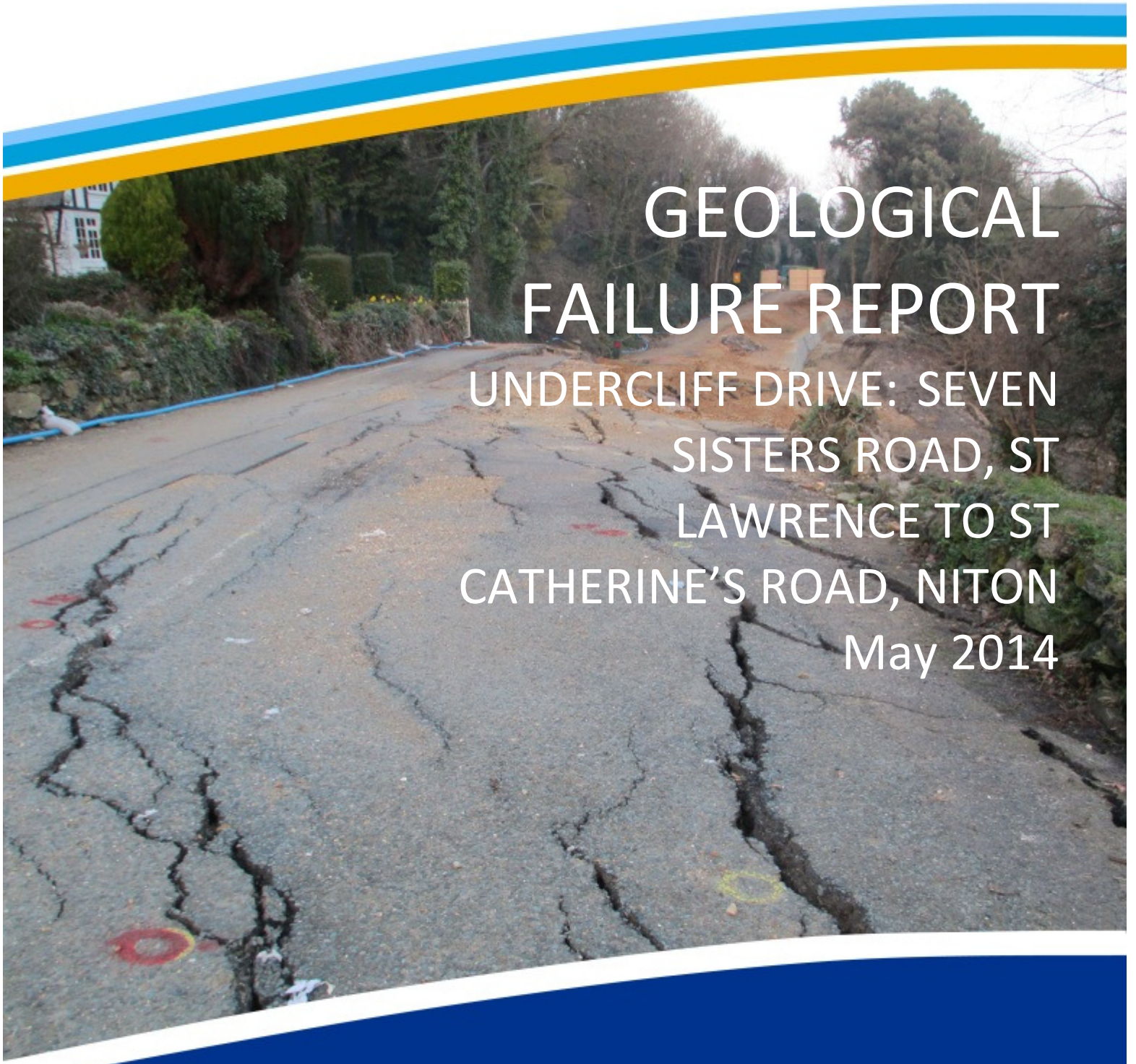
Island Roads



GEOLOGICAL FAILURE REPORT

UNDERCLIFF DRIVE: SEVEN SISTERS ROAD, ST LAWRENCE TO ST CATHERINE'S ROAD, NITON

May 2014

www.islandroads.com

Title	**Geological Failure Report – Seven Sisters Road, St Lawrence to St Catherine's Road, Niton**
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Document Status	Final
Date of Next Review	June 2014

Version	***Report Author***	***Report Checked***	***Report Approved***
4			

Approved for Island Roads Services Limited	**Date**	**Signed**

Contents

1 INTRODUCTION

A Geological Failure has occurred at Undercliff Drive between Seven Sisters Road, St Lawrence and St Catherine's Road, Niton.

Clause 12.11.1 of the Highways PFI contract stipulates that the Service Provider must provide a failure report detailing the nature and proposed costs of remediation, management and or rectification for each Amber or Red zone Geological Failure. This report follows on from the Failure Notice issued by the Service Provider to the Isle of Wight Council in March 2014. Below is a response to each of the clauses required within the contract.

Separate Failure Reports for Site 9 Woodlands and Site 10 Caravan Park have been completed and should be read in conjunction with this report. The remediation options summarised in Section 2.5 and detailed in Appendix 5 relate to Sites 9 and 10. Details of the clauses within the contract are given in Table 1 of the Ramboll report in Appendix 1.

2 CONTRACT RESPONSE

2.1 Contract Clause 12.11.1.1

The Geological Failure that has occurred along Undercliff Drive encompasses Geotechnical Site 8 Above Hunts Road, Geotechnical Site 9 Woodlands, Geotechnical Site 10 Caravan Park, Geotechnical Site 11 Mirables and Amber Risk Zone 6 Beauchamp.

A number of tension cracks have developed at the Ventnor end of Site 8 Above Hunts Road beyond the extent of the piles that were installed during December 2013/January 2014 as part of the geotechnical works at this site (see Figs. 1a and 1b). The cracks developed over a period from early March 2010 but have now slowed and no further movement has been detected. Ground movements here can be attributed to the exceptionally high rainfall over December 2013 and January/February 2014 coupled with the intrinsic instability of the area. Groundwater levels along this stretch of the Undercliff are still well above the trigger levels for ground movement as shown in Section 2 of Appendix 1 (Woodlands Failure Report) and Appendix 2 (Caravan Park Failure Report). Ground movement appears to have slowed at the Caravan Park but is continuing in the centre of the slip at Woodlands.

Monitoring data is detailed in the Ramboll reports for Site 9 Woodlands and 10 Caravan Park.

Figure 1a. *Undercliff Drive Geological Failure.* Tensions cracks developing at the Ventnor end of Site 8 Above Hunts Road.

Figure 1b. *Undercliff Drive Geological Failure.* Tensions cracks developing at the Ventnor end of Site 8 Above Hunts Road.

Details of the Geological Failures at Site 10 Caravan Park and Site 9 Woodlands are detailed in Appendices 1 and 2. These reports provide updated and more detailed information of those matters contained in the original Failure Notice.

Ground movement has also occurred at Site 11 Mirables over the same time period and has been characterised by the development of hairline cracks within the carriageway. Movement has been detected by the carriageway monitoring instrument at this site and groundwater levels remain high but are now beginning to drop. One instrument located downslope of the carriageway within the landslide itself has failed due to ground movement. Photographs of the site are shown in Figs 2a, 2b and 2c. Monitoring data for the area around Site 11 Mirables are given in Fig 3a and 3b.

Figure 2a. *Undercliff Drive Geological Failure.* Tensions cracks developing in the carriageway at Site 11 Mirables.

Figure 2b. *Undercliff Drive Geological Failure.* Tensions cracks developing in the carriageway at Site 11 Mirables.

Figure 2c. *Undercliff Drive Geological Failure.* Tensions cracks developing in the carriageway at Site 11 Mirables.

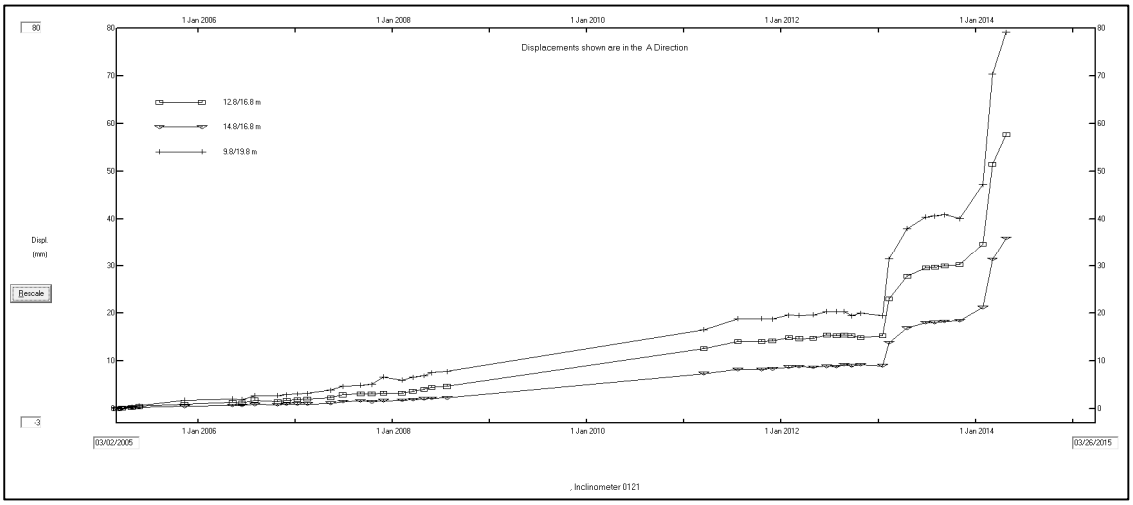

Figure 3a. Displacement time graph showing ground movement rates at Site 11 Mirables (instrument located within the carriageway). The A direction is downslope. The plot shows an increase in the rate of movement during January 2013 a further increase during January 2014.

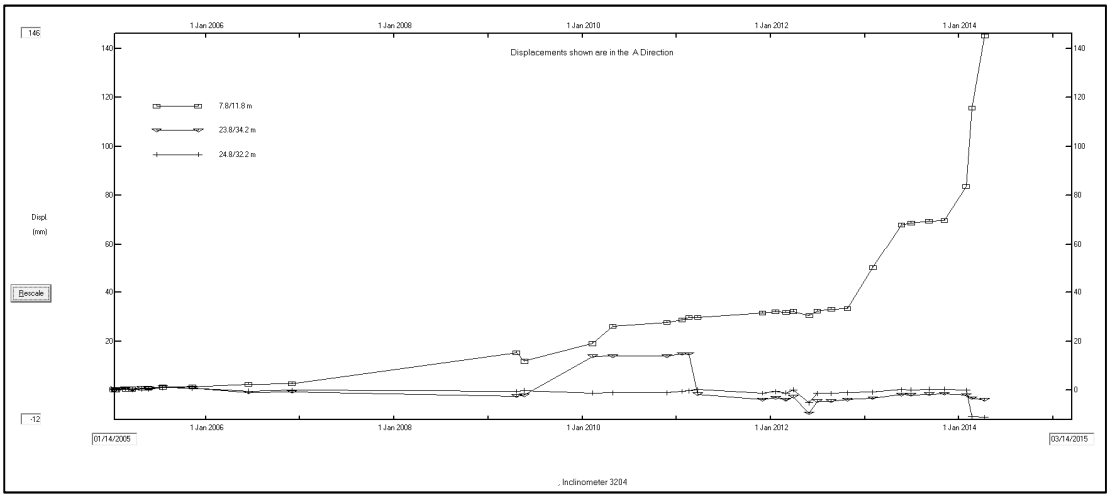

Figure 3b. Displacement time graph showing ground movement rates at Site 11 Mirables (instrument located within landslide). The A direction is downslope. Similarly with the plot in Figure 3a there are increases in the rates of movement in January 2013 and January 2014 to the present.

Amber Risk Zone 6 Beauchamp has also moved on a similar scale to those sites further towards Ventnor. Ground movement here has become apparent through the development of tension cracks both within the carriageway and further downslope within the landslide. Cracks have developed in residential buildings nearby, and adjacent monitoring instruments have detected movement and high groundwater water levels. Photos of the tension cracking developing at the surface are shown in Figs. 4a and 4b. Associated monitoring data is given in Figs. 5a, 5b and 5c.

Figure 4a. *Undercliff Drive Geological Failure.* Tensions cracks developing in the carriageway at Amber Risk Zone 6 Beauchamp.

Figure 4b. *Undercliff Drive Geological Failure.* Tensions cracks developing in the carriageway at Amber Risk Site 6 Beauchamp.

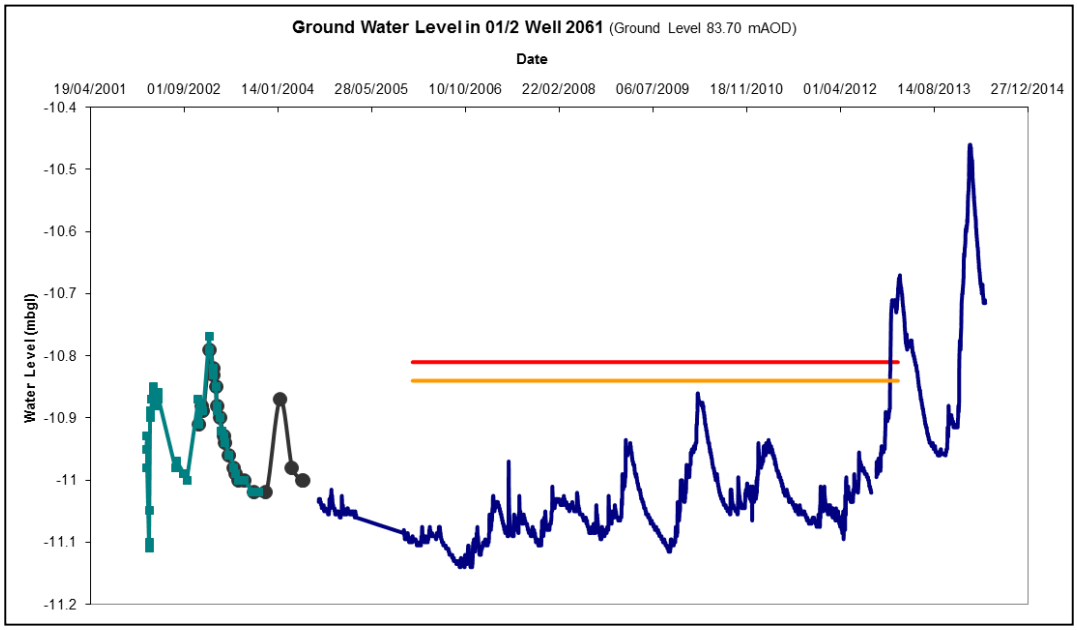

Figure 5a. Groundwater levels at Amber Risk Zone 6 Beauchamp. The red line denotes the trigger level for ground movement. Groundwater levels at this site have begun to drop however they remain high.

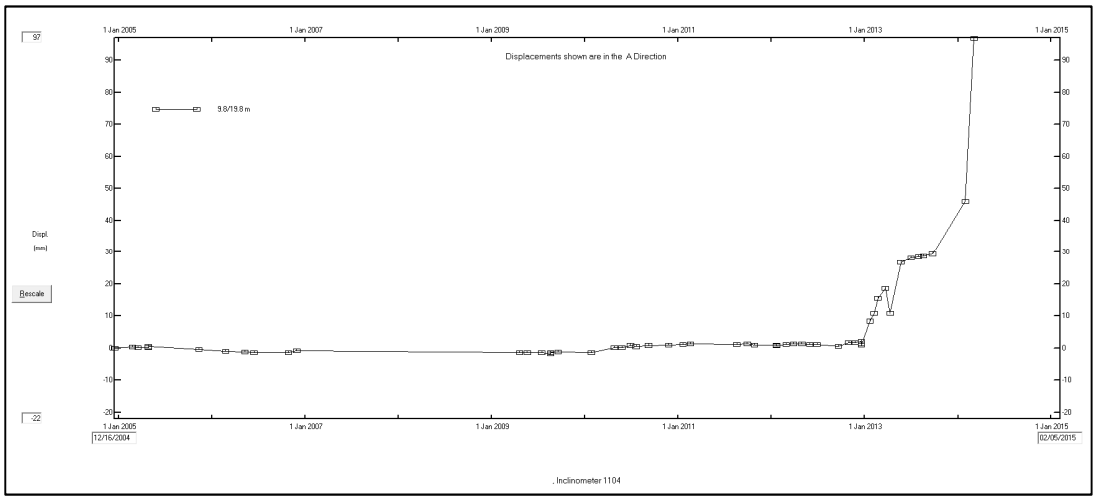

Figure 5b. Displacement time graph showing ground movement rate adjacent to the carriageway at Amber Risk Zone 6 Beauchamp (instrument located adjacent to the carriageway on the south side of the road). The 'A' direction is downslope. Increased movement during January 2013 and January 2014 is evident.

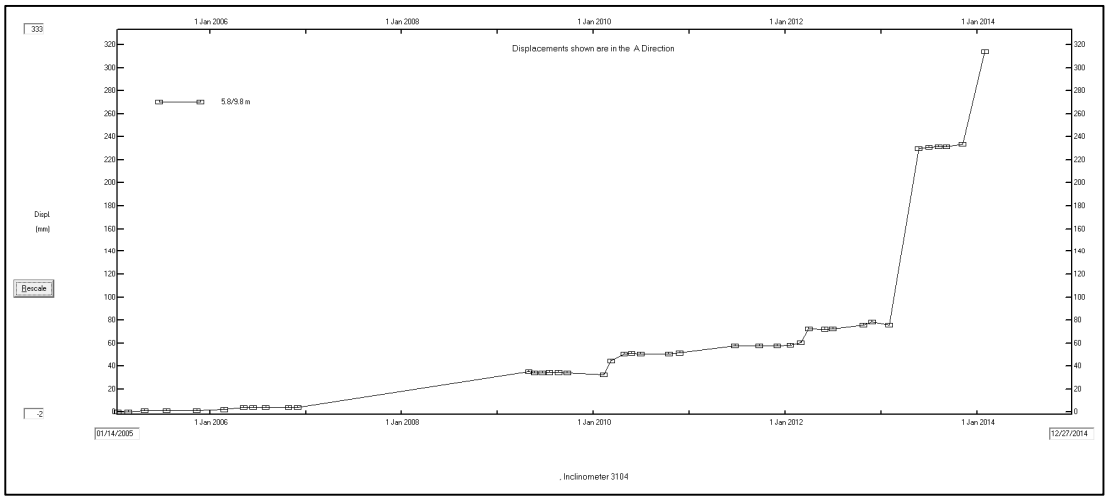

Figure 5c. Displacement time graph showing ground movement rate adjacent to the carriageway at Amber Risk Zone 6 Beauchamp. The 'A' direction is downslope. This instrument failed due to ground movement at ~10m depth between January and February 2014.

2.2 Clause 12.11.1.2

The road closure for the geotechnical works remains in place between Seven Sisters Road, St Lawrence and St Catherine's Road, Niton. Warning signs for road users are in place from Bath Road, Ventnor at the eastern end of the closure and from High Street, Niton at the western end. The closure will remain in place for this stretch of the road until such time as a solution can be implemented. A drawing showing the closure and diversion route for Undercliff Drive is given in Appendix 3.

At present the houses located between the two sites at Site 9 Woodlands and Site 10 Caravan Park cannot be accessed by vehicular traffic. Emergency services, waste collection and fuel delivery vehicles cannot therefore reach any of the residents along this section of the road.

Since gradual movement is still ongoing along Undercliff Drive the monitoring programme will be continued for the foreseeable future. Island Roads will continue to undertake weekly GPS (for Sites 8 to 10) and photographic (Site 11 and Amber Zone 6) surveys and continue with groundwater and ground movement monitoring (at all sites). A CCTV system has been put in place to provide security along the section between Site 9 Woodlands and Site 10 Caravan Park.

Groundwater levels remain high and there is still a high risk that ground movements will continue along the length of the site until levels drop. A full programme for rectification of the site has not been developed at this stage as it is dependent upon the length of time that groundwater continues to remain high (for more information on current groundwater levels for Site 9 Woodlands and Site 10 Caravan Park refer to Appendices 1 and 2 Section 6).

Island Roads will continue to develop proposals that consider the land instability further and will provide a more long term solution for Undercliff Drive. Any solution will depend upon future monitoring information. A number of options for remediation of the site are described in Section 2.5 of this report and in Appendix 5.

2.3 Contract Clause 12.11.1.3

In order to make the area safe for the public the Undercliff Drive road closure remains in place. Road closed signs and diversion signs are located along the road to re-route traffic via Whitwell Road.

The following measures are in place at Site 8 Above hunts Road:

- Pedestrian barriers are in place adjacent to the piles installed during December 2013/January 2014.
- Road closure signs and road narrows signs are in place.

The following measures are in place at Site 9 Woodlands:

- Padlocked hoarding has been erected at both ends of the site to prevent pedestrian access.
- A road closed sign and railway sleepers are located outside the hoarding at the Ventnor end of the site.
- Heras fencing is in place at the Ventnor end to prevent pedestrians from accessing the site around the side of the hoarding. Another section of Heras fencing has been established between Woodlands and the Caravan Park to barrier another slip that has occurred within the carriageway outside the property 'Allenmore'.

The following measures are in place at Site 10 Caravan Park:

- Heras fencing has been erected to barrier the area of the slip and to prevent access from the road. The footpath is of a sufficient and safe width to allow pedestrian access.
- A movable fence panel has been placed at the Niton end of the site to allow access for residents between the Caravan Park and Woodlands.
- Signs are in place on the fence panels to warn the public of the dangers of accessing the site.

The following measures are in place at Site 11 Mirables and Amber Risk Zone 6 Beachamp:

- A road closure is in place.

Photographs showing each site and the measures in place at present are given in Fig. 6a to 6d.

Figure 6a. *Undercliff Drive Geological Failure.* Measures in place at Site 8 Above Hunts Road.

Figure 6b. *Undercliff Drive Geological Failure.* Measures in place at Site 9 Woodlands (eastern end).

Figure 6c. *Undercliff Drive Geological Failure.* Measures in place at Site 9 Woodlands (western end).

Figure 6d. *Undercliff Drive Geological Failure.* Measures in place at Site 10 Caravan Park (western end).

2.4 Contract Clause 12.11.1.4

Site inspections are undertaken regularly by Island Roads. Ground movement monitoring and groundwater level measurements are taken from existing instrumentation along the length of the site. The most recent surveys have shown that small scale movement is continuing and groundwater levels are beginning to drop but still remain high.

The length of Undercliff Drive from Seven Sisters Road, St Lawrence to St Catherine's Road, Niton will continue to be monitored weekly through GPS survey, photographic survey and groundwater/ground movement monitoring. No other surveys assessments or investigations are currently planned.

