UNIT HYDROGRAPH METHODS IN CONJUNCTION WITH WALLRUS FOR LONG-TERM SIMULATION OF STORM OVERFLOW OPERATION

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ABSTRACT

A Unit-Hydrograph method calibrated using the WALLRUS modelling suite, is employed to simulate the long-term behaviour of storm overflows in combined sewerage systems. It is shown that this procedure synthesises overflow operation characteristics to acceptable engineering accuracy, measured relative to WALLRUS predictions. This is achieved at only a small fraction of the computer run-time and so makes practicable a wide range of overflow performance and river impact studies using local rainfall records of unlimited extent.

INTRODUCTION

The improvements made during recent years by the provision of effective sewage treatment has made storm water overflow a dominant source of pollution to rivers, lakes and coasts.

In the last decade or so, considerable attention has been focused on sewerage rehabilitation, but the models developed for sewer flow synthesis are often highly complex and time consuming to run. Application of these models has focused on the 'design' storm rather than on long-term simulation and, consequently, much emphasis has been placed on detailed treatment of rainfall, runoff and pipeflow processes.

To meet the environmental standards relating to the storm water overflows, it is essential to be able to quantify the load on the receiving waters from these overflows for representative periods of one year or more, to provide an unbiased appraisal of pollution risk and river impact. As the resources and time required for the extended simulation with an advanced hydraulic model is prohibitive for practical applications in many cases, simplifications are needed in the treatment of the flow process. A simple mathematical model is needed to enable synthesis of the pollution flows and their impact on receiving waters.

This study has the aim to replace the detailed hydraulic models, such as WALLRUS, which deal with a number of problems involved in design and operation of sewer systems (and make great computational demands) by a simple and less time-consuming model that can specifically deal with storm overflow operation and its' impact on receiving water bodies. In its' present state the Unit Hydrgraph approach described here is applied only to flow synthesis, later developments will attempt to incorporate suitable pollution determinands in the appraisal of overfllow performance.

