Procedure

PR0020 A3 Earth structures inspection

Contents

1 Purpose

1.1 The purpose of this document is to detail the procedure for carrying out inspection of Earth Structures, in accordance with London Underground (LU) standard S1054 'Civil Engineering – Earth Structures' and to inform managers and staff of their key duties, responsibilities and method of carrying out Inspections.

Note:	This document details the requirements of the Earth Structures inspection procedure. The assessment process for stage 2 and 3 are detailed in procedure PR0021 'Earth Structures – Assessment'.

2 Scope

2.1 This procedure applies to anyone trained, mentored and assessed as competent in carrying out inspection of Earth Structures on LU Civil assets.

Note:	Inspections are carried out in order to maintain the awareness of the condition of the assets at any given time, detecting any potential defects and identifying the need for corrective actions.

3 Process overview

3.1 General overview

3.1.1 The assessment of Earth Structures condition involves three stages with any uncertainties being progressively reduced in the subsequent stages, as follows:

- stage 1 – inspection and condition rating calculation
- stage 2 – desk study and walkover survey
- stage 3 – analytical Assessment.

3.1.2 There are four types of inspection identified in the LU Engineering standard S1054:

- general inspections
- principal inspections
- special inspections
- defect advice inspections.

Note:	S1054 is supplemented by two associated guidance documents: G0054A 'Civil Engineering – Earth Structures' G0054B 'Earth Structures - Guide for slope stability analysis'

3.1.3 The LU railway system consists of approximately 463 km of track route, of which 239 km are supported by earth structures. The earth structures comprise 116 km of cuttings and 123 km of embankments, most of which are over 75 years old. Many of these earth structures show signs of past instability, with over-steepened cutting slopes and/or poorly compacted embankment fill.

Prior to 1993 maintenance and renewal was carried out on a reactive basis following failure or reported problems. However, since 1993 there has been an earth structures inspection and assessment programme for which assets are periodically

inspected. The assets are listed in the Asset Condition Assessment and Certification (ACAC), which gives details of their location, condition and assessment status.

Asset Condition Assessment (ACA) classification is a two tiered condition assessment process. A Level 1 ACA Classification is assigned based on the results of a Principal Inspection (Stage 1) and/or a Desk Study (Stage 2). A Level 2 ACA Classification may be assigned after an Analytical Assessment (Stage 3) has been completed or after completion of remedial works. This Analytical Assessment ACA Classification will then be updated in the light of subsequent inspections.

3.2 General inspections

3.2.1 General inspections (formerly referred to as Superficial Inspections) are carried out as a cursory check of the entire earth structure. The purpose of the inspection is to highlight any defects or areas of deterioration in the condition of the asset and to record any unusual conditions on the asset which may compromise the stability of the asset and its ability to perform its required duty. All defects and deterioration shall be noted and reported where deemed necessary.

3.2.2 General inspections are undertaken in place of Principal Inspections where there is a limited risk from failure of the asset to rail traffic, passengers, staff and/or the public, e.g. Epping – Ongar branch or disused sidings roads where there is no service. In addition, General Inspections may be carried out between principal inspections for assets where there is an inclement weather risk or serviceability concern identified that justifies an increased inspection frequency but which does not require additional principal inspections.

3.2.3 General Inspections are to be carried out at a maximum interval of between 1 and 5 years based on the condition of the asset or the identified level of risk, as shown in Table 1, below. Where a General Inspection falls due in the same year as a Principal Inspection, only the Principal Inspection shall be carried out.

Table 1: Maximum Interval for General Inspections

Condition Rating Category	Maximum Interval between General Inspections - years
Earth Structures categorised as being at 'High' risk of flow failure, frost shattering or scour.	1
Earth Structures categorised as having 'Poor' (D_S) serviceability concern. Earth Structures categorised as being at 'Medium' risk of flow failure, frost shattering or scour.	2
Earth Structures categorised as having 'Moderate' (C_S or B_S) serviceability concern. Earth Structures categorised as being at 'Low' risk of flow failure, frost shattering or scour.	5

3.3 Principal inspections

3.3.1 Principal Inspections are comprised of close inspections of parts of the structure defined by transects as well as an overview of the condition of the entire structure, with attention paid to any defects located between transects. For assets which have been subject to analytical assessment, the transects shall coincide with the assessment transects. For all other assets, the transects will be undertaken at 100m intervals, to coincide with the BRS chainage plates on the track. In either case, additional transects may be carried out where the previous transects do not adequately cover a feature of interest. This might include the highest or steepest part of the asset, if this is not typical of the transects. In all cases, the interval between inspection transects should not normally exceed 100m, and shall never exceed 150m.

3.3.2 These cyclical inspections are carried out on prescribed intervals of maximum period between 1 year and 10 years depending upon the condition rating of the structure, as indicated in Table 2.

3.3.3 The result of the Principal Inspection is entered into the Earth Structures Condition Rating Tool (CRT otherwise known the ES algorithm) which determines a condition score for the unremediated asset. The CRT can be applied to remediated assets as well, with the resulting condition ratings adjusted as appropriate using engineering judgement.

3.3.4 A reduced scope Principal Inspection may be carried out where there is negligible risk to rail traffic, passengers, staff and the public provided no change in condition from the most recent full Principal Inspection is anticipated. Justification for the reduction in scope of the inspection will need to be agreed and recorded with the Head of Earth Structures. This reduced scope Principal Inspection is referred to as a General Inspection and is described in section 3.2.

3.3.5 Principal Inspections are also carried out as part of the assessment process. These Principal Inspections for assessment are carried out as a full Principal Inspection of the asset under assessment. The inspection transects are carried out at the ground investigation transect locations in order to compare data with the transect information recorded in the assessment report and to apply the factor of safety data within the Principal Inspection algorithm. These locations are carried forward and inspected at the next inspection to allow degradation to be monitored.

Table 2: Maximum Interval for Principal Inspections

Condition Rating Category	Maximum Interval between Principal Inspections - years
Earth Structures categorised as in 'Poor' condition and where further geotechnical investigation is recommended. It is generally expected that 'Poor' assets with an assessed factor of safety <1.15 will also be subject to annual inspection	1
Earth Structures categorised as in 'Poor' condition.	2
Earth Structures categorised as in 'Marginal' condition.	5
Earth Structures categorised as in 'Serviceable' or 'Good' condition.	10

3.4 Special inspections

3.4.1 Special inspections are close inspections of either the whole asset or a particular area of defect causing concern in a structure.

3.4.2 Special inspections are required for all structures that have either:

- concerns following a previous Principal Inspection in order to monitor and assess the degradation of known defects in a structure;
- structures that have a speed restriction (temporary or permanent) imposed (3 monthly maximum interval);
- structures that have failed to demonstrate an adequate Factor of Safety following assessment and require close monitoring of any deterioration or any signs of failure in the structure related to internal structural instabilities (3 monthly maximum interval unless it can be shown that a greater interval is acceptable, and this is approved by Head of Earth Structures);
- structures that have unresolved maintenance issues.

