Rother District Council Policy No BEX9 Development of land off Spindlewood Drive.

Reference: Rother District council RR/2017/1705/P

Supplementary Statement regarding the Revised SuDS proposals for Spindlewood Drive Development (BEX9) published on 6th November 2018 and 11th December 2018 and the Appropriate Assessment published on 4th February 2019.

By Geoffrey Lawson C Eng. MICE. Representor 7062, 12th April 2019

Modifications to the SuDS proposals

Since the lodging of Representations, the Applicant for the Spindlewood Drive site BEX9 has lodged modifications of the storm water and wetland design. The first modification proposed a slightly raised and deeper wetland in a submission dated 16th October 2018 and published on the Portal on 2nd November.

The second modification in response to further comment from Natural England and the Environment Agency was for a narrower but longer and deeper wetland with a detached but linked cascade of silt trap ponds, in a letter dated 6th December 2018 and placed on the Portal on the 11th December. This revision of layout was aimed at keeping the wetland completely out of winter ground water by raising it further. In their letter of 6th December the consultants stated that if neccessary the wetland could be raised to have the base at existing ground level so as to be completely out of winter ground water. The General Arrangement plan showing the narrow wetland and silt trap cascade in relation to existing ground level contours was published on the Planning Portal on 20th December.

The Environment Agency and Natural England accepted these revisions and withdrew their objections on the basis that *'the wetland is to be developed above ground so that groundwater is not intercepted. And that this will still be lined and will provide some protection against hydrostatic upwelling if groundwater levels rise'*.

The requirement for an Appropriate Assessment

The Spindlewood Drive development is in close proximity to the Pevensey Levels SAC and RAMSAR site, and because there are risks to the habitats of the protected species an Appropriate Assessment is required as part of the Planning permission documentation irrespective of whether this is an Outline Planning Application or a Full Planning Application. The stormwater attenuation pond or wetland for this development site is at its closest only 35metres from the designated site on the Pevensey Levels and the housing area is only 160 metres from the designated area.

An Appropriate Assessment Proportionate to the Case

In the case of this development the site is quite large at 8.07 hectares, and the number of dwelling proposed is large at 160, the wetland is part of the development envelope and this is only 35 metres from the protected Pevensey Levels. The wetland as initially proposed had an invert level of 3.00 to 3.18M above Ordnance Datum (AOD). The winter ground water level is higher than this and the wetland was to be constructed substantially within winter ground water and would require dewatering by pumping. The Pevensey Levels are at a level of between 1 and 2 metres AOD. The wetland invert would have only been 1 metre above the Levels. The risks to the water quality and fluvial ecosystems of the Pevensey Level is severe and a whole order of magnitude greater than was the case for the Ashridge Court site.

The requirements for an Appropriate assessment are set out in the European Council Directive 92/43/EEC at Article 6(3) and Article 6(4). These articles require that it must be demonstrated beyond reasonable scientific doubt that the project will not **in any circumstances lead to any harmful effects on the protected site.**

These requirements have been further developed in case law before the CJEU in several cases. One in Ireland in particular, the People over Wind, Sweetman v Coillte Teoranta (PoW) case where in their judgement the court stated that "the assessment carried out under Article 6(3) of the Habitats Directive **may not have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposals on the protected site**". This means that once a mitigation measure has been proposed all technical details that arise as a consequence of that mitigation must be established.

The Appropriate Assessment for this development posted on 4th February 2019 is incomplete in that it lacks detail on the level of winter ground water and the possibility of overland run-off water flows leading to contamination of the protected site and risks to the protected species because the applicant has not provided the data. The Appropriate Assessment presented is only a framework for the detailed work to follow.

The intention to raise the wetland completely out of ground water is clearly a mitigation measure. But the knock-on effects of this decision on swale gradient and possible flooding in the swales has not been assessed.

