Our Case Number: ABP-314724-22

Planning Authority Reference Number:

Your Reference: OPW (National Gallery of Ireland)

An Bord Pleanála

Downey Planning
29 Merrion Square
Dublin 2
D02 RW64

Date: 23 January 2023

Re: Railway (Metrolink - Estuary to Charlemont via Dublin Airport) Order [2022]
Metrolink. Estuary through Swords, Dublin Airport, Ballymun, Glasnevin and City Centre to Charlemont, Co. Dublin

Dear Sir / Madam,

An Bord Pleanála has received your recent submission and oral hearing request in relation to the above-mentioned proposed Railway Order and will take it into consideration in its determination of the matter.

The Board will revert to you in due course with regard to the matter.

The Board has absolute discretion to hold an oral hearing in respect of any application before it, in accordance with section 218 of the Planning and Development Act 2000, as amended. Accordingly, the Board will inform you on this matter in due course.

Please be advised that copies of all submissions/observations received in relation to the application will be made available for public inspection at the offices of the relevant County Council(s) and at the offices of An Bord Pleanála when they have been processed by the Board.

More detailed information in relation to strategic infrastructure development can be viewed on the Board's website: www.pleanala.ie.

If you have any queries in the meantime, please contact the undersigned. Please quote the above mentioned An Bord Pleanála reference number in any correspondence or telephone contact with the Board.

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Yours faithfully,

Niamh Thornton
Executive Officer
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OPW Oifig na nOibreacha Poiblí Office of Public Works

16th January 2023

An Bord Pleanála
64 Marlborough Street
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Re: Railway (Metrolink–Estuary to Charlemont via Dublin Airport) Order 2022 – Submissions by the Commissioners of Public Works in Ireland

To whom it may concern,

The Commissioners of Public Works in Ireland (hereinafter, The Office of Public Works (OPW)), wish to express their overall support for the Metrolink project and welcome the economic, social and tourism benefits of this major transport infrastructure to the city of Dublin.

The OPW is presenting individual submissions for consideration by An Bord Pleanála, as part of the Railway (Metrolink–Estuary to Charlemont via Dublin Airport) Order 2022 process. This cover letter forms part of the overall submission(s) and introduces observations relating to properties owned, controlled, or for which the OPW has a responsibility, along the proposed railway route.

Any issues raised in these submissions stem from the statutory role and responsibility of the Commissioners of Public Works to ensure the protection and preservation of critical State properties, historic/national monuments and the continuity of State business throughout the project.

The OPW wishes to acknowledge the positive engagement between officials from TII and the OPW over the past number of years. However, we note that there are a number of outstanding matters relating to the construction and operation phases of Metrolink which they would wish to have addressed as part of the confirmation process. While specific issues have been identified in the submissions prepared by Downey Planning,

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who have been retained as consultants advising the OPW, this covering letter sets out some, more general comments for consideration by An Bord Pleanála.

It should be noted that the submissions now made are based on the information provided at this consultation phase. Critical aspects of this project relating to physical construction methodologies have not yet been determined and, therefore, a full analysis of any impacts on properties is not possible. In that regard, submissions are only possible and limited to the information that has been made available at this juncture.

Legal Requirements

As noted above, the OPW is supportive of the Metrolink project. However, this is subject to all statutory requirements being complied with, in light of the Commissioners' duties under the Commissioners of Public Works (Functions and Powers) Act 1996 and other Acts.

Apart from that broad statutory provision, there are two specific statutory provisions to draw to the Bord's attention.

First, s.15 of the St Stephen's Green (Dublin) Act 1877 (the "**1877 Act**") provides that the Commissioners of Public Works shall maintain St. Stephen's Green as an ornamental park or pleasure ground for the recreation or enjoyment of the public and may erect any lodges or ornamental buildings or indeed provide ornamental fountains or waterworks.

This is subject to s.116 of the Dublin Transport Act 2008 (the "**2008 Act**") which dis-applies s.15 of the 1877 Act

A. to anything done for the purposes of surveys and inspections under s.36 of the Transport (Railway Infrastructure) Act 2001 (the "**2001 Act**"),
B. to any railway works (within the meaning of s.2 of the 2001 Act) carried out on or under Saint Stephen's Green pursuant to a railway order under s.43 of the 2001 Act, or
C. to restrict the operation of a railway, light railway or metro (within the meaning of s.2 of the 2001 Act) on or under Saint Stephen's Green.

While the OPW is of the view that this section is broad enough to capture the elements of construction and operation of the Metrolink project, insofar as it potentially affects or impacts on St. Stephen's Green, it only dis-applies s.15 of the 1877 Act in those particular circumstances and does not repeal same. Therefore, the confirmation of the Railway Order should ensure that the proposed Metrolink project properly falls into one or more of the criteria in s.116 of the 2008 Act.

Secondly, the Commissioners of Public Works are of the view that the requirements in the National Monuments Act 1930, as amended, would have to be complied with, irrespective of the confirmation of the Railway Order and that a Ministerial consent or consents will have to be obtained by TII where there is potential demolition of a national monument.

There is a further consideration that s.14D of the 1930 Act was inserted by the European Union (Environmental Impact Assessment of Proposed Demolition of National Monuments) Regulations 2012 (S.I. No.249/2012) (the "**2012 Regulations**") to give effect to the Environmental Impact Assessment ("**EIA**") Directive. The 2012 Regulations require the carrying out of an EIA where a decision to grant consent under s.14(2)(a) of the 1930 Act, or to issue directions under s.14A(4)(d) of that Act, would result in the demolition of a national monument. Thus, where the Minister is considering whether or not to grant a consent or issue directions, as the case may be, and it appears to the Minister that the granting of the consent or the issuing of the directions, as the case may be, would result in the demolition of a national monument but the applicant has not submitted an environmental impact statement ("**EIS**") (now an environmental impact assessment report ("**EIAR**")) to the Minister, the Minister is obliged to call for an EIAR to be submitted.

In particular, given the scale of loss of foliage at Saint Stephen's Green Park (which is a designated national monument), the proposed project could be deemed to amount to the destruction of part of a national monument and therefore a Ministerial consent will be required under the National Monuments legislation. While this will be required in any event, it is recommended that an express condition be attached to the railway order and have proposed some suggested wording later in this submission.

Staged Assessments

In the Railway Order application, the EIAR refers to Stage 3 assessments for certain properties of historical significance, cultural or monument status or protected structures. This will be a critical factor for the OPW and a requirement for detailed consultation in relation to the design development phase of the project. It is not possible at this stage to assess or fully comprehend the extent of the impacts on sensitive and historic properties. Therefore, it is imperative that the OPW is afforded an opportunity to input into this critical stage in the process, to protect such significant structures and ensure the success of the project overall for the State. Accordingly, it is recommended that the Bord exercises its power under s.43 of the Transport (Railway Infrastructure Act 2001) and attach a condition to the confirmation of the railway order which requires TII to consult with, (and provide and agree method statements), the OPW in advance of works being carried out. The proposed wording is set out later in this submission.

The properties for which a Stage 3 assessment is critical are listed in Appendix A.

In addition, while Stages 4 and 5 are not included in the Railway Order application or EIAR, the OPW considers these stages as key to the success of the project overall. The OPW would welcome the inclusion of the Stages in the process, to facilitate a process of monitoring the necessary mitigations implemented, in advance of closing out the completion of the project. These stages are further described in Appendix D. Additionally, any issues arising in Stages 3 and beyond, that result in material changes to the scheme and/or impacts on properties not set out in this current Railway Order Application should necessitate a new, additional Railway Order application, as it is likely to be materially different to that submitted in this current application. Alternatively, the Railway Order should be amended and the OPW would draw the Bord's attention to s.146D of the Planning and Development Act 2000, as inserted by s.30 of the Planning and Development (Strategic Infrastructure) Act 2006, which allows for the amendment of railway orders.

On a related point, clarity from TII is required on apparent discrepancies between drawings submitted by TII in the Railway Order. In particular, the tunnel alignment on contour drawings appear incorrect in certain places and this is referenced in some of the individual property submissions.

Property Submissions

There are individual submissions accompanying this letter with detailed observations on each property. We respectfully request that these detailed observations are considered by An Bord Pleanála and that the OPW is afforded the opportunity to discuss those observations at an oral hearing in due course. The opportunity to present at an oral hearing would be considered an important part of the process, given the national significance of the State properties that may be impacted by the Metrolink development. These include St. Stephen's Green Park (a national monument), the Houses of the Oireachtas, Government Buildings, the Cultural Institutions such as the National Museum, the National Gallery, the National Concert Hall and the GPO, among others.

In summary, the individual submissions to An Bord Pleanála cover a number of matters relating to State properties, including:

- **Building type**: All of the historic properties in the Government business district in Dublin 2, in particular, will have varying levels of sensitivity to settlement, vibration, etc. A number of these also house equipment that is sensitive to vibration, noise, etc. and have lower ground operational areas or deep foundations. The OPW would respectfully request that an express condition be

attached to the railway order that acknowledges and mitigates any adverse impact on the subject properties.

- **Future developments**: The OPW would seek to ensure that the routing of any MetroLink tunnel would not limit the State's capacity to develop its property - vertically or horizontally - particularly around or below Leinster House, Government Buildings, the National Gallery, the National Museum, and the National Concert Hall complexes. By way of example - the future of the National Concert Hall (NCH) property includes a Master Plan, currently being developed, and envisages a new Children's Science Museum on the complex. Planning Permission is in place for some extensive developments, including lower levels of buildings that may impact the MetroLink tunnel.

  The OPW would respectfully request that an express condition be attached to the railway order that acknowledges and mitigates any restrictions on future development of the subject properties.

- **Security**: The Preferred Route runs beneath the Dáil, Seanad, and Committee Chambers, as well as Government Buildings. A thorough risk assessment from the perspectives of State security will be critical to understanding the implications during any construction and operating phases.

  The OPW would respectfully request that an express condition be attached to the railway order that acknowledges and mitigates any adverse impact on the security of the subject properties.

- **Vibration, Noise, Electromagnetic Radiation and Interference**: The Oireachtas Chambers have extremely low tolerance for any external noise, vibration, or electromagnetic interference during and post construction.

  The National Museum of Ireland holds the National Archaeological Collection on behalf of the State. The National Collection contains hundreds of thousands of objects including fragile artefacts such as prehistoric ceramic vessels, and Greek and Roman ceramic and glass vessels. The National Gallery of Ireland, in particular, has concerns about the effect of ongoing low-level vibrations on priceless paintings in the State collection.

  In terms of the National Concert Hall's activities, the impact of noise and vibration during the construction and operational phases of the MetroLink are matters that would require to be mitigated.

  The former Department of Arts, Heritage and the Gaeltacht had previously expressed to the OPW the significant concerns of the Boards of Governors of the Cultural Institutions (the National Gallery, the National Museum, the National Library and the National Concert Hall).

The OPW would respectfully request that an express condition be attached to the railway order that acknowledges and mitigates any adverse impact on the subject properties.

- **Potential impacts to National Monuments:**
    - **St. Stephen's Green Park:** The OPW acts on behalf of the relevant Minister in the operation, care and maintenance of St. Stephen's Green Park; and so shares the concerns of our colleagues in the Dept. of Housing, Local Government & Heritage that the proposed station location would have a direct, severe, negative, profound and permanent impact on the heritage value of the Green.

      As presented, the proposals would not seem sufficiently sympathetic to the history and environment of the spaces within and around the Green. The OPW would urge An Bord Pleanála, when considering any Railway Order Application, to also consider the unique, inherent importance of St Stephen's Green Park to the people of Dublin and in light of the specific legal protection which has been identified above.

    - **Moore Street/Moore Lane**: The impact on the national monument properties on Moore Street now appears to be very significant, in particular in relation to the 'cut and cover' works zone proposed for the Metrolink station box. The proposed development works are very close to the boundary of the monument and includes the public roadway, Moore Lane, behind the monument site. There are also likely to be serious and lengthy impacts and disruption to the operation of a new centre of commemoration planned for the site, with a substantial State investment due to be made over the coming years.

The OPW has discussed most of these concerns with TII as part of a consultation process between our organisations over the past number of years, but would like to ensure these points are formally included in the conditions attached to any Railway Order granted.

Legal Agreements

The Commissioners of Public Works would seek to enter into appropriate, property-specific legal agreements with TII, to ensure the protection of key State properties and of the State's activities undertaken within those and other properties. Given the importance of such properties and activities, the Commissioners of Public Works consider it appropriate that An Bord Pleanála would make the Railway Order conditional on such legal agreements being in place between TII and the OPW. Creating such legal agreements between TII and the OPW would be possible only after TII make available the more detailed design and risk-mitigation measures for the construction and operational phases of the MetroLink project, and before any development begins. Therefore, the OPW would request that this aspect be reflected in the conditions set out

by An Bord Pleanála to TII, as this would provide assurances to the Commissioners of Public Works relating to future legal agreements that protect and secure State property and activities from risks associated with the construction or operations of the MetroLink.

In that regard, the OPW would suggest wording for conditions as follows (or such equivalent wording as the Bord determines appropriate). In respect of the need to ensure compliance with the National Monuments Acts:

"Prior to commencement of development, TII must ascertain whether the proposed Metrolink project will potentially result in the total or partial destruction of any national monuments and, if so, must comply with the requirements of s.14 of the National Monuments Act 1930, as amended,"

In terms of the sensitivity of the uses within many of the properties referenced in the submissions, coupled with their historic importance, the OPW respectfully requests that An Bord Pleanála consider attaching conditions to the Railway Order that ensures continuous monitoring of those properties to prevent any negative impacts. This is referenced further in the individual submissions.

In that regard, the following wording is proposed:

"Prior to commencement of development, TII will prepare detailed method statements which shall be submitted to the relevant planning authority for agreement by the planning authority. Insofar as the proposed works affect any State properties, TII shall consult and agree with the Commissioners of Public Works, and other impacted State bodies, any method statements prior to submitting to the relevant planning authority for agreement".

The OPW would also welcome the following condition to ensure that there is appropriate monitoring of the effects of the proposed Metrolink project on State parties:

"TII will be required to monitor the physical impacts of the proposed Metrolink project and future operations, on State properties in terms of noise, vibration, business interruption, loss of ecological and amenity value and submit reports (of a nature and to a standard agreed with the Commissioners and, as necessary, their clients at intervals to be agreed), to both the OPW and the relevant planning authority".

Flood Risk Management

The OPW also wishes to highlight to the Bord the area of flood risk management. As the Bord may be aware, the Guidelines on the Planning System and Flood Risk Management (DHPLG/OPW, 2009) set out a transparent framework for the

consideration of flood risk in the planning processes, including planning applications and development management. The Guidelines stress the need for a proportionate assessment of the flood risk, taking into account the potential impacts of climate change, and the need for the management of flood risk for development in flood-prone areas.

The Climate Change Sectoral Adaptation Plan for Flood Risk Management (OPW, 2019), that was approved by Government in October 2019, further emphasises the need for the consideration of the potential impacts of climate change on flooding and flood risk in the planning and design of future assets. The Metrolink will be a highly valuable piece of critical infrastructure that may well be highly vulnerable in the event of inundation, and as such, taking account of the policies referred to above, a detailed flood risk assessment might be expected of fluvial, coastal and pluvial flood risks (in addition to sealing against groundwater), with any flood risks, such as via inflow from station entrances, ventilation systems, etc., managed to a suitably high standard of protection (e.g., the 0.1% annual exceedance flood event probability), taking account of the potential impacts of climate change.

As stated above, we would respectfully welcome the opportunity to present to An Bord Pleanála at an Oral Hearing, should the Bord deem it appropriate.

