WPD INNOVATION

Transforming the electricity network

Spatially Enabled Asset Management (SEAM)

D03 Interim Findings Report

March 2021

Version 1.0

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D03 Interim Findings Report

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Name	Role
SEAM Project Team	Author
Jenny Woodruff / Dave Burnford	Reviewer
Jenny Woodruff	Approver

Purpose of this session

- Share our progress, key findings and direction of the project
- Validate our observations from the data and presence of error types
- Confirm that the report can be shared with the other networks as part of the knowledge share workshop (scheduled for 25/03)
- Agree areas to focus on comparison with SEAM outputs (e.g. INM)

Executive summary

The Spatially Enabled Asset Management (SEAM) project is carrying out a proof-of-concept to investigate the use of Machine Learning (ML) to identify and propose fixes for inaccuracies in GIS data. This interim report sets out the progress to date, key learnings and the future direction of the project.

The project is focused on four use case groups to evaluate data-driven and machine learning methods over a range of data inaccuracies. The use cases have been selected to provide new learning and complement the current rules-based approach being developed by the WPD Technology and Mapping team and previous work by Scottish Power Energy Networks that used ML techniques to verify network cables and topologies. A representative area covering Barnstaple has been selected for the purposes of the proof-of-concept with a focus on the LV, 11kV and 33kV networks.

A data model has been created based on datasets from WPD systems (GIS, asset management and customer) and potentially relevant external sources. Profiling and exploratory analysis has been carried out to build a greater understanding of the datasets and identify examples of the errors to be considered by the project or constraints in the data that may impact the performance of machine learning techniques. The conclusion at this stage of the project is that ML methods have the potential to deliver positive results based on the characteristics of the data and inaccuracies – but there remain challenges which are highlighted in this report (and discussed in more depth in the Model Definition deliverable) which will ultimately determine how well they perform.

Graph models are central to the project's proposed modelling approach. A traditional graph model that relies on electrical connectivity will be developed in addition to introducing a novel spatial graph model focussed on predicting asset attributes and relationships and emphasises the spatial relationship between assets. The models will allow a comparison of their performance in addressing the more complex GIS data issues.

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SEAM Use Case Groups

1 Customer Connectivity

- Identify potential errors and link customers to LV circuitry through connection points, where existent in Crown or Electric Office (EO), and also using spatial proximity if there are un-mapped customers.
- Estimate peak demand (i.e. on a winter's evening) up to substation level to identify potential areas in the LV network that the demand surpasses the capacity.
- Infer inaccurate or missing customer attributes with enriched customer datasets.

2 Incorrect or missing asset attributes and missing assets

- Identify missing or incorrect LV asset attributes using EO data and suggest corrections.
- Develop a graph model and apply Machine Learning techniques to identify relationships and patterns in the way that point and linear assets as well as their attributes are connected to highlight potential errors and suggest corrections.

3 Inconsistency across systems

- Where there are disparate systems that store data on the same asset (e.g. EO and CROWN) and there is associated locational data, it can be tested whether this can be used to verify any attributes that are stored in each system.
- Build on the graph model developed in Use Case group 2 by linking with CROWN dataset.

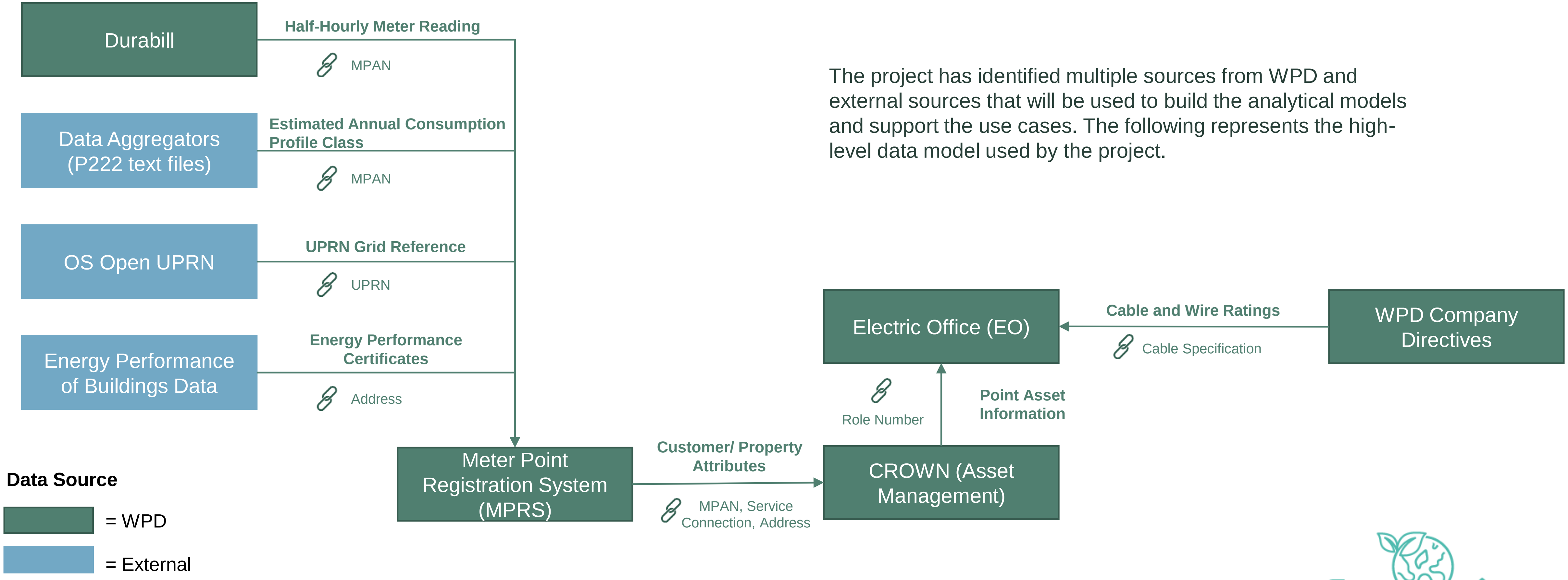
4 Technical inconsistencies

- Building a technical ruleset as well as 'learning' rules from the data to highlight where circuitry built from the GIS data is infeasible
- Use point/line topological graph modelling to assess possible paths from substation to customer to find exceptions where this is technically infeasible, illogical or unlikely

The Use Cases will be developed using the **Barnstaple area** (18km x 15km) and focus on the **LV, 11kV and 33kV** networks (results for the Results for 11kV and 33kV networks will be compared to the data quality issues reported by the Integrated Network Model)

High-level logical data model

The project has identified multiple sources from WPD and external sources that will be used to build the analytical models and support the use cases. The following represents the high-level data model used by the project.



See **Section 3** for learnings on data sources and the application of Machine Learning for GIS data cleansing

Electric Office data profiling

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The project has undertaken an initial profiling activity on the Electric Office data for the Barnstaple area (18km x 15km) that has been selected for the proof-of-concept. This is focused on a straightforward set of data completeness measures due to limited understanding of the data at this stage to consider its accuracy and validity.

In this section of the report we highlight key measures from the profiling and its implications for the project:

	Key profiling measures	Summary of key learnings
Network Connectivity	For circuits*, excluding special codes (e.g. non-energised and private): • **1,083** unique circuit IDs: 25 HV, 43 MV, 1,015 LV • **18,473** (47.4%) LV cable and **2,975** (42.1%) LV wire RWO with unknown or missing circuit IDs • **6,667** (23.8%) point assets (Keypole, Power Transformer, Isolating Equipment and Connector Point) with unknown or no assigned circuit ID	• A sufficient completeness of physical circuits is required to understand the relationship between assets in different locations and how this can be pooled and used to improve the data quality in all of those areas. The analytical approaches in Use Cases 1 and 4 in particular are dependent on this. • There remain a significant number of LV cables, wires and point assets with no circuit ID. Our evaluation at this stage is that there is sufficient completeness of the circuits to deliver results for Use Cases 1 and 4 that allow is to evaluate the performance of the analytical approaches. • The WPD Technology Mapping Team are currently undertaking a project to build LV network connectivity in EO (the circuits in our dataset include the outcome of Phase 1 of this project). SEAM is exploring the use of a graph model and physical proximity as a complementary approach to identifying missing circuit IDs.

* Circuit IDs equal to “”, “0/0”, “1/1” and those associated with zero or one wire/cable RWO asset are treated as “Unknown”.

Electric Office data profiling

	Key profiling measures	Summary of key learnings
Asset Attributes	• **59.6%** of cables and **22.8%** of wires have an explicit unknown component within the specification attribute. • **40.2%** of cables and **84%** of wires have a size label • **23.8%** of cables and **68.8%** of wires have a type/material label • **80.0%** of cables and **94.0%** of wires have a conductor/wire number label • Cables and wires specification where a combination of two or more labels exists for an asset is less likely. **12.6%** of cable assets and **62.8%** of wires have been found to have all 3 attributes detected within the specification column* • No missing voltages or network types	• The cable and wire specification attributes in EO are a concatenation of three associated components (size, type/material, number of conductors). A significant number of these contain at least one component that is ‘unknown’ (see next slide). • Extracts from the WPD Directive for cables and wires is used to map current ratings to the assets. The cable and wire ratings depend on size, material, number of conductors, location (i.e. in ground, duct or in air) and season/loading type. • There are no missing voltage or network type attributes which makes these a good candidate to develop a model for Use Case 2.

