Leveraging Information Systems for the Conservation of the Niki de Saint Phalle's Tarot Garden Artistic Legacy

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Abstract

This paper presents a Geographic Information Systems (GIS)-based digital framework developed to support the long-term conservation of the Tarot Garden (Il Giardino dei Tarocchi), a monumental sculpture garden in Italy created by French-American artist Niki de Saint Phalle. While GIS is widely recognized as a powerful tool for organizing and analyzing heritage data, this paper emphasizes that its complexity can limit its accessibility and effectiveness in conservation planning. To address this, the project prioritized stakeholder usability, data interoperability, and capacity building. The work was conducted by the Carleton Immersive Media Studio (CIMS) in collaboration with the Getty Conservation Institute (GCI), the Niki Charitable Art Foundation, and the Tarot Garden Foundation, under the GCI's Modern and Contemporary Art Research Initiative (ModCon). The initiative produced a suite of digital assets – including ortho-rectified images, measured drawings, and a photographic record portfolio – integrated into a GIS platform. Developed through an interdisciplinary approach involving conservators, documentation specialists, and site stakeholders, the system supports condition monitoring, comparative analysis, and evidence-based decision-making. By embedding digital tools into conservation workflows and training local staff in their use, the project fosters sustainable stewardship and helps preserve both the tangible and intangible heritage of the Tarot Garden.

1. Introduction

The Tarot Garden Conservation Project is the first field initiative under the Getty Conservation Institute's (GCI) Modern and Contemporary Art Research Initiative (ModCon), carried out through the GCI Collections Department. The project aims to ensure the long-term conservation of The Tarot Garden (Il Giardino dei Tarocchi), a monumental sculpture garden located in the Italian village of Capalbio, Tuscany, by integrating open-source Geographic Information Systems (GIS) and digital documentation with capacity-building efforts (Figure 1). A key objective is to provide the Foundation staff with accessible and sustainable tools for conservation management, ensuring they can actively safeguard the site's artistic legacy.

Designed and built by French American artist Niki de Saint Phalle (1930–2002) from the late 1970s to the early 2000s, the garden features 22 sculptures inspired by the Major Arcana of the Tarot, along with additional sculptural elements, including kinetic sculptures by Swiss sculptor Jean Tinguely and an entrance wall and café designed by Swiss architect Mario Botta. This magnificent surrealistic landscape (Beardsley, 2011) is under the stewardship of the Niki Charitable Art Foundation. The conservation of this unique artistic environment requires an adaptable, data-driven approach.

To support long-term maintenance and monitoring, the research team developed an open-source GIS platform that consolidates digital assets such as measured drawings, ortho-rectified images, condition assessments, and archival research. This system enables the Tarot Garden staff to systematically document, analyze, and track conservation interventions while ensuring that future management decisions are informed by accurate, spatially referenced data. The documentation and training efforts, conducted in collaboration with the Carleton Immersive Media Studio (CIMS) included a field campaign in May 2023 and a training campaign in November 2023, equipping staff with the skills to use GIS tools for conservation planning.

Figure 1. Aerial view of the Tarot Garden.

This contribution highlights the critical role of open-source GIS in empowering local caretakers, demonstrating how digital

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documentation and capacity-building initiatives contribute to The Tarot Garden's sustainable preservation and management while maintaining its artistic and historical integrity.

2. Scope of Work

The Tarot Garden posed significant challenges for digital recording due to its large-scale and irregularly shaped sculptures, dense vegetation, and highly reflective ceramic and mirror mosaic surfaces. To address these complexities, the project implemented a GIS-driven documentation strategy, integrating multiple recording technologies to create a comprehensive dataset for conservation planning and management.

A key objective of this project was to develop a GIS using open-source software (QGIS, 2024) to serve as the primary data repository and analytical tool for the site's conservation. The GIS consolidates spatially referenced digital assets, enabling efficient documentation, monitoring, and decision-making.

