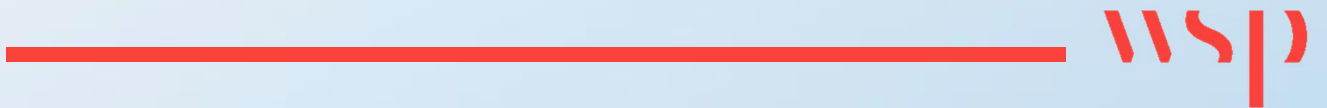
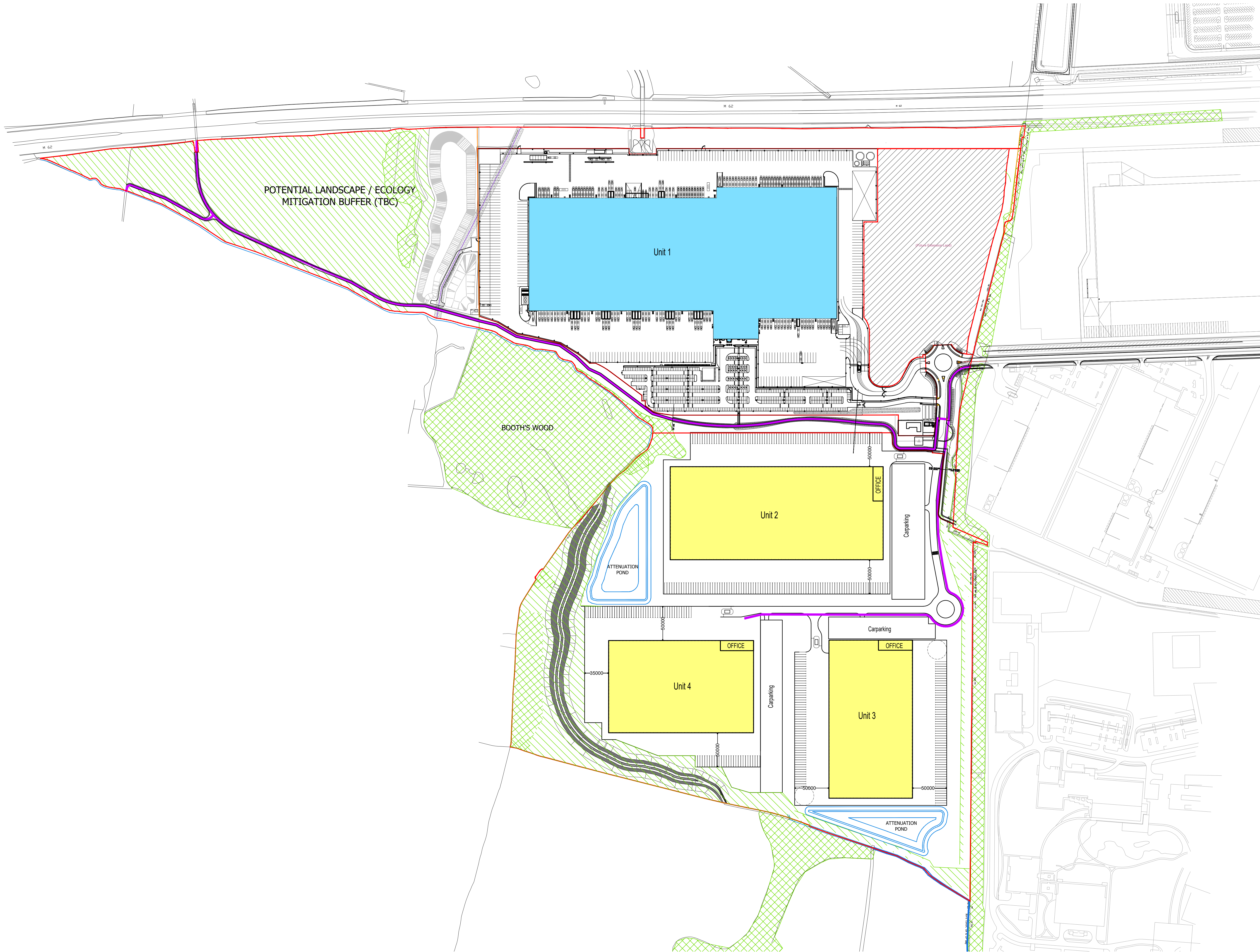


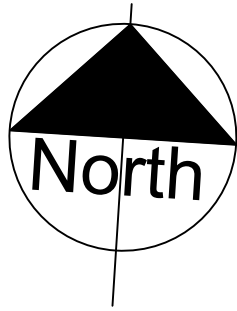
Appendix C

MASTERPLAN OF PROPOSED
DEVELOPMENT





NOTES:
Copyright Chetwoods (London) Limited. No implied licence exists.
Contractors must verify all dimensions on site before commencing any work or shop drawings. This drawing is not to be scaled. Use figured dimensions only.
Subject to statutory approvals and survey.
Building areas are liable to adjustment over the course of the design process due to the ongoing construction detailing developments.
Please note the information contained within this drawing is solely for the benefit of the employer and should not be relied upon by third parties.
The CDM hazard management procedures for the Chetwoods aspects of the design of this project are to be found on the "Chetwoods - Hazard Analysis and Design Risk Assessment" and/or drawings. The full project design teams comprehensive set of hazard management procedures are available from the Principle Designer appointed for the project.



Notes:

Please note Title Plans have been scaled using Ordnance Survey features which may have altered over time. Complete accuracy cannot be guaranteed without further on-site survey.

Any dimensions given are to be confirmed with site measure.

- KEYS:
- PEDESTRIAN / CYCLE ROUTE
 - Unit 1 TJM UNIT
 - OUTLINE UNITS
 - LANDSCAPE AREAS
 - EXISTING WOODLAND
 - TJM SUDS
 - OUTLINE SUDS
 - WATERCOURSE DIVERSION
 - EXPANSION LAND

SK15Pedestrian/Cycle Route updated		06/08/20	RC/SF
Rev	Revision Description	Date	Author/Reviewer
SKETCH			
32 Frederick Street, Birmingham, B1 3HH		+44 (0)121 234 7500 www.chetwoods.com	



Project

ZONE 8
OMEGA WEST, WARRINGTON

Client

OMEGA ST HELENS LTD / T.J.MORRIS LTD

Drawing Title

FIGURE 1-1 THE PROPOSED
DEVELOPMENT AREA

Scale	Size	Drawn	Checked	Date		
1:2500	A1	RC	SF	23/10/19		
Project	Originator	Zone	Level	Type	Role	Number
4150	CA	00	00	DR	A	05100 SK



DO NOT SCALE

KEY

HYBRID PLANNING APPLICATION BOUNDARY

WATERCOURSE DIVERSION CORRIDOR

D	06/06/2020	TS	MASTERPLAN ADDED	%	%
C	04/08/2020	TS	UPDATED FOLLOWING COMMENTS	%	%
B	31/07/2020	TS	SHADED AREA UPDATED	%	%
A	19/07/2020	TS	FIRST ISSUE	%	%
REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS: PLANNING

wsp

8 First Street, Manchester, M15 4GU, UK
T+ 44 (0) 161 200 5000
wsp.com

CLIENT:
OMEGA ST HELENS LTD / T.J. MORRIS LIMITED

ARCHITECT:
N / A

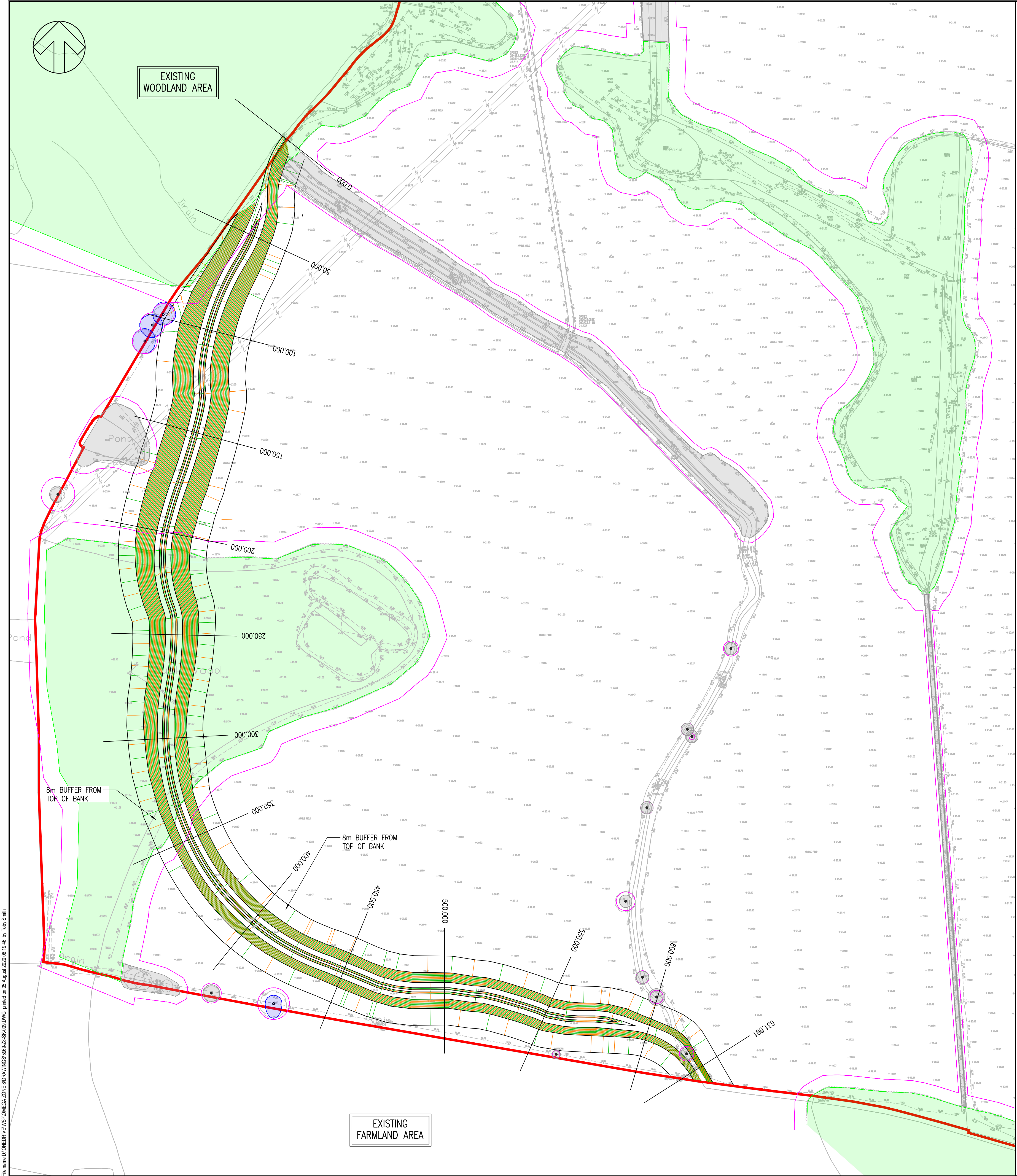
SITE/PROJECT:
OMEGA
ZONE 8
ST HELENS

TITLE:
PARAMETERS PLAN 4
WATERCOURSE DIVERSION
OPP DWG. 12

SCALE @ A1: 1:1000	CHECKED: SG	APPROVED: SG
PROJECT NO: 70065969	DESIGNED: TS	DRAWN: TS
DATE: July 20		REV: D

DRAWING NO:
5969-Z8-SK-015

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File name: D:\CONSERVATION\OMEGA_ZONE_8\DRAWINGS\969-Z8-SK-009.DWG, printed on: 05 August 2020 08:19:48, by: Jody Smith

KEY

- HYBRID PLANNING APPLICATION BOUNDARY
- EXISTING GROUND PROFILE
- PROPOSED GROUND PROFILE

NOTES

- ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

DO NOT SCALE

200.000

DATUM 16.000

PROPOSED LEVEL		EXISTING LEVEL	OFFSET
22.845	22.859	22.765	30.0
	22.858	22.771	28.0
	22.858	22.799	26.0
	22.858	22.821	24.0
	22.857	22.826	22.0
	22.857	22.835	20.0
	22.857	22.840	18.0
	22.857	22.843	16.0
	22.857	22.845	14.0
	22.857	22.845	12.0
	22.857	22.845	10.0
	22.857	22.845	8.0
	22.857	22.845	6.0
	22.857	22.845	4.0
	22.857	22.845	2.0
	22.857	22.845	0.0
22.845	22.859	22.765	30.0
	22.858	22.771	28.0
	22.858	22.799	26.0
	22.858	22.821	24.0
	22.857	22.826	22.0
	22.857	22.835	20.0
	22.857	22.840	18.0
	22.857	22.843	16.0
	22.857	22.845	14.0
	22.857	22.845	12.0
	22.857	22.845	10.0
	22.857	22.845	8.0
	22.857	22.845	6.0
	22.857	22.845	4.0
	22.857	22.845	2.0
	22.857	22.845	0.0

150.000

DATUM 17.000

PROPOSED LEVEL	EXISTING LEVEL	OFFSET
23.000	22.853	30.0
23.050	22.854	25.0
23.100	22.856	20.0
23.150	22.856	15.0
23.200	22.878	20.0
23.250	22.882	25.0
23.300	22.905	24.0
23.350	22.918	23.0
23.400	22.932	22.0
23.450	22.945	21.0
23.500	22.958	20.0
23.550	22.972	19.0
23.600	22.985	18.0
23.650	22.998	17.0
23.700	23.012	16.0
23.750	23.025	15.0
23.800	23.039	14.0
23.850	23.052	13.0
23.900	23.065	12.0
23.950	23.079	11.0
24.000	23.092	10.0
24.050	23.105	9.0
24.100	23.119	8.0
24.150	23.132	7.0
24.200	23.145	6.0
24.250	23.159	5.0
24.300	23.172	4.0
24.350	23.186	3.0
24.400	23.199	2.0
24.450	23.212	1.0
24.500	23.226	0.0
24.550	23.239	1.0
24.600	23.252	2.0
24.650	23.266	3.0
24.700	23.279	4.0
24.750	23.292	5.0
24.800	23.306	6.0
24.850	23.319	7.0
24.900	23.333	8.0
24.950	23.346	9.0
25.000	23.359	10.0
25.050	23.373	11.0
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25.650	23.533	23.0
25.700	23.547	24.0
25.750	23.560	25.0
25.800	23.574	26.0
25.850	23.587	27.0
25.900	23.601	28.0
25.950	23.614	29.0
26.000	23.628	30.0

100.000

DATUM 17.000

PROPOSED LEVEL	EXISTING LEVEL	OFFSET
23.063	22.800	30.0
23.063	22.815	28.0
23.063	22.830	26.0
23.063	22.845	24.0
23.063	22.860	22.0
23.063	22.875	20.0
23.063	22.890	18.0
23.063	22.905	16.0
23.063	22.920	14.0
23.063	22.935	12.0
23.063	22.950	10.0
23.063	22.965	8.0
23.063	22.980	6.0
23.063	22.995	4.0
23.063	23.010	2.0
23.063	23.025	0.0
23.063	23.040	2.0
23.062	23.055	4.0
22.901	23.070	6.0
22.988	23.085	8.0
22.985	23.100	10.0
22.985	23.115	12.0
22.985	23.130	14.0
21.568	23.145	16.0
21.568	23.160	18.0
21.234	23.145	7.0
20.901	23.160	6.0
20.567	23.175	5.0
20.234	23.190	4.0
20.234	23.205	3.0
20.234	23.220	2.0
20.234	23.235	1.0
20.983	23.250	0.0
20.983	23.265	1.0
20.233	23.280	2.0
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20.233	23.310	4.0
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20.903	23.357	6.0
21.238	23.395	7.0
21.568	23.430	8.0
21.908	23.463	9.0
22.243	23.511	10.0
22.578	23.550	11.0
22.912	23.588	12.0
23.247	23.627	13.0
23.581	23.665	14.0
23.668	23.668	15.0
23.670	23.670	16.0
23.670	23.670	17.0
23.672	23.672	18.0
23.673	23.673	19.0
23.674	23.674	20.0
23.675	23.675	21.0
23.676	23.676	22.0
23.676	23.676	23.0
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		25.0
		26.0
		27.0
		28.0
		29.0
		30.0

