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NOISE CONTROL FOR A BETTER ENVIRONMENT

Noise management during the construction of a light rail scheme through Dublin city centre

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ABSTRACT

Luas Cross City is the next stage of Dublin's integrated light rail network. The 5.6km long scheme extends the Luas Green Line through Dublin city centre before servicing a number of residential areas in the suburbs of north Dublin. Planning permission for the scheme was granted in August 2012. Construction works commenced in June 2013 and were completed in December 2017 with the commencement of operations. Ensuring compliance with the construction noise limiting conditions was always likely to prove challenging given the urban and suburban nature of the scheme and the close proximity to thousands of noise sensitive receptors. Innovative and effective noise management measures were implemented during both the planning and construction project phases to ensure a consistent and responsible approach was adopted by the Railway Procurement Agency (now Transport Infrastructure Ireland). This paper describes (i) the collaborative approach adopted with the local authority to manage noise emissions during the construction period (ii) the significant remote real time monitoring and attended noise monitoring regimes implemented to demonstrate compliance in a transparent manner and (iii) approaches adopted to engage with local communities and other sensitive receptors during the works including the deployment of community liaison officers throughout the city and implementation of 'quiet times'.

Keywords: Construction, Light Rail

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1. INTRODUCTION

The development of an extensive light rail network (Luas) for the Greater Dublin Area is a key element of the strategy for tackling congestion in Dublin, enhancing economic competitiveness and ensuring a sustainable, attractive city. In 2004, the Railway Procurement Agency (RPA now Transport Infrastructure Ireland) successfully delivered the first two unconnected lines of this system (Red and Green lines). Extensions were opened to both lines between 2009 and 2011 to Docklands, to Citywest and to Cherrywood. Although the Luas extensions extended Luas to a wider catchment, light rail in Dublin in the absence of a connecting line remained essentially

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two discrete lines and their extensions and spurs, rather than a network. There was considerable demand for cross city trips on both the Red and Green Lines.

Luas Cross City (LCC) fulfils this need and forms the backbone of a true light rail network in Dublin by linking the Red and Green Lines in Dublin city centre. By achieving greater access into the city centre area, the scheme offers increased accessibility to places of employment, education and retail centres as well as cultural and historic quarters.

LCC serves a 5.6km long corridor from the original Luas Green Line terminus at St. Stephen's Green West through the heart of Dublin City where it serves a number of key destinations. Northwest of the city the scheme reinstates a transport corridor along the former Broadstone railway cutting and provides increased access to the communities of Phibsborough and Cabra as well as the planned unified Technical University campus facility at Grangegorman.

Construction of LCC commenced in June 2013. Thirteen stops were constructed along with two substations and a light maintenance depot. Following a period of testing and commissioning, operations began in December 2017. The construction of such a significant linear infrastructure project through the historic core of Dublin city was always going to prove acoustically challenging. Thousands of sensitive receptors including residential dwellings, churches, theatres (e.g. Abbey Theatre), health care facilities (e.g. Rotunda Hospital) and educational facilities (e.g. Trinity College Dublin) were within metres of construction sites. The successful completion of the project on time and within budget, whilst ensuring impacts from construction noise were minimised, would require careful planning, innovation, communication and consistent implementation in approach. This paper details the framework adopted to reach a level of construction noise management never before achieved in Ireland for a major infrastructure project.

2. BACKGROUND - PLANNING PHASE

2.1 Preparing the Railway Order

A Railway Order is the principal legal authority required in Ireland to construct, operate and maintain a light railway under the Transport (Railway Infrastructure) Act, 2001 (as amended by the Planning and Development (Strategic Infrastructure) Act 2006). An application for a Railway Order is made to An Bord Pleanála (the Planning Board). Among the documents which must accompany the application is an Environmental Impact Statement (EIS) drafted in accordance with the provisions of Section 39 of the Act of 2001. The purpose of the EIS is to outline the nature and extent of the project, its effect on the environment and the likely impacts and measures which will be taken to reduce or monitor these impacts. The EIS is part of the Environmental Impact Assessment process governed by the EIA Directive (Directive 85/337/EEC, as amended).

