
RESEARCH ARTICLE

Thermal Sustainability: Renovation of Imperial Thermae in Late Antiquity

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Architectural sustainability was a time-honoured practice in the ancient world, seen through evidence of cyclical repair, renovation, and restoration of essential infrastructure. In so doing, the resilience of monuments and by extension, of cities themselves, was guaranteed into the long term.

Thermae, or baths of extraordinary size, were erected during the Roman Empire's ambitious Imperial period. In the wake of the social and economic upheavals of the 3rd century, however, most of them became redundant by the 4th. But against the odds, a select group of Imperial-period baths continued to provide bathing facilities to the public throughout this turbulent period. Archaeological evidence reveals their transformation into 'summer baths', of which a few survive. Through their sustainability — a phenomenon confirmed by evidence of substantial repair — a narrative of resilience may be recorded.

This article relies on the surviving archaeological material of these ruins — in particular, their campaigns of renovation — to argue not only for a rationale of sustainability in the ancient world, but also to introduce the concept of architectural resilience as a practice as old as the profession of building itself. While spoliated inscriptions and contemporary authors identify 17 summer baths in the Late Roman world, the five surviving structures in Sbeitla (Tunisia), Thuburbo Majus (Tunisia), Madaurus (Algeria), Fordongianus (Sardinia), and Aphrodisias (Turkey) bear witness to an understanding of thermal sustainability in Late Antiquity that prioritized conservation of heating and water resources, attuned bathers' activity to climate, and maintained these civic centres as sites of cultural and aesthetic value.

History of Late Antique Summer Baths

Although widely considered a modern phenomenon, architectural sustainability was a time-honoured practice in the ancient world. The time and investment dedicated to building repair, renovation, and restoration — or one might say, to making architecture resilient — were serious measures in antiquity, a fact frequently overlooked by historians in favour of connoisseurship of single-phase foundations. For not only did these endeavours extend the lives of monuments and reify their importance, but doing so increased the cultural capital of the cities to which the great buildings belonged (Brogiolo and Ward-Perkins 1999; Parrish and Abbasoğlu 2001; Mass 2005: 89–90; Webb 2009: 156; Dally and Ratté 2011; Raja 2012: 49). While initial construction was certainly the product of significant investment and concern, ensuring buildings' viability in the long term was equally important: an end cities took great pains to achieve. From this perspective, monumental architecture was distinguished not only by its being built, but also by having its long-term function and resilience guaranteed. In the act of renovation, the legacy of a city was secured into the foreseeable future.

Among the building types considered indispensable to Roman cities were *thermae*, bathing complexes of great

size. They were erected during an ambitious programme of urban monumentalization across the empire during the Imperial period (1st century BCE to 3rd century CE), when cities modelled themselves after Rome (**Figure 1**). For these Imperial baths especially, maintenance proved a significant challenge due to their enormity and dependence on vast quantities of water and fuel. Indeed, by the 4th century, many of these foundations were abandoned in the wake of extensive social and economic upheaval in the 3rd century, having already diminished in size due to uncertain fuel supplies, exorbitant heating costs, and restricted water usage because of ageing, failing aqueducts (Van Sickle 1938: 10). Other baths still in use by the 4th century were summarily converted to alternative, light industrial use, as they could no longer continue to fulfil their intended function. These transformations included conversion into churches; prisons; and pottery, glass, and metal workshops, as their impressive structures proved conducive to both incarceration and spiritual refuge, and their furnaces and water conduits useful for firing and smelting facilities (Bouras 2002: 525–26; Berger 1982: 1–172; Mango 1982: 338; Karpozilos et al. 1991: 271; Russell 2002: 221–28; Lavan and Sarantis 2007: 156 and 307). In far more numerous cases, *thermae* were left to decay by cities no longer able to maintain them for any useful purpose.

But amid a seeming trajectory of decline across the Roman Empire (Gibbon 1789), select *thermae* were transformed during the 4th to 6th centuries into a type known

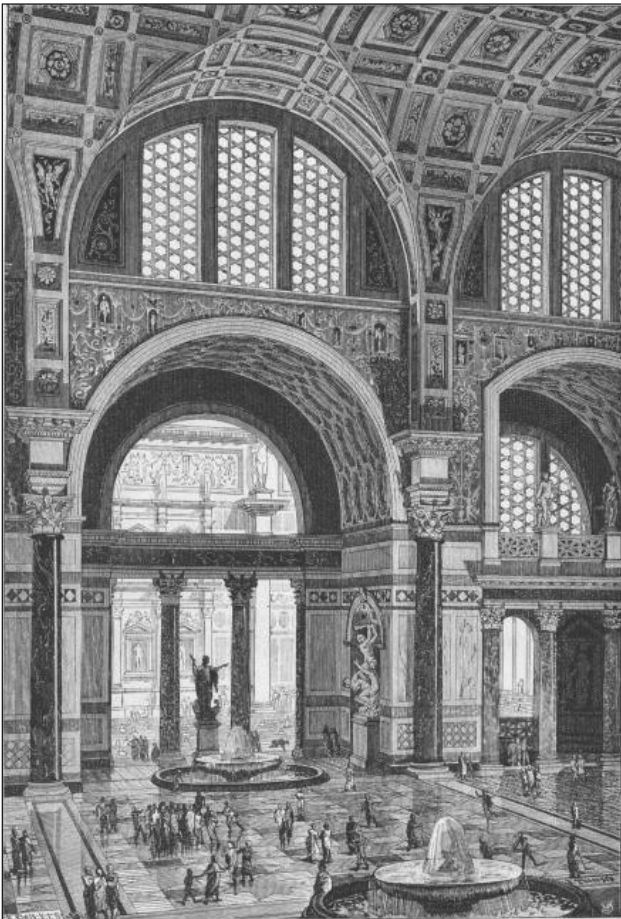


Figure 1: Frigidarium of the Roman Baths of Caracalla, 217 AD. Artist's rendition, 1901. The New York Public Library Digital Collections.

