An Roinn Ealaíon, Oidhreachta, Gnóthaí Réigiúnacha, Tuaithe agus Gaeltachta

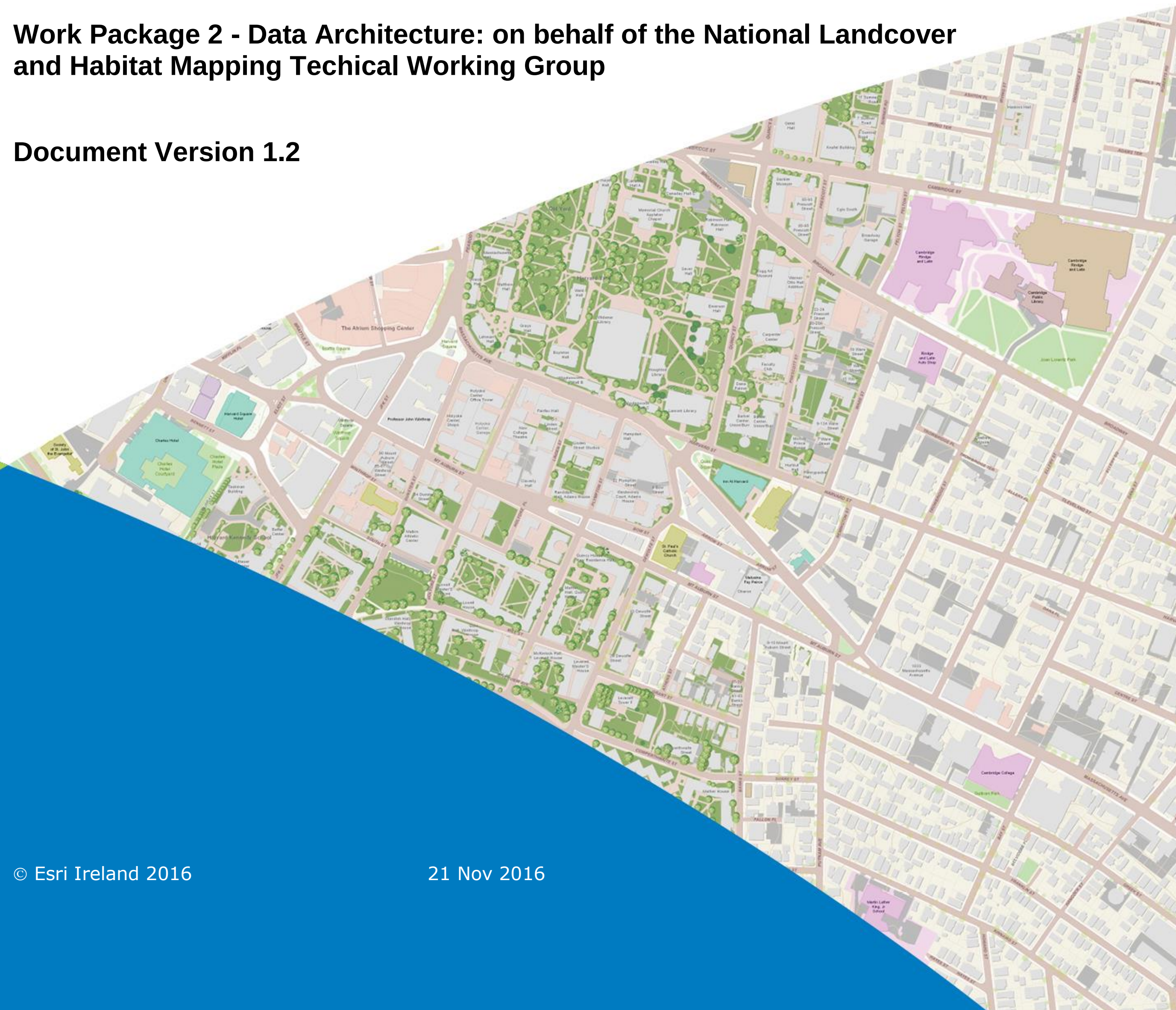
Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs

National Parks & Wildlife Service

# National Landcover and Habitat Mapping

**Work Package 2 - Data Architecture: on behalf of the National Landcover and Habitat Mapping Techical Working Group**

**Document Version 1.2**





21 Nov 2016

# Contents

# 1. Background

To ensure the sustainable use of Ireland's terrestrial land it is essential to have a good knowledge of the types of landcover and habitats. However, there are currently fundamental gaps in our knowledge of landcover and habitats in Ireland.

Ireland is one of the few remaining countries in Europe that does not have a national programme for either landcover or habitat mapping. As a result, there are significant deficiencies in data, as it is collected by many different bodies to differing standards, which is a barrier to integration of those data. This therefore impacts upon the efficient delivery of those public services outlined above, from the strategic planning of their provision, to the use of such data for evidence based decision making across the State.

During 2016, a National Geospatial Data Strategy is being developed by Ordnance Survey Ireland (OSi), under the aegis of the Department of Justice and Equality, for the Minister for Public Expenditure and Reform. This activity is in accordance with Action No. 1.2.4 (iii) of the Public Service Reform Plan 2014–16 and consistent with the e-Government Strategy 2012–2015 and the Public Service ICT Strategy. The key aim of the National Geospatial Data Strategy is to provide the infrastructure and policy for the State to effectively use its location (geospatial) data to support an efficient analytics approach to Government planning and decision-making.

Although much legislation requires knowledge of such data for successful implementation, there has never been a specific requirement for the production of national maps. Many national agencies have produced national data for certain thematic areas within landcover classes (e.g. DAFM agricultural Parcels) or within certain regions (e.g. Local Authorities producing focused habitat maps). The result of this has been that there is a significant amount of disparate data and overlap between organisations and no single authoritative National Landcover and Habitat Maps.

In 2011 a National Workshop on Landcover and Habitat Mapping identified that significant resources, by a number of different national agencies, were being invested in the development of relevant but incompatible landcover and habitat data programmes. It was agreed at the workshop that a national working group be established to explore the options around the development of a National Landcover & Habitats Mapping (NLCHM) Programme. This working group is comprised of the Environmental Protection Agency (EPA), National Parks & Wildlife (NPWS), The Heritage Council, Ordnance Survey of Ireland (OSi), Department Agriculture Food & Marine (DAFM), Teagasc, Geological Survey of Ireland(GSI) and Department of the Environment, Community and Local Government (DECLG).

In the past four years the working group has been working on defining the mapping requirements, such as the scale that maps should be produced at to meet the majority of stakeholder requirements, the technical details of how to implement a national mapping programme, and the development of a policy proposal document for consideration by the Minister of the Department of Arts, Heritage and the Gaeltacht (DAHG).

A technical methodology for mapping land cover was established through a pilot project for County Roscommon and through EPA STRIVE funded research projects with University College Cork/Teagasc: TALAM (focuses on the mapping of unenclosed upland areas) and also Irish Land Mapping Observatory (ILMO), which was tasked with developing an integrated Geoinformatics approach towards detecting land cover and use within Irish agricultural lands to facilitate reporting on national greenhouse gas emissions related to land use.

With a technical methodology agreed in principle the working group moved to develop proposals on how this might be implemented through a national programme.

Esri Ireland were contracted by DAHG on behalf of the NCLHM technical working group to help with the delivery of two work packages – A data Classification System and a Data Architecture. This document focuses on the Conceptual Data Model (CDM) that will allow the appropriate integration of data from distributed data providers into the OSI PRIME 2 data model, and defines the high level data architecture components that would be required to support a production lifecycle to realise the CDM.

# 2. Our Approach

To support the delivery of the 2016 work programme, the National Landcover and Habitat Mapping Technical Working Group applied a standardised methodology, tried and tested both locally and globally, to the development and refinement of classification systems and data architectures. The working group adapted this methodology to suit the needs of the project and deliver a fit for purpose Classification System and Data Architecture.

## 2.1. Project Initiation & Requirements Gathering

A Project Initiation meeting and two workshops aimed at identifying all the requirements were held. The **Project Initiation** was used to:

- Define the project objectives and critical success factors (CSF's).
- Identify any projects constraints that may prevent achievement of CSF's).
- Confirm the project scope.
- Establish a list of key stakeholders who will help shape the design of the classification system, data architecture and accompanying processes.
- This meeting enabled the NLCHM Team to develop a Project Plan, Risk Register and Communications Plan that would fulfil and exceed the needs of the project.

The first workshop was held with the key stakeholders (DAHRRGA, EPA, TEAGASC, GIS, OSI, DAFM) as identified at the Project Initiation meeting. The aim of the workshop was to capture the requirements to be met during the CDM and data architecture design phase and to
(1) Understand the current state of the project (based on findings of the Roscommon Pilot, TALAM, ILMO and other relevant work) as well as (2) Defining gaps – gaps between what exists and what is required.

The deliverable of this workshop was a Requirements Catalogue, which was presented for review in the second workshop to define and agree the scope for the model design. The aim of the second workshop was to achieve consensus on the requirements and move forward with design thinking to enable the:

- Definition and documentation of source and supply of data inputs (information boundaries).
- Definition of entities that are core to the capture and representation of NLCHM.
- Understand how NLCHM classifications could be linked and referenced back to entities in the OSi reference data model (Prime II).
- How the data architecture will be leveraged and consumed in the form of information products.
- What output mapping products are required?

This allowed the NLCHM Team to document and catalogue the design considerations, the data supply chain and associated schema as documentation of the source to target mappings.

## 2.2. Database Design

The NLCHM used industry standard database design methodology and outputs captured at workshops to date, to carry out the first iteration of database design.

A conceptual data architecture has been established, in line with the aims of the National Geospatial Data Strategy to ensure that there is:

- A baseline standard established for high resolution National Landcover and Habitat Mapping data, including important land use attribution information.
- Data sharing between public agencies.
- Integration with the Prime2 national spatial data platform from OSi.
- Reuse of available information where feasible, such as the use of Earth observation imagery via the European Space Agency's Sentinel satellites.

