URS

Bilston Glen

Scoping Study

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Prepared for:
The Coal Authority

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0	28 February 2014	Draft Bilston Glen review and Scoping Study report	Dr Selina Bamforth CGeol CSci Senior Consultant	Dr Lawrence Bowden CGeol EurGeol CSci Principal Consultant David Cragg CGeol CEng SiLC Technical Director	Selena Pearce CEng MICE Associate Director

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URS Infrastructure & Environment UK Ltd
4th Floor, Bridgewater House
Whitworth Street
Manchester
M1 6LT

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1 INTRODUCTION

1.1 Background

This document has been prepared by URS on behalf of the Coal Authority, and focuses on an area of the Midlothian coalfield to the south of Edinburgh. The 'study' area encompasses an area of approximately 27km^2, and comprises of a series of coal bearing strata, that has been termed in previous reports and studies as the 'Bilston Glen Coalfield'. For ease of reference and consistency, these mine workings will also be referred to as this in this document.

This document centres on the mine workings in the Bilston Glen Coalfield, with specific emphasis on mine water rebound and the potential ensuing pollution of surface water that may occur following mine water break through.

1.2 Project Purpose and Scope

The key purpose of this document is to provide The Coal Authority with a review and update on the progress of mine water rebound in the Bilston Glen Coalfield, via review of previous and current literature and data. No physical works have been undertaken by URS; however a site walkover was undertaken in January 2014 with the Coal Authority.

Information from this review will be used to provide the Coal Authority with a series of scenarios and remedial options applicable to the current hydrogeological situation and future management of mine water in the Coalfield.

The scope of this work is limited to assessment of the following:

- The mining related hydrogeology and hydrology across the Bilston Glen Coalfield with specific focus on the rate of mine water rebound, potential mine water quality and impact of the rising mine water upon the Water Environment.
- Identification of potential mine water breakout/ decant points.
- Assessment of treatability via assessment of existing mine water data provided by the Coal Authority.
- Reference to observations made during a site specific walkover.
- Identification of suitable mine water treatment locations and the identification of a preferred option.

During the site walk over no further water samples were taken, and flow rates were visually estimated where no data has been made available.

1.3 Key Objectives

The key objectives are summarised in the following points:

- To provide a high-level scoping study of the mining hydrogeology of the Bilston Glen Coalfield via reference to previous reports, additional data provided by the Coal Authority and recent field observations/ data.
- To establish the current condition of the rising mine water.
- Assess the available mine water chemistry with respect to treatability, and identify key locations where such a treatment system could be installed.

- Identify key stakeholders/interest groups and develop a communications plan (deferred until after this report has been submitted and approved by the Coal Authority).
- Identify any potential risk receptors from rising mine water, specifically potential areas of mine water emissions and possible impacts on water supply and any likely stakeholders at risk.
- Develop a risk register specific for the preferred site and treatment option.

2 MINING GEOLOGY, HYDROGEOLOGY & HYDROLOGY

2.1 Background

Mining began in the Bilston Glen Mining area in the 17th Century, exploiting shallow coal measures that were easily accessible from surface mining activities. These mines were simply drained via drainage/ adit levels into local watercourses, and as mining technologies advanced, a combination of steam engines, wind and water mills were used to dewater the mines.

Following the exhaustion of the shallow coal, the deeper coal measures were exploited, with Bilston Glen shaft extending up to 750m below ground level, and exploiting the deep Lower Limestone coal seams on the west of the Coalfield and Easthouses shaft exploiting the western Coalfield. Following closure of Bilston Glen mine in 1998/99, pumping of the coal field ended, and mine water rebound commenced.

2.2 Site Location

The study area is located approximately 5 miles south of Edinburgh, and encompasses a group of coal mines that exploited both shallow and deeper coal seams within the Midlothian Coalfield. The site is bounded by the towns of Dalkeith and Loanhead to the North, Easthouses and Bilston to the east and west respectively, and Newtongrange and Rosewell to the south. The Firth of Forth lies approximately 5 miles due north of the mining area. The site area is presented on Drawing 47068917/Figure 1.

The topography is characterised by rolling hills typical of the East Lothian area, with the study site broadly consisting of a NE to SW trending valley formed by the Rivers North and South Esk owing to the syncline formation of the Coalfield. The base of the valley lies at approximately 150m AOD at the southernmost end of the study site, reducing to approximately 45m AOD at the northernmost end. The Pentland Hills rise up steeply to the west of the study area, to a maximum of ~500m AOD at Allermuir Hill, with more gently rolling hills of heights of 200m to 250m AOD rising to the east of the valley.

2.3 Bilston Glen Mining Geology

The geology of the Bilston Glen Coalfield of the Midlothian Coal Measures is typical of the geology of the Lower and Upper Carboniferous periods, with three sequences of coal bearing units worked during the mining of the Bilston Glen area. Due to previous reports using different naming systems for the coal bearing sequence of strata, for ease of reference in this report, the BGS nomenclature has been used, as is summarised below:

- Shallow (opencast and drift) mining of the Upper Carboniferous units of the:
    - Upper Coal Measures.
    - Middle Coal Measures.
    - Lower Coal Measures.

Note, these three units have previously been termed the ‘Productive Coal Measures’

- Deep mining of the *Upper Carboniferous* units of the:
    - Upper Limestone Group.
    - Limestone Coal Group.
- Deep mining of the *Lower Carboniferous* units of the:

- Lower Limestone Group.

The Upper Carboniferous geology in the Bilston mining area consists of sandstones and mudstones (Blaes), interbedded with up to a dozen coal seams. It should be noted that there are no outcrops of the Upper Coal measures in the Bilston Glen Coalfield with only a small outcrop of the Middle Coal Measures located to the north, with the remainder the Lower Coal Measures strata. The Limestone Measures (which consist of the Upper and Lower Limestone and Limestone Coal Measures for clarity in this report consist predominantly of limestone shales and limestones interbedded with numerous coal seams. The shallow and deep mining sequences are separated by up to 500m of sandstones and gritstones (termed 'Passage Grit').

The geology of the area is dominated by a NE trending syncline, steeply dipping in the western limb with dips ranging from 500 to 700, and shallower dips in the eastern limb, of approximately 200. The whole geological sequence is heavily faulted, the most notable of which is an E-W trending fault (Sherriffhall fault) that provides hydrogeological separation between the Monktonhall colliery workings and the Bilston Glen mining area. Due to the workings to the north of the fault being downthrown, then this forms a hydrogeological barrier between the two sets of workings. An idealised cross section of the geology is provided as Drawing 47068917/Figure 2, which highlights the working levels of the shallow and deeper workings.

2.4 Bilston Glen Hydrogeology & Hydrology

The natural hydrogeology of the area has been greatly altered in the Bilston mining area as a result of the mining that has been undertaken. Early mining of the area focussed upon the shallower seams, located both within the Lower, Middle and Upper Coal measures (in the centre of the syncline, which corresponds to the base of the valley), and the outcrops of coal in the seams of the Limestone Groups (located along the edges of the syncline in topographically higher areas). These workings were dewatered where required via shallow drainage adits. Table 2.1 provides a summary of the main recorded adits utilised during the mining of the Bilston Glen area, and levels of each of the adits relative to ordnance datum. These adit levels may present the potential decant points for mine water decant during rebound dependent upon mining roadway connections and within mine flow restrictions.

Drawing 47068917/Figure 1 is provided for further information regarding the location of the adits.

Table 2.1Summary of adit locations across Bilston Glen

Adit / Day Level Name	Receiving watercourse	Shallow / Deep mining units	Details	Level (mAOD)
Glenesk	North Esk	Shallow	No flow: potential blockage in adit or hydraulically separate to other shallow workings	40
Eldin/Elginhaugh	North Esk	Shallow	Flow approx. 30 l/s	48
Junkies/Old Fordell	South Esk	Deep	47 l/s*[1]	37*[2]
Bryan's	Ochre Burn	Deep	No discharge	51*[2]
Burghlee	Bilston Burn	Deep	Reported as filled	110
Roslin	Kill Burn	Deep	Reported as filled	Not known
Vogrie No 1 & 2*[3]	Gore Water	Deep	12 l/s*[1]	150

*Note 1: Flow reported in WYG 2012

*Note 2: Adit levels of Junkies and Bryans are reported as 150ft (46m) and 200ft (61m) AOD in the IMC 1998 report but as 121ft (37m) and 167ft (51m) in recent correspondence from the Coal Authority. The Coal Authority data has been used in this report, which makes Glenesk Adit topographically above Junkies, whereas the IMC report makes it below Junkies.

*Note 3: Does not discharge into the Bilston Glen coalfield.

There are two key watercourses that flow over the mine site as referred to in Section 2.1; these are the North Esk, which flows in a SW to NE direction through the valley, and the South Esk, which flows S to N. The two rivers join to the north of the mine site at an elevation of 25m AOD prior to flowing into the Firth of Forth. A series of smaller tributaries to the rivers have been identified; the most notable of which are listed below:

- Tributaries of South Esk:
  - Ochre Burn.
  - Dalhousie Burn.
  - Mary Burn.
  - Queen Margaret's Burn.
- Tributaries of North Esk:
  - Bilston Burn.
  - Kill Burn (via Bilston Burn).

Each of these watercourses were assessed during the site walkover (see Section 5) with respect to approximate flow rate and location(s) for flow gauging if required, and for potential mine water impact from seepages and / or mine related drainage.

2.5 Mine workings connectivity

As discussed in the preceding sections, the mine workings consist of both shallow and deep workings, which can be further sub divided into five key categories, based on the location of the mines, which are summarised in Table 2.2 below.

Table 2.2 Mine workings of Bilston Glen

	Mine Workings	Collieries Mining each unit
Shallow Mine Workings	In the centre of the 'syncline valley' (termed the Elginhaugh Mining Block). From mining of the shallow Upper Carboniferous 'Upper, Middle and Lower Coal Measures'	Glenesk Polton Whitehill
	Along the western limb of the syncline. From mining of the shallow outcrops of the 'Upper and Lower Limestone Groups and the Limestone Coal Group'	Burghlee Ramsaay Roslyn Mavisbank*Note 1
	Along the eastern limb of the syncline. From mining of the shallow outcrops of the 'Upper and Lower Limestone Groups and the Limestone Coal Group'	Easthouses Lady Victoria Lingerwood
Deep Mine Workings	Along the eastern limb of the syncline and beneath the Elginhaugh Mining block of the deeper coal measures of the 'Upper and Lower Limestone Groups and the Limestone Coal Group'	Easthouses Lady Victoria Lingerwood
	Along the western limb of the syncline and beneath the Elginhaugh Mining block of the deeper coal measures of the 'Upper and Lower Limestone Groups and the Limestone Coal Group'	Bilston Glen

Note 1: Limited information is available / has been provided for Mavisbank, aside from the interconnectivity of the mine with the shallow mines of the western limb.

The degree of connectivity of these workings remains uncertain, but based on review of available literature (see Reference section) the following assumptions have been made by URS:

- Due to both the shallow and deeper workings of the Upper Limestone, Limestone Coal and the Lower Limestone measures (Table 2.2) mining the same coal seams, there is a high potential for a range of hydrogeological connections to have existed and still exist between the Upper Limestone and Limestone Coal measures, and the Lower Limestone. Mine water within the shallow workings of the Limestone measures may be surface sourced (via inflow through workings or

natural fissures) or groundwater sourced (via rising ground water) or potentially a combination of the two.

- Limited hydrogeological information (such as levels and water quality) is available for the shallow workings within the Upper Limestone and Limestone Coal measures, and the Lower Limestone measures, due to the infilling of many of the shafts associated with these mines and physical cover by new developments. Limited borehole data is available for the areas.
- Polton and Whitehill (and possibly Glenesk) shallow mines within the centre of the mining area are connected via the Eldin Day level that discharges water from the shallow workings of the Upper, Middle and Lower Coal Measures northwards into the North Esk. It has been reported in the WYG April 2005 report that there are 'probable connections' between the Productive Coal Measures workings and the Limestone Measures. This was based on evidence of water discharging at Junkies (a drainage adit for the Limestone Measures). URS believes that flow from Junkies adit does not necessarily suggest connectivity between the two workings. This is based upon a 500m lateral / vertical extent of low hydraulic conductivity Passage Grit between the units, and even taking into account faulting of the units, URS believe it unlikely that a connection between the two units will have been established a view which was shared by The Coal Authority. It is more probable that water within the shallow workings of the Coal Measures and the Limestone Measures are hydrogeologically and geologically distinct (i.e. central and outer working of the Coalfield). This is supported by the chemical data of the mine water, as presented in Section 4.
- Glenesk adit is located a few hundred metres east of Eldin adit, and is reportedly dry. At 40m AOD, Glenesk adit is the second lowest recorded adit level within the Bilston Glen mine area, being lower than Eldon which is discharging mine water. It is currently unclear as to why there is no discharge at Glenesk; suggested reasons are either a blockage in the adit, or Glenesk mine could be hydrogeologically separate to the Polton mine workings and the other shallow mines of the area, however, this is unclear from the detail of the mine plans provided. It is possible that water from the Glenesk mine is discharging to Eldin, as water levels should have recovered to equilibrium across all the shallow workings; however, the lack of hydrogeological and mining connectivity between the two mines does not support this.
- Burghlee, Ramsaay, Roslyn, and Mavisbank are known to be both physically and hydrogeologically interconnected within the western limb of the syncline, having all mined shallow outcrops of the Limestone Measures, with the mine shaft depths ranging from 119m to 351m below ordnance datum. Although limited data is available in this area, there are no visible 'mine water break outs' in the area. Therefore these workings may drain into the deeper Bilston Glen mine workings, but this is unconfirmed. In addition, water levels in these workings are unlikely to have reached equilibrium with the deeper workings and therefore may still be dry especially if underdrained. There is a possibility that, as with the eastern workings, that there may be surface water recharge to the shallow mines in the western outcrops, especially given that Bilston Burn and Kill Burn flow over and adjacent to the historic shallow workings in the Burghlee mining area. The Coal Authority has informed URS that these watercourses are culverted through the

Burghlee area of the site, though the condition and integrity of these culverts is unclear.

- Easthouses, Lady Victoria and Lingerwood are deeper mines in the eastern section and are interconnected at both shallow and deeper depths. Easthouses shaft is reported to be connected to the Lingerwood and Lady Victoria mines via the Parrot and Great Seams, and to Bilston Glen via the Great Seam.
- Bilston Glen is a deeper mine, and has various connections beneath the Elginhaugh Mining block with the workings of the Great Seam at Easthouses.

Drawing 47068917/Figure 2 has been produced as an indicative cross section of levels of interconnections and drainage levels. It is not to scale however indicates relative depths of shafts, interconnections between the shafts via workings and potential decant levels from adits.

3 MINE WATER REBOUND

3.1 Mine water Levels

Water levels in the mine were controlled during the operational phase via a network of deep pumping shafts in the western and eastern deeper workings. Bilston Glen was the deepest shaft of the mining complex at a depth of 600m BOD, to the west of the mining area, and Easthouses managed the water within the eastern mine area (the depth of the shaft is unknown). Both pumps were required to manage the water levels in the mining system. Although the hydraulic gradient / flow was from west to east (towards Easthouses in the east of the syncline), pump rates were highest from the Bilston Glen Shaft during the operational phase (circa 5000 litres per minute versus the combined Easthouses/ Lingerwood/ Lady Victoria workings of circa 3800 litres per minute). This is because the Bilston Glen workings extended deeper into the Lower Limestone Measures compared to the workings to the east of the syncline.

Rebound has been previously evaluated via assessment of water levels in all available shafts and by the visual assessment of potential decant points such as shafts and adits. This has been complicated by the fact that many of the shafts have been infilled after the cessation of mining, and that adits that should in theory be discharging are dry due to potential blockages.

Current levels within the shallow Upper, Middle and Lower Coal mine workings, and the deep Upper Limestone, Limestone Coal and Lower Limestone mine workings (as of data reported in April 2005 and October 2013 respectively) are:

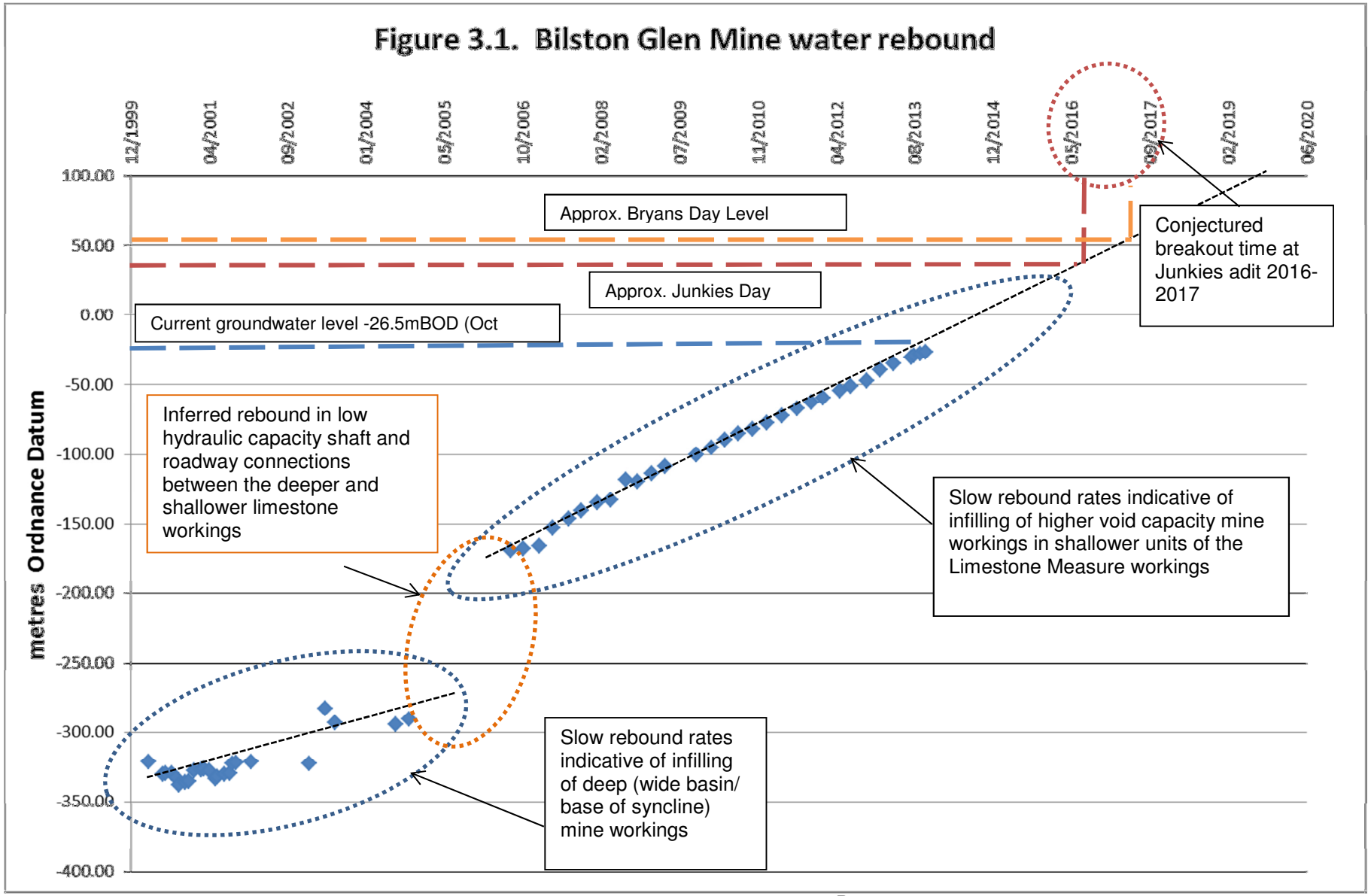
- 51m AOD: North Esk Shaft (shallow).
- 26m BOD: Bilston Glen and 28m BOD: Easthouses (deep).