Natural England has required that a second Appropriate Assessment must be presented at the detailed stage and before any Full Planning permission can be granted. It follows therefore that the Appropriate Assessment of 4th February 2019 is not complete **and the necessary full and precise analysis of the measures to avoid any significant effects on the protected site have not in fact been carried out and presented.** Therefore, the site BEX9 cannot be confirmed as suitable for housing and should be struck out of the DaSA Plan.

In addition to the risk that high ground water could compromise the base of the wetland if built too low, leading to deformation of the base and flooding of untreated run-off water into the protected site, there is also the risk that the pond if elevated completely out of the ground water will compromise the available gradient in the swales. This would also give rise to a risk of flooding which could result in contaminated water entering the ground water or being swept into the Cole Stream during intense rainfall. None of these risks have been fully considered in the Appropriate Assessment of 4th February 2019.

Reasons why the swale gradient is significant.

A swale with a very low gradient of less than the minimum recommended by CIRIA and of insufficient depth is at risk of the water level overtopping the banks at times of peak rainfall intensity in the future.

Winter ground water levels at the site

The BGS data on ground water is derived from boreholes taken in the upper parts of the site in late summer when ground water can be expected to be at its lowest. Ground water at the end of a wet winter will be at higher levels than those recorded in August or September. This is also noted in the detailed advice from the Lead Local Flood Authority and Pevensey and Cuckmere Water Level Management Board (LLFA PCWLMB) published on the Planning Portal on 19th December 2018.

Recent rainfall at the site

Local rainfall records from a rain gauge at Cooden Beach Golf Club located within 600 metres of the development site are shown in Table 1 below. These records show that high rainfall has occurred in five winters of which two have been exceptionally wet with ~800mm of rain falling between October and the following February.

A proportion of the total winter rainfall will gradually replenish ground water levels during these months so in spring ground water levels will be highest during March or early April. The ground water level can be expected to be exceptionally high following a very wet winter which it can be seen from the data is not uncommon and occurs with a periodicity of about 7 years. Since any housing development should be designed for at least 120 years use, the development's drainage system must take account of the very likely occurrence of the repeated incidence of very high winter ground water.Table 1 also shows in the last row of figures the variation in winter rainfall that has occurred over the last 15 years.

Increased rainfall intensity

The LLFA PCWLMB also requires development designers to take account of possible climate change with a 40% increase in peak rainfall intensity rates. With this increased level of run-off being designed for, it would make no sense not to consider the impact of very high ground water levels at the end of winter and in early spring.

TABLE 1 RAINFALL RECORDS AT COODEN BEACH GOLF CLUB some 600 metres from the site.

Rainfall in millimetres.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Calendar Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1	January	*15*	134	62	95	68	94	58	94	**191**	153	162	91	77	26
2	February	105	175	15	71	123	52	*13*	44	**146**	71	42	37	32	60
3	March	57	*3*	**82**	25	72	36	31	60	29	20	49	29	63	33
4	April	43	6	65	43	25	11	**92**	50	39	6	36	*5*	85	
5	May	**103**	82	94	43	47	*9*	52	68	66	71	68	64	12	
8	June	27	**164**	36	53	56	47	98	13	8	18	**83**	32	*3*	
7	July	28	**122**	50	67	25	52	98	28	65	56	*7*	71	23	
8	August	75	27	91	29	94	85	46	51	118	**123**	*25*	46	58	
9	September	**105**	25	53	23	36	44	67	46	*10*	92	20	62	27	
10	October	126	26	69	67	85	22	154	**158**	132	36	18	29	12	
11	November	**274**	71	113	**275**	102	23	106	107	136	87	97	34	123	
12	December	126	26	24	131	69	183	**191**	**191**	73	81	17	102	88	
	Annual total	**1084**	**861**	**754**	**922**	**802**	**658**	**1006**	**910**	**1013**	**814**	**624**	**602**	**603**	
	Winter rainfall October - February	**835**	200	372	664	402	299	589	**793**	565	408	260	274	309	

Hydraulic gradient of ground water

The Cooden Moat is a good indication of ground water as water level rises and falls in it with the seasons. It is dry in summer and floods gradually through the winter months with the water level reaching its highest level normally in March. These areas are consistent with a winter hydraulic gradient of at least 0.029 (or 2.9%) in a wet winter.

