Appendix 5a

Risk Assessment

Version	V1
Date	5.07.2.19
Date of next review	31.10.19

BMWG – APPENDIX 5a

Risk Assessment

Hazard arising from Beaver activity	Analysis of Risk – including experiences from River Otter Beaver Trial (ROBT)	Mitigation	Likelihood of impact	Severity	Risk Rating (Red/Amber/ Green)
Flooding of land and/or property caused by dam building. **Negative impacts on:** - **Key watercourses and culverts** - **Waste water treatment works** - **Key infrastructure** - **Highways, rights of way and access routes**	Beavers build dams to create areas of deep water. This means they rarely build resilient dams in major watercourses, but instead concentrate on streams and floodplain ditches. In many areas, this is desirable for the ecosystem services provided, and for the biodiversity benefits. In the wrong places these dams can cause a range of impacts for water management, increasing the risk of localised flooding and water inundation and impact on infrastructure. The severity of impacts is dependent on location, and as part of ROBT, the catchment has been comprehensively modelled to identify zones where the risk of conflict is high. In the first four years of the ROBT approximately 80 dams have been built in 26 locations. Many are very temporary and get washed out as water	In some cases, especially during the autumn and winter, beavers can be discouraged from building dams by regularly removing the structures. Later in the winter and into the spring, some dams may be protecting maternity burrows, and so the beavers may be more persistent. Removing them is likely to have welfare implications. Flow devices can be installed to reduce the extent of flooding in many cases, whilst retaining the beavers in the territory, which helps prevent new beavers moving in. These devices may need flood defence consent, and do not always work in heavily drained/flat landscapes, and can negatively impact	The likelihood of these impacts occurring is high. Beaver Dam Capacity (BDC) modelling is the best predictor for the frequency of dam building activity, and highlights how small watercourses and floodplain	Depending on the location within the catchment, the impacts are highly variable. In the majority of cases, dam building and water impoundment will go unnoticed. Elsewhere flooding of farmland which is significant in	This is highly variable depending on the location within the catchment.

- **Fencing and telegraph poles** - **EA weirs and gauging infrastructure / hydrometric Farmland and crops** - **Gardens** - **Notable trees** - **monitoring equipment** - **Potential risk to people and livestock from insect and parasite-borne diseases arising from wetland habitats**	levels rise. Of these, five have impacted on agricultural land; with three of these causing flooding of low lying fields. Land drainage impacts have also been observed in flat low-lying floodplain pastures. A number of dams have also flooded fencelines, probably impacting on the lifespan of posts. No impacts on notable trees have been observed, but this likelihood of this may increase in the future. There have been no observed impacts on waste water treatment works, telegraph poles or EA hydrometric monitoring equipment. One River Otter beaver living within low lying farmland tested positive for an unidentified fluke. This risk is included here due to the potential increase in the occurrence of fluke species if wetland areas increase in extent.	on fish passage. They can also prevent multi-channel systems forming which might enhance aquatic and facilitate fish passage. In high risk zones, dam removal and deterrents can be employed immediately before any decision are taken about the removal of the beavers.	drainage ditches are much more likely to be dammed than main rivers. Maps of key infrastructure (or many of the identified items listed) can be compared with the BDC outputs to determine high risk locations.	extent is very uncommon. Water impoundments which require interventions are comparatively rare.	
Beaver derived woody material and vegetation in the river causing	Beavers often fell trees into rivers and streams and feed on the upper branches, often breaking them up into smaller lengths and/or using them for building material.	In the event that a beaver territory is upstream of a culvert of particular risk, or beaver debris is reported by EA maintenance staff, the frequency of	High risk locations for larger woody material are	The background level of severity of	

