Hurst Peirce + Malcolm LLP
CONSULTING CIVIL & STRUCTURAL ENGINEERS

CHESTER TERRACE

BALUSTRADES

ADDENDUM REPORT

FOR

CROWN ESTATE PAVING COMMISSION

BY

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CONTENTS

1 INTRODUCTION

1.1.1 A structural appraisal of the balustrades along Chester Terrace, Regent's Park, was previously undertaken by Hurst Peirce and Malcolm LLP and reported on, on the 26th June 2020 (the original report). The addendum report should be read in conjunction with the original report.

1.1.2 This addendum report covers the additional investigations and discussion that have taken place since the original report was produced, namely:

(a) The supplementary soil classification testing undertaken by Listers

(b) The results of the statutory services search

(c) The deconstruction of the balustrade undertaken by Bradford Watts

(d) A summary of the repair scenarios incl. the ones that have been explored since the production of the original report.

2 LIMITATIONS OF REPORT

2.1.1 This report has been prepared on behalf of CEPC in connection with their present interest in the building. This report shall not be relied on by other parties without the express written authority of Hurst Peirce + Malcolm LLP. Neither the whole nor any part of this report, nor any reference thereto, may be included in any document or statement nor may it be published in any way without our prior approval in writing as to the form or content in which it will occur. If an unauthorised third party comes into possession of this report they rely upon it at their own risk and the authors owe them no duty of care and skill.

3 REVIEW OF THE FURTHER TESTING UNDERTAKEN BY LISTERS

3.1 Brief

3.1.1 Listers undertook the original site investigations, report for which is included in the appendices of our original report.

3.1.2 The tests undertaken in the original site investigations showed that, at certain locations, the soil contains high concentration of lead, which gives the soil a Hazardous classification where the high concentration of lead is present.

3.1.3 Listers were instructed to undertake further investigations to provide a better understanding of the extent of the soil that will fall within the Hazardous classification.

3.2 Review of the report

3.2.1 A copy of the report is included in Appendix A.

3.2.2 Based on the further investigations and testing, Listers established that for the purposes of Waste Acceptance Criteria (WAC) any soil within the top 0.5m depth approximately, and along the whole length of the garden, is classified as Hazardous, whilst any soil deeper than about 0.5m depth is classified as Non-hazardous.

3.3 Implications of the report

3.3.1 The classification of the shallow soil as Hazardous will have a cost implication on the disposal of excavated soil and will have a larger cost effect on the repair scenarios that require soil disposal.

4 REVIEW OF THE RESULTS OF THE STATUTORY SERVICES SEARCH

4.1 Brief

4.1.1 The brief was to undertake a stats search. This was undertaken by Envirocheck and the results can be downloaded in the link below:

https://www.dropbox.com/s/ayb6vamx2phvh1n/Chester%20Terrace%20Stats.zip?dl=0

4.2 Review of the results

4.2.1 The stats search indicates the presence of number of services along Chester Terrace, including:

(a) Electrics

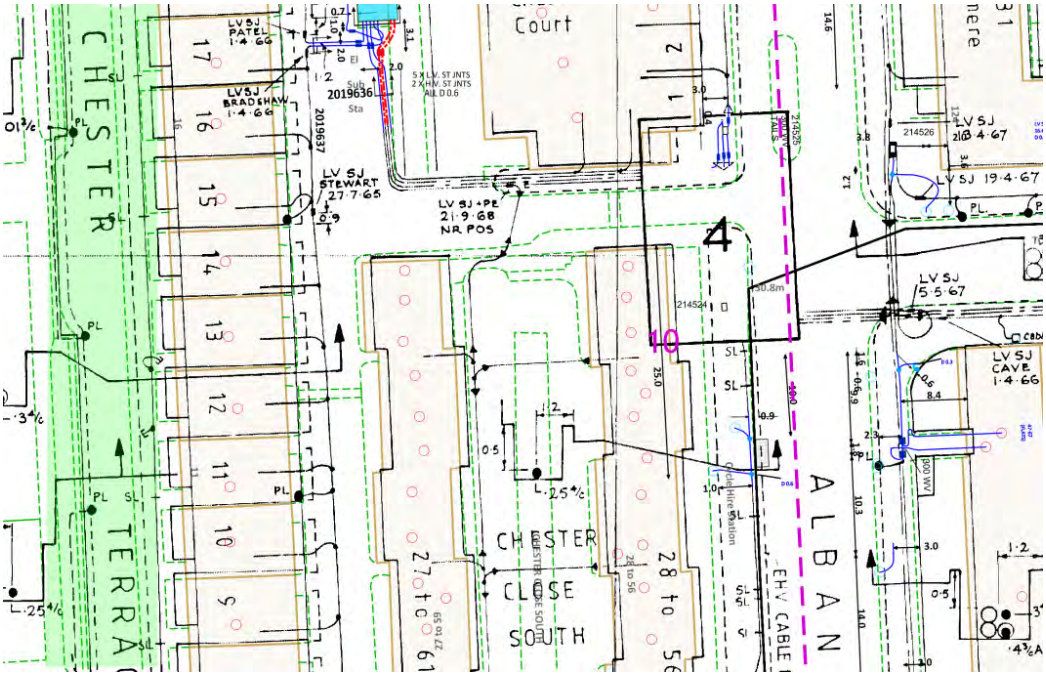
(b) Gas

(c) Telecoms

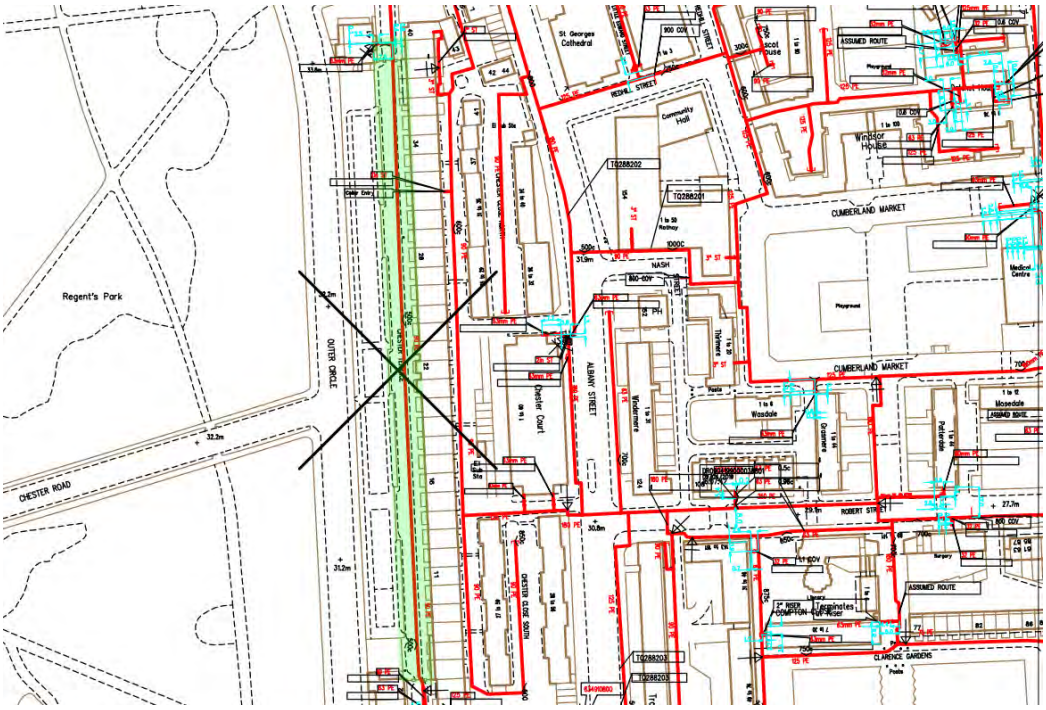
(d) Drainage

(e) Water

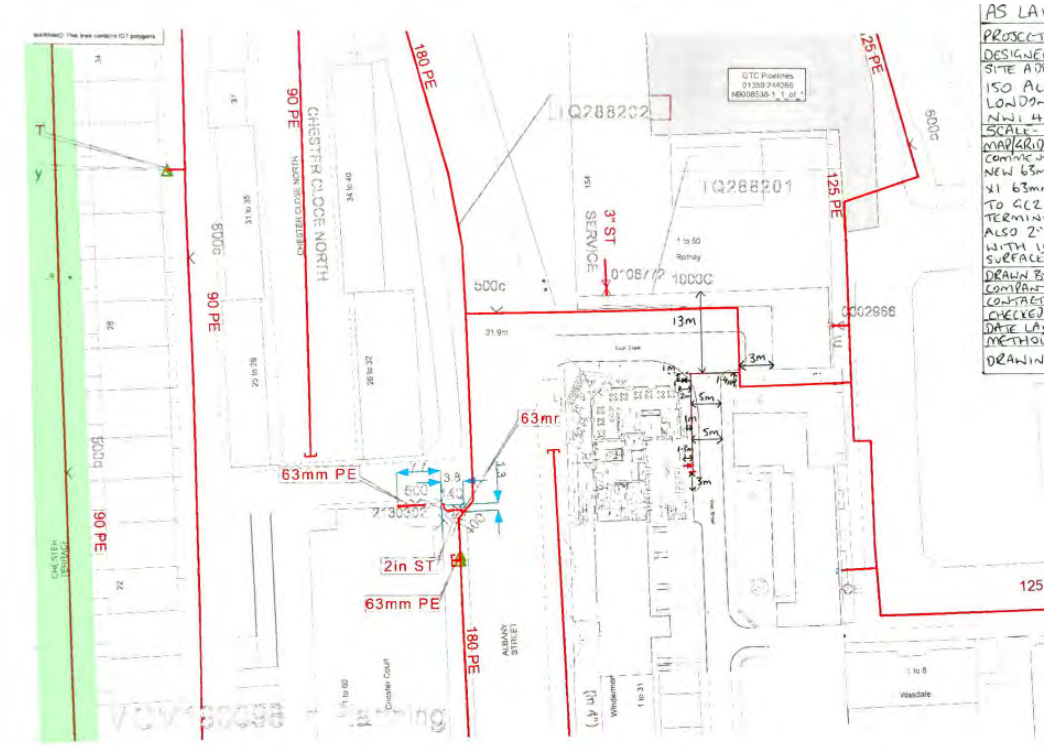
4.2.2 Extracts of the maps, with Chester Terrace highlighted in green, are shown below:



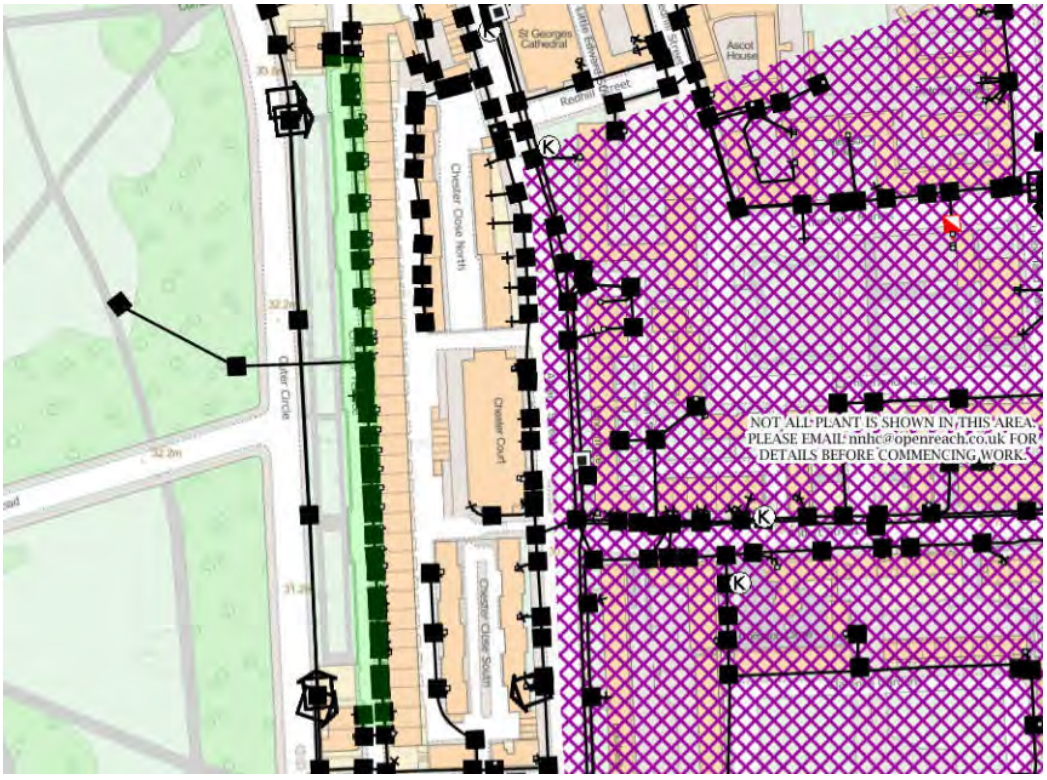
Electrics - UKPN



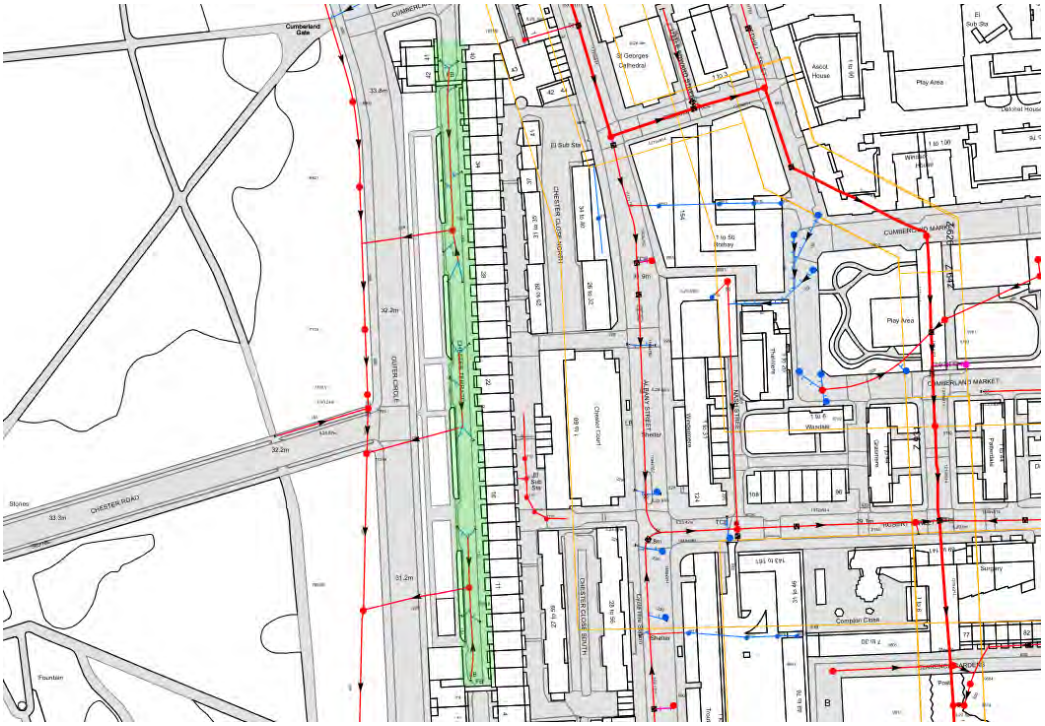
Gas – Cadent Gas



Gas – Fulcrum Pipelines



Telecoms - BT



Drainage – Thames Water

Water – Thames Water

4.3 Implications of the results

4.3.1 As expected, there are a number of statutory services along Chester Terrace. There will also be other private services, such as lamp post lighting cables, private drains, etc. which will not be shown on the stats search results.

4.3.2 Therefore, the presence of the services along Chester Terrace represents a risk item which affects repair scenarios that require ground anchors to be inserted into the ground behind the retaining walls. A detailed services scan and investigation trial pits will be required in due course to inform these repair scenarios.

5 REVIEW OF THE RESULTS OF THE DECONSTRUCTION OF THE BALUSTRADES

5.1 Brief

5.1.1 The brief was to review the deconstruction of three lengths of balustrades to establish how the balustrades were originally constructed.

5.1.2 The balustrades at three locations, as identified below with the red bars and arrows, were deconstructed down to the top of the retaining walls, and inspected. The location furthest to the right (or to the north) is above a concrete retaining wall, whilst the two other locations are above brickwork retaining walls.

5.2 Inspection

5.2.1 The details of the balustrades are identical at all locations. The plinths at the bottom sit on the retaining wall below on a bed of mortar and without any dowels. The bottles have small bronze pins below to the plinths and above to the coping stones. The plinths and copings have recesses on the sides, which when filled with mortar, provide keys for adjacent plinths or copings to work together. Below are photos taken during the inspection:


12/11/2020


12/11/2020

5.3 **Implications of the inspection of the deconstruction of the balustrades**

5.3.1 The deconstructed balustrades indicate that the balustrades are being held only by the bond of the mortar (which is not very strong in tension) and by the self-weight of the individual components and when dislodged, only by the self-weight. This is as assessed in the original report when the lateral loading capacity of the balustrades was calculated.

6 POSSIBLE REPAIR SCENARIOS

6.1 Repair Scenarios

6.1.1 We believe that there are four main repair scenarios. Two of the repair scenarios were put forward as part of the original report, of which one was assessed for cost by an external cost consultant. Two other repair scenarios, involving the use of ground anchors, were put forward as part of discussion with the stakeholders.

6.1.2 In addition to these four repair scenarios, a further alternative of strengthening the existing balustrades, was put forward. The latter is not discussed further in this addendum report and the practicality and cost for doing so have yet to be assessed. If it is practical and cost effective to do so, strengthening the existing balustrade can be an alternative that can be used with any of the four repair scenarios.

