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Mapping Risk on the Trunk Road Network to support Scotland's Road Safety Framework to 2030

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Principal GIS Consultant
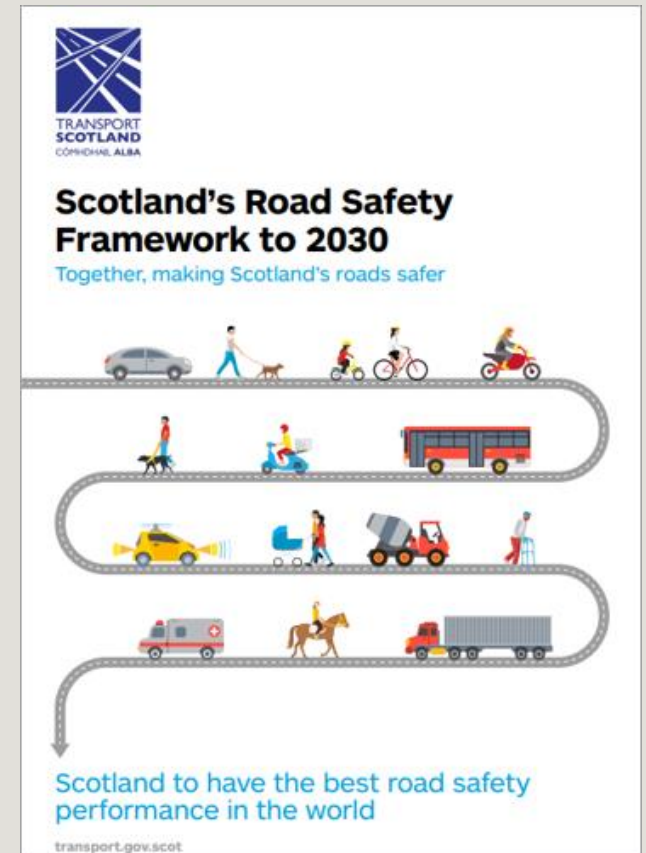
Overview

- Introduction
- Background
- Trunk Road Asset Data
- The Challenges
- The Solution
- The Benefits

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Introduction
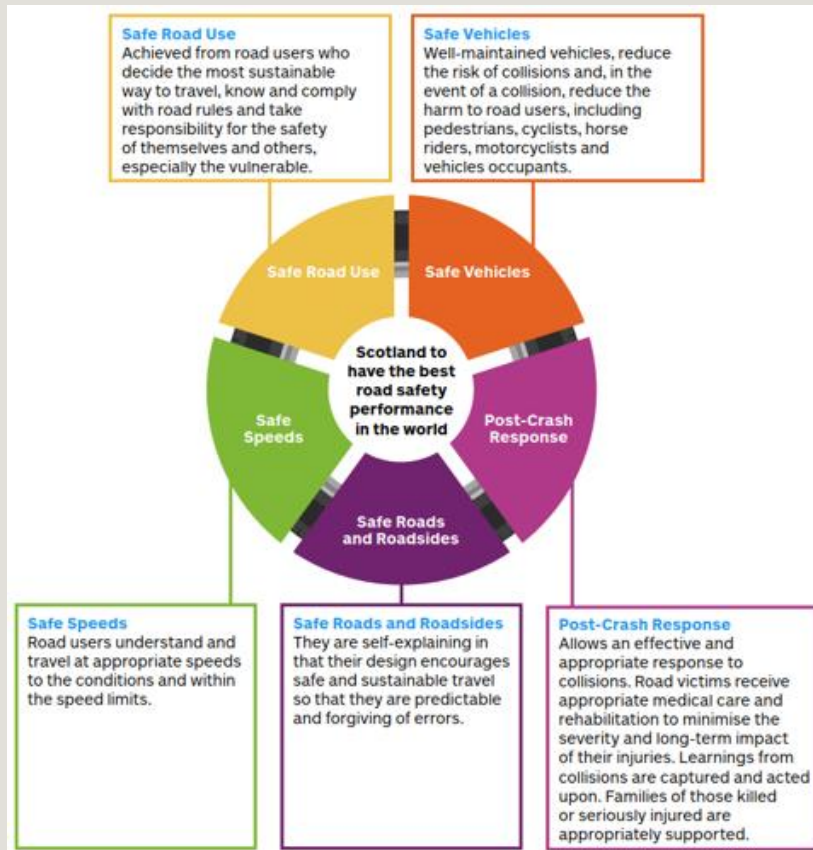## Road Safety Framework to 2030

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Why did Transport Scotland procure a **Route Risk Scoring Tool**?

- Scotland's **Road Safety Framework to 2030**

  - ✓ Scotland to have the best road safety performance in the world by 2030

  - ✓ Reduce the number of people killed or seriously injured on our roads by 2030 by 50%

  - ✓ An ambitious and compelling long-term goal for road safety where no-one dies or is seriously injured by 2050

- Develop **a system that identifies risk**, rather than collision clusters

- Provide **a comparison of risk** across network sections

- Have **a proactive approach** to reducing road traffic casualties

- Target **sections of higher risk** to prioritise **mitigation measures**

TRANSPORT SCOTLAND
CÒMHDHAIL ALBA

Scotland's Road Safety Framework to 2030
Together, making Scotland's roads safer

Scotland to have the best road safety performance in the world

transport.gov.scot

Introduction
Vision Zero and Safe System approach

Safe Road Use
Achieved from road users who decide the most sustainable way to travel, know and comply with road rules and take responsibility for the safety of themselves and others, especially the vulnerable.

