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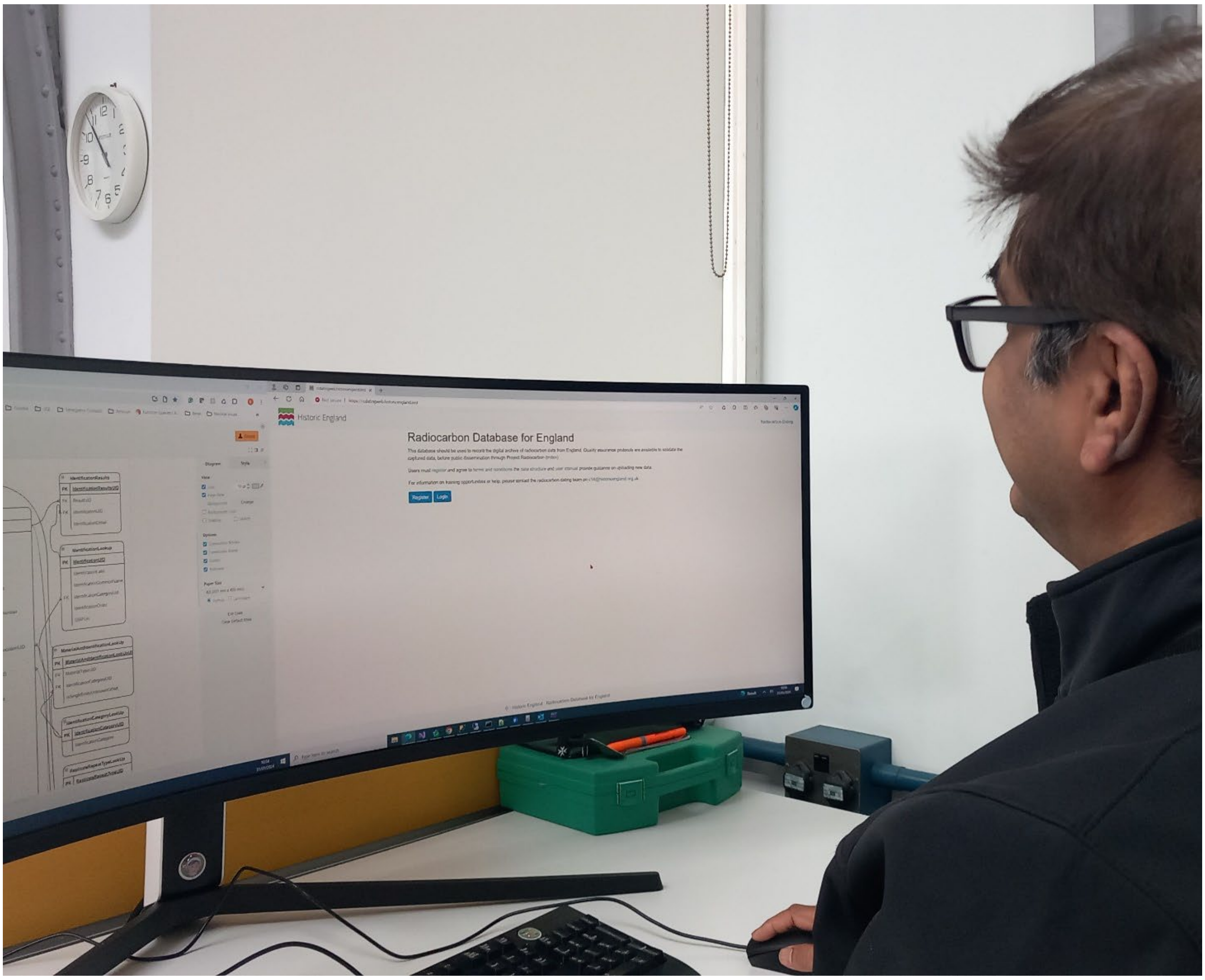
The Radiocarbon Database for England

Structure and Definitions

Edrich Gonsalves, Alex Bayliss, Bisserka Gaydarska and Peter Marshall



Scientific Dating

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Summary

This document details the design and content of the Radiocarbon Database for England, which is hosted by Historic England. The database is currently implemented in MS SQL Server® 2019, with a user front end implemented in MS Blazor Server. The database should be used to record the digital archive of radiocarbon data from England. Quality assurance protocols are available to check the captured data, and validated datasets are exported to the Project Radiocarbon database for public dissemination.

Contributors

Edrich Gonsalves, Alex Bayliss, Bisserka Gaydarska and Peter Marshall.

Acknowledgements

We thank Kate Cullen and Frances Healy for testing the implementation of the database and identifying faults in its structure during development, Phil Carlisle guided us in the implementation of indexing, Keith Austin helped us link to the Historic England Archive, and Gordon Mackay and David Thames helped with the implementation of spatial data.

Front cover image

Edrich Gonsalves developing the Radiocarbon Database for England (© Historic England, 2024; photograph by Brent Mullis).

Archive location

Historic England Archive, The Engine House, Fire Fly Avenue, Swindon SN2 2EH

Date of investigation

2022–24

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Contents

Introduction

This document details the design and content of the Radiocarbon Database for England. This database is designed to capture and hold radiocarbon and associated data from the historic environment in England.

The database is currently implemented in MS SQL Server® 2019, with a user front end implemented in MS Blazor Server. Quality assurance protocols are provided to validate the captured data to international standards. Datasets that meet these standards are exported to the Project Radiocarbon database for public dissemination using a JavaScript Object Notation (JSON) protocol.

The purpose of this report is to document definitions for the structure and content of the database.

The database design was moulded by the following objectives:

- to provide a robust platform for data entry and validation of the technical information on radiocarbon measurements from historic sites in England,
- to provide protocols to export validated data to the Project Radiocarbon database for public dissemination over the internet,
- to provide a computerised archive of the radiocarbon information, providing a backup to local computerised datasets and the paper archives in the event of disaster,
- to assist in the management of the programme of radiocarbon dating funded by Historic England.