as 'summer baths', of which a few survive. Such facilities would have been used only during temperate months of the year.¹ While 17 summer baths across the Late Antique empire have been identified by spoliated inscriptions and contemporary authors (Saliou 2004), only five remaining structures are known for certain: in Thuburbo Majus and Sbeitla (Tunisia), Madaurus (Algeria), Fordongianus (Sardinia), and Aphrodisias (Turkey). These baths represent multiple aspects of resilience: in the architecture of the baths themselves, because, in spite of decay, they were sufficiently intact to be restored for use in the Late Antique period; in the thermal sustainability and energy efficiency of these restored baths; and also in the practice of bathing – continued, though altered, for several centuries – into the early Byzantine period. The use of these baths was a defining characteristic of *Romanitas* – what it meant to be Roman. This article presents an account of these aspects of sustainability embodied in the summer baths. It illustrates how these five thermae were modified and demonstrates how sequential planning decisions that sustained such bathing establishments constituted both physical and cultural resilience. By investigating how urban planners and builders in Late Antiquity deliberated issues of siting, structural and spatial alteration, and decorative enhancement, the article also illustrates the palpable sense of duty felt by Late Antique urban philanthropists,

whose patronage ensured the baths' longevity. The architectural repairs that converted these expansive buildings into smaller, gender-segregated precincts and seasonal spaces – summer baths – reflect a philosophy of architectural resilience manifested through renovation, adaptation, and at times, reinvention.

Roman thermae of the Imperial period were designed to meet the year-round, public bathing needs of a large citizenry and also symbolized civic fortune that, it was assumed, would endure into perpetuity. During this time, seasonal thermal architecture was within the exclusive purview of private, aristocratic, domestic contexts, as in the summer and winter baths of the 3rd-century emperors Gordian III, at the Campus Martius, and Aurelian, at an unidentified location in Rome (*Historia Augusta* Gord. 32.7, Aur. 45.2, in Diehl 1913). In the 3rd century, little structural maintenance was done on public baths and other monumental construction, since not only had the empire's civic architectural needs been met, but crises, including debilitating internecine war and natural disasters, brought construction unrelated to fortification to a halt (Lenski 2002). This stasis in the building sector ended by the mid-4th century, when political and economic stability returned to the empire, and commissions were sponsored to repair and restore buildings considered vital to conservation of the city. Baths were a priority (Van Sickle 1930: 178; Saradi 1995: 37–56). Amid this dynamic landscape of a renewed economy, fiscal responsibility, a Christianizing empire, and upward social mobility, the culture of bathing as practised in the High Empire needed to change fundamentally.

Under these altered conditions, few Imperial thermae continued to function successfully as baths beyond the 4th century. The resilient few that endured did so by adapting their outsized, gender-neutral facilities to suit the needs of a chastened, Christianized, Late Antique society threatened with the dissolution of a long-held custom. To reinvigorate the beloved tradition, civic officials made significant architectural decisions that led to a typology of thermal sustainability.

Late Antique texts, spoliated inscriptions, and the five surviving summer baths – at Thuburbo Majus, Sbeitla, Madaurus, Fordongianus, and Aphrodisias – offer insight into this altered culture of public bathing. While authors such as Evagrius Scholasticus refer to the summer bath as a well-known feature of the 6th-century urban landscape (Bidez and Parmentier 1898, vol. 6: 8), the orator Libanius implies, in *Orationes* XI, that in as early as the 4th, these structures were essential to revitalizing public bathing across the eastern empire, an extraordinary achievement in an era of significant cultural change. His *ekphrasis* on seasonal baths in Late Antique Antioch, one of the premier classical cities of the empire, demonstrates their importance:

And the baths, who would they not please? Some adapted to the winter, others agreeing with the summer, some sheltered from the violence of the wind, others as it were hung in the air and without touching the earth ... For these men ... used it [their wealth] with all magnificence ... taking greater

pleasure in spending for the benefit of the city than others take in amassing wealth ... always enriching the whole city through the enjoyment of baths ... The place is so helpful to the body that, if you leave after even a brief stay, you will go away healthier than when you came ... Whoever has the means to erect a bath on the site of earlier ones does so the more confidently because of these streams, and he does not fear that it may be brought to the point of perfection and then called thirsty because of deficiency of water. (Downey 1938: 652–86).

While Libanius is vague on the architectural form of summer baths, he is eloquent about their recent restoration and adaptation from earlier establishments and in their provision of pleasure to the public. His commentary shows how patronage renewed a longstanding bathing culture amidst – and possibly despite – dramatic social, political, and economic upheaval. Although the seasonal baths he mentions have not yet been attributed to specific excavated remains, Libanius identifies qualities that help to trace the development of this typology, and to identify a period of efflorescence that prefigured the end of large public bathing complexes in the Byzantine era.²

All the baths considered were initially founded during the High Imperial period, and no later than the end of

the Severan dynasty in AD 235 (Thébert 2003, vol. 2: 411; Saliou 2004: 295). During this time, some 53 thermae were built across the empire (Nielsen 1990 vol. 1: 98). The 17 summer baths attested by inscription derive from this group, and their ensuing viability over several centuries was a result of their cities' investment in substantial, recurring campaigns of renovation, many of which were commemorated (Thomas and Witschel 1992: 135–77; Saliou 2004: 301–6) (**Figure 2**). While only 23 large baths appear to have been built *ex novo* between the fourth and sixth centuries, none of the summer baths in this period was a new construction. This fact suggests that not only would there have been significant investment to secure existing foundations, but also that the ritual of public bathing had to change to be viable in Late Antiquity.

Maintaining Vitruvian Tradition: Urban Beauty and Siting in Late Antiquity

Textual descriptions and evidence of repair support an established practice of thermal sustainability in the ancient world. Providing continuity with tradition, the Late Antique orators Libanius and Evagrius imitated their 2nd-century forebears Aelius Aristides and Menander Rhetor in lauding the *kallos* (beauty) of the city, in which baths played a pre-eminent role (Bidez and Parmentier 1898; Rhetor 1856; Downey 1959: 652–86; Lenz 1976). Their



Figure 2: Map of Late Antique summer baths. A. McDavid.

panegyric descriptions underscored the importance of a city's geographic setting and topography, the elegance and clarity of its organization, the perfection of its civic monuments (including temples, basilicas, porticoes, and baths), and the lavishness of its sculptural decoration. Baths, therefore, played a major role in ensuring urban beauty.