Safe Vehicles
Well-maintained vehicles, reduce the risk of collisions and, in the event of a collision, reduce the harm to road users, including pedestrians, cyclists, horse riders, motorcyclists and vehicles occupants.

Safe Speeds
Road users understand and travel at appropriate speeds to the conditions and within the speed limits.

Safe Roads and Roadsides
They are self-explaining in that their design encourages safe and sustainable travel so that they are predictable and forgiving of errors.

Post-Crash Response
Allows an effective and appropriate response to collisions. Road victims receive appropriate medical care and rehabilitation to minimise the severity and long-term impact of their injuries. Learnings from collisions are captured and acted upon. Families of those killed or seriously injured are appropriately supported.

Scotland's **Road Safety Framework to 2030**

- Targets are ambitious, but they are based on **Vision Zero**

- Concept implemented in Sweden in the 1990's and now adopted throughout Europe and further afield

- Works on the basic assumption that it is unacceptable for anyone to be killed or seriously injured on our roads

- Vision Zero follows a **Safe System** approach – i.e., road safety is the responsibility of everyone

- There are **five pillars** to the Safe System approach

- This tool helps address **Safe Road & Roadsides**

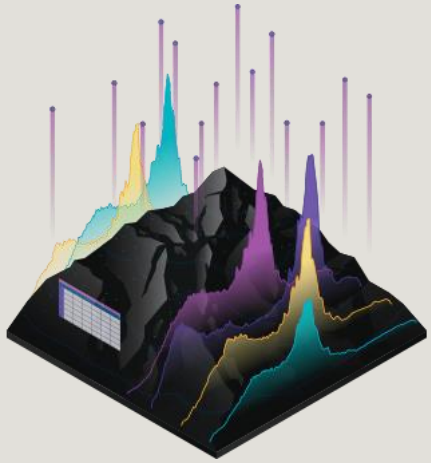# Background
What is GIS?

Main concepts

- A **Geographic Information System (GIS)** is a system that creates, manages, analyses, and maps all types of data

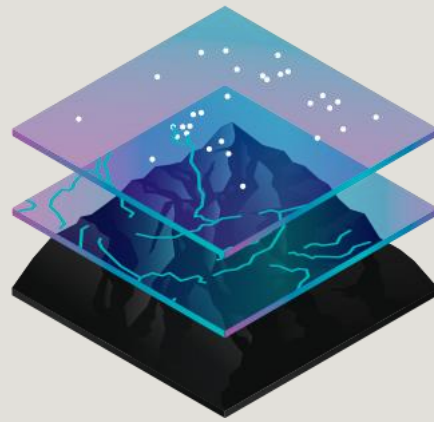- A GIS connects data to a map, integrating location data with all types of descriptive information
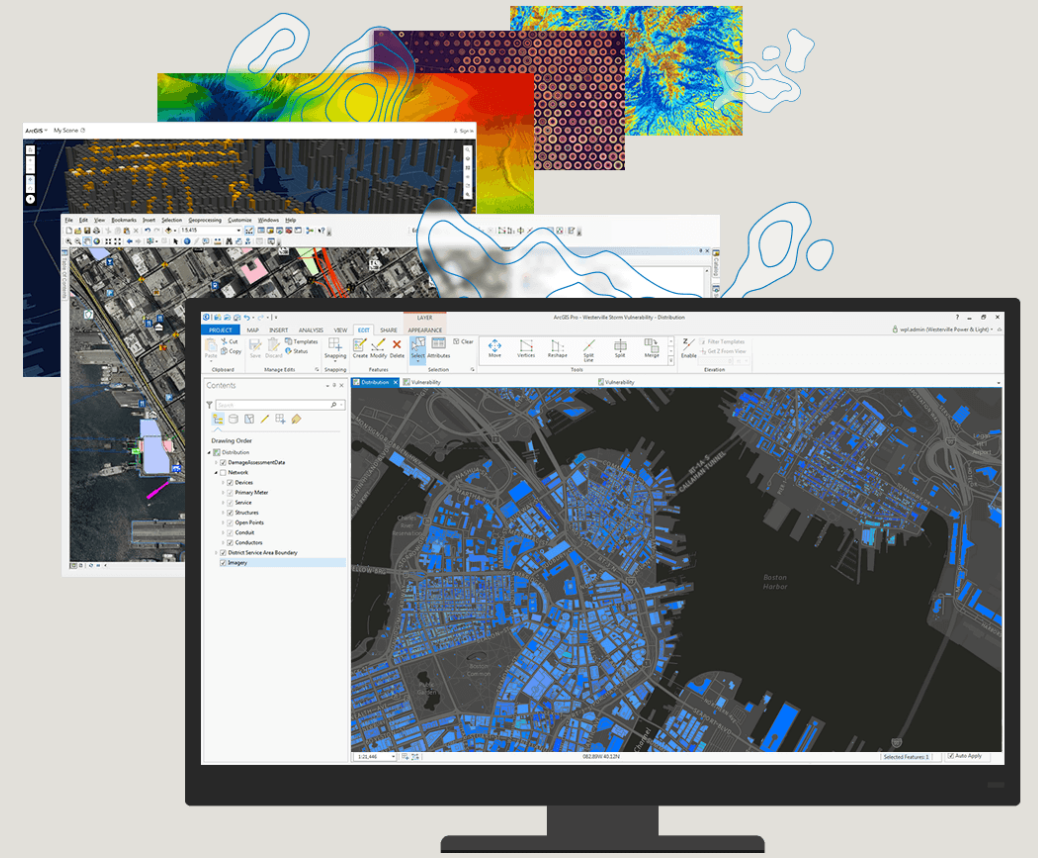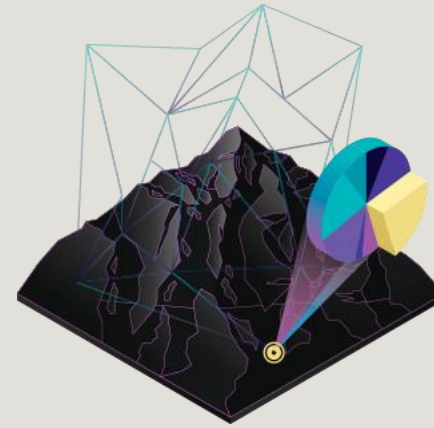
Background
What is GIS?