The Entity Relationship Model

The Radiocarbon Database is built upon a relational structure. The Entity Relationship Diagram can be seen in Figure 1. This is graphical representation of the relationships that exist between the entities. All entities are linked to at least one other in the database by a one-to-many relationship. For example, there is there is a one-to-many relationship between Site and Results. The 'one' side of the relationship is denoted with a line (Site.SiteUID) and the 'many' side is denoted by the >| symbol (Results.SiteUID). This means that a site can have many radiocarbon results, but each radiocarbon result comes from only one site.

The model is based upon two core entities: Site and Results. From each of these entities, Comments, Index Terms, and Bibliographic Citations may be related. Sites may also relate to Contacts and Identifiers that link them to other resources, and Results link to the sampled Material and its Identification, the Laboratory and Analysis Method used, and administrative fields such as the Financial Year or Project Radiocarbon Batch. Results from a Site may be linked as Replicate/Repeat measurements. A series of Look Up tables provide validation of entered data. Other relationships exist between specific tables, which are discussed on a table-to-table basis below.

Database Design

A number of factors affected the data modelling, particularly the definition of fields to be included in the database.

A core of detailed archaeological and scientific information is required to fulfil the basic objectives of the project. This includes the information contained within datelists published by the journal *Radiocarbon* since its inception in 1959, which formed the basis of the format of the Historic England series of *Radiocarbon Dates* volumes (Jordan et al. 1994; Bayliss et al. 2007, 2008, 2012, 2013, 2015, 2016, 2023; Marshall et al. 2020, 2024). Our data are also compliant with the reporting standards set out for England by Bayliss and Marshall (2022, §3.6), and with international best practice (Millard 2014; Bayliss 2015).

The definition of this data has been considerably simplified by the existence of an internationally agreed system of unique identifiers for every radiocarbon result, incorporating the laboratory code and laboratory number (sometimes with an additional suffix). There are also internationally agreed conventions for the calculation and citation of radiocarbon results (Stuiver and Polach 1977; Mook and van der Plicht 1999), although the database has been designed to capture legacy data produced before these conventions were adopted.

Beyond the core data we have considered the range of users who may be interested in accessing the ultimate on-line service. This includes professional and independent archaeologists, academic researchers, and members of the public who are interested in dates for particular archaeological sites, material types, or geographical areas. Many of these users will require the detailed information on the archaeological context of the dated material and its characteristics, and technical details of the radiocarbon measurements and associated data, so that legacy results can be included in Bayesian chronological models, both for sites and for wider studies.

For this reason, extensive contextual information has been included for every sample, along with references to published sources for sites and radiocarbon results. Indexing has been applied using terms from the Forum on Information Standards in Heritage (FISH)(https://heritage-standards.org.uk/) *Archaeological Sciences Thesaurus* (https://heritage-standards.org.uk/fish-vocabularies/#archaeological-sciences-thesaurus), *Components Thesaurus* (https://heritage-standards.org.uk/fish-vocabularies/#components-thesaurus), *Archaeological Objects Thesaurus* (https://heritage-standards.org.uk/fish-vocabularies/#archaeological-objects-thesaurus), and *Thesaurus of Monuments Type* (https://heritage-standards.org.uk/fish-vocabularies/#monument-types-thesaurus). For each result, an additional field allows more detailed typological or other information relevant to a particular measurement to be recorded. Further comments may also be supplied by radiocarbon laboratories relating to the preservation, contamination, or processing of individual samples.

Site identifiers allow information in the database to be linked to other national resources. There are links to associated information in the National Heritage List for England (https://historicengland.org.uk/listing/the-list/) and the Historic England Archive (https://historicengland.org.uk/images-books/archive). Other recorded identifiers also allow information to be traced in Historic Environment Records held by local authorities (https://www.heritagegateway.org.uk/gateway/chr/) and to the Online Access to the Index of Investigations (https://oasis.ac.uk/). Museum Accession Numbers may also be recorded.

Data Types

The data types used in the database are shown in Table 1.

Normalisation

Normalisation of the data takes place in order to minimise the amount of duplication in the data storage, and to provide data integrity. The database has been normalised to Third Normal Form (3NF), with one exception required by the current limitations of the Blazor software used to implement the user interface.

Integrity Constraints

Integrity constraints have been enforced on many of the fields within the database. These complement the constraints that enforce terminology described above.

Not Null – This constraint is used to ensure that a given field in a table is never assigned a null value. For example, a Site must always have a Sitename.

Unique – The value in the field may not be duplicated by another record. This constraint is used for unique identifiers (UID's) such as primary keys.

Referential Integrity – Referential integrity exits between related tables. This enforces the integrity between a parent and child table so that although a parent can exist without a child (e.g. a Site record can exist without having any records in the Result table), a child record cannot exist without a parent record.

Consistency of Terminology

Where possible, the database uses checks and constraints in order to maintain a consistency in terminology. These are enforced in a variety of ways:

- Look-up tables – the choice of data to be entered is selected from a list. This restricts the data entered/queried by the user by ensuring consistency controlled through the contents of look-up tables.
- Database level checks – constraints on the format of the data passed to the database can be enforced to allow only certain formats of data to be stored. For example, a unique constraint ensure that any combination of the laboratory code and laboratory number can only occur once (e.g. OxA-12345).
- Application level checks – constraints may also be enforced at the application (front-end) level. Enforcement at the stage when the data is being entered can be programmed into the forms in order to reject data that does not fit the required criteria. As the database may be accessed without the application, this level of enforcement is a complimentary level of constraint and is not relied upon solely. For

example, $\delta^{13}C$ values of archaeological materials are almost always negative, so a pop-up box in the front end asks users whether the value is really positive when a ‘-‘ sign is not the first character entered.

The Modelled Entities

The database consists of 28 entities: three containing information relating to sites, two containing information relating to radiocarbon results, three containing information relating to both sites and results, and one linking replicate/repeat results from the same site together. The other 19 entities are look-up tables that enforce data validation.

User information is referenced from a separate database that is hosted on a separate, secure server.