All five surviving examples of summer baths – at Sbeitla, Thuburbo Majus, Madaurus, Fordongianus, and Aphrodisias – were situated in the southern or southwestern quadrant of the city centre (Downey 1961: 626–27, Balty 1991: 281–85) (**Figure 3**). This setting certainly had climatic advantages as the sun's transit would mitigate fuel costs of baths and enhance their energy efficiency, in keeping with a Vitruvian criterion, insofar as his theoretical constructs could realistically be accommodated in practice (Vitruvius 1960, I: 2,7; VI: 4,1; V: 10,1). The ideal siting of these early foundations provided a clear rationale for continued patronage, rigorous upkeep, and adaptation to summer facilities. Less favourably sited facilities would not have been as cost-effective, as their long-term heating costs would have been higher. Heated areas of the bath within the well-sited complexes were also oriented towards the southwest, with large window bays facing the east to admit as much light as possible (Broise 1991). At the site of two of the baths under discussion – the Hadrianic Baths of Aphrodisias and the Forum Baths in Fordongianus – are Augustan-era thermal foundations that would reliably have subscribed to Vitruvian building principles (Taramelli 1903; Zucca 1986; Meloni 1990; Mastino 2005; Reynolds 1997: 397–402). Restoring only the environmentally best-positioned baths was a sound economic investment.

Seasonal baths existed in pairs, with one summer and one winter facility located near the city centre (Yegül 1992: 390; Nielsen 1993, vol. 2: 170; Thébert 2003, vol. 2: 153–56). While winter baths were also located near a forum, they were typically situated due east of the city centre, with a far smaller footprint than summer baths, and consisted of comparatively diminutive heated spaces bearing fewer windows. In Late Antiquity, while the far larger, older, and public foundations were converted to summer baths, winter baths, of compact size and in less demand in wintertime, were newly built or were older, privately held foundations that were easily renovated. Inscriptions affirm that Thuburbo Majus, Sbeitla, Madaurus, and Fordongianus possessed both summer and winter facilities. Although it has yet to be confirmed by further research, perhaps the 2nd-century Theatre Baths of Aphrodisias, the urban centre's only other known Roman bath foundation, served as the city's winter establishment in Late Antiquity (McDavid 2015: 183–84). It would likely have been the seasonal complement to the Hadrianic Summer Olympic Baths, which are identified by inscription (Roueché 1989: 137–38).

Inscriptional Evidence of Thermal Sustainability

In addition to Late Antique authorship, onsite building inscriptions attest to the orchestration of architectural, planning, and altruistic considerations to convert Imperial-era bath foundations for seasonal use, demonstrating civic support for sustainability. An overtly philanthropic

culture of Late Antiquity provided 17 summer baths across the Roman Empire, identified through such dedications (Merten 1983: 34–38; Rebuffat 1970: 26; Yegül 1992: 452; Nielsen 1993, vol. 1: 138–40; Thébert 2003, vol. 1: 461; Saliou 2004: 289–309; Leone 2007: 90–93). Examined together, the inscriptions from the five remaining summer baths illustrate a deeply considered rationale behind the rehabilitation of these formerly year-round baths.

The inscriptions primarily commemorated major commissions for building repair. While all baths underwent regular minor servicing every 10 or 20 years to counter the ill-effects of extensive foot traffic, standing and running water, steam, and extremes of temperature on the building fabric, those campaigns were not publicly recorded (Thomas and Witschel 1992: 159). Periodic replacement of windows, the mending of lead pipes, and cosmetic or decorative repair in the form of repainting, plasterwork, and resurfacing of floors and walls were matters of course that received no grand inscriptional tribute. However, during the 4th to 6th centuries, such interventions for baths are vividly described in surviving papyrus invoices from Roman Oxyrhynchus in Egypt, which were written between city administrators and contractors. These invoices record the costs of lime plaster preparation and its delivery to a bath in AD 306 (*P.Oxy* XII 1104, in Grenfell and Hunt 1898); a painting commission for a Hadrianic-era bath in AD 318 (*P.Oxy* VI 896); the 'payment for maintenance of a public bath' regarding delivery of charcoal for fuel in AD 324 (*P.Oxy* XII 1430, 85–88); the payment for lead and tin to repair the pipes of a bath in AD 572 (*P.Oxy* VI 915, 268–9); and the budget for replacing window glass in AD 584 (*P.Oxy* XII 1430, 85–88). Periodic minor repair work was unavoidable and would have been paid for from the city's annual maintenance budget. But in the case of larger-scale building works, onsite epigraphic evidence demonstrates transformative renovations. These included structural alteration, reconfiguration of water features and conduits, changes to pedestrian circulation within the complex, wall modifications, repair of the floor and wall-heating systems, and sculptural commemoration. Decorative finishes were likewise considered major commissions, as their visual aesthetic reassured citizens of the importance of urban enhancement.

The patrons responsible for bath restorations were characteristically celebrated in these inscriptions. The Hadrianic Baths of Aphrodisias in Turkey are an example of the high regard paid to architectural philanthropy. One of two summer baths known in Anatolia, these baths were extensively repaired between the 4th and 6th centuries (McDavid 2015).³ An inscription from AD 542 attributes the sweeping Late Antique renovation of this bathing complex to a local honorand:

To Good Fortune. The most magnificent Rhodopaios, the lover of his country and defender of the people, the originator of the generous gift of the summer Olympian bath, and giver of corn as well as founder, renewer of pleasures that had been forgotten, the never-to-be-forgotten benefactor to us

