TAPPING OF A SPRING
Based on a deep tapping (aquifer drawdown) carried out in the Dominican Republic

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INTRODUCION

A **spring** is the natural surface discharge of an underground water source; the discharge can be through a single outlet or seepage.

Reasons for tapping a spring:

- To protect the water discharge from external pollution (focused on water quality);
- To collect the maximum of the water available (focused on quantity of available water);
- To make water easily accessible to users (focused on water access).

Advantages of tapping a spring:

- The water, if correctly tapped, is <u>immediately drinkable</u> (potable).
- Springs are often <u>traditional water supply points</u>.
- The spring output is <u>continuous and regular</u> (perennial springs).
- Downstream of the tapping, <u>the site can be developed to improve the water supply point and maximize this resource</u>: ·
  - using gravity to supply water and bring users closer to the water (stairs to make water access easier if supplying by gravity is not feasible), ·
  - installing a storage tank to maximize the water available during peak hours, if the output is insufficient, ·
  - adding fountains for hygienic and convenient water distribution, ·
  - providing troughs, washtubs and other water maximization facilities.

SPRING TAPPING – GENERAL INFORMATION

* Before deciding to tap a spring, in-depth terrain and community studies will have to be conducted in order to learn the characteristics of the spring and the surrounding area (type of discharge and aquifer, flow and perenniality of the spring, water quality and contamination risks, topography, etc.).

It will also be necessary to find out the population's needs and customs (census, surveys, water usage, meetings with the elders who have known the spring for a long time, etc.), in order to build a facility suited to their needs and that will last (a facility that will be welcomed and appropriate, etc.).

* Regardless of the type of tapping considered, it will have to be built with the utmost care. In fact, it is the "head" of the water supply facility and if it deteriorates, the remaining downstream installations will no longer be useful (too often we see "beautiful" supply facilities that are no longer functioning because the tap is not working).

Optimum protection of the tap and the surrounding area is vital to limit the risks of erosion as much as possible. It is often necessary to closely manage this part of the project because the community often loses interest once the tapping is completed.

"AQUIFER DRAWDOWN" TAPPING

Aquifer drawdown

Near outlets, springs or working wells, the aquifer is depressed: that depression is called a "drawdown" and corresponds to a water speed increase in the aquifer. As a result, the piezometric surface bends towards the outlet.

For a well, the drawdown depends on the outlet output: the more the water is pumped out, the more the aquifer drawdown value increases. (see Water and Sanitation 1.6.1. *Les puits* [wells], Figure on page 6).

Increased drawdown during spring tapping

The flow rate of a discharge depends on the aquifer permeability and the piezometric surface slope (or hydraulic gradient). Therefore, as the drawdown is increased in the spring (by lowering the tap level), the flow rate is also increased because of the greater hydraulic gradient value in the aquifer.

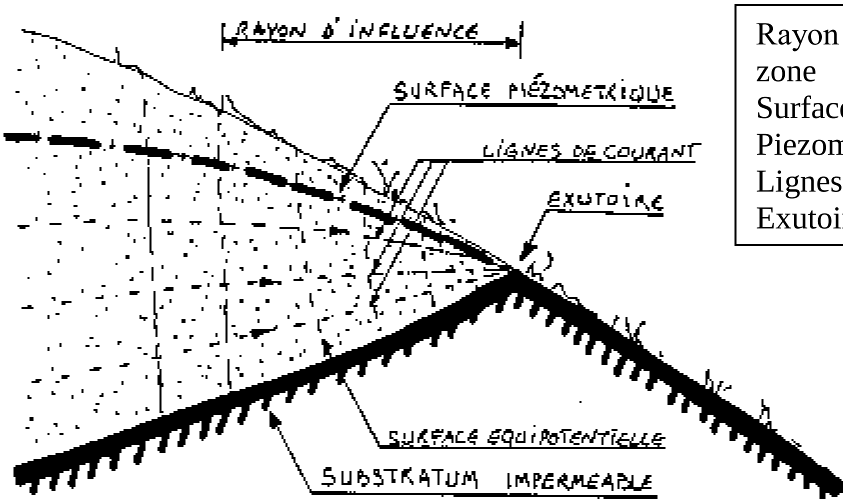
It is often a good idea to tap a spring at a lower level than its natural discharge; the aquifer productivity can thus be increased.

