Carew Quarry
ROMP Review

Appendices
Volume 2

December 2012

1. Landscape

A: LVIA Methodology

B: Landscape Character Areas

C: LANDMAP data

1.0 APPENDIX 1A – DETAILED LANDSCAPE AND VISUAL METHODOLOGY

1.1 Introduction

This section provides details on the methodology used for this assessment.

1.2 Format

After the Introduction to the main report the next sub-section consists of a "Baseline Study" for the existing site and its surroundings. This is carried out to divide the landscape down into component parts, and help to understand and identify any elements or receptors that might be particularly sensitive to the proposals. This stage consists of:

- A desktop assessment of potential landscape and visual receptors;
- An examination of the planning context of the proposals;
- A landscape appraisal of the existing site and its surroundings; and
- A visual assessment of the existing site and its surroundings.
- A study of the development proposals is then made to identify Potential Landscape and Visual Effects and impact generators within the proposals. This stage includes:
- Identification of the landscape and visual aspects of the proposals; and
- Development of mitigation measures to minimise any impacts.
- Following this, an assessment is made of the Residual Impacts likely to be generated after mitigation has been considered. This stage is divided into the following:
- Predicted residual landscape impacts;
- Predicted residual visual impacts;
- Significance of landscape and visual impacts; and
- Finally a conclusion and summary of the findings is presented.

1.2.1 Methodology and Staff

The format of this assessment is based on the principles produced by the Countryside Agency ("Landscape Assessment Guidance", 2002) and the Landscape Institute and Institute of Environmental Management and Assessment ("Guidelines for Landscape and Visual Impact Assessment", Second Edition, 2002). The assessment is also in accordance with the requirements of the Town and Country Planning (Environmental Impact Assessment) Regulations (1999).

1.2.2 Desktop Study

An initial desktop exercise was undertaken to identify the extent of the area to be studied and identify potential landscape and visual receptors within the area. This work was undertaken using, the 'Multi-Agency Geographical Information for the Countryside' (MAGIC) web site located at, and printed/digital map data. The size and type of project was considered in setting the size and extent of the study area, the aim being to ensure all landscape and visual receptors likely to experience more than negligible impacts were included.

In the case of waste and mineral development no specific guidance exists to define the size and extent of potential study areas. Thus, professional judgement and experience has been used in defining the final study area and limit of the Landscape and Visual assessment.

Once the study area was defined, a more detailed desktop review of the local landscape was undertaken to identify potential landscape and visual receptors and plan the scope and

extent of the assessment and necessary field work. This study was based on the following information:

- 1:25,000 Ordnance Survey (OS) map;
- OS Profile topography data;
- site survey and topographical data;
- the location and extent of receptors from the MAGIC web site;
- development proposals; and
- computer analysis of the above.

Specific documents referenced within this section of the Environmental Statement include the following:

- The Landscape Institute and Institute of Environmental Management and Assessment ("Guidelines for Landscape and Visual Impact Assessment", Second Edition, 2002);
- Countryside Agency ("Landscape Assessment Guidance", 2002);
- Mineral Planning Policy Wales – December 2001; and
- Pembrokeshire Coast national Park Local Development Plan December 2001.

1.2.3 Field Observations

Field observations were planned for periods of good visibility where ever possible, by reference to weather forecasts.

The landscape and visual receptors identified by the desktop review were further investigated by fieldwork. This included recording landscape and visual elements through photographs and assessing their potential sensitivity to the proposed development.

Photographs were taken using either a Nikon D90 digital camera. Where viewpoints consisted of more than one frame, the relevant frames where merged together using Photovista software (version 1.3.2). Photographs were taken wherever possible with the sun behind the viewer.

Where photographs were used for visual assessment they were reproduced with a viewing distance. To match the size of the elements within the photograph to elements in the actual view, the photograph should be viewed at the stated distance.

Access to private properties and third party land was not obtained. However, it is considered that this has not prevented the accurate assessment of potential landscape and visual impacts and the identification of appropriate mitigation measures. Where views from private land and dwellings have been considered of high importance, potential impacts have been assessed through the use of the computer model, map data and details of the proposals.

1.2.4 Technical Difficulties

No technical difficulties were encountered in assessing the landscape and visual impacts of the proposed development during the field observations or office based assessment procedures.

1.2.5 Detailed Methodology of Assessment Procedures

Current landscape assessment practice utilises landscape character assessment as the methodology for analysing and assessing the potential impacts of any development upon the local landscape.

By analysing the character of an area, its principal features and elements can be identified. Once these elements are identified, potential impacts caused by proposed development can be measured, and a judgement made as to the overall effect this may have on the local landscape character.

Existing landscape character assessments are an important starting point for any new assessment, due to the hierarchical nature of character assessment.

> "*Ideally assessments at different scales should fit together as a nested series or a hierarchy of landscape character types and/or areas so that assessment at each level adds more detail to the one above"* [1]

Study of landscape assessments at different levels is important for a number of reasons including:

- It aids the understanding of the landscape at a wider level;
- It allows the identification of landscape elements that may be present at a number of different scales, and thus of higher importance;
- It highlights landscape character that is 'out of context' with other levels of the hierarchy; and
- It may identify potential mitigation and restoration options that may not be present at the local scale, but can be beneficial at a higher level.

A search was also made to identify district and county level landscape character studies. This identified the Landscape Character Map of Wales, Pembrokeshire Landscape Character Assessment and LANDMAP studies as the main references to character in the area of the site. The components of these character areas may be related to the regional character or may be unique to the locality. The size and extent of district and county level landscape features can affect the capacity of the landscape to absorb changes caused by development. Some characteristics can be seen as negative and opportunities to improve the landscape character of an area may be identified.

The landscape components of the site were assessed using methodology outlined by the Countryside Agency[2] to identify the important local components of the landscape and how they relate to both the regional and district character. At this stage a decision was made as to the necessity of a local character assessment. This is usually needed if the local landscape is sufficiently different to lowest character assessment level carried out previously.

An appraisal was then made of the likely changes to the landscape whether they might be due to slow processes and trends such as agricultural uses, management or vegetation growth, or quicker changes such as planning policy change and permitted developments.

Viewpoint Photographs

The photographs for the various viewpoints have been scaled to match the size of components within the actual view when viewed from the stated viewing distance.

The size of the printed image required to match the actual view is calculated using the formulae below.

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1 Landscape Character Assessment – Countryside Agency and Scottish Natural Heritage (2002) – Paragraph 2.14

2 Landscape Character Assessment – Countryside Agency and Scottish Natural Heritage (2002

$$\frac{\text{Viewing Distance}}{\text{Focal Length of Lens}} = \text{Magnification Factor For Negative}$$

The camera used is a Nikon D90s with a fixed lens of 35 mm (this being the digital equivalent of a 52.5 mm optical camera lens). The result of the formulae is 8.5715 as shown below. The multiplication factor is applied to the 23.6 mm by 15.8 mm camera sensor to give a printed single frame size of 202.2874 x 135.4297mm. The photograph is therefore scaled to a height of 202.2874 mm as the photographs were taken in portrait format. The excess is trimmed off the image without changing the scale to be reproduced at an A3 printing size as shown on the viewpoint drawings.

$$\frac{300\text{mm}}{35\text{mm}} = 8.5715 \quad 8.5715 \times = 202.2874\text{mm}$$

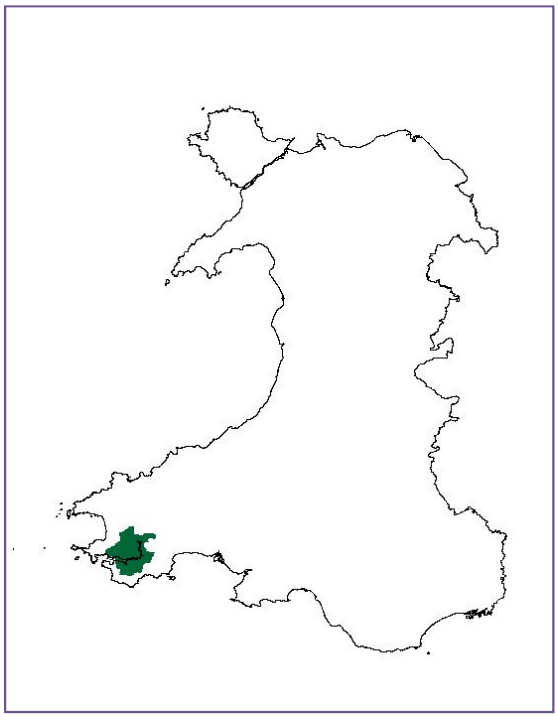
1.0 APPENDIX 1/B – NATIONAL LANDSCAPE CHARACTER AREAS

Introduction

1.1 This section reproduces the data used from the Landscape Character map for Wales landscape character assessment as prepared by Land Use Consultants and University of Sheffield June 2007.

2.048: HAFAN MILFFWRDD/MILFORD HAVEN

View to the mouth of Milford Haven from the town centre



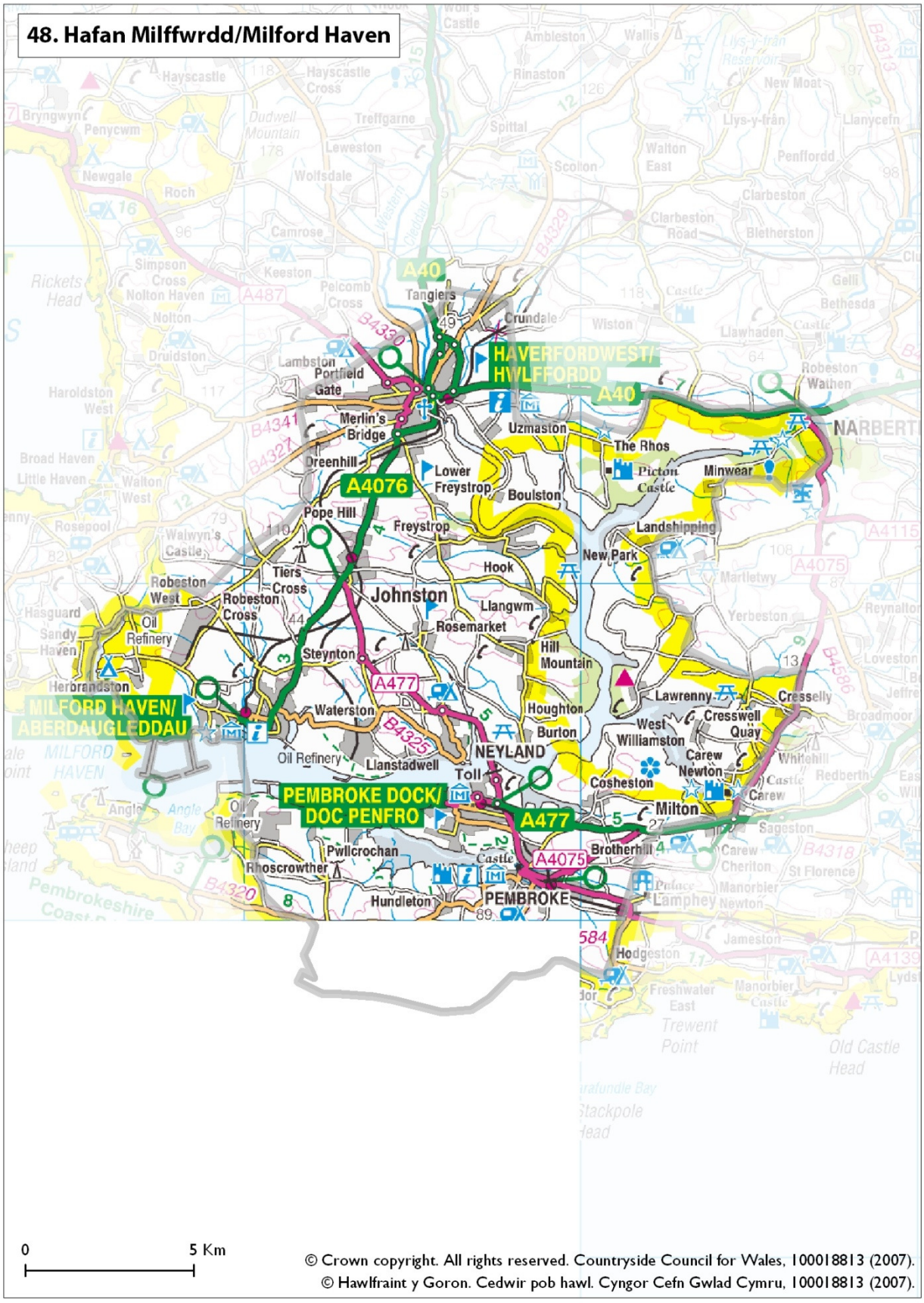
Summary

The Milford Haven character area is defined by the ria (drowned valley) landscape of Milford Haven, which extends inland to include the Daugleddau Estuary and Eastern and Western Cleddau tidal rivers. These are fringed by rich intertidal and coastal habitats, backed by a mixed agricultural landscape. The industrial towns of Milford Haven and Pembroke Dock are dominated by nearby oil refineries. The eastern half of the character area falls within Pembrokeshire Coast National Park, while the Milford Haven Waterway is a Landscape of Outstanding Historic Interest.

Key Characteristics

- This landscape is defined by the ria of Milford Haven which extends inland to include the Daugleddau Estuary and Eastern and Western Cleddau tidal rivers.
- The geological history of the landscape is complex, with a mixture of Devonian, Carboniferous, Silurian and Ordovocian rocks and mudstones. A band of uplifted igneous lava and tuff is exposed to the north of Milford Haven.
- The deep water of Milford Haven was initially formed along a faultline, widened by glacial meltwater flows. Post-glacial sea level rise flooded the valley to form today's extensive ria landscape.
- Agricultural land fringing the ria comprises a mosaic of mixed fields bounded by hedgerows.
- Mixed and conifer plantations fringe the tidal rivers and estuary with frequent copses and riparian woodlands found on slopes throughout.
- Coastal and intertidal species and habitats are of international and national importance, with populations of grey seals. Species-rich saltmarshes and ancient semi-natural sessile oak woodlands are among the area's valued habitats.
- A number of archaeological features are present, from Iron Age forts to significant and well-preserved, 19th century naval fortifications, including the Royal Dockyard at Pembroke.
- The area is served by the towns of Haverfordwest, Milford Haven and Pembroke. Elsewhere, villages and hamlets are dispersed along roads, their intersections or at former landing places for cross-Haven ferries.
- Oil refineries and their jetties, and a power station dominate the coastal landscape at the mouth of the Haven.
- The prominent industry at Pembroke Dock and Milford Haven contrasts with the intimate and rural landscapes of the ria and its surrounding farmland.
- The ria landscape has long been admired for its scenic qualities, with the Haven mentioned in Shakespeare's *Cymbeline*.

48. Hafan Milffwrdd/Milford Haven



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Physical Landscape

This landscape is defined by the extensive ria (or drowned valley) of Milford Haven. The waters of the Haven extend inland from its mouth some 30 kilometres, passing along the Daugleddau Estuary before splitting into the Eastern and Western Cleddau tidal rivers.

The geological history of the landscape is extremely complex, with a variety of different bands of rocks fringing the Haven. A mixture of Devonian sandstones and conglomerates are interspersed by older Silurian mudstones which extend westwards to the Pembrokeshire coast. These rocks are surrounded by a band of younger Carboniferous Limestone, which marks the transition to the shales of productive Middle and Lower Coal Measures found in the north of the character area. The northern boundary of the character area is marked by a further shift in geology to exposures of older Silurian and Ordovician argillaceous rocks.

The deep water of Milford Haven lies above a major fault (the Ritec Fault), overlooked to the north by a band of uplifted Precambrian lava and tuff. Exposures of these igneous rocks are visible in the cliffs at Little Castle Head. The Ritec Fault gradually developed into a river valley some 50 million years ago, which, on the onset of the last Ice Age, was filled by huge volumes of melt water from local ice sheets. A deep valley was gouged out by the water, which was drowned by rapid sea level rise following the end of the last Ice Age 10,000 years ago. Today's ria landscape is thought to be one of the most outstanding examples of a drowned valley in the UK, and at its mouth is Europe's biggest deep water port.

The waterway of Milford Haven cuts the character area in two, with the towns of Milford Haven and Pembroke Dock lying on its north and south shores respectively. The wider ria (including the Daugleddau Estuary and Cleddau rivers) is fringed by a rich diversity of internationally and nationally important intertidal habitats. These lie within the wider Pembrokeshire Marine candidate Special Area of Conservation (cSAC) and Milford Haven Waterway Site of Special Scientific Interest (SSSI). Habitats and species of importance include tidal swept sponge communities and colourful anemones; rich mudflats containing productive shellfish and worm assemblages; and species-rich saltmarshes with flowering plants including the nationally scarce lax-flowered sea lavender. Internationally important populations of grey seal are a primary reason for its international cSAC designation.

View north towards Blacktar Point from Port Lion

The estuary and tidal rivers are fringed by a mixture of coniferous and mixed plantations, along with swathes of ancient semi-natural sessile oak woodland. Around Lawrenny, these oak woodlands date back to at least 1600 and have a rich ground flora. Further inland a mosaic of pasture and cereal fields, interspersed by hay meadows, forms a regular pattern. These are bounded by hedgerows and frequent hedgerow trees. Small woodland copses and linear woodlands are scattered across the gentle slopes of the landscape, often fringing streams which form pills (muddy creeks) upon entry to the ria.

Farmland near Johnston

Historic/Cultural Landscape

The ria landscape of Milford Haven is nationally recognised as a landscape of outstanding historic interest, encapsulating a complete chronological range of features relating to maritime conquest, settlement, commerce, fishing and defence dating back to prehistoric periods.