3.4.3 Special inspections form part of the risk mitigation measures and they shall continue in order to provide an ongoing record of deterioration until repairs are carried out, the asset is under control of the Projects Team for remedial works or further assessment suggests otherwise.

3.4.4 Special inspections may also be required as a result of concerns arising from monitoring data collected for any of the ALARP or Observational Monitoring sites.

3.4.5 When carrying out special inspections measurements are taken to quantify movements and displacements of the asset itself and any associated infrastructure. This allows comparison of data over time in order to categorise the type of movement into seasonal/shrink swell movement or a deep or shallow seated failure mechanism.

3.5 Defect advice inspections

3.5.1 These inspections shall be carried out as a result of defect notification identifying unexpected deterioration from any source or in response to an Incident that causes damage to a structure or adversely affects its ability to carry out its required duty.

3.5.2 Defect advice inspections may initiate a special inspection on a structure, with the inspection continuing until such time as the initial defect has been repaired.

3.5.3 Where an asset includes structural elements that are classified under a combination of disciplines, parties from all the relevant disciplines may need to be in attendance for the inspection to ensure that the correct analysis of any failure situation is determined. The Civils Asset Manager shall inform the Civils Maintenance Engineering Manager of such a situation and he will ensure that all parties are notified and arrangements made in advance to carry out the works.

3.6 Inclement weather inspections

3.6.1 The Inclement Weather Report breaks down the risk of failure to assets into five categories:

- deep-seated or shallow rotational failures from prolonged rainfall and low Soil Moisture Deficit,
- flow failures resulting from storm events,

- flooding
- scour
- frost shattering of chalk.

3.6.2 The report groups the assets as either High, Medium, Low or Negligible risk with Inclement Weather inspections to be carried out as appropriate. General Inspections are used to monitor deterioration of these assets, as outlined in Section 3.2. The additional inspection requirements for the different modes of inclement weather are outlined in Table 3, below.

Table 3: inspections required for assets susceptible to inclement weather

Inclement Weather Mode	Criteria for Additional Inspection
Prolonged rainfall and low SMD	None – it is assumed that these assets are managed under the existing inspection regime
Flow failure	Following periods of heavy rain, it is envisaged that track will review risks to Earth Structures. In the event that the following trigger levels are exceeded: • 25mm of rainfall in 1 hour or; • 50mm of rainfall in 2 hours or; • 100mm of rainfall in 24 hours; Assets at high risk of flow failure should be inspected. However, it is currently unclear how this will be managed and who will carry this out. Assets susceptible to flow failure will also be inspected in accordance with the arrangements outlined in Section 3.2
Flooding	Assets susceptible to flooding will be inspected in response to reports of flooding from NOC or track
Scour	Assets susceptible to scour will be inspected in accordance with the arrangements outlined in Section 3.2
Frost shattering	Assets susceptible to frost shattering will be inspected in accordance with the arrangements outlined in Section 3.2

3.6.3 The impact of climate change has also been presented in the LU standard S1054 and LU guidance G0054B. For clay slopes the impacts may be as follows:

- the increase in the projected rainfall intensity is likely to lead to increased surface runoff. This may present challenges to drainage management and potentially cause more flooding or erosional failures.
- The increase in intensity of rainfall could surcharge the local drainage network and direct flow towards the adjacent earthworks, leading to flooding and surface erosion.
- The hotter and drier summers and wetter winters will lead to increases in the amplitude of shrink-swell cycles. This may increase desiccation cracking.

- The increased swell-shrink behaviour may lead to slope instability and serviceability concerns.

The inspector should pay particular attention to the above features during the inspection.

3.7 Chalk cutting inspections

3.7.1 The inspection of chalk cuttings requires a revised approach as compared with other LU earth structures. This is due to the differing significance of defects on these assets, and to working at height issues due to the height and steepness of the assets. A revised CRT for chalk cuttings has been proposed, but is not issued yet. A suitable proforma for the inspection of chalk cuttings is included in LU standard S1054.

3.7.2 Work at Height in relation to inspection of chalk cuttings is likely to be managed using rope access techniques. Staff involved in these inspections will be trained to IRATA Level 1 or alternatively this task may be outsourced to external competent suppliers. After the first series of inspection by abseiling the need for continued use of abseiling for subsequent inspection should be established based on the data collected through the previous inspections.

3.7.3. For chalk cuttings which have been remediated with an anchored mesh, the inspections will include a random check of the tightness of a proportion of the bolts securing the mesh and/or any other defects or damage which may have occurred subsequent to installation. The procedure for this should be documented in the maintenance manual for the asset. For this type of assets an anchor system have been installed on the crest of the cutting for future abseiling for inspection and maintenance.

4 Procedure

4.1 General

4.1.1 A checklist has been provided in Appendix A detailing preparation that should be carried out before embarking on an inspection, such as:

- information sources that can be checked regarding previous inspections and asset history;
- previous work order history and status;
- site access and protection booking;
- access on and around site once on the asset;
- collation of equipment to be used to carry out the inspection.

4.1.2 All inspections, irrespective of type, should be carried out in daylight during Traffic Hours. It may be necessary, due to access restrictions, for some inspections to be carried out during Engineering Hours or in a Possession. When this is necessary the Inspection Team must ensure that the correct procedures are in place and that there will be adequate light to carry out a full close inspection of the asset.

4.2 Preparation

4.2.1 Prior to commencement of an Inspection a review of all available information relating to the particular asset shall be carried out. Data to be reviewed shall include, but not be restricted to:

- the Asset Condition Assessment Register (ACA),
- Maximo for work order history and status
- previous inspection reports,
- previous assessment reports,
- the Inclement Weather Report Phase 2,
- results of any monitoring carried out on the asset,
- asset location plans,
- Web–GIS,
- known defects, and maintenance history where relevant,
- information pertaining to existing structures associated with the asset, e.g. retaining walls and drainage, lineside services amongst others.
- geological maps and memoirs,
- discussions with others having particular knowledge of the site.

4.2.2 The information reviewed shall be referenced on the inspection reports as appropriate.

4.2.3 Where a Principal Inspection is to be undertaken as an Inspection for Assessment, the scope of the inspection will be determined by the Assessment Team, for example specific chainages may be given for inspection in advance of planned GI works.

It may be necessary to carry out a reconnaissance visit to the site in order to plan for the inspection where it is likely that access is restricted by safety, security, operational or environmental reasons. This data should be collated and documented to develop a record of access requirements for all Earth Structure assets.

4.2.4 It may be necessary to arrange limited vegetation clearance in likely areas of instability which may be obscured in order to facilitate the Inspection. However, for routine inspections, it is preferable to retain the vegetation cover, and to schedule the inspection of assets during months of January to March whene the density of vegetation is not likely to significantly compromise the inspection of the asset.

4.3 Access booking

4.3.1 For Earth Structures non-intrusive surveys a Railsys access number is provided on an annual basis.

4.3.2 All access to the sites are to be arranged as per LU Access regulation as per the Rule Books and The Access Booking Procedures, including where a Protection of Workers on Track (PWT) or SPC is required for all track access work. Where necessary, other protection competencies (eg Network Rail protection staff) shall be booked using the same procedure, on an ad-hoc basis.

