Kier Services

Waterston, Milford Haven

Contaminated Land Review
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Contaminated Land Review

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EXECUTIVE SUMMARY

General
Hyder Consulting (UK) Limited received instructions from Kier Services on behalf of Welsh Government (WG) in March 2013 to undertake a Contaminated Land Review of the areas of land recently purchased by WG at the Tank Storage site at Waterston, Milford Haven ("the site"). The areas include the previous oil refinery, railway yard (railhead), land adjoining Blackbridge RNAD, the eastern and western perimeter roads and the daffodil fields. Reports (which are detailed in Appendix A) were provided to Hyder by Kier for this review.

Site Location
The Milford Haven Refinery ("the site") is approximately 109 hectares in size and is located to the south of Waterston village on the northern shore of Milford Haven. The approximate National Grid Reference is 193472, 205377. The immediate surrounding area is primarily agricultural grazing land with a scattering of houses / farms.

Site and Surrounding Area History

Site
Prior to construction of the refinery in the 1960s the site was agricultural land. The operations commenced in 1968 and the refinery closed in 1997. Ownership has changed over the years and details are included in Section 2.1. The land adjacent to the RNAD site previously had a mineral railway (1908) and an oil and manure works (1908). Several buildings are present on this area in the 1950s associated with the RNAD site, the use is however unknown. Tunnels / underground magazines are known to exist in this area and a plan is included in Section 2.1.2.

Environmental Setting

Geology
The site is located on a sequence of soils from the Coheston Group over Red Marls both of the Lower Old red Sandstone period. Due to industrial nature of the site, areas of Made Ground are known to be present such as the Asbestos Pit and the Old and New Landfarms. A cross section presenting a schematic of the ground conditions across the site is included in Section 2.2.1.

Hydrogeology
The bedrock is designated as Secondary A aquifers. A plan illustrating the groundwater regime on site is included as Fig 6. This shows that there is a groundwater divide on site. In the east groundwater flows to Hazelbeach Stream, whilst in the west groundwater flows in a westerly direction towards the boundary stream.

Hydrology
On site there are three catch basins and drainage flows into these prior to discharge from site. Surface water streams flow along the western boundary, southern boundary and north eastern boundary (Hazelbeach Stream).

Previous Investigations / Soil Remediation Plan
Investigations were undertaken in late 1990s which was supplemented with further works over the years. Based on the initial investigation data, a Soil Remediation Plan was prepared which focused on specific areas of the site which were considered to pose a risk to the environment. Remediation techniques were chosen depending on the type of contamination and the receptors at risk.

The areas now owned by WG which were remediated include the Process Area, Contractors Area, Railway yard and Flare Stack Stockpile (as shown on Fig 7).
Report Reviews

**RH Risk Assessment Reports** – A series of RA reports were prepared to provide supporting information to determine the potential risks to site receptors following remediation. The risk assessments undertaken used data from the previous investigations and groundwater monitoring between 1996 and 2008. Based on the findings Hyder has provided Priority Ratings for the residual risk for each area which are summarised below. Further details are included in Section 3.1.1 and drawings in Appendix B. These are based on the information available to Hyder and some of the risks may have been mitigated by additional monitoring/remedial works, however no evidence has been presented.

**Contractors Area**

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Amber 2</td>
<td>Amber 2</td>
</tr>
</tbody>
</table>

**Process Area**

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Amber 2</td>
<td>Amber 1</td>
</tr>
</tbody>
</table>

**Railway Yard**

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Amber 2</td>
<td>Amber 2</td>
</tr>
</tbody>
</table>

**Flare Stack Stockpile**

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

**RH Progress Reports / Reviews** – This series of reports detail the remediation works that had been undertaken over the reported year. These were then reviewed by the Environmental Expert Team to determine if they met the requirements. A review of the final report is included in Section 3.1.2 which details the remediation activities which were undertaken and volumes of contaminated material (eg soil / oil) removed / extracted from the specific areas. The close out of this report states that 

….there still are contaminations at the Milford Haven Tankstorage site. With exception of the area of the tank 115 incident, no significant elevated levels of contaminations are present in the monitoring wells along the boundary of the site. However it can be concluded that the contaminations present are under control and that the goals set in the remediation plan are achieved.

**RH Monitoring Reports** – Annual monitoring reports were prepared between 2001 and 2008. A review of the last monitoring report is included in Section 3.1.3. A plan showing the location of the monitoring wells is included in this section as Fig 13. This report concludes by stating

… that there still are groundwater contaminations at the tankstorage site. Decreasing trends were observed at several locations but also increasing trends. The contaminants in some wells fluctuate, but in general it can be concluded that the contaminants are more or less stable. More important is that ….. no significant elevated levels of contaminations are present in the monitoring wells along the boundary of the site.

An Environmental Certificate is available (Section 3.1.4) which was signed by the EET to confirm that the remedial programme has been undertaken in accordance with the Remediation Agreement.

**Dismantling Report** – This report (Section 3.1.5) provides information about the dismantling of the former refinery plant by Bosicor which took place between 2007 and 2011. Details include a summary of dismantling programme (ie what happened when), Health and Safety, Pollution Control and Waste Management and Auditing.
PPC Permit / Discharge Monitoring – A PPC Permit currently exists for the site which is for the ex-situ biological and physic-chemical treatment of waste including storage pending disposal and recovery. Monitoring (pH, flow rate, Total Oil and VOCs) associated with this permit is being undertaken and information is included in Section 3.1.6. The concentrations recorded are below the permit limits, however Hyder note that the limits set are high compared to Water Quality Standards.

Asbestos – A register is available of the buildings where asbestos containing materials are present. These were last inspected in April 2012. The main area where asbestos is present is the Asbestos Pit to the west of the railway yard. This area which is in WG ownership was historically filled with asbestos waste and covered with earth. Details of the construction are included in Section 3.1.7. This area is fenced off and is regularly inspected to ensure no damage has occurred.

PB Report – This is a desktop engineering appraisal to identify any significant constraints with the possible acquisition of eight parcels of land. The report looks at environmental liability issues for each area including permitting, asbestos, health and safety and waste management. Hyder has provided two areas of WG land with Priority Ratings based on the information presented (Section 3.1.8) which are given below.

Area C – Land adjoining Blackbridge RNAD

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Area H – Daffodil Fields

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section 3.2 provides a review of reports which relate to land outside WG ownership. This includes the API Separator area, Crude Tank Part Area, the Product and Park Area, the Old and New Landfarm areas and reports relating to the Tank 115 incident.

Recommendations

Based on the information reviewed, our recommendations are presented in Section 4.2 and summarised below:

- Arrange a meeting with the regulators (EA / Natural Resources Wales (NRW)) to establish their view of the contamination status of the site.
- Investigate the status of the PPC permit that would appear to be no longer required. An application would need to be submitted to the EA / NRW to seek their approval for surrender.
- Locate evidence that the recommendations detailed in the risk assessment reports and on completion of the SRP have been undertaken. If no evidence is available then investigation (monitoring / sampling) would be recommended to validate the risk assessment reports and the risks to the receptors.
- We would recommend that groundwater / surface water monitoring is undertaken across the WG land to establish the current status.
- The area to the west adjacent to the former RNAD base should be investigated in more detail to establish the location of the munitions factory and uses of other buildings on site. An intrusive investigation should then be undertaken targeting specific areas to establish if contamination is present.
- Prior to development of any of the areas, it would be prudent to undertake a baseline intrusive investigation to establish the current concentrations prior to development. This information could be provided to potential developers and may be required as part of a planning application.
1 INTRODUCTION

1.1 General

Hyder Consulting (UK) Limited (Hyder) received instructions from Kier Services (Kier) on behalf of Welsh Government (WG) in March 2013 to undertake a Contaminated Land Review of the areas of land recently purchased by WG at the Tank Storage site at Waterston, Milford Haven (“the site”).

The map below illustrates the areas (red and green) owned by WG. The areas include the previous oil refinery and the railhead in the eastern part of the site, land adjoining Blackbridge Royal Navy Armament Depot (RNAD) in the south west, the eastern and western perimeter roads and adjoining lands (shown in green) and the daffodil fields (to the north east).

Fig 1: Map showing areas owned by Welsh Government (provided by Welsh Government)

Other areas of the tank storage site are owned by SEM Logistics or Dragon LNG.

1.2 Scope of Works

A considerable amount of contaminated land work (site investigation / remediation / chemical analysis / monitoring etc) has taken place across the site during rationalisation of site operations, notable the dismantling of the Gulf Oil Refinery between 2007 and 2011. The purpose of the review of previous reports / documentation is to appraise the work undertaken and highlight information of importance to planning and to summarise key land quality aspects that are likely to require action in future development of the site. Following on from the review recommendations for further investigations / assessments to inform such future development is provided.

Reports have been provided to Hyder (via Kier) for review and a full list is included in Appendix A for reference. These include reports regarding areas of the site not owned by WG which are included in the list and this review for completeness.

The reports provided include a series of risk assessment reports under by Royal Haskoning (RH) related to different areas of the site, annual groundwater monitoring reports and corresponding progress reports / reviews. There are also reports which relate to the dismantling of the oil refinery,
asbestos present on the site and relating to the PPC permit held and associated monitoring. Reports relating to land not owned by WG included reports detailing the Tank 115 incident, risk assessment reports and the construction of the asbestos tip.

1.3 Limitations

This report has been compiled from a number of sources, which Hyder believes to be trustworthy but were not acquired by WG / Kier with any warranty. As a result, Hyder is unable to guarantee the accuracy of information provided by others. The report is based on information available at the time and provided to Hyder. Consequently, there is a potential for further information to become available, which may change this report’s conclusions and for which Hyder cannot be responsible.

The approach adopted by Hyder for the assessment of contamination at the site is based on critical evaluation of the methodologies currently available, to decide which are most applicable to the site conditions and proposed end-use. Guidance in land contamination is in a transitional state. Therefore, no responsibility can be accepted for future changes in legislation or guidance, which may affect the approach used or the findings of this report.
2 BACKGROUND INFORMATION

2.1 Site Location / History

The Milford Haven Refinery ("the site") is approximately 109 hectares in size and is located to the south of Waterston village on the northern shore of Milford Haven. The approximate National Grid Reference is 193472, 205377. The immediate surrounding area is primarily agricultural grazing land with a scattering of houses / farms. Before construction the site was agricultural land.

The refinery was constructed during the 1960s and operations commenced in 1968. It operated until it closed in 1997. The ownership of the site has changed over the years and is summarised below;

- The site was operated by Gulf Oil Refinery Limited (GORL) until 1998 when Petroplus International acquired GORL.
- In 2002 part of the site was sold to Dragon LNG for development of a Liquid Natural Gas (LNG) import terminal. (This is located on the southern side of the crude tank park and comprises the new landfarm and parts of the railyard and crude tank park.
- In 2005 Bosicor purchased the former refinery plant facilities (to ground level) in order to undertake the demolition of the plant and facilities to ground level and remove from site. Work began in 2007 and the contract was completed in January 2011.
- In July 2005 a feasibility study was undertaken by RH for developing the site into a power station. This application was withdrawn in 2007.
- In 2006 SEM Logistics (SEM Group) acquired Petroplus Tankstorage site.
- In 2007 the refinery and tank storage site was separated and the refinery site passed to 4Gas Limited (4Gas).
- In March 2012, the 4Gas areas were purchased by Welsh Government.