The earliest features include Iron Age promontory forts sited on several of the headlands at the entrances to the Haven and Daugleddau. For example, Picton Point Camp occupies a strategic location at the meeting point of the Cleddau Rivers. The Norman Conquest in the 11th century saw the construction of prominent castles, also taking advantage of the defensive positions afforded by the rivers and coast. The towns of Haverfordwest and Pembroke are both centred on Norman castles sited on the upper courses of rivers. The significant growth of these castle-boroughs by the 13th century was partly due to their use as springboards for the Norman invasions of Ireland.

Evidence relating to the use of the ria landscape as a key communication route is visible in the survival of small settlements, jetties, landing places and piers along the shores of the Daugleddau dating back to the Dark Ages. Settlements developed as thriving trade centres in the 16th to 19th centuries, serving the surrounding Pembrokeshire coal mines and limestone quarries at West Williamson. The wealth of the area led to the development of a series of gentry residences, often transforming earlier medieval ecclesiastical establishments and castles into grand mansions with

parks and gardens. Picton Castle is one such example, today being a popular tourist attraction.

The construction of the planned settlements of Milford and Pembroke Dock in the late 18th and early 19th centuries led to the relocation of coastal trade from the Daugleddau Estuary to the new ports, also accommodating changes in ship sizes and technology. The 19th century also saw the construction of naval defensive structures at the mouth of the Haven in the form of Palmerstonian Forts, which remain prominent structures today.

Today, the area's oil industry, which reached its peak in the 1970s following the oil supply crisis in the Middle East, retains a significant influence on the landscape around Milford Haven. Oil refineries and power stations occupy prominent locations along the coast.

The character area is served by the towns of Haverfordwest in the north, Pembroke in the south east and Milford Haven in the west. Outside the towns settlement is dispersed, with stone-built villages and hamlets located along roads, their intersections, or at former landing points for cross-Haven ferries. Modern farm buildings occur at intervals throughout the character area.

Visual/Perceptual Landscape

The industrial areas around Milford Haven town and Pembrock Dock contrast dramatically with the rural landscapes which surround them. Oil refineries, a power station, and a network of pylons are visible from a long distance across the surrounding gently undulating land, including from the adjacent *47. Arfordir De Sir Benfro/South Pembrokeshire Coast* character area. Chimneys, cooling towers and large industrial buildings punctuate the skyline, which is otherwise devoid of vertical forms.

View north to Rhoscrowther oil refinery from Castlemartin

The Haven itself is a striking and dominant feature of this character area. Its waters, dotted by boats, have long been celebrated in art and literature. Among the most famous references, which sums up its scenic qualities, comes from Shakespeare's Cymbeline. Imogen, upon hearing that her exiled husband may await her at Milford Haven, remarks:

'…how far it is

To this same blessed Milford; and by the way,

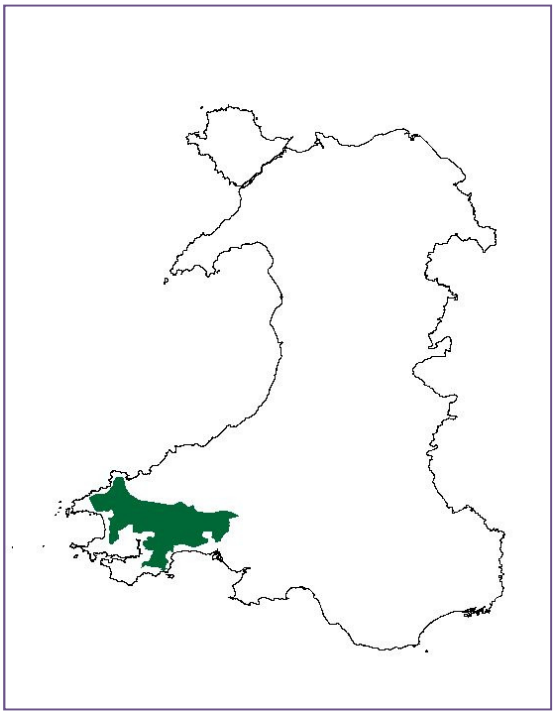
Tell me how Wales was made so happy as

To inherit such a haven….' (Act III, Scene 2)

The mosaic of rolling agricultural land, hedgerows and woodlands surrounding the Daugleddau Estuary and Cleddau rivers creates a strong sense of enclosure and intimacy. The meandering and picturesque course of the waterways, intersected by gentle inlets and creeks, has few visual detractors. This tranquil part of the character area lies in stark contrast to the heavy industrial areas found at the mouth of the Haven.

3.0 44: DYFFRYNNOEDD TAF A'R CLEDDAU/TAF AND CLEDDAU VALES

View south west towards Wolf's Castle from near Little Newcastle



Summary

The Taf and Cleddau Vales character area is located in south east Wales, straddling the two counties of Pembrokeshire and Carmarthenshire. The landscape is framed to the north by the Preseli Hills. The character area comprises a hilly topography of rich pasture and cereal fields, intersected by woodland-fringed rivers. The western edge of the character area lies within the Tywi Valley Landscape of Outstanding Historic Interest.

Key Characteristics

- The majority of the character area is underlain by Ordovician shales, mudstones and sandstones. Intrusions of Cambrian igneous rocks form craggy tors in the west. An outcrop of later Old Red Sandstone forms the boundary with Carboniferous coal measures to the south.
- The landscape was sculpted by the movement of a large ice sheet from the Irish Sea to leave behind an undulating topography with harder rocks forming hilly areas.
- Glacial meltwaters carved out deep channels now filled by streams and rivers, cutting south through the landscape. Channels at Maesprior are nationally recognised as SSSIs.
- The agricultural land use is mixed – with fields of pasture, cereals and hay meadows. Higher craggy land is of a heathy character.
- Fields are mainly medium sized, bounded by a regular pattern of hedgerows, hedgerow trees and hedgebanks.
- Small blocks of broadleaved woodland and mixed/coniferous

plantations are located on slopes. Watercourses are often fringed by oak-dominated woodlands.

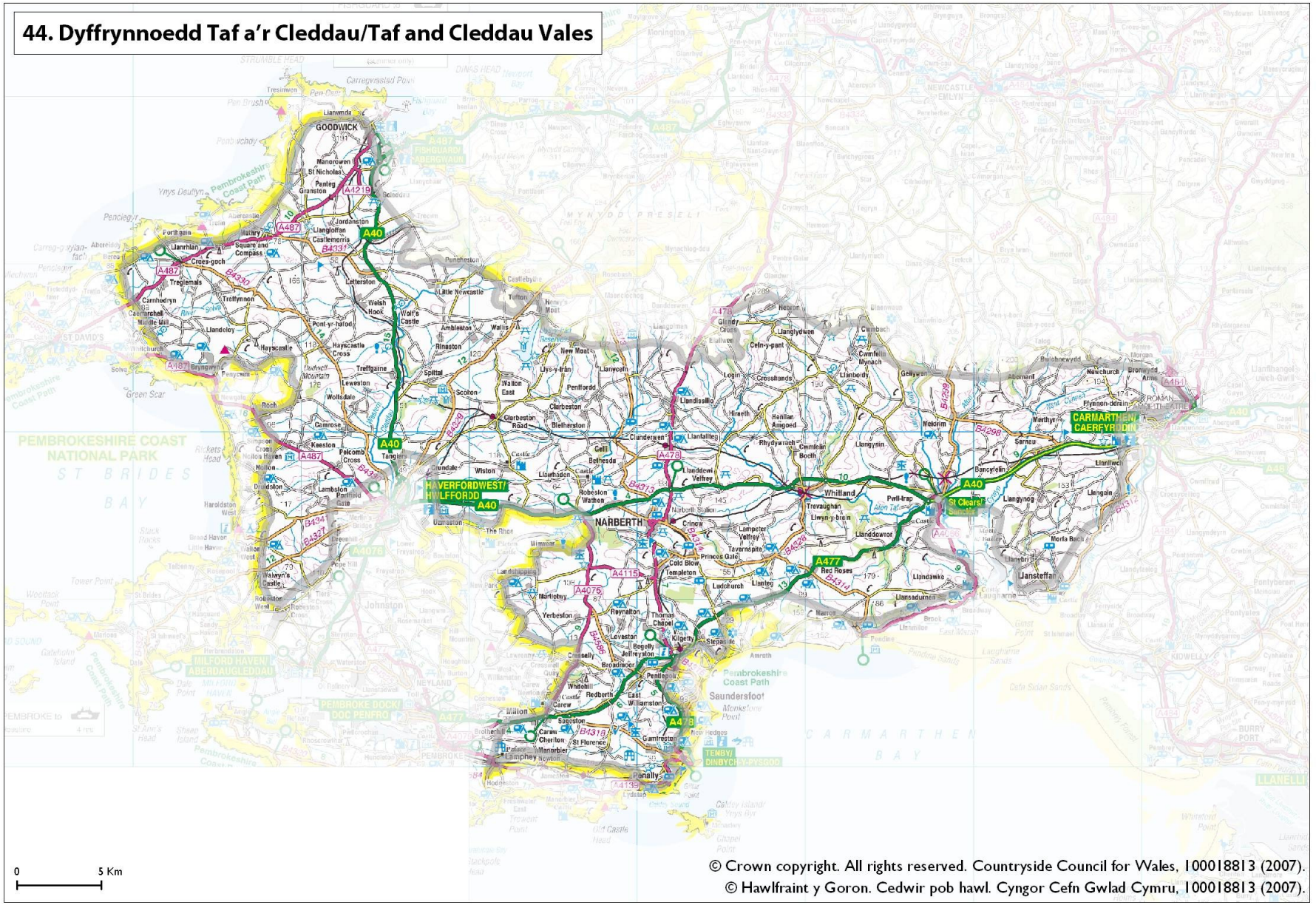
- The East and West Cleddau rivers are nationally and internationally recognised as important habitats for nature conservation. Both support populations of otter and submerged water crowfoot.

- A range of archaeological features are scattered across the landscape. Clusters of prehistoric ritual and funerary monuments occupy prominent positions.

- The area's settlement is dispersed; with hamlets and small villages in valleys. Narbeth, St Clears and Whitsand are the key towns which serve the area.

- The only detractors from the peaceful rolling countryside are the main A478 and A40 roads.

44. Dyffrynnoedd Taf a'r Cleddau/Taf and Cleddau Vales



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Physical Landscape

This large character area was formed by a variety of physical processes. Its underlying geology comprises a large band of Ordovician shales, mudstones and sandstones. These softer sediments are intruded by hard igneous rocks from the older Cambrian system in the west, forming prominent tors rising up to 178 m at Dudwell Mountain. These rocks were exposed during a period of underwater volcanic activity which lifted the former sea bed upwards to form this part of the Wales landmass. Softer sediments were eroded; leaving behind the more resistant igneous rocks.

The Ordovician geology is broken in the south by an outcrop of Lower Old Red Sandstone from the later Devonian system. This fringes narrow bands of Carboniferous limestone and Millstone Grit further south, which delineate the edge of the softer shales of the Lower Coal Measures series.

Rolling pasture near Bethesda

Today's landscape was smoothed by the movement of a massive ice sheet which passed over Wales from the Irish Sea. Glacial meltwaters carved deep channels through the softer underlying sediments, depositing large quantities of sand and gravel in the process. The resulting landscape is undulating and crossed by a number of valleys originally formed by the glacial meltwater containing southward flowing watercourses. Examples of meltwater channels at Maesprior are nationally valued as a geological Site of Special Scientific Interest (SSSI). The craggy volcanic rock tors around Wolf's Castle serve as a reminder of the turbulent processes that shaped its topography.

Fine silty loams define much of the character area, which become deeper and more prone to waterlogging in river and stream valleys. Agricultural land use is mixed, with a patchwork of medium sized pasture, hay meadow and cereal fields enclosed by hedgerows, hedgerow trees, or flower-rich hedgebanks. The higher ground around Wolf's Castle is of a heathy character, with patches of gorse, heather and bracken.

Small blocks of broadleaved woodland, coniferous and mixed plantations occupy slopes across the landscape. Rivers such as the Eastern and Western Cleddau and Taf are fringed by swathes of oak-dominated semi-natural woodland, as is the Llys-y-fran reservoir. The two Cleddau rivers and their tributaries are internationally protected (as the Cleddau Rivers Special Area of Conservation), and also separately designated as

SSSIs for their nature conservation interest. Both support important populations of otter, bullhead fish, and river and brook lamprey. Aquatic and wetland habitats contain submerged plants such as water crowfoot, and are used as feeding sites for wetland birds including snipe, curlew and lapwing.

The western shores of Llys-y-fran reservoir

Historic/Cultural Landscape

The landscape contains an array of archaeological sites and features which range from prehistoric ritual and funerary monuments to Norman castles and medieval ecclesiastical remains.

The earliest evidence of occupation comes in the form of a large number of prehistoric ritual, funerary and defensive monuments. A significant cluster of Neolithic standing stones and Bronze Age round barrows are in prominent positions on the higher ground above Wolf's Castle. Iron Age promontory forts occupy locations along watercourse, whilst hillforts stand on pockets of higher ground throughout affording long views across the lowlands.

The early Medieval period saw the development of a number of churches, around which settlements developed. Many church yards contain inscribed stones and crosses which are particularly distinctive. The ruins of the Cistercian monastery at Whitland Abbey, established in 1141, are visible in the landscape in the east of the character area. The Norman invaders utilised the landscape for the location of a number of motte and bailey castles and moated sites, including at Wolf's Castle and Narbeth.

The post-Medieval period witnessed the development of a number of country houses set within landscaped gardens. The Grade II listed Scolton Manor in Spittal was built in the mid 19th century on the site of an earlier 14th century house. It lies within designed parkland which is now used as a Country Park for recreation and educational purposes.

Today's landscape contains a dispersed settlement pattern, with hamlets, small villages and whitewashed farmsteads mainly located in valleys. Villages are nucleated in form, often centred on churches. Some settlements also stretch along roads in a linear pattern. The historic towns of Whitland, St Clears and Narbeth serve the area, with

pastel coloured render buildings with slate roofs being particularly distinctive. The agricultural landscape in the east also provides a setting for Carmarthen town – the key economic centre for the wider area which falls outside the character area within the *41. Dyffryn Tywi/Tywi Valley*.

Visual/Perceptual Landscape

This is a strongly rural landscape with a patchwork of lush green fields intersected by textured woodlands, winding rivers and thick hedgerows. The dispersed nature of the hamlets and villages, and a lack of larger urban centres, promotes strong levels of tranquillity. Minor roads that cross the landscape are quiet; often being free of traffic apart from farm vehicles. They are often enclosed by flower-rich hedge-topped banks, which serve to enhance the area's strong rural qualities.

In contrast to the sheltered nature of the wooded valleys and roads, higher ground can feel remote and open. Panoramic views across the mosaic of fields, hedgerows and woodlands can be enjoyed from hill summits. In the north, the Preseli Hills are visible on the horizon, forming a strong backdrop to the character area. The main A478 and A40 trunk road intersect the character area, forming the key detractors to the overriding rural and peaceful nature of this landscape.

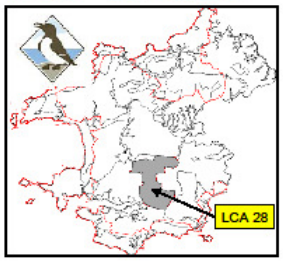
View north towards the Preseli Hills from near New Moat

1.0 APPENDIX 1B – PEMBROKESHIRE COAST NATIONAL PARK LANDSCAPE CHARACTER ASSESSMENT

1.1 Introduction

1.1 This section reproduces the data used from the Pembrokeshire Coast National Park Landscape Character Assessment Special Planning Guidance June 2011. This data refers to the landscape in which Carew Quarry is located.

Pembrokeshire Coast National Park
LCA 28 - DAUGLEDDAU



Map Notation:

- National Park Boundary
- LCA Boundary
- LCA Boundary defined by the National Park Boundary

Location, Context and Physical Characteristics

A unique area of upper tidal river estuary, with a branched form and associated rolling lowland. An detached part of the National Park with no visual link to the coast.

Visual and Sensory Characteristics

The Daugleddau is a peaceful, enclosed and intimate landscape of estuarine river and associated riparian areas and mudflats, surrounded by rolling woodland mosaic landscape of parkland, mixed woodland and fields. The river is the dominant unifying factor, provides a strong sense of place for the adjacent areas.

Vegetation and Habitat Characteristics

A very sheltered estuarine landscape. Estuarine habitats include saltmarsh, extensive inter-tidal mudflats and reed beds. Woodland is an important feature with both coniferous and semi-natural oak woodlands, together with small areas of wet woodland especially in the upper reaches associated with the reed beds.

Geological Characteristics

A classic example of a 'drowned' river system or ria, including broad meanders and extensive mudflats in marginal creeks. Upper parts of the system include areas of flood plain [Quaternary: Holocene]. Northern area is dominated by a block of Carboniferous Millstone Grit and Coal Measures' shales and a sandstone outcrop, forming a platform-like area within the fork of the Cleddau estuary. To the south, a triangular massif dominated by Old Red Sandstone, siltstones and sandstone forms a promontory between the main Cleddau estuary channel and side-creeks.

Historic and Cultural Characteristics

There are Bronze Age round barrows, Iron Age hill forts, standing stones, parkland landscapes and remains of limestone quarrying and coal mining industry which are of national significance. The area includes Carew castle and tide-mill. The great majority of this LCA lies within the extensive Milford Haven Waterway Registered Landscape of Outstanding Historic Interest in Wales.

