

320120158P

**Land at Barrow
near Clitheroe
between the A59
and Whalley Road**

Site 2 flood risk assessment

NGR SD 740 381

Michael Lambert Associates
Pear Tree House
1 Partridge Close
Winsford
Cheshire
CW7 1PY

Tel/fax: 01606 862373
Mobile: 07958 964054
Emails: floodriskengineer@gmail.com
sudsengineers@sky.com

Avalon Planning
2 Reedley Business Centre
Redman Road
Burnley
Lancs
BB10 2TY

I N D E X

1.0 Introduction

2.0 Executive summary

3.0 Existing site

4.0 Proposals and drainage

5.0 Hydrology, hydraulics

6.0 Proposals and drainage

7.0 PPS25 matters

8.0 Attachments

1.0 Introduction

The site is between Whalley and Clitheroe and is between the A59 and Whalley Road. It is between Whiteacre Lane to the south and an existing lake to the north and is close to Barrow business village. Housing is proposed for the site.

2.0 Executive summary

Housing is proposed for this greenfield site. Barrow Brook flows past the site after passing through a reservoir just upstream of the A59 and 1 in 1000 year flows stay within the stream channel and its banks. The site is floodzone 1 and is suitable for housing in accord with Table D3 of PPS 25 for this flood zone and new surface water runoff will be controlled and stored on site and released at greenfield runoff rates to the brook. Foul flows will connect to the public sewer network.

3.0 Existing site and area

The site is currently rough grass and is approx 4 hectares in area. The locality has undergone many changes in recent years with the demolition of Whalley Abbey Engraving Works, the start of the business village and the construction of the A59. We attach the Ribble Valley Enterprise Agency's historical article which outlines the history of the former mill and its reservoirs.

From the 1960's the A59 bypass was constructed. This took part of the middle reservoir away and also changed the nature of the upper reservoir in that its embankment became reinforced by the A59 roadway which was built at the same level as the reservoir. The middle reservoir became much smaller. The new printworks building was then built on the 'filled-in' lower reservoir and the middle reservoir embankment then had a new road built on top of the downstream embankment slope. The printworks building and the new road are at a similar level or higher than the middle reservoir and this has changed the status of the middle reservoir. The 1975 Reservoirs Act defines a reservoir as one that has an embankment wall raised above the surrounding ground and whilst the middle reservoir used to be governed by the Act, this is not now the case and it is no longer a reservoir under the Act but an ordinary lake.

Barrow Brook provides water for the upper reservoir and the overflow channel passes under the A59 and flows past the site. The overflow channel is built with a stone sett bed and walls and flows east to west towards Whalley.

4.0 Proposals and drainage

The proposals are to build approx 80 houses and a block of apartments. The site is flood zone 1 and we have estimated 1 in 100 years and 1 in 1000 year flows and input these to a channel model which shows that the site is flood zone 1.

The site is greenfield and the new development will have separate foul and surface water drains. The new rate of surface water runoff will not exceed the existing runoff rate and loH 124 calculations are attached.

5.0 Hydrology, hydraulics

To assess flood risk from the existing reservoir overflow channel risk flows have been estimated as follows:-

1. Catchment descriptors have been obtained from Flood Estimation Handbook software.
2. These have been input to the Re FSR/FEH spreadsheet with FARL set to 1 (reservoir index)
3. The reservoir does not have a bypass channel and inline reservoir buffering has been assumed to be 80% with a Q100 pass forward flow at 5.6 m³/sec.
4. A channel model has been built at a gradient of 1/61.2 with a channel width of 1.8m and depth of 0.8 m and Mannings 'n' = 0.025
5. The resulting flow depth at Q100 is 1 metre which stays within bank. Up-rating to Q1000 using a growth factor of 1.7 gives a flow of 9.5 m³/sec and this has a flow depth of 1.5m
6. The Q1000 flow depth of 1.5 is contained within the first 10m of the site edge and the site is flood zone 1 except for a thin strip of the northern boundary

6.0 Proposals and drainage

The proposals are for housing and an apartment block and all new buildings will be 8m away from the top of bank and an 8m strip next to the brook channel will be open space and not private gardens.

The new drainage system will have separate foul and surface water drains. Surface water will connect to the brook at green field runoff rates with storage for 1 in 30 year storms and shallow spill storage on roadways and parking areas for storm runoff spills generated by 1 in 100 year plus climate change storms.

Surface water runoff flows will be limited to 1 in 1 year greenfield runoff rate and 1 in 30 year greenfield runoff rate by a two hydrobrake system as per the Gibbs 2004 guidelines 'preliminary rainfall runoff management for developments', and the in principle proposed storage volumes are shown on the Flood 1.2 storage program summary sheet. An in principle surface water drainage layout is shown on the proposals plan.

Foul drainage will connect to the public network which for the eastern part of the site could be at Middle Lodge Road roundabout and for the western parts of the site could be the new estate sewers near to Whalley Road.

When ground data is made available, sustainable drainage techniques can be assessed.

7.0 PPS25 matters

The housing proposals are classed as 'more vulnerable' in Table D2 of PPS25 and are 'appropriate' in flood zone 1 as per Table D3.

Annex C forms of flooding are:-

- C4 – rivers – the site is almost all above the Q1000 risk level.
- C5 – sea – no tidal influence
- C6 – land – some undrained land to the east of the site slopes towards the site and perimeter cut-off drains will be specified for the eastern boundary
- C7 – groundwater – there are no springs or weep areas on site

C8 - sewers - there are no private or public sewers nearby at a higher level than the site

C9 - reservoirs, canals - the Pendle View Fishery reservoir is a large raised reservoir under the 1975 Reservoirs Act and will be managed to a 1 in 10,000 year risk standard by the owners who will have Panel Engineer inspections and reports. There is a slight risk that the reservoir wall could fail and this residual risk would mean that increased flows of water would flow under the A59 and cause flooding in Barrow. This rare risk is present whether or not new houses are built.

8.0 Attachments

- a. Location plan
- b. EA floodzone and ground water maps
- c. Public sewer records
- d. Site survey levels
- e. Proposals
- f. 1967 historic map showing previous reservoirs and Whalley Abbey works
- g. Ribble Valley Enterprise Park history
- h. OS contour map extract
- i. Barrow Brook catchment descriptors and Re FSR/FEH rain and flow data, surface water storage calculations summary plus IoH 124 runoff
- j. Site photos of Barrow Brook