Some of the core design steps that form part of the **design methodology** were;

- Identifying the key data themes based on information requirements.
- Defining the spatial behaviour, spatial relationships and integrity rules for each dataset.
- Initiating a geodatabase design.
- Building a working prototype geodatabase.
- Positioning candidate designs against core use cases defined for NLCHM.

## 2.3. Landcover Classification

During a previous proof-of-concept pilot project covering Co. Roscommon in 2012, it was first proposed that the existing Fossitt habitat classification system (Fossitt, 2000) could be redesigned to include a new landcover level which would replace the existing level 2 (Lydon, 2013). A draft version of this 'level 2B' was drawn up and the Roscommon pilot area of Prime 2 was classified to it successfully. Whilst the draft new 'Fossitt 2B' level was accepted in principle by the landcover working group, a wider user consultation to gauge public opinion on this approach was then assigned under Work Package 1 of the 2016 work programme for the NLCHM group. This work package 1 was completed by Gavin Smith and Kevin Lydon of the EPA.

The final list of recommendations arising from Work Package 1 include:

1. Adopt a 'landscape description' data model, similar to the EAGLE data model and matrix for an Irish land monitoring programme. This will involve producing a core landcover data level, mapped to the PRIME2 spatial database, which is then further augmented by attribution on landcover and environmental characteristics where such information is available.

2. Continue to base the core landcover level on the adapted Fossitt level 2, making provisions for the full Fossitt system to be revised in future to ensure full compatibility between all three classification levels.

3. Use the most recent draft of the Fossitt level 2B given in section 4 (fig 4.1) as the basis of a landcover description level and allow for final refinement during the production process.

4. Publish the finalised landcover classification level along with the first iteration of a national landcover dataset when complete.

## 2.4. Conceptual Data Model Components

The CDM can be described in terms of the high level entities required to model land cover and associated spatial and non-spatial relationships required to accommodate the variances highlighted in the requirements analysis and use case study. These entities are described below.

### 2.4.1.1. Surface

The database will consist of a Classified Landcover Surface with a series of links to tables that will contain more detailed information about the Landcover Surface.
The landcover surface represents a 'skin of the earth' view of NLCHM and is represented in the CDM as a reference dataset feature (polygon) that has been classified with NLCHM characteristics and properties captured in related tables and metadata.
The landcover surface will be based upon the most recent draft Fossitt level 2B or a finalised classification level once complete.

### 2.4.1.2. Sub-grouping

A classified Landcover Surface may also be sub-divided into more **Components**. This is of importance where the reference land parcel from OSi is too coarse grained to represent the variance in land cover characteristics present within a single 'skin of the earth' polygon boundary. These may have a different Fossitt Level 2B code than the code for the Landcover Surface

### 2.4.1.3. Aggregates

These may include **Aggregates** (classifications of separate tracts of land parcels that can be seen as a single entity in the context of NLCHM e.g. a farm), **Attribute Values** (e.g. the source of the landcover information) and **Attributes** (all the different attributes that may be related to a Landcover Surface).

### 2.4.1.4. Mosaic

Landcover Surfaces may consist of mosaics, which is a percentage of e.g. a specific plant species covering the extent of the surface. Mosaics are used where the area of classification is not typically suited to be represented by a fixed geometric boundary. In such a case a mosaic may be used to highlight the presence of land cover or habitat characteristics with or without a corresponding geometry

### 2.4.1.5. Conflicts

Not all the stakeholders may agree on the Fossitt Level 2B code for a piece of land. At this point there is a table of conflicts that are linked to the surface. Conflicts are used to record where input data analysis and processing has resulted in conflicting classifications for the same tract of land.

### 2.4.1.6. Fuzzy Surface

**A Fuzzy Surface** is a surface that may cross boundaries of the Landcover Surface. These are areas that may show habitats of endangered species. This is not necessarily data that should be available publically.

# 3. Use Cases

This section summarises some of the core use cases that would be satisfied by the availability and delivery of a national land cover and habitat mapping product.

The use case analysis was outside the scope of the conceptual data model and data architecture work package; however, it is important from a database design perspective that use cases identified can be satisfied by the data model.

The technical working group commissioned a business case study to identify the core use cases for land cover and habitat mapping products that are present throughout a diverse number of sectors. This study was carried out by Future Analytics on behalf of the group.
The conceptual data model is therefore cognisant of the use cases which were reviewed and introduced as part of the Conceptual Data Model (CDM) design workshop sessions.

Meetings were held between the CDM design team and the business analysis teams to inform each other's work streams. Draft issues of the use case report were shared with the CDM design team to support the conceptual data modelling exercise.

Here the main use cases for national land cover & habitat mapping initiative are described at a high level only. For further information, please refer to the business case analysis report.

## 3.1. Agriculture and food production

- Support fine tuning the targeting of biodiversity supports.
- Provide information on the relationships between farming activities and carbon sequestration.
- Identify the presence of areas of environmental value or vulnerability, for instance habitats and water resources.
- Support future targeting of agri-environmental policy, including payments for ecosystem services (PES).
- Identify locations that are most vulnerable to non-point pollution.
- Enable members of the public to access information that may be of relevance to them, encouraging a greater awareness of the relationships and interactions between different land use activities e.g. the effect of agricultural activity on water quality and soils.
- Support nutrient management planning.
- Support catchment management planning requirements under the Water Framework Directive.
- Support agri-productivity analysis.

## 3.2. Flood risk management

- Support decision making on the areas that should be prioritised for flood prevention and control measures allowing for more targeted investment in this area.
- Support planning, mitigate for and responding to flood events.
- Support the insurance industry in terms of gaining a full picture of land cover in a given area and how specific vulnerabilities might relate to water courses prone to flooding.
- improve the efficiency of flood risk management and deliver cost avoidance in terms of in appropriate singular intervention, damage to property and social costs.

## 3.3. Landuse planning

- Identify the critical functions provided by biodiversity.
- Support safeguarding the natural environment and meeting statutory obligations such as those set out under the Habitats Directive.s
- Improve availability and integration of habitats data reducing risk of important information being overlooked, such as the sensitivity of severance on biodiversity.
- Support planners with a new tool in which to analyse current and proposed development strategies against the wider environmental context, and to view interactions that take place across county boundaries.
- Support decision making on planning and investment in critical national infrastructure in areas such as transport, water services, housing, energy, communications and waste management.
- Support a robust 'evidence base' to demonstrate the rationale and integrity of policies and objectives set out in Development Plans at a regional and County level.
- Provide source data in the planning of development projects, particularly so those for major infrastructural projects, such as roads developments.

## 3.4. Air quality

- Support the identification of air pollution sources.
- Support the analysis of plume dispersal modelling of pollution incidences, and how this relates to the characteristics of land cover within the plume dispersal area.
- Inform a close-response relationship between pollution and external costs.
- Supporting dataset for demonstrating the risk of air pollution to public health, to crops, to building fabric or to water bodies.

## 3.5. Climate change mitigation/adaptation

- Provide supporting data source for climate change analysis and modelling.
- Support seamless integration of datasets on habitats and other land cover and land uses such as residential areas.
- Improve accuracy of climate research providing a stronger scientific basis for research findings.

- Identify the location of populations or heritage at risk and to design measures to strengthen resilience.
- Support the identification of risk factors (e.g. in forestry, the likely dispersal pattern of pest species).
- Support the modelling of change and projections in climate research.
- Provide a much more accurate overview of national carbon stocks supporting more robust assessment of greenhouse gas emissions and removals.
- Support improvements in how the decarbonisation of Ireland's energy resources can be managed.
- Support decision makers in government and local authorities to define the location for deployment of land extensive renewable energy systems on areas of marginal or suboptimal agricultural value.

## 3.6. Biodiversity applications

- Support the design of more effective policies to protect biodiversity and to integrate these strategies with other land use demands and pressures.
- Identify vulnerable areas and their interaction with infrastructure such as wind energy.
- Identify the distribution of protected species and threatened species, but also the movement of invasive species.
- Support enhancements in the modelling and monitoring of changes to key species at a national, regional and local scale.

# 4. Conceptual Data Model - Candidate Requirements

Data model requirements were captured throughout the design workshops and intervening feedback sessions. The following requirements in accompaniment with the use case study outputs help frame and define the overall needs of a national land cover and habitat mapping data model.

| Ref | Priority | Requirement |
|---|---|---|
| REQ001 | | The model must support the association of land cover classifications with OSi Prime2 geometry and associated identifiers |
| REQ002 | | The model must allow the integration of a list of land cover classifications derived from Fossitt Level 2B |
| REQ003 | | The model must allow for flexibility in the classifications list and support integration of updates to the list |
| REQ004 | | The model must support the capture of feature level metadata that describes the versions of ancillary data inputs and input geometry that the feature's land cover classification is based on |
| REQ005 | | The model must support the capture of feature level metadata which describes the source classification and coverage on which the final classification is based. E.g. LPIS classified a land parcel with 100% Pasture |
| REQ006 | | The model should support the generation of multiple thematic outputs at generalised resolutions and map scales |
| REQ007 | | The model should support the output of use case specific land cover products – for example 'Grasslands' or 'Carbon Accounting' |
| REQ008 | | The model must support the analysis and assessment of land cover change over time |
| REQ009 | | The model must support the capture and storage of sub groups of features which are more granular than prime2 geometry – e.g. Segmentation of upland areas, Unenclosed areas |
| REQ010 | | The model should support the recording of a hierarchy of classification from input data suppliers – Dominant Property? |
| REQ011 | | The model should support the recording of land cover classifications that are considered 'sub surface' – E.g. |

| | | |
|---|---|---|
| | | limestone pavement below the default classification of Heather (Z-order property) |
| **REQ012** | | The model should enable the identification of conflicts where land cover classification changes over time |
| **REQ013** | | The model should support the application of validation rules where change occurs – E.g. Crop can become grass; however, Forest cannot become crop |
| **REQ014** | | The model should support the representation of the management structure of the land – e.g. 'farm paddocks' or other entities which relate to the land parcel but are subject to change |
| **REQ015** | | The model should facilitate the recording of sub-grouping of land parcels without geometry e.g. define presence of land cover in % of total area of an OSi Prime2 polygon |
| **REQ016** | | The model must be extensible to accommodate classification of land use in the future |