Evaluation & Recommendations

LCA No.	Character Area	Visual & Sensory Aspect Areas	Geological Landscape Aspect Areas	Landscape Habitats Aspect Areas	Historic Landscape Aspect Areas	Cultural Landscape Aspect Areas
28	Daugleddau	50 - High 51 - Outstanding 52 - Moderate 68 - Low	128 - Moderate 185 - Moderate 208 - Moderate 210 - Moderate 215 - Moderate	392 - Moderate 441 - Outstanding 512 - Moderate 584 - High 624 - Outstanding 602 - High 612 - Moderate 696 - Moderate 731 - Moderate 796 - Outstanding 807 - Low 861 - Moderate	43903 - Outstanding 43907 - Outstanding 43909 - Outstanding 43910 - Outstanding 43912 - Outstanding 43899 - Outstanding 43906 - Outstanding	002 - Outstanding 006 - Outstanding

LANDMAP Aspect Evaluation Terms:

Outstanding:	Of International or National Importance
High:	Of Regional or County Importance
Moderate:	Of Local Importance
Low:	Of Little or No Importance

(The reference numbers in the table refer to the discrete Aspect Areas identified)

Special Qualities *(Key Landscape Characteristics)*

- This large LCA is unique in the National Park in that it is physically detached from the remaining areas of the Park by some distance. There is no sense of being close to the sea, except for the movement of the tides, and the smell of salt on the air and occasional lumps of seaweed on the strand line.
- There is a great sense of tranquillity here, produced by the enclosed large water body, whether at high or low tide, and the feeling of being on a quiet backwater. A strong sense of enclosure and shelter is provided by the surrounding landform, dense stands of woodland and belts of trees. There are framed views at intervals along shoreline roads and paths. The water body has a major unifying influence on the scene, whether at high or low tide
- There is a prevailing sense of a sheltered, well cared-for wooded farmland and parkland landscape of long-established private estates and secluded houses, contrasting with the more open shoreline villages and hamlets with views along the branches of the estuary
- This is a landscape of outstanding historical significance within Wales. This area includes traces of the county's small-scale coal mining industry as well as historic agricultural landscapes, including landed houses, farms and cottages set in distinctive field patterns. The working tide-mill at Carew is unique in Britain and contributes to the outstanding cultural value of this LCA.
- The Milford Haven Waterway Registered Landscape of Outstanding Historical Interest in Wales encompasses virtually all of this LCA. This river valley and estuary landscape has an unsurpassed concentration of remains, reflecting maritime conquest, settlement, commerce, fishing, defence and industry spanning the prehistoric to modern periods.

Discernible Landscape Trends

- Woodland management appears to be largely appropriate and favourable, except through planting of coniferous woodland in some areas

Management Guidance

- Encourage active management of woodlands and planting of broadleaved species where the naturalistic character has been altered through conifer planting; maintain parkland character by systematic re-planting to ensure continuity of tree cover
- Conserve the unspoilt estuarine character, with traditional rural built form on the margins and ensure that development in villages is in keeping with the character and respects outstanding historical significance of the area
- Conserve the agricultural and woodland mosaic character, with regular cyclical management of field boundary hedgerows, and appropriate woodland management methods to maintain canopy cover
- Ensure that recreational pursuits are monitored to allow continued sport but also minimise the disturbance and ensure the long term survival of the estuarine habitats and associated species
- Encourage landowners to participate in agri-environmental schemes and leave overgrown areas around the margins of arable fields for the benefit of wildlife
- Ensure that the risk of water pollution incidents is kept to a minimum
- Re-use historic farm buildings at end of their economic agricultural life.
- Ensure that as far as possible ancient monuments and remains are not lost or damaged.

1.0 APPENDIX 1C – LANDMAP VISUAL AND SENSORY AREAS

1.1.1 Introduction

1.1 This section reproduces the data used from LANDMAP as generated 01/12/2011.

1.2 Carew Quarry is located with LANDMAP area PMBRKVS052 – Sageston as detailed below.

Area Unique ID: PMBRKVS052
Aspect: Visual and Sensory
Survey Date: 26/09/2002
Area: Sageston
Region: Pembrokeshire
Classification Level 1: Lowland
Classification Level 2: Rolling Lowland
Classification Level 3: Open Rolling Lowland
Classification Level 4: Rolling Farmland
VS1: Has the information been verified in the field?
Yes
1:25,000
VS2: Does this area have a special or functional link with an adjacent area?
No
VS3: Summary Description (answer may exceed column length)
The Sageston Aspect Area is a moderately sized area of farmland landscape predominantly used for grazing... The area contains scattered small woodland clumps and occasional villages and small towns including East Williamston and Broadmoor, connected by major roads & a network of hedgebank bordered lanes... Caravan/camp sites concentrated around villages act as a detractor as do large pylons which traverse the landscape...
VS4: Physical Form And Elements: Topographic Form?
Rolling/Undulating
VS5: Physical Form And Elements: Landcover Pattern?
Field Pattern/Mosaic
VS6: Physical form and elements: Settlement pattern
Village
VS7: Physical form and elements: Boundary type
Clawdd/Hedgebanks
VS8: Aesthetic Qualities: Scale?
Medium
VS9: Aesthetic Qualities: Sense of Enclosure?
Open
VS10: Aesthetic Qualities: Diversity?
Simple
VS11: Aesthetic Qualities: Texture?
Mixture
VS12: Aesthetic Qualities: Lines?
Angular
VS13: Aesthetic Qualities: Colour?
Colourful
VS14: Aesthetic Qualities: Balance?
Balanced
VS15: Aesthetic Qualities: Unity?
Unity

VS16: Aesthetic Qualities: Pattern?
Organised
VS17: Aesthetic Qualities: Seasonal Interest?
Mixed
VS18: Other Factors: Level of Human Access?
Constant
VS19: Other Factors: Night Time Light Pollution?
Moderate
VS20: Other Factors: Use of Construction Materials?
Generally Inappropriate
VS21: What materials? Give Details: (answer may exceed column length)
The Aspect Area contains some traditional stone and render properties, and many recent constructions which have used more modern materials such as block stone with pebble dash render... These have a miixture of roofing material including reformed tiles... There are a large proportion of agricultural sheds made from breeze blocks, steel framing and metal sheet roofing...
VS22: There are attractive views...
...both in and out
The Aspect Area contains hedge bank bordered lanes whcih form an attractive visual feature, set in a farmland landscape... Views of surrounding estuarine landscapes further enhance the visual quality of the area...
VS23: There are detractive views...
...within
There are several caravan parks evident within the landscape, these tend to lie on the outskirts of villages... Pylons in the area around Carew village are also unattractive...
VS24: Perceptual and Other Sensory Qualities
Attractive
Unattractive
Tranquil
Noisy
Settled
The aspect area consists of a pleasant agricultural environment with scatttered woodland and tall hedgerow and hedgebank bordered lanes, although this is detracted from in several places by the busy and noisy roads and a small airfield beneath Sageston...
VS25: What is the sense of place/local distinctiveness
Moderate
The agricultural landscape is given geographical identity by the hedgebank bordered lanes and borrowed views of the estuary nearby...
VS26: Value:
Moderate
The Aspect Area contains some attractive rural lanes and farmland, yet is intersected by busy roads and contains large pylons and several caravan parks which detract from the value...
VS27: Condition:
Fair
The agricultural landscapes are generally under low maintainance yet do not appear neglected...
VS28: Trend:
Improving
The area was considered to be in a constant state of condition and management at the time of survey...
VS29: Existing management

Generally Appropriate

VS30: Existing management remarks: (answer may exceed column length)

Small grazed fields predominate the agricultural management which is largely appropriate, although the hedgebanks along some lanes and overgrown trees in hedges would benefit from more appropriate management... Kings Moor to the south east requires improved management.

VS31: Principal management recommendation: (answer may exceed column length)

Preserve agricultural character of area and improve Kings Moor.

VS32: Guideline

Long Term

Preserve the agricultural character of the area through considered development, particularly around settlement edges...

Medium Term

Hedge maintenance...

Medium Term

Careful siting (eg caravan sites) tourism development within landscape.

Medium Term

Improve management of Kings Moor including footpaths and nature conservation.

VS33: Define the key qualities that should be conserved: (answer may exceed column length)

Traditional agricultural nature of the landscape...

VS34: Define the key qualities that should be enhanced: (answer may exceed column length)

Character of infrastructure and tourism...

VS35: Define the key qualities that should be changed: (answer may exceed column length)

Kings Moor apparent neglect

VS36: Define the key elements that should be conserved: (answer may exceed column length)

Lanes with traditional hedgebanks that are regularly maintained and species rich...

VS37: Define the key elements that should be enhanced: (answer may exceed column length)

Hedgebanks which have been unmanaged should be restored to regular maintenance that is sympathetic to the visual character and nature conservation value of the hedgebanks overgrown hedges within the agricultural landscape should also be restored to retain a stock proof species rich form with occasional taller specimen trees...

VS38: Define the key elements that should be changed: (answer may exceed column length)

Kings Moor needs improvement

VS39: Are there any significant threats to the current integrity and condition of the visual & sensory features of the area?

Not known

VS40: To what level was this information site-surveyed?

Level 3

VS41: At 1:10,000, how much of the Aspect Area boundary is precise?

Some

Boundary with VS057 and defined by undulating landform...

VS42: What baseline information source was used for Aspect Area boundary mapping?

OS Landline

VS43: If OS Data was used, what was the scale?

1:10,000

VS44: What is the justification for the Aspect Area boundaries? (answer may exceed column length)

The Aspect Area contains a significant area of similar character agricultural landscape and villages intersected by hedgebank bordered lanes and includes more developed areas associated with larger busy roads in the Sageston and Kilgetty area.

VS45: List the key sources used for this assessment (answer may exceed column length)

OS plans and aerial photographs

VS46: Evaluation Criteria: Scenic quality

Moderate

The area has attractive views of hedgebank bordered lanes and rolling farmland with small traditional field patterns as well as borrowed views of the surrounding estuaries, yet has some significant unattractive views of roads, pylons, caravan parks and inappropriate buidlings.

VS47: Evaluation Criteria: Integrity

Low

The agricultural landscape with traditional field pattern has been largely conserved in general layout yet is intersected by some large and busy roads and is degraded around Kings Moor.

VS48: Evaluation Criteria: Character

Moderate

The landscape has some character given by the small fields with hedgebank bordered lanes...

VS49: Evaluation Criteria: Rarity

Moderate

The agricultural landscape with retained small traditional fields and hedgebank bordered lanes is of some note yet the level and style of development and infrastructure are not...

VS50: Evaluation Criteria: Overall Evaluation

Moderate

The traditional agricultural landscape of this part of Pembrokeshire has been affected by insensitive developments including modern buildings and busy and frequent roads...

VS51: Justification of overall evaluation (answer may exceed column length)

The Aspect Area has been given an overall evaluation of "moderate" taking into account its "moderate" valuation given for scenic quality, character and rarity and "low" value given for integrity, reflecting the extent of built up areas within the agricultural landscape...

VS52: Additional Assessments (answer may exceed column length)

None

VS53: Additional Comments (answer may exceed column length)

1.3 Carew Quarry is located approximately 0.1 km northeast of LANDMAP area PMBRKVS051 – Daugleddau as detailed below.

Area Unique ID: PMBRKVS051
Aspect: Visual and Sensory
Survey Date: 26/09/2002
Area: Daugleddau
Region: Pembrokeshire

Classification Level 1: Water
Classification Level 2: Inland Water (Including Associated Edge)
Classification Level 3: River
Classification Level 4: River
VS1: Has the information been verified in the field?
Yes
1:25,000
VS2: Does this area have a special or functional link with an adjacent area?
Yes
The estuarine Aspect Area of the Daugleddau estuary has a close functional link with the adjacent land at Martletwy (VS050)...
VS3: Summary Description (answer may exceed column length)
The Daugleddau Aspect Area is comprised of a peaceful intimate landscape of estuarine river and associated riparian areas and inlets... These include the tidal river and mudflats bordered by mixed, generally broadleaf woodland & occasional traditional small settlements... This is a particularly attractive landscape with low development levels having a slight visual detractor in the nonetheless interesting borrowed view of Pembroke Dock to the south... In sensory terms the Aspect Area provides probably a unique landscape within Pembrokeshire where the coastal areas are often more readily associated with rocky shorelines...
VS4: Physical Form And Elements: Topographic Form?
Hills/Valleys
VS5: Physical Form And Elements: Landcover Pattern?
Water
VS6: Physical form and elements: Settlement pattern
Clustered
VS7: Physical form and elements: Boundary type
None
VS8: Aesthetic Qualities: Scale?
Medium
VS9: Aesthetic Qualities: Sense of Enclosure?
Enclosed
VS10: Aesthetic Qualities: Diversity?
Simple
VS11: Aesthetic Qualities: Texture?
Smooth
VS12: Aesthetic Qualities: Lines?
Sinuous
VS13: Aesthetic Qualities: Colour?
Muted
VS14: Aesthetic Qualities: Balance?
Harmonious
VS15: Aesthetic Qualities: Unity?
Unity
VS16: Aesthetic Qualities: Pattern?
Regular
VS17: Aesthetic Qualities: Seasonal Interest?
Mixed
VS18: Other Factors: Level of Human Access?
Infrequent
VS19: Other Factors: Night Time Light Pollution?
Slight

The small scattered settlements along the estuary cause localised small scale light pollution...

VS20: Other Factors: Use of Construction Materials?

Generally Appropriate

VS21: What materials? Give Details: (answer may exceed column length)

Traditional stone built cottages with render and slate roofing tiles are used along the edge of the estuary...

VS22: There are attractive views...

...within

The estuary offers very attractive views of the water, bankside vegetation and cottages throughout...

VS23: There are detractive views...

...out

The borrowed view of Pembroke Dock provides a minor visual detractor...

VS24: Perceptual and Other Sensory Qualities

Attractive
Tranquil
Safe
Settled
Wild
Spiritual
Smell
Other

The estuaries of the Daugleddau and the tributary rivers of the Carew and Cresswell have a strong, peaceful and naturalistic character with strong sensory qualities of smell, sight and sound (estuarine birds)...

VS25: What is the sense of place/local distinctiveness

Strong

The peaceful intimate landscape of rivers and mudflats together with the adjacent Daugleddau estuary create a strong sense of place...

VS26: Value:

Outstanding

The Daugleddau estuary and the adjacent mouths of the Cressswell and Carew rivers with their associated mudlflats and Bankside scrub create a picturesque and interesting landcape that includes areas valiued as nature reserves such as that at West Williamston and fall within the Coastal National Park...

VS27: Condition:

Good

The Aspect Area features highly valuable areas that are in a good state of care or appropriate neglect in the case of "wilderness" areas, some of which are managed as nature reserves by the National Trust/ Widlife Trust of South & West Wales

VS28: Trend:

Constant

The area was judged to be in a constant state at the time of survey...

VS29: Existing management

Generally Appropriate

VS30: Existing management remarks: (answer may exceed column length)

The areas within the Aspect Area are in some cases relatively "unmanaged" in the case of the estuarine water body and its vegetated margins, this is appropriate for such naturalistic areas... Parts of the shoreline are under

active management for nature/ landscape conservation by the National Trust / Wildlife Trust of South and West Wales...

VS31: Principal management recommendation: (answer may exceed column length)

Conserve the unspoilt estuarine character of the area...

VS32: Guideline

Long Term

Conserve the unspoilt estuarine character of the Aspect Area through minimising development and changes to landscape management...

VS33: Define the key qualities that should be conserved: (answer may exceed column length)

Naturalistic environment with traditional rural built feel on the margins...

VS34: Define the key qualities that should be enhanced: (answer may exceed column length)

None

VS35: Define the key qualities that should be changed: (answer may exceed column length)

None

VS36: Define the key elements that should be conserved: (answer may exceed column length)

Estuarine rivers with saltmarsh/ woodland and scrub borders, particularly at areas of high nature conservation value...

VS37: Define the key elements that should be enhanced: (answer may exceed column length)

None

VS38: Define the key elements that should be changed: (answer may exceed column length)

None

VS39: Are there any significant threats to the current integrity and condition of the visual & sensory features of the area?

Not known

VS40: To what level was this information site-surveyed?

Level 3

VS41: At 1:10,000, how much of the Aspect Area boundary is precise?

Most

VS42: What baseline information source was used for Aspect Area boundary mapping?

OS Landline

VS43: If OS Data was used, what was the scale?

1:10,000

VS44: What is the justification for the Aspect Area boundaries? (answer may exceed column length)

The Aspect Area boudnary takes in the open estuarine reaches of the Daugleddau estuary and tributary rivers the Cresswell and Carew, together with their vegetated margins...

VS45: List the key sources used for this assessment (answer may exceed column length)

OS plans and aerial photographs

VS46: Evaluation Criteria: Scenic quality

Outstanding

The Aspect Area offers very attractive views of the open estuary, sheltered creeks and wooded margins with scattered traditional buildings in a rural setting...

VS47: Evaluation Criteria: Integrity

High

The estuarine environment of the Aspect Area is largely unspoilt with only small scale sensitive building along the shoreline...

VS48: Evaluation Criteria: Character

Outstanding

The Aspect Area has a strong sense of character provided by the open estuary waters, sheltered creeks and inlets and wooded margins throughout the area...

VS49: Evaluation Criteria: Rarity

Outstanding

The extent and quality of the estuarine river and creek network of the Daugleddau Aspect Area are particularly note worthy and unequalled within Pembrokeshire and even Wales...

