Aggregate Sales Report

On Behalf of Tungsten West

Abstract:

Construction aggregate is a fundamental raw material for all countries. Geological materials have been used in construction since the dawn of time. This is still the case with construction raw materials accounting for the largest volumes of any known production process on the planet. Natural aggregate is the most ubiquitous construction material and is used in buildings, civil engineering projects and transport infrastructure such as roads, railways and airport runways.

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1.0 INTRODUCTION

1.1 Following Tungsten West's recent purchase of Hemerdon Mine, Panoptic Consultancy have identified a high value in the biproduct produced as part of the previous mining operation. This bi-product holds varying values if sold in its current state, however if the bi-product is processed in a certain way, then certificated to the Specification for Highways Works (SHW) namely Series 600 & 800, this former bi-product becomes a highly valuable and sustainable source to support infrastructure project in the UK and abroad.

1.2 The construction aggregates sector is an important part of most modern developed economies. For example, in the UK, aggregates account for approximately 85% of the non-energy minerals extracted. They are essential for constructing and maintaining what is literally the physical framework of the buildings and infrastructure on which our society depends (British Geological Survey (BGS), 2013).

2.0 AGGREGATE OVERVIEW

2.2 Aggregates are used across multiple platforms ranging from pathways, roads, general and designed fills. Roads and pathways are designed and built up through various layers which comprise of various Granular and Cohesive products. The design codes for these products can be found in the Specification for Highway Works (SHW) Series 600.

2.4 The SHW contains the requirements for materials to be used in constructing and maintaining the UK's road network. The 600 Series describes the acceptable materials to be used in earthworks which include recycled and secondary materials and specifies the tests that need to be carried out on them. No more than 1% of contaminants, such as wood, plastic and metal are allowed in recycled materials. Recycled aggregates must be produced in accordance with the WRAP Quality Protocol for the production of aggregates from inert waste (Quality Protocol).

2.5 The 600 Series also sets out the requirements for other techniques that can be used to increase resource efficiency in earthworks, such as stabilisation with lime and/or cement, use of geosynthetics, soil reinforcement, ground improvement and foundation drainage.

2.6 The SHW provides definitions of the types of recycled material allowed. It also gives the specifications for each class of fill material and example types of material including recycled and secondary materials. In some cases, it sets limits on the proportion of different types of material allowed.

2.7 The suitability of naturally occurring rock for the production of construction aggregate relies on its testing against national and international standards. Construction aggregate broadly comes in two main categories. Hard rock aggregate is typically sourced from igneous rocks such as granite, dolerite and gabbro, sedimentary rocks such as sandstone and limestone, and metamorphic rocks such as gneiss and marble.

2.8 Sand gravel aggregate can also be produced through extraction in quarries by mechanical excavators. Both types of aggregate are washed and screened to create the required construction aggregate products. The testing of aggregate not only ensures its suitability for different construction applications it is also the basis for consumer specifications and enables the ongoing assurance that it continues to meet the required properties.

2.9 Important applications include concrete, mortar, road stone, asphalt, railway ballast, drainage courses and bulk fill. There are three main types: natural aggregate (from mineral sources with nothing more than physical processing, often referred to as 'primary aggregate'), manufactured aggregate (derived from industrial processes as a by-product, often referred to as 'secondary aggregate') and recycled aggregate (recovered from material previously used in construction).

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3.0 PRODUCTS ON SITE

3.1 There are a range of existing products onsite, produced as part of the previous operation, many of which could either be sold in their current state, or be subject to further processing, achieving higher sale values. Below is an example of the current products onsite.

Potential Class 1 A fill.

This material is holds multiple potential uses; however, it could be sold as a basic fill material.

Should this material be washed, crushed and screened, a high value granular product would be produced.

DMS Float

This material has been produced as aprt of the previous mining operation and ranges in size from 10mm – dust.

When screed, this product can produce 3 core sub-products. 4.75mm dust (service Sand), 9mm – 5mm concrete aggregates and 10mm chippings. The material holds a high shear capacity due to it's granite nature.

80mm low fines (Cohesive content)

This product can be used in many application such as sub base road layers. Should the cohesive content be washed out, a high value road formation layer.

The material can be blended with other products to produce a more cohesive material, suitable for a wide range infrastructure applications.

20mm Chippings with Cohesive Content

This product can be washed to produce and clear, Granular Fill, suitable for further sub-base layers of roads.

