Research

Dealing with Tar Bound Arisings and Producing a Safe System of Work

Prepared for

Scottish Road Research Board

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SECTION 1

Introduction

1.1 Scope and terms of reference

CH2M HILL have been commissioned by Transport Scotland under the Transport Research Framework to undertake a literature review and prepare a technical memo on the topic of coal tar bound road arisings. This issue represents a long term and widespread problem associated with the ageing road network, on which there appears to be little scope for the sustainable re-use of such material within the Scottish regulatory framework and guidance regarding the assessment of associated risks to human health and the environment.

As detailed in the proposal of February 9, 2015, this report represents the culmination of a literature review and comprises the first phase of a proposed two stage scope of work regarding the issue of coal tar bound arisings. The purpose of this memo is to:

1) Summarise the use of coal tar in road construction
2) Define the current regulatory position relating to waste classification, transport, storage, treatment, disposal and use of tar-bound materials nationally and in Scotland;
3) Outline the environmental risks (e.g. ecotoxicity, mobility, persistence and degradability) relating to coal tar bound material in the in-situ/undisturbed condition, during excavation, stockpiling and re-use, be it as part of unbound fill or following treatment.
4) Provide a review of the available information, including current practice nationally relating to the identification, testing, classification and use of coal tar bound materials;
5) Review and summarize the available information with respect to human health concerns during the excavation and handling of coal tar bound materials;
6) Outline the commonly adopted methods of treating coal tar-bound materials; and uses of the treated tar-bound arisings in highway / construction operations;
7) Define the standards, specifications and quality controls associated with these particular end uses and standards;
8) Review and outline the current and recommended mitigation measures including PPE and air monitoring (e.g. application of EH40, Workplace Exposure Limits).

SECTION 2

Background information

Bitumen-based surfacing materials predominate in present-day road construction in the UK, but coal-tar pitch based surfaces could have been used in all pavement layers including surface dressings up until the mid-1980s. Isolated materials may occur at later dates where it may have been used for its resistance to diesel.

Road tar is a complex mixture of hydrocarbons derived from the high temperature treatment of coal tar; some of these have been shown to be carcinogenic, others are highly toxic to aquatic life, some are both. A number of marker compounds (e.g. benzo[a]pyrene, phenols and cresols) are used to identify the presence of these potentially hazardous and toxic aromatic hydrocarbons. Some phenols and cresols are toxic to aquatic organisms, and some are carcinogenic. Phenols are relatively soluble in water and can leach easily (ADEPT 2013[1]).

ADEPT (2013) states that as road tar is processed from coal tar it does not contain all the chemicals that are present in unrefined coal tar. In particular there will be few volatile organic compounds, and it was usual for most of the phenols and cresols to be removed to make other products.

It is important to distinguish road tar from bitumen. Typically, bitumen is derived from crude oil and contains a lower proportion of polycyclic aromatic hydrocarbons (PAHs), by several orders of magnitude, than coal tar and therefore present a far lesser risk to the environment and human health. As such, milled uncontaminated bitumous asphalt road planings, can be used with the same environmental precautions as would be applied for virgin material[2].

[1] ADEPT (2013) Managing Reclaimed Asphalt – Highways and Pavements.

[2] Quarry Products Association and SEPA – guidance on the Production of Fully Recovered Asphalt Road Planings

SECTION 3

Waste Classification and Re-use

In the UK the three Environment Agencies generally take the view that all arisings from construction processes should be classed as waste, As such, anyone producing, managing, importing or transporting these materials must comply with the requirements of the relevant Duty of Care regulations and possess all appropriate permits and licenses (ADEPT 2013).

Despite some differences in waste legislation between England, Wales and Scotland, the classification of waste road planings containing bitumous mixtures (including coal tar) is driven by European law, namely the Hazardous Waste Directive (1991). The Hazardous Waste Directive (1991) provides a definition of waste and the framework for the correct management and regulation of hazardous waste throughout Europe. The directive requires identification of which wastes are deemed to be hazardous and has resulted in the publication of the European Waste Catalogue (EWC) in 2002. The EWC is a catalogue of wastes and with regard to bitumous road planings, there are three associated waste codes:

- 17 03 01* - bituminous mixtures containing coal tar
- 17 03 02 - bituminous mixtures other than those mentioned in 17 03 01
- 17 03 03* - coal tar and tarred products

For the above, the asterix identifies which wastes are classified as Hazardous Waste (or Special Waste in Scotland). It should also be noted that waste code "17 03 03 – coal tar and tarred products" is termed an "absolute entry" in the EWC, meaning they are classified as Hazardous Waste regardless of any threshold concentrations and 17 03 01- bitumous mixtures containing road tar are only classed as hazardous waste if threshold concentrations are exceeded (referred as a "mirror entry" in the EWC).

