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Design of a Drinking Water Supply System (WSS) from Boreholes to the 'Plateau Des Residents' in the University of Kinshasa (DR Congo)

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Abstract:- The 'Plateau des Résidents' neighborhood of the University of Kinshasa has been experiencing problems relating to the drinking water supply for several decades. To remedy this, we offer a Drinking Water Supply System (WSS) using Epanet software. The realization of this project requires the evaluation of a few parameters, in particular the number of the population benefiting from drinking water, its current and future needs as well as the production of this drinking water.In fact, the design of the WSS network also took into account future consumption estimated at 319,586 liters/day, or 319.586 m^3/day on the one hand and the daily borehole's production estimated at 10 m^3/borehole on the other hand.In addition, this sizing was calculated based on the peak flow, the water tower with sufficient capacity to properly play its storage role, and also the discharge and distribution networks. As for this distribution network, it depends on the sources (13 boreholes executed), the reservoirs (water tower) and the distribution points (standpipes).Ultimately, this system works as follows: the water from the borehole will be sent into a pipe which will transport it to a reservoir; starting from the tank, distribution will be done by gravity towards the network.

***Keywords**: - Water Supplying System, Boreholes, Plateau des Résidents, University of Kinshasa.*

I. INTRODUCTION

A Drinking Water Supply System (WSS) is made up of a set of structures which contribute to providing users with water of good quality and in sufficient quantity. Concerning the 'Plateau des Résidents'of the University of Kinshasa, 13 Boreholes were carried out and pumping tests were also carried out in order to determine the hydrodynamic parameters. These tests took into account the characteristics of the aquifer/works complex, the field measurement of hydrodynamic parameters, the quantitative study of the particular characteristics of the aquifer and the direct observation, on a full scale, of the effect of exploitation of the aquifer.

The OUIAP software allowed the evaluation of hydrodynamic parameters by analyzing and interpreting the data collected. It should be noted that the 13 Boreholes also made it possible to acquire valuable technical data without which this study would be mission impossible. These include, in particular, the litho-stratigraphic characteristics, the depth of drilling, some technical characteristics of the equipment used during the execution of drilling work (diameters before hole, length of the steel casing, drilling diameters, strainer length and length of full tubes). In addition, the different technical sections including the lithological log (litho stratigraphy)and the architecture of the wells (drilling, equipment and gravelling) were highlighted.

Finally, the evaluation of the number of the population living in the study area, the current and future drinking water needs of the Plateau des Résidents and the production in particular the hourly peak flow made it possible to size the network with a view to improvement of drinking water supply in this part of the City of Kinshasa faced with this thorny problem. The aim of this work is to show the effectiveness of the design of catchment structures as a multipurpose decision support tool and the most accessible to all.

II. MATERIALS AND METHODS

To carry out this study, 13 water boreholes were carried out. Then pumping tests were carried out in these boreholes in order to determine the hydrodynamic parameters, using the OUIAP software. Finally, with Epanet 2.0 software, we modeled the drinking water supply network in our study area.

A. Study area

- *Location*

The study area, the Plateau des Résidents(fig. 1)of Professors of the University of Kinshasa, is located in the Commune of Lemba, to the South-West of the City of Kinshasa. It is built on the hill of Mont-Amba, known as the "inspired hill". It is located between the northern slope of the Funa River, the southern slope of the Kemi River and the northern slope of the Matete River. (Flouriot J., 1973).

