231	480	30,88	0,55	448,57

Table 11 Data from piezometric monitoring of borehole GIHF4

Date	ID - HOLE	Pr (m)	Z (m)	ND (m)	Hs (m)	Cp (M)
07/09/2021	GIHF4	331	478	27,18	0,54	450,28
14/09/2021	GIHF4	331	478	27,18	0,54	450,28
21/09/2021	GIHF4	331	478	27,17	0,54	450,29
28/09/2021	GIHF4	331	478	27,12	0,54	450,34

05/10/2021	GIHF4	331	478	27,17	0,54	450,29
12/10/2021	GIHF4	331	478	27,12	0,54	450,34
19/10/2021	GIHF4	331	478	27,16	0,54	450,3
26/10/2021	GIHF4	331	478	27,15	0,54	450,31
02/11/2021	GIHF4	331	478	27,16	0,54	450,3
09/11/2021	GIHF4	331	478	27,19	0,54	450,27
16/11/2021	GIHF4	331	478	27,19	0,54	450,27
23/11/2021	GIHF4	331	478	27,14	0,54	450,32
30/11/2021	GIHF4	331	478	27,16	0,54	450,3
07/12/2021	GIHF4	331	478	27,15	0,54	450,31
14/12/2021	GIHF4	331	478	27,15	0,54	450,31
21/12/2021	GIHF4	331	478	27,18	0,54	450,28
28/12/2021	GIHF4	331	478	27,19	0,54	450,27
04/01/2022	GIHF4	331	478	27,19	0,54	450,27
11/01/2022	GIHF4	331	478	27,17	0,54	450,29
18/01/2022	GIHF4	331	478	27,24	0,54	450,22
25/01/2022	GIHF4	331	478	27,19	0,54	450,27
01/02/2022	GIHF4	331	478	27,21	0,54	450,25
08/02/2022	GIHF4	331	478	27,19	0,54	450,27
15/02/2022	GIHF4	331	478	27,19	0,54	450,27
22/02/2022	GIHF4	331	478	27,19	0,54	450,27
01/03/2022	GIHF4	331	478	27,19	0,54	450,27
08/03/2022	GIHF4	331	478	27,21	0,54	450,25

15/03/2022	GIHF4	331	478	27,21	0,54	450,25
22/03/2022	GIHF4	331	478	27,15	0,54	450,31
29/03/2022	GIHF4	331	478	27,15	0,54	450,31
05/04/2022	GIHF4	331	478	27,17	0,54	450,29
12/04/2022	GIHF4	331	478	27,16	0,54	450,3
19/04/2022	GIHF4	331	478	27,19	0,54	450,27
26/04/2022	GIHF4	331	478	27,18	0,54	450,28
03/05/2022	GIHF4	331	478	27,18	0,54	450,28
10/05/2022	GIHF4	331	478	27,18	0,54	450,28
17/05/2022	GIHF4	331	478	27,24	0,54	450,22
24/05/2022	GIHF4	331	478	27,22	0,54	450,24
31/05/2022	GIHF4	331	478	27,23	0,54	450,23
07/06/2022	GIHF4	331	478	27,23	0,54	450,23
14/06/2022	GIHF4	331	478	27,23	0,54	450,23
21/06/2022	GIHF4	331	478	27,23	0,54	450,23
28/06/2022	GIHF4	331	478	27,21	0,54	450,25
05/07/2022	GIHF4	331	478	27,23	0,54	450,23
12/07/2022	GIHF4	331	478	27,21	0,54	450,25
19/07/2022	GIHF4	331	478	27,19	0,54	450,27
26/07/2022	GIHF4	331	478	27,21	0,54	450,25
02/08/2022	GIHF4	331	478	27,2	0,54	450,26
09/08/2022	GIHF4	331	478	27,19	0,54	450,27
16/08/2022	GIHF4	331	478	27,19	0,54	450,27