A number of recommendations for increased monitoring of the landslide were outlined by Ramboll for Site 9 Woodlands and Site 10 Caravan Park in their March 2014 and January 2014 reports respectively (see Section 5 of Appendices 1 and 2 which include the reports updated to June 2014). The following were implemented by the Service Provider from January 2014:

- Increase inclinometer survey frequency to once per fortnight
- Monitor width of cracks and surface points in the road at Sites 8, 9 and 10 weekly
- Collect and carry out regular reviews of monitoring and rainfall data
- Review remediation proposals in view of revised ground conditions
- Once ground movement has ceased, the area seaward of the site will be re-surveyed

2.5 Contract Clause 12.11.1.5

The contract requires the Service Provider to provide a full and detailed explanation of proposals to rectify, manage and/or mitigate the failure (Proposed Failure Solution). However until ground movement at the site has stopped this cannot be finalised as indicated by the Ramboll Geotechnical Report (Appendix 1, Section 6). It was agreed with the Authority that the Service Provider would consider options for future consideration and these are as follows:

1. **Pedestrian only route** – upgrade the existing remaining access so it is suitable for pedestrians only. A path would be constructed slightly inland at the Niton end of Site 10 Caravan Park and a pedestrian safety barrier installed which would require liaison with the owners of the land on the north side of the road at this point. The route would therefore be permanently closed to vehicles (see Appendix 5 Access Option 1).
2. **Single lane traffic** – a possible one-way system and or passing places and traffic signals. Returning the route to a one-way vehicle access would involve removal of

some slipped material, slope re-profiling, drainage and some engineering works to stabilise the face of the slope at the Niton end of the Caravan Park. An example cross-section of this proposal is shown in Appendix 5 (Access Option 2).

3. **Two way traffic** – repair and re-open the road to two way traffic. This would involve similar works to those detailed in Option 2 however more extensive engineering works would be required such as further reinforcement and piling. (See Appendix 5 Access Option 3).

4. **Realignment of the road** – site an alternative route further inland along the original Undercliff track running behind the property 'Woodlands'. Moving the access away from the original route and inland towards the cliff would require either stabilisation of the cliff face to limit the occurrence of cliff falls and/or construction of a rock shelter to protect road users. Issues of land ownership must also be considered. This option is presented as Access Option 4 in Appendix 5.

5. **Temporary access** – interim measure for vehicular access. This would be a short term solution to allow vehicles to access the houses between Site 10 Caravan Park and Site 9 Woodlands. See Access Option 5 Appendix 5.

6. **Permanent road closure** - no vehicular or pedestrian access. Signage at the site would be improved and turning circles would be constructed at both the west end of the Caravan Park and the eastern end of Woodlands. The road would be closed permanently and the consequences of an alternative route would need to be considered if this option is chosen. This option is not detailed in Appendix 5.

It is recognised that some local residents are still using their properties and others are keen to return. To that end consideration has been given to providing a safe, but temporary vehicular access solution from the Niton end of Undercliff Drive. For residents to remain properties must be capable of being accessed by appropriate service vehicles in any emergency. It is therefore recommended that a temporary access could be provided by acquiring a small section of land on the landward side of the road at the Caravan Park in order to construct a light-weight one-way vehicular access track of sufficient width for emergency vehicles.

2.6 Contract Clause 12.11.1.6

Failure costs incurred to date and ongoing weekly costs associated with the failure are included within Appendix 6. Until such time as a final solution is selected detailed proposed failure costs cannot be determined. Once ground movement has ceased along Undercliff Drive a solution can be agreed and prepared. For a list of potential options is detailed in Section 2.5 and Appendix 5.

2.7 Contract Clause 12.11.2

Resurfacing was due to be completed up to and including Site 10 Caravan Park immediately after completion of the stabilisation works at Sites 9, 10 and 11. Seeing as the stabilisation works have not been completed due to the Geological Failures along Undercliff Drive, the resurfacing works will not be completed until such time as a proposal for rectification is agreed and implemented.

APPENDICES

APPENDIX 1:

Ramboll Report – Woodlands Site 9, Undercliff Drive Geological Failure

Intended for
ISLAND ROADS

Document type
REPORT

Date
March 2014

ISLE OF WIGHT HIGHWAYS PFI

WOODLANDS SITE 9 UNDERCLIFF DRIVE – GEOLOGICAL FAILURE

RAMBOLL

ISLE OF WIGHT HIGHWAYS PFI
WOODLANDS SITE 9 UNDERCLIFF DRIVE
GEOLOGICAL FAILURE REPORT

Revision **0**
Date **2014/06/03**
Made by
Checked by
Approved by
Description **Geological Failure Report**

Ref 61030594-9-R02

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APPENDICES

1. INTRODUCTION

Geological failure of Undercliff Site 9 – Woodlands was first reported on 10 February 2014. Site 9 is located at National Grid Reference 4525 0762 along Undercliff Drive, and is 218 metres long (Figure 1). This site lies immediately east of Undercliff Drive Site 10 – Caravan Park.

The existing road at Woodlands has been affected by repeated major land slippage some 90 metres from the western end of Site 9. Ground movement occurred in the winter 2012/13 prior to the award of the Highways PFI Contract. As a result of the 2012/13 ground movement Undercliff Site 9 was reprioritised, with work planned in the first year of the Highways PFI scheme. The highway was locally resurfaced prior to the commencement of the PFI Contract. The scheme was designed (July 2013) and construction works at this site had begun on 14 November 2013. Construction works had progressed to partial excavation of the existing carriageway, construction of the ground anchor beam and installation of eight ground anchors (unstressed). The east bound lane remained open. Construction photos are presented in Appendix A.

Following the initial notification the site was inspected by the Island Roads Geotechnical Engineer to map out the extent of surface cracking. In addition surface monitoring along the ground anchor beam and existing carriageway was initiated. A site inspection by the Ramboll Geotechnical Engineer was carried out on 13 February 2014 and 17 February 2014. The contract requires a Failure Report to include information as summarised in Table 1. This document summarises the proposed information and assessments required to assess the extent of Geological Failure.

Failure Report Clause	**Text**	**Reference in this Report**
12.11.1.1	Updated and more detailed information of those matters contained in the Failure Notification and Failure Notice;	Section 1 and 2
12.11.1.2	A full and detailed explanation of the impact of the rectification, management and/or mitigation (as applicable) of the Red Zone Failure.	Section 3
12.11.1.3	A full and detailed explanation of how the OpCo has made the affected Project Network Parts and its surroundings safe to the public (including the remediation of all Category 1 Defects in accordance with the provisions of Schedule 2 (*Output Specification*)).	See Island Roads report
12.11.1.4	A full and detailed explanation of what further actions the OpCo is to undertake (including any inspections, tests, surveys and/or assessments in order to determine the full extent of the Red Zone Failure, Amber Zone Failure and/or Geological Failure);	Section 4 and 5
12.11.1.5	A full and detailed explanation of how the OpCo proposes to rectify, manage and/or mitigate (as appropriate) the Red Zone Failure, Amber Zone Failure and/or Geological Failure (**"Proposed Failure Solution"**) which shall, where the OpCo believes no action is required, provide a full explanation of the reasons for such belief, including any implications arising from taking no action.	Section 6 and 7
12.11.1.6	An estimate of the total amount of Failure Costs which the OpCo shall calculate acting reasonably (including all Failure Costs incurred up to the issue of the Failure Report) required to carry out the	See Island Roads report

	Proposed Failure Solution, together with documentary evidence such as full bills of quantity where practicable.	
12.11.2	The OpCo shall at the same time as submitting the Failure Report, amend and submit to the Service Provider pursuant to Schedule 20 (*Review Procedure*) any OpCo Programmes affected by the Proposed Failure Solution.	See Island Roads report

Table 1 Summary of Failure Report Information

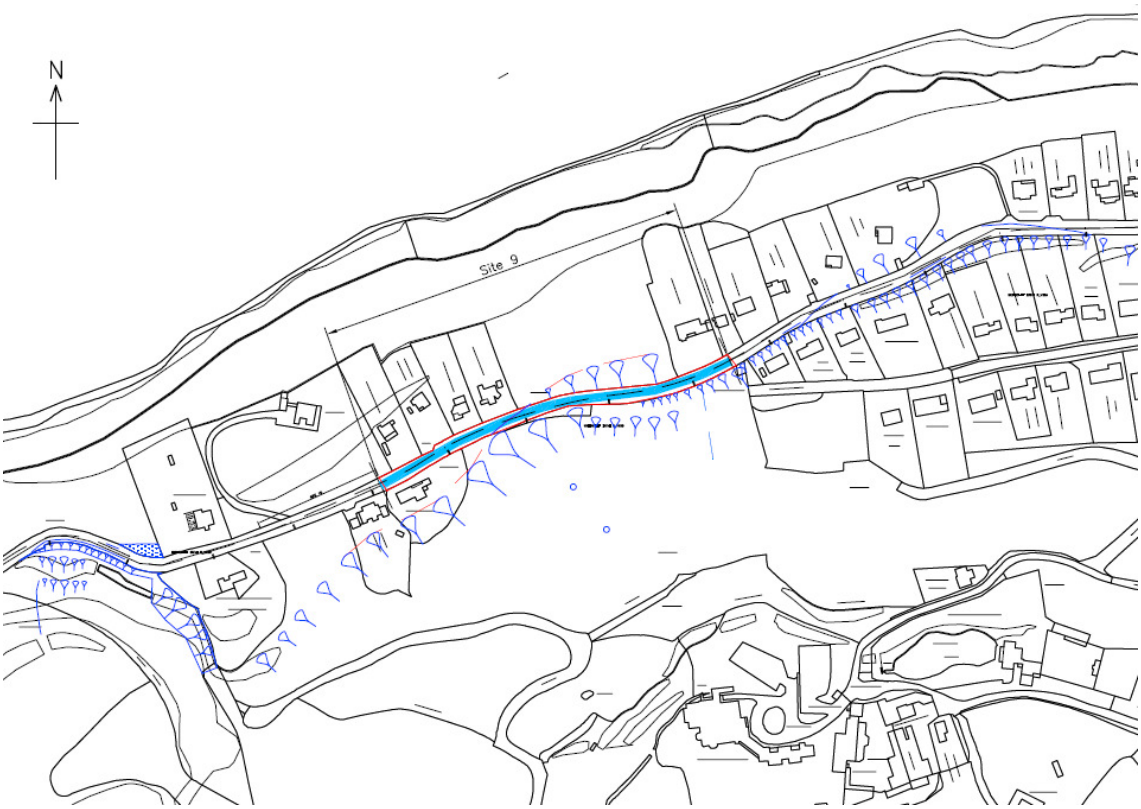


Figure 1 Location of Undercliff Drive Site 9 - Woodlands

2. INITIAL OBSERVATIONS OF LANDSLIDE FAILURE/ BEHAVIOUR

2.1 Site Observations

The main points from the site inspections are summarised in this Section and in Appendix B and Figure 2:

- Tension cracking was first reported on 8 February 2014 at "Allenmore".
- An inspection of the site was carried out on 10 February 2014. The first tension cracks were observed to extend between "Woodlands" and "Allenmore" in the road surface (shown in red) and had in three days extended both east and west.
- The tension cracks initially appeared as either re-opening of existing features or as hairline cracks.

- The westward extension of the tension cracks were aligned below and around "Allenmore". The tension crack in "Allenmore" driveway initially dropped approximately 100 mm in two days and external and internal damage was evident. Displacement then increased to 400 mm, and has since increased further. The north western corner to the foundations had moved along the dpc layer (Photo A1).
- New hairline tension cracks had developed along the Undercliff Drive to the western end of "Allenmore" (13 February 2014). These features continued to open up and displacement gradually developed from hairline to 200 mm wide on 17 February 2014.
- The tension crack opposite "Woodlands" and 30 metres east of "Woodlands" opened by 50 mm to 100 mm between 13 February and 17 February 2014 and began to show signs of downslope displacement.
- Inspection of the ground seaward of the site was difficult, hazardous and limited due to the extensive ivy coverage that masks underlying tension cracks. The following observations have been made:
    - Tension cracks 2 metres wide and 1.5 metres deep found downslope between "Allenmore" and the western half of the ground anchor beam (approximately downslope of where tension cracking was found in Undercliff Drive) on 10 February 2014 (estimated to be 50 metres to 75 metres forward of the site). During the second visit these features were not evident; this may have been due to the vegetation cover or possibly that further ground movement has closed them up.
    - Shallow ground movement downslope of the site within the Gault Clay (mudslide) debris is evident as shown in Photo A2, where the upper 3 metres of soil had moved several metres laterally.
    - There are zones where trees are tilted but it is not possible to assess if these are new or old features; they do coincide with the area where more recent features are evident.
    - A series of rotational blocks seaward of "Allenmore" and "Woodlands" show that the ground seaward of the exposed rotational blocks have moved relative to the blocks. These features have opened up to 300 mm to 400 mm wide tension features that were several metres deep (Photo A3) on the down slope side.
    - The lateral boundary of the shallow slide was seen during the site visit on 13 February 2014 and was approximately in line with the middle eastern quarter of the ground anchor beam.
    - Surface water features were encountered approximately 75 metres to 100 metres downslope of the site. It was not clear if these were spring feed and/or if the existing drainage system had become disrupted.
    - There is recent shallow movement in the Gault Clay scarp slope over a 40 metre width approximately 200 metres downslope of the site along with a series of trees that have been pushed over.
- The ground anchor beam had multiple hairline cracks at its mid-point (13 February 2014). The beam was subsequently mechanically cut before the larger scale movement began, to save as much of the beam as possible.
- The existing pumped drainage system that pumped water from the landward side of the road into an existing drainage system was disconnected and a temporary surface discharge pipe allowed water to flow over the beam downslope and back into the original discharge system, outfalling to the pond at the bottom of the slope.

Site 9 Woodlands and Site 10 Caravan Park, whilst situated immediately adjacent to each other and within the landslide complex, are subject to two different landslide mechanisms. An extract of the published Geomorphology Map (Sheet 5) is reproduced in Figure 3. This shows Site 9 to

be located in the head scarp position of an area of multiple rotational block failures that lies immediately above a retrogressing mudslide complex. The retrogressing slide complex extends approximately 160 metres downslopes of Site 9. This is in contrast to Site 10 where the mudslide complex extends to the shoreline. A zone of rotational blocks forms a feature separating the landslide complexes downslope of each site.

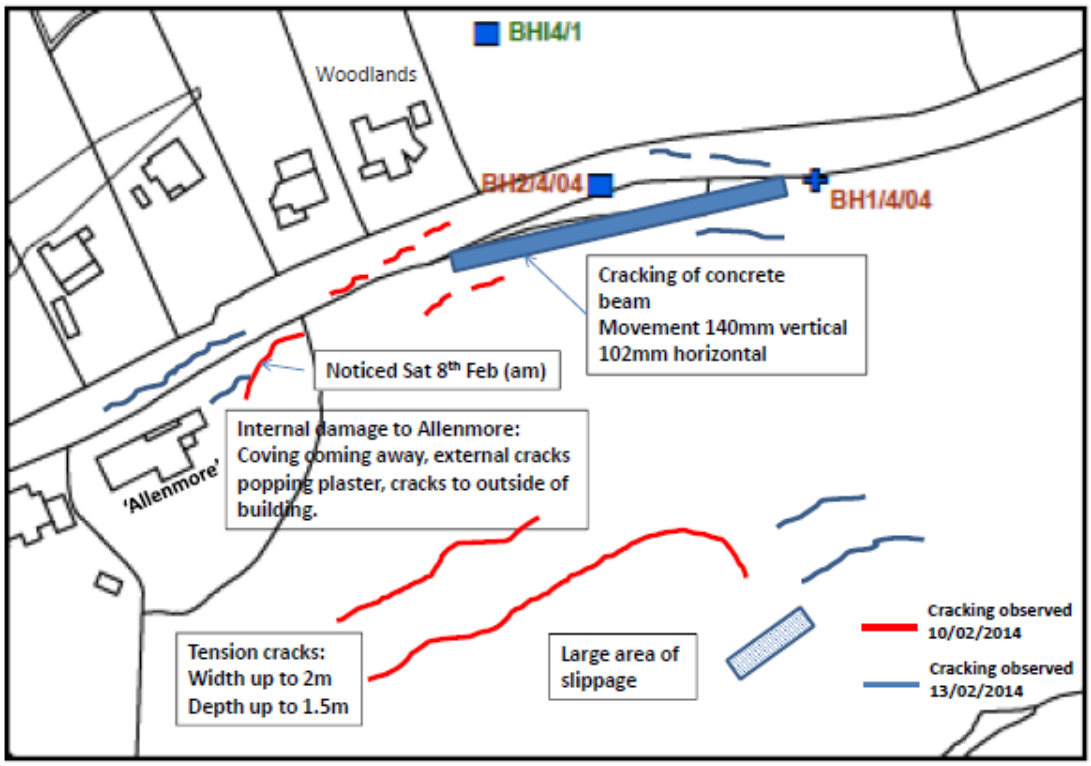


Figure 2 Summary of tension cracking observed on 10 and 13 February 2014

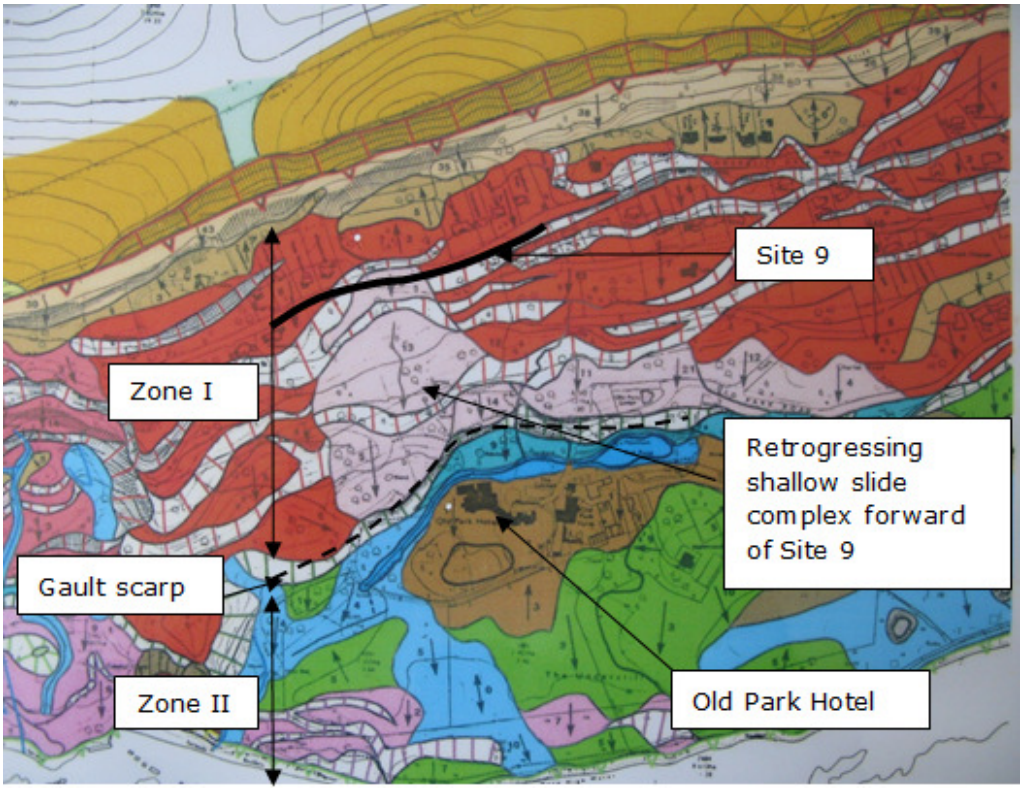


Figure 3 Extract of Geomorphology Map Site 9 and Site 10

The site observations suggest that shallow movement within the retrogressing mudslide complex has occurred, and this is likely to have removed support to the landward rotational blocks. A rotational block appears to have reactivated in the zone separating Site 9 and Site 10, and a new feature (or old dormant feature) developed 150 metres westwards, south of the red sites, to and beneath the Caravan Park.

2.2 Historical Landslide Behaviour

In 2001 a period of heavy rainfall resulted in major sliding at various locations along the Undercliff including Site 9. Further movement and cracking has occurred, with the most recent being in the winter of 2012/2013.

Subsequent to previous large scale ground movements along the Undercliff, a landslide forecast model was developed for the Undercliff by High-Point Rendel in 1996 based on the work by Lee *et al* (1991). In order to try and predict the likelihood of future movements along the Undercliff, data was collected concerning the occurrence and location of previous landslides and the volume of rainfall preceding them. The model gave a threshold value of effective rainfall (the percentage of total rainfall that enters the ground) over a preceding 4 month period which would be likely to cause instability or increased ground movement rates within the Undercliff landslide complex. When comparing the occurrence of previous landslide events with the corresponding 4 month antecedent effective rainfall (4AER) value it appears to correlate with ground movement events with a good degree of accuracy (Figure 4). Once the 4AER value drops back to below the threshold value the likelihood of further movements at that point in time is reduced. The Isle of Wight Council has employed this model in order to aid assessment of the likelihood of ground movements in areas throughout the Undercliff. Table 2 summarises the trigger threshold values. This placed the rainfall during February and March 2014 as Class 3, and at risk of major instability.

Landslide Forecast Class			
Class	**Trigger Value (4AER mm)**	**Location**	
		Major	**Minor**
Class 1	<410	Blackgang	The landslip, Luccombe, Mirables
Class 2	410 - 540	The landslip, Luccombe, Mirables, Blackgang	Woodlands
Class 3	540 - 640	ALL	Bonchurch, Ventnor, St Lawrence
Class 4	>640	ALL	ALL

Table 2 Summary of Landslide Forecast trigger values based on rainfall

Minor events at Woodlands typically occur in Class 2 events when the 4 month AER value is between 410 mm and 540 mm.

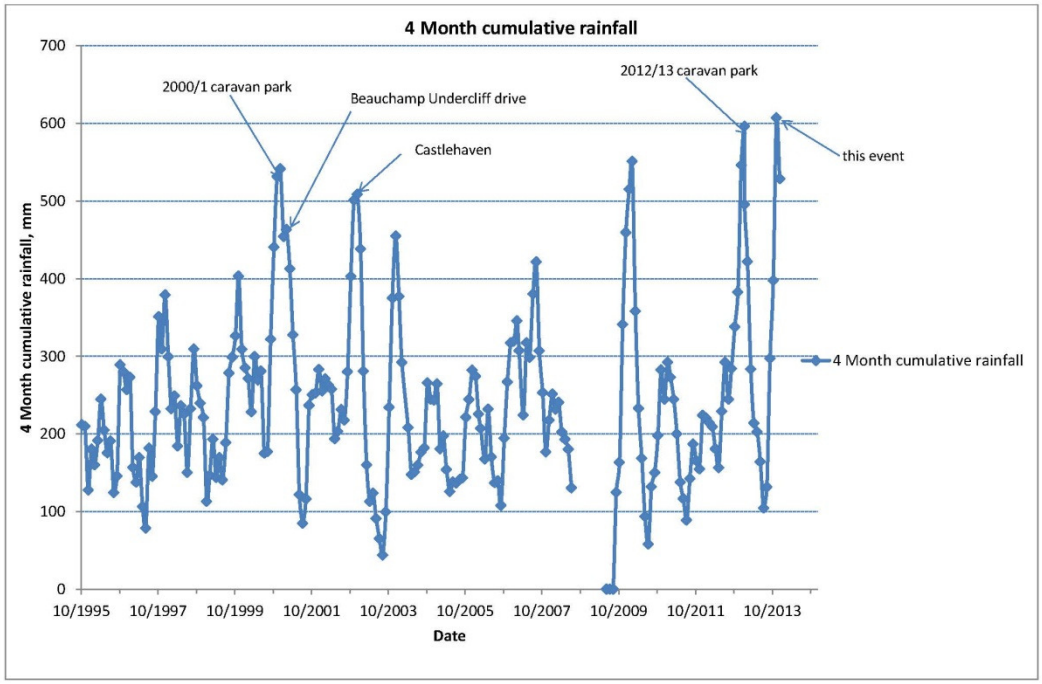


Figure 4 Four Month Moving Average Rainfall and Landslide Events

An image of the site taken on 12 March 2013 is shown in Figure 5. Localised resurfacing was carried out prior to Contract award. A site inspection was carried out on 24 July 2013 during the detailed design phase. An image taken of the site at that time is shown in Figure 6.