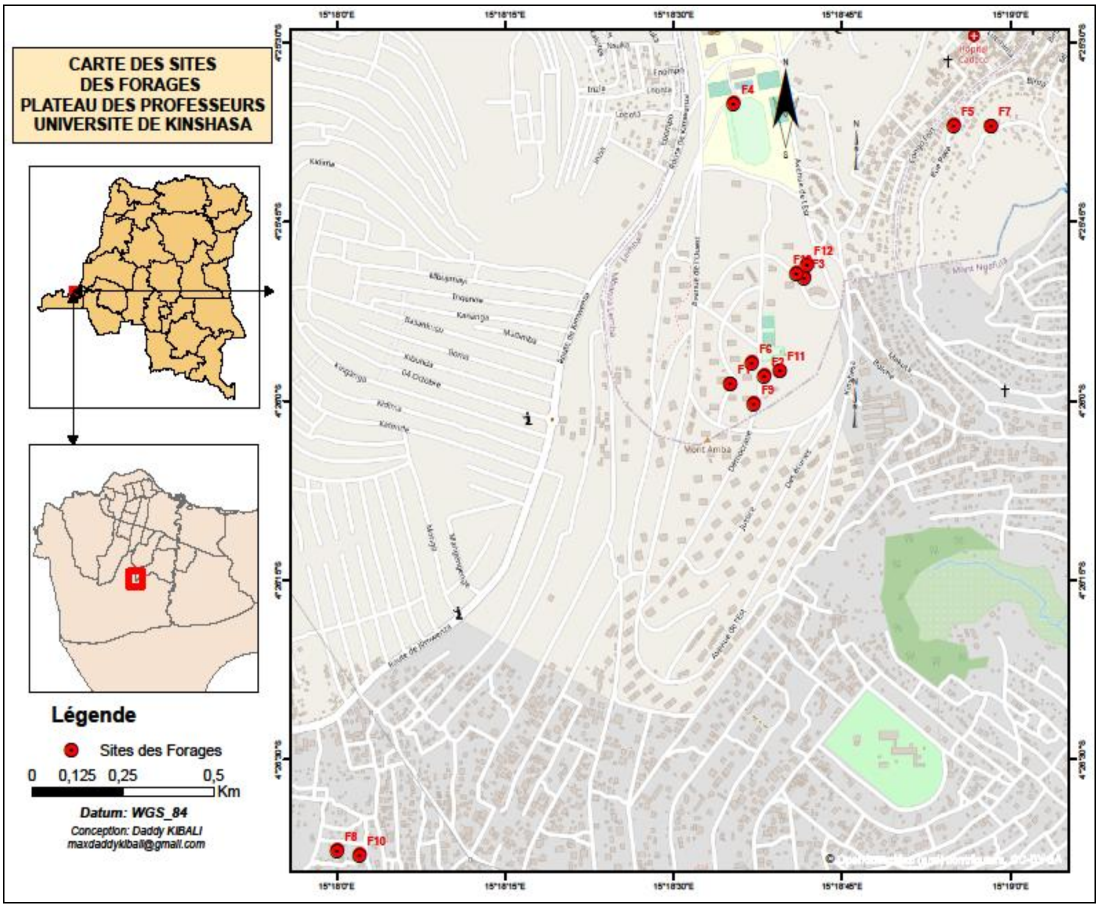

Fig. 1: Location map of the Plateau des Résidents of Professors of the University of Kinshasa.

➢ *Geological framework*

As for the lithostratigraphic succession of Kinshasa, the following presentation should be retained, from top to base:

- The valley bottom alluvium, medium and low terraces and ancient valleys of Stanley Pool (Holocene to Pliocene) occupying the proximity of the marshy area of Pool Malebo and the bottom of the valleys of the Ndjili and Nsele rivers. It should be noted that the mid-terrace alluvium constitutes the transition zone between the plain and the hilly region;
- More or less clayey sands generally with gravels at the base (Pleistocene to Pliocene);
- The series of 'sables ocres' (upper Kalahari) made up of very fine sands (Miocene to Pliocene) located to the east on the Bateke plateau;
- The series of polymorphic sandstones (lower Kalahari) with a portion of sands and soft sandstones (Paleogene). This series, distributed in an irregular or discontinuous manner in the plain zone, appears in the form of thick and continuous conglomeratic banks at the level of the Bateke plateau. These polymorphic sandstones provide hydraulic continuity between the underlying surface sands and soft sandstones;
- The series of soft sandstones (Cretaceous) covering the hilly area;
- The Inkisi series (Cambrian) outcropping in the southern part of the City and on the slopes of the land covered by ocher sands.

As for the study area, the analysis of geological data from the 13 boreholes carried out there revealed the following succession of geological formations, from summit to base:

- Blackish sandy humus;
- Brownish clay;
- Fine brownish sand;
- Soft siliceous sandstone;
- Hard reddish sandstone.

B. Results and discussions

➢ *Population of the study area*

Using the growth formula below (1), we were able to calculate the number of the population in 15 years, the duration for which the network will be sized:

$$Pn = P0\left(1+\frac{t}{100}\right)^{n} = 3 \qquad (1)$$

With $P0$: initial number of inhabitants, i.e. the value at the time of inauguration of the project, Pn: number of inhabitants to be determined after n years, t: growth rate in %, n: number of years of the period concerned (the horizon).

Thus, we will have for the domestic population: P2019= 3,432 inhabitants; t = 3% according to the Water Distribution Authority(REGIDESO) data for the City of Kinshasa; n = 1 year (from 2019 to 2020). Hence:$P2020 = P2019(1+0.03)^{1} = 3534.9$ inhabitants. And for the

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population of Public Establishments: P And pub (2020) =7451 inhabitants.