The material can also be further bound by cohesive materials to support a wider range of applications.

4.0 DEFINITIONS

3.1 When using aggregates in projects, there are 2 main types:

3.1.1 Granular – This represents a clean stone product, with no fines or silt content. Granular aggregates are generally washed and come in a range of sizes from 20mm, 40mm, 60mm, 80mm. and 125mm
3.1.2 Cohesive – This represents material with a higher fines content. The composition of said fines could be from sand, silt or clay.

3.1 Granular Subbase 1 (GSB 1) - The term GSB1 is specific to the SROH. The material specification for the reinstatement of openings in highways which is equivalent to SHW clause 803 Type 1 unbound mixture.

3.1 Hydraulic Binder Material (HMB) - (or a combination of materials) that sets and hardens by hydraulic reaction. This includes cement, fly ash, lime and processed blast furnace slag and factory produced hydraulic road binders.

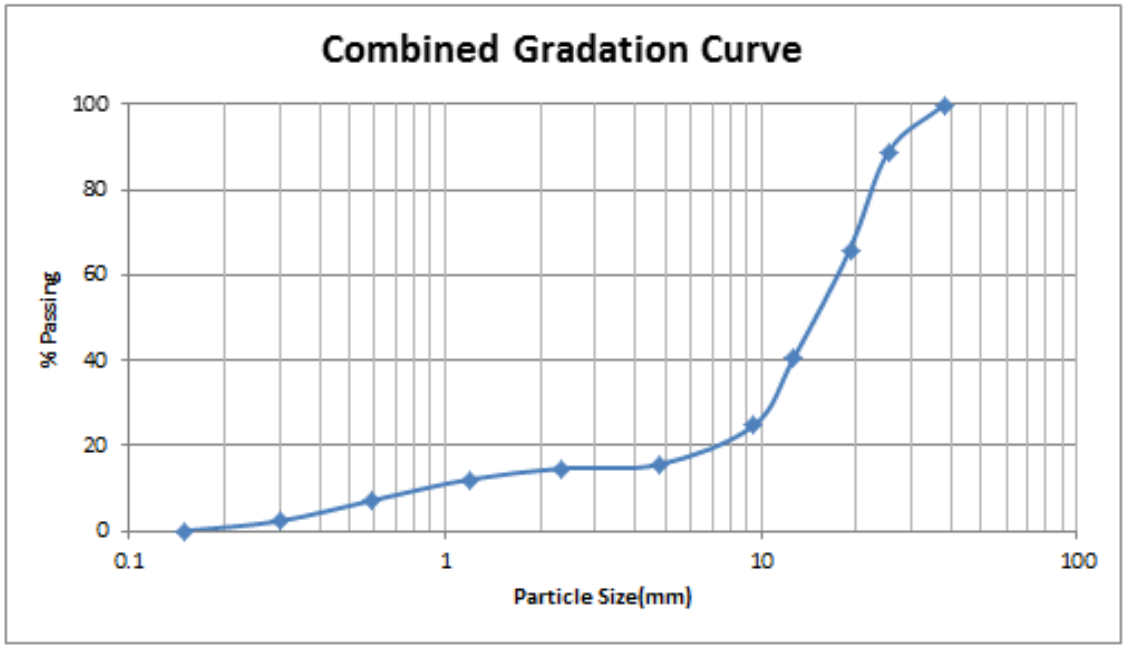
3.4 Recycled Aggregate - Aggregate derived from the processing of inert material previously used in construction.

3.5 Secondary Aggregate - Aggregates derived from by-products of other industrial processes and which have not been previously used in construction.

3.6 Stabilised Material for Fill (SMF) - It comprises an ad-hoc grouping of materials including processed, improved, modified or hydraulically bound materials (including stabilised). SMF can be derived from any source, including virgin materials and are not necessarily bound. Source and process are not specific to SMFs and they are instead defined by a set of compositional and performance requirements.

3.7 Structural Material for Reinstatement (SMR) - It comprises a material grouping generally falling within the hydraulically bound materials family, including specific materials such as foamed concrete. Broadly defined as a material that includes “cementiceous, chemical, hydraulic binder or are inherently self-cementing” (HAUC, 2002). They are generally differentiated from SMFs by superior performance.

