

A Specification for Recycled Aggregate for use in Minor Schemes



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Foreword

The development of this specification for recycled aggregate originated from the recognition that high quality virgin aggregates were and are being specified as the unbound sub-base materials for minor schemes such as car parks, cycle paths, estate roads, footpaths, etc. where very low traffic load is imposed.

This over specifying approach has been historically accepted due mainly to a lack of confidence in the performance of alternative more sustainable options. Resource efficiency is an essential element of sustainable development and is increasingly the focus for clients and specifiers. In situ performance and fitness for purpose should increasingly be the main criteria for assessing suitability of materials.

Managing rather than avoiding risk should be fundamental to the provision of engineering value and designers and specifiers can use this specification in appropriate engineering applications to demonstrate this to their clients.

The benefits are two-fold: use of recycled aggregate will make a considerable contribution to the landfill diversion targets quoted in the Welsh Government waste strategy – Towards Zero Waste, and in addition will go some way to preserving the mineral asset, the use of which should be confined to more demanding engineering applications.

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1.0 Introduction and Background

- 1.1 This specification provides a mechanism to enable material providers and users to incorporate inert recycled materials as unbound aggregates in the sub-base and or capping materials of minor highway schemes. A range of schemes is identified in section 3.0 below as an indication only, and may not necessarily be exhaustive.
- 1.2 A range of documentation exists that encourages and supports the use of secondary and recycled materials. In HD 35/04; Conservation and Use of Secondary and Recycled Materials, there is a clear acceptance of environmental benefits possible from the use of recycled materials.
- 1.3 This specification builds upon a series of reports by research bodies and practitioners, covering research carried out for Constructing Excellence in Wales on recycled inert aggregate across Wales. The results and outcomes give confidence that the consistency of the materials would provide suitable unbound foundation materials as lower base (capping) and sub-base. This specification for RAMS is seen as complementary and not a direct alternative to the materials detailed in the Series 800 of Volume 1 of the Specification for Highway Works; Manual of Contract Documents for Highway Works.
- 1.4 This specification when adopted will divert significant volumes of inert and in situ performing materials which is currently sent to landfill. The specification offers a 'route to market' for a material which might otherwise have become an environmental burden.
- 1.5 Three studies were undertaken which support this specification and these are summarized at Appendices 1, 2 and 3 i.e. Recycled Aggregates for Minor Schemes (RAMS) July 2010 (Appendix 1); Testing Recycled Aggregates for Minor Schemes (TRAMS) November 2010 (Appendix 2) and RAMS Logistics February 2011 (Appendix 3). Links to these documents are included.
- 1.6 The RAMS study detailed in Appendix 1, took a meaningful number of samples from specific producers. A series of particle size distribution, petrographic analyses, constituents' classification, chemical and physical properties assessments and Californian Bearing Ratio tests identified that a blended material (50/50 and 65/35 Coarse to Fine respectively) could satisfy the limits for a SHW Type 1 material.
- 1.7 Further tests on the RAMS materials investigated a set of characteristics including permeability, frost heave potential, loss on ignition and total organic content. Again the results for the blended material showed good correlation with the requirements of the SHW 800 Series Type 1 sub-base (see Appendix 1 for further details).
- 1.8 The work from the RAMS study justified a further review of feedstock from 20 prospective aggregate producers across Wales; TRAMS (see Appendix 2). An aggregate producer is defined as an organisation which processes inert waste into recycled product in accordance with a set of acceptance criteria as stated in "the quality protocol for the production of aggregates from inert waste" (commonly referred to as the WRAP Protocol). Produced material fundamentally relies upon the construction and demolition market and quantities will inevitably fluctuate in line with economic conditions.

1.9 The TRAMS study as detailed in Appendix 2, undertook a range of physical and chemical tests in line with those required by, but not limited to SHW 800 Series and BS EN 13242 : 2002. TRAMS examined potential risk elements associated with the use of recycled waste material if it were to conform as a material for use in highway schemes.

2.0 Scope

2.1 The scope of this specification is aimed at providing a means whereby specifiers, users and suppliers have a set of guidelines that will ensure adequate and consistent material produced as a specific product for a specific application of highway scheme.

2.2 The range of parameters has been selected to conform to wider convention but the limits are such that the risk of failure to deliver is consistent with the form of scheme.

2.3 For users there will be a clear definition of how recycled aggregate will become a product in line with the WRAP Protocol.

2.4 To ensure a balance between consistent production and robust quality limits a set of tests are given together with suggested frequency of testing.