4.3.3 Support resources, such as labour, plant or materials, are to be arranged through the appropriate manager.

4.4 Equipment

4.4.1 The inspections require certain types of measuring equipment and tools in the process and all staff shall be conversant with their use. All such equipment shall be kept in a serviceable condition and any bladed tools shall be sheathed during transportation.

4.4.2 The equipment used to carry out inspections may be expected to include:

- date stamp camera,
- 30m fibron tape,
- 2m wooden ruler,
- compass/clinometer,
- laser distance measuring device,
- marker paint,
- handheld PC,

4.4.3 The equipment listed above have no health and safety risks when handling.

4.4.4 Hatchets and secateurs shall be used for the removal of light vegetation on the lines of inspections. Staff shall be aware of the local conditions when using them and they must only be used behind the cable posts away from the track. Protective gloves and glasses shall be worn at this time. An authorisation letter from LU Asset Performance (AP) must be carried at all times when carrying these tools. Otherwise the person is liable to prosecution by the Police.

4.5 Fieldwork

4.5.1 The Inspection will be undertaken in accordance with the Generic Health, Safety and Environment Method Statement and the current LU standard S1054. Inspection Reports will be produced as detailed in Section 5.4 below.

4.5.2 Principal inspections shall be carried out along a series of transects at regular intervals, as described in section 3.3. The examination for all inspections shall include physically walking over the earthwork where it is safe to do so and access is permitted. Where necessary, this may involve using rope access techniques and will require the provision of a suitable safe system of work. Where any transect is considered by the Inspection Engineer to be at an inappropriate position, e.g. does not give a true representation of the asset, this shall be brought to the attention of the Earth Structures Inspection Manager (IM) or the Earth Structures Inspection Review Engineer (IRE) and the transect will be re-defined.

4.6 Measurements

4.6.1 A number of measurements can be taken when inspecting an asset. These may relate to the geometry of the asset, or the location of infrastructure or defects along the transect section.

4.6.2 Measurements carried out in inspection include, but are not limited to:

- width and depth of ballast,
- width of cess (If no cess then the distance between the rail and cable run/start of slope),
- length of slope sections and subsections,
- inclination of slope sections,
- width of crest,
- inclination of cable posts, retaining walls, kilometre post markers and fence posts,
- width of cracks in walls,
- horizontal and vertical displacements in blocks in walls,
- dimensions of retaining walls,
- dimensions of drainage infrastructure along the slope section,
- dimensions and locations of defects.

4.6.3 The slope geometry is to be measured either with an inclinometer and fibron tape or with a laser distance measuring device with built-in tilt sensor. The slope geometry is divided into three sections which are discussed below.

4.6.4 **Section 1**: This is the distance from the nearest running rail to the first breakpoint. On an embankment this is located at the shoulder and on a cutting this is located at the toe.

4.6.5 When recording data for slope section 1, the cess width is defined as the distance between the edge of the track construction and the cable run or the start of the slope. Where there is a sloping ballast shoulder, the cess will be the horizontal area between the bottom of the ballast shoulder and the cable run or start of slope; where the ballast is all horizontal (ie without a sloping ballast shoulder), the cess width can be taken to extend from the running rail. Contrary to previous practice, the presence of ballast in the cess does not preclude a cess being recorded. In all cases, the cess is expected to be subhorizontal – if there is no horizontal area between the track and the start of the slope or the cable run, the cess width shall be zero.

4.6.6 The old or first generation services are comprised of concrete cable posts. Services with metal cable posts are referred to as new or second generation. All displacement shall be recorded with irrespective of whether it is due to deterioration of the asset or from poor installation; however, consideration as to the likely cause shall be recorded in the inspection report.

4.6.7 Any assumptions made in the field as to the geology of the asset should be confirmed by checking the relevant assessment information or geological map, if available, when writing up the report.

4.6.8 **Section** 2: This is the distance covered by the slope section of the asset from the shoulder to the toe on an embankment, or from the toe to the shoulder on a cutting.

4.6.9 The data is to be recorded cumulatively working along the slope away from the track.

4.6.10 **Section 3**: is the horizontal area beyond the end of the slope section up to the LU boundary fence.

4.6.11 In some cases the boundary fence may be situated on the slope section or on top of a toe retaining wall. Where possible an estimate of the geometry to the end of slope section 2 and the length of slope section 3 should be recorded. It should also be noted if the slope is located on a larger slope. This will allow the full structure to be considered when calculating the condition rating score.

4.7 Measurements – Laser Scanning

Measurement of the slope geometry can be undertaken using laser scanning by the TfL Land Survey Department (LSD). This methodology is intended to provide more accuracy and improve safety by minimising access to the slope for undertaking manual measurements.

The procedure for undertaking the laser scanning and the data processing is as follows:

1. IM to arrange for vegetation clearance of approximately 2m wide strip along all the transects which are to be laser scanned in advance of the laser scanning.
2. Agree a programme of laser scanning survey of transects on earth structures with the LSD.
3. LASD to carry out laser scanning along the agreed transects as per the agreed programme with the IM.
4. The laser scans are carried out using a LEICA RTC360 laser scanner. As many 360 degree scans as is needed are taken in order to capture the full length of each individual transect. Typically, this will include nearest set of tracks, cable run, earth structure slope and boundary fence.
5. Photographs of each laser scan transect location are taken.
6. The data from the laser scanning will be processed by LSD. The data will generate a point cloud from which a cross section can be generated by a CAD modeller.
7. The CAD modeller measures the relevant offsets and angles for the section/sub-section data for each transect from the cross section.
8. The LSD are provided with the spreadsheet template from the CRT. The LSD enters the data into the CRT spreadsheet provided and submit to the Inspection Team.
9. In some cases the laser scan may not be able to capture some features such as structures/walls, etc. In this case manual measurement of these features will be undertaken manually by the inspector.
10. The above data can then be combined to complete the slope geometry measurement.
11. The remaining part of the inspection and reporting will continue as per the normal procedure.

12. The cross section generated from the laser scanning is then included in the appropriate location in the inspection report where the inspector is required to provide a sketch of the transect inspected.

CAD QA

A second CAD modeller will 'peer review' the spreadsheet information produced. This is both for the drawn cross section of the transect and measurements that have been derived from it.

A Senior Engineer will provide 'gross error' checks by visually comparing the data with previous inspection reports, vegetation clearance reports and survey site photographs.

Coordinate System

Each individual transect is a standalone survey and is therefore not normally related to any of the other transects on the same earth structure.

Each individual transect is positioned on its own - totally arbitrary grid, and so none of the transects are located in their absolute position relative to the London Survey Grid (LSG).

Survey Accuracy

Each surveyed point within the same laser scan is considered accurate to 1.2mm relative to all other points within that scan.

Each surveyed point within a fully registered point cloud for each transect is considered accurate to +/- 5mm or better. This is well within survey tolerance for this type of survey.

