# Flood Risk Assessment

# Wroxton Motocross

# Land at Manor Farm,
# Balscote, Banbury,
# Oxfordshire OX15 6HX

## Report LL071
## February 2021

## Prepared and submitted by
## Lidar-Logic

**Canon Court,**
**Canon Pyon, Hereford**
**Herefordshire, HR4 8NY**

**http://www.lidar-logic.co.uk/**

**01432 830006**

# Summary

This document is a Flood Risk Assessment for an existing motocross track in a rural area in the northern part of Oxfordshire, located on agricultural land between Wroxton, Balscote, Shenington and Hornton. The site was visited in November 2020, to inspect the area in relation to flood risk. In the text below, reference to documentation is provided by hyperlinks, which are shown as footnotes for clarity. The main findings of this assessment are as follows:

1. Wroxton Motocross track has been in use at least since 1981, providing facilities for motorcycle riders to develop and test their skills on a dirt track. The site currently requires Planning permission to continue its operations.

2. The racing circuit is located on land that is already used for agriculture. Land and buildings used for agriculture are regarded as “Less Vulnerable”, under NPPF guidelines while “outdoor sports and recreation” is classified as “Water Compatible”.

3. The site is located in fluvial flood zone 1, beyond the limits of 1:1,000-year fluvio-tidal flooding locally. Since the site covers more than 1 ha, flood risk has been assessed from all possible sources. No flood risks were found which could affect the site.

4. A small stream bounds the site’s northern margin, a headwater section of Ragnell Bottom, itself a tributary of the southward flowing Sor Brook, River Cherwell system.

5. The site is located within a broad valley, trending south west to north east and sloping down towards this headwater stream. No channels were seen within this valley or anywhere else on the site, except the northern boundary stream itself.

6. Two ponds are located in the lower part of the site, near to the northern boundary. The lower pond is fed by this stream, although there is evidence that this connection is a recent one, possibly established during recent flooding.

7. The lower pond is also supplied by water from the upper pond, almost 5 m higher. The upper pond is supplied by water from the south, as part of the site’s drainage system. Both ponds are located on the axis of the broad valley through the site.

8. The Flood Map for Planning shows no risk of fluvial flooding at the site or locally. There are extensive areas at flood risk downstream, within Sor Brook and the River Cherwell systems.

9. Surface water flood risk mapping shows no risk to the racetrack, although there is shown to be a low, less than 1:100-year surface water flood risk on the access road, near the site entrance.

10. There is evidence of groundwater release within the woodland to the north of the site, where springs are mapped. This area and the site are underlain by limestones, sandstones and mudstone which could detain and release groundwater.

11. Regional soil mapping shows most of the site to be underlain by restored soils, composed of quarry and opencast spoil. Their provenance is unknown, as is their texture and permeability.

12. The track and its drainage has been administered and maintained since 2007 by the Banbury Motocross Club, whose manager has identified at least two areas of groundwater emergence on the site.

13. The track includes several straight sections, aligned roughly perpendicular to the axis of the valley. Most sections of track are incised into the grassed surface, with swales beneath some slopes and inside hairpin bends and a pipe network to the upper pond.

14. The drainage system across the track was designed to manage runoff and the high sediment loads within it. The upper or “silt” pond is cleaned out every three years and sediment is spread back on to the track.

15. Additional structures have been recommended to manage sediment discharge in the western part of the track, associated with the starting grid. A series of short swales, aligned parallel with the contours are suggested to trap sediment.

16. In the area around the centre of the track, a permeable service road known as the “Stone Track” has become clogged with sediment. It is recommended that this be refreshed and the upper part lowered, to facilitate drainage to the existing silt pond.

17. Outflow from the silt pond uses a 150 mm diameter pipe with its offtake at the water surface and another, overflow pipe with a higher offtake. The overflow augments outflow during exceedance and may also alert of blockage.

18. The effect of the convoluted route used by the track, the swales, hairpin bends and two ponds all slow down runoff. The system that was designed to manage runoff at Wroxton Motocross track also has the effect of attenuating it.

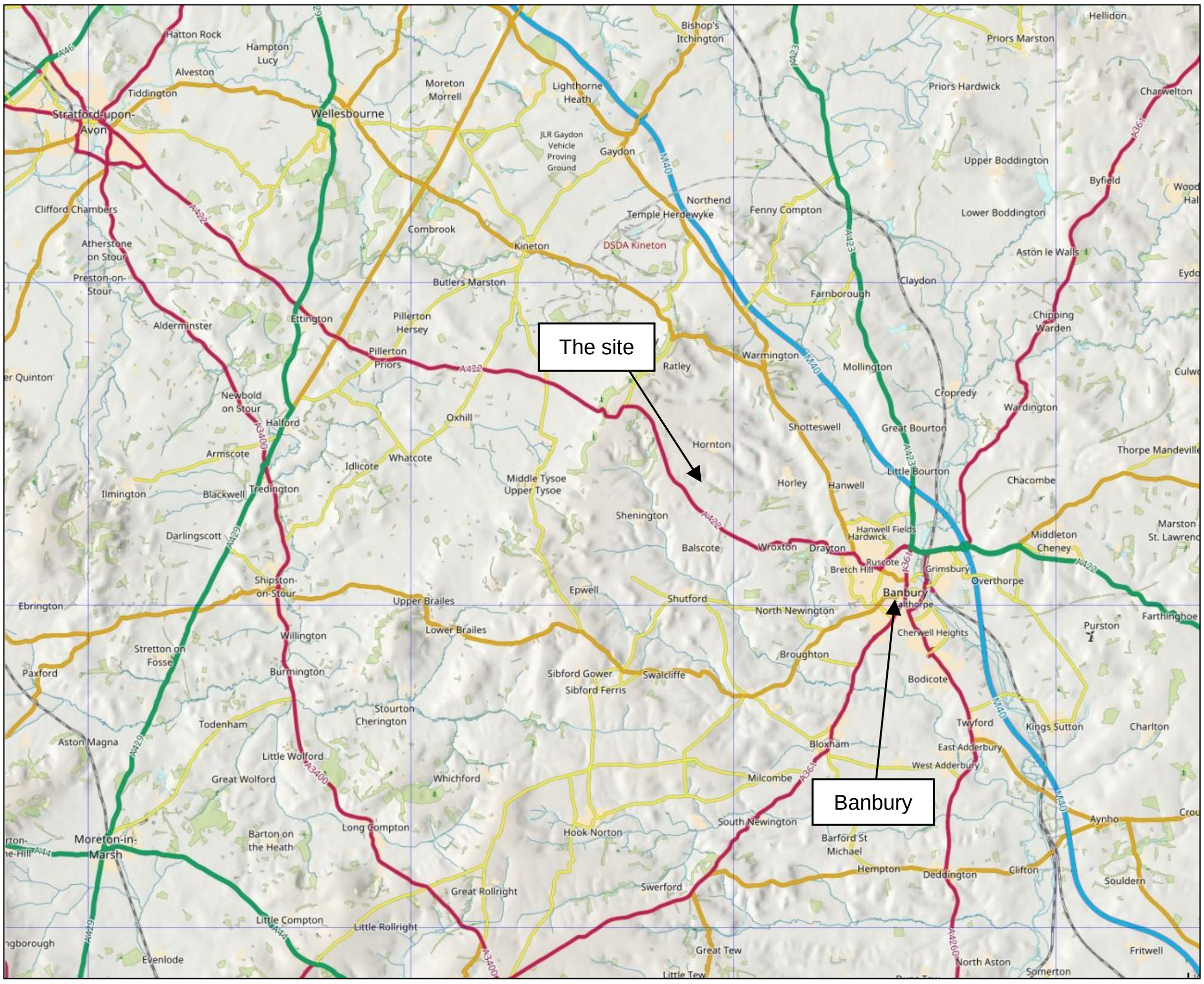
19. Ongoing maintenance of this system is guaranteed by the need to continue to provide the service that users of the track and visitors expect. Overtopping and degradation of the informal barriers to flow or exceedance require and receive rapid maintenance.

20. In summary, flood risk at the site is very low and a less vulnerable agricultural use or a water-compatible use as an outdoor sports venue are both appropriate. Runoff is already managed using a sophisticated system of swales, ditches, pipes and ponds. If the recommendations within this report are adopted, then Wroxton Motocross track and associated infrastructure will continue to comply with the flood risk provisions of the NPPF and maintain their contribution to reducing downstream flood risk.

# 1 Development site and location

A motocross track has been located near the village of Wroxton, north west of Banbury, for the last 40 years or more (Figure 1). The site is on agricultural land (Figure 2, Figure 3), within the ownership of Manor Farm, Balscote and used as a motocross track since 2007 by the "Banbury Motocross Club"[1]. The site was visited on 3rd November 2020, on a sunny day during a rainy period. The site drainage was examined, including two ponds near the site's northern boundary and the stream bounding woodland to the north. Detail of the site location is included as Table 1.