Asphalt waste containing coal tar will be classified as hazardous waste where the level of coal tar is >0.1%, this threshold based on the carcinogenity of coal tar. Guidance document WM2[3] states that where the concentration of benzo[a]pyrene is at or above 50 ppm (mg/kg) in the asphalt arisings alone (excluding other material) then the amount of coal tar should be considered to be sufficient for the material to be hazardous (i.e. >0.1%) and thus coded 17 03 01*. A full treatment of the classification of coal tar containing road planings is referred to in the WM2 guidance.

[3] Technical Guidance WM2, Interpretation of the definition and classification of hazardous waste. 3rd Edition 2013

SECTION 4

Regulatory Position Regarding Re-use of Asphalt Containing Materials

The regulatory position with regard to the reuse of asphalt waste containing coal tar differs between Scotland and England. In England, the approach of the Environment Agency enables 17 03 01 (i.e. hazardous) waste to be recovered where possible as detailed within a regulatory position statement[4] Specifically, the EA will not pursue an application for an environmental permit for the use of asphalt waste containing coal tar, in construction operations (e.g. for roads, pavements, car parks, hard standing etc), if complying with the conditions of its regulatory position statement, i.e. where:

- The asphalt waste containing coal tar is treated at a suitably permitted facility;
- The treated asphalt waste containing coal tar meets the requirements within the Specification for Highways Works Series 900[5] for ex-situ cold recycled bound material (excluding slow hydraulic binders) or within the Specification for Highway Works Series 800[6] for cement and other hydraulically bound mixtures;
- The subsequent movement of the treated asphalt waste is covered by a hazardous waste consignment note; and
- Meeting the relevant objectives of the Waste Framework Directive; '… ensuring that waste management is carried out without endangering human health and without harming the environment and in particular:

  (i) without risk to water, air, soil, plants or animals;

  (ii) without causing a nuisance through noise or odours; and

  (iii) without adversely affecting the countryside or places of special interest.'

The regulatory position statement only applies to the final use of the treated material in construction operations (i.e. the material will remain "waste" up until the point of use). The treatment, including the size reduction, screening and coating, of the asphalt waste containing coal tar at the site of production of the waste, site of use of the waste or at a another site will require an appropriate hazardous waste treatment permit, irrespective of whether the conditions of the regulatory position statement are met. This applies to both in-situ and ex-situ treatment, including mobile plant. Where the treatment plant has a capacity of more than 10 tonnes per day this will be regulated by the EA.

A Quality Protocol (QP) for asphalt waste containing coal tar is currently being considered by the European Pathway to Zero Waste Quality Protocols Team. The QP, if published, will define the standards which asphalt waste containing coal tar must achieve (to be considered a non-waste) to encourage its use as recycled aggregate. The EA's regulatory position statement is an interim position pending the outcome of the quality protocol process and will be withdrawn once a decision is made as to whether it is possible to develop a QP.

Within Scotland, SEPA have issued guidance on the production of fully recovered asphalt road planings. However, as stated in the document the guidance applies solely to source segregated asphalt road planings covered by the European Waste Catalogue Code 17 03 02 (i.e. non-hazardous) and does not cover road tar pitches that are derived from coal and are classed as special/hazardous waste, European Waste Catalogue Code 17 03 03. Furthermore the SEPA guidance states "Where a road has a tar content it is the responsibility

[4] Regulatory position statement on 'The use of treated asphalt waste containing coal tar in construction operations https://www.gov.uk/government/publications/using-treated-asphalt-waste

[5] Specification for Highways Works Series 900 - Clause 948.

[6] Specification for Highway Works Series 800 - clauses 810 to 880.

of the road owner/operator to identify and quantify this and make arrangements for its treatment/disposal at a suitably licensed facility".

As part of this study, preliminary discussions were held with representatives from the SEPA waste team regarding the reuse of coal tar containing road planings. SEPA have confirmed that there is currently no regulatory position for the reuse of planings containing tar and it should be treated as special / hazardous waste. During the discussions it was further confirmed that the designation of this material as hazardous waste precludes the adoption of waste management licensing exemptions for the use of this material and therefore, the only available option for re-use would be under a waste management license. It is recognised by SEPA that the use of waste management licencing for this purpose was "far from ideal" and that SEPA would be receptive to adopting a regulatory position for the reuse of coal tar containing planings should evidence be available to confirm that the reuse of these materials would not present environmental risks.

