Appendix to the 'River Otter Beaver Trial' Science & Evidence Report:

Flooding, Beavers and a Community in the River Otter Catchment

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EXECUTIVE SUMMARY

- Between January 2006 and December 2018, the River Otter area has been subject to 141 Flood Alerts and 25 Flood Warnings issued by the *Environment Agency*.
- One village which is the focus of this report has experienced historical flooding with between 2 and 60 properties recorded as effected in previous flood events. This village will not be named to anonymise landowners and survey participants.
- Following the 1968 floods, a flood intervention measure was installed in 1971.
- 52 properties are estimated to be at risk from flooding in the village in the event of a 0.1% chance flood event, one of which is non-residential.
- The *East Devon Catchment Flood Management Plan* recommends "allowing for more natural river processes, creation of wetland habitats, and the reconnection of rivers with their floodplains."
- A pair of Eurasian beaver (*Castor fiber*), licensed under the *River Otter Beaver Trial*, have established upstream of the village. The tenant farmer upon whose land they have established has experienced a number of impacts.
- The beavers have undertaken damming activity at the site which may alleviate flows in peak rainfall events and reduce flooding for the community downstream. The extent to which they may reduce flooding is unclear, but hydrological monitoring work is being undertaken by the University of Exeter.
- Research is ongoing into the degree of flood alleviation achieved by beavers and whether it is enough to effect the numbers of properties in *Environment Agency* flood categories. As such, a true economic benefit of weighted annual average damage costs avoided cannot yet be determined. However, using a calculator used by the *Environment Agency* based upon data from the *Flood Hazard Research Centre*, potential costs avoided are estimated for ten hypothetical scenarios.
- A range of comments from the local community about beavers are presented.

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1. Flood Warnings and Alerts in the River Otter Catchment

The *Environment Agency* issues flood warnings and alerts at times of high rainfall. These are categorised as follows:

- "*Flood Alerts (termed 'Flood Watch' until 2010): Flooding is possible, be prepared.*
- *Flood Warnings: Flooding is expected. Immediate action required.*
- *Severe Flood Warnings: Severe flooding. Danger to life.*"

Between January 2006 and December 2018 (the dates for which data is available), 141 Flood Alerts and 25 Flood Warnings have been issued for the River Otter area. There have been no Severe Flood Warnings. In this village, the Flood Alerts do not apply whereas the Warnings do so (K. Pearson, personal communication [verbal], 20th June 2019). The full sequence of those issued is illustrated in Figure 1 (data.gov.uk, 2019). Page 101 of the appendices of the *East Devon Catchment Flood Management Plan* (*Environment Agency*, 2008) states that:

> *"Urban areas at risk of flooding from the River Otter currently receive warning times of more than the national target of two hours."*