Furthermore, deep tapping of a spring ensures water quality by decreasing contamination risks by surface waters.

Another advantage of this method is to reduce the possibilities of the tap being bypassed; by lowering the discharge, the water seeks the tap as the preferred outlet rather than seeking another exit point.

This technique is risky for springs fed by a limited volume aquifer (springs which output is affected by important seasonal variations). An increase in the output discharge could cause the aquifer reserve to run dry before the end of the dry season. Before lowering the tap level of small local springs, their seasonal perenniality must be closely studied.

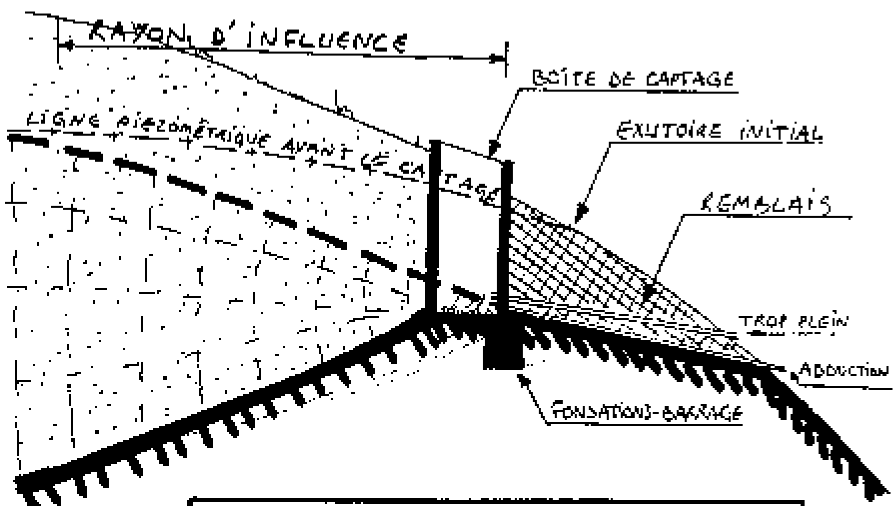
However, in the case of seeping springs, this is the best technique since it allows for good drainage and for directing the greatest number of rivulets towards the collection chamber. Lowering the discharge point increases the influence zone at that point (see Figure 1 below).