SECTION 5

Environmental and Human Health Risks Associated with Coal Tar Containing Arisings

The risks from coal tar to human health and the environment are well documented. Coal tar is classified as Category 1B Carcinogen due to the presence of Polycyclic Aromatic Hydrocarbons (PAHs). Road tar may also contain phenols and cresols, some of which are also hazardous to human health. The principle risk is through inhalation of vapours / fumes; prolonged or repeated contact with skin; inhalation of excessive quantities of dust during cutting, drilling, planning or surface treatment of hardened asphalt; and accidental ingestion of product. Operatives should avoid handling road planings without appropriate personal protective equipment including but not limited to coveralls, eye protection, gloves and respiratory protection. Dust caused by cutting or planing hardened asphalt should be controlled by containment, suppression and extraction/ filtration where possible.

Some PAH are also known to be highly toxic to aquatic life. Some phenols and cresols contained within coal tar are toxic to aquatic organisms. Phenols are relatively soluble in water and can leach easily.

These contaminants can be picked up by rainwater passing through stockpiles of planings or can seep out into the ground and for this reason excavated materials should be appropriately managed including covering and storing on an impermeable surface. Rainwater that runs through the planings can pick up contaminants and transport them into the groundwater or nearby watercourses. Water run-off should be collected and tested for contamination before disposal.

The Health and Safety Executive does not set maximum workplace exposure limits for PAH as there is potentially a wide range of exposure types and levels across industries making an overall exposure limit impossible to set (ADEPT 2013). However a range of measurement techniques exist for the determination of airborne PAH concentrations and HSE and NIOSH guidance exists for performing these measurements.

SECTION 6

Characterisation of Coal Tar Containing Planings

The presence of coal tar can have major implications for a construction project due to the health and safety issues posed by handling the material as well as the additional cost associated with the removal and disposal of a potentially hazardous waste. The early identification of such material can therefore be vital in reducing project costs and delays and implementing suitable solutions. Clearly construction projects could be exposed to considerable legal and financial risk should materials not be classified appropriately.

A key guidance document for the testing and characterisation of coal tar containing road planings is the ADEPT Guidance Note: Managing Reclaimed Asphalt – Highways and Pavements, 2013. The guidance note emphasises the variability of tar content within highways and pavement materials and the importance of providing representative samples of such materials for waste characterisation (i.e. hazardous or non-hazardous) and to determine reuse potential. The ADEPT guidance presents a suggested protocol for sample preparation and testing so that the variability of key coal tar containing components can be characterised.

As previously discussed, the determination of hazardous waste is made where coal tar content is greater or equal to 0.1%. However, it is understood that there is no single analysis that can conclusively identify the presence of coal tars and furthermore, the commonly adopted analytical test for PAHs the ("16 USEPA PAH suite") alone, can result in incorrect coal tar content being reported. Despite this the ADEPT Guidance note advocates the classification of tar containing road planings as hazardous waste where the PAH compound benzo(a)pyrene concentration alone is greater than or equal to 50mg/kg. The guidance note presents data corroborating an assertion that 50mg/kg of benzo(a)pyrene correlates to around 1,000mg/kg (i.e. 0.1%) coal tar

Recent developments in analytical testing may enable the determination of coal tar content and Jones Laboratories based in the UK are understood to have developed a series of tests that can enable the determination of coal tar to concentrations "less than or greater than 0.1%" by adopting a combination of analytical tests for "saturates, aromatics, resins and asphaltenes together with analysis for PAHs and biomarkers". Using this approach, Jones state that it is possible to determine whether the tarry material was derived from Coal Tar or Asphalt/Bitumen.

SECTION 7

Treatment of Tar-bound Road Planings

Coal tar containing planings can be used as aggregate in England in a bitumen bound material such as cold mix asphalt, cement bound material or a hydraulically bound material such as a structural material for reinstatement (SMR), assuming that any other specifications for that final product are met such as British Standards or Specification for Highways Works.

This following identifies current techniques for the widely adopted ex-situ treatment of reclaimed coal tar containing road planings to make Cold Recycled Bound Material (CRBM) with foamed bitumen technology. This process "encapsulates" tar[7], facilitating its reuse in the maintenance of highways and pavements, therefore eliminating disposal costs for an otherwise hazardous waste material.

Reclaimed tar containing planings are normally treated through encapsulation using a cold recycling bound mixture. TRL611[8] states that the stabilising (or treatment) agents are likely to be the dominant component in terms of the overall performance characteristics of a given mixture / material.