The documentation workflow involved multi-scale recording and mapping to capture the site's topography, sculptures, and structures such as the entrance wall and café. The resulting GIS database integrates:

- As-found measured drawings at various graphic scales
- Ortho-rectified aerial images and site maps
- Topographic contour lines and digital elevation models (DEM)
- Geo-referenced archival images and historical records
- Technical reports linked to specific sculptures
- A high-resolution photographic inventory providing a navigable, structured database of the condition of each artwork at the time of capture

The GIS platform allows the Tarot Garden staff to dynamically visualize, analyze, and manage conservation priorities, replacing traditional static documentation with an interactive, data-rich system. By integrating real-time site assessments with historical records, the GIS supports predictive conservation planning, enabling staff to track condition changes, plan interventions, and document conservation efforts over time.

Two components were at the core of this initiative to facilitate the accessibility and sustainability of the GIS and integrated assets. These included a photographic record portfolio – an inventory of high-resolution detail images of the site features – and capacity building, to ensure that the staff could independently manage and update the GIS and other digital assets. While the photographic record portfolio addressed some of the accessibility challenges of GIS requiring digital expertise, capacity building training sessions emphasized data input, spatial analysis, and visualization techniques to empower the site's caretakers with accessible, scalable tools for long-term conservation management.

The following sections detail the data acquisition and GIS integration process led by CIMS, followed by an analysis of the capacity-building program and its impact on the sustainable conservation of The Tarot Garden.

3. Recording the Tangible and Intangible Dimensions using Digital Technologies

CIMS conducted digital recording during two field campaigns: a comprehensive documentation phase in May 2023 and a supplementary documentation and capacity-building phase in November 2023. This multi-phase approach ensured the capture of both the physical attributes and the intangible cultural dimensions of The Tarot Garden, integrating spatial, material, and historical knowledge into a unified digital framework.

A geospatial positioning workflow was developed to integrate laser scanning, photogrammetry, and historical site data into a GIS to achieve a precise geospatial reference system. To establish a cartographically referenced geodetic network across the site, two Emlid REACH RS2 GNSS receivers were used to record points, which were converted into cartographic UTM coordinates in Zone 32 (North). A total station was used to establish a network of points across the site, which was transformed into a cartographic system using a rigid translation. The network of points included reflective targets, checkerboard targets, and natural points. These control points were spatial anchors for aligning all measured drawings, models, condition assessments, and site data into a unified accurate geographic coordinate system.

3.1 Tangible Heritage Documentation: Capturing the Site's Physical Features and as-found conservation condition

A 3D scanning workflow was implemented to accurately capture the sculptures' complex geometries and surface details. Two 3D laser scanners – a FARO Focus CAM2 HDR 330 and a FARO S70 – worked simultaneously to generate high-resolution point clouds, documenting the sculptures' exterior and interior geometries (Figure 2). Laser scanning spheres and checkerboard targets were spatially distributed throughout the scanning area in order to register the scans together, and to register the scan data to the geographic system established by the survey network.

Figure 2. 3D scanning of the garden.

The reflective ceramic and mirrored tile surfaces posed significant challenges in the processing phase of the laser scans, due to the laser being reflected off these surfaces. This challenge was mitigated by manual cleaning and post-processing of the registered point clouds to ensure accurate data representation. As a result of the scattered point cloud data caused by the reflective and mirrored surfaces, the point clouds from laser scanning did not record the details of the sculptures at a high level of detail (Figure 3). Rather, the point clouds were used to formulate an understanding of the geometry of the sculptures, which was used to create measured line drawings (Figure 4). The point cloud of each sculpture was attached in AutoCAD according to its geographic coordinates within the established network. The drawings – including plan, elevation, and section drawings at the scale of each sculpture and the site scale – were each set up with a User Coordinate System (UCS) aligned to the appropriate perspective (plan, elevation, section) of the point clouds in AutoCAD. To capture a high-resolution detail of the sculptures, including calibrated colour and detailed conditions of the tiled artwork, digital photogrammetry was used.

Figure 3. A view of the interior point cloud of The Empress sculpture after cleaning.

Terrestrial and aerial photogrammetry were conducted to capture the sculptures, pathways, and landscape features throughout The Tarot Garden. Terrestrial photogrammetry uses colour-calibrated, high-resolution mirrorless cameras to produce ortho-rectified images and photogrammetric models of each sculpture, while maintaining 'visual fidelity' of the recorded subject (MacDonald et al., 2006). Aerial photogrammetry, performed using off-the-shelf drones, provided site-wide topographic context and supplemented terrestrial data for comprehensive 3D reconstruction.

