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Part 6: Water & Air

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6 Environment: Water & Air

6.1 Introduction

6.1.1 This section examines the hydrology, climate, air quality & noise along the proposed canal route.

6.1.2 The hydrology section outlines river and drainage systems, the existing wetlands, the local aquifers and the type, quantity and composition of existing discharges. It notes both supplies and constraints upon supplies which may be relevant to the reinstatement of the canal.

6.1.3 The climate and air quality section examines local climatic factors, air quality and known discharges to air along the proposed canal route. It also examines the "noise-scape" of the proposed route and the possible noise impact of the proposed reinstatement.

6.2 Hydrological Context

6.2.1 The Killamarsh to Kiveton Park section of the canal crosses between two major hydrological catchments. The point where the canal crosses the boundary between them – the watershed – lies along the summit of the Coal Measures Escarpment roughly along the line taken by the M1 Motorway.

6.2.2 To the West of the line of the M1 Motorway is the catchment of the River Rother. This in turn drains into the River Don at Rotherham. The Don and Rother Catchments is one of the major catchments of England and, in common with all other major catchments, is subject to an Environment Agency Catchment Management Plan.

6.2.3 To the East of the M1 Motorway is the catchment of the River Ryton which joins the River Idle at Bawtry and thence joins the Torne before entering the Trent at West Stockwith. The Idle and Torne Catchment is also a Water Framework Directive Management Catchment.

6.2.4 Both the Don & Rother and Idle & Torne Catchments drain into the river Humber and form part of the Environment Agencies **Humber River Basin District** which covers much of the North East Midlands and Yorkshire.

6.2.5 The watercourses to the east and west of the watershed have different characteristics and it is a requirement of restoration that waters from different catchments are not mixed.

The Rother Catchment

6.2.6 The River Rother rises near Clay Cross and flows north to join the River Don at Rotherham. The River Don is, in turn, a tributary of the Ouse and Humber. The Don Catchment is employed as a management unit by the Environment Agency which treats the River Rother as one of four sub-catchments of the Don (the others being the Upper Don, Lower Don and the Dearne). The River Rother and its tributaries drains the majority of North East Derbyshire and a large part of East Sheffield and South Rotherham in South Yorkshire.

6.2.7 The course of the River Rother is determined by the underlying geology and geomorphic history (see above). The north – south orientated "dip slope, vale and scarp" landforms resulting from the eastwards dip of the Coal Measures give the Rother Valley its asymmetrical cross section and yields tributaries of different characters. The dip slope streams (River Hipper, River Drone, Moss Brook, Shire Brook) on the western bank are longer and have a gently sloping long profile. Those on the eastern bank (Smithy Brook, Park Brook, County Dike) flow down the Coal Measure escarpment and are generally much shorter with a steeper gradient. The east bank exceptions are those tributaries, such as the Doe Lea and the Dale Brook, which flow along the foot of the escarpment and collect several short scarp face streams before joining the Rother.

6.2.8 The River Rother in this section from Killamarsh to Rotherham (Environment Agency Waterbody ID GB104027057770) is a low, medium, calcareous stream which has a heavily modified channel cross section, long profile and flow regime (i.e. a heavily modified hydromorphology).

6.2.9 The long history of heavy industry and dense settlement in North East Derbyshire has left a varied pollution legacy in the Rother catchment. In 1974 the river was grossly polluted, being class F along most of its length. The main pollution stemmed from coal carbonisation (four coking plants), sewage treatment and chemical manufacture.

6.2.10 Since that date coal carbonisation has ended: Brookhouse closed in the early 1980's, Orgreave in 1991, Avenue in 1992 and Coalite at Bolsover finally ceased production in 2004. These works combined had the most significant impact on water quality – their closure has probably played the greatest role in the improvement of water quality along most of it length.

6.2.11 Improvements in sewage treatment have also played a very significant role - in 1974, 48 sewage treatment works served the catchment, 11 of which were classed as unsatisfactory at the time. Many of the smaller unsatisfactory works have since been closed leaving the total number of sewage works in the catchment at 29. The main treatment facilities today are Old Whittington, Staveley, and Woodhouse Mill. All have greatly improved the quality of discharge and have achieved lower phosphate and nitrate levels.

6.2.12 The chemical industry grew up with the coking industry and has suffered an equal decline. Of the four plants operating in 1974 only one remains. The Staveley plant has undergone many changes and is now exceedingly clean with no significant pollution outputs.

6.2.13 The above have helped to improve the water quality in the Rother markedly. Although the chemical condition of the river as described by the EA remains poor, and in chemical quality terms failing, over the last ten years a remarkable variety of plant and animal life has returned. While year on year improvements in biodiversity continue, there is still some way to go and the predicted chemical status of the river in 2015 is failing. The EA note the fragility of the recovery and class the river as "at risk".

6.2.14 Contributing to this risk are a number of potential water pollution factors which apply across the catchment and which may be impacted in some way by the reinstatement of the canal. Key factors affecting water quality in the Rother catchment today are:-

6.2.15 **Industrial Legacy**: The catchment has a great number of sites of former heavy industry including collieries, ironworks and chemical works. While the industrial activities have largely ceased, the spoil tips and dumps from these industries pose particular hazards and continue, via leachates, to contribute to ground and river water pollution. The coking plants at Bolsover and Wingerworth in particular discharged significant amounts of chemicals into the Rother and its tributary stream the Doe Lea and this has left a legacy of mobile chemicals in river sediments which pose problems for water management and land remediation.