In hydraulically bound materials the binder will be cement, pulverised fuel ash (PFA) / lime, or granulated blast furnace slag (GBS) / lime. The Specification for Highway Works (SHW) refers to these as Quick Hydraulic (QH); usually Portland cement, and Slow Hydraulic (SH); usually PFA / lime or GBS / lime.

The bituminous bound materials are referred to as Quick Visco-Elastic (QVE) where the binder has bitumen as the main constituent but with the addition of a small quantity of cement, or Slow Visco-Elastic (SVE) where the binder has bitumen as the main constituent but with no cement.

The following will concentrate on use of tar containing planings to manufacture Visco-Elastic (VE) materials with foamed bitumen technology.

7.1 CRBM: Visco-Elastic (VE)

VE can be made from a variety of feedstock, including recycled aggregate, TBP, and even Type 1 subbase. The VE is made by mixing the feedstock with bitumen and at the same time injecting jets of water, and a small amount of proprietary additive. As the water hits the hot bitumen it steams and causes the bitumen to froth; for this reason VE is often called foamed base, or foamix. The foamed bitumen spreads through the mix, mainly coating the fines in the material. At this stage the material resembles a granular material (see Figure 1).

[7] The term tar should be taken to mean road tar unless otherwise qualified.

[8] TRL Report TRL611 'A Guide to the use and specification of cold recycled materials for the maintenance of road pavements'.

Figure 1: Visco-Elastic Foamed base

Figure 2: Mobile treatment of Waste Tar Bound Planings (photo courtesy of A-one+)

The coating, or "curing" process continues with time but is slow until the material is spread and compacted. The usual feedstock is reclaimed asphalt planings but sometimes the planing operation may include some subbase or part of an underlying concrete layer.

7.2 Use of CRBM

Because of the curing time involved it is usual to surface VE with conventional hot-mix bituminous materials. The thickness will depend on the type of VE used, and the anticipated traffic load. VE should not be used in situations where it will be wetted, particularly in early life. It can be a very useful haunch repair material but not in wet haunches.

7.2.1 CRBM: Slow Visco-Elastic (SVE)

SVE is produced as described above. It is sometimes referred to as "Depot Stock" because it can be stored for up to six weeks before use. Even after spreading and compacting SVE can be susceptible to rutting under traffic. It is usual to leave for about 12 hours before trafficking, and if weather conditions are suitable, and traffic is light it can be left for longer. The overlay of new material would usually be in the range 40-100mm, depending on traffic levels. For higher traffic levels, where initial traffic will be high, QVE would usually be adopted. For low traffic situations the SVE can merely be surface-dressed.

Common uses of SVE include:

- Footway binder course;
- Combined footway subbase and binder course;
- Base material for lower trafficked roads / car parks;
- Base in trench reinstatements;
- Haunch repairs/ strengthening.

One advantage of SVE is that it can be delivered to site and stored without being used immediately.

7.2.2 CRBM: Quick Visco-Elastic (QVE)

QVE is initially produced in the same way as SVE. It is often referred to as “Structural Grade” because it is used in higher loading situations. When the QVE is produced a small amount of cement is added, usually no more than 2%. This gives the QVE a higher initial strength to avoid problems with rutting in early life. Care must be taken not to add too much cement merely to meet specified requirements of early strength; this can cause reflective cracking of overlying layers.

Common uses of QVE include:

- Structural base for higher traffic levels / car parks;
- Footway binder course;
- Combined footway subbase and binder course;
- Base material for lower trafficked roads / car parks;
- Base in trench reinstatements;
- Haunch repairs / strengthening.

One advantage of QVE is that it can be delivered to site and stored for short periods (hours) although it is usual to lay immediately.

SECTION 8

8 Standards, Specifications and Quality Assurance Controls

8.1 Specifications:

Current specifications for VE materials is included as Clause 948 (Ex-situ Cold Recycled Bound Material) in the SHW Series 900. Further information can be found in the Notes for Guidance for Clause 948 and the two appended guidance notes (see Appendix A). In addition, TRL Report 611 'A guide to the use and specification of cold recycled materials for the maintenance of road pavements' provides an end-performance based design guide and specification for cold recycled materials and covers a wide range of cold-mix recycled materials involving a range of binders and binder blends.

8.2 Construction:

SVE and QVE can be hand laid or paver laid. Initially it has the appearance of a granular material. The most important point to note is that it should be laid and compacted as a granular material and control of moisture content is vital, particularly where it will be trafficked. Bond coats should always be used over VE (tack coats in hand laid areas and footways) and the rate of spread should be adjusted for the lean substrate. The pictures below indicate spreading / laying, compaction, bond coat.

