



The Coal Authority

Study of the options for a mine water monitoring borehole in the Bilston Glen area

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The conclusions reached are those which can reasonably be determined from the sources of information referred to in the report and from our knowledge of current professional practice and standards. Any limitations resulting from the data are identified where possible, but both these and our conclusions may require amendment should additional information become available. The report is only intended for use in the stated context and should not be used otherwise.

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1 INTRODUCTION

This report was compiled by WYG Engineering Ltd, at the request of The Coal Authority, to assess the options for mine water monitoring in the Bilston Glen area of the Mid-Lothian coalfield in order to improve understanding of rising mine water levels. Reference is made to a report by IMC on 'Bilston Glen Colliery Rising Minewater' dated 1998, the scope of which was to prepare an overview of the potential for rising mine water in the area, and assess the potential for useful monitoring. This report reviews previous information provided to the Authority by WYG (and IMC) and updates this information in light of recent monitoring of mine water levels and discharges.

A key recommendation of the 1998 report was the installation of a monitoring borehole (or boreholes) into the workings on the eastern flank of the Bilston Glen area. Such monitoring is required to determine the state of mine water recovery and provide information on when and where future mine water discharges might occur.

Optimum borehole sites are assessed in this report in respect of both underground connectivity and potential drilling parameters and information is provided to facilitate liaison between the Authority's Estates Department and surface stakeholders and/or landowners. Further recommendations are made including, if considered necessary, a second monitoring site.

2 BACKGROUND

The Bilston Glen area, within the Mid-Lothian coalfield, comprises a NNE to SSW trending syncline, the axis of which runs approximately from Dalkeith in the north to Whitehill in the south (see Figure 1). In the central area of the syncline the Productive Coal Measures outcrop and are underlain by the non coal-bearing Passage Grit Series and the Upper Limestone Group (see Figure 2). This strata is in turn underlain by the Limestone Coal Group whose seams of coal outcrop on either side of the syncline, in the Roslin and Loanhead areas in the west and the Newton Grange and Kippilaw areas in the east.

The overall area has been regarded as separate mining blocks comprising what has been known as Bilston Glen, Elginhaugh and Old Fordell. The Bilston Glen area comprises shallow workings in the steeply dipping Limestone Coal Group seams in the west that were accessed from the old Roslin, Ramsay and Burghlee collieries, and the deeper Limestone Coal Group seams in the centre of the syncline that were accessed



from the relatively modern Bilston Glen Colliery. The Elginhaugh area comprises workings in the upper Productive Coal Measures present in the centre of the syncline that were accessed from the former Whitehill and Polton collieries. The Old Fordell area comprises shallow workings in the Limestone Coal Group on the eastern flank of the syncline, and also deeper workings accessed from the east towards the centre of the syncline from the former Lingerwood, Lady Victoria and Easthouses collieries.

Worked seams in the Limestone Coal Group on the eastern flank of the syncline range from the Great Seam, which is the shallowest, to the Parrot Seam, which is the deepest. Extensive workings exist in both seams in the area, ranging from shallow near-outcrop workings in the east to deeper workings towards the centre of the syncline. Several seams that lie between the Great and the Parrot have been worked to varying degrees. Some are limited to isolated areas near to outcrop whilst others contain more modern deeper workings.

3 INTER CONNECTIONS

In the Bilston Glen area the older collieries of Roslin, Ramsay and Burghlee that closed in the 1960s are regarded as a single unit although interconnections are mainly at shallow horizons in old nineteenth century workings. Between Burghlee and Bilston Glen, narrow permeable coal barriers facilitated flows in the order of 100 gpm (7.5 L/s) when Bilston Glen was operating and pumping before its closure in 1989.

On the eastern flank of the syncline, mining ceased with the closure of Lady Victoria Colliery in 1981. The shallow workings in this area are more laterally extensive than on the west of the syncline due to the relatively gentler nature of the seam dips at outcrop ($< 20^\circ$) and numerous interconnections exist at these shallow horizons. Connections exist to two in-seam drainage levels, these being Bryans Day Level in the Newbattle area, that was designed to discharge into Ochre Burn, and Newmills (or Junkies) Day Level in the Dalkeith area that discharges at Old Fordell. In addition to the numerous shallow connections, there are known mining connections in the area of the Easthouses pumping shaft between Lingerwood workings and Easthouses workings, and in the Newbattle Dooks area between Easthouses and Lady Victoria. The connections at Newbattle Dooks are two steep cross-measures drifts between the Easthouses Great Seam workings and the Lady Victoria Splint Seam workings that were dammed at levels of 518m BOD and 436m BOD. These dams were designed to withstand hydraulic heads of 400 and 500 feet (120m and 150m) respectively. Lingerwood and Lady Victoria are interconnected at many levels and worked as one unit.