Site Information

The core of information about the sites from which samples for radiocarbon dating have been recovered is held in the Site entity (Table 2). Each site has a unique system number (SiteUID), which forms the primary key of this entity. This is linked by one-to-many relationships to six other entities (Results, SiteContact, SiteIdentifer, C14Index, Citation, and Comments).

The SiteName field identifies a group of radiocarbon dates that have locational (and perhaps other) defining features. For example, the radiocarbon dates from the archaeological sequence on a site might be split into discussion of the settlement, the cemetery, and a pollen core. The Ordnance Survey National Grid Reference is used to auto-populate Latitude/Longitude, and the English Civil County, District, and Parish using an internal Historic England webservice. The date of excavation (or investigation), and the location of the paper/electronic and finds archives are recorded.

A site may have one or more site contacts. Depending on the circumstances of the research, this might be the excavation director, the project manager, or a principal investigator. Each of these individuals may be associated with an organisation. These details are held in the SiteContact entity (Table 3).

A site might also have one or more site identifiers. This information is held in the SiteIdentifier entity (Table 4). A look-up table, SiteIdentifierTypeLookUp (Table 5), holds the kinds of identifiers current held in the database, each of which has a unique system number (SiteIdentifierTypeUID). This has a one-to-many relationship with the Site Identifier entity.

Relationships to the C14Index, Citation, and Comments entities are discussed below as these also relate to the Results entity. The Site entity has a one-to-many relationship with the Results entity (Fig 1).

Information on Results

The core of information about the radiocarbon results and associated data is held in the Results entity (Table 6). Each radiocarbon measurement has a unique system number (ResultUID), which forms the primary key of this entity. This is linked by one-to-many relationships to five other entities (C14Index, Citation, Comments, IdentificationResults, and ReplicateRepeatResults), and by a many-to-one relationship to the Site entity.

Every radiocarbon measurement has an internationally agreed unique identifier, which is composed of the laboratory code assigned to each radiocarbon dating facility and the measurement number. This is held in the LabNumber field in the Results table. A look-up table, LaboratoryDetailsLookUp (Table 7), holds information about the radiocarbon dating laboratories included in the database, each of which has a unique system number (LabUID). This has a one-to-many relationship with the Results entity (and also with the Comments entity (*see* below)).

Each laboratory is linked to the analysis methods used for radiocarbon measurement in the facility in the LaboratoryMethod entity (Table 8), also with a one-to-many relationship. The LaboratoryMethod entity also has a one-to-many relationship with the Results entity, which ensures that the method used for each radiocarbon measurement is recorded. The analysis methods are held in another look-up table, C14AnalysisMethodLookUp (Table 9), which has a one-to-many relationship with the LaboratoryMethod entity.

Any tracking number within the radiocarbon laboratory (LabSampleNumber) and the year the measurement was made are also recorded, along with the submitter of the sample, when it was submitted, and the excavator's sample number. The association between the objective of the submission and the sample is also recorded, using values contained in the MeasurementAssociationLookUp table (Table 10). This has a one-to-many relationship with the Results entity. The financial year in which the sample was measured, and the funding source are also recorded using values held in the FinancialYearLookUp (Table 11) and FundingSourceLookUp (Table 12) tables respectively. Both of these look-up tables have one-to-many relationships with the Results entity.

Each radiocarbon measurement is made on a sample of material, and so is linked by a many-to-one relationship with the Material table (Table 13) where details of the material dated is recorded. Each material is composed of a MaterialType and a MaterialModification, which are held in the MaterialTypeLookUp (Table 14) and MaterialModificationLookUp (Table 15) tables respectively. Both of these look-up tables have one-to-many relationships with the Material entity. The Results entity may also record an additional comment about the material, the name of the person and the date when it was identified, and whether the sample was composed of a single entity (Ashmore 1999). This may be unknown.

The identification(s) of the material that composed a sample are held in the IdentificationResults table (Table 16), which has a many-to-one relationship with the Results table. Each identification is composed of a species or other appropriate identification, which is held in the IdentificationLookup table (Table 17) and an IdentificationDetail. The IdentificationResults entity has a many-to-one relationship with the IdentificationLookUp table. An appropriate group of potential identifications are selected for the user based on information about the material of the sample held in the Results table. The MaterialTypeUID (which is linked via the Material entity to the Results entity) is linked to IndentificationCategoryUID in the MaterialAndIdentificationLookUp table (Table 18), with the identification categories being defined in the IdentificationCategoryLookUp table (Table 19). The MaterialAndIdentificationLookUp table has one-to-many relationships with the MaterialTypeLookUp table and the IdentificationCategoryLookUp table. The IdentificationCategoryLookUp table also has a one-to-many relationship with the IdentificationLookUp table. Identifications within a category are placed in alphabetical order of Latin name using the IdentificationOrder field in the IdentificationLookUp table. These referential constraints ensure, for example, that an animal bone cannot be identified as *Corylus avellana* (hazel – a tree!). The IsSingleEntityUnknownOrNot field in the MaterialAndIdentificationLookUp table, along with the SingleEntity field in the Results table, ensure that single-entity and unknown samples can only have one entry in the IdentificationResults entity (a sample that is composed of two different species is, by definition, a bulk sample).

The Results entity also contains information about the radiocarbon measurement produced for a sample. Five forms of result are held in the database:

- Conventional Radiocarbon Age, calculated using the Libby half-life (5568±30 BP) and corrected for fractionation as described by Stuiver and Polach (1977). The age is held in the DateResult field, the error in the DateError field, and the CRA field is true.
- Other forms of Radiocarbon Age that have been used in the past, most commonly the Measured Radiocarbon Age (not corrected for fractionation) or radiocarbon ages calculated using the Cambridge half-life (5730±40 BP; Godwin 1962). The age is held in the DateResult field, the error in the DateError field, and the CRA field is false. A Result Laboratory Comment should be added explaining the value held in the database.