3.0 Definition of Minor Schemes

3.1 This part of the specification outlines a range of minor highway schemes that require a clear, defined foundation and loading type. The category of footway or cycle way deemed a minor highway scheme is either a pedestrian only or light-vehicle in line with Section 2 of HD 39/01.

3.2 In line with a sound basis for construction of these minor schemes a minimum sub-grade CBR of 5% should be provided. If the sub-grade is of a standard that a capping layer is required (in line with HD 25/94) then consideration should be given to using a recycled single layer replacing the capping and sub-base layers.

3.3 For pedestrian only or light-vehicle footways, the construction thicknesses specified are shown in Table 3.1 and 3.2 of HD 39/01.

3.4 To ensure that these minor highway schemes remain functioning for a design life consistent with their application, the environment for use should remain well drained and the aggregate should be non plastic.

3.5 The types of highway schemes described above are small and will limit the choice of construction plant. It is essential that consideration is given to this to ensure the sub-grade is leveled and compacted before the sub-base is placed and rolled. This is essential around obstructions such as street furniture. Reference should be made to Annex D Compaction by Method Statement Specification of HD 39/01.



4.0 Material Processing

- 4.1 An essential element of this specification is the confidence any specifier or user has in the consistency of the material and ultimately its in situ performance. To ensure a degree of conformity then the criteria outlined in the WRAP Protocol must be followed.
- 4.2 The adherence to the WRAP Protocol will allow the material forming the RAMS material to be fully recovered and be used as a product.
- 4.3 A system for factory production control (FPC) shall be established, documented and maintained for the material. The FPC will comply with Annex C of BS EN 13242.
- 4.4 The specified product shall conform to the limits defined in Table 5.1 below and be described as RAMS; Unbound Sub-base material for use in minor schemes.
- 4.5 The flow chart given in Appendix 4 is to be read with the Waste Process Activities in Annex B of PAS 402 ; 2009 Waste Resource Management – Specification for Performance Reporting.
- 4.6 The acceptance criteria specified by each supplier site/location must ensure that only inert material is provided. Two fundamentals for material acceptance that must be adhered to, in line with the WRAP Protocol are the types of waste and the FPC methodology.

- 4.7 The types of waste that can be accepted for processing include those permitted as inert wastes in Appendix C of the WRAP Protocol and more specifically those from table 2.1 in HD 35/04.
- 4.8 To ensure confidence and consistency a testing regime and frequency is outlined for both incoming waste and for the finished product. This is detailed in section 7.0 below.
- 4.9 To further comply with the requirements of the WRAP Protocol and to provide an audit trail for suppliers and users, records of incoming wastes and finished products shall be kept.

5.0 Material Specification Grading Limits

- 5.1 The material supplied as RAMS shall comply with the grading limits given in Table 5.1
- 5.2 The recycled aggregates used in unbound mixtures in accordance with Table 5.1 shall be certified as an inert granular product in line with the WRAP Protocol and in conformance with Section 4.0 above.

6.0 Material Requirements

- 6.1 RAMS unbound aggregates shall not be deposited within 500mm of concrete, cement bound materials, other cementitious mixtures or stabilised capping forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:
 - The water-soluble sulphate (WS) content exceeds 1500mg of sulphate (as SO4) per litre(Test No.1); or
 - The oxidisable sulphides (OS) content exceeds 0.3% of sulphate (as SO4) (Test No.2 and Test No.4)

Table 5.1

Sieve Size (mm)	Percentage by Mass Passing	
	Upper Limit	Lower Limit
63	100	100
31.5	100	90
16	90	50
8	80	30
4	60	15
2	45	5
1	35	0
0.063	12	0

6.2 RAMS unbound aggregates shall not be deposited within 500mm of metallic structural elements forming part of the Permanent Works if, when tested in accordance with TRL Report 447 either:

- The water-soluble sulphate (WS) content exceeds 300mg of sulphate (as SO₄) per litre (Test No.1);

or

- The oxidisable sulphides (OS) content exceeds 0.06% of sulphate (as SO₄) (Test No.2 and Test No.4)

6.3 Material shall not be frost susceptible if it is used within 450mm of the designed final surface of a **road** or **paved central reserve**, or 350mm if the Mean Annual Frost Index (MAFI) of the site is less than 50. Material is classed as non-frost-susceptible if the mean heave is 15mm or less, when tested in accordance with BS 812-124:1989.

