Bulla Regia Mosaic Conservation Project

A Model Field Project of the MOSAIKON Initiative

Project Report

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Tunis

MOSAIKON Initiative

World Monuments Fund
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The Getty Conservation Institute (GCI) works internationally to advance conservation practice in the visual arts—broadly interpreted to include objects, collections, architecture, and sites. The Institute serves the conservation community through scientific research, education and training, field projects, and the dissemination of information. In all its endeavors, the GCI creates and delivers knowledge that contributes to the conservation of the world's cultural heritage.

The Institut National du Patrimoine of Tunisia is a governmental and administrative institution with civil and financial autonomy. It works under the aegis of the Ministry of Culture and Protection of Heritage. The Institute's mission is both scientific and technical, and focuses on the inventory, study, protection, and presentation of the cultural, archaeological, historical, human, and artistic heritage of Tunisia.

MOSAIKON is a partnership of four institutions: the Getty Conservation Institute, the Getty Foundation, ICCROM, and ICCM. The aims of the project are to strengthen the network of professionals concerned with the conservation, restoration, maintenance, and management of mosaic heritage in the southern and eastern Mediterranean region; provide training to a variety of individuals involved in mosaics conservation and, more generally, with the management of archaeological sites and museums with mosaics; work with national and international bodies to provide a more favorable legislative, regulatory, and economic environment for the conservation of mosaics in the Mediterranean; and promote the dissemination and exchange of information.

World Monuments Fund (WMF) is the leading independent organization devoted to safeguarding the world's most treasured places to enrich people's lives and build mutual understanding across cultures and communities. Partnering with local communities, funders, and governments, WMF draws on heritage to address some of today's most pressing challenges: climate change, underrepresentation, imbalanced tourism, and post-crisis recovery. With a commitment to the people who bring places to life, WMF embraces the potential of the past to create a more resilient and inclusive society.

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The WMF project team was led by architect Gionata Rizzi, then by project manager Jeff Allen. The archaeologists Massimo Brizzi and Domenico Camardo, architect Thierry Grandin, and coordinator Domenico Santarsiero acted as consultants for documentation, assisted by INP topographers Yassine Rebai and Karim Benhadj Belgacem, INP architect Biliel Chebi, and INP mason Habih Okbi. The conservation team included stone conservator Stefano Volta, structural engineer Giovanni Vercelli, Alessandro and Ippolito Massari of Studio Massari for hydrology and drainage, and Giuseppina Campanale, architect. Gilles Seraphim, landscape architect, Anna Letizia Monti, agronomist, and Nicholas Warner, architect, contributed to site presentation studies and proposals. Ennio Paolo Bettino, Lorenzo Appolonia, materials scientist, and Samira Kazempour, architect, also contributed to various aspects of the project, under the leadership of Lisa Ackerman, WMF Executive Vice President and COO.

For the GCI, in addition to the report authors, the project team included consultant conservator Cristina Caldi and other members of Akhet srl. for recording and documentation: Daniele Sepio, Maria Brigida Casieri, Alberto Davide, and Louise Brodie. Getty Trust videographer Christopher Sprinkle and consultant photographer Scott Warren contributed to the documentation of the project itself. GCI graduate intern Juana Segura Escobar and consultant Anjo Weichbrodt contributed to the mosaic survey photography, while intern Thomas Bernecker assisted with reburial field test-

ing and monitoring, and interns Nityaa Iyer and Sara Marandola developed the designs for presentation and visitor protection measures for the Maison de la Chasse. Roger Hanoune was called on as a consultant archaeologist to assist with presentation issues in the Maison de la Chasse, since he had directed the most recent excavation of the building. In GCI Science, engineer Beril Bicer-Simsir provided laboratory support for the characterization and testing of mortars for mosaic and wall stabilization interventions. And finally, Jeanne Marie Teutonico, GCI associate director, and Susan Macdonald, head of Buildings and Sites, provided project leadership and guidance.

INTRODUCTION

The MOSAIKON Bulla Regia Field Project was a tripartite collaboration of the Getty Conservation Institute (GCI), Institut National du Patrimoine (INP) of Tunisia, and the World Monuments Fund (WMF). Although the official partner agreement lasted from 2013 to 2016, activities of the GCI and INP on-site began in 2010 and continued until 2017. The project built on fifteen years of collaboration between the GCI and the INP in the training of site personnel (mosaic conservation technicians and site directors) in the conservation of in situ mosaics and the management of archaeological sites (Roby, Alberti, and Ben Abed 2005; Roby et al. 2008; Dardes 2009). The site of Bulla Regia was chosen as the model field project of the MOSAIKON initiative, a collaboration of the GCI, Getty Foundation, the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), and the International Committee for the Conservation of Mosaics (ICCM), because of the presence of three mosaic conservation technicians recently trained by the GCI, a site director who had previously followed a GCI course for site managers on the conservation and management of archaeological sites with mosaics, and an architect who was involved in MOSAIKON training activities. The site was also chosen because a project funded by the WMF had already begun to assess the condition of all buildings there and to conserve parts of selected buildings at the site, including the Maison de la Chasse, where structural repairs had recently been made to decades-old architectural restoration work. Because the building contained significant mosaics, it provided an opportunity to complete the conservation of the entire building, including its mosaics, as an example of best practices. It also provided the opportunity to build and demonstrate the skills of the recently trained conservation technicians, by having them carry out the bulk of the conservation work on mosaics as well as on wall plasters and walls, which had been part of their training as well. The project focused on the implementation of conservation treatments and presentation methods for an entire building, as well as the implementation of model stabilization measures and reburial for an entire house not intended to be presented.

The site of Bulla Regia contains hundreds of exposed mosaics in numerous other excavated buildings, and their poor condition could not be ignored. Therefore, an additional component of the Bulla Regia project was to take a holistic approach to the conservation of the site and develop a conservation and maintenance plan for the almost 400 mosaics throughout the site as best practices in sustainable planning. For the plan to be successfully implemented and maintained, it had to be based on the existing resources of the site, both personnel and financial, as well as the ready accessibility of materials and equipment. This report presents the results of these project components: (1) site-wide mosaic conservation planning and (2) best practices conservation implementation of a building to be presented and a building to be reburied. However, the work on-site to present the Maison de la Chasse was not completed because of the deteriorating security situation in that area of Tunisia beginning in 2014, which contributed to the premature end of the project.

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SITE-WIDE CONSERVATION PLANNING

Experience from past GCI/INP training courses for site directors in Tunisia in the conservation and management of archaeological sites with mosaics demonstrated that the course participants would have benefited didactically from case study examples of in situ mosaic conservation planning. The decision to produce a site-wide planning document at Bulla Regia responded to the general need in the field for replicable conservation planning models, as well as the specific need at Bulla Regia to approach mosaic conservation in a holistic, programmatic manner.

The planning process at Bulla Regia was carried out in three phases. The first consisted of information gathering, the second involved analyzing the data, and the third was the actual planning of conservation work based on that site-wide analysis or assessment. The first phase was lengthy, as a great deal of basic site documentation was lacking despite the long history of excavation at Bulla Regia. There was no accurate, detailed plan of the site, including its topography and all excavated and above-grade ancient structures. Although past archaeological publications on Bulla Regia have produced documentation of selected buildings and their mosaics (Beschaouch, Hanoune, and Thebert 1977; Hanoune 1980; Dunbabin 1983), there is no official inventory of mosaics or published Corpus volume, despite Bulla Regia's significant and large in situ collection of ancient Roman and Byzantine mosaics. Therefore, the initial action taken was to carry out a preliminary or first-level rapid survey of the site to inventory and document all mosaics, which total nearly 400. Given the great number of excavated mosaics, and the limited resources of the site, the planning challenge was being able to assign relative priority of action to each mosaic, so that decisions could be made about the phasing of mosaic conservation activities over a multiyear period.

A mosaic survey form was created to facilitate the conservation planning by assigning priority rankings for conservation intervention to each mosaic, which is described below (appendix A).

1.1 Site and Mosaic Documentation, GIS, and Geodatabase Structure

Mosaic Survey Photography

An important part of the mosaic rapid survey process was the photographic documentation of each mosaic. A lightweight adjustable-length aluminum pole was used to take one or more photographs of each mosaic for inventory purposes (fig. 1). Where multiple photographs were needed for a mosaic, they were stitched together using Adobe Photoshop software. Later, the images were modified for use by the INP conservation technicians as photographic bases for their documentation work (fig. 2). Based on the experience of the survey photography, a protocol for mosaic photography was developed to assist with any future recording at the site (appendix B).

FIGURE 1
Example of mosaic survey photographic documentation (Juana Segura Escobar)

FIGURE 2
Same survey image modified for use as a photographic base for graphic documentation by INP technicians (Ermanno Carbonara)

This "low-tech" technique was chosen so that site personnel could carry it out in the future with little training and investment in equipment.

In addition to the mosaic photography undertaken by the team of conservators, professional photographers were engaged to take photographs and videos of the site and the work to document the project and disseminate it to a broader audience. Two project videos were ultimately produced.

Site Topography and Mapping

The production of a new site plan of Bulla Regia was the starting point for accurately positioning spatial data for mosaics throughout the site in their archaeological context. The new site plan was produced using a network of geo-referenced GPS points carried out previously by the WMF. The field survey was carried out using both a total station (Leica TCR 703) and 3D laser scanner (Leica Scan Station C10) to collect the maximum amount of data in a relatively short amount of time. In particular, the laser scanner was used along the Roman streets to collect very detailed data of the ancient urban street network and all the building facades, together with all the underground floors. The total station was used to connect and to georeference all the 3D point clouds to the main topographic network of the site. Based on these main reference points, a new and much more detailed topographical network was created with new survey benchmarks on the ground. Using the new topographic archaeological map of the site, many new archaeological features (buildings, pavements, etc.) and evidence of human activity in the northeastern part of the site were documented and referenced during the survey activities (fig. 3).

3D data gathering by laser scanning of the underground rooms of three ancient houses (Maison de la Chasse, de la Pêche, and d'Amphitrite) allowed detailed information about the preserved mosaics to be obtained. For example, elevation maps of mosaic pavement surfaces were produced using color gradation visuals, which were useful for identifying pavements at risk of water pooling and planning precise interventions to prevent surface water accumulation (fig. 4).

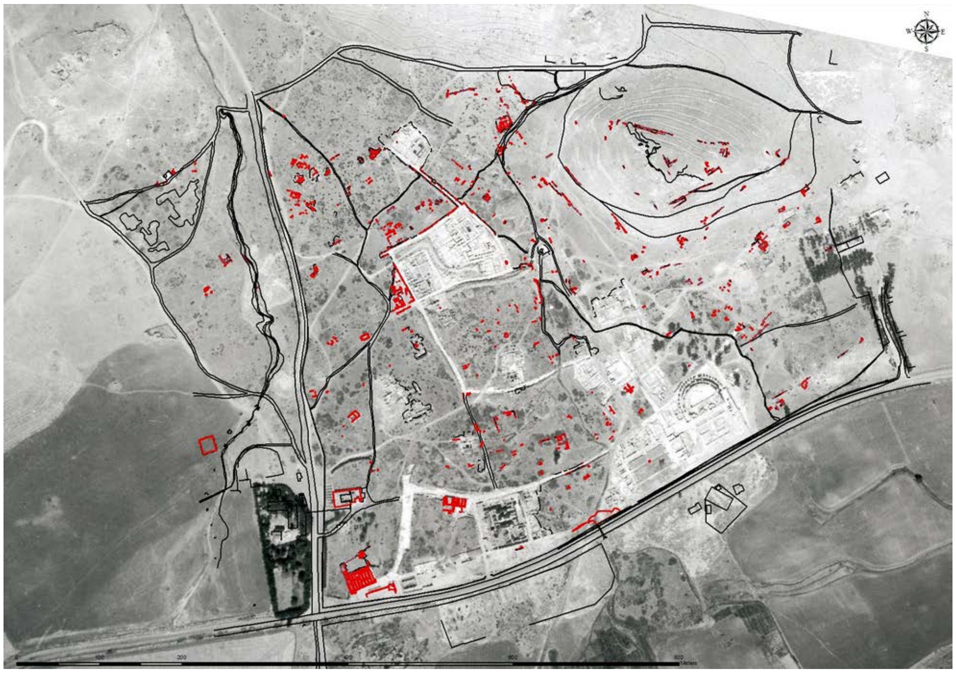


FIGURE 3
Updated topographic map with newly documented archaeological features (red) (Akhet)

An extensive and full topographic terrain survey was carried out to gather ground elevation data to create a Digital Elevation Model of the whole archaeological area (fig. 5). This type of recording tool was useful for evaluating the hydrogeological profile of the region and producing contour maps with drainage lines, thereby facilitating water management of the site in the future. The new

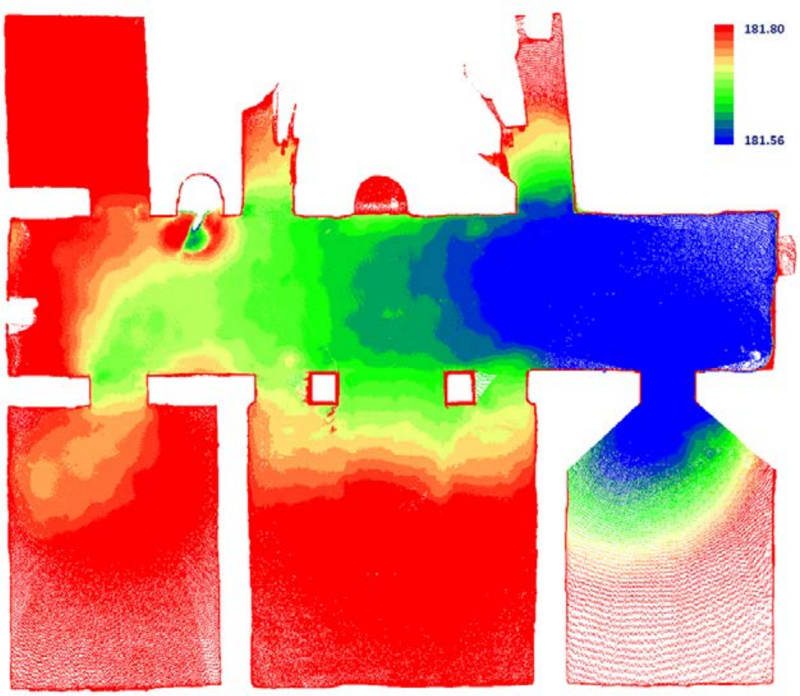


FIGURE 4
Elevation map of pavement in Maison d'Amphitrite (Akhet)

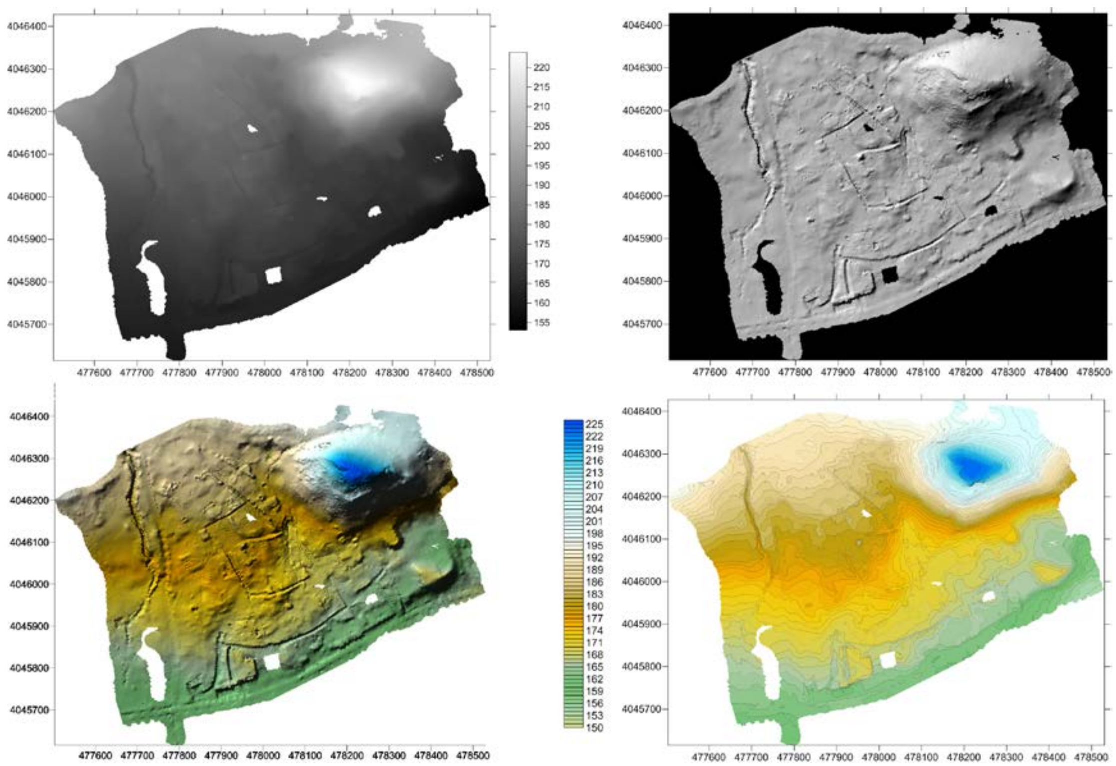


FIGURE 5
Digital Elevation Model of the site (Akhet)

base site map was structured to be able to show both archaeological features and three-dimensional data of the Digital Elevation Model (fig. 6).

Analyzing Data with GIS and Geodatabase

The massive transfer of mosaic survey data from Excel sheet format to a proper relational database system enabled the data to be queried and analyzed by means of the production of Survey Data Reports that could list mosaics, for example, by their conservation priority rating, both site-wide and building-specific. Reports could also be produced listing mosaics by their typologies or other characteristics useful to consider during the planning process.

To further facilitate the mosaic conservation and maintenance planning, as well as the future management of the site, a Geographical Information System (GIS) for the site was created. The two main types of site information, spatial data from the topographic and metric surveys of buildings (appendix C), and qualitative and quantitative data from the mosaic survey, were joined together inside the GIS in a single geodatabase to organize and visualize data at different scales, and to provide answers to questions useful for the conservation planning work.

For example, this made possible the production of different thematic maps that provided a graphic aid for developing planning strategies for future conservation interventions. These maps could visualize the location of mosaics according to their different assessment categories, condition, significance, and degree of exposure, or according to their overall conservation priority rating (appendix D).

FIGURE 6

General topographic map of the site with contour lines and archaeological features (Akhet)

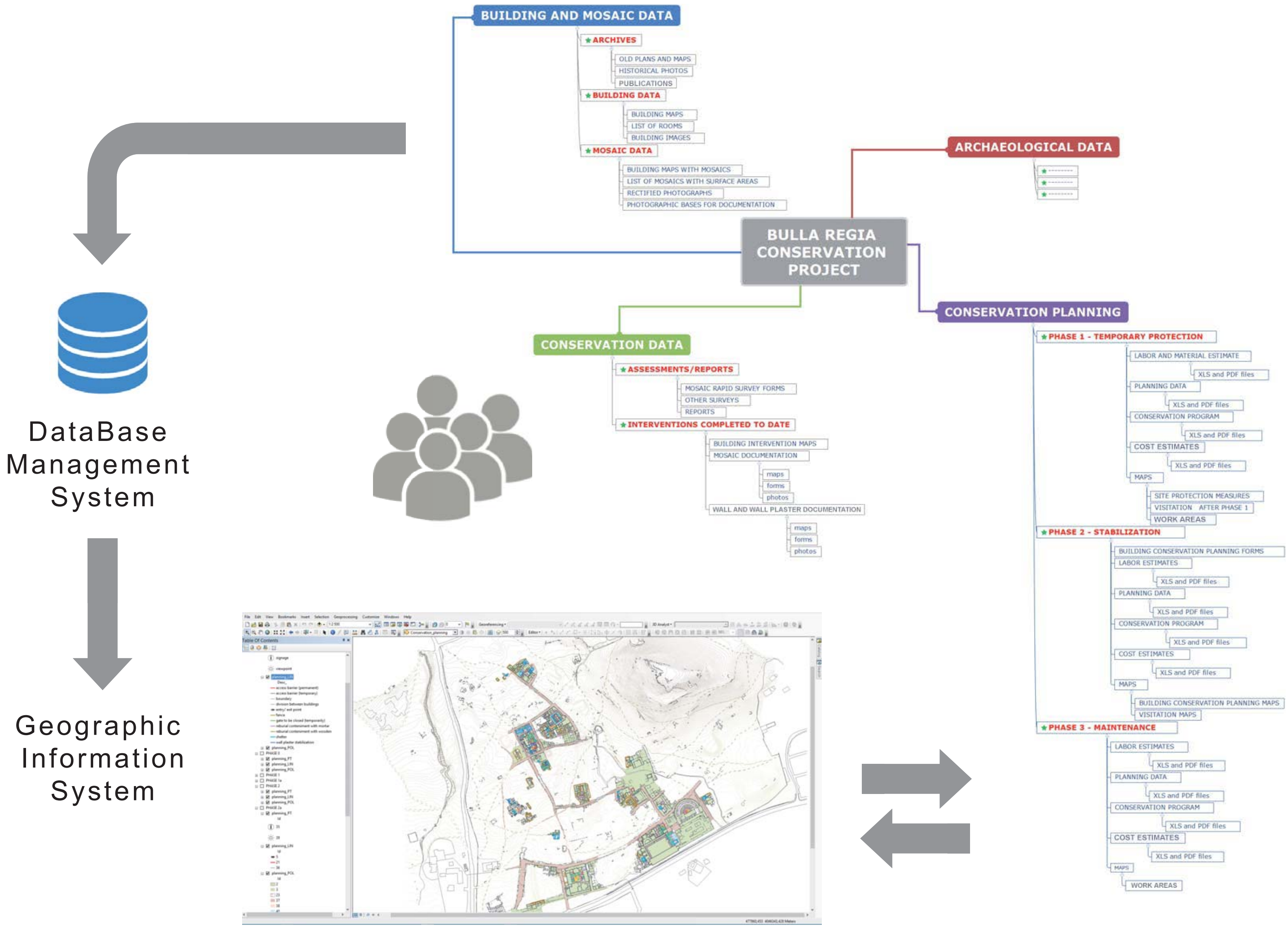


FIGURE 7

Data management system (Akhet)

The GIS can and should receive new, updated information about the mosaics, as well as other data to be collected related, for example, to the geology and hydrology of the site. All previous documentation regarding the site, including that carried out by the conservation technicians, can also be archived within it. In this way the GIS becomes a repository of information, both archival and dynamic in nature. Introductory training was provided at the end of the project to INP site personnel and database experts so that the GIS can continue to be used and updated and be a useful and accurate tool for conserving and managing all aspects of the site in the future.

To allow INP to easily access all the data collected during the project, a proper relational database has been created to organize information, images, and reports originating from different sources (fig. 7). The database has been structured around a main entity or table, the Documentation Unit. Each DU can store all metadata related to the single project activity: information about the authors and time period, for example. Each DU is georeferenced relating single records to site location following standard house codes used by GIS. This approach allows users to search for documentation based on location or on content. For each DU a full archive of files can be attached in order to store the documentation permanently.

In addition to the database structure, a series of graphic user interfaces has been created for the management of data within the GIS. A second section of the database has been dedicated to the conservation planning to allow users to interact with the documentation related to the activities planned for protection, stabilization, and maintenance of the mosaics (fig. 8).

FIGURE 8
Database main menu for documentation management (Akhet)

1.2 Mosaic Rapid Survey

As mentioned above, the first step in any site conservation planning activity is the gathering of information about the site's elements and their context to assess condition, significance, and degree of exposure or risk.

A rapid survey form was developed for this planning purpose (appendix A). Each line, rather than page, of the Excel format form is for one mosaic in order to keep all the mosaics of a building together on just one or at the most two pages. In the first section (colored green), one compiles data about the mosaic itself, an inventory (ID) number, type of mosaic, and square meters of surface. The inventory numbering system follows that developed for GCI technician training courses, which consists of the mosaic's location in a numbered room, of a named building (abbreviated), at a named site (abbreviated) (Alberti, Bourguignon, and Roby 2013).

In the second section (blue), one records the areas of the most significant or critical structural and surface conditions. This assessment is the basis for determining a condition rating for each mosaic and does not rely on carrying out a more time-consuming detailed condition survey. In the third section (yellow), the form calculates the number of workdays required to carry out stabilization work for each mosaic, based on the percentage of critical areas of the tessellatum, and depending on whether the mosaic will be left exposed or reburied. The workday evaluation is based on the experience of the GCI-trained technicians at the site since 2008 and their demonstrated pace of work. With this third section of the form, an approximate timeline and work plan of conservation activities can be produced, and in this way the survey form is more than an assessment method; it is a planning tool in itself. The conservation works can be prioritized using the survey form results and can be programmed over time based on the estimated days of work.

On the second page of the survey form the condition rating is carried over (the blue section), and the significance (the yellow section) and degree of exposure (the orange section) of each mosaic are assessed. For the survey to be as accurate and useful as possible, assessments of archaeological and art historical significance should normally involve an archaeologist or art historian with expertise in the history of mosaics, both locally and in a broader context. The assessment of degree of exposure seeks to provide a rating for how much a mosaic is exposed to the environment, considering factors such as whether the mosaic is in open air, sheltered, or reburied, and other factors such as aspect and slope of the surrounding terrain, and height of surrounding walls. The degree of exposure to visitation is also part of the assessment, considering the estimated number of visitors who pass by the mosaic and whether they are free to walk on the mosaic or whether access is limited by physical barriers or walkways.

These three categories of mosaic assessment are then combined to arrive at an overall conservation priority rating for each mosaic, from 0 to 100 (pink section). Rather than simply adding the three ratings together, which would produce an average among them, it was decided that a more correct method of calculating a conservation priority rating was to multiply the exposure rating by the addition of the condition and significance ratings. In this way, the ratings that represent characteristics of the mosaic itself (condition and significance) are treated differently from the rating of the external factors (degree of exposure) that act on the mosaic.

The overall conservation priority rating calculation also involved using a weighting system to give additional importance to the condition of the mosaic in relation to the other assessment categories. Weighting the condition rating in our case seemed appropriate because the priority rating is a basis for conservation planning, as opposed to management planning, where significance might be given more importance over condition as part of a values-based assessment survey. For conservation planning at Bulla Regia, it was decided to give condition a weighting of 4, while significance was given 2, and degree of exposure, 1. The weighting can be changed according to the aims and objectives of the survey as well as the conditions at a site. For example, for the purpose of management planning or at a different site where the mosaics are generally stable and in good condition, significance might be weighted higher than condition, resulting in very different overall priority ratings.

The time required for the survey per mosaic was not more than one hour, with two people, including the photography. So, while the survey form required considerable data to be collected, and time to understand the terminology and become efficient in its use, it was still a rapid survey. The survey methodology was developed for a large site with many mosaics and was considered a pilot project of its own. Because of its complexity and concerns about the uniformity of the data obtained, the collection was carried out by a restricted number of GCI conservator team members. The experience showed that this type of extensive survey data collection should be done by a small multidisciplinary team that included conservators and specialists from other professions: archaeologists and conservation architects or engineers.

An instruction manual and glossary of terms to accompany the survey form was also developed to ensure consistency in the field data collection by the project team, and as a reference document in the future (appendix A). It is recognized that survey data collection can produce different results depending on the knowledge and experience level of the surveyor. In this case survey team members compared their initial survey results with each other to make sure they were consistent. Despite the internal checking, some priority rating results seemed out of balance or sometimes incorrect compared to other mosaic priority ratings. In these cases, the survey data was verified on-site and adjusted as needed.

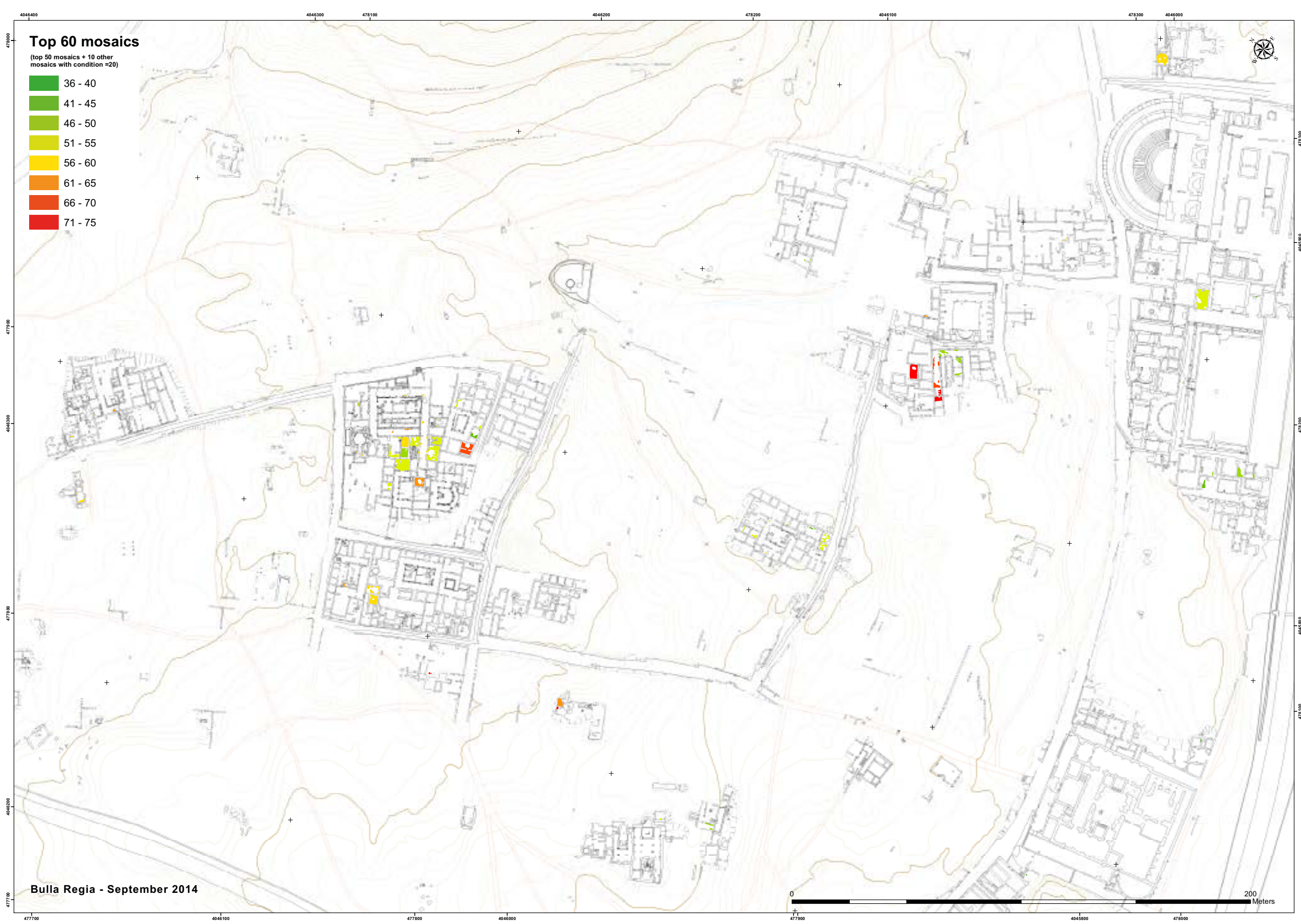


FIGURE 9
Map of highest priority mosaics (Akhet)

The survey data collected on paper on-site were transferred in digital form in Excel, as it is a simple and efficient calculation software. Once finalized, the survey data were then transferred to Access software, and ultimately incorporated into the GIS developed for the site.

The analysis of the mosaic survey data has resulted in an initial proposed plan of emergency conservation work over six months, aimed at stabilizing and protecting the sixty mosaics at the top of both the overall Priority List and the Condition List (fig. 9). The decision to also include mosaics in the worst condition, despite where they fell in the level of priority, ensured that they received needed conservation care in the short term. The proposed actions in this initial urgent phase included protection of mosaics with temporary coverings of cushions of sand, first-aid stabilization, and stabilization followed by short- or long-term reburial. The installation of perimeter fencing around eight selected buildings with large numbers of mosaics with high priority ratings and/or that posed serious risks to visitor safety was planned; and several fences were executed. The conservation technicians were provided with an initial work program that was discussed and prepared with the manager of the site (appendix E). The program included the work location, the operations to be carried out by each type of personnel, and the approximate time needed.

1.3 Mosaic Conservation Long-Term Planning Criteria

After the short-term planning for urgently needed protection measures and stabilization interventions across the site, the long-term mosaic conservation planning was carried out. The principal criterion for the planning was sustainability in the long term. For this reason, the implementation program and timeline were based largely on the available personnel and resources at the site at the time, assuming that the current staffing of technicians, workers, and masons, as well as budget levels, could be maintained.

Given the large size of the ancient city and excavated part of the site, the subsequent work program was also developed considering geographical location, so that the work could be carried out more efficiently without having to prepare worksites in disparate locations simultaneously. Annual maintenance was also built into the planning of the implementation program. The number of mosaics to be maintained will steadily grow each year following their initial stabilization until the multiyear stabilization program has been completed, and then only maintenance activities will be carried out throughout the site and throughout the year. To reduce the maintenance needs of mosaics to enable the available staff to carry out the maintenance of all mosaics once stabilized during one year, the reburial of many selected mosaics in the different buildings, and also entire buildings not to be presented, has been planned. The maintenance needs of a reburied mosaic are far fewer than the needs of an exposed mosaic, as previous experience has shown. And therefore reburial is a critical component to the sustainability of the conservation plan for mosaics at the site of Bulla Regia.

1.4 Mosaic Conservation Planning at the Building Level

Given these criteria, and the need to rebury many mosaics on the site to conserve them, it was necessary to first decide which buildings will be presented to visitors and which will be protected and preserved by reburial (fig. 10). These decisions were based on a variety of broader site-wide building assessment criteria including significance, condition, threats, and location within the site.

Once a decision was made by the project partners about whether a building will be presented or reburied, a visitation plan was created for those buildings to be visited. This included defining the areas of public access, which mosaics would be left exposed and maintained, which were to be reburied, and which were to be protected by a shelter. The basic principle of any visitation and protection plan is that for conservation reasons, visitors will not be allowed to walk freely and directly on mosaics, either by means of shallow reburials, access barriers, or coverings with mortar or matting.

Building Conservation Planning Form

A Building Conservation Planning Form was developed to plan conservation interventions and protection measures for houses and other buildings intended to be presented to the public (appendix F). It is a useful tool to collect and organize data to estimate the workdays and materials necessary for the conservation interventions and general presentation of a whole building. The first page deals with rooms with mosaics, including the treatment of large lacunae; the second, rooms without mosaics, such as *cocciopesto*, stone slab pavements, or without flooring. The third page considers the stabilization of walls and wall plasters, and other operations that can be carried out by workers and technicians available at the site. Conservation projects requiring other types of personnel are also listed on the third page. These Specialist Projects include structural interventions, water drainage, shelters, and conservation of wall paintings, among others. The fourth page of this Building Planning Form summarizes all the work to be carried out (normal and specialist projects) and the work time of the site personnel required.

The conservation planning at a building level, facilitated by the Form, is needed to put the conservation of mosaics in its architectural context, and to plan holistically while integrating the conservation activities with presentation and protection strategies for each building and the site as a whole that take into account the management context and available resources.

1.5 Mosaic and Building Presentation and Protection Measures

Together with conservation interventions, visitor access and presentation methods were developed for each building to be presented, guided by the principle that to prevent damage no presented mosaics should be walked on by visitors. To achieve this, a combination of access barriers and walkways and mortar coverings has been proposed, along with shelters where considered necessary. To avoid a single prescribed visitor path through a building and provide freer visitation to the buildings, different designated points of entrance or exit were proposed, along with viewpoints where limited signage is to be installed. More information about the building and the mosaics should be found through pamphlets at the site entrance to keep on-site signage to a minimum. The protection and presentation elements of walkways, access barriers, and signage should follow the design criteria of sustainability by using low-cost, locally available materials that are easily maintained. They should also be designed to not damage the archaeological remains

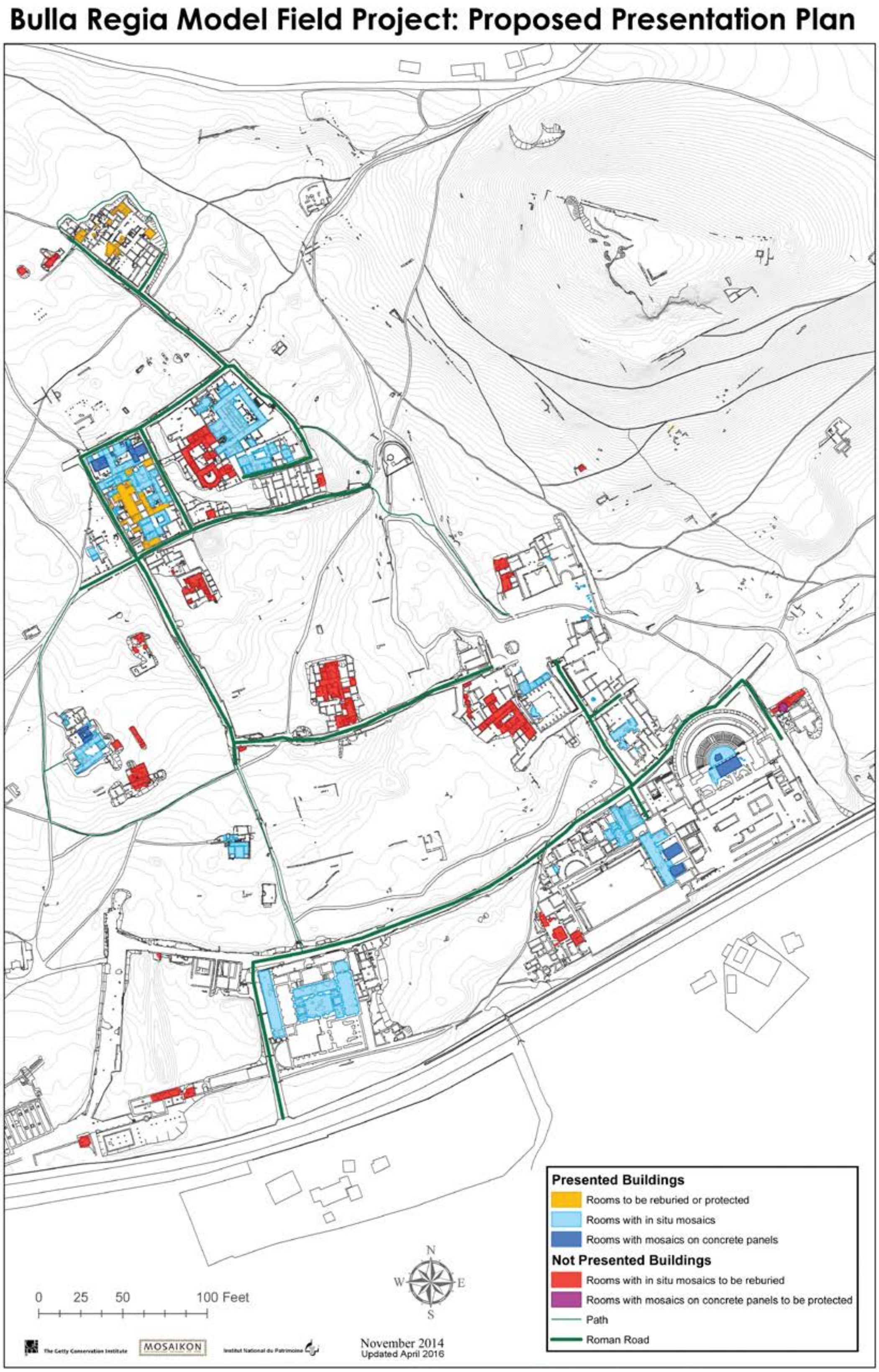


FIGURE 10

Building Presentation Plan (Akhet, base; Livia Alberti, Ermanno Carbonara, Leslie Friedman, and Thomas Roby) and produce a minimum of visual interruption of the site. The same criteria should also be applied to the design of protective shelters where required on-site.

By the end of the project, long-term conservation and presentation plans have been developed for all buildings with mosaics at the site to guide future work (appendix G).

1.6 Site-Wide Mosaic Conservation Plan in Three Phases

Within the context of planning at a building level, the mosaic conservation planning was carried out following several principles: visitation of the site without walking on mosaic surfaces, protection of mosaics by shelters and reburial, and regular maintenance of those left unprotected in the open air. These principles constitute a partial change from current practice, where there are no shelters, and visitors (and animals) can walk throughout the site, except in a few underground locations when a gate is locked to prevent all access. Through a variety of proposed protection measures—access barriers, reburials, and occasionally walkways and building perimeter fencing, visitors will view mosaics without walking on them. Information panels at the entrance to the site that will explain this policy to visitors are proposed.

Despite the lack of local precedents, the plan proposes thirty-eight new shelters over selected mosaics where reburial is not advisable. Such mosaics include those located in basins, those on reinforced concrete panels, and those with structural condition problems. The proposed shelters are intended to provide a protective function only, without an interpretive or reconstructive function, to limit the cost and their visual impact on the site.

There are several mosaic reburials already at Bulla Regia and at other sites in Tunisia, and many more are proposed in the plan, as it is the most effective and least costly measure of protecting mosaics from the environment and from visitors walking on them. There are 186 additional reburials proposed following stabilization of the mosaics. This will allow the current technician workforce to more quickly complete the mosaic stabilization work, since experience has shown that pre-reburial stabilization takes approximately 30% less time than stabilization of a mosaic to be left exposed and maintained. Subsequent maintenance time is also reduced because less time is needed to maintain a reburial. Less than half of the square meters of mosaics on-site will be left unprotected from the environment by either shelters or reburials; their preservation will rely on maintenance by the mosaic conservation technicians of the site.

Phase 1—Temporary Protection

The first phase of the Bulla Regia Conservation Plan aims to temporarily protect all mosaics from visitors (and animals) walking on them, by installing temporary access barriers and mosaic coverings, by erecting fencing around an entire excavated building or part of a building, and by carrying out short-term reburials. These temporary protection interventions are estimated to require ten months to implement, given the presence of the four technicians, plus four workers to install fencing for buildings and access barriers for rooms (appendix H). A cost estimate of labor and materials for the technician and worker activities and localized temporary protection measures of Phase 1 was calculated in 2017, based on previous project experience on-site. All labor, both staff salaries and external daily wages, would cost about 34,000 Tunisian Dinar (TD), and materials would cost nearly 11,000 TD, for a total of almost 45,000 TD or approximately 15,000 euros for the first phase.

Phase 2—Stabilization

In the second, multiyear, phase of the plan, all mosaics and other pavements, as well as walls and other building remains across the site, will be stabilized (appendix H). Those buildings to be presented to visitors will be stabilized in a controlled manner, protecting mosaics long term by a combination of access barriers and reburial, and occasionally by walkways. Calculations of work time for stabilization followed by maintenance have been summarized in a planning data table that led to the production of a timeline of the conservation program. During this phase, every six years a condition survey of each mosaic will be made again, using the Rapid Survey Form over a three-to-four-month period, and the conservation plan will be modified as needed to program any new first-aid or emergency treatment work.

The entire estimated time required to achieve stable conditions is seventeen years for all mosaics and other architectural remains, during which all initial stabilization treatments will be carried out. After that each mosaic will be maintained once a year, until only maintenance is required. The considerable length of time, as described above, is based on the number of conservation technicians currently working at the site on conserving mosaics and other pavements and wall plasters. It also is based on the presence of two masons and two workers to stabilize walls and rooms without mosaics, and to assist the technicians with large mortar infillings of pavements and the treatment of *cocciopesto* pavements, as well as mosaic drainage and reburial interventions. Vegetation control at the site has been planned based on two campaigns per year, in March–April and September–October, requiring a group of twelve to fifteen seasonal workers.

Phase 2 also includes conservation interventions and protection measures that cannot be carried out by current site personnel because they require different professional training and profiles, such as architects, engineers, and conservators. Specialist projects site-wide have been included in the conservation plan following four main categories of intervention: protection measures, such as shelters; conservation, such as wall paintings and carved stone treatments; structural and hydrological interventions; and site presentation, such as design and installation of information panels.

As with Phase 1, work time estimates for technician activities and cost estimates of labor and materials for initial stabilization work and maintenance, per building, have been calculated. The cost of Phase 2 labor, mainly staff salaries, is estimated at 1.5 million TD, and materials at 168,000 TD, for a total of about 1.7 million TD or 560,000 euros, which comes to about 33,000 Euros (96,000 TD) per year.

Phase 3—Maintenance

This final phase of the conservation plan begins when all the mosaics and structures have been stabilized, which is estimated to take place in the eighteenth year. In this phase the site is divided into ten areas, rather than by building, so that the work is less dispersed across the site and is carried out more efficiently. The complete maintenance cycle of the site can be accomplished over two years, based on the same number of personnel as in the previous phases, as well as the twelve to fifteen seasonal workers for vegetation control (appendix H). During this phase, the future rotation of exposed and reburied mosaics will be considered and incorporated into future maintenance plans. The exposed mosaics (1,350 square meters), and those protected by reburial, under a shelter, or under an ancient structure (1,670 square meters) can be maintained during one year, while the walls (10,000 linear meters, or 38,500 square meters of wall surface) can be maintained over two years. Shelters and other protection measures are planned to be maintained twice each year, in the spring and fall, during an estimated month and a half. Vegetation control, as in the second phase, is based on two months of work each spring and fall.

Cost estimates for labor and materials for maintenance of mosaics and walls, protection measures, and vegetation control site-wide have been calculated, as in the previous phases. The total cost of labor for Phase 3 is about 117,000 TD, with materials about 16,000 TD, for a total of about 133,000 TD or 45,000 euros, or about 23,000 euros (67,000 TD) per year.

The calculations of conservation work time at Bulla Regia have shown how much more time is needed to stabilize mosaics in poor condition than to subsequently maintain them. With four technicians available, it will take seventeen years of stabilization followed by maintenance cycles to reach a point where the technicians can maintain all the mosaics over one year. Given the total conservation plan costs and time, it is evident how much greater the cost of labor is compared to materials (about 30,000 euros per year compared to about 3,000 euros per year) (appendix H). Therefore, it is in the best interest of conservation authorities to have a level of staff sufficient to stabilize and then maintain a site in the long term, rather than contracting out to external labor.

Experience at Bulla Regia has shown that the site requires a range of profiles and personnel numbers to carry out such a conservation plan effectively. Under the direction of a site manager/director, the site needs an administrator, a conservator to supervise four conservation technicians, a foreman to supervise two masons and two workers, and ten to twelve guards. Workers could be hired externally and seasonally for site vegetation control.

Unfortunately, the conservator profile is the one profile still lacking at Bulla Regia, as in the region generally. Government cultural heritage authorities need to officially recognize the conservator profile and encourage the training of conservators in multiyear programs, for now, mostly outside the region. With more trained conservators employed at sites in the region, more significant advances can be made in conservation planning and implementation for mosaics on archaeological sites in the future, and this planning example can be a useful point of reference.

The planning has taken into consideration the personnel and budgetary resources of the INP for its implementation to be feasible and sustainable, and not to rely on special project funding from outside the government. If site staffing and budgets cannot meet the work programming of the plan, it remains a flexible management tool that the INP can adjust according to their future resource constraints .

The site-wide mosaic conservation planning component of the project has been summarized in publications during the project, first as a poster at the IIC 2012 Congress (Roby et al. 2012), and then in the proceedings of the 2011, 2014, and 2017 ICCM conferences (Roby et al. 2017a, 2017b, and 2020).

PROJECT COMPONENT 2:

CONSERVATION IMPLEMENTATION

The implementation component of the Bulla Regia project focused initially on conserving the architectural remains of an entire building with mosaics in order to provide a physical example of best practices of conservation in situ and presentation to visitors. Later, a complementary part of the implementation objectives of the project was to provide an example of long-term protection of a building with mosaics by reburial that had been decided not to be presented to the public, based on the site-wide survey and assessment.

2.1 Conservation, Protection, and Presentation of the Maison de la Chasse

Following the structural interventions carried out by the WMF in the two-story peristyle of the Maison de la Chasse, it was agreed that the GCI team and the trained conservation technicians would take on the comprehensive conservation of the mosaics and other pavements, walls, and wall plasters of the rest of the Roman house, as well as the planning and implementation of protection and presentation measures. The mosaic conservation work was carried out primarily by the local team of technicians employed by the INP for work on the site under the supervision and planning of the GCI team during their fall and spring missions, while working independently during the rest of the year.

Mosaics

The first step in the implementation of mosaic conservation work in the Maison de la Chasse was to decide which mosaics would be left exposed and presented to visitors, and which would be protected by reburial. The decision was based on the location of mosaics within the building, with reburial to be carried out where visitors would need to be able to walk to access other parts of the building, and where mosaics were not visible from accessible areas of the building. The decision to rebury a mosaic was also based on the condition assessment and whether the mosaic was considered too fragile to be left exposed, despite future regular maintenance. Once the rooms remaining open to visitation were specified, a proposed visitation plan was developed following the principle that visitors will not be allowed to walk freely and directly on mosaics, but they will not be forced to follow a prescribed route through the building. Visual access will be provided to almost all of the building, while physical access to rooms with mosaics will be controlled by the installation of access barriers primarily (figs. 11a, 11b, and 11c).

FIGURES 11A , 11B AND 11C

Maison de la Chasse Visitation Plan (left, with other houses above and to the right) (11A), Maison de la Chasse, ground (11B) and underground (11C) levels (Akhet, base; Livia Alberti, Ermanno Carbonara, Leslie Friedman, and Thomas Roby)

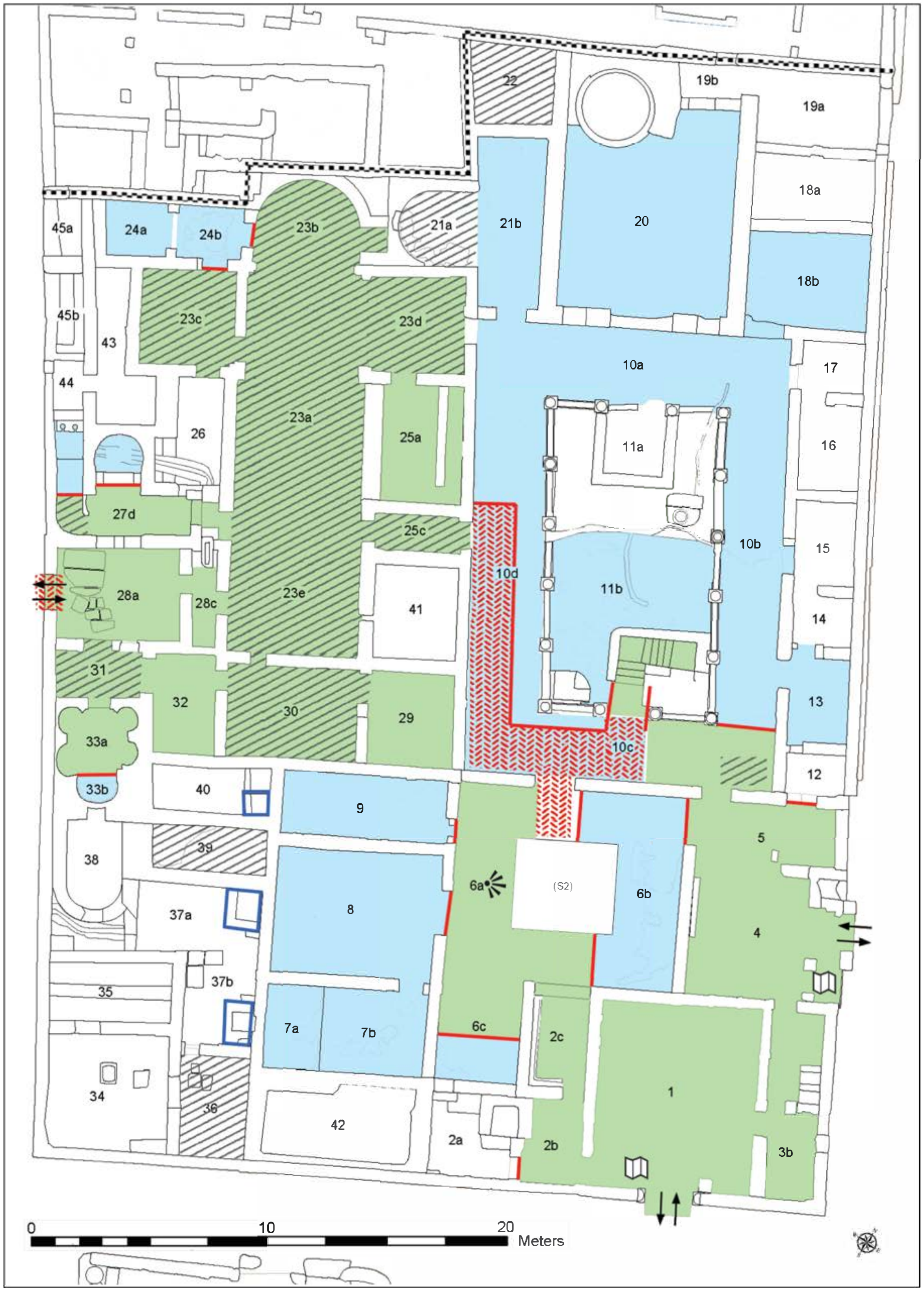


FIGURE 11 (B)

Maison de la Chasse Visitation Plan, ground level

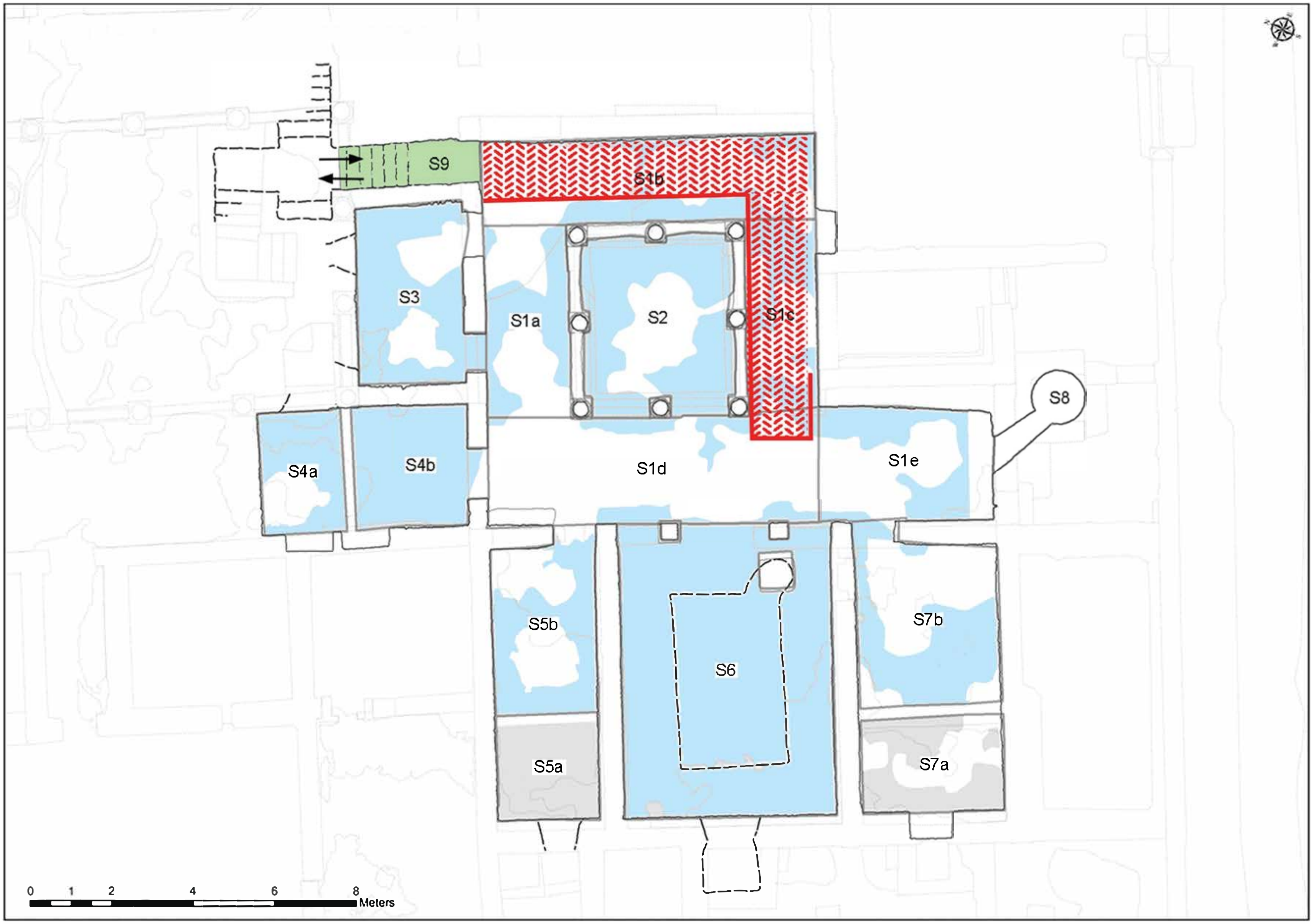


FIGURE 11 (C)

Maison de la Chasse Visitation Plan, underground level

In the case of the north peristyle on the ground floor of the building, instead of a possible walkway, a covering of mortar was proposed as protection over one corner where mosaics were present, and three different separation membranes between the mosaic surface and the mortar layers (3 cm thick) were tested. In the underground peristyle, a different protection measure was tested, using two types of rubber mats over a layer of geotextile in contact with the mosaic, to prevent visitors from walking directly on mosaics while not creating an impermeable barrier in contact with the surface. The results of both tests were positive, but the aesthetic aspect of the mats did not satisfy the partners. Other than these measures to protect mosaics in parts of peristyles where visitors would want to circulate, the access barriers and walkways, signage, and small shelters for light and air wells (all protection or presentation elements requiring design) were developed by GCI project architect interns over two years. The design elements utilized locally available and easily maintainable materials and were presented as prototypes to the INP at the end of the project (appendix K).

The conservation interventions in the Maison de la Chasse were carried out over several years and included a training worksite during the spring of 2012, when one of the four modules of the MOSAIKON regional technician training course in El Jem, Tunisia, was carried out there. The mosaics were cleaned mechanically by scalpel and by water and brushes, and were stabilized using lime-based mortars of lime putty and hydraulic lime produced in Tunisia, as well as by locally available sand and crushed limestone of various colors and grain sizes (fig. 12).

FIGURE 12
Stabilization of mosaics, Maison de la Chasse (Scott Warren)

The conservation treatments on the mosaics and other pavements demonstrated the conservation approach of the GCI, of minimum intervention with compatible lime-based materials, as well as the practical conservation skills of the trained technicians who carried out the vast majority of the treatment work while performing documentation of conditions and then their treatments.

Drainage

As with all other conservation interventions, structural and surface condition recording of pavements has been carried out as a first step, in order to plan the preventive measures such as drainage. In this case, the condition recording was also accompanied by mapping of water pooling after a significant rain event. This mapping informed where the drainage pits or channels should be carried out to lessen this phenomenon in case the pavements remained exposed. Particularly necessary were drainage interventions in the large and small peristyle on the ground floor, and in the peristyle of the underground floor. WMF consultant Studio Massari was brought in to assess the ancient drainage system and to determine if and how it could be reutilized, especially in the underground level. After some excavation was carried out to explore and clear the ancient system, supervised by the INP site director, a drainage pit was designed and constructed in the impluvium or central part of the underground peristyle. Two years later, in 2015, the GCI completed the drainage system to improve its functioning here and in rooms on the ground floor, including using a PVC perforated tube and perforated aluminum disc to construct a drainage pit in one room (fig. 13). The conservation interventions in both the ground floor peristyles required careful planning and execution so that the levels of the large mortar infilling repairs of lacunae of the mosaics sloped down to drainage channel pits or channels through adjacent walls.

FIGURE 13
Drainage pit within a room with a mosaic, Maison de la Chasse (Ermanno Carbonara)

Reburial

The other common preventive measure used to protect and conserve mosaics—and other pavements or mortar foundations of pavements in rooms where the surface no longer survived—was reburial (fig. 14). Such an intervention was carried out selectively in the Maison de la Chasse to reduce the need for maintenance of pavements, to protect them from the environment if they were particularly vulnerable, and to protect them from being walked on by visitors accessing other parts of the buildings. The design of a reburial depends on many factors, such as the degree and type of environmental exposure and whether salts from the ground are present, but also on whether the reburial is intended to be in place for the short term or long term. In many cases, in the Maison de la Chasse and elsewhere on-site, the reburial design involved an initial layer of

FIGURE 14
Reburial of lost part of pavement with a sand layer, non-woven geotextile separation membrane, and gravel layer covering, Maison de la Chasse (Ermanno Carbonara)

quarry sand on top of which was placed a separation membrane of a non-woven polyester fiber geotextile, obtained locally but imported from Italy, on top of which was placed a layer of limestone gravel to prevent the erosion of the sand layer and growth of vegetation within it (fig. 15). The sand and gravel were obtained locally, as their transport was the major cost consideration. The sand chosen was of small particle size, to ensure capillary rise of moisture through it, and of low clay content, so it would not absorb and hold moisture instead of allowing it to move through the sand.

FIGURE 15
Reburial with a gravel layer over a separation membrane of non-woven geotextile, Maison de la Chasse (Ermanno Carbonara)

In connection with reburial interventions planned and implemented on-site, it was decided to carry out field testing and monitoring to inform reburial design, especially the depth of fills required to obtain a stable moisture and temperature environment. In one room of the Maison de la Nouvelle Chasse, a mosaic pavement was reburied, and moisture and temperature sensors were placed at different levels in the stratigraphy. Unfortunately, the information collected in the data-loggers was not consistently obtained during the period between campaigns and was unreliable.

Walls and Wall Plasters

Because of the comprehensive nature of the conservation of all the excavated remains in the Maison de la Chasse, interventions to stabilize all the walls and wall plasters in the house were planned, and most were implemented. A training module on wall and wall plaster conservation treatments was included in GCI-INP technician training courses; therefore all of the wall plaster work and some of the wall conservation work was carried out by the technicians. Because of the volume of work on mosaics and wall plasters and the presence of an INP mason on site, the wall stabilization work was carried out largely by a mason and workers who had not undergone formal training by the GCI or the WMF but were supervised. Treatment trials on wall faces and wall tops were carried out under the supervision of the GCI and in coordination with the INP and WMF, including pointing with lime mortar between rubble stones and the replacement of missing stones on both wall faces and tops or caps (figs. 16 and 17). On wall faces the replacement stones were positioned at the same level as the original, while on wall tops the cappings with stones and mortar were placed so that rainwater would flow off the top and down the wall face, rather than pool on the wall top. Before the trials were carried out, the proposed local mortar materials of lime, sand, and gravel were analyzed and characterized in the GCI Science laboratory by Beril Becir-Simsir, and then mortar mixes were tested mechanically to verify their appropriate use on site (appendix I). The approach to the conservation of walls was to stabilize the surfaces of the walls without adding to their height with additional rows of rubble masonry. Several of the walls had been restored or capped previously, and these modern parts were generally not removed, even if carried out with cement mortars, but they were stabilized as needed.

FIGURE 16
Mortar repair stabilization of wall faces (Livia Alberti)

FIGURE 17
Mortar repair stabilization of wall faces and tops (Ermanno Carbonara)

The wall plaster remains in the Maison de la Chasse are mostly in the underground floor, where they have been protected by the ancient ceilings of the rooms that still exist. The wall plasters have been treated in the past with edging repairs using mortars, normally cement ones. In these cases, the previous repairs were removed for both conservation and aesthetic reasons, and new lime mortar repairs replaced them. This work was done by the trained technicians, as were the grouting operations used to fill voids and areas detached behind the surface layer of plaster (fig. 18). The liquid mortar used was not a proprietary or imported

FIGURE 18
Mortar repair and injection grouting stabilization of wall plasters (Scott Warren)

one but was composed of very fine stone powder obtained locally from Bir Halima quarry, as well as hydraulic lime and lime putty.

Additional Architectural Elements

Another significant architectural element in the house that was addressed by the GCI was the conservation of the Chemtou marble columns in the large peristyle on the ground floor. The conservation of the load-bearing columns in the small peristyle on the underground floor had been done by the WMF previously, but the free-standing columns on the ground floor of the large peristyle had not been conserved. Here, treatment trials were carried out to clean their surfaces, fill cracks and areas of loss, and consolidate the surfaces where needed, but the premature end of the project prompted by security concerns prevented the treatments from being carried out to the surfaces of the columns other than cleaning (fig. 19).

FIGURE 19
After cleaning treatment of Chemtou marble columns, Maison de la Chasse (Ermanno Carbonara)

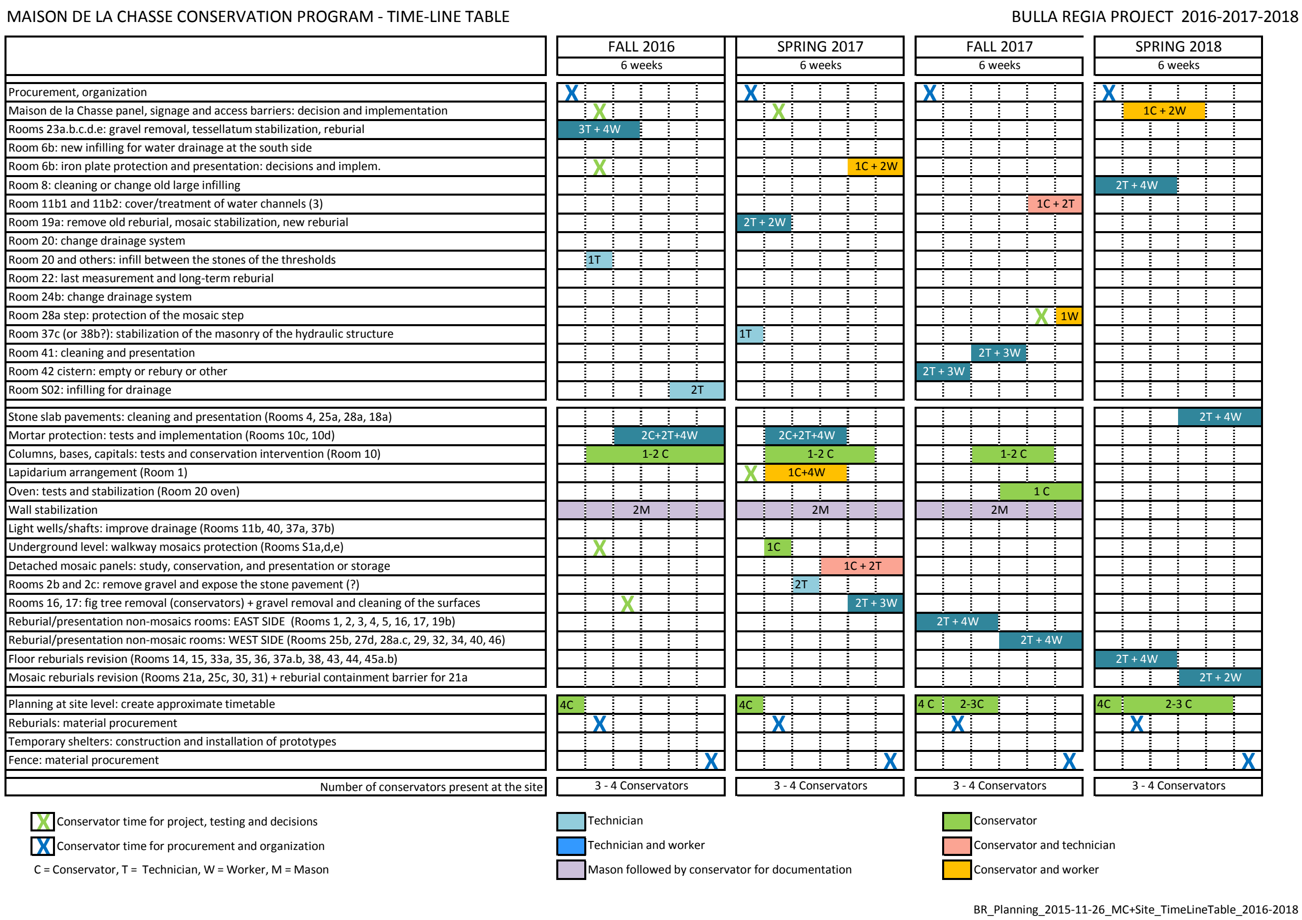


FIGURE 20

Maison de la Chasse conservation program (uncompleted) (Livia Alberti, Ermanno Carbonara, Leslie Friedman, and Thomas Roby)

The ground floor of the Maison de la Chasse contains a later addition to the house composed of a circular wall in earth, thought to be an oven or kiln. This was one building element that was not subject to conservation activities at all because of lack of time to finish the project. This and other conservation treatments to finish all the other elements and interventions to present the house to the public were planned for the future but were not completed (fig. 20). Despite the incomplete nature of the implementation of conservation and presentation interventions in the Maison de la Chasse, all of the mosaics and other pavements and wall plasters in the building were stabilized and in some cases also underwent maintenance operations during the years of the project. The results of the technician's considerable skills and effort have significantly improved the condition of an entire building and provided a conservation model for future treatment of other buildings to be preserved and presented to site visitors (figs. 21a and 21b).

FIGURE 21A
Ground floor peristyle of Maison de la Chasse after conservation of the mosaic pavements and columns (Ermanno Carbonara)

FIGURE 21B
A room in the Maison de la Chasse after conservation of the mosaic pavements, walls, and wall plasters (Ermanno Carbonara)

Conservation Intervention Protocols

The many years of conservation intervention experience in the Maison de la Chasse were the basis for establishing protocols for interventions on mosaics and other architectural remains throughout the site. The interventions on mosaics included first-aid stabilization, consisting of primarily edging repairs, less than complete stabilization of the tessellatum ahead of long-term reburial, almost complete stabilization ahead of short-term reburial, and complete stabilization for those mosaics to be left exposed. In addition, protocols for stabilizing mosaics relaid on concrete, and for maintaining mosaics once stabilized, were also developed.

Given the comprehensive nature of the conservation interventions on all the architectural remains found in the Maison de la Chasse—masonry walls, wall plasters, and other types of pavements and stone elements such as columns—an extensive list of protocols for all the interventions carried out there were developed as a reference guide for the site staff (appendix J). The interventions also include preventive ones such as reburial, short-term and long-term, as well as temporary protection coverings. To prevent the accumulation of rainwater on pavements, protocols for drainage by the construction of both channels and pits were developed, as were protocols for preventing vegetation growth by herbicide treatments and manual removal, as well as fence construction to prevent the entrance of visitors and grazing animals.

2.2 Conservation Interventions throughout the Site

While the main implementation goal of the project was the conservation and presentation of the Maison de la Chasse, the GCI team also collaborated with the WMF and INP on conservation activities where they had decided to construct shelters or vaults and where the mosaic survey had indicated the highest priority mosaics should be stabilized, protected, or both.

Maison de la Nouvelle Chasse

The WMF and the INP decided to design and implement a protective shelter to protect mosaics at the site, the first such shelter in Tunisia. It was decided to do so over the relaid mosaics of the triclinium (room 13) in the adjacent Maison de la Nouvelle Chasse because of their significance due to the figural decoration of the mosaics. The idea was to extend the model implementation field project to include not only the Maison de la Chasse but also the entire insula composed of the two houses. As a result, a conservation and presentation plan for the Maison de la Nouvelle Chasse was also undertaken by the GCI (fig. 22), taking into account the protective shelter to be constructed over the mosaics in the triclinium. The planning included a specific treatment and worksite training proposal for the removal of the reenforced concrete support panels of the mosaics and the relaying of the tessellatum on lime mortar foundations. These interventions were considered necessary to better protect and present the mosaics under a shelter, as the corrosion of the reenforcing iron rebar, while not advanced, would continue because of the decades of exposure they had been subject to, regardless of whether the mosaics were to be protected in the future by a shelter. The shelter designs proposed by the WMF project team were never entirely accepted by the INP, so the conservation work on the mosaics, walls, and wall plasters in the Maison de la Nouvelle Chasse was not carried out, with the exception of the stabilization and reburial of a priority mosaic in room 14, before the deteriorating security situation in the region of the site effectively ended the project.

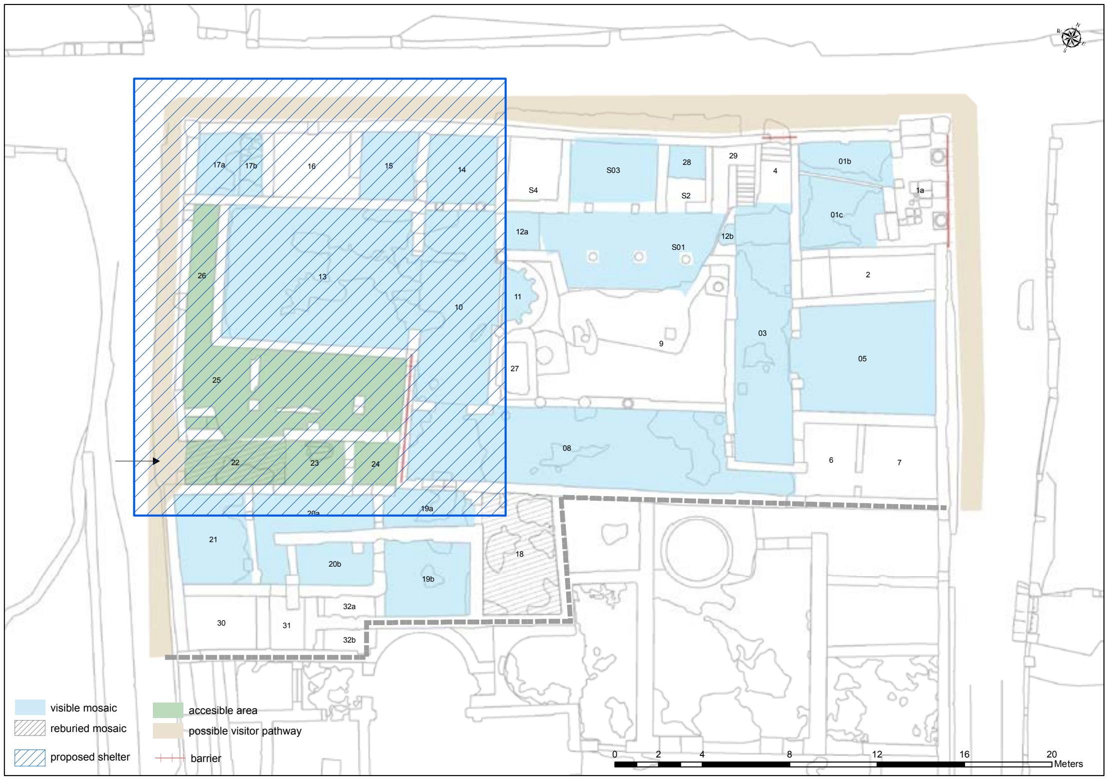


FIGURE 22
Maison de la Nouvelle Chasse conservation and presentation plan (Akhet, base; Livia Alberti, Ermanno Carbonara, Leslie Friedman, and Thomas Roby)

Maison d'Amphitrite

Another WMF-INP project at the site was the protection of the mosaics in the one uncovered underground room (S2) of the Maison d'Amphitrite. Proposals were made to construct a shelter or reconstruct a masonry vault over the exposed room, but again an agreement was not reached with the INP partner on how to proceed with the work. In preparation for the vault reconstruction or shelter, it was considered necessary to stabilize the mosaic pavement and wall plaster decoration at the base of the ancient walls and to install protective covers to prevent damage during the wall stabilization and vault or shelter construction. The technician trainees performed the stabilization work on the mosaic and wall plasters, as they had done in the Maison de la Chasse (fig. 23), but then the WMF work was not begun, and the protection plan developed and coverings designed were not implemented.

FIGURE 23
Stabilization of wall plasters by grouting, Maison d'Amphitrite (Ermanno Carbonara)

In winter-spring 2015 heavy rains in the region caused the water table to rise temporarily, which led to severe flooding of over a meter of clear spring water in the subterranean rooms of the Maison d'Amphitrite, including the room (S2) where the mosaic and wall plasters had been recently stabilized by grouting and edging repairs. With the aid of pumps, the floodwaters eventually receded, and it was possible to inspect the rooms. A report on the condition of mosaics, wall plasters, and walls in the underground floor was prepared, as were graphic documentation bases of walls to facilitate the condition and intervention recording by the technicians. The stabilized mosaic and wall plasters in room S2 were still in fair condition, despite some new areas of detachment, but the wall plasters in the other underground rooms were not, so they were the object of first-aid stabilization treatments by the technicians. No further flooding occurred during the project, but recommendations were made to the INP to consult with a hydraulic engineer to determine what preventive or interventive measures could be taken to prevent future flooding at the site.

Maison de la Pêche

Maison de la Pêche was another house where the WMF team carried out conservation interventions, particularly to improve drainage where rainwater impacted the condition of the building in both the underground and ground levels. This was another building where it was decided it would be presented to visitors, and therefore the second decision to be made, as with the Maison de la Chasse and the Maison de la Nouvelle Chasse, was which mosaics would be left exposed for presentation to visitors and which mosaics would be reburied. The mosaics to be reburied were located where visitors would need to walk, were not visible from areas to be accessed, or were too fragile to be left exposed. The mosaics to be reburied for the long term were stabilized first by the technicians with edging and infilling mortar repairs (fig. 24), while those to be left exposed were

FIGURE 24
Stabilization of a mosaic prior to long-term reburial, Maison de la Pêche (Ermanno Carbonara)

stabilized to a greater extent with additional and more extensive repair treatments so the surfaces could be more resistant to environmental exposure.

In addition to the stabilization of priority mosaics in the most significant and visited houses described above, other houses received conservation treatments as part of the initial phase of the conservation plan to address those mosaics with the highest priority for conservation, as determined from the survey results of condition, significance, and degree of exposure. The other houses included Maison 3, where a protective perimeter fence was also constructed to prevent access by people and domesticated animals, and Maisons 4, 8, 9, and 10.

2.3 Stabilization and Reburial of Mosaics in a House Not to Be Presented, Maison 4

In addition to providing a model example of conservation and presentation of an entire building with mosaics, it was also the aim of the Bulla Regia project to provide an example of the stabilization and reburial of an entire building not to be presented to the public. The conservation planning for the site included not presenting selected excavated buildings, and therefore it was considered important to provide an example to follow elsewhere at the site.

Maison 4 was chosen not to be presented, along with other buildings, because it is not located along the normal visitor routes of the site, and because it is in an area susceptible to seasonal flooding. It does not have mosaics of high significance, and they were generally in poor condition, as they had largely been abandoned since their excavation.

Some of the mosaics were the subject of first-aid stabilization treatments, while others were protected temporarily by coverings of bags of non-woven textile filled with sand. A fence was erected around the house to prevent animals from entering it, as they often did to gain access to a nearby source of drinking water. The mosaics were then cleaned of dirt and vegetation and stabilized by the technicians (fig. 25). The stabilization treatments were not completed to the extent that would be done to protect a mosaic if it were to be left exposed and presented to the public.

Following the stabilization treatments to the priority mosaics and the adjacent walls, the mosaics and the entire rooms in which they were situated were reburied with layers of sand and then gravel of around 30 cm thickness, with a separation membrane of non-woven polyester fiber geotextile 100–150 g/m^2 between them (fig. 26). Once completed, the reburial could then reduce the maintenance needs of the mosaics in this building, allowing the limited resources at the site to be utilized to stabilize and then maintain mosaics that were left exposed and presented, a critical component of the conservation plan for the entire site.

The entire Maison 4 was not stabilized and reburied before the project ended, but a return visit to the site by some project team members years later found that the technicians had largely completed the work.

FIGURE 25
Stabilization of a mosaic prior to long-term reburial, Maison 4 (Ermanno Carbonara)

FIGURE 26
Long-term reburial of Maison 4 pavements (Thomas Roby)

CONCLUSION

This project report presents the methodology and the different recording components that were produced to assess the mosaics of the site and prioritize and plan the interventions in response to that assessment, so that it can used as an example by other site managers at similar large mosaic sites. The report also presents the methodology of the conservation work carried out on mosaics and other architectural remains in more than one building to provide an example of best practices to follow by conservation practitioners and their site managers at other sites in Tunisia and elsewhere in the region.

Despite the considerable attention paid to the question of sustainability while carrying out the conservation planning, the INP has not followed the multiyear plan of conservation work after the involvement of the GCI and WMF ended. Foreign archaeological missions have subsequently been given permission to excavate parts of the site, and the technicians and other staff have been active in supporting their excavation work. The new excavation work has prevented the project conservation program from being followed, but at least the technicians have been used to carry out conservation work for the new excavations. The continuing archaeological excavations at the site are evidence that the fundamental approach to managing the site of Bulla Regia as a resource primarily for archaeological research has regrettably not changed, despite the models of site conservation planning and implementation that have been accomplished and the personnel trained to carry it out.

And while the designed protection and presentation measures were not carried out in the Maison de la Chasse, most of the planned conservation treatments on mosaics, other pavements, and wall plaster were completed, and they were done almost entirely by the trained technicians, demonstrating the INP's increased capacity to conserve mosaics, walls, and wall plasters using lime mortars. The lack of agreement by the INP to the proposed shelter designs proposed by the WMF in the Maison de la Nouvelle Chasse and the Maison d'Amphitrite, as well as their lack of interest in pursuing the GCI-proposed designs for protection and presentation measures, demonstrated how little enthusiasm there was among the INP project managers for proposals that introduced modern constructions and protection elements into an archaeological site, and that would prevent visitors from walking on the mosaics, as they have always done.

When the security situation in the Bulla Regia region made the foreign partner campaigns impossible or inadvisable, the official partner project agreement had expired. By that time it had become evident to the foreign partners that the implementation of the site-wide multiyear program for conserving mosaics and other architectural remains would not be followed, nor would the proposed shelters and other protection measures in the Maison de la Chasse, the Maison de la Nouvelle Chasse, and the Maison d'Amphitrite be realized. Although the project fell short of the foreign partners' ambitious program to provide model examples of conserving, protecting, and presenting an entire ancient insula using a combination of shelters, reburial, and maintenance, the stabilization of mosaics within an entire building to be presented and the reburial of stabilized mosaics in a building not to be presented were accomplished by a team of trained technicians, thereby demonstrating the enhanced capacity of INP personnel to conserve its mosaic heritage.

APPENDIX A

Mosaic Rapid Survey Form and Glossary

Rapid survey form
Mosaic Conservation Planning for Archaeological Sites

Site : | **Date:** | Part 1

Building : | **Recorded by :**

IDENTIFICATION									*CONDITION*									*INTERVENTION*						*NOTES*
									Micro-organisms		Critical tessellatum		Critical structural areas						Complete stabilzat. for exposure Work Days			Stabilization for reburial Work Days		
																				1		70%	30%	
Mosaic ID	Room/Space (m^2)	Mosaic (m^2)	Lacunae (m^2)	Mosaic in room (%)	Mosaic typology	Lacunae type	Reinforced concrete	Type of exposure	m^2	%	m^2	%	m^2	%	TOTAL critical areas (m^2)	TOTAL critical areas (%)	OVERALL CONDITION RATING (1-5)	Work days per m^2	Tessellatum stabilization	Micro-organism removal	TOTAL work days	Long-term	Short-term	
TOTAL																								
AVERAGE																								

Rapid survey form
Mosaic Conservation Planning for Archaeological Sites

Site :

Date :

Part 2

Building :

Recorded by :

	CONDITION		*SIGNIFICANCE*						*EXPOSURE*					*PRIORITY*		*NOTES*
Evaluation scale	1 - 5		1 - 5	1 - 5	1 - 5	1 - 5	1 - 5		1 - 5	1 - 5	1 - 5	1 - 5		6 - 150	0 - 100	
Weighting		4						2					1			
Mosaic ID	OVERALL CONDITION RATING	WEIGHTED OVERALL CONDITON	Archaeological-Iconographic value	Technical-Artistic Value	Integrity	Authenticity	OVERALL SIGNIFICANCE RATING	WEIGHTED OVERALL SIGNIFICANCE	Environment	Visitation	Structural collapse	OVERALL EXPOSURE RATING	WEIGHTED OVERALL EXPOSURE	SYNTHESIS WEIGHTED RATINGS	OVERALL PRIORITY RATING	
BUILDING AVERAGE																

Form version 18-03-2015

MOSAIKON

RAPID SURVEY FORM: MOSAIC CONSERVATION PLANNING FOR ARCHAEOLOGICAL SITES

GLOSSARY AND INSTRUCTIONS

INTRODUCTION

This Form and accompanying glossary and instructions were developed for the archaeological site of Bulla Regia in Tunisia. The purpose of this collected information is to inform and help develop a prioritized conservation plan for in situ mosaics. As a first step in the conservation planning process, this Form collects information regarding the condition, significance, and degree of exposure for each mosaic, which will be used as a basis for conservation planning for all of the mosaics of a site. Although this survey form was developed for the site of Bulla Regia, it can be adapted to other archaeological sites with large collections of mosaics, taking into account the contexts and particular set of conditions at each site.

The Form is composed of two Excel sheets, located in the same file, corresponding to Part 1 and Part 2. Excel software was chosen as the best way to collect the data, at least initially, as it allows for calculations to be embedded directly in the form and calculated automatically upon inputting of the data. In this glossary/instruction document the categories that can be automatically calculated by the software are marked by an asterisk (*).

Part 1 collects basic information about the size, type, and location of the mosaic as well as information related only to critical areas of deterioration. The "Intervention" section at the end of Part 1 collects information to provide the estimation of the work time needed to carry out each of the three main intervention options, information which will then be used during the mosaic conservation planning. Part 2 collects information related to the mosaic's significance and degree of exposure. The final step of Part 2 is a calculation, which provides an overall rating of priority. This rating will be utilized during a successive phase of the conservation planning process in which type and degree of interventions will be decided upon, considering other contextual factors at the site.

In the header of each part of the Form, one should also specify the site and building in which the evaluated mosaics are located, as well as the date when this information has been collected and the name of the person or persons who have gathered it.

Version: 20 November, 2014

A note about weighting in Part 2 of the Form: At the site of Bulla Regia, it was decided that the “Condition” category, being of utmost importance from a conservation perspective, required a heavier weighting and thus was given a weighting of 3; while “Significance” was weighted by 2 and “Exposure” weighted by 1. These weightings can change, however, depending on the particular conditions and threats at each site, but also by the goal pursued by the data collection. For example, it may be decided that for a site that receives a large number of visitors, or where there is a serious threat of flooding, the “Exposure” category might be weighted more heavily.

Part 1

Identification

All the dimension values (length, width, surface area) in this section will be recorded or calculated in meters or square meters, down to one decimal place.

Mosaic ID

This is the mosaic identification number, that is, a combination of numbers and letters that uniquely identifies the mosaic. This short name is used in all the documentation of this mosaic. If a numbering system does not yet exist for the site mosaics, a recommended method would include assigning an abbreviation for the site, a number or abbreviated name for the building, and a number for the room where the mosaic is located.

If a basin or any other type of space contains mosaics on both horizontal and vertical surfaces (walls, etc.), the feature should be divided in two entries for the purpose of the survey: the mosaics on the base and stairs should be considered as one floor pavement, and the mosaics on vertical surfaces should be counted as a separate entry. Each section of the mosaic will thus have its own Mosaic ID.

When it is decided to divide any mosaic into two or more parts for the purpose or ease of the survey calculations, the location of the division should be drawn on the building plan and a different number or letter assigned to each part, in addition to the room number. This should be explained in the Notes column.

SURFACE AREA OF THE ROOM OR SPACE IN SQUARE METERS (m^2)

Calculate the total surface area in square meters (m^2) of the entire room or space that contains the mosaic. For example, with pavements, the entire room would likely be measured; however, in other situations such as in the case of a basin or fountain, only the area that originally contained the mosaic will be measured. This is to avoid misrepresenting the ratio of mosaic to lacunae, which is particularly important in future calculations.

Additionally, if the limits of the room or space are not clear–for example have not been fully excavated–this box will not be filled and only the dimensions of the visible mosaic fragment will be recorded in the next box. The ratio of mosaic to lacunae cannot then be calculated. This should be noted in the Notes column.

SURFACE AREA OF THE MOSAIC IN SQUARE METERS (m^2)

Calculate the total surface area of the tessellatum in square meters (m^2).

SURFACE AREA OF THE LACUNAE IN SQUARE METERS (m^2) (*)

Calculate the total surface area of the lacunae in square meters (m^2).

For the purpose of this survey, lacunae are defined as:

- Continuous areas of loss of tesserae of at least one square meter (1 m^2) in size.
- Continuous areas of loss of tesserae less than one square meter (1 m^2) in size if the area of loss is more than 25% of the total surface area of the room.

The sum in square meters of the surface area of the mosaic and of the lacunae, if existing, must be equal to the surface area of the room in square meters.

If the limits of the room or area are not known, lacunae surface will not be calculated.

PERCENTAGE OF MOSAIC IN THE ROOM (%) (*)

Calculate the percentage (%) of the mosaic present in relation to the total room surface area. For example, if the surface area of the room is 14.8 m^2 and the surface area of the existing mosaic is 10.2 m^2, then the percentage of mosaic in the room is (10.2/14.8) x 100 = 68.9%

MOSAIC TYPOLOGY

Identify the mosaic type, using an abbreviation from the list below (e.g. CP for Cocciopesto). If more than one mosaic typology is present in the room, list all of them.

- Cocciopesto (CP)
- Opus Signinum (S)
- Opus Figlinum (F)
- Opus Spicatum (SP)
- Opus Scutulatum (SC)
- Opus Segmentatum (SG)
- Opus Sectile (SE)

- Opus Tessellatum
  - Monochrome (TM)
  - Bi-Chrome Geometric (TBG)
  - Bi-Chrome Figural (TBF)
  - Bi-Chrome Geometric-Figural (TBGF)
  - Polychrome Geometric (TPG)
  - Polychrome Figural (TPF)
  - Polychrome Geometric-Figural (TPGF)
  - Opus Vermiculatum (V)
  - Pseudo-Figlinum (PF)

- Other (O)

In the case of a typology not present in the list, mark the box with an O (Other) and write a short description in the Notes column.

LACUNAE TYPE

Identify the type of material that is currently visible in the lacunae, using an abbreviation from the list below (e.g. “G” for Gravel). If more than one kind of material is present in the lacunae, list all that exist.

- Earth (E)
- Mortar Repair (MR)
- Gravel (G)
- Original preparatory layers (PL)

- Other (O)

In the case of other kinds of materials present in the lacunae, but not listed, mark the box with an O (Other) and write a short description in the Notes column.

MOSAIC ON REINFORCED CONCRETE SUPPORT

Place a check or X in the box if the mosaic has been lifted and re-laid on a reinforced concrete support or if it is a modern mosaic on reinforced concrete panels.

TYPE OF EXPOSURE

Identify the type of exposure of the mosaic at the time of survey, using an abbreviation from the list below. If the mosaic is subject to more than one type of exposure, list all that exist. The term *shelter* here is used as a general term referring to any kind of sheltering system, either a modern construction or an original structure.

- Exposed (E)
- Under an open shelter (OS): roof only
- Under a partially enclosed shelter (PES): roof and walls with openings
- Within an enclosed shelter (ES): roof and walls with openings which can be closed
- Reburied (R)

- Other (O)

In the case of a different type of exposure not found in the list, mark the box with an O (Other) and write a short description in the Notes column.

Condition

In order to arrive at the Overall Condition rating, the most relevant deterioration phenomena, superficial, structural and micro-organism presence are quantified as percentages.

To determine the extent of each phenomenon as a percentage, first estimate the extent of each condition in square meters (m^2) and then convert it to a percentage (%) (*). The percentage is calculated in relation to the total surface area of the tessellatum (this can be done automatically by the Excel software). In some cases, it may be more practical to estimate the condition extent as a percentage first; this value should then be converted in square meters. Considering the need to record deterioration phenomena at a more precise scale for the purposes of record-keeping and future monitoring, the surface areas and percentages in this section will be recorded or calculated down to two decimal places.

MICRO-ORGANISMS

Estimate the extent of micro-organisms covering the tessellatum surface in both square meters (m^2) and as a percentage (%) (this can be done automatically by the software (*)). Micro-organisms will be present mostly in the form of mosses, lichens, and algae.

Micro-organism presence is not considered a critical condition; however, it can influence the overall condition rating if severe. As well, the extent of micro-organisms impacts the estimate of work time calculated in the Intervention section, which is why this information is gathered here.

CRITICAL TESSELLATUM AREAS

Estimate the extent of the surface area of the tessellatum that is in critical condition in both square meters (m^2) and as a percentage (%) (this can be done automatically by the software (*)). These are areas where tesserae are detached, the mortar between the tesserae is missing causing loose tesserae, or where the edges of the tessellatum are not adequately protected. This category includes damage to tesserae caused by vegetation growth, for example where small plants have dislodged the tessellatum. If the material itself is severely deteriorated or damaged, this should be added in the Notes column as the conservator may take this into account when making a final assessment. Damage to tesserae caused by critical structural areas (e.g., detachment, bulging) should be excluded from this estimate as they are factored in with the next category, critical structural areas. Only critical problems for the tessellatum should be considered here; work required for non-essential edging repairs, filling small lacunae, or overall interstices filling is not considered critical but is later incorporated into the estimation of work days when considering the time required for complete stabilization.

In addition, in the case of mosaics re-laid on reinforced concrete support, areas of lack of cohesion between the tessellatum and the backing panel can generally be considered critical tessellatum areas.

CRITICAL STRUCTURAL AREAS

Estimate the extent of surface area in critical condition within the mosaic structure (preparatory layers) in both square meters (m^2) and as a percentage (%) (this can be done automatically by the software (*)). These are areas of severe hollow bulging or depressions; or if the tessellatum surface is level but has severe (i.e., moving) areas of detachment, unfilled lacunae, and/or fractures. Additionally, if there are large roots that damage the mosaic structure, this should be written in the Notes column.

In the case of mosaics re-laid on reinforced concrete support, the critical structural areas are considered to be areas where the support panels are deformed.

TOTAL OF THE TWO CRITICAL AREAS IN SQUARE METERS (m^2) (*)

Add the surface areas in square meters in critical condition: tessellatum and structural.

For example, if the critical tessellatum surface area is 1.12 m^2 and the critical structural surface area is 0.35 m^2, the total sum is 1.47 m^2. This is the ***total critical area in square meters (m^2).***

TOTAL OF THE TWO CRITICAL AREAS IN PERCENTAGE (%) (*)

Add the percentages (%) of the two critical areas: tessellatum and structural.

For example, if the percentage of the critical structural area is 0.35%, and the percentage of the critical tessellatum area is 8.23%, the total sum is 8.58%. This is the ***total critical area as a percentage***.

OVERALL CONDITION

The overall condition of the mosaic is based on the percentage value, rounded up or down to reach a whole number, of the ***total critical area***. The overall condition, however, also takes into account the ***severity*** of the conditions.

This rating (1-5) will be used to calculate both the estimate for work (Part 1) and for assessing priority (Part 2). In the above example, an 8.58 % total critical area, rounded to 9 %, would give a rating of 1.5 for Overall Condition, according to the established equivalences which follow an exponential increase (see table below).

However, in exceptional cases, if the conditions are considered more or less severe, then the standard calculated value can be changed and a higher or lower rating given. In addition, if the extent of micro-organisms is particularly important, the standard rating can also be increased.

This change should be recorded in red and explained in the Notes column.

Total critical area	Rating
0 – 4 %	1 (good condition)
5 – 9 %	1.5
10 – 16 %	2 (fair condition)
17 – 25 %	2.5
26 – 36 %	3 (poor condition)
37 – 49 %	3.5
50 – 64 %	4 (bad condition)
65 – 81 %	4.5
82 – 100 %	5 (critical condition)

Intervention

In this section the amount of time needed for one conservation technician to complete the three following intervention options is estimated: a) complete conservation treatment for the tessellatum in order to keep the mosaic exposed, b) selective conservation treatment preceding long-term reburial, and c) selective conservation treatment preceding short-term reburial.

All the work days quantities estimated in this section will be rounded up or down to reach a whole number.

ESTIMATE OF WORK DAYS PER SQUARE METER (m²)

In order to transform the information collected into a work plan, the overall condition must be translated into the number of work days per square meter (m²). Based on experience and work completed to date, these estimates have been made for one conservation technician at the site of Bulla Regia (see table below). The equivalent estimate must be established for each site and requires knowledge about available resources such as personnel and materials, how easy or difficult it is to deploy those resources and implement work, and who will be implementing the work, among other factors. It is important to first verify the amount of time required for conservation treatments on a site and to adjust the time estimates up or down, notably if particular conditions or logistical issues are present.

Overall Condition Rating	1	1.5	2	2.5	3	3.5	4	4.5	5
Number of work days for complete stabilization of 1 m^2 of tessellatum by 1 technician	0.5	1	2	3	4	5	6	7	8

COMPLETE TESSELLATUM STABILIZATION TO KEEP THE MOSAIC EXPOSED (*)

Tessellatum stabilization (*)

In the first column, calculate the work days needed for the complete stabilization treatment of the **tessellatum**, multiplying the tessellatum surface area in square meters by the number of work days needed to treat 1 m^2. The number of work days for 1 m^2 is estimated according to the overall condition rating for the mosaic, as above.

For complete stabilization, treatment implies dry and/or wet cleaning (excluding micro-organism removal) and stabilization with lime-based mortars (excluding lacunae filling). This also does not include specialized treatments such as chemical consolidation, or other specialist interventions.

Treatment of lacunae is not considered in this calculation as the type of treatment (e.g., complete infilling or edging or something in between) depends on several other factors including, but not limited to, decisions regarding presentation and interpretation. Thus, treatment of lacunae will be decided during a later phase of the conservation planning process, and is not included here.

Micro-organism removal (*)

In the second column, calculate the time required for removing the **micro-organisms** from the surface of the mosaic by multiplying the total surface area of micro-organisms, recorded in the Condition section, by the number of days needed to remove 1 m^2 of micro-organisms. For the site of Bulla Regia, it has been estimated that it requires approximately 1 additional day of work per 1m^2 of micro-organisms. This estimate may be different for other sites.

Total work days for complete tessellatum stabilization (*)

Add here all the work days recorded in the previous two columns for tessellatum stabilization and micro-organism removal to give the total work days needed for 1 technician to carry out the complete tessellatum stabilization.

To sum up, using an example, for the complete stabilization of a mosaic that has **8.2 m^2** of tessellatum, including **7.35 m^2** covered by micro-organisms, and an overall condition rating of **4**, the calculations will be as follows:

- Work days to completely stabilize the tessellatum:
  Overall condition rating = 4 → 6 work days for 1 technician per 1m^2
  8.2 m^2 x 6 work days = 49.2 → 49 work days for the tessellatum. Record this result in the first column under tessellatum stabilization.
- Work days to remove the micro-organisms:
  7.35 m^2 x 1 work day = 7.35 → 7 work days for the micro-organisms. Record this in the second column under micro-organism removal.
- Total work days for complete tessellatum stabilisation:
  49 days + 7 days = 56 days. Record this result in the Total Work Days column.

In some cases it is necessary to plan different operations from the standard ones given here. Work days must be evaluated individually for each mosaic. For example, the estimate of work days will be different for a mosaic with a large area of water pooling, where it is chosen to carry out a drainage system. Or, if there is a mosaic that needs extensive in-filling of interstices, the number of work days should be increased. To the contrary, if there are extensive areas of tessellatum detachment considered critical areas, the number of work days obtained by the standard calculations will be decreased because this type of stabilization work is faster than interventions in tessellatum critical areas. This change should be recorded in red and explained in the Notes column, specifying the amount of the adjustment and the reason why it increases or reduces the amount of previously calculated work days.

In the case of a mosaic that is on reinforced concrete, or that has been reburied, the conservation interventions must be decided on a case-by-case basis, as these interventions can vary widely. Therefore, they are not considered in this part of the planning program.

SELECTIVE STABILIZATION OF THE TESSELLATUM BEFORE REBURIAL

Long-term reburial (*)

In this column calculate the time needed to treat the tessellatum before a long-term reburial. Once the time required for complete stabilization is calculated, it has been estimated that, in general, 70% of that time will be needed for a selective stabilization prior to implementing a long-term reburial.

Using the same example as above, a mosaic that has **8.2 m^2** of tessellatum, and an overall condition rating of **4**, but here calculating work days for the stabilization preceding long-term reburial:

- 70% of 49 work days (corresponding to a complete stabilization) → 49 x 70 / 100 = 34.3 → 34 work days. Record this in first column under Stabilization prior to reburial – Long-term.

As it is not necessary to remove micro-organisms or treat lacunae for a long-term reburial, the time needed for these operations is not factored in here.

The time required for the actual reburial will be calculated and added to the work plan during a later phase of the conservation planning process.

Short-term reburial (*)

In this column calculate the time needed to treat the tessellatum before a short-term reburial. This is estimated as 30% of the time required for complete stabilization.

Using the same example as above, a mosaic that has **8.2 m^2** of tessellatum and an overall condition rating of **4**, but here calculating work days for the stabilization preceding short-term reburial:

- 30% of 49 work days (corresponding to complete stabilization) → 49 x 30 / 100 = 14.7 → 15 work days. Record this in the second column under Stabilization prior to reburial – Short-term.

As it is not necessary to remove micro-organisms or treat lacunae for a short-term reburial, the time needed for these operations is not factored in here.

The time required for the actual reburial will be calculated and added to the work plan during a later phase of the conservation planning process.

NOTES

Record here any additional information that could be useful in understanding the ratings given in the Form.

PART 2

The information collected in Part 2 contributes to the calculation of the conservation priority for each mosaic of the site. The information is divided into three categories: Condition, Significance, and Exposure. The ratings of each category are then weighted differently to take into account their respective importance from a conservation perspective.

MOSAIC ID

The unique mosaic identification number is recorded again in the first column of Part 2.

Condition

OVERALL CONDITION RATING

Carry over the overall condition rating from Part 1 to Part 2. This will be included in the calculation of the conservation priority.

WEIGHTED OVERALL CONDITION RATING (*)

As mentioned, each category can be weighted differently depending on the particular needs of the site, as well as the aims of the survey. In this survey for the site of Bulla Regia the overall condition rating is multiplied by 3 in order to give Condition more importance than the other two categories when planning for the mosaic conservation at the site.

Significance

ARCHAEOLOGICAL-ICONOGRAPHIC VALUE

Give a rating, on a scale from 1 to 5, to the archaeological-iconographic values of the mosaic. This can be a broad category combining many different elements, and will change from site to site, but some aspects that should always be considered are the significance of the iconography or subject matter and the stratigraphic or surrounding architectural context. If the mosaic provides technological information, this should also be considered. This value does not, however, refer to the technical-artistic quality of the work, as this is considered separately.

Examples with corresponding ratings:

1 A mosaic with no decoration.
2 A monochromatic mosaic that has an intentional alignment of tesserae in a decorative pattern, such as the alternation of vertical and horizontal rows of tesserae or another type of pattern.
2-3 A mosaic with a locally common geometric design or that has simple common figural motifs.
3-4 A geometric mosaic that has rare decorative patterns or unusual geometric composition.
3-4 A figural mosaic with a locally common, everyday historical or mythological scene.
3-4 A mosaic that provides additional information about the archaeological-iconographic context for the site or region because of, for example, its location within a datable stratigraphic sequence (i.e., later walls constructed over a mosaic floor or ancient reintegrations); its situational (i.e., a mosaic found on a column which is a rare location) or architectural context (i.e., a small mosaic fragment but one that provides evidence of the presence of a mosaic in a room or building); or the presence of a particular iconographic detail or element representative of a certain time period or place. A rare typology can be included in this category as well.
4 A mosaic that, with its figural decoration, provides the name for the building (e.g., at the site of Bulla Regia the mosaic depicting a hunting scene is the reason for naming the house the "Hunting House").
4-5 A mosaic with an inscription.
5 A figural mosaic with a rare subject matter.

Other elements that should be taken into consideration and that may increase the given rating are, for example:

- If the preparatory layers are at least partly visible and provide information about the mosaic construction technique, or any other information of archaeological or technological interest.
- If the presence of the pavement is rare in the historic-geographic or architectural context; for example, if it is rare that there is evidence of a mosaic in a particular type of building, room, or space.
- If the materials used are rare or of high economic value.

TECHNICAL-ARTISTIC VALUE

Give a rating, on a scale from 1 to 5, to the technical and artistic execution of the tessellatum. This refers to the quality of the work, the selection of materials, and how they are used. The aspects that can be used to evaluate the quality of the execution are the dimensions, shape, alignment, materials, and colors of the tesserae.

Although a rating scale is provided below, this is only applicable for opus tessellatum, not other types of mosaics. These ratings are intended to serve only as a starting point for evaluating technical-artistic value. For other types of mosaics, the technical-artistic value must be evaluated using the other qualities listed above: shape, alignment, materials, and colors of the elements, as well as the quality of execution and complexity of the mosaic.

When applying the rating scale below, a lower rating should be given if the execution of the tessellatum is poor or very ordinary and the materials are common; and a higher rating if the execution of the tessellatum is good and the materials used are also of good quality and/or variety.

The ratings from 1 to 5 are assigned as follows, only for opus tessellatum:

1-2 Tesserae are on average larger than 20 mm per side.
2-3 Tesserae are on average between 20 and 12 mm per side.
3-4 Tesserae are on average between 12 and 5 mm per side.
4-5 Tesserae are on average less than 5 mm per side.

Other elements that must be taken into consideration and that can increase the given rating are:

- If the mosaic displays a high level of complexity of design or composition.
- If the execution is excellent

In the case of more than one mosaic typology present in the same pavement, or if there are areas of different technical-artistic quality, the rating for the whole mosaic will be determined by the higher value pavement or area.

INTEGRITY OF THE MOSAIC AND ITS CONTEXT

Give a rating, on a scale from 1 to 5, to the integrity of the mosaic and its context. The integrity of the mosaic is based on the extent of the surface area of the existing tessellatum and the completeness of its architectural context. The surface area of the tessellatum is determined as a percentage of the total surface of the room or space, as previously calculated in Part 1. The integrity of the architectural context is evaluated in relation to the extent of the remaining walls and structure. Here, primary importance is placed on the integrity of the pavement, and the architectural context is considered in relation to the mosaic.

The ratings from 1 to 5 are assigned as follows:

1-2 from 1 to 40% tessellatum remaining
2-3 from 41 to 60% tessellatum remaining
3-4 from 61 to 80% tessellatum remaining
4-5 from 81 to 100% tessellatum remaining

Within each category, a lower rating should be given for absent or poorly preserved walls, and the higher rating for highly preserved walls, vaults, roofs and columns, or other architectural elements.

If the surface area of the room or space cannot be calculated (see Room/space surface area (m^2) column in Part 1), the rating for this category will be given based on the surveyor's experience and judgement, as well as the integrity of the building's other mosaics.

AUTHENTICITY

Give a rating, on a scale from 1 to 5, to the authenticity of the mosaic. Authenticity is evaluated based on the absence or presence of modern restoration interventions, i.e., tesserae reintegration. The authenticity of a mosaic is affected by the quantity, extent, and location of previous interventions.

The ratings from 1 to 5 are assigned as follows:

1 modern copy
2 mosaic lifted and relaid in situ
2-3 in situ mosaic, with modern reintegration using tesserae
3-4 in situ mosaic, with modern mortar interventions
5 in situ mosaic, with no modern interventions

OVERALL SIGNIFICANCE RATING (*)

Calculate the average of the ratings of the four categories of the Significance section; it is the Overall Significance rating. Record the rating down to 2 decimal places.

WEIGHTED OVERALL SIGNIFICANCE RATING (*)

For the site of Bulla Regia, the Overall Significance rating is multiplied by 2. Record this weighted rating down to 2 decimal places.

Exposure

ENVIRONMENT

Give a rating, on a scale from 1 to 5, to the degree of exposure of the mosaic to rainwater, water pooling, ground moisture, solar radiation, and to any other environmental deterioration factors.

The ratings from 1 to 5 are assigned as follows:

1	Mosaic completely protected by original ceiling or vault, under an enclosed shelter and/or reburied.
2-3	Mosaic partially protected by original ceiling or vault, under an open shelter and/or partially reburied.
3-4	Mosaic partially protected under an open shelter, or under an enclosed or partially enclosed shelter but whose protection is in poor condition.
3	Mosaic exposed, without water pooling or evidence of ground moisture.
4	Mosaic exposed, with some localized areas of the surface subject to water pooling and/or ground moisture.
5	Mosaic exposed, with most of its surface subject to water pooling and/or ground moisture.

Other elements that should be taken into consideration and that may increase the rating are, for example:

- If the site is in a significantly polluted area.
- If the mosaic is relaid on reinforced concrete.

VISITATION

Give a rating, on a scale from 1 to 5, to the degree of exposure to visitors, local inhabitants and animals walking on the mosaic surface.

The ratings from 1 to 5 are assigned as follows:

1	Mosaic reburied or inaccessible to visitors, local inhabitants and animals
1-2	Mosaic open to the public only by special permit or occasionally and with access barriers (footbridges, ropes, fences).
2-3	Mosaic far from the visitor pathways, or difficult to access; if access is restricted or guards are present give a lower rating; or if there are no such restrictions give a higher rating.
3-4	Mosaic along a secondary visitor pathway; if access is restricted or guards are present give a lower rating; or if there are no such restrictions give a higher rating.
4-5	Mosaic along the main visitor pathway; if access is restricted or guards are present give a lower rating; or if there are no such restrictions give a higher rating.

Other elements that should be taken into consideration and that may increase or decrease the rating are, for example:

- The level of visitation the site receives
- The effectiveness of the access restrictions or guards

STRUCTURAL COLLAPSE

Give a rating, on a scale from 1 to 5, to the degree of exposure to agents of loss and collapse of the adjacent structures including slopes and baulks, or any other structural problems such as related to the foundations of the mosaics.

The ratings from 1 to 5 are assigned as follows:

1	Mosaic with adjacent walls, slopes or baulks lower than 30 cm in height, regardless of their condition, and the mosaic foundations in good condition.
2	Mosaic with adjacent walls, slopes and baulks in good condition, regardless of the height.
2-3	Mosaic with adjacent walls, slopes and baulks between 30 cm and 1 m in height, in poor or bad condition.
3-4	Mosaic with adjacent walls, slopes or baulks higher than 1 m, in poor or bad condition.
4-5	Mosaic with foundations in poor or bad condition.
5	Re-laid mosaic or modern copy on reinforced concrete, or on inappropriate backing (because of the high risk of developing structural problems).

- For walls in poor or bad condition, if the wall stones are small or if the risk elements are limited, the rating can be decreased.

In most cases, except for detached and re-laid mosaics, the rating can be reduced by 1 or more points if it is reburied.

OVERALL EXPOSURE RATING (*)

Calculate the average of the ratings of the three categories of the Exposure section, it is the Overall Exposure rating. Record the rating down to 2 decimal places.

WEIGHTED OVERALL EXPOSURE (*)

For the site of Bulla Regia, the Overall Exposure rating is multiplied by 1. Record this weighted rating down to 2 decimal places.

PRIORITY

This section compiles the results from the three preceding sections: Condition, Significance and Exposure, resulting in an overall conservation priority rating, on a scale from 0 to 100, for each mosaic, which will impact the mosaic conservation plan for the site.

The reburied mosaics, which are unable to be completely surveyed, are not included in the priority calculations here; however, they will be assessed in the second phase of the conservation planning process.

SYNTHESIS OF WEIGHTED RATINGS (*)

Add the two weighted overall ratings of the Condition section and the Significance section, and then multiply this result by the weighted overall rating of the Exposure section. The maximum and minimum values of the rating obtained by this calculation depend on the weightings chosen for the three sections.

Using the three weightings used at the site of Bulla Regia – 3 for Condition, 2 for Significance, and 1 for Exposure – this first calculation will give a result between 5 and 125.

OVERALL PRIORITY RATING (*)

The overall priority rating is the conversion of the synthesis of weighted ratings to obtain a rating ranging from 0 to 100. For this, the minimum value that can be obtained is first subtracted to the result of the first calculation to obtain a scale that starts at 0. Then, the previous result is divided by the new maximum value that can be obtained after subtraction. Finally, the last result is multiplied by 100 and rounded up or down to reach a whole number.

To sum up, using an example, if a mosaic from Bulla Regia has a Condition rating of 4, a Significance rating of 3, and an Exposure rating of 2, the calculation of the overall priority rating will be as follows:

- First the weighted overall ratings are calculated: Condition 4 x 3 =12; Significance 3 x 2 = 6 and Exposure 2 x 1 = 2.
- Then the weighted overall ratings of the Condition and Significance sections are added, thus 12 + 6 = 18; this number is then multiplied by the weighted overall rating of the Exposure section, thus 18 x 2 = 36. This first calculation gives a result between 5 and 125.
- The minimum value of this scale (5) is subtracted from previous result, thus 36 - 5 = 31; then the result is divided by the new maximal value (125 – 5 = 120), thus 31 / 120 = 0.258; finally this number is multiplied by 100 and rounded to the closest whole number, thus 0.258 x 100 = 25.8 → 26. This is the overall conservation priority rating for this mosaic.

If the surveyor disagrees with the overall conservation priority rating and wishes to raise or lower the rating, this comment can be noted here in red and the reasons for his/her disagreement should be explained in the Notes column.

NOTES

Record here any information that could be useful to understand the ratings given in the Form.

APPENDIX B

Mosaic Imaging Guidelines

Full-Scale Mosaic Imaging at Bulla Regia

Guidelines for Image Capture and Processing

Equipment

- Monopod with a tripod head to support camera [in this case a Manfrotto brand tripod was used]
- Camera [in this case a Nikon D7000 was used]
- Laptop
- Cable for connecting the camera to the computer (minimum 4.5 meters) [a USB cable was used in this case]
- Hand-held GPS
- GPS adapter [in this case a Nikon GP-1 was used]

Software

- A live viewing software that allows you to see what the camera is seeing. [NK Remote was used in this case]
- Adobe Photoshop and Adobe Bridge [in this case CS 4 or newer was required], and Xnview was also used at different points.

Contents

Planning the photo shoot

To capture contrast-rich images without shadows, it is best to do the photography at dusk and dawn. Depending on the surroundings of the mosaic, that allows approximately 30 minutes to one and a half hours to take the photographs. Overcast conditions during the day may extend the photo shoot time.

Planning the photo shoot well beforehand and knowing where to photograph at what time is very helpful in maximizing the time window.

Setting up the camera and the remote system

- Set the camera to manual capturing mode (M)
- Connect the GPS adapter and check that it is working [in this case there was a green indicator light]
- Adjust the focal length to 18 mm and keep it in position with tape
- Attach the tripod head to the monopod
- Attach the camera to the tripod head and extend the monopod to 15 ft (there are marks on the monopod to guide you)
- Connect the cable to the camera and attach the cable to the monopod, so it doesn’t appear in the images
- Switch on the camera
- Connect the cable to the computer and run the NK Remote or other viewing software.

Upon opening the software, set a filename prefix to label the images and choose a location in which to save the images. This location should be on the camera SD-card and not on the computer’s hard disk (this will be helpful later when using the importing option in *Adobe Bridge*).

Adjust the capture settings to the following:

Exposure Compensation:	none
Flash compensation:	none
Quality:	RAW
White Balance:	Auto
Metering:	Mode Matrix
Picture control:	Standard
AF:	Auto

Photographing floor mosaics

At this point, start the live view of the viewing software. Check the exposure value (‘exp:’). The number indicates how close the image is to the ideal exposure, described as 0. By changing exposure time, aperture and ISO, the range of ideal exposure of the image can be obtained.

Table 1 below lists the settings for Optimal light intensity as well as for Low light. For example, when shooting at dusk or dawn, often light intensity is lower, and a compromise is needed to reach the range of ideal exposure. The limits for the settings for low light are shown in Table 1.

Table 1: Camera settings when light intensity is optimal and the limits for low light intensity

	Optimal light intensity	**Low light intensity (max)**
Aperture (Av)	10	4
Exposure time (Tv)	≤1/250	1/80
ISO	100	800

Taking the photograph:

- Place the lens of the camera as parallel as possible to the surface that is going to be photographed
- Use the live view software to control the image-taking process
- Depending on the type of camera, Contrast-detect Auto Focus (Contrast AF) is used to focus on the mosaic area being photographed
- Using the live view software, take the image
- Take more than one image, varying slightly the angle of the camera by pulling the monopod back and forth and twisting it, to ensure full coverage.

Reference items (scale, north, grey card)

All final montages of the mosaics need a scale and an arrow pointing north. When taking the photos for the montages, take one photo with a measuring tape (1 meter), an arrow pointing north and a grey card. The grey card will help later during the raw image processing to balance the white.

Take a duplicate photo without the reference items.

Taking GPS coordinates manually

In some cases, it might not be possible to take advantage of the GPS camera adapter, for example when working inside a building. In such a case, you will need to take GPS coordinates manually from outside with a hand-held GPS.

Turn on the hand-held GPS and wait until the receiver has a signal of at least 4 satellites which compute latitude, longitude, altitude, and time, then mark a waypoint (see instructions for the

GPS you are using). When doing several readings around the same area, wait at least 10 seconds in the position you want to mark before taking the waypoint.

You can introduce the GPS coordinates to the metadata of the images easily with the help of Adobe Bridge.

Context images

Use the monopod to capture context images of the house or building where the mosaics are located. Take advantage of the maximum length of the monopod to get as high as possible so that you have a good shot of the building and its surroundings. It is easiest to take these photographs at the end, after photographing all the mosaic.

Photo import – DNG conversion, global metadata application

During the photo import, it is possible to include the tasks of RAW format conversion (NEF to DNG) and the automated application of the global metadata. Ideally a metadata template is created respecting the naming conventions of the project and including the name of the photographer. See Table 2 for an example of a metadata template.

Table 2 Global IPTC metadata for the Bulla Regia project

Creator name:	…
Keywords:	Bulla Regia, Mosaics, Mosaikon
City:	Bulla Regia
State/province:	Jendouba
Country:	Tunisia
ISO country code:	TU
Copyright status:	Copyrighted

Find further information on how to create, edit and import templates in Adobe Bridge here:

http://helpx.adobe.com/bridge/using/metadata-adobe-bridge.html#work_with_metadata_templates

Once you have started Adobe Bridge and have imported and adapted the related metadata template, there should be a Get Photos from Camera option under 'File.'

In the window, select the photo source (here the SD-card) and the destination folder. When importing, select the option to convert the images to DNG. With that option activated, different proprietary RAW formats, such as NEF, will be automatically converted into the lossless RAW image format DNG[1]. Find the drop-down menu called <<Apply Metadata>>. Select the metadata template which was previously created and imported.

The import process is started by clicking on <<Get Media>>.

Image selection

It is best to import all images taken during one campaign in the same folder and keep them untouched as a backup. Photos taken the same day go in the same sub-folder named with the date. From here you can copy them into a working folder.

With Bridge, one can quickly browse through all the images in the working folder and delete what is not useful and necessary. For this process it is helpful to enlarge the preview area and place the magnifying lens in the preview area. The small magnifying lens helps quickly identify photos which are blurred or out of focus.

The useful images can then be sorted into folders, usually by area or building. For example, '…\working_folder\BaN - Basilique Chretienne du Nord\BaN-2\raw'.

Adjusting RAW images

After the images have been sorted into folders, use Adobe Bridge to open a folder, select all the images and open them in CameraRAW (a free Adobe RAW image developing tool).

Select the image containing the scale, north arrow and grey card. Then click <<Select All>>. You can balance the white of all the pictures of one section by selecting the white-balance tool at the top  and then clicking on the grey card in the image. CameraRAW will define the selected point on the grey card as an area without color and apply this definition to the other images as well. Working with a grey card has the advantage that every section's white balancing will be based on the same grey card.

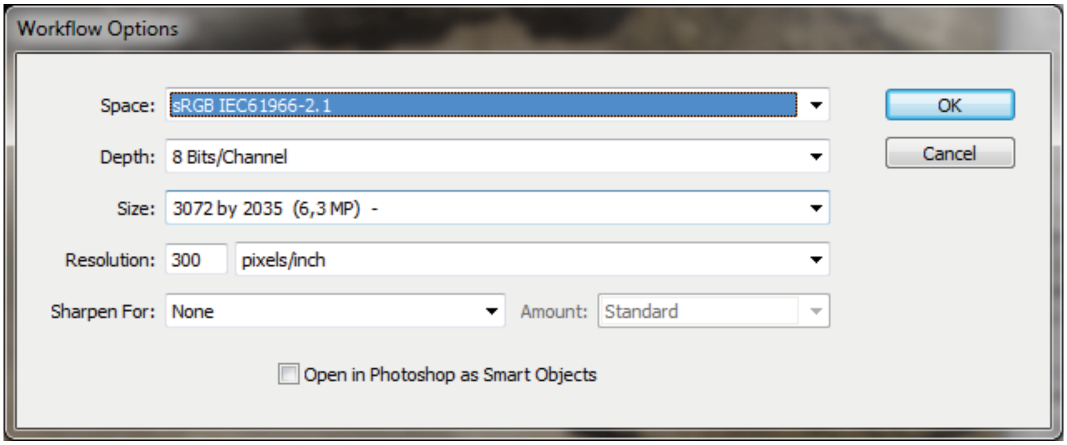
Keeping all the images selected, select <<Lens Correction>> . Check the box <<Enable Lens Profile Corrections>>. CameraRAW should now identify the camera and the lens with which you have taken the images and correct distortion caused by the low focal length.

Sometimes pictures might be slightly under or overexposed. It is possible to adjust the exposure manually using the exposure tool . .

Lastly, open the Workflow Options menu. These options will define the quality of the final montages. Select as below.

When all adjustments are taken, click on <<Done>>. The adjustments in DNG are saved within the file and can be changed or reversed again at any time without loss of quality.

[1] (http://en.wikipedia.org/wiki/Digital_Negative)



For slower computers

It is easiest to merge pictures directly from the RAW files rather than exporting extra JPEGs.

If the computer does not have enough resources to process the photomerge with DNGs, perform a JPEG export. Save images with the option, making sure all the images are still selected and save them as a JPEG of quality 12 (maximum).

Context images

Export JPEGs for the context images in quality 12 (maximum).

Photomerge

In Adobe Photoshop, go to File > Automate > Photomerge. Click on Browse and choose the images for the montage. You can also select images and initiate the photo merging process from Adobe Bridge.

Select the extent to which Photoshop is allowed to adapt the pictures in order to find the best matching points. In most cases <<Perspective>> works well, while sometimes <<Automatic>> gives the best results. It should be considered that processing the pictures in <<Automatic>> is more time consuming.

Never activate <<Geometric Distortion Correction>>, as it often results in areas of the image being randomly repeated in the montage. Each time a section is merged, it is recommended to first run the Photomerge without the <<Blend Images Together>> option. This way images will overlap without smoothing borders, allowing one to verify how precisely the borders match. If pictures match neatly, run the process again, this time with <<Blend Images Together>> activated.

When the final merge is of low precision or impossible, there is the option to work in sections, but this can be more time consuming than retaking the photographs if there is opportunity to do so.

The result of the montage will be saved in an uncompressed TIFF format in the folder to which it was assigned.

Inserting a scale and the north arrow in a montage

Open the montage and the image containing the reference items (scale, north arrow, grey card) in Adobe Photoshop. Also, open the document called 'scale' in Adobe Photoshop. Using the photo containing the scale and north arrow as a reference, copy and paste the scale into the montage at the bottom right corner. Include also the north arrow.

File naming and applying individual metadata

Name the montage using the established naming convention. In this case, including the name of the building and number of the room in the file name as well as the date (year and month). To distinguish it as a photomontage, include an underscore M' (_M) at the end of the file name.

8

Example: Room 10b in House 4 (Maison 4) taken June 2012
MOS_TUN_BUL_M4-10b_201206_M.tif

Batch rename the DNGs you used to obtain the montages. If you exported JPEGs to create the montages, delete them and continue working only with the DNGs.

For the mosaic in 10b in House 4, five images were used for the montage, they should look like this:

MOS_TUN_BUL_M4-10b_201206_001_M.dng
MOS_TUN_BUL_M4-10b_201206_002_M.dng
MOS_TUN_BUL_M4-10b_201206_003_M.dng
MOS_TUN_BUL_M4-10b_201206_004_M.dng
MOS_TUN_BUL_M4-10b_201206_005_M.dng

Even though Adobe Bridge is adequate for doing batch renaming, this can be done much quicker using a software called XnView. Browse in XnView to the folder containing the pictures of a section you want to rename. Select them all, right-click and <<Rename>>. When you relabel the next section, XnView will suggest the same filename you applied before, so you need to change only the building number.

Applying individual metadata to a montage

In the 'Description' line of the IPTC metadata section, type the name of the image following the established guidelines. In this case the naming followed the protocol outlined in the GCI *Technician Training* handbook (https://www.getty.edu/conservation/publications_resources/pdf_publications/pdf/technician_training_2014.pdf):

Ex: BR_E1-7_2012-06_1ID

Context images

For the context images, an established convention was used: Project_Country_Site_Building name _ Date (yyyymm) _ Sequential number_ suffix 'C' to indicate context. Rename DNGs and JPEG exports:

MOS_TUN_BUL_Th3_201206_001_C.dng	MOS_TUN_BUL_Th3_201206_001_C.jpg
MOS_TUN_BUL_Th3_201206_002_C.dng	MOS_TUN_BUL_Th3_201206_002_C.jpg
MOS_TUN_BUL_Th3_201206_003_C.dng	MOS_TUN_BUL_Th3_201206_003_C.jpg

If you are taking photos of conditions and construction techniques, they should be labeled with the same logic as above, using the next sequential number for each mosaic but without the _M suffix. File them in the mosaic folder and make a copy which should be filed under a folder 'Condition' or 'Construction Technique' as appropriate. In the Condition folder, create a new subfolder if the phenomena you are recording have not been recorded yet.

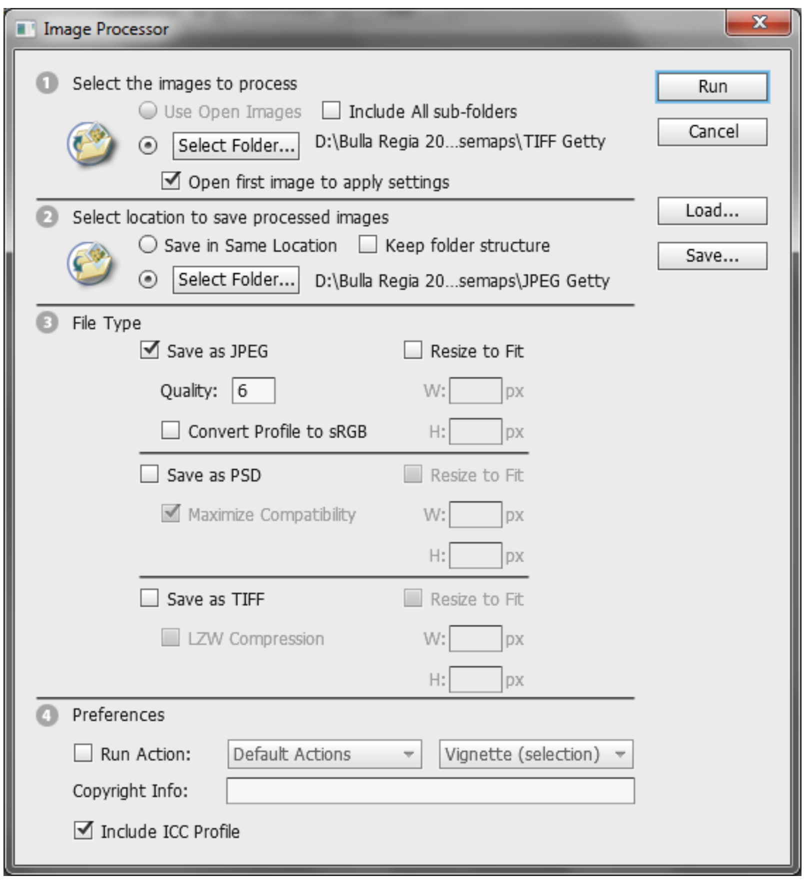
Converting TIFFs into JPEGs

Once all the montages have been saved in TIFF format, verify that:

- All global and individual metadata are included
- Scale and north arrow are inserted
- Naming has been performed correctly

Next, copy the montages into the permanent folder location. In our case, it is called ‘TIFF Getty’ (Bulla Regia Primary drive > Bulla Regia > 03 Visuals > 02 Basemaps > TIFF Getty).

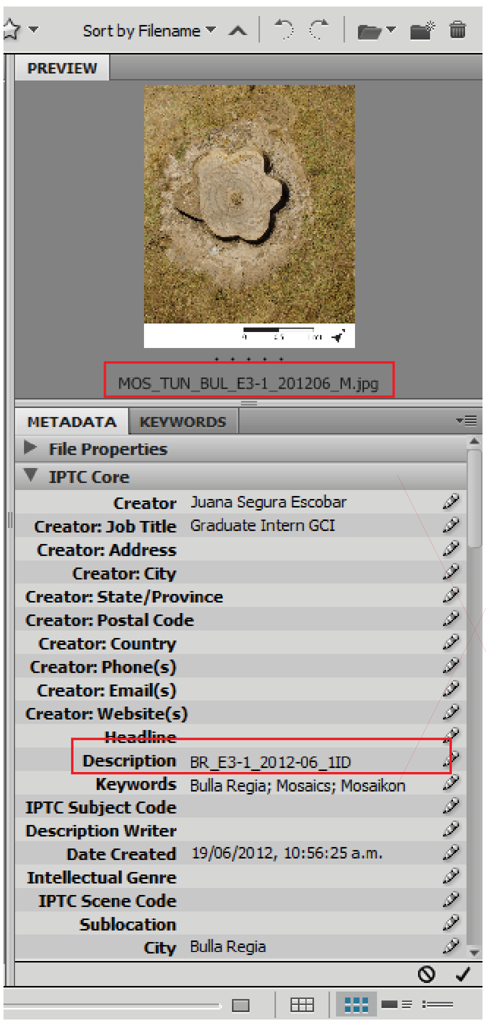
Open Adobe Photoshop, and in the menu <<File>> chose <<Scripts>> and then <<Image Processor>>. Select the folder of ‘TIFF Getty’ in the first menu. In the second menu chose the folder ‘JPEG Getty’ (Bulla Regia Primary drive > Bulla Regia > 03 Visuals > 02 Basemaps > JPEG Getty) as the saving location. Then set the file type as JPEG Quality 6. Click Run.

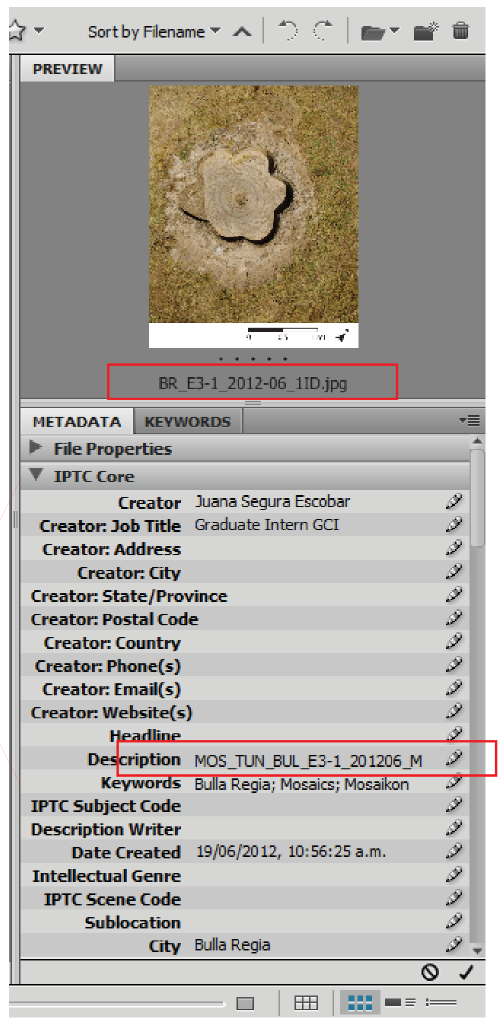


Duplicating a montage following the GCI *Technician Training* naming convention

Make a copy of the JPEG Getty folder and label it 'JPEG BR labeled'. Following the convention described in the *Technician Training* handbook (https://www.getty.edu/conservation/publications_resources/pdf_publications/pdf/technician_training_2014.pdf), change the 'Description' field of the metadata (montage by montage) and rename all images. For renaming the images, the software XnView can save time. You can rename all JPEGs at once in two steps: First replace 'MOS_TUN_BUL' with 'BR', in a next round, replace the date format and the last segment: '201206_M' to 2012-06_1ID'.

