To what extent does the discharge of the whitewell brook agree with theory? essay...

Here is a detailed view of the drainage basin of the Whitewell Brook. The drainage basin is clearly marked with the thick red line.

Describing the characteristics of the Whitewell Brook drainage system.

The Whitewell Brook drainage system is in the Pennines. It is a very complex system that flows into the River Irwell and then on into the Manchester Ship canal and then into the river Mersey which meets the Irish Sea at the Mersey Estuary. The land near the source of the river is mainly moor land used by farmers as rough grazing for sheep. This is poor quality and course grass. The source of the Whitewell Brook is on bent hill, this is very flat considering it is on top of a hill. We call this a PLATEAU. The plateau is about 350m above sea level but the highest tops range from approximately 350m-430m above sea level.

The Whitwell Brook is roughly 5 miles long. It is very narrow at the source (see figure 1. 5) and takes up most of the valley floor. The side of the valley are V-shaped. Towards the end of the Whitewell Brook the channel gets wider and the river takes up less of the valley floor because it is a lot wider (see figure 1. 6). The river flows down approximately 200metres, this is spread evenly, and we know this because there are no clusters of contour line on the course of the Whitewell Brook. There are three major tributaries that flow into the Whitwell Brook, these are called Heb Clough, Bridge Clough water and .

The Theoretical basis of the study

Rain falls evenly over the drainage basin. The rain water enters the Whitewell Brook by a large amount of tributaries, as mentioned before. Water enters the tributaries in three different ways, through flow, surface flow and underground flow (see diagram 1. 7). As each tributary enters the river the discharge of the river is increased. When a tributary enters the river the catchment area of the whole river increases by the size of the tributaries catchment area. So, as we move downstream there are more and more tributaries joining the river, therefore more and more catchment area flowing into the same river channel, therefore an increase in the velocity and the mass of water carried by the river. As there are more catchment areas there will be more debris and river load flowing down the same river, this means that there will be more erosion, transportation and deposition. There is a lot more power in the river and with that entire extra load, the stones and boulders in the river will erode the banks and the river floor. Therefore the channel will get deeper and wider.

The aim of the coursework

The aim of our coursework is the see to what extent the discharge of the Whitewell Brook agrees with theory.

The hypothesis we are going to use

The discharge of the Whitewell Brook increases downstream as theory says it should

Methods

Each group had the following equipment:

o Data sheet to record the measurements and observations gathered during the field trip.

o A 30 metre long tape measure to record the width of the river

o Metre ruler to record the depth of the river

o Some sort of float to sail along the water's surface to record the velocity of the river (e. g. bonio dog biscuit, tennis ball)

We worked in groups of four because we felt that was a sufficient number of people to record the data and found an efficient working speed working with this amount of people. We collected six sets of data in total, each set coming from different sites along the river. Everyone in the group rotated in the jobs they had top do so we had always done different jobs throughout the day. We decide on using six sites along the river because we felt that this was an adequate number of sites to get a good variation and to see the extent of changes the river has taken as we get nearer the source. Ideally, we could have made a lot more stops to record data but for three reasons we did not. These were: we did not have enough time to make any more stops, there was not always a safe place to stop along the river and, if we made too many stops, we would not be able to notice a change in the course of the river.

Recording data

To calculate the discharge of the river we needed to calculate the cross-sectional area of the river and velocity of the river. N. B. the discharge of the river is equal to the volume of water passing one point of the river bank each second, this is measured in cubic metres per second (CuMecs). To measure the cross-section we needed to measure the width and the depth of the river at that particular site.

Width

To measure the width of the river we put a marker on each site of the river where the edge of the water is. The point had to be parallel because if they were not straight the measurements would be wider. We used our tape measure to measure the distance between the two making sure that the tape is held taught and does not touch the water. If this is to happen, the reading you get is bound to be incorrect because the velocity of the water would pull the tape and the measurement would be too wide. The width was measured in metres or centimetres, depending if the width was greater or less than one metre.

Depth

We had to measure the depth in different places across the river bed because, as you can imagine, it varies quite a lot in certain places, such as, in a meander, the river channel is deeper on the outside of the turn. We had to decide how many readings to take across the channel according to how much time we had. Eleven measurements proved to be a sufficient number. SEE FIGURE 1. 7 BELOW

We measured the depth in different places by dividing the width of the river into 10 and going along the tape measure to that point and taking our metre ruler into the water and taking a reading. We had to be careful when using our ruler because the water would pool up the face of our ruler due to the speed of the river and the surface area of the face of the ruler. The amount of pooling differed with the speed of the river. At site six, at one point, there was 6cm difference from measuring using the face of the ruler, which recorded a depth of 17cm, to using the side of the ruler, which recorded a depth of 11 cm. Our group decide to use the ‘ side on’ measurement technique because we thought that there was little or no pooling up the ruler.