- Greater than ages which are beyond the limit of radiocarbon measurement. The age is held in the DateResult field and the GreaterThan field is true. These types of result do not have an error term.
- Conventional Radiocarbon Ages towards the limit of the technique that have asymmetric error terms. The age is held in the DateResult field, the positive error in the ASymErrorPlus field, and the negative error in the ASymErrorMinus field.
- Fraction modern (fM) results (Mook and van der Plicht 1999) for samples that date after AD 1950. The fraction modern value is held in the FMResult field, the error term in the FMError field, and FM is true.

Stable isotopic measurements associated with the radiocarbon determination are also held in the Results entity. These are:

- The $\delta^{13}C$ value used for age calculation. This value is held in the Delta13c field. If an error on this value is quoted, this is held in the Delta13cError field. If an assumed value has been used in age calculation, this is held in the Delta13c field and Delta13cAssumed is true.
- A $\delta^{13}C$ value that reflects the natural isotopic composition of the sample (i.e. not one that includes either the fractionation induced by the chemical processing of conventional samples or the measurement process in an Accelerator Mass Spectrometer). This is held in the Delta13cIRMS field. If an error on this value is quoted, this is held in the Delta13cIRMSError field. These values may be the same as those used for age calculation, in which case the values should be repeated in these fields and in those in the previous category.
- The $\delta^{15}N$ value of the sample. This is held in the Delta15nIRMS field. If an error on this value is quoted, this is held in the Delta15nIRMSError field.
- The atomic C:N ratio of the sample. This is held in the CNAtomic field.
- The $\delta^{34}S$ value of the sample. This is held in the Delta34sIRMS field. If an error on this value is quoted, this is held in the Delta34sIRMSError field.
- The atomic C:S ratio of the sample. This is held in the CSAtomic field.
- The atomic N:S ratio of the sample. This is held in the NSAtomic field.

Finally, the Results entity includes the Project Radiocarbon batch number, the details of which are held in the ProjectC14BatchNoLookUp table (Table 20). This has a one-to-many relationship with the Results entity.

Information relating to Sites and Results

The Sites and Results entities both have one-to-many relationships with the Comments entity (Table 21). Different types of comment are defined in the CommentTypeLookUp table (Table 22), which is linked to the Comments entity by a one-to-many relationship. The person or laboratory who made the comment and the date when it was made are recorded, in addition to the text of the comment itself. Laboratories are validated using the LaboratoryDetailsLookUp table (Table 7), which has a one-to-many relationship with the Comments entity.

Certain types of comment are mandatory for both Sites and Results. Sites must have a site description and site objectives and Results must have a sample initial comment and an entry under sample objectives. Multiple final comments on the result and laboratory comments may be made for both Sites and Results.

The Sites and Results entities also both have one-to-many relationships with the Citation entity (Table 23). In addition to linking to the bibliographic reference, a citation may also refer to pages, tables, or figures within a publication, which are held in the Pages field. Bibliographic references are held in the Bibliography table (Table 24), which holds both the text of the reference and the digital object identifier (DOI). This is linked to the Citation entity by a one-to-many relationship.

The Sites and Results entities also both have one-to-many relationships with the C14Index entity (Table 25). This table links to the index term and the thesaurus from which it comes. The Typology field can be used to record additional information about a result that is not covered by the available thesauri. The index terms are held in the THESAURUS_TERMS look-up table (Table 26). Each term has a unique system number (THE_TE_UID). The table defines the terms using scope notes and links them to a particular thesaurus, and also records the status of the term and whether it should be used in indexing. This allows the thesauri used by the database to be updated as the FISH thesauri are developed. This entity has a one-to-many relationship with the C14Index entity. The thesauri used by the database are defined in the CLASSIFICATION_GROUPS look-up table (Table 27). Each classification group has a unique system number (CLA_GR_UID), and the table records the name and description of the Thesaurus and whether it is an operational thesaurus that can be used. This entity has one-to-many relationships with both the THESAURUS_TERMS and C14Index tables. Strictly the relationship with the C14Index table is redundant because CLA_GR_UID links to the data in the CLASSIFICATION_GROUPS table via the THESAURUS_TERMS table. The current version of MS Blazor Server, however, cannot navigate through intermediate tables to retrieve data, and so this link is required so that the Classification of the Thesaurus as well as the Thesaurus Term can be selected on the front end.

Only operational thesauri and preferred terms can be used in the Radiocarbon Database for England. The THESAURUS_TERMS and CLASSIFICATION_GROUPS tables mirror those in the Historic England Unified Designation System.

Information linking Results

The ReplicateRepeatResults table (Table 28) links results from the same site that are from the same sample (replicates) or from the same context/feature (repeats). The table records the result and the repeat/replicate group with which it is associated. Each replicate/repeat group is of a type, which is recorded in the ReplicateRepeatTypesLookUp table (Table 29). The Results and ReplicateRepeatTypeLookUp tables both have one-to-many relationships with the ReplicateRepeatResults table.

A result can be a member of several different replicate/repeat groups but can only be a member of one group of each kind.

The Data Dictionary

The definitions of the fields in the Radiocarbon Database for England are provided in Tables 2–29. The data types used are defined in Table 1. The primary key is the first field listed in each table, and foreign keys are listed. Fields which database constraints ensure cannot be null are also indicated. There follows a definition of the data held in the field and, for clarity, an example entry.

Four other administrative fields are attached to all 28 entities in the Radiocarbon Database for England (Table 30). These provide a logging mechanism so that any systematic data or system errors can be tracked and rectified. CreatedBy and CreatedOn are populated when a record is initially created and are not updated, whereas LastModifiedBy and LastModifiedOn are over-written whenever a record is updated. CreatedBy and LastModifiedBy are anonymised user identifiers, which link to a separate database. This holds the anonymised user identifier, the user's name, the user's email address, and the user's organisation for all registered users on the system. This database is separate from the Radiocarbon Database for England for security reasons.

Conclusions

The Radiocarbon Database for England, which is hosted by Historic England, is designed to capture the digital archive of radiocarbon data from England. It is currently implemented in MS SQL Server® 2019, with a user front end implemented in MS Blazor Server. This document describes the Entity Relationship Model, including details of integrity constraints and database-level protocols to enforce data validation and consistent terminology. The Data Dictionary defines all the fields included in the database and provides examples of the data in each field.

