Magic or Myth?
Exploring the Facets of a Novel Electronic Surveying Technique

Speaker and Author: Stephanie Bostock, Senior Engineer, Pell Frischmann, sbostock@pellfrischmann.com
Co-Author: Johnathan Hubbard, Modeller, Pell Frischmann, jhubbard@pellfrischmann.com

What is Electronic Surveying?

Electronic surveying passes an electrode along a surcharged sewer which forms a circuit with a surface electrode. The system works with pipe materials that have high electrical resistance compared to water. Most sewer pipe materials such as clay, plastic, concrete, asbestos reinforced concrete, steel reinforced concrete and brick are electrical insulators and thus have high resistance to electrical current. Therefore a defect in the pipe that leaks water will also leak electrical current, whether or not water infiltration is occurring at the time of the test.

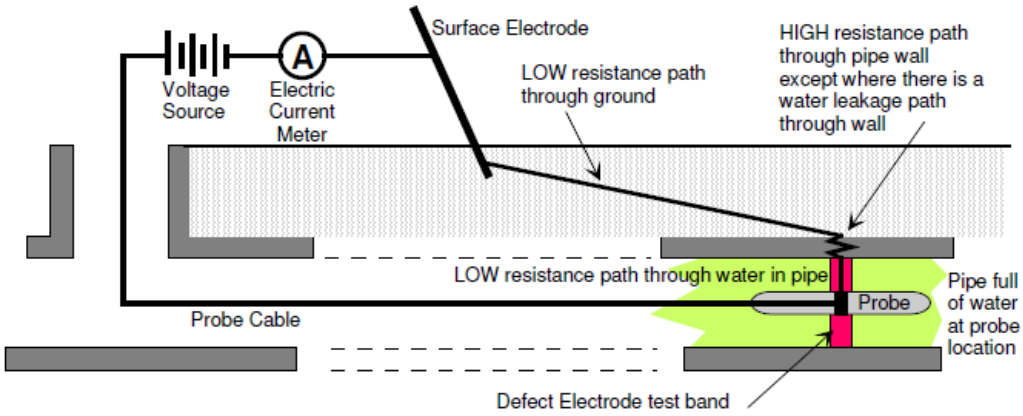


Figure 1: Simplified Circuit Diagram of Electronic Survey

The electronic survey is carried out by applying an electric voltage between an electrode in the pipe, called a probe, and an electrode on the surface, which is usually a metal stake pushed into the ground. The water in the pipe is at a level that ensures that the pipe is full at the probe location. The electrical resistance of the current path between the probe and the surface electrode is very low except for through the pipe wall. The high electrical resistance of the pipe wall prevents electrical current from flowing between the two electrodes unless there is a defect in the pipe, such as a crack, defective joint or faulty connection. The electronic survey is carried out by pulling the probe backwards through a pipe at a speed not exceeding 10 metres per minute.

Case Study – Flushing, Cornwall

Flushing was the first sewerage catchment pioneered by South West Water (SWW) to employ the electronic survey technique as it was a catchment with significant saline infiltration problems which previous CCTV surveys had failed to locate. Flushing is a Cornish fishing village located on the Falmouth Estuary with narrow streets and a gravity sewer network consisting of small diameter sewers gravitating to Flushing Sewage Pumping Station (SPS) on the foreshore.

Infiltration was identified as a problem in Falmouth from the high saline flows arriving at the sewage treatment works and our initial investigation of pump run times and power demand identified Flushing SPS and Prince of Wales Pier SPS both had high dry weather flows.
Initially a five week survey was commissioned to monitor performance of the Flushing SPS over a full month tidal cycle and to evaluate possible infiltration caused by the tidal cycle. The survey consisted of:
2x pump runtime loggers to monitor pump stop/starts
1x wet well depth monitor
1x conductivity probe to measure the conductivity of the wet well
1x raingauge
Power data for the pumping station was extracted from South West Water's "Nemesis" power database.

The survey findings are summarised in Figure2 below and shows the clear correlation between tide states and the pumping station operation.