blockages of culverts or other structures, and resulting in flooding	Larger trees often remain in situ and re-sprout. Smaller material is more mobile and commonly found in small quantities throughout active territories, and downstream of them. Larger trees enter watercourses frequently due to natural bank erosion (unrelated to beavers activity), and can potentially block bridges and culverts during flood conditions. In the longer term beavers may reduce this risk by coppicing bankside trees which may otherwise become unstable. No significant woody debris arising from beaver activity has been reported or observed in culvert screens in the River Otter.	screen monitoring and maintenance can be increased. If the presence of beavers creates a new risk in a more urbanised area, a permanent screen could be installed on the face of the culvert or 'trash screen' installed upstream.	regularly monitored already. Beavers are unlikely to alter this risk significantly. Based on the experience to date, the likelihood of impact arising is currently low.	impact can be high, as without screen/culvert maintenance, localised flooding can occur, impacting on residential or commercial property.	
Beavers blocking or interfering with culverts causing: - **raised water levels and flooding** - **impacts on migratory fish**	Beavers sometimes use culverts as suitable pinch points in which to build 'dams.' In the first four years of the ROBT, only two culverts have been affected in minor ways. Outside of the River Otter catchment this has been reported as a more significant issue.	Beaver sticks that are being deliberately placed in culverts should be removed by officers and/or volunteers. This is often effective in deterring further activity. High risk culverts in active territories should be regularly checked for build-up of deliberately placed material.	Culverts within floodplain ditches appear to be the most likely to be deliberately blocked by beavers. This	Impacts of culverts being blocked are most often on agricultural land, where severity would be lower.	Highly dependent on location

		Where particular issues are identified, protective fencing or more permanent engineering solutions can be employed.	may be related to flows, available building material and presence of occupied beaver territories nearby, but high-risk culverts in more urban locations shouldn't be discounted.	In more urban streams, impacts could be more severe.	
Failure of beaver dams causing flooding from - **surge of water** - **blockage of culverts from debris washed downstream**	Beaver dams are often stable semi-permanent structures, especially in low energy watercourses. In higher energy streams and rivers, they are less stable and more prone to erosion. In almost all cases, the erosion from the top of the dam is gradual as the water level rises, and over the course of a sequence of high flow events, the dam may disappear completely. Very rarely the entire structure may fail. In these cases, it can result in a surge of water, but during	Beaver dams located upstream of communities at risk of flooding have been shown to be highly beneficial. Where major dams are immediately upstream of culverts and pinch points however, the risks of failure should be considered as part of management options. The mapping of high-risk zones should take these risks into account.	Likelihood of dam failure causing any significant impact is low. Impacts arising from multiple linked dam failures are extremely	Impacts are usually highly localised This is unlikely to coincide with areas where the impacts would be significant.	

	the high flows when this occurs, the volume of water being stored behind the dam is usually a relatively small proportion of the peak flows being experienced, and impacts are likely to be localised. Multiple sequential failures caused by an upstream breach are considered to be highly unlikely. The greater risk may be from the relatively concentrated quantities of beaver sticks, debris and silt that could cause blockages in culverts downstream.	Where dam failures do occur most of the expelled debris is usually trapped just downstream by other impoundments or watercourse obstacles. Where this is an issue for high risk culverts, the addition of trash screens upstream of culverts could be considered.	rare and we have received no reports of this occurring.		
Trout and Salmon spawning areas and fish migration impacted by beaver dams and culvert blockages	The River Otter is primarily a sea trout fishery, although occasional salmon are also recorded. Beavers can have positive impacts on many fish species including migratory salmonids. Dams can trap silt and enhance flows, and the import of woody debris and the increased heterogeneity enhances habitats and resources for all aquatic life including fish. Whilst there is no scientific evidence of population scale negative impacts on salmonids, concern has been raised that beaver dams may impede the passage of individual migratory fish particularly where there are larger dams in incised channels.	If dams are retained and space is provided for new wetland habitats to be created, impacts may be mitigated naturally by the formation of new bypass channels. Net benefits for fish populations are likely to be accrued. Mitigation measures can be taken in high risk spawning locations – but data on fish spawning stretches has not been systematically collected. Where dams are identified as being of concern to EA or local fisheries stakeholders, intervention can be	Short term impacts may occur in some watercourses. Our experience to date shows they are often short lived and relatively minor, particularly when flows increase, enabling fish	Impacts on the passage of individual fish could occur, but overall impacts on populations of fish are likely to be positive.	