**Figure 1 Location of Wroxton Motocross within Oxfordshire**



Source: https://maps.the-hug.net/

**Table 1 Approximate location of the proposed new sheds**

| | |
|---|---|
| OS X (Eastings) | 438780 |
| OS Y (Northings) | 243760 |
| Nearest Post Code | OX15 6HX |
| Lat (WGS84) | 52.09080 |
| Long (WGS84) | W-1.43538 |
| Nat Grid Ref | SP 38780 43760 |

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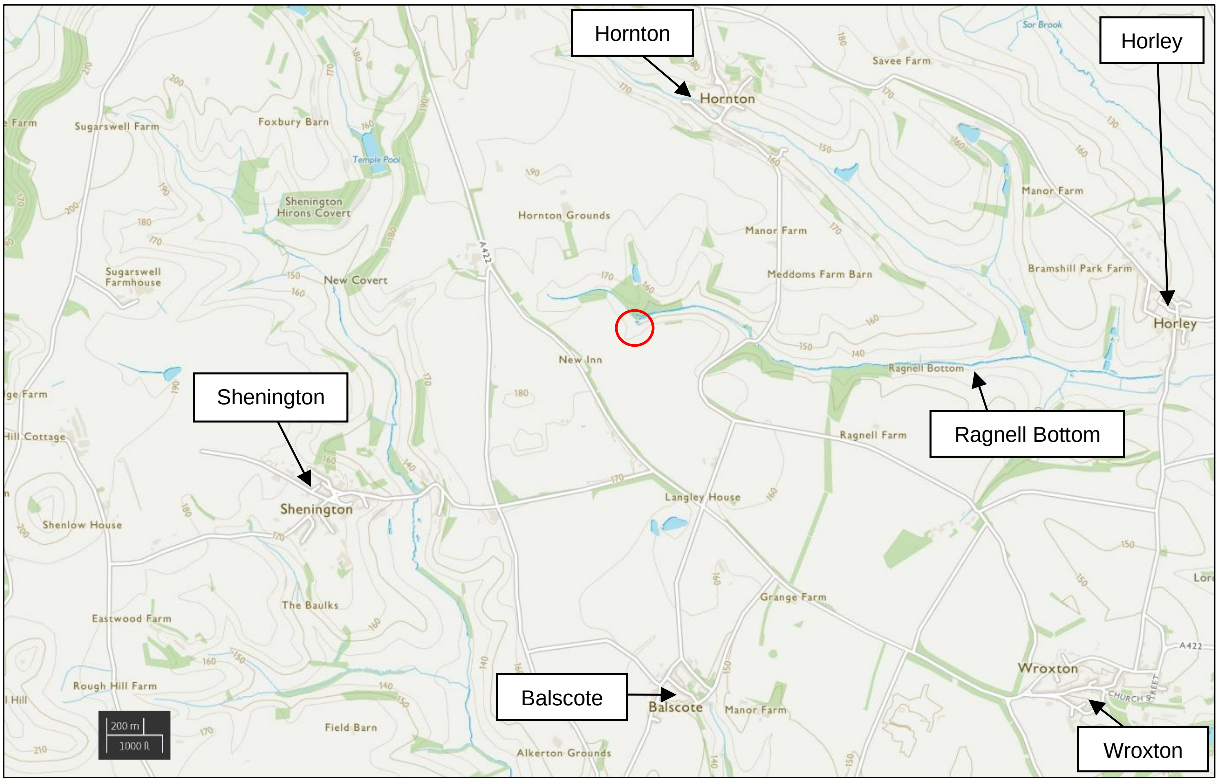
[1] http://www.banburymotocrossclub.co.uk/

**Figure 2  Location of Wroxton Motocross Track, in relation to the surrounding settlement and drainage**



Source: https://osmaps.ordnancesurvey.co.uk/52.09075,-1.43515,14

**Figure 3 Air photo of the site and surrounding area**

Source: Bing Maps[2]

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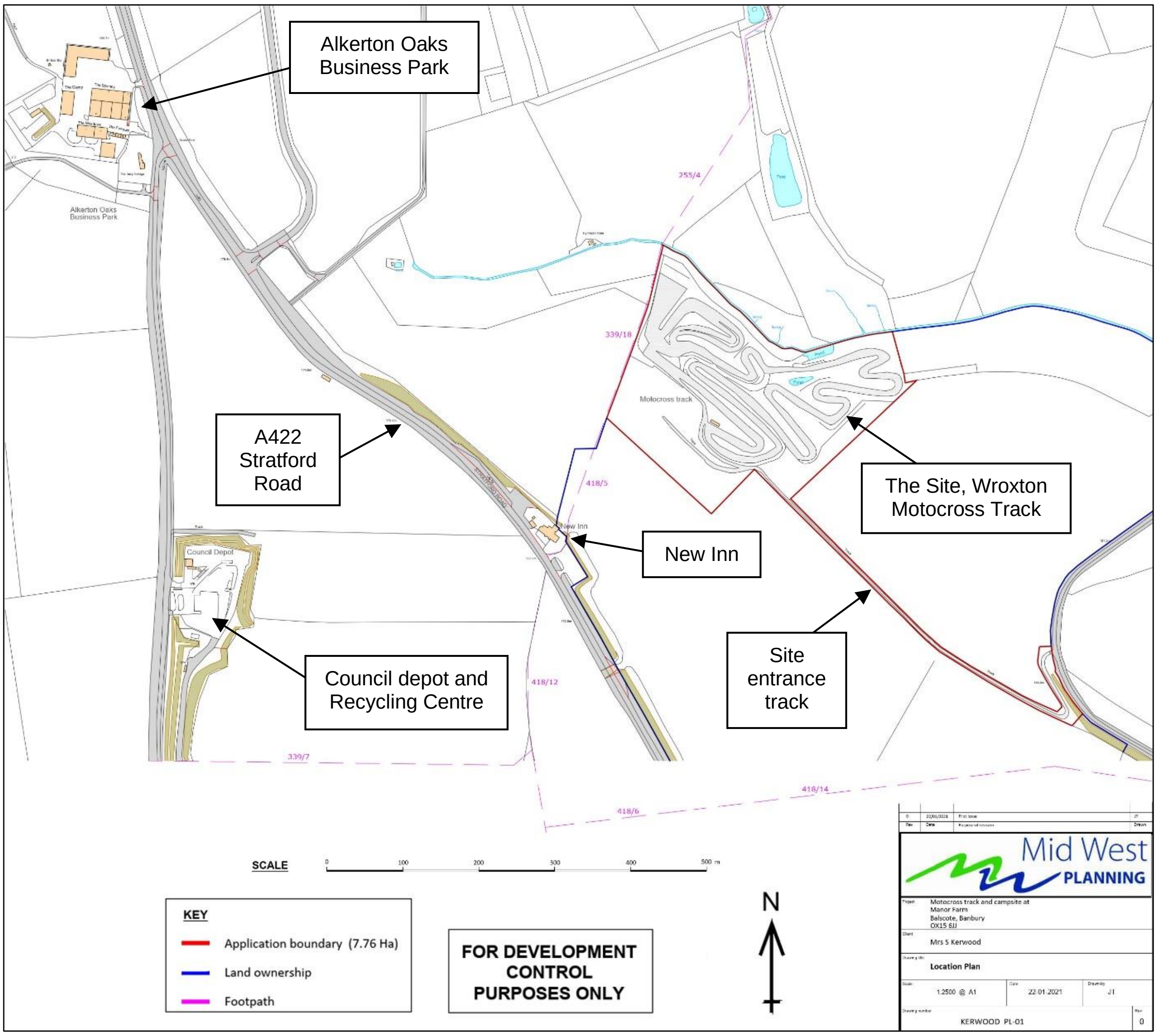
[2] https://www.bing.com/maps/aerial

# 2 Site Plans

The location of the site is shown in Figure 4, together with bounding roads, buildings and field boundaries. The application area is delineated in red, with other areas within the ownership of Manor Farm being located within the blue line boundary.

**Figure 4 Location Plan, showing the site in relation to bounding features**



The Wroxton Motocross Track, referred to within this report as "the site", is mapped in more detail in Figure 5, while detail of the existing and proposed planting is shown in Figure 6. Both Figures also show the locations of two small ponds on the site and the stream which forms part of the site's northern boundary. Although agricultural land use is regarded as having low vulnerability, "outdoor sports and recreation" is classified as "Water Compatible"[3] and therefore appropriate in areas with a relatively high flood risk.

It should be understood that most of the features shown in this mapping and described in this report are already in place, including site access, the track and associated facilities. Over the years, a sophisticated system of drainage has evolved, which is described below in terms of flood risk to the site and elsewhere in the catchment.

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[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6000/2115548.pdf