3.8 The below graph demonstrates how aggregates are graded.



5.0 CLASSIFICATION OF AGGREGATES

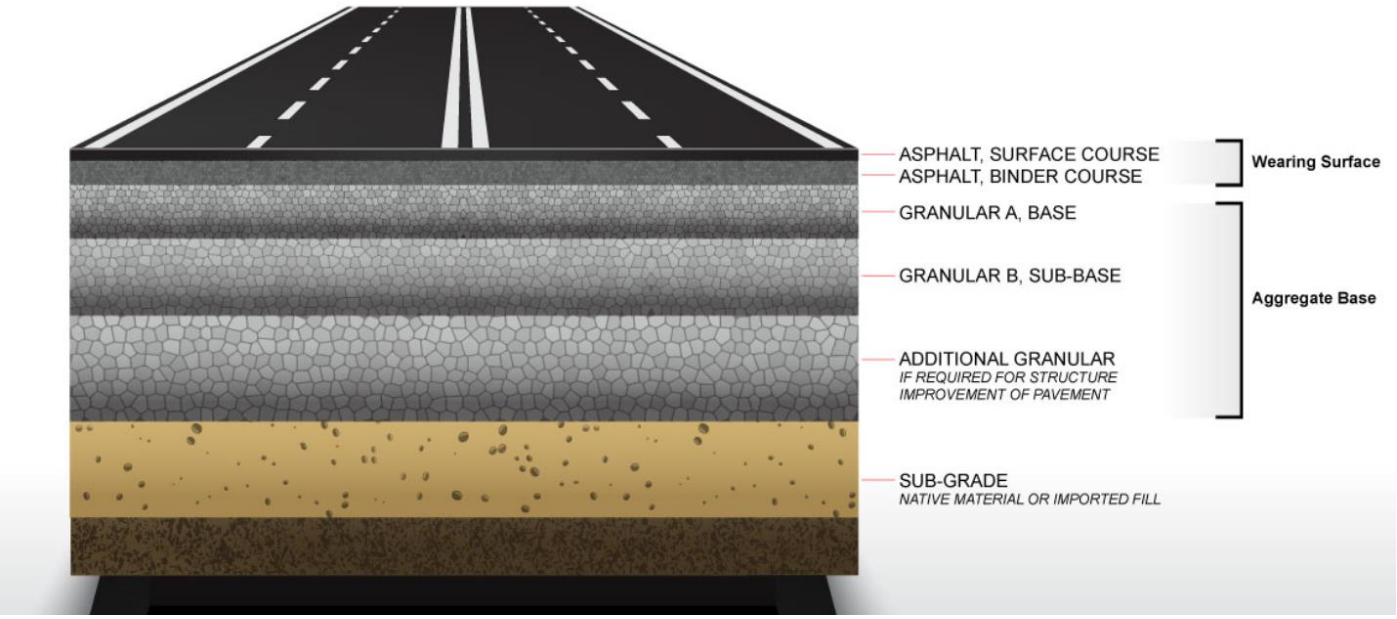
5.1 Below demonstrates the classification under SHW Series 600