Getty Naming Convention | **Technician Training Naming Convention**





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APPENDIX C

Mosaic Maps

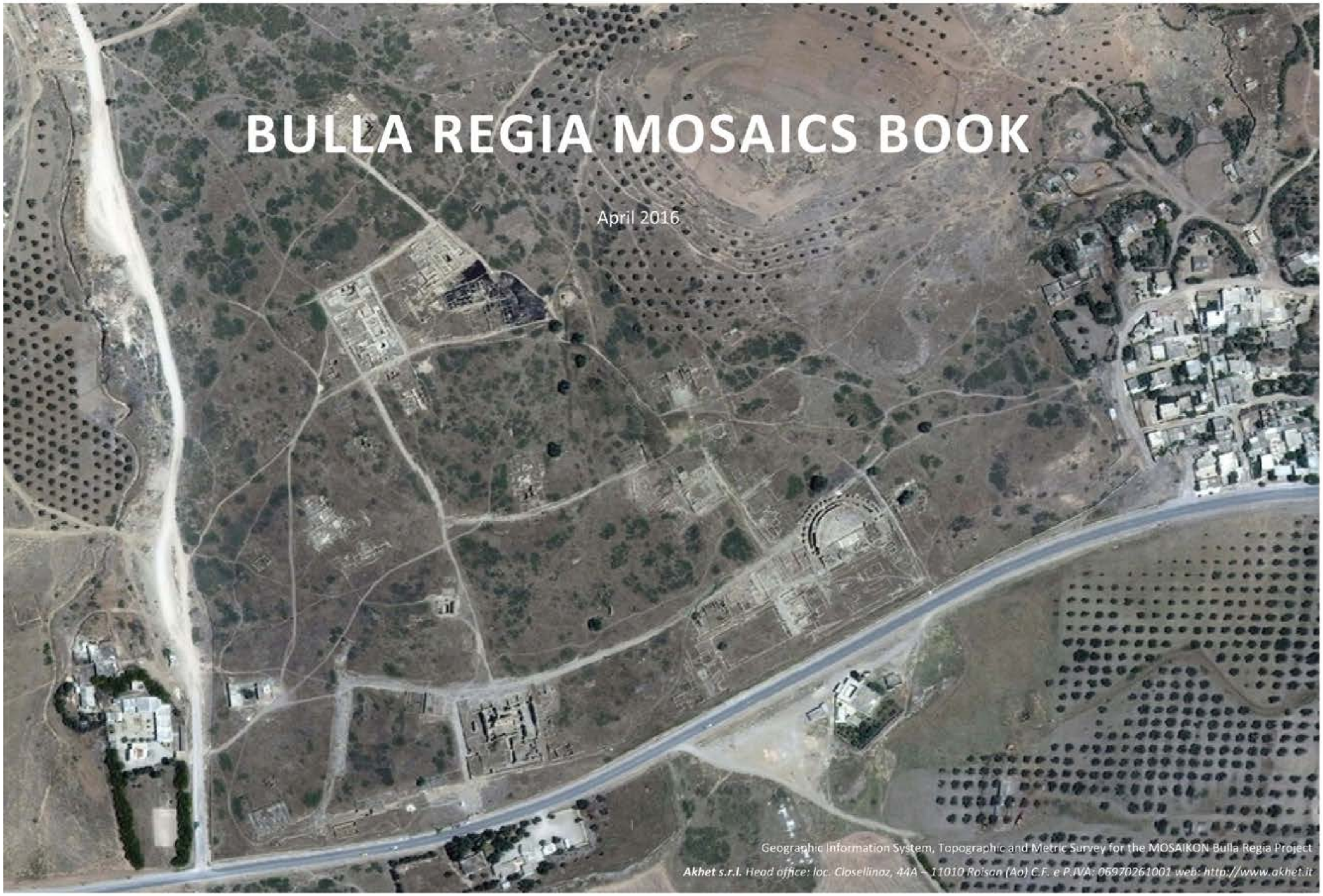
The Getty Conservation Institute

MOSAIKON
Getty Conservation Institute Getty Foundation ICCM ICCROM

Institut National du Patrimoine

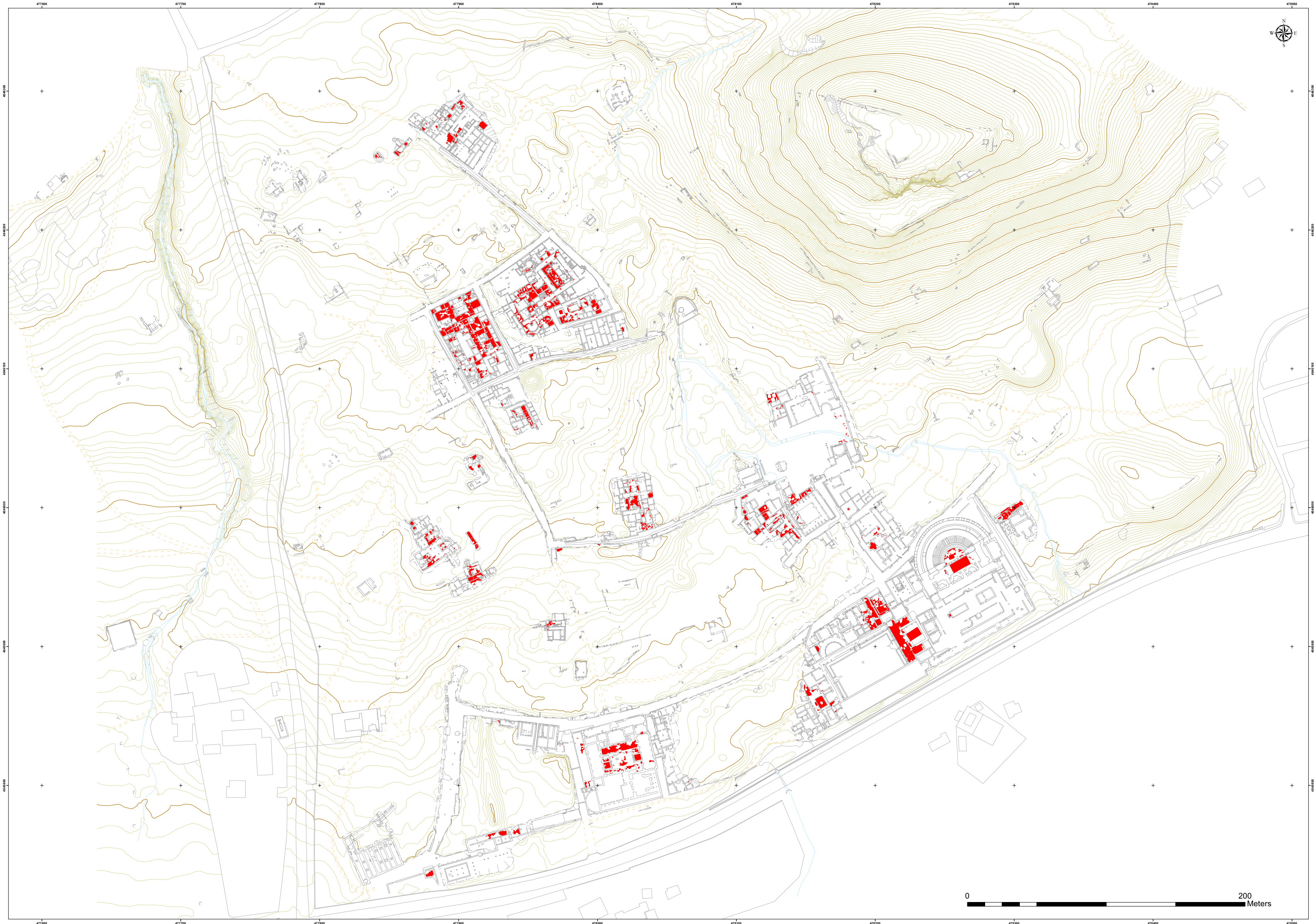
BULLA REGIA MOSAICS BOOK

April 2016



Geographic Information System, Topographic and Metric Survey for the MOSAIKON Bulla Regia Project

Akhet s.r.l. *Head office: loc. Closellinaz, 44A – 11010 Roisan (Ao) C.F. e P.IVA: 06970261001 web: http://www.akhet.it*


0
200
Meters

1	Basilique du Forum (B01)
2	Basilique Chrétienne du Nord (BaN)
3	Basilique Chrétienne du Sud (BaS)
4	Edifice au sud-ouest du Temple d'Apollon (E01)
5	Edifice dans le coin sud du Forum (E02)
6	Edifice au nord-est du Marché (E03)
7	Edifice au nord de la Deuxième Esplanade (E04)
8	Edifice à l'ouest de la Deuxième Esplanade (E05)
9	Edifice à l'est des Thermes de Iulia Memmia (E06)
10	Edifice au nord du monument en opus reticulatum (E07)
11	Edifice à l'ouest du monument en opus reticulatum (E08)
12	Edifice au sud de la Maison 3 (E09)
13	Edifice au nord de la Maison 7 (E10)
14	Edifice au carrefour entre M3 et M7 (E11)
15	Edifice au coin sud de l'insula de la Pêche (E12)
16	Edifice au nord de la source (E13)
17	Edifice au nord-est du Temple d'Apollon (E14)
18	Edifice au sud de la colline (E15)
19	Edifice à l'ouest du Temple 1 (E16)
20	Deuxième Esplanade Monumentale (EM2)
21	Maison 1 (M01) - ground level
22	Maison 1 (M01-S) - underground level
23	Maison 2 (M02)
24	Maison 3 (M03) - ground level
25	Maison 3 (M03-S) - underground level
26	Maison 4 (M04)
27	Maison 5 (M05)
28	Maison 7 (M07)- ground and underground level
29	Maison 8 (M08)
30	Maison 9 (M09)
31	Maison 10 (M10)

32	Maison 14 (M14)
33	Maison 15 (M15)
34	Maison d'Amphitrite (MA) - ground level
35	Maison d'Amphitrite (MA-S) - underground level
36	Maison de la Chasse (MC) - ground level
37	Maison de la Chasse (MC-S) - underground level
38	Maison de la Nouvelle Chasse (MNC) - ground level
39	Maison de la Nouvelle Chasse (MNC-S) - underground level
40	Maison de la Pêche (MP) - ground level
41	Maison de la Pêche (MP-S) - underground level
42	Maison du Paon (MPa) - ground level
43	Maison du Paon (MPa-S) - underground level
44	Maison du Trésor (MT) - ground level
45	Maison du Trésor (MT-S) - underground level
46	Marché (Mar)
47	Nymphée (Ny1)
48	Temple à l'ouest des Thermes de Iulia Memmia (T1)
49	Temple d'Apollon (TAp)
50	Thermes au nord-ouest du Théâtre (Th1)
51	Thermes à l'est du Théâtre (Th2)
52	Thermes au nord-ouest de la Deuxième Esplanade (Th3)
53	Thermes au nord-ouest des Basiliques (Th4)
54	Thermes du nord-est (Th5)
55	Thermes de Iulia Memmia (ThIM)
56	Thermes des Venantii (ThV)
57	Théâtre (Tt)

Building Map Key

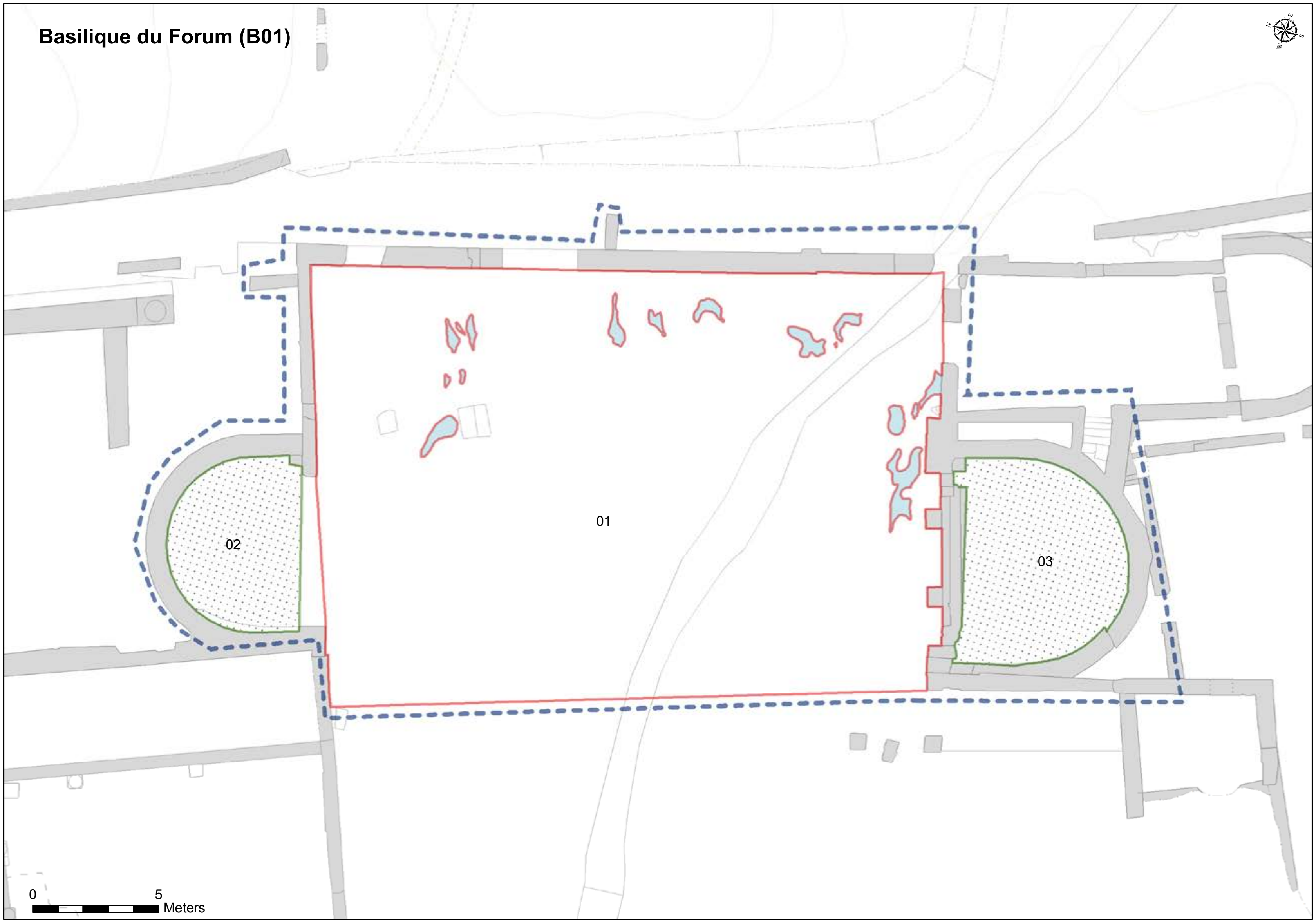
Room with in situ mosaic

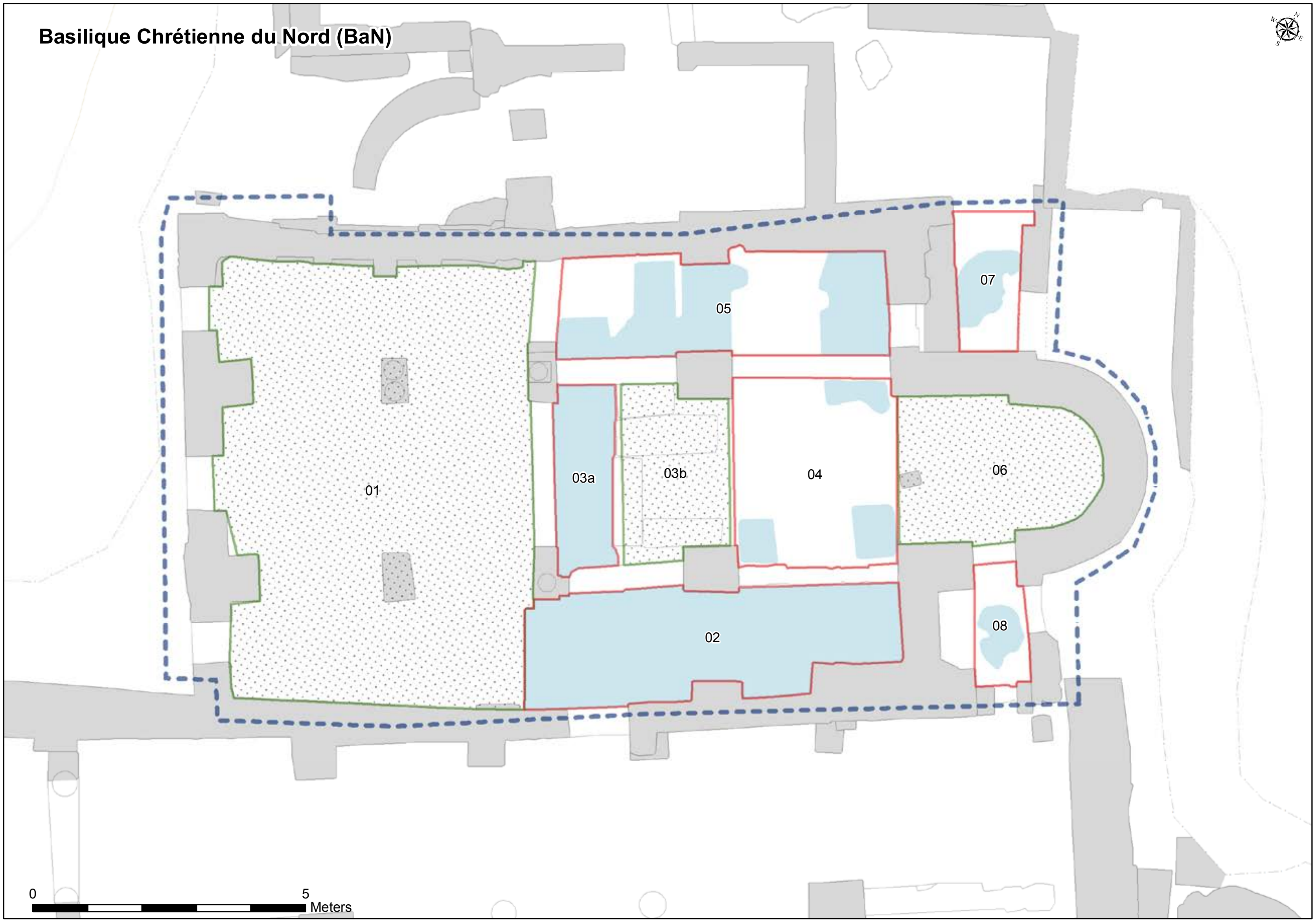
Room with mosaic on reinforced concrete panel

Room without mosaic

Wall

Building perimeter

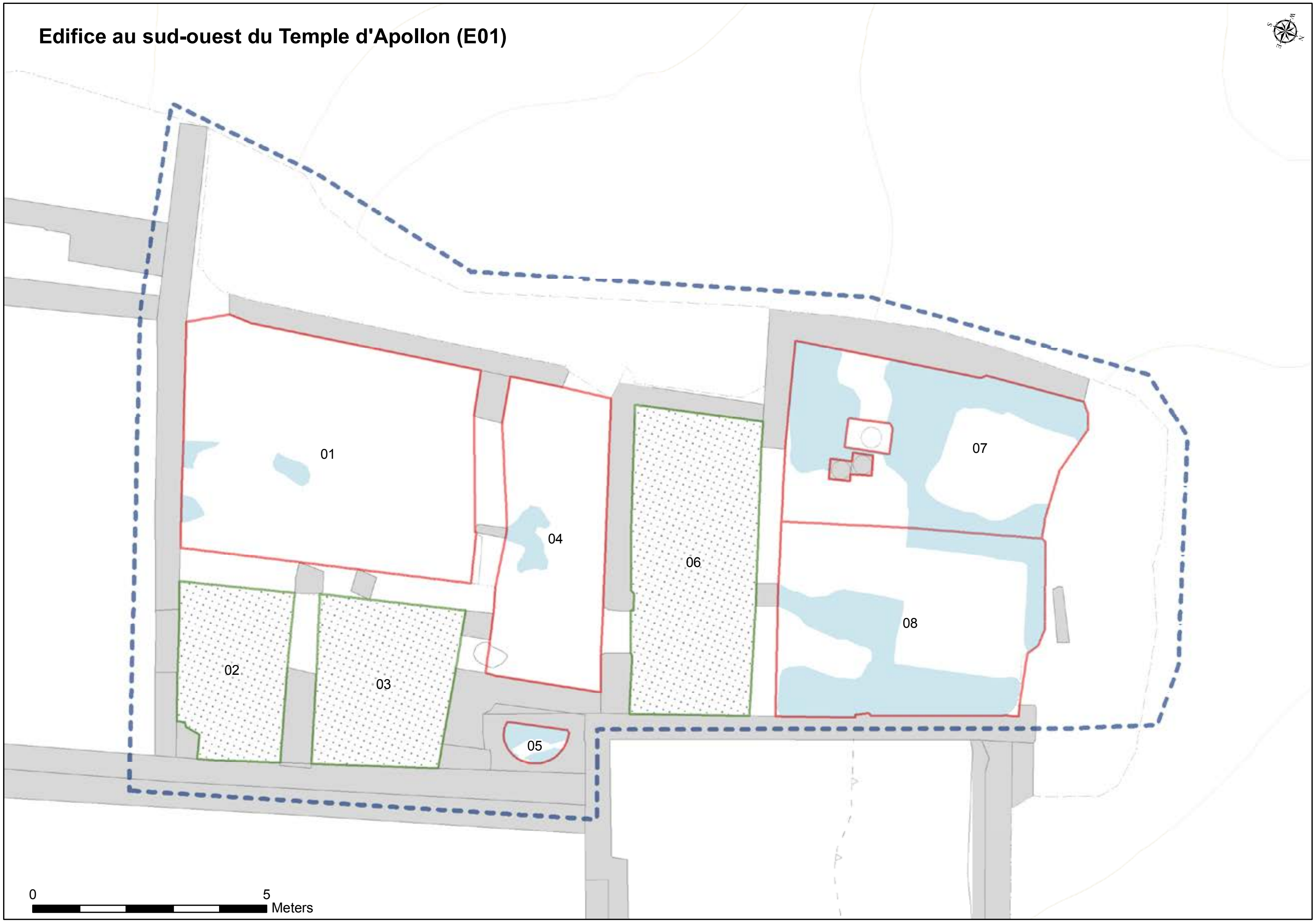

Basilique du Forum (B01)
01
02
03
0
5
Meters

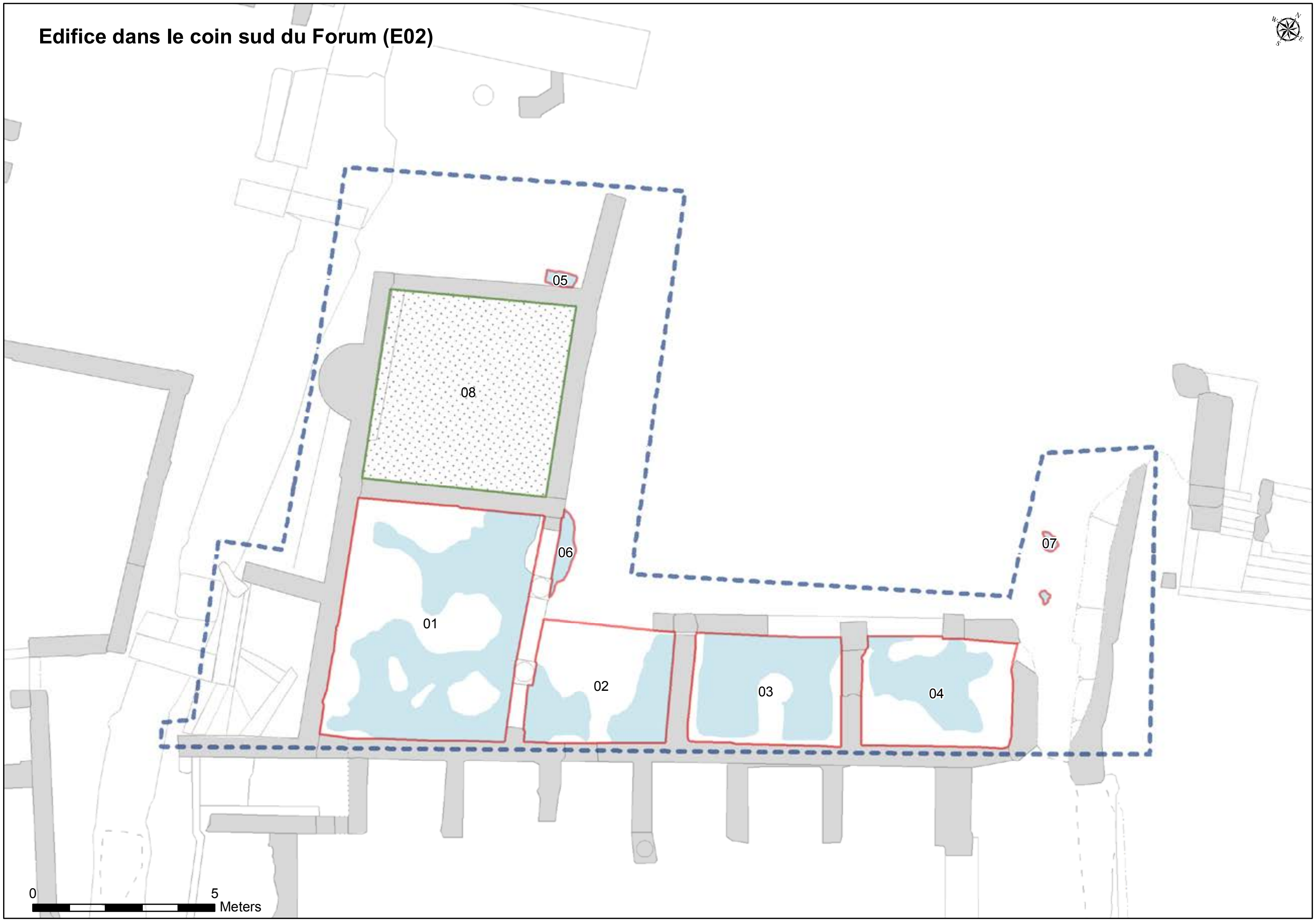


Basilique Chrétienne du Nord (BaN)
2
01
02
03a
03b
04
05
06
07
08
0
5
Meters

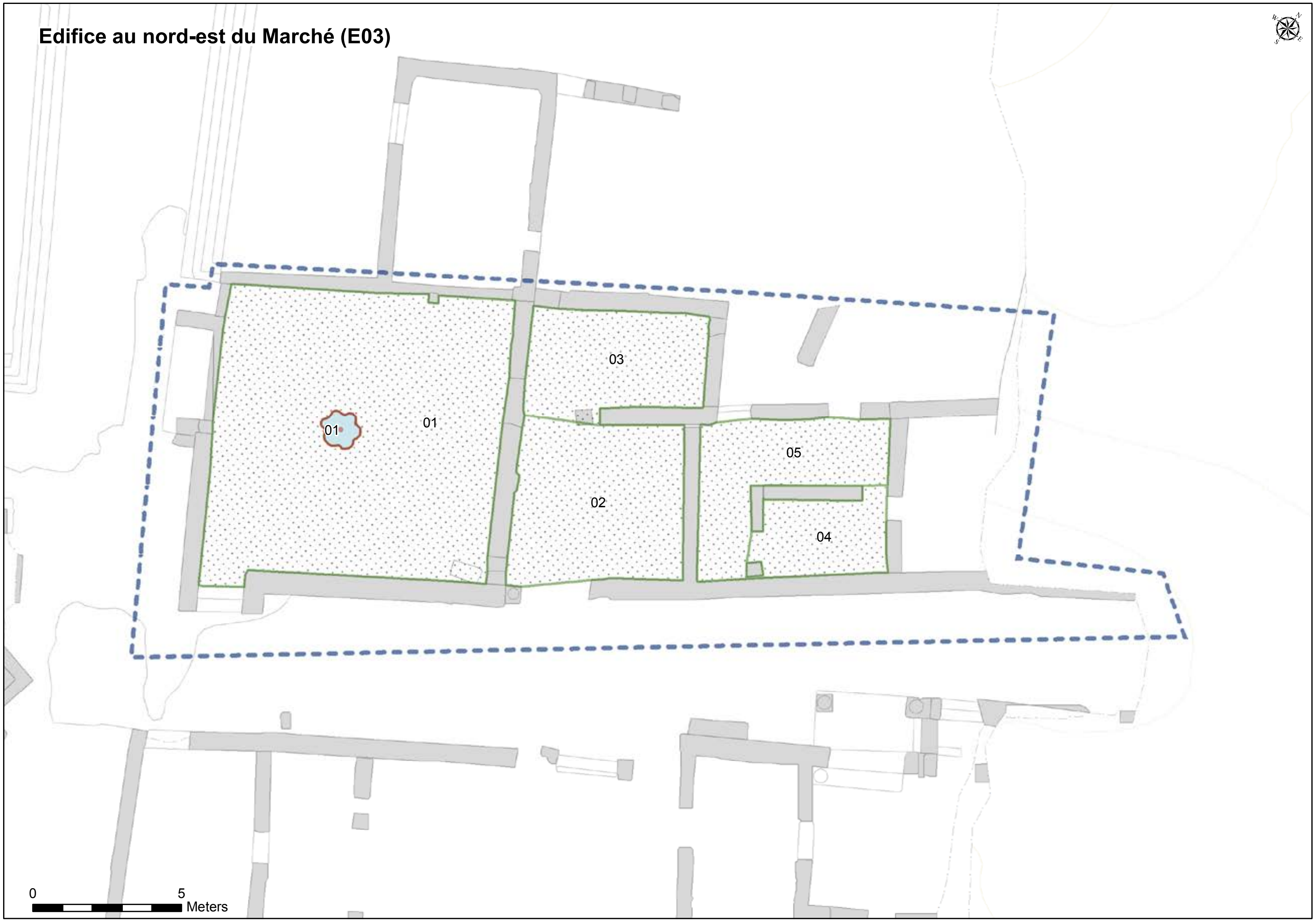

Basilique Chrétienne du Sud (BaS)
02
07
10
05
04
09
11
06
01
03
08
12
13
0
5
Meters

4

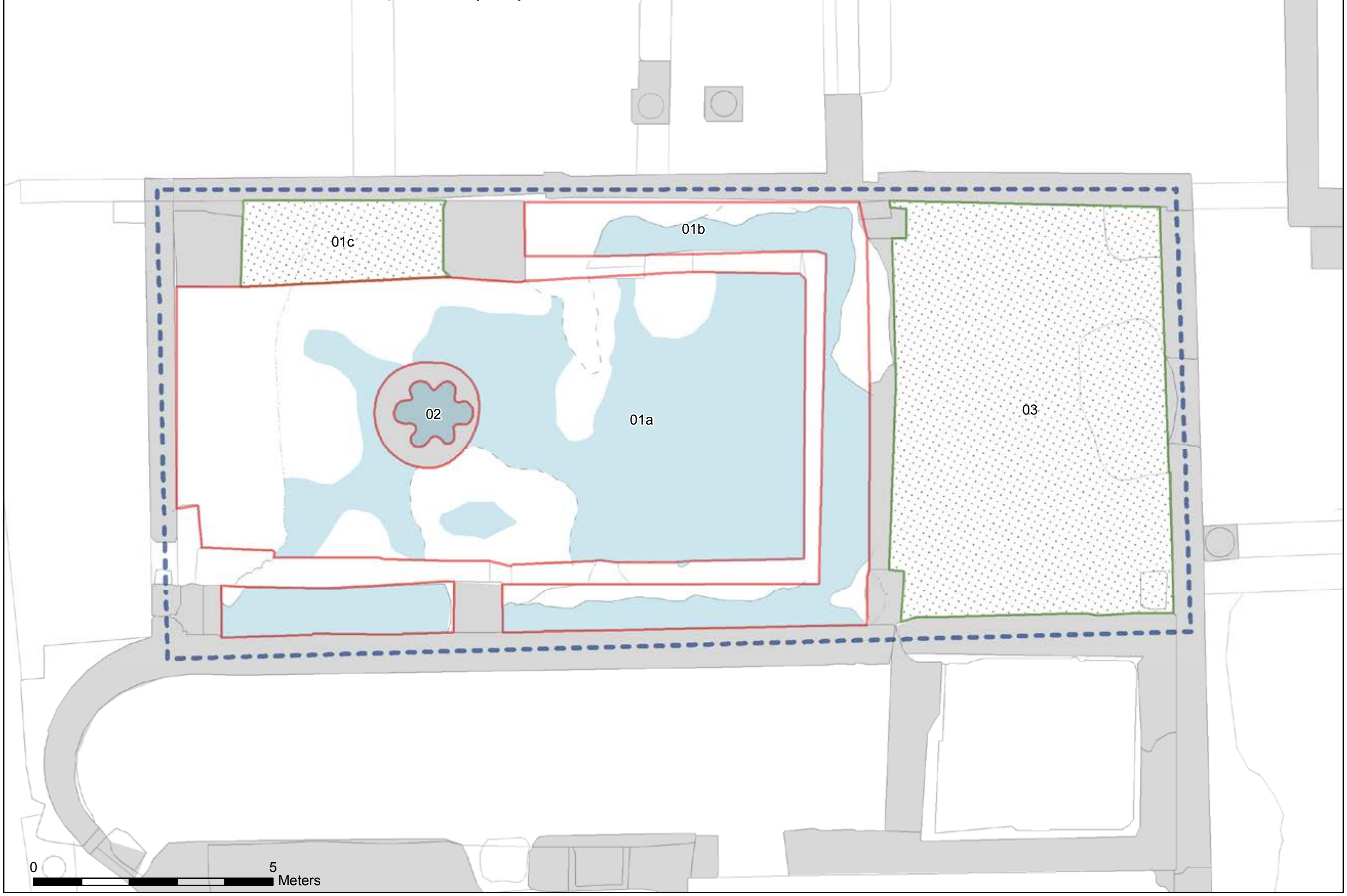

Edifice au sud-ouest du Temple d'Apollon (E01)
01
02
03
04
05
06
07
08
0
5
Meters


Edifice dans le coin sud du Forum (E02)
05
08
06
07
01
02
03
04
0
5
Meters

6

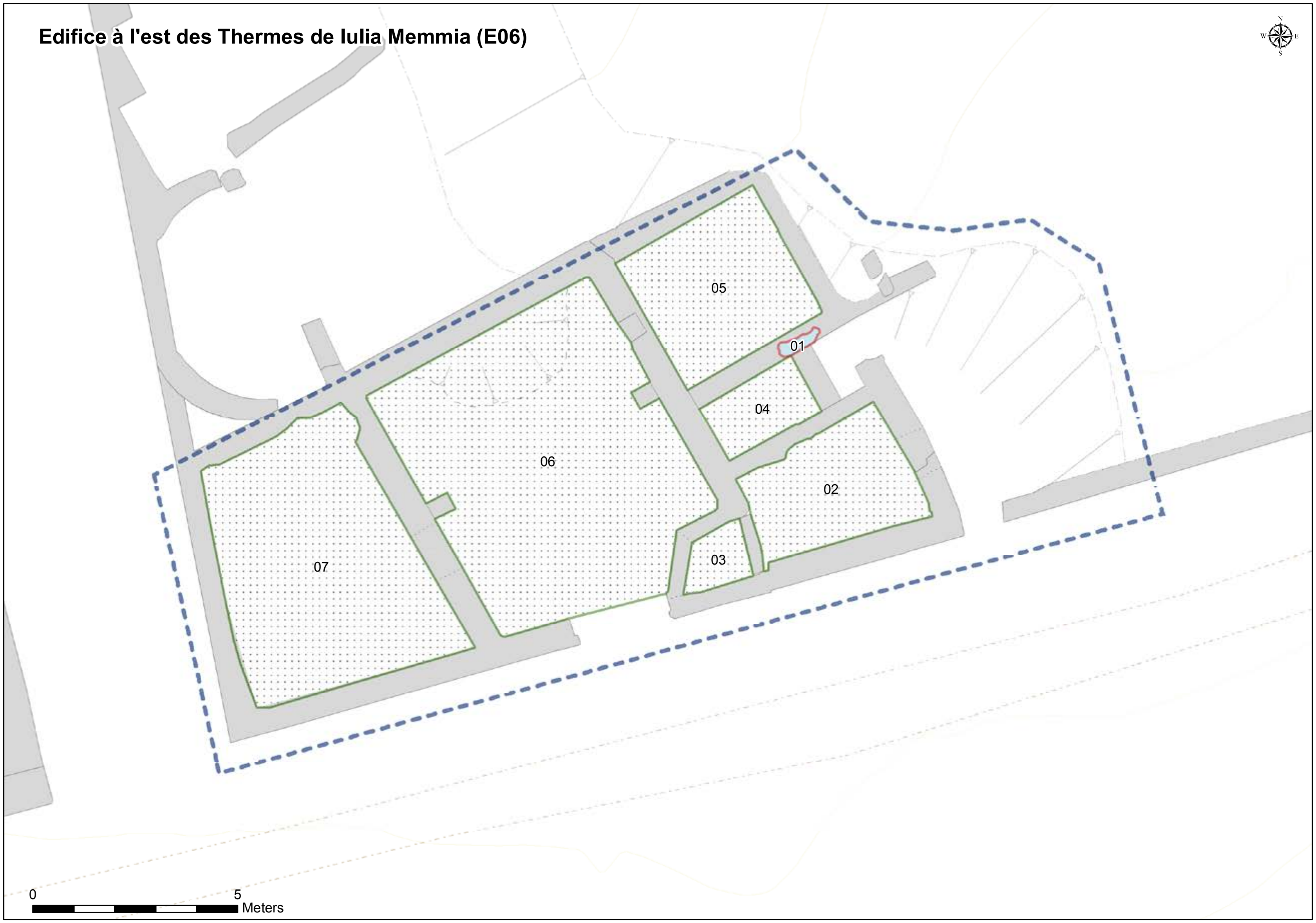


Edifice au nord de la Deuxième Esplanade (E04)



8

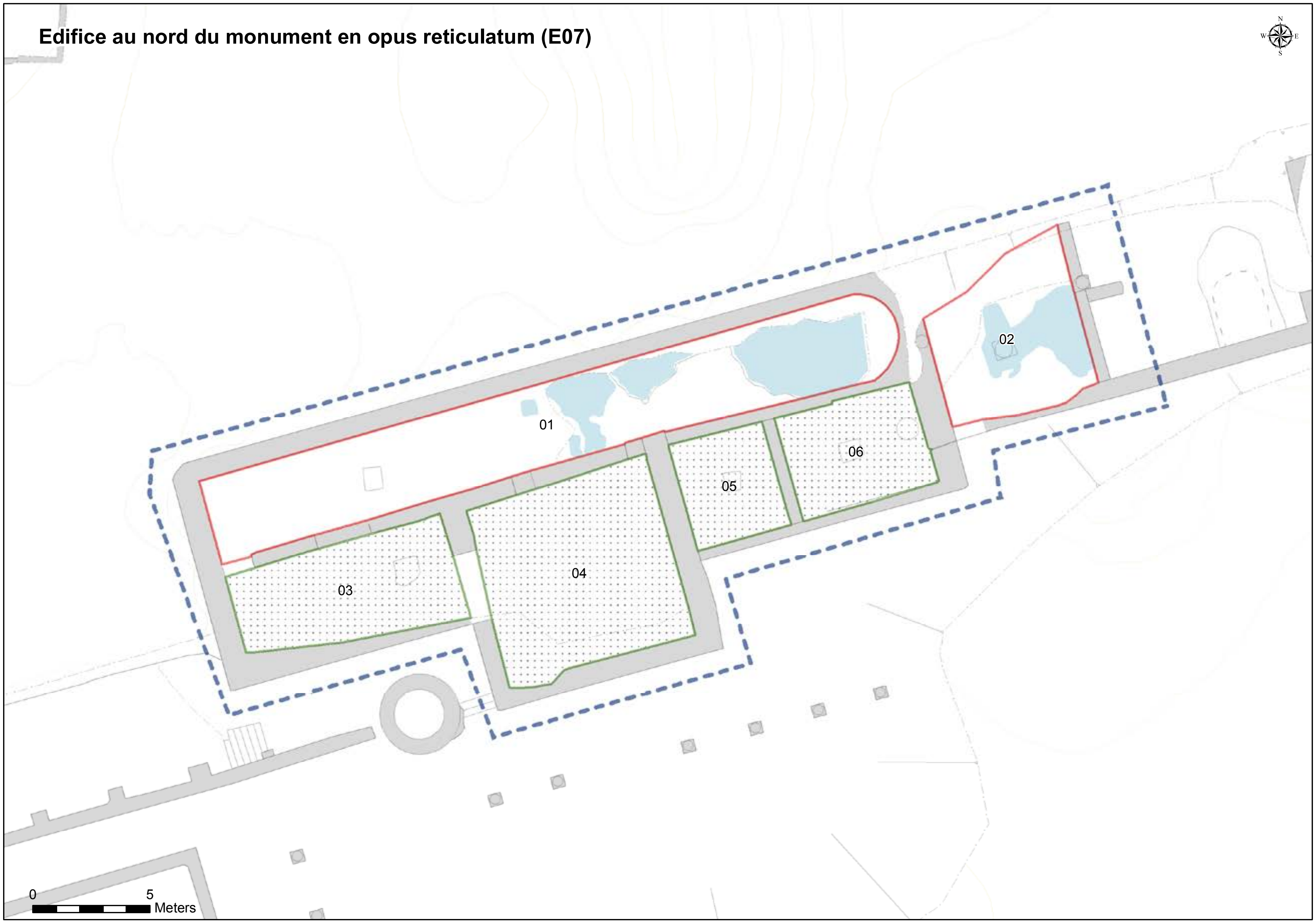

Edifice à l'ouest de la Deuxième Esplanade (E05)
01a
02
01b
03b
03a
06
04
05
0
5
Meters

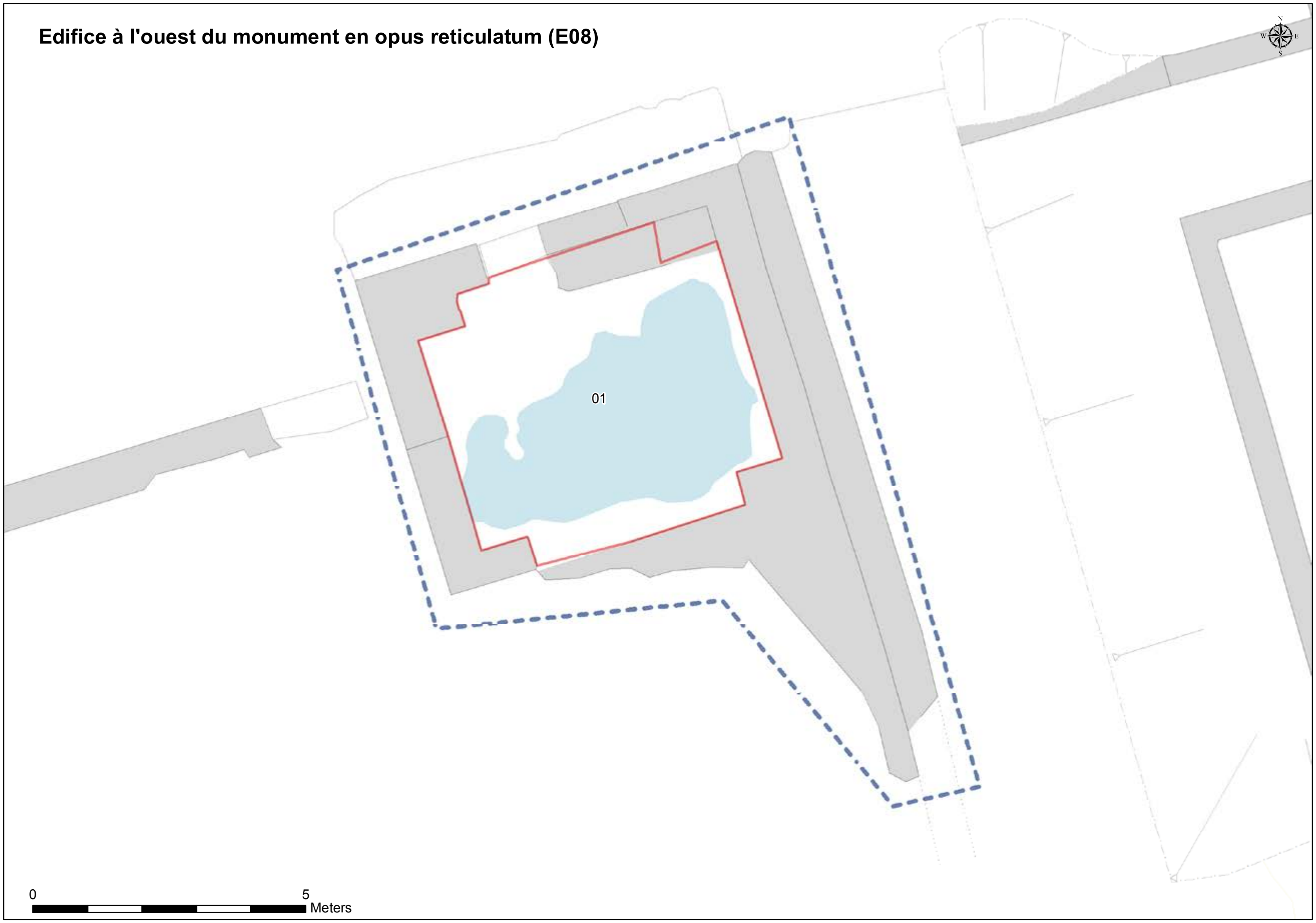


Edifice à l'est des Thermes de Iulia Memmia (E06)
N
W
E
S
05
01
04
06
02
03
07
0
5
Meters

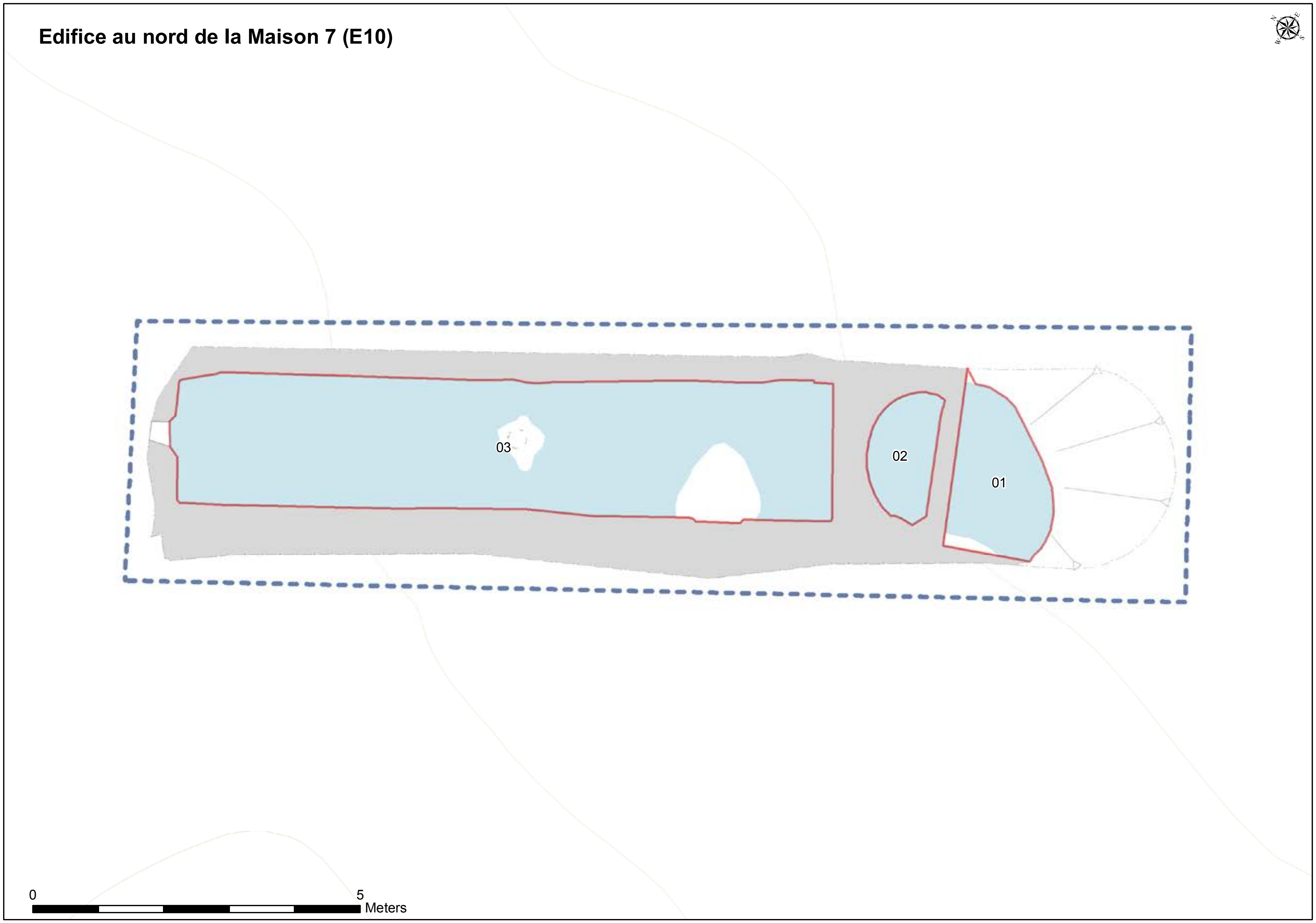
10

Edifice au nord du monument en opus reticulatum (E07)

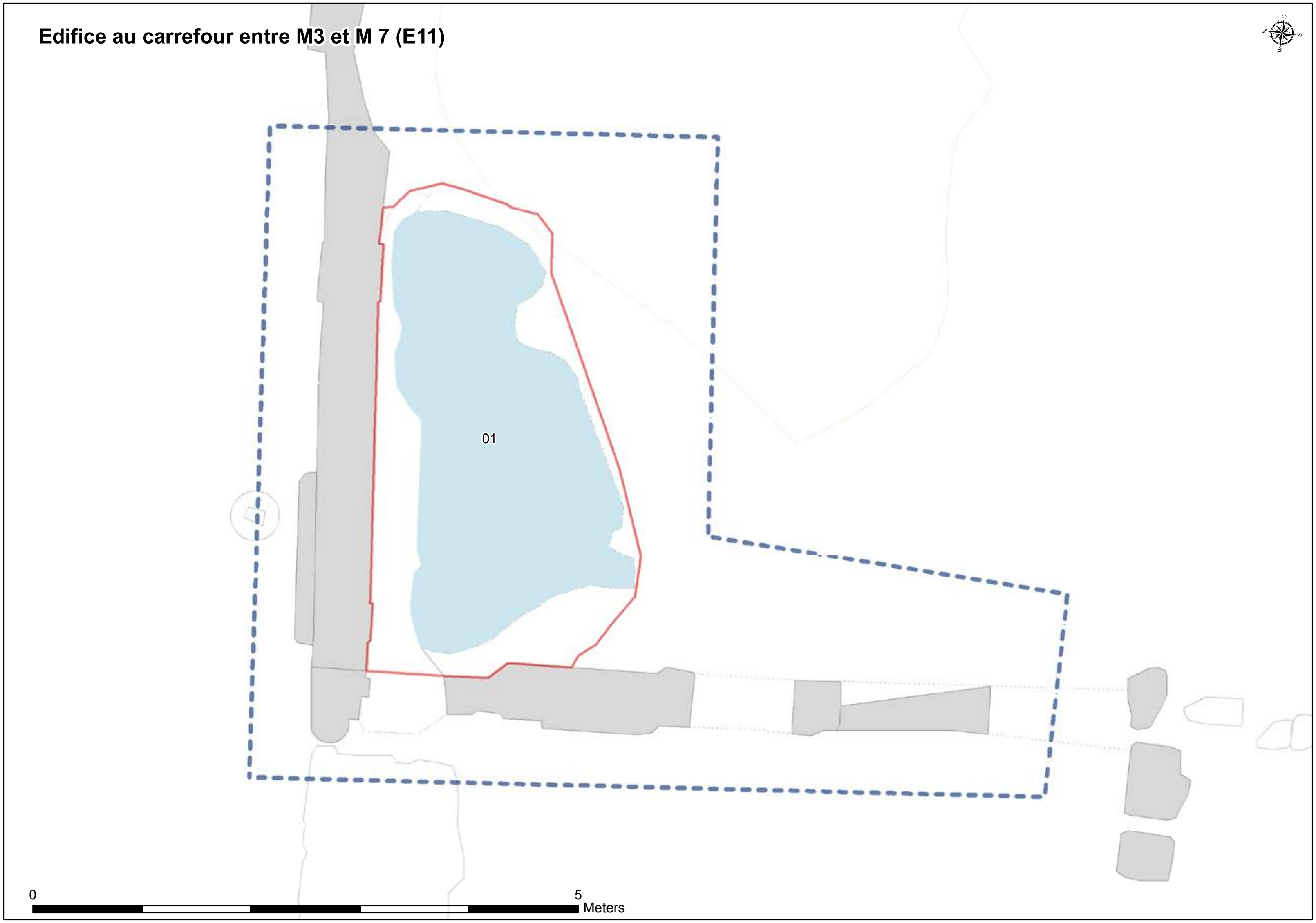


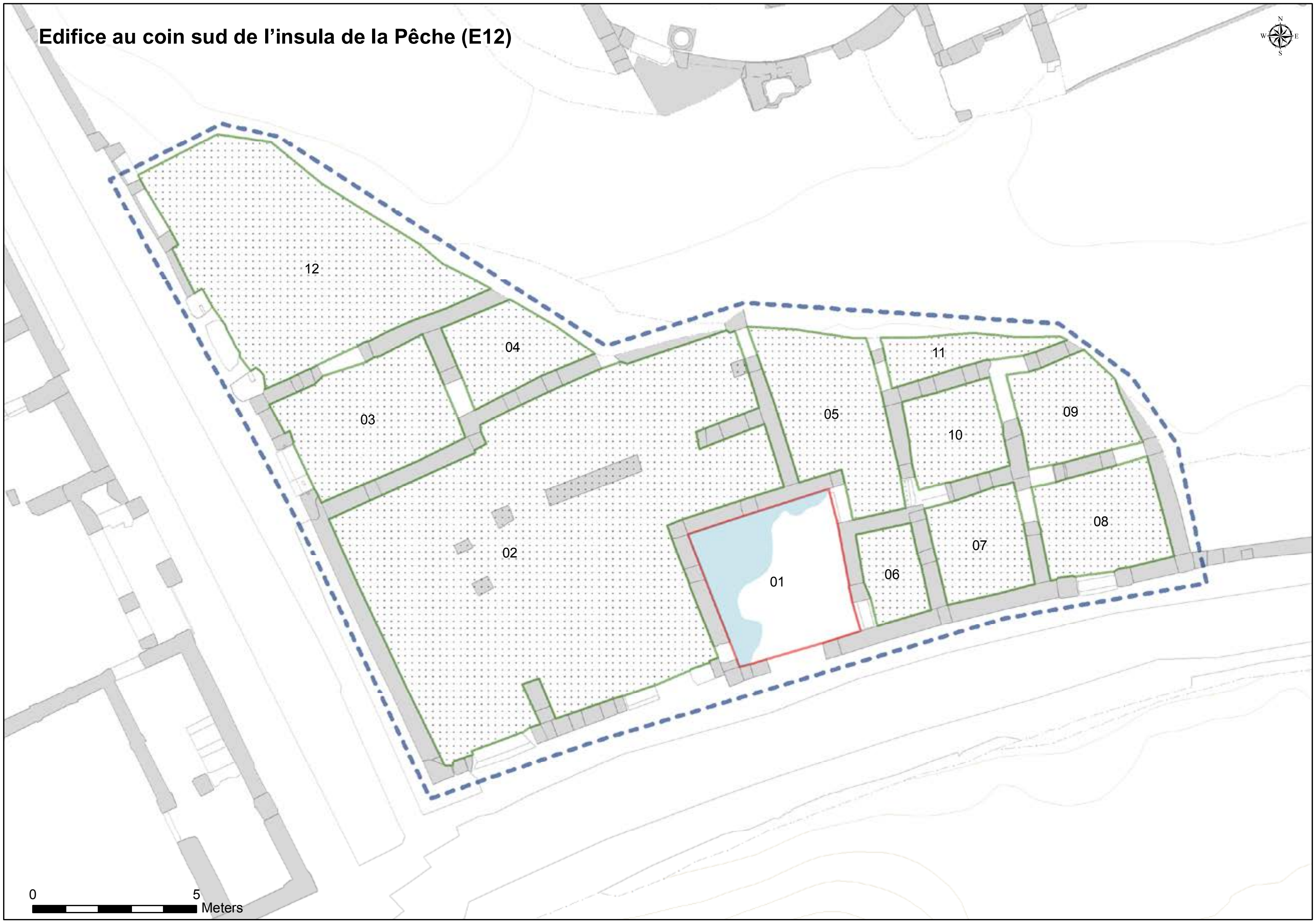

Edifice à l'ouest du monument en opus reticulatum (E08)
N
W
E
S
01
0
5
Meters

12


Edifice au nord de la Maison 7 (E10)
03
02
01
0
5
Meters

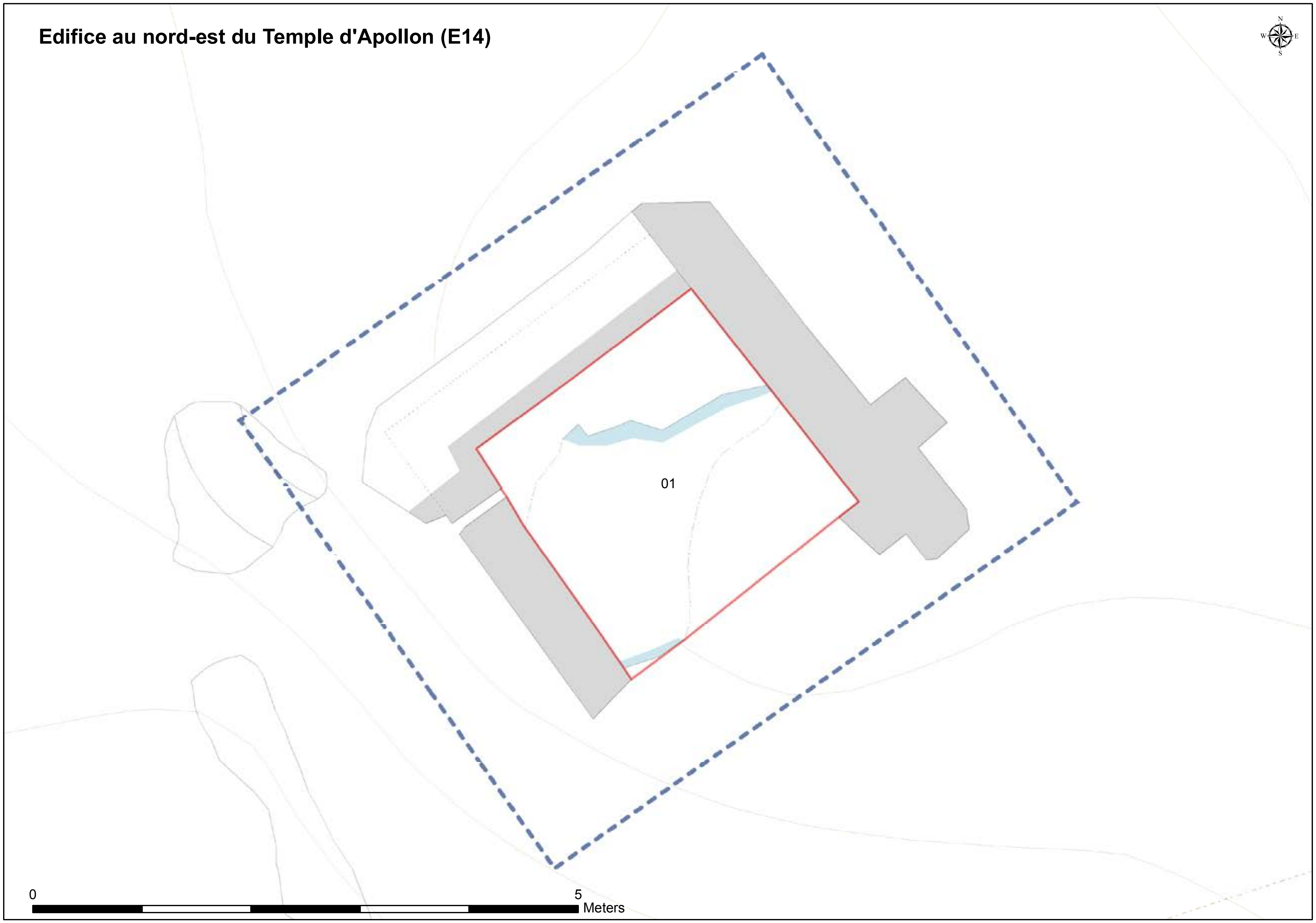
Edifice au carrefour entre M3 et M 7 (E11)

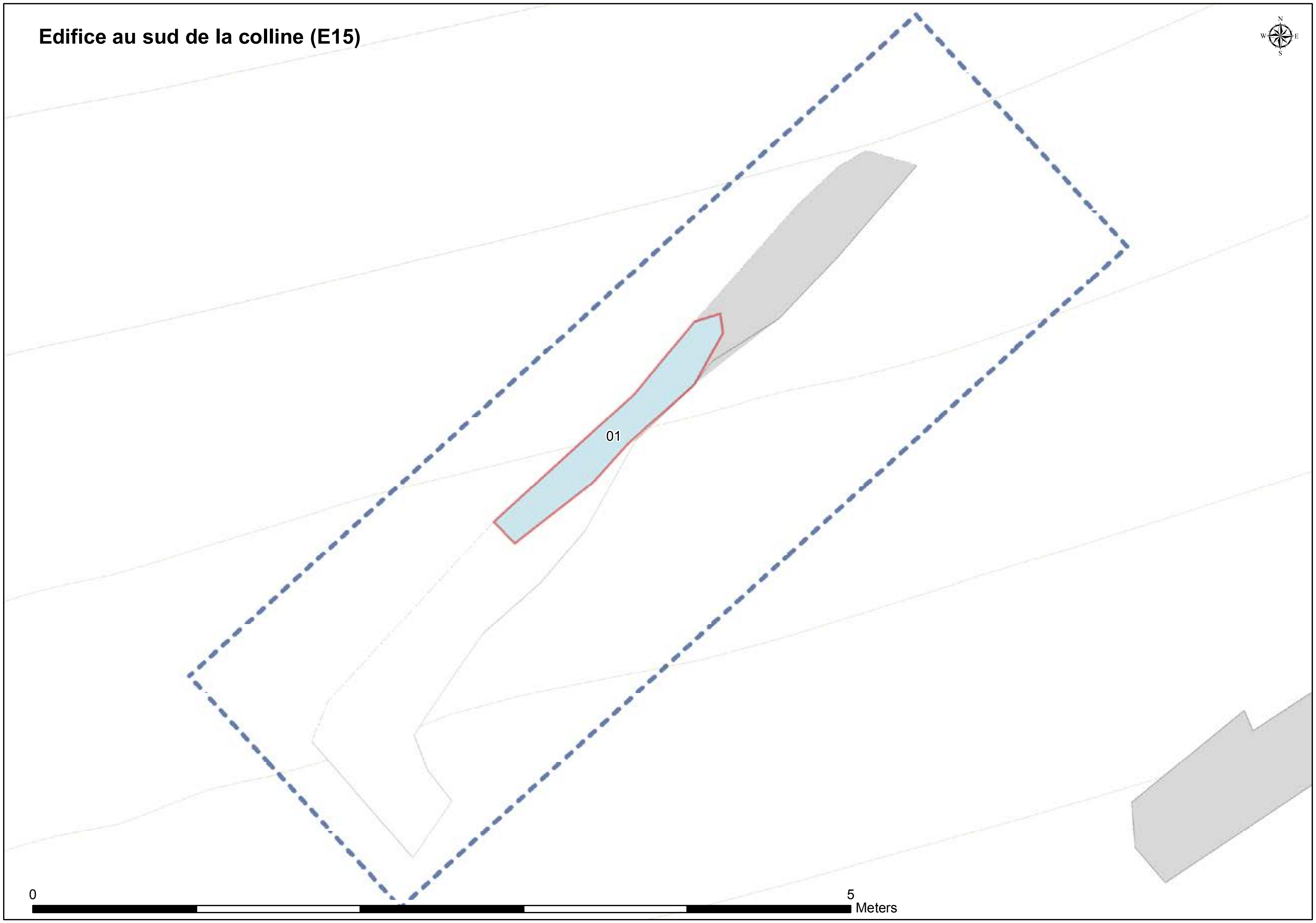


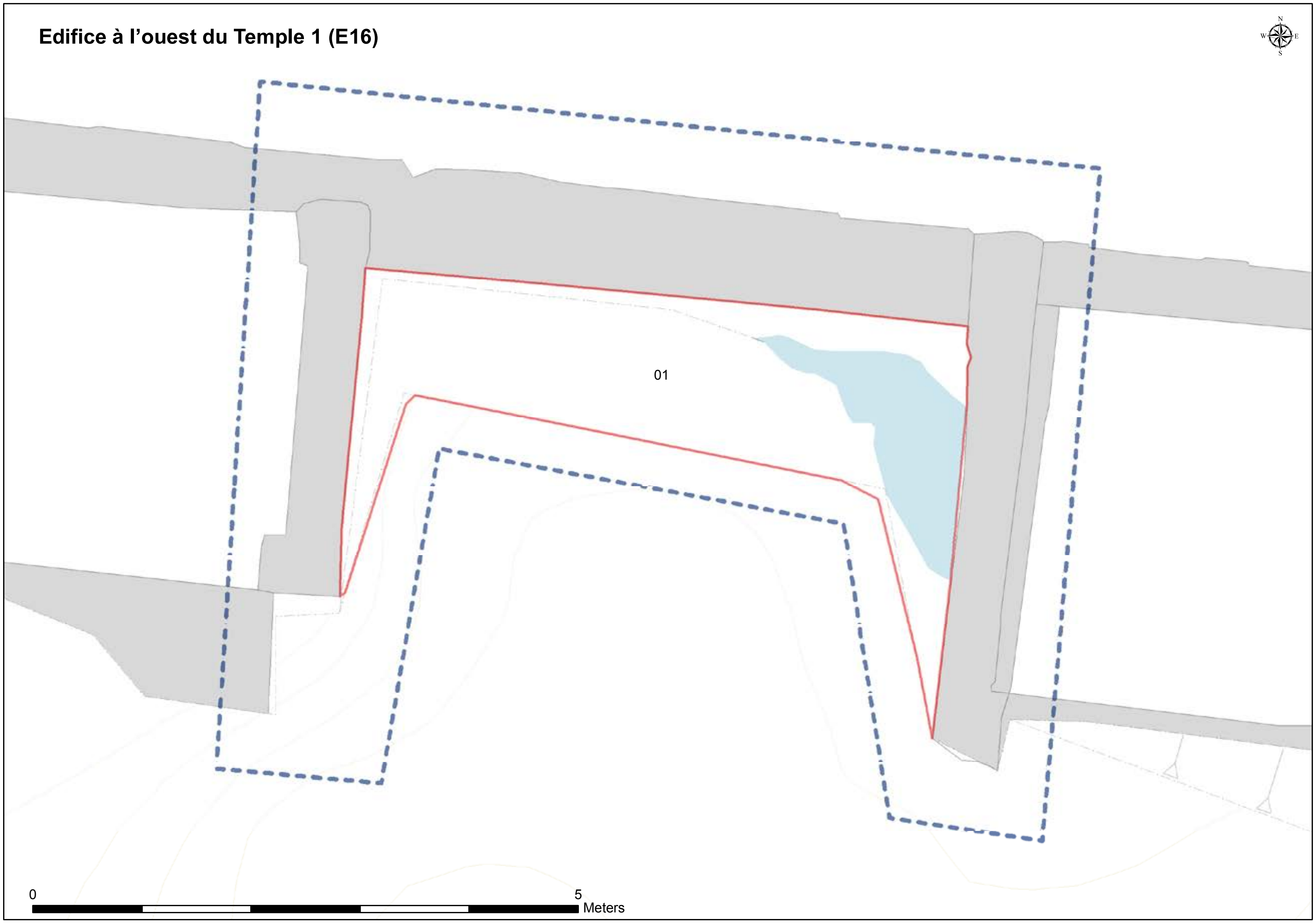

Edifice au coin sud de l'insula de la Pêche (E12)
12
04
03
02
01
05
11
10
09
08
07
06
0
5
Meters

16

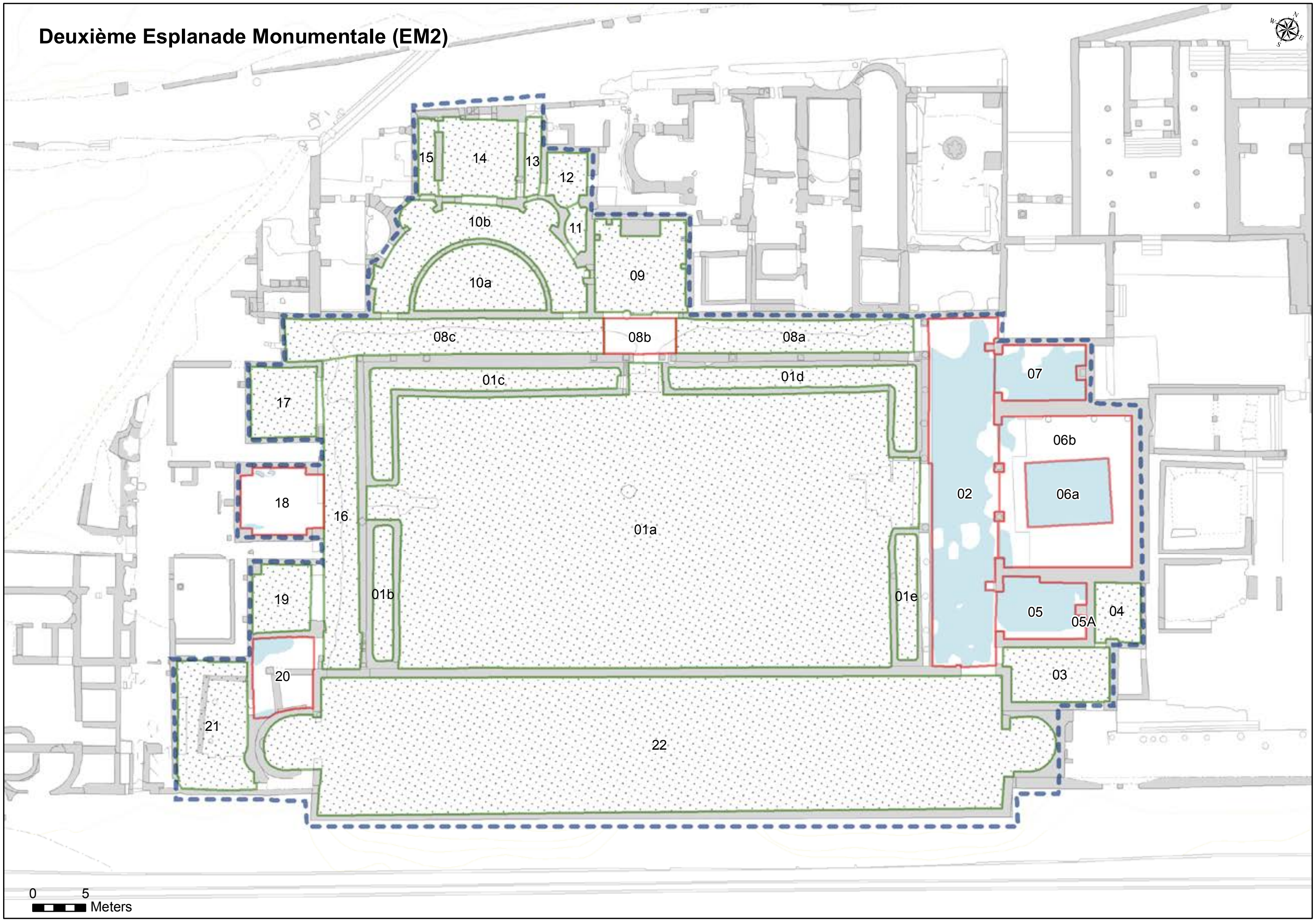
Edifice au nord de la source (E13)


Edifice au nord-est du Temple d'Apollon (E14)
N
W
E
S
01
0
5
Meters


Edifice au sud de la colline (E15)
01
0
5
Meters
N
S
E
W


Edifice à l'ouest du Temple 1 (E16)
N
W
E
S
01
0
5
Meters

20


Deuxième Esplanade Monumentale (EM2)
15
14
13
12
10b
11
09
10a
08c
08b
08a
17
01c
01d
07
06b
18
16
02
06a
01a
19
01b
01e
05
05A
04
20
03
21
22
0
5
Meters

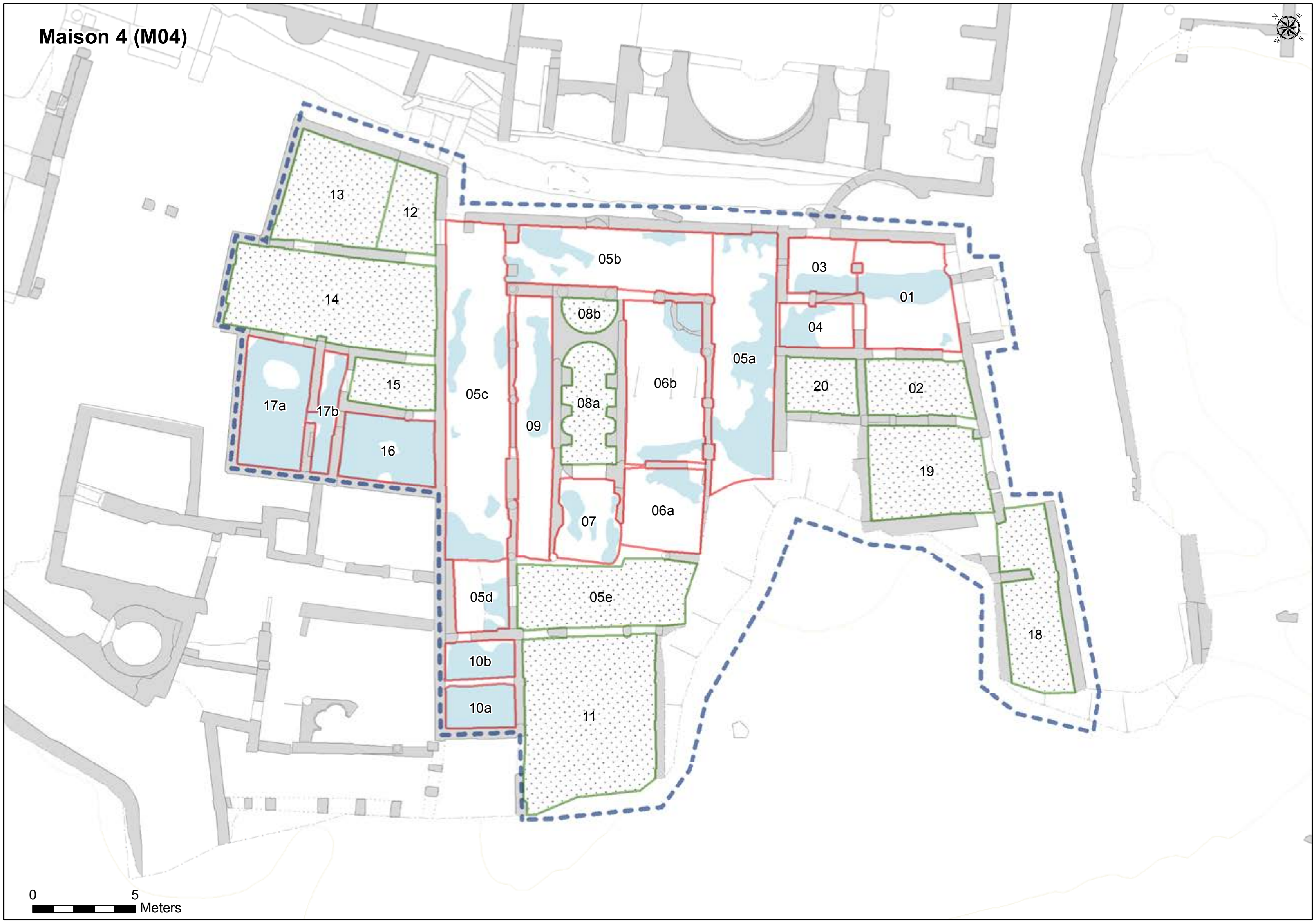

Maison 1 (M01) - ground level
23
22
21
20
24
01b
12
11
03
02
01a
11seuil
25
06
05
08
07
04
32
13
09
10
14
33
26
19
18
15
16
17_R
31
27
30
28
29
0
5
Meters

Maison 1 (M01-S) - underground level


Maison 2 (M02)
N
W
E
S
04
02
03
01
07
08
06
05
0
5
Meters

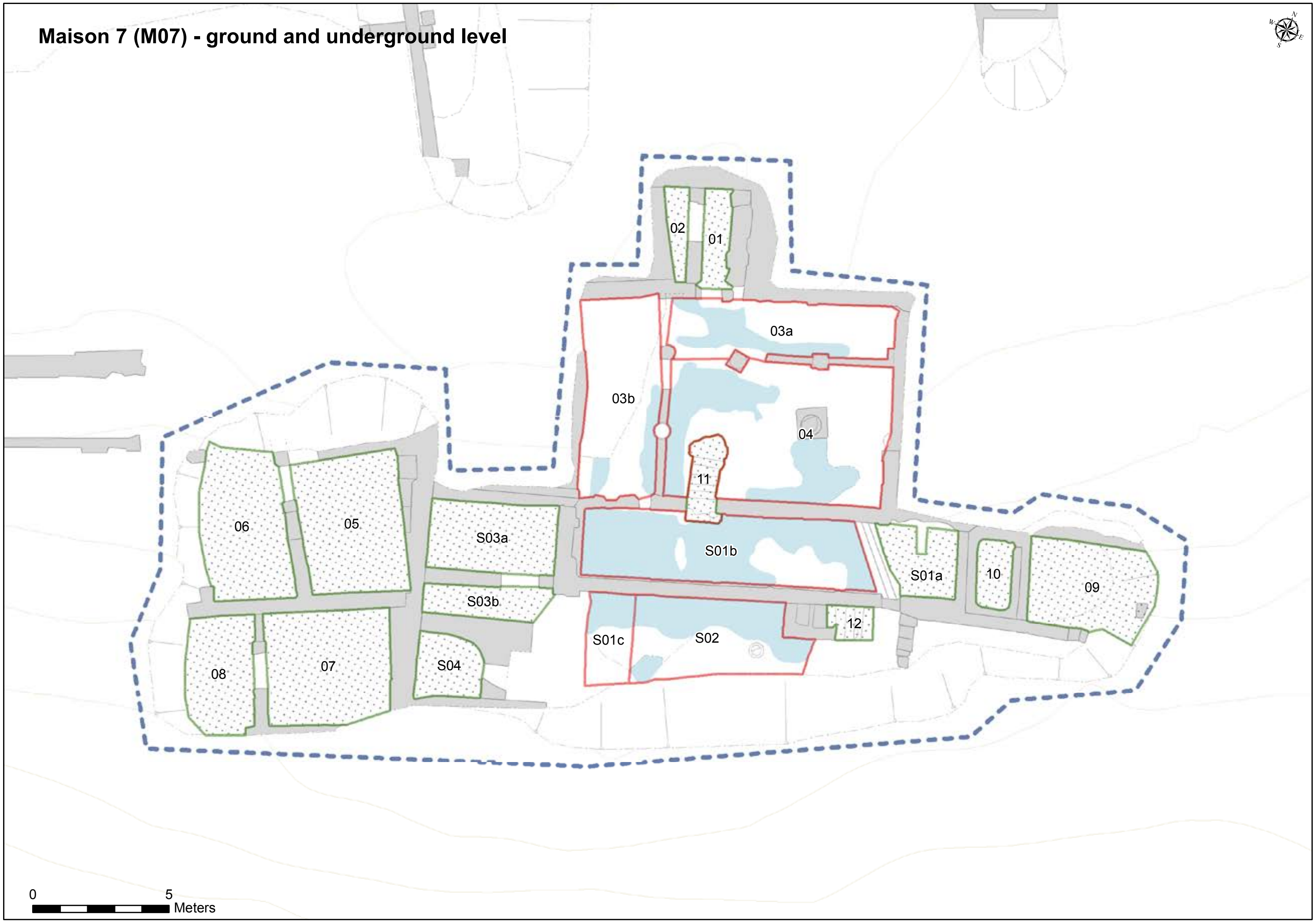

Maison 3 (M03) - ground level
32
31
30
28
29
35
36
15
14
13
08
07
06
12a
10
09
05
04
33
16
11b
11a
37
01
12b
18b
18a
17
12c
03
02
34
19
20
21
22
23
26
25
24
27
0
5
Meters


Maison 3 (M03-S) - underground level
N
W
E
S
S01
S02
S03
S04
S05
S06
0
1
2
4
6
8
10
Meters


Maison 4 (M04)
26
13
12
14
05b
03
01
08b
04
05a
17a
17b
15
05c
09
08a
06b
20
02
16
19
07
06a
18
05d
05e
10b
10a
11
0
5
Meters

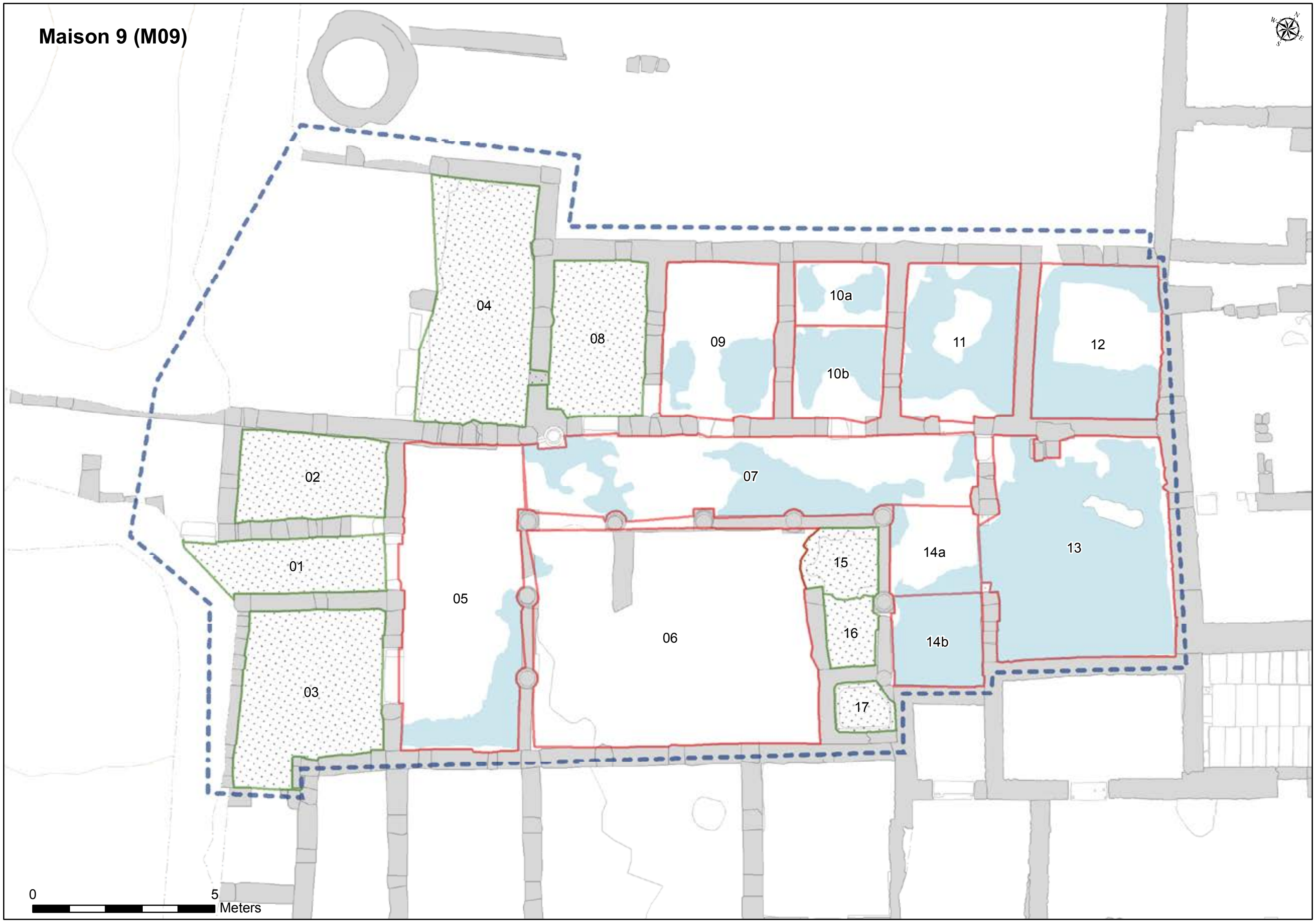

Maison 5 (M05)
15
16
17
14
11
10
13
01
09
12
04b
04a
08
03
05
07
02
06
0
5
Meters

28



Maison 7 (M07) - ground and underground level
02
01
03a
03b
04
11
06
05
S03a
S01b
S01a
10
09
S03b
12
S01c
S02
08
07
S04
0
5
Meters


Maison 8 (M08)
23
22
16
24
25
15
10
08
07
21
14
12
09
06
13a
13b
26
27
02
04
20
19
18
17
11
03
01
05
28
0
5
Meters


Maison 9 (M09)
04
08
09
10a
10b
11
12
02
07
01
05
06
15
14a
13
16
14b
03
17
0
5
Meters

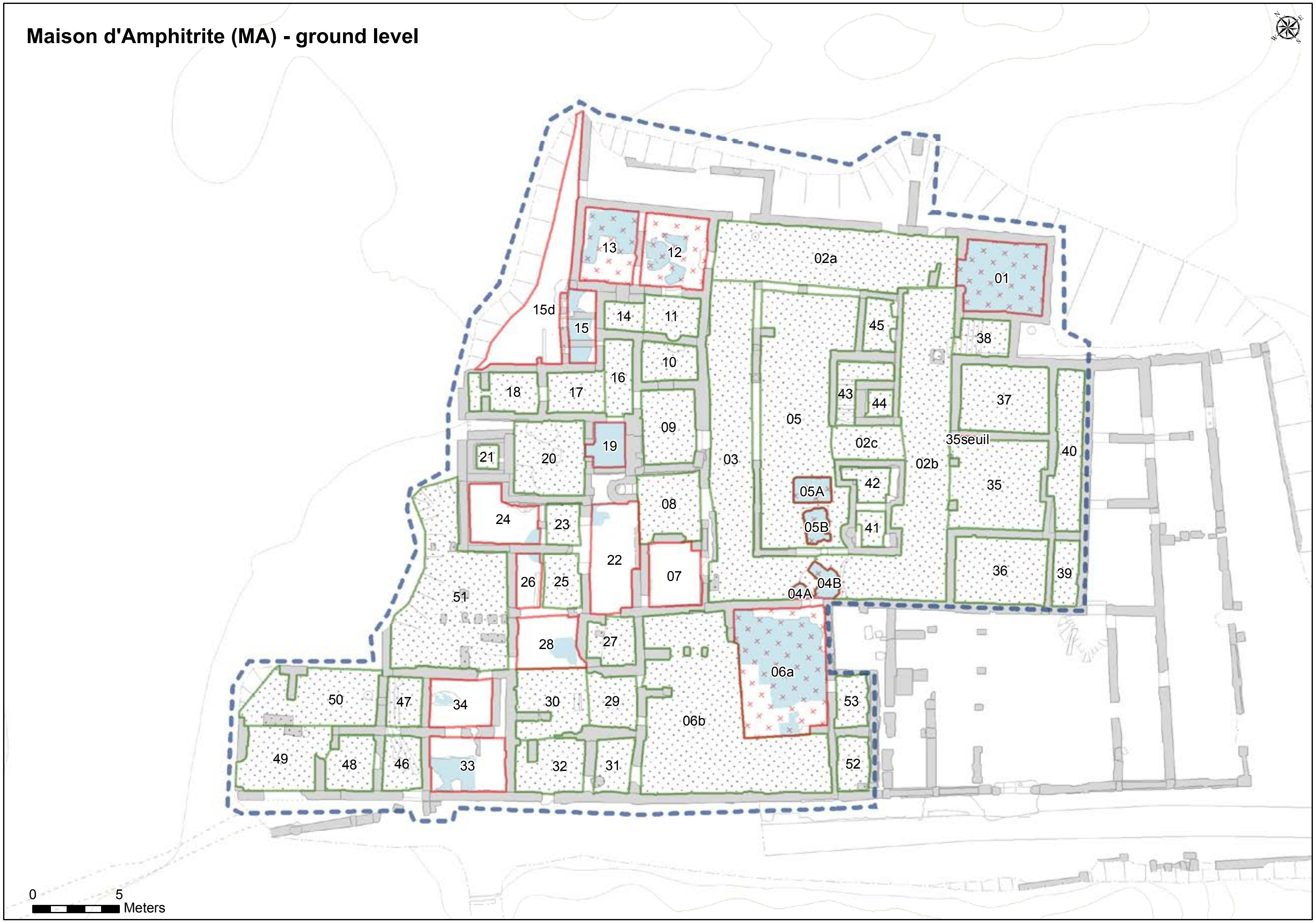
30


Maison 10 (M10)
22
20
17
04
03
05
15
21
06
14a
14b
07
18
02a
08
11
01
19
02d
02b
01b
09
12
10
13
02c
16
23
24
25
0
5
Meters

32

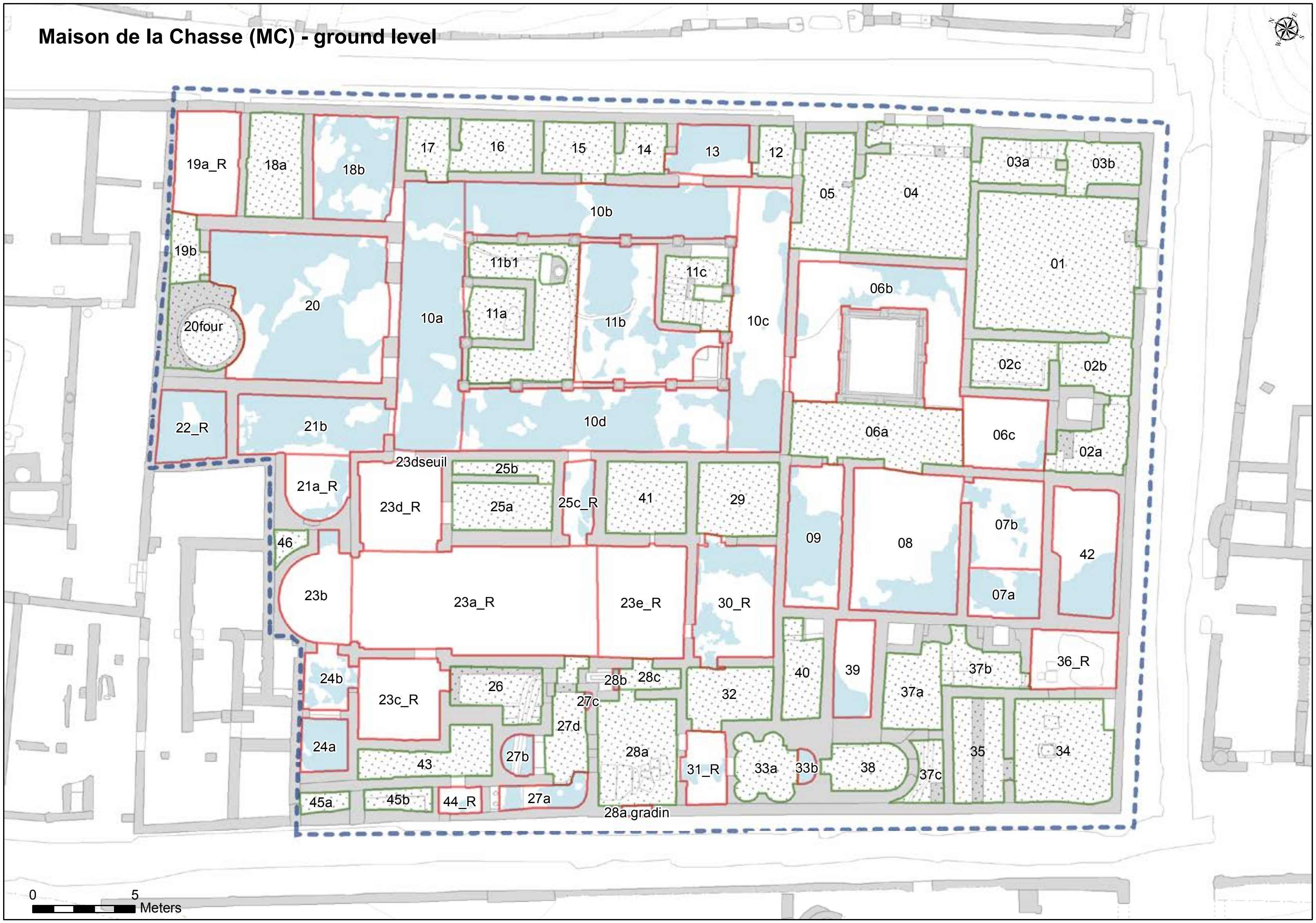

Maison 15 (M15)
01
02
03
04
05
06
07
08
09
10
0
5
Meters

34

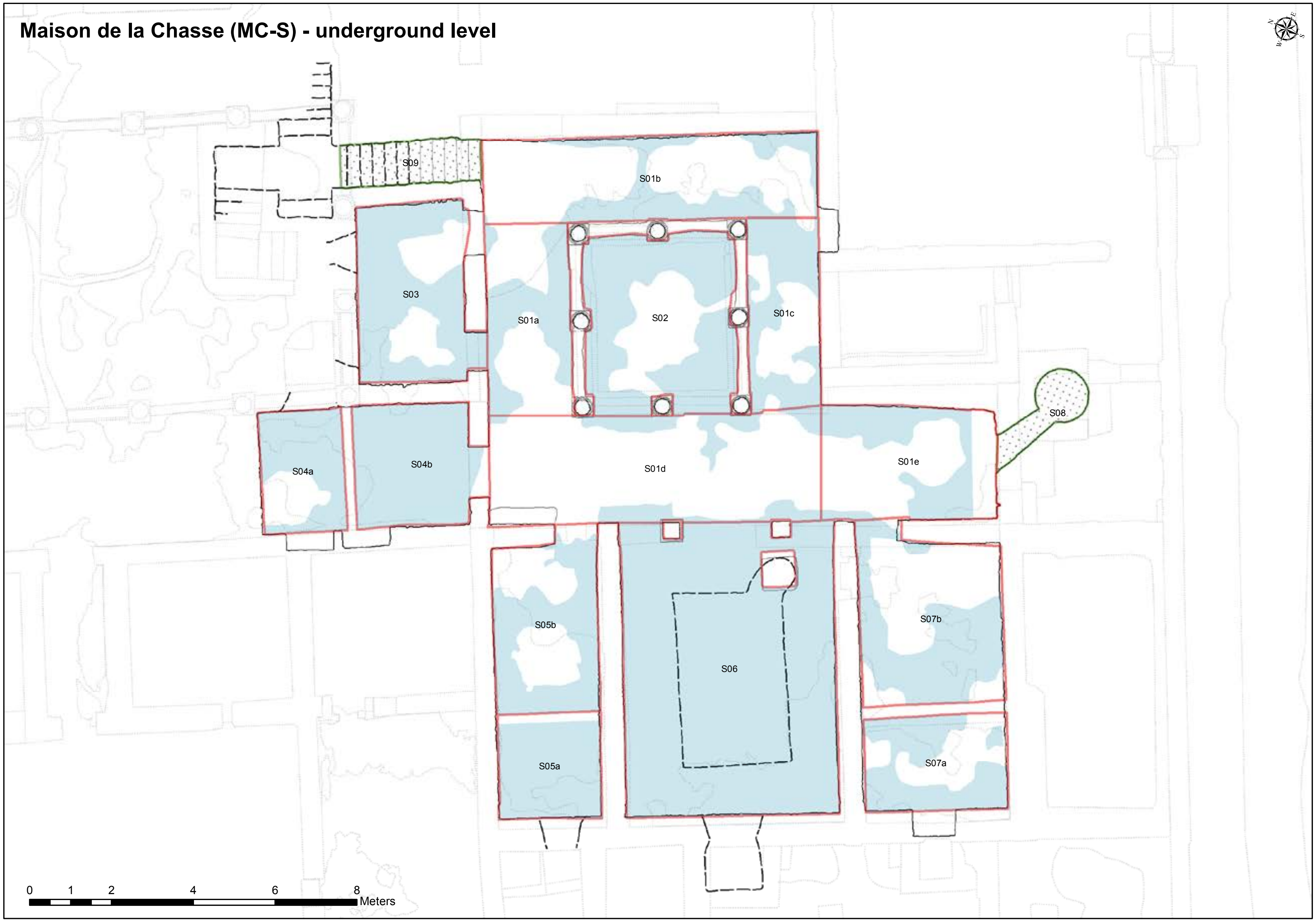

Maison d'Amphitrite (MA) - ground level
01
02a
02b
02c
03
04A
04B
05
05A
05B
06a
06b
07
08
09
10
11
12
13
14
15
15d
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
35seuil
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
0
5
Meters


Maison d'Amphitrite (MA-S) - underground level
S05
S06
S07
S01a
S01b
S01c
S08
S04
S03a
S03b
S02
0
1
2
4
6
Meters

36



Maison de la Chasse (MC) - ground level
19a_R
18a
18b
17
16
15
14
13
12
05
04
03a
03b
19b
10b
11b1
11c
01
06b
20
20four
10a
11a
11b
10c
02c
02b
22_R
21b
10d
06a
06c
02a
23dseuil
25b
21a_R
23d_R
25a
25c_R
41
29
09
08
07b
42
46
23b
23a_R
23e_R
30_R
07a
36_R
40
39
37b
24b
23c_R
26
28b
28c
32
37a
27c
27d
24a
43
27b
28a
31_R
33a
33b
38
37c
35
34
45a
45b
44_R
27a
28a gradin
0
5
Meters


Maison de la Chasse (MC-S) - underground level
S09
S01b
S03
S01a
S02
S01c
S08
S04a
S04b
S01d
S01e
S05b
S06
S07b
S05a
S07a
0 1 2 4 6 8
Meters

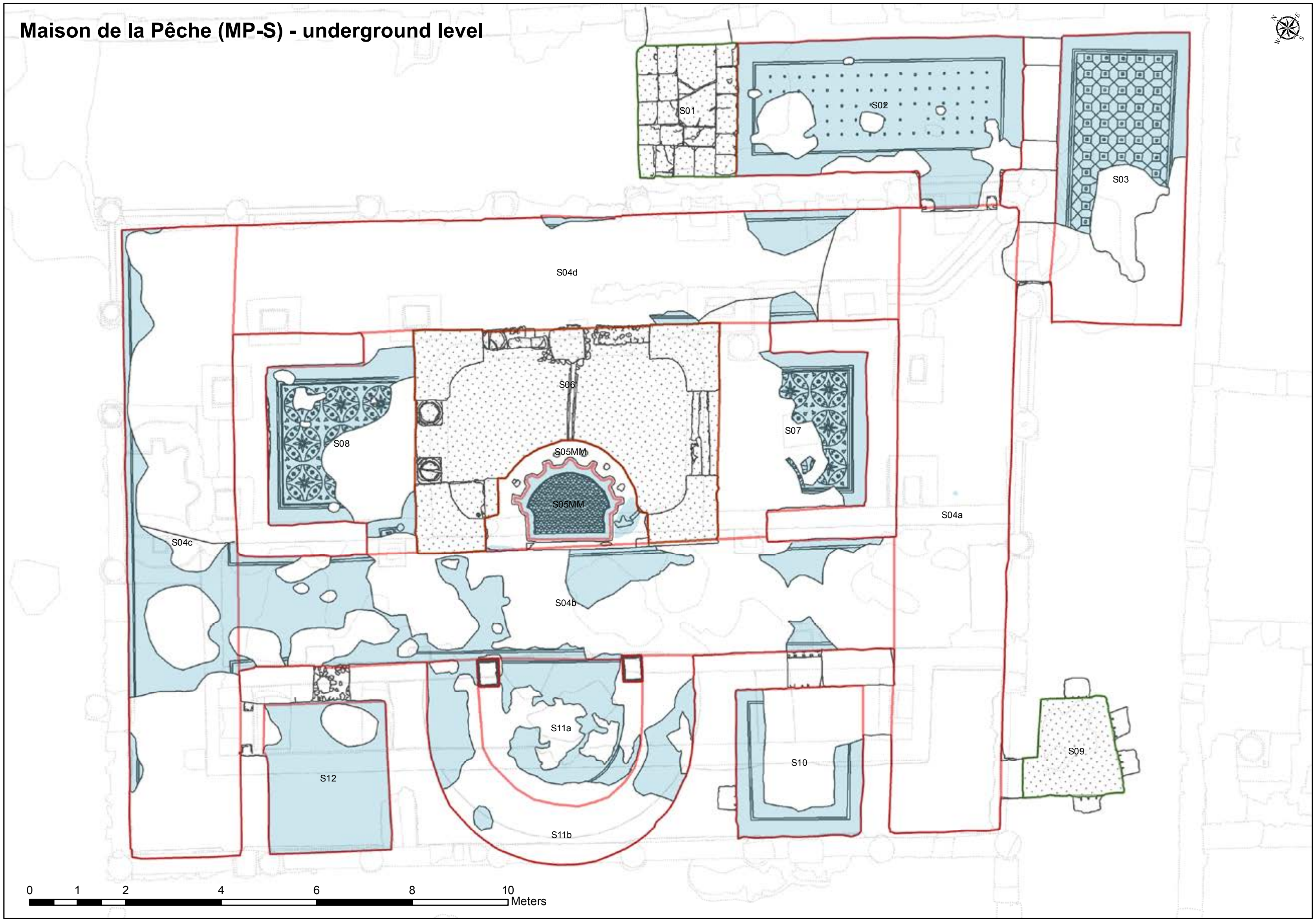

Maison de la Nouvelle Chasse (MNC) - ground level
17a
17b
16
15
14
28
29
04
01b
01a
01c
12a
12b
13
26
10
11
02
09
03
05
27
25
08
22
23
24
06
07
20a
19a
21
18
20b
19b
32a
30
31
32b
0
5
Meters

38

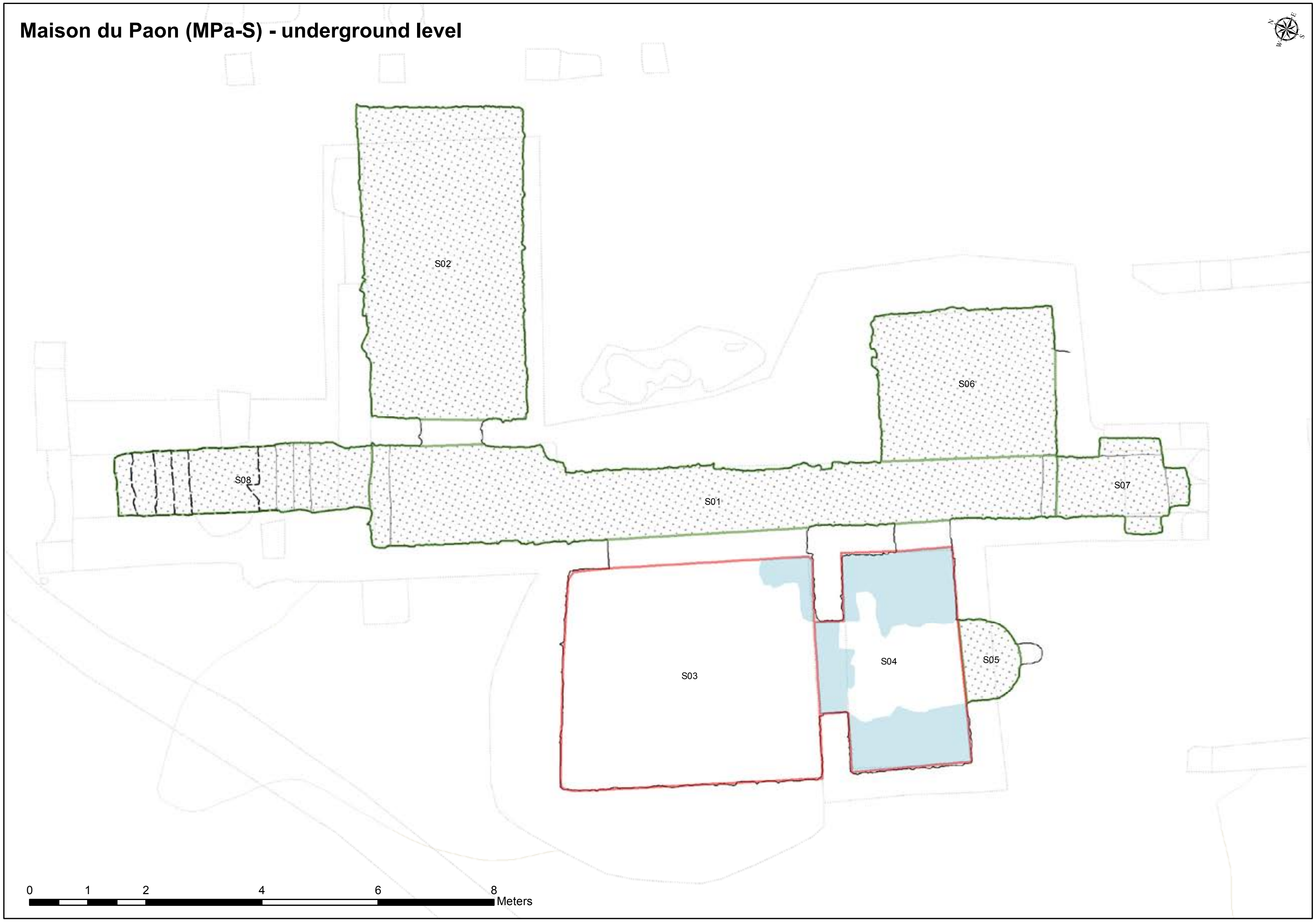

Maison de la Nouvelle Chasse (MNC-S) - underground level
S03
S04
S02
S01
0
1
2
4
Meters

40

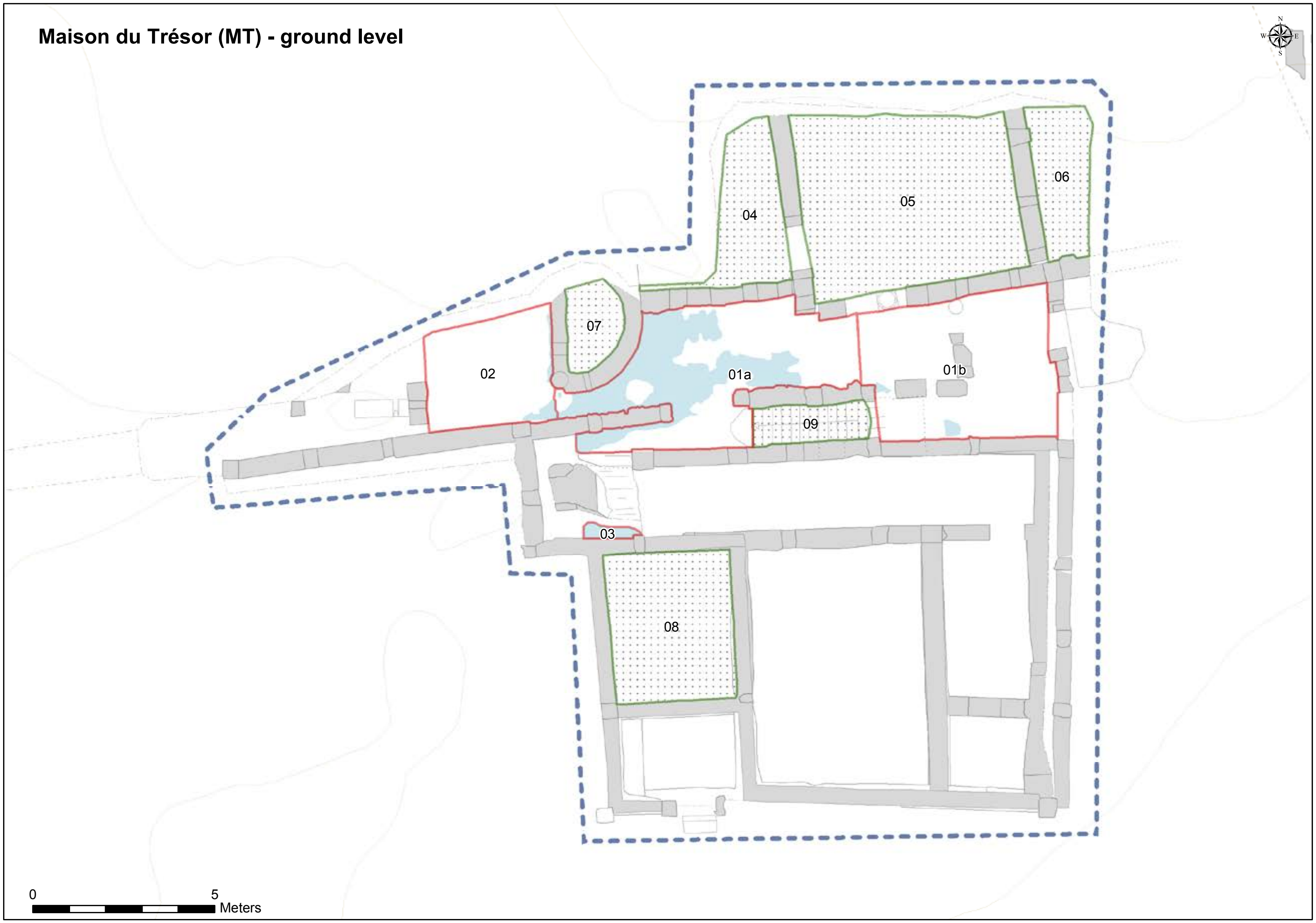

Maison de la Pêche (MP) - ground level
01a
01c
01b
11
12
13
14
43
15
02
06b
06a
06c
17
16
19
05
07
08
03
42
18
09
40
41
20
10
04
22b
22c
21
22a
28
31
33
37
25
30
26b
23
27
29a
24
26a
29b
32
34
35
38
45
44
36
39
0
5
Meters


Maison de la Pêche (MP-S) - underground level
S01
S02
S03
S04d
S06
S08
S07
S05MM
S05MM
S04a
S04c
S04b
S11a
S10
S09
S12
S11b
0 1 2 4 6 8 10
Meters


Maison du Paon (MPa) - ground level
02
01
N
W
E
S
0
5
Meters

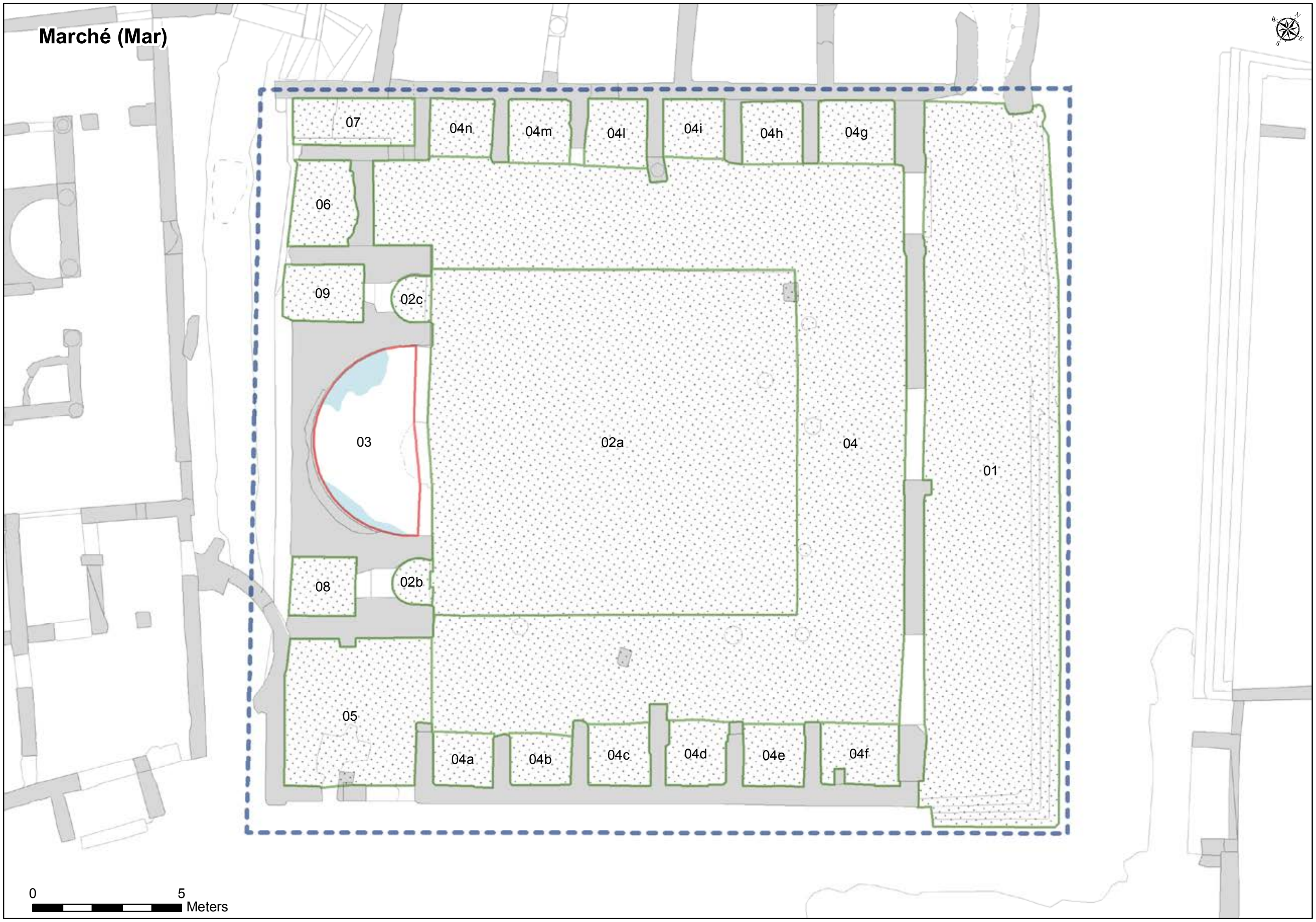


Maison du Paon (MPa-S) - underground level
S02
S06
S08
S01
S07
S03
S04
S05
0
1
2
4
6
8
Meters

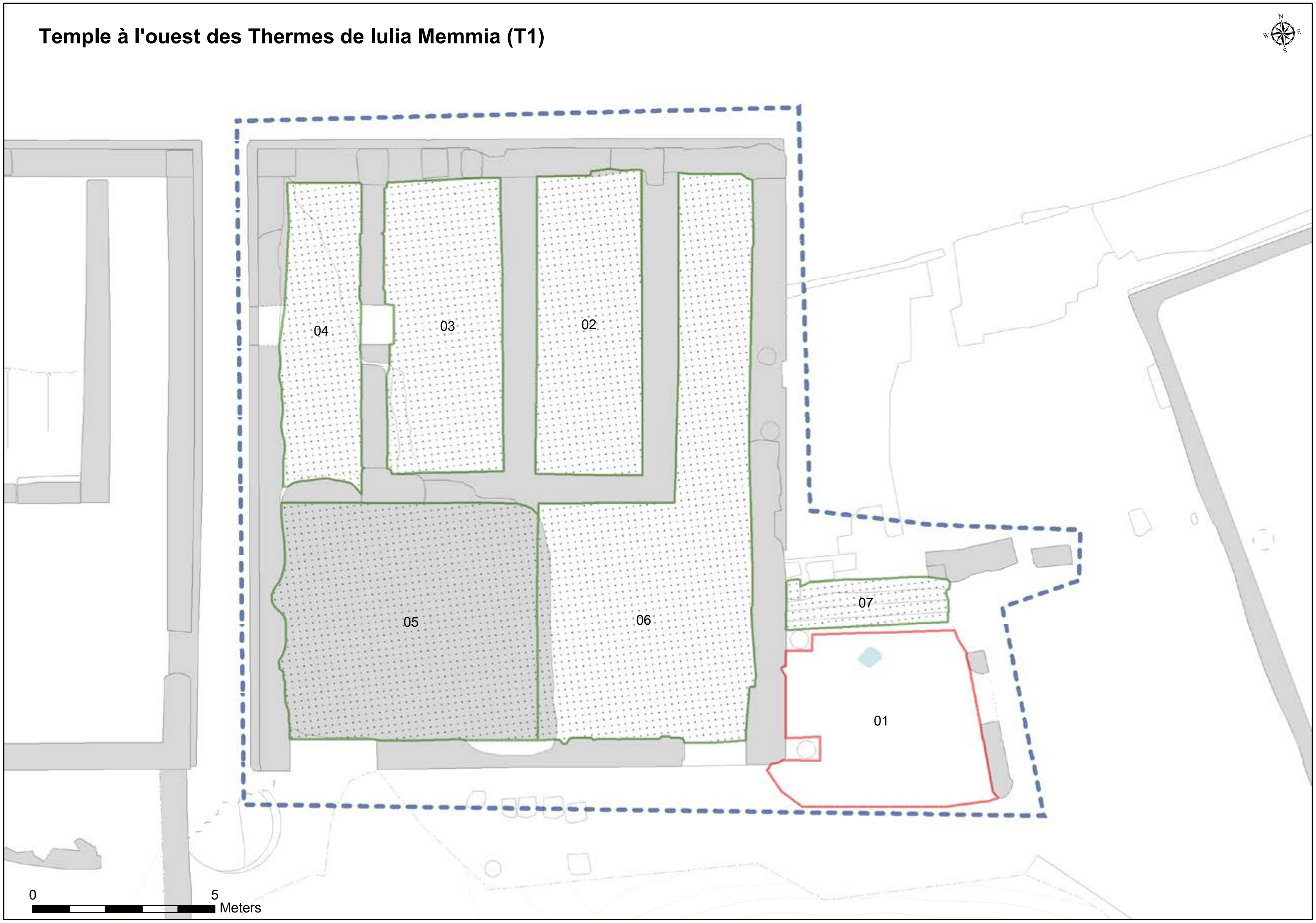

Maison du Trésor (MT) - ground level
01a
01b
02
03
04
05
06
07
08
09
0
5
Meters


Maison du Trésor (MT-S) - underground level
N
W
E
S
S01
S04
S03
S02
S05
S06
0
1
2
4
Meters

46

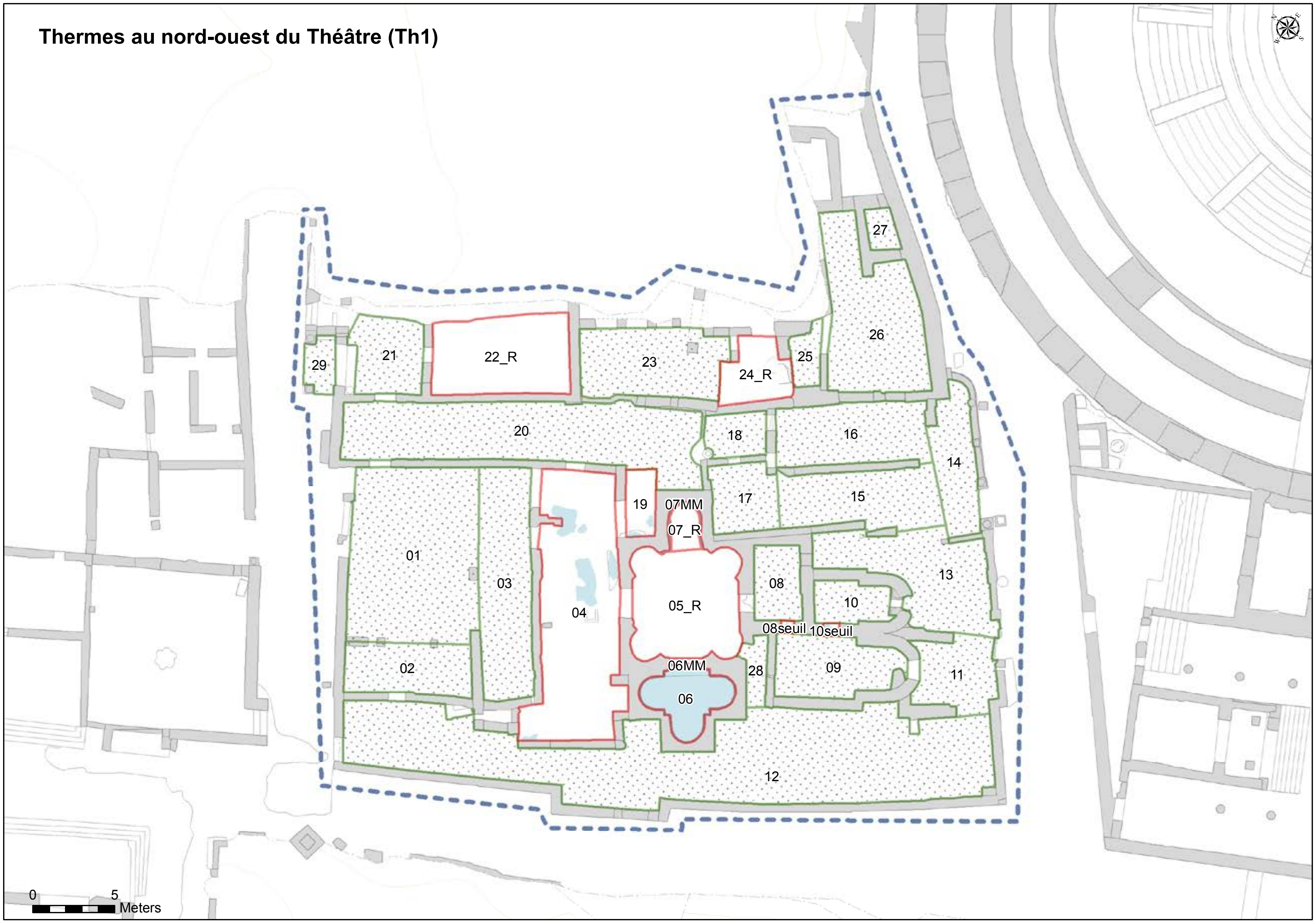

Marché (Mar)
07
04n
04m
04l
04i
04h
04g
06
09
02c
03
02a
04
01
08
02b
05
04a
04b
04c
04d
04e
04f
0
5
Meters


Nymphée (Ny1)
01a
01b
02
03a
03b
03c
03d
04a
04b
04c
04d
04e
04f
04g
04h
04i
04l
0
5
Meters

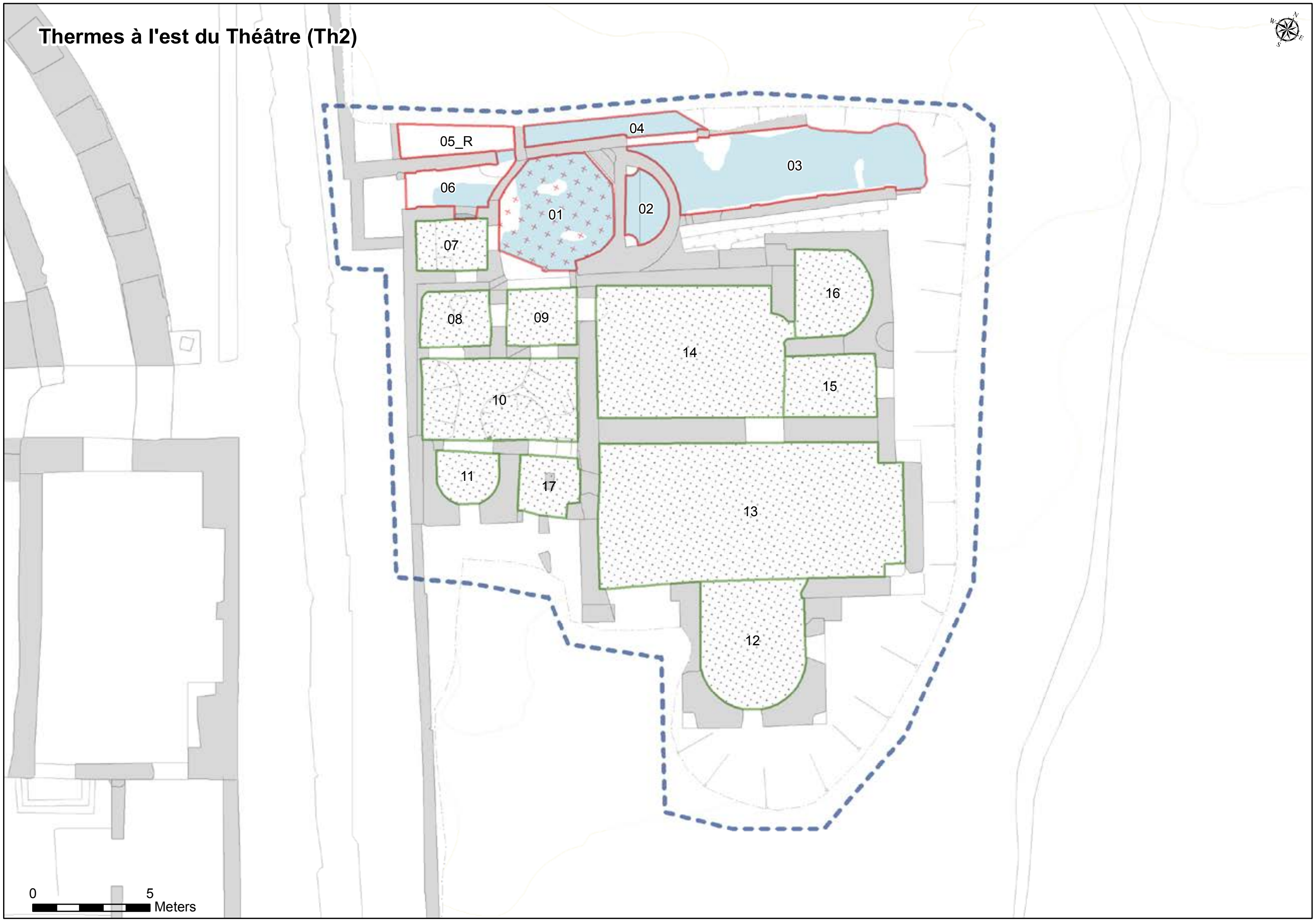

Temple à l'ouest des Thermes de Iulia Memmia (T1)
N
W
E
S
04
03
02
05
06
07
01
0
5
Meters

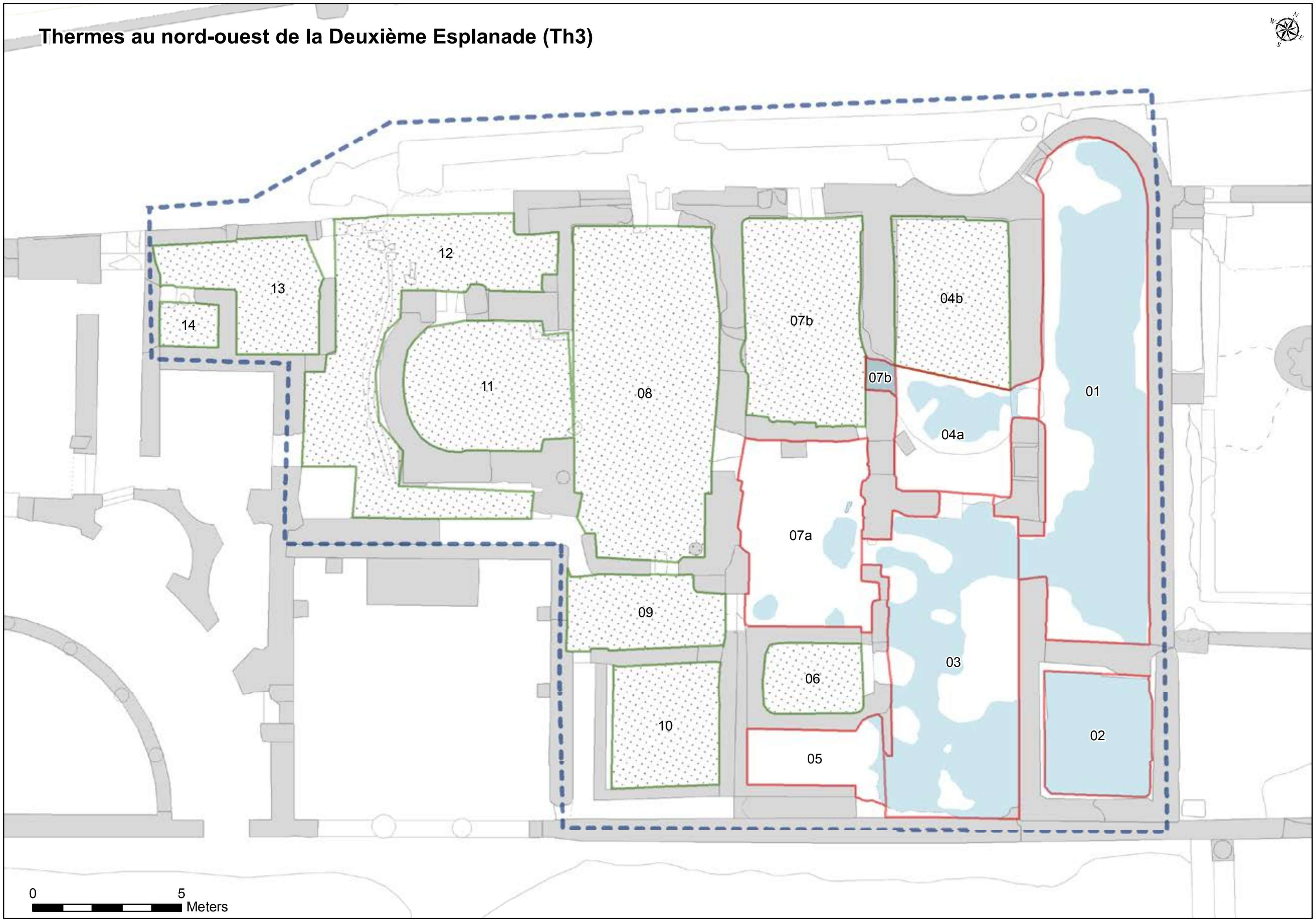

Temple d'Apollon (TAp)
04
03
02b
02a
01
02c
0
5
Meters

50



Thermes au nord-ouest du Théâtre (Th1)
29
21
22_R
23
24_R
25
26
27
20
18
16
14
01
03
04
19
07MM
07_R
17
15
05_R
08
10
13
08seuil
10seuil
02
06MM
06
28
09
11
12
0
5
Meters

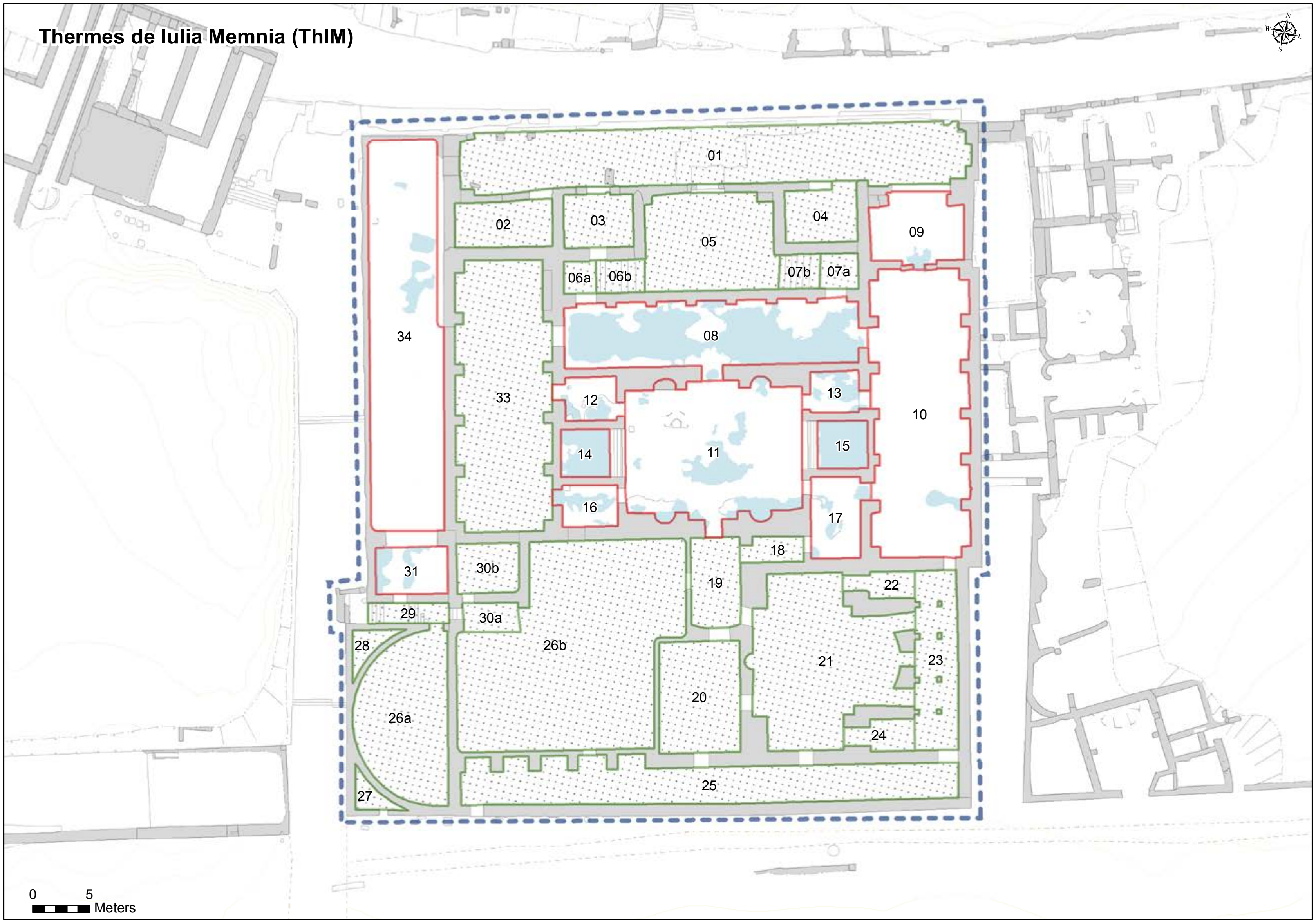

Thermes à l'est du Théâtre (Th2)
05_R
04
03
06
01
02
07
16
08
09
14
15
10
13
11
17
12
0
5
Meters

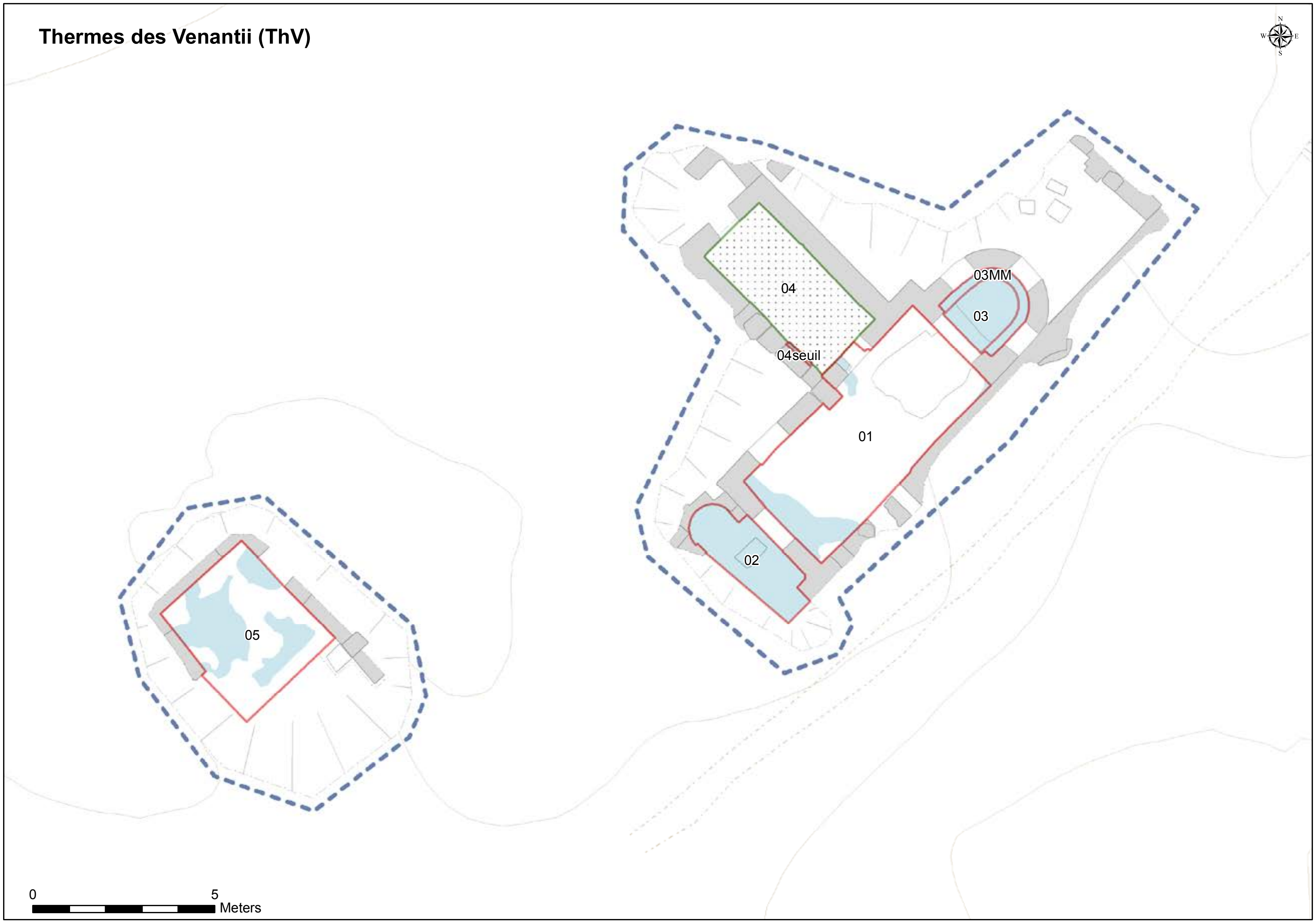

Thermes au nord-ouest de la Deuxième Esplanade (Th3)
13
12
14
11
08
07b
04b
07b
04a
01
07a
09
03
06
10
02
05
0
5
Meters

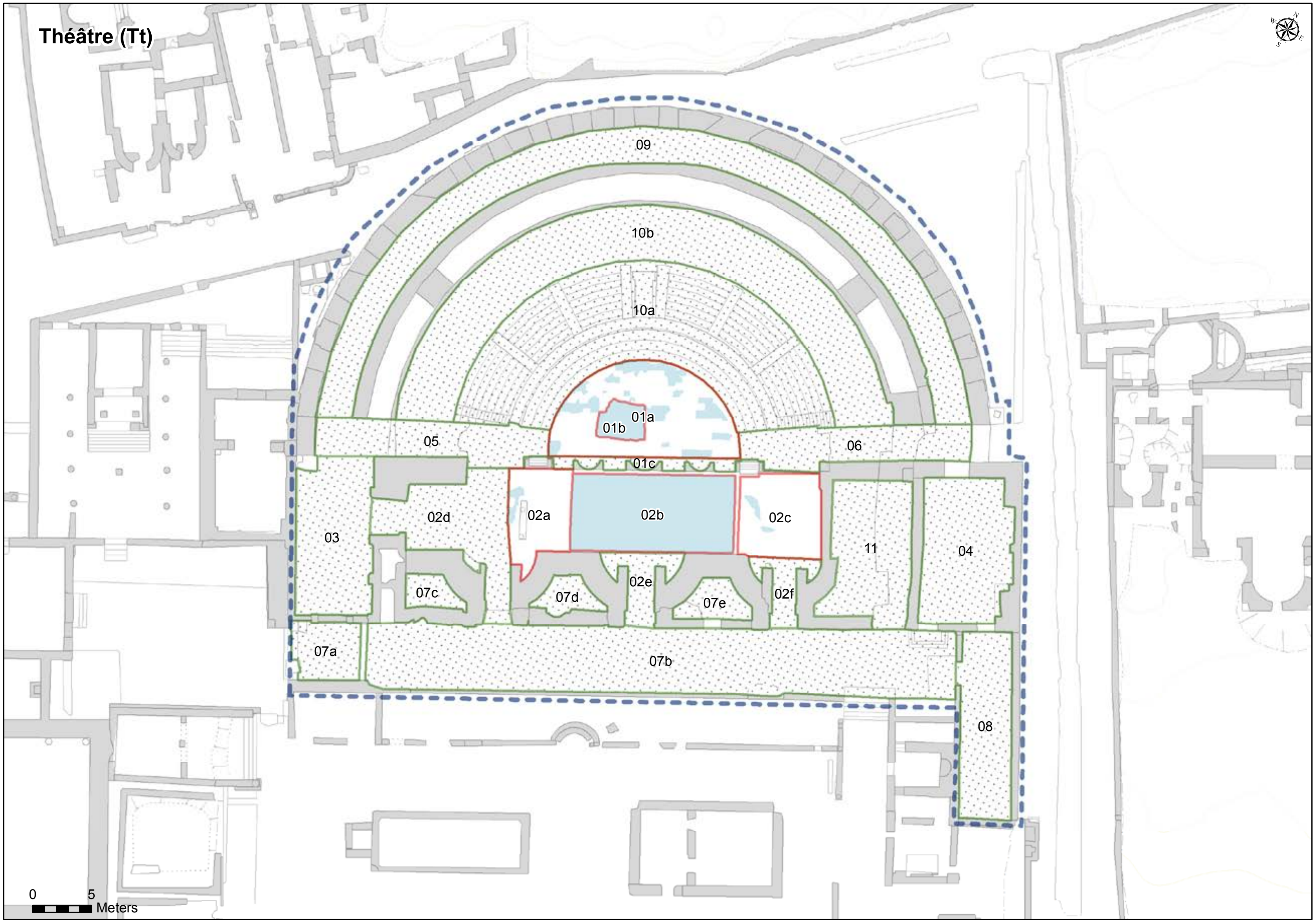

Thermes au nord-ouest des Basiliques (Th4)
02
03
10
01
06
05
04
07
08
09
0
5
Meters

54


Thermes du nord-est (Th5)
04
05
06
07
08
10
11
01_R
09
02
03
0
5
Meters


Thermes de Iulia Memnia (ThIM)
01
02
03
04
05
06a
06b
07b
07a
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26a
26b
27
28
29
30a
30b
31
33
34
0 5 Meters


Thermes des Venantii (ThV)
N
W
E
S
03MM
04
03
04seuil
01
02
05
0
5
Meters

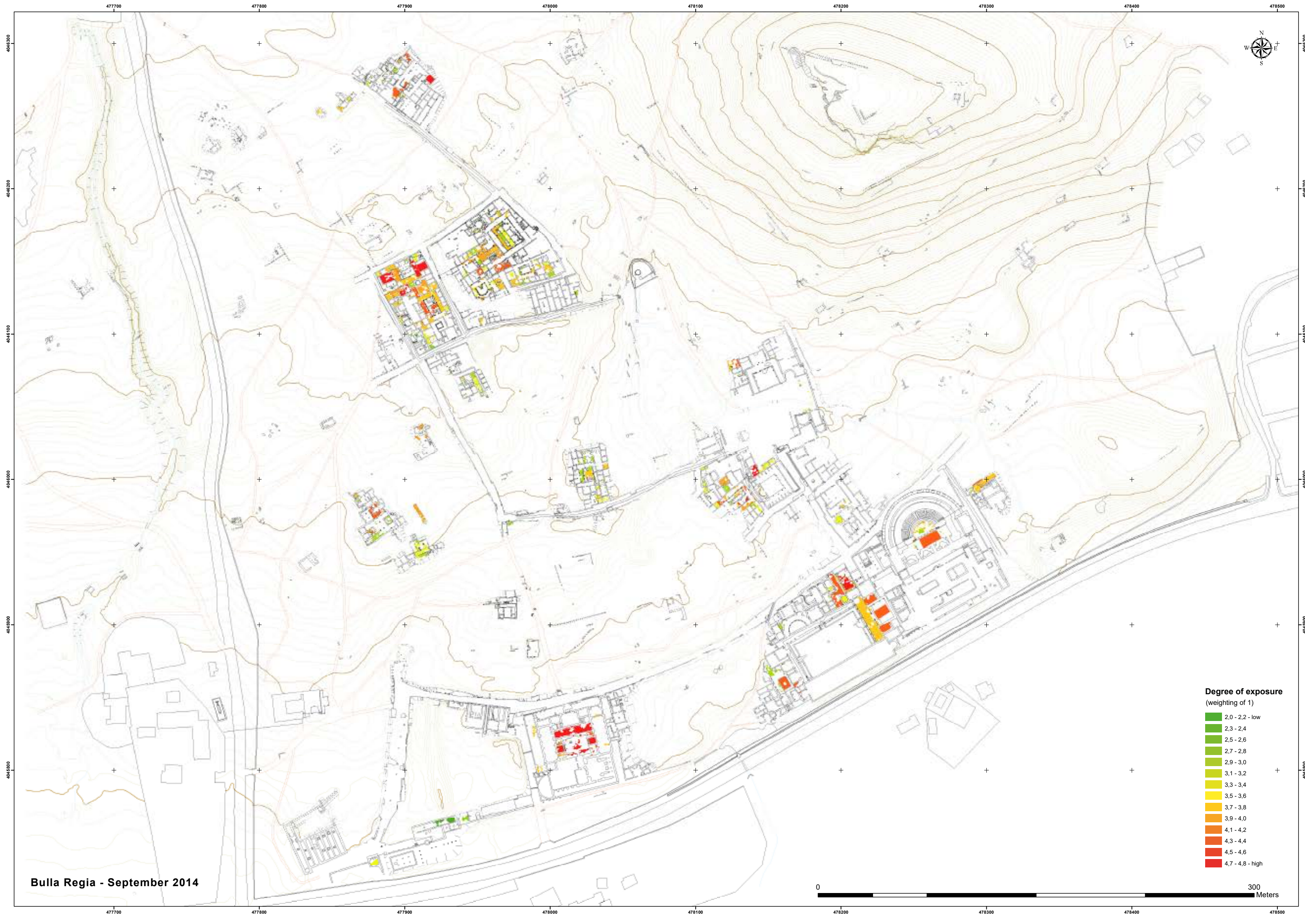

Théâtre (Tt)
09
10b
10a
01a
01b
05
06
01c
02a
02b
02c
02d
03
11
04
07c
07d
02e
07e
02f
07a
07b
08
0
5
Meters

APPENDIX D

Site Maps of Mosaic Condition, Significance, Exposure, and Priority


Bulla Regia - September 2014
Condition
(weighting of 4)
4 - 6 - good
6 - 8
8 - 10
10 - 12
12 - 14
14 -16
16 - 18
18 - 20 - critical
0
300
Meters
N
S
W
E
477700
477800
477900
478000
478100
478200
478300
478400
478500


477700
477800
477900
478000
478100
478200
478300
478400
478500
4046300
4046200
4046100
4046000
4045900
4045800
N
S
W
E
Significance
(weighting of 2)
3,5 - 4 - low
4 - 4,5
4,5 - 5
5 - 5,5
5,5 - 6
6 - 6,5
6,5 - 7
7 - 7,5
7,5 - 8
8 - 8,5
8,5 - 9
9 - 9,5 - high
0
300
Meters
Bulla Regia - September 2014



477700
477800
477900
478000
478100
478200
478300
478400
478500
4046300
4046200
4046100
4046000
4045900
4045800
N
S
W
E
Degree of exposure
(weighting of 1)
2,0 - 2,2 - low
2,3 - 2,4
2,5 - 2,6
2,7 - 2,8
2,9 - 3,0
3,1 - 3,2
3,3 - 3,4
3,5 - 3,6
3,7 - 3,8
3,9 - 4,0
4,1 - 4,2
4,3 - 4,4
4,5 - 4,6
4,7 - 4,8 - high
Bulla Regia - September 2014
0
300
Meters

Bulla Regia - September 2014
Priority for Conservation Intervention
0-10 - low
10-20
20-30
30-40
40-50
50-60
60-70
70-80 - high
No mosaics between 80-100
0
300
Meters
N
S
E
W
477700
477800
477900
478000
478100
478200
478300
478400
478500

APPENDIX E

Highest Priority Work Program

BULLA REGIA MOSAIC CONSERVATION PLANNING

07/07/2014

FIRST PHASE - HIGHEST PRIORITY 2014 -2015

	m^2 room	m^2 tessellatum	Condition Rating	Work Days Complete Stabilizat.	Work Days First Aid Stabilizat.	Work Days Local Protection	Work Days Stabilizat. for Short-Term Reburial	Work Days Execution of Short-Term Reburial	Work Days Stabilizat. for Long-Term Reburial	Work Days Execution of Long-Term Reburial	TOTAL WORK DAYS for 2 technicians (tess. stabil.)	TOTAL WORK DAYS for 1 technician + 2 workers	Special Projects at room level	Special Projects at building level	NOTES
work team composition				2 technic.	2 technic.	1 technic. 2 workers	2 technic.	1 technic. 2 workers	2 technic.	1 technic. 2 workers					
work days / m^2								0,15		0,30					
MAISON DE LA PECHE (MP)															
BR/MP/2	69,8	0,2	4,5	2											1 day added
BR/MP/3	69,3	1,3	4,5	5											
BR/MP/4	57,1	0,9	4,5	4											
BR/MP/17	12,8	0,9	4,5			1									
BR/MP/26a	16,0	0,8	4,5		2										
BR/MP/30	42,9	9,9	3,5				7	6							
BR/MP/31	13,7	13,7	4				12	2							
BR/MP/32+seuil	12,2	12,2	3				7	2							
BR/MP/33	15,7	13,4	3				8	2							
BR/MP/35+seuil	47,2	6,5	3,5				5	7							
BR/MP/37	18,7	13,7	3				8	3							
BR/MP/38+seuil	30,9	22,2	3				13	5							
BR/MP/41	15,7	1	5			1					73	29			
MAISON 9 (M9)															
BR/M9/9	13,3	3,5	4				3	2							
BR/M9/13+seuil	29,6	26,6	3		2						5	2			
MAISON 10 (M10)															
BR/M10/5	15,1	13,7	3,5		4						4	0	SHELTER		east wall stabilization needed
MAISON 3 (M3)															
BR/M3/4	9,3	2,7	5				5	1							2 days added
BR/M3/6	13,0	3,7	5				5	2							
BR/M3/7	28,0	0,3	5		2										
BR/M3/12b	32,6	0,8	5			1								FENCE	
BR/M3/14	9,5	0,1	5			1									
BR/M3/17	11,3	2,2	4,5				3	2							
BR/M3/18a	8,0	0,5	4,5				0	1							already stabilized
BR/M3/22	19,1	0,01	5			1					15	9			
EDIFICE 1 au sud-ouest du Temple d'Apollon (E1)															
BR/E1/1	30,2	0,1	5			1					0	1		FENCE	

Red= highest Condition Rating (Weighted by 4)

Green = highest Priority Rating (from 74,07 to 49,31 - Condition Rating weighted by 4)

BULLA REGIA MOSAIC CONSERVATION PLANNING

07/07/2014

FIRST PHASE - HIGHEST PRIORITY 2014 -2015

	m^2 room	m^2 tessellatum	Condition Rating	Work Days Complete Stabilizat.	Work Days First Aid Stabilizat.	Work Days Local Protection	Work Days Stabilizat. for Short-Term Reburial	Work Days Execution of Short-Term Reburial	Work Days Stabilizat. for Long-Term Reburial	Work Days Execution of Long-Term Reburial	TOTAL WORK DAYS for 2 technicians (tess. stabil.)	TOTAL WORK DAYS for 1 technician + 2 workers	Special Projects at room level	Special Projects at building level	NOTES
work team composition				2 technic.	2 technic.	1 technic. 2 workers	2 technic.	1 technic. 2 workers	2 technic.	1 technic. 2 workers					
work days / m^2								0,15		0,30					
MAISON 4 (M4)															
BR/M4/5c	50,3	13	5				20	8							4 days added
BR/M4/5d	9,1	2,7	5				5	1							2 days added
BR/M4/6b	29,9	6,7	3			2									
BR/M4/10b	6,2	6,2	5				8	1			55	15		FENCE	
BR/M4/17a	19,8	18,2	5				22	3							
MAISON 2 (M2)															
BR/M02/02	14,6	5,8	4,5		0										security problems
BR/M2/3	14,8	0,63	5			1					0	1		FENCE	
MAISON 8 (M8)															
BR/M8/10	10,8	0,8	5			1									
BR/M8/17	12,2	2,1	5			1					1	3		FENCE	
BR/M8/18	12,4	1,2	5		1	0,5									
BR/M8/20a.20b	27,2	6	5										SECTILE		specific conservation project
MAISON DU PAON (Mpa)															
BR/MPa/1	12,6	0,6	5			1									
BR/MPa/2		0,01	5			1					0	2		FENCE	
THERMES 2 à l'est du Théatre (Th2)															
BR/Th2/1	20,0	11,5	5		8						8	0	SHELTER	FENCE	
MAISON DE LA NOUVELLE CHASSE (MNC)															
BR/MNC/11bassin	3,0	0,7	4				1	0,4							
BR/MNC/18	18,7	5,2	3		5										
BR/MNC/19b	13,2	11,1	3		5										
BR/MNC/S03	11,8	11,8	3,5		4						15	0,4	ACCESS BARRIER		
MAISON D'AMPHITRITE (MA)															
BR/MA/04/A		0,5	4		2										
BR/MA/07	10,9	0,1	5						0	0,03					already stab. - rebury only tessell
BR/MA/34	9,8	0,6	4,5		2										
BR/MA/S3a	9,4	9,4	2								4	0,03	DETACHED MOSAIC		

Red= highest Condition Rating (Weighted by 4)

Green = highest Priority Rating (from 74,07 to 49,31 - Condition Rating weighted by 4)

BULLA REGIA MOSAIC CONSERVATION PLANNING

07/07/2014

FIRST PHASE - HIGHEST PRIORITY 2014 -2015

	m^2 room	m^2 tessellatum	Condition Rating	Work Days Complete Stabilizat.	Work Days First Aid Stabilizat.	Work Days Local Protection	Work Days Stabilizat. for Short-Term Reburial	Work Days Execution of Short-Term Reburial	Work Days Stabilizat. for Long-Term Reburial	Work Days Execution of Long-Term Reburial	TOTAL WORK DAYS for 2 technicians (tess. stabil.)	TOTAL WORK DAYS for 1 technician + 2 workers	Special Projects at room level	Special Projects at building level	NOTES
work team composition				2 technic.	2 technic.	1 technic. 2 workers	2 technic.	1 technic. 2 workers	2 technic.	1 technic. 2 workers					
work days / m^2								0,15		0,30					
DEUXIEME ESPLANADE MONUMENTALE (EM2)															
BR/EM2/5/A		0,2	5				1	0,03							
BR/EM2/7+seuil	42,9	32,5	3		2								ACCESS BARRIER		
BR/EM2/08b	23	0,1	5			1									
BR/EM2/18	47	2,1	3,5			2									with wooden barrier
BR/EM2/20	40,6	8,1	3		5						8	3,03			
NYMPHEE 1 (Ny1)															
BR/Ny1/2	11,8	1,7	5			2					0	2			
EDIFICE 2 dans le coin sud du Forum (E2)															
BR/E2/6	0,8	0,7	5			1					0	1			
EDIFICE 6 à l'est des Termes de Iulia Memmia (E6)															
BR/E6/1		0,3	5			1					0	1			
EDIFICE 13 au nord de la source (E13)															
BR/E13/1		0,01	5			1					0	1			
TEMPLE 1 à l'ouest des Thermes de Iulia Memmia (T1)															
BR/T1/1	24,6	0,2	5			1					0	1			
THERMES 1 au nord ouest du theatre (Th1)															
BR/Th1/19	7,5	0,6	5			1					0	1			
THERMES DES VENANTII (ThV)															
BR/ThV/1+seuil	21,3	1,3	4,5			1					0	1			
BASILIQUE CHRETIENNE DU SUD (BaS)															
BR/BaS/13	13,8	0,3	4			1					0	1			
MAISON 7 (M7)														FENCE	
Work Days TOTALS				11	44	26	133	49	0	1	188	74			

TOTAL 60 mosaics

Special Projects:

CONSERV. TREATMENTS = 1 mosaic on concrete panels + 1 opus sectile
FENCE = 8 buildings and 2 rooms
SHELTER = 2 rooms

Red= highest Condition Rating (Weighted by 4)

Green = highest Priority Rating (from 74,07 to 49,31 - Condition Rating weighted by 4)

APPENDIX F

Building Conservation Planning Form and Summary Table

Bulla Regia Building Planning Form

Building Name: .... Date: .... FORM: part 1

[data from GIS and Rapid Survey Form (RSF)] **Mosaics to be presented** **Mosaics to be reburied**

	m^2			from RSF ÷ 2			Lacunae Treatment Type			Lacunae Treatm. W/D 1 Techn. + 2 Workers									Reburial Materials			Barriers m					After Short-t Reburial			
Room ID	Room	Tessellatum	Lacunae	Tessellatum Stabilization W/D 2 Technicians	Micro-organism Removal W/D 2 Technicians	Tess. Stab.+ Microorg. Removal W/D 2 Technicians	m2 Infilling	m2 Gravel	m2 Other	W/D Infilling	W/D Gravel	W/D for Drainage or Other	Lacunae Treatment TOTAL W/D 1 Technician + 2 Workers	L-T= Long-term S-T= Short-term		Tess. Stab. for Reburial W/D 2 Technicians	Lacuna Treatm. for Reb. W/D 2 Technicians	Reburial area m^2	Sand m^3	Gravel m^3	Geotextile m^2	Wooden planks	Cement mortar	Stone blocks	Reburial W/D 1 Techn. 2 Workers	Barrier construction W/D 1 Techn. 2 Workers	Long-term reburial	Presentation	Other	Notes
										0.7	0.25			L-T →		70%	0.20		0.2	0.1	25%				0.16					
														S-T →		30%			0.1	0.05					0.08					
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
														L-T	□	0	0		0	0	0				0					
			0.0			0.0				0	0		0	S-T	□	0	0		0	0	0				0		□	□	□	
TOTALS	0	0	0	0	0	0	0.0	0	0	0	0	0	0	TOTALS		0	0	0	0	0	0	0	0	0	0	0				

Bulla Regia Building Planning Form

Building Name: ______________________ Date: ______________ FORM: part 2

Other types of pavements to be presented or reburied

Room ID	m² from GIS: Room	m² from GIS: Pavement	m² from GIS: Lacuna	Surface Treatment W/D – Cocciopesto (1 Techn. 2 Workers): Original Material	Cocciopesto: Lacuna	Stone Slab Pavements (2 workers): Original Material	Stone Slab Pavements: Lacuna	Preparat. Layers (1 Techn. 2 Workers): Original Material	Preparat. Layers: Lacuna	No Pavem. (4 work.): Cleaning	Drainage or Other (1 Techn. 2 Work.)	Reburial W/D and Materials: Reburial area m²	Material required 0.05: Sand m³	Material required 0.1: Gravel m³	Material required 25%: Geotextil m²	Barriers m: Wooden planks	Barriers m: Cement mortar	Barriers m: Stone blocks	W/D 0.07: Reburial W/D 4 workers	Barrier construction W/D 1 Techn. 2 Workers	TOTAL WORK DAYS 1 Technician 2 Workers	TOTAL WORK DAYS 2 Workers	TOTAL WORK DAYS 4 Workers	Notes
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
			0.0										0.0	0.0	0.0				0		0	0	0	
TOTALS	0	0.0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	0	0	0	0	0	0	0	

Bulla Regia Building Planning Form

Building Name: .... Date: .... FORM: part 3

Other types of remains

Room ID	Walls m²	Walls Work Days 2 Workers	Stairs steps	Stairs Work Days 2 Workers	Light wells quantity	Light wells Work Days 2 Technicians	Columns or bases in situ quantity	Columns or bases in situ Work Days 2 Technicians	Stone elements quantity	Stone elements Work Days 2 Technicians	Plasters number of fragments	Plasters Work Days 2 Technicians	Other Work Days 1 Technician	Other Work Days 1 Worker	TOTAL Work Days 2 technicians	TOTAL Work Days 2 workers	Notes
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
															0	0	
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															0	0	
															0	0	
															0	0	
TOTALS	0	0	0	0	0	0	0	0	0	0		0	0		0	0	

Bulla Regia Building Planning Form

Building Name: Date: FORM: part 4

SUMMARY | **Reburial Materials** | **Work Days**

Conservation work in the building		Quantity in the building	Sand m^3	Gravel m^3	Geotext m^2	Wooden planks m	Cement mortar m	Stone blocks m	Team 2 Technicians	Team 1 Technician + 2 Workers	Team 2 Workers	Team 4 Workers
Mosaics to be presented: (from Form Part 1)	Tessellatum stabilization of in situ mosaics + In situ stabilization of mosaics on concrete panels								0			
	Lacuna treatment									0		
Mosaics to be reburied: (from Form Part 1)	Tessellatum stabilization and lacuna treatment								0			
	Reburial and barrier construction		0.0	0.0	0.0	0.0	0.0	0.0		0		
Other types of pavements: (from Form Part 2)	Cocciopesto									0		
	Stone slab pavement										0	
	Preparatory layers									0		
	No pavement											0
	Drainage or Other									0		
	Barrier construction and reburial		0.0	0.0	0.0	0.0	0.0	0.0		0		0
Other types of remains: (from Form Part 3)	Walls										0	
	Stairs										0	
	Light wells								0			
	Columns or bases in situ								0			
	Stone elements								0			
	Plasters								0			
	Other								0		0	
	TOTAL material for reburials		0.0	0.0	0.0	0.0	0.0	0.0				
	Teams' Work Days								0	0	0	0

TOTAL Work Days / 1 Technician	0
TOTAL Work Days / 1 Worker	0

SPECIALIST PROJECTS

√ AT ROOM LEVEL	√ AT BUILDING LEVEL
☐ Room	☐ Shelter design and construction
☐ Room	☐ Structural stabilization
☐ Room	☐ Access restrictions and info panels
☐ Room	☐ Other:
☐	☐
☐	☐
☐	☐
☐	☐

BUILDING PLANNING FORMS SUMMARY TABLE

	BUILDINGS TO BE PRESENTED	m^2 tessellatum				Work days				Reburial materials										n. sheltered rooms/basins
		presented exposed	presented under ancient structure	presented sheltered	to be reburied	tessellatum stabilization, stone clean., (+ plasters)	tessellatum reburial, cocciop., drainage	wall stabilization, stone slab pavements	no mosaic room cleaning and reburial	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	
						2 technicians	1 technician + 2 workers	2 workers	4 workers	m^3 sand		m^3 gravel		m^2 geotextile		m wooden planks barriers		m mortar barriers		
1	Basilique du Forum (B1)	0			13	33	16	28	1	2	0	10	0	20	0	0	0	0	0	
2	Basilique Chrétienne du Nord (BaN)	0		22	1	33	22	24	6	1,5	2,2	0,8	4,5	9,4	55,6	0	0	0	0	4
3	Basilique Chrétienne du Sud (BaS)	4		14	12	65	58	45	12	4,7	0	12	7,3	150	92	3,1	0	10,7	1,2	1
4	Edifice dans le coin sud du Forum (E02)	44			1	92	21	37	1	0	0	0	0	0	0	0	0	0	0	
5	Edifice au nord-est du Marché (E03)	1			0	1	4	12	3	0	0	0	0	0	0	0	0	0	0	
6	Edifice au nord de la Deuxième Esplanade (E04)	56			1	102	42	8	2	0,3	0	0,1	0	1,8	0	0	0	0	0	
7	Edifice à l'ouest de la Deuxième Esplanade (E05)	8			0	14	1	40	1	0	0	0	0	0	0	0	0	0	0	
8	Deuxième Esplanade Monumentale (EM2)	238		34	11	204	176	167	35	17,5	9,9	8,8	27,1	110	338	0	0	1	11	1
9	Maison 8 (M08)	50			8	129	98	148	22	17	0	8,5	5,6	106	70,2	0	0	8	4,1	
10	Maison 15 (M15)	0			2	6	3	35	6	2,2	0	1,1	0	13,8	0	6,5	0	0	0	
11	Maison d'Amphitrite (MA) - ground level	11		42	16	92	43	80	20	4,3	0	2,2	0	27	0	34,2	0	0	0	5
12	Maison d'Amphitrite (MA-S) - underground level	0	101	19	0	43	1	48	0	0	0	0	0	0	0	0	0	0	0	1
13	Maison de la Nouvelle Chasse (MNC) - ground level	120		138	7	331	57	99	17	5,6	1	2,8	12,5	34,9	156	1	0	2	6,2	6
14	Maison de la Nouvelle Chasse (MNC-S) - undergr. level	37			0	53	4	19	0	0	0	0	0	0	0	0	0	0	0	
15.1	Maison de la Pêche (MP) - ground level (Version 1)	91		81	29	399	86	161	23	37,4	4,1	18,7	11,3	232	141	0	0	10	0	5
16	Maison de la Pêche (MP-S) - underground level	0	64	0	5	86	44	70	3	0	0,8	0	1,5	0	18,8	0	0	0	0	
17	Maison du Trésor (MT-S) - underground level	0	12	60	0	93	3	0	3	0	0	0	2,5	0	15,6	0	0	0	0	3
18	Marché (Mar)	3			0	10	16	123	3	0	0	0	1,3	0	15,6	0	0	0	0	
19	Temple d'Apollon (TAp)	0			1	10	1	91	5	0,2	0	0,1	0	1,4	0	2,2	0	0	0	
20	Thermes au nord-ouest du Théâtre (Th1)	2		31	9	84	29	70	13	17	0	18,7	0	106	0	0	0	10,2	0	1
21	Thermes au nord-ouest de la Deuxième Esplanade (Th3)	90			5	118	59	66	4	10	0	5	0	62,8	0	0	0	9,5	0	
22	Thermes au nord-ouest des Basiliques (Th4)	0		9	0	7	8	36	4	0	0	0	0	0	0	0	0	0	0	2
23	Thermes de Iulia Memmia (ThIM)	178	6	0	28	284	135	316	19	15,5	0	14,5	10,7	96,9	0	37	0	2,2	0	
24	Thermes des Venantii (ThV)	0		9	8	23	8	21	1	7,7	0	3,8	0	48	0	3,9	0	0	0	1
25	Théâtre (Tt)	124			4	91	88	294	11	0	2	0	15,7	0	24	0	0	0	0	
	TOTALS per Building	1055	183	459	160	2403	1023	2038	215	143	20	107	100	1020	927	88	0	54	23	30

BUILDING PLANNING FORMS SUMMARY TABLE

	BUILDINGS TO BE REBURIED	m^2 tessellatum				Work days				Reburial materials										n. sheltered rooms/basins
		presented exposed	presented under ancient structure	presented sheltered	reburied	tessellatum stabilization, stone clean., (+ plasters)	tessellatum reburial, cocciop., drainage	wall stabilization, stone slab pavements	no mosaic room cleaning and reburial	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	
						2 technicians	1 technician + 2 workers	2 workers	4 workers	m^3 sand		m^3 gravel		m^2 geotextile		m wooden planks barriers		m mortar barriers		
1	Edifice au sud-ouest du Temple d'Apollon (E01)	0		1	21	34	11	16	2	9,3		4,6		58		26		0		1
2	Edifice à l'est des Thermes de Iulia Memmia (E06)	0			0	3	0	71	4	0		0		0		0		0		
3	Edifice au nord du Monument en Opus Reticulatum (E07)	0			32	39	13	21	2	14		7		88		51		0		
4	Edifice à l'ouest du Monument en Opus Reticulatum (E08)	0			12	16	6	11	0	6		3		36		3		0		
5	Edifice au sud de la Maison 3 (E09)	0				8	1	7	2	1		0,4		4,6		1,2		0		
6	Edifice au nord de la Maison 7 (E10)	0			25	8	5	5	0	4,9		2,5		30,6		4,9		0		
7	Edifice au carrefour entre M3 et M7 (E11)	0			6	9	2	1	0	1,4		0,7		8,8		0		0		
8	Edifice au coin sud de l'insula de la Pêche (E12)	0			6	7	3	34	6	2		1		12,5		6,8		0		
9	Edifice au nord de la source (E13)	0			0	2	0	1	0	0		0		0		0		0		
10	Edifice au nord-est du Temple d'Apollon (E14)	0			0	2	0	3	0	0		0		0		0		0		
11	Edifice au sud de la colline (E15)	0			0	3	1	0,4	0	0		0		0		0		0		
12	Edifice à l'ouest du Temple 1 (E16)	0			2	4	2	4	0	0,8		0,4		4,9		5,8		0		
13	Maison 1 (M01) - ground level	0		2	39	20	19	93	10	12,5		6,3		78,4		19,2		0		1
14	Maison 1 (M01-S) - underground level	0	0,3		0	1	16	42	1	0		0		0		0		0		
15	Maison 2 (M02) - ground level	0			15	47	0	21	2	0		0		0		0		0		
16	Maison 3 (M03) - ground level	0			80	133	54	108	11	45,5		22,8		284,6		109		0		
17	Maison 3 (M03-S) - underground level	0			0	0	18		3	0		0		0		0		0		
18	Maison 4 (M04)	0			125	248	51	87	8	38,8		19,4		242,3		73,9		0		
19	Maison 5 (M05)	0		9	8	16	15	65	6	2,4		1,2		14,9		12		0		3
20	Maison 7 (M07) - ground and underground level	0			47	62	22	102	6	17,9		9		112		43,2		0		
21	Maison 9 (M09)	0			77	106	30	58	3	20,9		10,5		130,9		32		0		
22	Maison 10 (M10)	0,4		15	58	129	46	8	7	32,2		16,1		201		30,5		0		2
23	Maison 14 (M14)	0			4	6	4	22	4	1,1		0,6		6,9		7,8		0		
24	Maison du Paon (MPa) - ground level	0			1	3	2	10	0	0,5		0,2		2,9		8		0		
25	Maison du Paon (MPa-S) - underground level	0			7	9	11	34	2	1,9		1		12,9		3,2		0		
26	Maison du Trésor (MT) - ground level	0			1	3	3	19	2	0,1		0,1		0,9		6		0		1
27	Nymphée 1 (Ny1)	0		36	20	86	23	48	4	11,6		5,8		72,5		55		0		1
28	Temple à l'ouest des Thermes de Iulia Memmia (T1)	0			0	1	5	41	2	0,1		0		0,4		2,2		0		
29	Thermes à l'est du Théâtre (Th2)	0		23	33	16	16	76	5	9,3		4,7		58,4		4,8		0		2
30	Thermes du nord-est (Th5)	0				6	0	31	5	0,4		0,2		2,5		0		0		
	TOTALS per Building	0,4	0,3	86	619	1025	378	1039	97	235	0	118	0	1465	0	505	0	0	0	11

BUILDING PLANNING FORMS SUMMARY TABLE

		m^2 tessellatum				Work days				Reburial materials										
		presented exposed	presented under ancient structure	presented sheltered	reburied	tessellatum stabilization, stone clean., (+ plasters)	tessellatum reburial, cocciop., drainage	wall stabilization, stone slab pavements	no mosaic room cleaning and reburial	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	mosaic	no-mosaic	n. of sheltered rooms / basins
						team 2 technicians	team 1 technician + 2 workers	team 2 workers	team 4 workers	m^3 sand		m^3 gravel		m^2 geotextile		m wooden planks barriers		m mortar barriers		
BUILDINGS TO BE PRESENTED		1055	183	459	160	2403	1023	2038	215	143	20	107	100	1020	927	88	0	54	23	30
BUILDINGS TO BE REBURIED		0,4	0,3	86	619	1025	378	1039	97	235	0	118	0	1465	0	505	0	0	0	11
Total tessellatum m^2		1056	184	545	779															
Total exposed tessellatum		1056																		
Total visible tessellatum		1785																		
Total protected tessellatum			1508																	
Total work days per team						3428	1401	3077	312											
2 technicians	work days					3428	700													
	work months (20 days/month)					171,4	35,0													
	work years (200 days/year)					**17,1**	**3,5**													
4 technicians	work days					1714	350													
	work months (20 days/month)					85,7	17,5													
	work years (200 days/year)					**8,6**	**1,8**													
2 workers	work days						1401	3077	623											
	work months (20 days/month)						70,0	153,9	31,2											
	work years (200 days/year)						**7,0**	**15,4**	**3,1**											
4 workers	work days						700	1539	312											
	work months (20 days/month)						35,0	76,9	15,6											
	work years (200 days/year)						**3,5**	**7,7**	**1,6**											
Total materials for mosaic reburial										378		225		2485		593		54		
Tot. mat. for rooms without mosaics reburial											20		100		927		0		23	
Total sheltered rooms/basins																				41

APPENDIX G

Conservation Planning Maps

The Getty Conservation Institute

MOSAIKON

Getty Conservation Institute · Getty Foundation · ICCM · ICCROM

Institut National du Patrimoine
de la Tunisie

Bulla Regia
CONSERVATION PLANNING

March 2018

Planning data by: Livia Alberti - Ermanno Carbonara

GIS Maps by: Ascanio D'Andrea (Akhet s.r.l.)

