Midlothian Council
Tuesday 28 June 2016

Ironmills Park, Dalkeith: Access Route

Report by Ricky Moffat, Head of Commercial Operations

1 Purpose of Report

At its meeting of 23 September 2014 Council agreed to remedial works being carried out to stabilise the slope which supported a path from Cemetery Road to Ironmills Park in Dalkeith.

The purpose of this report is to advise Council on the findings of the recent consultant engineers report produced by Ironside Farrar, regarding further remedial works that are required to the access route from Cemetery Road to Ironmills Park, Dalkeith to allow the route to be re-opened and to avoid further landslips affecting adjacent property and Dalkeith cemetery. This follows on from a further significant land slippage which occurred in December 2015 and is continuing to date.

2 Background

Cause of the Current Closure of Ironmills Steps

The path and steps between Cemetery Road and Ironmills Park were closed in January 2016, following the wettest December on record in 2015, which led to a further land slippage. The access route required to be closed in the interests of public safety.

History of Site

The path and steps were initially closed as a result of a landslip on the steps, path and adjacent land in March 2013.

The route was reopened in December 2014 after land movement had ceased and the path and hand rail were reinstated. This was on a temporary basis with the path steps and the slope continuing to be monitored. The path was closed again in January 2016 due to further movement in the slope that coincided with the wettest December on record in 2015.

Unfortunately, the initial closure of this access route into the Park was followed shortly after by the permanent closure of the alternative access route via the Penicuik to Dalkeith Walkway viaduct, due to the Borders Railway works.

A map currently displayed on site provides information of alternative routes to Ironmills Park from Cemetery Road, during this period of closure.

Consequences of Closing Ironmills Steps

The closure of both routes means that the only firm surfaced access route into Ironmills Park is along Ironmills Road, which is very narrow and has no footway for some of its length.

There is however an informal access route from Lugton Brae to Ironmills Park via woodland, where the surface is beaten earth, and has steep slopes. This route is impractical for most park users and is not considered to be a suitable alternative to either the Ironmills Steps or Ironmills Road entrance.

The temporary loss of the access route via the steps also means the loss of an historical perspective, as it connects with the Memorial Bridge (Grade B listed). This is a masonry arch footbridge over the River Esk which was built one hundred years ago, as a result of Ironmills Park being gifted to the people of Dalkeith by the Duke of Buccleuch.

Council Report 2014 Recommendations

- At the Council meeting of 23 September 2014 Council considered a report Ironmills Park Dalkeith: Access Route and agreed to Option 2, which was a localised solution, with an estimated expenditure of £58,000.

The costs of localised solution works carried out to date:-

Consultants fees	£24,500
Installation of drainage at top of slope	£11,500
Steps, path and handrail repairs	£7,500
Planting and tree works	£3,550
Inspection, repair and registration of septic tank	£900
Erection of new ornamental steel gates	£3,500
Investigative ground pinning work	£900
Total to Date	**£52,350**

Assessing the Cause of the Landslip

The historic landslip has been regularly monitored since March 2013. There was a period between October 2014 and December 2015 when no movement or very minor movement was observed. Since January 2016 considerable and continuous movement has been evidenced. This movement is still ongoing. There are now crevasses at the top of the slope with areas having dropped by almost 4 metres and also crevasses across the slope and across the lower section of the footpath. A considerable amount of material has fallen from the cliff over a wide area from immediately below the steps to up to 50 metres down river from the steps and bridge.

A large tree at the bottom of the slope required to be felled due to its movement towards the cliff edge and due to fears of a catastrophic failure if this tree, with its reducing root plate, toppled. Half a dozen small to medium sized trees have fallen off the cliff and have had to be cleared from the river.

Consultant's Report - Brief and Findings (dated May 2016)

Ironside Farrar consultant engineers were appointed in August 2015 to re assess the slope and in particular the large tree and the risk of this possibly toppling and to provide to the Council a report outlining remediation proposals. At this time there was no movement on the slope.

The report outlines in detail the nature of the slope which has a sandstone base overlaid with clay and that both these materials are stable. However these are also overlaid with clay sands and gravels which are not stable and are at a sufficient angle that this layers stability, will always be of concern.

The report highlights that there continues to be substantial movement in the slope. It had been envisaged that the area would settle and movement would cease.

The report contains recommendations for the slope enabling the path to be re-opened. Until such time as the slope is stabilised or remediation effected, the report recommends the path remains closed in the interests of public safety.

Three options for remediation were recommended in the report:-

1 Localised remediation works take place by anchoring the area around the footpath with an anchoring drainage solution, or,

2 Wider Soil Anchoring solution which involves a much more extensive area of anchoring than the localised option with significant increased costs, or

3 Localised Piling Solution involving installing piles along the path edge in combination with ground anchors.

The options available to Council therefore are as follows.

1 Localised solution seeking to stabilise the slope adjacent to the path and steps using the platipus anchoring and drainage system in effect pinning between 100 m^2 to 200 m^2 of the ground adjacent and below the steps. In addition installing a temporary bridge and alternative path and steps.

2 Wider Soil Anchoring solution would involve stabilising the wider slope adjacent to the path and steps using the platipus anchoring and drainage system in effect pinning the whole area of ground adjacent and below the steps. The soil anchors are driven several metres into the ground and would include mesh to hold the loose surface materials in place.

3 Localised Piling Solution involving installing piles along the path edge in combination with ground anchors. It is not certain that this option is achievable due to issues with accessing the site with the necessary equipment.

3 Report Implications

3.1 Resource

The financial implications of the three options are:-

1 Localised solution seeking to stabilise the slope adjacent to the path and steps using the platipus anchoring system and drainage system in effect pinning up to 200 m² of the ground adjacent and below the steps at a cost of £105,000 and Install a temporary bridge and alternative path and steps at a cost of approximately £70,000.

Total estimated cost £175,000 (including path reinstatement).

2 Wider Soil Anchoring solution at a cost of approximately £170,000 (including path reinstatement).

3 Localised Piling Solution involving installing piles along the path edge in combination with ground anchors. Approximate cost £163,000 (including path reinstatement).

The following table summarises the financial implications of these options:-

	2016/17	**2017/18 Thereafter**
Option 1 Localised Solution		
Capital Expenditure	£175,000	£0
Revenue Cost (loan charges)	£3,062	£15,194
Option 2 Wider Soil Anchoring Solution		
Capital Expenditure	£170,000	£0
Revenue Cost (loan charges)	£2,975	£14,760
Option 3 Localised Piling Solution		
Capital Expenditure	£163,000	£0
Revenue Cost (loan charges)	£2,852	£14,152

3.2 Risk

The principle risk is to members of the public ignoring the safety notices and continuing to access Ironmills Park from Cemetery Road via the steep riverside embankments and climbing over the fencing and gates on the bridge. This risk remains for all options until works are complete.