D	05/06/2020	TS	POWER LINES REMOVED. KEY AMENDED	%	%
C	31/07/2020	TS	DRAWING RETITLED	%	%
B	29/07/2020	TS	BASIN ALIGNMENT AMENDED	%	%
A	01/07/2020	TS	FIRST ISSUE	%	%
REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS:	PLANNING
-----------------	----------



8 First Street, Manchester, M15 4GU, UK
T+ 44 (0) 161 200 5000
wsp.com

CLIENT:	OMEGA ST HELENS LTD / T.J. MORRIS LIMITED
---------	---

ARCHITECT:	N / A
------------	-------

SITE/PROJECT:	OMEGA ZONE 8 ST HELENS
---------------	------------------------------

TITLE:	INDICATIVE WATERCOURSE DIVERSION ROUTE AND SECTIONS OPP DWG. 13
--------	---

SCALE @ A1: 1:1000 (PLAN) 1:250 (SECTS)	CHECKED: SG	APPROVED: SG
PROJECT NO: 70065969	DESIGNED: TS	DRAWN: TS
		DATE: July 20

DRAWING NO: 5969-Z8-SK-009	REV: D
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DO NOT SCALE

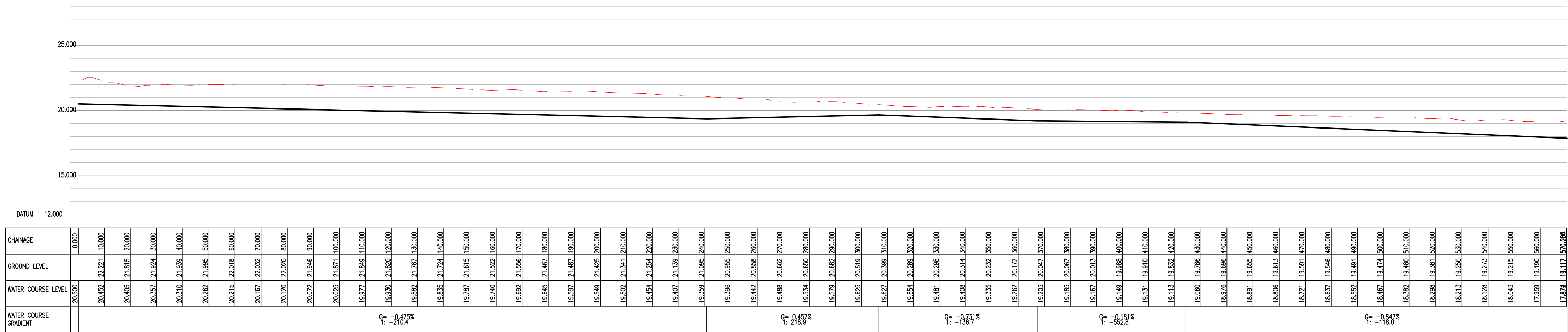
NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE

KEY

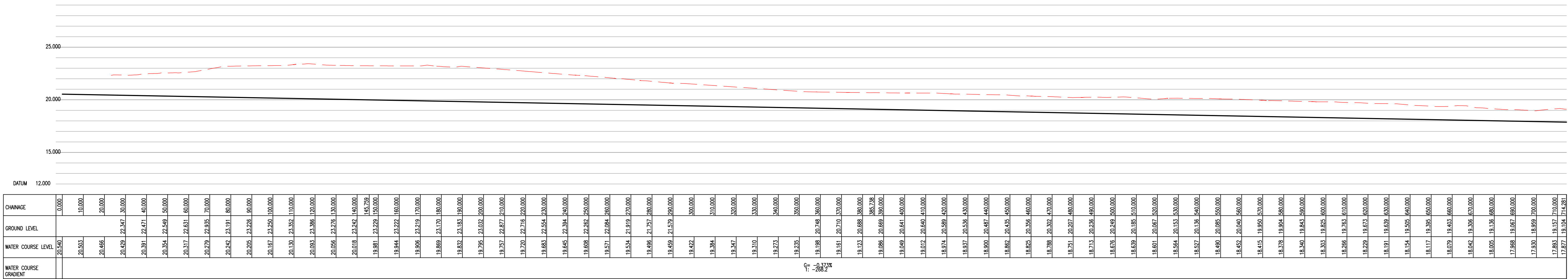
— — — EXISTING GROUND LEVEL

———— WATERCOURSE INVERT LEVEL



EXISTING WATERCOURSE

SCALE - 1:1000(H) 1:200(V)



PROPOSED WATERCOURSE

SCALE - 1:1000(H) 1:200(V)



PLAN
SCALE - 1:1250

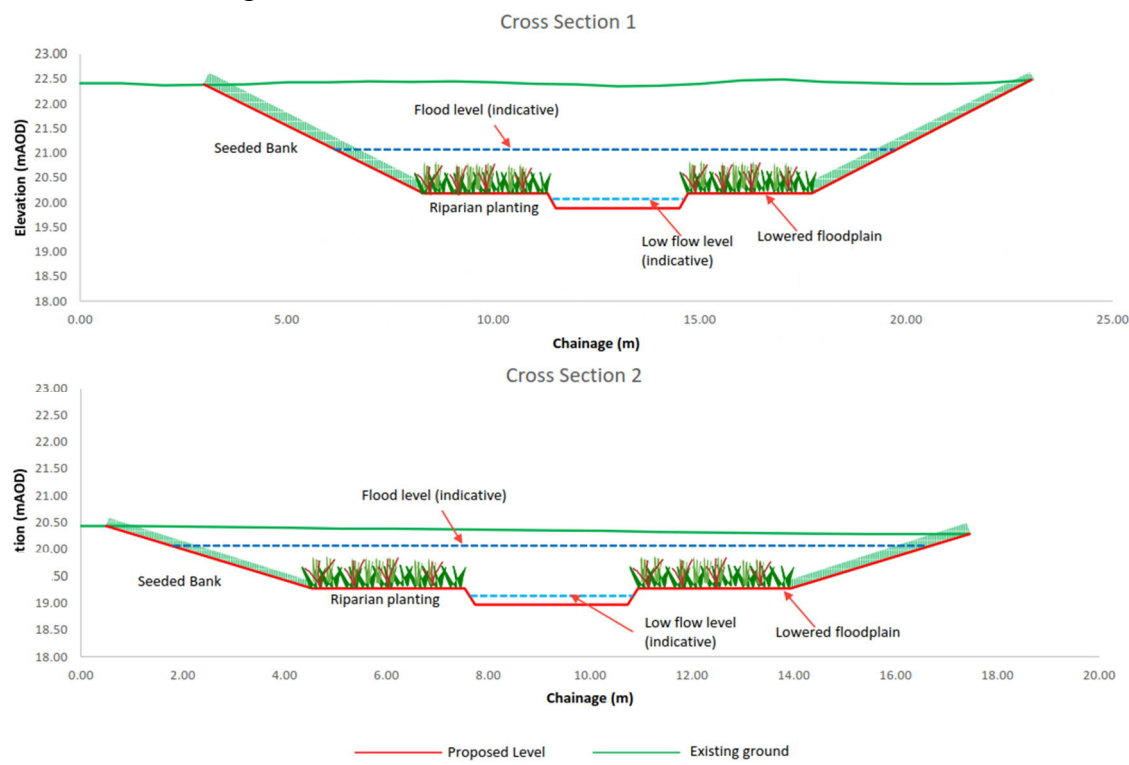
A	06/08/2020	TS	FIRST ISSUE	SG	SG
REV	DATE	BY	DESCRIPTION	CHK	APP
DRAWING STATUS:					
PLANNING					
 8 First Street, Manchester, M15 4GU, UK T+44 (0) 161 200 5000 wsp.com					
CLIENT:					
OMEGA ST HELENS LTD / T.J. MORRIS LIMITED					
ARCHITECT:					
N / A					
SITE/PROJECT:					
OMEGA ZONE 8 ST HELENS					
TITLE:					
FIGURE A-2 INDICATIVE WATERCOURSE DIVERSION LONG SECTIONS OPP DWG. 14					
SCALE @ A1: AS SHOWN		CHECKED: SG		APPROVED: SG	
PROJECT NO: 70065969		DESIGNED: TS		DATE: August 20	
DRAWING No:					REV:
5969-Z8-SK-016					A
© WSP UK Ltd					



OMEGA ZONE 8, ST. HELENS

OPP DOC. 11.24 ES VOL. 2 APPENDIX 11.1 INDICATIVE CROSS SECTIONS

Indicative cross sections showing the general design principle for the channel diversion. Note, these are for demonstration purposes only and specific dimensions and water levels will be elucidated at detailed design



Appendix D

PRELIMINARY FLOOD RISK
ASSESSMENT FLOOD MAPS

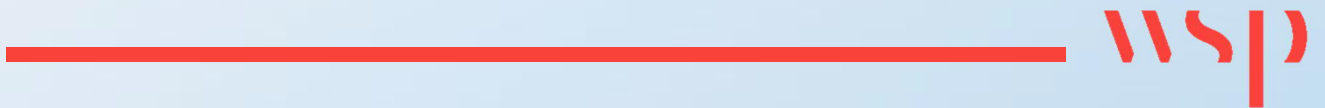
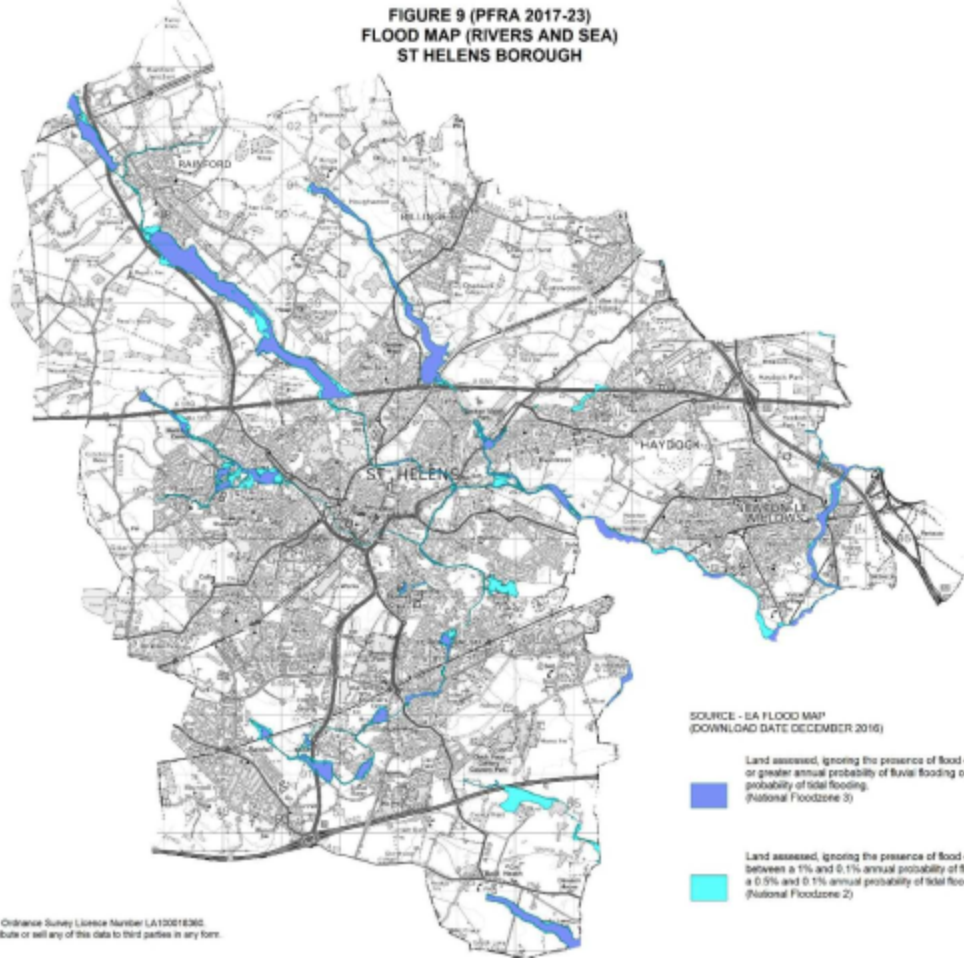


FIGURE 9 (PFRA 2017-23)
FLOOD MAP (RIVERS AND SEA)
ST HELENS BOROUGH



St. Helens
Council



SOURCE - EA FLOOD MAP¹
 (DOWNLOAD DATE DECEMBER 2016)

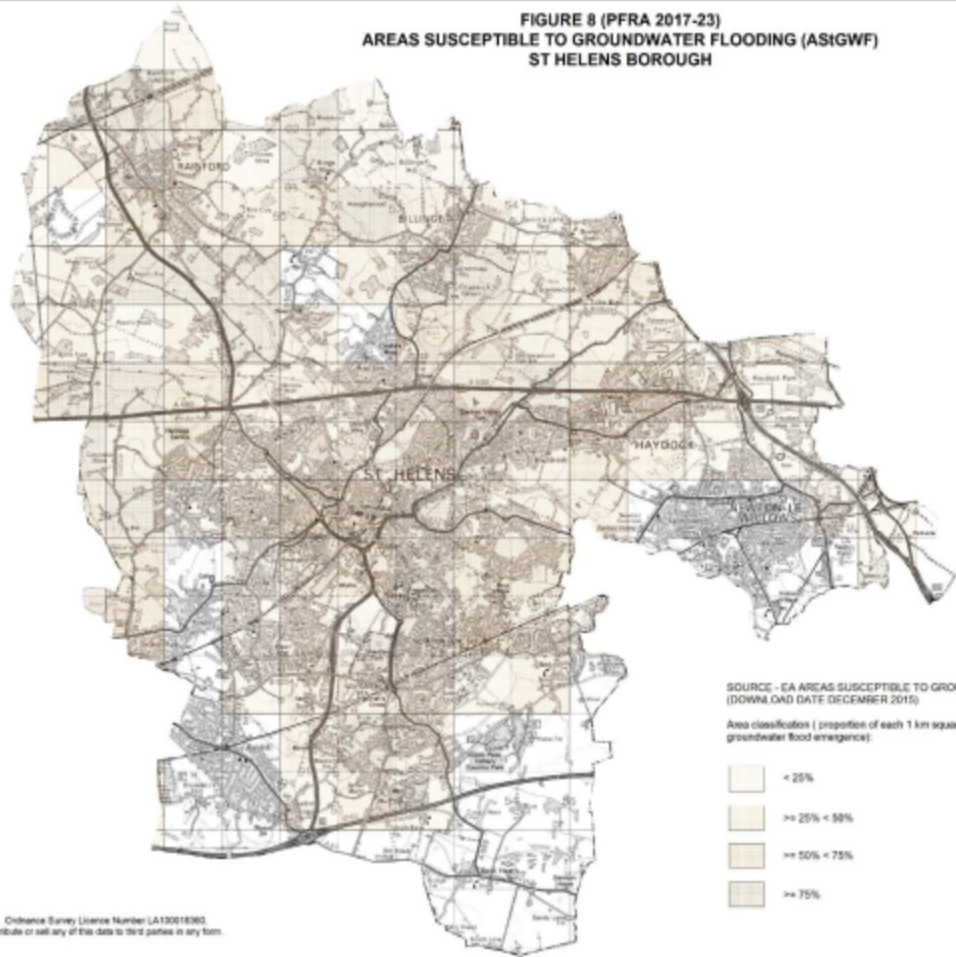
Land assessed, ignoring the presence of flood defences, as having a 1% or greater annual probability of fluvial flooding or a 0.5% or greater annual probability of tidal flooding.
 (National Floodzone 3)