Figure 1. Flood Alerts and Warnings in the River Otter Area

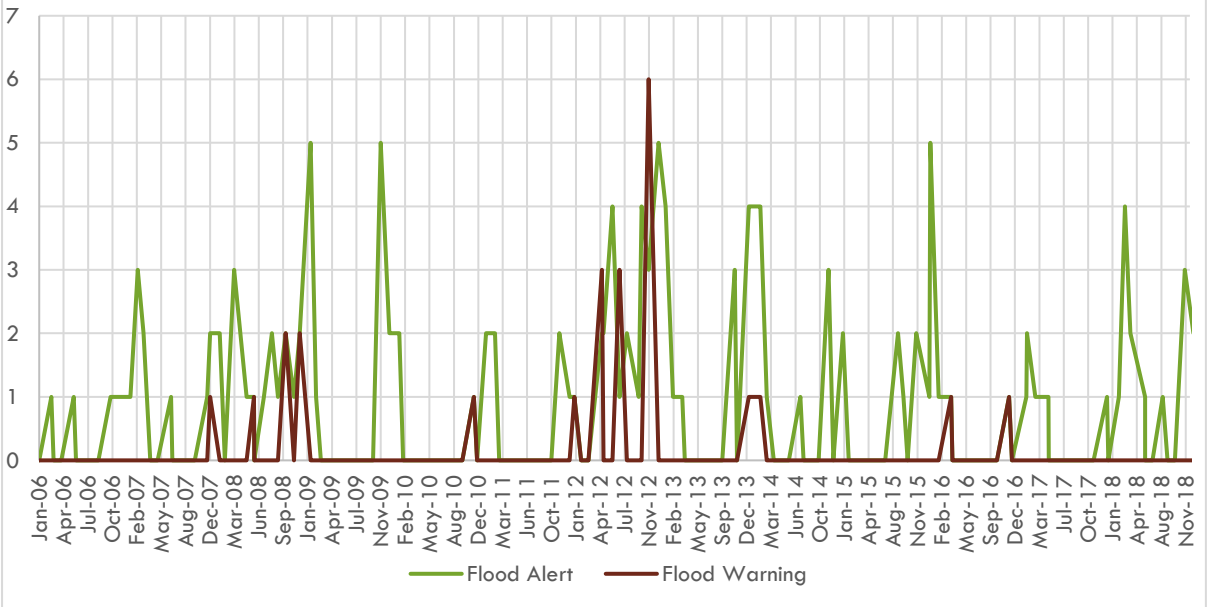


Figure 2 illustrates the frequency at which these Alerts and Warnings have been issued by Year. The year in which the most Alerts (25) and Warnings (13) were observed in 2012.