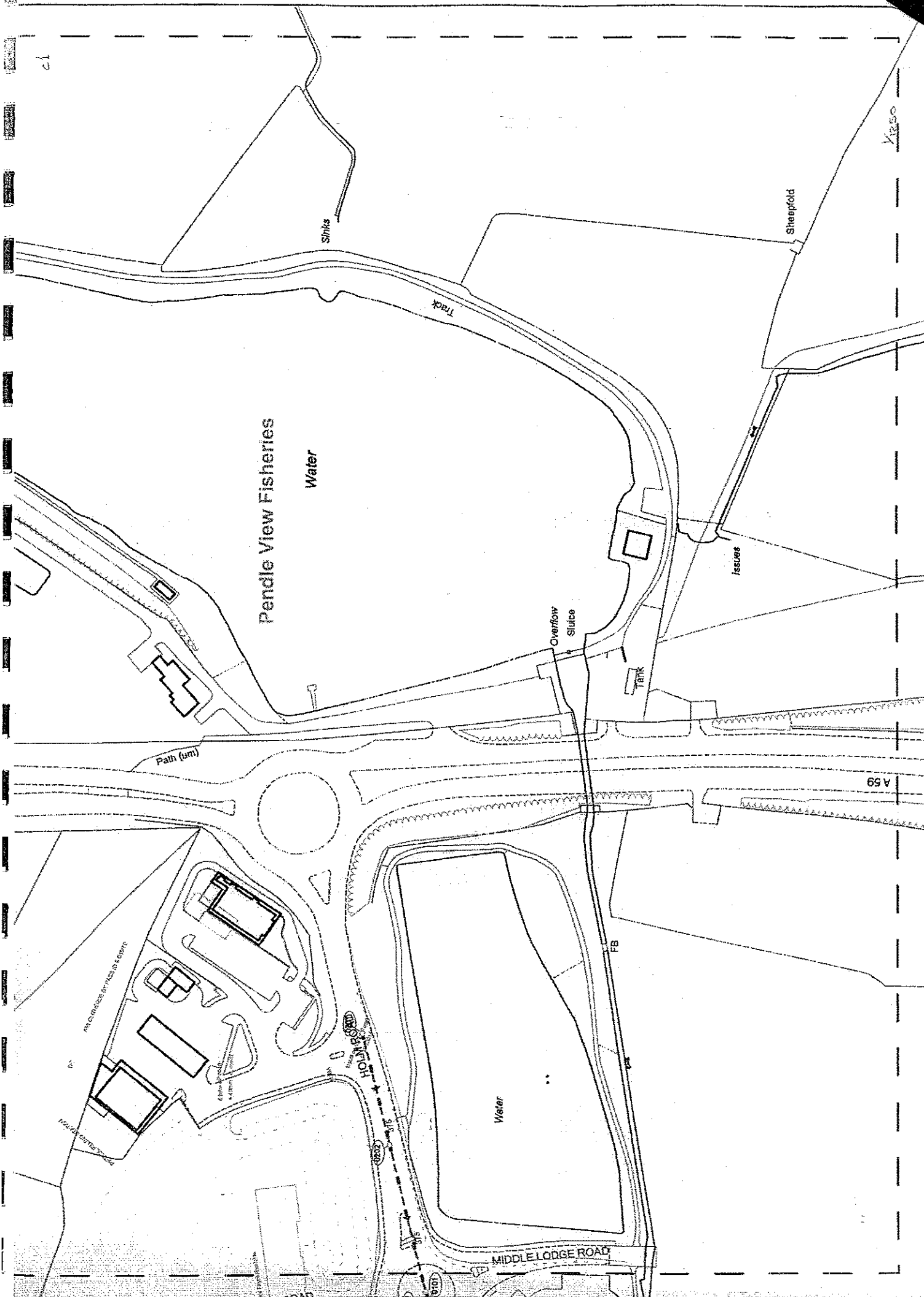
Please note

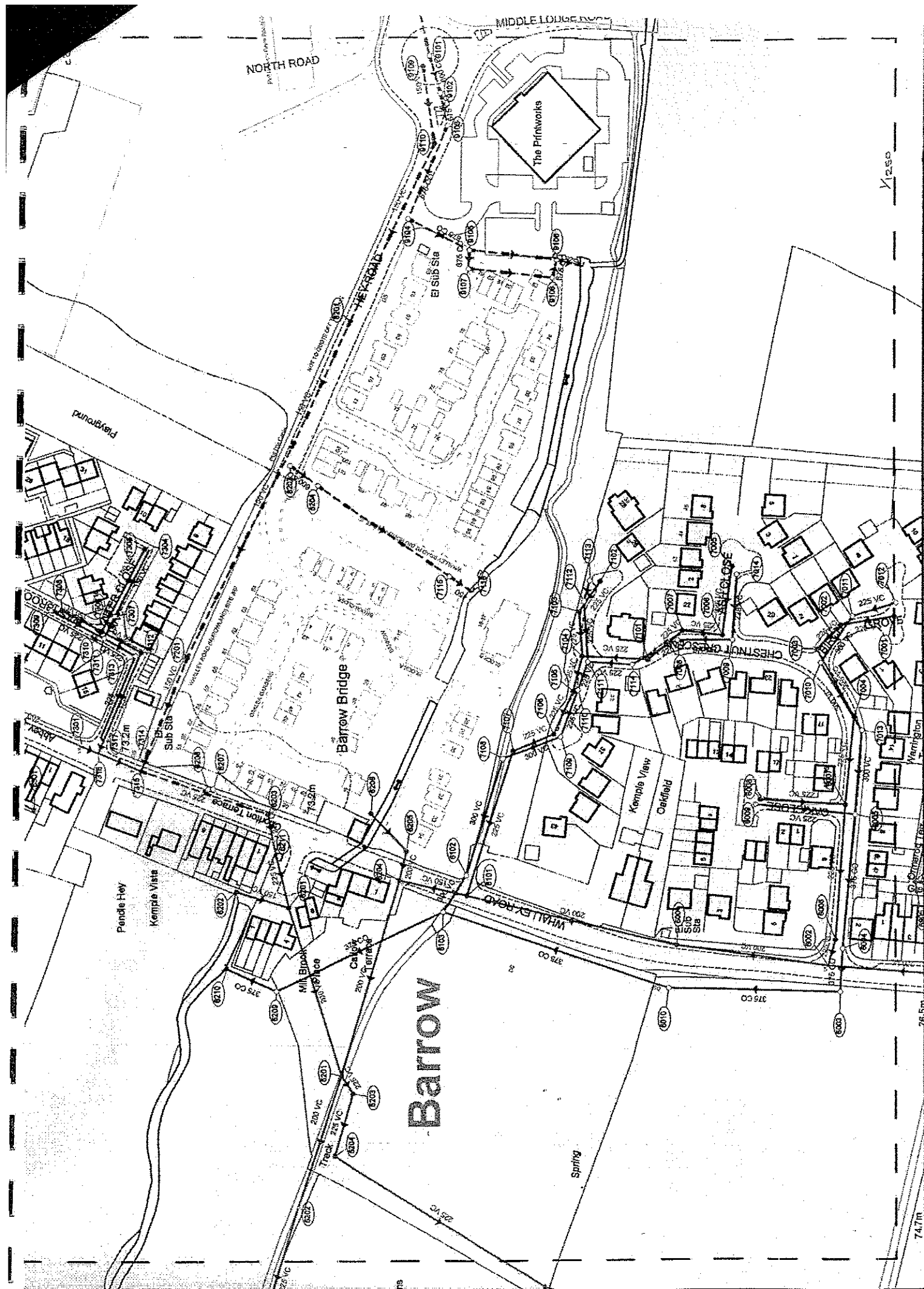
This report is an email report - if survey data or Hec Ras details are required please email floodriskengineer@gmail.com

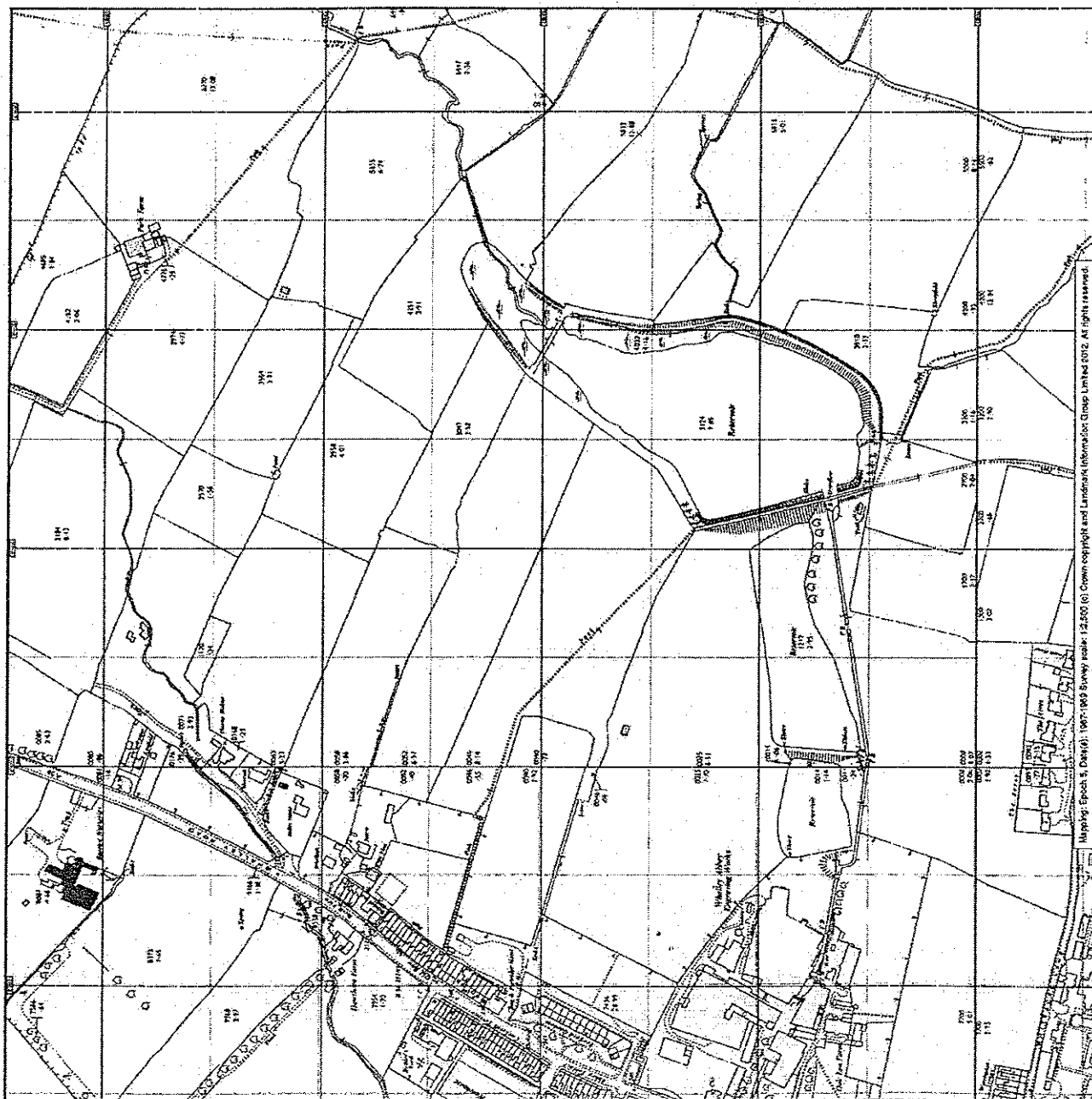
The email report comprises data files as follows

120209report
120209attach1-A4
120209attach-A3
120209photos-A4
120209survey1-A3
120209survey2-A3
120209survey3-A3

Attachments are grouped for scanning and can be put in order by using the pencil lettering in the top RH corners.