7.0 Testing Requirements

7.1 The work undertaken by TRAMS has identified a limited number of tests in line with SHW Series 800 that can be consistently applied to verify acceptance of the RAMS material.

7.2 Testing is in two phases and records shall be kept. The first testing phase shown in Table 7.1 relates to the incoming feedstock material and the second phase of testing shown in Table 7.2 relates to the recycled product supplied as sub-base material. These tests are in accordance with the WRAP Protocol.

7.3 To maintain the confidence of the material forming the RAMS, an appropriate set of tests that correlate with materials specified by SHW are to be undertaken. Table 7.2 lists those tests and their frequency and gives practical guidance as to the application of the specified tests. The results will give confidence in the material in line with the findings of TRAMS (see Appendix 2).

Table 7.1

Property Description	Minimum Frequency
Waste Transfer Note	Every incoming load
General description	Every incoming load
Visual assessment of stock pre-process	Daily
Visual assessment of processed stock	Daily

Table 7.2

Description	Physical Tests		Guidance
	Frequency	Limits	
Plasticity Index	1 per week or every 250 tonnes	Must be non plastic	
Particle Size Distribution	1 per week or every 250 tonnes	See Table 5.1	
Los Angeles Abrasion	1 per quarter	LA 50	
CBR	1 per quarter	>30	
Magnesium Sulphate Soundness Test	1 per month if required	MS35	Give consideration to local climate – only in areas where severe and prolonged frosts are likely should this test be required
	Chemical Tests		
Acid Soluble Sulphate	1 per month	<1%	Only relevant if adjacent to concrete structures or proximity to water courses
Leachate Analysis	1 every 6 months	Contract threshold levels	Consider relevance in respect of groundwater and water courses

Appendix 1

RAMS Report

Summary

A programme of testing was undertaken to determine the physical and mechanical properties of recycled aggregate derived from builders' skip waste. Following initial testing a single representative source of material was selected for the research programme. The materials for test were prepared by blending coarse aggregate with fine material which previously had been designated for landfill. Three blends were chosen for the programme and each blend subjected to a series of physical, mechanical and chemical tests which concluded with large scale pit tests at Birmingham University where the selected blends were subjected to dynamic cyclical loading in dry, wet and saturated conditions.

(follow link below)

<http://www.cewales.org.uk/cew/wp-content/uploads/Recycled-Aggregates-for-Minor-Schemes-RAMS-July-2010-Report.pdf>



Appendix 2

The TRAMS Report

Summary

The Testing of Recycled Aggregate for Minor Schemes Project (TRAMS) commenced in February 2010 with the objective of accumulating a body of test data for recycled aggregate produced by recycling operations throughout Wales. This report concludes that the materials, as tested, represent an adequate source of suitable recycled aggregate which could and should be utilised in minor engineering schemes within Wales. This would ensure avoidance of landfill and lessen the demand on finite sources of virgin stone.

The project objective was to recruit 20 recycled aggregate producers in Wales to take part in the programme. However, due to the downturn in construction activity only 15 producers participated.

The project has carried out a series of seven laboratory tests on 15 No sources of recycled material and one source of virgin quarry stone as a control.

The overall outcome of this testing programme indicates that recycled inert aggregate processed from construction waste consistently meets most of the criteria specified in the 800 series of the SHW.

(follow link below)

<http://www.cewales.org.uk/cew/wp-content/uploads/Testing-Recycled-Aggregates-for-Minor-Schemes-TRAMS-November-2010-Report.pdf>



Appendix 3

TRL Logistics Report

Summary

TRL undertook a logistics study to build on the previous work carried out by TRL and Tarmac on Recycled Aggregates for Minor Schemes (RAMS) in 2009. Significant quantities of lower grade recycled aggregates are produced in Wales, mostly by small producers, who do not always work to national standards or follow the WRAP Quality Protocol. These recycled aggregates are not suitable for use in high grade applications as those covered by the Specification for Highway Works, but may be suitable for use in low risk applications. The RAMS project has looked at how this material could be used more effectively. The test results so far indicate that lower grade material could be suitable for some minor works schemes.

In order to fulfil this potential increase in use, the material needs to be readily available, cost-effective and, ideally, have lower carbon emissions than primary aggregates. This related project focused on these issues. It involved an assessment of the availability of recycled aggregates in Wales, looking at the location of producers and the area they served. The project also looked at the economic costs and carbon emissions associated with using lower grade recycled aggregates where suitable applications arise, comparing it to virgin aggregates and Type 1 recycled aggregate. Information for the study was gathered from telephone interviews and questionnaires with recycled aggregate producers in Wales and a site visit to a producer near Cardiff.