Data

Different kinds of data layers with or without a geographic component

Maps

The geographic container for the data layers and analytics users work with

Analysis

Enables users to evaluate suitability and capability, estimate and predict, interpret and understand, and much more

Apps

Focused user experiences for getting work done on mobile phones, tablets, in web browsers, and on desktops

Background
What is GIS?

The Route Risk Scoring GIS solution was developed using

- the **ArcGIS System** for data management, geoprocessing and spatial analysis, risk modelling and automation, and mapping and visualisations

- **FME** for advanced spatial ETL (Extract, Transform and Load) workflows

Trunk Road Asset Data
Integrated Road Information System

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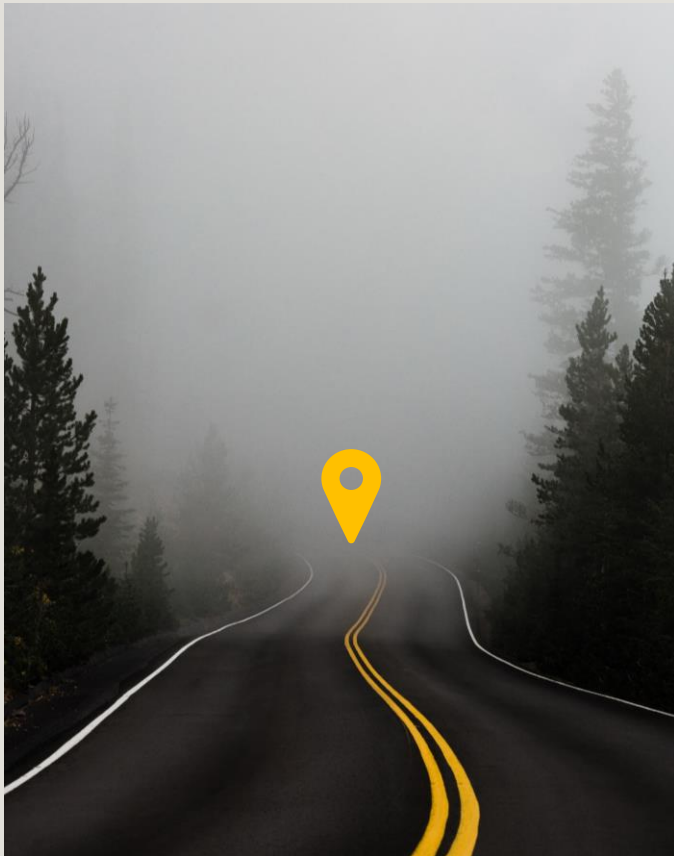|		
✓ Trunk Road Network links & sections	✓ Safety barriers	✓ Road markings
✓ Speed limit extents	✓ Traffic signs	✓ Road Condition Surveys
✓ Traffic flows	✓ Lighting columns	✓ Wind Speed
✓ Collisions	✓ Trees and stretches of woodland	✓ Elevation

The Challenges
## Towards the Route Risk Scoring System

- Limited **international examples** of route scoring systems

- **Availability, accuracy and consistency** of Transport Scotland's trunk road asset data

- Identification of **predominant road characteristics** that may increase the risk of accident or the severity of an accident were it to occur

- Development of a GIS that enables and empowers users to easily

  - ✓ **update** the information used

  - ✓ **calculate** the route risk scores

  - ✓ **visualise** the outputs

  - ✓ **interrogate** the information and make informed decisions

The Solution
Overview of the Route Risk Scoring GIS

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Development of the **Route Risk Scoring GIS**

- Integrates assets and features of the Scottish Trunk Road Network into a central ArcGIS **Geodatabase**

- Runs the **Route Risk Scoring Model**, a bespoke, multi-criteria analysis model within ArcGIS to calculate the required Risk Score and Key Performance Indicators (KPIs) per section

- Maps and visualises location-based analytics through the **Route Risk Scoring Dashboard**, an interactive, cloud-based ArcGIS Dashboard on ArcGIS Online