VS50: Evaluation Criteria: Overall Evaluation

Outstanding

The extensive and uspoilt estuary and creek environment of the Daugleddau, Carew and Cresswell, with low level traditional built development along the wooded margins account for the outstanding rating for this Aspect Area...

VS51: Justification of overall evaluation (answer may exceed column length)

The "outstanding" overall evaluation for this Aspect Area has been reached trhough consideration of the relative values attributed for integrity and character, which have been rated as "high" and scenic quality and rarity which have been rated as "outstanding"... This reflects the unspoilt nature of these extensive estuarine areas with rich riparian landscapes which are unique within south Wales...

VS52: Additional Assessments (answer may exceed column length)

None

VS53: Additional Comments (answer may exceed column length)

None

2. Ecology

A: Background data

B: Phase 1 Habitat Survey and Target Notes

West Wales Biodiversity Information Centre

Protected Sites

Carew Quarry

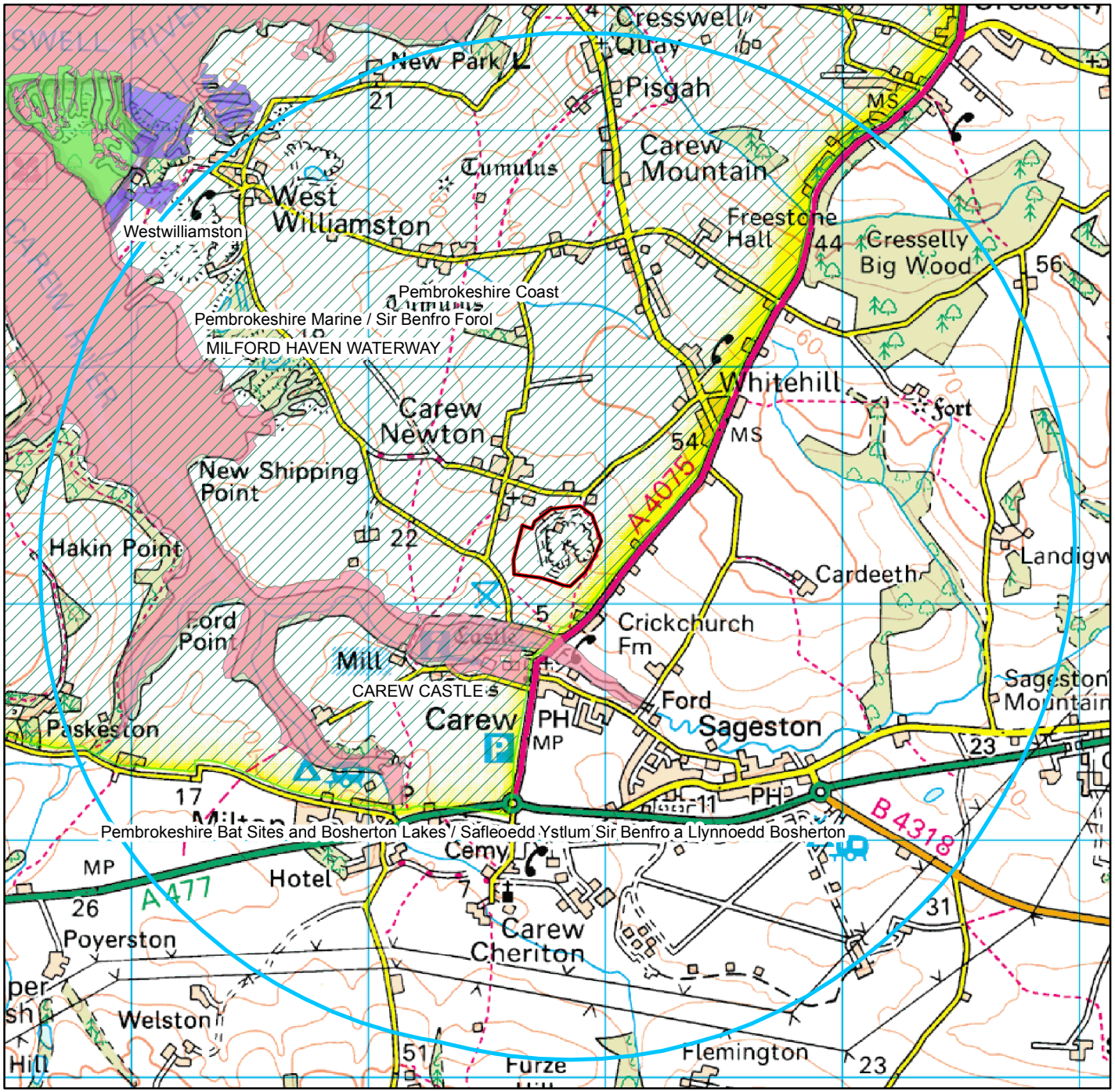
SN 048042

Report produced for SLR Consulting, on 11th October 2012 by West Wales Biodiversity Information Centre.

This is a data search for all statutory and locally designated protected sites within 2 km of the site at Carew

The following protected sites occur within the search area:

Pembrokeshire Coast National Park
Pembrokeshire Bat Sites & Bosherton Lakes SAC
Pembrokeshire Marine / Sir Benfro Forol SAC
Carew Castle SSSI
Milford Haven Waterway SSSI



0 245 490 980 1,470 1,960 Meters

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Legend

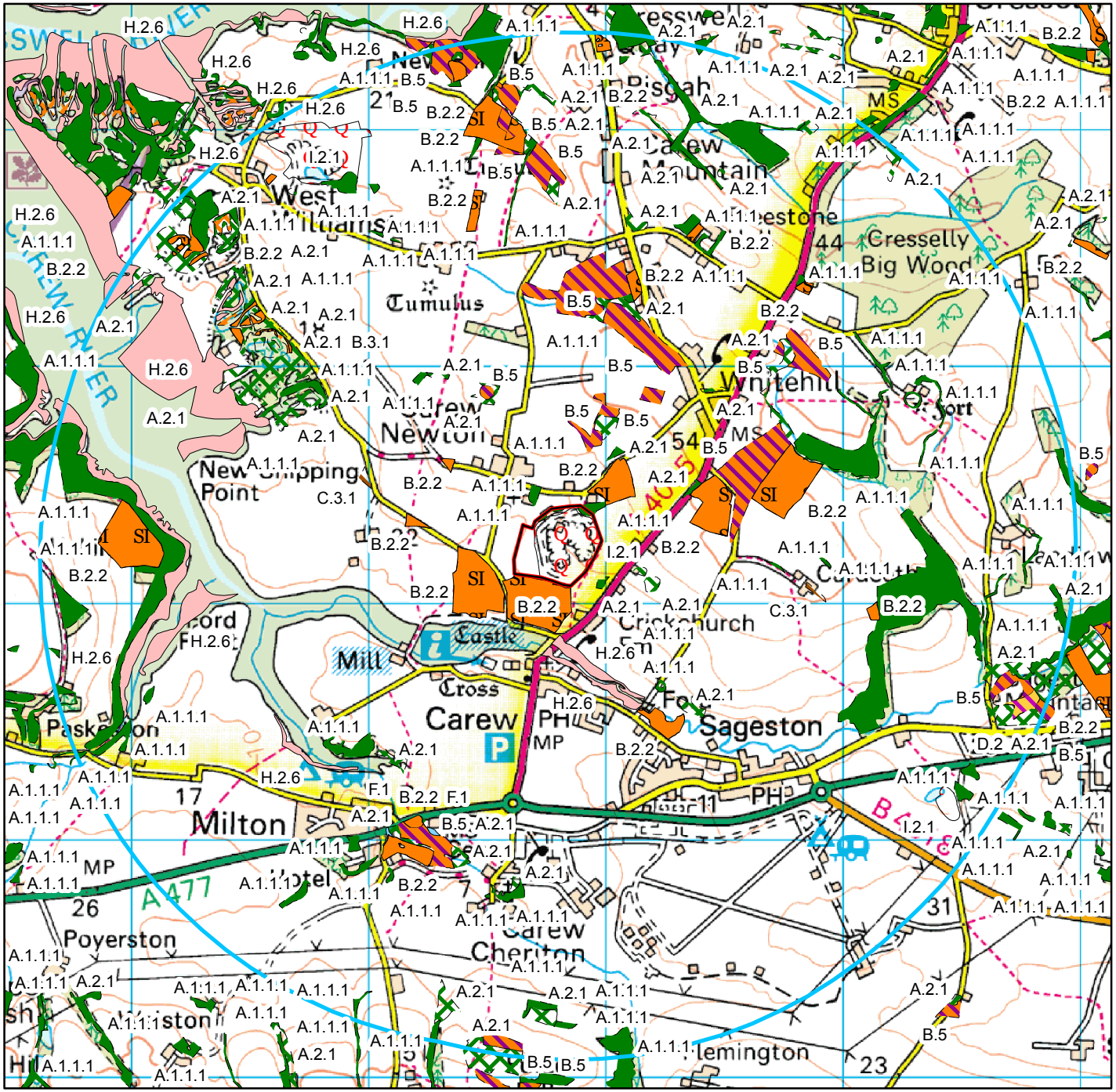
- Carew_Quarry
- 2km buffer

Protected Sites

TYPE

- Area of Natural Beauty
- Biosphere Reserve
- Local Nature Reserve
- Marine Nature Reserve
- National Nature Reserve
- National Park
- Ramsar Site
- Site of Interest for Nature Conservation
- Site of Special Scientific Interest
- Special Area of Conservation
- Special Protection Area
- Wildlife Trust Reserve

West Wales Biodiversity Information Centre



0 245 490 980 1,470 1,960 Meters

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Habitats

Carew Quarry

SN 048042

Report produced for SLR Consulting, on 11th October 2012 by West Wales Biodiversity Information Centre.

This is a data search for all Phase I Habitat records within 2 km of the site at Carew

The following Phase I Habitats occur within the search area:

A.1.1.1	Semi-natural broadleaved woodland
A.2.1	Dense scrub
B.2.2	Semi-improved neutral grassland
B.3.1	Unimproved calcareous grassland
B.5	Marshy grassland
C.3.1	Tall ruderal herb
D.2	Wet heath
F.1	Swamp
H.2.6	Salt marsh
1.2.1	Quarry

Legend

Carew_Quarry

2km buffer

West Wales Biodiversity Information Centre

Species

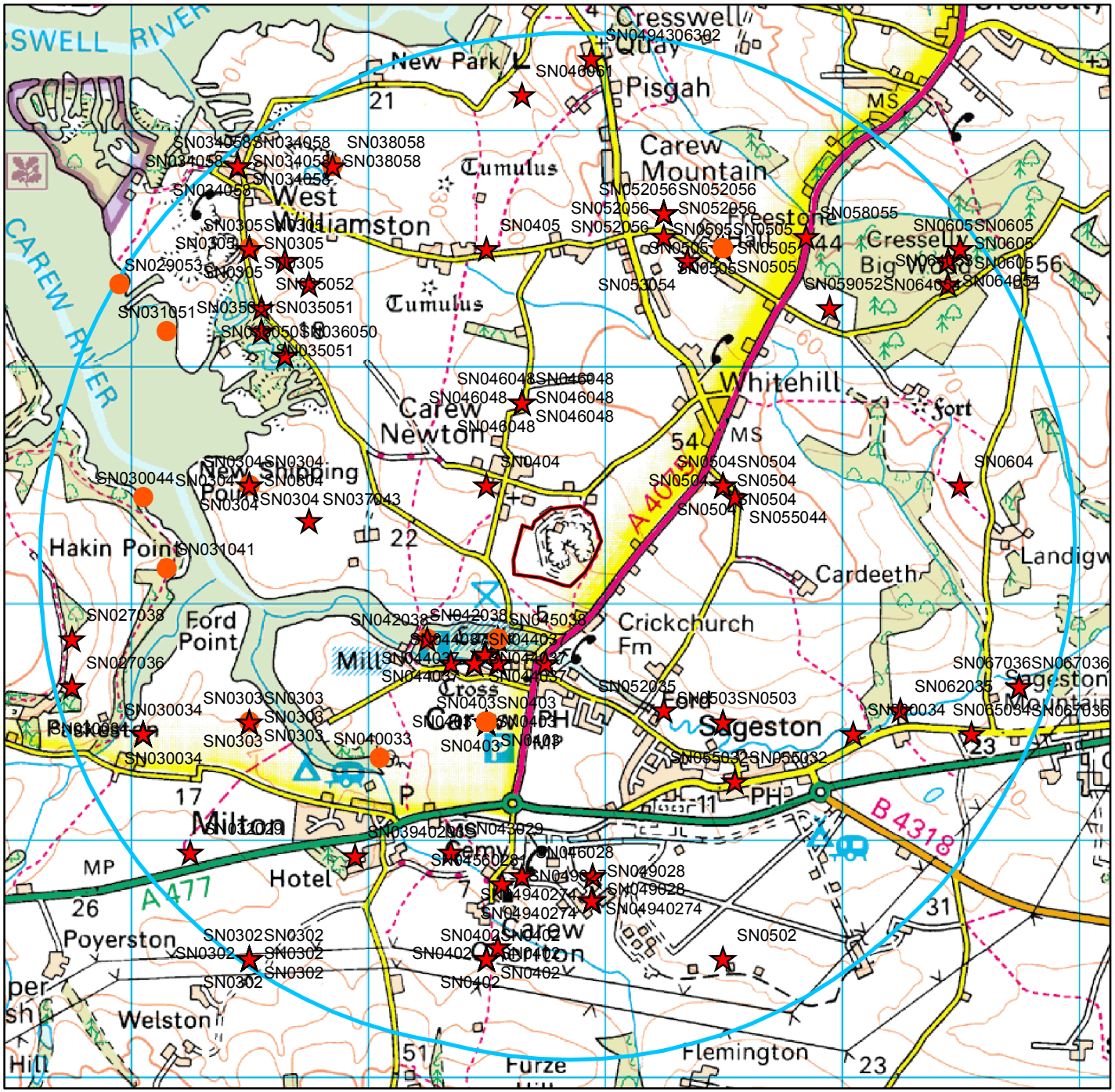
Carew Quarry

SN 048042

Report produced for SLR Consulting, on 11th October 2012 by West Wales Biodiversity Information Centre.

This is a data search for Protected and Priority Species and for Species of Conservation Concern within 2km of the site at Carew.

There are protected species records on our database within the search area. Please see the species list for details.



0 245 490 980 1,470 1,960 Meters

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Legend

- Carew_Quarry
- 2km buffer

Species Designation

- 1 - Protected and priority species
- 2 - Other species of conservation concern

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Lime Kiln (disused)
FB
Conveyor
Stone Quarry
Water
Drain
30.5m
Sunnyb

SI
SI

N
W
E
S

0 10 20 30 40m 60 80 100
Metres
1:1250

A

LEGEND

- APPLICATION BOUNDARY
- BUILDINGS AND OPERATIONAL STRUCTURES
- BARE GROUND/HARD STANDING
- WATER BODY
- DENSE SCRUB
- TALL RUDERAL VEGETATION
- RANK SEMI IMPROVED GRASSLAND
- SI — SEMI IMPROVED GRASSLAND
- I — IMPROVED GRASSLAND
- BROAD LEAVED WOODLAND
- NATIVE HEDGEROW
- A — ARABLE
- CRUSHED AGGREGATE
- SOLUTION HOLE
- 1 — TARGET NOTE
- TREE

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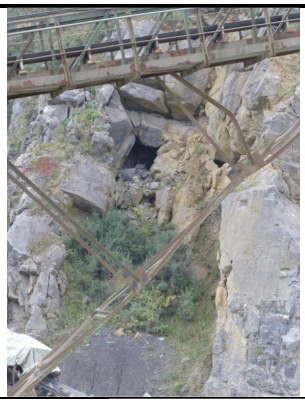
CAREW QUARRY
ROMP
PHASE 1 HABITAT SURVEY
DRAWING_NO 14/1

Scale: 1:1250 @ A3
Date: NOVEMBER 2012

03692.00002.05.01.PHASE 1 HAB.dwg

APPENDIX 14/1 – PHASE 1 TARGET NOTES

Target Note Number	Description	Photo
1	**Solution Holes** Rock fissures and solution holes x 4 in collapsed bedding planes or where blocks have fallen. The holes are approximately 1.5m x 2m in dimensions and of undetermined depth. They are situated at height (>20m) in vertical cliffs within the operational quarry.	 
2	**Waterbody** Formed in part of the quarry floor which has been recently excavated. Approximately 30m x 10m in area and of recent origin. No aquatic vegetation is present.	
3	**Waterbody** Flooded quarry void. Approximately 100m x 60m in area and of unknown depth. No aquatic vegetation is present. A small amount of buddleja (*Buddleja davidii*) scrub is present on the bank.	
4	**Processing Yard** An area of un-vegetated crushed aggregate with rock crushing and concrete batching equipment used for making concrete products. No vegetation is present and the area is subject to and high levels of activity and noise.	