4.8 Indicators of Instability

4.7.1 There are a number of indicators of instability which are common to both cutting slopes and embankment slopes. The indicators themselves appear in the same geometrical location on the slope but have differing maintenance requirements dependent on whether the slope is a cutting or an embankment. There are different indicators dependent on whether the instability is classed as shallow or deep (for deep instability the failure will affect the lineside services or the track).

4.7.2 Deep-seated instability

- toe bulges (which may be oversteepened and bare);
- back scars at the crest of the slope;
- tension cracks at the top of the slope;
- trees leaning;
- services leaning;

4.7.3 Shallow instability

- services leaning
- services displaced horizontally or vertically
- hummocky ground

- bare slopes
- toe debris;
- trees leaning
- leaning fence
- exposed roots.

4.7.4 The following indicators of instability apply to embankments only:

- exposed cable post toes;
- ballast ravelling down the slope;
- excessively deep ballast supporting the track;
- dips in track level.
- Thick ash layer on the crest combined with a toe bulge

4.7.5 The following factors may be indicators of inclement weather related movements:

- Flow failures

  Localised scars associated with water flow from adjacent land.
- Flooding

  Indicators outlined above, caused by elevated porewater pressures caused by the flooding.
- Scour

  Erosion of earth structure caused by watercourse or increased surface run-off. Possibly exacerbated adjacent to structures.
- Frost shattering

  Presence of toe debris on chalk cuttings. Frost shattering is likely to be worse where there is exposed chalk in the face of the cutting, and evidenced by fresh chalk and/or flint at the toe.
- Shrink-swell

  Desiccation cracking and seasonal movements of the slope and track and lineside services.

4.9 Shoulder condition

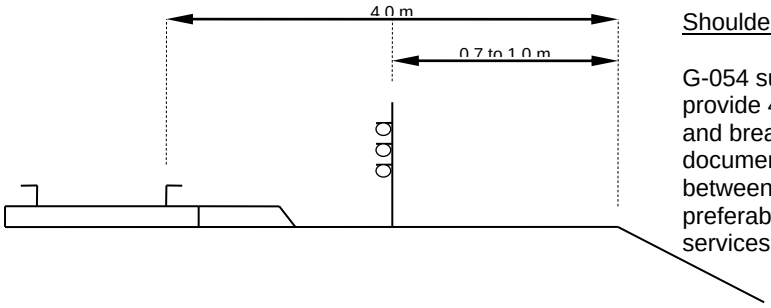
4.8.1 The algorithm in the condition rating tool considers deep seated instability when scoring an asset. It is also necessary to consider the condition of the shoulder of embankments in detail as any deterioration or defects due to shallow instabilities will not otherwise be considered in the overall condition rating score. Special consideration should be given to the following in order to have an overall view of the condition of the shoulder (see also Figure 1):

- Distance from the cable run and/or track to breakpoint of slope (See Figure 1)
- Steep or sloping shoulder
- Terraced shoulder

- Undulating shoulder
- Soft or loose ash shoulder, deteriorates easily under foot traffic
- Excessively deep ballast supporting the track
- Ballast ravelling down the slope
- Displaced and/or leaning cable posts
- Exposed cable post toes
- Exposed roots
- Dip in track level
- Excessive burrowing in the shoulder.

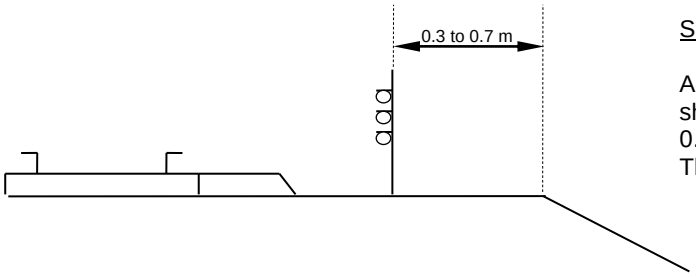
4.8.2 If a number of these defects are present in one area or along a length of the structure there may be underlying stability problems in the structure leading to a loss of support to the track. In the long term this may lead to the structure failing to carry out its required duty.

Figure 1: Shoulder Condition



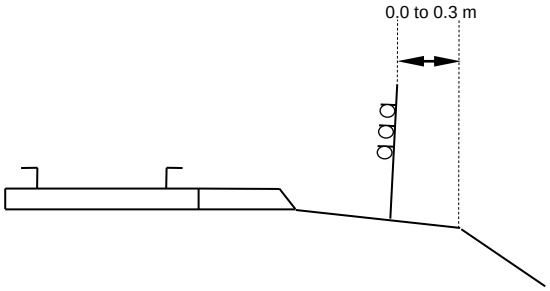
Shoulder condition: Good

G-054 suggests design for remediation should provide 4.0m distance between nearest running rail and breakpoint of asset (there is no requirement documented in 1-054). Asset has walkable area between the ballast shoulder and the services and preferably a minimum of 0.7m width beyond the services.



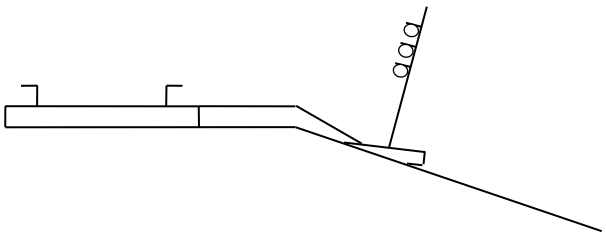
Shoulder condition: Serviceable

Asset has a flat walkable area between the ballast shoulder and the services and there is between 0.3m and 0.7m width beyond the services.
The services may have a slight lean.



Shoulder condition: Marginal

Walkable area between the ballast shoulder and the services is narrow and sloping away from the track and may be undulating along its length with between 0.0m and 0.3m width beyond the services. The above condition may have led to the following:
The depth of ballast may be increasing – up to 0.4m.
Services leaning down slope up to 5° and may be showing minor horizontal or vertical displacement.



Shoulder condition: Poor

No walkable area between the ballast shoulder and the services and less than 0.3m width beyond the services. Ballast shoulder ravelling down slope. Cable post toes are exposed. Access along the slope may be difficult due to localised oversteepening.
The above condition may have led to the following:
Ballast depth greater than 0.4m.
Services leaning down slope greater than 10° and showing distinct horizontal or vertical displacement.

4.10 Defects

4.9.1 The defects considered in 4.7 and 4.8 above along with information relating to slope condition, retaining structures, drainage, water, wildlife and vegetation are to be recorded in detail for each transect in the field proforma.

4.9.2 Where defects are identified between transects they should be recorded in detail in the defects sheet with clear descriptions and chainages delineating them. If a defect is particularly severe it should be reported to the Fault Report Centre and to the AP Civils Manager and Head of Profession (HoP) of Earth Structures, if necessary. It may be necessary to remain at the location of the defect, dependent on its nature, until a maintenance team is sent out to effect repairs.

4.9.3 The recorded defects in the defects sheet shall be reported in accordance with the requirements shown below in Table 4 - Earth Structure Defect Classification System.

4.9.4 Photographs should be taken to show any defects encountered. This can prove invaluable for the Inspection Review Engineer when considering their effect in the condition rating tool.