Known mining connections exist between Easthouses and Bilston Glen in the Great Seam that, it is assumed, were for drainage purposes during the working life of Bilston Glen as the Easthouses workings were at the lowest point of the syncline.

To the south and east of Lady Victoria and Lingerwood lies the Vogrie / Arniston area that has workings in the Limestone Coal Group on the eastern flank of the syncline. There are no known connections between this block of workings and the overall Bilston Glen block although some unrecorded connections may exist at shallow horizons. Notwithstanding mine water in the Vogrie / Arniston block has recovered and is controlled by the discharge at Vogrie (S689) into Gore Water and can be regarded as separate from the main Bilston Glen block.

4 CURRENT SITUATION

The mine water in the deep Bilston Glen workings is still recovering. In July 2011 the monitored depth to the water level in the No1 downcast shaft (S432) was 221.1m which equates to a level of 67.1m BOD. The level has shown a steady rise of 18m in the 12 months prior to this monitored level. There is no mine water level monitoring in the shallow workings in the west and no recorded mine water discharge from these workings. Unless there are small unrecorded discharges it is therefore assumed that mine water is migrating into the deeper Bilston Glen workings via the narrow permeable barriers.

The mine workings in the Junkies / Old Fordell area of Easthouses, Lingerwood and Lady Victoria are partly controlled by the discharge at Old Fordell (S345) where the flow has been measured as 46 L/s, with a total iron concentration of about 7 mg/L. The discharge from Bryans Day Level into Ochre Burn was monitored in the past by British Coal, but ochreous discharge has not been recorded over recent periods by IMC/WYG. Given the known connection between Easthouses and Bilston Glen, and the fact that the Bilston Glen workings are still recovering at depth, it is likely that the discharge at Old Fordell represents only a proportion of the potential flow from this area of workings. If the current rate of recovery recorded at Bilston Glen (S432) of around 18m per year is applied, then it is projected that this pond of water would reach the level of the discharge at Old Fordell in 2016.

Ochre Burn was observed during a site reconnaissance visit in September 2011 by WYG. It is culverted for much of its length along Newbattle Road, in the area where Bryans Day Level is recorded as meeting the

watercourse. The photographs below show the entrances to culverts at either end of an open section of the burn.



Ochre Burn 80m south of recorded Day Level



Ochre Burn at or near to recorded Day Level

The culvert 80m south of the recorded position of the day level (Abandonment Plan S675) is upstream. There was no indication of any ochreous discharge at either culvert entrance, or in the intervening open section of watercourse. It was noted that in the centre of Newbattle Road, at or near to the recorded position of the Day Level, the sound of a significant flow of water could be heard emanating from beneath a manhole cover. It is not known whether this is associated with the Day Level or other sub-surface drainage. It is recommended that water samples should be taken from Ochre Burn at the position of both culverts and analysed to check for the presence of mine water.

Mine water in the Elginhaugh area, in the upper Productive Coal Measures in the centre of the syncline, has recovered and is controlled by the discharge from the Eldin Day Level into the North Esk. The discharge is at a level of 48m AOD with an estimated flow of between 10 and 25 L/s. The Elginhaugh area lies vertically above parts of Bilston Glen, Easthouses and Lady Victoria workings and some vertical migration of mine water may be taking place via strata discontinuities. However, any such migration might be considered negligible given the vertical interval involved (see Figure 2) and the fact that the intervening strata of the Passage Grit Series and Upper Limestone Group contain several horizons of argillaceous strata that serve to restrict flows vertically.

5 FUTURE



As stated in the IMC report of 1998, the mine waters in workings at Bilston Glen, Lady Victoria, Easthouses and Lingerwood are expected to combine at some point and form one pond. This may already be the case should the dammed connections at Newbattle Dooks between Easthouses and Lady Victoria have failed.

As recovery continues, new or increased mine water discharges are likely. The aggregate quantity of mine water pumped at the various collieries when operational was recorded as 150 L/s. The likely flow at discharge will reduce as the hydraulic head reduces, but any future flow is likely to be in excess of that currently recorded at Old Fordell (S345).

Monitoring of mine water level in the Easthouses / Lady Victoria / Lingerwood workings will determine the extent of mine water recovery in the area; provide information on when and where any future discharges are likely to occur; and indicate the required scope of any treatment scheme at the Old Fordell discharge. The IMC report of 1998 indicated that (other than an old shaft in the Easthouses area that was sunk to the Parrot Seam) no suitable shafts exist to provide such monitoring and that a borehole (or boreholes) would be required.

6 OPTIONS FOR MONITORING BOREHOLES

The optimum level for connecting into the mine workings with a monitoring borehole is approximately 70m BOD, given that the latest monitored water level at the Bilston Glen shaft (S432) is 67.1m BOD. Should mine water not be encountered at, or near to, this level then it would probably indicate that the combination of the mine waters into one pond is not yet complete. Options for the siting of a mine water monitoring borehole at, or near to, this optimum level are limited due to the appreciable dip of the Coal Measures strata in this area.