23/08/2022	GIHF4	331	478	27,18	0,54	450,28
30/08/2022	GIHF4	331	478	27,18	0,54	450,28

Appendix 2: Water analysis results 2022

Table 12 Physico-chemical analysis sheet for the Elogazan borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : Flogazam	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 02/09/2022 au 03/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	9.2	-	6.5-9.5	Nitrates (NO_3^-)	14.52	mg/l	50mg/l
Température	26	°C	-	Nitrites (NO_2^-)	0.0066	mg/l	0.3mg/l
Conductivité	435	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.25	NTU	5 NTU	Potassium (K^+)	0.4	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	0.01	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.02	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.06	mg/l	100mg/l
Sulfate (SO_4^{2-})	8	mg/l	400 mg/l	Calcium (Ca^{++})	128	mg/l	100mg/l
Carbonate (CO_3^{--})	20	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	165	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	7.8	mg/l	10mg/l
Chlorures (Cl^-) libre	0.01	mg/l	0.5mg/l	Alcalinité totale	135.25	mg/l	< 500mg/l
Chlore total	0.12	mg/l	250mg/l	TDS	242	mg/l	1000 mg/l
Fluorures (F^-)	0.24	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, de teneur en **calcium** supérieure aux normes O.M.S en vigueur : Elle est **acceptable** pour la consommation humaine.

Agadez le : 03/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 13 Physico-chemical analysis sheet for the Agatara borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : Agatara	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse** : Du 02/09/2022 au 03/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.8	-	6.5-9.5	Nitrates (NO_3^-)	9.86	mg/l	50mg/l
Température	26.1	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	394	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.19	NTU	5 NTU	Potassium (K^+)	0.6	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	0.00	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.06	mg/l	100mg/l
Sulfate (SO_4^{2-})	10	mg/l	400 mg/l	Calcium (Ca^{++})	6	mg/l	100mg/l
Carbonate (CO_3^{--})	20	mg/l	-	Aluminium (Al^{3+})	0.04	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	170	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	10.7	mg/l	10mg/l
Chlorures (Cl^-) libre	0.01	mg/l	0.5mg/l	Alcalinité totale	139.34	mg/l	< 500mg/l
Chlore total	0.12	mg/l	250mg/l	TDS	215	mg/l	1000 mg/l
Fluorures (F^-)	0.08	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, de teneur en **phosphates légèrement** supérieure aux normes O.M.S en vigueur : Elle est **acceptable** pour la consommation humaine.

Agadez le : 03/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 14 Physico-chemical analysis sheet for Tagaza borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : Tagaza	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 02/09/2022 au 03/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.5	-	6.5-9.5	Nitrates (NO_3^-)	14.04	mg/l	50mg/l
Température	25.7	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	415	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.2	NTU	5 NTU	Potassium (K^+)	3.3	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	0.01	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.04	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.04	mg/l	100mg/l
Sulfate (SO_4^{2-})	1	mg/l	400 mg/l	Calcium (Ca^{++})	20	mg/l	100mg/l
Carbonate (CO_3^{--})	200	mg/l	-	Aluminium (Al^{3+})	0.00	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	15	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	13.2	mg/l	10mg/l
Chlorures (Cl^-) libre	0.01	mg/l	0.5mg/l	Alcalinité totale	12.3	mg/l	< 500mg/l
Chlore total	0.10	mg/l	250mg/l	TDS	230	mg/l	1000 mg/l
Fluorures (F^-)	0.04	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, de teneur en **phosphates** supérieure aux normes O.M.S en vigueur : Elle est **acceptable** pour la consommation humaine.

Agadez le : 03/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 15 Physico-chemical analysis sheet for the Exploration Camp borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : Base vie GAF	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 02/09/2022 au 03/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	9	-	6.5-9.5	Nitrates (NO_3^-)	15.93	mg/l	50mg/l
Température	25.8	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	511	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.34	NTU	5 NTU	Potassium (K^+)	0.4	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.06	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.06	mg/l	100mg/l
Sulfate (SO_4^{2-})	0.00	mg/l	400 mg/l	Calcium (Ca^{++})	133	mg/l	100mg/l
Carbonate (CO_3^{--})	40	mg/l	-	Aluminium (Al^{3+})	0.00	mg/l	2.9mg/l
Bicarbonate (HCO_3^-	205	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	10.4	mg/l	10mg/l
Chlorures (Cl^-) libre	0.01	mg/l	0.5mg/l	Alcalinité totale	168.03	mg/l	< 500mg/l
Chlore total	0.09	mg/l	250mg/l	TDS	289	mg/l	1000 mg/l
Fluorures (F^-)	0.08	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, de teneur en **calcium** supérieure aux normes O.M.S en vigueur : Elle est **acceptable** pour la consommation humaine.