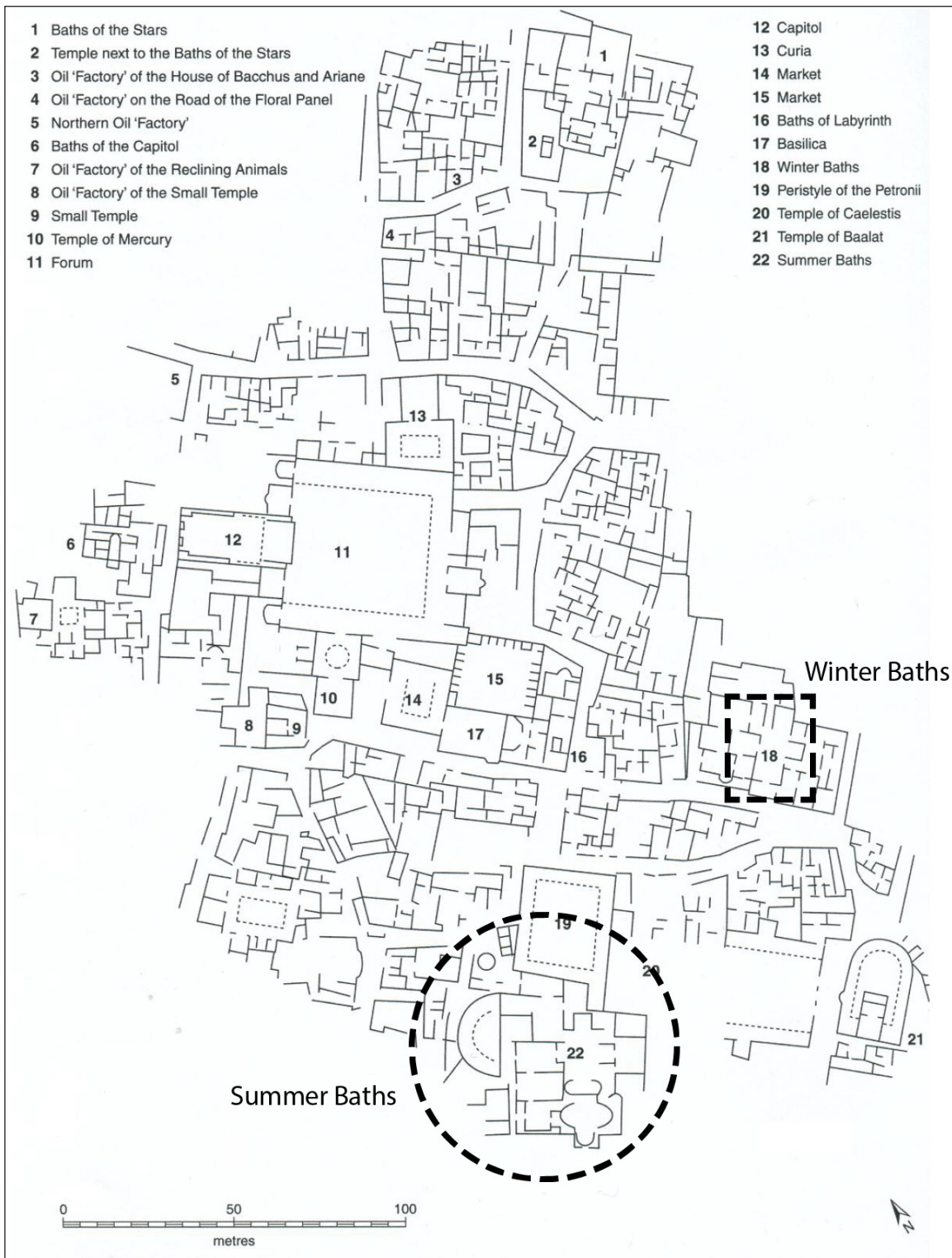


Figure 3: Site plan of Thuburbo Majus, Tunisia. Summer and winter baths. German Archaeological Institute.

in everything, privately and public—the city (has honoured him) adorning him with a statue for the third time. (Roueché 1989: 137–38)

In sponsoring the baths' transformation into a seasonal summer facility, Rhodopaios was acclaimed as both restorer and sponsor of a renaissance in bathing culture within the city, the kind of philanthropist to whom Libanius referred in *Orationes*. Rhodopaios's inscribed statue is

evidence not only of his generosity, but also of the forces against which the restored bath was made resilient. The period preceding the restoration was one of famine and plague, during which the ritual of bathing had suffered due to ageing infrastructure, neglect, damage, and economic crises at the end of the High Empire. Within this narrative, the endurance of the bath lay in its altered fortunes, a result of significant investment through patronage (Roueché 1989: 137–41).

An inscription from AD 361 documenting the rehabilitation of Thuburbo Majus Baths in Tunisia likewise underscores the importance of patronage:

In the very happy age of our lords Constantius Pious, Happy, great, invincible and August Julien, noble Caesar as proconsul of Clodius Hermogenianus with rank of clarissimus, proconsul of the province of Africa and in the legate Crepereius Optatianus with rank of clarissimus, legate of Carthage, Annius Namptoius, perpetual flamen, Legal Adviser, Office of the master, curator of the city, accompanied by very considerable municipal city council of Thuburbo and all its inhabitants, has completed construction of the summer baths, has filled it with Ornament and made the dedication, after eight years and seven months, carrying out all the finishing work as well as Annexes which the baths lacked. (*IL Afr* 273, in Wilmanns 1881)

While the likely impetus for this inscription was to commemorate the generosity of a member of Thuburbo Majus's political class who underwrote the rehabilitation project that took almost nine years, the inscription also indicates the changing needs of Late Antique society. The restoration was executed with the conviction that the existing Imperial-period baths needed more than repair – the structure required transformational alteration, as well as new facilities (the annexes mentioned in the inscription). The significant investment in decoration indicates that this was not merely a utilitarian commission: in keeping with Imperial tradition, it reaffirmed urban sophistication and the dignity of the city's residents.

Evidence of the structural dilapidation of the baths prior to their restoration is elucidated in other inscriptions. Three inscriptions at the Great Baths of Madaurus in Algeria offer a telling example of the extent of architectural rehabilitation. The first, from AD 364, reads:

For the great security of the age of our lords Valentinianus and Valens, perpetual Augusti. The summer baths, once the decoration of our most splendid colony, but for so many years hence deformed by the decay of ruins and by such destruction to the walls of all the communal pools that they were causing serious financial loss, now [?] were built in all usefulness and decorated with fine ornament; but also the patinae were strengthened with a greater weight of bronze in all usefulness ... Caecilius Pontilius Paulinus, priest for life, patron of the colony, curator of the city, completed [the baths] with public money. (*IL Alg* 1.2101, in Gsell 1864–1932)

A second inscription, from AD 366/7, is even more specific on the dilapidated condition of the baths prior to rehabilitation:

On behalf of the great happiness of the unconquered age of our emperors and lords, perpetual

Augusti, Valentinian and Valens. [?], curator of the city, among his other benefactions by which for some time already [he has favoured the city?], along with the eminent ordo and the entire people, restored and dedicated that pool room [?] and the *cella soliaris*, which were marred with frequent holes so that the lowest levels of the pavement were showing through and, accordingly, prevented the retention of heat; and, driven by his scrupulous regard for the sacred p[?] and by the comfort of the Roman [?] citizens, he introduced [?] choice marbles of different. (*IL Alg* 1.2102)

The third inscription, from AD 407/8, is notable in its reference to 'the bringing of foreign artisans' to complete the restoration of the baths (*IL Alg* 1.2108). Decorative commissions were of primary importance to benefactors as these contracts represented the visible, aesthetic culmination of restorative work; to guarantee the fine execution of finishes in the baths would include commissioning artisans from as far afield as their fame was known. This celebratory inscription is indicative of the high regard the city held for their imported skill, and of the collaboration that brought renewed pleasure to the city.