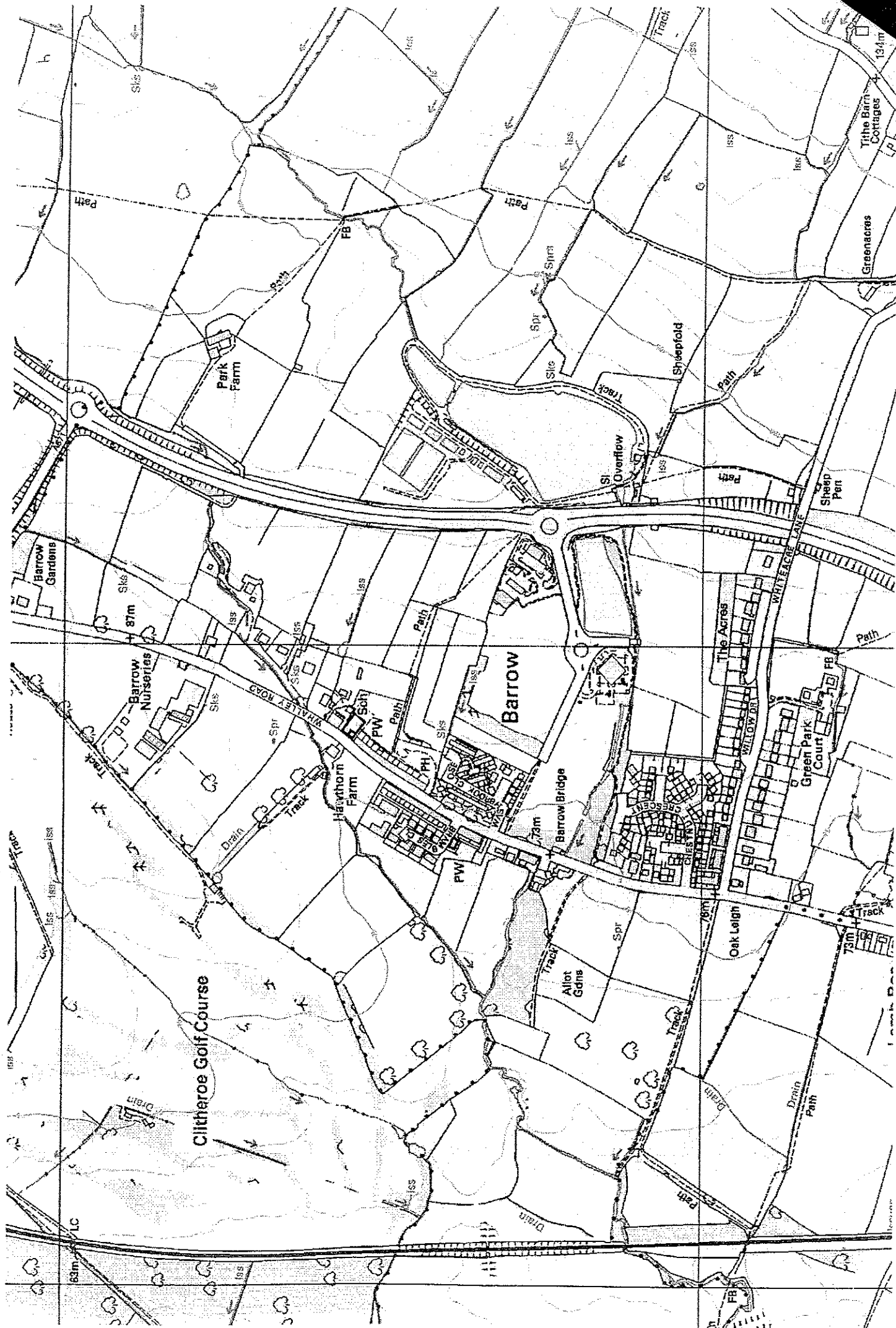


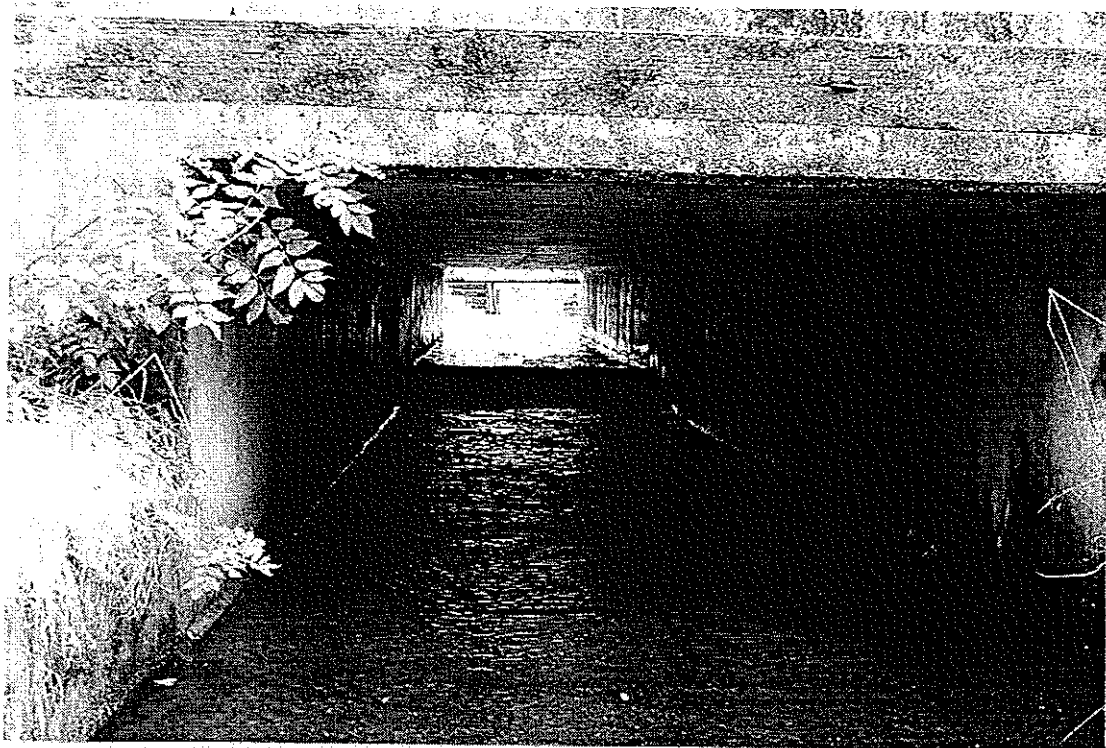




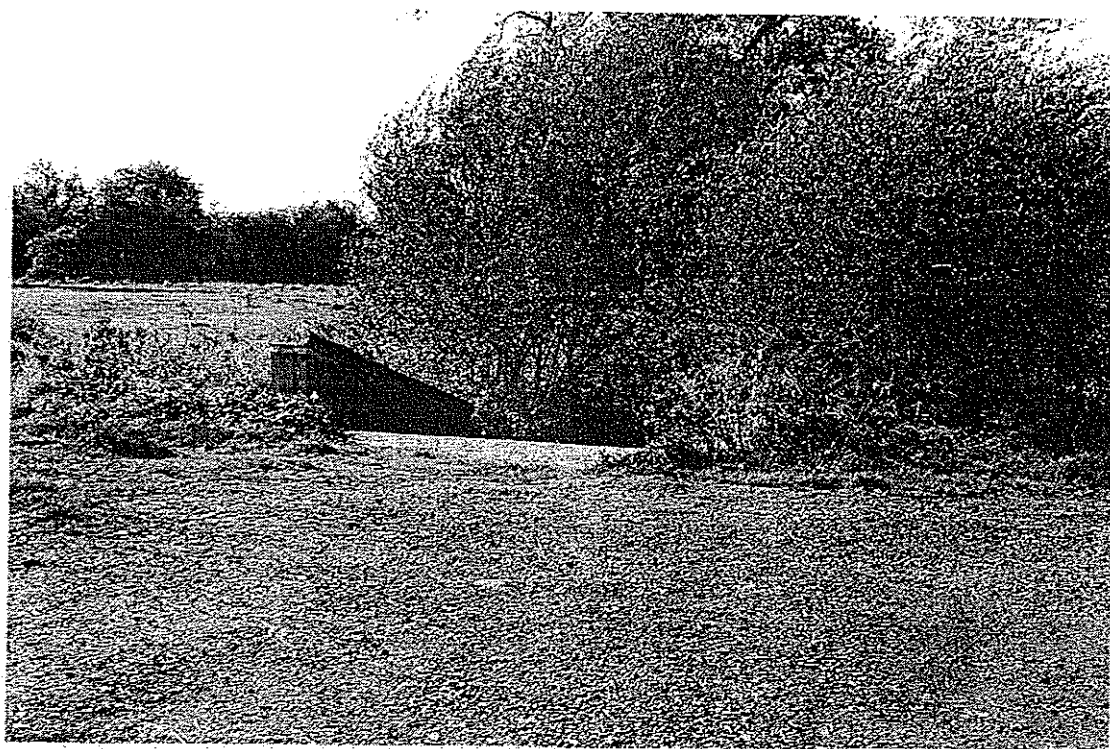
Landmark Historical Map
 Mapping: Epoch 6
 Published Date(s): 1987-1989
 Originally plotted at: 1:2,500

Mapping: Epoch 6, Data(s): 1987-1989 Survey scale: 1:2,500 (c) Crown copyright and Landmark Information Group Limited 2012. All rights reserved.