Agadez le : 03/09/2022

Responsable du laboratoire

Mamane Elh. Abdou

Table 16 Physico-chemical analysis sheet for the FORACO borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : FORACO	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 03/09/2022 au 04/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.9	-	6.5-9.5	Nitrates (NO_3^-)	14.21	mg/l	50mg/l
Température	27	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	491	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	2.52	NTU	5 NTU	Potassium (K^+)	0.1	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.00	mg/l	100mg/l
Sulfate (SO_4^{2-})	0.00	mg/l	400 mg/l	Calcium (Ca^{++})	0.00	mg/l	100mg/l
Carbonate (CO_3^{--})	20	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-	200	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	7.6	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	163.93	mg/l	< 500mg/l
Chlore total	0.09	mg/l	250mg/l	TDS	260	mg/l	1000 mg/l
Fluorures (F^-)	0.06	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau d'alimentation de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 04/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 17 Physico-chemical analysis sheet for borehole HYDRO 5

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : HYDRO 5	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 03/09/2022 au 04/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	9.5	-	6.5-9.5	Nitrates (NO_3^-)	9.02	mg/l	50mg/l
Température	26.6	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	771	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	23.3	NTU	5 NTU	Potassium (K^+)	0.4	mg/l	12mg/l
Couleur	Peu claire	-	-	Fer total	0.01	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.03	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.06	mg/l	100mg/l
Sulfate (SO_4^{2-})	128	mg/l	400 mg/l	Calcium (Ca^{++})	2	mg/l	100mg/l
Carbonate (CO_3^{--})	160	mg/l	-	Aluminium (Al^{3+})	Néant	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	0.00	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	Néant	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	0.00	mg/l	< 500mg/l
Chlore total	0.01	mg/l	250mg/l	TDS	411	mg/l	1000 mg/l
Fluorures (F^-)	1.9	mg/l	1.5mg/l	Ion hydroxyde (OH^-)	35	mg/l	-

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, **légèrement trouble** (5 NTU < valeur de turbidité≤ 30 NTU) et de teneur en **fluor** supérieure aux normes O.M.S en vigueur : Cette eau est **interdite** pour la **consommation humaine**.

Agadez le : 04/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 18 Physico-chemical analysis sheet for borehole GIHF2

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : GIHF2	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 03/09/2022 au 04/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	9.4	-	6.5-9.5	Nitrates (NO_3^-)	6.03	mg/l	50mg/l
Température	25.8	°C	-	Nitrites (NO_2^-)	0.017	mg/l	0.3mg/l
Conductivité	1283	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	6.68	NTU	5 NTU	Potassium (K^+)	1.3	mg/l	12mg/l
Couleur	Peu claire	-	-	Fer total	0.06	mg/l	0.3mg/l
Gout	Du natron	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.16	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.18	mg/l	100mg/l
Sulfate (SO_4^{2-})	132	mg/l	400 mg/l	Calcium (Ca^{++})	142	mg/l	100mg/l
Carbonate (CO_3^{--})	200	mg/l	-	Aluminium (Al^{3+})	0.00	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	270	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	7.2	mg/l	10mg/l
Chlorures (Cl^-) libre	0.11	mg/l	0.5mg/l	Alcalinité totale	221.31	mg/l	< 500mg/l
Chlore total	0.17	mg/l	250mg/l	TDS	680	mg/l	1000 mg/l
Fluorures (F^-)	7.9	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, **légèrement trouble** (5 NTU < valeur de turbidité≤ 30 NTU), de [conductivité et de teneurs (en **calcium** et en **fluor**)] supérieures aux normes O.M.S en vigueur : Cette eau est **strictement interdite** pour la **consommation humaine**.

Agadez le : 04/09/2022

Responsable du laboratoire
Mamane Elh Abdou

Table 19 Physico-chemical analysis sheet for borehole HYDRO 4

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : HYDRO 4	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 03/09/2022 au 04/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	9.2	-	6.5-9.5	Nitrates (NO_3^-)	9.28	mg/l	50mg/l
Température	25.4	°C	-	Nitrites (NO_2^-)	0.017	mg/l	0.3mg/l
Conductivité	685	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	5.52	NTU	5 NTU	Potassium (K^+)	1.4	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	0.03	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.08	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.10	mg/l	100mg/l
Sulfate (SO_4^{2-})	94	mg/l	400 mg/l	Calcium (Ca^{++})	2	mg/l	100mg/l
Carbonate (CO_3^{--})	50	mg/l	-	Aluminium (Al^{3+})	0.02	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	165	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	10.1	mg/l	10mg/l
Chlorures (Cl^-) libre	0.05	mg/l	0.5mg/l	Alcalinité totale	135.25	mg/l	< 500mg/l
Chlore total	0.09	mg/l	250mg/l	TDS	367	mg/l	1000 mg/l
Fluorures (F^-)	0.6	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, **légèrement trouble** (5 NTU < valeur de turbidités≤ 30 NTU): Elle est **acceptable** pour la consommation humaine.