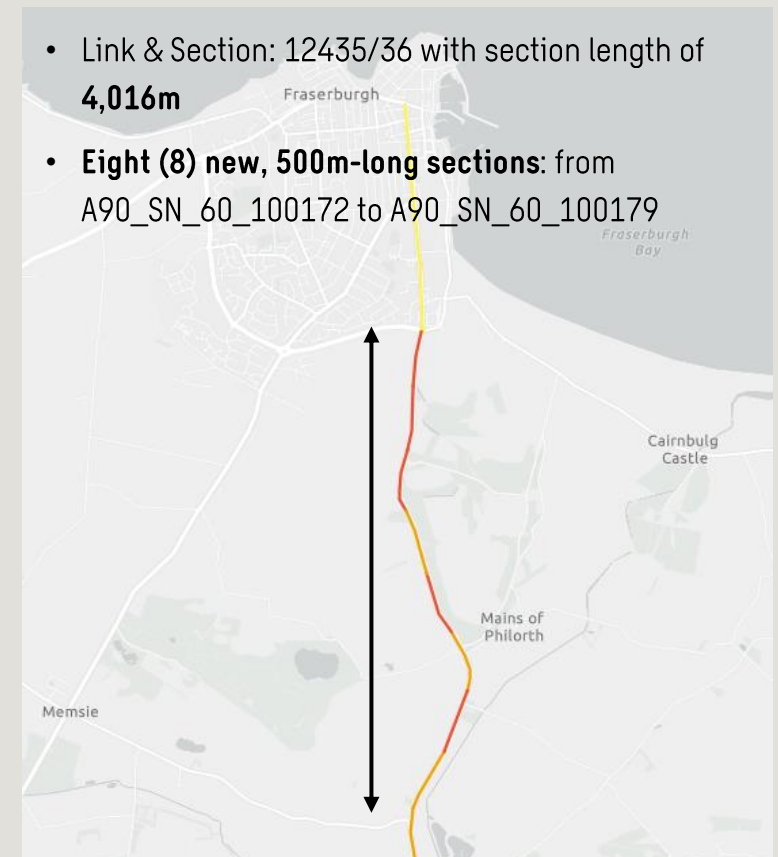| Data	Model	Dashboard

Route Risk Scoring GIS
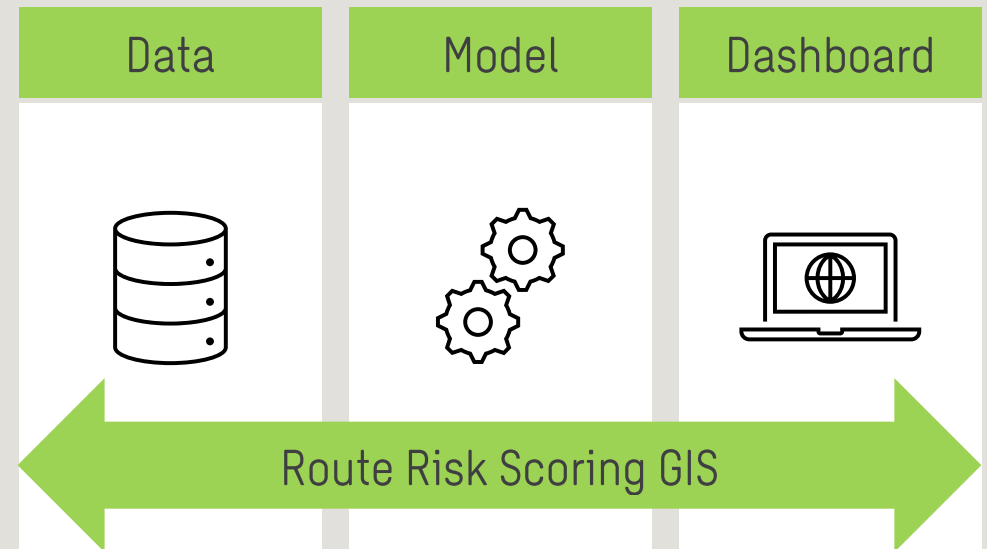
The Solution
The Route Risk Scoring Model

Split of the existing Links & Sections to **new, uniform, 500m-long sections** with **common characteristics** across the Scottish Trunk Road Network

- **Carriageway type**, i.e., singe carriageway, dual carriageway, slip road, roundabout

