

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW016		PAGE 1 of 1		
	NUMBER	TYPE					DRILLING DATES: 26/10/2000		DRILLING METHODS : Window Sampling		
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 78,68,58		
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE		
		CHECKED BY :		SCREEN SLOT SIZE: 1mm							
					0.0	CONCRETE				0.0	
					0.5	MADE GROUND Firm medium plastic clay with fine sand and occasional fine gravel		Moist		0.5	
					1.0	MADE GROUND Ash & Clinker					
			*27		1.0	MADE GROUND Soft to firm, grey, medium plastic clay with some fine sand		Wet		1.0	
					1.5	MADE GROUND Wet Ash & Clinker					
			*523		1.5	SAND Firm grey clayey medium plastic, fine sand				1.5	
					2.0					2.0	
					2.5					2.5	
					3.0					3.0	
					3.5					3.5	
LOCATION / NOTES: NVO = No visual or olfactory evidence						LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table			BOREHOLE LOG Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 		
						App'd: _____ Date: August 2002 Drawn: AR Ref: _____ Scale: _____ Job No: 39991-016 Drg. Size: _____ BOREHOLE LOG					

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW016A		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 13/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
				CHECKED BY :		SCREEN SLOT SIZE: 1mm				
					0.0		GRAVEL Loose blackfine gravel with some fine occasional sand and occasional clay	Moist	0.0	
					0.5		CLAY Firm, brown clay with fine occasional sand and occasional fine gravel	Moist	0.5	
					1.0		CLAY Firm grey fine sand medium plastic clay No Returns	Moist	1.0	
					1.5		SAND Firm grey sandy (coarse) with occasional gravel, becomes brown at 1.85m	Moist	1.5	
					2.0		SAND Loose black clayey (medium plastic) fine to coarse sand with some fine gravel		2.0	
					2.5				2.5	
				3.0		End of Borehole		3.0		
				3.5				3.5		
					4.0				4.0	
					4.5				4.5	
					5.0				5.0	

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or laboratory evidence	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
		App'd:	Date: August 2002
		Drawn: AR	Ref:
		Scale:	Job No: 39991-016
		Drg. Size:	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW017		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 13/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
DESCRIPTION							COMMENTS			
			0		0.0	MADE GROUND Loose, black ash and clinker	NVO	0.0		
			0		0.5	CLAY Intermediate plasticity, brown, moist CLAY with fine sand Soft tan colour at 1.1m	NVO	0.5		
			0		1.0			1.0		
			0		1.5	GRAVEL Poorly graded gravel with dark brown, moist clay. Fine gravel with medium plasticity and fine to coarse, loose sand	NVO	1.5		
			0		2.0			2.0		
			0		2.3	CLAY Intermediate plasticity CLAY with fine sand and gravel	Hydrocarbon odour	2.3		
		0		2.5	SAND Poorly graded brown, wet coarse sand, traces of loose gravel	2.5				
		0		3.0	SILTY SAND Brown moist silty sand	3.0				
		24		3.5			3.5			
		1630		4.0			4.0			
		50		4.5			4.5			
		164		5.0			5.0			
End of Borehole										

LOCATION / NOTES:	LEGEND	BOREHOLELOG	
NVO = No visual or laboratory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: August 2002 Drawn: AR Ref: _____ Scale: _____ Job No: 39991-016 Drg. Size: _____ BOREHOLELOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW018		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 13/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0		SAND Poorly graded, moist, brown, fine to coarse SAND	NVO	0.0	
					0.5		CLAY Intermediate plasticity, black, moist clay with some fine sand		0.5	
			*0.0		1.0		SILTY SAND Loose, fine, silty sand	NVO	1.0	
					1.5		CLAY Soft, moist clay with some coarse gravel		1.5	
			*21		2.0		SILTY SAND Grey, moist fine silty sand		2.0	
			168		2.5		CLAYEY SAND Grey, fine clayey sand with some fine gravels		2.5	
			8		3.0		CLAY Intermediate plasticity, brown, moist clay with some fine sands		3.0	
			64		3.5		CLAYEY SAND Brown, moist fine clayey sand with some fine to coarse gravels		3.5	
			*1886 109 75		4.0		SILTY SAND Brown, moist fine silty sand with some fine to coarse gravels		4.0	
			*69		4.5		SILTY SAND Brown, moist fine silty sand with some fine to coarse gravels		4.5	
				5.0		Collapsed at 04.65m Refusal at 5.0m		5.0		

LOCATION / NOTES:

NVO = No visual or laboratory evidence

LEGEND

- Disturbed Sample
- Undisturbed Sample
- Headspace Analysis
- Down Borehole Analysis
- Groundwater Table
- Perched Water Table

BOREHOLE LOG

Job Title: Sentinel Wells

Location: BP Llandarcy Refinery

Client: BP Oil UK

App'd:	Date: August 2002
Drawn: AR	Ref:
Scale:	Job No: 39991-016
Dwg. Size:	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW019		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 13/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
						DESCRIPTION	COMMENTS			
			*0		0.0	MADE GROUND Poorly graded gravel with sand	NVO	0.0		
					0.5	MADE GROUND Poorly graded loose sand		0.5		
			*31.9		1.0	MADE GROUND Med-firm, brown/black CLAY with some sand and interbedded ash and clinker.		1.0		
					1.5	CLAY Soft-firm, brown/black, moist, sandy CLAY, with some poorly sorted sandstone fragments	NVO	1.5		
					2.0	CLAY Med-firm, grey, sandy CLAY.	Hydrocarbon odour	2.0		
			*15.1		2.5	CLAY Firm, grey, sandy CLAY with some fine gravel.	Hydrocarbon odour	2.5		
					3.0	CLAY Firm, grey-brown, sandy clay with some gravel		3.0		
					3.5	SILTY SAND Dense, brown silty SAND	Hydrocarbon odour	3.5		
			*106.1		4.0			4.0		
					4.5	End of Borehole		4.5		
				5.0			5.0			

LOCATION / NOTES:		LEGEND		BOREHOLE LOG	
NVO = No visual or olfactory evidence		Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table		Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
				App'd:	Date: August 2002
				Drawn : AR	Ref:
				Scale:	Job No: 39991-016
				Drg. Size:	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW020		PAGE 1 of 2	
	NUMBER	TYPE					DRILLING DATES: 13/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
DESCRIPTION		COMMENTS								
	MADE GROUND Loose, red-brown, poorly sorted silty sand with some gravel.	NVO	0.0							
	MADE GROUND Stiff, brown clay		0.5							
	MADE GROUND Dark brown, fine, ash and clinker interbedded with clay and some gravel.		1.0							
	CLAY Firm, dark brown clay.	Slight hydrocarbon odour	1.0							
	Becoming grey in colour, with some sand.		1.5							
	Becoming brown-grey colour.	Hydrocarbon odour	1.5							
	Becoming grey in colour.		2.0							
	SAND Dense, grey, clayey sand.		2.5							
		Hydrocarbon odour	3.0							
	SILTY SAND Grey-brown, silty sand		3.5							
	SAND Loose, poorly sorted, silty SAND		4.0							
	SILTY SAND Dense, brown sand with some gravel	Hydrocarbon odour	4.0							
		Slight hydrocarbon odour	4.5							
			5.0							

LOCATION / NOTES:	LEGEND	BOREHOLELOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 16/09/2002 Drawn: SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLELOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW020		PAGE 2 of 2	
	NUMBER	TYPE					DRILLING DATES: 13/10/2000		DRILLING METHODS: Percussive	
							DRILLER: Geotechnical		BOREHOLE DIAMETER: 128mm	
							LOGGED BY: JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY:		SCREEN SLOT SIZE: 1mm	
						CLAY Firm-stiff, grey-brown clay with some sand. Drilled to 5.3m, collapsed at 4.9m			COMMENTS	
					5.5	End of Borehole				5.5
					6.0					6.0
					6.5					6.5
					7.0					7.0
					7.5					7.5
					8.0					8.0
					8.5					8.5
					9.0					9.0
					9.5					9.5
					10.0					10.0

LOCATION / NOTES: NVO = No visual or olfactory evidence	LEGEND  Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	BOREHOLELOG Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK			
				App'd:	Date: 16/09/2002
				Drawn: SS	Ref:
				Scale: As scale	Job No: 39991-016
				Dwg. Size: A4	BOREHOLELOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW021		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 17/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0	GRAVEL Loose, brown, clayey gravel with some rootlets.	NVO	0.0		
					0.5	CLAY Firm, brown, sandy clay.	NVO	0.5		
					1.0	SILTY SAND Brown, fine to coarse, silty sand.		1.0		
			*12.1		1.5	Increasing silt fraction from 1.7m	Hydrocarbon odour	1.5		
			*125		2.0		Hydrocarbon odour	2.0		
			*314		2.5	CLAY Stiff, brown clay with some sand and gravel		2.5		
		*6.4		3.0	End of Borehole		3.0			
				3.5			3.5			
				4.0			4.0			
				4.5			4.5			
				5.0			5.0			

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 16/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW022		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 17/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
					0.0	CLAY Firm, brown, sandy clay with rootlets, with a lense of dark silty sand.	NVO		0.0	
					0.5	Becoming brown with some ash and clinker			0.5	
					1.0	CLAYEY SAND Dense, brown clayey sand with some gravel	NVO		1.0	
					1.5	SAND Dense, brown, fine-coarse sand with some clay.			1.5	
					2.0	SILTY SAND Loose, brown, fine, silty sand with some coarse sand.	NVO		2.0	
					2.5				2.5	
					3.0	CLAY Firm, brown clay with some sand.	NVO		3.0	
					3.5	Increasing sand fraction from 3.4m			3.5	
					4.0	End of Borehole			4.0	
					4.5				4.5	
					5.0				5.0	

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
		App'd:	Date: 16/09/2002
		Drawn : SS	Ref:
		Scale: As scale	Job No: 39991-016
		Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW023		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 17/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM:	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
						0.0	MADE GROUND Firm, dark brown sandy CLAY with rootlets. Thin lense of ash and clinker at 0.3m	NVO	0.0	
						0.5	CLAY Soft, yellowish-brown CLAY with some sand	NVO	0.5	
						1.0	SILTY SAND Dense, brown, fine, silty SAND with coarse gravel	Wet. NVO	1.0	
						1.5	SANDY CLAY Firm, brown sandy CLAY with some gravel.	Moist. NVO	1.5	
						2.0	CLAYEY SAND Loose to dense, brown, fine clayey SAND.	Wet. NVO	2.0	
						2.5	SILTY SAND Loose to dense, brown silty SAND.	Wet. NVO	2.5	
						3.0	Becoming more silty from 2.7m	Wet. Hydrocarbon odour	3.0	
						3.5	CLAY Firm, brown CLAY with some sand.	Moist. Hydrocarbon odour	3.5	
						4.0	SILTY SAND Loose to dense, grey silty SAND with some gravel.	Wet. Hydrocarbon odour	4.0	
						4.5	End of Borehole		4.5	
5.0			5.0							

LOCATION / NOTES: NVO = No visual or olfactory evidence		LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table		BOREHOLE LOG Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
				App'd: _____ Drawn : SS Scale: As scale Drg. Size: A4	Date: 16/09/2002 Ref: _____ Job No: 39991-016 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW024		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 17/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
			9.5		0.0	MADE GROUND Loose, brown GRAVEL with roots		Moist. NVO	0.0	
					0.5	MADE GROUND Dense, brown silty SAND			0.5	
						MADE GROUND Loose, black ASH and CLINKER.				
					1.0	CLAY Firm, dark brown CLAY with some sand		Moist. Hydrocarbon odour	1.0	
			286			SANDY CLAY Firm, grey/brown sandy CLAY with some gravel				
		*504 35		1.5	SAND Loose, brown fine SAND		Moist. Hydrocarbon odour	1.5		
		116		2.0	SANDY CLAY Firm, brown, sandy CLAY with some gravel		Moist. Hydrocarbon odour	2.0		
		201 *163 155 *186		2.5					2.5	
				3.0					3.0	
				3.5					3.5	
				4.0					4.0	
				4.5					4.5	
				5.0					5.0	
							End of Borehole			