Geographic Information System, Topographic and Metric Survey for the MOSAIKON Bulla Regia Project

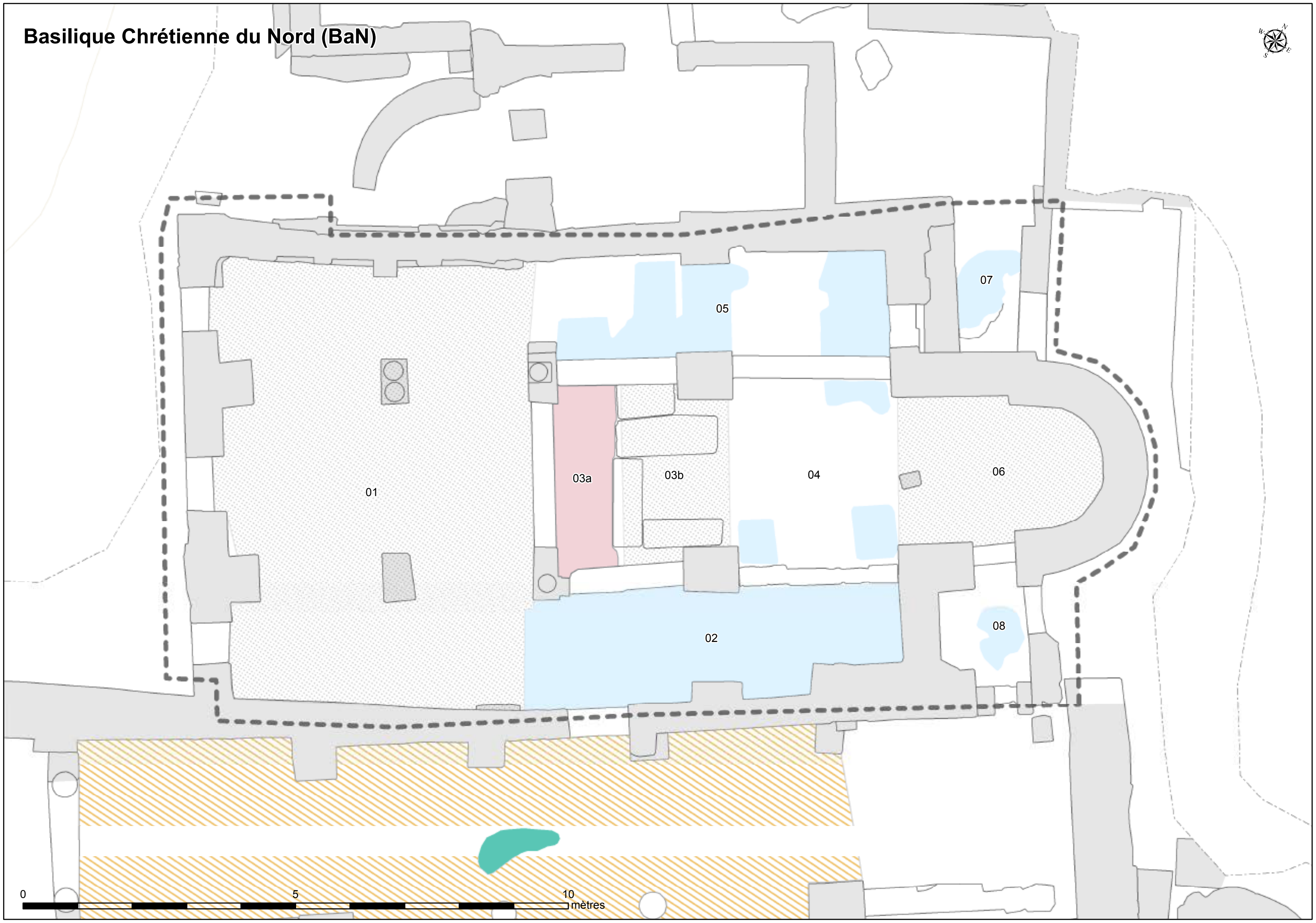
Akhet s.r.l. Head office: loc. Closellinaz, 44A– 11010 Roisan (Ao) C.F. e P.IVA: 06970261001 web: http://www.akhet.it

INDEX TO APPENDIX G

Interventions pre-2016

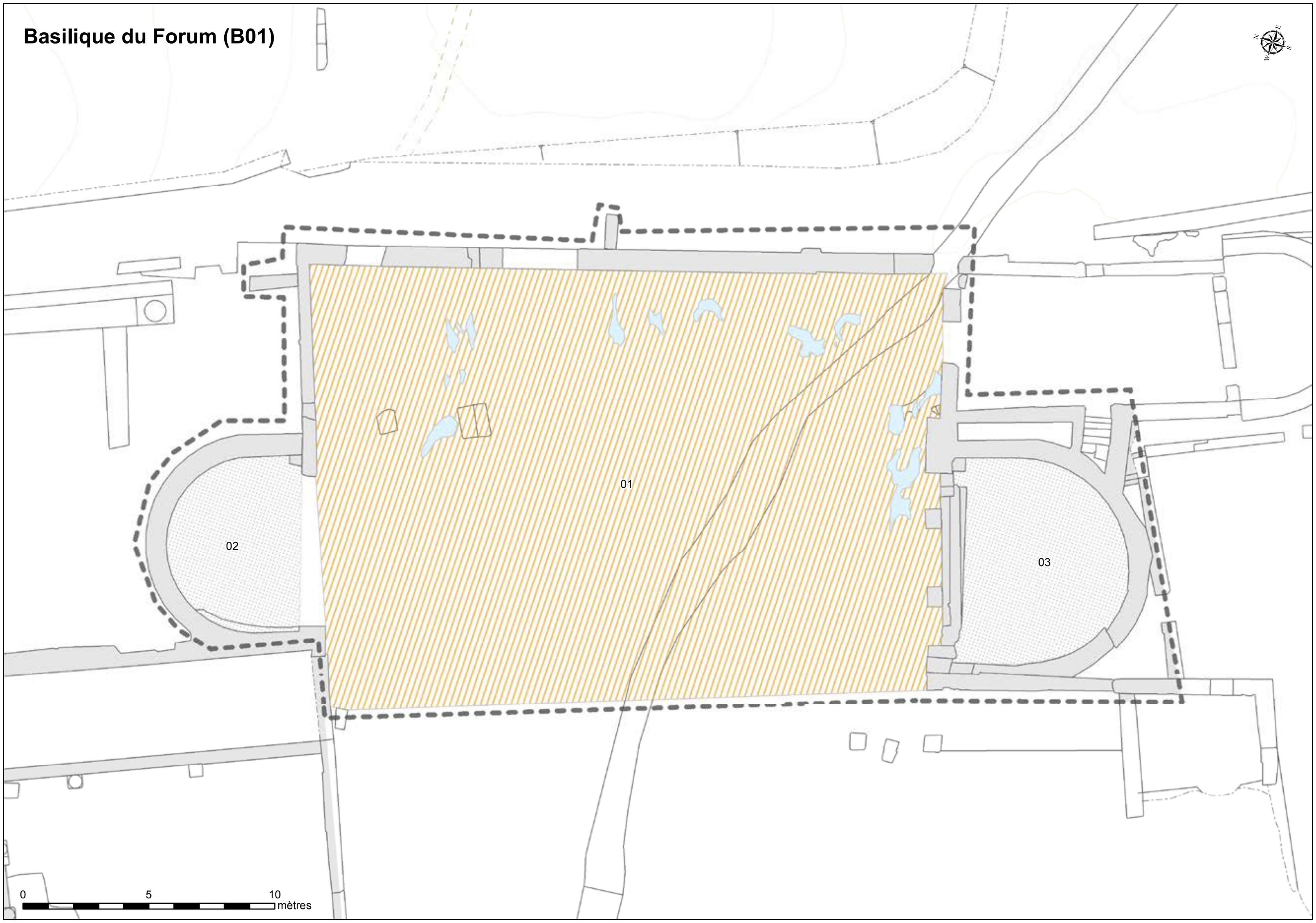
- exposed mosaic
- tessellatum stabilization
- tessellatum stabilization (first aid)
- tessellatum stabilization (mosaic on reinforced concrete panel)
- tessellatum mortar infilling
- cocciopesto treatment
- stone slab pavement treatment
- drainage
- reburial (before 2008)
- reburial

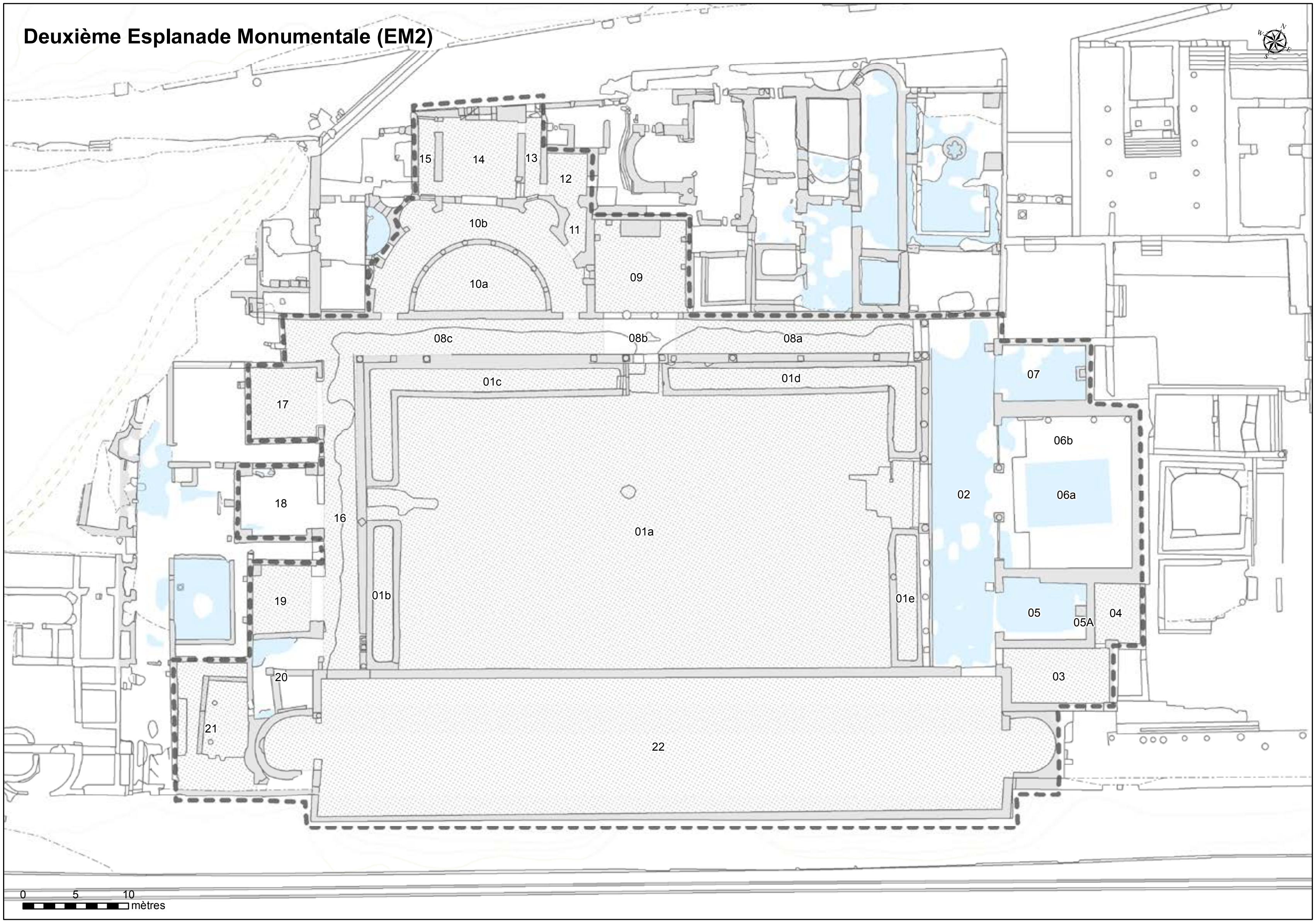
- reburial containment with wood
- reburial containment with mortar
- reburial containment with stone
- tessellatum protection with mortar covering
- mortar paving
- wall plaster stabilization
- shelter
- fence (temporary)

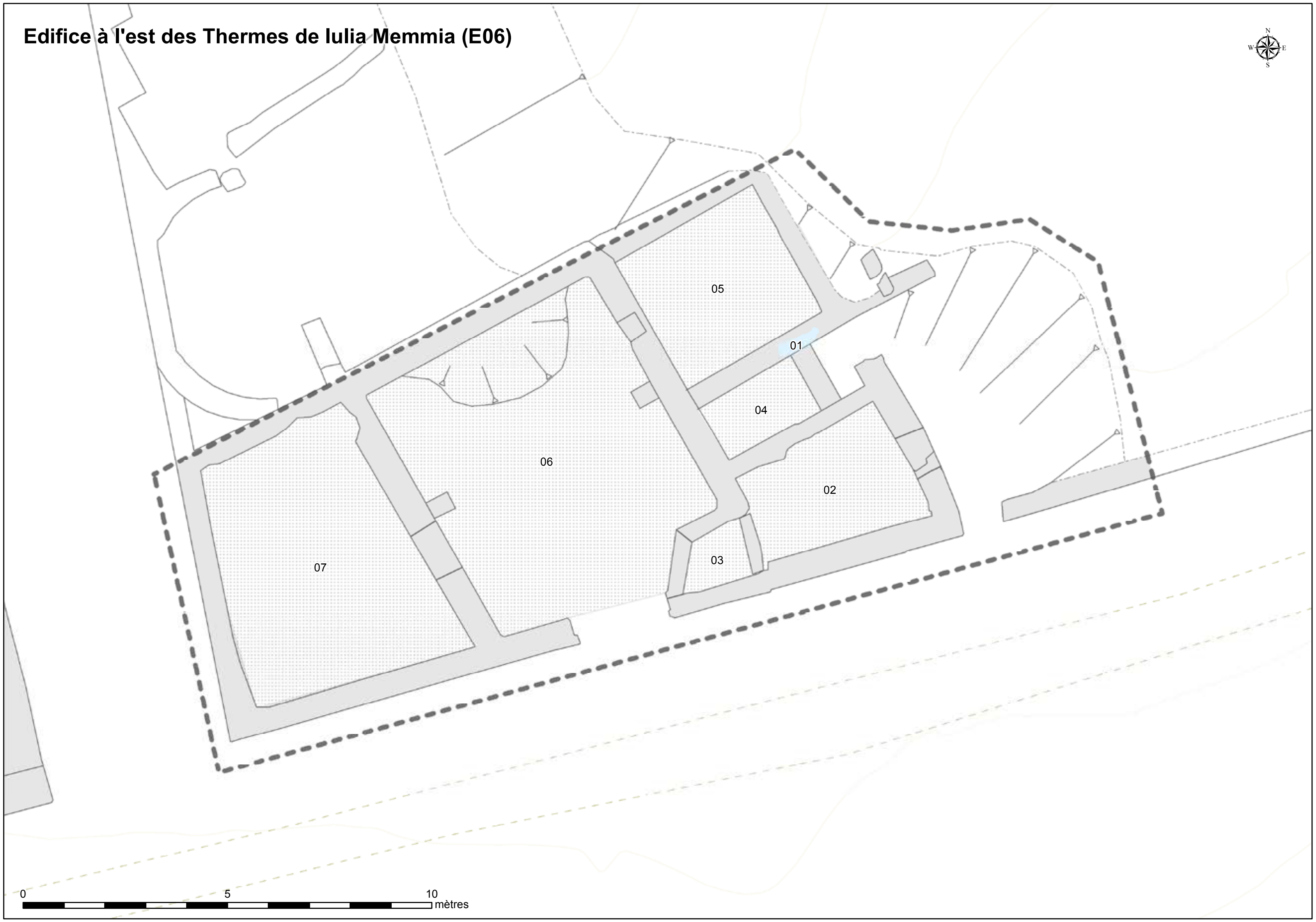

Basilique Chrétienne du Nord (BaN)
01
02
03a
03b
04
05
06
07
08
0
5
10
mètres

2


Basilique Chrétienne du Sud (BaS)
01
02
03
04
05
06
07
08
09
10
11
12
13
0
5
10
mètres

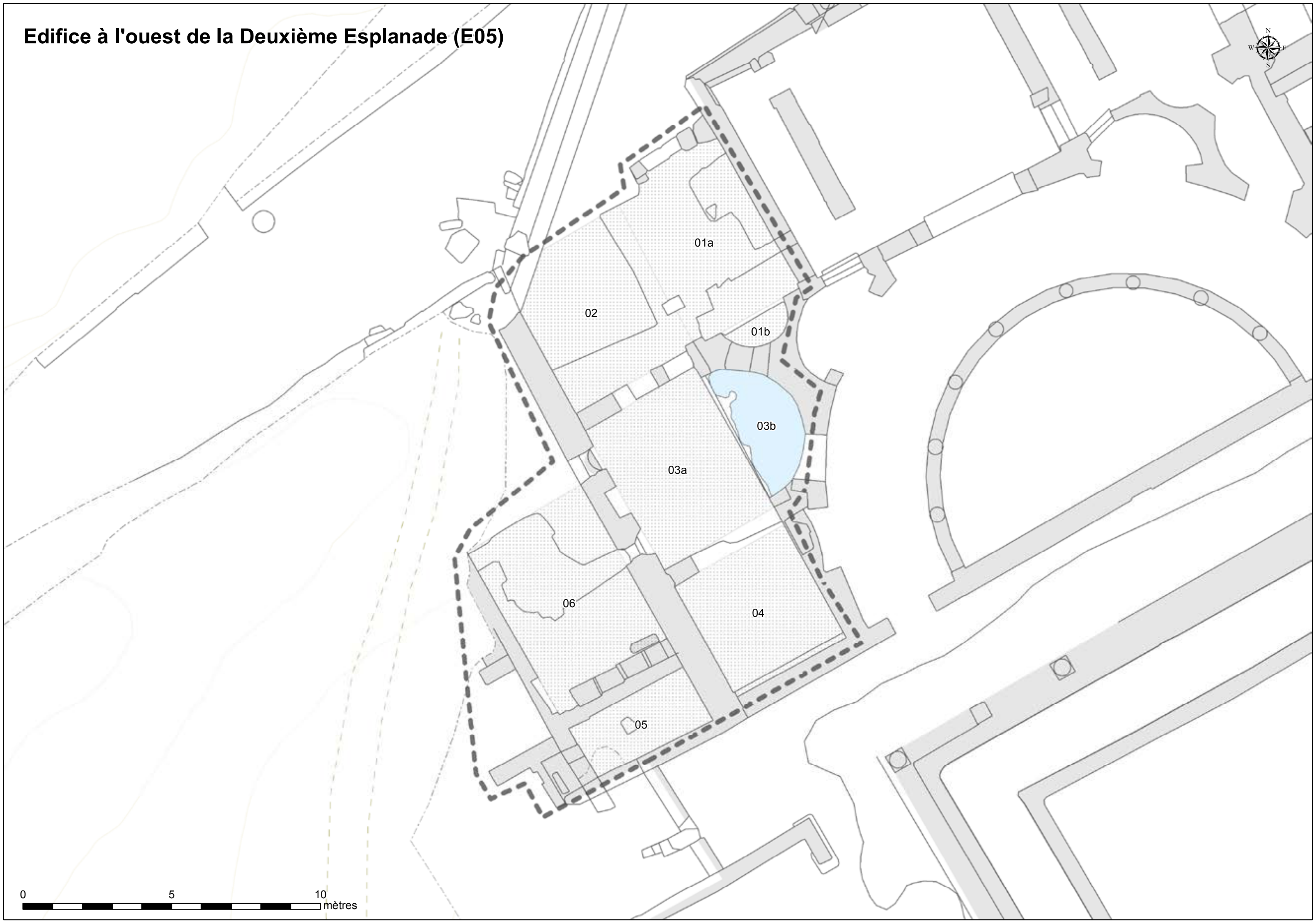

Basilique du Forum (B01)
01
02
03
0
5
10
mètres


Deuxième Esplanade Monumentale (EM2)
15
14
13
12
11
10b
10a
09
08c
08b
08a
01c
01d
17
18
16
01a
02
07
06b
06a
19
01b
01e
05
05A
04
20
03
21
22
0
5
10
mètres

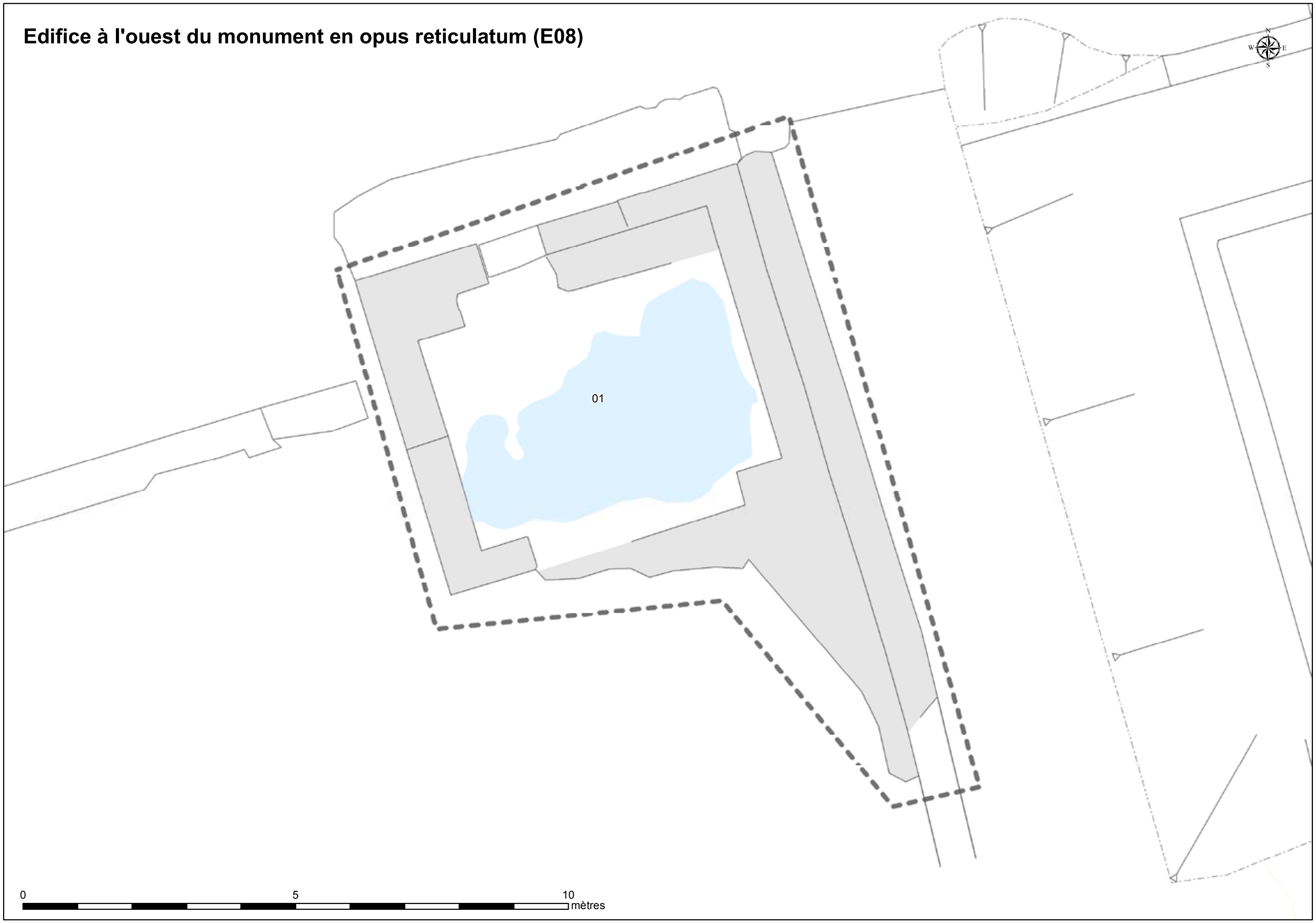


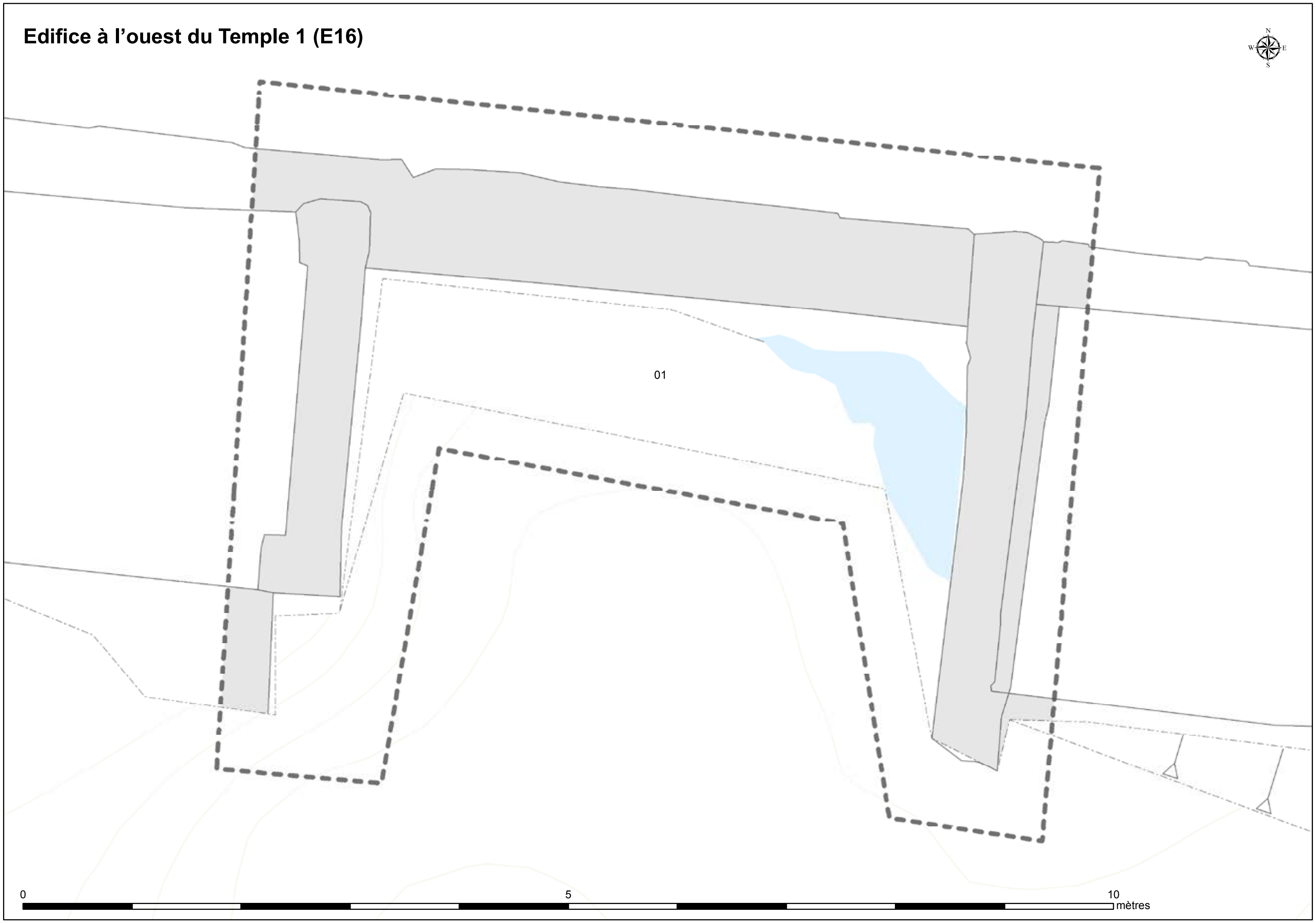
Edifice à l'est des Thermes de Iulia Memmia (E06)
N
W
E
S
05
01
04
06
02
07
03
0
5
10
mètres

Edifice à l'ouest de la Deuxième Esplanade (E05)

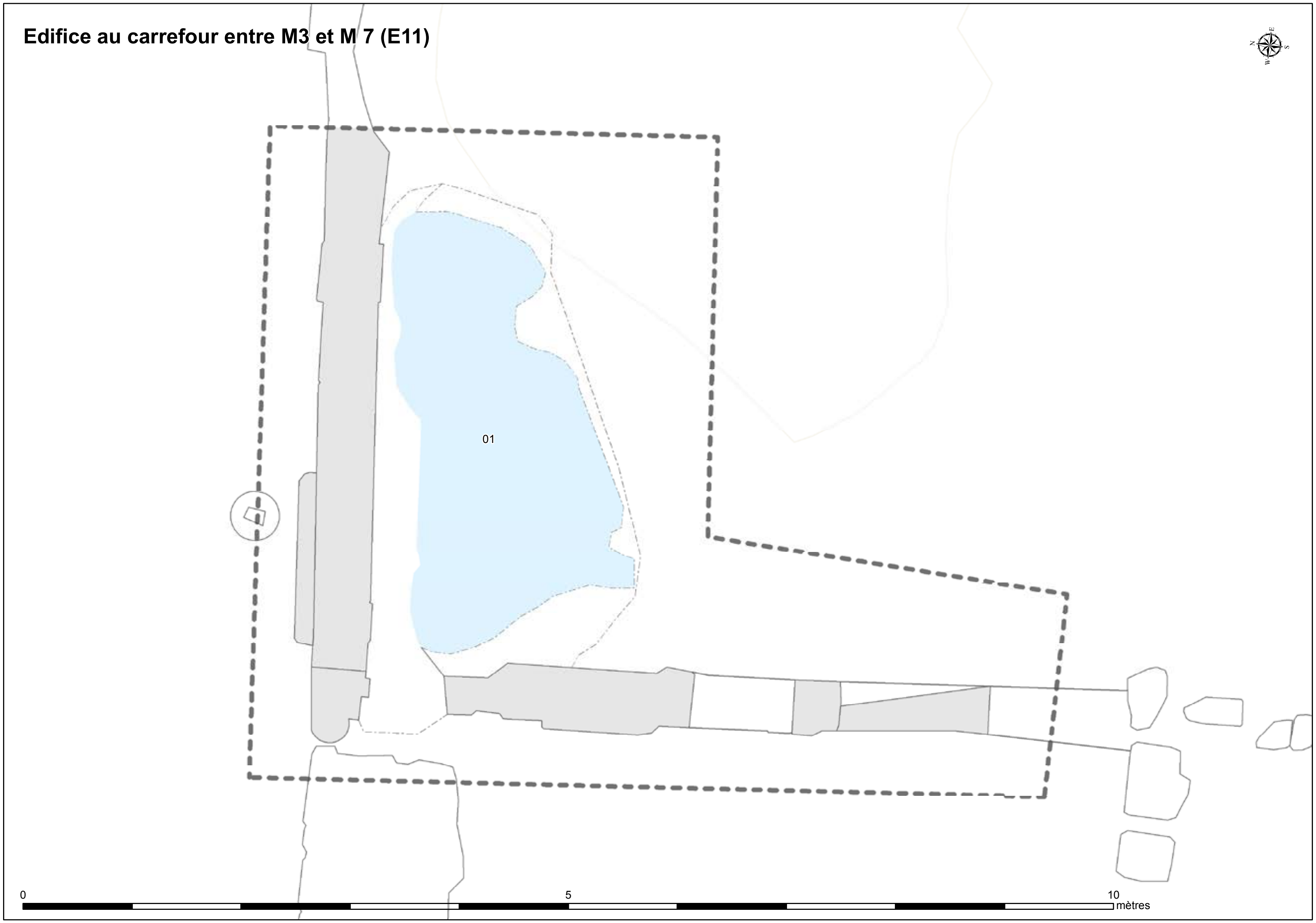


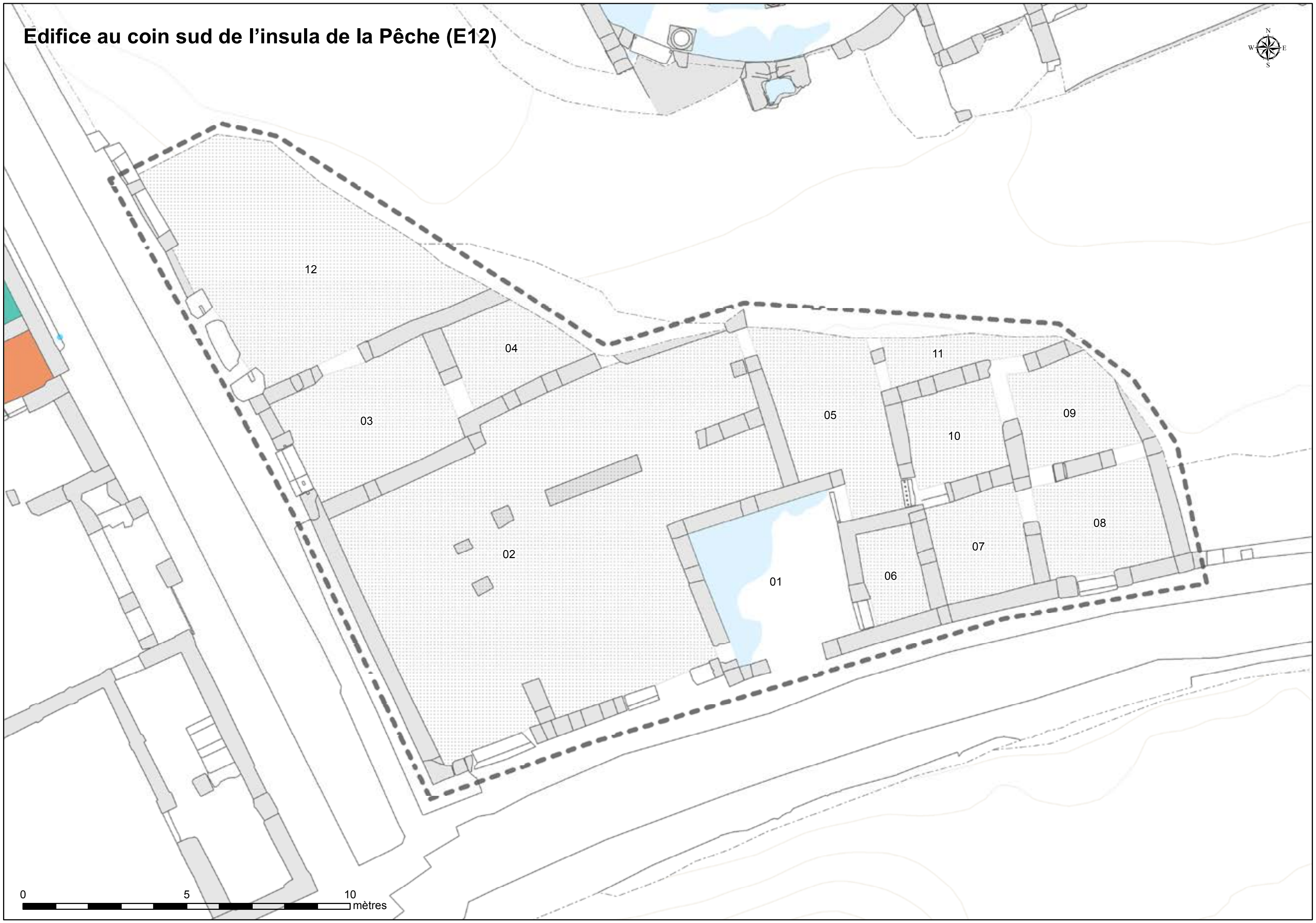
Edifice à l'ouest du monument en opus reticulatum (E08)

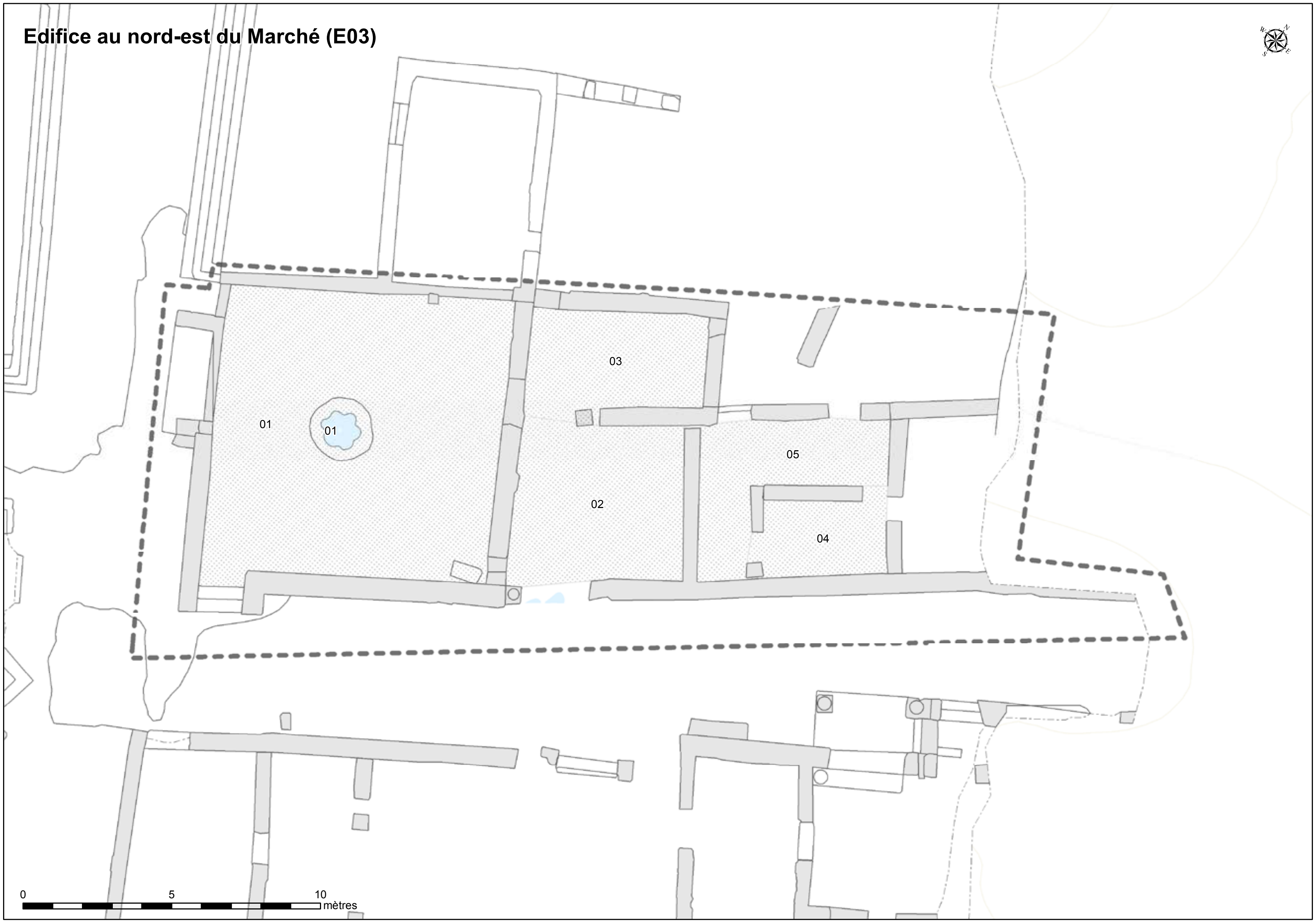



Edifice à l'ouest du Temple 1 (E16)
N
W
E
S
01
0
5
10
mètres

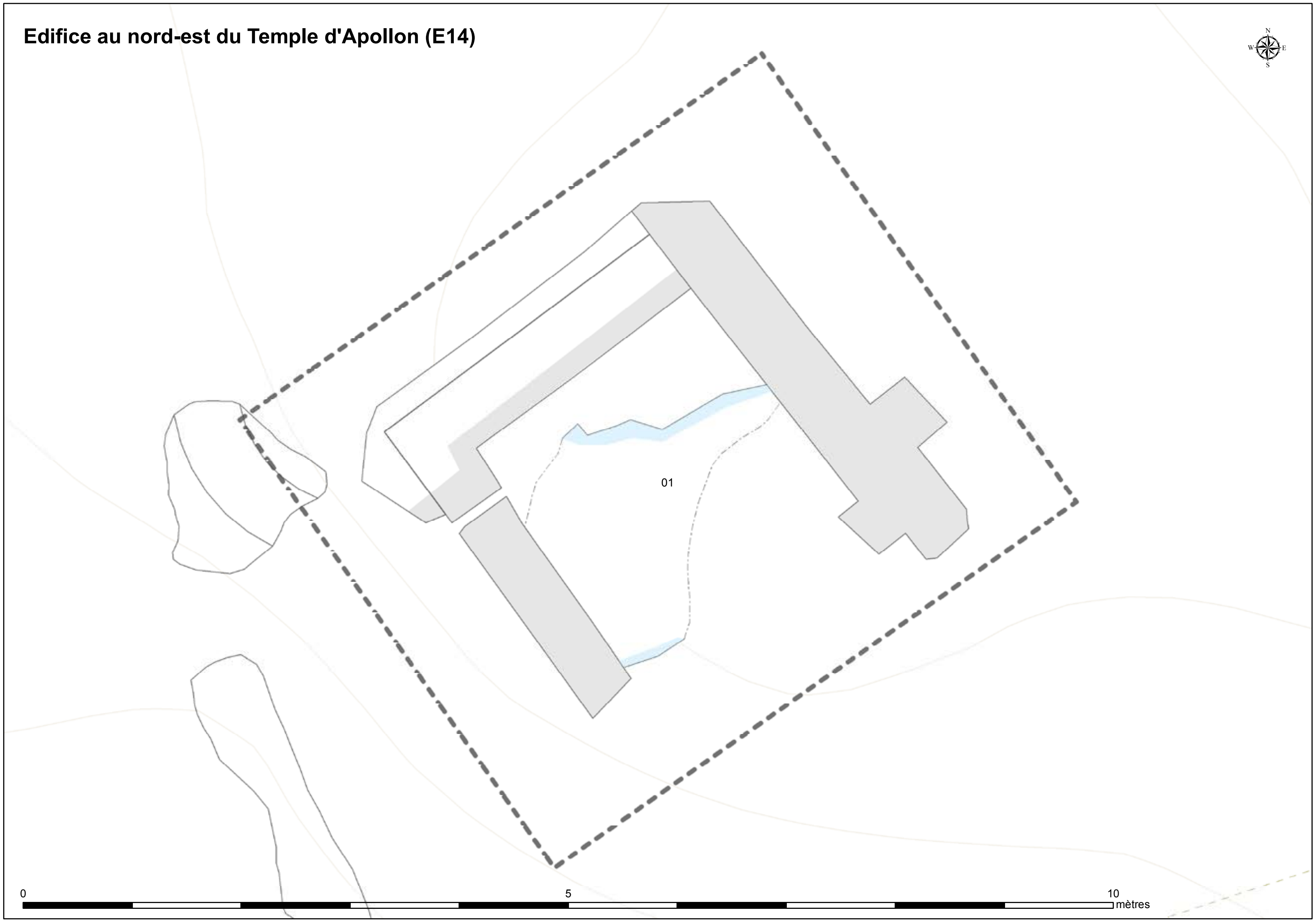
Edifice au carrefour entre M3 et M 7 (E11)

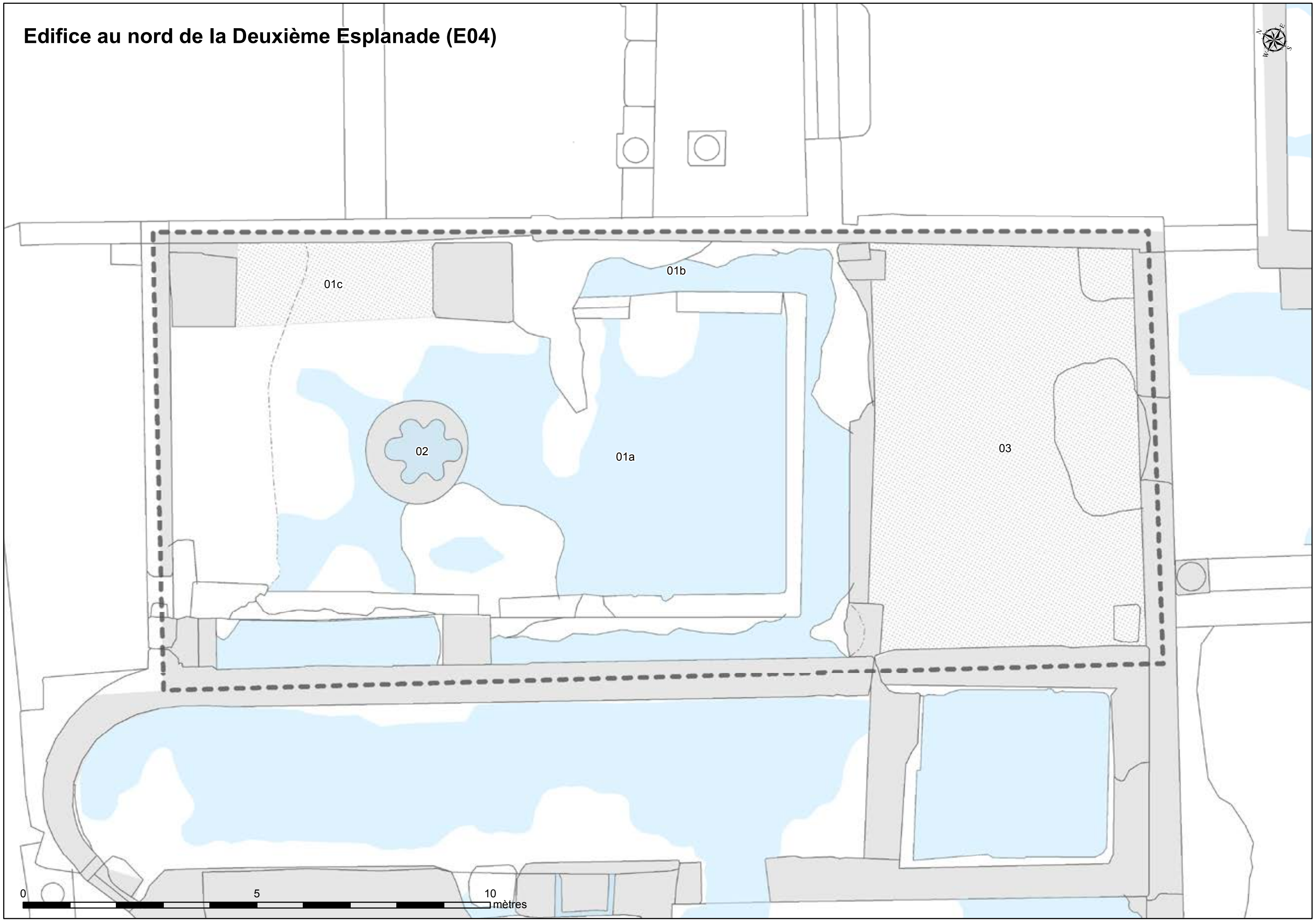



Edifice au coin sud de l'insula de la Pêche (E12)
12
04
03
02
01
05
11
10
09
08
07
06
0
5
10
mètres
N
W
E
S

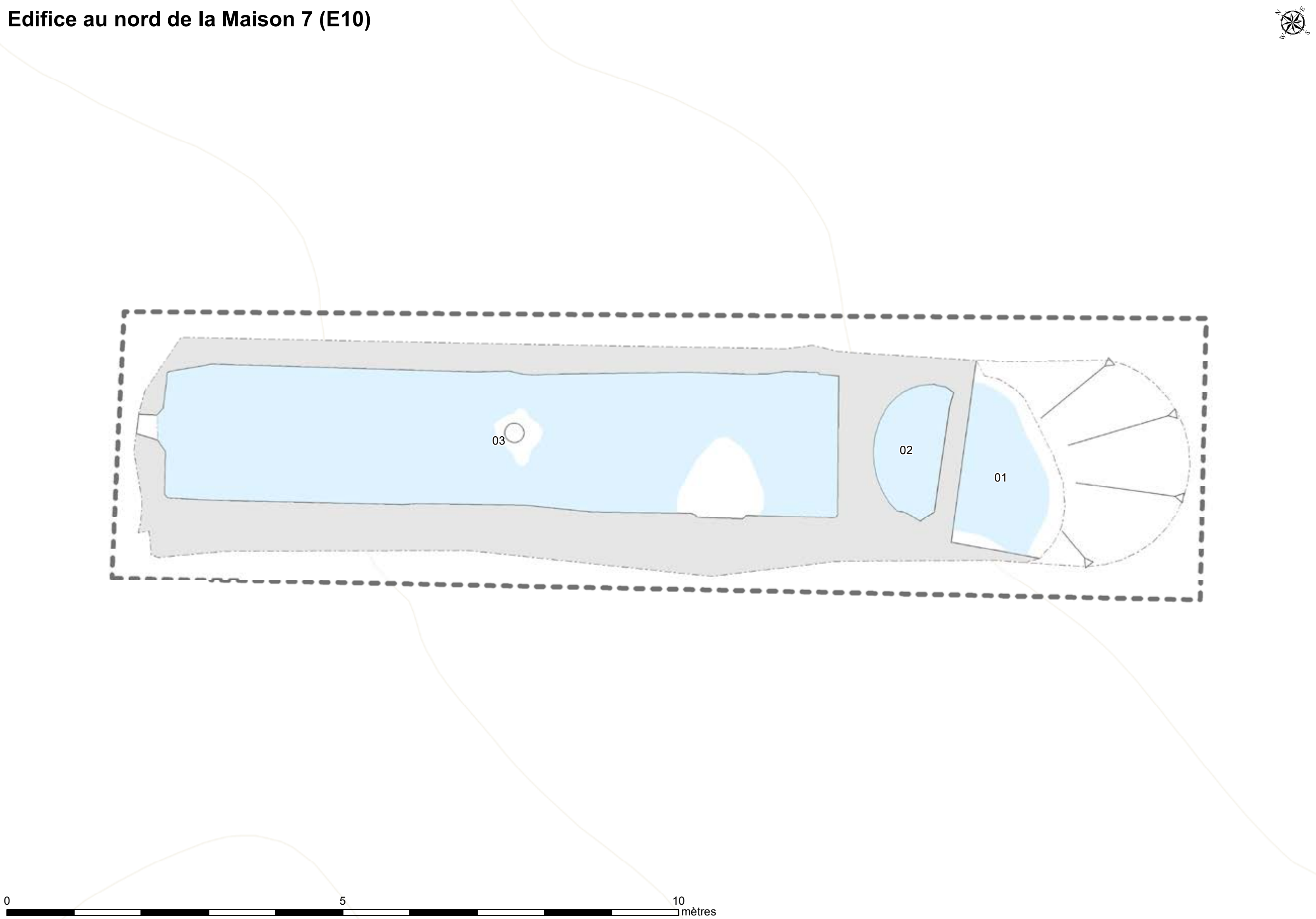

Edifice au nord-est du Marché (E03)
01
01
03
02
05
04
0
5
10
mètres

Edifice au nord-est du Temple d'Apollon (E14)



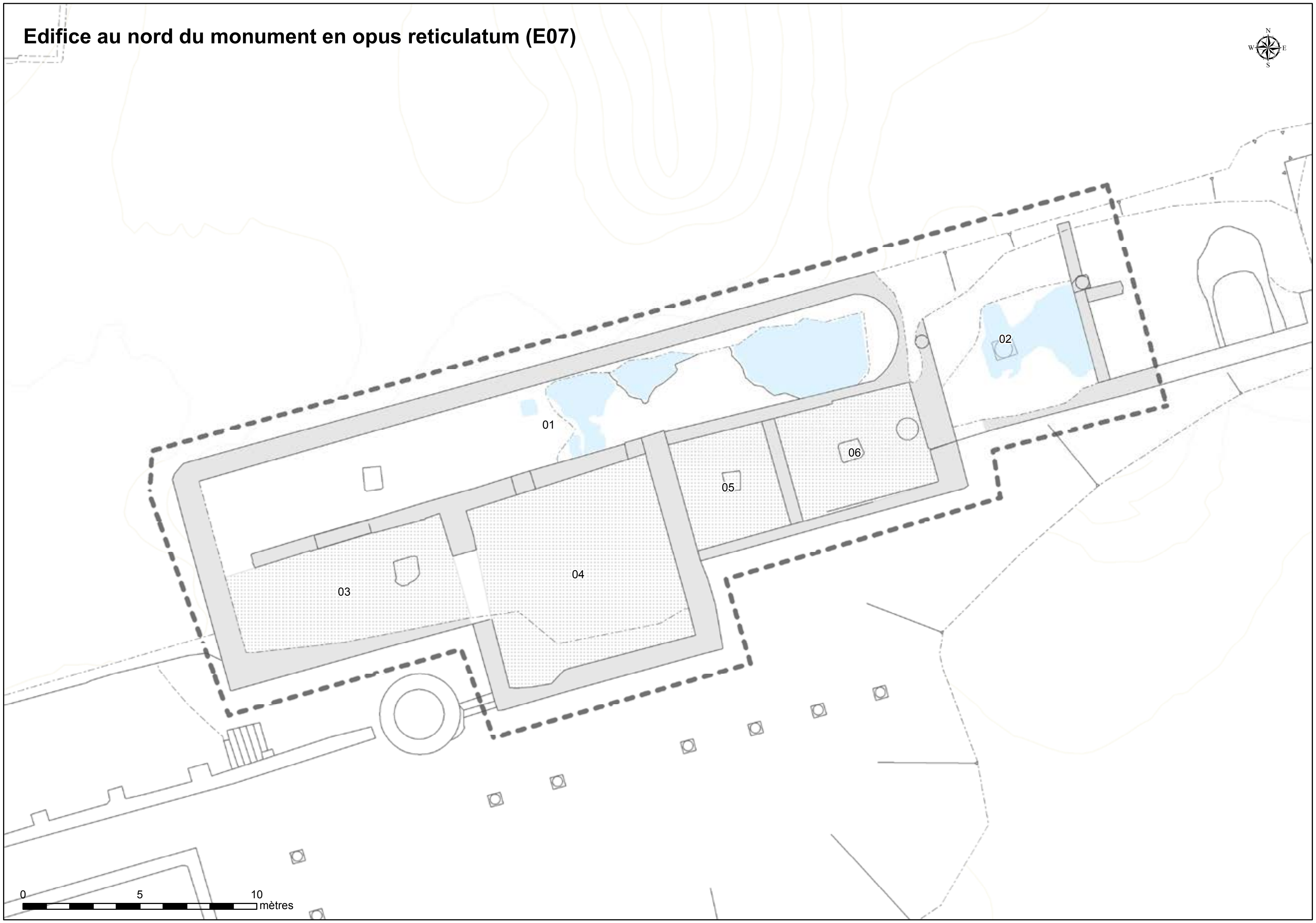

Edifice au nord de la Deuxième Esplanade (E04)
01c
01b
01a
02
03
0
5
10
mètres

Edifice au nord de la Maison 7 (E10)



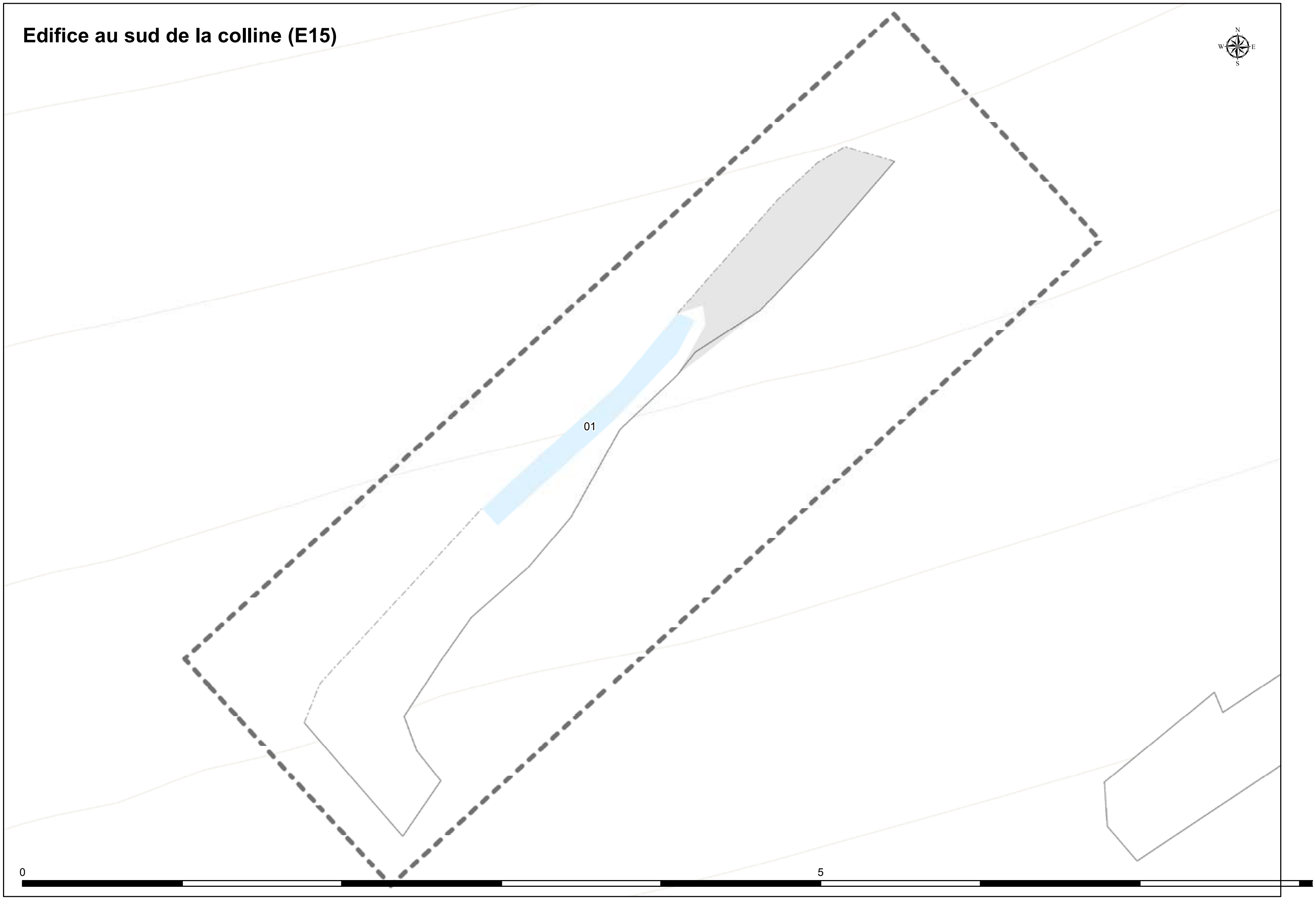
Edifice au nord de la source (E13)

Edifice au nord du monument en opus reticulatum (E07)



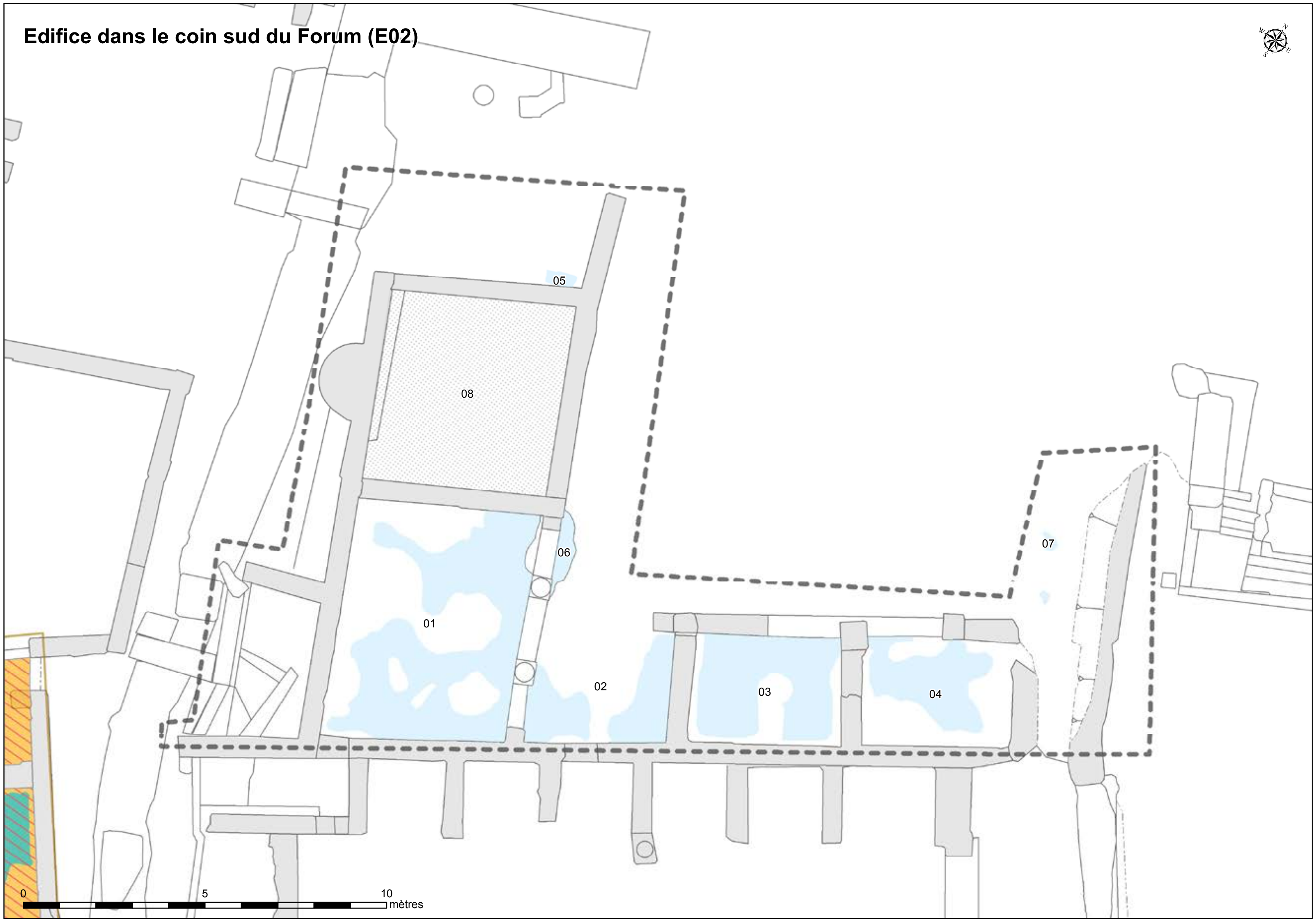
Edifice au sud-ouest du Temple d'Apollon (E01)

Edifice au sud de la colline (E15)



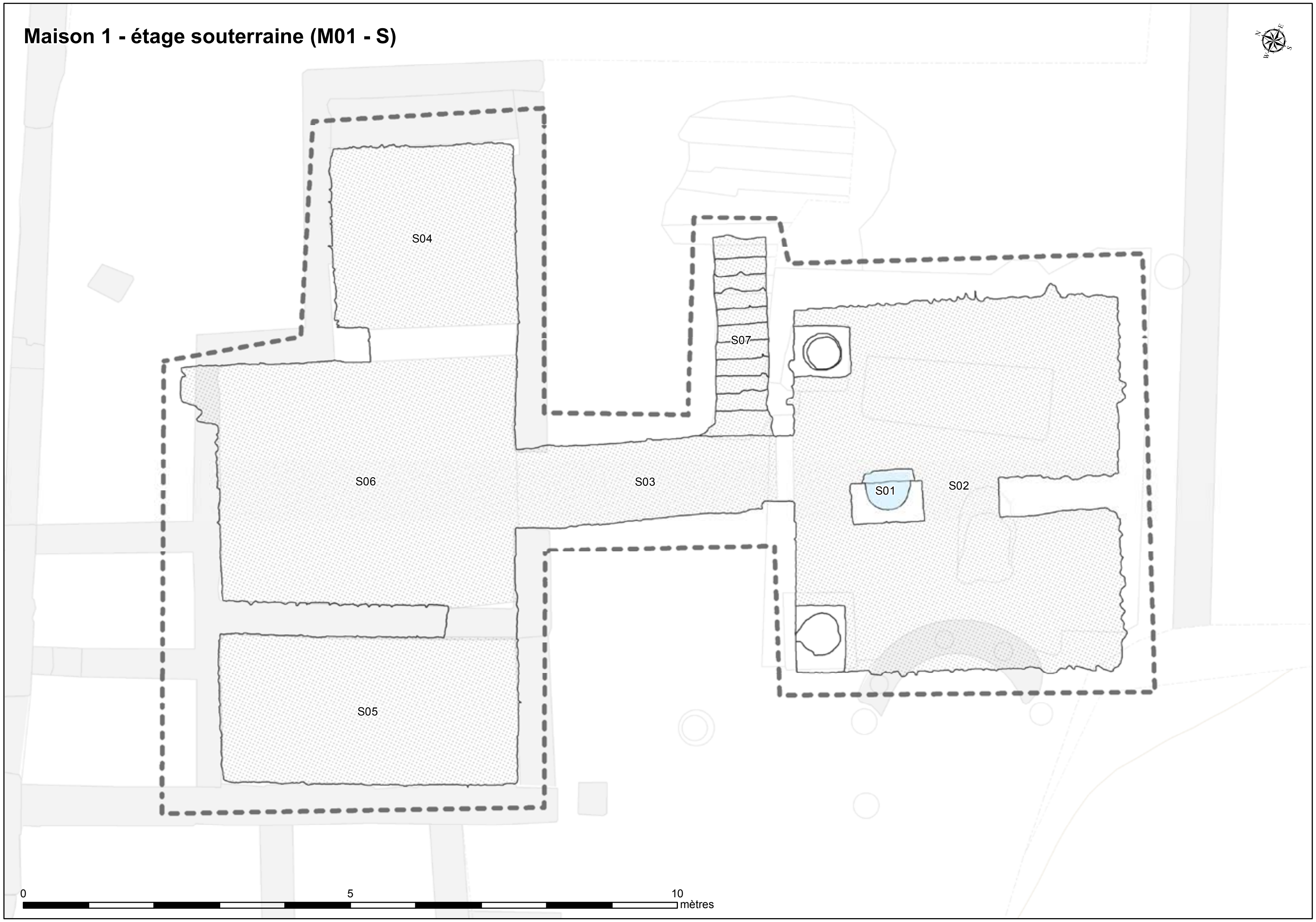
Edifice au sud de la Maison 3 (E09)

20


Edifice dans le coin sud du Forum (E02)
05
08
06
07
01
02
03
04
0
5
10
mètres


Maison 1 (M01)
23
22
21
20
24
01b
12
11
03
02
01a
11seuil
25
06
05
08
07
04
32
13
14
09
10
33
26
19
18
15
16
17_R
31
27
30
28
29
0
5
10
mètres

Maison 1 - étage souterraine (M01 - S)




Maison 10 (M10)
20
17
04
03
05
15
22
21
06
14a
14b
07
18
02a
08
11
01
19
02d
02b
01b
09
12
02c
10
13
16
23
24
25
0
5
10
mètres

Maison 14 (M14)
05
04
03
07
02
06
01
0
5
10
mètres

Maison 15 (M15)
01
02
03
04
05
06
07
08
09
10
0
5
10
mètres


Maison 2 (M02)
N
W
E
S
01
02
03
04
05
06
07
08
0
5
10
mètres

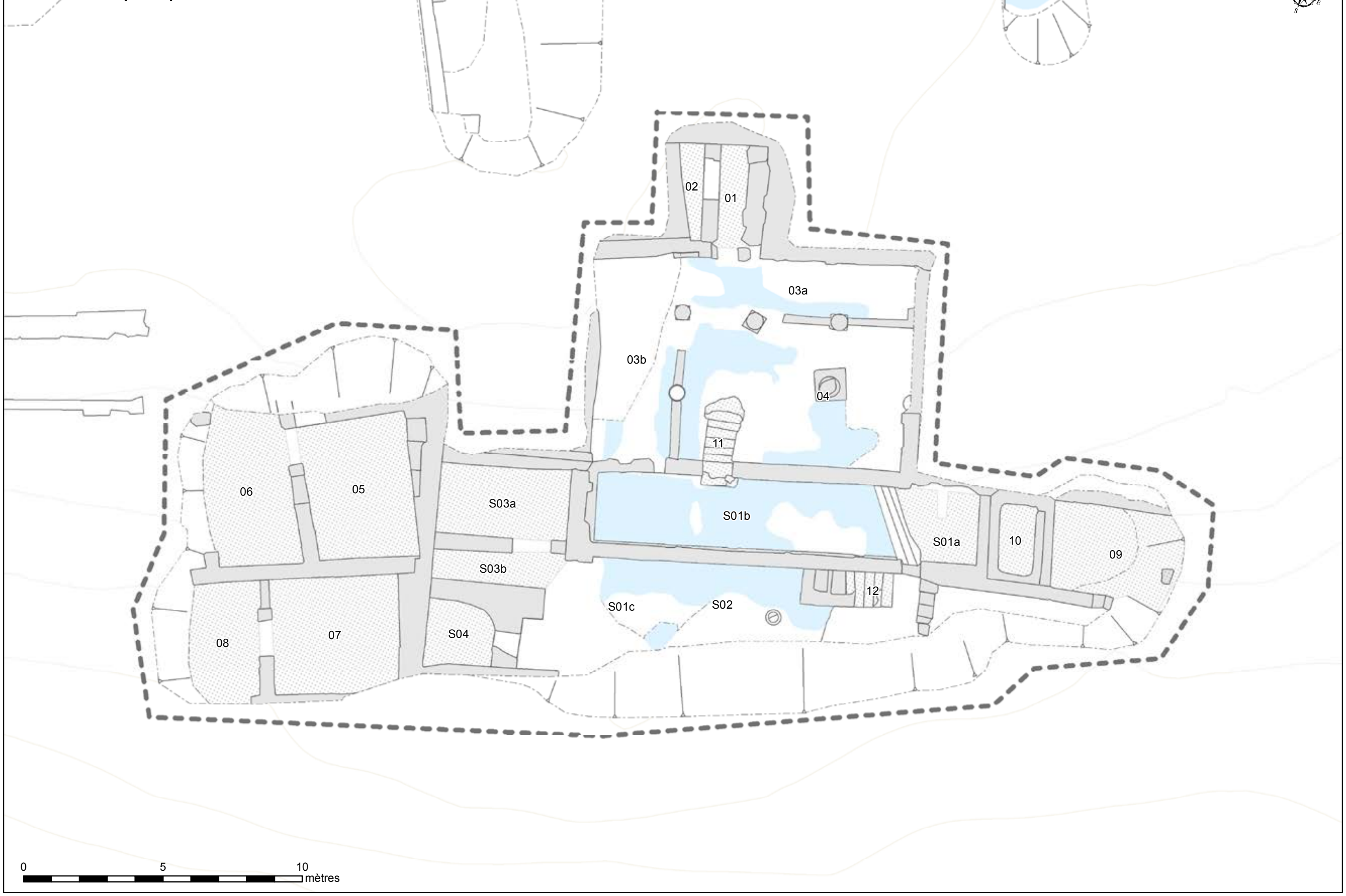

Maison 3 (M03)
32
31
30
28
29
35
36
15
14
13
08
07
06
12a
10
09
05
04
33
16
11b
11a
37
01
12b
18b
18a
17
12c
03
02
34
19
20
21
22
23
26
25
24
27
0
5
10
mètres

Maison 3 - étage souterraine (M03 - S)


Maison 4 (M04)
13
12
14
05b
03
01
08b
04
05a
17b
15
06b
20
02
17a
05c
08a
09
19
16
06a
07
05e
05d
18
10b
10a
11
0
5
10
mètres


Maison 5 (M05)
15
16
17
14
11
10
13
01
09
12
04b
04a
08
03
05
07
02
06
0
5
10
mètres

Maison 7 (M07)



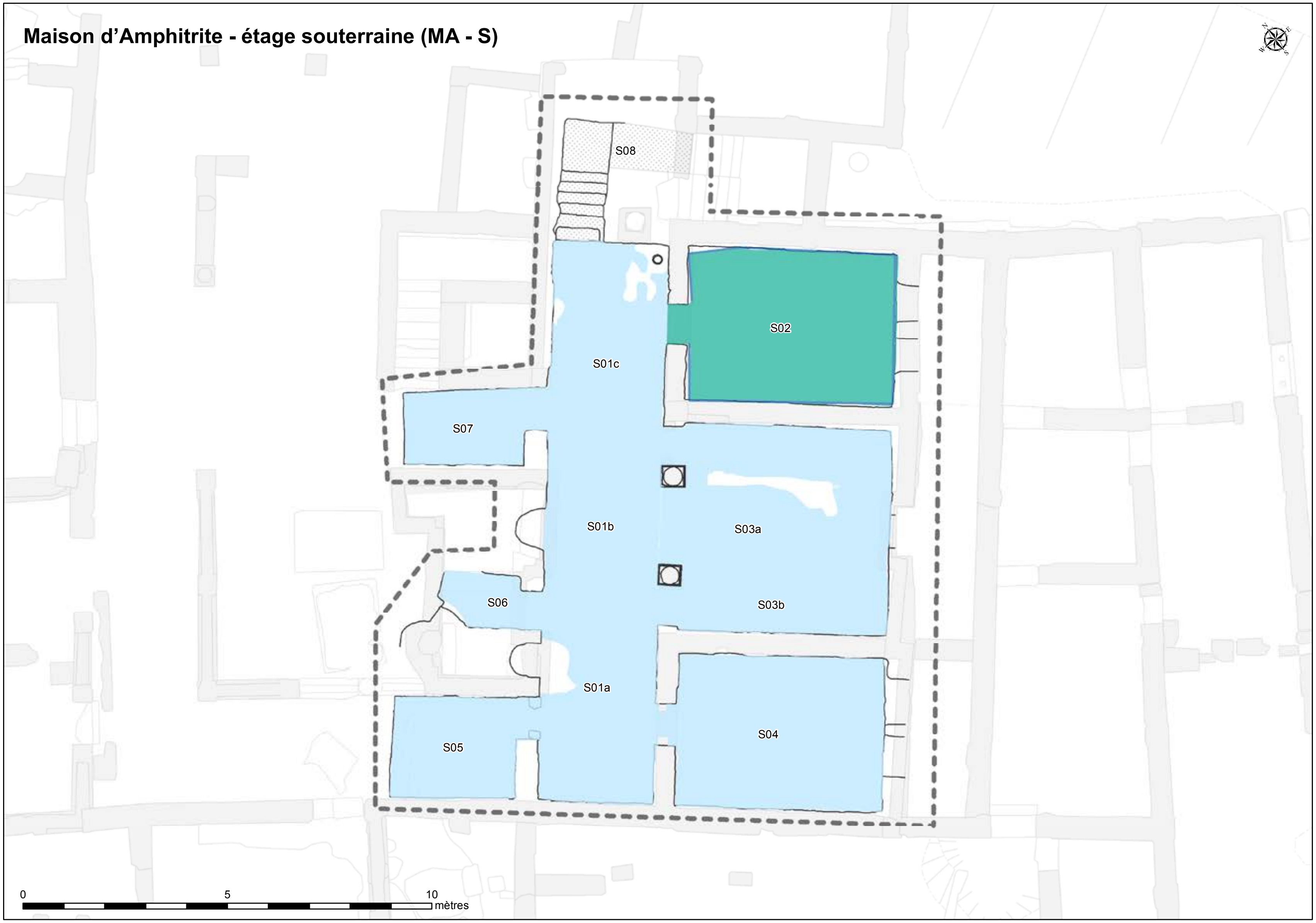
02
01
03a
03b
04
11
06
05
S03a
S01b
S01a
10
09
S03b
12
S01c
S02
08
07
S04
0
5
10
mètres

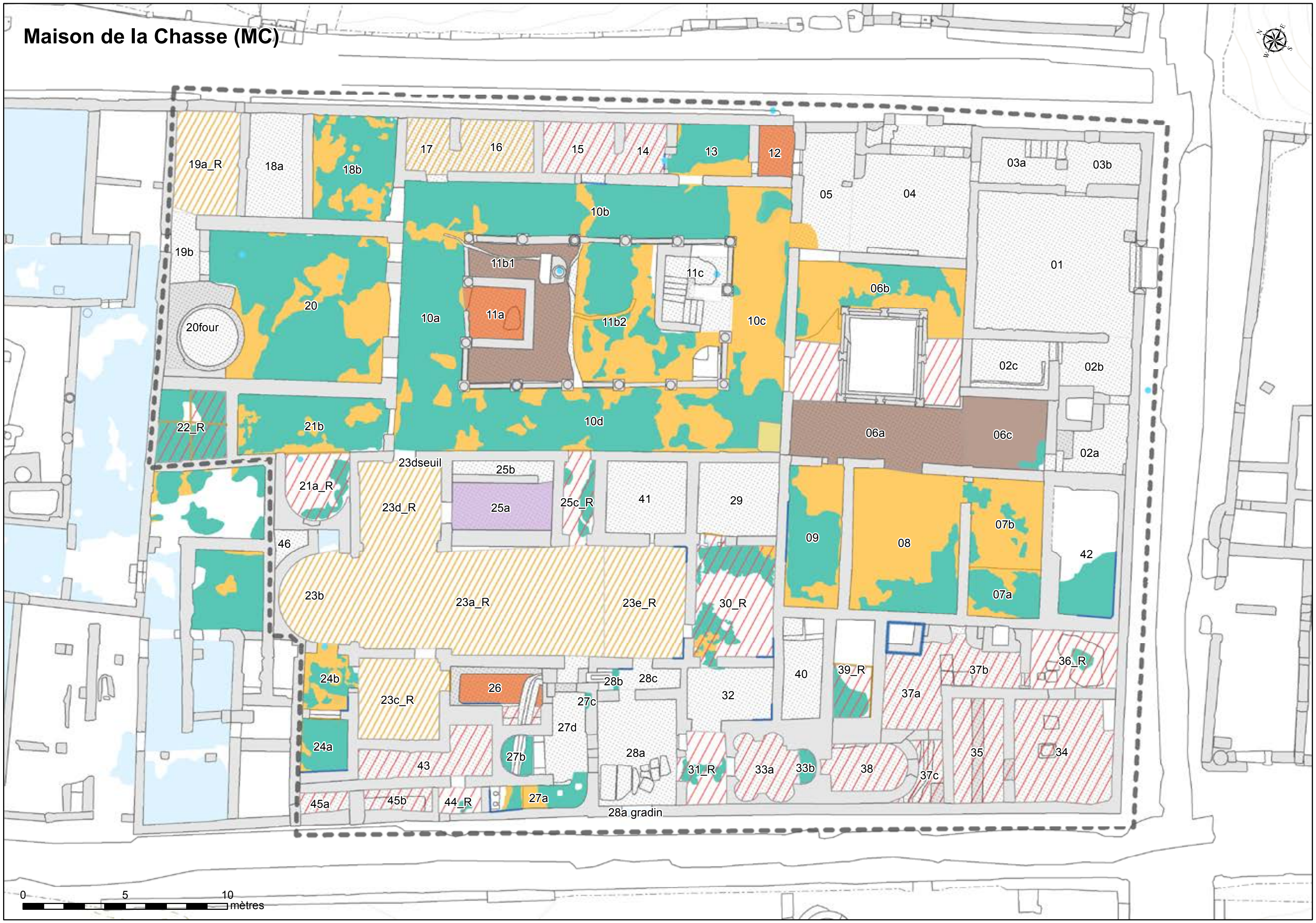
Maison 8 (M08)
23
24
22
16
25
15
10
08
07
21
14
12
13a
09
06
26
27
13b
02
04
20
19
18
17
11
03
01
05
28
0
5
10
mètres


Maison 9 (M09)
04
08
09
10a
10b
11
12
02
07
01
05
06
15
14a
13
16
14b
03
17
0
5
10
mètres

Maison d'Amphitrite (MA)

Maison d'Amphitrite - étage souterraine (MA - S)

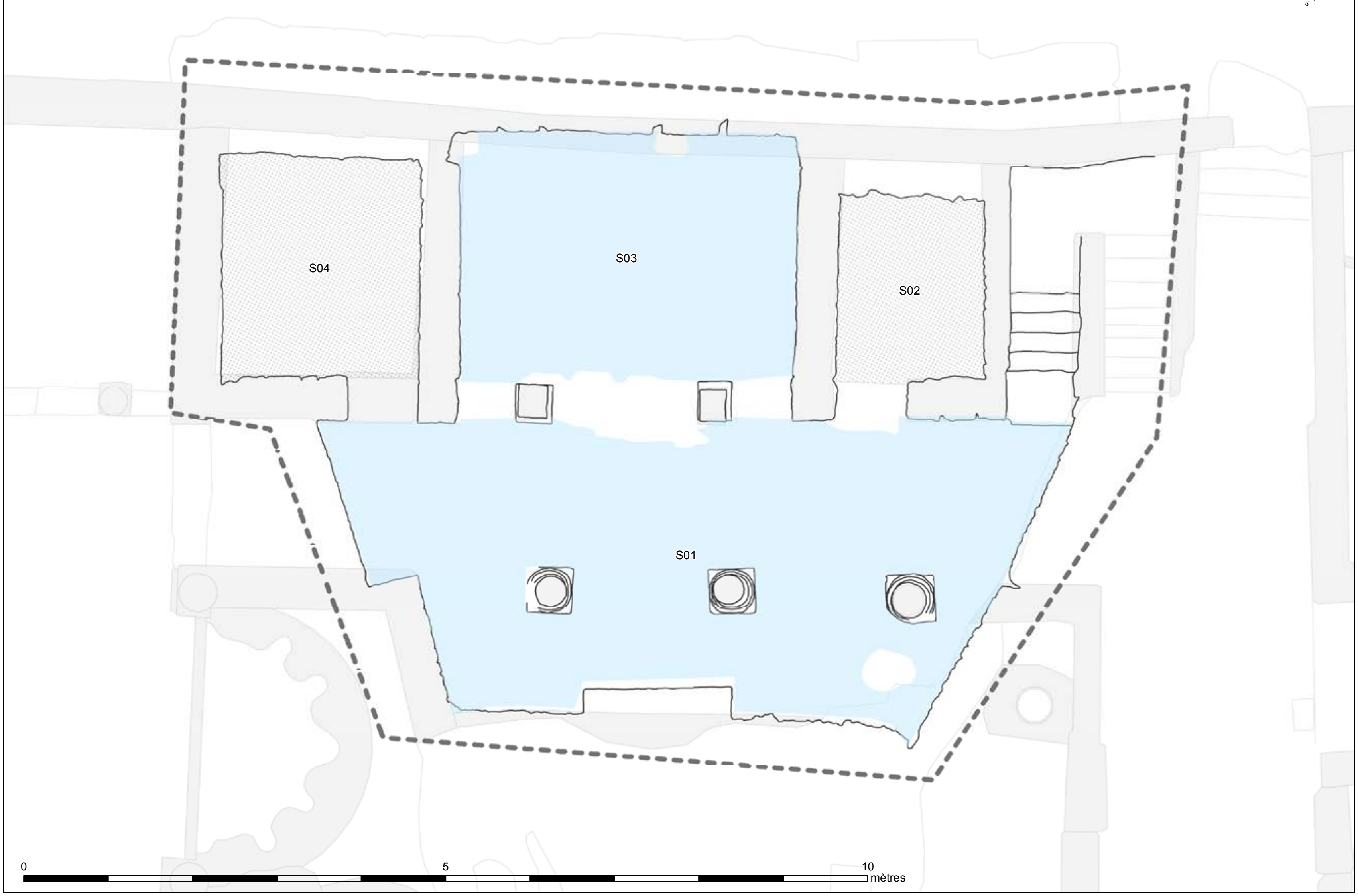



Maison de la Chasse (MC)
19a_R
18a
18b
17
16
15
14
13
12
03a
03b
05
04
19b
10b
11b1
11c
01
06b
20
10a
11a
11b2
10c
20four
02c
02b
22_R
21b
10d
06a
06c
02a
23dseuil
25b
21a_R
23d_R
25a
25c_R
41
29
09
08
07b
46
42
23b
23a_R
23e_R
30_R
07a
40
39_R
36_R
37b
24b
26
28b
28c
32
37a
23c_R
27c
27d
24a
28a
27b
43
31_R
33a
33b
38
35
34
37c
45a
45b
44_R
27a
28a gradin
0
5
10
mètres

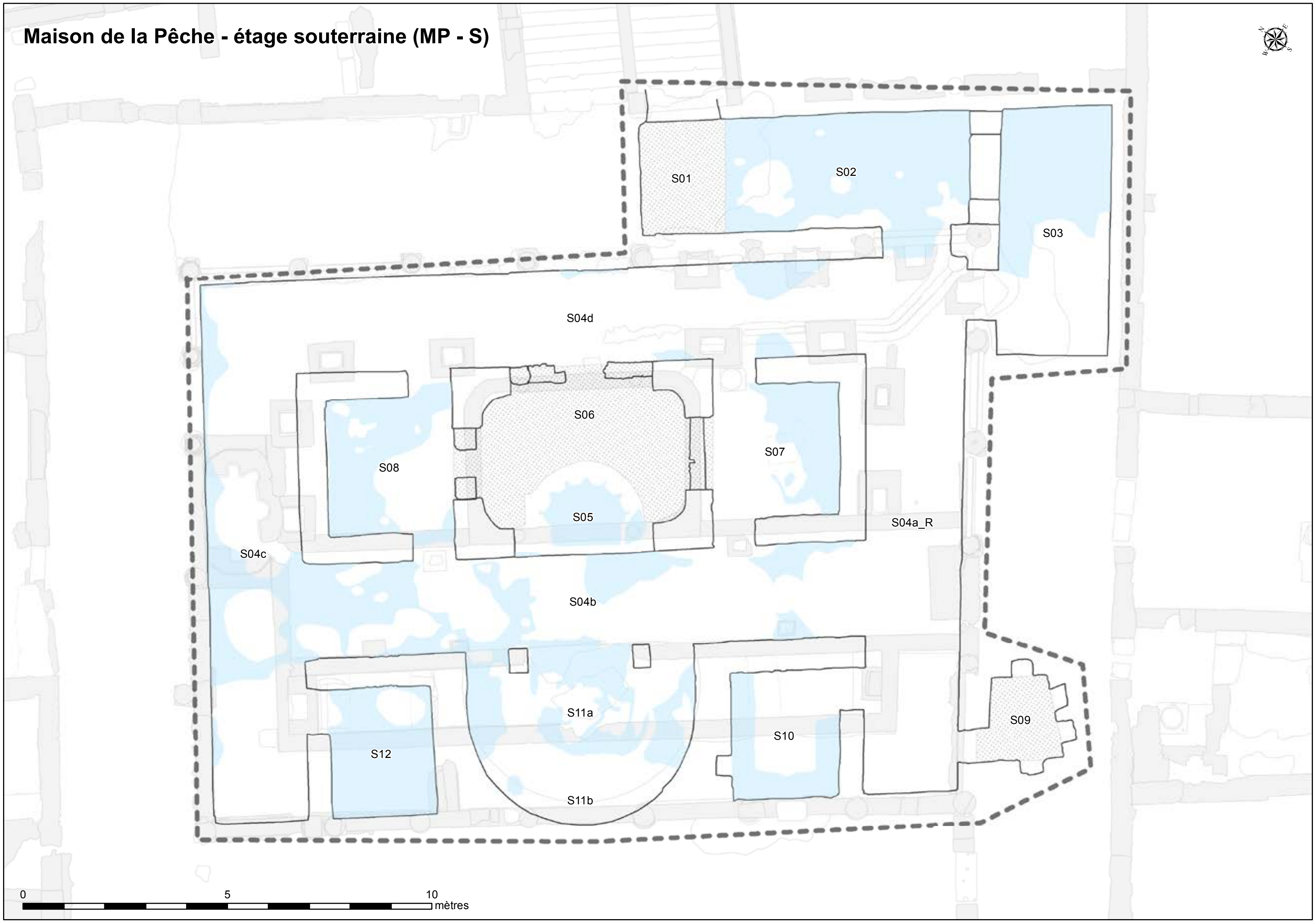
Maison de la Chasse - étage souterraine (MC - S)


Maison de la Nouvelle Chasse (MNC)
17a
17b
16
15
14
28
29
04
01b
01a
01c
12a
12b
26
13
10
11
02
03
09
05
27
25
08
22
23
24
06
07
19a
20a
21
18
20b
19b
32a
30
31
32b
0
5
10
mètres

Maison de la Nouvelle Chasse - étage souterraine (MNC - S)

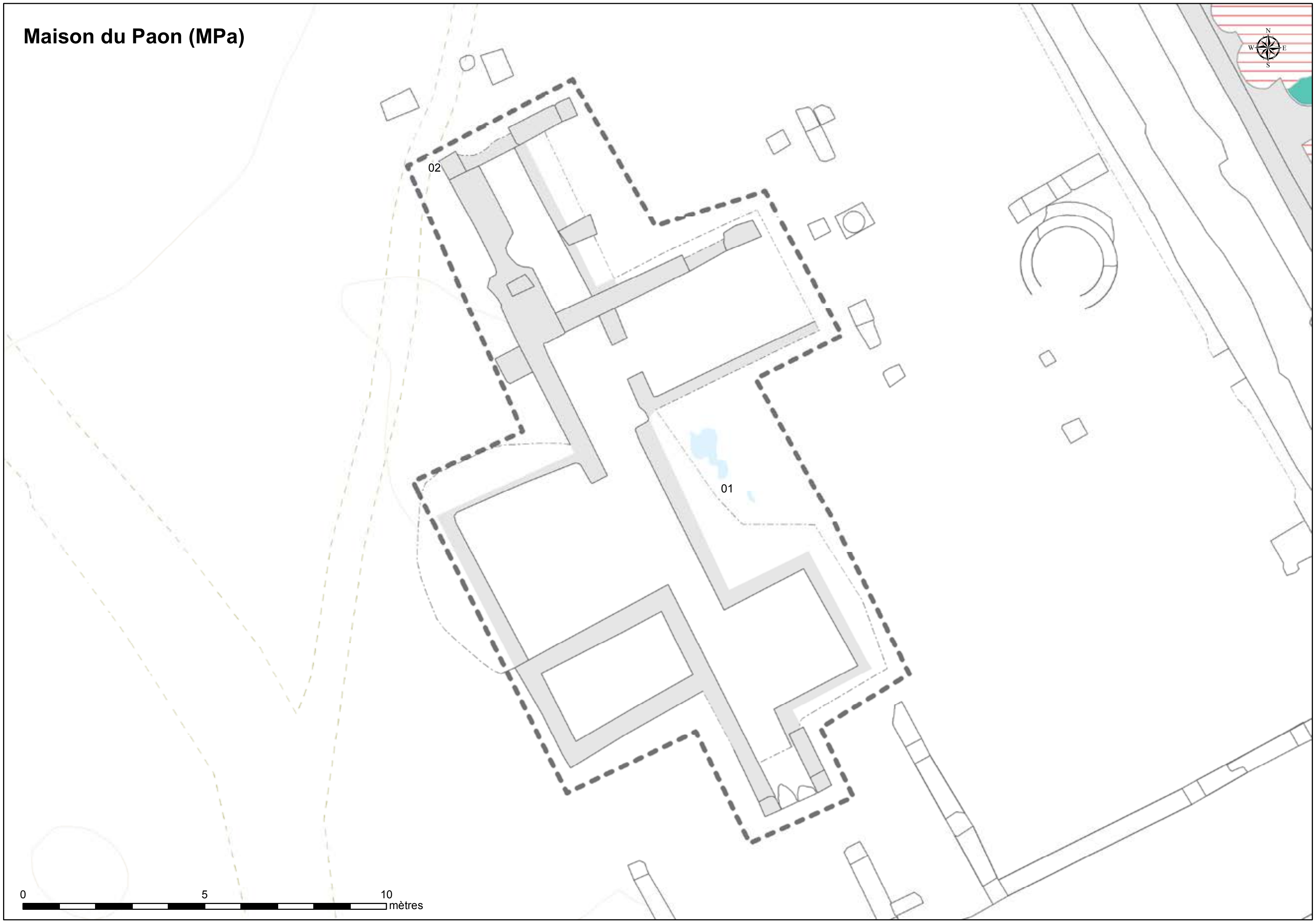


Maison de la Pêche (MP)



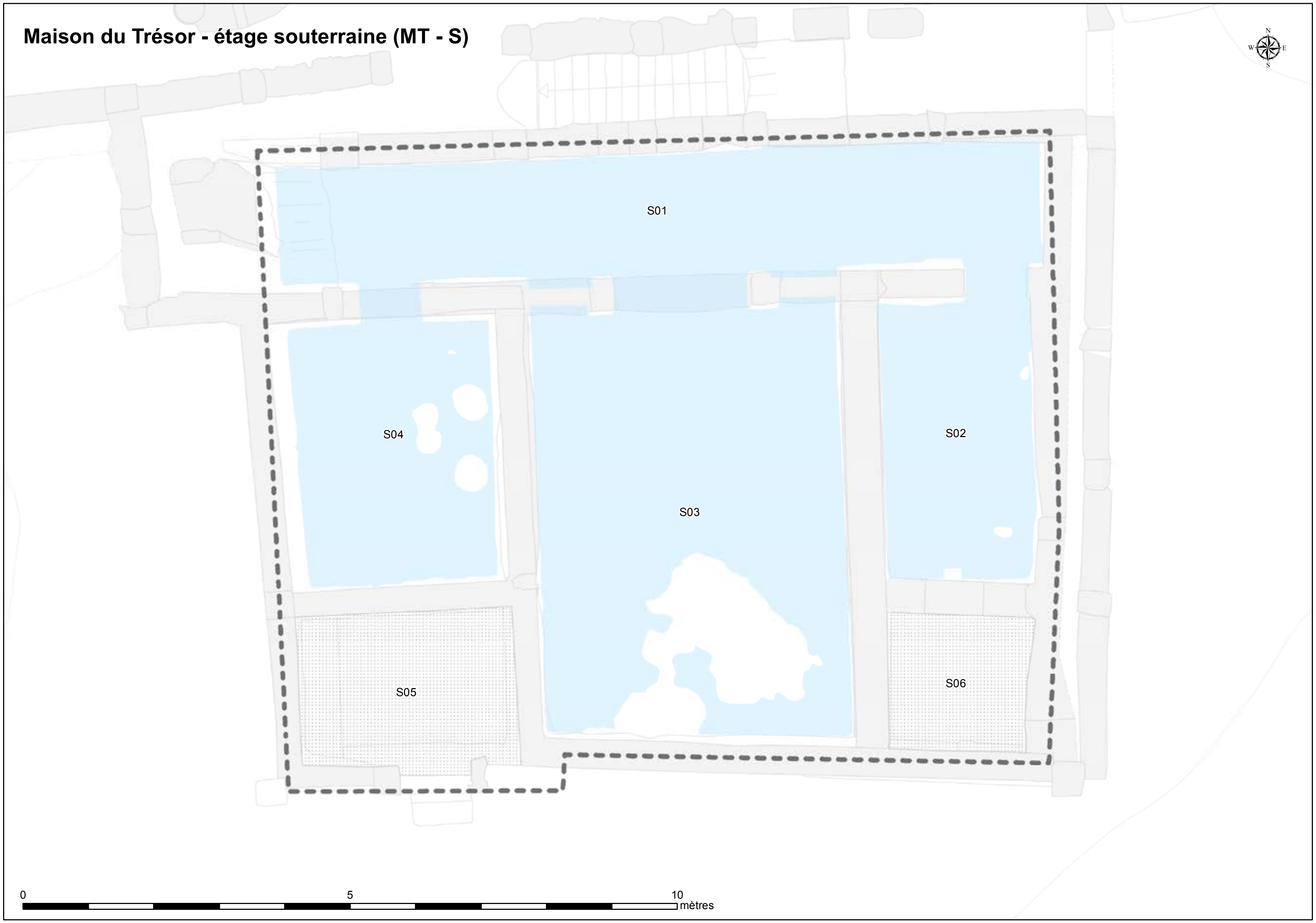
Maison de la Pêche - étage souterraine (MP - S)
S01
S02
S03
S04d
S06
S07
S08
S05
S04a_R
S04c
S04b
S11a
S09
S10
S12
S11b
0
5
10
mètres

Maison du Paon (MPa)

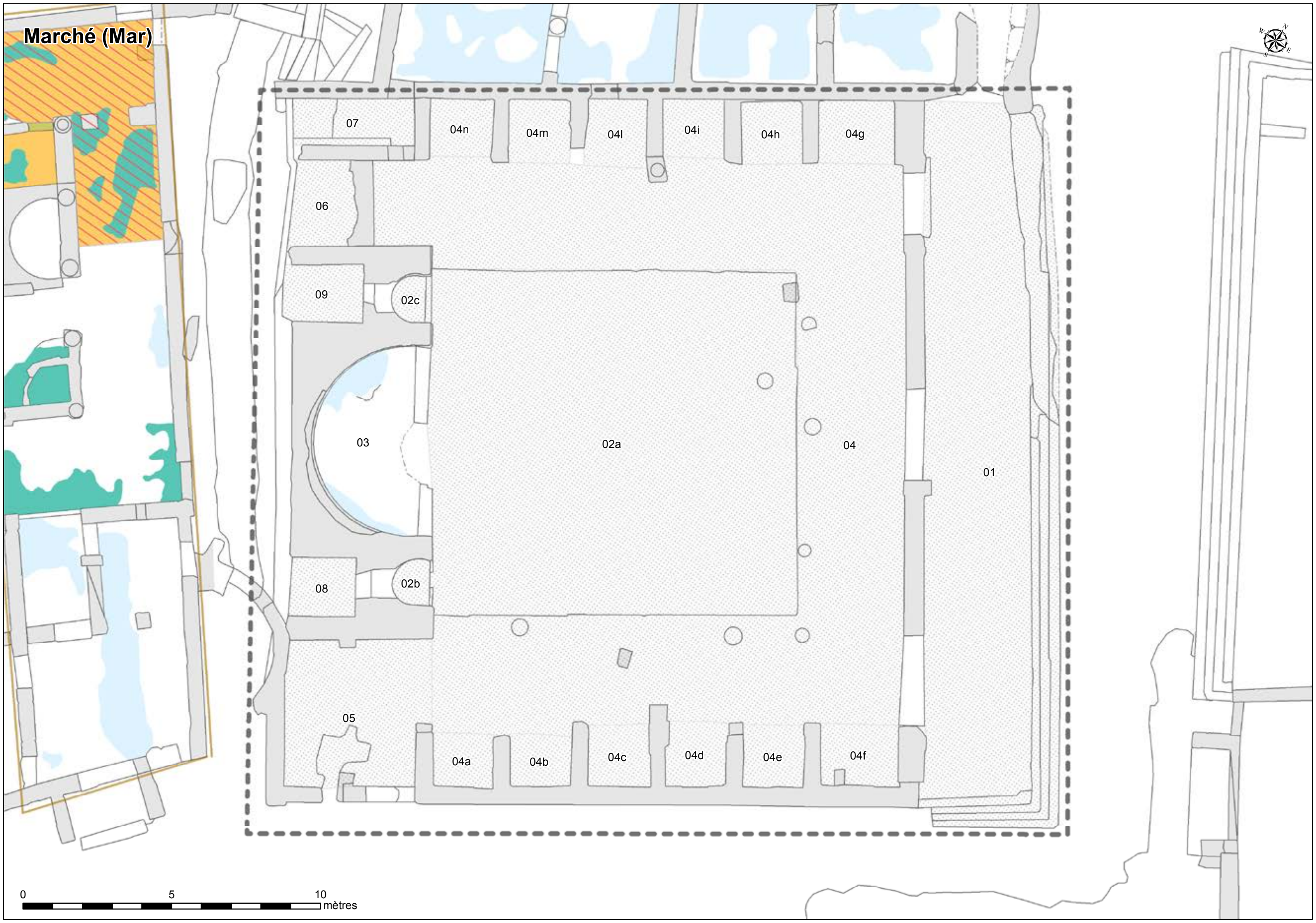


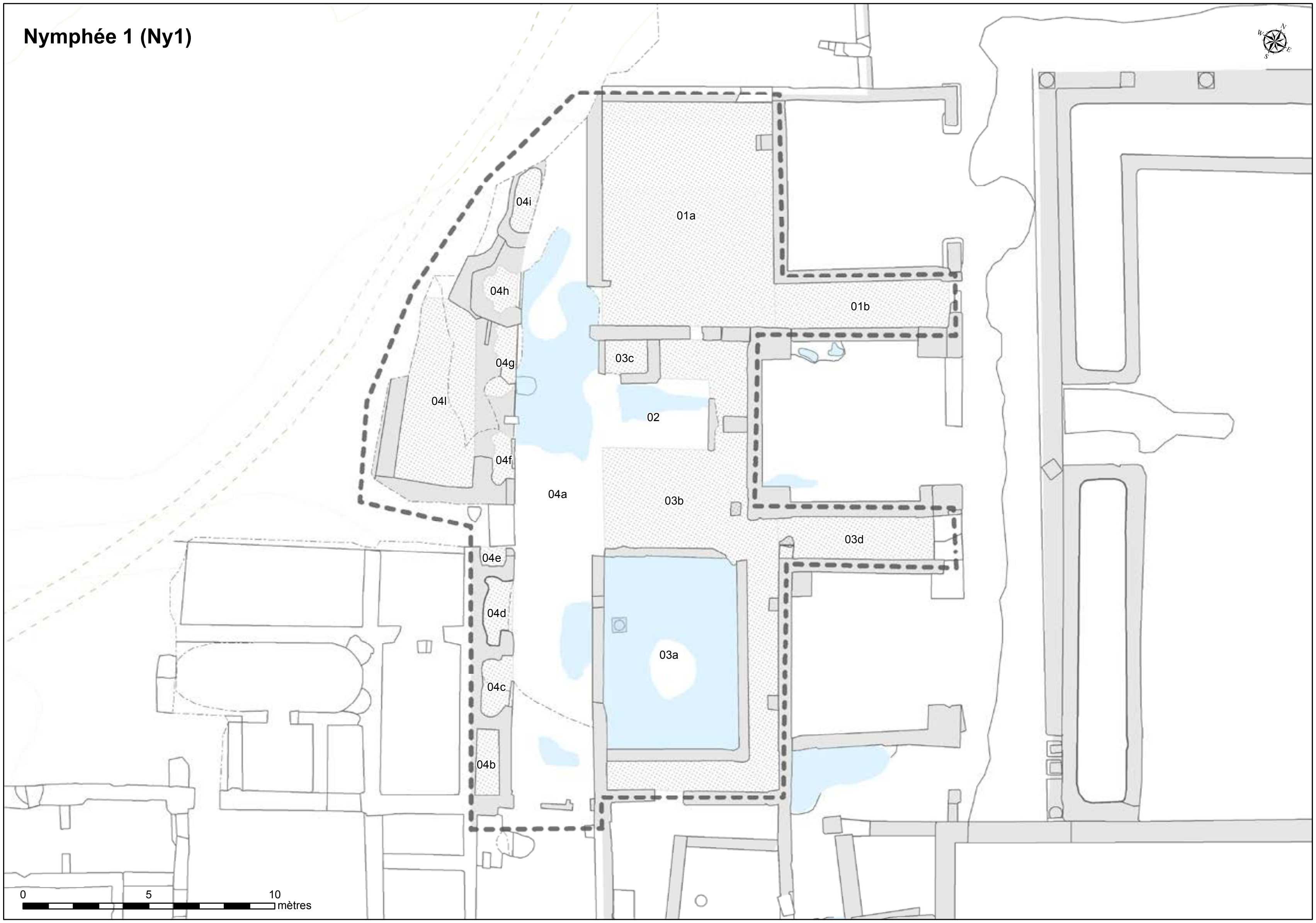
Maison du Paon - étage souterraine (MPa - S)

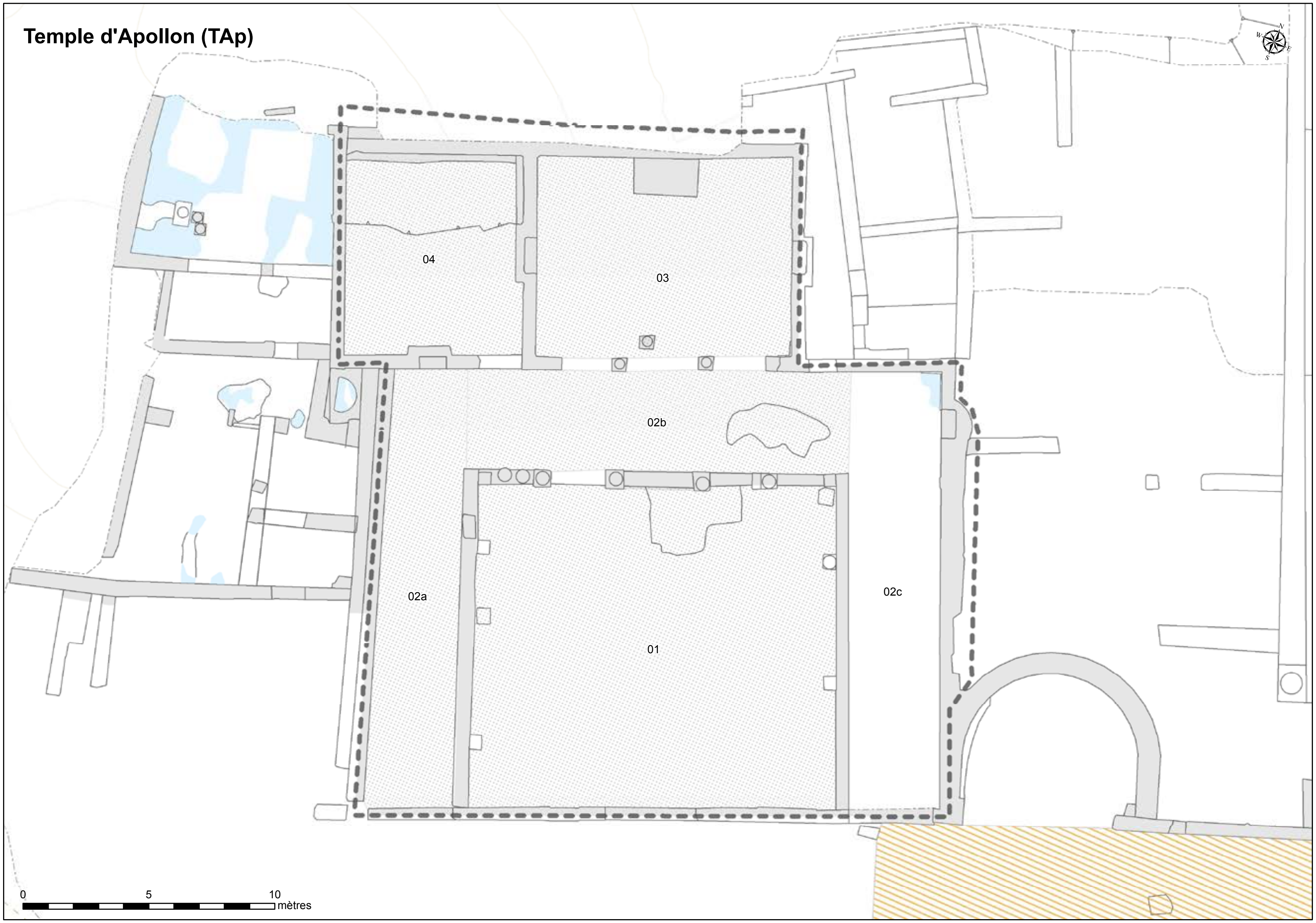
Maison du Trésor (MT)



Maison du Trésor - étage souterraine (MT - S)
N
W
E
S
S01
S04
S02
S03
S05
S06
0
5
10
mètres

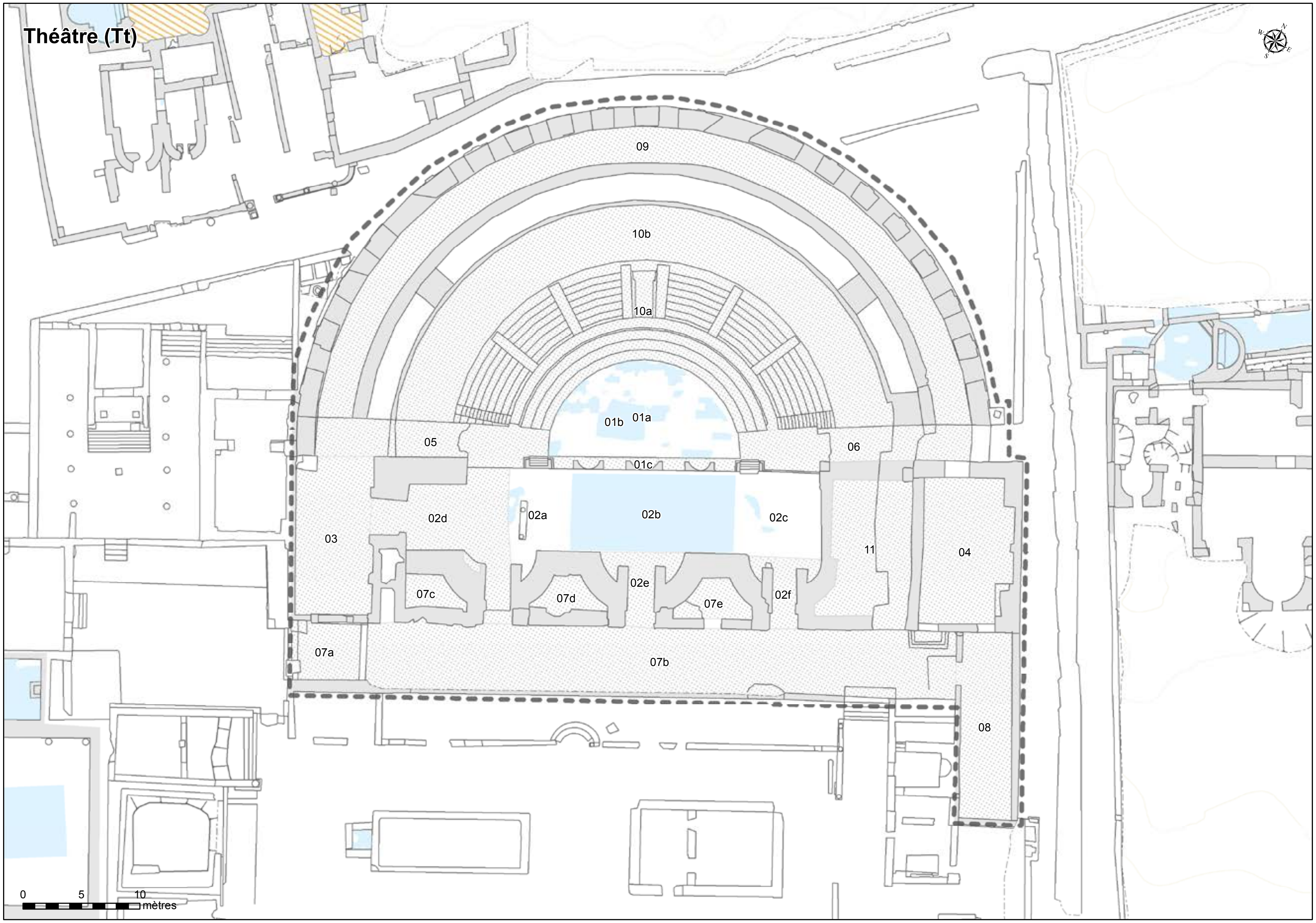

Marché (Mar)
07
04n
04m
04l
04i
04h
04g
06
09
02c
03
02a
04
01
08
02b
05
04a
04b
04c
04d
04e
04f
0
5
10
mètres

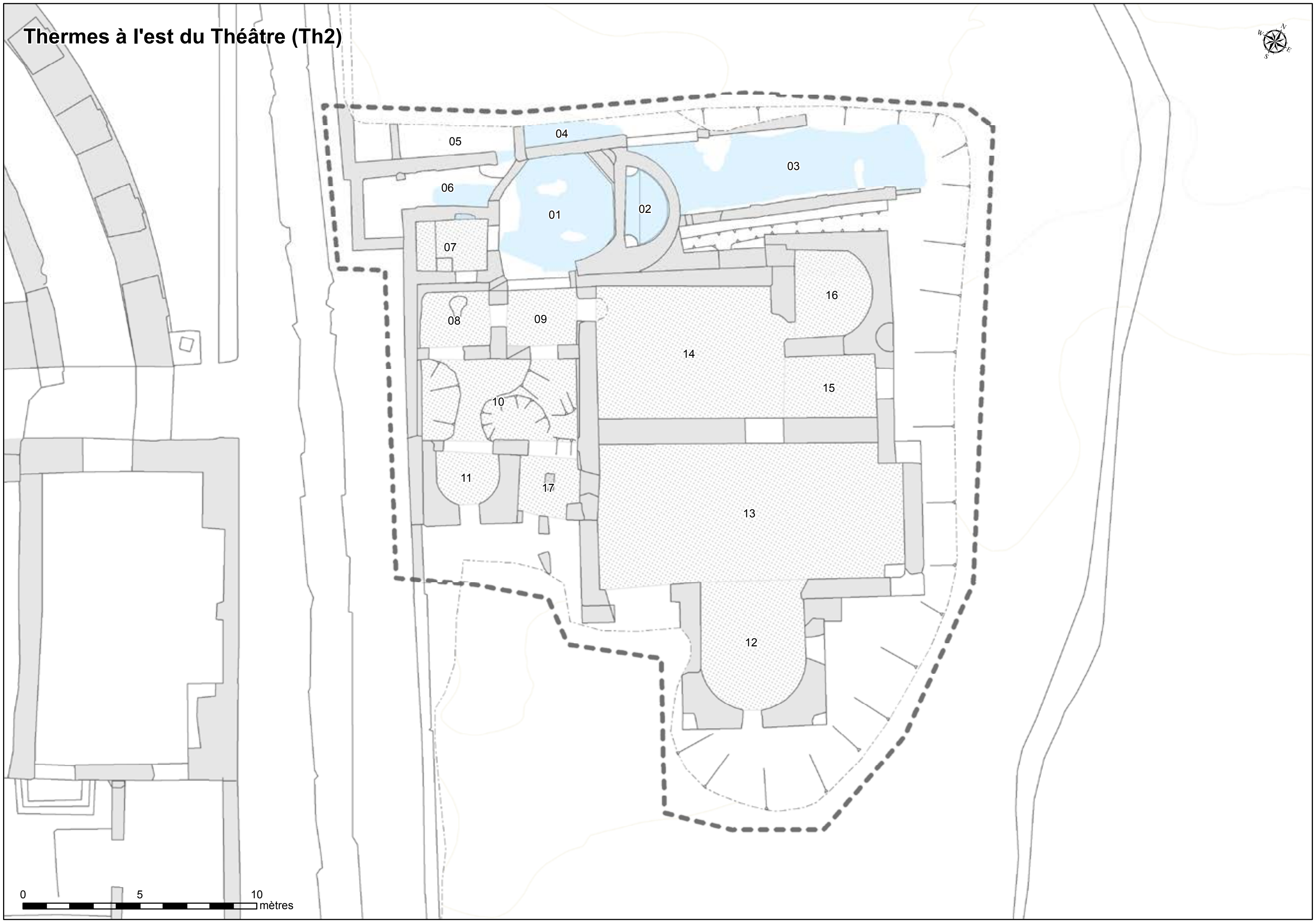

Nymphée 1 (Ny1)
01a
01b
02
03a
03b
03c
03d
04a
04b
04c
04d
04e
04f
04g
04h
04i
04l
0
5
10
mètres

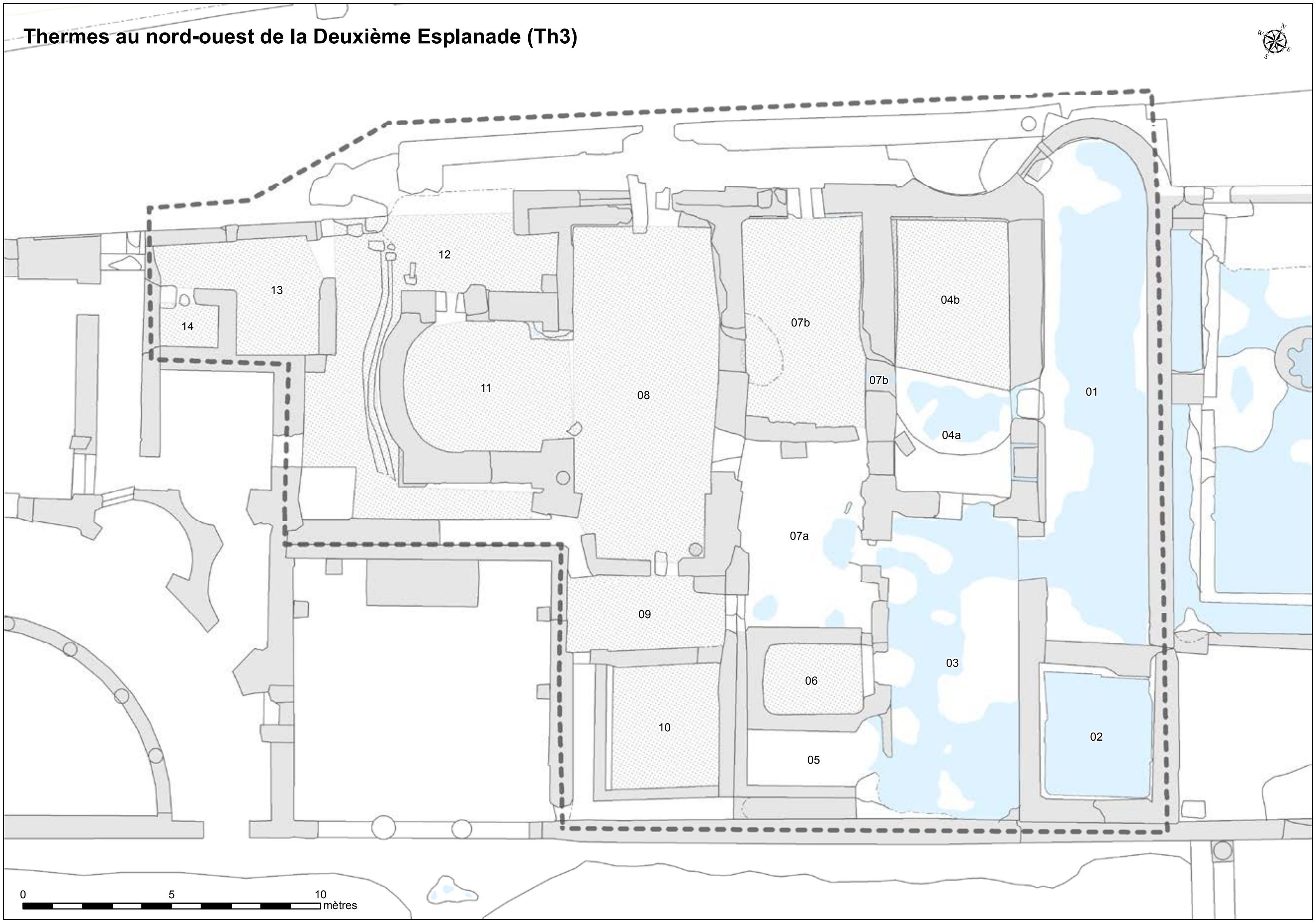


Temple d'Apollon (TAp)
04
03
02b
02a
01
02c
0
5
10
mètres

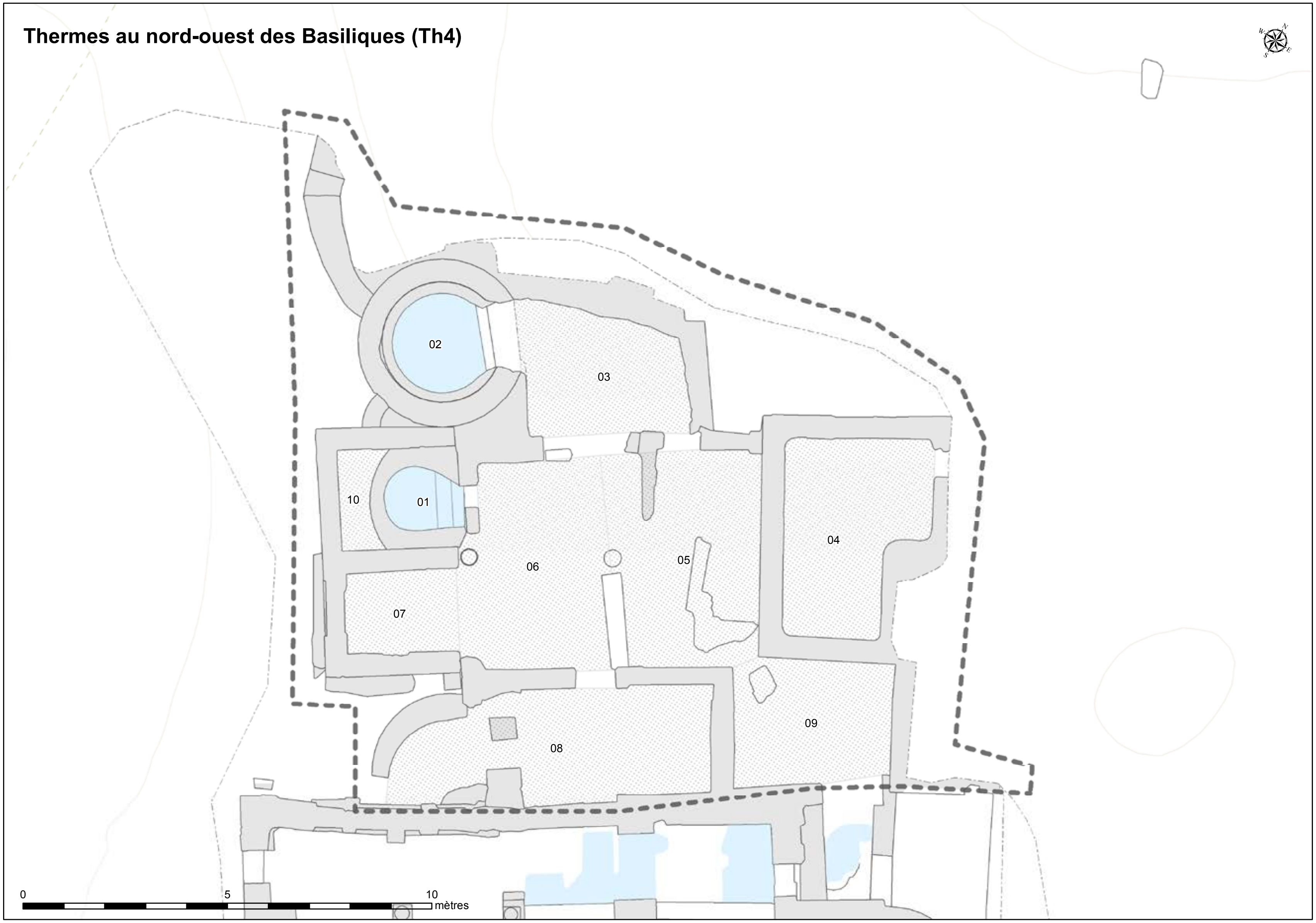
Temples à l'ouest des Thermes de Iulia Memmia (T1)


Théâtre (Tt)
09
10b
10a
01b
01a
05
06
01c
02d
02a
02b
02c
03
11
04
07c
07d
02e
07e
02f
07a
07b
08
0
5
10
mètres