2.1.1 Envirocheck Report

An Envirocheck Report was available for review within the AECOM Environmental Report (Ref 1) which was prepared for Pembrokeshire County Council for a Transport Appraisal in the area. The historical maps included within this report cover the majority of the refinery site and the area to the west adjacent to the former RNAD site.

1 Some of this information has been taken from the reports provided to Hyder.
A brief summary is provided in the table below;

<table>
<thead>
<tr>
<th>Date</th>
<th>Refinery Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1868-1869</td>
<td>The site is shown to be agricultural land with Newtown Road crossing the eastern and southern sections. There are a number of properties in the vicinity including Hazel Hill House to the north and Newton to the west.</td>
</tr>
<tr>
<td>(1:10,560)</td>
<td></td>
</tr>
<tr>
<td>1908-1909</td>
<td>An Old Quarry is shown in the eastern part of the site where a sludge pond is indicated (now East Catch Basin)</td>
</tr>
<tr>
<td>(1:10,560)</td>
<td>Site is developed in 1960s and is officially opened in 1968</td>
</tr>
<tr>
<td>1970-1976 /</td>
<td>Refinery is shown to be developed and 2 Jetties shown on the shore of Milford Haven</td>
</tr>
<tr>
<td>1977 (1:10,000)</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>Two additional tanks are shown to the south west of the main refinery site.</td>
</tr>
</tbody>
</table>

**Western Side of Site**

<table>
<thead>
<tr>
<th>Date</th>
<th>Refinery Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1868-1869</td>
<td>Area is shown to be undeveloped</td>
</tr>
<tr>
<td>(1:10,560)</td>
<td></td>
</tr>
<tr>
<td>1908-1909</td>
<td>A Mineral Line Railway is indicated along the south western boundary joining buildings (probably works) to the west to the Pier which is located on the foreshore. An Oil and Manure Works is shown at the head of the Pier. An Old Quarry is shown on the eastern side of this area in the location of the current reservoir.</td>
</tr>
<tr>
<td>(1:10,560)</td>
<td></td>
</tr>
<tr>
<td>1953 (1:10,560)</td>
<td>Several buildings are present on land to the south of this area – assumed to be associated with the RNAD base. A large building is now shown within the area (owned by WG) on a raised level. Oil and Manure Works is no longer shown.</td>
</tr>
<tr>
<td>1964 (1:10,000)</td>
<td>Building on site is no longer shown.</td>
</tr>
<tr>
<td>2000 (1:10,000)</td>
<td>Two covered reservoirs are indicated in the western part of this area and several buildings are shown in the central section of unknown use. By 2009 only one building is present.</td>
</tr>
</tbody>
</table>
2.1.2 Royal Naval Armament Depot (RNAD) Plan

A Plan was provided by Kier (via an email) that shows the locations of the tunnels / underground magazines (referenced A to I) that are present on the area adjacent to the RNAD site (western part of site). This plan (which originated from the MOD and is available in the Kier site office), also shows a number of buildings of unknown use and an incinerator is marked in the vicinity of the reservoir on the eastern side of this area. Further plans of the site are understood to be held in the site office.

Fig 4 Plan showing tunnels / buildings on former RNAD site
2.2 Environmental Setting

2.2.1 Geology

The British Geological Survey (BGS) map of Haverfordwest (Sheet 228, Scale 1:50,000 (Solid)) indicates that the site is located on a sequence of soils from the Coheston Group over Red Marls both of the Lower Old red Sandstone period.

Coheston Group comprise light brown, yellow and green sandstones interbedded with mudstone, with Red Marls comprise frequently interbedded red brown mudstone, siltstone and sandstone. The majority of the site is underlain by Red Marls with the Coheston Group outcropping in the southern part of the site. A fault line marks the boundary between the Red Marls and the Coheston Group. This runs west north west from Wear Point.

From the BGS website (http://www.bgs.ac.uk/geoindex/ accessed 14/03/13), the site is generally absent of superficial deposits. A thin band of Tidal Flat Deposits (sand silt and clay) is indicated running parallel with the coast line and corresponds to deposits encountered along the beach. Due to the industrial nature of the site, there are several known areas of Made Ground across the site. These include the Asbestos Pit, Old and New Landform (not on WG land) and location of the former munitions filling factory (area on western side of site).

Cross sections are included within the RH reports which present a schematic of the ground conditions across the site (see figure below). This indicates that there is Made Ground to varying depths across the entire site. Pockets of Clayey Silty Gravel are encountered in a number of places on the western side of the site with Mudstone encountered beneath. (Please note that this cross section appears to be at a very exaggerated scale).

![Cross section showing ground conditions across site](taken from RH Contractors Risk Assessment report) (NB the line of the cross section is shown on the next drawing)
2.2.2 Hydrogeology

The Environment Agency (EA) – from the 1st April 2013 now known as Natural Resources Wales (NRW) within Wales - apply aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems.

From the EA website (accessed 12 April 2013) the bedrock is designated as a Secondary A aquifer. These are described by the EA as being “permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers”.

The site is not located within an EA designated Groundwater Source Protection Zone.

The plan below is taken from a RH risk assessment report and illustrates the groundwater regime that is present across the site. This is supported by the cross section above (Fig 5) which indicates that there is a groundwater divide on site due to the topography. In the eastern areas the groundwater flows towards Hazelbeach Stream which runs along the north eastern boundary. In the west, groundwater flows in a westerly direction towards the boundary stream.

![Groundwater regime across the site](image)

**Fig 6 Groundwater regime across the site (taken from RH Contractor RA report)**

The line of the cross section in Fig 5 is shown on this plan (green dashed line).
2.2.3 Hydrology

The RH reports detail that there were 18 springs located on the site with 8 of these springs and associated streams having been culverted since the refinery construction.

Surface water streams flow along the western boundary, in a southerly direction and the southern boundary in a westerly direction. Both streams flow into a reservoir located in the south west of the site.

On site there are three catch basins - the North, East and West Catch Basins. Drainage from the site flows into these basins prior to discharge from the site.

Hazelbeach Stream flows along the north eastern boundary in a south easterly direction towards the coast.

The Milford Haven waterway is located approximately 250m to the south and south-east of the site (and borders the Eastern Perimeter Road and RNAD parts of the site).

2.2.4 Topography

The eastern side of the site is at approximately 56m AOD, the land then rises to approximately 64m AOD and then moving westwards falls away to the top of the cliff at approximately 30m AOD. This is illustrated in the (very exaggerated) cross section presented in Section 2.2.1 above.

2.2.5 Environmental Sensitivity

The site lies in an Environmentally Sensitive Area, with the Milford Haven waterway being part of the Pembrokeshire Marine Special Area of Conservation (SAC) and a number of Sites of Special Scientific Interest (SSSI) running along the intertidal areas.

2.3 Previous Investigations

Investigations across the site were undertaken in 1996 and 1997 by SECOR and Dames and Moore (now URS). The Soil Remediation Plan was based on the results of these investigations. A full list of reports relating to the investigations is included in Section 2.3 of the Royal Haskoning Soil Remediation Tankstorage Site Milford Haven Final Report (dated July 2008).

Over the years additional monitoring wells have been installed across the site and it is reported in aforementioned report that some 163 monitoring wells were present on the site. The labelling of the wells provides an indication of when they were installed; the initial monitoring wells from historical investigations started with A or B. Additional wells were installed and the new wells were labelled from 100, with the hundredth number representing the year of installation (i.e. well 407 was installed in 2004).

Surface water monitoring of the streams at the boundaries was also undertaken.

Given the extent of the remediation and monitoring undertaken at the site, a data management system called REMEDY was constructed to store and manage the data. The system was used to produce tables, graphs, drawings illustrating historical data and analysis. Monitoring and investigation data from 2000 to 2003, information relating to the remediation and locations of monitoring wells, interception trenches and trial pits are all included within REMEDY.

At the time of writing this report, it was unclear whether Hyder / WG could get access to REMEDY as it is understood to be held by SEM Logistics.
2.4 Soil Remediation Plan (SRP)

Following on from the investigations and assessments undertaken by Dames and Moore / SECOR, a soil remediation plan / programme was prepared for returning the site to agricultural use. This was later revised by RH on the basis that the site would remain in industrial use. Figure 7 below indicates the areas (shown in red) which were included within the SRP and a summary of the work to be undertaken is included in the following table which was taken from the RH report *Soil Remediation Tankstorage Site Milford Haven Final Report*.

The areas owned by WG are indicated with a green star. Other areas, which were included in the SRP, are not owned by WG.

![Fig 7 Plan showing the areas (in red) that were included within the SRP (taken from RH (2008) Soil Remediation Tankstorage – Final Report). Detail regarding the areas identified is provided in the table below.](image-url)
<table>
<thead>
<tr>
<th>Area</th>
<th>Risks</th>
<th>Proposed remedial technique</th>
<th>Need for investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank 2 (area 1)</td>
<td>• potential risk to controlled waters from leaching of PAH</td>
<td>• monitoring</td>
<td>• Groundwater: PAH and TPH</td>
</tr>
<tr>
<td></td>
<td>• risk to controlled waters from leaching of phenol and SVOC</td>
<td>• if needed interception drain</td>
<td>• Soil: TPH</td>
</tr>
<tr>
<td>Tank 12 (area 2)</td>
<td>• potential risk to controlled waters from leaching of phenol and TPH</td>
<td>• monitoring</td>
<td>• Groundwater: phenol, SVOC and TPH</td>
</tr>
<tr>
<td></td>
<td>• risk to controlled waters from free product</td>
<td>• interception drain</td>
<td>• Soil: TPH</td>
</tr>
<tr>
<td></td>
<td>• risk to controlled waters from TPH and benzene in groundwater</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail loading area (area 3)</td>
<td>• risk to controlled waters from leaching of TPH and benzene</td>
<td>• excavation of accessible hot spots in fills/mae ground at</td>
<td>• Soil: occurrence of natural attenuation and possibilities</td>
</tr>
<tr>
<td></td>
<td>• risk to controlled waters from leaching in bedrock of phenol,</td>
<td>loading area</td>
<td>of in-situ remediation</td>
</tr>
<tr>
<td></td>
<td>SVOC, cobalt and nickel</td>
<td>• skimming of product layers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• risk to controlled waters from TPH in groundwater</td>
<td>• in-situ remediation</td>
<td></td>
</tr>
<tr>
<td>Rail loading south</td>
<td>• potential risk to controlled water from leaching in bedrock of</td>
<td>• interception drains or trenches</td>
<td></td>
</tr>
<tr>
<td>(area 4)</td>
<td>phenol, SVOC, cobalt and nickel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• risk to controlled waters from TPH and benzene</td>
<td>• natural attenuation</td>
<td></td>
</tr>
<tr>
<td>Process unit (area 5)</td>
<td>• risk to controlled waters from TPH and benzene</td>
<td>• monitoring</td>
<td>• Soil and groundwater: possibilities of in-situ remediation</td>
</tr>
<tr>
<td></td>
<td>• potential risk to controlled waters from leaching in bedrock of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TPH</td>
<td>• skimming of product layers</td>
<td></td>
</tr>
<tr>
<td>Contractors area (area 6)</td>
<td>• risk to controlled waters from benzene and trichloroethene</td>
<td>• in-situ remediation</td>
<td>• Soil: occurrence of hot spots with volatile chlorinated</td>
</tr>
<tr>
<td></td>
<td>• potential risk to controlled waters from leaching in bedrock of</td>
<td>• tunnel and gate systems</td>
<td>organic compounds</td>
</tr>
<tr>
<td></td>
<td>TPH</td>
<td>• natural attenuation</td>
<td></td>
</tr>
<tr>
<td>Flare Stack Stockpile</td>
<td>• potential risk to controlled waters from leaching of SVOC, TPH,</td>
<td>• renovation of interception trench</td>
<td>• Soil leaching tests</td>
</tr>
<tr>
<td>(area 7)</td>
<td>phenol, nickel, cobalt and chromium</td>
<td>• if needed in-situ remediation of hot spots</td>
<td>• Groundwater: SVOC, TPH, phenol, nickel, cobalt and</td>
</tr>
<tr>
<td>Tanks 200-205 (area 8)</td>
<td>• risk to controlled water from leaching of TPH from bedrock</td>
<td>• monitoring</td>
<td>chromium</td>
</tr>
</tbody>
</table>
This will be discussed further within the report reviews in Section 3.