- **1A** – Well graded granular material (General fill)
- **1B** – Uniformly graded granular material (General fill)
- **1C** – Coarse granular material (General fill)
- **2A** – Dry cohesive material (General fill)
- **2B** – Dry cohesive material (General fill)
- **2C** – Stoney cohesive material (General fill)
- **2D** – Silty cohesive material (General fill)
- **2E** – Reclaimed pulverised fuel ash cohesive material (General fill)
- **5A** – Topsoil, or turf, existing on site (Topsoiling)
- **5B** – Imported topsoil (Topsoiling)
- **6A** – Selected well graded granular material (Below water)
- **6B** – Selected coarse granular material (Starter layer)
- **6C** – Selected uniformly graded granular material (Starter layer)
- **6D** – Selected uniformly graded granular material (Starter layer below pulverised fuel ash)
- **6E** – Selected granular material, Class 9A (For stabilisation with cement to form capping)
- **6F1** – Selected granular material, fine grading (Capping)
- **6F2** – Selected granular material, coarse grading (Capping)
- **6F3** – Selected granular material (Capping)
- **6F4** – Selected granular material, fine grading (Capping)
- **6F5** – Selected granular material, coarse grading (Capping)
- **6G** – Selected granular material (Gabion filling)
- **6H** – Selected granular material (Drainage layer to reinforced soil and anchored earth structures)
- **6I** – Selected well graded granular material (Fill to reinforced soil and anchored earth structures)
- **6J** – Selected uniformly graded granular material (Fill to reinforced soil and anchored earth)
- **6K** – Selected granular material (Lower bedding for corrugated steel buried structures)
- **6L** – Selected uniformly graded granular material (Upper bedding for corrugated steel buried structures)
- **6M** – Selected granular material (Surround to corrugated steel buried structures)
- **6N** – Selected well graded granular material (Fill to structures)
- **6P** – Selected granular material (Fill to structures)
- **6Q** – Well graded uniformly graded or coarse granular material (Overlying fill for corrugated steel buried structures)
- **6R** – Selected granular material (For stabilisation with lime and cement to form capping (Class 9F)
- **6S** – Selected well graded granular material (Filter layer below subbase)
- **7A** – Selected cohesive material (Fill to structures)
- **7B** – Selected conditioned pulverised fuel ash cohesive material (Fill structures and to reinforces soil)
- **7C** – Selected wet cohesive material (Fill to reinforced soil)
- **7D** – Selected stony cohesive material (Fill to reinforced soil)
- **7E** – Selected cohesive material (For stabilisation with lime to form capping, Class 9D)
- **7F** – Selected silty cohesive material (For stabilisation with cement to form capping, Class 9B)
- **7G** – Selected conditioned pulverised fuel ash cohesive material (For stabilisation with cement to form capping (Class 9C)
- **7H** – Wet, dry, stony or silty cohesive material and chalk (Overlying fill for corrugated steel buried structures)
- **7I** – Selected cohesive material (For stabilisation with lime cement to form capping, Class 9E)
- **8** – Class 1, Class 2 or Class 3 material (Lower trench fill)
- **9A** – Cement stabilised cohesive material (Capping)
- **9B** – Cement stabilised silty cohesive material (Capping)
- **9C** – Cement stabilised conditioned pulverised fuel ash cohesive material (Capping)
- **9D** – Lime stabilised cohesive material (Capping)
- **9E** – Lime cement stabilised cohesive material (Capping)
- **9F** – Lime and cement stabilised well graded granular material (Capping)

6.0 GENERAL FORMATION OF ROADS

6.1 A wide variety of materials are used in the construction of roads these are cohesive (naturally occurring or processed), aggregates (fine aggregates or coarse aggregates obtained from rocks), binders like lime, bituminous materials, and cement, and miscellaneous materials used as admixtures for improved performance of roads under heavy loads and traffic.

6.2 Below is a basic example of how a road is formed and the type of aggregates used.



7.0 WHAT PRODUCTS CAN BE PRODUCE

7.1 Following the previous mining operation from Wolf Minerals, extremely high volumes of usable biproduct has been produced. Due to the composition of this biproduct, nearly all classifications laid out in table 5.1, could be produced. There is potential for Arsenic and Sulphate contamination inside the existing stockpiles, due to hot spots located around the mine. However, this is a common problem when mining for primary aggregates and is something that can be managed and engineered into sub-surface designs.

7.2 Further consultation has been sought through John Grimes Partnership (JGP). John Grimes is a local Civil, Structural, Geotechnical and Environmental Engineering Consultancy, who offer a wide spectrum of engineering solutions. JGP currently reside as the design engineers for aggregates across many strategic projects, including but not limited to, Sherford (5,500 new homes in Plymouth) Forder Valley Link Road (Construction of a new Highway in Plymouth). JGP have further confirmed that even if the Arsenic levels are high, this can be managed and designed into projects.

7.3 The table below gives and initial indication of some stockpiles, their composition, location and suitability.

Location	Potential Aggregates	Approx Volume on Site	Remarks
Stockpile 1 (SP 1)	Class 1A, all ranges	390,000m3	Nearly all classification of Aggregates could be produced from this stockpile with screening, washing and crushing.
Stockpile 2 (SP 2)	Sand, various ranges	240,000m3	This particular material is what's classified under mining terms as DMS Float. SP 2's location on the map only

			represents a small portion of the actual volume onsite. There are various stockpiles scattered all over the mining area. This material is highly usable, with applications such as concrete, service sand, 10mm granite chippings and a cohesive binder for other aggregates.
Stockpile 3 (SP 3)	40mm – 20mm clean		This product is produced as a reject through the previous mining operation. If washed it works well as a high quality granular fill material, widely used in roads. If blended with SP 2 it produces the 6F class, again widely used.

7.4 Site Location Map

7.5 As previously mentioned, through screening, washing, crushing and blending, utilising existing infrastructure onsite, nearly all classifications of aggregates can be produced.