# 5. Conceptual Data Model

## 5.1. Data Architecture

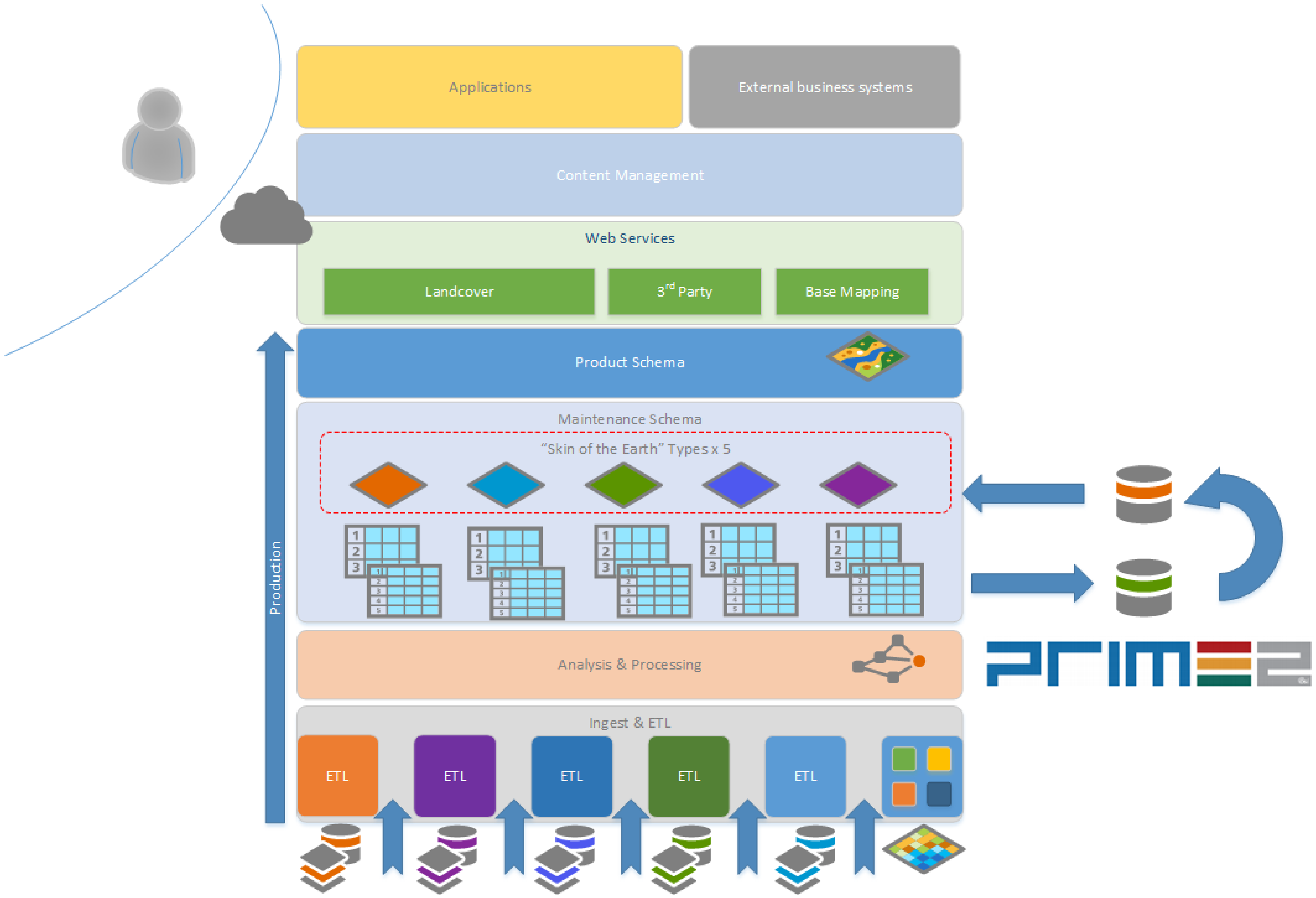



**Figure 1 - NLCHM Conceptual Data Architecture**

## 5.2. Conceptual Information Model

The diagram below, is a representation of the the main entities that comprise the proposed Data Model. The **Land Cover (and Habitat Mapping) Dataset** will be the product, or outputs, delivered by the Data Model. This product will be derived from Various **Sources and Inputs**. For example, this could be the various data supplied by the many data providers in the Technical Working Group, or other agencies throughout Ireland.
The Dataset will reference Ordnance Survey Irelands latest Digital Mapping Database, known to many OSI cutomers as Prime2. Prime2 is an internal OSi storage model, represented below with the entity **DLM Core 'Skin of the Earth'**. DLM in this diagram represents Ordnance Survey Irelands **Digital Landscape Model** (DLM)**.** DLM Core Entities are features representing a 'Skin of the Earth'. This concept identifies a set of polygon features that cover the complete surface of Ireland, and attribute them with OSi classifications. These polygon features will be associated with one or more Land Cover surfaces – as classified with Fossett Level 2b codes. To capture and provide more information on these land cover surfaces, associated attribution will be captured and stored as **Properties** and **Attributes**.