As for the future population, it is as follows:

- Domestic population (all people living on the Plateau des Résidents): $\mathrm{P2035} = \mathrm{P2020}(1+0.03)^{15} = 5508$ inhabitants;
- Population of Public Establishments (all students internal and external and administratives as well as any worker within the University of Kinshasa): $\mathrm{P\ and\ pub2035} = 7451 \times 1{,}2 = 8942$ inhabitants.

➢ *Assessment of the current and future drinking water needs of the population of the Plateau des Résidents*

Current and future drinking water needs of the population are calculated by the following formula (2):

$$WR = Dot * Pop \qquad (2)$$

With WR: water requirement or consumption; Dot: endowment and Pop: population

This endowment is as follows:

- For the domestic population in the case of supply by standpipe, we will take the value: 20 l/inhabitant/d;
- For public buildings: 15 l/inhabitant/d.

Having the current endowments, we can calculate the future endowments:

- Domestic endowment: $Dot\ 2035 = Dot\ 2020\ (1 + 0{,}01)^{15}$; $P2035 = 20(1+0.01)^{15} = 23{,}21$; or P2035= 23,21 ≈24 l/inhabitant/d
- Endowment of public establishments: As for the latter, we will keep the same value because the consumption system does not vary, except that the number of this category varies according to the years.

Thus, the future Endowments summaries are as follows:

- Domestic Endowments: 24 liters/inhabitant/d;
- Public Establishment Endowments:15 liters/inhabitant/d.

The table 1 below includes current and future consumption.

Table 1: Current and future consumption of the population of the Plateau des Résidents.

Current consumption					
N°	**Category**	**Population (inhabitant)**	**Endowments (l/inhabitant/d)**	**Consumption (l/d)**	
				l/d	**m^3/d**
1	Domestic	3535	20	70700	70.7
2	Public Establish.	7451	15	111765	111.765
	Average Daily Consumption (ADC)			182465	182.465
3	Loss (20% of ADC)			36493	36.493
	TotalADC			**218958**	**218.958**
Future consumption					
N°	**Category**	**Population (inhabitant)**	**Endowments (l/inhabitant/d)**	**Consumption (l/d)**	
				l/d	**l/d**
1	Domestic	5508	24	132192	132.192
2	Public Establish.	8942	15	134130	134.13
	Average Daily Consumption (ADC)			266322	266.322
3	Loss (20% of ADC)			53264.4	53.2644
	Total ADC			**319586.4**	**319.5864**

Thus, the drinking water requirement is the total quantity of raw water required at the production installation (i.e. a catchment, a well, a water intake, etc.) to meet the requirements of each consumer.

C. Production

The hourly peak flow makes it possible to size the distribution network. It corresponds to the product of the hourly average flow and the hourly peak coefficient. The average hourly flow is the quotient of peak daily demand and distribution time. The actual distribution time is 10 hours per day for SP (Standpipes).

➢ *Hourly peak flow calculation*

- Average daily flow

The Average daily flow is calculated by the following formula (3):

$$Qph = Qmh \times Cph = \frac{Bjp \times 1000}{10 \times 3600} \qquad (3)$$

with Qph: hourly peak flow in l/s;Qmh: hourly average flow in l/s and Cph: hourly peak coefficient.

The table 2 below includes current and future flow rates.

Table 2: Presentation of current and future flow rates

Description	Cp	Flow			
		Current		Future	
		Qmj (l/s)	Qp (l/s)	Qmj (l/s)	Qp (l/s)
Monthly	1.3	2.53	3.289	3.69	4.797
Weekly	1.5	2.53	3.795	3.69	5.535
Daily	1.8	2.53	4.554	3.69	6.642
Minimum	0.5	2.53	1.265	3.69	1.845

With Cp: Daily peak coefficient; Qmj: Average flow; Qp: Peak flow. The table 3 below includes current and future average flow rates.

Table 3: Presentation of current and future average flow rates

N°	Description	Current Q (l/s	Future Q (l/s)
1	Qavg	2.53	3.69
2	Qmax	4.55	6.64
3	Qmin	1.26	1.85

- Calculation of daily borehole's production

The daily drilling production is calculated by the following formula (4):

$$Pj = Qexp \times T \qquad (4)$$

With Pj: daily borehole's production m^3/d; $Qexp$: drilling operating flow in m^3/h; T: pumping time in h/d.

For a pumping time of 10 hours per day and an operating flow rate of 10 m^3/h, the production is then estimated at: $Pj = 10 \times 10$. Hence $Pj = 100$ m^3/d. Since the site has 13 boreholes and all with the same flow rate, therefore all these boreholes have the same daily production.

