



**British  
Geological Survey**

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# **High PSV Sandstone test results from the Cribarth area, Garth, Builth Wells, Powys.**

Geology and Landscape Wales

Commissioned Report CR/09/047



BRITISH GEOLOGICAL SURVEY

GEOLOGY AND LANDSCAPE WALES

COMMISSIONED REPORT CR/09/047

# High PSV Sandstone test results from the Cribarth area, Garth, Builth Wells, Powys.

J.R. Davies & A.J. Humpage

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## Foreword

This report, provided under contract for Powys County Council, describes test results obtained from ten samples collected from the Cribarth and Crychan formations near Garth, Powys, in the Builth Wells area. These samples were laboratory tested to determine their polished stone value (PSV) and to inform the advice given to the County Council in relation to mineral safeguarding within their Unitary Development Plan.

## Acknowledgements

The authors would like to thank the following BGS staff: J Mankelow for commenting on the text and placing the results of this study in the context of the National Mineral Map of Wales; G Lott for the photomicrographs and M Allen for laboratory support during this study.

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## Summary

Due to the failure of the draft Powys Unitary Development Plan (UDP) to identify high Polished Stone Value (PSV) resource areas, the British Geological Survey has undertaken a study jointly funded by Powys County Council and the Welsh Assembly Government to collect and test samples from the Cribarth and Crychan formations within the County.

The Cribarth and Crychan formations are broadly homogenous muddy sandstones, and whilst of different ages, were deposited in similar geological settings. A quarry in the Cribarth Formation currently extracts rock for use as a skid-resistant top dressing for major roads and motorways.

A total of ten rock samples from both formations were collected from surface outcrops and shallow cuttings and were sent for testing at an external, independent laboratory. None of the samples collected were totally unweathered, and as a consequence, the results obtained could be expected to be lower than those for unweathered rock currently being extracted from the quarry.

The specifications for High Skid Resistant Aggregate sets a PSV of 60 as the lower limit for materials classed as High Skid Resistant Aggregate. The results obtained for both the Cribarth and Crychan formations, even in the slightly weathered state, were above this lower limit value, the Cribarth Formation consistently showing the higher PSV values. As a consequence, both formations can be considered to be a high PSV aggregate resource and therefore should be considered for safeguarding within the Powys County Council UDP.

# 1 Introduction

## 1.1. BACKGROUND

Arising from Welsh Assembly Government (WAG) grant funded work in mid Wales the British Geological Survey (BGS) published in 2005 an *Inferred Mineral Resources* map for the Builth Wells area. This map showed the surface distribution of mineral materials inferred to have economic potential in an effort to inform local mineral planning. One of the mineral resources identified was ‘muddy sandstone’. Such material is worked at Cribarth Quarry [SN 953 524] where its exceptional properties as an aggregate with a high polished stone value (PSV), providing PSV test results of up to 71 (Thomson *et al.*, 2004) places it in the upper rank of materials used as a skid resistant top dressing for heavily trafficked trunk roads and motorways.

Following the publication of the BGS thematic map *Inferred Mineral Resources* (BGS, 2005b) for the Builth Wells district, Powys County Council initially used the information it presented to inform the mineral safeguarding policy as part of the county’s Deposit Draft Unitary Development Plan (UDP) in line with WAG guidance as expressed in *Mineral Planning Policy Wales* (2000). However, the Powys UDP failed to identify the high PSV resource area in accordance with national planning policy.