2.5 Pollution Prevention and Control (PPC) Permit

Hyder has been provided with a copy of one of the permits (number GP3034TW) that currently exist at the site. The status log of the permits at the site is detailed within this permit and is summarised below.

In July 2001 a permit (BK1341) was issued to Petroplus which covered activities across the entire site (tank storage and refinery). This has periodically been varied between August 2001 and 2005 and it allows for tank storage and handling of crude oil; ex-situ biological and physic-chemical treatment of waste, including storage and pending disposal or recovery of contaminated soils and inert wastes and wastes arising from directly associated activity at the site.

In May 2010 a transfer request was completed and two separate permits generated for the site; one for 4Gas (refinery plant site (GP3034TW)) and the other for SEM Logistics (oil storage site (XP3134TC)).

The area covered by each permit is shown on the drawing below, which is taken from the permit.

The key is as follows:

- Green area is operated by Dragon LNG (permit - EA/EPR/AP3136UA/V001)
- Blue area is operated by 4Gas (permit - GP3034TW). It is noted that the area adjacent to the former RNAD site is included. This is likely to relate to planning areas / areas owned by 4Gas.
- Within red line boundary is operated by SEM Logistics (permit - XP3134TC).
Fig 8 Plan showing different permits held across the whole site

The current 4Gas permit is for the ex-situ biological and physic-chemical treatment of waste including storage pending disposal and recovery. These operations have now been completed on site and therefore this permit is likely to be no longer required and the status of it should be reviewed.

The permit includes details of operational matters, groundwater protection, waste handling / storage and monitoring. Emissions to water are included within Section 6.3 and this details the emission point, frequency of monitoring required and the allowed limits. This is reviewed in more detail in Section 3.1.5 of this report.

An improvement programme is included in Section 9 of the permit. This includes 19 requirements such as reporting, review of emissions and monitoring. Dates for completion of each item are included. It is unknown by Hyder if all these requirements have been completed.
3 REPORT REVIEWS

Section 3.1 summarises the relevant information within each of the reports which relate to the land owned by WG. For completeness and to ensure all relevant information is captured, Section 3.2 summarises information from reports which relates to land outside of WG ownership but within the Waterston refinery complex.

3.1 Land in WG Ownership

3.1.1 RH Risk Assessment Reports

This series of RH reports were prepared to provide supporting information to determine the potential risks of the site on human health, groundwater and surface water bodies following remediation and thus relate most closely to the land quality likely to be present currently on site. The reports are based on data gathered from previous intrusive investigations in 1996/1997 and 2004 and groundwater monitoring at the site between 1996 and 2008.

The risk assessments undertaken followed current UK methodology (CLR 11) with a two tiered approach comprising; Generic Quantitative Risk Assessment (GQRA) followed by Detailed Quantitative Risk Assessment (DQRA) for contaminants that are elevated. RH used RBCA (Tool Kit V2) for this assessment (human health and controlled waters) and have adapted the model to comply with UK guidance. Source, pathways and receptors are identified for each area considered. A commercial / industrial end use has been used within the risk assessments. Further details are included within the risk assessment reports. Please note that Hyder has not undertaken a detailed review of the GQRA / DQRAs modelling referred to within this report, as this is beyond the scope of this project.

Priority Rating

At the end of each review, Hyder has provided a Priority Rating based on the residual risk identified in the RH risk assessment findings. A rating is given for each receptor (human health and surface water) assessed within the report. Groundwater which is a receptor but also acts as a pathway for contamination is also given a rating.

The rating given is to aid WG with the future management of the site. The rating relates to the current condition of the site (continued industrial / commercial end use) and does not apply for risks relating to redevelopment of the site. It provides an indication of where action is required such as finding more data, undertaking monitoring or confirmation that remedial work has taken place. In the RH reports, recommendations are given. Hyder has not seen evidence of the recommendations been undertaken and therefore the priority ratings assume that the work has not been carried out.

The Priority Ratings are as follows:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Current risk identified as acceptable (for continued industrial / commercial end use) <strong>No action required at this stage</strong></td>
</tr>
<tr>
<td>Amber 1</td>
<td>Potential risk identified – <strong>No action required at this stage</strong>, but attention is required of the potential risk.</td>
</tr>
<tr>
<td>Amber 2</td>
<td>Potential risk identified which may have an impact on receptor – <strong>Action required to determine risk</strong> (e.g. further monitoring / data collection)</td>
</tr>
<tr>
<td>Red</td>
<td>Significant risks to the receptor identified. – <strong>Urgent Action required</strong></td>
</tr>
</tbody>
</table>
Groundwater in this area is found to flow in an easterly direction towards and in hydraulic continuity with Hazelbeach Stream which flows along the north eastern boundary.

**Historical Impact**

Contamination in this area comprises TPH, PAH in soil, oil sheens, BTEX, VOC in groundwater and low TPH, VOC in surface water. Source area was situated around monitoring well B11 and former wash pad area (western side of area).

Details in the report include soil (2 locations / 1996), groundwater (monitoring between 1996 and 2008) and surface water (4 monitoring points in Hazelbeach stream and 3 points in an interception trench / ditch) analytical data concerning the area.

Maximum groundwater concentrations of hydrocarbons (e.g. TPH 1323ug/l / PRO 2200ug/l / 1,1,1-trichloroethane 4100ug/l) are mainly concentrated around B11 and A2 (western side of area). Chlorinated solvents and TPH have been found in Hazelbeach Stream and ditch in the Contractors Area.

**Remediation**

In situ remediation utilising air sparging and vacuum extraction was installed in May 2003 and monitored on a yearly basis. The risk assessment focuses on potential risks due to remaining contamination after remediation.

Remediation was considered successful by RH as contaminant concentrations in the monitoring wells showed a decreasing trend.

**Residual Risk (Post Remediation)**

Conclusions from the risk assessment within the report were;

- No potential risks have been identified with regards to human health for an industrial land use scenario.
- Potential risks to Hazelbeach Stream have been identified from soil leaching from TPH and PAH from particular areas (A4 and C10).
- Potential risks to Hazelbeach Stream have been identified from MTBE, TPH and chlorinated solvents in groundwater.

The report recommends that further groundwater and surface water monitoring with respect to above contaminants is undertaken to validate the outcome of the risk assessment and the requirement for continuation of active remediation. It is unknown by Hyder whether this has been carried out.

### Priority Rating

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Amber 2</td>
<td>Amber 2</td>
</tr>
<tr>
<td>Current risk identified as acceptable.</td>
<td>Groundwater impacted. Further monitoring required to determine risk to Surface Water receptor</td>
<td>Potential risk identified from soil leaching (TPH / PAH) and groundwater (MTBE / TPH / chlorinated solvents), further monitoring required</td>
</tr>
</tbody>
</table>

---

**Royal Haskoning (Sept 2008) Quantitative Risk Assessment of the Process Area Milford Haven Tankstorage site (GORL) Draft Report v1.0 (9S7043)**

The area covered by this assessment is detailed in the figure below (within red boundary area) which is taken from the report. This area is located between the Railyard and the Contractors area which is discussed above.

**Fig 10** Plan showing Process Area

The Process Area is located on the top of the hill and a groundwater divide is found to exist within this area. This is shown in the cross section in Section 2.2 above. To the west, groundwater flows in a south westerly direction and discharges into the boundary stream (1000m away) within the Crude Tank Park area. To the east groundwater flows in an easterly direction to the Hazelbeach Stream (70m away). Groundwater is thought to be in hydraulic conductivity with both streams.

Several investigations have been undertaken across this area between 1996 and 2003 including 6 trial pits and 7 groundwater monitoring wells installed in 1996 /1997. Additional groundwater monitoring wells (12) were installed in 2003, however the monitoring round in 2008 was only on 2 selected monitoring wells.
Historical Impact

TPH contamination was encountered in soil samples (maximum concentration 2900mg/kg) and TPH, PAH, BTEX and MTBE was encountered in groundwater. Surface water is not considered within this report as it has been assessed within the Contractors report which is summarised above.

Remediation

Remediation in this area included vacuum extraction from 9 monitoring wells. Since the start of the remediation 3723m$^3$ of hydrocarbon compacted groundwater has been extracted and discharged into the site oil-water system. A total of 1763kg of oil has been separated using the remediation unit. A decreasing trend was observed in 2005 and due to mechanical problems the remediation system was only operational for 3 months in 2006. Repairs of the system were proposed but due to decommissioning of the process plant remediation was not continued.

Residual Risk (Post Remediation)

Conclusions from the risk assessment report were;

- No potential risks have been identified with regards to human health for an industrial land use scenario.
- Potential risks to Hazelbeach Stream have been identified from soil leaching from TPH, however the risks are considered to be low as the impact to Hazelbeach Stream is likely to take over 1000 years.
- Potential risks to Hazelbeach Stream (to the east) have been identified from TPH in the groundwater and in the boundary stream (to the west) from TPH and PAH contamination in groundwater, however the risks are considered to be low as the impact to both the surface water receptors is likely to take over 1000 years.

The report recommends that a further groundwater monitoring is undertaken to validate the outcome of the risk assessment. It is unknown by Hyder whether this has been carried out. The report however concludes that the soil and groundwater in the remediated area poses no significant risk to site end users (based on an industrial end use) and the surrounding environment.

Priority Rating

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Amber 2 Groundwater impacted. Further monitoring required to validate / determine risk to Surface Water receptor</td>
<td>Amber 1 Potential risk identified from soil leaching (TPH) and groundwater (TPH / PAH), however risk considered low as impact is likely to take over 1000 years</td>
</tr>
<tr>
<td>Current risk identified as acceptable.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The area covered by this assessment is detailed in Figure 11 below (within red boundary area) which is taken from the report. This area is located on the western side of the Process Area which is discussed above.

**Fig 11  Plan showing Railway Yard**

**Environmental Setting**

The groundwater in this area flows in a south westerly direction towards the Crude Tank Park and discharges in the boundary stream (800m away). The groundwater is considered to be in hydraulic continuity with stream.

**Site Investigation**

Several investigations have been undertaken across this area between 1992 and 2002 including 22 trial pits in 1997 with 10 of the pits concentrated around the loading gantry. Three of the pits in the area of the rail tanker loading gantry were extended into boreholes. 15 groundwater monitoring wells were installed in 2000 and monitored in 2001. In 2002 a more detailed investigation was undertaken to assess the extent of contamination and location of any hotspots.