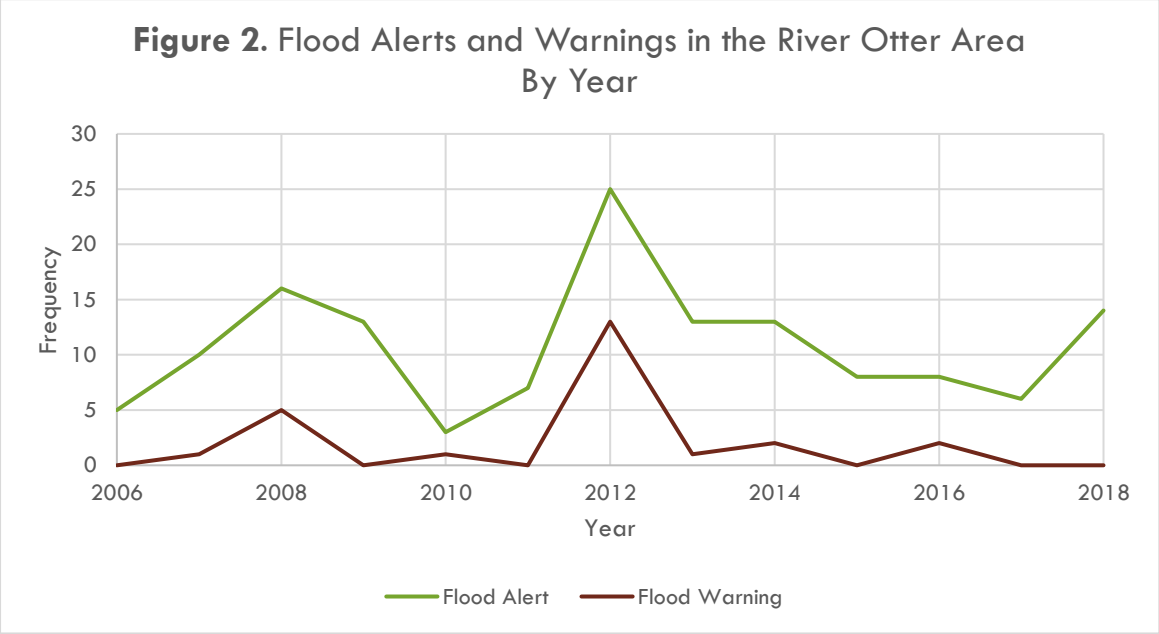
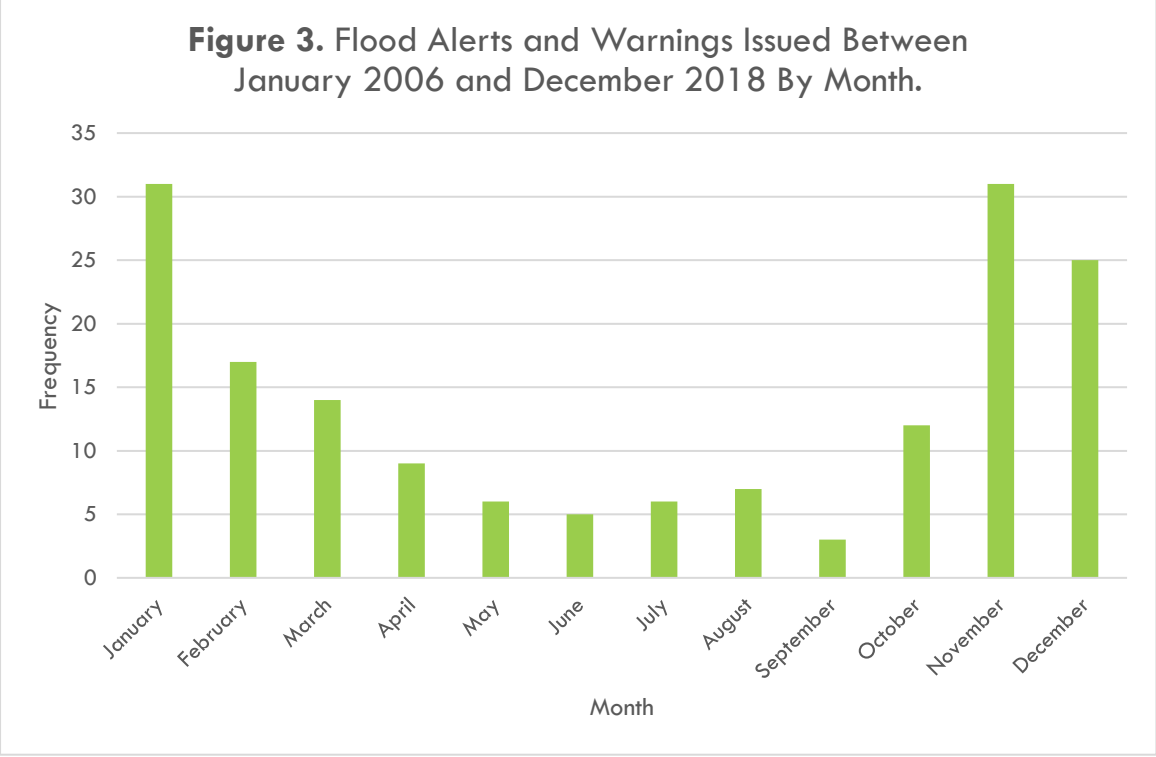


Figure 3 illustrates the months of the year in which these Alerts and Warnings have been issued. The majority of Warnings and Alerts have been issued in the winter months with 18.67% issued in November, 15.06% in December and 18.67% in January. Fewest have been issued in the month of September (1.81%).



The village referred to throughout the remainder of this report is situated upon a tributary brook. The alerts and warnings therefore do not necessarily relate to this community. However, a specific rain gauge flood warning system has been installed for this community (M. Walters, 2019, personal communication [verbal], 9th July).

2. Historical Records

2.1. Historical Flooding

This village has experienced a number of flood events in which properties have been flooded. Table 1 details the flood events recorded by the *Environment Agency* and the number of properties flooded in each event. Flooding is caused by high flow events from the channel as well as other surface water flows into the village (*Environment Agency*, 2008; K. Pearson, 2019, personal communication [email], 15th March).