- **Speed limit**, e.g., 70mph

- **Length**

10,197 new, 500m-long sections	**4,702.8km** of total road section length

- Link & Section: 12435/36 with section length of **4,016m**

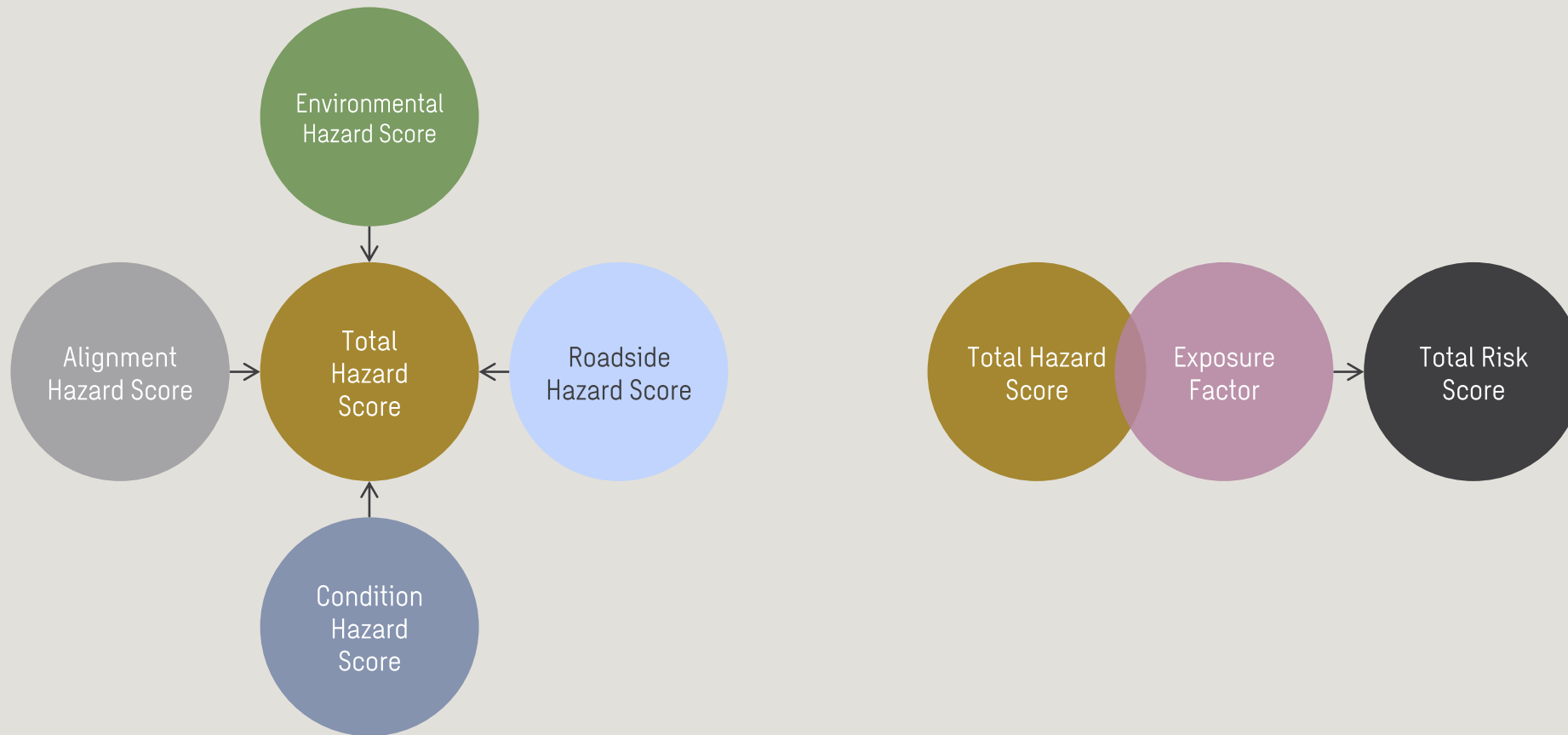- **Eight (8) new, 500m-long sections**: from A90_SN_60_100172 to A90_SN_60_100179

The Solution
The Route Risk Scoring Model

(1) Alignment Hazard Score	(2) Environmental Hazard Score	(3) Roadside Hazard Score	(4) Conditional Hazard Score
(1) Approaches to Crossings	(7) Distance to Coastline	(11) Lighting Columns	(17) Road Markings
(2) Approaches to Junctions and Roundabouts	(8) Elevation	(12) Other Hazards	(18) Rutting
(3) Carriageway Width	(9) Microclimate	(13) Safety Fences	(19) SCRIM*
(4) SCRIM* Investigatory Level	(10) Wind Speed	(14) Traffic Signs	(20) Texture
(5) Sinuosity		(15) Trees	
(6) Speed Limit		(16) Woodland	

* SCRIM stands for Sideway-force Coefficient Routine Investigation Machine and is used to measure wet skidding resistance on road surfaces

The Solution
The Route Risk Scoring Model

Environmental Hazard Score

Alignment Hazard Score

Total Hazard Score

Roadside Hazard Score

Condition Hazard Score

Total Hazard Score

Exposure Factor

Total Risk Score

The Solution
The Route Risk Scoring Model

Analytic Hierarchy Process (AHP) - Weights

- Each Hazard Factor and Score was assigned an individual weight after the application of the AHP, with the total sum of the weights being 100

- Each Hazard Factor was then normalised, with its maximum value being the weight assigned during the AHP, and the theoretical maximum value of the Total Hazard Score being 100

The Solution
The Route Risk Scoring Model

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Collision Rates

1	All Accidents (i.e., Personal Injury Collisions) Rate

4	Accidents where Vehicle hit Verge Object Rate

7	Cyclist Casualties Rate

2	Accidents recorded on Wet Road Surface Rate

5	Fatal Weighted Injuries Rate

8	Pedestrian Casualties Rate

3	Accidents recorded in Darkness Rate

6	Power Two-Wheeler Casualties Rate

9	Killed or Seriously Injured Rate

The Solution
System Architecture

Desktop GIS level

- ArcGIS File Geodatabase and other GIS-compatible files

- ArcGIS Desktop (incl. ModelBuilder)

