



# Gibraltar Monitoring Regime Assessment

2010-2014

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Report for Gibraltar Environmental Agency

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## Executive summary

The Air Quality Directive and 4<sup>th</sup> Daughter Directive establish a coherent framework under which the limit values (LVs) or target values (TVs) regulating ambient air pollutants are set within Europe. Under *Article 5* of the Air Quality Directive and *Article 4* of the 4<sup>th</sup> Daughter Directive, a requirement is placed upon Member States to undertake an investigation of ambient air quality at least every five years in order to establish estimates for the overall distribution and levels of pollutants and to identify monitoring requirements in line with the guidance provided by the Directives. In accordance with *Article 5* paragraph 2 of the Air Quality Directive, this document provides the second such review of pollutant levels and distribution since the original preliminary assessment was conducted in 2003. The review is based on the high quality monitoring data from the established network of fixed automatic monitoring stations as defined by the original assessment.

This review has utilised relevant measurements from Gibraltar's high quality, fixed monitoring network and these measurements have been compared with appropriate Upper and Lower Assessment Thresholds (UAT and LAT) and Long Term Objectives (LTO) presented in the relevant Directives. Exceedance of these values dictates the requirement for fixed monitoring. The results of the assessment are summarised in Table E1 below.

**Table E1 Summary of established monitoring requirements**

Pollutant	Assessment Threshold Status	Formal requirement for fixed continuous monitoring	Recommendation for fixed continuous monitoring	Comments
NO <sub>2</sub>	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
PM <sub>10</sub>	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
PM <sub>2.5</sub>	LAT-UAT	Yes	Yes	PM <sub>2.5</sub> considered to be most relevant size fraction from exposure/epidemiology perspective and for comparison against Limit Value (Stage 1 and 2). Need to achieve prescribed ratio of PM <sub>10</sub> to PM <sub>2.5</sub>
SO <sub>2</sub>	<LAT	No	Yes	Retain as useful indication of shipping emissions and to inform future monitoring regime assessments. Will demonstrate AQ impact of new power station at North Mole
CO	<LAT	No	Yes	Retain as useful indicator of traffic emissions (NO <sub>x</sub> , NO <sub>2</sub> and PM <sub>10</sub> , PM <sub>2.5</sub> ) and to inform future monitoring regime assessments
Benzene	<LAT	No	Yes	Retain as useful indicator of traffic emissions (NO <sub>x</sub> , NO <sub>2</sub> and PM <sub>10</sub> , PM <sub>2.5</sub> ) and to inform future monitoring regime assessments
O <sub>3</sub>	>LTO	Yes	Yes	Current monitoring satisfies Directive requirements
Arsenic	<LAT	No	Yes	No formal requirement but available as bi-product of mandatory nickel monitoring.
Cadmium	<LAT	No	Yes	No formal requirement but available as bi-product of mandatory nickel monitoring.
Nickel	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
Lead	<LAT	No	Yes	No formal requirement but available as bi-product of mandatory nickel monitoring.
BaP	<LAT	No	Yes	Retain to inform future monitoring regime assessments

This assessment shows that the current network of ambient air pollution monitoring stations in Gibraltar is compliant with the criteria specified in the Air Quality Directive and 4<sup>th</sup> Daughter Directive going forward.

We recommend the continuation of fixed monitoring for pollutants currently in place for local Government policy support, abatement strategy assessment and for scientific justification and analysis. Although these are not required for formal compliance with the Directives in all cases, they provide information essential to comprehensive and robust action planning and reporting to the Commission.

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# 1 Introduction

EU Council Directive 96/62/EC, (commonly known as The Framework Directive<sup>1</sup>), and subsequent 'Daughter Directives'<sup>2,3,4</sup> have established a coherent framework under which the limit values or target values regulating specified ambient air pollutants are set within Europe. More recently these Directives (excepting the fourth daughter Directive) have been revised and consolidated into a single Directive, known as the Air Quality Directive<sup>5</sup>.

Under Article 5 of Framework Directive, a requirement had been placed upon Member States to undertake a preliminary investigation of ambient air quality prior to the implementation of subsequent Daughter Directives setting limit values referred to in Article 4 of the Framework Directive. This was undertaken in 2003<sup>6</sup> to inform upon the commissioning of the Gibraltar Air Quality Network by establishing estimates for the overall distribution and levels of pollutants and to identify monitoring requirements in line with the guidance provided by the daughter Directives.

In accordance with Article 5 paragraph 2 of the Air Quality Directive, this document provides the second review of pollutant levels and distribution since the original preliminary assessment was conducted in 2003 and is based on the high quality monitoring data from the established network of fixed automatic monitoring stations as defined by the original assessment.

## 1.1 Scope of this report

The preliminary assessment undertaken prior to the establishment of the Gibraltar Air Quality Network shaped the network in terms of monitoring locations, numbers of monitors and the pollutants monitored.

In light of the measurements resulting from the Gibraltar Air Quality Network as it was originally defined, this document makes recommendations on the current and future composition of the monitoring network to ensure that the Gibraltar Environmental Agency and Government of Gibraltar can remain confident in the quality and compliance of the network. The review is focused on assessing the network relative to the requirements for minimum compliance with the Directives.

In some cases there may no longer be a formal requirement to maintain fixed monitoring based on recent measured concentrations from the existing network. However, there may still be valid scientific and policy support reasons to retain the measurements, for example to preserve a long-term data record, demonstrate continuing improvements in air quality (related to monitoring the success of implemented measures as part of an Air Quality Plan) or to provide defensible and robust support for policy decisions/ source apportionment analysis.