Levels in the shallow workings of the Productive Coal Measures are assumed to be at equilibrium, with rebound essentially completed. Water from these mines is currently draining from the Eldin Adit at Elginhaugh (48m AOD).

With regards the Limestone Measures, the similarity between the levels in Bilston Glen and Easthouses suggests that the workings beneath the Elginhaugh Mining complex (to the centre of the syncline) maintain at least one hydraulic connection to be presenting such similarity in rebound. Based on these levels (as of October 2013) there is a minimum of 72m between the water levels in the deeper mine workings, and the level of the lowest adit/ potential decant point of the deeper workings (Junkies; 37m AOD).

Bilston Glen mine closed in 1988/89 and URS assumes that mine water pumping will have stopped around the same time. Easthouses closed in late 1969, and therefore Bilston Glen would have been dewatering the entire set of the deeper workings for the period 1969 to 1988/89. Water level data from the Bilston Glen shaft has been collected from March 2000 onwards, with rebound rates very slow until 2004/05, at which point there was a sharp rise in groundwater levels during a 2 year period until 2006. This is presented on Figure 3.1.

Figure 3.1. Bilston Glen Mine water rebound



It is presumed that initial water level data from 1998/89 to 2004/05 relates to the time when the deeper level high void capacity mine workings filled. Fig 3.1 shows the higher void capacity in the initial years of recharge, relating to low recharge rates. Subsequent to this, rebound rates increased as the limited connections (shafts and roadways) between the deep and shallow workings Upper Limestone, Limestone Coal and Lower Limestone workings flooded. It is currently assumed that the shallow Limestone Measures workings of the Burghlee, Roslin etc on the western side, and Lady Victoria, Lingerwood and Easthouses to the east are now in the process of filling. Current rebound rates during this time (2006 onwards) have been steady, and on average circa 21m pa.

Based on this current rate of recharge (2006 to present), breakout at Junkies is likely to occur within 3 years.

3.2 Potential Decant Points

As discussed previously, the key decant/ break out points of mine water will be at the drainage adits and through any shallow workings where connections still exist.

It is currently anticipated that mine water breakout will occur to the east of the mining area initially, prior to the west, as the area is topographically lower than the west and hence the shallow workings and adits are also at a lower relative level as compared to the west.

The identified locations of potential decant points have been sub divided into the east and west and are discussed in this order below. The locations are discussed in what URS sees as the potential order of mine water break through at each of the locations, although without further investigations on the connectivity of Junkies Day level to the eastern mine workings, then this order is subject to change.

Note that Glenesk has been included in the potential decant points list as there is very little information available regarding this mine at this time. The mine workings are geographically closer to the eastern shallow workings of Easthouses and Lady Victoria than the Polton and Whitehill workings, and if any connection does exists from historic shallow mining, then Glenesk may become a decant point for the deeper mine water.

EASTERN AREA:

3.2.1 *Junkies Adit / Old Fordell (Dalkeith town)*

This adit is located in the town of Dalkeith, and is currently noted to be discharging ochreous water at a rate of approximately 46l/s (WYG, Overview of Mine Water in the UK Coal Fields, 2012) to the River South Esk. This is an adit designed to drain the Upper Limestone, Limestone Coal and Lower Limestone Measures, and therefore one would not expect a discharge from this location, as the adit is above the head level of rising mine water. URS considers it unlikely that: a) the water at Junkies is rebound from the deeper limestone workings, and b), that there are interconnections between the shallow workings at Polton and Whitehill with the shallow workings of any of the Limestone Measures, then the source of the water at Junkies is unaccounted for.

URS considers that there are two possible sources of the water at Junkies; these are:

1. Surface water entering the shallow workings of the Lingerwood/ Lady Victoria/ Easthouses mine system. The chemistry of the mine water at Junkies supports a low residence time of the water within the mine workings (section 4) and therefore supports the interpretation that it is not a deeper mine water. Assessment of historic maps along

the line of the shallow Junkies Day level has identified several old shafts and air shafts which are in line with the day Level. Although there are no specific sources of water identified in this review that may be feeding the level, the large areas of backfilled shallow workings may indeed be acting as a conduit for groundwater to enter the workings and the level.

2. The mine workings that drain to Junkies adit are in fact hydro-geologically separate to the deeper Limestone Measure workings and/ or to shallow Limestone Measure workings to the south of Junkies day level. There are both deep and shallow workings of the same Limestone Measures, which URS have assumed to be connected; however this may not be the case. Hydrogeological separation may have occurred through workings and/ or connections collapse or simply that the deeper workings of the Limestone Measures were not connected to the shallow workings of the Limestone Measures at any point. If this is the case, then the mine workings within the shallow Limestone Measures may have rebounded and stabilised, such as what has happened at the Arniston mine, which is described later in Section 4 of this report.

   Therefore, it is anticipated that the discharge water at Junkies is NOT from the deeper mine workings (as the discrepancy in mine water levels indicate), but either from surface water infiltration into the shallow workings of the deeper coal measures or that the workings that drain Junkies are hydrogeologically separate to Easthouses/ Lingerwood/ Lady Victoria.

   It has been suggested by the Coal Authority that when water levels are stabilised within the deeper workings, the flow rate from Junkies adit will increase, and the water quality will decrease. URS considers it possible that flow rates will increase if the water levels in the deeper workings are not controlled, however it is unlikely that controlling the water levels will actively reduce the flow at Junkies adit if it is receiving primarily above adit drainage.

   Topographically, this is the lowest adit, and should connections exist between the deeper and shallow workings within the limestone then it is anticipated that this will be the first outbreak point of mine water from the deeper mine workings.

   The impacted receptor would be the South Esk River.

3.2.2 *Bryan's Adit (Easthouses Colliery)*

This adit is located along the banks of Ochre Burn, a tributary to the South Esk. The level of the adit is reported as 51mAOD and is currently dry (January 2014). This is an adit designed to drain the workings of Lady Victoria and Lingerwood, via either gravity draining of the shallow workings above, or used as a pumping level for deeper workings. The level drains the workings in an approximate SE to NW direction.

One would not expect a discharge from this location currently, as the adit is above the head level of rising mine water. Given the unknowns relating to the interconnections between the Junkies Day Level and the deeper workings, it is possible that the first decant point may be Bryan's adit. Without further field based assessment of the Junkies day level, then, even though Bryans has a much higher elevation, the potential for Bryans adit being the first decant point for the deeper mine water cannot be discounted.

The impacted receptor would be Ochre Burn and the South Esk River.

3.2.3 ***Various shafts adjacent to the Easthouses colliery***

The area concerned is highlighted on Drawing 47068917/Figure 1. Assessment of old mine records has highlighted a large number of shafts that were sunk to the south and east of the Easthouses colliery, in order to access the shallow coal prior to the sinking of the main Easthouses shaft. Many of these will be shallow, and have been disused for many years, being infilled as the coal was exhausted. However, depending on the location / level of these shafts, there is the potential that these shafts, or relating mine workings will become flooded during recharge and breakout of mine water may occur.

WESTERN AREA:

3.2.4 ***Burghlee / Roslin adits***

Burghlee and Roslin adits are two adits that are recorded to have been used to dewater the shallow Limestone sequences on the western side of the syncline during the shallow mining in the area. URS holds limited information regarding these adits, which is summarised in the following three points:

- The mine workings and shafts relating to Burghlee have been covered by Bilston tip (presumed to be colliery spoil from the Bilston Glen mining operations but unconfirmed), therefore severely hindering the assessment of any mine water discharges or upwellings
- Burghlee and Roslin adits may have been filled alongside the related mine workings and shafts used during the extraction of the shallow coal in the area.
- Burghlee adit is reported to be on the banks of Bilston Burn at 110m AOD; during a recent site visit (URS, January 2014) the adit was not located, however there was no evidence of mine water impact in Bilston burn downstream of the mine, suggesting that the adit had not been discharging mine water

Based on the relative level of Burghlee shaft to the adits on the east of the mine site, it is unlikely that mine water would discharge at this point prior to the lower level adits of Junkies and Bryans. It is likely that these levels are underdrained by the deeper workings at Bilston Glen.

The impacted receptors would be the Bilston Burn and Kill Burn which are Sites of Special Scientific Interest.

4 MINE WATER GEOCHEMISTRY & FLOW RATES

4.1 Background & Development of CSM

Following the identification of potential decant points (as summarised in Section 3), of key importance for the preparation for, and long term management of the mine water within the Bilston Glen coalfield is an understanding of the anticipated chemistry of the mine water, and discharge volumes.

In order to develop a robust CSM based on our current understanding of the Bilston Glen Coalfield, a full assessment of the anticipated deep mine water geochemistry and predicted flow rates must be made. As URS do not believe that the deep mine water is discharging at any point within the Bilston Glen coalfield, both of these elements must be estimated based on available data.

The available data that has been used for this assessment is taken from three sources:

- Within the Bilston Glen Coalfield:
  - Eldin adit (Elginhaugh).
  - Junkies adit (Old Fordell).
  - Bilston Glen Shaft.
- The Monktonhall colliery shaft (to the north of the site).
- Vogrie adits 1 and 2 (draining Arniston colliery to the south of the site).

Eldin adit and Junkies Adit have been discussed earlier in this report. Mine water discharging from these locations is considered as representative of the Shallow Coal Measures (Upper Carboniferous) and the shallow workings of the Limestone Groups (Upper and Lower Carboniferous) respectively.

Samples from Bilston Glen were recovered at various depths in relation to different horizons of the mine workings (220m to 610m) from the original pumping shaft, with water samples taken at different levels in the shaft in order to be indicative of the water in the separate workings. The Coal Authority has advised that the samples may not be representative of the true water quality within the mine workings, and are planning on repeating the sampling exercise.

Workings of Monktonhall are not believed to be hydrogeologically interconnected to the Bilston Glen coalfield; Monktonhall colliery workings are located to the north of the Sherriffhall fault, which acts as a hydrogeological barrier to the Bilston Glen coalfield. Similarly, the workings of Arniston mine are believed to be separate to the workings of Easthouses / Lingerwood / Lady Victoria mines. Albeit that these mines are not connected to the Bilston Glen coalfield, both are known to have worked the same strata as those of Bilston Glen, and the mine water chemistry in these workings is therefore relevant and has been used in this assessment.

Monktonhall mine was a very deep mine (with the deepest shaft extending to circa 900m below ground level), and worked both the shallow Coal Measures (Upper, Middle and Lower Coal Measures) and deeper Limestone sequences (Upper Limestone, Limestone Coal and Lower Limestone groups). The workings of both these shallow and deep sequences are believed to be interconnected in this mine (WYG 2012 report). Water levels within the mine are currently being controlled via pumping, and held at approximately 75 to 80m below ground level. The pump head is at 100m below ground level (all information via pers. comm. Coal Authority). There are no identified drains /

adits from the shallow workings of Monktonhall, which would indicate that the mine workings are interconnected between the shallow and the deep workings, then it is probable that mine water within both the shallow and deep mine workings can be classified as one unit. It is therefore likely that the pumped water from the Monktonhall workings consists of both shallow and deep mine water, with the pumps essentially 'skimming off' the mine water from the workings of the combined shallow and deeper mined Coal Measures.

Conversely, water that discharges at the Vogrie adits from the Arniston mine drains from the shallow workings of the Limestone Measures only. There are two adits relating to Arniston, both of which are connected to the same level of the Arniston pumping shaft. The Arniston mine was a relatively shallow mine as compared to the Bilston Glen and Monktonhall mines, with the deepest shaft extending to circa 210m below ground level. The last mining in the area was completed in 1962. It is therefore accepted that mine water will have fully rebounded in these workings. Mine water discharging from these mines will be indicative of the mine water in the deeper workings of the Upper, Limestone, Limestone Coal and Lower Limestone measures, as the shallow Limestone measures worked at Arniston within the rising limb of the syncline is the same geology as the deeper geology at the base of the syncline.

4.2 Geochemistry Assessment of Mine Water

Mine water quality data has been assessed from each of the mine sites (where available). Similarities and differences in the chemical data have been used in order to identify the mine water pool or pools source of each data set. The following sections provide a discussion of the geochemistry of each of the mine waters (4.2.1 to 4.2.5), and section 4.3 offers a summary is provided below, and a Piper diagram, which is a graphical representation of the chemistry of a water sample, has been used to visually present the similarities between the mine water data.

A summary of the terminology used with regards to alkalinity and acidity balance is provided in the summary below to aid discussions regarding the mine water chemistry and treatability in the following sections.

1. **Total alkalinity**: A concentration measure of the carbonate and bicarbonate concentration in a water
2. **Total acidity**: Total Acidity of the mine water which is the sum of the acidity generated from the **protons (H+ ions; i.e. pH)** and the **carbonic acidity**. The carbonic acidity can be classed as a measure of the 'temporary' acidity generated due to dissolved carbon dioxide in the mine water. This carbon dioxide forms carbonic acid and increases the acidity.
3. **Net Alkalinity**: Expressed as the difference between the alkalinity and total acidity (alkalinity – acidity) and generally expressed as a positive figure. A net alkalinity of zero indicates that the mine water has no buffering capacity and may be net acidic (see below).
4. **Total NET Acidity**: As per 3 above, but is expressed as the difference between the total acidity and alkalinity (acidity-alkalinity) and can be either a positive or negative figure. A negative net acidity indicates that the mine water is net alkaline and has a buffering capacity, however a positive figure suggests that the water is net acidic.
5. **Mineral Acidity**: This is a calculated value and based upon those metals that are readily hydrolysed and oxidised within the mine water, generally comprising acidity generated from Fe, Mn, Al and Zn.
6. **Mineral Net Acidity**: As above but expressed as the difference between the mineral acidity and the alkalinity (acidity-alkalinity). A negative net acidity indicates that the mine water is net alkaline.

   Note: Net Acidity - The net acidity is a calculated value, and is indicative of the acidity based on the metals only without any carbonic acid effects. This is a 'best case scenario acidity' and is a measure of the difference between the mineral acidity and the alkalinity; it does not take into account carbonic acidity.

4.2.1 ***Elginhaugh mine water***

The Eldin Day level (at Elginhaugh), situated around the centre of the Bilston syncline, is proposed to drain the majority of the shallow mine workings of the Coal Measures. Mine water chemistry data is available from 1996 to present.

Based on the Coal Authority mine water quality data, the mine water is net alkaline and ferruginous with a slightly acidic pH. The iron is primarily present as ferrous iron suggesting that the mine water is reduced and has low oxygen content. The iron concentrations draining the workings have been highly variable (range from 2.3mg/l to 77.9mg/l, with a mean of 53.6mg/l) with a tentative downwards trend. Manganese is also elevated in this mine water, with an average concentration of 7.9 mg/l and a maximum of 9.9 mg/l. Mineral acidity, as calculated from the metal data in the mine water, suggests that the mine water is net alkaline, with a mean mineral acidity of 103.7mg/l (as CaCO3) and mean alkalinity of 175mg/l (as CaCO3).

Flow rate data from the adit has been provided from 1996 to 2005, with flow rates at the breakout time of 80l/s; flow rates have since decreased and currently range between 10 and 25l/s.

4.2.2 ***Junkies Adit***

Junkies Day Level drains the northern area of the shallow workings of the Easthouses/ Lingerwood/ Lady Victoria workings of the Upper Limestone, Limestone Coal and Lower Limestone Groups. Mine water chemistry data is available from 1998 to 2007.

Based on The Coal Authority mine water quality data, the mine water is strongly net alkaline and ferrugenous with a slightly acidic pH. The iron is primarily present as ferrous iron indicating that the mine water is reduced and has low oxygen content. The iron concentrations draining the workings have been highly variable (range from 0.5mg/l to 8.6mg/l, with a mean of 5.7mg/l) with a tentative increasing trend, but recent data will be required to confirm this trend. Manganese is also elevated, with an average concentration of 1.9 mg/l and a maximum of 2.25mg/l. It should however be noted that the last chemical data quality was taken in 2007, and therefore the mine water quality may have changed between 2007 and present.

A flow rate dataset has not been provided for this report, however a spot flow measurement has been provided in the 2012 WYG summary report of 46l/s. URS is unaware of how representative this flow rate is of the typical flow rate from this adit, however during the URS/ CA site visit (January 2014) a visual estimate of the flow from the adit was 20 to 50l/s.

4.2.3 ***Bilston Glen Shaft***

Bilston Glen shaft extends into the deep limestone workings and is interconnected to the workings that lie beneath the Elginhaugh mining bock. It is presumed that there are interconnections between this shaft and the shallow Limestone workings, although this is unconfirmed.

Mine water from the Bilston Glen shaft has been sampled from various levels within the shaft. One set of data is available from 2012; however the Coal Authority has suggested that this may not be representative of the mine water chemistry in the deeper limestone workings. The mine water within the workings is currently rising at a rate of circa 20m pa, with the water currently believed to be flooding the shallow mine workings of the Limestone Coal Measures (see Figure 2.1).

Analysis of the chemistry of the mine water demonstrates that this water is characteristic of a deep groundwater, but there is little evidence of mine related contaminants in the analysis. Both the iron and sulphate concentrations in the water are very low (iron <1mg/l), both of which are in general characteristically much higher in mine waters (receiving surface inputs with a diluting effect or inflow into the shaft). The water is net alkaline, with an average alkalinity of 507mg/l (as CaCO3), which is considerably higher than the water draining Eldin and Junkies adit, and from Monktonhall and Vogrie adit. Of note are elevated levels of the ions chloride and sodium, and the trace elements barium and strontium in the mine shaft water relative to the other mine waters assessed over the Bilston Glen Coalfield.

The elevated sodium chloride signature is characteristic of either:

- Sea water intrusions through the deep limestone aquifer units; or
- Natural saline connate groundwater from during the deposition of the limestone sediments (most likely provenance).

However, based on a low magnesium to calcium ratio in the Bilston Glen water, (which is characteristic of a natural groundwater rather than sea water) and the elevated strontium and barium (which are characteristic of the dissolution of limestone strata at depth), it is considered probable that the water in Bilston Glen is a deep natural groundwater in the limestone. Further analyses will be required to fully assess the degree of first flush and long-term salinity. This is an important factor as if the preferred option is the pumping of the deeper ground/ mine waters then this may increase the salinity in the pumped water.

The low metal loading in Bilston Glen may be due to stratification of the mine water in the mining system, with metal rich mine waters retained at depth beneath the 'cleaner' groundwaters; as rebound continues it is anticipated that more metal rich mine water will rise to a higher level in the shaft.

Further assessment and analysis will be required.

4.2.4 *Monktonhall*

Monktonhall shaft is situated to the north of the Sherriffhall fault and is believed to have driven through the shallow worked Coal Measures and into the deeper Upper Limestone, Limestone Coal and Lower Limestone Groups. The mine water is currently pumped from this location, with mine water chemistry data available from 2000 to 2013. Both the shallow Coal Measure strata and the deeper Limestone Groups were worked during the operation of Monktonhall.