Figure 5 View of Site 9 taken on 12 March 2013

Figure 6 View of Site 9 taken on 24 July 2013 showing resurfacing carried out prior to contract award

2.2.1 Ground instrumentation

A location of the available monitoring points is shown in Figure 7, which comprise piezometers installed at a range of depths to monitor groundwater, and inclinometers to 50 metres depth to measure ground movement.

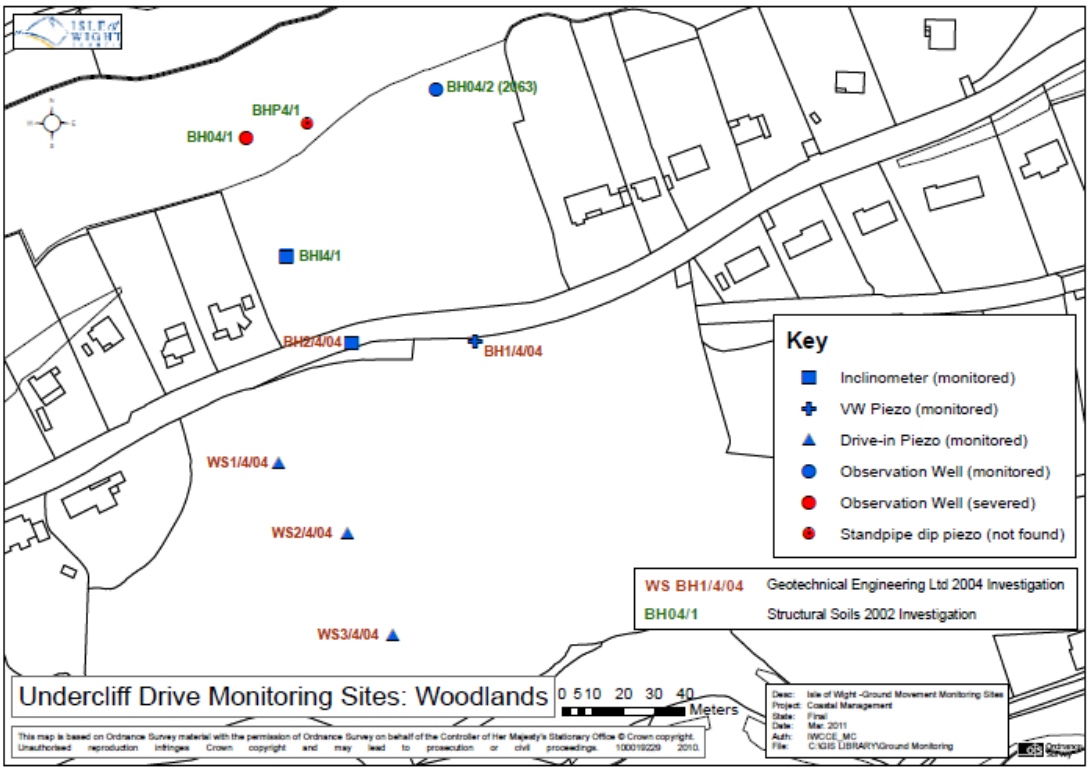


Figure 7 Monitoring locations, Undercliff Drive Site 9 - Woodlands

Figure 8 Ground anchor beam monitoring points

Data from ground instrumentation are presented in Appendix C.

During the 2012/13 landslide event surface ground markers were installed in Undercliff Site 9 and the adjacent Site 10 Woodlands. A summary of the records from this is presented in Appendix C. Surface movement of the road continued up to the last available record that was taken in 14 March 2013. The position of the ground anchor beam was re-surveyed on 11 February to compare it against the as-built location. The results are presented in Appendix C.

2.3 Observations from Monitoring Data

The following observations are made:

- Piezometers immediately landward of the site began to show increases in groundwater levels in the first two weeks in December 2013
- Groundwater levels in piezometer 2063 remained above trigger levels following the 2012/13 event until 24 September 2013. There was some evidence of ground movement affecting the road when the site was inspected during the detailed design.
- A rapid rise in levels began on 12 December 2013, and these increased significantly above trigger levels and above those recorded in the 2012/13 ground movement event. Levels here remain above landslide trigger levels.
- In contrast vibrating wire piezometers installed through the highway deeper into the landslide material do not show evidence of groundwater pressure increases.
- Groundwater levels in piezometers downslope of the site are 1 metre to 2 metres higher than previously recorded levels.
- Inclinometer 4304 located in the Undercliff Drive opposite Mount Lavinia shows start of ground movement at approximately 14 metres to 15 metres depth in the period January 2014 to date. There is approximately 10 mm incremental movement per week at this depth. Prior readings suggest negligible displacement at this level. Movement has begun to tail off at this location.
- Inclinometer I4 does not show any appreciable movement; this is located landward of Undercliff Drive, adjacent to "Woodlands".
- Inclinometer 2404 recorded 80 mm movement at approximately 9 metres depth during the 2012/2013 winter ground movement episode before becoming severed.
- In the 2012/13 event surface movement on the carriageway continued to at least the middle of March 2013, some three and a half months after its initiation.
- The change in survey position of the ground anchor beam shows a south-south easterly trend. The western half shows a drop in level of 100 mm, and a south-south east lateral movement of 100 mm to 150 mm on 13 February 2014. Movement at this location is continuing.
- Ground movement from the monitoring information ties in with surface observations. The highest movement is on the western half of the ground anchor beam, and is extending both east and west.
- Subsurface movement has also extended to the inclinometer opposite Mount Lavinia suggesting more extensive ground movement at depth in the top of the underlying Gault landslide debris.

2.4 Preliminary Stability Review

Construction at Site 9 commenced on 14 November 2013 and at the time of the geological failure excavation of the existing ground had been carried out to accommodate the ground anchor beam and select granular fill earthworks. The reinforced concrete ground anchor beam had been constructed, and eight ground anchors drilled but not connected to the beam or stressed.

A preliminary review of stability analysis has been carried out to assess if the works were detrimental to stability of the slope. This shows that the construction works have a slight improvement on overall stability, and therefore not a component driving failure.

The landslide system downslope of the site comprises a retrogressing mudslide within landslide debris, largely comprised of disturbed Gault Clay. Typically shallow near surface instabilities are reported to occur i.e. within the upper 3 metres to 4 metres of surface levels. Groundwater levels in this zone have risen by 1 metre to 2 metres above last year's levels, and currently approximately 3 metres below ground level (mbgl) 40 metres downslope of the site reducing to ground level approximately 120 metres downslope of the site. This is consistent with site observations of seepages/springs downslope of the site. The much higher groundwater in the shallow slide complex significantly increases the risk of the instigation of shallow slip surfaces. The increase in groundwater has been included in the stability model to assess the risk of shallow ground movement. It is found that shallow slips in the mudslide downslope of the site have factors of safety below unity and are more likely to fail than the larger slip mechanisms affecting the road directly.

It was recognised during the tender and detailed design that the stability of Undercliff Drive was sensitive to shallow landslides in the ground downslope of the site; this area lies several hundred metres outside of the designated red site and hence stabilisation of this element of the landslide is out of the scope of the current contract i.e. shallow ground movement downslope of the site was considered as a "geological failure mechanism".

The site observations and the stability model indicate that shallow slides downslope of the site had developed, with the formation of much wider tension cracks in the ground downslope of the site; at the same time hairline features and slight reopening of existing defects were apparent in Undercliff Drive. This type of movement would have led to rapid loss of support to the rotational blocks and may explain why the tension cracking and landslip features in Undercliff Drive developed in a relatively short timeframe.

It is noted that the existing drainage discharge pipe was observed to be intermittently exposed and likely to be leaking; surface water features were evident in the proximity of the discharge pipe; it is not clear if they represent one of the same feature. The current discharge system has been repaired and reconnected to the existing drainage pipe that outfalls to the pond at the bottom of the slope.

3. IMPLICATIONS OF FAILURE

- A significant Geological failure occurred prior to the installation of the proposed stabilisation solution for site 9. The failure has extended approximately 150 metres west from the previous defect and extends beyond the zone of support that would have been provided by current ground anchor strengthening solution.
- The geological failure has expressed itself in a relatively short time frame.
- The failure has occurred partly along the previous geological features, but during this event it has extended a significant distance west (by approximately 150 metres) and downslope of the red risk site boundaries, into private land. It is possible that these are new geological features or that the failure has resulted in reactivation of old dormant features.
- Groundwater levels in piezometer 2062 remained above trigger levels after the 2012/13 event. Site inspections carried out during the detailed design showed some evidence that the highway had suffered tension cracking/ settlement.
- From 12 December 2013 groundwater levels rose rapidly and continued to rise significantly higher (approximately 0.88 metres) than those recorded at the time of the 2012/13 failure.
- Site observations indicated that shallow ground movement downslope of the site was occurring in the early stages of landslide development, with tension cracks some two

metres wide seen immediately downslope of the site. Shallow ground movement will have led to loss of support (tension cracks seaward of the exposed rotational blocks) and most likely led to the subsequent reactivation of the smaller rotational blocks and rotational blocks adjacent to the Undercliff. This loss of support may explain why movement occurred relatively quickly in the Undercliff Drive.

- Groundwater levels at the site remain high and there remains a very high risk that movement will continue.

4. INTERIM MEASURES

A large scale geological failure has been initiated and developed in a relatively short time frame. The following measures have been carried out:

- Ground anchor beam was cut to avoid total loss
- Vehicular access is no longer possible due to the landward extent of the failure
- The existing pumped drainage system was diverted over ground to avoid subsurface leakage.
- Monitoring has been established and is continuing.

5. INFORMATION TO ASSESS EXTENT OF GEOLOGICAL FAILURE

The following information and actions have been implemented to assess the extent of the geological failure.

- Review remediation proposals given the revised site conditions
- Continue to collect all monitoring data available to date and rainfall data
- Increase frequency of inclinometer readings to fortnightly
- Monitor surface points in road surface at weekly intervals
- Monitor width of cracks in road surface at weekly intervals
- Carry out regular reviews of monitoring data with Island Roads to assess continuation of movement Resurvey the ground surface seaward of the site along the same cross section as that carried out during the design to establish the change in ground profile once the landslide event is complete
- Once the current landslide event is complete the ground surface seaward of the site should be resurveyed along the same cross-section as that carried out during the design to establish the change in ground profile

6. ESTIMATE FOR TIME FRAME FOR GEOLOGICAL FAILURE RECTIFICATION

At the time of preparing this report the full extent of landslide and its effect on Undercliff Drive Site 9 is unlikely to have been fully realised. Since the first issue of this report ground movement has continued. As a result a full programme for rectification of the red site has not been developed at this stage; this is dependent on the length of time ground movement continues. Ground movement continued for a period of 3 months to 4 months during the 2012/13 landslide

event. A timeframe for rectification will be developed subsequent to this failure report (or as to be agreed with the Isle of Wight Council). The initial outline programme of the proposed actions which have now been completed is given in Appendix D.

7. ESTIMATE OF FAILURE COST

An estimate of failure cost has not been established as the geological failure is still continuing. Given the movement that has occurred the current ground anchor solution is no longer suitable. If the road is to remain in its current alignment then significant fill would be required to raise the road back to an acceptable alignment. Remedial measures, if they were deemed possible, are likely to use a combination of techniques, and most likely include as one of the components deep wells to control groundwater levels. Groundwater control was initially proposed by during the tender stage, however subsequently not taken forward due to environmental restrictions associated with the site. A number of potential remediation proposals are presented in Appendix 5 of the Island Roads Report.

8. REFERENCES

Lee E M and Moore R 1991. Coastal Landslip Potential Assessment: Isle of Wight Undercliff, Ventnor. Report to the DoE.

APPENDIX A

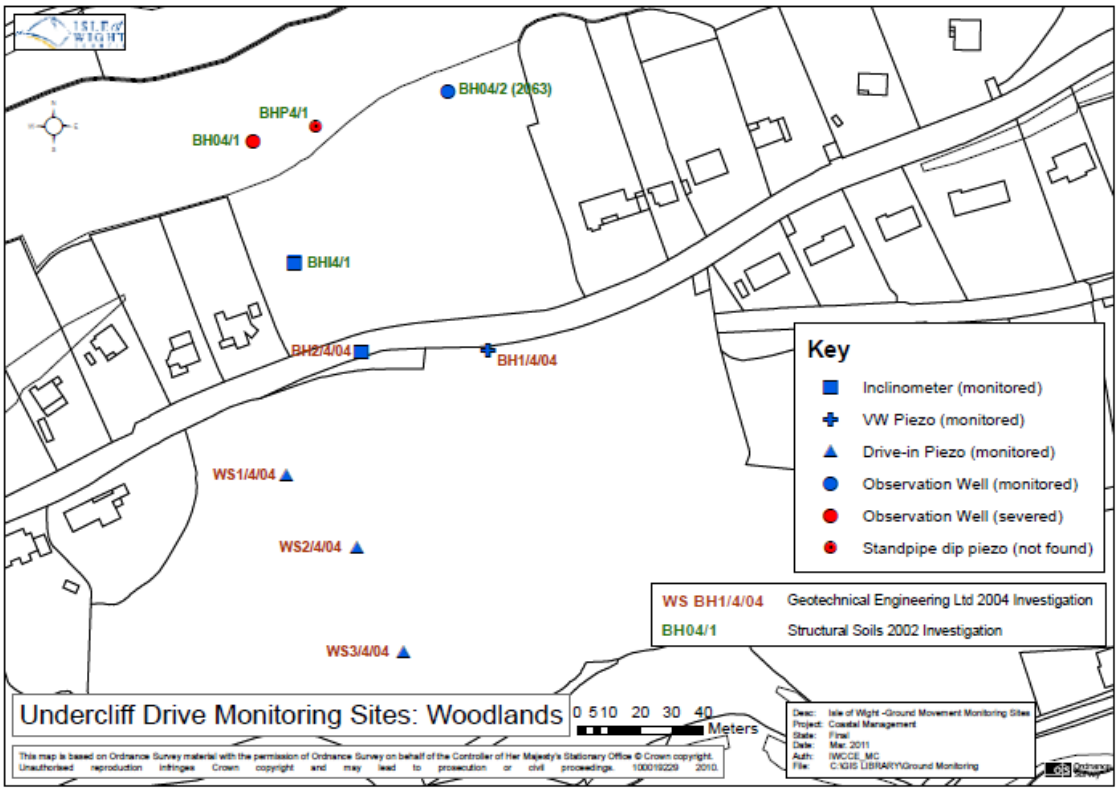
PHOTOGRAPHS

A 1 1 Photo of north west corner of Allenmore showing foundation displacement

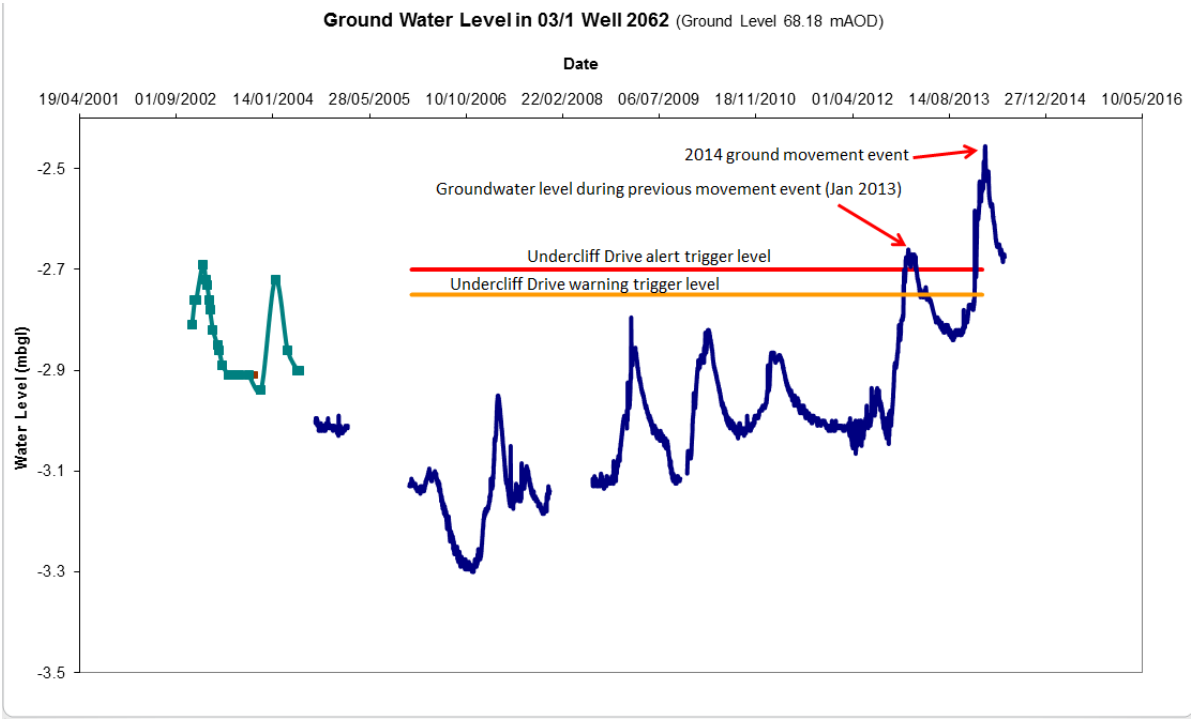
A 1 2 Shallow sliding Downslope of the Site

APPENDIX B

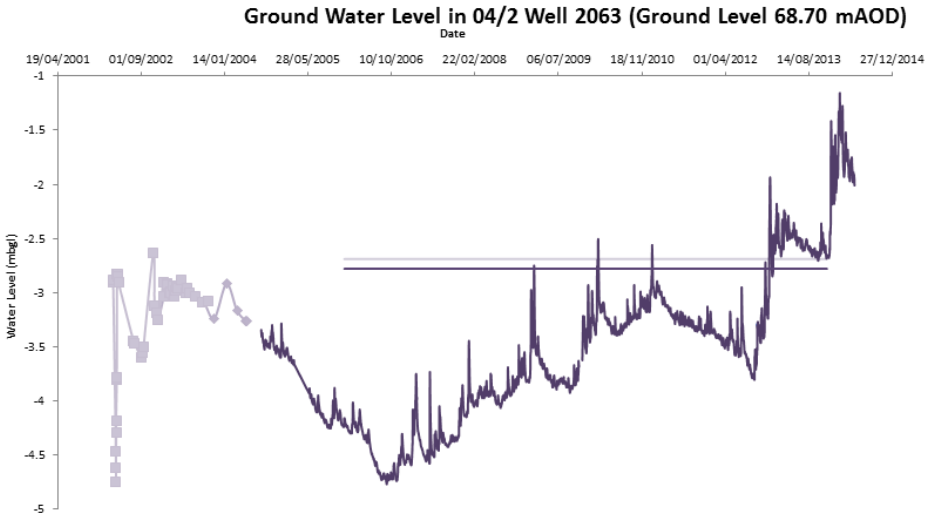
GROUND MONITORING DATA



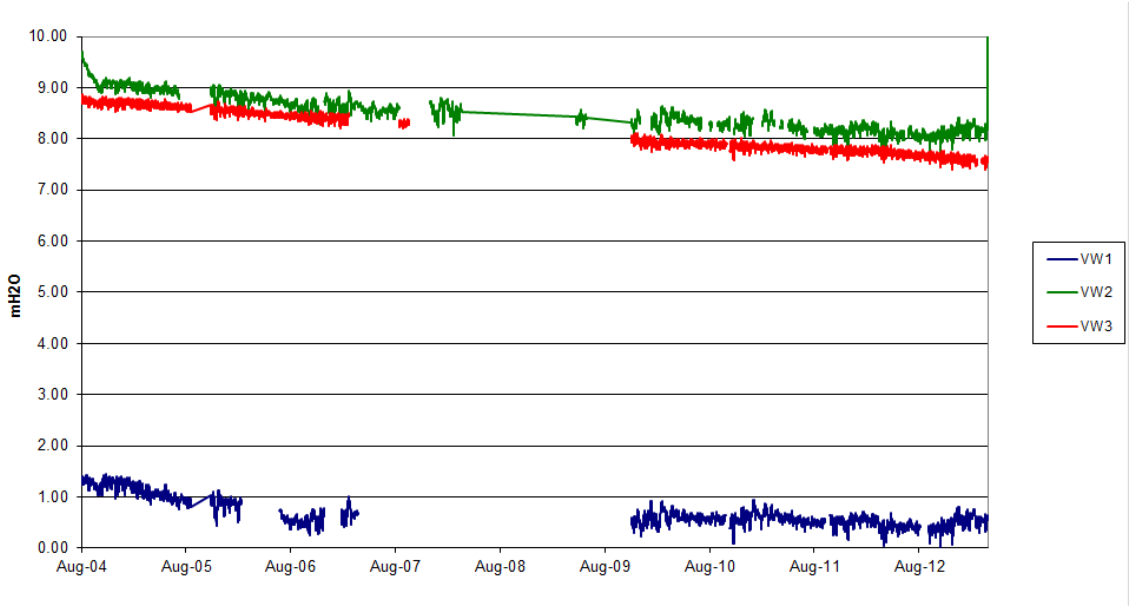
Appendix B- 1 Monitoring Locations, Site 9



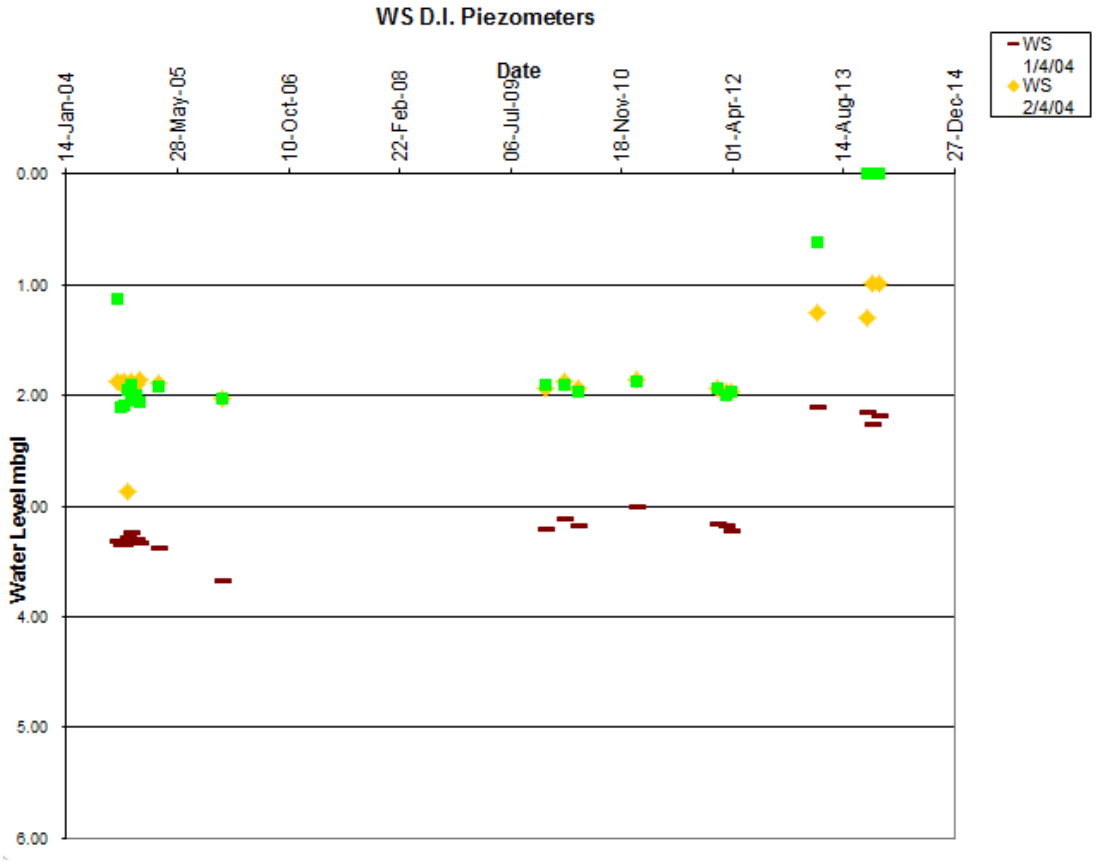
Appendix B- 2 Groundwater Records Well 2062