SEE FIGURE 1. 8 BELOW

We then called out the depth measurements to the person who was adding the data to our data sheets. Ripples at site six also posed a problem for the measurer because of the fast flow of the river. This was more apparent at site six than any other site.

Velocity

We were measuring the velocity to put it into our formula to calculate the discharge of the Whitewell brook to see to what extent its discharge agrees with theory. The formula for velocity is, VELOCITY = Distance / Time. We had to decide on the distance of the measurement course for velocity. We were advised to use five metres so we did because it has worked in the past and if it were too long it would waste valuable time. We wanted a spot that was typical of the site that we were at and a spot that had little or no obstacles. If there were any obstacles, the float might get caught and prolong the time taken to cover the five metre distance, therefore giving an inaccurate distance reading.

Our five metres was spread from 2. 5 metres upstream of the width measurement and 2. 5 metres downstream of the width measurement. We dropped the float in the middle of the river because the current of the river tended to be slower at the sides of the river. We timed the floats over the five metre distance using a stopwatch. We were advised to use a bonio dog biscuit because they are light and they float, they light brown so they are easy sighted in the water and they are cheap to replace and if they are lost down the river, they will not damage any part of the environment or animals because they are bio-degradable. We dropped the float an arms length above the start line so they float could match the speed of the river. We did this three times at each site so we could calculate an average and get the most accurate answer that would iron out mistakes made, if any.

Drainage Basin

Part – A

We identified cumulative watershed area for each measurement site by looking at an O. S. map and studying the relief of the location to work out where the watershed ridge is. We counted how many tributaries which bring tributaries to each site. We did this by counting each source of the tributaries upstream of that particular design. As you can imagine, the number of tributaries is cumulative. Finally, we displayed all this information in graphs, tables and charts.

Part – B

We measured the catchment area at each site by transferring the info from the map onto graph paper by holding it up to the window and going round the watersheds with a pencil. One thing that we had to watch out for was that, if we used a pen that was thicker than a square on the graph paper, it would make the counting up of the squares inaccurate because when fitting the number of little squares into the scale, we could get an inaccurate catchment area. The area was cumulative again because the catchment area of site two includes site one's catchment area also because site one's water flows through site two also. Some squares were only half full with the catchment area, so we included the squares that were 1/2 a square or over. This is as accurate as we could get it but it would still affect the overall outcome.

An Analysis

Graph 1

This graph shows discharge with the distance downstream. The graph has strong positive correlation. The trendline lies close to the most of the points. The discharge increases from 0. 01 cumecs to 0. 52 cumecs. Therefore the discharge gets to 52 times form site 6 to site1. Site 4 was quite an outlier and did not fit in at all. This may possibly be due to a bad measurement, an uneven distribution of tributaries or a large addition of the catchment area at site 4. The points match the trendline (most of them). This shows that the Whitewell Brook's discharge does agree with theory but does not increase uniformly with the distance downstream. The reason for an uneven discharge with the distance downstream because of the differing sizes of the catchment area and an uneven distribution of tributaries.

Graph 2

This graph shows the cross-sectional area with the distance downstream. This graph again has positive correlation. The trendline lies close to most of the points, although, there is one big outlier. The cross-sectional area increases from 0. 05mï¿½ to 0. 965mï¿½. Therefore the cross-sectional area increases by 19. 3 times up to site six. Site 2 was an outlier; there was a very big cross-sectional area. The effect of this could be a very slow velocity at site 2.

Graph 3

The graph has not got much correlation. The trendline is only close to two points on the graph this shows that velocity does not have ‘ increasing ratio’ with the distance downstream. As I predicted, there is an anomaly at site 2. The velocity is a lot slower so the cross-sectional area will be larger. There is a higher average velocity at site 4. This must mean that the water must be flowing through a smaller cross-sectional area

Influences of tributaries

In the last section I looked at the influences of the catchment area with the distance downstream on discharge. The sites that were on or near to the trendline showed that discharge increased further downstream as theory says it should. However, some sites were away from the trendline. This is because most water enters the Whitewell Brook via tributaries and it doesn't enter the river at the same rate all the way downstream.

The distance vs. tributaries graph can show if there distribution of tributaries along the Whitewell Brook. The graph has positive correlation. The trendline lies close to most of the points, there are no big outliers but site 2, 3, 4 and 5 do not lie exactly on the trendline. The tributaries increase from 4 at site 1 up to 90 at site 6. The sites that were above the trendline would make a bigger than average increase in the discharge and the sites below the trendline would make a smaller than average increase to the discharge. To see the increase of discharge with tributaries we look at the tributaries vs. discharge graph.

This graph again has positive correlation. The trendline matches the shape of the plotted slightly. The outliers are 3, 4, 5 and 6. these sites would not match the average because of the size or number of tributaries. The sites plotted above the trendline indicate that there would be big or lots of tributaries flowing into that site and the sites that have been plotted below the trendline indicate that these are small or not many tributaries flowing into this site. This change in number of tributaries and discharge is due to the differing catchment areas for each site.