Based on The Coal Authority mine water quality data, the mine water is net alkaline and ferruginous with a slightly acidic pH. Recent data (late 2006 to 2013) indicates that the iron is primarily present as ferrous iron indicating that the mine water is reduced and has low oxygen content. The iron concentrations in the workings have been highly variable and scattered (range from 0.1mg/l to 86.7mg/l, with a mean of 45.3mg/l), but recent data from 2013 suggests a more stable iron loading, with a lower average iron of 26mg/l iron. Manganese is also elevated, with an average concentration of 3.1mg/l and a maximum of 4.6mg/l.

As with the Bilston Glen shaft water, there is an elevated chloride signature, but this is highly variable and ranges from 10mg/l to 294mg/l, with an average of 146 mg/l. This high variability in the chemical determinands suggests an unstable system that may be affected by variation in pump rates, and stratification in the mine systems.

4.2.5 ***Vogrie adits (No 1 and 2)***

There are two adits at Vogrie (namely 1 and 2) both of which are believed to drain from the same shaft of the Arniston mine. The adits drain the shallow workings of the Arniston mine of the Upper Limestone, Limestone Coal and Lower Limestone Groups. Mine water chemistry data is available from 2007 to late 2013 for the adits.

Based on the Coal Authority mine water quality data, the mine water is net alkaline and ferruginous with a slightly acidic pH. The iron is primarily present as ferrous iron indicating that the mine water is reduced and has a low oxygen content. The iron concentrations draining the workings have been somewhat variable from Vogrie 1 (range from 0.3mg/l to 25.3mg/l, with a mean of 5.9mg/l total iron) and more stable from Vogrie 2 range from 1.6mg/l to 7.7mg/l, with a mean of 4.3mg/l total iron). However, it should be noted that two peak concentrations of circa 25mg/l iron in Vogrie 1 relate to much lower ferrous iron concentrations (5.5 and 12.2 mg/l respectively) suggesting that the high samples are spurious and may relate to iron ochre flocs. Manganese is also elevated, with an average concentration of 2 mg/l and 2.5mg/l in Vogrie 1 and 2 respectively.

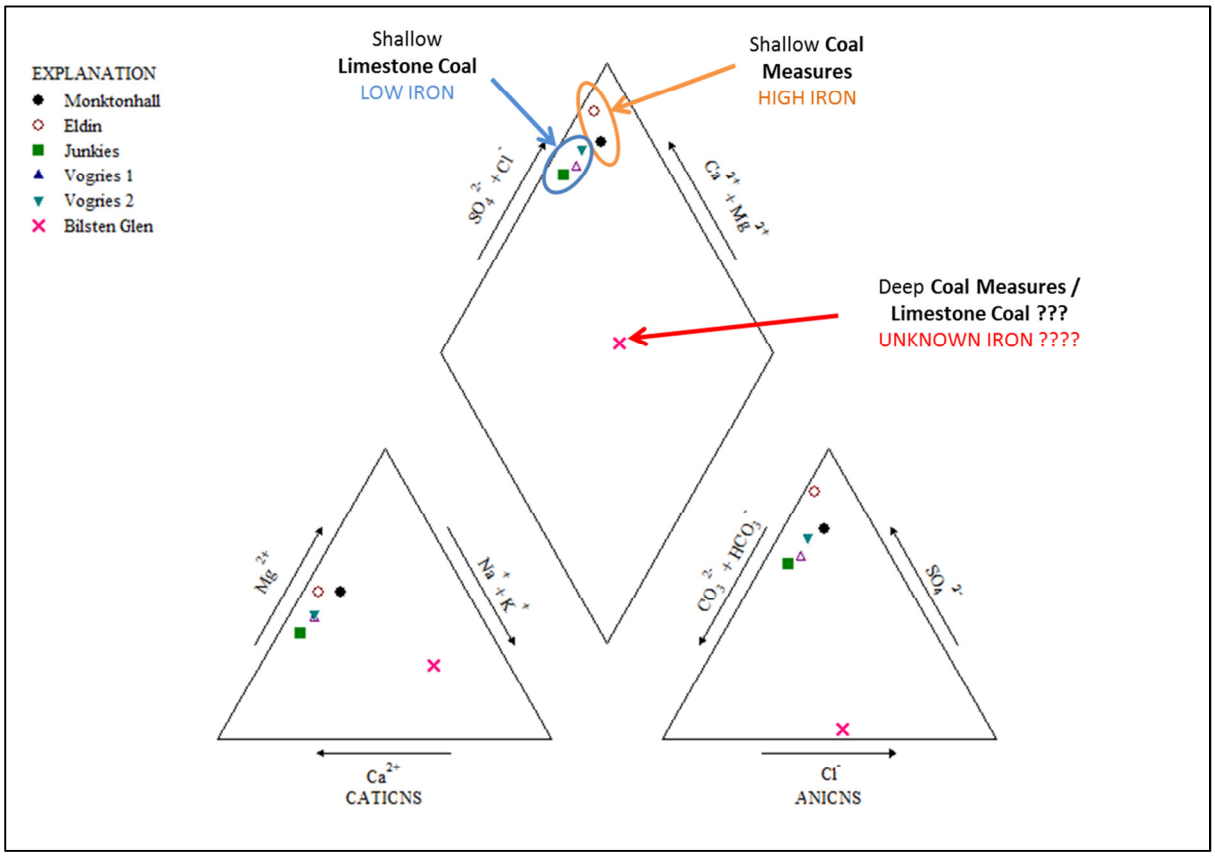
A flow rate dataset has not been provided for this report, however a combined 'spot flow' measurement has been provided in the 2012 WYG summary report of 12 l/s. URS is unaware of how representative this flow rate is of the typical flow rate from these adits.

4.3 Geochemistry Summary

In order to try to identify the mine pool(s) that each mine water originated from, an In order to try to identify the mine pool(s) that each mine water originated from, an assessment has been made using a Piper plot. The Piper diagram plots the major ions (total cations and the total anions) in the mine water, with the plot presenting relationships between water samples, with clustered data points indicating samples that have similar compositions.

For this Piper diagram, the major anions and cations, including the alkalinity, are used to identify similarities between the samples; however metal loading data (such as iron and manganese) is not accounted for. The piper plot for the mine waters assessed is presented in Figure 4.1

Figure 4.1 Piper plot to illustrate difference in chemistry between the mine waters



Based on this initial assessment, all mine waters except for the water from the Bilston Glen mine shaft appear to be of a similar composition. The marked difference between the Bilston Glen compared to the other mine waters is due to the higher salinity and low sulphate in the Bilston Glen water. This is characteristic of deeper ground waters and / or saline waters and is to be expected.

However, further interrogation of the data on the piper plot, including grouping samples based on iron concentrations, then differences in the mine water can be identified. Monktonhall and Eldin water quality group together, as do mine water from Junkies and Arniston. This can be explained by Monktonhall having shallow level interconnections with the shallow workings of the Upper, Middle and Lower Coal Measure mine workings, and the Eldin level drains from these shallow Coal Measures only, so this supports the hypothesis that Montknohall is pumping water from the shallower Coal Measures strata. Junkies and Arniston however both have low iron concentrations, and are characteristic of shallow Limestone Coals.

Based on assessment of the raw chemical data, the water from the two geological units appears to be markedly different, with more acidic metal rich mine waters associated with the Coal Measures, and more alkaline low metal waters associated with the Limestone Measures. What is not known however are details of the chemistry of the water in the deeper limestone workings of the Upper Limestone, Limestone Coal and Lower Limestone Measures. It stands to reason that long term, the water quality will not be dissimilar to that of the shallow limestone workings; however as the residence time of the water in the deeper workings is currently much longer than that in the shallow workings, this will have allowed greater dissolution of any iron / metal bearing minerals. This results in the commonly encountered first flush scenario when waters first outbreak from deeper workings.

Therefore, based on the given CSM, and with regards to treatability, URS considers that the chemistry of the deeper mine water in the limestone workings could fall into one of three types of mine water categories; these are:

- Worst case scenario: High iron, low alkalinity, low pH.
- Most probable case scenario: Medium iron, high alkalinity, slightly acid pH.
- Best case scenario: Low iron, high alkalinity, slightly acid pH.

The 'worst case' scenario water quality is based on the maximum recorded iron concentrations and lowest pH and alkalinity measured in the data assessment from both the shallow Coal Measures (notably the 'worst quality' mine water) and the shallow Limestone Measures (better quality) and represents 'first flush' conditions. The 'most probable' relates to the maximum iron and lowest pH and alkalinity (and represents the possible long-term condition) and the 'best case' is the average iron, pH and alkalinity .

These are summarised in the table below (Table 4.1).

Table 4.1 Mine water chemistry options appraisal summary

	WORST CASE (Maximum iron & acidity, lowest pH & alkalinity)	**MOST PROBABLE CASE** (Average iron & acidity, lowest pH & alkalinity)	**BEST CASE** (Average iron, acidity, pH & alkalinity)
Total Iron (mg/l)	86.7	19.3	19.3
pH	5.8	5.8	6.7
Alkalinity (mg/l)	127	127	265
Acidity (calculated as mineral acidity) (mg/l)	127.4	49.6	49.6

The treatability of this mine water will be discussed in section 7.

4.4 Mine Water Flow Rate at Potential Decant point (s)

Historic pumping rate data and flow data is available for the following locations:

- Eldin adit flow.
- Junkies adit flow.
- Easthouses/ Lady Victoria/ Lingerwood/ Bilston Glen pumping rates.

Mine water is currently rebounding within the Bilston Glen coalfield, with the groundwater within the shallow workings believed to be at equilibrium, whereas the mine water in the deeper workings continues to rise.

There are currently two recorded discharges within the Bilston Glen Coalfield; these are:

- At Elginhaugh, which is sourced from the shallow workings within the Coal Measures with a flow of 10 to 20 l/s.
- At Junkies, which is sourced from the shallow workings of the Limestone Group, with a flow of approximately 50 l/s.

The flow rate at Elginhaugh was first recorded in 1996 at 80l/s which probably relates to the first flush after breakthrough, whereas the flow rate over the last 20 years has been relatively stable with any fluctuations during that time probably relating to surface water infiltration effects rather than variations in mine water levels. Limited flow data is available for Junkies adit, however based on the assumption that the water discharging at Junkies is surface sourced, it is anticipated that long term monitoring at Junkies would yield variable flow rates, relative to precipitation rates, as it is not considered that water at Junkies is from the deep mines.

No other mine water issues have been identified, both from literature searches and from the URS site visit in January 2014.

Pumping rates, as covered in Section 3, during the operation of the mine were highest from the west from Bilston Glen at circa 86l/s, primarily it is thought as the mine workings were deeper in this area. Pump rates were lower from the individual mines of Lady Victoria / Lingerwood, and Easthouses, at 26l/s and 37.5l/s respectively. Note Lady Victoria and Lingerwood were dewatered as one unit.

In order to gauge the pump rates required to maintain the water level in the deeper workings below the lowest discharge / decant point (Junkies), previous Coal Authority experience suggests that the long term pump rates will be in the order of 30% of the original pumping rates from during the operation of the mine (Coal Authority, pers. comm.). Based on this relationship, then 30% of the combined pump rate measured during the dewatering of the mine system will be circa 45l/s.

The source of the high discharge rate at Junkies day level is not completely understood; it is possible that maintaining the levels at the current level (between 0 and 50m below OD) will have little or no impact on the discharge rate at Junkies. Given the fact that mine water has flowed from Junkies since at least 1998 (when the first chemical data has been provided) then it is likely unrelated to the deeper workings. However, without flow data from Junkies, and further data from a pumping test, then URS cannot draw any firm conclusions on the long term prognosis of Junkies adit.

Based on the limited information, URS suggest one of three scenarios for the likely pump rates and therefore treatment volumes to maintain the water level at 50mBOD; these are:

- Worst case scenario: Pump rate similar or same as the long term pumping rates from the Bilston Glen Coalfield: 150l/s.
- Most probable case scenario: Pump rate 30% of the long term pumping rates from the Bilston Glen Coalfield and including impact from surface water ingress through surface workings: 95l/s (50l/s surface water and 45l/s rising mine water).
- Best case scenario: Pump rate 30% of the long term pumping rates from the Bilston Glen Coalfield: 45l/s.

The amount of drawdown of the mine water levels within the limestone workings, and the free board required will need agreement with SEPA during the design of the pumping test.

5 SITE WALKOVER

A site walkover was carried out on the 23rd of January with Thomas Mills from the Coal Authority. The following key areas were assessed;

- The former Bilston Glen site area, including the former Burghlee mine site and the route of Bilston Burn.
- The Elginhaugh adit.
- The Glenesk mine site and adit.
- Junkies adit.
- The former Easthouses site area.
- Bryans adit and the route of Ochre Burn.

The aims of this walkover were to assess the potential decant points, as identified from the data review, and the suitability of the potential treatment site locations at Bilston Glen and Easthouses.

A short assessment of each area is provided in the following sub sections.

5.1 Bilston Glen

The former workings of the Bilston Glen mine are now almost entirely occupied by the Bilston Glen Industrial Estate. There is no evidence of the former usage of the site. The Upcast shaft has been infilled whereas the downcast has been capped, with manhole access available for water sample/ depth measurement purposes. The shaft entrance is located on a grass verge in front of Cromwells trade unit.

To the north of the industrial park, is the Pentland industrial estate, to the east open farm land and to the west farmland and residential housing. To the south and south east of Bilston Glen industrial estate are Bilston Glen and burn, and the Burghlee mine site. The industrial park is fenced around the perimeter; however access to the former Burghlee mine site and Bilston Glen Burn was gained via a footpath through the fenceline along the southern boundary of the industrial park. Bilston Burn flows along the southern boundary of the industrial park, and is situated within Bilston Wood, a heavily forested and vegetated area. There were several footpaths running through Bilston Wood, and several occupied 'tree dwellings' noted. It is believed that the 'tree dwellings' are occupied by activists from Edinburgh University who are against the Bilston bypass (A701), for which planning permission had been granted. It is thought that the route of the road has now been changed.

Bilston Burn is a substantial stream/ river with no visual or olfactory evidence of contamination either up or downstream of the Bilston/ Burghlee sites. The Bilston Glen area is a recorded SSSI. The burn is culverted beneath the mine spoil of the Bilston and/ or Burghlee mines. The flow rates / variance of flow are unknown however the area upstream of the culvert is liable to flooding (SEPA Flood risk mapping). The entrance to the culvert was not located due to dense vegetation; however the exit was located to the southeast of the Bilston industrial estate. Kill Burn, a stream originating south of the site is also culverted in this area, with the culvert exit located adjacent to the Bilston Burn culvert. Kill Burn and Bilston Burn join downstream of their respective culverts.

Burghlee mine site is situated to the south and east of the industrial park. No former mine buildings remain on the site, with the north of the site now occupied by various

buildings and caravans, although access was restricted so an assessment was not made of the northern area. The mine site is heavily vegetated by grasses, low levels bushes and birch. There is evidence of coal mine spoil at shallow level over the entire site. The area is used for recreational purposes, with several dog walkers encountered during the walkover and evidence of horse riding and mountain biking. There are several paths over the site. The main part of the Burghlee site is relatively flat, rising gently to the north, and steeply to the south down to a deeply incised valley through which Bilston Burn flows.

Burghlee adit was not located during the walkover; the grid reference provided was not correct, and access to the adit as marked on a plan was restricted due to the steep valley sides and unstable ground. However, no evidence of ochreous seepages were noted at any point downstream of the Bilston culvert, along the length of the river bank which would be impacted should the Burghlee adit be discharging.

Mine spoil from the Bilston mine is located to the south of Bilston Burn in a series undulating heaps. The spoil has been profiled, grassed and landscaped and is now grazed.

5.2 Elginhaugh

The Eldin adit is located at Elginhaugh, and is an adit that drains the shallow Coal Measures. The adit discharges directly into the River North Esk. Access was gained from the A7 bridge access road. Mine water was impacting the southern bank of the North Esk in several areas along an approximate 50m stretch of the riparian zone, with thick ochreous deposits forming along the bank. The Eldin adit was flowing at approximately 10l/s and entered the Esk via an ochreous spillway. There was visual impact of the Esk downstream of the adit.

The mouth of the adit was heavily overgrown, and flow gauging would likely prove difficult due to the deep ochre deposits and wide adit entrance.

5.3 Glenesk

The Glenesk mine site, located just outside the village of Eskbank, was undergoing engineering works during the site visit. It is thought that the works related to drainage works and/ or road construction (contractor BAM). The railway that served the mine site, running directly through the site, has been re-developed into a cycle/ walkway. Glenesk adit is located on the southern bank of the North Esk, adjacent to a large weir/ spillway. At the time of the inspection, there was no flow from the adit, nor had it any evidence of discharging previously.

5.4 Junkies Adit

Junkies adit is located in the town of Dalkeith, and drains the shallow workings of the Limestone Coal. The adit discharges directly into the River South Esk. Access to the adit was gained downstream of the Newmills bridge, and was located along the eastern bank of the river. The adit portal is constructed of brick, with an inner concrete chamber situated behind the portal into which the mine flows via a concrete drain. The adit was flowing at approximately 50 to 70l/s and entered the Esk via an ochre covered spillway. There was minimal visual impact of the Esk downstream of the adit.

Flow gauging should be relatively straightforward at the discharge point from the concrete chamber.

5.5 Easthouses

The former workings of the Easthouses mine are now almost entirely occupied by the Easthouses Industrial Estate. There is evidence of some mining buildings retained on the site which are currently occupied and used by the industrial estate users. The majority of the site is being used as a car breakers yard. There are not thought to be any open shafts relating to this colliery still present on the site (Coal Authority pers. comm. Matt Bailey) with the main pumping shaft situated south of the site at the Easthouses Pumping pit. The mine site is on two main levels rising up to the east from the main Easthouses road. The industrial estate/ mine site is bound to the north and east by former colliery spoil tips which are now grassed. This is open land that is being used for recreational purposes (dog walking). The site has open agricultural land to the north and east, and residential dwellings to the west and south.

5.6 Bryan's adit

Bryan's adit is believed to drain the workings of the Lingerwood and Lady Victoria mines, with Bryan's Day Level draining in a SE to NW direction, before discharging into Ochre Burn, a tributary of the South Esk. During the site walkover, it was noted that Ochre Burn was culverted for much if it's length along Newbattle road, before discharging into the South Esk at Newbattle Bridge. Ochre Burn showed no visual evidence of ochre impact. What is believed to be Bryan's adit was located along the eastern bank of the former route of Ochre Burn. The adit entrance portal is a concrete structure, with an old brick bridge down-gradient of the adit. The adit was dry; however there was evidence of historic flows, with large deposits of grey gravels and sand at the mouth, which were partially blocking the entrance. It is not clear if these deposits are mining related, but an upstream, inspection did not identify any surface derived water source to the area.

It is possible that the adit/ drain identified in the site walkover is not Bryan's adit, but simply a road drain. The adit may join Ochre Burn within the culverted section. Further works will be required to fully assess the hydrology of the Newbattle area.

6 POTENTIAL TREATMENT SCHEME LOCATION

6.1 Background

Based on the review of available chemistry data, mining plans and maps, and site walkover, URS confirms that the mine water from the deep Limestone workings of the Upper Limestone, Limestone Coal and Lower Limestone Measures over the Bilston Glen coalfield is currently rising with the most likely first decant point being to the east of the coal field, at Junkies adit/ Old Fordell. This is because the topography of the eastern coal field is generally lower than the western side. It is not anticipated that water will discharge from the western side in the short term, as there is a topographic difference of over 50m between the highest recorded adit in the east (Bryans; 51mAOD) and the lowest recorded adit in the west (Burghlee; 110mAOD).