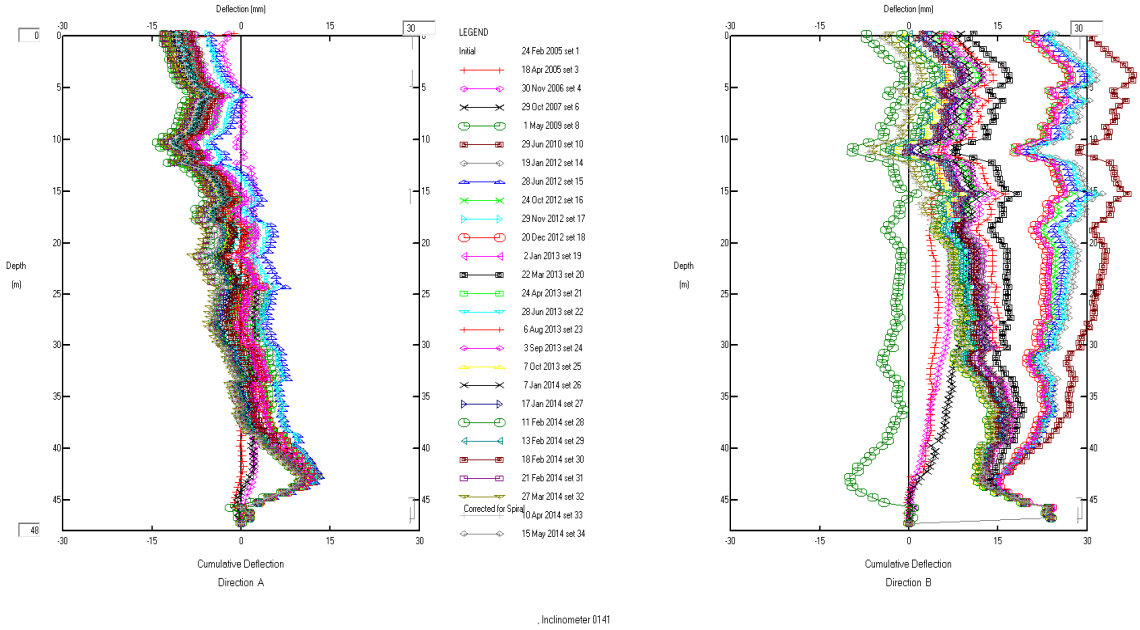
Appendix B- 3 Groundwater Records Well 2063, landward of the Highway



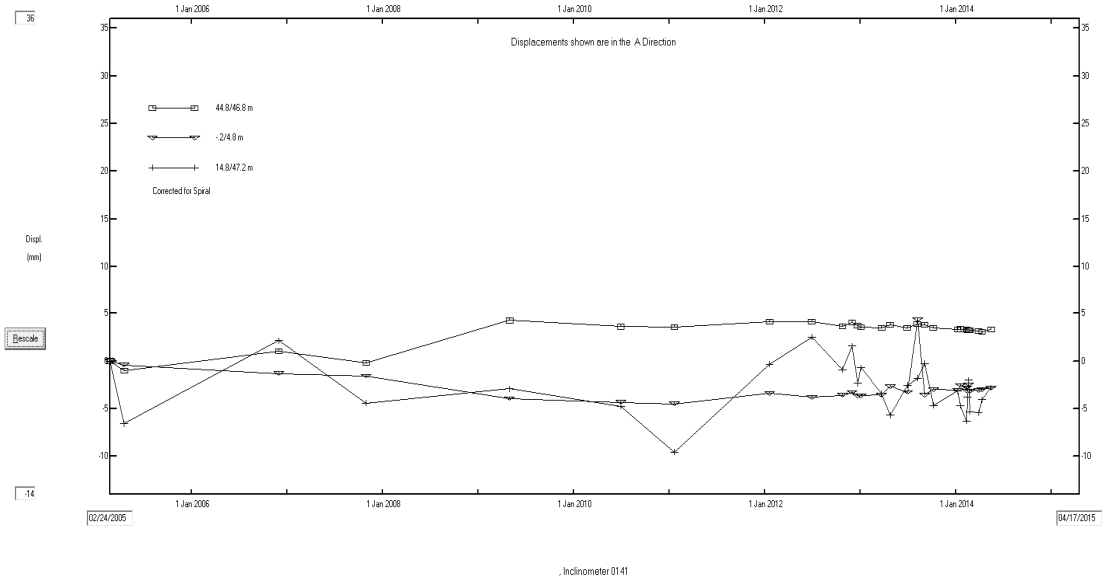
Appendix B- 4 Groundwater Records Vibrating Wire Piezometers 1404 with the Highway



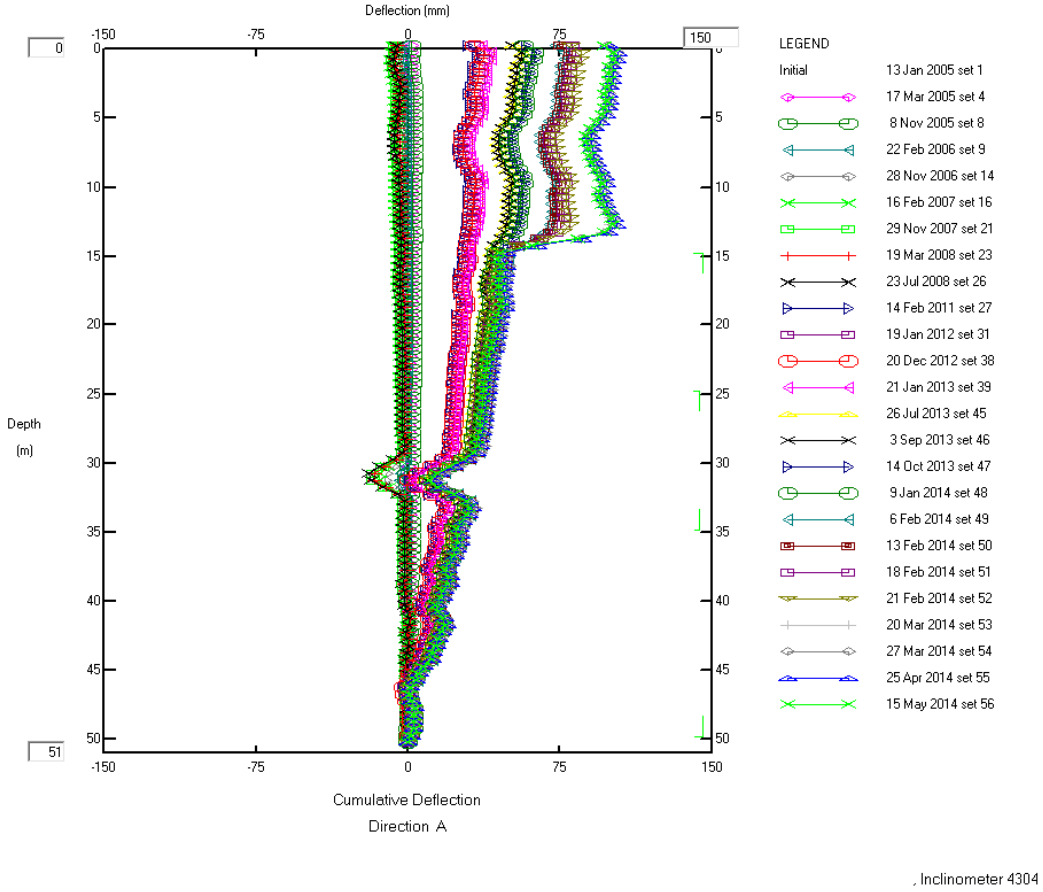
Appendix B - 5 Groundwater Records – Standpipe Piezometers Downslope of the Highway



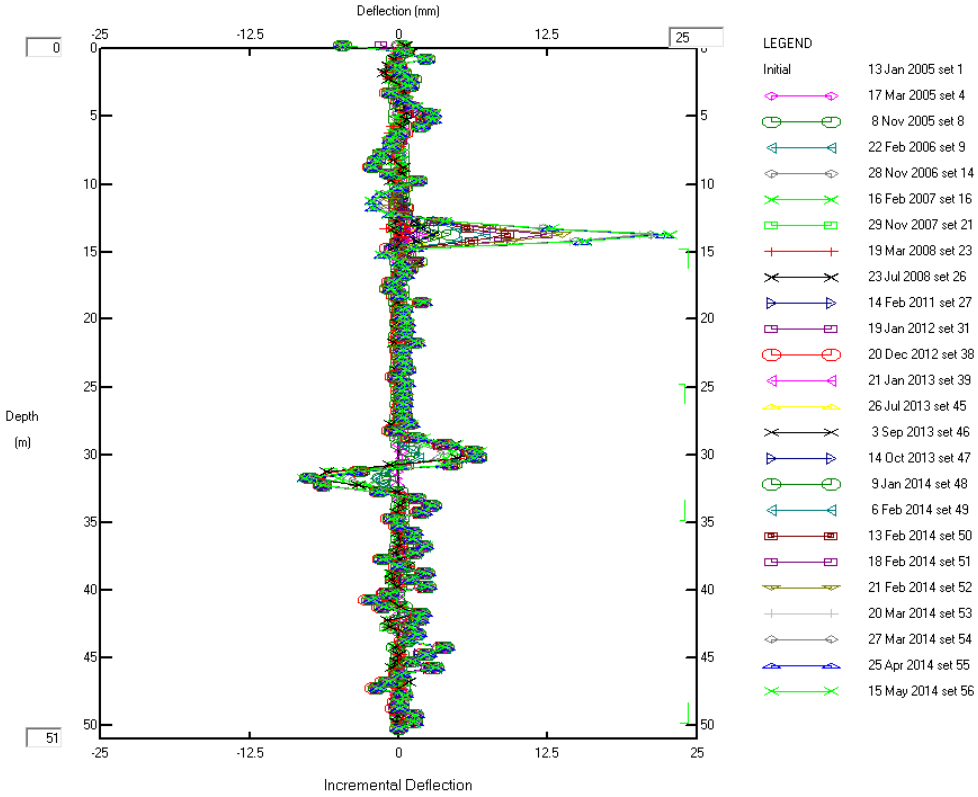
Appendix B- 6 Inclinometer I/4 - cumulative deflection plots



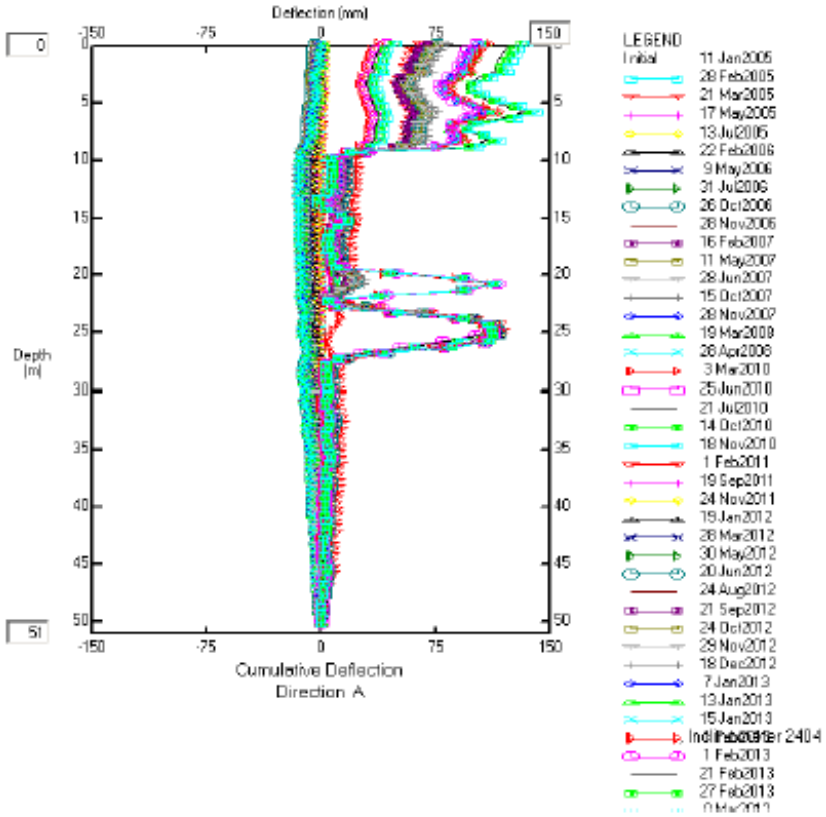
Appendix B- 7 Inclinometer I/4 - rate of displacement plots



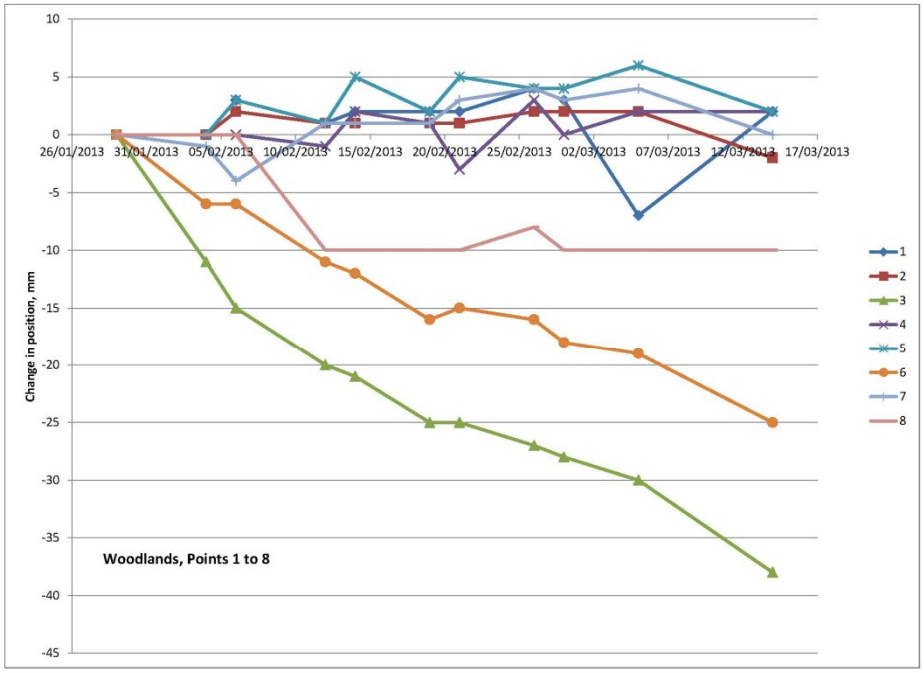
Appendix B- 8 Inclinometer 4304 Cumulative Displacement Plot



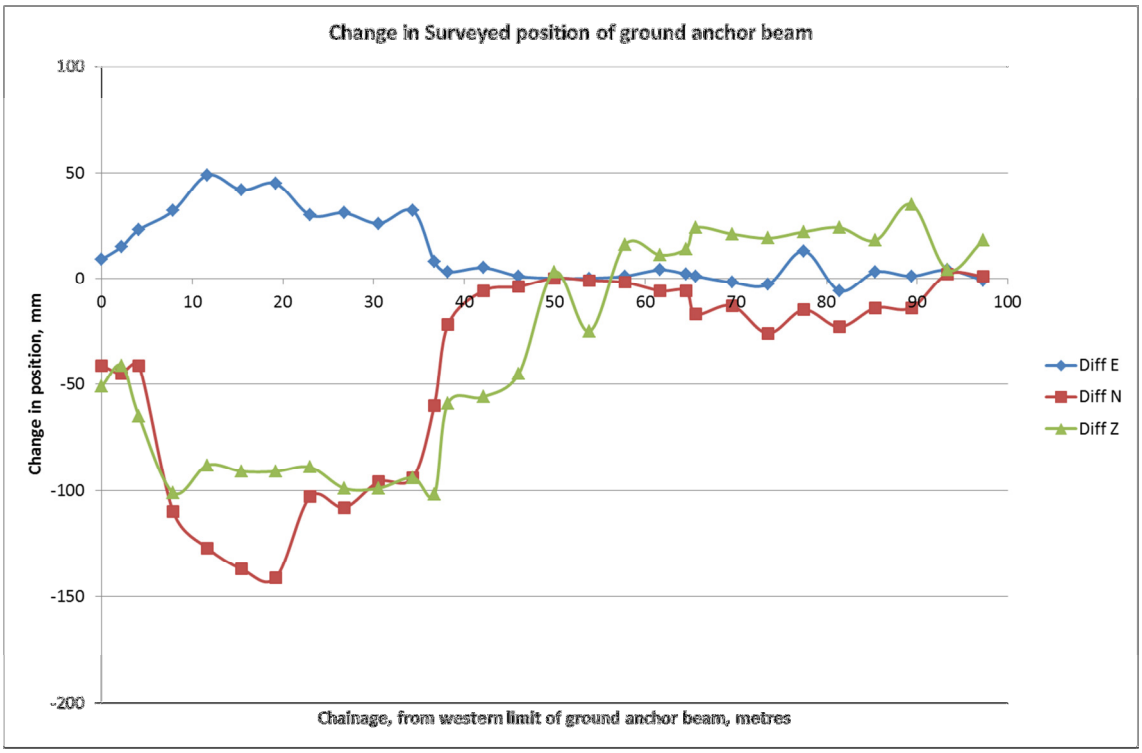
Appendix B- 9 Inclinometer 4304 Incremental Plot



Appendix B- 10 Inclinometer 2404 Incremental Plot. This instrument was severed due to ground movement during January/February 2013.



Appendix B- 11 Surface Monitoring Points Established 2012/13 event

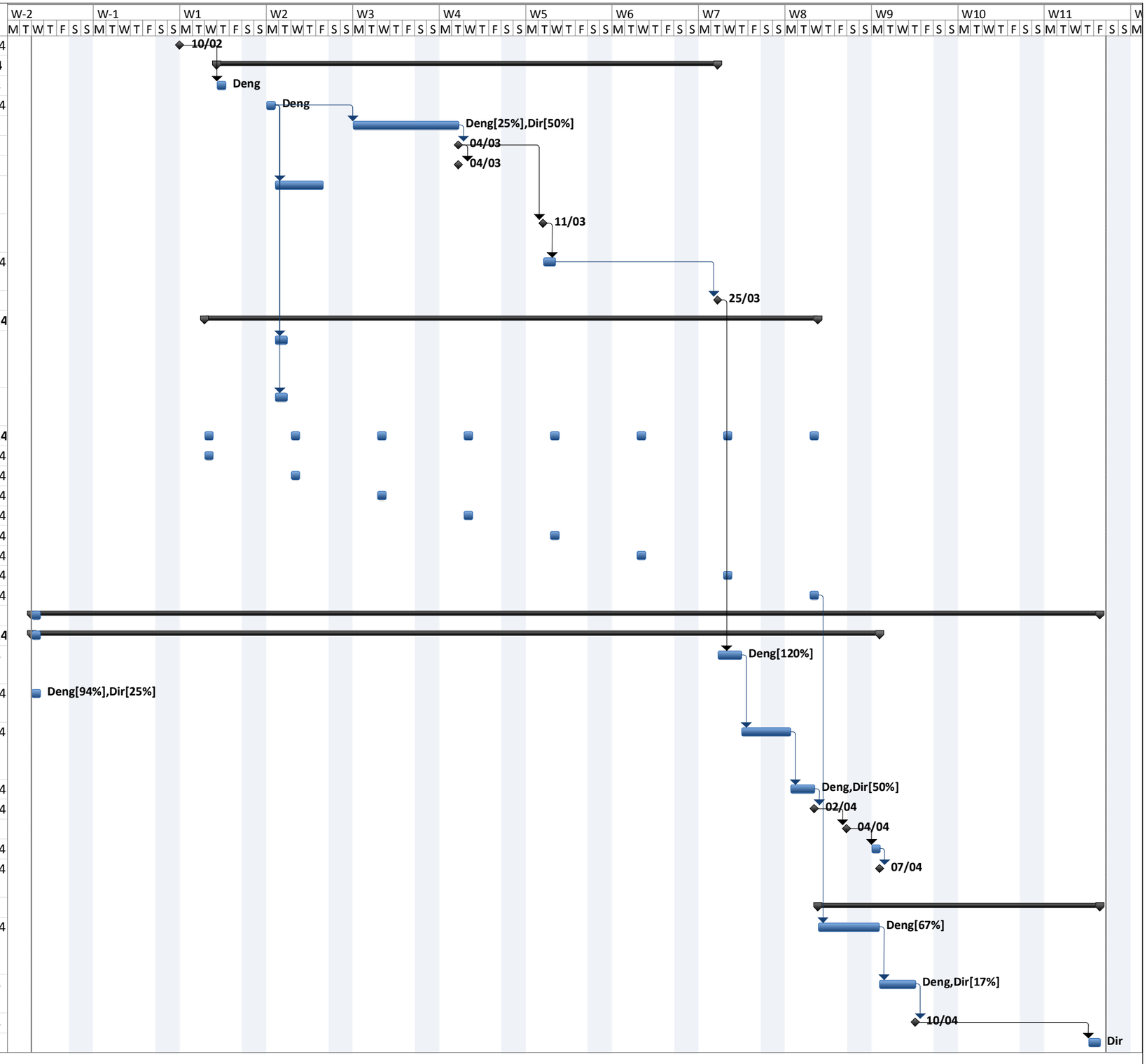


Appendix B- 12 Change in Ground Anchor Beam Level from construction to 14th February 2014 (Movement direction: Diff E: Easting, Diff N: Northing, Diff Z: Level).