**Figure 5 The site plan, showing the red line boundary and features of the track**

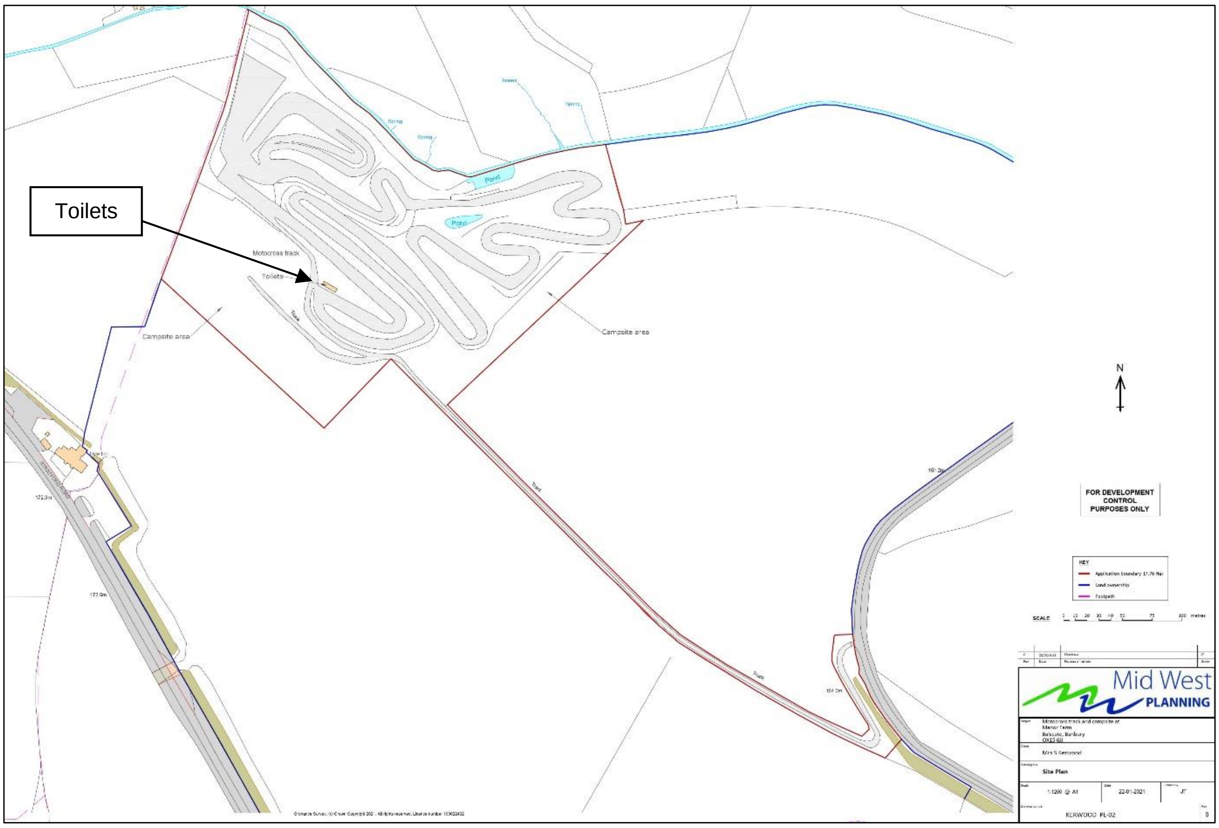
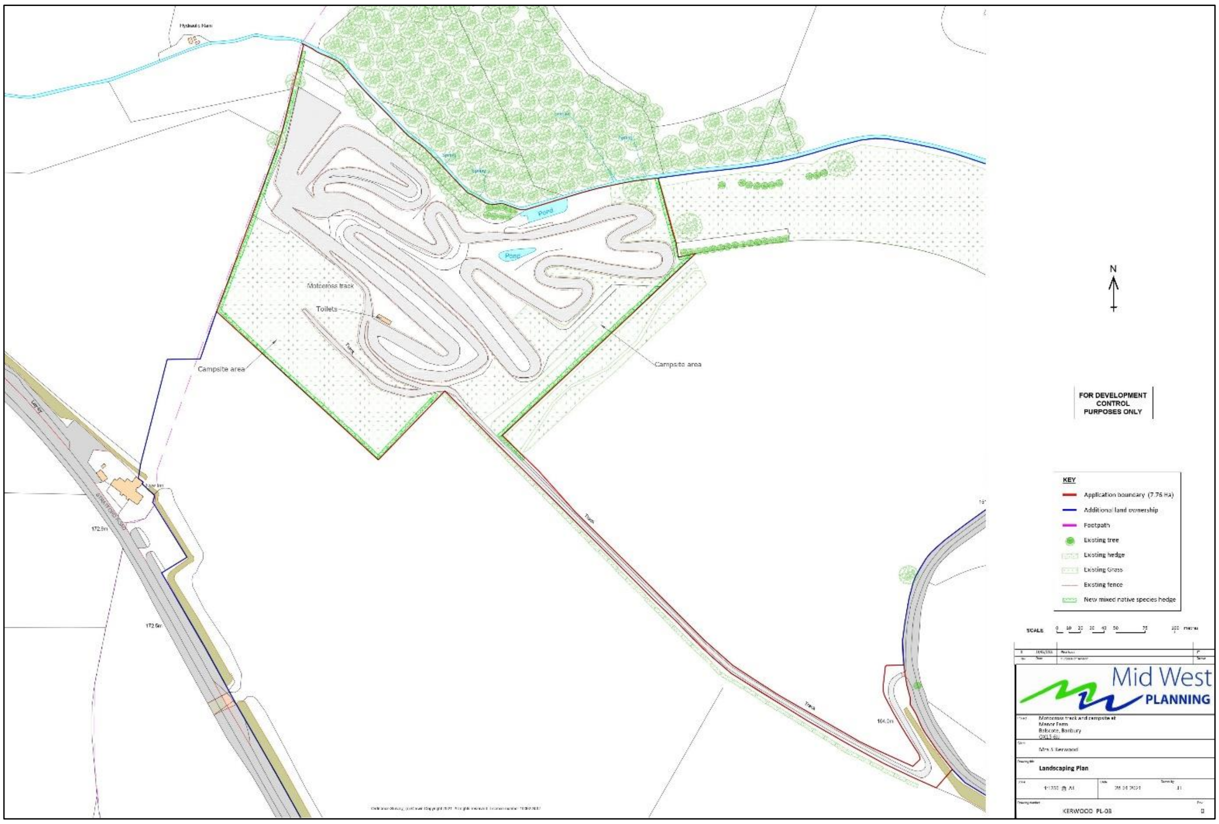


**Figure 6 Landscaping plan, existing and proposed features**



# 3 Topography and Drainage

## 3.1 Streams

The layout of the site is shown on OS mapping (Figure 7) as a convoluted track, labelled as “Motor Racing Circuit” on the map, located south of woodland. A stream crosses the area approximately from west to east, whose eastward continuation is shown on OS mapping as “Ragnell Bottom”. As shown in Figure 7, the stream flows some 10 m within the woodland margin, before emerging into a small pond. The stream’s eastward continuation follows the woodland margin. A smaller pond is located to the south of the woodland fringe, roughly on the 150 m contour. The ponds are referred to in this report as the “upper” and “lower” ponds, in reference to their relative heights above ordnance datum (AOD).

**Figure 7 Mapping of the Wroxton Motocross Track, showing its relationship to bounding features**

Source: Ordnance Survey Online Mapping[4]

The 160 m contour is also shown on Figure 7, cutting the racing circuit as a broad, open valley. It is noticeable that the only stream shown on OS mapping is the stream identified above as a headwater of Ragnell Bottom, flowing close to the woodland’s southern margin. No other stream is shown on OS mapping and none was seen during the site visit. The approximate axis of the valley is marked as a dashed orange line over the map and on the air photo (Figure 7, Figure 8).

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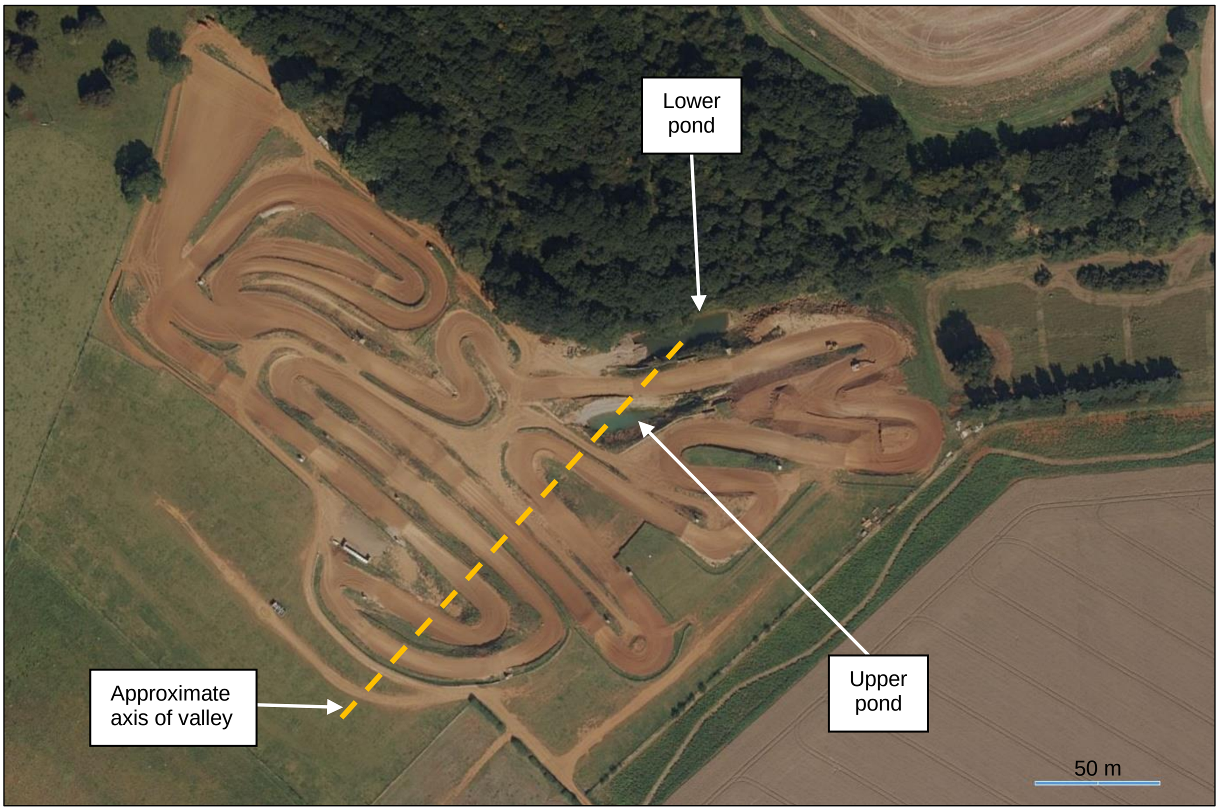
[4] https://osmaps.ordnancesurvey.co.uk/52.09102,-1.43503,17