*number of conductors and size is matched on a regex match, the type/material is matched on type/material found in the WPD directives: SD8B_4_part1 and SD8A_3

Electric Office data profiling

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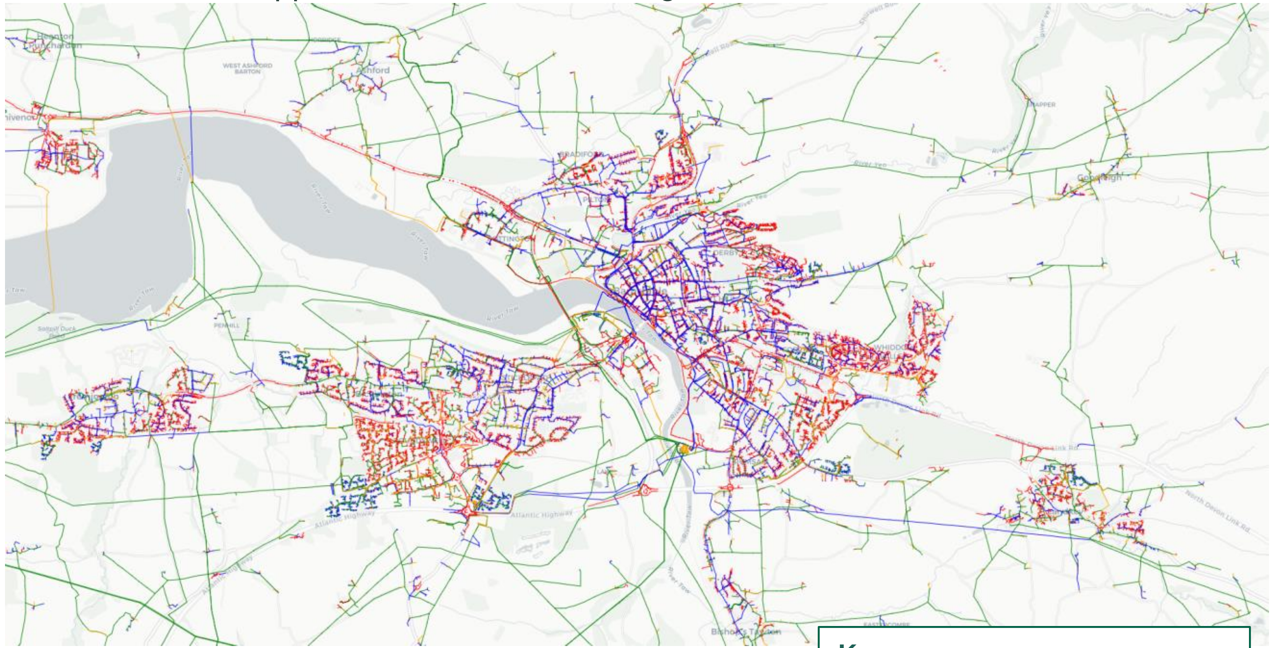
Mapping of cable and wire specification component (size, material/type, no. of conductors/wires) completeness

Barnstaple area specification availability. Overall coverage quality changes depending on area; patchiness of coverage and specification availability suggests that a graph-based / machine-learning approach to labelling missing cable specifications could be more successful than a traditional tabular approach to machine learning.



Specification availability at HV level is high due to previous work done in this area i.e. INM. However, at LV level, the data is less complete and available

Key
Red: all attributes missing
Orange: one attribute available
Blue: two attributes available
Green: all attributes available

Some areas have good coverage; this area appears to be new build. Even in relatively good areas, some service cables miss one or two attributes

High density areas with all missing does tend to have some assets with good specification availability, potentially owing to the way that cables and wires are labelled in legacy documentation

Electric Office data profiling

	Key profiling measures	Summary of key learnings
Customer Connectivity	• **75,867** MPANs and **54,275** UPRNs (covering the North Devon region that extends beyond the Barnstaple area in scope for the proof-of-concept) • **36,186** domestic and **1,854** non-domestic EPCs for the North Devon constituency (based on September 2020 data). • **28.5%** of MPANs with a missing UPRN	• The project is exploring the use of the Energy Performance Certificate (EPC) dataset to enrich the customer features (issued for domestic and non-domestic buildings constructed, sold or let since 2008). There is a challenge linking this to MPRS data because EPC does not contain UPRN (it includes a unique building reference number that has no relationship with UPRN). Our approach relies on address matching which is not 100% accurate due to differences in formats or structure across datasets. • The address data in CROWN is not well structured (the address is inconsistently ordered across 9 address lines). The use of UPRN and address (from addressbase premium) to match would provide a more structured dataset but this is not available to support the proof-of-concept.

See Appendix 1 for full data profiling of Electric Office tables

Data observations

In addition to the data profiling, the project has mapped (in QGIS) and visually inspected the EO data to build a greater understanding of the data and identify examples of the errors to be considered by the project or constraints in the data that may impact the analytical approaches. This section provides a selection of the findings:

2.1 Service Wires

Yeo Vale Road
Generally good coverage of service wires, but some are missing.
Some connector points missing where 3 or more wires join and end of wire doesn't necessarily match exactly with the corresponding subsequent wires: these make determining electrical connections difficult.

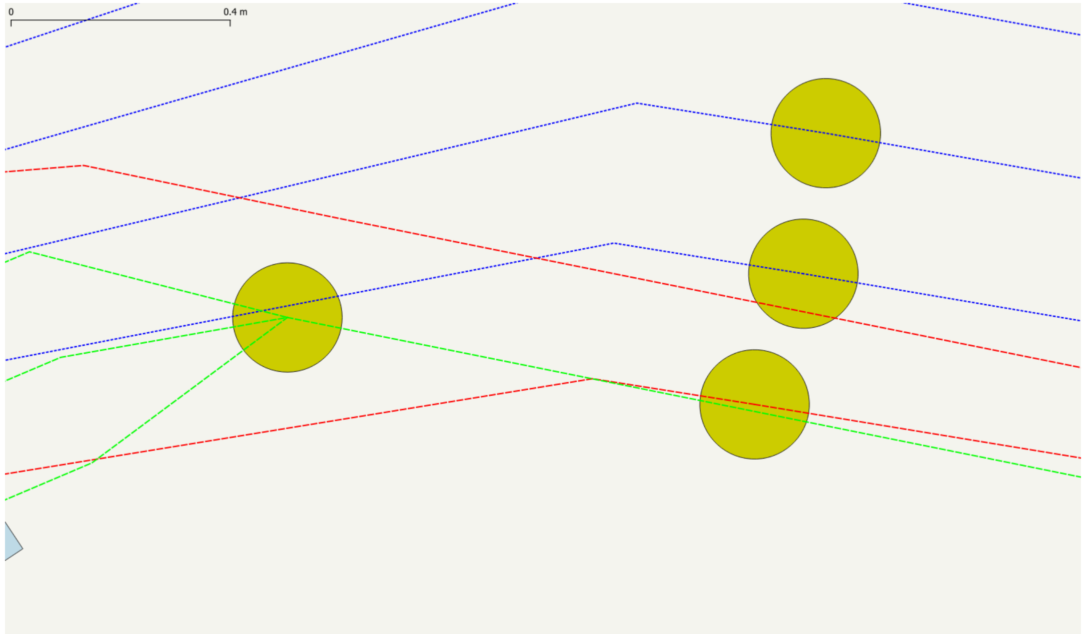
2.2 Missing Service Cables

Claude Dix Close
Missing service cables to properties. Makes mapping properties to circuits and determining loading of cable segments difficult.