With regards to the management of the rising deep mine water, four remedial options are presented in Section 8. These options range from a 'Do Nothing' option, to 'Passive' and an 'Active' Treatment option for the mine water. With regards to the treatability of the mine water, the preferred option is the pumping of the mine water to control the mine water levels and hence to prevent an uncontrolled discharge of mine water. In theory, the mine water could be pumped at any location across the Coal field, which would result in maintaining the water levels. However, in reality, the most cost effective option would be to intercept the rising mine water from the workings at the outcrops of the rising limbs of the syncline of the Limestone Measures. The mine water in the shallow workings of the Coal Measures (Upper, Middle and Lower Coal) is considered to be hydrogeologically separate to the Limestone Measures so will not be affected by pumping of the Limestone Measure mine waters.

During this review, and the site walkover, two key locations have been identified as potentially suitable pumping/ treatment locations; these are the Burghlee mine site at Bilston Glen, and the Easthouses mine site at Easthouses. The land considered suitable for a treatment scheme on the Easthouses mine site is described in Section 5. The land is open and thought to contain considerable quantities/ thicknesses of mine spoil. The land at Easthouses is open and undulating, and is thought to consist of spoil heaps. A high level assessment of these two locations was conducted to assess the suitability; this was based on the typical constraints that each site would pose, which has been summarised in a Benefits and Dis-Benefits table (Table 6.1) and detailed in the following sections. Additional details are provided in Appendix B, which details relevant land and other constraints of the entire Bilston Glen area. Only those pertinent to Easthouses and Bilston Glen areas are discussed in the following sections.

6.2 Planning Constraints/ Local Area Constraints

There are no recorded current planning constraints relating to the area around the Bilston Glen mine site. Bilston Glen woodland and Burn both upstream and downstream of the mine site are designated as a Site of Special Scientific Interest (SSSI) with respect to the geology in the stream bed and the ancient woodland. There would be issues relating to discharge of treated mine water to a watercourse in the SSSI, as any failure of the scheme would potentially result in the ochre staining of the burn and masking of the geology.

The Easthouses site is located within 500m of land recorded as land allocated for Strategic Housing. However, it is not considered that the land considered suitable for the treatment scheme will be suitable for any housing development.

6.3 Land Ownership

Both the mine sites hold recreational value to the current users, however based on geotechnical and land contamination constraints, the value of the land with regards to any future development is anticipated to be limited.

Further assessment will be required to determine land ownership and potential land uses.

6.4 Heritage Risks/ Conservation areas

Bilston Glen is classified as Green Belt Land, protected under: Protection of the countryside, Areas of great landscape value, Nationally important conservation sites and Regionally & locally important nature conservation sites. There are two listed buildings in close proximity to Burghlee; Dryden Tower and the Bilston Glen viaduct. It is not anticipated that either structure would be impacted by a scheme in this locality.

There are no heritage risks and / or conservation areas within 1000m of Easthouses.

6.5 Access Constraints & Services

Both sites have good access, provided by existing access routes to the industrial estate and a variety of tracks, potentially associated with the old mining site. Connections to supplies of electricity and water may be readily available due to the proximity to the respective industrial estates.

6.6 Hydrogeological/ Hydrological Constraints & Flood Risks

Both sites will require the mine water to be pumped via an abstraction borehole. A full assessment of the hydrogeology of each site has not been conducted at this stage of the review, and is termed outside of the scope of this report. A pump test and further review of the mine workings directly beneath the chosen mine site would be required during the design stage. With regards abstraction, a deeper borehole would be required at Bilston Glen, to ensure that water levels are maintained below adit level on the eastern mine site.

Water will then be treated on site. Treated water at Bilston can be discharged via pipework to Bilston Burn, the closest water course. However, treated water at Easthouses would require transfer via pipework and a culvert beneath a road from the scheme to the closest watercourse.

There are flood risks associated with the River North and South Esk, and Bilston Burn, however no flood risk associated with either of the potential treatment sites, due to the elevation/ distance from the respective watercourses.

6.7 Historic Mining Constraints and Geotechnical Risks

Both potential sites are located on former mines, and will be underlain by variable thicknesses of mine spoil, and potentially shallow workings. It is not anticipated that there will be any heritage value to either mine site, as all buildings have been demolished. The thickness, stability and composition of the Made Ground / spoil under the mine sites will need further investigation at the feasibility stage of the works to assess suitability for a treatment system.

At this stage however, based on knowledge of the ground conditions likely associated with these mine sites, URS does not consider that there will be any geotechnical ground hazards on either site that will not be able to be remedied to allow the

development. It is considered that both sites will be suitable for the construction of a treatment scheme.

6.8 Ecological Risks

An ecological survey has not been conducted as part of this review, however a Phase I ecology and habitat survey would be required as part of the feasibility stage of this work.

6.9 Summary

Based on the above summary and assessment, and as summarised in Table 6.1, both sites would be suitable for construction of an active or passive treatment scheme, both with similar construction issues and constraints. On this basis a pros and cons table was developed to identify the most suitable site.

This identified that Easthouses was the most suitable site for a treatment system from a score of 2 to 1. This result was based upon Easthouses mine water not requiring discharge into a SSSI and the long term pumping cost being lower than that that would be required for Bilston. The Bilston Glen site was more suitable with respect to not having to convey the water via a culvert and pipework from the scheme.

Table 6.1 Treatment scheme location assessment between Bilston Glen and Easthouses

	Bilston Glen (BG) on the former Burghlee Mine site	Easthouses (EH) on the former Easthouses mine site	Preferred Option
Land availability	The Burghlee mine site is currently unoccupied / has no formal use. Currently has recreational amenity value, but this would not be impacted by a treatment system if it is designed to complement existing uses. The land area that is considered available for construction of a scheme is 8.4 hectares.	The former Easthouses mine site is part occupied by an industrial estate, with the remainder unoccupied / no use. Currently has recreational amenity value, but this would not be impacted by a treatment system if it is designed to complement existing uses. The land area that is considered available for construction of a scheme is 2.3hectares, however the site is bounded to the north and east by agricultural land that maybe available to extend into if required.	Equal ranking.
Other planning and related constraints	BG is termed Green Belt land and protected under several designations. Burghlee mine site has no designations	EH is situated near to strategic housing allocation, and a gas main runs to the north of the site	Equal ranking.
SSSI	Bilston Glen woodland and Burn both upstream and downstream of the mine site is a designated SSSI. This relates to the geology in the stream bed and the woodland. Issues relating to discharge of treated mine water to a watercourse in the SSSI.	No SSSI on or within 1000m of the mine site / treatment area	EH
Listed Buildings and Heritage	There are two listed buildings in close proximity to the mine site; Dryden Tower and the Bilston Glen viaduct. It is not anticipated that either structure would be impacted by a scheme in this locality	No listed buildings on or within 1000m of the mine site / treatment area	The listed buildings at BG would not be impacted by a scheme. Equal ranking.
Flood risk	High risk of flooding upstream of the mine site and downstream of the site in the River N Esk	High risk of flooding in the River N Esk downstream of the mine site	Equal ranking.
Geotechnical constraints	Potential for shallow mine workings, poor ground conditions die to mine waste and contaminated ground	Potential for shallow mine workings, poor ground conditions die to mine waste and contaminated ground	Equal ranking.

	Bilston Glen (BG) on the former Burghlee Mine site	Easthouses (EH) on the former Easthouses mine site	Preferred Option
Pumping costs	Long term pumping costs likely to be higher than EH due to control of water at a lower level from ground level than required for EH and thus cost of driving the wel.	Long term pumping costs anticipated to be lower than BG	EH
Mine water discharge points	Mine water could be discharged either to Bilston Glen surface water or to sewer.	Mine water could be discharged either to Mary Burn of Queen Margaret's Burn, tributaries of the S Esk, or to sewer. The former option would require culverting the mine water from the treatment system under a road, and also under a main gas pipeline	BG
Overall ranking			EH

7 OUTLINE TREATMENT SCHEME OPTIONS APPRAISAL AT PREFERRED SITE

7.1 Treatment Scheme Options

Based on URS's review of available literature and data pertaining to the Bilston Glen coalfield, discussions with the Coal Authority and the site visit, a Conceptual Site Model (CSM) has been developed for the site area. As highlighted within this report, the established CSM for the Bilston Glen coalfield is a rising mine water system from deeper levels of the workings of the Upper Limestone, Limestone Coal and lower Limestone workings, that will likely outbreak at one of the adits within the shallow workings. From this, URS has considered the option required to control and treat the rising mine water over the coalfield. In section 4, three scenarios were presented with regards to mine water quality and pumping rates respectively and these were summarised in Sections 4.3 and 4.4. These are for the worst, most probable and best case scenarios and are summarised in Table 7.1 below.

Table 7.1 Mine water summary

	WORST CASE	MOST PROBABLE CASE	BEST CASE
Flow (l/s)	150	95	45
Iron (mg/l)	86.7	19.3	19.3
pH	5.8	5.8	6.7
Alkalinity (mg/l)	127	127	265
Acidity (calc. as Mineral acidity) (mg/l)	127.4	49.6	49.6

Each of these scenarios will be discussed in the following options appraisal for the preferred site which is Easthouses.

7.1.1 *Option 1: Do Nothing*

Based on assessment of the rate of the rising mine water, mine water outbreak at one or more adits in the eastern coalfield will occur between 2016 and 2017.

The first option, a 'Do Nothing' approach, although not the recommended approach by URS (as it will result in uncontrolled mine water outbreak and pollution) will allow the decant points in the coalfield to be identified prior to the design of a treatment scheme. This will also allow (dependant on breakout point) that the treatment scheme is located in the best possible place for capturing and treating the mine water. In addition, mine water quality can be assessed at source rather than making predictions based on current data.

Therefore, a 'Do Nothing' approach will likely result in one or more of the following scenarios:

- Increase in the flow rate and decrease in water quality at Junkies adit, resulting in subsequent deterioration in the water quality of the River South Esk.
- Discharge of mine water from Bryan's adit, resulting in subsequent deterioration in the water quality of Ochre burn and the River South Esk.
- Uncontrolled/ unpredicted mine water discharges/ upwellings from low level shafts and old surface workings in the eastern mine field around Easthouses.
- Discharge of mine water from Burghlee adit and/ or shallow workings of Burghlee, resulting in subsequent deterioration of the water quality of Bilston Burn.

- Discharge of mine water from Roslin adit and/ or shallow workings of Roslin, resulting in impact on the water quality of Kill Burn, and subsequently Bilston Burn.
- Pollution of the Bilston Burn SSSI area resulting in potential prosecution.

Clearly, a 'Do Nothing' approach may be considered as the most favourable short term financially, as instead of predicting the decant points and water quality, by waiting, the locations, flow and quality can be assessed in situ. However, a 'Do Nothing' approach will likely not aid the long term management of the mine water, as the identified decant points are not positioned in a location that will allow the capture and treatment of the mine water; Junkies adit is located in Dalkeith town centre and Bryan's adit in a steep sided Conservation area valley. Both locations would have insufficient space for a treatment scheme. Therefore the mine water would still require to be captured from within the mine workings prior to breakout.

7.1.2 ***Option 2: Pumping test with temporary dosed system***

Given the current uncertainty with regards both the primary mine water decant point and the quality of the water, URS considers that a pumping test would be required prior to the installation of a permanent treatment scheme. This would provide valuable chemical data and also allow an assessment of the potential pump rates (and therefore flow rates) required to maintain the water at the desired level.

An abstraction borehole would need drilling (nominal diameter 450mm??) to a depth of 20m above ordnance datum. It is anticipated that the most favourable location for the borehole and dosed treatment system would be on the open land adjacent to the Easthouses industrial units. Treated mine water could be discharged directly to sewer for the duration of the pump test.

It is considered that the mine water will be net alkaline with a low iron loading long term however short term, due to the uncertainties in the mine water quality, an alkali dosing system may be preferable to a peroxide dosing system for treatment of the mine water.

The amount of chemical require for dosing is dependent on the iron concentration, acidity of the mine water and the pH. This can only be reasonably assessed when an onsite test is conducted to ascertain those parameters.

However, an example calculation based on the 'Most Probable case scenario' is provided in the following section with a summary of potential requirement for the best and worst cases presented in Table 7.2.

<u>Most Probable:</u>

19.3mg/l Fe

pH of 5.8

Alkalinity 127 mg/l as CaCO3

Flow 95l/s

Dosing chemical of caustic soda as 40% solution (NaOH)

The mineral acidity can be calculated from the metal loading in the mine water, in this case we are considering iron as the key contributor of metal derived acidity:

A pH adjustment, from pH 5.8 to 8.5 is calculated by:

Amount of NaOH (mg) per litre raw mine water = ((1000 x 10-pH initial) - (1000 x 10-pH required)x 40

= 0.06 mg NaOH per litre of mine water

= 519 g NaOH/day (based on 95l/s and 24hrs/day pump rate)

It is anticipated that NaOH would be dosed as a 40% solution; given this, there would be a dosing requirement of 1,300 litres of NaOH/day.

Once the mine water has stabilised, the alkalinity balance of the mine water can be re assessed. If the mine water is net alkaline, it may be more applicable to use peroxide to increase the rate of ochre precipitation instead of lime or caustic.

Based on a peroxide solution of 35% strength, a 95 l/s pump rate and iron loading of 19.3mg/l, 0.35ml of peroxide are required to oxidise each gram of ferrous iron. Therefore, dosing of 2.3 litres of 35% peroxide per hour (during pump operation) equates to approximately 55 litres / day peroxide.

A summary of potential dosing requirements for the best and worst cases are presented in Table 7.2. It should be noted, however that these are based on the limited current data set and field analysis should be conducted to ascertain the exact dosing requirement.

As part of a temporary scheme, a settlement lagoon will be required to remove ochre before discharge of the treated mine water. This should be suitable sized in order to be incorporated into a final scheme (see option 3).

Table 7.2 Mine water summary

	WORST CASE	MOST PROBABLE CASE	BEST CASE
Flow (l/s)	150	95	45
Iron (mg/l)	86.7	19.3	19.3
pH	5.8	5.8	6.7
Alkalinity	127	127	265
NaOH dosing (40% soln) l day	2050	1300	615
Peroxide (35% soln) l/day	393	55	26
Approximate size of settlement pond (m3)	17,500*Note 1	12,000*Note 2	6,000*Note 2

*Note 1 this is the MINIMUM volume required for operation for a 6 month period only. Breakthrough of iron will occur after 6 months.

*Note 2 these sizing's are designed to have capacity for 2 years and therefore can be utilised in the permanent schemes.

7.1.3 *Option 3: Pumping test with Permanent Passive Scheme with pumping test*

Option 3 is a combination of an initial pumping test (Option 2) combined with a permanent passive treatment scheme. The settlement pond constructed as part of the pump test can be incorporated latterly as part of the passive treatment scheme.

It is anticipated that the passive scheme presented in this option will be revised following the pumping test, however the 'best case', 'most probable case' and 'worst cases' are presented below to provide a guide to the range of treatment system sizings that will be required to treat the mine water. The treatment systems are based upon treatment of a net alkaline mine water

which will be wholly treated via a passive scheme, consisting of settlement ponds and wetland combination.

Removal rates are based upon optimum conditions, which include but are not restricted to:

- Buffering capacity (alkalinity higher than acidity or acidity generated during Fe–oxyhydroxide formation).
- pH (circa 8.5 optimal).
- Fully aerated water.
- Optimal design depth and dimensions of settlement lagoon.

Based on these factors, it is proposed that a passive treatment system is required, consisting of:

- Aeration (to allow iron oxidation).
- settlement lagoons (to allow the precipitation and settlement of iron oxyhydroxides).
- One or more wetlands to strip remaining iron from the settlement pond discharge.

It is also recommended that there is provision built in for the dosing of the mine water to alter the pH should the mine water quality be such that dosing is needed. Currently the mine water is acidic but has sufficient buffering capacity to allow iron oxidation, however an acidic pH is sub optimal for rapid iron hydrolysis and precipitation, and the system may need dosing in the period of operation, during the equilibrating phase.

a) Aeration

It is anticipated that the mine water would have negligible concentrations of dissolved oxygen and high amounts of dissolved CO2 and therefore would need aeration prior to treatment. Carbon dioxide degassing is essential in achieving effective treatment to both allow the oxidation of iron and reduce temporary carbonic acidity.

One aeration cascade should impart sufficient oxygen to oxidise up to 50mg/l iron; should the concentration of iron be higher a series of cascades can be used, or if limited space a venturi aerator could be employed.

Table 7.3 Aeration cascades

	Worst case	**Most Probable case**	**Best Case**
	86.7mg/l Fe	19.3mg/l Fe	19.3mg/l Fe
Aeration cascades required	2	1	1

It is recommended that two aeration cascades should be provided at the commencement of the scheme to remove carbonic acidity. A further two aeration cascades are also recommended for any additional settlement ponds that are required for maintenance and desludging events, resulting in one or more of the settlement ponds being taken off line.

The proposed site has sufficient fall to allow the construction of a series of aeration steps at the influent of the settlement pond(s).

b) Settlement ponds

The sizing of settlement lagoons is based upon the pumping rates and the sludge accumulation rates. The size is based upon a linear relationship between the percentage reduction in the influent iron concentration required and the hydraulic retention time (Pyramid Guidelines). Iron concentrations in the mine water are required to be reduced to less than 10mg/l in the settlement lagoons as this is optimal for reed bed removal efficiency and health.

In general, a minimum of two settlement ponds are required in a treatment scheme as it is required to take one of the settlement ponds off-line during de-sludging. Both settlement ponds must have a sufficient volume for acting as a standalone pond during de sludging / maintenance operations, to prevent the overloading of the wetlands during these periods.

The settlement ponds can be operated in tandem or in line, depending on the topography and land availability.

The relationship used is:

Minimum residence time HOURS = % lowering of Fe required x 0.5

The minimum residence time refers to the time that is required within the settlement pond for iron to be removed. However, additional void space is required for volume 'lost' due to accumulation of iron oxyhydroxides.

An example calculation based on the 'Most Probable case scenario' is provided in the following section with a summary of potential requirement for the all case scenarios presented in Table 8.3. For this scenario, the settlement ponds are operated in tandem, both of which will discharge into a series of treatment wetlands.

Most Probable scenario:

19.3mg/l Fe

pH 5.8

Alkalinity 127 mg/l as CaCO3

Flow 95l/s

The % lowering of Fe required is: 10mg/l / 19.3mg/l = 52%

The required residence time in the settlement lagoons is: 0.5 x 52% = 26 hours.

At a flow rate of 95 l/s and an iron concentration of 19.3 mg/l then the minimum void space required for 52% iron removal is –

(95 x 60 x 60) / 1000 = 342m3/hr x 26hrs = 8892m3

Iron will accumulate as iron oxyhydroxides. At an influent iron concentration of 19.3mg/l and assuming that 9.3 mg/l iron will be removed in the settlement lagoon, then:

(9.3 x 95 x 60 x 60 x 24)/106 = 76kg/day Fe

145kg/day FeOOH

At a sludge density of 3%, the settlement lagoon will collect 1746.5m3/yr FeOOH.