The Environment Agency's Surface Water flooding map reproduced as Figure 3.2 in the July 2017 Flood Risk Assessment report by Herrington Consulting shows a high risk of the Cole Stream overtopping its banks and medium risk of surface water flooding some of the surrounding land. This Environment Agency's flooding map is reproduced below.

A raised wetland or attenuation pond

The pond now proposed is some 105 metres long but only 24 metres wide. The designers Herrington state that if need be the attenuation pond can be raised so that the base of the pond is completely above the level of the highest ground water. To provide sufficient capacity it would need to be 1.3 metres deep and 1.5 metres to the crest of the surrounding bund. It is on this basis that the Environment Agency and Natural England have accepted the proposals and withdrawn their objections.

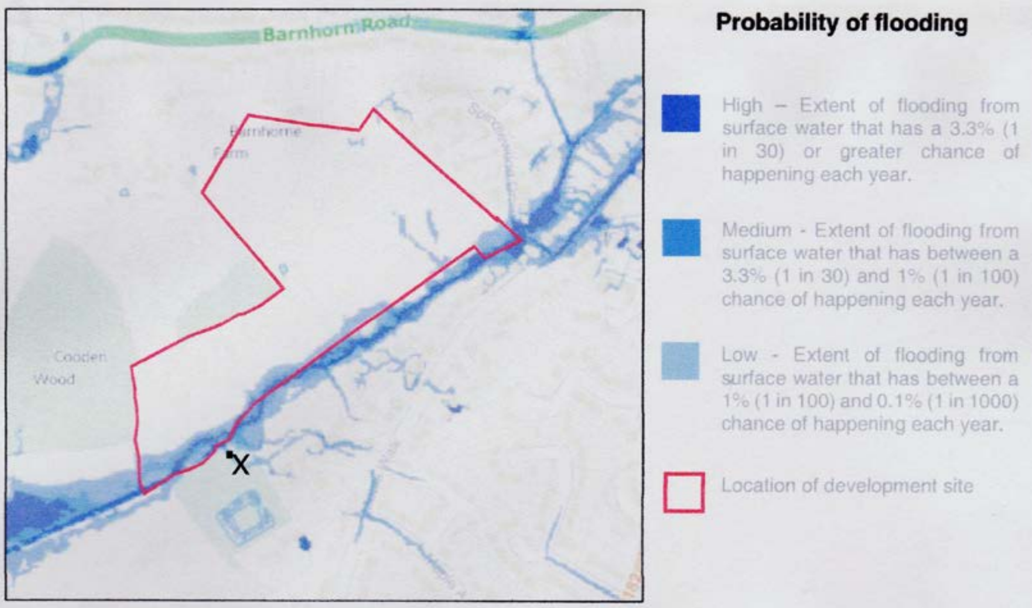

Figure 3.2 – Surface water flooding map showing the location of the development site (© Environment Agency)

At a hydraulic gradient of 2.9% the ground water at the far side of the pond from the Cole Stream, at the end of a wet winter could reach 5.19M AOD. The existing ground level is ~5.9M AOD here. The LLFA requires one metre of unsaturated ground so the base would need to be at a level of 6.19M AOD.

Using the Herrington design set out in drawing No 1764-P3-10, if the base of the wetland is at level 6.19M and with 300mm of puddled clay inside an impermeable membrane and 200mm of topsoil and 1.3 metres depth of water the wetland's normal TWL would be at 7.99M and the crest of the surrounding bund would be at 8.19M AOD. The wetland is to be approached through a cascade of shallow ponds designed to trap silt. The cascade would have an aggregate drop of 600mm so the top of the cascade would be at a level of 8.59M AOD. The cascade is preceded by a filter strip of approximately 30 metres length at a gradient of 1:250 so would have a fall of 0.12M. The lower end of the Swale system on entry to the filter strip must therefore have an invert of 8.71M AOD.

