DigVentures

Deep Time: Collective Intelligence and the search for our past

Project Design

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Purpose of document

This document has been prepared as a Project Design for *Deep Time: Collective Intelligence and the search for our past*. Its purpose is to outline aims and methodology for an execution stage of the project, and outline the resources required and timescale for delivery.

It illustrates how DigVentures intends to deliver services that meet accepted quality expectations, working in accordance with relevant CIfA Standards and relevant guidance.

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Project summary

This document provides a Project Design for *Deep Time: Collective Intelligence and the search for our past*. Its purpose is to outline aims and methodology for an execution stage of the project, and outline the resources required and timescale for delivery. The ambition of the Deep Time project is to explore the potential impact and contribution that trained citizen scientists can make for the large-scale discovery and mapping of cultural heritage. It is driven by a need to create sustainable and effective solutions able to support land use transformation projects responding to climate change, carbon capture and Net Zero agendas.

This Project Design has been updated following comments and dicussion with Historic England, and has been resissued to comprise an initial execution stage which will result in an Updated Project Design. The updated project model comprises five work packages, including Project Design (Stage 1, current stage) and Discovery and Infrastructure (Stage 2, intial execution stage). This Project Design also provides an outline of Stages 3 to 5, with indicative tasks, methods and resourcing. The outputs of Stage 2 will comprise an Updated Project Design incorporating detailed breakdown of each work package, detailing specific case studies, and a series of good practice guidance notes for citizen data projects in the historic environment. This newly identified output will build on the process of Design Sprints planned to be delivered with invited stakeholders within the Discovery and Infrastructure process (Stage 2), and will be added to as the project progresses to share knowledge gained through each stage of project delivery.

The Deep Time project will focus on the delivery of three case studies, tailoring an online community mapping platform and training resources to each area, utilising existing LiDAR data, heritage information (Historic Environment Record (HERs)) and other data layers (such as historic mapping and satellite imagery). Case study areas will be provided and facilitated by the National Trust with further orgainsations expected to join the project during the deliver stage. Each case study will facilitate testing the collective intellegence methodology and Deep Time platform approach against real-world management challenges driven by landscape transformation an Net Zero targets. The research is led by collaborative archaeology platform, DigVentures, heading an expert team of digital development and user experience specialists to create an online mapping platform to support participatory research. The project builds on a previous pilot study, funded by Nesta, investigating how a collective intelligence model has the potential to create a step change in rapid archaeology mapping methods, with a demonstrable increase in social impact (Wilkins et al 2022).

Within the scope of this project, the digital platform will be further developed, with improvements made to mapping tools and functionality to support data collection and recording. Training resources will be developed that are relevant to each case study. Citizen scientists will be trained to create heritage information for at least three distinct areas, mapping archaeology using online tools, which is then verified online and validated through digital assessment and ground-based survey. A key research strand will plan, review, and assess the quality of the data itself: can non-traditional methods of archaeology mapping create data which meets professional standards, uses clear and documented standards, and exports reusable data that can be easily reinvested into heritage information systems and professional databases.

Key objectives of this project are to:

- Develop new tools and processes within the online mapping platform to enhance the identification and management of buried archaeological remains.
- Work collaboratively with landscape managers and heritage information managers to test the efficacy of the platform across differing landscapes.

- Consult widely to inform development, data infrastructure and management, user experience and participation, and respond to challenges experienced in data reuse.
- Evaluate the contribution of citizen scientists and measure impact of participation through a robust evaluation framework.
- Measure results and model confidence ratings for enhanced heritage information datasets, demonstrating usability, application, and impact of the platform in real world scenarios.
- Provide recommendations and good practice guidance to stakeholders regarding community mapping projects based on delivery and results of this project.

The Deep Time project pushes the boundaries of tech-enabled heritage management, embedding and training citizen scientists from the outset. Results will provide quality research data able to support ongoing management of historic environments and will fully document the process. In addition to the archaeological research results, we will work collaboratively with our partners, a Project Advisory Board, and wider sector to develop new metrics to help measure the quality, impact and potential contribution of community mapping projects.

Evaluation forms a key strand of the proposed delivery programme, not only to gauge effectiveness of collective intelligence in supporting archaeologists through the challenges ahead but in reviewing the ethical frameworks and standards within which such work is undertaken. The project will contribute a series of good practice guidance notes for citizen data projects in the historic environment, based on collaborative project design and the production and use of big data created through community projects or other nontraditional methods. The project offers an exciting proposition that aligns well with Historic England's Research Strategy and Future Strategy, and contributes directly to Strategic Activities outlined in HE's Corporate Plan 2021-2022.

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1 COLLECTIVE INTELLIGENCE AND THE GLOBAL CHALLENGE

1.1 Background

1.1.1 Archaeology is a material consideration in any process of landscape change, helping to shape distinctiveness of places centred around the future needs and ideas of its citizens. Archaeology adds value to places, providing the Unique Selling Point of places, attracting investment, increasing amenities, and improving the wellbeing of citizens. The Net Zero agenda requires extensive transformation of land and the environmental processes triggered by climate change are actively destroying vulnerable heritage. These factors present a critical moment for heritage professionals, with the potential to harness new practices and digital tools that could further cement archaeology's contribution to communities and position in civic life.

1.1.2 In an era of climate transformation, with management challenges such as reforestation, peatland reclamation, coastal erosion and flooding, heritage resources are under threat (see Section 3.2). To meet these challenges, archaeologists need to experiment with tech-enabled models that harness the opportunity presented by the volume of available remote sensing data – and develop the organisational capacity to use them. Current mitigation decisions rely on existing records, using data gathered over decades and populated by results from multiple projects using different standards and methodologies. Expertise can be hampered by an inconsistent dataset, with little capacity to enhance existing information or to create new, rapid and comprehensive heritage information within the current system. A recent study reviewing archaeology mapping methodologies concluded that "the volume of available remote sensing data has already outstripped our capacity to engage with it, highlighting the need to develop approaches that exploit the richness of RS data and address the challenges of efficiently extracting information from complex digital sources" (Cowley et al 2020). In addition, the sector has recognised the need for systematic mapping of archaeology to support quantification, monitoring and risk management relating to governmental Net Zero strategies (eg Association of Local Government Archaeology Officers (ALGAO) 2022) and the impacts of climate change (Cook et al 2019, Historic England 2022).

1.1.3 The Deep Time project has been devised to test a potential solution to these challenges, designing digital workflows to support rapid mapping and systematic heritage data, working collaboratively with citizen scientists to increase capacity and ability to review large landscape areas. The project also aims to improve the consistency and completeness of the heritage information created (acknowledging that all heritage data will be incomplete to some extent), and provide data which is accompanied by standardised metadata ready to be re-ingested into HERs and professional databases to support the work of local authorities, landscape managers and national bodies. The delivery programme includes explicit evaluation of each step of the process, reviewing efficacy of the platform and training components, assessing the experience of participants and project partners, as well as investigating the wider ethical context and real-world applications with stakeholders. The result will be a fully tested process able to offer an effective solution to a major challenge, creating opportunities for community involvement at all stages and providing a transformative approach to rapid mapping of archaeology.

1.2 The challenge

1.2.1 Within the scope of this project, the Deep Time platform will create heritage information able to address two significant challenges to the heritage sector: our ability to meet the Net Zero agenda, and to manage the impact of climate change. A crowdsourced solution to archaeology mapping could offer a cost-effective approach, adding capacity and ability to assess large areas under the

management or stewardship of public bodies, charities and other organisations currently facing the Net Zero challenge (such as Dept for Environment, Food and Rural Affairs (DEFRA), Forestry Commission, National Parks and AONB, National Trust, Environment Agency, national heritage bodies). To address the Net Zero strategy, which promises to have huge impacts cross land under management of these bodies, the ability to review large areas ahead of land transformation projects will be vital. Targets for tree planting across the UK (300 km^2 per year) and peatland restoration (2500 km^2 by 2030) (see Section 3.2), will require speedy reconnaissance to evaluate impacts on archaeology. At the same time, major changes in global climate are stimulating coastal and terrestrial erosion, desiccation, and flooding, destroying vulnerable heritage. Research has shown the need to identify areas of importance to local heritage (buildings, historic landscapes, buried archaeology) and evaluate potential impacts.

1.2.2 Deep Time provides an innovative participatory solution, but mapped data will need to meet clear standards to provide heritage information than can then be utilised by professionals. We propose to create clear standards and metrics during a project discovery phase, informed through consultation with practitioners and a representative Project Advisory Board, which can then be used to review the outputs created. Case studies will facilitate the delivery of the model across three separate areas working with three partners, National Trust, Forestry England and Forest of Bowland AONB, each with their own heritage teams and in-house processes. This collaborative approach will provide results that can be fully scrutinised by the teams who will then be using the data. By taking this approach, we aim to create usable data for case study partners and publish a bank of transparent and documented case studies which will then be fully disseminated.

1.3 Pilot project results

1.3.1 A pilot project funded by Nesta and delivered in 2021 investigated the potential combination of artificial and collective intelligence to tackle social and environmental impacts on buried archaeology (Wilkins et al 2022). The project was devised by DigVentures in partnership with ArchAI, supported by Nesta's Centre for Collective Intelligence Design, and trialled within the Brightwater Landscape Partnership, a 220^2 km area in lowland County Durham. The results from the pilot project have informed the development of this new iteration of Deep Time, strongly focusing the project on crowdsourced intelligence, verification and validation processes and the export and reuse of heritage information.

1.3.2 The pilot addressed two related collective intelligence challenges; how can crowd and machine intelligence be utilised to improve and enhance Historic Environment information, and; what is the impact of taking part in a collective intelligence project. The pilot used a custom Collective Intelligence (CI) platform with an embedded Global Information System (GIS) enabling participants to make valid feature identifications from LiDAR data, satellite imagery and historic mapping. A six stage 'human in the loop' model was implemented over a 13-week delivery programme, with crowd's mapped data used as a training data set for Artificial Intelligence (AI) analysis, after which the crowd would validate the results of expanded AI survey.

1.3.3 Participant recruitment was very successful, with 970 applications received for 100 participant places, enabling the final selection to be equitably split along age, gender, socioeconomic and the ethnic backgrounds. Other selection criteria included geographic location (with half of participants locally based) and previous experience (26% of participants had no experience of archaeology, and 65% only on a voluntary basis). Archaeological features were identified by 100 participants, with 63 completing the validation stage and 47 completing the AI validation. The average number of feature identifications

per participant was 36.7, with a longtail slant towards superusers (80% of features were identified by 28% of participants).

1.3.4 A baseline analysis of the quantity and quality of the known archaeology recorded in the Brightwater study area HER revealed 3925 sites, comprising points, polygons, and associated metadata. The crowd augmented this number with a further 3670 archaeological features. As 1309 features identified by the crowd correlated with existing sites from the HER, the total number of new features (2361) represents a 60% uplift in positively identified archaeology compared to the pre-survey HER. Whilst the experimental project did not include comprehensive validation of every enhanced or new feature, a professional review of 5% of the community mapped data revealed promising results: the data quality audit recorded an average 94.32% rating for the fidelity, accuracy and completeness of the crowd's dataset compared to an average 88.71% rating for the HER dataset, demonstrating the effectiveness of the crowd to add information to existing records (such as polygonization of point data). The team are continuing to explore how the data created can be integrated fully into the Durham HER systems, including through additional validation work and by reviewing data ingestion possibilities.

1.3.5 The 'human in the loop' model of AI training faced obstacles, some of which could be addressed through better task and platform design. Whilst crowd transcriptions were broadly accurate, the experiment showed that AI training requires a 100% accuracy or a 'force multiplier' effect will lead to multiple false identifications. Crowd validation of AI features was also problematic, due in part to the crowd's confidence indicating whether the feature was true/false, preferring to expand on ambiguity with text descriptions. As a result, the use of AI within the Deep Time model has been removed from the methodology for the this phase of the project, which will now focus on CI for mapping. Instead, the team intend to review different ways of incorporating AI into a CI mapping model, assessing where AI could increase capacity or ability to rapidly assess large areas prior to targetted community mapping.

1.3.6 A quantitative and qualitative evaluation was undertaken for all pilot project participants, before and after their experience, to better understand how taking part had affected their understanding of archaeology in the planning process, their connection to the Brightwater study area, their skills in identifying archaeology and broader interest in the field. By the end of the project 96% of participants agreed that their understanding of archaeology and planning had improved, and many indicated an increased connection to the Brightwater study area. On registration, 75% of participants had little connection to the area but, having taken part in the mapping project, the same percentage (75%) agreed their connection and sense of place had increased. In additon, 90% of participants stated that their interest in archaeology had increased and 96% that their knowledge of archaeological sites had increased because of taking part.

1.3.7 The project demonstrated that a CI solution to archaeology's reconnaissance challenges has the potential to create a step change in data collection, with a demonstrable increase in social impact, as part of a cost-effective process. This project builds iteratively on those insights, expanding the model across multiple case study areas and addressing its limitations. Importantly, the process of validation will be explored and tested, developing a robust process and confidence metrics which will allow new heritage information to be seamlessly integrated into relevant heritage information systems and professional databases.

1.4 Project scope

1.4.1 The ambition of this project is to explore the potential impact that trained citizen scientists could have in the large-scale discovery and mapping of cultural heritage. It is driven by a need to create

sustainable and effective solutions able to support land use transformation projects responding to climate change, carbon capture and Net Zero agendas. The scope of the project focuses on the delivery of three case studies, tailoring an online community mapping platform and training resources to three case study areas, each utlilising existing LiDAR data, heritage information (HERs) and other data layers (such as historic mapping, PAS data, satellite imagery). Case study areas are provided by National Trust, and provide an opportunity to create an authentic participatory opportunity with real impacts for the management of areas through transformations expected as part of the governments Net Zero plans.

1.4.2 An online mapping platform will be built and data imported relating to each of the case study areas, supported by tailored controlled terms and worked examples for each. Citizen scientists will be trained to recognise, record and describe archaeological features using mapping tools, and new and enhanced descriptions of archaeology will be verified then validated through a process of crowd and expert-led ground observation. Throughout delivery, the project team will consult widely with practitioners, participants and the Project Advisory Board to inform and document the process. Building on our experience of the pilot project, the project will review how emerging technologies, such as AI, can enhance or support the proposed CI model. A robust evaluation framework will enable assessment of impact, and confidence metrics defined as part of the consultation process will be used to assess efficacy and quality of project outputs.

1.4.3 The following section describes key stages of delivery for the project, as well as for the development and implementation of the community mapping platform. It describes the methods used within each of these stages, providing supporting details from the pilot study where relevant and highlighting links to research aims and objectives.

2 PROJECT AIMS AND OBJECTIVES

2.1 Project model

2.1.1 This document has been prepared as a Project Design supporting a project funded by Innovate UK, NLHF Innovation Fund and the Young Foundation. The project will build on the work of the NESTA funded Deep Time pilot project, establishing that the successes gained represent a repeatable, consistent methodology. It will expand on the scope and range of the pilot, developing the system into a robust solution for Net Zero scale problems in cultural heritage resource management. The project will be delivered by DigVentures and collaborative partners, in close consultation with a Project Advisory Board made up of heritage professionals from across the sector (see project team, Section 5.1). The project model is structured with four research aims underpinned by a series of objectives (Sections 2.2 – 2.5) and supported by a clear project methodology (Section 5). The project model is articulated in Appendix 1, linking the research aims and objectives described below with methods, outcomes, and products (Appendix 1, Table 1). The model also articulates how aims are supported by the delivery tasks, resources and milestones (see Appendix 1, Table 2). The project delivery partners programme is described in Section 4, and details of individual products can be found in Section 7.1. Finally, project costs are outlined in summary in Section 9, with a detailed outline presented in Appendix 2.

2.1.2 This Project Design has been updated following comments and discussion with Historic England, and has been resissued to comprise an initial funded execution stage which will result in an Updated Project Design. The updated project model comprises five work packages, including Project Design (Stage 1, current stage) and Discovery and Infrastructure (Stage 2, intial execution stage). This Project Design also provides an outline of Stages 3 to 5, with indicative tasks, methods and resourcing. The outputs

of Stage 2 will comprise an Updated Project Design incorporating detailed breakdown of each work package, alongside good practice guidance focusing on collaborative design processes. This newly identified output will build on the process of Design Sprints planned to be delivered with invited stakeholders within the Discovery and Infrastructure process (Stage 2), and will be added to as the project progresses to share knowledge gained through each stage of project delivery.