Agadez le : 04/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 20 Physico-chemical analysis sheet for the Citernage borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Roufai ABDOU **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 02/09/2022
Localité : Citernage	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage	**Date d'analyse :** Du 03/09/2022 au 04/09/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : ..... m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.8	-	6.5-9.5	Nitrates (NO_3^-)	12.14	mg/l	50mg/l
Température	24.6	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	425	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.28	NTU	5 NTU	Potassium (K^+)	0.5	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.02	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.02	mg/l	100mg/l
Sulfate (SO_4^{2-})	2	mg/l	400 mg/l	Calcium (Ca^{++})	2	mg/l	100mg/l
Carbonate (CO_3^{--})	30	mg/l	-	Aluminium (Al^{3+})	Néant	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	165	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	8.8	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	135.25	mg/l	< 500mg/l
Chlore total	0.15	mg/l	250mg/l	TDS	228	mg/l	1000 mg/l
Fluorures (F^-)	0.13	mg/l	1.5mg/l	Manganèse (Mn^{++})	-	mg/l	0.4mg/l

(-) Non mesurés

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau d'alimentation de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 04/09/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 21 Physico-chemical analysis sheet for the Camp FORACO borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 08/04/2022 à 10H : 30
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°2 Base vie FORACO	**Date d'analyse :** Du 17/04/2022 au 18/04/2022
N° IRH:..... **X :** 365450 **Y :** 1968322	**Laboratoire :** DRHA/Az
Profondeur totale : 175 m **NS :** 53.56 m **HE :** 121.44 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.95	-	6.5-9.5	Nitrates (NO_3^-)	19.45	mg/l	50mg/l
Température	37.5	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	444	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	2.28	NTU	5 NTU	Potassium (K^+)	0.5	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.06	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.06	mg/l	100mg/l
Sulfate (SO_4^{2-})	1	mg/l	400 mg/l	Calcium (Ca^{++})	0.00	mg/l	100mg/l
Carbonate (CO_3^{--})	40	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-	205	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	6.1	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	168.03	mg/l	< 500mg/l
Chlore total	0.10	mg/l	250mg/l	TDS	272	mg/l	1000 mg/l
Fluorures (F^-)	0.2	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 18/04/2022

Responsable du laboratoire
Mamane Elh Abdou

Table 22 Physico-chemical analysis sheet for borehole GIHF2

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 06/04/2022 à 10H : 14
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°8 GIHF2	**Date d'analyse :** Du 17/04/2022 au 18/04/2022
N° IRH:..... **X :** 365329 **Y :** 1972996	**Laboratoire :** DRHA/Az
Profondeur totale : 231 m **NS :** 30.89 m **HE :** 200.11 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.64	-	6.5-9.5	Nitrates (NO_3^-)	11.4	mg/l	50mg/l
Température	37.82	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	650	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	4.31	NTU	5 NTU	Potassium (K^+)	0.9	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.06	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.10	mg/l	100mg/l
Sulfate (SO_4^{2-})	130	mg/l	400 mg/l	Calcium (Ca^{++})	123	mg/l	100mg/l
Carbonate (CO_3^{--})	40	mg/l	-	Aluminium (Al^{3+})	0.00	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	420	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	7.5	mg/l	10mg/l
Chlorures (Cl^-) libre	0.07	mg/l	0.5mg/l	Alcalinité totale	344.26	mg/l	< 500mg/l
Chlore total	0.17	mg/l	250mg/l	TDS	678	mg/l	1000 mg/l
Fluorures (F^-)	11.9	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, de teneurs (en **fluor**, en **bicarbonates** et en **calcium**) supérieures aux normes O.M.S en vigueur **:** Elle est **strictement interdite** pour la consommation humaine.