- FME Desktop

Web GIS level

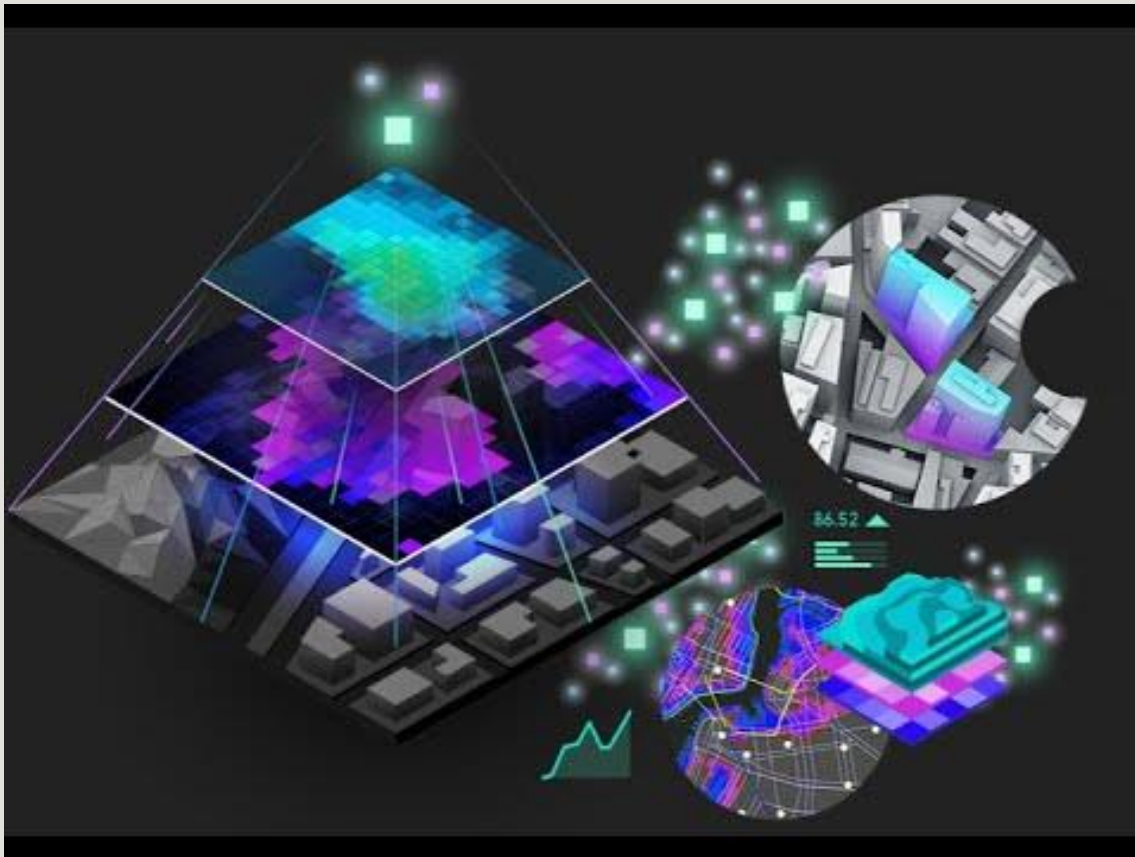- ArcGIS Online (incl. ArcGIS Dashboards)

End Users level

- Web

- Desktop

- Mobile device

The Solution
Geoprocessing & Spatial Analysis

Custom GIS tools were developed with ArcGIS and FME as part of the Route Risk Scoring Model using Geoprocessing and Spatial Analysis workflows for

- Data ingestion tasks

- Analysing the Hazard Factors against the 500m sections (Proximity, Overlay and Surface analyses)

- Calculating the Hazard Scores, Total Risk Score and Collision Rates
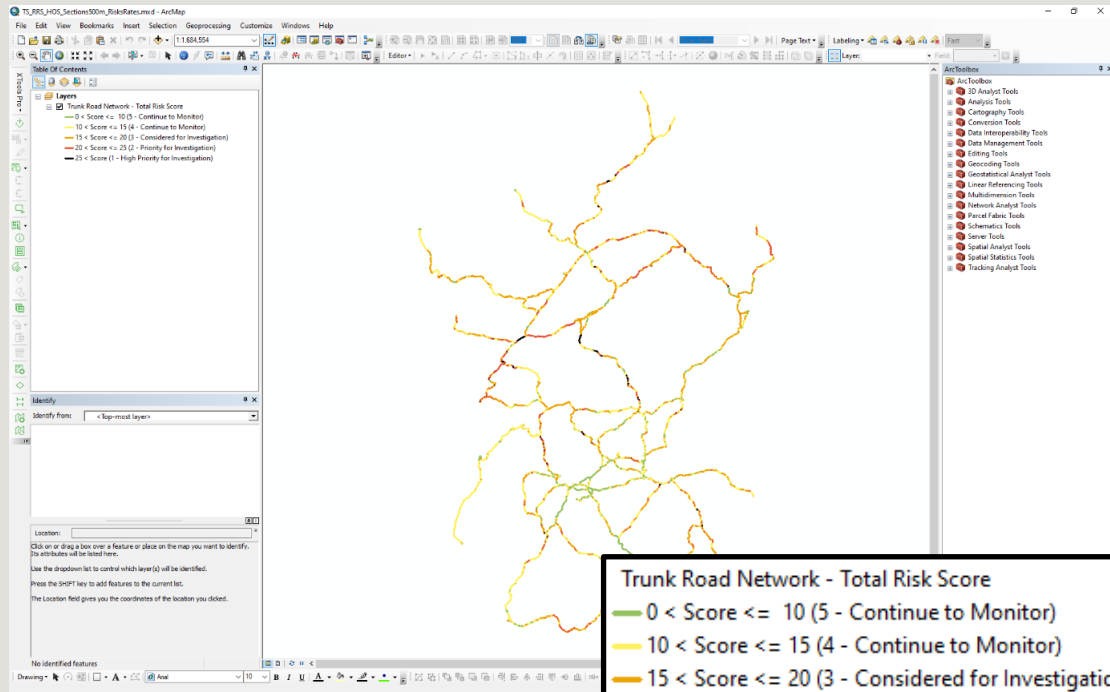
Route Risk Scoring Model