During the planning of a new infrastructure project, the preparation of a robust EIS is essential to ensure the acceptability of the scheme¹. As part of the EIS, a specific chapter was prepared assessing the likely significant effects of construction and operational noise emissions. The assessment methodology for construction impacts was based upon the guidance provided in BS 5228 *Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise*² and *Guidelines for the Treatment of Noise and Vibration in National Roads Schemes*³. The use of construction plant and equipment (e.g. hydrovacuum excavators, breakers, disc saws and compressors etc.) associated with the activities such the infill of historical cellars, utility

diversions, installation of the trackbed and rails and the construction of stops and substations were predicted to have the greatest impact.

The EIS for LCC was prepared between August 2008 and May 2010. A Railway Order application was made to the Planning Board in June 2010. Following an Oral Hearing in May 2011, a Railway Order⁴ was granted in August 2012.

2.2 Railway Order conditions

As part of the granted Railway Order, the Planning Board conditioned construction noise limiting criteria for different sensitive receptors types including residents, hotels, schools, churches and theatres. Table 1 below details the construction noise limiting criteria for residential receptors only.

Table 1 Construction noise level criteria for residential receptors

Day	Period and Limit	Notes
Monday - Friday	75 L _{Aeq} , 7am-7pm 65 L _{Aeq} , 7pm-10pm 45 L _{Aeq} , 1Hr 10pm-7am *	Non tonal, non-impulsive
Saturday	70 L _{Aeq} , 8am-4:30pm 55 L _{Aeq} , 4:30pm-10pm 45 L _{Aeq} , 1Hr 10pm-7am *	Non tonal, non-impulsive
Sundays, Bank and Public Holidays	60 L _{Aeq} , 8am-4:30pm 50 L _{Aeq} , 4:30pm-10pm 45 L _{Aeq} , 1Hr 10pm-8am *	Non tonal, non-impulsive

In addition to construction noise limiting criteria, the Planning Board conditioned RPA to agree all noise monitoring locations with the local authority prior to the commencement of construction works.

3. PRE-CONSTRUCTION PHASE

3.1 Construction strategy

The construction contract strategy for LCC involved the procurement of a number of separate Construction Contractors. The Cellar Infill Works (May 2013 – February 2014), Utility Diversions Works (October 2013 – March 2015) and Main Infrastructure Works (January 2015 – December 2017) contracts had the potential for greater noise impacts when compared to the relatively minor Heritage Works or Power & Systems Works contracts.

3.2 Consultations with Local Authority

Every project has stakeholders who are impacted by or can impact the project in a positive or negative way. While some stakeholders may have limited ability to influence the project, others may have significant influence on the project and its expected outcomes⁵. The key stakeholder for Luas Cross City was Dublin City Council (DCC). LCC was to be constructed entirely within the administrative boundary of DCC. Therefore, DCC would have both high interest and high power regarding the project outcome.

During the preparation of the LCC EIS and following the Oral Hearing, the Project Team met with the DCC Air Quality Monitoring and Noise Control Unit on a number of occasions. The purpose of these meetings was to specifically discuss acoustic emissions that would be associated with the construction of LCC. In addition, an

informal lesson learned exercise was undertaken from both a RPA and DCC viewpoint regarding previous Luas projects specifically the recently completed extension to the Docklands.

The Docklands extension was constructed between 2006 – 2009. DCC Air Quality Monitoring and Noise Control Unit felt that during the construction of the Luas extension, communication could have been better from RPA and their Construction Contractors specifically for works planned out-of-hours i.e. during the evening and night-time periods. DCC had received a number of complaints from local residents regarding construction related noise emissions. For many of these complaints, the local authority were unaware works were being undertaken out-of-hours. DCC Air Quality Monitoring and Noise Control Unit advised that such a situation should not materialise during LCC construction. Both RPA and DCC Air Quality Monitoring and Noise Control Unit agreed that the Construction Contractors Noise Management Procedures could be improved along with the level of noise monitoring to be undertaken. By increasing the number of monitoring events, ongoing compliance could be demonstrated in a transparent manner.

