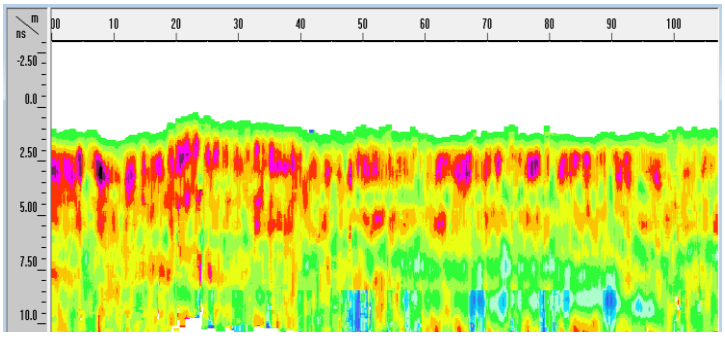
Carnell

SMART**scan** Survey Report

Area 6 – M11 Junction 6 – Junction 9



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31st MAY 2018

Introduction

This report sets out the findings of the SMART**scan** survey work undertaken on behalf of Kier Area 6 on the North and Southbound carriageway filter drain of the M11 junctions 6 - 9. The survey work was undertaken in 10 shifts ranging from the 15th January to 15th Feb 2018 and entailed working under a 12C Mobile Closure provided and maintained by Kier.

Background

Carnell's SMART**scan** survey technique uses Ground Penetrating Radar (GPR) to develop a readable image of the physical nature of a roadside filter drain, and in particular the make-up of the pores within the filter material. This is a key factor that determines the permeability and storage capacity of the drain and its effectiveness in speedily removing surface and sub-surface water from the highway.

After extensive research and development, Carnell has developed GPR technology to provide a unique filter drain surveying service for the highways industry that gives asset owner's valuable information about the make-up and performance of their filter drains, helping them make risk based assessments about maintenance intervention timescales and budget allocations for this element of their asset.

SMART**scan** uses bespoke software to analyse the reflected radio waves transmitted into the ground by the radar head, in order to create a colour coded survey image based on the variations in the received signal that are caused by the network of pores within the drain. This image can then be used to indicate areas of the filter drain where the capability to transmit surface water down to the carrier pipe is limited, or where the capacity to receive water from the adjacent pavement is restricted.

The depth of the SMART**scan** survey is dependent on the frequency of the signal, together with the electrical conductivity of the various materials encountered in the drain. As the conductivity increases, the penetration depth decreases due to the electromagnetic energy within the pulse being more quickly dissipated into heat, causing a loss in signal strength at depth. Even so, penetration depths of 750mm are readily achievable which is sufficient to provide strong indication of the filter drain condition.

Executive Summary

The following Executive Summary is taken from the results of the SMART**scan** survey, details of which are available from the 'Consolidated Information Sheet' supplied with this report – please refer to the 'SMART**scan** Results' section of this report for further information on the structure and operation of this sheet.

A total of 112 SMART**scan** surveys were completed along the verges; 54 on the Northbound verge, 37 on the Southbound verge and 21 in the central reserve. In addition, there were 42 sections (approx. 5.6km) of filter that our operatives were unable to scan due to the following reasons; all these sections have been noted in the 'Comments' section of the Consolidated Information sheet:

- where the in-situ safety barrier prevented the Radar head being placed directly over the centre of the filter drain
- where TM restrictions prevented access to the survey locations

Visual inspection of the photographs taken in conjunction with the SMART**scan** survey shows very few areas of clean stone with no visible build up of debris to the surface. Many of the sections of filter media show a steady build-up of silt and detritus along the sides and encroaching into the filter media, along with grass and vegetation covering the surface with only small sections visible. The majority of sections have a heavy build-up and dense covering of silt, grass and vegetation where the filter media is not visible at all. This has resulted in 21 of the surveys being noted as *'possible'* filter drain due to the survey engineers being unable to confirm the presence of filter material, despite the site layout indicating that a filter drain should be present.

Northbound verge

The SMART**scan** survey images suggest that 19 of the sections scanned show the filter material to be losing porosity at the surface of the drain; e.g. MP 25/5+30 to MP 25/6 or throughout the depths of the drain; e.g. MP 25/9+10 to MP 26/0+85. At these locations, the evident presence of vegetation and silt to the surface of the drain may be the cause of the low levels of porosity and any surface water may struggle to find its way off the carriageway and into the drain, which could lead to standing water at the edge of the carriageway. The remaining sections; e.g. MP 43/2+80 to MP 43/3+20 shows the drain to be in a reasonable condition, with 6 of the scans showing the filter material to have a good void capacity and able to route the surface water away from the carriageway.

The SMART**scan** *'Serviceability Condition Score (SCS)'* graphs support the survey images suggestions that the filter material has a low level of functionality with 11 of the scans scoring a 5, and 8 scoring a 4; e.g. MP 69/7+30 to MP 70/0+50 This suggests that the filter material at these locations has a low void capacity which contributes to the drains lack of permeability and poor functionality. The remaining 34 scans score either a 2 or 3; e.g. MP 47/0+90 to MP 47/1+90; which suggests that these sections of drain have a medium void capacity and a reasonable level of drainage efficiency.

Southbound verge

The SMART**scan** survey images suggest that 24 of the sections scanned show the filter material to be losing porosity at the surface of the drain; e.g. MP 42/4+80 to 42/2+70 or throughout the depths of the drain; e.g. MP 67/7 to MP 67/6+50. At these locations, the evident presence of vegetation and silt to the surface of the drain may be the cause of the low levels of porosity and any surface water may struggle to find its way off the carriageway and into the drain, which could lead to standing water at the edge of the carriageway. The remaining sections; e.g. MP 42/0 to MP 41/9+80 shows the drain to be in a reasonable condition, with 3 of the scans showing the filter material to have a good void capacity and able to route the surface water away from the carriageway.