2.2 Aim 1 – Discovery

2.2.1 In the delivery of Aim 1, the team will look to understand two key questions - what does the profession need, and what does the crowd want. Principally realised through desk-based research and consultation, this aim will produce a comprehensive analysis of crowd (CI) and machine-based (AI) methodologies in archaeology, with an emphasis on mapping archaeology using ALS data and the production of large datasets. Despite the AI element of the pilot scheme being disappointing, we will continue to explore the potential of CI/AI applications towards big data collection projects with a deskbased study and consultation, so elements of this study angle are retained within the PD. Discussions with practitioners will focus on professional confidence in the collection and integration of big data sets through these methods, as well as the use of data once integrated. Consultation will also involve community participants, responding to feedback from the pilot project as well as assessing how frameworks such as the ten principles of citizen science can be embedded in community mapping projects. Reintegration of project data to HERs will form part of the discovery process of the project, and is an important but complex issue. Our aim is to engage case study areas which provide the opportunity to pilot these issues, and the results of that will then feed into the delivery stages and confidence ratings. Case Study areas will be discussed with the HE team to ensure we are all confident we have the right opportunities to test this area. Case study areas will be finalised which are able to meet the needs of the project and our stakeholders. Specific research objectives which underpin Aim 1 are:

Q1: What examples exist of Collective Intelligence (CI) / Artificial Intelligence (AI) generated big data being used in archaeology, heritage or other sectors which contribute to professional practice?

Q2: Are we able to identify principles (eg MIDAS compliance), quality metrics and confidence ratings which professional stakeholders consider relevant to underpin or signpost integrity of data and which can used to measure baseline heritage data and that produced using CI / AI methods at different stages in the process (identification, mapping, metadata collection, verification, and validation)?

Q3: What does a FAIR approach to digital data mean for archaeological mapping projects? What processes, standards (eg Forum on Information Standards in Heritage (FISH), MIDAS Heritage compliance), metadata (collection, contextual and descriptive) and project details should be documented in a data management plan to a support access, interoperability, and re-use of data, including reingestion into the HER?

Q4: What do citizen scientists need and want to support their active involvement in high quality archaeological research projects? What are the implications for the Deep Time project, can this be built in to the platform and project delivery to ensure needs are embedded from the outset?

Q5: Can we engage delivery partners to facilitate access to three case study areas able to meet the needs identified in Q2 – 4, and to demonstrate the potential effectiveness of the proposed platform for land transformation projects responding to climate change, carbon capture and Net Zero agendas?

2.3 Aim 2 – Development

2.3.1 Using the insights gained from Aim 1, the research focus of Aim 2 will look to the development of the Deep Time platform itself. In meeting the research objectives for this aim, we will identify how the research findings of the discovery process can be built into a platform designed for both people and data. Once actioned, the platform infrastructure underpinning the generation of new data will meet the needs of professional and public stakeholders (HER, OASIS etc). This will include the data framework as well as resources to support implementation of the platform. Research objectives supporting this aim include:

Q6: Which technical features supporting needs of both people (crowd and stakeholders) and data (including creation, verification, and validation) can be developed to support successful mapping of archaeological features, collection of data / metadata and its export / re-use, within the Deep Time platform?

Q7: Are we able to identify and prepare structured and unstructured data sets, mapping and data layers (eg HER data, PAS data, background mapping layers and historic mapping layers) to support analysis of each case study area identified, and easily integrate them within the web-mapping portal?

Q8: Can we create simplified yet comprehensive data schema using controlled terms, compliant with the MIDAS Heritage Data Standard (2012) and using FISH terminology, to embed within a metadata collection tool and tailored to support mapping of each case study area?

Q9: What resources are needed to support the training of citizen scientists in recognition, segmentation, and description of archaeological features within case study areas (eg training materials, mapped exemplar areas)?

2.4 Aim 3 – Implementation

2.4.1 Following the development of the platform and integration of mapping layers with training resources (Aim 2), Aim 3 will determine how the crowd can be trained to identify, map and describe archaeology within the online platform, then helped to analyse and verify mapping results. Research objectives will explore how planned audience engagement provides an important tool in ensuring an inclusive and targeted cohort of citizen scientists, as well as documenting the degree to which that cohort can be successfully trained in the archaeology mapping exercise. Digital and real-world effort will be made to identify and recruit Pastronauts from the locality of Case Study areas to facilitate local 'Levelling Up' and ensure geographical parity and inclusiveness. The delivery of the training and tasks will have an impact on the timely completion and quality of results, including the extent and nature of cohort management and mentoring. Finally, the process of asset verification and data validation will be explored and fully documented in terms of how the platform records these processes and the extent to which the trained citizen scientists are involved in them. Research objectives for Aim 3 are:

Q10: How can we ensure that a diverse range of participants feel able to contribute to the project? Can specific groups be engaged which meet audience targets of stakeholder organisations, including underrepresented groups or specific demographics within the population? How can this be recorded?

Q11: Can citizen scientists be trained and supported to identify and map archaeology across different case study areas and landforms, within a predictable timeframe?

Q12: How can the crowd and workflow tasks be managed to avoid duplication of effort and maximise participation from all citizen scientists involved, with mapping activity spread evenly across the cohort of participants?

Q13: Can the process of verification (such as completion of records, selection of monument types, and accuracy of segmentation) and validation (reviewing accuracy in identification) be performed and documented against pre-defined quality metrics and confidence ratings? To what extent can trained citizens scientists be involved in this process?

2.5 Aim 4 – Analysis and evaluation

2.5.1 The final research aim will undertake analysis and evaluation of the platform and its ability to create social and research impact. An evaluation framework will be created at the start of the process which includes an audience and communications strategy, theory of change and standards of evidence, tailored to this project and linked to each of the three case study areas. Qualitative and quantitative data will be collected, presented and analysis to enable evaluation of the project and evidence its impact. The usability of data will be tested, working closely with project partners to assess how data can be reinvested into heritage environment record systems, and used by project teams. The project team will make a series of recommendations to stakeholders linked to community mapping projects and use of data generated from similar methods. Specific research objectives include:

Q14: Can an evaluation framework, including a theory of change and standards of evidence, be formulated which drives the collection and analysis of quantitative and qualitative data to demonstrate both social and research impact?

Q15: Can quantitative and qualitative data be collected, presented, and analysed to measure and evidence research impact and social impact?

Q16: Can mapped archaeological information be successfully reinvested back into HERs systems of project partners?

Q17: What recommendations can be made to stakeholders regarding community mapping projects and considering the delivery and results of this project? Can we provide good practice guidance to aid delivery of simliar projects in the future?

3 BUSINESS CASE AND PUBLIC VALUE

3.1 Introduction

3.1.1 The Deep Time project presents an opportunity to develop a robust methodology able to address major challenges for heritage resulting from climate change and the Net Zero agenda. The project model will be developed in close consultation with sector representatives (Project Advisory Board, see Section 5.1), heritage professionals and those working with the big data and citizen science projects. At the same time, public stakeholders will co-produce archaeological research as trained volunteer participants (crowd intelligence, see Section 5.7). As such, the project focuses on two key areas of prime relevance to the heritage sector: climate change and the Net Zero agenda (Section 3.2), and co-production and participation in archaeological research (Section 3.3). In addition, the project directly contributes to several Historic England priorities (Section 3.4) and has the potential to have wider impacts both within and beyond the heritage sector (Section 3.5).

3.2 Climate change and the Net Zero agenda – the need for a rapid solution

3.2.1 A significant proportion of the UK land mass of 240,000 km^2 is managed or under stewardship of bodies/schemes who A) protect land and B) are motivated by public engagement. These include National Trusts, National Parks, Forestry Commissions, Historic England, RSPB, Environmental Stewardship Schemes, AONB and Local/National Reserves. Together managing 94857.9 km^2 of UK land and coastline (plus 4000 km^2 by 2030 following UK "30 by 30" commitment), they also have a role in meeting land transformation Net Zero priorities which currently includes a minimum of 771 km^2/pa to 2030 (combining reforestation, peatland restoration and countryside stewardship: Environmental Land Management (ELM scheme), Scotland peatland restoration, England peatland restoration, tree planting across UK). In addition, management of heritage vulnerable to climate change is difficult to model but will require a comprehensive evidence base to support effective decision making. Mapping archaeology is needed to identify key risk areas and inform mitigation responses. A recent publication highlights the needs to develop assessments across Europe (EAC Paper 17, 2022).

3.2.2 To address both challenges, the ability to review and map archaeology across large areas ahead of land transformation projects will be vital (see Cowley et al 2020). Targets for tree planting across the UK and peatland restoration, require speedy reconnaissance to evaluate impacts on archaeology. In addition, major changes in global climate are stimulating coastal and terrestrial erosion, desiccation, and flooding, destroying vulnerable heritage (Cook et al 2019). Research has shown the need to identify areas of importance to local heritage (buildings, historic landscapes, buried archaeology) and evaluate potential impacts (ALGAO 2022, Historic England 2022). The potential cost effectiveness of the Deep Time platform means it could provide an affordable tool able to assess and map large areas. The pilot study demonstrated the successful application of AI in the recognition and mapping of possible archaeological features (also see Cowley et al 2020), but that the 'human in the loop' model was not wholly effective in training AI. However, the potential to utilise AI as a rapid reconnaissance tool, pre-scanning large areas to identify targets for more detailed commuity mapping, could be extremely beneficial. A combined CI / AI model could present a powerful opportunity relevant to public bodies and charities currently facing this challenge with limited resources. As such, the application of AI and machine learning to support this process will be reviewed as part of the project discovery phase (Stage 2), inlcuding both desk based review and consultation with interface projects.

3.3 Public stakeholders – co-production and participation

3.3.1 Public engagement, user experience and the positive impact that meaningful participation can provide, adds social value to the project. The citizen science approach of this project supports authentic participation in heritage, a strategic area for the Historic Environment Forum, which recognises the importance and interface between the two key areas identified here – participation and public benefit; and the need to shape positive impacts on the climate emergency.

3.3.2 Historic England's Public Value Framework requires projects to demonstrate awareness of stakeholder groups and what they want, as well as knowledge of user experience, and commitment to public participation. The project has these aspects baked into delivery from the outset, with a strong thread of consultation with both practitioner groups and participants included as a key method for delivery (Section 5.2). Consultation will allow the team to build and adapt our project tools, and feedback collected from the pilot project will inform initial set up stages. The human-centered approach to both platform design and participatory opportunities will enhance user experience and ongoing discussion with user groups and our citizen scientists.

3.3.3 Beyond designing for participation, our evaluation framework (Product 2) will clearly articulate how the project intends to achieve and demonstrate our impact, with a combined Theory of Change and

Standards of Evidence which outlines intended outcomes and outputs for participants and stakeholders (Aim 1, Q4; see Section 6). This framework will be informed by discussions with case study partners and Project Advisory Board, incorporating the strategic audience development needs and underpinned by an open ethics and values statement (Product 4). As well as being an integral element of the project delivery methods, our model of co-production and participation will also help to maximize value from charitable and/or publicly funded bodies or projects (such as collection of high resolution lidar data), at the same time facilitating organisations to reach non-traditional audiences with tech-enabled, home-based volunteering. An example of how the project can support organisational aims would be the incorporation of lifelong learning opportunities which aim to equip working age volunteers with the development of transferable skills, a key strategic objective for the National Trust (Challis, pers comm).

3.3.4 Two recent HE documents highlight areas relevant to public participation with heritage that this project will address. *Heritage and Society 2020* presents evidence about the value of heritage to society, individuals and community groups across England. The Historic England report recognises that heritage fosters a strong sense of belonging to places, and encourages behaviors of stewardship, conservation and protection of natural resources and historic places (2020, 19). Being engaged with heritage volunteering can improve quality of life by offering social and economic benefits for participants and can also support wider social cohesion (ibid 28). Making online heritage resources available as part of learning and skills programmes is seen as providing more equal access to digital learning for younger people and projects that support the understanding of local distinctiveness are seen as especially important as they create a sense of belonging and identity.

3.3.5 A second report, HE's *Heritage Recovery Plan* (2021) outlines actions needed to help the sector return to sustainable operation and contribute to the country's recovery (2021, 1). Though principally a call to action for those in government and working across the sector, the report makes key observations which underline the potential contribution that projects like Deep Time can make towards the resilience and recovery of the cultural heritage sector, such as:

- Providing opportunities for local communities to take more proactive approach to managing their local heritage.
- Without broadening its audiences and become more relevant to all of society, heritage organisations will be recruiting from an ever-decreasing supply of potential volunteers.
- Looking ahead and increasing the understanding of the principal threats to heritage assets (and the human and financial resources required to sustain them) will enable the sector to develop better mitigation strategies and target resources where they will make the most difference.
- Better co-ordination, training and resourcing is needed to support a range of local groups across England who actively care for their local heritage via monument management or adopt-a-monument schemes.

3.3.6 At a broader level, the project articulates with the European wide Amersfoort Agenda, particularly the ambition to stimulate and facilitate society's involvement in archaeology, and connecting archaeology with current policy and societal challenges. Our proposal is therefore situated to significantly contribute to Historic England's mission and strategy, as well as European agendas for cultural heritage.

Figure 1 – Volunteers at Moorsholm, North York Moors National Park, starting to excavate a newly identified feature recorded following assessment of the closed space Sirius LiDAR. Community excavation has recovered evidence for later Neolithic/early Bronze Age activity at the site, and a possible Mesolithic camp.

3.4 Historic England – strategic activities

3.4.1 The project contributes directly to key areas within Historic England's Corporate Plan 2021-22, namely Strategic Activities 2, 5 and 7. Specific Tier 2 activities which the Deep Time project is relevant to include; the clarification of threat and risk to the historic environment (2.2), building capacity to make the most of the HE (2.3), lead innovation in heritage protection and conservation (2.5), building capacity in communities (5.2), provide opportunities for volunteering (5.3). Significantly, the project can contribute directly to all activities within Strategic Activity 7, expanding the digital availability of our assets to improve access, participation, and user experience. In addition, specific case studies could be targeted within the project, that could support engagement with and management of assets within the National Heritage Collection (12.2).

3.4.2 Historic England's Research Strategy (2017) defines nine broad themes and several research outcomes which aim to deliver impact for the wider heritage sector. Key outcomes which are relevant to this project include:

- The positive effect of the historic environment on society, the economy and individual well-being.
- The values communities attach to their heritage are better understood.
- Harder-to-reach communities and demographics are more engaged in the heritage mainstream.

3.4.3 The Historic England *Future Strategy* (2021) is also relevant, with three key areas of focus comprising thriving places, connected communities and active participation. The Deep Time project will be especially effective in engaging community members with their place, offering a digital approach to enabling collaborative and participatory research between individuals, professionals and heritage organisations. Participation can also involve targeted audience groups, working closely with our case study partners and the Historic England team to activate key demographic groups in mapping archaeology and enriching heritage information.

3.4.4 In addition, the collaborative initiative to sustain and promote the historic environment in England, *Heritage 2020* was launched in 2016 (Historic Environment Forum 2015) and aimed to encourage collaboration and partnership to add value to the work of individual organisations across the historic environment sector. Whilst not a formal research framework, the programme delivered a series of working groups focusing on key challenges faced within the heritage sector. The public engagement working group identified that that 16-25 age group was particularly under-represented in terms of engagement with heritage and highlighted the lack of diversity in the historic environment as a cross-sector issue. There is an opportunity within tech-enabled and multi-strand projects such as Deep Time to target unrepresented audience groups, increase diversity and widen opportunities for inclusion in line with strategic objectives of partner organistions.

3.5 Wider sector impacts

3.5.1 Delivery of the project has wider relevance to the heritage sector and beyond, with applications which will inform and stimulate discussion around several relevant topics, including the following key areas.

- *Collaborative crowd-sourced methodology:* The CI / AI platform and project model supports effective collaboration between trained citizen scientists, professional archaeologists, local authorities, HERs, public bodies, and national agencies. The interface harnesses the crowd to tackle big challenges using geolocated datasets where change is visible using satellite imagery - a scenario not restricted to archaeology or heritage.

- *Artificial intelligence and rapid mapping of archaeology:* Our previous pilot demonstrated the use of an AI interface supported by training data created through community participation. Whilst the process discovered challenges within a 'human in the loop' model of machine learning, the process of data enhancement does potentially provide a cost-effective means to train AI in the recognition of key archaeological signatures across diverse landforms. In addition, the confidence metrics developed as part of the current project (see Aim 1, Q2) will provide a robust framework which could be applied to any nontraditional big data collection methods, especially for mapping of archaeology across large scale areas.

- *Applications beyond archaeology*: The platform could be applied to address other challenges outside of archaeology and heritage management including:

  - Climate change and natural heritage, mapping impact on landscapes, such as coastal and terrestrial erosion. The project data created within the CI provides usable baseline survey data for large landscape areas.

  - Sustainable tourism, mapping impact of tourism on landscapes, such as footpath erosion.

  - Habitat detection, mapping change at protected/at-risk habitats, such as ancient woodland or peatlands.

  - Estate management, supporting inspection of farming landscapes against criteria defined by government policy to monitor effective public investment.

4 STAKEHOLDERS AND INTERFACES

4.1 Stakeholders

4.1.1 Key stakeholders include:

Project delivery partner bodies:	*Stakeholder organisations:*
National Trust	NT
	ALGAO (esp ALGAO HER Committee)
	CIfA
	DEFRA
Direct stakeholders include:	HES
HER Officers	Cadw
Local authority archaeologists / curators	RCAHMW
Archaeologists (eg landscape stewardship roles)	HERoNI
Citizen science / archaeology specialists	CBA
AI / archaeology developers	Private estate landowners
Citizen scientists / general public	Landholding / stewardship organisations

4.2 Interface projects

4.2.1 Several interface projects or organisation initiatives have been identified which are relevant to the Deep Time project. These include those using nontraditional methods such as citizen science methodology and / or AI to collect big data, undertake large scale archaeology mapping projects or demonstrate a similar commitment to citizen science, open data and FAIR research principles.