See Appendix 2 for overview of symbology used

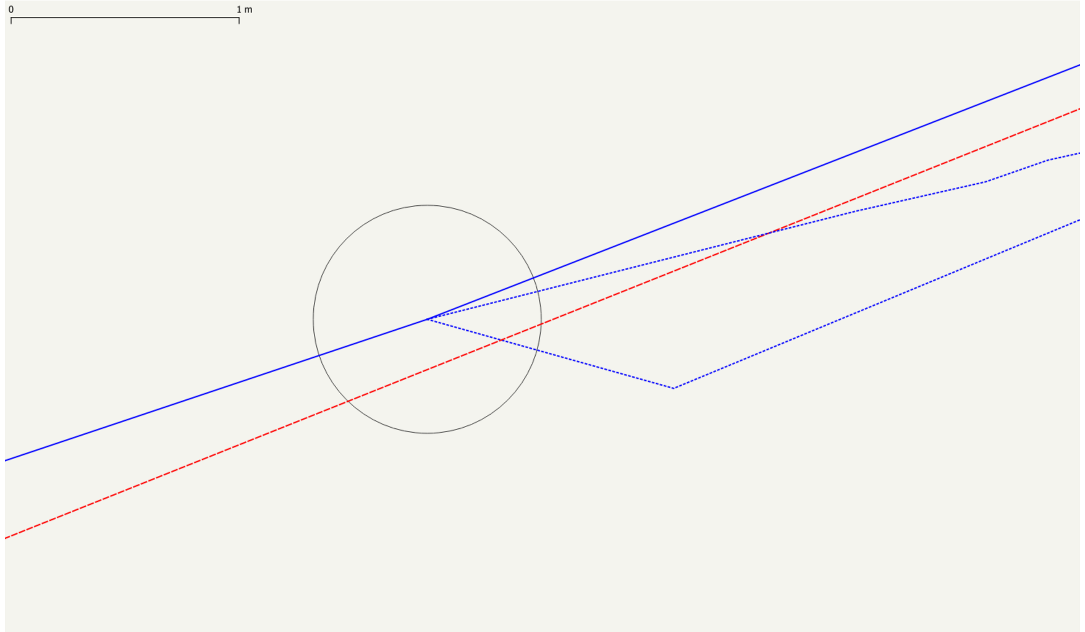
Data observations

2.3 Different network types in close proximity



St George's Road
Which cables do the connector points refer to? In this case, attributes do match closest cables, but there are plenty of examples of connector points with incorrect locations.

2.4 Unclear whether wires and cables are connected

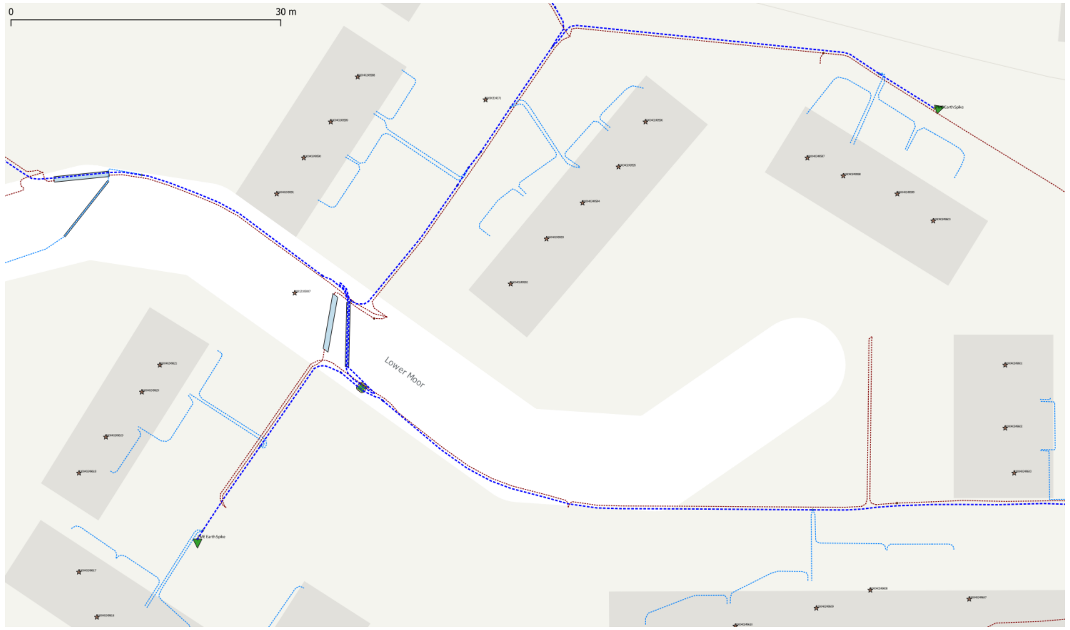


St George's Road
The 400V cables and wires all share co-ordinates with the pole, but is it guaranteed that they are electrically connected?

See Appendix 2 for overview of symbology used

Data observations

2.5 Gaps between service cables



Lower Moor
Service cables between properties often have gaps between them, which makes associating services with circuits and properties with services hard.

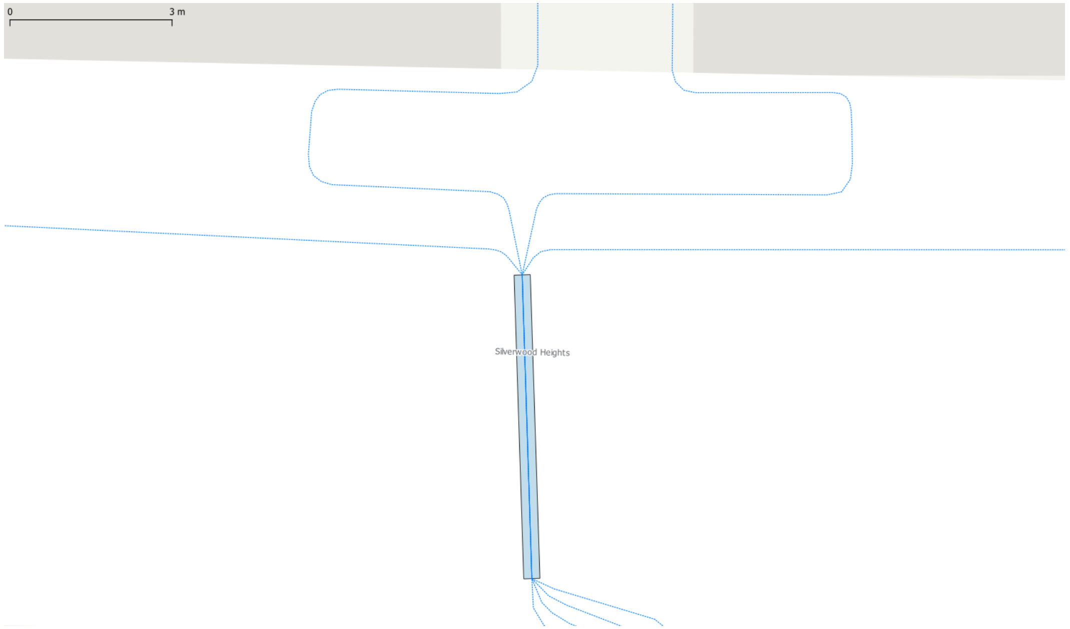
2.6 Gaps between distribution cable and service cables

Long Meadow Drive
Connector point and service cable co-ordinates do not match the co-ordinates of the distribution cable. Are these actually connected (i.e. geometry is wrong) or is a distribution cable missing?

See Appendix 2 for overview of symbology used

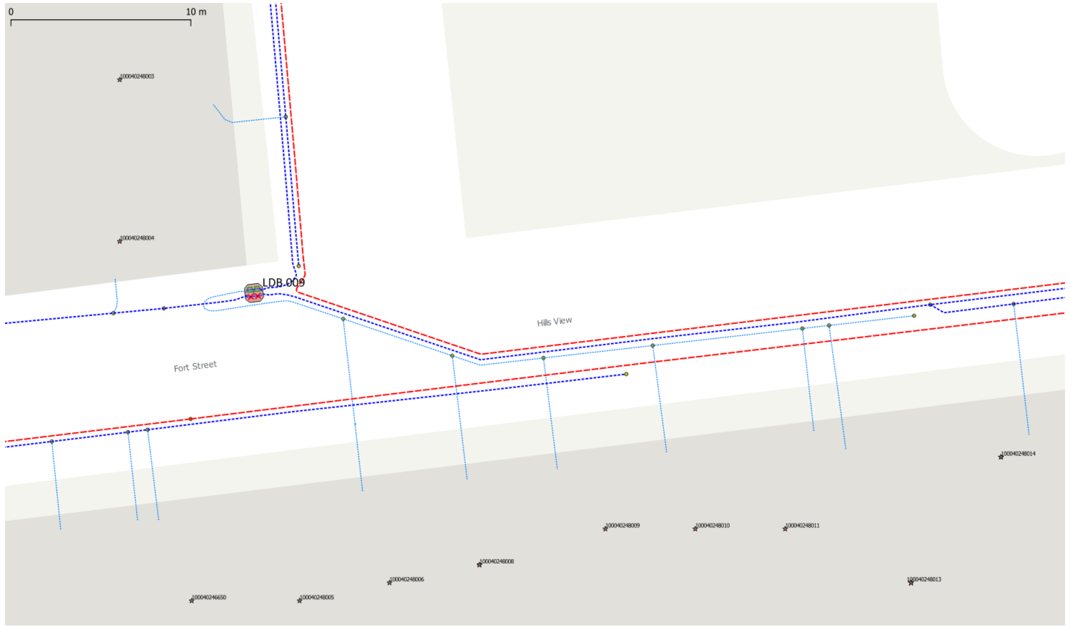
Data observations

2.7 Repeated coordinates between cables



Silverwood Heights
Service cables share co-ordinates at entry/exit from conduit, but are (probably) not directly connected at those locations.
Demonstrates that sharing a location does not guarantee electrical connectivity.

2.8 Multiple Distribution Cables, Properties not necessarily supplied from closest one



Hills View, Fort Street
Service cables are not necessarily connected to the closest distribution cable to the property. Closest distribution cable to each property might not be part of the same circuit. While services are (mostly) available here, this is not always the case.