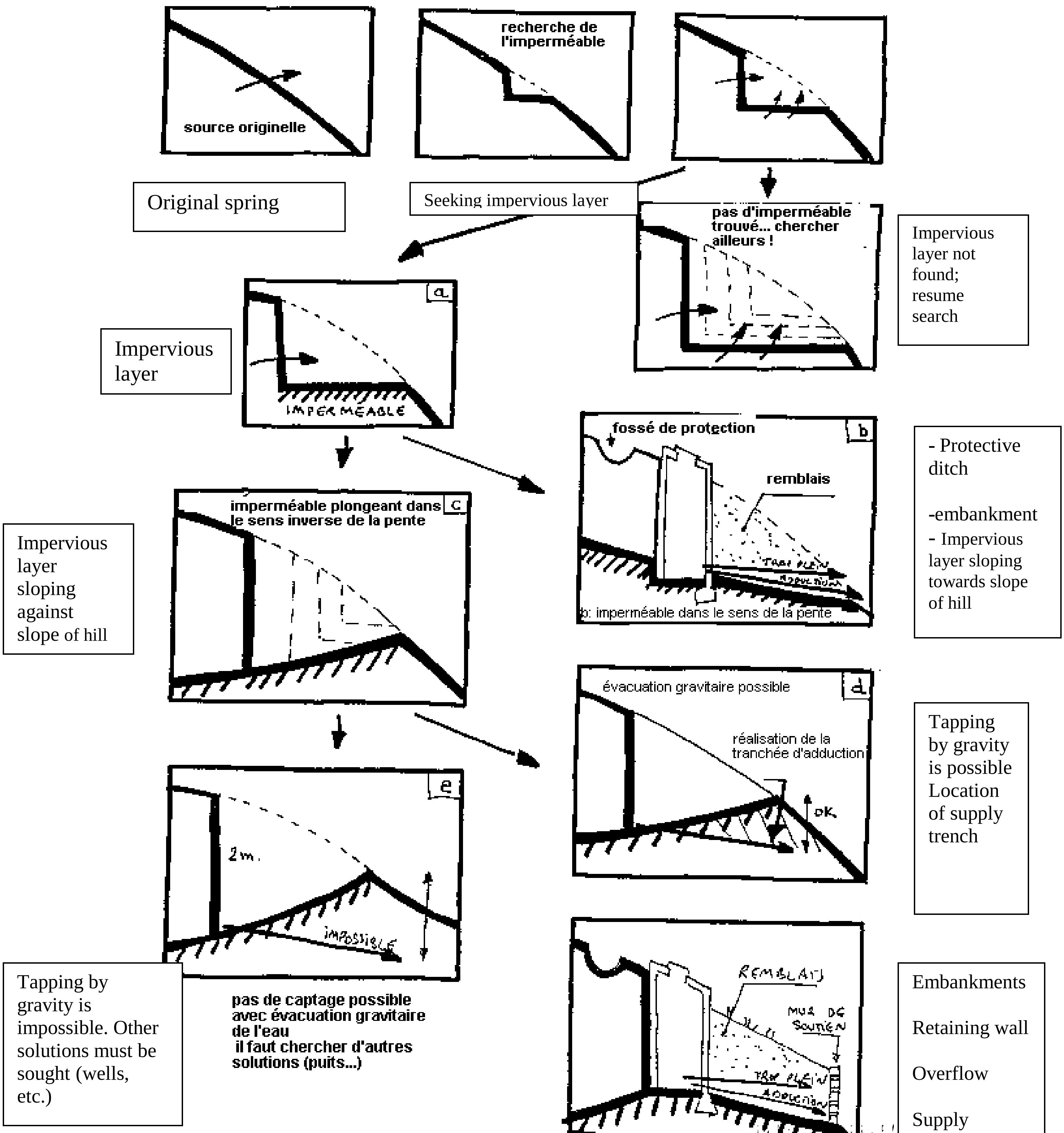
Rayon d’influence: Influence zone
Surface piézometrique: Piezometric surface
Lignes de courant: Stream lines
Exutoire: Outlet

Surface équipotentielle: Equipotential (level) surface

FIGURE 1-ⓑ



Rayon d’influence: Influence zone
Ligne piézométrique avant le captage: Piezometric line before tapping
Boîte de captage: Collection chamber
Exutoire initial: Initial outlet
Remblais: Embankments
Trop plein: Overflow
Adduction: Supply
Fondation-barrage: Dam foundation


source originelle
Original spring
recherche de l'imperméable
Seeking impervious layer
pas d'imperméable trouvé... chercher ailleurs !
Impervious layer not found; resume search
a
IMPERMEABLE
Impervious layer
b
fossé de protection
remblais
TROP PLEIN
ADDUCTION
b: imperméable dans le sens de la pente
- Protective ditch
-embankment
- Impervious layer sloping towards slope of hill
c
imperméable plongeant dans le sens inverse de la pente
Impervious layer sloping against slope of hill
d
évacuation gravitaire possible
réalisation de la tranchée d'adduction
OK.
Tapping by gravity is possible Location of supply trench
e
2m.
IMPOSSIBLE
pas de captage possible avec évacuation gravitaire de l'eau
il faut chercher d'autres solutions (puits...)
Tapping by gravity is impossible. Other solutions must be sought (wells, etc.)
REMBLAIS
MUR DE SOUTIEN
TROP PLEIN
ADDUCTION
Embankments
Retaining wall
Overflow
Supply

TAPPING

1. **Exploratory excavations**

During the initial site survey, vegetation is removed and the area around water discharges are cleared. During cursory excavations, superficial ground is removed (soil, alluvial deposits, embankments, etc.). The goal is to channel the rivulets and to measure the flow (a small trench will need to be dug downstream to evacuate the water).

Once changes have been made to the site, the spring is observed for a few days in that state.

At this time, it is important to find the actual discharge point, which is often located upstream of the visible discharge. This is especially true if the spring was not used by the population.