A user guide for the resources provided for data collation, computerisation, and validation (Bayliss et al. 2024) provides details of application-level protocols to enforce data validation and consistent terminology, as well as guidance in collating and adding new data to the system.

Validated data sets are publicly accessible through the Project Radiocarbon portal (https://doi.org/10.5284/1118748).

Figures

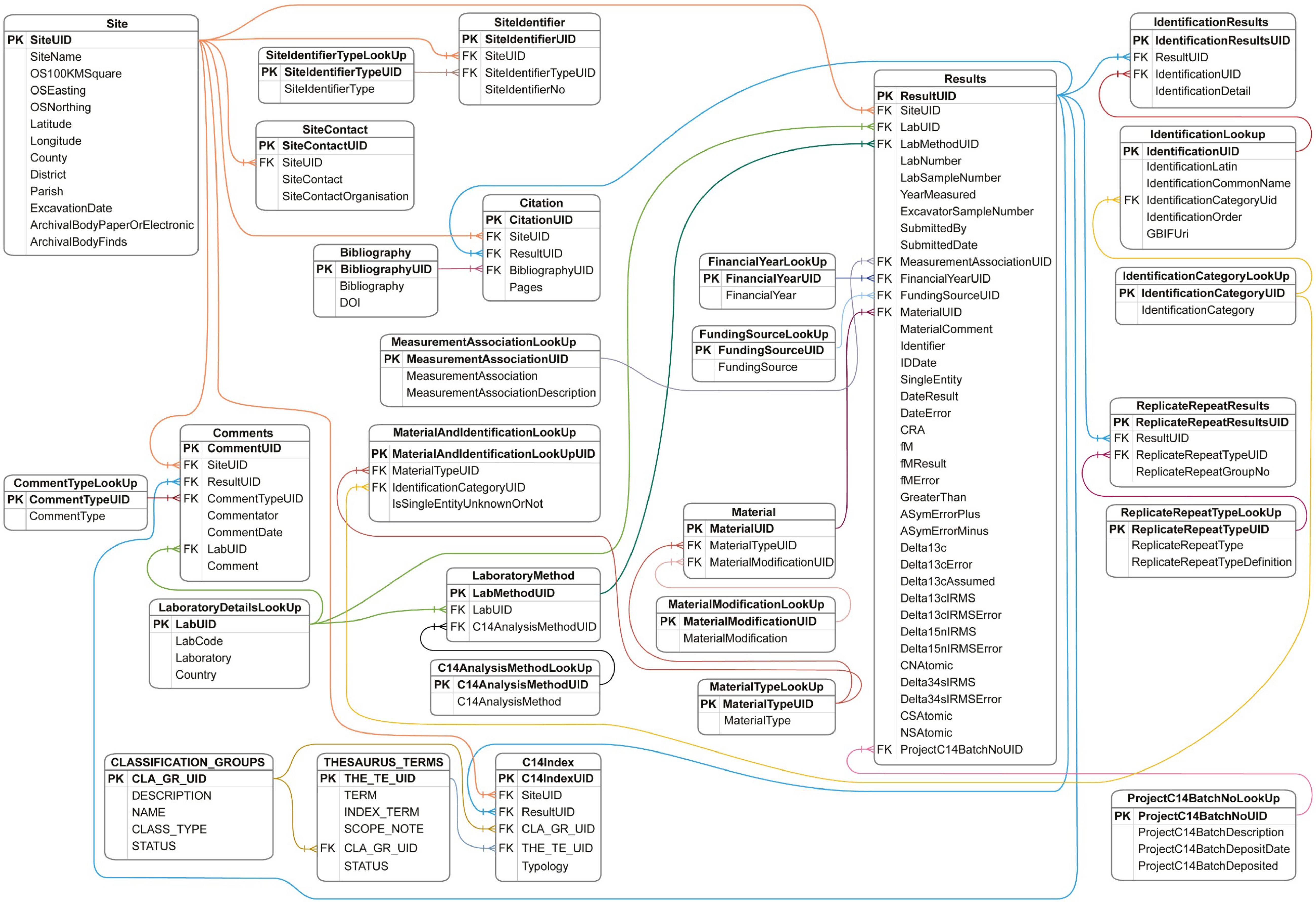

Figure 1. Entity Relationship Diagram for the Radiocarbon Database for England (note that all tables also include the four fields listed in Table 30); PK=primary key, FK=foreign key

Tables

Table 1. Data types used in the Radiocarbon Database for England.

Data Type	Description	Storage
Bit	An integer data type that can take a value of 1, 0, or NULL.	1 byte
Char(n)	A fixed-length string (can contain letters, numbers, and special characters). The (size parameter) specifies the length in characters, which must be between 1 and 8000.	n bytes
DateTime	A date and time combination. Format: YYYY-MM-DD hh:mm:ss.	8 bytes
Decimal(p,s)	An exact fixed-point number (can be negative). p stands for Precision, the total number of digits in the value; s stands for Scale, the total number of digits after the decimal point. The maximum number for the precision parameter is 38; scale ≤ precision.	5 bytes
Integer	A medium integer. Signed range is from -2147483648 to 2147483647.	4 bytes
Numeric(p,s)	An exact fixed-point number (can be negative). p stands for Precision, the total number of digits in the value; s stands for Scale, the total number of digits after the decimal point. The maximum number for the precision parameter is 38; scale ≤ precision. Numeric enforces the exact precision and scale specified.	5 bytes
NVarchar(n)	A variable length Unicode string (can contain letters, numbers, special characters, and formatting). The (size parameter) specifies the maximum length in characters, which must be between 1 and 4000.	2 x entered length + 2 bytes
NVarchar(max)	A variable length Unicode string (can contain letters, numbers, special characters, and formatting), which can be up to 2GB in size.	2 x entered length + 2 bytes
Varchar(n)	A variable length string (can contain letters, numbers, and special characters). The (size parameter) specifies the maximum length in characters, which must be between 1 and 8000.	n bytes +2 bytes

