Draft Trigger Action Plan

1. Introduction

A building Trigger Action Plan (TAP) will be compiled specifically for the identified building given the complexity of the facade and facade retaining system. This will be a live document and will be maintained and updated throughout the design and construction process.

The reason for putting in place a TAP at this early stage of the project is to define the process and controls to be employed to ensure that appropriate mitigation is defined and implemented in a timely manner such that the MetroLink works do not have any significant impacts on the identified building.

The TAP addresses the communication strategy and the building specific monitoring that will be implemented. It also identifies mitigation measures that will be applied including mitigation at source (i.e. controls to the tunnelling process to minimise movements) and mitigation at receptor (i.e. at the Building). A hierarchy of mitigation measures is identified.

2. Metrolink Programme

a. It is anticipated that, following the grant of the Railway Order, there will be a period of 1 year to procure the main works contractor for this section of MetroLink.
b. The TBM final design and Tunnel Management Plans will be completed by the end of Year 1 following the award of the main works contract.
c. Final Phase 3 building damage assessments will be completed by end of Year 2 following the award of the main works contract.
d. At any building location the ground movement data from earlier parts of the drive will be available to verify actual ground movements recorded from the specific machine when tunnelling.

Due to the overall schedule, it is considered appropriate to provide a phased approach to the implementation of the TAP process.

- Phase 1: Pre procurement of the Main Works Contractor
- Phase 2: Tunnel and TBM design, Phase 3 assessment
- Phase 3: In construction (from start of tunnelling at Northwood Portal/Airport South Portal)
- Phase 4: Close out

3. Phase 1: Pre-Procurement of the Main Works Contractor:

a. Collate all up to date building and ground information for inclusion in subsequent procurement packages.
b. If insufficient information is available, undertake detailed façade survey to include site surveys which may require some dismantling to measure relevant components,

junction, gaps, etc. to gather the necessary information to identify movement tolerances at façade connections.

c. Classify primary structure and façade areas according to risk.
d. Detailed façade survey and assessment information to be included in contract documents.
e. Contract to include the hierarchy of control.
f. Contract documents to specify constraints on how the contractor designs and constructs the works to include building specific requirements. This will identify the essentials, such as the need for monitoring of ground vibration and settlements, monitoring of structural and façade responses, statements of foreseen risk minimisation and damage mitigation measures.
g. Embedded controls to be included within the contract include:-
    i. The Contractor to use a full face pressurised Tunnel Boring Machine (TBM).
    ii. The TBM will not be permitted to operate in "Open Mode" unless otherwise agreed with TII.
    iii. The Contractor shall design and operate the TBM to minimise ground movement.
    iv. Identification of Volume loss control zones, if required.
    v. The Contractor will maintain an accurate reconciliation of excavated material, grouting volumes and pressures to demonstrate that no voids caused by the tunnelling process have been left outside the segmental lining. This reconciliation will be completed for every shift.
    vi. Reconciliation records for the previous 24 hours of tunnel advance will be provided to the Shift Review Group and Independent Monitoring Engineer.
h. The Contractor will establish and implement TBM operating principles to meet the following requirements including:
    i. Monitoring of the excavation to automatically measure and record the amount of material excavated per unit of advance and compare it with the theoretical excavation weight. Over-excavation will cause an alarm to activate in the sub-surface TBM control cabin and the surface TBM control room, and procedures will be in place to inform the Independent Monitoring Engineer (IME) of over-excavation.
    ii. Automatic measuring and recording of the pressure and volume of grout continuously injected per ring advance.
    iii. A method of reconciling the requirements of (i) and (ii) above and determining if there is a risk of voids being left in the ground as a continuous automatically generated record with a graphical visual display.
    iv. Indication of lower or higher grout volumes will raise an alarm in the TBM control cabin and the surface TBM control room and directly inform the IME.
    v. A method of measuring the face pressure at the crown, shoulder, axis and knee level of the cutting face.
    vi. All monitoring will be automatically recorded and stored and presented graphically for easy review.
    vii. The TBM operating parameters relating to the control of ground movement will be continuously recorded and provided in real-time to the sub-surface TBM control cabin, the surface TBM control room and the monitoring control area in a form that can be rapidly interpreted to allow optimum control of ground movement.

i. Tender programme to include key building specific milestones to ensure the timely design and implementation of all requisite measures including, but not limited to, Phase 3 assessments, building surveys and the design and use of instrumentation and monitoring.