Agadez le : 18/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 23 Physico-chemical analysis sheet for the Exploration Camp borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 06/04/2022 à 7H : 05
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°1 Base vie GAF	**Date d'analyse :** Du 17/04/2022 au 18/04/2022
N° IRH:..... **X :** 364950 **Y :** 1968322	**Laboratoire :** DRHA/Az
Profondeur totale : 154 m **NS :** 53.56 m **HE :** 100.44 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	9.1	-	6.5-9.5	Nitrates (NO_3^-)	25.52	mg/l	50mg/l
Température	29.6	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	470	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.53	NTU	5 NTU	Potassium (K^+)	0.3	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.00	mg/l	100mg/l
Sulfate (SO_4^{2-})	1	mg/l	400 mg/l	Calcium (Ca^{++})	136	mg/l	100mg/l
Carbonate (CO_3^{--})	40	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	215	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	4.9	mg/l	10mg/l
Chlorures (Cl^-) libre	Néant	mg/l	0.5mg/l	Alcalinité totale	176.23	mg/l	< 500mg/l
Chlore total	0.00	mg/l	250mg/l	TDS	276	mg/l	1000 mg/l
Fluorures (F^-)	0.35	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, de teneur en **calcium** supérieure aux normes O.M.S en vigueur : Elle est **acceptable** pour la consommation humaine.

Agadez le : 18/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 24 Physico-chemical analysis sheet for Tagaza borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 12/04/2022 à 10H : 25
Localité : Tagaza	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°7	**Date d'analyse :** Du 17/04/2022 au 18/04/2022
N° IRH:..... **X :** ..... **Y :**	**Laboratoire :** DRHA/Az
Profondeur totale : 331 m **NS :** ..... m **HE :** ..... m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	7.64	-	6.5-9.5	Nitrates (NO_3^-)	19.10	mg/l	50mg/l
Température	36.9	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	374	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.19	NTU	5 NTU	Potassium (K^+)	3	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.02	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.04	mg/l	100mg/l
Sulfate (SO_4^{2-})	1	mg/l	400 mg/l	Calcium (Ca^{++})	22	mg/l	100mg/l
Carbonate (CO_3^{--})	0.00	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	210	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	8.5	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	172.13	mg/l	< 500mg/l
Chlore total	0.05	mg/l	250mg/l	TDS	225	mg/l	1000 mg/l
Fluorures (F^-)	0.15	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité)ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 18/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 25 Physico-chemical analysis sheet for Tagaza borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 05/04/2022 à 15H : 57
Localité : Tagaza	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°11	**Date d'analyse :** Du 16/04/2022 au 17/04/2022
N° IRH:..... **X :** 356044 **Y :** 1962722	**Laboratoire :** DRHA/Az
Profondeur totale : 110 m **NS :** 44.23 m **HE :** 65.77 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.5	-	6.5-9.5	Nitrates (NO_3^-)	25.08	mg/l	50mg/l
Température	38.3	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	253	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.22	NTU	5 NTU	Potassium (K^+)	1.2	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.02	mg/l	100mg/l
Sulfate (SO_4^{2-})	0.00	mg/l	400 mg/l	Calcium (Ca^{++})	12	mg/l	100mg/l
Carbonate (CO_3^{--})	0.00	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-	165	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	3.6	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	135.25	mg/l	< 500mg/l
Chlore total	0.02	mg/l	250mg/l	TDS	161	mg/l	1000 mg/l
Fluorures (F^-)	0.18	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 17/04/2022

Responsable du laboratoire
Mamane Elh Abdou

Table 26 Physico-chemical analysis sheet for borehole HYDRO 4

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 05/04/2022 à 12H : 40
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°4 HYDRO 4	**Date d'analyse :** Du 16/04/2022 au 17/04/2022
N° IRH:..... **X :** 359976 **Y :** 1969220	**Laboratoire :** DRHA/Az
Profondeur totale : 175 m **NS :** 45.24 m **HE :** 129.76 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.66	-	6.5-9.5	Nitrates (NO_3^-)	17.69	mg/l	50mg/l
Température	38.92	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	528	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	208	NTU	5 NTU	Potassium (K^+)	Néant	mg/l	12mg/l
Couleur	**Trouble**	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.00	mg/l	100mg/l
Sulfate (SO_4^{2-})	74	mg/l	400 mg/l	Calcium (Ca^{++})	148	mg/l	100mg/l
Carbonate (CO_3^{--})	0.00	mg/l	-	Aluminium (Al^{3+})	0.16	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	190	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	Néant	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	155.74	mg/l	< 500mg/l
Chlore total	0.00	mg/l	250mg/l	TDS	368	mg/l	1000 mg/l
Fluorures (F^-)	1.17	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau de **bonne qualité bactériologique** mais, **trouble** (valeur de turbidité > 100 NTU) et de teneur en **calcium** supérieure aux normes O.M.S en vigueur : Ainsi, il **faut développer** puis **ramener l'échantillon d'eau** au **laboratoire** pour **vérification**.