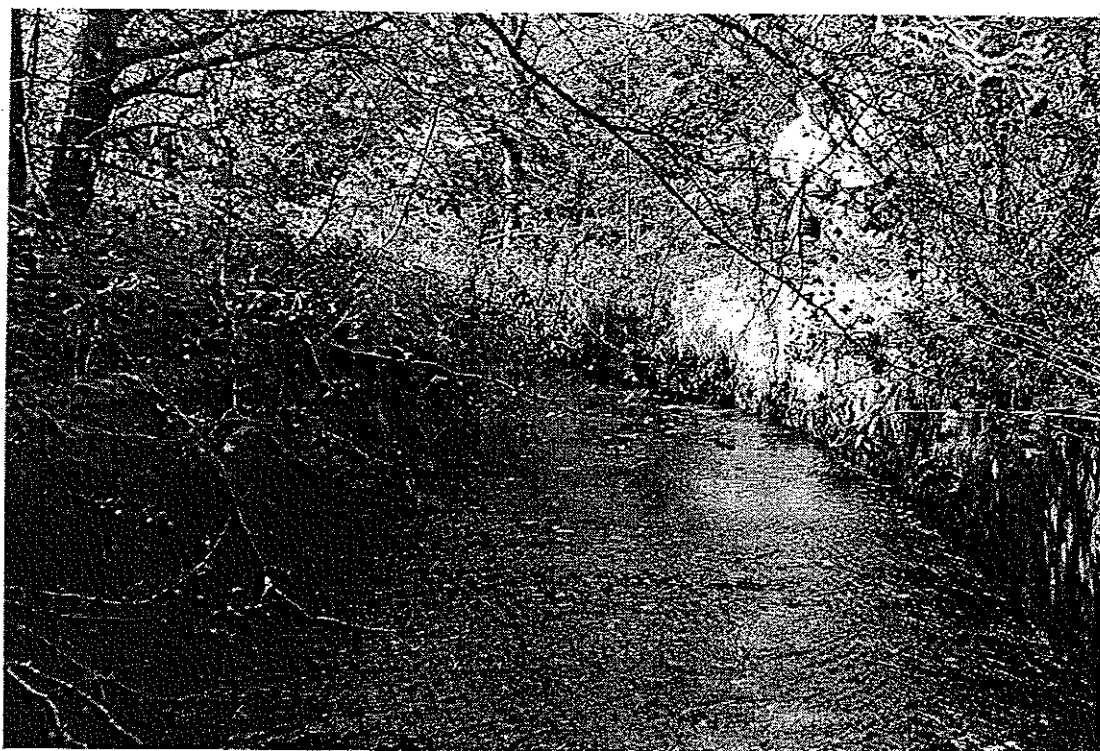




A59 culvert



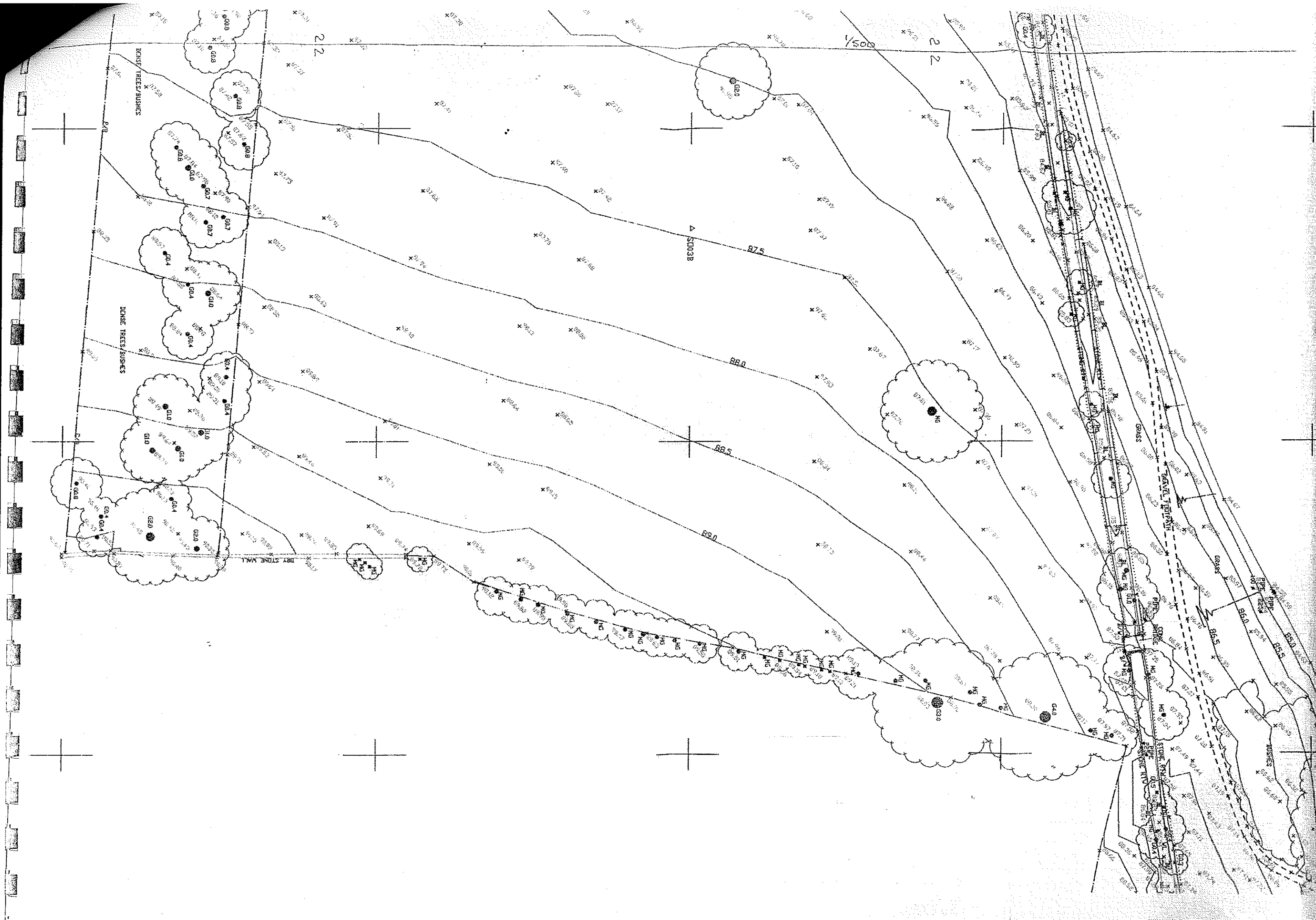
Middle Lodge Road with western part of site to the left

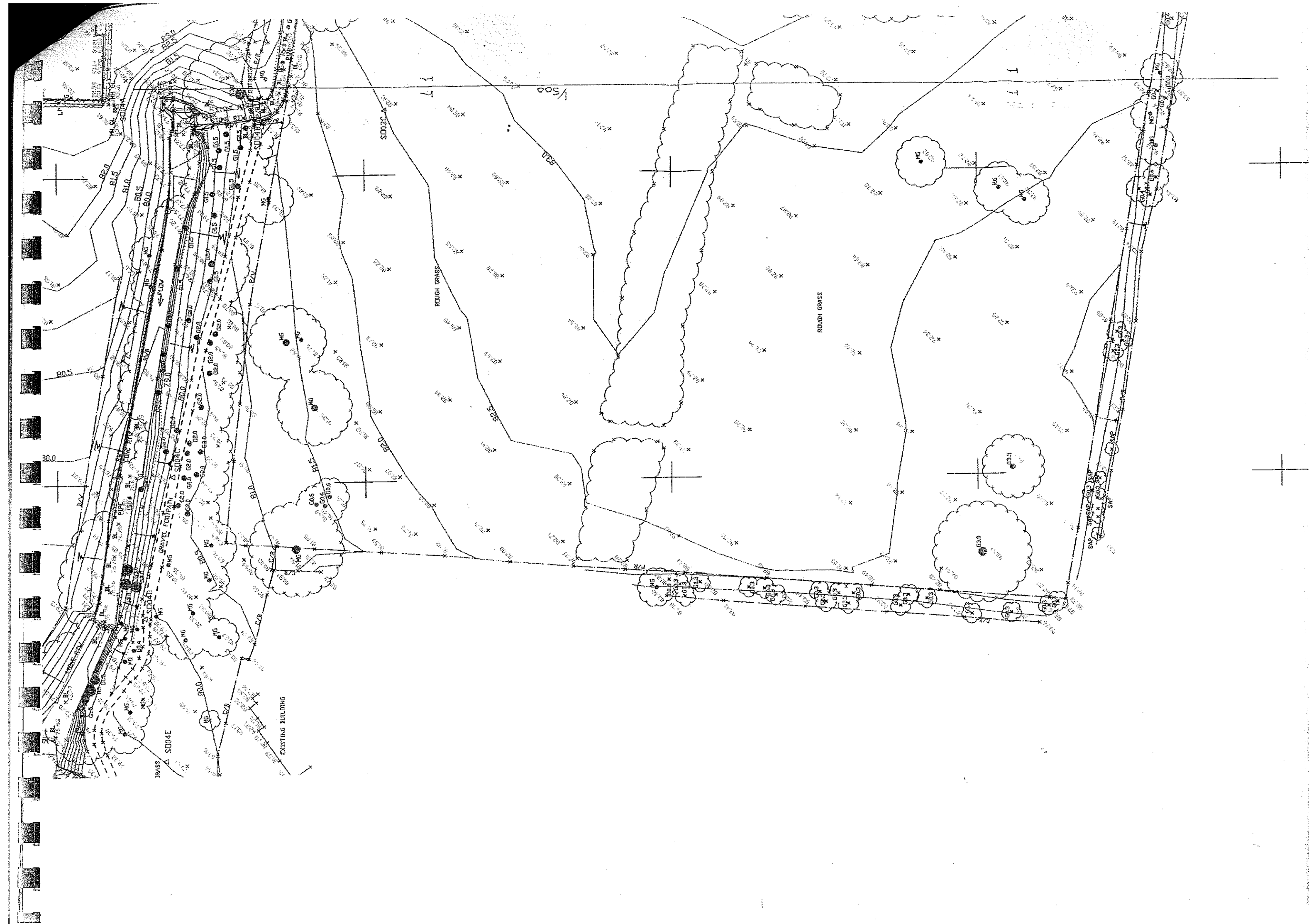


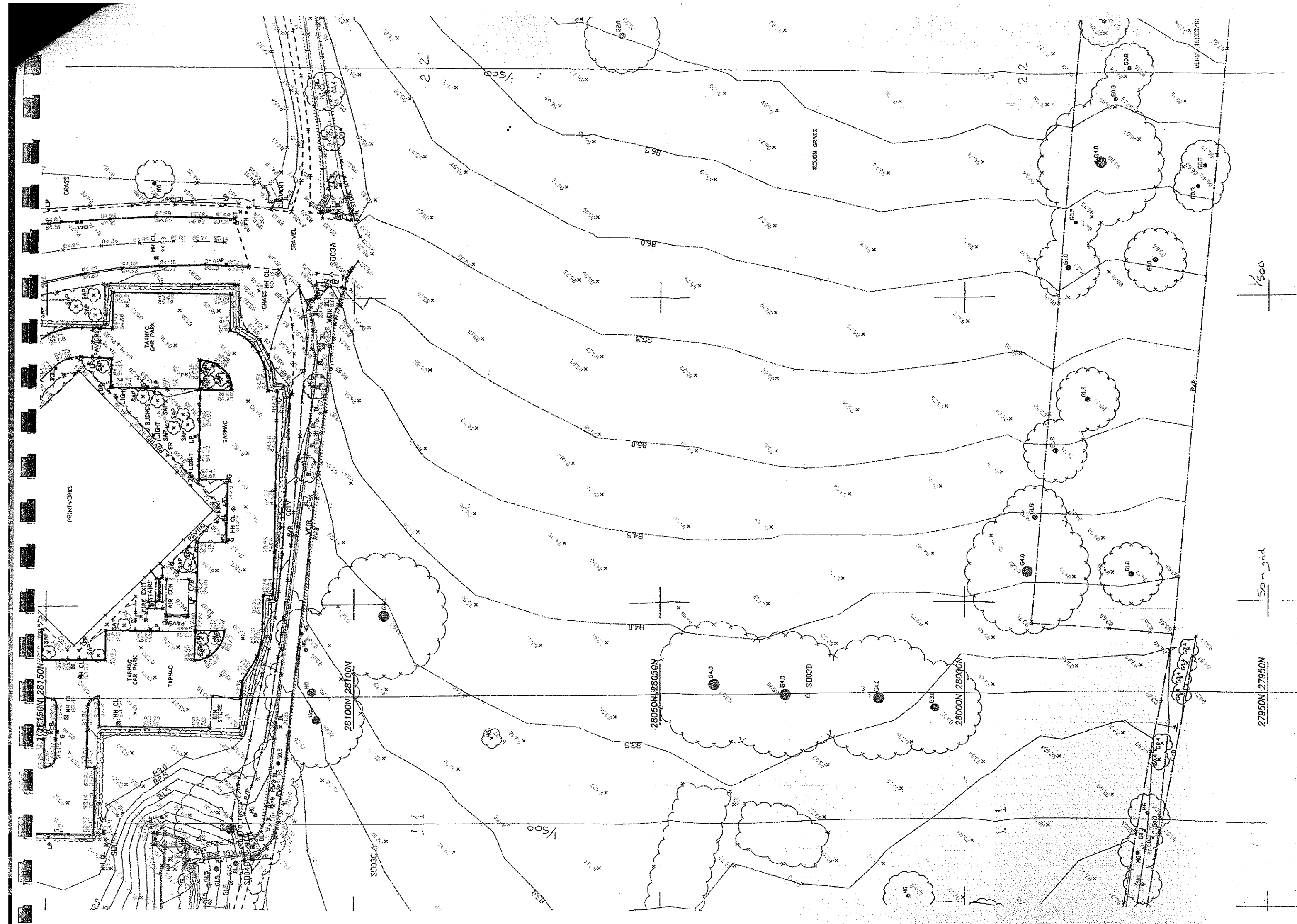
Sett paved overflow channel downstream of A59



Culvert at Middle Lodge Road







Q.



Enter a postcode or place name:

Other topics for this area...

Risk of Flooding

Clitheroe, Lancashire



Risk of Flooding from Rivers and Sea

Map legend

Click on the map to see what is the Risk of Flooding at a particular location.