4.9.5 Asset abuse may be recorded where there has been planned, unplanned or third party works or actions which may have caused damage to a structure. This may also include indirect damage to an asset through the failure of another structure and fly-tipping and dumping of waste onto the asset or (potential) undermining of an asset at the asset boundary due to modifications on adjacent properties.

4.11 Overall condition of assets

4.10.1 When carrying out an Earth Structures Inspection the asset as a whole should be inspected in order to identify defects on the structure. It is necessary to check the condition of not only the earth structure but also any associated structures that are either in contact with or in close enough proximity to the structure to have an adverse effect on its strength and/or stability.

4.10.2 Retaining walls associated with a structure are always to be recorded in Section 2 of the slope geometry and their condition is to be noted. Drainage running along either the toe of an embankment or the crest of a cutting slope is to be noted and recorded. The condition of adjacent property beyond the boundary fence should also be noted and recorded. In some cases the absence of drainage to divert overland flow should also be noted.

Attention should be paid to flooding and surface water features inside and outside the LU boundary fence. Attention should also be paid to the topography and size of the catchment outside the boundary fence and whether it is falling toward the asset or away.

4.10.3 When recording a Principal Inspection transect a swathe up to 5m either side of the transect is to be considered. This allows the Inspection Engineer to fill in the field proforma objectively.

Table 4: Earth Structure defect classification system

	Classification	Explanation
Extent	A B C D	No 'significant' defect 'Slight', not more than 5% affected (of area, length, etc) 'Moderate', 5% to 20% affected 'Extensive', over 20% affected
Severity	1 2 3 4	No 'significant' defect 'Minor' defects of a non-urgent nature 'Heavy' defects of an unacceptable nature 'Severe' defects where action is needed – to be reported immediately to the supervisor.
Recommended Action	R M I D C G T A S	Repair Monitor Special inspection regime Design remedial works Replace Ground investigation Topographic survey Slope stability assessment Speed restriction
Priority	I H M L R	Immediate (within 4 weeks) High (within 12 months) Medium (within 2 years) Low (before next Principal Inspection) Review (at next Principal Inspection)

4.12 Data collection and recording

4.11.1 The recording of information must be in accordance with the requirements of LU standard S1054. Data will be recorded in the correct report pro-forma for each respective structure. Appendix D shows the Principal Inspection Report proforma and Appendix E shows the special inspection Report proforma. The Inspection Engineer will make every reasonable effort to complete all relevant parts. Where it is deemed unsafe to walk on the asset a distant inspection of the structure may be carried out with the use of binoculars.

4.11.2 The proforma will be filled out as a paper version or digitally with a hand held PC.

4.11.3 The front page of the proforma is to be filled in with the correct information detailing the asset, location details and the inspector. For each transect a photograph of the general view of the asset along the track and a view up or down the recorded transect should be taken for inclusion in the report.

4.11.4 Each section of the proforma is filled in with details recorded relating to the features observed at the transect being inspected. Any defects that are located between inspection transects are to be recorded in the defects sheet unless their significance is such as to justify an additional inspection transect.

5 Responsibilities

5.1 Process owner

5.1.1 The process owner is Head of Earth Structures

5.1.2 The process owner shall:

- Ensure process continues to deliver corporate strategic objectives
- Set appropriate measures, monitor and improve the process
- Ensure appropriate resources are available for implementation of the process

5.1.3 The Head of Profession of Earth Structures is responsible for ensuring that all staff involved with Earth Structures inspection have had their competency assessed in accordance with the relevant Competency Assessment standard. The relevant Units of Competence for inspection are shown in Table 5.

Table 5: Pre-requisite Guidelines

Unit No	Unit title	Job Role
PR0785	Competency Assessment of Earth Structures Inspection Review Engineer	Earth Structures Inspection Review Engineer or delegated appointee
PR0788	Competency Assessment of Earth Structures Inspectors	Earth Structures Inspection Engineer

5.1.4 The standard of competence for persons in the Earth Structures inspection and assessment process requires Railway Safety Publication 1- Developing and Maintaining Staff Competence Guidance (ORR) and LU standards S1801 'Competence requirements for undertaking Civil Engineering Safety Critical Work' and S1548 'Safety Critical Work'.

6 Supporting information

6.1 Programme

6.1.1 The Inspection programme will be prepared by the Earth Structures IM based on a list of inspections due provided by the planning team. The programmes for Principal, General and special inspections are created in Maximo. The Inspection Programme is based upon the Preventative Maintenance (PM) Task in Maximo which automatically creates the Work Order at pre-set frequency for the asset. This is the frequency, in days, of the inspection cycle which is derived from the maximum intervals between inspections in accordance with the requirements of LU standard S1054, which is referenced in Table 3.

6.1.2 The programmes are reviewed by the Head of Earth Structures . The final programme may be subject to additions or cancellations of inspections. Such changes may be derived from feedback from the Head of Earth Structures, ad hoc inspection, the output from assessments carried out in any year and the planned remediation of assets. Changes to the programme will be submitted as a Change

Control Form (CCF). The CCF will detail the proposed change to the programme, the reason for the change and will include a copy of or reference to any relevant instruction regarding the change, for example a signed off Inspection report or Assessment report. The CCF is to be submitted by the IM to the Head of Earth Structures for approval and then the changes to the programme are to be implemented by the Civils Planning Team.

6.1.3 For each subsequent business quarter of the year (T2, T3, T4) the programme may be re-forecast to take into account any changes that may have occurred.

6.1.4 It is preferable to carry out Principal Inspections during the period October to April when there is reduced vegetation cover on the assets allowing a more detailed view of the condition. Where this is not possible, perhaps due to programme or resource constraints, assets may be inspected during the period May to September. Suitable assets may be selected due to their lack of vegetation cover. These may be identified through the use of recent aerial photography, available through Web-GIS, by carrying out a preliminary site visit, or through knowledge of the Earth Structures Team. Alternatively, in exceptional circumstances, vegetation clearance can be arranged to allow a clearer view of the asset. Where an inspection cannot be carried out due to density of vegetation, it may be rescheduled to be undertaken during the months January to March, when vegetation cover is expected to be at a minimum. Where the vegetation is such that it is unlikely to reduce significantly during the winter months, the inspector shall undertake sufficient vegetation clearance to record the required transect measurements using handtools and record in the inspection report any uncertainties due to the remaining vegetation cover. The inspection review engineer will take this into account in determining the future inspection regime for the asset.

As an alternative to the above, the transects can be cleared in advance and laser scanning of transects can be carried out by the TfL survey team as arranged and programmed by the Earth Structures IM. The inspection of the asset can then be carried out by the Earth Structures Inspector. This inspection will be looking at the overall condition of the asset and identification of any defects. No measurement at the transects will no longer be required as the measurement has already been taken by the laser scanning.

6.1.5 In order to carry out special inspections it is necessary to have a defined understanding of the risk associated with the structure. For the implementation of new special inspections clear instruction should be given in the CCF as to the reasons why the inspection regime is required. If the asset has failed assessment either due to shallow or deep instabilities, this should detail the potential failure mechanisms expected in the structure. Where the asset has a known maintenance defect to be monitored, this should be defined in order to focus the inspection.