Yours sincerely,

Maurice Buckley

Chairman

Appendix A:

List of properties that require Stage 3 and further Stage assessments:

- Houses of the Oireachtas, Leinster House complex
- Government Buildings
- National Gallery
- National Museum
- National Library
- Natural History Museum
- National Concert Hall
- St. Stephen's Green Park
- 14-17 Moore Street and Moore Lane
- Garden of Remembrance
- General Post Office (GPO), O'Connell Street

Appendix B: relevant correspondence between OPW and TII

- **"Re: Metrolink - Emerging Preferred Route"** – Suzanne Angley (Metrolink Stakeholder Communications Coordinator) to Chairman's Office, 21st March 2018 (by registered post)
- **"Re: Metrolink"** - Aidan Foley (Project Director, Metrolink, Transport Infrastructure Ireland) to Caoimhe Allman (Assistant Principal Officer, Property Management – Owned Properties), 28th May 2018
- **"Re: Observations of the Commissioners of Public Works in Ireland regarding the proposed MetroLink route (Emerging Preferred Route)"** - Caoimhe Allman (Assistant Principal, Property Management, Office of Public Works) to Aidan Foley (Project Director, MetroLink, Transport Infrastructure Ireland), 9th July 2018
- **"Re: Metrolink (Emerging Preferred Route)"** - Aidan Foley (Project Director, Metrolink, Transport Infrastructure Ireland) to Caoimhe Allman (Assistant Principal Officer, Property Management – Owned Properties), 8th August 2018
- **"Re: Observations of the Commissioners of Public Works regarding the proposed MetroLink route"** – Catherine Eddery (Principal Officer, Property Management – Owned Properties) to Aidan Foley (Project Director, Metrolink, Transport Infrastructure Ireland), 20th December 2018
- **"FW: Metrolink - OPW high level obs from Paul Tighe"** – Catherine Eddery (Principal Officer, Property Management – Owned Properties) to Aidan Foley (Project Director, Metrolink, Transport Infrastructure Ireland), 17th January 2019
- **"Re: Observations of the Commissioners of Public Works regarding the proposed MetroLink station at St. Stephen's Green"** - Catherine Eddery (Principal Officer, Property Management – Owned Properties) to Aidan Foley (Project Director, Metrolink, Transport Infrastructure Ireland), 5th April 2019
- **"Re: Proposed Metrolink Station at St. Stephen's Green"** - Aidan Foley (Project Director, Metrolink, Transport Infrastructure Ireland) to Catherine Eddery (Principal Officer, Property Management – Owned Properties), 9th August 2019
- **"St. Stephen's Green"** – John McMahon (Commissioner, OPW) to Michael Nolan (CEO, Transport Infrastructure Ireland), 10th June 2020
- **"Re: Metrolink Proposals for St. Stephen's Green"** – John McMahon (Commissioner, OPW to Michael Nolan (CEO, Transport Infrastructure Ireland), 20th June 2020

Appendix C: relevant meetings between OPW and TII

- **"OPW Presentation"** – 3rd May 2018
- **"TII presentation"** – 14th December 2018 (attended by Chairman)
- **"TII presentation in response to OPW concerns"** – 18th January 2019
- **"OPW St Stephen's Green Meeting"** – 22nd May 2019
- **"St. Stephen's Green"** – 12th September 2019
- **"TII MetroLink project update to OPW"** – 5th June 2020
- **"Project Update to: Office of Public Works (OPW)"** – 31st May 2021
- **"Project Update to: Office of Public Works (OPW)"** – 15th September 2022

Appendix D – Ground Movement Assessment

The following sets out the requirements for assessing the impact of ground movement resulting from underground construction, such as tunnelling, embedded wall installation, and excavation for station boxes, together with requirements for monitoring and the close out.

The Designer shall investigate the potential for ground movement associated with the design and possible construction:

a) to assess risk of building damage by identifying those zones where the implementation of the design is likely to cause ground movements which will result in risk of Damage Category 2 'Slight' being exceeded (see Table 1) or where damage exceeds the agreed tolerable limits. To assess the risks of such degrees of damage occurring and either investigate alternative designs or advise interfacing Designers that alternatives need to be considered and modify the design as necessary. To undertake an assessment of the potential consequences where there is a significant likelihood that Risk of Damage Category 2 'Slight' will be exceeded or where damage exceeds the agreed tolerable limits and identify specifically what the risks are. Design protective measures where necessary to mitigate against the risk of damage exceeding Risk of Damage Category 2 or where damage exceeds the agreed tolerable limits;
b) to demonstrate that the environmental effects of excavation induced ground movements have been considered and taken account of in the design;
c) to assess the risk of damage to utilities and to design mitigation measures in agreement with the utility owner;
d) to assess the effects of excavation to existing above-ground and underground infrastructure and to design suitable mitigation measures;
e) to indicate where property may require demolition or structural modification;
f) to enable the preparation of contingency plans to deal with residual risks.

Stage 1 – Scoping

Schedules and plans shall be prepared to identify all assets assessed to experience ground movement exceeding 1mm using conservative parameters.

Stage 2 – Initial Assessment

The designer shall carry out initial assessment calculations using simple empirically calibrated methods and moderately conservative parameters to classify the risk of damage to assets. For masonry building structures the risk should be classified in accordance with Table 1. For non-masonry buildings and infrastructure the level of risk should be determined by ensuring that deformations do not exceed tolerable values determined in consultation with the asset owner.

A schedule and plans of predicted damage shall be prepared, along with outline trigger levels.

The assessment calculations shall be based on record drawings, where available and an inspection for assessment. Assets estimated to be a risk of damage greater than Category 2 'Slight' or where damage exceeds the agreed tolerable limits require further detailed assessment at Stage 3.

Table 1 - Building damage classification

Damage Category	Description of degree of damage+	Description of typical and likely forms of repair for typical masonry buildings	Approx. crack width* (mm)	Max. tensile strain %
0	Negligible	Hairline cracks		<0.05
1	Very slight	Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection	0.1 to 1.0	0.05 to 0.075
2	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible; some repainting may be required for weather tightness. Doors and windows may stick slightly	1 to 5	0.075 to 0.15
3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Tuck pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired	5 to 15 or a number of cracks greater than 3	0.15 to 0.3
4	Severe	Extensive repair involving removal and	15 to 25 but also	> 0.3

		replacement of walls especially over door and windows required. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted	depends on number of cracks	
5	Very severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and required shoring. Windows broken by distortion. Danger of instability	Usually > 25 but depends on No. of cracks	

+ In assessing the degree of damage, account must be taken of its location in the building or structure.
* Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.
Burland, J.P. and Wroth, C.P., Settlement of Buildings and Associated Damage, Proceedings of a
Conference on the Settlement of Structures, Cambridge, 1974, pp 611 – 54 and 764 – 810;

The heritage value of a Listed or Protected Building should be considered during the initial assessment by reviewing the sensitivity of the building structure and of any particular features together with the initial assessment calculations. The heritage assessment examines the following:

a) the sensitivity of the building / structure to ground movements and its ability to tolerate movement without significant distress. The potential for interaction with adjacent buildings / structures is also considered. A score within the range of 0-2 should be allocated to the building/structure in accordance with the criteria setout in Table 2;
b) the sensitivity to movement of particular features within the building / structure and how they might respond to ground movements. A score within the range of 0-2 should be allocated to the building in accordance with the criteria set out in Table 2.

The scores for each of the two categories (a) and (b) should be combined and added to the category determined in Stage 2 to inform the decision making process. In general,

Listed Buildings which score a total of 3 or higher should be subject to further assessment as part of the Stage 3 – Detailed Assessment. Buildings that score a total of 2 or less are predicted to suffer a degree of damage which may be easily repairable using standard conservation based techniques and hence no protective measures for the building's particular features should be required. However, ultimately the professional judgement of engineering and historic building specialists should be used to determine whether additional analysis is required.

Table 2: Scoring for Sensitivity Assessment of Listed Buildings

Criteria		
Score	**a) Sensitivity of the structure to ground movements and interaction with adjacent buildings**	**b) Sensitivity to movement of particular features within the building**
0	Masonry building with lime mortar not surrounded by other buildings. Uniform facades with no particular large openings.	No particular sensitive features
1	Buildings of delicate structural form or buildings sandwiched between modern framed buildings which are much stiffer, perhaps with one or more significant openings.	Brittle finishes, e.g. tight-jointed masonry, which are susceptible to small movements and difficult to repair.
2	Buildings which, by their structural form, will tend to concentrate all their movements in one location.	Finishes which if damaged will have a significant effect on the heritage of the building, e.g. cracks through frescos.

Stage 3 - Detailed Assessment, Mitigation Design and Monitoring Plans

The Designer shall carry out detailed assessments of structures that will be affected by the works so that any monitoring works and mitigation works can be designed and implemented.

For structures at risk of exceeding Damage Risk Category 2 'Slight' or where damage exceeds the agreed tolerable limits the designer shall undertake a detailed assessment (more rigorous) to determine:

a) the influence of the structure and its foundations on the predicted ground movements (soil/structure interaction).
b) the volume loss at which the risk of damage to the structure (or any sensitive finishes/features) is 'slight' or better;
c) whether this volume loss may be achieved by the proposed excavation design/control measures;
d) any special control measures required to reduce the predicted damage to acceptable levels (i.e. Risk Category 2 'slight' damage category and below or below the agreed tolerable limits) such as significantly higher face pressures with EPBM tunnelling and the practicality of these;
e) the amount of ground movement that the structure (and or any sensitive finishes/features) can accommodate without exceeding Damage Risk Category 2 or where damage exceeds the agreed tolerable limits;
f) the level of residual risk if intrusive mitigation measures are not implemented.

The detailed assessments should include a number of iterations to determine how the risk of damage to a building may be reduced. Asset-specific empirical models shall be prepared successively using moderately conservative and best estimate parameters. If after these iterations the use of empirical methods do not reduce the risk of building damage to acceptable levels (i.e. Damage Category 2 'slight' damage category and below or below the agreed tolerable limits), the damage assessment shall be refined by increasing the sophistication of the analysis with the aim of reducing the risk of asset damage to acceptable levels and to eliminate the asset from further assessment.

If the risk of damage cannot be shown to be reduced by detailed assessment to acceptable levels, then mitigation measures shall be designed. The primary means of settlement mitigation shall be practical measures to control ground movement by good design and construction practice. This could include staged excavation sequences within sprayed concrete lining (SCL) works, ground treatment, face stabilisation, spiling / face dowels, increasing face pressure when using a tunnel boring machine (TBM), adopting stiffer walls/propping for rectangular shafts etc.

In the event that physical mitigation measures are still required (i.e. to control building damage to Damage Category 2 'slight' and below or below the agreed tolerable limits), the Designer shall seek to obtain the Asset Owners approval.

The Designer shall also undertake a comparative risk assessment to demonstrate that the risks associated with installation/implementation of any intrusive mitigation measures (such as compensation grouting) are no worse than the risks associated with the base case.

The relevant Local Authority and the OPW shall be consulted on the results of the Protected Building assessment reports and the proposals for protective measures, if any are required. The OPW shall also be consulted in relation to Listed or Protected Buildings where they would normally be notified or consulted on planning applications or listed building consent applications.

When considering the need and type of protective measures for Listed or Protected Buildings, due regard should be given to the sensitivity of the particular features of the building which are of architectural or historic interest and the sensitivity of the structure of the building to ground movement. Where the assessment highlights potential damage to the features of the building which it will be difficult or impossible to repair and/or if that damage will have a significant effect on its heritage value, the assessment may recommend appropriate measures to safeguard those features either in-situ or by temporary removal and storage off-site if those with relevant interest(s) in the building consent.

The form of monitoring of Listed Buildings should be determined based on the results of the assessment process.

Where repair works are necessary they will require the consent of those with relevant interest(s) in the building.

For railway track and track support structures the designer shall:

a) review the track surveys (including specifying additional surveys if required) and establish that ground movement can be accommodated without exceeding track standard operational tolerance in conjunction with the relevant Infrastructure Manager;
b) identify locations where fettling of the track is required pre construction and /or during construction to ensure the track geometry and clearances are acceptable.

The designer shall prepare plans and sections showing the zone of influence of the works that is defined by ground movements exceeding 1mm.

The designer shall develop an instrumentation and monitoring plan to validate that ground movements within the zone of influence are in accordance with design assumptions and that the infrastructure remains within acceptable limits. The designer shall ensure that there is a clear distinction between parameters measured to confirm the change in any parameter is in accordance with the design and parameters measured to limit damage to the assets. This plan shall identify the minimum period of time required to obtain base line data for each monitoring point.

Note: *A competent engineer responsible for the works shall consider those factors which may influence the monitoring data and shall determine an appropriate period and frequency for baseline monitoring. This decision making process will include an element*

of engineering judgement to account for the possible effects of any underlying environmental trends (seasonal, diurnal, tidal) in the assets under consideration.

Note: *The designer shall demonstrate that the monitoring system complies with the British Tunnelling Society Monitoring Underground Construction best practice guide.*

Note: A review of the monitoring system against the checklists provided in Appendix B of the BTS Monitoring Underground Construction best practice guide may be used as a tool to demonstrate compliance.

The detailed assessments shall define the control limits that need to be imposed on the TBM/SCL excavation in the zone of influence. The designer shall state these control measures on drawings and specifications.

The designer shall identify the critical parameters to be monitored and define the Asset Control Limits based on:

a) the ability of the asset or structure to withstand ground movement investigated
a) during the assessments carried out in Stage 2 and 3.
b) the risk to third party operations

The designer shall link the Asset Control Limits to actions within an Emergency Preparedness Plan.

The Instrumentation and Monitoring Plan and Emergency preparedness Plan shall be agreed with the relevant Asset Owner.

Stage 4 – Construction

Contingency plans shall be developed and agreed with the OPW to cover the risks posed to the OPW before commencement of the construction activity.

Contingency plans shall be implemented where the results of monitoring or inspection so indicate.

Ground movement and construction progress records shall be maintained and reported in regular reviews when construction processes are taking place within the zone of influence.

Predictions and assumptions made during design in respect of both ground movement and the effects which such ground movement will have on adjacent assets shall be verified by measurement during construction.

Stage 5 – Completion and Close-out

After ground movement has stopped, as confirmed by instrumentation and montoring, the designer shall prepare a "Completion Report". This shall include the following:

a) details of any modifications/mitigation measures to the existing structure;
b) graphs that show the ground movement and construction progress over time

a) with at least 3 months duration of readings which show no change;
b) a schedule showing actual movement compared to predicted movement;
c) a schedule of defects recording only the exceptions (changes) identified during the post construction defects survey;
d) details of any remedial works undertaken;
e) as-built records (including any temporary works remaining in situ on completion of the works).

Schedule of Defects

A schedule of defects shall be recorded prior to the start of construction for all buildings, structures, utilities and facilities and Outside Party assets predicted to experience ground movement exceeding 1mm.