**Historical Impact**

The main source of contamination was the rail tanker loading point where made ground was found to be contaminated. TPH concentrations (3,000 – 11,000mg/kg) were elevated in the central area in rock samples with low concentrations of BTEX, metals and SVOCs recorded in 2 samples.

Observations from analysis of groundwater monitoring is taken from the monitoring in 2001 and 2006 and divided into the north and south rail loading areas. In the northern part of the area, slightly elevated mineral oil concentration was identified in BH105 in 2001, however in 2006 EPH, PRO, Benzene and MTBE was found to fluctuate. Monitoring well A52 downstream of process area had a VOC concentration of 17.9ug/l. In comparison to 2005 results show an increase of EPH as recorded in 211 and 501. No free product was recorded in 105 and 211 but 20mm was recorded in 501.

In the southern part, mineral oil contamination was encountered in 3 out of 6 wells (maximum concentration 9100ug/l). Concentrations in 2001 had significantly increased in A44 (western side near tank) in comparison to year 2000 results. BTEX only slightly elevated / VOC concentrations between 5.8 and 38.4ug/l. From the 2006 monitoring report, limited monitoring has only been undertaken
since 2005 (3 wells upstream, 2 wells downstream), increase in EPH concentration in 355 since 2003 A43 illustrates a decrease after an increasing trend with 367 a decreasing trend of EPH. Free phase (15mm) was only recorded in well 355.

Surface water is not considered within this report as it has been assessed within the Crude Tank Park Area.

**Remediation**

Remediation system in this area comprised infiltration and interception trenches with 3 interception trenches and one infiltration trench installed. System was started in 2006 and groundwater was extracted from 4 trenches and infiltrated into 1 trench after being purified by oil / water separator. From start of remediation 16152m$^3$ water extracted by 2008 and 1244kg oil separated.

**Residual Risk (Post Remediation)**

Conclusions from risk assessment report were:

- Potential risks from TPH have been identified surrounding BH351 with regards to human health for an industrial land use scenario. This risk is driven by inhalation of outdoor vapour from groundwater. No DQRA was undertaken for this risk as RH recommended that action was required to reduce the risk. Potential human health risks are also present from TPH and chloromethane from inhalation of soil outdoor vapours in particular areas.

- Potential risks to the boundary stream have been identified from soil leaching from TPH.

- Potential risks to boundary stream have been identified from TPH and PAH contamination in groundwater, however the risks are considered to be low given the time to impact the boundary greatly exceeds 1000 years.

The report states that based on the soil sample results taken before the remediation and from the assessment undertaken, it is concluded that soil in specific areas should be excavated for off-site disposal to reduce the risk to controlled waters and human health. It then states that in respect of the remedial work done in this area, this outcome is very unlikely and it is recommended to further assess this by taking of additional samples.

A further recommendation within the report was that free phase product should continue to be removed from BH210 and BH351 using remediation system to improve groundwater quality and reduce risks to receptors.

It is unknown by Hyder if these recommendations were carried out.
Priority Rating

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red (due to uncertainties)</td>
<td>Amber 2</td>
<td>Amber 2</td>
</tr>
<tr>
<td>Potential risks identified from groundwater contamination (TPH / chloromethane) via outdoor inhalation pathway. Additional sampling recommended to ensure that contaminated areas have been removed during remedial works – confirmation required</td>
<td>Groundwater impacted (TPH / PAH) Free phase product should continue to be removed to improve groundwater quality / reduce risk to receptors – confirmation required</td>
<td>Potential risks identified from soil leaching (TPH) and groundwater (TPH / PAH). Risk from groundwater is low as impact is likely to take over 1000 years. Risk from soil leaching should be further investigated – likely that contamination has been removed during remedial process – confirmation required.</td>
</tr>
</tbody>
</table>

**Royal Haskoning (April 2006) Risk assessment of the Flare Stack Stockpile area Tankstorage Milford Haven (GORL) Final Report v1.0 (9R1883)**

This report was prepared to provide supporting information to accompany the remediation validation report to enable the regulators to give their approval for this part of the site. A validation completion report was prepared by Celtic Regeneration in April 2002 (this has not been reviewed by Hyder), however as part of the RH report sampling has been undertaken to confirm the findings of the validation report.

The area covered by this assessment is detailed in the figure below which is taken from the report.

**Fig 12 Plan showing Flare Stack Stockpile area**

**Historical Impact**

This area was historically used for the deposition / stockpiling of waste materials generated from the site and was known to contain materials including building rubble, tarmacadam and chemical waste (silty deposits infused with heavy mineral oil / tank bottom sludges). TPH concentrations of 84,000mg/kg had been recorded with heavy metals, SVOCs and PAH concentrations “low to very low”.

This area was remediated in conjunction with the API Separator area which is to the south and not in WG ownership. The works included excavation of contaminated material, remediation via the on-site bio-treatment cell and replacement of clean separated materials.
Remediation

A summary of the Celtic Validation report is included in the RH report which is included below. (Hyder has not seen the Celtic report). Works was carried out between August and December 2001. Total area excavated was approximately 13,750m$^2$. A summary table is included in the RH report which details the activities and volumes of material excavated. This includes volume of soil removed to biotreatment area (TPH > 1500mg/kg) 13,437m$^3$ and volume of clean material (TPH <1,500mg/kg) excavated and used as backfill at Flare Stack Stockpile (FSS) or Tank 12 on site – 17,196m$^3$ (FSS) and 12,496m$^3$ (Tank 12).

Residual Risk (Post Remediation)

On completion on validation works, Celtic undertook a validation survey of the material used as backfill. Approximately 1.4% of validation samples exceeded 1,000mg/kg however this was deemed acceptable for the works to be regarded as complete and no further impact would occur.

Further sampling was undertaken by RH prior to the preparation of the risk assessment report. 8 trial pits across the FSS area to characterise the soils, samples taken at varying 4 depths to 3.5m bgl and analysed for TPH (soil / leachate analysis). Concentrations were below the limit of detection, however low level concentrations were recorded for aliphatic and aromatic fractions (C12-16 and C21-C35).

Groundwater quality was assessed by comparing upstream and downstream analysis results. The results demonstrate that concentrations upstream are higher than those downstream which suggests that any potential contaminant loading from the FSS area is not resulting in an overall deleterious effect on the groundwater quality. Concentrations of aliphatic / aromatic hydrocarbons were below the laboratory detection limit. FSS area is not having a noticeable impact to the local groundwater quality.

The risk assessment report concludes that the FSS area is not considered to present a significant risk to the surrounding environment (including groundwater) or future continued industrial use. The risk assessment demonstrates that the remediated soils do not pose a significant risk to site end users / underlying groundwater and adjacent water body.

Priority Rating

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Current risk identified as acceptable.</td>
<td>Current risk identified as acceptable.</td>
<td>Current risk identified as acceptable..</td>
</tr>
</tbody>
</table>

A combined plan showing the areas and Priority Ratings is included in Appendix B for reference.
3.1.2 Progress Reports / Reviews

Hyder has been provided with a series of Progress Reports that have been prepared by RH detailing the remediation works that has been taken over the reported year. These reports were then reviewed by the Environmental Expert Team (EET) to determine if they met the set requirements. These have not been reviewed in detail / summarised below as it would be very repetitive and the outcome of the remediation works is the main aspect that informs WG’s future constraints. This is detailed in the following reports.

**Royal Haskoning (July 2008) Soil Remediation Tankstorage Site Milford Haven (GORL) Final Report (9S7043)**

This report evaluates the remedial activities undertaken at the site since the drafting of the Soil Remediation Programme (see Section 2.4 above) in 1998 until September 2008. Progress reports have been prepared on a yearly basis and the July 2008 report brings all the information together after 10 years when the remediation programme had come to an end.

Background information is provided followed by a description of the activities undertaken for each area and the results of remediation.

**Monitoring**

An intensive monitoring programme was undertaken across the site for 4 years. Since 2005 monitoring has focussed on 4 main items; remediation processes, migration of contaminations, natural attenuation and further investigation in accordance with the interim evaluation report. Monitoring of groundwater and surface water of site boundary streams was undertaken.

Information on the monitoring is provided in annual monitoring reports which are discussed in Section 3.1.3.
**Remediation Activities**

All areas where remediation took place are included in the summary table below, however areas in **Bold** are on WG owned land. Figure 7 in Section 2.4 shows the locations of the site (in red) which were involved with the Soil Remediation Plan (SRP).

Table 3.1 Summary of Remediation undertaken as part of SRP separated into each area

<table>
<thead>
<tr>
<th>Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank 2</td>
<td>Free product has been removed from BH101 by regular pumping (total 136.3kg removed). Since 2006 oil removed occasionally.</td>
</tr>
<tr>
<td>Interception Trenches</td>
<td>Records are provided of volume and discharge rates from the interception trenches (locations shown below). This indicates that a total of 177,186m$^3$ was removed. No records are provided after 2006.</td>
</tr>
<tr>
<td>Railyard</td>
<td>In 2005 a system comprising infiltration and interception trenches was installed at the southern part of the railyard and remediation commenced in 2006. Groundwater was extracted from 4 trenches and infiltrated into 1 trench after being purified by an oil/water separator. After October 2006 the water was discharged via the oily water system instead. Approximately 1244kg of oil was separated from groundwater during process which was completed in Sept 2008.</td>
</tr>
<tr>
<td>Process Area</td>
<td>Vacuum extraction undertaken using 9 monitoring wells. 3723m$^3$ of groundwater extracted and 1763kg oil separated using on-site remediation unit. System has not worked since first half of 2006.</td>
</tr>
<tr>
<td>Contractors Area</td>
<td>In-situ air sparging system (extraction and exhaust air treatment) to treat VOC contaminated groundwater. System ran from May 2003 until Nov 2005 when it was stopped to see effect on groundwater quality. System was later restarted and ran until 2008 (with a number of shutdowns due to technical problems). Results showed a decreasing trend in VOC concentrations.</td>
</tr>
<tr>
<td>Excavations</td>
<td>Two areas – <strong>Flare Stack Stockpile</strong> (on WG land) and <strong>API Separator Area</strong> (outside WG land) - were contaminated mainly with petroleum hydrocarbons. Excavation, screening, transport and stockpiling undertaken into 2 areas – clean material or to an on-site storage and biological treatment facility. Undertaken between August and December 2001. A completion report covering both areas was prepared by Celtic which provides details of validation and extent of excavations and backfilled materials. This has not been reviewed by Hyder. It is concluded within this RH report that all contaminated material has been removed from both areas. <strong>Flare Stack Stockpile</strong> – total cut volume 45303m$^3$.  <strong>API Separator Area</strong> – Product release trenches were constructed along the northern and western sides of the newly constructed API lagoon. Total volume removed...</td>
</tr>
</tbody>
</table>
13000m³ (mainly from centre and southern boundary).

| Old and New Landfarm | In 2001 remediation was implemented by ploughing / adding nutrients on both landfarms. After further investigation / assessment, remediation took place between July and September 2003 with soil excavated from both (New - 19500m³ and Old - 5600m³). Soil was classified into 3 categories: Grade A – TPH concentration <1,500mg/kg – soils could be re-used on site / redistributed over landfarm. Grade B – TPH concentration between 1,500mg/kg and 10,000mg/kg – biotreatable. Grade C – TPH concentration >10,000mg/kg which was disposed off site. (15650 tonnes removed to Pwll-fawatkin landfill). Validation report was prepared by RH in 2004. This has not been reviewed by Hyder. |
| East Catch Basin | Remediation undertaken between May and June 2004 with a total of 3650m³ of contaminated (TPH / VOCs) sediment being removed to off-site landfill. Validation report was prepared by GORL in 2004. This has not been made available for review. |
| Asbestos Tip | Discussed in SLR report in Section 3.1.7 below, however concluded in validation report that remedial activities at the asbestos tip were executed “according to plan”. |
| Bio-stockpile / treatment area | Area south of contractors area was prepared for stockpiling and treatment of contaminated soils. Installed on an old concrete floor, two layers of sand with drainage systems and HDPE liner in between. Approximately 14000m³ of excavated soils was held within the biostockpile/treatment area. By March 2008 8500m³ of soil had been treated to the target concentration of 1500mg/kg. Full details of activities within the bio-treatment cell is included within the RH report. A completion report prepared by Celtic but has not been reviewed by Hyder. Photo of bio treatment area taken from progress report 2005 / 2006 |

The close out of this report states that

..there still are contaminations at the Milford Haven Tankstorage site. With exception of the area of the tank 115 incident, no significant elevated levels of contaminations are present in the monitoring wells along the boundary of the site. However it can be concluded that the contaminations present are under control and that the goals set in the remediation plan are achieved.
Below is summary table from the report which concludes the status of remediation in each area and the RH recommendations. These include continued removal of free phase product, monitoring and continuation of remedial measures. It is unknown by Hyder if the recommendations have been carried out since the issue of this report in 2008.