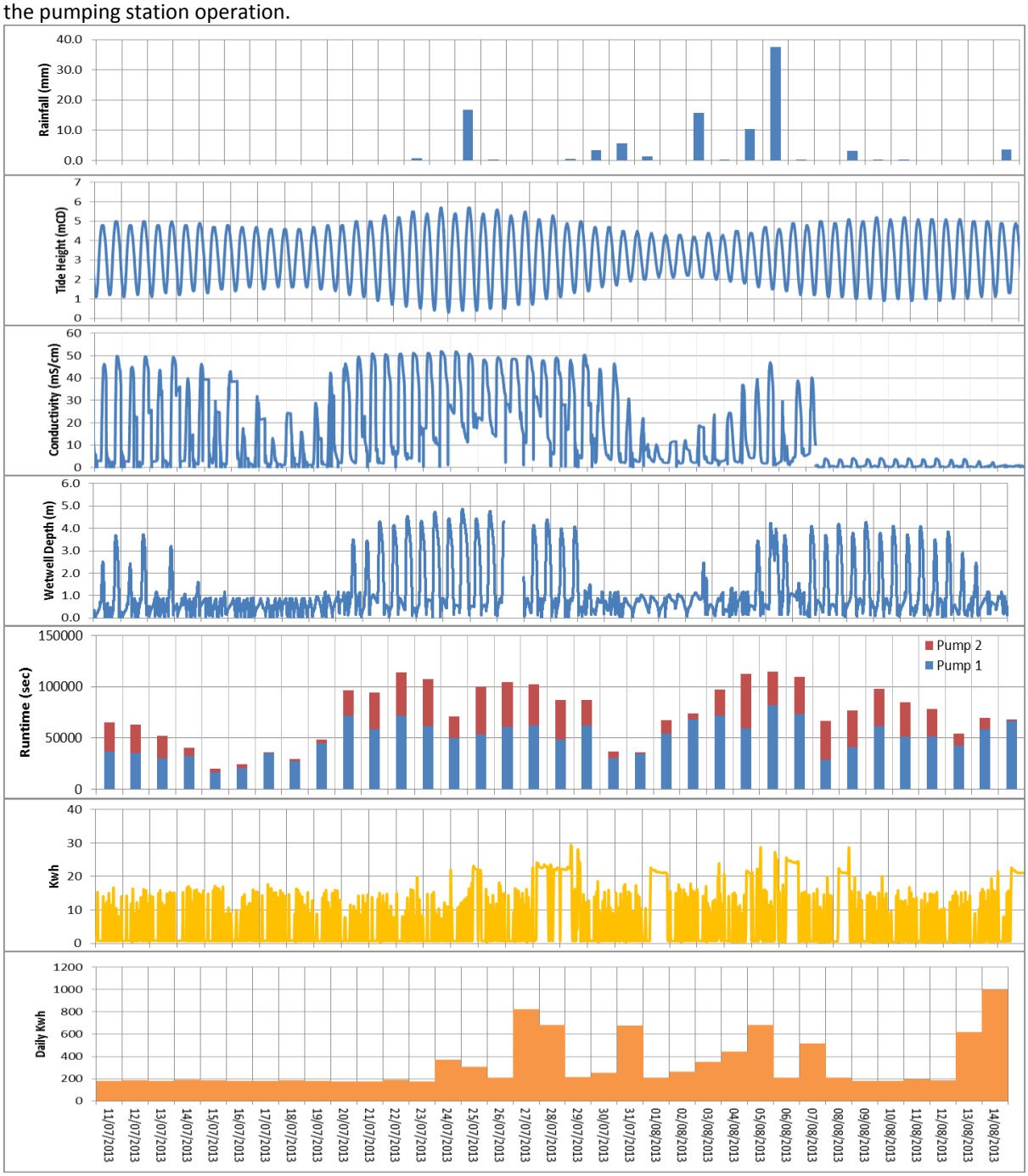