These inscriptions at Madaurus, which document three reconstruction campaigns between AD 364 and 408, emphasize the decay (*ruina, deformitas*) of the Great Baths prior to their repair. The first, made in AD 364, documents the rehabilitation of all the baths' communal pools, which had previously been in such extensive ruin that the baths had become a fiscal liability for the city. Just two years later, additional restoration was done on the *cella solaris* (caldarium), work that not only memorialized the complex's earlier form, but also restored the most costly parts of the bath (DeLaine 1987: 150–55). There, suspended floors had crumbled to expose the hypocaust system below, causing heated gases to escape instead of being properly channelled through the wall envelope. Only a sealed system would heat the room efficiently. These inscriptions show the baths' state of deterioration and a subsequent half-century of philanthropy – a long-term campaign to stimulate their physical and cultural survival that demonstrates the value these buildings had for their communities.

Informative details of structural alteration may also be gleaned from the 4th-century inscription of the Winter and Summer Baths of Sbeitla in Tunisia: 'The restoration or new installation of a frigidarium [cold pool] in the large baths' (*IL Afr* 141). Since its discovery in 1921, this inscription has been interpreted to mean that in the 4th century, a dedicated winter facility was built into the dilapidated, 2nd-century baths – one that integrated two typically discrete complexes into a single footprint (Lepelley 1981). At 3,500 m², the area dedicated to the summer baths exceeded two-thirds of the compound. This would be a singular example of a conjoined summer and winter facility, as it is described today. An alternative reading of the text suggests that it may not describe the creation of a winter enclosure within the original baths, but rather simply the insertion of an unheated pool into one of the

summer baths' chambers. This would allow the rededicated space to maximize the temperate, summer potential of the entire complex, a matter that will be discussed further. When compared with other summer baths, a trend of installing unheated pools in Late Antiquity emerges as a cost-effective practice that increased visitors' enjoyment.

In emphasizing the former ruin of bath complexes, these inscriptions magnify the value of work done to refurbish them. What is more, by calling attention to an existing structure, the Late Antique inscriptions amplify the importance of tradition and continuity while building upon the Imperial model. The inscription, of AD 379–83, on the Forum Baths at Fordongianus in Sardinia supports that rhetorical template:

O Lord, save our Flavius Gratian, Valentinian and Theodosius the victorious Prince! The baths were restored into the summer baths, the foundations of which once used to be in a miserable state and were constituted for now from the collapse of two great. (Sardaigne 1982: 82–88, inscription 323)

This summer bath complex was celebrated for the culmination of a major campaign of dual purpose: to harmonize two earlier phases of bath buildings of Julio-Claudian and Severan dates into a single complex and to rescue the earlier structures from their state of dilapidation. It appears that this was not to be the final commission but that more capital renovations were to come, although no additional inscriptions have been found. Structural improvement included the overhaul of the baths' foundations that would have included the sub-floor hypocaust system, as well as repair of the collapsed superstructure – perhaps one or more of its barrel-vaulted spaces, which were prone to failure over time. As with the inscription of the baths of Madaurus, those at Fordongianus describe patronage that not only led to structural transformation, but also restored cultural value to the city. In effect, Late Antique patrons were able to align themselves with their Imperial predecessors, as the grandiose constructions initially sponsored by the aristocracy were not immune to decay. It was in the power of later leaders to restore these baths into estimable facilities, and the execution of that duty resulted in commemoration, gratitude, and political capital.

Structural Rehabilitation: The Case of Aphrodisias

Comparing alterations to these five existing summer baths reveals certain patterns that suggest a Late Antique method of renovating baths to achieve thermal resilience. As mentioned, these renovations involved baths that were favourably sited; additionally, they were often adjacent to a dedicated civil basilica (*basilica thermarum*) (Downey 1937; Bidez and Parmentier 1898, vol. 27: l. 32–28, l. 1). Spatial reorganization of open-air facilities and the repurposing of the exercise *palaestra* attached to the bathing core were also frequently addressed in restoration work.

But evidence of transformative renovation that suggests the development of a sustainable summer bath typology may best be seen in changes to infrastructure. To

encourage more efficient use of water and fuel, the size of the building had to be reduced. Infrastructure was manipulated to reduce demand on convection, and to make heating more cost-effective (Ginouès 1955: 135–152; Rebuffat 1991: 12). Research on Aphrodisias traces the execution of architectural changes made to the Hadrianic Baths during Late Antiquity, and addresses structural modification in the context of resource management (McDavid 2015). The findings offer a template to consider the other summer baths in terms of their sustainability in which the subdivision of the caldarium, alterations to heating and ventilation systems, installation of indoor and outdoor pools, and decorative finishes constitute a vocabulary of sustainable, resilient thermal architecture.

Changes to the Caldarium

In 1963 the excavation of the caldarium at Aphrodisias exposed a hypocaust with an almost intact narrow brick wall dividing the subfloor into distinguishable halves: its western sector maintained much of the original grid of pillars that would have supported the heated floor *in situ*, while the east was devoid of pillars, perhaps indicating operational failure in that sector (**Figure 4**). With furnaces flanking east and west precincts, the divided system could allow each half of the caldarium to be heated independently. The wall may have been built to allow the two furnaces in this room to generate a temperature up to twice that of the neighbouring *tepidarium* of comparable size, as the caldarium was intended to be the hottest room of the complex; it could otherwise serve to cauterize failure in the heating armature, if one of the furnaces ceased to function. It may also signify saving energy by heating only half of the caldarium at a given time when accommodating fewer visitors to the bath. The division of the caldarium may also be a rare architectural expression of gender separation, a burgeoning trend in Late Antiquity identified primarily in textual records (Ward 1992: 125–47; Thébert 2003, vol. 2: 154, 461–62). For baths to continue to function in Late Antiquity, they could no longer remain gender neutral, and such new and pressing societal dictates would have demanded spatial reorganization.