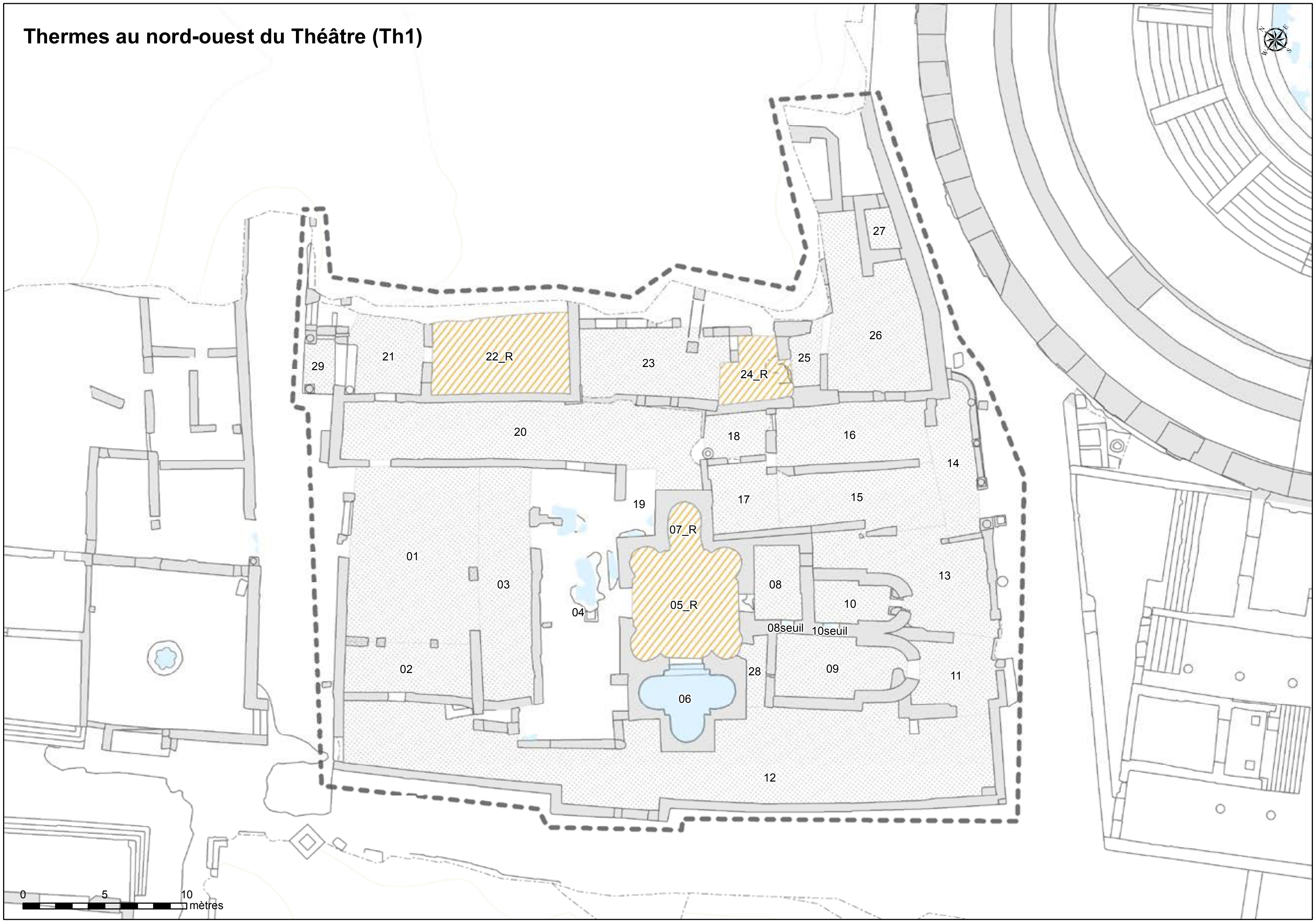

Thermes à l'est du Théâtre (Th2)
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
0
5
10
mètres

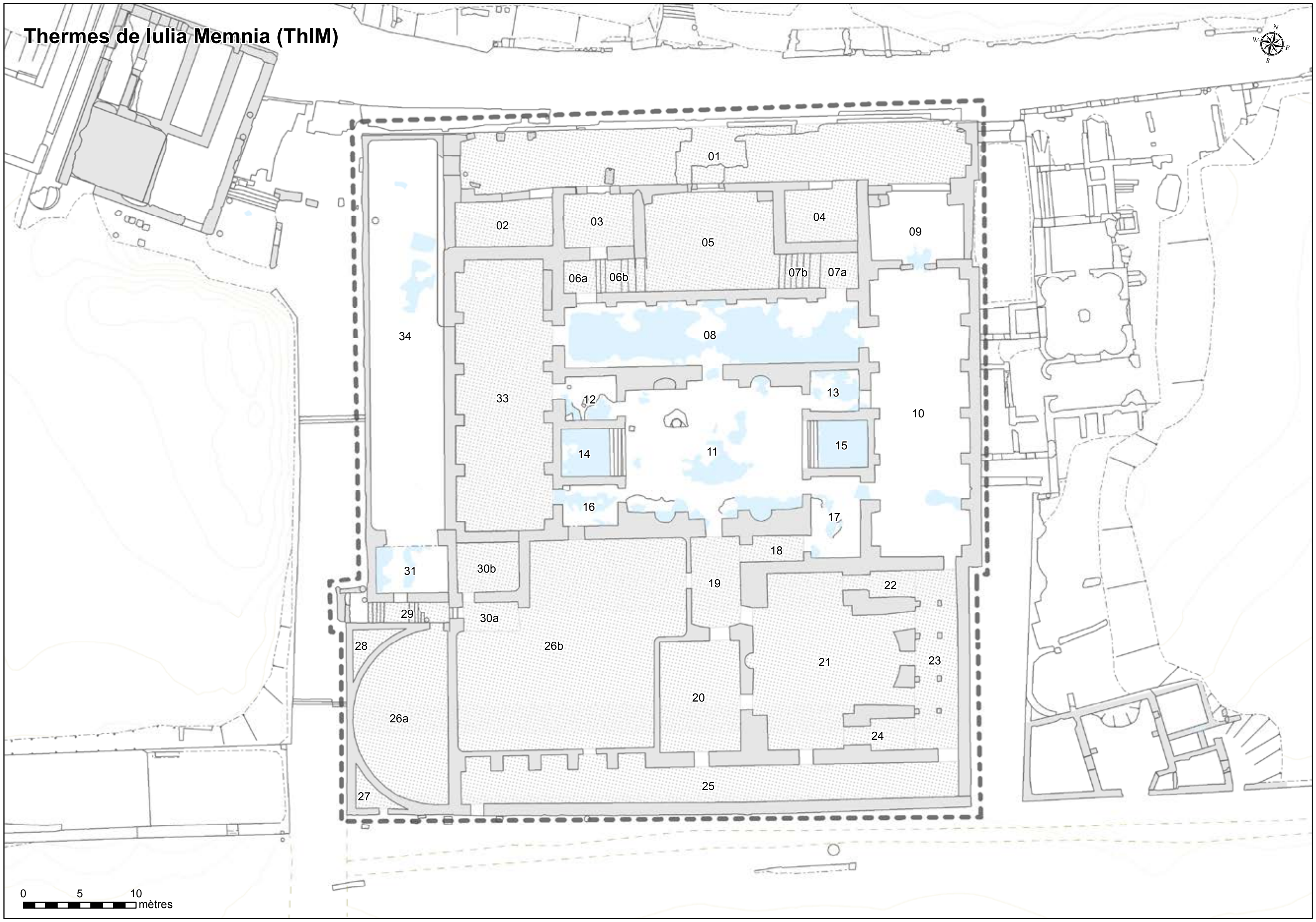

Thermes au nord-ouest de la Deuxième Esplanade (Th3)
12
13
14
11
08
07b
04b
07b
04a
01
07a
09
03
06
10
05
02
0
5
10
mètres

Thermes au nord-ouest des Basiliques (Th4)



Thermes au nord-ouest du Théâtre (Th1)




Thermes de Iulia Memnia (ThIM)
01
02
03
04
05
06a
06b
07b
07a
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26a
26b
27
28
29
30a
30b
31
33
34
0
5
10
mètres


Thermes des Venantii (ThV)
N
W
E
S
04
03
04seuil
01
02
05
0
5
10
mètres


Thermes du nord-est (Th5)
04
05
06
07
08
10
11
01_R
09
02
03
0
5
10
mètres

Phase 1 - Temporary protection

exposed mosaic

short-term reburial

temporary protection for mosaic

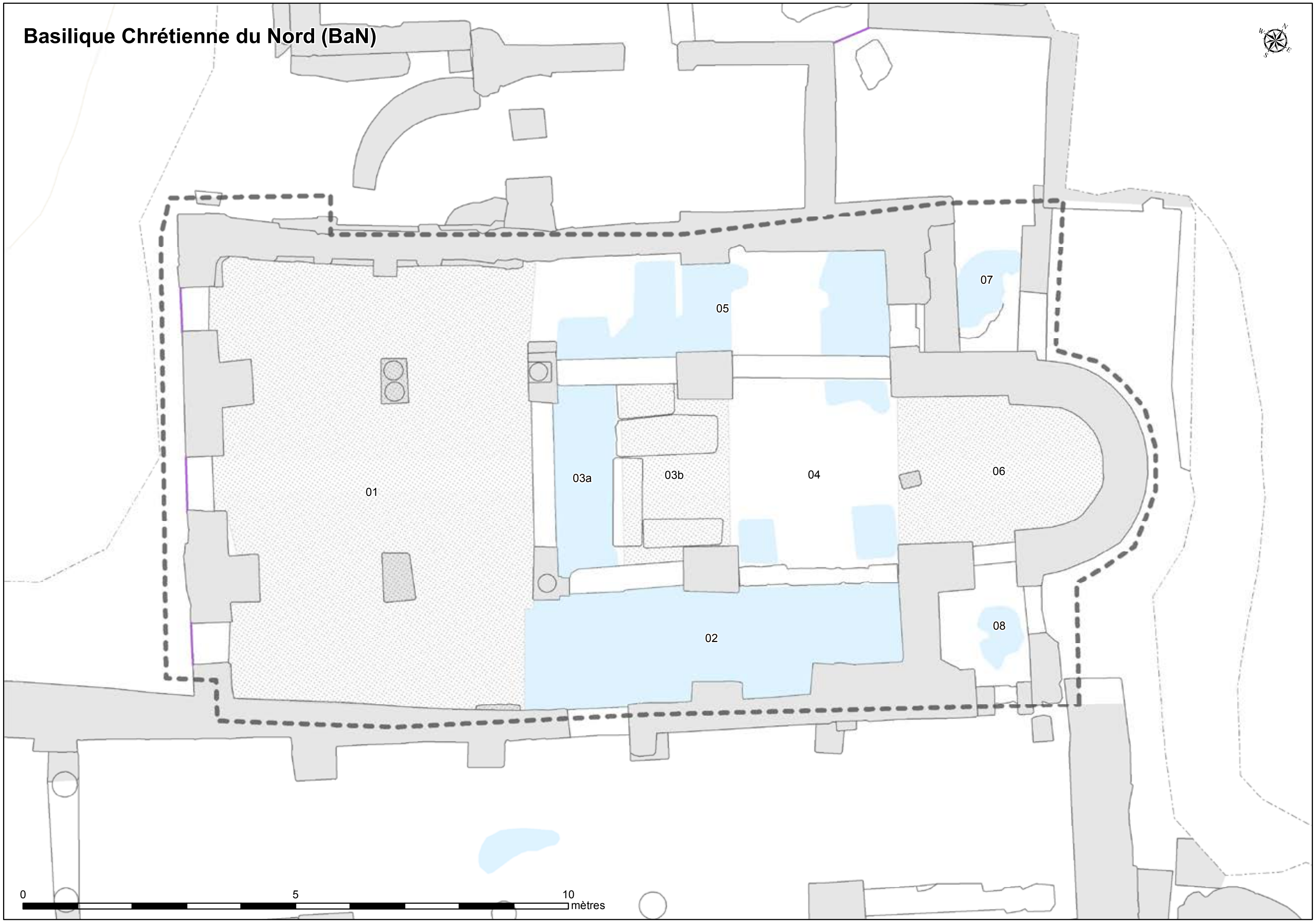
fence (temporary)

infilling of wall lacuna with stones

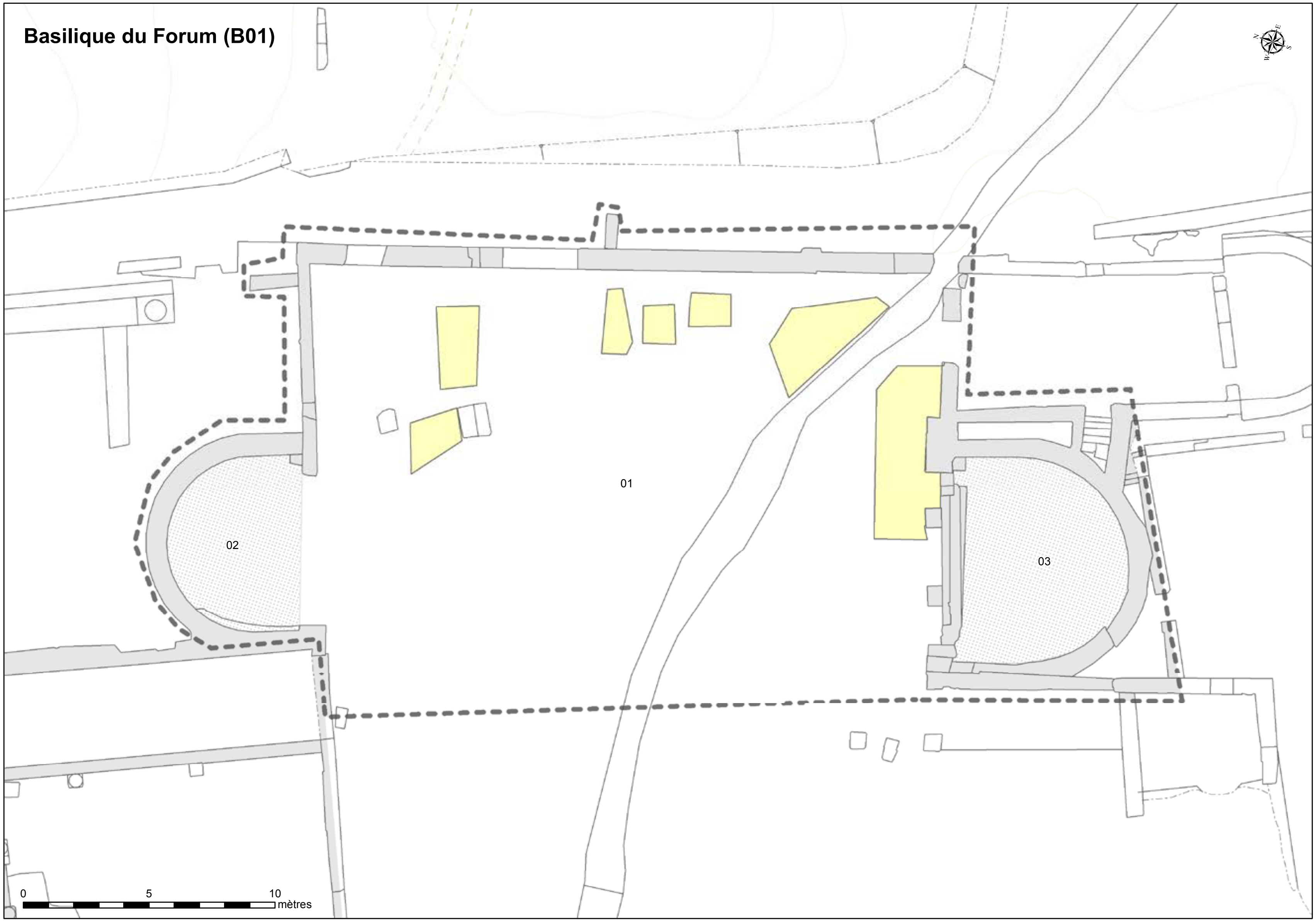
walkway

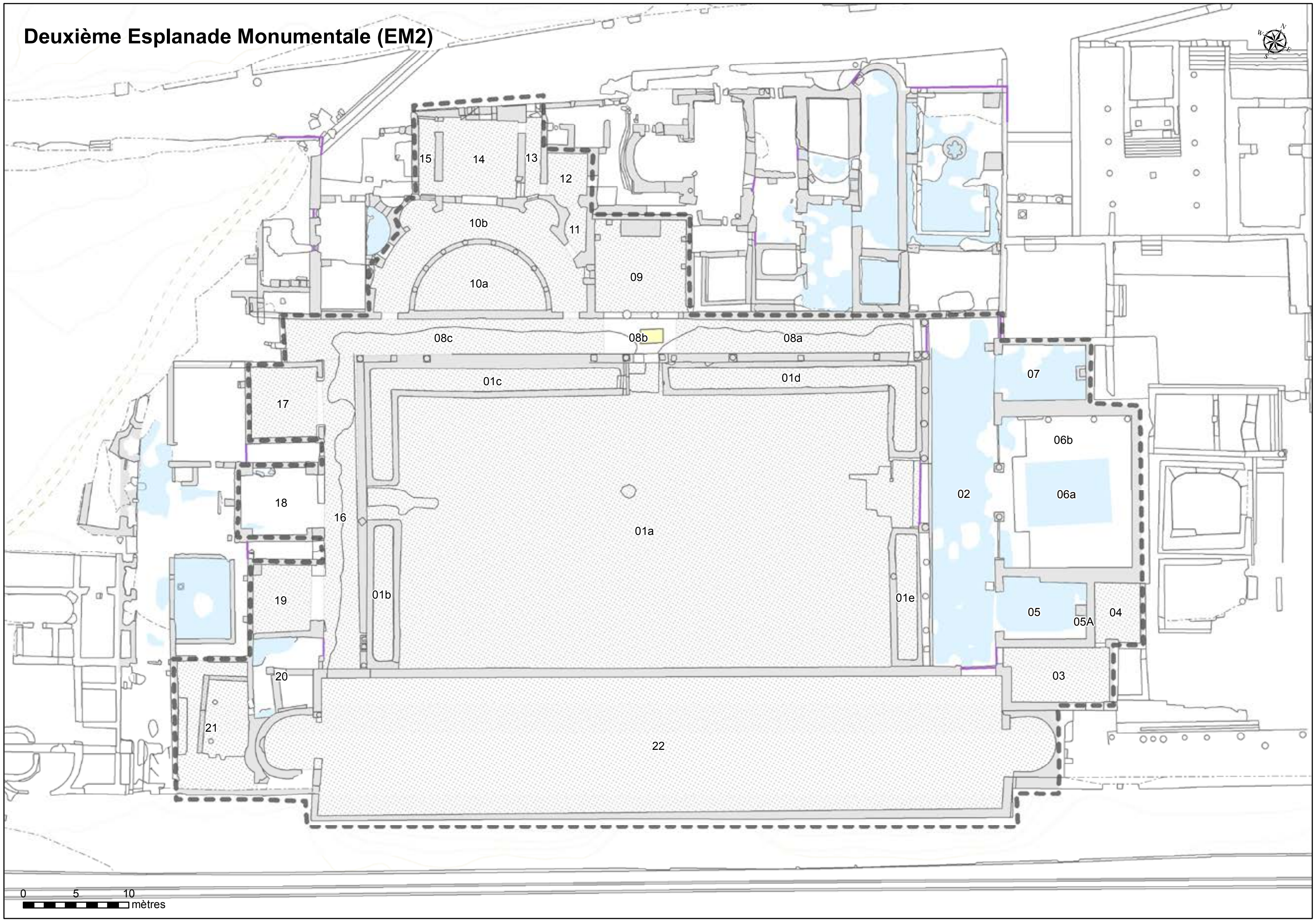
access barrier (temporary)

gate to be closed (temporary)

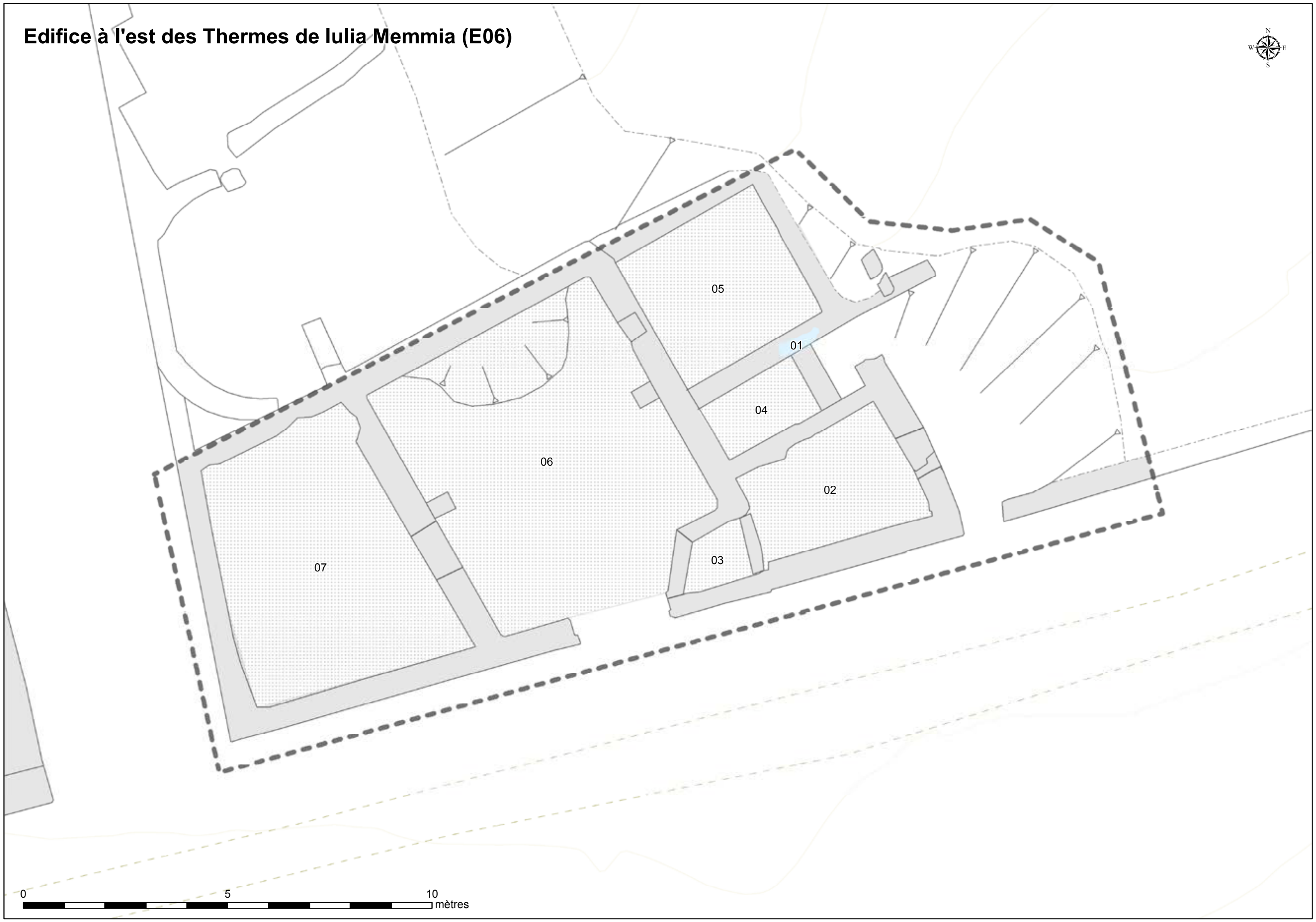

Basilique Chrétienne du Nord (BaN)
01
02
03a
03b
04
05
06
07
08
0
5
10
mètres


Basilique Chrétienne du Sud (BaS)
01
02
03
04
05
06
07
08
09
10
11
12
13
0
5
10
mètres


Basilique du Forum (B01)
01
02
03
0
5
10
mètres

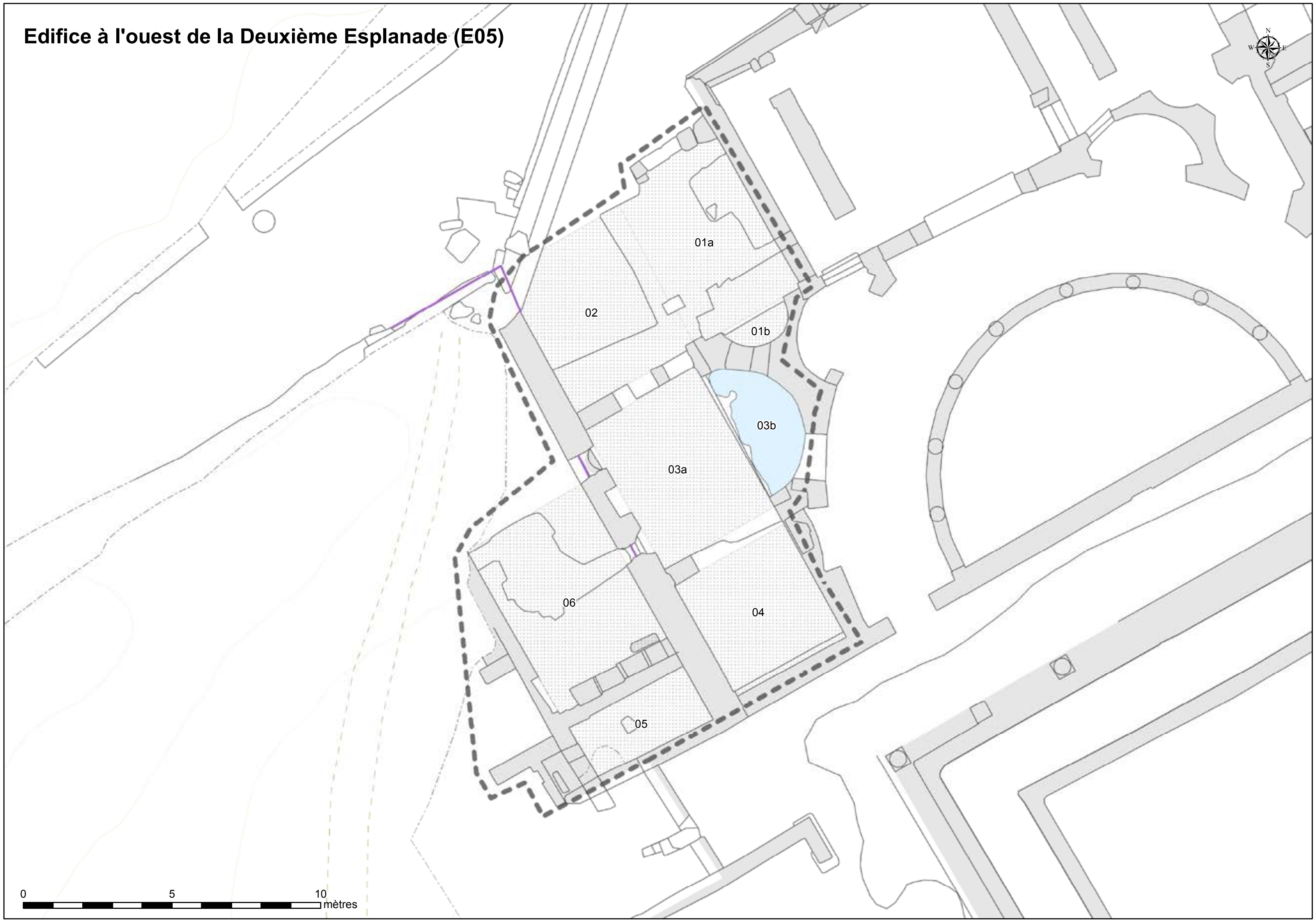

Deuxième Esplanade Monumentale (EM2)
15
14
13
12
10b
11
10a
09
08c
08b
08a
01c
01d
07
17
06b
18
16
02
06a
01a
19
01b
01e
05
05A
04
20
03
21
22
0
5
10
mètres

Edifice à l'est des Thermes de Iulia Memmia (E06)

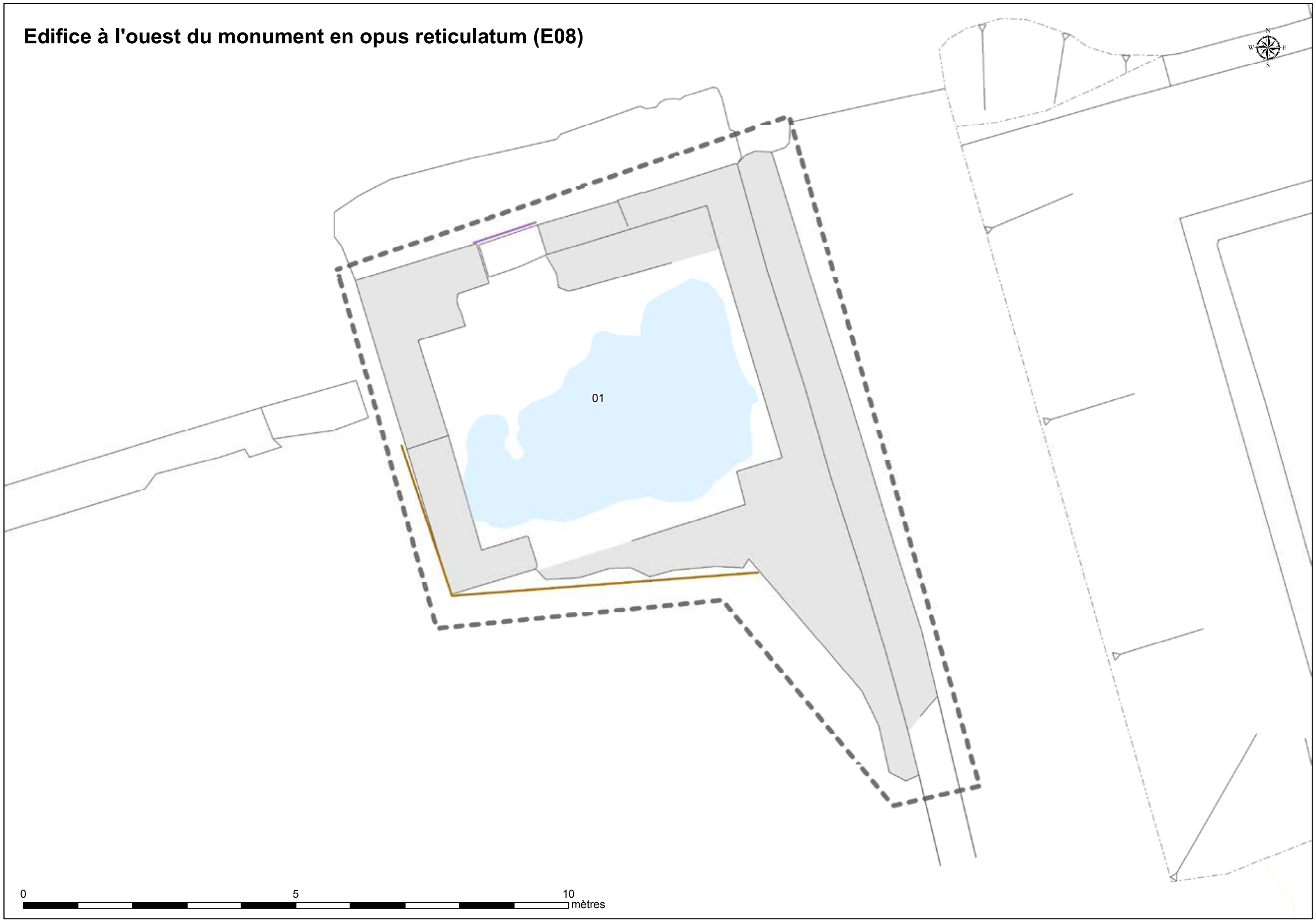


64

Edifice à l'ouest de la Deuxième Esplanade (E05)

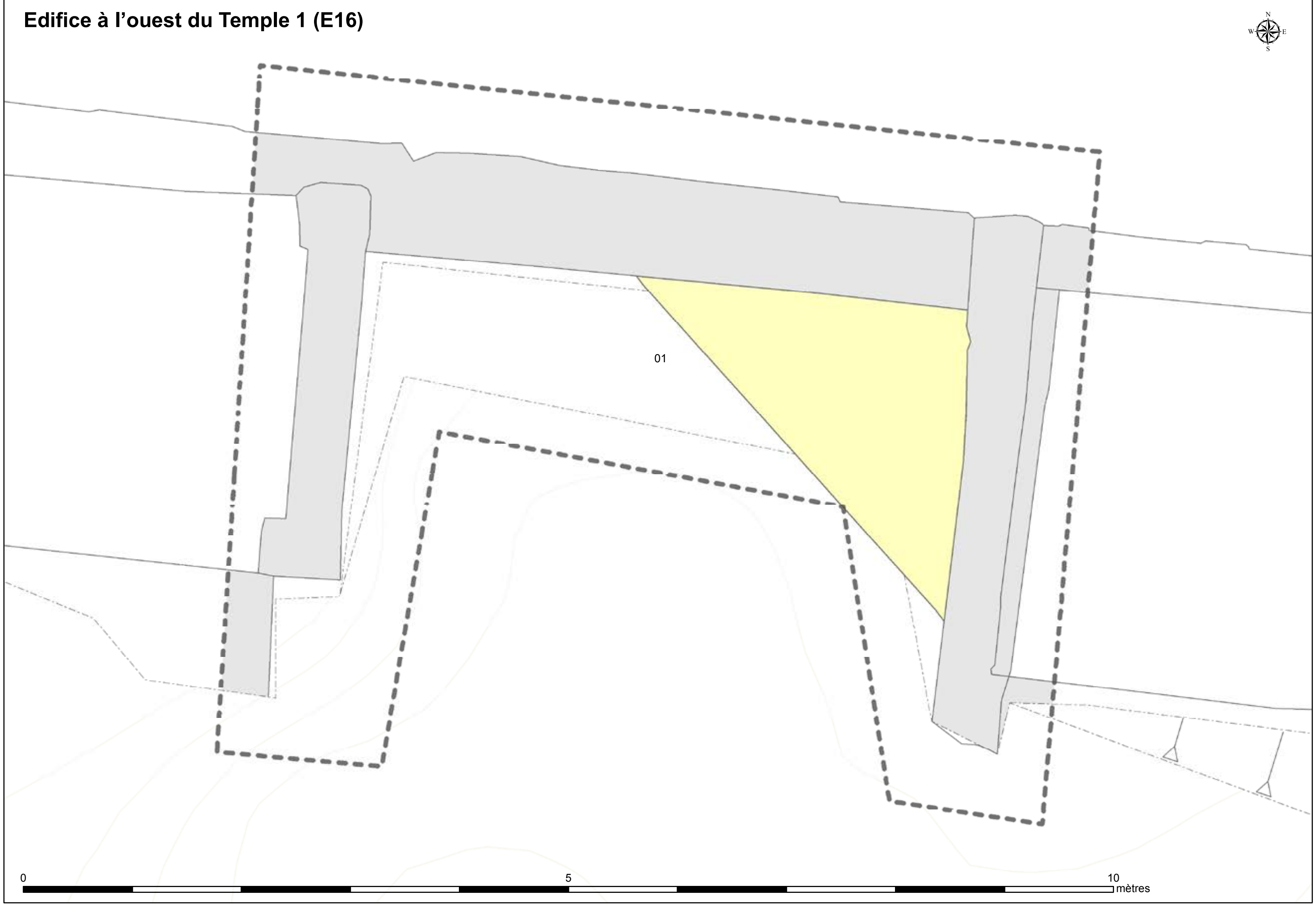


Edifice à l'ouest du monument en opus reticulatum (E08)

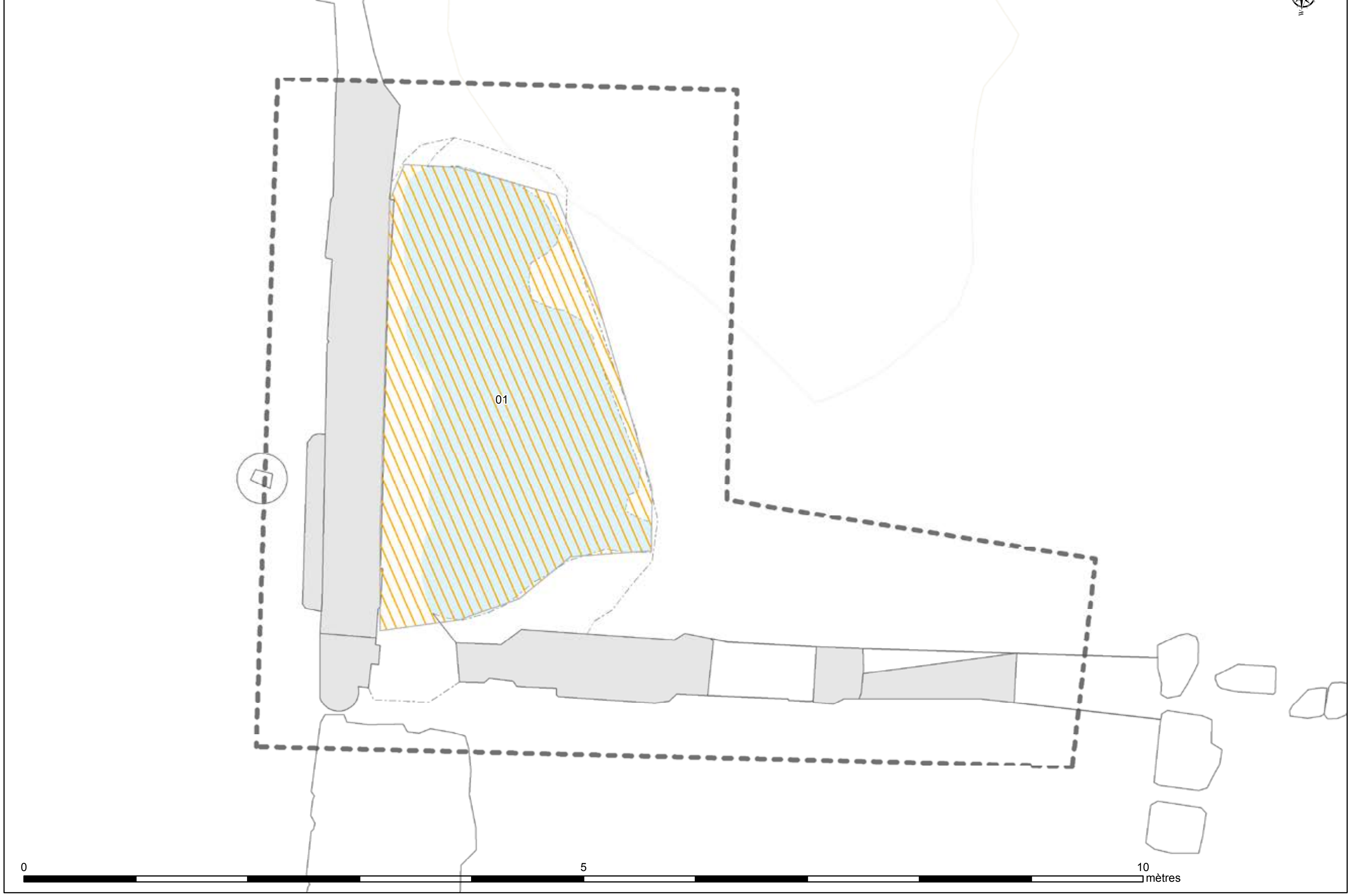


66

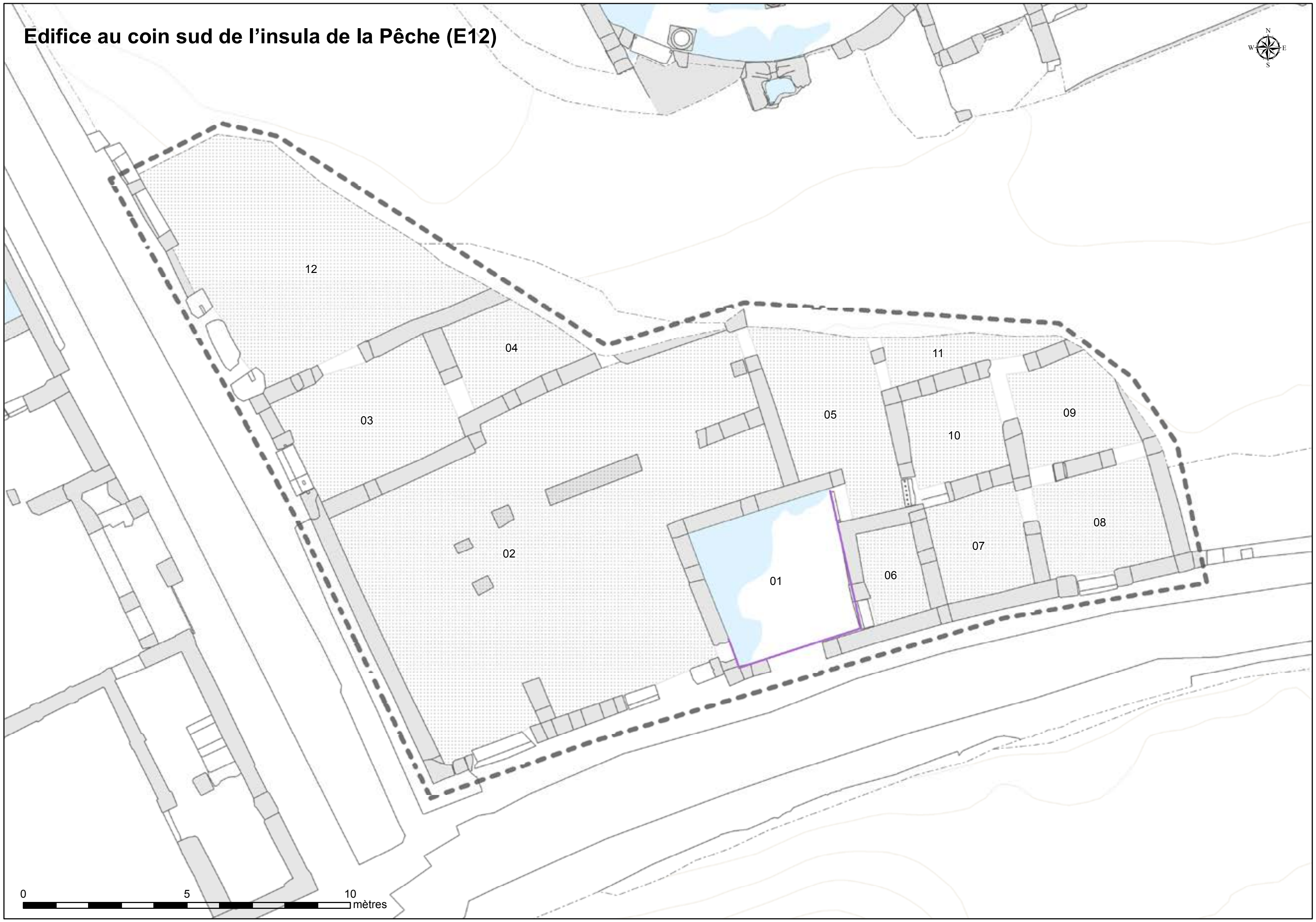
Edifice à l'ouest du Temple 1 (E16)



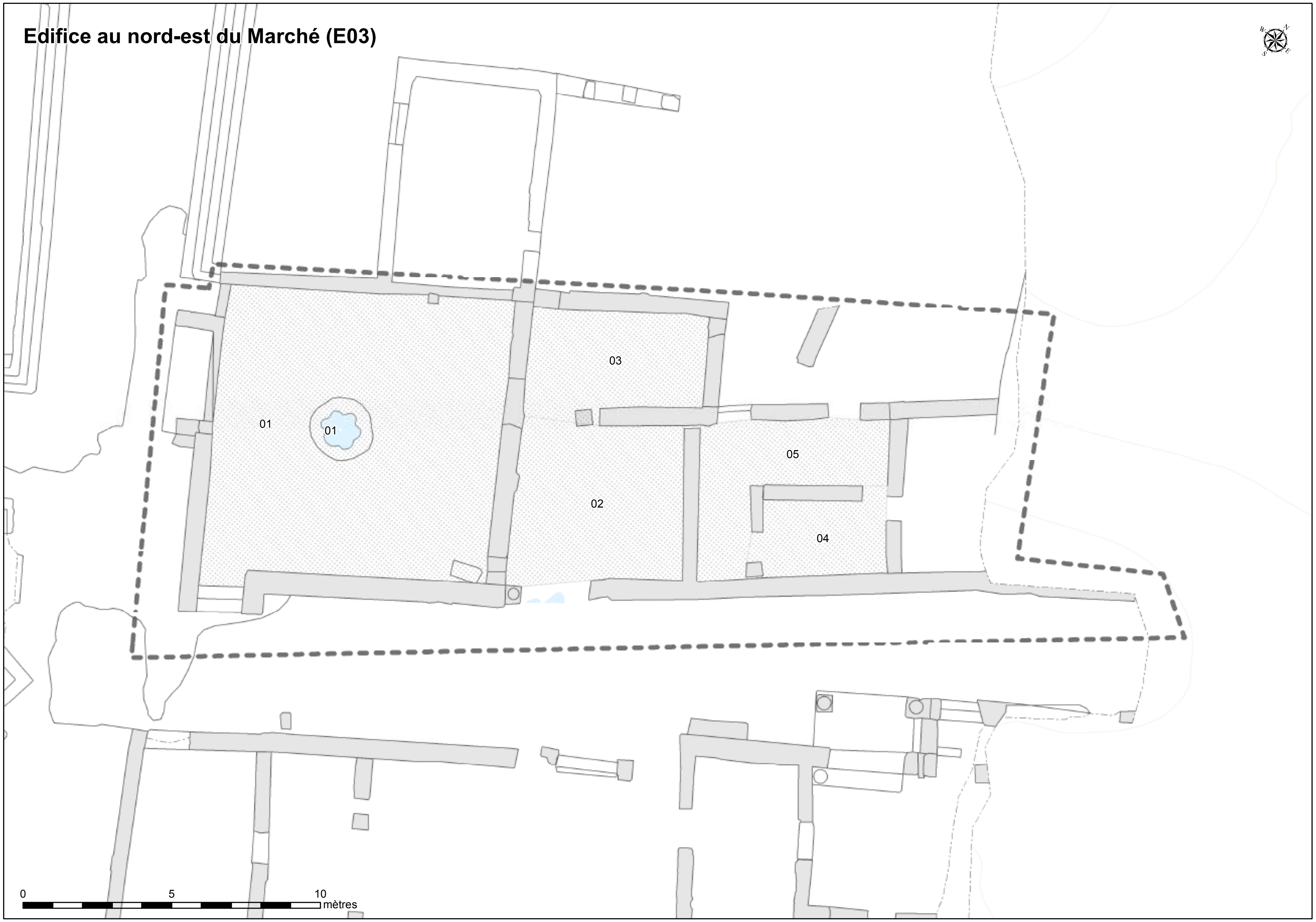
Edifice au carrefour entre M3 et M 7 (E11)



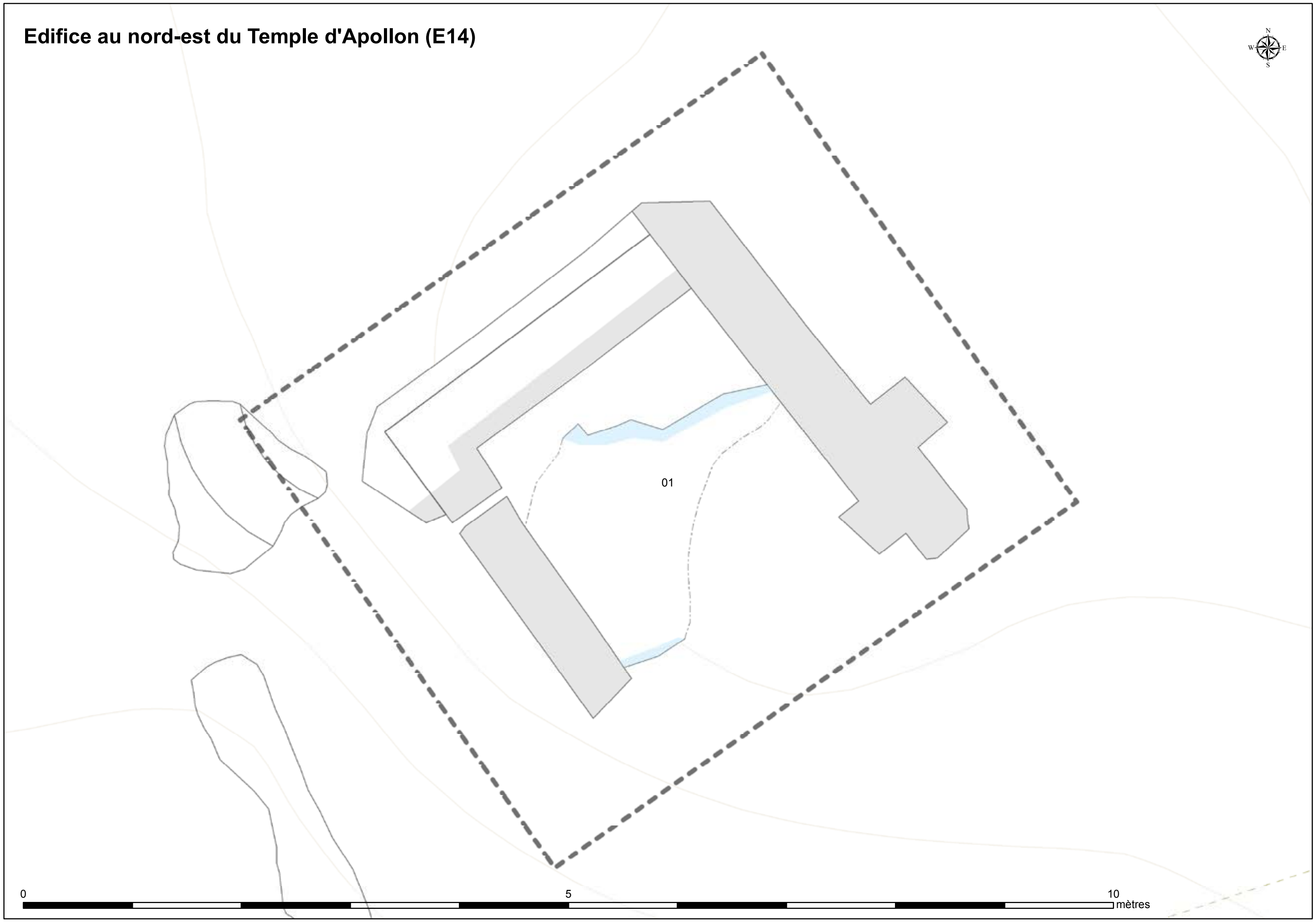
Edifice au coin sud de l'insula de la Pêche (E12)

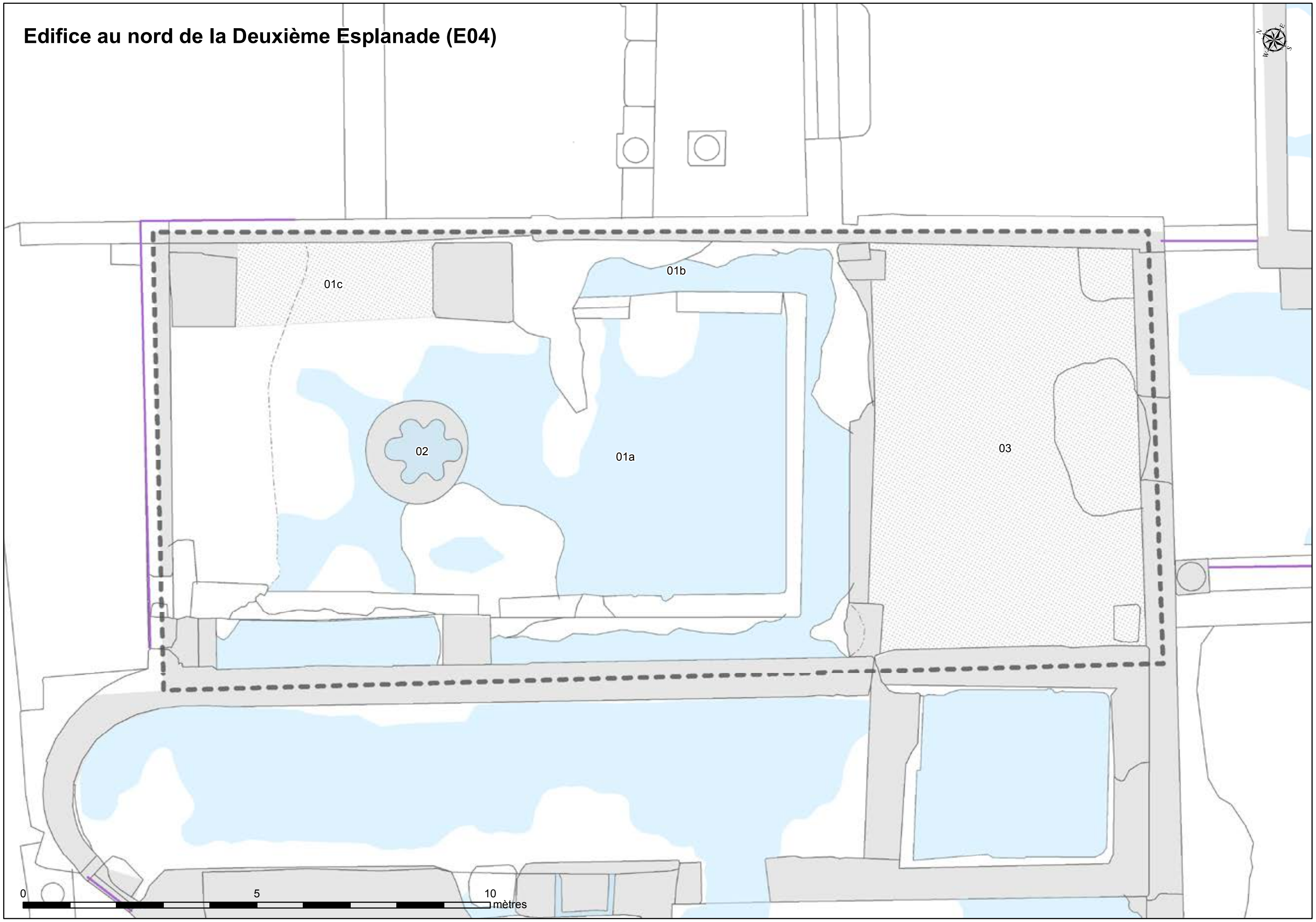


Edifice au nord-est du Marché (E03)

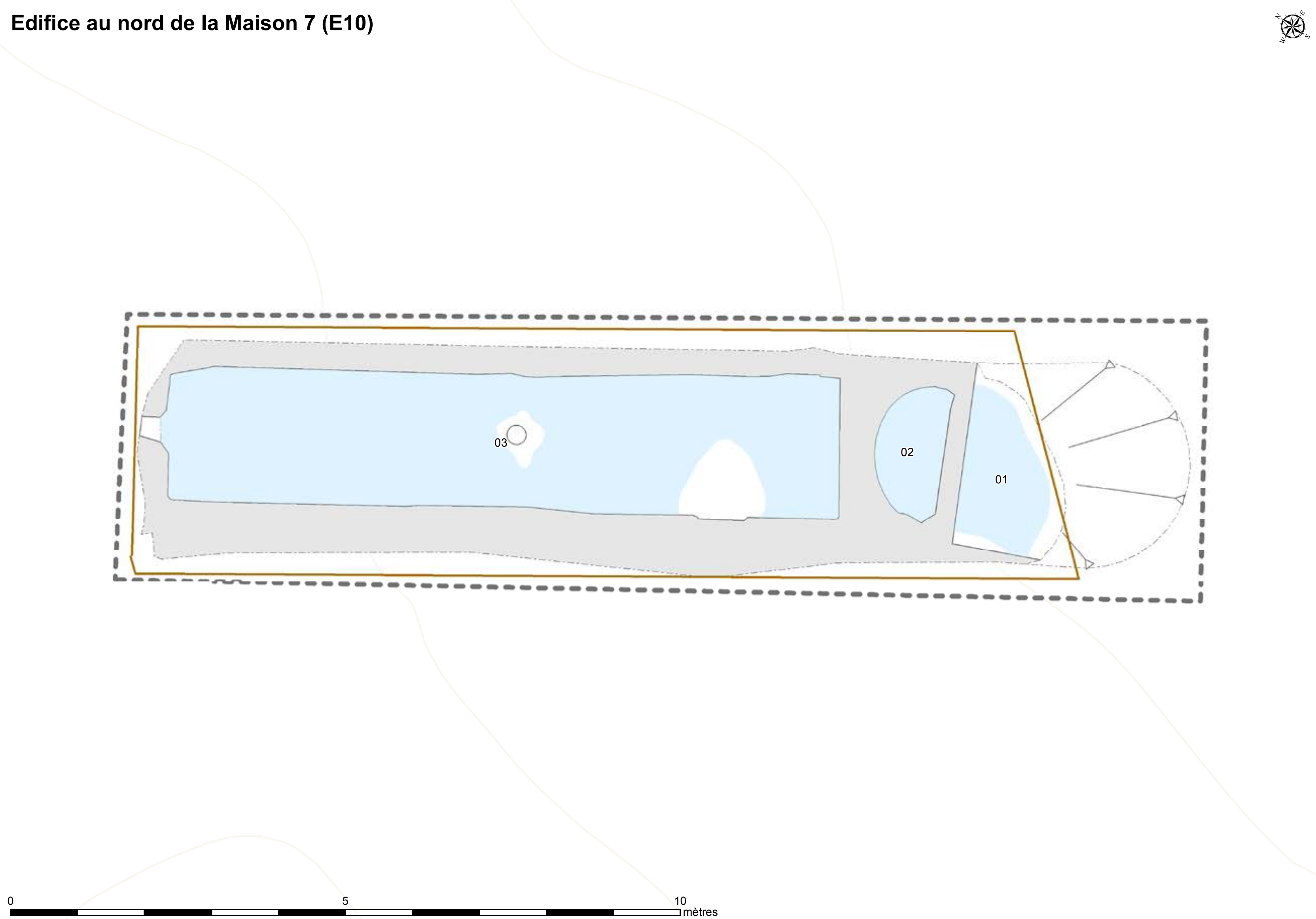


Edifice au nord-est du Temple d'Apollon (E14)



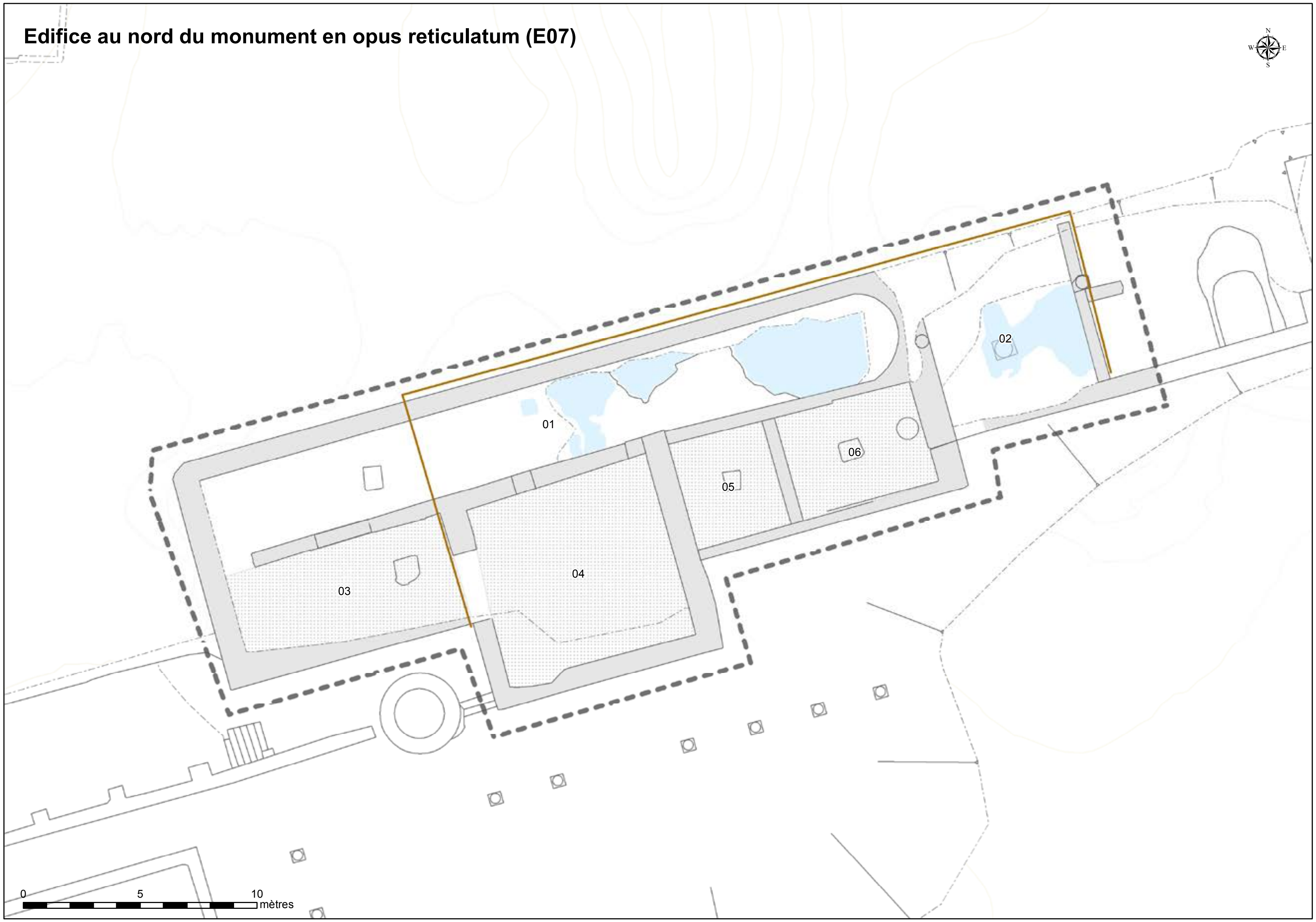

Edifice au nord de la Deuxième Esplanade (E04)
01c
01b
02
01a
03
0
5
10
mètres

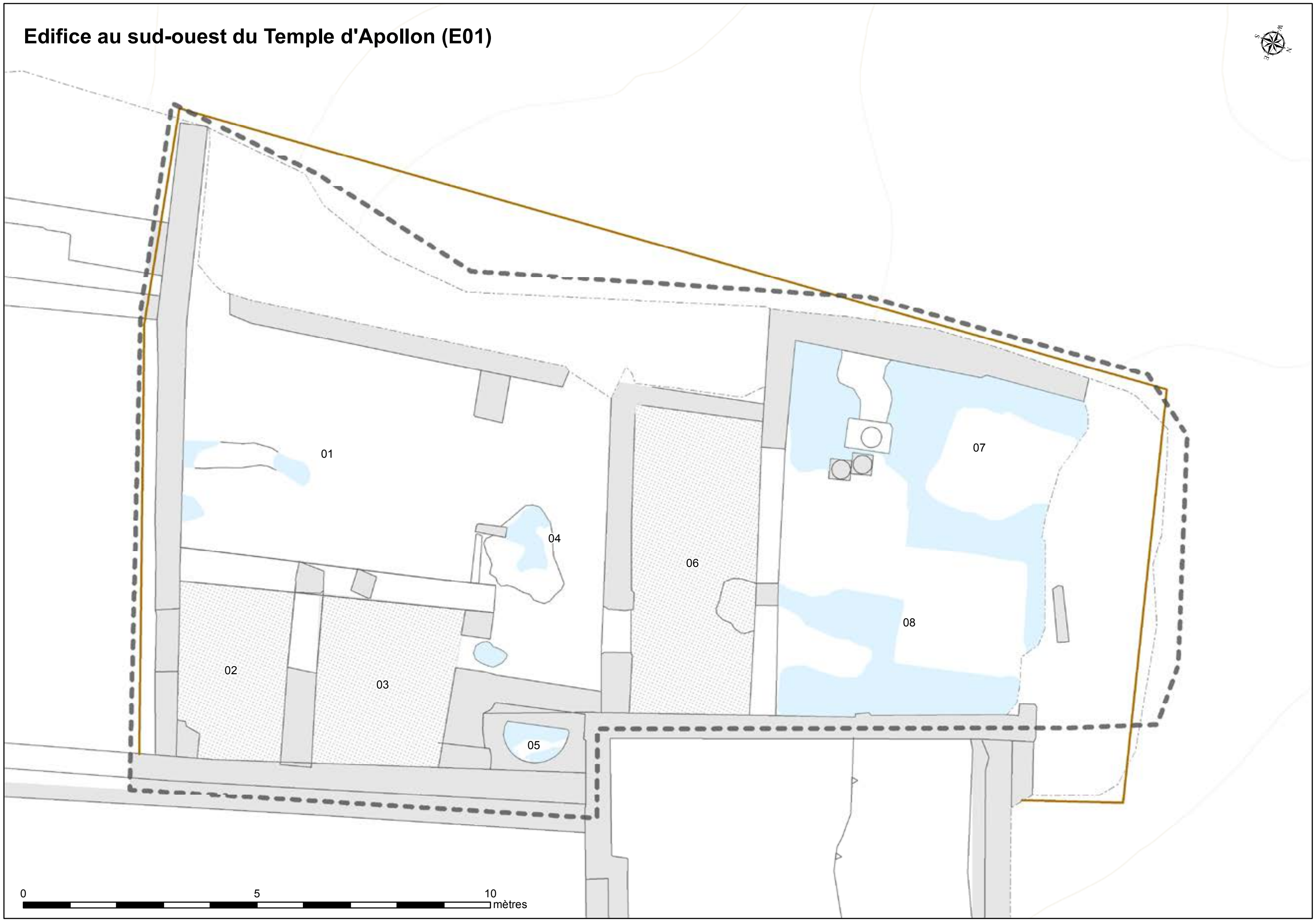
Edifice au nord de la Maison 7 (E10)



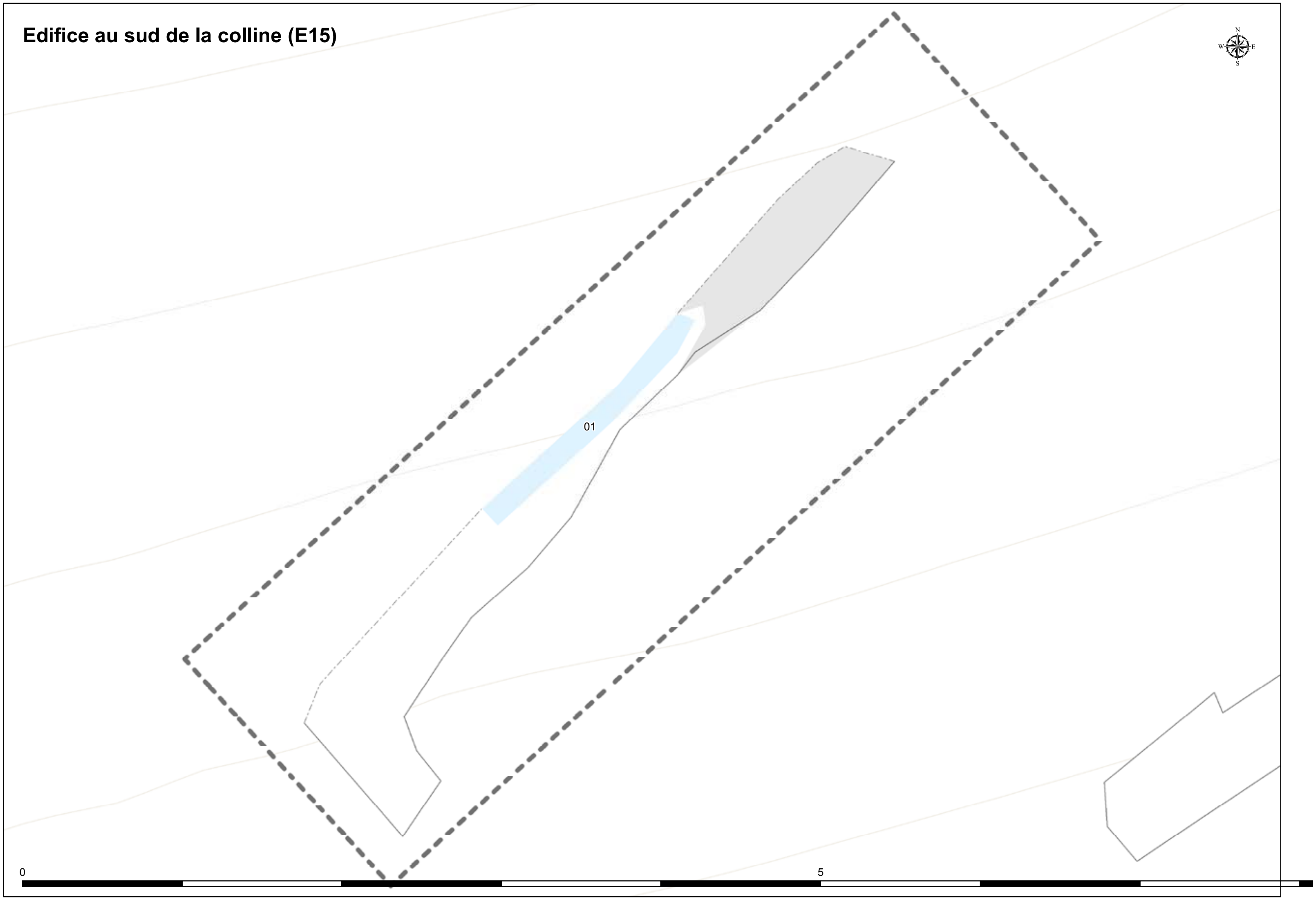
Edifice au nord de la source (E13)

Edifice au nord du monument en opus reticulatum (E07)



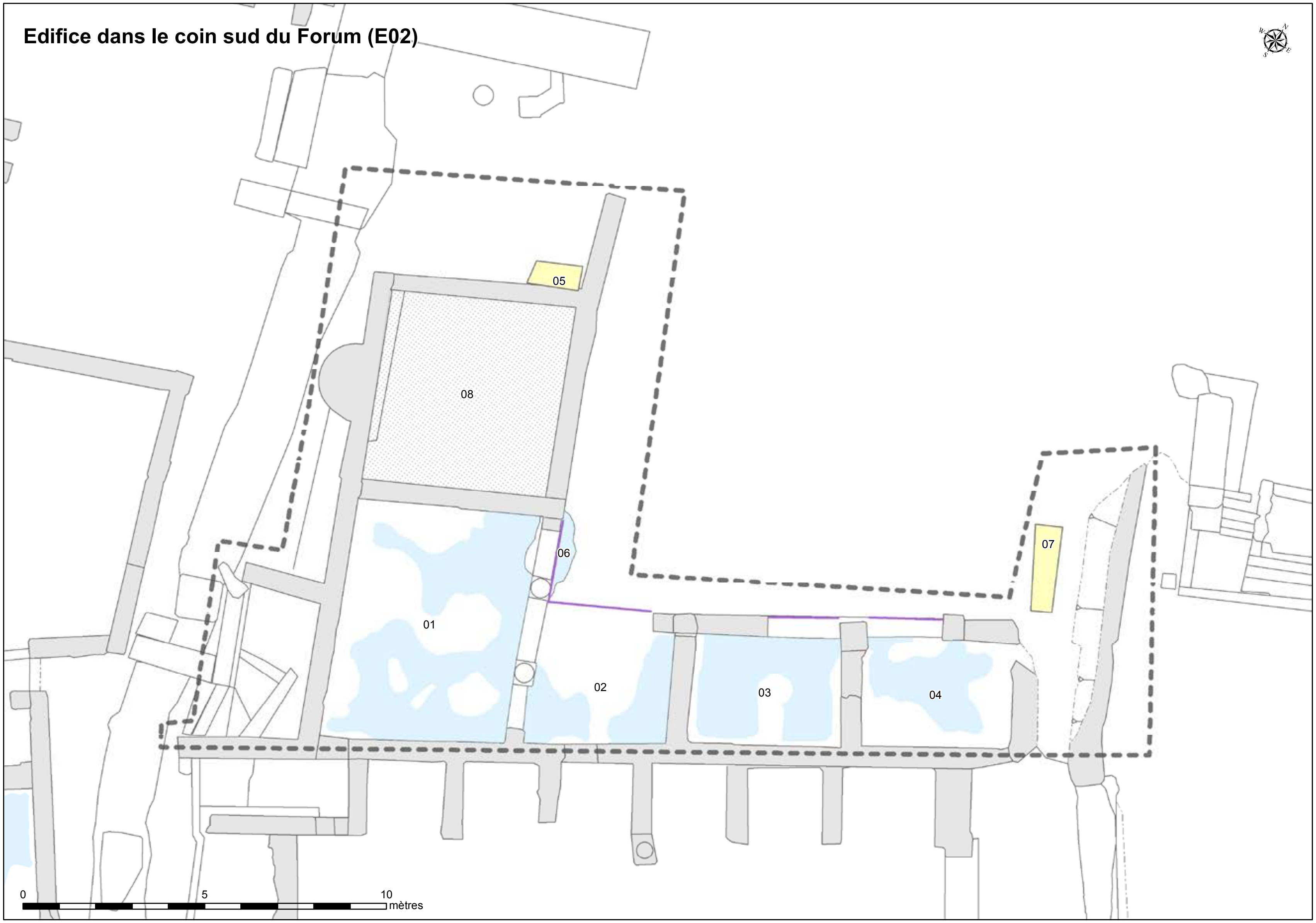

Edifice au sud-ouest du Temple d'Apollon (E01)
01
02
03
04
05
06
07
08
0
5
10
mètres

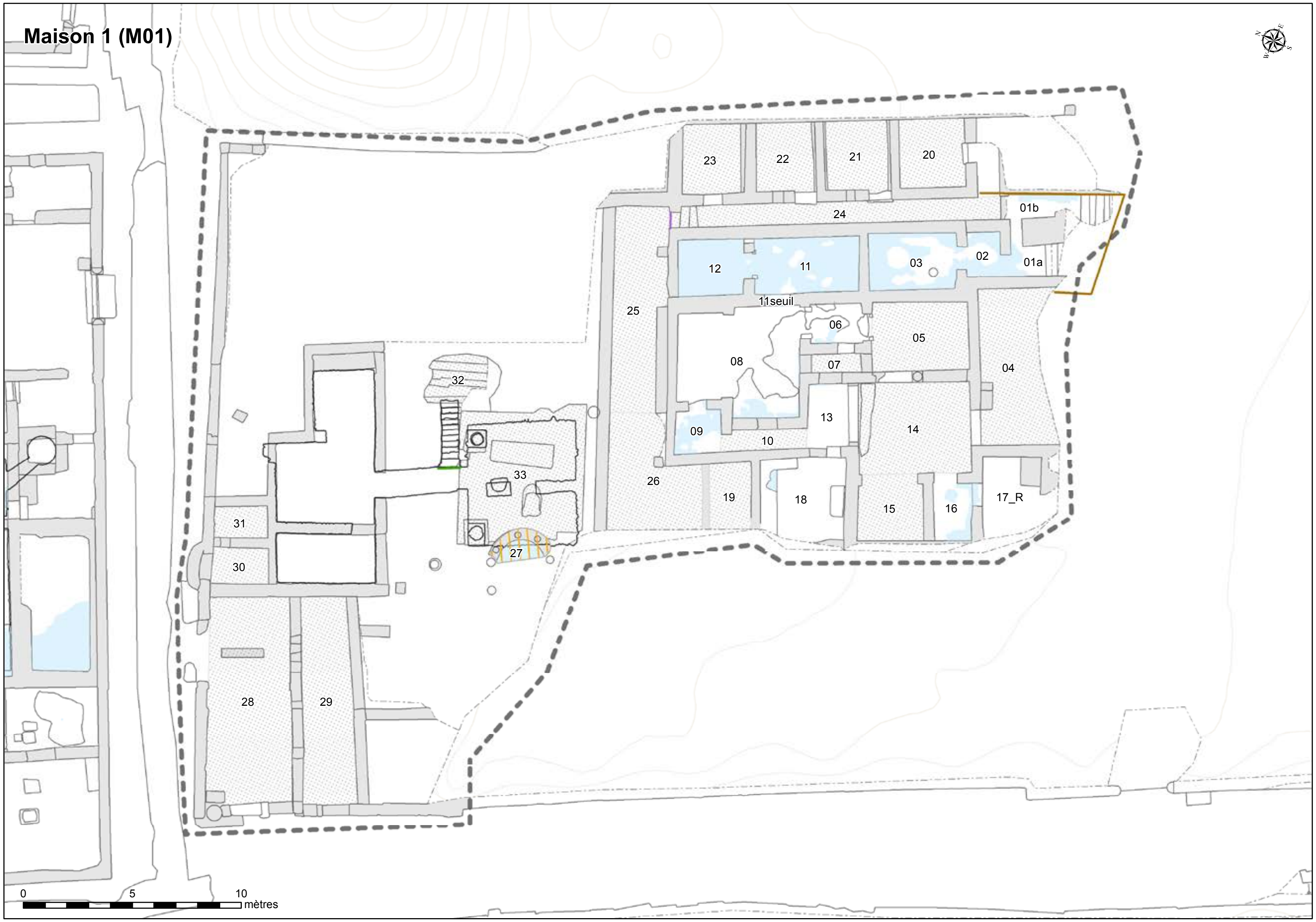
Edifice au sud de la colline (E15)

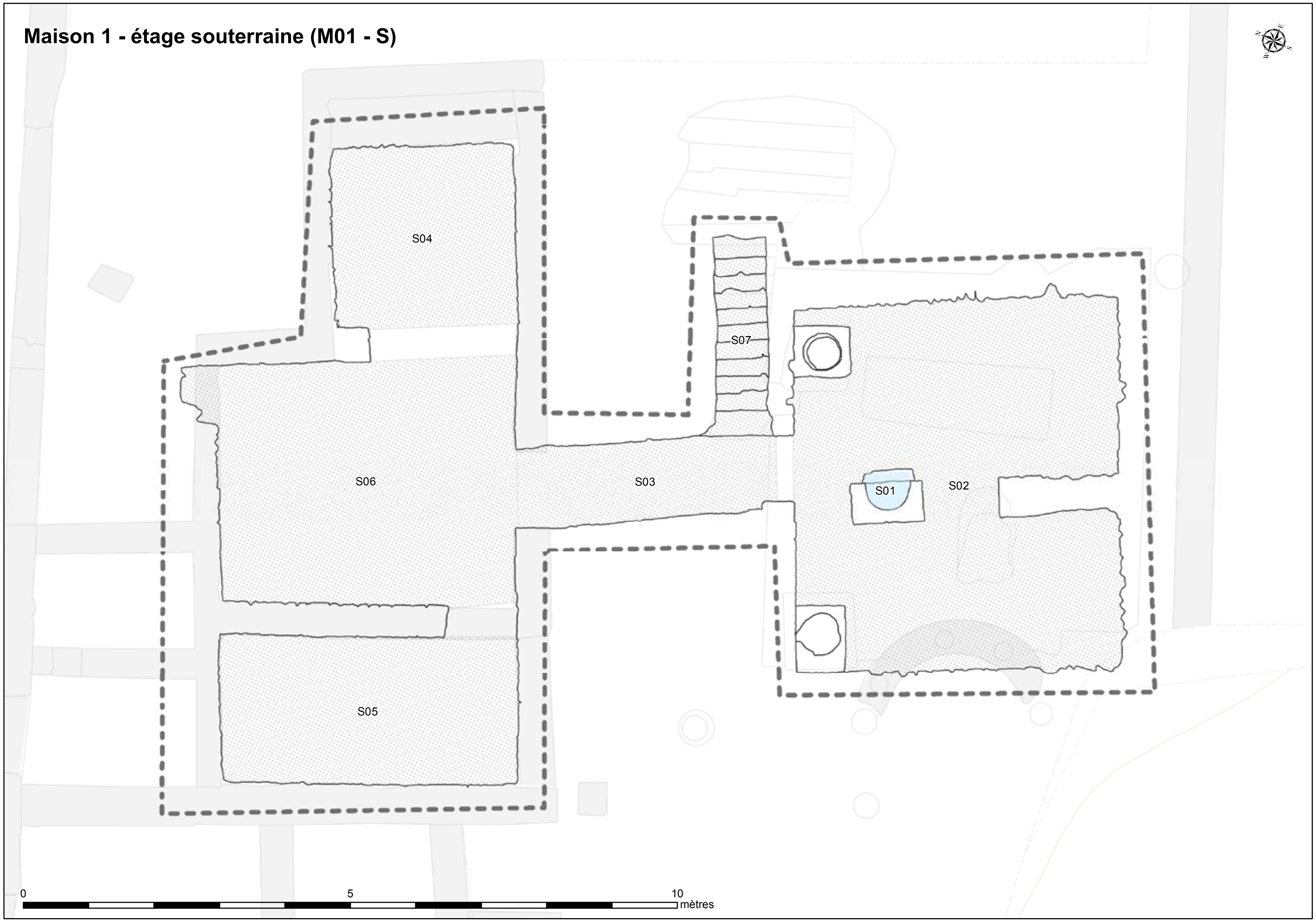


Edifice au sud de la Maison 3 (E09)

Edifice dans le coin sud du Forum (E02)




Maison 1 (M01)
23
22
21
20
01b
24
12
11
03
02
01a
11seuil
25
06
05
08
07
04
32
13
09
10
14
33
26
19
18
15
16
17_R
31
27
30
28
29
0
5
10
mètres


Maison 1 - étage souterraine (M01 - S)
S04
S07
S06
S03
S01
S02
S05
0
5
10
mètres


Maison 10 (M10)
20
21
17
04
03
05
22
15
06
14a
14b
07
18
02a
08
11
01
19
02d
02b
01b
09
12
02c
10
13
16
23
24
25
0
5
10
mètres

Maison 14 (M14)

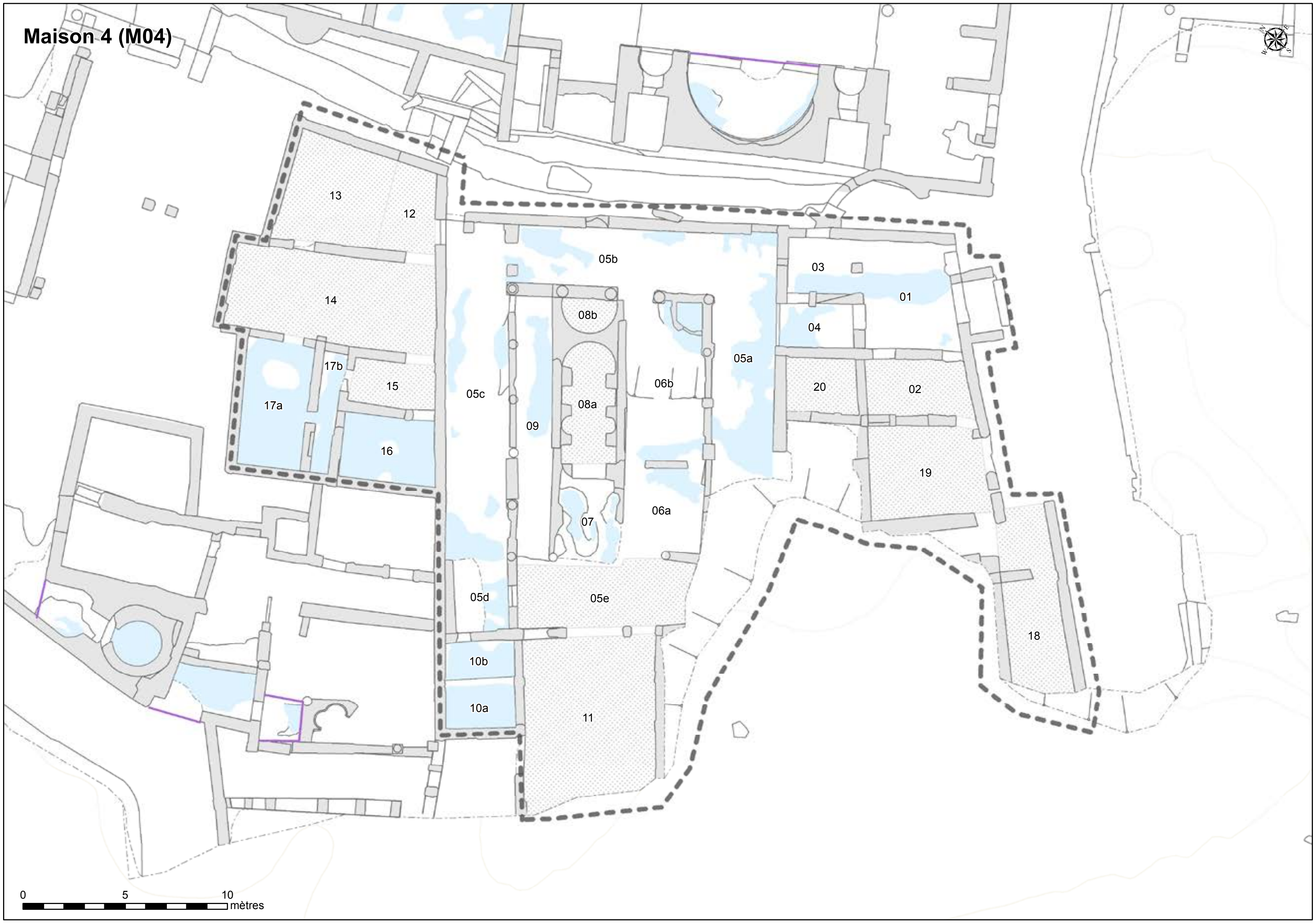

Maison 15 (M15)
01
02
03
04
05
06
07
08
09
10
0
5
10
mètres

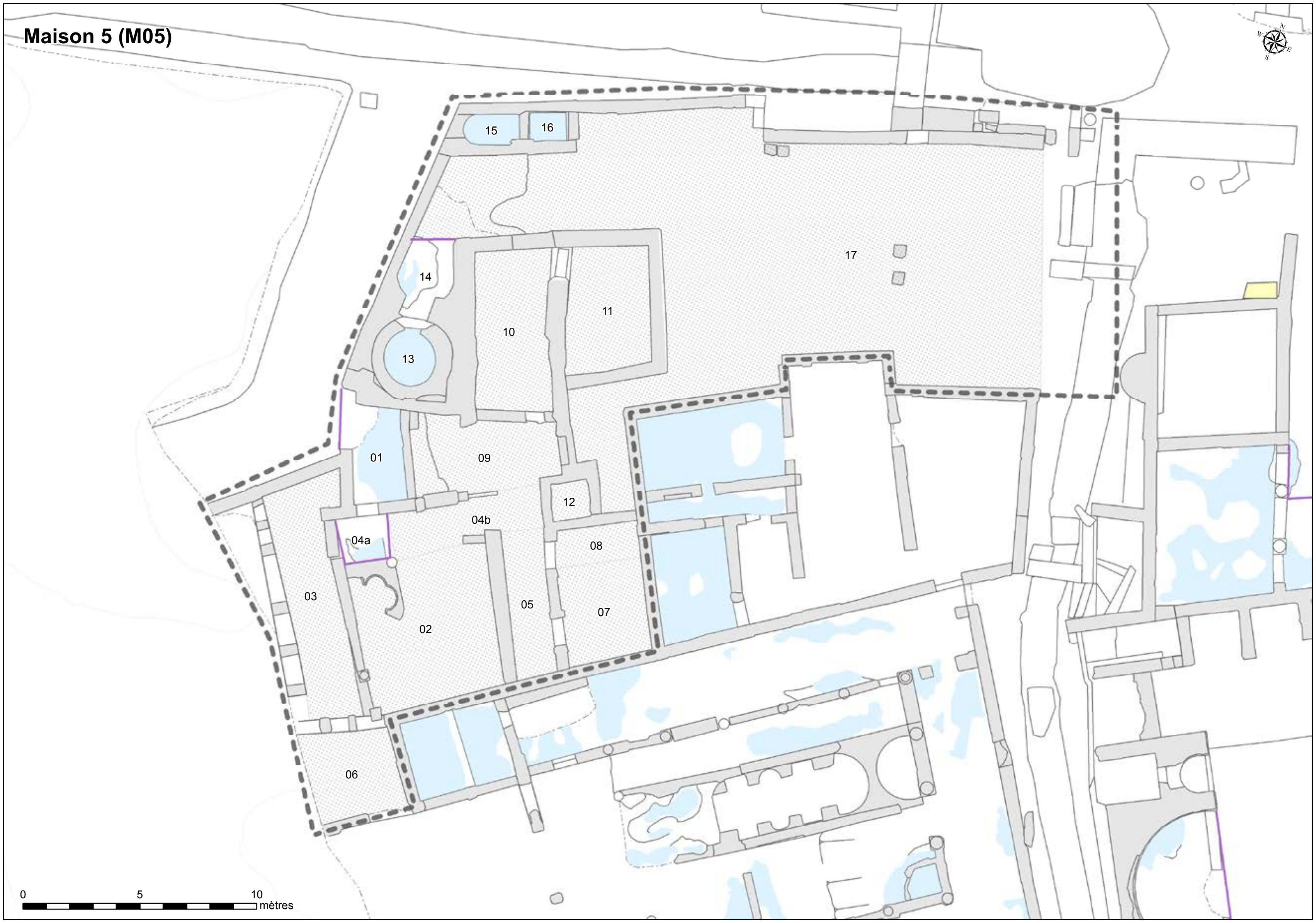
Maison 2 (M02)

Maison 3 (M03)


32
31
30
28
29
35
36
15
14
13
08
07
06
12a
10
09
05
04
33
16
11b
11a
37
01
12b
18b
18a
17
12c
03
02
34
19
20
21
22
23
26
25
24
27
0
5
10
mètres

Maison 3 - étage souterraine (M03 - S)
S01
S02
S03
S04
S05
S06
0
5
10
mètres


Maison 4 (M04)
13
12
14
17b
15
17a
16
05b
08b
05c
09
08a
06b
05a
07
06a
05d
05e
10b
10a
11
03
01
04
20
02
19
18
0
5
10
mètres


Maison 5 (M05)
15
16
17
14
11
10
13
01
09
12
04b
04a
08
03
05
07
02
06
0
5
10
mètres

Maison 7 (M07)


02
01
03a
03b
04
11
06
05
S03a
S01b
S01a
10
09
S03b
12
S01c
S02
08
07
S04
0
5
10
mètres

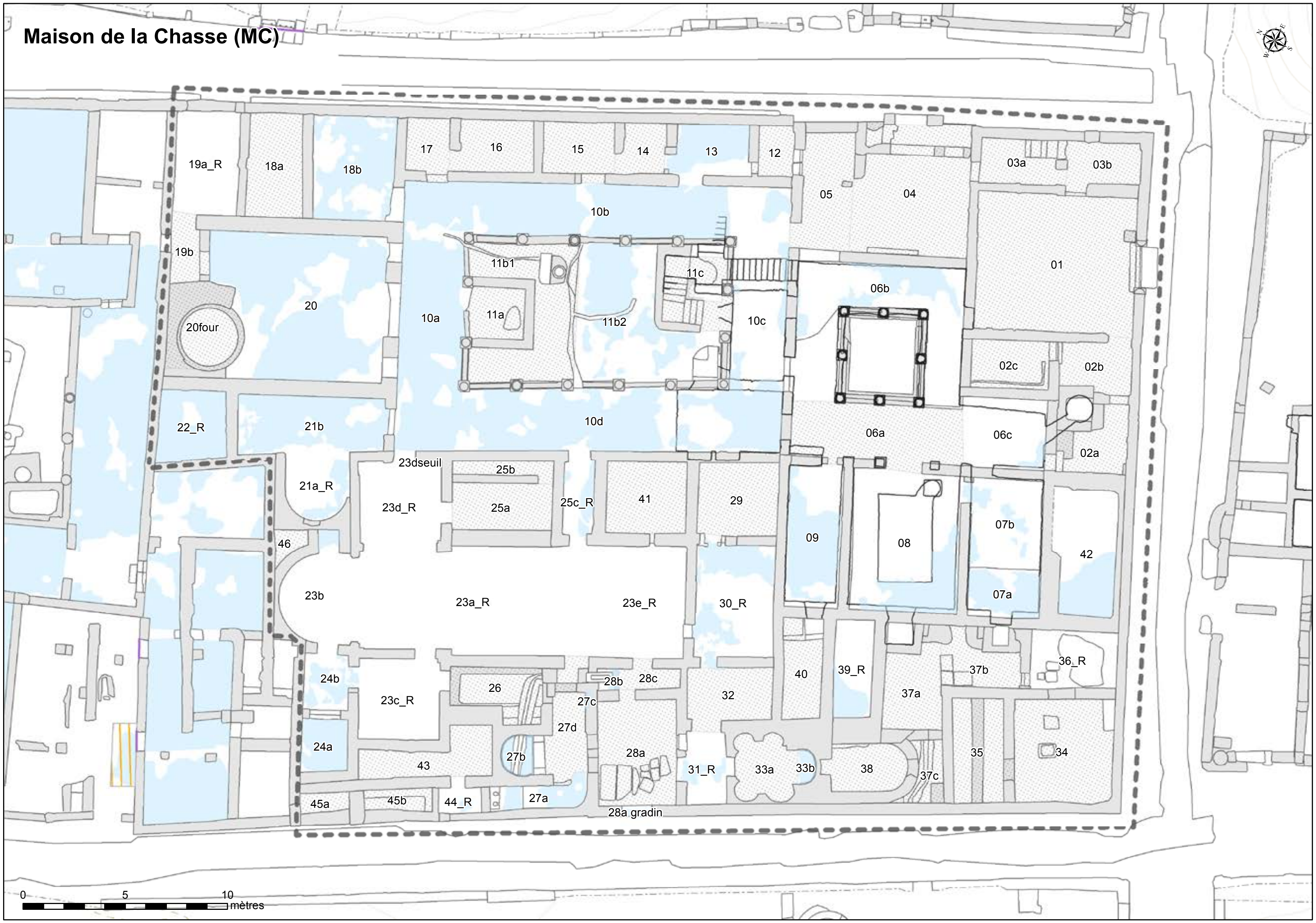

Maison 8 (M08)
23
24
16
22
10
15
25
08
07
21
14
12
13a
09
06
26
27
13b
02
04
20
19
18
17
11
03
01
05
28
0
5
10
mètres

Maison 9 (M09)
04
08
09
10a
10b
11
12
02
07
01
05
06
15
14a
13
16
14b
03
17
0
5
10
mètres

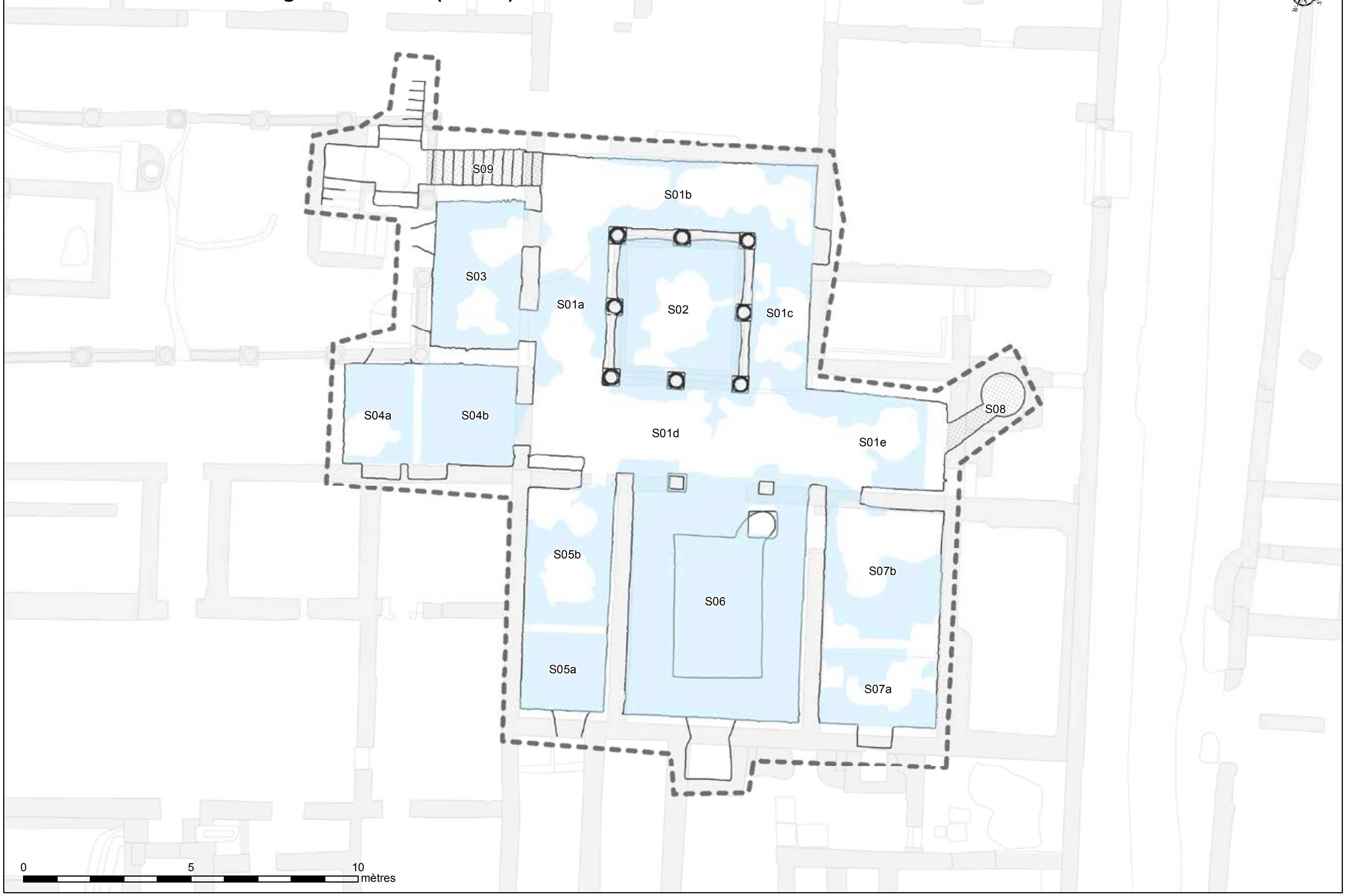
Maison d'Amphitrite (MA)

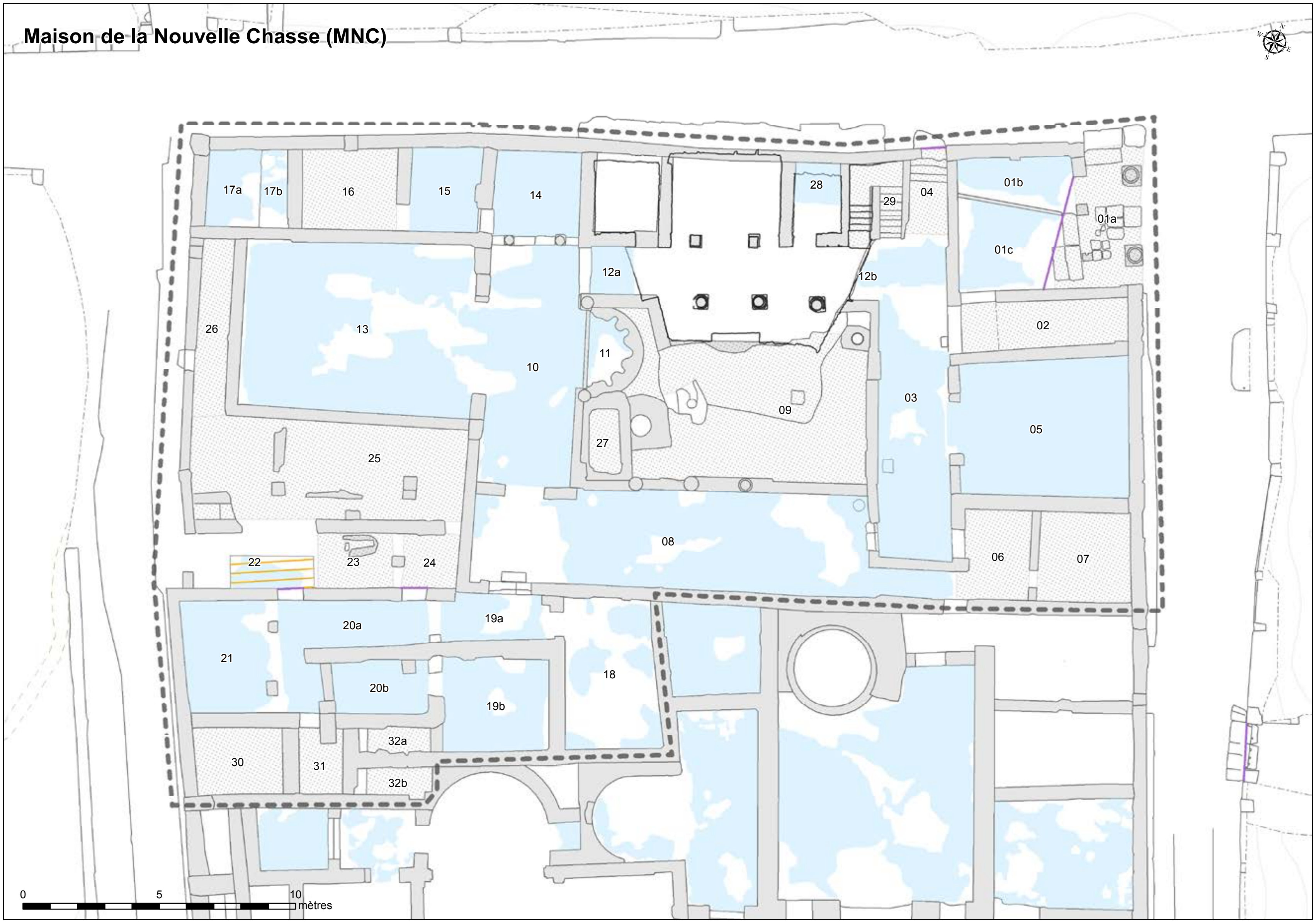
Maison d'Amphitrite - étage souterraine (MA - S)

255

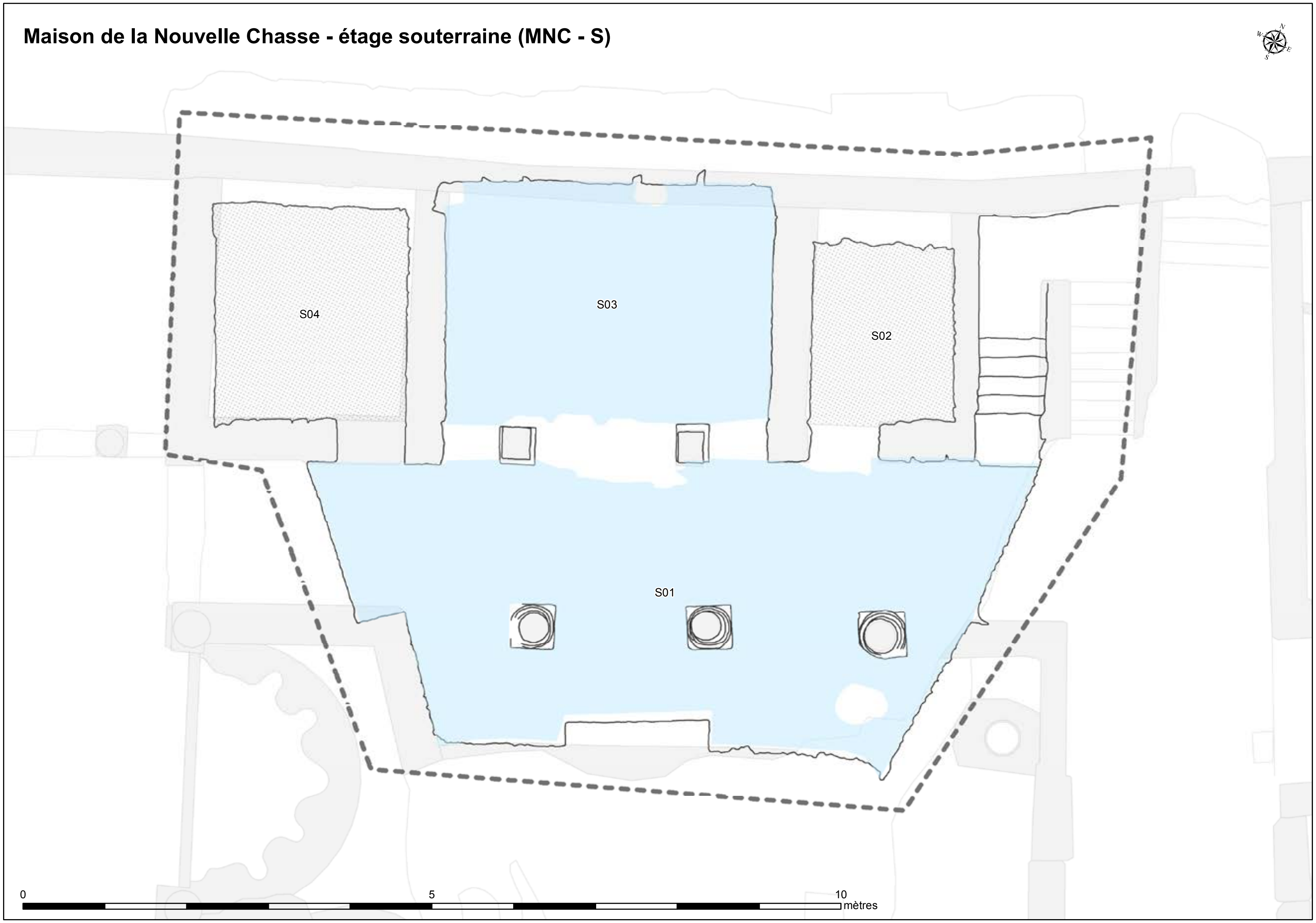

Maison de la Chasse (MC)
19a_R
18a
18b
17
16
15
14
13
12
05
04
03a
03b
10b
19b
11b1
11c
06b
01
20
20four
10a
11a
11b2
10c
02c
02b
22_R
21b
10d
06a
06c
02a
23dseuil
25b
21a_R
23d_R
25a
25c_R
41
29
09
08
07b
42
46
23b
23a_R
23e_R
30_R
07a
24b
26
28b
28c
40
39_R
37b
36_R
23c_R
27c
32
37a
27d
24a
43
27b
28a
31_R
33a
33b
38
35
34
37c
45a
45b
44_R
27a
28a gradin
0
5
10
mètres

Maison de la Chasse - étage souterraine (MC - S)

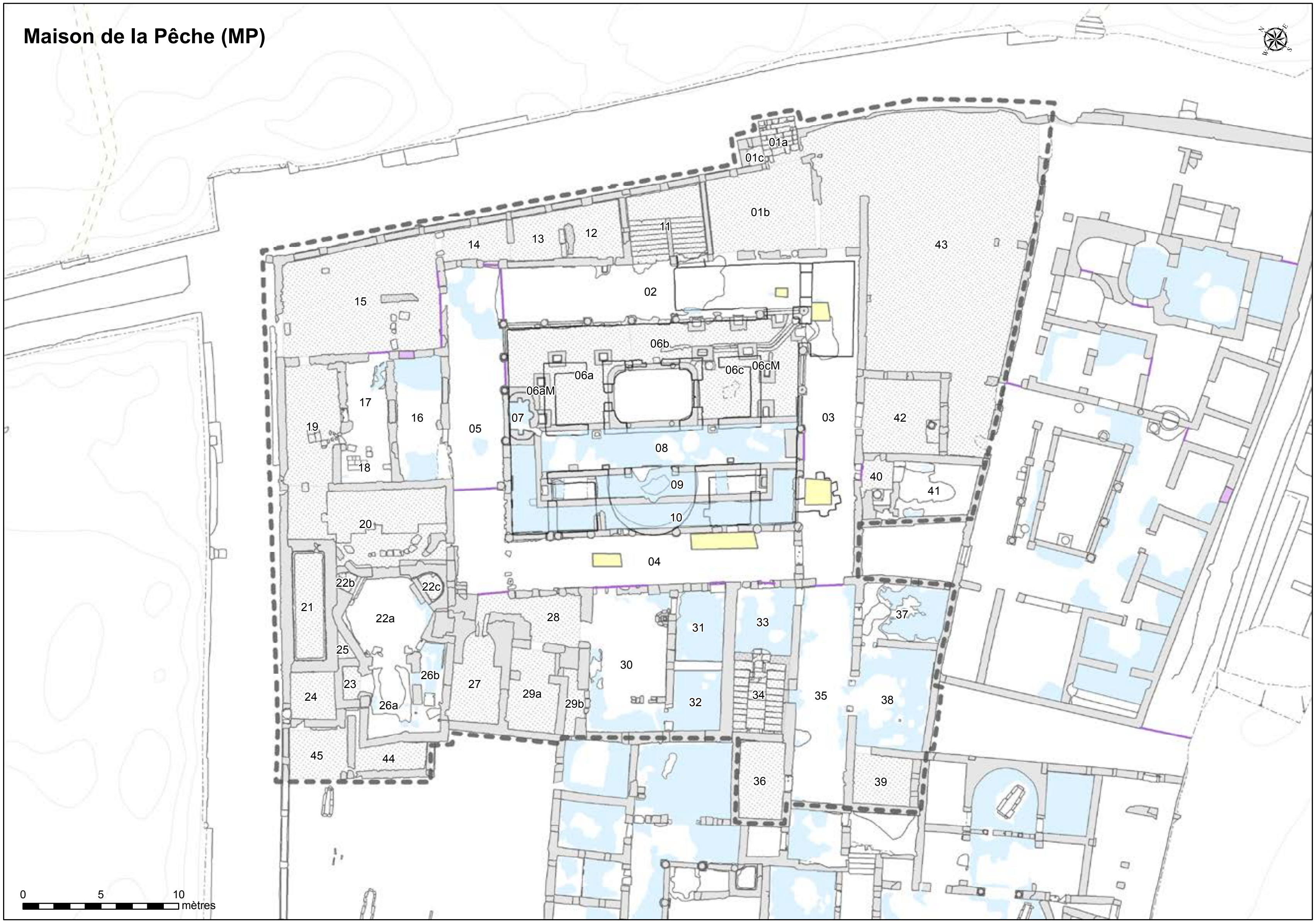


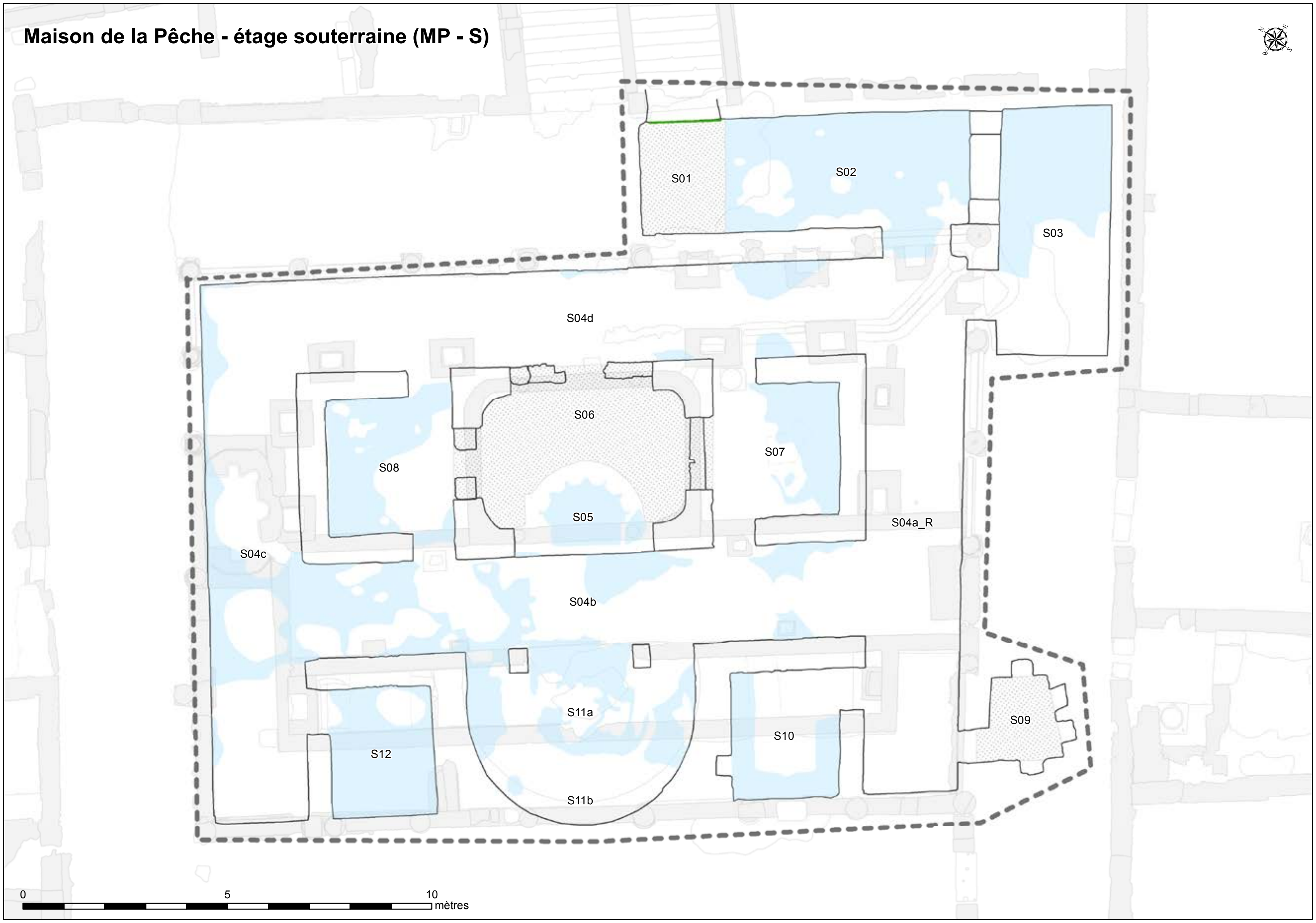

Maison de la Nouvelle Chasse (MNC)
17a
17b
16
15
14
28
29
04
01b
01a
01c
12a
12b
02
26
13
10
11
09
03
05
27
25
08
06
07
22
23
24
19a
20a
21
18
20b
19b
32a
30
31
32b
0
5
10
mètres

Maison de la Nouvelle Chasse - étage souterraine (MNC - S)



Maison de la Pêche (MP)

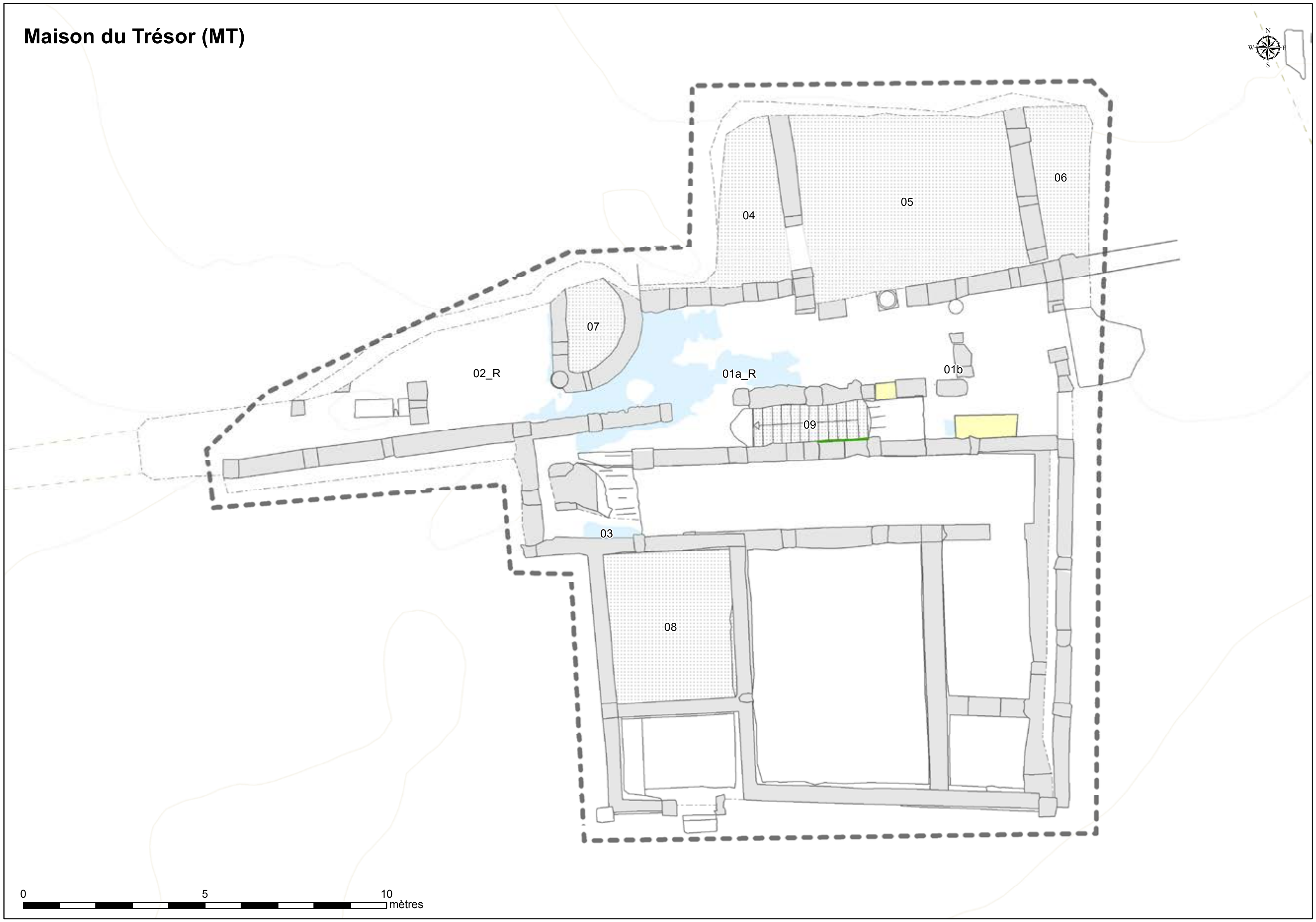



Maison de la Pêche - étage souterraine (MP - S)
S01
S02
S03
S04d
S06
S07
S08
S05
S04a_R
S04c
S04b
S11a
S10
S09
S12
S11b
0
5
10
mètres

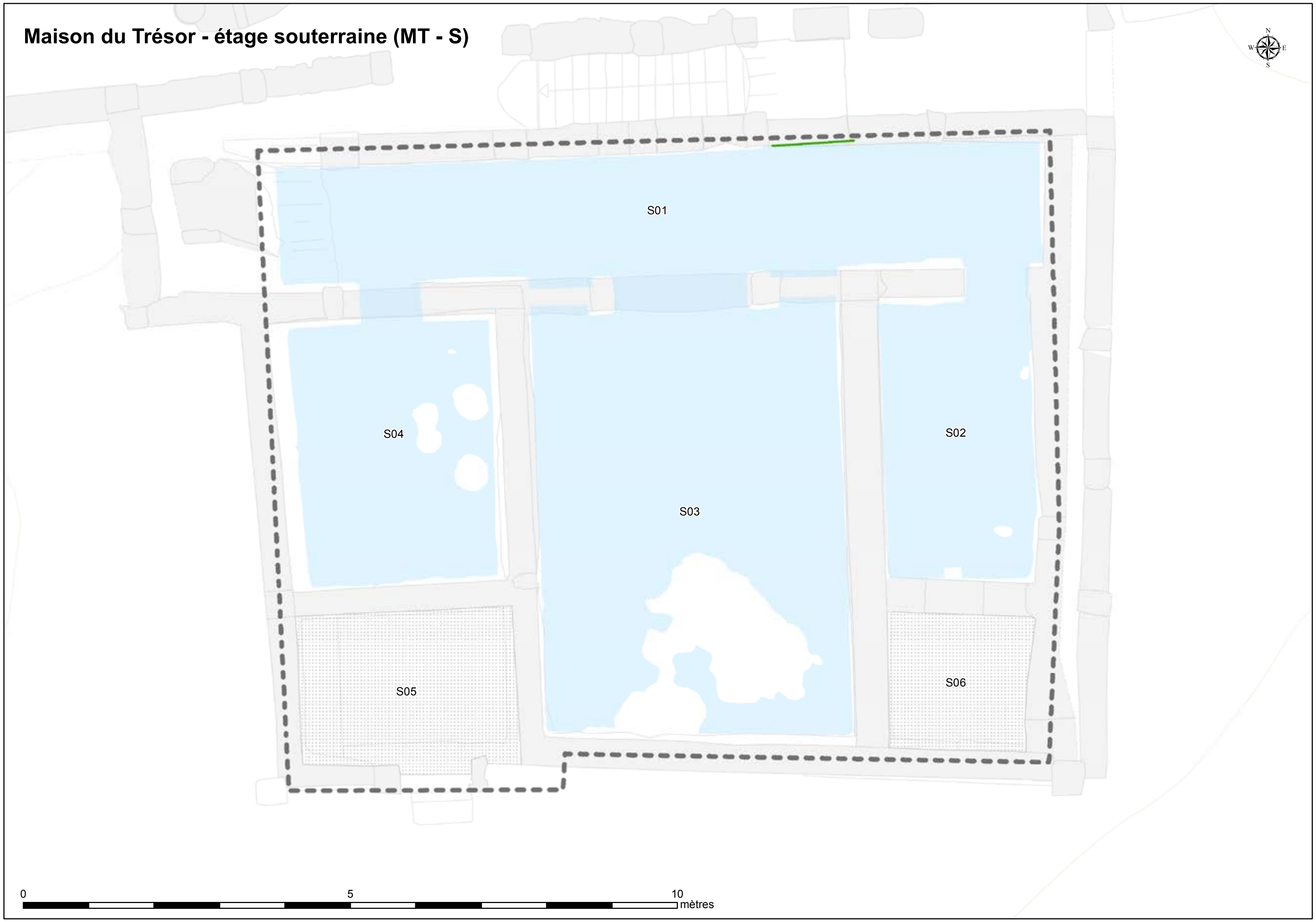
Maison du Paon (MPa)
N
W
E
S
02
01
0
5
10
mètres

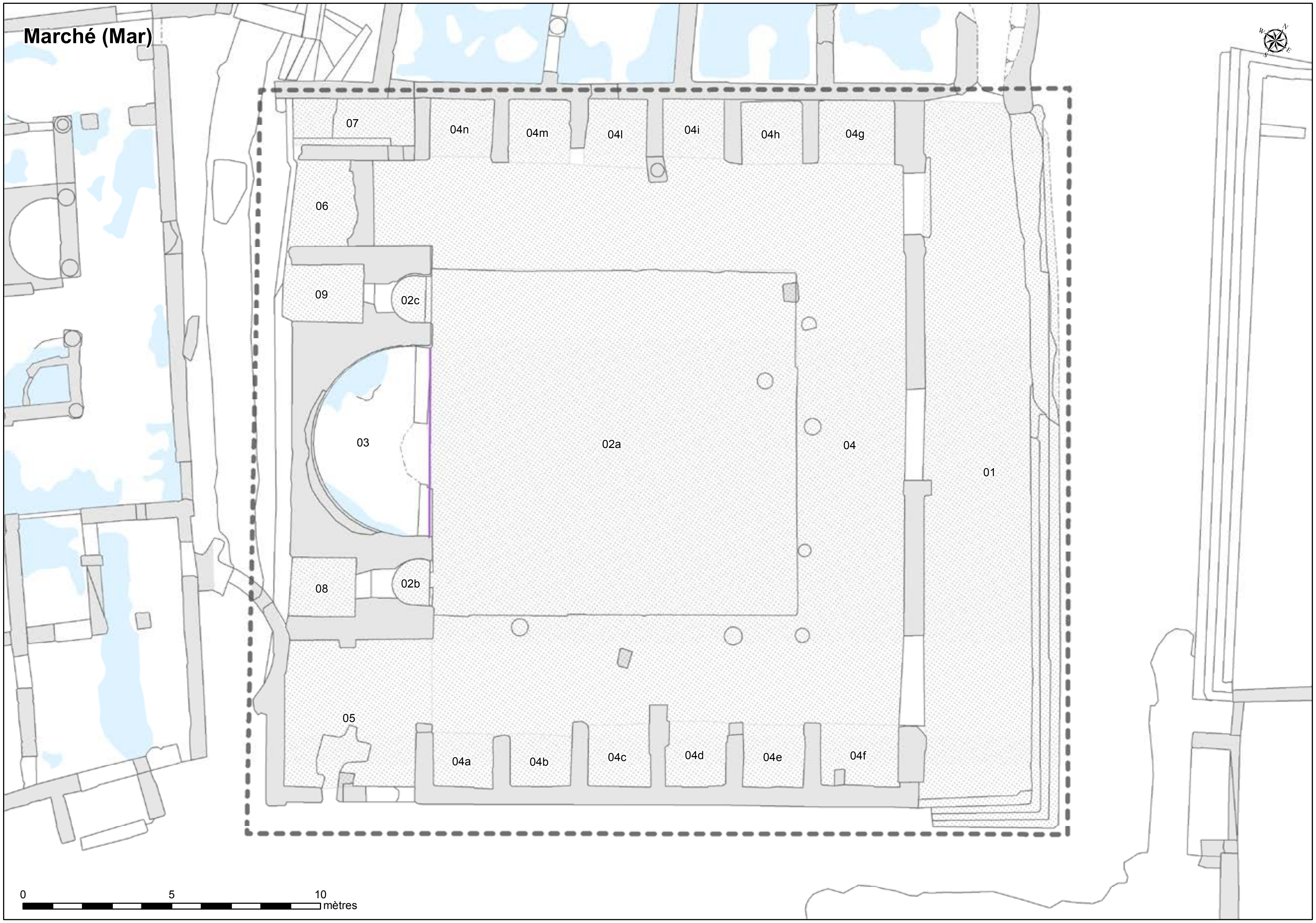
Maison du Paon - étage souterraine (MPa - S)

Maison du Trésor (MT)

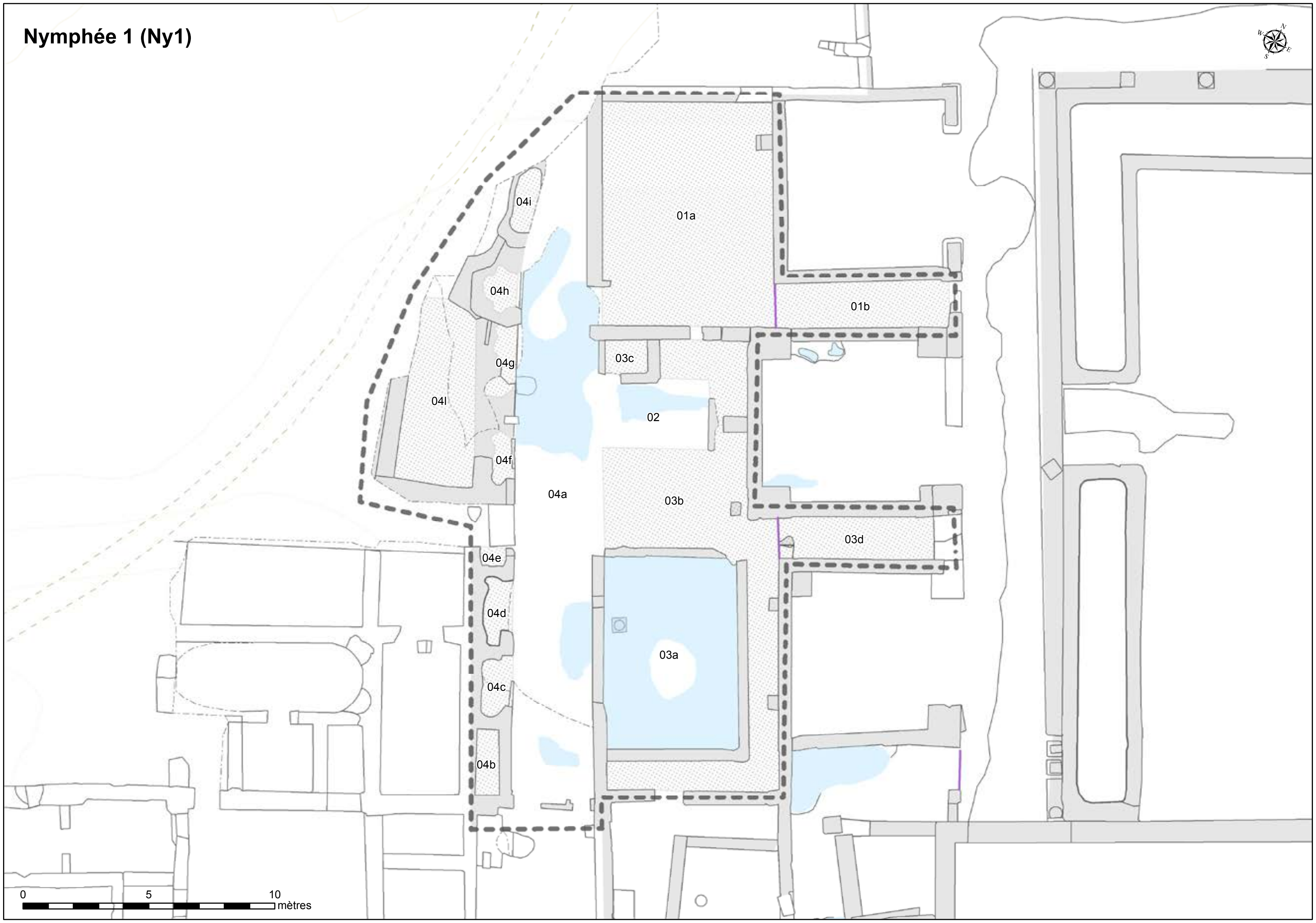


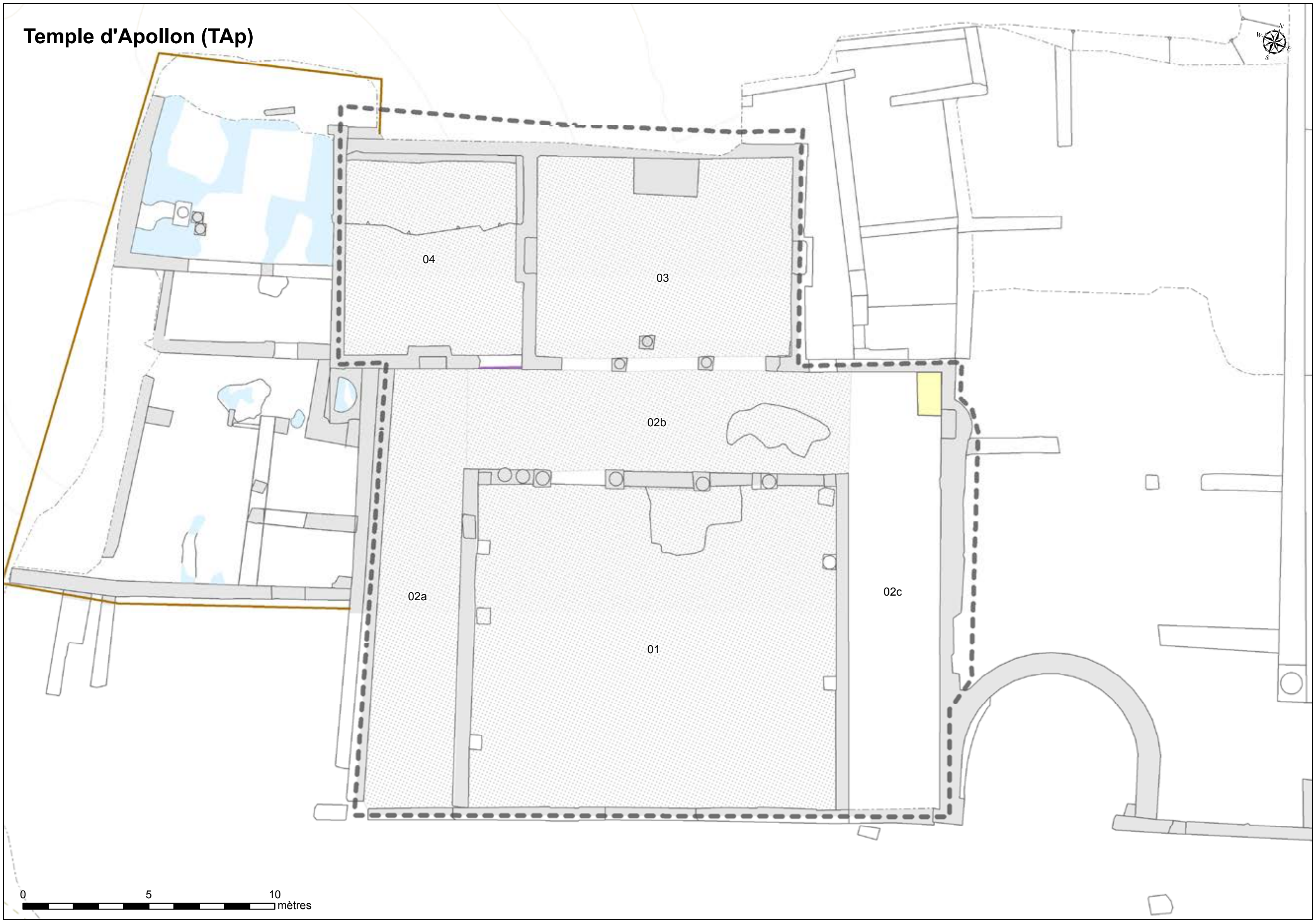
Maison du Trésor - étage souterraine (MT - S)



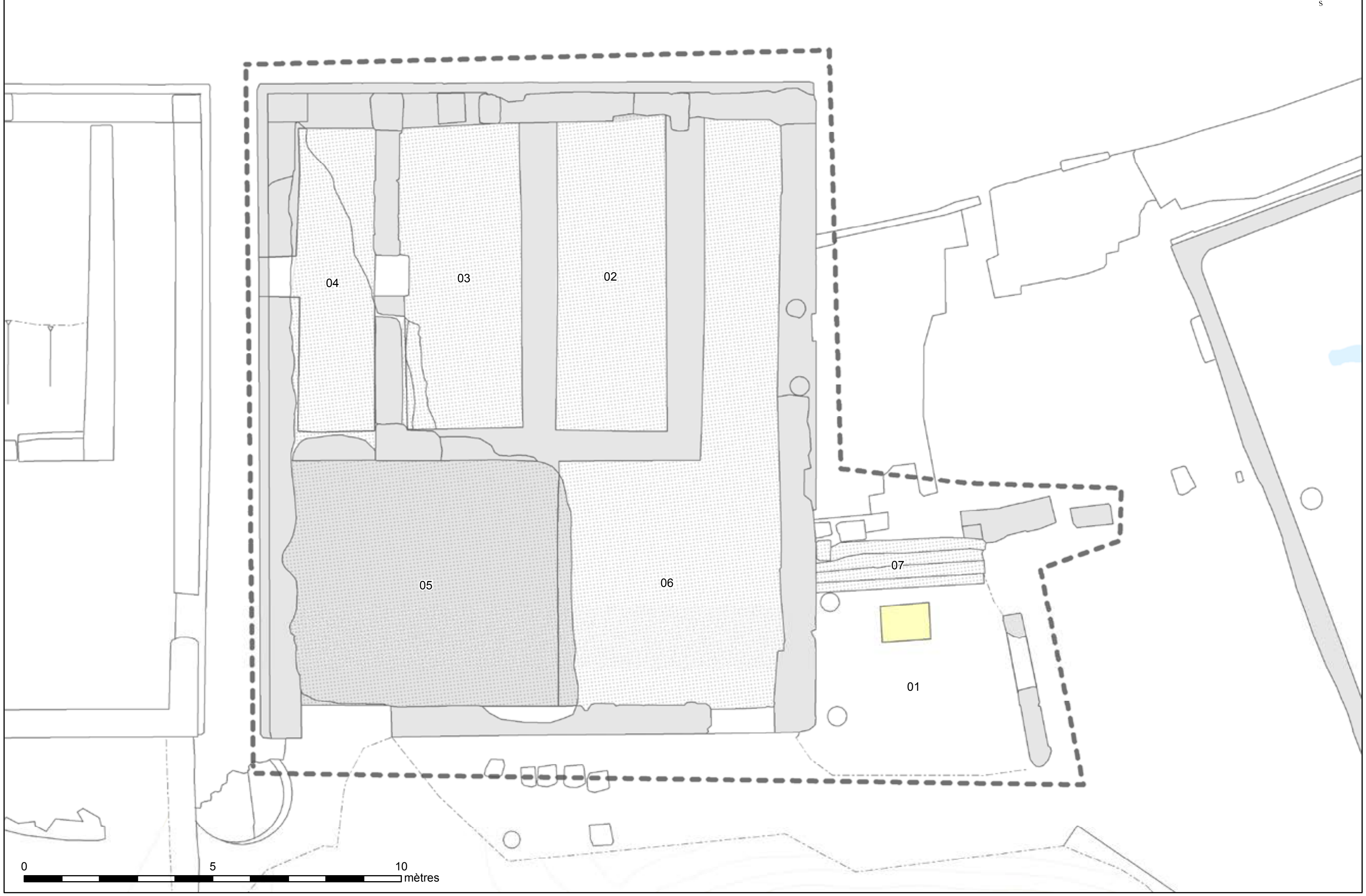

Marché (Mar)
07
04n
04m
04l
04i
04h
04g
06
09
02c
03
02a
04
01
08
02b
05
04a
04b
04c
04d
04e
04f
0
5
10
mètres

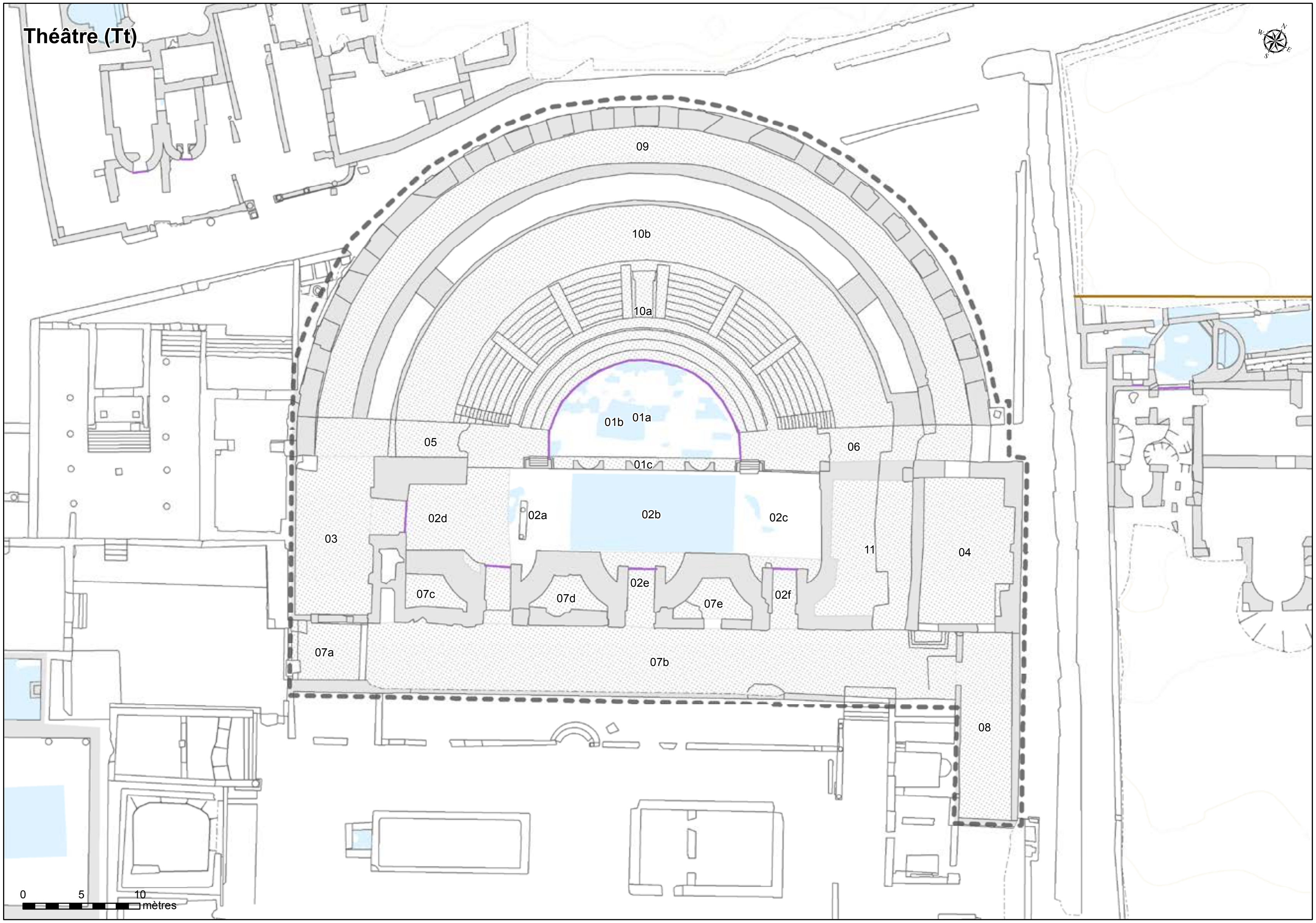
Nymphée 1 (Ny1)