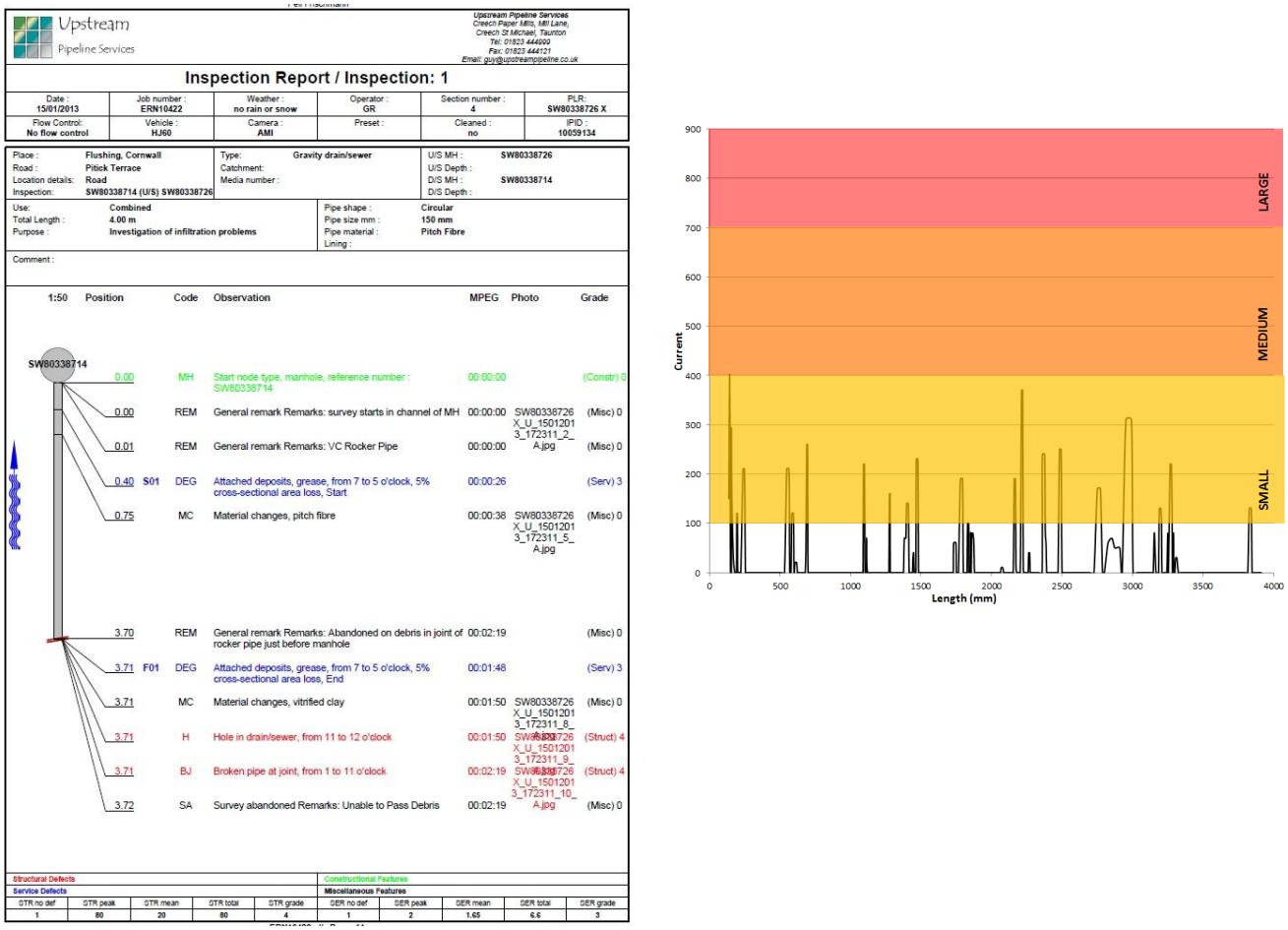