Assuming that the lagoons will be de-sludged every 2 years, the sizes of the lagoons can be calculated based on the required residence time, void space and sludge volume. The volumes presented in Table 7.4 do not account for the additional capacity required for de-sludging events. This can be calculated following the pump test

Table 7.4 Settlement pond summary

	Worst case	Most Probable case	Best Case
	86.7mg/l Fe	19.3mg/l Fe	19.3mg/l Fe
	150/sec	95l/s	45l/s
Settlement Pond Numbers	2	2	2
Settlement Pond Volume (total) note 1	20,000note 2	12,000	6,000

*Note1: Sizings are based on total volume required for iron removal

*Note2: Based on 1 settlement pond, breakthrough of iron will occur after 12 months based on this sizing.

*Note3: No account has been taken of additional capacity required during desludging and / or maintenance events.

Sludge drying beds will be required and can be sized following initial data from the pump test and operation of the scheme.

c) Wetlands

The settlement ponds will be designed to treat up water to a quantity of 10mg/l iron or less. Based on this, a wetland, or series of wetlands will be required to 'polish' the final iron from the mine water, prior to discharge from the scheme. These will be designed to achieve the anticipated discharge limit of <lmg/l total iron and a pH of 6-8.

The wetlands are sized according to guidelines of Hedin, where:

A = (Qd(Inf-Ef))/RA

A = wetland area (m2)

Qd = flow (m3/day)

Inf = Input concentration (mg/l)

Ef = Effluent concentration (mg/l)

RA = Area-adjusted contaminant removal rate (g/m2/d) (in this case we approximate the RA to 10 g/m2/d as recommended by the PIRAMID guidelines).

Table 7.5 Wetland summary

	Worst case	Most Probable case	Best Case
	86.7mg/l Fe	19.3mg/l Fe	19.3mg/l Fe
	150/sec	95l/s	45l/s
Wetlands required (No)	3	2	1
Wetland area (m^2)	11,700[*1]	7400[*1]	3500

*Note 1. The wetlands should be constructed in tandem and have multiple influent points where possible as a high flow rate will cause short circuiting and reed bed destruction.

d) Other sizing factors

It is recommended that the settlement lagoons and wetlands have a length to width ratio of no less than 2:1 and no more than 5:1.

Table 7.6 Treatment Summary table

	Worst case	Most Probable case	Best Case
Settlement Pond volume (m^3)	20,000	12,000	6,000
Settlement Pond Numbers	2	2	2
Wetland area (m^2)	11,700	7400	3500
Wetlands required (No.)	3	2	1
Aeration cascades (No.)	*2*	*1*	*1*
Total land area required (excluding ancillary infrastructure)	31,700	19,400	9,500

7.1.4 ***Option 4: Permanent Dosed Scheme (High Density sludge or similar)***

Option 4 is an active scheme that uses chemical dosing to facilitate the rapid removal of iron. As with Option 2, a settlement pond will be required, and dosing as per the calculations presented in Option 2. This will be re-measured based on a pumping test and following 'first-flush' effects.

High Density Sludge (HDS) could be employed to minimise the site footprint however based on the fact that this is a long term system and that land is available for the system, Option 3 would be the preferred option.

7.2 Mine Water Transfer Options & and Effluent Discharge Options

7.2.1 *Conveyance of Raw Mine Waters from Source to Treatment System*

Raw mine waters from either the pumping test or a permanent decant point are likely to be abstracted at a topographic high point of the Easthouses site. This is advantageous as it allows gravity flow of the raw mine waters to the inlet works of any prospective treatment works.

The distance between the likely site of the pumping test and the prospective treatment works location could be up to 50m, therefore it is proposed that the mine water can be simply conveyed in an open channel, constructed using a suitable ditch lining materials such as corrugated HDPE trapezoidal sections. The topography of the site is also considered to have sufficient fall to allow gravity flow of water through a passive scheme.

7.2.2 *Transfer from Treatment Scheme to Final Discharge*

The final effluent from the treatment system will need to be disposed of by releasing the flow to the public sewer or to a new outfall point into a nearby watercourse.

The nearest watercourses are Queen Margaret's Burn or Mary Burn, both of which are tributaries to the South Esk River. Both of these watercourses are considered to be suitable discharge points for the treated mine waters and are both located down-gradient of the proposed treatment works. A discharge consent will need to be applied for from the Scottish Environmental Protection Agency (SEPA) for either of these outfalls. The distance between the prospective treatment works and either watercourse is approximately 1km. It is proposed that the final effluent flows can be simply conveyed in an open channel where possible constructed using a suitable ditch lining materials such as corrugated HDPE trapezoidal sections. Some sections may need to be piped (for example around residential housing areas). Both watercourses are separated from the treatment works site by a public highway and a gas main, and it is therefore likely that flows will need to be culverted under these existing infrastructure items.

An alternative option requires piping the treated effluent in a buried pipeline over an approximate distance of 150m to the assumed location of the public sewer in the public highway. A connection to the sewer via an existing manhole would be required. This option assumes that the public sewer has sufficient capacity in the first instance to accept the abstracted mine water flows. A trade effluent discharge consent will need to be secured with the wastewater undertaker. An additional cost for this option will be the annual effluent discharge charges levied by the wastewater undertaker concerned, which could be a significant figure given the large volumes of mine water concerned, even for the Most Probable and Best Case scenarios. The likely annual charges were estimated using WRAP's Mogden Formula Tool 2013, based on 50mg/l of COD and 10mg/l of suspended solids in final effluent, to be of the order of £0.9M. For this reason, the sewer discharge option is unlikely to be economically feasible.

7.3 Estimated Costs

7.3.1 *Treatment Scheme Cost Estimate*

Indicative budget costs have been estimated for the options assessed in Section 7.1 and 7.2 above and are shown in Table 7.7. The cost estimates are based on the Most Probable Case flow rate of 95l/s and 19.3mg/l iron concentration.

7.4 Proposed Programme

An anticipated high level programme is proposed in Appendix C for the development of a prospective treatment works for the Bilston Glen Coalfield. This takes into account possible phasing of elements such as undertaking a pumping test in advance of designing a treatment scheme.

The possible implementation of a temporary or partially built treatment scheme followed by later addition of elements forming a treatment train is also suggested. The proposed programme is therefore based on Option 3.

Table 7.7 Indicative budget costs for capital and operational expenditure for the assessed treatment scheme options

Option	Description	Estimated capital cost	Estimated operating cost/year
1: Do Nothing			
	No further action until mine water breakthrough (costs will then be incurred)	£0M	£0M
2: Pumping test with temporary dosed system			
	450mm diameter 150m deep open hole borewell with 25m stainless steel casing; 12" pump ,8 weeks pumping test	£0.62M	-
	Design of test, site supervision and reporting	£0.05M	-
	Convey raw mine waters from extraction borehole to dosing system in a 50m long open channel by gravity flow (note dependant on location relative to scheme, may not be required)	£0.01M	-
	Caustic soda dosing package plant with integrated dosing basin and purchase of caustic soda	£0.02M	-
	Treatment works compound – access track, hard core hard standing, site fencing	£0.1M	-
	1 no. 12,000m^3 settlement pond, assumed 2m deep and lined with a geosynthetic membrane with cover of clay or stone materials; surplus materials from excavation works reused for site landscaping	£0.2M	-
	ESTIMATED TOTAL COSTS	**£1.0 M**	**-**
3: Pumping test with permanent passive scheme			
	450mm diameter 150m deep open hole bored well with 25m stainless steel casing; 12" pump ,14 day pumping test, design of test, site supervision and reporting	£0.67M	-
	Convey raw mine waters from extraction borehole to treatment works in a 50m long open channel by gravity flow	£0.01M	-
	Caustic soda dosing package plant with integrated dosing basin, visiting maintenance technician and purchase of caustic soda (priced in case needed in first-flush period)	£0.02M	£0.1M
	1 No. aeration cascade created as rapids in open flow channel	£0.03M	-
	2 no. 12,000m3 settlement pond, assumed 2m deep and lined with a geosynthetic membrane with cover of clay or stone materials;; surplus materials from excavation works reused for site landscaping	£0.4M	-
	Estimated desludging and sludge disposal cost	-	£0.25M
	2 no. constructed wetlands of approx. 3,700m^2 area each, lined with a geosynthetic membrane, infilled with suitable substrate and planted with reeds; surplus materials reused for site landscaping	£0.2M	-
	Estimated annualised wetland maintenance, reed/ media disposal and lining inspection/ repair and cost	-	£0.05M
	Convey treated effluent to discharge by gravity flow in 1 km long open channel (where possible), culverted beneath public highway and gas main, to a new outfall structure at either Queen Margaret's Burn or Mary Burn	£0.1M	-
	ESTIMATED TOTAL COSTS	**£1.43M**	**£0.4M**

Option	Description	Estimated capital cost	Estimated operating cost/year
4: Active treatment system			
	High density sludge system (based on caustic soda dosing) or sulphate reducing system (based on sodium sulphide dosing); includes package plant, tankage and all treatment works ancillaries	£5M to £7M	-
	Operating costs including sludge disposal	-	£0.3M to £1M
	Convey treated effluent to discharge by gravity flow in 1 km long open channel (where possible), culverted beneath public highway and gas main, to a new outfall structure at either Queen Margaret's Burn or Mary Burn	£0.1M	-
	ESTIMATED TOTAL COSTS	**£5M to £7M**	**£0.3M to £1M**

8 STRATEGIC RISKS AND EARLY WARNINGS

Please see Appendix A for Risk Register detailing project risks and early warnings.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The mine workings in the Bilston Glen Coalfield have been assessed in this report with specific focus on mine water rebound and the management of the rebounding water. The key objective of this document is to provide the Coal Authority with a series of scenarios and remedial options at scoping level (Checkpoint 1) applicable to the current hydrogeological situation in the Bilston Coalfield.

Based on this review, the key conclusions drawn by URS are:

- The shallow mine workings within the Upper, Middle and Lower Coal Measures are hydrogeologically separate to the Limestone Coal and Limestone series.
- Water quality in the Upper, Middle and Lower Coal Measures is distinctly different in quality as compared to the mine water related to the Limestone measures. Mine water quality of the Coal Measures is characteristically high iron and circum neutral water whereas the Limestone series is characterised by a low iron net alkaline mine water.
- The primary potential decant/ mine water breakout point has been identified as Junkies at Old Fordell. Mine water currently discharging at Old Fordell is believed to be sourced from the shallow workings of the Limestone Measures only.
- Treatment at any of the potential decant points will not be possible, therefore it is recommended that water is managed via pumping of the mine water at a suitable location with onsite treatment.
- Easthouses has been identified as the preferred option for the location n of the scheme, with the site of the old Burghlee mine the second option.
- Four remedial options have been presented, ranging from a 'Do Nothing' approach, to a fully active treatment system.

9.2 Recommended Option

URS considers that the most suitable option for the long term management of the rising mine water over the Bilston Glen coal field is that that the mine water is pumped at the preferred location (Easthouses) and treated via a passive system in situ. This is detailed in Option 3. Easthouses has been identified as the preferred location for both abstracting and treating the mine water due the long term pumping costs being significantly lower than those that would be required for Bilston Glen, and due to the inherent complications that discharging into, and working adjacent to a SSSI holds.

An indicative programme for Option 3 to be in place before mine water outbreak at Junkies before 2016 has been presented.

9.3 Recommendations for Further Works

Prior to any further sizing or related works in progressing the management of the mine water at Bilston Glen, URS recommends that the following works are carried out. These are not specific to the Eashouses site, but URS believes they will aide the overall management and understanding of the entire Bilston Glen coal field

- A topographical survey of the adits discussed in this report, and of the preferred treatment site.
- A condition survey of the Bilston Glen culvert.

- A mining record survey of the interconnections between Junkies adit and the Limestone workings, and the chosen site to assess the most suitable location for the pump test / long term abstraction location.
- Long term flow monitoring at Junkies Day Level, combined with regular water quality monitoring of the Junkies adit discharge, and Bilston shaft mine water.

Required works specific to the potential treatment site at Easthouses are:

- Land ownership searches.
- Phase 1 ecological survey.
- Ground Investigation (to assess geotechnical suitability and potential ground quality issues).
- A pump test to ascertain potential long term pumping rates and quality (Option 2 and 3).

1. REFERENCES

Hedin, R.S., Nairn, R.W. and Kleinmann, R.L.P. (1994*) Passive Treatment of Polluted Coal Mine Drainage*. Bureau of Mines Information Circular 9389. United States Department of Interior, Washington DC. 35 pp

International Mining Consultants 1998. Report on Bilston Colliery Rising Mine water. Prepared for the Coal Authority.

Brown, M., Barley, B, and Wood, H. (2002) Minewater Treatment: Technology, Application and Policy, IWA Publishing

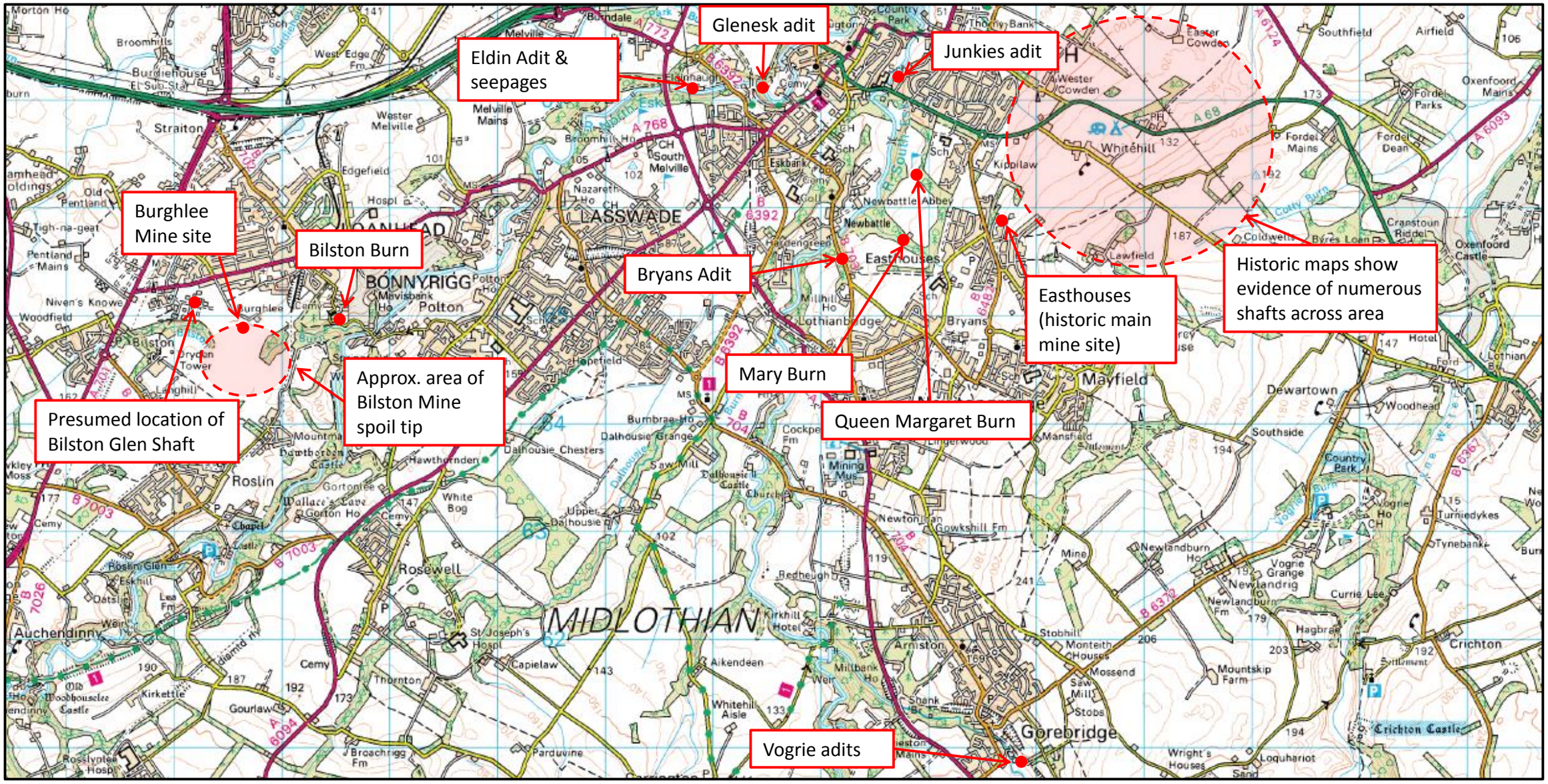
Younger, P.L., Banwart, S.A. and Hedin, R.S. (2002) Mine water: Hydrology, Pollution, Remediation. Kluwer Academic Publishers, Dordrecht.

PIRAMID Consortium (2003) Engineering guidelines for the passive remediation of acidic and/or metalliferous mine drainage and similar wastewaters. European Commission 5th Framework RTD Project no. EVK1-CT-1999-000021 "Passive in-situ remediation of acidic mine / industrial drainage" (PIRAMID). University of Newcastle Upon Tyne, Newcastle Upon Tyne UK. 166pp.

