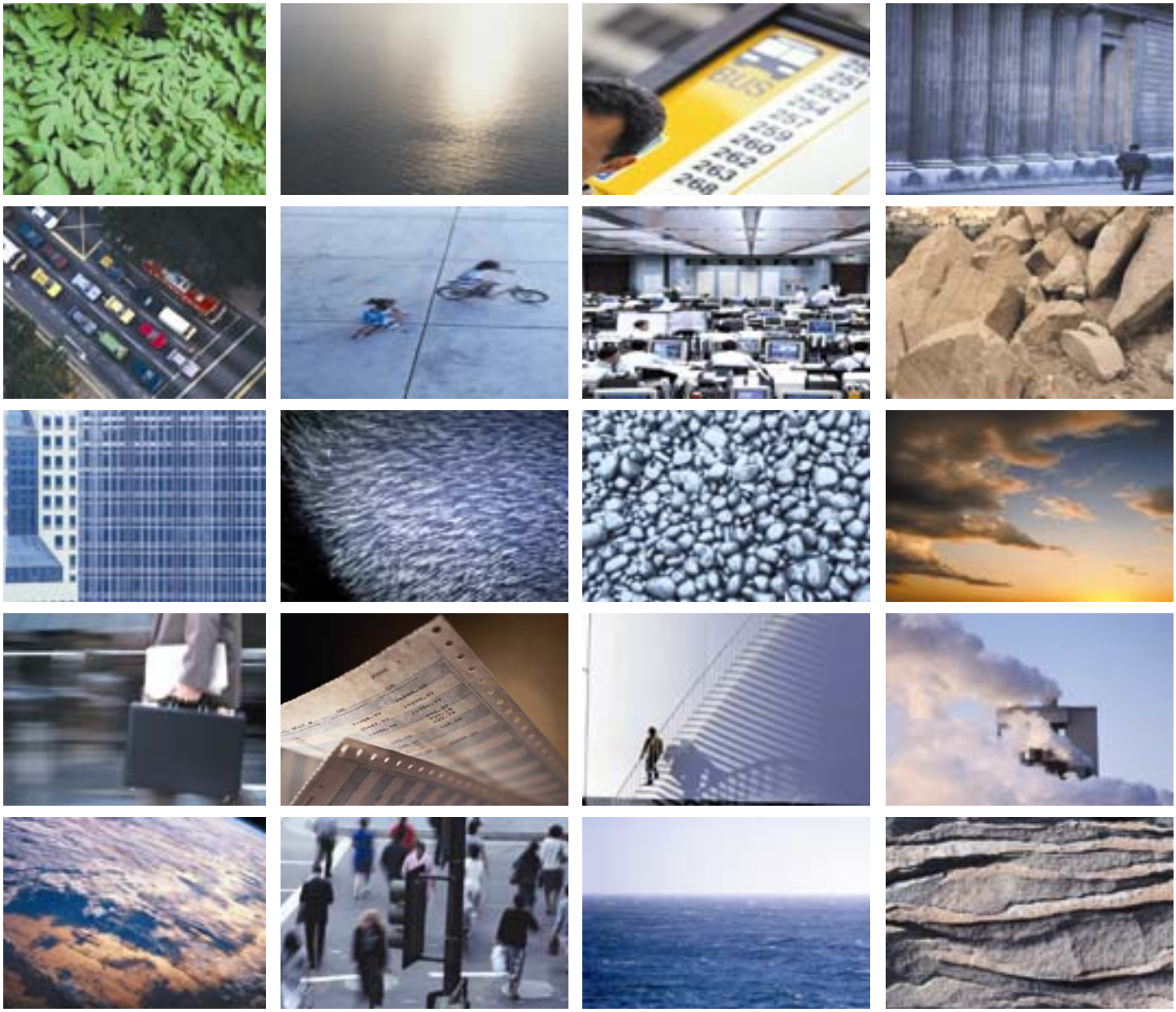
RPA
Railway Procurement Agency

# Metro North

## Baseline Vibration Monitoring Report

December 2008



# Dublin Metro North

**Baseline Vibration Monitoring Report**

FINAL REPORT

November 2008

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RPA

# Dublin Metro North: *Baseline Vibration Monitoring Report*

November 2008

Reference 0047054

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For and on behalf of
Environmental Resources Management

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Signed: 

Position: Technical Director

Date: 24 November 2008



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# 1 INTRODUCTION

ERM is carrying out an assessment of noise and vibration for the Dublin Metro North EIS. This assessment is to include consideration of the effect that vibration may have both on human beings and on vibration-sensitive equipment.

Existing levels of vibration from road traffic and other sources are normally negligible in the urban environment and are not normally noticed by the local population. Vibration impacts from any proposed development are therefore usually assessed by comparing predicted levels to absolute criteria or limits. The baseline is not usually considered. However, in exceptional cases, where receptors are located close to existing, significant sources of vibration, it is appropriate to take into account the effect of baseline vibration when considering the impact of the project. In Dublin, areas where this may be the case include those located close to speed bumps, other traffic calming measures and/or railway lines e.g. at Drumcondra.

RPA has asked ERM to carry out an investigation of baseline vibration levels at a sample number of areas along the proposed alignment in order to determine if significant vibration is present. ERM has reviewed the proposed Metro North alignment and, in consultation with RPA and the scheme engineers, has identified a number of locations that represent the "worst-case scenario" with regards to: (a) sensitivity of receptors and/or (b) potential magnitude of existing vibration levels.

The results of the monitoring exercise are considered in the Metro North EIS. If significant vibration is found to exist, then this is taken into account when devising the assessment criteria for the impact assessment phase of the EIA.

# 2 METHODOLOGY

## 2.1 EQUIPMENT

### 2.1.1 Measurements at Residential Properties

The vibration measurements at residential locations were made in terms of DIN 45669-1 (1). This enables the assessment of vibration using the appropriate standard DIN 4150-2 (2). Measurements were made using a RION DA20 data recorder and a RION VP 80 three channel charge pre-amplifier with three PV 87 accelerometers. The waveforms that were recorded have then been analysed to give the values that are required in the DIN 4150-2 assessment procedure. These measurements have been supplemented with measurements made using a Vibrock 901 dual channel seismograph to measure vibration from the Luas.

