

Greater Manchester Accessibility Levels (GMAL) Model

Overview


Greater Manchester Accessibility Levels (GMAL) are a detailed and accurate measure of the accessibility of a point to both the conventional public transport network (i.e. bus, metrolink and rail) and Greater Manchester's Local Link (flexible transport service), taking into account walk access time and service availability. The method is essentially a way of measuring the density of the public transport provision at any location within the Greater Manchester region.

The GMAL methodology is derived from the Public Transport Accessibility Level (PTAL) approach developed by the London Borough of Hammersmith and Fulham, but modified to consider flexible transport service provision (Local Link) and to reflect local service provision levels (different accessibility levels) within Greater Manchester.

The GMAL measure reflects:

- Walking time from the point-of interest to the public transport access points;
- The number of services (bus, Metrolink and Rail) available within the catchment;
- The level of service at the public transport access points - i.e. average waiting time; and
- The operating areas of Local Link (flexible transport) services

It does not consider:

- The speed or utility of accessible services¹;  Crowding, including the ability to board services; or,
- Ease of interchange.

Walk times are calculated from specified point(s) of interest to all public transport access points: bus stops, rail stations and Metrolink stations within pre-defined catchments. The GMAL then incorporates a measure of service frequency by calculating an average waiting time based on the frequency of services at each public transport access point. A reliability factor is added and the total access time is calculated. A measure known as an Equivalent Doorstep Frequency is then produced for each point. These are summed for all routes within the catchment and the values for the bus, Metrolink and rail are then added to give a single value. If the specified point of interest (i.e. Postcode) is located within a local link service area a value of 2.5 is added to the overall combined public transport index score.

¹ Journey times to key centre in Greater Manchester, based on Accession contours, are provided in the interactive bus mapping tool.

The accessibility index score is categorized into eight levels, 1 to 8, where level 8 represents a high level of accessibility and level 1 a low level of accessibility.

Components of the Greater Manchester Accessibility Level Model

The process can be broken down into a series of stages:

- Defining the point of interest (POI);
- Calculate the walk access times from the POI to the service access points (SAPs);
- Identify valid routes at each SAP and calculate average wait time;
- For each valid route at the SAPs calculate the minimum total access time;
- Convert total access times to the Equivalent Doorstop Frequencies - to compare the benefits offered by routes at different distances;
- Sum all EDFs with a weighting factor in favour of the most dominant route for each mode;
- Addition of 2.5 to the overall index score, if the POI is located within a Local Link operating area; and
- Application of eight banded accessibility levels.

Define the Points of Interest (POI)

The exact location of a POI will have a considerable bearing on the final accessibility index score and subsequent level. The proximity of the local public transport services will vary from point to point. If the GMAL is being calculated for a large development, for example a new supermarket, a number of points may be required to reflect different GMAL across the area. Accessibility index scores and levels have been generated for all postcode centroids in Greater Manchester, as well as the centroids of a 100 metre square grid system covering the Greater Manchester region.

Calculate the walk access times

Public transport access points

There are around 13,000 public transport network stops or access points within the Greater Manchester region. The location of public transport access points is based on data published by Transport for Greater Manchester in GTFS format. The Local Link (flexible transport service) operating areas have been provided by TfGM's Customised Transport Planning department.

Walk access times

Walk access times are measured from the POI to the conventional public transport SAPs based on the crow flies distance (straight line distance). The distances between the POI and the SAPs are converted to a measure of time using an assumed a walk speed of 4.8 kph (3 mph), which has been fractionally adjusted for crow flies optimism². A number of parameters define the extent of the walk catchment area. For buses the maximum walk time is defined as 8 minutes or a distance of 640 metres. For rail and Metrolink services the maximum walking time is defined as being 12 minutes or a walking distance of 960 metres. Any SAPs beyond these specified distances are rejected. This analysis does not currently take into account the nature of the urban environment on walk access times (i.e.

gradients and permitted walking routes).

Identify Valid Bus, Metrolink and Rail Routes/Services

Routes are identified for each valid SAP:

- The routes will depend on the time period chosen. Default service frequency data is selected for the morning peak period, specifically the maximum number of hourly departures between 07:00hrs and 10:00hrs;
- For each POI route information is only considered once. Where a route occurs twice or more - because it serves more than one SAP within the POI catchment area - the SAP that is nearest to the POI is used;
- At any SAP, routes will normally be bi-directional. In the accessibility model it is only the direction with the highest frequency that is considered; and
- For train services only those routes with at least 2 stops within the Greater Manchester boundary (i.e. the origin stop and at least one other station) are considered.