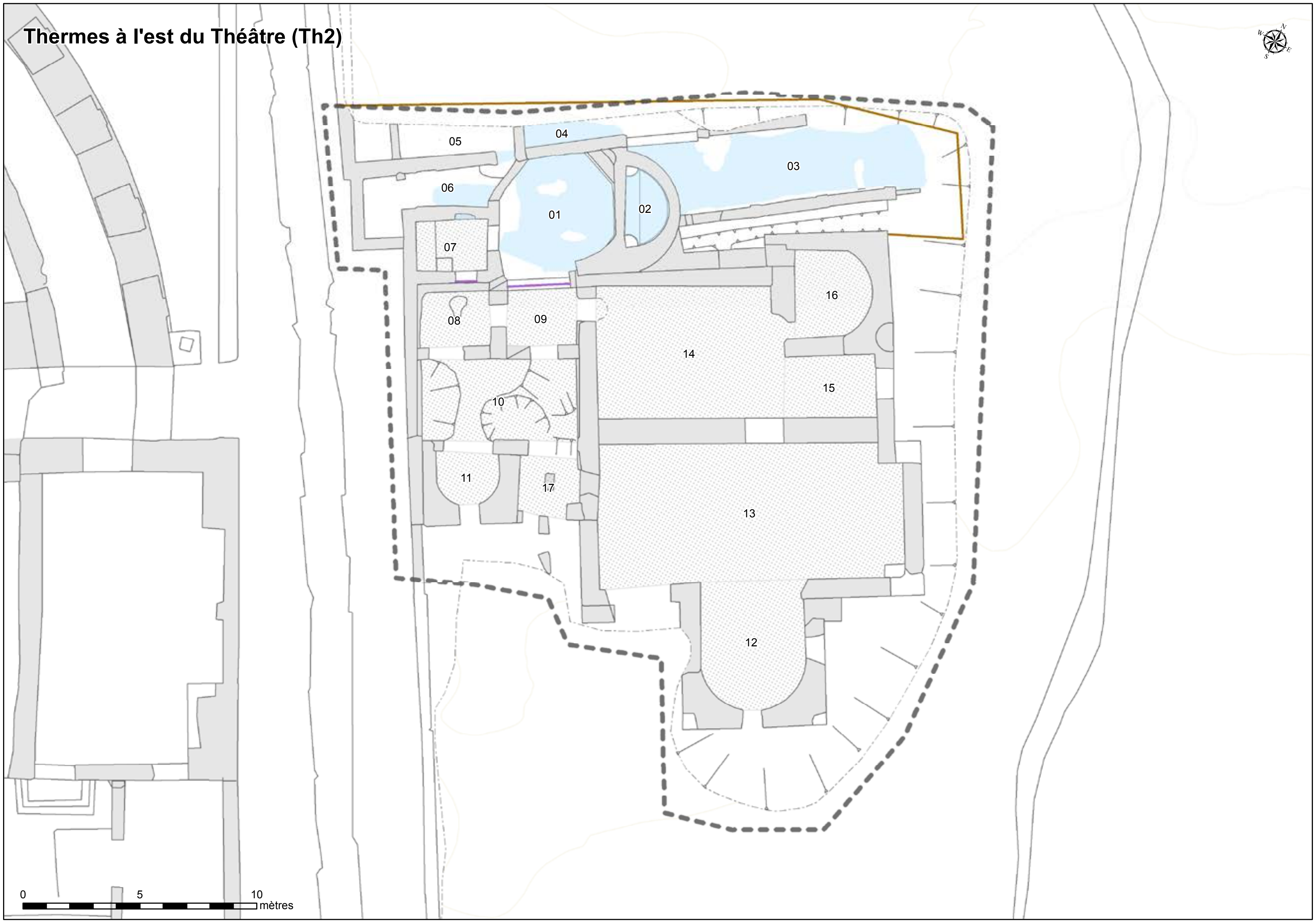


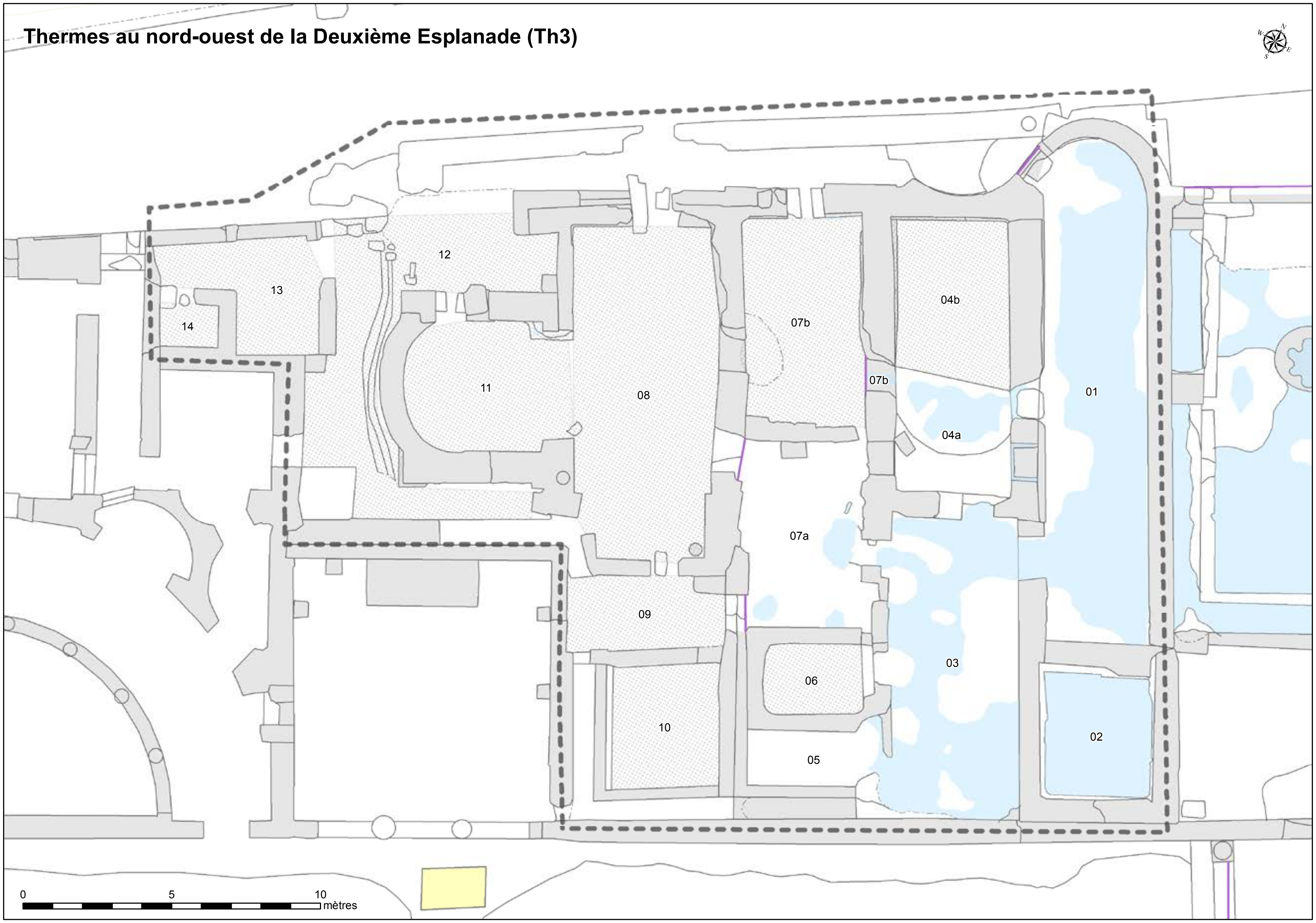

Temple d'Apollon (TAp)
04
03
02b
02a
01
02c
0
5
10
mètres

Temples à l'ouest des Thermes de Iulia Memmia (T1)



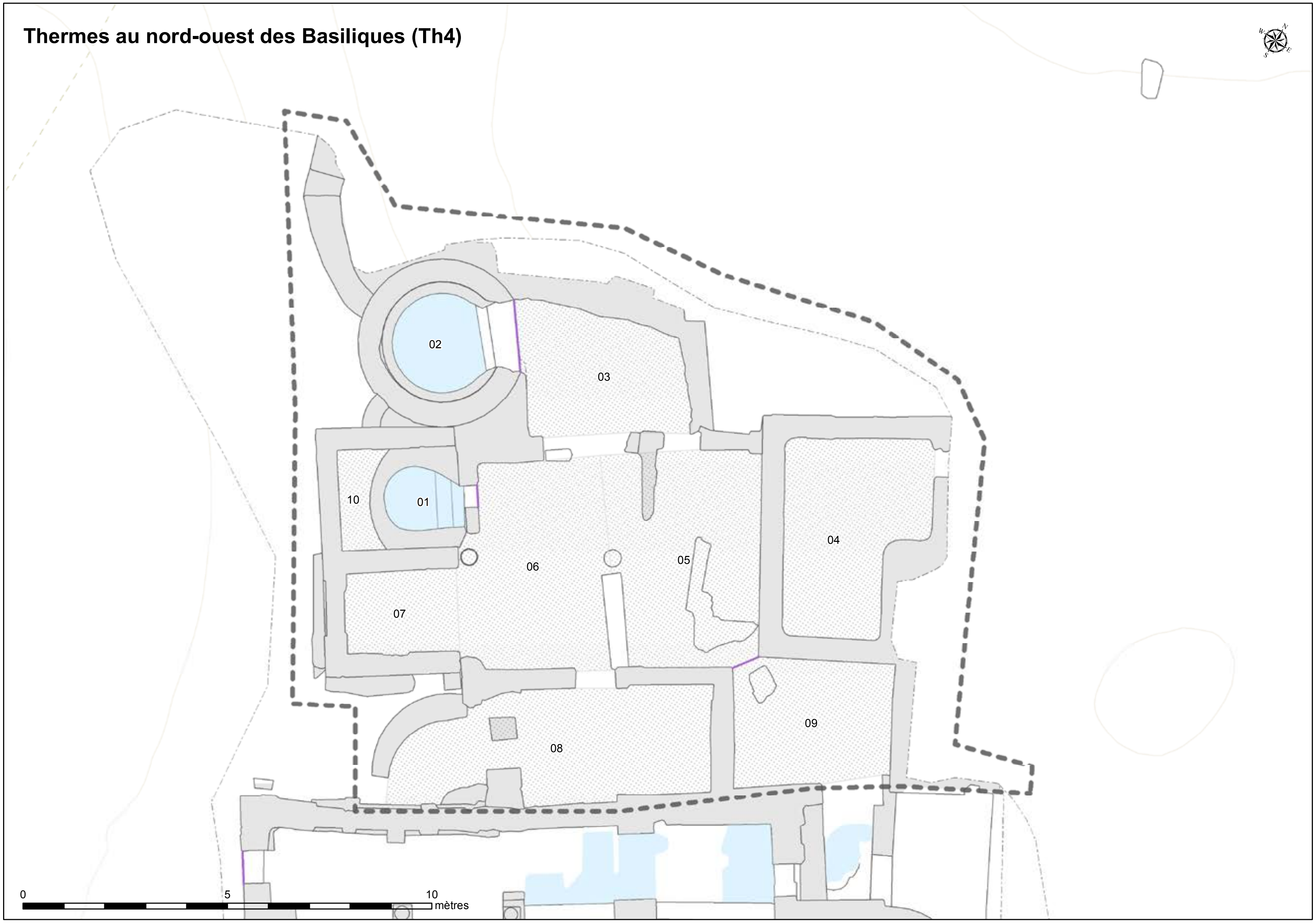

Théâtre (Tt)
09
10b
10a
01b
01a
05
06
01c
02d
02a
02b
02c
03
11
04
07c
07d
02e
07e
02f
07a
07b
08
0
5
10
mètres


Thermes à l'est du Théâtre (Th2)
05
04
03
06
01
02
07
16
08
09
14
15
10
11
17
13
12
0
5
10
mètres

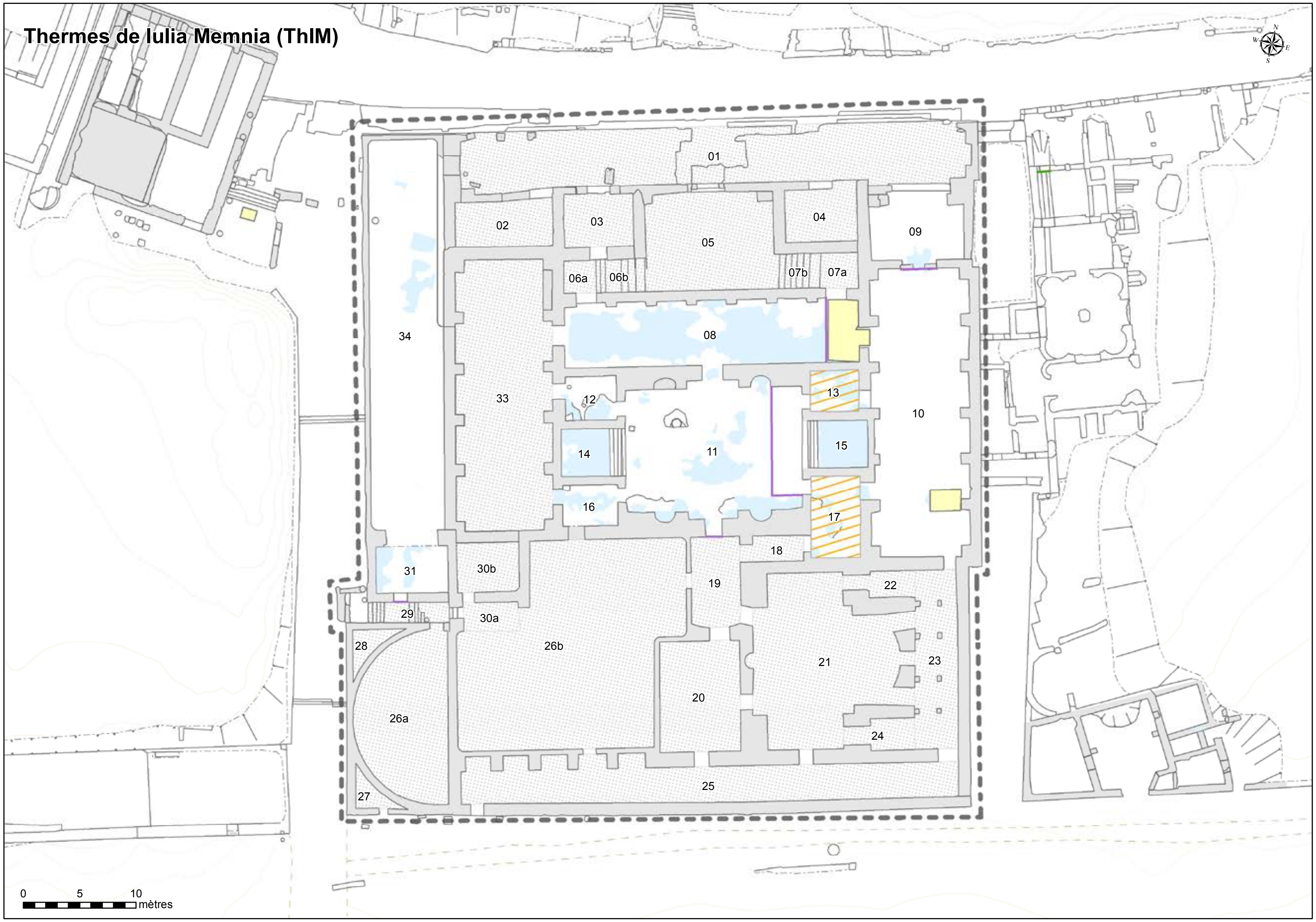


Thermes au nord-ouest de la Deuxième Esplanade (Th3)
12
13
14
04b
07b
07b
11
08
01
04a
07a
09
03
06
10
02
05
0
5
10
mètres

Thermes au nord-ouest des Basiliques (Th4)



Thermes au nord-ouest du Théâtre (Th1)


Thermes de Iulia Memnia (ThIM)
01
02
03
04
05
06a
06b
07b
07a
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26a
26b
27
28
29
30a
30b
31
33
34
0
5
10
mètres

Thermes des Venantii (ThV)


Thermes du nord-est (Th5)
N
S
E
W
04
05
06
07
08
09
10
11
01_R
02
03
0
5
10
mètres

Phase 1a - Visitation

exposed mosaic

accessible area

site visitation route

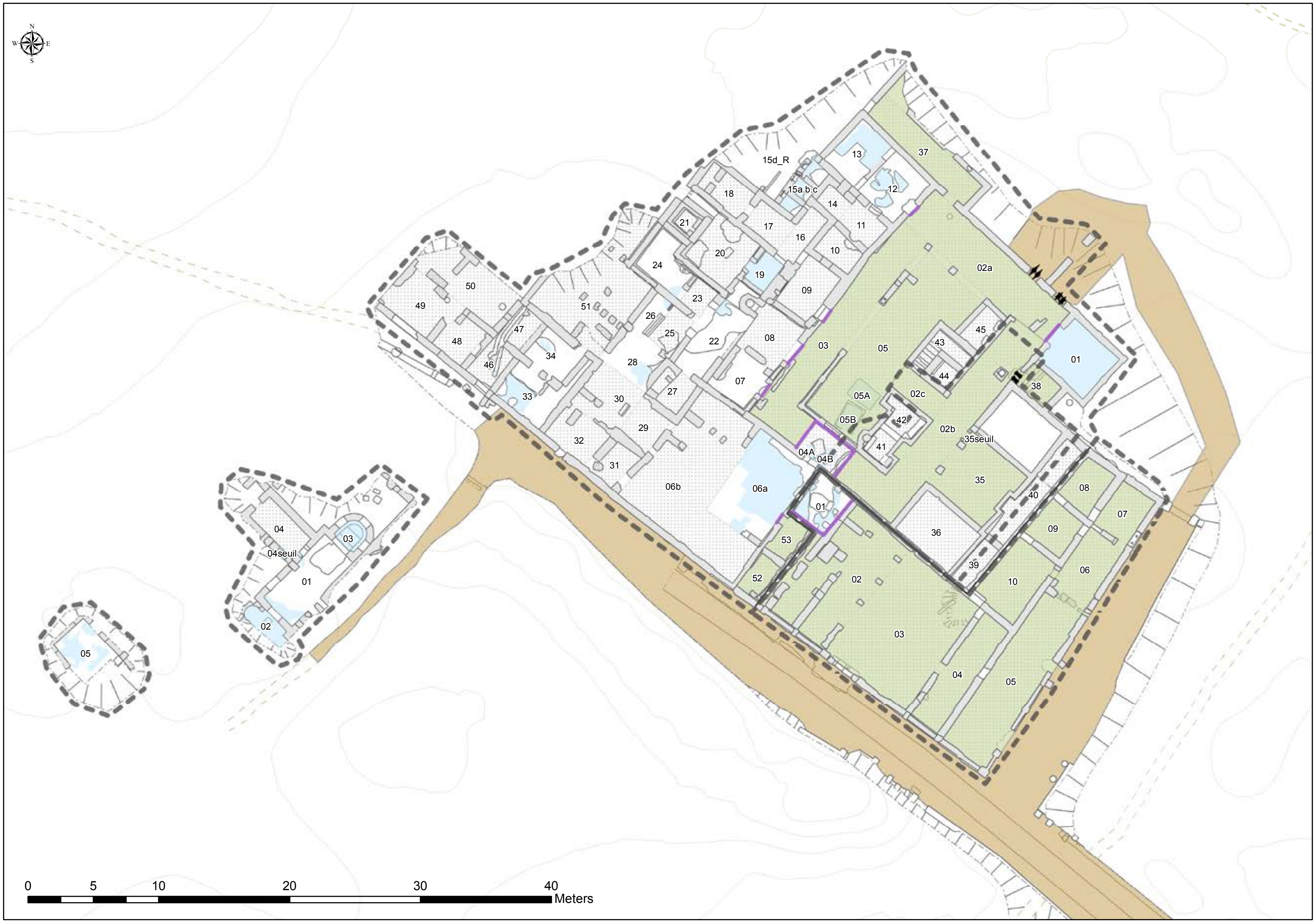
access barrier (temporary)

gate to be closed (temporary)

entry/exit point


N
W
E
S
18
10
08
11
13
07
06
24
15
14
05
03
16
02
17_R
04
01a
01b
03
02
04
01
07
08
05
06
02
03
10
01
06
05
04
07
09
08
07
05
06
01
03a
03b
04
08
02
10
02
07
04
09
11
06
05
08
12
13
03
01
03
02
01
02
01
03a
03b
04
11
06
05
S03a
S01b
S01a
10
09
S03b
S01c
S02
12
08
07
S04
01
0
5
10
20
30
40
Meters


0
10
20
40
60
80
Meters



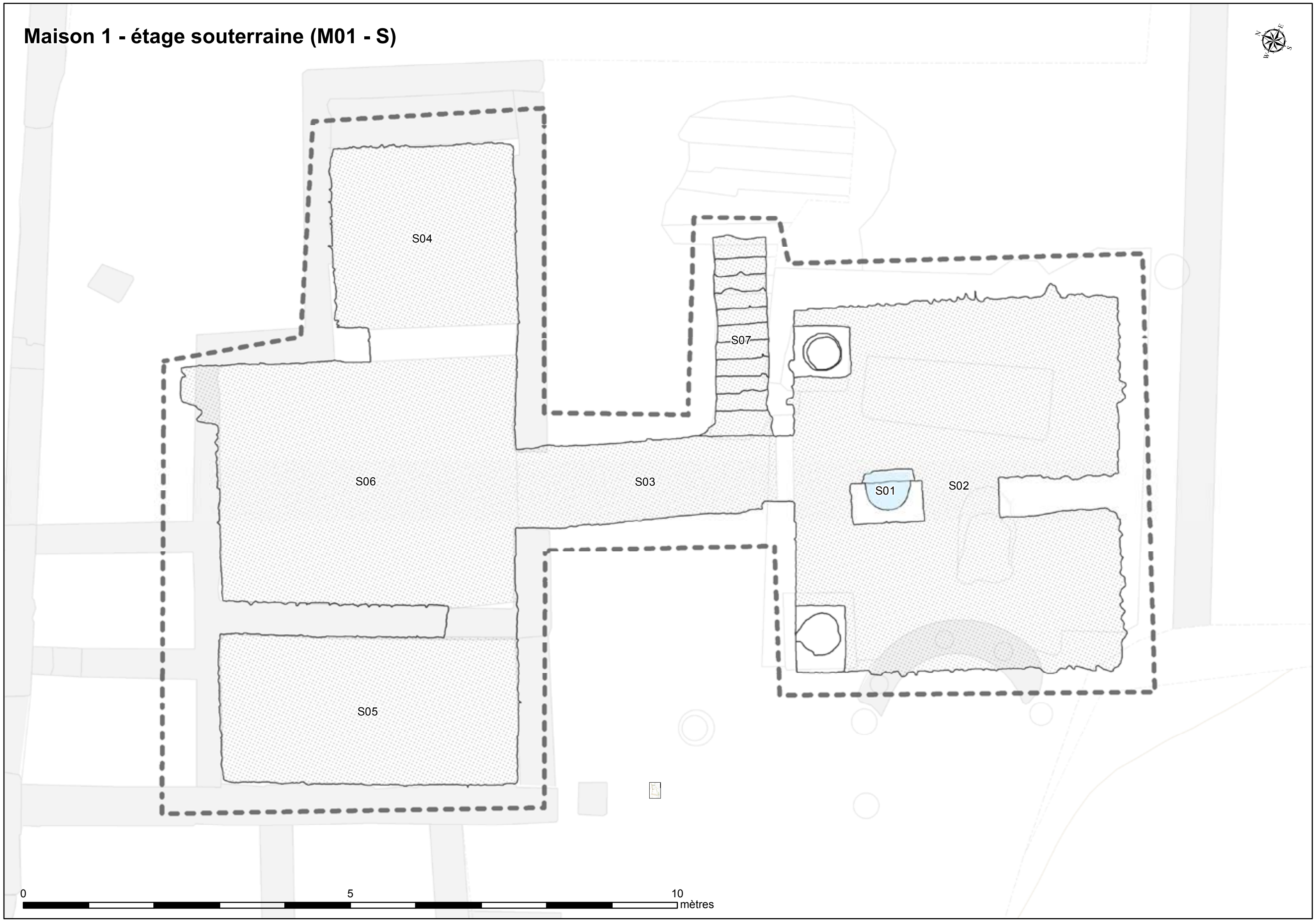
N
W
E
S
15d_R
13
37
12
15a.b.c
18
14
11
21
17
16
10
20
24
19
09
02a
50
49
51
23
26
47
25
22
08
03
05
43
45
01
48
34
46
28
07
44
38
33
27
05A
02c
30
05B
42
29
02b
35seuil
32
41
04A
04B
31
06b
06a
35
08
40
01
07
04
03
36
09
53
04seuil
39
06
01
52
02
10
02
03
04
05
05
0
5
10
20
30
40
Meters


0
10
20
40
60
80
Meters


0
10
20
40
60
80
Meters

0
10
20
40
60
80
Meters

Maison 1 - étage souterraine (M01 - S)

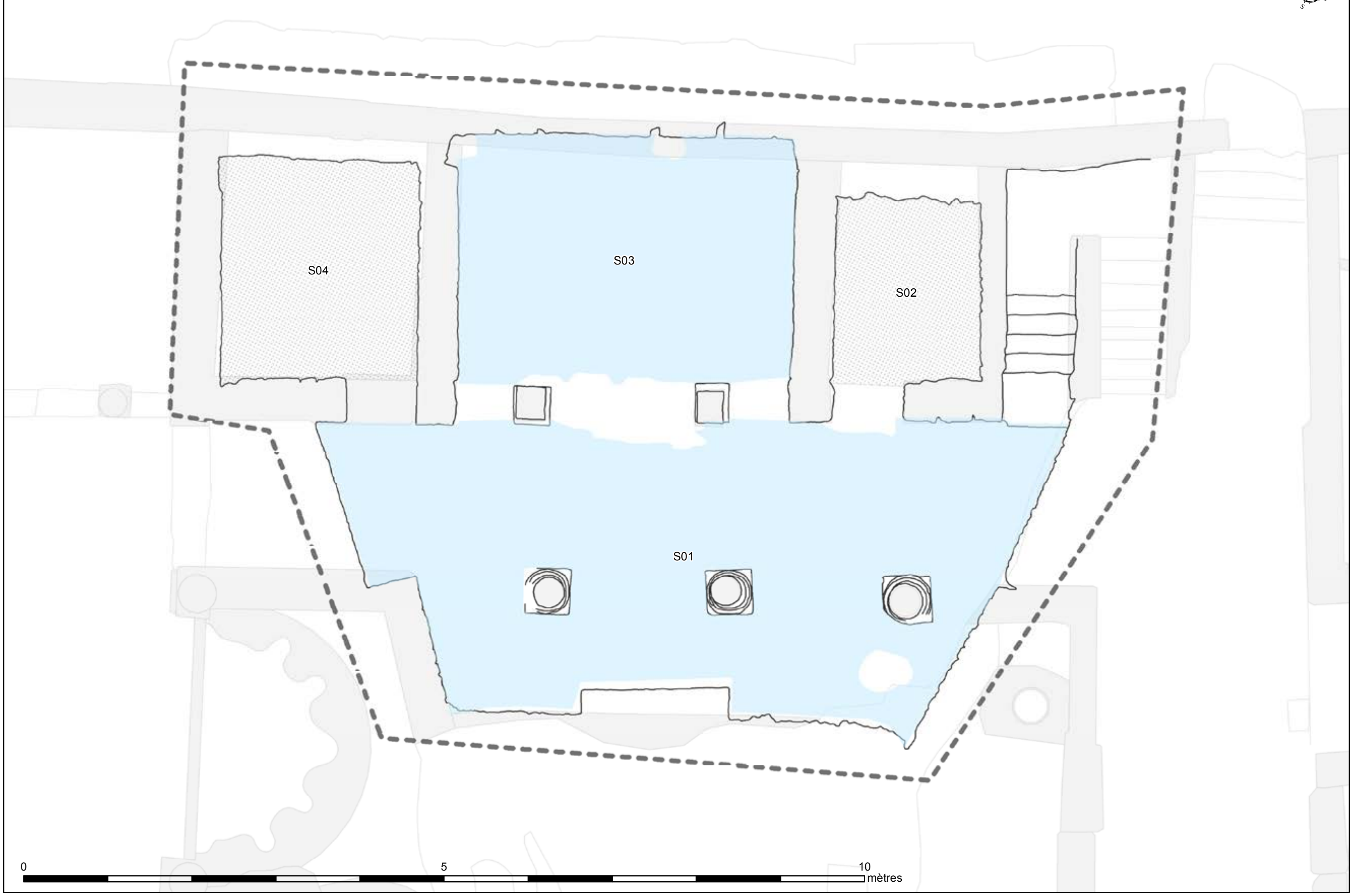


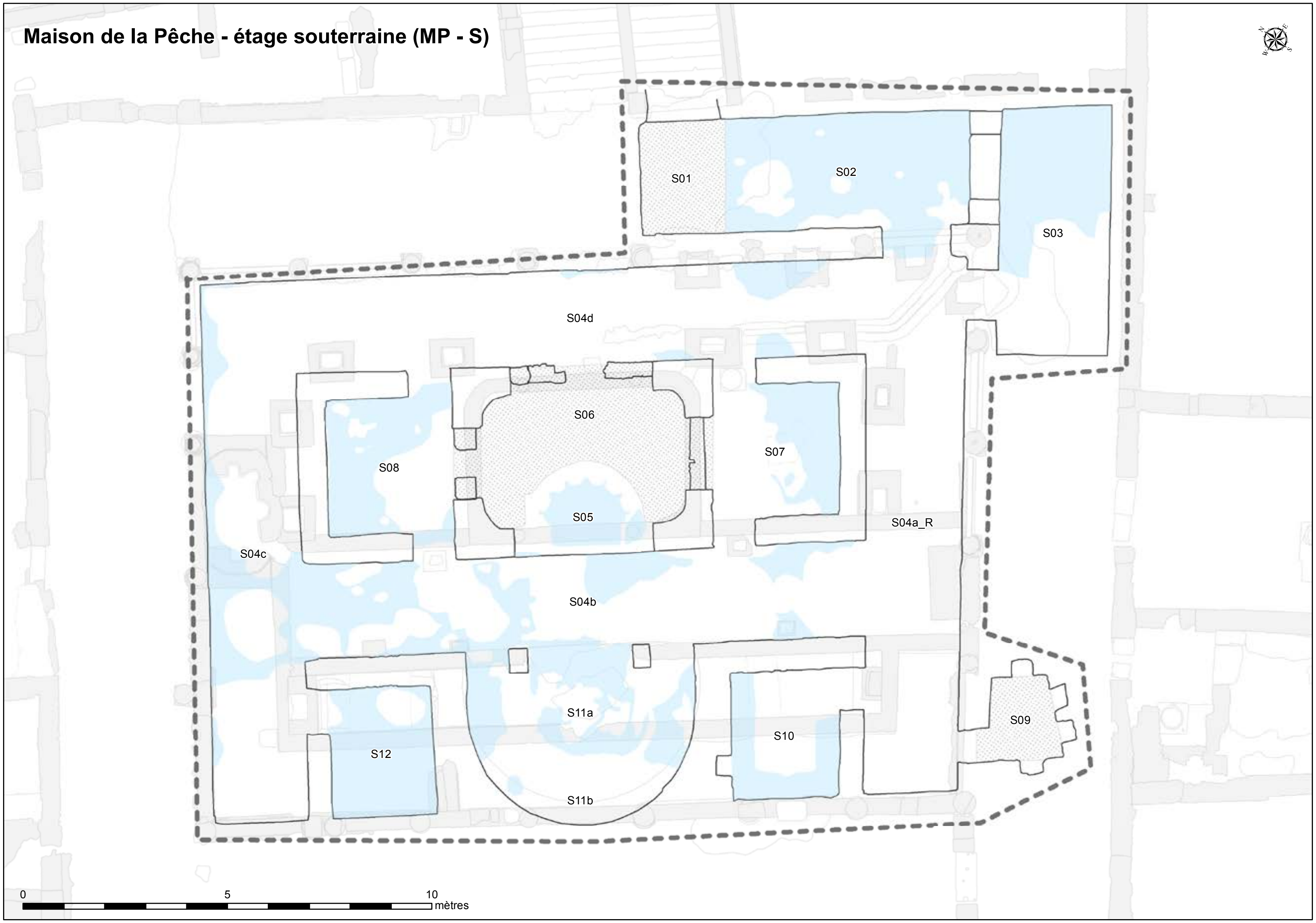
Maison 3 - étage souterraine (M03 - S)

Maison d'Amphitrite - étage souterraine (MA - S)

Maison de la Chasse - étage souterraine (MC - S)

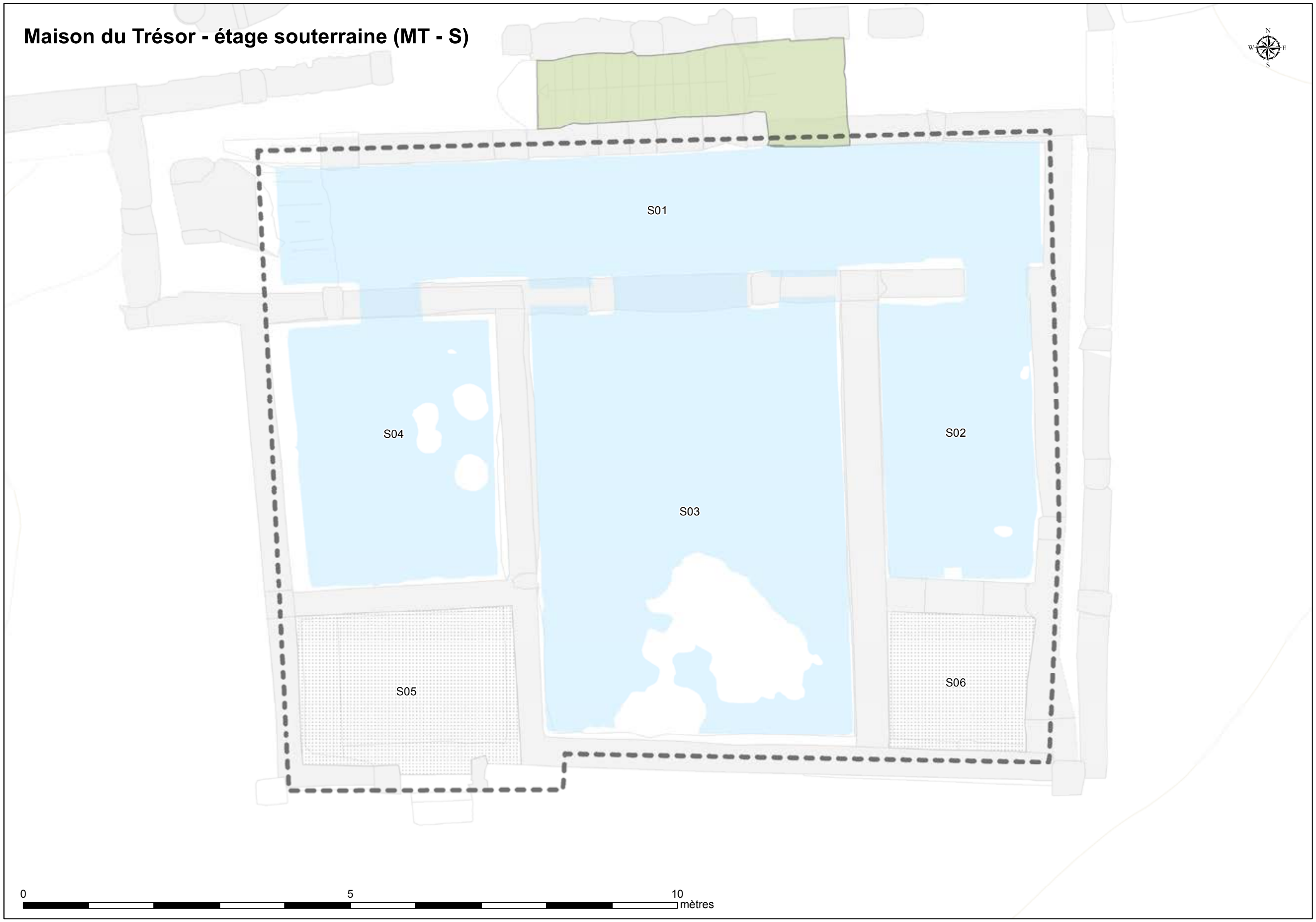
Maison de la Nouvelle Chasse - étage souterraine (MNC - S)




Maison de la Pêche - étage souterraine (MP - S)
S01
S02
S03
S04d
S06
S07
S08
S05
S04a_R
S04c
S04b
S11a
S09
S10
S12
S11b
0
5
10
mètres

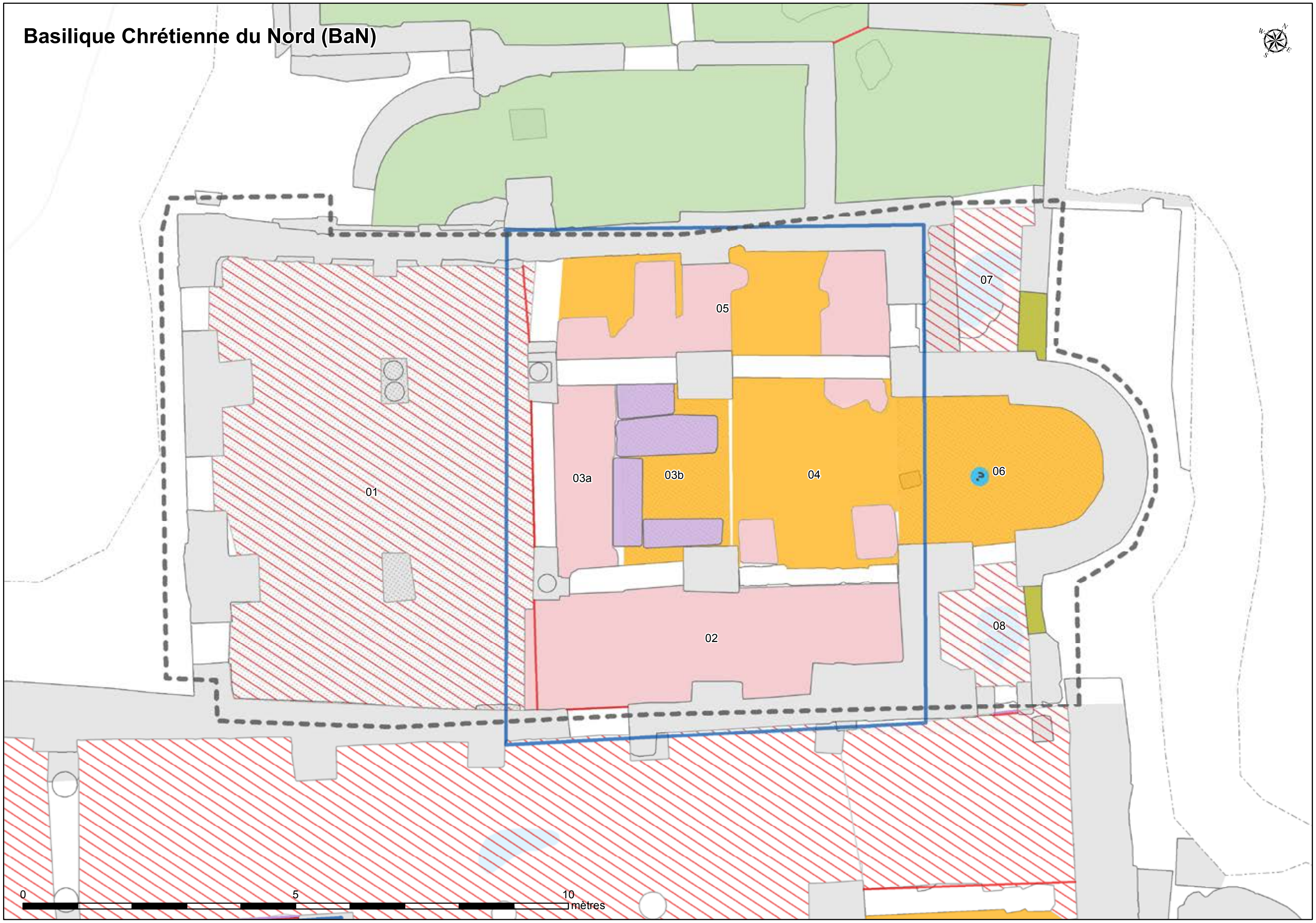
Maison du Paon - étage souterraine (MPa - S)

Maison du Trésor - étage souterraine (MT - S)



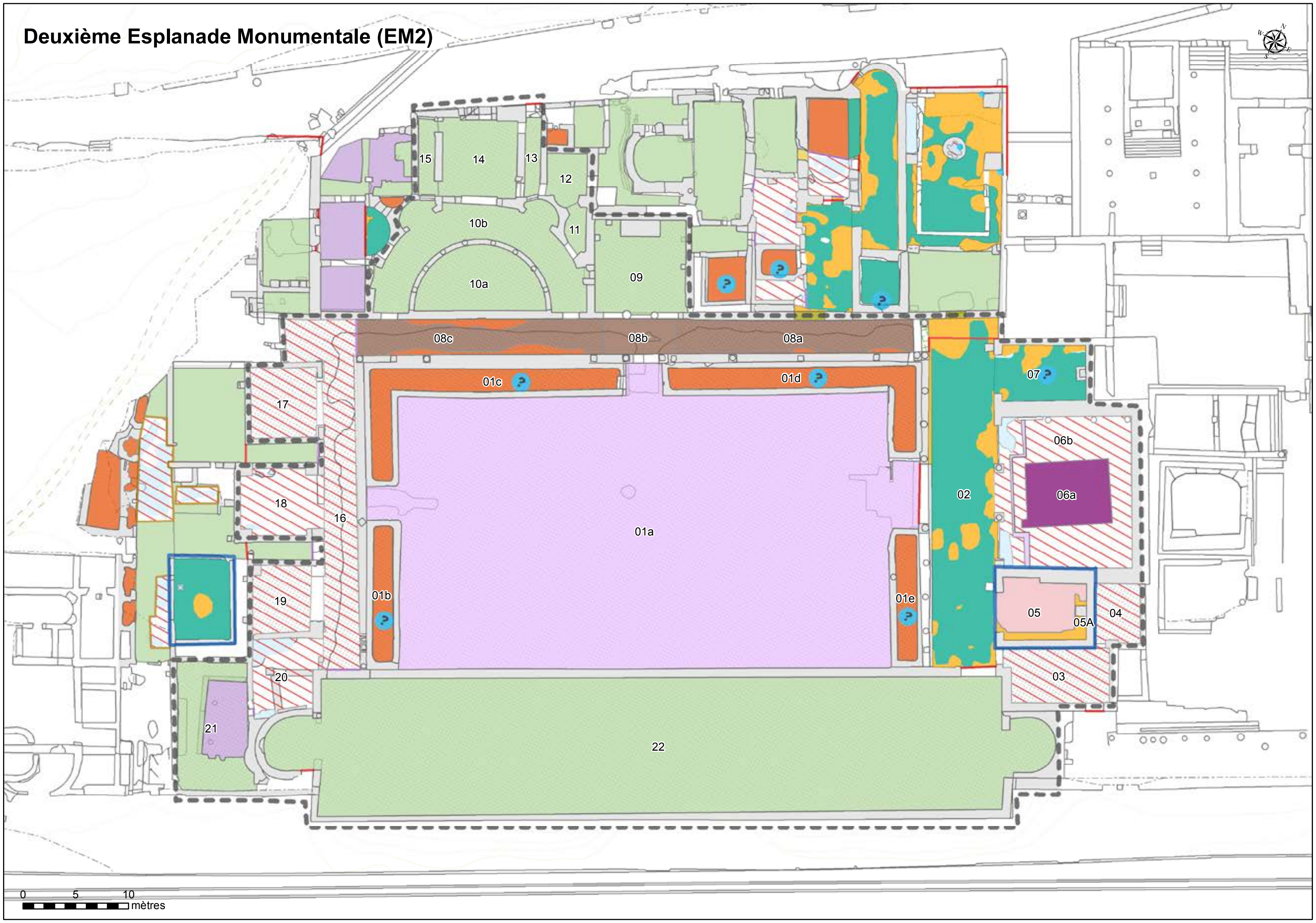
Phase 2 - Stabilization

- tessellatum stabilization
- tessellatum stabilization (mosaic on reinforced concrete panel)
- tessellatum mortar infilling
- cocciopesto treatment
- stone slab pavement treatment
- drainage
- drainage (location to be determined)
- reburial
- walkway
- reburial containment with wood
- reburial containment with mortar
- reburial containment with stone
- tessellatum protection with mortar covering
- mortar paving
- weed removal and grading
- removal of reinforced concrete panel to storage
- other interventions
- removal of reinforced concrete panel and replacement of the tessellatum in situ (specialist project)
- opus sectile stabilization
- shelter
- access barrier (permanent)


Basilique Chrétienne du Nord (BaN)
01
02
03a
03b
04
05
06
07
08
0
5
10
mètres

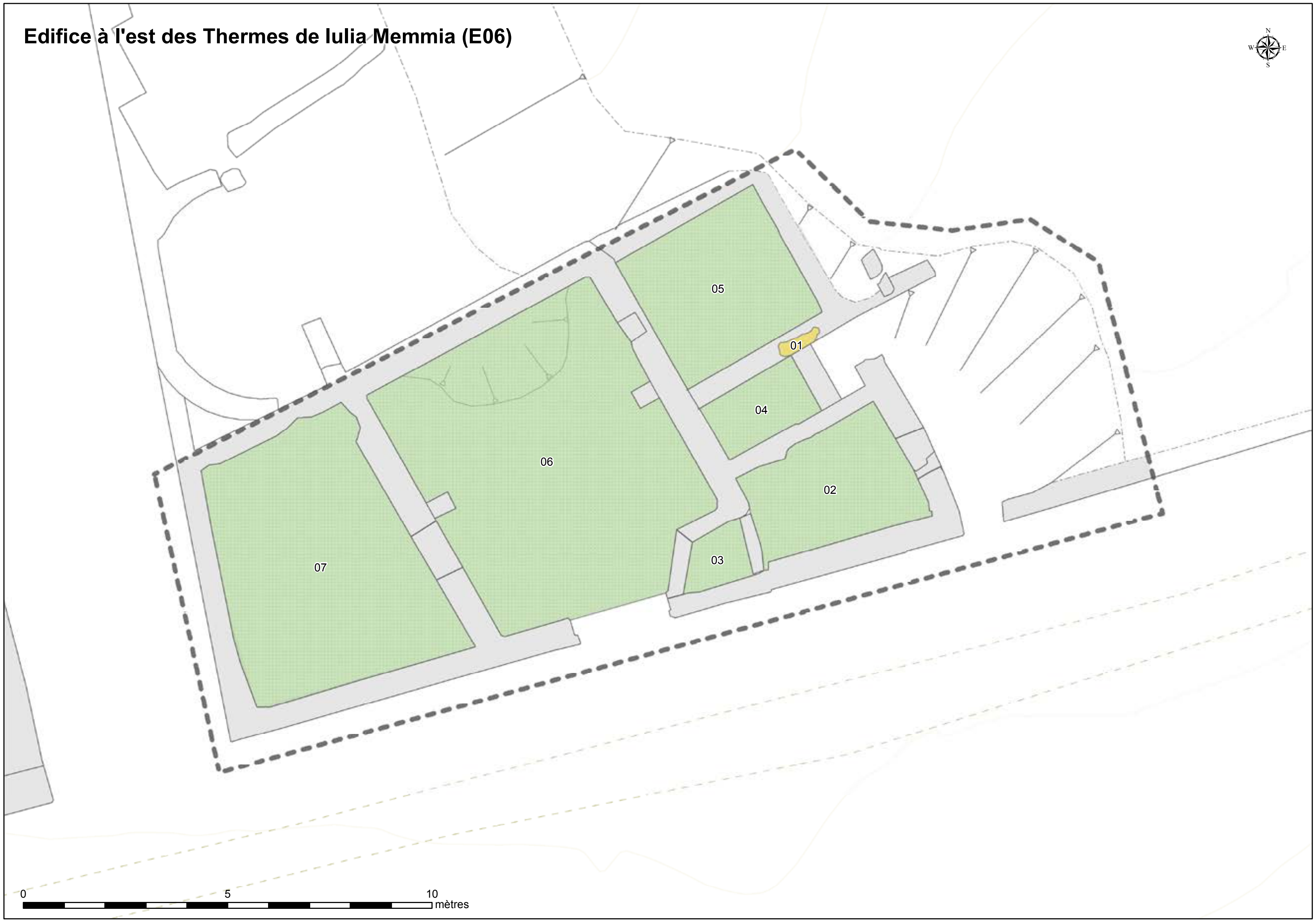

Basilique Chrétienne du Sud (BaS)
01
02
03
04
05
06
07
08
09
10
11
12
13
0
5
10
mètres


Basilique du Forum (B01)
01
02
03
0
5
10
mètres

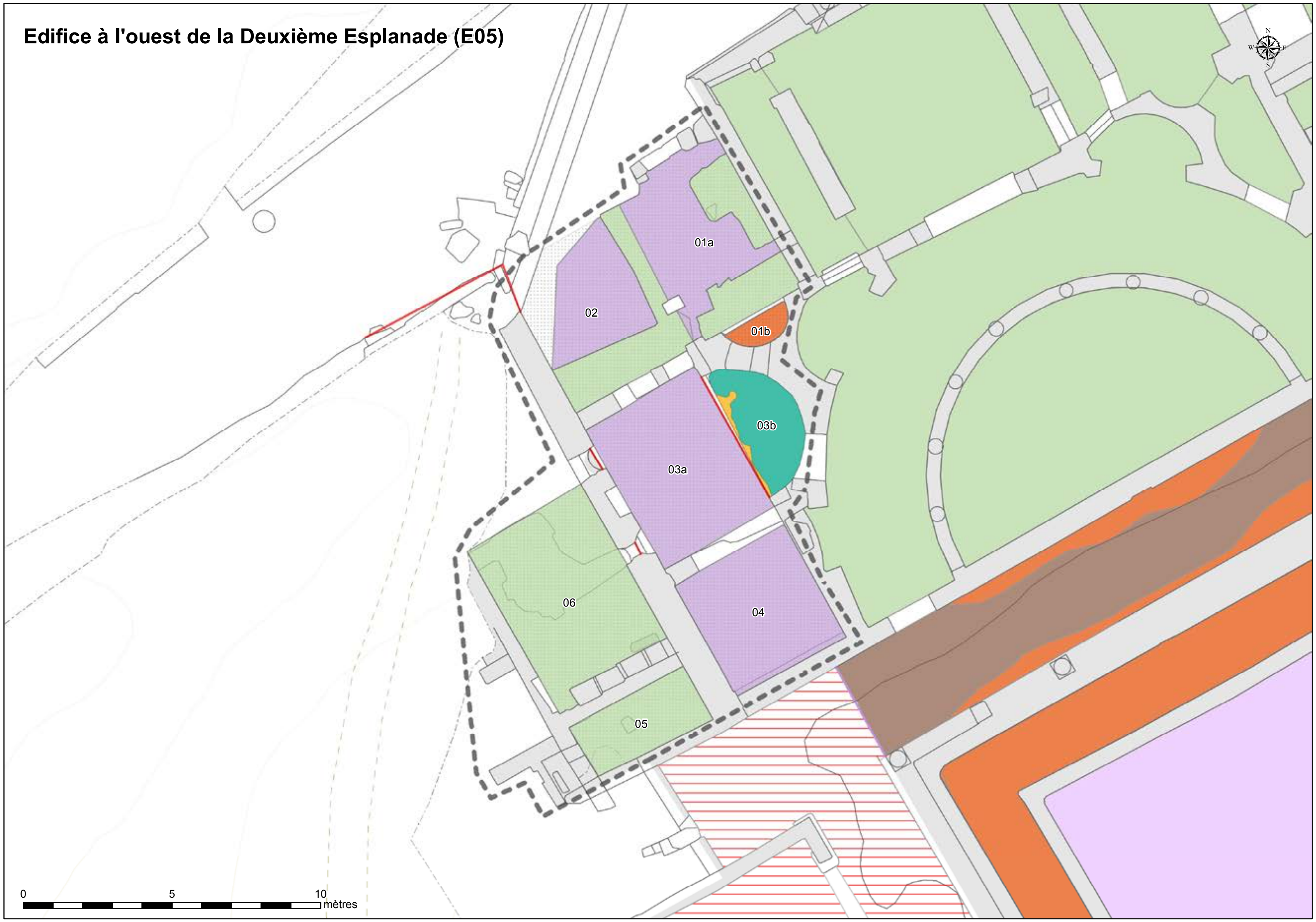


Deuxième Esplanade Monumentale (EM2)
15
14
13
12
10b
11
10a
09
08c
08b
08a
01c
01d
07
17
06b
18
16
02
06a
01a
19
01b
01e
05
05A
04
20
03
21
22
0
5
10
mètres

Edifice à l'est des Thermes de Iulia Memmia (E06)

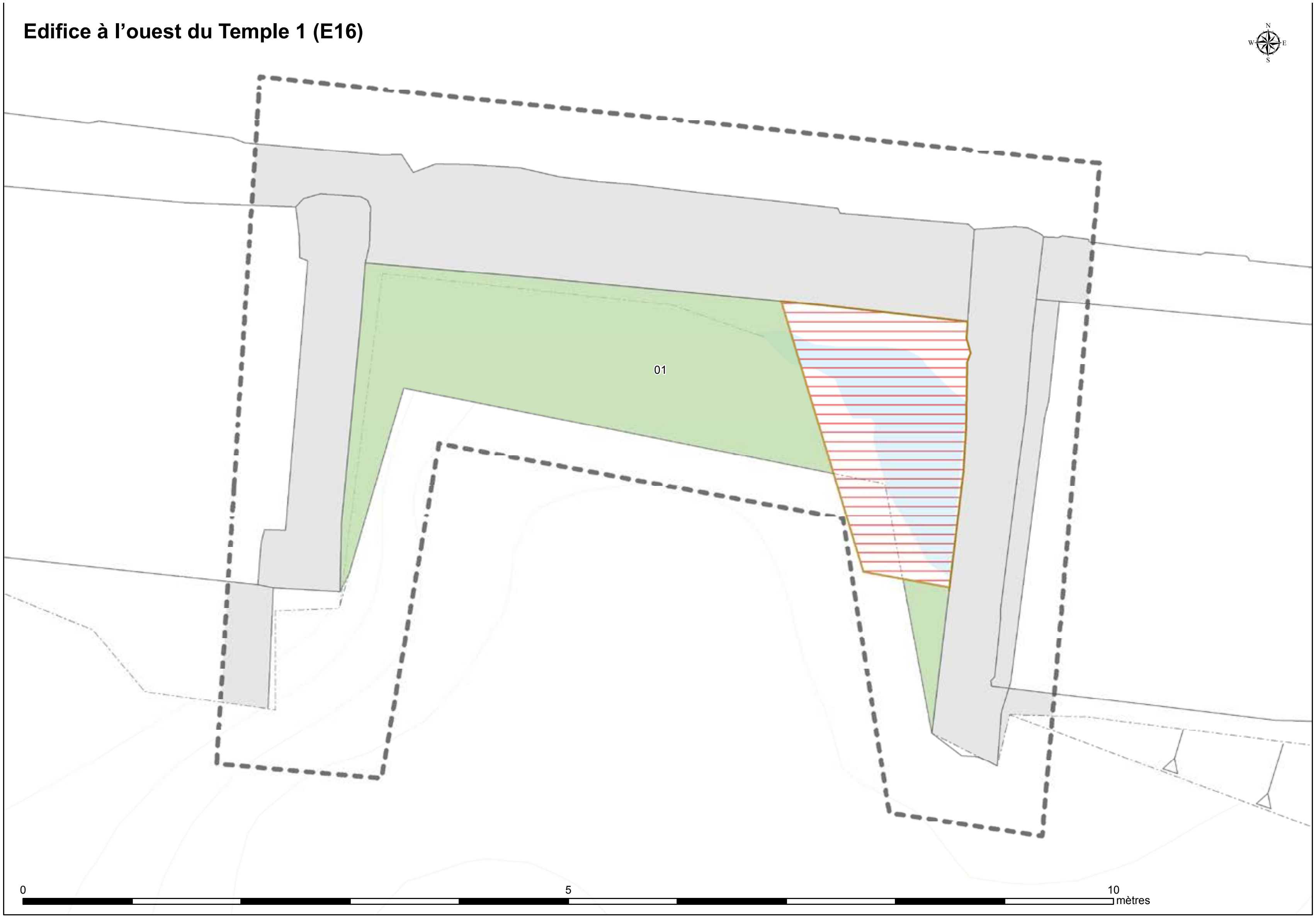


Edifice à l'ouest de la Deuxième Esplanade (E05)

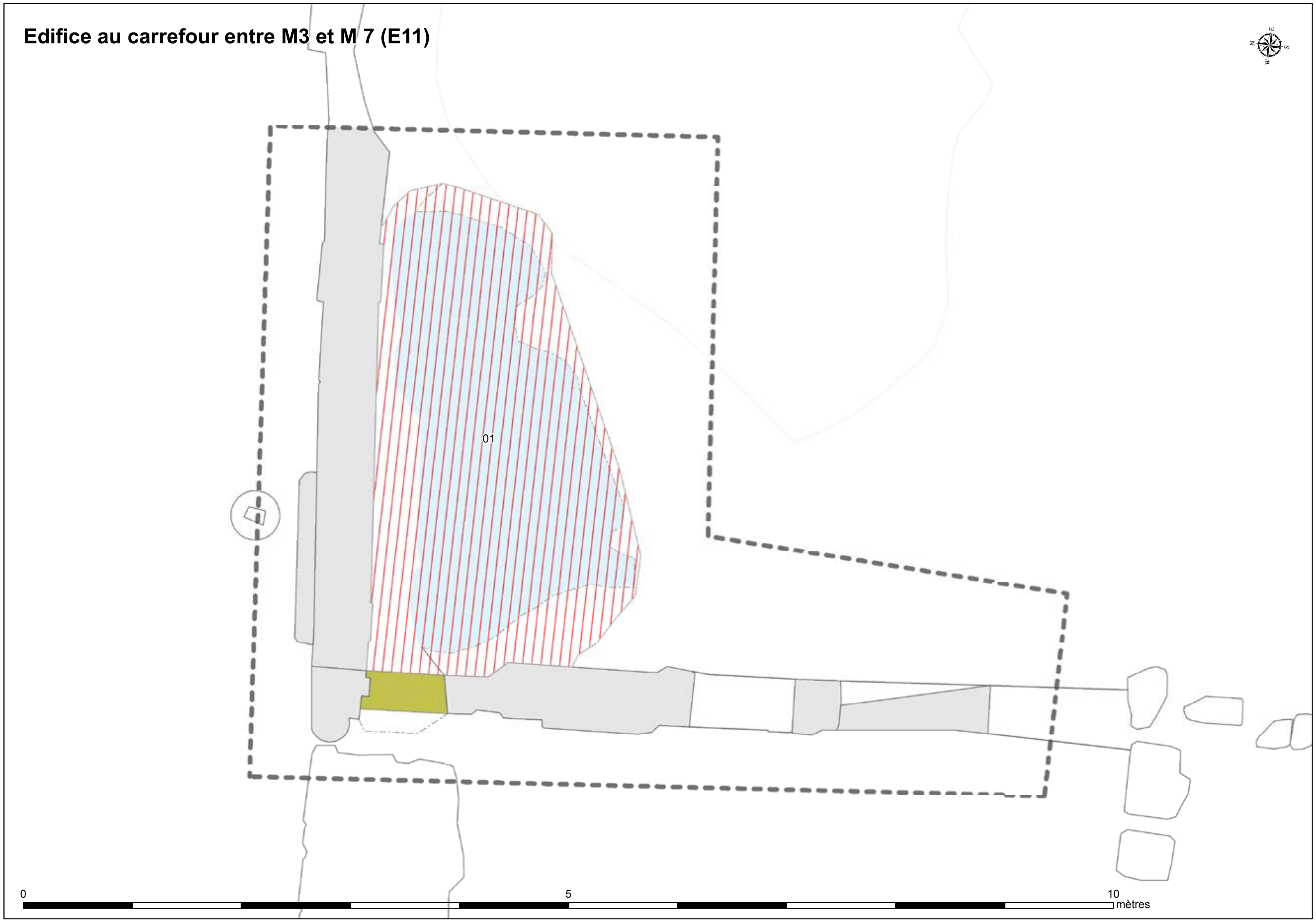


Edifice à l'ouest du monument en opus reticulatum (E08)

Edifice à l'ouest du Temple 1 (E16)



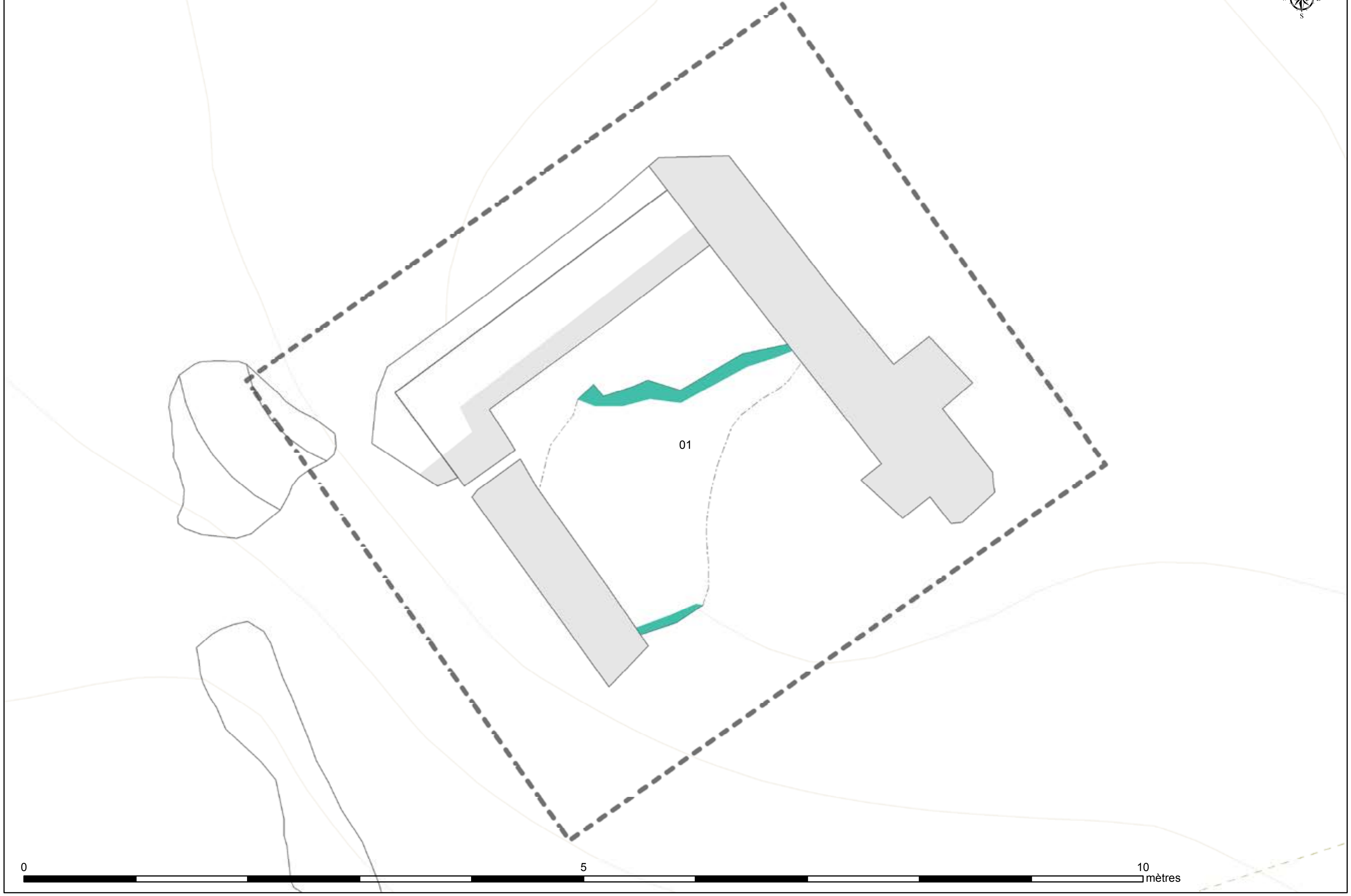
Edifice au carrefour entre M3 et M 7 (E11)



Edifice au coin sud de l'insula de la Pêche (E12)

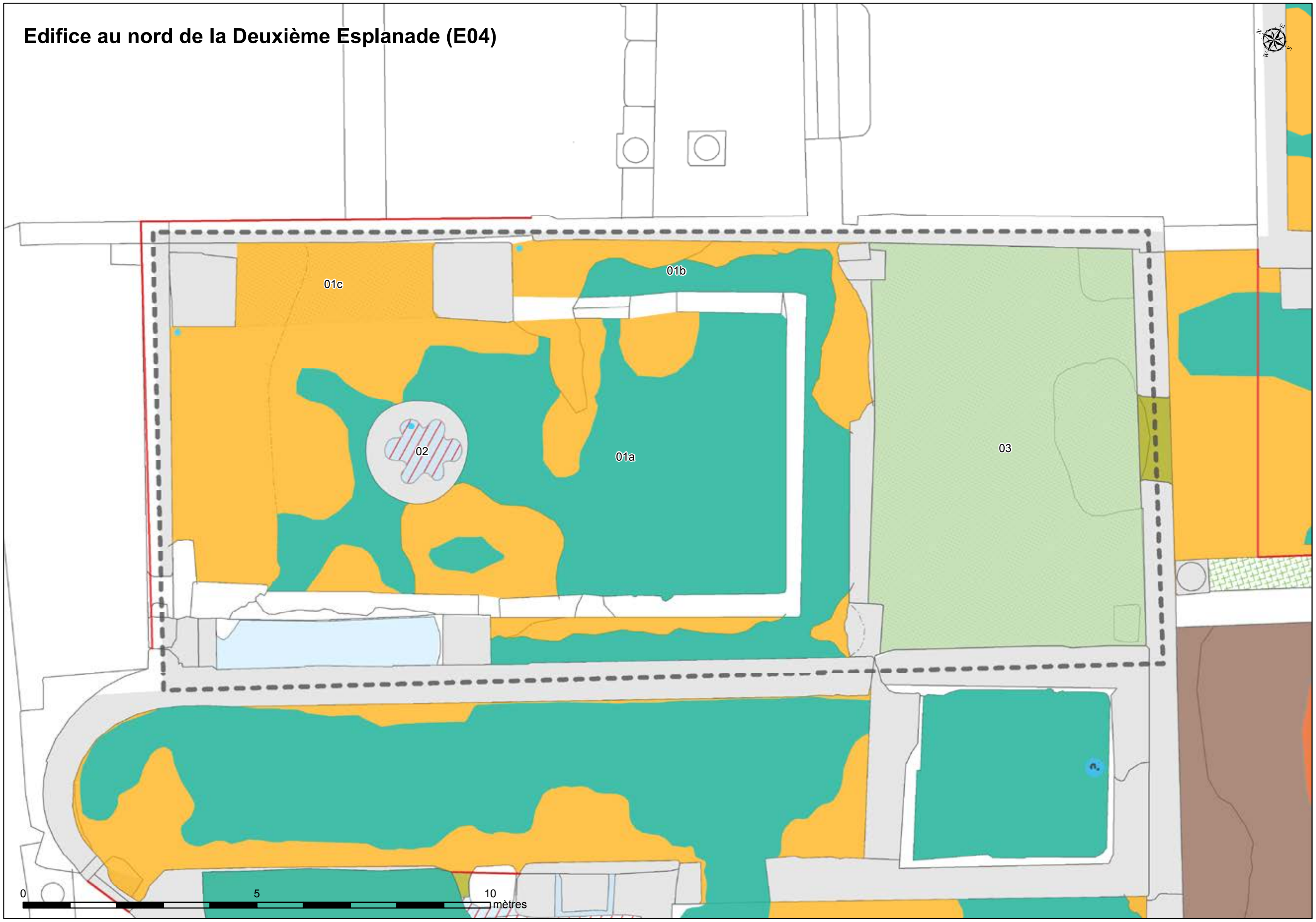
Edifice au nord-est du Marché (E03)

Edifice au nord-est du Temple d'Apollon (E14)

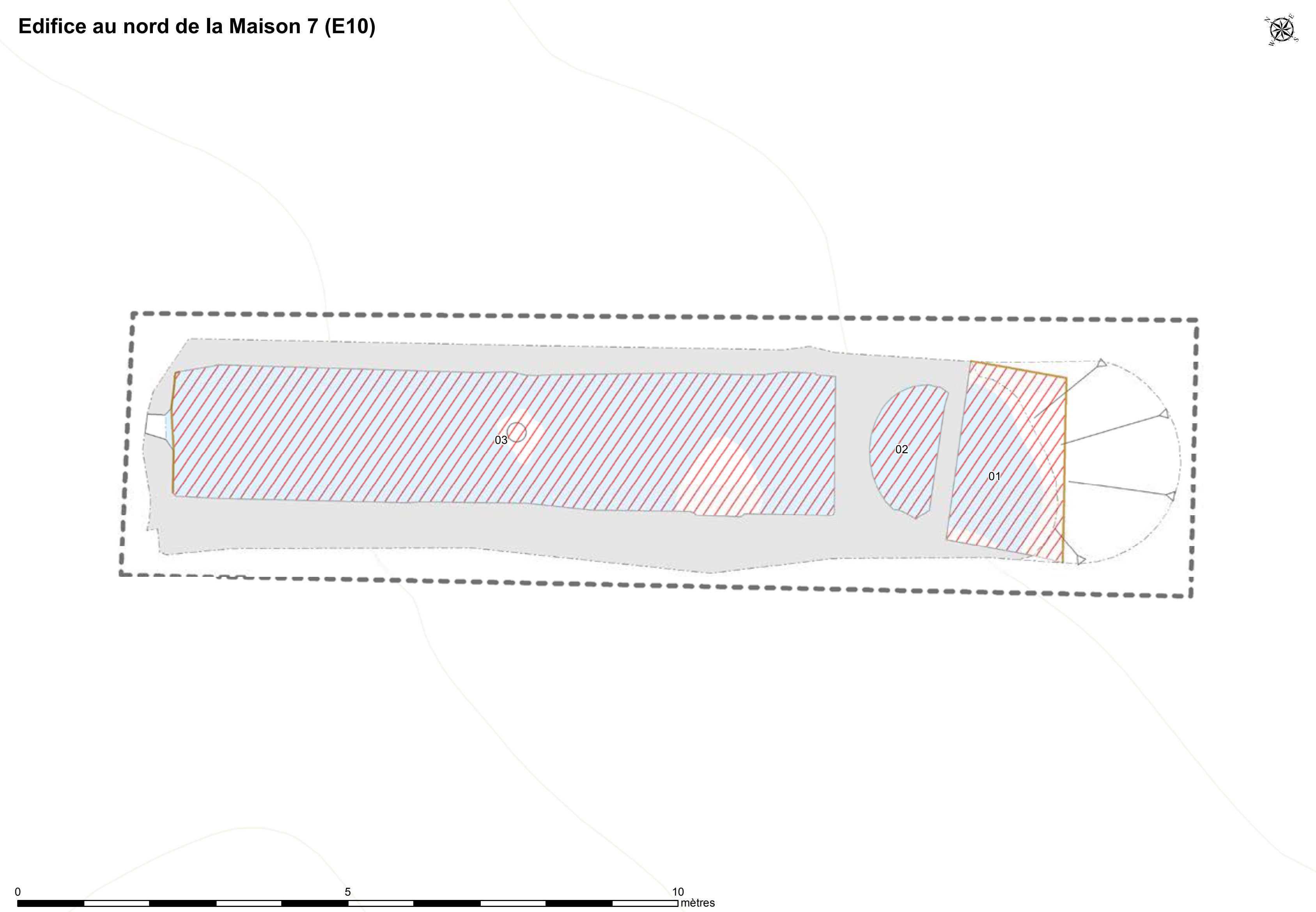


145

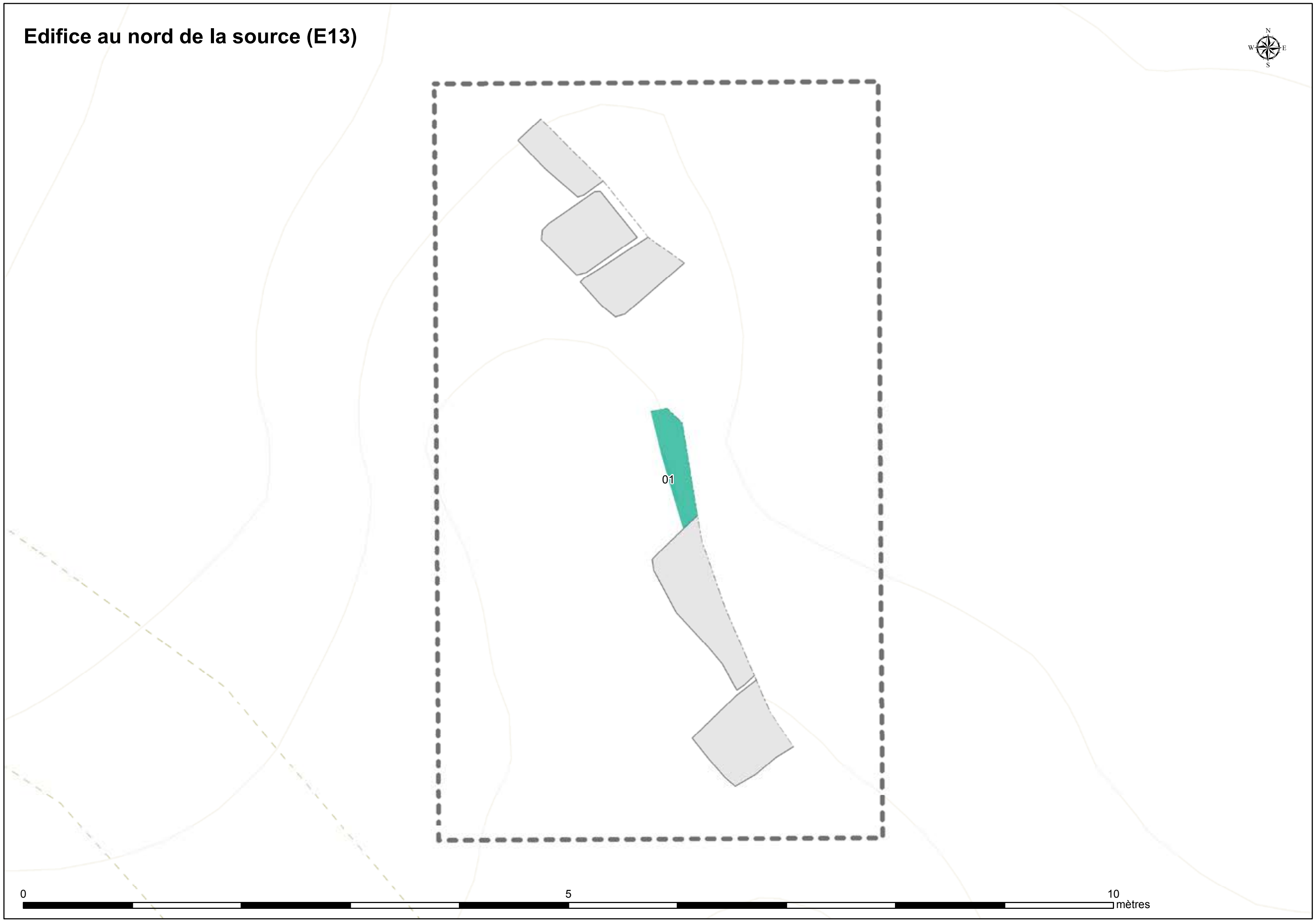
Edifice au nord de la Deuxième Esplanade (E04)



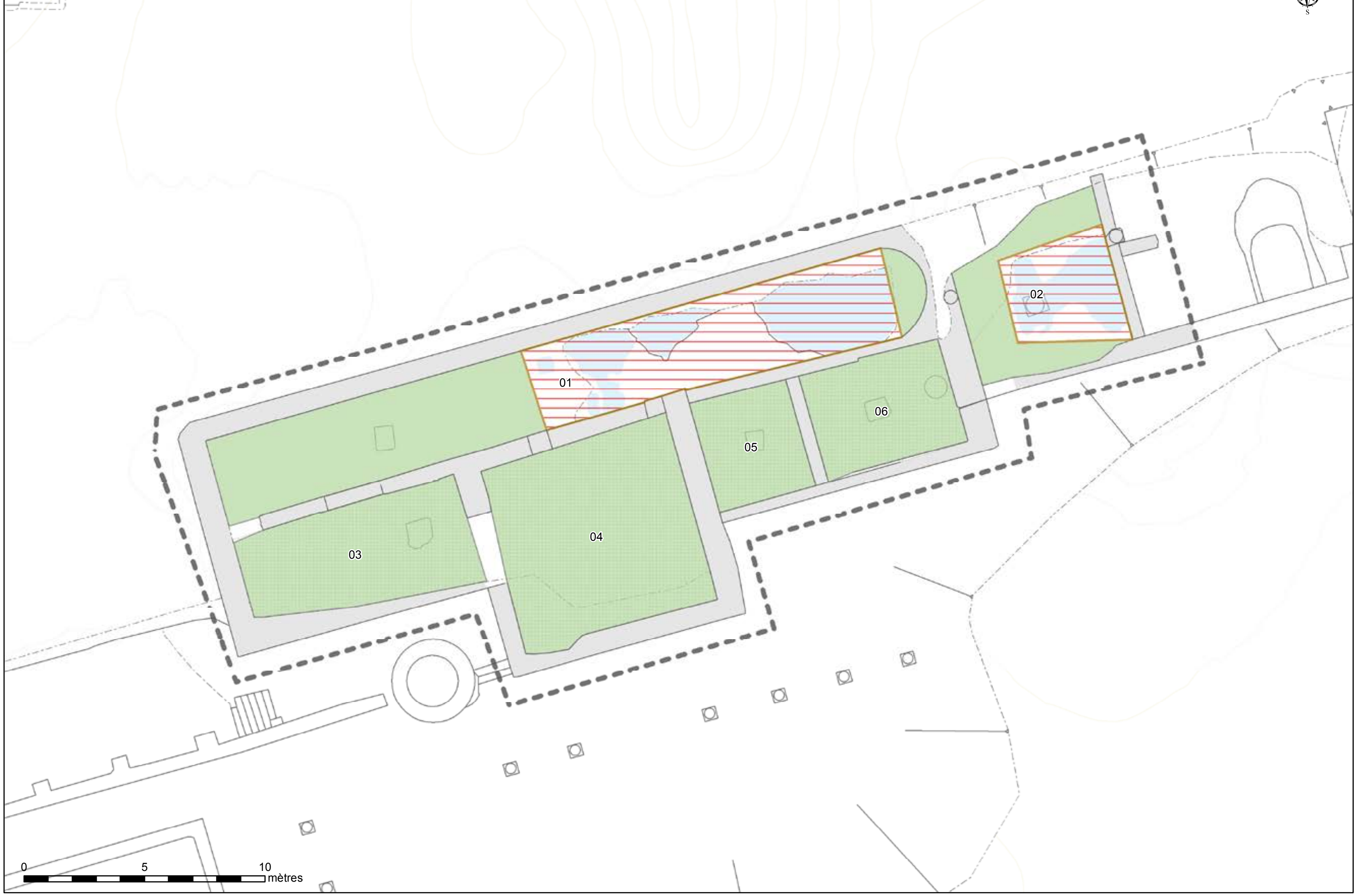
Edifice au nord de la Maison 7 (E10)

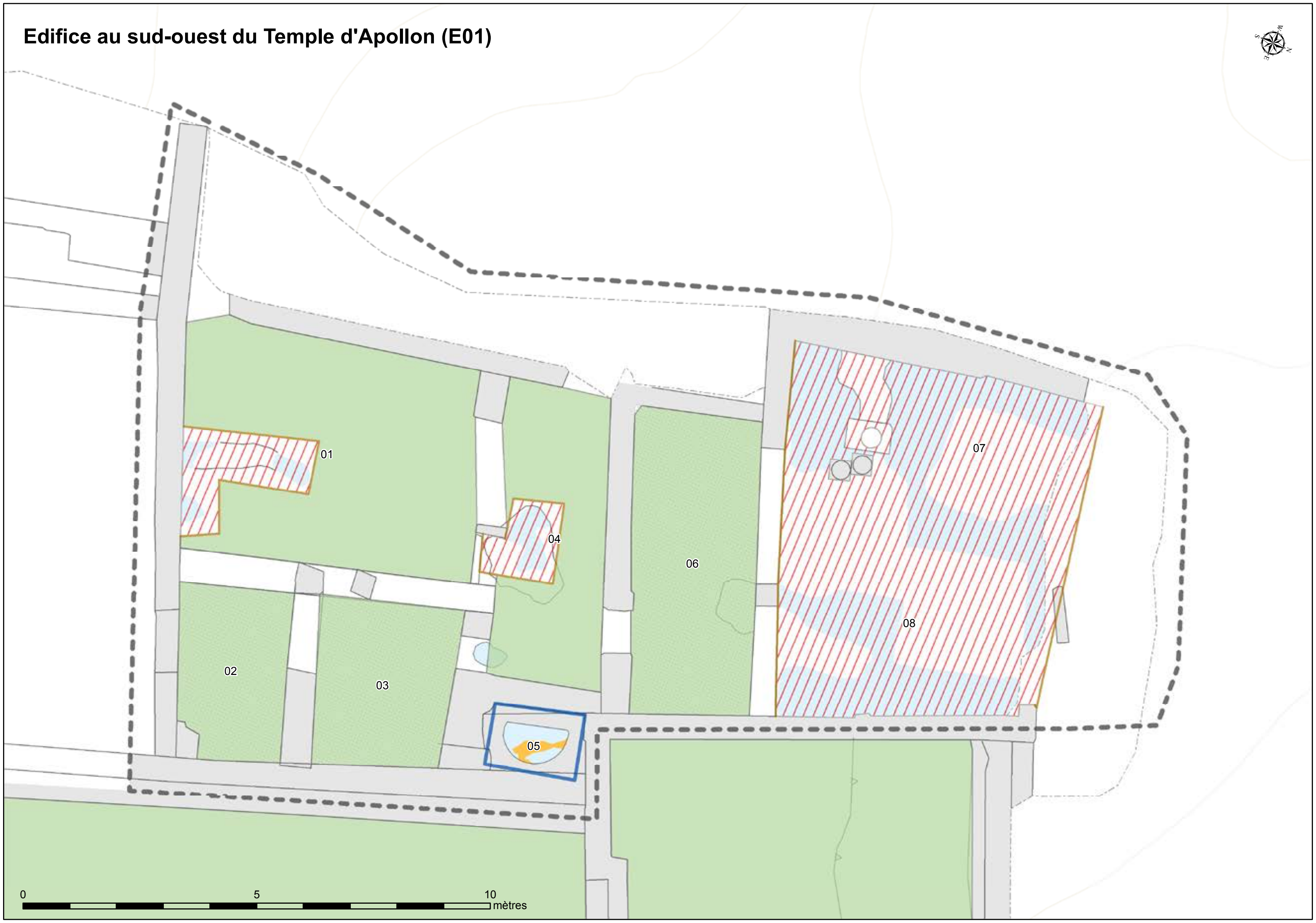


Edifice au nord de la source (E13)

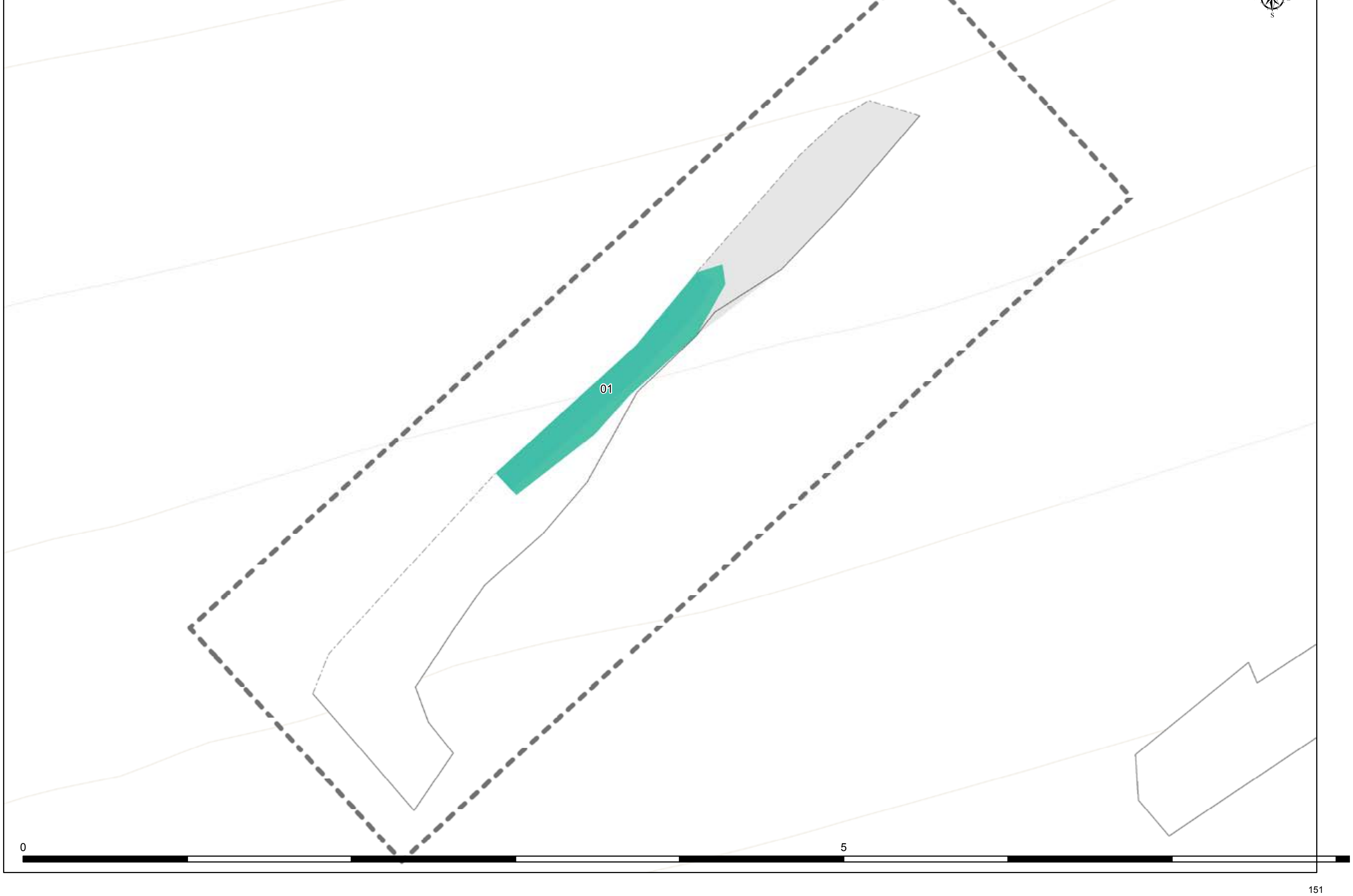


Edifice au nord du monument en opus reticulatum (E07)



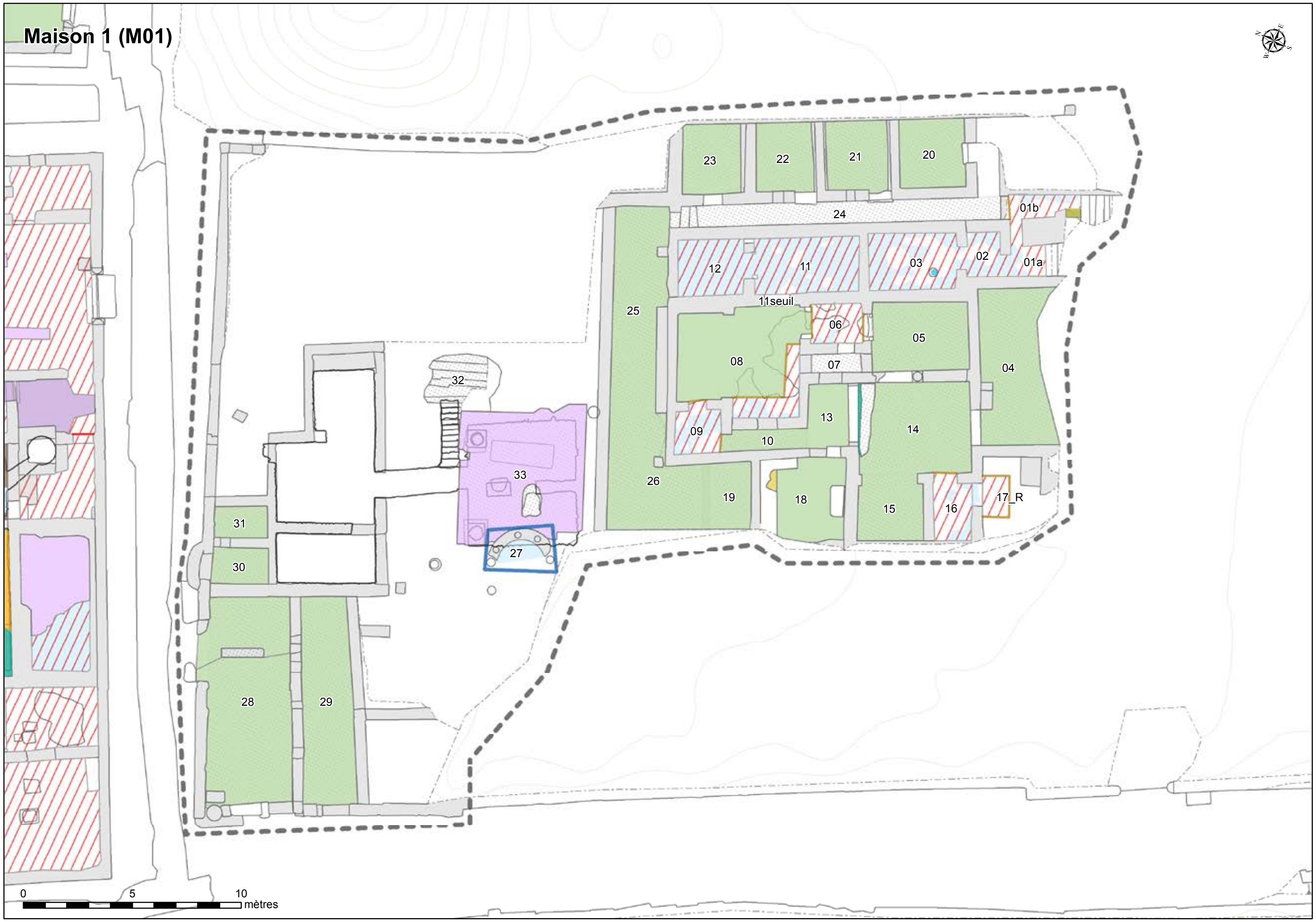

Edifice au sud-ouest du Temple d'Apollon (E01)
01
02
03
04
05
06
07
08
0
5
10
mètres

Edifice au sud de la colline (E15)



Edifice au sud de la Maison 3 (E09)


Edifice dans le coin sud du Forum (E02)
N
E
S
W
05
08
06
01
02
03
04
07
0
5
10
mètres


Maison 1 (M01)
23
22
21
20
24
01b
12
11
03
02
01a
11seuil
25
06
05
08
07
04
32
13
14
09
10
33
26
19
18
15
16
17_R
31
27
30
28
29
0
5
10
mètres


Maison 1 - étage souterraine (M01 - S)
S04
S07
S06
S03
S01
S02
S05
0
5
10
mètres

Maison 10 (M10)
20
17
04
03
05
15
22
21
06
14a
14b
07
18
02a
08
11
01
19
02d
02b
01b
09
12
10
13
02c
16
23
24
25
0
5
10
mètres


Maison 14 (M14)
05
04
03
07
02
06
01
0
5
10
mètres

Maison 15 (M15)
01
02
03
04
05
06
07
08
09
10
0
5
10
mètres

Maison 2 (M02)

Maison 3 (M03)


32
31
30
28
29
35
36
15
14
13
08
07
06
12a
10
09
05
04
33
16
12b
11b
11a
37
01
18b
18a
17
12c
03
02
19
20
21
22
23
34
26
25
24
27
0
5
10
mètres

Maison 3 - étage souterraine (M03 - S)


Maison 4 (M04)
13
12
14
17b
15
17a
16
05c
09
08b
08a
05b
06b
05a
03
01
04
20
02
19
07
06a
05e
05d
10b
10a
11
18
0
5
10
mètres


Maison 5 (M05)
15
16
17
14
11
10
13
01
09
12
04b
04a
08
03
05
07
02
06
0
5
10
mètres

Maison 7 (M07)

02
01
03a
03b
04
11
06
05
S03a
S03b
S01b
S01a
10
09
12
S01c
S02
08
07
S04
0
5
10
mètres

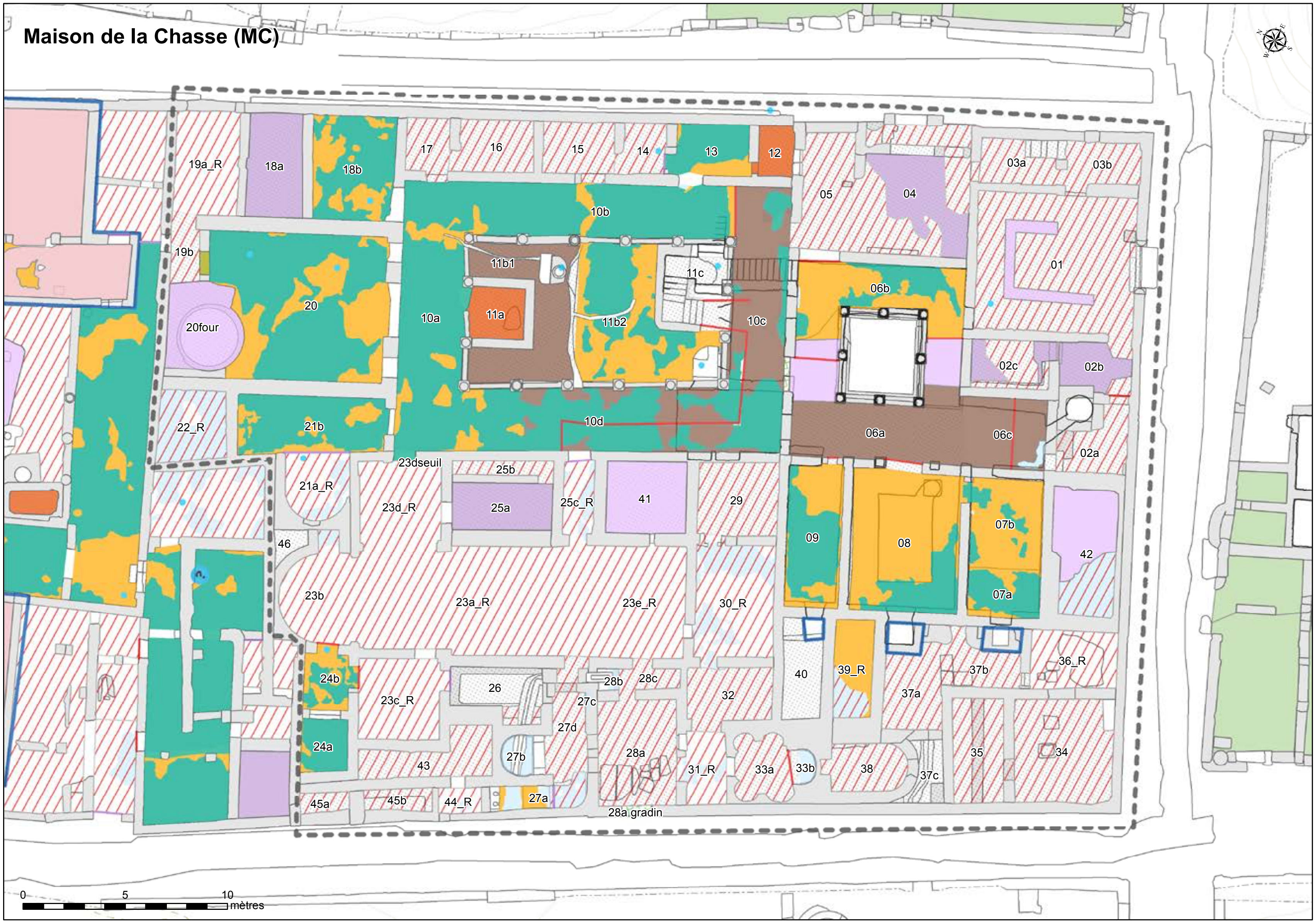
Maison 8 (M08)
23
24
22
16
25
15
10
08
07
21
14
12
09
06
13a
26
27
13b
02
04
20
19
18
17
11
03
01
05
28
0
5
10
mètres

Maison 9 (M09)

04
08
09
10a
10b
11
12
02
07
01
05
06
15
14a
13
16
14b
03
17
0
5
10
mètres


Maison d'Amphitrite (MA)
37
13
12
02a
01
15d_R
15a.b.c
14
11
45
38
10
16
18
17
43
44
05
09
19
02c
35seuil
21
20
03
02b
40
42
35
05A
08
24
23
05B
41
22
07
36
39
26
25
04B
04A
51
28
27
06a
50
47
34
30
29
53
06b
49
48
46
33
32
31
52
0
5
10
mètres

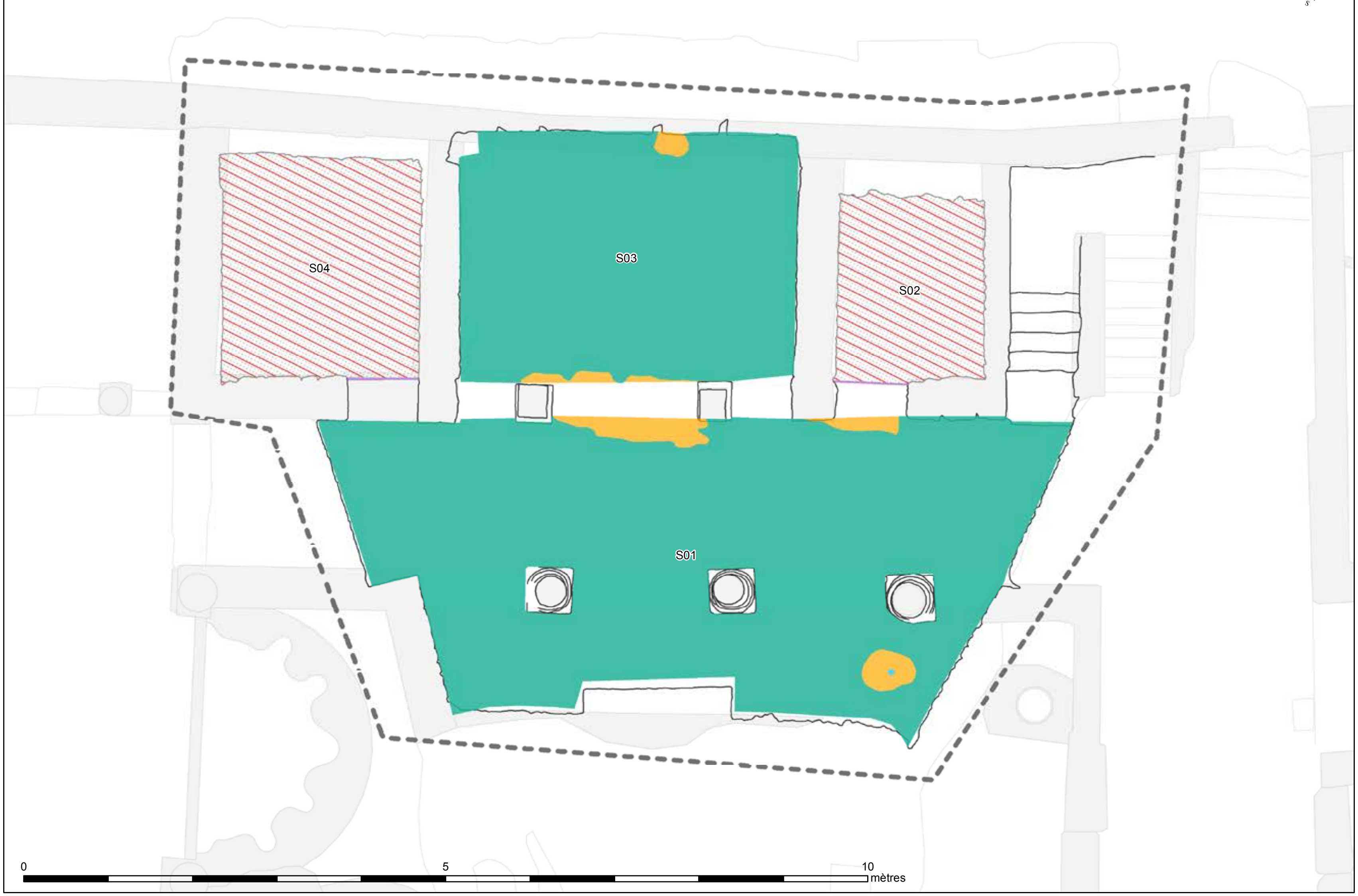
Maison d'Amphitrite - étage souterraine (MA - S)


Maison de la Chasse (MC)
19a_R
18a
18b
17
16
15
14
13
12
05
04
03a
03b
19b
10b
11b1
11c
06b
01
20
20four
10a
11a
11b2
10c
02c
02b
22_R
21b
10d
06a
06c
02a
23dseuil
25b
21a_R
23d_R
25a
25c_R
41
29
09
08
07b
42
46
23b
23a_R
23e_R
30_R
07a
40
39_R
37b
36_R
24b
26
28b
28c
32
37a
23c_R
27c
27d
24a
27b
28a
43
31_R
33a
33b
38
37c
35
34
45a
45b
44_R
27a
28a gradin
0
5
10
mètres

Maison de la Chasse - étage souterraine (MC - S)

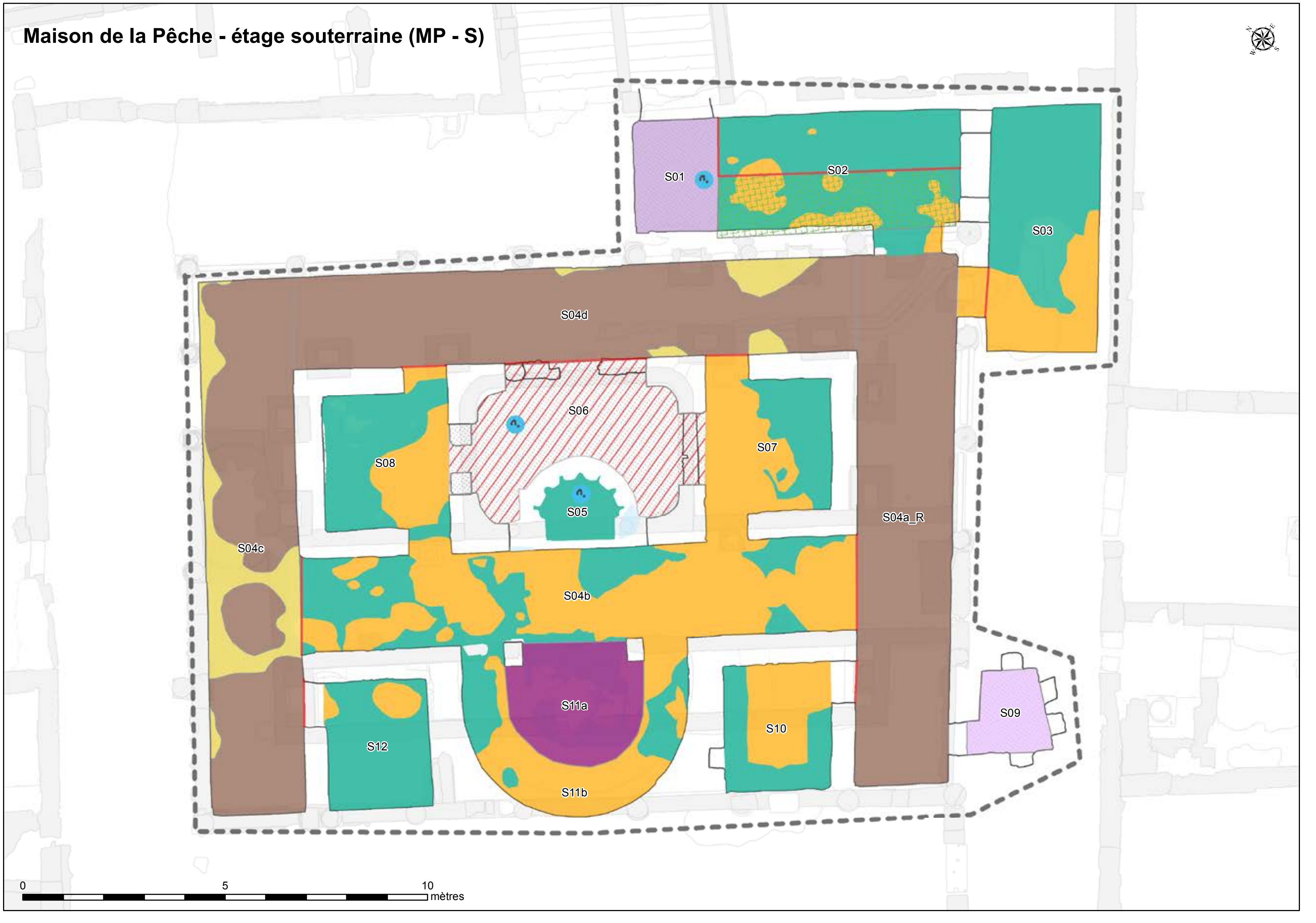

Maison de la Nouvelle Chasse (MNC)
17a
17b
16
15
14
28
29
04
01b
01a
01c
12a
12b
13
26
10
11
02
09
03
05
27
25
08
06
07
22
23
24
19a
20a
21
18
20b
19b
32a
30
31
32b
0
5
10
mètres

Maison de la Nouvelle Chasse - étage souterraine (MNC - S)

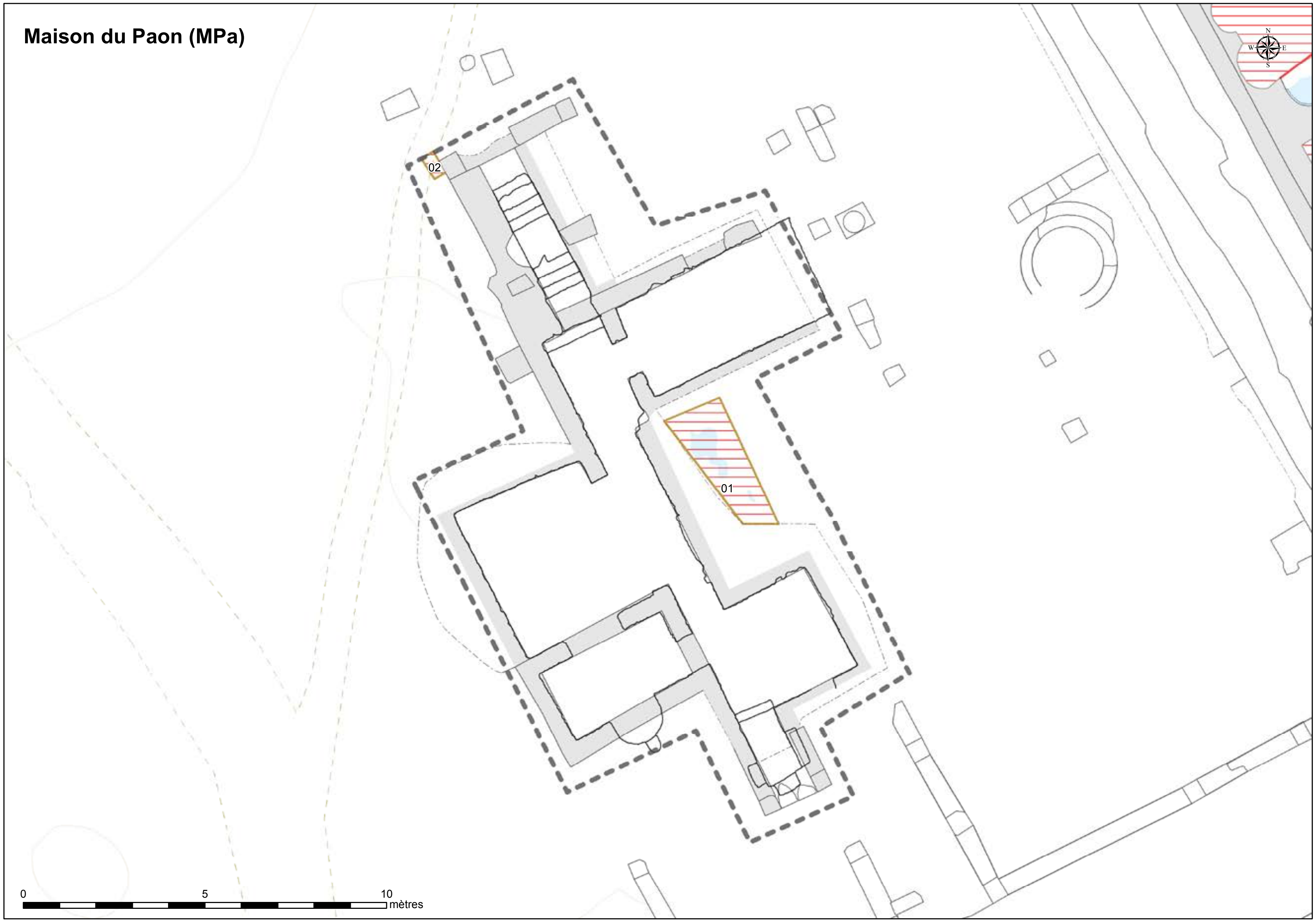



Maison de la Pêche (MP)
01a
01c
01b
11
12
13
14
43
15
02
06b
06a
06c
06cM
06aM
17
16
19
07
05
03
42
08
18
09
40
41
20
10
04
22b
22c
21
28
22a
31
33
37
25
30
26b
23
27
24
29a
29b
32
34
35
38
26a
45
44
36
39
0
5
10
mètres

Maison de la Pêche - étage souterraine (MP - S)

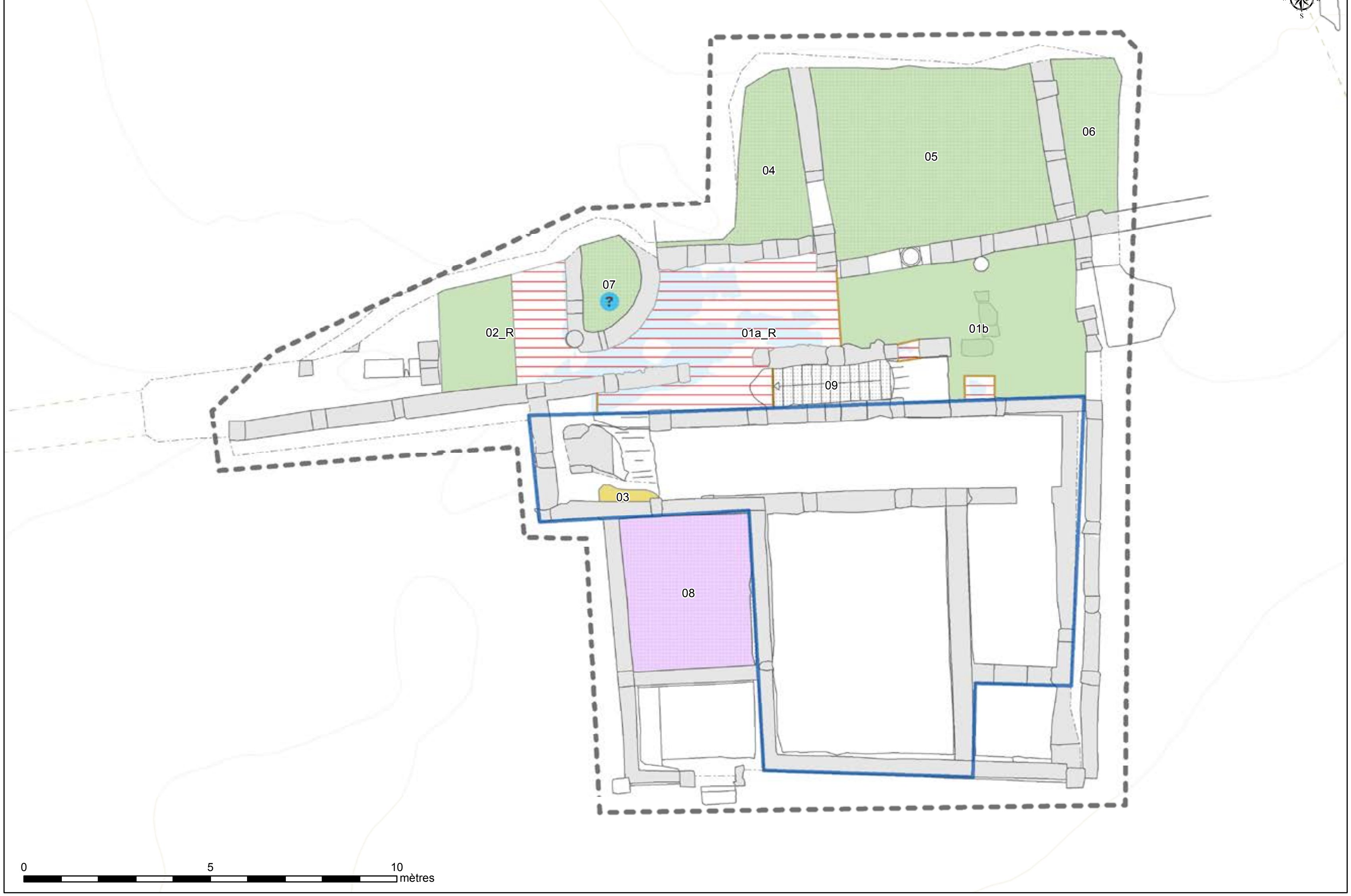


Maison du Paon (MPa)

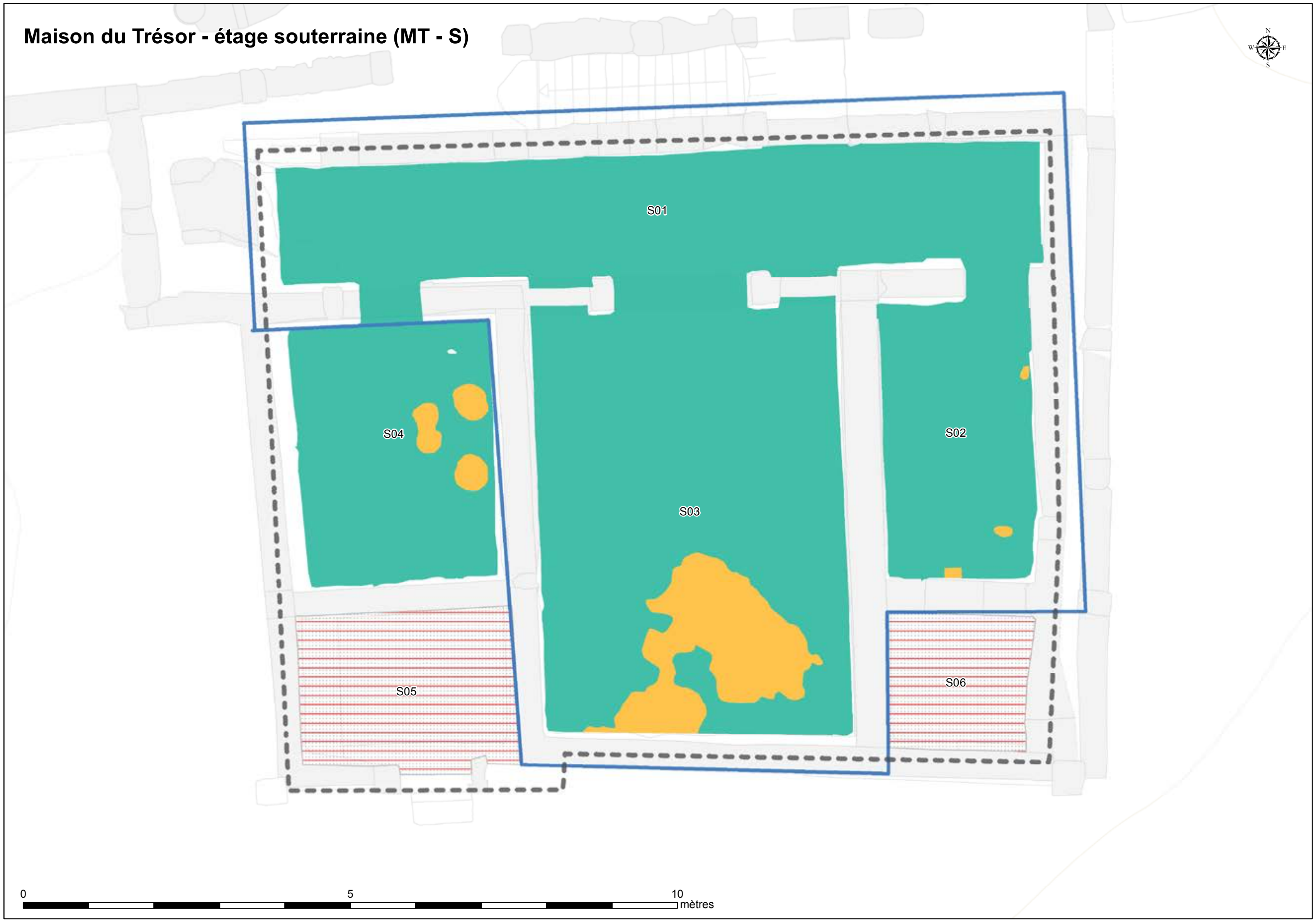


Maison du Paon - étage souterraine (MPa - S)

Maison du Trésor (MT)



Maison du Trésor - étage souterraine (MT - S)

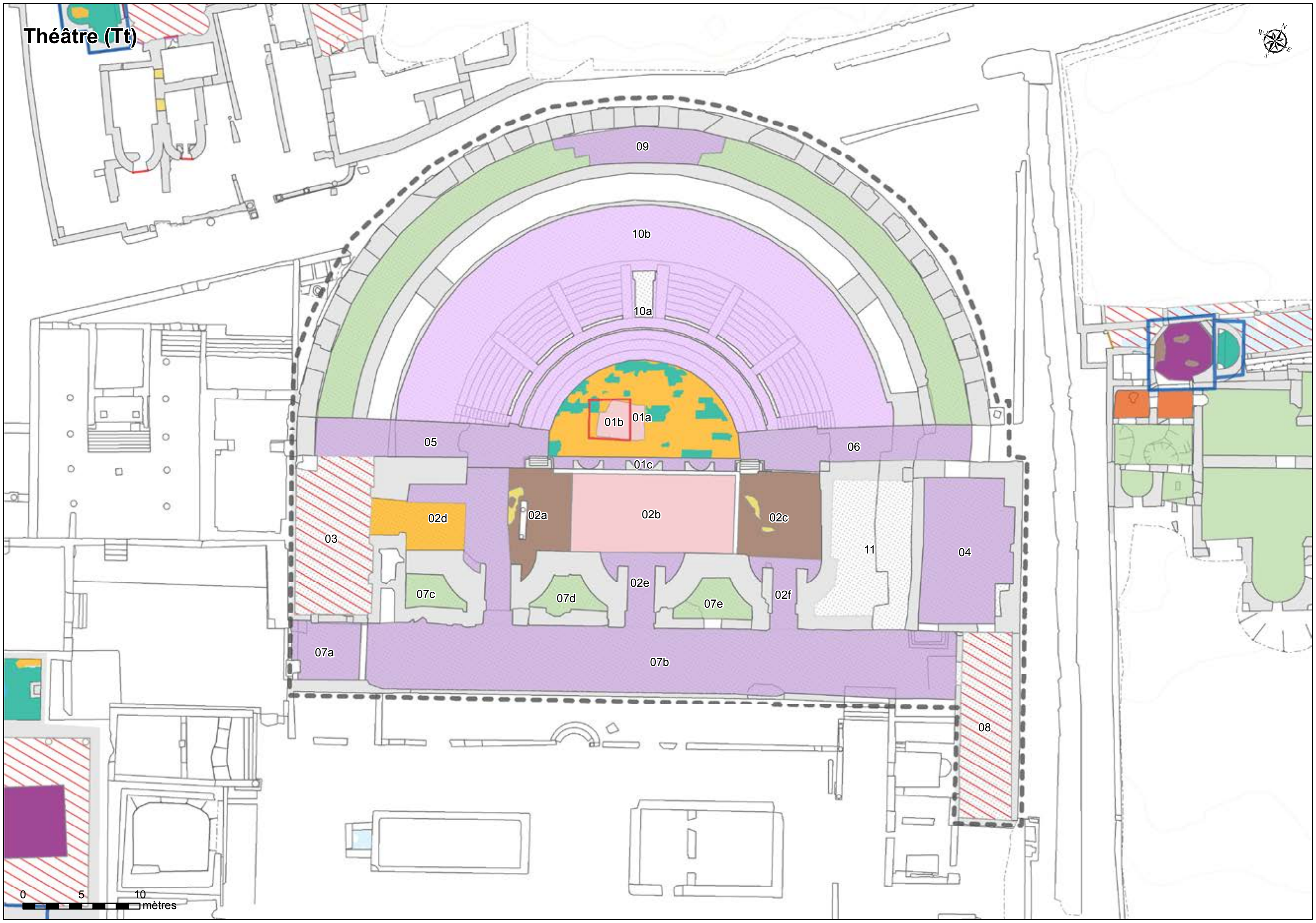



Marché (Mar)
07
04n
04m
04l
04i
04h
04g
06
09
02c
03
02a
04
01
08
02b
05
04a
04b
04c
04d
04e
04f
0
5
10
mètres

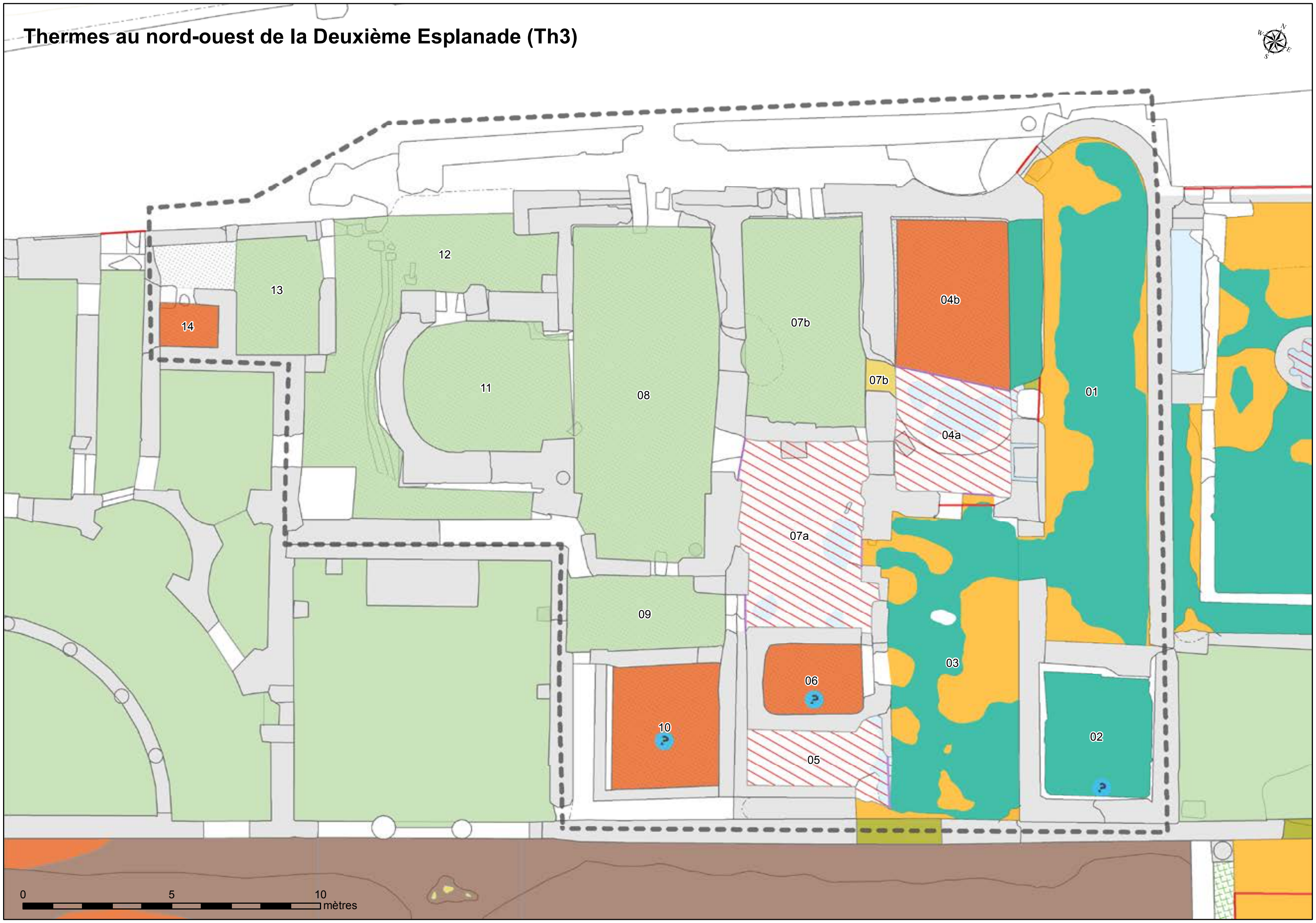
Nymphée 1 (Ny1)

Temple d'Apollon (TAp)

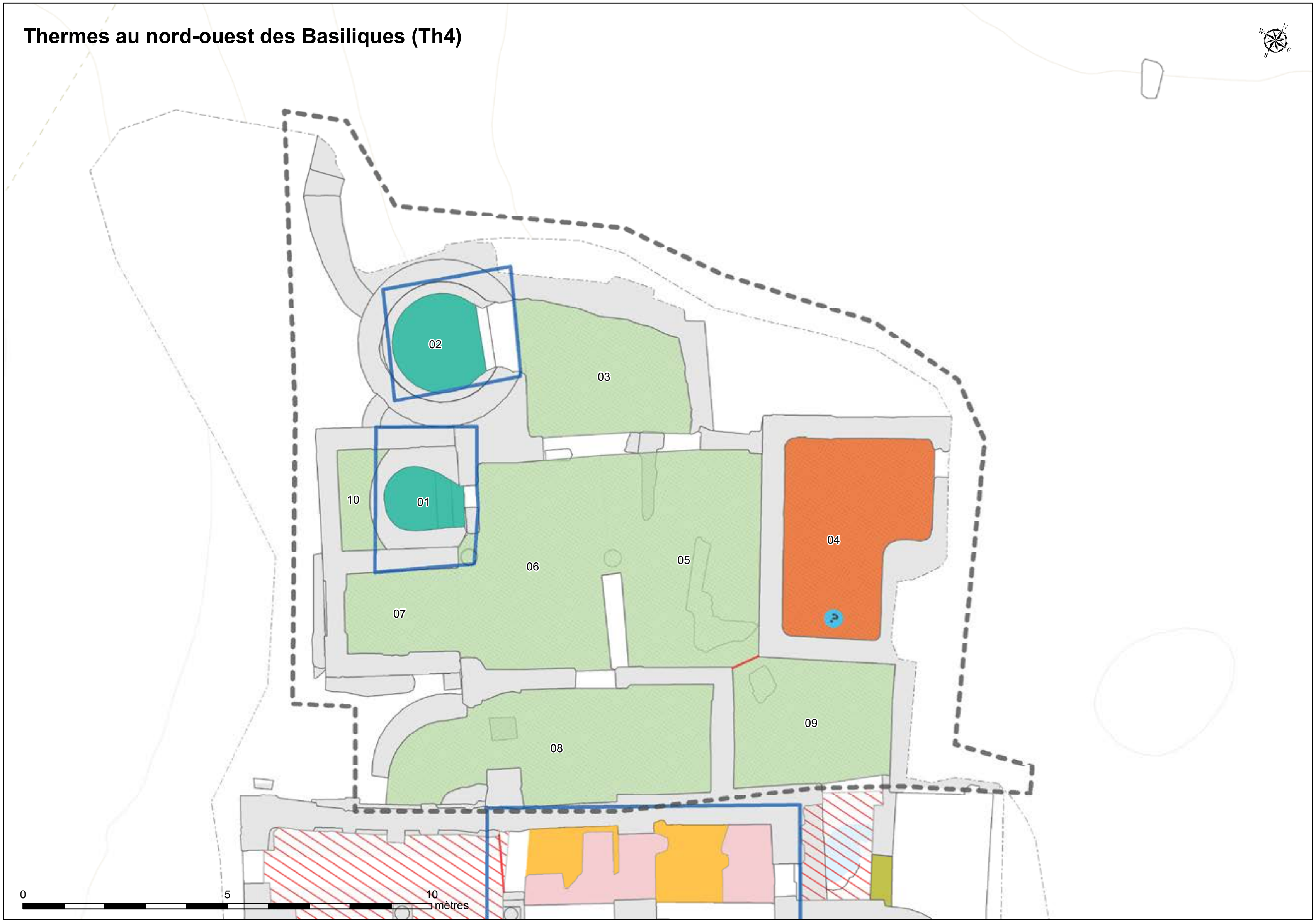
Temples à l'ouest des Thermes de Iulia Memmia (T1)


Théâtre (Tt)
09
10b
10a
01b
01a
05
06
01c
02d
02a
02b
02c
03
11
04
07c
07d
02e
07e
02f
07a
07b
08
0
5
10
mètres


Thermes à l'est du Théâtre (Th2)
05
04
03
06
01
02
07
08
09
16
14
15
10
11
17
13
12
0
5
10
mètres


Thermes au nord-ouest de la Deuxième Esplanade (Th3)
12
13
14
11
08
07b
04b
07b
04a
01
07a
09
03
06
10
05
02
0
5
10
mètres

Thermes au nord-ouest des Basiliques (Th4)




Thermes au nord-ouest du Théâtre (Th1)
27
26
29
21
22_R
23
24_R
25
20
18
16
14
19
17
15
07_R
01
03
08
13
04
05_R
10
08seuil
10seuil
02
28
09
11
06
12
0
5
10
mètres


Thermes de Iulia Memnia (ThIM)
01
02
03
04
05
06a
06b
07b
07a
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26a
26b
27
28
29
30a
30b
31
33
34
0
5
10
mètres

Thermes des Venantii (ThV)

Thermes du nord-est (Th5)

Phase 2a - Visitation

exposed mosaic

accessible area

visitation route - ancient road

visitation route - path

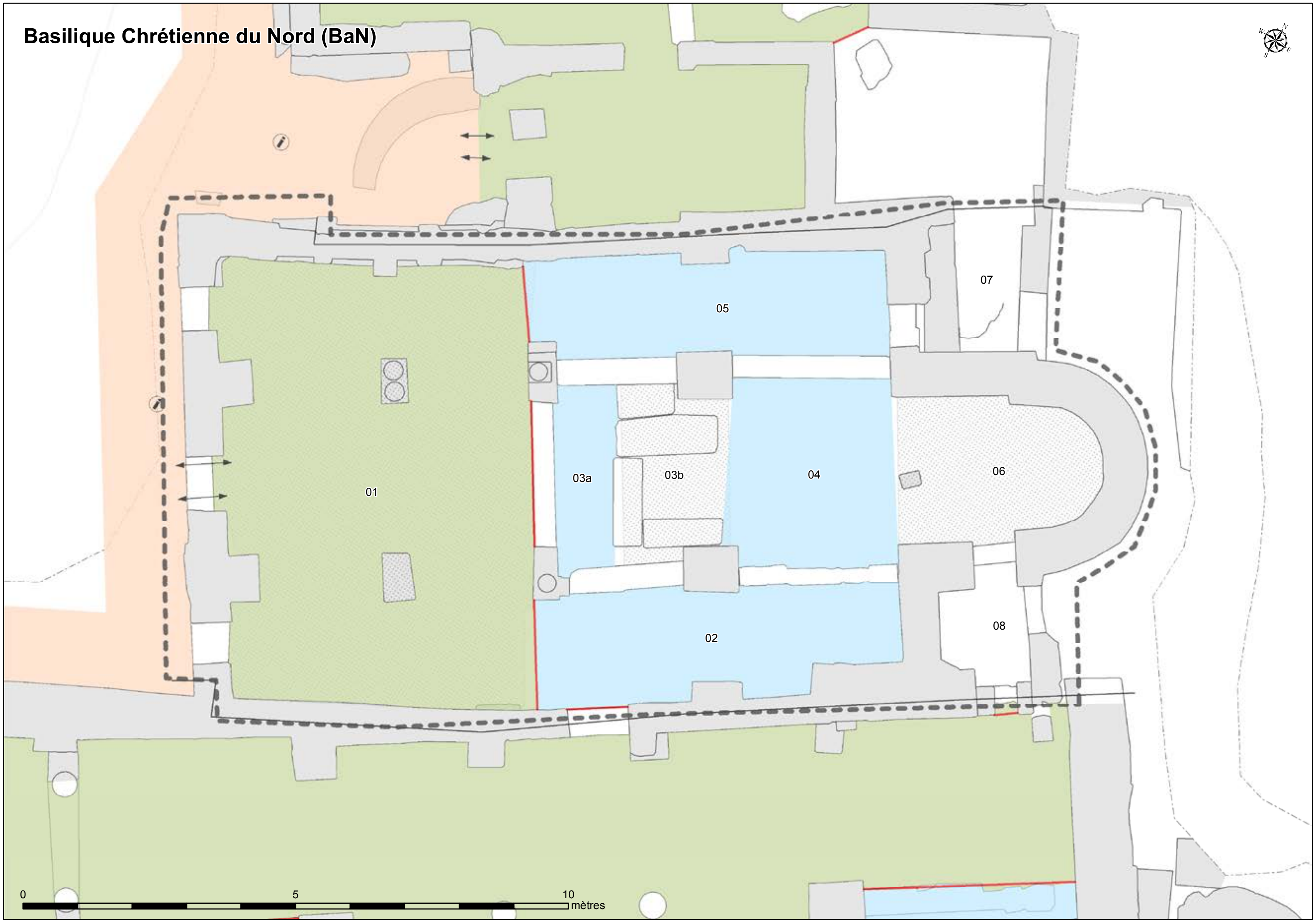
walkway

access barrier (permanent)

entry/exit point

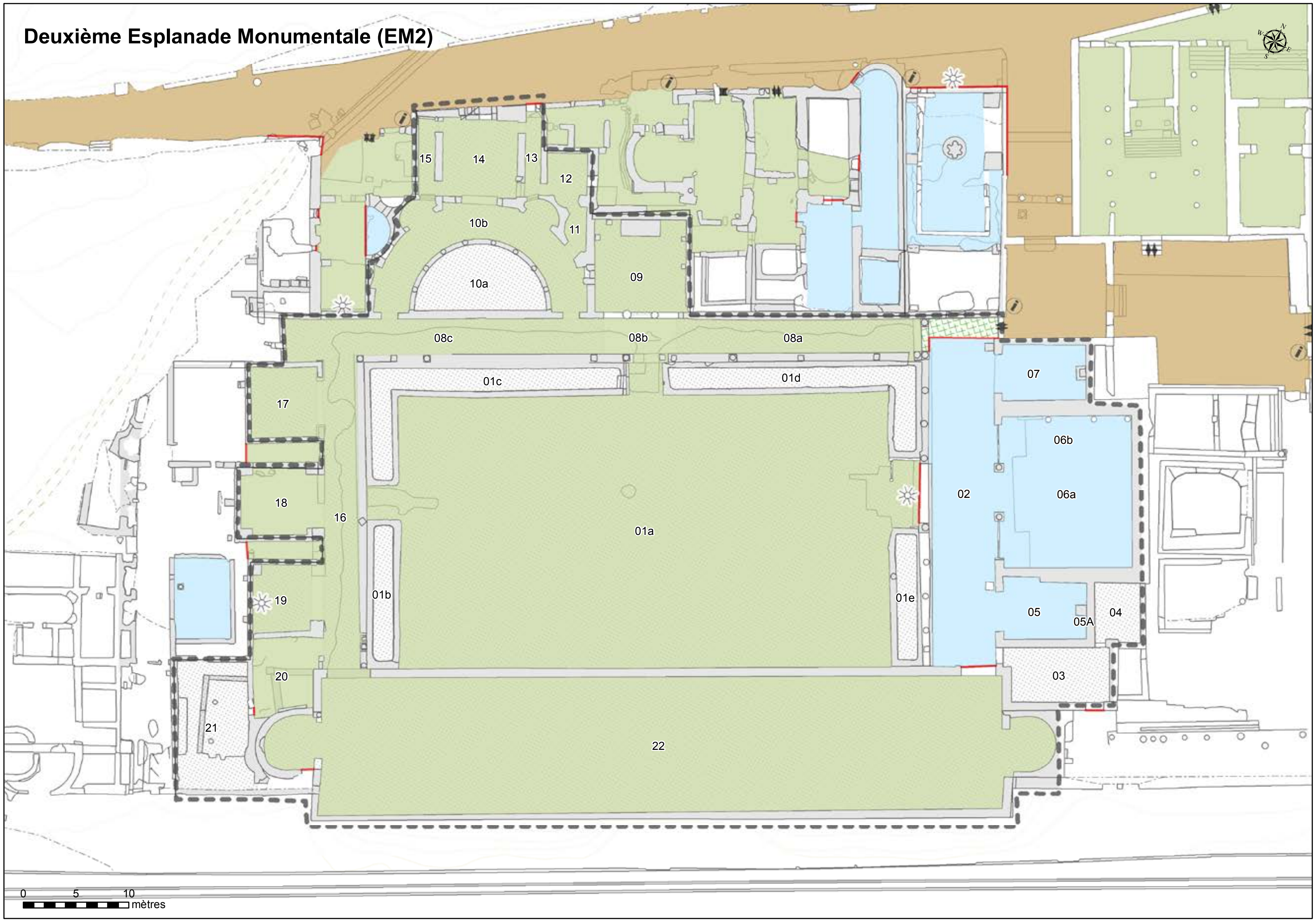
viewpoint

signage

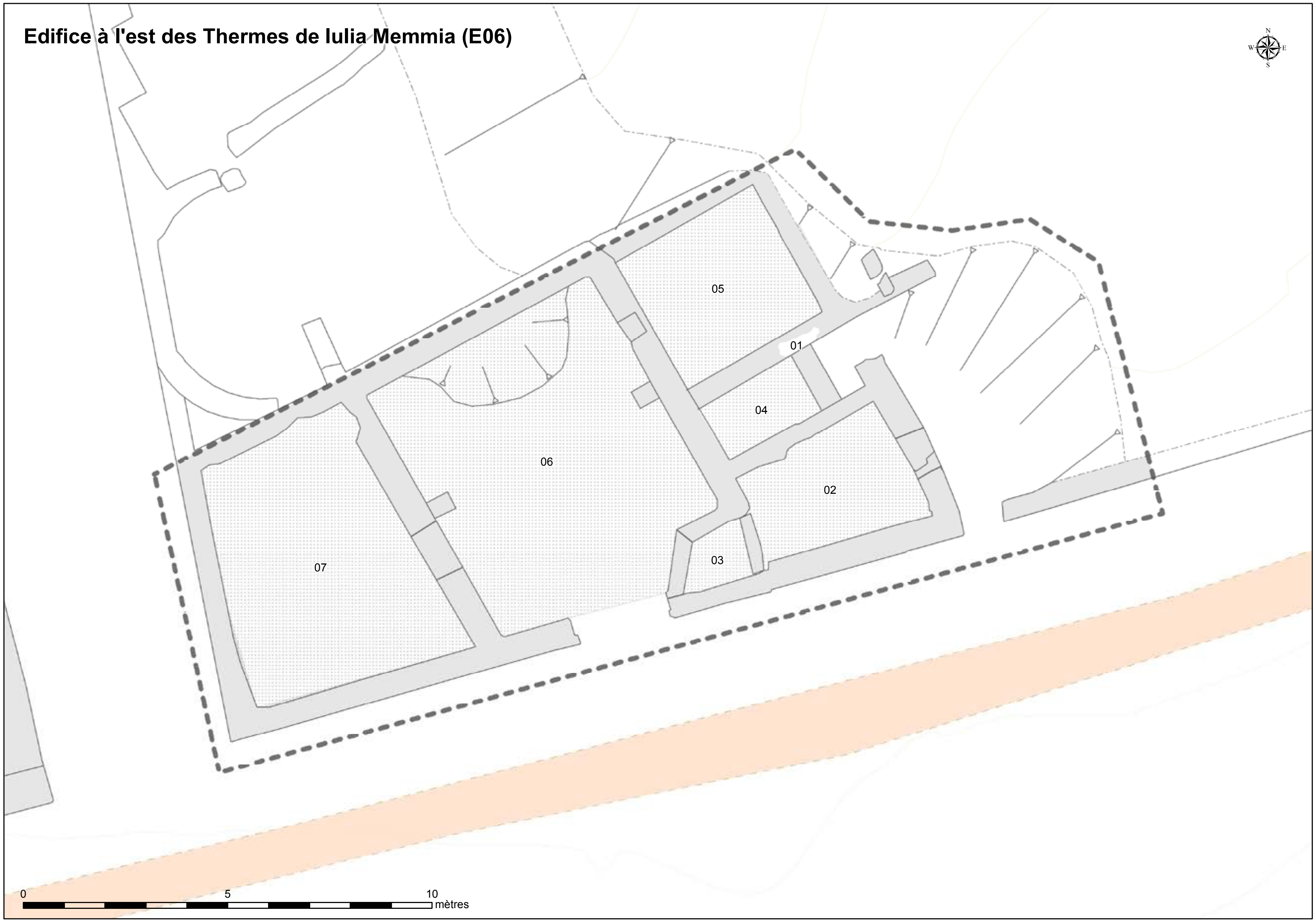

Basilique Chrétienne du Nord (BaN)
05
07
03a
03b
04
06
01
02
08
0
5
10
mètres

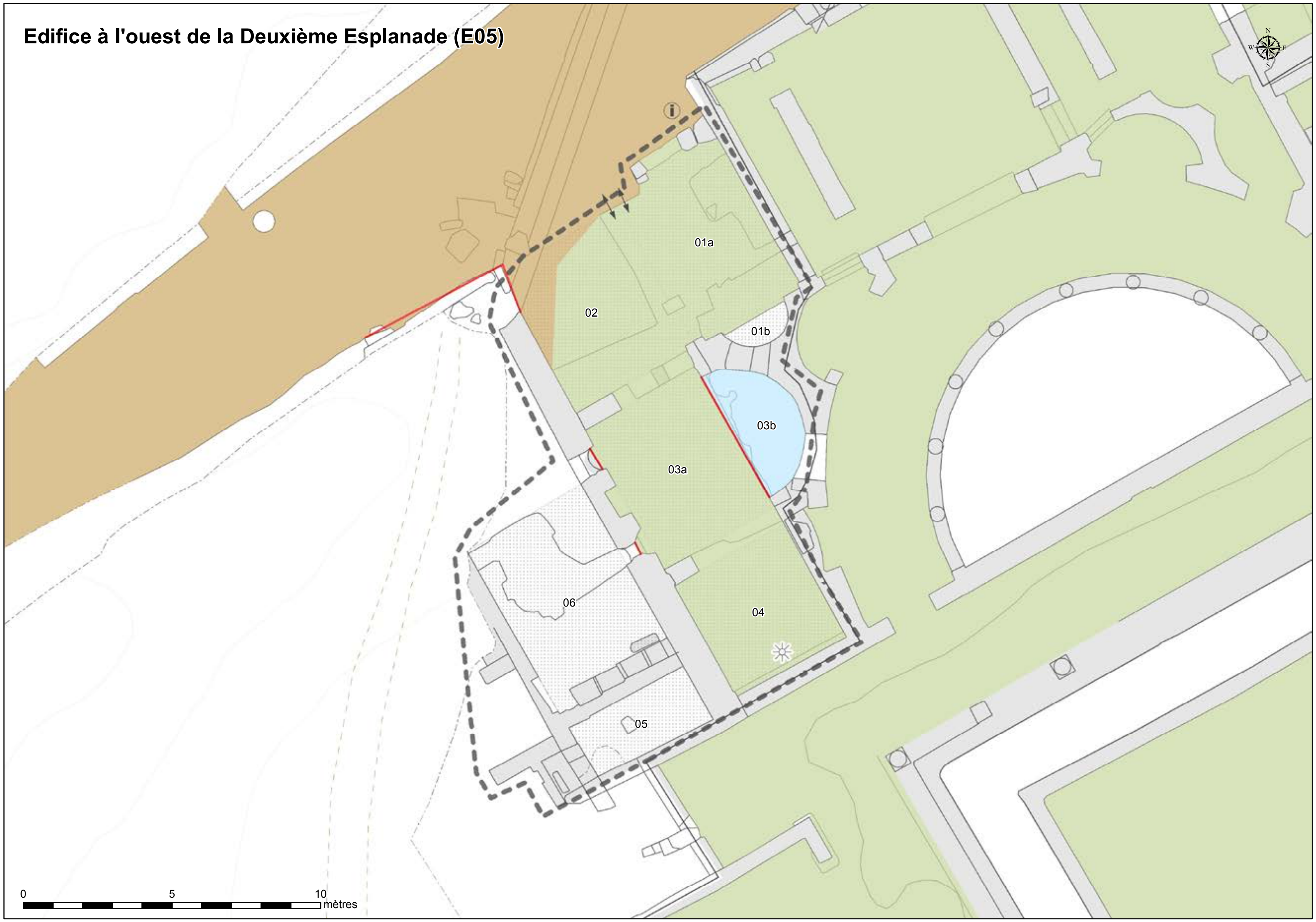

Basilique Chrétienne du Sud (BaS)
01
02
03
04
05
06
07
08
09
10
11
12
13
0
5
10
mètres