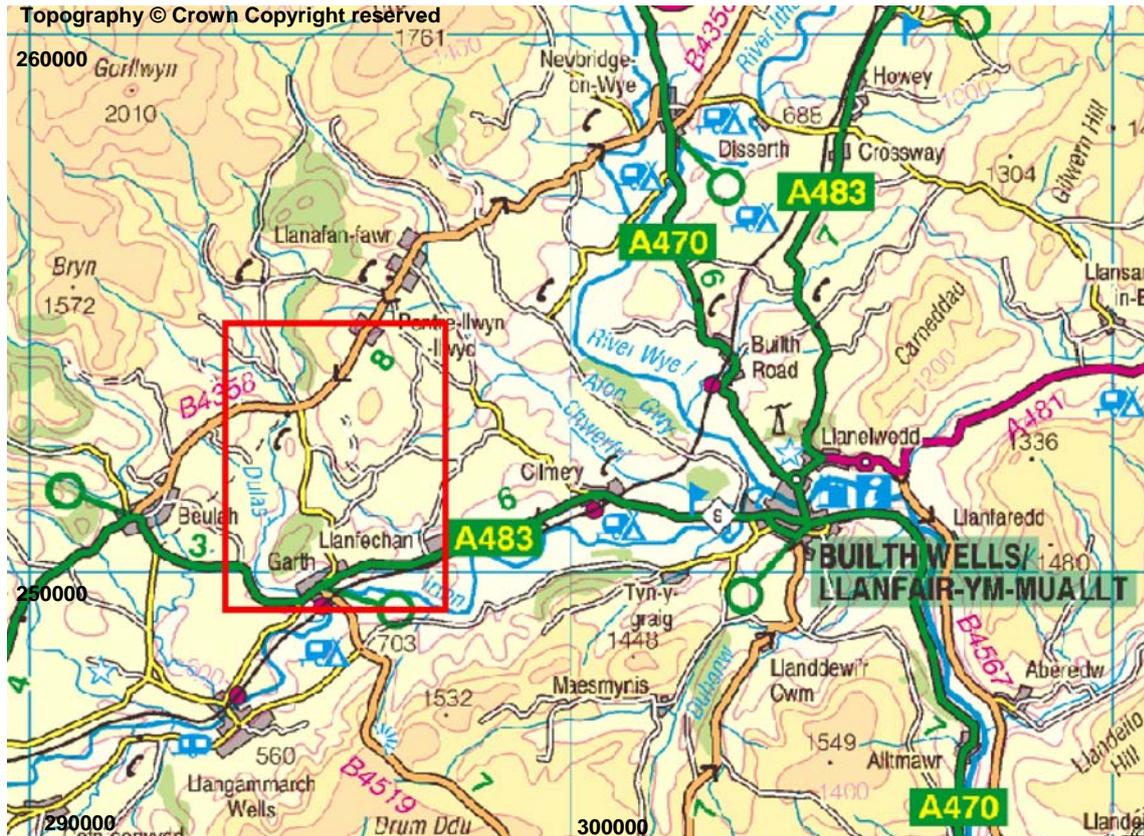
On page 6 of *Mineral Planning Policy Wales* (2000) it states that safeguarding ‘does not necessarily indicate an acceptance of working, but that ***the location and quality of the mineral is known***’ (authors italics). It is the interpretation of this last highlighted clause which appears to be at the core of the dispute. The WAG take the view that for BGS, as the UK’s national geological survey, to show a published map of the distribution of materials considered to have potential as sources for high PSV aggregate is sufficient to permit their safeguarding. The outcome of the Inquiry, however, suggests that more tangible data – specifically mechanical test results – are required to demonstrate the actual location and quality of the materials in question. At an exploratory meeting on 21<sup>st</sup> August 2008 in Llandrindod Wells between BGS staff and council officials the County Council asked for a costed proposal for BGS to undertake the collection and testing of a set of representative samples from both the Cribarth Formation and Crychan formations and to provide a report which presents and interprets the resulting test results. Costs for two options for this work were provided: Option 1) an assessment of the separate Cribarth and Crychan formation crops in the Cribarth area only; and Option 2) for an additional assessment of the other geological units considered to have high PSV potential which extend into north Carmarthenshire. Option 1 was subsequently approved and funded jointly by Powys County Council and the Welsh Assembly Government.

The project also needs to be appreciated in the context of an ongoing, WAG-funded, BGS initiative to produce a National Mineral Map of Wales, and the need for both the recommendations included in this report and the content of the Powys UDP to be compatible with the likely outputs of this pan-Wales investigation. As a consequence the comments and recommendations of the BGS Minerals Group staff responsible for the National Mineral Map project have been sought and included in this report.

## 1.2. LOCATION

The location of the area of interest is shown in Figure 1.

Note: Grid References referred to in the text and captions are given as three-figure National Grid References, except figures on map ticks, which are given as full six-figure National Grid References.



**Figure 1: Ordnance Survey map showing the location of the Cribarth study area, Garth, Powys.**

## 2 Geological Setting

The area lies within the British Geological Survey 1:50 000 map sheet 196, Builth Wells (BGS 2005a), and BGS 1:25 000 map SN95 (2001).

The Cribarth Formation and Crychan Formation are of late Ordovician and early Silurian age respectively and were deposited on a continental shelf setting on the margins of the deep-water Welsh Basin. Both formations are up to 400m in stratigraphic thickness. These rocks have been subjected to tectonic activity and as a consequence the Cribarth Formation dips East-north-east at between 32° and 41°, whilst the Crychan Formation exhibits steeper dips at of between 58°E and 65°SE.

Geologically Cribarth Quarry is sited principally within the surface crop of the Cribarth Formation. The broadly homogeneous nature of this unit suggests that the mechanical properties demonstrated at Cribarth Quarry would be typical of the whole formation and underpinned the BGS decision to flag the whole of its surface crop as an inferred mineral resource. Two areas were identified on the published map; one extending to the north and south of Cribarth Quarry with a second located in the Crychan Forest area close to the Powys-Carmarthenshire boarder.

Muddy sandstone closely comparable to that of the Cribarth Formation is also the dominant rock type of other geological units in the immediate region, including the Crychan Formation. On the assumption that this unit too is likely to display the same mechanical properties as the Cribarth Formation at Cribarth Quarry, the surface crop of the Crychan Formation was also flagged as an inferred resource. The principal crop of the Crychan Formation in Powys extends from Garth Bank, two kilometres to the south of Cribarth Quarry, for four kilometres in a NNE direction as far as the vicinity of Pentrebach [SN 973 540]. However, the Crychan Formation also crops out extensively in north Carmarthenshire (Figure 2), along with other units including the Cefnigarreg, Derwyddon and Goleugoed formations which all have potential as sources for high PSV aggregate. These latter units have not been examined as part of this study.