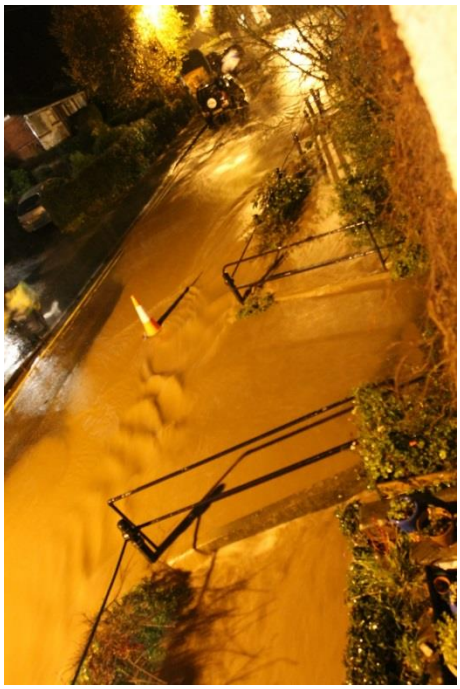
Table 1. (Data Source: *Environment Agency*, 2008; K Pearson 2019, personal communication [email], 15th March)

Date	No. Properties Effected	Other Impacts	Photographs (Freedom of Information Unit, 2018)
1914	60		
1938	45		
1956 December	10-20		
1960 September/October	45		
1964 January	10	Bridges Washed Away	
1967 January	15		
1968 July	25	Railway Line Collapse	1,2,3
2000 October	4		
2008 October	3		
2012 July	2		
2012 November	5	Surface Water	4

Photograph 1. Flood Event 1968.

Photograph 2. Flood Event 1968

Photograph 3. Flood Event 1968.



Photograph 4. Flood Event November 2012.

2.2. Economic Impact of Previous Flood Events

A Freedom of Information request was made to the *Environment Agency* to obtain any records of the economic impact of this flooding. However, there were no available records. As such, an estimate of the potential costs of these floods is made using five methods:

> **Method 1.** In the *Environment Agency* 'Estimating the economic costs of the 2015 to 2016 winter floods' report (*Environment Agency,* 2018), it is stated that the average national annual insurance claim for flood damages was £50,000. This figure uses the GBP values of 2015. Therefore, the figure has been adjusted to account for inflation to 2018: £54,450.98. This figure is then multiplied by the number of properties effected in each flood event.

Method 2. This method uses the same method as Method 1, but then accounts for non-insurance claims. In the same report (*Environment Agency,* 2018), the *Environment Agency* assumes a default 50% betterment figure. This would therefore amount to a further £25,000 per property in non-insurance claim costs. This figures use the GBP values of 2015. Therefore, the figures have been adjusted to account for inflation to 2018: an additional £27,225.49 per property. This figure is then multiplied by the number of effected properties in each flood event and added to the figure from Method 1.

Method 3. In 2014, the Royal Institute of Chartered Surveyors estimated that the cost of repairs to a flood-hit home would average £30,000 per property (Hayman, 2014). This figure has been adjusted to account for inflation until 2018: £32,994.06. This figure is then multiplied by the number of properties flooded in each event.

Method 4. This method uses the same method as Method 4, but then accounts for flood proofing. In 2014, the Royal Institute of Charted Surveyors estimated that the cost of property flood proofing is £15,000 per property (Hayman, 2014). This figure has been adjusted to account for inflation until 2018: £16,497.03 respectively. This figure is then multiplied by the number of effected properties in each flood event and added to the figure from Method 3.

Method 5. This method is calculates the average estimated figure from Methods 1-4.

The figures calculated from the outlined methods are prevented in Table 2. These figures include only the numbers of effected property and do **not** include the additional observed impacts.

NOTE: In Table 1, the 1956 flood event details that flooding effected 10-20 properties. For these calculations, the median number of 15 properties effected was used.