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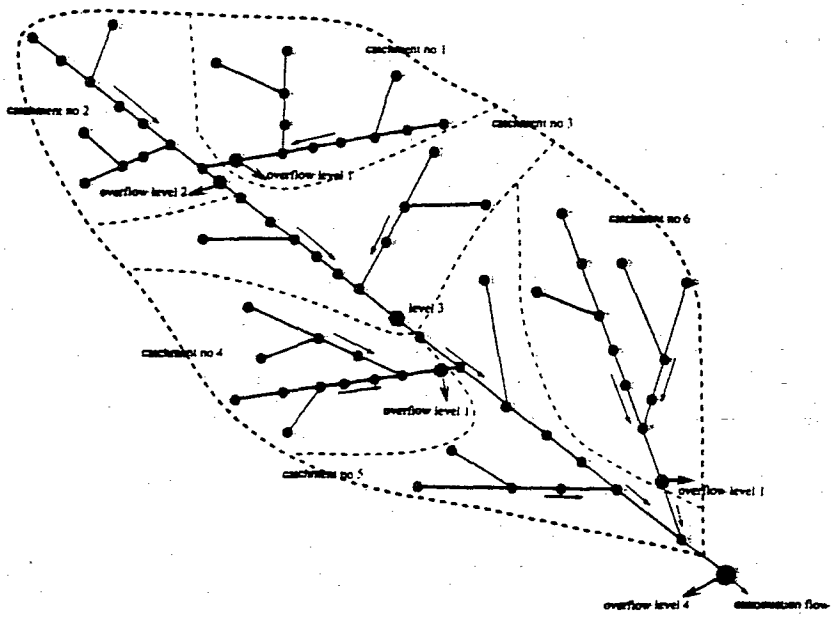
ITEM	PROGRAM	LIVERPOOL ONE YEAR RAINFALL DATA (1956) Rainfall Event no. Overflow Location	1 500	501 1000	1001 1500	1501 2000	2001 2500	2501 3000	3001 3500	3501 4000	4001 4500	4501 5000	5001 5500	5501 6000	6001 6520	TOTAL
INFLOW VOLUME m^3 sec	WALLRUS	D S C1	5078	5080	6504	6200	5472	5540	5122	7803	7801	6762	4807	5412	8832	8[illegible]
		D S C2	9887	9700	12175	11455	10664	10854	9614	13747	13589	12700	9145	10043	14967	148541
		D S C4	5078	5080	6504	6200	5477	5559	5134	7845	7870	6887	4918	5549	8867	80945
		D S C5	26813	25482	31915	28985	28429	25972	26468	33200	31471	32014	25611	26032	35310	381702
		D S C6	5087	5080	6504	6200	5477	5559	5134	7845	7870	6885	4920	5576	8891	81004
	FLOW94	D/S C1	5242	5047	6482	6016	5364	5480	4999	7682	7490	6452	4597	5033	8622	78273
		D S C2	9713	9633	12020	11163	10268	10622	9455	13423	12941	11857	8948	9444	14437	143824
		D/S C4	5242	5047	6482	6106	5364	5480	4999	7682	7490	6462	4597	5033	8622	78273
		D/S C5	25984	25816	31204	28450	28004	29459	25927	32191	30728	30131	24817	25398	34872	371981
		D S C6	5242	5047	6428	6016	5364	5480	4999	7682	7490	6500	4597	5105	8713	78374
OVERFLOW VOLUME m^3/sec	WALLRUS	D/S C1	266	302	997	1074	362	360	410	1688	1893	1100	324	613	2543	11932
		D/S C2	1224	2235	2653	2400	1345	1120	1256	3746	4200	2500	777	1500	4200	29156
		D/S C4	266	302	998	1046	361	355	409	1688	1893	1173	324	613	2543	11971
		D/S C5	1385	1440	2229	2610	1250	713	1599	4007	4200	2700	918	1300	4000	31466
		D/S C6	268	345	968	1060	372	363	423	1632	1800	1108	328	619	2543	11829
		Subtotal	3409	4624	7845	8190	3690	2911	4097	12761	13986	8581	2671	4645	15829	96354
	FLOW94	D/S C1	252	456	938	1046	459	338	490	1937	2034	1061	341	622	2781	12755
		D/S C2	1299	1504	2421	2511	1449	1329	1195	4031	4052	2735	833	1503	4318	29180
		D/S C4	252	469	923	1055	464	331	499	1942	2050	1076	332	645	2782	12815
		D/S C5	1150	1554	2372	2534	1253	787	1274	4160	4150	2766	836	1379	3931	28146
		D/S C6	252	456	938	1046	459	338	490	1937	2034	1061	341	622	2781	12755
		Subtotal	3055 (-10.4%)	4439 (-4.0%)	7592 (-7.7%)	8192 (-0.02%)	4084 (+8.5%)	3123 (+7.2%)	3948 (-3.8%)	14007 (+9.7%)	14320 (+2.4%)	8699 (+1.3%)	2683 (+0.4%)	4771 (+2.7%)	16593 (+4.8%)	95651 (+2.7%)
RUN TIME seconds	WALLRUS		2100	1980	2280	2520	2280	2400	1980	2100	2040	1800	1920	2520	2700	26838
	FLOW94		50	50	50	50	50	50	50	50	50	50	50	50	55	655

Note :- D/S C1 means downstream of catchment no. 1

Table 3.1 :- Overflow Calculations : 'Fig 3.1' sewerage system.



Typical Sewerage System with Overflows at Various 'Levels'

FIGURE : 3.1

Long Term CSO Simulation

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The techniques developed, allow long term simulation and prediction of CSO spill volumes, number of spill events and their duration. Time series runs can be undertaken in about 1 hour compared to 49 hours if WALLRUS is used - at an accuracy of 3%.

The method is presently accurate only in non-surcharged situations - Surcharge and flooding alters the catchment response "signature". Further development could overcome this constraint.