Roman Water Systems At Nesausus and Arelate

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The Roman ruins of Nesausas (modern-day Nimes) and Arelate (modern-day Arles) are located in France's Provence region. One popular introduction to the area is the ubiquitous Michelin *Green Guide*. This series of travel guidebooks has always been a fascination because it has the audacity to rate an areas's scenic attractions. The rating system gives *** (3 stars) if a site is "worth a visit", ** "worth a detour", and * for being merely "interesting". Historical water structures do not fair well with the *Green Guide* for Provence.

NESAUSUS

The one exception is Pont du Gard, a massive triple-tiered bridge, which crosses the the canyon of the Gardon River. The bridge was a critical link in the aqueduct system which once supplied water to the ancient Roman city of Nesausas. Pont du Gard rates *** and is flooded by more than 2 million tourists a year.

A colleague and I visited Pont de Gard on May 1, 1997, the french version of Labor Day, and the canyon area was awash with holiday revelers; finding parking was difficult. There were canoers, waders, sunbathers, picnickers, and swimmers in and along the Gardon River. The footbridge adjacent to the Roman bridge was covered with promenaders.

Despite the distractions of the crowds, I was amazed by what Roman engineers and builders had accomplished over 20 centuries ago. Pont du Gard is so large (160 feet high) and a such a dominant presence in the canyon, it's a monumental testimonial to the importance that the Romans placed on having large quantities of healthy drinking water.

The bridge is constructed of stone blocks, some weighing as much as a 6 tons, which were placed without mortar. According to the *Green Guide*, "The stone was lifted into position by block and tackle, with goats [the machine not the animal] as auxiliaries, and a winch controlled by a human-powered treadmill."

Finding and transporting high-quality water to Nemausus was not easy. The nearest source was a spring located near Ucetia (present-day Uzes). The direct route, a distance of 20 kilometers, is a difficult terrain of rolling hills and deep gorges. It would have required an impossibly-long, eight-kilometer tunnel. (Many centuries would pass before tunnels of that length could be constructed.) A detour to the west was out of the question, again because of hills. The only reasonable water course was a U-shaped detour to the east, a route which avoided many of the obstacles and allowed the aqueduct to be constructed on grade (see Illustration 1).

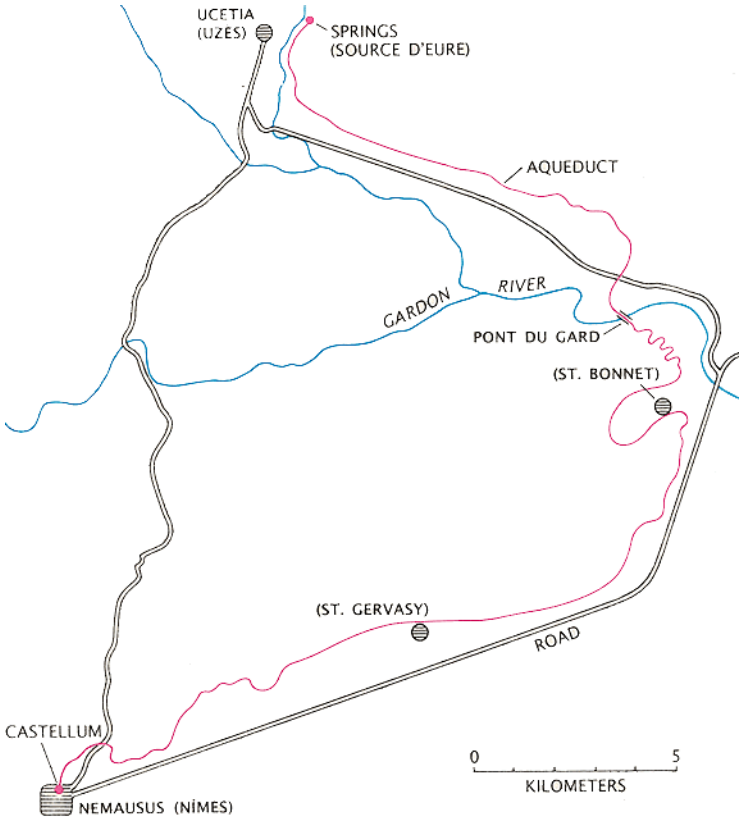


Illustration 1. Route of the aqueduct (red) began at the springs near present-day Uzes. From there it followed a 50-kilometer path to present-day Nimes (drawing from Scientific American).

One of the toughest problems was the relatively low elevation of the springs at Ucetia: a mere 17 meters above the entry to Nemausus. While designing tunnels and bridges to contend with forbidding obstacles, the designer--whose tools included only primitive levels, abaci, wax tablets, and the human brain--would also have to find a way to maintain a slight slope of no more than 0.34 meters per kilometer in the channel. Such a gradient is imperceptible to the human eye; a small error would have spelled disaster.

The U-shaped route avoided many of the obstacles, but this required the aqueduct to be 50 kilometers long, and it needed to cross Gardon Canyon, located about halfway between Ucetia and Nemausus. Thus the need for Pont du Gard (see photograph 1).

Some have described Pont du Gard as "lacy" in appearance. The bridge is in fact quite sturdy; "monumental" is a better descriptor. Despite its impressive appearance, it is structurally clumsy. The Roman's achieved its great height by the primitive technique of stacking bridges one on top of another in three distinct layers. The span is, however, well balanced; the lower tier is larger and heavier than the middle tier, which in turn is larger and heavier than the top tier, where the water channel rests (see photograph 2).