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Custom GIS tools

The Solution
Map Outputs

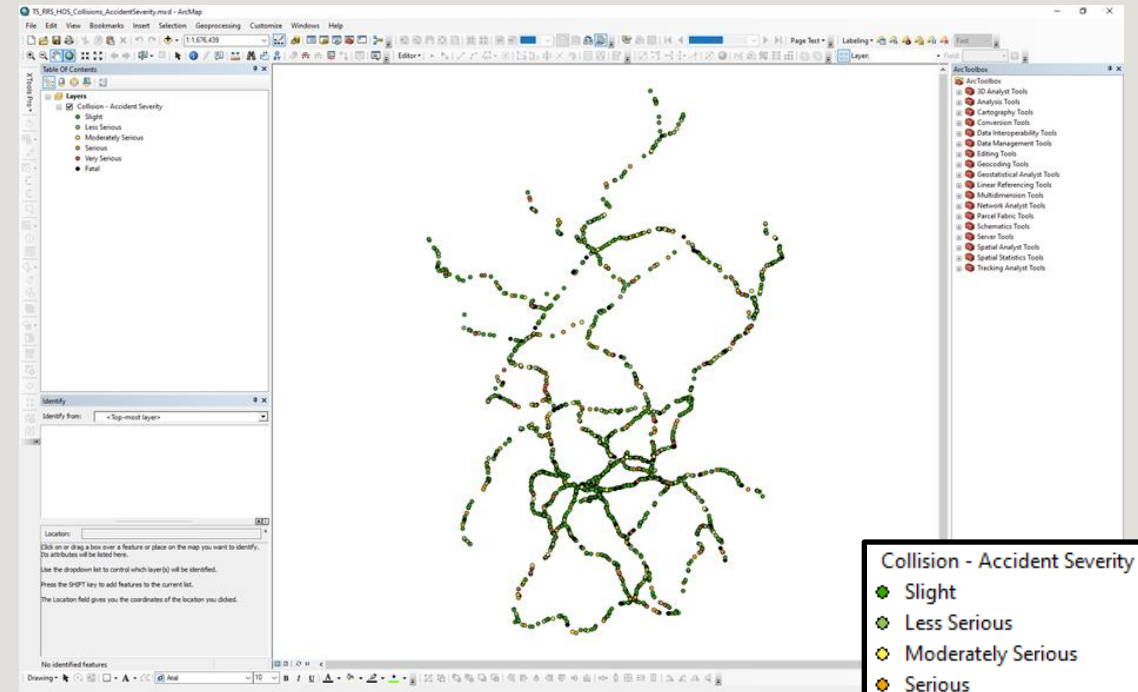Total Risk Score across the Scottish Trunk Road Network

Collision Locations across the Scottish Trunk Road Network

Trunk Road Network - Total Risk Score
- 0 < Score <= 10 (5 - Continue to Monitor)
- 10 < Score <= 15 (4 - Continue to Monitor)
- 15 < Score <= 20 (3 - Considered for Investigation)
- 20 < Score <= 25 (2 - Priority for Investigation)
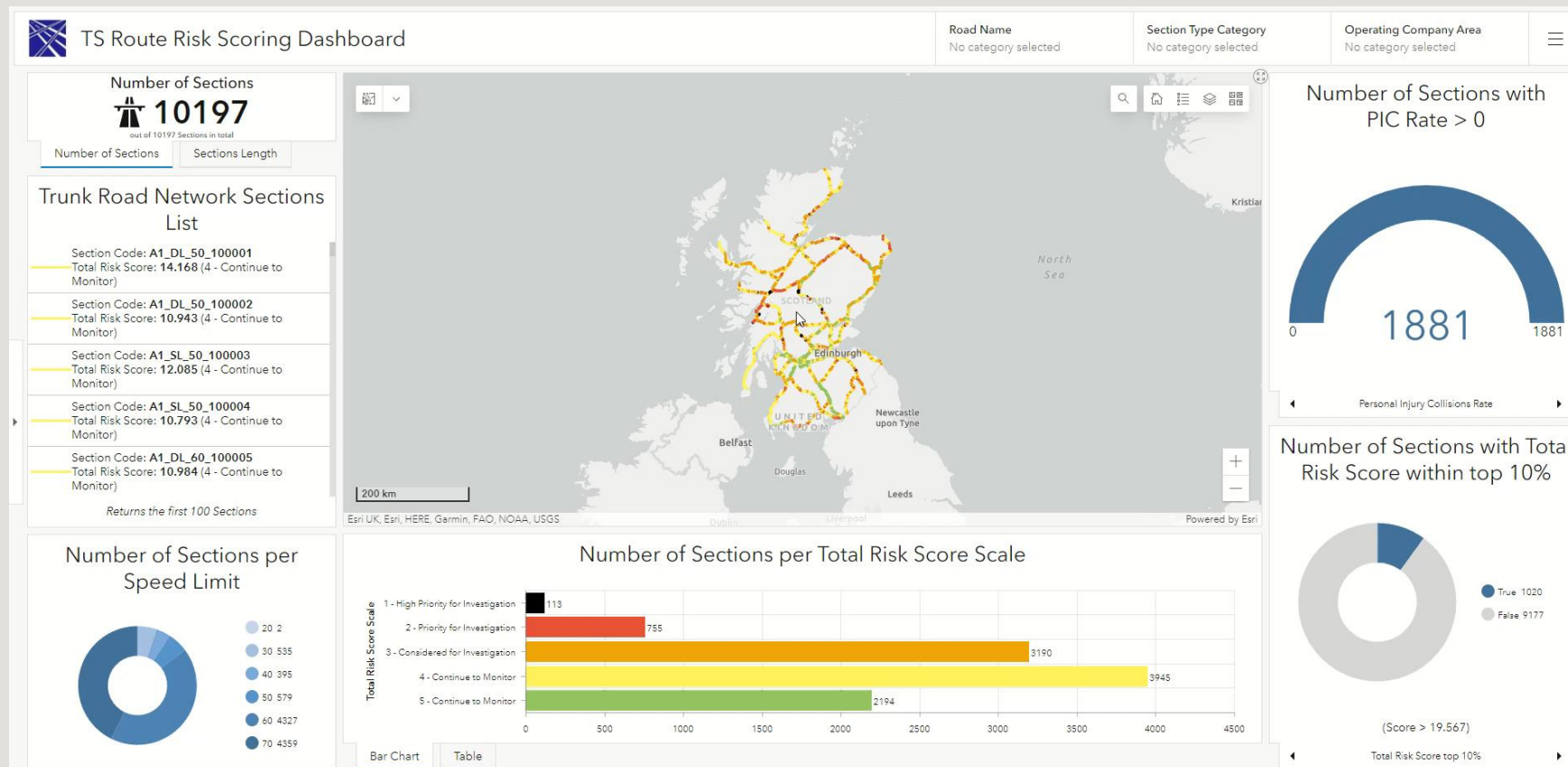- 25 < Score (1 - High Priority for Investigation)