**Figure 8 Air photo of the Wroxton Motocross Track**



Source: Bing Maps

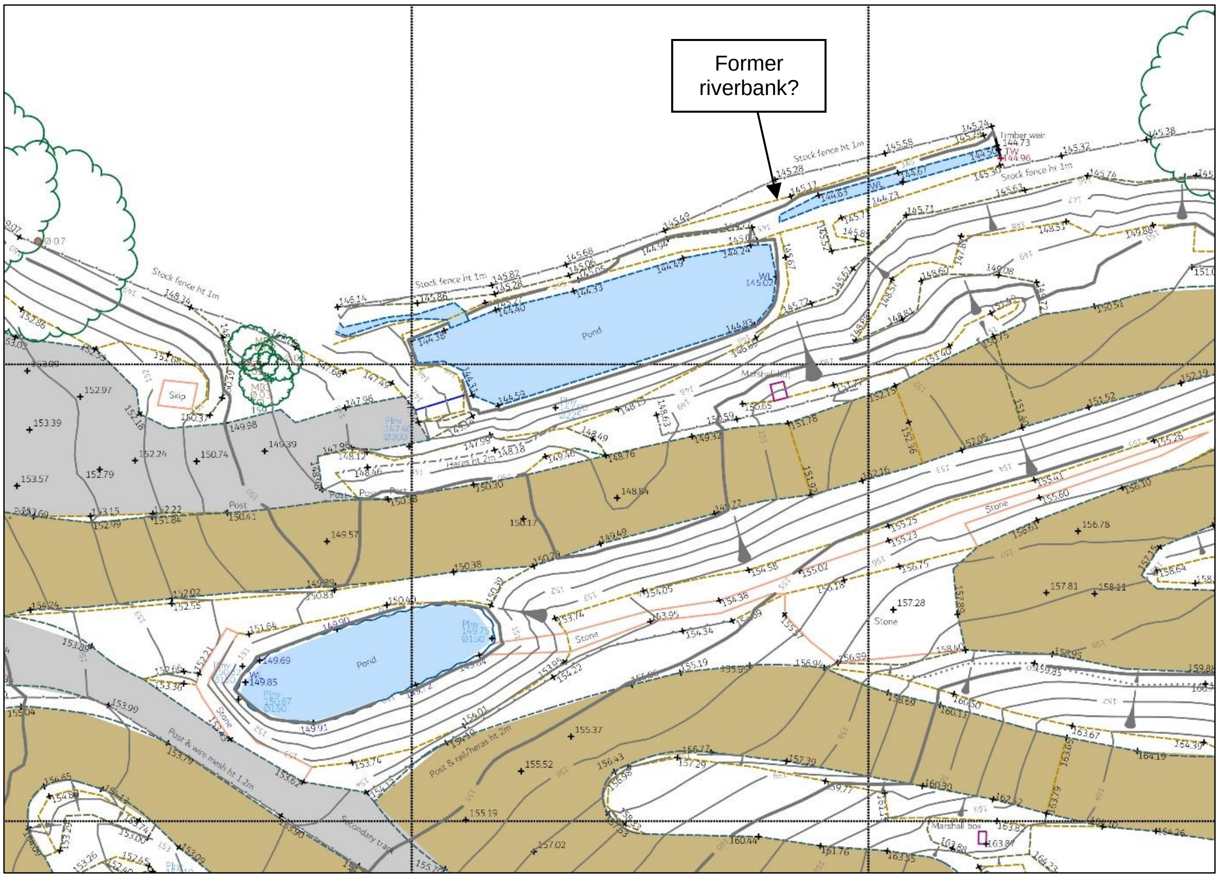
Looking obliquely across the site from the east, Figure 9 shows the track, perpendicular to the valley axis and generally below the bounding vegetated surface. No stream is visible in Figure 9. The existing relief makes the track more challenging for the motocross riders, although straight sections of the track are relatively flat in cross-section. The descent from south west to north east along the axis of the valley occurs mainly at the grassy strips, that divide the sections of track between them in the manner of terraces.

**Figure 9 Viewed across the broad valley, the track is bounded by strips of grassland, generally raised above track level**

## 3.2 Ponds

The two ponds and their relationship to the stream is mapped in Figure 10. Flowing from the west, the stream enters the western end of the more northerly, lower pond as a *circa* 0.2 m high waterfall (Figure 11). Looking behind the pond and stream in Figure 12, the land is low and a witness stated that the stream did not enter the pond in this way, until its course was diverted during recent flooding.

**Figure 10 Detailed topographic mapping of the two ponds**



Former riverbank?

Source: Drawing No. SU2192_2D-1, Topographical Survey & Mapping UK Ltd[5]

That observation is consistent with evidence. The small waterfall in Figure 11 appears to be a recent feature, spilling over the grassy pond margin. Within a short time, months or a few years perhaps, the stream would regrade itself, cutting a more gradual slope down to the pond. The detailed mapping in Figure 10 shows a west to east trending lineation north of the pond and south of a 1 m high stock fence. This is shown using a brown, dashed line that is designated in the key as “Bank top” and may represent the former riverbank.

It was also noted that although water is entering the lower pond both from the headwater tributary of Ragnell Bottom and from the upper pond (see below), no channel was seen to leave. A short stretch of channel is mapped to the east of the pond in Figure 10, albeit with no mapped connection to the pond. The channel was observed flowing further east during the site visit but was not seen to leave the pond (Figure 12) or identified as doing so by the map-makers who produced the drawing used in Figure 10. The absence of an established channel suggests that this connection is recent.

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[5] http://www.topographical.co.uk/

**Figure 11 Headwaters of Ragnell Bottom enter the lower pond via a small waterfall (inset)**

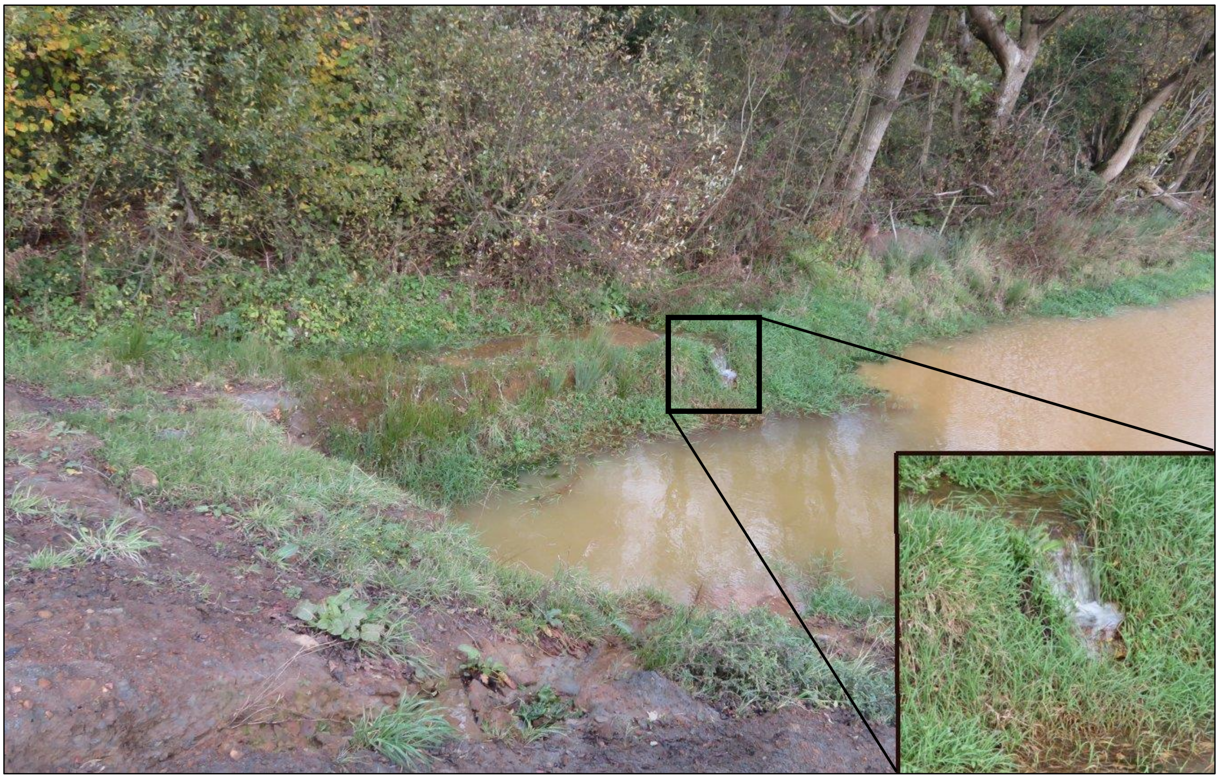

**Figure 12 Stream appears to leave pond through bank-side vegetation**

In addition to inflow from the headwaters of Ragnell Bottom, the lower pond receives inflow from the south (Figure 13), derived from the upper pond (Figure 14, Figure 15). In addition to the outflow in Figure 15, an overflow is located near the pond's northern margin (Figure 16). Comparison of Figure 15 and Figure 16 indicates that whereas the pond's outflow offtake (Figure 15) is at the water surface, the pond's overflow (Figure 16) is set above that level. It follows that if the water level reaches the overflow then either normal outflow rates are being significantly exceeded or there is blockage in the outflow pipe (or both). As well as providing relief for flow exceedance, the emergency overflow may warn of blockage. These facilities have been installed and maintained by Mr. Brian Pounder of the Banbury Motocross Club, who kindly provided further detail of the drainage system and how he has maintained it, to preserve the track and mitigate runoff, including the discharge of sediment.

**Figure 13 The lower pond, viewed from the west**

**Figure 14 The western end of the upper pond shows inflow from the south**

Figure 15 Outflow from the upper pond, set at the pond's eastern end

Figure 16 Overflow from the upper pond, installed as a precaution against blockage or exceedance of the outflow

All the flexible plastic pipes shown in these photographs and all those set underground have a 150 mm diameter. Mr. Pounder explained that he initially used 100 mm pipes but found that they were surcharged during high flow events. The larger diameter was installed a few years ago and has so far managed to convey the necessary flow. This system is considered below in terms of groundwater flood risk (Section 5.3) and sediment movement through the site (Section 7). The relationship between the two ponds can be seen from Figure 17. Water level in the upper pond was shown in Figure 10 as 149.75 mAOD and in the lower pond as almost 5 m lower at 145.02 mAOD. These values are expected to vary but a 5 m height difference can be regarded as a likely maximum.