Land assessed, ignoring the presence of flood defences, as having between a 1% and 0.1% annual probability of fluvial flooding or between a 0.5% and 0.1% annual probability of tidal flooding in any year.
 (National Floodzone 2)



FIGURE 8 (PFRA 2017-23)
AREAS SUSCEPTIBLE TO GROUNDWATER FLOODING (ASIGWF)
ST HELENS BOROUGH



SOURCE - EA AREAS SUSCEPTIBLE TO GROUNDWATER FLOODING
 (DOWNLOAD DATE DECEMBER 2015)

Area classification (proportion of each 1 km square that is susceptible to
 groundwater flood emergence):

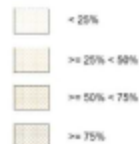
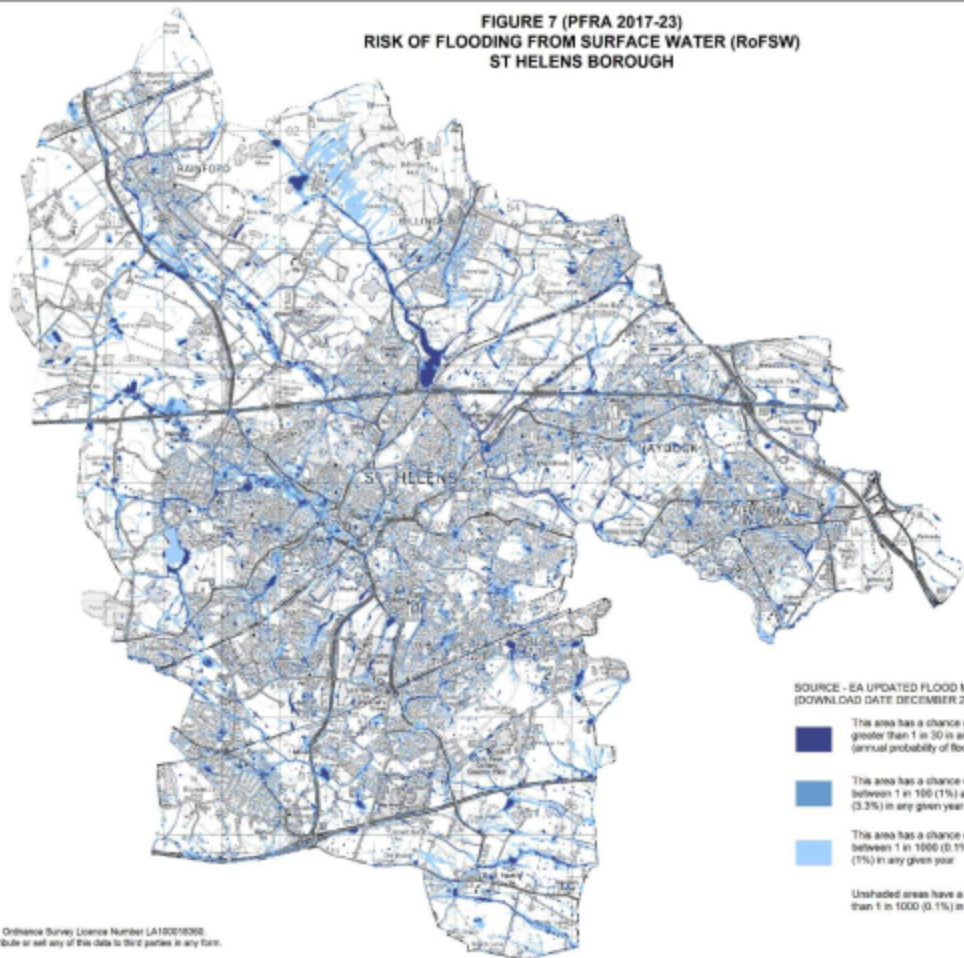


FIGURE 7 (PFRA 2017-23)
RISK OF FLOODING FROM SURFACE WATER (RoFSW)
ST HELENS BOROUGH



St. Helens
Council



Appendix E

ENVIRONMENT AGENCY
CONSULTATION DATA



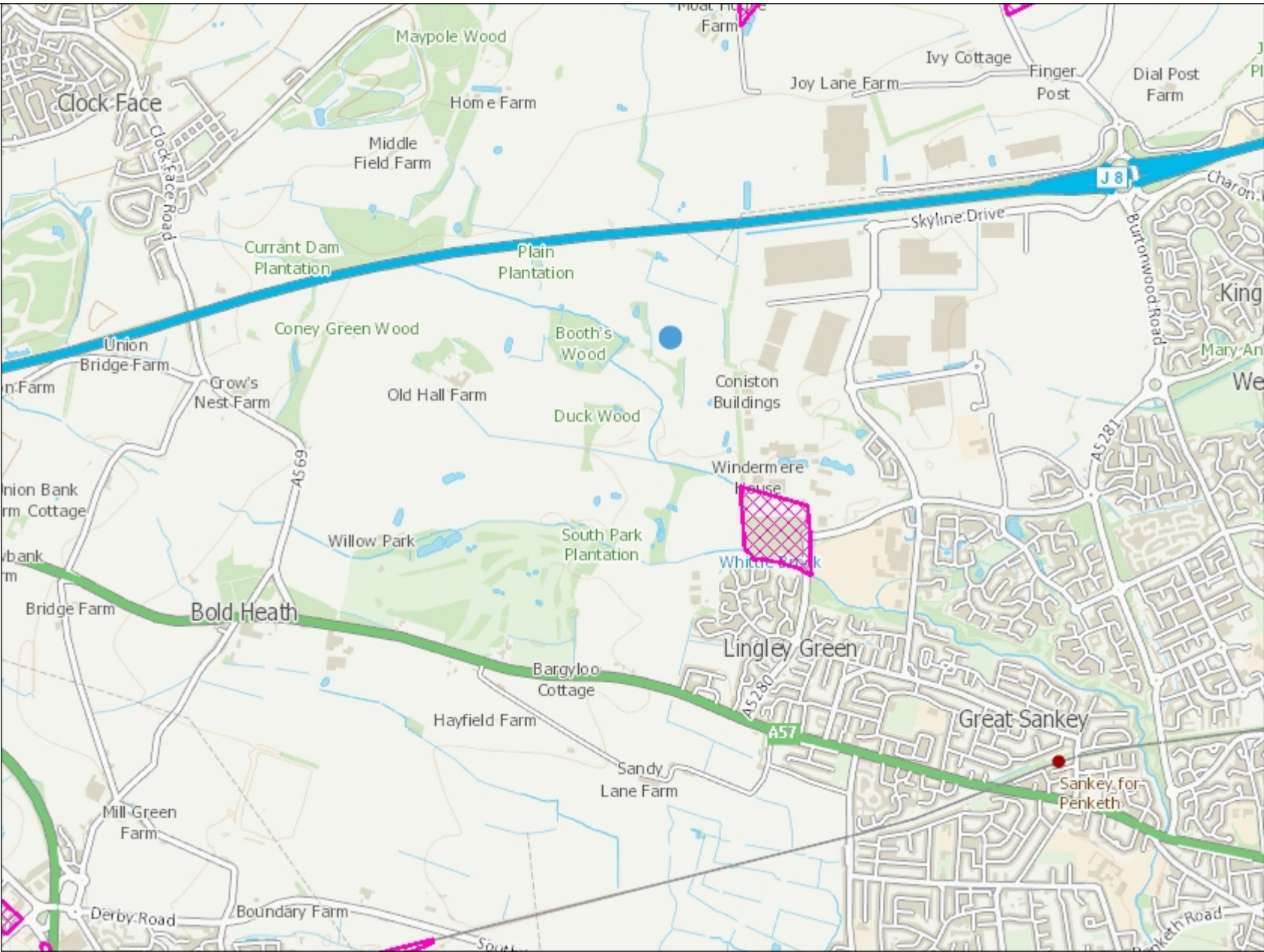
Consent number	Version number	Previous number	Date issued	Date effective	Date revoked	Short name	Long name	Permit Address line 1	Permit Address line 2
016993375	1		20/07/2000	20/07/2000		PASTURES PS	THE PASTURES PUMPING STATION	BOLD	
01STH0103	2	016993570	30/06/2004	30/06/2004		BOLD (CAPPER	BOLD (CAPPER NEILLS)	ST HELENS	
016982815	2	01STH0107	15/11/2005	15/11/2005		UNION BANK P	UNION BANK PS	BOLD	ST HELENS
016990248	6		16/05/2005	08/03/2005		SUTTON MANOR	SUTTON MANOR COLLIERY	OUTFALL D2	ST HELENS
0165/65	1		19/08/1965	19/08/1965		2 & 3 BOLDBR	2 & 3 BOLDBRIDGE COTTAGES	TIBBSCROSS LANE	BOLD
016990372	2			15/06/1992		UNION BRIDGE	UNION BRIDGE FARM	FINGER HOUSE LANE	BOLD
016982798	1	01STH0108		30/09/1994		CLOCK FACE R	CLOCK FACE ROAD PS	ST HELENS	
016990403	1			08/01/1983		HEATH HOUSE	HEATH HOUSE FARM	BOLD HEATH	WIDNES
016920641	3	01HAL0038	21/03/2018	01/04/2018		DERBY RD CSO	DERBY RD BARROWS LANE CSO 203DC	264 DERBY ROAD	.
016990469	1			15/02/1984		3 RAILWAY CO	3 RAILWAY COTTAGES STP	SOUTH LANE	BOLD
016990484	1			05/01/1984		RAILWAY COTT	RAILWAY COTTAGES(1)	SOUTH LANE	BOLD
016990222	1			17/07/1980		2 SUNNY BANK	2 SUNNY BANK COTTAGE	SOUTH LANE	BOLD
016992843	1			25/11/1994		BEMBRIDGE	O/S NO.10 BEMBRIDGE CLOSE PS	GREAT SANKEY	WARRINGTON
016982891	3	01WAR0113		01/11/1995	07/11/2019	BARROWHALL L	BARROWHALL LANE CSO	PENKETH	WARRINGTON
016992265	1			22/05/1991		DOMVILLE FAR	DOMVILLE FARM	OFF WHITTLE AVENUE	GREAT SANKEY
016982697	1	01WAR0105		30/09/1994		REAR OF 43 H	REAR OF 43 HIGHFIELD AVE	SANKEY	WARRINGTON
016982810	1	01WAR0111		30/09/1994		WHITTLE AVEN	WHITTLE AVENUE PS	WARRINGTON	
010000112	1		19/05/1954	19/05/1954		FOREST FARM	FOREST FARM COTTAGE STP	TAN HOUSE LANE	BURTONWOOD

Permit Address line 3	Permit Postcode	National Grid Reference	Easting	Northing	Discharge type
ST.HELENS		SJ5431093240	354310	393240	Pumping Station on Sewerage Network (water company)
		SJ5476093110	354760	393110	Pumping Station on Sewerage Network (water company)
		SJ5223090200	352230	390200	Pumping Station on Sewerage Network (water company)
		SJ5224091080	352240	391080	Mining of Coal + Lignite
WIDNES	WA8 OXB	SJ5248389476	352483	389476	Domestic property (multiple) (incl farm houses)
NR WIDNES		SJ5280090350	352800	390350	WwTW (not water co) (not STP at a private premises)
		SJ5340090800	353400	390800	Pumping Station on Sewerage Network (water company)
		SJ5354088870	353540	388870	WwTW (not water co) (not STP at a private premises)
WIDNES	WA8 3UE	SJ5355087980	353550	387980	Storm Tank/CSO on Sewerage Network (water company)
WIDNES		SJ5420087800	354200	387800	WwTW (not water co) (not STP at a private premises)
WIDNES		SJ5430087800	354300	387800	WwTW (not water co) (not STP at a private premises)
WIDNES		SJ5434087760	354340	387760	Domestic property (single) (incl farm house)
CHESHIRE		SJ5551089530	355510	389530	Pumping Station on Sewerage Network (water company)
		SJ5619089290	356190	389290	Storm Tank/CSO on Sewerage Network (water company)
WARRINGTON		SJ5700088900	357000	388900	Pumping Station on Sewerage Network (water company)
		SJ5712088130	357120	388130	Storm Tank/CSO on Sewerage Network (water company)
	WA5 4BZ	SJ5715088750	357150	388750	Pumping Station on Sewerage Network (water company)
WARRINGTON		SJ5748792109	357487	392109	Farms (not house)/Crop + Animal Rearing/Plant Nursery

Omega Zone 8 EIA



- Legend
- Authorised Landfill Sites
 - Historic Landfill Sites





 Site Location
 Model Measurements
 Main River
 Flood Zone 3
 Flood Zone 2

					Undefended		
Map Reference	Model Node Reference	Easting	Northing	Data	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change*	0.1 % AEP (1 in 1000 year)
1	EA01317_WHIT02_4849	353695	390808	Modelled Water Level (m aodN)	28.22	29.10	28.95
				Modelled Flow (cumecs)	2.40	1.41	1.30
2	EA01317_WHIT02_4449	354079	390754	Modelled Water Level (m aodN)	26.53	26.98	27.30
				Modelled Flow (cumecs)	2.40	2.88	4.31
3	EA01317_WHIT02_3266u	354994	390261	Modelled Water Level (m aodN)	21.00	23.57	23.87
				Modelled Flow (cumecs)	2.40	2.88	4.66
4	EA01317_WHIT02_2721	355190	389885	Modelled Water Level (m aodN)	18.87	20.80	21.12
				Modelled Flow (cumecs)	2.40	2.88	4.32
5	EA01317_WHIT02_2280	355441	389615	Modelled Water Level (m aodN)	16.57	19.00	19.40
				Modelled Flow (cumecs)	6.80	2.88	4.66

Model data taken from Whittle Brook 2008 Study

AEP - Annual Exceedence Probability

m aodN - metres above ordnance datum Newlyn

cumecs - cubic metres per second

Notes: *Climate Change Scenario - We only hold climate change measurements based on the previous climate change guidance (20% increase in flow). The new climate change guidance is available at <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