Ground levels in the site.

The ground level at the furthest point up the main swale from the filter strip near the existing Spindlewood Drive is shown from LIDAR data as 10.56M at point E on the existing long-section in Herrington's drawing No 1764-02. With a ground height of 10.56 the invert height of the top of the swale could not be above 10.16M AOD to allow for swale depth and freeboard.

Available level drop in the main swale

The available drop for the invert of the main swale through the site would therefore be 1.45 metres (=10.16 – 8.71). The swale is 360 metres long, vegetated to provide some run-off water treatment value and parallel to the main tree lined avenue. With a drop of 1.45 metres and a length of 360 metres the average gradient in the swale invert would be 0.403 per cent (or ~1:250). This is less that the CIRIA recommended minimum gradient of 0.5 per cent for swales and less than half the gradient shown in Table 2 on Herrington's December report which is reproduced below. A gradient of 1:250 would result in a very sluggish water flow in the vegetated swale.

Parameter	Drainage Catchment A	Drainage Catchment B	Drainage Catchment C	Drainage Catchment D
Area of drainage catchment	1.1ha	1.9ha	1.1ha	0.7ha
Assumed area of impermeable surfacing (~60% of drainage catchment)	0.7ha	1.1ha	0.7ha	0.4ha
Combined area draining to swale from all upstream drainage catchments	0.7ha	1.1ha	1.8ha	2.9ha
Peak runoff rate under the design rainfall event *rounded to nearest 10l/s	~500 l/s	~790 l/s	1290 l/s	2070 l/s
Approximate swale gradient within catchment area	~ 1:50	~ 1:70	~ 1:100	~ 1:100
Required width of swale assuming 1:3 side slope	~ 3m wide	~ 3m wide	~ 4m wide	~ 7m wide

Table 2 – Summary of calculations for the proposed Swales.

Tributary swales

Two subsidiary swales are shown entering the main swale with confluences at 105 metres above the filter strip and 245 metres from the filter strip. Both of these subsidiary swales would have much steeper gradients of up to 5% and would need to have check dams in them to control the speed of water flow but because of the steep slopes fast water flow would be unavoidable at times of storm.

Risk of flooding at swale confluences

Because of the sluggish flow in the main swale and the much faster flow in the tributary swales there is a substantial risk of water backing up and overtopping the swale banks at these confluences. In particular at point A shown on my Figure 2 below.

Invert levels at the confluence points

With a swale invert level at the filter strip of 8.71M and a gradient of 0.403% the invert level after 105 metres would be 9.13M AOD and after 245 metres rise the invert level would be 9.58M AOD.

Existing ground levels at the confluence

The existing ground level at the point 105 metres above the filter strip is approximately 9.8M AOD on a steep transvers slope. The available depth to the invert of the swale is therefore 0.67 metres (without land raising 9.8M -9.13M). It can be deduced from Herrington's Table 2 that the main swale depth would need to be at least 1 metre at this point with some freeboard for safety in addition, but with available depth of only 0.67M and with storm water from the subsidiary swale entering the main swale with some force the water level at times of intense storm is almost certain to overtop the swale bank and cause overland flooding to occur.