## 1.2 General Approach

Our approach to the assessment of air quality regulated by the Air Quality and 4<sup>th</sup> daughter Directives has been to utilise relevant measurements from Gibraltar's high quality, fixed monitoring network that was not available to support the original preliminary assessment. A data capture threshold of 75% has been applied in the calculation of relevant metrics to ensure that values have been used that are representative of the entire year. These measurements (i.e. the number of hours, number of days or annual mean exceeding) have been compared with appropriate Upper and Lower Assessment Thresholds (UAT and LAT) and Long-term Objectives (LTO) presented in the relevant Directives to determine an assessment threshold status for each pollutant. The LAT and UAT for pollutants covered by the Air Quality Directive are based on the LV for the respective pollutant with the exception of ozone, for which monitoring is assessed against the LTO. The LAT and UAT for pollutants covered by

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1 The Framework Directive – Council Directive 96/62/EC of 27 September 1996 on ambient air quality and assessment.

2 1<sup>st</sup> Daughter Directive - Council Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air

3 2<sup>nd</sup> Daughter Directive - Council Directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air.

4 3<sup>rd</sup> Daughter Directive – Council Directive 2002/3/EC relating to ozone in ambient air.

5 Directive 2008/50/EC of the European Parliament and of the council of 21 May 2008 on ambient air quality and cleaner air for Europe

6 Bush, T. et al. (2003) Preliminary Assessment of air quality in Gibraltar (report: netcen/ED50212/Issue1 to the Gibraltar Environmental Agency)

the 4<sup>th</sup> Daughter Directive are based on the Target Value (TV) for the respective pollutant. The pollutants assessed in this review are presented in Table 1.1, below.

**Table 1.1 Pollutant assessment thresholds and criteria**

Pollutant	Metric	LAT	UAT	Directive reference for assessment threshold/criteria
NO <sub>2</sub>	Hourly *	100 µg m <sup>-3</sup>	140 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
	Annual	26 µg m <sup>-3</sup>	32 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
PM <sub>10</sub>	Daily **	25 µg m <sup>-3</sup>	35 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
	Annual	20 µg m <sup>-3</sup>	28 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
PM <sub>2.5</sub>	Annual	12 µg m <sup>-3</sup>	17 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
SO <sub>2</sub>	Daily	50 µg m <sup>-3</sup>	75 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
CO	Daily max 8-hr	5 µg m <sup>-3</sup>	7 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
Benzene	Annual	2 µg m <sup>-3</sup>	3.5 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
Ozone	Daily max 8-hr	LTO: 120 µg m <sup>-3</sup>		Air Quality Directive (Annex VII, Section C)
Arsenic	Annual	2.4 ng m <sup>-3</sup>	3.6 ng m <sup>-3</sup>	4 <sup>th</sup> daughter Directive (Annex II)
Cadmium	Annual	2 ng m <sup>-3</sup>	3 ng m <sup>-3</sup>	4 <sup>th</sup> daughter Directive (Annex II)
Lead	Annual	0.25 µg m <sup>-3</sup>	0.35 µg m <sup>-3</sup>	Air Quality Directive (Annex II)
Nickel	Annual	10 ng m <sup>-3</sup>	14 ng m <sup>-3</sup>	4 <sup>th</sup> daughter Directive (Annex II)
BaP	Annual	0.4 ng m <sup>-3</sup>	0.6 ng m <sup>-3</sup>	4 <sup>th</sup> daughter Directive (Annex II)

\* 18 exceedances permissible

\*\* 35 exceedances permissible

### 1.2.1 Fixed continuous monitoring requirement

The need for fixed continuous monitoring is determined by the assessment threshold status for each pollutant (i.e. below LAT, above UAT or between LAT and UAT). Guidance on the number of fixed monitoring stations required for minimum compliance is provided in the relevant Directive(s) and incorporates reference to the population of the zones and agglomerations being assessed.

Pollutants classified as above the LAT for three or more of the five years<sup>7</sup> of the assessment period require fixed continuous monitoring.

There is a minimum requirement for fixed continuous monitoring but this can be supplemented with alternative information such as modelling in order to reduce the monitoring burden as long as the minimum monitoring requirements are met. Gibraltar's geographical scale and population (two significant criteria of the Directive) mean that even in cases where the zone is classified as above the UAT for a pollutant, the required monitoring is no more than the minimum. In effect, the implications for monitoring requirement of being classified as above the UAT and between the LAT and UAT are the same – i.e. the minimum monitoring specified by the Directive is required and so there is no advantage to being able to use supplementary forms of assessment such as modelling to reduce the monitoring requirement.

Where pollutants are classified as below the LAT for three or more years of the assessment period, there is no formal requirement according to the Directives to have fixed continuous monitoring, although there may be compelling reasons for this other than the legislative requirement (as discussed in Section 4).

<sup>7</sup> Air Quality Directive Annex II, part B

## 1.3 Gibraltar air quality monitoring network

### 1.3.1 Fixed continuous monitoring

Three fixed automatic monitoring stations exist within the network and are illustrated in Figure 1-1. These are:

1. Rosia Road (GB0050A)
2. Bleak House (GB0051A)
3. Witham's Road (GB0951A)

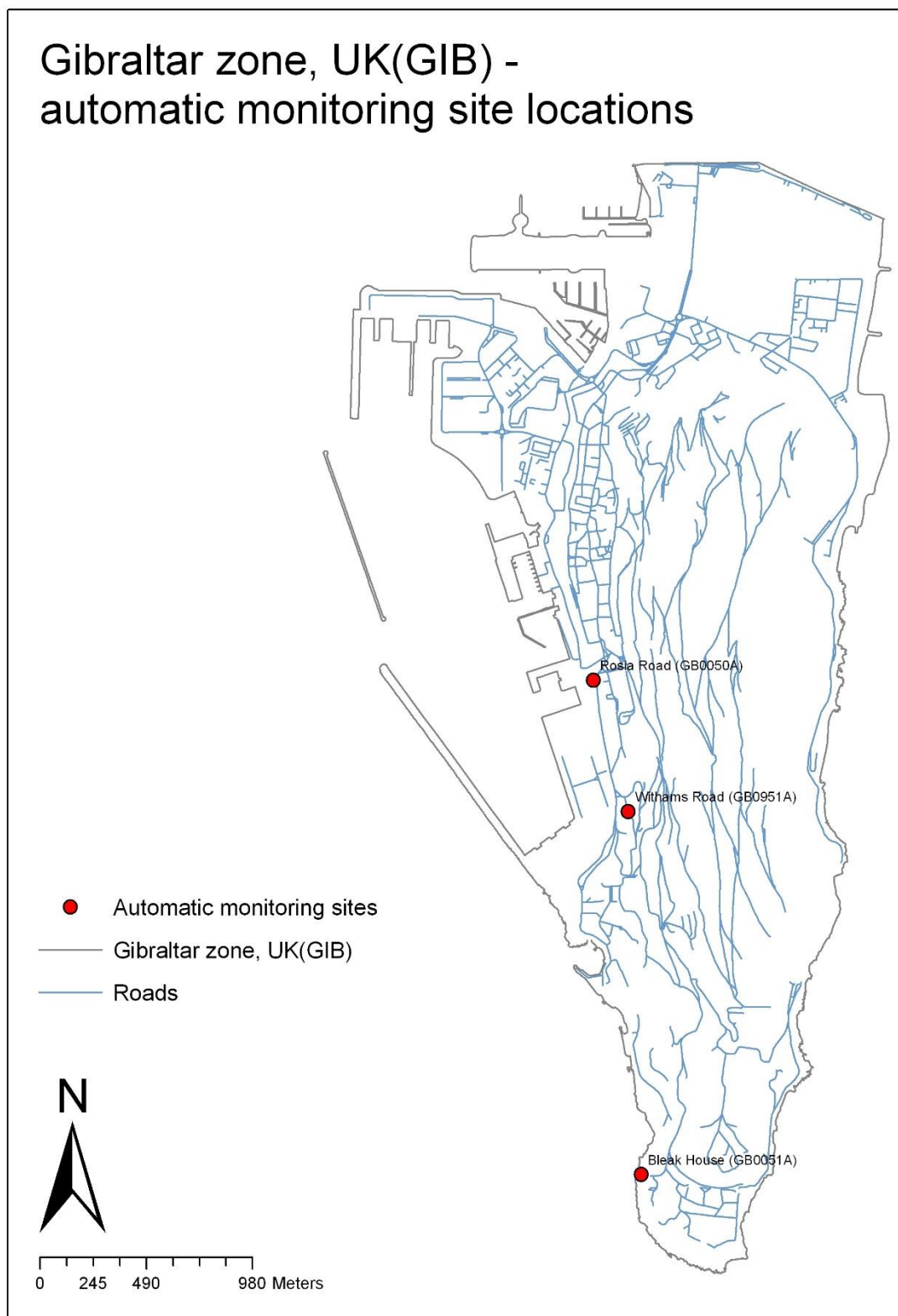
Rosia Road is the principal monitoring station and is located in a roadside environment. Here a full suite of Air Quality and 4<sup>th</sup> Daughter Directive pollutants are measured - NO<sub>x</sub>, NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, benzene, arsenic (As), cadmium (Cd), lead (Pb), nickel (Ni) and Benzo[a]Pyrene (BaP).

Bleak House is an urban background monitoring location and measures PM<sub>10</sub>, ozone, NO<sub>x</sub> and NO<sub>2</sub>.

Witham's Road measures only NO<sub>x</sub> and NO<sub>2</sub> and was established in 2008 following successively high indicative monitoring results (by diffusive sampler) and a modelling assessment that suggested this location was a pollution hotspot driven by emissions from the OESCO and MOD power stations. Though Witham's Road is officially classed as a roadside site under criteria specified in the Directives (i.e. it is within 5 metres of the kerb), the traffic count on this small road is exceptionally low and is not thought to contribute significantly to measured concentrations.