6.1.3 It should also be noted that the repair scenarios are based on assumptions, e.g. that routes will be available for ground anchors in between services, that vaults belonging to the Chester Terrace properties do not extend too far into the road, etc. These assumptions will need to be verified in due course.

6.1.4 The four repair scenarios are as follows:

(a) Repair Scenario 1 – Cosmetic repairs

(b) Repair Scenario 2 – New balustrades and ground anchors. Underpinning as and when required.

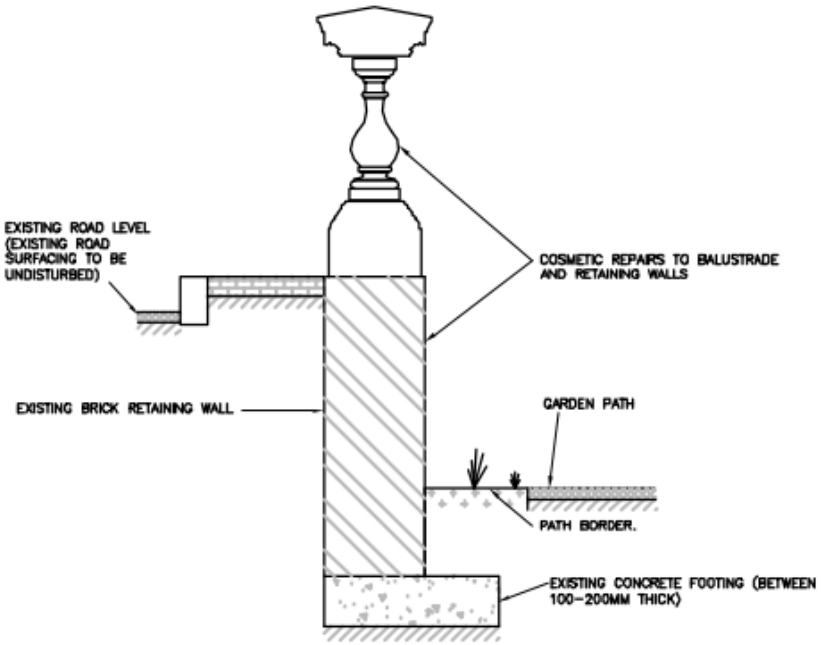
(c) Repair Scenario 3 – New balustrades, ground anchors and underpinning.

(d) Repair Scenario 4 – Complete replacement

7 REPAIR SCENARIO 1 – COSMETIC REPAIRS

7.1 Description

7.1.1 Repair Scenario 1 relates to the elemental repairs of the damaged elements of the balustrades and retaining walls. Repair Scenario 1 does not attempt to deal with the structural engineering issues and therefore is more or less a cosmetic repair. Below is a sketch showing the intent.



7.2 Positives

7.2.1 The cost of Repair Scenario 1 will be the lowest by far.

7.2.2 In addition, the vegetation and trees in the garden will not be affected.

7.3 Negatives

7.3.1 Following the repairs, the balustrades can be as strong as when they were originally constructed. As established in our original report, the balustrades will however not have sufficient strength to resist contemporary lateral loads.

7.3.2 In addition, the retaining walls and foundations will be subject to ongoing movement as a result of inadequately sized foundations, foundations being founded on made ground, tree root action on the clay type ground and lateral loading arising from surcharge on the road. Therefore, ongoing repairs will be required.