Figure 3: Spreading/laying, compaction, bond coating of VE CRBM

8.3 Use of CRBM (Containing Tar)

Once the CRBM product is mixed, the tar around the constituent aggregate becomes encapsulated and bound. CRBM containing tar is not used in surfacing, and is only used as a binder course or base material, and the tar present in the recycled aggregate will be fully bound by the bitumen and cement that are added as part of the process. As such this material is understood to present little hazard provided the following advice given below is followed (Tarmac 2012[9])

8.3.1 Human Health Risks

The main hazards are presented by the tar contained in the planings which constitute the matrix around the aggregate used in the material.

Under normal conditions, CRBM is not expected to give rise to any health hazards unless it is heated, cut / abraded, or if it is in repeated and prolonged contact with skin (Tarmac 2012).

Inhalation of vapours / fumes: Tarmac (2012) suggests that as the CRBM material is mixed and laid at ambient temperatures, and the tar-bound aggregate is bound with foamed bitumen, the low volatility of the material makes inhalation unlikely. CRBM should only be laid in well ventilated areas. Suitable respiratory protection should be used if required, in poorly ventilated or enclosed areas, to ensure exposure is below the Workplace Exposure Levels provided in the product Safety Data Sheets.

Dermal contact: Tarmac (2012) states that overalls and/or long-sleeved jackets and full length trousers should be worn to protect skin from exposure to tar or bitumen (clean overalls as necessary to prevent tar or bitumen permeating to clothing or skin underneath). Impermeable gloves and safety boots should also be worn to protect the hands and feet. The use of skin barrier cream is further recommended. Goggles should be worn if there is a risk of product entering the eyes (including dust).

Inhalation of dust: Dust caused by cutting or planing hardened asphalt should be controlled by containment, suppression and extraction / filtration where possible (Tarmac 2012).

Accidental Ingestion: Ingestion is considered, by Tarmac (2012), to be very unlikely.

8.3.2 Environmental Risks

Tarmac (2012) reports that when used as intended, no significant environmental effects are likely to occur, and CRBM (containing tar) should not pose a significant ecological hazard. Nevertheless, CRBM (containing tar) should be prevented from entering watercourses, ditches and drains, or being deposited anywhere other than the intended placement site. The following is summarised from Tarmac (2012).

Mobility: Low mobility; will sink in water and form a solid layer on the surface of the ground.

Persistence and Degradability: Resistant to degradation and will persist in the environment.

Ecotoxicity: Bound and hardened product is not expected to be toxic to aquatic organisms.

[9] Tarmac (January 2012) Safety Data Sheets (Foamaster – Containing Tar-Bound Recycled Aggregate).

8.4 Post-treatment legislative controls

Due to the presence of tar in the manufactured CRBM product, it will remain classified as hazardous waste, and will need to be transported and stored in accordance with legislative requirements, i.e.:

- The subsequent movement of the treated asphalt waste to proposed site of use is covered by a hazardous waste consignment note[10]; and
- Unless the product is used upon receipt, it will need to be stored under S2 Waste Storage Exemption (Storage at a Site Different to Where the Waste was produced[11]).

[10] Hazardous waste guidance: https://www.gov.uk/dispose-hazardous-waste/overview

[11] Waste exemptions guidance (storing waste): https://www.gov.uk/waste-exemptions-storing-waste

SECTION 9

9 Recommendations for further work

It is considered that the following steps would be advisable in order to develop this further:

9.1 Engagement with SEPA

Initial contact has been made with the SEPA Waste Protocol Team whom have indicated that they are receptive to progressing this issue with the aim of providing formal guidance in collaboration with THe Scottish Road Research Board.

9.2 Engagement with the Environment Agency

It is recommended that contact is made with the Environment Agency regarding the Quality Protocol (QP) for asphalt waste containing coal tar, currently being considered by the European Pathway to Zero Waste Quality Protocols Team. It is understood that the Quality Protocols Team are assessing the likely environmental issues associated with the reuse of coal tar containing planings and the findings of the Quality Protocol team could provide very useful in creating Scottish guidance.

9.3 Engagement with laboratories

It is recommended that consultation is made with laboratories regarding the testing available and the opportunities do develop an appropriate testing suite to accurately assess the presence of coal tar, which could be available in most laboratories.

Further to potential developments in testing to determine if coal tar is present, it is recommended that further analysis be undertaken to determine the leachate potential from recycled road planings which may help to determine the effects of the process and provide more confidence in the re-use of this material.

9.4 On site monitoring

In order to develop protocols for site controls during excavation of tar bound arisings, it would be beneficial to gain an understanding of the actual vapor risks associated with the excavation of tar bound arisings, both to construction workers and also to the general public passing by.