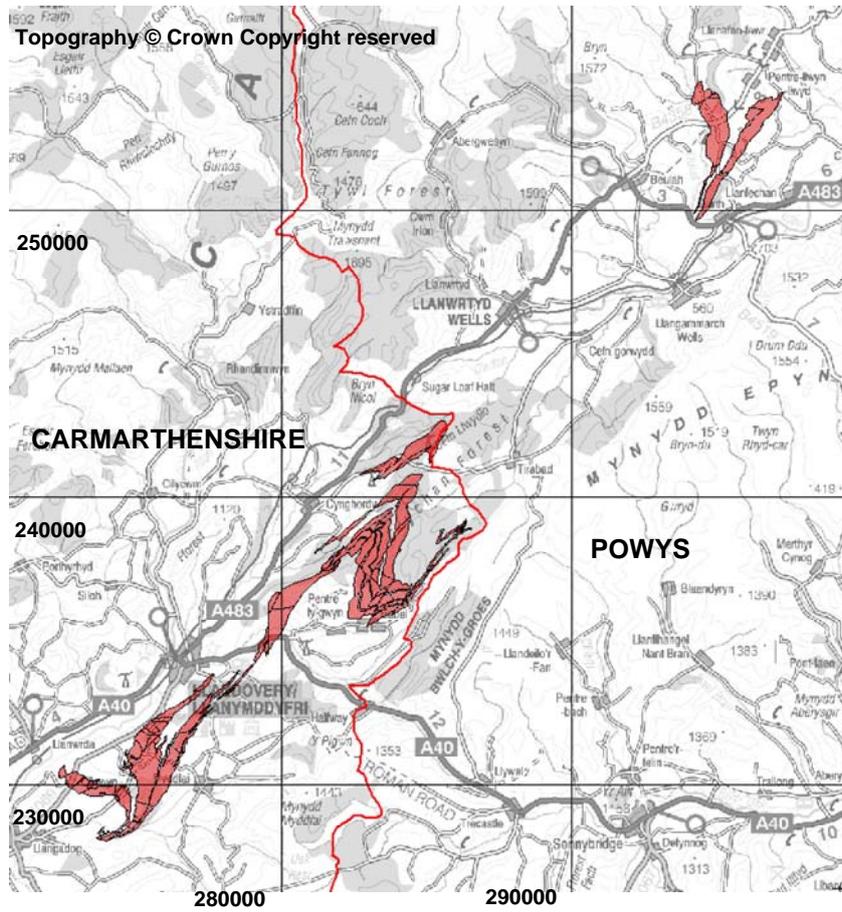
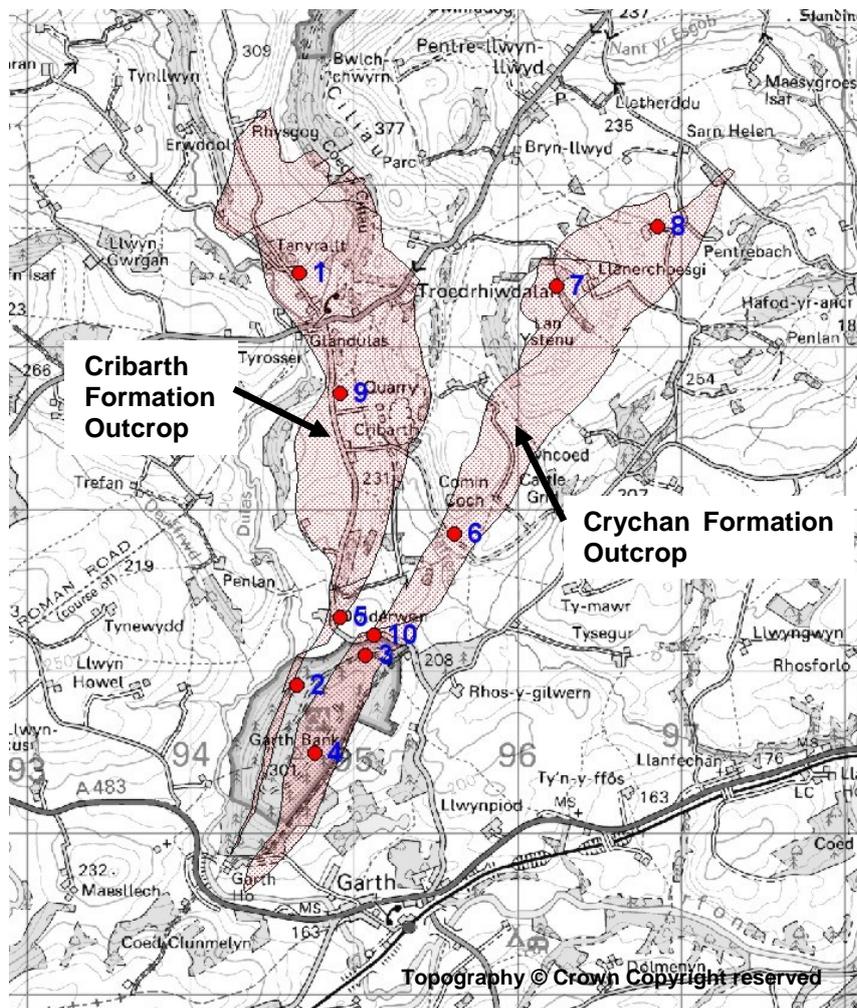


Figure 2: Outcrop of formations in Powys and north Carmarthenshire previously identified by BGS as having potential high PSV values.

### 3 Methodology

BGS geologists collected samples from four sites in the Cribarth Formation crop both to the north and south of the existing Cribarth Quarry workings, including localities close to the geological boundaries of the unit. An additional six samples were obtained from the Crychan Formation crop extending between Garth Bank and Pentrebach again including some samples from close to the crop edge. Details of the sampled sites are provided in Appendix 1 and the localities shown on Figure 3.

The samples, 10 in total, were submitted to an external aggregate testing facility (Celtest Company Limited) for processing. The test results were received on 2<sup>nd</sup> March 2009.