In addition to the safety risk, it is currently inconvenient for users coming from Eskbank and the surrounding area to access Ironmills Park requiring a long detour via Eskbank Road and/or Old Edinburgh Road and then Ironmills Road.

For children in particular, this risk is compounded by the fact that the only entrance to the park is via Ironmills Road which is used by vehicles and pedestrians. This is a very narrow road with blind bends and there are stretches with no pavement, or a very narrow pavement, along its length.

If no work is carried out to address the problem of the landslip and re-opening the access route, the public safety risks will continue with the likelihood that this will have a negative impact on the public's perception of Midlothian Council.

Further substantial land slips could affect Dalkeith Cemetery and the made up ground at the top of the slope. Further slippage could also impact on the eco house and adjacent land and could affect local services i.e. electricity supply to the houses in Ironmills Park.

Option 1 Risk: Localised solution seeking to stabilise the slope adjacent to the path using the Platipus anchoring and drainage system.

This option does not remove the risk that there will be further land slippage.

However, this would secure the path and steps from the likelihood of a sudden catastrophic failure and will therefore greatly reduce the risks to users of the paths and steps.

The Consultant has suggested this has a 50% chance of being successful in the long term.

There may be occasions in the future when the path has to be closed due to further land slippage due to the nature and steepness of the slope and the path and steps are currently closed. Therefore installing a temporary bridge and path is considered prudent to cater for the current closure and possible future closure of the path and steps.

Option 2 Risk: Wider soil anchoring solution. This option would minimise the risk of any further works in the future.

Option 3 Risk: Localised Piling Solution involving installing piles along the path edge in combination with ground anchors.

This option would reduce the risk of any further works in the future but is considered to be not as robust a solution as option 2 at this time.

3.3 Single Midlothian Plan and Business Transformation

Themes addressed in this report:

- Community safety
- Adult health, care and housing
- Sustainable growth

The option chosen to restore this access route will ensure suitable accessibility for all users of Ironmills Park and thus provide continued opportunities to maintain/increase the health and well being of the local community. The current diversion could mean the difference between a short walk and a car journey to access Ironmills Park.

This route provides access to Midlothian's Core Paths Network.

3.4 Impact on Performance and Outcomes

If this project is not undertaken there is a risk that this will have a negative impact on targets, e.g. walking/cycling.

However, of greater concern is the risk to property and Dalkeith cemetery in the longer term.

3.5 Adopting a Preventative Approach

Carrying out remedial works will reduce safety implications and enable pedestrian access to be restored.

The pinning work will also reduce the risk of a catastrophic failure on the slope and therefore reduce the risk of a large landslide that could affect the Cemetery and adjacent properties.

3.6 Involving Communities and Other Stakeholders

Communities and other stakeholders have been informed (and will continue to be updated as the project progresses) by:

- displaying notices on the temporary site safety fencing informing the public of the events as they have been happening – with maps showing diversion routes to Ironmills Park
- press releases
- details on the Council web page
- lettering local residents

3.7 Ensuring Equalities

If this project is not undertaken there is a risk that this will have a negative equalities impact due to the difficulty for children/disabled people to access the park for the reasons described in para 3.2.

3.8 Supporting Sustainable Development

If this project is not undertaken there is a risk that this will have a small negative impact on targets eg reduced walking/cycling.

3.9 Digital Issues

There are no IT implications arising from the proposals outlined in this report.

4 Summary

This report describes the extent of the recent landslip at the footpath access to Ironmills Park, Dalkeith and the options identified for consideration by Council to provide an access route from Dalkeith to Ironmills Park.

Option 1

The Localised remediation option with an alternative route being created with a temporary bridge which involves anchoring the area around the footpath with an anchoring drainage solution at a cost of £105,000, affecting an area of approximately 200m^2 would demonstrate a willingness to address this problem within the tight budget constraints the Council faces and the anchoring and drainage system proposed may well negate any further land slips affecting the cemetery which would be of major concern and significant expense. However, there are no guarantees that this will resolve the land slip issues and result in the path remaining closed.

A low cost temporary timber bridge with timber steps constructed 300 metres downstream of the existing steps and bridge would be required to ensure pedestrian access to the park.

The estimated cost of a basic bridge and steps is £70,000. Total cost of this option is £175,000.

Option 2

Wider Soil Anchoring solution which, has an estimated cost of £170,000 which has a greater degree of confidence in its success to ensure the path and steps are reopened and mitigate the risks of further land slippage affecting the Cemetery, local properties and the local electricity supply.

Option 3

Piling solution along the path at an estimated cost of £163,000.

5 Recommendations

The Council is asked to note the contents of the Consultant's Report and:

- Agree to progress Option 2, Wider soil anchoring Solutions, at a cost of £0.170 million,

- Approve the addition of £0.170million to the General Services Capital Plan in 2016/17, approve a supplementary estimate of £2,975 in 2016/17 and add £14,760 to 2017/18 revenue budget to provide for the loan charges.

