WASTEWATER SAMPLING AND CHARACTERISATION - RAW SEWAGE MONITORING AND RESULTS ANALYSIS

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ABSTRACT

Composite sampling is a widely used technique to monitor and analyse daily flow pattern and quality variations for council's sewage treatment plants (STPs). Programs are usually run over several days and are used to collect information for examination of peak and non-peak loadings, investigation of abnormal conditions, exploration of legal or illegal trade wastes and provision of a basis for the augmentation of an existing STP and forward planning.

Composite sampling involves the use of an auto sampler as well as a portable level sensor equipped with data logger in the inlet flume. There are a number of important considerations to be taken when planning and establishing a successful sampling program.

The paper will provide an overview of sampling and the reasons for composite sampling. A number of case studies will be discussed to demonstrate the benefits achieved in the areas of making decisions for design loads for plant augmentation, trade waste acceptance and understanding of plant inflow diversion to different biological treatment units.

KEY WORDS

72 hour monitoring program, sampling, wastewater characterization, design loads, flow pattern, quality variation, trade waste.

1.0 INTRODUCTION

NSW Public Works is a State Government agency which provides both specialist engineering advice and professional services to Local and State government agencies. Our focus is to provide and drive public value for money in the community. NSW Public Works has successfully undertaken numerous investigations into hydraulic and pollution loads for Councils throughout regional NSW since the 1980's. This information has provided the basis for the development of design parameters used by NSW Public Works for the serviced sites and unserviced areas. This has delivered reliable performance in a cost effective manner for the design of sewage treatment plants.

Composite sampling and wastewater characterisation is a valuable operational tool for Councils. Plant loading information can provide information on poor performance due to overloading, trade waste, illegal connections, inflow and infiltration and indicate capacity issues and timelines for augmentation and upgrade.

2.0 DISCUSSION

The key issues regarding on samplings programs are discussed below.

2.1 Flow Measurement and Flow Division

After having visited many STPs throughout NSW, many operational issues relating to incorrect inflow data have been observed due to age of the plant, lack of proper maintenance of existing flow sensors and inflow measurement flume.

Consequently, the inflow data does not represent the real inflow into the plant, which results in misinformed decisions for future planning and augmentation of existing sewage treatment plants.

Many local governments have realized these issues and have put more effort in getting real inflow and current hydraulic and biological loads to their STPs. This has allowed local governments to gain a greater understanding of their existing STPs hydraulic and biological capacities and thus support decision makers in their future planning.

Many STPs have parallel process streams for secondary treatment, i.e. two Pasveer channels sharing the load. Inaccuracies in flow division can see one stream overloaded and the other under loaded giving an overall poor result and additional work for the operator.

Where an inlet flume is used it should be checked that flow should get away freely. Any blockage downstream may result in building up of water level before the flume. This will contribute higher flow readings than normal. Extra attention should be given to the flume downstream flow conditions during monitoring periods, if the water level is building up more than 70% of water depth before the flume caused by downstream blockage, the monitoring will be compromised.

Accurate flow measurement is essential for a successful loading assessment. NSW Public Works will verify the existing flow measurement and install a temporary flow meter for a sampling program.

2.2 Monitoring/Sampling Conditions

Rainfall will disturb sample quantity and quality and contribute to misleading results. Based on our experience if rainfall is less than the 5 mm threshold, the rainfall induced inflows may not be considered significant. Results will be checked to ensure wet weather has not affected sampling.

2.3 Sample Collection Methods (Grab Samples vs Composite Samples)

Two types of samples are generally taken, grab samples and composite samples. The samples may be obtained either automatically or manually:

Grab samples represent conditions at the instant when the sample was taken. A grab sample may be used when the wastewater characteristics are relatively constant, i.e. effluent from maturation pond, MLSS from reactor, etc. or when a sample requires immediate analysis because of instability of the component to be measured, i.e. bacteriological sample.

Composite samples represent conditions over a longer period. Samples can be collected based on time composite or flow-paced composites where samples are collected every time when a certain amount of flow has been detected by the inlet flow meter. A composite sample gives a reasonable average of the wastewater during the sampling period and aims to eliminate peaks and inconsistencies from single grab samples. Composite samples are the preferred method for raw sewage.