7.0 PRICES OF THOSE PRODUCTS

7.1 Over the past 3 weeks we have conducted market research on aggregates rates from exiting local suppliers. We have requested rates for the basic products, easily produced from the existing stockpiles at Tungsten West. The below table demonstrates existing, market rates. Having assessed Glendenning's rates, we do not believe this is a true reflection of current, sustainable rates.

7.2 Rates List

Price per tonne	Glendenning's		Brooklands		Aggregates South West
Aggregate Type	**Collection**	**Delivery**	**Collection**	**Delivered**	**Collection**
MOT Type 1 / 803	£14.75	£17.04	£ 7.50	£15.80	£11.20
6F5			£ 6.40	£14.70	£10.50
75mm Clean	£ 20.25	£ 22.54	£ 12.05	£ 20.35	£15.85
40mm Clean	£ 23.45	£ 25.74	£12.05	£ 20.35	£16.95
20mm Clean	£ 23.45	£ 25.74	£12.05	£ 20.35	£16.45
10mm – Dust	£ 25.95	£ 28.34	£ 9.50	£ 17.80	£ 20.95
Class 1 A Fill	£ 8.75	£ 11.04	£ 5.00	£ 13.30	£ 7.50

7.3 For additional confirmation on aggregate rates, please refer to Appendix A – Orkney Price List

7.4 As stated item 7.5, nearly all classifications of aggregates can be produced, with rates to reflect the suitability and durability of those types. When reviewing mainstream suppliers such as B & Q, the rates increase by circa 50%. For example, a one tonne bag of 10mm to dust will cost £42.35. These are however supplied in smaller quantities, and do not supplement mainstream construction works.

8.0 CURRENT TESTING REGIME

8.1 John Grimes Partnership have been appointed to carry out initial testing and classification of the aggregates shown in 7.4 Site Location Map (SP 1, SP 2, SP 3). Concrete and aggregate used in construction projects has to meet strict regulations and quality standards. As these standards are often compulsory, concrete and aggregate testing by an independent third-party is necessary to help assure compliance.

8.2 Aggregate testing can be carried out in the following fields:

8.2.1 Physical: Grading, Shape, Relative Density, Bulk Density, Water Absorption
8.2.2 Strength: AIV, ACV and TFV, Franklin Point Load
8.2.3 Mechanical: AAV, PSV, Los Angeles Abrasion, Wet Attrition
8.2.4 Durability: Sulphate Soundness, Frost Heave, Slake Durability Index, Methylene Blue, Drying Shrinkage
8.2.5 Chemical: Organic Matter, Chloride, Sulphate or full analysis
8.2.6 Specialist: AAR Assessment using Petrography, Gel Pat, Chemical Test, Mortar Bar and Accelerated Mortar Bar and Concrete Prism Method

8.3 John Grimes Partnership have proposed to take samples from the mine itself, as well as the stockpiles. The methodology behind this is to find the point source of the Arsenic, while collaborating with existing data. Once the primary source values of Arsenic have been evaluated, it will better inform on the potential spread of contamination across the wider site. Even if Arsenic is present it only becomes a problem that needs carful management if the Bio-accessibility and leachate values are also high.

9.0 Immediate sales opportunities

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9.1 There are a number of high value projects currently underway in the Plymouth area, all of which have a large demand on aggregate supply.

9.2 Sherford Housing Project: Construction is currently underway to develop 5,500 new homes on the outskirts of Plymouth. There is a current demand of around 250,000 tonnes of aggregates which are imported to the site each year. These range from Type 1 803 to concrete for both roads, slabs and foundations. We are already engaging with Brookbanks (site consultants) and Groundfix (site Ground Workers) on supply. This site is estimated to last for 15 years.

9.3 Forder Valley Link Road: Plymouth City Council have appointed Balfour Beatty to complete a new highway, linking the A38 with Derriford Hospital in Plymouth. There is an extremely high demand on aggregates for this site and the project is already substantially over budget. We are already in talks with Plymouth City Council and Balfour Beatty to supply the first wave of aggregates which is Class 1 A 36,396m3. Below is a table showing the total amount of aggregates required for Phase 1 of the works.