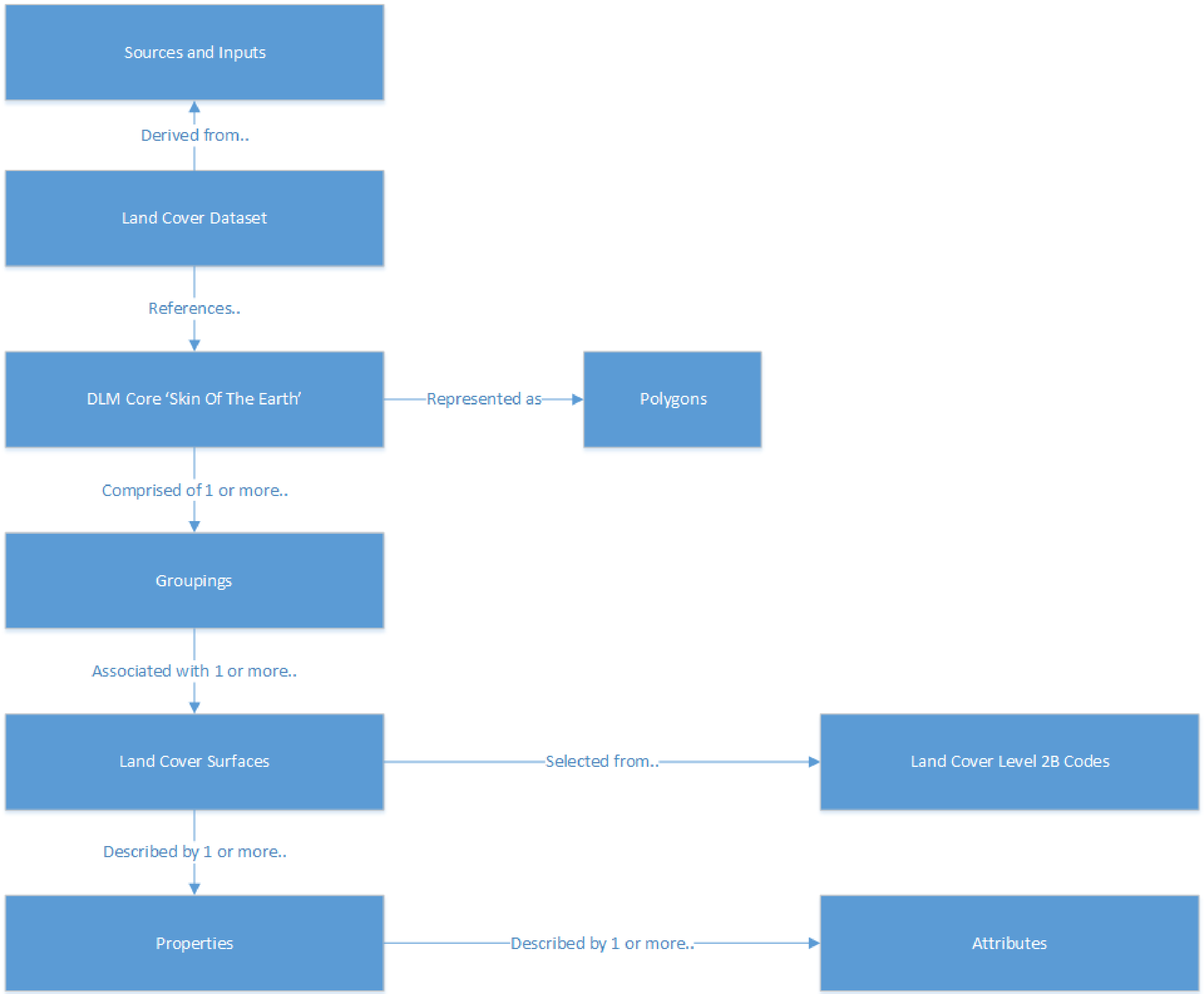



Figure **2** - Draft Information Model

## 5.3. Conceptual Data Model

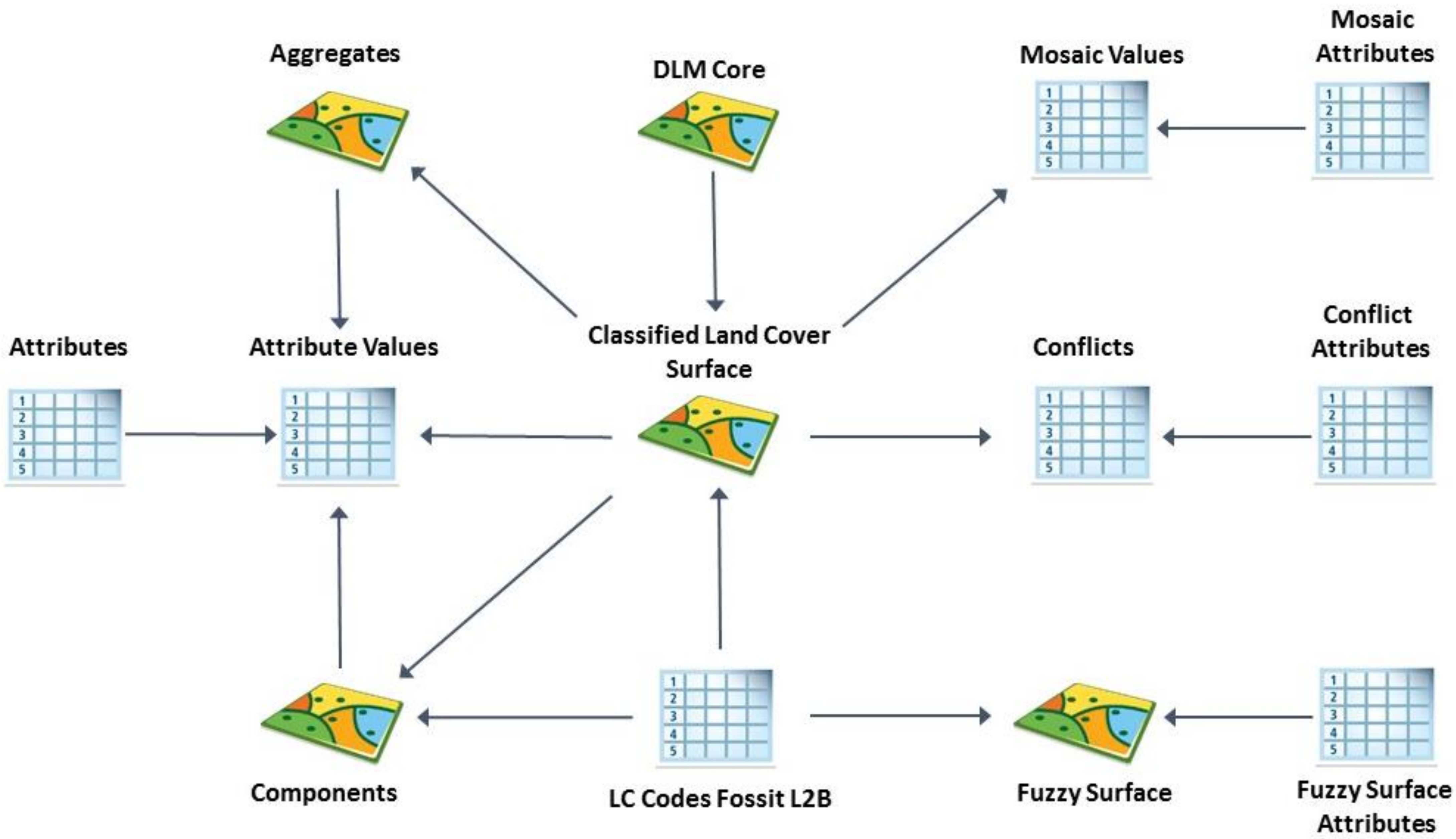



**Figure 3 – Conceptual Data Model**

This diagram provides a visual representation of the proposed logical data model components. These consist of Tables represented by the image. Tables with a Geographic component are represented by images. Arrows represent the relationship between the tables. Each of the tables will be modelled further in section 5.4 below with each table

## 5.4. Sample Logical Data Model

In order to inform and illustrate the potential use of the conceptual model, additional modelling was undertaken to produce a sample logical model.

The logical model components are depicted in detail in the diagram on page 17 and each table explained in the subsequent section of the document. In addition to the diagram, the proposed Logical Model has been exported to a Generic XML schema document and a word document. These two items are embedded in this document below.

Microsoft Word
Template

GenericNLCHMModel.XSD

Sample data based upon this model was created and then used to produce a sample application. The sample application contained illustrations of the various Data concepts mocked up for one particular area.

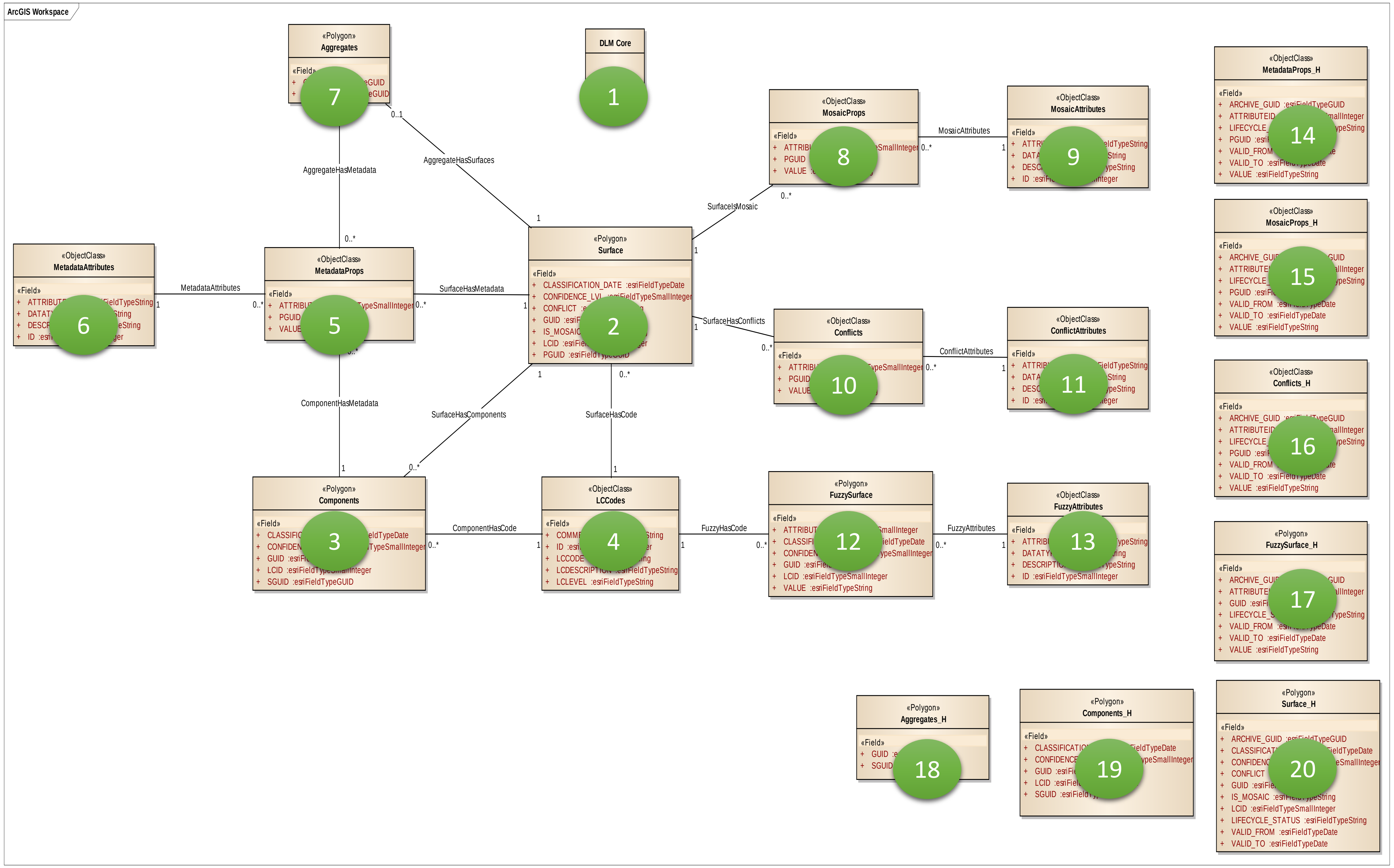



**Figure 4 - Draft Logical Data Model**

### 5.4.1. Key to Core Entities

The following tables provide a representation of the components of the logical data model described above. These individual tables constitute the core components of the model that will contain Land Cover Entities and also provide an extensible mechanism to record properties (attributes) against a core component.

**Entity No. 1** — DLM Core

Table
**DLM_Core**

| Field name | Data type | Allow nulls | Default value | Domain | Precision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |

This object represents the Ordnance Survey Ireland reference data used in the generation of land cover and habitat mapping. DLM core is the product database derived from the Prime2 maintenance database. DLM core provides a set of 5 vector polygon classes which provide a 'skin of the earth' coverage for Ireland.
The classes are categorised according to surface type consisting of:

- WAY
- WATER
- VEGETATION
- ARTIFICIAL
- EXPOSED

Each polygon is identified by a unique reference ID – or globally unique identifier (GUID) Ordnance Survey maintain the integrity of a features GUID over time. In the event that a land parcel's geometry changes, every effort is made to retain the original identifier.
When a land parcel's geometry is split to reflect on the ground boundary change, a system of 'logical successor' is maintained to ensure that the original field parcel GUID is retained.
The complete coverage of land parcel geometry and associated GUID which makes DLM core ideally suited for managing the creation, maintenance, output and maintenance of land cover and habitat mapping over time.

**Entity No. 2** — Surface

Simple feature class
**Surface**
Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Precision | Scale | Length |
|---|---|---|---|---|---|---|---|
| PGUID | | Yes | | | 0 | 0 | 38 |
| GUID | | Yes | | | 0 | 0 | 38 |
| LCID | Short integer | Yes | | | 0 | | |
| CLASSIFICATION_DATE | Date | Yes | | | 0 | 0 | 8 |
| CONFIDENCE_LVL | Short integer | Yes | | | 0 | | |
| IS_MOSAIC | String | Yes | | | | | 50 |
| CONFLICT | String | Yes | | | | | 50 |

This object represents the primary land parcel representing an area of land cover linked to an OSi DLM core geometry. The surface features are derived from a 1 to 1 relationship with DLM objects. GUID stores the unique identifier of the surface object and PGUID (parent guid) stores the identifier to the DLM object it relates to. The surface feature is therefore an abstraction of a DLM core feature with additional attribution to store land cover characteristics.
The PGUID field stores the parent guid of the DLM core object from which the land cover feature is derived.