Station name	PARK FARM					
Station number	SJ58_74					
External number	---					
River	---					
Operator	---					
NGR	SJ0552308954					
Easting	355230					
Northing	389540					
Parameter-name	WL [Water Level]					
Parameter Type	Groundwater Level					
Time series name	GMC/SJ58_74/WL/Cmd.RelAbs.P					
Time series unit	m					
Time level	High-resolution					
Time series type	Other					
Equidistant time series	no					
Time series value distance	---					
Time series quality	Production					
Time series measuring method	---					
Period of record in file:	05/02/1988 12:00:00 to 01/03/2019 11:46:00					
Quality code description	G = good; E = estimated; S = suspect; U = unchecked; M = missing; C = complete; I = incomplete; Ed = edited; WR = within rating; NR = no rating; EX> = extrapolated upper part; EX< = extrapolated lower part; BL> = beyond upper limit; BL< = beyond lower limit; MH = weir modular (head); NH = weir non modular (head); EH = weir extremely non modular (head); MT = weir modular (tail); NT = weir non modular (tail); ET = weir extremely non modular (tail); MC = weir modular (crest); NC = weir non modular (crest); EC = weir extremely non modular (crest); -H = weir head only; RAS = rastered time stamp; A = apportioned/interpolated; D = dry; SN = snow; T = trace					
Time stamp	Dip[m]	State of va	Interpolati	Groundwa	State of ab	Interpolati Tags
05/02/1988 12:00	43.8 G	101	-24.24 G	101		
16/03/1988 12:00	40.04 G	101	-20.48 G	101		
13/09/1988 12:00	43.25 G	101	-23.69 G	101		STATIC and ROUTINE
06/12/1988 12:00	42.27 G	101	-22.71 G	101		STATIC and ROUTINE
09/03/1989 12:00	42.25 G	101	-22.69 G	101		STATIC and ROUTINE
08/09/1989 12:00	49.71 G	101	-30.15 G	101		STATIC and ROUTINE
08/12/1989 12:00	41.37 G	101	-21.81 G	101		
07/03/1990 12:00	48.93 G	101	-29.37 G	101		
13/06/1990 12:00	41.41 G	101	-21.85 G	101		STATIC and ROUTINE
12/12/1990 12:00	41.14 G	101	-21.58 G	101		STATIC and ROUTINE
12/03/1991 12:00	40.98 G	101	-21.42 G	101		STATIC and ROUTINE
28/06/1991 12:00	--- M	101	--- M	101		STATIC and ROUTINE;Not Dipped - Crop in field
10/10/1991 12:00	40.59 G	101	-21.03 G	101		STATIC and ROUTINE
13/03/1992 12:00	40.22 G	101	-20.66 G	101		STATIC and ROUTINE
16/06/1992 12:00	40.13 G	101	-20.57 G	101		STATIC and ROUTINE
11/09/1992 12:00	39.74 G	101	-20.18 G	101		STATIC and ROUTINE
08/01/1993 12:00	39.52 G	101	-19.96 G	101		STATIC and ROUTINE
03/03/1993 12:00	39.46 G	101	-19.9 G	101		STATIC and ROUTINE
09/09/1993 12:00	38.51 G	101	-18.95 G	101		STATIC and ROUTINE
10/12/1993 12:00	38.17 G	101	-18.61 G	101		STATIC and ROUTINE
08/09/1994 12:00	37.03 G	101	-17.47 G	101		STATIC and ROUTINE
10/03/1995 12:00	36.62 G	101	-17.06 G	101		STATIC and ROUTINE
07/09/1995 12:00	35.57 G	101	-16.01 G	101		STATIC and ROUTINE
05/12/1995 12:00	35.79 G	101	-16.23 G	101		STATIC and ROUTINE
07/03/1996 12:00	35.9 G	101	-16.34 G	101		STATIC and ROUTINE
13/06/1996 12:00	34.92 G	101	-15.36 G	101		STATIC and ROUTINE

05/09/1996 12:00	34.53 G	101	-14.97 G	101	STATIC and ROUTINE
07/03/1997 12:00	33.98 G	101	-14.42 G	101	STATIC and ROUTINE
04/06/1997 12:00	33.6 G	101	-14.04 G	101	STATIC and ROUTINE
11/09/1997 12:00	33.36 G	101	-13.8 G	101	STATIC and ROUTINE
12/12/1997 12:00	33.49 G	101	-13.93 G	101	STATIC and ROUTINE
12/03/1998 12:00	32.97 G	101	-13.41 G	101	STATIC and ROUTINE
02/06/1998 12:00	32.45 G	101	-12.89 G	101	STATIC and ROUTINE
01/09/1998 12:00	32.41 G	101	-12.85 G	101	STATIC and ROUTINE
07/12/1998 12:00	32.06 G	101	-12.5 G	101	
12/03/1999 12:00	31.77 G	101	-12.21 G	101	
23/09/1999 12:00	30.53 G	101	-10.97 G	101	
16/12/1999 12:00	30.14 G	101	-10.58 G	101	
23/03/2000 12:00	30.34 G	101	-10.78 G	101	
16/06/2000 12:00	30 G	101	-10.44 G	101	
21/09/2000 12:00	29.86 G	101	-10.3 G	101	
21/09/2000 12:01 ---	M	101 ---	M	101	period of foot and mouth outbreak
23/01/2002 10:25	27.32 G	101	-7.76 G	101	
04/12/2002 14:00	26.44 G	101	-6.88 G	101	
04/03/2003 15:20	26.14 G	101	-6.58 G	101	
04/06/2003 12:30	25.83 G	101	-6.27 G	101	
22/09/2003 15:25	25.4 G	101	-5.84 G	101	
03/12/2003 15:55	25.39 G	101	-5.83 G	101	
25/03/2004 10:15	24.99 G	101	-5.43 G	101	
29/06/2004 08:37	24.74 G	101	-5.18 G	101	
23/09/2004 13:10	24.35 G	101	-4.79 G	101	
16/12/2004 08:55	24.07 G	101	-4.51 G	101	
22/03/2005 07:20	23.74 G	101	-4.18 G	101	
03/06/2005 09:29	23.6 G	101	-4.04 G	101	
06/09/2005 15:05	23.34 G	101	-3.78 G	101	
01/12/2005 12:06	22.99 G	101	-3.43 G	101	
05/03/2006 13:20	22.92 G	101	-3.36 G	101	
15/06/2006 09:40	22.72 G	101	-3.16 G	101	
10/10/2006 09:30	22.35 G	101	-2.79 G	101	
10/01/2007 13:02	22 G	101	-2.44 G	101	
16/04/2007 14:07	21.95 G	101	-2.39 G	101	
20/06/2007 15:05	21.56 G	101	-2 G	101	
28/09/2007 10:54	21.31 G	101	-1.75 G	101	
18/12/2007 14:31	21.25 G	101	-1.69 G	101	
04/04/2008 10:45	20.69 G	101	-1.13 G	101	
04/06/2008 08:00	20.34 G	101	-0.78 G	101	
12/09/2008 08:25	20 G	101	-0.44 G	101	
18/12/2008 13:25	19.69 G	101	-0.13 G	101	
16/03/2009 11:30	19.6 G	101	-0.04 G	101	
12/06/2009 12:15	19.24 G	101	0.32 G	101	
12/09/2009 11:05	19.17 G	101	0.39 G	101	
18/12/2009 14:10	19.01 G	101	0.55 G	101	
01/03/2010 13:10	18.7 G	101	0.86 G	101	
14/06/2010 13:40	18.44 G	101	1.12 G	101	
04/09/2010 11:30	18.31 G	101	1.25 G	101	
22/12/2010 12:15	17.99 G	101	1.57 G	101	

15/03/2011 10:20	17.89 G	101	1.67 G	101	
17/06/2011 12:30	17.63 G	101	1.93 G	101	
07/09/2011 14:55	17.49 G	101	2.07 G	101	
05/12/2011 13:50	17.22 G	101	2.34 G	101	
21/03/2012 13:20	17.33 G	101	2.23 G	101	
18/06/2012 11:05	16.97 G	101	2.59 G	101	
22/09/2012 11:20	16.79 G	101	2.77 G	101	
19/12/2012 13:06	16.3 G	101	3.26 G	101	
11/03/2013 13:00	15.89 G	101	3.67 G	101	
04/06/2013 13:10	15.73 G	101	3.83 G	101	
14/09/2013 11:35	15.39 G	101	4.17 G	101	
05/12/2013 13:20	15.29 G	101	4.27 G	101	
12/03/2014 12:14	15.26 G	101	4.3 G	101	
13/06/2014 12:45	14.92 G	101	4.64 G	101	
02/10/2014 12:35	14.72 G	101	4.84 G	101	
09/12/2014 13:30	14.49 G	101	5.07 G	101	
10/03/2015 13:10	14.45 G	101	5.11 G	101	
29/06/2015 12:30	14.15 G	101	5.41 G	101	
01/09/2015 12:00	14 G	101	5.56 G	101	
18/12/2015 12:50	13.73 G	101	5.83 G	101	
30/03/2016 14:01	13.39 G	101	6.17 G	101	null
24/06/2016 12:31	13.29 G	101	6.27 G	101	null
26/09/2016 13:39	13.1 G	101	6.46 G	101	null
12/12/2016 10:24	12.93 G	101	6.63 G	101	null
07/03/2017 12:39	13.25 G	101	6.31 G	101	null
30/05/2017 14:12	12.55 G	101	7.01 G	101	null
14/09/2017 14:42	12.17 G	101	7.39 G	101	null
01/12/2017 10:01	12.29 G	101	7.27 G	101	null
01/03/2018 11:01	11.92 G	101	7.64 G	101	null
01/06/2018 12:34	11.67 G	101	7.89 G	101	null
28/09/2018 13:37	11.58 G	101	7.98 G	101	null
24/12/2018 09:50	11.16 G	101	8.4 G	101	null
01/03/2019 11:46	11.3 G	101	8.26 G	101	null

Station name BOLD ETW REPLACEMENT
Station number SJ59_151B
External number ---
River ---
Operator ---
NGR SJ0533909089
Easting 353390
Northing 390890
Parameter-name WL [Water Level]
Parameter Type Groundwater Level
Time series name GMC/SJ59_151B/WL/Cmd.RelAbs.P
Time series unit m
Time level High-resolution
Time series type Other
Equidistant time series no
Time series value distanc ---
Time series quality Production
Time series measuring m ---

Period of record in file: 06/09/1988 12:00:00 to 01/03/2019 11:28:00

Quality code description G = good; E = estimated; S = suspect; U = unchecked; M = missing; C = complete; I = incomplete; Ed = edited; WR = within rating; NR = no rating;
EX> = extrapolated upper part; EX< = extrapolated lower part; BL> = beyond upper limit; BL< = beyond lower limit; MH = weir modular (head); NH = weir non modular (head);
EH = weir extremely non modular (head); MT = weir modular (tail); NT = weir non modular (tail); ET = weir extremely non modular (tail); MC = weir modular (crest);
NC = weir non modular (crest); EC = weir extremely non modular (crest); -H = weir head only; RAS = rastered time stamp; A = apportioned/interpolated; D = dry; SN = snow; T = trace

Time stamp	Dip[m]	State of va	Interpolati	Groundwa	State of ab	Interpolati	Tags	Comments
06/09/1988 12:00	96.47	G	101	-55.89	G	101		STATIC and ROUTINE
06/12/1988 12:00	96.3	G	101	-55.72	G	101		STATIC and ROUTINE
23/06/1989 12:00	96.28	G	101	-55.7	G	101		STATIC and ROUTINE
05/09/1989 12:00	96.2	G	101	-55.62	G	101		STATIC and ROUTINE
08/12/1989 12:00	95.9	G	101	-55.32	G	101		
12/12/1990 12:00	---	M	101	---	M	101		
12/03/1991 12:00	---	M	101	---	M	101		Probe catching side of borehole
28/06/1991 12:00	---	M	101	---	M	101		Dipper catching in borehole
10/10/1991 12:00	---	M	101	---	M	101		Dipper catching on sides of borehole, No dip recorded
03/03/1992 15:30	95.44	G	101	-54.86	G	101		
11/09/1992 12:00	94.08	G	101	-53.5	G	101		
07/10/1992 12:00	94.08	G	101	-53.5	G	101		STATIC and ROUTINE
08/01/1993 12:00	93.46	G	101	-52.88	G	101		STATIC and ROUTINE
18/03/1993 12:00	92.97	G	101	-52.39	G	101		STATIC and ROUTINE
26/04/1993 15:20	92.6	G	101	-52.02	G	101		STATIC and ROUTINE
04/06/1993 12:00	92.48	G	101	-51.9	G	101		STATIC and ROUTINE
23/08/1993 14:00	91.99	G	101	-51.41	G	101		STATIC and ROUTINE
10/12/1993 12:00	91.15	G	101	-50.57	G	101		STATIC and ROUTINE
01/03/1994 16:15	90.82	G	101	-50.24	G	101		STATIC and ROUTINE
18/05/1994 16:27	90.32	G	101	-49.74	G	101		STATIC and ROUTINE
06/09/1994 11:26	89.47	G	101	-48.89	G	101		STATIC and ROUTINE
27/11/1994 12:30	89.2	G	101	-48.62	G	101		STATIC and ROUTINE
17/03/1995 15:29	88.04	G	101	-47.46	G	101		STATIC and ROUTINE
08/06/1995 12:00	87.85	G	101	-47.27	G	101		STATIC and ROUTINE
02/09/1995 12:00	87.25	G	101	-46.67	G	101		STATIC and ROUTINE
07/09/1995 12:00	87	G	101	-46.42	G	101		STATIC and ROUTINE

05/12/1995 12:00	87.22 G	101	-46.64 G	101	STATIC and ROUTINE
03/01/1996 10:41	86.5 G	101	-45.92 G	101	STATIC and ROUTINE
03/01/1996 12:00	86.5 G	101	-45.92 G	101	STATIC and ROUTINE
07/03/1996 12:00	86.19 G	101	-45.61 G	101	STATIC and ROUTINE
13/06/1996 12:00	85.67 G	101	-45.09 G	101	STATIC and ROUTINE
25/06/1996 12:00	85.5 G	101	-44.92 G	101	STATIC and ROUTINE
05/09/1996 12:00	85.06 G	101	-44.48 G	101	STATIC and ROUTINE
07/03/1997 12:00	83.95 G	101	-43.37 G	101	STATIC and ROUTINE
04/06/1997 12:00	83.37 G	101	-42.79 G	101	STATIC and ROUTINE
15/07/1997 09:16	83.14 G	101	-42.56 G	101	STATIC and ROUTINE
11/09/1997 12:00	82.77 G	101	-42.19 G	101	STATIC and ROUTINE
12/12/1997 12:00	83.16 G	101	-42.58 G	101	STATIC and ROUTINE
12/03/1998 12:00	81.89 G	101	-41.31 G	101	STATIC and ROUTINE
02/06/1998 12:00	80.94 G	101	-40.36 G	101	STATIC and ROUTINE
07/07/1998 13:22	81.14 G	101	-40.56 G	101	STATIC and ROUTINE
01/09/1998 12:00	80.8 G	101	-40.22 G	101	STATIC and ROUTINE
07/12/1998 12:00	80.32 G	101	-39.74 G	101	
12/03/1999 12:00	79.72 G	101	-39.14 G	101	
17/03/1999 17:30	79.89 G	101	-39.31 G	101	
11/06/1999 12:00	79.43 G	101	-38.85 G	101	
17/09/1999 13:53	78.66 G	101	-38.08 G	101	
23/09/1999 12:00	78.6 G	101	-38.02 G	101	
16/12/1999 12:00	75.33 G	101	-34.75 G	101	
23/03/2000 12:00	73.92 G	101	-33.34 G	101	
16/06/2000 12:00	77.3 G	101	-36.72 G	101	
21/09/2000 12:00	76.85 G	101	-36.27 G	101	
21/09/2000 12:01 ---	M	101 ---	M	101	period of foot and mouth outbreak
23/01/2002 10:00	74.05 G	101	-33.47 G	101	
04/12/2002 13:15	72.75 G	101	-32.17 G	101	
04/03/2003 14:55	72.27 G	101	-31.69 G	101	
04/06/2003 12:10	71.82 G	101	-31.24 G	101	
22/09/2003 15:15	71.22 G	101	-30.64 G	101	
03/12/2003 15:25	71.14 G	101	-30.56 G	101	
26/03/2004 17:06	70.52 G	101	-29.94 G	101	
30/06/2004 15:40	69.92 G	101	-29.34 G	101	
21/03/2005 07:45	68.5 G	101	-27.92 G	101	
03/06/2005 09:04	68.24 G	101	-27.66 G	101	
06/09/2005 14:53	68.81 G	101	-28.23 G	101	
01/12/2005 11:55	67.23 G	101	-26.65 G	101	
05/03/2006 12:47	67.08 G	101	-26.5 G	101	
15/06/2006 09:57	67.66 G	101	-27.08 G	101	
10/10/2006 09:42	66.07 G	101	-25.49 G	101	
10/01/2007 12:10	65.56 G	101	-24.98 G	101	
16/04/2007 13:53	65.33 U	101	-24.75 U	101	
18/06/2007 13:13	64.81 G	101	-24.23 G	101	
28/09/2007 10:37	64.46 G	101	-23.88 G	101	
27/06/2008 08:05	63.16 G	101	-22.58 G	101	
12/09/2008 08:40	62.78 G	101	-22.2 G	101	
19/12/2008 11:00	62.92 G	101	-22.34 G	101	
16/03/2009 12:25	62.1 G	101	-21.52 G	101	