10 June 2016

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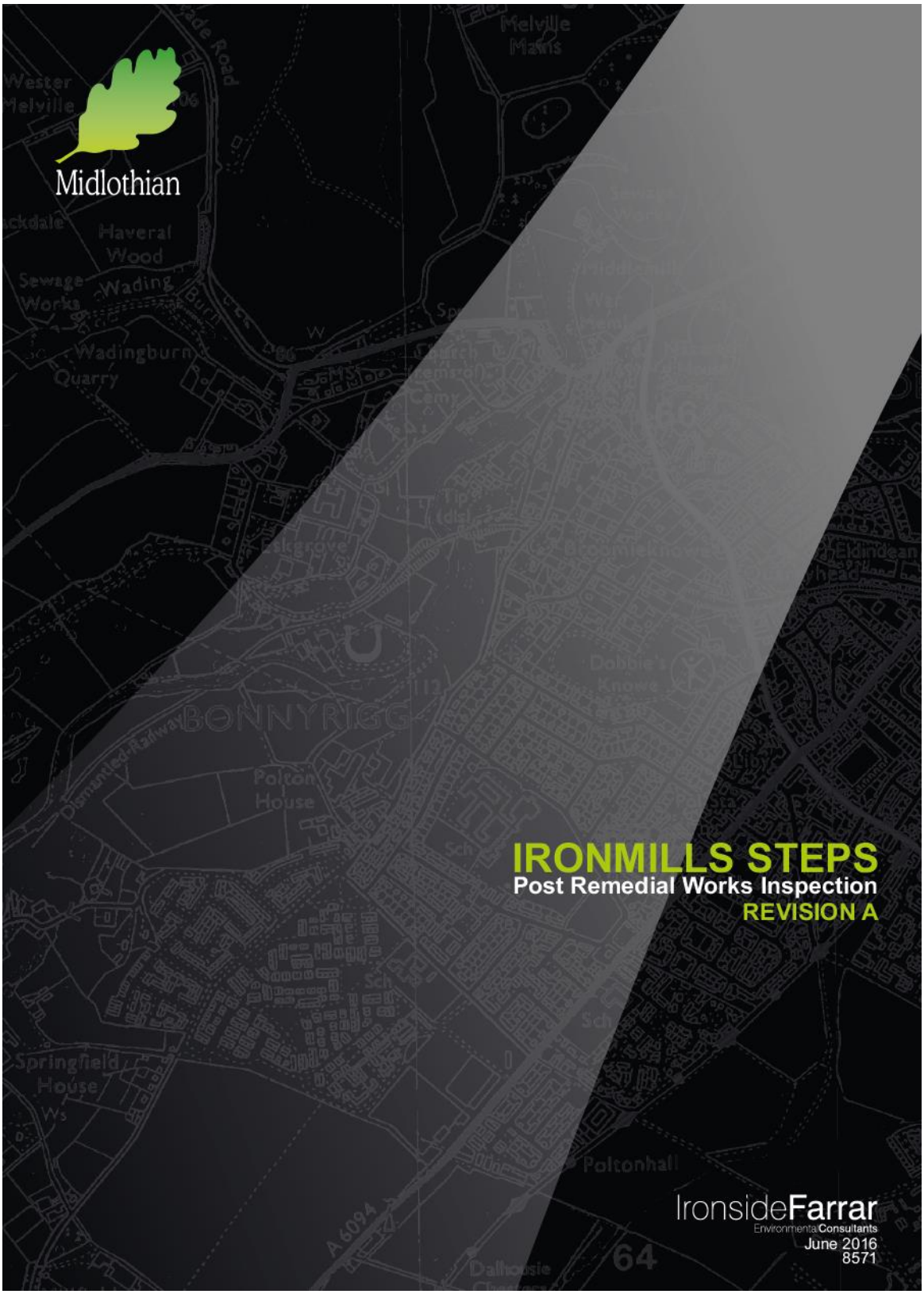
Background Papers:

Appendix 1 Ironside Farrar's report on Ironmills Steps Post Remedial Works Inspection Revision A, dated May 2015

Appendix 2 Ironmills Steps - Photos showing damage caused by landslip taken on 31 May 2016

APPENDIX 1


Midlothian
IRONMILLS STEPS
Post Remedial Works Inspection
REVISION A
IronsideFarrar
Environmental Consultants
June 2016
8571

APPENDIX 1

Midlothian Council

IRONMILLS STEPS

Post Remedial Works Inspections

Revision A

IronsideFarrar
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8571/MRC/ June 2016

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1.0 Introduction

Post the remediation works at Ironmills Steps by Midlothian Council (MC), Ironside Farrar Ltd (IFL) has been re-appointed to provide advice relative to the current situation and any recommendations considered necessary.

The scope of works has been agreed as:

- Undertake site walkovers.
- Review current situation relative to stability of the steps.
- Provide recommendations for any works considered necessary relative to stability issues.
- Review potential for local stabilisation of the path via soil anchoring system.

2.0 Site Walkovers/ Soil Anchor Trial

Mark Chapman and Roger Clark of Ironside Farrar undertook a site walkover on 24 August 2015 to review engineering and landscape related issues in conjunction with John Park of Midlothian Council.

The walkover comprised a review of the remedial works and inspection of the steps and slope area within Council ownership.

Further walkovers were undertaken by Mark Chapman and John Park on 19th January 2016 and 15th February 2016, the latter also with Justin Venton.

A soil anchor trial was undertaken on 21st March 2016 by Holequest Ltd.

A visual inspection was undertaken by Mark Chapman, John Park, Justin Venton and Craig Rodger of Holequest (Remediation Contractor) on 23rd May 2016.

2.1 Remedial Works

Midlothian Council outlined the extent of works designed and undertaken by the Council in December 2014. These measures were in part based on the indicative recommendations for the localised stabilisation measures option included in previous Ironside Farrar reporting, modified to suit MC's considerations at the time of detailed design/ construction.

In outline, the works comprised:

- Installation of cut off drain along top bank.
- Inspection/ modifications/ repairs to existing drainage system (Drawing "Cemetery Road Dalkeith, New Drainage 2014" refers).
- Repair of ground movement to the area below the main dog leg in the steps together with new whin surfacing, timber steps and timber edging.
- Willow planting (whips) to bank areas.

2.2 Walkover 24 August 2015 - Comments and Observations

The following provides commentary on observations made during the site walkover. Photos are included in Appendix 1.

- **Remedial Works to Steps**
  These works appeared to be successful and no sign of movement to the path itself was visually observable, some eight months after the works were undertaken.

- **Planting**
  Extensive willow planting has been undertaken to the banks with whips. The vegetation was not noticeably established as would be anticipated given the short period since planting. MC noted that it appeared that a number of the plants look like they may not have taken although the full extent was not reviewed at the time of the walkover.

- **Existing Sycamore Tree**
  No obvious sign of movement to the large sycamore tree immediately on the downhill side of the main dog leg on the steps was noted.

- **Marker Posts**
  MC noted that they had reviewed the movement of the marker posts twice since the remedial works. This comprised a predominantly visual inspection, coordinated positions were more difficult to undertake due to access and vegetation issues.

  A drawing showing the latest review of marker pegs was handed over to IFL. Post installation of the remedial works the following two observations were made by MC:

  15.04.15 Movement noted on cliff face, visual observation only.

  04.08.15 Marker 4 (some 15m away from the dog leg in the steps) movement noted approximately 0.080m.

  A brief check with a pocket spirit level of the two marker posts installed at the furthest points from the path, some 30m north of the point of the dog leg identified that they were some 30mm and 40mm out of plumb on the above ground sections tilting downslope. The posts were installed vertically suggesting a degree of movement. Note that this movement had occurred at some stage since March 2014 when the pegs were installed and not necessarily post the remedial works, as the recorded monitoring by MC makes no specific reference to the observations noted above.

- **Lower Slope Area/ Rock Face**
  An observation of the lower slope/ interface with steep rocks face down to the River Esk was made from the west bank of the river (closer access was not possible for H&S reasons).

  Previous observations of this area had identified significant movement including:

  - Wash out of the superficial materials above the rock face.
  - Loss of vegetation.
  - Water flows/ erosion from over ground and potentially through ground water movement.
  - Formation of a cavity or hollow section parallel to the river bank above the rock face.