**Figure 17 The relationship between the two ponds, whose water levels differ by almost 5 m**

# 4 Climate Change

The Environment Agency and NPPF require a consideration of the impacts of climate change on flood risk for any development. In February 2016, the Environment Agency updated the climate change allowances required in Flood Risk Assessments. This advice updates previous climate change allowances to support the NPPF (DCLG, 2012). The Environment Agency (2016) state:

> "Making an allowance for climate change in your flood risk assessment will help to minimise vulnerability and provide resilience to flooding and coastal change in the future. The climate change allowances are predictions of anticipated change for:
>
> - peak river flow by river basin district;
> - peak rainfall intensity;
> - sea level rise;
> - offshore wind speed and extreme wave height".

Cherwell District Council and West Oxfordshire District Council Strategic Flood Risk Assessment (SFRA, 2009)[6] confirms that national allowances are followed locally. Sea level rise and extreme wave height are very unlikely to affect the site. Since outside sport is a water compatible land use, it would not be affected by increased flood peaks. For rainfall, Table 2 shows the anticipated changes in peak intensity in small catchments, recommending a progressive increase. Possible consequences of increases in peak rainfall intensity are considered, in terms of any impact of the site on flood risk downstream.

**Table 2 Peak rainfall intensity allowance in small and urban catchments**

| | Total potential change anticipated | | |
|---|---|---|---|
| Applies across all of England | 2010 to 2039 | 2040 to 2059 | 2060 to 2115 |
| Upper end | 10% | 20% | 40% |
| Central | 5% | 10% | 20% |

Source: Environment Agency (2016)[7]

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[6] https://www.cherwell.gov.uk/info/84/evidence-for-adopted-local-plan-part-1/222/environmental-and-energy-evidence/10

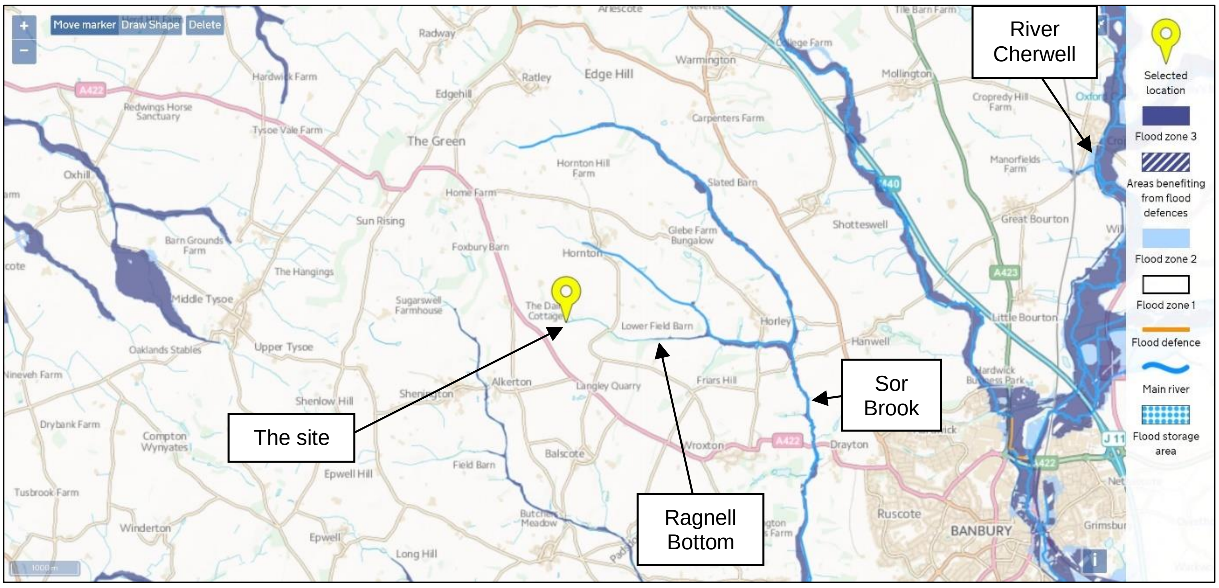
[7] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1

# 5 **Flood Risk**

## 5.1 Fluvial Flood Risk

There is no record of flooding at the site. The Flood Map for Planning (Figure 18) shows fluvial flood risk to be concentrated along rivers to the east, with a narrow flood zone along Sor Brook and a wider zone along the River Cherwell system, through Banbury. The site is located in Flood Zone 1, beyond the limits of 1:1,000-year flooding from rivers, within the catchment of Ragnell Bottom.

**Figure 18 Flood map for Planning shows fluvial flood risk in the region around the site**



Source: [https://flood-map-for-planning.service.gov.uk/confirm-location?easting=438517&northing=243565&placeOrPostcode=OX15%206HX](https://flood-map-for-planning.service.gov.uk/confirm-location?easting=438517&northing=243565&placeOrPostcode=OX15%206HX)

## 5.2 Surface Water Flood Risk

Surface water flooding occurs when rainwater does not flow away along drainage channels or soak into the ground but accumulates over low-lying areas. This can occur naturally but is augmented by man-made surfaces, which are often impermeable or have low permeability. The map of surface water flood extent (Figure 19) shows that most of the site is at “Very low” risk of surface water flooding. A small area near to the site entrance has been assessed as having a “Low risk”.

Low risk means that each year this area has a chance of flooding of between 0.1% and 1%. That is, surface water flooding is not expected up to the 1:100-year rainstorm but is expected at some point between this and the 1:1,000-year rainstorm. Guidance on surface water flooding[8] also points out that “*Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding*”. Such a rare event in full view on the entrance track does not represent a significant risk to people and can be safely ignored for Planning purposes. Should it occur during a scheduled event it is recommended that visitors should be provided with suitable warning and an alternative route, if necessary.

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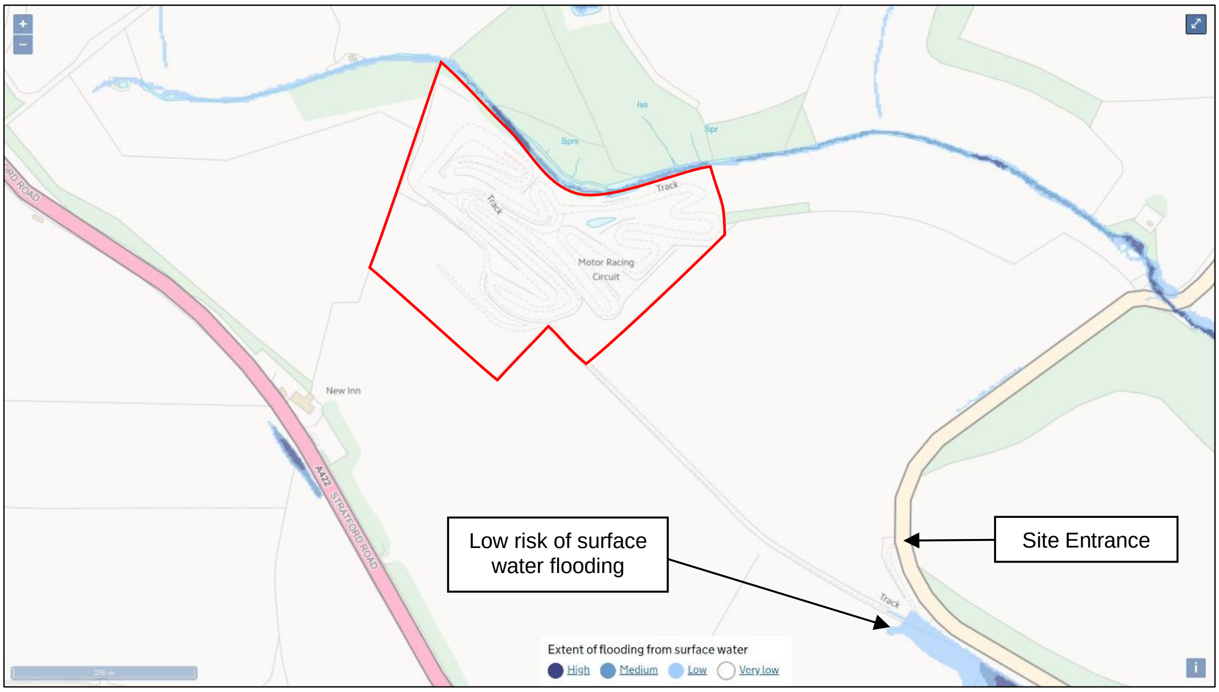
[8] [https://flood-warning-information.service.gov.uk/long-term-flood-risk/map](https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)