Basilique du Forum (B01)
N
E
S
W
01
02
03
0
5
10
mètres

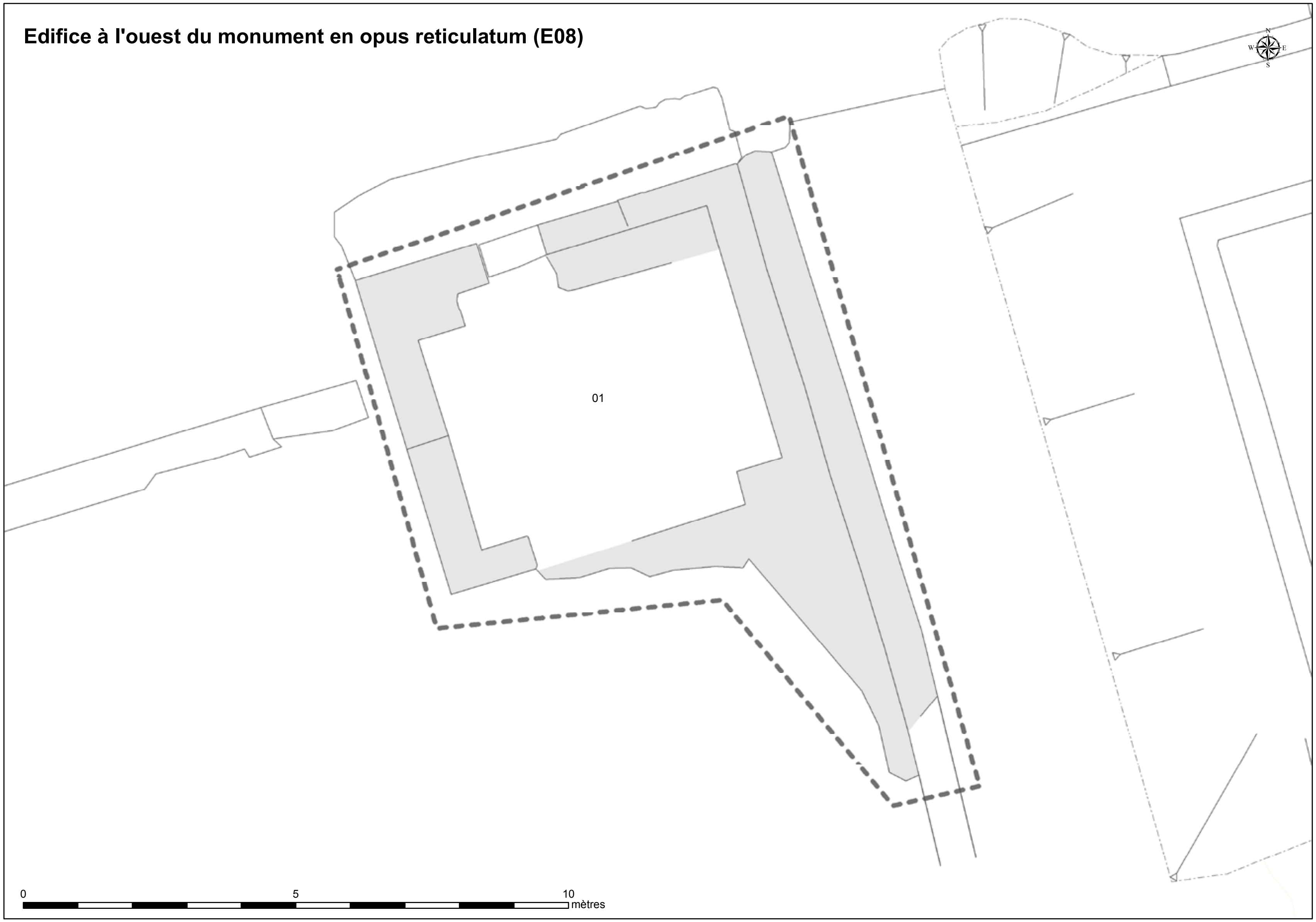


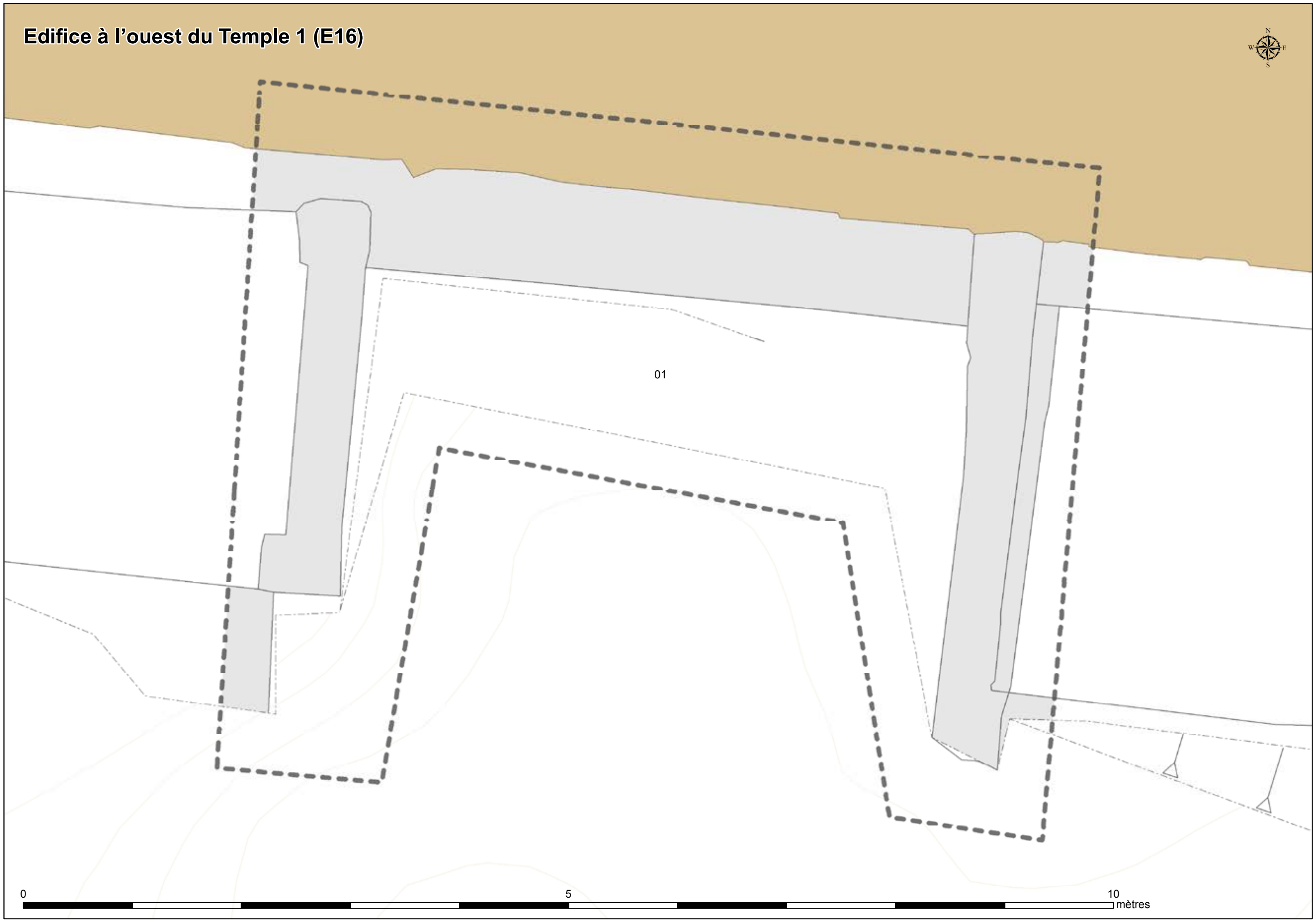
Deuxième Esplanade Monumentale (EM2)


Edifice à l'est des Thermes de Iulia Memmia (E06)
N
W
E
S
05
01
04
06
02
03
07
0
5
10
mètres

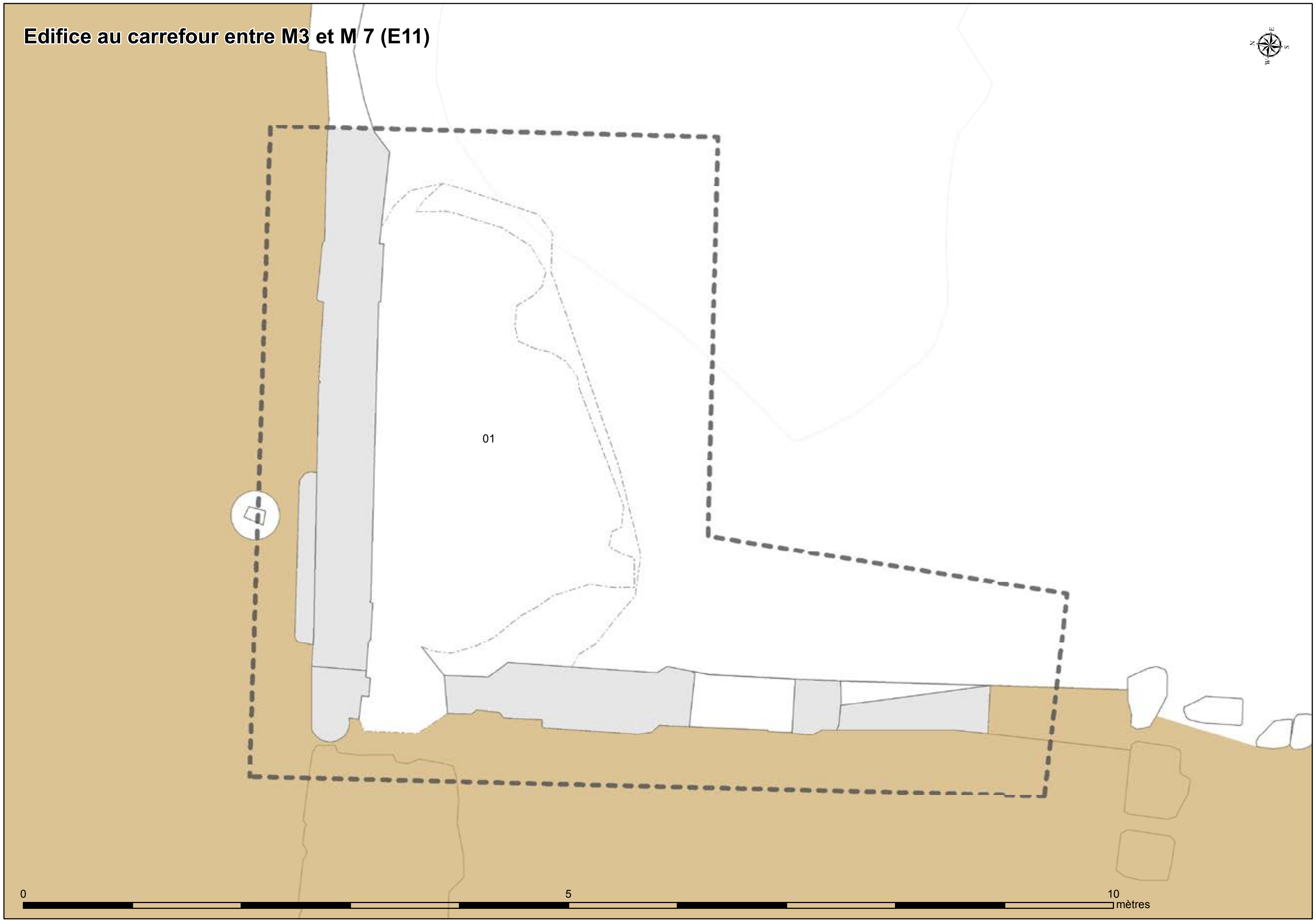

Edifice à l'ouest de la Deuxième Esplanade (E05)
01a
01b
02
03a
03b
04
05
06
0
5
10
mètres

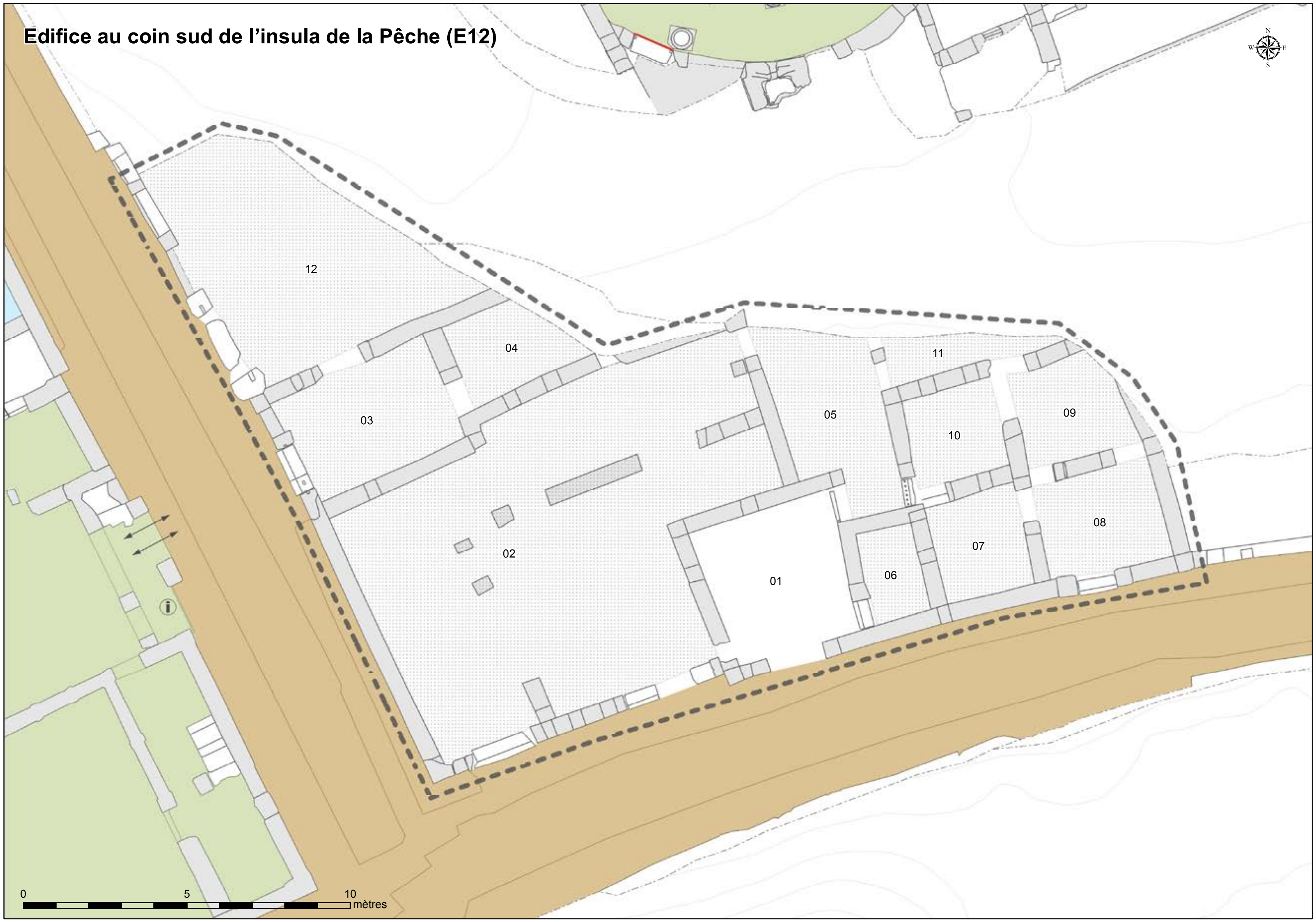
Edifice à l'ouest du monument en opus reticulatum (E08)

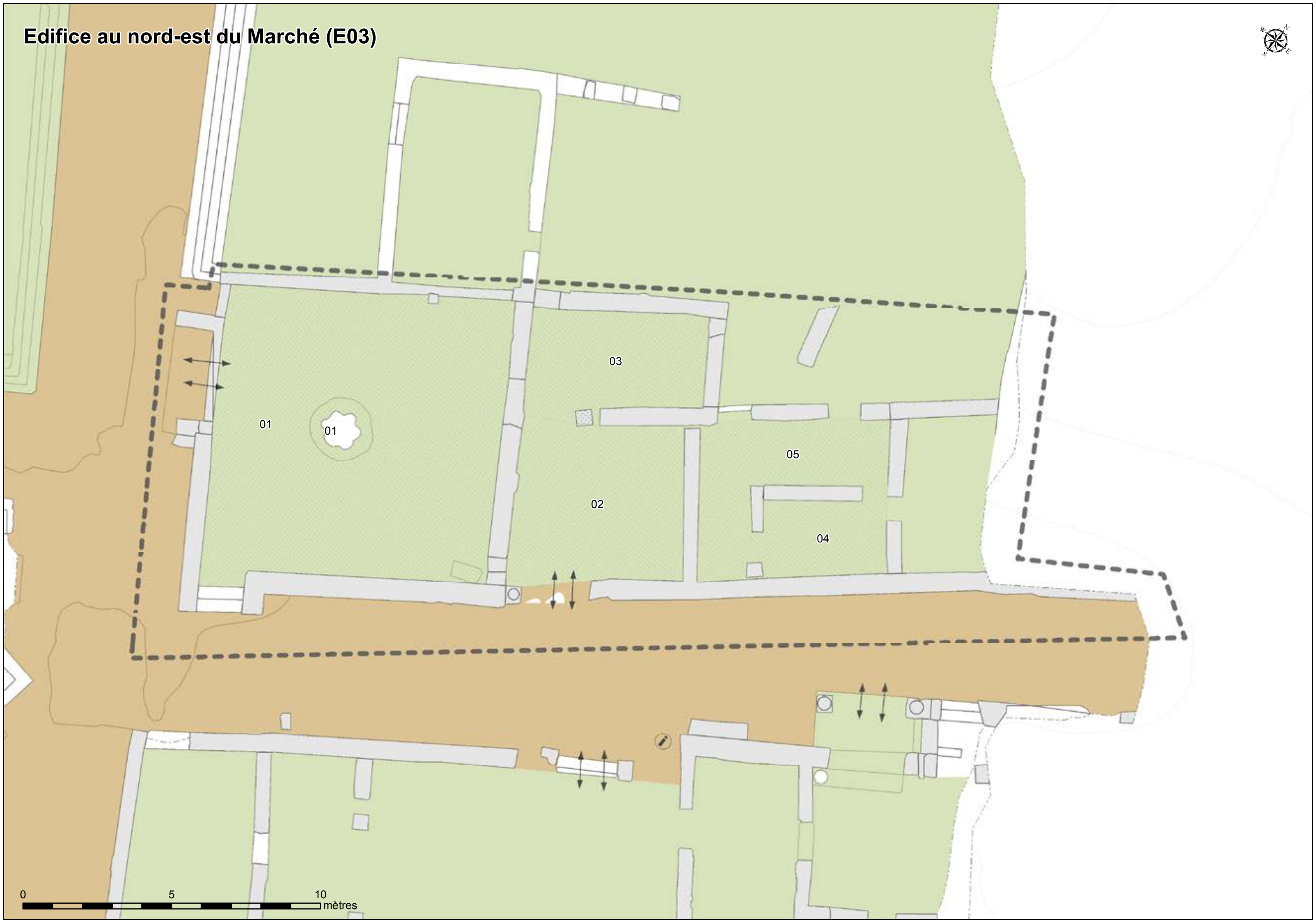




Edifice à l'ouest du Temple 1 (E16)
N
W
E
S
01
0
5
10
mètres

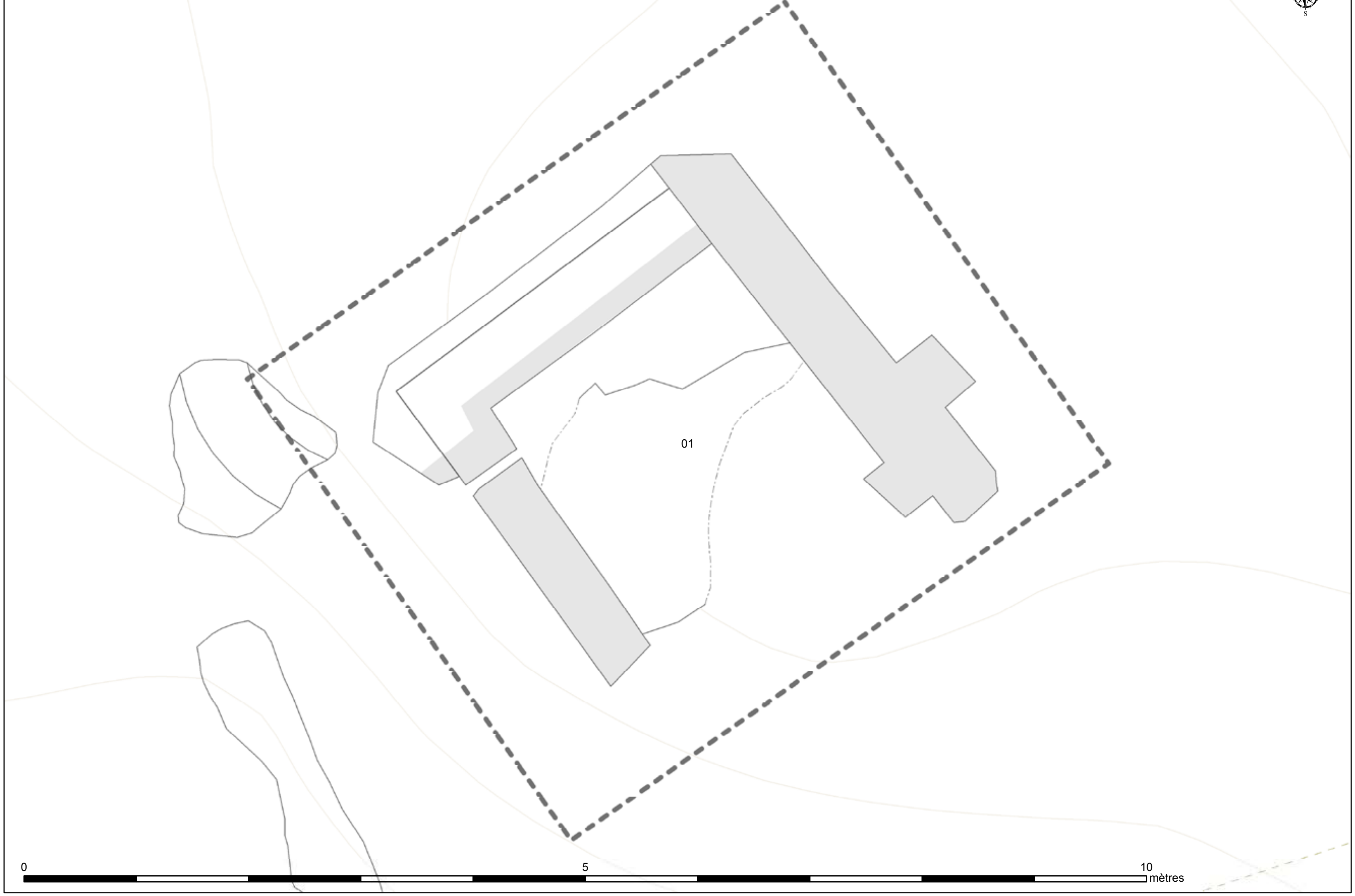

Edifice au carrefour entre M3 et M 7 (E11)
01
0
5
10
mètres

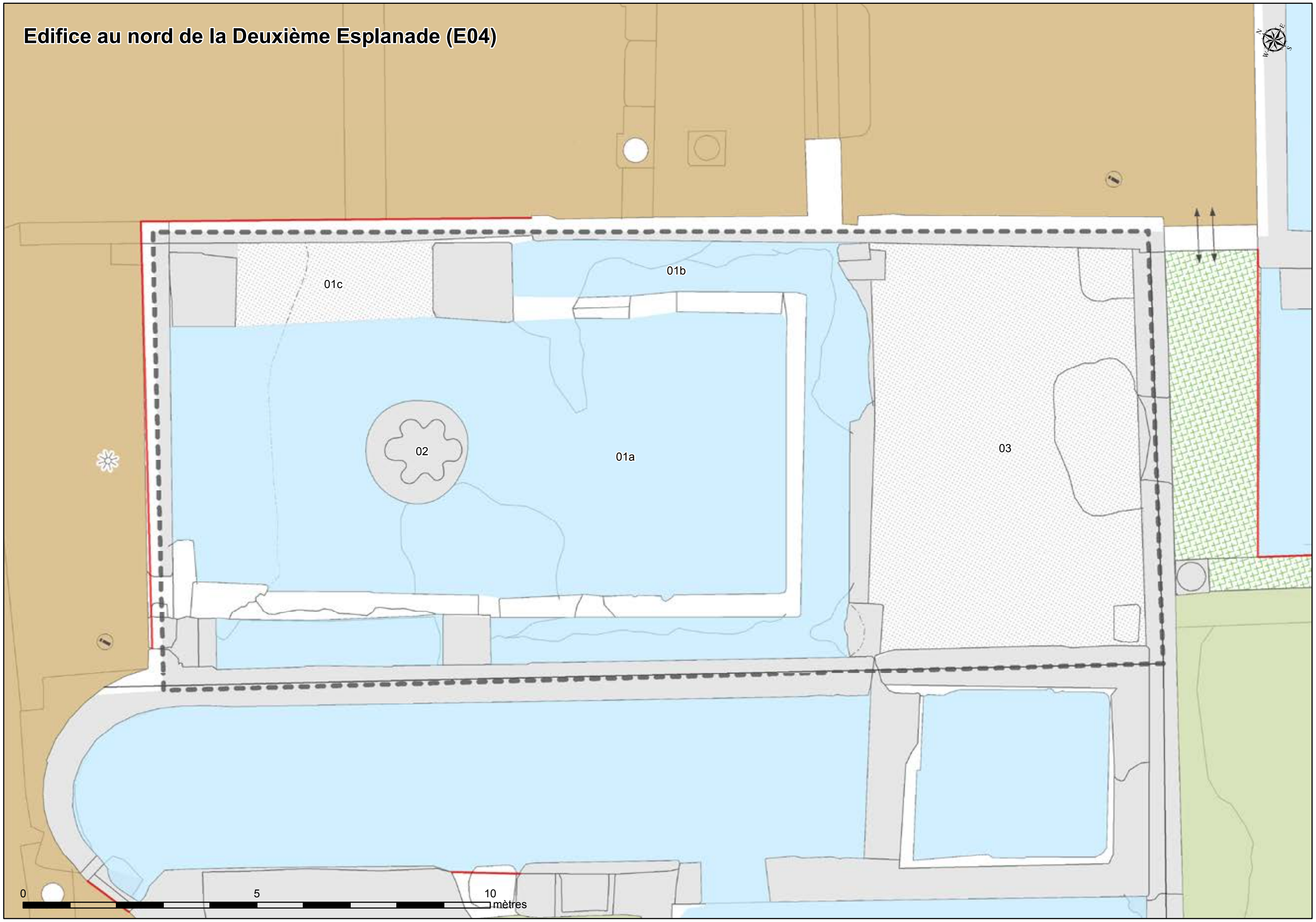

Edifice au coin sud de l’insula de la Pêche (E12)
12
04
03
05
11
10
09
02
01
06
07
08
0
5
10
mètres
N
W
E
S



Edifice au nord-est du Marché (E03)
03
01
01
05
02
04
0
5
10
mètres

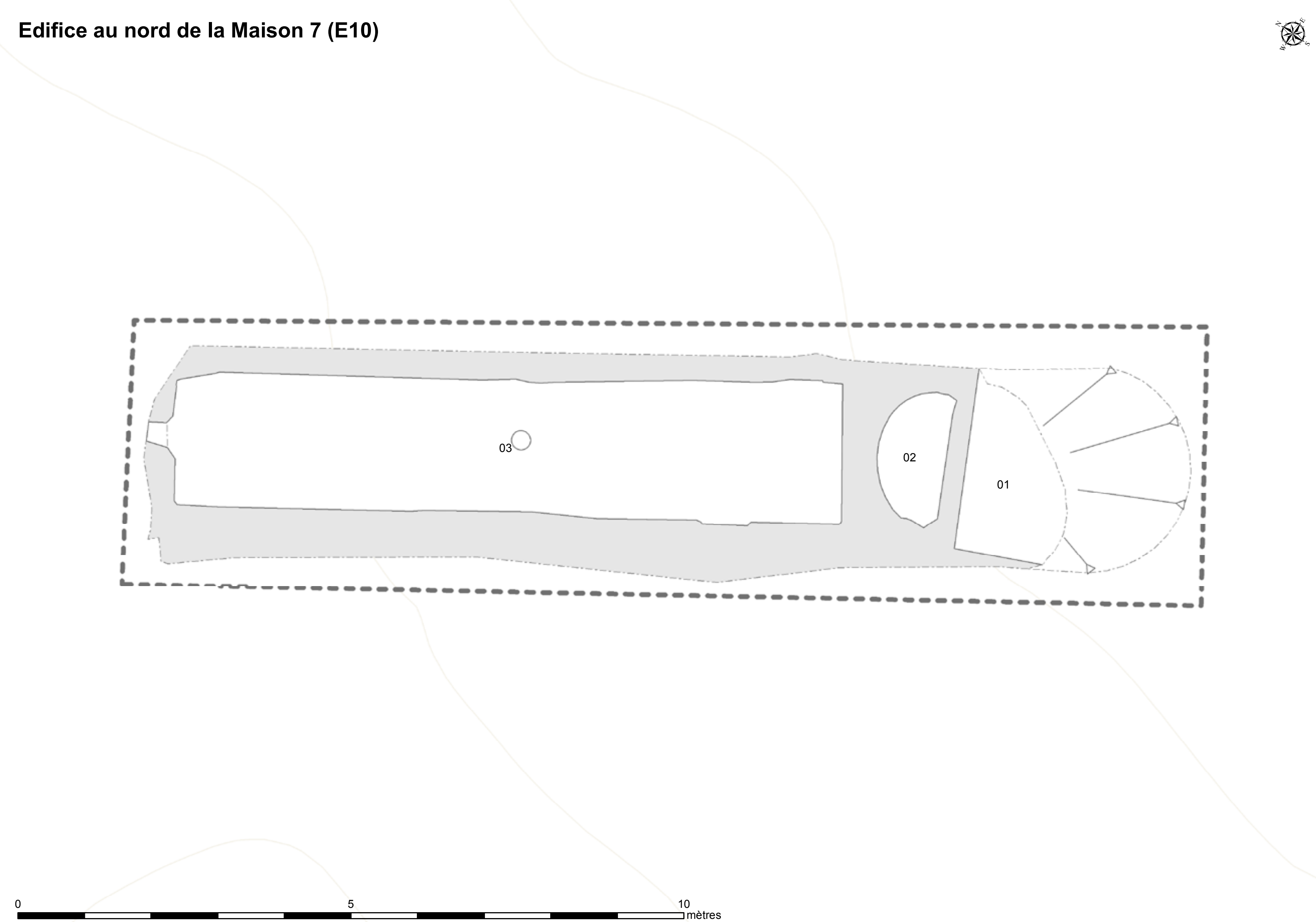
Edifice au nord-est du Temple d'Apollon (E14)



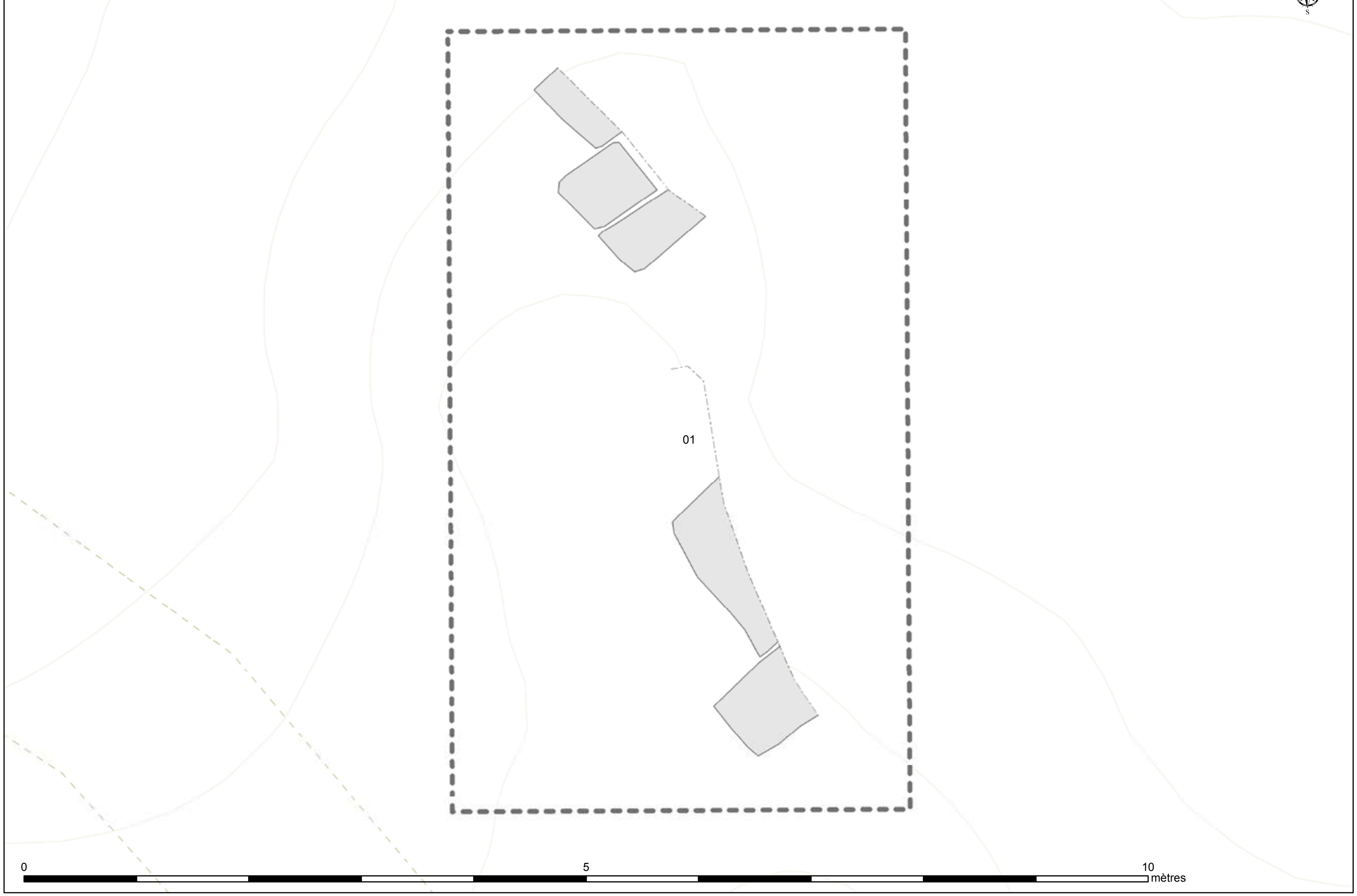


Edifice au nord de la Deuxième Esplanade (E04)
01c
01b
02
01a
03
0
5
10
mètres

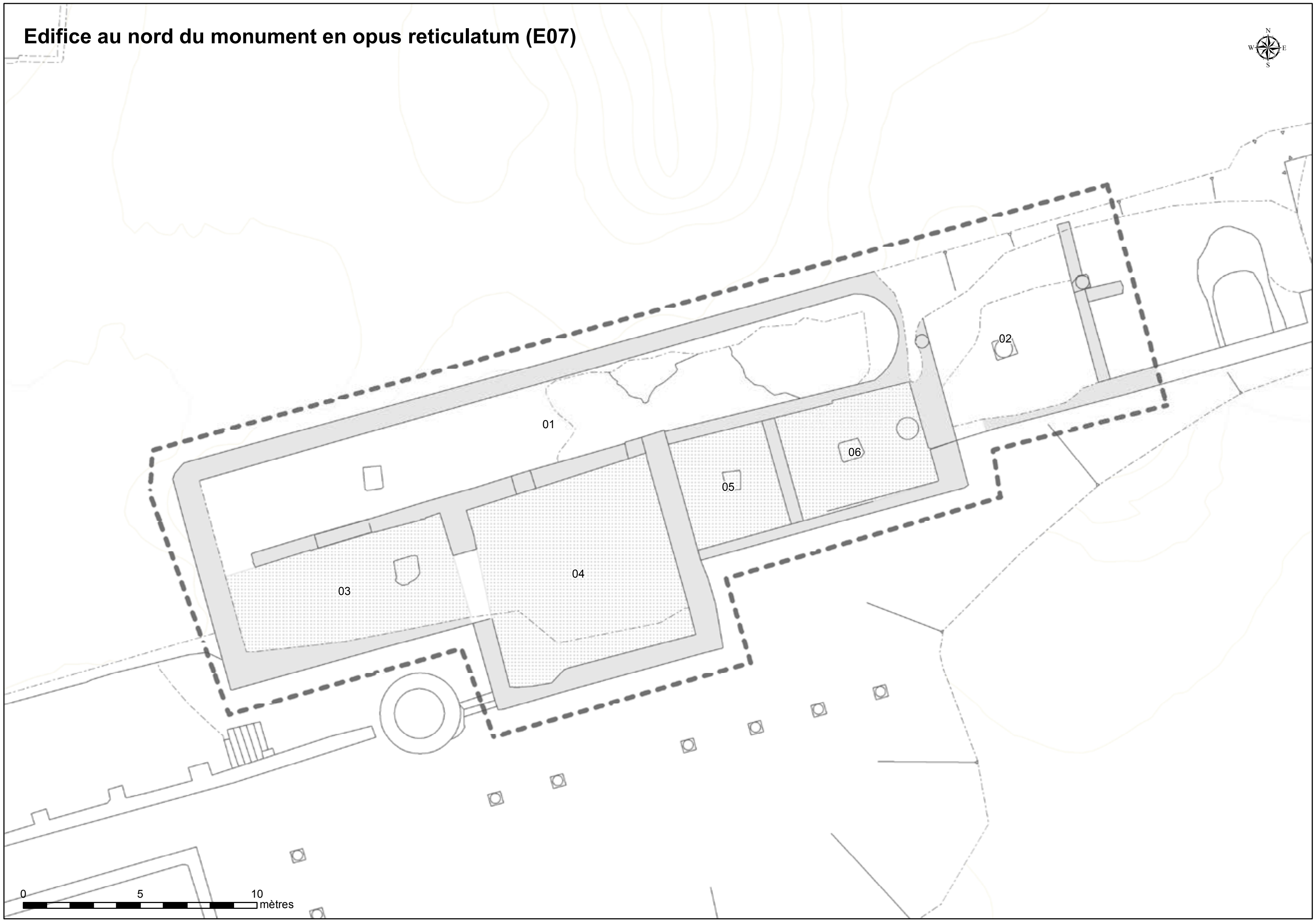
Edifice au nord de la Maison 7 (E10)



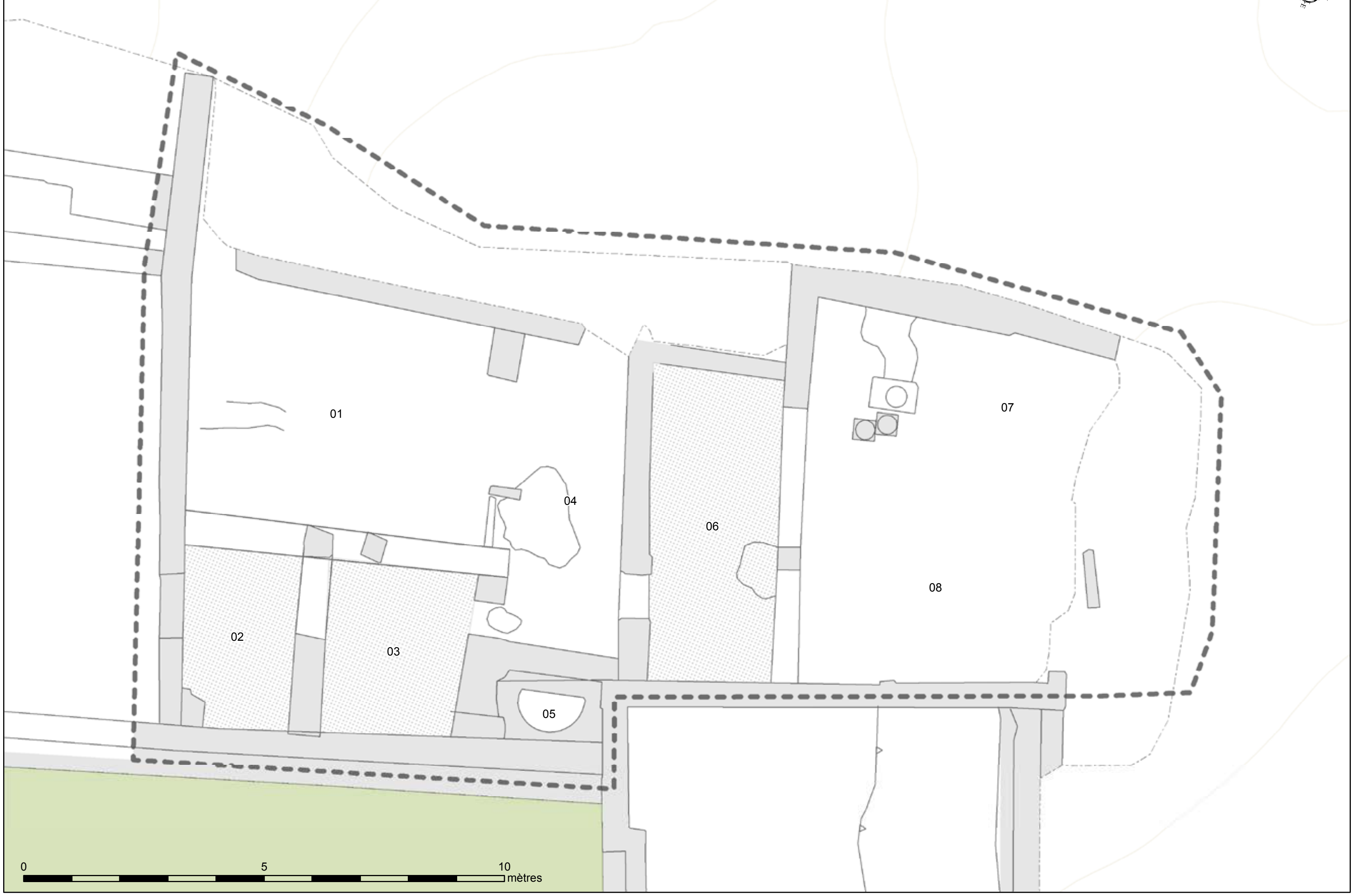
Edifice au nord de la source (E13)



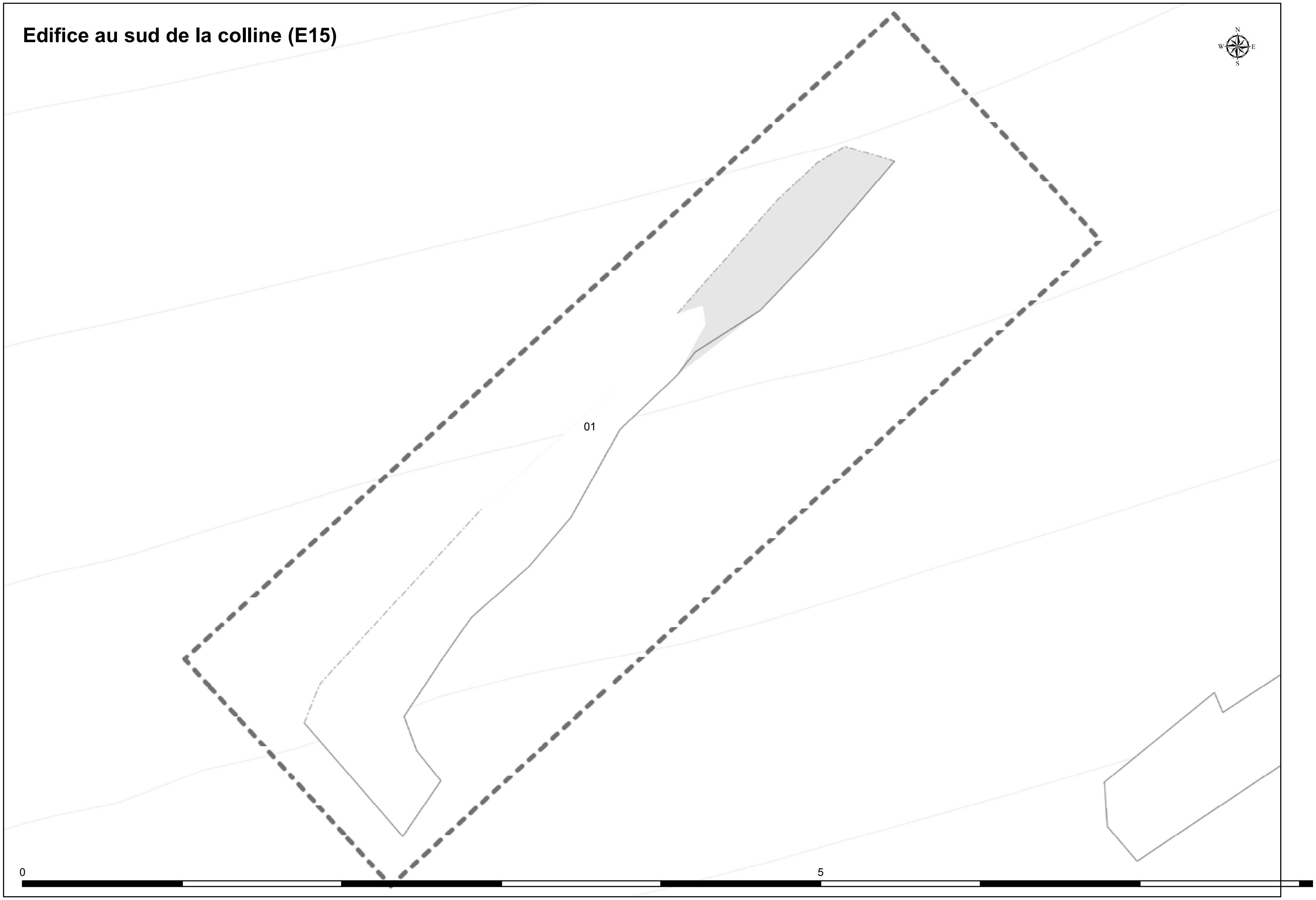
Edifice au nord du monument en opus reticulatum (E07)



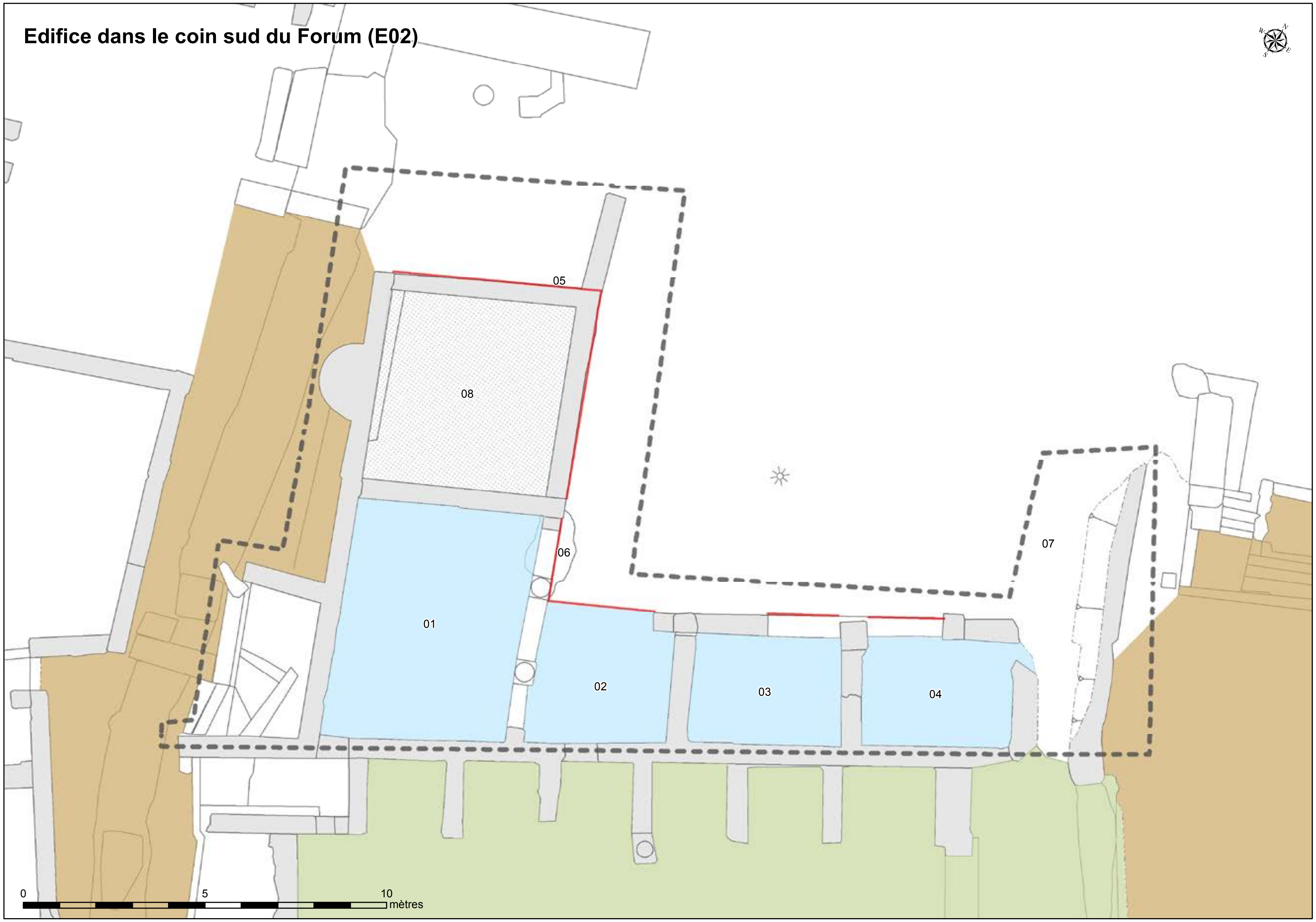
Edifice au sud-ouest du Temple d'Apollon (E01)



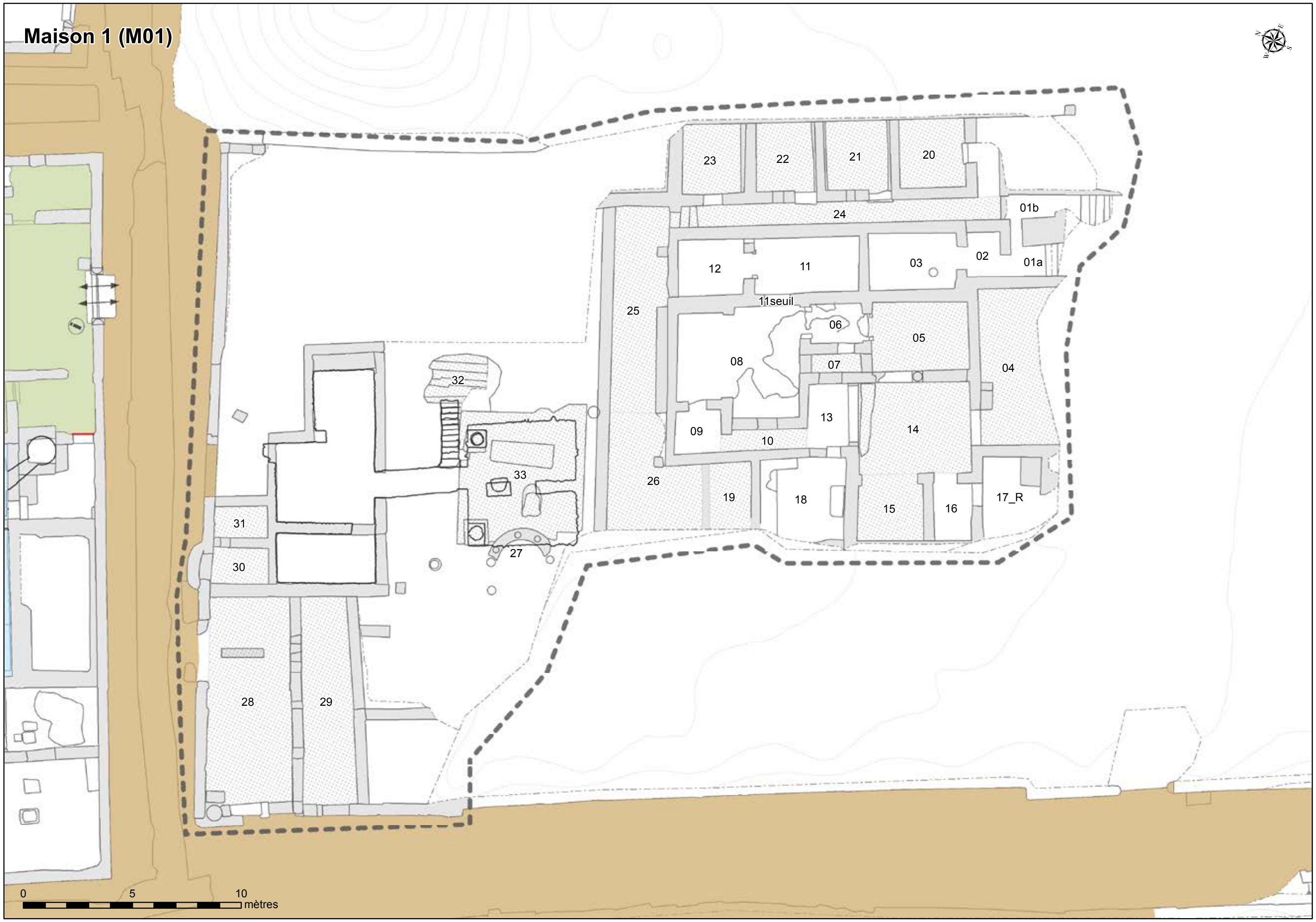
Edifice au sud de la colline (E15)



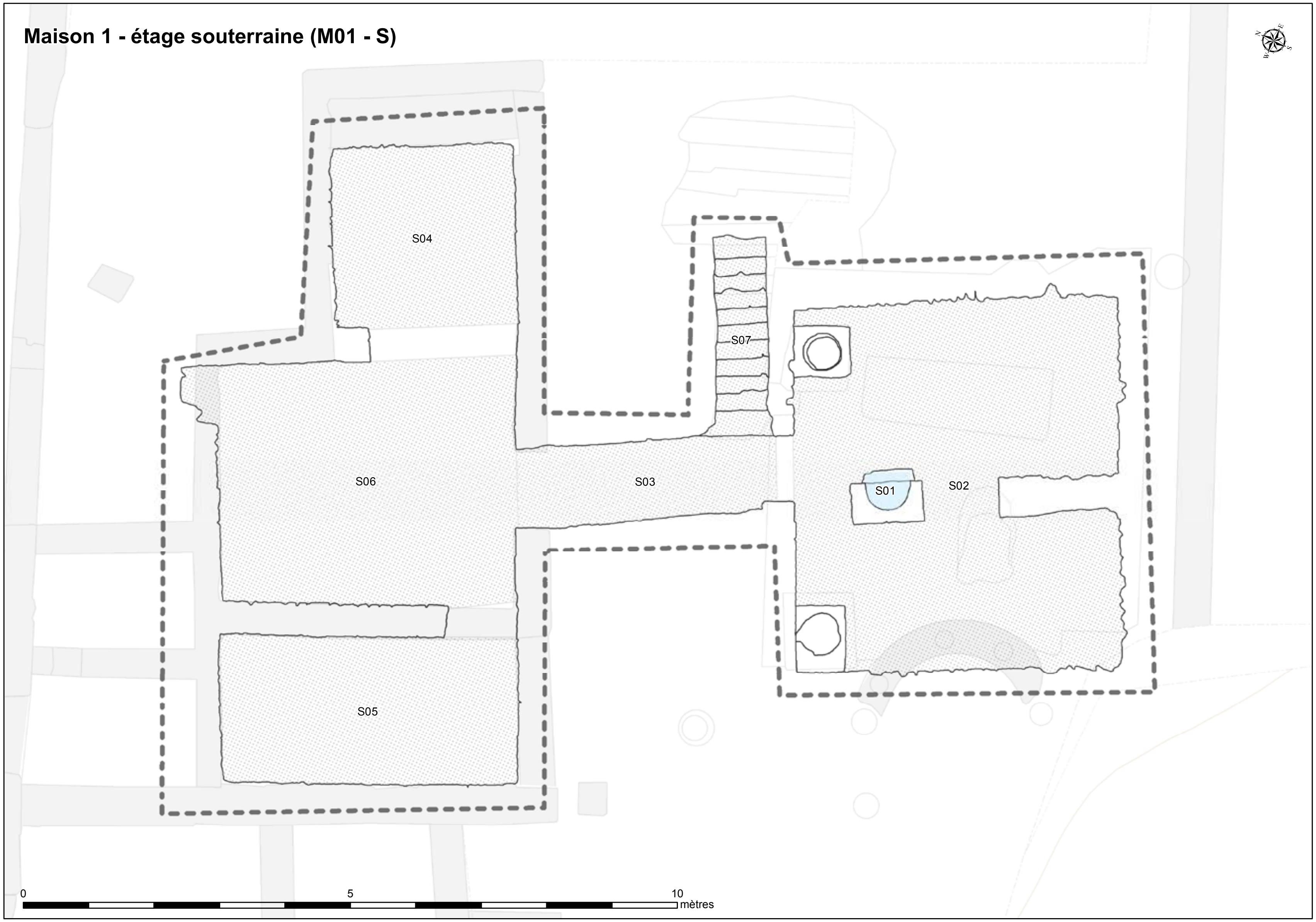
Edifice au sud de la Maison 3 (E09)

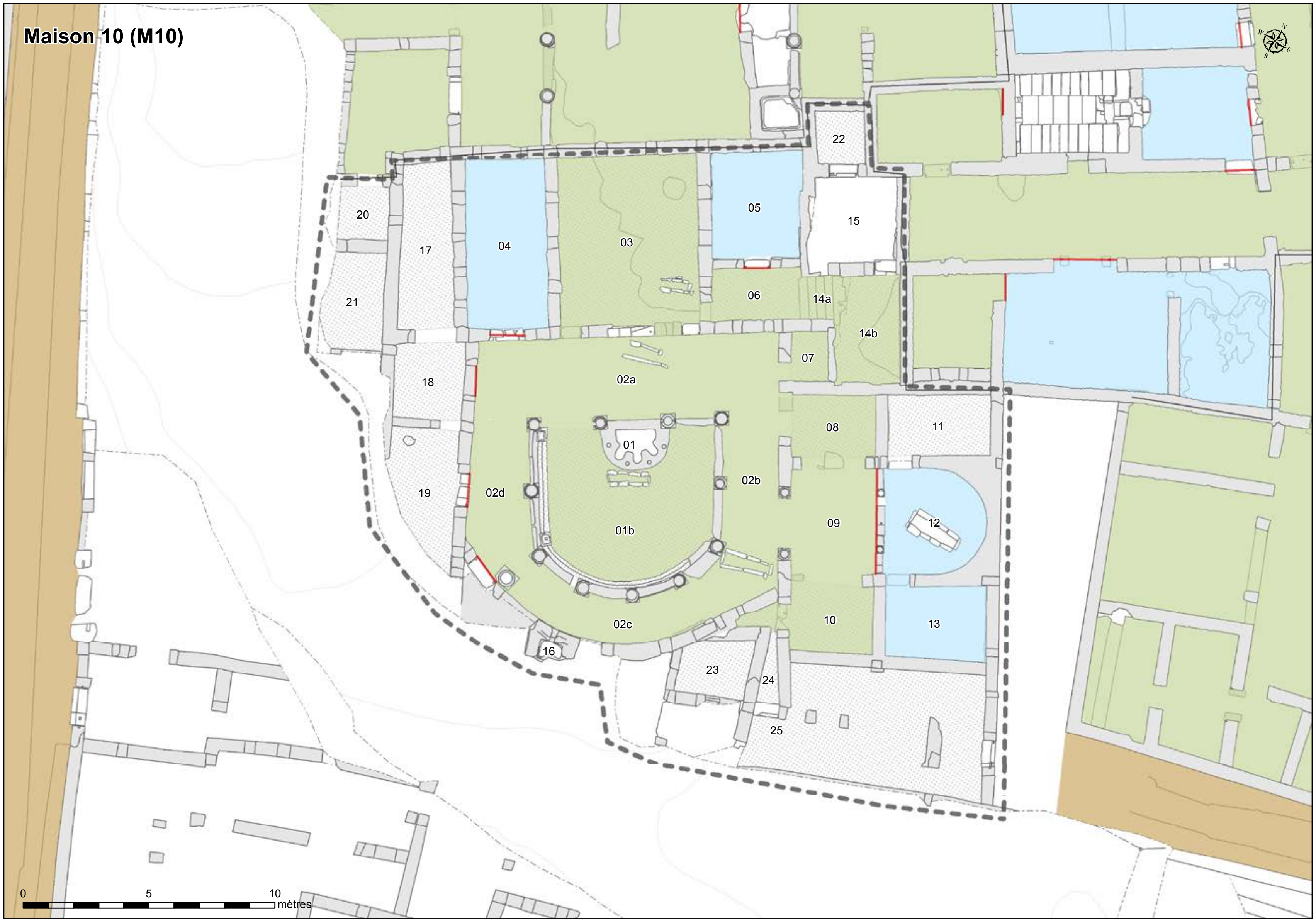


Edifice dans le coin sud du Forum (E02)
05
08
06
07
01
02
03
04
0
5
10
mètres


Maison 1 (M01)
23
22
21
20
01b
24
12
11
03
02
01a
11seuil
25
06
05
08
07
04
32
13
09
10
14
33
26
19
18
15
16
17_R
31
27
30
28
29
0
5
10
mètres

Maison 1 - étage souterraine (M01 - S)





Maison 10 (M10)
20
17
04
03
05
15
22
21
06
14a
14b
07
18
02a
08
11
01
02b
19
02d
01b
09
12
02c
10
13
16
23
24
25
0
5
10
mètres


Maison 14 (M14)
05
04
03
07
02
06
01
0
5
10
mètres

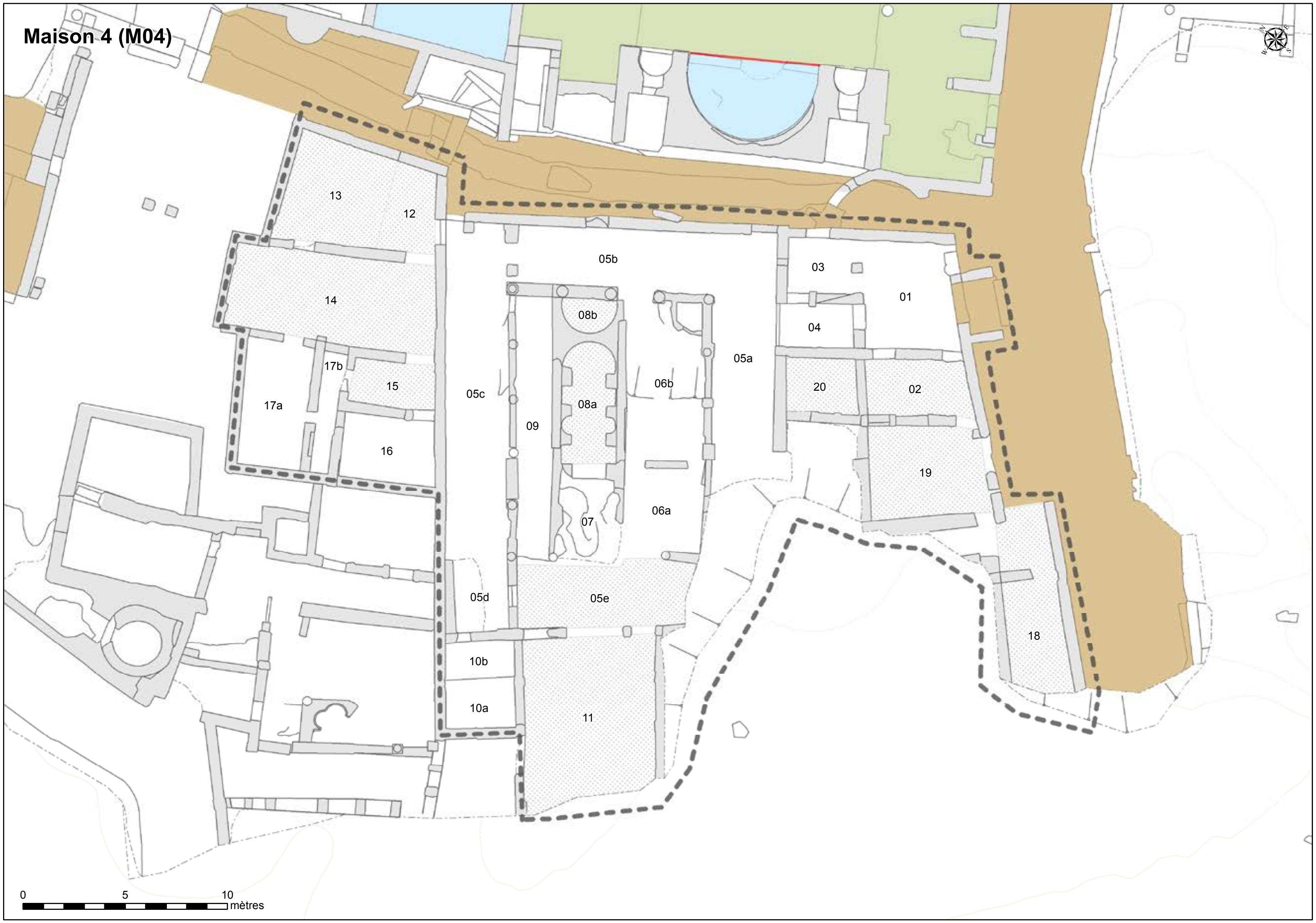

Maison 15 (M15)
08
07
09
06
10
01
05
02
03
04
0
5
10
mètres

Maison 2 (M02)

Maison 3 (M03)


32
31
30
28
29
35
36
15
14
13
08
07
06
12a
10
09
05
04
33
16
11b
11a
37
12b
01
18b
18a
17
12c
03
02
19
20
34
21
22
23
26
25
24
27
0
5
10
mètres

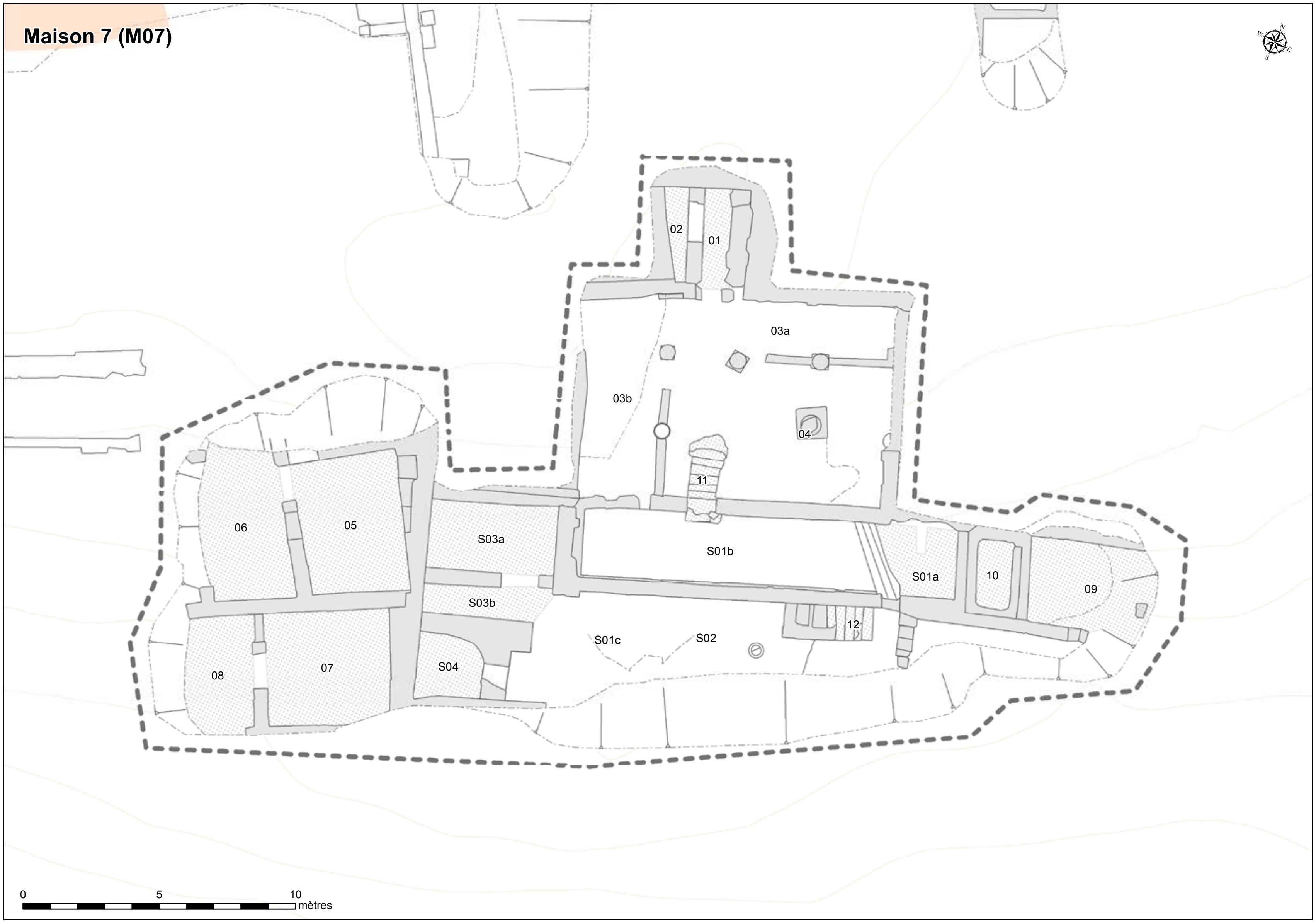
Maison 3 - étage souterraine (M03 - S)



Maison 4 (M04)
13
12
14
05b
03
01
08b
04
05a
17b
15
06b
20
02
17a
05c
08a
09
16
19
07
06a
05d
05e
18
10b
10a
11
0
5
10
mètres


Maison 5 (M05)
15
16
17
14
11
10
13
01
09
12
04b
04a
08
03
05
07
02
06
0
5
10
mètres

381


Maison 7 (M07)
02
01
03a
03b
04
11
06
05
S03a
S01b
S01a
10
09
S03b
12
S01c
S02
08
07
S04
0
5
10
mètres

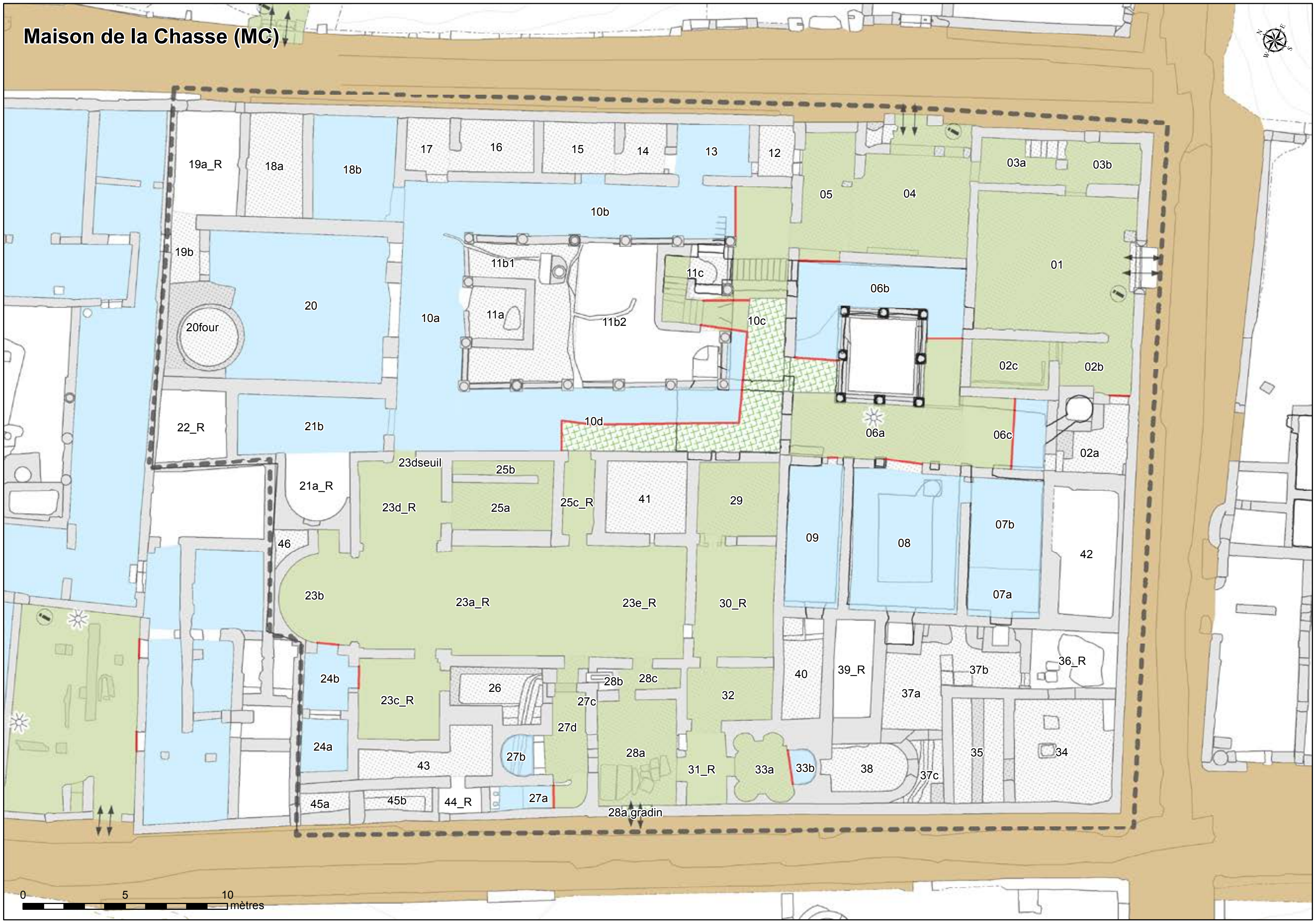
Maison 8 (M08)
23
24
22
16
15
10
08
25
07
21
14
12
09
06
13a
26
27
13b
02
04
20
19
18
17
11
03
01
05
28
0
5
10
mètres

Maison 9 (M09)

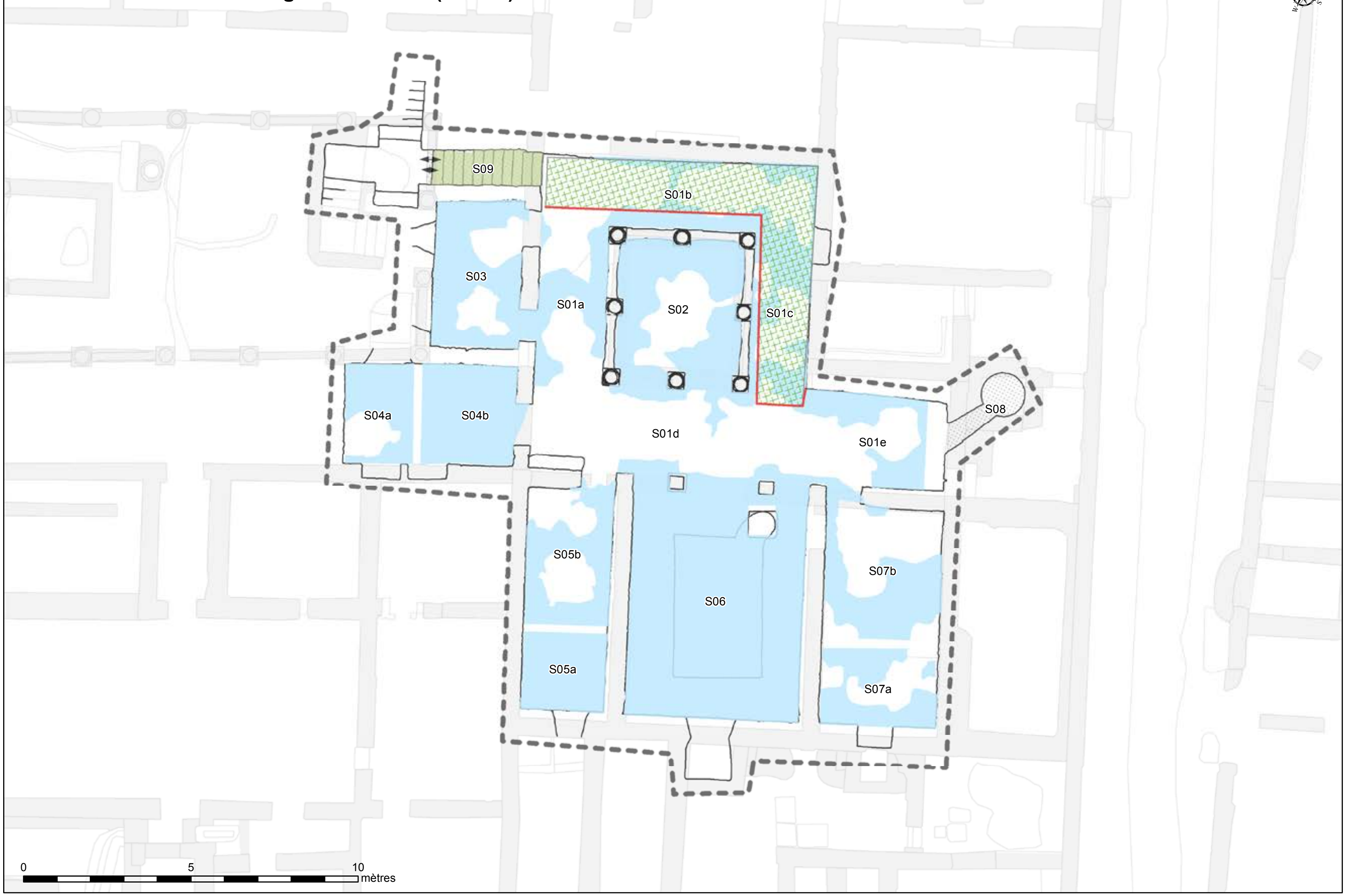

04
08
09
10a
10b
11
12
02
07
01
05
06
15
14a
13
16
14b
03
17
0
5
10
mètres

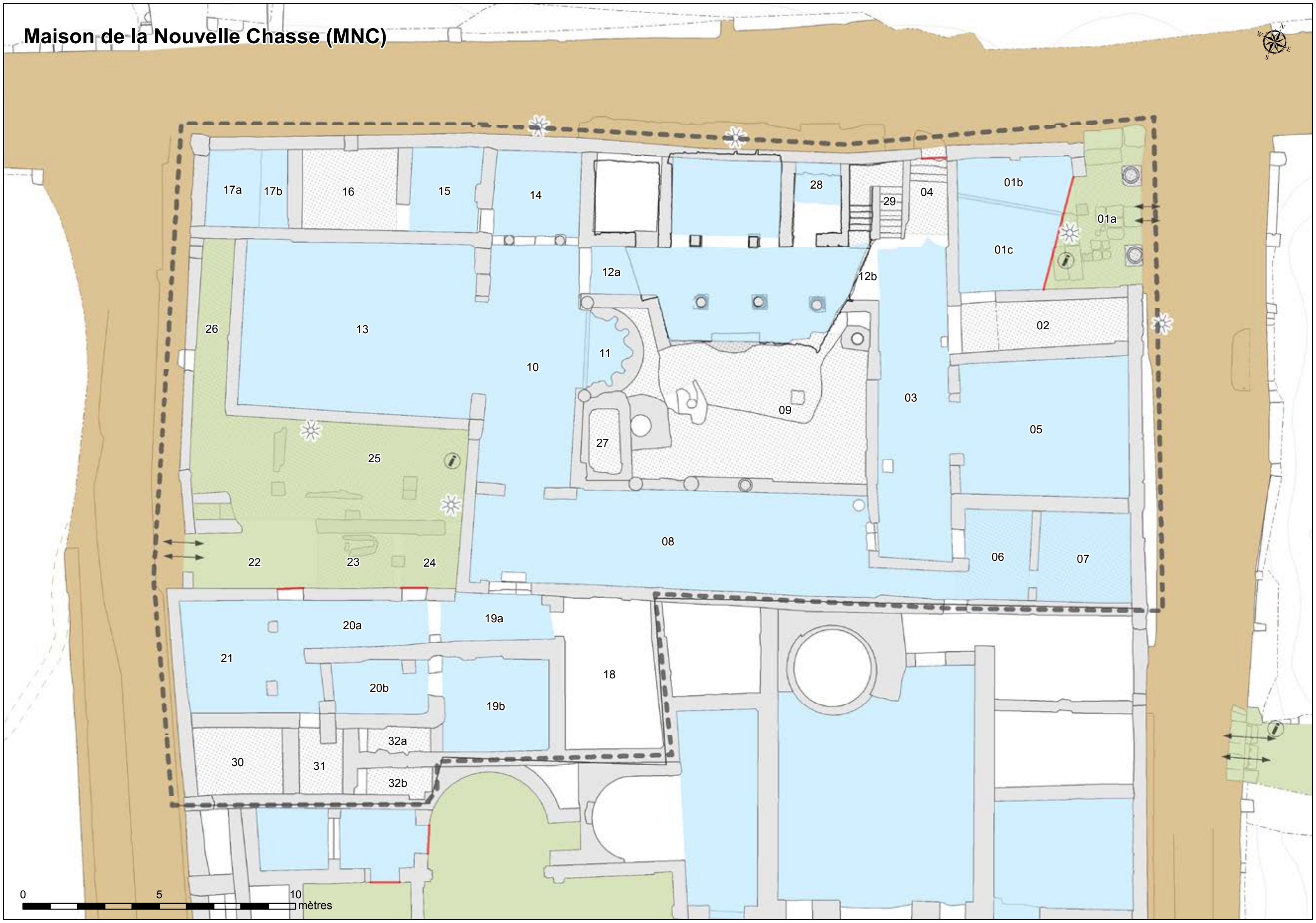

Maison d'Amphitrite (MA)
37
13
12
02a
01
15d_R
15a.b.c
14
11
45
38
10
16
17
18
43
44
05
09
19
21
20
35seuil
02c
03
02b
40
42
35
05A
08
24
23
05B
41
22
36
39
26
25
07
04A
04B
51
28
27
06a
50
47
34
30
29
53
06b
49
48
46
33
32
31
52
0
5
10
mètres

Maison d'Amphitrite - étage souterraine (MA - S)


Maison de la Chasse (MC)
19a_R
18a
18b
17
16
15
14
13
12
05
04
03a
03b
10b
19b
11b1
11c
01
06b
20
10a
11a
11b2
10c
20four
02c
02b
22_R
21b
10d
06a
06c
02a
23dseuil
25b
21a_R
23d_R
25a
25c_R
41
29
09
08
07b
42
46
23b
23a_R
23e_R
30_R
07a
36_R
37b
40
39_R
24b
26
28b
28c
32
37a
23c_R
27c
27d
24a
28a
35
34
43
27b
31_R
33a
33b
38
37c
45a
45b
44_R
27a
28a gradin
0
5
10
mètres

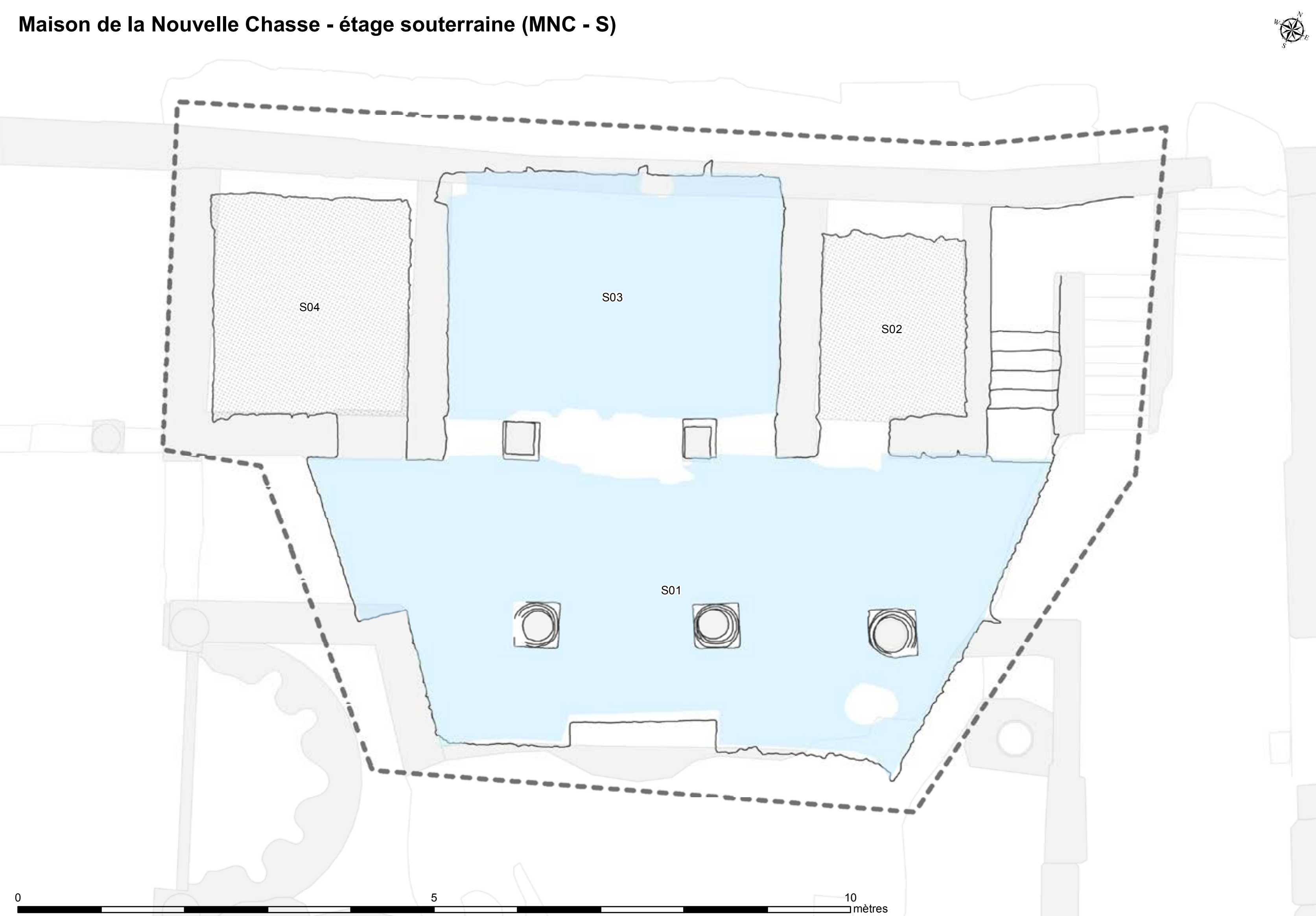
Maison de la Chasse - étage souterraine (MC - S)

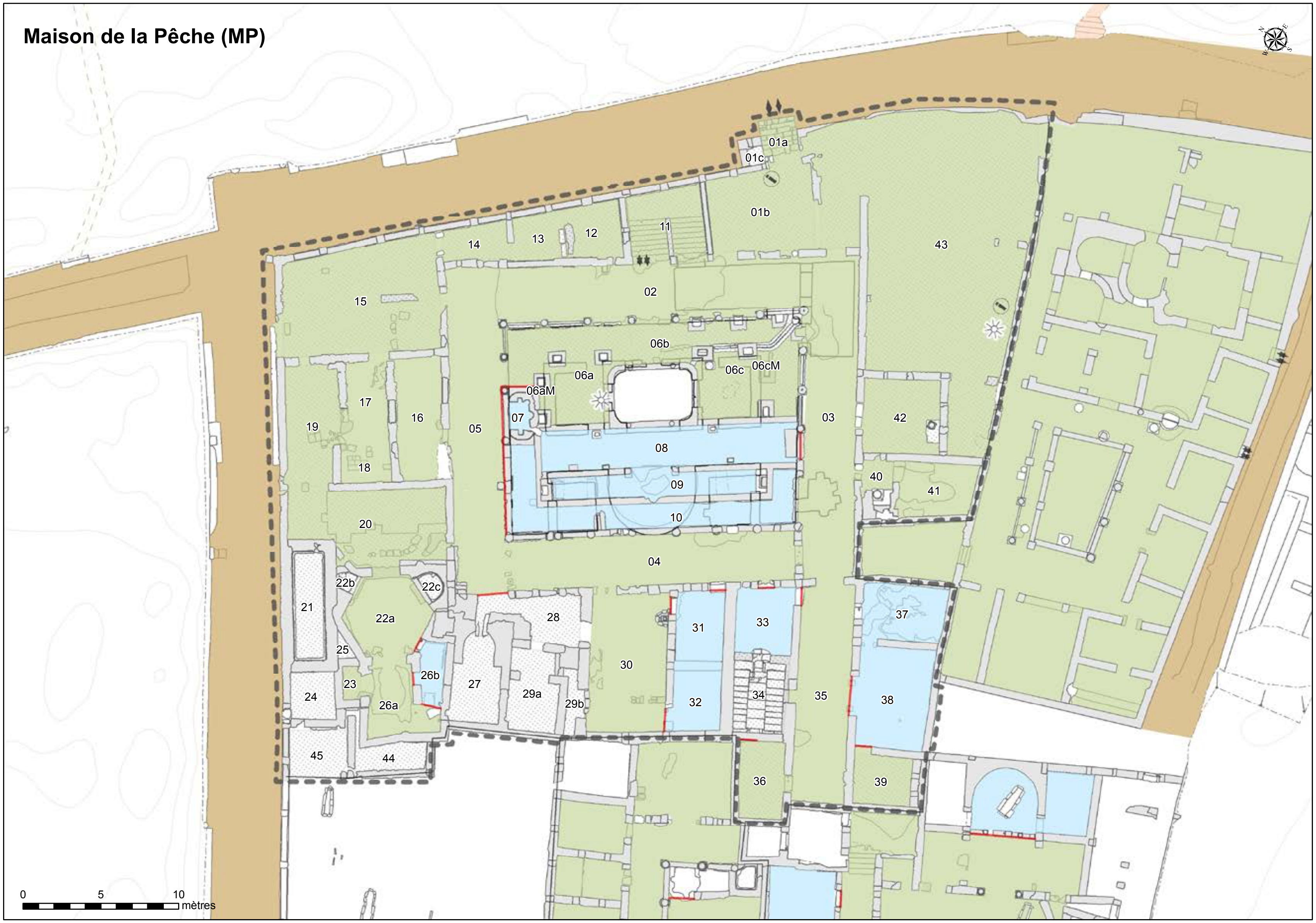




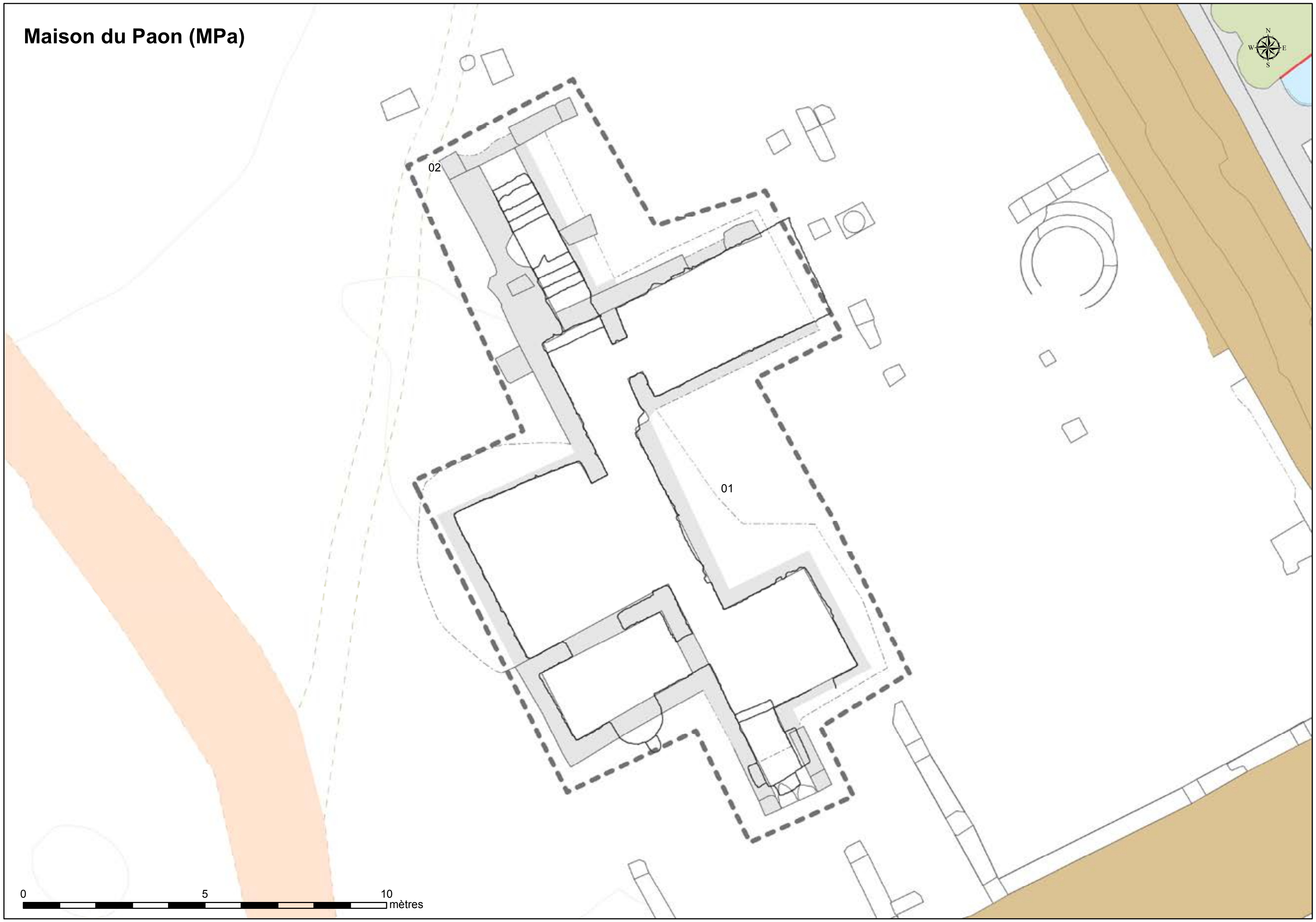
Maison de la Nouvelle Chasse (MNC)
N
W
E
S
17a
17b
16
15
14
28
29
04
01b
01a
01c
12a
12b
02
26
13
11
10
09
03
05
27
25
08
22
23
24
06
07
20a
19a
21
18
20b
19b
32a
30
31
32b
0
5
10
mètres

Maison de la Nouvelle Chasse - étage souterraine (MNC - S)



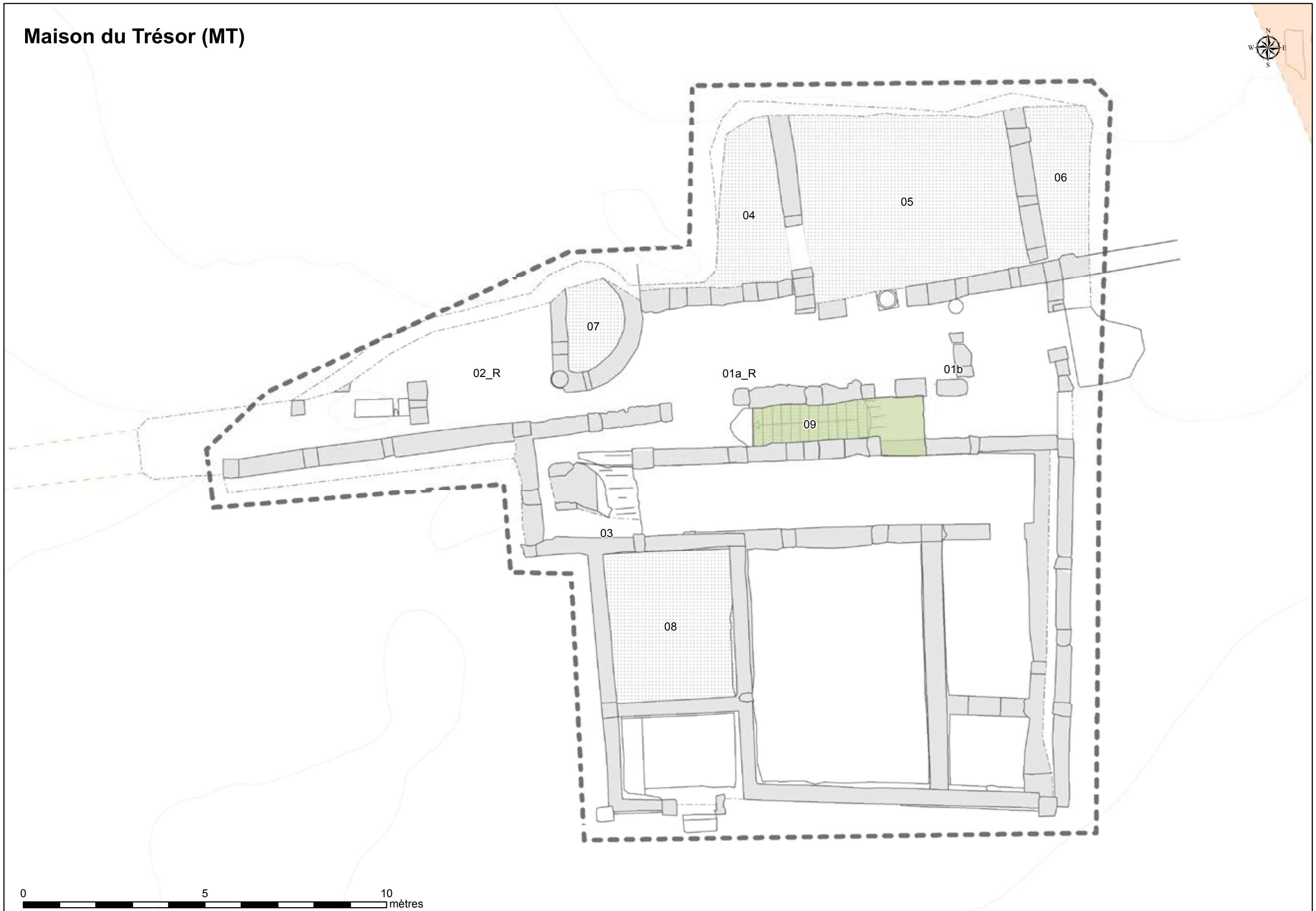

Maison de la Pêche (MP)
01a
01c
01b
11
12
13
14
43
02
15
06b
06a
06c
06cM
06aM
17
16
07
05
03
42
19
08
18
40
09
41
10
20
04
22b
22c
21
22a
28
37
31
33
25
30
26b
23
27
24
29a
29b
32
34
35
38
26a
45
44
36
39
0
5
10
mètres

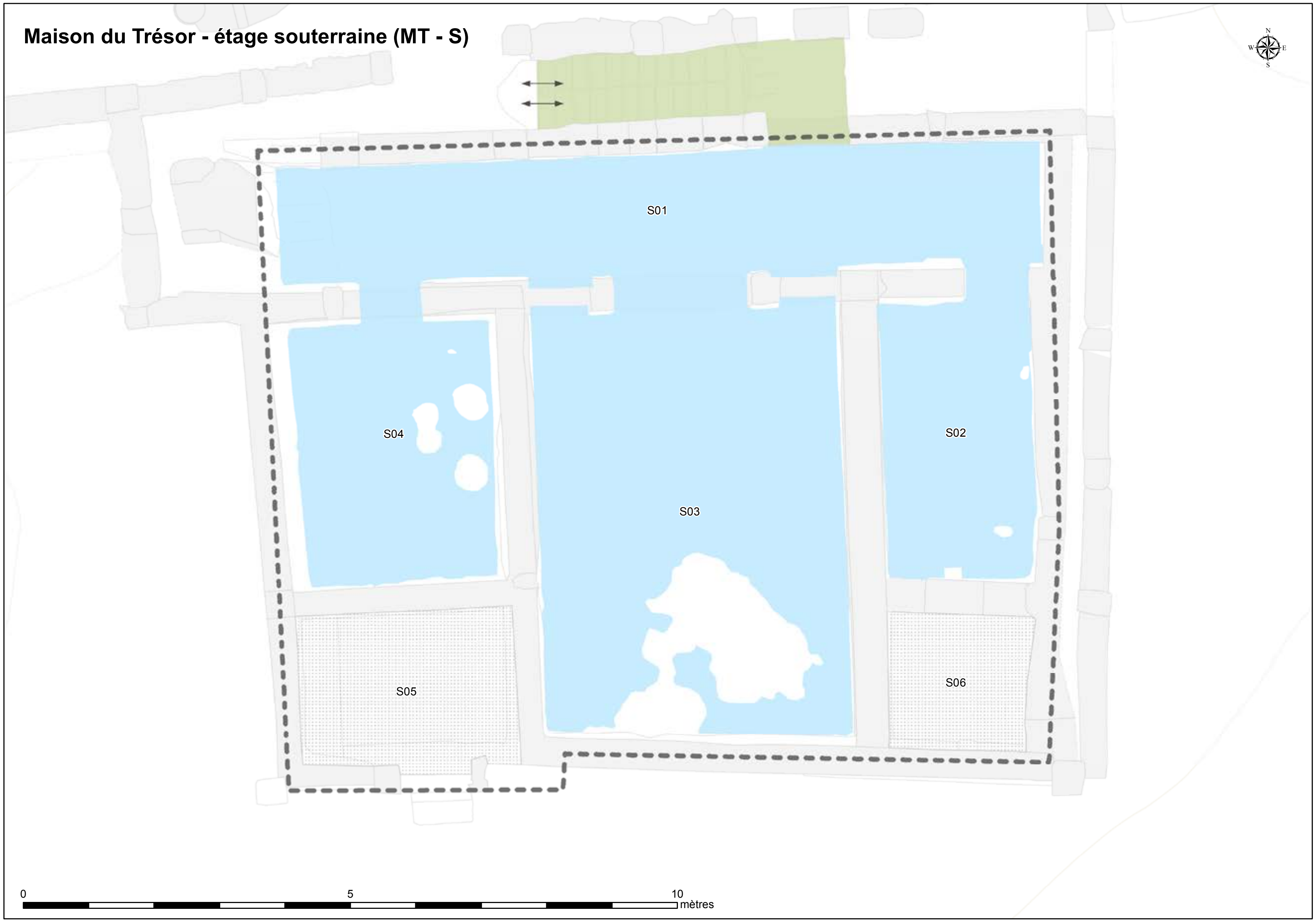
Maison de la Pêche - étage souterraine (MP - S)

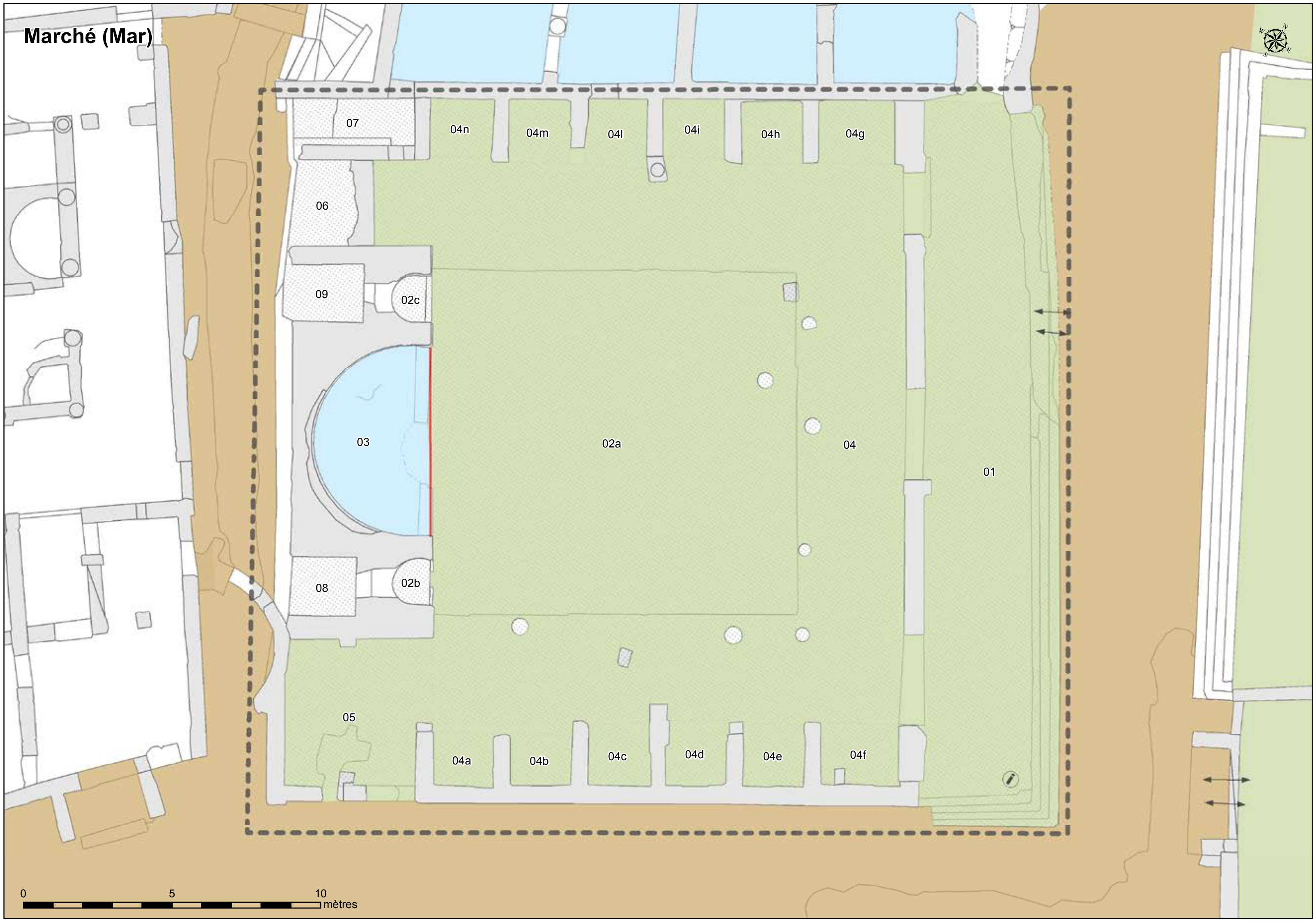

Maison du Paon (MPa)
02
01
0
5
10
mètres
N
W
E
S

Maison du Paon - étage souterraine (MPa - S)

Maison du Trésor (MT)

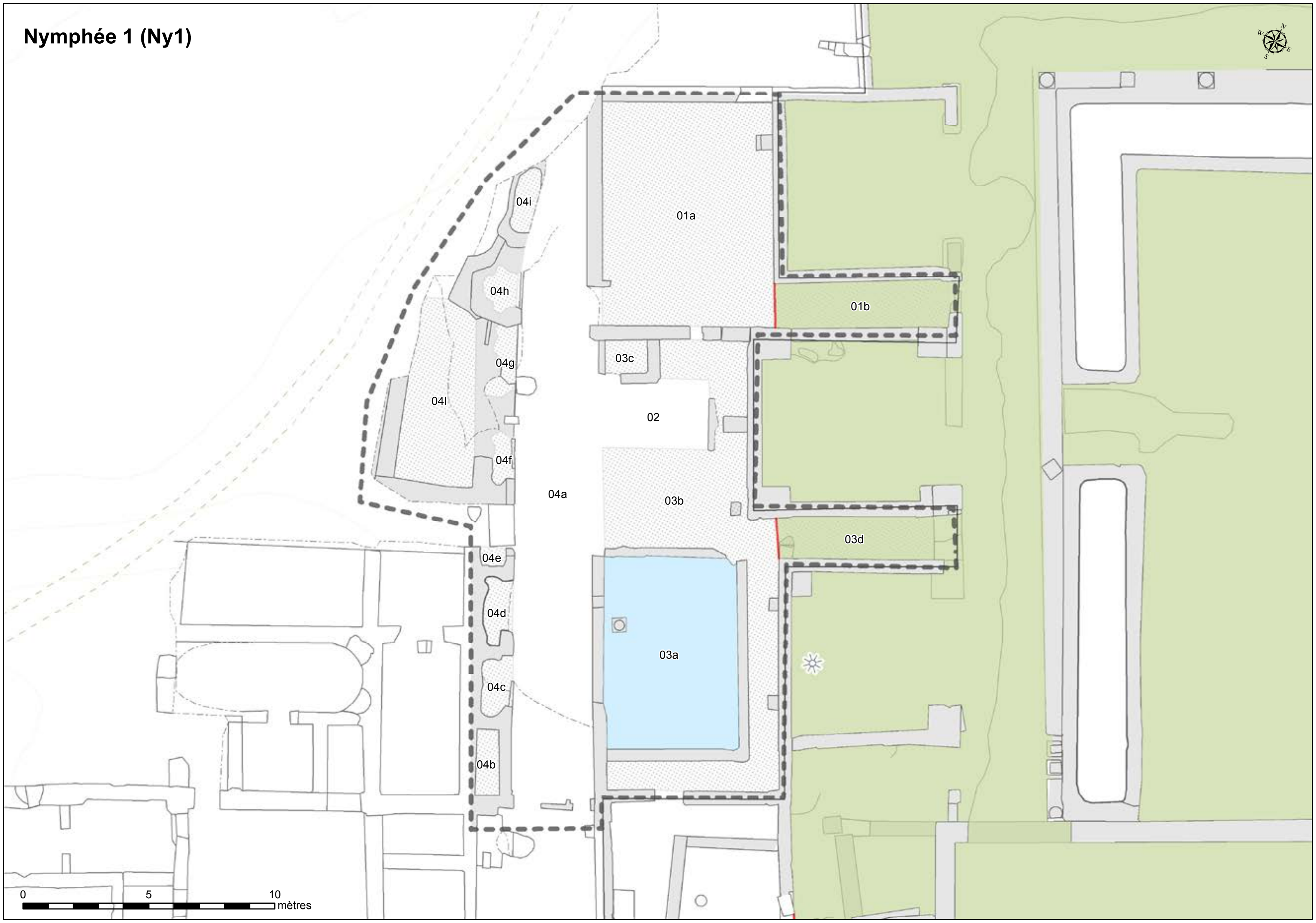


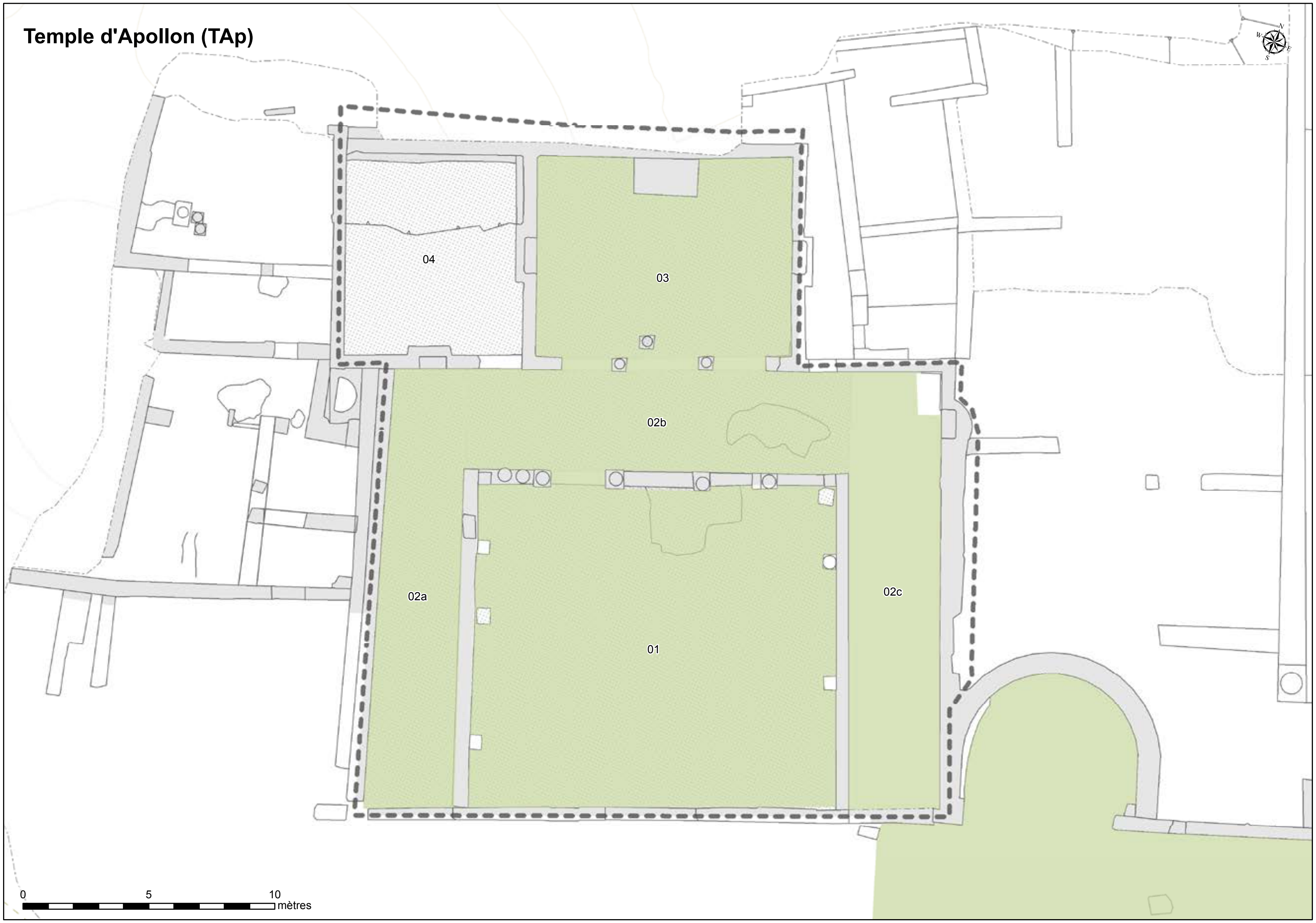

Maison du Trésor - étage souterraine (MT - S)
S01
S02
S03
S04
S05
S06
0
5
10
mètres



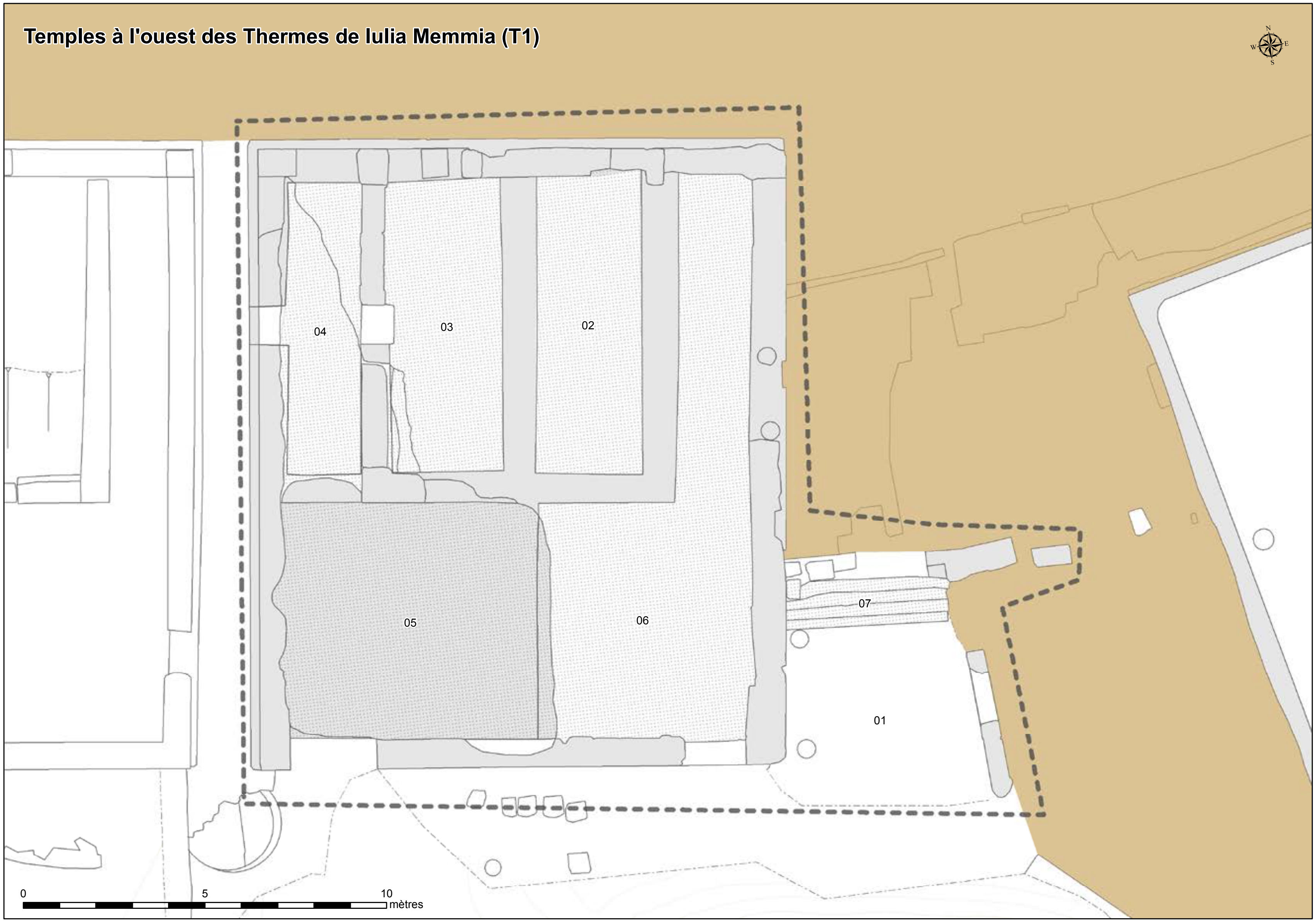
Marché (Mar)
07
04n
04m
04l
04i
04h
04g
06
09
02c
03
02a
04
01
08
02b
05
04a
04b
04c
04d
04e
04f
0
5
10
mètres

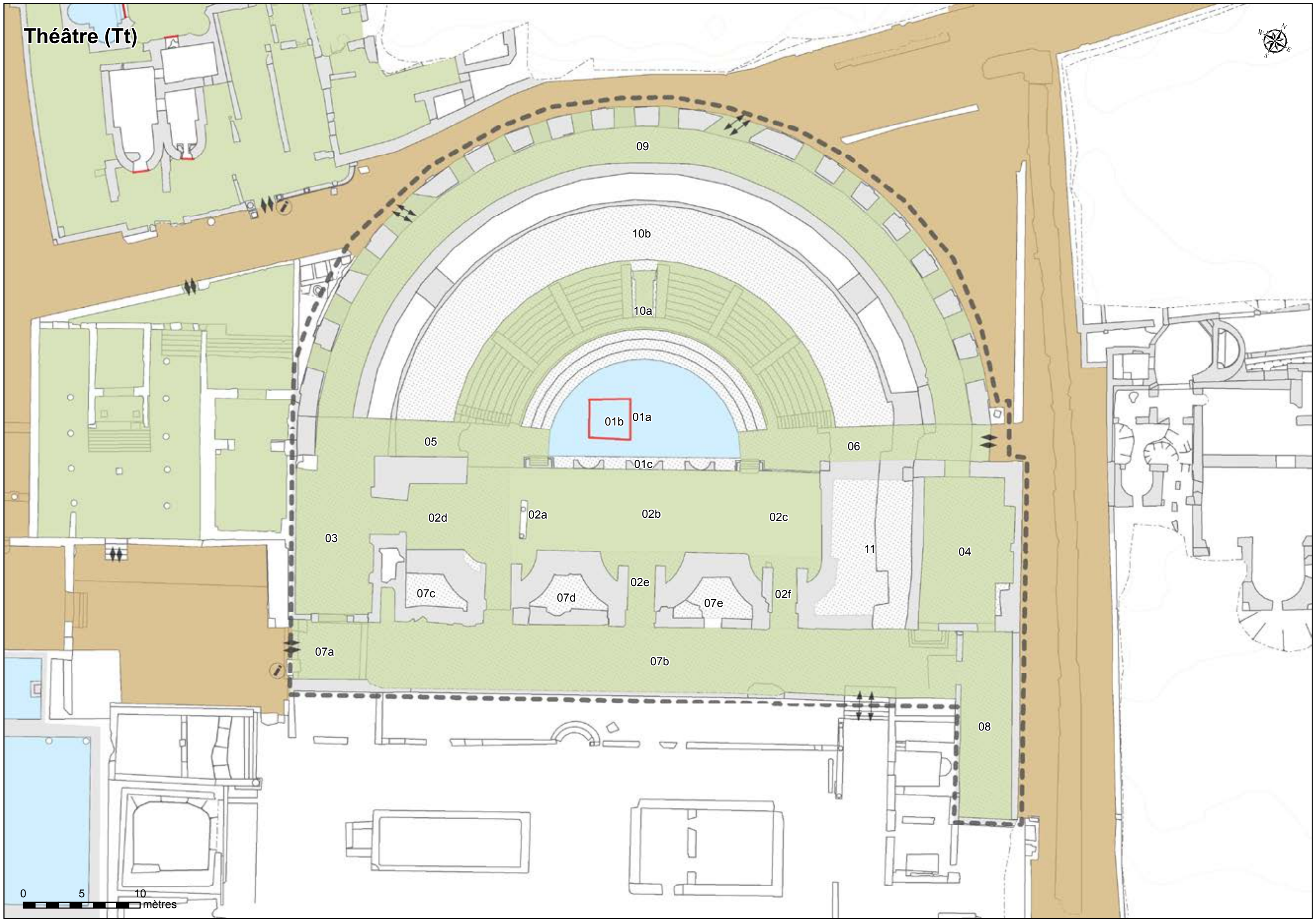
Nymphée 1 (Ny1)

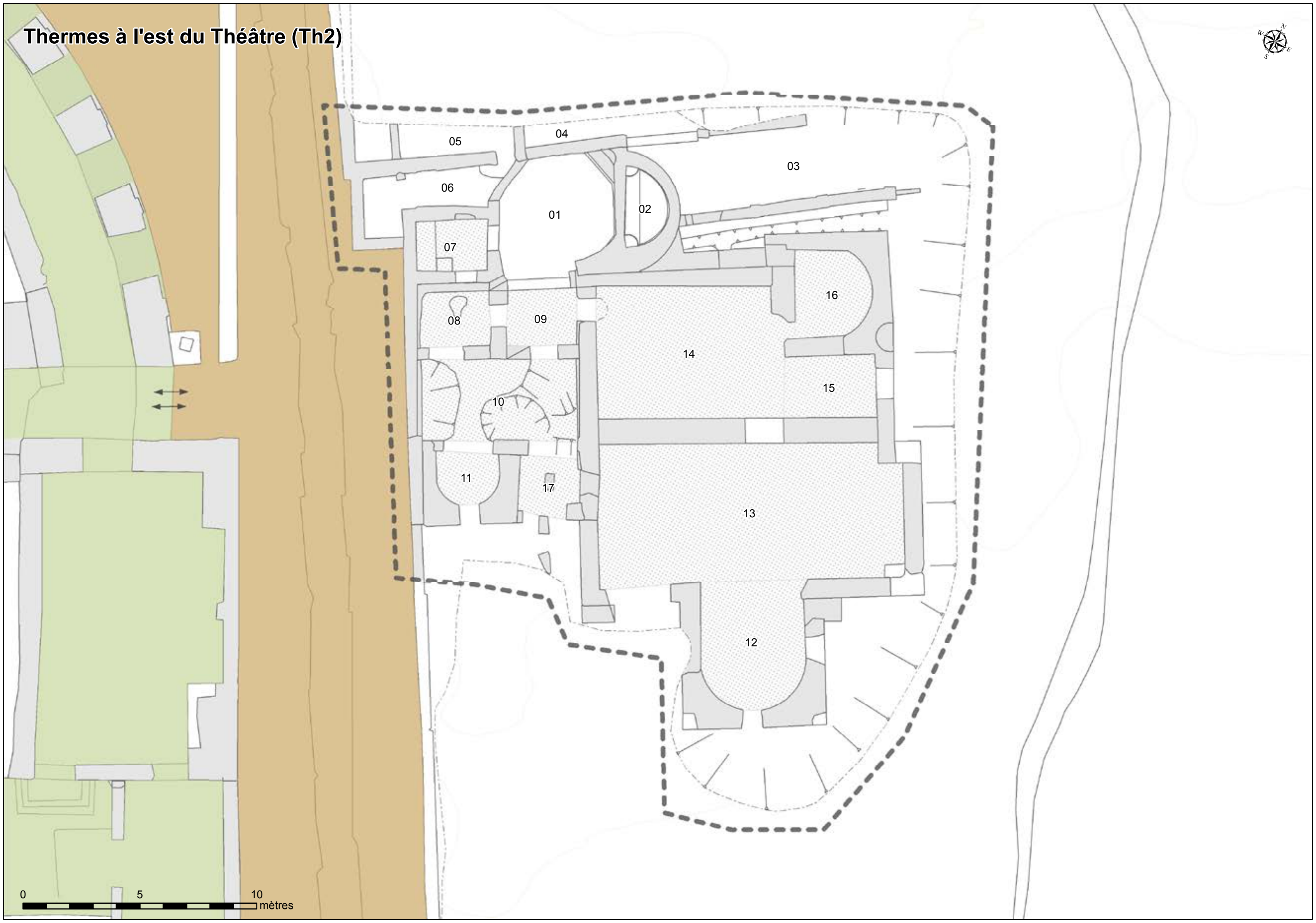


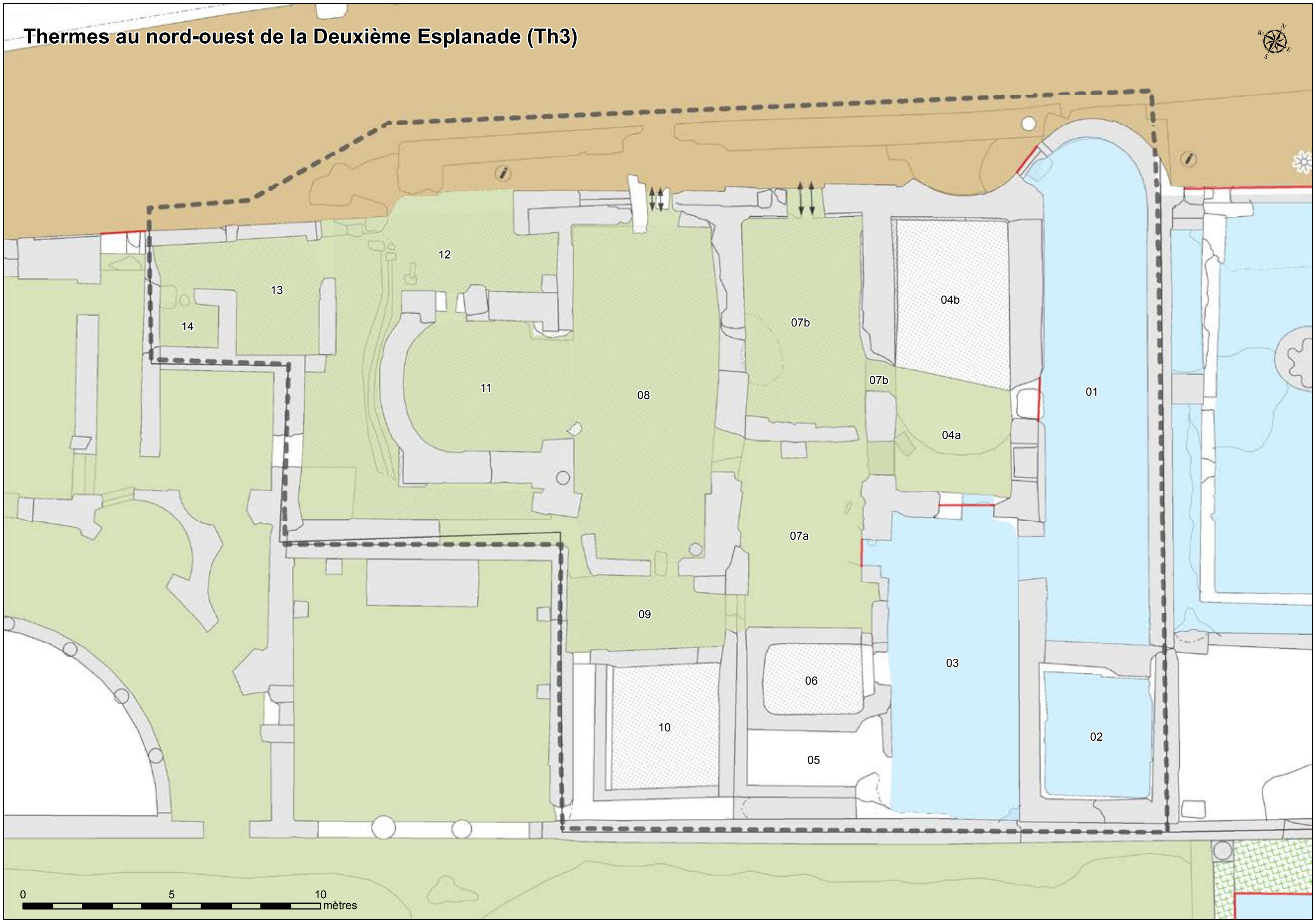

Temple d'Apollon (TAp)
04
03
02b
02a
02c
01
0
5
10
mètres

Temples à l'ouest des Thermes de Iulia Memmia (T1)

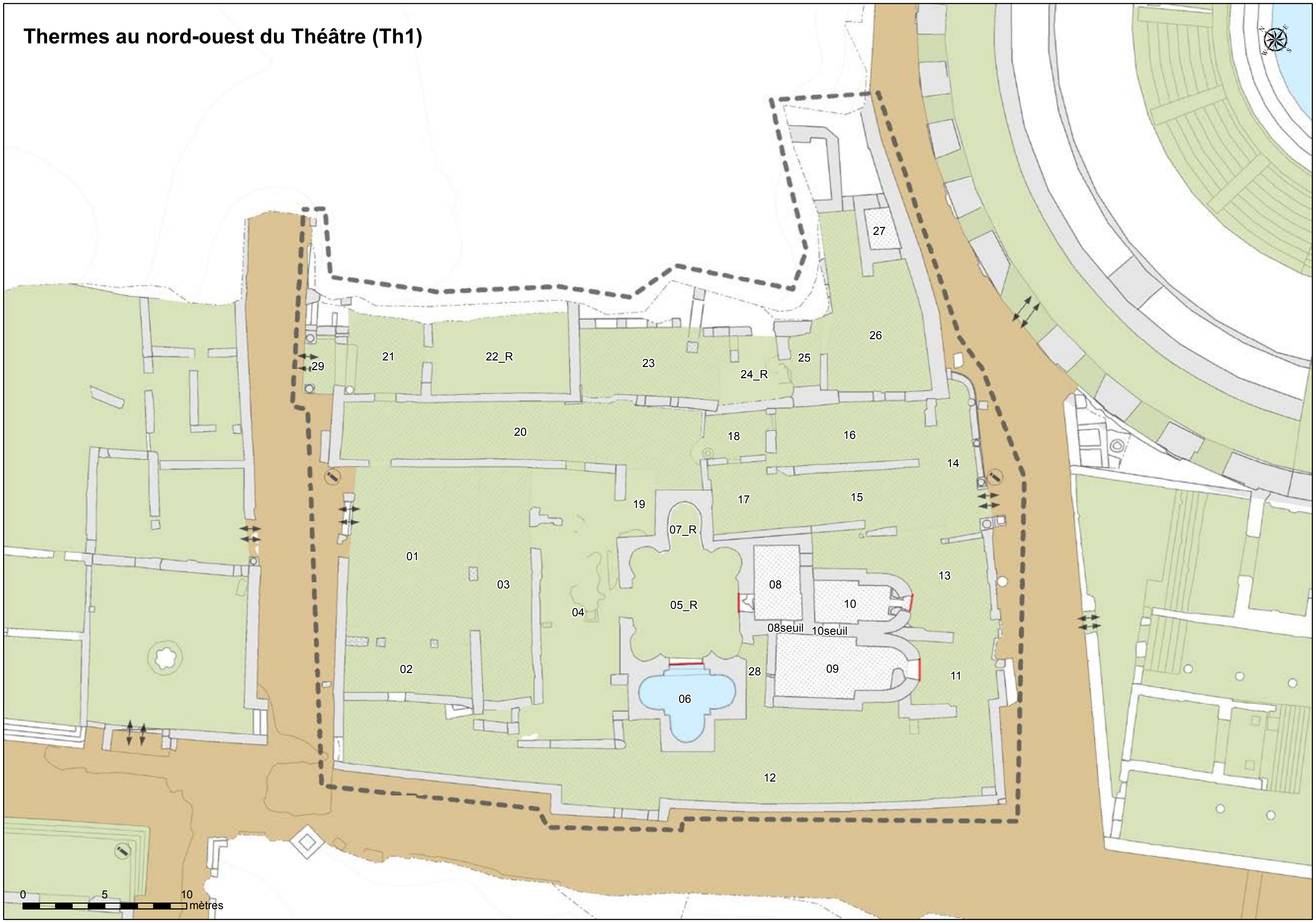


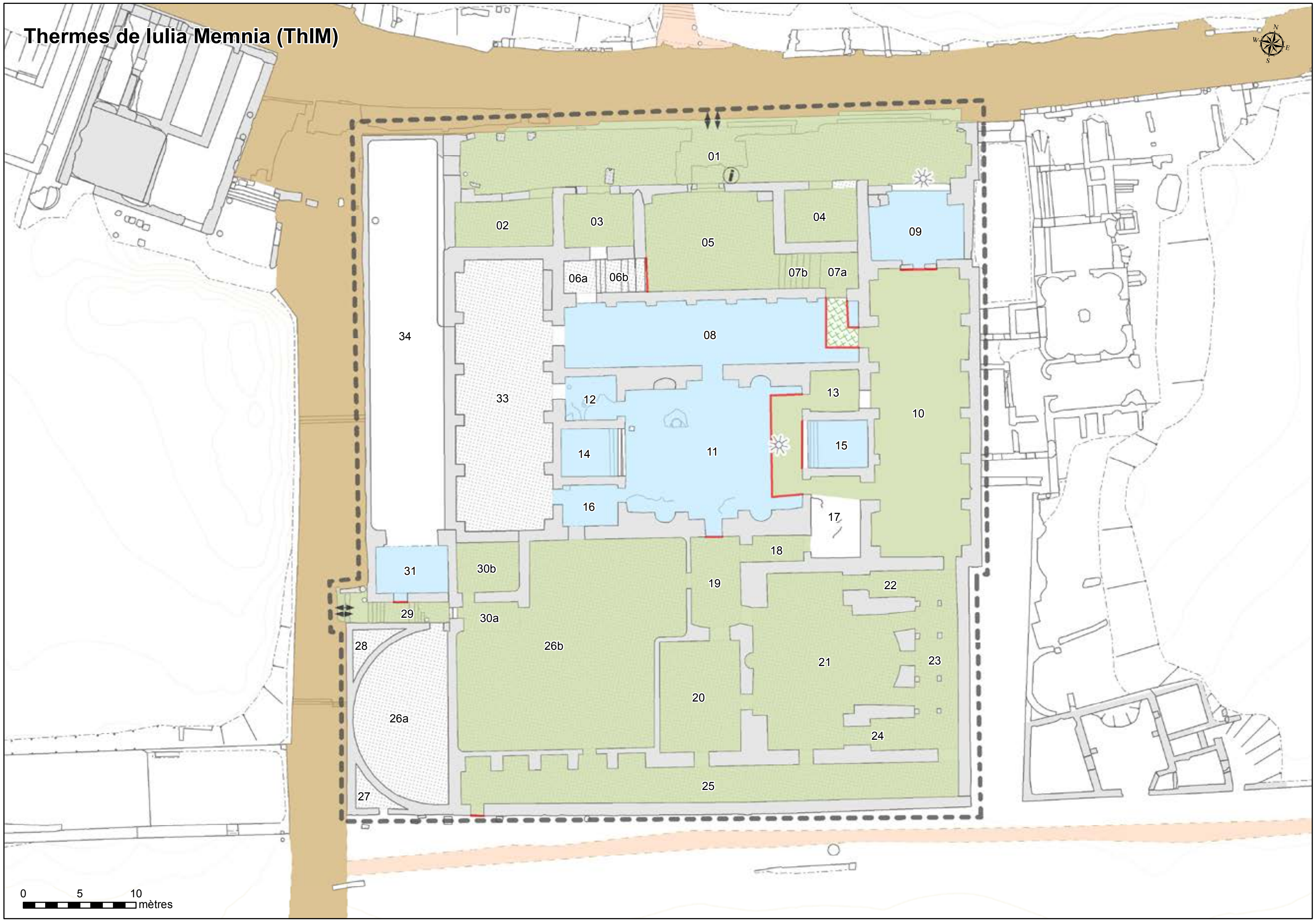

Théâtre (Tt)
09
10b
10a
01a
01b
01c
05
06
02a
02b
02c
02d
03
04
11
02e
02f
07c
07d
07e
07a
07b
08
0
5
10
mètres


Thermes à l'est du Théâtre (Th2)
05
04
03
06
01
02
07
16
08
09
14
15
10
11
17
13
12
0
5
10
mètres


Thermes au nord-ouest de la Deuxième Esplanade (Th3)
13
12
14
04b
07b
07b
11
08
01
04a
07a
09
03
06
10
02
05
0
5
10
mètres

Thermes au nord-ouest des Basiliques (Th4)


Thermes au nord-ouest du Théâtre (Th1)
27
26
21
22_R
23
25
24_R
29
20
18
16
14
19
17
15
07_R
01
03
08
13
10
05_R
04
08seuil
10seuil
02
28
09
11
06
12
0
5
10
mètres


Thermes de Iulia Memnia (ThIM)
01
02
03
04
05
06a
06b
07b
07a
08
09
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26a
26b
27
28
29
30a
30b
31
33
34
0
5
10
mètres

Thermes des Venantii (ThV)


Thermes du nord-est (Th5)
04
05
06
07
08
10
11
01_R
09
03
02
0
5
10
mètres

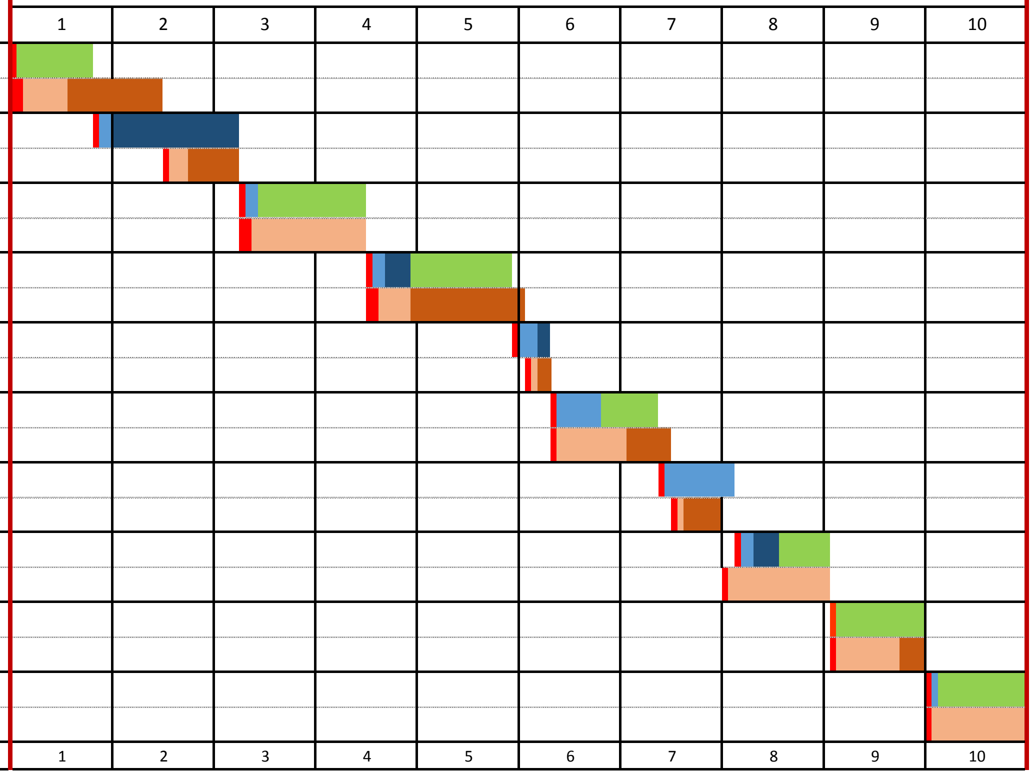
APPENDIX H

Conservation Planning Timelines and Budgets

PHASE 1 - TEMPORARY PROTECTION - CONSERVATION PROGRAM

BUILDINGS WITH MOSAICS BY AREA		T = Technicians W = Workers	WORK DAYS BY AREA: Material Transport and Worksite Organization	Local. Temp. Protect. and Short-Term Reburials	Maintenance Cycles	Wall Plaster Stabilizat. + First Aid Interventions	Temporary Access Barriers	Temporary Fences
A	MA, MA-S, M15, ThV, Th5	T	1	0	0	12		
		W	2				7,3	15,2
B	MNC, MNC-S, MC, MC-S, MPa, MPa-S	T	1	2,0	20 MC	0		
		W	1				2,8	7,7
C	MP, MP-S, M8, M9, M10, M14, E12	T	1	1,9		17		
		W	2				18,5	0,0
D	BaN, BaS, Th4, M7, E10, M2, M2-S, MT, MT-S	T	1	1,7	4 BaS	16		
		W	2				5,0	18,3
E	M1, M1-S, E11, M3, M3-S , E9	T	1	3,3	2 M1	0		
		W	1				1,0	1,5
F	ThIM, E6, E7, E8, E16, T1	T	1	7,3		9		
		W	1				11,3	6,8
G	E01, TAp, B1, E13, E14, E15	T	1	11,1		0		
		W	1				0,8	6,1
H	M04, M05, E02, Mar, E03, Th1	T	1	2,0	4 M4	8		
		W	1				16,0	0,0
I	Tt Th2	T	1	0		14		
		W	1				11,0	4,1
J	E04, Th3, EM2, E05, Ny1	T	1	1,1		14		
		W	1				13,7	0,0
TOTALS			23	30	30	90	87	60

PHASE 1 - 10 MONTHS



(16,5 days per month, 200 days per year)

TECHNICIAN SCHEDULE (Team of 4 technicians)

- Local temporary protection and short-term reburial
- Maintenance cycle
- Wall plasters stabilization + First Aid interventions

WORKER SCHEDULE (Team of 4 workers)

- Material transportation and work site organization
- Temporary access barrier preparation and installation
- Temporary fence preparation and installation

PHASE 1 - TEMPORARY PROTECTION - COST ESTIMATE - Technician activities

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

BUILDINGS WITH MOSAICS BY AREA			Work site organizat.		Localized Temporary Protection				Short-term Reburial										Mosaic maintenance					Wall plaster stab. and First Aid interventions				TOTAL cost LABOR by area	TOTAL cost MATERIALS by area
			LABOR		LABOR		MATERIALS		LABOR		MATERIALS								LABOR		MATERIALS			LABOR		MATERIALS			
			work days	1 day / 4 techn. TD 120 Tot. cost	work days	1 day / 4 techn. TD 120 Tot. cost	L T P area	cost m^2 TD 8 Tot. cost	work days	1 day / 4 techn. TD 120 Tot. cost	Sand	cost m^3 TD 25 Tot. cost	Gravel	cost m^3 TD 35 Tot. cost	Geo-textile	cost m^2 TD 1,5 Tot. cost	Wooden planks	cost m TD 20 Tot. cost	work days	1 day / 4 techn TD 120 Tot. cost	Mosaics	Reburials	Flat rate Tot. cost	work days	1 day / 4 techn TD 120 Tot. cost	work days	cost mat./ day 5 Tot. cost		
			w.d.	TD	w.d.	TD	m^2	TD	w.d.	TD	m^3	TD	m^3	TD	m^2	TD	m	TD	w.d	TD	m^2	m^2	TD	w.d.	TD	w.d.	TD	tot TD	tot TD
	MA	Maison d’Amphitrite - gr. level				0		0		0		0		0		0		0		0			0						
	MA-S	Maison d'Amphitrite - und.gr. Level				0		0		0		0		0		0		0		0			0						
A	M15	Maison 15				0		0		0		0		0		0		0		0			0						
	ThV	Thermes des Venantii				0		0		0		0		0		0		0		0			0						
	Th5	Thermes du nord-est	1	120		0		0		0		0		0		0		0		0			0	12	1440	12	60	1560	60
	MNC	Maison Nouvelle Chasse - gr. level				0		0	2	240	1	15	0	11	8	11	7	140		0			0						
	MNC-S	Maison Nouvelle Chasse - und.gr. level				0		0		0		0		0		0		0		0			0						
B	MC	Maison de la Chasse - ground level				0		0		0		0		0		0		0	20	2400	244	304	50						
	MC-S	Maison de la Chasse - undergr. level				0		0		0		0		0		0		0		0			0						
	MPa	Maison du Paon - ground level				0		0		0		0		0		0		0		0			0						
	MPa-S	Maison du Paon - undergr. level	1	120		0		0		0		0		0		0		0		0			0	0	0	0	0	2760	227
	MP	Maison de la Pêche - ground level			2	228	7	58		0		0		0		0		0		0			0						
	MP-S	Maison de la Pêche - undergr. level				0		0		0		0		0		0		0		0			0						
	M08	Maison 8				0		0		0		0		0		0		0		0			0						
C	M09	Maison 9				0		0		0		0		0		0		0		0			0						
	M10	Maison 10				0		0		0		0		0		0		0		0			0						
	M14	Maison 14				0		0		0		0		0		0		0		0			0						
	E12	Edifice coin sud de l’ins. de la Pêche	1	120		0		0		0		0		0		0		0		0			0	17	2040	17	85	2388	143
	BaN	Basilique Chrétienne du Nord				0		0		0		0		0		0		0		0			0						
	BaS	Basilique Chrétienne du Sud			1	96	1,1	9		0		0		0		0		0	4	480	29	120	15						
	Th4	Thermes nord-ouest des Basiliques				0		0		0		0		0		0		0		0			0						
	M07	Maison 7 - gr. and undergr. level				0		0		0		0		0		0		0		0			0						
D	E10	Edifice au nord de la Maison 7				0		0		0		0		0		0		0		0			0						
	M02	Maison 2 - ground level				0		0		0		0		0		0		0		0			0						
	M02-S	Maison 2 - underground level				0		0		0		0		0		0		0		0			0						
	MT	Maison du Trésor - ground level			1	108	1,4	11		0		0		0		0		0		0			0						
	MT-S	Maison du Trésor - undergr. level	1	120		0		0		0		0		0		0		0		0			0	16	1920	16	80	2724	115
	M01	Maison 1 - ground level				0		0	1	60	0,1	4	0,1	2	2	3		0	2	240	64	1	15						
	M01-S	Maison 1 - underground level				0		0		0		0		0		0		0		0			0						
E	E11	Edifice au carrefour entre M3 et M7				0		0	3	330	0,8	20	0	14	11	16	14	280		0			0						
	M03	Maison 3 - ground level				0		0		0		0		0		0		0		0			0						
	M03	Maison 3 - underground level				0		0		0		0		0		0		0		0			0						
	E09	Edifice au sud de la Maison 3	1	120		0		0		0		0		0		0		0		0			0	0	0	0	0	750	353

PHASE 1 - TEMPORARY PROTECTION - COST ESTIMATE - Technician activities

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

BUILDINGS WITH MOSAICS BY AREA			Work site organizat.		Localized Temporary Protection				Short-term Reburial										Mosaic maintenance					Wall plaster stab. and First Aid interventions				TOTAL cost LABOR by area	TOTAL cost MATERIALS by area
			LABOR		LABOR		MATERIALS		LABOR		MATERIALS								LABOR		MATERIALS			LABOR		MATERIALS			
			work days	1 day / 4 techn. TD 120 Tot. cost	work days	1 day / 4 techn. TD 120 Tot. cost	L T P area	cost m² TD 8 Tot. cost	work days	1 day / 4 techn. TD 120 Tot. cost	Sand	cost m³ TD 25 Tot. cost	Gravel	cost m³ TD 35 Tot. cost	Geo-textile	cost m² TD 1,5 Tot. cost	Wooden planks	cost m TD 20 Tot. cost	work days	1 day / 4 techn TD 120 Tot. cost	Mosaics	Reburials	Flat rate Tot. cost	work days	1 day / 4 techn TD 120 Tot. cost	work days	cost mat./ day 5 Tot. cost		
			w.d.	TD	w.d.	TD	m²	TD	w.d.	TD	m³	TD	m³	TD	m²	TD	m	TD	w.d	TD	m²	m²	TD	w.d.	TD	w.d.	TD	tot TD	tot TD
F	ThIM	Thermes de Iulia Memnia			5	648	22	173		0		0		0		0		0		0			0						
	E06	Edifice à l'est des Th.de Iulia Memmia				0	2,4	19		0		0		0		0		0		0			0						
	E07	Edifice au nord du monum. opus retic.				0		0		0		0		0		0		0		0			0						
	E08	Edifice à l'ouest du monum. opus retic.				0		0		0		0		0		0		0		0			0						
	E16	Edifice à l'ouest du Temple 1			1	132		0		0		0		0		0		0		0			0						
	T1	Temples à l'ouest Th.Iulia Memmia	1,0	120	1	90	1,0	8		0		0		0		0		0		0			0	9	1080	9,0	45	2070	245
G	E01	Edifice sud-ouest Temple d'Apollon				0		0		0		0		0		0		0		0			0						
	TAp	Temple d'Apollon			1	108	1,5	12		0		0		0		0		0		0			0						
	B1	Basilique du Forum			10	1218	39	308		0		0		0		0		0		0			0						
	E13	Edifice au nord de la source				0		0		0		0		0		0		0		0			0						
	E14	Edifice nord-est Temple d'Apollon				0		0		0		0		0		0		0		0			0						
	E15	Edifice au sud de la colline	1,0	120		0		0		0		0		0		0		0		0			0	0	0	0,0	0	1446	320
H	M04	Maison 4				0		0		0		0		0		0		0	4	480	0	194	20						
	M05	Maison 5				0		0		0		0		0		0		0		0			0						
	E02	Edifice dans le coin sud du Forum			1	150	5,0	40		0		0		0		0		0		0			0						
	Mar	Marché				0		0		0		0		0		0		0		0			0						
	E03	Edifice au nord est du Marché				0		0		0		0		0		0		0		0			0						
	Th1	Thermes au nord ouest du Théâtre	1,0	120	1	90	1,0	8		0		0		0		0		0		0			0	8	960	8,0	40	1800	108
I	Tt	Théâtre				0		0		0		0		0		0		0		0			0						
	Th2	Thermes à l'est du Théâtre	1,0	120		0		0		0		0		0		0		0		0			0	14	1680	14	70	1800	70
J	E04	Edifice au nord de la II Esplanade				0		0		0		0		0		0		0		0			0						
	Th3	Thermes au nord-ouest de la II Esplan.				0		0		0		0		0		0		0		0			0						
	EM2	Deuxième Esplanade Monumentale			1	126	2,1	17		0		0		0		0		0		0			0						
	E05	Edifice à l'ouest de la II Esplanade				0		0		0		0		0		0		0		0			0						
	Ny1	Nymphée 1	1,0	120		0		0		0		0		0		0		0		0			0	14	1680	14	70	1926	87
TOTALS			10	1200	25	2994	83	663	5	630	2	39	1	27	20	30	21	420	30	3600	337	619	100	90	10800		450	**19224**	**1728**

TECHNICIAN ACTIVITIES IN PHASE 1 - TOTAL COST TD	**20.952**

Time for **Work site Organization** is estimated at 1 day per area.