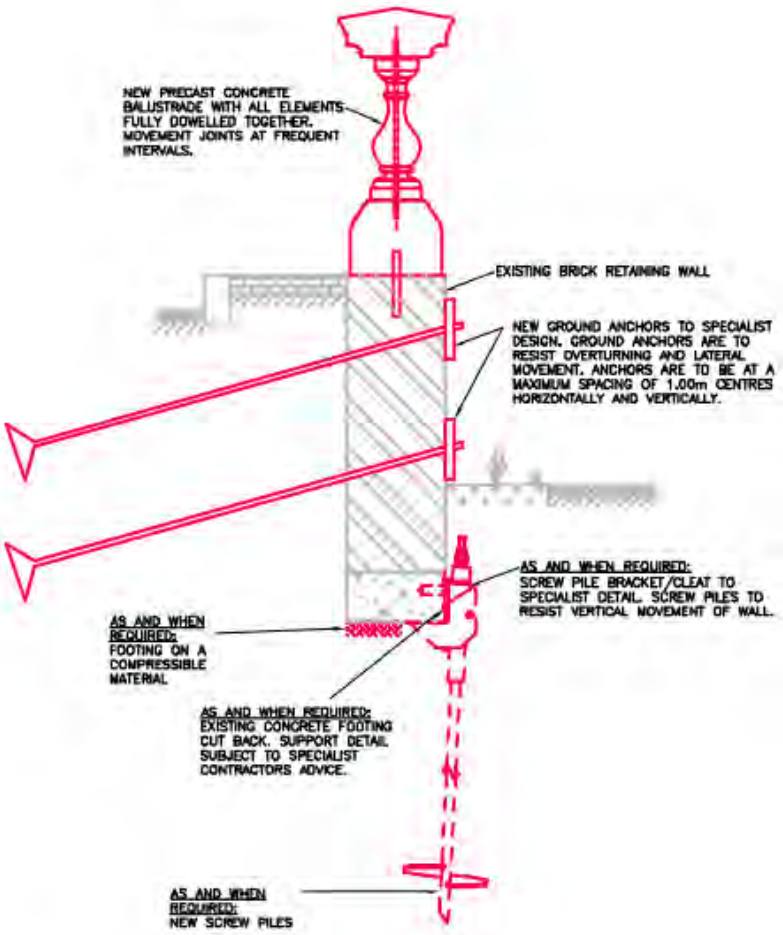
8 REPAIR SCENARIO 2 – NEW BALUSTRADE AND GROUND ANCHORS. UNDERPINNING AS AND WHEN REQUIRED.

8.1 Description

8.1.1 In repair scenario 2, new balustrades designed to resist contemporary lateral loads will be installed and the retaining walls restrained with new ground anchors.

8.1.2 In this scenario, the vertical movement of the retaining walls (due to the presence of made ground and trees) will not be dealt with at the outset, but underpinning will be undertaken to bays that exhibit movement.

8.1.3 Below is a sketch showing the intent:



8.2 **Positives**

8.2.1 With this repair scenario:

(a) The balustrades will be strong enough to resist lateral loads

(b) The retaining walls will be strong enough to resist sliding and overturning

8.2.2 The initial cost of the scenario will be less than Repair Scenarios 3 and 4.

8.3 **Negatives**

8.3.1 With this repair scenario:

(a) Vertical movement of the retaining walls and balustrades will be ongoing and will need to be dealt with by underpinning as and when required.

(b) Partial underpinning is likely to lead to differential settlement between the underpinned and non-underpinned sections

(c) Damage may occur to the new balustrades, which will be stiffer than the current ones. Ongoing repairs may therefore be required.

(d) If significant portions of the retaining walls need to be underpinned and/or damage occurs to the balustrades, the overall cost could end up being higher than Repair Scenarios 3 and 4.

(e) There is a risk element associated with the use of ground anchors and the presence of services and extents of vaults in Chester Terrace. Further surveys will be required.

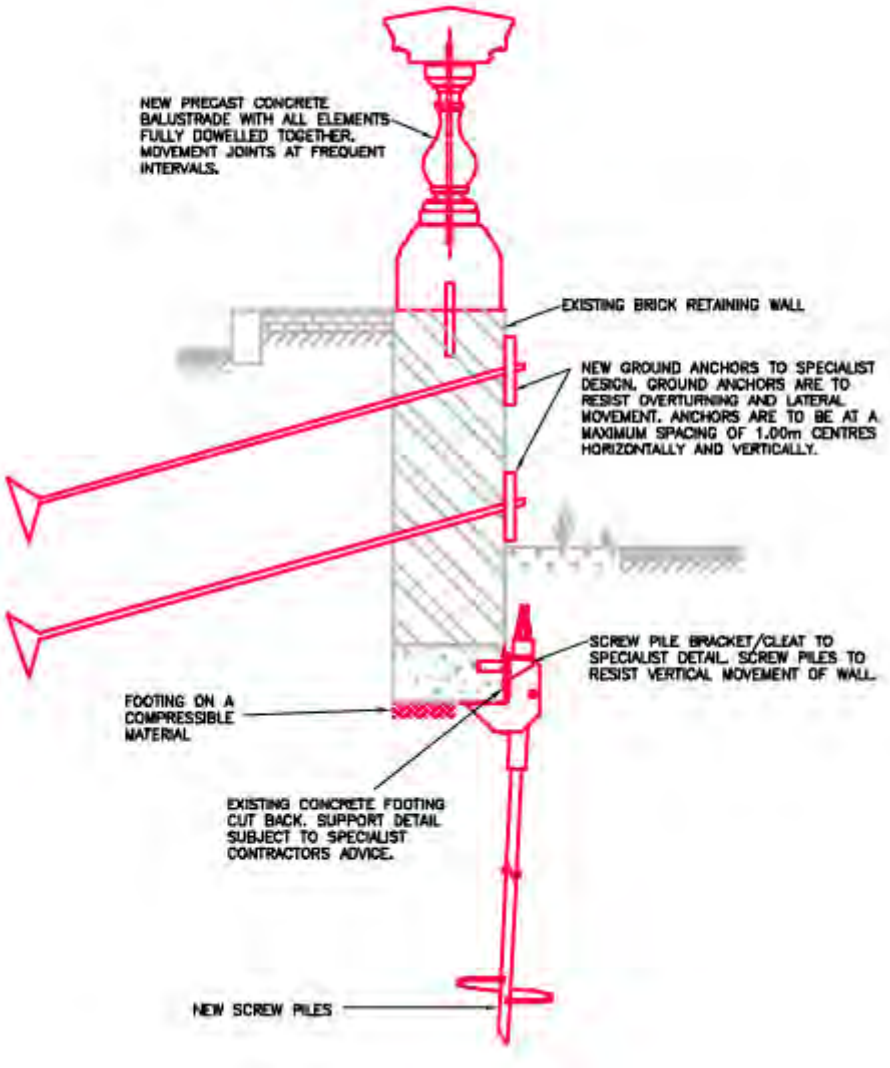
(f) Damage to trees and vegetation is likely.