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 17/09/2002 Drawn: SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW025		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 17/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
					0.0	MADE GROUND Firm, dark brown sandy CLAY with rootlets and some fine gravel.	Moist. NVO	0.0		
			230		0.5	MADE GROUND Loose, black ASH and CLINKER. CLAY Firm, brown CLAY becoming softer with depth	Wet. Hydrocarbon odour	0.5		
			*510		1.0	SANDY CLAY Soft to firm, grey-brown, sandy CLAY.	Moist. Hydrocarbon odour	1.0		
			130		1.5	SILTY SAND Dense, grey, fine silty SAND	Wet. Hydrocarbon odour	1.5		
			34		2.0		Hydrocarbon odour	2.0		
		*731 16		2.5				2.5		
				3.0	End of Borehole				3.0	
				3.5				3.5		
				4.0				4.0		
				4.5				4.5		
				5.0				5.0		

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 17/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-016 Org. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW026		PAGE 1 of 1		
	NUMBER	TYPE					DRILLING DATES: 16/10/2000		DRILLING METHODS : Percussive		
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm		
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE		
							CHECKED BY :		SCREEN SLOT SIZE: 1mm		
							DESCRIPTION	COMMENTS			
							MADE GROUND Firm, brown, CLAY with some ash, clinker and rootlets.	Moist. NVO	0.0		
									0.5		
									1.0		
									SANDY SILT Firm, brown-grey, fine sandy SILT	Moist, NVO	1.5
											2.0
											2.5
									SANDY GRAVEL Loose, black, fine sandy GRAVEL	Wet with free product	2.0
									SANDY CLAY Firm, brown sandy CLAY		2.5
									SANDY SILT Firm, brown sandy SILT		3.0
									SILTY SAND Firm, brown silty SAND with some fine gravel.	Wet. Hydrocarbon odour	3.5
		Becoming less silty from 3.4m	4.0								
			4.5								
		SANDY SILT Firm, brown sandy SILT		4.5							
		End of Borehole		5.0							

LOCATION / NOTES: NVO = No visual or olfactory evidence	LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	BOREHOLE LOG	
		Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 17/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW027		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 16/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
						DESCRIPTION	COMMENTS			
			0		0.0	HARDSTANDING Asphalt/Concrete		0.0		
					0.5	CLAYEY SAND Loose, brown clayey SAND	Moist. NVO	0.5		
			0		1.0	CLAY Soft to firm, brown CLAY with minor sand	Moist. NVO	1.0		
			0		1.5	SILTY SAND Loose, brown silty SAND with some gravel.	Moist. NVO	1.5		
			*317		2.0		Wet	2.0		
			345 *880		2.5		Hydrocarbon odour	2.5		
			0 *30		3.0		Hydrocarbon odour	3.0		
					3.5	Becoming more sandy from 2.5m		3.5		
					4.0			4.0		
					4.5			4.5		
				5.0			5.0			
					End of Borehole					

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample ✱ Headspace Analysis ⬇ Down Borehole Analysis ⬇ Groundwater Table ⬇ Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK URS App'd: Date: 17/09/2002 Drawn : SS Ref: Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG	

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW028		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 16/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
						DESCRIPTION	COMMENTS			
			0		0.0	HARDSTANDING Concrete.		0.0		
			0		0.5	CLAYEY GRAVEL Loose, dark brown/black, fine to coarse clayey GRAVEL.		0.5		
					1.0	CLAY Soft to firm, grey-brown, CLAY with some sand	Moist. Hydrocarbon odour	1.0		
			84		1.5	SANDY CLAY Firm, grey-brown sandy CLAY with some gravel	Moist. Hydrocarbon odour	1.5		
			165 *836		2.0	SILTY SAND Dense, grey-brown silty SAND with some gravel. Lenses of poorly sorted gravel below 2.3m.	Moist. Hydrocarbon odour	2.0		
			175 *22.9 648		2.5		Wet. Hydrocarbon odour	2.5		
		0		3.5			3.5			
				4.0	Becoming more sandy below 4.0m		4.0			
				4.5			4.5			
			*413		5.0	End of Borehole		5.0		

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
		App'd:	Date: 17/09/2002
		Drawn : SS	Ref:
		Scale: As scale	Job No: 39991-016
		Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW030		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 18/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
			0		0.0	SAND Loose, brown/black, poorly sorted SAND with some silt.			0.0	
			39		0.5	CLAY Firm, brown CLAY with some sand. Becoming soft from 0.45m	Moist. Hydrocarbon odour		0.5	
			122		1.0	CLAY Soft, brown gravelly CLAY	Moist. Hydrocarbon odour		1.0	
			*307		1.5	SANDY CLAY Firm, grey-brown sandy CLAY	Moist. Hydrocarbon odour		1.5	
			*405		2.0	SILTY SAND Dense, brown silty SAND	Wet, strong hydrocarbon odour		2.0	
					2.5				2.5	
					3.0		Wet. Hydrocarbon odour		3.0	
					3.5				3.5	
			*230		4.0	CLAYEY SAND Stiff, brown clayey SAND	Weak hydrocarbon odour		4.0	
					4.5	End of Borehole			4.5	
				5.0				5.0		

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence		Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
		App'd:	Date: 17/09/2002
		Drawn : SS	Ref:
		Scale: As scale	Job No: 39991-016
		Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW031		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 18/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM:	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
							DESCRIPTION	COMMENTS		
					0.0	MADE GROUND Loose ASH and CLINKER with some clay	NVO		0.0	
					0.5	CLAY Firm, brown CLAY with some sand.			0.5	
			5.6		1.0	Becoming soft from 0.75m Increasing sand from 0.9m	Wet. Hydrocarbon odour		1.0	
			34		1.5	CLAYEY SAND Dense, grey clayey SAND	Wet. Hydrocarbon odour		1.5	
			*173		2.0	GRAVEL Loose, grey, fine to coarse GRAVEL with some clay			2.0	
			*409		2.5	CLAYEY SAND Loose to firm, grey, fine clayey SAND			2.5	
		122		3.0	End of Borehole			3.0		
				3.5				3.5		
				4.0				4.0		
				4.5				4.5		
				5.0				5.0		

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK 	
		App'd:	Date: 17/09/2002
		Drawn : SS	Ref:
		Scale: As scale	Job No: 39991-016
		Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW032		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 18/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0	GRAVEL Loose, fine to coarse GRAVEL with some clay			0.0	
					0.5	CLAY Firm, brown CLAY with some gravel			0.5	
					1.0	CLAY Soft to firm, brown CLAY.	Moist. NVO		1.0	
					1.5	Becoming yellow-brown from 1.25m			1.5	
					2.0	SILTY SAND Dense, brown-grey silty SAND with some coarse gravel	Wet		2.0	
					2.5	CLAYEY SAND Dense, brown-grey fine clayey SAND.			2.5	
					3.0	BEDROCK Fractured SANDSTONE bedrock			3.0	
				3.5	End of Borehole			3.5		
				4.0				4.0		
				4.5				4.5		
				5.0				5.0		

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 17/09/2002 Drawn : SS Ref: _____ Scale: As scale Job No: 39991-016 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW033		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 18/10/2000		DRILLING METHODS : Percussive	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 128mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
				CHECKED BY :		SCREEN SLOT SIZE: 1mm				
					0.0	MADE GROUND Loose, brown-black ASH and CLINKER, with some clay	NVO	0.0		
					0.5	SANDY CLAY Firm, brown sandy CLAY with some gravel	NVO	0.5		
					1.0	CLAY Firm, brown CLAY with some sand		1.0		
					1.5	SANDY CLAY Soft, yellow-brown sandy CLAY with some gravel		1.5		
					2.0			2.0		
					2.5	CLAYEY SAND Firm, brown, fine, clayey SAND	Wet. Hydrocarbon odour	2.5		
					3.0	SILTY SAND Loose, grey, fine silty SAND with some gravel.	Wet. Hydrocarbon odour	3.0		
					3.5	Some cobbles from 3.5m		3.5		
					4.0			4.0		
					4.5	End of Borehole		4.5		
				5.0			5.0			

LOCATION / NOTES:	LEGEND	BOREHOLE LOG									
NVO = No visual or olfactory evidence		Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK <table border="1"> <tr> <td>App'd:</td> <td>Date: 17/09/2002</td> </tr> <tr> <td>Drawn : SS</td> <td>Ref:</td> </tr> <tr> <td>Scale: As scale</td> <td>Job No: 39991-016</td> </tr> <tr> <td>Drg. Size: A4</td> <td>BOREHOLE LOG</td> </tr> </table>		App'd:	Date: 17/09/2002	Drawn : SS	Ref:	Scale: As scale	Job No: 39991-016	Drg. Size: A4	BOREHOLE LOG
App'd:	Date: 17/09/2002										
Drawn : SS	Ref:										
Scale: As scale	Job No: 39991-016										
Drg. Size: A4	BOREHOLE LOG										

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW035		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 26/10/2000		DRILLING METHODS : Window Sampling	
							DRILLER : Geotechnical		BOREHOLE DIAMETER : 78mm	
							LOGGED BY : JG		SCREEN TYPE & DIAM: 50mm HDPE	
							CHECKED BY :		SCREEN SLOT SIZE: 1mm	
					0.0		DESCRIPTION	COMMENTS	0.0	
			*88.3		0.5	CLAY Soft to firm, grey CLAY with some fine sand.	NVO		0.5	
			*73.2		1.0		Moist. Hydrocarbon odour		1.0	
					1.5	SILTY SAND Dense, greyy fine silty SAND with some gravel.	Wet. NVO		1.5	
					2.0	End of Borehole			2.0	
					2.5				2.5	
					3.0				3.0	
					3.5				3.5	
					4.0				4.0	
					4.5				4.5	
					5.0				5.0	

LOCATION / NOTES: NVO = No visual or olfactory evidence	LEGEND Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	BOREHOLE LOG	
		Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
			App'd: _____ Date: 17/09/2002
		Scale: As scale Drg. Size: A4	Ref: _____ Job No: 39991-016 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: RFSW038		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 25/10/2000		DRILLING METHODS: Window Sampling	
							DRILLER: Geotechnical		BOREHOLE DIAMETER: 78mm	
							LOGGED BY: JG		SCREEN TYPE & DIAM: 40mm HDPE	
							CHECKED BY:		SCREEN SLOT SIZE: 1mm	
					0.0	MADE GROUND Black, moist, loose ash & clinker			0.0	
			*0.0		0.5	CLAY Soft, dark brown, moist, slightly sandy clay.	NVO		0.5	
					1.0		NVO		1.0	
			22.0 *3.7		1.5	CLAY Medium plasticity, very soft, very gravelly clay	Wet. Hydrocarbon odour		1.5	
					2.0	Refusal at 2.1m			2.0	
					2.5	End of Borehole			2.5	
					3.0				3.0	
					3.5				3.5	
					4.0				4.0	
					4.5				4.5	
					5.0				5.0	

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence	Disturbed Sample ■ Undisturbed Sample ✱ Headspace Analysis ⊕ Down Borehole Analysis ▽ Groundwater Table ⋈ Perched Water Table	Job Title: Sentinel Wells Location: BP Llandarcy Refinery Client: BP Oil UK	
		URS	App'd: _____ Date: Sept 2002 Drawn: AR _____ Ref: _____ Scale: _____ Job No: 39991-016 Drg. Size: _____ BOREHOLE LOG

Borehole Record - Cable Percussion

Borehole Number: SBH 04

Project Number: 80132

Contract Name: Coed Darcy

Client: St Mowden

Engineer: PT

Date Started: 14/7/09

Date Completed: 14/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
1.0		MADE GROUND: Red/grey sandy GRAVEL and COBBLE of crushed brick and concrete.	1.50	D	0.50			
2.0		Soft grey sandy silty CLAY.	2.80	D	2.00			
3.0		Loose grey silty SAND.	3.00	D	3.00			
4.0		Soft brown gravelly sandy CLAY. Gravel is fine to coarse sub-angular of sandstone...Strong hydrocarbon odour.		W	3.10			
5.0				D	4.00			
					5.00			

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling: 1.50m bgl for 30 mins

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 3.10m bgl.