### 2.1.2 Measurements at Hospitals

Some of the equipment that is used in the hospital environment is significantly more sensitive to vibration than is the case with human beings, and very low standards to protect vibration sensitive equipment are required. Consequently, the equipment was selected so that it is capable of recording vibration at very low levels as described in *Section 2.1.1*. Recorded vibration velocity waveforms were then analysed relevant frequency bands.

## 2.2 SURVEY DETAILS AT RESIDENTIAL PROPERTIES

Monitoring was carried out at five residential properties during the period 9th to 10th of January 2008. The location of the residential properties was chosen in consultation with RPA. The following locations were selected:

- a residential property in St Joseph's Avenue, Drumcondra, close to the base of the railway bridge carrying the rail line between Dublin and Maynooth (see *Figure 2.1*);
- a residential property in close proximity to a speed bump;
- a residential property in Seatown Walk, Swords, close to a busy road (*Figure 2.2*);
- a residential property in Walnut Rise (close to the junction with Griffith Avenue (*Figure 2.3*); and
- a residential property in close proximity to the Red Luas Line at Mary's Abbey/Chancery Street to simulate the tram vibration at the intersection of the proposed Metro North Route (*Figure 2.4*).

Due to equipment failure at the location shown in *Figure 2.4* the measurements have been replaced by measurements on slab track at Tullagh and the viaduct

(1) DIN 45669-1 Mechanical Vibration and Shock Measurement: Part 1 Measuring Equipment, DIN, 1995.
(2) DIN 4150-2 Structural Vibration: Part 2 Human Exposure to Vibration in Buildings, DIN, 1999.

approach at Charlemount Ramp made during a measurement visit between the 14th and the 16th of September 2006. Measurements were made at 3, 3.5 and 7 m from the track. Receptors that may be affected by the Luas, and which also lie close to the Metro North alignment, are best represented by the measurements at 7 m.

Measurements at other residential properties were made as close as possible to the receptor. All measurements were made outside of vibration sensitive properties. Daytime measurements were made at each residential property and monitoring was also carried out during the night for receptors that were affected by road and rail vibration.

For trains, DIN 4150-2 allows for a simplified comparison of vibration from trains with absolute scoping standards for peak vibration to determine if is necessary to consider the daily total vibration which depends on the train headways. If peak vibration values are below the *Au* scoping value then vibration meets the standard without further analysis. Since passenger trains at Drumcondra exceed this *Au* scoping value, it has been necessary to consider the train headways to establish a $KB_{FTr}$ value which can be compared to the Ar value specified in the standard. Freight trains were not recorded at the Drumcondra location, making the baseline a worst-case (lowest) value.

A similar approach is adopted for road traffic where a $KB_{FTm}$ value has been calculated in order to allow a comparison with the Ar value specified in DIN 4150-2. In this case we have assumed that traffic vibration is continuous at the sampled levels, so that it is not necessary to calculate a $KB_{FTr}$ value which would account for any times when vibration levels were lower than those that were recorded during the survey.

## *2.3 SURVEY DETAILS AT MATER HOSPITAL (PRIVATE, ADULT AND CHILDREN'S) AND THE ROTUNDA HOSPITAL*

Vibration-sensitive equipment (e.g. electron microscopes) is used at the Mater Hospital and Rotunda Hospital. Baseline vibration monitoring was carried out at both receptors in order to determine the existing vibration levels. The results obtained were analysed with reference to the criterion which has been agreed between the vibration specialists representing the RPA and the Mater hospitals (Rupert Taylor and Chris Manning respectively).

The Rotunda Hospital authorities have not proposed vibration criteria, and in the absence of specific criteria the vibration signals have been analysed in terms of the same parameters agreed for the Mater Hospitals (in third octave band velocity). The limit agreed for the Mater Hospitals has also been referred to when presenting the results for the Rotunda Hospital, but it should be noted that this does not imply that this will form the appropriate vibration criterion for equipment within this building.

ERM met with hospital representatives before the survey to ensure that access to the relevant areas was available and that the hospital authorities understood what work was to be carried out. Night-time monitoring at the hospital locations is not required because the sensitivity of the equipment in the hospital will not change during the night and vibration levels in this area are likely to be lower during the night than is the case during the day.

Measurements were made in the existing Mater Adult Hospital. Although this existing building is a long way from the proposed Metro North alignment some activities will be transferred to the new building which is not yet under construction. The area where the hospital will be built is currently a car park, which would make measurements inappropriate. Baseline has therefore been recorded to represent existing equipment exposure levels. Photographs of the measurement locations are shown in *Annex A*.

# 3 RESULTS

## 3.1 RESIDENTIAL

The results of the monitoring showed that vibration levels are low for all road sources including speed humps. The measurements of railway vibration at Drumcondra were also low. Based on the recorded levels, vibration at most residential receptors are expected to be below the standards in DIN 4150-2 and are not therefore a significant factor in the assessment of vibration from the Metro North scheme. At the measurement locations in Seatown Walk in Swords and at Griffiths Avenue vibration was in excess of DIN 4150-2 guidelines, although subjectively the levels were low. However, the assessment in the EIS has taken the conservative approach based on the absolute standards in DIN 4150-2.

Various measurements were taken on the Luas Red Line that enabled vibration magnitudes to be established at 3 to 3.5 m and 7 m from the tracks. For Metro North the receptors that might be affected by baseline vibration from the Luas are approximately 7 m from the tracks. The baseline measurements showed that at typical track to receptor distances of 7 m the vibration from the Luas is likely to meet the requirement of the standard, and therefore is not expected to be a significant factor in the assessment of the vibration from the Metro North scheme.

The full results are shown in *Annex B*.

## 3.2 HOSPITALS

### 3.2.1 *Mater Private Hospital*

A velocity criterion of 12 μm/s, which is equivalent to 81.6 dB re 1 nm/s in any third octave band has been agreed with the hospital authorities to protect the most sensitive equipment. Whilst this may not apply to all equipment we have compared the levels to this criterion. Levels were generally below the criterion, with some excursions above the criterion at very low frequencies that are not associated with tram vibration. These low frequency levels were thought to be associated with the noise floor of the instrumentation.

### 3.2.2 *Mater Adult Hospital*

As discussed above a velocity criterion of 12 μm/s (or 81.6 dB re 1 nm/s), in any third octave band has been agreed with the hospital authorities to protect the most sensitive equipment. Levels were generally below the criterion, with some excursions above the criterion at very low frequencies that are not associated with tram vibration. These low frequency levels were thought to be associated with the noise floor of the instrumentation.