- HE – Aerial Archaeology Mapping Explorer, open access tool that displays archaeology that has been identified, mapped and recorded using aerial photographs and other aerial sources across England.
- HES – rapid archaeological mapping programme (RAMP), landscape archaeology mapping team enhancing the mapping process and rapid ingestion of GIS data into Canmore, HES.
- The Discovery Programme, Ireland – working actively to facilitate collaboration within and beyond the profession and fostering the recognition of the wider value of a collaborative approach in Irish archaeology, recently launched a new collaborative LiDAR project funded by Transport Infrastructure Ireland (TII).
- Know Your Place, Bristol and West of England – map based website that allows members of the public to explore neighbourhoods through historic maps, images and linked information
- Dig Digital, CIfA – FAIR principles, access and reuse of data.
- Heritage Quest, Leiden – The Heritage Quest project is a citizen science project in which volunteers participate in archaeological research.

- University of Cambridge, Mapping Archaeological Heritage in South Asia (MAHSA) – remote identification of cultural heritage sites that could be at risk today and in future in the Indus River Basin and surrounding regions. Combining planetary-scale satellite imagery and machine learning to explore new, sustainable solutions for the management of archaeological heritage.

- Arch AI and National Trust, AI Mapping of orchards, using machine learning to respond to nature and biodiversity crisis through mapping historic orchards.

- Greenmap.org – community mapping for engaged and active communities. Established by Wendy Brawer in 1992 and using a shared iconography, green map makers are a global network of open access and shared community produced maps.

5 PROJECT SCOPE AND METHOD

5.1 Project Advisory Board

5.1.1 A Project Advisory Board (PAB) will be engaged during the project Discovery Stage (Aim 1) and will include representatives of key stakeholder groups as well as those suggested by the HE team. The Advisory Board will have access to a cloud-based project group via Knowledge Hub, providing access to documentation, discussion, and feedback.

5.1.2 The engagement of the PAB will add a layer of advice and feedback to the project from the outset, working with PAB members to review the project model, development, delivery and outputs throughout the programme. The PAB group will be invited to attend project discussion workshops at key stages within the programme, helping to shape and inform delivery, and to understand and enhance impacts where possible. Specific research aims that will directly benefit from support and input from the Advisory group include Aim 1 (Q1 – 3, 5), Aim 2 (Q8), Aim 3 (Q13) and Aim 4 (Q14-17). Outcomes of PAB meetings will be included in project highlight reports. The PAB will be finalised and hold its initial meeting during the Discover phase of the project (Stage 2, Section 8).

5.2 Collaborative design

5.2.1 Design sprints are a rapid process for cross-functional teams to brainstorm, define, and model new approaches to strategic business and operational challenges (see Appendix 5 for design spring methodology). They will typically include 7 to 10 participants, drawn from the project team, case study partners, key stakeholders and funders. The outputs of the design sprint (such as notes, user journey maps, story boards, workflow diagrams) enable the team to clearly define goals, validate assumptions, and determine a roadmap before commencing the development or build stage of the project. The Deep Time project will adopt and adapt Nesta's Collective Intelligence Playbook, facilitating online zoom sessions, break out rooms and collaborative Miro boards to collate participant contributions. Nesta's playbook comprises a series of structured design canvases and tools aiming to harness the power of people, data and technology to enable organisations and practitioners to address sustainable development goals.

5.2.2 This stage will be structured into five design sprints: (1) defining the challenge; (2) gathering information, data and ideas; (3) mobilising people; (4) connecting and interpreting; (5) creating change. In addition to informing the updated project design (P2) and underpinning Project Stage 3 (develop participatory GIS mapping platform), sprints will contribute to a series of good practice guidance notes for citizen data projects in the historic environment which we intend to create as a project outcome (Product 15). This will aim for a broader relevance than the specific Deep Time project use case,

detailing other successful case studies within and adjacent to our sector to identify FAIR workflows for projects which create big data through citizen science and other non-traditional methods (P15).

5.3 Consultation – practitioner and participant

5.3.1 Consultation workshops will be held with a wider group of project stakeholders, including representatives of project partner groups, interface projects, heritage professionals and relevant sector organisations (Practice based consultation) and citizen scientists (Crowd based consultation). Consultation methods will contribute significantly to Aim 1 (Q2 – 5), Aim 3 (Q13) and Aim 4 (Q16). Our aim is to engage practitioners and participants to take part in online discussion sessions, supported by survey methods. Similar discussion workshops have been delivered successfully by the project team as part of wider consultation for previous HE funded projects, including Dig Digital (7796), Metal Detecting (7851) and the ACE funded Sustainable Options for Archaeological Archives project. We propose to use a similar methodology during the delivery of the Deep Time project, providing consultation and feedback throughout the programme. A communications plan will outline how audience groups will be engaged and retained throughout the project delivery (Product 2). Wider consultation will also take place through dissemination opportunities identified in this project design and as the project delivers (see Section 7.2).

5.3.2 A survey will be undertaken during the Discovery phase (Stage 2) to gather views on the collection and use of community mapped heriatge data, and other relevant techniques such as AI, to provide a baseline for expectations and perceptions of similar projects. Desk based research and consultation will inform the development of a framework of quality metrics and data confidence ratings which the project team will adopt to support dissemination and reuse of results (Q2). Consultation workshops including the PAB and wider practitioner audiences will be designed to understand which metrics professional stakeholders consider most relevant to underpin or signpost integrity of data. This framework can then be used to measure baseline heritage data used for case study areas (Q7) and to provide data to accompany information produced using crowd methods at different stages in the process (identification, mapping, metadata collection, verification, and validation – Q11, Q13).

5.3.3 The project will be delivered with a strong ethics framework, including an ethics and values statement linked to both to participatory research and to archaeology, and a commitment to user-centred design, design thinking processes and FAIR principles (Aim 1, Q4). These existing and well utilised frameworks can offer tried and tested methodologies for the creation and delivery of citizen science projects which are supported by a suite of tools and resources developed from user-centred design approaches. Particularly important to this project are the methodological approaches enshrined in the ten principles of citizen science, FAIR principles for digital research data, CIfA code of conduct and user centred design principles.

5.4 Case study areas

5.4.1 An important stage in meeting our discovery objectives (Aim 1, also Stage 2) will be finalising case study areas which meet the needs / wants identified through consultation, and are also able to provide the breadth of data / landforms and monument types to offer a suitable project area (Aim 1, Q5; Aim 2, Q7). The National Trust is engaged as a case study partner and potential areas for inclusion are summarised below:

- **Wallington – a 54 km^2 area in Northumberland, with specific project relevance associated with ongoing peat reclamation and forestry management.**

  National Trust staff liasion – Mark Newman

- **Peak Group – a total of 123 km^2 of National Trust property distributed across the Peak District National Park and vicinity.**

  National Trust staff liasion – Janine Young, Philippa Puzey-Broomhead

- **Purbeck and Studland – 27 km2 area of mixed landscape on the south coast of Dorset.**

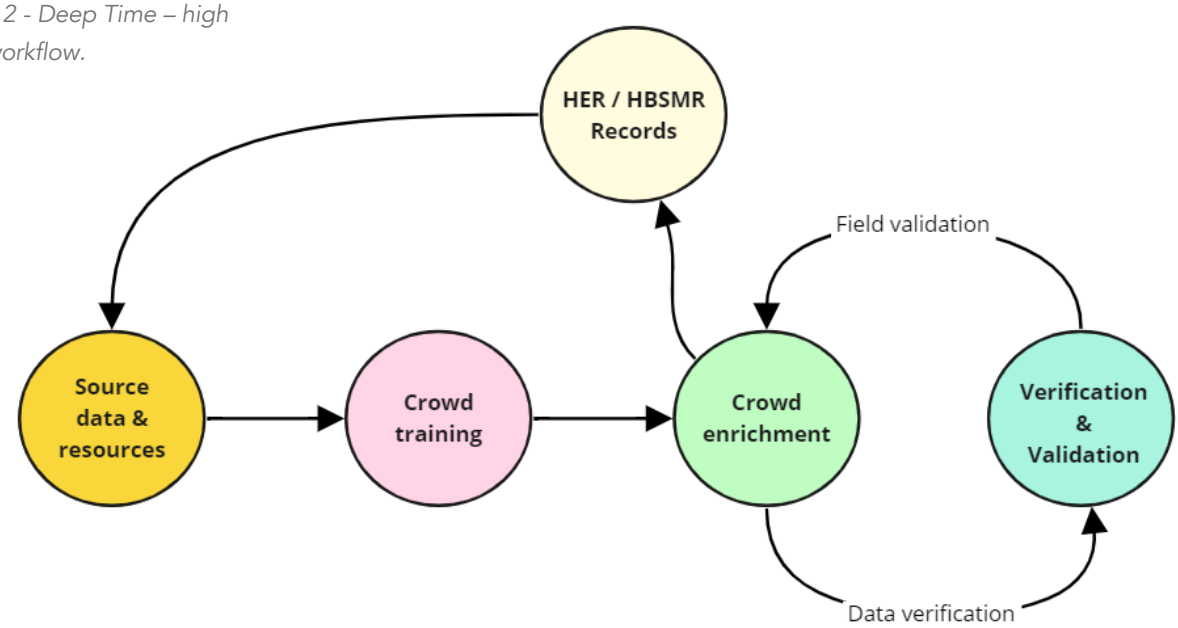
  National Trust staff liasion – Martin Papworth

5.5 Participatory GIS mapping platform: technical background

5.5.1 The platform uses the WordPress content management system to bring together learning resources and the participatory GIS platform. No additional software downloads are required for users to access and use the various data layers or supporting tools. Prepared datasets are imported in the web-mapping platform and can be viewed, interrogated, and annotated within the resource frame, or a full screen view to maximise visibility. Training resources, exemplars and supporting documentation are embedded within an easily navigable system, allowing users to toggle between learning materials and mapping layers (see below). A high level workflow illustrates the platform model (Figure 2) and the following sections describe the methods used within each of the main work stages.

5.5.2 The web mapping functionality provides the ability to import and easily compare layers of geolocated information. The map viewer and crowd mapping functionality use Humap Placemaker, which combines best practices from GIS, user experience design and web accessibility (as defined by W3C WAI 2.1 Level AA compliance). The platform is built on a PostGIS database, a Ruby on Rails backend, GraphQL middleware and modern javascript frontend. Data is transferred securely to the web user interface using an open-source GraphQL middleware called Hasura, which gives scope for reading and writing only the data required for the specific activity. The frontend web application is built in React. Industry standard approaches to performance management, caching and data security are used throughout the product. Users (community participants and project team members) can create and store any geographic primitive on the map– points, polygons and lines - which are saved directly into the PostGIS database. These shapes will then be enriched with metadata, provided by project participants and inputted using input forms with embedded controlled or standardised vocabularies (FISH thesauri) or, where appropriate, free text descriptions.

Figure 2 - Deep Time – high level workflow.



5.5.3 There is a comprehensive admin interface for the project team to manage and add their data. Bulk transfer from third-party systems can be facilitated using an ETL (Extract, Transform and Load) pipeline, available for sources as disparate as CSV files, collections management systems, and other databases. Data created can be exported in any standard geodata format: GeoJSON, shapefiles, vector tiles for web maps, and many others. The data is stored using the *EPSG:4326* coordinate system but can be converted into other systems and re-projected as necessary.

5.5.4 Performance is ensured using caching, batched requests, asynchronous tasks and vector tilesets for map display, and makes heavy use of cloud technologies to ensure the site performance remains consistent for large traffic volumes. Humap is a multi-tenant solution with strong guarantees of logical data segregation underpinned by a robust quality management process for feature development: data typing, automated testing, CI/CD pipelines and code reviews are all used to ensure consistent quality. Data centres and providers used adhere to ISO 27001.

5.6 Platform data: structure and layers

5.6.1 During the discovery phase (Aim 1, Q3) a Data Management Plan will be produced in line with CIfA guidelines, providing a clear strategy and plan for all levels of metadata, as well as the organisation and storage of files, which can then be accessed and discussed with stakeholders as the project is delivered. A DMP will be produced for each case study area to ensure it is relevant to unique circumstances in each example.

5.6.2 Digital heritage data will be obtained from case study partners and added to QGIS to undertake data review and audit by the project team (Aim 2, Q7). The audit will be based on quality metrics developed in the discovery phase (Aim 1, Q2), and will enable a clear understanding of the fidelity, accuracy and completeness of baseline data, to facilitate comparison with that produced by community participation. The audited data will be filtered into polygons, points and lines and split further into periods, using controlled terminology (FISH), from the Mesolithic through to Post-Industrial (Aim 2, Q7). This audit will establish a baseline of the quantity of known archaeology across each case study area, helping to establish the extent and significance of different monument types and period classifications. A detailed data schema will be developed with the project team and case study partners, defined from what is recorded in pre-existing HER datasets for each area. The team will create a more focused and user-friendly set of controlled terms to form the framework for monument description (Aim 2, Q7). This will provide a standardised vocabulary and thesauri for the metadata collection tool which will be used across the project that is fully compliant with MIDAS heritage data standards and will use the FISH thesauri.

5.6.3 In addition to a background mapping layer, which uses Open Street Map data, additional datasets can be easily integrated, for instance unstructured mapping layers such as historical maps from National Library of Scotland subscription and / or Ordnance Survey maps. Structured data, such as shapefiles from national scheduled monument data or Portable Antiquities Scheme data can also be added to provide a comprehensive account of known heritage assets and findspots across the region (Aim 2, Q6 - 7).

5.7 Crowd intelligence: training, resources and management

5.7.1 Community participation and research will be supported through a comprehensive training resource embedded within the platform and delivered as an online course (Aim 2, Q9). The course structure has been tried and tested through the DigVentures virtual learning environment platform which can accommodate large numbers of active participants at any one time. The Deep Time platform enables

participants to register interest and provide some information to help project delivery teams widen audiences (Aim 3, Q10). For example, participant recruitment for the Deep Time / Brightwater project was extremely successful, with 970 applications received for 100 participant places. This enabled a final selection of participants to be equitably split along age, gender, socioeconomic and the ethnic backgrounds. Other selection criteria included geographic location (with half of participants locally based) and previous experience (26% of participants had no experience of archaeology, and 65% only on a voluntary basis).

5.7.2 The training programme is structured around five chapters which are designed to train a cohort of community participants over the course of 10 weeks (Aim 3, Q11). Delivery of training can then take place over a clearly defined period, supported by mentoring sessions and prompts to encourage participation within the cohort chat function, encouraging peer-to-peer support, creating new contacts, and developing confidence as they use the mapping tools. The course materials will be structured around five key chapters, which can be tailored to include content unique or relevant to each project area. Each chapter will contain a series of sub-topic learning modules with introductory and tutorial videos and screencasts, along with a wealth of links and resources to dig deeper, with a quiz at the end to help reiterate learning points.

- *Chapter 1 – What is Collective Intelligence?* This chapter will highlight how archaeology can be part of the movement to involve communities and the power of people to tackle our most pressing social and environmental challenges.

- *Chapter 2 – Introducing GIS and LiDAR:* In the last few years archaeology has been revolutionised by new digital tools that can help locate and explore sites without digging. This chapter takes a detailed look at two of them - GIS and LiDAR. The chapter will look at how the landscape can be viewed digitally as a series of different 'layers', helping to reveal the surface traces of what is buried beneath the soil.

- *Chapter 3 – Initiation and Launch:* In this chapter participants will discover how archaeologists describe and record archaeological features visible on LiDAR. The Historic Environment Record will be introduced, and course materials will show how different types of site are identified on each layer, introducing participants to the digital advances which are helping to speed up the discovery and understanding of archaeological sites. Worked examples of four areas will be included with training materials to introduce the types of archaeological feature our participants should expect to get mapping.

- *Chapter 4 – Mission Data Log:* This chapter introduces the purpose-built interactive GIS where citizen scientists can test their knowledge and get stuck into recording archaeological features. Working in teams, participants are able to review each other's work, refining map annotations and feature descriptions. Participants will also be given pointers on how to fully document their findings using metadata and be asked to indicate which sites they think would make the best candidates for additional validation options, such as ground observation or futher research. This process involves a desk-based verification process to ensure that mapping is both clear, comprehensive and supported by rich metadata.

- *Chapter 5 – Validation Methods:* The final stage of training will discuss how mapped data can be validated through additional desk based work or in the field ground observation. Citizen scientists will to join professional archaeologists in testing the findings of the participants as part of the data validation process. Online training content will introduce different methodws of validation, such as landscape survey, and discuss how the mapped data might be used, added to and integrated into

heritage systems. Participants will continue to have access to the results online and see how the validation data can be used to support ongoing management of heritage within the project area.