  A review of photographs of 14.01.14 and 15.08.15 was undertaken. Although close observation was not possible, it appears from these photographs that the area was stabilising and was not noticeably worse in August 2015 than January 2014. There may have been some further loss of soil material from the central

section of the soil face immediately above the rock face since January 2014 (prior to remediation works). However vegetation was evident over a significant extent of both the exposed/ eroding soil face and at the base of the hollow area in the 2015 photographs that was not previously present.

- **Other Areas of Movement**
  No other areas of significant movement were readily apparent on the site walkover. Previous areas of slippage were still evident but did not appear to have deteriorated.

2.3 Walkover 19 January 2016 – Comments and Observations

The following provides commentary on observations made during the walkover: Photos are included in Appendix 1.

- **Weather**
  The walkover followed a period of some weeks of heavy rainfall followed by a freeze/ thaw cycle. (It was later understood to be the wettest December on record in the UK as a whole although no records were reviewed for Dalkeith/ Midlothian and this part of the country was not as badly impacted as many locations).

- **Steps**
  Visible movement of the steps had occurred.

  A crack of some 50-100mm was visible along the top edge of the return leg of the steps. This extended through the lower step itself of the bottom step before the return leg.

  Movement in the earth below and parallel to the return leg of the steps had also occurred with cracking apparent. MC noted that there had been noticeable movement since their visit of the previous day.

- **Upper/ Mid Slope Areas**
  Obvious movement of slope areas out with the immediate area of the steps within Council owned land were observed. This included:

  - Cracking and slumping of an area of the top of slope in the vicinity of the new planting.
  - Extensions to previous cracks/ areas of visible slope failure.

- **Lower Slope Area/ Rock Face**
  Again, this area was viewed from the opposite bank of the River Esk. Visible and significant deterioration was noted. This included washout of soils and water running over the face of the slope over significant extents. Sands and gravels washed out of the slope had formed a pile at the river's edge/ base of rock face.

2.4 Walkover 15 February 2016 – Comments and Observation

The following provides commentary on observations made during the walkover; photos are included in Appendix 1.

Weather
Previous week had been relatively dry but with heavy prolonged rainfall on Saturday 13th February followed by low temperature.

- **Steps**
  Significant movement of the section of the path starting at and below the dog leg was apparent including:

  - Cracks of order 500mm to 600mm at top edge of step.
  - Dropping of sleepers on down slope side of path by up to 500mm.
  - A number of strainers in the post and mail fence were tight due to the slope movement.
  - Cracking in soils below the steps.
  - Saturated clays noted near the surface in the small void under the steps. The void was held up by sleepers/ concrete edging.

- **Upper/ Mid Slope Area**

  Significant movement noted in this area including:

  - Slipping of soils over several metres at the crest of the slope.
  - Extension both laterally and vertically to the mid slope slumping.

- **Lower Slope Area/ Rock Face**

  - Ongoing of washout of soils noted with significant deposits at the base of the cliff face, some movement noted at time of walkover. Soils appeared completely saturated.
  - Lateral cracks appearing above the area of washout.
  - Lateral extent of washout widened along cliff face.

- **Existing Sycamore Tree**

  No obvious signs of movement to tree. Given drop in path sleepers/ washout of soils noted over cliff edge it was suspected (not known) that washout of soils around the root system was occurring.

2.5 Walkover Assessment – 23rd May 2016

A walkover inspection and assessment was undertaken with Holequest (Remediation Contractor) to review the viability of remediation options, H&S issues working on the slope and other factors influencing construction works. It was noted at the time that further significant deterioration had occurred since the 15 February walkover. This included:

- A drop of several feet of the path, with maximum movement noted at the dog leg/ corner.
- Significant loss of vegetation, soils and cutting back of the slope below the path.
- Significant slumping of soils from the crown of the slope in front of the cemetery.
- Significant built up of soils and vegetation below the rock face, on the riverbank.

MC confirmed that their own more regular visits noted deterioration ongoing and on an almost weekly basis.

3.0 Potential Remediation Options

A soil anchor trial was undertaken and a number of remediation options were considered:

3.1 Soil Anchor Trial

A trial to test the potential for anchoring the path was undertaken on Monday 21st March 2016. This was undertaken by Holequest Ltd using the Platipus anchoring system. Test anchors were driven into the path at two locations to a maximum depth of approximately 5m using hand held equipment. Load tests were undertaken on the anchors.

The weather prior to the test had been mainly dry for a period of ten days/ 2 weeks coinciding with a period of high pressure.

The results of the tests indicated that it was possible to drive the anchors through the weaker superficial soils into the more competent and stable underlying clays via hand held tools together with a small compressor. The anchors penetrated the clays a sufficient depth to provide an anchor to hold the overlying loose/ sliding more granular soils.

3.2 Localised Soil Anchoring Remediation Option

As in previous reporting/ discussions, it is understood that MC may not have the funds available to stabilise the whole slope area. A localised remediation option was considered. The benefits of local stabilisation could be to:

(i) Reduce risks of any H&S issues for persons using the path if it were to re-open – i.e. help prevent large scale or catastrophic movements of the path by pinning it to the underlying competent soils and:

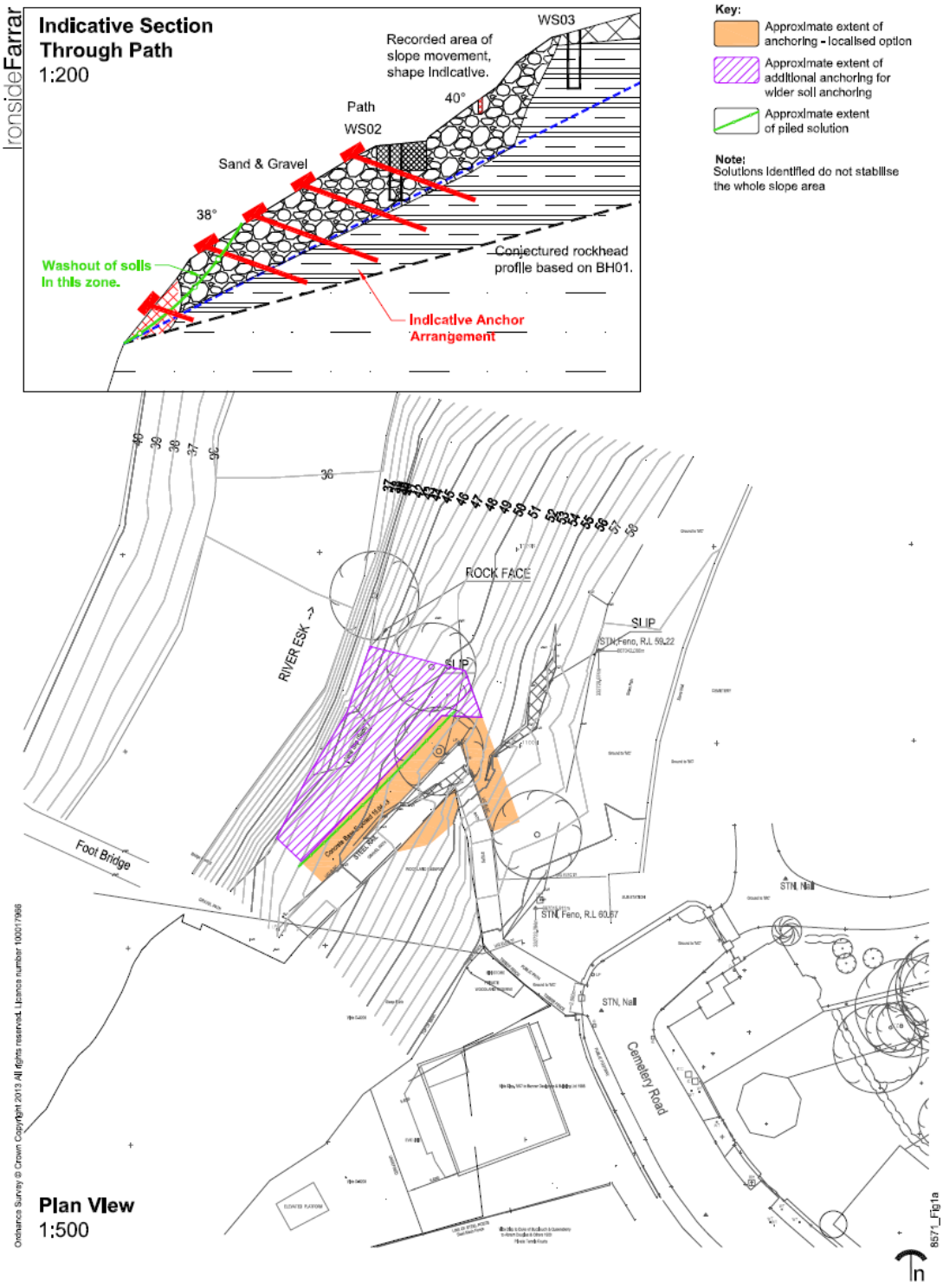
(ii) Shore up local sections of the path/ slope and areas immediately above/ below/ to the side of it.

There are issues with partial stabilisation and it should be noted that if only part of the slope is stabilised, the areas around it could and probably will still move. Any extensive movement of non-stabilised slope areas could still comprise the ability to use the path in future as they could impact on the stabilised areas. Discussions with Platipus confirm previous discussions with MC in that a design cannot be indemnified for a local solution due to risks from adjacent areas.

The Platipus anchoring system also has a sister drainage option in which local drains are driven into the slope. It is considered that these would be beneficial to help with the slope drainage/ stability given the observed saturated conditions and the fact that water is a significant contributing factor to stability.

Detailed design would be required to confirm the configuration and spacing of any scheme. An outline scheme to stabilise the worst impacted area of an approximate 23m length of path by driving anchors in a grid to 3m below the path plus an additional area of 10m by 3m around the dog leg has been costed, with a sketch design provided on Figure 1:

Figure 1
Potential Remediation Options



APPENDIX 1

Approximate area of Stabilisation = 23m x 3m + 10m x 3m = 99m², say 100m²

Budget Costs	
• Mobilisation	£3,200
• Insurance	£1,650
• Welfare	£1,500
• Contractor's Supervision	£1,650
• Temporary Safety Measures	£1,000
• Surface Matting	£1,950
• Soil Anchors to 5m, 80 no. @ £395 per anchor	£31,600
• Reporting to existing footway	£5,000
Sub Total	£47,550
• Design/ Supervision/ Attendance @ meetings and validation report @ approximately 10% of above	£5,000
TOTAL	**£52,550**

The above budget excludes:
- *VAT*
- *Vegetation Clearance – Assumed by MC*
- *Repairs to the steps themselves (see discussion section)*

Following the walkover assessment with Holequest and given the amount of deterioration noted in the two months since the last visit, it is considered that a localised option is unlikely to be effective in the medium to long term. This is because if the amount of soil washout continues at the same rate seen over the past two months below the stabilised area, this is likely to compromise the localised stabilisation works.

3.3 Wider Soil Anchoring Solution

In order to mitigate the impact of soil washout noted above, a wider solution has been considered.

The slope below the footpath would benefit from the restorative effects of an appropriately designed and installed ground anchoring scheme with associated positive drainage. However, this scheme would have to incorporate the whole of the slope below the path including the oversteep section immediately above the vertical rock face. This would require rope access specialists. In broad terms the additional cost per m² treated by rope access techniques would be in the order of £650.00 per m² + VAT, the exact area would require to be determined from the existing topography.

An initial estimate of the area of additional stabilisation would be to take the anchoring out from the corner of the steps an additional 5m (parallel to the river) and stabilise the slope/exposed soils down to the rock face.

This would add an additional 160m² to the localised solution above and at £650/m², this would add £105,000 to the scheme at a total budget of around £160,000 plus appropriate contingencies.

3.4 Localised Piling Solution

Having reviewed the access conditions, it was considered by Holequest that a piled solution along the path edge in combination with ground anchors may provide an appropriate retention, although it would not control the movement of the material below the piled wall that may eventually be lost in slip to the river creating a potential for a steep slope of some metres from the footpath edge. Given the temporary works required to get the drilling plant to the work location this approach may be of the order of £150,000 plus appropriate contingencies for 20m of stabilisation. It comes with the caveat that a design that suited the equipment the contractor could get to site was achievable. A benefit would be that it would hold the path firmly and prevent upwards migration of any instability due to soil loss.

Costs Excluded from Estimates
All above estimates exclude VAT, repairs to the path itself, vegetation clearance and appropriate contingencies (tentatively suggested at 20%).

General
Repair of the path should be of as lightweight construction type as possible and avoid building up significant depths of fill which would add weight to the slope. Flexible construction types such as a timber walkway that could be adjusted if a small amount of movement occurred could be considered and this could also be of benefit in the area of drop at the corner of the path to avoid building up levels. Use of a geotextile could also be considered. Some limited narrowing of the path at the critical location may be of benefit when reprofiling this key area of the steps before or after remediation.

4.0 Other Issues

4.1 Sycamore Tree

The large sycamore tree on the corner of the steps was considered during the period of this report. It appears to date that the root system had been holding together soils/ helping stability. No significant movement of the tree has been observed, however, given the movement in the steps/ soil washout it is likely that the tree was being/ would be affected by the slope movement.