Figure 1-1 Map of fixed automatic monitoring locations in Gibraltar

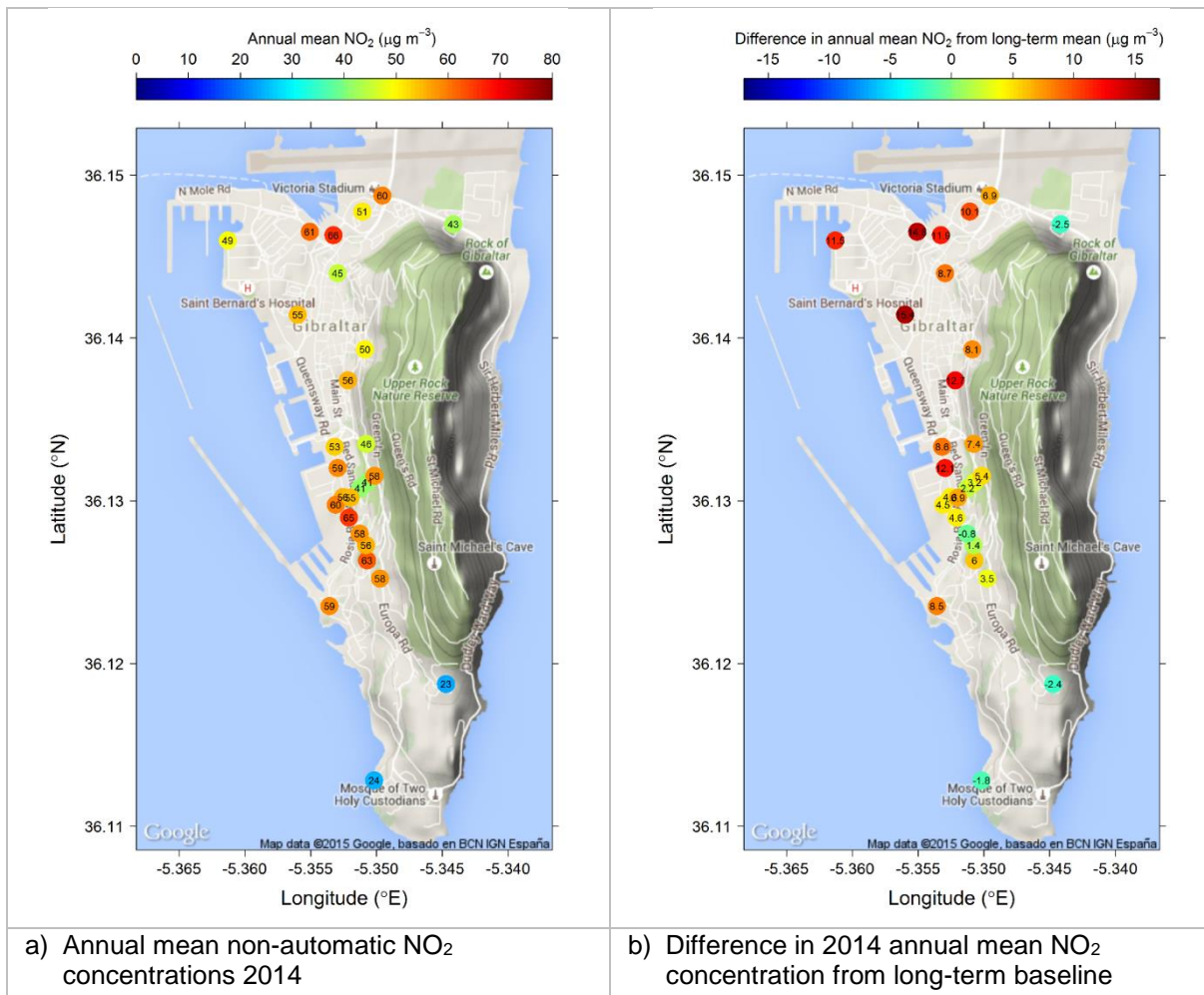


### 1.3.2 Indicative monitoring by diffusive sampler

In addition to the fixed automatic monitoring sites in Gibraltar established to satisfy Directive requirements as identified in the original preliminary assessment, an indicative passive sampler monitoring campaign to measure NO<sub>2</sub> and benzene, toluene, ethyl-benzene and xylene (BTEX) by Palmes diffusion tube has been established in Gibraltar. Though less accurate than automatic monitoring (hence its indicative status), these samplers are distributed more widely across Gibraltar and provide better spatial representation of concentrations.

These diffusion tubes have been considered as part of the exercise to determine whether sources relevant to the outcome of the compliance assessment are being adequately represented with the existing fixed monitoring network. Diffusion tubes do not meet the strict measurement criteria specified by the Directive so these non-automatic concentrations cannot be directly compared with the defined assessment thresholds. However they can be used to inform expert judgement on the presence of sources at distance from fixed monitoring within the compliance network.

The only pollutants that this passive sampler data could inform upon are NO<sub>2</sub> and benzene, both of which are independently (based on automatic measurements) recommended for continued fixed monitoring in the future.



**Figure 2 Annual mean NO<sub>2</sub> diffusion tube time series plot**

Figure 2a shows the non-automatic NO<sub>2</sub> concentrations in 2014 and Figure 2b shows a general upward trend relative to the baseline (all years averaged), particularly in the vicinity of the North Mole. While this data is temporally too coarse to meaningfully link with meteorological data to help identify a source and it is hard to discern the relative contribution from roadside sources, it is likely that temporary power generators installed from 2013 onwards are contributing to this upward trend. Given

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the ephemeral nature of this source and the fact that there is already an Air Quality Plan<sup>8</sup> in place for its abatement, it is not recommended that an additional fixed monitoring station be established solely to capture the impact of this source for compliance assessment purposes. Such additional monitoring would not affect the compliance status of the zone or provide additional information to inform abatement strategies. This decision should be reviewed if measurements from the fixed monitoring network subsequently demonstrate compliance where the non-automatic measurements still comprehensively suggest exceedance in some areas (i.e. they suggest that new fixed monitoring would change the compliance status of the zone).

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<sup>8</sup> Gibraltar Air Quality Plan [https://www.gibraltar.gov.gi/new/sites/default/files/HMGoG\\_Documents/REF\\_NO2\\_1%20\(1\).pdf](https://www.gibraltar.gov.gi/new/sites/default/files/HMGoG_Documents/REF_NO2_1%20(1).pdf)

## 2 Air Quality Directive Pollutants

### 2.1 Nitrogen dioxide

The comparatively small spatial extent of Gibraltar (approximately 6.25 km<sup>2</sup>) and the presence of point sources means that there are no defined vegetation or ecosystem protection areas relevant to the Directives. This means that the NO<sub>x</sub> annual mean metric is not relevant for the compliance of Gibraltar's monitoring network.

The hourly LAT for NO<sub>2</sub> is defined as 50% of the hourly Limit Value (LV) (i.e. 100 µg m<sup>-3</sup>). The hourly UAT for NO<sub>2</sub> is defined as 70% of the hourly LV (i.e. 140 µg m<sup>-3</sup>). The Directive states there are 18 permissible exceedances for these metrics per year. Calculated exceedances for LAT and UAT for NO<sub>2</sub> in Gibraltar are presented in Table 2.1.

**Table 2.1 Calculated exceedances of hourly LAT and UAT for NO<sub>2</sub> in Gibraltar (2010-2014)**

Year	Rosia Road			Bleak House			Witham's Road			Assessment Threshold status
	Data capture %	Hours above LAT	Hours above UAT	Data capture %	Hours above LAT	Hours above UAT	Data capture %	Hours above LAT	Hours above UAT	
2010	97	314	19	98	22	0	97	647	8	ABOVE UAT
2011	85	248	18	85	17	0	94	606	21	ABOVE UAT
2012	99	221	2	76	5	0	98	708	12	LAT-UAT
2013	88	222	12	83	9	0	95	364	6	LAT-UAT
2014	94	417	27	98	6	0	95	324	12	ABOVE UAT

The annual LAT for NO<sub>2</sub> is defined as 65% of the annual LV (i.e. 26 µg m<sup>-3</sup>). The annual UAT for NO<sub>2</sub> is defined as 80% of the annual LV (32 µg m<sup>-3</sup>). Calculated annual means for NO<sub>2</sub> in Gibraltar are presented in Table 2.2.

