# A COMPARISON OF WASSP-SIM WITH THE WALLRUS SIMULATION PROGRAM

N.R.Orman - Water Research Centre April 1989

## 1.1 INTRODUCTION

WALLRUS is an updated and enhanced version of the WASSP package. Like WASSP, WALLRUS is a suite of programs. This paper relates solely to the Simulation programs of both packages as this is where the main changes are. It comments on the new features of WALLRUS and compares the performance of the two programs with test models.

WALLRUS was released to a limited number of test sites in February 1988. Full release of version 1.0 took place in August 1988, which was followed by version 1.1 in February 1989.

Before using WALLRUS on any project WRc wished to gain some experience with the program and, more importantly, to establish that the programs were producing sensible results.

## 2.1 NEW FEATURES

- o A spatially varied rainfall capability.
- o Both Summer and Winter rainfall profiles.
- o UK runoff model is applied on an individual pipes basis.
- o Alternative runoff models are available.
- o Diurnal variation in dry weather flow can be modelled.
- o Free surface backwater effects can be modelled in specified pipes.
- o Overland flow routing.
- o Modelling of silted pipes.
- o Improved tank modelling.
- o Various bug fixes.

## 3.1 THE STRUCTURE OF WALLRUS

The functions previously all in WASSP-SIM are now split into three programs in WALLRUS.

- o SIMPART1 carries out preliminary sewer system data checking and processing.

- o RAIN is used to generate UK synthetic rainfall profiles.

- o SIMPART2 carries out the simulation using the rainfall data and the output from SIMPART1.

## 4.1 THE COMPARISON

### 4.1 Changes to the application of the UK runoff model

The UK runoff model used in WASSP uses the percentage runoff equation to calculate a percentage runoff for the whole catchment. This runoff factor is an average and some parts of the catchment may vary significantly from this average. The most common source of such error is caused by variations in the percentage impermeable area. By calculating the PR separately for each pipe WALLRUS can produce better results in catchments with a widely varying PIMP.

A model where the percentage impermeable varied widely was used to test this and WALLRUS was found to produce a better fit against measured data than WASSP.

### 4.2 Comparisons of the Pipe Routing Models without backwater

Tests were run on a small model of a flat catchment to compare the pipe routing performance of WALLRUS with WASSP. A flat catchment was chosen as it represents the most severe test to the pipe routing model.

Direct comparisons of WALLRUS with WASSP showed that for free surface flow, WALLRUS gave a slightly later peak, with peak flows slightly reduced. For surcharged pipes the difference in peak flows became more pronounced. There was also a small loss of volume which did not occur in WASSP.

## 4.3 Tests on the WALLRUS pipe routing model with backwater

The models were then rerun on WALLRUS first with backwater flags set on some of the pipes and then with the backwater flag set on all the pipes. Early tests with version 1.0 gave some rather anomalous results. In the part backwater option the hydrograph was less attenuated and there was a small loss in volume. In the full backwater option this was much more pronounced with a dramatic reduction in the total travel time, a 5% loss of volume and a 30% increase in peak flow. In addition, the imposition of differing downstream level constraints had no effect on the shape of the hydrographs. It had been expected that the use of the backwater flags would cause the hydrographs to be more attenuated, what actually occurred was quite the reverse. This was reported to HR who completely rewrote the backwater routines and these were released in version 1.1 in February this year. However there is a bug in these new routines which caused the model to crash when the tests were rerun. HR have identified the cause of this bug and it will be corrected in version 1.2 which is due to be released in July.

## 4.4 Comparison of tank performance

Tests with a high level overflow generally showed a good correlation between the results from the two programs. There was however a problem in version 1.0 when the backwater flag was set, causing a large volume of water to be generated in the overflow pipe.

Tests on low level overflow showed that on WALLRUS the model was significantly less stable than with WASSP even with no backwater. Shortening the program timestep from 15 seconds to 3 improved this.

Tests with a symmetrical level bifurcation showed that above a certain threshold flow rate, WALLRUS tended to divert most of the flow to the overflow whereas WASSP gave an equal split between the flows.

## 4.5 Run Times

Where the backwater flag was not set WALLRUS gave significantly improved run times over WASSP using the same timestep (a 30% reduction was found on some models). Significant use of the backwater flag however increased run times by up to a factor of 10 for full backwater. Shortening the program timestep from 15 seconds to 5 seconds increases run times by a factor of three. The overall effect on run times will therefore depend on the use of backwater, the need to use a shorter program timestep for some models, balanced by an overall increase in efficiency. It seems likely, however that in general use the run times are likely to be significantly longer than with WASSP in many instances.

## 5.1 SUMMARY

In the areas where the two models can be directly compared, the results from the tests correlated well. The enhancements built into WALLRUS are valuable, and the tests on the new application of the PR equation proved it to be a significant advance. The tank routines appear to be more prone to mathematical instabilities particularly for low level overflows, but this can be overcome by reducing the programme timestep, albeit at a cost in run times. WALLRUS does not appear to be as effective at modelling level bifurcations as WASSP at present.

The new backwater routines still do not work properly and will require testing when version 1.2 is released. It is recommended that if WALLRUS has been used in any study, then the results should be rigorously checked, in the light of the problems mentioned above, before using the data.

WALLRUS has the potential to be significantly better than WASSP in the future when the initial problems have been corrected, and I would expect it, ultimately to replace WASSP in general use.

WALLRUS/WASSP Comparison : N. Orman, WRc

R Dew : Yorkshire Water : Who funded the comparison exercise ?

Answer : It was included in the general research programme.

---

A K Harden : Travers Morgan : Are all the bugs fixed ?

M Osborne : HR : There will always be problems with the backwater routines, perhaps we need to specify conditions where they will work successfully. I believe I know how to fix the bugs in the tank routines.

---

J Packman : IH : Was there site data to confirm which of WASSP or WALLRUS was right ?

Answer : Yes there was, the models were verified using WASSP and testing them with WALLRUS produced poorer fits.

---

I. Noble : Watson Hawksley : Did you use design storms in your comparison ?

Answer : No rainfall was used during tests, we used input hydrographs to isolate surface run-off effects.