The following observations were made:

- It appeared that the tree was getting undermined but it wasn't visible to what extent.
- There was considered to be a significant risk that the tree may fall. When it came into leaf there would have been larger over turning moments (forces) due to increased surface area that may increase the risk of falling, potentially balanced a little by better weather/ lower winds/ drier soils - although this is supposition.
- If the tree were to fall it will create a significant disturbance/hole in the corner of the path. This would be an H&S risk if the path were in use - say for example after installing anchors. It may also locally damage any anchors in place, depending on location of anchors, surface stabilisation system, rooting depth and extent of disturbance. Further movement of looser soils could then occur around the area of disturbance
- It required someone with specialist knowledge to look at erosion around the roots and see if they agree with the view that there is significant risk of it falling. Midlothian Council contacted a specialist to review this.

Wilson Jamison visited site and noted that the tree was at significant risk of falling/ could be taken down safely. Following this assessment, it was considered that on balance, the tree should be taken down to avoid potential future damage to the path and surrounding area. This was particularly so if an engineered solution is proposed/ the path is to be reopened but it would also avoid damage/ disturbance if no works were to occur.

Taking down the tree will also remove some weight from the slope at a key point. The root system is currently helping stabilise the slope locally and WJ noted there may be some regrowth at the base, which is considered to be beneficial as it would keep some of the root system alive. Even if the roots die, they will continue to bind the soils locally for a period of time, which would be better than the alternative if it were to fall.

It is understood that the tree was subsequently taken down during week commencing 02 May 2016.

4.2 Existing Utilities

Existing utilities and drainage runs down the steps are at risk of fracture due to the slope movement. Drainage should be inspected regularly and utilities companies (street lighting/ gas/ electricity) contacted to identify their requirements/ remedial actions.

It is understood from a meeting with MC of 19 May 2016 that a further CCTV survey of the drainage has identified that it has refractured in multiple locations. This will require to be repaired, potentially on an ongoing basis/ with flexible pipework etc. until the slope has stabilised.

5.0 Discussion & Conclusions

General
On the basis of the initial site walkover in August 2015, significant further deterioration of the slope/ steps had not visibly occurred and they appeared to have been relatively stable since the remediation works in December 2014.

However, it was evident during the second, third and subsequent walkovers that noticeable and significant movement and washout had occurred to the steps and upper/ mid/ lower slopes with MC's land ownership. The general impression was of surface slip(s) of the upper, more granular, surface deposits and the made ground at the top of the cemetery path. Movement appeared to be ongoing on a weekly basis and at the time of the last visit, the corner of the steps had dropped several feet, there was an area of significant slumping at the top of the slope near the cemetery wall/ path and significant amounts of soil washout and vegetation loss on the lower slope areas. Significant ground water was observed in the areas of washout.

Path Closure
On the basis of their own visits, MC made the decision to close the steps to the public access on 19 January 2016 and it is considered that this was the appropriate course of action given the deterioration noted.

Causes
The heavy rain and freeze/ thaw cycle will have acted to destabilise the slope. The rain will have added mass and washed out the finer particles as well as potentially create/ enhance slip planes via softening of soils. If ice had formed in the upper/ open soil faces due to cold weather, this may have increased pressure on the soils, potentially adding to movement.

It was noticeable that soils that had been washed out (visible at top and base of sandstone cliff face) and soils visible in the void under the steps appeared to be heavily saturated. This was even at the time of the test anchors after a relatively dry previous fortnight when the surface soils were relatively dry. MC commented that monitoring the drainage at the top of the slope indicated it was generally dry previously and only recorded water after a prolonged period of rainfall (December 2015). It is possible that in those heavy/ prolonged rainfall events water moves through the ground from the cemetery area and runs down the slope. This could lead to heavily saturated soils which take a long time to dry out/ movement continues over a period of time. The drainage, which is understood to have refractured after repairs, is likely to have contributed to the water ingress. Both the initial 2013 and later 2015/ 2016 movements occurred after prolonged spells of wet weather and the slope appeared more stable in drier periods.

The destabilising forces over the winter period have been greater than the stabilising remedial works and slippage/ deterioration has visibility occurred. The remedial works to date have not therefore solved the problem. Given this, it is now considered that further surface slippage will continue, especially after wet periods.

Future Performance
Whilst over time, establishment of the new vegetation may help to bind the upper soil levels together and remove/ inhibit ingress of precipitation, it is difficult to conclude that this will solve the issue. This is given that there now has been significantly more movement along slip planes, potential softening of soils and wash out of fines and new areas of movement.

As in previous reporting, it is considered that to more confidently stabilise the slope, more extensive remediation works will be required. Without these works, ongoing

slippages are likely to continue to occur necessitating closure/ extension of closure of the footpath.

Re-opening the footpath without undertaking these more significant works is not recommended unless a prolonged period of monitoring/ recorded stability/ vegetation establishment provides confidence that future slippages are unlikely or will not result in movement that could present an H&S issue.

On the basis of recent observations, this scenario is not likely to be realised in the short to medium term without intervention

With no intervention, ongoing slippages will continue to occur until such point as a natural equilibrium is reached. This will be via ongoing loss of the less competent upper layers of soils, made ground and vegetation. It is not possible to say how much should will be lost or what the timescale would be but the slope is likely to be dynamic for years to come and a significant amount of soil could be lost. There is a risk that the plan area/ extent of impact continues to increase due to the progressive deterioration of the current area. This will be dependent on a number of factors including slope angle, underlying geology, precipitation and vegetation. This situation should be monitored on the ground and would benefit from a degree of additional assessment.

Areas to be monitored in the wider area would prudently include the cemetery path and wall, the edge of the cemetery and the property owned by the Goldwyres. Monitoring ideally would be both visual and more accurately via measured monitoring points. Boreholes previously installed would be usefully monitored if they could be recommissioned.

Although it has its limitations, slope stability analysis calculations could be undertaken to check factors of safety in these areas. This would include use of existing data and back analysis of actual slippages observed. It may be that completion of further boreholes would increase confidence in the assessment of ground conditions including water levels, depending on amount of available existing data and areas to be considered.

Potential Solutions
A number of possible solutions have been considered. These do not include stabilising the whole slope as it is understood that budgets are not available. Solutions include:

- Localised soil anchoring. Budget = £60,000. Not recommended as unlikely to be effective in the medium/ long term.
- Wider soil anchoring. Budget = £150,000 to £200,000 inc contingencies. Requires rope access.
- Piling Solution along Path. Budget = £150,000 to £200,000 inc contingencies. Could be extended. Dependent on confirmation of access/plant for solutions. Soils below path likely to be lost resulting in steep slopes.