Each land cover surface polygon is classified with a land cover classification (LCID).
Classification_Date records the date the land cover classification was assigned
Confidence_Lvl describes the level of confidence associated with the classification. For example, subject to the source data available (e.g. remote sensing confirmed by field survey) some records will have a high level of confidence associated with the assignment.
IS_MOSAIC Is a flag that highlights if the land parcel geometry is known to contain a 'mosaic' of finer grained land cover types or the presence of habitats which cannot be easily defined in terms of a mappable boundary but their presence is known to be in situ somewhere within the containing boundary. Details of the mosaic characteristics of the land parcel are captured in the Mosaic table.

CONFLICT Is a flag used to indicate where a potential conflict exists around classification determined from source data and ancillary inputs. For example, in the event that a forestry parcel supplied by Coillte conflicts with the species cover detail in data supplied by forestry (DAFM) this could be recorded as a conflict to indicate that multiple classification exists for the same land parcel.

| Entity No. 3 | Components |
|---|---|

Simple feature class
**Components**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| PGUID | | Yes | | | 0 | 0 | 38 |
| CGUID | | Yes | | | 0 | 0 | 38 |
| LCID | Short integer | Yes | | | 0 | | |
| CLASSIFICATION_DATE | Date | Yes | | | 0 | 0 | 8 |
| CONFIDENCE_LEVEL | Short integer | Yes | | | 0 | | |

The components class is used to model discreet areas of land cover, that are more finely grained than the available OSi geometry. For example, where an upland area is delimited by an OSi boundary which covers a considerable surface area within which land cover characteristics are diverse. In such a scenario, a set of nested (within the OSi parent boundary) geometries are created which represent the discreet areas of land cover diversity that the parent OSi boundary is too coarse grained to represent.
Component polygons are related to OSi features using a primary-foreign key relationship which sees the parent OSi identifier (PGUID) being store against the child land cover record.
Component polygons are assigned their own GUID and are individually assigned a land cover classification through the storage of a land cover code.

| Entity No. 4 | LCCodes |
|---|---|

Table
**LCCodes**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| ID | Short integer | Yes | | | 0 | | |
| LCLEVEL | String | Yes | | | | | 50 |
| LCCODE | String | Yes | | | | | 50 |
| LCDESCRIPTION | String | Yes | | | | | 50 |
| COMMENTS | String | Yes | | | | | 200 |

The LCCode table is used to store and manage the full list of land cover and habitats classifications. Land cover and habitat classifications are based on the Fossitt level 2B

classifications, however the table can accommodate classifications from any level. The list of land cover and habitat classifications is extensible in that the list can be appended, amended or replaced if required, over time to accommodate new classifications.
Each classification is described in terms of the following field values:

- ID – unique identifier for the classification
- LCCode – Coded value for the description. Look up value for land cover surface records
- LCDescription – A text based description of the classification
- LCLevel – Level of granularity for the classification (E.g. Fossitt level 2B, 3 other)
- Comments – Comments or notes specific to the classification

Each land cover geometry stored in the surface / components table is tagged with a land cover code (LCID) which is the key value used to look up the classification description stored and managed in LCCodes

| Entity No. 5 | AttributeValues |
|---|---|

Table
**AttributeValues**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| PGUID | | Yes | | | 0 | 0 | 38 |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |

The AttributeValues table is used to record additional properties of land cover records (surface, components and aggregates) A land cover record can have one or more attributes uniquely identified by an AttrributeID and can be defined in terms of one of three data types – date (DATE_VALUE), number (NUM_VALUE) or string (STR_VALUE)
Rather than defining and documenting each attribute upfront, the conceptual data model design manages attributes using a key relationship and associated value description. This supports the requirement for extensibility in that additional attribution may be introduced over time. This methodology for attribute management is known as 'Entity-Attribute-Value' in data modelling terms.
Each attribute is related back to its parent land cover record by storing the parent identifier (PGUID) with the attribute.
Further metadata and description of the attribute can be held in an associated look-up table – Attributes if required.

| Entity No. 6 | Attributes |
|---|---|

Table
**Attributes**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| ID | Short integer | Yes | | | 0 | | |
| ATTRIBUTENAME | String | Yes | | | | | 50 |
| DESCRIPTION | String | Yes | | | | | 50 |
| DATATYPE | String | Yes | | | | | 50 |

The Attributes table may be used to store a detailed description describing each attribute / property captured against a land cover record in the Attributes table. Further information specific to an attribute / property of the land cover record may be described in terms of NAME, DESCRIPTION and DATATYPE

| Entity No. 7 | Aggregates |
|---|---|

Simple feature class
**Aggregates**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| AGUID | | Yes | | | 0 | 0 | 38 |

The Aggregates table can be used to group multiple land cover surface geometries that represent a region that has common characteristics in terms of land cover or habitats. The use of the aggregates table may also be used to represent groups of surface geometries in terms of classifications other than land cover & habitats alone – for example land use.
Where a land cover geometry participates in an aggregate or group is must be tagged with the identifier (AGUID) of the aggregate group to which it belongs.
Each aggregate grouping is stored and managed in the Aggregates table with attributes, characteristics and properties describing the aggregate group defined in the AttributeValues / Attributes tables.

| Entity No.8 | Mosaic |
|---|---|

Table
**Mosaic**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| PGUID | | Yes | | | 0 | 0 | 38 |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |

The mosaic table is used to store records describing the presence of 'mosaic' features known to be present within a given land parcel.
A 'mosaic' represents the location of finer grained land cover types or the presence of habitats which cannot be easily defined in terms of a mappable boundary but are known to be in situ somewhere within the containing boundary.
A mosaic feature may optionally be represented with a geometry. In scenario where the mosaic feature is not mappable, the mosaic feature(s) may be represented in terms of coverage – e.g. % Wet grassland
All mosaic features are contained within a parent land parcel geometry and are linked back to the parent by storing the parent features identifier (PGUID) against each mosaic record. This relationship to parent geometry support reporting and analysis of land cover and habitat mapping at a finer level of detail

| Entity No. 9 | MosaicAttributes |
|---|---|

Table
**MosaicAttributes**

| Field name | Data type | Allow nulls | Default value | Domain | Precision | Scale | Length |
|---|---|---|---|---|---|---|---|
| ATTRIBUTENAME | String | Yes | | | | | 50 |
| ID | Short integer | Yes | | | 0 | | |
| DESCRIPTION | String | Yes | | | | | 50 |
| DATATYPE | String | Yes | | | | | 50 |

The mosaic attributes table provides a means to record attribution, properties and metadata in relation to mosaic features

| Entity No. 10 | Conflicts |
|---|---|

Table
**Conflicts**

| Field name | Data type | Allow nulls | Default value | Domain | Precision | Scale | Length |
|---|---|---|---|---|---|---|---|
| PGUID | | Yes | | | 0 | 0 | 38 |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |

A CONFLICT Is a flag used to indicate where a potential conflict exists around classification determined from source data and ancillary inputs or where further clarification is required. For example in the event that a forestry stand supplied by Coillte conflicts with the species cover detail in data supplied by forestry (DAFM) this could be recorded as a conflict to indicate that multiple classification exists for the same land parcel.

A conflict flag may be applied to a surface feature or a component feature. Where features are tagged with the conflict attribute, further information specific to and describing the conflict may be recorded in the conflicts table.

Additional metadata may also be recorded in a the ConflictAttributes table.

| Entity No. 11 | ConflictAttributes |
|---|---|

Table
**ConflictAttributes**

| Field name | Data type | Allow nulls | Default value | Domain | Precision | Scale | Length |
|---|---|---|---|---|---|---|---|
| ID | Short integer | Yes | | | 0 | | |
| ATTRIBUTENAME | String | Yes | | | | | 50 |
| DESCRIPTION | String | Yes | | | | | 50 |
| DATATYPE | String | Yes | | | | | 50 |

The ConflictAttributes table may be used to records additional metadata and attribution associated with a classification 'conflict' i.e. where the final classification assigned is subject to conflicting data in the source inputs and ancillary datasets used in the land cover dataset processing.

| Entity No. 12 | FuzzySurface |
|---|---|

Simple feature class
**FuzzySurface**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| FGUID | | Yes | | | 0 | 0 | 38 |
| LCID | Short integer | Yes | | | 0 | | |
| CLASSIFICATION_DATE | Date | Yes | | | 0 | 0 | 8 |
| CONFIDENCE_LVL | Short integer | Yes | | | 0 | | |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |

The FuzzySurface table is used to store areas which cannot be discreetly mapped in the context of underlying OSi geometry. These areas are not suited to being mapped by a 'hard' boundary or edge.
The application of 'fuzzy' boundaries can be used as a means of storing areas where the presence of land cover classification exists but is not suited to being mapped against existing reference geometry representing boundaries on the ground.

FuzzySurface records can be classified and attributes in the same manner as surface and component features using core fields and attributes (stored in FuzzyAttribues)
FuzzySurface features are uniquely identified with a guid (FGUID), however no logical link relates a fuzzy feature to reference OSi geometry. To understand the OSi features which are related to a fuzzy feature a spatial overlay operation can be applied.

| Entity No. 13 | FuzzyAttributes |
|---|---|
| | |
| The FuzzyAttributes table may be used to records additional metadata, properties and attribution associated with a record captured in FuzzySurface | |

## 5.4.2. Key to Archive Entities

In the data model, provision has been made for managing the historical archival record of land cover features and their properties over time. This provision ensures that the data model is equipped to manage landcover change over time and assessment of change in the context of change to source data inputs and also changes to underlying OSi reference geometry.