5.7.3 Chapters 1 to 4 of this learning model have previously been fully tested within the Deep Time pilot project (Brightwater). In that example, the crowd were given three weeks to work through Chapters 1 – 3, before beginning their investigations of the mapping layers in Chapter 4 and undertaking peer-to-peer verification of results. Within the pilot study, validation was undertaken as a professional data audit (see below). For this project, the team will develop additional training materials to support comprehensive verification of crowd mapped data and selection for field validation (Aim 3, Q11). Chapter 5 will therefore cover the survey techniques and process of validation for selected records, including how to update records with new information and metadata (Aim 3, Q13).

5.7.4 The chat function will be embedded as a constant feature within the training resources and has proven to be an invaluable tool for crowd enrichment. Participants can ask questions directly to the project trainers and to each other, sharing learning points as they progress through the portal discovering and mapping archaeology. This means that the crowd will be able to learn about the archaeology of the area as they develop and apply new skills in lidar review and transcription.

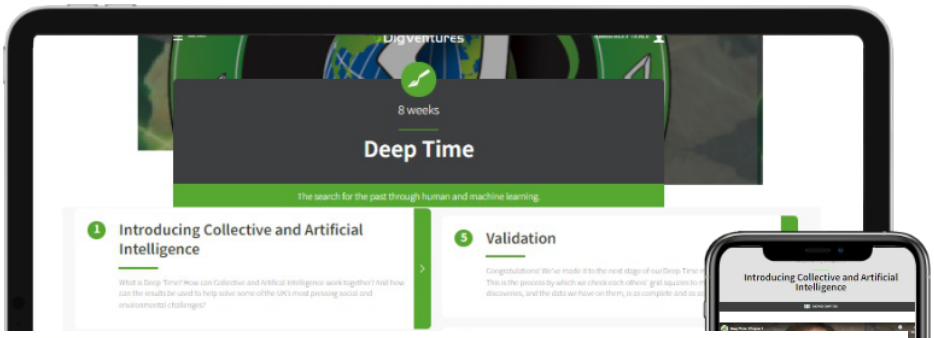


Figure 3 - Deep Time training resources can be accessed on smart devices and an embedded chat function is linked to different learning topics.

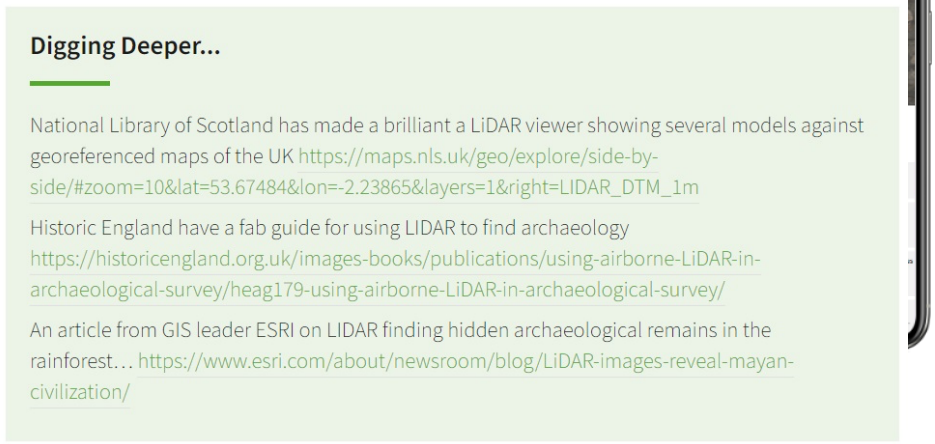


Figure 4 - Deep Time training resources – additional links signpost extra information and places that citizen scientists can explore further. This adds to the content and helps with pacing - providing lots of material for people to get stuck into.

5.8 Exemplars: Testing data structure, mapping, verification, and validation process

5.8.1 Training resources will be supported by the inclusion of worked examples, creating an exemplar dataset across areas selected with case study partners (Aim 2, Q9). The exemplar process provides an opportunity to fully test and implement the online mapping process, including the use of controlled terms used, use of online mapping tools, metadata structure, feature mapping information and functionality, and verification process (Stage 3). Example areas will also be validated by the team, with field survey and records updated appropriately, and the process documented with a step-by-step explanation which can then be embedded into training resources.

5.8.2 The exemplar areas will be distributed across case study regions and able to provide examples of key monument types, supported by a MIDAS compliant simplified list of controlled terms (Aim 2, Q8). The team will document the process of desk-based research, lidar review, transcription, and validation, providing a step-by-step illustrated set of examples (Task 3.6). Exemplar data can be exported and readiness for reuse can be tested with project partners (Aim 4, Q16). Rigorous collection of data, metadata and documentation through the exemplar process will also contribute to the creation of quality metrics and inform the development of usable confidence ratings to accompany the resulting data (Aim 1, Q2).

5.8.3 Where undertaken, field-based survey to review case study exemplar sites will be led by a professional team in collaboration with case study partners, undertaken to validate and record exemplar area sites on the ground using GPS survey (Aim2, Q9). Data collected in the field will be incorporated into the metadata for each monument and associated images uploaded to the record as appropriate. This will fully test the process of online record verification (which reviews completeness) and incorporation of validation notes (evaluating accuracy and fidelity). Supplementary data collected (such as images and notes) can be incorporated into the record. Any technical or process issues will be identified and can be addressed prior to launching to the participatory cohorts. Exemplars will also provide a fully worked example to supplement training materials.

5.9 Annotation and augmentation process

5.9.1 Through delivery of course modules, crowd participants will be trained in the recognition of key site types within the study regions, looking to both enhance existing information through provision of enhanced metadata and locate and describe new sites. Access to the interface is closely managed, avoiding duplication of work, and allowing citizen scientists to view the progress being made (Aim 3, Q12). This will be achieved by segmenting the area into 1km squares which participants can select and are able to see which squares are being reviewed by others. During the pilot project, the average number of feature identifications per participant was 36.7, with a longtail slant towards super users (80% of features were identified by 28% of participants).

5.9.2 A control panel allows citizen scientists to look in detail at different reference layers, such as the HER data, historic mapping and the different LiDAR models (Figure 5). Embedded metadata allows participants to query existing data, and a comprehensive toolkit can be used to add markers, create segmented polygons or trace visible features (Aim 3, Q11). Participants can add metadata to describe the feature(s) they have discovered using controlled terminology and standardised vocabulary (Aim 2, Q8). An example of the workflow can be seen here, as part of a training screen cast delivered within the Deep Time pilot project.

Figure 5 – Deep Time – Drawing layers, tools and embedded metadata

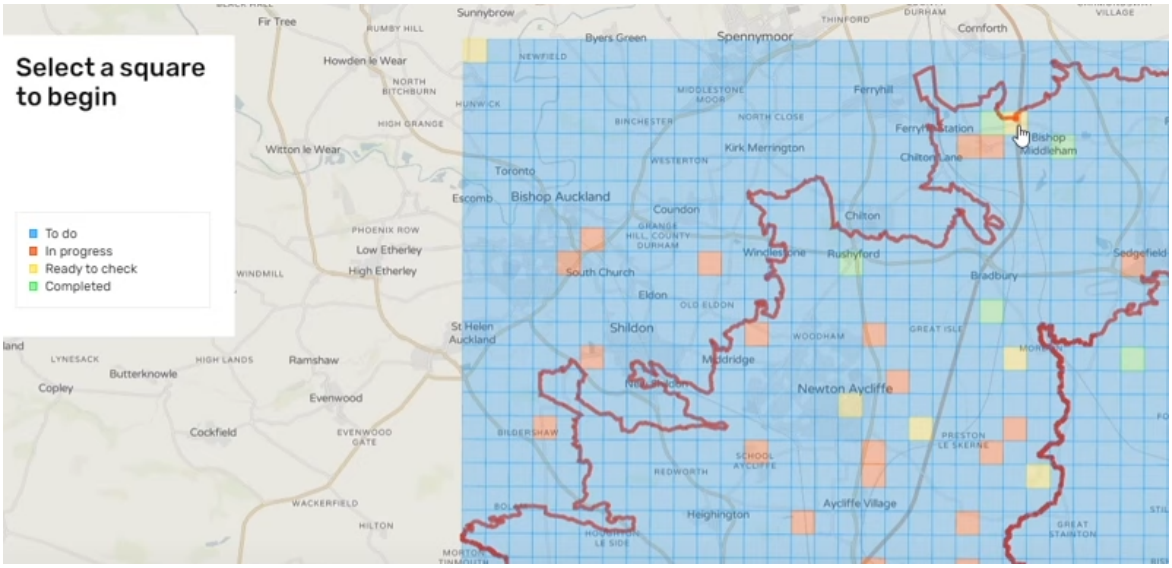
5.10 Record verification and data validation

5.10.1 The final stage of the online crowd mapping process is record verification (Chapter 4). At this stage, the project's community of trained citizen scientists will peer review the 1km squares which have been completed by other members of the cohort (see Figures 5 and 6). This process assesses record completeness and ensures that identified features are segmented correctly and accompanied by the appropriate metadata (Aim 3, Q13). Records can be signposted as appropriate for addition research to support validation, or highlighted as a target for field survey validation at this stage (where apprioriate). An access hierarchy of users and participants links user rights with certain actions, meaning more experienced users are able to comment, edit and amend both site segmentation and descriptions, always retaining an archive of original records. The project will test and document this process of peer verification and selection for validation, which may differ between case studies depending on the nature of the historic environment and monument examples, and in consultation with project partners. This process will contribute to the confidence rating which then accompanies the exported data (Aim 1, Q2).

5.10.2 Online verification is followed by validation, reviewing recommendations for additional and expert-led validation, including a professional data audit of an agreed sample of records. The process and extent of validation will be intrinsically linked to the confidence rating and metrics for data use and re-use identified as part of this project delivery (Aim 1, Q2). Each square is colour coded according to progress made, and once the peer verification process has been completed (see Figure 7), data audit and validation can start (Aim 3, Q13). Expert led data validation may continue into the field, the process for which will be discussed with case study partners with ground observation and survey adding to online records with additional media and notes (Aim 3, Q13). The record is then further enriched and provides additional information for the HERs, as well as informing future stages of community engagement and research.

Figure 6 – Deep Time – Screen grab from a live screencast of the verification tutorial, showing how site type data can be selected from controlled terms during this process

Figure 7 – Deep Time – Colour coding of each 1km square, which flags progress made and signposts verifiers to the 'ready to check' squares. This means the data completion and verification of metadata can take place as soon as a square is completed.



5.10.3 Where undertaken, site based validation could provide an additional opportunity for participants to learn the methods of ground-based survey. Participants able to attend in-person activities will be trained to undertake field survey, checking and recording features visited and undertaking basic condition surveys as appropriate (Aim 3, Q13). Field survey participants will be trained in how to input data, including location information, field descriptions and images, once they have been collected. Training resources will demonstrate field validation tools to all participants to contribute to the learning outcomes and the whole cohort.

Figure 8 – Landscape survey – DigVentures worked with the North York Moors National Park Authority as part of the Ryevitalise Landscape Partnership to train volunteers in survey and recording techniques. These participants joined us for a wintery weekend of walkover survey training, examining peatland for traces of eroding archaeology and earthworks.

5.11 Data structure, security and export

5.11.1 A comprehensive Data Management Plan (DMP) will be created during project setup and updated throughout the project, in line with deposition guidance provided by an appropriate Trusted Digital Repository (eg ADS) and designed to meet FAIR principles (Aim 1, Q3). Data will be collected to technical standards consistent with export, deposition, and ingestion into the partner systems and relevant HERs. Specific guidance and data standards relevant to the project will be listed in the DMP, which will be updated as the project progresses. The project will be supported by IT facilities and associated policies of DigVentures / Humap, who will provide technical hardware for the storage and management of the project data and implementation of the DMP during and after the lifetime of the project, including daily on-site and off-site data backups.

5.11.2 Data collected will include standard formats which maximise opportunities for use and reuse in the future. Collection Level Metadata will be completed, and file level metadata will be collected using a standard format. Data documentation will utilise existing metadata standards and refer to recognised heritage industry standards and utilise standardised vocabularies for metadata description including Heritage Data Vocabularies. Community participants will create rich metadata linked to new / amended LiDAR transcriptions following proforma embedded in the online toolkit. Each vector created as part of the digitisation process will have a metadata table attached and additional metadata fields will be recorded for vector files (see Table 1).

5.11.3 Data exports can be created at any point, but key outputs from this project will include the unvalidated crowd mapped dataset (Aim 3, Q11) and the validated crowd mapped dataset (Aim3, Q13. As described above (Section 5.3), data created can be exported in any standard geodata format: GeoJSON, shapefiles, vector tiles for web maps, and many others.

Table 1: Data management and documentation

Each vector created as part of the process will have a metadata table attached to it, which as a minimum, will contain the following information:	✓ Site type; Monument type; and Period ✓ What map layer was the feature identified in ✓ Description and comments about the feature ✓ Completed By; Validated By
When the data is imported into GIS, these metadata fields will come through as attribute data. Within the GIS, the following additional metadata fields should be recorded for the vector files:	✓ The data type, Point, Line or Polygon ✓ Origination of the data ✓ Projection system ✓ Co-ordinate system
The data collection process will be discussed with the partner organisations and HERs during the project discovery, and the Data Management Plan will inform management of the digital archive, which will contain:	✓ A description of all the files in the archive ✓ Line, point and polygon data and their relevant attributes that can be imported and read by most GIS software ✓ Image files that represent the data; and relevant report(s) ✓ Applicable metadata and relevant documentation ✓ Review process to consider record concordance and record duplication

Exported data will be accompanied by comprehensive and robust metadata and documentation, including, at a minimum:	✓ Collection level metadata ✓ File level metadata ✓ Documentation describing – data processing and ingestion – mapping process – verification and validation process – confidence metric and rating

5.12 Evaluation framework and methodology

5.12.1 Creating a lasting legacy should be an integral aspect of any archaeological venture and is central to the ethos of Deep Time (see Wilkins et al. 2022 for an applied example of the proposed framework). To engender and manage diverse participation, DigVentures has developed a Theory of Change comprising intrinsic outcomes for research to instrumental outcomes for participants and communities, paired with a Standards of Evidence Framework incorporating five ascending levels of surety that our work is responsible for the impact observed (Wilkins 2019; Wilkins et al 2022). Alongside the project's Theory of Change and Standards of Evidence, a range of quantitative and qualitative indicators will be measured in order to build a coherent picture of the project's achievements, underpinned by robust evidence. The evaluation must necessarily be formed of a mix of process assessments (that is, an element of action research to ensure that the programme develops successfully and is responsive to significant developments in learning and understanding as it proceeds), outcomes assessment and policy impact.

5.12.2 Outcome assessments will focus primarily on the volumes of participants entering the programme from targeted backgrounds, assessing awareness and interest in archaeological or heritage work at the outset and again when they leave the programme. Rapid feedback helps us understand our impact in real time through data dashboards shared with partners and stakeholders, pivoting activities if target communities are not being reached, or quickly scaling activities that successfully engage target groups. A distinction will be made between impact breadth and depth, to determine how effective the programme is in supporting young people from more disadvantaged and from BAME backgrounds. We want to learn from the evaluation what factors worked well, or less well, in promoting a more diverse participation in the collaborative archaeological programmes. From a policy and practice perspective, the project may be shown to have significant impact on the attitudes and behaviours of senior management, operational staff and volunteers in the archaeology sector.

5.12.3 As it will be important to assess the extent to which the sector has responded to these new participatory opportunities and why, feedback will be synthesised and refined on the basis of consultation during the discovery phase of the project (Aim 1, Q2 and 4; Stage 2, Tasks 2.3 and 2.5). The resulting framework will be fully articulated within the UPD document (Product 1.2), providing further opportunity for comment. Evaluation will be ongoing and adaptive, enabling the project team to respond to feedback during delivery, as well as provide comprehensive evaluation and reccomendations at project closure (Products 10 and 15).

6 PROJECT STAGES AND TASKS

6.1 Project stages and workflows

6.1.1 The project plan and Gannt chart (see Appendix 3) included with this project design provides a breakdown of main work packages, stages and milestones, dependencies, and the proposed timetable (see Tables 2 and 3). During set up, the delivery programme will be expanded further into individual tasks for team members within each work package. Each of the project stages is mapped against the four key research aims of the project, and the project model including aims, objectives and tasks is fully articulated below (see Appendix 1).

6.1.2 The Deep Time platform will be developed from clearly stated principles of citizen science, ensuring that participatory research values and ethics are aligned coherently with tasks, workflows and interfaces (Aim 1, Q4). Content can be tailored to the needs of each project case study, with bespoke training resources developed to reflect the unique historic environment of the region (Aim 2, Q8 – 9). The platform will provide access to a virtual learning environment, with mapping layers and tools embedded alongside rich training resources. Training is deliverable within a highly structured and reflexive format, with inbuilt chat forums and mentoring sessions planned to facilitate support (Aim3, Q11 - 12). The existing suite of capabilities and tools have been tried and tested within the pilot study. Feedback from public participants and consultation undertaken as part of Aim 1 research objectives will enhance the implementation of the platform (Aim 3).

6.1.3 Each work stage is described below, highlighting associated tasks, products and documentation. The nature of the staged delivery provides several milestone and review opportunities, allowing strong collaboration with the Project Advisory Board and delivery partners, as well as facilitating opportunities to evaluate progress against structured standards of evidence as the project is delivered.