**Figure 19 Surface water flood extent map**

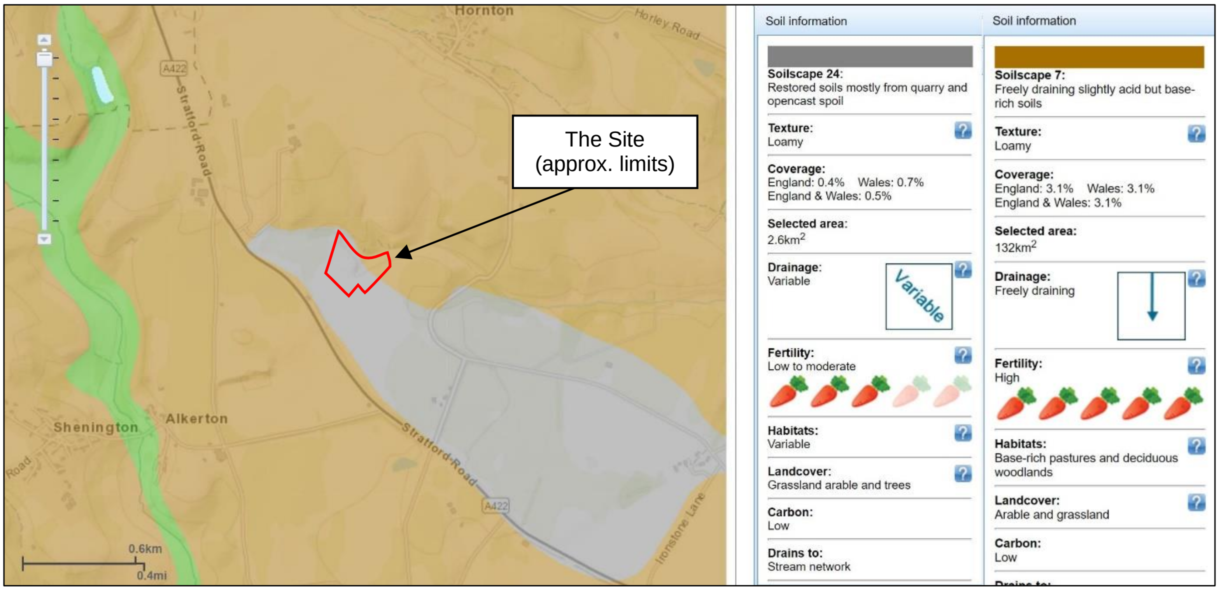


Source: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

## 5.3 Groundwater Flood Risk

Looking at the Surface water flood extent map (Figure 19), the woodland to the immediate north of the site includes three small labels, reading “Spr”, “Sprs” and “Iss”. The first two refer to a spring or springs and “Iss” stands for issues, meaning almost the same thing, water issuing from the surface. To better understand this process, the regional soil map has been reproduced as Figure 20 and the regional geological map as Figure 21.

**Figure 20 Soil map of the site and surrounding area**



Soil information

**Soilscape 24:**
Restored soils mostly from quarry and opencast spoil

**Texture:**
Loamy

**Coverage:**
England: 0.4% Wales: 0.7%
England & Wales: 0.5%

**Selected area:**
2.6km$^2$

**Drainage:**
Variable

**Fertility:**
Low to moderate

**Habitats:**
Variable

**Landcover:**
Grassland arable and trees

**Carbon:**
Low

**Drains to:**
Stream network

Soil information

**Soilscape 7:**
Freely draining slightly acid but base-rich soils

**Texture:**
Loamy

**Coverage:**
England: 3.1% Wales: 3.1%
England & Wales: 3.1%

**Selected area:**
132km$^2$

**Drainage:**
Freely draining

**Fertility:**
High

**Habitats:**
Base-rich pastures and deciduous woodlands

**Landcover:**
Arable and grassland

**Carbon:**
Low

Source: http://www.landis.org.uk/soilscapes/

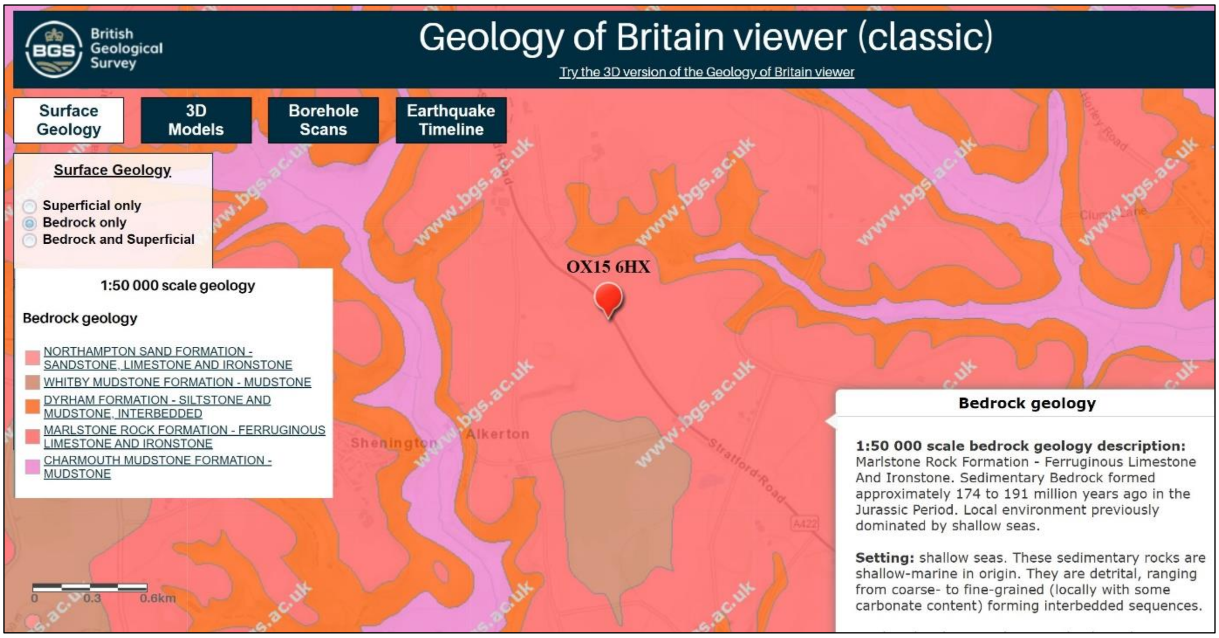
It can be seen from Figure 20 that the greater part of the site is underlain by “Restored soils mostly from quarry and opencast spoil”. As such, the material that makes up their structure has been deposited and may be unrelated to the underlying geology. Attempts have been made to trace the provenance of this material, which remains unknown. The north eastern corner of the site is mapped as being underlain by a different soil type, described as “Freely draining slightly acid but base-rich soils”. The presence of springs within woodland on the site’s northern margin cannot be understood from the soil type alone.

The British Geological Survey (BGS) website[9] provides summary geological mapping at 1:50,000 scale. No superficial deposits have been identified in this area and the bedrock mapping is reproduced as Figure 21. This map locates the site as underlain by the “Marlstone Rock Formation” of Mesozoic (Jurassic) age. This geology is described[10] as:

> “*Sandy, shell-fragmental and ooidal ferruginous limestone interbedded with ferruginous calcareous sandstone, and generally subordinate ferruginous mudstone beds. Locally any of these lithologies may pass by increase in iron content into generally ooidal ironstone, and in places any of these may dominate*”

This rock may be suitable for the storage and transmission of groundwater. Limestone can act as an aquifer, as water can be trapped within the matrix, removing some of its volume in solution. Sandstone can also have a high permeability, unless of course the grains are cemented within a matrix of iron minerals, such as haematite, magnetite or pyrite. Mudstone generally has a low permeability and these clastic rocks (sandstone and mudstone) could form the confining layers. Assuming that any such emerging groundwater found its way through the overlying regolith, it could appear as springs or issues, such as those mapped within the woodland on the north bank (Figure 19).

**Figure 21 Regional Geology, superficial and bedrock**



Surface Geology

○ Superficial only
● Bedrock only
○ Bedrock and Superficial

1:50 000 scale geology

Bedrock geology

- NORTHAMPTON SAND FORMATION - SANDSTONE, LIMESTONE AND IRONSTONE
- WHITBY MUDSTONE FORMATION - MUDSTONE
- DYRHAM FORMATION - SILTSTONE AND MUDSTONE, INTERBEDDED
- MARLSTONE ROCK FORMATION - FERRUGINOUS LIMESTONE AND IRONSTONE
- CHARMOUTH MUDSTONE FORMATION - MUDSTONE

Bedrock geology

**1:50 000 scale bedrock geology description:** Marlstone Rock Formation - Ferruginous Limestone And Ironstone. Sedimentary Bedrock formed approximately 174 to 191 million years ago in the Jurassic Period. Local environment previously dominated by shallow seas.

**Setting:** shallow seas. These sedimentary rocks are shallow-marine in origin. They are detrital, ranging from coarse- to fine-grained (locally with some carbonate content) forming interbedded sequences.

Source: British Geological Survey, 1:50,000 mapping

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[9] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

[10] https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=MRB

This same mechanism could explain the emergence of water on the site. Whatever the properties of the “Restored soils” at this location, if the geological conditions to the north of the site are the source of springs and “issues”, similar processes can be anticipated beneath the restored soils. Water is shown in to be issuing from the near-surface layers in Figure 14 and it was assumed during the site visit that this was groundwater emergence. Discussion with Brian Pounder, who has maintained the site since Banbury Motocross Club started to use it in 2007, confirmed that groundwater does emerge from several points on and around the track. The two ponds discussed in Section 3.2 do not mark the location of emergence but were created to manage it and are discussed in Section 6.

Under certain circumstances, groundwater flooding can pose a risk to people. As described in Section 6, all the known sites of groundwater emergence have been managed in such a way that flow is directed into the upper pond, from where it is piped to the lower pond. In terms of risk to people, the source and route taken by surface water is less important than how it is managed. Rather than risk repetition, the sources and management of groundwater are both treated together in Section 6.

# 6 **Surface water management**

## 6.1 Impermeable Surfaces

The only built structures shown on the site plan (Figure 5) are a small group of toilets (porta-loos) near the south west of the track area and visible in Figure 25. A number of small wooden shelters were noticed at various locations around the track similar to that shown in Figure 22. These are observation shelters, for the use of officials during race days. The surface area of the structure shown in Figure 22 was not measured but is probably in the order of 2 $m^2$ or 3 $m^2$, about that of a small car. Runoff from structures such as these and the toilets are likely to be negligible, *de minimis*, having a minimal impact of runoff within the site or elsewhere. Such structures are already managed as part of the drainage design across the whole track area (see below).