Time for **Localized Temporary Protection** installation is estimated considering a half day for each square meter, plus 1 day per building for material preparation and transport.

LTP: geo-textile cushions filled with sand or other protection material, or mats/carpets, or other protection measure in contact with mosaic, as required.

Time for **Short-term Reburial** is taken from the Rapid Survey Form estimate.

Short-term Reburial: sand, 10 cm depth; gravel, 5 cm depth; geo-textile on the whole surface with 25% overlap between sheets; wooden plank containment where walls are not present.

Time for **Mosaic maintenance** is estimated considering 13 m²/ day for exposed mosaics, 30 m²/day for sheltered mosaics and 50 m²/day for reburied mosaics.

Mosaic and reburial maintenance: building materials, consumable materials, tools and equipment, as required.

Time for **Wall Plaster Stabilization** and **First Aid Interventions** is determined by area considering technician availability during workers' work in the same area.

Wall Plaster stabilization and **First Aid Interventions**: building materials, consumable materials, tools and equipment, as required for each day of work.

PHASE 1 - TEMPORARY PROTECTION - COST ESTIMATE - Worker activities

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

BUILDINGS WITH MOSAICS BY AREA			Work site organization		Temporary access barrier						Temporary fence						TOTAL cost LABOR by building	TOTAL cost LABOR by area	TOTAL cost MATERIALS by building	TOTAL cost MATERIALS by area
			LABOR		LABOR		MATERIALS				LABOR		MATERIALS							
			work days	1 day / 2 masons 2 workers TD 100 Tot. cost	work days	1 day / 2 masons 2 workers TD 100 Tot. cost	Barrier length	cost m TD 6 Tot. cost	Barrier posts	unit cost 8 Tot. cost	work days	1 day / 2 masons 2 workers TD 100 Tot. cost	Fence length	cost m TD 7 Tot. cost	Fence posts	unit cost 5 Tot. cost				
			w.days	TD	w.days	tot TD	m	tot TD	#	tot TD	w.days	tot TD	m	tot TD	#	tot TD	tot TD	tot TD	tot TD	tot TD
	MA	Maison d'Amphitrite - ground level			5	525	16,8	101	21	168	11	1105	92	644	46	230	1630		1143	
	MA-S	Maison d'Amphitrite - undergr. level			1	50	1,2	7	2	16		0		0		0	50		23	
A	M15	Maison 15			2	150	6,0	36	6	48		0		0		0	150		84	
	ThV	Thermes des Venantii				0		0		0	4	410	34	239	17	85	410		324	
	Th5	Thermes du nord-est	2	200		0		0		0		0		0		0	0	2240	0	1574
	MNC	Maison Nouvelle Chasse - ground level			3	275	6,9	41	11	88		0		0		0	275		129	
	MNC-S	Maison Nouvelle Chasse - undergr. level				0		0		0		0		0		0	0		0	
B	MC	Maison de la Chasse - ground level				0		0		0		0		0		0	0		0	
	MC-S	Maison de la Chasse - undergr. level				0		0		0		0		0		0	0		0	
	MPa	Maison du Paon - ground level				0		0		0	8	770	64	449	32	160	770		609	
	MPa-S	Maison du Paon - undergr. level	1	100		0		0		0		0		0		0	0	1045	0	739
	MP	Maison de la Pêche - ground level			9	875	26,7	160	35	280		0		0		0	875		440	
	MP-S	Maison de la Pêche - undergr. level				0		0		0		0		0		0	0		0	
	M08	Maison 8			4	375	9,1	55	15	120		0		0		0	375		175	
C	M09	Maison 9			1	75	2,2	13	3	24		0		0		0	75		37	
	M10	Maison 10				0		0		0		0		0		0	0		0	
	M14	Maison 14			3	275	10,7	64	11	88		0		0		0	275		152	
	E12	Edifice coin sud de l'ins. de la Pêche	2	200	3	250	9,4	56	10	80		0		0		0	250	1850	136	941
	BaN	Basilique Chrétienne du Nord			2	150	2,5	15	6	48		0		0		0	150		63	
	BaS	Basilique Chrétienne du Sud			2	150	3,8	23	6	48		0		0		0	150		71	
	Th4	Thermes nord-ouest des Basiliques			2	200	3,6	22	8	64		0		0		0	200		86	
	M07	Maison 7 - ground and undergr. level				0		0		0	7	660	55	385	30	150	660		535	
D	E10	Edifice au nord de la Maison 7				0		0		0	5	455	38	266	18	90	455		356	
	M02	Maison 2 - ground level				0		0		0	7	710	59	414	30	150	710		564	
	M02-S	Maison 2 - underground level				0		0		0		0		0		0	0		0	
	MT	Maison du Trésor - ground level				0		0		0		0		0		0	0		0	
	MT-S	Maison du Trésor - undergr. level	2	200		0		0		0		0		0		0	0	2325	0	1674
	M01	Maison 1 - ground level			1	50	0,7	4	2	16	2	150	13	88	7	35	200		143	
	M01-S	Maison 1 - underground level				0		0		0		0		0		0	0		0	
E	E11	Edifice au carrefour entre M3 et M7				0		0		0		0		0		0	0		0	
	M03	Maison 3 - ground level			1	50	0,8	5	2	16		0		0		0	50		21	
	M03	Maison 3 - underground level				0		0		0		0		0		0	0		0	
	E09	Edifice au sud de la Maison 3	1	100		0		0		0		0		0		0	0	250	0	164

PHASE 1 - TEMPORARY PROTECTION - COST ESTIMATE - Worker activities MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

		BUILDINGS WITH MOSAICS BY AREA	Work site organization		Temporary access barrier						Temporary fence									
			LABOR		LABOR		MATERIALS				LABOR		MATERIALS							
			work days	1 day / 2 masons 2 workers TD 100 Tot. cost	work days	1 day / 2 masons 2 workers TD 100 Tot. cost	Barrier length	cost m TD 6 Tot. cost	Barrier posts	unit cost 8 Tot. cost	work days	1 day / 2 masons 2 workers TD 100 Tot. cost	Fence length	cost m TD 7 Tot. cost	Fence posts	unit cost 5 Tot. cost	TOTAL cost LABOR by building	TOTAL cost LABOR by area	TOTAL cost MATERIALS by building	TOTAL cost MATERIALS by area
			w.days	TD	w.days	tot TD	m	tot TD	#	tot TD	w.days	tot TD	m	tot TD	#	tot TD	tot TD	tot TD	tot TD	tot TD
F	ThIM	Thermes de Iulia Memnia			10,8	1075	37,2	223	43	344		0		0		0	1075		567	
	E06	Edifice à l'est des Th.de Iulia Memmia				0		0		0		0		0		0	0		0	
	E07	Edifice au nord du monum. opus retic.				0		0		0	5,65	565	47	329	24	120	565		449	
	E08	Edifice à l'ouest du monum. opus retic.			0,5	50	1,4	8	2	16	1,15	115	10	67	5	25	165		116	
	E16	Edifice à l'ouest du Temple 1				0		0		0		0		0		0	0		0	
	T1	Temples à l'ouest Th. Iulia Memmia	1	100		0		0		0		0		0		0	0	1805	0	1132
G	E01	Edifice sud-ouest Temple d'Apollon				0		0		0	6,1	610	51	356	26	130	610		486	
	TAp	Temple d'Apollon			0,8	75	1,7	10	3	24		0		0		0	75		34	
	B1	Basilique du Forum				0		0		0		0		0		0	0		0	
	E13	Edifice au nord de la source				0		0		0		0		0		0	0		0	
	E14	Edifice nord-est Temple d'Apollon				0		0		0		0		0		0	0		0	
	E15	Edifice au sud de la colline	1	100		0		0		0		0		0		0	0	685	0	521
H	M04	Maison 4				0		0		0		0		0		0	0		0	
	M05	Maison 5			3,3	325	16,1	97	13	104		0		0		0	325		201	
	E02	Edifice dans le coin sud du Forum			3,0	300	9,2	55	12	96		0		0		0	300		151	
	Mar	Marché			1,8	175	6,3	38	7	56		0		0		0	175		94	
	E03	Edifice au nord-est du Marché				0		0		0		0		0		0	0		0	
	Th1	Thermes au nord-ouest du Théâtre	1	100	8,0	800	27,0	162	32	256		0		0		0	800	1600	418	864
I	Tt	Théâtre			9,8	975	35,0	210	39	312		0		0		0	975		522	
	Th2	Thermes à l'est du Théâtre	1	100	1,3	125	3,6	22	5	40	4,1	405	34	236	17	85	530	1505	383	905
J	E04	Edifice au nord de la II Esplanade			3,0	300	12,9	77	12	96		0		0		0	300		173	
	Th3	Thermes au nord-ouest de la II Esplan.			2,0	200	4,6	28	8	64		0		0		0	200		92	
	EM2	Deuxième Esplanade Monumentale			4,5	450	16,4	98	18	144		0		0		0	450		242	
	E05	Edifice à l'ouest de la II Esplanade			2,7	265	8,6	52	11	88		0		0		0	265		140	
	Ny1	Nymphée 1	1	100	1,5	150	3,3	20	6	48		0		0		0	150	1365	68	715
		TOTALS	13	1300	87	8715	284	1702	349	2792	60	5955	496	3473	252	1260	14670	14670	9227	9227

WORKER ACTIVITIES IN PHASE 1 - TOTAL COST TD **23.897**

Time for **Worksite Organization** is estimated at 1 day for each area.

Time for **Temporary Access Barrier** installation is estimated considering 4 days of 2 workers to prepare and install 8 posts with double rope barriers and cement supports for half of them.

Time for **Fence** installation is estimated considering 6 days of 2 workers to prepare and install 25 m of fence, with 12 posts.

Temporary Access Barriers: double rope barrier; iron post (square section 4x4 cm) 1,2 m in height, at 1 meter distance (all posts cut and treated with anti-rust coating and paint); cement support for half of the posts.

Fence: 1,3 m in height; iron post (L section 4x4 cm) 1,5 m in height, at 2 meter distance; double galvanized iron wire reinforcement along the entire fence; anti-rust coating and paint.

BUILDINGS WITH MOSAICS BY AREA			TECHNICIAN ACTIVITY IN PHASE 1			WORKER ACTIVITY IN PHASE 1			TOTAL LABOR PHASE 1	TOTAL MATERIAL PHASE 1	PHASE 1 TOTALS
			TOTAL cost LABOR by area	TOTAL cost MATERIALS by area	TOTAL cost labor and materials by area	TOTAL cost LABOR by area	TOTAL cost MATERIALS by area	TOTAL cost LABOR and MATERIALS by area			
			tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD
A	MA	Maison d'Amphitrite - ground level									
	MA-S	Maison d'Amphitrite - underground level									
	M15	Maison 15									
	ThV	Thermes des Venantii									
	Th5	Thermes du nord-est	1560	60	1620	2240	1574	3814	3800	1634	5434
B	MNC	Maison Nouvelle Chasse - ground level									
	MNC-S	Maison Nouvelle Chasse - underground level									
	MC	Maison de la Chasse - ground level									
	MC-S	Maison de la Chasse - underground level									
	MPa	Maison du Paon - ground level									
	MPa-S	Maison du Paon - underground level	2760	227	2.987	1045	739	1.784	3805	966	4.771
C	MP	Maison de la Pêche - ground level									
	MP-S	Maison de la Pêche - underground level									
	M08	Maison 8									
	M09	Maison 9									
	M10	Maison 10									
	M14	Maison 14									
	E12	Edifice coin sud de l'insula de la Pêche	2388	143	2.531	1850	941	2.791	4238	1084	5.322
D	BaN	Basilique Chrétienne du Nord									
	BaS	Basilique Chrétienne du Sud									
	Th4	Thermes nord-ouest des Basiliques									
	M07	Maison 7 - ground and underground level									
	E10	Edifice au nord de la Maison 7									
	M02	Maison 2 - ground level									
	M02-S	Maison 2 - underground level									
	MT	Maison du Trésor - ground level									
	MT-S	Maison du Trésor - underground level	2724	115	2.839	2325	1674	3.999	5049	1789	6.838
E	M01	Maison 1 - ground level									
	M01-S	Maison 1 - underground level									
	E11	Edifice au carrefour entre M3 et M7									
	M03	Maison 3 - ground level									
	M03	Maison 3 - underground level									
	E09	Edifice au sud de la Maison 3	750	353	1.103	250	164	414	1000	518	1.518

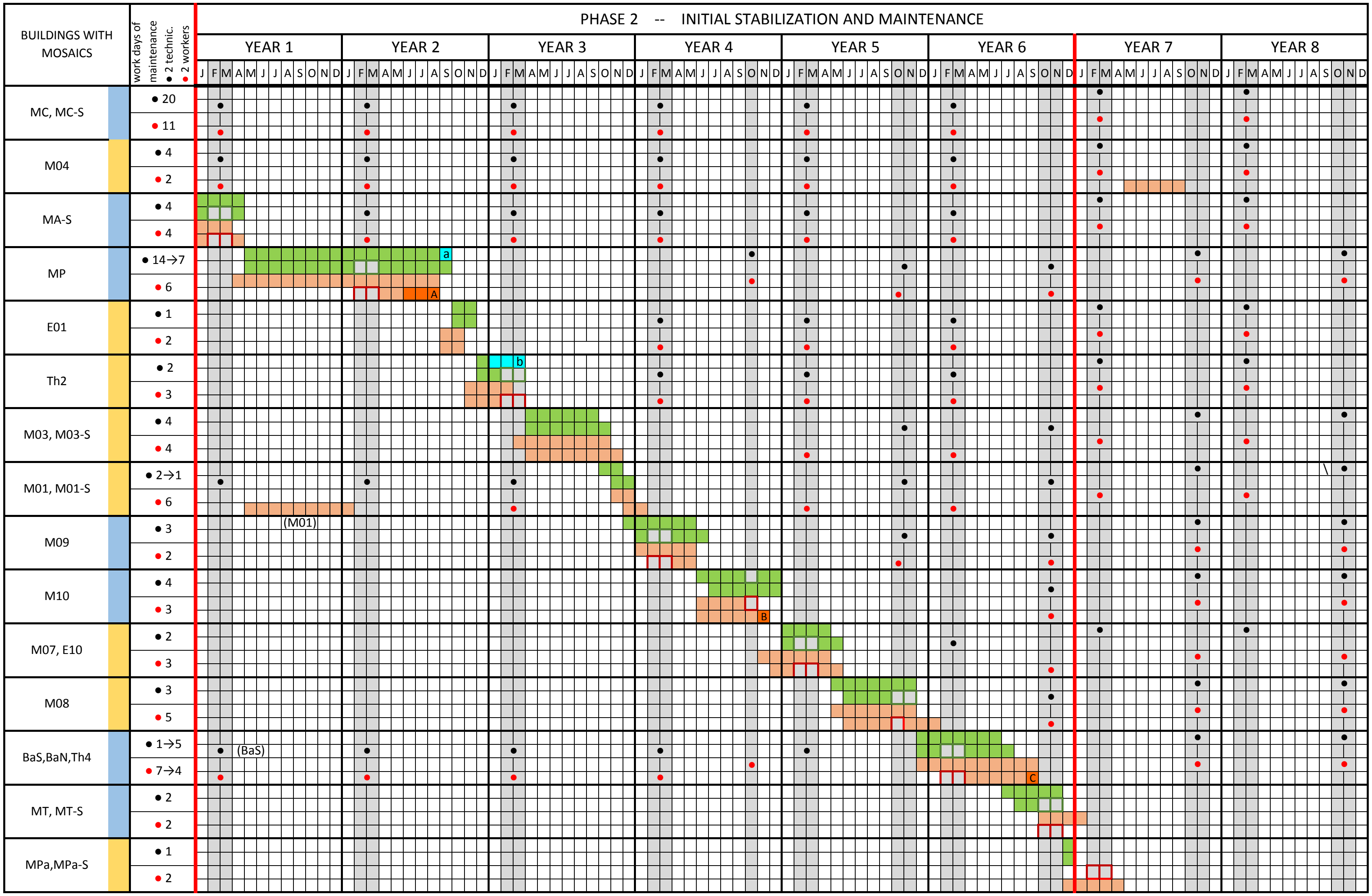
PHASE 1 - TEMPORARY PROTECTION - COST ESTIMATE - Phase 1 Totals

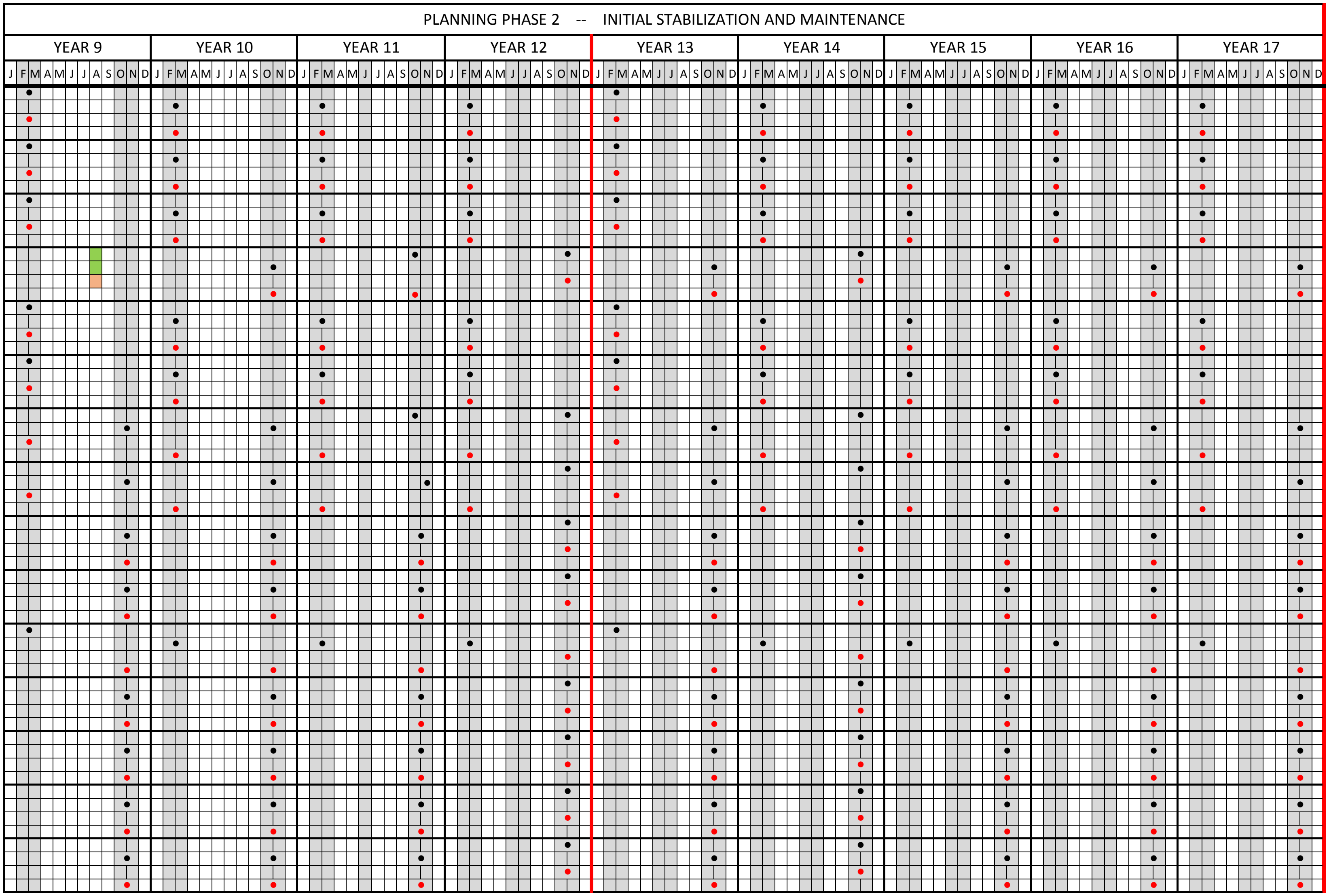
BUILDINGS WITH MOSAICS BY AREA			TECHNICIAN ACTIVITY IN PHASE 1			WORKER ACTIVITY IN PHASE 1			TOTAL LABOR PHASE 1	TOTAL MATERIAL PHASE 1	PHASE 1 TOTALS
			TOTAL cost LABOR by area	TOTAL cost MATERIALS by area	TOTAL cost labor and materials by area	TOTAL cost LABOR by area	TOTAL cost MATERIALS by area	TOTAL cost LABOR and MATERIALS by area			
			tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD
F	ThIM	Thermes de Iulia Memnia									
F	E06	Edifice à l'est des Thermes de Iulia Memmia									
F	E07	Edifice au nord du monument en opus retic.									
F	E08	Edifice à l'ouest du monument en opus retic.									
F	E16	Edifice à l'ouest du Temple 1									
F	T1	Temples à l'ouest Thermes de Iulia Memmia	2070	245	2315	1805	1132	2937	3875	1377	5252
G	E01	Edifice au sud-ouest du Temple d'Apollon									
G	TAp	Temple d'Apollon									
G	B1	Basilique du Forum									
G	E13	Edifice au nord de la source									
G	E14	Edifice au nord-est du Temple d'Apollon									
G	E15	Edifice au sud de la colline	1446	320	1766	685	521	1206	2131	841	2972
H	M04	Maison 4									
H	M05	Maison 5									
H	E02	Edifice dans le coin sud du Forum									
H	Mar	Marché									
H	E03	Edifice au nord-est du Marché									
H	Th1	Thermes au nord-ouest du Théâtre	1800	108	1908	1600	864	2464	3400	972	4372
I	Tt	Théâtre									
I	Th2	Thermes à l'est du Théâtre	1800	70	1870	1505	905	2410	3305	975	4280
J	E04	Edifice au nord de la II Esplanade									
J	Th3	Thermes au nord-ouest de la II Esplanade									
J	EM2	Deuxième Esplanade Monumentale									
J	E05	Edifice à l'ouest de la II Esplanade									
J	Ny1	Nymphée 1	1926	87	2013	1365	715	2080	3291	802	4093
TOTALS			19224	1728	**20952**	14670	9227	**23897**	33894	10955	**44849**

PHASE 1 TOTAL	**44849**

PHASE 2 - STABILIZATION - CONSERVATION PROGRAM

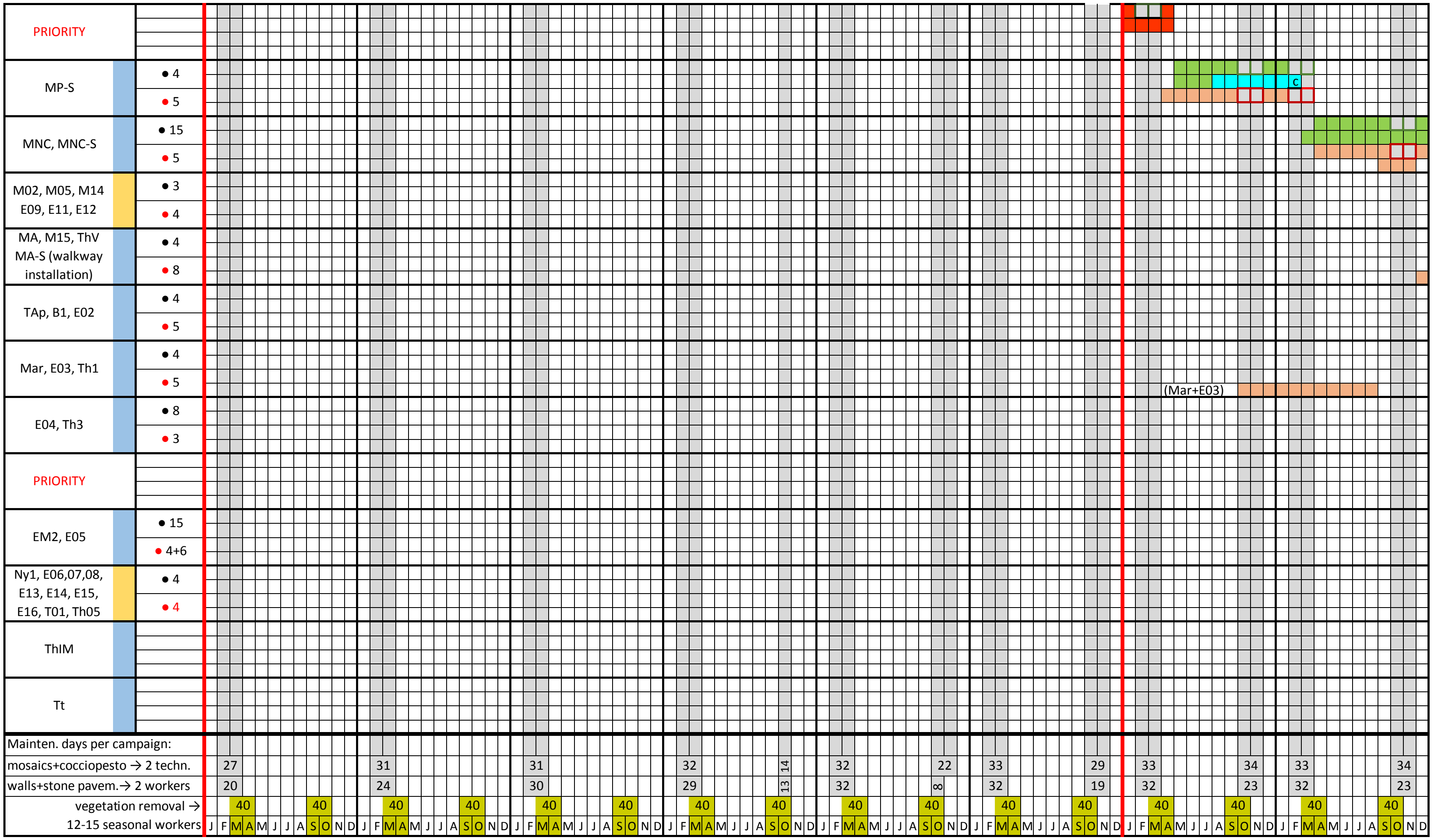
MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT




PLANNING PHASE 2 -- INITIAL STABILIZATION AND MAINTENANCE
YEAR 9
YEAR 10
YEAR 11
YEAR 12
YEAR 13
YEAR 14
YEAR 15
YEAR 16
YEAR 17
J F M A M J J A S O N D

PHASE 2 - STABILIZATION - CONSERVATION PROGRAM

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT



Buildings to be presented

Buildings not to be presented

Mosaic stabilization, reburial, wall plaster treatment, cocciopesto treatment, stone cleaning, drainage
(one square: 2 technicians / month of 16,5 work days)

Walls, stone slab pavements, non-mosaic room treatment, assistance of technicians, material preparation, reburial
(one square: 2 workers / month of 16,5 work days)

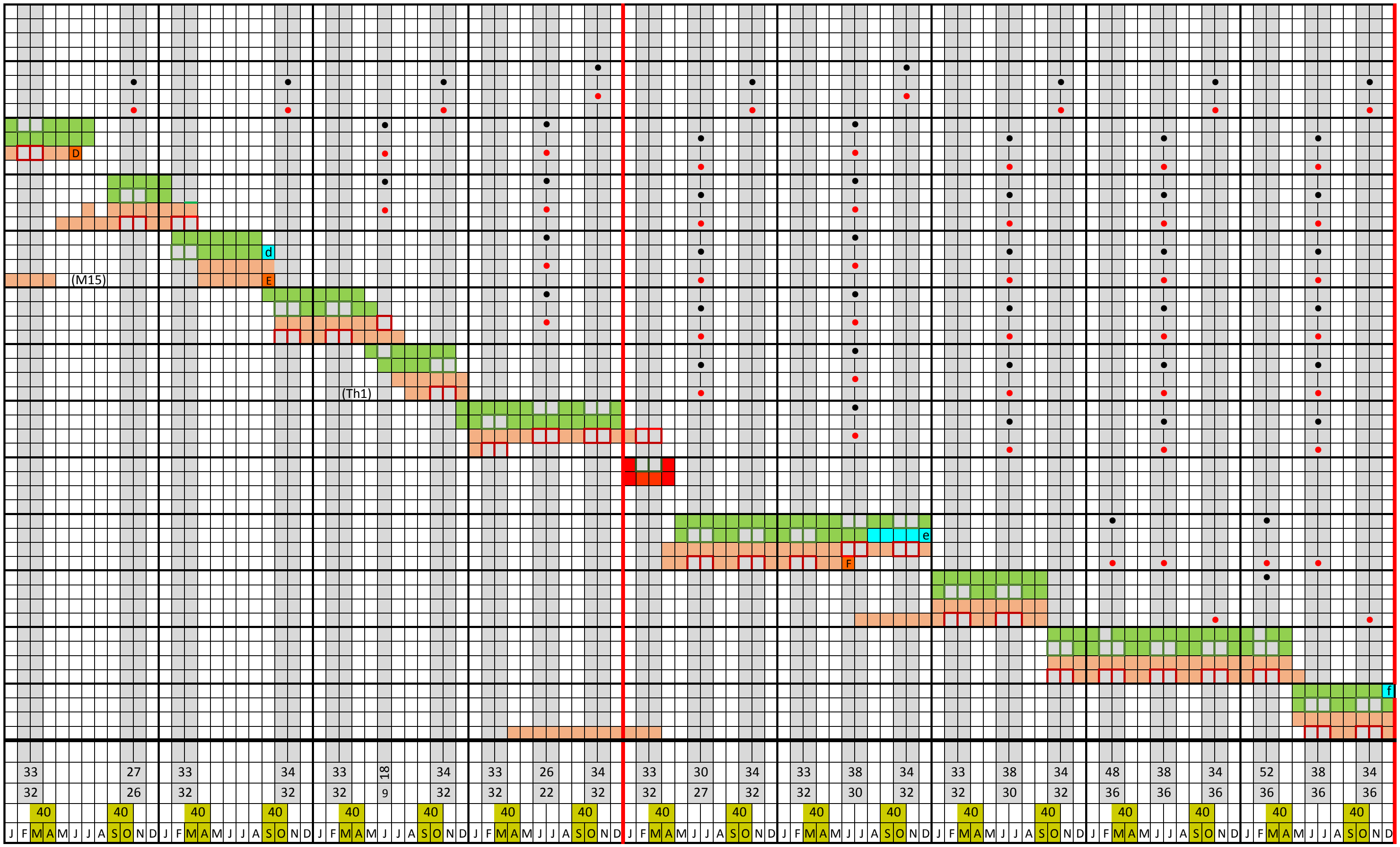
a b c d e f = Technician participation in Specialist Projects (list attached)

A B C D E F = Worker participation in Specialist Projects (list attached)

Technician work time for priority mosaic conservation interventions

PHASE 2 - STABILIZATION - CONSERVATION PROGRAM

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT



Months for technician and worker maintenance cycles

Scheduled maintenance cycles:
one maintenance cycle for 2 technicians
one maintenance cycle for 2 workers

Deadline for planning reassessment

Vegetation removal campaigns for 12 - 15 seasonal workers 2 months, twice a year

20/06/2017

PHASE 2 - STABILIZATION - CONSERVATION PROGRAM - Specialist Projects

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

		PROTECTION MEASURES			CONSERVATION	STRUCTURAL WORK and HYDROLOGY				SITE PRESENTATION				
	BUILDINGS TO BE PRESENTED	**Access barrier**	**Walkway**	**Shelter design and construction**	**Conservation treatment**	**Structural assessment / masonry stabilization**	**Structural assessment / mosaic depression stabilization**	**Structural assessment / in situ column stabilization**	**Hydrological assessment/ intervention**	**Info panel**	**Pavement treatment**	**Column or other architectural element repositioning**	**Lapidarium organizat.**	**Archaeolo-gical investiga-tion**
1	B1 - Basilique du Forum	X							Flooding problems related to the natural stream	X				
2	BaN - Basilique Chrétienne du Nord	X		Room 02 Room 03 Room 04 Room 05				Room 03a		X		X	X	
3	BaS - Basilique Chrétienne du Sud	X		Room 05 bapt. font				X		X		X		
4	E02 - Edifice dans le coin sud du Forum	X					Room 01			X				
5	E03 - Edifice au nord-est du Marché	X								X				
6	E04 - Edifice au nord de la Deuxième Esplanade	X								X				
7	E05 - Edifice à l'ouest de la Deuxième Esplanade	X							Flooding problems related to the water conduit	X				
8	EM2 - Deuxième Esplanade Monumentale	X	Room 02 north side	Room 05+ threshold	Room 06a: reinforced concrete panel removal and replacement of the opus sectile in situ Room 06b: condition inspect. of protection measure and possible cons. interv. on fresco paintings			Room 02 Room 10a		X	Rooms 08a, 08b, 08c: large lacuna infilling	Room 10a	Room 08c	Room 01a: ancient garden study
9	M09 - Maison 9	X								X				
10	M10 - Maison 10	X		Room 1a basin Room 5		Room 5 east wall Room 16				X				
11	M15 - Maison 15	X								X				

PHASE 2 - STABILIZATION - CONSERVATION PROGRAM - Specialist Projects

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

		PROTECTION MEASURES			CONSERVATION	STRUCTURAL WORK and HYDROLOGY				SITE PRESENTATION				
	BUILDINGS TO BE PRESENTED	**Access barrier**	**Walkway**	**Shelter design and construction**	**Conservation treatment**	**Structural assessment / masonry stabilization**	**Structural assessment / mosaic depression stabilization**	**Structural assessment / in situ column stabilization**	**Hydrological assessment/ intervention**	**Info panel**	**Pavement treatment**	**Column or other architectural element repositioning**	**Lapidarium organizat.**	**Archaeolo-gical investiga-tion**
12	MA - Maison d'Amphitrite ground level	X		Room 01+threshold Room 06a Room 12 Room 13 Room 37 Room 38	Room 4B: reinforced concrete panel removal and replacement of the tessellatum in situ					X	Inspection and possible improvement of drainage of the modern mortar pavement			
13	MA-S - Maison d'Amphitrite underground level	X	Room S01c	Room S02					Flooding problems related to natural springs and water table	X				
14	Mar - Marché	X								X	Stone slab pavement leveling (INP project)			
15	MC - Maison de la Chasse ground level	X	Room 10c and Room 10d Room 28a step: step protection	Room 37a light well Room 37b light well Room 40 light well	Room 11b: restoration of original form of water channel Rooms 10a, b, c, d: conservation of the columns (also struct. condition inspection)					X			Room 01	
16	MC-S - Maison de la Chasse underground level	X	Room S01b Room S01c and part of Room S01d		Stabilization and display of mosaics on concrete panels					X				
17	MNC - Maison de la Nouvelle Chasse ground level	X		Room 03 Room 05 Room 10 Room 13						X		X	X	
18	MNC-S - Maison de la Nouvelle Chasse underground level	X			Room S01: painted wall plaster Room S01: vaulting tube ceiling consolid. treatm. Room S01, S03: stone conservation Room S02: modern vaulting tube to be checked for stability	Room S04b: structural stabilization (fractured architrave)				X				

		PROTECTION MEASURES			CONSERVATION	STRUCTURAL WORK and HYDROLOGY				SITE PRESENTATION				
	BUILDINGS TO BE PRESENTED	**Access barrier**	**Walkway**	**Shelter design and construction**	**Conservation treatment**	**Structural assessment / masonry stabilization**	**Structural assessment / mosaic depression stabilization**	**Structural assessment / in situ column stabilization**	**Hydrological assessment/ intervention**	**Info panel**	**Pavement treatment**	**Column or other architectural element repositioning**	**Lapidarium organizat.**	**Archaeolo-gical investiga-tion**
19	MP - Maison de la Pêche ground level	X Room 43: east corner security barrier		Room 06 Room 07 Room 08 Room 09 Room 10				In situ columns and stone screens		X	Rooms 02, 03, 04, 05: large lacuna infilling + tessellatum protection with mortar Room 11: drainage	X	X	Room 09: archeolog. excavat.
20	MP-S - Maison de la Pêche underground level	X	Room S02		Room S11a: reinforced concrete panel removal and replacement of the tessellatum in situ Room S05MM: conserv. interv. of the basin wall (mosaic + masonry) All rooms: plaster conservation interv.					X	Room S04a, S04d: large lacuna infilling + tessellatum protection with mortar.			
21	MT - Maison du Trésor ground level									X				
22	MT-S - Maison du Trésor underground level	X		Rooms S01, S02, S03						X				
23	TAp - Temple d'Apollon	X				Structural stabilization and partial wall reconstruct-ion (INP project)				X		Possible re-positioning of column bases and shafts (INP project)		
24	Th1 - Thermes au nord-ouest du Théâtre	X		Room 6 basin						X				
25	Th3 - Thermes au nord-ouest de la Deuxième Esplanade	X								X				
26	Th4 - Thermes au nord-ouest des Basiliques	X		Room 01 basin Room 02 basin						X				

		PROTECTION MEASURES			CONSERVATION	STRUCTURAL WORK and HYDROLOGY				SITE PRESENTATION				
	BUILDINGS TO BE PRESENTED	**Access barrier**	**Walkway**	**Shelter design and construction**	**Conservation treatment**	**Structural assessment / masonry stabilization**	**Structural assessment / mosaic depression stabilization**	**Structural assessment / in situ column stabilization**	**Hydrological assessment/ intervention**	**Info panel**	**Pavement treatment**	**Column or other architectural elements repositioning**	**Lapidarium organizat.**	**Archaeolo-gical investiga-tion**
27	ThIM - Thermes de Iulia Memmia	X	Room 08: east side of the room			All the rooms: scaffolding installation for wall stabilization work				X	Room 01: stone slab pavement lacuna infilling			Room 32: inspection for possible presentat-ion arrange-ment (inaccess. space)
28	ThV - Thermes des Venantii	X		Room 03 basin						X				
29	Tt - Théâtre	X			Room 05: statue conservation treatment Stone condition assessment and specialist cons. treatment. (fragment reattachment and stone infilling)	All rooms: scaffolding installation for wall stabilization work				X	Room 2a, Room 2c: large lacuna infilling + tessellatum protection with mortar			

		PROTECTION MEASURES			CONSERVATION	STRUCTURAL WORK and HYDROLOGY				SITE PRESENTATION				
	BUILDINGS NOT TO BE PRESENTED	**Access barrier**	**Walkway**	**Shelter design and construction**	**Conservation treatment**	**Structural assessment / masonry stabilization**	**Structural assessment / mosaic depression stabilization**	**Structural assessment / in situ column stabilization**	**Hydrological assessment/ intervention**	**Info panel**	**Pavement treatment**	**Column or other architectural element repositioning**	**Lapidarium organizat.**	**Archaeolo-gical investiga-tion**
1	E01 - Edifice au sud-ouest du Temple d'Apollon													
2	E06 - Edifice à l'est des Thermes de Iulia Memmia													
3	E07 - Edifice au nord du Monument en Opus Reticulatum													
4	E08 - Edifice à l'ouest du Monument en Opus Reticulatum													
5	E09 - Edifice au sud de la Maison 3													
6	E10 - Edifice au nord de la Maison 7													
7	E11 - Edifice au carrefour entre M3 et M7													
8	E12 - Edifice au coin sud de l'insula de la Pêche													
9	E13 - Edifice au nord de la source				Room 01: tessellatum protection with mortar									
10	E14 - Edifice au nord-est du Temple d'Apollon													
11	E15 - Edifice au sud de la colline													
12	E16 - Edifice à l'ouest du Temple 1													
13	M01 - Maison 1 ground level			Room 27 basin										
14	M01-S - Maison 1 underground level													
15	M02 - Maison 2 ground level					X								
16	M03 - Maison 3 ground level					X								

		PROTECTION MEASURES			CONSERVATION	STRUCTURAL WORK and HYDROLOGY				SITE PRESENTATION				
	BUILDINGS NOT TO BE PRESENTED	**Access barrier**	**Walkway**	**Shelter design and construction**	**Conservation treatment**	**Structural assessment / masonry stabilization**	**Structural assessment / mosaic depression stabilization**	**Structural assessment / in situ column stabilization**	**Hydrological assessment/ intervention**	**Info panel**	**Pavement treatment**	**Column or other architectural element repositioning**	**Lapidarium organizat.**	**Archaeolo-gical investiga-tion**
17	M03 - Maison 3 underground level					X								
18	M04 - Maison 4													
19	M05 - Maison 5			Room 13 Room 15 Room 16 basin										
20	M07 - Maison 7 ground + underground level													
21	M08 - Maison 8	X			Room 20a, 20b: opus sectile conservation (supervision of technicians' work)	Reconstruct-ion of east side and north-east corner wall								
22	M14 - Maison 14													
23	MPa - Maison du Paon ground level					X								
24	MPa - Maison du Paon underground level					X								
25	Ny1 - Nymphée 1			Room 03a			Room 03a							
26	T1 - Temple à l'ouest des Thermes de Iulia Memmia													
27	Th2 - Thermes à l'est du Théâtre			Room 1 Room 2 basin Room 2 basin MM	Room 1: mosaic on concrete panel conservation									
28	Th5 - Thermes du nord-est													

PHASE 2 - STABILIZATION - COST ESTIMATE - Initial Stabilization Intervention

BUILDINGS WITH MOSAICS		MOSAIC AND COCCIOPESTO STABILIZATION																	WALL AND STONE SLAB PAVEMENT STABILIZATION					
		LABOR			MATERIALS														LABOR			MATERIALS		
		2 Technicians work time	1 month/ 2 techn. TD 1800 Cost mosaic stabiliz.	Cost LABOR mosaic stabil. by area	Tessellatum stabilization area	cost m² TD 14 Cost stabil. mat.	Sand	cost m³ TD 25 Cost rebur. mat.	Gravel	cost m³ TD 35 Cost rebur. mat.	Geo-textile	cost m² TD 1,5 Cost rebur. mat.	Wooden planks	cost m² TD 20 Cost rebur. mat.	Cement mortar barriers	cost m² TD 3 Cost rebur. mat.	Cost MATER. mosaic stabil. by build.	Cost MATER. mosaic stabil. by area	1 mason + 1 worker work time	1 month/ 1 mason 1 work.TD 1500 Cost wall stabiliz.	Cost LABOR wall stabil. by area	Wall face area	cost m² TD 0,8 Cost stabil. mat.	Cost MATER. wall stabil. by area
		months	tot TD	tot TD	m²	tot TD	m³	tot TD	m³	tot TD	m²	tot TD	m	tot TD	m	tot TD	tot TD	tot TD	months	tot TD	tot TD	m²	tot TD	tot TD
MC	Maison de la Chasse - ground level		0			0		0		0		0		0		0	0		0	0		0	0	
MC-S	Maison de la Chasse - undergr. level		0	0		0		0		0		0		0		0	0	0	0	0	0	0	0	0
M04	Maison 4		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	7500	7500	437	350	350
MA-S	Maison d'Amphitrite - undergr. level	6	10800	10800	120	1680	0	0	0	0	0	0	0	0	0	0	1.680	1680	5	7500	7500	852	682	682
MP	Maison de la Pêche - ground level	34	61200	61200	201	2814	42	1038	30	1048	374	562	0	0	10	30	5.492	5492	23	34500	34500	1387	1110	1110
E01	Edifice au sud-ouest du Temple Apollon	4,0	7200	7200	22	308	9,3	232	4,6	163	58,1	87	26	528	0,0	0	1318	1318	4	6000	6000	108	86	86
Th2	Thermes à l'est du Théâtre	6,0	10800	10800	56	784	9,3	234	4,7	163	58,4	88	4,8	96	0,0	0	1365	1365	7	10500	10500	530	424	424
M03	Maison 3 - ground level	11,8	21240		80	1120	46	1139	23	797	285	427	109	2178	0,0	0	5660		13	19500		529	423	
M03-S	Maison 3 - underground level	1,2	2160	23400	0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0	5660	3	4500	24000	294	235	658
M01	Maison 1- ground level	2,9	5220		41	574	13	314	6,3	219	78,4	118	19	384	0,0	0	1609		9,4	14100		1094	875	
M01-S	Maison 1 - underground level	1,1	1980	7200	0,3	4	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	4	1613	3,6	5400	19500	395	316	1191
M09	Maison 9	10	18000	18000	77	1078	27	664	13	464	166	249	14	272	0	0	2.727	2727	7	10500	10500	351	281	281
M10	Maison 10	12	21600	21600	84	1176	22	556	11	389	139	208	33	666	0	0	2.995	2995	10	15000	15000	466	373	373
M07	Maison 7 - ground and undergr.level	6,0	10800		47	658	18	448	9,0	314	112	168	43	864	0,0	0	2452		9,2	13800		591	473	
E10	Edifice au nord de la Maison 7	1,0	1800	12600	25	350	4,9	123	2,5	86	30,6	46	4,9	98	0,0	0	702	3154	0,8	1200	15000	32	26	498
M08	Maison 8	11,0	19800	19800	58	812	30	757	15	530	189	284	69	1372	0,0	0	3755	3755	14	21000	21000	1166	933	933
BaS	Basilique Chrétienne du Sud	8	14580		27	378	5	119	19	678	242	363	3	62	12	36	1.635		8,9	13350		348	278	
BaN	Basilique Chrétienne du Nord	4	6840		23	322	4	93	5	182	65	98	0	0	0	0	695		3,9	5850		200	160	
Th4	Thermes au nord-ouest des Basiliques	1	1980	23400	9	126	0	0	0	0	0	0	0	0	0	0	126	2455	3,2	4800	24000	215	172	610
MT	Maison du Trésor - ground level	0,5	900		10	140	0	4	0	2	1	1	6	120	0	0	267		2	3000		160	128	
MT-S	Maison du Trésor - undergr. level	6,5	11700	12600	72	1008	0	0	2	87	16	23	0	0	0	0	1.118	1386	2	3000	6000	172	138	266
MPa	Maison du Paon - ground level	0,4	720		1	14	0,5	12	0,2	8	2,9	4	8,0	160	0,0	0	198		1	1500		67	54	
MPa-S	Maison du Paon - undergr.level	1,6	2880	3600	7	98	1,9	47	1,0	36	12,9	19	3,2	64	0,0	0	264	462	4	6000	7500	225	180	234
MP-S	Maison de la Pêche - undergr. Level	17	30600	30600	69	966	1	19	2	53	19	28	0	0	0	0	1.065	1065	8	12000	12000	1244	995	995
MNC	Maison Nouvelle Chasse - ground lev.	25	45720		265	3710	7	165	15	536	191	287	1	20	8	25	4.741		12,6	18900		796	637	
MNC-S	Maison Nouvelle Chasse -undergr.lev.	4	6480	52200	37	518	0	0	0	0	0	0	0	0	2	6	524	5265	1,4	2100	21000	279	223	860
M02	Maison 2 - ground level	3,3	5940		15	210	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	210		3,1	4650		113	90	
M05	Maison 5	2,0	3600		17	238	2,4	60	1,2	42	14,9	22	12	240	0,0	0	601		5,6	8400		326	261	
M14	Maison 14	0,7	1260		4	56	1,1	28	0,6	19	6,9	10	7,8	156	1,0	3	272		2,2	3300		152	122	
E09	Edifice au sud de la Maison 3	0,6	1080			0	0,7	19	0,4	13	4,6	7	1,2	24	0,0	0	62		0,8	1200		74	59	
E11	Edifice au carrefour entre M3 et M7	0,7	1260		6	84	1,4	35	0,7	25	8,8	13	0,0	0	0,0	0	157		0,2	300		10,7	9	
E12	Edifice au coin sud ins. de la Pêche	0,7	1260	14400	6	84	2,0	50	1,0	35	12,5	19	6,8	136	0,0	0	324	1626	3,1	4650	22500	236	189	729

PHASE 2 - STABILIZATION - COST ESTIMATE - Initial Stabilization Intervention

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

BUILDINGS WITH MOSAICS		MOSAIC AND COCCIOPESTO STABILIZATION – LABOR: 2 Technicians work time (months)	1 month/2 techn. TD 1800 – Cost mosaic stabiliz. (tot TD)	Cost LABOR mosaic stabil. by area (tot TD)	MATERIALS: Tessellatum stabilization area (m²)	cost m² TD 14 – Cost stabil. mat. (tot TD)	Sand (m³)	cost m³ TD 25 – Cost rebur. mat. (tot TD)	Gravel (m³)	cost m³ TD 35 – Cost rebur. mat. (tot TD)	Geo-textile (m²)	cost m² TD 1,5 – Cost rebur. mat. (tot TD)	Wooden planks (m)	cost m² TD 20 – Cost rebur. mat. (tot TD)	Cement mortar barriers (m)	cost m² TD 3 – Cost rebur. mat. (tot TD)	Cost MATER. mosaic stabil. by build. (tot TD)	Cost MATER. mosaic stabil. by area (tot TD)	WALL AND STONE SLAB PAVEMENT STABILIZATION – LABOR: 1 mason + 1 worker work time (months)	1 month/1 mason 1 work. TD 1500 – Cost wall stabiliz. (tot TD)	Cost LABOR wall stabil. by area (tot TD)	MATERIALS: Wall face area (m²)	cost m² TD 0,8 – Cost stabil. mat. (tot TD)	Cost MATER. wall stabil. by area (tot TD)
MA	Maison d'Amphitrite - ground level	10,3	18540		69	966	4	108	2	75	27	40	34	684	0	0	1.874		11,2	16800		751	601	
M15	Maison 15	0,6	1080		2	28	2	55	1	39	14	21	7	130	0	0	272		3,5	5250		278	222	
ThV	Thermes des Venantii	2,1	3780	23400	17	238	8	192	4	134	48	72	4	78	0	0	714	2860	2,3	3450	25500	105	84	907
TAp	Temple d'Apollon	0,8	1440		1	14	0	6	0	4	1	2	2	44	0	0	69		7,0	10500		606	485	
B1	Basilique du Forum	3,4	6120		13	182	2	50	10	350	20	30	0	0	0	0	612		3,6	5400		334	267	
E02	Edifice dans le coin sud du Forum	7,8	14040	21600	45	630	0	0	0	0	0	0	0	0	0	0	630	1311	3,4	5100	21000	298	238	990
Mar	Marché	1,8	3240		3	42	0	0	1	44	16	23	0	0	0	0	109		9,3	13950		493	394	
E03	Edifice au nord-est du Marché	0,5	900		1	14	0	0	0	0	0	0	0	0	0	0	14		1,3	1950		119	95	
Th1	Thermes nord-ouest du Théâtre	7,7	13860	18000	42	588	17	425	19	654	106	159	0	0	10	31	1.857	1981	9,4	14100	30000	599	479	969
E04	Edifice nord de la II Esplanade	9,0	16200		57	798	0	7	0	5	2	3	0	0	0	0	813		2,3	3450		61	49	
Th3	Thermes nord-ouest de la II Esplanade	11,0	19800	36000	95	1330	10	251	5	176	63	94	0	0	10	29	1.879	2692	7,7	11550	15000	523	418	467
EM2	Deuxième Esplan. Monumentale	29,0	52200		282	3948	27	685	36	1254	448	672	0	0	12	36	6594		23,3	34950		2449	1959	
E05	Edifice à l'ouest de la II Esplanade	1,0	1800	54000	8	112	0	0	0	0	0	0	0	0	0	0	112	6706	2,7	4050	39000	222	178	2137
Ny1	Nymphée 1	7,2	12960		56	784	12	290	5,8	203	72,5	109	55	1100	0,0	0	2486		4,8	7200		289	231	
E06	Edifice à l'est des Th. de Iulia Memmia	0,2	360		0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0		4,9	7350		568	454	
E07	Edifice nord Monum. Opus Retic.	3,5	6300		32	448	14	351	7,0	246	87,8	132	51	1026	0,0	0	2202		2,6	3900		167	134	
E08	Edifice ouest Monum. Opus Retic.	1,4	2520		12	168	5,7	143	2,9	100	35,8	54	3,3	66	0,0	0	531		1,2	1800		74	59	
E13	Edifice au nord de la source	0,1	180		0,02	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0		0,1	150		5	4	
E14	Edifice au nord-est Temple d'Apollon	0,1	180		0,3	4	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	4		0,2	300		24	19	
E15	Edifice au sud de la colline	0,2	360		0,3	4	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	4		0,1	150		2	2	
E16	Edifice à l'ouest du Temple 1	0,4	720		2	28	0,8	20	0,4	14	4,9	7	5,8	116	0,0	0	184		0,3	450		33	26	
T1	Temple à l'ouest Th. Iulia Memmia	0,5	900		0	0	0,1	2	0,0	1	0,4	1	2,2	44	0,0	0	47		3,0	4500		359	287	
Th5	Thermes du nord-est	0,4	720	25200		0	0,4	10	0,2	7	2,5	4	0,0	0	0,0	0	21	5480	2,8	4200	30000	185	148	1365
ThIM	Thermes de Iulia Memmia	26	46800	46800	211	2954	16	388	25	879	97	145	37	740	2	7	5.112	5112	29,0	43500	43500	7533	6026	6026
Tt	Théâtre	12	21600	21600	128	1792	2	50	16	550	24	36	0	0	0	0	2.428	2428	23,0	34500	34500	6352	5082	5082
	TOTALS	320	576000	**576.000**	2456	34383	367	9180	303	10622	3156	4734	573	11468	67	201	70588	**70.588**	335	502500	**502.500**	35279	28223	**28.223**

The work month is considered 16,5 work days → 200 days / year.

Measurements and **work day estimates** are taken from the Building Planning Form.

PHASE 2 - STABILIZATION - COST ESTIMATE - Maintenance Cycles during Phase 2

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

BUILDINGS WITH MOSAICS		MOSAIC MAINTENANCE – LABOR: no. maintenance cycles in Phase 2	work days / 2 techn. 1 mainten. cycle	1 day / 2 techn. TD 60 – Cost labor 1 cycle	Cost LABOR Phase2 by area	MATERIALS: Mosaic area / 1 mainten. cycle	cost m² TD 1,5 – Cost mosaic 1 cycle	Reburial area / 1 mainten. cycle	cost m² TD 0,3 – Cost rebur. 1 cycle	Cost mate-rials 1 cycle	Cost MATE-RIALS Phase2 by area	WALL MAINTENANCE – LABOR: no. maintenance cycles in Phase 2	work days / 1m.+1w. 1 mainten. cycle	1 day / 1 mason 1 work. TD 50 – Cost labor 1 cycle	Cost LABOR Phase2 by area	MATERIALS: Wall area / 1 mainten. cycle	cost m² TD 0,1 – Cost mater. 1 cycle	Cost MATE-RIALS Phase2 by area	VEGETATION CONTROL – LABOR: Vegetation control area	work days / 12-15 w. 1 cycle (2 camp.)	1 day / 12-15 workers TD 180 – Cost labor 1 cycle	Cost LABOR Phase2 by area (17 cycles)	EQUIPMENT: 2 camp. TD 560 – Cost equipm 1 cycle	Cost EQUIP. Phase2 by area (17 cycles)
		#	w.d.	tot TD	tot TD	m²	tot TD	m²	tot TD	tot TD	tot TD	#	w.d.	tot TD	tot TD	m²	tot TD	tot TD	m²	w.d.	tot TD	tot TD	tot TD	tot TD
MC	Maison de la Chasse - gr. level					244	366	304	91							1793	179		927					
MC-S	Maison de la Chasse - undergr. lev.	17	20	1200	20400	114	171	0	0	628	10679	17	11	550	9350	1285	129	5233	154	3,6	652	11077,2		
M04	Maison 4	17	4	240	4080	0	0	194	58	58	989	17	2	100	1700	437	44	743	554	1,8	331	5630,4		
MA-S	Maison d'Amphitrite - undergr. lev.	16	4	240	3840	120	180	0	0	180	2880	16	4	200	3200	852	85	1363	70	0,2	43	734,4		
MP	Maison de la Pêche - ground level	13	9,7	582	7566	172	258	452	136	394	5117	13	6	300	3900	1387	139	1803	1187	4,0	713	12117,6		
E01	Edifice sud-ouest Temple Apollon	14	1	60	840	1	2	46	14	15	214	14	2	100	1400	108	11	151	160	0,5	95	1621,8		
Th2	Thermes à l'est du Théâtre	14	2	120	1680	23	35	47	14	49	683	14	3	150	2100	530	53	742	452	1,5	270	4590		
M03	Maison 3 - ground level					0	0	228	68							529	53		882					
M03-S	Maison 3 - underground level	13	4	240	3120	0	0	0	0	68	889	13	4	200	2600	294	29	1070	144	3,4	616	10465,2		
M01	Maison 1- ground level					2	3	63	19							1094	109		783					
M01-S	Maison 1 - underground level	16	1,2	72	1152	0	0	0	0	22	358	14	6	300	4200	395	40	2085	97	2,9	529	8996,4		
M09	Maison 9	13	3	180	2340	27	41	75	23	63	821	13	2	100	1300	351	35	456	243	0,8	148	2509,2		
M10	Maison 10	12	4	240	2880	49	74	110	33	107	1284	12	3	150	1800	466	47	559	362	1,2	216	3672		
M07	Maison 7 - gr. and undergr. lev.					0	0	90	27							591	59		350					
E10	Edifice au nord de la Maison 7	12	2	120	1440	0	0	25	8	35	414	12	3	150	1800	32	3	748	24	1,2	223	3794,4		
M08	Maison 8	12	3	180	2160	0	0	151	45	45	544	12	5	250	3000	1166	117	1399	432	1,4	259	4406,4		
BaS	Basilique Chrétienne du Sud					29	44	120	36							348	35		287					
BaN	Basilique Chrétienne du Nord					22	33	8	2							200	20		88					
Th4	Thermes nord-ouest Basiliques	16	3,8	225	3600	9	14	0	0	128	2054	16	4,9	247	3944	215	22	1221	150	1,8	317	3794,4		
MT	Maison du Trésor - ground lev.					0	0	26	8							160	16		243					
MT-S	Maison du Trésor - undergr. level	9	2	120	1080	72	108	0	0	116	1042	9	2	100	900	172	17	299	42	1,0	173	2937,6		
MPa	Maison du Paon - ground level					0	0	2	1							67	7		123					
MPa-S	Maison du Paon - undergr.level	9	1	60	540	0	0	10	3	4	32	9	2	100	900	225	23	263	151	0,9	166	2815,2		
MP-S	Maison de la Pêche - undergr.l.	9	4	240	2160	64	96	94	28	124	1113	9	5	250	2250	1244	124	1120	253	0,8	151	2570,4		
MNC	Maison Nouvelle Chasse - gr.lev.					258	387	28	8							796	80		328					
MNC-S	Maison Nouvelle Chasse -undgr.l.	7	15	900	6300	37	56	0	0	450	3153	7	5	250	1750	279	28	753	44	1,2	223	3794,4		
M02	Maison 2 - ground level					0	0	15	5							113	11		229					
M05	Maison 5					9	14	12	4							326	33		467					
M14	Maison 14					0	0	6	2							152	15		137					
E09	Edifice au sud de la Maison 3					0	0	4	1							74	7		30					
E11	Edifice carrefour entre M3 et M7					0	0	7	2							11	1		19					
E12	Edifice coin sud ins. de la Pêche	7	3	180	1260	0	0	10	3	30	209	7	4	200	1400	236	24	638	274	3,9	695	11811,6		

PHASE 2 - STABILIZATION - COST ESTIMATE - Maintenance Cycles during Phase 2

BUILDINGS WITH MOSAICS		MOSAIC MAINTENANCE										WALL MAINTENANCE							VEGETATION CONTROL					
			LABOR			MATERIALS							LABOR			MATERIALS				LABOR			EQUIPMENT	
		no. maintenance cycles in Phase 2	work days / 2 techn. 1 mainten. cycle	1 day / 2 techn. TD 60 Cost labor 1 cycle	Cost LABOR Phase2 by area	Mosaic area / 1 mainten. cycle	cost m^2 TD 1,5 Cost mosaic 1 cycle	Reburial area / 1 mainten. cycle	cost m^2 TD 0,3 Cost rebur. 1 cycle	Cost mate-rials 1 cycle	Cost MATE-RIALS Phase2 by area	no. maintenance cycles in Phase 2	work days / 1m.+1w. 1 mainten. cycle	1 day / 1 mason 1 work. TD 50 Cost labor 1 cycle	Cost LABOR Phase2 by area	Wall area / 1 mainten. cycle	cost m^2 TD 0,1 Cost mater. 1 cycle	Cost MATE-RIALS Phase2 by area	Vegetation control area	work days / 12-15 w. 1 cycle (2 camp.)	1 day / 12-15 workers TD 180 Cost labor 1 cycle	Cost LABOR Phase2 by area (17 cycles)	2 camp. TD 560 Cost equipm 1 cycle	Cost EQUIP. Phase2 by area (17 cycles)
		#	w.d.	tot TD	tot TD	m^2	tot TD	m^2	tot TD	tot TD	tot TD	#	w.d.	tot TD	tot TD	m^2	tot TD	tot TD	m^2	w.d.	tot TD	tot TD	tot TD	tot TD
MA	Maison d'Amphitrite - ground level					53	80	22	7							751	75		931					
M15	Maison 15					0	0	11	3							278	28		289					
ThV	Thermes des Venantii	6	4	240	1440	9	14	38	11	114	686	6	8	400	2400	105	11	680	131	3,8	680	11567		
TAp	Temple d'Apollon					0	0	1	0							606	61		489					
B1	Basilique du Forum					0	0	100	30							334	33		529					
E02	Edifice dans le coin sud du Forum	6	4	240	1440	44	66	0	0	96	578	6	5	250	1500	298	30	743	153	3,9	706	11995		
Mar	Marché					3	5	0	0							493	49		564					
E03	Edifice au nord-est du Marché					1	2	0	0							119	12		298					
Th1	Thermes nord-ouest du Théâtre	5	4	240	1200	33	50	187	56	112	558	5	5	250	1250	599	60	606	1135	6,7	1199	20380		
E04	Edificeau nord de la II Esplanade					56	84	1	0							61	6		105					
Th3	Thermes nord-ouest II Esplanade	4	8	480	1920	90	135	50	15	234	937	4	3	150	600	523	52	234	376	1,6	288	4896		
EM2	Deuxième Esplan. Monumentale					272	408	88	26							2449	245		3327					
E05	Edifice ouest de la II Esplanade	2	15	900	1800	8	12	0	0	446	893	2	10	500	1000	222	22	534	144	11,6	2084	35435		
Ny1	Nymphée 1					36	54	58	17							289	29		253					
E06	Edifice est des Th. Iulia Memmia					0	0	0	0							568	57		157					
E07	Edifice nord Monum. Opus Retic.					0	0	70	21							167	17		364					
E08	Edifice ouest Monum. Opus Retic.					0	0	30	9							74	7		30					
E13	Edifice au nord de la source					0	0	0	0							5	1		25					
E14	Edifice nord-est Temple d'Apollon					0	0	0	0							24	2		23					
E15	Edifice au sud de la colline					0	0	0	0							2	0		10					
E16	Edifice à l'ouest du Temple 1					0	0	4	1							33	3		21					
T1	Temple ouest Th. Iulia Memmia					0	0	1	0							359	36		202					
Th5	Thermes du nord-est	1	4	240	240	0	0	2	1	104	104	2	4	200	400	185	19	341	251	4,5	803	13648		
ThIM	Thermes de Iulia Memmia	0	0	0	0	184	276	145	44	320	0	0	0	0	0	7533	753	0	2516	8,4	1508	25642,8		
Tt	Théâtre	0	0	0	0	123	185	4	1	186	0	0	0	0	0	6352	635	0	2041	6,8	1224	20808	560	9520
	TOTALS	250	126	7539	74478	2165	3248	2939	882	4129	36231	249	109	5447	54644	38357	3836	23782	24050	80	14312	241709	560	9520

Time for **Mosaic Maintenance** is estimated, considering 2 technicians, at 20 m^2/ day of exposed mosaics and mosaics on concrete panels, or 40 m^2/day of in situ mosaics protected under ancient structures or modern shelters, or 60 m^2/day of reburials and mortar protections.

Time for **Wall Maintenance** is estimated, considering 1 mason and 1 worker, at 300 $m^{2/}$day

Time for **Vegetation Control** is estimated, considering 12-15 seasonal workers, at 600 m^2/day; the work is carried out inside buildings with mosaics, in areas where there is no tessellatum.

Materials for M**osaic, Reburial and Wall Maintenance**: building materials, consumable materials, tools and equipment, as required.

Equipment for **Vegetation Control**: 6 wheelbarrows, 6 hoes, 6 small hoes, 4 shovels, 4 rakes, 2 saws, 15 scissors, 15 gloves every 2 campaigns in a year

PHASE 2 - STABILIZATION - COST ESTIMATE - Phase 2 Totals

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

BUILDINGS WITH MOSAICS		MOSAIC STABILIZATION			WALL STABILIZATION			MOSAIC MAINTENANCE			WALL MAINTENANCE			VEGETATION CONTROL			PRIORITY INTERV.				
		Cost LABOR mosaic stabil. by area	Cost MATER. mosaic stabil. by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR wall stabil. by area	Cost MATER. wall stabil. by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR Phase2 by area	Cost MATER. Phase2 by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR Phase2 by area	Cost MATER. Phase2 by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR Phase2 by area	Cost EQUIPMENT Phase 2	TOTAL cost Phase2 LABOR and EQUIP-MENT	Work time during Phase 2	1 month/ 2 techn. TD 1800 TOTAL cost Phase2 LABOR	TOTAL LABOR PHASE 2	TOTAL MATERIAL PHASE 2	PHASE 2 TOTAL
		tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	months	tot TD	TD	TD	TD
MC	Maison de la Chasse - gr. level																				
MC-S	Maison de la Chasse - undergr.l.	0	0	0	0	0	0	20400	10679	31079	9350	5233	14583	11077,2							
M04	Maison 4	0	0	0	7500	350	7.850	4080	989	5069	1700	743	2443	5630,4							
MA-S	Maison d'Amphitrite - undergr. l.	10800	1680	12.480	7500	682	8.182	3840	2880	6720	3200	1363	4563	734,4							
MP	Maison de la Pêche - ground level	61200	5492	66.692	34500	1110	35.610	7566	5117	12683	3900	1803	5703	12117,6							
E01	Edifice sud-ouest Temple Apollon	7200	1318	8.518	6000	86	6.086	840	214	1054	1400	151	1551	1621,8							
Th2	Thermes à l'est du Théâtre	10800	1365	12.165	10500	424	10.924	1680	683	2363	2100	742	2842	4590							
M03	Maison 3 - ground level																				
M03-S	Maison 3 - underground level	23400	5660	29.060	24000	658	24.658	3120	889	4009	2600	1070	3670	10465,2							
M01	Maison 1- ground level																				
M01-S	Maison 1 - underground level	7200	1613	8.813	19500	1191	20.691	1152	358	1510	4200	2085	6285	8996,4							
M09	Maison 9	18000	2727	20.727	10500	281	10.781	2340	821	3161	1300	456	1756	2509,2							
M10	Maison 10	21600	2995	24.595	15000	373	15.373	2880	1284	4164	1800	559	2359	3672							
M07	Maison 7 - ground and undergr.lev.																				
E10	Edifice au nord de la Maison 7	12600	3154	15.754	15000	498	15.498	1440	414	1854	1800	748	2548	3794,4							
M08	Maison 8	19800	3755	23.555	21000	933	21.933	2160	544	2704	3000	1399	4399	4406,4							
BaS	Basilique Chrétienne du Sud																				
BaN	Basilique Chrétienne du Nord																				
Th4	Thermes nord-ouest Basiliques	23400	2455	25.855	24000	610	24.610	3600	2054	5654	3944	1221	5165	3794,4							
MT	Maison du Trésor - ground level																				
MT-S	Maison du Trésor - undergr. level	12600	1386	13.986	6000	266	6.266	1080	1042	2122	900	299	1199	2937,6							
MPa	Maison du Paon - ground level																				
MPa-S	Maison du Paon - undergr.level	3600	462	4.062	7500	234	7.734	540	32	572	900	263	1163	2815,2							
MP-S	Maison de la Pêche - undergr.l.	30600	1065	31.665	12000	995	12.995	2160	1113	3273	2250	1120	3370	2570,4							
MNC	Maison Nouvelle Chasse - gr. lev.																				
MNC-S	Maison Nouvelle Chasse -undergr.l.	52200	5265	57.465	21000	860	21.860	6300	3153	9453	1750	753	2503	3794,4							
M02	Maison 2 - ground level																				
M05	Maison 5																				
M14	Maison 14																				
E09	Edifice au sud de la Maison 3																				
E11	Edifice carrefour entre M3 et M7																				
E12	Edifice coin sud ins. de la Pêche	14400	1626	16.026	22500	729	23.229	1260	209	1469	1400	638	2038	11811,6							

PHASE 2 - STABILIZATION - COST ESTIMATE - Phase 2 Totals

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

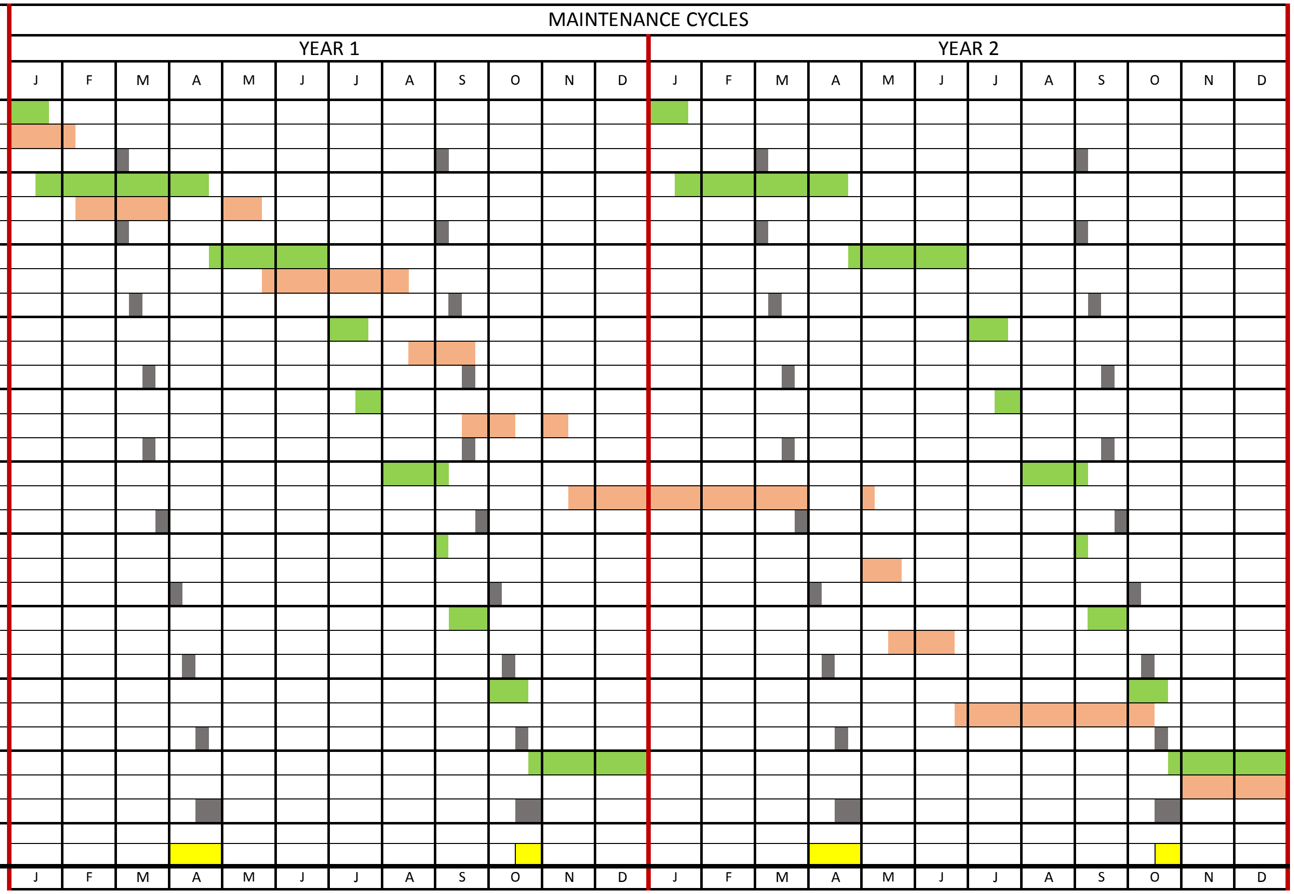
BUILDINGS WITH MOSAICS		MOSAIC STABILIZATION			WALL STABILIZATION			MOSAIC MAINTENANCE			WALL MAINTENANCE			VEGETATION CONTROL			PRIORITY INTERV.				
		Cost LABOR mosaic stabil. by area	Cost MATER. mosaic stabil. by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR wall stabil. by area	Cost MATER. wall stabil. by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR Phase2 by area	Cost MATER. Phase2 by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR Phase2 by area	Cost MATER. Phase2 by area	TOTAL cost Phase2 LABOR and MATER. by area	Cost LABOR Phase2 by area	Cost EQUIPMENT Phase 2	TOTAL cost Phase2 LABOR and EQUIP-MENT	Work time during Phase 2	1 month/ 2 techn. TD 1800 TOTAL cost Phase2 LABOR	TOTAL LABOR PHASE 2	TOTAL MATERIAL PHASE 2	PHASE 2 TOTAL
		tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	months	tot TD	TD	TD	TD
MA	Maison d'Amphitrite - gr. level																				
M15	Maison 15																				
ThV	Thermes des Venantii	23400	2860	26.260	25500	907	26.407	1440	686	2126	2400	680	3080	11567							
TAp	Temple d'Apollon																				
B1	Basilique du Forum																				
E02	Edifice dans le coin sud du Forum	21600	1311	22.911	21000	990	21.990	1440	578	2018	1500	743	2243	11995							
Mar	Marché																				
E03	Edifice au nord-est du Marché																				
Th1	Thermes nord-ouest du Théâtre	18000	1981	19.981	30000	969	30.969	1200	558	1758	1250	606	1856	20380							
E04	Edifice nord de la II Esplanade																				
Th3	Thermes nord-ouest II Esplanade	36000	2692	38.692	15000	467	15.467	1920	937	2857	600	234	834	4896							
EM2	Deuxième Esplan. Monumentale																				
E05	Edifice ouest de la II Esplanade	54000	6706	60.706	39000	2137	41.137	1800	893	2693	1000	534	1534	35435							
Ny1	Nymphée 1																				
E06	Edifice est des Th. Iulia Memmia																				
E07	Edifice nord Monum. Opus Retic.																				
E08	Edifice ouest Monum. Opus Retic.																				
E13	Edifice au nord de la source																				
E14	Edifice nord-est Temple d'Apollon																				
E15	Edifice au sud de la colline																				
E16	Edifice à l'ouest du Temple 1																				
T1	Temple ouest Th. Iulia Memmia																				
Th5	Thermes du nord-est	25200	5480	30.680	30000	1365	31.365	240	104	344	400	341	741	13648							
ThIM	Thermes de Iulia Memmia	46800	5112	51.912	43500	6026	49.526	0	0	0	0	0	0	25643							
Tt	Théâtre	21600	2428	24.028	34500	5082	39.582	0	0	0	0	0	0	20808	9520	251.229	12	21600			
	TOTALS	576000	70588	646588	502500	28223	530723	74478	36231	110709	54644	23782	78426	241709	9520	251229	12	21600	1.470.931	168.345	1.639.276

PHASE 2 TOTAL	1.639.276

PHASE 3 - MAINTENANCE - CONSERVATION PROGRAM

MOSAIKON - BULLA REGIA MOSAIC CONSERVATION PROJECT

	BUILDINGS WITH MOSAICS BY AREA	work day maintenance cycles by area
A	MA, MA-S, M15, ThV, Th5	10,2
		19,7
		2,8
B	MNC, MNC-S, MC, MC-S, MPa, MPa-S	52,6
		40,4
		2,9
C	MP, MP-S, M8, M9, M10, M14, E12	35,0
		45,5
		4,8
D	BaN, BaS, Th4, M7, E10, M2, M2-S, MT, MT-S	11,7
		18,4
		2,4
E	M1, M1-S, E11, M3, M3-S , E9	6,1
		21,8
		3,3
F	ThIM E6, E7, E8, E16, T1	18,6
		79,4
		5,5
G	E01, TAp, B1, E13, E14, E15	3,1
		9,8
		2,1
H	M04, M05, E02, Mar, E03, Th1	13,0
		20,7
		5,3
I	Tt Th2	11,7
		62,6
		4,2
J	E04, Th3, EM2, E05, Ny1	38,0
		32,2
		7,0
	Protection measure maintenance	



- Mosaic and reburial maintenance schedule
Team of 4 technicians
(16,5 work days per month, 200 work days per year)
1 year cycle for the entire site

- Wall maintenance schedule
Team of 2 masons and 2 workers
(16,5 work days per month, 200 days per year)
350 days within 2 year cycle for the entire site

- Vegetation removal schedule
Team of 12-15 seasonal workers
(20 workdays per month, total 4 months per year)
2 months cycle for the entire site - 2 cycles per year

- Protection measure maintenance schedule
Team of 2 masons and 2 workers
25 work days per year divided in 2 campaigns
(about 15 days in April and 10 days in October)

BUILDINGS WITH MOSAICS BY AREA			MOSAIC MAINTENANCE 1 year cycle						TOTAL cost labor and mater. by building	TOTAL cost labor and mater. by area for 1 cycle	WALL MAINTENANCE 2 year cycle				TOTAL cost labor and mater. by building	TOTAL cost labor and mater. by area for 1 cycle	PROTECTION MEASURE MAINTEN. 2 campaigns per year			TOTAL cost labor and mater. by site for 2 camp.
			LABOR		MATERIALS						LABOR		MATERIALS				LABOR		MATERIALS	
			Maintenance	1 day / 4 techn. TD 120 Cost labor 1 cycle	Mosaic	cost m² TD 2 Cost mosaic 1 cycle	Reburial	cost m² TD 0,3 Cost rebur. 1 cycle			Maintenance	1 day / 4 work. TD 100 Cost labor 1 cycle	Wall	cost m² TD 0,1 Cost mater. 1 cycle			Maintenance	1 day / 4 work. TD 100 Cost labor 2 camp.	2 campaigns TD 500 Cost materials 2 camp.	
			w.days	tot TD	m²	tot TD	m²	tot TD	tot TD	tot TD	w.days	tot TD	m²	tot TD	tot TD	tot TD	w.days	tot TD	tot TD	tot TD
A	MA	Maison d'Amphitrite - ground level	4,5	540	53	106	22	7	653		6,8	683	751	75	758					
	MA-S	Maison d'Amphitrite - undergr. level	4,4	528	120	240		0	768		7,7	775	852	85	860					
	M15	Maison 15	0,20	24		0	11	3	27		2,5	253	278	28	281					
	ThV	Thermes des Venantii	1,1	132	9	18	38	11	161		0,9	95	104	10	105					
	Th5	Thermes du nord-est	0,04	5		0	2	1	5	1.615	1,7	168	185	19	187	2.191				
B	MNC	Maison Nouvelle Chasse - gr. level	20,4	2448	258	515	28	8	2972		7,2	724	796	80	803					
	MNC-S	Maison Nouvelle Chasse - undergr. l.	2,8	336	37	74		0	410		2,5	253	279	28	281					
	MC	Maison de la Chasse - ground level	24,9	2988	244	488	304	91	3567		16,3	1630	1.793	179	1809					
	MC-S	Maison de la Chasse - undergr. level	4,3	516	114	228		0	744		11,7	1168	1.285	129	1297					
	MPa	Maison du Paon - ground level	0,04	5		0	2	1	5		0,6	61	67	7	68					
	MPa-S	Maison du Paon - undergr. level	0,2	24		0	10	3	27	7.725	2,0	205	225	23	227	4.486				
C	MP	Maison de la Pêche - ground level	18,7	2244	172	344	452	136	2724		12,6	1261	1.387	139	1399					
	MP-S	Maison de la Pêche - undergr. level	4,1	492	64	127	94	28	648		11,3	1131	1.244	124	1255					
	M08	Maison 8	3	360		0	151	45	405		10,6	1060	1.166	117	1177					
	M09	Maison 9	3,6	432	27	54	75	23	509		3,2	319	351	35	354					
	M10	Maison 10	5,3	636	49	99	110	33	768		4,2	424	466	47	471					
	M14	Maison 14	0,1	12		0	6	2	14		1,4	138	152	15	154					
	E12	Edifice coin sud de l'ins. de la Pêche	0,2	24		0	10	3	27	5.093	2,1	215	236	24	239	5.048				
D	BaN	Basilique Chrétienne du Nord	1,9	228	22	44	8	2	274		1,8	182	200	20	202					
	BaS	Basilique Chrétienne du Sud	4	480	29	58	120	36	574		3,2	317	348	35	352					
	Th4	Thermes nord-ouest des Basiliques	0,3	36	9	18		0	54		2,0	196	215	22	217					
	M07	Maison 7 - ground and undergr. level	1,8	216		0	90	27	243		5,4	538	591	59	597					
	E10	Edifice au nord de la Maison 7	0,5	60		0	25	8	68		0,3	29	32	3	33					
	M02	Maison 2 - ground level	0,3	36		0	15	5	41		1,0	103	113	11	114					
	M02-S	Maison 2 - underground level	0,0	0		0		0	0		1,8	177	195	20	197					
	MT	Maison du Trésor - ground level	0,5	60		0	26	8	68		1,5	145	160	16	161					
	MT-S	Maison du Trésor - undergr. level	2,4	288	72	144		0	432	1.753	1,6	156	172	17	173	2.045				
E	M01	Maison 1 - ground level	1,3	156	2	4	63	19	179		9,9	994	1.094	109	1104					
	M01-S	Maison 1 - underground level	0,01	1	0	1		0	2		3,6	359	395	39	398					
	E11	Edifice au carrefour entre M3 et M7	0,1	12		0	7	2	14		0,1	10	11	1	11					
	M03	Maison 3 - ground level	4,6	552		0	228	68	620		4,8	481	529	53	534					
	M03	Maison 3 - underground level	0,0	0		0		0	0		2,7	267	294	29	297					
	E09	Edifice au sud de la Maison 3	0,1	12		0	4	1	13	828	0,7	67	74	7	74	2.418				

BUILDINGS WITH MOSAICS BY AREA			MOSAIC MAINTENANCE 1 year cycle – LABOR: Maintenance	LABOR: 1 day / 4 techn. TD 120 – Cost labor 1 cycle	MATERIALS: Mosaic	MATERIALS: cost m² TD 2 – Cost mosaic 1 cycle	MATERIALS: Reburial	MATERIALS: cost m² TD 0,3 – Cost rebur. 1 cycle	TOTAL cost labor and mater. by building	TOTAL cost labor and mater. by area for 1 cycle	WALL MAINTENANCE 2 year cycle – LABOR: Maintenance	LABOR: 1 day / 4 work. TD 100 – Cost labor 1 cycle	MATERIALS: Wall	MATERIALS: cost m² TD 0,1 – Cost mater. 1 cycle	TOTAL cost labor and mater. by building	TOTAL cost labor and mater. by area for 1 cycle	PROTECTION MEASURE MAINTEN. 2 campaigns per year – LABOR: Maintenance	LABOR: 1 day / 4 work. TD 100 – Cost labor 2 camp.	MATERIALS: 2 campaigns TD 500 – Cost materials 2 camp.	TOTAL cost labor and mater. by site for 2 camp.
			w.days	tot TD	m²	tot TD	m²	tot TD	tot TD	tot TD	w.days	tot TD	m²	tot TD	tot TD	tot TD	w.days	tot TD	tot TD	tot TD
F	ThIM	Thermes de Iulia Memnia	16,8	2016	184	368	145	44	2428		68,5	6849	7533	753	7602					
F	E06	Edifice à l'est des Th.de Iulia Memmia	0,01	1		0	0	0	1		5,2	516	568	57	573					
F	E07	Edifice au nord du monum. opus retic.	1,4	168		0	70	21	189		1,5	152	167	17	169					
F	E08	Edifice à l'ouest du mon. opus retic.	0,6	72		0	30	9	81		0,7	67	74	7	74					
F	E16	Edifice à l'ouest du Temple 1	0,1	12		0	4	1	13		0,3	30	33	3	33					
F	T1	Temples à l'ouest Th.Iulia Memmia	0,01	1		0	1	0	1	2713	3,3	327	359	36	363	8814				
G	E01	Edifice sud-ouest Temple d'Apollon	1	120	1,0	2	46	14	136		1,0	98	108	11	109					
G	TAp	Temple d'Apollon	0,0	2		0	1	0	3		5,5	551	606	61	612					
G	B1	Basilique du Forum	2	240		0	100	30	270		3,0	304	334	33	337					
G	E13	Edifice au nord de la source	0,002	0	0,0	0		0	0		0,0	4	5	0	5					
G	E14	Edifice nord-est Temple d'Apollon	0,02	2	0,3	1		0	3		0,2	21	23	2	24					
G	E15	Edifice au sud de la colline	0,02	2	0,3	1		0	3	415	0,0	2	2	0	2	1089				
H	M04	Maison 4	3,9	468		0	194	58	526		4,0	397	437	44	441					
H	M05	Maison 5	0,5	60	9,0	18	12	4	82		3,0	296	326	33	329					
H	E02	Edifice dans le coin sud du Forum	3,4	408	44	88		0	496		2,7	271	298	30	301					
H	Mar	Marché	0,2	24	3,0	6		0	30		4,5	448	493	49	497					
H	E03	Edifice au nord-est du Marché	0,1	12	1,0	2		0	14		1,1	108	119	12	120					
H	Th1	Thermes au nord-ouest du Théâtre	4,9	588	33	66	187	56	710	1858	5,4	544	599	60	604	2293				
I	Tt	Théâtre	9,5	1140	127	254		0	1394		57,7	5774	6.352	635	6409					
I	Th2	Thermes à l'est du Théâtre	2,2	264	23	46	47	14	324	1718	4,8	482	530	53	535	6944				
J	E04	Edifice au nord de la II Esplanade	4,4	528	56	112	1	0	640		0,6	55	61	6	61					
J	Th3	Thermes au nord-ouest de la II Esplan.	7,9	948	90	180	50	15	1143		4,7	475	522	52	527					
J	EM2	Deuxième Esplanade Monumentale	22,7	2724	272	544	88	26	3294		22,3	2226	2.449	245	2471					
J	E05	Edifice à l'ouest de la II Esplananade	0,6	72	8	16		0	88		2,0	202	222	22	224					
J	Ny1	Nymphée 1	2,4	288	36	72	58	17	377	5543	2,6	263	289	29	292	3575	25	2500	500	3000
TOTALS			200	24045	2169	4337	2935	881	29263	**29263**	350	35047	38551	3855	38902	**38902**	25	2500	500	**3000**

Time for **Mosaic maintenance** is estimated, considering 4 technicians, at 13 m²/day of exposed mosaics, or 30 m²/day of sheltered mosaics, or 50 m²/day of reburials; 1 complete cycle for the whole site in 1 year (200 work days)

Time for **Wall maintenance** is estimated, considering 2 masons and 2 workers, at 110 m²/day; 1 complete cycle for the whole site in 1 year and 9 months (350 work days)

Time for **Protection Measures maintenance** is estimated considering 4 workers working 25 days a year divided in two campaigns (about 15 days in April and 10 days in October)

Materials for M**osaic, Reburial and Wall Maintenance (**building materials, consumable materials, tools and equipment are estimated 2 TD/1m² for mosaic, 0,3 TD/1m² for reburial, 0,2 TD/1m² for walls.

Materials for **Protection Measures Maintenance** is estimated at a flat rate at 500 TD per year (2 campaigns)

		BUILDINGS WITH MOSAICS BY AREA	VEGETATION CONTROL 2 month cycle: Vegetation control area	LABOR: work days / 1 cycle	LABOR: 1 day / 12-15 w. TD 180 Cost labor 1 cycle	EQUIPMENT: 1 cycle TD 280 Cost equipm. 1 cycle	TOTAL cost labor and equipm. by site 1 cycle	TOTALS FOR SITE MAINTENANCE CYCLE - 2 YEARS: MOSAIC TOTAL cost material and labor by area for 2 cycles (2 years)	WALL TOTAL cost material and labor by area for 1 cycle (2 years)	PROTECT. MEAS. TOTAL cost material and labor by site for 4 campaigns (2 years)	VEGETATION TOTAL cost material and labor by site for 4 cycles (2 years)	TOTAL LABOR 1 SITE MAINTEN. CYCLE	TOTAL MATERIAL 1 SITE MAINTEN. CYCLE	TOTAL 1 CYCLE PHASE 3
			m^2	w.days	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD
A	MA	Maison d'Amphitrite - ground level	931											
A	MA-S	Maison d'Amphitrite - underground level	70											
A	M15	Maison 15	289											
A	ThV	Thermes des Venantii	131											
A	Th5	Thermes du nord-est	251	2,8	504			3229	2191					
B	MNC	Maison Nouvelle Chasse - ground level	328											
B	MNC-S	Maison Nouvelle Chasse - undergr. lev.	44											
B	MC	Maison de la Chasse - ground level	927											
B	MC-S	Maison de la Chasse - undergr. level	154											
B	MPa	Maison du Paon - ground level	123											
B	MPa-S	Maison du Paon - undergr. level	151	2,9	522			15451	4486					
C	MP	Maison de la Pêche - ground level	1187											
C	MP-S	Maison de la Pêche - undergr. level	253											
C	M08	Maison 8	432											
C	M09	Maison 9	243											
C	M10	Maison 10	362											
C	M14	Maison 14	137											
C	E12	Edifice au coin sud de l'ins. de la Pêche	274	4,8	864			10187	5048					
D	BaN	Basilique Chrétienne du Nord	88											
D	BaS	Basilique Chrétienne du Sud	287											
D	Th4	Thermes nord-ouest des Basiliques	150											
D	M07	Maison 7 - ground and undergr. level	350											
D	E10	Edifice au nord de la Maison 7	24											
D	M02	Maison 2 - ground level	229											
D	M02-S	Maison 2 - underground level	0											
D	MT	Maison du Trésor - ground level	243											
D	MT-S	Maison du Trésor - underground level	42	2,4	432			3507	2045					
E	M01	Maison 1 - ground level	783											
E	M01-S	Maison 1 - underground level	97											
E	E11	Edifice au carrefour entre M3 et M7	19											
E	M03	Maison 3 - ground level	882											
E	M03	Maison 3 - underground level	144											
E	E09	Edifice au sud de la Maison 3	30	3,3	594			1657	2418	0	0			

BUILDINGS WITH MOSAICS BY AREA			VEGETATION CONTROL 2 month cycle – Vegetation control area	LABOR – work days / 1 cycle	LABOR – 1 day / 12-15 w. TD 180 – Cost labor 1 cycle	EQUIPMENT – 1 cycle TD 280 – Cost equipm. 1 cycle	TOTAL cost labor and equipm. by site 1 cycle	TOTALS FOR SITE MAINTENANCE CYCLE - 2 YEARS – MOSAIC – TOTAL cost material and labor by area for 2 cycles (2 years)	WALL – TOTAL cost material and labor by area for 1 cycle (2 years)	PROTECT. MEAS. – TOTAL cost material and labor by site for 4 campaigns (2 years)	VEGETATION – TOTAL cost material and labor by site for 4 cycles (2 years)	TOTAL LABOR 1 SITE MAINTEN. CYCLE	TOTAL MATERIAL 1 SITE MAINTEN. CYCLE	TOTAL 1 CYCLE PHASE 3
			m^2	w.days	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD	tot TD
F	ThIM	Thermes de Iulia Memnia	2516											
F	E06	Edifice à l'est des Th.de Iulia Memmia	157											
F	E07	Edifice au nord du monum. opus retic.	364											
F	E08	Edifice à l'ouest du monum. opus retic.	30											
F	E16	Edifice à l'ouest du Temple 1	21											
F	T1	Temples à l'ouest des Th.Iulia Memmia	202	5,5	990			5427	8814					
G	E01	Edifice sud-ouest du Temple d'Apollon	160											
G	TAp	Temple d'Apollon	489											
G	B1	Basilique du Forum	529											
G	E13	Edifice au nord de la source	25											
G	E14	Edifice nord-est Temple d'Apollon	23											
G	E15	Edifice au sud de la colline	10	2,1	378			830	1089					
H	M04	Maison 4	554											
H	M05	Maison 5	467											
H	E02	Edifice dans le coin sud du Forum	153											
H	Mar	Marché	564											
H	E03	Edifice au nord-est du Marché	298											
H	Th1	Thermes au nord-ouest du Théâtre	1135	5,3	954			3716	2293					
I	Tt	Théâtre	2041											
I	Th2	Thermes à l'est du Théâtre	452	4,2	756			3437	6944					
J	E04	Edifice au nord de la II Esplanade	105											
J	Th3	Thermes au nord-ouest de la II Esplan.	376											
J	EM2	Deuxième Esplanade Monument.	3327											
J	E05	Edifice à l'ouest de la II Esplananade	144											
J	Ny1	Nymphée 1	253	7,0	1260	280	7534	11086	3575	6000	30136			
TOTALS			24052	40	7254	280	7534	58525	38902	6000	30136	117.152	16.411	133.563

PHASE 3 - SITE MAINTENANCE CYCLE (2 years)	133.563	TD

Time for **Vegetation Control** is estimated, considering 12-15 seasonal workers, at 600 m^2/day; the work is carried out inside buildings with mosaics, in the areas where there is no tessellatum

Equipment for **Vegetation Control** is estimated at a flat rate of 560 TD for 1 year (2 cycles) (6 wheelbarrows, 6 hoes, 6 small hoes, 4 shovels, 4 rakes, 2 saws, 15 scissors, 15 gloves)

APPENDIX I

Characterization of Local Mortar Materials

Built Heritage Research Analytical Report

Report Date:	Updated on August 2017; June 5, 2015
Objectives:	Characterization of locally available mortar materials for Bulla Regia Project
Scientist(s):	Beril Bicer-Simsir, Associate Scientist Iago Pozo, Graduate Intern Arezoo Razavi Zadeh, Graduate Intern

In Fall 2013, Spring 2014, and Fall 2016, a set of locally available materials (gravel, sand, brick, soil and binder specimens) that were intended to be used for reburial or preparing repair mortars in Bulla Regia were provided by Tom Roby and Leslie Friedman. This report summarizes the laboratory test results of these materials and analyzes their appropriateness for their intended use. A complete list of submitted materials is provided in the Appendix.

1. Particle Size Distribution of Aggregates

A total of ten aggregate samples were provided to determine their particle size distribution in compliance with ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates. The aggregate names, their intended use and available amounts were given in Table 1. All the aggregates were tested through a sieve column (ASTM E 11) including No. 4 (4.76 mm), No. 6 (3.35 mm), No. 10 (2 mm), No. 16 (1.18 mm), No. 30 (0.60 mm), No. 100 (0.15 mm) and No. 230 (0.063 mm) except Beige Gravel from Bulla Regia (4-15 mm), for which 5/16" (8 mm) sieve was also added to the column.

Table 1: Aggregates for the Bulla Regia Project

	Sample Name	**Purpose**	**Quantity (g)**
GRAVEL, SAND, BRICK, AND SOIL SPECIMENS	Gravel Rouissat	mortar (candidate)	761
	Beige Gravel from nearby quarry	mortar (candidate)	137
	Beige Gravel from Bulla Regia (0-5mm)	mortar	2623
	Beige Gravel from Bulla Regia (4-15 mm)	reburial	327
	Fired brick from Beja (1-4mm)	mortar	1780
	Fired brick from Beja	mortar	209
	Orange Sand	reburial	1306
	Light yellow sand	mortar (mosaics)	320
	White sand	mortar (mosaic interstices)	235
	Yellow sand (0-3 mm)	wall mortar	3781

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1000 g or the maximum available aggregate amount was placed into the top sieve and shaken for 5 minutes. The retained weights on each sieve were recorded and used to calculate the cumulative percent passing through each sieve as followed:

$$\text{Cumulative \% Passing} = 100 - \frac{\textit{cumulative grams retained}}{\text{total weight of sample}} \times 100 \qquad \textbf{(Eq.1)}$$

The gradation curves were plotted as the passing percentage of the aggregate in Y-axis and the sieve opening, which was also the effective diameter of particles in X-axis using log-scale (Figures 1 and 2).

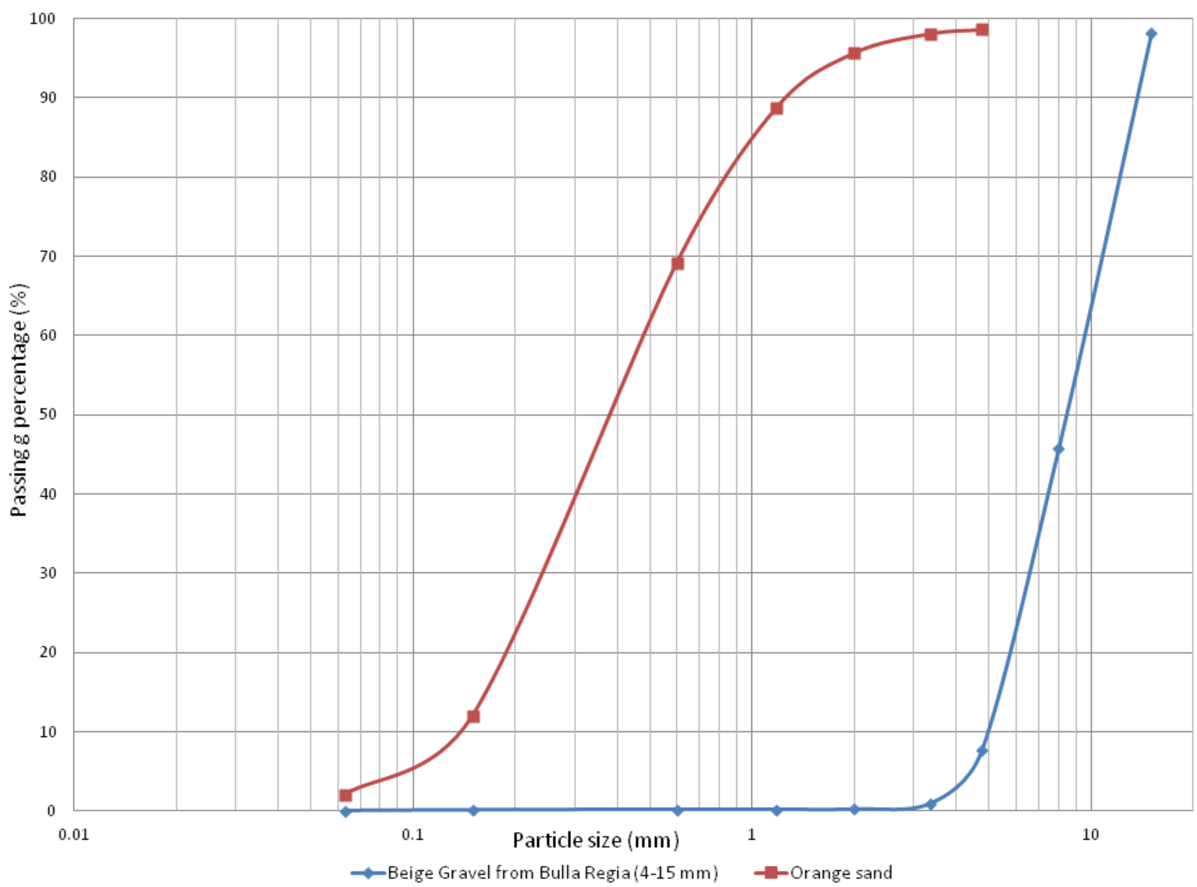

Figure 1: Gradation curves of aggregates for reburial.

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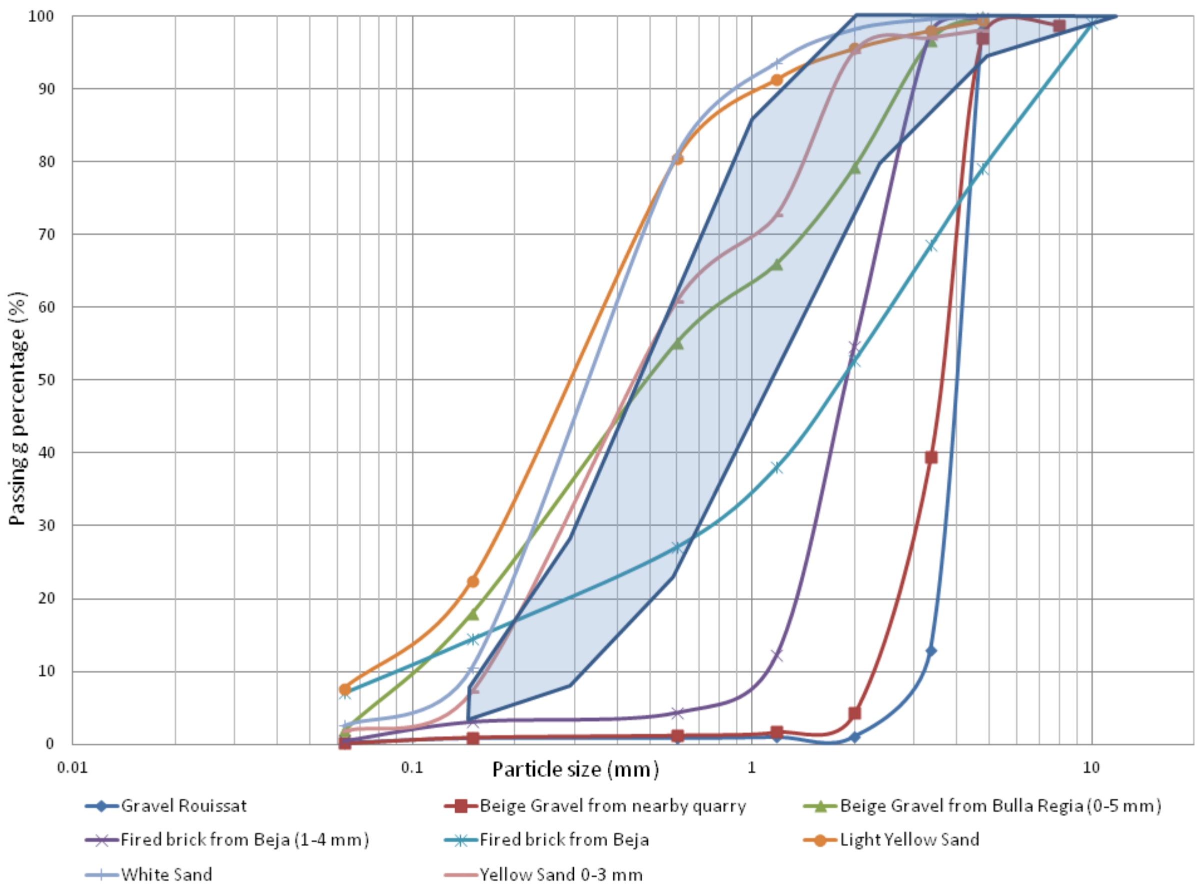

Figure 2: Gradation curves of aggregates for mortar. Blue shaded area indicates the limits specified in ASTM C 33 for fine aggregates.

The Unified Soil Classification System was used to characterize the aggregates based on their gradation. A summary of the classification system including symbols that were related to the results was provided in Table 2. The coefficient of uniformity (C_u) and the coefficient of curvature (C_c) were obtained according to ASTM D 6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis and Norm UNE 103 101 Soil particle size analysis by sieving. C_u, which assesses the uniformity of the particles, was calculated by:

$$C_u = \frac{D_{60}}{D_{10}} \qquad \textbf{(Eq.2)}$$

where D_{10} was the sieve opening through which 10% of particles passes and D_{60} was the sieve opening through which 60% of particles passes. C_u represents the extent of the distribution curve. If the curve had a greater extension, it would have a greater variety of sizes, which was typical of a well-graded aggregate. C_c, which identified whether the aggregate was well graded or not, was calculated by:

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$$C_c = \frac{D_{30}^2}{D_{60} \times D_{10}} \qquad \textbf{(Eq.3)}$$

where D_{30} was the sieve opening through which 30% of particles passes. Following ASTM D 6913, a sample was well-graded when $C_u > 4$ and $1 < C_c < 3$, see Table 2 for details.

Table 2: Unified Soil Classification (ASTM D 6913). Symbols: gravel (G), sand (S), well graded (W), poorly-graded (P), silt (M) and clay (C)

	Fraction smaller than No. 200 sieve size	**Fraction smaller than No. 4 sieve size**			
COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size)	<5% (clean)	<50%	If Cu>4 and 1<Cc<3		GW
			Not meeting requirements for GW		GP
		>50%	If Cu>4 and 1<Cc<3		SW
			Not meeting requirements for SW		SP
	5%-12% (borderline cases requiring dual symbols)	<50%	If Cu>4 and 1<Cc<3	Plasticity requirements	GW-GM
					GW-GC
			Not meeting requirements for GW	Plasticity requirements	GP-GM
					GP-GC
		>50%	If Cu>4 and 1<Cc<3	Plasticity requirements	GW-GM
					GW-GC
			Not meeting requirements for GW	Plasticity requirements	GP-GM
					GP-GC

The fineness modulus (FM) defined in ASTM C 125 Standard Terminology Relating to Concrete and Concrete Aggregates was calculated as an index of the fineness of aggregate and provided in Table 3 along with C_c and C_u results. FM was calculated by adding the cumulative percentages by weight retained on each of a specified series of sieves and dividing the sum by 100. The specified sieves used were No. 100, No. 50, No. 30, No. 16, No. 10, No.6, No. 4, and for Beige Gravel from Bulla Regia (4-15 mm), No. 5/16". The higher the FM of an aggregate sample was, the coarser the sample was.

According to the Unified Soil Classification System, all the tested aggregates were coarse-grained with less than 12 % fines. Beige Gravel from Bulla Regia (4-15 mm) was the only gravel, and the rest of the aggregates are classified sands (Table 4). All the samples were poorly-graded clean aggregates except Fired brick from Beja and Light Yellow Sand based on C_u and C_c values (Table 3 and 4). Fired brick Beja and Light Yellow Sand were well-graded sands (SW) with more than 5% fines passing No. 200 sieve size (7% and 8%, respectively) and require dual symbol identification (-SM or -SC). In order to determine whether they included silt (M) or clay (C), Atterberg limits (plasticity and liquid limits) were needed to be obtained. Due to the limited available quantity of these aggregates, these tests were not conducted and both options were indicated in Table 4. However, simple field tests conducted using very small quantities of these

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sands indicated the presence of silt for both Fired brick Beja and Light Yellow Sand. Light Yellow Sand was the finest (FM=1.13) and Beige Gravel from Bulla Regia (4-15 mm) was the coarsest (FM=6.44) of all the tested aggregates. It might be important to emphasize that Gravel Rousissat and Beige Gravel except (4-15mm) were classified as sand according to the unified soil classification system and not as gravels as their names used in the region indicate.

Table 3: C_u, C_c and FM results

	Sample Name	% Passing No. 200	% Passing No. 4	D_{10}	D_{30}	D_{60}	C_u	C_c	FM
GRAVEL, SAND, BRICK AND SOIL SPECIMENS	Gravel Rouissat	0	98	3.3	3.7	4.1	1.2	1.0	4.9
	Beige Gravel from nearby quarry	0	97	2.4	3.0	3.9	1.7	1.0	4.6
	Beige Gravel from Bulla Regia (0-5mm)	2	100	0.1	0.3	0.8	8.0	0.8	1.9
	Beige Gravel from Bulla Regia (4-15 mm)	0	8	5.0	6.6	9.5	1.9	0.9	6.4
	Fired brick from Beja (1-4mm)	1	100	1.2	1.6	2.1	1.8	1.1	3.3
	Fired brick from Beja	7	79	0.1	0.7	2.5	27.8	2.8	3.2
	Orange Sand	2	99	0.1	0.3	0.5	3.6	0.9	1.4
	Light yellow sand	8	99	0.1	0.2	0.4	5.1	1.1	1.1
	White sand	3	100	0.2	0.2	0.4	2.7	1.0	1.2
	Yellow sand (0-3 mm)	2	98	0.2	0.3	0.6	3.5	0.8	1.7

Table 4: Aggregate classification of aggregates according to Unified Soil Classification

	Sample Name	Aggregate classification
GRAVEL, SAND, BRICK AND SOIL SPECIMENS	*Gravel Rouissat*	SP
	Beige Gravel from nearby quarry	SP
	Beige Gravel from Bulla Regia (0-5mm)	SP
	Beige Gravel from Bulla Regia (4-15 mm)	GP
	Fired brick from Beja (1-4mm)	SP
	Fired brick from Beja	SW- SM or SW- SC
	Orange Sand	SP
	Light yellow sand	SW-SM or SW-SC
	White sand	SP
	Yellow sand (0-3 mm)	SP

The suitability of the gradation of tested aggregates as mortar aggregate was evaluated by comparing the obtained gradation curves with the suggested particle size ranges according to ASTM C 33-blue shaded area in Figure 2. Only the gradation of Yellow Sand (0-3 mm) was in the suggested range however it was at the borderline for the particles smaller than 0.6 mm. Beige Gravel from Bulla Regia (0-5 mm) was in the suggested ranges for the particles larger than 0.6 mm but included much higher amounts smaller than 0.6 mm. Fired brick from Beja (1-4 mm) (B), Yellow Sand (YS) and Beige Gravel from Bulla Regia (0-5 mm) (BG) were mixed at volume proportions used in repair mortars (2B:4YS:3BG) and the combined gradation curve was calculated and compared with suggested gradation limits for mortars (Figure 3). The gradation curve of the mixture (2B:4YS:3BG) was at the borderline for the particles smaller than 0.3 mm and classified as poorly-graded sand (C_c= 0.4, C_u= 6.9 and FM= 2.0). In order to reduce the aggregate

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amount smaller than 0.3 mm, all the aggregates finer than No. 100 sieve size (1.5 mm) were removed from Beige Gravel from Bulla Regia (0-5 mm) (BG*). When BG* was used instead of BG in the aggregate mixture (2B:4YS:3BG*), the gradation (Figure 3) was in suggested range for the particles smaller than 0.3 mm but still classified as poorly-graded sand (C_c= 0.5, C_u= 6.7 and FM: 2.2) according to the Unified Soil Classification System. One might expect that less amount of fines will reduce water amount needed for kneading, reduce shrinkage upon drying and increase strength and durability of the mortars.

In order to study whether the removal of fines from 2B:4YS:3BG sand mixture would have notable effects on the development of strength, beams were prepared using mortars including 2B:4YS:3BG* and 2B:4YS:3BG sand mixtures. The strength comparison of the mortars prepared using varied aggregates were provided in the following section.

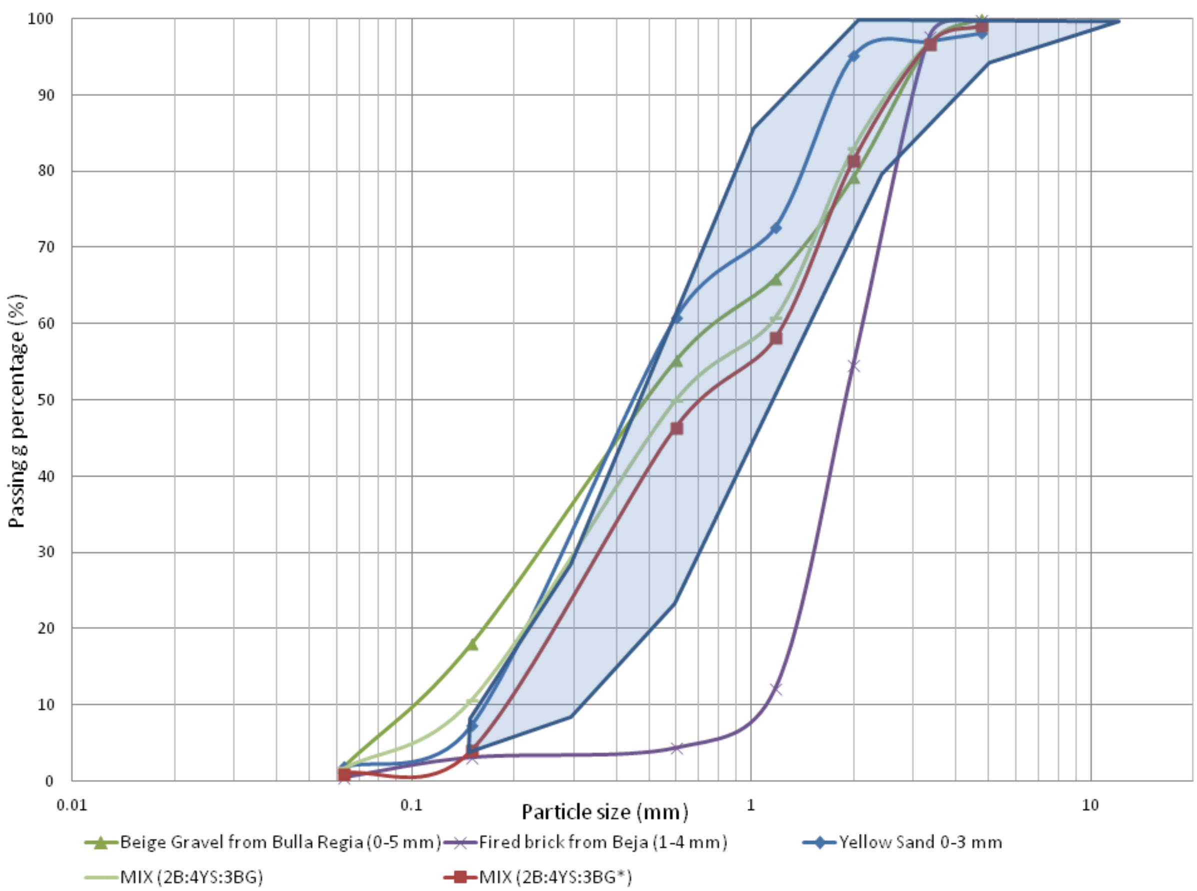

Figure 3: Comparison of the gradation curve of mixed aggregates used for preparing wall mortars. Shaded area indicates the limits specified in ASTM C 33 for fine aggregates.

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2. Repair Mortars for Walls

The quality of mortar materials purchased in Tunisia was studied by comparing the strength development of mortars prepared using these materials with the mortars prepared by ingredients purchased in the USA and regularly used in our laboratory. The ingredients purchased in Tunisia and their abbreviations used in the mortar names were: *Soliman* slaked lime (TL), aggregates (Gravel (0-5mm) (G); Yellow sand (0-3mm) (Y); Crushed brick (1-4 mm) (CB) and Sieved Gravel (0.3-5mm) (G*)), and white Portland cement CEM II/A-L 42,5 N[1] (*SOTACIB- Société Tunis o-Andalouse de Ciment Blanc*)(C(CEM II)). The ingredients purchased in the USA and their abbreviations used in the mortar names were: slaked lime putty (L) (*US Heritage Group),* ASTM C 778 graded sand and 20/30 sand (S) (*U.S Silica*, Ottawa, IL) and white Portland cement TYPE V[2] (C(Type V)) (Lehigh Cement). Table 5 summarizes the proportions and ingredient amounts of all five mortars. 2TL: 1C (CEM II): 3G: 4Y: 2CB was the mortar currently used at the site and the water content of all the other mixes were based on its water content which was determined to obtain acceptable workability in the laboratory.

Table 5: Tested mortar mix designs

Lime: Cement: Sand (vol ratio)	Graded sand (g)	20/30 sand (g)	G (g)	G* (g)	Y (g)	CB (g)	C (Type V) (g)	C (CEM II) (g)	L (g)	TL (g)	Water (g)
2L: 1C(Type V): 9S	727	728	0	0	0	0	114	0	295	0	154
2TL: 1C(Type V): 9S	727	728	0	0	0	0	114	0	0	267	144
2L: 1C(CEM II): 9S	727	728	0	0	0	0	0	105	295	0	151
2TL: 1C (CEM II): 3G: 4Y: 2CB	0	0	497	0	659	202	0	105	0	267	141
2TL: 1C (CEM II): 3G*: 4Y: 2CB	0	0	0	497	659	202	0	105	0	267	141

4 cm x 4 cm x 16 cm metal prism molds, complying ASTM C 348, EN 196-1, and EN 1015-11, were used for preparing specimens. Mortar was placed in two approximately equal layers and each layer was rodded 25 times with a 2.5cm x 1.2cm x 15cm plastic tamper. A releasing agent spray (Miller-Stephenson MS-122AX) was applied into the molds before placing the mortar for easy demolding. Six mortar beams were prepared for each mortar type. All specimens were demolded after 3 days. Three beams of each mortar type were tested after 28 days (kept at RH> 90%) and the rest were tested after 180 days (kept at RH> 90% for 38 days and at RH 70% for 142 days).

The three-point flexural-tensile strength test was performed using an Instron 5885H universal mechanical testing machine (Figure 4(A)). Specimens were loaded at a rate of 1.27 mm/min. The theoretical maximum tensile strength, flexural strength or modulus of rupture, σ_f, was calculated in MPa as follows:

$$\sigma_f = \frac{1.5 \times F_t \times l}{b^3} \qquad \textbf{(Eq.4)}$$

where, F_t was the load at failure, in N, l was the span between the supports, in mm, and b was the side of the square cross-section of the prism, in mm.

[1] This Portland cement includes 6-20% limestone powder in compliance with EN 197-1.

[2] This Portland cement does not include any limestone powder and meets ASTM C150. Type V indicates that it has higher sulfate resistance than normal (Type I) Portland cement.

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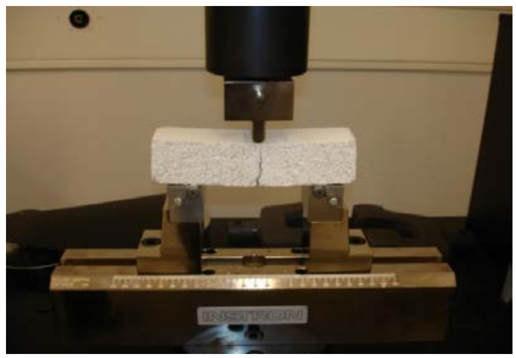
The compressive strength test was carried out on the two fragments of each beam specimen broken during the flexural-tensile strength test (Figure 4(B)). Specimens were loaded at a rate of 1.27 mm/min. The compressive strength, σ_c , in MPa was calculated as follows:

$$\sigma_c = \frac{F_c}{1600} \quad \textbf{(Eq.5)}$$

where, F_c was the compressive load at failure, in N.

(A)



(B)

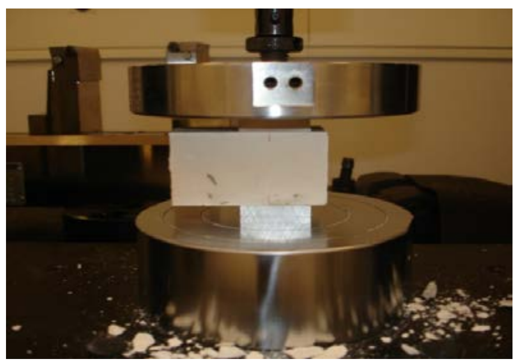


Figure 4(A) Three-point flexural-tensile strength test **(B)** Compressive strength test

All the test results and the coefficient of variance (CV) [3] obtained for each set of specimens were given in Table 6. Low CV values (< 15%) indicates that the results were highly repetitive for each mortar type. In general, longer-term cured specimens had larger CV values, while they were still in the acceptable range (< 20%). Higher CV values indicated an increased dispersion in the measured strength possibly due to the formation of fine drying shrinkage cracks. As expected, all the mortars, while at different rates, continued to increase their strength with time (Figure 5 and 6).

[3] **Coefficient of variation (CV)** for a single variable aims to describe the dispersion of the variable in a way that does not depend on the variable's measurement unit. The higher the CV, the greater the dispersion in the variable is. It is defined as the ratio of the standard deviation to the mean.

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Figure 5 demonstrated that the use of Soliman slaked lime (TL) instead of US Heritage slaked lime (L) increased the compressive (from 2.6 MPa to 3.1 MPa) and flexural tensile (from 0.8 MPa to 1.0 MPa) strength development at 28 days. Early strength development could be attributed to the presence of impurities (e.g., alkali metal salts) that could enhance the early hydration of Portland cement. However, this early effect on strength development diminished after 180 days, and the strength values of mortars including TL were rather lower than that of the mortars including L. It was also expected that the mortar including TL would continue to have lower strength than the mortar with L in the long term.

The use of European CEM II/A-L 42,5 N Portland cement instead of US Type V resulted in significant reduction (around 50%) of mortar strength (Figure 5). The main reason for the low strength development of the mortar including CEM II was the presence of inert limestone powder (up to 20%) in CEM II while US Type V contained only clinkers and had no inert fillers. According to the British Cement Association Fact Sheet 13, 1:2:8 to 9 (CEM II: Lime : Sand) mortar would create masonry mortar mixes equivalent to M1 or M2[4] mortars. Results in Figure 5 (A) confirmed that tested mortar could be classified as M1.

Mortar used at the site, 2TL: 1C(CEM II): 3G: 4Y: 2CB, obtained 3.3 MPa compressive (Figure 6(A)) and 1.0 MPa flexural-tensile (Figure 6 (B)) strength at 28 days. After five additional months of curing, strength values increased to 3.9 MPa for compressive and 1.1 MPa for flexural-tensile strengths. When the fines were sieved from G, 2TL: 1C(CEM II): 3G*: 4Y: 2CB mortar obtained lower strength values. Therefore it was expected that when the water used in 2TL: 1C(CEM II): 3G*: 4Y: 2CB mortar was reduced by 10-20%, mortar would still have similar workability and strength properties but would have superior durability when compared with the mortar currently used at the site. Reduction of fines in aggregate is especially recommended since CEM II already includes up to 20% inert fines.

Table 6: Flexural-tensile and compressive strength test results at 28 and 180 days.

Mortar	**Curing condition** (days in 90% RH / days in 70% RH)	σ_f (MPa)	CV (%)	σ_c (MPa)	CV (%)
2L: 1C(Type V): 9S	28/0	**0.8**	5.8	**2.6**	1.0
	38/142	**1.2**	7.3	**3.8**	3.8
2TL: 1C(Type V): 9S	28/0	**1.0**	2.7	**3.1**	1.3
	38/142	**1.1**	10.1	**3.4**	14.0
2L: 1C(CEM II): 9S	28/0	**0.4**	1.6	**1.2**	4.5
	38/142	**0.5**	16.1	**1.5**	12.0
2TL: 1C(CEM II): 3G: 4Y: 2CB	28/0	**1.0**	3.0	**3.3**	3.1
	38/142	**1.1**	12.0	**3.9**	4.3
2TL: 1C(CEM II): 3G*: 4Y: 2CB	28/0	**0.9**	7.9	**3.1**	2.6
	38/142	**1.0**	6.9	**3.3**	4.2

[4] M class mortar designation defined in BS 5268-3 for designed and prescribed mortars in EN 998-2 and EN 1996-1-1. Number following M 'designation' indicates the compressive strength of mortar at 28 days.

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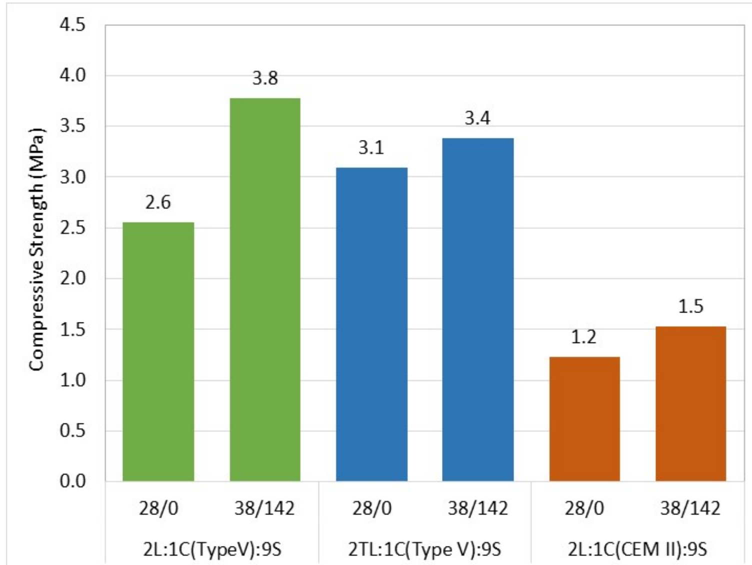
(A)



(B)

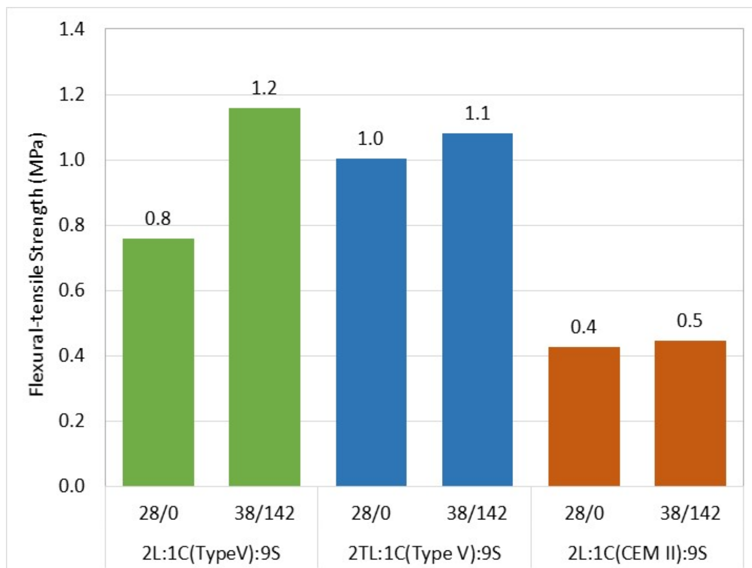


Figure 5 Comparison of **(A)** compressive and **(B)** flexural-tensile strength of mortars including Soliman (TL) or US Heritage slaked limes (L) and Type V (C(Type V) or CEM II/A-L 42,5 N (C(CEM II)) white Portland cement.

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(A)

(B)

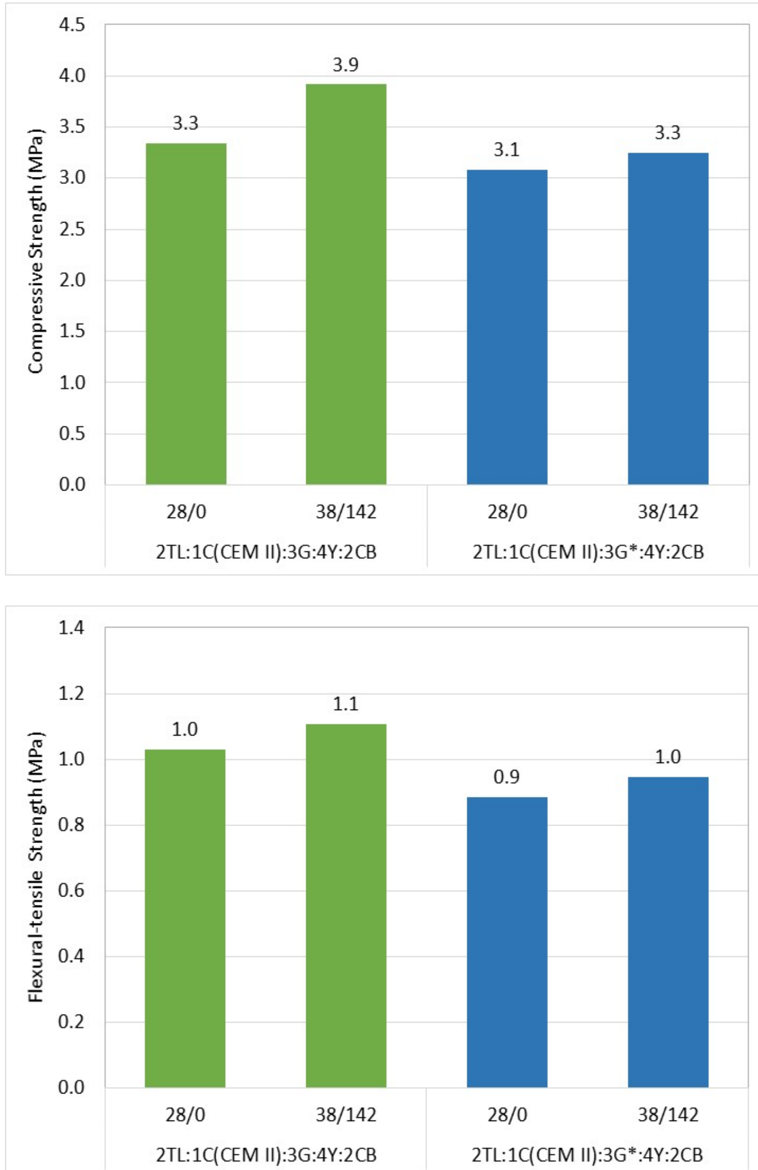

Figure 6(A) Compressive and **(B)** flexural-tensile strength of mortars prepared with unsieved (G) and sieved Gravel (G*).

3. Pozzolanicity of Brick Dusts

Pozzolanicity of four brick dusts (BD) were studied by comparing the strength development of mortars including one part BD with (1:3) lime mortar. Table 7 summarizes the proportions and ingredient amounts of all five mortars. All the mortars included slaked lime putty (L) (*US Heritage Group*) and a mixture of 1 part of ASTM C 778 graded sand and 1 part of ASTM C 778 20/30 sand (S) (*U.S Silica*, Ottawa, IL). Bricks used to obtain brick dusts were green brick (BD-G), yellow brick (BD-Y), red brick, all from Kairouan kiln (BD-RK), and red brick from Beja (BD-RB). All the bricks were crushed, and material passing through No. 60 sieve (<0.25 mm) were used in the mortars. Water to binder ratio of all the mortars were kept same.

Table 7: Tested mortar mix designs

Lime: Brick Dust : Sand (vol ratio)	Graded sand (g)	20/30 sand (g)	Brick dust (g)	L (g)	Additional Water (g)
1L: 3S	727	728	0	440	0
2L: 1BD-RB: 9S	727	728	88	295	53
2L: 1BD-Y: 9S	727	728	86	295	52
2L: 1BD-G: 9S	727	728	119	295	71
2L: 1BD-RK: 9S	727	728	81	295	49

5 cm x 5 cm x 5 cm metal molds, complying ASTM C 109, were used for preparing specimens. Mortar was placed in two approximately equal layers, and each layer was rodded 25 times with a 2.5cm x 1.2cm x 15cm plastic tamper. A releasing agent spray (Miller-Stephenson MS-122AX) was applied into the molds before placing the mortar for easy demolding. Six mortar cubes were prepared for each mortar type. All specimens were demolded after 3 days. Three cubes of each mortar type were tested after 28 days, and the rest were tested after 168 days (kept at RH> 90%).

The compressive strength test was carried out on 5-cm mortar cube specimens (Figure 7). Specimens were loaded at a rate of 1.27 mm/min. The compressive strength, σ_c, in MPa was calculated as follows:

$$\sigma_c = \frac{F_c}{2500} \qquad \textbf{(Eq.6)}$$

where, F_c was the compressive load at failure, in N.

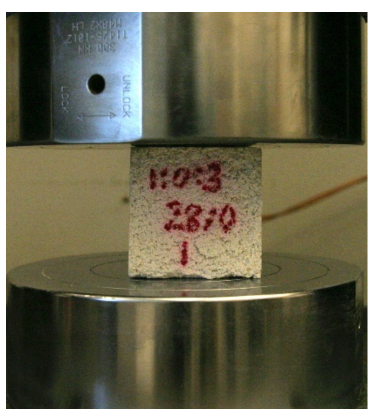

Figure 7 Compressive strength test

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All the test results and the coefficient of variance (CV) obtained for each set of specimens were given in Table 8. Low CV values (< 10%) indicated that the results were highly repetitive for each mortar type. As expected, all the mortars, while at different rates, continued to increase their strength with time (Figure 8). Mortars 1L:3S, 2L:1BD-Y:9S, and 2L:1BD-G:9S obtained at least 100% strength increase in five months.

Table 8: Compressive strength test results at 28 and 168 days.

Mortar	**Curing condition (days in >90% RH)**	**σ_c (MPa)**	**CV (%)**
1L: 3S	28	**0.5**	**2.6**
	168	**1.1**	**5.1**
2L: 1BD-RB: 9S	28	**1.4**	**8.0**
	168	**2.4**	**3.8**
2L: 1BD-Y: 9S	28	**0.5**	**6.4**
	168	**1.0**	**5.6**
2L: 1BD-G: 9S	28	**0.6**	**6.3**
	168	**1.4**	**3.6**
2L: 1BD-RK: 9S	28	**1.0**	**9.3**
	168	**1.5**	**5.3**

Among four brick dusts, brick dust obtained from Beja red brick (RB) had the highest influence on increasing the compressive strength (from 0. 5 MPa to 1.4 MPa after 28 days and from 1.1 MPa to 2,4 MPa after 168 days), therefore showing the highest pozzolanicity (Table 8 and Figure 8). Brick dust from yellow brick (Y) had no influence on the compressive strength, therefore it had no pozzolanic effect. While mortars including BD-G and BD-RK reached improved but similar strengths (1.4 MPa and 1.5 MPa) at 168 days, the reactivity of BD-G was slower when compared with the reactivity of BD-RK at early ages.