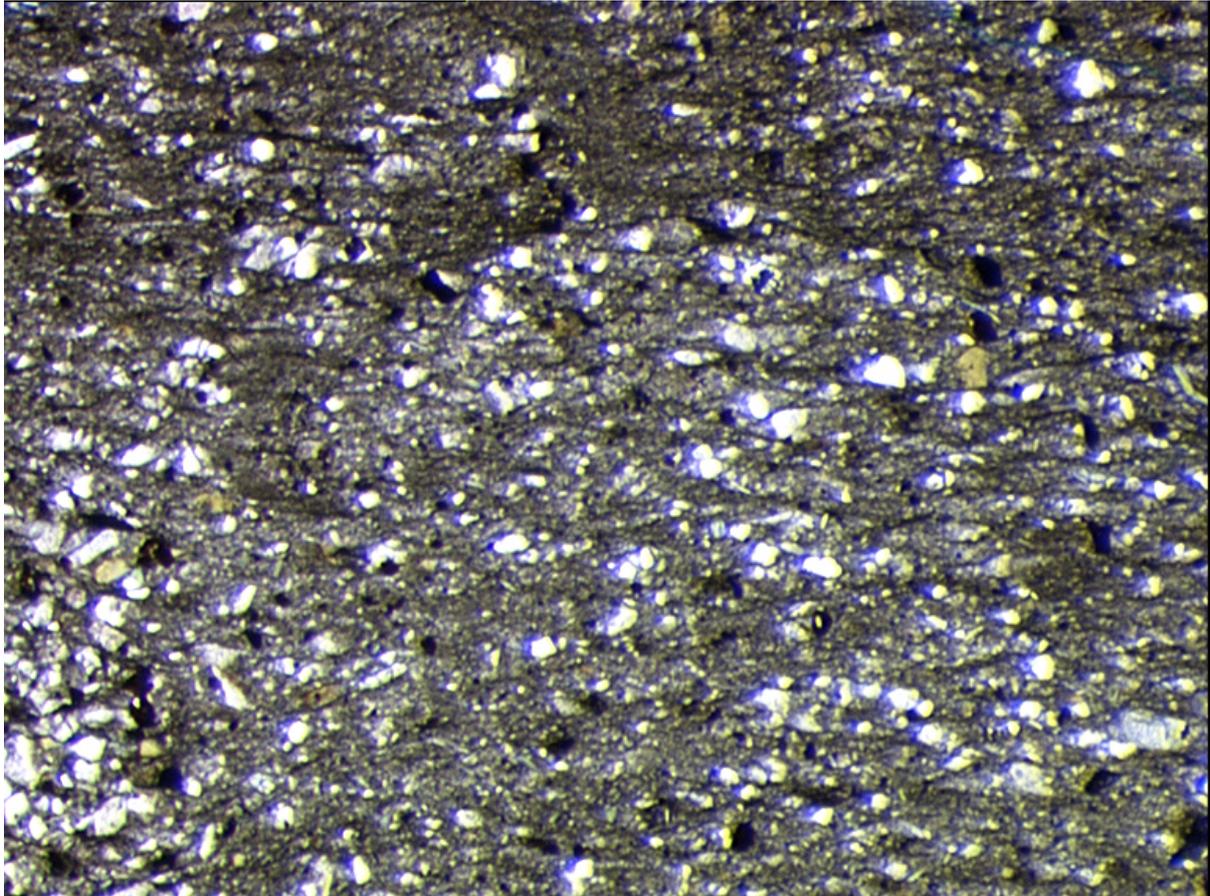
**Figure 3: Outcrop of Cribarth and Crychan formations showing sampling locations. Scale 1:50 000.**

#### 3.1. NOTE ON SAMPLING PROCEDURES

Sampling was by hand from existing surface exposures including natural outcrops, disused quarries and roadside and forestry cuttings, from where samples with a maximum depth of 2-3m below the original ground surface were obtained. Every effort was made, by use of sledge hammer, pickaxe and chisels, to obtain as fresh material as possible, but nowhere was it possible to collect completely unweathered material.