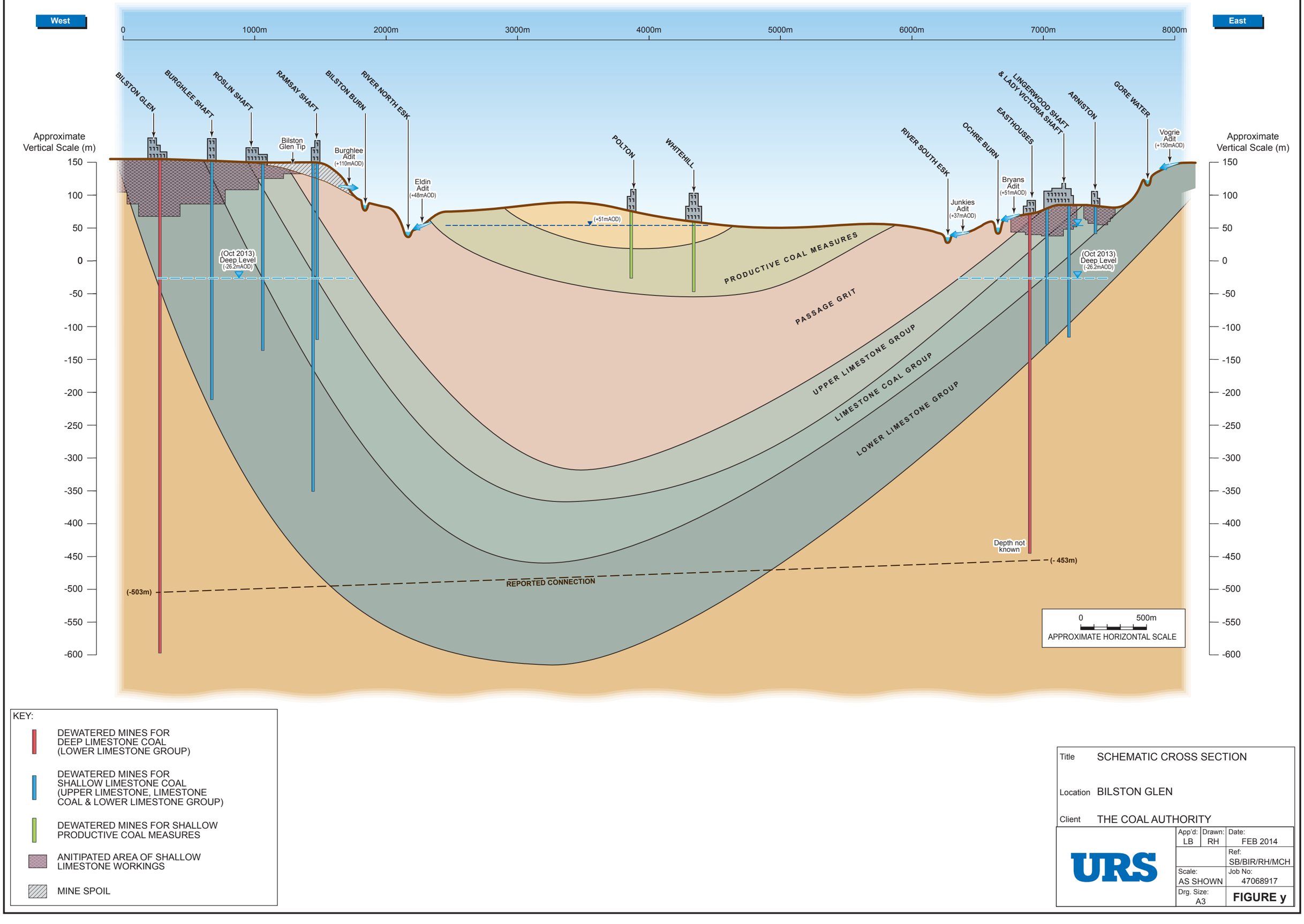
White Young Green Engineering, 2005. Report on Options for Mine Water Control in the Area Connected to the Elginhaugh Discharge. Prepared for the Coal Authority

White Young Green Engineering, 2012. Overview of Mine Water in the UK Coal Fields: Advice on Mine water recovery and Mine Gas. Prepared for the Coal Authority

DRAWINGS



Project: Bilston Glen	Drawing title: Site Location Plan and Pertinent Features.	47068917/Figure 1 Scale at A3: NTS	URS Bridgewater House Whitworth Street Manchester M1 6LT www.urs-global.com
		Drw SB / App SP / Rev	
		Chk LB / Date 28/02/14 / Date	



KEY:

- DEWATERED MINES FOR DEEP LIMESTONE COAL (LOWER LIMESTONE GROUP)
- DEWATERED MINES FOR SHALLOW LIMESTONE COAL (UPPER LIMESTONE, LIMESTONE COAL & LOWER LIMESTONE GROUP)
- DEWATERED MINES FOR SHALLOW PRODUCTIVE COAL MEASURES
- ANITIPATED AREA OF SHALLOW LIMESTONE WORKINGS
- MINE SPOIL

Title	SCHEMATIC CROSS SECTION
Location	BILSTON GLEN
Client	THE COAL AUTHORITY

URS

App'd:	Drawn:	Date:
LB	RH	FEB 2014
		Ref: SB/BIR/RH/MCH
Scale: AS SHOWN		Job No: 47068917
Drg. Size: A3		**FIGURE y**

APPENDIX A RISK REGISTER

ENVISION

IMPACT / LIKELIHOOD

PROJECT	Bilston Glen	COAL AUTHORITY	
REVISION	1	CONTRACTOR	
DATE	25/02/2014	DESIGNER	

Risk No.	Description of Risk	Description of Impact	Likelihood (1-improbable 2-remote 3-occasional 4-probable 5-near certain)	Impact (A-negligible B-marginal C-serious D-critical E-catastrophic)	Priority L=low M=medium H=high	Mitigate/ Eliminate/ Insignificant	Likelihood (1-improbable 2-remote 3-occasional 4-probable 5-near certain)	Impact (A-negligible B-marginal C-serious D-critical E-catastrophic)	Priority L=low M=medium H=high	Risk Manager	Impact Costs of event after mitigation	Probability Likelihood of occurrence	Project Risk	Comments/Action plan/Further mitigation measures	Date of last update	Impact Cost (Estimate only)	Current Status (e.g. closed, reducing, increasing)
A - GENERAL / COMMON																	
A1	Inflation allowance	Increase in costs	4	A	M	Make allowance in budget for realising inflation in construction and professional fees	1	A	L					It is considered unlikely that there will be any impact on the construction costs of the scheme short term. Long term implications arise from on-going operation of the scheme (electricity costs and maintenance).			
A2	Availability of construction resources	Scheme delays	1	A	L	Agree preliminary programme with framework contractor for construction	1	A	L					The proposed scheme options use widely available standard construction materials			
A3	Cost benefit too high to justify scheme proceeding	Scheme removed from main programme	1	A	L	The scheme will manage mine water over the Bilston Glen mine field at a single location therefore providing an essential prevention solution to mine water breakout at several locations, and therefore protecting two key rivers in the area. It is considered that costs are well justified for the large area that would be impacted if no action was taken	1	A	L								
A4	Changes to discharge quality and / or flow rate	Scheme no longer viable or practical or requires significant modification and reworking to achieve successful capture and treatment	2	C	L	URS recommends a pumping test to gauge the chemistry / required pump rates. From the chemistry assessment of the chemistry from adjacent mine workings, and from previous knowledge of pumped mine water schemes, it is anticipated that the water will be of a good quality that will likely improve over time.	1	A	L								
A5	Mine water flow conceptual model and our assumptions about shallow v deep mine water chemistry, rate of rise from deep mine water and where the outbreaks might occur	Scheme no longer viable or practical or requires significant modification and reworking to achieve successful capture and treatment	2	C	H	Further sampling, pump testing and chemical analysis	1	A	L								
A6	Scheme fails to achieve required discharge standards	Scheme operates while causes are investigated and addressed. Costs and loss of reputation, public confidence. Unlikely to be legal implications	1	C	L	By performing a pump test the scheme will be designed specifically to treat the abstracted water. By performing a pump test, many of the parameters requiring treatment will be better understood, therefore giving less opportunity for the scheme to fail	1	A	L								
A7	Project fails to meet agreed programme for development and construction	Delays and additional cost arise as scheme fails to achieve agreed programme milestones	1	A	L	PM to develop comprehensive scheme programme focusing on particular Streamline stage, covering all known issues to be addressed	1	A	L								
A8	Project exceeds agreed/authorised budgets	Additional costs, internal political pressure, impact on overall budgets. Reputation and confidence undermined	1	B	L	PM to monitor on-going spend and identify additional costs early and obtain approval for any overspend in advance of works	1	A	L								
B - Scheme Specific Environmental / Ecological																	
B1	Environmental constraints to construction	Scheme delay / additional cost	1	A	L	No SSSIs or Conservation areas etc on or near to the site, no anticipated problems relating to environmental issues	1	A	L								
B2	Removal of protected trees to achieve proposed scheme design	Scheme delay / additional cost while permission obtained or design modified to avoid removal.	1	A	L	An assessment of the proposed location for the treatment plant has not identified any protected trees on our near to the proposed site	1	A	L								
B3	Protected species found on site	Delay and costs due for additional ecological surveys and licences from Natural England	1	B	L	Undertake Phase 1 habitat / ecological assessment of site to check for protected species. Identify potential habitats for Bats, Badgers and/or GCNs. Consider programme for site clearance and any mitigation measures.	1	A	L								
C - Scheme Specific Planning																	
C1	Failure to obtain planning permission	Scheme no longer viable or practical or requires significant modification and reworking to achieve successful capture and treatment	1	C	L	Early engagement with planning local planning officer to seek support for scheme and understand key planning aspects to be addressed	1	C	L								
C2	Poor public / local perception of scheme	Planning application rejected	3	B	M	Engage with local stakeholders to learn of concerns and promote aims of project, consider areas where scheme may account for local issues and or concerns	2	B	L								
C3	Failure to discharge planning conditions	Planning authority take action to stop works proceeding on site until all conditions satisfactorily discharged	1	A	L	CA PM to monitor progress against all Planning Conditions	1	A	L								
C4	Failure to provide required notifications of start of works on site	Planning authority take action to stop works proceeding on site until all required notifications are in place	1	A	L	CA PM to make delivery team aware of all applicable notifications and include in any project programme	1	A	L								
C5	Highways Authority object to proposed scheme due to poor access arrangements	Delay to project while junction layout designed to meet Highways Authority requirements	1	A	L	Unlikely - access is off a main access road for the Easthouses site	1	A	L								
D - Scheme Specific Land Purchase and Site Conditions																	
D1	Unable to secure purchase of required land for capture and/or treatment	Relocation of scheme may be required	1	B	L	An alternative scheme location was identified in the URS ROA that could be further investigated	1	B	L								
D2	Permissions to access site to undertake surveys, investigations and assessments	Delays to scheme while access agreements are put in place with land owners / tenants etc.	1	B	L	Unlikely due to the land being open access	1	B	L								
D3	Relationship with landowners deteriorates	Landowner delays agreement, or becomes hostile to scheme	1	A	L	Unlikely due to the land being open access	1	A	L								
D4	Buried services present on site	Service diversions required to accommodate required scheme. Delays and additional costs as diversions are implemented by utility companies	1	C	L	Unlikely - the land is reclaimed colliery spoil and services are unlikely to cross the site, as they are likely to follow the adjacent road. A gas main has been identified to the north of the site during searches and this will need to be considered in the design of the water transfer from the site to the receiving watercourse.	1	C	L								
D5	Difficulties with obtaining/installing new power supply for treatment or pumping	Scheme not able to be commissioned. Scheme not viable, additional costs for power connections	1	C	L	Unlikely, power supply available to adjacent industrial park.	1	C	L								
D6	Ground collapse owing to shallow mine workings below treatment works	Scheme not able to be commissioned. Scheme not viable, additional costs for power connections	2	E	M	Undertake ground investigation and ground improvement.	1	C	L								
D7	GSM signal not available to provide remote site management or alarm system to Operator	Processes monitoring and alarms will need to be connected via landline telecoms connection. Additional costs, route to site	1	B	L	Unlikely, goof mobile signal recorded on site.	1	B	L								
D8	Site subject to flooding - within EA flood zone / flood plain	Planning restrictions under NPPF imposed. Additional costs for design and construction of flood compensation volumes. Costs for additional resilience to be built into scheme infrastructure	1	C	L	Not applicable - not classified as a zone impacted by flooding	1	A	L								

ENVISION

IMPACT / LIKELIHOOD

PROJECT	Bilston Glen	COAL AUTHORITY	
REVISION	1	CONTRACTOR	
DATE	25/02/2014	DESIGNER	

Risk No.	Description of Risk	Description of Impact	Likelihood (1-improbable 2-remote 3-occasional 4-probable 5-near certain)	Impact (A-negligible B-marginal C-serious D-critical E-catastrophic)	Priority L=low M=medium H=high	Mitigate/ Eliminate/ Insignificant	Likelihood	Impact	Priority L=low M=medium H=high	Risk Manager	Impact Costs of event after mitigation	Probability Likelihood of occurrence	Project Risk	Comments/Action plan/Further mitigation measures	Date of last update	Impact Cost (Estimate only)	Current Status (e.g. closed, reducing, increasing)
D9	Unable to provide suitable vehicular access to site for construction / operation & maintenance	Time and costs for negotiations with land owners. Scheme not viable without suitable access	1	C	L	Unlikely - there is good vehicular access to the adjacent industrial park via roadways and a series of paths cross the site. Open access to the south of the site via a track.	1	A	L								
D10	Unknown liabilities associated with purchased land	Cost and time delay for remedial works to existing structures etc. on the site.	1	B	L	A GI will be required prior to construction to assess ground condition.	1	B	L								
E - Scheme Specific Consents and Licences																	
E1	Discharge Consent	Delay to scheme while licence application determined (13 weeks)	1	B	L	The license can be drafted prior to the scheme construction and dialogue commenced with SEPA both prior and during planning / construction to expedite the process	1	A	L								
E2	Abstraction Licence	Delay to scheme while licence application determined	1	B	L	As above											
E3	Section 34 Water Features Surveys	Cost and time delay in running scheme while surveys and reports are compiled and submitted to EA for approval	1	A	L	Not required											
E4	River works Licence	Time delay to construction while licence application is completed. Scheme not viable without suitable collection / discharge structures	1	A	L	Not required											
E5	Water company licences for connection / diversion of sewers and drains	Cost and time delay to construction while service diversions are undertaken by statutory undertakers etc. Scheme not viable where services cross sites and cannot be easily diverted	1	A	L	Not applicable											
			1	A	L												
F - Site Specific Ground Conditions																	
F1	Contaminated soils / buried waste	Very high cost for removal or treatment of contaminated materials, and H&S controls on site	2	C	L	Based on previous experience, it is unlikely that any contaminants associated with a coal mine site will require removal. A GI will be required to assess the thickness, composition and geotechnical stability of the mine waste, and identify any voids.	2	B	L								
F2	Treating soft spots and voids	Works to remove or cap over areas of soft ground lead to additional costs and time delays during construction	2	C	L	As above	2	B	L								
F3	High ground water table	Excavations problematic, impacts on stability and settlement of earthworks. Poor site drainage. Additional costs for design and construction	3	C	M	It is anticipated that ground conditions are predominately mine spoil, which is a granular free draining material. Poor site drainage not anticipated. Unknown if there is a perched water table present within the colliery spoil; this will be identified in the GI.	3	C	M								
F5	Mine gasses from shafts or underground workings	H&S controls on site lead to increased cost and time for construction	3	B	M	As above, a ground gas assessment will be conducted during the GI. No shafts believed to be on the proposed site however shallow historic workings are possible	2	B	L								
G - Site Specific Construction																	
G1	Adverse weather	Leads to increased cost and time for construction, due to unsuitable ground conditions for earthworks.	3	B	M	Plan the main bulk of the earthworks during summer months	1	B	L								
G2	Suitable location for contractor's compound	Site security and health and safety implications of not securing a suitable contractors compound proximal to the site	1	B	L	The site is open access with suitable location for contractors areas both on the site and potentially within the Easthouses industrial park for security	1	A	L								

APPENDIX B CONSTRAINTS

Appendix B. Potential Constraints Plan Bilston Glen, Midlothian.

1. SSSIs

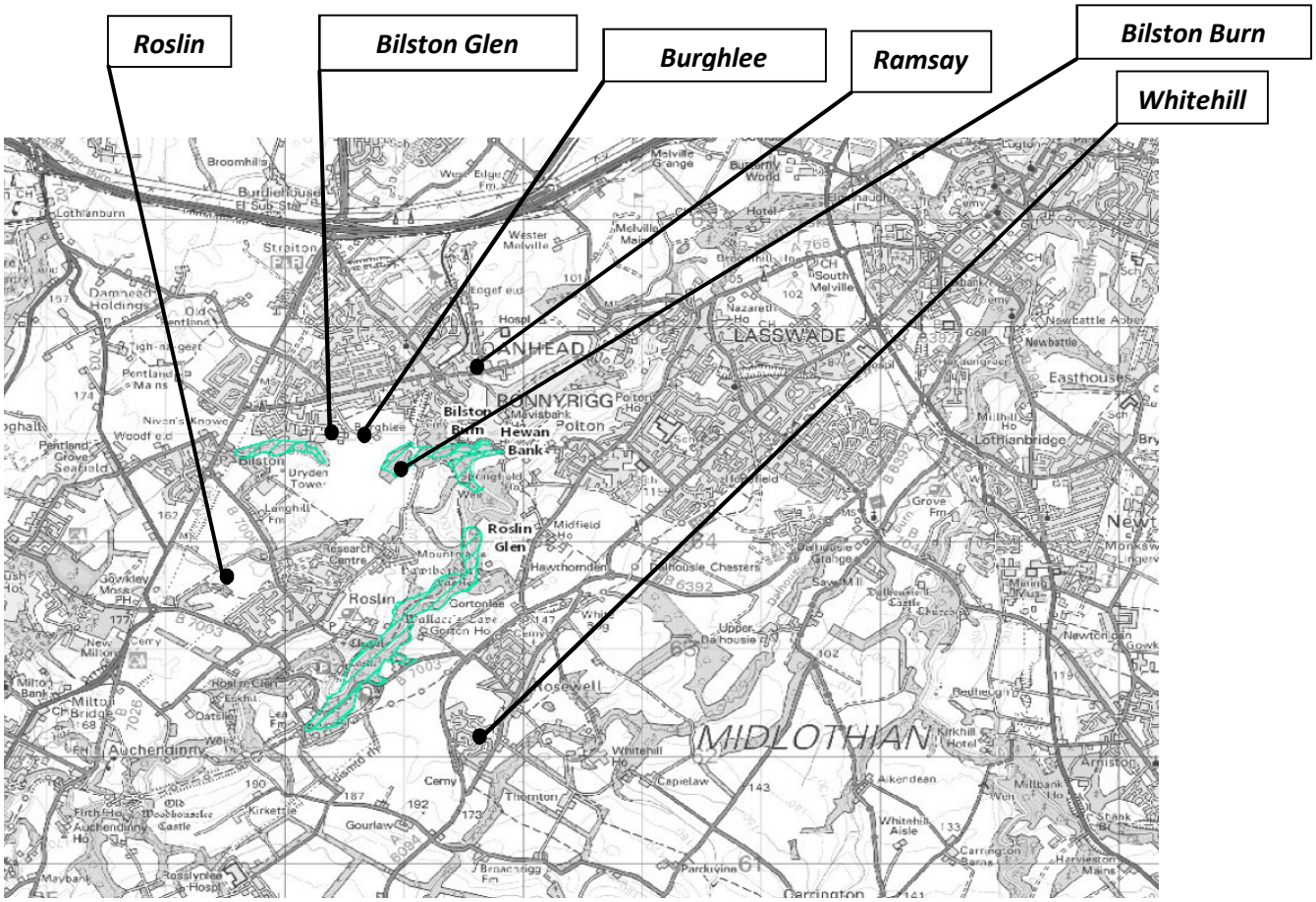


Figure 1: Mine locations in relation to SSSIs (West)
(SSSIs highlighted in blue)

The western area contains several mines close to SSSIs.

Note: There are no SSSIs within the eastern side of the designated area.