Installation of the earth anchoring system will require vegetation removal for access and to install matting to bind the upper soil surface/prevent surface erosion.

Repair of the path should be of as lightweight construction type and avoid building up significant depths of fill. Flexible construction types such as a timber walkway could be considered. Use of a geotextile could also be considered. Some limited narrowing of the path at the critical location may be of benefit.

The proposed solutions do not address the cemetery footway area.

6.0 Recommendations

On the basis of this report, the following recommendations are made:

- The footpath should not be re-opened until after remediation takes place or a significant period of no movement has occurred when the risks/ issues should be reassessed (considered unlikely as a short/ medium term scenario).

- Undertake remediation works if budgets available, consider risk assessment/ potential consequences if budgets not available.

- Repair broken drainage, may require repeated visits and use of flexible pipework if slope movement continues.

- All proposed works/ monitoring to be subject to ongoing H&S review of operatives/ operations to keep abreast of any ongoing deterioration that may impact on safety of operatives. Include RAMS (Risk Assessments and Method Statements)

- Undertake regular visual observations whilst footpath remains closed:

  - Drainage performance.
  - Any movement/ deterioration noted in path – some settlement monitoring should be completed to provide systematic record of movement.
  - Any movement noted in general slope.
  - Any significant movement in lower slip areas.
  - Vegetation establishment and any signs of distress in existing vegetation.
  - Review utilities/ fence movement.

Suggested frequency is fortnightly and after significant rainfall. Record all observations on brief, check/ tick list with any comments to provide systematic record of any changes/ observations. Settlement monitoring could be monthly and after rainfall/any significant visual indications of movement.

- Undertaken regular visual and settlement monitoring of surrounding area including cemetery footpath/ wall, adjacent cemetery areas, adjacent property.

- Ensure input from engineer on regular basis to review data and undertake inspections.

- Assess factor of safety for surrounding area using existing data, back analysis of slips and potential new SI information.

7.0 Drainage Issues

7.1 Background

A meeting was held on 1st September 2015 between Mark Chapman of Ironside Farrar, John Park of Midlothian council and Gerry Goldwyre, resident at RP9. The meeting was held at Mr Goldwyre's request to discuss drainage issues.

Mr Goldwyre is concerned with the stability of his property – he *"wanted to ensure that his property had not been compromised by the landslip, and enquire if the faulty drainage works to road drains had contributed to the landslip"*.

Mr Goldwyre asked a number of questions at the meeting and it was agreed *that "the risk factors in the final report would now be re-assessed"*. This essentially arose from Mr Goldwyre's ascertain that MC had been 15 months previously advised in writing by him that there *"may have been problems with the drainage and may have been a source of the landslip, and as such should have been checked"*.

A further meeting was held 23rd March 2016 between MC and Mr Goldwyre where it was noted:

IF would be expected to re-assess the root cause analysis (RCA) for the original slope failure in order to ensure corrective actions (CA) and preventative actions (PA) were as robust as possible. The RCA should take account of all and any information available. The assessment of the drainage failures should now be included in the RCA since these were largely overlooked during the process of CA/ PAs after the first failure.

7.2 Review of Drainage Issues

Mr Goldwyre's question is after the event and it is not always straightforward to identify *"what would we have done if we had thought/ known/ been advised differently at the time"* and what the resultant actions would then have been. However the following provides comment:

- For clarity, it is noted that the May 2014 report was concerned solely with the stability of Ironmills steps and those aspects of the immediately slope within MC ownership. It did not consider the Goldwyre's property and no access was taken to their ground.
- The initial desk study element of the report (including Table 1) comprised the first element of work undertaken and assessed factors that may potentially be contributing to the slippage issue.
- If at the time of the desk study element, Ironside Farrar had believed that there was, or might be a problem with the drainage system, it is now considered likely that the wording in the "Likelihood of being a contributing factor" column would have changed to "Medium" or "High" or "Medium to High".
- This would probably have then resulted in a recommendation to conduct an investigation of the drainage system – potentially comprising items such as CCTV survey, tracing, excavation, capacity check etc. Any faults or subsequently identified issues considered to be of potential significance relative to slope stability would then have probably resulted in a recommendation to repair or upgrade them.
- It is understood that subsequent to the report, MC did then further investigate the drainage and make repairs/ modifications. IFL have no direct knowledge of any actual faults and repairs to the drainage as this was dealt with by MC.

- Beyond the desk study aspect, none of the subsequent works that Ironside Farrar undertook during the ground investigation proved definitively that faulty drainage was or was not, in fact a contributing issue. There were no visual indications on the steps during the time IFL was on site and boreholes on the steps WS02 and WS03, the latter which was fitted with a ground water monitoring installation, did not record significant ground water at that location. This does not mean though that drainage wasn't a contributing factor, simply that it was not observed by IFL to be one at the time. At the time of the initial investigation, no significant ground water levels were identified across the whole area of investigation so IFL's opinion at the time that heavy rainfall was probably a contributory factor was not confirmed by the investigation either. There was observed to be some saturated soils washed out at the base of the cliff which suggested that water had been a contributing issue, this may have possibly been due to faulty drainage allowing water into the slope or precipitation or ground water flow or some combination of these.
- Also subsequent to the desk study element of the report discussed above, ground investigation and analysis identified, within the limits of the assessment that parts of the surface deposits in the slope were around their theoretical limit of stability in any event, irrespective of any additional influencing factors.
- Whilst faulty drainage may potentially have been a contributory factor if it was penetrating the slope, it is considered unlikely that it was the only factor. The lateral extent of the slips in the slope, which reach up to 45m from the steps as shown on the MC's survey plan (and which visibly now extend further than that monitored at the time of the survey), is outwith the likely zone of influence of water from the faulty drainage system. Significant movement down slope of the drains would have been required for the influence from faulty drainage alone to cause movement that far along the slope and this is not observed.
- Ongoing deterioration and movement of the slope has been observed since January 2016 subsequent to the reported repairs to the drainage system. This was after a period of heavy rainfall and one in which presumably the drainage was functioning satisfactorily. Monitoring boreholes at the top of the slope were reported by MC have water in them at this time for the first time since their installation and large amounts of saturated soils were observed to have been washed out from the base of the slope/cliff edge.
- On the basis of the works/ observations undertaken by IFL, it is considered that the reason for the slip is a combination of a steep slope with less stable surface soils being destabilised by water after periods of heavy rainfall. The water acts to add weight to the slope and soften the ground/ create slip planes. This water is likely to be a combination of water falling on the slope itself and soaking into the ground, water falling on the area above the slope and running through the ground and potentially also from the reportedly faulty drainage, if it was in fact allowing significant water to penetrate into the ground.