11/06/2009 14:25	61.56 G	101	-20.98 G	101	
12/09/2009 08:20	61.3 G	101	-20.72 G	101	
18/12/2009 10:30	60.73 G	101	-20.15 G	101	
03/03/2010 10:40	60.41 G	101	-19.83 G	101	
15/06/2010 11:20	60.01 G	101	-19.43 G	101	
13/09/2010 12:10	59.48 G	101	-18.9 G	101	
22/12/2010 09:30	58.96 G	101	-18.38 G	101	
15/03/2011 09:45	58.63 G	101	-18.05 G	101	
28/06/2011 07:30	58.11 G	101	-17.53 G	101	
09/09/2011 13:05	57.75 G	101	-17.17 G	101	
06/12/2011 11:20	57.36 G	101	-16.78 G	101	
22/03/2012 14:25	57.1 G	101	-16.52 G	101	
19/06/2012 14:30	56.6 G	101	-16.02 G	101	
25/09/2012 14:40	55.85 G	101	-15.27 G	101	
20/12/2012 09:30	55.63 G	101	-15.05 G	101	
11/03/2013 13:30	55.41 G	101	-14.83 G	101	
04/06/2013 14:00	55.17 G	101	-14.59 G	101	
14/09/2013 11:20	54.61 G	101	-14.03 G	101	
11/12/2013 13:00	54.31 G	101	-13.73 G	101	
21/01/2014 13:00	54.31 G	101	-13.73 G	101	Entered on wrong date. Removed from .P time series
12/03/2014 13:50	54 G	101	-13.42 G	101	
13/06/2014 12:30	53.52 G	101	-12.94 G	101	
02/10/2014 12:20	53.07 G	101	-12.49 G	101	
09/12/2014 13:15	52.67 G	101	-12.09 G	101	
10/03/2015 13:00	52.42 G	101	-11.84 G	101	
29/06/2015 12:40	51.85 G	101	-11.27 G	101	
01/09/2015 12:15	51.56 G	101	-10.98 G	101	
18/12/2015 12:35	51.05 G	101	-10.47 G	101	
30/03/2016 13:48	50.57 G	101	-9.99 G	101	null
24/06/2016 12:14	50.3 G	101	-9.72 G	101	null
30/09/2016 13:59	50.82 G	101	-10.24 G	101	null
06/12/2016 11:33	49.71 G	101	-9.13 G	101	null
28/02/2017 13:16	48.96 G	101	-8.38 G	101	null
14/09/2017 14:07	48.39 G	101	-7.81 G	101	null
01/12/2017 10:15	48.25 G	101	-7.67 G	101	null
01/03/2018 11:16	47.71 G	101	-7.13 G	101	null
01/06/2018 12:21	47.44 G	101	-6.86 G	101	null
11/09/2018 12:56	47.03 G	101	-6.45 G	101	null
20/12/2018 12:04	46.46 G	101	-5.88 G	101	null
01/03/2019 11:28	46.35 G	101	-5.77 G	101	null

Appendix F

HYDRAULIC MODELLING
TECHNICAL NOTE



TECHNICAL NOTE

DATE:	02 December 2019	CONFIDENTIALITY:	Public
SUBJECT:	Whittle Brook Proposed Diversion		
PROJECT:	Omega 8	AUTHOR:	Ismini Sarikou
CHECKED:	Nicola Earley	APPROVED:	Hilary Hampton

INTRODUCTION

WSP were commissioned to undertake initial hydraulic modelling of the proposed realignment of the Whittle Brook watercourse as part of the Omega 8 development proposals to inform the Flood Risk Assessment (FRA), Environmental Statement (ES) and a Water Framework Directive Assessment (WFDa).

The Environment Agency (EA) has previously modelled this reach of main river as part of the work undertaken between August 2007 and March 2008 to produce 'Flood Zone 2' (FZ2) and 'Areas Benefiting from Defences' (ABD) outlines for the Middle and Lower Mersey catchments for use in planning and flood warning decisions. This study produced a 1D hydraulic model that covered the watercourse of interest, which was used for the current study.

The hydraulic model of Whittle Brook extends 7.4km from Clock Face Road bridge to the confluence with Sankey Brook and the River Mersey (NGR 352931 390897 to 357549 387071) as illustrated in Figure 1 below. The original model runs in steady state and was not calibrated due to a lack of available data. The downstream boundary to the model, at the confluence with the River Mersey and Sankey Brook, was set to a 100% Annual Exceedance Probability (AEP) tidal peak (1 in 1 year return period).

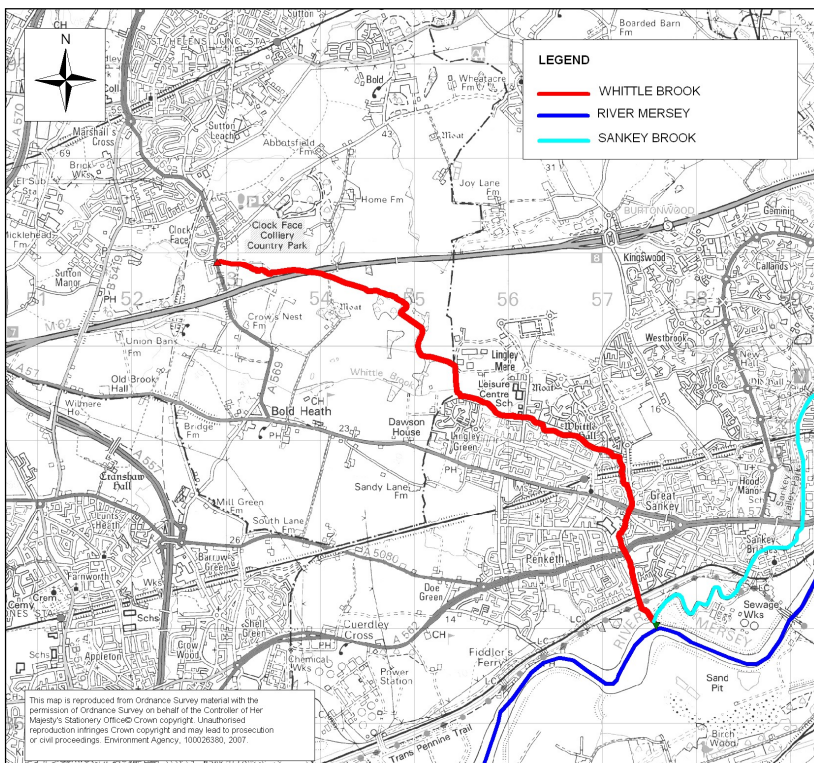


Figure 1. Whittle Brook study reach

TECHNICAL NOTE

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The existing Whittle Brook model contained six direct inflows. One at the top of the modelled reach represents an inflow from the upstream Whittle Brook catchment. The additional inflows coincide with the location of Union Bank Brook, Barrow Brook, two un-named tributaries and a housing estate downstream of Whittle Lane bridge. The Whittle Brook model is run in steady-state mode and therefore only requires peak flows which have been entered as QTBDY units.

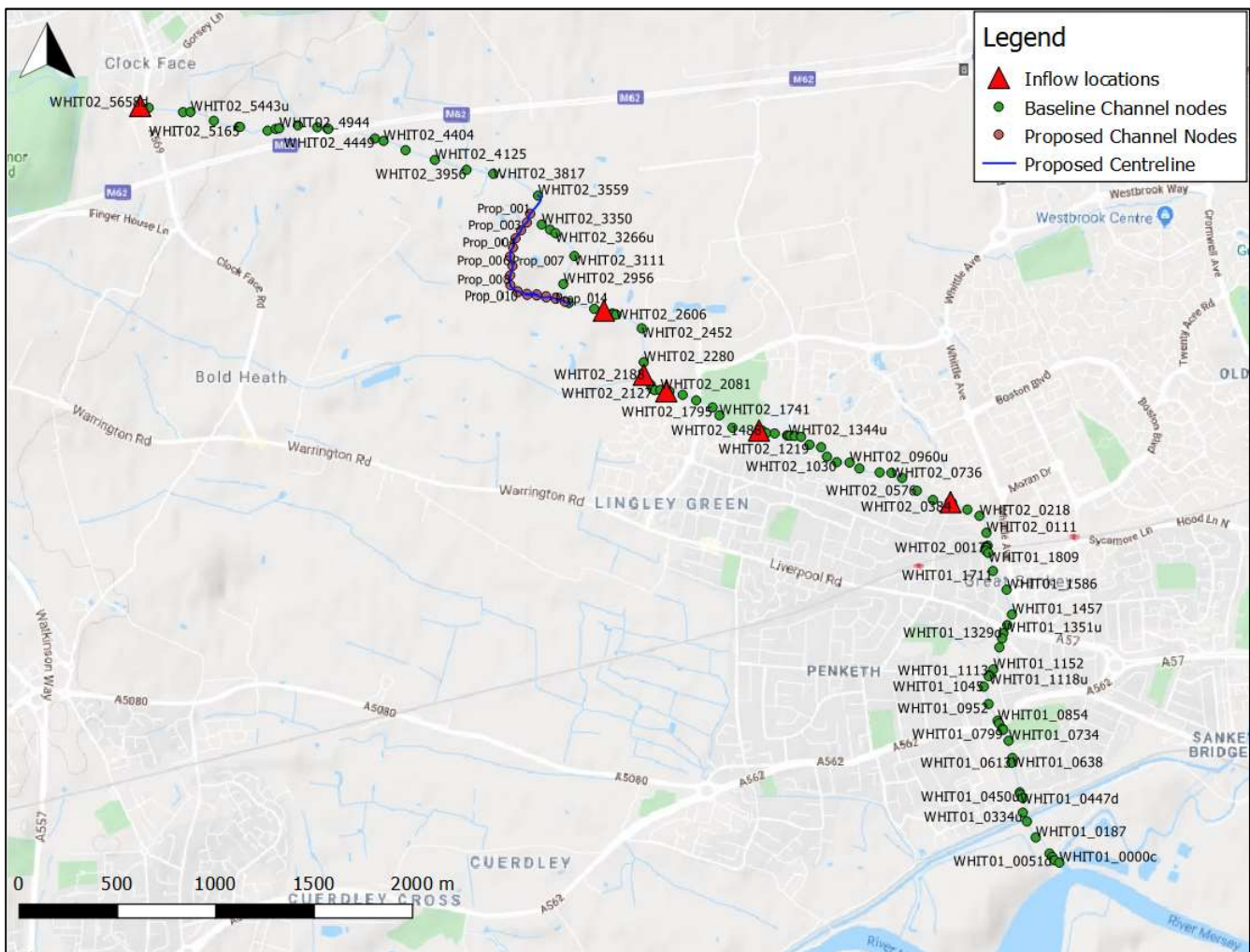


Figure 2: Model cross sections and Inflow locations

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The following outputs were produced as part of the EA study and have been updated for the current study. An additional climate Change scenario was added to reflect the updated EA guidance¹ for climate change.

- 0.1% AEP 'without defences'
- 1% AEP 'with defences'
- 1% AEP 'without defences'
- 1% AEP 'without defences' plus 20% climate change
- 1% AEP 'without defences' plus 35% climate change (not included in the original EA study)

All the baseline scenarios were rerun with a newer version of Flood Modeller (version 4.2) in steady mode and checks made between the 2008 results and the results from the newer version of Flood Modeller. The results comparison show that they compared relatively well, particularly near the area of the proposed diversion (Cross section WHIT02_3559 to WHIT02_2721). The largest discrepancies are noted in the climate change scenario which, in addition to the version differences, is due to the model run being on Steady Timestep mode, compared to the Steady Direct that the 2008 model run. Using the Steady Direct method in the new version of Flood Modeller introduced instabilities to the model with high QRatio values indicating model instability, It was therefore decided to use the 'Steady Timestep' model to improve the model performance. If this was not done, improvements would have had to have been made to the model geometry which would have meant a direct comparison could not have been made between the 2008 model runs and the updated model runs.

Table 1. Comparison between 2008 original results and 2019 rerun

Model Node	Chainage (m)	0.1% AEP Without Defences	1% AEP With Defences	1% AEP Without Defences	1% AEP Plus 20CC Without Defences
WHIT02_5658d	0	0.00	0.00	0.00	0.00
WHIT02_5570i	88	0.00	0.00	0.00	0.00
WHIT02_5530i	128	0.00	0.00	0.00	0.01
WHIT02_5506i	152	0.00	0.00	0.00	0.00
WHIT02_5496i	162	0.00	0.00	0.00	0.00
WHIT02_5481	177	0.00	0.00	0.00	0.00
WHIT02_5443u	215	0.00	0.00	0.00	0.00
WHIT02_JL_IN	215	0.00	0.00	0.00	0.00

¹<https://www.gov.uk/environment/climate-change-adaptation>



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CHECKED:	Nicola Earley	APPROVED:	Hilary Hampton

WHIT02_JL_OU	222	0.00	0.00	0.00	0.00
WHIT02_5429c	222	0.00	0.00	0.00	0.00
WHIT02_5429C	223	0.00	0.00	0.00	0.00
WHIT02_5429d	223	0.00	0.00	0.00	0.05
WHIT02_5429D	230	0.00	0.00	0.00	0.06
WHIT02_5429	230	0.00	0.00	0.00	0.06
WHIT02_5371i	288	0.00	0.00	0.00	-0.08
WHIT02_5312	347	0.00	0.00	0.00	0.11
WHIT02_5242i	417	0.00	0.00	0.00	-0.14
WHIT02_5195i	464	0.00	0.00	0.00	0.19
WHIT02_5171	488	0.00	0.00	0.00	-0.08
WHIT02_5165	494	0.00	0.00	0.00	-0.08
WHIT02_5086i	573	0.00	0.00	0.00	0.03
WHIT02_5006	653	0.00	0.00	0.00	-0.01
WHIT02_CD_IN	653	0.00	0.00	0.00	-0.01
WHIT02_CD_OU	657	0.00	0.00	0.00	-0.02
WHIT02_5002d	657	0.00	0.00	0.00	0.00
WHIT02_5001u	658	0.00	0.00	0.00	0.00
WHIT02_5001d	658	0.00	0.00	0.00	0.00
WHIT02_4963	697	0.00	0.00	0.00	0.00
WHIT02_4944	716	0.00	0.00	0.00	0.00
WHIT02_CU_IN	716	0.00	0.00	0.00	0.01
WHIT02_CU_OU	722	0.00	0.00	0.00	0.01
WHIT02_4938d	722	0.00	0.00	0.00	0.02
WHIT02_4937u	723	0.00	0.00	0.00	0.02
WHIT02_4937d	723	0.00	0.00	0.00	0.02
WHIT02_4849	811	0.00	0.00	0.00	-0.01
WHIT02_4799i	861	0.02	0.00	0.00	-0.01
WHIT02_4749	911	0.03	0.00	0.00	0.01