See Appendix 2 for overview of symbology used

Key requirements for the application of Machine Learning in GIS data cleansing

Based on learnings from the data profiling and initial observations from inspection of the data we have assessed the key criteria for successfully developing a Machine Learning approach to GIS data cleansing:

Criteria	Characteristic for application of Machine Learning (for GIS data)	Interim project observations
Relevancy of data inputs	• Having the right datasets to support each use case is fundamental to the application of Machine Learning. This includes sufficient data quality and volume to train the models and evaluate their performance.	• The datasets and geographical area selected for the PoC provide the coverage that is typically required to apply and evaluate Machine Learning. • In order to effectively test data-driven and machine learning methods to identify data errors, the process will need to be able to introduce data quality exceptions in a way that simulates real life to most effectively measure the success of testing any algorithm. • The sensitivity of each modelling algorithm will be tested against pervasiveness of errors as to test the limitations of each methodology.
Data engineering/ preparation	• To make the proof-of-concept models reusable and potentially scalable the data preparation and engineering needs to be constructed in a way that is repeatable and highly automated.	• Complete and detailed data dictionaries do not exist for every WPD data source. Further investigation and ongoing engagement with data owners is required to establish an understanding of the data in sufficient detail to design the analytical approaches. • There are different naming conventions for attributes across the different systems/sources. A data catalogue is being created to support the project data model to ensure there is a clear understanding of the relationship between datasets. • The EO and CROWN data extracts are not standard reports. They require a system user to select the data attributes and geographical coverage. To make the analysis repeatable in the PoC tool the data inputs will need to be in the same format to read into the model and evaluate the relevant features.

Key requirements for the application of Machine Learning in GIS data cleansing

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Criteria	Characteristic for application of Machine Learning (for GIS data)	Interim project observations
Data engineering/ preparation	• See previous slide	• The data extraction process for EO and CROWN exports differ due to the nature of the data (i.e. while EO asset data can be exported within a set geographical boundary because it includes geospatial coordinates, CROWN is not set up that way but is more likely to group assets by other factors such as maintenance responsibility or network hierarchy).
GIS model selection	• Traditional machine learning works with tables of observations, where the absolute values of the attributes can be compared with the other observations in the dataset in order to extract patterns. In context of geospatial data the absolute location of each asset is of limited utility on its own: what matters more is the local neighbourhood of each asset, i.e. what are the attributes of the other assets in the surrounding area?	• For power networks, the physical connectivity of the assets is more important than the relative locations. However, constructing this information is difficult if it is not already available, especially in the presence of missing assets. Also, encoding the connectivity in a form that can be directly used by a machine learning algorithm is also not straightforward; while this naturally fits in a graph model, there are many potential methods for constructing such a model, and advanced algorithms will be required to work with these data. The presence of loops in the network means that linear distances, such as the distance along wires and cables from a substation, may not be well defined. Lack of vertical position information also makes it harder to determine which assets might be connected together. This would be especially beneficial for crossing assets. • The project will focus on developing a graph model (for Use Cases 2 and 3) focussed on predicting asset attributes and relationships and emphasises the spatial relationship between assets. See Section 4.2 for further detail.

D02 Model Definition includes further discussion on the technical challenges of applying to Machine Learning to GIS data cleansing

Model selection

- Our approach to all use cases will utilise a graph model (i.e. based on a connected graph of nodes and relationships with properties and labels). Other applications of graph models in this field include the Integrated Network Model data process and Scottish Power Energy Networks for representing an LV Network as a Network Tree Graph to verification of network cables and topologies.
- Traditional graph models for power networks are focused on power systems analysis and network management, rather than on asset management. They typically rely on electrical properties and require complete electrical connectivity – ignoring spatial relationships. This approach is well suited to Use Cases 1 and 4 where the physical connectivity of the model is central to conducting the modelling or forms a part of the pattern identification.
- One of the key learnings from our initial data exploration is that traditional Machine Learning approaches that work with table-based observations (e.g. regression techniques such as k-nearest neighbours) will have limited usefulness. This was an initial hypothesis and a proposed approach for Use Cases 2 and 3.
- A new graph model is required that is focussed on predicting asset attributes and relationships and emphasises the spatial relationship between assets. This will be a novel approach based on a spatial graph model that contains a layer of point location nodes, with distance relationships between them to create a spatial mesh, and edges between each asset or feature and the location nodes that are part of it.

4.1 Traditional graph model

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Can power system network topology (built using asset GIS data from Electric Office) and asset attributes (i.e. nominal voltage, current rating) be used to detect any erroneous customer connections? Assuming radial topology, aggregate demand from leaf node (customer).

Construct network topology (directed graph) → Traverse from the consumer to the substation → Updating representative demand at each intersection → Use Case 1

Traverse from the consumer to the substation → Analysis of pathways → Use Case 4

Use Case 1: Exception where demand is above asset capacity. Exception consumer pool and asset pool analysis:

- Consumer wrongly assigned to circuit?
- Erroneous UPRN?
- Wrongly assigned EAC profile?
- Consumer disconnect not recorded?
- Missing open points?
- Open points (normally open) wrongly assigned?

Use Case 4: Exception where technical infeasibility exists:

- Is change in cross-sectional area technically feasible?
- Does wiring change from three phase to single phase unexpectedly?
- Are there inherent patterns in paths to customer in some way that can be used to backfill missing data?
- Are there inherent patterns in paths to customer in some way that can be used to identify anomalies?

Challenges with approach

- Requires good connectivity: ‘Connectivity’ in GIS data does not infer ‘electrical connectivity’, small disconnections appear in the data.
- Missing service cables creates challenges in connecting customers to feeders.
- EAC data is not exact

Methods to overcome

- Current approach on the test circuit is sampling points along the LineString, finding intersections and where there are disconnects apply clustering approaches to find centre and add new ‘theoretical’ edges to make connection
- Similar clustering approach is taken with customer connections with missing service cables
- Using metered data where possible, EAC and applying diversity formulation in interim when smart meter data not available

4.1 Traditional graph model

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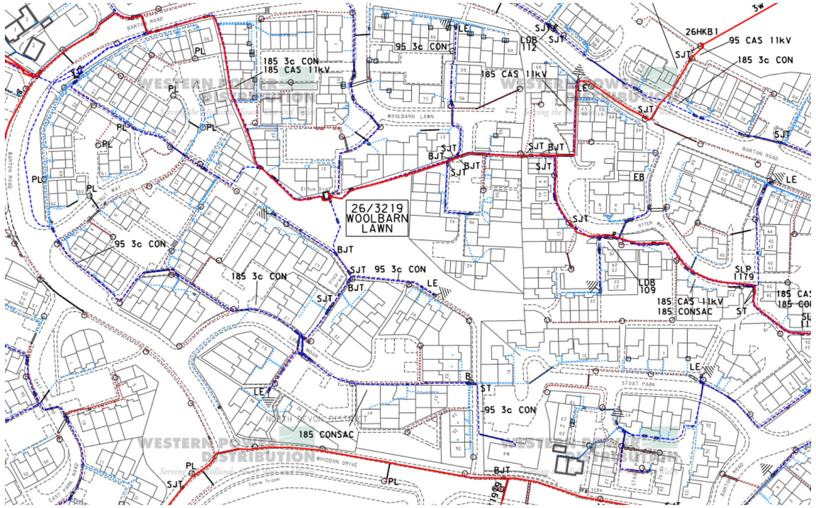
Can power system network topology (built using asset GIS data from Electric Office) and asset attributes (i.e. nominal voltage, current rating) be used to detect any erroneous customer connections?



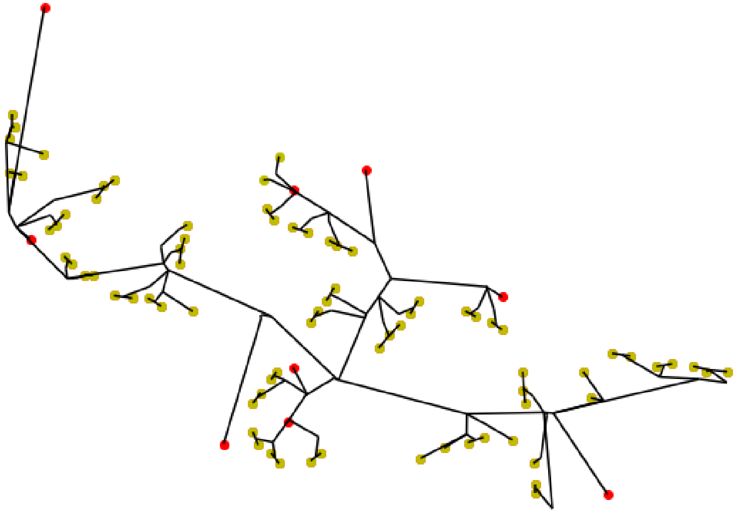


Diagram showing the process of creating a basic 'connectivity graph model' from GIS data, using Node (point) edge (line) representation
Yellow nodes show customer connections for this circuit

4.2 Spatial graph model

Spatial Graph Model

SEAM will use a graph model that contains a layer of point location nodes, with distance relationships between them to create a spatial mesh, and edges between each asset or feature and the location nodes that are part of it (see next slide for illustration).