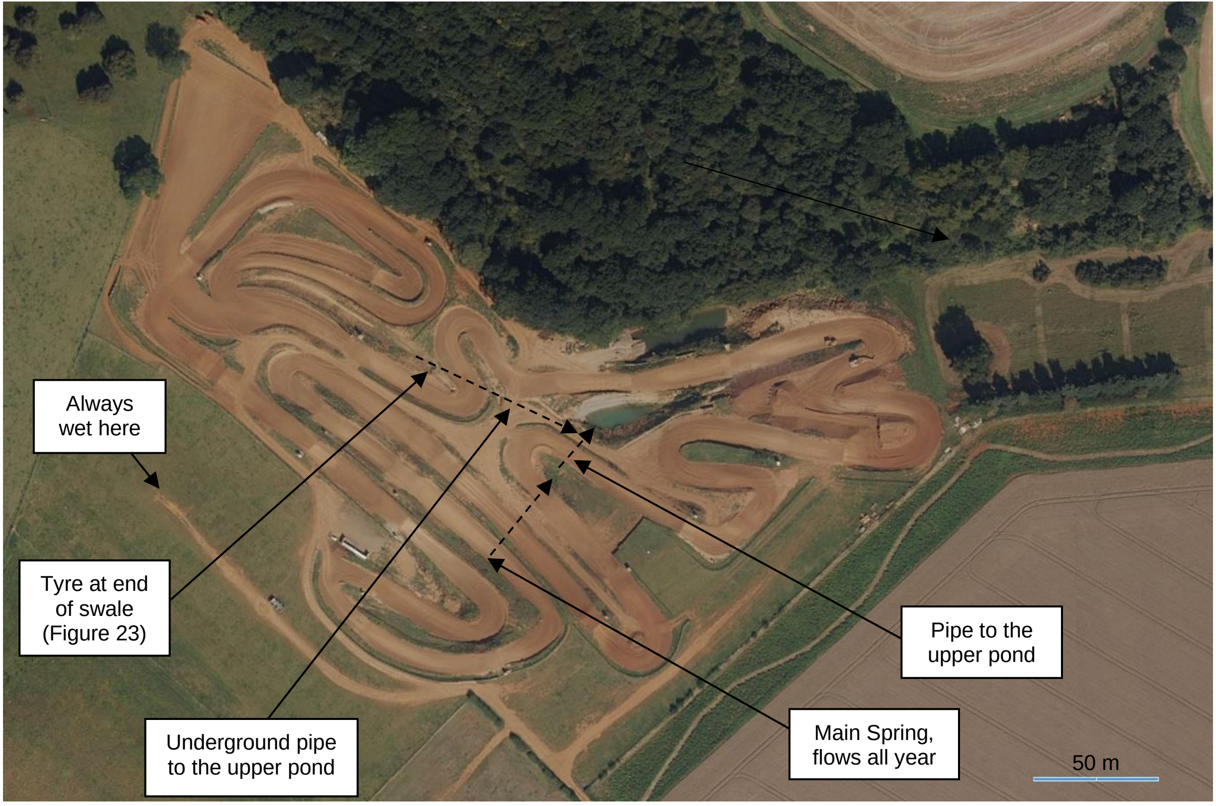
**Figure 22 An observation shelter raised above ground to provide a view of a section of racetrack**

## 6.2 Existing Site Drainage

As described in Section 3.1, no stream could be identified along the axis of the valley through the site (Figure 7) and the track and retaining slopes evidently hold any such flow back, in a manner similar to a series of terraces. It is clear from the air photo (Figure 8) that sections of track which cross this axis are perpendicular to it or nearly so. In places, the surface drops almost vertically, as it does above the two ponds (Figure 13, Figure 14). Some sections of track are steeply embanked, to form slopes which end in swales (Figure 23). These allow infiltration and convey excess water to where it can be managed, at the upper pond. Except for the crest of hill sections, it can be seen from photographs of the track eg. Figure 9 and Figure 23, that all the track is cut below the landscape surface, the area covered in grasses and low-lying plants in these photographs.

**Figure 23 A swale located at the base of a slope, excess runoff is conveyed towards the tyre and piped to the upper pond**

**Figure 24 Springs located on the site and associated underground pipes (shown as dashed lined)**



An area to the southwest of the track was identified by Brian Pounder as almost always wet. He also located the “main spring”, on Figure 24, within the yellow circle in Figure 25, where water reaches the surface almost all the time. Within the orange circle, Mr. Pounder reported that a spring started to flow one day but that flow there is lower and more erratic. Spring flow is collected and piped beneath the track to the area within the hairpin bend, emerging within the blue circle in Figure 25, before being conveyed by another pipe to the upper pond.

**Figure 25 The yellow and orange circles locate springs.  A pipe emerges in the blue circle, within the hairpin bend**

## 6.3 Rates of Runoff and Flood Risk Elsewhere

In the absence of the racetrack, the site would probably be under pasture.  Rainwater reaching the ground and groundwater reaching the surface would flow rapidly to the axis of the valley and down that to the headwater stream at its base.  It is likely that runoff would become concentrated into a system of channels, increasing the rate of flow.  Runoff is no quicker and, in most cases, slowed by the effect of taking a more convoluted route and being detained temporarily in the swales, hairpin bends and the two ponds.  Additional attenuation and possibly infiltration is provided by the track itself, as runoff passes over its lowered stretches.

The system that was designed to manage runoff also has the effect of attenuating it.  Since the soil that underlies the area has been emplaced in the past as restored soils, presumed to be from quarry and opencast spoil, infiltration characteristics are unknown.  The soil probably has a fairly local provenance and may include many of the lithological features described in Section 5.3, including elements of limestone, sandstone, mudstone and various unspecified iron minerals.  Whether or not that is the case, there is likely to be potential for infiltration and since the effect of the track and associated features is to detain runoff on these surfaces, any potential for infiltration at the site will be increased by features of the circuit.

The cumulative effect of these features on rates of runoff and flood risk downstream is expected to be small but broadly positive, when compared with the rate of runoff and flood risk from a field under pasture, hay or cereal crops.  There will be thresholds built into this system, as the various impediments to flow are overtopped.  This is predicted to become more common with increases in rainfall intensity that come with climate change (Section 4).  As long as the site is being operated as a motocross track, the maintenance regime will need to be constantly adapted to these changing circumstances.  Just as 100 mm diameter piping was replaced by 150 mm piping (Section 3.2), any failures in the system will need to be remedied rapidly.  Adapting to climate change would be a commercial imperative, driven by the needs of the many users of this facility.

## 6.4 Track and Drainage Maintenance

The drainage system including the various swales, ditches, pipes and ponds as well as the track itself are already being maintained to a very high standard and as long as that work continues, then the system will continue to function as designed. The problem is different to the ongoing maintenance of a system designed to promote infiltration or to attenuate runoff. In the case of this site, there are no significant structures whose impermeable surfaces could increase the rate of runoff. As described in the previous section, the structures on site are more likely to impede runoff and reduce its rate, thus reducing flood risk downstream, albeit to an unknown degree.

The one area in which maintenance is believed to be important to the proper functioning of the drainage system is the management of sediment. During the site visit the track was seen to be covered by a discontinuous layer of relatively fine-grained material. The issue of sediment discharge and management does not normally feature in a flood risk assessment, presumably because it is not normally a material consideration for flood risk but it is considered in this report, within the next Section.

# 7 Sediment Discharge

## 7.1 Existing Management

The effect of motorbikes and riders repeatedly travelling around a dirt track is to mobilise some of the surface material and also to mechanically break up the aggregates (clods) and possibly even the grains themselves. The track was visited on a dry day but after rain the night before. Puddles were seen on the access road and the surface of the track was seen to be well graded but with water and mud within the low points (Figure 26) and tyre-tracks (Figure 27). Another rainstorm would mobilise much of this material, some of which would be discharged along with the water, through the drainage system.

**Figure 26 Water accumulates temporarily in low points along the track**

Figure 27 Water accumulated in small surface irregularities, such as tyre tracks

While discussing the flow of water through the system, Brian Pounder referred to the upper pond as “the silt pond”. When asked, he explained that this pond had been constructed to trap sediment and prevent it from reaching the stream. When asked how big the pond is, he explained that this varies but it fills with sediment within three years, after which material can be seen at water level and needs to be removed. Mr. Pounder explained that he removes it with his 13-ton mechanical digger. He last removed the sediment in 2018 and expects to do it again this year (2021). He was asked what he does with it, he explained that he spreads it back over the track.

One year, Brian Pounder explained, he tried dumping the sediment on land at the top of the circuit, where he did not expect it to wash back on to the track. That, he said was a mistake. When visitors came to race meetings, they often brought their young children. Toddlers saw the mound of sand as an opportunity for play and frequently lost their wellington boots in the heap. Mr. Pounder described the sediment as being of a very strange consistency, which was particularly liable to trap boots, when wet. After that experience, he reverted to spreading the sediment on to the track itself, where it would then get graded and form the new surface.

When asked whether sediment ever accumulated in the lower pond, Brian Pounder explained that the water reaching the lower pond was always relatively clean. The offtake from the upper, Silt Pond is set near to the water surface, at the pond’s eastern end (Figure 15). The inflow (Figure 14) is near to the western end of the pond, more than 20 m away. Having travelled that distance, all but the finest particles held in suspension within the water column, will have dropped out. Hence, the arrangement of ponds at the site not only provides more runoff attenuation than would be expected from a field of pasture or crops, it also limits the sediment discharge. It is anticipated that due to this maintenance regime, sediment discharge into the river system will be lower than would be expected from a purely agricultural land use.

## 7.2 Recommended Management

The system described above manages sediment discharge from the axis of the valley that passes through the centre of the site (Figure 8, Figure 25) and its catchment. There remains a part of the track that is not currently managed in this way and this Section of the report covers recommended management of sediment in this area. Having visited the site on a rainy day, Mr. Nigel Baskerville took the photographs shown in Figure 28, Figure 29 and Figure 30, we are grateful to him for permission to reproduce them here.