9.4 Forder Valley Link Road Aggregate Supply

Description	**Quantity**	**Unit**	**Conversion**	**tonnes**
AGGREGATES Materials				
Imported Class 6I/J reinf earth (internal angle of friction 36 degrees)	18,089	m3	2.25	40,700
Imported Class 6I/J reinf earth (internal angle of friction 40 degrees)	6,107	m3	2.25	13,741
Primary Type 1 subbase roads and paths	13,449	m3	2.30	30,933
Imported Class 1A	36,396	m3	2.20	80,071
Imported acceptable (1A or 2C) and see above	23,896	m3	2.20	52,571
Imported class 6N	12,697	m3	2.25	28,567
Capping or recycled subbase (haul & comp)	8,689	m3	2.20	19,116
Imported 6H graded gravel	6,338	m3	2.00	12,676
Imported Filter Type B 80-10mm	3,732	m3	1.80	6,718
Imported Class 1A1 (internal angel of friction 40 degrees)	2,506	m3	2.20	5,513
Imported pond material (Clay)	2,348	m3	1.80	4,226
Imported type 3 subbase	248	m3	2.25	557
Primary Type 1 subbase misc	440	ton	1.00	440
ROCK Rip Rap 75mm-150mm	119	ton	1.00	119

9.5 Broadmoor Farm: Broadmoor Farm is a new development which is just about to start, developing 1,500 new homes. This is being managed through Brookbanks Consultancy, who we are currently already engaging with for Sherford.

9.6 In addition to the above, the is an extremely high demand from local haulage firms. Below is a table showing their existing requirements.

Haulage Company	**Tonnes per week required**	**Type**
Burcombe Haulage	4,000 (Currently unable to source)	Various
JB Haulage	2,000 (Currently recycling demolition waste to meet demand)	6f5, 6f2, type1
Steve Wills	1,500	Various
RW Carter	1,000	Various
Brunel Haulage	1,000	Various

9.7 The above table only shows the larger haulage firms in the immediate Plymouth area. These haulage firms are currently driving to Redruth (1 hour 30 minutes away from Plymouth) to collect aggregates. This is mainly due to the level of supply and types available from existing local sources.

10.0 MARKET POTENTIAL SIZE, INCLUDING EXPORTS

10.1 The need for Aggregates: In recent years, total aggregate consumption in England has been around 210,00 – 220,000 million tonnes a year, 96% of which comes from English sources. Approximately 55-60 million tonnes of this come from recycled or secondary sources. This production contributes more than £1 billion to the English economy each year.

10.2 The UK is an important producer of a range of minerals that are consumed in many sectors of the economy. Some 198.1 million tonnes of minerals were extracted from the UK landmass for sale in 2017. These can be broken down into the following main categories with percentages of total production in brackets:

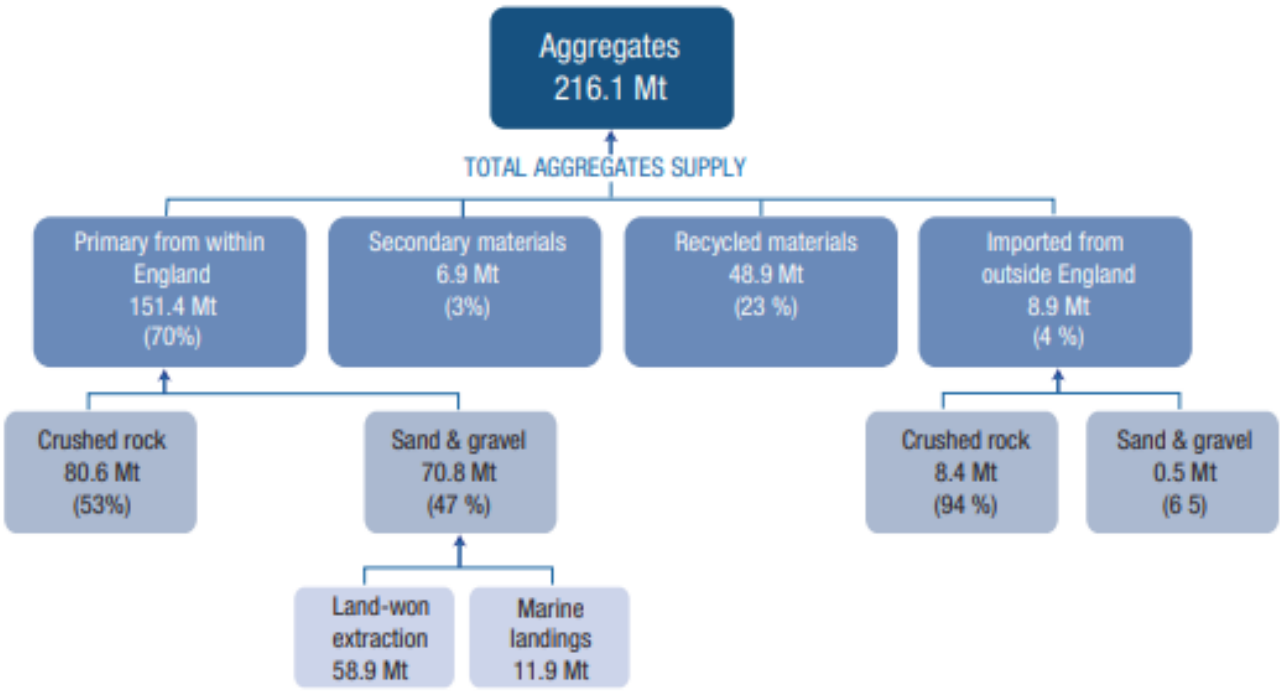
- 125.9 million tonnes (63.6%) of crushed rock (for both construction and industrial uses)
- 56.8 million tonnes (28.7%) of construction minerals (other than crushed rock)