Date: 30/7/09

Status: Prelim 1

Borehole Record - Cable Percussion

Borehole Number: SBH 04

Project Number: 80132

Contract Name: Coed Darcy

Client: St Mowden

Engineer: PT

Date Started: 14/7/09

Date Completed: 14/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
		Soft brown gravelly sandy CLAY. Gravel is fine to coarse sub-angular of sandstone...Strong hydrocarbon odour.	5.80					
6.0		Borehole terminated at 5.80m bgl.						
7.0								
8.0								
9.0								
10.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling: 1.50m bgl for 30 mins

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 3.10m bgl.

Date: 30/7/09

Status: Prelim 1

Borehole Record - Cable Percussion

Borehole Number: SBH 05

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 15/7/09

Date Completed: 15/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
1.0		MADE GROUND: Compact dark grey/black very sandy GRAVEL of clinker and ash. Gravel is fine to coarse sub-angular to angular.	1.30	D	0.50			
				D	1.00			
2.0		Firm patchy black/dark grey slightly silty CLAY. Strong hydrocarbon odour.	2.00	D	1.50			
				D	2.50			
3.0		Firm grey with dark grey patches slightly gravelly sandy SILT. Becoming gravelly with depth. Gravel of fine to coarse sandstone. Strong hydrocarbon odour.	3.90	D	3.50			
4.0		Dense grey silty gravelly SAND. Gravel is fine to coarse of sandstone with some sandstone cobbles. Strong hydrocarbon odour.	4.80	B	4.00-4.50			
5.0				B	5.00-5.30			

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling: 4.80m bgl-5.70m bgl for 45 mins

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 4.80m bgl.

Date:

Status:

Borehole Record - Cable Percussion

Borehole Number: SBH 05

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 15/7/09

Date Completed: 15/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
		Dark grey/brown slightly silty sandy sandstone GRAVEL and COBBLES. Gravel is fine to coarse sub-angular.	5.80					
6.0		Borehole terminated at 5.80m bgl due to refusal on obstruction of sandstone.						
7.0								
8.0								
9.0								
10.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling: 4.80m bgl-5.70m bgl for 45 mins

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 4.80m bgl.

Date:

Status:

Borehole Record - Cable Percussion

Borehole Number: SBH 06

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 15/7/09

Date Completed: 15/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
1.0		MADE GROUND: Soft grey sandy SILT and black peat with some ash and clayey patches.	0.90	D	0.50			
2.0		Firm brown/grey silty CLAY.	2.00	D	1.00			
3.0		Brown/grey gravelly sandy SILT. Gravel is fine to coarse sub-angular to tabular of sandstone.	4.00	D	2.00			
4.0		Brown GRAVEL and some cobbles of sandstone...hydrocarbon odour.	4.20	W D	4.00 4.10			
5.0		Brown/grey silty SAND and GRAVEL of fine to coarse angular to sub-angular sandstone...strong hydrocarbon odour.	4.50	G	4.50			
6.0		Borehole terminated at 4.50m bgl due to refusal.						

Key

B. Bulk (Bag)	D. Disturbed	T. Plastic Tub
W. Water	G. Amber Glass Jar / Bottle	N. 'N' Value
U100. 100mm Undisturbed	CPT. Cone Penetration Test	HV. Hand Shear Vane
U38. 38mm Undisturbed Sample	U100. Blows (Recovery mm)	PID. Photo Ionisation Detector
SPT. Standard Penetration Test	V. 40ml Glass Vial	

Notes

Chiselling: 30 mins

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 4.00m bgl.

Date:

Status:

Borehole Record - Cable Percussion

Borehole Number: SBH 07

Project Number: 80132

Contract Name: Coed Darcy

Client: St Mowden's

Engineer: PT

Date Started: 16/7/09

Date Completed: 16/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussive



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
		MADE GROUND: Very compact sandy GRAVEL and COBBLE fill of sandstone, brick and concrete.	0.30					
		Dark mottled grey brown silty CLAY with some fine to coarse sandstone gravel.	0.60					
1.0		Grey silty sandy GRAVEL and COBBLE of sandstone. Some very clayey zones.						
2.0								
3.0			2.90					
4.0		Grey slightly sandy coarse GRAVEL and COBBLE of sandstone...Strong hydrocarbon odour.						
5.0			5.00					

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling: 1 hour

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 2.90m bgl...2.50 after 20 mins

Date:

Status:

Borehole Record - Cable Percussion

Borehole Number: SBH 08

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 17/7/09

Date Completed: 17/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
		MADE GROUND: Loose sandstone gravel and cobble with soil and ash.	0.30					
		Dense grey/brown clayey sandy GRAVEL and COBBLE of sub-angular to tabular sandstone.		D	0.50			
1.0		Distinct hydrocarbon odour.	1.30					
		Obstruction on boulder of SANDSTONE.	1.60				Strike at 1.60m bgl.	
2.0		Borehole terminated at 1.60m bgl due to obstruction.						
3.0								
4.0								
5.0								
6.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling:

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: None encountered.

Date: 12/8/09

Status: Prelim 1

Borehole Record - Cable Percussion

Borehole Number: SBH 12

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 16/7/09

Date Completed: 16/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment:



Resource & Environmental Consultants Ltd
Osprey House
Pacific Quay
Broadway
Manchester, M50 2UE
Tel: 0161 868 1300 / Fax: 0161 868 1301
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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
		MADE GROUND: Loose grey silty GRAVEL of ash and stone.	0.30					
		Firm to stiff brown CLAY with sandstone pieces.		D	0.50			
1.0				D	1.00			
			1.30					
		Firm to stiff grey/brown clayey SILT with some fine to medium sandstone.		D	1.50			
2.0				D	2.00			
3.0				D	3.00			
			3.90					
4.0		Brown clayey GRAVEL and cobbles of sub-angular to tabular sandstone.		B	4.00-4.50			
5.0				D	5.00			
			5.30					
		Borehole terminated at 5.30m bgl due to refusal.						
6.0								

Key

B. Bulk (Bag)	D. Disturbed	T. Plastic Tub
W. Water	G. Amber Glass Jar / Bottle	N. 'N' Value
U100. 100mm Undisturbed	CPT. Cone Penetration Test	HV. Hand Shear Vane
U38. 38mm Undisturbed Sample	U100. Blows (Recovery mm)	PID. Photo Ionisation Detector
SPT. Standard Penetration Test	V. 40ml Glass Vial	

Notes

Chiselling: 3.90m bgl-5.30m bgl for 30 minutes

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 5.30m bgl.

Date:

Status:

Borehole Record - Cable Percussion

Borehole Number: SBH 13

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 16/7/09

Date Completed: 16/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
		MADE GROUND: Reddish dark grey gravelly SAND of brick, sandstone, ash and coal.		D	0.50			
1.0		Firm grey/dark grey clayey SILT with sandy silt lenses and some fine to coarse sub-angular sandstone gravel. Becoming sandy SILT and more gravelly toward base of unit. Some fine coal fragments noted in sample D4 (3.5m).	0.90	D	1.20			
2.0				D	2.50			
3.0				D	3.50			
4.0		Grey silty sandy GRAVEL with some cobbles. Fine to coarse gravel and cobbles of sub-angular to tabular sandstone.	4.00	D	4.00			
			4.20	B	4.20-4.50			
			4.50					
5.0		Strong hydrocarbon odour. Grey slightly silty sandy GRAVEL and COBBLES of sub-angular to tabular sandstone. Strong hydrocarbon odour. Borehole terminated at 4.50m bgl due to refusal on obstruction of sandstone.						
6.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling:

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 4.20m bgl.

Date:

Status:

Borehole Record - Cable Percussion

Borehole Number: SBH 14

Project Number: 80132

Contract Name: Llandarcy

Client: St Modwen

Engineer: PT

Date Started: 16/7/09

Date Completed: 16/7/09

Elevation AOD (m): N/A

Co-ordinates: N/A

Drilling Equipment: Cable percussion



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SUBSURFACE PROFILE

SAMPLES AND IN-SITU TESTING

Depth (mbgl)	Legend	Description	Depth of Strata (mbgl)	Type	Depth (mbgl)	In-Situ Testing SPT / U100	Water Level (mbgl)	Monitoring Installation
1.0		MADE GROUND: Soft brown gravelly clayey SILT with frequent fine ash and coal fragments. Gravel of fine to coarse sandstone.		B	0.50			
				D	1.00			
			1.80					
2.0		Soft grey sandy CLAY/silty SAND with some fine to medium sandstone gravel. Strong hydrocarbon odour.		G V	2.00			
			3.00					
3.0		Brown-grey slightly silty sandy fine to coarse GRAVEL and cobbles of sub-angular to sub-rounded and tabular sandstone. Strong hydrocarbon odour.		G V	3.00			
					3.50			
4.0				G V	4.00			
			4.70					
5.0		Medium dense grey silty SAND with some fine sandstone gravel. Hydrocarbon odour.	5.00	D	5.00			
		Borehole terminated at 5.00m bgl.						
6.0								

Key

B. Bulk (Bag)

W. Water

U100. 100mm Undisturbed

U38. 38mm Undisturbed Sample

SPT. Standard Penetration Test

D. Disturbed

G. Amber Glass Jar / Bottle

CPT. Cone Penetration Test

U100. Blows (Recovery mm)

V. 40ml Glass Vial

T. Plastic Tub

N. 'N' Value

HV. Hand Shear Vane

PID. Photo Ionisation Detector

Notes

Chiselling:

Services: Prior to drilling the location was scanned with a Cable Avoidance Tool (CAT).

Addition of water: Limited amounts of water were added to aid drilling in hard strata.