The most favourable target seam is the Great Seam, being the shallowest worked seam in the area with extensive workings throughout. The Great Seam is also overlain by a band of sandstone that is recorded as being approximately 5.0 to 5.5m thick in the shaft at Lady Victoria Colliery. The worked thickness of the seam was generally in the region of 2.1m. Workings in the Great Seam were accessed by ENE to WSW surface drifts at Easthouses Colliery (see Figure 3). The dip of the seam in this area is about 1 in 2.4 (23°) to the WNW, meaning that the area of opportunity between a borehole being too shallow to be representative of the overall situation and too deep to be feasibly drilled is quite narrow.



After the Great seam, the next most favourable target seam is the Parrot Seam which has a general worked thickness of 1.3m. However, due to the dip of the strata and the depth of the workings (the Parrot Seam is some 170m vertically below the Great Seam in the geological sequence), the area that might offer an option for a borehole of a depth which might feasibly be drilled is limited to that which contains workings on the extreme east of the syncline. Such workings may be locally flooded and, as a result, may not provide data representative of the wider coalfield, at least until a later date.

The likely scenario of rising mine water leads to the potential for increasing gas pressures in some workings. Should a borehole intercept target workings that are not yet water-saturated, gas monitoring data may be gleaned in advance of any water monitoring data. Notwithstanding, detailed design of a borehole should incorporate facility for the management and containment of gas under pressure and its safe dispersal.

Workings beneath the Great Seam and above the Parrot Seam are summarised in the table below.

Seam	Extent of workings
Stairhead	Limited shallow near-outcrop workings northeast of Newmills/Junkies Day Level
Gillespie	Limited shallow near-outcrop workings northeast of Newmills/Junkies Day Level
Blackbird	No workings
Coronation	Workings at depth (approx. \geq 500m BOD)
Smithy	Limited workings at depth
Splint	Extensive workings (approx. \geq 380m BOD)
Alecks	Limited shallow near-outcrop workings east of Newmills/Junkies Day Level
Kaleblades	Limited shallow near-outcrop workings east of Newmills/Junkies Day Level
South	Workings at depth (approx. \geq 550m BOD)
Little	No workings

No recorded workings in the ironstone horizons that lie above the Great Seam have been identified.

The optimum position for the borehole from an underground perspective is at or around the position where the Great Seam workings are at a level of 70m BOD. The inclination of the workings, and their extent laterally from the main access roadways that connect to the surface drifts at Easthouses (see Figure 3), means that achieving such a target depth would require the borehole to be positioned within a residential



area of Easthouses between Newbattle High School and the northern extent of the residential area along the line of Mayburn Road (see Figure 4). It is therefore assumed that installation of a monitoring borehole in this area, to suit the optimum drilling parameters, is not possible.

The alternative options discussed below have been assessed with the view that occupation of the corresponding area of land on the surface and access to such land may subsequently be agreed with owners and/or stakeholders by the Authority's Estates department. Areas where it is probable that agreement might not be reached have not been considered. Notwithstanding, the preference for each option has been assessed purely from the perspective of underground connectivity and potential drilling depths.

6.1 Option 1

The preferred option is to intersect a roadway in the Great Seam at the former Easthouses Colliery that connects to Easthouses Main No1 Incline (see Figure 3).

Surface level	91m AOD
Level of workings	125m BOD
Depth of drilling	216m

The surface position for the borehole would be on open ground to the west of Lothian Drive, Easthouses (see below and Figure 4). Access would be off Easthouses Road via Mayburn Road and Carrick Crescent. A photographic record of the proposed site is given in Appendix A.



Site of Option 1

The need to intersect a roadway would require that the borehole be carefully monitored for deviation from vertical which, given the steeply dipping nature of the strata, would be problematic. However informed positioning of the borehole may allow for it to intersect workings regardless of any deviation, particularly if the position is designed such that the borehole intersects the workings in an area where a junction with a lateral roadway(s) occurs. The integrity of the roadway is unknown and, having been driven in the early twentieth century, is likely to be compromised. However the fact that the roadway was a main access for the colliery throughout its life would suggest that it was well maintained up to closure in 1969. Should the borehole fail to intersect the workings it may be possible to achieve connectivity via probable mining-induced fractured strata adjacent to the workings and/or the sandstone band that lies immediately above the seam.

6.2 Option 2

The next preferred option is to intersect a roadway in the Great Seam at the former Easthouses Colliery that connects to the main access roadways (see Figure 3).