The basic model comprises:

- one node for each asset/feature
- one node for every unique point location (subject to some tolerance)
- edges from each asset/feature to every location that is associated with it:
    - points: one location from Point geometry
    - lines: two or more locations that make up the LineString geometry
    - polygon: every location within the Polygon geometry
- edges between "nearby" locations with "distance" attribute to create a complete mesh

Note that, if required, this can be constructed using only a subset of the assets/features and attributes.

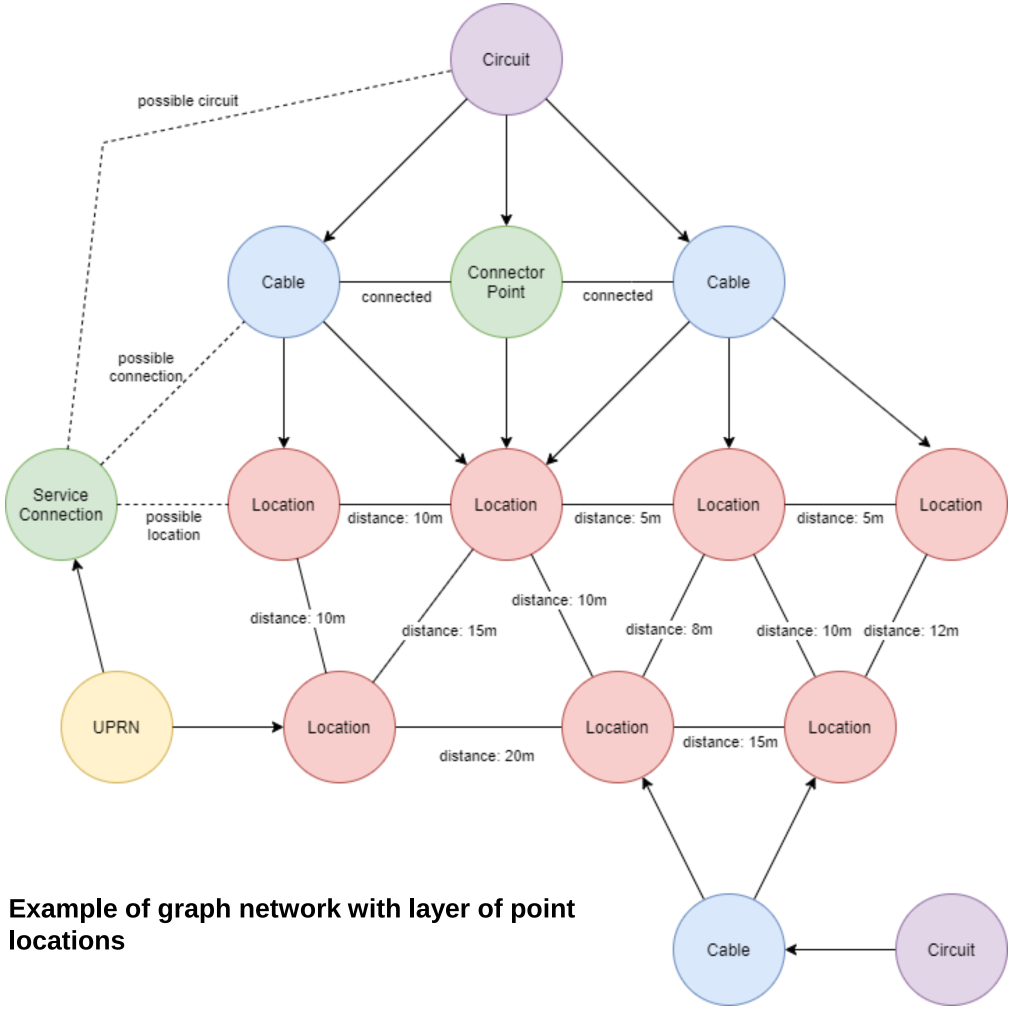
Node Classification

- cable/wire specification from cable/wire assets, locations and attributes only
- connector point joint type from cable/wire assets

Link Prediction

- electrical connections between assets that are not exactly co-located
- circuit membership even when there are missing conductor assets
- location(s) associated with an added cable given one location, circuit ID and other selected attribute

4.2 Spatial graph model



Example of graph network with layer of point locations

4.2 Spatial graph model

Advantages

- Can be constructed using only the assets, attributes and relationships of interest.
- All assets are connected to all other assets via the location layer.
- Separate, complementary concepts of sharing location and electrical connection.
- Information about electrical connection is not mandatory, but can be included, even when incomplete.
- Allows other location-based data, such as UPRN and property classification, to be added.
- No edges with zero distance (or very short).
- The problem of selecting distance edges to add is reduced to creating a mesh on a point set in 2-D Euclidean space.
- Spatial relationships with linear assets take into account every point that is part of its LineString geometry, not just the ends or middle.
- Distances through the spatial mesh are only approximate (i.e. not exactly the same as the Euclidean distance between arbitrary locations), which will reduce the risk of the model overfitting on proximity.

Disadvantages

- Curved geometries will result in lots of point locations.
- Extent of polygon geometries are not stored: only the locations of other assets that are within them.
- Still need to choose an approach for deciding which distance edges to include in the graph.
- Exact distances along the circuits may not be available, depending on which distance edges and length attributes are included.

4.2 Spatial graph model

The graph model is planned to be explored in 3 stages (if time allows) with the attributes grouped as follows.

1. Voltage

These attributes are relatively straightforward to model, expect to find spatial patterns and common to many asset types, while still meaningful when taking a subset of asset types.

- Operational voltage
- Network type
- Usage
- Running 3 phase
- Design Voltage

It is expected that this will not identify many (if any) real errors in the sample dataset. However, it will demonstrate the ability of the graph model to extract relevant patterns to identify and correct synthetic errors.

2. Specification

These attributes are harder to model and include attributes that are known to have lots of missing data in the sample dataset, but are mostly only relevant to conductors.

- Specification description
- Number of wires
- Armouring
- Fluid filled
- PVC insulation
- Capable 3 phase

3. Circuits

This attribute is important for building the electrical connectivity of the network and is known to have lots of missing values in the sample dataset.

- circuit_id

Using the graph model, it should be possible to link assets to circuits even in the presence of missing assets, by exploiting spatial patterns and other attributes. This would provide a complementary, data-driven approach to the current rules-based approach being developed by the mapping team.

Future direction of the project

A key learning objective for the project is to evaluate the degree to which machine learning can be applied to GIS data to find and fix the more complex errors. Based on this objective and our assessment of the data the project will focus on two modelling approaches:

- **Traditional graph model focused on electrical connectivity:** The application of analytical approaches to a model that represents physical/electrical connectivity of the network. This is in line with the more traditional approach used by network operators (e.g. power systems analysis, network management) with a focus on electrical properties and requires complete electrical connectivity.
- **Alternative graph model with layer of point location nodes:** A graph model where all assets are connected to all other assets via the location layer and information about electrical connection is not mandatory. This graph model contains a layer of point location nodes, with distance relationships between them to create a spatial mesh, and edges between each asset or feature and the location nodes that are part of it.

The traditional graph model approach will be used to develop the modelling of customer connectivity (Use Case 1). Our approach for this use case requires an understanding of network connectivity to assess peak demand against cable ratings at a given point of a circuit and traverse different segments of a feeder to the substation.

The same graph model will also be used to develop the approach for identifying technical inconsistencies (Use Case 4) through the pathways (from feeder to end of network) as a standalone dataset to understand whether there are inherent patterns within the set. We can apply unsupervised machine learning algorithms to understand the behaviour of paths and identify any potential anomalies to highlight persistent data quality issues along anomalous paths.

Future direction of the project

Traditional machine learning works with tables of observations, where the absolute values of the attributes can be compared with the other observations in the dataset in order to extract patterns. In context of geospatial data, the absolute location of each asset is of limited utility on its own: what matters more is the local neighbourhood of each asset. As a result the project has decided for Use Cases 2 and 3 to develop a new graph model that is focussed on predicting asset attributes and relationships and emphasises the spatial relationship between assets. To evaluate the effectiveness of the approach, the project will start with a straightforward prototype based on voltage attributes and build in complexity by introducing asset specifications (and potentially circuit IDs).

The models will allow a comparison of their performance in addressing complex GIS data issues. In particular, the development of a new graph model which emphasises the spatial relationship between assets will open opportunities to explore novel applications of Machine Learning within the context of addressing GIS data issues.