2.4 Sampler Location

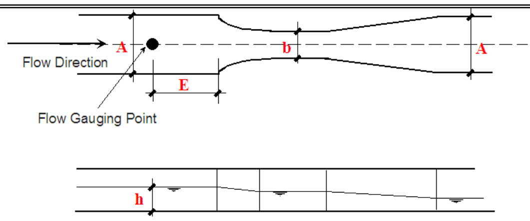
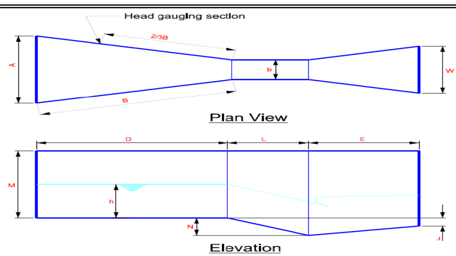
The location of the sampling point will be chosen to present the sewage quality with good mixing and free from floating materials. The inlet of the sampling tube and its strainer should be fully immersed within the inflow at all times, i.e. at the inlet structure upstream of the flume, as shown in Figure 1.

<u>Figure 1:</u> ***Auto Sampler Setup Locations***

2.5 Level Sensor/Flow Measurement Locations

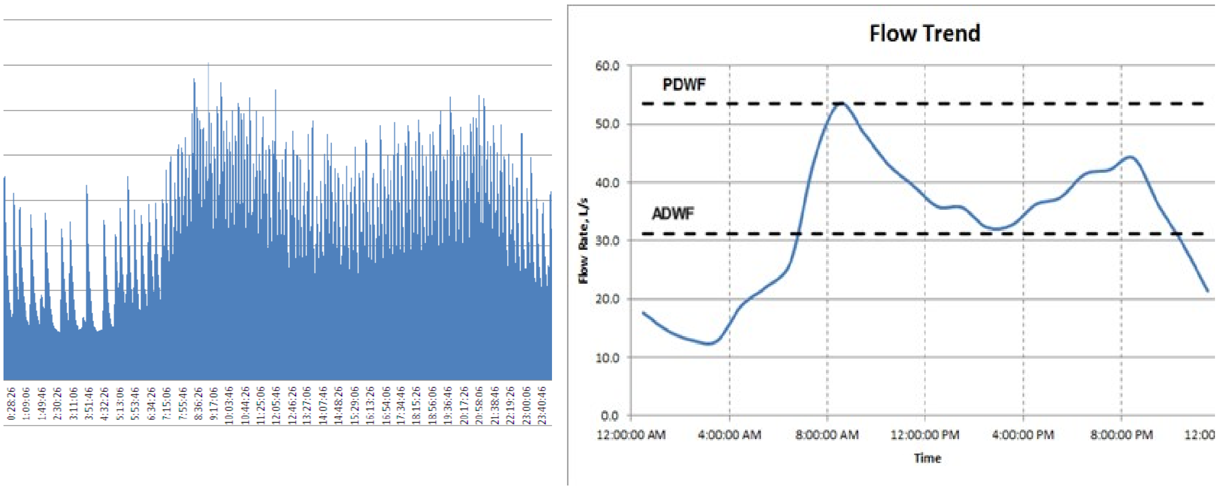
A portable level sensor will typically be installed temporarily at the flume gauging point for inflow measurement during the monitoring period. The gauging point for different flumes is summarised in Table 1.

<u>Table 1:</u> ***Level Sensor Setup Location for Different Flume***

<table>
<tr><th></th><th>ARKON</th><th>PARSHALL</th></tr>
<tr><td>Flume Layout</td><td>
</td><td>
</td></tr>
<tr><td>Example</td><td>channel width A = 610 mm and flume throat b = 305 mm, b/A =0.5, E = 610 mm, ARKON flume -Ref. 1
$Q = 0.5367 \times h^{1.50}$
Where:
Q = inflow, m^3/s
h = water depth at the gauge point, m</td><td>channel width A = 397 mm and flume throat b = 152 mm (6 inch), B=621 mm, 2/3B= 414 mm.-Ref. 1
$Q = 0.3812 \times h^{1.58}$
Where:
Q = inflow, m^3/s
h = water depth at the gauge point, m</td></tr>
<tr><td>Photos</td><td>
</td><td></td></tr>
</table>