Table 2. (Values have been rounded to the nearest £1)

Date	No. Properties Effected	Method 1	Method 2 (Highest Estimate)	Method 3 (Lowest Estimate)	Method 4	Method 5 (Average Estimate)
1914	60	£3,267,059	£4,900,588	£1,979,644	£2,969,466	£3,279,189
1938	45	£2,450,294	£3,675,441	£1,484,733	£2,227,099	£2,459,392
1956 Dec	15	£816,765	£1,225,147	£494,911	£742,366	£819,797
1960 Sep/Oct	45	£2,450,294	£3,675,441	£1,484,733	£2,227,099	£2,459,392
1964 Jan	10	£544,510	£816,765	£329,941	£494,911	£546,532
1967 Jan	15	£816,765	£1,225,147	£494,911	£742,366	£819,797
1968 July	25	£1,361,275	£2,041,912	£824,852	£1,237,277	£1,366,329
2000 Oct	4	£217,804	£326,706	£131,976	£197,964	£218,613
2008 Oct	3	£163,353	£245,030	£98,982	£148,473	£163,959
2012 July	2	£108,902	£163,353	£65,988	£98,982	£109,306
2012 Nov	5	£272,255	£408,382	£164,970	£247,455	£273,266

3. Number of Properties at Risk from Flooding

Table 2 details the number of properties to be at risk, including whether they are residential or commercial properties (*Environment Agency*, 2008).

Table 2. (Data Source: *Environment Agency, 2008*)
Res. = Residential Use. Com. = Commercial Use)

Flood Category	10% (High Risk)			1% (Medium Risk)			0.1% (Low Risk)		
Use	Total	Res.	Com.	Total	Res.	Com.	Total	Res.	Com.
No. Properties	31	30	1	50	49	1	52	51	1

It is further estimated that 10% of Conservation Areas in the village are at risk from flood events (*Environment Agency, 2018*).

4. Intervention

Following the floods of 1968, the *Environment Agency* installed an engineered flood alleviation scheme in the village in l971. The scheme was designed to provide a 14.5 cumec capcity for a period of 30 years (K Pearson 2019, personal communication [email], 15th March). It is estimated that this flood prevention measure provides a "3% standard of protection from the __ Brook" (*Environment Agency*, 2012).

Further, the local parish council is in the process of developing a flood response plan.

5. Catchment Flood Management Plan Recommendations

The *East Devon* catchment flood management plan makes the following policy recommendation for the 'Rural Mid and Lower Catchment', which includes this village amongst other areas.

> *"Policy Option 2 - we can generally reduce existing flood risk effectively. Future increases in flood risk will mainly be driven by climate change, but land use and management changes will also have an effect. Generally, spending on flood risk management activities will be reduced, allowing for more natural river processes, creation of wetland habitats, and the reconnection of rivers with their floodplains. Localised defence measures would continue to be maintained in settlements at risk such as __ and __."* (*Environment Agency*, 2012).

This flood plan is currently in the process of updating at the *Environment Agency*. As such the 2012 catchment flood management plan may soon be decommissioned, but these are still in action until that point.

6. Beaver Presence

In 2016/17, the first signs of beaver activity were observed upstream of the village. A pair of beavers have since built a dam of approximately 6ft in height, behind which dam water from the brook is being held and released at a slower rate downstream. This is being monitored currently by hydrologists at the University of Exeter.

6.1. Tenant Farmers' Experience

The beavers have had a number of impacts upon the tenant farmers' land upon which they are present. These are being addressed between the farmer and the 'River Otter Beaver Trial'. A summary of impacts include:

- Water held on water meadows set aside by the farmer for an Environmental Scheme.
- Felling of 4/5 poplar trees. One fell onto the farmers' fence.
- A waterlogged cattle crossing.
- Backlog of water onto an organic arable field at the time of planting seed.

The economic costs relating to these impacts are reported in Case Study 2 of the River Otter Beaver Trial Science & Evidence Report.

6.2. Potential Economic Benefit in Flood Alleviation

The scientific evidence would indicate that beaver damming reduces the potential for downstream flooding (Puttock *et al*, 2017). This would therefore indicate that the community downstream may benefit from flow attenuation as a result of the beaver damming upstream. However, it is currently unclear as to the extent to which this benefit may occur. In particular, there is currently insufficient data to indicate whether the beavers would attenuate the flow enough to alter the extents covered by the flood risk categories assigned by the *Environment Agency*. Ongoing research is looking into this area.