The SMART**scan** *'Serviceability Condition Score (SCS)'* graphs support the survey images suggestions that the filter material has a low level of functionality, with 19 of the scans scoring a 5, and 5 scoring a 4; e.g. MP 63/4+40 to MP 63/1+80 This suggests that the filter material at these locations has a low void capacity which contributes to the drains lack of permeability and poor functionality. The remaining 13 scans score either a 1, 2 or 3; e.g. MP 26/6+20 to MP 26/4+50; which suggests that these sections of drain have a medium to high void capacity and a reasonable level of drainage efficiency.

North/Southbound Centre

The SMART**scan** survey images suggest that 17 of the sections scanned show the filter material to be losing porosity throughout the depths of the drain; e.g. MP 59/7+90 to 60/0+35. At these locations, the evident presence of vegetation and silt to the surface of the drain may be the cause of the low levels of porosity and any surface water may struggle to find its way off the carriageway and into the

drain, which could lead to standing water at the edge of the carriageway. The remaining sections show the drain to be in a reasonable condition or showing the filter material to have a good void capacity being able to route the surface water away from the carriageway.

The SMART**scan** *'Serviceability Condition Score (SCS)'* graphs support the survey images suggestions that the filter material has a very low level of functionality, with 17 of the scans scoring a 5; e.g. MP 28/8+80 to MP 28/2 This suggests that the filter material at these locations has a very low void capacity which contributes to the drains lack of permeability and poor functionality. The remaining 4 scans score either a 3 or 1; e.g. MP 28/7 to MP 29/2; which suggests that these sections of drain have a high void capacity and a reasonably good level of drainage efficiency

Overall Summary

The SMART**scan** data submitted in this report should be viewed in conjunction with other available data before making a decision on the performance of a particular section of filter drain. Where Particle Size Distribution (PSD) data is not available for a section of filter drain, or a section in the immediate vicinity, collection of this data should be considered to help validate the SMART**scan** results.

SMARTscan Results Table

The results for the SMART**scan** survey have been collated into a single spreadsheet (*Consolidated Information Sheet*) stored on the 'CD/Data Stick' provided with this report, with internal hyperlinks to the SMART**scan** trace, SMART**scan** condition assessment; PSD analysis and site photographs for each section surveyed.

Consolidated Information Sheet

The '*Consolidated Information Sheet*' contains a *traffic light* guidance system suggesting the condition of the sections of filter drain, allowing for ease of identification of problematic areas.

- Filter material suggests the drain is not working efficiently and would benefit from immediate investigation
- Filter material suggests the drain is in an average condition but may require investigation in the medium term
- Filter material suggests the drain is in an acceptable condition

SMART**scan** Trace

The equipment used during the survey collects condition analysis to an average depth of 750mm. The colours within the trace range from black and pink through to green and are a representation of the level of porosity recorded within the filter material; black being the lowest levels. I have set out the following key as a guide:

- Minimal number of voids within the filter material, filter drain almost certainly blocked
- Minimal number of voids within the filter material, filter drain offering minimal levels of porosity
- Small volume of voids within filter material, filter drain offering low levels of porosity
- Medium volume of voids within the filter material, filter drain offering average levels of porosity
- Some loss of void volume within the filter material, filter drain offering good levels of porosity
- Minimal loss of void volume, filter drain offering good levels of porosity

- blue sections within the trace are an indication of water or high moisture content

SMART**scan** Condition Assessment

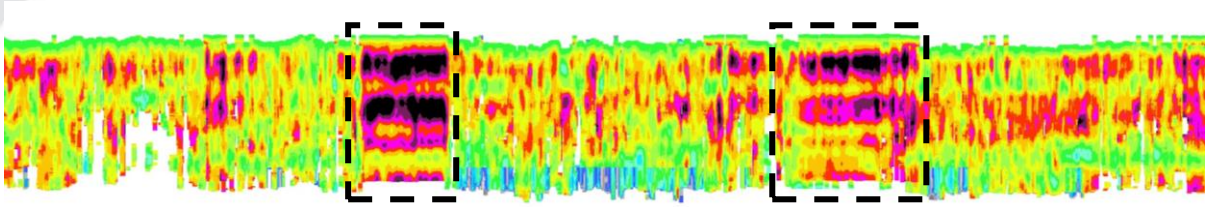
Carnell have developed a process that allows a *'Serviceability Condition Score (SCS)'* to be allocated to the filter material, based on the pixel colouration of the SMART**scan** trace; as shown above.

The SMART**scan** trace is first divided into 20 metre sections and the spectrum of pixels within each section is analysed for each of the top and bottom halves of the scan. Using this pixel analysis, an average weighted score is assessed, based on the number of pixels within each colour band; this allows each 20 metre section to be given a rating score in the range 1 (good condition) to 5 (poor

condition). A line graph showing the results of the SCS grade for each trace is available by following the hyperlink from each section entry within the Consolidated Information Sheet.

Each SMART**scan** trace is then given an overall score that matches the highest score of all individual scores for the scan. However, some of the overall scores for a scan may not be true reflections of the overall condition of the drain, this can occur when the RADAR receives signals from non-filter material i.e. catch-pits, concrete footings for barriers or over-bridges, or the carriageway itself. These sections are counted as '*peaks*' within the drain (see below) and the *'Serviceability Condition Score (SCS)'* graphs should then be inspected to give a more accurate reflection of the condition of the drain.

Peaks in the trace caused by concrete footings for an over-bridge resulting in a high SCS score



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