**Table 2.2 Calculated exceedances of annual LAT and UAT for NO<sub>2</sub> in Gibraltar (2010-2014)**

Year	Rosia Road		Bleak House		Witham's Road		Assessment Threshold status
	Data capture %	Annual mean (µg m <sup>-3</sup> )	Data capture %	Annual mean (µg m <sup>-3</sup> )	Data capture %	Annual mean (µg m <sup>-3</sup> )	
2010	97	48.1	98	25.6	97	54.7	ABOVE UAT
2011	85	48.8	85	27	94	56.2	ABOVE UAT
2012	99	45.5	76	27.3	98	53.9	ABOVE UAT
2013	88	43.5	83	22.3	95	48.6	ABOVE UAT
2014	94	54.4	98	24.6	95	46.9	ABOVE UAT

All three monitoring sites have data captures in excess of the 75% threshold for each year. The hourly concentrations of NO<sub>2</sub> are above the UAT in 2010, 2011 and 2014, meeting the criteria for exceedance in Annex II part B of the AQD. The annual mean concentrations exceed the UAT in all five years. The Gibraltar zone has been classified as above the UAT for NO<sub>2</sub> and according to Annex V of the AQD this results in a requirement of at least one fixed continuous monitoring station. The current monitoring network therefore meets the Directive requirements and provides additional information on the complex sources of NO<sub>x</sub> at different environment types (background, roadside, industrial).

## 2.2 Particulate matter

The requirement to measure particulate matter prescribed by the AQD does not specifically discern between the different size fractions other than to prescribe

- a network-wide ratio between the size fractions of no more than 2:1 (of the required number of sampling points – sampling in excess of the requirement could deviate from this)
- additional criteria related to PM<sub>2.5</sub> for exposure assessment (as described below).

Annex II of the AQD provides a specific LAT and UAT for annual mean PM<sub>10</sub>, 24-hr PM<sub>10</sub> and annual mean PM<sub>2.5</sub>. Therefore, the requirement for PM monitoring has been based on the most conservative ('worst case') outcome for any of these PM assessment thresholds.

### 2.2.1 PM<sub>10</sub>

The 24-hr LAT for PM<sub>10</sub> is defined as 50% of the 24-hr LV (i.e. 25 µg m<sup>-3</sup>). The 24-hr UAT for PM<sub>10</sub> is defined as 70% of the 24-hr LV (i.e. 35 µg m<sup>-3</sup>). The Directive states there are 35 permissible exceedances for these metrics. Calculated exceedances for LAT and UAT for PM<sub>10</sub> in Gibraltar are presented in Table 2.3.

**Table 2.3 Calculated exceedances of 24-hr mean LAT and UAT for PM<sub>10</sub> in Gibraltar (2010-2014)**

Year	Rosia Road			Bleak House			Assessment Threshold status
	Data capture %	Days above LAT	Days above UAT	Data capture %	Days above LAT	Days above UAT	
2010	95	305	214	90	230	78	ABOVE UAT
2011	88	289	188	97	223	106	ABOVE UAT
2012	90	263	148	89	147	39	ABOVE UAT
2013	83	256	147	93	176	49	ABOVE UAT
2014	82	259	133	93	160	44	ABOVE UAT

The annual LAT for PM<sub>10</sub> is defined as 50% of the annual LV (i.e. 20 µg m<sup>-3</sup>). The annual UAT for PM<sub>10</sub> is defined as 70% of the annual LV (28 µg m<sup>-3</sup>). Calculated annual means for PM<sub>10</sub> in Gibraltar are presented in Table 2.4.

**Table 2.4 Calculated exceedances of annual mean LAT and UAT for PM<sub>10</sub> in Gibraltar (2010-2014)**

Year	Rosia Road		Bleak House		Assessment Threshold status
	Data capture %	Annual mean ( $\mu\text{g m}^{-3}$ )	Data capture %	Annual mean ( $\mu\text{g m}^{-3}$ )	
2010	95	40.6	90	30.6	ABOVE UAT
2011	88	38.3	97	30.3	ABOVE UAT
2012	90	34.3	89	25.5	ABOVE UAT
2013	83	35.6	93	26.7	ABOVE UAT
2014	82	36.3	93	27.7	ABOVE UAT

PM<sub>10</sub> measurements at Rosia Road and Bleak House show exceedances of the annual mean UAT in all five years under assessment.

### 2.2.2 PM<sub>2.5</sub>

The annual LAT for PM<sub>2.5</sub> is defined as 50% of the annual LV (i.e. 12  $\mu\text{g m}^{-3}$ ). The annual UAT for PM<sub>2.5</sub> is defined as 70% of the annual LV (17  $\mu\text{g m}^{-3}$ ). Calculated annual means for PM<sub>2.5</sub> in Gibraltar are presented in Table 2.5.

**Table 2.5 Calculated exceedances of annual mean LAT and UAT for PM<sub>2.5</sub> in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean ( $\mu\text{g m}^{-3}$ )	
2010	94	14.6	LAT-UAT
2011	96	15.8	LAT-UAT
2012	92	15.4	LAT-UAT
2013	75	14.2	LAT-UAT
2014	89	14.8	LAT-UAT

### 2.2.3 PM<sub>2.5</sub> Average Exposure Indicator

Irrespective of the annual mean PM<sub>2.5</sub> LAT and UAT, there are separate requirements set out by the AQD for monitoring PM<sub>2.5</sub>. Article 15 and Annex XIV explain the application of an Average Exposure Indicator (AEI) to a National Exposure Reduction Target (NERT) and an Exposure Concentration Obligation (ECO). The AEI is required to be assessed at urban background locations according to Annex XIV section A. Annex V section B states that a single station is required per million population and additional urban areas in excess of 100,000 population. Gibraltar's population of approximately 30,000 does not meet this criteria. Therefore there is no requirement to monitor PM<sub>2.5</sub> for the purposes of calculating the AEI for assessment against the NERT and ECO.