Modern-day engineers like George Hauck (1986, 1989), have made detailed studies of Pont du Gard and its aqueduct and are impressed with the Roman's overall understanding of engineering principles. For example, the triple-tiered bridge was carefully designed to withstand the canyon's fierce winds and the region's sporadic flash floods.

Water at the aqueduct's terminus flowed into a distribution tank *(castellum)* located in Nemausus, where it was distributed throughout the city in lead pipes. The system provided enough culinary water for the city's 50,000 inhabitants.

The *castellem* has been restored (see photograph 3), and with a little effort my colleague and I located it on a narrow street near downtown Nimes. Here there were no crowd; we were alone, except for an occasional passerby.

The *castellem*, while mentioned in the *Green Guide*, does not warrant any *'s. I guess you have to be an engineer to care about a relatively small circular tank. A few blocks away is a Roman attraction which rates ***, a beautifully-preserved Roman amphitheater.

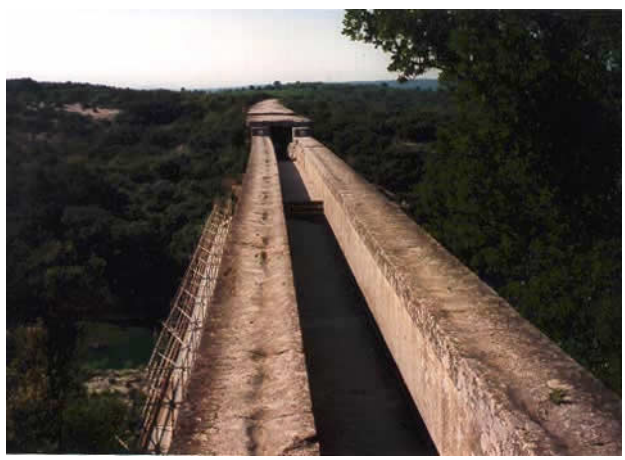
The oval amphitheater is one of the most important in southern France. In Roman times, the action inside the arena was brutal, bloody, and frequently involved conflict between some combination of gladiators and animals. While the exotic African animals were reserved for Rome, that did not preclude the use of bulls, bears, and boars in the Nemausus amphitheater. While the Roman water system represents a higher level of civilization, the amphitheater represents something far baser.

Circumstantial evidence indicates that the Nesausus aqueduct was built in 19 B.C. by Marcus Agrippa, a lifelong friend and colleague of Caesar Augustus. In addition to being a military and administrative genius, Agrippa was a brilliant engineer. He was the chief designer of many public works in the Roman Empire, water-supply systems in particular. He is known to have been in or near Nemausus at the time.

The Roman ruins in the Nimes' area have had a difficult history. For example, the Nemausus aqueduct was breached every time the city was besieged. After the 4th century A.D., with the fall of the Roman Empire, the aqueduct ceased to be maintained and lime deposits started to clog the water channel. Finally, by the 9th century, the course was blocked and the aqueduct fell into disuse.

Pont du Gard suffered greatly during the Middle Ages. It was during this period that someone had the less-than-brilliant idea to narrow the second tier of pillars to make a road across the bottom tier. The ill-conceived roadway remained in use until an adjacent road bridge was constructed in 1740. Pont du Gard was not adequately restored until 1855, when the emperor Napolean III had the structure repaired. Today Pont du Gard is a world historical site and UNESCO, an agency of the United Nations, has made additional repairs.

Photograph 1. Pont du Gard carried drinking water across the Gardon River Canyon to the ancient Roman community of Nemausus, modern-day Nimes.



Photograph 2. The water channel on top of Pont du Gard was covered to prevent contamination and solar heating.

ARELATE

East of Nemausus, straddling the Rhone River, was the Roman city of Arelate. It too had an aqueduct system,

one which imported water from the distant Alpille Range. The aqueduct system was double channeled (see photograph 4). One channel provided water to power a flour-mill complex at Barbegal (located near Arelate), the other provided culinary water to Arelate.

Barbegal is an example of something, according to some "experts", that never existed: an ancient Roman, water-powered factory. According to modern-day classicist A. Trevor Hodge, "Barbegal is significant because it calls into question the 'technology theory' of the decline and fall of the Roman Empire. The theory maintains that the availability of cheap slave labor prevented the Romans from developing alternative sources of power, without which large-scale manufacturing is impossible."

My *Green Guide* had a brief description of Barbegal, but the site warrants no *s, a sure sign my colleague and I were not headed to a tourist trap. At the point where the aqueduct crosses the road, we left the rental car and hiked 300 meters along the ruins of a double line of arches. Soon I arrived at the fork where one channel makes a 90-degree turn, but the second proceeds straight, slicing through a rock ridge. The aqueduct with the rock cut flowed straight to ruins of an adjacent flour mill. The channel with the 90-degree turn provided water to Arelate.

In ancient times, once in the city, water was distributed from a central *castellum*s to latrines, baths, a few private homes and, of course, fountains. There were fountains aplenty in Roman cities. Many Roman fountains were beautiful, and they were constant subjects for Horace and other poets. But the aesthetic appeal was secondary; the practical Romans built their fountains mainly for functional purposes. They were an important water dispensing apparatus and could provide an important air-conditioning effect during hot summer days.

Photograph 3. This circular tank (castellum), located at the terminus of the Nemausus (modern-day Nimes) aqueduct. The holes were for lead pipes which distributed water throughout the city.

Photograph 4. This aqueduct provided water to a Roman mill at Barbegal and to the city of Arelate (modern-day Arles).

CONCLUSION

It is impossible to tour the countryside around either Nimes or Arles without being impressed with the remarkable energy that the Roman infused into their water systems. The Roman lifestyle required large quantities of

high-quality water.

REFERENCES

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