6.1.4 The main delivery stages include:

- **Stage 1: Project Design**. Creation of project design outlining the scope, research aims and objectives, project methods, programme and resourcing for the project.
  - Output / products include; Project Design (P1.1 – this document).
  - Milestone 1 – circulation of PD.
- **Stage 2: Set-up and development of project infrastructure** (Aim 1). This stage corresponds closely with Aim 1 and will provide a detailed resource programme and plan, data management plan, and evaluation framework with communications strategy (Aim 1, Q1-4). Desk based research will review application of CI and AI within lidar mapping projects, asessing the potential to utilise AI as a rapid reconnaissance tool within the Deep Time model to maximise capacity and research outputs. Boundaries of case study areas will be finalised with stakeholders (M2), targeting regions with existing ALS/LiDAR data and where archaeology is likely to be impacted by development, climate events or where change is expected to be actively in process (Aim 1, Q5). Consultation to inform development of confidence metrics, identify needs of professionals and wants of citizen scientists (Aim 1, Q1-5, M3). Delivery partnerships will be underpinned by partnership agreements and the Project Advisory Board will be initiated. An audience and engagement strategy will be developed in consultation with project partners (Aim 3, Q10) and the updated UPD circulated (M4).
  - Outputs / products include; Updated Project Design (P1.2), incorporating evaluation framework and communications plans (P2), Data Management Plan (P3), Ethics and Values Statement (P4).
  - Milestone 2 – Partnership agreements / Milestone 3 – Confidence metrics / Milestone 4 – UPD.

- Stage 3: Develop participatory GIS mapping platform. Stage 3 includes the development of the bespoke CI platform, incorporating interactive user interface and recording modules, with input from UX developers and Humap (Aim 2, Q6, M5). Existing heritage data (HERs) is imported into a standard GIS and audited for baseline quality (Aim2, Q7). MIDAS compliant controlled terms for each case study area developed (Aim2, Q8). Source data can then be added to the back-end of the platform, with LiDAR prepared and processed into archaeologically-relevant visualisations, with structured and unstructured mapping and data layers added. Training resources are developed which support regional characteristics and landscape (Aim 2, Q8). The project team will develop web-based training content, including text, image and video media, and utilising DigVentures' bespoke Virtual Learning Environment. Training content will be tailored for the archaeological site types which feature within Case Study areas, ensuring that explanatory notes, visual aids and resources are accessible (Aim 2, Q9, M6). The platform will be fully tested at this stage though the development of exemplars for each case study (Aim 2, Q9).

  - Outputs / products include: Participatory GIS platform (P5) incorporating platform-ready HERs dataset, with MIDAS compliant controlled terms and LiDAR data processed into relevant visualisations, plus additional data and mapping layers embedded. Online course and training resources, with case study mapped exemplars incorporated into platform (P6).

  - Milestone 5 – Mapping platform ready, Milestone 6 – Training resources uploaded.

- Stage 4: Implementation. During this stage, the team will engage and train citizen scientists to review and map archaeology across the three case study areas (Aim 3, Q10). Participants will be recruited widely through established partner audiences and across DigVentures extensive community, as well as establishing links with new audience targets identified during Stage 2 (above). Training will be delivered over a 10-week structured course to recognise, annotate, and describe archaeological features (Aim 3, Q11). Additional training and support provided by mentoring workshops, newsletters and an active discussion forum, will maximise participation across the cohort (Aim 3, Q12). Once crowd mapped, the three case study areas will be reviewed and verified by trained citizen scientists, supported by a single-track validation system (Aim 3, Q13). Expert support is provided throughout, and a quality audit will assess verified data collected during the experiment, evaluate the documented transcriptions and associated metadata, and review and add targets selected for validation. Expert led and, in some cases, field-based validation will review the results with case study partners and community participants.

  - Outputs / products include: Unvalidated CI mapped archaeological assets and metadata (P7), validated CI mapped archaeological data and metadata (P9), participant evaluation data (P8), GPS survey data and field notes (P13).

  - Milestone 7 - Community mapped data exported, Milestone 8 – Validated data.

- Stage 5: Evaluation and Dissemination - review and evaluation of the project results against a clearly defined framework (Aim 4, Q14), articulating how a crowd-based model can contribute to the enhancement of heritage data and explore potential impacts for the ongoing management of historic environment within case study areas (Aim 4, Q15 – 16). The evaluation will assess the efficacy of the crowd to screen and enhance HERs data, segment and recognise archaeological sites, verify site segmentation and description, and contribute to the validation of mapping and transcriptions. The fidelity, accuracy and completion of the enhanced dataset will execute and review the process of export, re-ingestion and re-use by case study partners. Consultation will include both discussion of results with project partners and project stakeholders to review project results, consider ethics and applications in real world heritage projects (Aim 4, Q15 - 16).

Dissemination of results will be assured through a series of freely accessible products and knowledge sharing activities, including a reports, peer-reviewed paper, a stakeholder workshop and deposition of the digital research archive with ADS. Recommendations will be made to HE and stakeholders via a project closure report.

- Outputs / products include: evaluation data and report (P10), technical report (P11), peer reviewed paper (P12), digital archive (P13), closure report (P15).
- Milestone 9 – Reporting completed, and recommendations made.

6.2 Project tasks and milestones

6.2.1 A detailed project delivery programme, linking tasks, resources, costs, milestones and products can be found in Appendix 2, and a Gannt charts in Appendix 3. We propose to deliver the project across 20 months from the initiation of Stage 2 – Discovery (see Appendix 2). Team members and indicative days estimated against tasks are also shown in Appendix 1. The project will be delivered from August 2022 to February 2024, and several milestones have been identified which will help track progress. The programme is designed to run broadly from stage to stage, with some tasks running concurrently and some dependent on the completion of others.

Table 2: Milestones

Milestone number	Description	Programme	Associated product	Owner
1 - PD	Completed Project Design	June 22	P1.1 PD	DV
2 – Partnership agreements	Agreements for case studies signed and agreed with partners	January 23	n/a	DV Partners
3 – Confidence metrics	Framework for confidence metrics for data audit, use and reuse agreed	Sep 22	P2 Evaluation framework P1.2 UPD	DV Partners PAB HE
4 – UPD	Updated Project Design	March 23	P1.2 UPD	DV
5 – Mapping platform	Community mapping platform ready for use	May 23	P5 - Participatory GIS platform	DV Humap
6 – Training resources	Training resources uploaded and ready for use	June 23	P6 - Online course and resources	DV Pixel Parlour
7 – Unvalidated community mapped data	Export of community mapped data made	Aug – Oct 23	P7 - Unvalidated community mapped data	DV Humap
8 – Validated data	Export of community mapped and validated data made	Jan 24	P9 - Validated community mapped data	DV Humap
9 – Reporting completed, and recommendations made	All reporting submitted with recommendations	May 24	P11 - Technical report P12 - Peer reviewed paper P13 - Digital archive P16 – Closure report	DV

Table 3: Project programme

A full task, resource and costs programme can be found in Appendix 2, and a Gannt chart in Appendix 3.

Stage	Stage / Task description	Products / Milestones	Start	Finish
Stage 1	***Project Design***			
1.1	Project team / design meetings		Apr-22	Jun-02
1.2	Project liasion with HE		Apr-22	Jun-02
1.2	Detailed project plan, resources and programme delivery		Apr-22	Jun-02
1.3	Explore Case Study locations and engage delivery partners		Apr-22	Jun-02
1.4	Identify Advisory Group		Jun-22	Jun-22
1.5	Submit project design (P1)	P1 - PD / M1 - PD	Jun-22	Jun-22
1.6	Review, amend and finalise PD (P1)		Sep-22	Oct-22
	Circulate and HE review		Jul-22	Nov-22
Stage 2	***Discovery and infrastructure***			
2.1	Project initiation meeting		Dec-22	Dec-22
2.2	Finalise case study areas and partnership agreements	M2 - Partnership agreements	Dec-22	Jan-23
2.3	Collaborative design sprints with HE team x 4		Dec-22	Feb-23
2.4	Wider consultation (PAB, Crowd and practice based), including survey		Feb-23	Feb-23
2.5	Ethics and values statement	P5 - Ethics and values statement	Jan-23	Jan-23
2.6	Evaluation Framework & Comms Plan	P3 - Evaluation framework	Jan-23	Jan-23
2.7	Data Management Plan (x 3) and update	P4 - Data Management Plan	Feb-23	Mar-23
2.8	Review use of controlled teams / MIDAS within platform	M3 - Metrics	Jan-23	Feb-23
2.9	Develop baseline metrics for structured / unstructured data	M3 - Metrics	Jan-23	Feb-23
2.10	Develop baseline metrics for data verification / validation / reuse	M3 - Metrics	Jan-23	Feb-23
2.11	Audience engagement strategy		Jan-23	Feb-23
2.12	Relevant heritage data audited for use		Jan-23	Feb-23
2.13	List of MIDAS compliant controlled terms for case study areas		Jan-23	Feb-23
2.14	UPD workshop and presentation		Jan-23	Feb-23
2.15	Update project plan, resources and programme delivery		Jan-23	Feb-23
2.16	Highlight report > Updated Project Design (P2)	P2 UPD / M4 - UPD	Mar-23	Mar-23
	Circulate and HE review			Apr-23
Stage 3	***Develop participatory GIS mapping platform***			
3.1	Set up of GIS platform and mapping tools	P6 - Participatory GIS platform	May-23	May-23
3.2	Data layers added to platform	M5 - Platform ready	May-23	May-23
3.3	Develop training resources (x 3) to support citizen scientists	P7 - Online course and resources	May-23	Jun-23
3.4	Case study exemplars for each area (desk & survey)		May-23	Jun-23
3.5	Populate Deep Time platform with bespoke training materials	M6 - Resources uploaded	Jun-23	Jun-23
3.6	Test platform interfaces, mapping tools, data creation, data export		Jun-23	Jun-23
3.7	Consultation and feedback (PAB)		May-23	Jun-23
3.8	Highlight report > Deep Time platform		Jul-23	Jan-22
	Circulate and HE review			Jul-23
Stage 4	***Implementation***			
4.1	Engage and register citizen scientist cohort		May-23	Jul-23
4.2	Launch training course		Aug-23	Aug-23
4.3	Community mapping - Case Study 1		Aug-23	Oct-23
4.4	Community mapping - Case Study 2	P8 - Unvalidated community mapped data	Aug-23	Oct-23
4.5	Community mapping - Case Study 3	M7 - Community mapped data exported	Aug-23	Oct-23
4.6	Professional desk-based validation	P14 - Survey data	Nov-23	Dec-23
4.7	Update online mapping data and metadata	M8 - Validated data	Jan-24	Jan-24
4.8	Collect participation evaluation data	P9 - Evaluation data	Jan-24	Jan-24
4.9	Export mapped dataset for each case study area	P10 - Validated community mapped data	Jan-24	Jan-24
4.10	Consultation and feedback (PAB, Crowd and Practice)		Aug-23	Jan-24
4.11	Highlight report > CI Case Study Area review / segmented datasets		Feb-24	Feb-24
	Circulate and HE review		Feb-24	Feb-24
Stage 5	***Evaluation and dissemination***			
5.1	Review efficacy of crowd to screen existing HER / HBSMR data		Feb-24	Mar-24
5.2	Review efficacy of crowd to recognise / record new archaeological sites		Feb-24	Mar-24
5.3	Review efficacy of crowd to verify peer data		Feb-24	Mar-24
5.4	Review efficacy of contribute to validation process		Mar-24	Mar-24
5.5	Review fidelity, accuracy, completeness of exported enhanced dataset		Mar-24	Mar-24
5.6	Consultation and feedback (PAB, Crowd and Practice)		Mar-24	Mar-24
5.7	Collate report presenting project results and evaluation	P12 - Technical report	Mar-24	Apr-24
5.8	Collate results for peer reviewed paper	P11 - Evaluation report	Mar-24	Apr-24
5.9	Dissemination workshop	P13 - Peer reviewed paper prepped	Apr-24	May-24
5.10	Prepare data for digital archive	P14 - Digital archive prepped	Mar-24	May-24
5.11	Project recommendations	M9 - Reporting completed and reccs made	May-24	May-24
5.12	Highlight report > Closure report	P15 - Closure report	May-24	May-24
	Circulate and HE review		Jun-24	Jul-24

7 PRODUCTS, DISSEMINATION AND ARCHIVING

7.1 Products

7.1.1 Several products will be generated thought the delivery of this project that will underpin its dissemination and longer-term impact. The table below describes the main products, providing a short description, type and dissemination (Table 4). The project model (Appendix 1) shows how products relate to project aims, and the programme delivery table (Appendix 2) links project stages and tasks to resources and products.

Table 4: Products

No	Product	Description	Type	Dissemination
P1	Project Design	Project Design to support grant application	Document	Historic England
P2	Updated Project Design	Updated PD to disseminate agreed aims, methods and outcomes for the project and including final details of case study areas, data standards and evaluation framework.	Document	Historic England Project Advisory Board Project partners
P3	Evaluation framework and communications plan	Living framework document	Document to accompany UPD and be updated during delivery	National Trust Project Advisory Board
P4	Data Management Plan	Living management document	Living document to accompany UPD and be updated during delivery	National Trust Project Advisory Board Project partners
P5	Ethics and values statement	Living management document	Document to accompany UPD	National Trust Project Advisory Board Project partners
P6	Participatory GIS platform	Online mapping platform incorporating data layers and participatory tools	Web based platform	Project participants
P7	Deep Time online course	Multi chapter course to accompany and support community mapping projects	Digital resources	Project participants
P8	Unvalidated crowd mapped data and metadata	Exported data from community mapping exercise	Digital data	National Trust
P9	Participant evaluation data	Data collected during project delivery, as outlined in the evaluation framework	Digital data	National Trust Project Advisory Board Project partners
P10	Validated crowd mapped data, with metadata and confidence rating	Exported data from community mapping exercise, following validation	Digital data	National Trust

P11	Project evaluation report	Technical report describing and presenting evidence for outputs and outcomes against the project evaluation framework	Document Digital data	National Trust Advisory Group Stakeholders Public
P12	Technical report	The project will be fully written up in line with the CIfA standards, presenting an illustrated and detailed analysis of research project.	Document Digital data	National Trust Advisory Group Stakeholders Public
P13	Peer reviewed paper	An Open Access paper will be published, providing a summary of the research project and findings and signposting the project archive.	Document Digital data	National Trust Advisory Group Stakeholders Public
P14	Digital archive	The project will result in the co-production of an accessible and usable research archive, maintained for 5 years post project. A stable and comprehensive archive will also be prepared and deposited with the appropriate bodies, including ADS.	Documents Digital data	Advisory Group Public
P15	Good practice guidance	The project will take a collaborative approach to both project design and programme delivery, culminating with a series of good practice guidance notes for data projects. This will start with collaborative research design approaches, and the results of the design sprints which will identify FAIR workflows for projects which create big data through citizen science and other nontraditional methods.	Document	National Trust Advisory Group Stakeholders
P15	Closure report	Internal document.	Document	National Trust

7.2 Dissemination

7.2.1 As consultation and stakeholder engagement is a key method and activity for successful delivery, the team are keen to ensure the project is well disseminated from the outset. The following opportunities and products have been identified which will provide the project with a platform across different stakeholder groups throughout delivery:

- HER Forum (Speaker) / July 2022 – heritage professionals working within the HER sector
- Remix Google (Keynote) / September 2022 – Making waves in a changing world: culture, technology, entrepreneurship, global summit held in London with cross sector tech and culture audiences
- CIfA Conference (Session) 2023 / April 2023 – Focused on public benefit and working practices with innovative design and approaches, audience of heritage professionals from UK and beyond
- Project evaluation report (P10) – a publicly accessible report describing the evaluation outcomes and outputs from the project, accompanied by evaluation data, will be widely distributed, form part of the project archive and made accessible via the DigVentures website.

- Technical report (P11) - a publicly accessible report describing the technical and research outcomes and outputs from the project, accompanied by heritage data and information, will be widely distributed, form part of the project archive and made accessible via the DigVentures website.

- Peer reviewed paper (P12) – an open access paper will be published to disseminate project results to research and academic audiences.

7.2.2 The project will also utilise heritage media outlets to reach wider professional and public audiences, such as British Archaeology, Current Archaeology and The Archaeologist magazines. DigVentures have a strong record in both heritage, regional and national media, and will use outlets to both engage audiences for consultation and also to disseminate project results as they are delivered. We will also use social media platforms to engage widely with public audience.

7.2.3 Project dissemination and knowledge exchange with citizen scientists will be embedded from the outset with the development of the community mapping platform, a sophisticated web interface which will facilitate participation and dissemination. The project results will be housed within the platform and can be made available for different levels of access as the project progresses. The data will be visible as part of the online interactive mapping platform and will also house interrogated information and new data prior to more public release following validation.

7.3 Wider engagement

7.3.1 A communications plan will be developed as part of the Updated Project Design stage (P2 – Evaluation framework and communications strategy), to fully articulate how the project will engage a diverse group of volunteers, as well as disseminate information to key audiences and stakeholders during its delivery. The document will collate key information relating to project communications, including the project team and advisors, stakeholders, media platforms and products. The communications plan will act as a living document to be reviewed and updated throughout the lifespan of the project.