### 2.2.4 PM monitoring requirements

The most conservative assessment of PM<sub>10</sub> and PM<sub>2.5</sub> across all metrics shows exceedances of the UAT and therefore the requirement to continue fixed monitoring in the zone. Annex V of the AQD shows the requirement for two fixed PM stations. PM<sub>10</sub> is measured by Partisol sampler at both Rosia Road and Bleak House. PM<sub>2.5</sub> is measured by Partisol at Rosia Road only. An additional instrument (TEOM FDMS) located at Rosia Road measures PM<sub>10</sub> – this instrument provides near real time observations to support dissemination of public health information through the Gibraltar Air Quality website (<http://www.gibraltarairquality.gi/>). The TEOM FDMS is not formally used for compliance reporting. The three Partisol samplers that are used for compliance reporting represent an increase of monitoring above the minimum requirement. Therefore the network-wide ratio of PM<sub>10</sub> to PM<sub>2.5</sub>

monitoring is met by the existing monitoring network. It is recommended that Partisol PM<sub>10</sub> monitoring be continued at both Rosia Road and Bleak House (allowing essential background against roadside comparisons) and that Partisol PM<sub>2.5</sub> be continued at Rosia Road, thereby informing on the most harmful component of PM. It is also recommended that PM<sub>10</sub> measurements by the TEOM FDMS continue at Rosia Road to inform the public of changing concentrations on an hourly basis to help them manage their exposure.

## 2.3 Sulphur dioxide

As for NO<sub>x</sub>, there is no requirement for Gibraltar to monitor SO<sub>2</sub> for protection of vegetation as there are no areas defined within Gibraltar according to the Directive criteria. This means that annual mean and annual and winter mean SO<sub>2</sub> metrics are not relevant for the compliance of Gibraltar's monitoring network.

The LAT for SO<sub>2</sub> is defined as 40% of the 24-hr LV (i.e. 50 µg m<sup>-3</sup>). The 24-hr UAT for SO<sub>2</sub> is defined as 60% of the 24-hr LV (i.e. 75 µg m<sup>-3</sup>). The Directive states three permissible exceedances for these metrics. Calculated exceedances for LAT and UAT for SO<sub>2</sub> in Gibraltar are presented in Table 2.6.

**Table 2.6 Calculated exceedances of 24-hr mean LAT and UAT for SO<sub>2</sub> in Gibraltar (2010-2014)**

Year	Rosia Road			Assessment Threshold status
	Data capture %	Days above LAT	Days above UAT	
2010	97	0	0	BELOW LAT
2011	88	0	0	BELOW LAT
2012	90	0	0	BELOW LAT
2013	83	0	0	BELOW LAT
2014	82	0	0	BELOW LAT

Rosia Road is the sole monitoring site for fixed automatic measurements of SO<sub>2</sub>. Table 2.6 shows that the zone is below the LAT for all five years of the assessment.

## 2.4 Carbon monoxide

The LAT and UAT for CO are based on a maximum daily running 8-hour mean concentration with the LAT being 50% of the LV (i.e. 5 mg m<sup>-3</sup>) and the UAT being 70% of the LV (i.e. 7 mg m<sup>-3</sup>). Calculated exceedances for LAT and UAT for CO in Gibraltar are presented in Table 2.7.

**Table 2.7 Calculated exceedances of LAT and UAT for CO in Gibraltar (2010-2014)**

Year	Rosia Road			Assessment Threshold status
	Data capture %	Days above LAT	Days above UAT	
2010	97	0	0	BELOW LAT
2011	88	0	0	BELOW LAT
2012	90	0	0	BELOW LAT
2013	83	0	0	BELOW LAT
2014	82	0	0	BELOW LAT

Rosia Road is the sole monitoring site for fixed automatic measurements of CO. The data in Table 2.7 show that the zone is below the LAT for all five years of the assessment.

## 2.5 Benzene

The LAT and UAT for benzene are based on the annual mean concentration with the LAT being 40% of the LV (i.e.  $2 \mu\text{g m}^{-3}$ ) and the UAT being 70% of the LV (i.e.  $3.5 \mu\text{g m}^{-3}$ ). Calculated exceedances for LAT and UAT for CO in Gibraltar are presented in Table 2.8.

**Table 2.8 Calculated exceedances of LAT and UAT for benzene in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean ( $\mu\text{g m}^{-3}$ )	
2010	94	1.7	BELOW LAT
2011	84	1.8	BELOW LAT
2012	95	1.8	BELOW LAT
2013	74	1.6	LOW DC
2014	86	1.5	BELOW LAT

Rosia Road is the sole monitoring site for fixed automatic measurements of benzene. Data in Table 2.8 shows that the zone is below the LAT for four of the five years of the assessment (one year omitted due to low data capture).

## 2.6 Ozone

Since its entry into force, ozone has been regulated by the Air Quality Directive. Unlike other pollutants there is no specific LAT or UAT for ozone. Instead the need for fixed monitoring is dictated by a single threshold (the Long Term Objective, LTO) for two metrics (one for health and one for vegetation protection), evaluated over 5 years, as stated in Article 9.1 of the Directive. The LTOs (defined in Annex VII, Section C of the Directive) are:

- for human health:  $120 \mu\text{g m}^{-3}$  as the maximum daily 8-hour mean ozone concentration
- for vegetation protection: AOT40 (May to July) of  $6000 \mu\text{g m}^{-3}\cdot\text{h}$

Historical exceedances of the LTOs are shown in Table 2.9 (the health-based LTO) and Table 2.10 (the vegetation-based LTO).