10.3 in 2003 under the classification code of Combined Nomenclature (CN) Code 25.17 the UK traded in the flowing amounts:

- Imports – 1,327,049 tonnes at a value of £18.9 million
- Exports – 11,349,089 tonnes at a value of £48.9 million

10.4 The majority of aggregate that comes under this code is, pebbles, gravel, broken or crushed stone, concrete aggregates and aggregates for road metaling, all of which can be produced from Tungsten West.

Figure 1 *Aggregates supply chain in England, 2005.*



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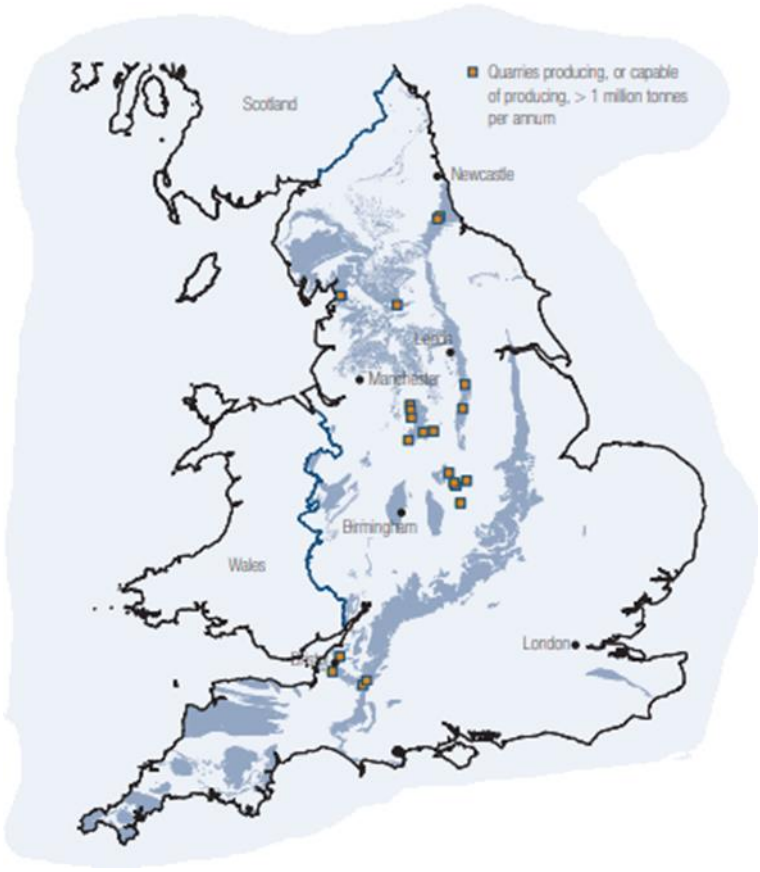
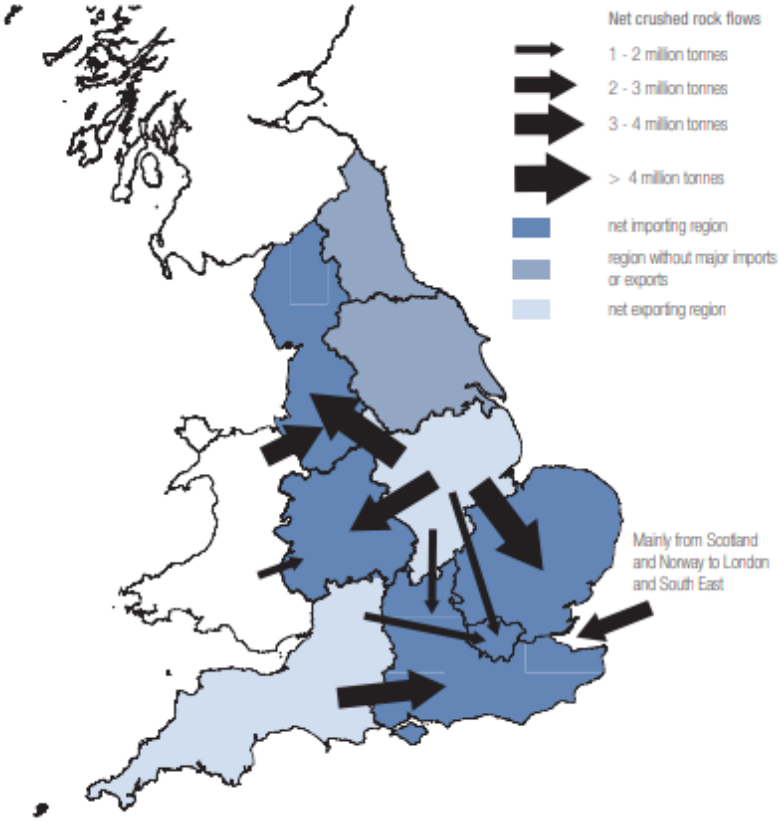