2. **Tapping**

If the decision is made to tap the spring following the observations above and the initial site survey (flow meeting the needs, perennial spring reported, etc.), the tapping excavations are scheduled (preferably during dry season). These excavations will modify the site and large quantity of soil will have to be moved. It is important to proceed step by step (often taking several days to do so) in order to identify the aquifer and the impervious substratum[1] and to evacuate the water permanently (**be careful not to put a load on the discharge**). The goal is to deeply anchor a collection chamber that will drain the area slowly, in the same manner that a well "dewaters" from the bottom. (See Figure 3 on next page.)

Figure 2 drawings (above) shows the various steps to tap a spring depending on the conditions.

Starting from the discharge, the first step is to dig a trench on the slope, approximately 50 centimetres wide, that will be gradually deepened as the search for the impervious layer is carried out. Retrace the paths of rivulets if they are flowing from upstream. Deepen the trench if water accumulates at the bottom. During this step, it is important to evacuate the water rapidly. No two springs are alike; there is no magic solution. Study the materials extracted, the flow of the spring, etc.

If the substratum is not found, search downstream or upstream (the discharge could be hidden by fallen rocks, for example). It may be an impossible to find! It is the case for springs seeping over a wide area.

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[1] The impervious layer is not always easy to identify, as it is not always a hard rock. It could be made up of material that is more clayey, more compact, less altered. In other words, less permeable than the aquifer, which is usually located above (except in the case of confined ground water).

FIGURE 3↓

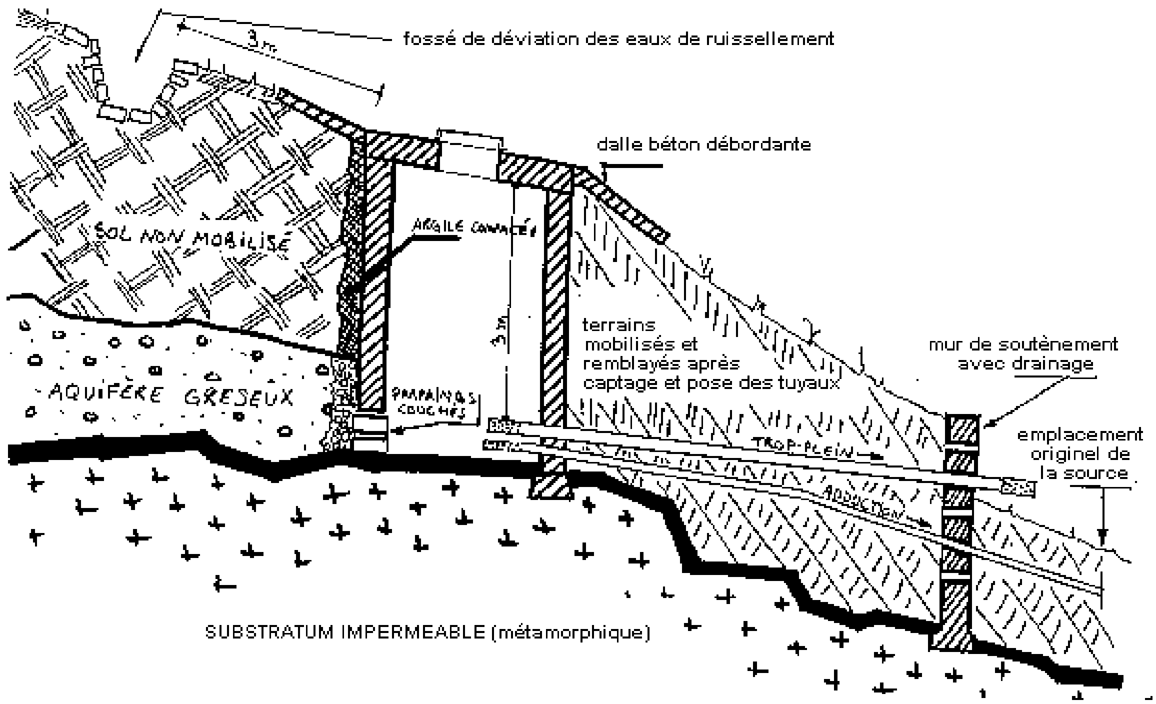

Figure 3 captions:

fossé de déviation des eaux de ruissellement: Runoff diversion ditch
dalle béton débordante: Oversized concrete slab
sol non mobilisé: Untouched soil
aquifère gréseux: Sandstone aquifer
substratum impermeable (métamorphique): Impervious substratum (metamorphic)

terrains mobilisés et remblayés après captage et pose des tuyaux: Soil replaced after tapping and pipes installation
trop plein: Overflow
adduction: Water supply
mur de soutènement avec drainage: Retaining wall with drainage
emplacement originel de la source: Original location of spring

If the impervious layer is found, follow the rivulets, which will appear on the side of the trench, upstream. Keep on digging (*see Figure 2, Drawing a*) until sufficient depth is achieved (greater than 2 meters) to ensure a reliable quality of the tapped water.