2.6 Inflow Pattern

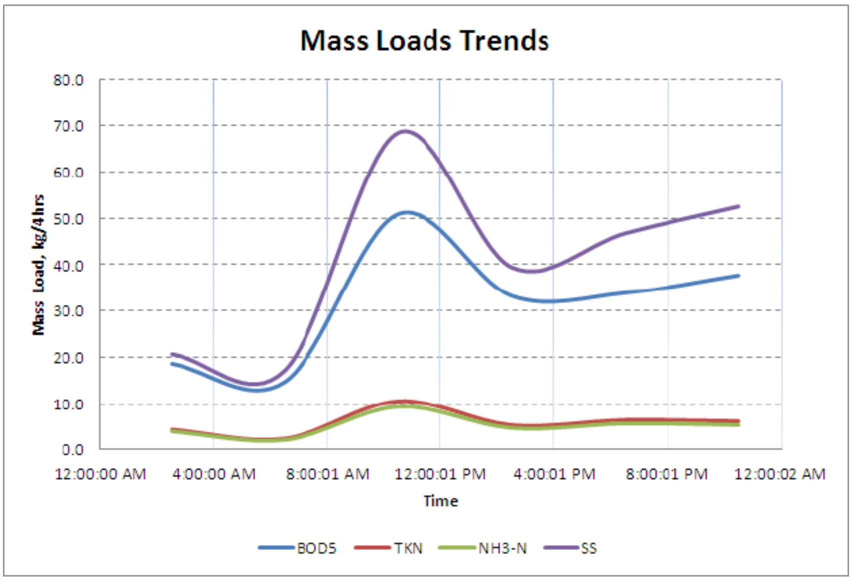
For typical municipal sewerage schemes, the diurnal inflow pattern will be presented a morning peak and an evening peak (**Figure 2**). The highest peak flow between morning peak and evening peak is defined as peak dry weather flow (PDWF). PDWF to average dry weather flow (ADWF) ratio is varied depending on numbers of populations in the serviced sewage scheme. Based on our experience, for a STP less than 1,000 EP, PDWF/ADWF ratio is between 2 and 3.



<u>**Figure 2:**</u> ***Daily Flow Trend***

2.7 Sample Results Analysis and Representation

The analysis of test results will be undertaken using plant inflow data, corresponding to the sample compositing intervals, to produce mass biological loads and derive flow weighted averages for concentrations of the various influent quality parameters. The flow weighted average methodology is a universally accepted procedure. Results can be used for determining available capacity and performance and as an indication of anomalies in either the contaminant concentrations or hydraulic loads such as trade waste and infiltration. Figure 3 shows an example of daily biological mass load trends, which presents daily mass loads variation.



<u>**Figure 3:**</u> ***Daily Biological Mass Load Trends***

2.8 Case Studies

Case 1: Upgrade of an Existing STP

The purpose of the monitoring was to analyse hydraulic and biological loads to be used for upgrading existing STP. The trade waste was observed in the 72 hour inflow monitoring program, in terms of sewage colour, high COD and BOD values. The Council decided to repeat the 72 hour monitoring program to check biological loads after an inspection to find potential sources of trade waste. The results from the second 72 hour monitoring program indicated it was typical domestic wastewater, no trade waste was observed. The summary of two monitoring results is shown in Table 2.

Table 2: ***Summary of STP's Biological Unit Load***

Parameter	**Unit Load (g/EP/d)**		
	First 72 hr monitoring	**Second 72 hr monitoring**	**PW Typical Design Value**
Chemical oxygen demand, COD	**239.2**	123	
Biochemical oxygen demand, BOD_5	**107.5**	56	70
Total Kjeldahl nitrogen, TKN	8.9	6.5	12.5
Ammonia nitrogen, NH_3-N	7.5	5.5	
Suspended solids, SS	**135.2**	78.3	70
Oil and grease, O&G	4.4	2.1	
Total phosphorus, TP	2.6	1.68	2.7
Ortho-phosphate, Ortho P	1.7	1.1	

This avoided over design in the upgrade and increased operational cost of treating the much higher load.