The yellow dots to the left show quarries currently capable of producing aggregates required to meet the UK demand. As you can see by the map, quarries are not evenly place, putting pressure on local supply.

The map to the right shows the reginal imbalances in supply and demand. To facilitate this demand, movements of large amounts of crushed rock from surplus areas are required to support regions in aggregate deficit.

Inter-regional flows of sand and gravel are smaller and mostly over shorter distances.



11.0 PLANNING PERMISSION CONSTRAINTS

11.1 The site is currently subject to planning constraints around the amount of lorry movements allowed per day, plus the total amount of export allowed per year. This currently stands at 50 lorry movements per day, with a total export allowance of 150,000 tonnes per year.

11.2 Long term we are looking to lift this planning restriction under section 73, varying the exiting consent. Having already consulted with local councils, there is a healthy appetite to lift this existing condition, through supporting their projects with a sustainable source of aggregate supply. Current supply locations are outside of the city limits, placing an extremely high volume of lorries on local roads to facilitate current demand. This places a high carbon footprint on the south west, with further concerns around prolonged transportation moves.

11.3 Short term, we have already consulted with both Plymouth City Council and Devon County Council to all allow a temporary lift on the planning restriction, subject to the following document being produced:

1. Letter of consent from both Councils
2. Photo Graphic Survey of Highway around main transport route
3. Environmental management Plan
4. Transport Management Plan
5. Monitoring of transport movements

11.4 These documents are currently being produced and we are hopeful to have them submitted in the next 3 weeks. Both councils are happy to move forward with the section 73, subject to monitoring data showing little disruption to exiting transport network. Local councils are onside with the mining operations, understanding the value it will bring through jobs, sustainability and costs savings. We have the support from councils to vary the existing conditions through demonstrating support to their local projects such as Sherford, Forder Valley and Broadmoor Farm.

SUMMARY

Aggregate Sales to support both UK and global demands is extremely viable and lucrative secondary business model, allowing financial support to the primary operation of mining Tungsten. Both local and global markets are currently stretched through supply, requiring input from additional sources to support Britain’s growth in the infrastructure sector. Initial testing does need to be completed, however following initial consultations and assessments, prospects are extremely positive. Samples results will be returned in the next 7 days.

To ensure that construction aggregates are fit for purpose and meet end-use requirements it is important to have an understanding of the geology of the resources, the production processes, and the standards and test methods used to evaluate their suitability. Primary construction aggregate can be produced from any source of rock as long as it meets the specification of the end-user.

The testing of construction aggregate is carried out to international standards. The particle size distribution (‘grading’) is the key defining characteristic of construction aggregate and is often used as a product classification. Particle shape, density, strength, mechanical wear and chemical soundness are important criteria for evaluating the suitability of aggregate for use in construction.

Reference:

Appendix A – Orkney Price List