Appendix 1: Data Profiling

A1.1 Electric Office data profiling overview

Table	No. of variables	No. of observations	Missing cells	Missing cells (%)	Duplicate rows	Duplicate rows (%)
CABINET	10	527	8	0.2%	0	0.0%
CABLE	23	45169	179169	17.2%	0	0.0%
CONDUIT	14	10210	10210	7.1%	0	0.0%
CONNECTOR POINT	16	17430	34761	12.5%	0	0.0%
CONNECTOR SEGMENT	11	8633	1290	1.4%	0	0.0%
ENERGY CONSUMER	12	276	0	0.0%	0	0.0%
ENERGY SOURCE	11	2	0	0.0%	0	0.0%
ISOLATING EQPT	21	4553	17195	18.0%	0	0.0%
KEYPOLE	18	5125	20026	21.7%	0	0.0%
POLE	11	9392	11564	11.2	0	0.0%
POWER TRANSFORMER	21	1117	2596	11.1	0	0.0%
PROTECTIVE EQPT	13	2889	0	0.0%	0	0.0%
SERVICE CONNECTION	12	2780	5282	15.8%	0	0.0%
SERVICE POINT	10	2934	0	0.0%	0	0.0%
SUBSTATION GM	10	354	354	10.0%	0	0.0%
SUBSTATION PM	12	764	764	8.3%	0	0.0%
TOWER	12	84	0	0.0%	0	0.0%
WIRE	28	12452	96971	27.8%	0	0.0%

Initial data profiling report on Electric Office data sets

The overview will provide an insight into the data statistics of the assets within electric office.

The individual Electric Office tables will provide a further breakdown into the uniqueness & completeness of the data sets.

*data profiling results displayed in tables have excluded attributes which are not applicable.

A1.2 Cabinet

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
CABINET	id	527	100.00%	0	0.00%	0	0.00%		289018880, 237121264, 187704044, 237121258, 237121256
	status	1	0.19%	0	0.00%	0	0.00%	'Existing'	'Existing'
	type	4	0.76%	0	0.00%	0	0.00%	'Link Box', 'Multi-Service Pillar', 'Feeder Pillar', 'Public Lighting Feeder Pillar'	'Link Box', 'Multi-Service Pillar', 'Feeder Pillar', 'Public Lighting Feeder Pillar'
	design	8	1.52%	0	0.00%	0	0.00%		'Multi-Service Pillar', 'Link Box - 4 Way', 'Feeder Pillar', 'Link Box - 2 Way', 'Public Lighting Feeder Pillar'
	number	455	87.67%	8	1.52%	0	0.00%		'FP', 'MSP', 'LDB', 'PILLAR', 'PLP'
	geometry	527	100.00%	0	0.00%	0	0.00%		

A1.3 Conduit

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
CONDUIT	id	10151	99.42%	0	0.00%	0	0.00%		138230087, 1120120613, 1118560503, 1151574435, 752415269
	wpd_status	2	0.02%	0	0.00%	0	0.00%	'Existing', 'Abandoned'	'Existing', 'Abandoned'
	wpd_type	1	0.01%	0	0.00%	0	0.00%	'Duct'	'Duct'
	wpd_pipes_total	5	0.05%	0	0.00%	9937	97.33%	'Unknown', '1', '2', '3', '4'	'Unknown', '1', '2', '3', '4'
	wpd_pipes_free	4	0.04%	0	0.00%	9940	97.36%	'Unknown', '0', '1', '2'	'Unknown', '0', '1', '2'
	wpd_pipe_size	7	0.07%	0	0.00%	9983	97.78%	'Unknown', '150', '38', '100', '50', '125', '0'	'Unknown', '150', '38', '100', '50'
	wpd_material	4	0.04%	0	0.00%	9957	97.52%	'Not Set', 'Plastic', 'Alkathene Tube', 'PVC'	'Not Set', 'Plastic', 'Alkathene Tube', 'PVC'
	Geometry	10209	99.99%	0	0.00%	0	0.00%		

A1.4 Cable

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
CABLE	id	45001	99.63%	0	0.00%	0	0.00%		38200837, 378304080, 407962033, 37966761, 23567347
	status	1	0.00%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	3	0.01%	0	0.00%	0	0.00%	'LV', 'MV', 'HV'	'LV', 'MV', 'HV'
	nominal_voltage_pp	6	0.01%	0	0.00%	0	0.00%	'230', '400', '11000', '33000', '132000', '110'	'230', '400', '11000', '33000', '132000'
	mounting	2	0.00%	0	0.00%	0	0.00%	'Underground', 'Submarine'	'Underground', 'Submarine'
	usage	4	0.01%	0	0.00%	0	0.00%	'Service', 'Distribution', 'Unmetered Service', 'Earth'	'Service', 'Distribution', 'Unmetered Service', 'Earth'
	wpd_commissioning_history_date	682	8.65%	37287	82.55%	0	0.00%		'2015-07-01T00:00:00', '2016-02-01T00:00:00', '2017-03-01T00:00:00', '2017-06-01T00:00:00', '2013-03-01T00:00:00'
	bool_wpd_assumed_route	2	0.02%	34159	75.62%	0	0.00%	0.0, 1.0	0.0, 1.0
	bool_wpd_fully_ducted	2	0.15%	43794	96.96%	0	0.00%	0.0, 1.0	0.0, 1.0
	circuit_id	1192	4.51%	18761	41.54%	2973	6.58%		'1/1', '0/0', '265868/0/0', '260108/0/0010', '265033/0/0010'
	bool_wpd_capable_3_phase	2	0.00%	0	0.00%	0	0.00%	0, 1	0, 1
	bool_wpd_running_3_phase	2	0.00%	0	0.00%	0	0.00%	0, 1	0, 1
	wpd_design_voltage	5	0.01%	0	0.00%	0	0.00%	'230', '400', '11000', '33000', '132000'	'230', '400', '11000', '33000', '132000'

A1.4 Cable

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
CABLE	wpd_fluid_filled_	2	0.00%	0	0.00%	0	0.00%	0, 1	0, 1
	bool_normally_energised	2	0.00%	0	0.00%	0	0.00%	1, 0	1, 0
	wpd_armouring	17	0.04%	0	0.00%	805	1.78%		'Standard', 'Unknown', 'PI LC', 'PLYSWS', 'SWA'
	specification_description	197	0.44%	0	0.00%	26925	59.61%		'SV Unknown from Unattributed', 'US Unknown from Unattributed', '11kV Earthwire', '185 3c WCON', '25 Hyb'
	geometry	44582	98.70%	0	0.00%	0	0.00%		

A1.5 Connector Point

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
CONNECTOR POINT	id	17430	100.00%	0	0.00%	0	0.00%		76584963, 399901930, 183880947, 204627185, 48082163
	status	1	0.01%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	3	0.02%	0	0.00%	0	0.00%	'LV', 'MV', 'HV'	'LV', 'MV', 'HV'
	nominal_voltage_pp	6	0.03%	0	0.00%	0	0.00%	'230', '400', '11000', '33000', '132000', '110'	'230', '400', '11000', '33000', '132000'
	mounting	4	0.02%	0	0.00%	0	0.00%	'Underground', 'Under Eaves', 'Wall', 'Overhead'	'Underground', 'Under Eaves', 'Wall', 'Overhead'
	usage	4	0.02%	0	0.00%	0	0.00%	'Service', 'Distribution', 'Unmetered Service', 'Earth'	'Service', 'Distribution', 'Unmetered Service', 'Earth'
	bool_normally_energised	2	0.01%	0	0.00%	0	0.00%	1, 0	1, 0
	circuit_id	931	7.87%	5600	32.13%	0	0.00%		'989998/9998', '260037/0/0', '260250/0024', '260220/0026', '260590/0154'
	device_type	20	0.11%	0	0.00%	0	0.00%		'Service Tee Off', 'Straight', 'Live End', 'Breach', 'Tee'
	geometry	17428	99.99%	0	0.00%	0	0.00%		

A1.6 Connector Segment

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
CONNECTOR SEGMENT	id	8606	99.69%	0	0.00%	0	0.00%		47769423, 21273527, 52697043, 52697058, 52697145
	status	1	0.01%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	3	0.03%	0	0.00%	0	0.00%	'LV', 'MV', 'HV'	'LV', 'MV', 'HV'
	nominal_voltage_pp	5	0.06%	0	0.00%	0	0.00%	'400', '11000', '33000', '230', '132000'	'400', '11000', '33000', '230', '132000'
	mounting	3	0.03%	0	0.00%	7869	91.15%	'Unknown', 'Underground', 'Overhead'	'Unknown', 'Underground', 'Overhead'
	bool_normally_energised	2	0.02%	0	0.00%	0	0.00%	1, 0	1, 0
	circuit_id	1471	20.03%	1290	14.94%	0	0.00%		'979997/9997', '260220/0027', '260250/0024', '260590/0157', '260220/0024'
	device_type	2	0.02%	0	0.00%	0	0.00%	'Internal', 'Busbar'	'Internal', 'Busbar'
	geometry	8633	100.00%	0	0.00%	0	0.00%		