Similar alterations of caldaria are evident at the summer baths of Thuburbo Majus, Fordongianus, and Madaurus. The major renovation of the 4th century, commemorated in AD 361 at Thuburbo Majus, included the division of the original caldarium into a unit of three segments unified by a vaulted roof (Yegül 1980: 242) (**Figure 5**). These divided spaces lent themselves to more controlled management of heating and water resources and likely would have been used independently to separate genders in a rapidly Christianizing empire. At Fordongianus, two building phases of the 1st and 3rd centuries, each with discrete heating facilities, were unified by a centralized *natatio* (unheated pool); this reconfigured environment would have allowed men and women to perform the entire bathing ritual separately yet simultaneously (**Figure 6**). Alternatively, one half of the complex could be used at a time instead of the whole, if overall heating output was to be reduced, if fewer bathers were to be accommodated, or if genders were separated by attending specific days of



Figure 4: Late Antique wall dividing the caldarium. Hadrianic Baths of Aphrodisias, Turkey. Photo by A. McDavid.

the week. The extensive renovation of the caldarium at Madaurus was crucial in providing a thermally sustainable facility, because heat retention improved significantly after consolidation (*ILAlg* 1.2102).

Heating Systems

Heating required the greatest investment for baths, in terms of both infrastructure and the consumption of natural resources. Documented cash distributions for two of the largest bathing establishments in Italy during the High Imperial period were for their maintenance, each budgeting about \$650,000 annually for its fuel of wood (Duncan 1965: 204). A third site, without financial details, provided 400 cartloads of hardwood per year ‘ad lavacrum balnear(um)’, and indicates this was the main expense for these baths (Duncan 1965: 208). This budget became unsustainable in the 3rd century, and to remain viable, the demand for fuel had to be reduced, requiring the overhaul of their heating systems in size and scope. For some baths, large heated rooms were subdivided so that a single segment could be used at a given time, instead of heating the whole; it could additionally mean contraction or closure of some of the heating apparatus.

At the Hadrianic Baths at Aphrodisias, three pairs of furnace arches located at its western excavated limit indicate an extensive furnace quarter that serviced three of

the largest heated rooms of the complex – the central caldarium and two flanking rooms that were the north and south tepidaria (**Figure 7**). In the alterations of some of these arches, a degree of redundancy is evident in the western heating zone. In the North Tepidarium, one arch was entirely sealed with brick and mortar infill. This intentional closure suggests that access to the furnace serving this room was no longer feasible. Although its adjacent pool indicates continued function, it was turned into an unheated one. Bathers would not miss heated pools during temperate months. Whether precipitated by dilapidation or economic pressure, closing the furnace arches helped to restore the enjoyment of some measure of traditional bathing amenities in the 2nd century. Similar alteration of the heating armature is also evident in the rebuilt furnaces of the summer baths of Thurburbo Majus, Sbeitla, and Fordongianus, which used Late Antique brick instead of ashlar-cut limestone to constrict the size of the original furnace conduits and to slow the distribution of heat.

Diverse wall-heating systems were used for vertical convection in Roman baths (Yegül 1992: 364; Adam 2005: 557–61; Koçyiğit 2006; Graciani 2009: 721–28). In terms of resource management, the rate at which heated gas would be drawn through the walls was directionally proportional to the thickness of the wall cavities; if the cavities were narrowed, the overall cost of fuel would be

