6. Conclusion and Recommendation.

When more than one element is involved in a channel with low flow, the total resistance in that channel is not the algebraic sum of the form and bed resistances but is always greater.

The total resistance to flow in a smooth bed channel is similar to the total resistance to flow in a rough bed channel after subtracting the resistance due to element causing the roughness.

Ways of predicting the total resistance in a channel with obstructions, irregularities or vegetation present in a channel at one time exists and have been helpful to find the total resistance in a channel given one physical parameter of the channel (i.e. either discharge or depth) as seen in section 5.9 of chapter 5

The form roughness due to one element present in a channel is not the same as the form roughness present in that channel when two elements are combined as seen in section 5.51-5.54 of chapter 5. This shows that the relationship between the total resistance due to elements in a channel and the channel itself is not a linear one.

Obstructions, irregularities and vegetation when present in a channel affect the total resistance in that channel in ways that exaggerates the total resistance in that channel.

In an attempt to explain the conclusion directly above James (2012) stated that under low flow conditions the drag coefficient can be expected to vary considerably with Reynolds number.

The variation of overall resistance coefficient with depth depends on the relative dominance of the two contributions. If bed shear dominates (e.g. with a very rough bed and/or sparse form element distribution) f and n decrease with flow depth; if form drag dominates (e.g. high form element concentration due to different elements in the flume) f and n increase with flow depth. For intermediate form element concentrations the trend of resistance coefficient can reverse as flow depth increases. This explains the high resistance coefficients computed when there are three elements present in the flume as the Reynolds number decreases considerably thereby increasing the drag force and hence the resistance is increased.

The SCS method can also be used to compute the total resistance with little average absolute errors in a flume when only two elements are combined in that flume for sparse populations of these elements in the flume especially when the bed is rough.

HR Wallingford's method cannot not be used to compute the total resistance in a channel when more than one element is involved in the channel.

The overall resistance for flow in a channel with large composite roughness elements can be accounted for by the addition of bed surface shear and form resistance contributions. Using the Manning equation, the overall n value is the square root of the sum of the squares of the Manning's resistances coefficients of the components of the flume (i.e. bed and form roughness) while accounting twice for the bed roughness when two elements are combined in the flume and trice when three elements as combined as seen in equation 5.1-5.4 for the different permutations respectively.

Finally the findings from these experiments can be used to obtain the total resistance in a river with low flow with similar arrangement of composites (i.e. three different elements in the river channel with spatial density of the elements).

Further investigations will have to be carried out to see if these formulas can be used for higher flows and for denser or other arrangement of composites.