6.2.16 **Contaminated Ground**: Areas of contaminated ground occur where there are former landfill sites. Two former landfill sites at the Derbyshire (Norwood) Chemical Works site and at the Railway Cutting north of Kiveton West Colliery (both noted in part 5) lie within 500 m of the canal track and this falls within the sites landfill gas consultation zones. They may also have impacts on local ground water.

6.2.17 **Mine Water Drainage**: Water from abandoned mine workings is common. Most of the mines concerned are small (often small drift mine adits) and were abandoned prior to the formation of the National Coal Board and its inheritor, the Coal Authority, and hence there is no legal responsibility for them. Drainage water is often strongly acidic and iron-rich leading to ochre deposition down stream of the emergence point.

6.2.18 **Agricultural Activity**: Agriculture is not a strong influence in this area but the combination of relatively poor soils and high groundwater leads to intense phosphate fertiliser use coupled to artificial ground drainage. This has significant drainage impacts on local streams and rivers. In addition poor faming practice leading to accidents, malpractice and inadequate storage of waste can give rise to major pollution incidents. Implementation of the MAFF Code of Good Agricultural Practice and the 1989 Farming Regulations controlling the storage of silage, slurry and agricultural fuel oil has given the Environment Agency an active part in waste management on farms and in preventing pollution by requiring improving farm waste storage facilities.

6.2.19 **Surface Water Drainage from Roads and Housing**: The superficial greening of the area has led to increased housing provision as it has become an attractive commuter suburb of Sheffield. This in turn has led to increased surface water run off from roads and hard landscaped areas. Much of this run off is contaminated with domestic detergents, oil and road tar.

The Ryton (Idle & Torne) Catchment

6.2.20 The River Ryton starts within the canal corridor as a very minor stream which flows eastwards to merge with several other small streams (notably the Anston Brook) before reaching Worksop. After looping through the town it turns north-east then north towards Blyth and thence to Bawtry were it joins the River Idle. The Ryton is thus part of the Idle & Torne catchment and, like the Rother, ultimately part of the Humber River Basin District.

Biological Quality Classification Grades		Chemical Quality Classification Grades	
Classification	Description	Classification	Description
A - very good	Biology similar to that expected for an unpolluted river	A - very good	All abstractions Very good salmonid fisheries Cyprinid fisheries Natural ecosystems
B - good	Biology is a little short of an unpolluted river	B - good	All abstractions Very good salmonid fisheries Cyprinid fisheries Ecosystems at or close to natural
C - fairly good	Biology worse than expected for an unpolluted river	C - fairly good	Potable supply after advanced treatment Other abstractions Good cyprinid fisheries Natural ecosystems, or those corresponding to good cyprinid fisheries
D - fair	A range of pollution tolerant species present	D - fair	Potable supply after advanced treatment Other abstractions Fair cyprinid fisheries Impacted ecosystems
E - poor	Biology restricted to pollution tolerant species	E - poor	Low grade abstraction for industry Fish absent or sporadically present, vulnerable to pollution ** Impoverished ecosystems **
F - bad	Biology limited to a small number of species very tolerant of pollution	F - bad	Very polluted rivers which may cause nuisance Severely restricted ecosystems
			*providing other standards are met **where the grade is caused by discharges of organic pollution

Figure 6.1 Environment Agency, Biological and Chemical Water Quality Grades and Descriptors

To monitor biological quality the Environment Agency compare the macro-invertebrates in the sample with the range of species expected to inhabit the river if it was not polluted and assign a grade. To monitor chemical quality the EA test samples for ammonia, biochemical oxygen demand (BOD) and dissolved oxygen. The results for each site are averaged and percentiles are calculated, and a grade assigned to the river. The figure above shows the descriptions of the grades.

6.2.21 The River Ryton within the canal corridor is little more than a ditch and from source to Aniston Brook (Environment Agency Waterbody ID GB104028058160) is classed as a low, small calcareous stream with no designated hydromorphological status (for most of this stretch it is running in field ditches). In this length is has a moderate ecological quality and a passing chemical quality. Its predicted ecological quality for 2015 is Good and its predicted Chemical quality is a pass. It is described as at risk but does lie in a protected area (Nitrate protected zone). The chief potential pollution issues facing the Ryton are:-

6.2.22 **Agricultural Activity**: Agriculture is a very strong influence in this area and has significant quality impacts due to sediment and fertiliser run-off. Poor farming practice leading to accidents, malpractice and inadequate storage of waste can give rise to major pollution incidents. As noted above, the Environment Agency has an active role in waste management on farms and in preventing pollution by requiring improving farm waste storage facilities.

6.2.23 **Surface Water Drainage from Roads and Housing**: Pressure to expand the many attractive small villages across the area has led to increased housing provision and increased surface water run off from roads and hard landscaped areas. Much of this run off is contaminated with domestic detergents, oil and road tar.

6.2.24 **Industrial Legacy and Contaminated Ground**: Although not as heavily industrialised as the Rother catchment, the area does have a number of former colliery sites. These are generally later, larger and deeper pits than those to the east and were worked until the 1980's and 90's. Several pits near the canal line had large spoil tips which have now been reclaimed and landscaped but there are still issues of ground water pollution in surrounding areas.

6.2.25 Areas of contaminated ground occur where there are former landfill sites. Two former landfill sites occur at the former quarries to the north of Kiveton Park Station (both noted in part 5). The south western edge of one lies within 500 m of the canal track (the east portal of Norwood Tunnel) and this falls within the sites landfill gas consultation zones. They may also have impacts on local ground water.