Target Note Number	Description	Photo
5	**Small area of mature trees** Ash (*Fraxinus excelsior*) dominated with abundant sycamore (*Acer pseudoplatanus*) and occasional hazel (*Corylus avellana*). The ground is dominated by ivy (*Hedera helix*) with abundant harts tongue fern (*Phyllitis scolopendrium*), soft shield fern (*Polystichum setiferum*), occasional hemp-agrimony (*Eupatorium cannabinum*) and false wood brome (*Brachypodium sylvaticum*) colt's foot (*Tussilago fara fara*), common nettle (*Urtica dioica*) and privet (*Ligustrum vulgare*).	
6	**Scrub and trees** Growing on a long unworked cliff overlooking the active plant area. Dominated by blackthorn (*Prunus spinosa*), ivy and bramble (*Rubus fruticosus*), abundant sycamore and red valerian (*Centranthus ruber*). Frequent semi-mature and seedling ash, English oak (*Quercus robur*), occasional western gorse (*Ulex gallii*), teasel (*Dipsacus fullonum*), pendulous sedge (*Carex pendula*), barren strawberry (*Potentilla sterilis*) and a locally dominant patch of montbretia (*Crocosmia x crocosmiiflora*).	
7	**Developing calcareous grassland on cliff slope**. With abundant cock's foot and occasional ragwort (*Senecio jacobea*), ribwort plantain (*Plantago lanceolata*), rough hawkbit (*Leontodon hispidus*), bristly ox tongue (*Picris echioides*), birds foot trefoil (*Lotus corniculatus*), creeping cinquefoil (*Potentilla reptans*), teasel and curled dock	

Target Note Number	Description	Photo
	(*Rumex crispus*).	
8	**Woodland block** Dominated by ash with frequent sycamore. The understory is dominated by blackthorn with abundant hazel, bramble, western gorse, and bracken (*Pteridium aquilinum*), Wilsons honeysuckle (*Lonicera nitida*) is present occasionally. Ivy dominates the groundflora with occasional colt's foot.	
9	**Semi-improved grassland, trackway and cliff top bund** The field is dominated by cock's foot with occasional Yorkshire fog (*Holcus lanatus*) amd perennial rye (*Lolium perenne*), frequent soft rush (*Juncus effusus*), occasional creeping cinqfoil, ribwort plantain, dandelion (*Taraxacum officinalis* agg.), curled dock and silver weed (*Potentilla anserina*). The bund displays a distinct calcareous character imparted by the limestone aggregate from which it is formed, with occasional, glaucous sedge (*Carex flacca*), ribwort plantain, red fescue (*Festuca rubra*), wild carrot (*Daucus carota*), self heal (*Prunella vulgaris*), bird's-foot trefoil, common centaury (*Centaurium erythraea*), black medic (*Medicago lupulina*), ragwort, western gorse, red bartsia (*Odontites vernus*), white clover (*Trifolium repens*), cock's foot and rough hawkbit.	

Target Note Number	Description	Photo
10	**Ruderal vegetation on bund** With frequent false oat-grass (*Arrhenatherum elatius*), common nettle, cock's foot and common bent (*Agrostis capillaris*) with ragwort, common figwort (*Scrophularia nodosa*), teasel, silverweed and bramble.	
11	**Quarry void** A large expanse of crushed limestone which in the less disturbed areas has a thin covering of colonising species. Includes haulroads, small cliffs and spoil heaps and aggregate storage areas. Species present include occasional ribwort plantain, creeping bent (*Agrostis stolonifera*), barren strawberry (*Potentilla sterilis*), wild strawberry (*Fragaria vesca*), red valerian, colt's foot, buddleja, broad-leaved willowherb (*Epilobium montanum*) and hoary mustard (*Hirschfeldia incana*).	
12	**Species-poor hedgerow and Scrub** Dominated by hawthorn (*Crataegus monogyna*) and blackthorn and occasional ash on a low earth bank covered in dense ivy with occasional harts tongue fern. The field margin comprises frequent bracken and bramble with cocks foot and creeping bent. Common couch (*Elymus repens*) occurs occasionally along with red campion (*Silene dioica*), dog's mercury (*Mercurialis perennis*), common nettle (*Urtica dioica*) and lesser stitchwort (*Stellaria graminea*).	

Target Note Number	Description	Photo
13	**Plantation screening bund** Semi-mature ash dominate, frequent grey willow (*Salix cinerea*) and occasional alder (*Aldus glutinosa*), English oak and hazel. The understory is dominated by cock's foot (*Dactylis glomerata*), creeping bent and ivy with occasional meadow foxtail (*Alopecurus pratensis*), soft shield fern, Harts tongue fern, male fern (*Dryopteris filix-mas*), black bryony (*Tamus communis*) and herb Robert (*Geranium robertianum*). Indications of badger foraging were observed at the western end of the plantation strip.	
14	**Small stream and pond** Created by dewatering pumping of the main void. The stream channels and the pond lack any aquatic vegetation apart from a small area of sweet float grass (*Glyceria fluitans*) and are situated in an area of rough grassland.	
15	**Planted trees** A triangular wedge of planting alongside existing hedgerows and mature woodland. With field maple (*Acer campestris*), blackthorn, alder, ash, silver birch (*Betula pendula*), sessile oak (*Quercus petraea*), hazel and holly (*Ilex aquilinum*). The mature woodland block is dominated by ash. Access was not possible due to the dense blackthorn and bramble scrub though mammal paths were present leading into the woodland.	

3. Hydrology and Hydrogeology

A: Water Features Survey

B: Assessment of effects of varying discharge from Carew Quarry

Figure 7.1 Hydrogeological Assessment

Figure 7.2 Site Geology

Water Features Survey
Carew Quarry
Pembrokeshire

Thomas Scourfield & Sons

November 2012

PARSONS BRINCKERHOFF

Water Features Survey

Carew Quarry

Pembrokeshire

Prepared for
Thomas Scourfield & Sons
Carew Quarries
Carew Cheriton
Nr Tenby
Pembrokeshire

Prepared by
Parsons Brinckerhoff
Queen Victoria House
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Tel: 0117 933 9300

www.pbworld.co.uk

Report Title	**:**	**Water Features Survey, Carew Quarry Pembrokeshire**
Report Status	**:**	**Final**
Job No	**:**	**3512339A**
Date	**:**	**November 2012**
Prepared by	**:**	**.....** **A C D Groves**
Checked by	**:**	**.....** **L Gibb**
Approved by	**:**	**.....** **A C D Groves**

Document History and Status

Report Issue	Date of Issue	Prepared By:	Checked By:	Approved By:
1	14.11.12	ACDG	LG	ACDG

PARSONS BRINCKERHOFF

CONTENTS

1 INTRODUCTION

1.1 The following report has been prepared by Parsons Brinckerhoff Limited on behalf of Thomas Scourfield and Sons. It presents a water features survey in the vicinity of Carew Quarry in Pembrokeshire (the quarry) in support of the review of the Mineral Planning Permission at the quarry, currently being undertaken. The report is an update of a similar report prepared by Kennedy & Donkin Ltd (now Parsons Brinckerhoff Ltd), which was undertaken in 1998 [1], in accordance with Condition 66 of the Planning Permission granted by Pembrokeshire Coast National Park, dated 17th December 1997.

1.2 The quarry is situated to the south east of Carew Newton in Pembrokeshire and is centred on National Grid Reference (NGR) SN 048 043. The geology of the quarry is dominated by massive beds of the Carboniferous Limestone Series, producing a range of crushed aggregate for the local construction market.

1.3 The survey has two components:

- A regional, desk-based assessment of water usage within a 2km radius of the quarry; and
- A more detailed survey, confirmed by field investigation on 16 October 2012, of water features present in the area to the south and west of the quarry to the Carew River and 500m from the other existing quarry boundaries.

1.4 The extent of the survey is shown in Figure 1.

1.5 The survey included locating water features such as wells, springs and streams and also geomorphological features associated with subterranean groundwater movement common in some limestone areas. Obvious wetland vegetation was also observed.

2 REGISTERED WATER SUPPLIES

2.1 The Public Register of licensed abstractions held by the Environment Agency (EA) was reviewed to ascertain whether there are any licensed surface water or groundwater abstractions within 2 km of the quarry. The Environment Health Department of Pembrokeshire County Council was also consulted for records of private, unlicensed potable supplies.

2.2 There is one licensed surface water abstraction within 2km of the quarry, Licence No. 22/61/6/0090, which is located at NGR 0556 0341, 1 km to the south-east, as shown on Figure 1. The water is taken from the Carew River for the purpose of providing through flow to a fish farm.

2.3 There are no licensed groundwater abstractions as the Carew area is classified by the EA as a groundwater exempt area. The largest groundwater source is the Milton Springs, to the south of the Carew River. The published groundwater source protection zone associated with this source (Inner Protection Zone - Zone 1) is shown on Figure 1.

[1] Water Features Survey, Carew Quarry, Pembrokeshire. Kennedy & Donkin Limited, March 1998.

2.4 Pembrokeshire County Council has records of one unlicensed supply at Tything Barn utilised by a caravan site. The supply is located at NGR 034 052, 1.6 km to the west-north-west of the quarry. The location is shown on Figure 1.

3 WATER FEATURES

3.1 The water features identified during the survey are shown on the annotated Ordnance Survey (OS) map reproduced at 1:2500 scale, which is presented as Figure 2. These are shown in square brackets, such as **[1]** and discussed in the text that follows.

3.2 The largest water feature in the survey area is the Mill Pond to the south of the quarry **[1]**. The Mill Pond is created by the impoundment of the Carew River at the French tide mill, which traps seawater by flap valves located on its upstream side.

3.3 Two wells are marked on OS publications; Russan's Well **[2]**, 500m to the north of the quarry (NGR 0508 0480 and a second 800m to the west-south-west at New Shipping Farm (NRG 0406 0416) **[3]**. The latter no longer exists, however at the time of the original survey in 1998, a very small flow was observed from this location which flowed into the Carew River[2].

3.4 Russan's Well exists as a small pond that occurs in an area of poorly drained land with clay soils. There was no obvious upwelling in the pond at the time of the inspection, however large areas of adjoining land were waterlogged, with standing water present on the clay soils. The outflow flows along a field boundary into a small, second pond in the southern corner of the same field at NRG 0500 0470 **[4]** and then south-south-west along the field boundary. The land around these features is owned by Carew Newton Farm.

3.5 The spring marked on OS publications along this field boundary, 300m south-west of Russan's Well **[5]** was not observed, although a small flow was present in the ditch, estimated at 0.5l/sec. In 1998 the farmer stated that he had never observed any up-welling in this area. The ditch flows into a very overgrown area to the north of Brooklyn, which is shown as "sinks" on the published maps **[6]**. This feature was not observed, nor was there any evidence for the observed surface flows immediately downstream of it. This system appears to control drainage on the western side of the road from the quarry up to Whitehill. Standing water was observed in the ditch bordering the road **[7]**.

3.6 Drainage on the eastern side of the road between Whitehill and the quarry is controlled by field drainage which outflows into the boundary ditch **[8]**. This flows to the east of the quarry and 'daylights' on the western side of the A4075 Carew Lane, however its outflow was not observed. It is assumed that this is probably into the limestone bedrock in the vicinity of the old workings opposite Sunnybank.

3.7 At the time of the inspection, a small stream was observed within the garden of Hillgate **[9]**, which flowed into the heavily vegetated area immediately to the east, discussed below.

3.8 Several other areas of standing water were observed; typically to the north of the quarry, although the ponds shown on OS publications at **[10]** and **[11]** were not observed. Standing water was observed in the south-western corner of a field to the north of Poplars Farm, immediately to the north of what was judged to be a topographic divide **[12]**. Road ditches to the north of this drain to the north **[13]**, as

[2] Kennedy & Donkin Ltd, 1998 *op.cit*.

does that on the western side of the road leading out of Whitehill, which was flowing at approximately 0.5 l/sec at the time of the inspection **[14]**.

3.9 The small pond shown on published OS maps to the east of The Olde Vineyard **[15]** was present, in the southern corner of some rough and unimproved grazing. This is fed by ditches on both the northern and southern sides of the road, which contained standing water **[16, 17]**.

3.10 Drainage on the eastern side of Carew Lane of The Olde Vineyard is controlled by a ditch on its eastern side **[18]**, which was flowing at about 1 l/sec at the time of the inspection. This diverges from the road to pass behind two roadside properties **[19]** and may enter the abandoned lime kilns to the east of Sunnybank, however this could not be verified.

4 QUARRY DEWATERING

4.1 The water which collects at the base of the quarry **[20]** is pumped to the southern side of the quarry and piped to soakaways in the field immediately to the south **[21]**. The pumped water percolates into the ground approximately 70-80m north of the Mill Pond. The soakways overflow at times of high discharge into the highway drainage at the bottom of Butts Lane, which outflows to the Mill Pond **[22]**.

4.2 At times of heavy rainfall surface flows generated off the higher ground to the north is significant, which flows down the access road and cascades over the quarry hanging wall. The quarry owners report that sump water levels can flood the quarry on these occasions, rising by an estimated 15-20m over the course of a weekend.

5 GEOMORPHOLOGY

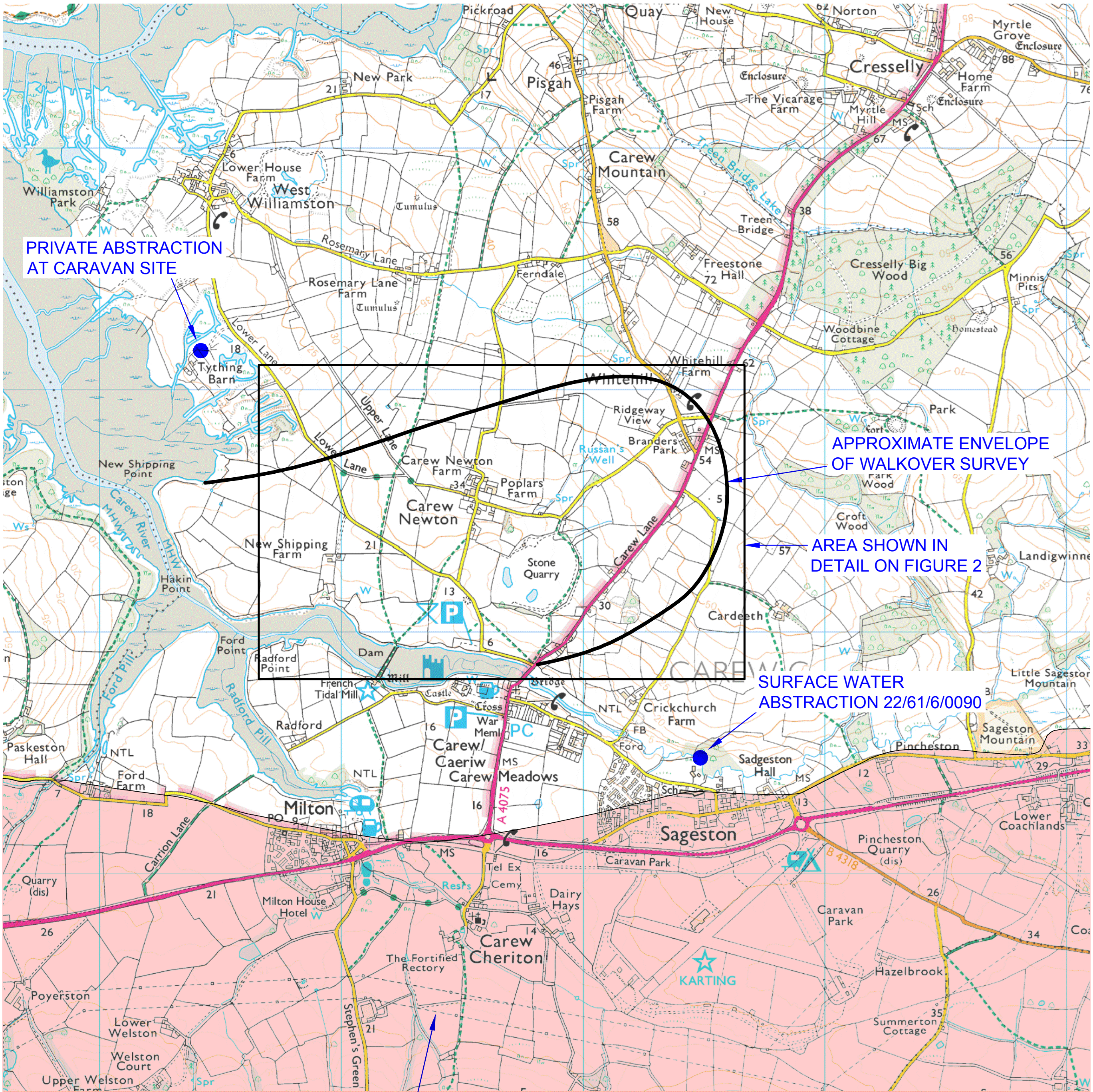
5.1 The quarry is situated within a south-west facing topography between Whitehill and the Carew River. Ground elevations around the quarry are typically between 20-30m AOD, rising to a local maximum of 57m AOD at Whitehill.

5.2 The soils are clay-rich, and are locally poorly drained, which leads to waterlogging and, in places, to abundant growth of *Juncus sp*, clearly visible on aerial photographs. These are shown on Figure 2 but are particularly noticeable in the vicinity of Russan's Well and in the fields to the east of The Olde Vineyard.

5.3 Some drainage improvement has taken place, however, with field drains installed in some fields in the vicinity of the quarry, particularly the large field to the north-east **[8]**. The quarry owners report that when this field drainage was installed several decades ago, it was routed to a shallow depression known locally as the "gunkle", situated between Hillgate and the quarry car park **[23]**. This feature is a swallet or sink hole and appears to take the local drainage from Hillgate, the garden of which regularly floods during periods of rainfall. The increase in inflow witnessed by the quarry caused the owners to plug the inflow ditch with clay, to divert surface flows away from the quarry **[24]**. This appears to have been successful because no inflows or evidence of standing water were observed.