<table>
<thead>
<tr>
<th>No.</th>
<th>Area</th>
<th>Conclusion</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tank 2</td>
<td>Remediation and monitoring was executed according to plan. Only one well is contaminated (101).</td>
<td>It is recommended to continue regular removal of free product.</td>
</tr>
<tr>
<td>4</td>
<td>Tank 12</td>
<td>Contamination in tank bund 12 is concentrated around one well (103) and fluctuates. The surrounding monitoring wells do not show elevated concentrations.</td>
<td>No further action recommended</td>
</tr>
<tr>
<td>5a</td>
<td>Rail Loading North</td>
<td>In general contaminants are decreasing. Some concentrations fluctuates.</td>
<td>No further actions required, monitoring is recommended</td>
</tr>
<tr>
<td>5b</td>
<td>Rail Loading South</td>
<td>In general a decreasing trend was observed. Contaminated water and product is being removed by interception trenches.</td>
<td>Remediation measures are installed. It is recommended to continue groundwater extraction from the installed trenches.</td>
</tr>
<tr>
<td>8a</td>
<td>Process Area</td>
<td>The contaminations at the process area are still present. With the except of some wells (i.e. B2) it can be concluded that the concentrations are low.</td>
<td>The remediation system(s) were removed due to decommissioning of the process plant. No further action in required. Continue monitoring is recommended</td>
</tr>
<tr>
<td>8b</td>
<td>Contractors Area</td>
<td>In general a decreasing trend was observed. Most recent results show no significant elevated levels of VOC in interception trench C or Haze/Beach stream.</td>
<td>It is recommended to continue aeration of trench C and to monitor the VOC contamination.</td>
</tr>
<tr>
<td>8c</td>
<td>Stockpile and biotreatment facilities</td>
<td>No contaminants present</td>
<td>Bio-treatment facility remains operational for the last batch. However remaining soil to be treated seems below target level.</td>
</tr>
<tr>
<td>12 and 14</td>
<td>Tank 200-205 and Tank Park</td>
<td>In general EPH concentration in wells located at the source are decreasing. However increasing concentrations are identified in the wells at the boundary of the tank park. Especially well 516 show a strong increase of EPH/TPH</td>
<td>It is recommended to continue monitoring. Attention is required for the increase of contamination in well 516.</td>
</tr>
<tr>
<td>14a</td>
<td>API-Separator</td>
<td>The interception trench successfully prevents migration of EPH to offsite receptors. However EPH is increasing.</td>
<td>It is recommended to continue monitoring and to keep Trench F (API) operational.</td>
</tr>
<tr>
<td>14b</td>
<td>Site Borders</td>
<td>No elevated concentrations of EPH, PRO or BTEX were identified, with the exception of monitoring wells, 216, 283 and A9.</td>
<td>It is recommended to continue monitoring.</td>
</tr>
<tr>
<td></td>
<td>Surface water</td>
<td>Generally contaminant concentrations do not or only slightly exceed the detection limit. With the exception of SW4 located at the south east.</td>
<td>It is recommended to continue monitoring.</td>
</tr>
<tr>
<td></td>
<td>Monitoring NA</td>
<td>The NA conditions for degradation of petroleum hydrocarbons are favourable.</td>
<td></td>
</tr>
</tbody>
</table>
3.1.3 Monitoring Reports

Annual monitoring reports have been prepared between 2001 and 2008. Over the years, additional monitoring wells were installed across the site. The general conclusion from each of the reports over the years were that the Soil Remediation Plan and subsequent monitoring should continue as planned.

Below is a review of the last monitoring report covering 2007 – 2008 as this provides an overview of the situation after specific remedial works (as described earlier) and the extensive monitoring programme. It is assumed that monitoring across the site has not continued on such a scale since the publication of this report.

The objective of the monitoring was to provide information about the changes of groundwater quality across the site. After 4 years of intensive monitoring in 2004, it was recommended to focus the monitoring more specific to initial trends and remediation results. Monitoring focussed on remediation processes, migration of contaminants and natural attenuation.

The 2007 / 2008 report is the last monitoring report prepared for the Soil Remediation Plan.

In total 53 monitoring wells were sampled in 2007 (October / December) and an additional 24 in 2008 (June) which are shown in Fig 13 below. 12 surface water samples were taken including from a pond and stream to the west of the site and 12 samples were taken from interception trenches across the site.

Chemical analysis included EPH (C10-40), BTEX, MTBE, VOCs and parameters to indicate natural attenuation.
Fig 13  Plan showing locations of monitoring wells
The results are discussed for each area in turn which is summarised below. Graphs and results are included within the RH report. Please note that not all areas are under WG ownership. Those in Bold are on WG land.

<table>
<thead>
<tr>
<th>Area</th>
<th>Monitoring Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tank 2</strong></td>
<td>Based on field and analytical results it was concluded that the concentrations of EPH and product thickness in well 101 in 2007 was decreased in comparison to the 2006 results. Hyder note that the results presented in table in report show an increase in EPH results (2006 – 1231ug/l and 2007 – 1800ug/l). TPH concentration in 2008 (7900ug/l) was lower than result in 2002 (13166ug/l).</td>
</tr>
<tr>
<td><strong>Tank 12</strong></td>
<td>Monitoring focussed on 103 (source of contamination), 503 and 504 (monitor migration). EPH concentration in 103 has increased in 2007 compared to 2006 result, however results in 2008 indicate a decrease again. Free product was not observed. Concentrations in 503 and 504 were below detection limit in 2007 as in previous years.</td>
</tr>
<tr>
<td><strong>Rail Loading North</strong></td>
<td>Monitoring focussed on 105, 211 (centre of contamination) and 501 (monitor migration). Results shown to fluctuate however a strong increase of EPH in 105 in 2008 indicated on graph. MTBE below detection in all wells with only Benzene detected in 105. No free product in 105, but 6cm recorded in 501 in 2007. This was only identified as an oil sheen in 2008.</td>
</tr>
<tr>
<td><strong>Rail Loading South</strong></td>
<td>Downstream monitoring wells seem stable or show a decreasing trend of EPH, whilst the upstream well 325 shows an increase in EPH.</td>
</tr>
<tr>
<td><strong>Process Area</strong></td>
<td>4 wells monitored in 2007. Concentrations in B2 were found to be relatively high however no indication of free product was recorded. Other wells found to have low concentrations.</td>
</tr>
<tr>
<td><strong>Contractors Area</strong></td>
<td>6 wells monitored. Elevated concentrations (Benzene, VOC, GRO) were identified in B11 at the source of the contamination (south of former cleaning area) but generally the concentrations are decreasing which is a continuation from previous monitoring rounds.</td>
</tr>
<tr>
<td><strong>Product Tank Park</strong></td>
<td>Monitoring was focussed on wells where high concentrations (EPH, GRO, mineral oil and MTBE) were recorded in the plume (403, 222, 516 and 226A) and boundaries of the tank park. EPH was decreasing in wells up to 2007, however in 2008 a concentration of 610mg/l TPH was recorded and a free product of 86cm in well 516. Free product removed by vacuum truck by SEM Logistics. In wells located near to the boundaries, an increase in EPH was recorded in 2 wells (226B and 226C) whilst a decreasing trend was indicated in the others. Further monitoring was undertaken in 2008 which indicated free phase in a number of wells. It states that the results indicate a contaminated area which is stable with slightly decreasing levels of contamination at the boundary of the plume.</td>
</tr>
<tr>
<td><strong>API Separator Area</strong></td>
<td>One well sampled 322. EPH concentration was found to be increasing and 2cm of free product was confirmed to be present in 2007 (an increase from 0.5cm in 2005).</td>
</tr>
<tr>
<td><strong>Bioretreatment facility</strong></td>
<td>To comply with the IPPC permit monitoring was undertaken in 3 wells (112, 115 and A6) and all parameters were found to be below detection limit.</td>
</tr>
<tr>
<td><strong>Site Border</strong></td>
<td>Monitoring wells surrounding the contamination sources were selected to monitor the site borders. In wells 226a, 226b and A9 (very high) (all along eastern boundary near FSS) elevated EPH was identified. In A9 free product</td>
</tr>
</tbody>
</table>

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Hyder Consulting (UK) Limited-2212959
18cm was observed – this may relate to the tank 115 incident. All other results (EPH, PRO and BTEX) from boundary wells sampled in 2007 and 2008 did not identify significant groundwater concentrations.

| Surface Water | SW4 (discharge water from south eastern boundary near to outfall of the East Catch Basin) indicates elevated EPH (470ug/l) in 2007. SW2 (western boundary), SW5 (Hazelbeach Stream) and SW7 (near to asbestos pit) showed slightly elevated TPH results in 2008. Migration of contamination from the contractor’s area was monitored from 4 locations but no significant elevated levels of VOC or other contaminants were identified. |
| Interception Trenches | These were monitored in 2007 to assess the remediation. Trench C in the contractor’s area had EPH and VOC concentrations below detection or slightly elevated values. Some trenches had been destroyed due to developments on site. Trenches B and D showed no elevated contaminants. Trenches in the rail yard showed elevated EPH concentrations. Trench 3a showed elevated BTEX and MTBE. |
| Natural Attenuation | Selected wells based on 2006 results and focuses on locations from Tank Park and Process Unit. In the reference well 506 based on the results of the macro parameters it was concluded that the natural redox conditions are oxic, allowing aerobic degradation to take place when sufficient nutrients are available. When results from the monitoring wells where petroleum hydrocarbon contamination is present were compared to reference well, it is concluded that degradation can take place in a number of wells (109, 222 and 304). |

The report concludes by stating:

...that there still are groundwater contaminations at the tank storage site. Decreasing trends were observed at several locations but also increasing trends. The contaminants in some wells fluctuate, but in general it can be concluded that the contaminants are more or less stable. More important is that ...... no significant elevated levels of contaminations are present in the monitoring wells along the boundary of the site.