Table 2. Data dictionary for the **Site** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
SiteUID	Integer		Y	Unique system number for each Site	215
SiteName	Varchar(400)		Y	The name of the Site	Abingdon: Ashfield Trading Estate
OS100KMSquare	Char(2)			To arrive at this map reference, the United Kingdom is first divided into a series of 100km squares. Each 100km square is then given a unique two letter code such as NT, SU, TQ, etc.	SU
OSEasting	Varchar(10)			The vertical lines are called 'eastings', as they increase in value as you travel east on the map.	483
OSNorthing	Varchar(10)			The horizontal lines are called 'northings' as they increase in value as you travel north on the map.	973
Latitude	Decimal(9,6)			Latitude (decimal) WGS84; autopopulate from NGR	51.672403
Longitude	Decimal(9,6)			Longitude (decimal) WGS84; autopopulate from NGR	−1.302939
County	Varchar(100)			Civil County at time of data entry; autopopulate from NGR	Oxfordshire
District	Varchar(100)			Civil District at time of data entry; autopopulate from NGR	Vale of White Horse
Parish	Varchar(100)			Civil Parish at time of data entry; autopopulate from NGR	Abingdon on Thames

Column Name	Data Type	Foreign Key References	Required	Definition	Example
ExcavationDate	Varchar(100)			The date(s) of the excavation covered by the site	1974–6
ArchivalBodyPaperOrElectronic	Varchar(200)			The archival body which holds the paper archive or electronic archive	Somerset County Council Records Office
ArchivalBodyFinds	Varchar(200)			The archival body which holds the finds	Somerset County Museum

Table 3. Data dictionary for the **SiteContact** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
SiteContactUID	Integer		Y	Unique system number for each Site Contact	76
SiteUID	Integer	Site	Y	Unique system number for each Site	80267
SiteContact	Varchar(100)		Y	The initial(s) and surname of the excavator or responsible project manager from a single organisation. More than one person maybe included from the organisation.	A Whittle
SiteContactOrganisation	Varchar(200)			The name of the organisation the excavator or project manager is associated with	Cardiff University

Table 4. Data dictionary for the **SiteIdentifier** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
SiteIdentifierUID	Integer		Y	Unique system number for each Site Identifier	837
SiteUID	Integer	Site	Y	Unique system number for each Site	10634
SiteIdentifierTypeUID	Integer	SiteIdentifierTypeLookUp	Y	Unique system number for each Site Identifier Type	3
SiteIdentifierNo	Varchar(100)		Y	Identifier number	Bedfordshire 20050

Table 5. Data dictionary for **SiteIdentifierTypeLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
SiteIdentifierTypeUID	Integer		Y	Unique system number for each Site Identifier Type	3
SiteIdentifierType	Varchar(100)		Y	Site Identifier Type description	HER No

Table 6. Data dictionary for the **Results** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
ResultUID	Integer		Y	Unique system number for each Radiocarbon Result	80743
SiteUID	Integer	Site	Y	Unique system number for each Site	837
LabUID	Integer	LaboratoryDetailsLookUp	Y	Unique system number for each Laboratory	13
LabMethodUID	Integer	LaboratoryMethod	Y		2
LabNumber	Varchar(50)		Y	The part of the internationally agreed unique identifier for the Radiocarbon Result after the laboratory code.	1964R
LabSampleNumber	Varchar(50)			Radiocarbon Laboratory sample identifier	P17806
YearMeasured	Varchar(10)			The date when the Radiocarbon Result was measured or reported	07/07/2011
ExcavatorSampleNumber	Varchar(100)			Sample identifier provided by the submitter	SAHMG37
SubmittedBy	Varchar(100)			The initial(s) and surname of the person who submitted the sample	M Russell

Column Name	Data Type	Foreign Key References	Required	Definition	Example
SubmittedDate	Varchar(10)			The date the sample was submitted	25/11/1996
MeasurementAssociationUID	Integer	MeasurementAssociationLookUp		Unique system number for each type of Measurement Association	1
FinancialYearUID	Integer	FinancialYearLookUp		Unique system number for each Financial Year	61
FundingSourceUID	Integer	FundingSourceLookUp		Unique system number for each Funding Source	1
MaterialUID	Integer	Material		Unique system number for each Material	57
MaterialComment	Varchar(2000)			Additional details relating to the material type	*c.* 50% identified
Identifier	Varchar(100)			The initial(s) and surname of the person who identified the material	C Wells
IDDate	Varchar(4)			The year the material was identified	1989
SingleEntity	Varchar(7)		Y	Was the dated sample a single entity	Yes/No/Unknow n
DateResult	Integer			Radiocarbon Age	2170
DateError	Integer			The uncertainty quoted by the dating laboratory on the Radiocarbon Age at one standard deviation	70

Column Name	Data Type	Foreign Key References	Required	Definition	Example
CRA	Bit			Prompt to indicate whether the quoted DateResult is a Conventional Radiocarbon Age (Stuiver and Polach 1977)	Y/N (if N user must draft a ResultLaboratoryComment to explain)
fM	Bit			Prompt to indicate whether the result is expressed as fraction modern	Y/N
fMResult	Decimal(7,6)			The fraction modern result (Mook and van der Plicht 1999)	1.065000
fMError	Decimal(7,6)			The error on the fraction modern result	0.005000
GreaterThan	Bit			Prompt to indicate that the sample is older than background	Y/N
ASymErrorPlus	Integer			Older error at one standard deviation for asymmetric error close to background	930
ASymErrorMinus	Integer			Younger error at one standard deviation for asymmetric error close to background	830
Delta13c	Decimal(7,2)			The ratio of ^{12}C to ^{13}C ($\delta^{13}C$ value) used in age calculation	−18.76
Delta13cError	Decimal(7,2)			The error at one standard deviation of the $\delta^{13}C$ value used in age calculation	0.2