### *3.2.3 Rotunda*

Vibration levels are reported in *Annex B* for the measurements made at the Rotunda Hospital. No vibration limit has been set for the Rotunda Hospital. However, to put the results into perspective the measured levels have been compared to criteria that have been agreed for sensitive equipment in the Mater Hospitals. Vibration levels were generally below 12 μm/s (or 81.6 dB re 1 nm/s) with some excursions above the criterion at very low frequencies that are not associated with tram vibration. These low frequency levels were thought to be associated with the noise floor of the instrumentation.

# 4 CONCLUSION

Vibration was measured at selected locations along the route and in hospital buildings that house vibration sensitive equipment. This report describes the baseline measurements, and discusses the magnitude of the results.

Most residential receptors along the proposed Metro North alignment are affected by road traffic vibration, but at a low level which is unlikely to be above the DIN 4150-2 guideline levels. However, at Seatown Walk in Swords and at Griffiths Avenue vibration was in excess of DIN 4150-2 guidelines, although subjectively the levels were low.

At Drumcondra where receptors are close to existing rail traffic the baseline vibration is low, and is not above DIN 4150-2 guidelines due to the low train service frequencies. Relatively few receptors along the proposed alignment are currently affected by rail related vibration, and the only other example is at the junction of O'Connell Street and Abbey Street Middle. At typical receptor to track distances (of the order of 7 m) the vibration from the existing street running Luas track is also unlikely to result in vibration levels that exceed DIN 4150-2 guidance levels.

The measurements carried out in the hospitals are currently below the standard which has been agreed for the Mater Private, Adult and Children's Hospitals. The only exceptions to this are at very low frequencies which are not associated with tram vibration frequencies, and so are not directly relevant to the assessment of the vibration from the Metro North vehicles. The measurements at these frequencies were also thought to be associated with the noise floor of the instrumentation.

The levels in the Rotunda Hospital were also measured. No criteria have been proposed for this building by the hospital authorities. Comparison with the agreed standards for the Mater Hospitals suggests that the existing levels are low at frequencies associated with tram vibration with some excursions above the guidance levels in Biochemistry, Serology and Histiopathy.

Annex A

# Vibration Monitoring Locations

*Figure A1.1 Seatown Walk, Swords*

*Figure A1.2 Griffith Ave / Walnut Rise*

*Figure A1.3 Griffith Ave / Walnut Rise*

*Figure A1.4 Rotunda Hospital: Electron Microscope*

*Figure A1.5 Rotunda Hospital: Biochemistry Lab with Mass Balance - Integra 800*

*Figure A1.6 Rotunda Hospital: Room MH/G/61 with Thinprep Imaging System*

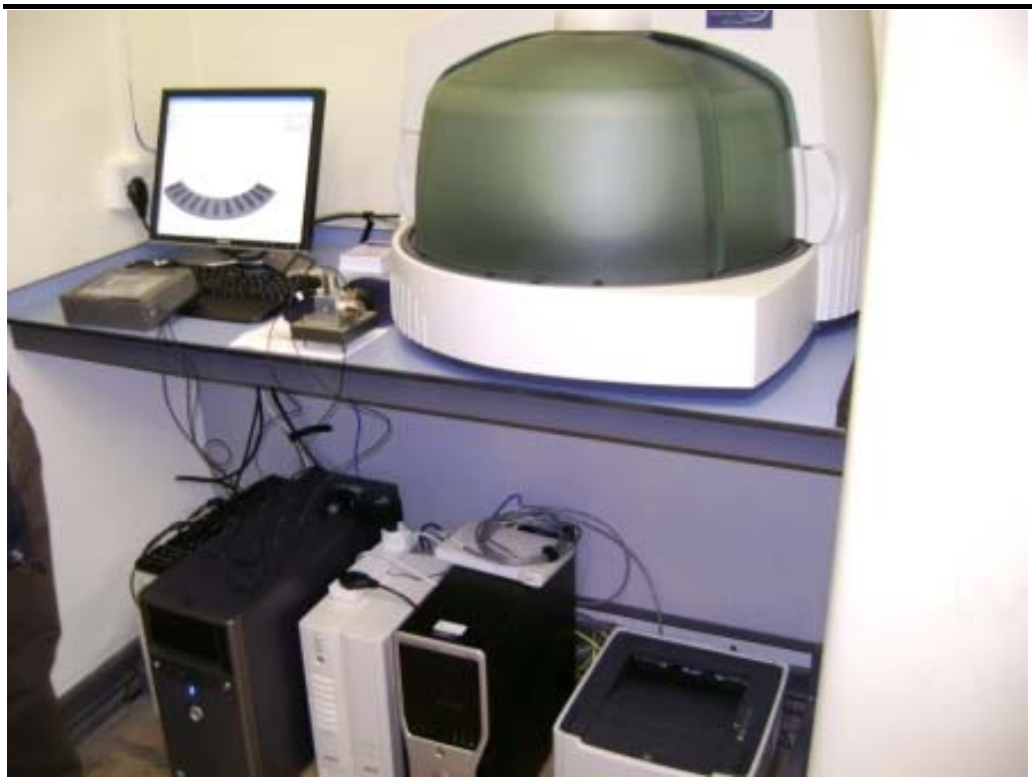


*Figure A 1.7 Mater Private: Concrete floor in room adjacent to MRI machine*

*Figure A1.8* *Mater Private: Anti room to radiopharmacy (This room – typing room – reporting room – control room – MRI room)*