OPW Oifig na nOibreacha Poiblí Office of Public Works

Property: National Gallery of Ireland

Location: Merrion Square West/Clare Street, Dublin 2

Submission to the Draft Railway Order 2022 (MetroLink - Estuary to Charlemont via Dublin Airport)

January 2023

GZ Gall Zeidler Consultants

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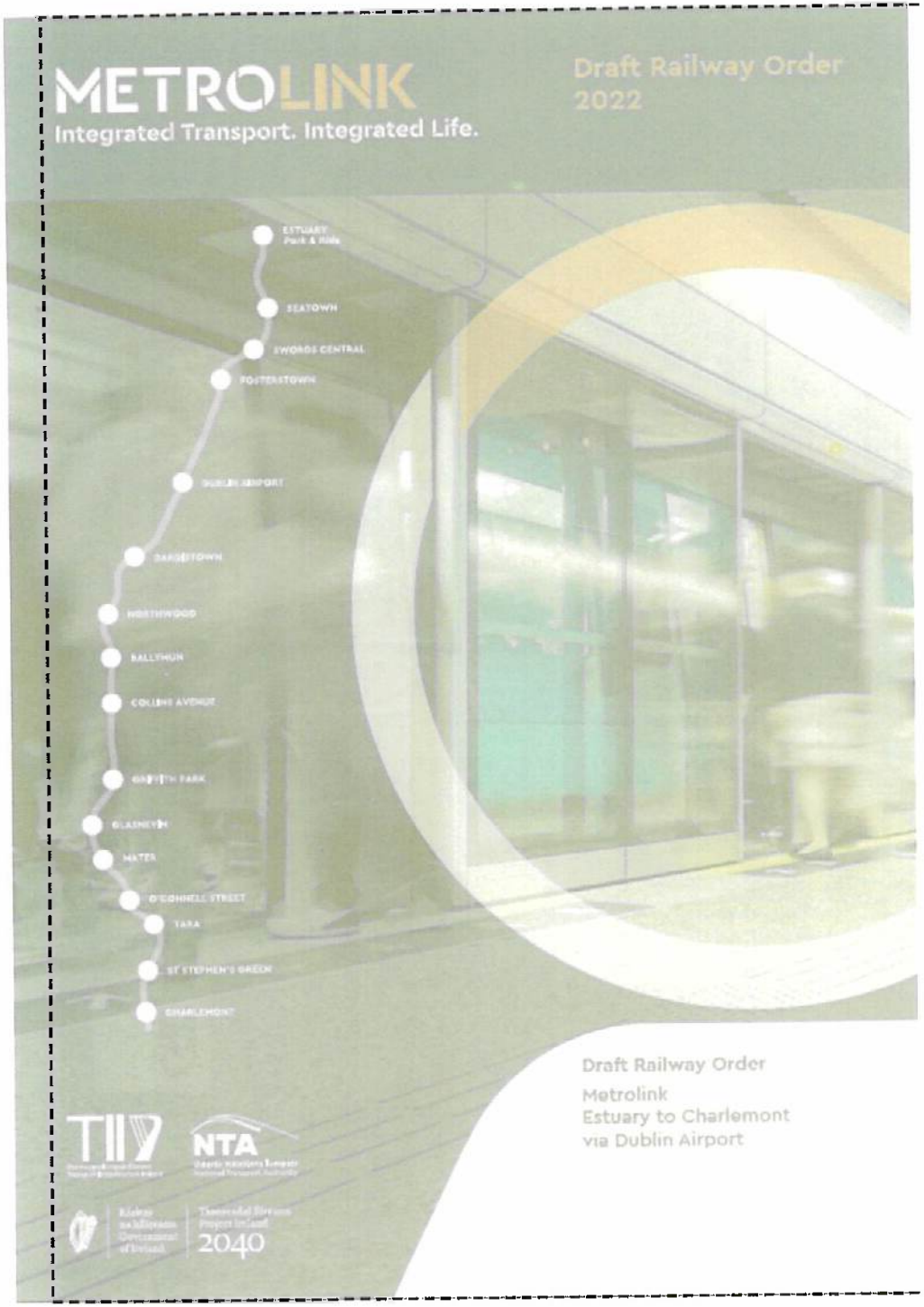


EXECUTIVE SUMMARY

With reference to the Draft Railway Order 2022 (MetroLink - Estuary to Charlemont via Dublin Airport), the Office of Public Works (OPW), OPW Headquarters, Jonathan Swift Street, Trim, Co. Meath, welcomes this strategic project and recognises the significance of its delivery to provide for a sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre.

With respect to the proportion of the State's property portfolio managed by the OPW, we will endeavour to share knowledge and information with Transport Infrastructure Ireland (TII) to facilitate the successful delivery of the project through a collaborative approach.

This submission has been prepared by DOWNEY in conjunction with Gall Zeidler Consultants, on behalf of The Commissioners of Public Works in Ireland (hereinafter the Office of Public Works (OPW)) and on foot of extensive consultation(s) with the OPW and its clients, which relates to the MetroLink route and its relationship with the National Gallery of Ireland at Merrion Square West/Clare Street, Dublin.

With respect to this property, the OPW requests that An Board Pleanála notes the sensitivity of the historic buildings and national collections located within. The OPW also seeks:

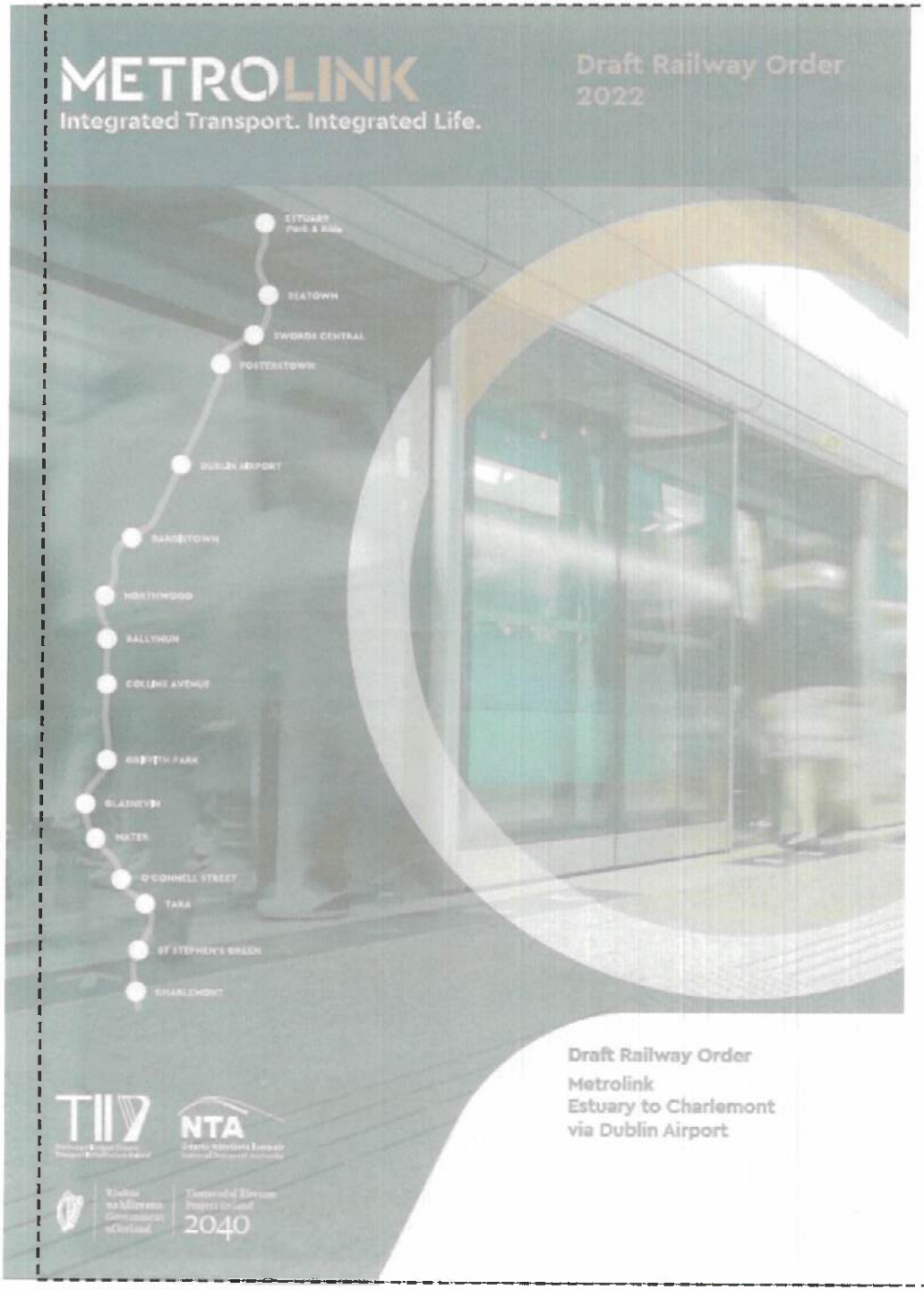
1) To ensure no disruption to the public access of the building and its day-to-day uses and functions. This includes c. 4,800 events being run by the NGI on an annual basis.

2) To ensure no damage to the building, its architectural detailing, or the collections housed therein, pre-construction and post-construction surveys, trials and monitoring is required. This is mainly concerned with noise, vibration, and dust which can damage the building, which is of historical significance as well as the valuable art works and stain glasses stored in the NGI.

3) To ensure liaising with the OPW and NGI regarding timeline of the work that needs to be carried out from site investigation through to post commissioning.

4) Basement level of the building is currently being used as a storage space with the collections kept in cabinets. Whether on the display or in the cabinets, no objects and collections are fixed in place, rather they are balanced on their own weight, and this needs to be acknowledged by TII and within the risk assessments in stage 3 to ensure no damage to the collections.

5) Precedents to be applied to the risk assessments to ensure utilising best industry practice within implementation of the Project.



6) To mitigate the noise and vibration to the acceptable levels for this cultural and government block by installing floating track slab between Chainage 17+980 and 18+400, which is the St. Stephen's Green Station.

7) Regarding the tunnel boring machine noise over a 2-weeks period when the noise is predicted to exceed the acceptable threshold, it is respectfully requested for the timeline of the work to be pushed during recess of the Dáil in order to avoid any disruption to the functions of the NGI.

TABLE OF CONTENTS

This submission is made in response to the statutory review of the Draft Railway Order. Accordingly, this submission has been prepared in the context of "Draft Railway Order 2022; MetroLink - Estuary to Charlemont via Dublin Airport" which seeks to deliver the construction of a fully segregated and automated railway and metro mostly underground c. 18.8km in length with 16 stations running from north of Swords at Estuary through Swords, Dublin Airport, Ballymun, Glasnevin, and the City Centre to Charlemont. The Draft Order is currently on public display. We would respectfully request that An Bord Pleanála consider the content within this submission. DOWNEY would like to thank the Board for the opportunity to make this submission, on behalf of the Commissioners of Public Works in Ireland (hereinafter the Office of Public Works (OPW), a prescribed body for the project as advised by An Bord Pleanála.

Downey Planning Document Control			
	Name	**Date**	**Version**
Prepared by	S.M. MIPI/N.M. CEng FICE	10/11/2022	V_01_DRAFT
	E.S. MIPI	17/11/2022	V_02_DRAFT
	E.S. MIPI	25/11/2022	V_03_DRAFT
	E.S. MIPI	04/01/2023	V_04_DRAFT
	E.S. MIPI	09/01/2023	V_05_DRAFT
	E.S. MIPI	12/01/2023	V_06_DRAFT
Approved by	E.B. MIPI	12/01/2023	V_06_ FINAL
	D.R MIPI	15/01/2023	V_06_FINAL

1.0 INTRODUCTION

This submission has been prepared by DOWNEY, Chartered Town Planners, 29 Merrion Square, D02 RW64, in conjunction with Gall Zeidler, International Consulting Engineers specialising in tunnel and underground schemes, on behalf of the Commissioners of Public Works in Ireland (hereinafter the Office of Public Works (OPW)), OPW Headquarters, Jonathan Swift St, Trim, Co Meath and on foot of extensive consultation(s) with the OPW's clients, which relates to the MetroLink route and its relationship with the National Gallery of Ireland at Merrion Square West/Clare Street, Dublin.

With reference to the Draft Railway Order 2022 (MetroLink - Estuary to Charlemont via Dublin Airport), the OPW welcomes this strategic project and recognises the significance of its delivery to provide for a sustainable, safe, efficient, integrated, and accessible public transport service between Swords, Dublin Airport and Dublin City Centre.

2.0 THE OFFICE OF PUBLIC WORKS MANDATE

The OPW was established in 1831, by an Act of Parliament: An Act for the Extension and Promotion of Public Works in Ireland. Since then, generations have enjoyed and benefited from the OPW's specialist work on state buildings, heritage sites, national parks, and flood relief measures. The primary function of the OPW continues as a key player in the implementation of Government policy and advisory to the Minister of State in the disciplines of property (including heritage properties) and flood risk management.[1] The OPW has a strong reputation for expert knowledge and is an important resource for Government and State Agencies on specialist and professional advice on architectural projects, estate management, historic properties, engineering services, and flood risk management. This expert knowledge is crucial in supporting decisions across Government and is vital within the MetroLink's plan making process. The OPW will endeavour to share its knowledge and provide advice to Transport Infrastructure Ireland (TII hereinafter) as part of this submission to An Bord Pleanála on the Draft Railway Order application.

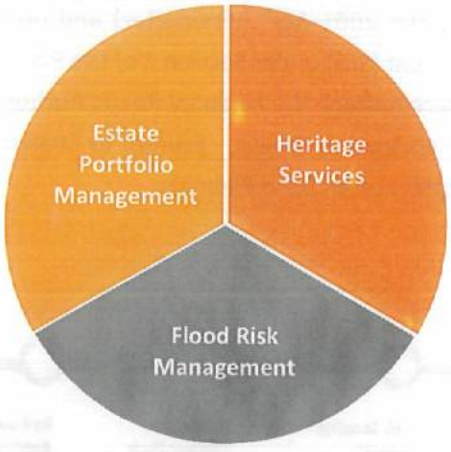


Figure 1. The OPW's Main Areas of Work

[1] *For more information, you can read the "Office of Public Works; Statement of Strategy 2021-2024" retrievable here: https://assets.gov.ie/134839/b52e1b97-bfe4-4948-9434-de0118f111bd.pdf*

The OPW provides a shared service in the area of property management and property maintenance incorporating architectural, engineering, valuation, quantity surveying, project management, art and facilities management and the conservation, preservation and presentation of heritage and cultural properties. The OPW is the lead agency for flood risk management in Ireland. This expertise will be maintained within the OPW's submission to support and engage with TII and the Draft Railway Order application.

The OPW manages a significant proportion of the State's property portfolio which stands at c. 2,500 properties and which accommodate Government Departments and includes c. 700 Garda properties. A key function of the OPW is the maintenance and operation of Ireland's most iconic heritage properties, including the State's two World Heritage Sites, c. 800 National Monuments and over 2,000 hectares of gardens and parklands.

Additionally, the OPW is a key player in infrastructure delivery for the State. In relation to flood risk management, the OPW has delivered some 150 flood relief schemes under the National Development Plan 2018-2027 as part of Project Ireland 2040 and maintains some 12,000km of river channels and 800km of embankments.

The OPW considers good governance to be central to the effectiveness of its operations, and recognises its importance in discharging its statutory, administrative and policy obligations.

It is the OPW's priority to maximise the efficient use and value of the State property portfolio, minimise the extent and impact of flooding, protect and promote our national built heritage, and excel in organisational performance and service. The OPW manages a significant number of properties along the route, including a number of historical and nationally important properties.

3.0 OVERVIEW OF THE DRAFT RAILWAY ORDER

On 30th September 2022, governed by Section 37 of the Transport (Railway Infrastructure) Act 2001 (as amended and substituted) ("the 2001 Act" hereinafter) and proposed within the definition of Strategic Infrastructure Development (SID) under Section 2 of the Planning and Development Act 2000 (as amended) ("the 2000 Act" hereinafter), the National Roads Authority (operating as TII) submitted the Draft Railway Order for the MetroLink Project - Estuary to Charlemont via Dublin Airport [2022] ("the proposed Project" hereinafter) to An Bord Pleanála.