Following these meetings, both RPA and DCC Air Quality Monitoring and Noise Control Unit committed to work closely with each other to ensure the best possible outcome for all stakeholders along the alignment. It was agreed that there would be 360⁰ dialogue with regular meetings and near daily communication between RPA, Construction Contractors and DCC Air Quality Monitoring and Noise Control Unit during the construction phase of the scheme. A procedure for out-of-hours works was to be developed between RPA, DCC Traffic Department and DCC Air Quality Monitoring and Noise Control Unit. Furthermore, it was agreed that approval from both RPA and DCC would be required for matters relating to Construction Contractors management plans. To demonstrate compliance with limiting criteria and to ensure an open and transparent relationship between RPA and DCC Air Quality Monitoring and Noise Control Unit, RPA committed to submit all monitoring data and reports to the local authority on a monthly basis or if a specific request was made, within 48 hours. Should there be an exceedance, RPA would inform the local authority as soon as was reasonably practicable. The responsibilities and accountabilities of RPA, Construction Contractors and the local authority were agreed and documented.

3.3 Demonstrating Compliance with Noise Limiting Criteria

As detailed in Section 2.2 of this paper, the Planning Board set construction noise limiting criteria for different sensitive receptor types. Often, sensitive receptors were within metres of the construction activities as illustrated in Photographs 1 and 2.

The construction noise limiting criteria conditioned did not consider the real life pre-existing noise levels within Dublin city centre. It was recognised by both RPA and DCC during consultation meetings that demonstrating compliance with construction noise limits was going to be very difficult due to the existing noise environs within the city. When undertaking construction noise measurement surveys, it would not possible to distinguish between the different noise sources i.e. construction noise, road traffic noise and the general loud ambient noise environment associated with a large city centre. Noise levels measured during the construction works would be the Total Noise Level i.e. construction noise in addition to ambient noise (e.g. road traffic and other noise sources).

Given the urban nature of the work fronts associated with the construction phase of the project, and in order to demonstrate compliance with the construction noise levels, it was agreed with DCC that construction noise measurement results would be

determined by the subtraction of the pre-existing ambient noise level from the Total noise levels measured (Equation 1). This approach was informed by a recommendation of the Dublin Metro North Oral Hearing in which the appointed Planning Board airborne noise advisor advocated such an approach in highly urbanised locations⁶.



Photographs 1-2 Utility diversions on Marlborough Street (left) Rail installation on Nassau Street (right)

$$\text{Construction noise} = \text{Total noise} - \text{pre-existing ambient noise level} \quad \text{Equation 1}$$

To determine the pre-existing ambient noise levels along the alignment, RPA committed to (i) undertake a noise measurement survey conducted over an adequate and appropriate period of time and (ii) review Phase II strategic noise mapping data prepared by DCC in 2012 in accordance with the Environmental Noise Regulations⁷ which implemented the Environmental Noise Directive⁸.

In April 2013 RPA procured eight Sonitus Systems EM2010 continuous noise monitoring systems to be installed at sensitive receptors along the alignment. The eight locations were agreed with the local authority prior to installation, in accordance with the Railway Order conditions. Between May and September 2013 RPA obtained pre-existing ambient noise level data at seven of the eight monitoring stations. The eighth station was located on the northern suburban stretch of the alignment where construction works did not commence until 2015.

Table 2 Westmoreland Street (Location 3) Total Noise Limits

Day	Period	DCC Strategic Noise Mapping	RPA Pre-existing monitored levels	Pre-existing level	Construction limit	Total Noise Limit
Monday - Friday	Day	X		75.7	75.0	78.4
	Evening	X		76.0	65.0	76.3
	Night		X	72.4	45.0	72.4
Saturday	Day		X	70.3	70.0	73.2
	Evening	X		76.3	55.0	76.3
	Night		X	74.5	45.0	74.5
Sunday & Bank Holidays	Day		X	70.3	60.0	70.7
	Evening	X		76.3	50.0	76.3
	Night		X	74.5	45.0	74.5

In tandem with undertaking the pre-existing ambient noise level surveys, RPA reviewed the Phase II façade level strategic noise mapping results. A decision was made by RPA that the higher level between the predicted Strategic Noise Mapping Phase II and the measured pre-existing noise level would be used as the ‘pre-existing ambient noise level’ in determining the Total Noise Level (Equation 1). Table 2 provides an example of the process for determining the Total Noise Level for Location 3 - Westmoreland Street.