7.3.2 Within the proposed project, the team intend to include extensive consultation within the heritage sector, and to review the use and application of citizen science within archaeological research, heritage management and development led projects. In addition to the appointment of a representative Project Advisory Board (PAB) for the project (see Section 5.1), we propose to undertaken a consultation survey to inform a series of dissemination and knowledge exchange workshops exploring the wider ethical and professional context for the project. This work will contribute directly to the evaluation of the Deep Time project but have far wider implications for participatory research and learning for future HE research programmes, archaeological researchers and HERs.

7.4 Project archive

7.4.1 Data produced within each of the project case studies will be described using a Data Management Plans at the outset of the project, to ensure the collection and dissemination of data is able to meet FAIR principles wherever possible. Data provided by project partners will be managed and archived in line with details confirmed through partnership agreements, to be finalized during Stage 2 of project delivery (see Section 7.1). All data collected through the community mapping project will be exported and deposited with project partners and relevant stakeholder bodies, such as HERs. Where possible, project data will be deported with ADS, depending on ownership, risk and data sensitivity identified with project partners.

7.4.2 A project archive, including editable versions of materials used for the web materials, step by step guides and case studies will also be kept on DigVentures' own server. A full archive of the final version of documents included will also be deposited with ADS and provided with a DOI.

7.5 Ownership

7.5.1 The hard copy and digital documentation produced under this project will be the copyright of Historic England. Copyright on reports and guidance notes will reside with Historic England, although a third-party in-perpetuity licence will be requested by DigVentures as originator, subject to agreement from Historic England. Copyright for the GIS platform will reside with DigVentures and Humap.

7.5.2 Copyright for additional content produced in case study areas and using data from partnership organisations, will rest with origin organisations. Copyright for training materials, such as video content, produced purely to be delivered as part of the online training course with rest with DigVentures.

8 PROJECT TEAM

8.1 Organisations

8.1.1 The project will be led by DigVentures, working with sector leading organisations Humap (online platform and mapping interface) and Pixel Parlour (UX design, web platform development) to develop the Deep Time web platform and mapping tool. Our organisations have a memorandum of understanding in place which defines the nature of our partnership working agreement, including the role of each organisation. We will also be working closely with case study partners National Trust, underpinned by a partnership agreement to define the relationship and articulate parameters for data use, export and archive.

8.1.2 DigVentures is a not-for-profit social business and Chartered Institute for Archaeologists (CIfA) Registered Organisation, pioneering a collaborative, tech-enabled model of participation in archaeology (Wilkins 2020). Through the delivery of high-quality archaeological work, we enable civic participation in archaeology and heritage projects, providing opportunities for real people to purposefully participate in real research. The DV team combines creative thinking, skilled research and technical expertise, with sector-leading experience of delivering volunteer training and educational programmes, with high professional standards in archaeological projects. In May 2021, DigVentures 'Archaeology at Home' was awarded the prestigious Europa Nostra Award following an expansion of our digital content in direct response to COVID-19, with online courses and a digital festival attracting 11,242 participants, with our Virtual Field School accounting for 7,942 from 80 countries. With a proven track-record at over 40 large-scale archaeological excavations and raising over £2M through matched crowd and grant funding, we design projects which challenge perceived barriers to people-powered archaeology, annually bringing thousands of people from all socio-economic and demographic backgrounds to our projects.

8.1.3 Key project delivery partners include:

- Humap, a platform designed to tell stories using maps. As a formative tool, the platform can be used to identify new features on existing geography, or record crowd-sourced content with the platform's user-generated content functions. As a summative tool, Humap has a rich set of features to search, explore and make connections about records and overlays. Since its launch, the platform has grown its customer base with clients such as the Institute for Historical Research, Islington

Council, Coventry City of Culture, The Wiener Holocaust Library, London School of Economics, and Great Yarmouth Council. A focus on user experience and accessibility is at the heart of the company's ethos, and the ongoing aim of Humap is to provide powerful creation and exploration tools for maps, without needing users to understand how to use complicated GIS software. Humap's extensive experience in developing user-friendly, human-centred mapping tools for major citizen-science projects, includes numerous exciting projects, such as Layers of London (2018-21), Coventry Atlas archive (2021) and Islington's Pride (2022).

- Pixel Parlour, a UK-based agency who will support the design of the web interface for the mapping platform tool and online training resources. The team at Pixel Parlour, led by Nick Barron, will support the design of the interface for the HER platform, ensuring the recording forms and data interrogation modules offer an intuitive and functional user experience. The Pixel Parlour is a UK-based agency founded in 2011 and specialising in User Experience Design and programming for digital platforms. The agency's diverse client base includes charities, local government, arts and heritage organisations and venture-backed startups. The team is comprised of experienced designers, coders and developers who together have delivered several award-winning projects over the past nine years.

8.2 The CI community

8.2.1 A vital delivery partner is our community of online and in person citizen scientists. The Deep Time pilot project demonstrated high levels of interest and a successful methodology in recruiting representative groups based on pre-identified selection criteria. Participants are able to register interest and provide information which can help project delivery teams widen audiences, responding to needs articulated within the heritage sector to diversify, digitise and engage a new generation with archaeology. The Historic England report, *Heritage and Society 2020*, recognised that heritage fosters a strong sense of place, encourages behaviours of stewardship, conservation and protection of natural resources and historic places (2020, 19). Being engaged with heritage volunteering can improve quality of life by offering social and economic benefits for participants and can also support wider social cohesion (ibid, 28). Making online heritage resources available as part of learning and skills programmes is seen as providing more equal access to digital learning for younger people and projects that support the understanding of local distinctiveness are seen as especially important as they create a sense of belonging and identity.

8.2.2 The Deep Time pilot project demonstrated that participant recruitment for online community archaeology mapping projects can be very successful, with 970 applications received for 100 participant places. DigVentures have a community mailing list of around 36,000 individuals and a track record in attracting new audience groups for specific projects. Recruitment will be guided by a community strategy linked to the evaluation framework (P2), informed by the strategic objectives of project partners and key stakeholders. Through various project streams, the DV team manages around 12,000 project participants across different levels of engagement within an annual cycle.

8.2.3 During the pilot project, selection of participants was equitably split along age, gender, socioeconomic and the ethnic backgrounds, and an audience target will be defined with case study partners which widens audiences based on partner target groups. Other selection criteria included geographic location (with half of participants locally based) and previous experience (26% of participants had no experience of archaeology, and 65% only on a voluntary basis), and these can also be built into the current project model. Positive uptake results in increased representation and responds to needs identified by HE's Heritage Recovery Plan (2021) to broaden audiences and become more relevant to all of society. Participants who took part in the pilot project felt overwhelmingly positive about the

experience and their own connection to the project region. At the start, 75% were 'basically indifferent' to the landscape pre-experiment to 75% saying the opposite after, with 32 percent having a 'strong' connection to it.

8.3 People and project roles

8.3.1 DigVentures specialises in delivery quality-assured public engagement and participation in archaeology and heritage projects. DV's Co-CEO and Founder, Brendon Wilkins, will offer internal project assurance, with day-to-day delivery and management handled by Manda Forster, Chief Operating Officer and Kimberley Teale, Programme Manager (Digital Projects). Manda has extensive experience of managing complex digital and landscape level projects, having previously managed community mapping projects (Living Levels), skills training and archaeology (Garnock Connections) and written guidance for the management of digital data in archaeological archives for CIfA (Dig Digital). Kimberley is DVs digital programme manager and has recently coordinated and delivered the Deep Time pilot project. Kimberley will coordinate the development of the platform and training resources, processing and managing data and managing LiDAR mapping, transcription and ground observation survey.

8.3.2 Our project contractors supporting platform design and development include Humap (team leads Ed Jones and Martin Chapman Fromm) and Pixel Parlour (team lead, Nick Barron), bringing a wealth of experience in user experience research design and technical web-based mapping functionality, platform security and resilience. The table below includes individual roles and responsibilities, with summary biographies below. CVs of core team members can be found in Appendix 3.

Table 5: Project Team – roles and responsibilities

Name / Organisation	Project role / area of responsibility
Lisa Westcott Wilkins BA MA MCIfA FRSA Managing Director, DigVentures	Client relationship management, contract fulfilment manager, communications design and audience strategy
Brendon Wilkins BSc MSc MIAI MCIfA Projects Director, DigVentures	Contract fulfilment, project design, fieldwork strategy
Manda Forster BSc PhD MCIfA FSA Scot Director of Operations, DigVentures	Operations, finance, resource and programme oversight
Jonski Millar MCIfA Chief Digital Officer, DigVentures	Project design and strategy, stakeholder relationships, project management.
Maiya Pina-Dacier BSc MSc Head of Community, DigVentures	Volunteer relationship management, community management, on-site training and online communication
Kimberley Teale ACIfA Programme Manager (Digital), DigVentures	GIS, survey and geophysics, volunteer management, photogrammetry and interpretation
Maggie Eno BA Programme Officer (Video and content), DigVentures	Videographer, media production, community management, training and mentoring
Ginny Cole BA Community Archaeologist (Digital), DigVentures	Community management and administration, participant facilitator and mentoring
Project delivery contractors – Platform design and development	
Ed Jones, Humap Founder and GIS & Technology Lead	Technical design, development and quality assurance

Name / Organisation	Project role / area of responsibility
Martin Chapman Fromm, Humap Founder and User Experience Development	User experience design, research and design
Nick Barron, Pixel Parlour User Experience Director	Platform and web interface design and development
Project case study partner liaison	
Keith Challis FSA MCIfA FRGS FRSPSoc, National Trust, Remote Sensing Coordinator	Case Study partner liaison – National Trust

8.4 The project team – experience

- Brendon Wilkins BSc MA PhD MIAI MCIfA FRSA FSA – Co-CEO, DigVentures – will shape the overall strategy for the project. Brendon is an experienced field archaeologist and researcher, with over twenty years of directing and leading large, complex projects as a senior manager in two of the largest commercial contractors in the EU. As Project Lead for the Deep Time project, he works closely with online and interactive archaeological mapping, and is also lead for DVs innovative web-based archaeological recording system, Digital Dig Team. Brendon specialises in bringing innovation to the archaeological process and has published widely on social value and impact of archaeological community projects.

- Lisa Westcott Wilkins BA MA MCIfA FRSA FSA – Co-CEO, DigVentures. Lisa will perform the role of Project Executive and has extensive experience delivering high-profile community archaeology projects. She has primary responsibility for managing client relationships and ensuring contract fulfilment and has performed this function across 35 community archaeology projects within DVs portfolio since 2012. An accredited coach and facilitator, Lisa leads on volunteer engagement strategies and designing flexible training programmes.

- Manda Forster BSc PhD MCIfA FSA Scot – Director of Operations, DigVentures. Manda is an experienced project manager with a background in project design, training, programme and post excavation management. She has worked closely with multiple project partners, including local and national government, natural heritage bodies and community volunteer groups. Her recent projects have included community engagement projects (Unloved Heritage), public consultation and heritage appraisal (Destination Tweed), digital data management standards and guidance (Dig Digital) and feasibility studies (Options for Archaeological Archives, Institute for Metal Detecting).

- Jonski Millar BA MCIfA, Chief Digital Officer, DigVentures – is digital lead on Deep Time, with responsibility to coordinate and deliver the project for DigVentures. Jonski joins the team specifically to support and develop Deep Time, coming from a commercial archaeological background, managing IT, geomatics, digital illustration and dissemination, GIS and survey for a large private organisation since 2004. Jonski is a member of the CIfA Professional Standards Advisory Panel (PSAP) and the Treasurer of the CIfA Graphic Archaeology Group (GAG).

- Maiya Pina Dacier, Head of Community, is behind all of DigVentures' online communications and engagement. She has successfully built our global community, reinforced by tailored programmes of media content communicated via project microsites. Maiya recently developed course materials for Audience Development as part of DVs new online course, Realigning Resources. Maiya will ensure that the stakeholder and community engagement find the targeted audience groups, and that all communications and digital interfaces are clear, accessible and user friendly.

- Kimberley Teale BSc ACIfA ISAP NSGG – Programme Manager, DigVentures. Kimberley is committed to digital innovation, and the development of our GIS and digital capabilities are a key part of her role. Deep Time is one of her current projects, and she has recently coordinated our Nesta funded research and design project combining Collective Intelligence and Artificial Intelligence project, training citizen scientists to search for archaeological remains through digital platforms including LiDAR, aerial photographs and HER datasets. Kimberley is a member of the Historic England Landscape Survey Group and the CIfA Scottish Special Interest Group.

- The project team will be supported by DigVentures' team of Community Archaeologists and Programme Officers, offering a depth and breadth of experience in participatory archaeological research.

Delivery partners

- Ed Jones, Humap - Founder and GIS & Technology Lead, Humap. As a founder of Humap, Ed has overseen the development of the entire platform, and continues to ensure its security and functionality. He is technical consultant on every project, and leads on technical design, development and quality assurance, as well as client onboarding and consultancy.

- Martin Chapman Fromm, Humap - Founder and User Experience Development. With a background in design and user experience research, Martin is responsible for the strategic direction of Humap's products and services and how best they service customers and users. Martin takes an active development role in the user experience of Humap's place-based product development and is a key figure in the research and design of the mapping interfaces developed for key Humap customers.

- Nick Barron, Pixel Parlour – User Experience Director. Nick is co-founder of Pixel Parlour and will be leading digital design, coding, programming and user experience relating to the web interface. In his role as UX Director at Pixel Parlour, Nick ensures that all projects reflect a clear understanding of project needs and clients aims, as well the expectations of audiences. Nick brings his experience working for industry-leaders across marketing, multi-media production and digital publishing.

8.5 Organisational experience

8.5.1 The DigVentures team have successfully delivered many high-profile projects, maximising value and impact from archaeological research in collaboration with partners and using innovative solutions to engage audiences and support authentic participation. We have pioneered the use of crowdfunding, crowdsourcing and digital methods to increase access and opportunities for real people to purposefully participate in real research. We achieve high levels of engagement with our projects and specialise in delivering an exciting range of both online and offline experiences for project audiences. Our approach enabled us to adapt to the challenges of 2020, pivoting our usual participatory archaeological field schools to an inspiring and Europa Nostra award-winning virtual engagement project of substantially increased digital content, offering free access to our digital 'How to do Archaeology' (HTDA) Virtual Fieldschool and online course for kids, 'How To Be A Junior Archaeologist', creating an 'Archaeology at Home' collection, as well as delivering a weekend virtual archaeology festival, DigNation. Through our courses and online field school, we reached 11,242 participants: the Virtual Field School accounting for 7,942 from 80 countries, including one cohort for children, comprising 1,844 children and their parents/guardians from 11 countries. The DigNation Festival was also a major engagement success, attracting an audience of 3,300 from 61 countries, resulting in 42,471 page views over the course of the weekend, and 550 audience comments.

8.5.2 Examples of our recent and current projects are include: Deep Time pilot project (crowdsourced online heritage training, rapid mapping and lidar transcription project, citizen science and artificial intelligence), Archaeology at Home (online engagement, heritage skills, video documentary, virtual participation), Brightwater Landscape Partnership (including community archaeology mapping, community archaeological excavation, co-designed heritage trails and Village Atlas delivery, ecomuseum legacy project); Ryevitalise (community archaeology walkover survey), Pontefract Castle (embedded community training, archaeology and workshop programme), Destination Tweed (Heritage appraisal, community consultation and activity programme design), Spodden Valley Revealed (an ecomuseum project exploring heritage with the community in the Spodden Valley) and Unloved Heritage (working with the kids of Treherbert to recreate the Fernhill Colliery in Minecraft).

9 RISK AND ISSUES MANAGEMENT

9.1 Risk management approach

9.1.1 The project team will use a standard risk register to track all risks, using a risk register based on DigVentures layout (see Risk Register, Appendix 4). The Project Lead (Brendon Wilkins) will be responsible for overseeing the risk management procedure, and the Chief Operating Officer (Manda Forster) for keeping risk documents up to date following regular review and providing reports to disseminate to the project team. The core project team will review the risk register reports at project team meetings held regular intervals through project delivery (at a minimum, monthly), and on completion of milestones identified on the programme (see Appendices 1 and 3). Regular review of risks at key stages of the projects will also be required by individual team members involved with specific aspects of the project delivery.

9.1.2 Team members will also be asked to be aware of their environments on any in-person training or field visits, undertaking dynamic risk assessment on delivery of appropriate project aspects, such as topographic survey, ground observation or in person training of volunteers. Results of any dynamic risk assessment will be included in the risk management approach described above.

9.1.3 The Risk Register (Appendix 4) identifies and assesses each risk, articulating the appropriate response to the risk as well as risk category, description, probability, impact, response, and risk owner. During project set up, this document will be finalised and included as a document within the Project Design, then updated throughout delivery.