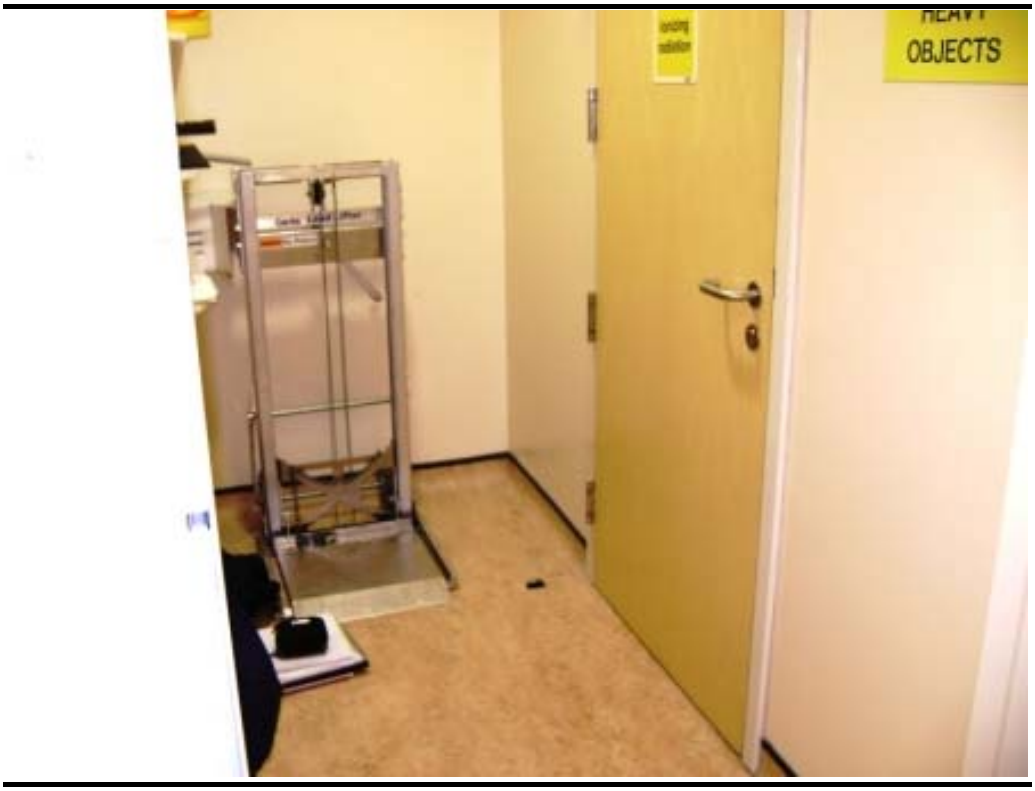



*Figure A1.9* *Mater Private: Radiotherapy room – Primus Machine (Siemens)*

*Figure A1.10 Mater Private: Radiotherapy room (2) – Varian Clinac (Linac)*

*Figure A1.11 Mater Private: Laser Eye Room – Bausch & Lomb Technolas 217z100*

*Figure A1.12 Mater Private: Cath Lab 2 – Radioactive Screening and Scanning*

*Figure 1.13 Mater Public – Main X-Ray / Main X-Ray corridor*

Annex B

# Detailed Measurements of Vibration

## *B1 DETAILED RESULTS*

The detailed results of vibration measurements that were made as part of this study are shown below in *Table B1.1*. Where not stated the values in column six are $KB_{Fmax}$ (weighted velocity in m/s) values which can be compared directly to the *Au* value in column seven which is derived from DIN 4150-2. If the measured velocity is below this level then the requirements of the standard are met and baseline is not expected to be a determining factor in the assessment of vibration from the proposed Metro North. If the $KB_{Fmax}$ values are above the *Au* values, the $KB_{FTr}$ value has been calculated for trains and the $KB_{FTm}$ value has been calculated for road traffic, so that these can be compared with the *Ar* values to determine if the requirements of the standard are met.

Where the measurements represent vibration sensitive equipment the values have been compared to the standard which has been agreed with the consultant who is advising for the most sensitive equipment in the Mater Hospitals. A velocity criterion of 12 μm/s (or 81.6 dB re 1 nm/s) has been agreed. Although levels have been compared to this value for the Rotunda Hospital, no criteria have been agreed for this building, and the comparison is therefore intended purely to benchmark the vibration levels against a stringent equipment standard.

Graphical results are shown in *Figure B1.1* to *Figure B1.8* for selected samples.

*Table B1.1 Results of Baseline Vibration Measurements*

| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 9/1/08 | 12:45 | 5 | 04 | On kerb adjacent with residential receptor at No. 20 and level with the front of the school, Seatown Walk, Swords. | 0.37<br>0.46<br>0.48<br><br>$KB_{FTr}$ = 0.24 | Au=0.15/0.1<br><br>Ar =0.07/0.05 | No discernable vibration.<br>No local traffic. |
| 9/1/08 | 13:22 | 5 | 05 | Griffith Ave / Walnut Rise junction. On pavement 1.5 metres from Walnut Rise traffic. Nearest receptor (house) 10 metres from road. | 0.11<br>0.14<br>0.07<br><br>$KB_{FTr}$ = 0.08 | Au=0.15/0.1<br><br>Ar =0.07/0.05 | No discernable vibration.<br>Cars passing on Walnut Rise gave rise to increased vibration levels on data recorder. |
| 9/1/08 | 15:00 | 5 | 06 | Electron Microscope (Room MH/B/10) room at Rotunda hospital. | < 12 µm/second (velocity). See *Figure B1.1* | | No discernable vibration.<br>Some heavy traffic on the road outside. |
| 9/1/08 | 15:10 | 5 | 07 | Biochemistry lab in Rotunda hospital | Some excursions above 12 µm/second (velocity). See *Figure* B1.2 | | No discernable vibration.<br>Lab technician moving around. |
| 9/1/08 | 15:32 | 3:45 | 08 | Rotunda hospital room MH/G/61 | < 12 µm/second (velocity). See *Figure B1.3* | | No discernable vibration.<br>Monitoring took place on the floor with equipment on a table/shelf. Computers are mounted on floor underneath shelf. |

| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 9/1/08 | 15:36 | 3:45 | 09 | As above | | | No discernable vibration.<br>Monitoring took place on the table alongside equipment. |
| 9/1/08 | 15:45 | 5 | 10 | Serology room at Rotunda Hospital | Some excursions above 12 µm/second (velocity). See *Figure* B1.4 | | No discernable vibration.<br>People moving about the lab.<br>Floor is flexible and is understood to be made from light weight materials. |
| 9/1/08 | 15:55 | 5 | 11 | Histopatholgy in Rotunda Hospital | Some excursions above 12 µm/second (velocity). See *Figure* B1.5 | | No discernable vibration.<br>Lab technician moving through lab. |
| 9/1/08 | 16:10 | 5 | 12 | Theatre corridor at Rotunda Hospital | 0.05<br>0.03<br>0.03 | 0.15/0.1 | No discernable vibration<br>People moving in the corridor 4 – 5 metres from accelerometer. |
| 9/1/08 | 16:50 | 5 | 13 | Drumcondra Station Adjacent to bridge support on pavement. (Nearest residential receptor is less than 5 m from bridge.) | 0.05<br>0.05<br>0.07 | 0.15/0.1 | |

| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 9/1/08 | 16:55 | 5 | 14 | Drumcondra Station Adjacent to bridge support | 0.19<br>0.16<br>0.15<br><br>$KB_{FTr}$<br>= 0.05 Day<br>= 0.02 Night | Au=0.15/0.1<br><br>Ar =0.07/0.05 | |
| 9/1/08 | 17:16 | 5 | 15 | Drumcondra Station Adjacent to bridge support | 0.08<br>0.09<br>0.16 | 0.15/0.1 | Missed start of train pass-by. |
| 9/1/08 | NK | 5 | 16 | Drumcondra Station Adjacent to bridge support | 0.06<br>0.07<br>0.06 | 0.15/0.1 | 2 local cars at 0:10 – 0:12<br>(Minutes: seconds)<br>Train inbound: 0:38 – 0:50<br>Idle: 0:50 – 1:37<br>Outbound: 1:37 – 2:04 |
| 9/1/08 | NK | 5 | 17 | Drumcondra Station Adjacent to bridge support | 0.03<br>0.05<br>0.07 | 0.15/0.1 | Large car @ 1 minute passing on road adjacent to equipment. |
| 9/1/08 | 17:40 | 5 | 18 | Drumcondra Station Adjacent to bridge support | 0.03<br>0.06<br>0.12 | 0.15/0.1 | Inbound at 2:30<br>Outbound at 03:25 |
| 9/1/08 | NK | 5 | 19 | Drumcondra Station Adjacent to bridge support | 0.05<br>0.10<br>0.11 | 0.15/0.1 | Idle after 37 seconds<br>Pull out @ 2:33<br>Gone @ 2:57<br>Person walking past @ 2:03 |

| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 9/1/08 | 17:58 | 5 | 20 | Drumcondra Station Adjacent to bridge support | 0.11<br>0.15<br>0.17 | 0.15/0.1 | Pulls out @ 1:56<br>Gone @ 2:14 |
| 9/1/08 | 18:10 | 2 | 21 | Drumcondra Station Adjacent to bridge support | Not Recorded for 30 seconds | | Missed start of trace |
| 9/1/08 | 18:12 | 5 | 22 | Drumcondra Station Adjacent to bridge support | 0.03<br>0.06<br>0.04 | 0.15/0.1 | Coming in @ 0:40<br>Leaving @ 1:25 |
| 9/1/08 | NK | 5 | 23 | Drumcondra Station Adjacent to bridge support | | | Up to 1:18 train to Maynooth<br>From 1:18 to Dublin |
| 10/1/08 | 12:30 | 5 | 24 | Mater Private Hospital in room adjacent to MRI room | < 12 µm/second (velocity) except at very low frequencies that are not typically associated with tram vibration. See *Figure B1.6.* | | Monitoring on concrete slab (beneath false floor) which is the same as the one that the MRI machine is located on.<br><br>Vibration felt on false floor but not as discernable on the concrete floor. Large computers in room may be the major source of vibration. Slight movement of people in the room. |
| 10/1/08 | 12:50 | 5 | 25 | Mater Private hospital – Antiroom of Radiopharmacy (same slab as MRI) | 0.06<br>0.12<br>0.15 | 0.15/0.1 | No discernable vibration |

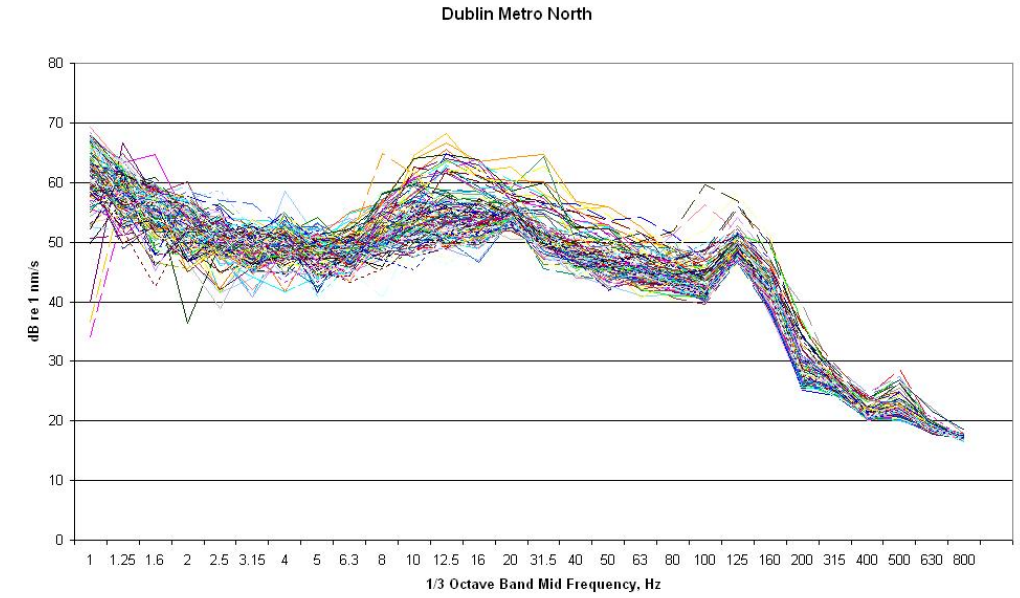
| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 10/1/08 | 13:15 | 5 | 26 | Mater Private hospital - Radiotherapy room | < 12 µm/second (velocity). See *Figure B1.7.* | | No discernable vibration |
| 10/1/08 | 13:28 | 5 | 27 | Mater Private hospital - Radiotherapy room (2) | < 12 µm/second (velocity) except occasional exceedance at third octave band with 1 Hz centre frequency. This frequency is not typically associated with tram vibration. | | No discernable vibration |
| 10/1/08 | 13:50 | 5 | 28 | Mater Private hospital - Laser Eye Room (5th floor) | < 12 µm/second (velocity) except at very low frequencies that are not typically associated with tram vibration and bands with centre frequencies from 5Hz to 10 Hz. See *Figure B1.8.* | | No discernable vibration<br>2:30 – 2:40 stimulation of footfall from nurse assisting in procedure. |
| 10/1/08 | 14:10 | 5 | 29 | Mater Private hospital Cath Lab 2 | < 12 µm/second (velocity) except at very low frequencies that are not typically associated with tram vibration | | Preparing for a patient<br>No patient in the room |
| 10/1/08 | 15:45 | 5 | 30 | Mater Public hospital - operating theatre | < 12 µm/second (velocity) except at very low frequencies that are not typically associated with tram vibration | | No discernable vibration<br>Nurses walking around |

| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 10/1/08 | 16:00 | 5 | 31 | Mater Public hospital X-ray | < 12 µm/second (velocity) except at very low frequencies that are not typically associated with tram vibration | | No discernable vibration<br>People moving in the corridor |
| 10/1/08 | 16:13 | 5 | 32 | Mater Public hospital – Cardiac Theatre | < 12 µm/second (velocity) except at very low frequencies that are not typically associated with tram vibration . Very close to 12 µm/second at 20 Hz. | | No discernable vibration<br>People moving in corridor<br>Trolley past @ end |
| 10/1/08 | 17:45 | 6:15 | 33 | Luas track – 1.5 metre from building façade; 4 metre from near track; 6 metre from far track | Equipment Failure: Not Recorded | | Luas (far track) 0:45 – 1:02<br>Luas (near track) 1:14 – 1:29<br>Luas (near track) 5:38 – 5:55<br>Luas (far track) 6:00 – 6:08 |
| 10/1/08 | 18:00 | 7:15 | 34 | As above | Equipment Failure: Not Recorded | | Luas (near track) 0:15 – 0:25<br>Luas (far track) 0:59 – 1:15<br>Luas (near track) 6:15 – 6:40<br>Luas (far track) 6:56 – 7:15 |
| 10/1/08 | 23:05 | 5 | 35 | On kerb adjacent with No. 20 and level with the front of the school, Seatown Walk, Swords | 0.16<br>0.11<br>0.15<br><br>$KB_{FTr}$ =0.11 | Au=0.15/0.1<br><br>Ar =0.07/0.05 | No discernable vibration<br>No local traffic passing<br>1 x car passing @ 4:45 |
| 10/1/08 | 23:15 | 5 | 36 | Speed bump / table | 0.12<br>0.10<br>0.08 | 0.15/0.1 | Complies with standard assuming that speed bumps generate vibration during the day and infrequently at night. |

| Date | Time | Duration (mins) | Record No. | Location | $KB_{Fmax}$ (weighted velocity in mm/s) in three orthogonal axes x, y and z<br><br>(and $KB_{FTr}$ where $KB_{Fmax}$ exceeds Au value) | Au value (day/night in mm/s)<br><br>(and Ar day/night in mm/s for comparison with $KB_{FTr}$) | Notes |
|---|---|---|---|---|---|---|---|
| 10/1/08 | 23:32 | 5 | 37 | Griffith Ave / Walnut Rise junction. On pavement 1.5 metres from Walnut Rise traffic. Nearest receptor (house) 10 metres from road | 0.10<br>0.15<br>0.20<br><br>$KB_{FTr}$ =0.15 | Au=0.15/0.1<br><br>Ar =0.07/0.05 | |
| 10/1/08 | 23:39 | 5 | 38 | Griffith Ave / Walnut Rise junction. On pavement 1.5 metres from Walnut Rise traffic. Nearest receptor (house) 10 metres from road | 0.62<br>0.80<br>0.86<br><br>$KB_{FTr}$ =0.29 | Au=0.15/0.1<br><br>Ar =0.07/0.05 | New scale:<br>Ch1: 2.5 E-1<br>Ch2: 2.4 E-1<br>Ch3: 2.4 E-1 |
| 10/1/08 | 23:50 | 5 | 39 | Drumcondra Station Adjacent to bridge support | Equipment Failure: Not Recorded | | Train in station from start until 2:02<br>Taxi @ 3:57 until end |