	Concern has also been articulated regarding the impacts that dams may have on existing spawning gravels. In the first four years of the ROBT, beaver dams have been constructed in three streams where there are spawning gravels for migratory fish species. In most cases, beaver dams and any impacts on fish passage and spawning gravels have been temporary. As flows increase, many dams become easily passable. Furthermore, dams may be partly or wholly washed out by winter floods and this has been shown to actually create and enhance spawning gravels.	carried out during salmonid migration periods. A protocol for this is being developed by ROBT – the Protocol for the Passage Assessment of Beaver Dams to Aid Fish. (PAD Protocol – see appendix 7).	passage over more obstacles.		
People, machinery or livestock falling into beaver burrows - **Collapsing burrows causing damage to farm/heavy machinery**	Beaver burrows can extend several metres into riverbanks where substrate allows digging. The sandy soils of the River Otter are suitable for excavating burrows but are susceptible to collapse. Multiple burrows are known to exist in the lower reaches of the River Otter. Beaver burrows have underwater entrances which makes detection very difficult. There has been one case of a burrow collapsing in an agricultural field during the first four years of	The most effective mitigation to prevent conflicts with burrows is to provide a buffer strip alongside watercourses. This would prevent the overwhelming majority of machinery and livestock impacts. Where high risk / collapsed burrows have been identified adjacent to paths, local people / landowners have covered	Likelihood of conflict with agricultural machinery accessing riverbanks is relatively low. Potential impacts on people and	The collapse of a burrow during harvesting of maize or other activities has the potential to cause a broken tractor axil.	

- **Injury to people, livestock and pets**	the ROBT. Most of the burrows have been associated with large riverside trees and within the buffer strip that exists along much of the main river, and not in open farmland. No cases of farm machinery or livestock falling into burrows have been recorded in the catchment, but incidents have been reported from other EU geographies. One site in the River Otter was carefully monitored during riverside maize harvesting operations, but no collapses were recorded. ROBT staff surveying for beaver activity have occasionally found burrows by falling through the shallow soil above them. The risk of injury in these cases is minimal. In the first four years of the ROBT, three burrows have collapsed adjacent to public footpaths, but the risk of impact is deemed insignificant due to density of bankside vegetation.	them with dense brush to prevent accidents. Where farming operations are taking place very close to watercourses, operators of heavy machinery need to be aware of risks and work accordingly. Direct contact with them in high risk locations, particularly within active territories, is an important mitigation measure. Speed of harvesting must be reduced if there is a risk of burrows being present. Collapsed burrows can be infilled to prevent injury to people and livestock.	livestock are occasional.	Risk of injury to livestock.	
Burrowing into riverbanks, reservoir or lake dams or other key water	Outside of the River Otter beaver burrowing has been reported which has compromised the integrity of floodbanks / bunds, and the consequences can be serious in these cases.	Regular and detailed monitoring of important infrastructure should be carried out by the Beaver Officer, trained volunteers and professional partners.	The extent of engineered infrastructure in the River Otter means that the	The severity of impact due to flooding could be high.	

management infrastructure - **Flood defence embankments collapsing** - **Dams failing** - **Canal banks failing** - **Pond / lake bunds failing** - **Interference with hydrometric monitoring data collection** - **Release of excessive sediments into watercourse from excavation activity**	The only floodbanks in the Otter catchment are downstream of Otterton, and these are mostly set back from the riverside. In this location, burrowing has been restricted to the 'berm' (shelf) between the floodbank and the river. Beavers are holding territory in Otterhead lakes where two dams impound reservoirs. Regular inspections of dams have been carried out by ROBT staff as part of the Trial in addition to routine checks by the owners, but no issues have been detected. There are no canals in the River Otter catchment. No signs of beavers burrowing in the vicinity of EA gauging equipment has been recorded. Beavers were observed burrowing into the riverbank on one occasion, releasing sediment into the river.	In the event that burrowing into the banks or dams is detected, weld mesh sheets can be installed to deter burrowing. Management of vegetation has the dual benefit of deterring activity and facilitating access for monitoring. In the event that burrowing cannot be prevented in a high-risk location, removal of beavers from that location may be necessary. Low level impacts of beaver burrows should be accepted as a natural process within the river.	number of high-risk locations is low. These are easily mitigated through active monitoring.		
Damage to crops and fruit trees by foraging beavers	Beavers are unlikely to forage >20m from riverbanks, but crops such as root crops and maize	Where significant beaver damage to crops is reported, advice and resources (such as temporary electric fencing)	Damage to riverside fruit trees is likely	Localised loss or damage to crops.	