6.2 Progress reporting

6.2.1 The Earth Structures IM shall produce the Inspection Programme.

6.2.2 The Earth Structures IM with the Civils Planning Team is responsible for reporting on the progress of the Inspection Programme in accordance with AP Vizboard requirements. Inspection progress is reported upon on both a weekly basis and on a period basis.

6.3 Report submission

6.3.1 At the time of inspection, faults shall be raised and reported with their number by the inspector where the defects or conditions discovered are likely to affect the safe and continued operation of the railway.

6.3.2 The reports will be submitted electronically to the Inspection Review Engineer who shall be a Chartered Civil/ Structural Engineer or a Chartered Geologist, and assessed as Competent to review Earth Structures Inspection reports for approval. Each inspection shall be given an work order number which shall be shown on the front page of the report.

6.3.3 Inspection reports will be submitted to the Head of Earth Structures for review when there is a recommendation to change the ACA classification or inspection frequency, or for information where there is a significant new concern.

6.3.4 The Inspection Review Engineer will consider the output from the condition rating tool and may make changes to the condition rating using the review adjustment boxes on the score sheets, where appropriate, given that a full review of all relevant information has been carried out, e.g. the recorded defects associated with the structure along with the recorded assessment and maintenance history. The reviewed condition scores for the asset will be recorded in the inspection report alongside the basic condition scores. The Inspection Review Engineer will review the condition rating scores for each transect along with the current ACA classification and may need to recommend changes to ACA classification.

6.3.5 The Inspection Review Engineer has responsibility for ensuring that the Condition Monitoring is updated in Maximo for the asset. This involves reviewing and updating as necessary the ACA classification and updating the transect ratings following a Principal Inspection. The date for the condition monitoring to be recorded in Maximo will be the date the inspection was carried out.

6.3.6 Where defects or problems are identified by Principal Inspection and the potential for, or rate of, deterioration is unknown, it may be necessary to implement a number of frequent special inspections to check and report on any change. A recommendation for further, more frequent, inspections shall not substitute the need for immediate action especially where there is any doubt about the safety of the structure.

6.3.7 The Inspection Review Engineer will review the current open maintenance work orders as referenced on the front of the report. The Inspection Review Engineer is responsible for closing any completed work orders and actioning any outstanding work orders.

6.3.8 Recommendations for all maintenance works required to the asset will be stated in the report by the Inspection Engineer with guidance as to the expected means for carrying out the works. The Inspection Review Engineer is responsible for the creation of any new work orders in response to the defects. The work orders will be incorporated into the maintenance work bank and prioritised as necessary. Where there is evidence that the existing assessment information for the asset is no longer valid, the Inspection Review Engineer may recommend that an assessment of the asset be carried out.

6.3.9 The work orders shall then be reviewed and actioned by the Civils Asset Delivery Manager. Where considered necessary a quantitative risk assessment will be carried out by the Inspection Review Engineer to support the prioritisation.

6.3.10 Risk must be highlighted and recorded on the Risk Register by the Accredited Assuror (as described in the Commercial Manual) whenever it arises. This could include risk arising when:

- an inspection reveals that an asset has suddenly deteriorated or has become dangerous
- the inspection programme cannot be completed fully or on time for whatever reason
- an ad hoc report is received indicating that an asset requires urgent inspection or attention.

6.4 Safety considerations

6.4.1 A Generic Health, Safety & Environmental Method Statement has been produced covering the common activities for all Inspection types and assets and which has been approved by the HSE advisor.

6.4.2 The AP Civils Construction Manager (CM) will brief staff on the particular content of the Method Statement, which should include technical, environmental and safety aspects of the inspections.

6.4.3 In certain circumstances a site specific Method Statement will be produced for the cyclical inspections as an addendum to the generic document. This may be needed to detail unusual site or access restrictions and where normal working practice may not be able to be adhered to. This will be approved by the AP Civils CM prior to the inspection being carried out.

6.4.4 A risk assessment will be carried out by the Inspection Engineer in accordance with the procedures in the Generic Method Statement. The risk assessment is detailed in Appendix B. The Inspection Engineer shall carry out a risk assessment on any asset which they, or anybody accompanying the party, are visiting for the first time or with which they are unfamiliar. The risk assessment details expected access difficulties, unfavourable ground conditions and other factors which may pose unexpected risks on the structure. The risk assessment is to be reviewed by AP Civils CM.

6.4.5 All staff shall wear safety footwear and a high visibility vest during the inspection. The vest should not be obscured by the carrying of a back pack or similar. Required PPE for site works also include gloves, to protect against cuts from infrastructure and vegetation and against infection such as leptospiral jaundice, and safety goggles, to be worn as necessary. Binoculars may be carried when it is anticipated that access onto the asset for close inspection may not be possible, especially where the structure is oversteepened or loose or the ground may be saturated. Staff should carry a personal first aid kit at all times when out on site.

6.4.6 Staff shall be aware of local conditions when taking measurements e.g. live rails, moving trains, lineside services, slope gradient and changes of gradient, loose slope material or soft shoulders, vegetation, animal burrows, obscured catchpits, culverts, ditches and watercourses.

6.4.7 In respect to sharps, where discarded needles are discovered, the location should be highlighted/demarcated with spray paint or sealed off, if possible, so that access to the location is restricted until the needles have been removed. The location should be reported to the LU Fault Report Centre or Station Supervisor of the nearest station to arrange for their safe removal and disposal.

6.4.8 As a minimum requirement all inspection staff shall hold LU Basic Track Awareness and Network Rail Personal Track Safety certification. Other certification shall be held as required for the work being undertaken (eg IRATA Level 1, substation access). Prior to the inspection being carried out the Inspection Engineer shall brief the Protection of Workers on Track (PWT) / SPC for those assets that are to be inspected. The PWT / SPC will ensure that a Safe System of Work is adhered to for the duration of the work and for the duration of time that the Inspection Engineer is within the track environment.