Surface level	78m AOD
Level of workings	274m BOD

Depth of drilling 352m

The surface position for the borehole would be on agricultural land known as Talbot Park between Easthouses and Newbattle Bridge (see below and Figure 4). Access to Talbot Park is via a lane off Newbattle Road. However the borehole site would be situated approximately 400m from the limit of this access lane across Talbot Park to the northeast and it was noted, during the site reconnaissance visit, that the area was particularly boggy in the southwest corner of Talbot Park close to the access lane. A photographic record of the proposed site is given in Appendix B.



Site of Option 2

The need to intersect a roadway would require that the borehole be carefully monitored for deviation from vertical which, given the steeply dipping nature of the strata, would be problematic. However informed positioning of the borehole may allow for it to intersect workings regardless of any deviation, particularly if the position is designed such that the borehole intersects the workings in an area where a junction with a lateral roadway(s) occurs. The integrity of the roadway is unknown and, having been driven in the early twentieth century, is likely to be compromised. However the fact that the roadway was a main access for the colliery throughout its life would suggest that it was well maintained up to closure in 1969. Should the borehole fail to intersect the workings it may be possible to achieve connectivity via probable mining-induced fractured strata adjacent to the workings and/or the sandstone band that lies immediately above the seam.

6.3 Option 3

The next preferred option is to intersect workings in the Parrot Seam at the former Easthouses Colliery (see Figure 5). Three borehole sites (3A, 3B and 3C) have been identified that would offer the potential to intersect the workings at a level similar to the optimum target level for the borehole (70m BOD) due to the sites being positioned approximately on (or near to) the line of strike of the seam. However the Parrot Seam abandonment plan does not record seam levels in this area and therefore target levels are an interpolation based on the Parrot Seam level in the nearby Easthouses pumping shaft and the estimated seam gradient.

Option 3A:

Surface level	113m AOD
Level of workings	40m BOD (interpolated)
Depth of drilling	153m

The surface position for the borehole would be on open ground immediately west of Broadhurst Road, Easthouses (see below and Figure 4). A photographic record of the proposed site is given in Appendix C.



Site of Option 3A

Option 3B:

Surface level	107m AOD
Level of workings	70m BOD (interpolated)
Depth of drilling	177m

The surface position for the borehole would be within a recreational park area in Easthouses that includes sports pitches and play areas, part of which is occupied by Easthouses Bowling Club (see below and Figure 4). Access to the site would be by the entrance off Easthouses Road. A photographic record of the proposed site is given in Appendix C.



Site of Option 3B

Option 3C:

Surface level	108m AOD
Level of workings	70m BOD (interpolated)
Depth of drilling	178m

The surface position for the borehole would be within playing fields east of Easthouses Road opposite Newbattle High School (see below and Figure 4). Access to the site would be by the entrance off Easthouses Road in the northwest corner of the playing fields. A photographic record of the proposed site is given in Appendix C.



Site of Option 3C

Boreholes at each of the three potential sites would be designed to intersect late nineteenth century workings in the Parrot Seam from the former Lingerwood Colliery. The abandonment plan records unworked pillars of coal amongst areas that are recorded as being totally extracted. Such areas may also contain unworked pillars of coal that are not recorded. The workings are likely to be heavily compacted given their age, but should contain sufficient void space to facilitate permeability.

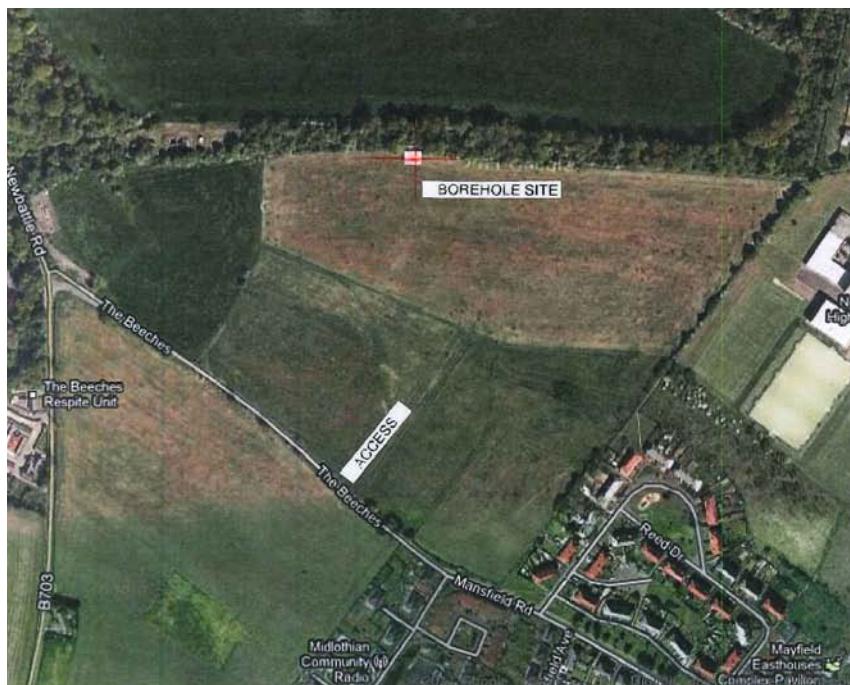
The connectivity of this area of Parrot Seam workings to the main body of workings may be compromised as there are no local recorded mining connections below the connection at Easthouses pumping shaft. However it is known that there is a goaf connection at the Parrot Seam horizon between Lingerwood and Lady Victoria to the south, whilst it is also known that Lingerwood and Lady Victoria were interconnected at several levels and worked as one unit.