	can be palatable to beavers living nearby and may encourage longer feeding forays. Localised impacts from beavers grazing on riverside crops has been reported elsewhere, although there have been no complaints within the River Otter catchment. Windfall apples have been found to be very attractive to beavers in the River Otter. There have also been isolated cases of beavers felling fruit trees in the catchment. Minor cases of suspected grazing on pasture have been identified during routine surveys.	should be provided to deter further feeding. Riverside apple trees can be individually protected or enclosed within a larger fence. High risk locations can easily be identified, and proactively protected. Three small riverside orchards have been proactively protected. Beaver Management staff and volunteers should have mitigation resources such as temporary electric fencing available for immediate use.	in the few locations where they occur. Proactive advice and protection measures should be implemented to minimise impacts. Major conflicts with other riverside crops are a much lower risk. Mitigation steps should be reactive when crop damage has been observed through routine monitoring.		

Large beaver cut trees falling (or at risk of falling), impacting on: - **people, livestock and pets,** - **highways and rights of way** - **telephone or electricity cables** - **Livestock fencing** - **Other property**	Beavers can take many weeks or months to fell larger trees, and sometimes will leave trees partially cut and at risk of wind-blow. The majority of trees cut by beavers are in, or immediately adjacent to, watercourses or in buffer strips or other semi-natural areas where risks where the severity of any impact is likely to be low. Where key infrastructure, buildings or highways lie close to a water course there is a risk of more severe impacts. Through the first four years of the ROBT, two high risk trees adjacent to a power lines needed protecting to prevent further beaver feeding. Damage to fencing from tree felling has occurred on one occasion in the first four years of the ROBT. Two other fences were impacted but not significantly damaged.	Any high-risk trees reported to the Beaver Officer as being impacted or at risk should be protected or immediately made safe by contractors / volunteers. Trees can easily and inexpensively be protected from beaver gnawing with fencing or deterrent paint. Landowners are often best placed to assess likely impacts from tree felling, and should report concerns through appropriate channels. Beaver feeding signs should be considered as part of any tree safety surveys carried out by landowners and responsible parties.	The likelihood of conflict is relatively high. The associated risk needs to be carefully managed to ensure it remains at acceptable levels. Routine survey of high-risk locations such as riverside PROW is essential.	Severity of impacts vary considerably, from very high to minimal.	
- **Damage or felling of important trees. They**	The majority of woody feeding is on smaller trees and branches, and in or over water, or semi-natural areas. However occasionally larger or important trees (e.g. veteran trees or those	Trees can be proactively protected from beaver gnawing with low costs fence netting or deterrent paint (containing sand).	This is a medium likelihood, but due to the	The loss of some important trees will have	

can be of importance for a wide range of reasons – ecology / landscape / cultural etc. - **Coppicing of trees potentially having both positive and negative impacts on ecology and fisheries (depending on location). This can include in-combination impacts with other browsing animals such as deer.**	containing bat roosts) may be impacted or felled. Key trees in the catchment, such as black poplar, have been identified and are actively monitored. <20 significant trees have been reported to be at risk of beaver felling during the first four years of the Trial by landowners or other interested parties, and subsequently protected (this figure does not include fruit trees protected). All ecological impacts of tree felling / coppicing within the River Otter catchment have been reported as positive impacts; in particular coppicing of willow scrub encroachment in semi-natural grassland habitats. Coppicing of riverside trees has been localised and at a scale where impacts on watercourses are too insignificant to be recorded.	Proactive advice should be provided to owners of trees at risk of beaver damage. Provision of factsheet advice / volunteer support will be the most appropriate way to monitor and support the protection of important trees. Materials could be provided as part of a mitigation budget administered by the BMG.	number of trees and their variable importance to riverside communities, mitigation should be considered on a case by case basis. Advice should be proactively made available to riverside communities.	a localised effect on the River Otter landscape.	