6.3 Hydrology of the Canal Track & Corridor from Killamarsh to Kiveton Park

6.3.1 In each section between Killamarsh and Kiveton Park the proposed canal route intersects the following watercourses:-

<u>Killamarsh Town</u>

6.3.2 From the edge of Killamarsh to Nethermoor Lake the route intersects one stream, the **Dale Brook**, which drains the Dale valley to the South-East of Killamarsh. At one time the brook passed under the canal in a culvert and continued down the shallow Dale valley onto the floor of the Rother Valley. Since the construction of housing in the 1970's the Brook enters a culvert on the south side of Kirkcroft Road and passes under the housing estate where it sporadically surfaces for a short distance before returning to its culvert. It finally emerges from a modern concrete box culvert on the north side of Sheffield Road. In its passage through the housing estate, the brook also receives surface water run-off from the Church Town and Nether Moor areas of the village.

6.3.3 From Sheffield Road the brook then flows in an open ditch (which also takes drainage from the areas behind the flood banks surrounding Rother Valley Country Park) before passing through a floodgate to enter Nethermoor Lake.

6.3.4 The flow of the brook is low. Its biological and chemical quality is fair to poor - contributing factors include drainage water from ancient shallow colliery workings in the Dale Valley and the detergents and oils derived from surface water run-off.

6.3.5 Nethermoor Lake is an artificial pond formed following open cast mining on the floor of the Rother Valley. It has a fairly good biological status and a fair chemical status.

6.3.6 It forms part of the Rother Valley Flood defence system and is surrounded by a flood bank. During extreme events the area around the lake can be flooded to increase the storage capacity of the floodplain. The lake discharges though flood gates to the River Rother.

Killamarsh East

6.3.7 From Nethermoor Lake the proposed route climbs back to the original canal line up a minor scarp slope. The slope has several active springs along its foot. Flow from these springs passes into field drains which take it under Barber's Lane and thence into Nethermoor Lake or Meadowgate Lake. The flow of these springs is low but sufficiently constant to support permanent spring "flush" vegetation communities. None of the springs recorded to date lie on the canal line but the presence of a spring line has implications for the engineering of the lock flight.

6.3.8 The existing, original canal line to the foot of the Norwood Flight takes field and surface water drainage from the surrounding area. Before the foot of the flight is reached the canal crosses over the **County Dike**.

6.3.9 The County Dike is a small stream which drains the Norwood Valley to the East of Killamarsh and passes under the Canal in a culvert near Norwood Bridge before flowing down to join the River Rother north of Meadowgate Lake. Like the Dale Brook, the County Dike collects drainage water from old mine workings and industrial sites. In consequence the Dike is biologically poor and has only a fair chemical status (see below).

Norwood

6.3.10 The shallow valley in which the Norwood Flight sits must have had its own valley stream (a tributary of the County Dike) before the canal was built on its alignment. Water flow down the valley was incorporated in the canal and the derelict lock flight still carries water. The flow down the valley is low but sufficient to keep filled the three large ponds which formed part of the water control and supply system.

6.3.11 Water currently comes from (1) water from surrounding land and woodland and (2) drainage water from the remains of the Norwood Tunnel. The quality of the water in this short section is fairly good and the chemical status fair. The volume and quality of the water from the remains of the Norwood Tunnel is at present un-quantified and needs further investigation, although the volume of water is not large and the water is not ochreous (iron stained) at this point.

6.3.12 At the base of the Norwood Flight a side or regulating weir once discharged excess water in to the County Dike via a short open culvert. This side weir has been blocked (without permission) since 2005 and water now overspills the canal bank beyond Norwood Bridge in an unauthorised side cut. This action is undermining the canal bank at this point.

Wales

6.3.13 The short ascent of the proposed route from the top of the existing flight to the M1 Motorway "watershed" intercepts no existing watercourses but will be liable to take field drainage.

6.3.14 To the east of the M1 Motorway the proposed canal line intercepts a field boundary drain. The drain is shallow and has very limited flow. It appears to take sediment and chemical run off from arable fields. Not biologically diverse, the chemical status is fair.

Kiveton Park

6.3.15 The proposed canal line continues along the line of the field edge drain which becomes larger at the junction with the drains surrounding the former Kiveton Colliery tip. The drain then accepts a surface water drain from a new housing estate to the north. A present the water from this combined drain is directed into a reed bed on the eastern side of the former Kiveton Colliery tip. This bed removes much of the silt, iron and nitrate load of the water and improves its oxygenation before it is discharged into the Broadbridge Dike.

6.3.16 The route of the field drain is surrounded by a planning authority water protection buffer zone. Similar zones are placed around Harthill and Pebley Reservoirs and along the watercourses on the dip slope of the escarpment.

6.3.17 The proposed canal route then intersects the Broad Bridge Dike (the canal feeder from Harthill reservoir). This has a fairly good biological status and a very good chemical status. The canal will bisect the Dike - the reinstatement proposals (see Chapter 10) call for the southern half of the Dike from Harthill reservoir to discharge into the new canal and for the overflow from the canal to leave via the northern half of the Dike. This will maintain both halves of the Dike in water and retain the cascade at Kiveton Park (outside this study area) which is important for helping to oxygenate the water at this point.

Hydrological / Water Quality Data from the Canal Corridor

6.3.18 In addition to the sport surveys under taken for this report, the Environment Agency (EA) monitors the quality of representative local watercourses on a regular basis, based on the results of biological and chemical water quality analyses from samples collected regularly at set locations. These have the advantage of being long term observations. The figure below shows the water classification results for watercourses close to the site of the reinstated canal. Data for the most recent year available has been included. The locations of the sampling points are shown on the ecological survey base map.