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WHIT02_4723i	937	0.03	0.01	0.01	0.00
WHIT02_4696	964	0.03	0.01	0.01	0.00
WHIT02_4692u	968	0.03	0.01	0.01	0.00
WHIT02_62_IN	968	0.04	0.03	0.03	0.01
WHIT02_62_c1	1030	0.01	0.02	0.02	0.00
WHIT02_62_c2	1030	0.01	0.02	0.02	0.00
WHIT02_62_OU	1092	-0.01	0.00	0.00	0.00
WHIT02_4568d	1092	0.00	0.00	0.00	0.00
WHIT02_4567u	1093	0.00	0.00	0.00	0.01
WHIT02_4567d	1093	0.00	0.00	0.00	0.01
WHIT02_4449	1211	0.00	0.00	0.00	0.00
WHIT02_4404	1256	0.00	0.00	0.00	0.00
WHIT02_LW_IN	1256	0.00	0.00	0.00	-0.01
WHIT02_LW_OU	1261	0.00	0.00	0.00	-0.01
WHIT02_4399d	1261	0.00	0.00	0.00	-0.01
WHIT02_4398u	1262	0.00	0.00	0.00	-0.01
WHIT02_4398d	1262	0.00	0.00	0.00	-0.01
WHIT02_4283	1377	0.00	0.00	0.00	0.01
WHIT02_4125	1535	0.00	0.00	0.00	-0.02
WHIT02_3956	1704	0.00	0.00	0.00	0.02
WHIT02_3817	1843	0.00	0.00	0.00	-0.02
WHIT02_3688i	1972	0.00	0.00	0.00	0.01
WHIT02_3559	2101	0.00	0.00	0.00	-0.01
WHIT02_3455i	2205	0.00	0.00	0.00	0.00
WHIT02_3350	2310	0.00	0.00	0.00	0.00
WHIT02_3300	2360	0.00	0.00	0.00	0.00
WHIT02_3266u	2394	0.00	0.00	0.00	0.00
WHIT02_DW_IN	2394	0.00	0.00	0.00	-0.01
WHIT02_DW_OU	2399	0.00	0.00	0.00	0.00



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WHIT02_3261d	2399	0.00	0.00	0.00	0.00
WHIT02_3260u	2400	0.00	0.00	0.00	0.00
WHIT02_3260d	2400	0.00	0.00	0.00	0.00
WHIT02_3111	2549	0.00	0.00	0.00	0.00
WHIT02_2956	2704	0.00	0.00	0.00	-0.01
WHIT02_2858	2802	0.00	0.00	0.00	0.01
WHIT02_2790i	2870	0.00	0.00	0.00	-0.01
WHIT02_2721	2939	0.00	0.00	0.00	0.01
WHIT02_2721c	2939	0.00	0.00	0.00	0.01
WHIT02_2626u	3034	0.00	0.00	0.00	-0.01
WHIT02_2619d	3041	0.00	0.00	0.00	-0.03
WHIT02_2606	3054	0.00	0.00	0.00	0.01
WHIT02_2529i	3131	0.00	0.00	0.00	0.00
WHIT02_2452	3208	0.00	0.00	0.00	-0.02
WHIT02_2366i	3294	0.00	0.00	0.00	0.03
WHIT02_2280	3380	0.00	0.00	0.00	-0.03
WHIT02_2188	3472	0.00	0.00	0.00	0.02
WHIT02_2188c	3472	0.00	0.00	0.00	0.02
WHIT02_2150	3510	0.00	0.00	0.00	-0.01
WHIT02_2127	3533	0.00	0.00	0.00	0.00
WHIT02_2112	3548	0.00	0.00	0.00	0.00
WHIT02_2081	3579	0.00	0.00	0.00	0.00
WHIT02_2034	3626	0.00	0.00	0.00	0.00
WHIT02_2034c	3626	0.00	0.00	0.00	0.00
WHIT02_1963	3697	0.00	0.00	0.00	0.00
WHIT02_1883u	3777	0.00	0.00	0.00	0.00
WHIT02_LG_IN	3777	0.00	0.00	0.00	0.00
WHIT02_LG_OU	3801	0.00	0.00	0.00	0.00
WHIT02_1859d	3801	0.00	0.00	0.00	0.00



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WHIT02_1858u	3802	0.00	0.00	0.00	0.00
WHIT02_1858d	3802	0.00	0.00	0.00	0.00
WHIT02_1795	3865	0.00	0.00	0.00	0.00
WHIT02_1741	3919	0.00	0.00	0.00	0.00
WHIT02_1647	4013	0.00	0.00	0.00	0.00
WHIT02_1488	4172	0.00	0.00	0.00	0.00
WHIT02_1488c	4172	0.00	0.00	0.00	0.00
WHIT02_1460	4200	0.00	0.00	0.00	0.00
WHIT02_1415	4245	0.00	0.00	0.00	0.00
WHIT02_1352u	4308	0.00	0.00	0.00	0.00
WHIT02_1344u	4316	0.00	0.00	0.00	-0.01
WHIT02_1335	4316	0.00	0.00	0.00	-0.01
WHIT02_1313	4347	0.00	0.00	0.00	0.00
WHIT02_1280	4380	0.00	0.00	0.00	0.02
WHIT02_1219	4441	0.00	0.00	0.00	-0.03
WHIT02_1159	4501	0.00	0.00	0.00	0.02
WHIT02_1094	4566	0.00	0.00	0.00	0.02
WHIT02_1030	4630	0.00	0.00	0.00	-0.02
WHIT02_0960u	4700	0.00	0.00	0.00	0.00
WHIT02_0905	4755	0.00	0.00	0.00	0.01
WHIT02_0796	4864	0.00	0.00	0.00	-0.01
WHIT02_0766i	4894	0.00	0.00	0.00	0.01
WHIT02_0736	4924	0.00	0.00	0.00	-0.01
WHIT02_0676	4984	0.00	0.00	0.00	0.01
WHIT02_0576	5084	0.00	0.00	0.00	0.00
WHIT02_0481	5179	0.00	0.00	0.00	0.00
WHIT02_0394u	5266	0.00	0.00	0.00	0.00
WHIT02_0384	5266	0.00	0.00	0.00	0.03
WHIT02_0384c	5267	0.00	0.00	0.00	0.03



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WHIT02_0383c	5267	0.00	0.00	0.00	0.03
WHIT02_0295	5364	0.00	0.00	0.00	-0.02
WHIT02_0257i	5402	0.00	0.00	0.00	0.00
WHIT02_0218	5441	0.00	0.00	0.00	0.01
WHIT02_0111	5548	0.00	0.00	0.00	-0.01
WHIT02_0032	5607	0.00	0.00	0.00	0.01
WHIT02_0021	5618	0.00	0.00	0.00	0.00
WHIT02_0020	5618	0.00	0.00	0.00	0.00
WHIT02_0019u	5620	0.00	0.00	0.00	0.00
WHIT02_0017	5620	0.00	0.00	0.00	0.00
WHIT02_0011u	5628	0.00	0.00	0.00	0.00
WHIT02_BCIIN	5628	0.00	0.00	0.00	0.00
WHIT02_BCIOU	5635	0.00	0.00	0.00	-0.01
WHIT02_0004l	5635	0.00	0.00	0.00	-0.01
WHIT02_0003l	5636	0.00	0.00	0.00	-0.01
WHIT02_BCrIN	5636	0.00	0.00	0.00	0.00
WHIT02_BCrOU	5643	0.00	0.00	0.00	-0.01
WHIT02_0004r	5643	0.00	0.00	0.00	-0.01
WHIT02_0003r	5644	0.00	0.00	0.00	-0.01
WHIT02_0003d	5644	0.00	0.00	0.00	-0.01
WHIT01_1818i	5652	0.00	0.00	0.00	-0.02
WHIT01_1815i	5655	0.00	0.00	0.00	-0.02
WHIT01_1812i	5658	0.00	0.00	0.00	0.01
WHIT01_1810i	5660	0.00	0.00	0.00	0.05
WHIT01_1809	5661	0.00	0.00	0.00	0.07
WHIT01_1760i	5710	0.00	0.00	0.00	-0.03
WHIT01_1711	5759	0.00	0.00	0.00	-0.01
WHIT01_1586	5884	0.00	0.00	0.00	0.01
WHIT01_1522i	5948	0.00	0.00	0.00	0.00



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WHIT01_1457	6013	0.00	0.00	0.00	0.00
WHIT01_1396u	6074	0.00	0.00	0.00	0.00
WHIT01_SW_IN	6074	0.00	0.00	0.00	0.00
WHIT01_SW_01	6092.5	0.00	0.00	0.00	0.00
WHIT01_SW_OU	6111	0.00	0.00	0.00	0.00
WHIT01_1359d	6111	0.00	0.00	0.00	0.00
WHIT01_1358c	6112	0.00	0.00	0.00	0.00
WHIT01_1358d	6112	0.00	0.00	0.00	0.00
WHIT01_1351u	6119	0.00	0.00	0.00	0.00
WHIT01_LR_IN	6119	0.00	0.00	0.00	0.00
WHIT01_LR_OU	6141	0.00	0.00	0.00	0.00
WHIT01_1329d	6141	0.00	0.00	0.00	0.00
WHIT01_1328u	6142	0.00	0.00	0.00	0.00
WHIT01_1328d	6142	0.00	0.00	0.00	0.00
WHIT01_1302i	6168	0.00	0.00	0.00	0.00
WHIT01_1275	6195	0.00	0.00	0.00	0.00
WHIT01_1152	6317	0.00	0.00	0.00	0.00
WHIT01_1118u	6351	0.00	0.00	0.00	-0.01
WHIT01_1113	6351	0.00	0.00	0.00	0.00
WHIT01_1045	6424	0.00	0.00	0.00	0.00
WHIT01_0952	6517	0.00	0.00	0.00	0.00
WHIT01_0903i	6566	0.00	0.00	0.00	0.00
WHIT01_0854	6615	0.00	0.00	0.00	0.00
WHIT01_0835u	6634	0.00	0.00	0.00	0.00
WHIT01_HBIIN	6634	0.00	0.00	0.00	0.00
WHIT01_HBIOU	6656	0.00	0.00	0.00	0.00
WHIT01_0813I	6656	0.00	0.00	0.00	0.00
WHIT01_0812I	6657	0.00	0.00	0.00	0.00
WHIT01_HBrIN	6657	0.00	0.00	0.00	0.00



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WHIT01_HBrOU	6679	0.00	0.00	0.00	0.00
WHIT01_0813r	6679	0.00	0.00	0.00	0.00
WHIT01_0812r	6680	0.00	0.00	0.00	0.00
WHIT01_0812d	6680	0.00	0.00	0.00	0.00
WHIT01_0799	6693	0.00	0.00	0.00	0.00
WHIT01_0734	6758	0.00	0.00	0.00	0.00
WHIT01_0638	6853	0.00	0.00	0.00	0.00
WHIT01_0613	6878	0.00	0.00	0.00	0.00
WHIT01_0450u	7041	0.00	0.00	0.00	0.00
WHIT01_0450d	7041	0.00	0.00	0.00	0.00
WHIT01_0447d	7044	0.00	0.00	0.00	0.00
WHIT01_0420	7071	0.00	0.00	0.00	0.00
WHIT01_0334u	7157	0.00	0.00	0.00	0.00
WHIT01_STIIN	7157	0.00	0.00	0.00	0.00
WHIT01_STIOU	7197	0.00	0.00	0.00	0.00
WHIT01_0295I	7197	0.00	0.00	0.00	0.00
WHIT01_0294I	7198	0.00	0.00	0.00	0.00
WHIT01_STrIN	7198	0.00	0.00	0.00	0.00
WHIT01_STrOU	7238	0.00	0.00	0.00	0.00
WHIT01_0295r	7238	0.00	0.00	0.00	0.00
WHIT01_0294r	7239	0.00	0.00	0.00	0.00
WHIT01_0294d	7239	0.00	0.00	0.00	0.00
WHIT01_0187	7346	0.00	0.00	0.00	0.00
WHIT01_0071u	7462	0.00	0.00	0.00	0.00
WHIT01_LFIIN	7462	0.00	0.00	0.00	0.00
WHIT01_LFIOU	7481	0.00	0.00	0.00	0.00
WHIT01_0052I	7481	0.00	0.00	0.00	0.00
WHIT01_0051I	7482	0.00	0.00	0.00	0.00
WHIT01_LFrIN	7482	0.00	0.00	0.00	0.00

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WHIT01_LFrOU	7501	0.00	0.00	0.00	0.00
WHIT01_0052r	7501	0.00	0.00	0.00	0.00
WHIT01_0051r	7502	0.00	0.00	0.00	0.00
WHIT01_0051d	7502	0.00	0.00	0.00	0.00
WHIT01_0031	7522	0.00	0.00	0.00	0.00
WHIT01_0000c	7553	0.00	0.00	0.00	0.00

PROPOSED REALIGNMENT

The channel realignment was designed using the principle of a two-stage channel, whereby low-flows are accommodated by a primary channel, and higher flows, generally those exceeding a 50% AEP event, inundate the wider, secondary zone of the channel cross-section. This design would serve to alleviate flooding of the Proposed Development, whilst maintaining lateral connectivity that is important for a range of ecology and hydromorphological receptors. The channel planform was designed to have a low sinuosity to avoid reducing channel gradient as far as practicable –the proposed channel diversion would gain an additional ~130m in length to the Whittle Brook.

Figure 2 below shows the proposed realignment of the Whittle Brook watercourse as part of the Omega 8 development proposals.