NK – not known

*Figure B1.1 Analysis of Vibration in Rotunda Hospital Electron Microscope Room*




*(MH/B/10) dB re 1 nanometre per second*

*Figure B1.2 Rotunda Hospital Biochemistry Room dB re 1 nanometre per second*

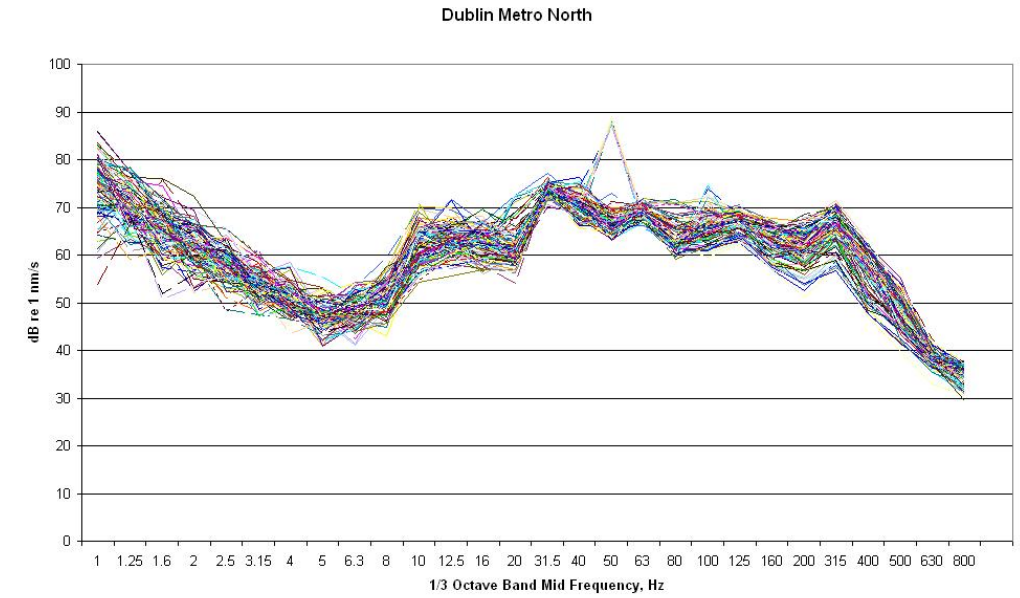


*Figure B1.3 Rotunda Hospital MH_G_61 Room dB re 1 nanometre per second*

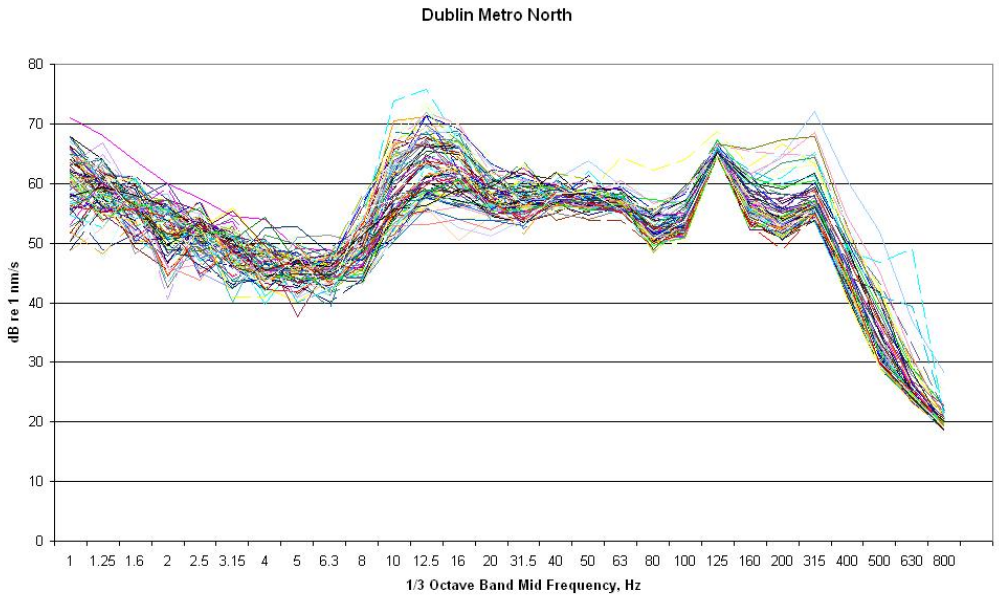



*Figure B1.4 Analysis of Vibration in Rotunda Hospital Serology Room dB re 1 nanometre per second*

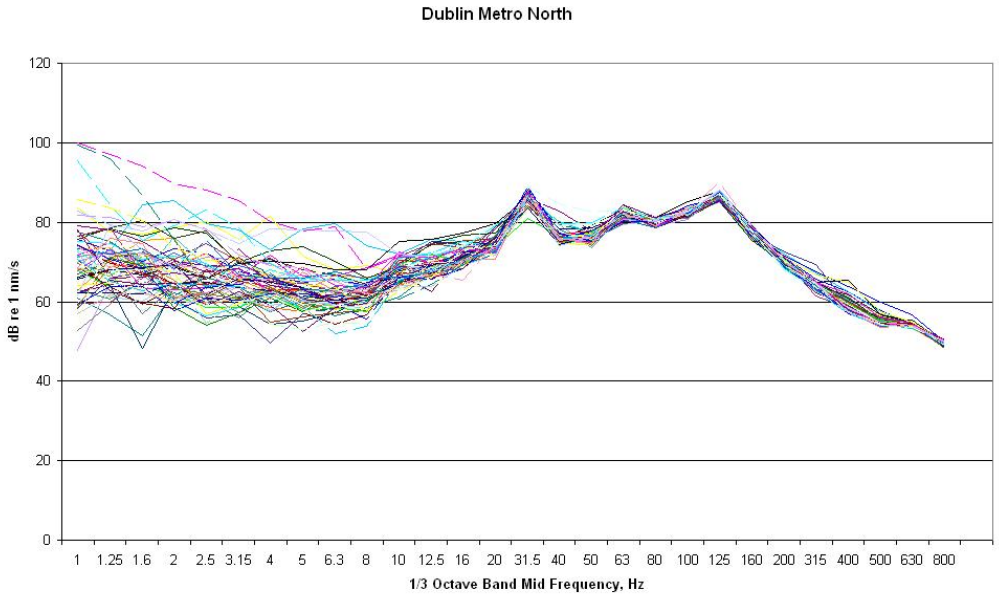


*Figure B1.5 Rotunda Hospital Histiopathy Room dB re 1 nanometre per second*

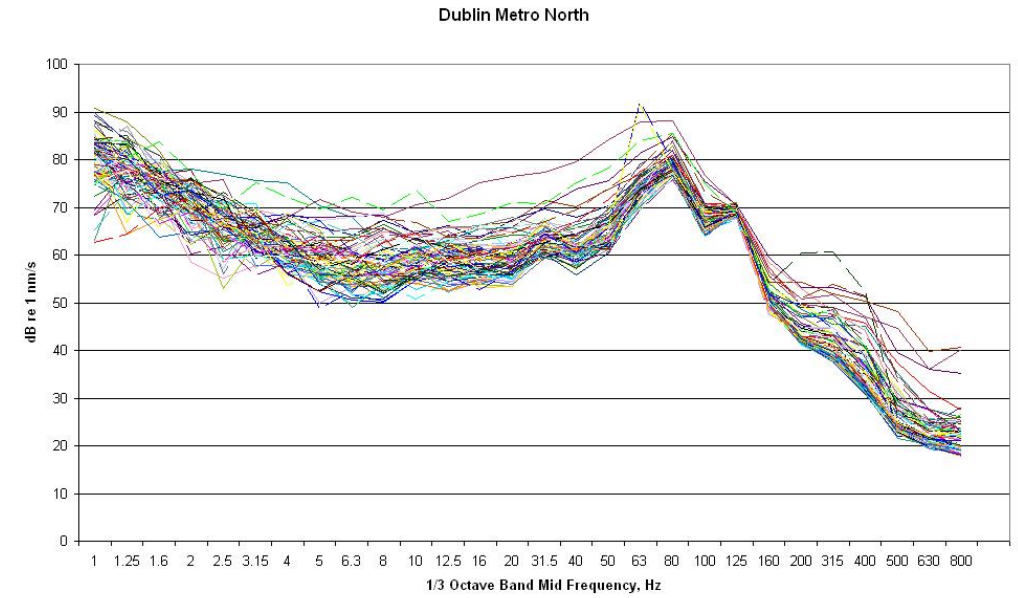



*Figure B1.6 Mater Private Hospital Room Adjacent to MRI Scanner dB re 1 nanometre per second*