Catchment	Watercourse & Sampling Point	Biological Quality	Chemical Quality
Rother	County Dyke (Norwood Split)	E	D
Rother	County Dyke (Split 1, Split 2)	E	D
Ryton (Idle)	Broadbridge Dyke	C	A

Figure 6.2 Environment Agency Analysis of Biological and Chemical Water Quality from three sampling points on streams to the West and East of the watershed in proximity to the proposed canal route.

Riparian Rights and Licensed Abstraction within the Canal Corridor

6.3.19 Environment Agency Land Drainage Consent will be required for any works affecting watercourses, for example temporary culverts for access purposes. The Partnership and British Waterways (as developers of their respective sections) will have a responsibility to ensure that the rights of riparian landowners are not affected if any watercourses crossing the site need to be interrupted or diverted. The current plans do not require the permanent diversion of watercourses with riparian rights.

6.3.20 The Partnership is also required to ensure that licensed abstractions are not affected by the works. At present there are NO licensed abstractions within the canal track and immediate canal corridor.

6.4 The Potential Hydrological Impact of Reinstatement and Possible Constraints to Development

6.4.1 The hydrological impact of canal reinstatement can be considered in terms of (1) impact during the construction phase and (2) impact during operation.

<u>Impact During Construction Phase</u>

6.4.2 The chief potential hydrological impacts during the construction phases come from:-

- Incidental earth moving and consequent sediment inwash to watercourses
- Accidental contamination of watercourses with fuel oil, oil and construction materials such as cement and lime
- Accidental disturbance and chemical liberation of leachates from contaminated land

6.4.3 During construction there is the potential for sediment-laden water to enter nearby waterbodies, both directly through the crossing of steams and ditches, and indirectly through run-off from the construction area. Sediment laden water can have a highly damaging effect on aquatic ecology and lead to significant pollution problems. Construction can also trigger the release of currently “bound” pollutants into ground and surface water.

6.4.4 Watercourses with poor biological and chemical quality, typical of this area, have less resilience to pollution incidents during construction and are therefore very sensitive to this type of contamination.

6.4.5 The use of “within track” construction methods (working within the existing hedgerows and natural boundaries) is common in canal reconstruction. It has the advantages of minimising disturbance to adjacent areas and retains the original boundary features. Boundaries such as hedgerows and scrub woodland form natural “filters” and reduce surface sediment run-off leaving the site. Retaining as much spoil as possible on-site and reducing off-site transfer to a minimum will also reduce sediment wash out.

6.4.6 The potential for accidental contamination of watercourses with fuel oil, oil and construction materials such as cement and lime is always present. Construction site “housekeeping” will include adequate secure storage for all potential contaminants together with appropriate pollution control / emergency plans.

6.4.7 The accidental disturbance of contaminated ground and the mobilisation of currently bound pollutants will be avoided by detailed investigation at the design stage, pre-commencement site investigations and adequate planning.

6.4.8 In respect to all major threats, comprehensive pollution prevention measures as detailed in guidance including CIRIA C650 "Environmental Good Practice: Site Guide" and C649 "Control of Water Pollution from Linear Construction Projects: Site Guide" and Environment Agency Pollution Prevention Guidelines will be adhered to in order to minimise the risk of pollution to local watercourses and groundwater.

6.4.9 Prior to the commencement of ground operations the contractors will be required to produce an environmental management plan. This will identify potential hazards to watercourses and indicate how these will be eliminated or reduced to acceptable risk levels.

<u>Impact During Operation</u>

6.4.10 Only small sections of the proposed canal exist at present as disconnected ponds. These are shallow with poor to fair water quality. Reinstatement of the canal will require these ponds to be dredged and joined with extensive sections of new channel.

6.4.11 The biological impacts of reinstatement are addressed in Chapter Seven.

6.4.12 Water supply is a major issue and is addressed in detail in Chapter Ten.

6.4.13 Positive consequences of reinstatement include:-

- Increased water storage capacity in the catchment – opportunity for reducing storm flow and increasing dry season flow in streams down stream of the canal system (increasing the resilience and robustness of the system).
- Potential decrease in overland flow rate as the canal acts a barrier, interceptor and temporary store
- Potential to use the canal to increase groundwater infiltration (a leaking canal bed can be useful!)
- Potential to use the canal reedbeds and aquatic flora to improve water quality.

6.4.14 Negative consequences may include:

- Poorly engineered, the canal may increase flow rates during a storm event not decrease them. The importance of designing in storm water storage capacity is emphasised (see IWAC 2009).
- The potential for flooding of areas away from current flood risk areas due to bank collapse or structural failure (discussed further in 6.5 below).
- The potential for a leaking canal bed to create downslope seeps and springs with possible effects on agriculture and property.
- The potential for high levels of boat traffic to disturb channel sediments and to increase the opacity of the water column.

6.4.15 To a great extent the mitigation of potential impacts during operation is dependent upon the quality of the design work and the quality of the works undertaken. Properly addressed the works should provide an opportunity to put in place measures to improve water quality of nearby watercourses, particularly those with poor water quality records such as County Dyke.

6.5 Flooding & Flood Risk

6.5.1 Canals are artificial watercourses which of necessity have an intimate relationship with their feeder rivers. In consequence they often occupy low lying and high flood risk locations in the landscape and in these situations are likely to suffer from externally generated flood events.

6.5.2 Canals may also be the cause of flooding, either through the failure of water regulation systems to prevent excessive water input (and thus output) or through the failure of structures such as embankments or aqueducts, leading to localised flooding of surrounding, downslope, land.