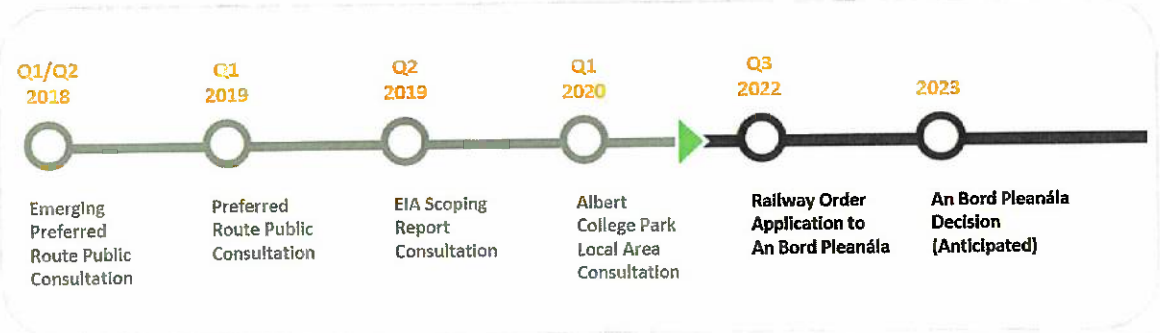


Figure 2. The Proposed Project Roadmap (extracted from Chapter 8 of EIAR enclosed with the proposed Project application)

With an objective to "*provide a sustainable, safe, efficient, integrated and accessible public transport service between Swords, Dublin Airport and Dublin City Centre*", the proposed Project seeks to deliver the construction of a fully segregated, high-capacity, and high-frequency automated railway and metro between Estuary Station and the Park and Ride facility, north of Swords via Dublin Airport to Charlemont Station, with approximately 18.8km length, which is mostly underground. The proposed Project comprises 16 new stations along the alignment, comprising of Estuary Station at surface level, four stations at Seatown, Swords Central, Fosterstown and Dardistown in retained cut, and Dublin Airport Station along with the remaining ten stations which will be underground.

Other principal project elements include a multi-storey 3,000-space Park & Ride facility at Estuary, two viaducts, one over the Broadmeadow and Ward Rivers, and one over the M50 Motorway, an Operational Control Centre, and Maintenance Depot at Dardistown, and intervention tunnels and shafts associated with Dublin Airport South Portal (DASP), located on the City Tunnel at Albert College Park, and south of Charlemont station.

The proposed Project has been designed to interchange with existing and future elements of the transport network. The key interchanges are as follows:

- Dublin Airport.
- The Western Commuter Line also known as the Maynooth Line (formerly the Midland Great Western Railway) and the South-Western Commuter Line also known as the Kildare Line (formerly Great Southern and Western Railway) at Glasnevin Station.
- The DART at Tara Station.
- Luas Lines (at O'Connell Street, St Stephen's Green and Charlemont Stations).
- The Dublin Bus network and the future BusConnects network.

Temporary elements to the proposed Project will comprise Construction Compounds, Logistics Sites, and Tunnel Boring Machine Launch Sites, which are essentially to facilitate the construction phase of the development. This encompasses 34 Construction Compounds, including 20 main Construction Compounds at each of the proposed station locations, the portal locations, and the Dardistown Depot location, as well as 14 Satellite Construction Compounds located at other locations along the alignment. Main logistics sites will be located at Estuary, near Pinnock Hill east of the R132 Swords Bypass and north of Saint Margaret's Road at the Northwood Compound. There will be two main Tunnel Boring Machine (TBM) launch sites, with one located at DASP, which will serve the TBM boring the Airport Tunnel and the second located at the Northwood Construction Compound, which will serve the TBM boring the City Tunnel.

TII carried out numerous public consultations on the Preferred Route over an eight-week period from the 26th of March 2019 to the 21st of May 2019. Over 1,000 people attended the five public events, which were held at key locations along the route. While extensive pre-planning consultations also took place between TII and the OPW, a detailed assessment of the individual properties affected has not yet taken place. The Draft Railway Order application 2022 is a Draft Order, and should the route be approved by An Bord Pleanála, further detailed design will be submitted which will require further consideration and approval. Factors such as the internal uses of the properties, their construction methods, age and historical importance and the effect of construction on these sensitivities has not

been assessed as part of the Project thus far. Additional consideration needs to be given to the potential effects on the built environment before a route and construction method can be confirmed. The OPW reserves the right to make further commentary, pending more detailed design proposals.

The statutory consultation period commenced on the 7th of October 2022, with an initial 6-week timeframe for submissions, i.e., the closing date for submissions was the 25th of November 2022 at 5.30pm. Pursuant to Section 40(1)(b) of the Act and as stated in the public notice published on the 25th of November 2022, this consultation period was further extended to the 16th of January 2023.

4.0 NATIONAL GALLERY OF IRELAND

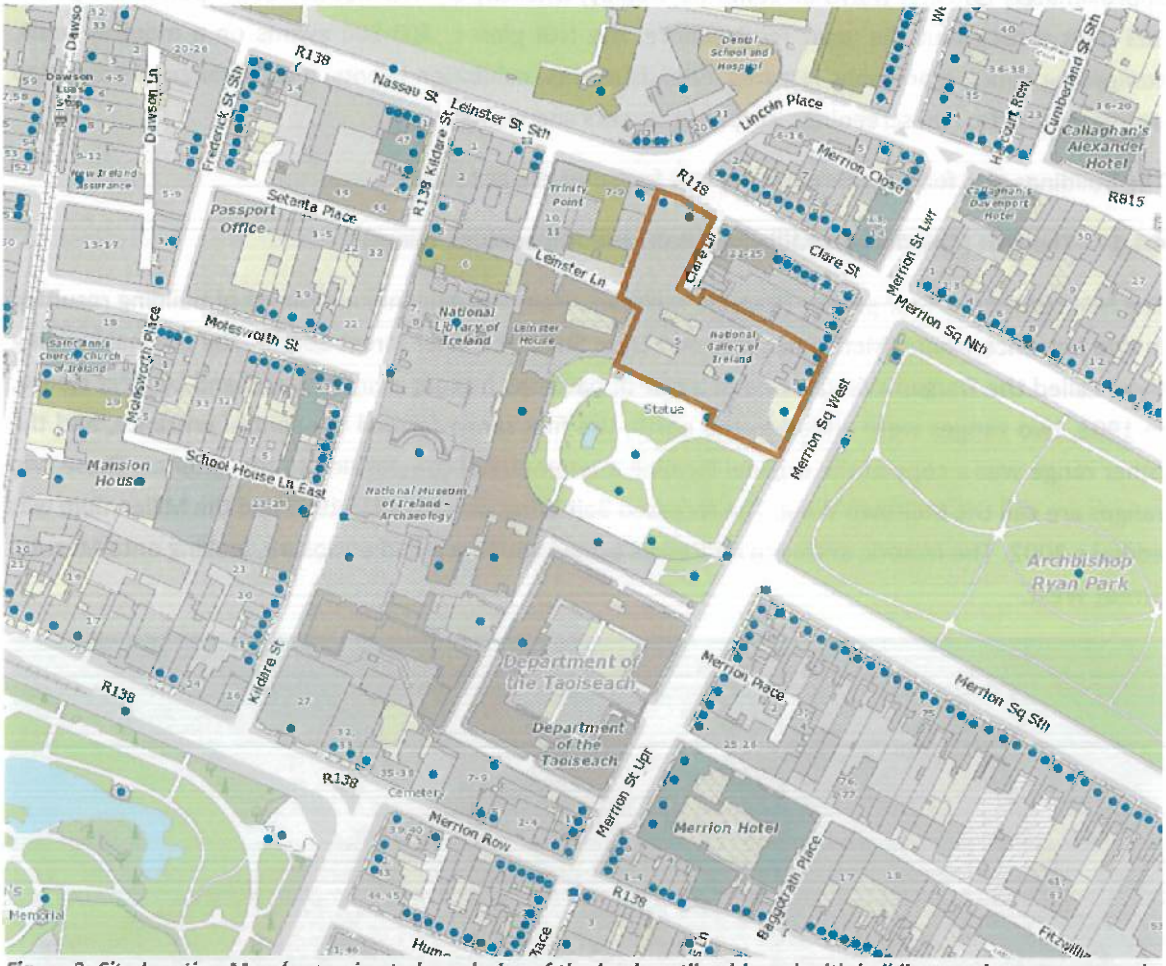


Figure 3. Site Location Map (approximate boundaries of the lands outlined in red with buildings and structures on the National Inventory of Architectural Heritage (NIAH) marked in blue (Map extract from archaeology.ie with Ordnance Survey Base-map)

4.1 Property Location & Description

The **National Gallery of Ireland** (Gailearaí Náisiúnta na hÉireann) is one of the most significant national cultural institutions in Ireland, located at Merrion Square West/Clare Street, Dublin 2 Ireland. Situated in the historic Georgian heart of Dublin, it is part of a museum quarter that comprises the National Museum, Natural History Museum, National Library and is immediately adjacent to the Dáil at Leinster House. The property is bounded by Merrion Square West to the east, Leinster Lawn to the south, LH2000 to the west, and Clare Street to the north.

The original design was by Francis Fowke. However, the complex has been enlarged a number of times. The historic entrance of the NGI faces onto an enclosed garden off Merrion Square West. A 2002 iconic entrance front addresses Clare Street and is orientated towards the tourist centre of Trinity College. In addition, the Georgian townhouses at Nos. 88-92 Merrion Square West accommodate the NGI administration offices.

The NGI house national collection of Irish and European Art and has an extensive, representative collection of paintings, sculptures, and engravings. Some of the metrics apply to the NGI activities,

include c. 750,000 visitors per annum, a collection of approximately 16,000 art works, a collection of approximately 600 arts works on continual display, whereby the NGI has its doors open to the public 363 days throughout the year. Furthermore, the NGI plan c. 400-500 events on a monthly basis, comprising tours, workshops lectures, Friends events, exhibition events, a wide range of education events, concerts, film screenings, corporate events and more.

The buildings and features forming the NGI footprint are as follows:

4.1.1 The NGI (The Dargan, Milltown, Beit, and Millennium Wings)

The NGI consists of four phases (Dargan, Milltown, Beit, and Millennium Wings) of building resulting in two entrance fronts (Merrion Square and Clare Street/Leinster Street South). The original building (now called the Dargan Wing) is one of a pair of pavilions framing Leinster Lawn and Leinster House. In 1902, two ranges were added to the north; the first range formed the central entrance, and the other range was a copy of the original forming a symmetrical composition to the exterior. These two ranges are call the Milltown Wing. The recessed Beit Wing was added in 1966 and the Millennium was added c.2002. The historic entrance addresses a lawn within a railed enclosure, looking onto Merrion Street West.

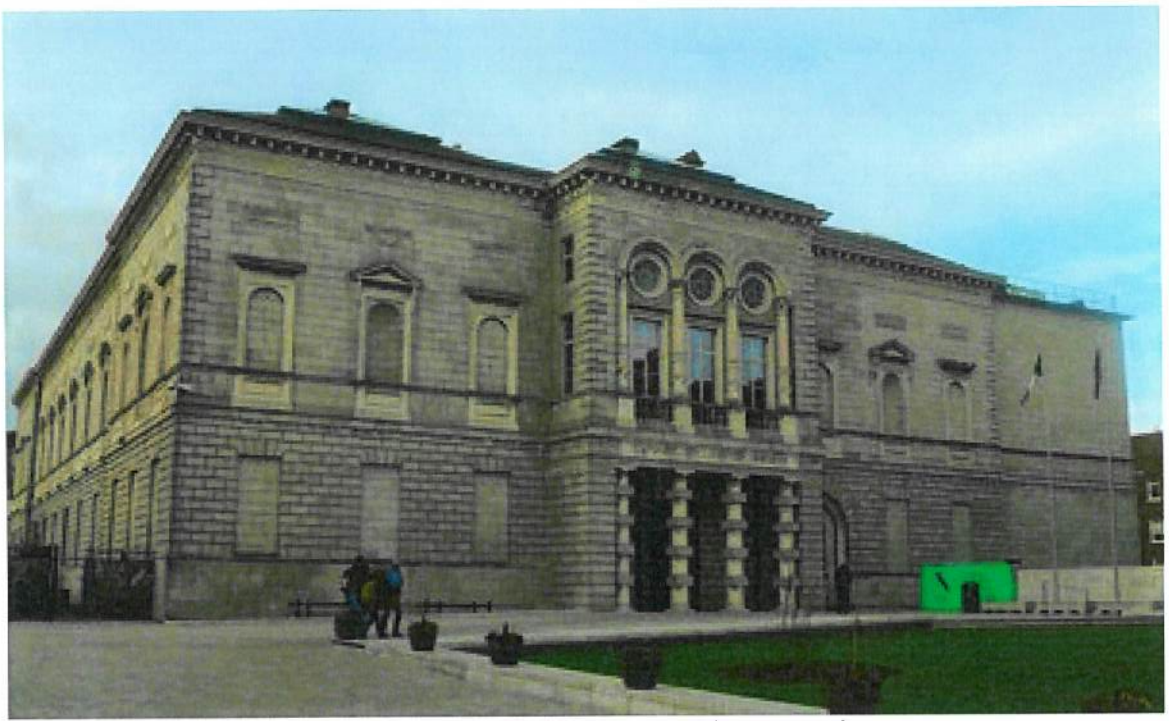


Figure 4. The National Gallery of Ireland, Merrion Square Front Elevation (Image: NIAH)

This building is a large free-standing rectangular-plan two-storey building built in 1854 with its doors opened ten years later. With square-headed window openings to short sides with moulded surrounds, the east elevation (entrance front) consists of the c. 1902 two-storey breakfront with single storey rusticated loggia, flanked by three-bay two-storey blank façades dating from c. 1858 and c. 1902. A c. 1968 plain blank recessed façade has extended the building to the north. The south elevation addressing Leinster Lawn is blind twelve-bay two-storey elevation in the same style as the recessed flanks. Other elevations abutted by later blocks and are not visible. The 1858-1902 building is

constructed of granite ashlar with rustication to the ground floor and Portland stone detail. The 1968 extension continues the materials and stringcourses on an otherwise blank elevation. The interior is single- and two-storey over partial basement, top-lit by skylights from the restored roof lights. The interior displays good joinery detailing in the entrances between the exhibition rooms.

The Millennium Wing of 2001 to the north links with a secondary entrance on Clare Street. Designed by Benson and Forsyth, following an international design competition, this Wing is a significant instance of contemporary architecture utilising modern construction with possible reinforced concrete and it is understood to have limestone cladding to the exterior. This building is a corner-sited multiple-bay four-storey extension with flat roof and roof lights concealed behind Portland stone parapet.

The interior comprises a quadruple-height entrance hall with plastered walls, square-headed openings, tapestry by Louis le Brocquy to the east wall, stairs hall with plastered walls and Portland stone steps, double-height winter garden to the west, Portland stone walls to the east and west, bounded by ballroom to the south and rear elevation of No. 5 Clare Street to the north with glazed roof. Many aspects of the buildings could be susceptible to vibration or changes to its environment. The Millennium Wing contains the gallery space, a restaurant, a shop, and administrative offices.

Figure 5. he National Gallery of Ireland, Clare Street North Elevation (Image: NIAH)

4.1.2 5 Clare Street/Leinster Street South

5 Clare Street is an attached four-bay four-storey over basement former Georgian townhouse, built in c. 1760 and re-modelled c. 1850, incorporated into the Millennium Wing of the NGI. It has the typical construction of brick elevation, M-profile pitched roof and suspended timber floors with delicate plasterwork. The front elevation has 19th century applied decorative plaster work.

The interior contains unique plasterwork due to its specific history. It is unusual for the whole rear to be flanked with bow windows. These rooms created in the late 18th century have Neo-Classical plasterwork. The rear elevation fronts an internal roofed courtyard occupied by the Gallery café. A free-standing ballroom is also incorporated into this space. The building was conserved in c. 2007.

Figure 6. Left Photo: The Millennium Wing; Right Photo: Clare Street 5/Leinster Street South

4.1.3 88-90 Merrion Square West

Nos. 88-90 is a unified four-storey terrace forming a Georgian streetscape along Merrion Square West. Developed as part of the Fitzwilliam Estate, the square has the best-preserved Georgian streetscapes in Ireland. Three sides have terraced houses of eighteenth and nineteenth-century date, while the west side is interrupted by the garden to Leinster House and the neighbouring Natural History Museum and National Gallery. This Georgian terrace, having some of the earliest of the square's houses, maintains a relatively uniform building height and design, attributed to standards promoted in Fitzwilliam's leases.