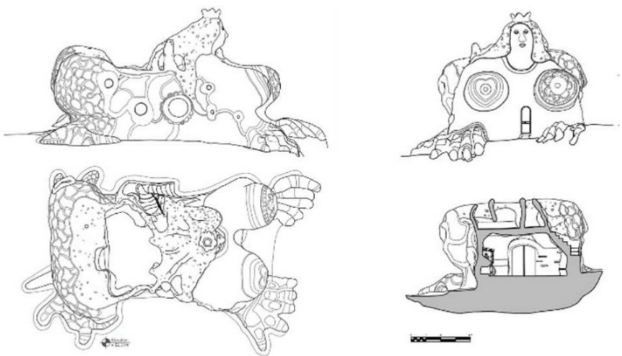

Figure 4. Measured line drawings of The Empress sculpture in The Tarot Garden.

An important consideration in photogrammetric data acquisition is the resolution of the resulting ortho-rectified images. This resolution is calculated based on the Ground Sampling Distance (GSD), which equates camera and image specifications to the distance from the subject and the spatial resolution per image pixel (Luhmann et al., 2020). The GSD was calculated to achieve an optimal resolution and graphic scale for photogrammetric outputs, and the distance from each sculpture during photogrammetric recording was determined and maintained based on this calculation. A *Sony Alpha A7RIV* camera with a 24 mm lens and a *Sony* Mirrorless *ILCE-7* camera with a 28 mm lens were used to record the terrestrial images for photogrammetric processing. A *Sekonic Light Meter Litemaster L-478D-U* was used to determine the optimal exposure settings for each photographed space, and photos were taken with an *x rite* colour checker in each new location across the site, in order to colour correct the RAW photos during the processing phase. The camera settings were systematically kept in a range of aperture f8 to f11, shutter speed 1/60 - 1/100, and ISO100, although they were adjusted according to the lighting conditions in each separate space. In interior low light conditions, images were taken with the camera supported on a tripod, with a long shutter speed in combination with a time delay to ensure the camera was static upon image capture. All photographs were taken in the RAW file format to allow for any necessary exposure or colour adjustments during processing. Photos were captured using an overlap of approximately 60 - 80%. Figure 5 illustrates the systematic pattern followed to capture overlapping images of the sculptures.

Figure 5. Camera positioning around a sculpture using combined terrestrial and aerial photogrammetry.

The aerial photogrammetry was conducted using a *Mavic 3 Enterprise* drone*,* a *Mavic 3* drone, and a *DJI Mini 3 Pro* drone, selected given their portability and performance in terms of flight duration and image quality. The *Mavic 3E* and *Mavic 3* are equipped with 24 mm equivalent focal lenses, and the *DJI Mini 3 Pro* is equipped with a 24 mm equivalent focal lens. Two types of flights were conducted on the site. First, the *DJI Mini 3 Pro* and *DJI Mavic 3* were used to manually capture overlapping drone images in close range of the sculptures. These flights provided images of the sculptures inaccessible through terrestrial photography. Drone images were captured both at plan view of the subject sculptures and at angled views, resulting in 60 - 80% overlap between images and ranging in 5 m to 15 m distance from the sculptures. Additional panoramic photographs were also taken along with drone videos at each sculpture. The *Mavic 3E* was used to conduct double grid flights across the extents of the site for the second type of flight. Each automated flight path was planned using DJI Pilot, with pre-determined specifications of drone flight height, GSD, photograph overlap, and flying speed.

The aerial photographs supplemented the terrestrial photogrammetry in generating photogrammetric point clouds of the exteriors of the sculptures as well as a point cloud of the full site. Following colour correction and white balancing of the terrestrial images, the drone images and terrestrial images were processed in Agisoft Metashape to generate point clouds, high-resolution ortho-rectified images, 3D models, and topographic datasets in the established survey network. The resulting digital assets form a detailed spatial archive to support long-term conservation planning and monitoring. Access to a combination of 2-dimensional and 3-dimensional data facilitate conservators in the analysis of surface topography, to monitor material conditions at a high level of detail (Wong et al., 2021). These digital assets were integrated into the GIS platform using surveyed checkerboard targets and natural points to register them into the established survey network.