Figure 2: Graph Output of Flow Survey

Sewers were selected to be surveyed if located below the mean high water spring tide level of 3.21mAOD or in area of potential groundwater infiltration zone based on Shallow GroundwaterMaps provided by the British Geological Society together with previous site observations. In total approximately 1100m of public sewer were identified for survey.

Comparison of Results

A comparison of results at one location can be seen in Figure 3 below.



Upstream Pipeline Services

Upstream Pipeline Services
Creech Paper Mills, Mill Lane,
Creech St Michael, Taunton
Tel: 01823 444999
Fax: 01823 444121
Email: guy@upstreampipeline.co.uk

Inspection Report / Inspection: 1

Date :	Job number :	Weather :	Operator :	Section number :	PLR:
15/01/2013	ERN10422	no rain or snow	GR	4	SW80338726 X
Flow Control:	Vehicle :	Camera :	Preset :	Cleaned :	IPID :
No flow control	HJ60	AMI		no	10059134

Place :	Flushing, Cornwall	Type:	Gravity drain/sewer	U/S MH :	SW80338726
Road :	Pitick Terrace	Catchment:		U/S Depth :	
Location details:	Road	Media number :		D/S MH :	SW80338714
Inspection:	SW80338714 (U/S) SW80338726			D/S Depth :	

Use:	Combined	Pipe shape :	Circular
Total Length :	4.00 m	Pipe size mm :	150 mm
Purpose :	Investigation of infiltration problems	Pipe material :	Pitch Fibre
		Lining :	

Comment :

1:50	Position		Code	Observation	MPEG	Photo	Grade
SW80338714							
	0.00		MH	Start node type, manhole, reference number : SW80338714	00:00:00		(Constr) 0
	0.00		REM	General remark Remarks: survey starts in channel of MH	00:00:00	SW80338726 X_U_1501201 3_172311_2_ A.jpg	(Misc) 0
	0.01		REM	General remark Remarks: VC Rocker Pipe	00:00:00		(Misc) 0
	0.40	S01	DEG	Attached deposits, grease, from 7 to 5 o'clock, 5% cross-sectional area loss, Start	00:00:26		(Serv) 3
	0.75		MC	Material changes, pitch fibre	00:00:38	SW80338726 X_U_1501201 3_172311_5_ A.jpg	(Misc) 0
	3.70		REM	General remark Remarks: Abandoned on debris in joint of rocker pipe just before manhole	00:02:19		(Misc) 0
	3.71	F01	DEG	Attached deposits, grease, from 7 to 5 o'clock, 5% cross-sectional area loss, End	00:01:48		(Serv) 3
	3.71		MC	Material changes, vitrified clay	00:01:50	SW80338726 X_U_1501201 3_172311_8_ A.jpg	(Misc) 0
	3.71		H	Hole in drain/sewer, from 11 to 12 o'clock	00:01:50	SW80338726 X_U_1501201 3_172311_9_ A.jpg	(Struct) 4
	3.71		BJ	Broken pipe at joint, from 1 to 11 o'clock	00:02:19	SW80338726 X_U_1501201 3_172311_10_ A.jpg	(Struct) 4
	3.72		SA	Survey abandoned Remarks: Unable to Pass Debris	00:02:19		(Misc) 0

Structural Defects | Constructional Features
Service Defects | Miscellaneous Features

STR no def	STR peak	STR mean	STR total	STR grade	SER no def	SER peak	SER mean	SER total	SER grade
1	80	20	80	4	1	2	1.65	6.6	3

Figure 3: Flushing CCTV Survey Report and Electronic Survey Report for the same length of sewer