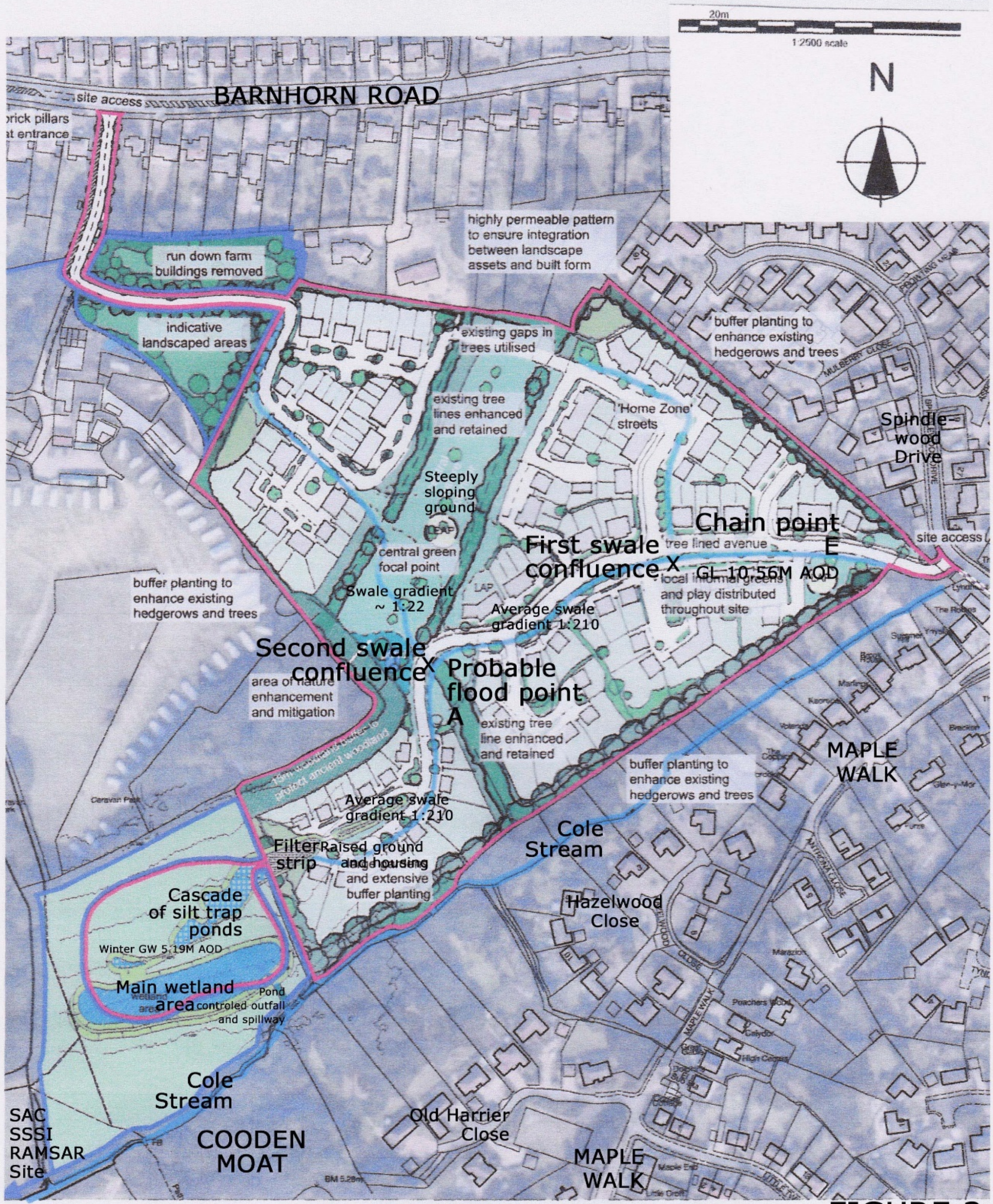

FIGURE 2
RAISED ATTENUATION POND
REDUCED GRADIENT IN MAIN SWALE AND INCREASED FLOODING RISK AT POINT A

Land areas and drainage catchments

Field sizes in hectares and acres are given in the Land Ownership Plan attached to the Aspect Ecology letter 8th February 2018. This is compared with the drainage area calculations shown in Table 2 from Herrington's report shown above and consolidated in Table 2 below. No allowance appears to have been made for overland flows on clay ground in the event of an intense rainfall event (+40%) in the central nature corridor most of which slopes towards the swale from Drainage area A as it approaches the confluence with the main swale and there appears a large discrepancy between the total field area and the 'gross area of drainage catchment in Herrington's table 2 above.