D. Evaluation of hydrodynamic parameters

Long-term pumping tests were carried out with a constant flow rate of approximately 10 m^3/h during 12 hours of ascent. During the pumping test, the SPM-100-12 pump was installed at a depth of approximately 190 m. The data from the long-term tests were processed by the OUAIP software to evaluate the different hydrodynamic parameters around this well, the results of which are presented in Table 4 below.

Table 4: Results of hydrodynamic parameters

Boreholes	T (m2/s)	K (m/s)	Q (m3/h)	Corresponding aquifers
1	5.25*10-5	1.16*10-6	10.00	Siliceous sandstone
2	4.89*10-5	1.40*10-6	10.30	Siliceous sandstone
3	2.37*10-5	6.78*10-7	10.05	Brown siliceous sandstone
4	1.26*10-4	3.51*10-6	9.95	Reddish siliceous sandstone
5	1.96*10-4	2.16*10-6	9.63	Siliceous sandstone
6	2.36*10-4	4.17*10-6	10.83	Pale brown siliceous sandstone
7	1.50*10-4	2.39*10-6	10.27	Brown siliceous sandstone
8	1.63*10-4	2.39*10-6	10.05	Reddish siliceous sandstone
9	1.15*10-4	1.74*10-6	10.45	Brownish siliceous sandstone
10	1.09*10-4	1.78*10-6	10.02	Brown siliceous sandstone

E. Design of the drinking Water Supply System (WSS) using Epanet 2.0 software

- *System design*

For sizing the discharge pipe from the well to the reservoir, we offer an economical diameter pipe taking into account the safety range (reduction in pressure loss and energy expenditure for water circulation). Thus, the economic diameter of the discharge pipe is DN 125 (because D min = 90 mm and D max = 140.7 mm) with a linear pressure loss. As for the size of the network, the design flow of the network is the peak flow calculated above with an increase of 50% in order to provide a sufficient safety margin for calibration.Hence, Q= 22*1.5=33 l/s.

As for the simulation of the drinking water network, it is based on the Epanet software which is defined by pipes (sections), nodes (intersections of two pipes and the end of an old one) but also other features (tanks, pumps, valves, different types of valves, etc.). For the sizing of the water tower, it is at this point a matter of comparing the dimensions of the existing tank to the dimensions that the calculations will give us. The dimensions of the existing tank are as follows: volume: 6875 m^3, Height: 15 m, diameter: 24.16 m and radius: 12.08 m. Knowing that the daily production requirement is 575.244 m^3/d, the water tower must be sized in order to balance daily fluctuations in consumption. It will therefore have sufficient capacity to properly play its storage role. The evaluation of the useful capacity of the reservoir is carried out taking into account the variation in demand.

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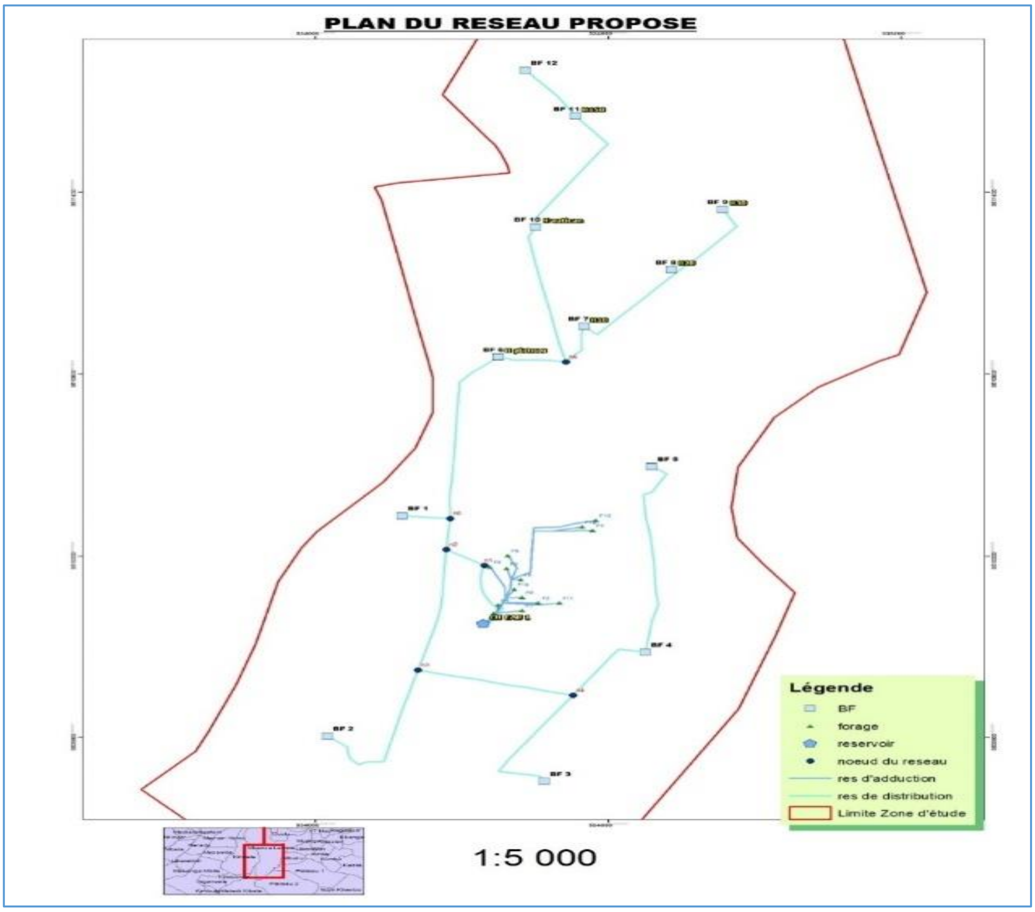