9.2 Risks

9.2.1 A risk register for the project is provided in Appendix 4.

9.2.2 Piloting undertaken has tested the concept, the CI interface and efficacy/quality of results. Risks identified are manageable and can be mitigated though project design and assessment. Ethical risks and professional performance are mitigated though accreditation with professional bodies and relevant health and safety schemes. Key risks identified are linked to engagement of citizen scientists, performance and quality of collective intelligence, and technical risks around the operations of the platform itself and quality of exported data.

9.2.3 Participant recruitment is a key risk, although DigVentures are experienced in engagement and community management. Our pilot study was oversubscribed by 800 individuals wishing to take part as volunteers. National Trust provides additional security in participant recruitment, facilitating access to 60,000 registered volunteers. Other partner bodies also have substantial reach, comprising the Forestry England and links into the AONB network.

9.2.4 The main performance risk is efficacy of citizen scientists to output data at the quality / quantity required for HERs, decision-makers and land managers. The training programme will provide accessible and detailed training content, providing structured learning supported by mentors, peer-to-peer discussion and worked examples. Our pilot evaluation indicated CI-enriched data can be more comprehensive or complete than existing data in some areas (which has been collected over years and via multiple stages and projects). This project will focus on the standards and validation processes which support use of data from the perspective of HERs and those managing heritage information. This funding will facilitate development of processes and validation standards into results to support stakeholder and user confidence.

9.2.5 Technical risks focus on accessibility and interoperability of data, although pilot work allays concerns. The collection and management of data will be underpinned by a Data Management Plan tailored to each case study area (Product 3) which offers a clear strategy for data built around FAIR principles. Data outputs can be exported as GeoJSON and are therefore easily integrated in other GIS systems. Additional risks include operational issues (subcontractor management, team illness, project partnerships) and cultural considerations (readiness of sector). Consultation will aim to address potential cultural issues, and the Risk Log provides details of planned mitigation of all risks and expected impacts.

9.3 Issues log

9.3.1 In the development of this Project Design, potential issues have been highlighted which the Project Team will consider and continue to review and update as the project is delivered.

ID	Issue	Description	Raised by / when	Project Team comment
01	Timescale	Allow sufficient time for project delivery	HE – project proposal	The delivery programme has been extended in the PD and will be under constant review, with an updated at all Review Points. Milestones provide output related tracking.
02	CI / AI ambitious scope	Incorporating both CI and AI is ambitious and perhaps difficult to retain a clear scope. Suggestion to focus project on community engagement and clarify interface with HER enhancement.	HE – project proposal	The scope is now focused on the crowdsourced and participatory elements of the project, with an aim to refining the process of data enhancement and reinvestment in HERs systems.
03	Interaction with HERs	Interest and buy-in from the HER community is essential, as the HER community are key stakeholders.	HE – project proposal	Consultation has been embedded within the project methodology and HER representatives are included in the proposed PAB. Whilst partners use a HERs, there will be an opportunity to review reinvestment into different HE information management systems with AONB and Forestry England examples.
04	Data sources	Clarification on data sources would be useful, as this poses a potential issue – eg use of EA data or specifics re 'high resolution'	HE – project proposal	During Discovery phase (Stage 2) a detailed case study proposal will be provided which will outline all available data sources and technical details, to be disseminated via a UPD.

05	Terminology	Deep Time platform should conform with the Midas Heritage data content standard and should incorporate nationally accepted standardized terminologies for indexing in order to ease interoperability with HER databases.	HE – project proposal	During Discovery phase (Stage 2) existing heritage information for each case study will be reviewed and a Data Management Plan created, and during Development (Stage 3) a list of MIDAS compliant standardized terms will be defined for each case study area.
06	Validation	Experience on community archaeology projects suggests that (as stated in the proposal) ongoing training and support are required so this needs to be clearly specified.	HE – project proposal	Metrics for data audit and validation will be identified during Stage 2, and co-defined with consultation input from practitioners and PAB members. The validation process will be reviewed and discussed with Case Study partners to ensure data exported is useable and has a clear confidence rating associated.

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APPENDIX 1 – PROJECT MODEL

Deep Time - Project Model
Appendix 1, Table 1 - Project research questions, methods, outputs and products

Aim 1	Discovery	Key methods	Outputs	Products
Q1	What examples exist of CI / AI generated big data being used in archaeology, heritage or other sectors which contribute to professional practice?	Desk based research Consultation (Practice)	Position paper / research context	P2 - UPD
Q2	Are we able to identify principles, quality metrics and confidence ratings which professional stakeholders consider relevant to underpin or signpost integrity of data and which can used to measure baseline heritage data and that produced using CI / AI methods at different stages in the process (identification, mapping, metadata collection, verification, and validation)?	Desk based research Advisory Group Consultation (Practice)	Confidence metrics for data audit, use and reuse	P2 - UPD P3 - Evaluation framework M3 - Confidence metrics
Q3	What does a FAIR approach to digital data mean for archaeological mapping projects? What processes, standards, metadata (collection, contextual and descriptive) and project details should be documented in a data management plan to a support access, interoperability, and re-use of data?	Desk based research Advisory Group Consultation (Practice) FAIR principles	Iterative framework for data management for project meeting CIfA Standards	P2 - UPD P4 - Data Management Plan
Q4	What do citizen scientists need and want to support their active involvement in high quality archaeological research projects? What are the implications for the Deep Time project, can this be built in to the platform and project delivery to ensure needs are embedded from the outset?	Desk based research Consultation (Crowd) Citizen Science principles	Theory of change Standards of evidence Ethics and Values Statement	P3 - Evaluation framework P5 - Ethics and values statement
Q5	Can we engage delivery partners to facilitate access to three case study areas able to meet the needs identified in Q2 – 4, and to demonstrate the potential effectiveness of the proposed platform for land transformation projects responding to climate change, carbon capture and Net Zero agendas?	Desk based research Consultation (Crowd and Practice)	Partnership agreement	P2 - UPD M2 – Partnership agreements M4 - UPD
Aim 2	Development			
Q6	Which technical features supporting needs of both people (crowd and stakeholders) and data (including creation, verification, and validation) can be developed to support successful mapping of archaeological features, collection of data / metadata and its export / re-use, within the Deep Time platform?	Citizen Science principles UX design principles Technical platform design	Deep Time platform and resource interface	P6 - Participatory GIS platform
Q7	Are we able to identify and prepare structured and unstructured data sets, mapping and data layers (eg HER / HBSMR data, PAS data, background mapping layers and historic mapping layers) to support analysis of each case study area identified, and easily integrate them within the web-mapping portal?	Data management planning (acquisition and preparation for web mapping)	Platform ready HER / HBSMR dataset	P6 - Participatory GIS platform
Q8	Can we create simplified yet comprehensive data schema using controlled terms, compliant with the MIDAS Heritage Data Standard (2012) and using FISH terminology, to embed within a metadata collection tool and tailored to support mapping of each case study area?	Desk based research Advisory Group Consultation (Practice)	MIDAS compliant simplified controlled monument terms	P6 - Participatory GIS platform M5 - Mapping platform ready
Q9	What resources are needed to support the training of citizen scientists in recognition, segmentation, and description of archaeological features within case study areas (eg training materials, mapped exemplar areas)?	Desk based research UX design principles	Training resources Exemplars	P7 - Deep Time online course M6 - Training resources ready
Aim 3	Implementation			
Q10	How can we ensure that a diverse range of participants feel able to contibute to the project? Can specific groups be engaged which meet audience targets of stakeholder organisations, including underrepresented groups or specific demographics within the population? How can this be recorded?	Citizen Science principles Crowd management	Audience engagement strategy for each case study area	P2 - UPD
Q11	Can citizen scientists be trained and supported to identify and map archaeology across different case study areas and landforms, within a predictable timeframe?	Citizen Science principles Crowd management Archaeological landscape survey: mapping	Crowd mapping for each case study area	P8 - Unvalidated crowd mapped data and metadata M7 - Community mapped data
Q12	How can the crowd and workflow tasks be managed to avoid duplication of effort and maximise participation from all citizen scientists involved, with mapping activity spread evenly across the cohort of participants?	Crowd management	Crowd participation data	P9 - Participant evaluation data
Q13	Can the process of verification (such as completion of records, selection of monument types, and accuracy of segmentation) and validation (accuracy of identified sites) be performed and documented against pre-defined data quality metrics and confidence ratings? To what extent can trained citizens scientists be involved in this process?	UX design principles Consultation (Crowd and Practice) Archaeological research and landscape survey	Crowd verification for each case study area Validation by experts and crowd participants	P10 - Validated crowd mapped data, with metadata and confidence rating M8 - Validated data
Aim 4	Evaluation			
Q14	Can an evaluation framework, including a theory of change and standards of evidence, be formulated which drives the collection and analysis of quantitative and qualitative data to demonstrate both social and research impact?	Desk based research Consultation (Crowd and Practice)	Theory of change Standards of evidence	P3 - Evaluation framework
Q15	Can quantitative and qualitative data be collected, presented, and analysed to measure and evidence research impact and social impact?	Consultation (Practice)	Participant evaluation data	P9 - Participant evaluation data P11 - Project evaluation report P13 - Peer reviewed paper
Q16	Can mapped archaeological information be successfully reinvested back into HER / HBSMR systems of project partners?	Consultation (Practice)	Stakeholder evaluation data	P12 - Technical report P13 - Peer reviewed paper P14 - Digital archive
Q17	What recommendations can be made to Historic England and other stakeholders regarding community mapping projects and considering the delivery and results of this project?	Consultation (Practice)	Project reccomendations	P15 - Closure report M9 - Report and recommendations

Deep Time - Project Model
Appendix 1, Table 2 - Project tasks and research questions

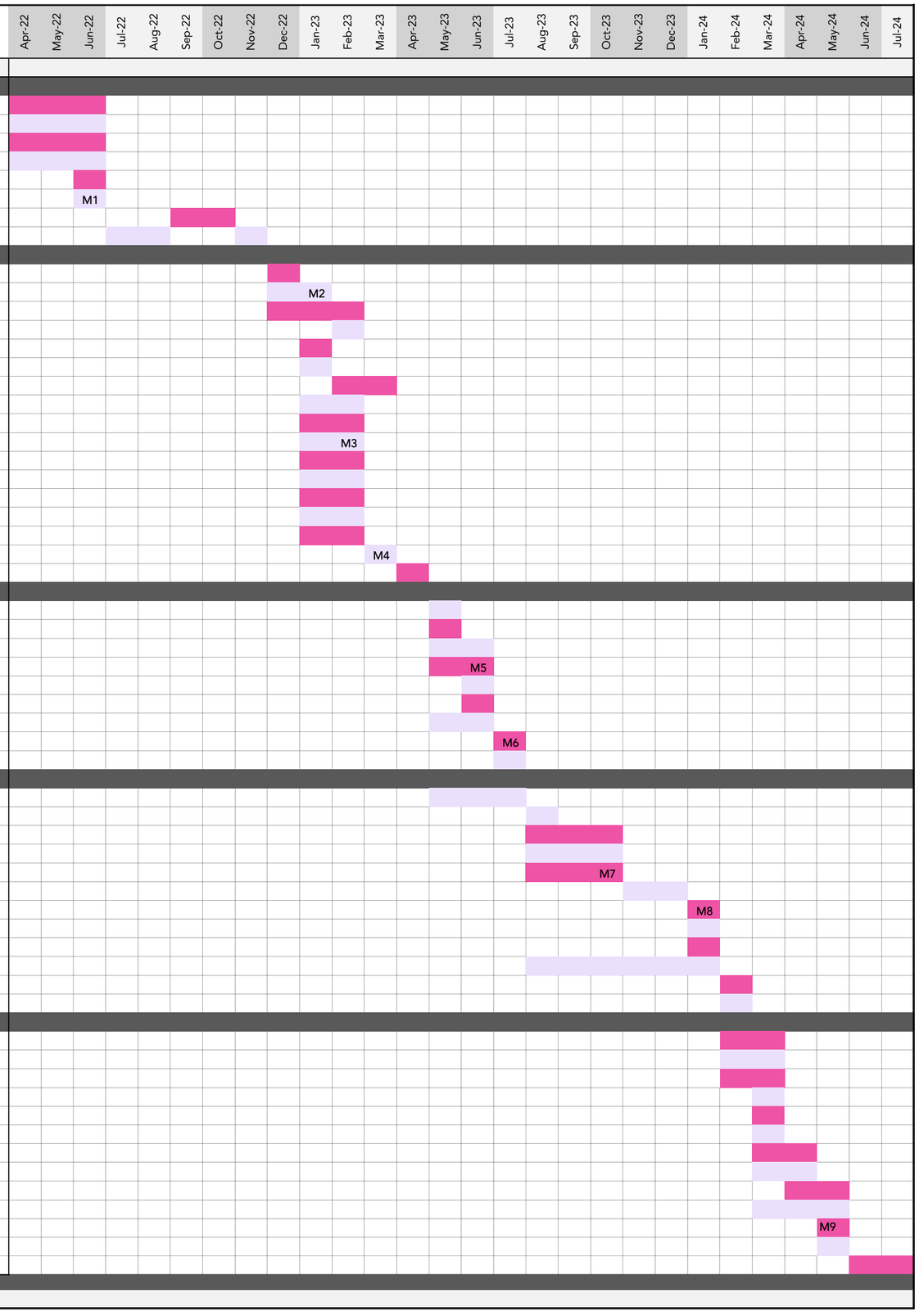
Stages and tasks			Research aims and objectives															
Stage	Stage / Task description	Admin	Aim 1					Aim 2				Aim 3				Aim 4			
Stage 1	Project Design		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.1	Project team / design meetings	✓																	
1.2	Project liasion with HE	✓																	
1.2	Detailed project plan, resources and programme delivery	✓																	
1.3	Explore Case Study locations and engage delivery partners	✓																	
1.4	Identify Advisory Group	✓																	
1.5	Finalise and submit project design (P1)	✓																	
Stage 2	Discovery and infrastructure																		
2.1	Project initiation meeting	✓																	
2.2	Finalise case study areas and partnership agreements						✓												
2.3	Consultation (PAB, Crowd and practice based), including survey		✓												✓			✓	
2.4	Ethics and values statement					✓													
2.5	Evaluation Framework & Comms Plan											✓				✓			
2.6	Data Management Plan (x 3) and update				✓														
2.7	Develop baseline confidence metrics for data audit, use and reuse			✓															
2.8	Audience engagement strategy				✓														
2.9	Update project plan, resources and programme delivery	✓																	
2.10	Highlight report > Updated Project Design (P2)	✓																	
Stage 3	Develop participatory GIS mapping platform																		
3.1	Technical development of GIS platform and mapping tools							✓		✓									
3.2	Heritage data audited and prepared			✓					✓	✓									
3.3	MIDAS compliant controlled terms			✓	✓					✓									
3.4	Data layers added to platform								✓										
3.5	Develop training resources to support citizen scientists					✓					✓			✓					
3.6	Case study exemplars for each area (Desk & survey)					✓					✓			✓					
3.7	Populate Deep Time platform with bespoke training materials										✓								
3.8	Test platform interfaces, mapping tools, data creation, data export							✓											
3.9	Consultation and feedback (PAB, Crowd and Practice)			✓											✓	✓		✓	
3.10	Highlight report > Deep Time platform	✓																	
Stage 4	Implementation																		
4.1	Engage and register citizen scientist cohort											✓							
4.2	Launch training course												✓	✓					
4.3	Community mapping - Case Study 1												✓	✓					
4.4	Community mapping - Case Study 2												✓	✓					
4.5	Community mapping - Case Study 3												✓	✓					
4.6	Field based validation / topographic mapping			✓											✓				
4.7	Update online mapping data and metadata			✓											✓				
4.8	Collect participation evaluation data													✓		✓			
4.9	Export mapped dataset for each case study area																		
4.10	Consultation and feedback (PAB, Crowd and Practice)														✓	✓		✓	
4.11	Highlight report > CI Case Study Area review / segmented datasets	✓																	
Stage 5	Evaluation and dissemination																		
5.1	Review efficacy of crowd to screen existing HER / HBSMR data			✓												✓	✓	✓	
5.2	Review efficacy of crowd to recognise / record new archaeological sites			✓												✓	✓	✓	
5.3	Review efficacy of crowd to verify peer data			✓												✓	✓	✓	
5.4	Review efficacy of contribute to validation process			✓												✓	✓	✓	
5.5	Review fidelity, accuracy, completeness of exported enhanced dataset			✓	✓											✓	✓	✓	
5.6	Consultation and feedback (PAB, Crowd and Practice)															✓	✓	✓	
5.7	Collate report presenting project results and evaluation																		✓
5.8	Collate results for peer reviewed paper																		✓
5.9	Dissemination workshop			✓										✓					✓
5.10	Prepare data for digital archive				✓														✓
5.11	Project recommendations																		✓
5.12	Highlight report > Closure report	✓																	