The is achieved with the addition of an accompanying history table for each of the core entities described above. When change is being applied to any record, a copy of the previous state of the changed record is added to the relevant history table with a date time stamp reflecting the time of change, a lifecycle status value which records the current status of the record along with the recording of a date-time period indicating the window during which the record was 'active' or valid.

| Entity No. 14 | AttributeValues_H |
|---|---|

Table
**AttributeValues_H**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| PGUID | | Yes | | | 0 | 0 | 38 |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |

The history table for the AttributeValues table

| Entity No. 15 | Mosaic_H |
|---|---|

Table
**Mosaic_H**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| PGUID | | Yes | | | 0 | 0 | 38 |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |

The history table for the Mosaic table

| Entity No. 16 | Conflicts_H |
|---|---|

Table
**Conflicts_H**

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| PGUID | | Yes | | | 0 | 0 | 38 |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |

The history table for the Conflicts table

| Entity No. 17 | FuzzySurface_H |
|---|---|

Simple feature class
**FuzzySurface_H**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| Shape | Geometry | Yes | | | | | |
| FGUID | | Yes | | | 0 | 0 | 38 |
| ATTRIBUTEID | Short integer | Yes | | | 0 | | |
| STR_VALUE | String | Yes | | | | | 200 |
| NUM_VALUE | Double | Yes | | | 0 | 0 | |
| DATE_VALUE | Date | Yes | | | 0 | 0 | 8 |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |
| Shape_Length | Double | Yes | | | 0 | 0 | |
| Shape_Area | Double | Yes | | | 0 | 0 | |

The history table for the FuzzySurface table

| Entity No. 18 | Aggregates_H |
|---|---|

Simple feature class
**Aggregates_H**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| Shape | Geometry | Yes | | | | | |
| AGUID | | Yes | | | 0 | 0 | 38 |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |
| Shape_Length | Double | Yes | | | 0 | 0 | |
| Shape_Area | Double | Yes | | | 0 | 0 | |

The history table for the Aggregates table

| Entity No. 19 | Components_H |
|---|---|

Simple feature class
**Components_H**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| Shape | Geometry | Yes | | | | | |
| PGUID | | Yes | | | 0 | 0 | 38 |
| CGUID | | Yes | | | 0 | 0 | 38 |
| LCID | Short integer | Yes | | | 0 | | |
| CLASSIFICATION_DATE | Date | Yes | | | 0 | 0 | 8 |
| CONFIDENCE_LEVEL | Short integer | Yes | | | 0 | | |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |
| Shape_Length | Double | Yes | | | 0 | 0 | |
| Shape_Area | Double | Yes | | | 0 | 0 | |

The history table for the components table

| Entity No. 20 | Surface_H |
|---|---|

Simple feature class
**Surface_H**

Geometry *Polygon*
Contains M values *No*
Contains Z values *No*

| Field name | Data type | Allow nulls | Default value | Domain | Prec-ision | Scale | Length |
|---|---|---|---|---|---|---|---|
| OBJECTID | Object ID | | | | | | |
| SHAPE | Geometry | Yes | | | | | |
| PGUID | | Yes | | | 0 | 0 | 38 |
| SGUID | | Yes | | | 0 | 0 | 38 |
| AGUID | | Yes | | | 0 | 0 | 38 |
| CLASSIFICATION_DATE | Date | Yes | | | 0 | 0 | 8 |
| CONFIDENCE_LVL | Short integer | Yes | | | 0 | | |
| LCID | Short integer | Yes | | | 0 | | |
| IS_MOSAIC | String | Yes | | | | | 1 |
| CONFLICT | String | Yes | | | | | 1 |
| VALID_FROM | Date | Yes | | | 0 | 0 | 8 |
| VALID_TO | Date | Yes | | | 0 | 0 | 8 |
| ARCHIVE_GUID | | Yes | | | 0 | 0 | 38 |
| LIFECYCLE_STATUS | String | Yes | | | | | 1 |
| SHAPE_Length | Double | Yes | | | 0 | 0 | |
| SHAPE_Area | Double | Yes | | | 0 | 0 | |

The history table for the surface table

# 6. Constraints, Risks and Issues

This section contains a catalog of constraints, risks and issues identified during the workshops. Additional information relating to the risks of not establish a National Landcover and Habitat mapping programme are found in the Use Case Analysis and Economic value study document.

1. Data Ingestion and analysis is not a trivial task.
    a. Consideration should be given to the resourcing, organisation and structure required to manage the production. For example, considerable investment was made by OSi into the resourcing, organisation and structure around the production of Prime2, and the associated production systems.
    b. Lifecycle & change / update maintenance – this task is expected to be considerably challenging given the requirement for appropriate organisational and technical infrastructure.
    c. It is not feasible to have a fully automated NLCHM production process
2. OSi Prime2 is a normalised data structure. While it is the group's intent to align land cover mapping to OSi Prime2, it should be aware that such a model can introduce constraints when applying analysis. The normalised data structure does not lend itself well to complex Spatial analysis where data is sometimes best stored in a denormalised way. We envisage that land cover analysis to support use cases will be applied against the output LC products in conjunction with other 3rd party data – rather than against the production model which is normalised.
3. The land cover model needs to accommodate updates triggered by changes available in source inputs. The standard lifecycle of the various input sources will vary, for example agriculture (LPIS) mandates intra-annual changes whereas Forestry updates may be bi-annual. The non-standard update cycles may impact upon the reliability of any analysis undertaken against these datasets. This is more of a risk for LC production and output generation rather than being a risk specific to the CDM. At the design stage we are noting that attention will be needed to manage LC production lifecycle against source inputs – i.e. at specified intervals or agreed versions of input data. The metadata containers in the CDM have placeholder for storage of input data properties.
4. If Z-Order was to be included, consideration must be given to the fact that certain mapping products which represent 'sub-surface' features (E.g. Teagasc soils map) are not (and cannot) be mapped explicitly against high resolution vectors stored in OSi Prime2. Z-order is an ordering of overlapping two-dimensional objects and came up during workshop discussions. It was subsequently agreed that z-order was not relevant to a 'skin of the earth' model which is used to model surface classifications.

# 7. Production

The diagram below describes the business processes required to implement a National Land Cover and Habitat mapping infrastructure. It starts with describing the inputs required from the various disparate organisations, outlines high level data transformation requirements, analysis processes, data load, outputs and approaches to dissemination and communication.

The design and elaboration of each of the business processes below should be approached as an iterative based design, informed by proof of concepts. This will aid refinement of, not only the business processes, but also the land cover and habitat mapping data model itself

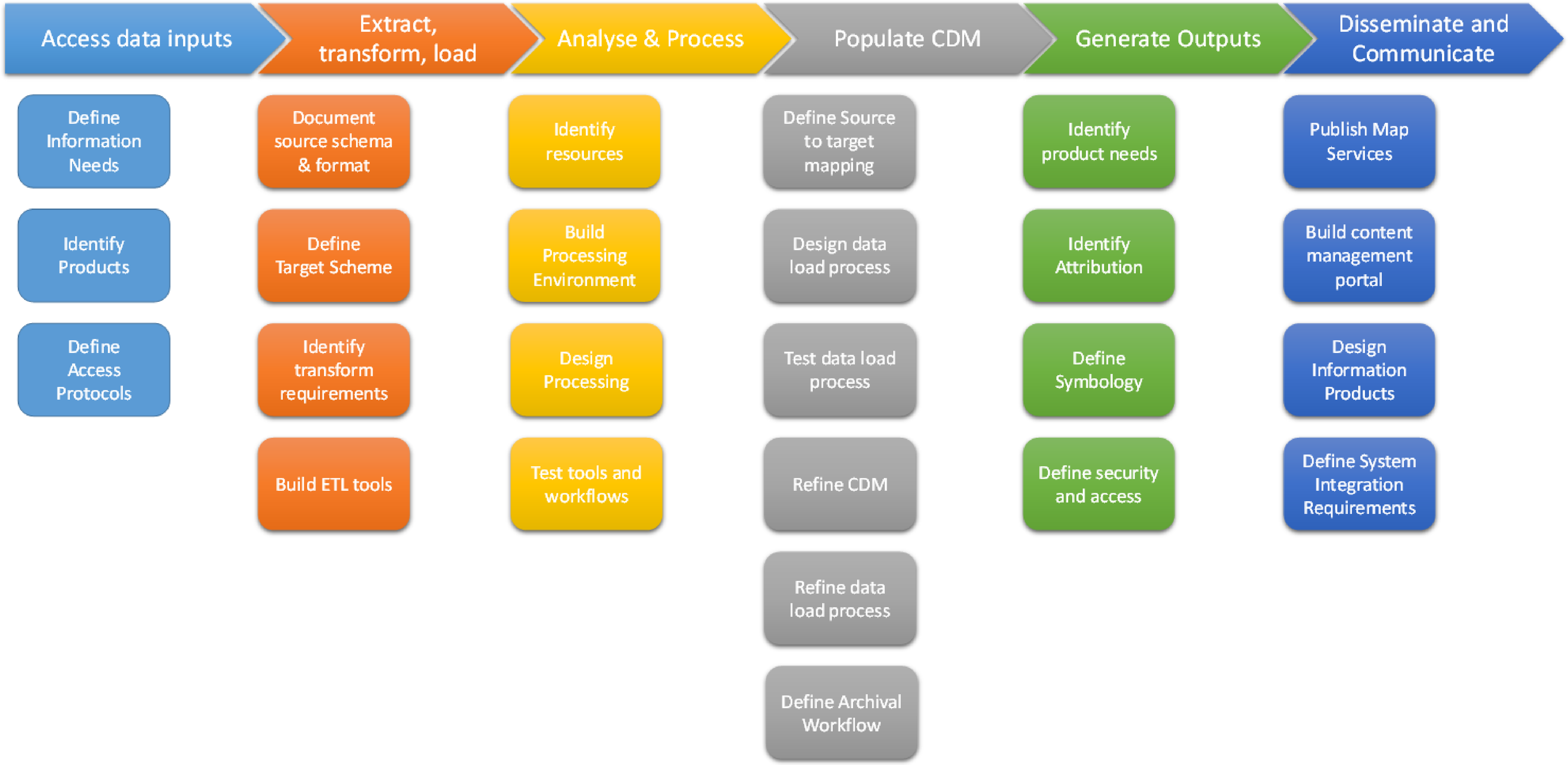
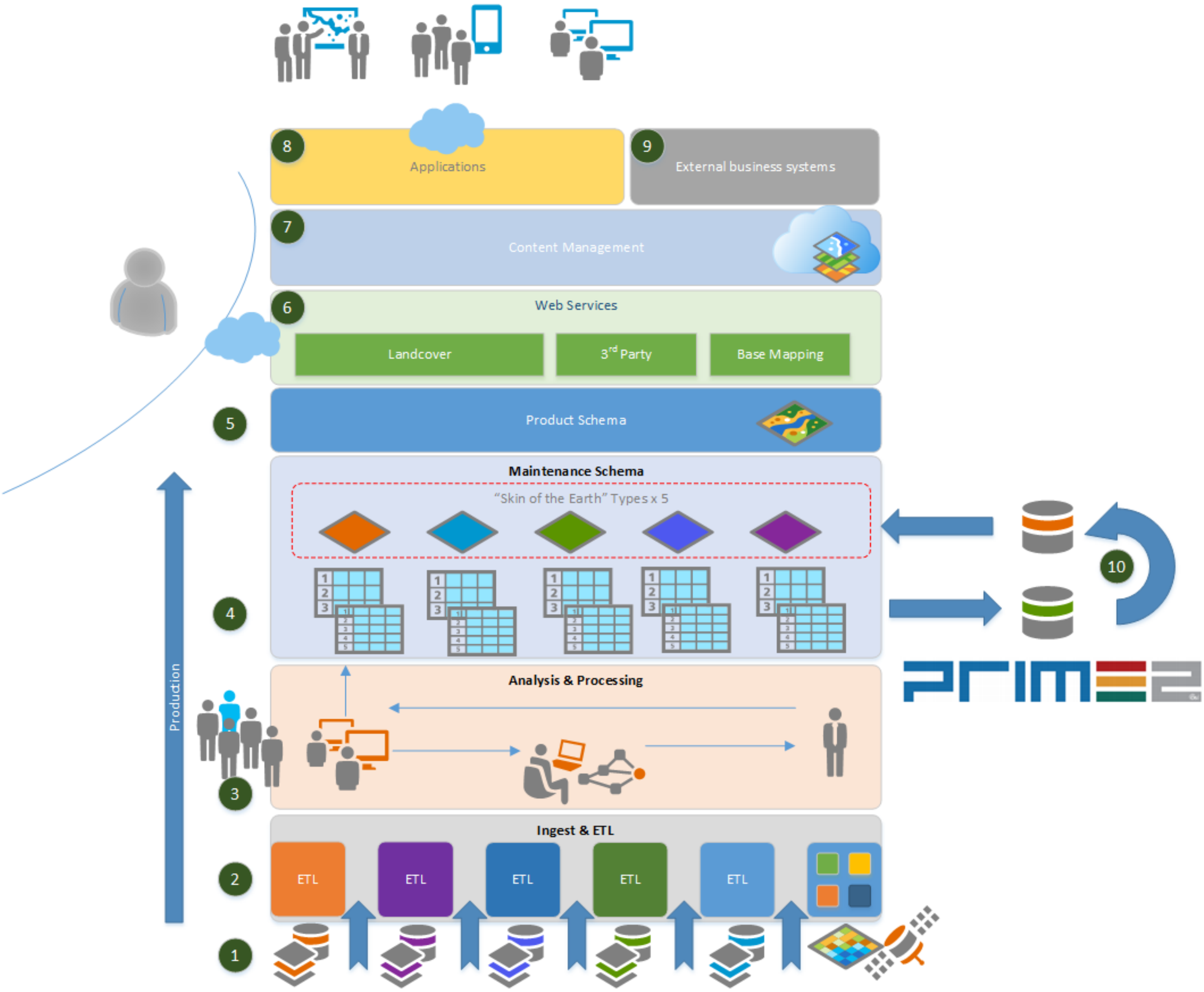