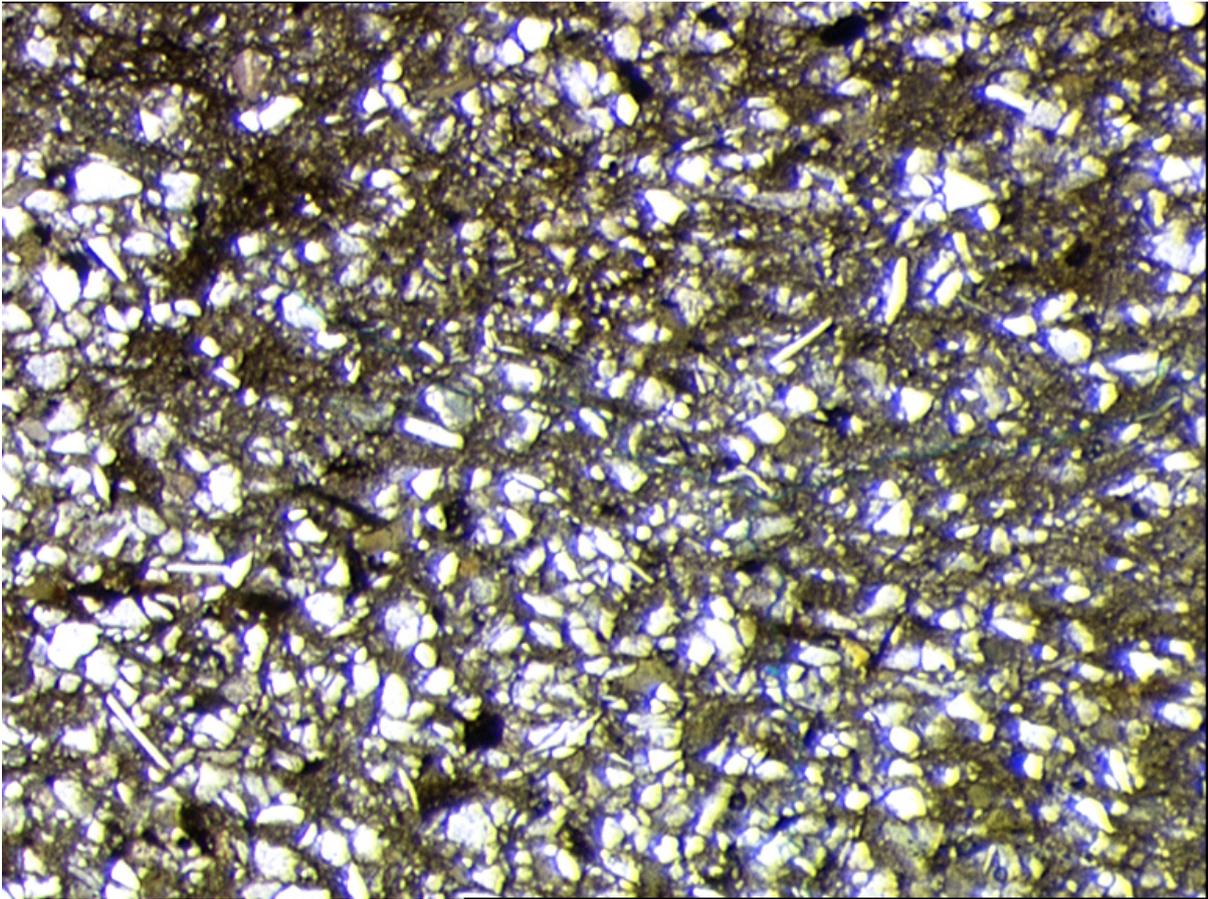
## 4 Lithology

The Cribarth Formation comprises homogeneous, fine- to very fine-grained muddy sandstones in which angular to sub-rounded silt and fine sand grains of quartz and feldspar and lithic fragments are set in a mudstone matrix (Figure 4). The rocks have suffered low grade metamorphism and are cleaved.



**Figure 4: Photomicrograph of sample 2 (*field of view 3 mm left to right*) (Corrected PSV 67)**

In the Crychan Formation, closely comparable muddy sandstone is the dominant lithology (Figure 5), but lenses and thin bed of hard fine-grained sandstone are also present at most localities. In the southern region of its outcrop, on Garth Bank, coarser sand grains, granules and small pebbles are common. This formation has also been subjected to low grade metamorphism and is weakly cleaved.



**Figure 5: Photomicrograph of sample 8 (*field of view 3 mm left to right*) (Corrected PSV 61)**

## 5 PSV Test Results

The test results obtained for the samples submitted to Celtest are summarised in Tables 1 and 2. The full test results for each sample obtained from Celtest are provided in Appendix 2. Testing was undertaken in accordance with BS EN 1097-8: 2000. The results should be read in the context of Transport Research Laboratory guidance (see Thomson *et al.*, 2004 and references therein) on the specifications for High Skid Resistant Aggregate which sets a PSV of 60 as the lower limit for materials classed as High Skid Resistant Aggregate, with values of 65 and over sought for as top dressing for heavily trafficked roads, motorways and critical sites.

Cribarth Formation: The test results obtained show that the samples of muddy sandstone obtained from the Cribarth Formation, in the sampled area (Figure 3), have Mean Corrected PSVs ranging from 61 to 67. Uncorrected values ranged from a minimum of 59.0 to a maximum of 67.7. The most northerly sample (location 1) gave the highest Mean Corrected PSV (67), but was only marginally greater than the value (63) obtained from the southernmost sample (locality 2). The sample closest to Cribarth Quarry (locality 9) provides the lowest Mean Corrected PSV of 61 of the samples collected and contrasts with the published results from the quarry of up to 71 (Thomson *et al.*, 2004), but was also one of the least fresh of the Cribarth Formation samples. The Mean Corrected PSV for the Cribarth Formation, based on the 4 BGS samples, is 63 rising to 64.6 if the Cribarth Quarry data is included; and if the results for weathered sample 9 are excluded, the Cribarth Formation mean increases to 65.5.

Crychan Formation: The muddy sandstones of the Crychan Formation (Figure 3) provided Mean Corrected PSVs of between 59 and 63. Uncorrected values ranged from 61.3 to 64.0. The lowest value (59) was provided by the most southerly and badly weathered sample (locality 4), but samples from the remaining parts of the crop, including two from close to its northern limit (localities 7 and 8), provided Corrected PSVs consistently in the 61 to 63 range. The Mean Corrected PSV for the Crychan Formation, based on the six BGS samples, is 61.3; and exclusion of the data for weathered sample 4 increases this mean to 61.8.

### 5.1. SUMMARY OF RESULTS

The results broadly confirm that both the Cribarth and Crychan formations in the sampled region comprise muddy sandstones with PSVs consistently above 60 – the threshold for High Skid Resistant Aggregate. They confirm that BGS was justified in identifying the outcrops of both these formations in the Inferred Mineral Resources map for the Builth Wells district as having significant resource potential for such aggregate.