Casing diameter: 150mm

Groundwater: Water strike at 3.00m bgl...2.9m bgl after 20 mins

Date: 12/8/09

Status: Prelim 1

Appendix B

DTP = Depth To Product
DTW = Depth To Water
Thickness = Thickness of product
Screened = BH screening details

Rap Feature 1 (A1-A2)																										
MSMW076			14-Aug-08	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11											
	Screened 6.8-12.5m	DTP																								
	Sandstone bedrock	DTW	9.264	9.110	9.150	9.200	9.41	9.04	9.41	9.75	9.72	9.06	9.60	9.43	9.50											
		Thickness																								
MSMW078d			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11											
	Screened 5.3-18.5m	DTP																								
	Sandstone bedrock	DTW	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.700	5.400	5.8	DRY	DRY											
		Thickness																								
MSMW078e			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11	19-Jul-11										
	Screened 0.8-4.3m	DTP		1.05	0.89	0.98	1.40	1.40	1.2	1.3	1.42															
	Natural soils	DTW	0.94	1.12	0.92	1.01	1.43	0.57	1.81	DRY	1.04	0.6	1.4	1.54	1.56	3.95										
		Thickness	0.080	0.070	0.030	0.020	0.03					0.25	0.2	0.24	0.24											
MSMW092			25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11												
		DTP																								
		DTW	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY											
		Thickness																								
MSTP243			14-Aug-08	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11													
	Screened 1.0 - 1.5m	DTP																								
	Natural soils	DTW	0.511	0.880	1.290	1.290	DRY	0.830	DRY	DRY	DRY	0.540	DRY													
		Thickness																								
NSMW001			19-Aug-08	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11											
	Screened 4.0-6.5m	DTP																								
	Sandstone bedrock	DTW	4.284	4.390	4.390	4.450	4.40	4.37	4.41	4.47	4.46	4.40	4.20	4.41	4.45											
		Thickness																								
NSMW002			14-Aug-08	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11	02-Oct-11	05-Dec-11	22-Feb-12	01-May-12	13-Jul-12	29-Aug-12	10-Oct-12	15-Nov-12			
	Screened 1.5-3.0m	DTP																								
	Sandstone bedrock	DTW	1.165	2.39	2.66	2.7	2.98	2.25	DRY	DRY	2.66	1.65	2.2	2.88	DRY	2.41	2.18	2.69	2.69	2.12	2.33	1.92	1.85			
		Thickness																								
NSMW013			14-Aug-08	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11	02-Oct-11	05-Dec-11	22-Feb-12	01-May-12	13-Jul-12	29-Aug-12	10-Oct-12	15-Nov-12	25-Apr-13	09-Jun-13	18-Sep-13
	Screened 3.0-11.5m	DTP																								
	Sandstone bedrock	DTW	4.378	2.63	3.65	3.71	3.83	3.01	3.68	4.21	2.75	3.06	3.75	3.5	3.02	4.06	3.33	3.44	2.28	2.04	2.34	2.42	2.54	3.02	2.95	2.11
		Thickness																								
RFSW035			19-Aug-08	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11	02-Oct-11	05-Dec-11	22-Feb-12	01-May-12	13-Jul-12	29-Aug-12	10-Oct-12	15-Nov-12	25-Apr-13	09-Jun-13	
	Screened 0.8-1.8m	DTP																								
	Natural soils	DTW	1.104	1.090	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	1.1	DRY	DRY	DRY	DRY	
		Thickness																								
SBH07			25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	24-Jan-11														
	Screened 2.0-4.9m	DTP																								
	Natural soils	DTW	2.29	2.47	2.6	2.61	2.13	2.62	2.87	2.68	1.65	2.01														
		Thickness																								

DTP = Depth To Product
DTW = Depth To Water
Thickness = Thickness of product
Screened = BH screening details

[illegible]

DTP = Depth To Product
DTW = Depth To Water
Thickness = Thickness of product
Screened = BH screening details

RAP Feature 1 (C1- C2)																											
MSMW051d			Sept RAP 2008	25-Aug-09	24-Jan-11	23-Mar-11	12-May-11	19-Jul-11	02-Oct-11	22-Feb-12	01-May-12	29-Aug-12	10-Oct-12	15-Nov-12	25-Apr-13	21-May-13	09-Jun-13										
	Screened 15.5-18.0m	DTP																									
	Natural soils	DTW	7.6	7.74	7.3	7.6	7.92	7.97	7.6	7.59	3.77	7.64	7.55	7.5	7.75	7.96	7.96										
		Thickness																									
MSMW051s			Sept RAP 2008	25-Aug-09	24-Jan-11	23-Mar-11	12-May-11	19-Jul-11	02-Oct-11	22-Feb-12	01-May-12	29-Aug-12	10-Oct-12	15-Nov-12	25-Apr-13	21-May-13	09-Jun-13										
	Screened 3.0-6.0m	DTP	2.88	3	2.94	3.6	3.04	2.89	2.8	2.71	2.7	2.68	2.7	2.71	2.88	2.95	2.95										
	Natural soils	DTW	2	3	3.04	3.13	3.13	3.13	2.84	2.84	2.85	2.77	2.84	2.84	2.9	2.96	2.96										
		Thickness	0.120	0.000	0.100	0.110	0.090	0.240	0.240	0.130	0.150	0.090	0.140	0.130	0.020	0.010	0.010										
MSMW052d			25-Aug-09	19-Jul-10																							
	Screened 18.5-20.6m	DTP																									
	Sandstone	DTW	3.06	1.83																							
		Thickness																									
MSMW052s			25-Aug-09																								
	Screened 3.0-5.0m	DTP																									
	Sandstone	DTW	2.21																								
		Thickness																									
RFSW001			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	10-May-10	23-Jun-10	19-Jul-10	23-Mar-11	12-May-11	19-Jul-11	02-Oct-11	05-Dec-11	22-Feb-12	01-May-12	25-Apr-13	21-May-13	09-Jun-13							
	Screened 0.6-4.5m	DTP																									
	Natural	DTW	2.78	3.4	2.97	2.95	3.17	2.44	3.62	3.02	3.15	3.02	2.77	3.07	3	3.03	2.8	3.14	3.12	2.8							
		Thickness																									
RFSW004			28-Aug-08	25-Aug-09	15-Jan-10																						
	Screened 0.6-2.0	DTP																									
	Natural	DTW	1.824	0.89	1.53																						
		Thickness																									
RFSW005			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	10-May-10	23-Jun-10	19-Jul-10	23-Mar-11	12-May-11	19-Jul-11	02-Oct-11	05-Dec-11	22-Feb-12	01-May-12	13-Jul-12	29-Aug-12	10-Oct-12	15-Nov-12	25-Apr-13	21-May-13	09-Jun-13				
	Screened 0.6-3.7m	DTP																									
	Natural	DTW	1.57	1.59	1.65	1.55	1.86	2.02	1.81	1.4	1.87	1.45	1.65	1.5	1.48	1.41	1.42	1.47	1.52	1.46	1.62	1.66	1.54				
		Thickness																									
RFSW011			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10																		
	Screened 1.0-3.6m	DTP																									
	Natural	DTW	1.26	1.2	1.35	1.42	1.47	1.42	1.45																		
		Thickness																									
RFSW012			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10																	
	Screened 1.3-4.5m	DTP																									
	Natural	DTW	2.38	1.28	1.48	1.49	1.64	3.78	1.58	1.7																	
		Thickness																									
RFSW014			Sept RAP 2008	25-Aug-09	15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	23-Mar-11	12-May-11	19-Jul-11	02-Oct-11	05-Dec-11	22-Feb-12	01-May-12	13-Jul-12	29-Aug-12	10-Oct-12	15-Nov-12	25-Apr-13	21-May-13	09-Jun-13		
	Screened 0.7-4.2m	DTP																									
	Natural	DTW	1.21	1.27	1.36	1.42	1.7	1.34	1.68	2.04	0.98	1.73	1.93	1.34	1.45	0.94	1.3	0.76	0.86	0.981	1.04	0.92	1.97	1.83	1.78		
		Thickness								0.01										0.001							
SBH04			25-Aug-09																								
	Screened 1.0-4.5m	DTP																									
	MCI Natural	DTW	1.470																								
		Thickness																									
WSMW002			10-May-10	19-Jul-10	14-Sep-10	24-Jan-11	23-Mar-11	12-May-11	19-Jul-11	02-Oct-11	05-Dec-11	01-May-12	29-Aug-12	10-Oct-12	25-Apr-13												
	Screened 1.0-3.5m	DTP																									
	Natural	DTW	2.06	2.68	2.90	1.8	2.6	2.4	2.31	1.98	1.56	1.41	1.81	1.48	1.81												
		Thickness																									
WSMW003			08-Apr-10	10-May-10																							
	Screened 1.0-4.0m	DTP																									
	Natural	DTW	2.40	2.71																							
		Thickness																									

DTP = Depth To Product
DTW = Depth To Water
Thickness = Thickness of product
Screened = BH screening details

[illegible]

DTP = Depth To Product
DTW = Depth To Water
Thickness = Thickness of product
Screened = BH screening details

C1-C2 (RAP Feature 24)																								
RFSW016			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13				
1.0-2.3 MG / Natural soils	DTP DTW Thickness		Not monitored	Not monitored	Dry	1.97	Dry	Not Monitored	Not Monitored	Not Monitored	Not Monitored	Not Monitored	Not Monitored	Not Monitored	Not Monitored	1.9	1.49	Not Monitored	1.67	1.44				
RFSW018			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13	17-Jul-13	14-Aug-13	18-Sep-13	
0.5-4.0 Natural soils	DTP DTW Thickness		2.20 2.21	2.29 2.30	2.60 2.61	1.77 1.9	2.68 2.73	3.15 3.4	2.29 2.61	1.7 1.8	2.36 2.6	2.3 2.52	3.01 3.25	2.65 2.89	Not Monitored	0.96 1.06	0.72 0.8	0.87 0.97	2.63 2.64	3.2 3.21	1.78	1.72	1.58	
RFSW019			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13	17-Jul-13	14-Aug-13	18-Sep-13	
0.7-4.0 Natural soils	DTP DTW Thickness		1.78	1.81	1.92	1.46	2.7	3.46	2.81	1.42	1.76	1.7	2.85	2.3	1.16	1.17	1.145	0.95	1.82	3.12	3.62	1.74	2.72	
RFSW020			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13	17-Jul-13	14-Aug-13	18-Sep-13	
1.1-4.7 Natural soils	DTP DTW Thickness		3.77	3.81	3.8	4.57	3.95	4.19	4.01	3.43	3.75	3.61	4.11	3.99	3.29	3.2	3.29	2.98	3.58	4.1	3.6	3.63	3.34	
MSMW071 S1			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13	17-Jul-13	14-Aug-13	18-Sep-13	
1.5-0.8 Natural soils	DTP DTW Thickness		1.52	1.52	1.48	1.62	1.72	Dry	1.37	1.5	1.63	1.6	1.44	1.31	1.32	3.11	1.06	1.06	1.06	1.58	Not Monitored	3.47	3.78	
MSMW071 S2			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13				
4.1-5.0 Made Ground	DTP DTW Thickness		3.52	3.55	3.58	3.5	3.62	3.72	3.47	3.4	3.57	3.5	2.45	2.01	Dry/Blocked	1.13	3.065	3.05	3.065	3.6				
MSMW071 D			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12							
6.7-10.0 Natural soils	DTP DTW Thickness		5.55	5.7	5.68	5.55	5.64	5.73	5.6	5.51	5.68	5.5	6.17	6.04	6.11	3.49	Blocked							
SBH12			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13					
2.0 - 5.0 Natural soils	DTP DTW Thickness		3.66	3.75	4.17	3.78	4.2	4.5	3.95	3.53	4	3.86	Not Monitored	Not Monitored	Not Monitored	Not Monitored	Not Monitored	Not Monitored	3.41					
SBH13			15-Jan-10	02-Feb-10	16-Mar-10	12-Apr-10	10-May-10	23-Jun-10	19-Jul-10	14-Sep-10	19-Oct-10	24-Jan-11	12-May-11	19-Jul-11	05-Dec-11	22-Feb-12	29-Aug-12	15-Nov-12	25-Apr-13	19-Jun-13	17-Jul-13	14-Aug-13	18-Sep-13	
1.5 - 4.5 Natural soils	DTP DTW Thickness		2.42	2.45	2.71	2.25	2.27	3.16	2.86	1.51	2.48	Not Monitored	3.05	2.55	1.73	1.46	1.568	1.46	3.12	2.49	3.21	2.91	1.72	

Coed Darcy

RA Features

Western Margin RA Works Assessment Report

Notice

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References

Ref 1- Coed Darcy Remedial Action Plan

Ref 2 – S106 Deed of Planning Obligations – NPTC, Coed Darcy Limited, St Modwen Developments Ltd, St Modwens Properties plc and BP Oil Llandarcy Refinery Limited, 2008

Ref 3 – British Geological Survey Sheet 247, Swansea, 1:50,000 Solid and Drift Edition

Ref 4 – 1:10,560 British Geological Survey Map of SS79NW Solid and Drift Composite, 1951

Ref 5 – FR1287 Whole site investigation complete report (URS 2005)

Ref 6 - Llandarcy Desk Study_44382742_BRRP0001 (URS 2007)

List of drawings

5041216-RAP-DWG-0433 – Western Margin RAP Features
5041216-RAP-DWG-503 – Geological Cross-sections through the Process Area and Western Margin
5041216-DIME-DWG-728 – Historical Exploratory Holes with Evidence of Free Product
5041216-DIME-DWG-729 – Historical Exploratory Holes with Recent Evidence of Free Product
5041216-RAP-DWG-0817 – Historical Uses of the Process Area and Western Margin
5041216-REM-DWG-863 – Western Margin Water Seepage Assessment
5041216-REM-DWG-864 – Composite Exploratory Hole Location Plan
5041216-REM-DWG-1149 – Plan of Western Margin & Adjacent Area
5041216-REM-DWG-1164 – Western Margin Phase Boundaries 2-5
1332/400/MP/SK/TECT – Coed Darcy Urban Village Development Masterplan, Alan Baxter

Appendix A – Sump Monitoring Data

Appendix B – Historical Borehole Monitoring Data

Appendix C – URS Exploratory Hole Logs

Appendix D – Atkins Exploratory Hole Logs

1. Introduction

1.1 General

Atkins Limited was commissioned by St. Modwen Developments Ltd to provide consultancy advice with regards to the works and in general for the re-development of the former Llandarcy Oil Refinery.