**Figure 1 - Candidate business process design for production workflow**




Here we view the conceptual data architecture presented in section 4.1 in the context of the conceptual set of operational 'Level 1' business processes that would need to be designed and enabled to realise the conceptual data model and produce a set of land cover / habitat mapping output products that satisfy the core use cases described in section 3.

Complexity Key:

- H – high
- M – medium complexity
- L – low complexity

| Process | Description |
|---|---|
| 1. Access Data Inputs<br><br>Complexity:M | This process relates to how the data inputs and ancillary data related to the creation of land cover & habitat mapping products are collected.<br><br>Data and inputs relevant to land cover and habitat mapping are derived from a number of sources including<br><br>• OSi DML Core<br>• LPIS (Land Parcel Inventory System) DAFM<br>• Forestry - Forestry Service (DAFM) & Coillte<br>• Habitats Data<br>• Nextmap 5m digital elevation model<br>• Multi-spectral satellite imagery including but not limited to:<br>*IRS 25m multi-spectral satellite imagery*<br>*Worldview 2m satellite imagery*<br><br>This business process would ensure that data is accessed collected and stored in a repeatable process with defined inputs, storage formats, locations and associated security and data access constraints.<br><br>This would involve the definition of a full catalog of available information assets, describing their source format, access protocols (e.g. ftp, web services, on-disk), security negotiation, update frequency & lifecycle and schema documentation.<br><br>Inputs: Source datasets, Web Services<br><br>Resources: Disk, RDBMS, Hosting Infrastructure<br><br>Outputs: Standardised data structures for analysis purposed |
| 2. ETL<br><br>Complexity:M | The design of an ETL process would see the input data sources harvested in 1 transformed into a common data model against which analysis and processing routines can be applied to create land cover and habitat mapping products.<br><br>It is expected that most if not all of the Extract Transform & Load (ETL) operations could be automated and scheduled using Commercial off The shelf software and complemented by bespoke scripting tools. |

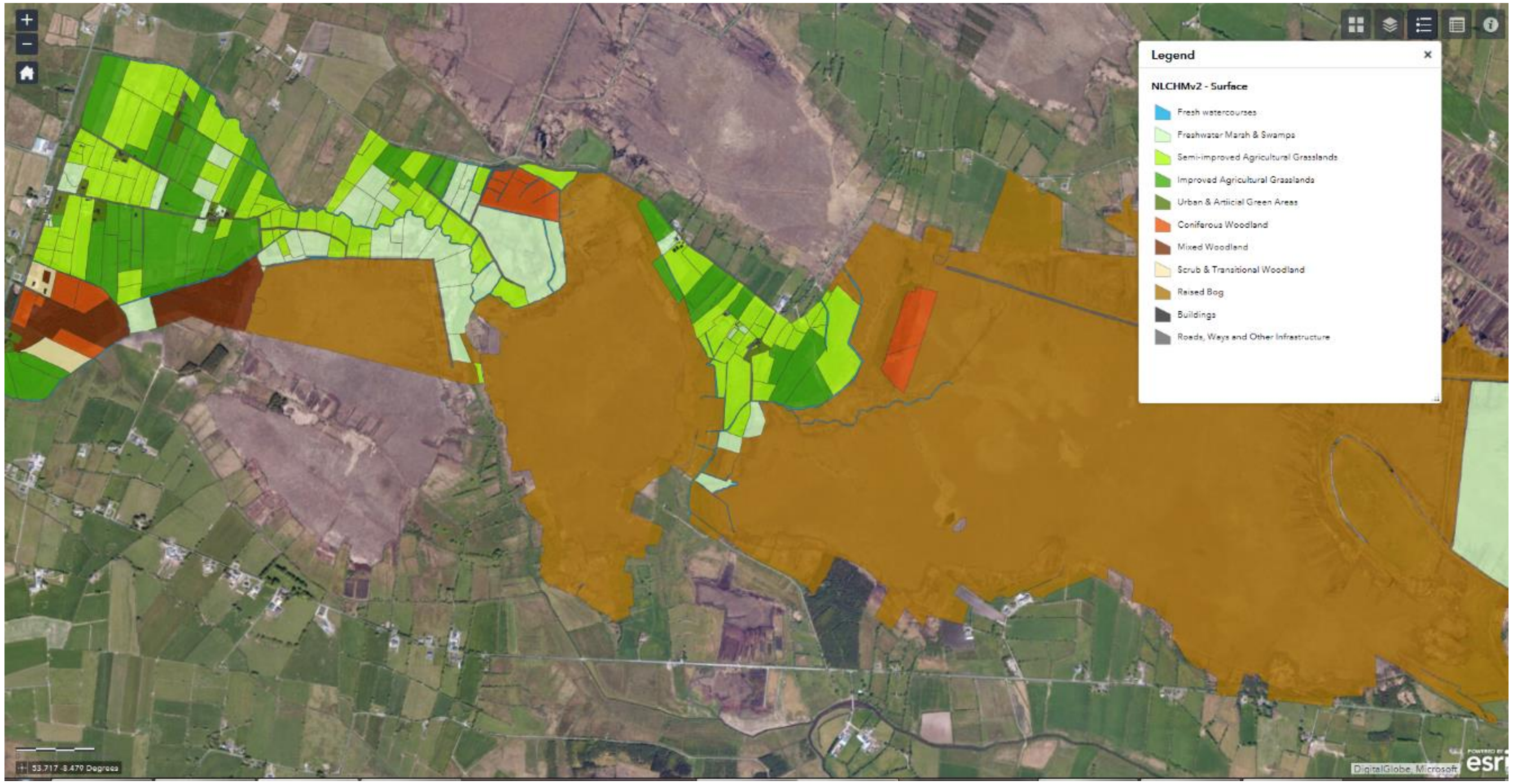
| | |
|---|---|
| | Inputs: Source datasets, Satellite Imagery<br><br>Resources: Commercial off The shelf software, Geoprocessing<br><br>Outputs: Standardised data structures for analysis purposed |
| 3. Analyse & Process<br><br>Complexity:H | The design of analysis and processing process (or suit of processes) is considered as high complexity. Findings from the work carried out to date (when designing the conceptual data model) suggest that while many of the tasks to be carried throughout this process could be automated, it is clear that operationally much human input is required to deliver this process requiring the establishment of a team of skilled expert to oversee and manage this aspect of land cover and habitat mapping production<br><br>Inputs: OSi DLM core, ETL outputs<br><br>Resources: People, Commercial off the shelf software Desktop GIS, Image Analysis Tools, Geoprocessing<br><br>Outputs: NLCHM maintenance schema |
| 4. Populate Maintenance schema<br><br>Complexity: H | This process takes the outputs of the analysis and processing process (land cover and habitat mapping classifications) and populates the maintenance schema complete with OSi geometry references, Attribution, Metadata population, Mosaic and conflict references.<br><br>The normalised nature of the sample logical model would make the population of the maintenance schema difficult in that parent-child relationships would need to be created and maintained during the load process. |
| 5.Generate Output Product(s)<br><br>Complexity:M | This process sees the maintenance database being transformed into an output land cover and mapping product.<br><br>Consideration should be given to core attribution to be surfaced from the maintenance, land cover classification level to be applied, output map scale and symbology |
| 6.Disseminate & Communicate - *Web service publication*<br><br>Complexity:L | This process sees the transformation of output land cover and habitat mapping products into a set of web map services. The data architecture designed here is based on the web GIS paradigm and ensures the delivery of open access to land cover mapping products over the web.<br><br>Consideration should be given to output map projections, symbology, aliasing, metadata, web hosting and scalability |
| 7.Disseminate & | This process involves the creation of one or more meaningful information products from the land cover and habitat mapping web services. |