3.2 Intangible Heritage Documentation: Capturing traditional construction materials, sound and motion

Beyond the physical documentation, the project recorded intangible heritage elements essential to understanding The Tarot

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Garden’s conservation needs. Through conversations with the site staff, the team documented:

- The original construction techniques and materials used by Niki de Saint Phalle and her collaborators
- The sound and motion of the garden’s kinetic elements
- The evolution of conservation practices at the site over time

This information was integrated into the GIS database as metadata and files linked to shapefiles defining each sculpture and site feature (Figure 6). The digital integration of intangible recorded data linked historical knowledge with digital models, to ensure that future conservation efforts respect the artistic intent, materials, and construction methods used in the creation and ongoing maintenance of The Tarot Garden.

This project establishes a comprehensive foundation for conserving The Tarot Garden by combining high-resolution digital documentation with historical and artisanal knowledge. The resulting GIS-based system serves as a technical archive and a living tool for adaptive conservation planning, staff training, and knowledge transfer, ensuring that the sculpture garden’s artistic legacy is preserved for future generations.

4. Geographic Information System (GIS) for Conservation and Maintenance

A GIS was developed using QGIS, an open-source platform, to consolidate, manage, and support conservation efforts at The Tarot Garden. The GIS is a centralized digital repository that integrates a wide range of spatial and technical data to facilitate informed conservation and maintenance decisions.

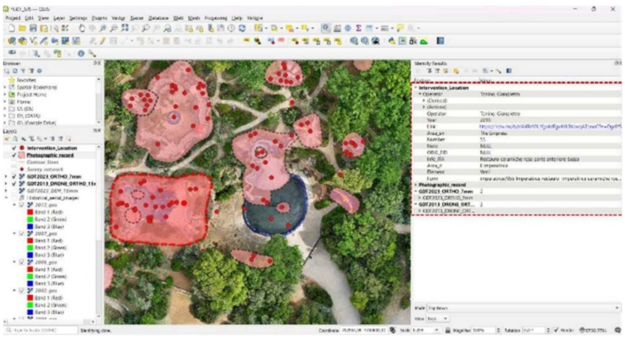

Figure 6. Interface of the Geographic Information System linking to archival reports and supplementary data on each sculpture.

The system incorporates:

- Archival aerial images, documenting the site’s historical transformations
- A geodetic control network, established using GNSS RTK and total station surveys
- Aerial ortho-rectified images, providing accurate spatial references for the site layout
- Digital elevation models (DEMs) and contour lines, supporting landscape analysis
- Site plan drawings, detailing sculpture placements and infrastructure
- Intervention reports (up to 2022), documenting past conservation actions
- A photographic record portfolio, linked directly to each sculpture for visual reference

5. Integrating GIS into Conservation and Maintenance Planning

The GIS is structured to support conservation management through multiple means. The GIS enables tracking past and ongoing conservation interventions; each sculpture is linked to intervention records, allowing for a historical review of treatments and repairs. Condition assessment mapping is supported using the GIS: spatial analysis of deterioration patterns can be conducted across sculptures, highlighting areas requiring preventive or urgent conservation measures. Future maintenance strategies are supported by integrating topographic, environmental, and intervention data. In this way, the GIS helps predict areas susceptible to weathering, vegetation overgrowth, or structural instability. Finally, decision-making is enhanced. Conservation staff can use GIS overlays to analyze factors such as exposure to sunlight, moisture levels, and vegetation encroachment, improving the precision of conservation planning.

6. Photographic Record Portfolio: Linking Visual Documentation to GIS

The Photographic Record Portfolio serves as an essential complement to the GIS, providing a structured and interactive visual database for documenting, assessing, and managing the conservation of The Tarot Garden’s sculptures. Designed to enhance accessibility, this digital resource links high-resolution images to spatial and technical data within the GIS, enabling detailed condition monitoring and informed conservation planning.