3.4 Out-of-Hours Construction Works

In the United Kingdom, a Section 61 application, under the Control of Pollution Act 1974⁹, is prepared by a Contractor and submitted to a local authority for approval to undertake works that are likely to have a significant impact on sensitive receptors due to the generation of noise and vibration. Within a Section 61 application, details are provided of the type of works to be undertaken, the working hours of the site and mitigation measures to be put in place to reduce noise and vibration impacts.

In Ireland, there is no system equivalent to the Section 61 process. Whilst the EIS for LCC considered construction impacts in sensitive receptors, the assessment was primarily based on works being undertaken during the daytime periods i.e. Monday-Friday 8am-6pm and Saturday 9am-4:30pm. However, to ensure that the city was kept moving during the construction works, the DCC Traffic Department often required the Construction Contractors to work out-of-hours in the evening and at night-time.

To ensure that construction noise impacts during out-of-hours were fully assessed, mitigated in accordance with best practice and clearly communicated to sensitive receptors, RPA and the local authority developed the Environmental Health Unit Works Notification (EHU-WN) procedure. Contractors were required to prepare an EHU-WN for all out-of-hours works. All EHU-WNs were required to detail the following:

- The nature of works including the proposed working hours and location;
- Equipment to be used on site, for the proposed working hours including size, number and associated noise emissions through the use of British Standard 5228-1:2009² (and BS 5228-1:2009 +A1: 2014¹⁰);
- Sensitive receptors located within 200m of the proposed works site;
- Predicted noise levels associated with the out of hours works at each identified sensitive receptor;
- Best practicable means to reduce noise including details of how the Contractor shall notify stakeholders and sensitive receptors.

RPA developed a template for the EHU-WN to ensure a minimum standard would be met by all Contractors. RPA also developed a simple construction noise model using Microsoft Excel which would allow Contractors to vary equipment types, duration of activities and distance to sensitive receptors to limit noise levels to as low as practicable whilst still completing the works.

Having this clear procedure in place helped to structure and manage the process. The quality of the applications ensured that they could be reviewed quickly by both RPA and the local authority. During the construction of LCC, 890 EHU-WNs were approved by the local authority. A number of applications were rejected. In such cases, the Contractors rescheduled their work plans.

Figure 1 illustrates the procedure and timelines for Construction Contractors to make an EHU-WN application.