Fig. 2: Proposed Plan of the WSS Network at the Plateau des Résidents

The table 5 below includes Some practical tank capacity values.

Table 5: Some practical tank capacity values (Ouédraogo Bega, 2005)

Operating conditions	**Useful capacity**
Nocturnal adduction	90 % Vd
Adduction with solar pumping (approximately 8h/d)	50 % Vd
Continuous adduction (24h/24h)	30 % Vd
Daytime supply, during consumption periods	10 %Vd à 30 %Vd

With Vd: Daily Volume.

Let us consider the daytime supply, during periods of consumption 10%Vd to 30%Vd.Given that Vd=575.244 m^3/d, hence, we will have 10%Vd: 57.52 m^3 and 30%Vd: 172.57 m^3. Let's take an average of 100 m^3. Thus, for a corrected volume: 6875+100 = 6975 m^3, which is the useful capacity of the water tower to be retained. The dimensions of the water tower will be determined using the formula of a cylinder (5):

$$V = \frac{\pi \times D^2}{4} \times H \qquad (5)$$

And the new dimensions of the tank will be:

- Volume (useful capacity of the tank): 6975 m^3;
- Height (H) = 15 m;
- Diameter $(D) = \sqrt{\frac{6975\times4}{3.14\times15}} = 24.34\ m$; and
- Radius $(D) = 12.12$ m.

➢ *Sizing of the discharge network*

The discharge network consists of the part located between the pump and the tank. The study includes a field of 13 boreholes (from F1 to F13); each borehole will be equipped with a submerged generator which will ensure the flow of water. The water is transported from the borehole to the water tower through the discharge pipe; this having a well-determined length. To properly approach this part, it is important to characterize the boreholes (table 6) and the Discharge pipe (table 7).

Table 6: Boreholes characteristics

Description	SL(m)	DL (m)	Depth (m)	Qexp (m^3/h)	Altitude (m)
F1	104	140	201	10	497
F2	109	144	204	10	494
F3	100	146	204	10	466
F4	109	140	204	10	496
F5	110	140	203	10	495
F6	110	140	203	10	498
F7	110	140	205	10	496
F8	110	140	207	10	497
F9	110	140	205	10	495
F10	110	140	205	10	497
F11	110	136	205	10	494
F12	110	139,84	205	10	463
F13	110	140,16	203	10	482,9

With SL: Static Level; DL: Dynamic Level.

Table 7: Discharge pipe characteristics

Pipes	Length (m)
F1 - R	41.46
F2 - R	197.28
F3 - R	464.85
F4 - R	71.21
F5 - R	182.44
F6 - R	132.06
F7 - R	100.16
F8 - R	205.58
F9 - R	243.57
F10 - R	130.24
F11 - R	197.26
F12 - R	485.86
F13 - R	445.15

- **Flowrate:** The discharge pipe is sized according to the borehole flow rate. Q = 10 m^3/h=2.77 l/s. Since all 13 boreholes have the same flow rate, this means that all the discharge pipes will have the same characteristic.
- **Diameter:** For the diameter calculation, we will use the Bresse formula (6) because it offers diameters of better quality with a reduction in operating costs:

$$D = 1.5 \times Q^{0,5} \tag{6}$$

With Q: the discharge flow rate expressed in m^3/s and D: the internal diameter in m.

Table 8 below presents the parameters of the Discharge pipe diameter.