Flooding & Flood Risk

6.5.3 A location is at risk of flooding if it is in a landscape position which is liable to receive, rather than shed, water.

6.5.4 The Staveley to Killamarsh section follows the valley of the River Rother and its tributary the Doe Lea. Both these rivers have notably rapid responses to heavy rainfall events and the Rother in particular is prone to flooding. The original canal engineers were aware of the volatility of the River Rother and engineered the canal to follow a course which lies above the active floodplain throughout its length. Because the canal follows a level course the vertical separation between active floodplain and the canal increases from around 2 m at Staveley to around 10 m at Killamarsh.

6.5.5 The Eastern Division from Killamarsh to Kiveton Park commences on the hill slope to the west of Killamarsh. At this point the canal is well above the potential 1 in 100 year flood as modelled by the Environment Agency. The canal then descends to the level of the Rother floodplain and enters the Nethermoor Lake. The lake forms part of a major flood defence system which utilises progressive flooding of areas of the Rother Valley Country Park to store floodwaters during a major event. The flood control system was integral to the landscaping of the Park when it was reclaimed after opencast coal mining in the 1980's.

6.5.6 This section will obviously be vulnerable to flooding and will require engineering to minimise the potential impact of major events. For example, any moorings should be placed on "rise and fall" pontoons with sufficient rise to accommodate the normal flood levels within the Nethermoor controlled flood lagoon.

6.5.7 The route then passes out of the lake and returns to the level of the original canal. As it does so it rapidly climbs beyond the 1 in 100 year or very severe flood limit. For the rest of the route to Killamarsh it remains above the predicted severe flood limit. Given the steepness of the hill slopes and the small collection areas above the canal level, it is unlikely that the summit area will suffer flooding due to an external event.

6.5.8 The descent to the former Kiveton Colliery site will bring the canal to Kiveton Waters. The Kiveton Waters ponds are within the 1 in 100 year flood limit for the Broadbridge Dike and it is, therefore, possible that the area my be flooded by a severe event. The reopening of the tunnel will provide an additional drainage route for this water and will reduce the potential for major flooding.

6.5.9 The overall potential impact of major flooding events is likely to be low provided the engineering design takes full account of the potential for flooding at Nethermoor Lake and at Kiveton Waters Ponds.

Potential for the Canal to Cause Flooding

6.5.10 Canals may also be the cause of flooding either through the failure of water regulation systems to prevent excessive water input (and thus output) or through the failure of structures such as embankments or aqueducts leading to localised flooding of surrounding, downslope, land.

6.5.11 The canal may cause local flooding though either bank failure or through the failure of a structure or an element of the structure (such as a lock gate). Failure due to the latter is extremely rare as the structures are simple and relatively over engineered. Flooding due to bank failure is slightly more common but still rare relative to the length of the British Waterways network (for example in the four year period from 2004 to 2008 only three bank failures occurred on a system of over 3000km).

6.5.12 The likelihood of bank or structural failure occurring is a function of the condition and maintenance regime of the waterway. The Killamarsh to Kiveton section will be effectively a new waterway – around 70 % of the route will be either new canal or sufficiently rebuilt to qualify as new canal. The relining of the remaining 30% of the route which is original canal will enable the underlying structure to be assessed in detail and the appropriate remedial work undertaken if required. Given the use of quality materials with a use life in excess of 100 years together with an adequate maintenance regime, the likelihood of structural failure is slight.

6.5.13 The likelihood of a bank failure occurring at a particular point and causing flooding is a function of the position of the canal in the landscape at that point. Put simplistically, bank failure in a cutting is less likely to lead to a breach than bank failure on an embankment. In consequence it is possible to assess the likelihood of failure giving rise to water leaving the canal. Further, it is obvious that the likelihood of flooding occurring downstream of a breach is a function of the slopes and barriers which exist in the landscape. The possible significance / impact of the flooding on surrounding communities can also be estimated – a breach leading to flooding of field has a lower potential health, safety and economic impact than the flooding of houses, schools, businesses or transport links.

6.5.14 In consequence it is possible to generate a simple flood risk model based on the exposure of the canal channel and banks, and the angles of and barriers present on, the surrounding slopes, together with the land-use and density of settlement. This is summarised in Figure 6.3, below.

Section & Length	Floodplain or Within 100 year flood limit?	Risk of "natural" flooding	Overall Landscape Position of the Canal Channel	Relationship of Land Level to Canal Level on west & north bank (i.e. LEFT side of Canal facing Kiveton Park)	Land-use on west & north banks	Relationship or Land Level to Canal level on east & south banks (i.e. RIGHT side of Canal facing Kiveton Park)	Land-use on east & south banks	Consequences of bank or structural failure leading to local release of water
Killamarsh Town								
6/1	no	very low	hill top,	below,	housing	above gentle	housing	very significant