5.4 The quarry owners report that caves have been encountered in the past, notably between 20-30 years ago, approximately in the centre of the current quarry **[25]**. Two small caves / solution features are currently visible high up within the western face, at the western edge **[26]** and immediately above the Black Rock Limestone in the south-western corner **[27]**. The only other feature possibly demonstrating limestone

dissolution is a shallow dry valley in the field immediately south of Brooklyn **[28]**, potentially related to the Russan's Well.



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EXTENT OF SURVEY

GROUNDWATER SOURCE PROTECTION ZONE
INNER ZONE (ZONE 1) FOR MILTON SPRINGS

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Client/Project: THOMAS SCOURFIELD AND SONS

Title: WATER FEATURES SURVEY

Drawn: JSdS	Checked: ACDG		
Designed: JSdS	Approved:		
Date: 10/10/2012	Scale: 1:25,000	A4	Sheet:
Project Number: 3512339A	Drawing Number: FIGURE 1	Revision:	

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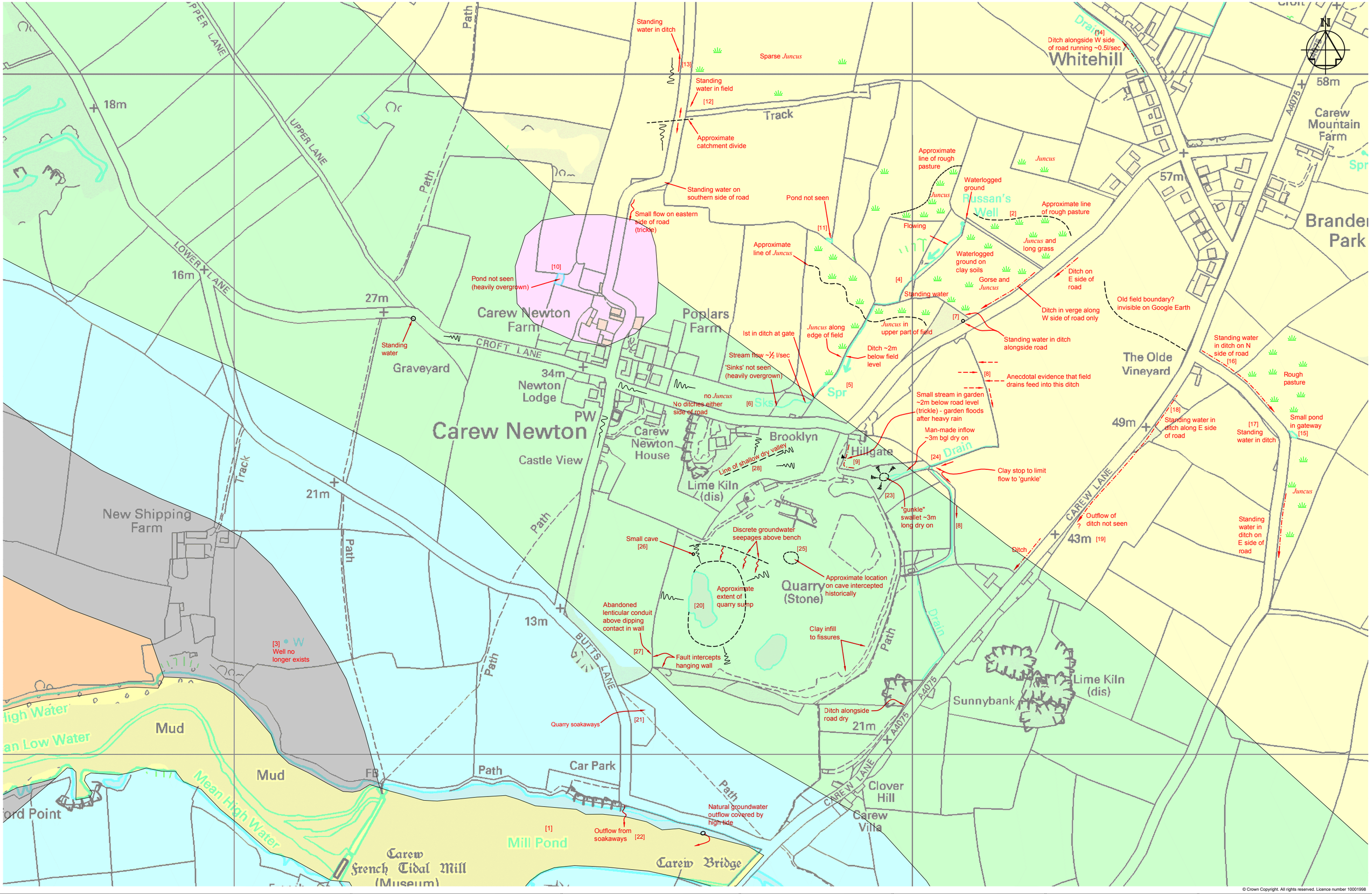

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Rev	Date	Description	By	Chk	App
		[21] References mentioned in report			

Notes:

Superficial Deposits
- Tidal flat deposits
- Glacial fluvial deposits

Bedrock Geology
- Bishopston Mudstone Formation
- Avon Group
- Black Rock Subgroup and Gully Oolite Formation (undifferentiated)
- Pembroke Limestone Group
- Cosheston Group

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Client: THOMAS SCOURFIELD AND SONS

Site/Project: CAREW QUARRY CAREW NEWTON

Title: WATER FEATURES SURVEY SHOWING OBSERVATIONS 16.10.12

Drawn: JSdS		Checked: ACDG	
Designed:		Approved:	
Date: 10/10/2012	Scale: 1:2,500	A1	Sheet:
Project Number: 3512339A		Drawing Number: FIGURE 2	Revision:

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THOMAS SCOURFIELD & SONS

ASSESSMENT OF THE EFFECT OF VARYING THE DISCHARGE FROM CAREW QUARRY ON THE WATER QUALITY IN CAREW MILL POND

March 2004

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Report Title	**:**	**Assessment of the Effect of Varying the Discharge from Carew Quarry on the Water Quality in Carew Mill Pond**
Report Status	**:**	**Issue No. 2**
Job No	**:**	**KDBENCF012/040**
Date	**:**	**March 2004**
Prepared by	**:**	**.....** **A C D Groves**
Checked by	**:**	**.....** **J Price**
Check Cat	**:**	**C**
Approved by	**:**	**.....** **A Limage**

CONTENTS

Assessment of the Effect of Varying the Discharge from Carew Quarry on the Water Quality in Carew Mill Pond

Background

Carew Quarry is currently licensed to discharge water collected in its sump at a maximum rate of 3600 m^3/day. Monitoring of the discharge has shown that this volume is insufficient to support the effective operation of the quarry, particularly in periods of wet weather, when quarry inflows increase dramatically. The quarry owners, Thomas Scourfield & Sons therefore intend to apply to the Environment Agency Wales (EA) to increase the allowable discharge.

The sump water is discharged to a series of soakaways, from where it infiltrates into the host rock as groundwater. A proportion of this returns to the quarry (and the sump), whilst the remainder enters the Mill Pond to the south. The Mill Pond is the impounded section of the Carew River estuary, which is designated as a candidate Special Area for Conservation (cSAC).

The Countryside Commission for Wales (CCW) and the EA have confirmed that because of the cSAC status of the Mill Pond and the hydraulic connection between it and the quarry soakaways, the application to vary the existing discharge consent should be accompanied by an 'appropriate assessment' under the Habitats Regulations 1994. This report provides this assessment. It has been prepared by Parsons Brinckerhoff (PB) on behalf of the quarry owner and follows the methodology agreed with the EA at the meeting with CCW on 16 January 2003.

The report examines the potential for the proposed discharge consent variation to affect the salinity of the Mill Pond, which supports the Tentacled Lagoon Worm *Alkmaria romijni* within its bottom sediments. *Alkmaria romijni* is understood to be able to tolerate salinity between 5 - 20 mS/cm.

Hydrology of the Mill Pond

The Mill Pond is formed by impoundment of the Carew River, about 650m downstream (west) of the tidal limit. Flap valves (sluices) are located on the upstream side of the dam at three locations, allowing entrapment and containment of seawater on high tides, as well as freshwater flowing down the Carew River. The sluices allow the Pond to be emptied, if required. The area impounded between the dam and the Mean High Water Springs (MHWS) mark, is about 7 ha.

It is assumed that when originally constructed the tidal flaps operated efficiently. In time, however, these became worn and for many years significant leakage occurred through the tide dam, between high and low water. As recently as 2001, the leakage was such that the floor of the Mill Pond was exposed on most tides. More recently, however, Pembrokeshire National Park has undertaken refurbishment of the dam and sluices, such that the Mill Pond is now regularly full. It is understood that the refurbishment was completed in 2002.

Prior to the refurbishment of the tide dam, PB Kennedy & Donkin (now PB) confirmed that there were three main variables influencing the quantity and quality of water within the Mill Pond [(1)]:

- The flow regime of the Carew River;
- Discharge from Carew Quarry; and
- The state of the tide.

These are illustrated on the schematic of the Mill Pond hydrology, which is presented as Figure 1.

Quarry Discharge

The quarry discharge has been measured since May 2000, when an in-line flowmeter was installed on the pump rising main. Records have typically been taken at a weekly or fortnightly frequency and the data obtained are summarised in Table 1.

In the period between 1 May 2000 and 1 March 2004, a total of 5.943 Mm^3 of water was discharged through the rising main, corresponding to a mean daily flow of 4,245 m^3. A marked seasonal variation is apparent in the data, however, with average flows in wetter (generally winter) periods significantly exceeding those in drier weather. The maximum recorded mean daily discharge was 5,723 m^3 (between 13-20 February 2001), with a minimum of 2,792 m^3, between 11 June and 2 July in the same year.

The variation is caused because the quarry acts as the focus for drainage within a catchment significantly greater than the quarry footprint, which reacts rapidly to incident rainfall on the Carboniferous Limestone strata.

Discharge Quality

The water within the sump at Carew Quarry has been routinely monitored since February 1998 and is summarised on Figure 2. This shows the conductivity of the sump water to have varied between 0.5 mS/cm and about 3.5-4 mS/cm, with a mean value of 1.83 mS/cm. (The value of 6.1 mS/cm in early 2000 does not have a correspondingly elevated chloride value and appears to be spurious). It has been assumed that this data is an accurate representation of both the conditions during the monitoring period as well as the future conditions predicted under any revised consent.

Carew River Flows and Quality

The flow data for the Carew River Carew were provided by the Environment Agency Wales and a copy of their correspondence of 24 January 2003 is included in Appendix A. This indicates computed flows entering the Mill Pond as follows:

- Annual Mean Flow (ADF) 0.364 m^3/s (31,450 m^3/day)
- Annual 95 percentile low flow 0.027 m^3/s (2333 m^3/day)

For the purposes of this assessment, it has been assumed that the runoff within the Carew River has a conductivity of 250 µS/cm (0.25 mS/sm).

Estimated Volume of Mill Pond

The surface area of the Mill Pond upstream of the Tide Dam to the Mean High Water Springs (MHWS) mark, shown on published Ordnance Survey maps is 7.1 ha. For the purposes of this assessment it has been assumed that the *mean* depth of water impounded in this area is 1m. The impounded volume is therefore of the order of 71,000 m^3.

Mass Balance of Mill Pond

The assessment uses a simple mass balance approach to the hydrology of the Mill Pond, which can be summarised as follows:

$$V_P.C_P = V_T.C_T + V_Q.C_Q + V_S.C_S \quad (1)$$

Where, V, C refer to Volume and Conductivity respectively; and
subscripts $_{P,Q,T}$ refer to the Mill Pond, Quarry and Tidal Inflows respectively.

This equation is summarised on Figure 1.

It follows that:

$$C_P = [V_T.C_T + V_Q.C_Q + V_S.C_S] / V_P \quad (2)$$

In solving this equation to assess the effect of varying the quarry discharge (V_Q) into the Mill Pond, it is assumed that the volume of the Mill Pond (V_P) remains constant at 71,000 m^3, with the rest of the Mill Pond water comprising tidal inflow (V_T) and flows from the Carew River (V_S). It follows that,

$$V_T = 71{,}000 - V_Q - V_S \quad (3)$$

It is further assumed that with the refurbishment of the tide dam, leakage from the Mill Pond is negligible over a tidal cycle.

The equations have been solved for three different values of quarry discharge:

- 3600 m^3, the current consented volume;
- 4,245 m^3, the mean daily volume actually discharged between 1 May 2000 and 1 March 2004; and
- 10,000 m^3. This approximates to the maximum volume that could be discharged from the existing quarry with the existing infrastructure, which is limited by available electricity to power pumps (currently discharge is limited to about 7 hours per day).

The mass balance assumes full mixing within the Mill Pond. In assessing the historic situation, it has been assumed that mixing occurred over one tidal cycle (approximately 12 hours), reflecting the fact that leakage through the tide dam was significant and the bottom muds were often exposed at low water.

In assessing the current and future scenarios, the effect of varying the allowable quarry discharge upwards has assumed that mixing occurs over two tidal cycles, allowing relatively *more* freshwater inflows and dilution from the Carew River.

In each case, equation (2) has been solved for both mean and low flow conditions in the Carew River. The input parameters for each situation analysed are summarised in Table 2.

Results

The results of the mass balance model are summarised in Table 2. These show that:

- in the historic situation, increased discharges from the quarry were likely to have been marginally beneficial in improving the quality of impounded water in the Mill Pond;
- in the current situation, servicing of the tide dam should likewise have caused improvements in the quality of the impounded water, principally by allowing more freshwater flows from the Carew River to dilute saline inflows; and
- increasing the quarry discharge should lead to further improvements in the quality of the impounded water, which should not be harmful to the habitat of the Tentacled Lagoon Worm *Alkmaria romijni*.

Comment on Validity of Results

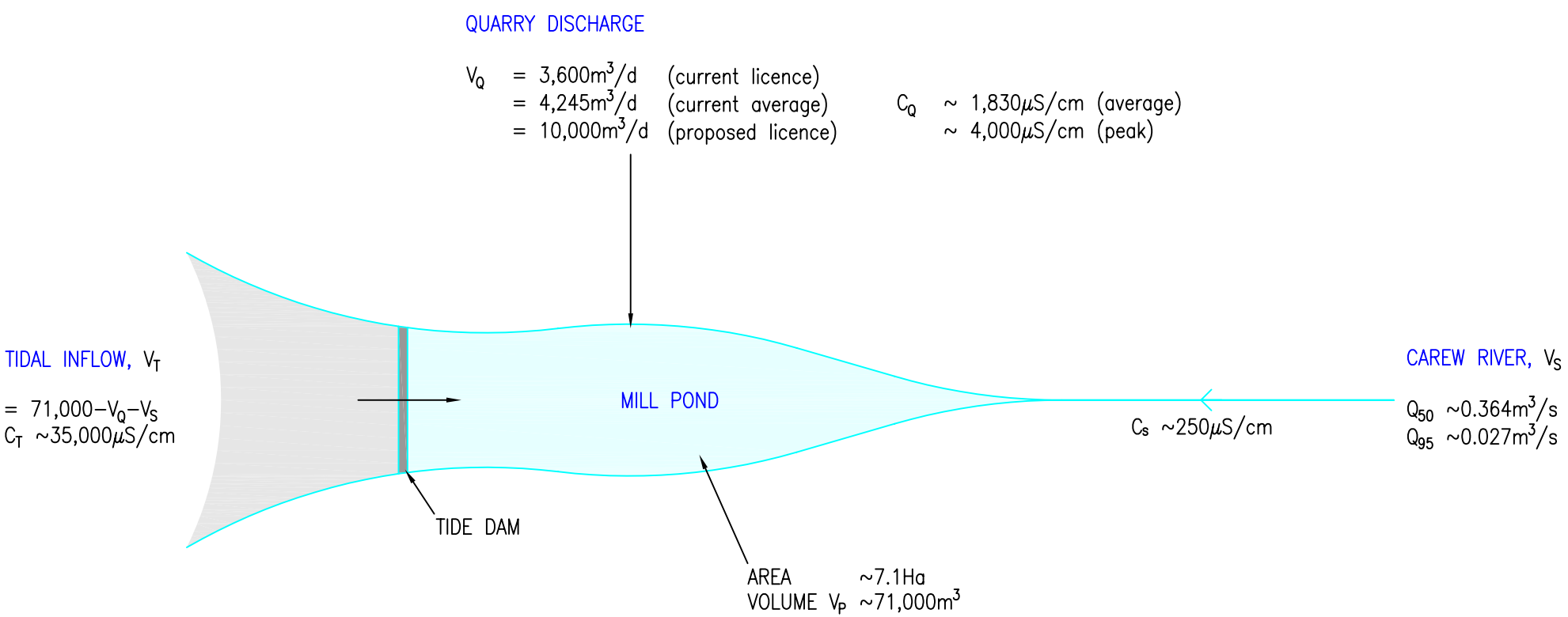
It is emphasised that the detailed hydrology of the Mill Pond is complex and the results presented in Table 2 are only 'valid' for the assumptions that have been made to simplify the natural situation. Whilst these are considered to be reasonable for the purpose of this report, it is emphasised that the hydrology of the Mill Pond is variable, in terms of both the volume and quality of the impounded water. In literal terms, the resultant quality of water in the Mill Pond, summarised in Table 2 for the current and future situations, actually represents the best estimate *following 24 hours of impoundment at Mean High Water Springs* for the purposes of comparison. At all other states of the tide, river inflow and durations of impoundment, variations in water quality from those shown in Table 2 can be expected. Such variations should not have a material effect on the overall conclusion of this assessment, provided below.