(a) No. 88 Merrion Square West

No. 88 Merrion Square West, Dublin is an attached two-bay, four-storey former townhouse over basement, built in c. 1765, forming part of a unified terrace (Nos. 88-93). No. 88 Merrion Square West was built by Columbine Lee Carré as part of a unified architectural composition with its neighbours and has granite quoins to one end of the facade. The house was modified by J.J. McCarthy in the mid-nineteenth century, with the addition of larger oriel windows overlooking Leister Lawn, and a projecting porch with good detailing. It is likely that the staircase, with its heavily carved starting newel, was also inserted at this time. The continuous balcony to the first floor is a very decorative addition, and other details, such as the woodwork to the oriels, the brick cogging to the eaves, and the railings enhance the building, make the whole a notable and visually pleasing composition next to the NGI.

Located within the Conservation Area in Dublin City Development Plan 2022-2028 and registered under RPS Ref. No. 5195 of the Dublin City Council's Record of Protected Structures, this Georgian building is designated as a Protected Structure. The building is currently in office use by the NGI.

Figure 7. Street View to No. 88 Merrion Square West, Dublin

(b) No. 89 Merrion Square West

No. 89 Merrion Square West, Dublin is an attached three-bay, four-storey former townhouse over basement, built in c. 1755, forming part of a unified terrace (Nos. 88-93). This elegant Georgian building breaks forward slightly from neighbouring houses and having four-bay rear elevation abutted to the south end by three-storey tower-like return with chamfered corners linked to the main building by slightly lower and recessed block with glazed roof.

Developed as part of the Fitzwilliam Estate, the square is one of the best-preserved Georgian streetscapes in Ireland. The north, east and south sides of the square have houses of eighteenth and nineteenth-century date, while the west is terminated by the garden front of Leinster House and the neighbouring Natural History Museum and National Gallery buildings. The terraced houses on the west side maintain a relatively uniform building height and design, attributed to standards promoted in Fitzwilliam's leases and are among the earliest on the square, dating from the 1750s-60's. No. 89 was built by Columbine Lee Carré as part of a unified architectural composition with its neighbours terminated to the north and south ends by granite quoins. This house is treated as a central breakfront, standing slightly forward of its neighbours. The Georgian façade of the building is enhanced by its lively brickwork, which is finished with distinctive tuck-pointing, and by its fine doorcase, well-retained setting and decorative details.

Located within a Conservation Area in Dublin City Development Plan 2022-2028 and registered under RPS Ref. No. 5196 of the Dublin City Council's Record of Protected Structures, this Georgian building is designated as a Protected Structure. The building is currently in office use of NGI.

Figure 8. Street View to No. 89 Merrion Square West, Dublin

(c) No. 90 Merrion Square West

No. 90 Merrion Square West, Dublin is an attached two-bay, four-storey former townhouse over basement, built in c. 1755, forming part of a unified terrace (Nos. 88-93). Having a three-bay rear elevation, this building has an M-profile slate roof, hipped to the north end, and pitched to the south, concealed behind brick parapet with granite coping, and having rendered chimneystack to south party wall with clay pots.

Developed as part of the Fitzwilliam Estate, the square is one of the best-preserved Georgian streetscapes in Ireland. The north, east and south sides have houses of eighteenth and nineteenth-century date, while the west side is terminated by the garden front of Leinster House, the Natural History Museum and National Gallery. The houses maintain a relatively uniform building height and design, attributed to standards promoted in Fitzwilliam's leases. The residential houses on the west side are among the earliest, dating from the 1750s and 1760s. It was built by Columbine Lee Carré as part of a unified architectural composition with its neighbours and the quoin work indicates that it was built after its neighbour to the south and before its neighbour to the north. The interior retains some delicate plasterwork. It was modified in the early twentieth century with the insertion of the purpose-built Edwardian study, retaining fitted bookshelves, timber over-doors and a good chimneypiece.

Located within a Conservation Area in Dublin City Development Plan 2022-2028 and registered under RPS Ref. No. 5197 of the Dublin City Council's Record of Protected Structures, this Georgian building is designated as a Protected Structure. The building is currently in office use NGI.

4.2 Historical Context/Conservation Status

The history of urban ensemble centred on the garden front of Leinster House commenced with the construction of then Kildare House in 1744 by James Fitzgerald, the 20th Earl of Kildare, later 1st Duke of Leinster, with alterations to a completion of interiors in 1775. Merrion Square was laid out in 1752, and in 1762 townhouses on the west side, including Nos. 88-91 were already in place. In 1814, Leinster House and lawn was sold to Royal Dublin Society. In 1857, the Natural History Museum was completed

on the south side of Leinster Lawn and linked to Leinster House by a stone screen wall. Dargan Wing (the first part of the NGI complex) was founded and built between 1859-64. The design was clearly inspired by Natural History Museum building and was built symmetrically to Leinster House leaving Leinster Lawn in the middle of an urban ensemble.

Structure	RPS No.	NIAH Ref	Importance	NIAH Categories
The National Gallery of Ireland	5191	50100233	National	Architectural, Artistic, Cultural, Social
Statue of William Dargan, in grounds of the NGI	5192	50100234	Regional	Artistic, Historical
Statue of George Bernard Shaw, in grounds of the NGI	5193	-	-	-
5 Clare Street	1882	50100205	Regional	Architectural, Artistic, Historical
88 Merrion Square West	5195	50100232	Regional	Architectural, Artistic
89 Merrion Square West	5196	50100231	Regional	Architectural, Artistic
90 Merrion Square West	5197	50100230	Regional	Architectural, Artistic

4.3 Current Use/Uses

The NGI is a three-story over basement building situated to the rear of Leinster House fronting onto Merrion Square and Lincoln Place. The gallery has recently been refurbished and includes an open atrium to roof level. The uses of the buildings are directly related to the public display of art or ancillary to this purpose, and this includes:

- Display of art, including temporary and permanent exhibition spaces and show rooms.
- Storage of art, including library, archive, and recordings.
- Conservation of art.
- Prints and drawings study room.

This is complemented by ancillary uses that facilitate every-day use of the gallery, consisting of the administration offices, buildings services, etc. For this purpose, there is minimal office space that has modern office services and is carpeted throughout. A restaurant and café, as well as a gift shop have also been provided within the complex. It is important to note that the NGI building infrastructure, including the (a) Basement Plant Rooms, (b) Basement Stores, (c) Art Storage and Art Handling Rooms, (d) House No. 5 which contains collections material, and (e) Energy Centre, and having access to these areas are of high significance for the NGI.

There is a concern that these construction activities will cause vibrations to such an extent as to risk damaging the Art Works. For the most recent development at the NGI, the OPW appointed PUNCH Consulting Engineers to manage the impact of vibrations of buildings and collections. Monitoring was conducted at critical points throughout the buildings and daily "graphically" reports issue to Conservation to monitor conditions. This proved to be very successful and enabled the NGI to have confidence in and maintain some level of influence over factors outside of their control.

The NGI would like the same practice to be implemented from site survey investigation stage right through to post commissioning. Typically, to receive benchmarks, the NGI would like Vibration Monitoring to begin six months in advance of site survey investigations and remain in place for one year post Metro Rail operation.

It is important to note that during the previous Luas Constructions Works and the NGI Masterplan development Works, vibration monitoring proved to be a key stage to ensure the protection of the NGI and collections. As cited in the research paper "*The Effects of Vibrations on the Condition of Sensitive Paintings*" by Patricio Chiriboga Arroyo, TU Delft of The Netherlands: "*Vibration effects on canvas paintings have been a major concern for museums due to the dramatic increase in loans in the recent years. The precautions to mitigate vibration effects for works of art in museum environments are taken without truly understanding the nature of the problem... A "sensitive" canvas painting refers to one with severely cracked paint layers and aged materials. Vibrations are induced in the structure from a variety of excitation sources (transport, construction, traffic, loud events, and concerts, etc.) in each subsequent vibration motion of the canvas, this is a delamination growth in the interface between canvas and paint layers (flakes). The progressive and localised damage is cumulative over the history of the painting with a final structure failure or paint loss which produces decay in the aesthetic value of the work of art.*"[2] In addition, outlined in the research paper "*Vibration*" by Dr Bill Wei, "*While some museums allow, as an average level, vibrations up to 1.4mm/s, but that constantly staying above can adversely impact art collections.*" For further information in this regard, please see Appendix 1 of this submission.

In conclusion, vibration limits of 5mm/s are standard for dwellings or general building stock reducing to 3mm/s for sensitive or listed buildings. It has been advised by the NGI that vibration tolerance bands for the NGI during construction and operation phases of the MetroLink should be as follows:

- Acceptable Tolerance Level is 0.8mm/s.
- Upper Permitted Tolerance Level be 1.0mm/s.
- Outer Tolerance Level be 1.4 mm/s – All works should cease.

For further information in this regard, please refer to the Appendix 2 of this submission, which is a Vibration Monitoring Method Statement, carried out by PUNCH Consulting Engineers for the NGI.

4.4 Planning Context

In terms of the planning history pertaining to the subject property and the surrounding area, in particular, recent and live application(s) with an expected notable impact, and as outlined in the Planner's Report of the Draft Railway Order 2022, "*No planning applications are affected by the tunnel alignment between St. Stephen's Green Station and Charlemont.*"

It is noted that DOWNEY have also carried out an examination of the planning history pertaining to the subject property and the surrounding area, which determined that there is no planning application made on the site nor its adjacent properties.

In relation to the Draft Railway Order's consistency with planning policy and planning guidelines, a non-exhaustive list of planning policy and legislation at National, Regional, and Local levels, is included in Appendix 3 of this submission, and the Board are invited to refer to this for further details. We

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[2] *For further information in this regard, please see:* https://repository.tudelft.nl/islandora/object/uuid:a30b358e-d0de-4a81-92f3-e9f255443043/datastream/OBJ/download

would respectfully request that An Bord Pleanála ensure that TII have fully assessed the Project regarding existing planning policy, as well as adherence to the relevant local policies and guidelines pertaining to each individual property.

DOWNEY note that this proposed Draft Railway Order is a strategic long-term development and An Bord Pleanála may consider Draft Development Plans in assessing the Project. It is also crucial to note that on foot of a granted Order and during the detailed design stage, a revision to planning policy is expected, whereby adopted plans and legislation may have to be adhered within this stage. This may require an amendment to the Draft Railway Order and further assessment, including public consultation.

4.5 Potential Development of the Property

The NGI building itself is a protected structure in a sensitive location. It is unlikely that permission will ever be sought in the future to extend upwards. However, development potential of this property includes the possibility of building multiple basement levels.

As mentioned earlier, the NGI footprint includes the Dragan Wing, Milltown and the Millennium Wings as well as the Merrion Square West 88/90, together with the OPW's control of 91/92 Merrion Square West. The two latter are potential sites for the Masterplan Phase 4 development of the NGI.

Moreover, the NGI reserved a site behind Nos. 90-93 Merrion Square West that extends to Clare Lane and the Clare Court apartments. This is also for the future development of the NGI, as part of the Masterplan development with essential access from Clare Street and Clare Lane that cannot be undermined. Access to this site will be required at all times.

Furthermore, as part of the refurbishment works to the Historic Wings, the NGI are installing a new racking storage system as part of the relocation of the art storage area from within the Milltown Wing to the Millennium Wing adjacent. The refurbishment works to the Milltown Wing will consist of the excavation, underpinning and breaking out for basement level ducts as well as forming the vertical distribution routes.

5.0 MATERIAL CONSIDERATIONS

The alignment drawing ML1-JAI-EIA-ROUT_XX-DR-Y-04025 and the Contour drawing ML1-JAI-EIA-ROUT_XX-DR-Y-21148 show different alignments. This error has resulted in deficient information within the SID application submitted under Section 2 of the Planning and Development Act 2000 (as amended), to assess the vulnerability of damage due to vibration cause by both tunnelling and operation of underground train on this section of the alignment. This affects several buildings under the management of the OPW, particularly within the Kildare Street, Merrion Square and St. Stephen's Green areas.

6.0 LEGAL CONSIDERATIONS

The Commissioners of Public Works would seek to enter into appropriate, property-specific legal agreements with TII, to ensure the protection of key State property and of the State's activities undertaken within those and other properties. Given the importance of such properties and activities,

the Commissioners of Public Works consider it appropriate that An Bord Pleanála would make the Railway Order conditional on such legal agreements being in place between TII and the OPW. Creating such legal agreements between TII and the OPW would be possible only after TII make available the more detailed design and risk-mitigation measures for the construction and operational phases of the MetroLink project, and before any development begins.

Therefore, the Commissioners of Public Works would request that this aspect be reflected in the conditions set out by An Bord Pleanála to TII, as this would provide assurances to the Commissioners of Public Works relating to future legal agreements that protect and secure State property and activities from risks associated with the construction or operations of the MetroLink.

7.0 ENGINEERING CONSIDERATIONS

This Section will cover the technical information from the engineers as it relates to the property.

7.1 General Considerations

7.1.1 Route Alignment

The tunnel alignment does not pass directly beneath the NGI, however there is inconsistency in the alignment between Tara Station and St. Stephen's Green. The alignment drawing ML1-JAI-EIA-ROUT_XX-DR-Y-05025 and the Contour drawing ML1-JAI-EIA-ROUT_XX-DR-Y-21148 show different alignments.

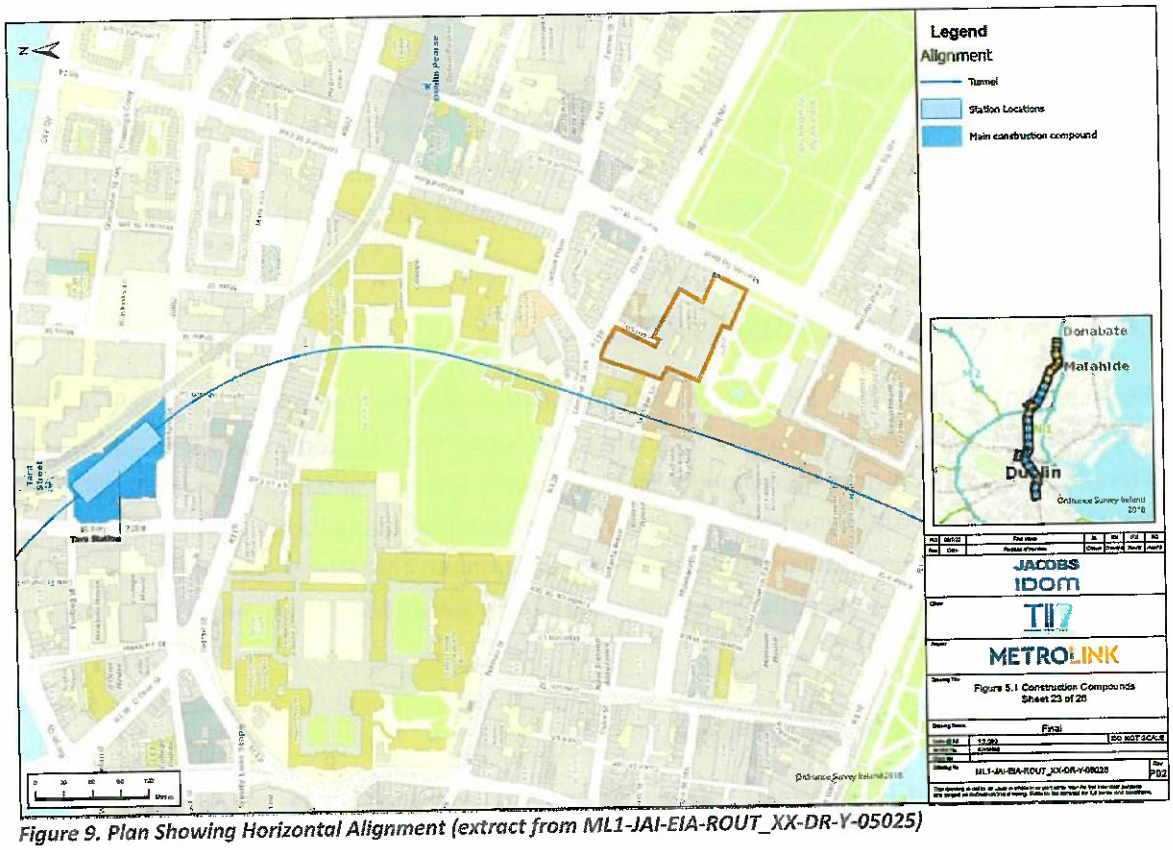

Figure 9. Plan Showing Horizontal Alignment (extract from ML1-JAI-EIA-ROUT_XX-DR-Y-05025)

Figure 10. Geological Section

Beneath the NGI, the proposed MetroLink 8.5m ID tunnel will be excavated through Argillacous Limestone rock (CLU) that underlies Brown Boulder Clay (QBR), containing fluvio-glacial sands and gravels. Cover to the tunnel crown is 18m including 5m of rock cover.