Agadez le : 17/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 27 Physico-chemical analysis sheet for the Piezo well

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 29/03/2022 à 10H : 30
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°6 Piézo	**Date d'analyse :** Du 15/04/2022 au 16/04/2022
N° IRH:..... **X :** 360008 **Y :** 1969087	**Laboratoire :** DRHA/Az
Profondeur totale : 182 m **NS :** 45.64 m **HE :** 136.36 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.69	-	6.5-9.5	Nitrates (NO_3^-)	13.42	mg/l	50mg/l
Température	40.22	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	622	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	5.12	NTU	5 NTU	Potassium (K^+)	1.3	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	0.02	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.08	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.10	mg/l	100mg/l
Sulfate (SO_4^{2-})	150	mg/l	400 mg/l	Calcium (Ca^{++})	2	mg/l	100mg/l
Carbonate (CO_3^{--})	60	mg/l	-	Aluminium (Al^{3+})	0.02	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	140	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	6.2	mg/l	10mg/l
Chlorures (Cl^-) libre	0.05	mg/l	0.5mg/l	Alcalinité totale	114.75	mg/l	< 500mg/l
Chlore total	0.07	mg/l	250mg/l	TDS	353	mg/l	1000 mg/l
Fluorures (F^-)	1.51	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau **acceptable** pour la consommation humaine. Si possible le suivi de la teneur en **fluor** est nécessaire.

Agadez le : 16/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 28 Physico-chemical analysis sheet for the Citernage borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 29/03/2022 à 12H : 50
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°3 Citernage	**Date d'analyse :** Du 16/04/2022 au 17/04/2022
N° IRH:..... **X :** 359420 **Y :** 1968508	**Laboratoire :** DRHA/Az
Profondeur totale : 175 m **NS :** 45.24 m **HE :** 129.76 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.30	-	6.5-9.5	Nitrates (NO_3^-)	17.69	mg/l	50mg/l
Température	36	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	370	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.32	NTU	5 NTU	Potassium (K^+)	0.3	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.00	mg/l	100mg/l
Sulfate (SO_4^{2-})	10	mg/l	400 mg/l	Calcium (Ca^{++})	4	mg/l	100mg/l
Carbonate (CO_3^{--})	150	mg/l	-	Aluminium (Al^{3+})	0.00	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	65	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	4	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	53.28	mg/l	< 500mg/l
Chlore total	0.01	mg/l	250mg/l	TDS	225	mg/l	1000 mg/l
Fluorures (F^-)	0.29	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: : Eau de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 17/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 29 Physico-chemical analysis sheet for the Agatara borehole

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 05/04/2022 à 15H : 20
Localité : Agatara	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°9	**Date d'analyse :** Du 16/04/2022 au 17/04/2022
N° IRH:..... **X :** 352588 **Y :** 1969202	**Laboratoire :** DRHA/Az
Profondeur totale : 200 m **NS :** 46.12 m **HE :** 153.88 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.17	-	6.5-9.5	Nitrates (NO_3^-)	10.78	mg/l	50mg/l
Température	38.2	°C	-	Nitrites (NO_2^-)	0.00	mg/l	0.3mg/l
Conductivité	352	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	0.27	NTU	5 NTU	Potassium (K^+)	0.2	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	Néant	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.00	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.00	mg/l	100mg/l
Sulfate (SO_4^{2-})	13	mg/l	400 mg/l	Calcium (Ca^{++})	4	mg/l	100mg/l
Carbonate (CO_3^{--})	0.00	mg/l	-	Aluminium (Al^{3+})	0.01	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	190	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	4	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	155.74	mg/l	< 500mg/l
Chlore total	0.04	mg/l	250mg/l	TDS	214	mg/l	1000 mg/l
Fluorures (F^-)	0.39	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: : Eau de **qualités** (physico-chimique et bactériologique) **conformes** aux exigences **des normes O. M. S. en vigueur.**