| | |
|---|---|
| Communicate - *Manage Content*<br><br>Complexity:L | Information products or 'web maps' are designed for a particular purpose or use case.<br><br>Consideration should be given to the use cases identified by NLCHM consumers. |
| 8.Disseminate & Communicate – *Client Applications*<br><br>Complexity: L | This process involves the creation and update of web applications which enable view, search, query and analyse capabilities against the land cover web services and information products created during the previous |
| 9.Disseminate & Communicate - *System Integration*<br><br>Complexity:M | Systems integration covers the design of business processes which enable 3rd party organisations to take a feed of land cover data into their own business systems. As land cover products will be available as web services, the integration recommend pattern for SI is based on an (service oriented architecture) SOA |
| 10.Disseminate & Communicate - *OSi Update Provision*<br><br>Complexity:H | This process looks at how the OSi maintenance database (Prime2) can import and adopt standards for land cover mapping for application across OSi suite of mapping product databases including DLM core. For example, the existing placeholder for land cover and land use within DLM core (Form and Function) could be updated based on outputs from land cover and habitat mapping products and maintenance. |

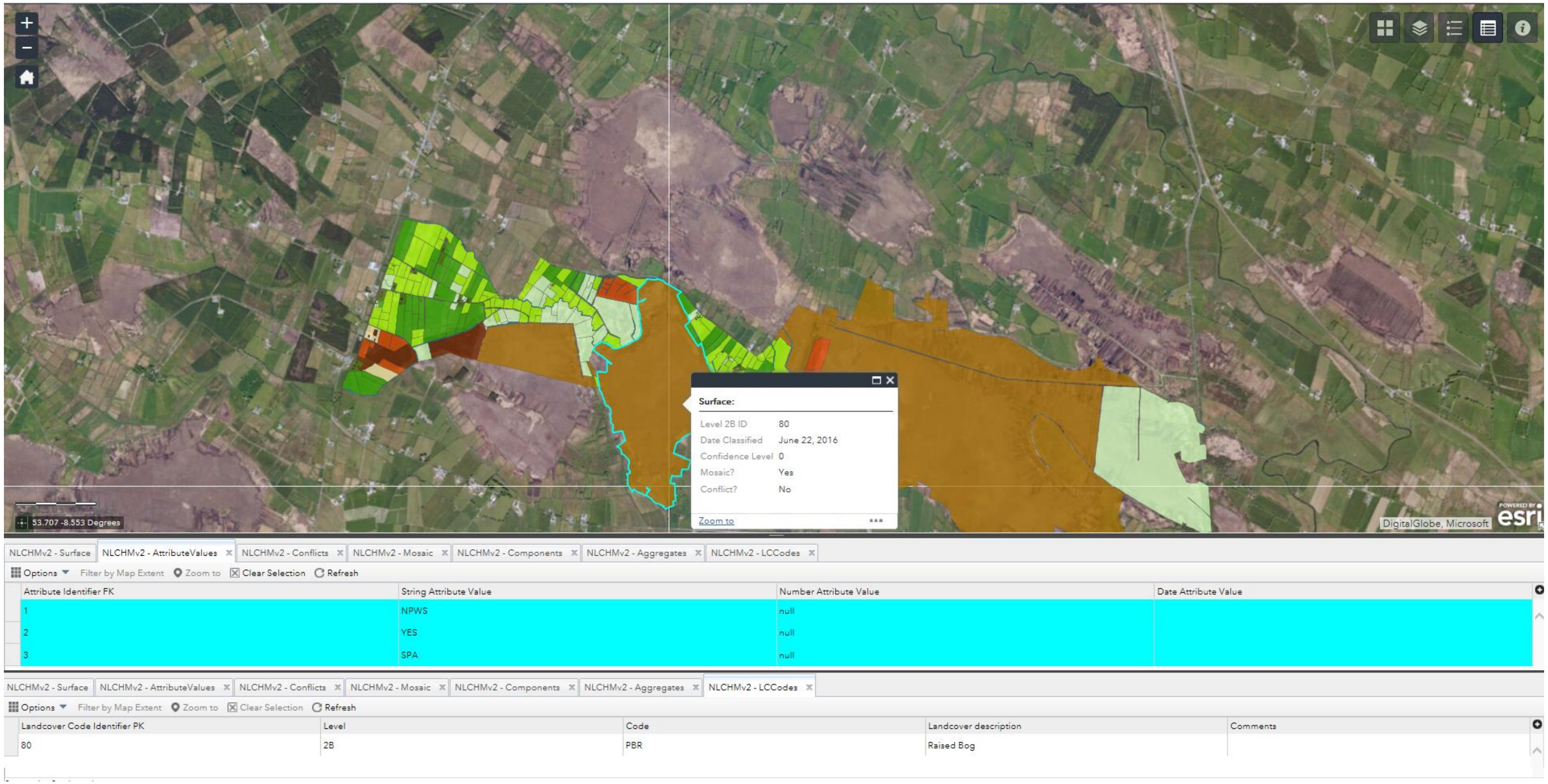
# 8. Outputs

The CDM considers the full lifecycle of NLCHM from ingest of source data, analysis and population of a production schema through to final delivery of NLCHM outputs or products.
Final output datasets may be realised from the CDM production scheme as de-normalised ‘flatter’ data structures. Final outputs must meet the needs of the use cases highlighted earlier in this report.
Consideration must be given to the core attributes and metadata properties to be included as well as the output map scales and resolution.

An example output of how the NLCHM data could be presented, can be found at the following link: http://arcg.is/2dUz54W
The image below provides an example of the visualisation that can be applied to Surface features.




The sample web based application http://arcg.is/2dUz54W provides examples of the main concepts for the CDM – For example Viewing Attributes of a Surface.




Users could click on the surface they want to see the attributes of. Any related records to this surface would be displayed – for example a window could open showing all the tables (as different tabs) related to the higlighted surface. The LCCodes table in the example above shows it is a Raised bog.

An example of how the Product schema could look can be found at the example web service referenced by the example Application. The Service will contain various Layers and Tables to comprise the content captured and can be inspected at the following address:

http://services.arcgis.com/pMnvm7HXxTmNXxGi/arcgis/rest/services/NLCHM/FeatureServer

The webservice currently consists of the following items:
**Layers:**
FuzzySurface
Components
Surface

**Tables:**
FuzzyAttributes
ConflictAttributes
Conflicts
DLM_Core
LCCode
MetadataAttributes
MosaicAttributes
MosaicProps
MetadataProps
AggregateLU

## 8.1. Extensibility

The scope of this engagement including design workshops and associated activities has been focussed on the need to deliver a conceptual model that will meet the demands of the community for a national land cover and habitat mapping data model.

While the content of this report sets the CDM in the context of land cover and habitat mapping specifically, the CDM has been designed to best accommodate future extensibility. At the heart of the CDM lies the ability to set surface type classifications, associated metadata against a bcakground canvas of authoritative reference data (OSi Prime2).

The CDM as a conceptual data model, becomes realised as a database representing real world values (surface classifications) through a logical database design phase and subsequent implementation as a physical database.

In principal the CDM design lends itself to be realised in the form of other logical and physical representations. For example a land use representation, would see the use of a separate list of classifications and an alternative set subgroupings, aggregates and mosaics linked to a different set of OSi Prime2 polygon guids.

While extensibility is at the core of CDM design, we would urge caution to consider this as a pure ‘plug and play’ model to be used with other classification systems. We stress this as the required stakeholder input, use analysis and design activities for an alternative classification system have not been discussed in the scope of this delivery.

# 9. Implementation Planning

List of recommendations for future work and / or activities to address constraints. Here we consider a phased approach to developing a NLCHM. A phased approach with early prototyping is recommended for such an initiative, with each phase informing the next iteration.

## 9.1. Phase 1

- Business Analysis and Business Process Design
- Solution Architecture Design
- Technical Architecture Definition
- Proof of Concept # 1
- Catalog risks and recommendations

## 9.2. Phase 2… Phase(n)

- Business Analysis and Business Process Design
- Solution Architecture Design
- Technical Architecture Definition
- Proof of Concept # 2
- Catalog risks and recommendations

# 10. Glossary of Terms

| Phrase | Meaning |
|---|---|
| **Type** | *Refers to one of the 5 'skin of the earth' categories modelled in OSi Prime II – Vegetation, Artificial, Way, Water, Exposed* |
| **Product Schema** | *Final schema of land cover product which meets the visualisation and analysis needs of a target user group* |
| **Maintenance Schema** | *Operational schema from which output land cover products are derived. This scheme supports the storage of classification detail and associated metadata required for the generation of output land cover products* |
| **Processing Schema** | *A database structure where the characteristics of input data sources are aligned in a common schema which enables classification analysis. Input data sources are transformed to conform to this schema through an extract-transform-load (ETL) process* |
| **Ingest Schema** | *A staging area where input data resides before being transformed to the processing area. The ingest schema defines input data set format, structure, sourcing and update information. The ingest schema informs the source to target mapping to the processing schema* |

End of document