Collision - Accident Severity
- Slight
- Less Serious
- Moderately Serious
- Serious
- Very Serious
- Fatal

The Solution
Route Risk Scoring Dashboard

The Solution
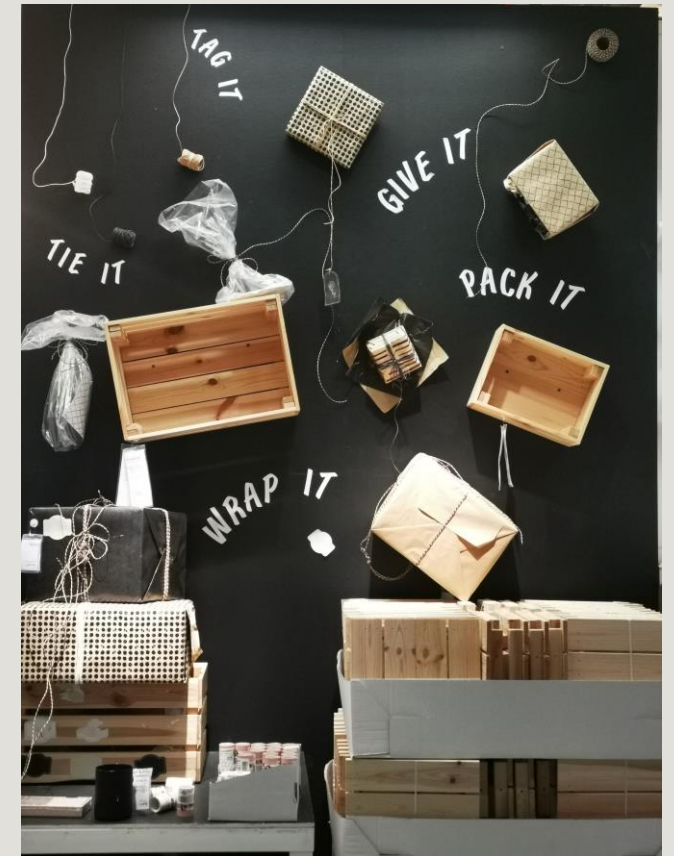## Delivery to Transport Scotland

Desktop GIS deliverables

- Data

- Map documents

- Custom tools

Web GIS deliverables

- Hosted feature layers and views

- Web map

- Dashboard

URL parameters have enhanced the Dashboard by providing the Operating Companies with access to their areas of interest only

The Benefits
Key Takeaways

- The central Geodatabase provides a **single source of truth** for the data used as part of the Route Risk Scoring System

- The custom GIS tools **ensure accuracy** in performing the required spatial analysis and geoprocessing tasks, while they **create efficiencies** by minimising the time required to run the processes

- The Dashboard provides a **dynamic, data-driven view of geographic information**, designed to display multiple visualisations that work together on a single screen, offering a comprehensive view of the data and providing **key insights** for an **at-a-glance decision-making**

- Sweco has enabled Transport Scotland to **proactively identify risk** along Scotland's trunk road network and **prioritise mitigations measures**

- Sweco has **successfully leveraged the ArcGIS technology** that Transport Scotland has access to, by creating an innovative, bespoke technical solution that **improves their return on investment** and **adds value to their assets data inventory**

Thank you

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