**Table 2.9 Calculated exceedances of LTO (protection of health) for ozone in Gibraltar (2010-2014)**

Year	Bleak House		Assessment Threshold status
	Data capture %	Maximum daily 8-hr mean ( $\mu\text{g m}^{-3}$ )	
2010	97	151	ABOVE LTO
2011	98	133	ABOVE LTO
2012	95	142	ABOVE LTO
2013	98	123	ABOVE LTO
2014	97	122	ABOVE LTO



**Table 2.10 Calculated exceedances of LTO (protection of vegetation) for ozone in Gibraltar (2010-2014)**

Year	Bleak House		Assessment Threshold status
	Data capture %	AOT40 ( $\mu\text{g m}^{-3}\cdot\text{h}$ )	
2010	92	13475	ABOVE LTO
2011	99	11306	ABOVE LTO
2012	96	7963	ABOVE LTO
2013	99	8496	ABOVE LTO
2014	99	7457	ABOVE LTO

Bleak House is the sole monitoring station for ozone in Gibraltar. Both metrics in all five years of the assessment exceeded the LTO indicating a requirement to continue fixed monitoring in the zone.

## 2.7 Lead

The LAT and UAT for lead are based on an annual mean concentration, with the LAT being 50% of the LV (i.e.  $0.25 \mu\text{g m}^{-3}$ ) and the UAT being 70% of the LV (i.e.  $0.35 \mu\text{g m}^{-3}$ ). Calculated exceedances for LAT and UAT for lead in Gibraltar are presented in Table 2.11.

**Table 2.11 Calculated exceedances of LAT and UAT for Pb in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean ( $\mu\text{g m}^{-3}$ )	
2010	99	0.0079	BELOW LAT
2011	91	0.0077	BELOW LAT
2012	99	0.01	BELOW LAT
2013	84	0.008	BELOW LAT
2014	84	0.017	BELOW LAT

Table 2.11 shows that measured concentrations are below the LAT for all five years of the assessment, meaning there is no specific requirement to assess lead by fixed continuous monitoring.

## 2.8 Arsenic

The LAT and UAT for arsenic (As) are based on an annual mean concentration with the LAT being 40% of the TV (i.e.  $2.4 \text{ ng m}^{-3}$ ) and the UAT being 60% of the TV (i.e.  $3.6 \text{ ng m}^{-3}$ ). Calculated exceedances for LAT and UAT for lead in Gibraltar are presented in Table 2.12.

**Table 2.12 Calculated exceedances of LAT and UAT for As in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean ( $\text{ng m}^{-3}$ )	
2010	84	0.97	BELOW LAT
2011	91	0.05	BELOW LAT
2012	99	1.1	BELOW LAT
2013	84	0.83	BELOW LAT
2014	84	0.62	BELOW LAT

Table 2.12 shows that measured concentrations are below the LAT for all five years of the assessment, meaning there is no specific requirement to assess arsenic by fixed continuous monitoring.

## 2.9 Cadmium

The LAT and UAT for cadmium (Cd) are based on an annual mean concentration with the LAT being 40% of the TV (i.e. 2 ng m<sup>-3</sup>) and the UAT being 60% of the TV (i.e. 3 ng m<sup>-3</sup>). Calculated exceedances for LAT and UAT for cadmium in Gibraltar are presented in Table 2.13.

**Table 2.13 Calculated exceedances of LAT and UAT for Cd in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean (ng m <sup>-3</sup> )	
2010	99	0.23	BELOW LAT
2011	91	0.11	BELOW LAT
2012	99	0.25	BELOW LAT
2013	84	0.32	BELOW LAT
2014	84	0.16	BELOW LAT

Table 2.13 shows that measured concentrations are below the LAT for all five years of the assessment, meaning there is no specific requirement to assess cadmium by fixed continuous monitoring.

## 2.10 Nickel

The LAT and UAT for nickel (Ni) are based on an annual mean concentration with the LAT being 50% of the TV (i.e. 10 ng m<sup>-3</sup>) and the UAT being 70% of the TV (i.e. 14 ng m<sup>-3</sup>). Calculated exceedances for LAT and UAT for nickel in Gibraltar are presented in Table 2.14.

**Table 2.14 Calculated exceedances of LAT and UAT for Ni in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean (ng m <sup>-3</sup> )	
2010	84	16	ABOVE UAT
2011	91	11	LAT-UAT
2012	99	24	ABOVE UAT
2013	66	16	LOW DC
2014	77	17	ABOVE UAT

Table 2.14 shows that data capture for 2013 fell below 75% but three of the remaining years show exceedance of the UAT. As a result there is a definitive requirement for continued fixed measurements of nickel in Gibraltar. A continuation of measurements at Rosia Road is therefore recommended.

Modelling studies<sup>9</sup> undertaken on behalf of the Gibraltar Environmental Agency have indicated that fuel-oil and gas-oil combustion by nearby shipping activities is likely to be a significant source of nickel in the area. Further modelling (unpublished) has shown that Spanish sources across the Bay of Gibraltar. (e.g. CEPSA refinery and Acerinox plant) are also likely to be significant contributors to Gibraltar's measured nickel concentrations.

<sup>9</sup> Abbott, J (2009) Contribution from shipping emissions to PM<sub>10</sub> and nickel contents on Gibraltar (AEA Report to Gibraltar Environmental Agency: AEA/ED43072/R2833 Issue 1)

## 2.11 Benzo[a]Pyrene

The LAT and UAT for Benzo[a]Pyrene (BaP) are based on an annual mean concentration with the LAT being 40% of the TV (i.e. 0.4 ng m<sup>-3</sup>) and the UAT being 60% of the TV (i.e. 0.6 ng m<sup>-3</sup>). Calculated exceedances for LAT and UAT for BaP in Gibraltar are presented in Table 2.15.

**Table 2.15 Calculated exceedances of LAT and UAT for BaP in Gibraltar (2010-2014)**

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean (ng m <sup>-3</sup> )	
2010	97	0.091	BELOW LAT
2011	97	0.099	BELOW LAT
2012	97	0.1	BELOW LAT
2013	91	0.083	BELOW LAT
2014	95	0.09	BELOW LAT

Table 2.15 shows that measured concentrations are below the LAT for all five years of the assessment, meaning there is no specific requirement to assess BaP by fixed continuous monitoring.