☐ Flood Maps

Flooding from rivers or sea without defences

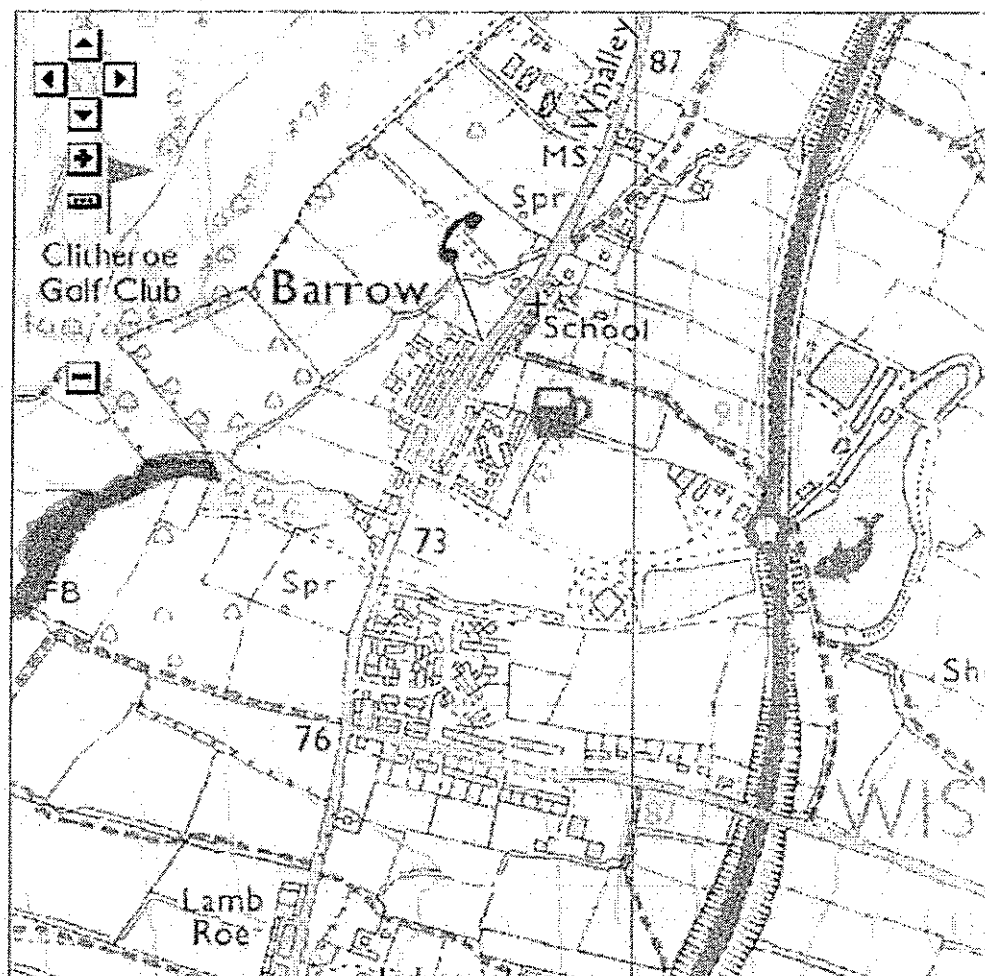
Extent of extreme flood

Flood defences

Areas benefiting from flood defences

Main rivers

X: 374,148;Y: 438,283 at scale 1:10,000



© Environment Agency copyright and database rights 2011 © Ordnance Survey Crown copyright. All rights reserved. Contains Royal Mail data © Royal Mail copyright and database rights 2011

Flood Map – Information Warnings

Manchester Ship Canal

Flood Mapping of the Manchester Ship Canal in Trafford, Salford and Warrington made for information purposes only. For further information please contact the Environment Agency on 0161 275 2000. Users of the Flood Zone Map should be aware that we have received a Judicial Review of the Flood Zone Map for the Manchester Ship Canal at Trafford, Salford and Warrington on the ground that the Environment Agency's consideration of the role of the sluice gates in preventing flooding was flawed. We are defending the challenge and believe and are advised that it is ill-founded. No

Enter a postcode or place name:

Other topics for this area...



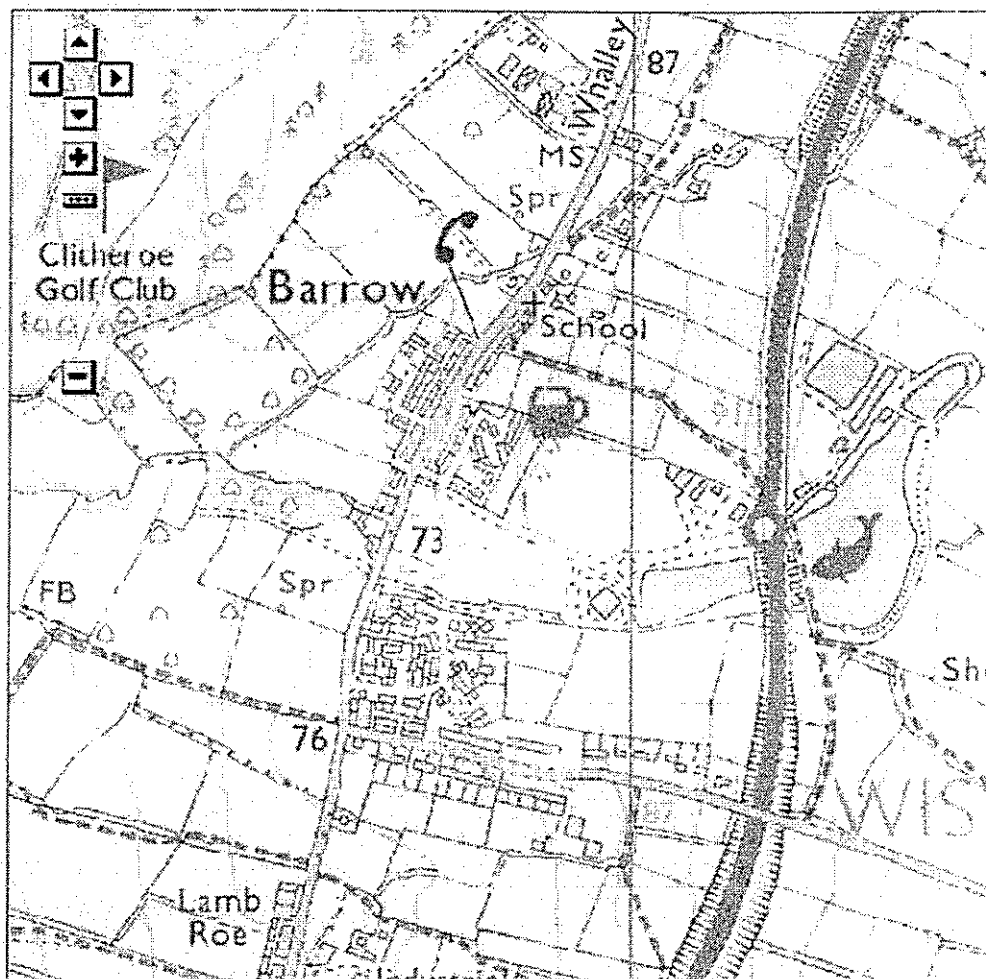
Groundwater



Map legend

Map of X: 374,148.1; Y: 438,282.67 at scale 1:10,000

The map displays the extents of groundwater zones	
☐	☒ Groundwater source protection zones ⓘ
	Inner zone (Zone 1)
	Outer zone (Zone 2)
	Total catchment (Zone 3)
	Special interest (Zone 4)
☐	☒ Aquifer Maps - Superficial Deposits Designation ⓘ
	Principal
	Secondary A
	Secondary B
	Secondary (undifferentiated)
	Unknown (lakes and landslip)
☐	☒ Aquifer Maps - Bedrock Designation ⓘ
	Principal
	Secondary A
	Secondary B
	Secondary (undifferentiated)
☐	☒ Groundwater Vulnerability Zones ⓘ
	Major Aquifer High
	Major Aquifer Intermediate
	Major Aquifer Low
	Minor Aquifer High



© Environment Agency copyright and database rights 2011. © Ordnance Survey Crown copyright. All rights reserved. Contains Royal Mail data © Royal Mail copyright and database rights 2011.

[Tell me more](#)

British Geological Survey Aquifer data:

The Aquifer Extents are not displayed at scales greater than 1:75,000 (Ordnance Survey map was only modelled to this level and is not accurate past this).

RIBBLE VALLEY
ENTERPRISE


Home



Location


The Ribble
Valley Team

Business
Directory


Case Studies



Contact Us



Links

Ribble Valley Enterprise Agency Location

Business Grants
Is my business eligible?

What can RVEA offer my business?
So much!

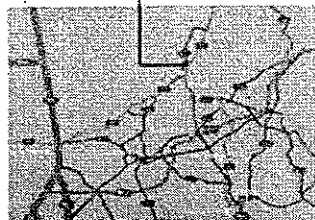
Click on Clitheroe
Check out Clitheroe
in the online
cultural
guide.

Learn
before
you Leap!
Check out our
workshops &
Seminars.

or sign-up to the
Business Club
- attend events
for the Ribble
Valley business
community

Want to
know how
to write a
Business Plan?
Our experts can
help...

Case Studies
are a great way of
learning by other
people's mistakes
and triumphs!
Arts & Crafts
Virtual Gallery of
local talent



[Enlarge](#)

Ribble Valley Enterprise Agency
Suite 3
The Printworks
Barrow Brook Business Village
Barrow
Nr Clitheroe
Lancashire
BB7 9WA

Tel: 01254 828820
Fax: 01254 822858

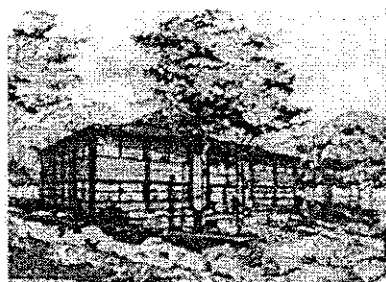
info@ribblevalleyenterpriseagency.co.uk

The Ribble Valley

The Ribble Valley is the largest district in Lancashire in terms of area, comprising 224 square miles of market towns, picturesque villages and rolling countryside. Its population of 53,000 stretches from Longridge in the west over to Gisburn in the east and from Mellor on its southern borders up to its northern borders in the Forest of Bowland.

The Ribble Valley is a rural area of growing attraction to tourists and those seeking a pleasant place to live. There are good motorway links (M6 and M65) and an hourly train service to Manchester from Clitheroe, Whalley and other Ribble Valley Stations. A regular bus service operates from the new Clitheroe Interchange to all villages and places further a field.