Table 8: Discharge pipe diameter

Parameters	Values
Flow rate	2.77l/s
Calculated diameter	0.078946184 m
Calculated diameter	78.9461842 mm
Choice of diameter given by the Bresse formula	
Diameter PN10 75/63.8	

- **The flow speed** in the discharge pipes is equal to 0.56 m/s and obtained from the formula (7) below:

$$V = \frac{4 \times Q}{D^2 \times \pi} \tag{7}$$

With:V: the discharge speed in m/s.

- **Checking Flamingo Condition:**$V \leq 0.60 + D$. So, $0.60 + 0.0789 = 0.6638$ and $0.56 \leq 0.6638$; The condition is respected.

The characteristics of the discharge pipe for the field of 13 boreholesare recorded in the summary table 9 below.

Table 9: Characteristics of discharge pipes

Pipes	Length (m)	Nature	Speed (m/s)	Diameter (mm)
F1 - R	41.46	PVC / PN10	0.56	75 / 63.8
F2 - R	197.28	PVC / PN10	0.56	75 / 63.8
F3 - R	464.85	PVC / PN10	0.56	75 / 63.8
F4 - R	71.21	PVC / PN10	0.56	75 / 63.8
F5 - R	182.44	PVC / PN10	0.56	75 / 63.8
F6 - R	132.06	PVC / PN10	0.56	75 / 63.8
F7 - R	100.16	PVC / PN10	0.56	75 / 63.8
F8 - R	205.58	PVC / PN10	0.56	75 / 63.8
F9 - R	243.57	PVC / PN10	0.56	75 / 63.8
F10 - R	130.24	PVC / PN10	0.56	75 / 63.8
F11 - R	197.26	PVC / PN10	0.56	75 / 63.8
F12 - R	485.86	PVC / PN10	0.56	75 / 63.8
F13 - R	445.15	PVC / PN10	0.56	75 / 63.8

➢ *The pumping stations*

The choice of the pump which will allow water to be drawn from the borehole and sent to the reservoir requires knowledge of two parameters, namely: the operating flow rate of the borehole and the Total Manometric Head (TMH).

- **Flow rate:** This is the quantity of water necessary for the proper functioning of the installation. This is the operating flow of the drilling. $Q = 10\, m^3/h$.
- **Total Manometric Head (TMH):**This is the energy which will allow the transport of water in the pipes and to raise it to the highest point of the installation. The TMH is the addition of the geometric discharge height ($H_{geo)}$ and the total pressure losses (H_T). thus, $H_{geo} = Cr - (C_{sp} - DL)$. With Cr: discharge rating; C_{sp}: Rate of pumping station.

➢ *Calculation of total pressure losses*

The total pressure losses (H_T) are obtained using the Manning Strickler formula (8):

$$\mathrm{H}_T = \frac{10.29 \times Q^2}{Ks^2 \times D^{\frac{16}{3}}} \times L \qquad (8)$$

With Q: flow rate passing through the pipe in m^3/s; L: length of the pipe in m; Ks: roughness coefficient and D: pipe diameter in m.

Note that the sum of linear and singular pressure losses makes it possible to obtain the total pressure losses. For the calculation of the total pressure losses, we consider that the singular pressure losses are worth 10% of the linear pressure losses, the Manning Strickler formula is then written (9):

$$\mathrm{H}_T = \left(1.1 \times \frac{10.29 \times Q^2}{Ks^2 \times D^{\frac{16}{3}}} \times L\right) \qquad (9)$$

Where Ks = 115 for PVC pipes at the network level.

H_{geo} and $H_T$having been found, we calculate the TMH for each pipe.The calculation of the hydraulic power of the pump is given by formula (10):

$$Ph = \rho \times g \times Q \times TMH \qquad (10)$$

With: Ph: hydraulic power of the pump in Watts; ρ: density of water = 1000 kg/m^3; g: acceleration of gravity = 9.81m/s^2; Q exp: Borehole operating flow rate in m^3/s.

The calculation with the values of ρ, g, Q, TMH cited above allows us to obtain the Ph of each installation and we present the values in a table 10.