6.4 Option 4

The next preferred option is to intersect a roadway in the Great Seam at the former Easthouses Colliery. The roadway forms part of an area of room and pillar workings that were accessed laterally from the main Easthouses roadways that connect to the surface drifts (see Figure 3).

Surface level	79m AOD
Level of workings	312m BOD
Depth of drilling	391m

The surface position for the borehole would be on agricultural land known as Campbell Park that is situated between Easthouses and Newtongrange (see below and Figure 4). Access would be via a field entrance off The Beeches which is some 300m from the borehole site. A photographic record of the proposed site is given in Appendix D.



Site of Option 4

The need to intersect a roadway would require that the borehole be carefully monitored for deviation from vertical which, given the steeply dipping nature of the strata, would be problematic. However informed positioning of the borehole may allow for it to intersect workings regardless of any deviation, particularly if the position is designed such that the borehole intersects the workings in an area where a roadway junction occurs. The integrity of the roadway is unknown and having been driven in the early twentieth century is



likely to be compromised. Should the borehole fail to intersect the workings it may be possible to achieve connectivity via probable mining-induced fractured strata adjacent to the workings and/or the sandstone band that lies immediately above the seam.

7 SUMMARY AND RECOMMENDATIONS

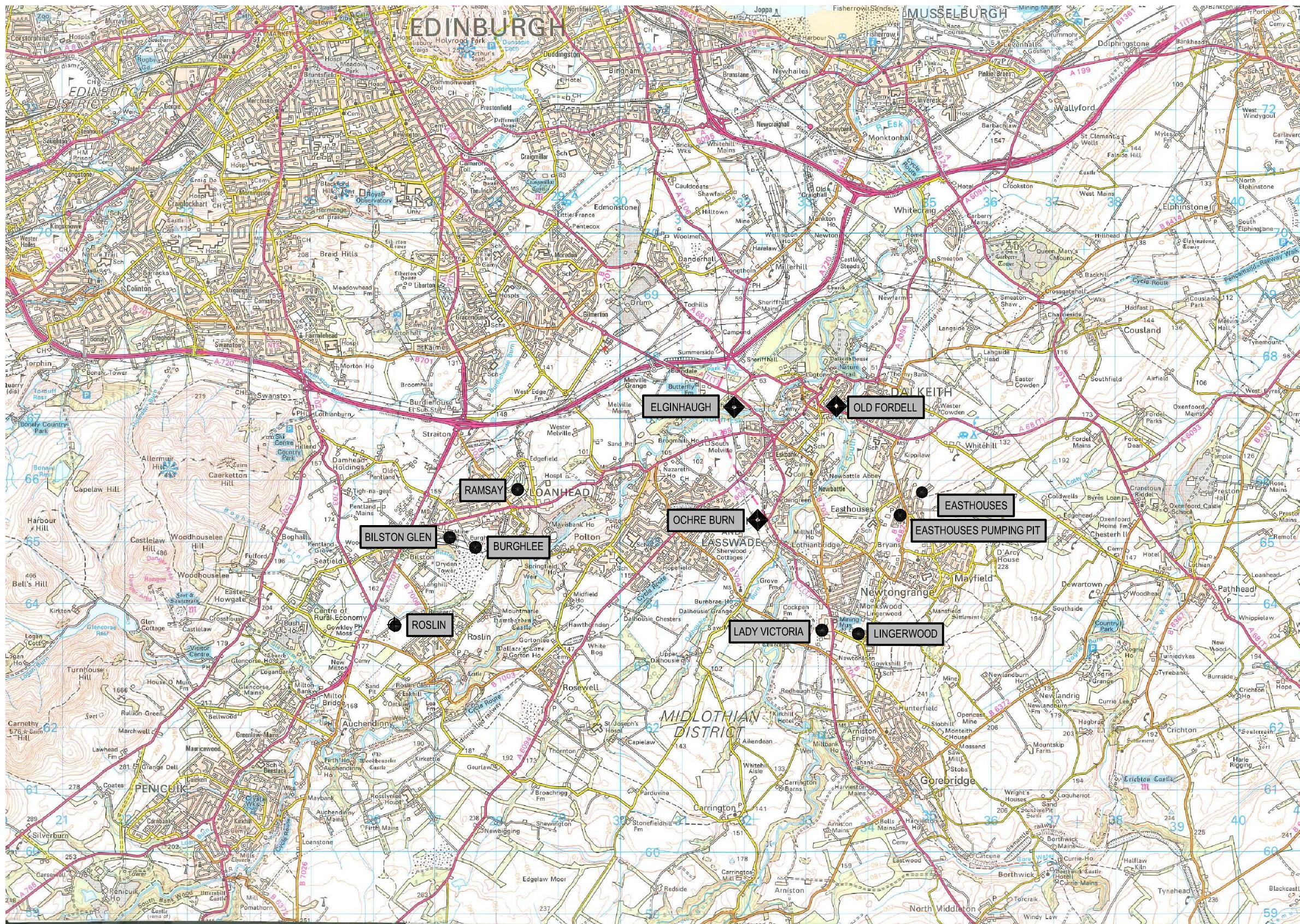
- The Bilston Glen mine water block comprises workings on both flanks of a NNE to SSW trending syncline in the Limestone Coal Group.
- Workings from Bilston Glen and the collieries of Easthouses, Lingerwood and Lady Victoria are interconnected and are expected to form one pond of rising mine water.