Flushing Case Study Conclusion

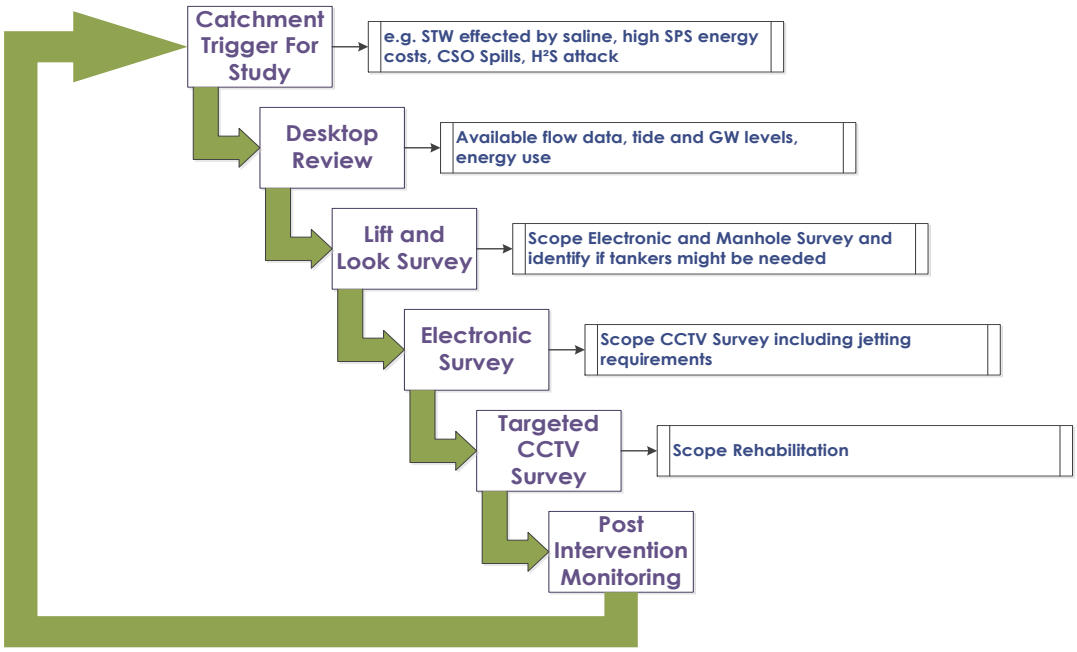
The Flushing Case Study recommended rehabilitation to 419m of sewer ranging between 100mmØ to 225mmØ at a total estimated cost of £178k.

The primary benefit to the reduction in infiltration will be reducing operational costs at Flushing SPS, Prince of Wales Pier SPS and Falmouth STW. Operational cost savings include reduced power and chemical costs at the STW where they currently dose for odour control and sludge dewatering.

The rehabilitation will provide the added benefits of pro-actively removing future issues with pitch fibre pipes and reducing CSO spills to the Falmouth Estuary, a designated EU Shellfish Water.

Lessons Learned

- Electronic surveying out performs CCTV in areas with high debris
- Salinity affects conductivity and this can be difficult to predict – particularly in estuarine locations
- Often no need for tankers because the flow rate is sufficient to surcharge the sewer
- Electronic surveying is faster than CCTV
- In surcharged sewers manhole infiltration can be identified and infiltration is often picked up in rocker pipes
- Care needs to be taken in surcharging sewers particularly adjacent to watercourses
- Electronic Surveying is most effective when used to target CCTV surveys, see Figure 4 below.



F

Advantages

- Electronic Surveying identifies locations where infiltration can occur, rather than defect locations, therefore it is less subjective.
- The Electronic Survey covers significantly more meterage than CCTV.
- There are generally no survey abandonments caused by debris, unlike CCTV.
- Timing of surveys is less critical where there is significant infiltration such as tidal zones and areas with high groundwater tables.

Disadvantages

- Sewers must be surcharged.
- Defects may require further definition by CCTV prior to scoping sewer rehabilitation.
- Approximately twice the cost of CCTV day rate although similar per metre rate.

Future Development Opportunities

A key advantage of the electronic survey is being able to accurately target effective rehabilitation however it is also possible to start developing information and predict which pipes are likely to fail in the future. Where the survey data identifies a number of current peaks below the infiltration threshold level, this suggests that the pipe walls are thin, possibly suffering from micro-fractures; such defects simply cannot be detected using a CCTV camera.
Such data and appropriate interpretation offers potential to develop Asset Management Tools to plan future rehabilitation.

Conclusion

1. The electronic survey system has proven repeatable data capture and identified defects in a saline catchment that previously alluded CCTV inspections;
2. By employing an experienced contractor, high work rates can be achieved such that costs effectiveness compares with conventional CCTV techniques;
3. Downtime and abandonment is not anticipated from the Case Study and other sewer investigations compared with conventional CCTV techniques.
4. The electronic survey system offers significant future potential to develop the ability to monitor and plan asset management of vital buried infrastructure.