The Photographic Record Portfolio was developed using a systematic format to facilitate navigation and long-term use (Figure 7). A site map and sculpture index form the basic structure of the portfolio. Both the site map and index are visually structured interactive navigation pages listing all sculptures, allowing users to locate specific artworks in the extensive digital document quickly. To facilitate navigation through the portfolio, measured drawings and detail photos are hyperlinked, inter-connecting the sculptures to their drawings within the document. The measured drawings include embedded photo keys that link directly to corresponding high-resolution images. The hyperlinks embedded in the photo keys connect the portfolio to an integrated cloud-based storage platform. Rather than embedding high-resolution images directly into the portfolio (which could compromise file size and accessibility), hyperlinked frames guide users to images stored securely on a cloud-based platform, ensuring optimal resolution and easy access. Within the cloud storage platform, a dated folder structure is implemented to support sustainable organization practices. Images are systematically organized by sculpture name and date, supporting chronological tracking of conservation interventions and facilitating future updates. Within the folder structure, a standardized naming convention is followed. A consistent and intuitive file-naming system was established to ensure efficient image retrieval and structured long-term documentation.

Recognizing the need for a sustainable digital tool that does not require advanced GIS or technical expertise, the Photographic Record Portfolio was designed for ease of use, based on three premises. First, interoperability with common software: the portfolio functions as a static digital document, accessible through open-source programs such as PDF readers or web-based viewers, eliminating the need for specialized software. Second, seamless GIS integration: while the GIS hosts spatial and technical conservation data, the portfolio provides an intuitive, image-based reference system that allows conservators to visually assess each sculpture’s condition without requiring GIS training. Finally, ongoing condition monitoring: by regularly updating the cloud-based database with newly captured images, conservation staff can track changes over time, document restoration work, and record degradation patterns in a structured manner.

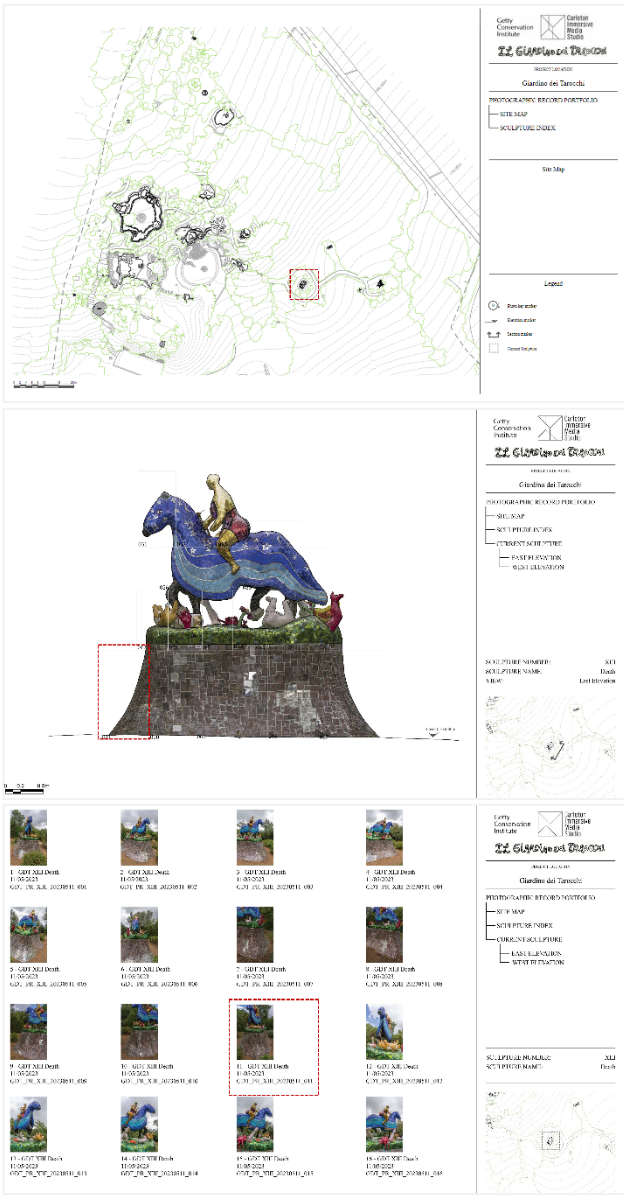

Figure 7. Photographic record portfolio sample showing navigation from site map to sculpture and index of detail photos.

A key focus of the project was ensuring that site staff could effectively manage and use the portfolio. Training sessions covered navigation and use of the photographic record portfolio and database, updating data in the GIS, and best practices for condition photography and documentation. Combining GIS-based spatial analysis with a photographic record tailored for practical use ensures long-term conservation monitoring while remaining accessible to non-technical users. The following section outlines how the photographic portfolio was integrated into the training program to support staff in maintaining The Tarot Garden’s artistic and cultural legacy.