			shedding	gentle slope	10 properties	slope, small catchment	10 properties	
6/2	no	very low	valley side, shedding	below, gentle slope	housing 32 properties	above, gentle slope	recreational grassland	very significant
6/3	no	very low	valley side, shedding	below, gentle slope	housing 22 properties	above, gentle slope	recreational grassland & housing 5 properties	very significant
6/4	no	very low	valley side, shedding	below, gentle slope	housing 20 properties	above, gentle slope	housing 18 properties	very significant
6/5	no	very low	valley side, shedding	same level as (on slope down)	recreational grassland	same level as (on slope down)	housing 30 properties	significant
6/6	yes	low	valley bottom, receiving	same level	housing 1 property	same level	housing 7 properties	significant
6/7	yes	medium	valley bottom, receiving	same level	fenwood & parkland	same level	fenwood & parkland	significant
Nethermoor Lake	yes	high	valley floor, receiving, (flood control) pond)	same level, flood control bund above	parkland, short grass	same level, flood control bund above	parkland, short grass	none
Killamarsh East								
7/1	yes	high	valley floor, receiving	same level, flood control bund above	parkland, short grass	same level, flood control bund above	parkland, short grass	none
7/2		high	valley side	same level as (on steep slope)	parkland, short grass pasture	same level as (on slope)	parkland, short grass pasture	low
7/3a	no	medium	valley side, shedding	below, steep slope	parkland, short grass pasture	above, very gentle slope (small catchment)	rough pasture (horse paddock)	none
7/3b	no	low	valley side, shedding	below, steep slope	parkland, rough pasture	above, very gentle slope (small catchment)	rough pasture (horse paddock)	low
7/3c	no	none	hill top, shedding	below, steep slope	rough pasture & scrub woodland	above, very gentle slope (small catchment)	rough pasture (horse paddock)	low
7/4	no	low	hill top, shedding	below, moderate slope	road & industrial estate >20 units	above, gentle slope	rough pasture (horse paddock)	significant
7/5	no	low	cutting, receiving	above, gentle slope	road & industrial estate >10 units	above, gentle slope	industrial estate >10 units	none
7/6	no	low	embankment, shedding	below, moderate slope	woodland	above to below, gentle slopes	agricultural yard & farm buildings	low
Section & Length	Floodplain or Within 100 year flood limit?	Risk of "natural" flooding	Overall Landscape Position of the Canal Channel	Relationship of Land Level to Canal Level on west & north bank (i.e. LEFT side of Canal facing Kiveton Park)	Land-use on west & north banks	Relationship or Land Level to Canal level on east & south banks (i.e. RIGHT side of Canal facing Kiveton Park)	Land-use on east & south banks	Consequences of bank or structural failure leading to local release of water
Norwood								
8/1	no	medium	valley floor, receiving	below, moderate slope	woodland	above, gentle slope	housing 2 properties & grounds	none
8/2	no	low	valley floor, receiving	above, gentle slope	pasture	above, gentle slope	woodland	moderate

8/3	no	low	valley floor, shedding	above, gentle slope	pasture & scrub	above, gentle slope	grounds & woodland	low
8/4	no	low	valley floor, shedding	above, gentle slope	pasture & scrub	above, mod. slope	housing 1 property & grounds	moderate
8/5	no	low	valley floor, shedding	above, moderate slope	woodland & pasture	above, moderate slope	woodland	none
Wales								
9/1	no	low	on hill slope, shedding	above, gentle slope (in cutting)	woodland	above, moderate slope	woodland	none
9/2	no	low	on hill slope, shedding	below, gentle slope	pasture	above, mod. slope	pasture	none
9/3	no	low	on hill slope, shedding	below, gentle slope	pasture	above, gentle slope	arable	none
9/4	no	low	hill top, shedding	above, gentle slope	pasture	below, gentle slope	arable	none
9/5	no	low	minor valley floor, receiving	above, gentle slope	arable	above, very gentle slope	arable	none
9/6	no	low	minor valley floor, receiving	above, gentle slope	arable	above, very gentle slope	arable	none
Kiveton Park								
10/1	no	low	minor valley floor, receiving	above, gentle slope	arable	above, mod. slope	woodland on old colliery tip	low
10/2	no	low	cutting, receiving	above, gentle slope	parkland, short grass	above, mod. slope	parkland scrub woodland	none
10/3	no	low	cutting, receiving	above, gentle slope	parkland, short grass	above, mod. slope	parkland scrub woodland	none
10/4	yes	low	level ground, receiving	same level as	parkland, fishing ponds & short grass	same level as	parkland, short grass	low
10/5	yes	low	level ground, receiving	same level as	parkland, fishing ponds & short grass	slightly above, very gentle slope	parkland, short grass & scrub woodland	low
10/6	yes	low	cutting, receiving	above, mod. slope	parkland	above, mod. slope	rough pasture	low
10/7	yes	low	Tunnel	na	na	na	na	low

Figure 6.3 Initial assessment of Flood risk due to “natural” flood (external causes) and assessment of the consequences of a release of water from the canal caused by internal factors such as bank or lock gate failure.

The columns “Relationship of Land Level to Canal Level…etc” describe the relative level of land adjacent to the canal track in that section. If the land is above the canal level it is unlikely to be flooded by bank failure or structural collapse and is less likely to be flooded by a canal over-bank event caused by extreme rainfall. Conversely any adjacent land below canal level is likely to be susceptible to flooding by both bank collapse/structural failure and also by an over-bank event.

6.6 Climate

6.6.1 There are no current climatic factors which will impact the development of the Chesterfield Canal. The impact of global climate change will, however, impact on the use of the waterway in the future. The recent IWAC report on the impact of climate change on inland waterways is especially relevant (IWAC 2009). The report draws attention to a number of factors which will be significant. These include:

- Increased winter rainfall
- Decreased summer rainfall
- Increased frequency of intense rainfall events and storms.

6.6.2 The implications for the Killamarsh to Kiveton Park reinstatement are likely to include:

- Need for increased water storage along the entire canal
- Need for back-pumping along most of the canal in Derbyshire and possibly in Rotherham
- Need for increased buffering and regulating capacity in the water control systems. This may include increased freeboard on canal banks, longer and more frequent side weirs together with balancing ponds to hold surplus capacity of canal run off before returning the water to the river system – these may also function as seasonal reservoirs.