APPENDIX C

OUTLINE PROGRAMME

ID	Task Mode	Task Name	Duration	Start	Finish
1		Undercliff 9- Woodlands	0 days	Mon 10/02/14	Mon 10/02/14
2		**Initial Site Review**	**30.47 days**	**Thu 13/02/14**	**Tue 25/03/14**
3		Site Visit	1 day	Thu 13/02/14	Thu 13/02/14
4		Site Visit	1 day	Mon 17/02/14	Mon 17/02/14
5		Prepare Failure Notice	7 days	Mon 24/02/14	Tue 04/03/14
6		Issue Action Plan to IR	0 days	Tue 04/03/14	Tue 04/03/14
7		Meeting IR	0 days	Tue 04/03/14	Tue 04/03/14
8		IR collate monitoring data	4 days	Mon 17/02/14	Fri 21/02/14
9		Finalise Action Plan and issue IR	0 days	Tue 11/03/14	Tue 11/03/14
10		Issue to IOW Council for review	1 day	Tue 11/03/14	Wed 12/03/14
11		Address IOW Comments	0 days	Tue 25/03/14	Tue 25/03/14
12		**Monitoring**	**38.33 days?**	**Wed 12/02/14**	**Wed 02/04/14**
13		Establish surface peg monitoring in landslide forward of site	1 day?	Mon 17/02/14	Tue 18/02/14
14		Establish surface monitoring in road	1 day?	Mon 17/02/14	Tue 18/02/14
15		**Monitoring**	**38.33 days**	**Wed 12/02/14**	**Wed 02/04/14**
16		1	1 day	Wed 12/02/14	Wed 12/02/14
17		2	1 day	Wed 19/02/14	Wed 19/02/14
18		3	1 day	Wed 26/02/14	Wed 26/02/14
19		4	1 day	Wed 05/03/14	Wed 05/03/14
20		5	1 day	Wed 12/03/14	Wed 12/03/14
21		6	1 day	Wed 19/03/14	Wed 19/03/14
22		7	1 day	Wed 26/03/14	Wed 26/03/14
23		8	1 day	Wed 02/04/14	Wed 02/04/14
24		**Failure Report (Cl 12.8)**	**66.67 days?**	**Wed 29/01/14**	**Fri 25/04/14**
25		**Interim Failure Report**	**52.2 days**	**Wed 29/01/14**	**Mon 07/04/14**
26		Review data up to failure	2 days	Tue 25/03/14	Thu 27/03/14
27		Interim monitoring review	1 day	Wed 29/01/14	Wed 29/01/14
28		Assess sensitivity/adequacy of existing solution	2 days	Thu 27/03/14	Mon 31/03/14
29		Prepare report	2 days	Mon 31/03/14	Wed 02/04/14
30		Issue to IR	0 days	Wed 02/04/14	Wed 02/04/14
31		Meeting with IR	0 days	Fri 04/04/14	Fri 04/04/14
32		Address IR comments	1 day	Mon 07/04/14	Mon 07/04/14
33		Issue to IOW Council for review	0 days	Mon 07/04/14	Mon 07/04/14
34		**Finalise report**	**17.67 days?**	**Wed 02/04/14**	**Fri 25/04/14**
35		Review monitoring and incorporate monitoring review	3 days	Wed 02/04/14	Mon 07/04/14
36		finalise assessment of existing	3 days	Mon 07/04/14	Thu 10/04/14
37		Issue Report	0 days	Thu 10/04/14	Thu 10/04/14
38		Meeting with IR	1 day?	Thu 24/04/14	Fri 25/04/14



Project: Undercliff 9 Notice programme
Date: Wed 04/06/14

Task	Summary	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only		
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Deadline		
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Progress		

APPENDIX 2:

Ramboll Report – Caravan Park Site 10, Undercliff Drive Geological Failure

Intended for
RINGWAY ISLAND ROADS

Document type
REPORT

Date
January 2014

ISLE OF WIGHT HIGHWAYS PFI

UNDERCLIFF SITE 10, CARAVAN PARK

GEOLOGICAL FAILURE REPORT

RAMBOLL

ISLE OF WIGHT HIGHWAYS PFI
UNDERCLIFF SITE 10, CARAVAN PARK
GEOLOGICAL FAILURE REPORT

Revision	**0**
Date	**09.01.2014**
Made by	
Checked by	
Approved by	
Description	**Report**
Ref	61030594/10/R02

Revision	Date	Purpose / Status	Document Ref.	Comments
3	04.06.2014	For review	61030594/10/R02	Incorporate IR comments
2	27.2.2014	For review	61030594/10/R02	Changed to Failure Notice. Added 12.11.1 requirements
1	21.01.2104	For review	61030594/10/R02	Incorporating IR comments
0	09.01.2014	For IR review	61030594/10/R02	

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CONTENTS

FIGURES

APPENDICES

1. INTRODUCTION

Geological failure of the landslide complex at *Undercliff Site 10 – Caravan Park* was first reported on 6th January 2014 after returning from the Christmas holiday period. Undercliff Site 10 is located at National Grid Reference 4522 0761 immediately adjacent to and west of the Caravan Park along Undercliff Drive (Figure 1). The site is 301 metres long and begins just to the west of the traffic lights and extends 115 metres east of the Caravan Park. The existing road was been reduced to single carriageway following a major land slippage event in 2001. Ground movement occurred in the winter 2012/13 prior to the award of the Highways PFI Contract. As a result of the 2012/13 ground movement Undercliff site 10 was prioritised, with work planned in the first year of the Highways PFI scheme. The Contract required the works to be carried out over the Winter Period. The scheme was designed and construction works at this site had begun on 28th November 2013. Construction works had progressed to partial excavation and removal of the westbound carriageway. The east bound lane remained open. Groundwater levels reached amber trigger levels on 23rd December 2013 and red trigger levels on 29th December 2013.

Following the initial notification a site inspection by Ramboll Geotechnical Engineer was carried out on 7th January 2014. A site inspection record is presented in Appendix A. This document was initially issued as a geological failure action plan, but now has been renamed the Failure Report as per Section 12.11.1 of the highways PFI contract, and additional sections added to cover the full requirements of a Failure Report.

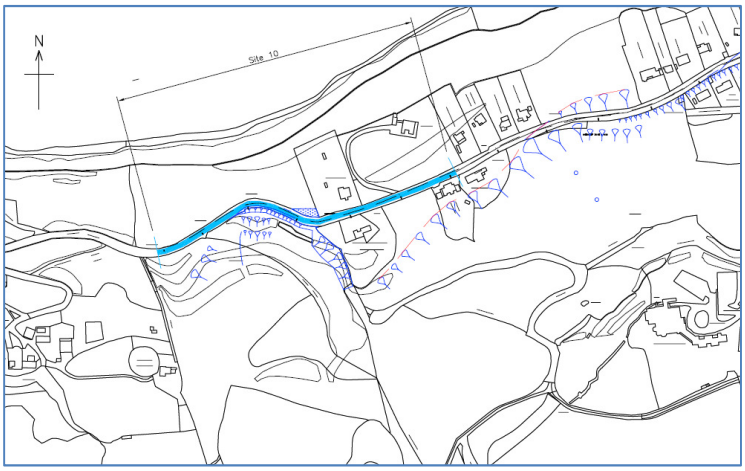

Figure 1 Undercliff Site 10 - Caravan Park Location Plan

The contract requires a Failure Report to include information as summarised in Table 1.

Failure Report Clause	Text	Reference in this Report
12.11.1.1	Updated and more detailed information of those matters contained in the Failure Notification and Failure Notice;	Section 1 and 2
12.11.1.2	A full and detailed explanation of the impact of the rectification, management and/or mitigation (as applicable) of the Red Zone Failure.	Section 3
12.11.1.3	A full and detailed explanation of how the OpCo has made the affected Project Network Parts and its surroundings safe to the public (including the remediation of all Category 1 Defects in accordance with the provisions of Schedule 2 (*Output Specification*)).	See Island Roads report
12.11.1.4	A full and detailed explanation of what further actions the OpCo is to undertake (including any inspections, tests, surveys and/or assessments in order to determine the full extent of the Red Zone Failure, Amber Zone Failure and/or Geological Failure);	Section 4 and 5
12.11.1.5	A full and detailed explanation of how the OpCo proposes to rectify, manage and/or mitigate (as appropriate) the Red Zone Failure, Amber Zone Failure and/or Geological Failure (**"Proposed Failure Solution"**) which shall, where the OpCo believes no action is required, provide a full explanation of the reasons for such belief, including any implications arising from taking no action.	Section 6 and 7
12.11.1.6	An estimate of the total amount of Failure Costs which the OpCo shall calculate acting reasonably (including all Failure Costs incurred up to the issue of the Failure Report) required to carry out the Proposed Failure Solution, together with documentary evidence such as full bills of quantity where practicable.	See Island Roads report
12.11.2	The OpCo shall at the same time as submitting the Failure Report, amend and submit to the Service Provider pursuant to Schedule 20 (*Review Procedure*) any OpCo Programmes affected by the Proposed Failure Solution.	See Island Roads report

Table 1 Summary of Failure Report Information

2. INITIAL OBSERVATIONS OF LANDSLIDE FAILURE/ BEHAVIOUR

2.1 Site Inspection

The site inspection note in Appendix A describes the observations made during the site visit. The main points from the site inspection are:

- The existing landslide from the sea to the Undercliff Site 10 has been remobilised.

- Existing and multiple new tension cracks have developed within the undercliff carriageway.
- The form of the landslide varies making it difficult from site observations to ascertain relative movement, but where visible surface effects appear more severe lower down the complex. At the time of the inspection ground movement comprised opening of tension cracks in the road, whereas metre scale ground movement is evident approximately 70 to 80 metres downslope of the site.
- The tension cracks in the existing road are opening in response to the movement further downslope.
- The movement is understood to have started around Christmas 2013.
- There has been loss of ground at the seaward end of the landslide complex through sea erosion during the stormy weather.
- Surface water on the landslide complex is significantly higher and more extensive than that observed during site visits carried out during the tender period (2010, 2011 and 2013) and during the design period (2013).
- Construction work had involved excavation and removal of the westbound carriageway; unloading the top of a landslide is beneficial to overall stability. In addition, the size of the excavation relative to the landslide is very small.

2.2 Historical Landslide Behaviour

Over the last ten years there have been three significant ground movement events at the Undercliff Site 10 Caravan Park. In 2001 a prolonged period of wet weather caused a major landslide. The rear extent of this landslide reached Undercliff Drive and the area of land adjacent to the road occupied by the Caravan Park. This event resulted in a number of large tension cracks developing and subsequently this section of the west bound carriageway was closed. A single carriageway and traffic light system was installed.

Subsequent to previous large scale ground movements along the Undercliff, a landslide forecast model was developed for the Undercliff by High-Point Rendel in 1996 based on the work by Lee et al (1991)[1]. In order to try and predict the likelihood of future movements along the Undercliff, data was collected concerning the occurrence and location of previous landslides and the volume of rainfall preceding them. The model gave a threshold value of effective rainfall (the percentage of total rainfall that enters the ground) over a preceding 4 month period which would be likely to cause instability or increased ground movement rates within the Undercliff landslide complex. When comparing the occurrence of previous landslide events with the corresponding 4 month antecedent effective rainfall (4AER) value it appears to correlate with ground movement events with a good degree of accuracy (Figure 2). Once the 4AER drops back to below the threshold value the likelihood of further movements at that point in time is reduced. The Isle of Wight Council has employed this model in order to aid in assessing the likelihood of ground movements in areas throughout the Undercliff. Table 2 summarises the trigger threshold values. This placed the rainfall during February and March 2014 as Class 3, and at risk of major instability.

Landslide Forecast Class			
Class	Trigger Value (4AER mm)	Location	
		Major	Minor
Class 1	< 410	Blackgang	The landslip, Luccombe,

			Mirables
Class 2	410 - 540	The landslip, Luccombe, Mirables, Blackgang	Woodlands
Class 3	540 - 640	ALL	Bonchurch, Ventnor, St Lawrence
Class 4	>640	ALL	ALL

Table 2 Summary of Landslide Forecast Trigger Values based on rainfall

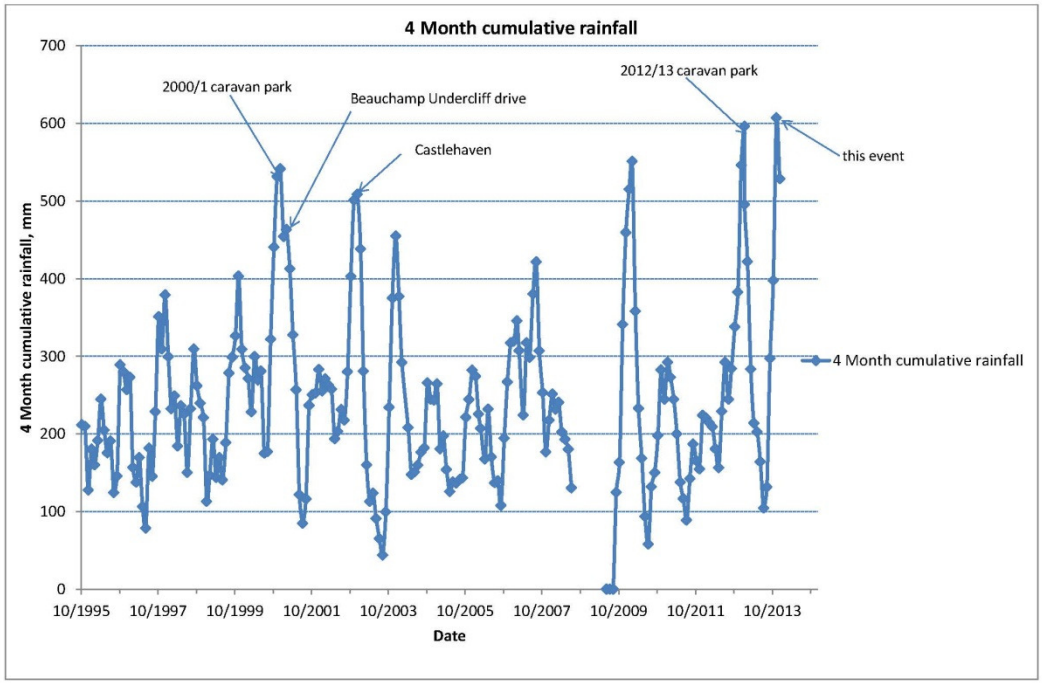

Figure 2 Four Month Moving Average Rainfall and Landslide Events

In December 2012 another period of heavy rainfall caused new cracks to develop in the open east bound carriageway and extension of those already present on the west bound side. During similar heavy rainfall in December 2013/January 2014 significant ground movements occurred throughout the area of the 2001 landslide characterised by the opening of large tension cracks across the adjacent footpath, very slow moving clay flows (within the landslide and down to the beach at Binnel Bay) and a number of fallen trees. Movement was also evident on the carriageway with the extension and propagation of the tension cracks in the west bound carriageway.

A location of the available monitoring points is shown in Figure 3, which comprise piezometers installed at a range of depths to monitor groundwater, and inclinometers to 50 metres depth to measure ground movement.

Records of ground instrumentation are presented in Appendix B.

During the 2012/13 landslide event surface ground markers were installed in Undercliff Site 10 and the adjacent Site 9 Woodlands. A summary of the records from this is presented in Appendix C. Surface movement of the road continued up to last available record that was taken in 14/3/2013.

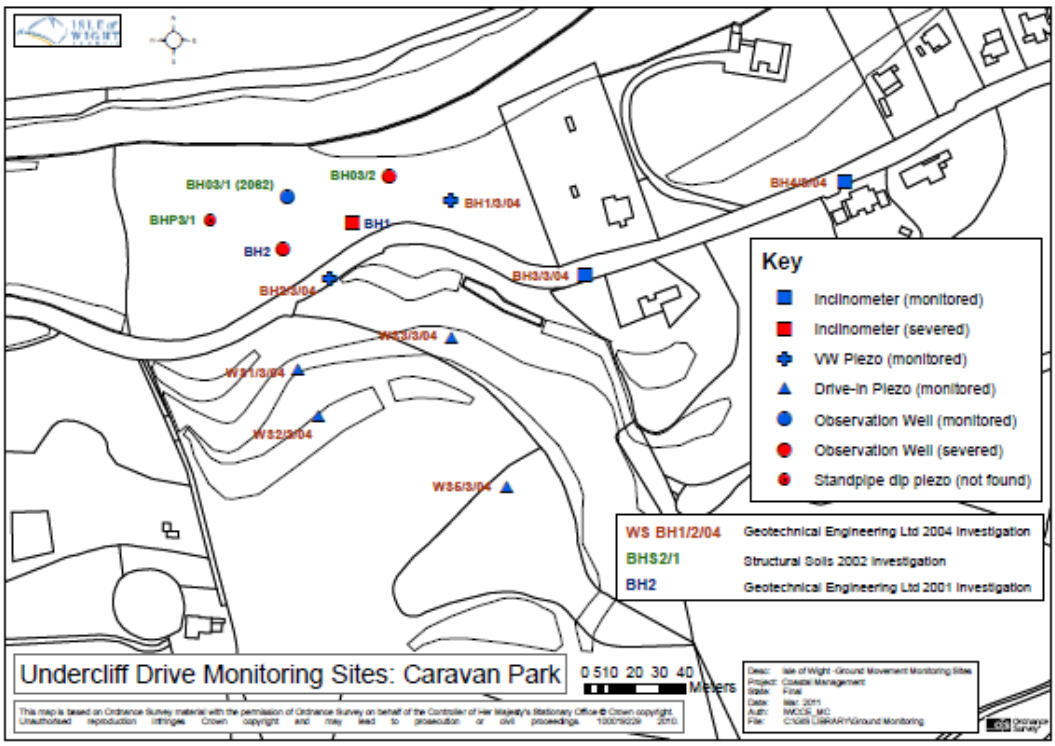

Figure 3 Undercliff Drive Site 10 Monitoring Location Plan

Observations from monitoring data:

- Ground water levels have been and remain above set trigger levels for movement (see Piezometer 2062 plot). The amber level was reached on 23rd December and the Red trigger level on 29th December 2013.
- Ground water levels are much higher than levels at the same time after heavy rain the previous year over December 2012/January 2013 and exhibit a rapid rise beginning around 17th December 2013.
- The four monthly cumulative rainfall preceding this landslide event exceeds those that triggered landslide events in 2001, and 2012/13.
- The groundwater regime is complex, and deeper piezometers have lower associated groundwater pressures, however they do show increases in response to rainfall
- Inclinometer readings showed ground movement over a period of approximately 4 months during the 2012/13 event; this was initially relatively rapid, and then reduced in its rate as the landslide complex found its next resting position.
- In the 2012/13 event surface movement on the carriageway continued to at least the middle of March 2013, three and a half months after its initiation.
- The full effects of the recent and continued heavy rainfall may have not fully expressed themselves in the landslide groundwater regime and movement at and forward of the Undercliff Site 10- Caravan Park during this current landslide event to date.

- The Amber and Red Trigger levels previously established in Piezometer 2062 differ by only 5 cm

3. IMPLICATIONS OF FAILURE

- A geological failure has occurred prior to implementing the proposed stabilisation works.
- Construction works began on 28th November 2013.
- Groundwater levels have risen and amber trigger levels were reached on 23rd December 2013 and red alert levels on 29th December 2013. On reaching the amber levels groundwater levels rose sharply.
- Ground movement was first reported on 6th January after returning from the Christmas period.
- Ground movement is most probably continuing and likely to continue for a period of months.
- It is possible that the full effects of rainfall and movement of the toe of the landslide complex have not fully expressed themselves at the site to date.
- The current geotechnical solution cannot be implemented within a moving mass for reasons of both safety and adequacy/effectiveness.
- The sensitivity of the current proposal to landslide movement (geological failure) seaward of the site was considered at the design stage. This indicated that proposal was sensitive to ground loss due to landsliding seaward of the site.
- A range of options, including dewatering, were considered during the tender process. However, this was not taken forward due to environmental constraints
- It is likely that the current solution will be inadequate in its current form. Depending on the actual recorded movement over the next few months it is likely only to return the site to its original stability condition and no better than its 2012/2013 condition i.e. at the point of failure. It is considered most likely that additional measures will be required.

4. INTERIM MEASURES

A large scale geological failure has been initiated with groundwater pressures providing the main driving mechanism. The following measures have been carried out:

- Following failure the site works included trimming of site levels, and demobilising.
- Consideration was given to managing surface water; sealing cracks was attempted but as the cracks were developing they opened again.
- Covering the surface was considered to control rain infiltration however this was not carried out as the driving mechanism for the failure was subsurface groundwater, and surface disposal would be downslope back into the moving landslide. There were health and safety concerns with placing surface covering as this would mask any developing landslide features. Covering the surface cracks was assessed to have negligible benefit as rising groundwater levels were and remain the driving mechanism.

- The road has been closed to vehicular access as the geological failure has left 1.2 metres wide remnant of the eastbound carriageway.

5. INFORMATION TO ASSESS EXTENT OF GEOLOGICAL FAILURE

The following information and actions have been implemented to assess the extent of the geological failure.

- Review remediation proposals given the revised site conditions
- Continue to collect all monitoring data available to date and rainfall data
- Increase frequency of inclinometer readings to fortnightly
- Monitor surface points in road surface at weekly intervals
- Monitor width of cracks in road surface at weekly intervals
- Likely period of monitoring 4 months but continue with monitoring with interim reviews say at monthly intervals
- Resurvey the ground surface seaward of the site along the same cross section as that carried out during the design to establish the change in ground profile once the landslide event is complete
- Carry out reviews of monitoring data with Island Roads to assess continuation of movement

6. ESTIMATE FOR TIME FRAME FOR GEOLOGICAL FAILURE RECTIFICATION

At the time of preparing this report the full extent of the landslide and its effect on Undercliff Drive Site 10 has not been fully realised. Since the first issue of this report ground movement has continued. As a result a full programme for rectification of the red site has not been developed at this stage; this is dependent on the length of time ground movement continues. It is likely that movement will continue until groundwater levels drop to below trigger levels for ground movement. A timeframe for rectification but will be developed subsequent to this failure report (or as to be agreed with the Isle of Wight Council). The initial outline programme of the proposed actions which have now been completed is given in Appendix C.

7. ESTIMATE OF FAILURE COST

An estimate of failure cost has not been established as the geological failure is still continuing. Given the movement that has occurred the current ground anchor solution is no longer suitable. If the road is to remain in its current alignment then significant fill would be required to raise the road back to an acceptable alignment. Remedial measures, if they were deemed possible, are likely to use a combination of techniques, and most likely include as one of the components deep wells to control groundwater levels. Groundwater control was initially proposed by Island Roads during the tender, however subsequently not taken forward due to environmental restrictions associated with the site.

REFERENCES

Lee E M and Moore R 1991. Coastal Landslip Potential Assessment: Isle of Wight Undercliff, Ventnor. Report to the DoE.

APPENDIX A

SITE INSPECTION RECORD

RECORD OF SITE VISIT

JOB TITLE	IOW PFI	JOB NO.	61030594
DATE	10/01/2014	FILE REF.	GEOTECHNICAL
VISIT TO	UNDERCLIFF SITE 10	BY	ROSS ADAMS
MET	KIERON BLAMEY, MADELINE CLEWETT	CIRCULATION	DAVID GIBBY, BOB BINDER
PURPOSE	TO INSPECT UNDER CLIFF SITE 10 FOLLOWING RECENT GROUND MOVEMENT		

Notes of Site Inspection 7th January 2014

I attended the Undercliff site 10 on Tuesday 7th January 2014 following reports that there had been movement of the Ventnor landslide complex over the Christmas period.

I arrived at 10:15am and met with Kieron Blamey and Madeline Clewett from Island Roads, as well as a representative from John Peck Construction. Kieron informed me that he had heard from the owner of the caravan park that movement had begun after Christmas. Kieron had walked down the footpath on Boxing Day and the footpath was intact. No work had been carried out on site since 20th December and the westbound lane remained in a state of partial excavation. An excavator was removing material from the excavation during my visit in an effort to unload the slope, but this stopped later on in the afternoon and has not been resumed.

We began by walking down the footpath from the western end of the site, following it all the way down to the beach. The walk down was used to familiarise ourselves with the extent and direction of the movement, as well to see if there were any signs of movement at the toe of the landslide. Madeline informed us that is was difficult to see any signs of movement at the toe of the landslide, as it creeps forward and is constantly being eroded by the sea. There is likely to have been significant toe erosion in the weeks preceding the site visit due to the stormy seas that were prevalent during that time. There were no visible signs of movement in the lower half of the landslide. It is expected that this is because this section is creeping forward as a degraded mass with little differential movement between blocks. We were able to orientate ourselves with the site by looking up and seeing the arm of the excavator that was working at road level.