Conclusion

The mass balance approach undertaken in this assessment indicates that increasing the allowable discharge volume from Carew Quarry to 10,000 m^3 will be beneficial to the habitat of the Tentacled Lagoon Worm *Alkmaria romijni*.

(1) Carew Quarry, Carew Cheriton, Pembrokeshire. Review of Hydrological Information and Preliminary Assessment. PB Kennedy & Donkin Limited, July 2000.

FIGURES



MASS BALANCE

$$V_P.C_P = V_T.C_T + V_Q.C_Q + V_S.C_S$$

Where V,C = Volume, Conductivity
P = Pond
T = Tide
Q = Quarry Discharge
S = Surface Water

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• CLIENT/PROJECT
THOMAS SCOURFIELD & SONS
CAREW QUARRY
APPROPRIATE ASSESSMENT
OF MILL POND

• TITLE
SCHEMATIC SHOWING
HYDROLOGY OF MILL POND

• DATE 05/03/04
• SCALE Not to Scale
• CAD REF \BEN\CF\012\Z\1\BENCF012-F01.DWG

DRAWN BY BRG
PRODUCED BY ACDG
CHECKED ACDG
APPROVED

• DRAWING NUMBER
FIGURE 1

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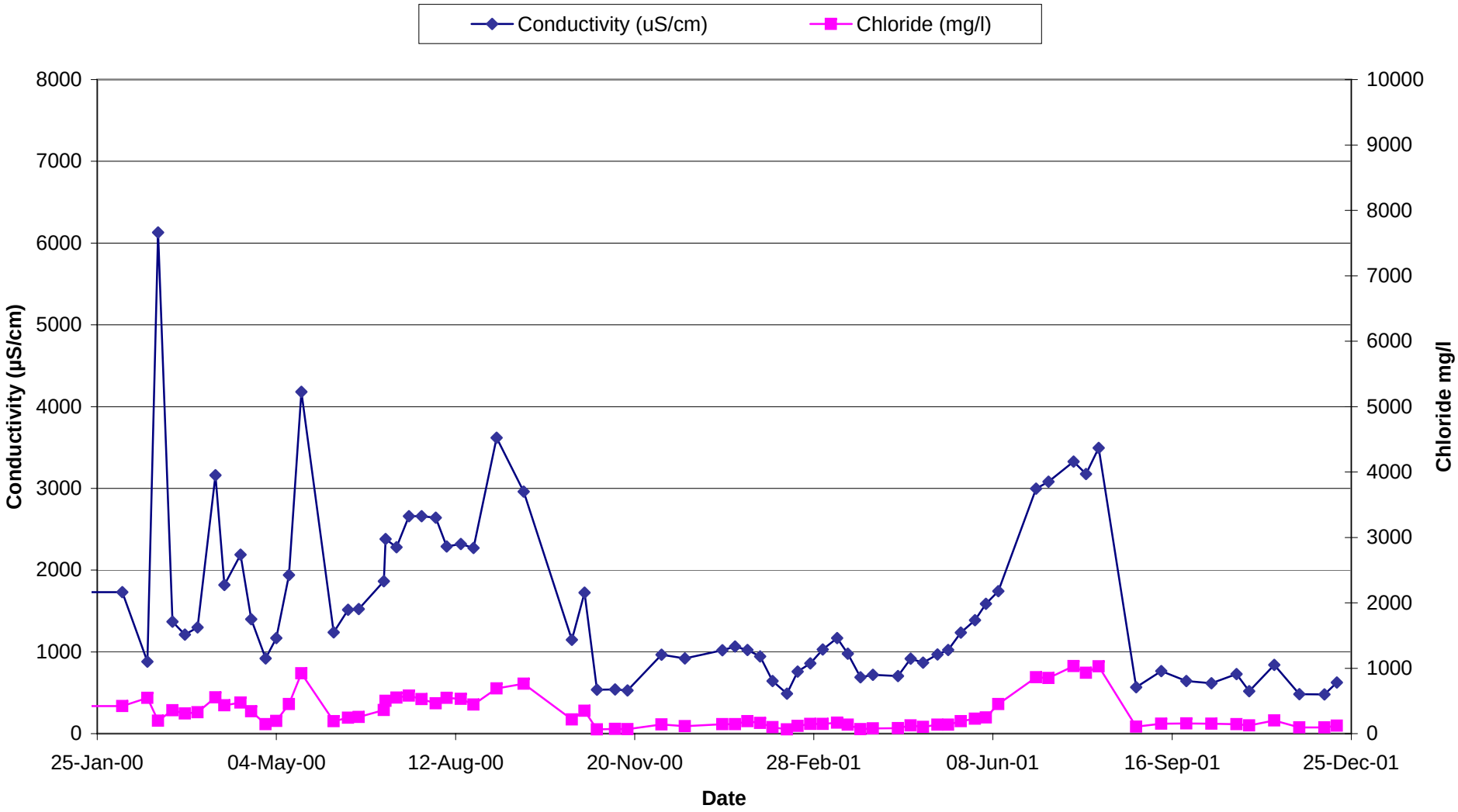


Figure 2: Sump Water Quality, 2000 - 2001

TABLES

Date	Meter Reading cu. m. (x10)	Accreted Vol. cu. m.	Time Interval (Days)	Mean Daily Vol. cu. m.
01-May-00				
12-Jun-00	12941	129410	42	3081
08-Jan-01	98562	856210	210	4077
15-Jan-01	102373	38110	7	5444
22-Jan-01	105684	33110	7	4730
29-Jan-01	109151	34670	7	4953
05-Feb-01	112721	35700	7	5100
13-Feb-01	116852	41310	8	5164
20-Feb-01	120858	40060	7	5723
26-Feb-01	123804	29460	6	4910
05-Mar-01	127795	39910	7	5701
12-Mar-01	130933	31380	7	4483
19-Mar-01	134483	35500	7	5071
26-Mar-01	138161	36780	7	5254
02-Apr-01	141764	36030	7	5147
17-Apr-01	150332	85680	15	5712
23-Apr-01	153384	30520	6	5087
30-Apr-01	156897	35130	7	5019
08-May-01	160955	40580	8	5073
14-May-01	164029	30740	6	5123
21-May-01	167491	34620	7	4946
29-May-01	170895	34040	8	4255
04-Jun-01	173165	22700	6	3783
11-Jun-01	175418	22530	7	3219
02-Jul-01	181282	58640	21	2792
09-Jul-01	183643	23610	7	3373
23-Jul-01	189539	58960	14	4211
30-Jul-01	191744	22050	7	3150
06-Aug-01	195385	36410	7	5201
13-Aug-01	198964	35790	7	5113
20-Aug-01	202432	34680	7	4954
28-Aug-01	206486	40540	8	5068
29-Oct-01	231930	254440	62	4104
12-Nov-01	238783	68530	14	4895
26-Nov-01	243139	43560	14	3111
10-Dec-01	250782	76430	14	5459
17-Dec-01	254306	35240	7	5034
07-Jan-02	262278	79720	21	3796
21-Jan-02	267740	54620	14	3901
19-Mar-02	297364	296240	57	5197
Pumping Statistics for Jan 2001- Mar 2002			Max	5723
			Mean	4667
			Min	2792

Table 1: Summary of Discharge Volumes, May 2000 - March 2004

Date	Meter Reading cu. m. (x10)	Accreted Vol. cu. m.	Time Interval (Days)	Mean Daily Vol. cu. m.
02-Dec-02	398916	1015520	258	3936
06-Jan-03	417964	190480	35	5442
13-Jan-03	421739	37750	7	5393
20-Jan-03	425483	37440	7	5349
27-Jan-03	429061	35780	7	5111
03-Feb-03	432639	35780	7	5111
10-Feb-03	436217	35780	7	5111
17-Feb-03	439233	30160	7	4309
24-Feb-03	443022	37890	7	5413
03-Mar-03	445749	27270	7	3896
10-Mar-03	449064	33150	7	4736
17-Mar-03	452138	30740	7	4391
31-Mar-03	457921	57830	14	4131
07-Apr-03	460458	25370	7	3624
14-Apr-03	462560	21020	7	3003
28-Apr-03	468465	59050	14	4218
05-May-03	471911	34460	7	4923
12-May-03	474300	23890	7	3413
29-May-03	481650	73500	17	4324
04-Jun-03	483439	17890	6	2982
09/06/2003	485670	22310	5	4462
23-Jun-03	491126	54560	14	3897
17-Jul-03	498841	77150	24	3215
21-Jul-03	500593	17520	4	4380
28-Jul-03	503503	29100	7	4157
11-Aug-03	509716	62130	14	4438
18-Aug-03	512230	25140	7	3591
08-Sep-03	520536	83060	21	3955
15-Sep-03	523030	24940	7	3563
22-Sep-03	525782	27520	7	3931
13-Oct-03	533302	75200	21	3581
20-Oct-03	535872	25700	7	3671
27-Oct-03	538529	26570	7	3796
03-Nov-03	541366	28370	7	4053
10-Nov-03	544018	26520	7	3789
24-Nov-03	549854	58360	14	4169
01-Dec-03	552870	30160	7	4309
15-Dec-03	558599	57290	14	4092
05-Jan-04	568396	97970	21	4665
19-Jan-04	575218	68220	14	4873
26-Jan-04	578484	32660	7	4666
09-Feb-04	585122	66380	14	4741
16-Feb-04	588031	29090	7	4156
23-Feb-04	591231	32000	7	4571
01-Mar-04	594300	30690	7	4384
Pumpage Statistics for 2003 - February 2004			Max	5442
			Mean	4272
			Min	2982

Table 1 (cont'd): Summary of Discharge Volumes, May 2000 - March 2004

	HISTORIC SITUATION				CURRENT		FUTURE	
	MEAN	**LOW FLOW**	**MEAN**	**LOW FLOW**	**MEAN**	**LOW FLOW**	**MEAN**	**LOW FLOW**
Quarry Discharge V_Q (m^3/day)	3600	3600	4245	4245	4245	4245	10,000	10,000
Discharge Quality C_Q (mS/cm)	1.83	4	1.83	4	1.83	4	1.83	4
River Inflow, V_s (m^3)	15,725	1166.5	15,725	1166.5	31,450	2,333	31,450	2,333
River Quality, C_s (mS/cm)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Tidal Inflow, V_T (m^3)	51,675	66,533.5	51,675	66,533.5	35,305	64,422	29,550	58,667
Tidal Quality, C_T (mS/cm)	35	35	35	35	35	35	35	35
Mill Pond Quality, C_P (mS/cm)	25.62	32.86	25.32	32.58	17.62	32.0	14.94	29.49
Calculations	p.3	p.3	p.4	p.4	p.5	p.5	p.6	p.6
Assumptions	Mixing Over 1 Tidal Cycle = 12 hrs				Mixing Over 2 Tidal Cycles = 24 hrs			

Table 2: Summary of Mass Balance Calculations

APPENDICES

APPENDIX A

EA CORRESPONDENCE, 24 JANUARY 2003

RECEIVED 27 JAN 2003

ASIANTAETH YR AMGYLCHEDD CYMRU
ENVIRONMENT AGENCY WALES

Ein cyf/Our ref. SW/WQRT/TJW

Dyddiad/Date: 24 January 2003

Mr. Alistair Groves
Parsons Brinckerhoff
Queen Victoria House
Redland Hill
Redland
Bristol BS6 6US

Dear Mr. Groves

RE: DISCHARGE CONSENT VARIATION APPLICATION – BP0236901

Further to my letter of 17th January, I write, as promised, to confirm the effect of your proposals on the discharge limit for Total Suspended Solids (TSS).

I have established that with regard to this parameter, strict application of the Agency's 'no deterioration' policy need not be applied in this instance, as the consent limit thus derived would be deemed unreasonably onerous. Instead, the consent variation application, once complete, will be determined to include a general sector discharge standard, which I confirm for TSS to be 50mg/l.

Please feel free to contact me should you wish to discuss any of the above.

Yours sincerely,

Trevor J. West
Water Quality Regulatory Officer

cc. Rod Thomas (Environment Officer - EAW)

Asiantaeth yr Amgylchedd Cymru
Glan Tawe, 154 Ffordd San. Helen, Abertawe, SA1 4DF Ffon 01792 645300, Ffacs 01792 648652

Environment Agency Wales
Glan Tawe, 154 St. Helens Road, Swansea, SA1 4DF Tel 01792 645300, Fax 01792 648652

RECEIVED 24 JAN 2003

WATER RESOURCES REF :	CONSENT REF :
Gen03_03	none

Location Reference : SN04800380

Summary:
River Carew where it passes under main road above the Carew Mill Pond

Flow Estimates/Calculations	Value	Comment
Annual MF (*ADF)	0.364 m^3/s	Natural Flow Estimate using Low Flows 2000
Annual 95%(ile) Flow	0.027 m^3/s	

Additional Comments	Catchment area measured by Low Flows 2000 is 18.68km^2. Confidence Intervals For Low Flows 2000: MF + 10%, Q95 + 65%

Signed (WR staff) : TAD	Date : 21/01/2003

Replied & thanks
23/1/03.

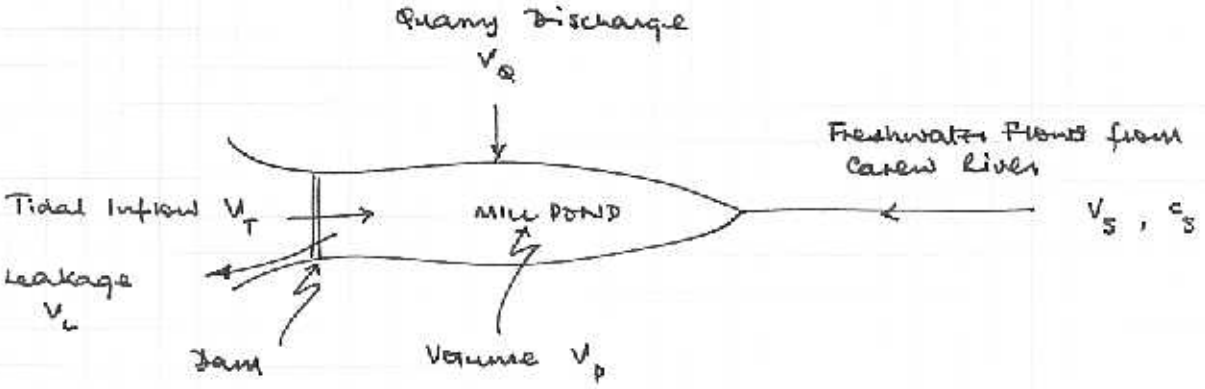
APPENDIX B

CALCULATION SHEETS

PB 100 YEARS

CALCULATION SHEET

Contract Title	CAREW QUARRY		Job No KD BENCF012.040.
Subject	Appropriate Assessment of Mill Pond.		Drawing No.
Calc. by	ACBG7	Date 5.3.2004.	Dept. Ref.
Checked by	JP	Date 8/3/04	Calc. Sheet 1. of 7



Area of Mill Pond upstream of tide dam on published OS plans = 71,000 m² (7.1 ha) to MHWS

Assume mean water level in Mill Pond = 1m (probably conservative)

∴ Volume of Mill Pond, V_p = 71,000

Assume ∴ $V_T + V_Q + V_S$ = $71,000 - V_L$

Assume leakage is negligible over one tidal cycle

∴ V_T = $71,000 - V_Q - V_S$ (1) V_S ? ✓

Assuming full mixing in Mill Pond

$$V_p \cdot C_p = V_T \cdot C_T + V_Q \cdot C_Q + V_S \cdot C_S$$

where C is concentration (eg of $[Cl^-]$ or salinity or conductivity)

∴ Resultant concentration within the Mill Pond

$$C_p = \frac{V_T \cdot C_T + V_Q \cdot C_Q + V_S \cdot C_S}{V_p} \quad (2)$$

where,

C_T = quality of tidal inflow
C_Q = quality of quarry discharge
C_S = quality of surface flows

PB 100 YEARS

CALCULATION SHEET

Contract Title	CAREW QUARRY	Job No.	KD BENBL012.040
Subject	Appropriate Assessment of Mill Pond	Drawing No.	
Calc. by	AC[illegible]	Date	5.3.04
Checked by	[signature]	Date	8/3/04
Dept. Ref.		Calc. Sheet	2 of 7

Q_{50} (mean daily flow) of Carew River ~ 0.364 m^3/sec (31,450 m^3/d)

Q_{95} (5% low flow) ~ 0.027 m^3/sec (2,333 m^3/day)

(Data provided by EA Wales @ NGR SN 0480 0380 using Low Flows 2000)

Assume C_S low throughout year, reflecting surface flows

~ 250 µS/cm (probably conservative)

Assume C_T ~ 35,000 µS/cm, reflecting seawater

C_Q taken from quarry sump quality (2000-2001)

~ 1,830 µS/cm (mean)
~ 4,000 µS/cm (peak)

(see figure)

Solve equations (1), (2) for the following situations:

(i) @ V_Q = 3600 m^3/day (existing consent)

(ii) V_Q = 4245 m^3/day (current mean discharge 2000 - 2003)

(iii) V_Q ~ 10,000 m^3/day (proposed revised consent)

Solve each for:

(a) V_S = 31,450 m^3/day (mean river flows)
for C_S = 0.25 mS/cm ;
C_Q = 1.83 mS/cm (mean discharge quality)

(b) V_S = 2,333 m^3/day (low flows)
C_S = 0.25 mS/cm
C_Q = 4 mS/cm (assuming quarry discharge quality passes @ low flow).