The Printworks, Barrow: A Brief History



The name Barrow derives not from the presence of an ancient burial mound, but from Old English meaning 'a grove of trees'. It seems likely that the Printworks and later the village took their name from Barrow Brook; in the nineteenth century they were originally called Barrow Bridge after the bridge over the stream.

The village of Barrow is situated on what was, before the section was by-passed, the main A59 road from Preston to Skipton in Yorkshire. Barrow lies approximately 2.5 miles south of Clitheroe and 1.5 miles north of Whalley and owes its existence entirely to the large calico printing works, now demolished, at its southern end.

The site of the old printing works is now Ribble Valley Enterprise Park and is where the new Printworks building is.

The reason for the establishment of a factory at Barrow is due solely to the existence of Barrow Brook, a fairly fast-flowing stream, which flows down from the lower slopes of Pendle Hill to join the River Ribble just to the north east of the village of Milton. Copious supplies of water are vital to the printing, and especially the bleaching, industries and it must also be remembered that, before the adoption of the steam engine, a good fall of water was also essential to provide motive power.

In a lease dated September 1st 1785, the first mention of industry in Barrow appears, when Thomas Weld of Sonyhurst leased to Thomas Drinkwater of Whalley, Yeoman, "Land in Wiswald called Part of the Holm and Part of the Hey and Land on the west of the Road from Whalley to Clitheroe adjoining the Bridge, to erect a mill for the purpose of carding and roving cotton or grinding corn by water and to erect a weir across the brook

to provide enough water for the mill". The lease was for ninety nine years and the annual rent was £10. 92

The mill changed hands in April 1789 when the lease was passed from Mr Thomas Drinkwater to Mr Thomas Clegg

On 23rd June 1804, there was another change of ownership. George Clegg, an innkeeper of Whalley (perhaps the son of Thomas Clegg) and Mr John Aspinall, described as a shopkeeper, also of Whalley, sold to Roger Pollard of Preston, also an innkeeper, "the newly erected building now used as a carding or roving mill, with the water wheel and gears and with dam, reservoirs (of which there were originally three) etc."

The change from cotton spinning to calico printing came in 1811 when the mill was leased to James Simpson and Thomas Peet, both of Manchester, and both described as calico printers. The lease was for 21 years at a rent of £31 per year. It is unlikely that the size of the factory inferred by the list of equipment in it given in 1804 would be at all suitable for the complex processes of calico bleaching and printing and it was probably at this time that the mill began to expand to its final large and complex form. In Greenwood's map of Lancashire dated 1818, the works is shown as a few scattered buildings and is simply labelled "Printworks", there being no mention of the name Barrow.

After some years Simpson went to become owner of Foxhill Bank in Oswaldtwistle and Peet went to Horwich Vale. After standing idle for a short time Barrow was taken by Ainsworth, Holding & Catlow in 1815.

By 1834 it would appear that Holding & Catlow had left and the company became known as Ainsworth Sykes & Co. The Ainsworth side of the company being run by three brothers, two of them marrying daughters of Robert Sykes. So it remained until 1855. By 1854 Robert Sykes had died but two of the Ainsworth brothers were still involved with the business, though by that time it appeared to be in financial difficulties and a deed of sale dated 1855 states that the property was sold "for the benefit of their creditors".

It seems likely that the works closed for a time at this point because the notes in the Census of 1861 highlights "a decrease in the population of the Townships of Wiswell and Whalley which is attributed to the discontinuance of employment in the Printworks." The Cotton Famine of the early 1860's caused by the American Civil War was probably the cause of the same note being made on the Census of 1871.

In November 1855 the works was valued at £8,192 13s. 2d (or £8,192 66p)

What happened to the works after this sale is not clear. However, the Census of 1861 shows George Ainsworth as still living in Barrow and working as a calico printer employing 120 men.

There is a Schedule of Deed stating that in 1866 ownership passed to WD Coddington Esq., who then became landlord. "The Lancashire Directory" of 1869 lists the works as "The Foxhill Bank Printing Company, Barrow Bridge Print Works, and at Accrington." This was probably the company run by Messrs Taylor & Co., because in the same Schedule of Deeds there is a lease dated 1871 between W Coddington Esq. and Others and G I Taylor Esq.

By 1874 the company was again in financial difficulty and it was at this point that the next owner, Mr Bryce-Smith, a wealthy cotton merchant from Manchester, stepped in. He probably rented the works for a period of about three years before becoming the owner. The Bryce-Smith family carried on their cotton merchants business in Manchester but eventually moved to Barrow and by 1891 were living in Oakfield House, next to the works. They went on to become generous local benefactors.

The valuation carried out in 1874 for sale by Mr Bryce-Smith puts the total value of the buildings, machinery and land given at this time at £18,037. 16s. 6d (or £18,037.82p). This valuation would suggest that the works at this time must still have been expanding as there is evidence of quite a lot of recently installed equipment. A point which emerges from both valuations of 1855 and 1874 is the almost total self sufficiency of the works. Water, of course, was in plentiful supply, but they produced their own gas supply, there was a laboratory, a smithy, a joiners shop and a very well equipped mechanics shop, enabling them to carry out virtually all the maintenance required around the works, which must have been of prime importance.

Under Bryce-Smith's ownership the works expanded considerably. The increases in the number of printing machines must have created a large increase in the total amount of

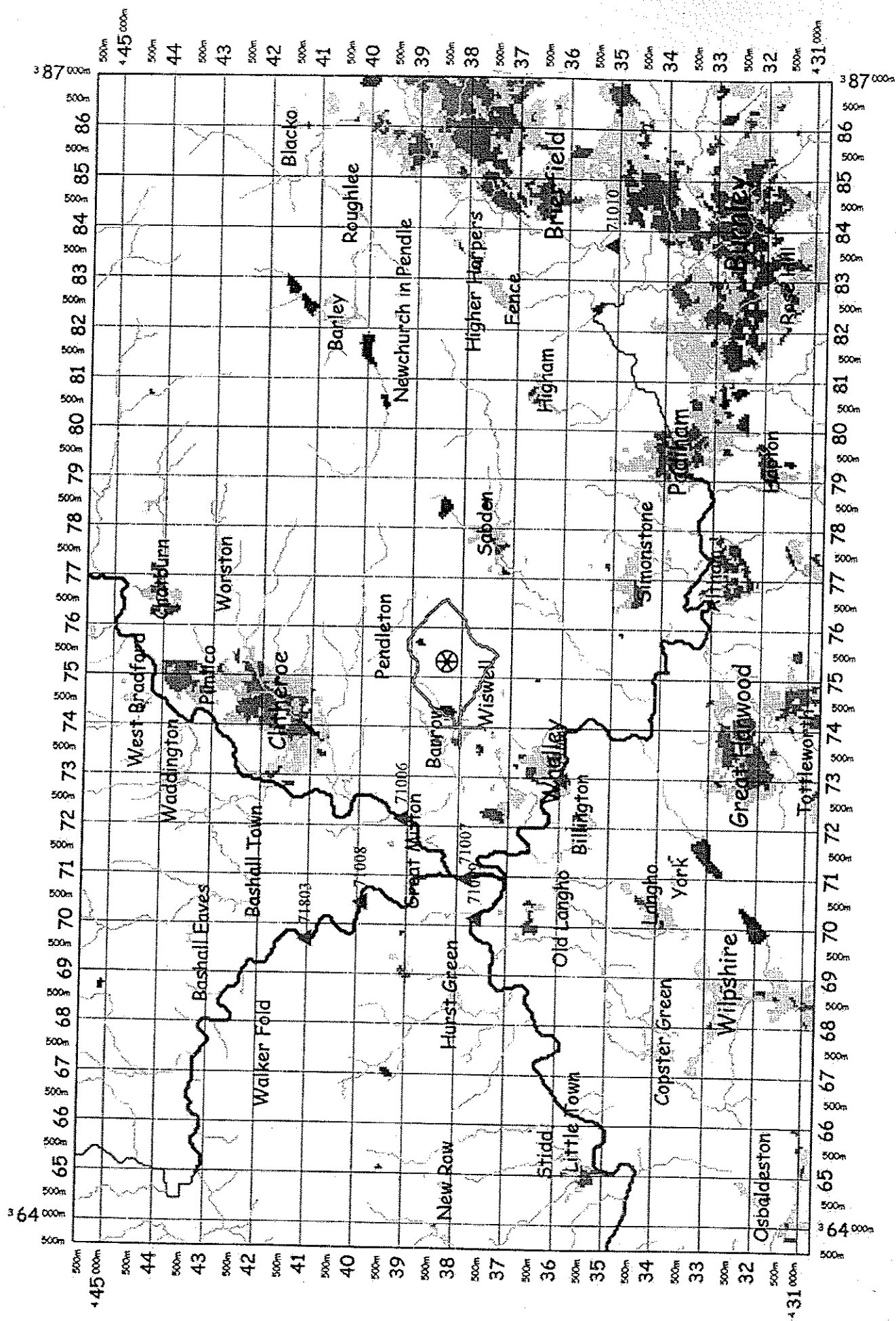
material handled at the works and consequently all the associated machinery to process it. Several new buildings were erected, including a clock tower in 1888 which, with its four faces, became not only a feature of the works but of the locality.

In 1990, the company became part of The Calico Printers Association and their prospectus states that it was then called "The Whalley Abbey Printing Company Limited". The company was bought by The Calico Printers Association, the contract being dated December 2nd 1899.

By 1909 Oakfield House was occupied by WH Hopwood who took over the running of the works as manager, probably put there by the CPA to increase production, which he did. According to Barretts Directory of Blackburn, 1925, Hopwood was still living in Barrow and so it seems he must have remained as manager until the works closed around 1930, due to the Depression. After it had closed the works was emptied and much of the machinery was taken to Strines Printworks in Derbyshire (another CPA member), including many of the patterns and styles individual to Barrow. What was then the largest printing machine in the world was contained in the works and when the works was emptied it was broken up for scrap.

The closure in 1930 marked the end of printing in Barrow. The works remained empty until it was used by the army as a barracks during the Second World War. In 1948 it was opened again using a new photographic process to engrave rollers but only about half of the buildings were used for this. Also, due to the high demand for textiles after the War, one building was used for a time for screen printing but this finished as soon as demand fell away. Due to rationalisation the engraving process was taken away to Levenshulme Works in 1972 and the works was finally closed to await demolition.

The above is extracted from : *Barrow - The Development of an Industrial Village* by Arnold Bettes.



Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name: mikel
Company name: mla
Project name: barrow brook clitheroe

Catchment name: 374000
Catchment easting: 436100
Catchment northing: 2.48
Catchment area: 2.48

Date/Time modelled: 08-Feb-2012 15:07
Version: 1.4

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	100	C_{max} (mm)	262	T_p (hr)	1.23	BL (hr)	25.3
Duration (hr)	27	C_{int} (mm)	133	U_p	0.65	BR	0.96
Timestep (hr)	0.1	α factor	0.83	U_s	0.8	BF_0 (m ³ /s)	0.2
Season	Winter						

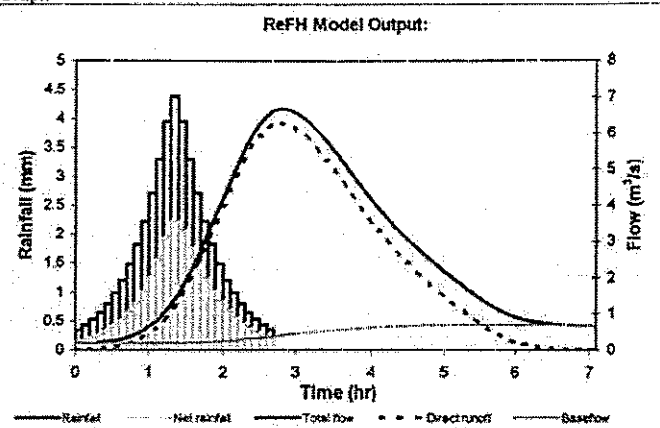
Summary of results

FEH DDF rainfall (mm)	61.8	Peak rainfall (mm)	4.4
Design rainfall (mm)	45.1	Peak flow (m ³ /s)	6.7

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m ³ /s	m ³ /s	m ³ /s
0.0	0.3	0.1	0.0	0.2	0.2
0.1	0.4	0.2	0.0	0.2	0.2
0.2	0.5	0.2	0.0	0.2	0.2
0.3	0.6	0.3	0.0	0.2	0.2
0.4	0.8	0.3	0.0	0.2	0.2
0.5	1.0	0.4	0.1	0.2	0.3
0.6	1.2	0.5	0.1	0.2	0.3
0.7	1.5	0.7	0.2	0.2	0.3
0.8	1.8	0.8	0.2	0.2	0.4
0.9	2.2	1.0	0.3	0.2	0.5
1.0	2.7	1.3	0.5	0.2	0.8
1.1	3.3	1.6	0.8	0.2	0.8
1.2	3.9	1.9	0.8	0.2	1.0
1.3	4.4	2.2	1.1	0.2	1.2
1.4	3.9	2.1	1.4	0.2	1.5
1.5	3.3	1.8	1.7	0.2	1.9
1.6	2.7	1.5	2.1	0.2	2.3
1.7	2.2	1.2	2.5	0.2	2.8
1.8	1.8	1.0	3.0	0.2	3.2
1.9	1.5	0.8	3.5	0.2	3.7
2.0	1.2	0.7	4.0	0.2	4.2
2.1	1.0	0.6	4.4	0.3	4.7
2.2	0.8	0.5	4.9	0.3	5.1
2.3	0.6	0.4	5.3	0.3	5.6
2.4	0.5	0.3	5.6	0.3	5.9
2.5	0.4	0.3	5.9	0.3	6.3
2.6	0.3	0.2	6.1	0.4	6.5
2.7	0.0	0.0	6.3	0.4	6.6
2.8	0.0	0.0	6.3	0.4	6.7
2.9	0.0	0.0	6.2	0.4	6.7
3.0	0.0	0.0	6.1	0.4	6.6
3.1	0.0	0.0	5.9	0.5	6.4
3.2	0.0	0.0	5.7	0.5	6.2
3.3	0.0	0.0	5.5	0.5	6.0
3.4	0.0	0.0	5.2	0.5	5.8
3.5	0.0	0.0	5.0	0.5	5.5
3.6	0.0	0.0	4.7	0.6	5.2
3.7	0.0	0.0	4.4	0.6	4.9
3.8	0.0	0.0	4.1	0.6	4.7
3.9	0.0	0.0	3.8	0.6	4.4
4.0	0.0	0.0	3.5	0.6	4.1
4.1	0.0	0.0	3.3	0.6	3.9
4.2	0.0	0.0	3.1	0.6	3.7
4.3	0.0	0.0	2.8	0.6	3.5
4.4	0.0	0.0	2.6	0.6	3.3
4.5	0.0	0.0	2.4	0.7	3.1
4.6	0.0	0.0	2.2	0.7	2.9
4.7	0.0	0.0	2.0	0.7	2.7
4.8	0.0	0.0	1.8	0.7	2.5
4.9	0.0	0.0	1.7	0.7	2.3
5.0	0.0	0.0	1.5	0.7	2.2
5.1	0.0	0.0	1.3	0.7	2.0
5.2	0.0	0.0	1.2	0.7	1.8
5.3	0.0	0.0	1.0	0.7	1.7
5.4	0.0	0.0	0.9	0.7	1.6
5.5	0.0	0.0	0.7	0.7	1.4
5.6	0.0	0.0	0.6	0.7	1.3
5.7	0.0	0.0	0.5	0.7	1.2
5.8	0.0	0.0	0.4	0.7	1.1
5.9	0.0	0.0	0.3	0.7	1.0
6.0	0.0	0.0	0.2	0.7	0.9
6.1	0.0	0.0	0.2	0.7	0.8
6.2	0.0	0.0	0.1	0.7	0.8
6.3	0.0	0.0	0.1	0.7	0.8
6.4	0.0	0.0	0.1	0.7	0.7
6.5	0.0	0.0	0.0	0.7	0.7
6.6	0.0	0.0	0.0	0.7	0.7
6.7	0.0	0.0	0.0	0.7	0.7
6.8	0.0	0.0	0.0	0.7	0.7
6.9	0.0	0.0	0.0	0.7	0.7
7.0	0.0	0.0	0.0	0.7	0.7
7.1	0.0	0.0	0.0	0.7	0.7
Total (mm)	45.1	23.0	23.0	4.9	27.8

Graph



Audit comments

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name: mikel
Company name: mia
Project name: barrow brook citheroe

Catchment name:
Catchment easting: 374000
Catchment northing: 438100
Catchment area: 2.48

Date/time modelled: 08-Feb-2012 15:06
Version: 1.4

Summary of model setup

Design rainfall parameters

Return period (yr): 30
Duration (hr): 2.7
Timestep (hr): 0.1
Season: Winter

Loss model parameters

C_{max} (mm): 262
 C_{tot} (mm): 133
 α factor: 0.91

Routing model parameters

T_p (hr): 1.23
 U_p : 0.65
 U_k : 0.8

Baseflow model parameters

BL (hr): 25.3
BR: 0.96
 BF_0 (m^3/s): 0.2

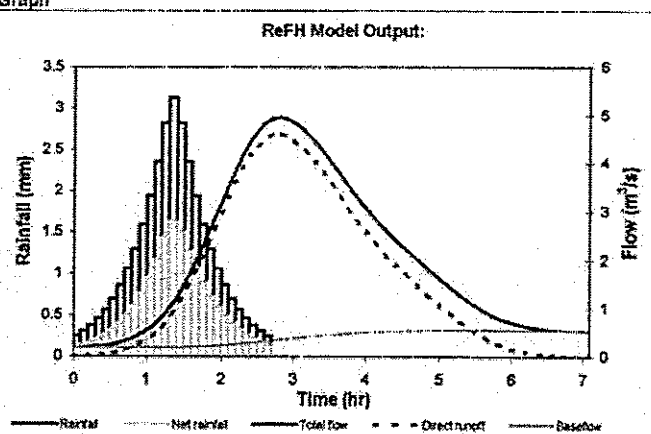
Summary of results

FEH DDF rainfall (mm): 44.2
Design rainfall (mm): 32.2
Peak rainfall (mm): 3.1
Peak flow (m^3/s): 5

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.0	0.2	0.1	0.0	0.2	0.2
0.1	0.3	0.1	0.0	0.2	0.2
0.2	0.4	0.2	0.0	0.2	0.2
0.3	0.5	0.2	0.0	0.2	0.2
0.4	0.6	0.3	0.0	0.2	0.2
0.5	0.7	0.3	0.1	0.2	0.2
0.6	0.9	0.4	0.1	0.2	0.3
0.7	1.1	0.5	0.1	0.2	0.3
0.8	1.3	0.6	0.2	0.2	0.4
0.9	1.6	0.8	0.3	0.2	0.4
1.0	1.9	1.0	0.4	0.2	0.5
1.1	2.3	1.2	0.5	0.2	0.6
1.2	2.8	1.4	0.6	0.2	0.8
1.3	3.1	1.6	0.8	0.2	1.0
1.4	2.6	1.5	1.0	0.2	1.2
1.5	2.3	1.3	1.3	0.2	1.5
1.6	1.9	1.1	1.6	0.2	1.8
1.7	1.6	0.9	1.9	0.2	2.1
1.8	1.3	0.7	2.3	0.2	2.5
1.9	1.1	0.6	2.6	0.2	2.8
2.0	0.9	0.5	3.0	0.2	3.2
2.1	0.7	0.4	3.3	0.2	3.5
2.2	0.6	0.3	3.6	0.2	3.9
2.3	0.5	0.3	3.9	0.3	4.2
2.4	0.4	0.2	4.2	0.3	4.4
2.5	0.3	0.2	4.4	0.3	4.7
2.6	0.2	0.1	4.5	0.3	4.8
2.7	0.0	0.0	4.5	0.3	4.9
2.8	0.0	0.0	4.6	0.3	5.0
2.9	0.0	0.0	4.6	0.4	4.9
3.0	0.0	0.0	4.5	0.4	4.8
3.1	0.0	0.0	4.3	0.4	4.7
3.2	0.0	0.0	4.2	0.4	4.6
3.3	0.0	0.0	4.0	0.4	4.4
3.4	0.0	0.0	3.8	0.4	4.2
3.5	0.0	0.0	3.6	0.4	4.0
3.6	0.0	0.0	3.4	0.5	3.8
3.7	0.0	0.0	3.2	0.5	3.6
3.8	0.0	0.0	3.0	0.5	3.4
3.9	0.0	0.0	2.8	0.5	3.2
4.0	0.0	0.0	2.6	0.5	3.1
4.1	0.0	0.0	2.4	0.5	2.9
4.2	0.0	0.0	2.2	0.5	2.7
4.3	0.0	0.0	2.1	0.5	2.6
4.4	0.0	0.0	1.9	0.5	2.4
4.5	0.0	0.0	1.7	0.5	2.3
4.6	0.0	0.0	1.6	0.5	2.1
4.7	0.0	0.0	1.5	0.5	2.0
4.8	0.0	0.0	1.3	0.5	1.9
4.9	0.0	0.0	1.2	0.5	1.7
5.0	0.0	0.0	1.1	0.5	1.6
5.1	0.0	0.0	1.0	0.5	1.5
5.2	0.0	0.0	0.8	0.5	1.2
5.3	0.0	0.0	0.7	0.5	1.3
5.4	0.0	0.0	0.6	0.5	1.2
5.5	0.0	0.0	0.5	0.5	1.1
5.6	0.0	0.0	0.4	0.5	1.0
5.7	0.0	0.0	0.3	0.5	0.9
5.8	0.0	0.0	0.3	0.5	0.8
5.9	0.0	0.0	0.2	0.5	0.8
6.0	0.0	0.0	0.2	0.5	0.7
6.1	0.0	0.0	0.1	0.5	0.7
6.2	0.0	0.0	0.1	0.5	0.6
6.3	0.0	0.0	0.1	0.5	0.6
6.4	0.0	0.0	0.0	0.5	0.6
6.5	0.0	0.0	0.0	0.5	0.6
6.6	0.0	0.0	0.0	0.5	0.5
6.7	0.0	0.0	0.0	0.5	0.5
6.8	0.0	0.0	0.0	0.5	0.5
6.9	0.0	0.0	0.0	0.5	0.5
7.0	0.0	0.0	0.0	0.5	0.5
7.1	0.0	0.0	0.0	0.5	0.5
Total (mm)	32.2	16.9	16.9	4.0	20.9