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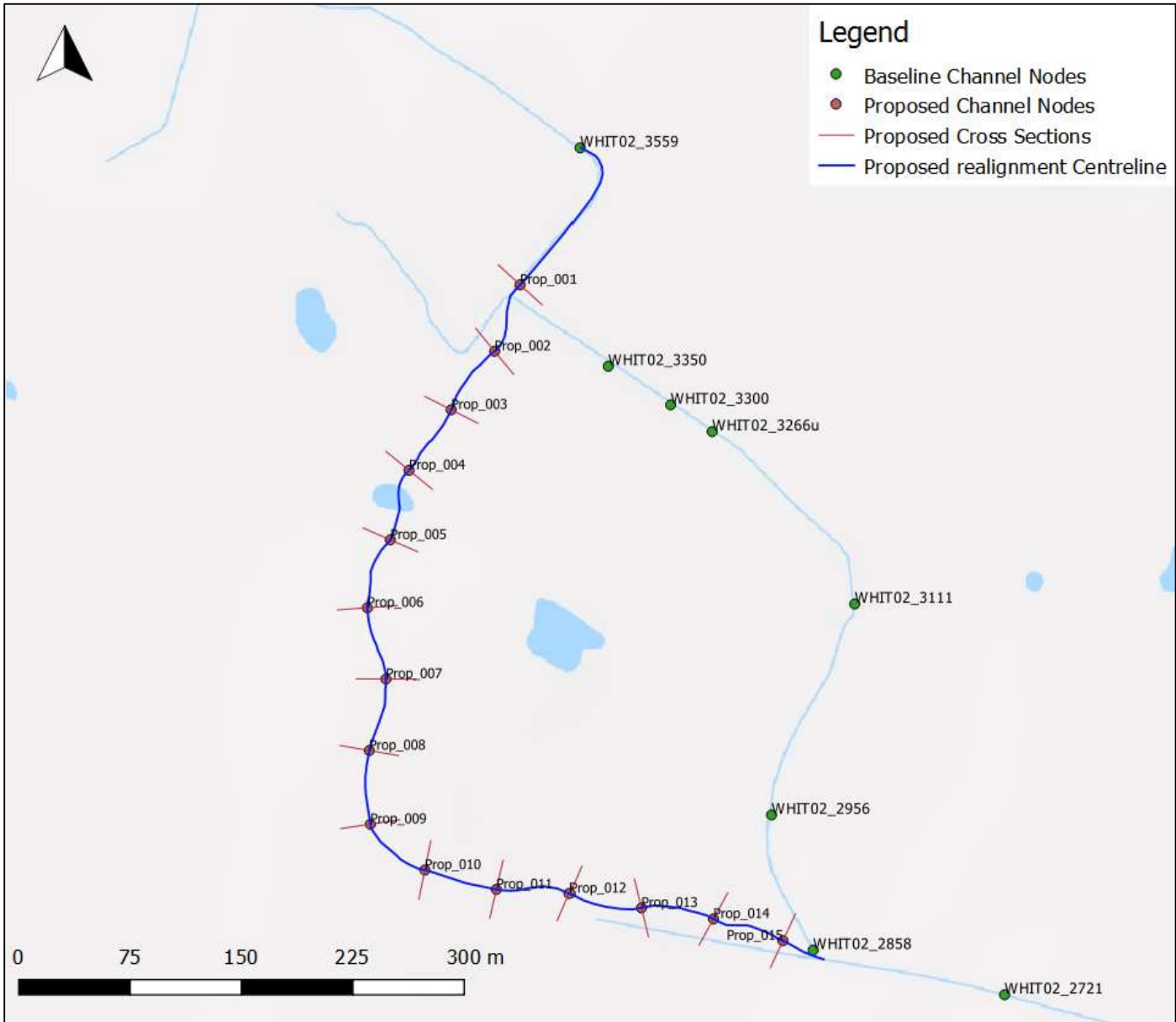
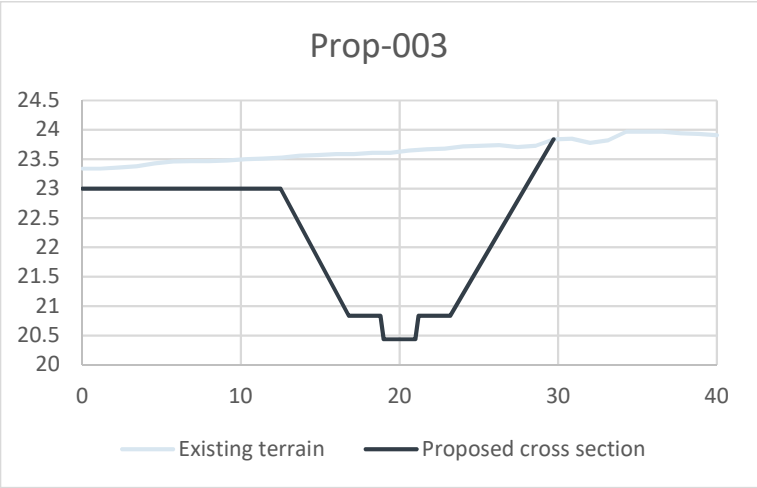
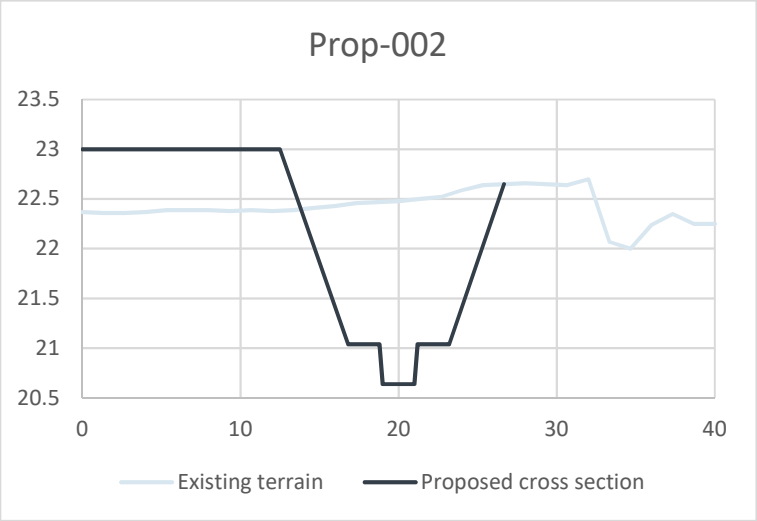
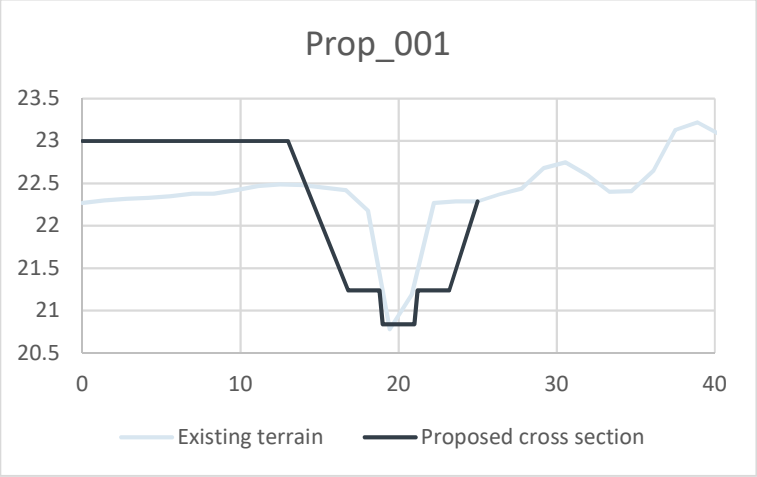


Figure 3. Proposed realignment

The proposed cross sections are shown in the figures below.

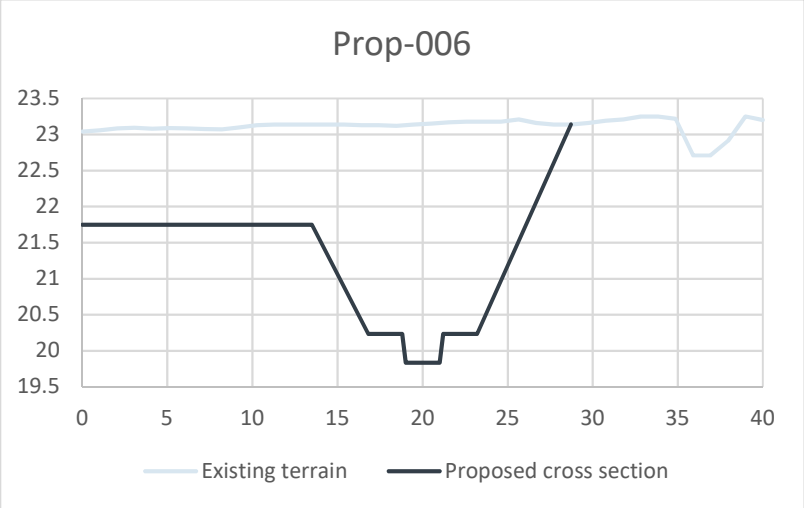
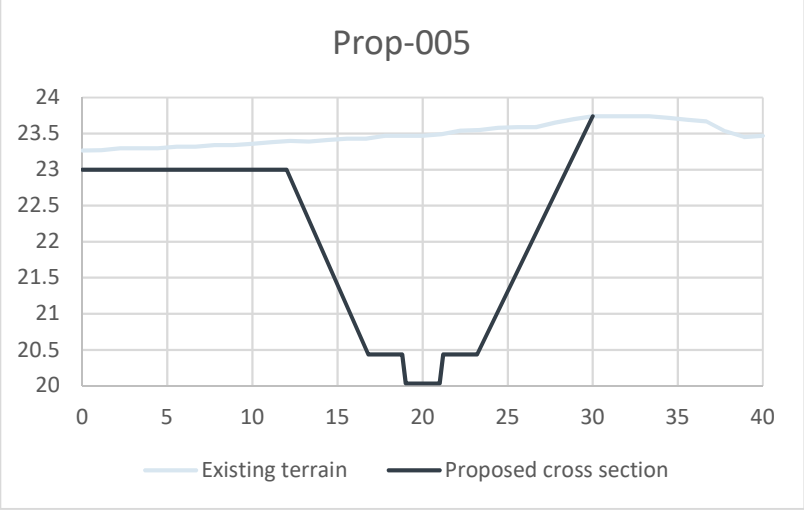
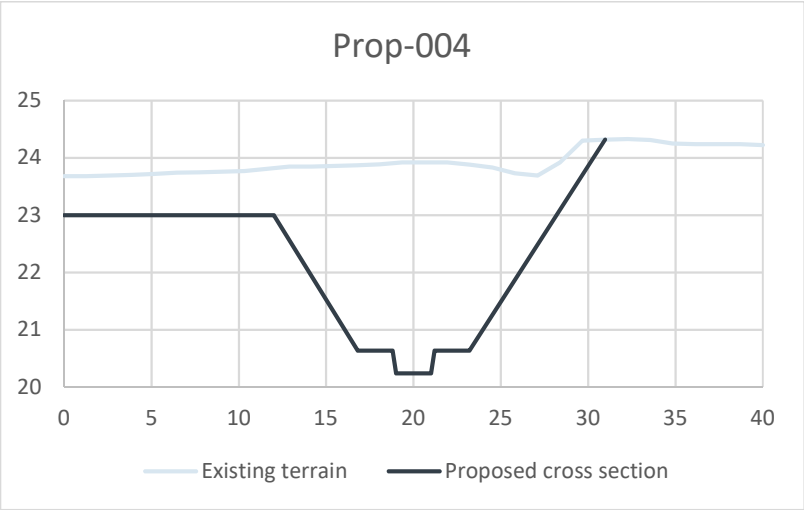
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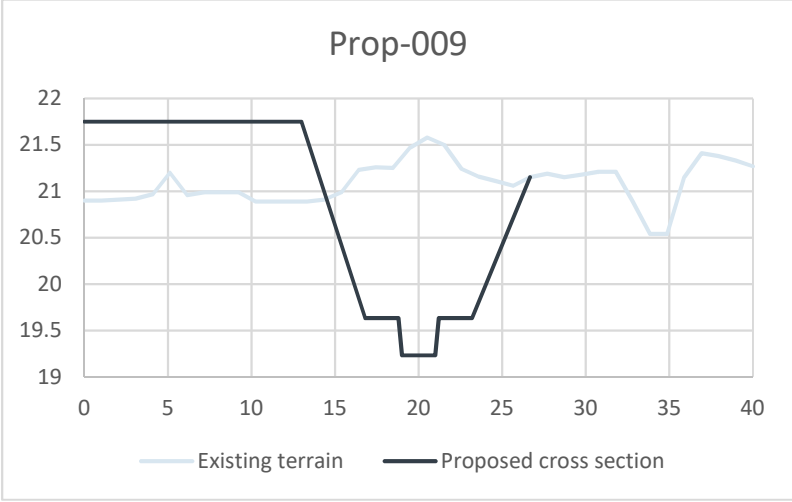
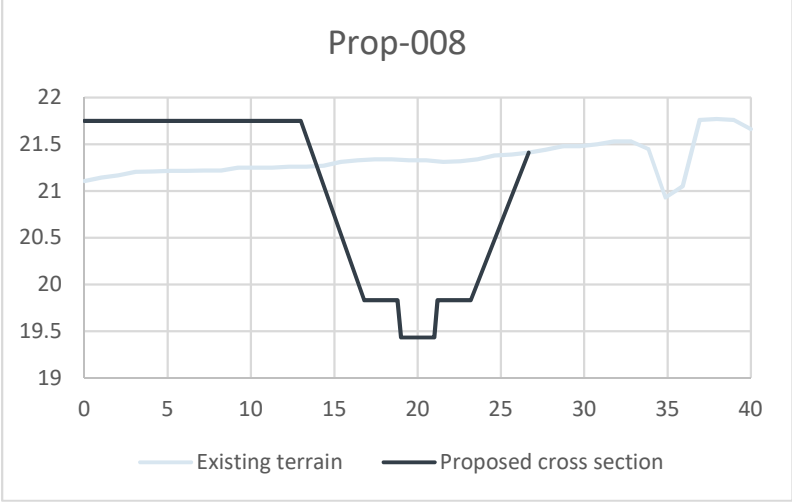
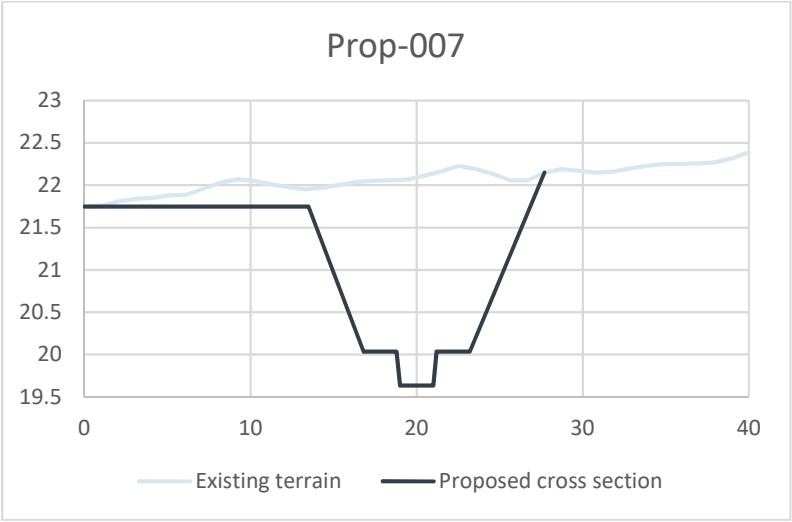
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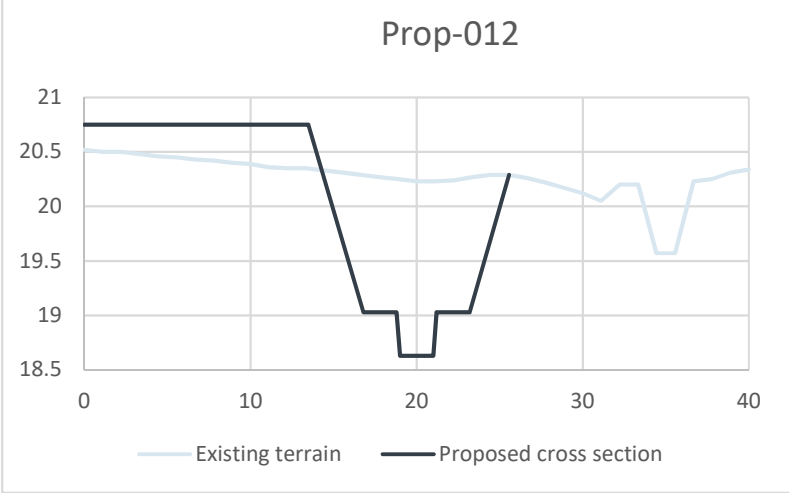
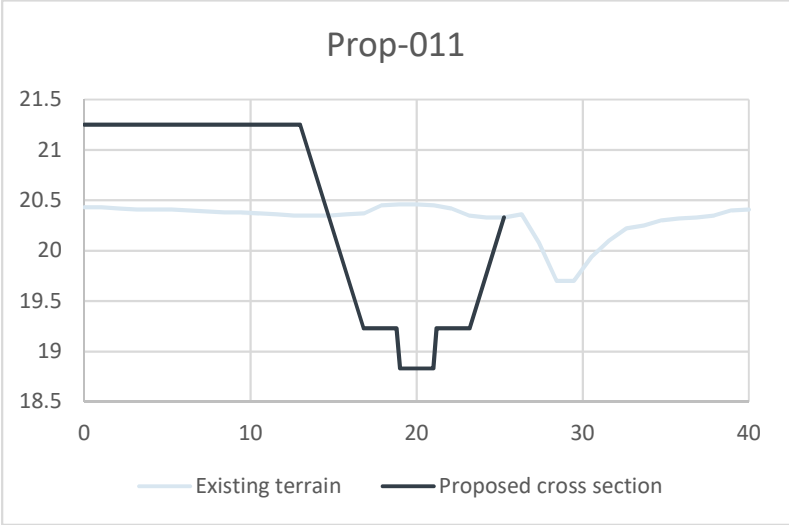
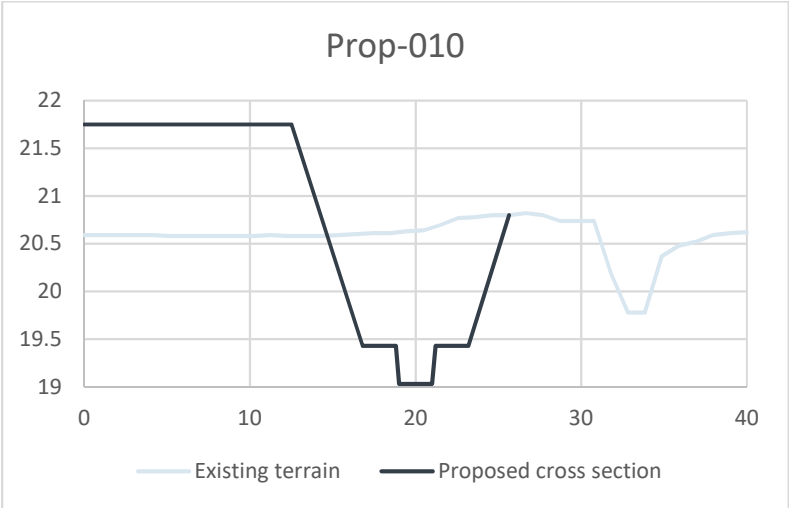
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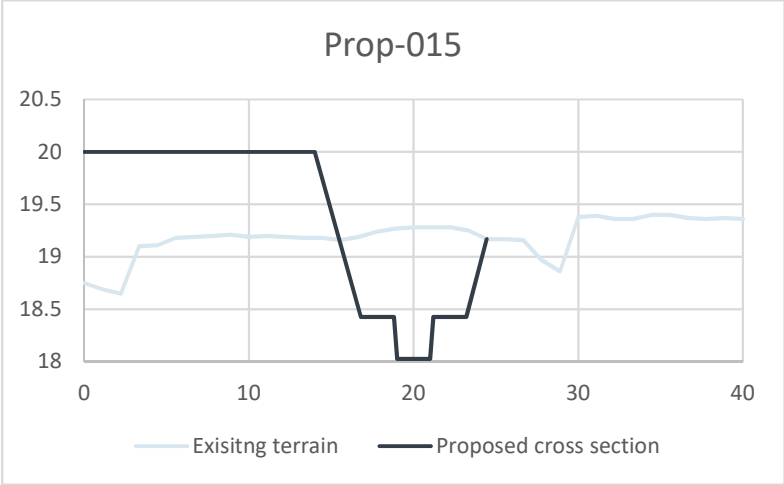
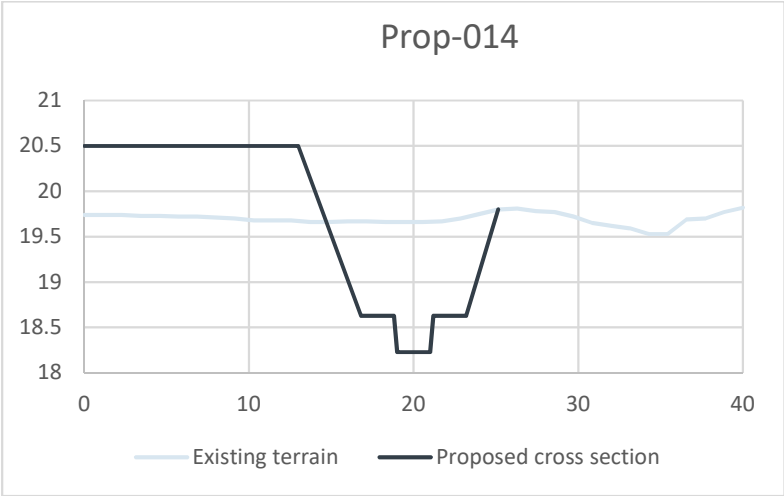
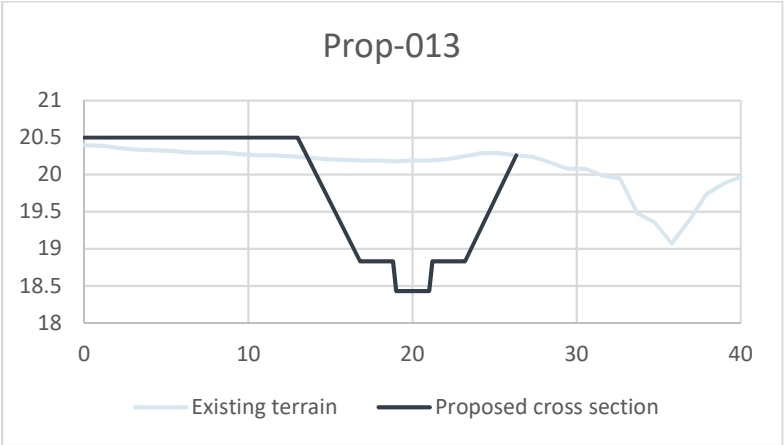