Feature Category	Feature	Statutory Interest
Broad-leaved, mixed and yew woodland	Upland mixed ash woodland	Notified feature
Stratigraphy	Lower Carboniferous [Dinantian - Namurian (part)]	Notified feature

Showing 1 to 2 of 2 entries

2. Category A - Listed Buildings

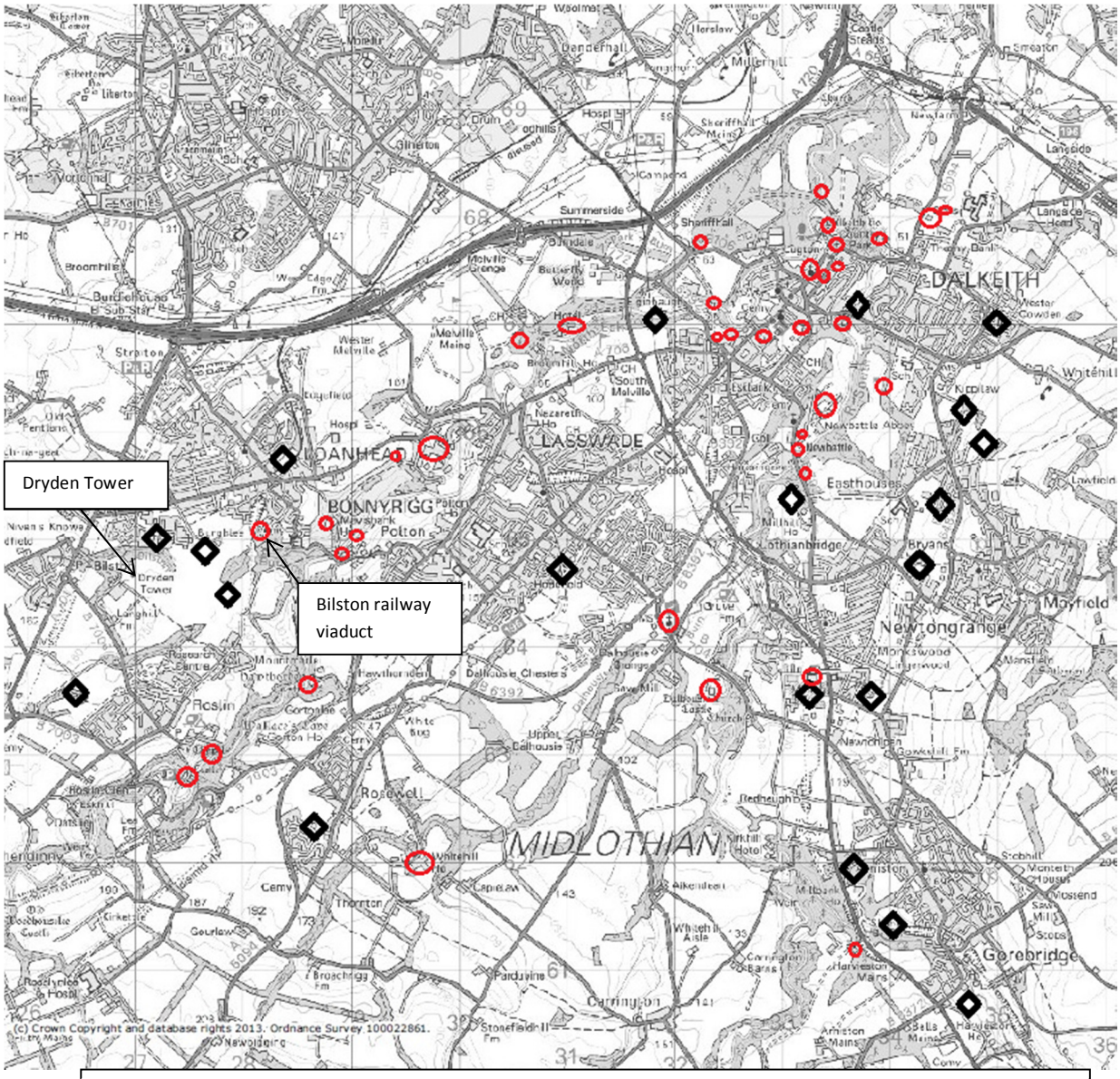
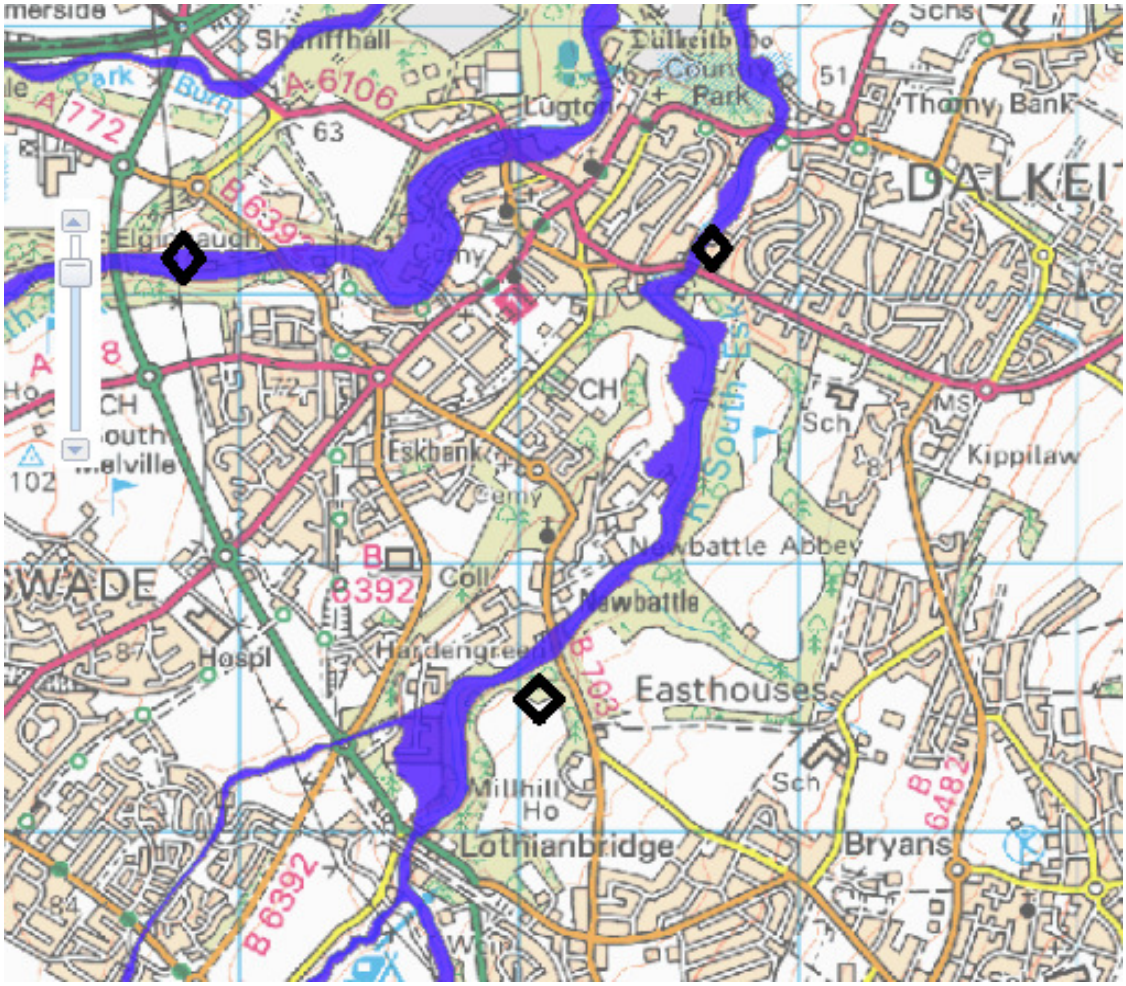


Figure 2 – Locations of Category A listed buildings (Red) and mine locations (Black).

Listed buildings compiled by Historic Scotland. Structured as categories A, B and C. A being of the highest importance, similar to the system in place in England.

3. Flood Risk Mapping



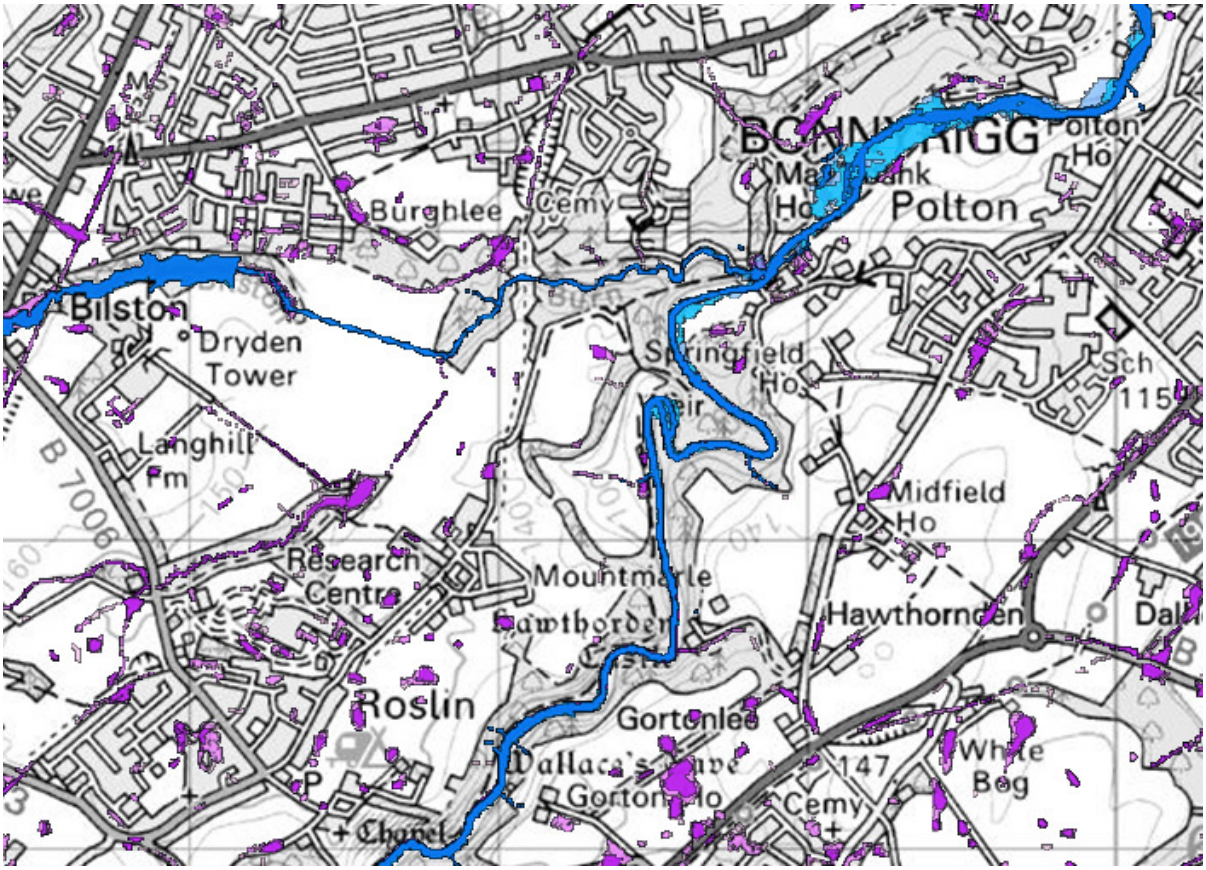


Figure 3 –Blue areas indicate flood risk

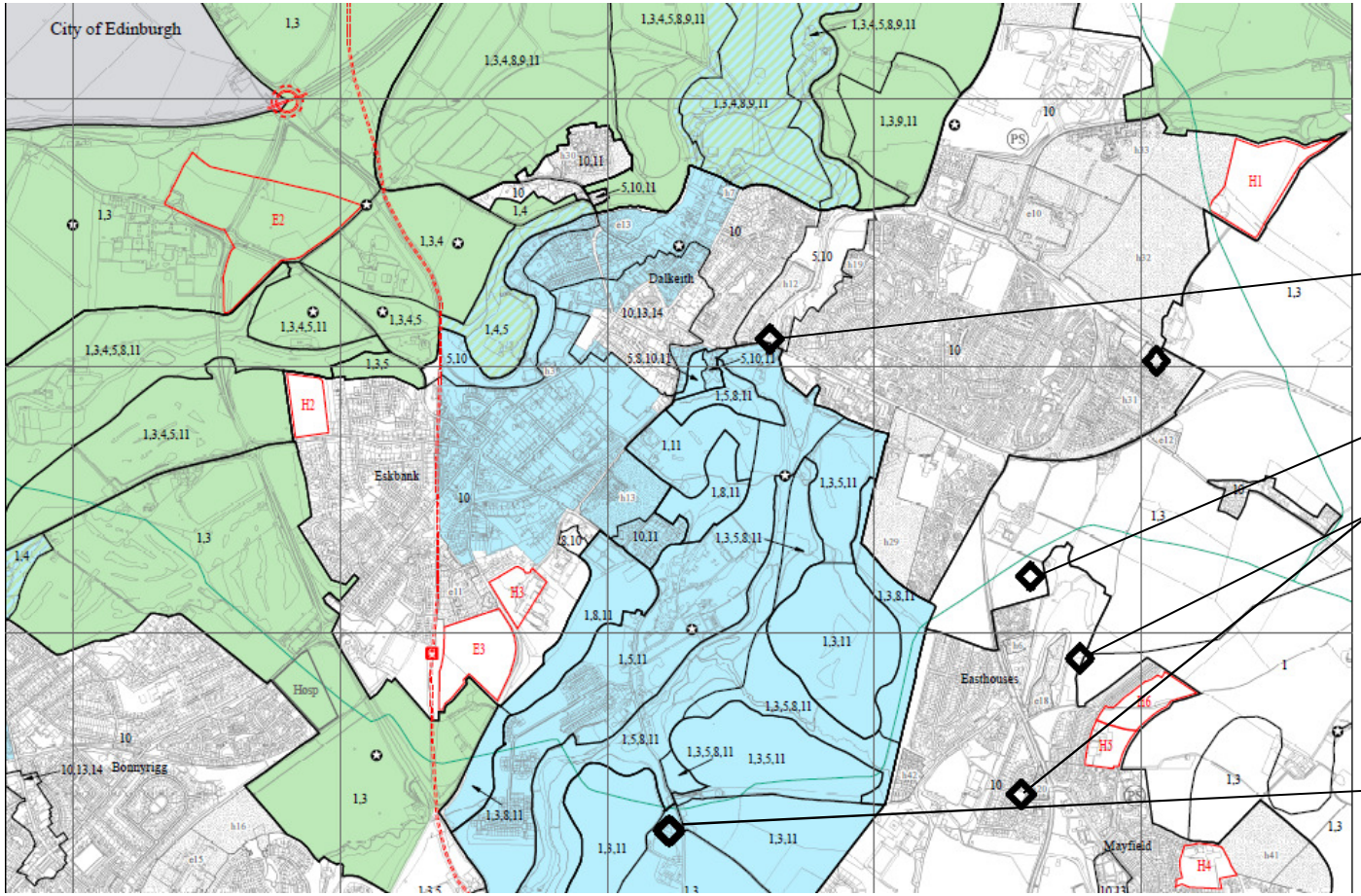


Figure 4 – Midlothian Local Plan Map 1
A7-A68 Corridor North
(Mines highlighted in black)

(1) **Old Fordell** adjacent to conservation area, protection due to:
5: Protection of Riverways
10: Development within built up area
11: Nationally important gardens and designated landscapes.

(2) **Shaws Pit** situated within proximity of gas pipeline.

(3) **Easthouses** and **Easthouses Pumping Pit** situated near to strategic housing allocation sites H5 and H6.

(4) **Ochre Burn** situated within Conservation Area, protected under following policies:
1: Protection of the countryside
3: Prime agricultural land

KEY

Number / Symbol	Text Ref.
Policies	
The following policies apply to specific parts of the Local Plan area	
1 Protection of the countryside	RP1
Protection of the Green Belt	RP2
2 Major non-conforming land-uses in the Green Belt	RP3
3 Prime agricultural land	RP4
4 Areas of Great Landscape Value	RP6
5 Protection of river valleys	RP9
6 Internationally important nature conservation sites	RP10
7 Nationally important nature conservation sites	RP11
8 Regionally & locally important nature conservation sites	RP12
9 Regional and Country Parks	RP16
10 Development within the built-up area	RP20
Conservation Areas (boundaries as at 2008 but subject to change through seperate statutory process - refer to Council website for details)	RP22/RP23
11 Nationally important gardens and designed landscapes	RP25
Scheduled Ancient Monuments (locations indicative only as sites can be extensive)	RP26
12 Low density rural housing	HOUS5
Safeguarded rail schemes	TRAN4
Safeguarded road schemes	TRAN4
Safeguarded park and ride	TRAN4
13 Town centres	SHOP1
14 Strategic town centres	SHOP2/SHOP3
15 Straiton Retail Park	SHOP4
16 Midlothian Ski and Snowboard Centre	COMF7
Areas of search: opencast coal	MIN1
Areas of search: sand and gravel	MIN1
The remainder of the policies contained in the Written Statement apply to the whole Local Plan area	
Proposals	
H Strategic housing land allocations	HOUS1
VH Village housing land allocations	HOUS2
E Strategic economic land allocations	ECON1
B Biotechnology land allocations	ECON2
Waverley rail line	TRAN2
Waverley rail line stations	TRAN2
Trunk roads	TRAN3
PS Education facilities - primary	COMF1
L Leisure and community facilities	COMF4
Committed Developments	
Established housing land supply	COMD1
Established economic land supply	COMD1
PS Committed educational facilities - primary	COMD1
L Committed leisure and community facilities	COMD1
TC Shawfair town centre	COMD1
Hosp Midlothian Community Hospital	COMD1
Park and ride (Sheriffhall Extension)	COMD1
WC Waste management complex	COMD1
MC Former Monktonhall Colliery	COMD1
Constraints	
Gas pipeline	

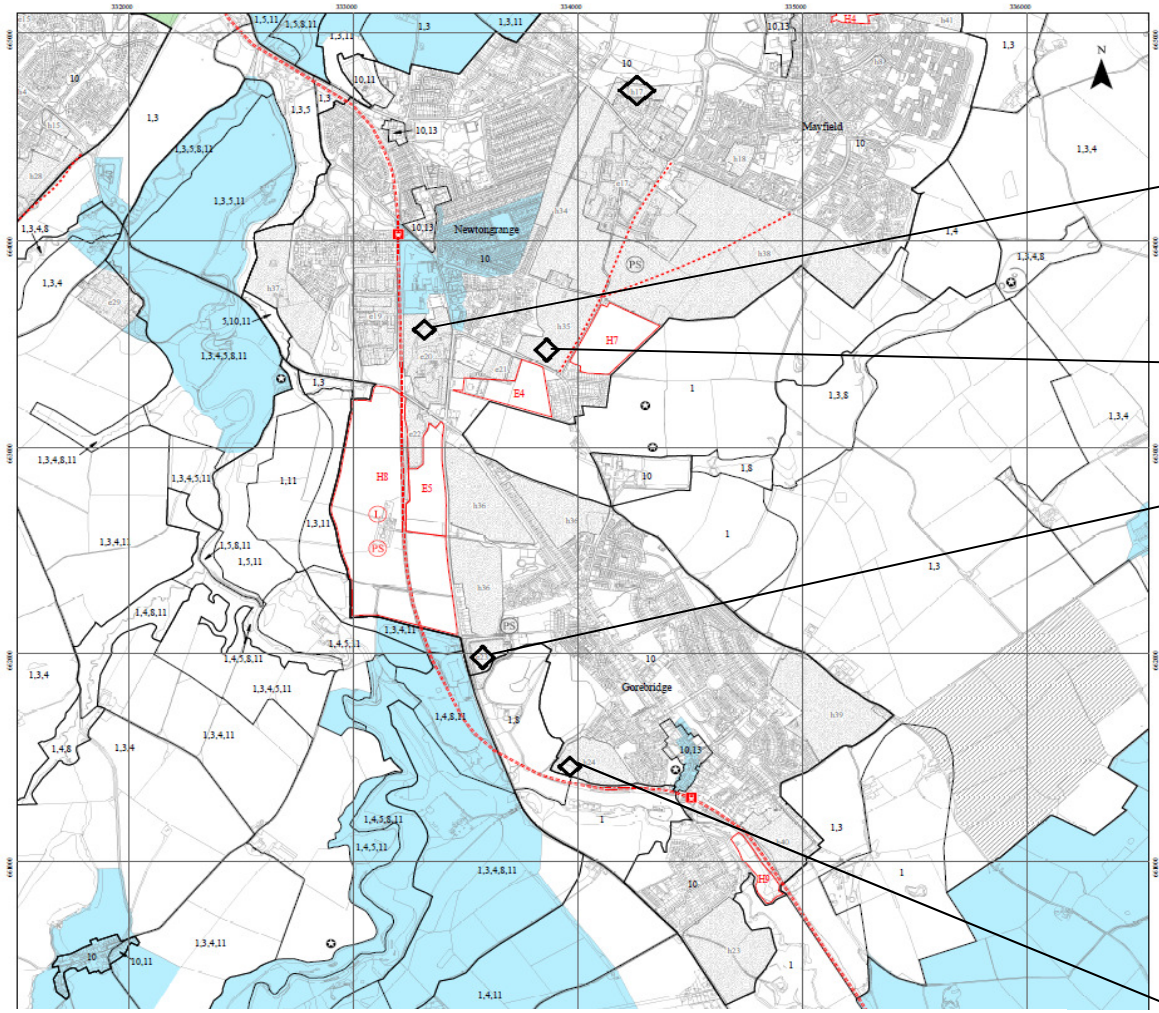


Figure 5: Midlothian Local Plan Map 2
A7-A68 Corridor South
(Mines highlighted in black)

(1) **Lady Victoria** situated adjacent to railway line and conservation area, protected due to:
10: Development in the built up area

(2) **Lingerwood** situated adjacent to safeguarded road scheme and strategic housing allocation site H7, and strategic economic allocation site E4.