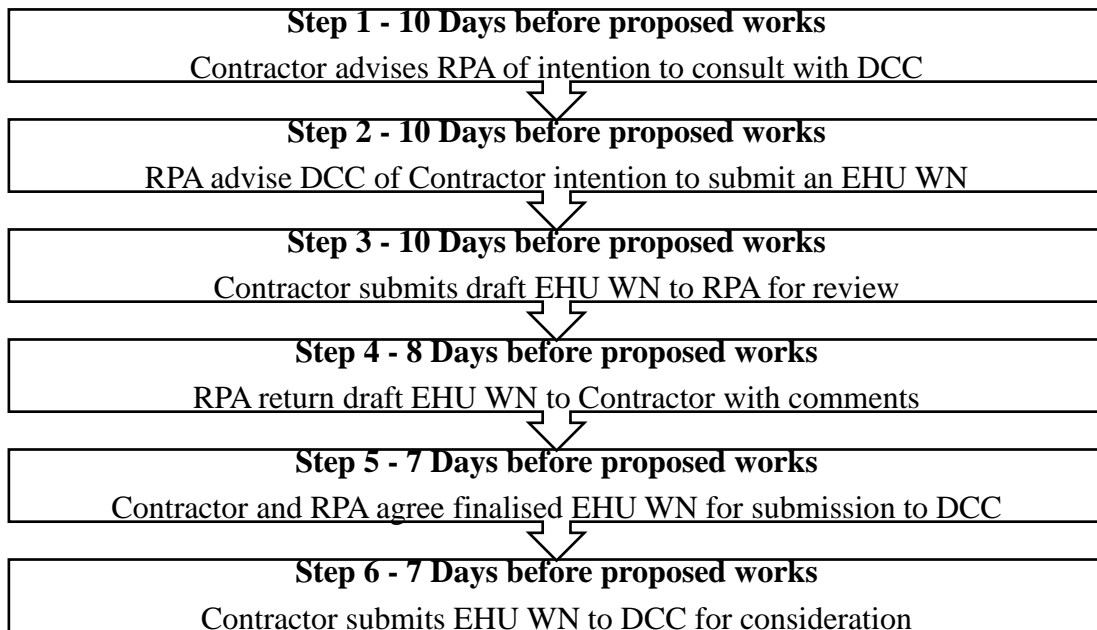


Figure 1 The Environmental Health Unit Works Notification (EHU WN) Procedure

3.5 Construction Contract Requirements

RPA prepared the Construction Contract Requirements for each contract in accordance with the strategy detailed in Section 3.1. Within each contract, a dedicated section was included for noise management during construction works. The following requirements were included for each contract:

- i. Contractor's Environmental Co-ordinator
- ii. Construction Noise and Vibration Management Plan (CNVMP)
- iii. Noise Monitoring (Section 4.3.2)

3.5.1 Construction Contractor's Environmental Co-ordinator

On previous Luas schemes, the Health and Safety officer also managed environmental matters. For LCC there was a contractual requirement that there would be an individual resource appointed by each Contractor to manage environmental issues including noise full time. This single point of contact was required to have the relevant environmental knowledge, training and experience. RPA had the contractual right to approve all proposed Environmental Co-ordinators. The Environmental Co-ordinator was responsible for preparing the CNVMP, preparing EHU-WNs, managing acoustic subcontractors and all noise complaints received. In addition, the Environmental Co-ordinator undertook weekly joint inspections with RPA personnel to ensure that the mitigations measures detailed within the CNVMP were being strictly adhered to.

3.5.2 Construction Noise and Vibration Management Plan (CNVMP)

During the construction of previous Luas schemes, all Construction Contractors were required to develop Environmental Management Plans. Both noise and vibration were considered within these Plans to varying degrees. However, given the increased awareness of noise management in major construction projects and stakeholder expectations, RPA included the requirement for all Construction Contractors to develop a contract specific CNVMP.

The CNVMP was to be the overarching framework for the successful noise management of LCC construction. Within the CNVMP the following were detailed:

- a) Contact details for key stakeholders
- b) A Stakeholder Notification Procedure
- c) Identification of contract specific noise and vibration sources
- d) Noise management measures
- e) Complaint and Incident management procedures
- f) Recording and reporting procedures

To ensure a minimum standard for the CNVMP, RPA developed a CNVMP Template in conjunction with DCC. The EHU-WN procedure was included within the template. Whilst Construction Contractors were not required to utilise the template, they were contractually required to produce a CNVMP of equivalent standard.

Once the submitted CNVMP had been approved by RPA, the Construction Contractors were required to submit their CNVMP to DCC for approval prior to commencement of construction. Contractors were also required to update their CNVMPs quarterly and submit to RPA and DCC. By ensuring that the comprehensive CNVMP was approved by both RPA and DCC, a clear message was being communicated to all Contractors that both RPA and DCC required an improvement to the standards which had been accepted on previous Luas projects.

By meeting the objectives of the CNVMP Construction Contractors would minimise noise and vibration during the construction phase, minimise exceedances of noise and vibration limits, prevent non-conformances with construction hours and minimise complaints from sensitive receivers.