Appendix 1 - Photographs

Appendix A
Site Photographs
(taken 24.08.15)

IronsideFarrar

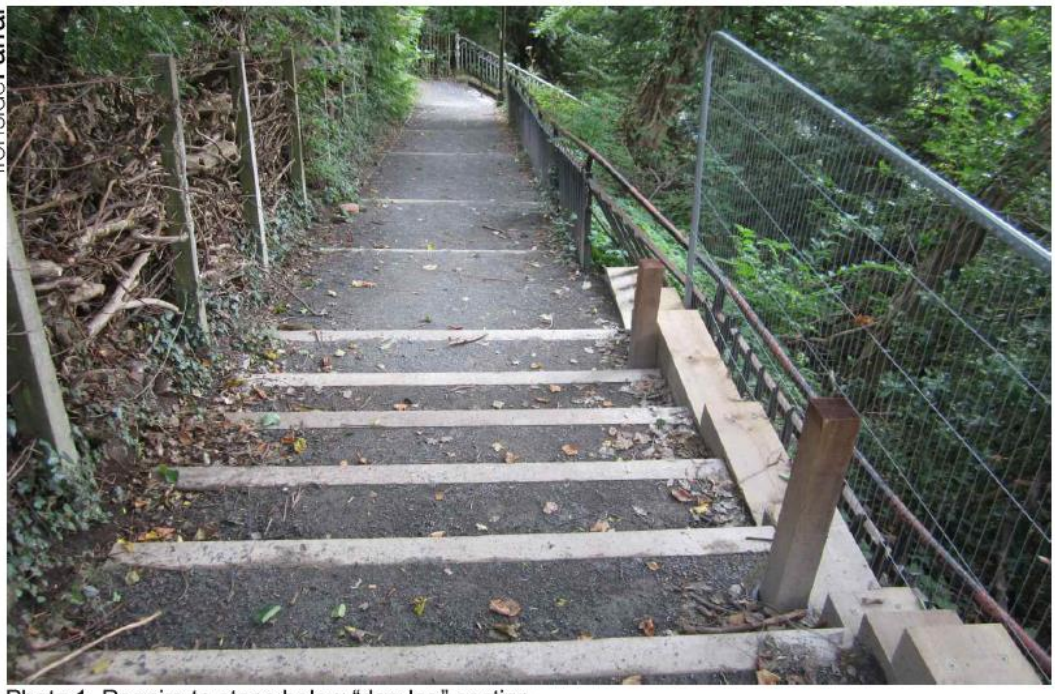


Photo 1. Repairs to steps below “dog-leg” section.

Photo 2. New timber edging and Sycamore tree at “dog-leg” insteps.

Appendix A
Site Photographs
(taken 24.08.15)

IronsideFarrar

Photo 3. Section of slippage prior to December 2014, no deterioration noted.

Photo 4. Marker post out of plumb.

Appendix A
Site Photographs
(taken 24.08.15)

IronsideFarrar

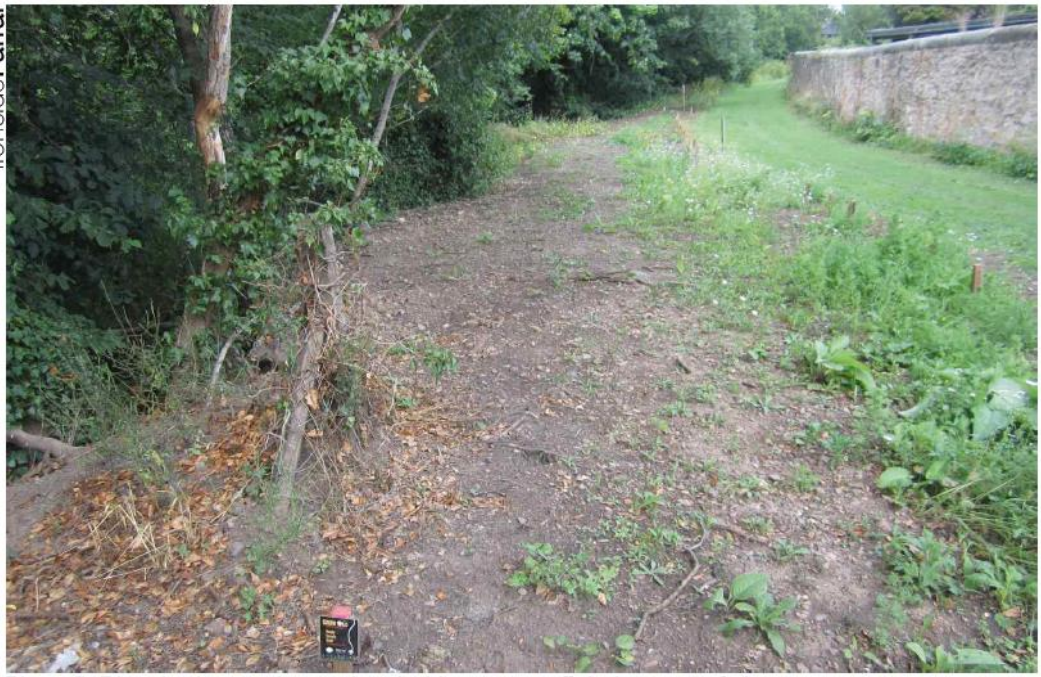


Photo 5. Disturbed ground associated with new cut off drain at top of slope.

Photo 6. Upper section of steps.

Appendix A
Site Photographs
(taken 24.08.15)

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Photo 7. New willow plant-whip.

Photo 8. New planting.

Appendix A
Site Photographs
(taken 19.01.16)

Photo 9. View at corner of steps

Photo 10. Slope slipping

Appendix A
Site Photographs
(taken 19.01.16)

IronsideFarrar

Photo 11. View up steps

Photo 12. Area of wash out above rock face

Appendix A
Site Photographs
(taken 19.01.16)

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Photo 13. Area of top of slope

Appendix A
Site Photographs
(taken 15.02.16)

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Photo 14. View down steps

Photo 15. Slope slipping

APPENDIX 1

Appendix A
Site Photographs
(taken 15.02.16)

Photo 16. View up slope

Photo 17. Area of wash out above rock face

Appendix A
Site Photographs
(taken 15.02.16)

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Photo 18. Area at top of slope

Appendix A
Site Photographs
(taken 16.04.16)

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Photo 19. View at Corner of steps (16.04.16).

Photo 20. Washout at rock face / lower slope (23.04.16).

IRONMILLS STEPS - Photos showing damage caused by landslip taken on 31 May 2016

APPENDIX 1