A1.7 Energy Consumer

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
ENERGY CONSUMER	id	276	100.00%	0	0.00%	0	0.00%		342971400, 203274104, 203274110, 203274109, 203274108
	status	1	0.36%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	1	0.36%	0	0.00%	0	0.00%	'LV'	'LV'
	nominal_voltage_pp	1	0.36%	0	0.00%	0	0.00%	'230'	'230'
	phasing	1	0.36%	0	0.00%	276	100.00%	'Unknown'	'Unknown'
	consumer_type	1	0.36%	0	0.00%	0	0.00%	'Meter Box'	'Meter Box'
	wpd_usage	1	0.36%	0	0.00%	0	0.00%	'Service'	'Service'
	geometry	275	99.64%	0	0.00%	0	0.00%		

A1.8 Energy Source

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
ENERGY SOURCE	id	2	100.00%	0	0.00%	0	0.00%	250499640, 337633295	250499640, 337633295
	status	1	50.00%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	1	50.00%	0	0.00%	0	0.00%	'MV'	'MV'
	nominal_voltage_pp	1	50.00%	0	0.00%	0	0.00%	'11000'	'11000'
	geometry	2	100.00%	0	0.00%	0	0.00%		

A1.9 Isolating Equipment

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
ISOLATING EQPT	Id	4553	100.00%	0	0.00%	0	0.00%		453230592, 416753010, 445277566, 312089981, 463061469
	Status	1	0.02%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	3	0.07%	0	0.00%	0	0.00%	'LV', 'MV', 'HV'	'LV', 'MV', 'HV'
	nominal_voltage_pp	4	0.09%	0	0.00%	0	0.00%	'400', '11000', '33000', '132000'	'400', '11000', '33000', '132000'
	wpd_asset_id	1429	39.43%	929	20.40%	0	0.00%		'0010', '0020', '0', '0030', '1'
	mounting	3	0.07%	0	0.00%	0	0.00%	'Ground Mounted', 'Pole Mounted', 'Underground'	'Ground Mounted', 'Pole Mounted', 'Underground'
	bool_normally_energised	1	0.02%	0	0.00%	0	0.00%	1	1
	circuit_id	1595	38.26%	384	8.43%	0	0.00%		'260220/0027', '260250/0024', '260220/0024', '260480/0034', '260590/0157'
	device_type	7	0.15%	0	0.00%	0	0.00%	'LV Fuseway', 'Switch', 'Fuse', 'Link', 'Switch Disconnector', 'Circuit Breaker', 'Recloser'	'LV Fuseway', 'Switch', 'Fuse', 'Link', 'Switch Disconnector'
	specification	38	0.84%	4	0.09%	0	0.00%		'(LV) Fuse', '(LV) Link', '(HV) OIS', '(HV) PM Fuses', '(LV) B.Bridges'
	normal_status	2	0.04%	0	0.00%	0	0.00%	'Closed', 'Open'	'Closed', 'Open'
	structure_type	5	0.42%	3375	74.13%	0	0.00%	'Single Pole', 'Single Pole + Stay', 'H Pole', 'H Pole + 2 Stays', 'H Pole + 4 Stays'	'Single Pole', 'Single Pole + Stay', 'H Pole', 'H Pole + 2 Stays', 'H Pole + 4 Stays'

A1.9 Isolating Equipment

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
	structure_number	905	89.34%	3540	77.75%	3	0.07%		'26AJ16B', '26J32', '26ZAJ47', '26ZAG10', 'UNKNOWN'
	site_number	969	35.65%	1835	40.30%	0	0.00%		260467.0, 260250.0, 260037.0, 260465.0, 265758.0
	role_number	801	86.78%	3630	79.73%	24	0.53%		'UNKNOWN', '26AJ16B', '26ZAJ47', '26J14B', '26ZAG10'
	geometry	4553	100.00%	0	0.00%	0	0.00%		

A1.10 Pole

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
POLE	id	9392	100.00%	0	0.00%	0	0.00%		400162816, 204450472, 70937224, 137147019, 243600012
	status	1	0.01%	0	0.00%	0	0.00%	'Existing'	'Existing'
	number	6614	97.81%	2630	28.00%	132	1.41%		'UNKNOWN', 'BT', '2', '1', '26-2806-4'
	usage	5	0.05%	0	0.00%	0	0.00%	'Single Pole', 'Single Pole + Stay', 'H Pole', 'H Pole + 2 Stays', 'H Pole + 4 Stays'	'Single Pole', 'Single Pole + Stay', 'H Pole', 'H Pole + 2 Stays', 'H Pole + 4 Stays'
	network_type	3	0.06%	4467	47.56%	0	0.00%	'MV', 'HV', 'LV'	'MV', 'HV', 'LV'
	nominal_voltage_pp	5	0.10%	4467	47.56%	0	0.00%	'11000', '33000', '400', '132000', '230'	'11000', '33000', '400', '132000', '230'
	geometry	9388	99.96%	0	0.00%	0	0.00%		

A1.11 Protective Equipment

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
PROTECTIVE EQPT	id	2889	100.00%	0	0.00%	0	0.00%		31846922, 78160592, 105165475, 441085953, 125149195
	status	1	0.03%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	3	0.10%	0	0.00%	0	0.00%	'LV', 'MV', 'HV'	'LV', 'MV', 'HV'
	nominal_voltage_pp	4	0.14%	0	0.00%	0	0.00%	'400', '11000', '33000', '230'	'400', '11000', '33000', '230'
	mounting	2	0.07%	0	0.00%	0	0.00%	'Underground', 'Pole Mounted'	'Underground', 'Pole Mounted'
	device_type	2	0.07%	0	0.00%	0	0.00%	'PME Earth Spike', 'Earth Spike'	'PME Earth Spike', 'Earth Spike'
	protection_type	2	0.07%	0	0.00%	0	0.00%	'Current', 'Voltage'	'Current', 'Voltage'
	geometry	2885	99.86%	0	0.00%	0	0.00%		

A1.12 Power Transformer

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
POWER TRANSFORMER	id	1117	100.00%	0	0.00%	0	0.00%		441085648, 262819206, 266683799, 187703958, 262819215
	status	1	0.09%	0	0.00%	0	0.00%	'Existing'	'Existing'
	source_network_type	2	0.18%	0	0.00%	0	0.00%	'MV', 'HV'	'MV', 'HV'
	source_nominal_voltage_pp	2	0.18%	0	0.00%	0	0.00%	'11000', '33000'	'11000', '33000'
	load_network_type	2	0.18%	0	0.00%	0	0.00%	'LV', 'MV'	'LV', 'MV'
	load_nominal_voltage_pp	2	0.18%	0	0.00%	0	0.00%	'400', '11000'	'400', '11000'
	mounting	2	0.18%	0	0.00%	0	0.00%	'Pole Mounted', 'Ground Mounted'	'Pole Mounted', 'Ground Mounted'
	bool_normally_energised	1	0.09%	0	0.00%	0	0.00%	1	1
	circuit_id	37	3.31%	0	0.00%	37	3.31%		'260220/0027', '260590/0157', '260250/0024', '260220/0024', '260240/0084'
	device_type	2	0.18%	0	0.00%	0	0.00%	'Distribution', 'Metering'	'Distribution', 'Metering'
	site_number	1095	98.65%	7	0.63%	0	0.00%		'264411', '260853', '262053', '263018', '262984'
	asset_id	4	0.36%	0	0.00%	0	0.00%	'0', '1', '2', '01'	'0', '1', '2', '01'
	structure_number	759	98.70%	348	31.15%	0	0.00%		'26HGB20A', '26EBL11', '26ADA4', '26EA1A', '26JP9'
	Geometry	1117	100.00%	0	0.00%	0	0.00%		

A1.13 Service Connection

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
SERVICE CONNECTION	id	2780	100.00%	0	0.00%	0	0.00%		436662272, 450277299, 445386721, 49699532, 352573176
	phasing	3	0.11%	0	0.00%	2670	96.04%	'Unknown', 'ABC', 'B'	'Unknown', 'ABC', 'B'
	connection_type	4	0.14%	0	0.00%	2474	88.99%	'Unknown', 'Residential', 'Commercial', 'Street Lighting'	'Unknown', 'Residential', 'Commercial', 'Street Lighting'
	phase_colour	13	0.47%	0	0.00%	357	12.84%		'L1', 'L2', 'L3', 'U/K 1ph', 'Unknown'
	premise_id	2773	99.75%	0	0.00%	0	0.00%		'2200042888039', '2200031822786', '2200043022970', '2200042930328', '2200042619672'
	geometry	2777	99.89%	0	0.00%	0	0.00%		

A1.14 Service Point

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
SERVICE POINT	id	2934	100.00%	0	0.00%	0	0.00%		445386752, 343890296, 429097382, 343890284, 144257640
	status	1	0.03%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	1	0.03%	0	0.00%	0	0.00%	'LV'	'LV'
	nominal_voltage_pp	3	0.10%	0	0.00%	0	0.00%	'230', '400', '110'	'230', '400', '110'
	phasing	2	0.07%	0	0.00%	2827	96.35%	'Unknown', 'ABC'	'Unknown', 'ABC'
	geometry	2934	100.00%	0	0.00%	0	0.00%		