(3) **Arniston (Emily)** situated adjacent to railway line, housing allocation site H8 and two conservation areas.

Protection of northern conservation area under:
1: Protection of countryside
3: Prime agricultural land
4: Areas of Great Landscape Value
11: Nationally important gardens and designated landscapes

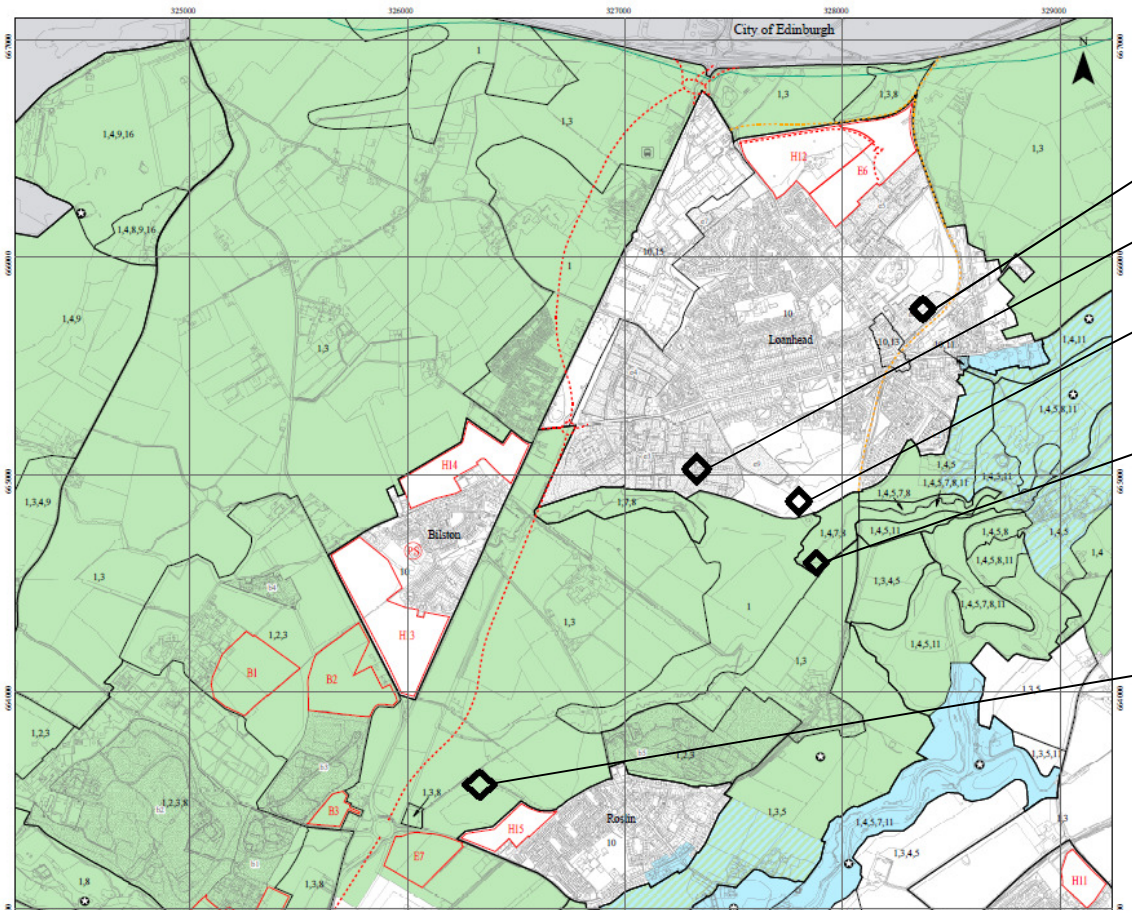
Protection of southern conservation area under:
1: Protection of the countryside
4: Areas of Great Landscape Value
8: Regionally & locally important nature conservation sites
11: Nationally important gardens and designated landscapes

(4) **Arniston (Gore)** situated adjacent to railway line.

KEY

Number / Symbol	Text Ref.
Policies	
The following policies apply to specific parts of the Local Plan area	
1 Protection of the countryside	RP1
Protection of the Green Belt	RP2
2 Major non-conforming land-uses in the Green Belt	RP3
3 Prime agricultural land	RP4
4 Areas of Great Landscape Value	RP6
5 Protection of river valleys	RP9
6 Internationally important nature conservation sites	RP10
7 Nationally important nature conservation sites	RP11
8 Regionally & locally important nature conservation sites	RP12
9 Regional and Country Parks	RP16
10 Development within the built-up area	RP20
Conservation Areas (boundaries as at 2008 but subject to change through seperate statutory process - refer to Council website for details)	RP22/RP23
11 Nationally important gardens and designed landscapes	RP25
Scheduled Ancient Monuments (locations indicative only as sites can be extensive)	RP26
12 Low density rural housing	HOUS5
Safeguarded rail schemes	TRAN4
Safeguarded road schemes	TRAN4
Safeguarded park and ride	TRAN4
13 Town centres	SHOP1
14 Strategic town centres	SHOP2/SHOP3
15 Straiton Retail Park	SHOP4
16 Midlothian Ski and Snowboard Centre	COMF7
Areas of search: opencast coal	MIN1
Areas of search: sand and gravel	MIN1
The remainder of the policies contained in the Written Statement apply to the whole Local Plan area	
Proposals	
H Strategic housing land allocations	HOUS1
VH Village housing land allocations	HOUS2
E Strategic economic land allocations	ECON1
B Biotechnology land allocations	ECON2
Waverley rail line	TRAN2
Waverley rail line stations	TRAN2
Trunk roads	TRAN3
PS Education facilities - primary	COMF1
L Leisure and community facilities	COMF4
Committed Developments	
Established housing land supply	COMD1
Established economic land supply	COMD1
PS Committed educational facilities - primary	COMD1
L Committed leisure and community facilities	COMD1
TC Shawfair town centre	COMD1
Hosp Midlothian Community Hospital	COMD1
Park and ride (Sheriffhall Extension)	COMD1
WMC Waste management complex	COMD1
MC Former Monktonhall Colliery	COMD1
Constraints	
Gas pipeline	

Figure 6: Midlothian Local Plan Map 3
A701 Corridor North
(Mines highlighted in black)



(1) **Ramsey** situated adjacent to safeguarded rail scheme.

(2) **Bilston Glen** situated close to numerous green belt sites.

(3) **Burghlee** borders with a Green Belt site, protected under:
1: Protection of the countryside

(4) **Bilston Burn** is situated on Green Belt land, protected under:

1. Protection of the countryside
4. Areas of great landscape value
7. Nationally important conservation sites
8. Regionally & locally important nature conservation sites

(5) **Roslin** is situated on land bordering with strategic housing allocation site H15 and strategic economic allocation site E7. The site is also classified as Green Belt land and protected under:

1. Protection of the countryside
3. Prime agricultural land

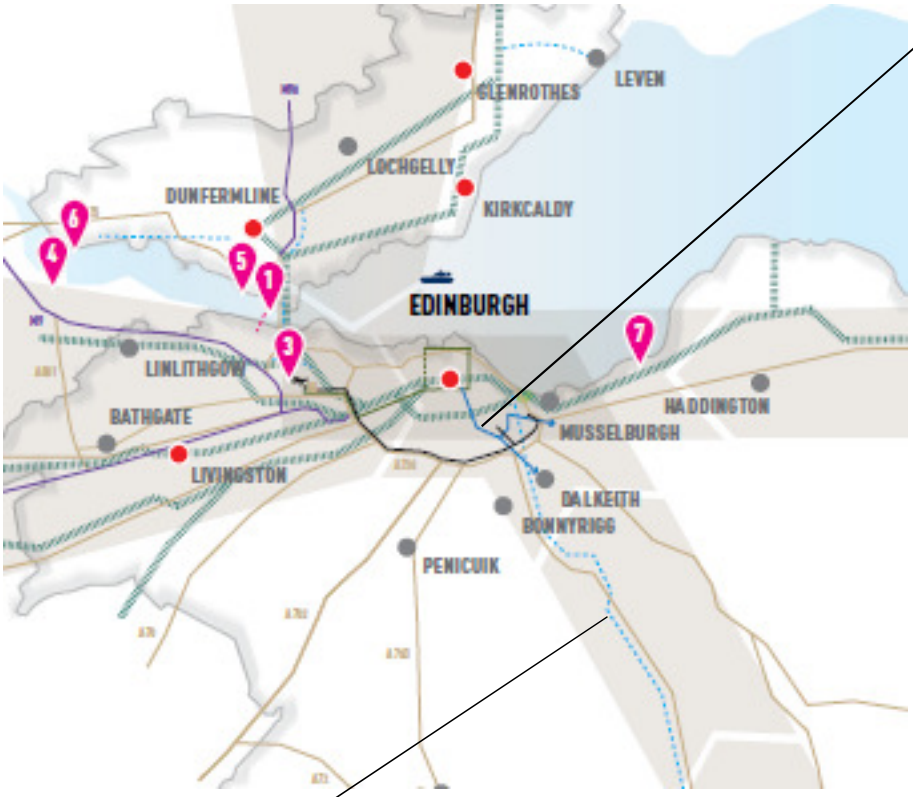
KEY

Number / Symbol		Text Ref.
Policies		
The following policies apply to specific parts of the Local Plan area		
1	Protection of the countryside	RP1
	Protection of the Green Belt	RP2
2	Major non-conforming land-uses in the Green Belt	RP3
3	Prime agricultural land	RP4
4	Areas of Great Landscape Value	RP6
5	Protection of river valleys	RP9
6	Internationally important nature conservation sites	RP10
7	Nationally important nature conservation sites	RP11
8	Regionally & locally important nature conservation sites	RP12
9	Regional and Country Parks	RP16
10	Development within the built-up area	RP20
	Conservation Areas (boundaries as at 2008 but subject to change through seperate statutory process - refer to Council website for details)	RP22/RP23
11	Nationally important gardens and designed landscapes	RP25
	Scheduled Ancient Monuments (locations indicative only as sites can be extensive)	RP26
12	Low density rural housing	HOUS5
	Safeguarded rail schemes	TRAN4
	Safeguarded road schemes	TRAN4
	Safeguarded park and ride	TRAN4
13	Town centres	SHOP1
14	Strategic town centres	SHOP2/SHOP3
15	Straiton Retail Park	SHOP4
16	Midlothian Ski and Snowboard Centre	COMF7
	Areas of search: opencast coal	MIN1
	Areas of search: sand and gravel	MIN1
The remainder of the policies contained in the Written Statement apply to the whole Local Plan area		
Proposals		
H	Strategic housing land allocations	HOUS1
VH	Village housing land allocations	HOUS2
E	Strategic economic land allocations	ECON1
B	Biotechnology land allocations	ECON2
	Waverley rail line	TRAN2
	Waverley rail line stations	TRAN2
	Trunk roads	TRAN3
PS	Education facilities - primary	COMF1
L	Leisure and community facilities	COMF4
Committed Developments		
	Established housing land supply	COMD1
	Established economic land supply	COMD1
PS	Committed educational facilities - primary	COMD1
L	Committed leisure and community facilities	COMD1
TC	Shawfair town centre	COMD1
Hosp	Midlothian Community Hospital	COMD1
	Park and ride (Sheriffhall Extension)	COMD1
WMC	Waste management complex	COMD1
MC	Former Monktonhall Colliery	COMD1
Constraints		
	Gas pipeline	

Constraints outlined in the SES Strategic Development Plan (June 2013)

1. Proposed Tram Line 3 Development

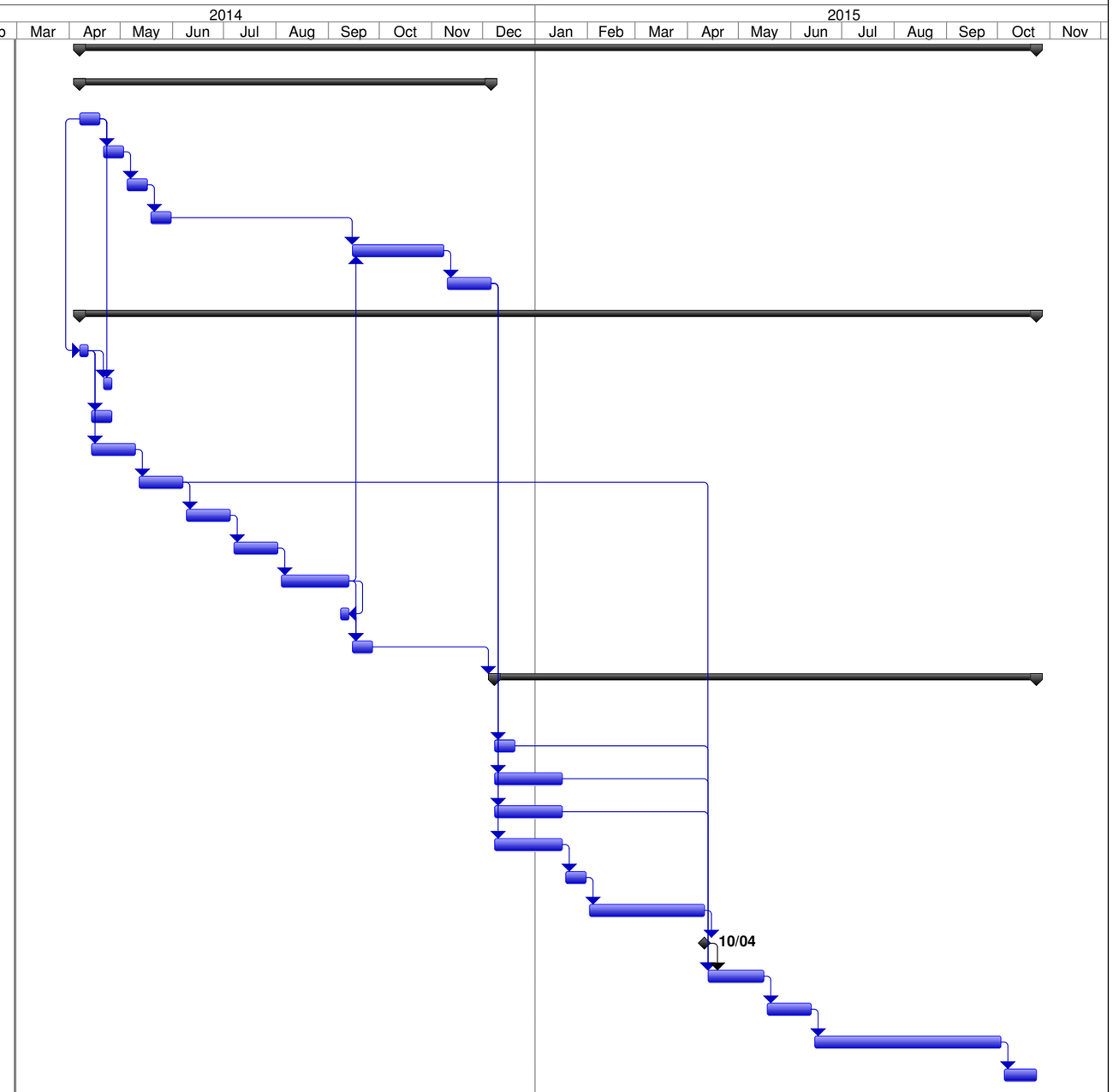
As outlined in the SES plan (2013), the proposed construction of 'tram line 3' linking Dalkeith to Edinburgh has been identified as a key strategic infrastructure improvement 'required for existing and future development' in the region. (Section 45, SES Plan, 2013).



2. The area is also subject to a new proposed rail route running parallel to the A701 corridor (Section 70, SES Plan, 2013

APPENDIX C PROPOSED PROGRAM OF WORKS

ID	Task Name	Start	Finish
1	**BILSTON GLEN COALFIELDS MINE WATER TREATMENT SCHEME**	**Mon 07/04/14**	**Fri 23/10/15**
2	**Pumping test**	**Mon 07/04/14**	**Fri 05/12/14**
3	Design pumping test	Mon 07/04/14	Fri 18/04/14
4	Procure drilling/ pump test contractor	Mon 21/04/14	Fri 02/05/14
5	Mobilise to site	Mon 05/05/14	Fri 16/05/14
6	Drill abstraction borehole	Mon 19/05/14	Fri 30/05/14
7	Undertake pump test	Mon 15/09/14	Fri 07/11/14
8	Analyse data and prepare report	Mon 10/11/14	Fri 05/12/14
9	**Phase 1 of Passive Treatment Scheme (Settlement Pond 1)**	**Mon 07/04/14**	**Fri 23/10/15**
10	Detailed topographical survey	Mon 07/04/14	Fri 11/04/14
11	Specify and order caustic soda dosing plant	Mon 21/04/14	Fri 25/04/14
12	Design influent minewater channel	Mon 14/04/14	Fri 25/04/14
13	Detailed design of settlement pond No. 1	Mon 14/04/14	Fri 09/05/14
14	Procure civil engineering works	Mon 12/05/14	Fri 06/06/14
15	Mobilise to site	Mon 09/06/14	Fri 04/07/14
16	Prepare site compound	Mon 07/07/14	Fri 01/08/14
17	Construct settlement pond No. 1	Mon 04/08/14	Fri 12/09/14
18	Set up dosing plant	Mon 08/09/14	Fri 12/09/14
19	Commissioning of Phase 1	Mon 15/09/14	Fri 26/09/14
20	**Phase 2 of Passive Treatment Scheme (Settlement Pond 2 and Wetlands)**	**Mon 08/12/14**	**Fri 23/10/15**
21	Detailed design of aeration cascades	Mon 08/12/14	Fri 19/12/14
22	Detailed design of settlement pond No. 2	Mon 08/12/14	Fri 16/01/15
23	Detailed design of constructed wetlands No.1&2	Mon 08/12/14	Fri 16/01/15
24	Detailed design of effluent discharge channel/ outfall structure	Mon 08/12/14	Fri 16/01/15
25	Discharge consent application preparation for submission to SEPA	Mon 19/01/15	Fri 30/01/15
26	Discharge consent application period	Mon 02/02/15	Fri 10/04/15
27	Obtain discharge consent from SEPA	Fri 10/04/15	Fri 10/04/15
28	Procure civil engineering works	Mon 13/04/15	Fri 15/05/15
29	Mobilise to site	Mon 18/05/15	Fri 12/06/15
30	Construct Phase 2 works	Mon 15/06/15	Fri 02/10/15
31	Commissioning of Phase 2	Mon 05/10/15	Fri 23/10/15



Project: Bilston Glen Proposed Progra
Date: Fri 28/02/14

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