7.1.2 Tunnelling

The MetroLink 8.5m ID tunnel will be excavated by Tunnel Boring Machine (TBM). The ground conditions along the route are variable and therefore the machine could be either Earth Pressure Balance (EPB) or Slurry (STB). A modern Variable Density TBM would also be suitable and is currently being used in the UK for similar ground conditions. All these machines are able to control the ground movement with appropriate tunnel management. The 980m drive between Tara Station and St. Stephen's Green will be entirely within the Argillaceous Limestone.

7.1.3 Station Excavation

The NGI is situated approximately 535m from Tara Station Box and approximately 335m from St. Stephen's Green Station Box. The excavation for these stations is unlikely to affect the NGI.

7.2 Programme Overview

Overall Project duration 9 years

Station construction 3 to 6 years

Tunnelling – Airport Tunnel 30 months, City Tunnel 45 months

7.3 Contractual Arrangement

TII intend to procure the detailed design and construction of the proposed Project using Design and Build contracts that will be divided up by geographical section and by type of works. Under this form of contract, the contractor(s) will ultimately be responsible for the final detailed design of the proposed Project and for preparing a more detailed Construction and Environmental Management Plan (CEMP) for each specific package of works, as outlined in Section 1.3.

The contractor(s) appointed will be responsible for the organisation, direction, and execution of environmental related activities during the detailed design and construction of the proposed Project. The contractor(s) is required to undertake all activities in accordance with the relevant environmental requirements including the consent documentation and other regulatory and contractual requirements.

8.0 POTENTIAL IMPACTS ON THE PROPERTY

DOWNEY and Gall Zeidler have carried out a detailed examination of the property subject to this submission. Having regard to the status and current use of the property and identified constraints, the following raises concerns regarding potential impacts of the MetroLink on the property. This has been elaborated to include potential impacts during the construction and operation phases of developing MetroLink, as well as any impediments and/or implications for future development of the property.

8.1 Monitoring

Given the sensitivity of the uses within this property, coupled with its historic importance, we request that An Bord Pleanála attach a condition to the Draft Railway Order that ensures continuous monitoring of the property to prevent any negative impacts. Access to all properties must be agreed in advance with the OPW and its clients. It is recommended that this monitoring takes place at least 3 months in advance of the construction of the Project and at least 6 weeks post the operational stage of the MetroLink.

8.2 Security Issues

Given the nature of the State properties affected by the Project, we would respectfully refer An Bord Pleanála to Part XI of the Planning & Development Act 2000 (as amended), which states that:

> *"Development by State authorities. 181.—(1) (a) The Minister may, by regulations, provide that, except for this section F902[and sections 181A to 181C], the provisions of this Act shall not apply to any specified class or classes of development by or on behalf of a State authority where the development is, in the opinion of the Minister, in connection with or for the purposes of public safety or order, the administration of justice or national security or defence and, for so long as the regulations are in force, the provisions of this Act shall not apply to the specified class or classes of development.*
>
> *b(iii) the making available for inspection by members of the public of any specified documents, particulars, plans or other information with respect to the proposed development;"*

It is essential that security issues do not arise in the event of sensitive information being shared on the structure and operation of these properties. However, the OPW understands the importance of the detailed design stage of the Project and the wish to ensure that the detailed assessment of these properties takes place in the early stages of the design process, in conjunction with the OPW, to ensure that these sensitive State buildings are not negatively impacted upon by the proposed Project. The OPW will liaise with TII and An Bord Pleanála on this matter.

All employees contracted to work on behalf of the TII on this Project, and any associated works, must adhere to the properties protocol around access, security, and safety. This applies to all persons entering or working in proximity of the property.

The day-to-day operations of the property cannot be interrupted by disruptions to any utilities.

The design and operation of the MetroLink should be in line with best international practice, in relation to anti-terrorism and security measures.

8.3 During Construction of the MetroLink

This building is a fully functioning Art Gallery. It provides functional spaces and office accommodation and the impact of any proposed works in terms of noise, vibration, etc. which effects the quality of the working environment would need to be carefully considered (see Appendices 2-4).

8.3.1 Ground Movement

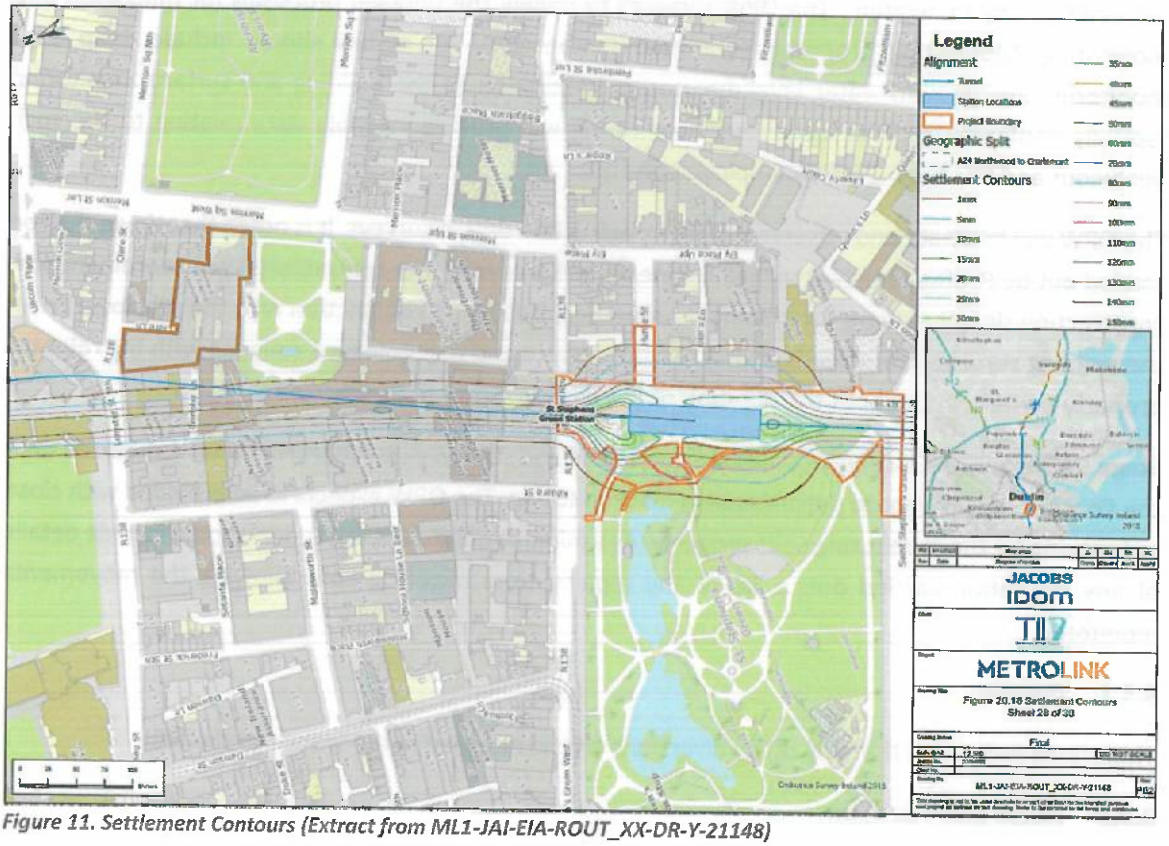

Figure 11. Settlement Contours (Extract from ML1-JAI-EIA-ROUT_XX-DR-Y-21148)

Stage 1: Defines extent of ground movement using Moderately Conservative parameters. The parameters considered by MetroLink are:

- Volume Loss, $V_s = 0.75$
- Trough Width parameter, $k = 0.4$

These are considered appropriate for defining the zone of influence.

The extent of the zone of influence is defined by the 1mm contour line (Dark Red) and the NGI lies outside the zone of influence.

Stage 2: Three sections were considered in the assessment. The assessment concludes that the risk of damage to the NGI is Category 0, Negligible

Stage 3: The EIAR states that a Stage 3 assessment will be carried out for the NGI by the Contractor appointed to construct this section of the MetroLink. The OPW expects to be consulted on the detail, scope of this assessment and programme for these assessments. It would be helpful if TII were to develop a Design Standard to ensure that all Stage 3 analyses of the OPW properties are carried out equally.

No mention of Stage 4 or 5 has been found in the Draft Railway Order or EIAR. Industry best practice as applied to London's Elizabeth Line (Crossrail) required that two further Stages in the Assessment of ground movement were undertaken during the project.

Stage 4 (Construction Stage): This is stage where any mitigation is implemented, and the monitoring of the stakeholder's infrastructure is carried out. Also, the pre-construction defect surveys are carried out prior to any excavation. The OPW requires to review the detailed proposals for mitigation and monitoring. Monitoring proposals submitted to the OPW for review should include deep level monitoring and ground water level monitoring in addition to the building and surface monitoring typically implemented. The deep level monitoring will provide valuable data relating to the rock behaviour and has been usefully employed on HS2.

The OPW will facilitate and observe the pre-construction defect surveys. It is noted that these shall be carried out by Professionally Qualified Engineers or Surveyors. The contractor(s) will coordinate pre-construction defect surveys for identified properties, liaising (in conjunction with the employer) with the building surveyor employed to carry out the surveys and maintaining a dialogue with the relevant property owners throughout the duration of the works.

Stage 5 (Close out): Once the excavation (tunnelling and station excavation) has been completed then the Contractor will want to decommission his monitoring. The OPW expects to be provided with close out reports for the monitoring of its property. As a minimum the close out report should include details of any mitigation carried out, a list of any repairs, time history graphs showing the movements monitored.

8.3.2 Utilities

There is no indication that any utility diversions will be required in the vicinity of the NGI.

8.3.3 Noise and Vibration

(a) Tunnelling

EIAR Chapter 14 Ground Borne Noise and Vibration Measures identifies the impact on the NGI during TBM excavation:

- Ground borne noise 44 dBA L_{Amax} – Not Significant Impact
- Ground borne vibration – No Significant Impact

EIAR Table 6.2- GNV1 states that there is no effective mitigation available and therefore the impact will be managed by detailed consultation with the building owners. The OPW requests specific

vibration limits that will be applied to the NGI and ensure that a monitoring regime is implemented (as per detail in section 4.3). EIAR Table 6.2- ANV16. sets out requirement for pre- and post-construction surveys of structures vulnerable to vibration induced damage. The OPW seeks that pre- and post-construction surveys of structures vulnerable to vibration induced damage to be carried out and this should include the NGI.

(b) Station Excavation

GNV2 states that Monitoring of blasting and re-optimising the blast design (minimising the explosive charge considering the results) will be carried out as standard. A5.20 Blasting Strategy provides information on the classification of buildings and potential damage due to blasting for the station excavations. There are also calculations for estimated magnitude of the peak particle velocity (ppv) for various explosive charges. The assumption is that the lowest charge would be implemented to avoid damage. The NGI is located far enough away from either station excavation for the predicted peak particle velocity to be less than 1mm/s.

8.3.4 Work Sites

(a) Dust

Appendix A16.4 of the EIAR requires a Dust Management Plan to be produced and implemented. The tunnelling will not generate dust in the vicinity of the NGI. The station construction sites are at least 335m from the NGI and therefore dust from these constructions sites is unlikely to affect this building.

(b) Ground Water Control

There is an assumption that the tunnelling will not affect the ground water above the tunnel. However, there should be a ground water monitoring scheme implemented to confirm this and a contingency plan to manage any residual risk.

(c) Working Hours

Tunnelling: Working Hours will be 24 hours a day, 7 days a week for the tunnelling works using a 3x8hr shift pattern, with a total of 4 crews.

Station Excavation: Working Hours will be:

- Monday to Friday: 07:00 to 19:00
- Saturday: 07:00 to 13:00

The NGI is located between Tara Street and St. Stephen's Green stations. The construction of these stations will generate additional lorry movements, for both deliveries and spoil removal, that TII and its contractors will need to manage to minimise impact in the vicinity.

(f) Intervention Strategy

Maintenance of the TBM is crucial for efficient and safe operation this is carried out during Interventions. Mostly these are planned to avoid sensitive receptors and an approval process will be

implemented to manage the locations. However, unplanned interventions will be unavoidable to deal with unexpected events.

8.4 During Operation of the MetroLink

8.4.1 Noise and Vibration

TII proposes to mitigate the noise and vibration resulting from the railway operations by installing floating track slab to meet thresholds of 25 dBLamax, s and VC-D respectively. EIAR Chapter 14 Table 14.47 provides some guidance on where this will be constructed but it is not clear exactly where. The OPW requests that floating track slab is installed between Chainage 17+980 and 18+400 (St. Stephen's Green Station). This would mitigate the noise and vibration to acceptable levels under all the Government buildings, museums, and the National Concert Hall.

The vibration during railway operations will not impact the building fabric or structure.

8.4.2 Future Development

Provided the proposed railway alignment does not change then there will be no restriction on future development for the NGI.

8.4.3 Evacuation Strategy

The are no planned intervention/evacuation shafts between Tara Station and St. Stephen's Green, however it is understood that the Fire Brigade have not accepted the strategy proposed by TII. This may have an impact on the NGI should any intermediate shafts be required.

8.5 Future Development

The OPW reserves the right to develop the subject property in the future, which includes property above and below ground, subject to normal planning criteria.

It is important that the development of the MetroLink does not interfere with extant planning permissions pertaining to the subject property and the right of the applicant to develop these, in advance, in tandem or post operation of the MetroLink Project.

9.0 CONCLUSION

This submission has been prepared by DOWNEY, Chartered Town Planners, 29 Merrion Square, D02 RW64, in conjunction with Gall Zeidler, International Consulting Engineers specialising in tunnel and underground schemes, on behalf of the Commissioners of Public Works in Ireland, OPW Headquarters, Jonathan Swift St, Trim, Co Meath and on foot of extensive consultation(s) with the OPW's clients, which relates to the MetroLink route and its relationship with the National Gallery of Ireland at Merrion Square West, Dublin.

With reference to the Draft Railway Order 2022 (MetroLink - Estuary to Charlemont via Dublin Airport), the OPW welcomes this strategic project and recognises the significance of its delivery to provide for a sustainable, safe, efficient, integrated, and accessible public transport service between Swords, Dublin Airport and Dublin City Centre.

With regard to the Gall Zeidler assessment, the risk of damage to the NGI from ground movement is negligible. Pre- and post-construction surveys and monitoring are requested. During the passage of the Tunnel Boring Machine (TBM) the noise is predicted to approach the acceptable threshold (45 $dBL_{Amax, s}$) and this may last for 2 weeks. The vibration from the passage of the TBM is predicted to be less than the threshold (1.6 VDV_{db}, $ms^{-1.75}$).