- Monitoring at Bilston Glen No.1 Shaft (S432) indicates that the mine water level is steadily rising.
- The workings in the centre of the syncline in the Productive Coal Measures are controlled by the discharge at Elginhaugh and can be regarded as independent of the Bilston Glen block.
- The current discharge at Old Fordell is likely to represent only part of the potential flow in the area.
- There is currently no evidence of any other discharge in the area including at Ochre Burn.
- Ochre Burn should be sampled in and around the known position of Bryans Day Level in order to check for the presence of mine water.
- Additional monitoring of water level is required before formulating treatment requirements at Old Fordell.
- Options for the siting of a monitoring borehole are limited due to the appreciable dip of the workings in the area.
- Options for monitoring boreholes are discussed in Section 6 in order of preference from the perspective of underground connectivity and drilling parameters.
- Utilising the Great Seam as the target horizon is preferred due to it being the shallowest worked seam with extensive workings throughout the area and the fact that it is overlain by a band of sandstone that might aid connectivity.
- Where roadways are considered as target options, the steeply dipping nature of the strata and the small target area means that control of borehole deviation will be critical.
- Steered directional drilling would be an expensive option, however careful and informed positioning of boreholes allied to careful control of deviation may allow sufficient confidence in being able to successfully intercept a target.
- Depths and levels at any selected location would require verification prior to any detailed design being undertaken.