On the way back up, I mapped the tension cracks and failures that were visible from the footpath as accurately as possible. The footpath winds its way down the landslide following the top of the scarp slopes, and so the damage to the path was very visible. Movement was seen from approximately halfway up the landslide all the way to the road, with the most severe movements occurring lowest down the landslide. Movement tended to be shown as large cracks with large drops in the ground surface lower down the landslide, and as developing tension cracks as you moved closer towards road level. Tension cracks up to 1m wide were seen in the lower slopes, with a change in height of up to 1m (Photo 1). As we progressed up the footpath, there were areas where a number blocks had formed, with an approximate height difference of 1m between blocks (Photo 2). Just below the level of the road large tension cracks were evident in the footpath, with up to 300mm differential movement (Photo 3).

At road level, a long tension crack was evident in the excavation made for the installation of the anchor blocks (Photo 4). From the western end of the site the crack followed the curve in the road at the base of the temporary cut, and then turned downslope before the caravan park (Photo 5). A total of seven tension cracks had appeared in the road surface. The longest two, approximately 10m and 15m long respectively, are cracks that have re-opened having previously been sealed. Differential movement is 20mm. The remaining cracks are generally all new cracks in the road surface, and not in the same location as a historic crack (Photo 6).

Following the site visit a conference call was held between Ramboll and Island Roads on Wednesday 8th January to discuss the landslide and any resulting action. It was agreed that no work is to be carried out at Site 10 until a full review of the available data has been completed, including stability analyses to assess the adequacy and effectiveness of the ground anchor solution with the landslide in its current form. It is expected that further ground movements will occur over the course of the next few months, as the groundwater level responds to the recent very heavy rainfall.

Following completion of this site visit report the following actions are required;

RECORD OF SITE VISIT

JOB TITLE	IOW PFI	JOB NO.	61030594
DATE	10/01/2014	FILE REF.	GEOTECHNICAL
VISIT TO	UNDERCLIFF SITE 10	BY	ROSS ADAMS
MET	KIERON BLAMEY, MADELINE CLEWETT	CIRCULATION	DAVID GIBBY, BOB BINDER
PURPOSE	TO INSPECT UNDER CLIFF SITE 10 FOLLOWING RECENT GROUND MOVEMENT		

- Programme for work drawn up
- Review of monitoring data (piezometers and inclinometers)
- Review of movement of landslide
- Stability analysis carried out of landslide in current form
- Analyses to determine the adequacy and effectiveness of the proposed ground anchor solution.

Photograph notes

Refer to sketch for locations (locations are approximate).

Photo 1.

Taken approximately 80 metres seaward of the site. This shows the edge of the landslide, where surface vegetation has been pulled downslope due to landslide movement. Lateral displacement estimated to be at least 2 metres

Photo 2
Severe tension crack development disrupting the existing footpath approximately 70 metres seaward of the site. Cumulative affects 1 to 2 metres relative vertical displacement.

Photo 3
Tension crack within existing footpath 20 to 30 metres seaward of the site

Photos 4 , 5 and 6

Tension cracks within the construction area.

RECORD OF SITE VISIT

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PURPOSE	TO INSPECT UNDER CLIFF SITE 10 FOLLOWING RECENT GROUND MOVEMENT		

Photographs

Photo 1

Photo 2

Photo 3

RECORD OF SITE VISIT

JOB TITLE	IOW PFI	JOB NO.	61030594
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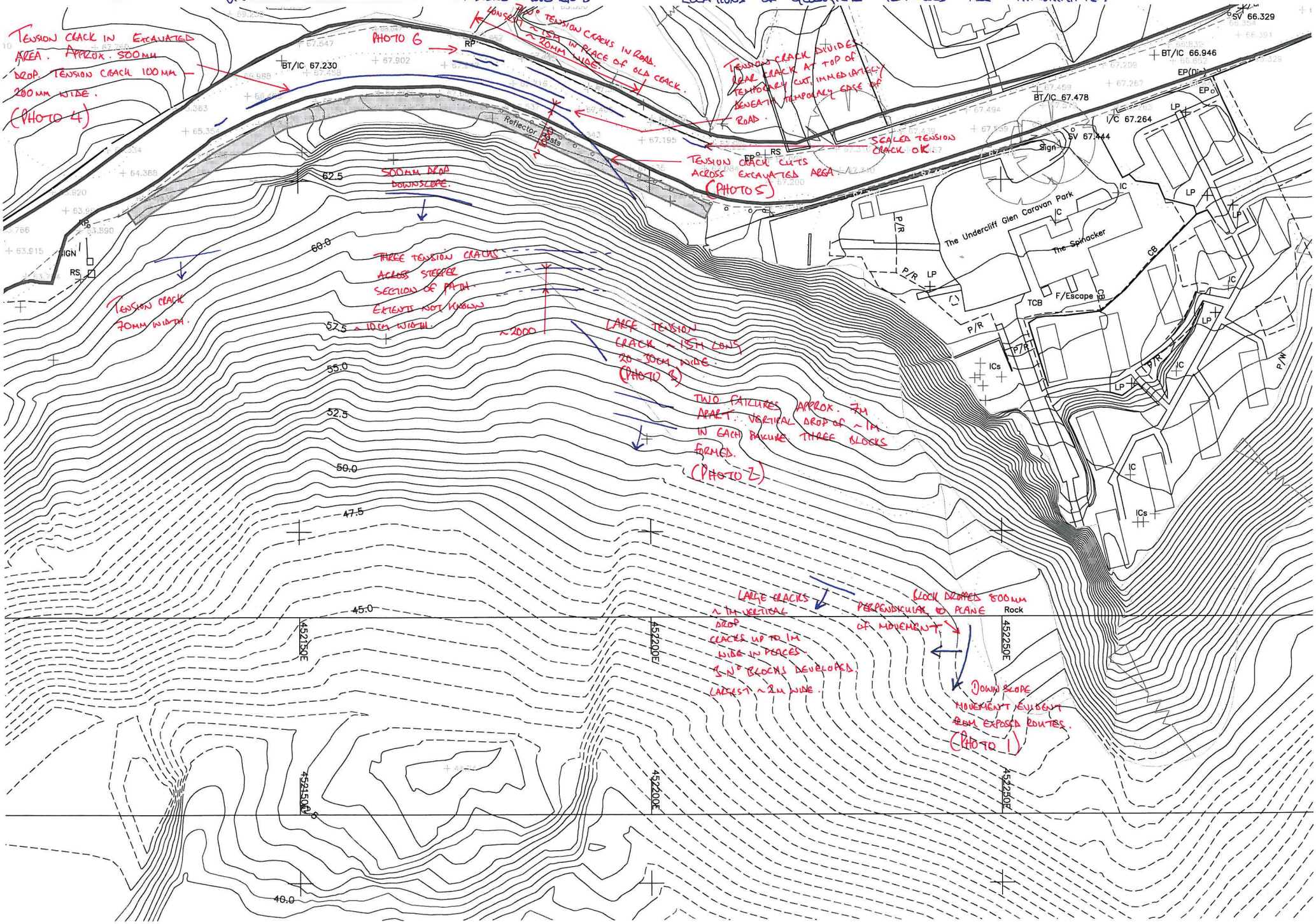
PURPOSE	TO INSPECT UNDER CLIFF SITE 10 FOLLOWING RECENT GROUND MOVEMENT		

Photo 4

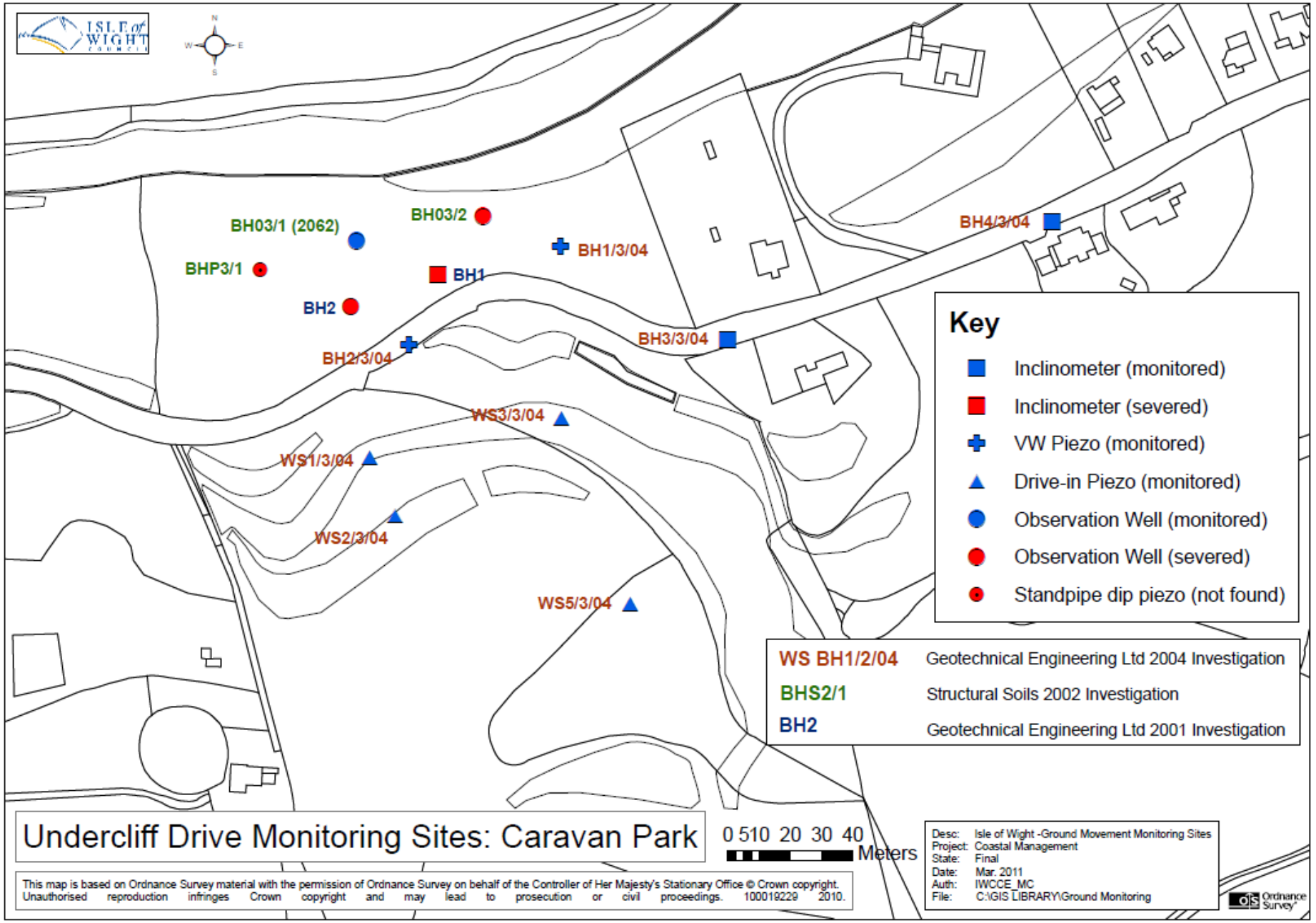
Photo 5

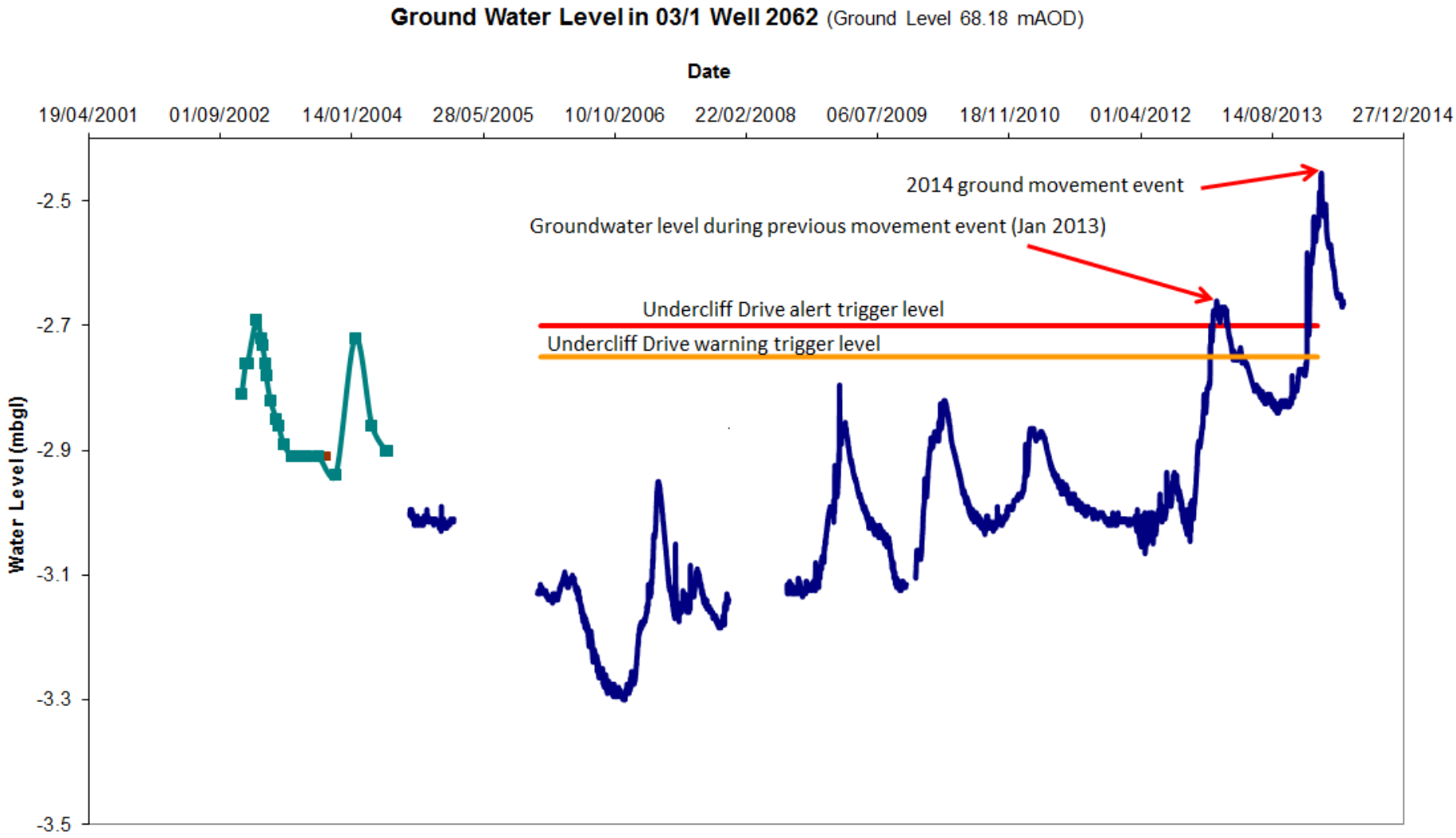
Photo 6


UNDERCLIFF DRIVE - SITE 10 - LANDSLIDE MOVEMENT
LOCATIONS OF GEOLOGICAL FEATURES ARE APPROXIMATE.
TENSION CRACK IN EXCAVATED AREA. APPROX. 500MM DROP. TENSION CRACK 100MM - 200MM WIDE. (PHOTO 4)
PHOTO 6
LONGER TWO TENSION CRACKS IN ROAD. ~15M IN PLACE OF OLD CRACK. ~20MM WIDE.
TENSION CRACK DIVIDES LEAD CRACK AT TOP OF TEMPORARY CUT, IMMEDIATELY BENEATH TEMPORARY CASE OF ROAD.
SCALED TENSION CRACK OK.
TENSION CRACK CUTS ACROSS EXCAVATED AREA. (PHOTO 5)
500MM DROP DOWNSLOPE.
THREE TENSION CRACKS ACROSS STEEPER SECTION OF PATH. EXTENTS NOT KNOWN
~2000
~10CM WIDTH.
TENSION CRACK 70MM WIDTH.
LARGE TENSION CRACK ~15M LONG 20-30CM WIDE. (PHOTO 3)
TWO FRACTURES APPROX. 7M APART. VERTICAL DROP OF ~1M IN EACH FRACTURE THREE BLOCKS FORMED. (PHOTO 2)
LARGE CRACKS ~1M VERTICAL DROP CRACKS UP TO 1M WIDE IN PLACES 3 NO° BLOCKS DEVELOPED LARGEST ~2M WIDE.
BLOCK DROPPED 800MM PERPENDICULAR TO PLANE OF MOVEMENT.
DOWN SLOPE MOVEMENT EVIDENT FROM EXPOSED ROOTES. (PHOTO 1)
BT/IC 67.230
BT/IC 67.478
BT/IC 66.946
I/C 67.264
SV 67.444
SV 66.329
EP(Dis)
EP
LP
RP
RS
IC
ICs
IGN
TCB
F/Escape
CB
P/R
Sign
Reflector Posts
The Undercliff Glen Caravan Park
The Spinnacker
Rock
62.5
60.0
57.5
55.0
52.5
50.0
47.5
45.0
40.0
452150E
452200E
452250E