TABLE 2 LAND AREAS IN DRAINAGE CATCHMENTS

Drainage catchment area	A	Central nature corridor	B/C	D
Field area from ownership plan in Ha	1.41	0.9	3.63	1.3
Gross area from Table 2	1.1	Not recorded	3.0	0.7
Ratio Gross development area to field size	0.78	-	0.83	0.54
Assumed net impermeable area from Table 2	**0.7**	**-**	**1.8**	**0.4**
Ratio of net impermeable area to field size	0.5	-	0.5	0.3

Existing surface water flooding and overland flows

The photographs in Figure 3 are of the lower back garden of No 3 Hazelwood close in November 2014 (one of the wet winter seasons) and in April 2019. The Cole Stream runs through the back gardens of Nos 3,4,5 and 12 Hazelwood Close. In the garden of No 3 the stream is in a clear and well made channel. Rainfall on already sodden ground however very soon results in surface water flooding at No 3 and 4. An area of about 1200 square metres floods to a depth of up to 1 metre. To create this volume of flooding in addition to the flows coming down from the Cole Stream headwaters, overland flows come off the entire open fields at the back including the area designated as the *central nature corridor* which is not included in the peak run-off figures quoted in table 2 from Herrington's report above.

FIGURE 3. Flooded back garden of No 3 Hazelwood Close in 2014 and in 2019. The water level in 2014 is over the paving in the foreground. The Cole stream runs from right to left in the trees as can be seen in the following photograph taken from the same viewpoint.

Such a volume of water would overwhelm the swale particularly in the event of a storm with a rainfall intensity of +40% above existing intensities and for a swale with insufficient depth. For the wetland to be elevated the drainage swales would have to be considerably larger than presently proposed at least in areas C and D. But the swale through drainage area D is already proposed at 7 metres wide – wider than any of the roads in this estate.

Effect on the system if swale gradients are maintained

The alternative of maintaining the swale gradient at 1:100 (1%) means the attenuation pond's invert cannot be higher than 4.04M AOD. This will be 1.15 metres below the level of winter ground water at the back of the pond as shown in Table 3 below.

TABLE 3 Effect of maintaining Swale gradient and Ground levels on the site

Location	Drop/ Difference	Level AOD
Ground level at point 'E' near Spindlewood Drive (see Herrington's Drawing No 1764-02)		**10.56**
Swale invert level at 'E' (at highest possible level)		**10.16**
Drop in swale to filter strip at 1:100 gradient and 360M	3.6 metres	
Swale invert at filter strip		6.56
Filter strip level at top of Cascade (gradient of 1:250)		6.44
Drop in Cascade of silt trap ponds	0.6 metres	
Main wetland / attenuation pond top water level		5.84
Main wetland / attenuation pond invert (sacrificial membrane with 1.3 metres depth and 0.2 metres of top soil)		4.34
Main wetland / attenuation pond base with 300mm clay lining		**4.04**
Level of impermeable geotextile membrane under wetland with 300mm clay lining.		4.04
Base of unsaturated ground required by LLFA	1 metre	3.04
Level of Cole Stream bed at wetland / attenuation pond outfall (from topographic survey)		3.23

Probable highest level of winter ground water at back of pond		5.19
Depth of base of wetland / attenuation pond below highest winter ground water	**1.15 metres**	
Potential buoyancy thrust of 1.15 metres ground water is 1.15 tonnes per square metre. Additional ballast will be required within the wetland lining to give a factor of safety and prevent deformation of the base when the wetland is empty but ground water is still high.		

Either swale gradients are reduced with risk of flooding as I have shown above, or the pond is below winter ground water level and needs to be ballasted to prevent any risk of deformation from ground water induced buoyancy. This would require additional depth of excavation and probable pumping out of silty ground water.

July 2017 Flood Risk Assessment

The risk of flooding at the swale confluences is also shown in the Flood Risk Assessment report of Herrington dated July 2017 at section 7.11 and in Figure 7.3 in that report. The plan of residual flooding risk is reproduced below.