Agadez le : 17/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Table 30 Physico-chemical analysis sheet for borehole HYDRO 5

REPUBLIQUE DU NIGER
REGION D'AGADEZ
DIRECTION DE L'HYDRAULIQUE ET DE L'ASSAINISSEMENT
LABORATOIRE DE CONTROLE DE LA QUALITE DES EAUX
BP : 23/AGADEZ TEL :(227)20440052

LOCALISATION :

Région : Agadez	**Prélevé par :** Rabiou GONDAH ABDOURAZAK **A la demande de** : GLOBAL ATOMIC
Département : Tchirozérine	**Motif de la demande d'analyse :** Contrôle sanitaire de l'eau
Commune Rurale : Tchirozérine	**Date de prélèvement** : 05/04/2022 à 11H : 10
Localité : Dajy	**Analysé par :** Mamane Elh. Abdou 96727879 / 90343074
Origine de l'eau : Forage N°5 HYDRO 5	**Date d'analyse :** Du 16/04/2022 au 17/04/2022
N° IRH:..... **X :** 360177 **Y :** 1969128	**Laboratoire :** DRHA/Az
Profondeur totale : 183 m **NS :** 47.20 m **HE :** 135.8 m	**Qualification de l'opérateur :** Ingénieur chimiste

FICHE D'ANALYSE PHYSICO-CHIMIQUE DE L'EAU :

RESULTATS :

PARAMETRES	RESULTATS	UNITES	NORMES OMS	PARAMETRES	RESULTATS	UNITES	NORMES OMS
pH	8.44	-	6.5-9.5	Nitrates (NO_3^-)	14.74	mg/l	50mg/l
Température	41.9	°C	-	Nitrites (NO_2^-)	0.0033	mg/l	0.3mg/l
Conductivité	446	µS/cm	≥ 200 et ≤1100 µS/cm	Sodium (Na^+)	-	mg/l	200mg/l
Turbidité	1.96	NTU	5 NTU	Potassium (K^+)	0.5	mg/l	12mg/l
Couleur	Claire	-	-	Fer total	0.01	mg/l	0.3mg/l
Gout	ND	-	Non Désagréable (ND)	Cuivre libre (Cu^{2+})	0.06	mg/l	2mg/l
Odeur	ND	-	Non Désagréable (ND)	Cuivre total (Cu^{++})	0.08	mg/l	100mg/l
Sulfate (SO_4^{2-})	150	mg/l	400 mg/l	Calcium (Ca^{++})	0.00	mg/l	100mg/l
Carbonate (CO_3^{--})	40	mg/l	-	Aluminium (Al^{3+})	0.02	mg/l	2.9mg/l
Bicarbonate (HCO_3^-)	170	mg/l	400mg/l	Ammoniac (NH_3)	Néant	mg/l	-
Ammonium (NH_4^+)	Néant	mg/l	0.5mg/l	Phosphates (PO_4^{3-})	4.9	mg/l	10mg/l
Chlorures (Cl^-) libre	0.00	mg/l	0.5mg/l	Alcalinité totale	139.34	mg/l	< 500mg/l
Chlore total	0.07	mg/l	250mg/l	TDS	398	mg/l	1000 mg/l
Fluorures (F^-)	1.52	mg/l	1.5mg/l	Manganèse (Mn^{++})	Néant	mg/l	0.4mg/l

(-) Non mesurés **NB : Les paramètres in situ (pH, Température et conductivité) ont été mesurés par Rabiou Gondah A.**

FICHE D'ANALYSE BACTERIOLOGIQUE DE L'EAU :

RESULTATS :

PARAMETRES MICROBIOLOGIQUES	NOMBRE DE COLONIES
Coliformes fécaux/100ml d'échantillon filtrés	0
Coliformes totaux/100ml d'échantillon filtrés	0

Observation pour l'ensemble des paramètres mesurés: Eau **acceptable** pour la consommation humaine. Si possible le suivi de la teneur en **fluor** est nécessaire.

Agadez le : 17/04/2022

Responsable du laboratoire

Mamane Elh Abdou

Appendix 3: Field photos

Photo 1 View of the kori taken on: 2/08/2022 at 18:13

Photo 2 View of the kori taken: 2/08/2020 at 18:13

Photo 3 View of the kori taken: 26/06/2020 at 17:13

Photo 4 View of the kori taken: 26/06/2020 at 17:13