9 REPAIR SCENARIO 3 – NEW BALUSTRADES, GROUND ANCHORS AND UNDERPINNING.

9.1 Description

9.1.1 Repair Scenario 3 is similar to Repair Scenario 2, except that the underpinning to the retaining wall is undertaken from the outset. Repair Scenario 3 involves the installation of new balustrades, the use of ground anchors to restrain the retaining walls and the use of underpinning to deal with the vertical movement of the foundations.

9.1.2 Below is a sketch showing the intent:



9.2 **Positives**

9.2.1 With this repair scenario:

(a) The balustrades will be strong enough to resist lateral loads

(b) The retaining walls will be strong enough to resist sliding and overturning

(c) The foundations will be underpinned and will not be susceptible to vertical movement or differential movement.

9.2.2 Compared with Repair Scenario 4, this scenario will require less intervention on the road side of the balustrades.

9.3 **Negatives**

9.3.1 With this repair scenario:

(a) The cost of the works will be one of the highest, perhaps on par with Repair Scenario 4.

(b) There is a risk element associated with the use of ground anchors and the presence of services and extents of vaults in Chester Terrace. Further surveys will be required.

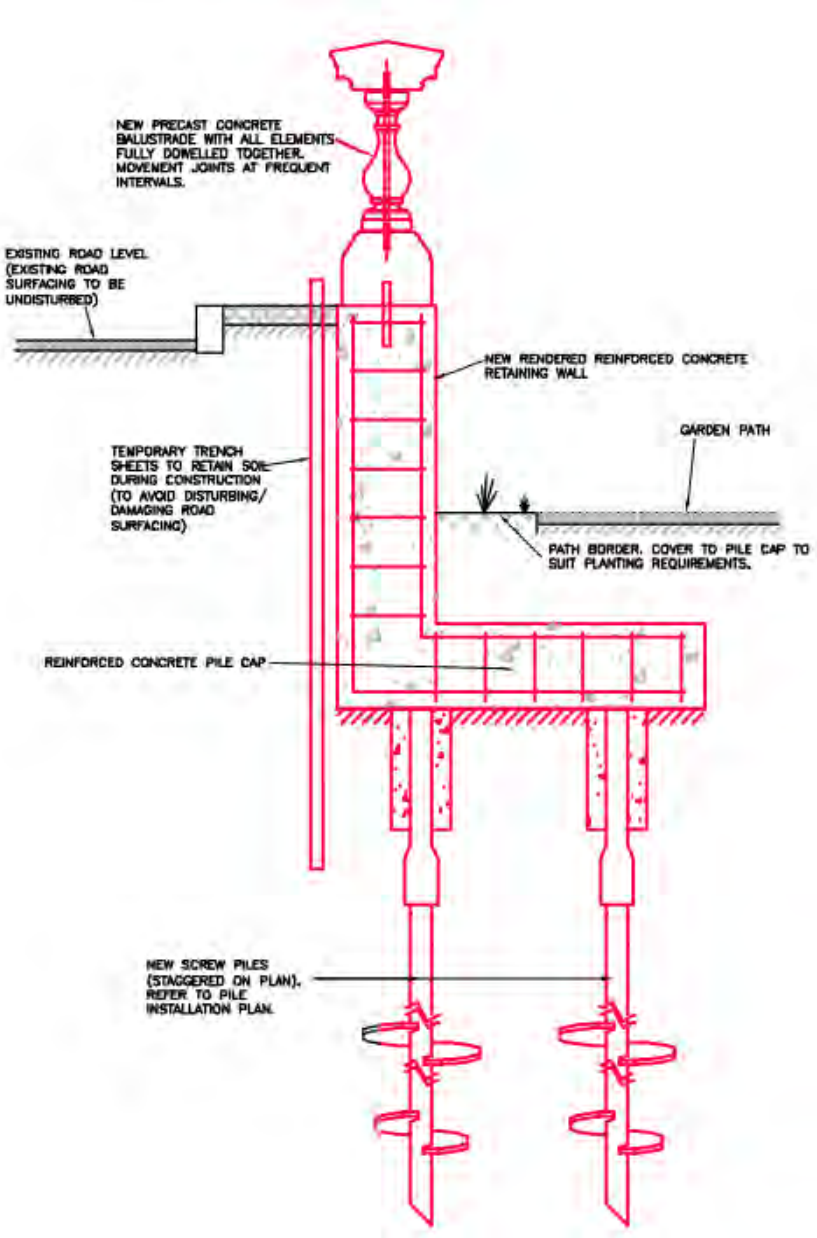
(c) Damage to trees and vegetation is likely.