7 Person accountable for this document

Name	Job title
Nader Saffari	Profession Head of Earth Structures

8 Definitions

Term	Definition	Source
At Grade	At original ground level including minor excavation or filling to a depth or height of less than 1.0m.	Jargon Buster
Accredited Assuror	The head of internal Assurance of the Civils Earth Structures team, responsible for the quality and direction of Inspection processes.	Jargon Buster
Change Control Form (CCF)	Used for documenting amendments to the Inspection programmes.	Jargon Buster
Condition Rating Tool (CRT)	LU algorithm used to calculate a condition rating score from Principal Inspection defects.	Jargon Buster
Cutting	Section of an earth structure formed by excavation below original ground level to a depth in excess of 1.0m, which generally has a length greatly in excess of its width.	Jargon Buster
Embankment	Section of an earth structure formed by filling above original ground level to a height in excess of 1.0m, which generally has a length greatly in excess of its width.	Jargon Buster
Maximo	An Asset Management system to generate Works Orders for Planned and Unplanned Maintenance and Fault Management.	Jargon Buster
Line Asset Network Plan (LANP)	Annual report setting out maintenance and project works.	Jargon Buster
Overbridge	A bridge which crosses over the railway.	Jargon Buster

Underbridge	A bridge which crosses under the railway.	Jargon Buster

9 Abbreviations

Abbreviation	Meaning
CRT	Condition Rating Tool
LANP	Line Asset Network Plan
CCF	Change Control Form
SPC	Site Person in Change
HSE	Health, Safety and Environment
ACA	Asset Condition Assessment
IRATA	Industrial Rope Access Trade Association
CRT	Condition Rating Tool
ACAC	Asset Condition Assessment and Certification
ORR	Office of Rail and Road
ALARP	As Low As Reasonably Practicable
RSPG	Railway Safety Principles and Guidance
AP	Asset Performance
IM	Inspection Manager
CM	Construction Manager

10 References

10.1 Statutory documents

Document no.	Title or URL
	Construction (Design and Management) Regulations
	The Fire Precautions (Sub-surface Railway Stations) Regulations
	Goal-setting Principles for Railway Health and Safety, Office of Rail and Road (ORR)
	Railway Safety Publication 1- Developing and Maintaining Staff Competence Guidance (ORR)

10.2 TfL company documents

Document no.	Title or URL
S1054	Civil Engineering – Earth Structures
S1801	Competence requirements for undertaking Civil Engineering Safety Critical Work
S1042	Managing LU Asset Risk: Recording of Assets and Data for Condition Reporting
S1548	Safety Critical Work
G0054A	Civil Engineering – Earth Structures
G0054B	Earth Structures - Guide for slope stability analysis
PR0021	Earth Structures – Assessment Procedure
PR0019	Earth Structures – Monitoring Procedure
PR0017	Earth Structures – Design Procedure
CPD-9999-EST-RPT-00001	Effects of Inclement Weather on Earth Structures, Transport for London, December 2023.

11 Document history

Issue no.	Date	Changes	Author
A1	April 2017	Work instruction W0020 updated and rewritten as aprocedure as per change No. 05204.	N Saffari / R Sidhpura
A2	October 2019	General update on roles, responsibilities and the Accountable Person. Change request No. CR- 11881.	N Saffari
A3	December 2023	Update to include laser scanning, climate change, roles and responsibilities, references and other general updates. Change Request No. CR-18510.	Nader Saffari

12 Attachment

12.1 Earth Structures Inspection Checklist

Inspection Preparation Checklist

Early arrangements/information:

- Safe Working Requirements
- Engineering Hours/Traffic Circular and Special Notices
- Line clear/Line safe
- Access arrangements
- Inspection equipment

Later arrangements/information:

- Earth Structure details
- Outline drawings
- Inspection Work order number
- Previous Inspection details
- Previous Assessment details
- Report proformas
- Confirmation of early arrangements

Inspection Equipment:

- Safety Equipment/PPE
- Survey book
- Handheld PC
- 30m fibron tape
- 2m wooden ruler
- Date stamp camera
- Clinometer
- Compass
- Hazard tape
- Marker paint
- Disto
- Binoculars

Access Checklist

Basic Requirements:

- Safety
- Practicality
- Efficiency

Additional Requirements:

- Access over cable run
- Environment – vegetation clearance
- Transportation to site
- Rope Access for chalk cuttings or assets with other wrk at height risks
- Laser scanning by the Land Survey Department

Inspection Programme Checklist

- Prepare detailed programme of work
- Inform Manager

12.2 Earth Structures Team Risk Assessment for Site Visits

This document is to be used to consider the site features prior to going to site, with the aim of identifying particular hazards associated with the site visit, or areas of uncertainty. The document should be completed and then discussed with the relevant team leader before the site visit is carried out to agree any procedures that may be required for the work.

Names					
Work to be carried out (delete as appropriate)	Special Inspection	Principal Inspection	Walkover Survey	Site Visit	Other (state)
Site Location					
Protection Arrangements	Protection Master	Are lookouts required?	Network Rail	Other	None
Date of site visit	☐ Embankment ☐ Cutting		Are you familiar with the area?	☐ Yes	☐ No
Access Route to site	Via gate	Via station platform	Along cess	Along shoulder	Along track
Site Hazards	Present (tick)	Comment			
Complex Track Layout	☐				
Limited Clearances	☐				
Multiple Tracks	☐				
Network Rail Lines	☐				
Cable Runs	☐	Where are they?		Are there cable stiles?	☐ Yes ☐ No
Is there a safe route to walk around site, considering sloping ground, loose or poor shoulder etc.?	☐ Yes ☐ No ☐ Not known				
PPE Requirements	☐ Hard Hat	☐ Gloves	☐ Safety glasses	☐ Other	
Risks and areas of uncertainty for the site					
Completed by:		Agreed with: (Manager)			
Signature		Signature		Date	

12.3 Principal Inspection Report Proforma

Guidance notes are highlighted in yellow

Forms part of Inspection Summary	Inspection W/O number	

Earth Structures Principal Inspection Report

Inspection Engineer/Inspector	Choose an item.	Signature	Date
Reviewing Engineer		Signature	Date Click here to enter a date.
Accredited Assuror		Signature	Date

All Inspections carried out to LU Standard 1-054 – A3. Superficial or Principal Inspection Sheets attached as appropriate

Client:	Originator:
UNDERGROUND	Transport for London London Underground Earth Structures Inspections 15 Westferry Circus E144HD

Line	Choose an item.				
Asset Name	/		Chainage from		to
At Station	Choose an item.		Direction		Choose an item.
Station Name					
From Station					
To Station					

Current Inspection Cycle:		Choose an item.	**Current Authorised Maintenance Work Orders**
Assessment:		Choose an item.	Check Ellipse. If none, state "None".
Basic Condition Rating:		Reviewed Rating:	
Transect	*Score %*	*Score %*	Reference any OPEN work orders for maintenance or project work listed in Ellipse.

Preliminary Information
i.e. previously recorded "features" between 100m transects, Documents and Persons consulted prior to Inspection & Comments

ACA (by length)
00/01 –
List the contract ACA score, **lowest condition first.**
List subsequent ACA scores where there is a **CHANGE ONLY.**
List the current ACA score.
DO NOT LIST EVERY YEAR unless the score changes every year.

Contract Status: Choose an item.

Assessment Details
Reference Assessment type, author and document number + hyperlink all relevant documents.

Additional Information
Reference monitoring data where available + hyperlink.

Inclement Weather Risk

Inspection Engineer / Inspector's Summary and Overall Comments on Deterioration

Embankment shoulder condition. Current condition of asset and any change in condition of asset.
Deterioration to asset or previously listed defects. Any new defects. Any work carried out. Any urgent/high priority work to be carried out.
Reasons for reductions in transect scores.
Any access difficulties: track; boundary fence; vegetation.
Make explicit statement if inspection has been at all compromised by density of vegetation.

Format	*Document Number*	*Revision*
A4		*01*

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You must confirm that you hold the latest version, before using this document for its intended purpose.