The results suggest that the PSVs for the Cribarth Formation sandstones are generally higher than those for the Crychan Formation, though both overlap in their range of Corrected PSVs (Cribarth: 61-67; Crychan: 59-63). The results also suggest that the PSVs of both formations are largely maintained throughout their areas of outcrop. The Crychan Formation is more lithologically variable than the Cribarth Formation, yet, despite the presence of harder sandstone lenses and beds, the majority of PSVs obtained for the Crychan Formation are remarkably consistent within the 61 to 63 range.

At face value the results suggest that the PSVs for the Cribarth Formation are variable and that the very high PSVs obtained for the material worked at Cribarth Quarry is not a consistent feature of the formation. Only one locality in the Cribarth Formation (locality 1) provided a Corrected PSV of greater than 65. However, the slight to moderately weathered nature of the much of the sampled material may be a factor in depressing the PSVs obtained from surface exposures. Significantly, some of the lowest test results for both formations were from localities (4 and 9) where the sandstone sampled is moderately weathered and fresher material could not be obtained.

## **5.2. NATIONAL MINERAL MAP OF WALES**

In the context of the National Minerals Map of Wales, the BGS Minerals Group has advised that BGS would show both the Cribarth and Crychan formations as potential high PSV resources. When inferring the aggregate and mineral resources to be depicted on this map BGS will utilise published literature, geologists' knowledge and industry input. However, the laboratory analyses presented here provide no indication as to why the outcrops of both these formations should not be included as potential high PSV resources on the national map.

## 6 Conclusions and Recommendations

The results of the BGS sampling and testing programme confirm that the outcrops of the Cribarth and Crychan formations in the Cribarth area (Figure 3) comprise predominantly muddy sandstones which yield consistently high PSV results (>60). The Cribarth Formation sandstones appear to display generally higher PSVs than the Crychan Formation. Only one Cribarth Formation sample (locality 1) provided a PSV greater than the 65 threshold for the higher specification skid resistant aggregate. However, the results also suggest that the degree of surface weathering impacts on the PSV and that less weathered material, obtained from depth and as worked in Cribarth Quarry, may provide higher PSV test results.

The evidence suggests that the outcrop of the Cribarth Formation, in the Cribarth area, does have significant potential as a high PSV resource to service the >65 PSV specification market; assuming that its other mechanical properties (e.g. Aggregate Abrasion Value, Wet Attrition Value, etc) also meet the necessary standards.

Although the PSV results obtained for the Crychan Formation are generally lower, the formation does appear to provide consistent PSV results in the 61-63 range and, acknowledging the impact of weathering, it is reasonable to expect fresher material to provide still higher values. Thomson *et al.* (2004) cite three other existing quarries in Powys which work material for road surfaces which give test results within the same range of PSVs (Builth Wells, PSV 61; Criggion, PSV 62; Rhayader, PSV 63).

This study examined only the outcrop of the Cribarth and Crychan formations within the county of Powys. The outcrop of these formations extends south-westwards into north Carmarthenshire, and it is recommended that any future investigations should also consider analyses of the formations in this area, to provide a regional context for the resource.

The results from this study have indicated that surface weathering has an effect upon the material properties. It is recommended that for any future investigations and analyses, material that is in an unweathered state should be obtained by mechanical excavation or from boreholes.

The BGS recommendations are that the outcrops of both formations in the Cribarth area should be considered for safeguarding within the Powys County Council UDP. However, it is acknowledged that the evidence of this study provides stronger support for the safeguarding of the Cribarth Formation outcrop than it does for the outcrop of the Crychan Formation. The County Council may wish to consider the case for safeguarding the Crychan Formation outcrop in the context of the usage and known reserves of materials with similar PSVs worked at existing aggregate quarries within the county (see Thomson *et al.*, 2004). However, based on the current state of knowledge, the outcrops of both formations are expected to be included as inferred resources on the forthcoming National Mineral Map of Wales and to be flagged as in need of safeguarding. In making these recommendations, BGS acknowledges that other planning factors may influence the County Council's decision whether or not to proceed with the safeguarding of either outcrop area.

## 7 References

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NATIONAL ASSEMBLY FOR WALES (2000). Minerals Planning Policy Wales. Cardiff, National Assembly for Wales

THOMSON, A, BURROWS, A, FLAVIN, D AND WALSH, I. 2004. The Sustainable Use of High Specification Aggregates for Skid Resistant Road Surfacing in England. Report to the Deputy Prime Minister and the Minerals Industry Research Organisation. Capita Symons Ltd, East Grinstead.

## Tables

**Table 1: Summary of sample details and test results**

| Sample No | Formation | Locality                         | Grid Reference | Min/ max Recorded PSV | Mean Recorded PSV | Corrected PSV |
|-----------|-----------|----------------------------------|----------------|-----------------------|-------------------|---------------|
| 1         | Cribarth  | Tanyrallt (roadside excavation)  | SN 9465 5346   | 65.0/67.7             | 66.4              | 67            |
| 2         | Cribarth  | Garth Bank (Cwm Clyd Quarry)     | SN 9464 5091   | 62.7/64.7             | 63.6              | 63            |
| 3         | Crychan   | Garth Bank (forestry cutting)    | SN 9506 5110   | 61.3/64.0             | 62.3              | 63            |
| 4*        | Crychan   | Garth Bank (forestry cutting)    | SN 9475 5049   | 58.0/61.0             | 59.8              | 59            |
| 5         | Cribarth  | Dolderwen (road cutting)         | SN 9490 5133   | 61.3/63.0             | 62.3              | 61            |
| 6         | Crychan   | Comin Coch (roadside excavation) | SN 9560 5185   | 61.7/63.7             | 62.8              | 63            |
| 7         | Crychan   | Llanerchpesgi (farm quarry)      | SN 9623 5338   | 62.3/63.7             | 63.0              | 61            |
| 8         | Crychan   | Llwyncanol (farm cutting)        | SN 9685 5375   | 62.3/64.3             | 63.6              | 61            |
| 9*        | Cribarth  | Coed Caedwl (road cutting)       | SN 9490 5272   | 59.0/62.0             | 60.5              | 61            |
| 10*       | Crychan   | Garth Bank (road cutting)        | SN 9511 5122   | 60.7/62.7             | 61.7              | 61            |