Case 2: Assessment of Trade Waste Load for Establishment of a Discharge Agreement

The purpose of the monitoring was to consider whether to accept the trade waste. The factory has its own primary and secondary treatment processes. The results indicated high strength biological concentrations in terms of COD, BOD, SS, and TP in the effluent from the primary treatment process. The secondary process still indicated high strength of TP in the effluent. This provided Council with sufficient information to support their decision. The summary of the trade waste loads is shown in **Table 3**.

Table 3: ***Summary of Factory' Trade waste Loads***

Parameter	**Effluent from Factory's Primary Treatment**		**Effluent from Factory's Secondary Treatment**	
	kg/d	**EP**	**kg/d**	**EP**
BOD_5	293	4,186	3.2	46
TKN	217	18,083	2.1	175
SS	476	6,800	0.3	4
TP	18.5	6,167	12.1	4,033

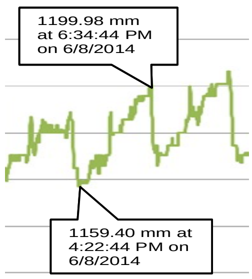
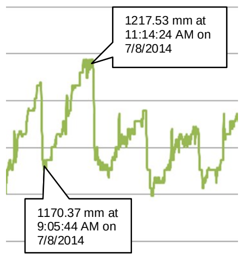
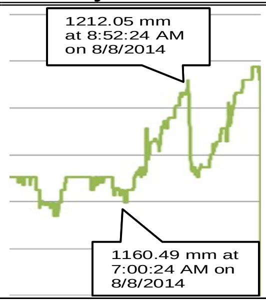
Note: *Chemical allowance BOD_5 / SS: 70 g/EP/day, TN/TKN: 12 g/EP/day and TP: 3 g/EP/day- Ref2*

Case 3: Assessment for STP Capacity & Spilt Ratio between Pasveer Channels Inflow

A 72hr sampling program was undertaken on a plant with two Pasveer channels. This gave the parameters of BOD_5, NH_3-N and SS, as being 31.2 %, 18.5 %, and 46.4 % of plant design capacity, respectively. This indicated the plant was lightly loaded at the time of sampling.

There were concerns on the accuracy of the plant flow divider. A portable level sensor was installed to monitoring water level in Pasveer channel (PC) No.2. A data logger recorded level data every 20 seconds. The inflow was calculated based on the level data and compared to the plant flow meter at the inlet works. Three cycles were assessed and show that plant inflow does not split equally to each PC. PC No.2 receives about 68.8% plant inflow and the other around 31.2%. This results in overall poor performance. Details of the testing are shown in Table 4.

Table 4: ***Assessment for Pasveer Channel No.2 Inflow***

<table>
<tr><th></th><th>Cycle No.1</th><th>Cycle No.2</th><th>Cycle No.3</th></tr>
<tr><td>Trends, Date/Time</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Start/ Stop Levels, mm</td><td>1159.40/1199.98</td><td>1170.37/1217.53</td><td>1160.49/1212.05</td></tr>
<tr><td>Inflow, kL</td><td>29.575</td><td>34.557</td><td>37.672</td></tr>
<tr><td>Total Plant Inflow, kL</td><td>41.267</td><td>52.112</td><td>55.186</td></tr>
<tr><td>Ratio, %</td><td>71.7 %</td><td>66.3 %</td><td>66.3 %</td></tr>
<tr><td>Average Ratio,%</td><td colspan="3">68.8 %</td></tr>
</table>

3.0 CONCLUSION

Based on our experience, the following conclusions are made in relation to inflow monitoring program.

- Very useful tool in optimising and investigation of plant performance;
- Often identifies unusual results ;
- Selection of the right sampling methods is essential, to assure the sampling objective is achieved;
- Setup of monitoring equipment at right locations to ensure right samples are collected; and
- Use of right methodology for assessing monitoring results is important.

4.0 ACKNOWLEDGEMENTS

I would like to thank our team to provide valuable suggestions for the paper.

5.0 REFERENCES

A Guide to the Design of Flow Measuring Flumes, NSW Public Works, April 1985.
Hydraulic and Pollution Load on Sewage Treatment Plants – NSW Department of Public Works, January 1994