The purpose of this report is to assess whether there is free product present and whether there is a need for the construction of permanent oil recovery features to replace the temporary features currently installed. The phase boundaries for RAP Features 2, 3, 4, & 5 are shown on Drawing 5011216-RAP-DWG-1164.

The Remedial Action Plan (RAP) works (Ref. 1), as listed within the S106 (Ref. 2) for the Western Margin, details the proposed installation of a permanent system to intercept and recover free product to prevent the migration of oil off-site. The proposed remedial solution comprised the installation of four interception trench systems listed as items 2, 3, 4 and 5 on Drawing 5041216-RAP-DWG-433, with a 200m linear wetland feature included as part of RAP Feature 2.

The scope of currently envisaged remedial actions for RAP Features 2 to 5, as described in the S106 agreement, is as follows:

Product interception and recovery, consisting of the following programme elements:

1. *Design-level investigations to assess specific requirements (RAP 2, 3, 4 & 5)*
2. *Design and installation of permanent system to intercept and recover free-phase product (RAP 2, 3, 4 & 5)*
3. *Diffuse discharge of water arising from interception system to Bog, via purpose-constructed wetland features. (RAP 2)*
4. *System specific monitoring of surface and groundwater (RAP 2, 3, 4 & 5)*

The performance criteria for RAP Features 2, 3, 4 and 5 and the proposed wetland feature within the S106 (Ref. 2) states the following:

- *Install permanent measures to prevent free product from crossing the site boundary and entering Crymlyn Bog to the satisfaction of the Environment Agency (EA) and Countryside Council for Wales (CCW), (RAP 2, 3 & 5)*
- *Diffuse discharge of water arising from interception system to the Crymlyn Bog, via a purpose-constructed wetland features to reduce dissolved hydrocarbon load and without the requirement for a discharge consent, (RAP 2) and*
- *Prevent ochreous precipitate discharges from site to the Crymlyn Bog arising from the interception feature. (RAP 2)*
- *Install permanent system to prevent free product migration to railhead to satisfaction of EA and NPT (RAP 4)*

The performance criteria and RAP features identified within the S106 were developed on the assumption that the former refinery would remain undeveloped. As such, the primary objective of the proposed RAP works was to deal with potential statutory liabilities associated with the site and any remaining contamination. The requirement for a series of interception features along the western margin of the site was, therefore, largely proposed in order to provide protection from migrating oil into the Crymlyn Bog SSSI to the west.

The former refinery is, however, now proposed for redevelopment. The most recent Masterplan for the former refinery (Alan Baxter Drawing No. 1332/400/MP/SK/TECT) suggests the presence of residential housing within the Western Margin which will increase the scope of any remediation works required in this part of the site as follows:

- *All oil saturated soil should be removed.*
- *All soils must be remediated so as to meet the RBSLs for TPH, BTEX and PAHs at the relevant depth relative to FFL and the aesthetic criteria Class 2 or better at greater than 1m below FFL.*
- *The aesthetic quality of soils shall be Class 1 or better for at least the first metre below FFL.*
- *Soils where there is visible ash and clinker, or metal concentrations above RBSLs, are to be removed so that none is retained within the first metre below FFL in garden areas*
- *Where it is not practicable to address groundwater contamination within bedrock this must be controlled, e.g. where seeps, sheens and iron staining discharge from the bedrock. Acceptable methodologies for remediation may include, but are not limited to, the use of land drainage via interceptors. Control measures should result in no visible discharge at surface and little or no odour observable.*
- *All soil potentially containing dispersed asbestos fibres or visible ACM must be removed or remediated to meet in bulk, considering both dispersed fibres and pieces of ACM, the appropriate ACM RBSL, or to meet the requirements of relevant Environmental Authorities, whichever is the more conservative.*

A residential end use will ultimately minimise the risks associated with any the migration of remaining contamination towards the adjacent SSSI. The area around RAP Feature 2 remains shown to lie within an area designated as 'accessible green space' within the most recent Masterplan.

This report has been prepared to demonstrate an understanding of ground conditions along the Western Margin and to provide an assessment of the need for free product interception and recovery, as proposed in the S106.

1.2 Limitations

This report and geological cross sections are based on available existing information and the findings of exploratory hole logs largely carried out by third parties. The accuracy of third party borehole logs has not been verified and it has been necessary, on occasion, for Atkins to reassess previous interpretation of geological units.

2. Site Setting

2.1 Site Location

Coed Darcy is located to the west of Junction 43 on the M4 Motorway in Port Talbot, South Wales.

The locations of RAP Features 2, 3, 4 & 5 are presented on Drawing 5041216-RAP-DWG-433. The phase boundaries for RAP Features 2, 3, 4 & 5 are presented on Drawing 5041216-RAP-DWG-864. These all lie along the western boundary of the former refinery, known as the Western Margin.

The approximate Ordnance Survey National Grid Reference for the Western Margin is SS707959.

2.2 Site Description

The Western Margin relates to the western parts of the former refinery, immediately adjacent to Crymlyn Bog to the west (refer to Drawing 5041216-RAP-DWG-0864). Existing slopes within this area are well vegetated and blend indistinctly towards the base of the slopes into Crymlyn Bog SSSI.

The Western Margin comprises an area of former railway sidings (Railhead Area), which lie on an existing embankment, associated with historical terracing operations.

The Railhead Area lies at a level of approximately 27.5m AOD and sweeps in a southerly arc from the intersection of the former sidings with the Great Western Mainline Railway.

2.3 Surrounding Area

The main processing area of the former refinery lies to the east of the Western Margin and lies at a higher level (~65m to 72.5mAOD), formed by excavation and filling works upon an east-west trending sandstone ridge to create a series of plateaux/working areas. Former buildings and the majority of structures associated with the former oil refinery operations have been demolished to ground level and remediation works are ongoing across this area.

A tank farm, used for the mass storage of oil, was located on the western side of the main processing area, upslope of the western margin. Sandstone bedrock is visible across parts of this area from which ochreous discharges are noted to emanate (see Drawing 5041216-RAP-DWG-863).

The South Site Reservoir (SSR), Triangular Separator (oil-water separator which fed into the SSR) and the Crymlyn Bog form the areas to the north and west of the Railhead Area and Western Margin.

The Crymlyn Bog is located to the west of the Western Margin and is designated as a Site of Special Scientific Interest (SSSI), a Ramsar site and a Special Area of Conservation (SAC).

2.4 Historical Site Use and Sources of Contamination

Details of historical operations within the Western Margin, Railhead and Process Area of the site are shown on drawing 5041216-RAP-DWG-000817. The drawing is based on the BP Refinery (Llandarcy) Ltd Drawing 02-01-133.

The location of the proposed RAP Features 2, 3, 4 & 5 is shown on 5041216-RAP-DWG-000433.

Main Process Area

The Main Process Area housed a number of refinery operations including the cracking and blending of hydrocarbons. The URS Desk Study Report (Ref. 5) contains historical plans showing the layout of the site and activities undertaken. Notable activities/buildings located within the Process Area include a hydrofiner unit, a sulphur recovery unit, catalytic reformer and a catalytic cracking plant. During the years that the site was operational the majority of the Process Area

was covered with concrete or tarmac hardstanding. The majority of surface spills and leaks within this area are likely to have migrated overland, prior to collection within a dedicated recovery system or via the refineries surface water drainage system. Due to the activities undertaken within the Process Area, sources of contamination are considered likely to have arisen due to damage of underground pipes and the drainage system.

Contaminants which did enter the ground across the majority of the Process Area are likely to have migrated northwards, down slope, towards the DiMe Area rather than towards the Western Margin.

The barrelling plant and lube oil filling areas were located towards the toe of the slope adjacent to the Railhead Area between 22.5m and 32.5mAOD. The barrelling plant was in operation between approximately 1940 and 1960 and was located near the northern end of the proposed RAP 5 trench. The barrelling plant dealt with the barrelling of gasoline range products and is understood to have been operational 24 hours a day during the Second World War. An oil pump house with two dozen tanks and a railcar loading station were also located towards the southern end of the proposed location of RAP 5 trench. The pump house is understood to have been constructed before WWII. The area was mainly used for filling and emptying tanks with/of lubricating oil.

The majority of surface spills and leaks within this area will have migrated overland towards the Railhead Area prior to collection within a dedicated recovery system or via the refineries surface water drainage system due to the hardstanding covering.

Bitumen Plant and Site haul Road

The Bitumen Plant was located to the east of the Railhead Area and lies at a level of approximately 40mAOD. Operations at the Bitumen Plant ceased in June 2009. The plant comprised a number of buildings, large storage tanks and cooling bays.

A sulphur dispatch unit was located to the west of the Bitumen Plant. Similarly to the Main processing area, the majority of surface spills and leaks within this area should have been collected within a dedicated recovery system or via the refineries surface water drainage system due to the hardstanding covering.

The Railhead Area

The Railhead Area itself historically housed a number of sidings, gantries and machinery associated with the loading and unloading of railcars used to move goods and materials to and from site.

It is understood that the Railhead Area was created largely as a result of filling operations, rather than excavation, in order to create a level platform.

South Site Reservoir

The South Site Reservoir is located to the north-west of the Railhead Area, at a level below the railhead area at an elevation of approximately 20mAOD.

The reservoir was used to store process water emanating from an oil separator located between the triangular spurs of the rail lines. It was constructed before the 1930s and remains in place today but is no longer connected to the main site drainage system. The reservoir is understood to be fed by groundwater flow and the limited outflow discharges to the Tal-y-Fedw discharge point. A pump house was also located to the south of the South Site Reservoir.

2.5 Historical Services

A number of services have been recorded within the area and these are presented on Drawing No 5041216/ENG/114.

2.6 Historical Evidence of Contamination

The former refinery has been subject to a number of historical investigations. Drawing 5041216-DIME-DWG-728, prepared by Atkins, shows the location of historical boreholes within the Western

Margin and Railhead area which are recorded as having visual and or olfactory evidence of free product in either recoverable quantities or in the form of oily sheens or droplets on the surface of groundwater.

Staining was recorded predominantly within the Glacial Deposits underlying the Made Ground.