With respect to this property, the OPW is seeking:

1) To ensure no disruption to the public access of the building and its day-to-day uses and functions. This includes c. 4,800 events being run by the NGI on an annual basis.
2) To ensure no damage to the building, its architectural detailing, or the collections housed therein, pre-construction and post-construction surveys, trials and monitoring is required. This is mainly concerned with noise, vibration, and dust which can damage the building, which is of historical significance as well as the valuable art works and stain glasses stored in the NGI.
3) To ensure liaising with the OPW and NGI regarding timeline of the work that needs to be carried out from site investigation through to post commissioning.
4) Basement level of the building is currently being used as a storage space with the collections kept in cabinets. Whether on the display or in the cabinets, no objects and collections are fixed in place, rather they are balanced on their own weight, and this needs to be acknowledged by TII and within the risk assessments in stage 3 to ensure no damage to the collections.
5) Precedents to be applied to the risk assessments to ensure utilising best industry practice within implementation of the Project.
6) To mitigate the noise and vibration to the acceptable levels for this cultural and government block by installing floating track slab between Chainage 17+980 and 18+400, which is the St. Stephen's Green Station.
7) Regarding the tunnel boring machine noise over a 2-weeks period when the noise is predicted to exceed the acceptable threshold, it is respectfully requested for the timeline of the work to be pushed during recess of the Dáil in order to avoid any disruption to the functions of the NGI.

In light of the above, DOWNEY respectfully request that An Bord Pleanála take into consideration the issues raised by the OPW and National Gallery of Ireland when assessing the Draft Railway Order 2022 (MetroLink - Estuary to Charlemont via Dublin Airport).

APPENDIX 1: VIBRATION BY BILL WEI, MARCH 2007

Cons DistList [Date] [Subject] [Author] [SEARCH]

Subject: Vibration

Vibration

From: Bill Wei <bill.wei>
Date: Monday, March 26, 2007

Hyttinen Kaisa <kaisa.hyttinen [at] nurminenprima__com> writes

>I am looking for any commercially available solutions/manufacturers
>(worldwide) to protect mainly 2-dimensional hanging artworks from
>vibration during construction and explosion work. I am aware of
>using mirror plates and similar systems to secure paintings into the
>wall but I am more interested in hearing if anyone knows of actual
>vibration reduction systems which maybe could be used with wires.
>But, any information is appreciated.

I cannot see from your address if you are serving a museum or your own depot. Also, it is hard to advise you without actually being on site. However, the general advice which I and the institute give to museums at this moment is the following:

* I'm not sure what you mean by "securing a painting into a wall", but firmly securing a painting into a wall is not a good idea. The painting will then do whatever the wall does. In fact, the small study we did shows that a canvas itself moves much more than the wall. A panel painting will, of course, do what the wall does. You want to isolate the painting from the vibrations, but that is where I cannot properly advise you at the moment.

* If you can, convince the construction companies to reduce vibrations as much as possible. For shock (which is *not* the same as vibrations), my colleagues have never seen damage below 1.1 mm/s acceleration (to keep it simple, I won't explain what this number is, but any measurement engineer will know). This is very low, and difficult for a construction company to maintain, so you will probably have to negotiate.

  Some museums here allow 1.4 mm/s as an average level, with "occasional" jumps to 1.8 - 2.0 mm/s. You should be really careful in defining "occasional". What we mean is that a company is warned when the vibration level stays too long above 1.4 mm/s and asked to take measures to bring the levels down. However, it gets a "yellow" card if the shock/vibration level goes above 1.8 - 2.0 mm/s, even for just one shock. Three yellow cards is red, that means that the museum has the right to stop all activities.

* I don't know if hanging paintings from wires or those long rods will damp all vibrations, but if you hang them that way, you have a better chance of making sure that the painting does not touch the wall, or bang into it when there is an explosion.

* I assume that the construction is on one side of the museum. You might want to consider removing "sensitive" objects from the side closest to the construction, and put things that are less sensitive on that side, or just close that side of the building until the worst part of the construction is over.

* If you are really talking about explosives (blasting), you need to think about your building as well. Do you have underground depots that might get exposed to ground water if the walls crack? Is your museum a historic building / national monument?

Unfortunately, I cannot guarantee that this advice will prevent (unseen) damage in your specific situation, but these are general practical tips we are following until our research gives us a better idea of what is happening.

If you are interested, I am organising a partnership to study vibrations and look for solutions. ... There are several museums, another transport company, a measurement device company, and two technical universities interested. This is a preparation meeting for a possible proposal for European research funding.

Dr. W. (Bill) Wei
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Conservation DistList Instance 20:48
Distributed: Tuesday, April 10, 2007
Message Id: cdl-20-48-004
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APPENDIX 2: NGI HISTORIC WINGS VIBRATION MONITORING METHOD STATEMENT

PUNCH consulting engineers

NGI Historic Wings Vibration Monitoring Method Statement

Revision	Date	Comment
A	22-02-2011	Issued for discussion

Authorised for issue by:		Date:	22/02/2011
(CEng / Approved Engineer)			

052.317
NGI Historic Wings Refurbishment

VIBRATION MONITORING METHOD STATEMENT

1.0 Background

As part of the refurbishment works to the Historic Wings, the National Gallery are installing a new racking storage system as part of the relocation of the art storage area from within the Milltown wing to within the Millenium Wing adjacent. The refurbishment works to the Milltown wing will consist of the excavation, underpinning and breaking out for basement level ducts as well as forming the vertical distribution routes.

There is a concern that these construction activities will cause vibrations to such an extent as to risk damaging the Art work. Vibration limits of 5mm/s are standard for dwellings or general building stock reducing to 3mm/s for sensitive or listed buildings. It has been advised by the NGI that a vibration limit of 1.4 mm/s is more relevant for art work.

A theoretical analysis to determine the likely vibration from one area of a building to another caused by variable construction activities is not possible due to the many variables involved. As such, it was agreed by all parties that preliminary testing should be carried out to measure the actual vibration levels caused by varying construction activities and the attenuation or dissipation of these vibrations through the adjacent building slabs and walls to determine the magnitude of the issue. A report would then be issued by Punch outlining their findings and recommendations. This report will then form the basis of assessing whether an issue actually exists, what more detailed investigations and testing are required and whether an art specialist should be retained by the Gallery to advise on relaxations of the generic vibration limits advised. The more detailed investigations would be scheduled to coincide with the investigative works which are planned for later this year.

This document describes the proposed method statement for this initial high level testing.

2.0 Survey Requirements

Resource:

1 x Punch supervising engineer

2 x OPW maintenance personnel

Plant:

1 x Vibration monitoring equipment – Instantel Minimate Plus, with appropriate expansion anchors

1 x lump hammer

1 x sledge hammer

1 x kango electric breaker

1 x transformer

1 x extension lead

2 x 2 way radios

1 x drill with 14mm drill bit

1 x dust extraction unit

1 x trowel

Material:

1 x lightweight portable enclosure

1 x 25kg bags Sand

1 x roll Duct tape

2 x G clamps

Location:

Basement of storage area in Milltown Wing as indicated on the attached sketch.

Duration:

1 day

3.0 Methodology

1. Mark out testing locations spaced at 1m, 2m 3m and 4m from the wall as indicated.
2. Drill and fix vibration monitoring sensor to ground floor slab adjacent to the storage area marked A and commence monitoring.
3. Drop lump hammer from 0.5m, 1m and 1.5m heights at 10 sec intervals at 1m from wall.
4. Continue step 3 at 2m, 3m and 4m from wall.
5. Drop sledgehammer from 0.5m, 1m and 1.5m at 10 sec intervals at 1m from wall as step 3.
6. Repeat step 5 at 2m, 3m, and 4m from wall.
7. Move portable lightweight enclosure to corner of basement adjacent the testing location at 1m from the wall and seal to ground floor slab with duct tape.
8. Turn on dust extractor within the enclosure and turn on kango breaker over corner of slab adjacent to basement walls for a 10 sec duration. Turn off dust extractor after 1 min. Kango breaker will have blunt chisel attached to end and no pressure will be applied however a nominal area of the ground floor slab may break up. Should the slab break up locally, the area will be cleared on completion of the exercise and any depressions in the slab filled in with sand until a more permanent suitable repair is carried out. Dust extractor will collect all dust in filter to be emptied external to building and disposed off appropriately.
9. Vibration monitoring from location A will be concurrent with steps 3-8.
10. Unbolt vibration monitoring sensor from GF slab at A and move to location B on other side of Milltown Wing wall.
11. Fix vibration sensor to ground floor slab at location B as step 2.
12. Repeat steps 3-8.
13. Vibration monitoring from location B will be concurrent with step 12.
14. Unbolt vibration monitoring sensor from GF slab at B and move to location C 2m from other side of Milltown Wing wall away from location B.
15. Fix vibration sensor to ground floor slab at location C.
16. Repeat steps 3.8.
17. Vibration monitoring from location C will be concurrent with step 16.
18. Turn off vibration monitoring equipment.
19. Make good to slab area if required with sand. Permanent repair will be carried out at future date as required.
20. Plant and materials from basement.

3.0 Methodology

1. Mark out testing locations spaced at 1m, 2m 3m and 4m from the wall as indicated.
2. Drill and fix vibration monitoring sensor to ground floor slab adjacent to the storage area marked A and commence monitoring.
3. Drop lump hammer from 0.5m, 1m and 1.5m heights at 10 sec intervals at 1m from wall.
4. Continue step 3 at 2m, 3m and 4m from wall.
5. Drop sledgehammer from 0.5m, 1m and 1.5m at 10 sec intervals at 1m from wall as step 3.
6. Repeat step 5 at 2m, 3m, and 4m from wall.
7. Move portable lightweight enclosure to corner of basement adjacent the testing location at 1m from the wall and seal to ground floor slab with duct tape.
8. Turn on dust extractor within the enclosure and turn on kango breaker over corner of slab adjacent to basement walls for a 10 sec duration. Turn off dust extractor after 1 min. Kango breaker will have blunt chisel attached to end and no pressure will be applied however a nominal area of the ground floor slab may break up. Should the slab break up locally, the area will be cleared on completion of the exercise and any depressions in the slab filled in with sand until a more permanent suitable repair is carried out. Dust extractor will collect all dust in filter to be emptied external to building and disposed off appropriately.
9. Vibration monitoring from location A will be concurrent with steps 3-8.
10. Unbolt vibration monitoring sensor from GF slab at A and move to location B on other side of Milltown Wing wall.
11. Fix vibration sensor to ground floor slab at location B as step 2.
12. Repeat steps 3-8.
13. Vibration monitoring from location B will be concurrent with step 12.
14. Unbolt vibration monitoring sensor from GF slab at B and move to location C 2m from other side of Milltown Wing wall away from location B.
15. Fix vibration sensor to ground floor slab at location C.
16. Repeat steps 3.8.
17. Vibration monitoring from location C will be concurrent with step 16.
18. Turn off vibration monitoring equipment.
19. Make good to slab area if required with sand. Permanent repair will be carried out at future date as required
20. Plant and materials from basement.

APPENDIX 3: LIST OF PLANNING LEGISLATION & POLICY DOCUMENTS

This appendix provides a non-exhaustive list of planning policy, legislation, and guidelines. We would respectfully request that An Bord Pleanála ensure that TII have fully assessed the Project with regard to existing planning policy, as well as adherence to the relevant local policies and guidelines pertaining to each individual property.

DOWNEY, note that this proposed Draft Railway Order is a strategic long-term development and An Bord Pleanála may consider Draft Development Plans in assessing the Project. It is also crucial to note that on foot of a granted Order and during the detailed design stage, a revision to planning policy is expected, whereby adopted plans and legislation may have to be adhered within this stage. This may require an amendment to the Draft Railway Order and further assessment, including public consultation.

Legislative Context

- **Planning and Development Act 2000 (as amended)**

The proposed Project comes within the definition of Strategic Infrastructure Development (SID) under Section 2 of the Planning and Development Act 2000 (as amended). 'Strategic Infrastructure Development' means *"any proposed railway works referred to in section 37(3) of the Transport (Railway Infrastructure) Act 2001 (as amended by the Planning and Development (Strategic Infrastructure) Act 2006."*

- **Planning and Development Regulations 2001 (S.I. No. 600 of 2001)**

The principal regulations underpinning the Planning and Development Acts are the Planning and Development Regulations 2001 (S.I. No. 600 of 2001). A number of Regulations amending the 2001 Regulations have been made, which, taken together, are collectively cited as the Planning and Development Regulations 2001 to 2022.

An unofficial consolidation of the Planning and Development Regulations 2001-2022 has been prepared for ease of reference by users and has no legal status. This can be accessed here: Planning and Development Regulations 2001-2022.

- **Directive 2014/52/EU3**

Directive 2011/92/EU, passed on 13th December 2011, pertains to the assessment of the effects of certain public and private projects on the environment as amended by Directive 2014/52/EU (hereafter referred to as the 'EIA Directive'), passed on 16th April 2014, which sets the requirements for EIA in European law. It requires EIA to be carried out for certain public and private projects listed in Annexes I and II of the EIA Directive.

The requirements of Directive 2014/52/EU were transposed into Irish law with the adoption of the S.I. No. 743/2021 - European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 (hereafter referred to as the EIA Regulations), which amend the Transport (Railway Infrastructure) Act 2001 to bring it in line with Directive 2014/52/EU.

- **Transport (Railway Infrastructure) Act 2001 (as amended)**

The 2001 Act provides for a Draft Railway Order application to be made by the Applicant to An Bord Pleanála.

> *"37(1) An application may be made to An Bord Pleanála ('the Board') for a railway order by the Dublin Transport Authority ('DTA'), the Agency, CIÉ or another person. Where any part of the proposed railway works in the application is within the functional area of the DTA the applicant (not being the DTA) must have obtained the prior written consent of the DTA for the application*
>
> *(2) An application under subsection (1) shall specify whether the application is in respect of a light railway, metro or otherwise.*
>
> *(3) An application under subsection (1) shall be made in writing in such form as the Minister may specify and shall be accompanied by—*
>
> > *(a) a draft of the proposed order,*
> >
> > *(b) a plan of the proposed railway works, MetroLink Planning Report*
> >
> > *(c) in the case of an application by the Agency or a person with the consent of the Agency, a plan of any proposed commercial development of land adjacent to the proposed railway works,*
> >
> > *(d) a book of reference to a plan required under this subsection (indicating the identity of the owners and of the occupiers of the lands described in the plan), and*
> >
> > *(e) a statement of the likely effects on the environment (referred to subsequently in this Part as an 'environmental impact assessment report') of the proposed railway works, and a draft plan and book of reference shall be in such form as the Minister may specify or in a form to the like effect."*

Section 37 (4) of the 2001 Act sets out that "*The construction of railway works, the subject of an application for a railway order under this Part, shall not be undertaken unless the Board has granted an order under Section 43*".

A number of other relevant documents have also been prepared as part of the Draft Railway Order application, including the following, provided as stand-alone documents.

- Wider Effects Report; and
- Natura Impact Statement
- National Cultural Institutions Act 1997

- **The National Cultural Institutions Act**

The National Cultural Institutions Act sets the framework for which National Cultural Institutions must operate. The act provides for the establishment of Boards for the national institutions.

- **National Cultural Institutions (National Concert Hall) (Amendment) Bill 2022**

Bill entitled an Act to provide for the transfer of certain functions, staff, property, rights and liabilities of RTÉ to the National Concert Hall; to provide for the validity and effect of acts by RTÉ and the National Concert Hall in relation to that transfer; to extend the functions of the National Concert Hall and to make certain changes to its board and, for those purposes to amend the National Cultural Institutions (National Concert Hall) Act 2015; to increase the aggregate amount of liability in respect of undertakings given for cultural objects on loan from a person resident outside the State and, for that purpose to amend the National Cultural Institutions Act 1997; to make certain changes to the objects of RTÉ and, for that purpose to amend the Broadcasting Act 2009; and to provide for related matters.