6.7 Air quality

6.7.1 Air quality is an important issue from an environmental quality, human health and nuisance point of view. Air quality assessment considers emissions generated during the construction, operation and decommissioning stages of a site's life from traffic and construction activities. The significance of any impact relates to the number and sensitivity of potential receptors in the vicinity of the site.

6.7.2 The air quality of the Killamarsh to Kiveton Park corridor is governed by the impact of major industries and transport routes. With the closure of local collieries, the impact of the former has diminished and the relative importance of the latter has increased.

6.7.3 The main source of air pollution within the study area is the M1 motorway. The high Nitrogen Dioxide (NO_2) levels from vehicles using the Motorway have led Rotherham Metropolitan Borough Council to establish a Local Air Quality Management Area (AQMA) either side of the point where School Road in Wales crosses the M1. This is outside the canal corridor but the presence of pre-existing high NO_2 levels at this point may restrict the roads use as an east–west access for plant and machinery during construction. Fortunately the levels of traffic envisaged in this plan are small and, where required, alternative east-west routes exist.

6.7.4 Further, smaller, sources of point source air pollution are recorded by the Environment Agency as follows:-

Chemical Discharged	Quantity Discharged (tonnes)	Location of Discharge	Owing Company	Years Discharged
Carbon Dioxide	<10000	Norwood Industrial Estate, Rotherham Road, Killamarsh, Sheffield, S21 2DR	Polymeric Treatments Ltd	2002, 2003, 2004, 2005, 2006, 2007, 2008,
Nitrogen Oxides	<1000	Norwood Industrial Estate, Rotherham Road, Killamarsh, Sheffield, S21 2DR	Polymeric Treatments Ltd	2003, 2004, 2005, 2006, 2007
Nitrogen Oxides	<1000	Waleswood Food Factory Mansfield Road, Kiveton, Sheffield, South Yorkshire.	Hazlewood Convenience Group 1	2005, 2006, 2007

Sulphur Oxides	<100	Norwood Industrial Estate, Rotherham Road, Killamarsh, Sheffield, S21 2DR	Polymeric Treatments Ltd	2003, 2004, 2005, 2006, 2007
Sulphur Oxides	<100	Waleswood Food Factory Mansfield Road, Kiveton, Sheffield, South Yorkshire.	Hazlewood Convenience Group 1	2005, 2006, 2007

Figure 6.4 Environment Agency Discharge to Air consent records for the Canal Corridor.

6.7.5 The above point sources lie within the canal corridor but at some distance from the canal track. None are significant sources of pollution and none will be affected by the canal proposals. None of these sites discharge or handle any chemical which would preclude development within the canal track or wider corridor and thus none place restrictions on development as planned.

Impact of the Reconstruction of the Canal upon Air Quality

6.7.6 Impacts during reconstruction will be (1) release of exhaust gasses (notably NO_2 & CO_2) from construction vehicles and (2) generation and release of dust. Both are short-lived effects which can be minimised through planning and can be balanced by the long term benefits of creating a low carbon, low environmental impact recreation facility

6.7.7 Exhaust emissions can be minimised by (1) minimising the movement of spoil through maximising the local cut/fill balance and utilising on site storage and disposal of material, (2) minimising the movement of material off site for disposal and (3) reducing the multiple handling of construction materials through detailed programming and “just in time” delivery.

6.7.8 The generation of dust from construction work is almost inevitable. Dust generation is likely to be localised and variable. It will depend upon the type and extent of the activity, soil conditions (moisture), track surface conditions and weather conditions. Soils are inevitably drier during the summer period and periods of dry weather combined with higher than average winds have the potential to generate the most dust. Airborne dust has a limited ability to remain airborne and readily drops from suspension as a deposit. Research (Cowheard et al, 1990) shows that in excess of 90% of total airborne dust has returned to rest within 100m of the emission source and over 98% within 250m. This indicates that the potential for dust impact is greatest within 100m of construction activities.

6.7.9 Key receptors in the area are likely to be residential areas in proximity to the Canal. Properties within 100m and 250m of dust generating activities have now been identified. Much of the route has no adjacent housing, however, two main areas are affected – those properties along the canal track in Killamarsh (>200 properties) and those properties to the north of the canal line at Kiveton Park (>50 properties). It will be possible to reduce dust impact by programming excavation works for the spring and autumn and in crucial cases through the use of water sprays to damp down construction tracks, etc.

6.7.10 Construction impacts on air quality will be limited to the construction period and will be temporary in nature. General site best practice such as that included in CIRIA C650 ‘Environmental Good Practice – Site Guide’ and Environment Agency Pollution Prevention Guidelines should be adhered to in order to ensure impacts on local air quality are minimised.

Levels & effects of emissions during normal operation

6.7.11 The operation of waterways produce no significant emissions. No significant impacts on air quality are anticipated once the canal is operational.

6.7.12 Wherever possible the proposed design will use local energy generation to off-set energy usage and thus reduce “remote emissions”. The proposed lock back-pumping will be electrically powered. Investigation of local energy generation to offset purchased supplies is part of the design brief for each lock structure.

6.7.13 Those using the waterway may contribute to the general background transport emissions, for example in travelling to the waterway, but this will be minimised by encouraging local use and designing in good public transport access.