Boreholes MSMW109 and MSMW119D, located near the former Lube Oil Pumping Plant and down slope of the tank farm, noted evidence of heavy hydrocarbon contamination. Free product, was generally recorded at the interface between the Made Ground and the underlying Glacial Deposits.

Evidence of free product (predominantly at the interface of the Made Ground and Glacial Deposits) was recorded within three exploratory holes (WSTP071, MSMW105 and WSMW006) close to the former barrelling plant.

Exploratory hole data around the Bitumen Plant is limited due to the plant remaining operational until June 2009. Free product was recorded within the upper sections of the slightly granular Glacial Deposits in several boreholes located within the triangular spurs.

Hydrocarbon contamination has been recorded in the areas of the former railhead tankage and, pipetracks. Where present, contamination tended to be more prevalent in shallow soils than at depth.

Benzene was noted in samples from 12 locations, at concentrations up to 103 mg/kg and at concentrations in groundwater between 100 and 1000 µg/l. Concentrations increase to 1,000 and 10,000 µg/l close to Crymlyn Bog.

Areas of limited historical use, such as the open ground west of the bitumen plant and former sulphur recovery operation had modest levels of contamination. PAH in shallow samples (<1mbgl) were noted at concentrations above 1mg/kg in ten locations in this zone

Section 3 provides a brief summary of the geological model, which is further developed in Section 4. Reference has been made to British Geological Survey Sheet 247 (Ref. 3), the URS Site Investigation Report for BP Llandarcy (Ref. 5) and available exploratory hole records for the Western Margin and Process Area.

5041216-RAP-DWG-503 presents the geological cross sections through Process Area and Western Margin, which are based upon the findings of the exploratory holes.

The historical groundwater dip data for the exploratory holes along the Western Margin and within up gradient process area records a number of wells as containing free product. Drawing 5041216-RAP-DWG-728 shows the location of the wells with either recoverable free product or evidence of free product (sheens).

South Site Reservoir (SSR) is understood to have contained hydrocarbon impacted sludge that would have accumulated while the refinery was in operation as part of the site drainage. The SSR also would have collected any residual oil from leaks and spillages that may have migrated into the reservoir. The sludge from SSR was removed in June 2011 and to date no peripheral seepages of oil have been recorded within the remediated water body indicating an absence of free oil within the Western Margin adjacent to the reservoir.

3. Geology, Hydrology and Hydrogeology

3.1 Geology

Sitewide

The British Geological Map Sheet 247 (Ref. 3) and the 1:10,000 geological map (Ref. 4) shows Glacial Till blanketing the former refinery. The solid geology comprises the Hughes Beds (mudstones, siltstones, and sandstones) and Hughes Sandstones, of the Upper Coal Measures with occasional minor coal seams. The bedrock dips in a northerly direction beneath the site.

The Coed Darcy development is crossed by faults to the north, east, south and west. The site has been extensively mined for coal beneath both the southern Tank Farm Area, and the former Process Area, although the workings are believed to have been at depth beneath the site. In addition to observations of the bedrock in the exploratory borings, considerable bedrock exposure exists on the main site, which has allowed for confirmation of the lithologies and detailed evaluation of the strike and dip of the formation and tectonic structures.

During URS' initial Stage 1 work in 1998 (Ref. 5), numerous measurements were collected from bedrock exposures situated in the South Site Tank Farm, Top Terrace, Warehouse and Stores Area, Process Area, Railhead Area, and North Site. The geological information provided within the URS Whole Site Investigation Report 2005 (Ref. 6) for Coed Darcy has been summarised by Atkins below.

The formation was observed to be massively bedded, well-cemented, indurated sandstone, blue-grey on fresh faces but rapidly oxidising to dark rust brown. Well developed cross-bedding structures were observed at exposures. Occasional finer, siltstone layers were observed, though no coal, seat earth, et cetera was observed in the bedrock exposures.

The strike of the formation was observed to be within 20 degrees of an east-west alignment and dipping gently north at between 12 - 20 degrees. Well developed joint sets and other fracture planes were also noted with the two most developed orthogonal sets being aligned north-northeast and west-northwest with a number other less developed sets also being observed. Dips were generally close to vertical in the major fracture sets.

Minor faults were observed in the cores recovered from the boreholes. The continuous core showed evidence for the presence of faulting in the lithologies, the structure, slickensides and brecciated breaks in the sequence. The weathered zone at the top of the rock was clearly visible as were near vertical fracture sets. The lithologies observed confirmed the presence of the Pennant Sandstone Formation. In addition to the massive sandstone, siltstone, seatearth and coal were observed as well as slough/slump structures.

Crymlyn Bog, to the west of the Western Margin, is indicated as being underlain by Peat.

Western Margin

The Western Margin (see Drawing 5041216-RAP-DWG-1149) is characterised by the steep slopes around the base of an existing sandstone ridge upon which the main processing area for the refinery was located.

The geology beneath the Western Margin is complex, the result of variable thicknesses (between 0.15 – 9.0m) of made ground and overburden overlying a bedrock bluff which is sufficiently shallow to outcrop at a number of locations.

Glacial Deposits within this part of this site typically comprise sandy gravelly silts with occasional cobbles and boulders, predominantly of sandstone.

The principal manmade influence on the overburden thickness within the Western Margin is the presence of former railway sidings, which have been built up to form a platform, on what would otherwise have been a steep slope down towards Crymlyn bog. The embankment is formed from

a significant thickness of ash and other fill materials which may be up to 10 metres thick in places, overlying glacial soils of similar composition to those noted elsewhere on site, or bedrock.

In the north of the western margin the ashy material has been used not only beneath the railway, but also beneath the main pipe track that runs parallel to the railway leading to the bitumen plant. Ash and clinker has been observed principally beneath the railway and pipe track locations, and only sporadically elsewhere within the remainder of the northern part of the western margin.

The southern part of the western margin is characterised by natural and occasionally reworked silty soils, with only occasional accumulations of ash, typically in areas where infrastructure once existed, i.e., beneath pipe tracks, road embankments, etc.

To demonstrate the variation within this area, ground conditions beneath three areas of the Western Margin have been assessed in more detail, as discussed below:

Bitumen Plant

The former Bitumen Plant lies to the East of the Western Margin (refer to Drawing 5041216-RAP-DWG-1149).

As a result of its continued use up until June 2009, the exploratory hole coverage for the Bitumen Plant is limited. Assessment of the geology underlying the Bitumen Plant is, therefore, predominantly based upon data collated from boreholes located around the periphery of the former plant.

Made Ground within this area varies between 0.2m and 4.0m, with the thickest Made Ground noted near the Site Haul Road and along the sloped ground down to the former rail tracks where ground level was likely increased in order to construct a development plateau. As with Made Ground across the site ash and clinker was noted to be prevalent throughout the Made Ground.

Where encountered, the Glacial Deposits underlying the Made Ground ranged between 3.3m and 13.6m in thickness. The thickest Glacial Deposits were recorded in the east of the Bitumen Plant. Glacial Deposits in the area of the Bitumen Plant predominantly comprise clays with varying proportions of sand and gravel and increasing in cobble and boulder content with depth.

Where proven, sandstone bedrock underlies the Bitumen Plant between 6.5m and 19m. Bedrock appears to be at a greater depth in the north of the Bitumen plant.

Railhead Area and Site Haul Road

This area represents the central part of the Western Margin.

The topography of this area is characterised by the steep slopes around the base of the hill upon which the main process area was founded. The geology within the area is highly variable due to a bedrock bluff which outcrops at a number of locations, particularly along Tank Farm Road and near the former access track to the LPG storage facility in the south of this area.

The predominant manmade influence within this area was the construction of the Railhead Area on what was historically a steeply sloping hillside running down towards the Crymlyn Bog. The Railhead Area and embankment has been constructed upon a significant thickness of ashy Made Ground, which is understood to be up to 10m thick in places. Made Ground along the line of the site haul road appears to comprise re-worked Glacial Deposits similar in composition to those identified within the other areas around the former refinery.

Thin coal bands, approximately 0.2m thick, have been recorded within boreholes in this area. There is no evidence of these having historically been worked.

Crymlyn Bog and South Site Reservoir

This area represents the lower part of the Western Margin.

The geology within this area is generally reflective of pre-refinery conditions, with topsoil present overlying the Glacial Deposits which are noted as being sandier in the area around the South Site

Reservoir. Bedrock is also shallow in the area surrounding the reservoir, having been encountered at approximately 3m bgl.

Some ashy material is present along the track which leads down to the Crymlyn Bog. No historical development took place within this area suggesting the ash is likely to have been placed during the construction of the plateaux for the Railhead Area

3.2 Hydrology and Hydrogeology

In terms of natural hydrology, most surface water from the former is inferred as flowing generally westwards, discharging to the Crymlyn Bog catchment, either as surface water channels or as seepages from the toe of the slopes where the water table within the glacial and bedrock units reaches the surface and drains to the bog.

The remaining natural discharge from the site occurs to the east towards the River Neath catchment.

The URS Whole Site Investigation Complete Report, 2005 (Ref. 6) outlines the hydrogeological activity as a discontinuous shallow water body within the overburden materials and as a groundwater table at depth within the bedrock.

The deep groundwater regime flows within the sandstone bedrock and predominantly follows the topography of the site either flowing north towards the railway cutting, north-west towards the South Site Reservoir or west towards the Crymlyn Bog.

URS state that the sandstone bedrock provides a continuous geological unit beneath the entire site, with the water table generally a few metres below ground and mimicking the topography of the site. Groundwater is resident in fractures within the rock resulting from bedding structures, and structural features. The distribution of the fractures means that the permeability is likely to be highly variable, however, the specific yield is generally low.

A long-term aquifer pumping test was performed by URS in the sandstone at the main site. Drawdown and recovery analysis indicated permeability's ranging from 0.1 m/d to 2.3 m/d with a geometric mean value of 0.7 m/d. Storage values were low, with a geometric average value of 0.005, reflecting the low percentage of storage within the fractures.

Rising head slug tests were also performed on wells installed within the sandstone bedrock. Values for the bedrock at the main site range from 0.001 m/d up to 6.7 m/d, with a geometric mean value of 0.65m/d. The permeability is expected to be represented almost entirely by the fractures in the rock, rather than by the rock matrix, which may also account for the variability observed.

In lower lying areas of the site, the groundwater within the bedrock is often observed to be confined, i.e., trapped beneath the overlying overburden, such that groundwater is artesian or sub-artesian. Due to the low specific yield, the bedrock is likely to be sensitive to recharge and the fluctuation in groundwater levels has been observed to be several metres in areas of high ground.

In addition to the bedrock, groundwater has also been observed in the overlying glacial soils, although these units are generally believed to be laterally discontinuous. Glacial materials are generally of low permeability, and the presence of groundwater is generally dependent on the presence of sandy or gravelly materials. The mobile water table is generally quite shallow (0.5 - 2.5m) in the glacial units, and during prolonged dry spells, some boreholes have been observed to go dry.

Groundwater is present in the overburden, and is variable in depth consistent with the degree of filling and reworking of the soils, as well as the soil type. It is likely that as well as flowing within more permeable stringers within the glacial soils, groundwater flows along the top of the natural soil/base of the fill, especially where ashy fill material is present.

Evidence for this is noted as seepages from the toe of the slopes along the Western Margin, at its boundary with Crymlyn Bog. Such seepages are also common to the east of the railhead where

the site topography is steepest, the bedrock is closest to the surface, and the wedge of scree acts to convey groundwater quickly to the surface. These seepages are characterised by iron precipitation (ochre) and staining where the road and railhead had been cut into the hillside. This is likely have tapped into a natural springline where there is increased connectivity with the underlying regional groundwater in the bedrock. Hydrocarbon sheens have occasionally been noted in this area.