Therefore, an exact estimate of costs avoided is currently not yet possible. However, the possible costs avoided have been assessed under ten hypothetical scenarios using the '*Funding calculator for flood and coastal erosion risk management grant-in-aid allocation*' - a tool which is used in Environment Agency assessments, openly available on the UK Government website (Environment Agency, 2014; T. Buxton-Smith, 2019, personal communication [verbal], 27th July).

The calculator uses statistical data presented in the *Multi-Coloured Handbook: Flood and Coastal Erosion Risk Management Handbook and Data for Economic Appraisal* produced by the *Flood Hazard Research Centre* (Penning-Rowsell *et al.,* 2014). The costs avoided are a weighted annual average damage cost and the data was published in 2014, as such an adjustment for inflation until 2018 is included in the hypothetical scenario assessments.

Of these ten hypothetical scenarios, it is expected the impacts of beavers are more likely to contribute towards scenarios 1 to 6 rather than scenarios 7 to 10. This is as a result of other surface water flows which contribute towards flood risk in the village.

Table 3. Potential weighted annual average damage costs avoided by the reduction of flooding by beavers under hypothetical scenarios.

Scenario	Details	Moderate Risk	High Risk	Very High Risk	Pre-Inflation			Post-Inflation		
					Benefit Per Year	**5 Year Benefit**	10 Year Benefit	Benefit Per Year	**5 Year Benefit**	10 Year Benefit
Properties Currently At Risk		***7***	***38***	***5***						
1	One moderate risk property downgraded to low risk	6	38	5	£150	£750	£1,500	£163	£815	£1,631
2	One high risk property downgraded to moderate risk	8	37	5	£450	£2,250	£4,500	£489	£2,446	£4,892
3	One very high risk property downgraded to high risk	7	39	4	£750	£3,750	£7,500	£815	£4,076	£8,153
4	All moderate risk properties downgraded to low risk	0	38	5	£1,050	£5,250	£10,500	£1,141	£5,707	£11,414
5	All high risk properties downgraded to moderate risk	45	0	5	£17,100	£85,500	£171,000	£18,588	£92,939	£185,877
6	All very high risk properties downgraded to high risk	7	43	0	£3,750	£18,750	£37,500	£4,076	£20,381	£40,763
7	All moderate and high risk categories downgraded one risk category	38	0	5	£18,150	£90,750	£181,500	£19,729	£98,645	£197,291
8	All high and very high risk categories downgraded one risk category	45	5	0	£20,850	£104,250	£208,500	£22,664	£113,320	£226,640
9	All properties downgraded one risk category	38	5	0	£21,900	£109,500	£219,000	£23,805	£119,027	£238,053
10	All properties downgraded to low risk	0	0	0	£30,600	£153,000	£306,000	£33,262	£166,311	£332,622

To note, in the *East Devon Catchment Flood Management Plan,* an estimated average annual damage cost was estimated. On page 102 of the appendices, the estimated figure of **£0.5million** is provided for this village and two others combined (*Environment Agency,* 2008).

6.3. Tenant Farmer's Viewpoint on Flow Attenuation

The tenant farmer upon whose land the beavers have dammed was asked for their perspective on the potential flow attenuation impact of those beavers. The farmer stated that the level of flood alleviation that could occur as a result of the beaver dam would be limited due to the fact that they felt no more water could really be stored beyond what was already present.

> *"They've put the activity in there which is fine and good. I can't quite see there can be any more holding capacity of water than there is at the moment because obviously a flooded area can't hold any more than, it's not like it's a big tank which drains down and then fills up again during flooding."*

However, the farmer then stated that the dam would slow the flow rate of water passing through the site…

> *"The only thing it obviously does do is for the water to pass through the area, there's a physical slowing down of the channel."*

…but they wished to highlight that other variables would also have had an impact. In particular, the farmer highlighted that the farming of approximately 100 outdoor pigs upstream of the site may have contributed towards surface run-off in the past and that this activity ceased shortly before the beavers arrived.