Column Name	Data Type	Foreign Key References	Required	Definition	Example
Delta13cAssumed	Bit			Prompt to indicate that the $\delta^{13}C$ value used in age calculation was assumed	Y/N
Delta13cIRMS	Decimal(7,2)			The $\delta^{13}C$ value measured by IRMS	−18.76
Delta13cIRMSError	Decimal(7,2)			The error at one standard deviation of the $\delta^{13}C_{IRMS}$ value	0.2
Delta15nIRMS	Decimal(7,2)			The ratio of ^{14}N to ^{15}N ($\delta^{15}N$ value) measured by IRMS	+15.7
Delta15nIRMSError	Decimal(7,2)			The error at one standard deviation of the $\delta^{15}N_{IRMS}$ value	0.3
CNAtomic	Decimal(7,2)			Atomic carbon:nitrogen ratio	3.25
Delta34sIRMS	Decimal(7,2)			The ratio of ^{32}S to ^{34}S ($\delta^{34}S$) measured by IRMS	3.1
Delta34sIRMSError	Decimal(7,2)			The error at one standard deviation of the $\delta^{34}S_{IRMS}$ value	0.3
CSAtomic	Decimal(7,2)			Atomic carbon:sulphur ratio	630
NSAtomic	Decimal(7,2)			Atomic nitrogen:sulphur ratio	194
ProjectC14BatchNoUID	Integer	ProjectC14BatchNoLookUp	Y	ProjectC14 Batch Submission No	1

Table 7. Data dictionary for the **LaboratoryDetailsLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
LabUID	Integer		Y	Unique system number for the LabUID	1
LabCode	Varchar(50)		Y	Internationally agreed Laboratory code	OxA
Laboratory	Varchar(200)		Y	Laboratory name	Oxford Radiocarbon Accelerator Unit
Country	Varchar(100)		Y	Country	UK

Table 8. Data dictionary for the **LaboratoryMethod** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
LabMethodUID	Integer		Y	Unique system number for the Laboratory Method	567
LabUID	Integer	LaboratoryDetailsLookUp	Y	Unique system number for each Laboratory	1
C14AnalysisMethodUID	Integer	C14AnalysisMethodLookUp	Y	Unique system number for the C14 Analysis Method used	1

Table 9. Data dictionary for the **C14AnalysisMethodLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
C14AnalysisMethodUID	Integer		Y	Unique system number for the C14 Analysis Method	1
C14AnalysisMethod	Varchar(100)		Y	Method used for C14 measurement	Accelerator Mass Spectrometry

Table 10. Data dictionary for the **MeasurementAssociationLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
MeasurementAssociationUID	Integer		Y	Unique system number for Measurement Association	4
MeasurementAssociation	Varchar(50)		Y	Degree of association of sample within original objective	Possible
MeasurementAssociationDescription	Varchar(200)		Y	Kind of Association	Relationship less obvious because material small and scattered

Table 11. Data dictionary for the **FinancialYearLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
FinancialYearUID	Integer		Y	Unique system number for Financial Year	61
FinancialYear	Varchar(7)		Y	Financial year in which the sample was submitted, or submission date where this is unknown	2021-22

Table 12. Data dictionary for the **FundingSourceLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
FundingSourceUID	Integer		Y	Unique system number for Funding Source	1
FundingSource	Varchar(100)		Y	Funding source organisation	Ministry of Public Buildings & Works

Table 13. Data dictionary for the **Material** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
MaterialUID	Integer		Y	Unique system number for Material	1
MaterialTypeUID	Integer	MaterialTypeLookUp	Y	Unique system number for Material Type	1
MaterialModificationUID	Integer	MaterialModificationLookUp	Y	Unique system number for Material Modification	3

Table 14. Data dictionary for the **MaterialTypeLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
MaterialTypeUID	Integer		Y	Unique system number for Material Type	1
MaterialType	Varchar(200)		Y	The type of Material	antler

Table 15. Data dictionary for the **MaterialModificationLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
MaterialModificationUID	Integer		Y	Unique system number for Material Modification	3
MaterialModification	Varchar(100)		Y	A list of how materials can be modified	calcined

Table 16. Data dictionary for the **IdentificationResults** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
IdentificationResultsUID	Integer		Y	Unique system number for each IdentificationResult	1
ResultUID	Integer	Results	Y	Unique system number for each Result	8087
IdentificationUID	Integer	IdentificationLookUp	Y	Unique system number for each Species	188
IdentificationDetail	Varchar(500)			Additional details relating to the species of the identified material	17 seeds

Table 17. Data dictionary for the **IdentificationLookup** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
IdentificationUID	Integer		Y	Unique system number for each Species	188
IdentificationLatinName	Varchar(200)			Species Latin Name	Urtica dioica
IdentificationCommonName	Varchar(200)			Species Common Name	Nettle
IdentificationCategoryUID	Integer	IdentificationCategoryLookUp	Y	The identification group	bone
IdentificationOrder	Integer		Y	The identification order within each group	279
GBIFUri	Varchar(200)			The GBIF Uri of the Species	https://api.gbif.org/v1/species/match?name=Urtica%20dioica

Table 18. Data dictionary for the **MaterialAndIdentificationLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
MaterialAndIdentificationLookUpUID	Integer		Y	Unique system number for material and identification category	2
MaterialTypeUID	Integer	MaterialTypeLookUp		Unique system number for material type	1
IdentificationCategoryUID	Integer	IdentificationCategoryLookUp		Unique system number for each identification group	188
IsSingleEntityUnknownOrNot	Bit			Whether the sample is single-entity/unknown or bulk	Y/N

Table 19. Data dictionary for the **IdentificationCategoryLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
IdentificationCategoryUID	Integer		Y	Unique system number for each identification group	188
IdentificationCategory	Varchar(50)		Y	The identification group	bone

Table 20. Data dictionary for **ProjectC14BatchNoLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
ProjectC14BatchNoUID	Integer		Y	Unique system number for Project C14 Batch No	2
ProjectC14BatchDescription	Varchar(500)		Y	The batch description	Measurements funded by MPBW
ProjectC14BatchDepositDate	DateTime			The batch deposit date and time	2024-04-17 14:38:54.230
ProjectC14BatchDeposited	Bit		Y	Whether the batch has been deposited	Y

Table 21. Data dictionary for the **Comments** table.