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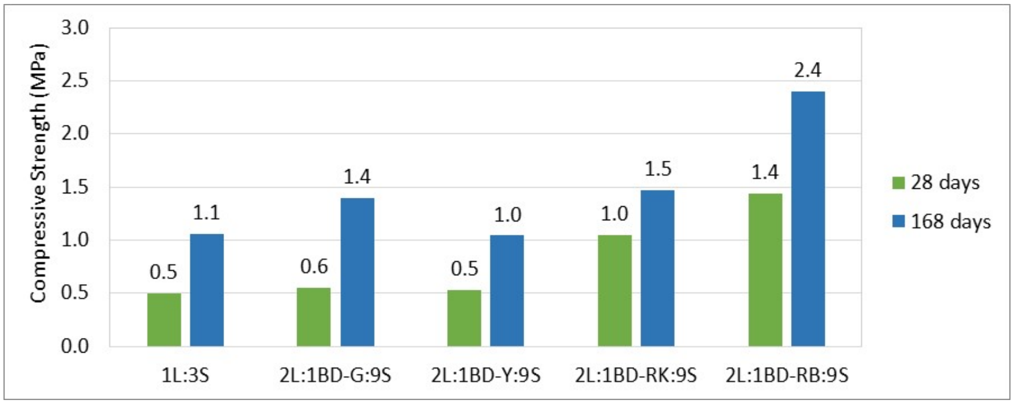

Figure 8 Comparison of compressive strength of mortars including brick dusts.

4. Hydraulicity of limes

The composition of three slaked limes and three natural hydraulic lime (NHL) pastes were studied by differential thermal and thermogravimetric analysis (DTA/TG) using a METTLER TOLEDO TGA/SDTA 851e. Their water content, hydration and pozzolanic reaction products, residual lime, and carbonation product were identified for each lime. Slaked limes studied were *Soliman* slaked lime (TL), *Sfax* slaked lime, and Kairouan (*Chaux rouge*) slaked lime. NHLs were NHL 2.0 (*St. Astier*), NHL 5.0 (*St. Astier*), and NHL 6.0 (*Interchaux SARL.*). While the slaking age of TL was not known, Sfax and Kairouan were tested after four weeks of slaking. NHL pastes (prepared using 0.5 water to NHL weight ratio) were tested at 7 days.

About 35 mg of the specimen was put in a 70 µm Al_2O3 crucible and analyzed in a nitrogen atmosphere (50ml/min) by applying heating rates of 20 ^oC/min from 30 to 1000 ^oC. The main endothermic peaks observed during the degradation of slaked and hydraulic lime pastes were grouped into four temperature ranges as shown in Table 9. A summed amount of hydration and pozzolanic reaction products was determined between the temperature ranges from 110 ^oC to 460 ^oC without a distinction among the type of the products. The temperature ranges shown in Table 9 were approximations and should be considered as guidelines to be adapted case by case evaluating each curve. The variations in the specimen weight and in the proportions of the products in the system can widen or narrow the range of temperature in which a product decomposes.

Results showed that TL included 53.5% H_2O and 46.5% solids. Its solid content was 91.6% $Ca(OH)_2$, 6.7 % $CaCO_3$ and 1.7% calcium aluminum and/or silicate hydrates (Table 10). Kairouan slaked lime included 53.1% H_2O, similar to TL but Sfax included only 45.3% H_2O. When solid content of three slaked lime were compared (Table 10), Sfax had the highest amount of hydraulic products (17.6%) and TL had the lowest amount (1.7%). Considering the amount of hydration products in the slaked limes, both Sfax and Kairouan slaked limes would expect to perform as hydraulic limes. However, the strength development of mortars prepared with Sfax may not be higher than the ones prepared with Kairouan since Sfax also included the highest amount of $CaCO_3$ while Kairouan included less than 10% $CaCO_3$ and more than 80% $Ca(OH)_2$ (Table 10 and Figure 9). Relatively very high $CaCO_3$ (53.1%) content of Sfax under wet conditions indicated the existence of over-burned calcite and could explain the low percentage of $Ca(OH)_2$ formation (29.3%). Based on higher hydraulic product content (11.0% compared to 1.7%) and similar $Ca(OH)_2$ (81.5 % compared

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to 91.6%) and $CaCO_3$ content (7.5% compared to 6.7%) of Kairouan slaked lime, one would expect that the mortars prepared with Kairouan lime would produce mortars with higher strength than the ones prepared with TL.

Table 9 Degradation products and temperature ranges

Temperature (°C)	Reactions involved
<110	Loss of adsorbed water
110-460	Loss of chemical water bound to several calcium aluminum silicate Hydrates (CSH, CAH, CASH)
460-610	Loss of chemical water bound to Portlandite (CH)
>610	Loss of CO_2 due to decomposition of $CaCO_3$

Table 10 Solid content distribution of Tunisian slaked limes

Reaction involved	TL (wt %)	Sfax slaked lime (wt %)	Kairouan slaked lime (wt %)
Decomposition of calcium aluminum/silicate hydrates	1.7	17.6	11.0
Decomposition of $Ca(OH)_2$	91.6	29.3	81.5
Decomposition of $CaCO_3$	6.7	53.1	7.5

DTA/TG analysis of three NHL pastes (Table 11) showed that NHL 6.0 paste had the highest amount of hydraulic products (26.4%) and NHL 2.0 paste had the lowest amount (8%). Based on higher hydraulic product content (26.4% compared to 11.7%) and similar $Ca(OH)_2$ content (25.5 % compared to 22.0%) of NHL 6 paste when compared with NHL 5, results confirmed that the mortars prepared with NHL 6.0 would produce mortars with higher strength than the ones prepared with NHL 5.0.

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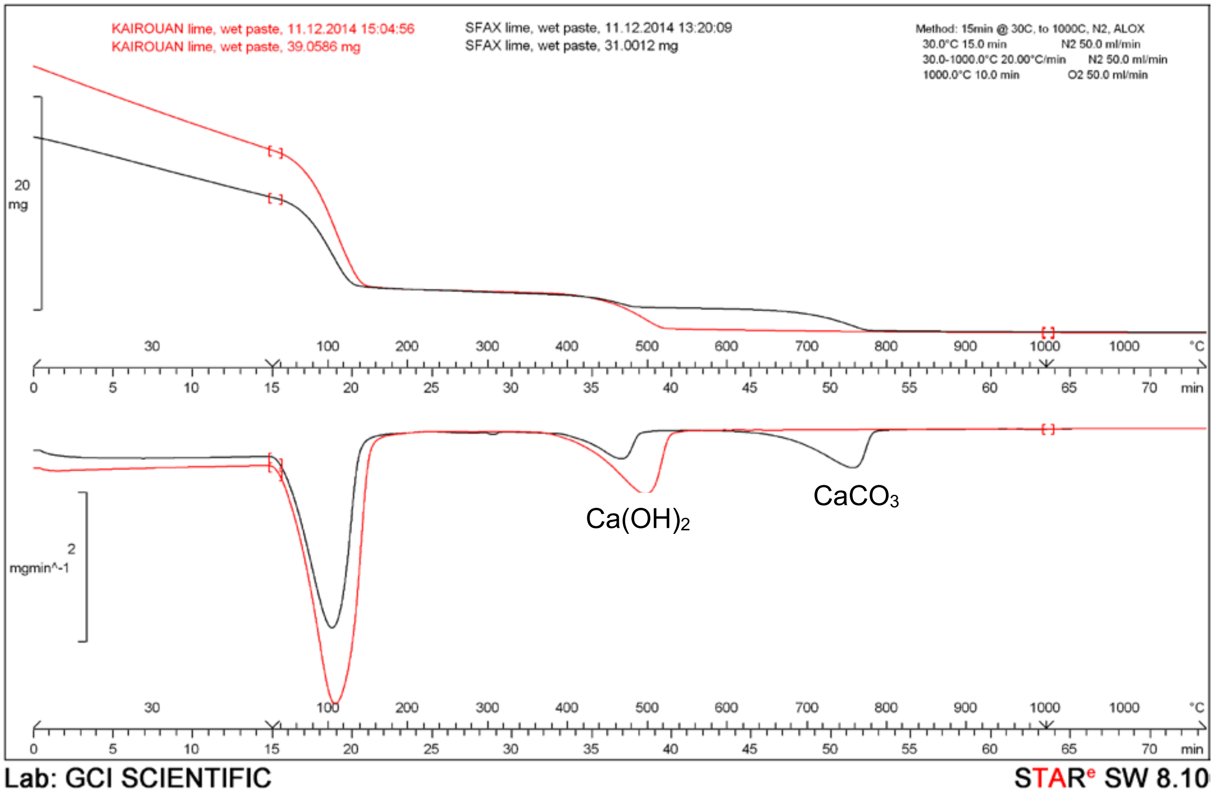

Figure 9 DTA/TG analysis of Sfax and Kairouan slaked limes.

Table 11 Composition of NHL pastes including varying NHL types.

Reaction involved	NHL 2 (wt %)	NHL 5 (wt %)	NHL 6 (wt %)
Evaporation of H_2O	2.6	3.9	4.9
Decomposition of calcium aluminum/silicate hydrates	8.0	11.7	26.4
Decomposition of $Ca(OH)_2$	48	22	25.5
Decomposition of $CaCO_3$	41.4	62.4	43.2

5. Comparison of the strength development of Interchaux Natural Hydraulic Limes

The quality of Interchaux natural hydraulic limes (NHL3.5), currently produced in Tunisia and provided by Tom Roby in Fall 2016, was studied by comparing the strength development of mortars prepared using two production batches of the new product (Int_NHL 3.5 (2016/48) and Int_NHL 3.5 (2016/49)) with the mortars prepared by Interchaux NHLs

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brought back by Tom Roby from Tunisia in Spring 2010 (Int_NHL 3.5 and Int_NHL 6.0) and St Astier NHLs (SA_NHL 2.0, SA_NHL 3.5, and SA_NHL 5), which were purchased in the US.

The proportions and ingredients of the mixes used in this study were summarized in **Table 12.** The mortars were proportioned using volume measurements while the weight of each ingredient was also recorded. Instead of using a constant weight of NHL for all the mortars as used in EN 459-2, NHL and aggregate weight values were determined from the volume measurements made by a measurement cup in order to represent mortars likely to be used in the field. Mortars having 1:2.5 and 1:3.0 binder to aggregate volume ratios were prepared for each binder type, except Int_NHL 6, only 1:3 binder to aggregate volume ratio was tested. Standard EN 196-1 sand was used for all the mortars and the water to binder weight ratio was kept as 1.0.

Mortars were mixed with a Hobart mixer satisfying ASTM C 305 requirements. Mortar preparation was started with mixing water and NHL for one minute at low speed. Following this, the sand was added into the bowl in 30 seconds, and mixing continued for another 30 seconds. Then the speed of the mixing was increased to medium speed and the mortar was mixed for one more minute. Following this step, the mixer was stopped, and mortar was rested for one minute. Finally, the mortar was mixed for another one minute at medium speed.

Table 12: Tested mortar mix designs.

Mortar Name	NHL:Aggregate volume ratio	EN 196-1 Sand (g)	NHL (g)	Water (g)
SA_NHL 2	1:2.5	1500	230	230
	1:3.0	1500	221	221
SA_NHL 3.5	1:2.5	1500	230	230
	1:3.0	1500	222	222
SA_NHL 5	1:2.5	1500	279	279
	1:3.0	1500	233	233
Int_NHL 3.5	1:2.5	1500	287	287
	1:3.0	1500	239	239
Int_NHL 6	1:2.5	-	-	-
	1:3.0	1500	272	272
Int_NHL 3.5 (2016/48)	1:2.5	1500	287	287
	1:3.0	1500	239	239
Int_NHL 3.5 (2016/49)	1:2.5	1500	287	287
	1:3.0	1500	239	239

Three 4 cm x 4 cm x 16 cm mortar beams were prepared for each mortar type following the procedure explained in Section 2 of this report. Beams were tested after 28 days (kept at RH> 90%). The three-point flexural-tensile and compressive strength test were also carried out, and strength values were obtained as explained in Section 2.

It is important to note that the compressive strength values obtained in this study deviate from the expected standardized values, which are also used for naming the NHLs according to the EN 459-1, since the mix proportions

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used in this study are different from the ones used in the related standard. On the other hand, the compressive strength values obtained in this study are much closer to the ones that will be obtained for commonly used mortars, and their comparative compressive strength relation will be still valid (i.e., NHL 5.0 mortar shows the highest compressive strength and NHL 2.0 mortar shows the lowest.)

The average compressive strength of 1:2.5 mortars including Interchaux NHL 3.5 (2016/48) was comparable to the compressive strength of the 1:2.5 mortars made by Interchaux NHL 3.5 and St Astier NHL 3.5 (**Figure 10**). However, compressive strength of Int_NHL 3.5 (2016/49) (1:2.5) was the highest among all the mortars given in **Figure 10.** The compressive strength of the current product (Int_NHL 3.5 (2016/48) and (2016/49)) was higher than the strengths of Int_NHL 3.5 and SA NHL 3.5 for 1:3 mortars, and the strength difference was much more pronounced (**Figure 10**). Except for the mortars prepared with the current Interchaux NHL, compressive strength of 1:2.5 mortars were higher than the strength of 1:3 mortars. This was reversed for mortars including Int_NHL 3.5 (2016/48) and Int_NHL 3.5 (2016/49). This result demonstrated that increased amounts of current Interchaux NHL 3.5 in the mortar (i.e., 1:2.5 mortars) reduced compressive strength, indicating that the drying shrinkage of the mortars including current Interchaux NHL was higher than that of the previously produced Interchaux NHL and St Astier NHL 2 and NHL 3.5. The same trends were observed for the measured flexural-tensile strength of NHL 2 and NHL 3.5 mortars (**Figure 11**). However, the flexural-tensile strength of mortars including Int_NHL 3.5 (2016/48) and Int_NHL 3.5 (2016/49) were significantly higher than that of mortars including other NHL 3.5 (**Figure 11**). It was also important to note that the strength development of mortars prepared by two batches of Int_NHL 3.5 (2016/48) and (2016/49)) was significantly different and possibly indicating some manufacturing inconsistencies. The compressive strength of the mortars made by recently manufactured Interchaux NHL3.5 was comparable with the mortars including St. Astier NHL 5 but much lower than the mortars including Int-NHL 6 (**Figure 12**).

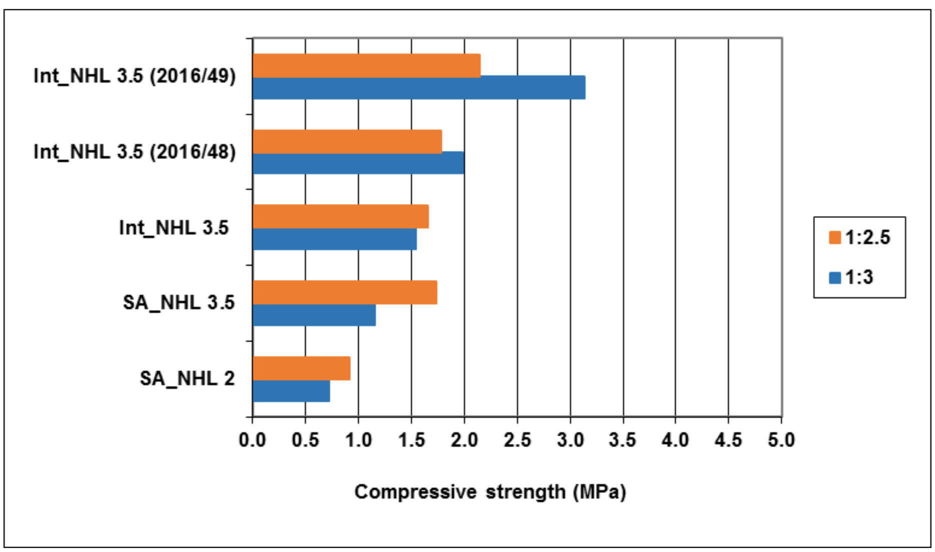

Figure 10 Comparison of compressive strength of NHL 2 and NHL 3.5 mortars.

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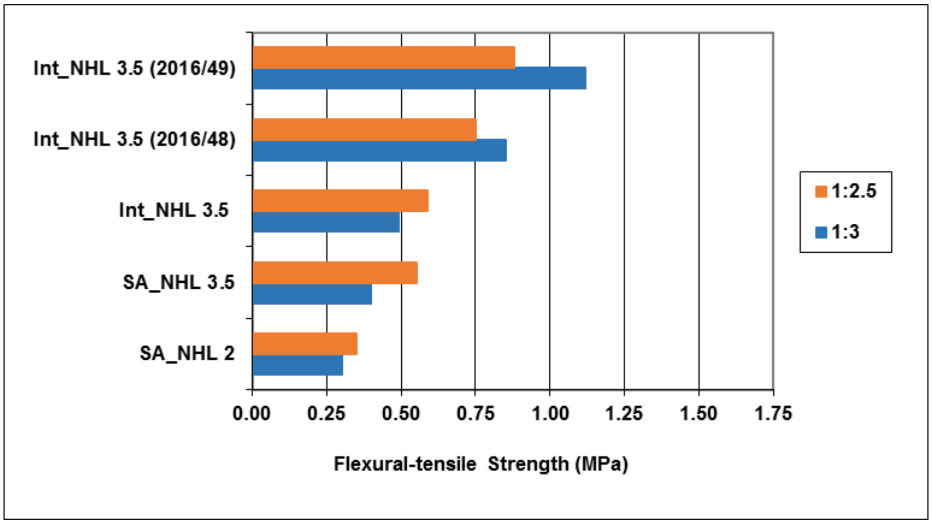

Figure 11 Comparison of flexural-tensile strength of NHL 2 and NHL 3.5 mortars.

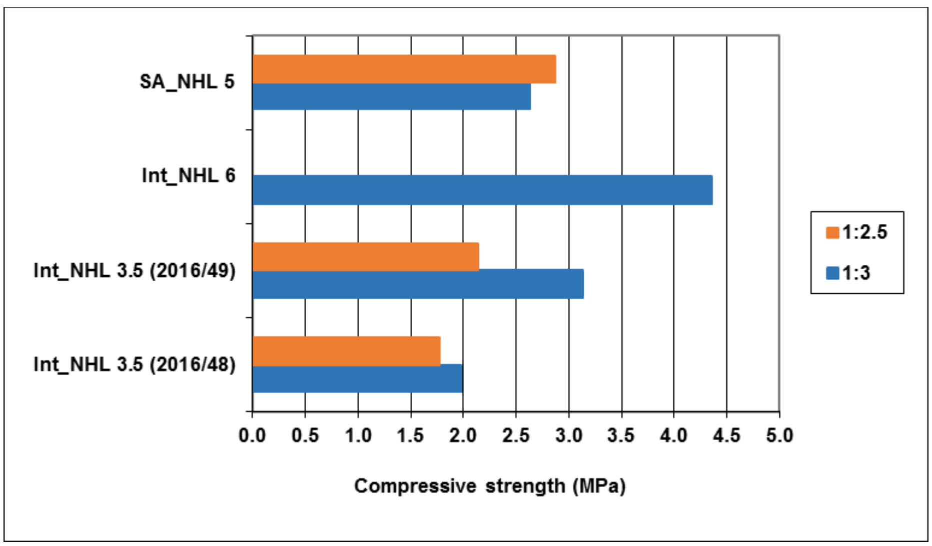

Figure 12 Comparison of compressive strength of NHL 3.5, NHL 5 and NHL 6 mortars.

6. Summary

Yellow Sand (0-3 mm) was the only aggregate whose gradation was suitability as mortar aggregate based on the suggested particle size ranges in ASTM C 33. However, it was at the borderline for the particles smaller than 0.6 mm. Beige Gravel from Bulla Regia (0-5 mm) was in the suggested ranges for the particles larger than 0.6 mm but included much higher amounts grains smaller than 0.6 mm. The gradation curve of the aggregate mixture used at the site (2B:4YS:3BG) was also at the borderline for the particles smaller than 0.3 mm and classified as poorly-graded sand (C_c=

0.4, C_u= 6.9 and FM= 2.0). All the aggregates finer than No. 100 sieve size (1.5 mm) were removed from Beige Gravel from Bulla Regia (0-5 mm) (BG*) in order to reduce the aggregate amount smaller than 0.3 mm. When BG* was used instead of BG in the aggregate mixture (2B:4YS:3BG*), the gradation (Figure 3) was in suggested range for the particles smaller than 0.3 mm but still classified as poorly-graded sand (C_c= 0.5, C_u= 6.7 and FM: 2.2) according to the Unified Soil Classification System.

Mortar used at the site, 2TL: 1C(CEM II): 3G: 4Y: 2CB, obtained 3.3 MPa compressive and 1.0 MPa flexural-tensile strength at 28 days. After five additional months of curing, strength values increased to 3.9 MPa for compressive and 1.1 MPa for flexural-tensile strengths. When the fines were sieved from G, 2TL: 1C(CEM II): 3G*: 4Y: 2CB mortar obtained lower strength values. It would be expected that when the water used in 2TL: 1C(CEM II): 3G*: 4Y: 2CB mortar was reduced by 10-20%, mortar would still have similar workability and strength properties but would have superior durability when compared with the mortar currently used at the site. Reduction of fines in aggregate was especially recommended since CEM II already included up to 20% inert fines.

The use of Soliman slaked lime (TL) instead of US Heritage slaked lime (L) increased the compressive (from 2.6 MPa to 3.1 MPa) and flexural tensile (from 0.8 MPa to 1.0 MPa) strength development at 28 days. Early strength development could be attributed to the presence of impurities (e.g., alkali metal salts) that could enhance the early hydration of Portland cement. However, this early effect on strength development diminished after 180 days, and the strength values of mortars including TL were rather lower than that of the mortars including L. It was also expected that the mortar including TL would continue to have lower strength than the mortar with L in the long term.

Among the four brick dusts, brick dust obtained from Beja red brick (RB) showed the highest pozzolanicity. Brick dust from yellow brick (Y) had no influence on the compressive strength, therefore it had no pozzolanic effect. While mortars including BD-G and BD-RK reached improved but similar strengths (1.4 MPa and 1.5 MPa) at 168 days, the reactivity of BD-G was slower when compared with the reactivity of BD-RK at early ages.

DTA-TG results showed that Sfax had the highest amount of hydraulic products (17.6%) and TL had the lowest amount (1.7%). Considering the amount of hydration products in the slaked limes, both Sfax and Kairouan slaked limes would expect to perform as hydraulic limes. However, the strength development of mortars prepared with Sfax may not be higher than the ones prepared with Kairouan since Sfax also included the highest amount of $CaCO_3$ while Kairouan included less than 10% $CaCO_3$ and more than 80% $Ca(OH)_2$. Relatively very high $CaCO_3$ (53.1%) content of Sfax under wet conditions indicated the existence of over-burned calcite and could also explain the low percentage of $Ca(OH)_2$ formation (29.3%). Based on higher hydraulic product content (11.0% compared to 1.7%) and similar $Ca(OH)_2$ (81.5 % compared to 91.6%) and $CaCO_3$ content (7.5% compared to 6.7%) of Kairouan slaked lime, one would expect that the mortars prepared with Kairouan lime would produce mortars with higher strength than the ones prepared with TL.

Interchaux NHL 3.5 manufactured in 2016 produced mortars with compressive strength higher than the strength of mortars including St Astier 3.5 and comparable to the strength of the mortars including St Astier NHL 5. Results also demonstrated that increased amounts of current Interchaux NHL 3.5 in the mortar (i.e., 1:2.5 mortars) reduced compressive strength, indicating that the drying shrinkage of the mortars including current Interchaux NHL was higher than that of the previously produced Interchaux NHL and St Astier NHL 2 and NHL 3.5. Finally, the strength development of mortars prepared by two batches of Int_NHL 3.5 (2016/48) and (2016/49)) was significantly different and possibly indicating some manufacturing inconsistencies.

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7. References

ASTM C 33 Standard Specification for Concrete Aggregates

ASTM C 125 Standard Terminology Relating to Concrete and Concrete Aggregates

ASTM C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C150 Standard Specification for Portland Cement

ASTM C 348 Standard Test Method for Flexural Strength of Hydraulic Cement Mortars

ASTM D 6913 Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

ASTM E 11 Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

BS 5268-3 Code of practice for use of masonry – Part 3: Materials and components, design and workmanship

British Cement Association (BCA) Fact Sheet 13 Specifying factory-made CEM II cements for use in masonry mortars

EN 196-1 Methods of testing cement – Part 1: Determination of strength

EN 197-1 Cement. Composition, specifications and conformity criteria for common cements

EN 998-2 Specification for mortar for masonry – Part 2: Masonry mortar

EN 1015-11 Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar

EN 1996-1-1 Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures

Norm UNE 103 101 Soil particle size analysis by sieving

Unified Soil Classification System. Website of Virginia Department of Transportation. http://www.virginiadot.org (Last visited: 3/25/2014)

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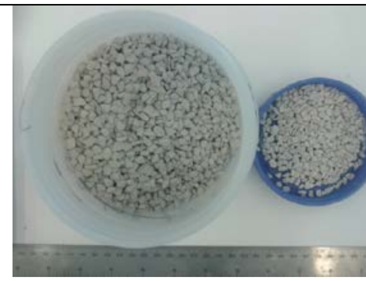
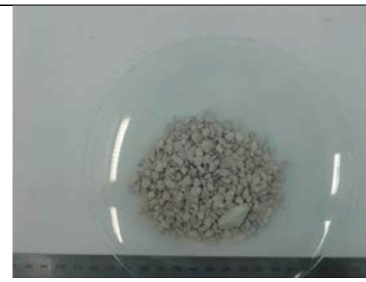
APPENDIX

A. GRAVEL, SAND, BRICK AND SOIL SPECIMENS			
Material	**Comments**	**Weight (g)**	**Picture**
Gravel Rouissat	• Particle size analysis • Being considered to be used as a mortar ingredient	761	
Beige Gravel from nearby quarry	• Particle size analysis • Being considered to be used as a mortar ingredient	137	
Beige Gravel from Bulla Regia (0-5mm)	• Sieve <5 mm and obtain gradation curve • Currently used as a mortar ingredient	2623	
Beige Gravel from Bulla Regia (4-15mm)	• Particle size analysis • Reburial material	327	

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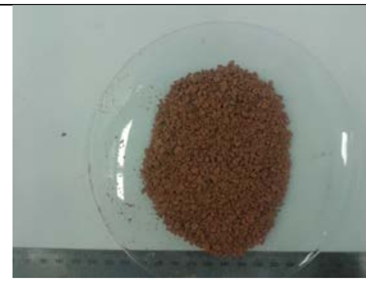
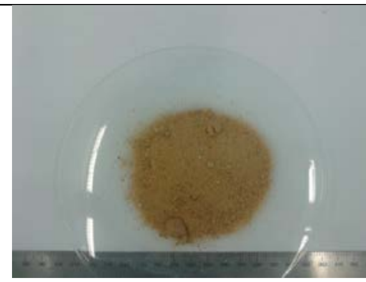
A. GRAVEL, SAND, BRICK AND SOIL SPECIMENS (continued)			
Material	**Comments**	**Weight (g)**	**Picture**
Fired brick from Beja (1-4mm)	• Crush and sieve <0.25mm • Prepare mortar cubes and test pozzolanacity by mortar strength • Mortar ingredient	1780	
Fired brick from Beja	• Particle size analysis • Mortar ingredient	209	
Fired bricks from Kairouan kiln	• Crush and sieve <0.25mm • Prepare mortar cubes and test pozzolanacity by mortar strength • Mortar ingredient Note: These three brick samples of different colors (red, green and yellow-white) from kilns near Kairouan. Presumably they have been fired at different temperatures and have different hydraulic properties. If so, we would like to know which brick would provide the greater degree of pozzolanicity. A sample of clay not fired was also provided.	190 each	

A. GRAVEL, SAND, BRICK AND SOIL SPECIMENS (continued)			
Material	**Comments**	**Weight (g)**	**Picture**
Orange Sand	• Particle size analysis • Mortar cube for color change and staining identification • Reburial sand from Jendouba sieved <4 mm	1306	
Light yellow sand	• Particle size analysis • Mortar cube for color change and staining identification • Mosaic mortar sand	320	
White sand	Particle size analysis • Mortar cube for color change and staining identification • Mosaic mortar sand for interstices	235	
Yellow sand (0-3 mm)	• Particle size analysis • Mortar cube for color change and staining identification • Wall mortar sand	3781	

B. BINDER SPECIMENS

Material	Comments	Weight (g)	Picture
Quicklime CHAUX ROUGE *KAIROUAN kiln/ ROUISSAT limestone*	• Check setting if it is found semi-hydraulic lime • TGA after slaking (water content) • Being considered to be used as a mortar ingredient Note: Lime (quick lime and slaked) from kiln near Kairouan, called *chaux rouge,* is produced from stone from Rouissat which is a semi-hydraulic lime. The stone of Rouissat has a significant clay component and is also used to produce cement. Gravel from Rouissat was provided as well.		
Slaked lime CHAUX ROUGE *KAIROUAN kiln/ ROUISSAT limestone*	• TGA to determine existence of hydration products • Being considered to be used as a mortar ingredient	1038	
Quick lime Sfax	• Check setting if it is found to be semi-hydraulic lime • TGA after slaking (water content) • Being considered to be used as a mortar ingredient Note: lime (quick lime and slaked) from kiln near Sfax is also semi-hydraulic	1724	

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B. **BINDER SPECIMENS** (continued)			
Material	**Comments**	**Weight (g)**	**Picture**
Slaked lime Sfax	• TGA to determine existence of hydration products • Being considered to be used as a mortar ingredient	1190	
Quicklime SOLIMAN/ FOUNDUK JADID Limestone	• Mortar ingredient Note: Lime (quick lime and slaked) from wholesaler near Soliman (kiln in Cap Bon area), produced from limestone from the quarry near Founduk Jadid. This is the lime that we have generally used for many years and is a good quality hydrated lime. A fragment of the limestone was provided as well.	907	
Slaked lime SOLIMAN	• TGA • Mortar ingredient	2 bottles	

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B. BINDER SPECIMENS (continued)

Material	Comments	Weight (g)	Picture
NHL 6.0	• Powder XRD (compare with the previous results) • Mortar ingredient Note: Chaux hydraulique natural CHN 6	456	
Gray portland cement	• Powder XRD • Being considered to be used as a mortar ingredient Note: Grey Ciment Portland	310	
White cement (unknown local Tunisian source)	• Powder XRD • Being considered to be used as a mortar ingredient Note: Ciment blanc	480	
CEM II/ A-L 42.5 N White Cement (Tunisian standards)	• Powder XRD • Mechanical testing • Being considered to be used as a mortar ingredient Note: Empty bag of Ciment super blanc. SOTACIB	171	
		2146	
Hydraulic lime	• Powder XRD • Being considered to be used as a mortar ingredient Note: Chaux hydraulique artificalle	314	

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APPENDIX J

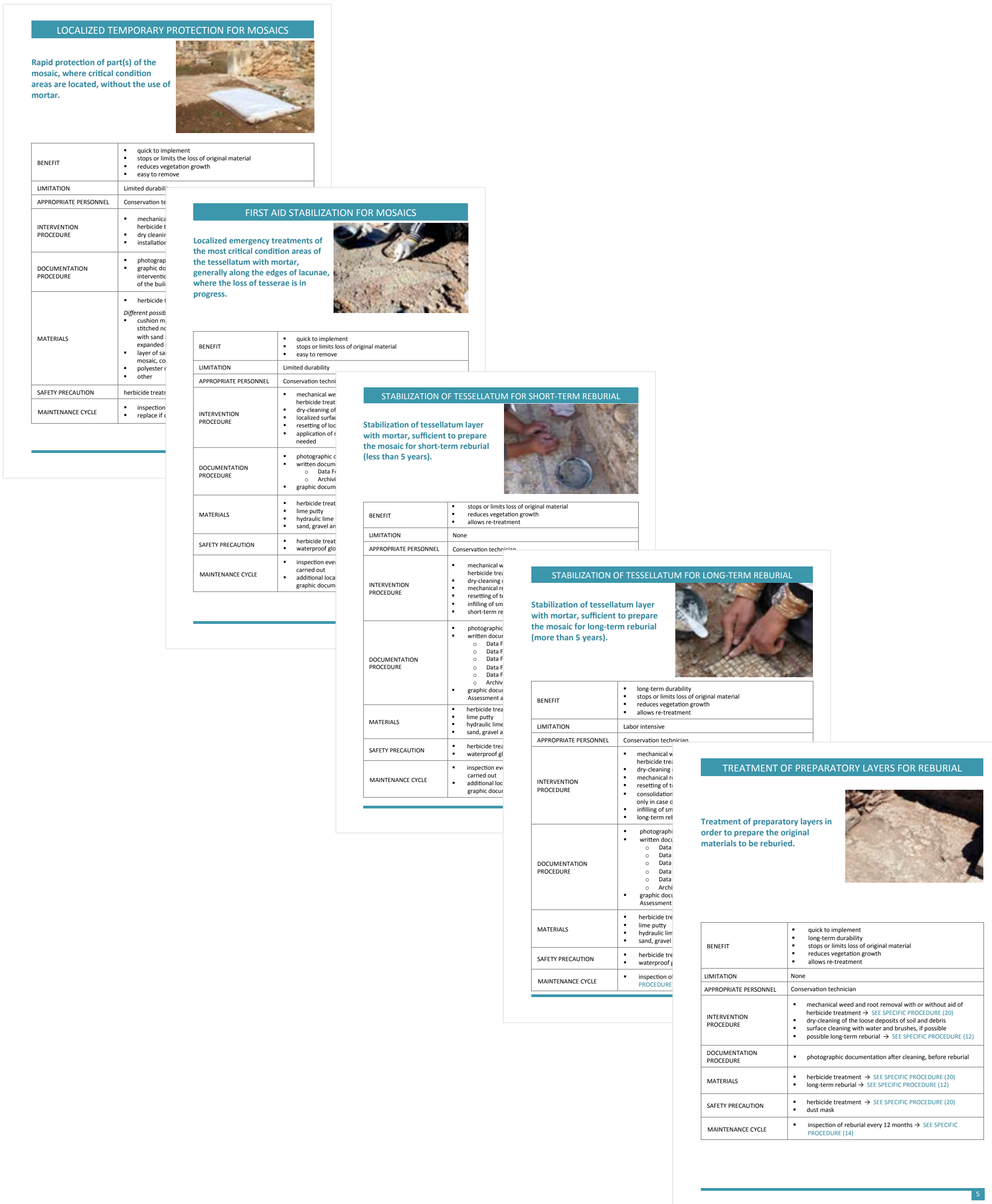
Conservation Intervention Protocols

The Getty Conservation Institute

MOSAIKON

Institut National du Patrimoine de Tunisie

INTERVENTION PROTOCOLS



Bulla Regia model field project, Tunisia

TYPE OF INTERVENTION	
Localized Temporary Protection for Mosaics	1
First Aid Stabilization for Mosaics	2
Stabilization of Tessellatum for Short-Term Reburial	3
Stabilization of Tessellatum for Long-Term Reburial	4
Treatment of Preparatory Layers for Reburial	5
Treatment of Preparatory Layers for Presentation	6
Treatment of Floors without Mosaics or Preparatory Layers for Presentation	7
Stabilization of Tessellatum for Presentation	8
In Situ Treatment of Mosaics Re-laid on Reinforced Concrete	9
Mosaic Maintenance	10
Short-Term Reburial	11
Long-Term Reburial	12
Tessellatum Protection with Mortar Covering	13
Reburial Maintenance	14
Conservation Treatment of *Cocciopesto* (crushed ceramic mortar)	15
Conservation Treatment of Stone Slab Pavements	16
Conservation Treatment of Wall Plasters	17
Conservation Treatment of Walls	18
Conservation Treatment of Stone	19
Herbicide Treatment	20
Channel Drainage	21
Pit Drainage	22
Construction of Fences and Access Barriers	23
Site Maintenance – Vegetation Removal	24

LOCALIZED TEMPORARY PROTECTION FOR MOSAICS

Rapid protection of part(s) of the mosaic, where critical condition areas are located, without the use of mortar.

BENEFIT	▪ quick to implement ▪ stops or limits the loss of original material ▪ reduces vegetation growth ▪ easy to remove
LIMITATION	Limited durability
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry cleaning of loose deposits of soil and debris ▪ installation of specific protection method
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ graphic documentation: note the location and the date of the intervention on the mosaic photographic base (or on the plan of the building)
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) *Different possible methods of temporary protection:* ▪ cushion made with a double bag (woven plastic bag inside and stitched non-woven geotextile 150-200 gr/m^2 outside), filled with sand and/or fine gravel (2-5 mm), lightened with expanded clay, if possible, and closed with PVC ties ▪ layer of sand over geotextile (100 gr/m^2) in contact with mosaic, contained by wooden plank frame ▪ polyester mats ▪ other
SAFETY PRECAUTION	herbicide treatment → SEE SPECIFIC PROCEDURE (20)
MAINTENANCE CYCLE	▪ inspection every 6 months ▪ replace if deteriorated

FIRST AID STABILIZATION FOR MOSAICS

Localized emergency treatments of the most critical condition areas of the tessellatum with mortar, generally along the edges of lacunae, where the loss of tesserae is in progress.

BENEFIT	▪ quick to implement ▪ stops or limits loss of original material ▪ easy to remove
LIMITATION	Limited durability
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris ▪ localized surface cleaning with water and brushes ▪ resetting of loose tesserae ▪ application of mortar along the tessellatum edges where needed
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: ○ Data Form 1 - Identification ○ Archiving Data Form ▪ graphic documentation of Current Interventions
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel, and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ waterproof gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 6 months until complete stabilization is carried out ▪ additional localized mortar repairs where/when needed, with graphic documentation of Current Interventions

STABILIZATION OF TESSELLATUM FOR SHORT-TERM REBURIAL

Stabilization of tessellatum layer with mortar, sufficient to prepare the mosaic for short-term reburial (less than 5 years).

BENEFIT	▪ stops or limits loss of original material ▪ reduces vegetation growth ▪ allows re-treatment
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment→ SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris ▪ mechanical removal of old damaged infillings ▪ resetting of tesserae with lime-based mortar ▪ infilling of small lacunae and/or edging repairs ▪ short-term reburial → SEE SPECIFIC PROCEDURE (11)
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: ○ Data Form 1 - Identification ○ Data Form 2 - Previous Interventions ○ Data Form 3 - Condition Assessment ○ Data Form 4 - Intervention Planning ○ Data Form 5 - Current Interventions ○ Archiving Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel, and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ waterproof gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 6 months until complete stabilization is carried out ▪ additional localized mortar repairs where/when needed, with graphic documentation of Current Interventions

STABILIZATION OF TESSELLATUM FOR LONG-TERM REBURIAL

Stabilization of tessellatum layer with mortar, sufficient to prepare the mosaic for long-term reburial (more than 5 years).

BENEFIT	▪ long-term durability ▪ stops or limits loss of original material ▪ reduces vegetation growth ▪ allows re-treatment
LIMITATION	Labor intensive
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris ▪ mechanical removal of old damaged infillings ▪ resetting of tesserae with lime-based mortar ▪ consolidation of voids between detached preparatory layers, only in case of bulging, by grouting with hydraulic mortars ▪ infilling of small lacunae and/or edging repairs ▪ long-term reburial → SEE SPECIFIC PROCEDURE (12)
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: ○ Data Form 1 - Identification ○ Data Form 2 - Previous Interventions ○ Data Form 3 - Condition Assessment ○ Data Form 4 - Intervention Planning ○ Data Form 5 - Current Interventions ○ Archiving Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel, and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ waterproof gloves when handling lime
MAINTENANCE CYCLE	▪ inspection of the reburial every 12 months → SEE SPECIFIC PROCEDURE (14)

4

TREATMENT OF PREPARATORY LAYERS FOR REBURIAL

Treatment of preparatory layers in order to prepare the original materials to be reburied.

BENEFIT	▪ quick to implement ▪ long-term durability ▪ stops or limits loss of original material ▪ reduces vegetation growth ▪ allows re-treatment
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of the loose deposits of soil and debris ▪ surface cleaning with water and brushes, if possible ▪ possible long-term reburial → SEE SPECIFIC PROCEDURE (12)
DOCUMENTATION PROCEDURE	▪ photographic documentation after cleaning, before reburial
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ long-term reburial → SEE SPECIFIC PROCEDURE (12)
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dust mask
MAINTENANCE CYCLE	▪ inspection of reburial every 12 months → SEE SPECIFIC PROCEDURE (14)

TREATMENT OF PREPARATORY LAYERS FOR PRESENTATION

Stabilization of the preparatory layers with mortar, in order to prepare the original materials to be presented to visitors.

BENEFIT	▪ long-term durability ▪ stops or limits loss of original material ▪ reduces vegetation growth ▪ allows re-treatment
LIMITATION	Labor intensive
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris ▪ surface cleaning with water and brushes ▪ mechanical removal of non-functional repair mortars ▪ stabilization of the original materials that are detached with lime-based mortar ▪ stabilization in depth by grouting voids between preparatory layers with hydraulic mortar ▪ infilling of lacunae and cracks, and edging repairs with lime-based mortar
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: 　○ Conservation Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months ▪ localized mortar repairs, if necessary, with graphic documentation of Current Interventions

TREATMENT OF FLOORS WITHOUT MOSAICS OR PREPARATORY LAYERS FOR PRESENTATION

Treatment of floor surfaces without pavement remains to be presented to visitors.

BENEFIT	▪ quick to implement ▪ reduces vegetation growth ▪ allows quick removal ▪ allows re-treatment
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician and worker
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris and/or removal of old repair mortar fills ▪ level grading of surface *If necessary:* ▪ installation of reburial fill containment system ▪ placement of a geotextile on the surface ▪ one layer, minimum 5 cm, of gravel over the geotextile
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ gravel ▪ geotextile ▪ containment system: wooden planks or mortar barriers
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dust mask ▪ work gloves
MAINTENANCE CYCLE	▪ reburied area inspection every 12 months → SEE SPECIFIC PROCEDURE (24) ▪ non-reburied area inspection every 6 months → SEE SPECIFIC PROCEDURE (14)

STABILIZATION OF TESSELLATUM FOR PRESENTATION

Surface cleaning and stabilization of tessellatum and preparatory layers with mortar (to satisfy both functional and aesthetic requirements), in order to present the mosaic to the public.

BENEFIT	▪ long-term durability ▪ stops or limits loss of original material ▪ reduces vegetation growth ▪ allows re-treatment
LIMITATION	Labor intensive
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ cleaning of the surface with water and brushes ▪ mechanical removal of micro-organisms ▪ mechanical removal of old damaged infillings ▪ resetting of tesserae with lime-based mortar ▪ filling interstices between tesserae with lime-based mortar ▪ stabilization in-depth by grouting of voids between detached preparatory layers with hydraulic lime-based mortar ▪ infilling of lacunae and/or edging repairs with lime-based mortar
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: o Data Form 1 - Identification o Data Form 2 - Previous Interventions o Data Form 3 - Condition Assessment o Data Form 4 - Intervention Planning o Data Form 5 - Current interventions o Archiving Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ waterproof gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months using Data Form 3 - Condition Assessment ▪ localized lime mortar repairs, if necessary, with graphic documentation of Current Interventions

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IN SITU TREATMENT OF MOSAICS RE-LAID ON REINFORCED CONCRETE

Localized treatment of critical condition areas of the tessellatum where tesserae are detached due to the oxidation and expansion of the steel rebar of the support panels.

BENEFIT	▪ limits loss of original material
LIMITATION	▪ only a partial intervention ▪ difficult to re-treat
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ dry-cleaning of loose deposits of soil and debris ▪ localized cleaning of the surface with water and brushes ▪ facing of the area to be treated with gauze or canvas and vinyl resin adhesive ▪ cutting of the facing and temporary removal of the detached area of the tessellatum located above the corroded rebar ▪ cutting and removal of the exposed rebar, and cleaning of the area to remove debris ▪ filling of the voids left by the removed rebar and concrete debris with lime and white cement-based mortar, inserting a new fiberglass bar, if necessary ▪ re-setting the tessellatum area on a new bed of lime and white cement-based mortar ▪ removal of the facing and adhesive with hot water or steam ▪ filling the interstices, cracks and lacunae with hydraulic mortar
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: o Data Form 1 - Identification o Data Form 2 - Previous Interventions o Data Form 3 - Condition Assessment o Data Form 4 - Intervention Planning o Data Form 5 - Current interventions o Archiving Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ vinyl resin ▪ cotton gauze ▪ mini-drill with disk blades to cut iron ▪ lime putty ▪ white cement ▪ sand, gravel and crushed ceramic/brick ▪ fiberglass bars, if needed
SAFETY PRECAUTION	▪ rubber gloves when handling lime and cement ▪ goggles when using mini-drill
MAINTENANCE CYCLE	▪ inspection every 12 months using Form 3 - Condition Assessment

MOSAIC MAINTENANCE

Periodic and regularly scheduled inspection and maintenance of the tessellatum and preparatory layers to insure their good, stable condition.

BENEFIT	▪ long-term durability ▪ quick to implement ▪ stops or limits loss of original material ▪ limits vegetation growth ▪ allows re-treatment
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris ▪ localized cleaning of the surface with water and brushes ▪ mechanical removal of micro-organisms from surface ▪ mechanical removal of the old damaged mortar infillings ▪ localized resetting of tesserae with lime-based mortar ▪ filling of interstices between tesserae with lime-based mortar ▪ stabilization in-depth by grouting of voids between detached preparatory layers with hydraulic lime-based mortars ▪ in-filling of new lacunae and/or edging repairs with lime-based mortars
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: ○ Data Form 3 - Condition Assessment (update) ○ Data Form 5 - Current interventions (update) ○ Archiving Data Form ▪ graphic documentation of Condition Assessment (update) and Current Interventions (update)
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ waterproof gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months using Data Form 3 - Condition Assessment ▪ localized lime mortar repairs, if necessary, with graphic documentation of Current Interventions

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SHORT-TERM REBURIAL

Temporary protection (less than 5 years) of ancient pavements by covering with fill material; to be carried out after the partial or complete stabilization of the original remains.

BENEFIT	▪ quick to implement ▪ reduces vegetation growth ▪ allows quick removal ▪ easily maintained
LIMITATION	Short-term durability
APPROPRIATE PERSONNEL	Conservation technician and worker
INTERVENTION PROCEDURE	*General procedure:* ▪ construction of the reburial fill material containment system ▪ one layer, minimum 10 cm, of sieved sand (0-2 mm), directly in contact with the original materials ▪ placement of a separation membrane, such as a geotextile or plastic netting, on top of the sand ▪ second layer, minimum 5 cm, of gravel (4-15 mm) on top of membrane
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: Data Form 5 - Current Interventions ▪ graphic documentation: Current Interventions Map
MATERIALS	▪ sand ▪ gravel ▪ geotextile or plastic netting ▪ containment system: wooden planks or mortar barriers
SAFETY PRECAUTION	▪ dust mask ▪ work gloves
MAINTENANCE CYCLE	▪ inspection every 6 months → SEE SPECIFIC PROCEDURE (14)

LONG-TERM REBURIAL

Long-term protection (more than 5 years) of ancient pavements by covering with fill material; to be carried out after the partial or complete stabilization of the original remains.

BENEFIT	▪ long-term durability ▪ highly effective ▪ reduces vegetation growth ▪ easily maintained ▪ allows removal
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician and worker
INTERVENTION PROCEDURE	*General procedure* ▪ construction of reburial fill material containment system ▪ one layer, minimum 20 cm, of sieved sand (0-2 mm), directly in contact with the original materials ▪ placement of a separation membrane, such as geotextile or plastic netting, above sand layer ▪ second layer, minimum 10 cm, of gravel (4-15 mm) on top of membrane
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: Data Form 5 - Current Interventions
MATERIALS	▪ sand ▪ gravel ▪ geotextile or plastic netting ▪ containment system: wooden planks or mortar barriers
SAFETY PRECAUTION	▪ dust mask ▪ work gloves
MAINTENANCE CYCLE	▪ inspection every 12 months → SEE SPECIFIC PROCEDURE (14)

TESSELLATUM PROTECTION WITH MORTAR COVERING

Protection of ancient pavements by covering with different layers of mortars; to be carried out after complete stabilization of the tessellatum.

BENEFIT	▪ long-term durability ▪ highly effective ▪ easily maintained ▪ reduces vegetation growth ▪ allows removal ▪ allows re-treatment
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ placement of a separation membrane, such as a thin geotextile or Japanese paper, on the tessellatum surface to be protected ▪ first layer, about 2 cm, of lime putty mortar (binder-poor) above the separation membrane ▪ second layer, about 2 cm, of hydraulic mortar on top of the first mortar layer
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: Data Form 5 - Current Interventions
MATERIALS	▪ thin geotextile or Japanese paper ▪ sand ▪ gravel ▪ lime putty ▪ cement or hydraulic lime
SAFETY PRECAUTION	▪ waterproof gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months

REBURIAL MAINTENANCE

Periodic and regularly scheduled inspection and maintenance of reburials to insure their good, stable condition and continued effectiveness.

BENEFIT	▪ quick to implement ▪ highly effective ▪ reduces vegetation growth
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician or possibly trained worker
INTERVENTION PROCEDURE	▪ mechanical removal of weeds and roots, if roots have not passed through a separation membrane nor into the mosaic ▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) , if roots have passed through a separation membrane or into the tessellatum ▪ replace lost fill materials as needed to restore their original thickness ▪ if reburial fill material has been lost because of damage or deterioration of the containment system, repair or replace it and replace lost fill materials
DOCUMENTATION PROCEDURE	▪ if it is a mosaic reburial, document the interventions using Data Form 5 - Current Interventions ▪ if it is reburial of preparatory layers, record the date of inspection ▪ if it is a treatment of floors without archaeological remains, no documentation is necessary
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ sand ▪ gravel ▪ containment system: wooden planks or mortar barriers
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ work gloves
MAINTENANCE CYCLE	Complete procedure annually; or every 6 months if needed (if weather is severe, vegetation grows rapidly, etc.)

CONSERVATION TREATMENT OF *COCCIOPESTO* (CRUSHED CERAMIC MORTAR)

Stabilization of ancient *cocciopesto* pavements and wall surfaces.

BENEFIT	▪ long-term durability
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ mechanical weed and root removal with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ dry-cleaning of loose deposits of soil and debris ▪ surface cleaning with water and brushes ▪ removal of non-functional repair mortars ▪ stabilization in-depth by grouting of voids between detached preparatory layers with hydraulic mortars ▪ in-filling of lacunae and edging repairs with lime mortars
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: o Conservation Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty ▪ hydraulic lime ▪ sand, gravel and crushed ceramic/brick
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months ▪ localized lime mortar repairs, if necessary, documented using Current Interventions Map

CONSERVATION TREATMENT OF STONE SLAB PAVEMENTS

Stabilization and protection of ancient stone slab pavements.

BENEFIT	▪ reduces weed growth between the stone slabs
LIMITATION	None
APPROPRIATE PERSONNEL	Trained Worker
INTERVENTION PROCEDURE	▪ mechanical removal of weeds and roots with or without aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ removal of loose deposits of soil and debris from between the slabs ▪ possible filling of the deeper part of gaps with mortar ▪ filling of gaps between slabs with fine gravel (2-5 mm)
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: o Conservation Data Form
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ lime putty and/or hydraulic lime ▪ sand and/or gravel
SAFETY PRECAUTION	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ rubber gloves if handling lime ▪ work gloves
MAINTENANCE CYCLE	▪ inspection every 12 months

CONSERVATION TREATMENT OF WALL PLASTERS

Stabilization of ancient wall plasters.

BENEFIT	▪ long-term durability
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ dry-cleaning of loose deposits of soil and debris ▪ surface cleaning with water and brush if necessary ▪ removal of non-functional repair mortars ▪ stabilization in-depth by grouting of voids between detached preparatory layers with hydraulic lime mortar ▪ lacunae in-filling and edging repairs with lime mortar
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: o Conservation Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ lime putty ▪ hydraulic lime ▪ sand, gravel and crushed ceramic/brick
SAFETY PRECAUTION	▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months ▪ localized lime mortar repairs, when necessary, documented using Current Interventions Map

CONSERVATION TREATMENT OF WALLS

Stabilization and protection of ancient masonry walls.

BENEFIT	▪ long-term durability ▪ reduces weed and root growth inside walls ▪ reduces infiltration of water inside walls
LIMITATION	None
APPROPRIATE PERSONNEL	Specialized mason and worker
INTERVENTION PROCEDURE	▪ mechanical removal of weeds and roots ▪ dry-cleaning of loose deposits of soil and debris ▪ removal of non-functional repair mortars ▪ lacunae in-filling with lime/white cement mortar and appropriate stones or bricks ▪ pointing with lime/white cement mortar as needed between stones or bricks ▪ addition of lime/white cement mortar and stones as needed on wall tops to prevent water pooling
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ written documentation: o Conservation Data Form ▪ graphic documentation of Previous Interventions, Condition Assessment and Current Interventions
MATERIALS	▪ lime putty ▪ hydraulic lime and/or white cement ▪ sand, gravel and crushed ceramic/brick
SAFETY PRECAUTION	▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 2 years ▪ localized lime/cement mortar repairs, if necessary

CONSERVATION TREATMENT OF STONE

Surface cleaning and stabilization of carved stone materials.

BENEFIT	▪ reduces surface deterioration and loss of material ▪ allows re-treatment ▪ reduces growth of micro-organisms
LIMITATION	Short duration of cleaning treatment results
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ dry-cleaning of loose deposits of soil and debris ▪ surface cleaning with water and brushes ▪ mechanical removal of micro-organisms ▪ infilling of fractures and small areas of loss with lime mortars
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after
MATERIALS	▪ brushes with synthetic bristles of different hardness ▪ lime putty ▪ sand and gravel
SAFETY PRECAUTION	▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months

HERBICIDE TREATMENT

Elimination of weed and root growth through the application of a chemical herbicide product to be carried out as preparation for other conservation treatments.

BENEFIT	▪ quick to implement
LIMITATION	▪ short duration of treatment results ▪ toxicity of material ▪ not effective for all types of plants
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ product is generally diluted in water ▪ application by sprayer on leaves of the plant; the treatment will have better results when the plant is in full growth, and if done early in the morning
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after the intervention (optional)
MATERIALS	▪ broad spectrum herbicide ▪ pump sprayer with nozzle and extension
SAFETY PRECAUTION	▪ gas mask ▪ Tyvek protective overalls with hood ▪ rubber gloves
MAINTENANCE CYCLE	▪ treatment is generally carried out before an initial conservation treatment or to prepare for specific operations, rather than as part of a maintenance cycle

CHANNEL DRAINAGE

Removal of rainwater from floor surfaces such as mosaics or other archaeological remains.

BENEFIT	▪ reduces rainwater pooling and the deterioration it causes ▪ easy to maintain
LIMITATION	None
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ determine the areas of rainwater pooling ▪ determine the location of potential water outflow from the pooling area ▪ create a sloped grade for the channel to carry water to that location
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after
MATERIALS	▪ lime putty ▪ sand and gravel
SAFETY PRECAUTION	▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months

PIT DRAINAGE

Removal of rainwater from floor surfaces such as mosaics, and other archaeological remains.

BENEFIT	▪ reduces rain water pooling and the deterioration it causes ▪ easily maintained
LIMITATION	Pit may cause drainage problems at the foundation level
APPROPRIATE PERSONNEL	Conservation technician
INTERVENTION PROCEDURE	▪ determine the areas of water pooling ▪ determine the best location for the pit (avoiding original surfaces) to prevent pooling ▪ excavate the pit ▪ cover the walls of the pit with geotextile ▪ install drainage tube at the center of the pit ▪ fill the area around the drainage tube with gravel ▪ insert an aluminum filter in the drainage tube ▪ fill the drainage tube with gravel ▪ create a sloped grade with mortar infilling around the pit so that water flows to it
DOCUMENTATION PROCEDURE	▪ photographic documentation before and after ▪ archaeologist documents the excavation and all material removed from the pit
MATERIALS	▪ lime putty ▪ sand and gravel ▪ geotextile ▪ drainage tube ▪ aluminum filter
SAFETY PRECAUTION	▪ rubber gloves when handling lime
MAINTENANCE CYCLE	▪ inspection every 12 months

CONSTRUCTION OF FENCES AND ACCESS BARRIERS

Limit public access to a building, or part of it, for purposes of visitor safety or protection of mosaics and archaeological remains from visitors, local residents and animals.

BENEFIT	▪ quick to implement ▪ limits damage due to visitors or animals walking on pavements and archaeological remains ▪ limits risk of injury to the public ▪ reversible ▪ long-term durability
LIMITATION	▪ partial temporary protection ▪ aesthetic impact ▪ initial cost of materials and installation
APPROPRIATE PERSONNEL	Trained workers + 1 conservation technician for documentation
INTERVENTION PROCEDURE	▪ mechanical removal of vegetation with or without the aid of herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ identify the areas for restriction of access ▪ estimate the fence length and number of access barriers ▪ install the fence and access barrier supports, without causing damage to the archaeological remains
DOCUMENTATION PROCEDURE	▪ graphic documentation: ○ draw the line of the fence, the location of the posts and the date of construction on the building plan; ○ draw the location of the access barriers and the date of installation on the building plan
MATERIALS	▪ herbicide treatment → SEE SPECIFIC PROCEDURE (20) ▪ fence or access barrier posts made of durable material ▪ metal fencing material/wire and barriers
SAFETY PRECAUTION	▪ herbicide treatment→ SEE SPECIFIC PROCEDURE (20)
MAINTENANCE CYCLE	▪ inspection every 6 months ▪ replacement of damaged parts ▪ repeat vegetation removal if necessary

SITE MAINTENANCE - VEGETATION REMOVAL

Vegetation removal around archaeological remains, where conservation interventions will occur or for general site maintenance.

BENEFIT	▪ quick to implement ▪ reduces vegetation growth and the deterioration it causes
LIMITATION	▪ short duration of intervention results
APPROPRIATE PERSONNEL	Trained workers
INTERVENTION PROCEDURE	▪ remove as much as possible all parts of weeds and plants, including the roots, from the site
DOCUMENTATION PROCEDURE	No documentation
MATERIALS	▪ garden shears ▪ manual saws ▪ hoes ▪ scythe
SAFETY PRECAUTION	▪ dust mask ▪ work gloves ▪ goggles
MAINTENANCE CYCLE	Seasonal

APPENDIX K

Design Prototypes for Access Barriers, Walkways, and Shelters for Maison de la Chasse

MOSAIKON INITIATIVE

MOSAIKON is a collaborative regional initiative dedicated to improving the conservation, presentation and the management of mosaics in the southern and eastern Mediterranean region. Through a series of interrelated activities, MOSAIKON aims to build capacity, develop replicable models of best practice, strengthen the network of conservation professionals, and promote the dissemination and exchange of information regarding the conservation and management of archaeological mosaics, both those in situ and those in museum and storage.

One of these activities is the **Bulla Regia Model Conservation Project**.

BULLA REGIA MODEL CONSERVATION PROJECT

At the ancient city of BULLA REGIA, Tunisia, a Roman and Byzantine-era archaeological site, the Getty Conservation Institute in collaboration with the World Monuments Fund and the Institut National du Patrimoine, is leading a project to conserve an entire archaeological structure (*Maison de la Chasse*) along with its architectural decoration, while developing a conservation and maintenance plan for the site's nearly four hundred exposed mosaics excavated over the past century.

Through these model planning and conservation treatment activities, this project aims to disseminate the results in order to improve the state of conservation of archaeological mosaics at similar sites in Tunisia and throughout the region.

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Thomas Roby, Senior Project Specialist
Leslie Friedman, Project Specialist
Sara Marandola, Graduate Intern (2016-2017)
Nityaa Iyer, Graduate Intern (2015-2016)

CONSULTANTS

Livia Alberti, Conservator
Ermanno Carbonara, Conservator
Akhet s.r.l., topographic site plan, GIS, 3D reconstruction of Maison de la Chasse

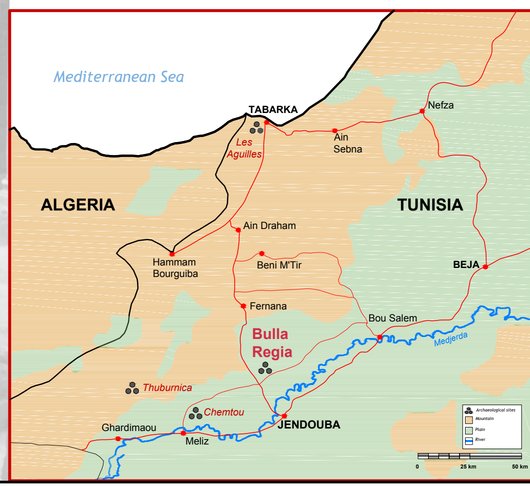
PROJECT PARTNER

Institut National du Patrimoine
Moheddine Chaouali, Site director
Hamida Rhouma, Architect

FORMER PROJECT PARTNER

World Monuments Fund

The **Republic of Tunisia** is the northernmost country in Africa, covering 165,000 square kilometres (64,000 square miles). It is situated on the Mediterranean coast of North Africa and bordered by Algeria on the west and southwest, and Libya on the south east. It lies between latitudes 30° and 38° N, and longitudes 7° and 12° E.



DRAWING INDEX

Date: 25 August 2017
Scale: As Noted
Sheet No.: 1.1

Issuance: Design prototypes for the protection and presentation of Maison de la Chasse
Drawn: S. Marandola
Checked: T.Roby, L. Friedman, C. McCoy, K. Wong, S. Lardinois.

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Building: MAISON DE LA CHASSE
Sheet Title: GEOGRAPHICAL CONTEXT

BULLA REGIA MODEL CONSERVATION PROJECT

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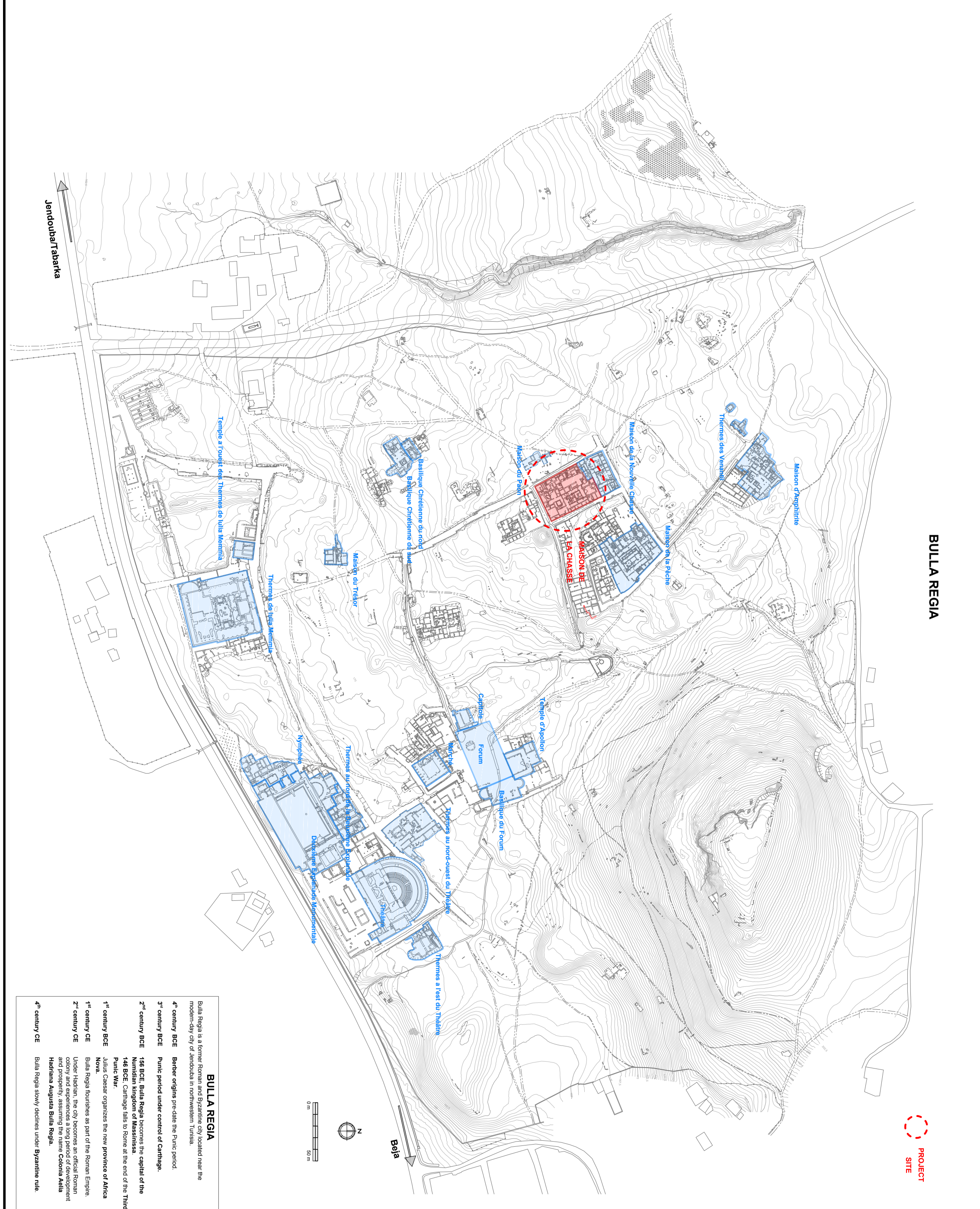

BULLA REGIA MODEL CONSERVATION PROJECT	**Building:** MAISON DE LA CHASSE	**Issuance:** Design prototypes for the protection and presentation of Maison de la Chasse		**Date:** 25 August 2017
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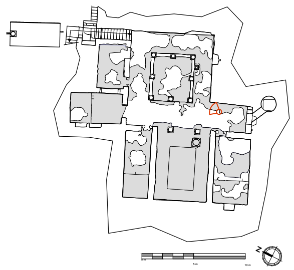
MOSAIKON / Institut National du Patrimoine / The Getty Conservation Institute / World Monuments Fund	**Sheet Title:** TOPOGRAPHIC SITE PLAN	The Getty Conservation Institute PROJECT TEAM MEMBERS Thomas Roby, Senior Project Specialist Leslie Friedman, Project Specialist Sara Marandola, Graduate Intern (2016-2017) Nityaa Iyer, Graduate Intern (2015-2016)	CONSULTANTS Livia Alberti, Conservator Ermanno Carbonara, Conservator Akhet s.r.l.	**Sheet No.:** 1.2

Ⓒ MAISON DE LA CHASSE, 3D RECONSTRUCTION



Ⓑ MAISON DE LA CHASSE, PLAN OF THE UNDERGROUND LEVEL (see D, Photographic view of the portico of the underground level)

Ⓐ BULLA REGIA, TOPOGRAPHIC SITE PLAN

The Maison de la Chasse is named after a hunting scene that adorned one of its pavements beneath the western portico of underground peristyle.

Ⓓ MAISON DE LA CHASSE, PHOTOGRAPHIC VIEW OF THE PORTICO OF THE UNDERGROUND LEVEL (see B, Plan of the underground level)

KEY

- Documented mosaics *(See E)*
- Project site *(See A)*
- Underground level area *(See E)*
- Photographic view *(See B and D)*
- Site entrance / exit

Ⓔ MAISON DE LA CHASSE, PLAN OF THE GROUND LEVEL

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Building: MAISON DE LA CHASSE

Sheet Title: THE 'MAISON DE LA CHASSE' EXISTING CONDITIONS

BULLA REGIA MODEL CONSERVATION PROJECT

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PROTECTION MEASURES
GROUND LEVEL

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Scale: 1:75

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Building: MAISON DE LA CHASSE

Sheet Title: PROTECTION MEASURES GROUND LEVEL

BULLA REGIA MODEL CONSERVATION PROJECT

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Institut National du Patrimoine
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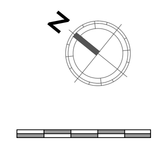
The Getty Conservation Institute

PROTECTION MEASURES
UNDERGROUND LEVEL

KEY

- Accessible area
- Visible mosaic
- Reburied / protected mosaic
- A — Shelter *(see sheets 4.1 - 4.3)*
- B — Walkway with railing *(see sheets 2.1 - 2.8)*
- C — Access barrier *(see sheets 3.1 - 3.2)*
- Site entrance / exit
- Masonry of irregular stones and mortar
- Stone block
- Room / space (S01 - S08)



BULLA REGIA MODEL CONSERVATION PROJECT

MOSAIKON

Institut National du Patrimoine

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World Monuments Fund

Building: MAISON DE LA CHASSE

Sheet Title: PROTECTION MEASURES UNDERGROUND LEVEL

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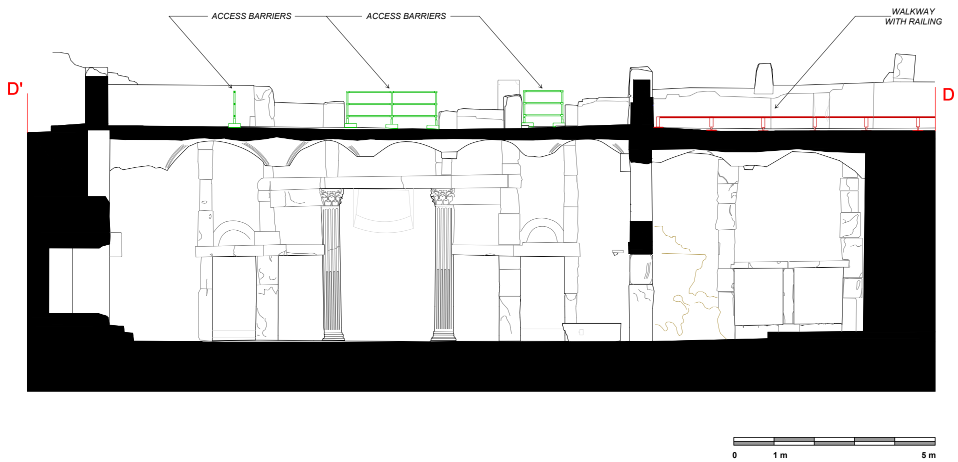
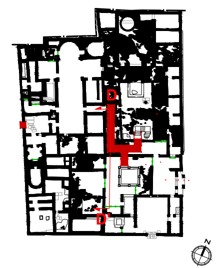
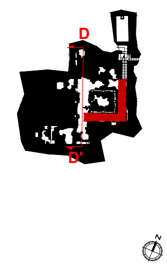


SECTION DD'
SCALE 1:50



GROUND LEVEL
NOT TO SCALE



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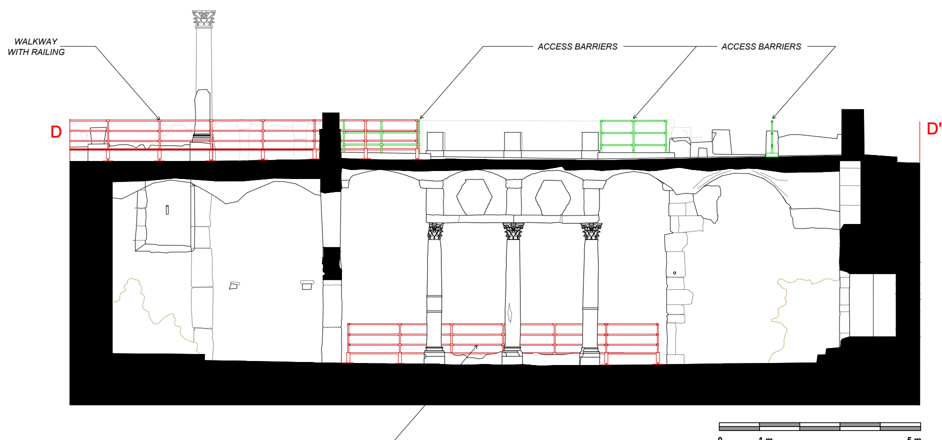

SECTION FF'
SCALE 1:50

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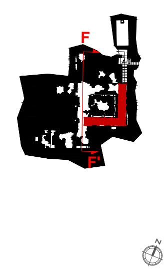
NOT TO SCALE



UNDERGROUND LEVEL
NOT TO SCALE

BULLA REGIA MODEL CONSERVATION PROJECT

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Building:
MAISON DE LA CHASSE

Sheet Title:
PROTECTION MEASURES
BUILDING SECTION DD' and FF'

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Scale:
1:50

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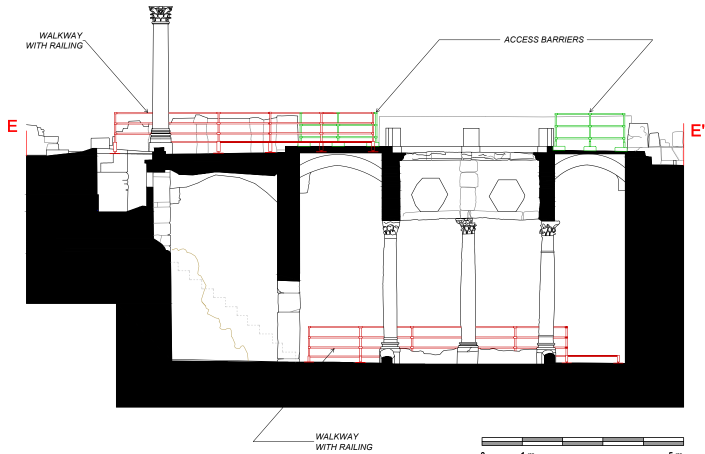
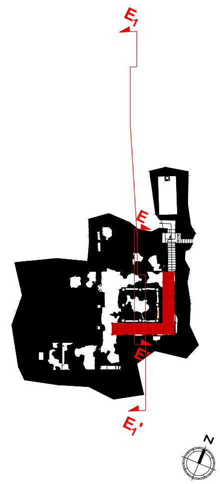
1.6

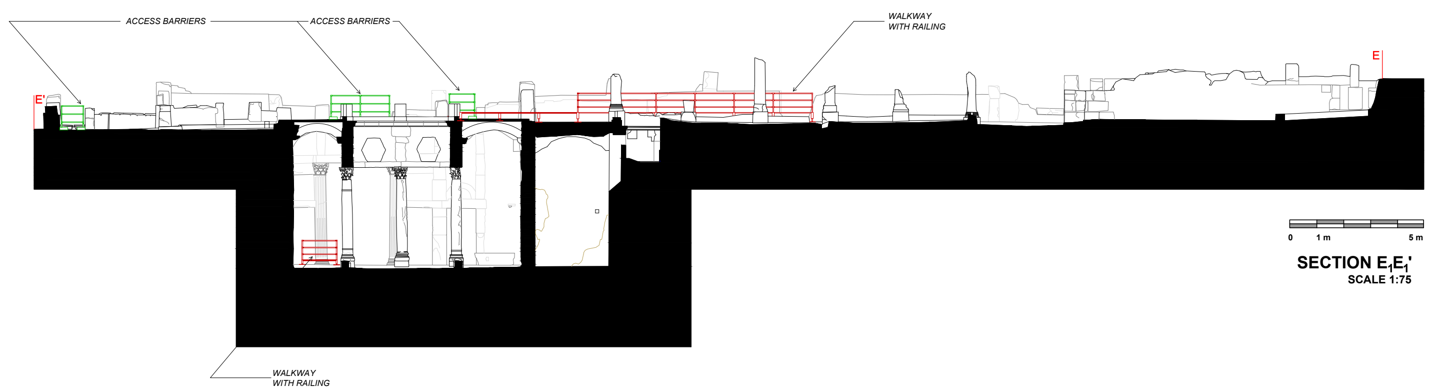


SECTION EE'
SCALE 1:50



UNDERGROUND LEVEL
NOT TO SCALE

GROUND LEVEL
NOT TO SCALE



SECTION E_1E_1'
SCALE 1:75

Date: 25 August 2017

Scale: As Noted

Sheet No.: **1.7**

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Building: **MAISON DE LA CHASSE**

Sheet Title: **PROTECTION MEASURES BUILDING SECTIONS EE' - E_1E_1'**

BULLA REGIA MODEL CONSERVATION PROJECT

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GROUND LEVEL PLAN

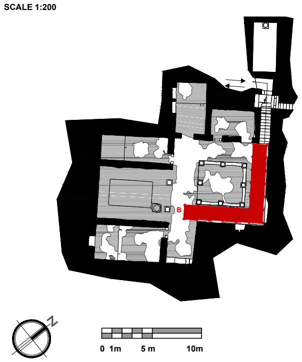
SCALE 1:200

LEGEND

Visible mosaic | Shelter (A) | Walkway with railing (B) | Access barrier (C) | Site entrance / exit

UNDERGROUND LEVEL PLAN

SCALE 1:200

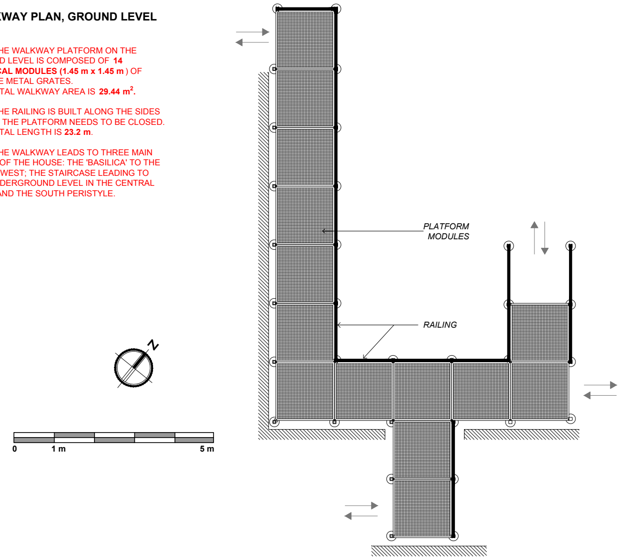


WALKWAY PLAN, GROUND LEVEL

1. THE WALKWAY PLATFORM ON THE GROUND LEVEL IS COMPOSED OF **14 IDENTICAL MODULES (1.45 m x 1.45 m**) OF SQUARE METAL GRATES.
THE TOTAL WALKWAY AREA IS **29.44 m^2.**

2. THE RAILING IS BUILT ALONG THE SIDES WHERE THE PLATFORM NEEDS TO BE CLOSED.
THE TOTAL LENGTH IS **23.2 m**.

3. THE WALKWAY LEADS TO THREE MAIN AREAS OF THE HOUSE: THE 'BASILICA' TO THE NORTH WEST; THE STAIRCASE LEADING TO THE UNDERGROUND LEVEL IN THE CENTRAL AREA, AND THE SOUTH PERISTYLE.



DESIGN FEATURES

1. THE WALKWAY PLATFORM CONSISTS OF A SERIES OF **SQUARE METAL GRATES** THAT CAN EASILY ACCOMMODATE THE DESIRED LAYOUT OF THE WALKWAY.

2. THE WALKWAY **WILL NOT BE ANCHORED** TO ANY ANCIENT SURFACES. IT WILL BE FREE STANDING, SUPPORTED BY A **MINIMUM NUMBER OF PEDESTALS.**

3. THE PEDESTALS WHICH SUPPORT **THE PLATFORM WILL BE ADJUSTABLE** TO ELIMINATE ANY DIFFERENCES OF LEVEL OR SLOPES, WITHOUT THE ADDITION OF OTHER MATERIALS. WHEN THE PAVEMENT IS DAMAGED OR IRREGULAR, IT IS POSSIBLE TO ADD A WOODEN SHIM TO HELP THE STABILITY OF THE PEDESTALS.

4. **A SAFETY RAILING WILL BE SUPPORTED BY THE SAME PEDESTALS** (ON WHICH THE PLATFORM STANDS). IT CONSISTS OF THREE HORIZONTAL TUBES, THE TOP ONE OF WHICH IS THE HANDRAIL.

5. A WALKWAY WITH ITS OWN RAILING FACILITATES **PROTECTION OF THE MOSAICS** AND GUARANTEES **THE BEST VISIBILITY** OF THE ROOMS OF THE UNDERGROUND LEVEL, ALLOWING VISITORS TO SEE THE ROOMS WITHOUT OTHER PEOPLE OR ADDITIONAL ACCESS BARRIERS.

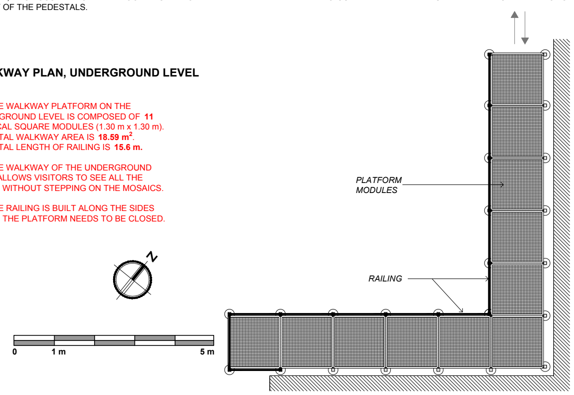
7. THE MATERIAL CHOSEN FOR THE ENTIRE CONSTRUCTION IS METAL (POSSIBLY GALVANIZED IRON, STAINLESS STEEL OR HOT ROLLED MILD STEEL) TO GUARANTEE THE MINIMUM MAINTENANCE IN THE LONG-TERM.

WALKWAY PLAN, UNDERGROUND LEVEL

1. THE WALKWAY PLATFORM ON THE UNDERGROUND LEVEL IS COMPOSED OF **11** IDENTICAL SQUARE MODULES (1.30 m x 1.30 m).
THE TOTAL WALKWAY AREA IS **18.59 m^2**.
THE TOTAL LENGTH OF RAILING IS **15.6 m.**

2. THE WALKWAY OF THE UNDERGROUND LEVEL ALLOWS VISITORS TO SEE ALL THE ROOMS WITHOUT STEPPING ON THE MOSAICS.

3. THE RAILING IS BUILT ALONG THE SIDES WHERE THE PLATFORM NEEDS TO BE CLOSED.



WALKWAY EXAMPLES

Massaciuccoli Romana (Lucca, Italy), Arch. Riccardo Pieraccini, 2013.

Doria Castle in Dolceacqua (Imola, Italy), Arch. LD+SR, 2015.

Massaciuccoli Romana (Lucca, Italy), Arch. Riccardo Pieraccini, 2013.

Date: 25 August 2017

Scale: As noted

Sheet No.: 2.1

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Building: MAISON DE LA CHASSE

Sheet Title: WALKWAY

BULLA REGIA MODEL CONSERVATION PROJECT

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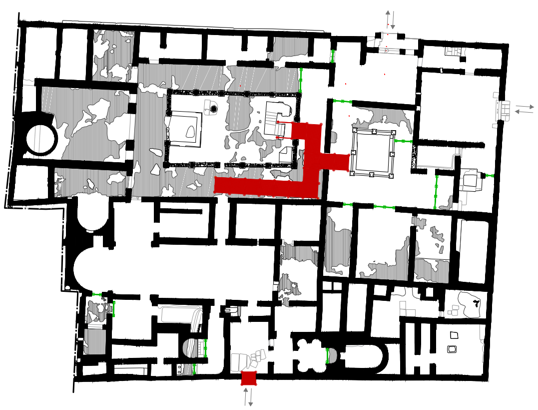
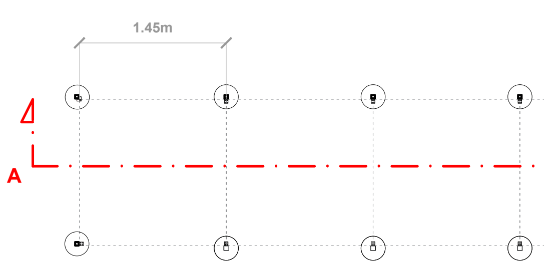
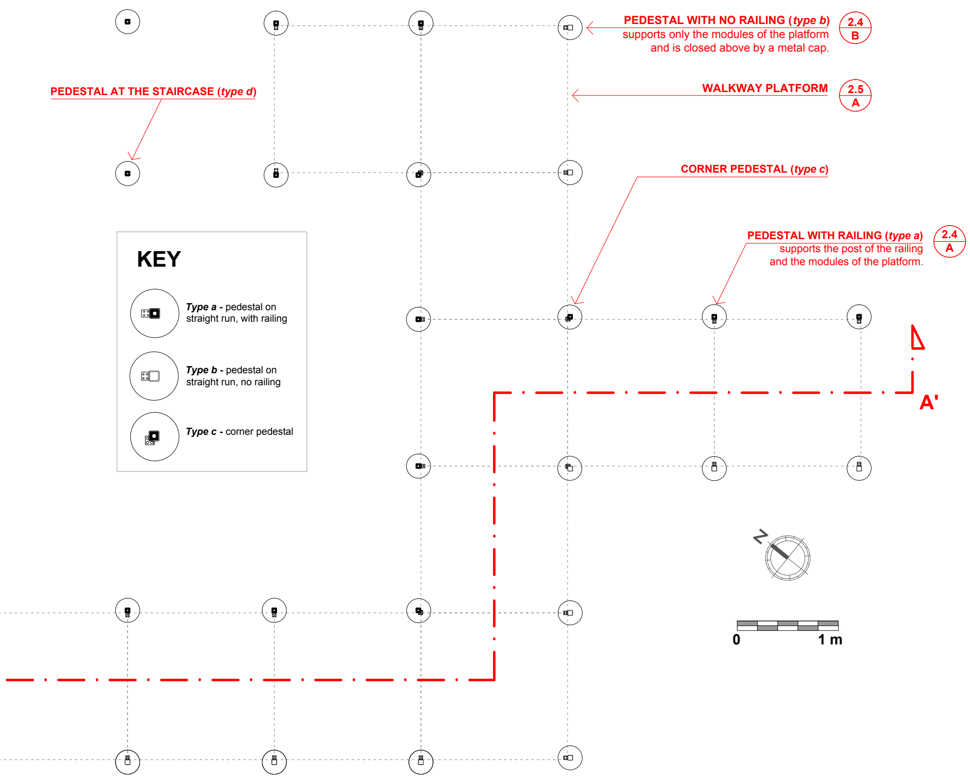


GROUND LEVEL PLAN
SCALE 1:200

0 1m 5 m 10m

KEY

- *Type a* - pedestal on straight run, with railing
- *Type b* - pedestal on straight run, no railing
- *Type c* - corner pedestal

(A) PLAN OF WALKWAY PLATFORM PEDESTALS
GROUND LEVEL

(B) SECTION AA'
(at pedestals only)

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Scale: As Noted

Sheet No.: 2.2

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Building: MAISON DE LA CHASSE

Sheet Title: WALKWAY PLATFORM PEDESTALS GROUND LEVEL

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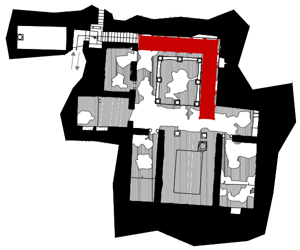
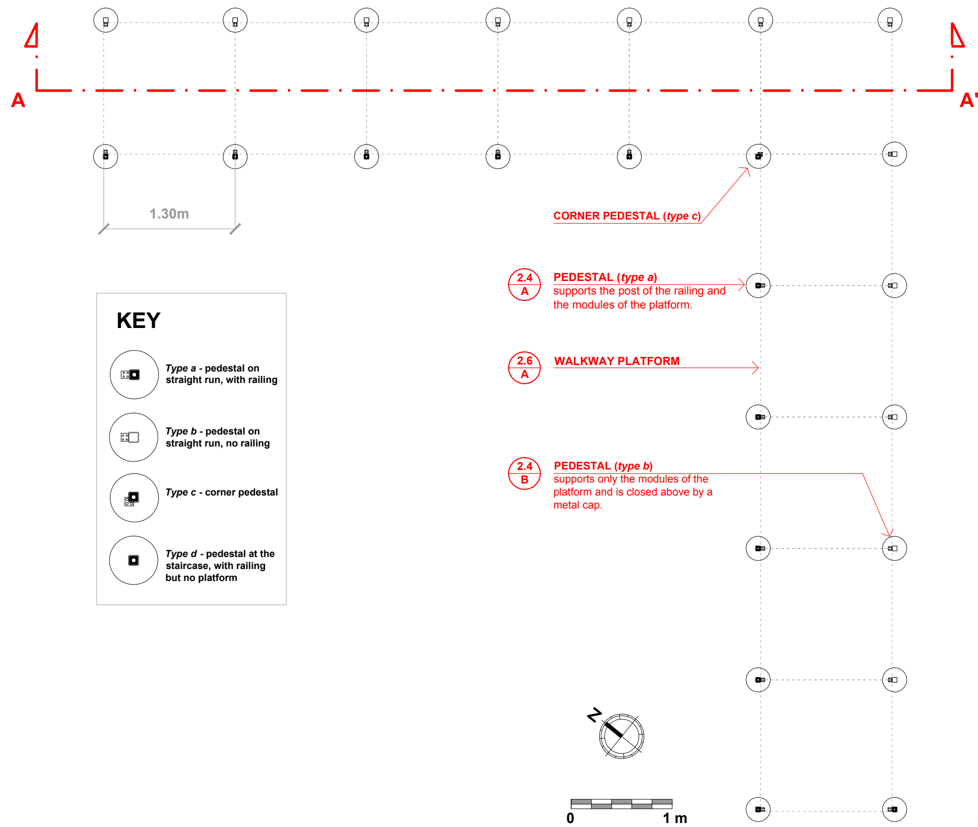
WORLD MONUMENTS FUND



UNDERGROUND LEVEL PLAN
SCALE 1:200

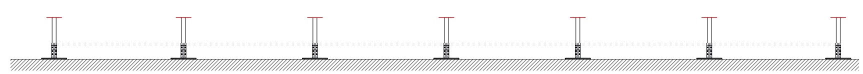
0 1m 5 m 10m



KEY

- *Type a* - pedestal on straight run, with railing
- *Type b* - pedestal on straight run, no railing
- *Type c* - corner pedestal
- *Type d* - pedestal at the staircase, with railing but no platform

A PLAN OF WALKWAY PLATFORM PEDESTALS UNDERGROUND LEVEL



B SECTION AA'
(at pedestals only)

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Sheet Title: WALKWAY PLATFORM PEDESTALS UNDERGROUND LEVEL

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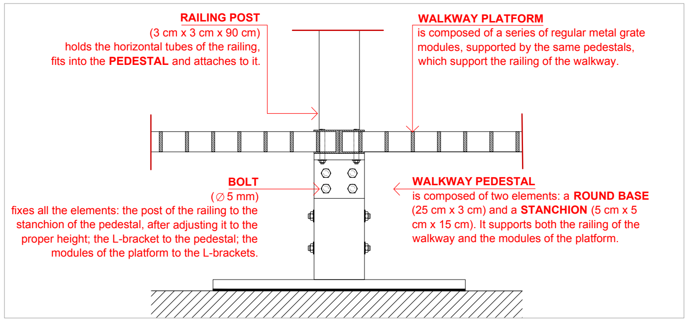
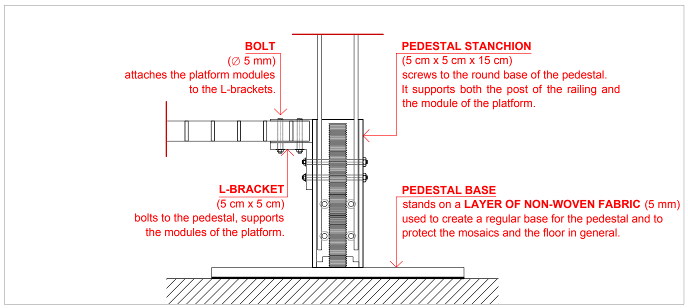
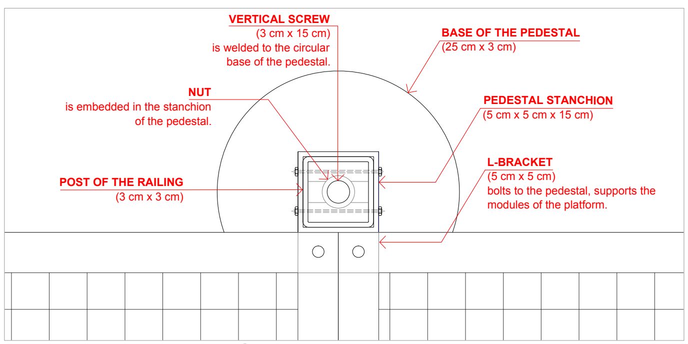


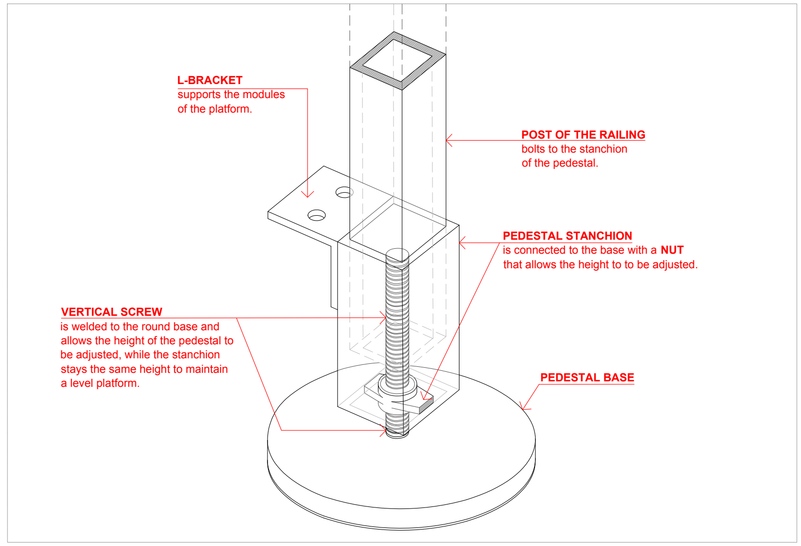
C **PEDESTAL ELEVATION** ***(type a)***
SCALE 1:2



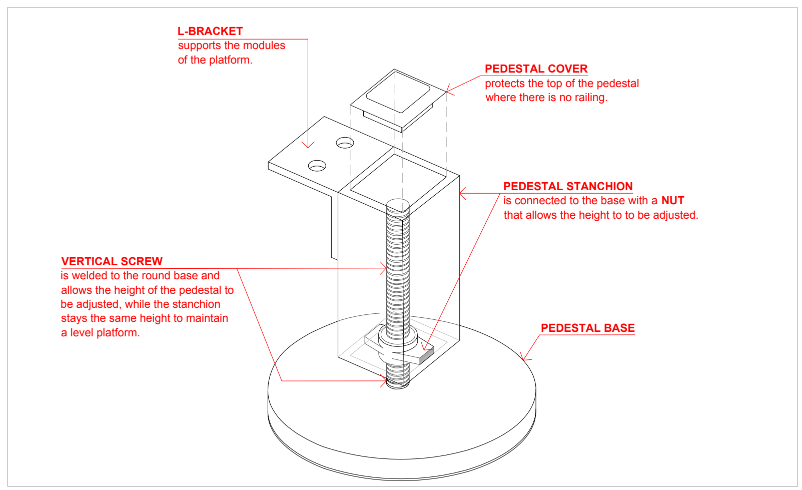
D **PEDESTAL SECTION** ***(type a)***
SCALE 1:2



E **PEDESTAL PLAN** ***(type a)***
SCALE 1:2



A **PEDESTAL AXONOMETRY (*type a*)**



B **PEDESTAL AXONOMETRY (*type b*)**

Date: 25 August 2017

Scale: 1:2

Sheet No.: 2.4

Issuance: Design prototypes for the protection and presentation of Maison de la Chasse

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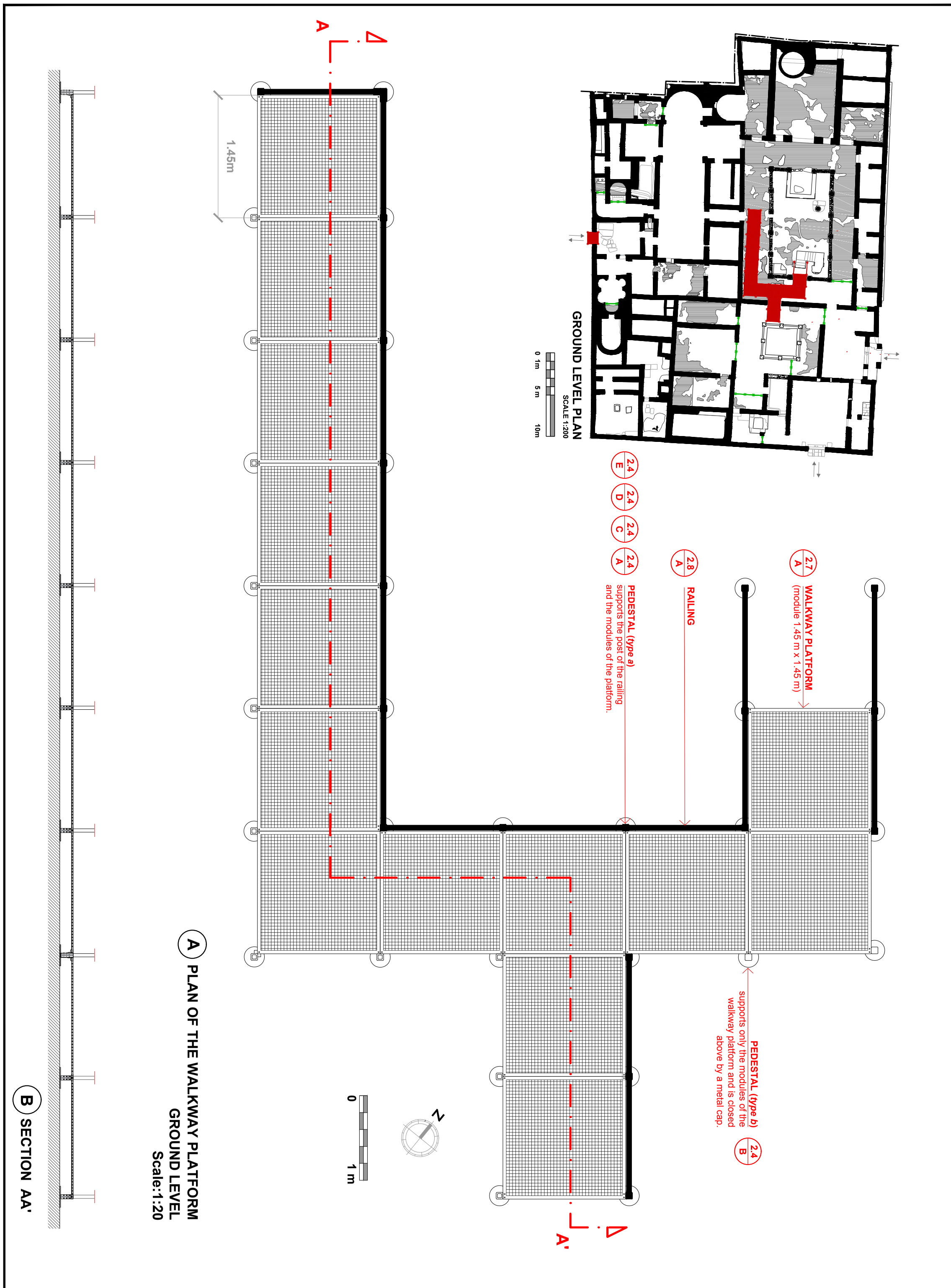
Building: MAISON DE LA CHASSE

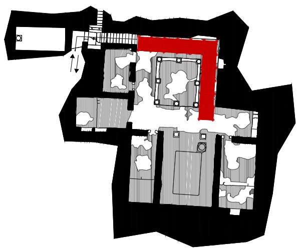
Sheet Title: WALKWAY PEDESTAL (*type a* and *type b*) DETAILS

BULLA REGIA MODEL CONSERVATION PROJECT

MOSAIKON
Institut National du Patrimoine
The Getty Conservation Institute
WORLD MONUMENTS FUND

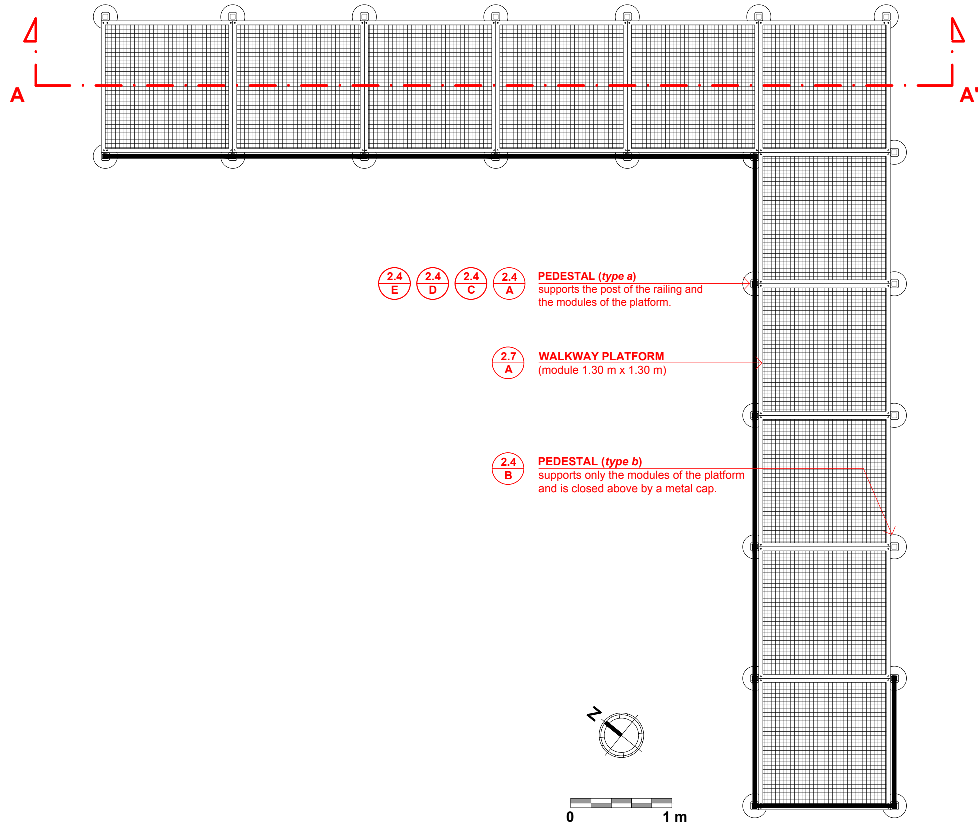


BULLA REGIA MODEL CONSERVATION PROJECT	Building: MAISON DE LA CHASSE	Issuance: Design prototypes for the protection and presentation of Maison de la Chasse Drawn: S. Marandola Checked: T.Roby, L. Friedman, C. McCoy, K. Wong, S. Lardinois.	Date: 25 August 2017 Scale: As Noted
MOSAIKON Institut National du Patrimoine The Getty Conservation Institute WORLD MONUMENTS FUND	Sheet Title: WALKWAY GROUND LEVEL	The Getty Conservation Institute PROJECT TEAM MEMBERS Thomas Roby, Senior Project Specialist Leslie Friedman, Project Specialist Sara Marandola, Graduate Intern (2016-2017) Nityaa Iyer, Graduate Intern (2015-2016) CONSULTANTS Livia Alberti, Conservator Ermanno Carbonara, Conservator Akhet s.r.l.	Sheet No.: **2.5**

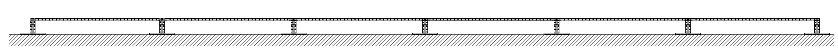


UNDERGROUND LEVEL PLAN

NOT TO SCALE



A PLAN OF THE WALKWAY PLATFORM UNDERGROUND LEVEL



B SECTION AA'

Date: 25 August 2017

Scale: As Noted

Sheet No.: 2.6

Issuance: Design prototypes for the protection and presentation of Maison de la Chasse

Drawn: S. Marandola

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Building: MAISON DE LA CHASSE

Sheet Title: WALKWAY UNDERGROUND LEVEL

BULLA REGIA MODEL CONSERVATION PROJECT

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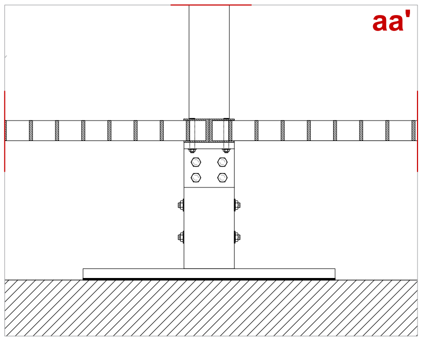
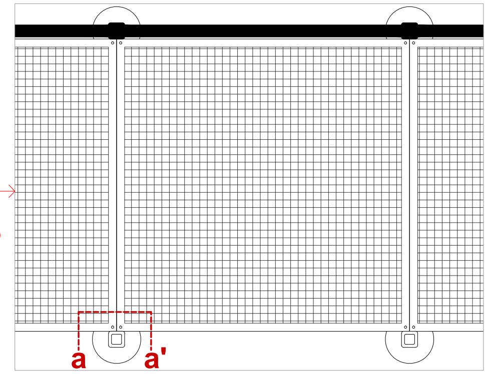
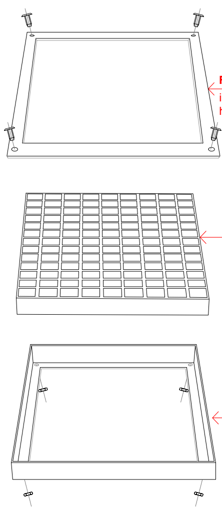


D GRATE SECTION, DETAIL OF THE CONNECTION WITH THE PEDESTAL Scale 1:2

PLATFORM MODULE
is a square grate with 2 cm openings
ground level module (1.45 m x 1.45 m)
underground level module (1.30 m x 1.30 m)



A PLAN OF THE PLATFORM GRATE MODULE Scale 1:10

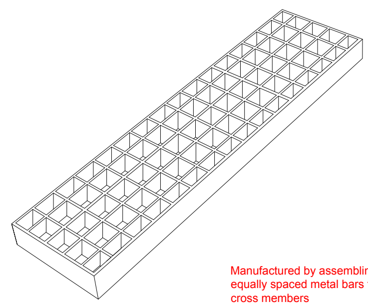


FLAT RECTANGULAR PLATE
in which the bolts are placed to hold the grid to the carrier tray

PLATFORM GRATE MODULE

CARRIER TRAY

E GRATE ASSEMBLY



Manufactured by assembling a series of equally spaced metal bars to connecting cross members

B GRATE AXONOMETRY

C GRATE DETAIL

Date: 25 August 2017
Scale: As Noted
Sheet No.: 2.7

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Building: MAISON DE LA CHASSE

Sheet Title: WALKWAY PLATFORM GRATE DETAILS

BULLA REGIA MODEL CONSERVATION PROJECT

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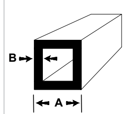
Railings are made of **HOT ROLLED MILD** (low-carbon) **STEEL.**

Other options are galvanized iron and stainless steel (see sheet 2.1).



All the railing elements, horizontal and vertical, are **SQUARE TUBES** with the same dimension.

A = 3 cm (1.25")

B = 0.5 cm (0.1875")

Length of the vertical posts:

90 cm

Length of the horizontal bars:

130 cm underground level

145 cm ground level

B METAL TUBES

All the elements that compose the railing are linked by metal joints of **HOT ROLLED MILD STEEL** bolted to the vertical and horizontal bars.

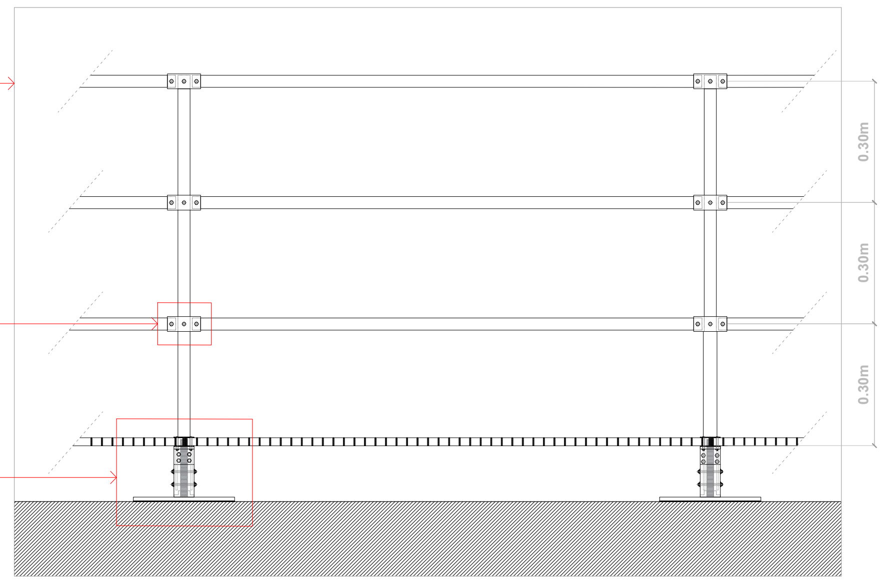
All the joints and tubes, horizontal and vertical, are the same size, in order to simplify the assembly and to reduce the production costs.

C METAL JOINTS

RAILING
is a regular module composed of 5 elements: 2 vertical posts and 3 horizontal bars. All elements have the same section (3 cm x 3 cm).

METAL JOINT
bolts to the bars, connects all the elements.

2.4 D **PEDESTAL BASE**
rests on the ground protected by a layer of non-woven fabric.



A WALKWAY RAILING MODULE, ELEVATION

Scale1:5

Date: 25 August 2017

Scale: 1:5

Sheet No.: 2.8

Issuance: Design prototypes for the protection and presentation of Maison de la Chasse

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Building: MAISON DE LA CHASSE

Sheet Title: WALKWAY PLATFORM RAILING
DETAILS

BULLA REGIA MODEL CONSERVATION PROJECT

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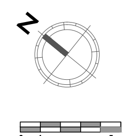
ACCESS BARRIER COMPONENTS

1. TWO ADJUSTABLE CONCRETE PEDESTALS (30 cm x 30 cm x 15 cm)
2. TWO VERTICAL METAL POSTS (∅ 3 cm)
3. THREE HORIZONTAL TUBES (∅ 3 cm)
4. ACCESS BARRIERS ON GROUND LEVEL ONLY, NOT UNDERGROUND

GROUND LEVEL

KEY

- Visible mosaic
- A — Shelter
- B — Walkway with railing
- C — Access barrier
- Site entrance / exit



BULLA REGIA MODEL CONSERVATION PROJECT

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Building: MAISON DE LA CHASSE

Sheet Title: **ACCESS BARRIERS** GROUND LEVEL

Issuance: Design prototypes for the protection and presentation of Maison de la Chasse

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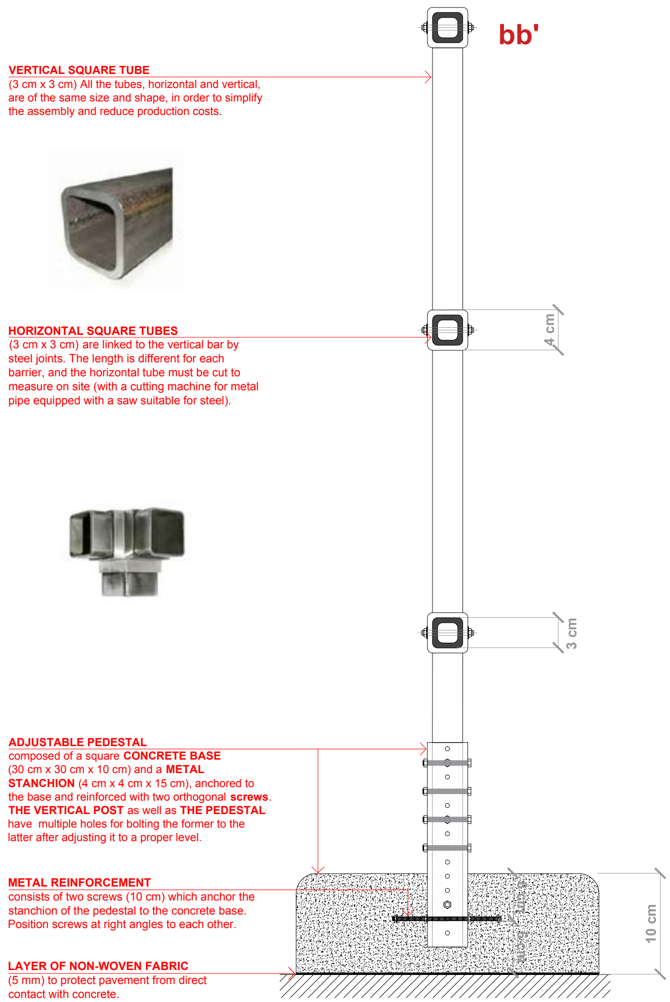
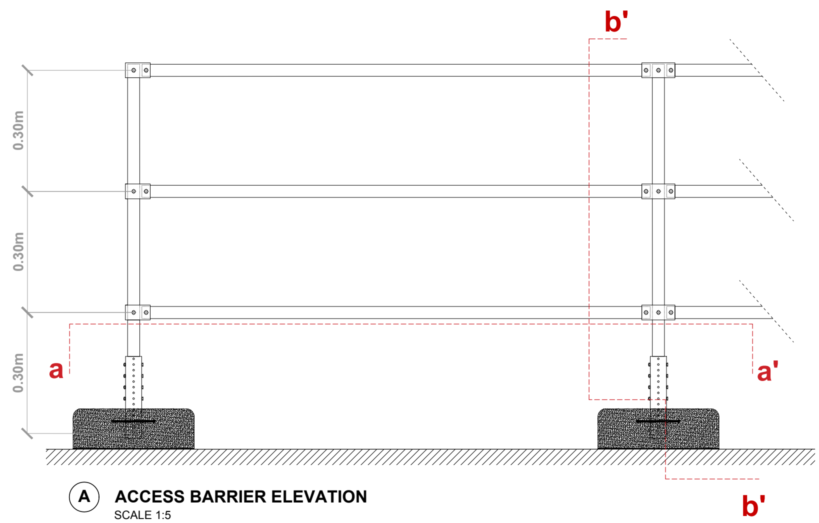
Date: 25 August 2017

Scale: 1:100

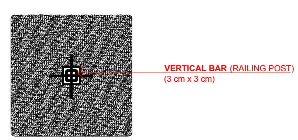
Sheet No.: 3.1



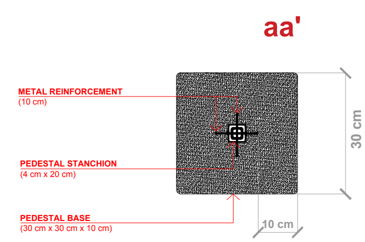
Ⓒ **ACCESS BARRIER SECTION**
SCALE 1:2



Ⓐ **ACCESS BARRIER ELEVATION**
SCALE 1:5



Ⓑ **ACCESS BARRIER PLAN**
SCALE 1:5



Date: 25 August 2017
Scale: As Noted
Sheet No.: 3.2

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Building: MAISON DE LA CHASSE

Sheet Title: ACCESS BARRIERS DETAILS

BULLA REGIA MODEL CONSERVATION PROJECT

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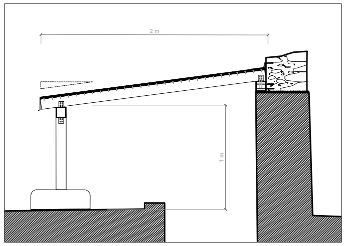
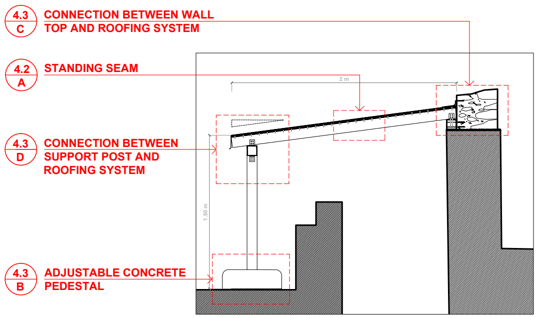
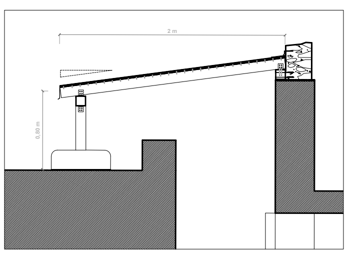


1 SECTION C-C'
SCALE 1:20



2 SECTION F-F'
SCALE 1:20



3 SECTION G-G'
SCALE 1:20

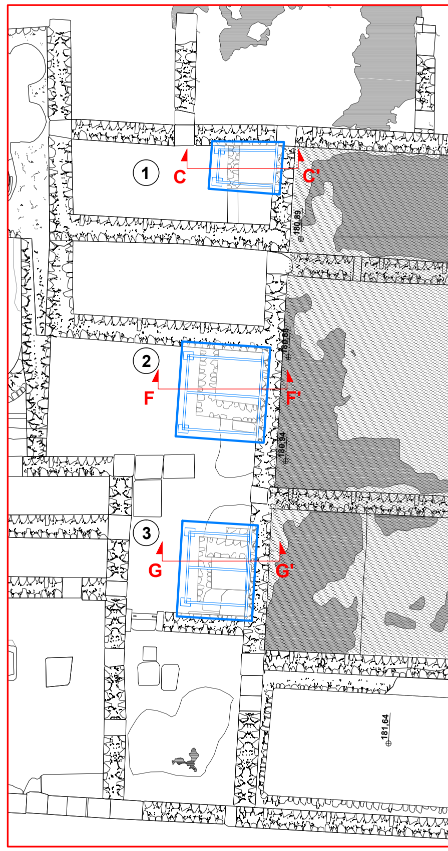
SHELTERS

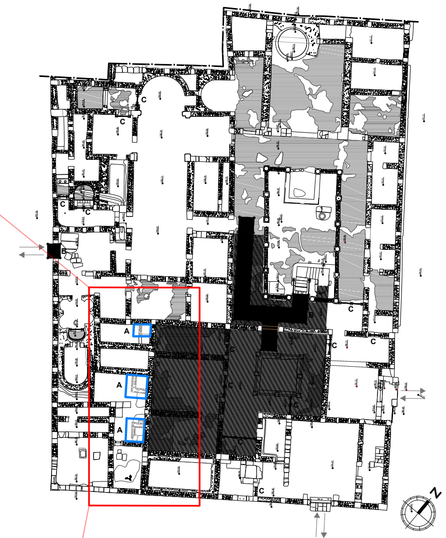
Consist of one sloping cover, resting on one side on two vertical posts, and on the other side on the ancient wall, previously restored with a stone and mortar capping.

COMPONENTS

1. TWO ADJUSTABLE CONCRETE PEDESTALS
2. TWO VERTICAL METAL POSTS (10 cm x 10 cm)
3. FOUR OR FIVE HORIZONTAL METAL AND WOOD BARS (10 cm x 10 cm)
4. STANDING SEAM METAL OVER WOOD PLANKS

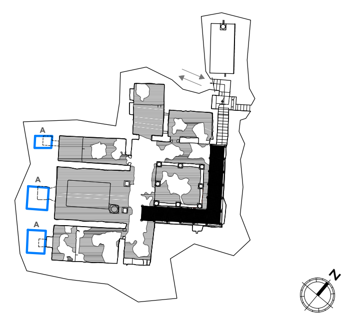
SCALE 1:50





GROUND LEVEL PLAN
SCALE 1:200

VISIBLE MOSAIC	UNDERGROUND LEVEL AREA
WALKWAY WITH RAILING (B)	ACCESS BARRIER (C)
SHELTER PROFILE (A)	ENTRY / EXIT



UNDERGROUND LEVEL PLAN
SCALE 1:200

BULLA REGIA MODEL CONSERVATION PROJECT

Building: MAISON DE LA CHASSE

Sheet Title: SHELTERS

Issuance: Design prototypes for the protection and presentation of Maison de la Chasse

Date: 25 August 2017

Scale: As Noted

Sheet No.: 4.1

Drawn: S. Marandola

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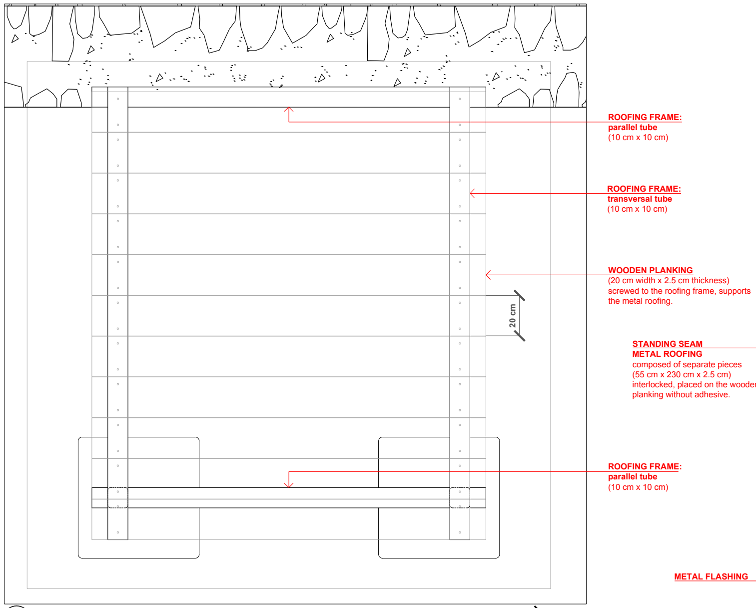
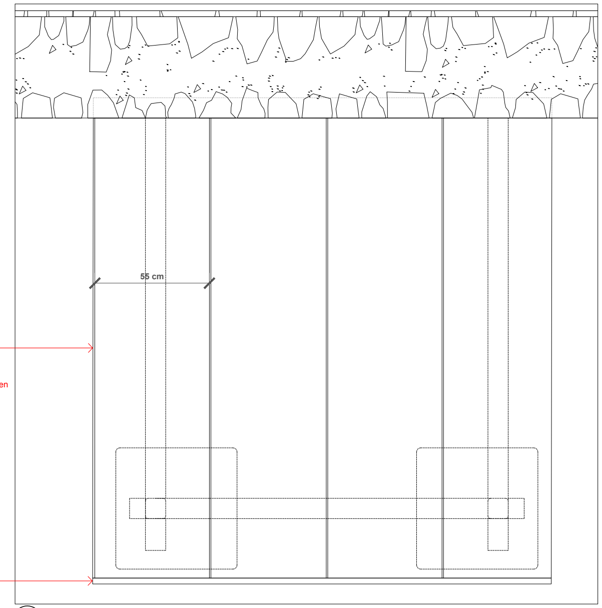
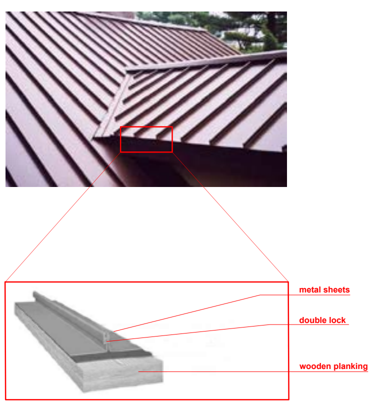


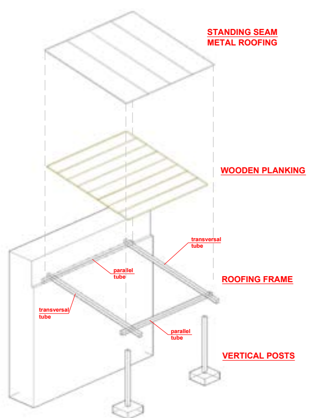
C FRAME SUPPORTING SHELTER SCALE 1:10



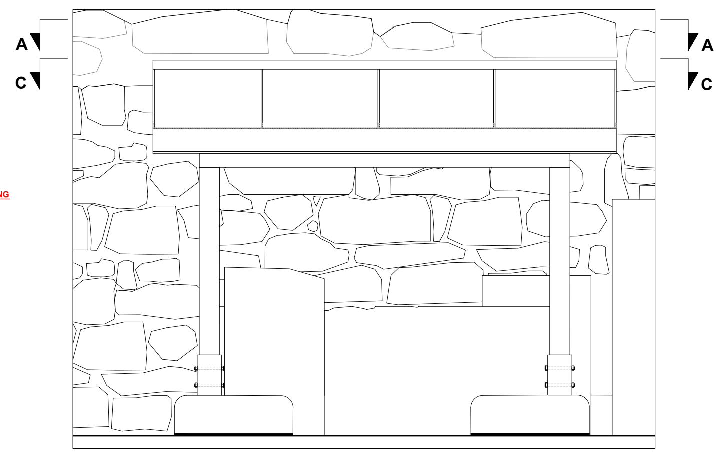
A SHELTER PLAN SCALE 1:10



D ROOFING DETAIL



E ROOFING ASSEMBLY



B SHELTER ELEVATION SCALE 1:10

BULLA REGIA MODEL CONSERVATION PROJECT

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Building: MAISON DE LA CHASSE

Sheet Title: SHELTER 3
PLAN SECTION AND ELEVATION

Issuance:
Design prototypes for the protection and presentation of Maison de la Chasse

Drawn:
S. Marandola

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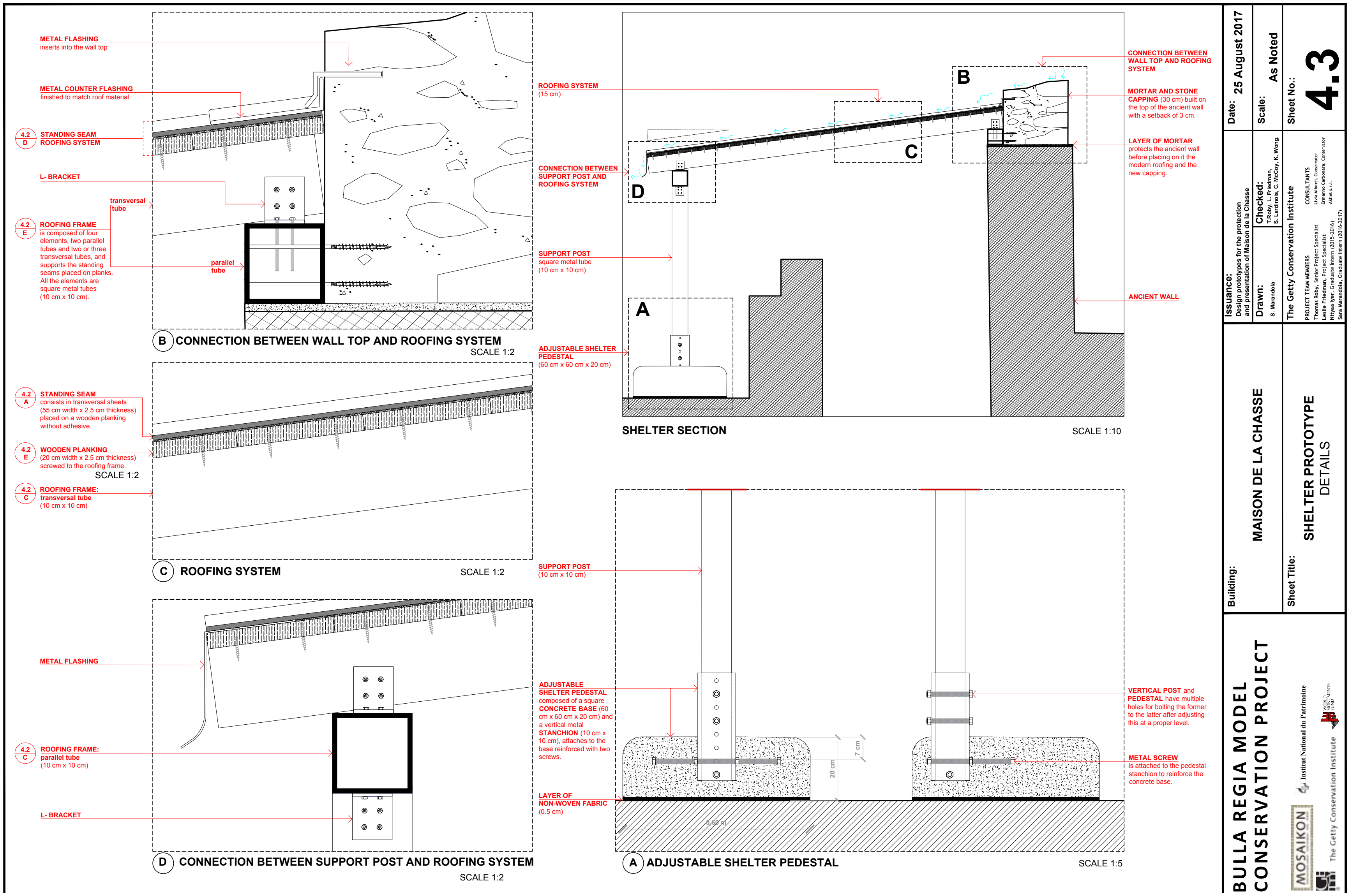
Date: 25 August 2017

Scale: 1:10

Sheet No.: 4.2


METAL FLASHING
inserts into the wall top
METAL COUNTER FLASHING
finished to match roof material
4.2 D STANDING SEAM ROOFING SYSTEM
L- BRACKET
transversal tube
4.2 E ROOFING FRAME
is composed of four elements, two parallel tubes and two or three transversal tubes, and supports the standing seams placed on planks. All the elements are square metal tubes (10 cm x 10 cm).
parallel tube
B CONNECTION BETWEEN WALL TOP AND ROOFING SYSTEM
SCALE 1:2
4.2 A STANDING SEAM
consists in transversal sheets (55 cm width x 2.5 cm thickness) placed on a wooden planking without adhesive.
4.2 E WOODEN PLANKING
(20 cm width x 2.5 cm thickness) screwed to the roofing frame.
SCALE 1:2
4.2 C ROOFING FRAME:
transversal tube
(10 cm x 10 cm)
C ROOFING SYSTEM
SCALE 1:2
METAL FLASHING
4.2 C ROOFING FRAME:
parallel tube
(10 cm x 10 cm)
L- BRACKET
D CONNECTION BETWEEN SUPPORT POST AND ROOFING SYSTEM
SCALE 1:2
ROOFING SYSTEM
(15 cm)
CONNECTION BETWEEN SUPPORT POST AND ROOFING SYSTEM
SUPPORT POST
square metal tube (10 cm x 10 cm)
ADJUSTABLE SHELTER PEDESTAL
(60 cm x 60 cm x 20 cm)
CONNECTION BETWEEN WALL TOP AND ROOFING SYSTEM
MORTAR AND STONE CAPPING (30 cm) built on the top of the ancient wall with a setback of 3 cm.
LAYER OF MORTAR
protects the ancient wall before placing on it the modern roofing and the new capping.
ANCIENT WALL
A
B
C
D
SHELTER SECTION
SCALE 1:10
SUPPORT POST
(10 cm x 10 cm)
ADJUSTABLE SHELTER PEDESTAL
composed of a square CONCRETE BASE (60 cm x 60 cm x 20 cm) and a vertical metal STANCHION (10 cm x 10 cm), attaches to the base reinforced with two screws.
LAYER OF NON-WOVEN FABRIC
(0.5 cm)
7 cm
20 cm
VERTICAL POST and PEDESTAL have multiple holes for bolting the former to the latter after adjusting this at a proper level.
METAL SCREW
is attached to the pedestal stanchion to reinforce the concrete base.
A ADJUSTABLE SHELTER PEDESTAL
SCALE 1:5
Date: 25 August 2017
Scale: As Noted
Sheet No.: 4.3
Issuance:
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Drawn: S. Marandola
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The Getty Conservation Institute
Building: MAISON DE LA CHASSE
Sheet Title: SHELTER PROTOTYPE DETAILS
BULLA REGIA MODEL CONSERVATION PROJECT
MOSAIKON
Institut National du Patrimoine
The Getty Conservation Institute

APPENDIX L

Bulla Regia Bibliography

Bulla Regia Bibliography Listed by Year: Updated May 23, 2023

19--? (1)

Getty Research Institute. 19--? Study Photographs of Ancient Mosaics: Bulla Regia. Getty Research Library, Los Angeles # 1382-151, Box 97-99 Bulla Regia. Finding aid: http://hdl.handle.net/10020/cifa76p8

2023 (1)

Nikita, Efthymia, Michelle Alexander, Samantha Cox, Anita Radini, Petrus Le Roux, Moheddine Chaouali, and Corisande Fenwick. 2023. Isotopic evidence for human mobility in late antique Bulla Regia (Tunisia). *Journal of Archaeological Science: Reports* 47: art. 103816. https://doi.org/10.1016/j.jasrep.2022.103816

2022 (2)

Fenwick, Corisande, Andrew Dufton, Stefan Ardeleanu, Moheddine Chaouali, Heike Möller, Julia Pagels, and Philipp von Rummel. 2022. Urban transformation in the Central Medjerda Valley (north-west Tunisia) in late antiquity and the middle ages: A regional approach. *Libyan Studies* 53: 142-60. https://doi.org/10.1017/lis.2022.17

Rubio Gonzalez, Raquel. 2022. Estudio tipológico de los espacios domésticos subterráneos en Bulla Regia (Túnez) [Typological study of underground domestic spaces in Bulla Regia (Tunisia)]. *Antesteria: debates de Historia Antigua* (11): 195-214. https://www.ucm.es/preharq-hantigua/file/11.-estudio-tipol-%C2%A6gico-de-los-espacios-dom-%C2%AEsticos-subterr-ineos-en-bulla-regia-t-%C2%A6nez-.

2021 (2)

Dennis, Nathan S. 2021. Optical games and spiritual frames. A reassessment of imitation-marble mosaics in Late Antique North Africa. *Convivium* 8 (1): 52-71. https://doi.org/10.1484/J.CONVI.5.126195

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Fatta, Francesca, and Domenico Mediati. 2020. Geometric references of Roman mosaics in North Africa. *Nexus Network Journal* 22 (1): 91-111. https://doi.org/10.1007/s00004-019-00433-8

Fenwick, Corisande, ed. 2020. *Early Islamic North Africa: A New Perspective*. Debates in Archaeology. London: Bloomsbury Academic.

Roby, Thomas, Leslie Friedman, Moheddine Chaouali, Hamida Rhouma-Ghmari, Livia Alberti, and Ermanno Carbonara. 2020. The conservation plan for mosaics at Bulla Regia: A component of the MOSAIKON model field project. In *What Comes to Mind When You Hear Mosaic?: Conserving Mosaics from Ancient to Modern: The 13th Conference of the International Committee for the Conservation of Mosaics, Barcelona 15-20 October 2017*, edited by Roberto Nardi and Montserrat Pugès i Dorca, 337-48. Firenze: Edifir.

Rubio Gonzalez, Raquel. 2020. La decoración musiva y pictórica de ámbito privado en Bulla Regia (Túnez). Ph.D. diss., Universidad Complutense de Madrid. https://eprints.ucm.es/id/eprint/62590/

Teutonico, Jeanne Marie, and Leslie Friedman. 2020. Mosaikon 2008-2018: Objectives, outcomes, opportunities. In *What Comes to Mind When You Hear Mosaic?: Conserving Mosaics from Ancient to Modern: The 13th Conference of the International Committee for the Conservation of Mosaics, Barcelona 15-20 October 2017*, edited by Roberto Nardi and Montserrat Pugès i Dorca, 325-26. Firenze: Edifir.

2019 (1)

Rubio Gonzalez, Raquel. 2019. 'Stibadia subterranea: Un ambiente para el banquete en la "casa de la pesca" en *Bulla Regia* (Túnez) ['*Stibadia subterranea*: A convivial space in the "House of the Fishing" in *Bulla Regia* (Tunisia)]. *Antesteria: Debates de Historia Antigua* (8): 85-106. https://www.ucm.es/data/cont/docs/106-2019-09-20-6.%20Rubio%20Gonz%C3%A1lez.pdf

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APPENDIX M

List of GCI Project Reports

List of GCI Project Reports

Campaign Reports, 2010–2015

Livia Alberti, with contributions by Ermanno Carbonara (2012-15), Cristina Caldi (2012) and Thomas Roby

2010 Mosaic Conservation and Maintenance Plan and Maison de la Chasse Conservation Project

2011 May – June, Mosaic Conservation and Maintenance Plan and Maison de la Chasse Conservation Project

2011 October, Campaign Report

2012 June, Mosaic Survey and Maison de la Chasse Conservation Project

2012 October, Mosaic Survey and Maison de la Chasse Conservation Project

2013 March – June, Mosaic Conservation Planning and Maison de la Chasse Conservation Activities

2013 October, Mosaic Conservation Planning and Maison de la Chasse Conservation Activities

2014 March, May and June, Mosaic Conservation Planning and Maison de la Chasse Conservation Activities

2014 November, Mosaic Conservation Planning and Maison de la Chasse Conservation Activities

2015 Spring and Fall, Mosaic Conservation and Maison de la Chasse Conservation Activities

Other Reports

2013 Spring and Fall Campaign Survey Reports, Akhet, (Ascanio D'Andrea)

2014 Archaeological Consultancy Report, Insula de la Chasse, Roger Hanoune

2015, 2017 GCI Built Heritage Research and Analytical Report, Beril Bicer-Simsir, et al.

Partner Meeting Reports

2013 GCI-INP-WMF Partner Meeting, Tunis

2016 GCI – INP Partner Meeting Binder, Rome

Internal Project Update Reports

December 2014

July 2015

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June 2016

APPENDIX N

List of WMF Project Reports

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Report of a mission to Bulla Regia and Tunis, Tunisia, October 3-6, 2008, Gaetano Palumbo, 2008

Campaign Reports, Gionata Rizzi, 2009-2014

Building Condition Reports, Giuseppina Campanale, 2009

Mortar Analyses, Lorenzo Appolonia, 2009

Vegetation et paysage dans la conservation du site, Anna Letizia Monte, 2009?

Riqualificazione paesaggistica e proposte gestionali per il sito archeologico di Bulla Regia, Anna Letizia Monte, 2010?

Rapport de visite, Gilles Seraphim, 2010

Hydrology

Water Supply and Drainage at Bulla Regia, Domenico Camardo 2010

Report on the inspection of 05-08/05/2010 aimed at defining a programme of studies and works for hydrogeological safeguard and water management at the archaeological site of Bulla Regia (Tunisia), Ippolito Massari, 2010

Mission to Bulla Regia, Studio Massari, 2012

Water Infiltration and Stagnation Issues, Studio Massari 2013

Shelters and Vaults

Coverings and Shelter Priorities, Gionata Rizzi?

The Shelter for the Maison de la Nouvelle Chasse, Gionata Rizzi 2014

The House of the New Hunt, Proposed reconstruction of the fourth-century AD domus, Domenico Camardo 2014

A Shelter for the Maison de la Nouvelle Chasse: Concept and Design Proposal, Gionata Rizzi 2015

Schemes for the re-integration of the missing vaults in the Maison de la Chasse, Maison du Tresor and Maison d'Amphitrite, Gionata Rizzi

Draft report (02) related to the reconstruction of the vault of the eastern room – Maison d'Amphitrite, Thierry Grandin, 2014

Survey Campaign (02) Maison de la Chasse, Maison de la Nouvelle Chasse, Maison du Tresor, Maison d'Amphitrite, March-April 2014, 2014, Thierry Grandin

Other

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AUTHOR BIOGRAPHIES

Thomas Roby is an architectural conservator in the Buildings and Sites Department of the GCI, where he has been manager and co-instructor since 2001 of the training project for mosaic conservation technicians in collaboration with the INP of Tunisia, and, since 2010, as part of the regional MOSAIKON Initiative. Prior to joining the GCI, he worked in private practice, mostly on archaeological sites in the Mediterranean region, including Italy, Tunisia, Jordan, Lebanon, Turkey, and Egypt. He has published articles on site and mosaic conservation in the conference proceedings of the International Committee for the Conservation of Mosaics and the International Institute for Conservation (IIC), and in the journal *Conservation and Management of Archaeological Sites*. His academic degrees include a BA in Classical and Near Eastern Archaeology (Haverford/Bryn Mawr College), an MA in Architectural History/Historic Preservation (University of Virginia), and an MA in Conservation Studies (University of York, UK). He also attended the ICCROM/UNESCO Stone Conservation Course in Venice, and later was awarded a research fellowship in Conservation/Historic Preservation at the American Academy in Rome. He is a Fellow of the IIC.

Leslie Friedman is a conservator specializing in the conservation and management of archaeological heritage and sites. Her academic background is in social anthropology, archaeology, and conservation. She received her MSc degree in Historic Preservation from the University of Pennsylvania, where she focused on the conservation of architectural material. She joined the GCI in 2009, where she works on activities of the MOSAIKON Initiative, including managing the series of courses for archaeological site managers. Her other current projects include the Nea Paphos Conservation and Management project, the publication of Guidelines for Archaeological Shelters, and the organization of an experts' symposium on climate change and archaeological sites in the Mediterranean region. Prior to coming to the GCI, she worked for ICOMOS Paris and the US National Park Service, and also in private practice in conservation projects ranging from stone and earthen architecture, plasters, wall paintings, and mosaics, to contemporary sculpture. She is an expert member of ICAHM and the ICOMOS International Committee on Archaeological Heritage Management, and an Assistant Coordinator for the ICOM-CC Archaeological Materials and Sites Working Group.

Livia Alberti is a conservator/restorer and graduate of the Istituto Centrale per il Restauro in Rome, with a specialization in painting, mosaic, stucco, and stone conservation, and professional experience in both conservation and teaching. For more than twenty years she has worked internationally in private practice, collaborating with UNESCO and the GCI, and as a partner of Consorzio Arké. She teaches at the University of Viterbo, Italy, on mosaic conservation and does training in the field of mosaics and wall paintings. Since 2001 she has been working in North Africa and the Middle East as a consultant for the GCI on technician training for in situ mosaic maintenance and for MOSAIKON projects.

Ermanno Carbonara is an art conservator in private practice with twenty-five years of experience working in Italy, throughout North Africa and the Middle East, and in the United States. He was an instructor for several years at the Scuola per il Restauro del Mosaico in Ravenna and has worked on the Byzantine wall mosaics of the Basilica of Saint Apollinare in Classe and Saint Apollinare Nuovo World Heritage sites.

He has been a consultant for the last fifteen years for the GCI and its mosaic conservation projects in Tunisia, Morocco, and Lebanon, doing both training of local mosaic conservation technicians and conservation implementation works on-site. He has been a contractor for UNESCO on a multiyear conservation program for the site of Mes-Aynak in Afghanistan.

He worked at the National Museum of Kabul conserving ancient Buddha sculptures of painted unfired clay and training Afghani archaeologists and conservators from the Ministry of Culture of Afghanistan in documentation techniques for conservation.

He currently works for the L.A. County Museum of Art at the Watts Towers by Simon Rodia, in Los Angeles.

Ascanio D'Andrea has wide-ranging expertise in data management and impact assessment for cultural heritage with a focus on World Heritage Sites. He has worked for more than twenty-five years for archaeological and conservation projects all around Italy, the Mediterranean, and the Middle East area and has gained considerable experience of a wide range of digital tools for documentation, values-based approaches for impact assessments, and heritage management–based approaches to the specific needs of heritage places.

He has taken part in several huge GIS and documentation projects at the national and international levels for long-term GIS consultancy work, including the Diriyah At-Turaif and the Historic Jeddah Gate to Makkah World Heritage Sites in Saudi Arabia. In Italy he is data manager within the Herculaneum Conservation Project in Herculaneum, the Geographic Archaeological Information System of Rome, and the Risk Map of the In Situ Mosaic and Marble Floors Surfaces of the Parco Archeologico del Colosseo in Rome.

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