The best condition is when the impervious layer is horizontal or follows the slope of the hill (*see Figure 2, Drawing b).*

If the impervious layer slopes against the slope of the hill (*Figure 2, Drawing c*), the collection chamber can still be built if the downstream topography allows it (*Figure 2, drawing d*). If that proves to be impossible, other solutions will have to be sought (*Figure 2, Drawning e*).

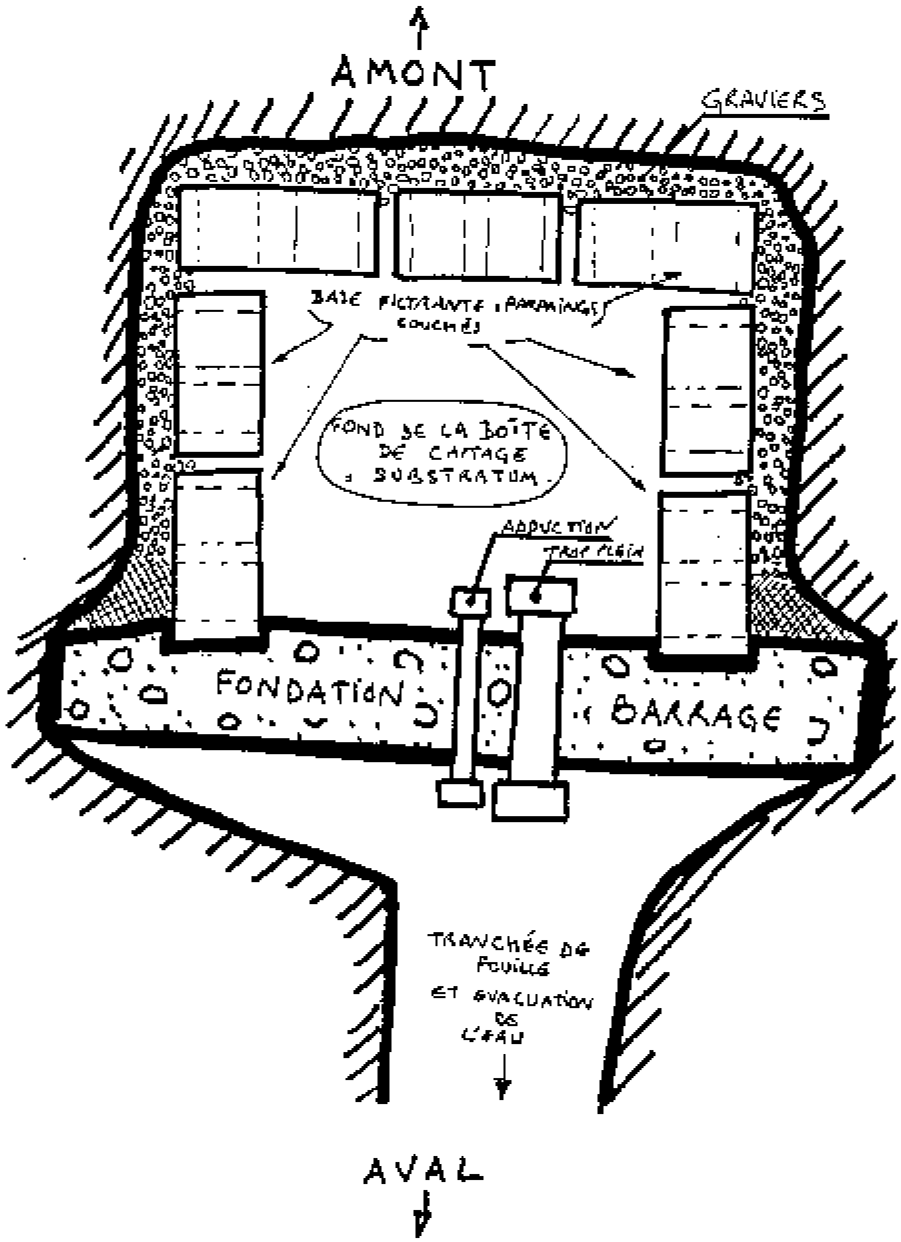

FIGURE 3 *bis* captions:

amont: Upstream
graviers: Gravel
base filtrante, parpaing couchés: Filtering base, laid down perpend
fond de la boîte de captage, substratum: Bottom of collection chamber, substratum
adduction: Supply
trop plein: Overflow
tranchée de fouille et évacuation de l'eau: Exploratory and evacuation trench
aval: Downstream

3. **Building the collection chamber**

Once the appropriate depth has been reached on the slope (maximum draining water, the terrain does not allow to go further), the trench is widened where the collection chamber will be located. The width of the excavation depends on the terrain and the water discharge; it also determines the size of the collection chamber, which must be at least 1 sq m to allow for its inspection. If the aquifer drawdown is correctly carried out, every rivulet will flow towards the chamber; the outlet influence zone thus created will then drain the entire area.

If required (in the case of springs seeping over a wide area), additional deep transversal drains to the collection chamber can be installed.

Once the site has been excavated and the substratum at the bottom is well exposed, a transversal trench is dug in the downstream portion of the excavation in order to properly anchor the foundation of the chamber (a foundation that will act as a dam, see Figure 3 and 3 *bis*). Concrete (lean and leak proof concrete) is poured in the bottom of the trench and the foundation is built up to approximately 15 centimetres from the bottom of the chamber. Two galvanized "nipples" are placed in the concrete: one for water supply, 5 to 10 centimetres above the bottom of the chamber; the other, just above, for the overflow[2] (the diameter will depend on the expected flow and must be sufficient to prevent water from accumulating in the chamber, which must always be empty). The nipples and the first few meters of the supply pipe must be placed in an angle (> 5%) to ensure that the tapped water is properly evacuated.

On the sides and upstream part of the collection chamber, a filtering base is built (non-contiguous stones or laid perpend). The space between the aquifer and this base is filled with gravel (see Figure 3 *bis*).

On top of the base, four blind walls are raised to the top of the chamber. Once the supply and overflow pipes are installed, the trench is filled with available material. The perimeter of the collection chamber (above the level of the aquifer) is filled with clay to the top to prevent superficial water infiltration.

The collection chamber is covered by a reinforced concrete slab (angled), which has an inspection hatch (*see Figure 3*). Access to the collection chamber is necessary to facilitate its maintenance. The tap, if cleaned regularly, will not fill with clay, silt, rootlets and roots that inevitably collect.

The bottom of the collection chamber is covered with a layer of well-washed gravel. Before it is put in service, the chamber is disinfected.

[2] See Water and Sanitation 1.3.5 *Les trop-pleins* [overflow]

4. **Protecting the tapping**

Once the area around the tapping has been backfilled and levelled (gentle slope) to prevent surface water stagnation, the area is seeded (grass) or lined with stones.

Then, installations to protect the "head" of the work are built to ensure a long life.

Nothing is spared! It is better to overestimate the risks of erosion; the combined effects of water and time are always significant, not to mention risks of flood and cyclone.

In several cases, embankments will have to be stabilized with retaining walls, which must be equipped with drains.

Streams and gullies must be carefully protected (wire baskets retaining wall, diversions, etc.).

Access to the installation must be downstream to prevent runoff from the road.

A ditch must be dug around the tapping area (lined with concrete, if necessary) to collect and redirect runoffs and to prevent erosion. This ditch must be quite wide, with sloping sides, and must completely surround the tapping area.

Animals and all polluting activities (washing, effluents, etc.) must be kept out of the tapping area and influence zone; a fence is the best option.

Users are to be made aware of the importance of protecting the drainage area (afforestation), and if re-timbering is necessary, it can be a cooperative effort.

It is advisable to complete all the work necessary to protect the tapping before tackling the downstream installations (supply, fountain, etc.); it is very difficult to get people to finish the work once they have access to water.

Bibliography: *Le point sur le captage des sources*. 1987 – GRET/AFVP Dossier no. 10

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