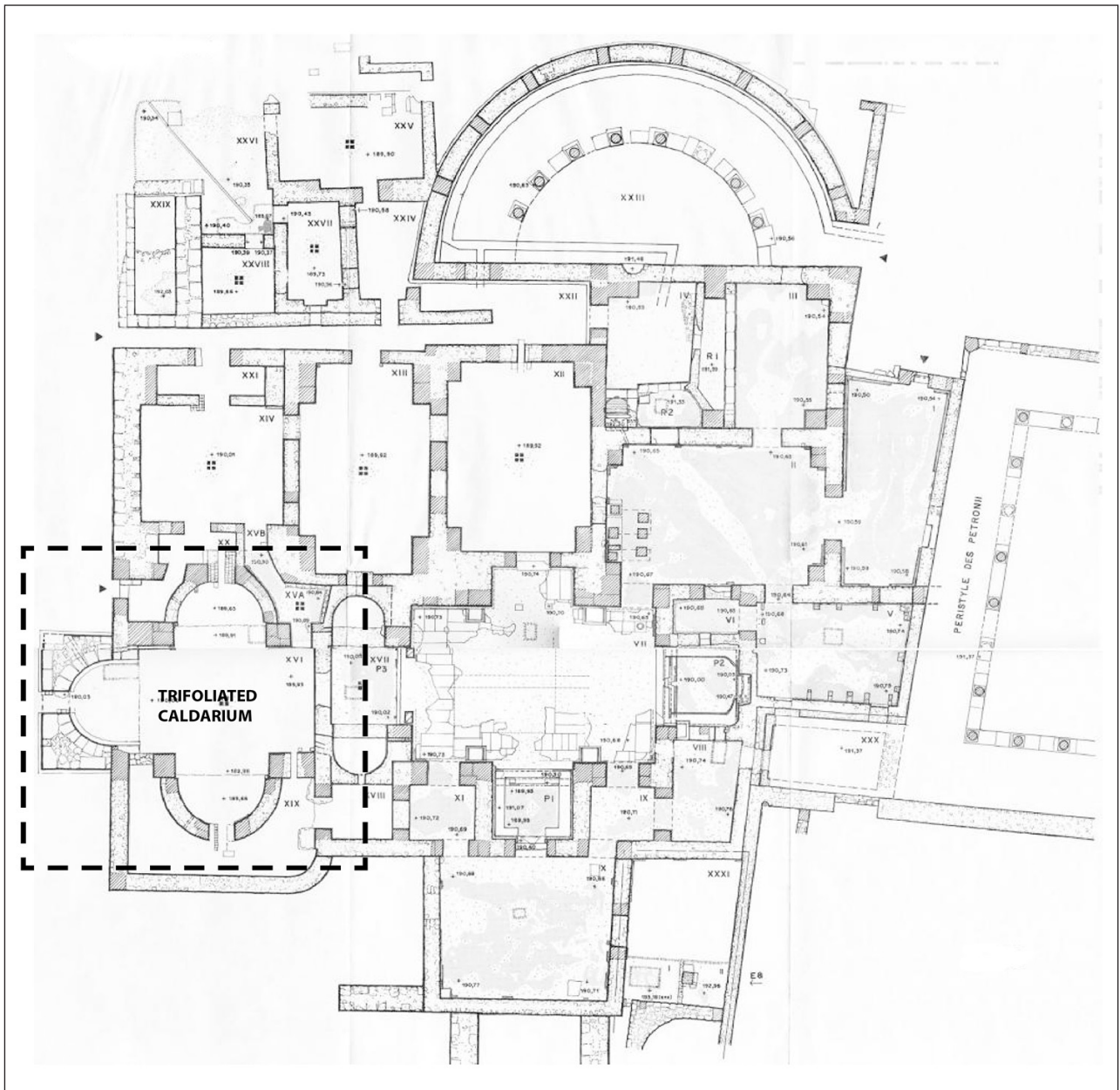


Figure 5: Plan of the Baths of Thuburbo Majus, Tunisia. Alteration of the caldarium. German Archaeological Institute.

lowered. A Late Antique terracotta plaque configuration offered this flexibility, while standardized *tubuli* installed in the High Imperial period did not.

Two heating systems are found curiously overlaid *in situ* in the Hadrianic Summer Baths at Aphrodisias: *tubuli* in two sizes and clamped terracotta plaques (Figure 8). This layering is likely the result of accretive campaigns of repair in which one heating system, perhaps redundant, was superseded by another during a time of economic recovery. None of the published work on the other baths discusses variants or overlap in their heating systems, but numerous Late Antique restorations of small baths in Greece also show a preference for reducing rates of convection (Biers 1985: 46–47, 55; Sanders 1999: 451, 453, 461, 473; Charitonidis and Ginouvès 1955: 112, fig. 9). Other reasons that may account for this hybrid arrangement include regional preferences in Anatolia, and

inventive attempts at repair when importing new *tubuli* may have become prohibitively expensive (Yegül, Bolgil, and Foss 1986).⁴

Much of the material evidence for renovation of the other summer baths is visible within their heating infrastructure: at the *fornices* (furnace openings) of Sbeitla and Thuburbo Majus, and in the hypocausts at Madaurus and Fordongianus. Through overhaul of the components of these areas — extensively repaired or newly built furnace openings, subfloor structures, and wall conduits — an investment was made to ensure the long-term conservation of formerly lavish bathing facilities.

Indoor and Outdoor Pools

With the need to reduce heating costs, many pools inside these complexes were heated less frequently; additionally, several small, new, and entirely unheated pools were



Figure 6: Baths of Fordongianus, Sardinia. View to the *natatio* built upon 1st-century ruins. Photo by A. McDavid.



Figure 7: Blocked furnace arch, left. Hadrianic Baths of Aphrodisias, Turkey. Photo by A. McDavid.



Figure 8: Wall convection system. Hadrianic Baths, Aphrodisias. Photo by A. McDavid.

installed in rooms that increased access to cold immersion, a desirable feature during temperate months of the year. Within the Hadrianic Baths, the original entry through the caldarium's two central arches – one in each of the north and south walls – was blocked in Late Antiquity by tiered, marble-faced brick parapets that framed small immersion pools within these arches (**Figure 9**).

These pools were likely used simultaneously with the larger pre-existing ones (Ginouvé 1955: 149, figs. 1, 7, 36; Biers 1985: pl. 38; Yegül 1991: 108). Their provision appears to be part of a widespread development across the eastern provinces in the 4th and 5th centuries (Shear 1969: 382–417; Höghammar 1984: 83, table 3; Biers 1985: 314–15; Yegül 1986: 67, 131; and 1992: 329–39; Charpentier 1994: 113–42; Cameron 2008: 938). The numerous interior, unheated pools built into the older

frames of the baths in Thuburbo Majus, the frigidarium at Sbeitla, and the central pool at Fordongianus support similar aims (**Figure 10**).

Pools of cold water were also introduced into rooms previously used for other services, such as the conversion of the ambulatory hall of the Hadrianic Baths into a frigidarium in the 5th century by inserting an unheated pool into the west of the room where none previously existed (McDavid 2015). Similarly, the restoration work at the baths of Sbeitla may have been the installation of an interior cold pool into the surviving building frame; this intervention, undertaken in the 4th century, would have designated the room as a Late Antique frigidarium in the reconfigured summer bath complex identified by inscription (*IL Afr* 141; Lepelley 1981: 310; Leone 2013: 92; Jouffroy 1986: 307). Although the inscription is



Figure 9: Indoor pools built into original caldarium entrances. View from southern to northern pools. Hadrianic Baths, Aphrodisias. Photo by A. McDavid.

currently understood to designate an entire winter complex embedded within a larger summer facility, I suggest it simply may have meant the insertion of an unheated pool within an establishment entirely dedicated to summer use, while a discrete winter complex would have been located elsewhere in the city centre. Given the practice of installing unheated pools in temperate summer baths and the interchangeability of the term *frigidarium* to represent either a single pool or an entire room, the alteration of an existing room into an unheated bathing space may best explain a sustainability effort that reduced the need for heating, while increasing amenities for immersion.

Outdoors at the Hadrianic Baths' northeast precinct, an honorific fountain of first century date was appropriated into the complex in the early to mid-fifth century (McDavid 2016: 217–18) (**Figure 11**). Converted to a functional pool using spoliated marble blocks and ornamented with statuary that had been moved from elsewhere in the city, the renovated Tetrastyle Court became the formal northeast entry to the baths and was an important orientation node for the beginning and end cycles of the Late Antique bathing ritual. A fifth-century statue of a benefactor and his children was erected in a southern, contemporary niche of the Tetrastyle Court, perhaps to commemorate this restoration, and provides

a plausible *terminus post quem* for the renovation of the court (Smith 2007: 61).

The summer baths at Thuburbo Majus and Fordongianus also acquired Late Antique additions of oval pools situated outside the covered sector of their respective complexes, in stark contrast to their interior, ashlar-cut pools which generally distinguish High Imperial construction (**Figure 12**). Located on the eastern, cooler orientation of their respective sites, their style of construction and use of spoliated materials give an approximate date of installation as the 5th century, around the time when smaller, interior pools became popular across the eastern empire. These outdoor pools were unheated, and bathers relied on temperate weather for their enjoyment. As they also did not require costly subfloor infrastructure to build, this Late Antique development would have been embraced by resource-conscious cities eager to provide low-cost public bathing amenities.