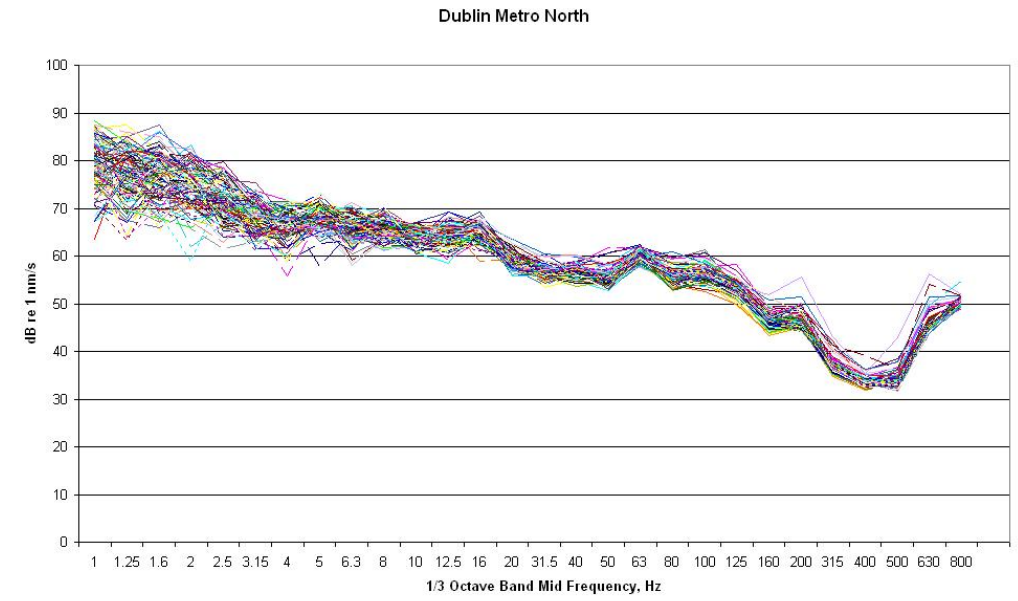


*Figure B1.7 Mater Private Hospital Radiotherapy Room dB re 1 nanometre per second*

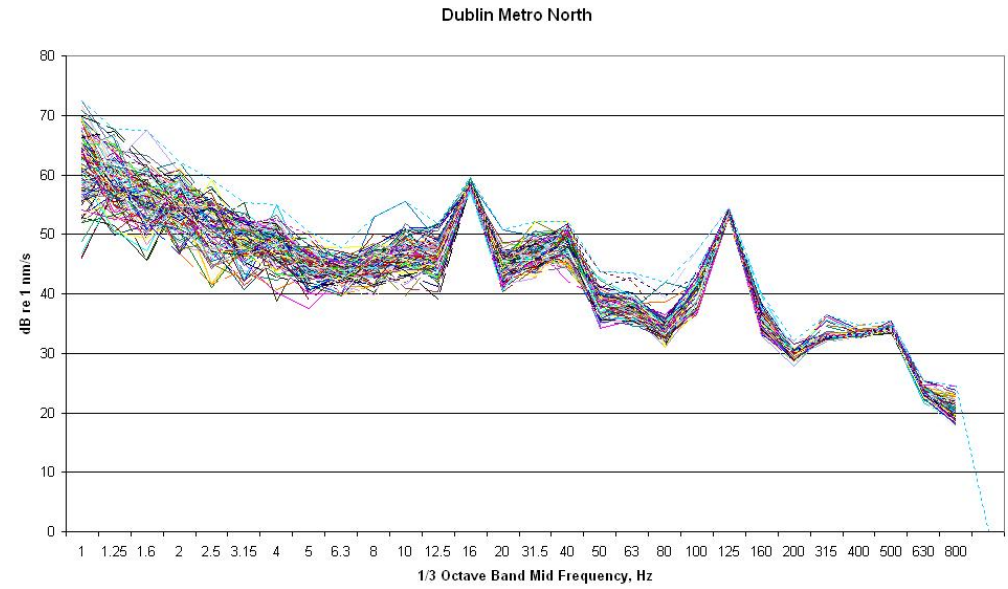
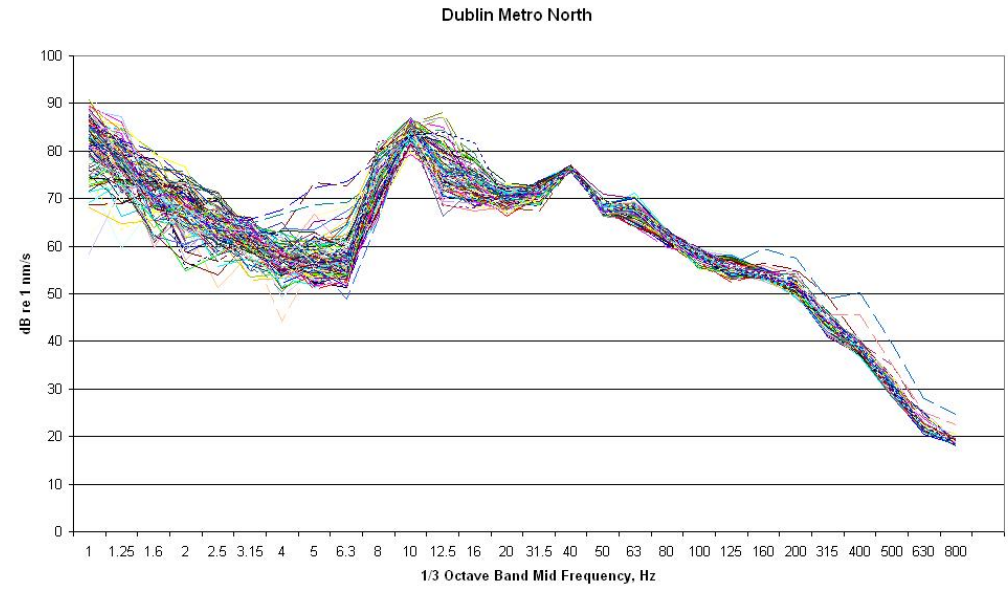



*Figure B1.8 Mater Private Hospital Laser Eye Surgery Room dB re 1 nanometre per second*



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