**Figure 28 The motocross start line, at the base of a steep section of track**

**Figure 29 Runoff from the start line, follows the service road towards the east**

**Figure 30 Runoff from the track could convey sediment into the stream valley**

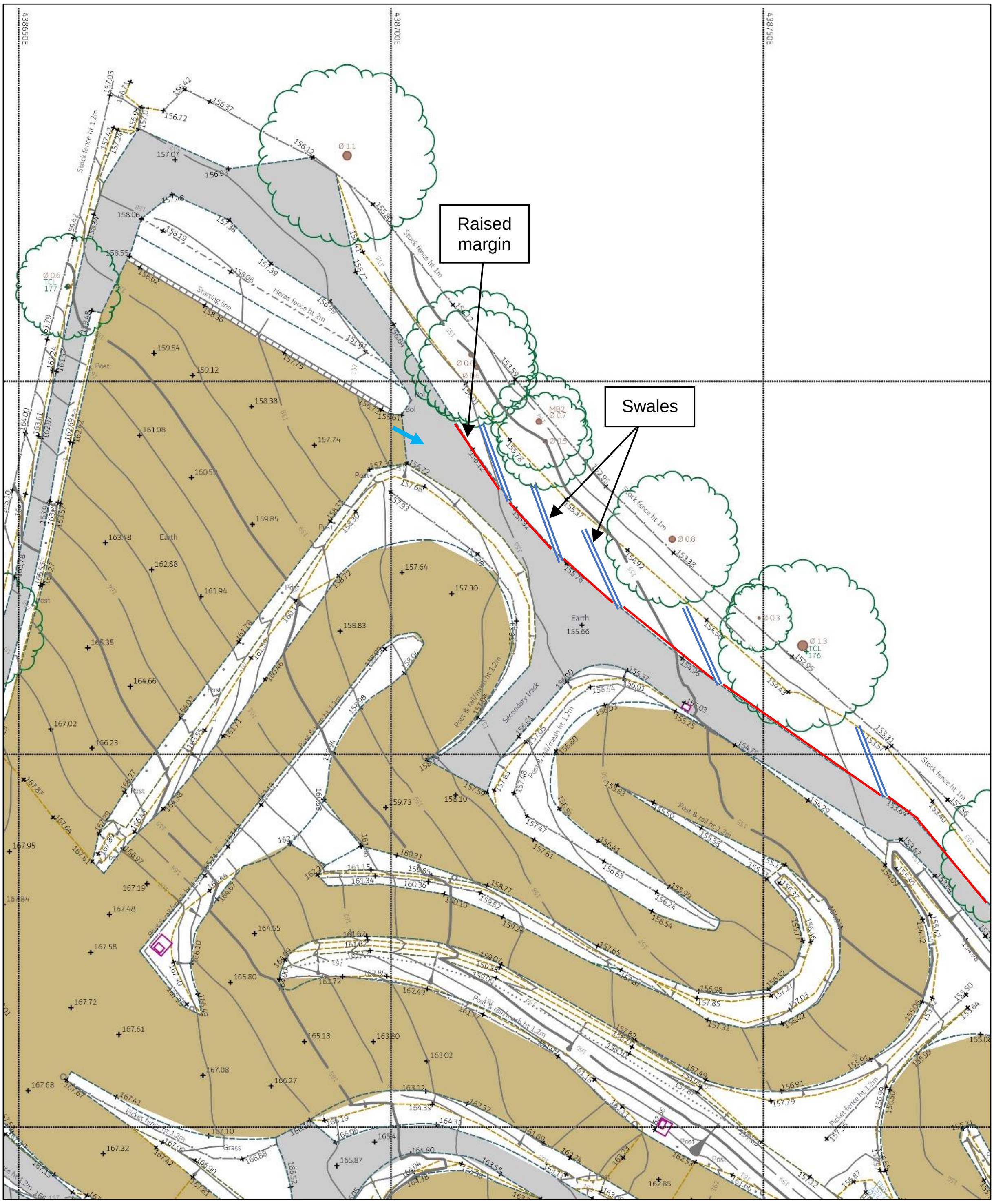
Figure 28 shows the starting grid in the centre of the shot, with the first straight section of track angled up to the left. The service road on the right has evidently been damaged by the passage of runoff over its surface, forming a rill in the foreground of the photo. Looking further east along the service road (Figure 29), runoff is carried within similar small channels, set either side of the road surface. This photo shows the start of a raised area that forms the track margin at this point and is labelled in Figure 29. At about this point, flow follows the local slope, turning towards the north, where it is free to drop into the valley of the headwater stream (Figure 30). The moderate runoff shown in these photographs is unlikely to convey significant sediment, leading to relatively clean water dropping into the valley. High intensity rainstorms could carry a much higher sediment load and should be managed accordingly.

Following discussion with the course manager, Brian Pounder, a solution has been identified that would mitigate such runoff, ensuring that only clean water can be discharged into the valley. The scheme is represented on the topographic map in Figure 31, where outflow from the starting grid shown in Figure 28 is represented by a small blue arrow. From there, set along the service road's northern margin, a series of swales have been located to intercept runoff and convey it off the road. Five such swales are shown, interspersed with barriers shown on Figure 31 as a raised margin to the road and there to prevent runoff from flowing between the swale segments, which are aligned with the contours.

The swale segments would accept runoff and any sediment within it. Having reached a swale, slope and water velocity would drop off and sediment would be deposited. It has been suggested by Mr. Pounder that the northern margin of each swale should be fitted with a length of plastic pipe, so the swale can outflow in the same way as the silt pond in Figure 15. Mr. Pounder suggested that such pipes should be set to discharge over a suitable surface within the valley, such as existing rocks that would resist erosion of the earth at the base of the bank. Depending on the soil permeability within each swale, it may turn out that much or all the inflow is infiltrated.

An important consideration is the root zone of the bounding woodland. It can be seen from Figure 31 that the proposed swales have been located between the mapped crowns of the bounding trees, which approximately defines the edge of the root zone. A more precise measure is provided by the diameter of tree trunks and there should not be a problem in defining suitable locations and limits to the proposed swales. These would be cleaned out on a regular basis, possibly annually, by mechanical digger. Mr. Pounder suggested this scheme, which he would welcome as an addition to his programme of regular maintenance.

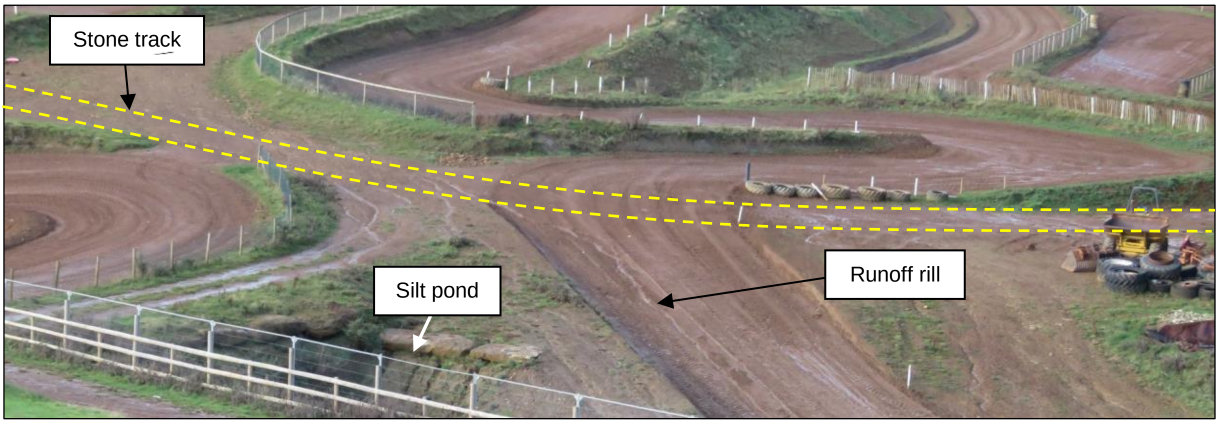
**Figure 31 Recommended sediment control measures, along the track's north eastern margin**



## 7.3 The Stone Track

When asked about the area between the central axis of the valley and the starting grid area, Brian Pounder explained the route that he referred to as the "Stone Track". Explaining that this route provides access to the circuit for officials and medical personnel, the extension of the Stone Track to the right of Figure 32 follows the route shown in Figure 29 to the starting grid. Evidence of runoff from the Stone Track can be seen on Figure 32 as a small channel or rill, from a section of the Stone Track to the south, on the left of Figure 32.

**Figure 32 Section of the Stone Track, with runoff mitigation suggested by Brian Pounder**



Brian Pounder explained that the Stone Track had been emplaced as a permeable route that had become clogged with sediment from the racing track. He explained that he intends to lift the higher sections of the Stone Track and replace them at a lower level, so that runoff from its surface could be directed into the silt pond. When asked about the lower section of the Stone Track, Mr. Pounder explained that this would also be lifted and refreshed, to improve its permeability. This process, he explained, could easily be achieved using his mechanical digger and he suggested that such regular maintenance should be repeated more frequently in the future.

# 8 Residual risk

Residual risks are confined to the surface water management system. Risks may involve exceedance of design rainfall or failure of elements of the system. As explained in Section 6, there is a commercial imperative to continue to manage surface water and sediment, for the ongoing benefit of users and spectators. As long as the site is being used as a motocross circuit, its commercial viability will depend on it being maintained in an optimal way and central to that is the ongoing maintenance of the surface water and sediment management systems.

# 9 Surface water management credentials

This surface water management plan was written by Chris Nugent of Lidar-Logic. Chris has worked since 1981 in areas of hydrology and fluvial geomorphology, specialising in flood risk assessment and surface water management in 2007. Since then, working for Hydro-Logic Services (HLS), he has written and / or managed well over 500 assessments of flood risk across the UK, most of which included a surface water management component. Chris left HLS to form Lidar-Logic in August 2018. The current work was prepared for submission to Planning between November 2020 and February 2021.