It was recommended that the current users of the site continue monitoring and that trench F at the API separator area is kept operational and remedial operations continue at the railyard and trench C.
3.1.4 Environmental Expert Team (EET) Sign Off

Hyder has been provided with the Environmental Certificate (dated September 2008) which was signed by the EET (URS / Witteveen-Bos) which confirms that the remedial programme has been undertaken in accordance with the Remediation Agreement.

**Environmental Certificate**

We refer to the Remediation Agreement dated 7 September 1998, made between Chevron North Sea Ltd (formerly Chevron UK Ltd) and GORL Ltd (formerly Gulf Oil Refining Ltd), (the Remediation Agreement).

This document constitutes the Environmental Certificate issued pursuant to the Remediation Agreement.

The Remediation Agreement included the appointment of an Environmental Expert. The duties of the Environmental Expert were specifically defined in the document 'Instructions to the Environmental Expert Team' and communicated to the latter by e-mail dated 15 June 2000.

We, being the Environmental Expert (as defined in the Remediation Agreement), confirm that the remedial programme has been undertaken by GORL Ltd pursuant to the Remediation Agreement.

For the purposes of this confirmation, it can be stated that:

a) The Remediation Plan (Pomacor 1996) was accepted as being suitably robust and the remediation measures were considered sufficient to mitigate the (potential) risks related to historical soil and groundwater contamination from the perspective of the prevailing legislative requirements for an (ongoing) operational industrial facility.

b) As such, it was considered likely that implementation of the Plan would broadly satisfy the statutory requirements of the competent Authority, the Environment Agency, based upon existing legislation.

c) As a result of the discussions between both parties that took place subsequent to signing of the Agreement, the Environmental Expert Team understands that Petroplus was allowed by Chevron to execute this Remediation Plan as a risk-based remediation plan based on the intention to continue to use the site for industrial purposes. This contrasts with the assumption that the site would revert to agricultural land use for which the risk based clean up levels set out in the Remediation Agreement were originally intended, and as such, are no longer applicable. It was further noted that the Remediation Plan stated that the scope of work may vary at the discretion of the Environmental Expert.

d) Therefore, the Remediation Plan that was adopted, satisfied the intention for Petroplus to use reasonable endeavours to achieve the criteria for ongoing industrial use of the site. These criteria are based on the assumption of an acceptable level of risk with respect to residual soil and groundwater contamination that can be managed through the implementation of appropriate ongoing procedures.

e) Petroplus/NGO together with Royal Haskoning as advisor have executed remediation measures from the start of the Remediation Plan until September 2008, and have produced yearly Monitoring Reports and Remediation Progress Reports describing the monitoring and remediation results and progress;

f) The EET has reviewed the remediation activities on the basis of the reports presented and site visits, 8 in total, and has presented their review findings and conclusions in their EET Review Reports and in the EET meetings, 8 in total, on site.

g) Based on this information, the EET has come to the conclusion that the works undertaken are consistent with achieving the objectives of the Remediation Plan and according to (d) above and that the expenditure of the $1 million has been appropriately incurred for the purposes of the Remediation Plan.

For and on behalf of the Environmental Expert

---

[Signatures]

For URS Corporation Ltd

Dr. Richard Beowers
BSc, PhD, CEng, MInstMC

For Witteveen+Bos

William Hendriks
MSc

Jeanne Qua
MSc
3.1.5 Dismantling Report

*Royal Haskoning (Sept 2011) Milford Haven Refinery Plant Dismantling Final Report (9S5742)*

This report provides information about the dismantling of the former refinery plant by Bosicor, who bought it from GORL in 2005. Bosicor was responsible for the disassembling or demolition of all the plant and facilities to ground level and removal from site. Work began in 2007 and was completed by January 2011. Under the Asset Purchase Agreement, hazardous materials were the responsibility of the seller (4Gas) excluding asbestos which remained Bosicor’s responsibility. Other clearance items carried out by 4Gas continued until autumn 2011 RH was employed by 4Gas to provide independent specialist advice and guidance to report on health and safety, environmental issues and liability.

Details included in this report include a summary of dismantling programme (ie what happened when), Health and Safety, Pollution Control and Waste Management and Auditing. Relevant points concerning WG land are discussed below.

A PPC permit was in place to undertake the work – this is discussed in more detail in Section 2.5. Pollution prevention measures on site included the following;

- **Oily Water Drainage System** During the operational lifetime of the refinery a concrete washpad was used for washing down vehicles and plant that were contaminated with oils. This was connected to a subsurface water drainage system which was used to collect ground level surface water from across the refinery site. The system carried the water to the API oil-water separator (on SEM Logistic land) which drains to the East Catch Basin.

  As the condition of the drainage system was unknown, during the demolition, it was not permitted to allow oil spillages to enter the system. The washpad was sealed by 4Gas and was used as a sealed bunded area for storage of oily and other liquid wastes contained in intermediate bulk containers (IBCs) and drums.

  Any minor oil spillages which occurred during demolition were dealt with by local measures to collect and remove the oil contamination.

Below is a plan showing the location of the wash pad within the Contractors Area.

![Fig 14. Plan showing the location of the wash pad within the Contractors Area of site](image-url)
During dismantling process Measures were put in place to ensure that contamination did not occur during the demolition. Measures implemented included risk assessments prior to opening any equipment that was known to contain or suspected of containing hazardous liquids. Facilities for dealing with spills / leaks etc were put in place before dismantling occurred.

Solid hazardous waste was stored in plastic or metal containers / barrels.

Contaminated water present on site e.g. within the caustic soda tank (Plant 36), sulphur pit (plant 9) and amine sump and were analysed prior to disposal via drainage system (at a controlled rate) if appropriate.

Waste. Within the dismantling report is a summary of hazardous waste arisings and their subsequent disposal is provided.

A completion certificate (included in Appendix 1 of report) was issued to Bosicor and signed by 4Gas and Royal Haskoning dated January 2011.

Within the report it stated that 4Gas proposed to remove the concrete roof and walls of the sulphur tank and remove the heating coils by mechanical plant for disposal off site to avoid the need for entry into the emptied tank. It has been confirmed by current personnel that this has not occurred to date. The sulphur pit is regularly checked for ingress of water. All liquid and elemental sulphur has been removed and heating coils have been decommissioned.

### 3.1.6 Discharge (Release Point E) Monitoring

Monitoring data is available from Release Point E which is located on the northern part of the site (North Catch Basin) near to Hazelbeach Stream. Monitoring of this discharge point is part of the current permit requirements.

Data is available from June 2010 to 2012 which includes flow rate, oil concentration, pH and chlorinated solvents concentration. From the permit (reviewed by Hyder) the flow rate is to be recorded 3 times a week, with pH twice a week and Total Oil on a weekly basis. Chlorinated Solvents are to be recorded every 2 months.

On review of the results the following is observed;

- All pH values recorded are within the specified limits (minimum 6 and maximum 9)
- Flow rates are generally low. Maximum recorded over the 3 year period is $64 \text{m}^3/\text{day}$ in October 2011.
- Total Oil concentrations are generally below limit of detection (1mg/l) with a maximum value of 5mg/l recorded in December 2012. All results are below the permit limit of 10mg/l.

Hyder note that the permit concentration of 10mg/l for Total Oil is high compared to Water Quality Standards (WQS) for total petroleum hydrocarbons (TPH) which is 10 µg/l (ie 1000 times lower). The permit limits are therefore unlikely to be compatible with WQS required by NRW / EA for future development of the site.

VOC data is available on a separate spreadsheet between February 1999 and December 2012. The VOC suite includes the following compounds:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl Chloride</td>
<td></td>
</tr>
<tr>
<td>Chloroethane</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td></td>
</tr>
<tr>
<td>1,1-Dichloroethene</td>
<td></td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td></td>
</tr>
<tr>
<td>MIBK</td>
<td></td>
</tr>
<tr>
<td>Trichloroethene</td>
<td></td>
</tr>
<tr>
<td>Cis-1,2-Dichloroethene</td>
<td></td>
</tr>
<tr>
<td>Isopropylbenzene</td>
<td></td>
</tr>
<tr>
<td>n-Propylbenzene</td>
<td></td>
</tr>
<tr>
<td>1,2,4-Trimethylbenzene</td>
<td></td>
</tr>
<tr>
<td>sec-Butylbenzene</td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td></td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td></td>
</tr>
<tr>
<td>Methylene Chloride</td>
<td></td>
</tr>
<tr>
<td>tert-butyl methyl ether</td>
<td></td>
</tr>
<tr>
<td>Freon 113</td>
<td></td>
</tr>
</tbody>
</table>
The maximum total VOC concentration is 0.25mg/l which was recorded in August 2011.

From the results 1,1-Dichloroethane has the highest concentration (95µg/l), with 1,1,1-Trichloroethane recording 74µg/l. The majority of the results are less than 10µg/l. There is no VOC threshold limit set within the permit.

Hyder note that the highest concentration of 1,1,1 Trichloroethane is below the WQS for freshwater which is set at 100µg/l. No WQS value is available for 1,1-Dichloroethane, however a value of 10µg/l is available for 1,2-Dichloroethane which the maximum concentration of 1,1-Dichloroethane detected on site exceeds.

Below is a graph taken from the provided Excel spreadsheet which illustrates the fluctuations of the VOC concentrations over the monitoring period.

![Graph showing VOC concentrations within Emission Point E over monitoring period](image-url)
3.1.7 Asbestos

An asbestos register and location plan have been provided. The last inspection date was April 2012. The areas within WG ownership include:

- Old rail engine shed (4th Street)
- Mower shed and adjoining shed
- Refinery workshop north, and
- Refinery workshop south.

These all concern corrugated sheeting within the buildings. Some damage is noted but the asbestos / buildings are monitored on an annual basis to ensure that the ACM material has not deteriorated.

The other main area on site where asbestos is encountered is the Asbestos Pit which is located on the western side of the railway yard / head as shown in the figure below. This is a pit which was historically filled with asbestos waste and covered with earth. It is fenced off with a chain linked fence and is monitored on a regular basis to ensure no damage has been caused to the fence or covering of the pit.

**Fig 16 Plan showing location of asbestos pit**

A report was prepared by SLR in 2002 (Ref 2) detailing the design of the encapsulation of this area and the Construction Quality Assurance (CQA) for the system. The encapsulation system comprises the installation of a geotextile, geomembrane, geocomposite layer, the provision of protection soils and a fence surrounding the area.

Below is a cross section through the area showing the encapsulation details. Further information on the construction of the installation details is provided within the report.
A report was prepared by Redhills in 2012 for Kier which details a Management Survey that was undertaken for the presence of asbestos containing materials (ACMs). ACMs (mainly Chrysotile) were encountered in the following locations:

- Rail Yard Blocks 1 and 4
- Sub-station 4
- Warehouse 1 and 2.

This was in items such as ceiling panels, spark arresters, floor tiles under sheet and roof sheets. In all cases the recommendations were to manage the ACMs.

Full details (locations / photographs) are included within the report.