Column Name	Data Type	Foreign key References	Required	Definition	Example
CommentUID	Integer		Y	Unique system number for each Comment	1234
SiteUID	Integer	Site		Unique system number for each Site	837
ResultUID	Integer	Results		Unique system number for each Radiocarbon Result	This example is a site comment, therefore there is no ResultUID
CommentTypeUID	Integer	CommentTypeLookUp	Y	Unique system number for each Comment Type	2
Commentator	Varchar(100)			The initial(s) and surname of the person who made the comment	A Whittle
CommentDate	Varchar(10)			Date of Comment	00/03/2004 = March 2004
LabUID	Integer	LaboratoryDetailsLookUp		Unique system number for each Lab	947
Comment	NVarchar(max)			The full text of the comment	One further sample (UB-3191: HA4, grave fill 4221/1) was lost.

Table 22. Data dictionary for **CommentTypeLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
CommentTypeUID	Integer		Y	Unique system number for each Comment Type	2
CommentType	Varchar(100)		Y	Type of Comment	Site laboratory comment

Table 23. Data dictionary for the **Citation** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
CitationUID	Integer		Y	Unique system number for each Citation	10073
SiteUID	Integer	Site		Unique system number for each Site	837
ResultUID	Integer	Results		Unique system number for each Radiocarbon Result	This example is a site reference, therefore there is no ResultUID
BibliographyUID	Integer	Bibliography	Y	Unique system number for each Bibliographic Reference	9943
Pages	Varchar(100)			Pages for Citation	153, figs 10.2-3, and table 10.1

Table 24. Data dictionary for the **Bibliography** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
BibliographyUID	Integer		Y	Unique system number for each Bibliographic Reference	9943
Bibliography	NVarchar(4000)		Y	Bibliographic Reference	Hedges, R E M, Housley, R A, Bronk, C R, and van Klinken, G J, 1992 Radiocarbon dates from the Oxford AMS system: *Archaeometry* datelist 14, *Archaeometry*, **34**, 141–59
DOI	Varchar(1000)			DOI Information	https://doi.org/10.1017/s0003598X00108373

Table 25. Data dictionary for the **C14Index** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
C14IndexUID	Integer		Y	Unique system number for Index	1
SiteUID	Integer	Site		Unique system number for Site	837
ResultUID	Integer	Results		Unique system number for C14 Result	Blank (this is a site index term)
CLA_GR_UID	Numeric(3,0)	ClassificationGroups	Y	Unique system number for classification groups	1 (Monument Type)
THE_TE_UID	Numeric(7,0)	ThesaurusTerms	Y	Unique system number for Thesaurus Terms	2743 (Barrow)
Typology	Varchar(500)			Additional typological details	SW4

Table 26. Data dictionary for the **THESAURUS_TERMS** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
THE_TE_UID	Numeric(7,0)		Y	Unique system number to define a Thesaurus term	68928
TERM	Varchar(50)		Y	The actual term, as used in reports, forms etc	HOUSE
INDEX_TERM	Varchar(1)		Y	Whether the term can be used in indexing. Only preferred and Candidate terms can be indexed	Y
SCOPE_NOTE	Varchar(255)			The definition of the term and, where appropriate, how it should be used.	A building for human habitation, especially a dwelling place. Use more specific type where known.
CLA_GR_UID	Numeric(3,0)	ClassificationGroups	Y	Identifies the particular thesaurus (e.g. cla_gr_uid = 1 means MONUMENT TYPE)	1
STATUS	Varchar(1)		Y	Identifies the preference of a term, whether Preferred, Non Preferred or Candidate	P

Table 27. Data dictionary for the **CLASSIFICATION_GROUPS** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
CLA_GR_UID	Numeric(3,0)		Y	Unique number used to identify each thesaurus or other classification. e.g. Monument Types = '1'	1
DESCRIPTION	Varchar(240)			Short description of the content / origin of the thesaurus or other classification	Classification of monument type records by function
NAME	Varchar(40)		Y	Name assigned to the thesaurus or other classification	MONUMENT TYPE
CLASS_TYPE	Varchar(1)		Y	Distinguishes Thesauri 'T' from other classifications 'O'	T
STATUS	Varchar(1)		Y	Distinguished Operational 'O' from Test 'T' thesauri	O

Table 28. Data dictionary for the **ReplicateRepeatResults** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
ReplicateRepeatResultsUID	Integer		Y	Unique system number for Replicate Repeat Results	1
ResultUID	Integer	Results	Y	Unique system number for Result	8074
ReplicateRepeatTypeUID	Integer	ReplicateRepeatTypeLookUp	Y	Unique system number for Kind of Replicate Repeat	2
ReplicateRepeatGroupNo	Integer		Y	Identification Number for each Replicate Repeat Group	117

Table 29. Data dictionary for the **ReplicateRepeatTypeLookUp** table.

Column Name	Data Type	Foreign Key References	Required	Definition	Example
ReplicateRepeatTypeUID	Integer		Y	Unique system number for Replicate Repeat Type	2
ReplicateRepeatType	Varchar(50)		Y	Type of Replicate measurement	True replicate
ReplicateRepeatTypeDefinition	Varchar(200)		Y	Definition of Type of Replicate measurement	replicate measurement on the same single-entity sample, where the whole laboratory process has been repeated from an aliquot of the original sample

Table 30. Data dictionary for additional common fields held in all 28 entities of the Radiocarbon Database for England (Tables 2–29)

Column Name	Data Type	Foreign Key References	Required	Definition	Example
CreatedBy	Varchar(100)	External database	Y	Unique identifier for registered user	08bcf864-bc3d-4cfb-8da3-40631b738ac6
CreatedOn	DateTime		Y	The date and time when a record was first created	2024-04-17 14:38:54.230
LastModifiedBy	Varchar(100)	External database		Unique identifier for registered user	08bcf864-bc3d-4cfb-8da3-40631b738ac6
LastModifiedOn	DateTime			The date and time when a record was last updated	2024-04-18 17:42:51.110

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