CALCULATION SHEET

Contract Title: CAREW QUARRY			Job No: KDBENCF012 · 040
Subject: Appropriate Assessment of Mill Pond			Drawing No.
Calc. by: ACBQ	Date: 5.3.04		Dept. Ref.
Checked by:	Date: 8/3/04		Calc. Sheet: 3 of 7

Historic Situation:

Leakage occurred thro' tide dam ∴ solve for (2) over 1 no. tidal cycle (assume 12 hours).

Consented discharge $V_Q = 3600\ m^3/d$; $C_Q = 1.83$ mS/cm (av.)

Mean river flows $V_{QS} = (31,450/2)\ m^3/d$; $C_S = 0.25$

$$\therefore \quad V_T = 71,000 - 3600 - 15725 = 51,675 \text{ ; } C_T = 35$$

∴ with full mixing

$$C_p = \frac{(51,675 \cdot 35) + (3600 \cdot 1.83) + (15725 \cdot 0.25)}{71,000}$$

$$= \underline{25.62 \text{ mS/cm.}}$$

Under low flow conditions:

$$V_S = (2,333/2)\ m^3/d \quad ; \quad C_S = 0.25$$
$$V_T = 71,000 - 1166.5 - 3600 = 66,233.5$$
$$C_Q = 4 \text{ mS/cm}$$

$$\therefore \quad C_p = \frac{(66,233.5 \cdot 35) + (3600 \cdot 4) + (1166.5 \cdot 0.25)}{71,000}$$

$$= \underline{32.86 \text{ mS/cm}}$$

In other words, the quality of water within the mill Pond falls in summer (dry) conditions because of the small proportion of 'sweetening flow' from the Carew River and leakage through the tide dams

PB 100 YEARS

CALCULATION SHEET

Contract Title	CAREW QUARRY		Job No. KDBENCF012.040
Subject	Appropriate Assessment of Mill Pond		Drawing No.
Calc. by	ACBBY	Date 5.3.04	Dept. Ref.
Checked by	JP	Date 8/3/04	Calc. Sheet 4 of 7

under mean conditions with the actual discharge, assuming mixing over one tidal cycle:

ie $V_Q = 4245$; $C_Q = 1.83$
$V_S = 15725$; $C_S = 0.25$

$V_T = 71,000 - 4245 - 15725 = 51,030$; $C_T = 35$

$$\therefore C_p = \frac{(51,030 \cdot 35) + (4245 \cdot 1.83) + (15725 \cdot 0.25)}{71,000}$$

$$= \underline{25.32 \text{ mS/cm}}$$

At low flows

$V_Q = 4245$; $C_Q = 4$
$V_S = 1166.5$; $C_S = 0.25$

$V_T = 71,000 - 4245 - 1166.5 = 65,588.5$; $C_T = 35$

$$\therefore C_p = \frac{(65,588.5 \cdot 35) + (4245 \cdot 4) + (1166.5 \cdot 0.25)}{71,000}$$

$$= \underline{32.58 \text{ mS/cm}}$$

In other words, the historic quality of water within the Mill Pond was marginally better with the increased inflows from the quarry.

PB 100 YEARS

CALCULATION SHEET

Contract Title	CAREW QUARRY		Job No. KDBENCP012 · 040 .
Subject	Appropriate Assessment of Mill Pond		Drawing No.
Calc. by	AC[illegible]	Date 5.3.04	Dept. Ref.
Checked by	[signature]	Date 8/3/04	Calc. Sheet 5. of 7

Current Situation

Tide dam now refurbished ∴ assume mixing over 2 no. tidal cycles

ie V_Q = 4245 ; C_Q = 1·83
V_S = 31,450 ; C_S = 0·25

V_T = 71,000 − 4245 − 31,450 = 35,305 ; C_T = 35

$$\therefore C_p = \frac{(35{,}305 \cdot 35) + (4245 \cdot 1{\cdot}83) + (31{,}450 \cdot 0{\cdot}25)}{71{,}000}$$

= 17·62 mS/cm (cf first soln on p.4) ✓

At low flows:

V_Q = 4245 ; C_Q = 4
V_S = 2333 ; V_S = 0·25

V_T = 71,000 − 4245 − 2333 = 64,422 ; C_T = 35

$$\therefore C_p = \frac{(64{,}422 \cdot 35) + (4245 \cdot 4) + (2333 \cdot 0{\cdot}25)}{71{,}000}$$

= 32 mS/cm * (cf 2nd soln on p.4). ✓

These results show / illustrate that refurbishment of the tide dam led to marginally better quality within the Mill Pond by allow more freshwater inflows.

NOTE: * 2nd solution at low flows reflects the quality that would result at Q_{95} in the Carew River if the tide dam was opened every 24 hours. In reality, this does not happen regularly and Mill Pond is progressively diluted by continued quarry discharge & river flow.

Eg after 5 days, with full mixing Cp → ≈ 20 mS/cm.

PB 100 YEARS

CALCULATION SHEET

Contract Title: CAREW QUARRY			Job No. KDBENCP012.040.
Subject: Appropriate Assessment of Mill Pond			Drawing No.
Calc. by: ACH	Date: 5.3.04		Dept. Ref.
Checked by: JP	Date: 8/3/04		Calc. Sheet: 6 of 7

Future Situation

Assuming mixing over 1 tidal cycle, for comparison with results on p.6.

ie $V_Q = 10,000$; $C_Q = 1.83$

$V_S = 31,450$; $C_S = 0.25$

$V_T = 71,000 - 10,000 - 31,450 = 29,550$; $C_T = 35$

$$\therefore C_p = \frac{(29,550 \cdot 35) + (10,000 \cdot 1.83) + (31,450 \cdot 0.25)}{71,000}$$

$= 14.94$ mS/cm ✓ (cf soln #1 on p5)

At low flows:

$V_Q = 10,000$; $C_Q = 4$

$V_S = 2,333$; $C_S = 0.25$

$V_T = 71,000 - 10,000 - 2,333 = 58,667$

$$\therefore C_p = \frac{(58,667 \cdot 35) + (10,000 \cdot 4) + (2,333 \cdot 0.25)}{71,000}$$

$= 29.749$ mS/cm * ✓ (cf soln #2 on p.5)

In other words, increased quarry discharge is beneficial to the quality of water in the Mill Pond when compared with the current situation.

* Again this result shows av. quality in Mill Pond at Q_{95} after the tide dam has been shut for 24 hrs.

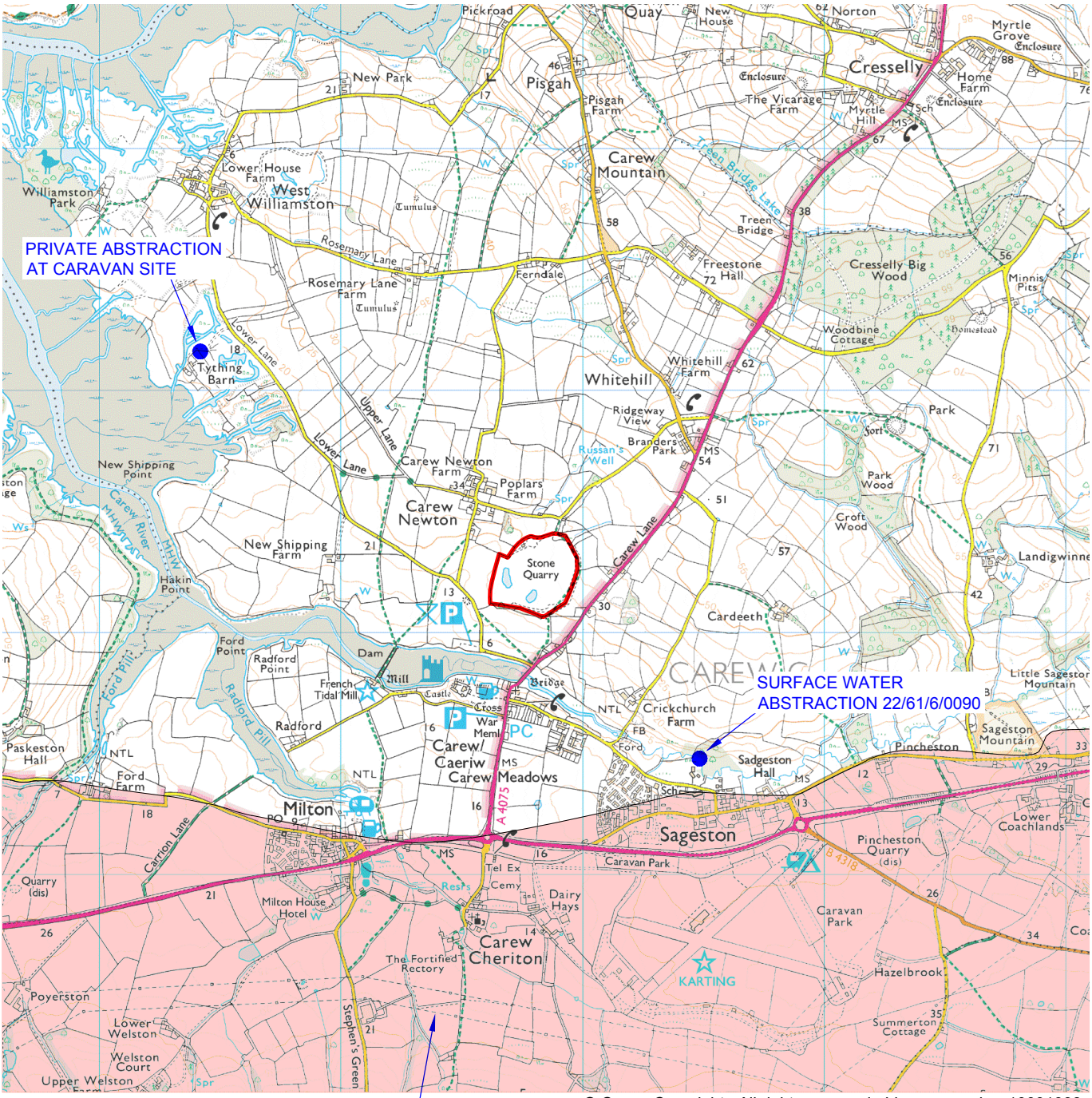
After 5 days with full mixing $C_p \rightarrow 7.5$ mS/cm.

PB 100 YEARS

CALCULATION SHEET

Contract Title	CAREW QUARRY	Job No.	KDBENCH012.04.
Subject	Appropriate Assessment	Drawing No.	
Calc. by	ACDG7	Date 5.3.04	Dept. Ref.
Checked by	JP	Date 6/3/04	Calc. Sheet 7. of 7

	HISTORIC SITUATION				CURRENT		FUTURE.	
	MEAN	LOW FLOW	MEAN	LOW FLOW	MEAN	LOW FLOW	MEAN	LOW FLOW
QUARRY DISCHARGE (m^3/day)	3600	3600	4245	4245	4245	4245	10,000	10,000
DISCHARGE QUALITY (mS/cm)	1.83	4	1.83	4	1.83	4	1.83	4
RIVER INFLOW (m^3)	15,725	1166.5	15,725	1166.5	31,450	2,333	31,450	2,533
RIVER QUALITY (mS/cm)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TIDAL INFLOW (m^3)	51,675	66,233.5	51,675	66,233.5	35,305	64,422	29,550	58,667
TIDAL QUALITY (mS/cm)	35	35	35	35	35	35	35	35
MILL POND QUALITY (mS/cm)	25.62	32.86	25.32	32.58	17.62	32.0	14.94	29.49
CALCULATIONS	p.3	p.3	p.4	p.4	p.5	p.5	p.6	p.6
ASSUMPTIONS.	MIXING OVER 1 TIDAL CYCLE = 12 HRS				MIXING OVER 2 TIDAL CYCLES = 24 HRS			



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EXTENT OF SURVEY

SITE LOCATION

PARSONS BRINCKERHOFF
Queen Victoria House
Redland Hill, Redland
Bristol BS6 6US
Tel: 44-(0)117-933-9300
Fax: 44-(0)117-933-9253

Client/Project:
THOMAS SCOURFIELD AND SONS

Title:
HYDROGEOLOGICAL ASSESSMENT

Drawn: BRG		Checked: ACDG	
Designed: ACDG		Approved:	
Date: 13/11/2012	Scale: 1:25,000	A4	Sheet:
Project Number: 3512339A		Drawing Number: FIGURE 7.1	Revision:

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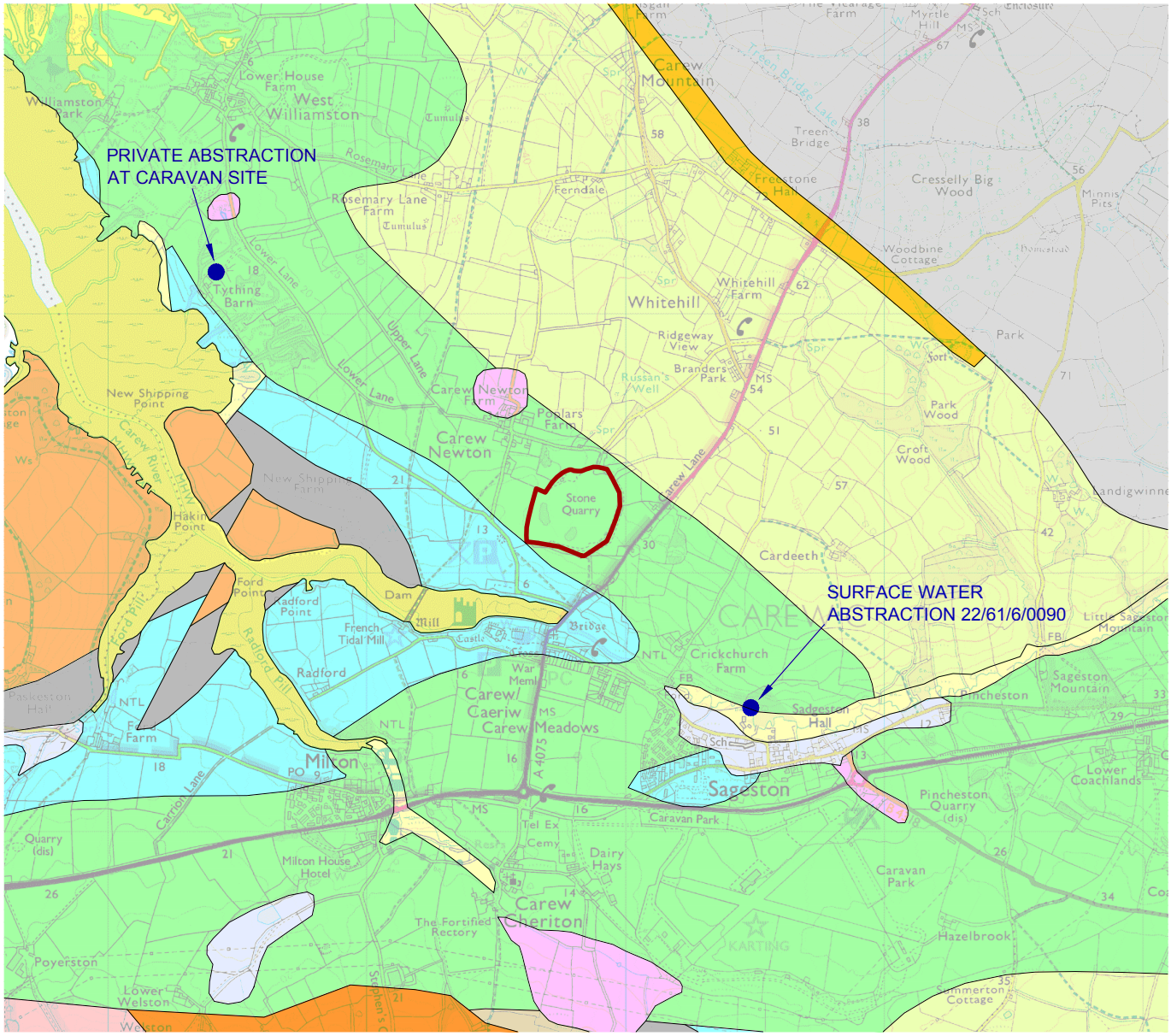

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EXTENT OF SURVEY

SITE LOCATION

Superficial Deposits

- Alluvium
- Tidal flat deposits
- Glacial fluvial deposits
- Till, mid pleistocene

Bedrock Geology

- South Wales Lower Coal Measures Formation
- Telpyn Point Sandstone Formation
- Bishopston Mudstone Formation
- Avon Group
- Black Rock Subgroup and Gully Oolite Formation (undifferentiated)
- Pembroke Limestone Group
- Skrinkle Sandstone Formation
- Ridgeway Conglomerate
- Cosheston Group
- Milford Haven Group

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Client/Project:
THOMAS SCOURFIELD AND SONS

Title:
SITE GEOLOGY

Drawn: JSdS		Checked: ACDG	
Designed: JSdS		Approved:	
Date: 13/11/2012	Scale: 1:25,000	A4	Sheet:
Project Number:		Drawing Number:	Revision:
3512339A		FIGURE 7.2	

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4. Noise

A: Glossary of Terms

APPENDIX 4A NOISE – GLOSSARY OF TERMINOLOGY

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale, is used. The decibel scale typically ranges from 0dB (the threshold of hearing) to over 120dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

Table 1
Common Noise Levels Commonly Found in the Environment

Sound Level	Typical Source
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside a factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft at take off
140dB(A)	Threshold of pain

Acoustic Terminology

dB (decibel) — The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ($2x10^{-5}$ Pa).

dB(A) — A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

L_{Aeq} — L_{Aeq} is defined as the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.

L_{10} & L_{90} — If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L_{10} index to describe traffic noise.

L_{Amax} — L_{Amax} is the maximum A-weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.