4. CONSTRUCTION PHASE

4.1 Communication with stakeholders

“Good relations with people living and working in the vicinity of site operations are of paramount importance. Early establishment and maintenance of these relations throughout the carrying out of site operations will go some way towards allaying people’s fears.”¹⁰

Where noise disturbance to the occupants of sensitive receptors is a principal project concern, the most successful mitigation approach during construction works is often through consultation and good public relations¹. For LCC it was recognised by both Senior Management and the Project Team that effective communication with stakeholders would be key to success. RPA and their Contractors were committed to developing and maintaining good communications throughout the construction of LCC.

To ensure effective communications with sensitive receptors the RPA and their appointed Construction Contractors initiated the following:

- Both RPA and all Construction Contractors appointed Community Liaison Officers. These Officers met business owners, hospital and university representatives, the public on a daily basis providing constant project updates. Working with the Environmental Co-ordinator’s, these Officers investigated complaints thoroughly. By building a relationship with stakeholders, the Officers could advise the Project Team of specific requests that some receptors may have. For example, during services at churches or matinee performances at theatres “quiet time” working was initiated.
- RPA established a Project Office in the heart of Dublin city centre. Stakeholders could drop in to discuss any concerns, complaints or issues

that they may have had. The city centre Project Office also facilitated stakeholders to be informed of the most up-to-date project developments.

- A LCC project website was developed providing project updates. LCC was the first Luas project to make full use social media. Twitter and Facebook accounts were established providing updates in real time.
- On a monthly basis the Community Liaison Officers issued a Construction Update leaflet to properties in proximity to planned works. This update provided information of upcoming works and why works were necessary.
- As detailed in Section 3.4 above, for every approved EHU-WN the Construction Contractors were required to notify stakeholders and sensitive receptors of planned and approved out-of-hours Works.

4.2 Management Measures

Within the CNVMP Contractors detailed noise management measures to be implemented on site including:

- On site inductions for all workers;
- Planned toolbox talks on being a ‘Considerate Contractor’;
- Reactive toolbox talks when complaints or exceedances occurred;
- Reduction of noise at source by using electric equipment where feasible and procuring quieter models of equipment e.g. super silenced generators;
- Attended noise monitoring of new items of equipment arriving on site;
- Extensive use of noise blankets at temporary sites and hoarding at longer term sites and at construction compounds (Photographs 3-4);
- Comprehensive investigations of complaints and exceedances and a commitment to continual improvement; and
- Internal reviews and management meetings were held to discuss noise management performance and where improvements could be made.



Photographs 3-4 Acoustic blankets installed on Marlborough Street (left) and Hawkins Street (right)

4.3 Noise monitoring

4.3.1 RPA Unattended noise monitoring

RPA procured eight continuous noise monitoring systems along the alignment (Section 3.3). The purpose of installing the noise monitoring systems was twofold. In the first instance, the pre-existing ambient noise levels along the alignment could be determined over a suitable time period. However, the primary purpose of installing the monitoring system was to continuously monitor Contractors compliance with the limits as agreed with DCC.



Photographs 5-6 Continuous noise monitors on Dawson Street (left) and at Trinity College Dublin (right)

The eight monitors were configured to log selected broadband noise indices every 30 minutes. Noise indices that were measured included L_{Aeq} , L_{AFMax} , L_{A90} and L_{A10} . All LCC Contractors were provided with access to the eight continuous noise monitoring systems to view in real-time. It was a contractual requirement for the Contractors Environmental Co-ordinator to periodically check the real time results throughout the day to ensure ongoing compliance. Furthermore, all monitors were set to issue SMS and text alerts when preassigned trigger levels were breached. Continuous monitoring with real time access to the data helped enabled the contractor to proactively mitigate issues as they arose on site.

RPA downloaded data on a daily basis and monthly reports were submitted to DCC Air Quality and Noise Control Unit for each of the monitoring units. Any exceedances were clearly identified accompanied by the Contractors Complaint and Incident Management form submitted in accordance with their CNVMP.