APPENDIX 2 – RESOURCES: TASKS AND BUDGET

APPENDIX 3 – PROGRAMME DELIVERY: TIME, MILESTONES AND GANTT CHART

8542 Deep Time
Tasks and Programme

Stage	Stage / Task description	Products / Milestones	Start	Finish
Stage 1	***Project Design***			
1.1	Project team / design meetings		Apr-22	Jun-02
1.2	Project liasion with HE		Apr-22	Jun-02
1.2	Detailed project plan, resources and programme delivery		Apr-22	Jun-02
1.3	Explore Case Study locations and engage delivery partners		Apr-22	Jun-02
1.4	Identify Advisory Group		Jun-22	Jun-22
1.5	Submit project design (P1)	P1 - PD / M1 - PD	Jun-22	Jun-22
1.6	Review, amend and finalise PD (P1)		Sep-22	Oct-22
	Circulate and HE review		Jul-22	Nov-22
Stage 2	***Discovery and infrastructure***			
2.1	Project initiation meeting		Dec-22	Dec-22
2.2	Finalise case study areas and partnership agreements	M2 - Partnership agreements	Dec-22	Jan-23
2.3	Collaborative design sprints with HE team x 4		Dec-22	Feb-23
2.4	Wider consultation (PAB, Crowd and practice based), including survey		Feb-23	Feb-23
2.5	Ethics and values statement	P5 - Ethics and values statement	Jan-23	Jan-23
2.6	Evaluation Framework & Comms Plan	P3 - Evaluation framework	Jan-23	Jan-23
2.7	Data Management Plan (x 3) and update	P4 - Data Management Plan	Feb-23	Mar-23
2.8	Review use of controlled teams / MIDAS within platform	M3 - Metrics	Jan-23	Feb-23
2.9	Develop baseline metrics for structured / unstructured data	M3 - Metrics	Jan-23	Feb-23
2.10	Develop baseline metrics for data verification / validation / reuse	M3 - Metrics	Jan-23	Feb-23
2.11	Audience engagement strategy		Jan-23	Feb-23
2.12	Relevant heritage data audited for use		Jan-23	Feb-23
2.13	List of MIDAS compliant controlled terms for case study areas		Jan-23	Feb-23
2.14	UPD workshop and presentation		Jan-23	Feb-23
2.15	Update project plan, resources and programme delivery		Jan-23	Feb-23
2.16	Highlight report > Updated Project Design (P2)	P2 UPD / M4 - UPD	Mar-23	Mar-23
	Circulate and HE review			Apr-23
Stage 3	***Develop participatory GIS mapping platform***			
3.1	Set up of GIS platform and mapping tools	P6 - Participatory GIS platform	May-23	May-23
3.2	Data layers added to platform	M5 - Platform ready	May-23	May-23
3.3	Develop training resources (x 3) to support citizen scientists	P7 - Online course and resources	May-23	Jun-23
3.4	Case study exemplars for each area (desk & survey)		May-23	Jun-23
3.5	Populate Deep Time platform with bespoke training materials	M6 - Resources uploaded	Jun-23	Jun-23
3.6	Test platform interfaces, mapping tools, data creation, data export		Jun-23	Jun-23
3.7	Consultation and feedback (PAB)		May-23	Jun-23
3.8	Highlight report > Deep Time platform		Jul-23	Jan-22
	Circulate and HE review			Jul-23
Stage 4	***Implementation***			
4.1	Engage and register citizen scientist cohort		May-23	Jul-23
4.2	Launch training course		Aug-23	Aug-23
4.3	Community mapping - Case Study 1		Aug-23	Oct-23
4.4	Community mapping - Case Study 2	P8 - Unvalidated community mapped data	Aug-23	Oct-23
4.5	Community mapping - Case Study 3	M7 - Community mapped data exported	Aug-23	Oct-23
4.6	Professional desk-based validation	P14 - Survey data	Nov-23	Dec-23
4.7	Update online mapping data and metadata	M8 - Validated data	Jan-24	Jan-24
4.8	Collect participation evaluation data	P9 - Evaluation data	Jan-24	Jan-24
4.9	Export mapped dataset for each case study area	P10 - Validated community mapped data	Jan-24	Jan-24
4.10	Consultation and feedback (PAB, Crowd and Practice)		Aug-23	Jan-24
4.11	Highlight report > CI Case Study Area review / segmented datasets		Feb-24	Feb-24
	Circulate and HE review		Feb-24	Feb-24
Stage 5	***Evaluation and dissemination***			
5.1	Review efficacy of crowd to screen existing HER / HBSMR data		Feb-24	Mar-24
5.2	Review efficacy of crowd to recognise / record new archaeological sites		Feb-24	Mar-24
5.3	Review efficacy of crowd to verify peer data		Feb-24	Mar-24
5.4	Review efficacy of contribute to validation process		Mar-24	Mar-24
5.5	Review fidelity, accuracy, completeness of exported enhanced dataset		Mar-24	Mar-24
5.6	Consultation and feedback (PAB, Crowd and Practice)		Mar-24	Mar-24
5.7	Collate report presenting project results and evaluation	P12 - Technical report	Mar-24	Apr-24
5.8	Collate results for peer reviewed paper	P11 - Evaluation report	Mar-24	Apr-24
5.9	Dissemination workshop	P13 - Peer reviewed paper prepped	Apr-24	May-24
5.10	Prepare data for digital archive	P14 - Digital archive prepped	Mar-24	May-24
5.11	Project recommendations	M9 - Reporting completed and reccs made	May-24	May-24
5.12	Highlight report > Closure report	P15 - Closure report	May-24	May-24
	Circulate and HE review		Jun-24	Jul-24



APPENDIX 4 – RISK LOG

Deep Time Risk Register									
#	Risk	Risk Owner	Probability (1-5) 1=insignificant 2=minor 3=significant 4=major 5=severe	Severity (1-5): 1=insignificant 2=minor 3=significant 4=major 5=severe	Risk Category (1-25) (Probability x Risk)	Mitigation	Post-mitigation Probability (1-5)	Post-mitigation Severity (1-5)	Post-Mitigation Risk Category
Technical Risks									
1	Participant skills development is not as efficient as hoped, and data enrichment not consistent or of high enough quality.	DV	2	4	8	High quality training resources will be beta tested, supported by FAQs and professional mentoring. Validation process encourages peer-to-peer review. All work is supported / verified by professional teams who will continually review and assess results.	1	2	2
2	Participants provide consistent and high-quality results, but are not as efficient at reviewing large land areas.	DV	2	3	6	Engage and train sufficient participant numbers. Volunteer opportunities promoted to DV / NT / FE / AONB volunteer communities. Case study areas can be adjusted in response to engagement levels and work flow rates of delivery if necessary.	1	2	2
3	Crowd output is not of a suitable quality for HER/ HBSMR use.	DV	3	5	15	Pilot work has provided successful segmentation and export of data which is useable for HER & HBSMRs. Data Management Plan will identify data requirements, export and metadata needs.	1	3	3
4	Technical performance or user experience is not sufficient to deliver a sustainable product	DV	2	4	8	The technical architecture of the platform is designed with scale and performance in mind. The Humap / Pixel Parlour team has many years' experience building products with a focus on user experience and technical excellence. Best practices for the design of cloud-centric and scalable solutions will be used, including load-testing and dynamic provisioning. The product will be beta tested with users part of the development cycle.	1	3	3
Operational Risks									
5	Illness of project team and/or participants, heightened due to COVID.	DV / partners	3	3	9	Clearly define team roles, task management and progress, and provide shared access to documents and data. Reduce impact by ensuring Risk Assessments include COVID19 protocols; online meetings / training embedded as main delivery for CI.	2	2	4
6	Project partnership arrangements are not fully understood / articulated.	DV / partners	2	5	10	DigVentures will put in place partnerhsip agreements which define the nature of partnership working agrangements, including the role of each organisation and how copyright and data rights will be managed.	1	3	3
7	Subcontractors do not deliver services as agreed.	DV / partners	2	3	6	Prepare an engagement contract for all deliverables. Subcontractors will be managed as a member of the project team, will full access to shared project management and file access. Regular management meetings will check on programme and delivery of services.	1	2	2
Confidence / reinvestment and use									
8	The CI process is not sufficiently effective to deliver confidence in results	DV	3	3	9	Whiste the Deep Time project has proven the CI model can work well for enhanceing heritage information, the team will ensure careful ongoing assessment of the quality of data as we deliver the project across case study areas. Confidence metrics will be identifed during project planning stages to underpin data audit, use and reuse.	1	2	2
9	Negative stakeholder feedback.	DV / partners	2	3	6	Review relationships, communications and business processes / maintain strong links with stakeholders and fully articulte and respond to issues. Maintain Issues Log.	1	2	2
10	Stakeholders are not ready for change.	DV	4	3	12	Communications around the product delivery, implementation and impact is vital to aid stakeholders confidence in the data produced, and avoid misperceptions in the project's intention or application.	2	2	4
Ethical framework									
11	Working with volunteers within process is questioned, or perceived as unethical	DV / partners	4	3	12	The platform and any project will be supported by an Ethics and Value Statement, and equal consideration is given to ensuring a mutually beneficial relationship with participants as generating usable data. DV is a Registered Organisation, regulated by CIfA, working within a clear professional and ethical framework in archaeology.	1	2	2

Design Sprints

Design sprints are a rapid process for cross-functional teams to brainstorm, define, and model new approaches to strategic business and operational challenges. They will typically include 7 to 10 participants, drawn from the project team, case study partners, key stakeholders and funders. The outputs of the design sprint (such as notes, user journey maps, story boards, workflow diagrams) enable the team to clearly define goals, validate assumptions and determine a roadmap before commencing the development or build stage of the project. The Deep Time project will adopt and adapt Nesta's Collective Intelligence Playbook, facilitating online zoom sessions, break out rooms and collaborative Miro boards to collate participant contributions. Nesta's playbook comprises a series of structured design canvases and tools aiming to harness the power of people, data and technology to enable organisations and practitioners to address sustainable development goals.

The project will be structured into five design sprints: (1) defining the challenge; (2) gathering information, data and ideas; (3) mobilising people; (4) connecting and interpreting; (5) creating change. In addition to informing the updated project design underpinning the project stage 3 (develop participatory GIS mapping platform), sprints will culminate with a series of good practice guidance notes for citizen data projects in the historic environment. This will aim for a broader relevance than the specific Deep Time project use case, detailing other successful case studies within and adjacent to our sector to identify FAIR workflows for projects which create big data through citizen science and other non-traditional methods.

Sprint 1: Defining the Challenge

This design sprint will be to address the key question: What is our issue and our purpose for using collective intelligence? It will clarify the specific challenge of bringing a collaborative model into HER workflows, the broader challenges facing the sector (such as climate change/Net Zero) and the potential benefits of a collective intelligence approach. The sprint will address the following discussion points:

1/ What is the issue we want to understand?
2/ Who does the issue affect?
3/ What is the change we want to bring about?
4/ What is our timeframe for action?
5/ What are our constraints?

Sprint 2: Gathering information, data and ideas

Building on Sprint 1, this session will focus on practicalities, with the key question: What data/information/ideas do we need to find, and how will we do it? The emphasis will be on producing a baseline understanding of the current state, as well as explore uncommon sources of data and insight that might illuminate the challenge in a new way, and the methods we can use to gather them effectively. The following questions will guide this sprint:

6/ What do we specifically need to know/find?
7/ What data might help us understand our problem?
8/ How will we collect this data?

9/ Are there any ethical issues with collecting or using this data?

Sprint 3: Mobilising people

If Sprint 2 is about designing for data, Sprint 2 is focussed on the equally important challenge of designing for people, addressing the key question: Who might be able to help, and how can we best engage them? Collective intelligence/citizen science projects have demonstrably tapped into distributed experience and expertise to tackle societal or scientific challenges. For this to happen, the goal needs to be clear, 'the crowd' needs to be carefully defined and targeted, and the motivations and incentives of those participating need to be considered. This sprint will focus on the people side of the collective intelligence workflow in the specific context of historic environment projects, addressing the following questions:

10/ Who could help us understand our problem?
11/ What do we want them to do?
12/ How will we reach those people?
13/ What might motivate them to be involved?

Sprint 4: Connecting and interpreting

If Sprints 2 and 3 dealt with the formative side of a collective intelligence workflow, Sprint 4 is focussed on the summative stage, guided by the key question: How will we bring together people and/or data, and make sense of the results? The sprint will focus on how to store and process any data collected, and a plan for turning often messy data or unstructured text into actionable results and insights. Design will be guided by the following questions:

14/ How will people interact and share information?
15/ How will we ensure everyone gets a chance to contribute?
16/ How will we bring together our data (store/ clean/process)?
17/ How will we make sense of the data we've collected?
18/ What biases might there be in our data?

Sprint 5: Creating Change

The final Sprint will turn design thinking outwards to the wider sector – turning the results of collective intelligence into action in the real world by asking: Who do we need to act, and what do they need to do this? This sprint is about identifying the demand and assessing if a collective intelligence model can be scaled to meet it. This final Sprint will lead directly into project stage 3 (develop participatory GIS mapping platform) of the Deep Time project, culminating in a UPD detailing specific case studies, and a series of good practice guidance notes for citizen data projects in the historic environment.

19/ Who do we need to act on the collective intelligence, and what do we want them to do?
20/ What do they need to see or know to do this?
21/ How will we open this data/ information to citizens?
22/ How will we feedback to participants?
23/ How will we know if we're on track and creating change?

Project summary

This document provides a Project Design for *Deep Time: Collective Intelligence and the search for our past*. Its purpose is to outline aims and methodology for an execution stage of the project, and outline the resources required and timescale for delivery. The ambition of the Deep Time project is to explore the potential impact and contribution that trained citizen scientists can make for the large-scale discovery and mapping of cultural heritage. It is driven by a need to create sustainable and effective solutions able to support land use transformation projects responding to climate change, carbon capture and Net Zero agendas.

This Project Design has been updated following comments and dicussion with Historic England, and has been resissued to comprise an initial execution stage which will result in an Updated Project Design. The updated project model comprises five work packages, including Project Design (Stage 1, current stage) and Discovery and Infrastructure (Stage 2, intial execution stage). This Project Design also provides an outline of Stages 3 to 5, with indicative tasks, methods and resourcing. The outputs of Stage 2 will comprise an Updated Project Design incorporating detailed breakdown of each work package, detailing specific case studies, and a series of good practice guidance notes for citizen data projects in the historic environment. This newly identified output will build on the process of Design Sprints planned to be delivered with invited stakeholders within the Discovery and Infrastructure process (Stage 2), and will be added to as the project progresses to share knowledge gained through each stage of project delivery.

The Deep Time project will focus on the delivery of three case studies, tailoring an online community mapping platform and training resources to each area, utilising existing LiDAR data, heritage information (Historic Environment Record (HERs)) and other data layers (such as historic mapping and satellite imagery). Case study areas will be provided and facilitated by the National Trust with further orgainsations expected to join the project during the deliver stage. Each case study will facilitate testing the collective intellegence methodology and Deep Time platform approach against real-world management challenges driven by landscape transformation an Net Zero targets. The research is led by collaborative archaeology platform, DigVentures, heading an expert team of digital development and user experience specialists to create an online mapping platform to support participatory research. The project builds on a previous pilot study, funded by Nesta, investigating how a collective intelligence model has the potential to create a step change in rapid archaeology mapping methods, with a demonstrable increase in social impact (Wilkins et al 2022).

Within the scope of this project, the digital platform will be further developed, with improvements made to mapping tools and functionality to support data collection and recording. Training resources will be developed that are relevant to each case study. Citizen scientists will be trained to create heritage information for at least three distinct areas, mapping archaeology using online tools, which is then verified online and validated through digital assessment and ground-based survey. A key research strand will plan, review, and assess the quality of the data itself: can non-traditional methods of archaeology mapping create data which meets professional standards, uses clear and documented standards, and exports reusable data that can be easily reinvested into heritage information systems and professional databases.

Key objectives of this project are to:

- Develop new tools and processes within the online mapping platform to enhance the identification and management of buried archaeological remains.
- Work collaboratively with landscape managers and heritage information managers to test the efficacy of the platform across differing landscapes.

- Consult widely to inform development, data infrastructure and management, user experience and participation, and respond to challenges experienced in data reuse.
- Evaluate the contribution of citizen scientists and measure impact of participation through a robust evaluation framework.
- Measure results and model confidence ratings for enhanced heritage information datasets, demonstrating usability, application, and impact of the platform in real world scenarios.
- Provide recommendations and good practice guidance to stakeholders regarding community mapping projects based on delivery and results of this project.

The Deep Time project pushes the boundaries of tech-enabled heritage management, embedding and training citizen scientists from the outset. Results will provide quality research data able to support ongoing management of historic environments and will fully document the process. In addition to the archaeological research results, we will work collaboratively with our partners, a Project Advisory Board, and wider sector to develop new metrics to help measure the quality, impact and potential contribution of community mapping projects.

Evaluation forms a key strand of the proposed delivery programme, not only to gauge effectiveness of collective intelligence in supporting archaeologists through the challenges ahead but in reviewing the ethical frameworks and standards within which such work is undertaken. The project will contribute a series of good practice guidance notes for citizen data projects in the historic environment, based on collaborative project design and the production and use of big data created through community projects or other nontraditional methods. The project offers an exciting proposition that aligns well with Historic England's Research Strategy and Future Strategy, and contributes directly to Strategic Activities outlined in HE's Corporate Plan 2021-2022.