6.7.14 Some activities on the canal may produce emissions. For example, at present most narrow boats are powered by diesel engines and produce CO_2 emissions comparable with those for a small diesel powered car. The emission levels for small boats are now regulated by European Legislation and limits are set to fall over the next decade.

6.7.15 Research by the Inland Waterways Advisory Council (2009) has identified canal boating as a leisure activity which has the potential to be carbon neutral. Successful experiments with electric powered boats are being undertaken on several waterways (using both mains charged batteries and onboard solar cell) and similar projects will be encouraged on the restored Chesterfield Canal.

6.8 Noise & Vibration

6.8.1 Noise & vibration have significant impacts on human health and both are regulated by law. Both may be considered in terms of (1) noise and vibration during construction and remediation work and (2) noise and vibration during operation.

Noise and Vibration During Construction and Remediation Work

6.8.2 Noise and vibration are most likely to be an issue during the construction phase of the development. During construction the main sources of noise and vibration will be from construction plant and activities on site and the transportation of material to and from site.

6.8.3 Disruption due to construction is a localised phenomenon, with around 50 % of people living within 50 metres and 20% of people within 100 metres of construction sites being seriously bothered by noise.

6.8.4 Construction traffic-related noise could have an impact on people living within 300 metres of the affected road network. Vibration caused by works traffic could have an impact on people living within 40 metres of the affected road network

6.8.5 Further study will be required to estimate the noise and vibration levels during construction. Noise levels will be minimised by the application of best practice.

6.8.6 Construction noise is regulated under the Control of Pollution Act 1974. Under this act the approved Code of Practice is British Standard, BS 5228: Part 1 1997 "Noise and Vibration Control on Construction and Open Sites". This standard does not give noise or vibration limits for construction sites but requires that the best practical means are adopted to control noise and vibration on site.

Assessment of Potential Impact of Works

6.8.7 Ground borne vibration from construction work has broadly two potential impacts. At very high levels, damage to structures may occur. For buildings in a good state of repair, damage by vibration from construction works is extremely rare. Conversely, humans are sensitive to vibration and therefore perceptible vibration may give rise to complaints of disturbance over a wide area from the works. Vibration that is potentially a problem depends not only upon the magnitude of vibration, but also upon its frequency content, duration, building type and activities within buildings.

6.8.8 Receptor baseline noise levels is dominated by road traffic noise where the site is in proximity to the M1. Key receptors will be the housing close to the route of the Canal in Kiveton Park and Norwood.

6.8.9 No especially noise or vibration sensitive non-residential uses, e.g. schools and hospitals, have been identified on neighbouring sites.

6.8.10 Nuisance from noise and vibration will be limited to the construction period.

Noise and Vibration During Operation

6.8.11 Once completed, the reinstated Canal is unlikely to generate significant quantities of road traffic and likewise is unlikely to use noisy equipment and machinery. Where back pumping is required then noise reduction is integral to the design.

6.8.12 Canals are widely recognised as tranquil locations. The relative quietness and low intensity of the canal soundscape is one of the defining features of the canal environment and one which has been actively promoted in both conservation and development schemes.

6.8.13 The variability and richness of the canal soundscape is governed by the physical properties of water. Water is acoustically hard and as a consequence sound propagates readily over its surface. Further, the openness of waterscapes means that wind speeds are higher and can scatter sound or carry it further downwind producing a variable and distinctive soundscape.

6.8.14 The reintroduction of a significant length of water will therefore change the current soundscape of the area. There is no established methodology for establishing the likely noise of canal operation on the lines of that set out by the Department of Transport guidance on Road or Railway noise (DMRB 1994 & 1998). Indeed there is no guidance from any national body on canal noise impact and we are not aware of any published studies on the soundscapes of canals outside preliminary work undertaken by British Waterways on the canals and rivers of London.

6.8.15 In the absence of guidance or comparable studies, the Partnership has taken note of the guidance for road and railway noise and attempted to formulate similar measures for waterways. To that end, a desk-based assessment of the potential sources of noise along canal corridors was undertaken.

6.8.16 In London it was found that the majority of ambient sound within the canal track is derived from sources external to the canal – the single largest source being noise from road vehicles and traffic. Ambient noise was recorded as being greatest at road crossings and at those points where roads run parallel to canals without being separated from them by buildings or earthworks. The values for the ambient noise produced by boats were so low as to be entirely masked by the noise from road traffic. Values observed with the canal track (waterspace plus towpath) were equivalent to that seen in the larger London parks, suggesting the built up margins of the canal in London act as an effective sound barrier.

6.8.17 The existing studies demonstrated that the vast majority of noise within the canal track is derived from sources outside the waterspace and towpath.

6.8.18 It was concluded that noise perception along the functioning canal corridor is a function of both ambient noise and noise produced within the canal track. Further, it is probable that the single greatest source of ambient noise within the corridor is road / traffic noise from the M1 motorway. The points of greatest intrusion occur where the canal is crossed by main roads. Appropriate marginal earthwork bunds, fences and, to a far lesser extent, dense tree and shrub planting of the road boundaries, will reduce but not eliminate this intrusion.

6.8.19 The single greatest source of noise within the canal track will be that from boats. At present the vast majority of boats are powered by diesel engines. Maximum sound levels from diesel engineer boats are now governed by European Regulation and are set to fall. The development of electrically powered boats is currently in its infancy but is to be encouraged as they are inherently cleaner and quieter than diesel engines. As electric boat numbers rise, the noise “footprint” of boating will decrease.

6.8.20 It was concluded that there is no reasonable expectation that restoration of the canal would lead to any increase in noise levels within the canal corridor over and above those already exhibited by road traffic.