A number of rising head tests have been conducted on wells installed within the made ground and glacial deposits across the site. Values for the made ground and glacial deposits ranged from 0.006 m/d to 14.1 m/d, with a geometric mean value of 1.3 m/d. It should be noted, however, that monitoring wells were purposely installed in productive units within the drift and made ground unit and unlike the bedrock are therefore probably unrepresentative (i.e. much higher than) of the mean hydraulic conductivity of the glacial drift considered as a single hydrogeological unit. That the glacial drift is acting as a confining layer to fluids within the bedrock suggests considerably less permeability.

3.3 Simplified Geological Model for the Western Margin

A review of the topographical and geological data for the Western Margin, in conjunction with information contained within the URS Site Investigation Report (Ref. 5), indicates the topography from the Process Area to the Western Margin varies considerably by up to 60m. Drawing 5041216-RAP-DWG-503 shows indicative cross sections from the Process Area to the western-side of the Western Margin. The thickness of the Made Ground is not continuous.

The depth to bedrock along the Western Margin is relatively deep compared to adjacent areas such as the Process Area. Based upon available historical exploratory hole data the depth to bedrock on the western-side of the railway line and within the Bitumen Plant is typically in excess of 5m.

Within the area surrounding the former lube oil pump house and barrelling plant, the depth to bedrock is typically between 3m and 5m becoming shallower upslope towards the former Process Area. Shallow bedrock was also encountered along the line of the site haul road within the south of the Western Margin area.

Given the depth to bedrock within the Western Margin a substantial thickness of Made Ground and Glacial Deposits is anticipated. Thicker Made Ground has been recorded within historically developed areas where buildings/structures were formerly present or in locations such as the Railhead Area where the ground level was raised using ashy material to create a suitable development plateau. The Glacial Deposits are believed to be near continuous running from the former Process Area to the western boundary as indicated on Drawing 5041216-RAP-DWG-503.

4. Future Development

The current masterplan for the Coed Darcy Urban Village Development proposes residential development upon the Railhead Area, as shown on the Alan Baxter drawing “1332/400/MP/SK/TECT”. Detailed development proposals relating to this area, including proposed layouts and finished development levels are, however, not known at the date of this report.

The proposed construction of residential housing across this area is anticipated to require remediation, as per the requirements of the S106 (detailed in Section 1.1) and including the removal of relict hardstanding and obstructions. On completion, remedial works would require validation in order to demonstrate the removal of contamination and to demonstrate the suitability of these areas for redevelopment.

The proposed redevelopment of this area, in the long term, will result in a significant reduction in the volume of any remaining contamination within the former refinery and, as such, help to minimise the long term risks to the SSI associated with the migration of free product off site.

5. Works Undertaken by Atkins

5.1 General

Supplementary fieldwork has been carried out, by Atkins, in three phases between 27th May 2009 and winter 2010 in order to obtain recent information on the volumes of free product within the Made Ground/Glacial Deposits in the areas of RAP Features 2, 3, 4 and 5.

The works comprised the following:

- A series of trial pits were excavated within the proposed locations of the RAP Features 2, 3, 4 and 5, to replicate the interception trenches. A total of thirty one trial pits were excavated and twenty six were left open, to enable monitoring of the free product / groundwater ingress.
- 18 sumps were installed within the approximate locations of RAP2-RAP5 to replace the open trial pits carried out during the first phase of the investigation.
- A large interception trench was installed along the majority of the length of the Western Margin at the toe of the embankment which Tank Farm Road sits atop.

The information recorded during the monitoring of these features would indicate whether the construction of permanent interception features was necessary or whether continued monitoring and oil recovery (where required) of the temporary features would be sufficient.

5.2 Groundwater Monitoring Data

Atkins has carried out ongoing monitoring of the historical exploratory boreholes installed by URS. A complete list of monitoring data for historical boreholes is included within Appendix B. Atkins has also reviewed historical information for exploratory hole installed by URS. Drawing 5041216-RAP-DWG-728 shows exploratory hole locations and highlights the ones having recorded evidence of free product since their installation or during subsequent monitoring by URS (from 1997 to 2005). The results of historical monitoring indicated the presence of free product, or evidence of free product, in a number of wells within the vicinity of RAP Feature 2.

The findings of recent monitoring by Atkins from April 2009 to January 2012 are shown on Drawing 5041216-RAP-DWG-729. Comparison of this recent monitoring with the extent of product recorded historically (Drawing 5041216-RAP-DWG-728) indicates a marked reduction in the number of wells containing free product along the Western Margin and within the up gradient process area.

5.3 Trial Pitting Works Summer 2009

Following an initial review of the available historical data for the Western Margin, it was considered necessary to undertake additional investigation and secure existing pits to allow a monitoring programme. The monitoring pits were designed to replicate the shallow (likely to be perched) groundwater ingress to interception trenches by intercepting the free product / shallow groundwater off-site towards the Crymlyn Bog.

Thirty one trial pits (MP201-209, MP301-306, MP401-404 and MP501-509) were excavated, predominantly within the Railhead Area, as shown in drawing 5041216-REM-DWG-864. The trial pits were excavated on the 27th and 28th May, 18th June and 9th July 2009 and were positioned along the proposed lines of the RAP Features 2, 3, 4 & 5.

The logs for the trial pits are presented in Appendix D.

RA Trench

- Nine trial pits MP201-209, were positioned along the proposed location of RAP 2 trench. The trial pits were excavated along a footpath running parallel to both the Railhead Area and the boundary with the Crymlyn Bog.
- The trial pits recorded ashy Made Ground to depths of between 0.3m (MP202) and 1.5m (MP201). The base of the Made Ground was not proven in trial pits MP206-209. Glacial Till was proven underlying the Made Ground in three of the trial pits (MP201, 202 and 205) but was not proven beyond 2.0m (MP202) and 3.0m (MP205) due to either pit collapse or shallow groundwater ingress.
- Black hydrocarbon staining and odours were noted within the Glacial Deposits in the three pits and. Free product was observed within the groundwater entering MP208, at a depth of 1.3m bgl. These monitoring pits are localised in the northern part of RAP Feature 2.

RA Trench

- Trial pits MP301-306 were positioned along the proposed location of RAP 3 trench. The trial pits were excavated along the former railway sidings, west of the former Barrelling Plant.
- The trial pits recorded a thin layer of Made Ground to depths of between 0.3m (MP301, 302 & 304) and 0.5m (MP303). The Made Ground predominantly comprised coarse gravel of sandstone.
- Thin layers of ashy Made Ground were recorded in MP303 (0.2-0.5m) and MP304 (0.2-0.3m) underlying the granular Made Ground. Glacial Deposits underlie the Made Ground in the six trial pits but was not proven beyond 2.8m (MP303). Hydrocarbon staining and odours were noted throughout the Glacial Deposits underlying the Made Ground in trial pits MP301-306. These monitoring pits are localised and are adjacent to RAP Feature 3. No recoverable mobile free phase was observed.

RA Feature

- Four trial pits MP401-404 were positioned along the proposed location of RAP 4 trench, at the northern end of the Western Margin. The trial pits were excavated on the eastward spur of the on-site railway lines, where the two lines split.
- The trial pits recorded Made Ground to depths of between 0.3m (MP401) and 0.5m (MP402), comprising 0.2m layer of coarse sandstone gravel which was in turn underlain by between 0.1m to 0.3m thickness of black ashy gravel.
- Glacial Deposits were found to underlie the Made Ground in the four trial pits but was not proven beyond 2.5m (MP403). Hydrocarbon odours and staining were noted within the underlying Glacial Deposits within trial pits MP401-404. No recoverable mobile free phase was observed.

RA Feature

- Trial pits MP501-505 were positioned along the approximate proposed location of RAP 5 trench, at the northern end of the Railhead Area, west of the former Lube Oil Pumping Plant and Tank Farm. Trial pits MP506-512 were positioned along the railway line further to the west and south-west.
- Made Ground was absent in trial pits MP501-505. In the remaining trial pits, the Made Ground typically comprised a 0.2m thick layer of coarse sandstone gravel underlain by 0.1m of ashy material.
- Glacial Till was proven underlying the Made Ground and from the surface in MP501-505. In two of the trial pits the base of the Glacial Deposits was proven to extend to depths of up to 2.8m (MP503) and 3m (MP504), where sandstone bedrock was encountered. The base of the Made Ground was not proven in the remaining ten trial pits.

- Hydrocarbon staining and light odours were noted in all monitoring pits within the underlying Glacial Deposits recorded at depths ranging between 0.2m and 2.5m. No recoverable mobile free phase was observed.
- Following the excavation, the area surrounding each trial pit was secured with fencing and the trial pits left open to allow weekly monitoring of the groundwater entering the pit.

Monitoring Results

The results of the monitoring carried out on the excavated pits are summarised in the following section. A full list of the monitoring results is presented within Appendix A.

RA

- Evidence of free product was observed within five of the nine trial pits during the first monitoring round. This was recorded as free product covering the surface of groundwater present in MP207 and MP208 and which remained on the surface of MP207 for the duration of the monitoring program. In monitoring pit MP202, MP203 and MP206, product was described as comprising droplets on the surface of the groundwater or as a sheen. After the first visit and subsequent oil recovery no free product was recorded within MP203 and 206. The volume of recoverable oil was not sufficient to justify the continuation of oil recovery in the area.
- No evidence of free product was recorded within MP201, MP204, MP205 and MP209 during the monitoring.
- Ochreous discharge or water discolouration was recorded in MP203 and MP204 during the first monitoring visit.

RA

- Evidence of a hydrocarbon sheen was recorded within trial pits MP302, MP303 and MP304 for the duration of the monitoring programme. Ochreous discolouration was also noted in the groundwater within MP302 but absent in MP303 and MP304.
- Trial pits MP305 and 306 were excavated on 9 July 2008 and remained open for one monitoring round on the 10 July 2009. Evidence of hydrocarbon was not recorded within MP305 but an ochreous discolouration was noted whilst MP306 remained clear.
- Ochreous discolouration was noted in MP301 during the monitoring visits.

RA

- Trial pits along RAP Feature 4 were excavated on 9 July 2009 and remained open for one monitoring round on the 15 July 2009.
- Hydrocarbon droplets and a sheen were noted on trial pits MP401-MP404 during the monitoring visit.

RA

- Trial pits MP501- MP505 were backfilled after excavation. Evidence of a hydrocarbon sheen was noted within MP506-MP508 and MP512.
- Monitoring pit MP507 recorded a free product discharge at the base of the ashy Made Ground during the first monitoring visit. However during subsequent visits only a product sheen was recorded. Ochreous discharges were recorded in MP506.
- Evidence of hydrocarbon or ochreous discharge was not recorded in the water within monitoring pits MP509-MP511 during monitoring.

5.4 Draw Down Tests (autumn 2009)

Draw down tests were carried out in ten of the existing historical exploratory holes located along the Western Margin.

The tests were undertaken in order to determine whether free product recorded within the exploratory holes recharged and was representative of a large plume of product locally or whether it was representative of a smaller volume of free product trapped within the standpipe and/or immediate surrounding soils.

The draw down tests were undertaken at locations RHRW001c, RHRW007, RHRW008, RHRW009, RHRW010, RHRW011, RHRW015b, RHRW024, RHRW029 and RHRW035 where hydrocarbon had historically been recorded. The tests were conducted using a peristaltic pump and tubing.

New tubing was used at each location to avoid cross contamination and to accurately record the groundwater level and thickness of free product. The exploratory holes were purged until the hole either ran dry or until 3 well volumes of water had been removed.

After the pumping ceased the depths to groundwater and product (if present) were recorded. The levels were then recorded at frequent intervals over a minimum period of at least 30 minutes or until groundwater / free product returned to those obtained pre-testing.