Table 10: Characteristics of discharge stations

Pipes	Pumps	Length (m)	Speed (m/s)	HT (m)	Hgeo (m)	TMH (m)	Q (m^3/h)	Ph (kW)
F1 – R	P1	41.46	0.56	0.11	155.8	156	10	1.8
F2 – R	P2	197.28	0.56	0.53	162.8	163	10	1.9
F3 – R	P3	464.85	0.56	1.25	192.8	194	10	2.2
F4 – R	P4	71.21	0.56	0.19	156.8	157	10	1.8
F5 – R	P5	182.44	0.56	0.49	157.8	158	10	1.8
F6 – R	P6	132.06	0.56	0.35	154.8	155	10	1.8
F7 – R	P7	100.16	0.56	0.27	156.8	157	10	1.8
F8 – R	P8	205.58	0.56	0.55	155.8	156	10	1.8
F9 – R	P9	243.57	0.56	0.65	157.8	158	10	1.8
F10 – R	P10	130.24	0.56	0.35	155.8	156	10	1.8
F11 – R	P11	197.26	0.56	0.53	154.8	155	10	1.8
F12 – R	P12	485.86	0.56	1.31	189.64	191	10	2.2
F13 – R	P13	445.15	0.56	1.20	170.06	171	10	1.9

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The choice of pump will be based on the Grundfos pump range. This type of pump was favored because it is a robust pump and available on the market with, above all, easy access to spare parts.

➢ *Design of distribution network sizing*

This distribution network is made up of distribution points or Standpipes (SP). Their number of SPs to meet the water needs at the University of Kinshasa until 2035 is 12 distributed in the area taking into account the AEP (Drinking Water Supply) standard which provides for: 500 people per SP within a radius of 500m.The SPs will be sized assuming that a SP operates for a time (TSP) of 12 hours per day with a specific consumption (Cs) of 24 l/d serving a population of 500 inhabitants. The flow rate(Q_{SP}) to be supplied to the SP can be calculated by the following formula (11):

$$Q_{SP} = \frac{Cs \times 500}{3600 \times TBF} = 0.2\,\frac{l}{s} \tag{11}$$

To this distribution flow we add 0.28 l/s coming from the population of the second category (Students and members of the university); which gives a total distribution flow rate equal to 0.48 l/s which will be distributed equitably to the 12 SPs for the dimensioning of the network.As for the distribution pipes, their distribution flow rate is calculated on the basis of a peak hour flow rate $Qmax = 23.9\ m^3/s = 6.6\ l/s$.The flow rate of 6.6 l/s will be considered for the rest of the calculations. The characteristics of the distribution pipes are recorded in the summary table 11 below.

Table 11: Characteristics of distribution pipes

Sections	Length (m)	Flow rates (l/s)	Flow rates (m^3/s)
SP12 - B11	183.26	0.55	0.00055
SP11 - B10	427.04	1.1	0.0011
SP10 - n6	457.73	1.65	0.00165
SP9 - SP8	268.71	0.55	0.00055
SP8 - SP7	304.79	1.1	0.0011
SP7 - n6	131.41	1.65	0.00165
n6 - SP6	140.18	3.3	0.0033
SP6 - n5	566.88	3.85	0.00385
SP1 - n5	98.21	0.55	0.00055
n5 - n2	102.78	4.4	0.0044
SP5 - SP4	650.56	0.55	0.00055
SP4 - n4	234.83	1.1	0.0011
SP3 - n4	398.05	0.55	0.00055
n4 - n3	328.17	1.65	0.00165
SP2 - n3	483.88	0.55	0.00055
n3 - n2	403.98	2.2	0.0022
n2 - n1	94.16	6.6	0.0066
n1 - CH	219.59	6.6	0.0066

The satellite image below (fig. 3) shows us the aerial view of the Drinking Water Supply System (WSS) Diagram.