Figure 4: Proposed cross sections

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PROPOSED REALIGNMENT MODELLING RESULTS

The proposed cross sections have been amended in the existing model between cross sections WHIT02_3559 and WHIT02_2721. The proposed model was run at steady mode for all the scenarios below:

- 0.1% AEP ‘without defences’,
- 1% AEP ‘with defences’,
- 1% AEP ‘without defences’,
- 1% AEP ‘without defences’ plus 20% climate change
- 1% AEP ‘without defences’ plus 35% climate change

The results were compared with the baseline rerun results to assess any possible impacts. The comparison shows that the impact is negligible for all scenarios at most of the cross sections. The impacts are higher at the cross sections immediately upstream and downstream of the realignment. These are positive changes as the water levels have decreased due to the additional capacity of the proposed channel. Table 2 below shows the difference in water level at selected cross sections upstream and downstream of the realignment. The water levels at the cross sections not included in the table remained unchanged. Cross section WHIT02_4692u is 1253m upstream of the realignment and cross section WHIT02_LG_OU is 854m downstream of the realignment (refer to table below).

Table 2: Water level differences in meters at selected cross sections between proposed model and baseline

Model Node	0.1% AEP Without Defences	1% AEP With Defences	1% AEP Without Defences	1% AEP Plus 20CC Without Defences	1% AEP Plus 35CC Without Defences
WHIT02_4692u	0.000	0.000	0.000	0.000	0.000
WHIT02_62_IN	0.000	0.000	0.000	-0.001	0.001
WHIT02_62_c1	0.000	0.000	0.000	0.001	-0.001
WHIT02_62_c2	0.000	0.000	0.000	0.001	-0.001
WHIT02_62_OU	0.000	0.000	0.000	-0.001	0.001
WHIT02_4568d	0.000	0.000	0.000	-0.001	0.001
WHIT02_4567u	0.000	0.000	0.000	-0.002	0.001
WHIT02_4567d	0.000	0.000	0.000	-0.002	0.001
WHIT02_4449	0.000	0.000	0.000	0.002	-0.001
WHIT02_4404	0.000	0.000	0.000	-0.002	0.001



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WHIT02_LW_IN	0.000	0.000	0.000	0.000	0.001
WHIT02_LW_OU	0.000	0.000	0.000	0.000	0.003
WHIT02_4399d	0.000	0.000	0.000	0.000	0.003
WHIT02_4398u	0.000	0.000	0.000	0.001	0.001
WHIT02_4398d	0.000	0.000	0.000	0.001	0.001
WHIT02_4283	0.000	0.000	0.000	0.003	-0.001
WHIT02_4125	0.000	0.000	0.000	-0.004	0.002
WHIT02_3956	0.000	0.000	0.000	0.005	-0.002
WHIT02_3817	0.000	0.000	0.000	-0.006	0.002
WHIT02_3688i	-0.001	0.000	0.000	0.008	-0.003
WHIT02_3559	-0.166	-0.052	-0.052	-0.117	-0.129
Proposed realignment					
WHIT02_2721	0.000	0.000	0.000	-0.043	-0.014
WHIT02_2721c	0.000	0.000	0.000	-0.043	-0.014
WHIT02_2626u	0.000	0.000	0.000	0.010	0.012
WHIT02_2619d	0.000	0.000	0.000	0.005	-0.002
WHIT02_2606	0.000	0.000	0.000	0.011	-0.001
WHIT02_2529i	0.000	0.000	0.000	-0.003	0.001
WHIT02_2452	0.000	0.000	0.000	0.001	-0.001
WHIT02_2366i	0.000	0.000	0.000	0.000	0.001
WHIT02_2280	0.000	0.000	0.000	0.000	-0.001
WHIT02_2188	0.000	0.000	0.000	0.000	0.001
WHIT02_2188c	0.000	0.000	0.000	0.000	0.001
WHIT02_2150	0.000	0.000	0.000	0.000	-0.001
WHIT02_2127	0.000	0.000	0.000	0.000	0.001
WHIT02_2112	0.000	0.000	0.000	0.000	-0.001
WHIT02_2081	0.000	0.000	0.000	0.000	0.001

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WHIT02_2034	0.000	0.000	0.000	0.000	-0.001
WHIT02_2034c	0.000	0.000	0.000	0.000	-0.001
WHIT02_1963	0.000	0.000	0.000	0.000	0.001
WHIT02_1883u	0.000	0.000	0.000	0.000	-0.001
WHIT02_LG_IN	0.000	0.000	0.000	0.000	-0.001
WHIT02_LG_OU	0.000	0.000	0.000	0.000	0.000

The water level within the proposed channel has decreased compared to the water levels at the replaced baseline channel. This is due to a number of changes, such as difference in the bed elevation, changes in the geometry of the cross sections, in particular the two-stage channel, as well as the increase in the length of the channel by 137m as a result of the river realignment. This has resulted in the proposed channel having a larger capacity than the original channel which can contain higher flows.

Table 3: Proposed cross sections – Water elevation results (mAOD)

Model Node	Chainage (m)	0.1% AEP Without Defences	1% AEP With Defences	1% AEP Without Defences	1% AEP Plus 20CC Without Defences	1% AEP Plus 35CC Without Defences
WHIT02_3499i	2161	21.936	21.737	21.737	21.736	21.733
Prop_001	2221	21.676	21.479	21.479	21.478	21.482
Prop_002	2271	21.475	21.278	21.278	21.280	21.275
Prop_003	2321	21.273	21.078	21.078	21.077	21.082
Prop_004	2371	21.074	20.876	20.876	20.876	20.871
Prop_005	2421	20.872	20.677	20.677	20.678	20.683
Prop_006	2470	20.671	20.477	20.477	20.475	20.470
Prop_007	2520	20.472	20.276	20.276	20.278	20.283
Prop_008	2570	20.271	20.075	20.075	20.074	20.070
Prop_009	2620	20.072	19.876	19.876	19.876	19.880
Prop_010	2670	19.881	19.675	19.675	19.677	19.673
Prop_011	2721	19.697	19.473	19.473	19.470	19.474
Prop_012	2771	19.558	19.275	19.275	19.279	19.275
Prop_013	2821	19.491	19.095	19.095	19.090	19.093
Prop_014	2872	19.449	18.973	18.973	18.978	18.975

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Prop_015	2921	19.437	18.921	18.921	18.920	18.924
Prop_016i	2973	19.427	18.895	18.895	18.887	18.882
Prop_017i	3024	19.416	18.879	18.879	18.909	18.918

Table 4: Cross sections removed from the baseline – Water elevation results (mAOD)

Model Node	Chainage (m)	0.1% AEP Without Defences	1% AEP With Defences	1% AEP Without Defences	1% AEP Plus 20CC Without Defences	1% Plus 35CC AEP Without Defences
WHIT02_3455i	2205	21.891	21.541	21.541	21.620	21.629
WHIT02_3350	2310	21.669	21.164	21.164	21.284	21.296
WHIT02_3300	2360	21.625	21.068	21.068	21.203	21.230
WHIT02_3266u	2394	21.606	21.002	21.002	21.155	21.172
WHIT02_DW_IN	2394	21.153	20.728	20.728	20.821	20.864
WHIT02_DW_OU	2399	21.117	20.704	20.704	20.799	20.836
WHIT02_3261d	2399	20.843	20.519	20.519	20.594	20.631
WHIT02_3260u	2400	20.839	20.514	20.514	20.589	20.627
WHIT02_3260d	2400	20.839	20.514	20.514	20.589	20.627
WHIT02_3111	2549	20.369	20.000	20.000	20.077	20.073
WHIT02_2956	2704	19.595	19.388	19.388	19.449	19.440
WHIT02_2858	2802	19.440	19.031	19.031	19.146	19.193
WHIT02_2790i	2870	19.424	18.889	18.889	19.018	19.117

It has to be noted that there is glass-walling at some cross sections both in the baseline and in the proposed model. The areas with the glass-wall are:

- The last proposed cross section and the two cross sections downstream of the realignment (Prop_0015, WHIT02_2721 and WHIT02_2721c) for the 0.1% AEP.
- The cross sections at the railway (WHIT02_0011u to WHIT02_0003r) and at the St Helens Canal crossing (WHIT01_02951 to WHIT01_0294r) for the 0.1% AEP.
- The cross sections at A562 crossing (WHIT01_0813l to WHIT01_0812r) for the 0.1% AEP and 1%AEP + 35%CC.

The cross sections were not extended and the glass wall was accepted since the scope of this study was to provide a comparison of the proposed channel realignment with that of the existing baseline model. The glass-wall gives more conservative results since the water levels are higher than what they would have been

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without the glass wall and given all the uncertainties and limitations of the model it was concluded that the glass-wall is not an issue at this stage of the study.

CONCLUSIONS

The baseline scenarios were rerun with the newer version of Flood Modeller in steady mode. The results have been compared with the 2008 results from the EA model and they compared relatively well, particularly around the location of the proposed realigned channel. (Cross section WHIT02_3559 to WHIT02_2721). The biggest discrepancy is noted in the climate change scenario which is in steady timestep run mode chosen as a result in instabilities in the model. The only way to improve the model would be to make changes to the geometry, however the model would not be comparable with the 2008 model results which opposes the purpose of this test.

In addition, glass walling was observed at several cross sections in both the baseline and proposed model due to poor cross section data.

For the purpose of this study the original EA 'fit for purpose' baseline model was not improved since the scope was to provide a comparison between the existing baseline model and incorporate the proposed channel realignment to inform the likely post scheme flood risk and to provide information for the Water Framework Direction assessment.

The results show that the proposed realignment conveys all the estimated flow for all return periods apart from the last cross section where there is glass-wall for the 0.1% AEP which is most likely because of the glass-wall at the cross sections downstream of the realignment.

In addition, the comparison between the baseline and the proposed models showed that the impact is negligible for most of the cross sections and the water levels have decreased at the influenced cross sections. This is because the capacity of the channel has increased due to the altered bed levels, the two-stage and wide cross sections and the increased length of the channel by 137m.

Based on the results of this study the proposed realignment is an acceptable solution as it does not impact negatively on water levels in the watercourse or increase flooding elsewhere. The capacity is sufficient to convey the estimated flows for all return periods tested without spilling to the floodplain.

There are a number of limitations associated with the model and it is recommended that a full model review is undertaken with associated improvements and updates made to the model for the detailed design of the realigned channel. The main limitations are listed below:

- The hydrology data has not been reviewed since the original model was developed in 2008. It is recommended that a full review and update is made to the hydrology;
- Update the model from steady mode to unsteady using full flow hydrographs;

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- Extend the cross sections with glass-walling at the baseline model, check if the floodplain needs to be represented in a 2D domain by converting the model to 1D-2D Flood modeller – TufLOW or trim the model at the downstream part to avoid a 2D model.
- Check if the possible flooding at the area downstream of the realignment has any impact at the proposed development with the updated model.