Variability in Total Sediment Load Using BORAMEP on The Rio Grande Low Flow Conveyance Channel

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Abstract. The Bureau of Reclamation Automated Modified Einstein Procedure (BORAMEP) is a computer program developed by the US Bureau of Reclamation to estimate total sediment load in open sand bed channels. In previous studies using BORAMEP, the program produced obvious calculation errors and error message. In one case, the program was used to estimate the total sediment and suspended sediment loads within the Low Flow Conveyance Channel (LFCC). On average the total sediment load calculated using BORAMEP was lower then the measured load at the sampling sills.

This thesis documents work utilizing measured data from the LFCC in a series of BORAMEP calculation to check the program and identify possible improvements. In the detailed analysis, input data were purposefully varied to evaluate the effect on total sediment load calculated using BORAMEP. The LFCC data includes three measured cross sections sampled on three occasions at 300 cfs and 600 cfs. Section LF-11 at 300 cfs was identified as the most suitable cross section and three vertical profiles were selected for further BORAMEP application. In calculations using the baseline conditions, the overlap between the measured suspended sediment and bed load were varied from 0 to 5%. Minimal errors were found when the overlap ranged from 1 to 2%, and an overlap of 1.3% was chosen for additional analysis. The total load calculated at each vertical profile varied by less than 8 tons per day, which is less than 9% variability.

Variability analyses of BORAMEP parameters were performed. The following parameters and combinations were varied to develop fifteen case studies: flow depth, top width, discharge, velocity, concentration, vertical sampling depth, d35, d65, and water temperature. Summary of results suggested inconsistencies in error message and total load calculations. When flow depth, top width, discharge or mean flow velocity were modified BORAMEP would calculate total load, even though continuity was violated and flow depth did not equal measured plus unmeasured depth. Occasionally, the program calculated total sediment load when d35 was greater than d65 and when d35 and d65 were outside the measured particle distribution, which is physically impossible. As the input for water temperature fell below freezing (32ºF), the program did not account for the effects of ice; and occasionally, calculated total load when it should have provided an error. In addition, the program could not calculate total load when concentration, flow depth, top width, discharge or velocity were set equal to zero. In all these cases the total load should have been calculated as zero. Finally there is no criterion for incipient motion within the program. Reasonable results were obtained when continuity was satisfied. In many scenarios, error messages occurred and the program terminated not clearly providing an explanation to the actual problem that occurred during the total load calculations, making trouble shooting difficult.

A summary of suggested changes in the program are provided. This variability analysis resulted in a list of recommended input and calculation checks, and additional error messages for incorporation in the program. Ten recommended checks and seven additional error messages have been suggested.

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