7. Empowering local staff: Training for digital stewardship

The project aimed at empowering the Tarot Garden’s staff through targeted training, enabling them to effectively manage and utilize digital assets for the ongoing conservation of Niki de Saint Phalle's artistic legacy. The training program, conducted in November 2023, consisted of four days of hands-on sessions covering digital photography, point cloud navigation, GIS management, and the use of the photographic record portfolio. Staff were given laptops preloaded with necessary applications and project files, allowing them to apply the skills in real time. The training ensured staff could independently use the tools for documenting sculpture conditions, managing data, and updating the GIS and photographic portfolio. The staff demonstrated enthusiasm and capability, and since the training, they have continued using the digital assets for conservation activities. The project successfully integrated digital tools into daily site management, supporting the long-term preservation of the garden without requiring advanced technical expertise.

8. Balancing Digital Capacity and Sustainability

While the GIS provides a robust framework for managing conservation data, it was recognized that its long-term usability depends on the technical expertise of site staff. To ensure sustainable conservation practices, an adaptive strategy was implemented in this project. The development of a photographic record portfolio, which offers a user-friendly, image-based reference system for site staff with limited GIS experience, addressed challenges of digital navigation and accessibility. The integration of hyperlinks and metadata within shapefiles in the GIS allows for intuitive navigation of digital assets. Finally, training sessions were designed to build local capacity in managing and updating the GIS system for future conservation needs. By bridging digital documentation with practical conservation workflows, this GIS-based approach ensures that The Tarot Garden’s artistic and architectural legacy can be effectively maintained, monitored, and preserved for future generations.

9. Conclusion

The Tarot Garden Conservation Project demonstrates the transformative potential of digital documentation in heritage preservation. Detailed digital records – ranging from geospatial data to photographic archives – serve as foundational tools for future conservation efforts. These assets not only establish a baseline for monitoring change but also guide restoration strategies and ensure the long-term integrity of the sculptures and the site as a whole.

A key achievement of the project was the integration of advanced digital recording methods into a sustainable conservation framework. Initially centered on the development of a GIS for site-wide data management, the methodology evolved to include a complementary photographic record portfolio. This dual approach was designed with accessibility, operability, and the long-term capacity of the local team in mind, ensuring that the digital tools could be effectively maintained and utilized.

Central to the project’s success was the active involvement and empowerment of The Tarot Garden staff. Capacity-building initiatives focused on equipping the team with the skills necessary to manage and update the GIS and photographic portfolio. These training efforts ensured that the digital assets would not remain static but continue to support ongoing conservation activities.

The GIS provided a robust framework for organizing and accessing conservation data, while the photographic portfolio offered an intuitive, image-based reference for users with limited GIS experience. By embedding metadata and hyperlinks within shapefiles, the system enabled seamless navigation and enhanced usability.

Importantly, the documentation strategy extended beyond the physical to embrace the intangible heritage of the site. Through the use of laser scanning, photogrammetry, and digital elevation models, the team captured not only the garden’s spatial and environmental context but also its cultural and historical significance. These digital assets preserve the artistic and symbolic essence of the garden, ensuring that its role in cultural memory is honored alongside its physical preservation.

As Levy poignantly notes, “making the Tarot Garden cost Saint Phalle a great deal: her health, decades of her life, millions of dollars. But, in the process, she managed to mother an entire community” (Levy, 2016). This sentiment underscores the profound personal and communal investment in the garden, reinforcing the importance of a documentation approach that safeguards both its tangible and intangible dimensions.

Ultimately, the combination of digital innovation and community engagement ensures that The Tarot Garden’s artistic, architectural, and cultural legacy will endure – preserved not only in form but in spirit – for generations to come.

The project successfully integrated advanced digital recording methods with capacity-building activities, allowing the local team to take ownership of the conservation efforts. By equipping the staff with the skills to operate the GIS and photographic record portfolio, the project has ensured the long-term conservation of The Tarot Garden. Continued staff involvement is essential to preserving the site’s legacy and guiding future conservation campaigns.

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Figure 8. CIMS and GCI team with the Tarot Garden staff.

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