Import of non-native diseases into UK through beaver reintroduction e.g. *Echinococcus multilocularis* and associated risks to people, pets and livestock	*Echinococcus multilocularis* is a tape worm which is currently not present in the UK, but there is a risk of it being imported in beavers brought in from continental Europe. The life cycle means that it can only be contracted by beavers if the eggs are ingested after being excreted by infected foxes or dogs. Infected beavers cannot directly pass it to other beavers or people. If contracted in egg form from the faeces of infected carnivores it can be transmitted to humans and cause serious illness or death. Other diseases that beavers can carry, such as rabies or tularaemia should also be considered.	Use UK bred animals to supplement populations. Where this is not possible then imported beavers must be fully health screened beavers. Ideally, source beavers from known *Echinococcus multilocularis* free populations. When dead beavers are recovered, they should be subject to post mortem examination where possible.	With correct procedures and restrictions, it is possible to eliminate the risk of *Echinococcus multilocularis* or other diseases being introduced into the catchment by beavers. Other routes of infection (i.e. through imported dogs) are considered more likely.	Some diseases that beavers can carry can be lethal to humans, so maintaining disease-free status in Britain is vital.	
Spread of water borne pathogens in water (e.g.	Like many other rodent species, beavers can carry and transmit a wide variety of pathogens that they are exposed to from within the environment.	Following IUCN guidelines, any new beavers introduced into the catchment should be screened for a variety of	This is a low risk of occurrence	Severity of impacts can be high.	

***Leptospirosis*, *Giardia, Cryptosporidium*) presenting a disease risk to people.** **NB. Increased occurrence of water-borne diseases also mentioned in impacts of damming (above).**	Relative to animals like rats which are very widespread throughout the River Otter catchment, the presence of beavers is unlikely to significantly increase the risk of transmission to humans. The River Otter and the local coast is used extensively for recreation. Raising awareness of the steps to take to minimise the general risks to health from water borne pathogens is important.	diseases, and informed decisions based on sound science. Health screening of wild living beavers could also be conducted periodically if concerns are raised. This risk can be adequately managed by following normal personal and food hygiene procedures appropriate for exposure to pets, livestock and through outdoor activities.	but impacts of contracting water borne diseases are significant. Continuing to provide advice on ensuring good standards of hygiene after contact with water will lower the risk further.		
Spread of pathogens causing disease risks to livestock **NB. Increased occurrence of water-borne diseases also mentioned in**	Like many other rodent species, beavers can carry a variety of pathogens that are commonly found in the riparian environment. A wide range of pathogens are potentially applicable here. A case of liver fluke (probably *Fasciola hepatica*) has been identified in a beaver that was health screened as part of the ROBT. The wetland creation activities of beavers might make some areas of grassland more suitable for some pathogens.	Livestock farms should have access to best practice advice on disease risk associated with wetlands, and existing guidelines for biosecurity and disease management on farms should be adhered to. Health screening of wild living beavers could also be conducted where disease prevalence was directly attributed to beavers – a very low risk.	The risk is considered low. Where new wetlands are established which are grazed by livestock the risk to those livestock should be	Water borne diseases can exert high impacts on livestock health and should be routinely monitored.	

impacts of damming (above)			taken into account. Advice and mitigation measures can reduce conflicts.		
Burrowing, dam building and tree felling causing scour and changing rates of bank erosion	The soft sandy soils of the River Otter erode very quickly, and as a result the river geomorphology is dynamic in lower floodplain locations, which is of concern to local landowners. The impacts that beavers exert are considered minor. Dams have caused minor scour on one site, and burrows may have created small scour points in highly localised situations during the first four years of the ROBT. In one location on the Tale, a dam is expected to gradually result in a more significant change of watercourse and the channel becomes more 'connected' to the floodplain. In that time major new erosion points have been detected caused by cattle and dogs entering the river, and by trees falling naturally into the river.	Buffer strips with extensive woody growth are the best way of stabilising river banks in this catchment. Research and education would be a useful mitigation measure to clearly demonstrate the level of impact caused by beavers. No other routine mitigation is considered necessary or desirable.	Likelihood of major impact is low.	Rivers may change course within the floodplain causing actual or functional loss of land. Localised infrastructure may be at increased risk as a result.	