(\* samples including a higher proportion of moderately weathered material)

**Table 2: Mean Recorded and Corrected PSV results per formation**

| Formation | Number of samples | Recorded Min/Max PSV | Mean Recorded Min/Max PSV | Corrected Min/Max PSV | Mean Corrected PSV |
|-----------|-------------------|----------------------|---------------------------|-----------------------|--------------------|
| Cribarth  | 4                 | 59.0/67.7            | 62/63.9                   | 61/67                 | 63                 |
| Crychan   | 6                 | 58.0/64.3            | 61/63.2                   | 59/63                 | 61.3               |

# Appendices

## Appendix 1. High PSV sample list

Samples collected by JRD on 28/11/08 and 1/12/08 in connection with Project E3230R under contract for Powys County Council:

**Sample 1:** Cribarth Formation, Tanyrallt, roadside excavation [SN 9465 5346]. Homogeneous, fine-grained muddy sandstone; slightly to moderately weathered.

**Sample 2:** Cribarth Formation, Cwm Clyd Quarry [SN 9464 5091]. Homogeneous, fine-grained muddy sandstone; slightly weathered.

**Sample 3:** Crychan Formation, Garth Bank, forestry track floor exposure [SN 9506 5110]. Fine-grained, muddy sandstone with scattered lenses of hard fine-grained sandstone; slightly weathered.

**Sample 4:** Crychan Formation, Garth Bank, forestry track cutting [SN 9475 5049]. Fine-grained, muddy sandstone with lenses and thin beds of hard, fine-grained sandstone; moderately weathered

**Sample 5:** Cribarth Formation, Dolderwen, road cutting [SN 9490 5133]. Homogeneous, fine-grained muddy sandstone; slightly to moderately weathered.

**Sample 6:** Crychan Formation, Comin Coch, roadside excavation [SN 9560 5185]. Fine-grained, muddy sandstone with scattered lenses of hard fine-grained sandstone; slightly weathered.

**Sample 7:** Crychan Formation, Llanerchpesgi, farm quarry, [SN 9623 5338]. Fine-grained, muddy sandstone with scattered lenses of hard fine-grained sandstone; slightly to moderately weathered.

**Sample 8:** Crychan Formation, Llwyncanol, farm cutting [SN 9685 5375]. Very fine-grained muddy sandstone with scattered thin sandstone beds; slightly to moderately weathered

**Sample 9:** Cribarth Formation, Coed Caedwl, road cutting [SN 9490 5272]. Homogeneous, fine-grained muddy sandstone; moderately weathered.

**Sample 10:** Crychan Formation, Garth Bank, road cutting [SN 9511 5122]. Homogeneous, fine-grained, muddy sandstone; moderately weathered.

# Appendix 2. Test Results (as supplied by Celtest Company Limited)

# celtest

independent materials testing — diamond core drilling &amp; sawing

Celtest Company Ltd  
Trefelin  
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Nottingham  
NG12 5GG

Date: 04 February 2009  
Our Ref. TR: 171446

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Your Order No. Mark Allen 2K22875

## LABORATORY TEST REPORT

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with BS EN 1097-8 : 2000

### SAMPLE DETAILS:

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 1                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test:            | 01/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

### RESULTS:

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 67.7 | Mean<br>Recorded<br>Value (S)<br>= 66.4 |
|                |            | (ii)  | 65.0 |   |
|                | Test Run 2 | (iii) | 67.0 |   |
|                |            | (iv)  | 66.0 |   |
| Control Stone: | Test Run 1 | (i)   | 52.0 | Mean<br>Recorded<br>Value (C)<br>= 52.3 |
|                |            | (ii)  | 53.0 |   |
|                | Test Run 2 | (iii) | 52.3 |   |
|                |            | (iv)  | 52.0 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 67$ 

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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 2                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 23/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 64.7 | Mean<br>Recorded<br>Value (S)<br>= 63.6 |
|                |            | (ii)  | 62.7 |   |
|                | Test Run 2 | (iii) | 63.7 |   |
|                |            | (iv)  | 63.3 |   |
| Control Stone: | Test Run 1 | (i)   | 54.3 | Mean<br>Recorded<br>Value (C)<br>= 53.6 |
|                |            | (ii)  | 52.7 |   |
|                | Test Run 2 | (iii) | 54.0 |   |
|                |            | (iv)  | 53.3 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 63$

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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 3                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 01/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 61.3 | Mean<br>Recorded<br>Value (S)<br>= 62.3 |
|                |            | (ii)  | 64.0 |   |
|                | Test Run 2 | (iii) | 62.0 |   |
|                |            | (iv)  | 62.0 |   |
| Control Stone: | Test Run 1 | (i)   | 52.0 | Mean<br>Recorded<br>Value (C)<br>= 52.3 |
|                |            | (ii)  | 53.0 |   |
|                | Test Run 2 | (iii) | 52.3 |   |
|                |            | (iv)  | 52.0 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 63$