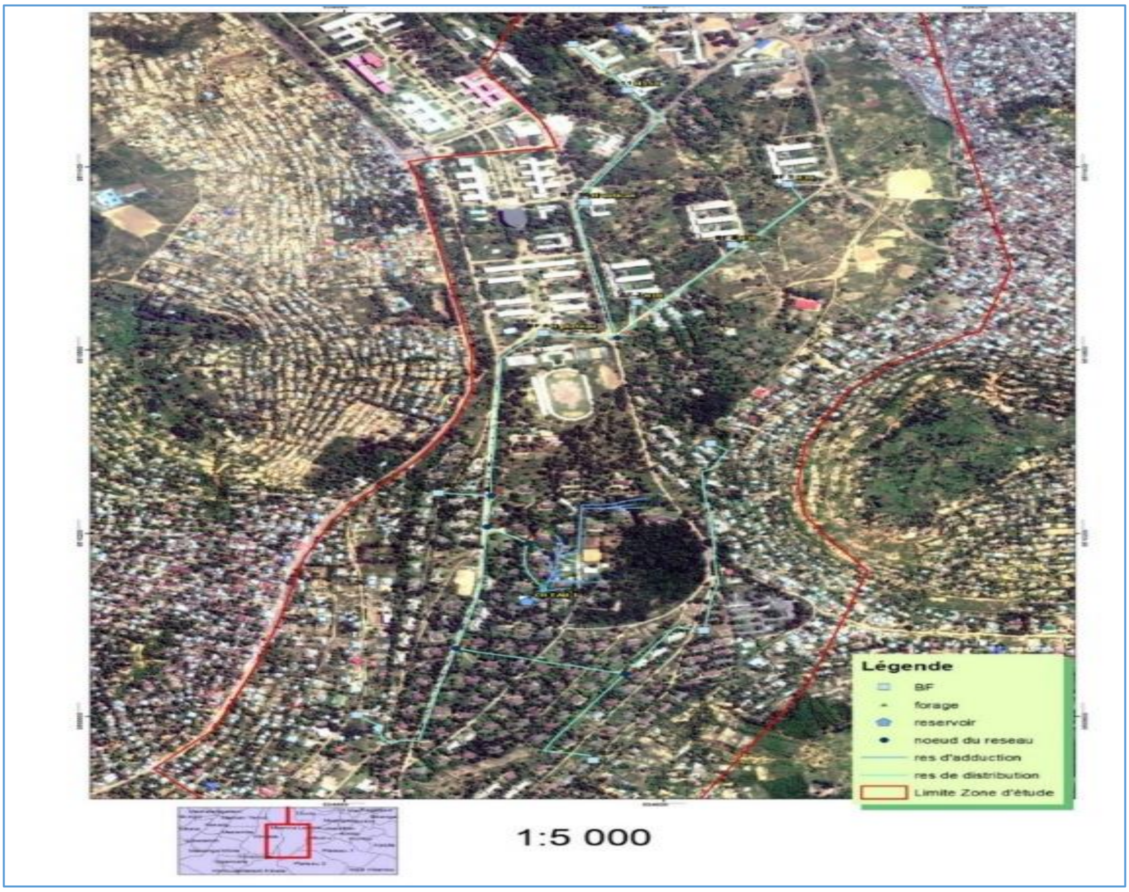

Fig. 3: Diagram of the WSS for the Plateau des Résidents

III. CONCLUSION

The production and distribution of water in Kinshasa remains essentially ensured by the Water Distribution Authority (REGIDESO) despite the liberalization of the sector almost 5 years ago. However, certain districts of the City of Kinshasa are still facing problems with drinking water supply for several decades. This is particularly the case for the Plateau des Résidents of the University of Kinshasa. This work has the advantage of proposing a possible solution which consists of a Drinking Water Supply System (WSS) from boreholes using Epanet software. Given that the network will be designed for a period of 15 years, we were then able to estimate the future population of the Plateau des Résidents at 5508 inhabitants, its consumption corresponding to 319.58 m^3/day (i.e. 319,586 liters/day) and the average future flow estimated at 3.69 liters/second. Regarding the characteristics of this WSS, it should be noted that the discharge pipe has a diameter of 125 mm (DN 125).As for the distribution network, it is made up of distribution points or Standpipes (SP). The number of standpipes to meet the water needs at the University of Kinshasa until 2035 is 12 distributed in the area taking into account the AEP(Drinking Water Supply) standard which provides for: 500 people per SP within a radius of 500 m.

REFERENCES

[1]. A.G.T.M« Les stations de pompage d'eau »Lavoisier, tec. Et doc. Paris, 1994 ;
[2]. Association française pour l'étude des eaux « fiabilité de la distribution d'eau potable- l'entretien des réseaux d'eau » centre national de documentation et de l'information sur l'eau ;
[3]. BONIN J. « hydraulique urbaine appliquée aux agglomérations de petite et moyen importance » EYROLLES, paris 1997 ;
[4]. BRIERE F.G « distribution et collecte des eaux » Ecole Polytechnique, Montréal, 2000 ;
[5]. CASTANY.G., Principes et Méthodologie de l'Hydrogéologie, Paris Dunad, 1982, p.90-130 ;
[6]. CELERIER J.L et FABY J.A « la dégradation de la qualité de l'eau dans le réseau » FNDAE- office international de l'eau, document internet 98p ;
[7]. DEVRED (1959) La végétation de la Ville de Kinshasa ;
[8]. GOFFAUX (1990) : notion de climatologie, sprKinshasa, p241 ;
[9]. JEAN- LOUP ROBERT « hydraulique urbaine : département génie civil »ph. ING 2004 ;
[10]. MAC DONALD A. et al., 2005 developing groundwater: a guide for rural water supply. Bourton on dunsmorepractical action publishing;
[11]. POF JACQUES BONVIN « hydraulique urbaine : captage- réseaux d'adduction- réservoir- pompes- petites centrales hydrauliques » tome 1 département EC+G 2005.