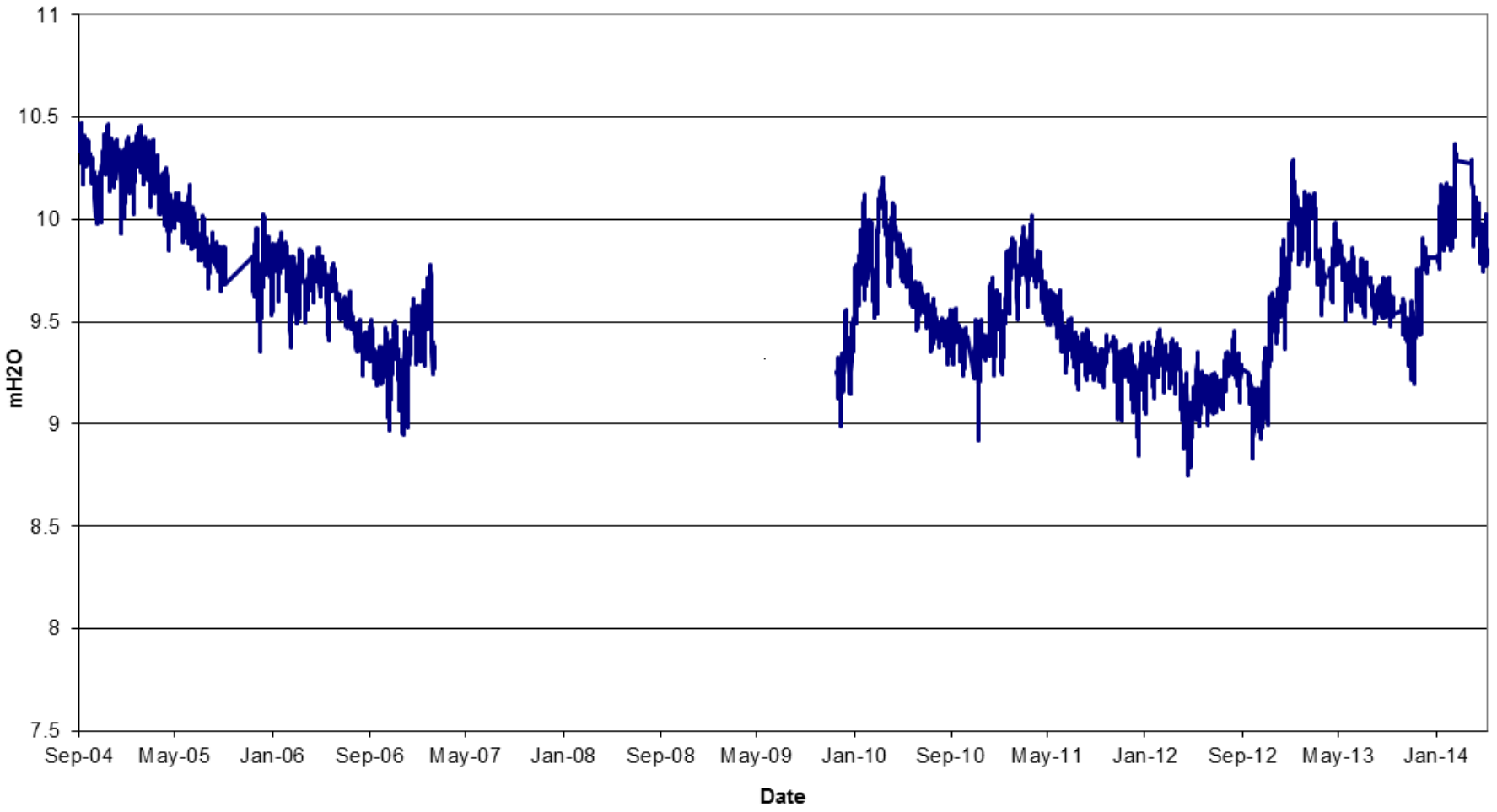
APPENDIX B

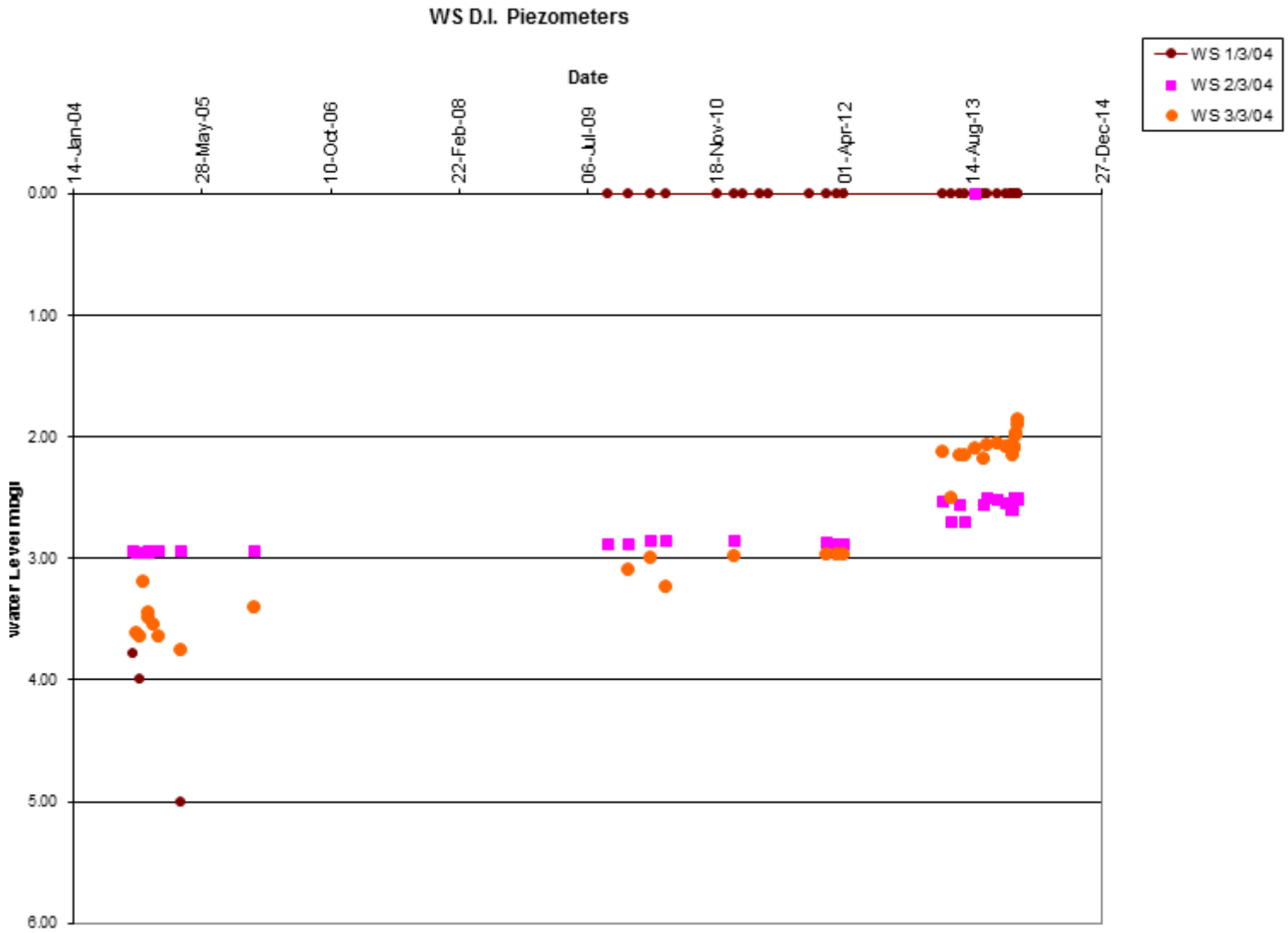
SUMMARY OF GROUND MONITORING DATA

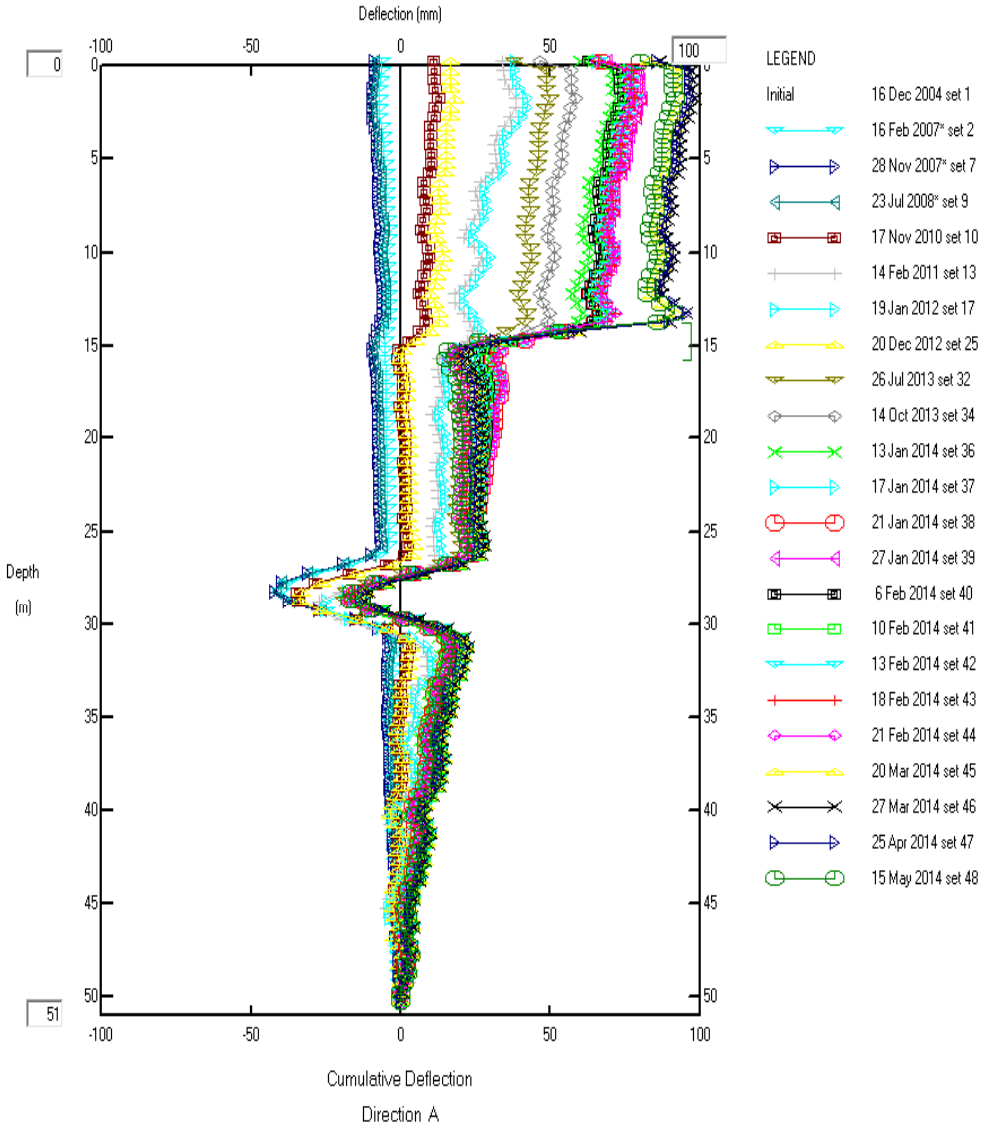

BH03/1 (2062)
BH03/2
BH1/3/04
BH4/3/04
BHP3/1
BH1
BH2
BH3/3/04
BH2/3/04
WS3/3/04
WS1/3/04
WS2/3/04
WS5/3/04
Key
Inclinometer (monitored)
Inclinometer (severed)
VW Piezo (monitored)
Drive-in Piezo (monitored)
Observation Well (monitored)
Observation Well (severed)
Standpipe dip piezo (not found)
WS BH1/2/04 Geotechnical Engineering Ltd 2004 Investigation
BHS2/1 Structural Soils 2002 Investigation
BH2 Geotechnical Engineering Ltd 2001 Investigation
Undercliff Drive Monitoring Sites: Caravan Park
0 5 10 20 30 40
Meters
This map is based on Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationary Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. 100019229 2010.
Desc: Isle of Wight -Ground Movement Monitoring Sites
Project: Coastal Management
State: Final
Date: Mar. 2011
Auth: IWCCE_MC
File: C:\GIS LIBRARY\Ground Monitoring
Ordnance Survey

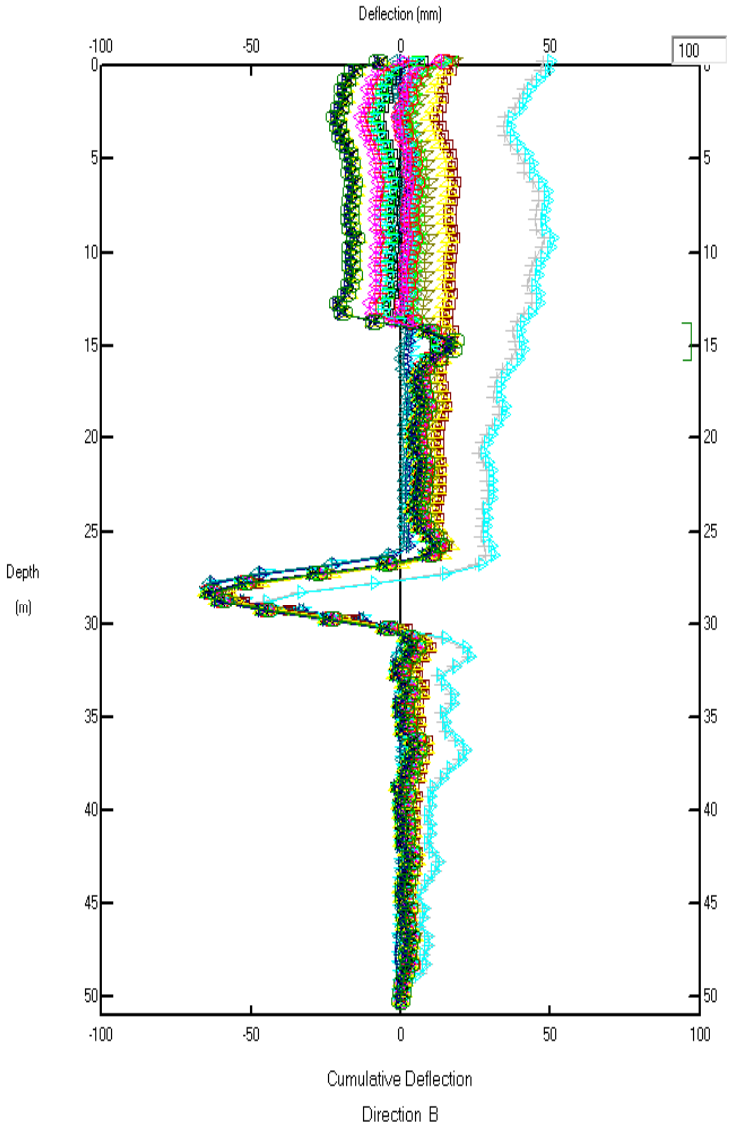

Ground Water Level in 03/1 Well 2062 (Ground Level 68.18 mAOD)
Date
19/04/2001
01/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
Water Level (mbgl)
-2.5
-2.7
-2.9
-3.1
-3.3
-3.5
2014 ground movement event
Groundwater level during previous movement event (Jan 2013)
Undercliff Drive alert trigger level
Undercliff Drive warning trigger level

BH 1.3.04 VW1 at 15.5 mbgl

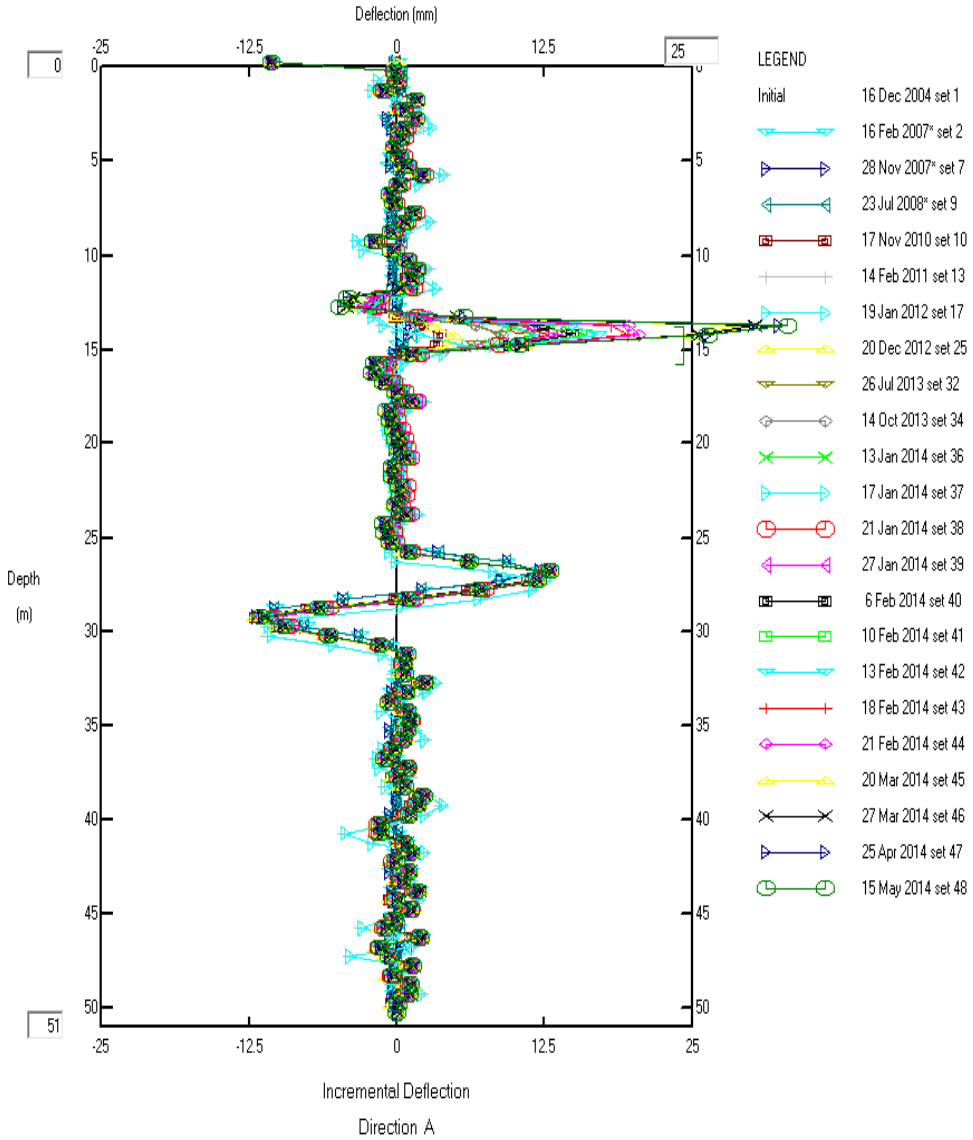


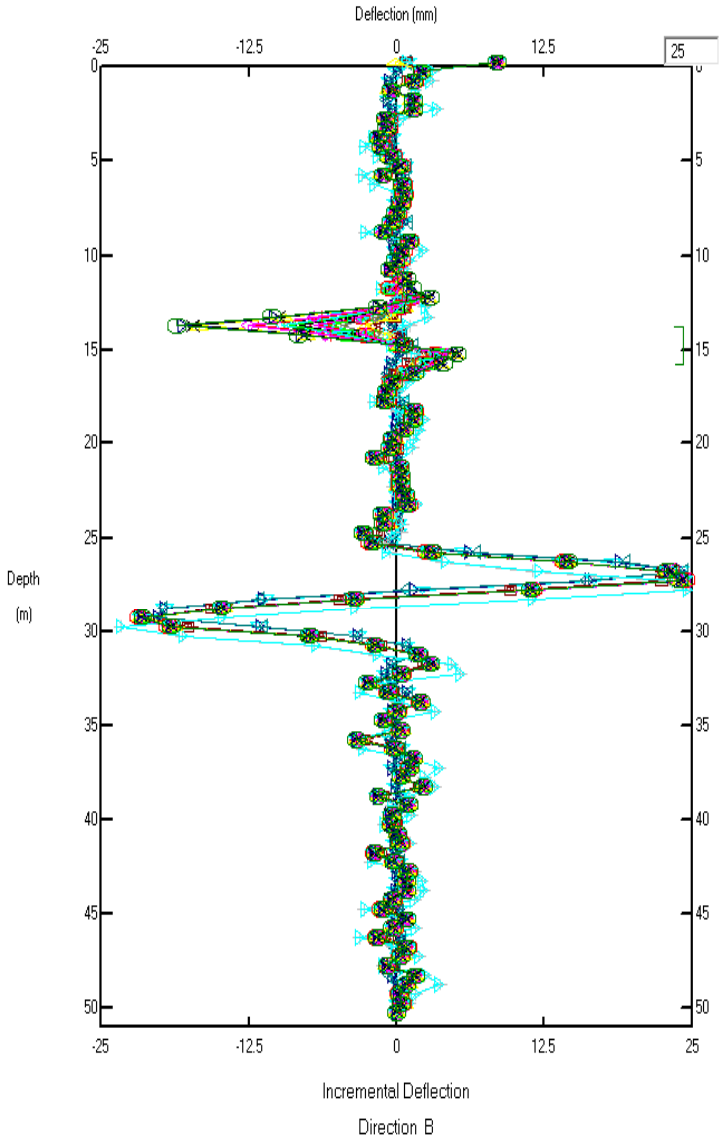

WS D.I. Piezometers
Date
14-Jan-04
28-May-05
10-Oct-06
22-Feb-08
06-Jul-09
18-Nov-10
01-Apr-12
14-Aug-13
27-Dec-14
0.00
1.00
2.00
3.00
4.00
5.00
6.00
WS 1/3/04
WS 2/3/04
WS 3/3/04



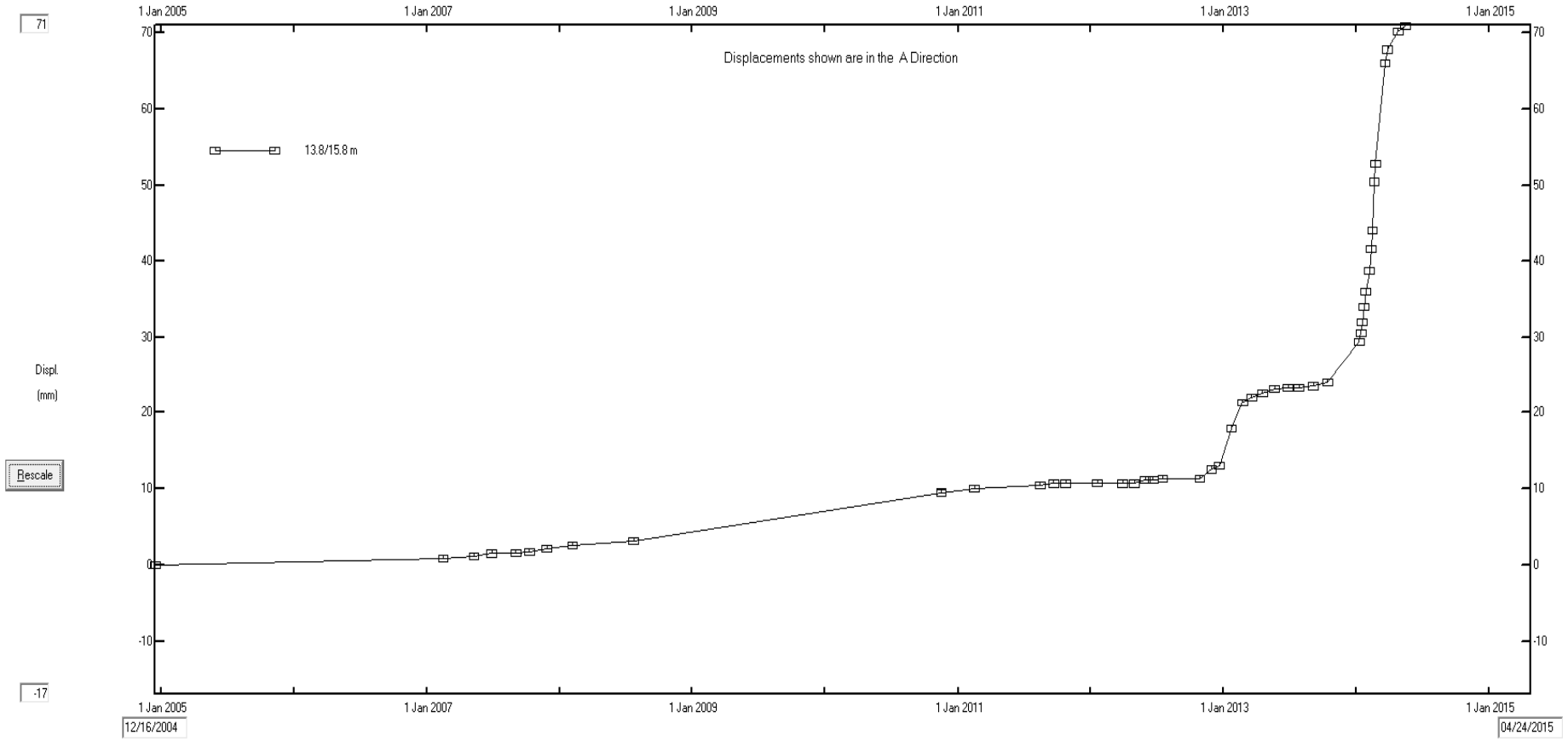


, Inclinometer 3304





, Inclinometer 3304

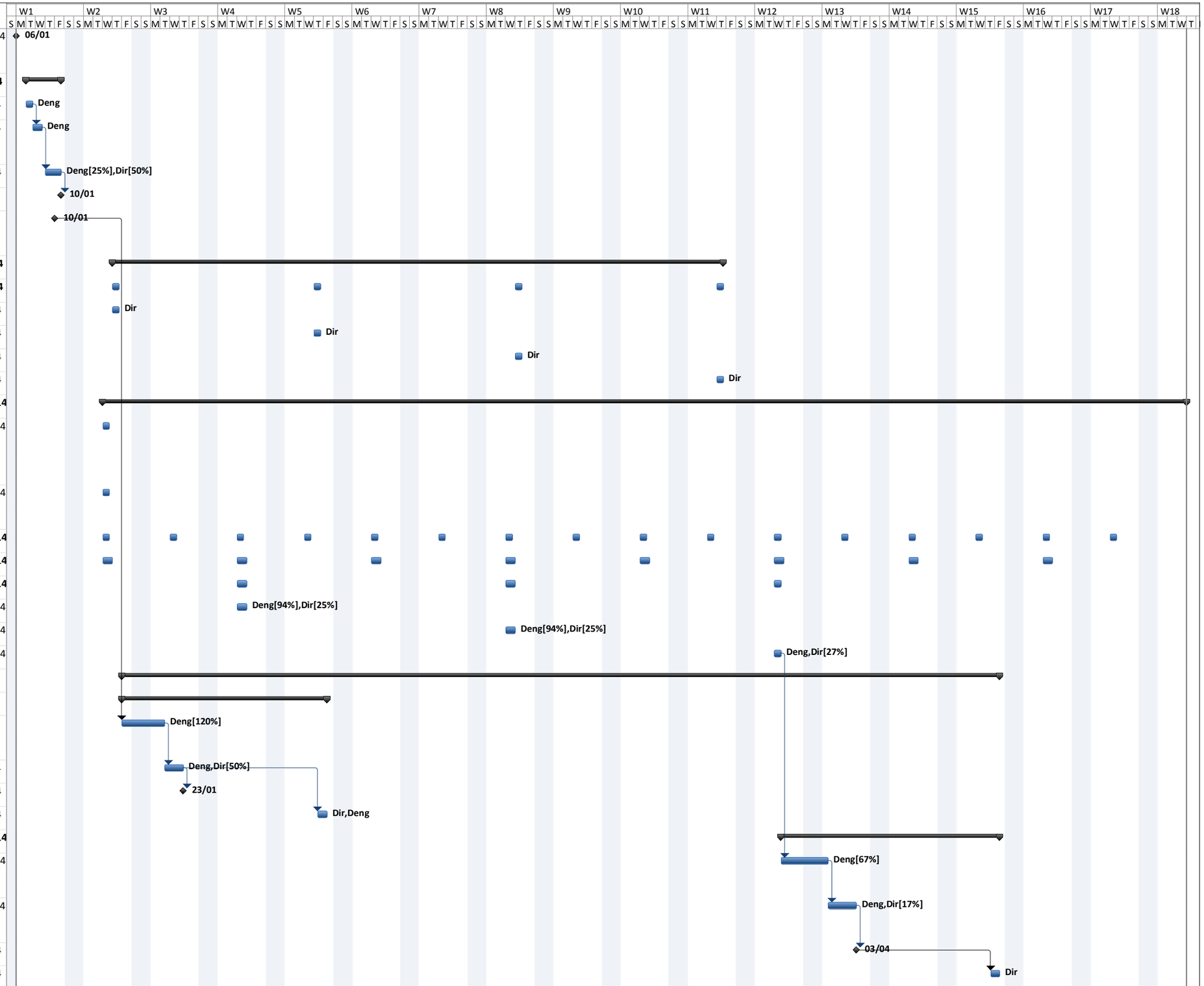


, Inclinometer 3304

APPENDIX C

PROGRAMME OF COMPLETED ACTIONS

ID	Task Mode	Task Name	Duration	Start
1		Undercliff Site 10- Caravan Park	0 days	Mon 06/01/14
2		**Initial Site Review**	**4.13 days**	**Tue 07/01/14**
3		Site Visit	1 day	Tue 07/01/14
4		Site Inspection report (factual)	1 day	Tue 07/01/14
5		Prepare Action Plan	2 days	Thu 09/01/14
6		Issue Action Plan to IR	0 days	Fri 10/01/14
7		Request Additional information	0 days	Fri 10/01/14
8		**Meetiings**	**49 days**	**Thu 16/01/14**
9		**IR**	**49 days**	**Thu 16/01/14**
10		IR 1	1 day	Thu 16/01/14
11		IR 2	1 day	Thu 06/02/14
12		IR 3	1 day	Thu 27/02/14
13		IR 4	1 day	Thu 20/03/14
14		**Monitoring**	**86.4 days?**	**Wed 15/01/14**
15		Establish surface peg monitoring in landslide forward of site	1 day?	Wed 15/01/14
16		Establish surface monitoring in road	1 day?	Wed 15/01/14
17		**monitor road surface**	**81.07 days**	**Wed 22/01/14**
34		**monitor inclinometers**	**75.73 days**	**Wed 15/01/14**
43		**interim monitoring review**	**65.07 days**	**Wed 29/01/14**
44		1	1.07 days	Wed 29/01/14
45		2	1.07 days	Wed 26/02/14
46		3	1 day	Wed 26/03/14
47		**Failure Report (Cl 12.8)**	**69.87 days?**	**Fri 17/01/14**
48		**Interim Failure Report**	**16.17 days?**	**Fri 17/01/14**
49		Review data up to failure	2.5 days	Fri 17/01/14
50		Prepare Report	2 days	Tue 21/01/14
51		Issue to IR	0 days	Thu 23/01/14
52		Meeting with IOW	1 day?	Thu 06/02/14
53		**Finalise report**	**17.67 days?**	**Wed 26/03/14**
54		Incorporate monitoring reviews	3 days	Wed 26/03/14
55		finalise assessment of existing	3 days	Mon 31/03/14
56		Issue Report	0 days	Thu 03/04/14
57		Meeting with IOW	1 day?	Thu 17/04/14