Bus and Metrolink frequency data is derived from public transport schedule data for all bus and Metrolink tram services within the Greater Manchester boundary published in General Transit Feed Specification (GTFS) format: [GM Public Transport Schedules – GTFS and TXC datasets - data.gov.uk](#). GTFS is an open standard for publishing public transport information defining a common format for data such as stop locations, route information, trips, stop times and service calendars and exceptions. This feed is updated nightly giving a reliable, accurate and up-to-date source of information for calculating GMALs.

The rail frequency data for Northern Rail, TransPennine Express, Arriva Trains Wales and East Midlands trains is compiled from automatic station passenger counts, supplied by directly from the train operating companies. Additional calling patterns for Virgin Trains

² Design Manual For Road and Bridges (Section 11.5.3), specifies a walking speed of 5kph (3.1mph)

and Arriva Cross Country services were compiled through consulting the individual operator's published timetables.

GMAL calculation for a single point of interest

Calculating Total Access Time (TAT)

Total access time is made up of a combination of factors: combining the walk time from the POI to the SAP and the time spent waiting at the SAP for the desired service to arrive.

$$\text{Total Access Time} = \text{Walk Time} + \text{Average Waiting Time}$$

Average Waiting Time (AWT)

Waiting time is the average time between when a passenger arrives at a stop or station, and the arrival of the desired service. In the calculation process passengers are assumed to arrive at the SAP at random.

For each selected route the scheduled waiting time (SWT) is calculated. This is estimated as half the headway (i.e. the interval between services,) so $\text{SWT} = 0.5 * (60/\text{Frequency})$. Thus a 10 minute service frequency (6 buses per hour) would give an SWT of 5 - on average a passenger would have to wait 5 minutes for a bus/train to appear.

To derive the Average Waiting Time, reliability factors (RF) are applied to the SWT according to the mode of transport used. The regularity of buses, metrolink and rail services are affected by a variety of factors, with bus services the worst affected. To allow for reliability additional wait times assumed are 2 minutes for buses and 0.75 minutes for rail/Metrolink services. These factors will be updated with Automatic Vehicle Location (AVL) bus performance statistics when available.

Calculating Equivalent Doorstep Frequency (EDF)

The access time is converted to an Equivalent Doorstep Frequency where:

$$\text{EDF} = 30/\text{Total Access Time (minutes)}$$

This treats access time as a notional Average Waiting Time as though the route was available at the "doorstep" of the selected POI.

Calculating the AM Peak Accessibility Index (AI) for the POI

Summation of all EDF values for a POI gives the accessibility index. There are a number of additional factors that should be considered:

- Routes often travel in parallel for some distance so the range and frequency of destinations are likely to be less than that suggested by the number of routes included in the calculation; and
- Travellers often have to change routes in order to reach the desired destination - this can add significant delays to the journey.

Halving the EDF values for all but the most accessible or dominant route for each transport mode compensates for these factors. Transport modes are divided into three groups:

- Buses;
- Metrolink; and
- Rail

Thus for a single transport mode the AI (at a single POI) can be calculated using the following formula:

$$AI_{mode} = EDF_{max} + (0.5 * \text{All other EDFs})$$

Calculating the overall accessibility index is a sum of the individual AIs over all modes and the addition of 2.5 to the index score if the POI is located within a local link operating area (LL). :

$$AI_{poi} = \Sigma(AI_{mode1} + AI_{mode2} + \dots AI_{mode n}) + LL$$

Accessibility Levels

The final formula given above calculates the Greater Manchester Accessibility Index (GMAI). Each POI index score is allocated to an accessibility level where Level 1 represents the lowest level of accessibility and 8 the highest level of accessibility. The table below shows the relationship between GMAI scores and the final GMAL.

Accessibility Level	Range of Index Scores	Description	Map Colour
1	0 , <=0.5	Very Low	
2	>0.5 , <=2.5		
3	>2.5 , <=5.0		
4	>5.0 , <=7.5		
5	>7.5 , <=12.5		
6	>12.5 , <=17.5		

7	>17.5 , <=25.0		
8	>25	Very High	

List of Abbreviations

AWT	Average Waiting Time
EDF	Equivalent Doorstep Frequency
POI	Point-of-Interest - the point for which the PTAL is being calculated. This can be an individual point or a grid of point.
GMAI	Greater Manchester Accessibility Indices (inc. Local Link)
GMAL	Greater Manchester Accessibility Levels (inc. Local Link)
RF	Reliability Factor
SAP	Service Access Point - bus stops, Metrolink stations and rail stations. Points at which people have access to the public transport network.
SWT	Scheduled Waiting Time
TAT	Total Access Time