Graph



Audit comments

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	mikel	Catchment name		Date/time modelled	08-Feb-2012 15:06
Company name	mia	Catchment easting	374000	Version	1.4
Project name	barrow brook clitheroe	Catchment northing	438100		
		Catchment area	2.48		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	1.01	C_{max} (mm)	262	T_p (hr)	1.23	BL (hr)	25.3
Duration (hr)	27	C_{int} (mm)	133	U_p	0.65	BR	0.96
Timestep (hr)	0.1	α factor	1	U_k	0.8	BF_0 (m ³ /s)	0.2
Season	Winter						

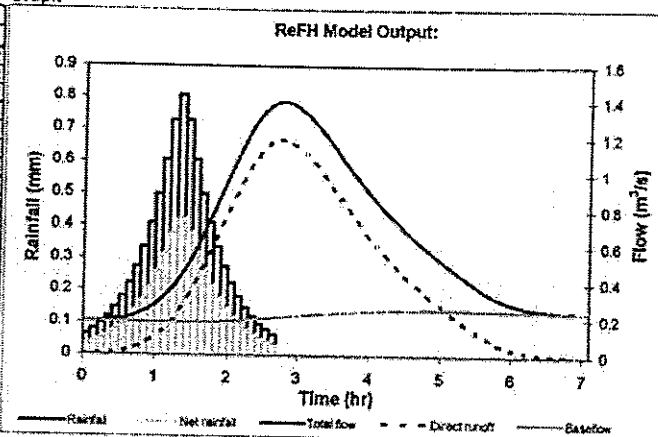
Summary of results

FEH DDF rainfall (mm)	11.4	Peak rainfall (mm)	0.8
Design rainfall (mm)	8.3	Peak flow (m ³ /s)	1.4

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m ³ /s	m ³ /s	m ³ /s
0.0	0.1	0.0	0.0	0.2	0.2
0.1	0.1	0.0	0.0	0.2	0.2
0.2	0.1	0.0	0.0	0.2	0.2
0.3	0.1	0.1	0.0	0.2	0.2
0.4	0.1	0.1	0.0	0.2	0.2
0.5	0.2	0.1	0.0	0.2	0.2
0.6	0.2	0.1	0.0	0.2	0.2
0.7	0.3	0.1	0.0	0.2	0.2
0.8	0.3	0.2	0.1	0.2	0.2
0.9	0.4	0.2	0.1	0.2	0.2
1.0	0.5	0.3	0.1	0.2	0.3
1.1	0.6	0.3	0.1	0.2	0.3
1.2	0.7	0.4	0.2	0.2	0.3
1.3	0.8	0.4	0.2	0.2	0.3
1.4	0.7	0.4	0.3	0.2	0.4
1.5	0.8	0.3	0.4	0.2	0.5
1.6	0.5	0.3	0.4	0.2	0.6
1.7	0.4	0.2	0.5	0.2	0.7
1.8	0.3	0.2	0.6	0.2	0.8
1.9	0.3	0.1	0.7	0.2	0.9
2.0	0.2	0.1	0.8	0.2	1.0
2.1	0.2	0.1	0.9	0.2	1.1
2.2	0.1	0.1	1.0	0.2	1.1
2.3	0.1	0.1	1.0	0.2	1.2
2.4	0.1	0.1	1.1	0.2	1.3
2.5	0.1	0.0	1.1	0.2	1.3
2.6	0.1	0.0	1.2	0.2	1.4
2.7	0.0	0.0	1.2	0.2	1.4
2.8	0.0	0.0	1.2	0.2	1.4
2.9	0.0	0.0	1.2	0.2	1.4
3.0	0.0	0.0	1.1	0.2	1.4
3.1	0.0	0.0	1.1	0.2	1.3
3.2	0.0	0.0	1.1	0.2	1.3
3.3	0.0	0.0	1.0	0.2	1.2
3.4	0.0	0.0	1.0	0.2	1.2
3.5	0.0	0.0	0.9	0.2	1.1
3.6	0.0	0.0	0.9	0.2	1.1
3.7	0.0	0.0	0.8	0.2	1.0
3.8	0.0	0.0	0.8	0.2	1.0
3.9	0.0	0.0	0.7	0.2	0.9
4.0	0.0	0.0	0.7	0.2	0.9
4.1	0.0	0.0	0.8	0.2	0.8
4.2	0.0	0.0	0.8	0.2	0.8
4.3	0.0	0.0	0.5	0.2	0.7
4.4	0.0	0.0	0.5	0.2	0.7
4.5	0.0	0.0	0.4	0.2	0.7
4.6	0.0	0.0	0.4	0.2	0.7
4.7	0.0	0.0	0.4	0.2	0.6
4.8	0.0	0.0	0.3	0.2	0.6
4.9	0.0	0.0	0.3	0.2	0.6
5.0	0.0	0.0	0.3	0.2	0.5
5.1	0.0	0.0	0.2	0.2	0.5
5.2	0.0	0.0	0.2	0.2	0.5
5.3	0.0	0.0	0.2	0.2	0.4
5.4	0.0	0.0	0.2	0.2	0.4
5.5	0.0	0.0	0.1	0.2	0.4
5.6	0.0	0.0	0.1	0.2	0.3
5.7	0.0	0.0	0.1	0.2	0.3
5.8	0.0	0.0	0.1	0.2	0.3
5.9	0.0	0.0	0.0	0.2	0.3
6.0	0.0	0.0	0.0	0.2	0.3
6.1	0.0	0.0	0.0	0.2	0.3
6.2	0.0	0.0	0.0	0.2	0.3
6.3	0.0	0.0	0.0	0.2	0.3
6.4	0.0	0.0	0.0	0.2	0.3
6.5	0.0	0.0	0.0	0.2	0.2
6.6	0.0	0.0	0.0	0.2	0.2
6.7	0.0	0.0	0.0	0.2	0.2
6.8	0.0	0.0	0.0	0.2	0.2
6.9	0.0	0.0	0.0	0.2	0.2
7.0	0.0	0.0	0.0	0.2	0.2
7.1	0.0	0.0	0.0	0.2	0.2
Total (mm)	8.3	4.4	4.4	2.3	6.6

Graph



Audit comments

HEC-RAS Plan: p01 River: barrow brook Reach: overflow Profile: PF 1

Q100

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
overflow	61.2	PF 1	5.600	85.000	86.000	85.99	86.49	0.016	3.11	1.80	1.80	0.99
overflow	0	PF 1	5.600	84.000	85.002	84.99	85.49	0.016	3.11	1.80	1.80	0.99

HEC-RAS Plan: p02 River: barrow brook Reach: overflow Profile: PF 1

Reach	River Sta	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude # Chl
overflow	61.2	PF 1	9.500	85.000	86.511	86.41	87.13	0.016	3.49	2.72	1.80	0.91
overflow	0	PF 1	9.500	84.000	85.513	85.41	86.13	0.016	3.49	2.72	1.80	0.91

Q (cfs)

Barrow site 2, Clitheroe			08/02/2012 mel			B1200
FLOOD 1.2 storage calculations		Gross site 40,000m ² Hard area 22,000m ²				
Basic data from FSR maps is M5-60 is 20mm R= 0.42						
Multiples of Tc	Duration mins	1 in 1 year storms Flow limit 23.5 l/sec Runoff vol m3	Storage m3	1 in 30 year storms Flow limit 44.6 l/sec runoff vol m3	storage m3	
1	8	101	80	242	201	
5	40	218	153	519	395	
10	80	279	160	673	445	80 minute storm requires highest storage
15	120	332	157	774	441	
20	160	376	146	851	413	
25	200	405	119	911	367	
30	240	429	88	964	314	
Notes						
1. Flood 1.2 is a DOS program and was written to assist engineers with the design of flow control and flood attenuation schemes.						
2. Flood will produce rainfall intensities and runoff volumes for a specified storm, return period and impervious area						
3. Flood will calculate the volume of storage requirements and the critical storm duration given the maximum permitted discharge rate						
4. Flood uses formulae and statistics information originally published in the 1975 Flood Studies Report, Rainfall intensities and storm profiles for the 'point' rainfall at any location can be calculated.						
5. The method of storage estimation has been based on a simplified storm profile						
6. Storm profiles provided in FSR have not changed see 1999 Flood Estimation Handbook vol2 rainfall frequency estimation						
IoH 124						
QBAR= 0.00108 x area in km ² to the power 0.89 x SAAR power 1.17 x soil power 2.17						
Use area as 1, SAAR is 1191 soil is 0.4						
Maths Q = 0.00108 x 1 x 3970 x 0.137 = 0.587 m ³ /sec						
Greenfield runoff is thus 587 litres/sec for 100 ha and greenfield runoff is 5.87 l/sec/ha						
A 4 ha site generates 23.5 l/sec and uprating this to 1 in 30 year using a growth factor of 1.9 gives a 1 in 30 year greenfield runoff of 44.6 l/sec						
MLA	floodriskengineer@gmail.com					B1200