- A second monitoring borehole would need to be drilled to an excessive depth to give meaningful information in addition to that provided by a single monitoring borehole.



FIGURES



REV	DESCRIPTION	BY	CHK	APP	DATE
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Project:

BILSTON GLEN
OPTIONS FOR MINEWATER MONITORING

Drawing Title:
LOCATION PLAN

Scale @ A3 NTS	Drawn Date GE 02.11.11	Checked Date DP 02.11.11	Approved Date DP 02.11.11
Project No. A031899-25101C&S	Office Type C&S	Drawing No. FIGURE 1	Revision 1

PRODUCTIVE COAL MEASURES

PASSAGE GRIT

UPPER LIMESTONE GROUP

GREAT SEAM

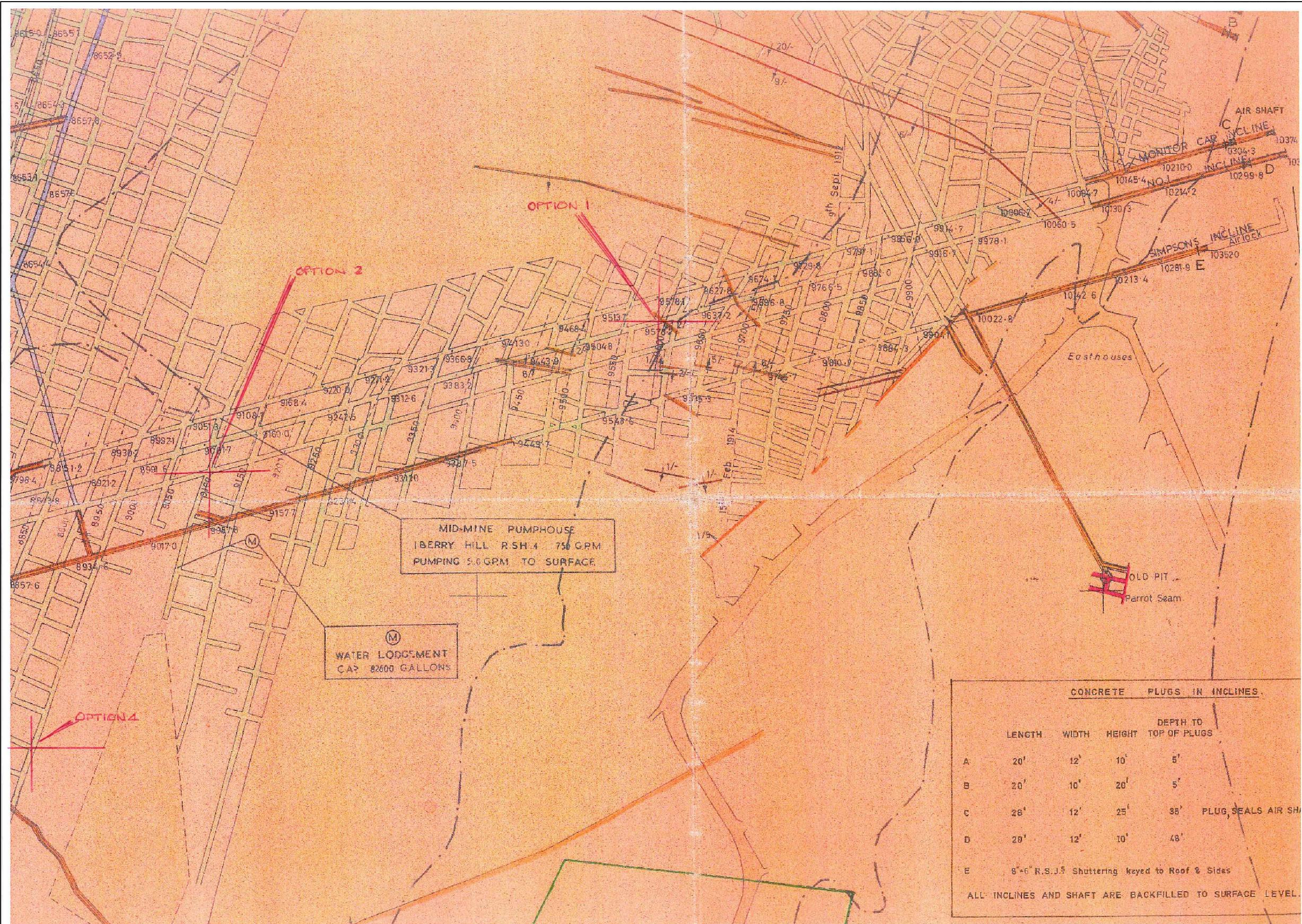
LIMESTONE COAL GROUP

PARROT SEAM

LOWER LIMESTONE GROUP



REV	DESCRIPTION				BY	CHK	APP	DATE
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	NTS	GE	02.11.11	DP	02.11.11	DP	2.11.11	
A31899-2	5101	C&S	FIGURE 2					Revision



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Project:
BILSTON GLEN
OPTIONS FOR MINEWATER MONITORING

Drawing Title:
GREAT SEAM WORKINGS

Scale @ A3 NTS	Drawn GE	Date 02.11.11	Checked DP	Date 02.11.11	Approved DP	Date 02.11.11
Project No. A031899-25101	Office C&S	Type FIGURE 3	Drawing No. Revolution			