Over the duration of LCC construction works, in excess of half a million 30 minute monitoring events were measured. Table 3 identifies the eight monitoring locations along with the number of monitoring days and exceedances experienced at each location. For each exceedance, the Contractor undertook an investigation and submitted a Contractors Complaint and Incident Management form to RPA. If there were a number of exceedances or complaints in a short duration, a meeting would be held between RPA, the Contractor and the local authority to identify why such events occurred and agreed measures, including the revocation of approved EHU-WNs, to ensure these events were not repeated.

Table 3 Unattended noise monitoring compliance per location

Monitoring Location	No. of Monitoring Days	Exceedances	% Compliance
St. Stephens Green	1,482	1	99.9%
Dawson Street	1,613	11	99.3%
Westmoreland Street	1,574	18	98.7%
The Rotunda Hospital	1,545	0	100%
Marlborough Street	1,546	11	99.3%
Trinity College Dublin	1,486	0	100%
Dominick Street	1,578	30	98.1%
St. Peters Avenue	1,282	14	98.9%

Continuous real time noise monitoring provided a valuable tool to RPA, DCC and Construction Contractors. The data allowed the demonstration of compliance with or exceedance of the noise limiting criteria. Predictions made within EHU-WNs could be compared against measured levels during ‘out-of-ours’ works. Furthermore, complaints made by the public with respect to excessive noise being experienced could be either proved or disproved.

4.3.2 Contractors attended noise monitoring

All Contractors were required to undertake a number of attended noise monitoring events. To ensure a minimum level of competency, RPA had the contractual rights to approve all acoustic subcontractors. Each event was 15 minutes in duration. All monitoring locations were agreed with the local authority in advance. Equation 1 was utilised in determining compliance. Table 4 details the number of events per contract and levels of compliance.

Table 4 Attended noise monitoring compliance per Contract

Contract	Attended Events	Exceedances	% Compliance
Cellar Infill	30	6	83%
Utility Diversion	150	37	75.3%
Main Infrastructure	300	31	89.7%

To ensure consistency, RPA prepared templates for the Contractor’s attended noise monitoring. Construction Contractors prepared a noise monitoring report for each monitoring event. This approach was of significant benefit when managing complaints from stakeholders as complainant details could easily be cross checked against individual events. In addition to the information that would be expected within a construction noise monitoring report in accordance with best practice¹¹, each report was required to contain detailed information on the type of construction equipment active during the monitoring survey along with the distance (often 1-15m) from the monitoring position. As in excess of 450 individual reports were prepared, detailed information on the noise emissions associated with construction equipment was generated. This noise library of source measurements will be very useful when preparing Environmental Impact Assessment Reports for future light rail schemes.

5. LESSONS LEARNED

Upon completion of the construction works RPA undertook a lessons learned exercise on the construction noise management of LCC. For most aspects, it was felt that the management measures worked very well. Construction noise management was effective on LCC because it was planned early. Risks were identified and mitigated using best practice methods. Simple measures were found to be highly effective once planned properly and fully implemented e.g. use of templates, toolbox talks, noise blankets etc. The importance of managing the relationship with DCC was identified as paramount to success as was good clear communication with all other stakeholders. The approaches adopted encouraged improved collaboration and the sharing of good practice and innovation between the RPA and Construction Contractors.

Complaints were still received from stakeholders. The Construction Contractors, RPA and DCC Air Quality and Noise Control Unit all received complaints, primarily from residents, in relation to construction noise. However, it was felt that all complaints were managed in a professional manner. Where complaints were justified, additional

measures including change to work practices and the revocation of approved EHU-WNs were implemented to prevent a reoccurrence.

Upon reflection it was felt that too much reliance was made of the out-of-hours procedure. In excess of 900 EHU-WNs were prepared by Contractors. This was not envisaged when the procedure was developed. Future projects will need to have a deeper understanding of likely working hours imposed due to traffic restrictions.

6. CONCLUSION

The management of construction noise emissions through the city centre was very challenging. However, with effective planning, consistent implementation and significant stakeholder and community engagement, the LCC construction noise emissions were well managed. The approaches adopted will help drive improved performance on future infrastructure schemes in Ireland.

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