### 3.1.8 Parsons Brinckerhoff (PB) report

**Parsons Brinckerhoff (June 2012) Environment Report Land adjoining LNG Terminal, Waterston, Milford Haven (3511939A-HHC/2)**

PB was commissioned by Department for Business, Enterprise, Technology and Science (BETS) at the WG to conduct a desktop engineering appraisal to identify any significant constraints with a possible acquisition of eight parcels of land and the freehold at the Dragon LNG site in Milford Haven. In order to undertake this appraisal, PB was provided with documents / report originating from 4Gas and these are listed in the reference section of the PB report.

Prior to this report, PB had undertaken a desk study report covering the eight parcels of land as shown on the figure below which concluded with potential development options of each area.

The parcels of land included the following:

- Area A – Field
- Area B – Previous Oil Refinery
- Area C – Land Adjoining Blackbridge RNAD
- Area D – Railhead
- Area E – Eastern Perimeter Road and Adjoining Land
- Area F – Western Perimeter Road and Adjoining Land
- Area G – Land Housing Offices
- Area H – Daffodil Fields

The report looks at environmental liability issues for each area which includes permitting, asbestos, health and safety and waste management.

Fig 18 Plan showing parcels of land discussed within PB report

Relevant information regarding land owned by WG (that has not previously been discussed within this report) is detailed below. To aid WG with the management of these areas, Priority Ratings (see Section 3.1.1) have been given.

**Area C - Land Adjoining Blackbridge RNAD**

- Asbestos lagging and cement is detailed in the 1991 Armstrong report (not seen by Hyder) on the Decontamination of RNAD (Ref 3) and therefore there is the potential for asbestos to be present.
- Evidence of munitions filling factory which was demolished (in 1990) and covered with soil. Residue munitions may be present, however 1991 report indicates site clear of TNT / munitions. No Decontamination Certificate is however available.
- MOD was exempt from Waste licensing so areas of landfill could exist – evidence of landscaped landfill mound to the north east.
Priority Rating

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No investigation has been undertaken on this area and from (the limited) information gathered, there are a number of potential sources of contamination such as asbestos, munitions filling factory, buildings (unknown use), incinerator and therefore to determine the risks to receptors, further investigation including intrusive investigation is recommended.

Area H – Daffodil Fields

- PB anticipate that the development potential of this area will be restricted by the requirements of the local planning authority who may utilise Hazelbeach Road as a boundary to future expansion of energy related services within the area.
- Potential liabilities for this area relate to the discharge consent in this area and the presence of two below ground fuel pipelines (exact locations not stated).

Priority Rating

<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The site is greenfield and understood never to have been developed. It is therefore considered unlikely that high levels of contamination would be present associated with its use.

Within this report is a list of documents that are required to be able to surrender the PPC permit. Also several reports are referenced that have not been seen by Hyder.
3.2 Land outside WG Ownership

Hyder was provided with a number of reports which relate to land outside of WG ownership. For completeness these have been briefly reviewed and relevant information has been provided in the sections below.

3.2.1 RH Risk Assessment Reports

Royal Haskoning (July 2007) Risk Assessment of the API Separator area Tank storage Milford Haven (GORL) Final Report (9S0293)

This report relates to an area in the south east of the Waterston site, which is shown in the figure below.

![Fig 19 Plan showing location of API separator](image)

This area was historically used for the deposition of waste oil sludge materials generated by the site. It was partly remediated in the 1980s but monitoring suggested it had been recontaminated by light petroleum hydrocarbons. In 2001 this area was remediated by Celtic Technologies by excavation and use of the biotreatment cell on site. This was undertaken in conjunction with the FSS area on site which is discussed above.

This area lies close to the former path of a stream. This was infilled when the site was terraced during development and a site drainage system was installed. The groundwater in this area flows to the east away from the site and therefore Hyder note that any contamination in the groundwater from this area is unlikely to impact the rest of the site including WG land and the coastal path to the south.

Using data from previous investigations, the conclusions of the risk assessment were that the remediated area does not present a significant continued risk to human health or groundwater.
This report relates to the area on the western side of the Waterston site and is shown in the figure below.

Remediation in this area included:

- Tank 2 – removal of free phase from BH101
- Tank 12 – interception trenches installed between Tank 12 and Railyard.

Groundwater in this area flows towards the south west and is in hydraulic continuity with the boundary stream that flows along the western boundary. From this Hyder note that any contamination in the groundwater from this area is therefore unlikely to impact the site to the east.

Using data from previous investigations, the conclusions of the risk assessment were that no potential risks were identified with respect to human health for an industrial land use scenario. No potential risks to the boundary stream have been identified from soil leaching, however TPH and PAH in the groundwater has the potential to impact the stream. The risk is considered to be low given that the impact is likely to take over 1000 years.

The report recommended that the free phase was still removed from BH101 to improve groundwater quality. It is unknown to Hyder if this was undertaken.
This report relates to the area to the south of the Contractors / Process and FSS areas and is shown in the figure below. The tanks in this area store(kerosene, gasoline, gas oil and diesel. This report does not include Tank 115 which is situated on the eastern side of this area. An incident (leakage of kerosene) occurred in 2005 and is discussed in later reports.

![Plan showing Product Tank area](image)

Groundwater in this area flows in a radial pattern in a westerly / south westerly direction for the area to the west of the groundwater divide and in a southerly / south easterly direction for the area to the east of the groundwater divide. Groundwater is thought to be in hydraulic continuity with the boundary stream to the west and Haven Estuary to the east.

Using data from previous investigations, the conclusions of the risk assessment were that no potential risk to human health was present for an industrial scenario, however some contaminant concentrations may pose a risk to human health via inhalation of groundwater vapours and it was recommended that additional monitoring be undertaken to delineate these areas.

A potential risk to the Haven was identified from leaching of TPH in soil and potential low risks have been identified to impact the boundary stream and Haven from hydrocarbons in the groundwater. Potentially significant risks have been identified from MTBE and light aliphatic hydrocarbons from groundwater travelling from Area 2 to the Haven.

Free phase contamination has been recorded during the 2008 monitoring in a number of boreholes. The report recommends that product removal is undertaken to reduce the risk to groundwater and that further groundwater monitoring is undertaken to validate the assessment. It is unknown by Hyder if this was undertaken.
Royal Haskoning (July 2004) Risk Assessment of the Old and New Landfarm Final Report v1.0 (9P6212/02/34A)

This report was prepared to provide supporting information to accompany the surrender application for the old (west or A) and new (east or B) landfarms. These stopped receiving waste in 1994 and 1997 respectively and were remediated in November 2003 by excavation and disposal off site of contaminated materials.

Details in the report include the remediation that has taken place in both landfarms and subsequent risk assessment.

This risk assessment document concludes that both the old and new landfarm areas are not considered to present a significant risk to the surrounding environment (including groundwater) or future continued industrial use of the site (including human health) to future (industrial) site users.

3.2.2 Tank 115 Incident

During July 2005, over 650 tonnes of Kerosene was lost from Tank 115 which is located on the eastern side of the tank storage facility. An active kerosene recovery programme was undertaken which recovered approximately 81% of the amount lost. In the ground the kerosene migrated along discrete well connected fractures in the bedrock and emerged at a number of springs / seepages along Hazelbeach Stream to the north east and at the cliff to the east.

RPS undertook work at the site in connection to this incident and the work is detailed in the following reports:

- RPS (Sept 2010) Tank 115 Incident Site Investigation and Human Health Risk Assessment The Mill Farm (JER4638)
- RPS (Sept 2010) Tank 115 Incident, Site Investigation Completion Report (JER4683)

Within these reports additional documents are referenced, however these have not been made available to Hyder for review.

In October 2005 / January 2006 soil and sediment samples (50 locations) were collected on land (Mill Farm) to assess potential impact from contamination. A risk assessment was undertaken as requested by regulators in order to assess the potential risk to human health from residual contamination in shallow ground originating from the spillage.

The human health risk assessment demonstrated that there was no significant risk through exposure to contaminated soils and vapours. Further testing / assessment was undertaken to verify that the concentrations that had been identified were declining through natural biodegradation. The regulators were fully satisfied that there were no significant risks posed by the concentrations identified. In September 2009 the suspension notice (IPPC2308) was withdrawn by the EA Wales.
Further sampling was done in July 2010 to establish conditions 5 years after the event. TPH concentrations were found to be low in both soils and water sampled.
4 CONCLUSIONS / RECOMMENDATIONS

4.1 Conclusions

The site has an industrial history covering the last 40 years. Investigations were undertaken in the late 1990s and the early 2000s to establish the ground conditions across the whole refinery complex. The original investigation reports have not been made available or the information within the REMEDY database so the exact sample locations and testing undertaken is only partially known from the reports reviewed.

A Soil Remediation Plan (SRP) was implemented (based on the investigation data) which spanned 10 years and was completed in 2008. The remediation involved 11 areas across the site as shown in Figure 7 (in Section 2.4). Five of these areas are on land which is now owned by WG. The remedial techniques used in each area depended on the level of contamination present and the risks identified. Technologies used included excavation of contaminated soils, bio treatment, construction of interception trenches, removal of free phase product and pump and treat processes. Details of the work undertaken in specific areas and the level of success is included within Section 3.1.2 and 3.1.3.

A series of risk assessment reports were completed by RH for particular areas of the site, to determine the residual risks after remediation had taken place. These reports used the information gathered from the previous investigations (1996 / 1997 and 2004) and groundwater monitoring between 1996 and 2008. Based on the findings of the risk assessments Hyder has given Priority Ratings for each area to aid WG with the future management of the site. The reader should note that the ratings given assumes that the recommendations within the RH reports have not been completed as no evidence has been presented to Hyder to indicate that they have.

The area with the highest priority rating, Red, is the Railway Yard, where potential risks (inhalation pathway) to human health have been identified from hydrocarbon contamination encountered in the groundwater. In this area the groundwater and surface water have been given ratings of Amber 2 due to the levels of contamination encountered and the likely impacts. Remedial works has been carried out in this area and therefore it is possible that this contamination has been removed, reducing the risk, however no evidence has been found to confirm this.

In the Process and Contractors areas, groundwater has been given an Amber 2 rating as impact from hydrocarbons has occurred and further monitoring is required to determine the risk to the surface water receptors and validate the risk assessment. The surface water in the Contractors Area has an Amber 2 rating as potential risks from hydrocarbon contamination have been identified from soil leaching and groundwater and further monitoring is required.

The Priority Ratings are summarised on drawings included in Appendix B

A Remediation Certificate signed off by the EET is available. It is assumed that whilst no documentation from the Environment Agency has been viewed by Hyder that some regulatory input would have been involved in the agreement of the remedial works and risk assessments undertaken.

Whilst the remediation was “signed off”, there were recommendations for continuing the remedial measures in particular areas (e.g. removal of free phase product / groundwater extraction) and further groundwater monitoring. It is unknown whether these actions were undertaken.
Little investigation (if any) has taken place on the land adjacent to the RNAD Blackbridge site. This area includes a number of tunnels / underground magazines which were used to store ammunitions. It is understood that there was a munitions filling factory on this area which was demolished in 1990 and covered with soil. Asbestos lagging is potentially present in this area from the decommissioning of the RNAD site. From historical maps there was a mineral railway and an oil and manure works present on this area.

No investigation has taken place on the Daffodil Fields to the north west of the site. This area has been given an Amber 1 Priority Rating as the site is and has always been greenfield. It is therefore considered unlikely that high levels of contamination are present in this area.

A PPC permit is currently held by 4Gas for the bio remediation that was carried out. This operation has now ceased and therefore this permit could be surrendered. Release Point E is currently monitored in relation to this permit. Concentrations recorded are below the permit limits, however it is noted that the limits set are high compared to Water Quality Standards.