10 REPAIR SCENARIO 4 – COMPLETE REPLACEMENT

10.1 Description

10.1.1 In Repair Scenario 4, the existing retaining wall is removed and replaced with a new reinforced concrete retaining wall supported on piled foundations. New balustrades are also installed.

10.1.2 Below is a sketch showing the intent:



10.2 **Positives**

10.2.1 With this repair scenario:

(a) The balustrades will be strong enough to resist lateral loads

(b) The retaining walls will be stable horizontally and vertically

10.2.2 With this solution, the installation of new elements means that any future maintenance requirement will be minimal compared with the other ones.

10.3 **Negatives**

10.3.1 With this repair scenario, the cost of the works will be one of the highest. The cost for this scenario was previously assessed to be circa £1.7M (excluding contingency and VAT), but this figure will need to be adjusted to omit the run outside no.2 Chester Terrace (which is outside the scope) and to include the additional cost for disposing of hazardous waste from the excavation.

10.3.2 This repair scenario is the most intrusive, both on the trees and vegetation in the garden and the footpath along Chester Terrace.

11 CONCLUSIONS AND RECOMMENDATIONS

11.1.1 The further soil sampling undertaken by Listers indicates that the top 0.5m of soil (approximately) is classified as hazardous waste, whilst the soil beneath is classified as non-hazardous waste. This will have an impact on disposal cost for excavated material.

11.1.2 The statutory services search indicates the presence of services along Chester Terrace. These services will have an impact on any solution that involves the use of ground anchors. Further surveys will be required to establish the locations of the services, as well as the extent of the vaults for the Chester Terrace properties.

11.1.3 The deconstruction of the balustrades indicates that the components of the balustrades are held up by the bond in the mortar and self-weight of the precast concrete pieces. The lateral strength of the balustrades is therefore as assessed in our original report and does not meet contemporary requirements.

11.1.4 We have considered four repair scenarios, namely:

(a) Repair Scenario 1 - Cosmetic repairs

(b) Repair Scenario 2 - New balustrades and ground anchors. Underpinning as and when required

(c) Repair Scenario 3 - New balustrades, ground anchors and underpinning

(d) Repair Scenario 4 - Complete replacement

11.1.5 As we understand that there are funding constraints on the project, there are no straightforward solutions. We however recommend that a solution that will provide the correct engineering result (i.e. Repair Scenarios 3 and 4) is considered and if necessary, the works undertaken in stages to suit budgets. Nonetheless, provided that CEPC and the stakeholders are happy with the risks and negatives associated with a particular scenario, HPM are happy to progress the detailed design for any scenario.

11.1.6 In addition to these four repair scenarios, a further alternative of strengthening the existing balustrades, was put forward. If it is practical and cost effective to do so, strengthening the existing balustrade can be an alternative that can be used with any of the four repair scenarios.

12 APPENDICES

12.1 Appendix A – Listers' Supplementary Soil Classification Report