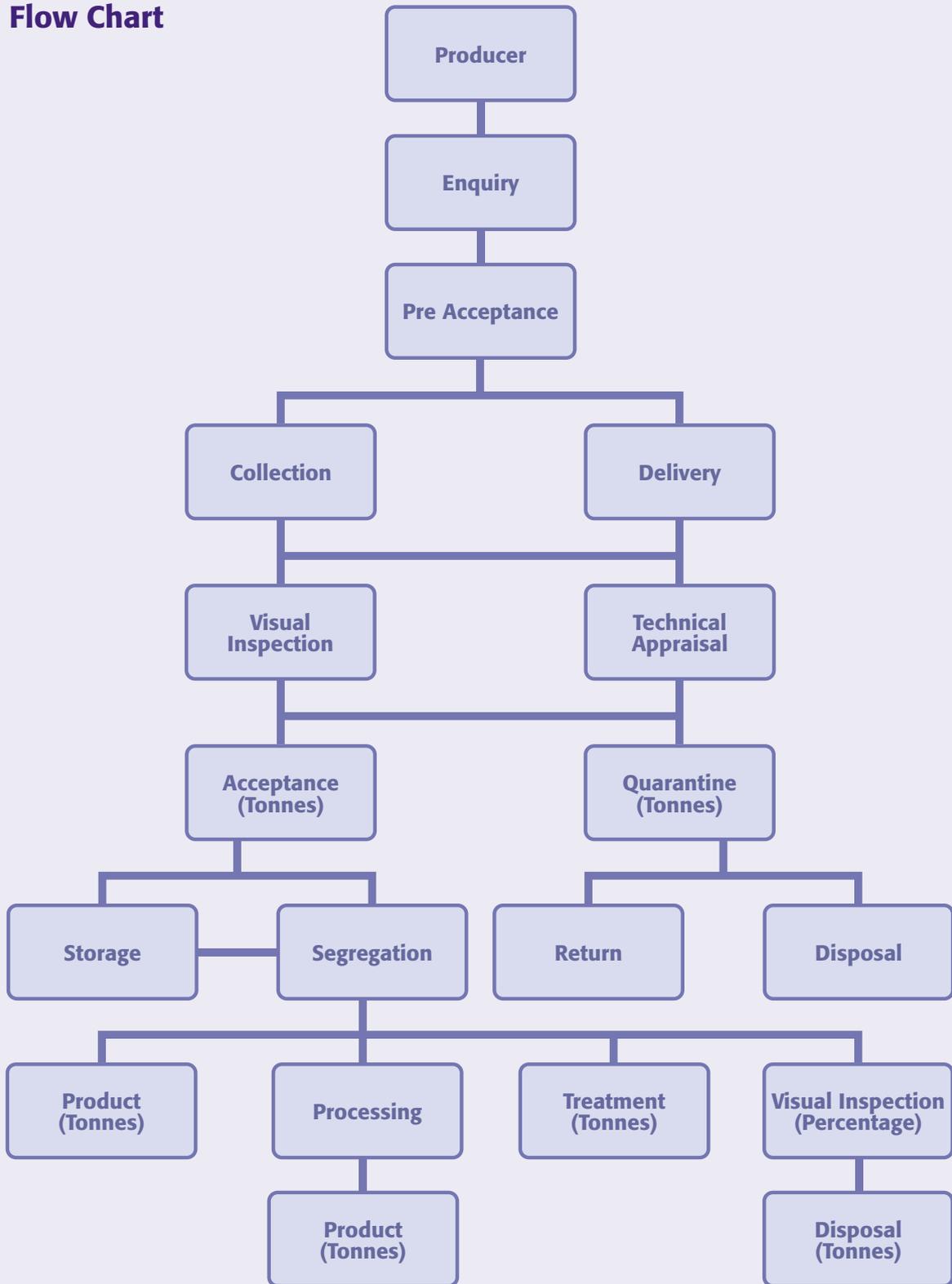
The project has shown that, where it is suitable for the proposed application, lower grade recycled aggregates are likely to be readily available and cost effective compared to virgin and higher quality recycled aggregates and will yield benefits in reduced carbon emission compared to these alternatives.

(follow link below)

<http://www.cewales.org.uk/cew/wp-content/uploads/RAMS-Logistics-February-2011-Report.pdf>

Appendix 4 Waste Process Flow Chart

Waste Flow Chart





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