If the swales or outfall from the wetland area were to become overwhelmed following an extreme rainfall event, or the piped sections of the drainage network become blocked, water would exit the system and would flow overland. The areas where water is most likely to exit the drainage system and the most likely path water would take as it flows across the site are shown in Figure 7.3 (below).

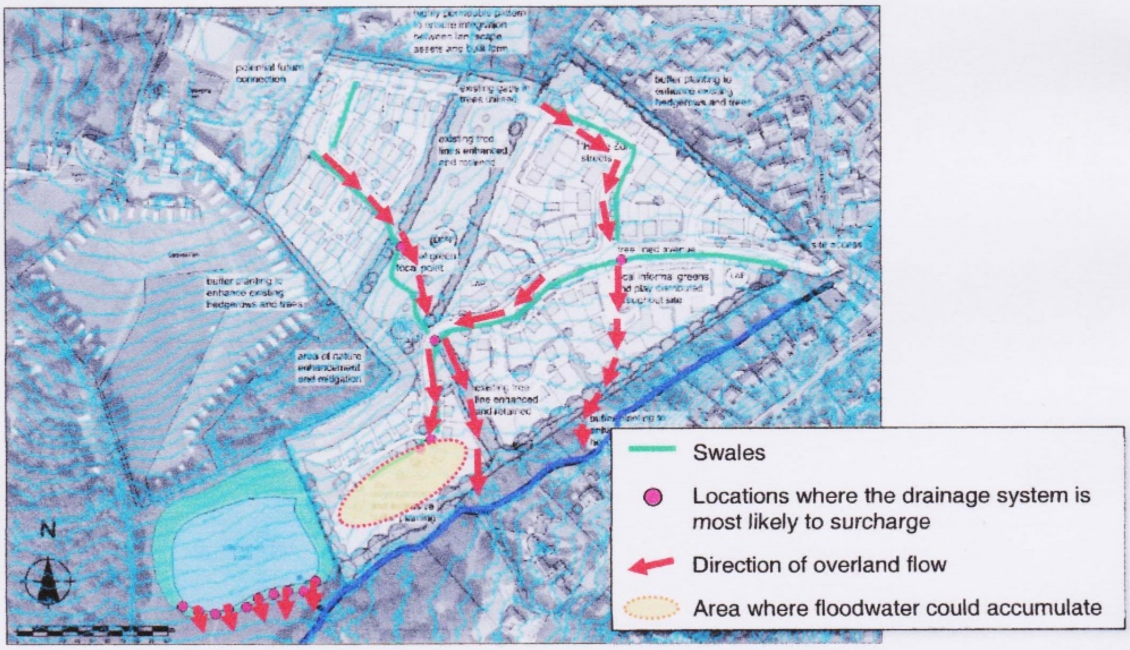

Figure 7.3 – Indicative drainage layout plan indicating direction of overland flow during residual risk scenario.

This assessment of residual flooding risk was produced when only a 20% increase in rainfall intensity due to climate change was assumed. But this has to be increased to +40% and the allowance for ‘urban creep’ increasing the impermeable area has been introduced. Both these factors will increase the risk of residual flooding in intense rainfall resulting in untreated water reaching the ground water and possibly directly entering the Cole Stream as shown in Figure 7.3 in Herrington’s report.

The source of contamination would not only be wind blown sand and other material forming sediment but also hydrocarbons from oil and petrol spillage from road and hard standing areas.

Conclusion

The assurances of Herrington Consulting that the wetland can be elevated without compromising the rest of the SuDS system, specifically the swales should not be accepted. T**his is not proven at all**. I have shown that either swale gradients are reduced with almost a certainty of flooding, or the pond is below winter ground water level and needs additional depth of excavation and pumping with a risk to the Levels of contamination during construction by silt.

The area of BEX9 is not suitable for housing, the storm water drainage system cannot be made to work without truly enormous open drainage swales in the housing areas and the Policy BEX9 should be struck out of the Development and Site Allocation plan.