An asbestos register is available for the site which details 4 locations where asbestos containing materials (ACMs) are present. A report undertaken in 2012 for Kier identified ACMs (mainly chrysotile) in the Railyard Blocks 1 and 4, Substation 4 and Warehouse 1 and 2. An Asbestos Pit is located on the western side of the railway yard.

### 4.2 Recommendations

Based on the information reviewed, our recommendations are presented below:

- **Arrange a meeting with the regulators (EA / Natural Resources Wales (NRW)) to establish their view of the contamination status of the site – do they have any on-going concerns regarding the areas owned by WG and what would need to be done to progress them suitable for (industrial) re-development?**

- **Investigate the status of the PPC permit that would appear to be no longer required. An application would need to be submitted to the EA / NRW to seek their approval for surrender.**

- **Locate evidence (in other reports / documents) that the recommendations detailed in the risk assessment reports and on completion of the SRP have been undertaken. If no evidence is available then investigation (monitoring / sampling) would be recommended to validate the risk assessment reports and the risks to the receptors.**

- **Notwithstanding the above point, whilst investigation / monitoring data is available, some / the majority of it is old and does not necessarily reflect the current situation on site. We would therefore recommend that groundwater / surface water monitoring is undertaken across the WG land to establish the current status. In order to do this, the previous boreholes drilled should be located and serviced to assess which ones are operational. Whilst the depth of each borehole would give an indication of the groundwater being sampled, without borehole logs / records the exact response zone would be unknown. If boreholes cannot be located then new boreholes should be installed (mainly along the boundaries) to enable potential off-site migration risks to be better understood.**

- **The area to the west adjacent to the former RNAD base should be investigated in more detail to establish the location of the munitions factory and uses of other buildings on site. An intrusive investigation should then be undertaken targeting specific areas to establish if contamination is present.**

- **Prior to development of any of the areas, it would be prudent to undertaken a baseline intrusive investigation to establish the current concentrations prior to development. This information could be provided to potential developers and may be required as part of a planning application.**
5 REFERENCES

1 AECOM (Jan 2012) Waterston /Blackbridge WelTAG Stage 2, Environmental Report

2 SLR Contracting (Feb 2002) design, Construction and Construction Quality Assurance Report For the Asbestos Tip Encapsulation at Waterston Refinery (SLR Job no CT/009/001/01)

# ABBREVIATIONS

<table>
<thead>
<tr>
<th>ACM</th>
<th>Asbestos Containing Materials</th>
</tr>
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<tbody>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>BETS</td>
<td>Department of Business, Enterprise, Technology and Science</td>
</tr>
<tr>
<td>BGS</td>
<td>British Geological Survey</td>
</tr>
<tr>
<td>BTEX</td>
<td>Benzene, Toluene, Ethyl Benzene and Xylene</td>
</tr>
<tr>
<td>CQA</td>
<td>Construction Quality Assurance</td>
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<tr>
<td>DQRA</td>
<td>Detailed Quantitative Risk Assessment</td>
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<tr>
<td>EA</td>
<td>Environment Agency</td>
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<tr>
<td>EET</td>
<td>Environmental Expert Team</td>
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<tr>
<td>EPH</td>
<td>Extractable Petroleum Hydrocarbons</td>
</tr>
<tr>
<td>FSS</td>
<td>Flame Stack Stockpile</td>
</tr>
<tr>
<td>GORL</td>
<td>Gulf Oil Refinery Limited</td>
</tr>
<tr>
<td>GORA</td>
<td>Generic Quantitative Risk Assessment</td>
</tr>
<tr>
<td>GRO</td>
<td>Gasoline Range Organics</td>
</tr>
<tr>
<td>HDPE</td>
<td>High Density Polyethylene</td>
</tr>
<tr>
<td>IBC</td>
<td>Intermediate Bulk Containers</td>
</tr>
<tr>
<td>LNG</td>
<td>Liquid Natural Gas</td>
</tr>
<tr>
<td>MTBE</td>
<td>Methyl tert-buty ether</td>
</tr>
<tr>
<td>NRW</td>
<td>Natural Recourses Wales</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbons</td>
</tr>
<tr>
<td>PB</td>
<td>Parsons Brinckerhoff</td>
</tr>
<tr>
<td>PPC</td>
<td>Pollution Prevention and Control</td>
</tr>
<tr>
<td>PRO</td>
<td>Petroleum Range Organics</td>
</tr>
<tr>
<td>RA</td>
<td>Risk Assessment</td>
</tr>
<tr>
<td>RBCA</td>
<td>Risk Based Corrective Action</td>
</tr>
<tr>
<td>RH</td>
<td>Royal Haskoning</td>
</tr>
<tr>
<td>RNAD</td>
<td>Royal Naval Armament Depot</td>
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<tr>
<td>SAC</td>
<td>Special Area of Conservation</td>
</tr>
<tr>
<td>SRP</td>
<td>Soil Remediation Plan</td>
</tr>
<tr>
<td>SSSI</td>
<td>Site of Special Scientific Interest</td>
</tr>
<tr>
<td>SVOC</td>
<td>Semi Volatile Organic Compounds</td>
</tr>
<tr>
<td>TPH</td>
<td>Total Petroleum Hydrocarbons</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
<tr>
<td>WG</td>
<td>Welsh Government</td>
</tr>
</tbody>
</table>
Appendix A

List of Reports Provided to Hyder
Reports relating to WG owned Land

Reports relating to Soil Remediation Programme

Royal Haskoning (July 2008) Soil Remediation Tankstorage Site Milford Haven (GORL) Final Report (9S7043)

Royal Haskoning (Sept 2011) Milford Haven Refinery Plant Dismantling Final Report (9S5742)

Environmental Expert Team Remediation Certificate (signed 05/09/08 by URS / Witteveen–Bos)

Risk Assessment Reports

Royal Haskoning (Sept 2008) Quantitative Risk Assessment of the Contractors Area Milford Haven Tankstorage site (GORL) Draft Report v1.0 (9S7043)

Royal Haskoning (Sept 2008) Quantitative Risk Assessment of the Process Area Milford Haven Tankstorage site (GORL) Draft Report v1.0 (9S7043)

Royal Haskoning (Sept 2008) Quantitative Risk Assessment of the Railway Yard Milford Haven Tankstorage site (GORL) Draft Report v1.0 (9S7043)

Royal Haskoning (April 2006) Risk assessment of the Flare Stack Stockpile area Tankstorage Milford Haven (GORL) Final Report v1.0 (9R1883)

Monitoring Reports


Royal Haskoning (June 2007) 2006 Groundwater Monitoring at Petroplus Tankstorage Milford Haven Final Report (9R8777)


Progress Reports


Review Progress Reports / Letters

URS / Witteveen-Bos (Sept 2002) Review of Progress Reports and associated documentation
URS / Witteveen-Bos (August 2003) Soil Remediation, Petroplus Tank Storage, Milford Haven
URS / Witteveen-Bos (May 2005) Soil Remediation, Petroplus Tank Storage, Milford Haven

Reports relating to Asbestos

Welsh Government Asbestos Register Status Report (19/04/2011) and Location Plan

Others

PPC Permit with introductory note for 4Gas Limited - Permit Number BK1341 / GP3034TW (issued 17 May 2010)
Parsons Brinckeroff (June 2012) Environment Report Land adjoining LNG Terminal, Waterston, Milford Haven (3511939A-HHC/2)
Release Point E Water Results from 2010 - 2012
Release Point E – VOCs Results, 2010-2012, 4Gas Ltd
Release Point E – Water Results, 2010-2012, 4Gas Ltd

Reports relating to land outside WG ownership

Risk Assessment Reports
Royal Haskoning (July 2007) Risk Assessment of the API Separator area Tank storage Milford Haven (GORL) Final Report (9S0293)
Royal Haskoning (Sept 2008) Quantitative Risk Assessment of the Crude Tank Park Area Milford Haven Tankstorage site (GORL) Draft Report v1.0 (9S7043)
Royal Haskoning (Sept 2008) Quantitative Risk Assessment of the Product and Park Area Milford Haven Tankstorage site (GORL) Draft Report v1.0 (9S7043)
Royal Haskoning (July 2004) Risk Assessment of the Old and New Landfarm Final Report v1.0 (9P6212/02/34A)

Reports relating to Tank 115 Incident
RPS (Sept 2010) Tank 115 Incident Site Investigation and Human Health Risk Assessment The Mill Farm (JER4638)
RPS (Sept 2010) Tank 115 Incident, Site Investigation Completion Report (JER4683)

Reports relating to Asbestos
SLR (Feb 2002) Design, Construction and Construction Quality Assurance report for the Asbestos Tip Encapsulation at Waterston Refinery (CT/009/001/01)
Appendix B

Plans showing Priority Ratings
<table>
<thead>
<tr>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
<th>Human Health</th>
<th>Groundwater</th>
<th>Surface Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Red</strong></td>
<td></td>
<td></td>
<td><strong>Amber 2</strong></td>
<td></td>
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<td><strong>Green</strong></td>
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<td></td>
<td><strong>Amber 2</strong></td>
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<tr>
<td>(due to uncertainties)</td>
<td>Potential risks identified from groundwater contamination (TPH / chloromethane) via outdoor inhalation pathway.</td>
<td>Free phase product should continue to be removed to improve groundwater quality / reduce risk to receptors – confirmation required</td>
<td>Groundwater impacted (TPH / PAH)</td>
<td>Groundwater impacted</td>
<td>Groundwater impacted</td>
<td>Current risk identified as acceptable.</td>
<td>Groundwater impacted</td>
<td>Current risk identified as acceptable.</td>
<td>Groundwater impacted</td>
<td>Current risk identified as acceptable.</td>
<td>Flare Stack Stockpile</td>
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<tr>
<td>Potential risks identified from soil leaching (TPH) and groundwater (TPH / PAH). Risk from groundwater is low as impact is likely to take over 1000 years. Risk from soil leaching should be further investigated – likely that contamination has been removed during remedial process – confirmation required.</td>
<td>Further monitoring required to validate / determine risk to Surface Water receptor</td>
<td>Further monitoring required to validate / determine risk to Surface Water receptor</td>
<td>Further monitoring required to validate / determine risk to Surface Water receptor</td>
<td>Further monitoring required to validate / determine risk to Surface Water receptor</td>
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<tr>
<td><strong>Green</strong></td>
<td></td>
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<td><strong>Amber 1</strong></td>
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<td><strong>Amber 2</strong></td>
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<td><strong>Green</strong></td>
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<td><strong>Green</strong></td>
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<td><strong>Amber 2</strong></td>
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<td>Area C - Land Adjoining Blackbridge RNAD</td>
<td>Area H - Daffodil Fields</td>
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<tr>
<td><strong>Human Health</strong></td>
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<tr>
<td><strong>Groundwater</strong></td>
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<td><strong>Surface Water</strong></td>
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**Amber 2**
No investigation has been undertaken on this area and from (the limited) information gathered, there are a number of potential sources of contamination such as asbestos, munitions filling factory, buildings (unknown use), incinerator and therefore to determine the risks to receptors, further investigation including intrusive investigation is recommended.

**Amber 1**
The site is greenfield and understood never to have been developed. It is therefore considered unlikely that high levels of contamination would be present associated with its use.