Forms part of Inspection Summary

Inspection Engineer / Inspector's Comments – Sheet 1 of 1 .

LAR	/	LCS		Chainage from		to	
At Station	Choose an item.			Station Name			
From Station				To Station			
Line Owner	Choose an item.			Line Direction	Choose an item.	Line Type	Choose an item.
Weather	Choose an item.			Special Inspection cycle		None / Last	
Recorded by	Choose an item.			Date		Time	

Location of Defect	Slope Section	Description of Defect (Compare to previous report) /Feature	Extent[2]/Severity[3]/Recommendation[4]/Priority[5]			
			E	S	R	P
		List all defects and features encountered along the asset in chainage order. Where applicable group similar defects. Break down shoulder condition along the length of an embankment. You need to provide a clear recommendation on what needs to be done with the defect having given consideration to the risk to the railway. Any urgent issues should be raised on site to the fault report centre. High priority works are those that are needed to be complete before the next inspection. Report asbestos to the fault report centre, and state the fault reference number. For fencing issues or hazardous vegetation, email the respective line Environmental Managers, copying Neil and Rob. For third party issues where action is required, send details to Mark Hart, copied to Neil and Rob.				

[2] Extent	A – No significant defect	B -Slight, not more than 5% affected	C -Moderate, 5% to 20% affected	D - Extensive, over 20% affected	
[3] Severity	1 – No significant defect	2 - "Minor" defects of a non-urgent nature	3 –"Heavy" defects of an unacceptable nature	4 – "Severe" defects where action is needed	
[4] Recommendation	R – Repair	M - Monitor	I – Special Inspection Regime	D – Design Remedial Works	C – Replace
	G - Ground Investigation	T – Topographic Survey	A – Slope Stability Assessment	S – Speed Restriction	
[5] Priority	I - Immediate (within 4 weeks)	H - High (within 12 months)	M - Medium (within 2 years	L - Low (before next Principal Inspection	R - Review (at next Principal Inspection

Forms part of Inspection Summary

Reviewing Engineer's Information – Sheet 1 of 1

LAR	/	LCS		Chainage from		to	
Recorded by	Choose an item.			Date		Time	

Livelink Condition Rating Tool:	

Current Inspection Scores (date): Click here to enter a date.				
Current Inspection Cycle:	Choose an			Comments on defects and condition ratings:
Assessment:	Choose an item.			
Basic Condition Rating:		Reviewed Rating:	Slope Height	Explanation is required for any transect score that is less than 90; any score that is notably different to the previous inspection and for any slope heights that are notably different from the previous inspection. A summary of the defects reducing the score and the impact of any FoS used.

Previous Inspection Scores (date): info is as per the previous signed off inspection report in CAI				
Previous Inspection Cycle:	Choose an			Comments from previous inspection:
Assessment:	Choose an item.			
Basic Condition Rating:		Reviewed Rating:	Slope Height	Seek out previous signed off inspection report in CAI and reproduce the information here.

Additional Information – summarise details from assessment report (where available) to include geology encountered, FoS and any assumptions from the ground model.
Details from the assessment report to include geology, FoS, any assumptions made in the model or in the choice of the FoS. If remediated, details of renewal works carried and state assumptions for FoS.

Forms part of Inspection Summary

Reviewing Engineer's Recommendations – Sheet 1 of 1 .

Reviewing Engineer's recommendations (including any work orders to be raised):			
Recommended Inspection cycle: Next Inspection (MM/YYYY): Recommended classification:			
Name		Date	Click here to enter a date.
Signed			

Accredited Assuror* (optional):			
Name		Date	Click here to enter a date.
Signed			

*Required where change of ACA classification recommended by any Reviewer.

Inspection Defect/Feature Photos – Sheet __1_ of ___ .

Photo title Full asset name, full chainage, full description.

Include at least one photograph for every type of defect or feature that is encountered on the asset, both described in the defects sheet and recorded in the CRT.

In general one photograph per type of defect will suffice, unless the inspector deems that numerous examples are necessary.

Photographs be should clear and should be described above in the title.

Inspection Transect Photos – Sheet _1_ of ___ .

Photo title	Photo title
Include two photographs for every transect inspected. The first photograph should clearly show the up or down slope view of the transect, perpendicular to the track. If you clear vegetation to inspect, take the photograph afterwards in order to show more detail.	The second photograph should be with or against traffic, parallel to the track in order to highlight the location of the transect for comparison in future inspections.

Transect Slope sketch

Insert current
Asset Location Plan
here

to be lifted
from WebGIS – copy
and paste as Bitmap.

12.4 Special Inspection Report Proforma

Forms part of Inspection Summary	Inspection W/O number	

Earth Structures Special Inspection Report

Inspection Engineer / Inspector	Signature	Date
Reviewing Engineer	Signature	Date
Accredited Assuror	Signature	Date

All Inspections carried out to LU Standard 1-054 – A3. Superficial or Principal Inspection Sheets attached as appropriate

Client:	Originator:
UNDERGROUND	Transport for London **London Underground** Earth Structures Inspections Parnell House 25 Wilton Road, London SW1V 1LW

Line							
Asset Name		/		Chainage from		to	
At Station	Yes/No			Direction			
Station Name							
From Station							
To Station							

Current Inspection Cycle		**Current Authorised Maintenance Work Orders**
Assessment	Yes/No	Check Ellipse. If none, state "None".

Preliminary Information
i.e. previously recorded "features" between 100m transects, Documents and Persons consulted prior to Inspection & Comments

ACA (by length)
00/01 –
Subsequent ACA where any change occurring

09/10 – where available Assessment: where advised classification different from ACA.

Contract Status: Grey / Non-Grey

Assessment Details
Reference Assessment type, author and document number.

Additional Information
Include monitoring data where available.

Inclement Weather Risk	Consult Inclement Weather Report and state severity of risk and potential mode of failure.

Inspection Engineer / Inspector's Summary and Overall Comments on Deterioration

Date of Next Inspection:

Format	*Document Number*	*Revision*
A4		*01*

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Forms part of Inspection Summary

Inspection Engineer / Inspector's Comments – Sheet __ of __ .

LAR		LCS		Chainage from		to	
At Station				Station Name			
From Station				To Station			
Line Owner				Line Direction		Line Type	
Weather				Last Special Inspection			
Recorded by				Date		Time	

Location of Defect	Slope Section	Description of Defect[1]	Recommendation[2]

[1] compare to previous reports
[2] R – Repair; M – Monitor; D – Design Remedial Works; C – Replace; G - Ground Investigation; T – Topographic Survey; A – Slope Stability Assessment; S – Speed Restriction

Forms part of Inspection Summary

Reviewing Engineer's Recommendations – Sheet __ of __.

Reviewing Engineer's recommendations (including any work orders to be raised):			
Recommended Inspection cycle: Next Inspection (MM/YYYY): Recommended classification:			
Name		Date	
Signed			

Accredited Assuror* (optional):			
Name		Date	
Signed			

*Required where change of ACA classification recommended by any Reviewer.

Title

Date

Date

Title

Date

Date