Apart from the pressing aim to reduce heating costs, there were additional concerns for stricter water management as well as a social mandate to accommodate emerging preferences in individual or segregated bathing. All were significant contributing factors to building resilience as economic, gendered, and religious imperatives became paramount for Late Antique society (Ginouvés 1955: 133–52). Consequently, a practice developed of



Figure 10: Indoor pool. Forum Baths at Fordongianus, Sardinia. Photo by A. McDavid.

dividing rooms and pools to facilitate these burgeoning needs so as to keep these baths viable for a society in cultural transition.

Decoration

Substantial investments in decoration were made to rehabilitate these baths into seasonal facilities. They included freestanding, moveable sculpture, polychromatic architectural finishes, floor and wall mosaics, and wall frescoes (Stirling 2012). At the Hadrianic Baths in Aphrodisias, sculpture was used in abundance throughout a complex that illustrates a rich topography of philanthropy over five long centuries of the baths' use. In particular, the landscape of commemoration related to restoration of the baths provides copious evidence of Aphrodisian society's sustained commitment to their bathing culture (Smith 2007).

Textual evidence from Sbeitla shows that the last major renovation of its summer baths was commissioned in the 4th century. While there is no reference in the fragmentary

inscription to decorative finishes as a part of this work, the remains of the baths indicate a substantial investment in floor and wall decorations to complete the restoration. These include diamond reticulation, meanders, and other geometric shapes in graphic contrasts of white and dark stone. They are found in the palaestra and in several rooms of the complex, installed for the visual delight of Late Antique bathers.

The 4th-century renovations of the Summer Baths of Thurburbo Majus were only considered complete once the rooms were 'filled with ornament' (*IL Afr* 273). While the moveable sculptures that once adorned these spaces have been lost or are no longer displayed on-site (Ben Abdallah 1986; Friedland 2003), many of the stone mosaics that remain *in situ* illustrate the extraordinary level of expertise commissioned for surface decoration (**Figure 13**). The scope and the diversity of styles show the involvement of a large number of artisans and the value of adornment to the success of the nine-year project (Lepelley 1981: 200, Thébert 2003, vol. 2: 147, Leone 2013: 91).



Figure 11: Tetrastyle court. Hadrianic Baths, Aphrodisias. Photo by A. McDavid.



Figure 12: Outdoor pool. Fordongianus, Sardinia. Photo by A. McDavid.



Figure 13: Mosaic decoration. Frigidarium, Summer Baths of Thuburbo Majus, Tunisia. Photo from Art Resource.

Extensive repairs were made to the Great Baths of Madaurus, where foreign mosaicists installed new decorative finishes during the latter half of the fifth century (*ILAlg* 1.2108). Their sought-after skills and fame, which extended over great distances, illustrate the level of investment the urban élite was prepared to make for the beautification of a city ('Chronique', 1953). Far from minor repair, these decorative surfaces overlaid and insulated water and heating conduits that were crucial to the sustainability effort, and were further symbolic of transformation, rededication, and renewal (Barry 2007: 627–56). Fine marble architectural elements, lavish surface decoration, and both freestanding and embedded relief sculpture were essential to the earlier, 4th-century, campaigns of renovation at Madaurus' renewed summer baths (*ILAlg* 1.2101, 1.2102). Few surface finishes remain of the baths at Fordongianus, save for fragmented frescoes of brightly pigmented colour on white plaster dating to the 4th century. Nonetheless, they would have overlaid substantial repairs to wall heating and are

stylistically similar to contemporary wall frescoes in the Hadrianic Baths at Aphrodisias (**Figure 14**).

Conclusion: A Mandate for Thermal Sustainability in Late Antiquity

By comparing the archaeological evidence of the five attested summer baths — at Sbeitla, Thuburbo Majus, Madaurus, Fordongianus, and Aphrodisias — we observe distinct parallels in the processes of building renovation and use of the baths. It is also possible to identify multiple forms of architectural resilience. The baths were large, public facilities, physically adapted from thermae of the High Imperial period from the 4th century onward. The complexes were favourably situated close to the city centre and oriented to maximize climatological advantage. Spatial reconfiguration was undertaken to maximize efficiency and to ensure long-term use. Their exercise palaestrae were converted to ambulatory and decorative purposes. The summer baths were in use during temper-



Figure 14: Wall fresco. Fordongianus. Photo by A. McDavid.

ate months of the year and then closed during the coldest months, allowing the city to save considerably on natural resources and thus to ensure the viability of the baths in an era of conscious resource management.

Perhaps the most striking feature of this summer typology is that all were transformational restorations of bath complexes that initially had been built to represent luxury and excess, but were adapted to suit burgeoning demands for conservation in a society recently recovered from social and economic challenges in the third century. The status quo of overabundance during the Imperial period had led to ruin for many cities and to the abandonment of rituals they once enjoyed. Urban nobles and philanthropists in the later Roman Empire understood the value of engendering a happy and healthy society, as evidenced by their dedication to sustaining the thermal infrastructure of baths. In particular, for cities that did recover in the 4th century, where inhabitants believed that the loss of their bathing culture meant the loss of classical *Romanitas*, major structural and decorative campaigns were undertaken to upgrade their dilapidated baths and restore the pleasures they once provided. In so doing, renovation strategies were enacted to ensure long-term continuity of the tradition. The archaeological evidence of these changes verifies the importance of renewal, resilience,

and recovery to a Late Roman society whose interest in sustainability mirrors our own.

Notes

- ¹ There were no designated 'spring' or 'fall' baths, as the summer baths could facilitate mild climates; only when temperatures had fallen significantly would dedicated 'winter' baths be needed. Additionally, fewer people would visit winter baths than summer baths during warmer months.
- ² This may perhaps be Bath C of Antioch, though prior scholarship fails to assign any of the 10 excavated baths of the city to seasonal use (Yegül 2000: 146–51; Elderkin 1934: 19–31; Levi 1947: 289–91).
- ³ The other is commemorated by Libanius, at Antioch (see n. 2, *supra*).
- ⁴ As in the baths in Turkey: the Balboura Baths in Burdur, the Central Baths at Laodiceia, the Imperial Baths at Sardis, and the Bath-gymnasium at Pergamon.

Competing Interests

The author has no competing interests to declare.

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
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