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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 4                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 23/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 62.0 | Mean<br>Recorded<br>Value (S)<br>= 59.8 |
|                |            | (ii)  | 58.0 |   |
|                | Test Run 2 | (iii) | 61.0 |   |
|                |            | (iv)  | 58.3 |   |
| Control Stone: | Test Run 1 | (i)   | 54.3 | Mean<br>Recorded<br>Value (C)<br>= 53.6 |
|                |            | (ii)  | 52.7 |   |
|                | Test Run 2 | (iii) | 54.0 |   |
|                |            | (iv)  | 53.3 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 59$

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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 5                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 23/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 63.0 | Mean<br>Recorded<br>Value (S)<br>= 62.3 |
|                |            | (ii)  | 63.0 |   |
|                | Test Run 2 | (iii) | 61.7 |   |
|                |            | (iv)  | 61.3 |   |
| Control Stone: | Test Run 1 | (i)   | 54.3 | Mean<br>Recorded<br>Value (C)<br>= 53.6 |
|                |            | (ii)  | 52.7 |   |
|                | Test Run 2 | (iii) | 54.0 |   |
|                |            | (iv)  | 53.3 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 61$

  
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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 6                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 01/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 63.7 | Mean<br>Recorded<br>Value (S)<br>= 62.8 |
|                |            | (ii)  | 63.7 |   |
|                | Test Run 2 | (iii) | 62.0 |   |
|                |            | (iv)  | 61.7 |   |
| Control Stone: | Test Run 1 | (i)   | 52.0 | Mean<br>Recorded<br>Value (C)<br>= 52.3 |
|                |            | (ii)  | 53.0 |   |
|                | Test Run 2 | (iii) | 52.3 |   |
|                |            | (iv)  | 52.0 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 63$

E. R. Goulden – Technical Manager



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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 7                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 25/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 63.7 | Mean<br>Recorded<br>Value (S)<br>= 63.0 |
|                |            | (ii)  | 62.3 |   |
|                | Test Run 2 | (iii) | 63.7 |   |
|                |            | (iv)  | 62.3 |   |
| Control Stone: | Test Run 1 | (i)   | 55.3 | Mean<br>Recorded<br>Value (C)<br>= 54.8 |
|                |            | (ii)  | 55.0 |   |
|                | Test Run 2 | (iii) | 54.0 |   |
|                |            | (iv)  | 54.7 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 61$

E. R. Goulden – Technical Manager



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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 8                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 25/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 64.3 | Mean<br>Recorded<br>Value (S)<br>= 63.6 |
|                |            | (ii)  | 63.7 |   |
|                | Test Run 2 | (iii) | 64.0 |   |
|                |            | (iv)  | 62.3 |   |
| Control Stone: | Test Run 1 | (i)   | 55.3 | Mean<br>Recorded<br>Value (C)<br>= 54.8 |
|                |            | (ii)  | 55.0 |   |
|                | Test Run 2 | (iii) | 54.0 |   |
|                |            | (iv)  | 54.7 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 61$

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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 9                  |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 01/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 59.0 | Mean<br>Recorded<br>Value (S)<br>= 60.5 |
|                |            | (ii)  | 62.0 |   |
|                | Test Run 2 | (iii) | 61.0 |   |
|                |            | (iv)  | 60.0 |   |
| Control Stone: | Test Run 1 | (i)   | 52.0 | Mean<br>Recorded<br>Value (C)<br>= 52.3 |
|                |            | (ii)  | 53.0 |   |
|                | Test Run 2 | (iii) | 52.3 |   |
|                |            | (iv)  | 52.0 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 61$

  
E. R. Goulden – Technical Manager



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Your Order No. Mark Allen 2K22875

**LABORATORY TEST REPORT**

**TEST REQUIREMENTS:** To determine the Polished Stone Value (PSV) of aggregate sample in accordance with **BS EN 1097-8 : 2000**

**SAMPLE DETAILS:**

|                                   |                    |
|-----------------------------------|--------------------|
| Certificate of sampling received: | No                 |
| Laboratory Ref. No:               | S26551             |
| Client Ref. No:                   | 10                 |
| Date and Time of Sampling:        | Unknown            |
| Date of Receipt at Lab:           | 21/01/2009         |
| Date of Start of Test.:           | 23/02/2009         |
| Sampling Location:                | Unknown            |
| Name of Source:                   | Powys              |
| Method of Sampling:               | BS EN 932-1 : 1997 |
| Sampled By:                       | Client             |
| Aggregate Type and Nominal Size:  | Gritstone 10 mm    |
| Target Specification:             | N/A                |

**RESULTS:**

Recorded Polished Stone Value

|                |            |       |      |   |
|----------------|------------|-------|------|---|
| Test Specimen: | Test Run 1 | (i)   | 62.0 | Mean<br>Recorded<br>Value (S)<br>= 61.7 |
|                |            | (ii)  | 62.7 |   |
|                | Test Run 2 | (iii) | 60.7 |   |
|                |            | (iv)  | 61.3 |   |
| Control Stone: | Test Run 1 | (i)   | 54.3 | Mean<br>Recorded<br>Value (C)<br>= 53.6 |
|                |            | (ii)  | 52.7 |   |
|                | Test Run 2 | (iii) | 54.0 |   |
|                |            | (iv)  | 53.3 |   |

Corrected Polished Stone Value:  $S + 52.5 - C = 61$

E. R. Goulden – Technical Manager

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