	Beaver coppicing activity will exert generally positive impacts of bank erosion rates.				
Significant detrimental impact upon designated features of SAC/SSSI, or protected or Priority BAP species	East Devon Pebblebed Heaths SAC and a restricted number of SSSIs are located within the catchment. The presence of beavers in many of these designated sites is likely to significantly enhance ecological interest, but negative impacts on specific localised designated interest features are possible. In the first four years of the ROBT, only minor influences on the Otter Estuary SSSI have been seen, and no detrimental impacts recorded.	Appropriate Assessment monitoring of features by Natural England supported by field staff and volunteers. Active monitoring of beaver impacts on designated interest features or protected species could be carried out by local experts and volunteers in the event that beaver impacts were detected in these sites. Management / removal of animals if beaver activity is considered to have a significant negative impact.	Likelihood of significant negative impacts on designated interest features or key species is low.	Highly localised but severe impacts may occur (e.g. change in conditions of southern damselfly breeding habitats) but these can be easily mitigated.	
Road traffic accidents and near misses due to beavers getting onto roads.	There are a large number of highways that cross the River Otter. Injury to road users and beavers. Damage to vehicles. There has been a single case of a beaver being killed by a vehicle near the River Otter, and cases are sometimes recorded elsewhere. No damage to the vehicle was reported.	Active field monitoring of beaver locations and activity by volunteers may allow high risk sites to be identified. If required, fencing of key points can prevent beaver access to roads.	Likelihood of severe RTAs causing personal injury is considered very low.	Severity of impact could be high in event of an RTA.	

Beaver bites causing human injuries	Beavers are not known to attack people in the wild. However beavers could inflict nasty bites on anyone attempting capture or handling. Beaver workers are therefore at greatest risk of injury. Adequate training on safe handling practices can reduce these risks significantly, but occasional incidents remain possible. An angler in the River Otter at dusk in a beaver territory reported possible aggressive posturing by a beaver. Reports from experts from other parts of the world show that aggressive behaviour leading to unprovoked physical attack is unknown.	Wherever possible members of the public must be made aware of the risks associated with attempting to touch or capture a beaver. Information and advice should be made available to eliminate the unnecessary concerns of anglers and beaver watchers. Only adequately trained persons will be involved in trapping and handling animals, using best practice and appropriate PPE.	Likelihood among beaver workers trapping and handling beavers is moderate, and safe working practices must be adopted. The risk associated with other negative physical interactions with beavers is very low.	Beavers can inflict serious bites to people handling them.	Risk to beaver handlers
Injuries to dogs / pets due to beaver bites.	Beavers will defend their territories from dogs and other perceived threats especially during the period when they have young kits. Dogs entering the water near lodges during breeding season are at heightened risk.	Ensure all dog walkers are aware of the risks of allowing their dogs into the river near beaver lodges especially during the breeding season.	The likelihood of conflict is moderate. Deployment of	Injury or death to dogs.	

	There has been one case of a dog being injured by a beaver in the River Otter. These negative interactions are also reported on rare occasions from the continent.	Informal education campaigns will be required at higher risk periods of the year. The public should be made aware of the general location of lodges to ensure dog owners can take the necessary steps to keep dogs under close control. Signage has been designed for the ROBT and can be deployed throughout the catchment by the Beaver Officer and volunteers.	recommended mitigation can effectively reduce this risk to low.		
Significant detrimental impact on local area infrastructure or riverside vegetation, due to marked increase in visitor numbers to River Otter hotspots.	There could be capacity problems which cause damage to infrastructure at local car parks in close proximity to beaver territories. RTAs could occur as a result of busy use of unsuitable roadside parking locations. Beaver watchers trampling riverside vegetation has been reported as an issue.	Information and media campaigns to manage visitor numbers and focus activity in areas with high carrying capacity. To be completed with support and advice from local authorities and associated highways teams. Visitor numbers monitored and interventions made if numbers cause an unacceptable risk. Interpretative materials should include reference to staying on footpaths and following the Countryside Code.	Likelihood of major conflict, or RTA, is low, especially as beavers disperse into other publicly accessible areas.	Severity of RTA could be high