4. Phase 2: Tunnel and TBM design, Phase 3 building assessments:

    a. Designer to undertake a detailed Phase 3 building assessment using best estimate parameters:
        i. Supported by collated information on the building and ground along with survey information.
        ii. Asset-specific empirical models and more sophisticated analysis where appropriate to be used in the assessment.
        iii. Include a specific façade assessment.
        iv. If insufficient building and facade information is available, carry out site surveys.
    b. Carry out detailed desktop analysis using the information gathered, including the following to establish levels of risk of damage to the facades:
        i. Establishing façade system movement accommodation capacity.
        ii. Establishing ACTUAL expected structural sway and deflections.
        iii. Establishing ADDITIONAL movement capacity, over and above that needed for the in-service movements
    c. Identify appropriate trigger levels for primary structure.
    d. Identify appropriate movement monitoring trigger levels for facades.
    e. Define the hierarchy of controls to be considered by subsequent designs linked to trigger levels.
    f. The design of the instrumentation and monitoring will be designed based on the results of the assessment.
    g. Identify mitigation measures.
        i. The primary mitigation measure will be measures to control the movement at source.
        ii. If predictions still indicate a **risk of damage to facades**, mitigation measures at the receptor (the relevant building) will be implemented following consultation with the building owner.
    h. In the event of a risk to facades, the mitigation measures at receptor may include the following:
        i. **Removal and replacement of façade elements:** remove fixings/supports and temporarily replace these with alternatives to achieve agreed standard of performance for the temporary condition. Original elements to be re-installed and re-set in position, once all significant tunnelling movements have taken place.
        ii. **Modification of façade elements and systems**: remove fixings/supports and temporarily replace these with alternatives to achieve agreed standard of performance for the temporary condition. Install modified façade elements.
        iii. **Permanently replacing facade elements:** replacement of fixings/supports, with alternatives to achieve agreed standard of performance for the permanent condition, once all significant tunnelling movements have taken place. To be implemented only where removal and reinstallation or removal and modification is not feasible.

iv. **Retain and modify in-situ** potentially including fixings/supports.
v. Temporary loosening of façade connections to allow greater movements.
vi. Taping of glass.
vii. Temporary safety measures and weather protection measures.
viii. In respect of mitigation measures (i) to (iv) above, works to be described in a Façade Design, Specification, Manufacture and Installation reports.

i. The assessment will be overseen by the Independent Monitoring Engineer. In the event of a disagreement with the building owner as to the mitigation measures required, these will be determined by the Independent Monitoring Engineer.

5. Phase 3: In construction:

    a. Install tunnel monitoring systems at ground level to verify movements are within agreed tolerances.
    b. Review and implement mitigations in accordance with hierarchy of control.
    c. Monitoring of building/façade responses along the route and calibrating movement prediction analysis so that results better reflect reality. Relook at predicted movements and adjusting hierarchy of control based on the calibration. Agree frequency of re-calibration.
    d. Install building and façade specific monitoring. Building specific monitoring will be installed more than 3 months prior to the TBM reaching the zone of influence of the building.
    e. The Independent Monitoring Engineer to review all data and confirm in-tunnel controls.
    f. Wherever modified and or new façade elements are agreed to be necessary, where modification or replacement of façade elements has been unavoidable, a 3rd party/Independent Façade Engineer will be appointed by TII, on behalf of the Building Owner to agree appropriate specifications of the new or modified façade elements.

6. Phase 4: Close out:

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

        i. Details of any modifications/mitigation measures to the existing structures and facades.
        ii. Removal of instrumentation including making good of any fixing details.
        iii. Graphs that show the ground movement and construction progress over time with at least 3 months duration of readings which show no change.
        iv. Graphs of actual movement vs predictions.
        v. Details of any remedial works undertaken.
        vi. Post Condition Survey.

7. Construction Communication and Engagement with the Building owners/occupiers:

    a. TII to advise on the design and delivery programme prior to the commencement of tunnelling.

b. TII to provide quarterly progress and ground movement updates until the TBM is within 3 months of the identified building, weekly update will be provided thereafter until the TBM reached the zone of influence.
c. Once the TBM approaches the zone of influence, daily updates will be given until such time as the TBM leaves the zone of influence.