A1.15 Substation GM and PM

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
SUBSTATION GM	id	349	98.59%	0	0.00%	0	0.00%		76663886, 275863626, 343890036, 275863610, 445279199
	status	1	0.28%	0	0.00%	0	0.00%	'Existing'	'Existing'
	number	346	97.74%	0	0.00%	0	0.00%		'260465', '261906', '262420', '263220', '352994'
	type	1	0.28%	0	0.00%	0	0.00%	'Grd Mtd Dist. Substation'	'Grd Mtd Dist. Substation'
	geometry	354	100.00%	0	0.00%	0	0.00%		
SUBSTATION PM	id	764	100.00%	0	0.00%	0	0.00%		257575936, 442454276, 19660446, 106732191, 352572905
	status	1	0.13%	0	0.00%	0	0.00%	'Existing'	'Existing'
	number	764	100.00%	0	0.00%	0	0.00%		'261944', '263029', '262403', '263018', '261029'
	type	1	0.13%	0	0.00%	0	0.00%	'Pole Mtd Dist. Substation'	'Pole Mtd Dist. Substation'
	geometry	764	100.00%	0	0.00%	0	0.00%		

A1.16 Tower

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
TOWER	id	84	100.00%	0	0.00%	0	0.00%		434661248, 172099513, 442041924, 437911360, 436639965
	status	1	1.19%	0	0.00%	0	0.00%	'Existing'	'Existing'
	type	1	1.19%	0	0.00%	0	0.00%	'Section'	'Section'
	number	83	98.81%	0	0.00%	0	0.00%		'81J243', '81ZBH42', '81ZBH48', '81J253', '81ZBH50'
	use	1	1.19%	0	0.00%	0	0.00%	'Distribution'	'Distribution'
	network_type	1	1.19%	0	0.00%	0	0.00%	'HV'	'HV'
	nominal_voltage_pp	2	2.38%	0	0.00%	0	0.00%	'132000', '33000'	'132000', '33000'
	Geometry	84	100.00%	0	0.00%	0	0.00%		

A1.17 Keypole

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
KEYPOLE	id	5125	100.00%	0	0.00%	0	0.00%		44359680, 312462343, 94420329, 244987240, 130590054
	status	1	0.02%	0	0.00%	0	0.00%	'Existing'	'Existing'
	usage	2	0.04%	0	0.00%	0	0.00%	'Distribution', 'Service'	'Distribution', 'Service'
	network_type	3	0.06%	0	0.00%	0	0.00%	'MV', 'HV', 'LV'	'MV', 'HV', 'LV'
	nominal_voltage_pp	5	0.10%	0	0.00%	0	0.00%	'11000', '33000', '400', '132000', '230'	'11000', '33000', '400', '132000', '230'
	role_number	4970	96.98%	0	0.00%	83	1.62%		'UNKNOWN', 'UINKNOWN', '26FAA1', '81J243', '81K18'
	support_number	4968	97.72%	41	0.80%	26	0.51%		'UNKNOWN', '81J243', '26FAA1', '26AE34', '81J228'
	pole_type	6	0.12%	3	0.06%	0	0.00%	'Single Pole', 'Single Pole + Stay', 'H Pole', 'Section', 'H Pole + 2 Stays', 'H Pole + 4 Stays'	'Single Pole', 'Single Pole + Stay', 'H Pole', 'Section', 'H Pole + 2 Stays'
	circuit_id	156	3.10%	86	1.68%	0	0.00%		'260220/0027', '260240/0084', '260590/0157', '260220/0024', '260430/0054'
	pole_rwo	417	95.64%	4689	91.49%	0	0.00%		16628813.0, 137146919.0, 343889738.0, 127967140.0, 429096722.0
	tower_rwo	24	100.00%	5101	99.53%	0	0.00%		172099512.0, 62877098.0, 171330677.0, 166246841.0, 166246839.0
	geometry	5123	99.96%	0	0.00%	0	0.00%		

A1.18 Wire

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
WIRE	id	12413	99.69%	0	0.00%	0	0.00%		67091932, 339172739, 269981159, 313093603, 157289981
	status	1	0.01%	0	0.00%	0	0.00%	'Existing'	'Existing'
	network_type	3	0.02%	0	0.00%	0	0.00%	'LV', 'MV', 'HV'	'LV', 'MV', 'HV'
	nominal_voltage_pp	5	0.04%	0	0.00%	0	0.00%	'230', '11000', '400', '33000', '132000'	'230', '11000', '400', '33000', '132000'
	mounting	2	0.02%	0	0.00%	0	0.00%	'Overhead', 'Under Eaves'	'Overhead', 'Under Eaves'
	usage	3	0.02%	0	0.00%	0	0.00%	'Distribution', 'Service', 'Unmetered Service'	'Distribution', 'Service', 'Unmetered Service'
	circuit_id	534	4.67%	1021	8.20%	1987	15.96%		'1/1', '260220/0027', '260240/0084', '260590/0157', '260220/0024'
	bool_wpd_pvc_insulation	2	0.02%	0	0.00%	0	0.00%	0, 1	0, 1
	bool_wpd_capable_3_phase	2	0.02%	0	0.00%	0	0.00%	1, 0	1, 0
	bool_wpd_running_3_phase	2	0.02%	0	0.00%	0	0.00%	1, 0	1, 0
	wpd_design_voltage	5	0.04%	0	0.00%	0	0.00%	'400', '11000', '230', '33000', '132000'	'400', '11000', '230', '33000', '132000'
	bool_wpd_dual_circuit	2	0.02%	0	0.00%	0	0.00%	0, 1	0, 1
	wires_2	1	2.86%	12417	99.72%	0	0.00%	1	1
	specification_description_2	3	8.57%	12417	99.72%	0	0.00%	'1w 16 HDC', '1w 38 HDC', '1w 25 AL AL'	'1w 16 HDC', '1w 38 HDC', '1w 25 AL AL'
	bool_tower_route	2	0.02%	0	0.00%	0	0.00%	0, 1	0, 1
	geometry	12452	100.00%	0	0.00%	0	0.00%		

A1.18 Wire

Table	Attributes	Unique count	Unique ratio	Missing count	Missing ratio	Unknown count	Unknown ratio	Unique values	Top values (top 5)
WIRE	wpd_tower_section_id	149	73.04%	12248	98.36%	0	0.00%		'81J255=81J256=GREEN/RED/GREEN', '81J247=81J248=RED/YELLOW/RED', '81J247=81J248=GREEN/RED/GREEN', '81K1=81K2=BLUE/YELLOW/GREEN', '81K1=81K2=BLUE/BLACK/BLUE'
	from_tower_support	68	33.50%	12249	98.37%	0	0.00%		'81K1', '81J228', '81J247', '81J243', '81K11'
	from_tower_role	69	33.99%	12249	98.37%	0	0.00%		'81J247', '81K1', '81J228', '81K17', '81J250'
	to_tower_support	67	34.01%	12255	98.42%	0	0.00%		'81J248', '81K2', '81J229', '81K23', '81K10'
	bool_normally_energised	2	0.02%	0	0.00%	0	0.00%	1, 0	1, 0
	wires_1	5	0.04%	0	0.00%	0	0.00%	2, 3, 4, 1, 5	2, 3, 4, 1, 5
	specification_description_1	167	1.34%	0	0.00%	2845	22.85%		'2w SV Unknown from Unattributed', '3w 25 HDC', '2w 25 HDC', '4w 120 ABC', '3w 0.15 HDC'
	wires_2	1	2.86%	12417	99.72%	0	0.00%	1	1
	specification_description_2	3	8.57%	12417	99.72%	0	0.00%	'1w 16 HDC', '1w 38 HDC', '1w 25 AL AL'	'1w 16 HDC', '1w 38 HDC', '1w 25 AL AL'
	bool_tower_route	2	0.02%	0	0.00%	0	0.00%	0, 1	0, 1
	geometry	12452	100.00%	0	0.00%	0	0.00%		

Appendix 2: QGIS Mapping Symbology

QGIS Mapping Symbology

Aims to be close to the symbology used in WPD DataPortal2 but adapted for the data we have and the limitations of data exploration using QGIS. Base map is OS Open Zoomstack (Light style).

Conductor Voltage

Black = Earth

Maroon = Unmetered Service (110V or 230V)

Light Blue = 230V

Blue = 400V

Red = 11kV

Lime Green = 33kV

Fuchsia = 132kV

Conductor Type

Solid = Wire (OH)

Dashed or Dotted = Cable (UG)

Thin solid = Connector Segment

Markers

Green triangle = Protection Equipment

Black circle outline = Pole

Black octagon outline = Keypole

Diamond = Service Point or Service Connection (with MPAN)

Lime green square = Isolating equipment (normal status = closed)

Red cross = Isolating equipment (normal status = open)

Olive circle = Connector point

Light blue rectangle = Conduit

Green polygon = Substation (GM) (with substation number)

Purple circle (large) = Substation (PM) (with substation number)

Dark Red octagon = Cabinet (with cabinet number)

Green circle (large) = Power Transformer

Black star = UPRN location (with UPRN ID)