### 3 Conclusions and recommendations

The status of Gibraltar zone for different pollutants relative to the assessment threshold criteria prescribed in the Directives is summarised in Table 3.1 along with the formal or recommended requirement for monitoring.

**Table 3.1 Summary of monitoring requirements for compliance with Directives**

Pollutant	Assessment Threshold Status	Formal requirement for fixed continuous monitoring	Recommendation for fixed continuous monitoring	Comments
NO <sub>2</sub>	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
PM <sub>10</sub>	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
PM <sub>2.5</sub>	LAT-UAT	Yes	Yes	PM <sub>2.5</sub> considered to be most relevant size fraction from exposure/epidemiology perspective and for comparison against Limit Value (Stage 1 and 2). Need to achieve prescribed ratio of PM <sub>10</sub> to PM <sub>2.5</sub>
SO <sub>2</sub>	<LAT	No	Yes	Retain as useful indication of shipping emissions and to inform future monitoring regime assessments. Will demonstrate AQ impact of new power station at North Mole
CO	<LAT	No	Yes	Retain as useful indicator of traffic emissions (NO <sub>x</sub> , NO <sub>2</sub> and PM <sub>10</sub> , PM <sub>2.5</sub> ) and to inform future monitoring regime assessments
Benzene	<LAT	No	Yes	Retain as useful indicator of traffic emissions (NO <sub>x</sub> , NO <sub>2</sub> and PM <sub>10</sub> , PM <sub>2.5</sub> ) and to inform future monitoring regime assessments
O <sub>3</sub>	>LTO	Yes	Yes	Current monitoring satisfies Directive requirements
Arsenic	<LAT	No	Yes	No formal requirement but available as bi-product of mandatory nickel monitoring.
Cadmium	<LAT	No	Yes	No formal requirement but available as bi-product of mandatory nickel monitoring.
Nickel	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
Lead	<LAT	No	Yes	No formal requirement but available as bi-product of mandatory nickel monitoring.
BaP	<LAT	No	Yes	Retain to inform future monitoring regime assessments

The automatic measured data shows that several pollutants have exceeded the LAT (or LTO in case of ozone) for three or more years over the assessment period and therefore require fixed continuous monitoring. These are NO<sub>2</sub>, PM<sub>10</sub>, ozone and nickel.

The assessment indicates that concentrations of other pollutants over the assessment period are below the LAT for three or more years and therefore future fixed continuous monitoring is not strictly required for compliance. These pollutants are SO<sub>2</sub>, CO, lead, arsenic, cadmium and BaP.

Despite the lack of mandatory requirement to continue measuring these pollutants, there are compelling arguments to retain these instruments in the network:

- **Tracking progress of abatement measures and policy strategy**

Pollutants such as SO<sub>2</sub> and CO are vital components to the network in terms of source apportionment and characterization. For Gibraltar, the need to monitor and demonstrate the success of abatement measures put in place for PM<sub>10</sub> and NO<sub>2</sub> (e.g. for Air Quality Plans reporting), provides an argument to retain some pollutants. For example, measured SO<sub>2</sub> concentrations will demonstrate that a new power station is not causing limit value exceedances when it becomes operational. SO<sub>2</sub> is also associated with fuel combustion by shipping which is known to be a significant source of nickel in the Bay of Gibraltar. Maintaining monitoring for this pollutant in the network may provide useful proxy information for shipping contributions to measured concentrations in the future. CO is a useful proxy for road traffic exhaust emissions and this data can be used to provide context for other associated exhaust emissions (PM<sub>10</sub> and NO<sub>x</sub> and NO<sub>2</sub>) that will require mandatory fixed monitoring.
- **Metals analysis**

Continued fixed monitoring of lead, cadmium and arsenic is not formally required but the requirement for fixed monitoring of nickel concentrations remains. Due to the method of collection (by chemical speciation from a Partisol filter) all heavy metals are obtained in the same process. Therefore, by retaining monitoring for nickel, monitoring for these other heavy metals is effectively retained.
- **Evidence base for future assessment**

Despite the fact that recent historical data illustrates low concentrations of some pollutants, concentrations change continuously over time in relation to meteorology, local and transboundary sources. This is why the requirement to conduct regular Article 5 Assessments exists in the Directives. Retaining fixed monitoring of non-essential pollutants in the network provides a strong evidence base to inform future assessments rather than relying on less reliable evidence from indicative monitoring campaigns (such as passive sampling) or emissions inventories (the detailed information for which Gibraltar may not easily be able to provide).

The Environmental Agency's long term strategy for the monitoring network is determined in collaboration with the Government of Gibraltar. The strategy is continually reviewed in the context of compliance with the Directives, cost-efficiency relative to budgetary considerations and scientific value. Future monitoring, including newly established sites or site moves, are informed by all available information including automatic and non-automatic measurements, expert opinion and by model results where available.

The continuation of fixed monitoring for all pollutants, even those that are not formally required for compliance according to the assessment criteria specified in the Directives has value. Without these measurements there exists little alternative information about these pollutants to inform future requirements for monitoring and compliance (i.e. future Monitoring Regime Assessments). In other Member States there is often a large volume of proxy information related to emissions or a large number of monitoring stations. This information does not exist for Gibraltar, therefore the few monitoring sites that exist are the only source of information on levels of pollutants. Given the lack of alternatives, each site in the Gibraltar Air Quality Monitoring Network can be considered 'critical' in terms of information. There are other reasons to retain monitoring of all pollutants – they provide vital information for policy and abatement strategy assessment and for scientific justification and analysis that underpins other submissions and legislative requirements (such as the time extension applications and associated monitoring). Monitoring is often used to moderate dispersion model studies, either in calibrating the process or by testing the result in a validation exercise, thereby grounding the result in reality (a key component of QA). Given Gibraltar's exceedance status there is a need for as much data as possible to help support policy design, implementation and review over the time extension period and years immediately afterwards.





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