> *"I think we've also got to recognise that, until a similar time scale, there was a thousand outdoor pigs immediately above the site which are no longer there. So with the removal of these pigs and with the seeding out of all that area it's meant that there's a lot less run-off there anyway, it's not just, there's been a lot of other changes in the landscape apart from the beaver dam as well."*

6.4. Relevance to Catchment Flood Management Plan

As seen in Section 5, the *East Devon Catchment Flood Management Plan* recommended policy option includes the "creation of wetland habitats" and "allowing for more natural river processes".

6.5. Community Views

In this section, a number of comments from the local community are presented. These are the relevant comments received in response to an invitation delivered to 303 properties to partake in an online questionnaire, to which 15 responses were received (4.95%). These comments are from residents in the community, the identities of which will remain anonymous.

6.5.1. Community Views of the Beavers' Potential Role in Flood Alleviation

6.5.1.1. Positive Comments

"Seems a good natural solution."

"I am grateful to this project – and the beavers of course! Any reduction in flooding is good and I am a believer in natural solutions to problems wherever possible."

"Having read the effects of beavers in reducing peak flood risks, I believe this could be a fantastic opportunity to increase animal biodiversity in the area, and is a positive measure that is environmentally friendly that can reduce flood risk."

"I think this is a great idea – if beavers can help regulate the flow of water then that may reduce the need for expensive flood defences."

"I agree with the research as any possibility of reducing flooding should be looked into, particularly using nature itself."

"It would seem to be beneficial to the area to allow the beavers to continue to do their excellent work. With the aid of some clearing of waterways – balsam species. The natural flood plain can be used to everyone's benefit."

"This is interesting and I would like to think introducing beavers on the River Otter would help with the flooding problems… This seems a much more 'natural' idea than any other ideas."

6.5.1.2. Negative Comments

"Will this not just create flooding further up river?"

"I would have thought that flood reduction by beavers would be minimal, and unreliable – to say the least."

"If it reduces flooding downstream, does that mean there may be flooding elsewhere?"

"Logically, it seems to me, that if beavers build dams which slows the water flow down river in one place, the water will build up further upstream, if there is a flood. This appears to mean that the flood will occur further up-river."

6.5.2. Community Views on Beavers in Flood Alleviation Compared to Other 'Natural' and 'Engineered' Flood Management Techniques

6.5.2.1. Comments Favouring Beavers

"I think it's great to reintroduce beavers, if they don't create further problems."

"We live on the brook. The flow in winter does seem to have been slower and lower in recent winters after heavy rain since beavers have dammed the brook near [location]."

"I believe in harnessing nature to help relieve problems. A long time ago in Geography lessons I became aware that man-made engineered solutions normally cause a consequential equally damaging problem up/down stream."

"I am no expert in this field, but what I have heard and read is positive. It appears to be a means of using nature to solve the problem of flood risk and may well reduce the need to more expensive and perhaps more environmentally damaging engineered solutions."

"Beavers should be investigated, as should other natural methods, rather than engineering techniques."

"It will certainly help as a natural defence alongside the man made solutions."

"Nature will often find its own route over time, given that the low lying land floods easier. Natural flood plains have evolved over time, it is only for the convenience of humans that we choose to alter route of water. I favour beavers working with nature, and would rather leave areas to be left alone for all wild life as building has rapidly increased and habitat is shrinking."

6.5.2.2. Comments Unfavourable Towards Beavers

"Very unreliable and unpredictable."

"I am not too keen on having beavers on the River Otter, prefer only seeing otters."

6.5.2.3. Neutral Comments about Beavers

"I think if it can be shown that beavers can regulate flow then this is good. I suppose the only issue could be that they might move from an area, or their own dams fail – so it might be best not to rely on them."

"My perspective is to wait until there is a proper flood and see what effect this has on the river and its flood plain."

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