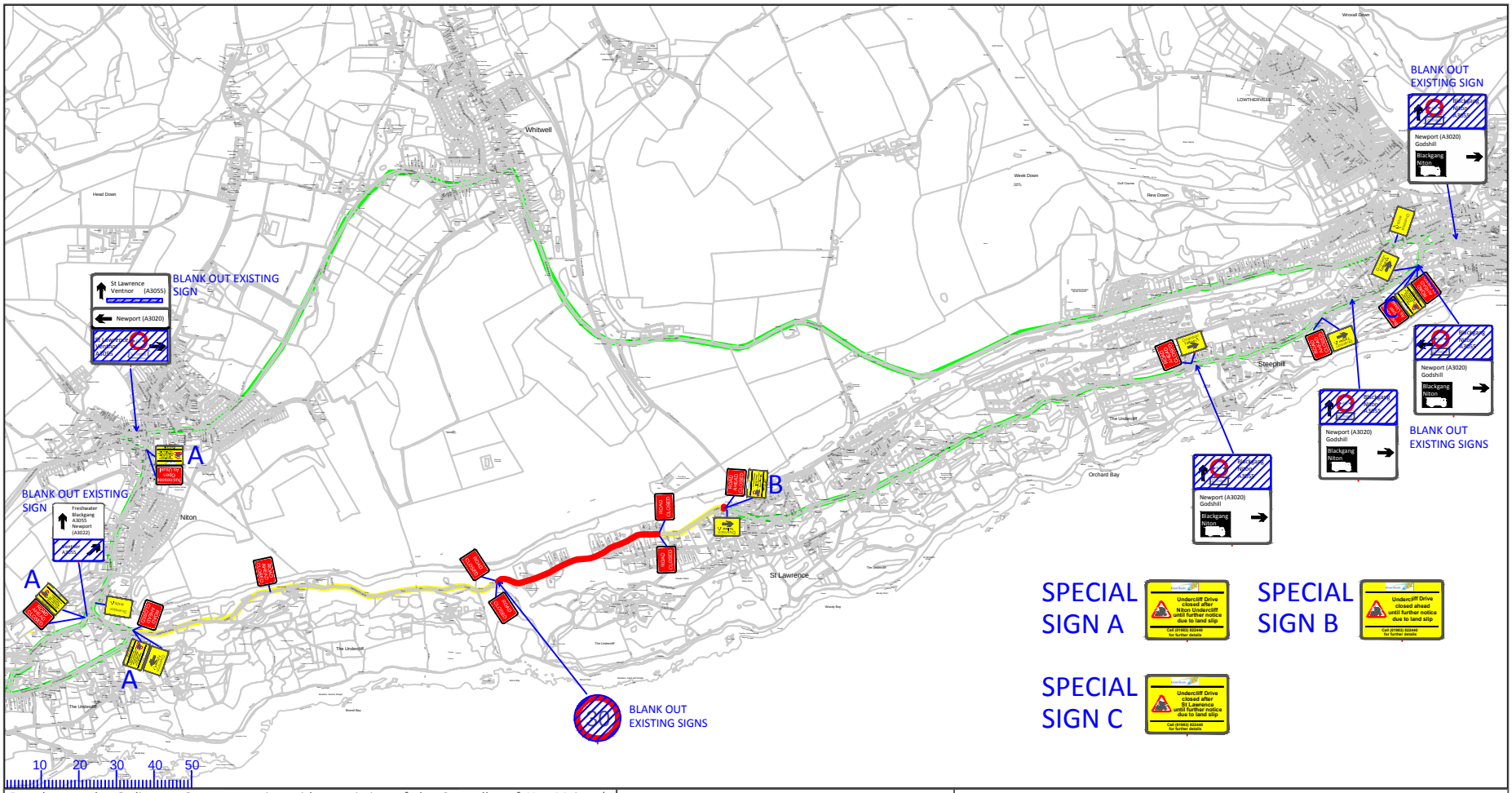


Project: Undercliff Site 10 action plan
Date: Wed 04/06/14

Task	Summary	External Milestone	Inactive Summary	Manual Summary Rollup	Finish-only		
Split	Project Summary	Inactive Task	Manual Task	Manual Summary	Deadline		
Milestone	External Tasks	Inactive Milestone	Duration-only	Start-only	Progress		

APPENDIX 3:

Drawing 1 – Undercliff Drive Landslip Diversion



UNMARKED

Rev.	Description	Initials	Date

Island Roads

Paul Herbert, Service Director, Island Roads
Island Roads, St. Christopher House, 42 Daish Way, Newport, Isle of Wight, PO30 5XJ

Project	Geological Failure Report Red Zone 9: Woodlands, Undercliff Drive	Drawing Title	Drawing 1: Undercliff Drive Landslip Diversion
Checked	BM IS	Date	30/04/14
Approved	IS	Date	
Scale	Not to scale	Revision	
Classification		Contract Sheet No.	
Drawing Number	1	Sheet x of x	1 of 1

APPENDIX 4:

Drawing 2 – Extent of Ground Movement Along Undercliff Drive

(2014 Event)

Notes

Rev.	Description	Initials	Date

K:\AutoCAD Templates\IWC logo landscape colour.jpg

K:\AutoCAD Templates\iwgov_islandroads.bmp

Island Roads
St. Christopher House
42 Daish Way
Newport
Isle of Wight
PO30 5XJ

Paul Herbert
Service Director, Island Roads

Classification: UNMARKED

Project

Extent Of Ground Movement Along Undercliff Drive, 2014 Event

Drawn		Date	20/05/2014
Checked		Date	
Approved		Date	
Scale		Revision	
Contract Sheet No.		Sheet x of x	
Drawing Number	Issue 1		

North Point

10 20 30 40 50

Path: \\ukisleomcdc0000\design drive\Internal Design File\Ben Meakin\Undercliff Failure Report.dwg

APPENDIX 5: Remediation Options and Approximate Costs

Undercliff Highway Options

Key Access Options:

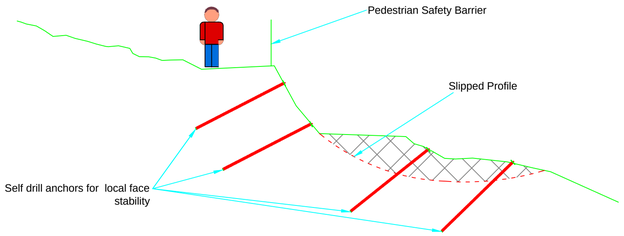
1. Re-establish Pedestrian Access Only
2. Repair and re-open road with access from one direction only
3. Repair and re-open road
4. Establish new inland access route to properties
5. Construct a temporary vehicle access route
6. Permanent road closure

Access Option	Stabilisation Option	Pros	Risks	Prelim outline cost range*
1	Self-drill anchors and pedestrian barrier	No substantial removal of failed material required	Does not address the long term geological risk	£250k - £500k
		Pathway can be moved further inland (north) to reduce requirements for stabilisation of slipped mass	Long term loss of vehicle access	
		Use of flexible footpath surface to absorb minor movements	Will require regular monitoring, inspection, and repair	
		Limited impact on environment		
2	Self-drill anchors and deep wells	Relatively quick construction method	Will require limited change inland of road route	£1m - £2.5m
		Only limited removal of slipped material required	Location still at risk from overall geological failure	
			Will require regular monitoring, inspection, and repair	
			Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
2	Reinforced Soil Block and Drainage	Will allow route of road along current alignment	Removal of slipped material required, temp works/monitoring needed to reduce	£2m - £4m

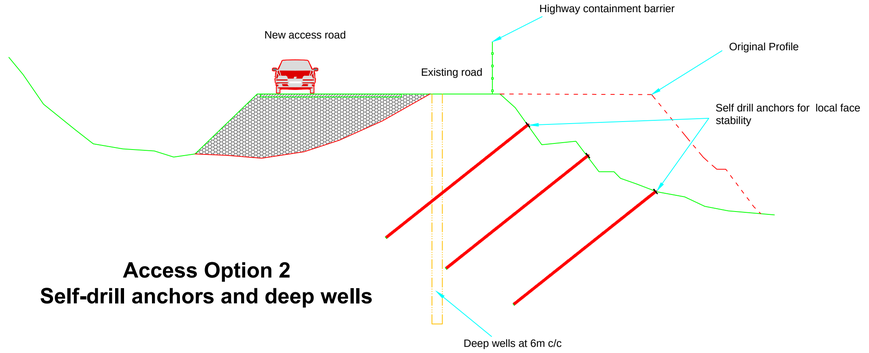
			risk of re-activation of slip	
		Drainage helps address overall geological failure mechanism	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
		'Soft' facing for the reinforced soil works to allow planting	Ongoing monitoring, inspection and maintenance regime required	
			Reduced risk of geological failure but still not complete removal of risk	
			Limited Working area, special measures may be required for safe access	
3	Reinforced soil block with hard facing, drainage, strand anchors	Drainage and strand anchors help address overall geological failure mechanism	Hard facing not in keeping with surrounding environment	£6m - £10m
		Hard facing reduces maintenance requirements	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
			The Environmental Impact of the Permanent Works will require approval from EA and associated agencies	
			Reduced risk of geological failure but still not complete removal of risk	
			Removal of slipped material required, temp works/monitoring needed to reduce risk of re-activation of slip	
3	Pile supported road deck	Provide long term solution which is resistant to increased range of geological failures	Significant temporary works required for construction access	£12m - £20m
		Reduced scope of maintenance required	Will require cosmetic measures to bring in keeping with local environment	
		Can be designed to provide long term stabilisation for deep slips but this will	Disturbs sub-surface groundwater environment	

		have a cost implication		
			Potential for slope failure either side of the structure will need to be considered, potential need for non-piled stabilisation at either end of route	
			Long term monitoring required	
4	Up-slope face stabilised by bolting and netting	Provides longer term protection for road and properties	Return visits will be required to stabilise emerging failures	£200k - £500k
		Reduced quality route pavement can be used	Access for works will be difficult, almost certainly roped access	
		Route independent of overall geological failure mechanism	Long term maintenance of rock slope vegetation will be required	
4	Establish rock fall protection structure	Provides long term protection with no upslope measure needed	Rockfalls will still occur therefore continuing property risk	£300k - £500k
		Route independent of overall geological failure mechanism	Protection structure will have a visual impact	
			Protection structure will require regular inspection	
5	Temporary Road at Niton End of Failure	Low Cost	Short Life solution, will require further works in the near future	Less than £100k but will require further expenditure in future
		Low environmental impact	Ongoing monitoring of temporary road and slipped zone will be required	
6	Permanent Road Closure	Low cost and environmental impact	No vehicular or footpath access to properties between 'Woodlands' and Undercliff Glen Caravan Park'	Less than £100k

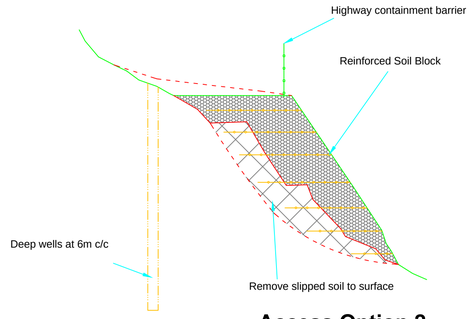
*Preliminary cost estimate based on cost of comparable schemes and industry data. A more detail cost assessment can be produced following further detailing of options and assessment of length of application.



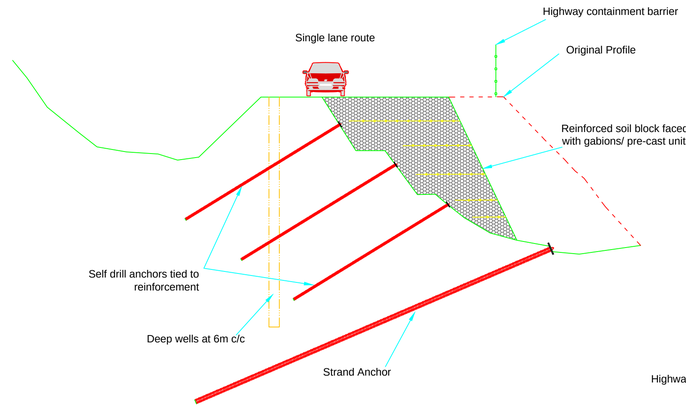
Access Option 1
Self-drill anchors and pedestrian barrier



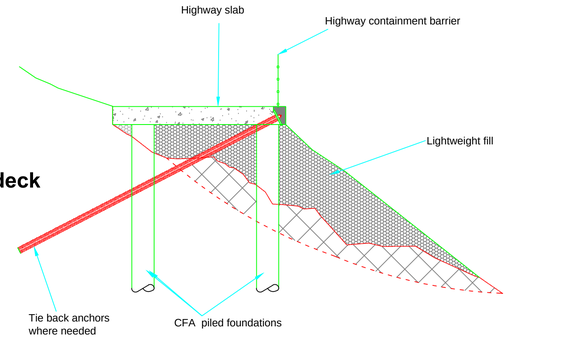
Access Option 2
Self-drill anchors and deep wells



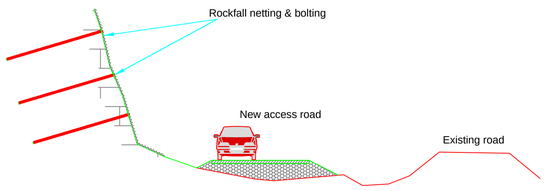
Access Option 2
Reinforced Soil Block and Drainage



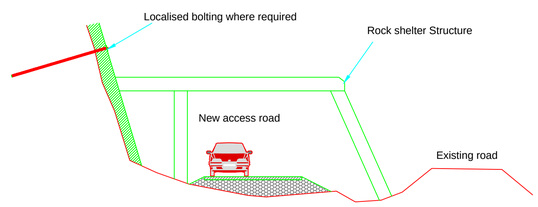
Access Option 3
Reinforced soil block with hard facing, drainage, strand anchors



Access Option 3
Pile supported road deck



Access Option 4
Up-slope face stabilised by bolting and netting



Access Option 4
Rock fall protection structure

Access Option	Stabilisation Option	Pros	Risks	Prelim outline cost range
1	Self-drill anchors and pedestrian barrier	No substantial removal of failed material required	Does not address the long term geological risk	
		Pathway can be moved further inland (north) to reduce requirements for stabilisation of slipped mass	Long term loss of vehicle access	
		Use of flexible footpath surface to absorb minor movements	Will require regular monitoring, inspection, and repair	
		Limited impact on environment		
2	Self-drill anchors and deep wells	Relatively quick construction method	Will require limited change inland of road route	
		Only limited removal of slipped material required	Location still at risk from overall geological failure	
			Will require regular monitoring, inspection, and repair	
			Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
2	Reinforced Soil Block and Drainage	Will allow route of road along current alignment	Removal of slipped material required, temp works/monitoring needed to reduce risk of re-activation of slip	
		Drainage helps address overall geological failure mechanism	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
		'Soft' facing for the reinforced soil works to allow planting	Ongoing monitoring, inspection and maintenance regime required	
			Reduced risk of geological failure but still not complete removal of risk	
			Limited Working area, special measures may be required for safe access	
3	Reinforced soil block with hard facing, drainage, strand anchors	Drainage and strand anchors help address overall geological failure mechanism	Hard facing not in keeping with surrounding environment	
		Hard facing reduces maintenance requirements	Discharge of water may require new outfall to sea subject to EA Approval and Discharge consent	
			Limited Working area, special measures may be required for safe access	
			The Environmental Impact of the Permanent Works will require approval from EA and associated agencies	
			Reduced risk of geological failure but still not complete removal of risk	
			Removal of slipped material required, temp works/monitoring needed to reduce risk of re-activation of slip	
3	Pile supported road deck	Provide long term solution which is resistant to increased range of geological failures	Significant temporary works required for construction access	
		Reduced scope of maintenance required	Will require cosmetic measures to bring in keeping with local environment	
		Can be designed to provide long term stabilisation for deep slips but this will have a cost implication	Disturbs sub-surface groundwater environment	
			Potential for slope failure either side of the structure will need to be considered, potential need for non-piled stabilisation at either end of route	
			Long term monitoring required	
4	Up-slope face stabilised by bolting and netting	Provides longer term protection for road and properties	Return visits will be required to stabilise emerging failures	
		Reduced quality route pavement can be used	Access for works will be difficult, almost certainly roped access	
		Route independent of overall geological failure mechanism	Long term maintenance of rock slope vegetation will be required	
4	Establish rock fall protection structure	Provides long term protection with no upslope measure needed	Rockfalls will still occur therefore continuing property risk	
		Route independent of overall geological failure mechanism	Protection structure will have a visual impact	
			Protection structure will require regular inspection	
5	Temporary Road at Niton End of Failure	Low Cost	Short Life solution, will require further works in the near future	

NOTES

Key Access Options:

1. Re-establish Pedestrian Access Only
2. Repair and re-open road with access from one direction only
3. Repair and re-open road
4. Establish new inland access route to properties

Rev.	Description	Drawn	Chkd.	Apprvd.	Date
-	FOR REVIEW	SKH	RA	SLW	20.05.14

Client: Island Roads

Project: ISLE OF WIGHT HIGHWAYS PFI

RAMBOLL
tel 023 8081 7500 fax 023 8081 7600 southampton@ramboll.co.uk
www.ramboll.co.uk

Drawing Title: UNDERCLIFF DRIVE
HIGHWAY STABILISATION OPTIONS
FOR REVIEW

Scale (at A1): AS SHOWN | Date: MAY 14 | Drawn: SKH

Drg. no.: 61030594/9/SK/600/06 | Rev.: -

10 0 10 20 50 100mm NATURAL SCALE

ORIGINAL DRAWING SIZE 841 x 594

APPENDIX 6: Failure Costs Incurred and On-going Costs

Undercliff 9

Costs incurred

Item	Description	Quant	Unit	Rate	Total
	John Peck Construction Costs				
1	Costs from John Peck Construction for A.J Geotechnical Services Ltd (drillers) abortive cost. The cost was a settlement sum to cover the rig and equipment back to the mainland, payment of hotel bookings made, loss of profit due to cancellation of works etc. Island Roads agreed sum	1.00	sum		
2	De-mobilisation of John Peck. Island Roads agreed sumsum	1.00	sum		
3	Site Hoarding as per photos provided in the Geological Failure Report.	1.00	sum		
4	Office and Toilet for security team (period 20/02/14 to 31/03/14)	5.00	weeks		
5	Gateman (period 20/02/14 to 28/02/14)	1.00	sum		
	Reports				
6	Failure Report from Ramboll (note that hopefully as conditions improve, Ramboll will be able to provide further recommendations, the costs of which will be considered seperately at a later date)	1.00	sum		
	Site Security				
7	Heras fencing (hire from Monday 10th February 2014 to 04th May 2014) 22 No panels	12.00	week		
8	Visit to maintain fence line and check security	12.00	visit		
9	Signage	8.00	No		
10	Barriers & cones	1.00	sum		
	Surveys				
11	Weekly Survey costs from Topographical & Engineering Surveys Ltd which commenced 06th March 2014	8.00	week		
	CCTV Cameras				
12	CCTV Cameras (cost split two ways between sites)	1.00	sum		
	Total				**£ 28,345.15**

Ongoing Costs (w/c 05th May 2014 onwards)

Item	Description	Quant	Unit	Rate	Total
1	Weekly Survey Cost from Topographical & Engineering Surveys Ltd	tba	week		
2	Weekly Broadband Cost for CCTV cameras (provisional sum)	tba	week		
3	Weekly site visits to check site	tba	week		
4	Heras Fencing Panels in conjunction with permanent hoarding	tba	week		
	Total	**tba**	**week**		**tba**

Undercliff 10

Costs incurred

Item	Description	Quant	Unit	Rate	Total
	John Peck Construction Costs				
1	Costs from John Peck Construction for A.J Geotechnical Services Ltd (drillers) abortive cost. Island Roads agreed sum	1.00	sum		
2	Boring consumables relating to ground anchors such as disposable sleeves bought to match the anchors. Island Roads agreed sum	1.00	sum		
3	Seal cracks formed from failure with bitumen. Island Roads agreed sum	1.00	sum		
4	Supply and fill voids formed from failure with aggregate to site 10. Island Roads agreed sum	1.00	sum		
	Reports				
5	Failure Report from Ramboll (note that hopefully as conditions improve, Ramboll will be able to provide further recommendations, the costs of which will be considered seperately at a later date)	1.00	sum		
	Site Security				
6	Heras fencing (hire from Monday 06th January 2014 to 04th May 2014) 39 No panels	17.00	week		
7	Visit to maintain fence line and check security	17.00	visit		
8	Signage	8.00	No		
	Surveys				
9	Weekly Survey costs from Topographical & Engineering Surveys Ltd which commenced 06th March 2014	8.00	week		
	Hoarding				
10	Supply and install fixed hoarding complete with gate & lock at Niton end of site	1.00	sum		
	CCTV Cameras				
11	CCTV Cameras (cost split two ways between sites)	1.00	sum		
	Total				**£ 35,330.45**

Ongoing Costs (w/c 05th May 2014 onwards)

Item	Description	Quant	Unit	Rate	Total
1	Weekly Survey Cost from Topographical & Engineering Surveys Ltd	tba	week		
2	Weekly Broadband Cost for CCTV cameras (provisional sum)	tba	week		
3	Weekly site visits to check site	tba	week		
4	Heras Fencing Panels in conjunction with permanent hoarding	tba	week		
	Total	**tba**	**week**		**tba**

Island Roads

www.islandroads.com