National Planning Policy Context

The key provisions of the national planning policy, including the Planning Guidelines, as it relates to the proposed project are set out. A summary list of the relevant national planning policies and planning guidelines consist of the following:

- All-Ireland Pollinator Plan 2021-2025
- Architectural Heritage Protection Guidelines for Planning Authorities
- Climate Action Plan 2023
- Guidelines for Landscape and Visual Impact Assessment
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (August 2018)
- Heritage at the Heart: Heritage Council Strategy 2018-2022
- Housing for All – A New Housing Plan for Ireland
- Investing in Our Transport Future – Strategic Investment Framework for Land Transport 2015
- National Adaptation Framework 2018 accompanied with Sectoral Adaptation Plan for Transport Infrastructure 2019
- National Biodiversity Action Plan 2017-2021
- National Development Plan 2021-2030
- National Investment Framework for Transport in Ireland 2021
- National Landscape Strategy for Ireland 2015-2025
- National Planning Framework (Project Ireland 2040)
- National Sustainable Mobility Policy
- Places for People – National Policy on Architecture
- Road Safety Strategy 2021-2030
- Smarter Travel – A Sustainable Transport Future; A new Transport Policy for Ireland 2009-2020
- Sustainable Urban Housing: Design Standards for New Apartments – Guidelines for Planning Authorities December 2022
- The National Cycle Policy Framework 2009-2020
- The Sustainable Development Goals National Implementation Plan 2018-2020
- The White Paper, Ireland's Transition to a Low Carbon Energy Future 2015-2030

- Town Centre First
- Traffic and Transport Assessment Guideline
- Transport Access for All 2012
- Urban Development and Building Height Guidelines 2020

Regional Planning Policy Context

The key provisions of the regional planning policy as it relates to the proposed project are now set out in the following sections. A summary list of the relevant regional planning policies consists of the following:

- Draft Greater Dublin Area Cycle Network Plan 2021
- Draft Greater Dublin Area Transport Strategy 2022-2042
- Dublin Agglomeration Environmental Noise Action Plan 2018-2023
- Dublin Metropolitan Area Strategic Plan (MASP)
- Greater Dublin Area Cycle Network Plan
- Regional Spatial and Economic Strategy for the Eastern and Midland Region 2019-2031
- Transport Strategy for the Greater Dublin Area 2016-2035

Local Planning Policy Context

The key provisions of the local planning policy as it relates to the proposed project are now set out. A summary list of the relevant local planning policies consists of the following:

- Ballymun Local Area Plan 2017
- Barryspark & Crowcastle Masterplan 2019
- Dardistown LAP 2013
- Docklands Public Realm Plan
- DRAFT Fingal County Development Plan 2023-2029
- DRAFT Lissenhall East Local Area Plan
- DRAFT Scheme of Special Planning Control: O'Connell Street and Environs 2022
- DRAFT Sustainable Swords Strategy
- Dublin Airport Local Area Plan
- Dublin City and County Archaeology GIS Dataset
- Dublin City Biodiversity Action Plan 2021-2025
- Dublin City Centre – Developing the Retail Core
- Dublin City Council Climate Action Plan 2019-2024
- Dublin City Development Plan 2016-2022
- Dublin City Development Plan 2022-2028
- Dublin City Industrial Heritage Record
- Dublin City Park Strategy 2019-2022
- Dublin City Strategic Heritage Plan 2022-2028
- Estuary Central Masterplan
- Fingal County Development Plan 2017-2023

- Fostertown Masterplan 2019
- George's Quay Local Area Plan 2012 (Extended to July 2022)
- Grafton Street Quarter Public Realm Plan
- Local Environmental Improvement Plans
- Merrion Square Conservation Plan
- Moore Street and Environs Local Area Plan
- Moore Street Battlefield Site Plan
- National Concert Hall Statement of Strategy 2022-2026
- National Gallery of Ireland – Strategic Plan 2019-2023
- National Library Ireland 2022 – 2026 Strategy
- National Museum 2019 – 2022 Strategic Plan: Building Capacity, Driving Change
- Oireachtas Strategic Plan 2022-2024
- Scheme of Special Planning Control: O'Connell Street & Environs 2016
- Seatown North Masterplan
- Seatown South Masterplan
- South Fingal Transport Study 2019
- St. Stephen's Green Park Conservation Management Plan 2015-2020
- Strategic Development Regeneration Area 2: Ballymun
- Strategic Development Regeneration Area 18: National Concert Hall Quarter
- The Future of the South Georgian Core
- The Heart of Dublin – City Centre Public Realm Masterplan
- Your City Your Space – Dublin City Public Realm Strategy
- Your Swords – An Emerging City Strategic Vision 2035

APPENDIX 4: GROUND MOVEMENT ASSESSMENT

The following sets out the requirements for assessing the impact of ground movement resulting from underground construction, such as tunnelling, embedded wall installation, and excavation for station boxes, together with requirements for monitoring and the close out.

The Designer shall investigate the potential for ground movement associated with the design and possible construction:

a) To assess risk of building damage by identifying those zones where the implementation of the design is likely to cause ground movements which will result in risk of Damage Category 2 'Slight' being exceeded (see Table 1) or where damage exceeds the agreed tolerable limits. To assess the risks of such degrees of damage occurring and either investigate alternative designs or advise interfacing Designers that alternatives need to be considered and modify the design as necessary. To undertake an assessment of the potential consequences where there is a significant likelihood that Risk of Damage Category 2 'Slight' will be exceeded or where damage exceeds the agreed tolerable limits and identify specifically what the risks are. Design protective measures where necessary to mitigate against the risk of damage exceeding Risk of Damage Category 2 or where damage exceeds the agreed tolerable limits.

b) To demonstrate that the environmental effects of excavation induced ground movements have been considered and taken account of in the design.

c) To assess the risk of damage to utilities and to design mitigation measures in agreement with the utility owner.

d) To assess the effects of excavation to existing above ground and underground infrastructure and to design suitable mitigation measures.

e) To indicate where property may require demolition or structural modification.

f) To enable the preparation of contingency plans to deal with residual risks.

Stage 1 – Scoping

Schedules and plans shall be prepared to identify all assets assessed to experience ground movement exceeding 1mm using conservative parameters.

Stage 2 – Initial Assessment

The designer shall carry out initial assessment calculations using simple empirically calibrated methods and moderately conservative parameters to classify the risk of damage to assets. For masonry building structures, the risk should be classified in accordance with Table 1. For non-masonry buildings and infrastructure, the level of risk should be determined by ensuring that deformations do not exceed tolerable values determined in consultation with the asset owner.

A schedule and plans of predicted damage shall be prepared, along with outline trigger levels.

The assessment calculations shall be based on record drawings, where available and an inspection for assessment. Assets estimated to be a risk of damage greater than Category 2 'Slight' or where damage exceeds the agreed tolerable limits require further detailed assessment at Stage 3.

Table 1. Building Damage Classification

Damage Category	Description of degree of damage*	Description of typical and likely forms of repair for typical masonry buildings	Approx. crack width** (mm)	Max. tensile strain %
0	Negligible	Hairline cracks		<0.05
1	Very slight	Fine cracks easily treated during normal redecoration. Perhaps isolated slight fracture in building. Cracks in exterior visible upon close inspection	0.1 to 1.0	0.05 to 0.075
2	Slight	Cracks easily filled. Redecoration probably required. Several slight fractures inside building. Exterior cracks visible; some repainting may be required for weathertightness. Doors and windows may stick slightly	1 to 5	0.075 to 0.15
3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Tuck pointing and possible replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired	5 to 15 or a number of cracks greater than 3	0.15 to 0.3
4	Severe	Extensive repair involving removal and replacement of walls especially over door and windows required. Window and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably. Some loss of bearing in beams. Utility services disrupted	15 to 25 but also depends on number of cracks	> 0.3
5	Very severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and required shoring. Windows broken by distortion. Danger of instability	Usually > 25 but depends on No. of cracks	

** In assessing the degree of damage, account must be taken of its location in the building or structure.*

*** Crack width is only one aspect of damage and should not be used on its own as a direct measure of it. Burland, J.P. and Wroth, C.P., Settlement of Buildings and Associated Damage, Proceedings of a Conference on the Settlement of Structures, Cambridge, 1974, pp 611-54 and 764-810.*

The heritage value of a Listed or Protected Structure should be considered during the initial assessment by reviewing the sensitivity of the building structure and of any particular features together with the initial assessment calculations. The heritage assessment examines the following:

a) The sensitivity of the building/structure to ground movements and its ability to tolerate movement without significant distress. The potential for interaction with adjacent buildings/ structures is also considered. A score within the range of 0-2 should be allocated to the building/structure in accordance with the criteria set out in Table 2.

b) The sensitivity to movement of particular features within the building/structure and how they might respond to ground movements. A score within the range of 0-2 should be allocated to the building in accordance with the criteria set out in Table 2.

The scores for each of the two categories (a) and (b) should be combined and added to the category determined in Stage 2 to inform the decision-making process. In general, Listed Buildings which score a total of 3 or higher should be subject to further assessment as part of the Stage 3 – Detailed Assessment. Buildings that score a total of 2 or less are predicted to suffer a degree of damage which may be easily repairable using standard conservation-based techniques and hence no protective measures for the building's particular features should be required. However, ultimately the professional judgement of engineering and historic building specialists should be used to determine whether additional analysis is required.

Table 2. Scoring for Sensitivity Assessment of Listed Buildings

Criteria		
Score	**a) Sensitivity of the structure to ground movements and interaction with adjacent buildings**	**b) Sensitivity to movement of particular features within the building**
0	Masonry building with lime mortar not surrounded by other buildings. Uniform façades with no particular large openings.	No particular sensitive features
1	Buildings of delicate structural form or buildings sandwiched between modern framed buildings which are much stiffer, perhaps with one or more significant openings.	Brittle finishes, e.g., tight-jointed masonry, which are susceptible to small movements and difficult to repair.
2	Buildings which, by their structural form, will tend to concentrate all their movements in one location.	Finishes which if damaged will have a significant effect on the heritage of the building, e.g., cracks through frescos.

Stage 3 – Detailed Assessment, Mitigation Design and Monitoring Plans

The Designer shall carry out detailed assessments of structures that will be affected by the works so that any monitoring works and mitigation works can be designed and implemented.

For structures at risk of exceeding Damage Risk Category 2 'Slight' or where damage exceeds the agreed tolerable limits the designer shall undertake a detailed assessment (more rigorous) to determine:

a) The influence of the structure and its foundations on the predicted ground movements (soil/structure interaction).

b) The volume loss at which the risk of damage to the structure (or any sensitive finishes/features) is 'slight' or better.

c) Whether this volume loss may be achieved by the proposed excavation design/control measures.

d) Any special control measures required to reduce the predicted damage to acceptable levels (i.e., Risk Category 2 'slight' damage category and below or below the agreed tolerable limits) such as significantly higher face pressures with EPBM tunnelling and the practicality of these.

e) The amount of ground movement that the structure (and or any sensitive finishes/features) can accommodate without exceeding Damage Risk Category 2 or where damage exceeds the agreed tolerable limits.

f) The level of residual risk if intrusive mitigation measures are not implemented.

The detailed assessments should include a number of iterations to determine how the risk of damage to a building may be reduced. Asset-specific empirical models shall be prepared successively using moderately conservative and best estimate parameters. If after these iterations the use of empirical methods do not reduce the risk of building damage to acceptable levels (i.e., Damage Category 2 'slight' damage category and below or below the agreed tolerable limits), the damage assessment shall be refined by increasing the sophistication of the analysis with the aim of reducing the risk of asset damage to acceptable levels and to eliminate the asset from further assessment.

If the risk of damage cannot be shown to be reduced by detailed assessment to acceptable levels, then mitigation measures shall be designed. The primary means of settlement mitigation shall be practical measures to control ground movement by good design and construction practice. This could include staged excavation sequences within sprayed concrete lining (SCL) works, ground treatment, face stabilisation, spiling/face dowels, increasing face pressure when using a Tunnel Boring Machine (TBM), adopting stiffer walls/propping for rectangular shafts etc.

In the event that physical mitigation measures are still required (i.e., to control building damage to Damage Category 2 'slight' and below or below the agreed tolerable limits), the Designer shall seek to obtain the Asset Owner's approval.

The Designer shall also undertake a comparative risk assessment to demonstrate that the risks associated with installation/implementation of any intrusive mitigation measures (such as compensation grouting) are no worse than the risks associated with the base case.

The relevant Local Authority and the OPW shall be consulted on the results of the Protected Building assessment reports and the proposals for protective measures, if any are required. The OPW shall also be consulted in relation to Listed or Protected Buildings where they would normally be notified or consulted on planning applications or listed building consent applications.

When considering the need and type of protective measures for Listed or Protected Buildings, due regard should be given to the sensitivity of the particular features of the building which are of architectural or historic interest and the sensitivity of the structure of the building to ground movement. Where the assessment highlights potential damage to the features of the building which it will be difficult or impossible to repair and/or if that damage will have a significant effect on its heritage value, the assessment may recommend appropriate measures to safeguard those features either in-situ or by temporary removal and storage off-site if those with relevant interest(s) in the building consent.

The form of monitoring of Listed Buildings should be determined based on the results of the assessment process.

Where repair works are necessary, they will require the consent of those with relevant interest(s) in the building.

For railway track and track support structures the designer shall:

a) Review the track surveys (including specifying additional surveys if required) and establish that ground movement can be accommodated without exceeding track standard operational tolerance in conjunction with the relevant Infrastructure Manager.

b) Identify locations where fettling of the track is required pre-construction and/or during construction to ensure the track geometry and clearances are acceptable.

The designer shall prepare plans and sections showing the zone of influence of the works that is defined by ground movements exceeding 1mm.

The designer shall develop an instrumentation and monitoring plan to validate that ground movements within the zone of influence are in accordance with design assumptions and that the infrastructure remains within acceptable limits. The designer shall ensure that there is a clear distinction between parameters measured to confirm the change in any parameter is in accordance with the design and parameters measured to limit damage to the assets. This plan shall identify the minimum period of time required to obtain base line data for each monitoring point.

Note: *A competent engineer responsible for the works shall consider those factors which may influence the monitoring data and shall determine an appropriate period and frequency for baseline monitoring. This decision-making process will include an element of engineering judgement to account for the possible effects of any underlying environmental trends (seasonal, diurnal, tidal) in the assets under consideration.*

Note: *The designer shall demonstrate that the monitoring system complies with the British Tunnelling Society Monitoring Underground Construction best practice guide.*

Note: *A review of the monitoring system against the checklists provided in Appendix B of the BTS Monitoring Underground Construction best practice guide may be used as a tool to demonstrate compliance.*

The detailed assessments shall define the control limits that need to be imposed on the TBM/SCL excavation in the zone of influence. The designer shall state these control measures on drawings and specifications.

The designer shall identify the critical parameters to be monitored and define the Asset Control Limits based on:

a) The ability of the asset or structure to withstand ground movement investigated.

a) During the assessments carried out in Stage 2 and 3.

b) The risk to third party operations.

The designer shall link the Asset Control Limits to actions within an Emergency Preparedness Plan.

The Instrumentation and Monitoring Plan and Emergency preparedness Plan shall be agreed with the relevant Asset Owner.

Stage 4 – Construction

Contingency plans shall be developed and agreed with the OPW to cover the risks posed to the OPW before commencement of the construction activity.

Contingency plans shall be implemented where the results of monitoring or inspection so indicate.

Ground movement and construction progress records shall be maintained and reported in regular reviews when construction processes are taking place within the zone of influence.

Predictions and assumptions made during design in respect of both ground movement and the effects which such ground movement will have on adjacent assets shall be verified by measurement during construction.

Stage 5 – Completion and Close-out

After ground movement has stopped, as confirmed by instrumentation and monitoring, the designer shall prepare a "Completion Report". This shall include the following:

a) Details of any modifications/mitigation measures to the existing structure.

b) Graphs that show the ground movement and construction progress over time.

c) With at least 3 months duration of readings which show no change.

d) A schedule showing actual movement compared to predicted movement.

e) A schedule of defects recording only the exceptions (changes) identified during the post construction defects survey.

f) Details of any remedial works undertaken.

g) As-built records (including any temporary works remaining in situ on completion of the works).

Schedule of Defects

A schedule of defects shall be recorded prior to the start of construction for all buildings, structures, utilities and facilities and Outside Party assets predicted to experience ground movement exceeding 1mm.