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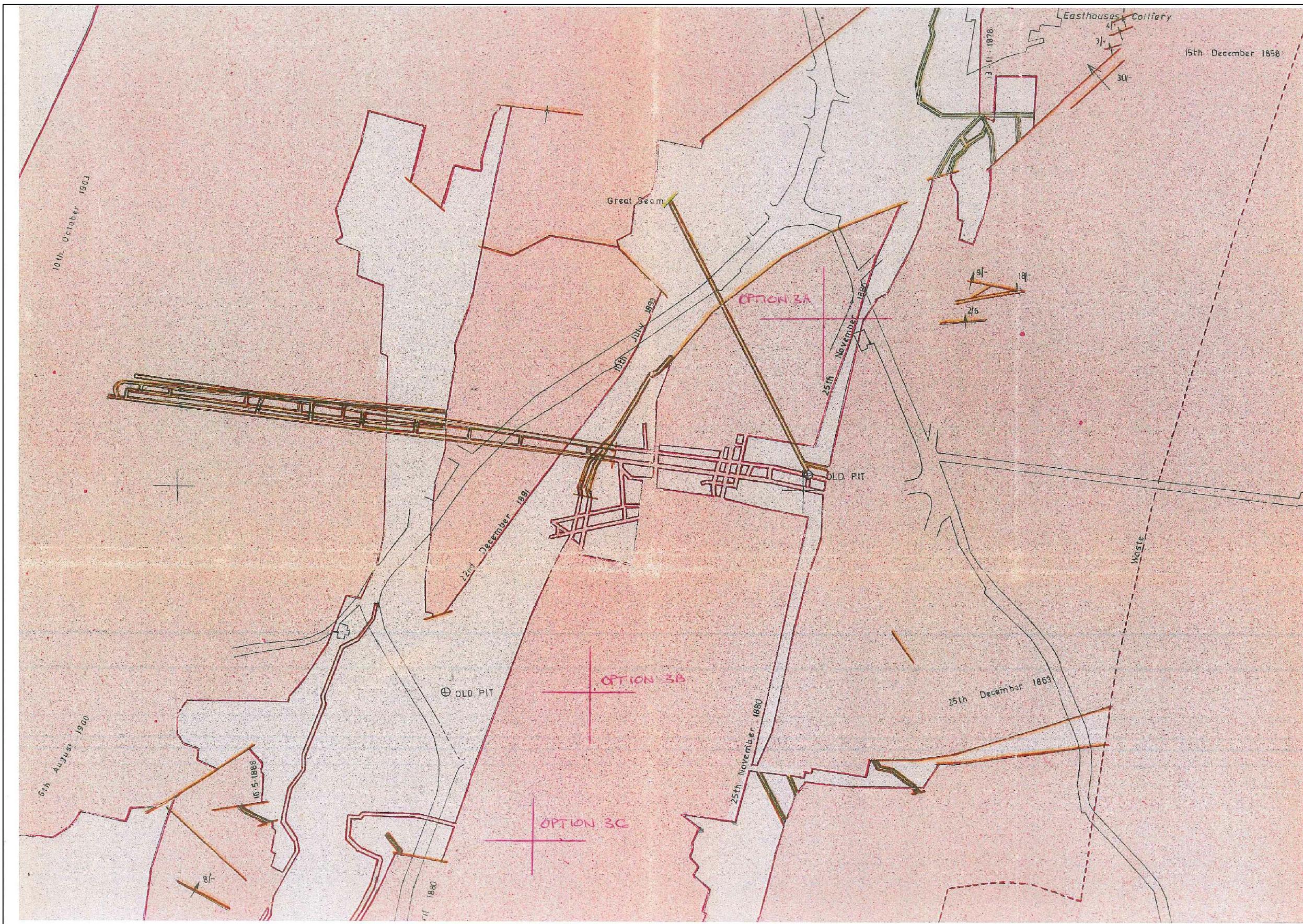
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Project:
BILSTON GLEN RISING
OPTIONS FOR MINEWATER MONITORING

Drawing Title:
BOREHOLE SITE OPTIONS

Scale @ A3 NTS	Drawn Date GE 02.11.11	Checked Date DP 02.11.11	Approved Date DP 02.11.11
Project No. A031899-25101C&S	Office C&S	Type Drawing No. FIGURE 4	Revision



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Project:
BILSTON GLEN RISING
OPTIONS FOR MINEWATER MONITORING

Drawing Title:
PARROT SEAM WORKINGS



Scale @ A3 NTS	Drawn Date GE 02.11.11	Checked Date DP 02.11.11	Approved Date DP 02.11.11
Project No. A031899-25101C&S	Office FIGURE 5	Type C&S	Drawing No. Revision



APPENDIX A



Site of option 1 from Lothian Drive



Site of option 1 access



View from site of option 1 looking north



View from site of option 1 looking south



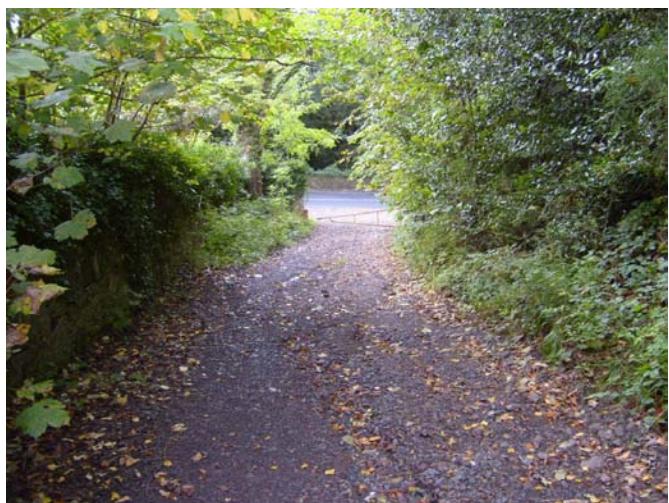
APPENDIX B



View from site of option 2 looking east



View from site of option 2 looking west



Access lane of Newbattle Road



Access lane



Boggy area in south-west corner of field



APPENDIX C



Option 3A west of Broadhurst Road



Entrance to recreational park (option 3B)



Southern corner of park (option 3B)



Access to playing fields (option 3C)



View across playing fields from access



APPENDIX D



View from site of option 4 looking east



View from site of option 4 looking west



View from centre of Campbell Park to access



Access to Campbell Park off the Beeches