Results

The results of the draw down tests showed that product returned to six of the ten exploratory holes (RHRW001c, RHRW007, RHRW009, RHRW011, RHRW029, RHRW035) as summarised in the Table 3.4 below.

Table 3.4 – Thicknesses of product pre and post draw down testing

Exploratory Hole Ref.	Thickness of product pre-test (m)	Thickness of product post-test (m)	Variation in product thickness (m)	Installation Response Zone (m)
RHRW001C	0.01	0.01	None	2.5 – 3.0 Glacial Till
RHRW007	0.04	Sheen	-0.04	1.5 – 2.7 Glacial Till
RHRW009	Not Proven	0.15	-	1.3 – 2.9 Glacial Till
RHRW011	0.18	0.02	-0.16	0.6 -2.5 Made Ground/Glacial Till
RHRW029	Sheen	Sheen	0	Unknown
RHRW035	0.01	Sheen	-0.01	Unknown

*The response zones for RHRW029 is not indicated on the historical borehole log and the exploratory hole log for RHRW035 was absent.

In RHRW009 the thickness of the free product was 'Not Proven', possibly due to its highly viscous nature, and accurate readings could not be taken as a result of the interface meter becoming coated with free product.

The boreholes were monitored on a second occasion two weeks after the completion of the initial test to determine whether a more gradual return of product had occurred. The results of this monitoring and the comparison between the thickness of product pre-test and two weeks later are shown within the Table 3.5 below.

Table 3.5 – Thickness of product two weeks after the completion of the draw down tests

Exploratory Hole Ref	Thickness of product pre test (m)	Thickness of product 2 weeks after (m)	Variation in product thickness (m)
RHRW001C	0.01	0	-0.01
RHRW007	0.04	Sheen	-0.04
RHRW008	0.03	0.05	+0.02
RHRW009	Not proven*	>0.15	-
RHRW010	1.58	0.02	-1.56
RHRW011	0.18	Not proven*	-
RHRW024B	0.40	Not proven*	-
RHRW029	Sheen	0.0	Sheen removed
RHRW035	0.01	0.01	None

*Where the thickness of the product was 'not proven' the product at this location was highly viscous and accurate readings could not be taken from the interface meter.

The results of the two tests reveal that free product returned to eight of the ten holes tested. The draw down test indicates a reduction in the free product available and a slow recharge into the monitoring wells consistent with a viscous free product.

5.5 Monitoring Installations (Winter 2009)

The trial pits within the Railhead Area were backfilled on completion, due to the risks associated with potential collapse and the risk to unauthorised entry to the site.

In December 2009, a series of 600mm HDPE slotted sumps were installed to 1m below the perched water level. The sumps were left 1m proud of ground level with a netted opening to provide a safer stable monitoring feature of the perched groundwater.

Eighteen sumps (WMS1-18) were constructed within the Western Margin, the locations are shown on drawing 5041216-RAP-DWG-000864. The monitoring sumps WMS1-WMS8 & WMS17-WMS18 were positioned in the vicinity of RAP 2 trench near the site's boundary, adjacent to Crymlyn Bog. WMS9-WMS11 were located adjacent the South Site Reservoir at the proposed location of RAP 3 trench. WMS12 and WMS13 were installed along the proposed location of RAP 4 trench. The monitoring sumps WM14-WM16 were installed within the Railhead Area along the proposed location of RAP 5 trench.

The sumps were observed for the presence/absence of free product and were monitored once a week for 13 weeks from February 2010 before it was reduced to monthly monitoring, which is currently ongoing.

Trial Trench

In order to extend the monitoring area for RAP Feature 2, which had been previously restricted due to the topography and dense coverage of vegetation, an additional investigation was undertaken in July 2010.

A 72m long trial trench was excavated to the north of RAP Feature 2 and at the southern end of RAP Feature 4. The additional works focused on the area of RAP Feature 2 in order to increase the number of monitoring installations and improve the understanding of the ground conditions. The trench was logged (see Appendix D) at four locations, spaced at regular intervals (AT2 P1-AT2 P4) along its length, as shown on Drawing 504121-REM-DWG-864. Two sumps were installed at the location of AT2 P2 (identified as WMS17) and AT2 P3 (identified as WMS18) and comprised a 600mm diameter HDPE pipe which enabled subsequent monitoring to be carried out.

Made Ground was identified along the length of the trench from surface level to depths ranging between 0.2m to 1.8m. The Made Ground predominantly comprised ashy granular material, similar in composition to the Made Ground encountered within the Railhead Area. The Made Ground was underlain by Glacial Deposits comprising grey/brown clayey sandy gravel, the base of which was not proven beyond 2.8m. Hydrocarbon staining (VO=1 to 3) and odours (VO=1 to 3) were noted within the Glacial Deposits between 2.2m in AT2 P1 and the base of the trial trench at 2.8m in AT2 P2. Groundwater was observed entering the trench at AT2 P2, AT2 P3 and AT2 P4 at depths ranging between 1.3m and 2.3m. No evidence of sheens or product was recorded on the groundwater.

Sumps WMS17 and WMS18 were also included within the monitoring programme. A copy of the monitoring results is presented in Appendix A.

Surface Water Interception Trench

During late 2010, a preliminary interception trench was excavated within the Railhead Area along the toe of the embankment atop which Tank Farm Road runs. The trench runs from the start of the Railhead Area south of RAP Feature 5 to near monitoring sump WMS 4 (see Drawing 5041216-REM-DWG-864, Trench marked in blue).

The trench was excavated to a depth of approximately 1m below ground level into the coarse gravel and ashy Made Ground deposits within the Railhead Area. The groundwater along this part of the Railhead is very near to ground level and includes ochreous groundwater discharges and surface water flow (see Drawing 5041216-REM-DWG-863). The trench flows into either the Crymlyn Bog via site drainage or to the South Site Reservoir.

The surface water monitoring trench (as shown on Drawing 5041216-RAP-DWG-864) has been included within the monitoring programme for the sumps.

Monitoring Results

The monitoring programme comprised twenty five rounds over a 24 month period between 25th February 2010 and 26th January 2012. The monitoring included the 600mm sumps (WMS1 to WMS18) and the interception trenches on the Railhead.

The monitoring visits carried out to date have not recorded evidence of free product within the surface water monitoring trench. The monitoring trench has been noted to be heavily discoloured by ochreous precipitate.

Temperature and rainfall data was also collected during the monitoring period to determine if weather conditions had an impact on the monitoring data obtained. A graph showing the daily maximum temperature and rainfall is also presented in Appendix A to provide graphic illustration of the variation in weather conditions over the course of the monitoring period.

RA Trench Linear Wetland Feature

Monitoring sumps WMS2-WMS7 recorded an oily sheen or slight sheen with the exception of WMS2 and WMS5, where free product was recorded ranging between 0.5cm and 5cm. The monitoring sumps WMS2 and WMS5 initially recorded a product sheen or slight sheen but this has gradually increased over a number of months to a layer of free product up to 5cm in WMS2 and 1cm in WMS5. In addition to the product sheen and slight sheen recorded in WMS7, free product was also noted on the surface of sump WMS7 up to 0.01cm on 14th July 2010. Droplets of free product were also observed within sumps WMS6 and WMS7 on two of the five monitoring visits undertaken in March 2010.

Monitoring sumps WMS1, WMS6, and WMS8 have occasionally recorded sheens but since April 2010 have recorded no evidence of free product. No oil recovery was undertaken for sheening on the surface of the water within the monitoring sumps. Monitoring sumps WMS17 and WMS18 have not recorded any evidence of free product following their installation in July 2010.

The groundwater monitoring data collected from the existing exploratory holes installed by URS supports the monitoring data collected from the monitoring pits and sumps installed by Atkins. The combined data indicates a minimal thickness of free product is present in a number of installations within the area of RAP Feature 2.

RA Trench S S

Product droplets were observed on the surface of groundwater within WMS10 on one occasion in March 2010, with a sheen recorded on one other occasion in September 2010. A hydrocarbon sheen was observed during the monitoring visit in September 2010. The sump has remained clear of free product or sheen during the last fifteen months of monitoring.

Product droplets or a slight sheen were recorded on the surface of WMS11 on six of the first seven occasions from the commencement of the monitoring. The groundwater quality however appears to have improved after this period with only a slight sheen having been recorded on two of the nineteen remaining visits with no evidence of hydrocarbon recorded in the last six visits between March 2011 and January 2012.

Monitoring sump WMS9 remained dry with no product observed within the sump for the duration of the monitoring program before it was decommissioned following the 19 October 2010.

Ochre was not recorded within monitoring sumps WMS9-WMS11.

RA Trench S S

Droplets of free product or product sheen were observed within WMS12 on two occasions during the second and fourth monitoring visits which were undertaken in March 2010. WMS12 has not recorded evidence of free product or ochre since April 2010.

Occasional droplets of product were observed on the surface of WMS13 when monitored on 17 February 2010. On subsequent monitoring visits the quantity of free product decreased with a sheen recorded on the surface of the groundwater. No product or sheen was observed on the visit undertaken in mid May 2010. WMS13 has predominantly remained dry since this date with no evidence of free product recorded on the shallow groundwater when present.

RA Trench S S and down slope sumps S and S

Sump monitoring within WMS14 and WMS15 consistently reported a hydrocarbon sheen on the surface of the groundwater. The location of the sumps is impacted by ochreous seepages and it possible that the sheen is metallic rather than organic. The last three monitoring visits undertaken between November 2011 and January 2012 recorded no evidence of free product.

Evidence of free product was recorded on five occasions in WMS16 as a sheen and a slight sheen. The most recent record of a sheen was in July 2011. The monitoring of sumps WMS14 and WMS15 has recorded no free product on any of the last three monitoring rounds.

5.6 Monitoring of Upslope Boreholes

A round of monitoring was undertaken on the upslope boreholes on the 26th January 2011. The monitoring round included the remaining serviceable boreholes upslope of RAP Features 2-5.

The results are included in Table 3.6 with monitoring data from the same wells from February 2011.

Table 3.6 - Summary of upslope borehole monitoring

Borehole Number	February 2011		January 2012	
	Depth to Product (mbgl)	Depth to Groundwater (mbgl)	Depth to Product (mbgl)	Depth to Groundwater (mbgl)
MSMW049	-	1.704	-	2.45
MSMW050D	-	2.677	-	2.38
MSMW050S	-	1.975	-	1.88
MSMW051D	-	7.1	-	7.59
MSMW051S	2.74	2.91	2.71	2.84
MSMW119	-	0.0	-	0.00
RFS001	-	2.94	-	3.03
WSMW002	-	1.625	-	1.42
WSMW004	-	-	-	1.14
WSMW005	-	0.22	-	0.42
WSMW006	-	4.652	-	4.00
WSMW037	-	2.89	-	Dry
WSMW038	-	0.90	-	1.39
WSMW071	-	2.745	-	2.99

One of the fourteen boreholes monitored upslope of RAP Features 2-5 recorded free product. MSMW051S is located on the former Bitumen Plant and was installed within shallow glacial material. The presence of free product appears to be localised as RFS001 and WSMW002 are down gradient and have not recorded any evidence of free product during the last two monitoring visits.

5.7 Comparison of Free Product Quantities and Rainfall

The sump monitoring data was compared with the weather summary to assess the effect of rainfall on the presence of free product within the monitoring installations. A discernable correlation between rainfall and the presence of could not be identified but the presence of free product generally decreased during the assessment. There is, however, a noticeable relationship between water levels within the sumps and rainfall. Water levels were typically at their highest between mid and late March 2011 when a prolonged period of rainfall was recorded.

The increase in water levels within the sumps associated with local rainfall indicates a quick response time from precipitation events to increases in the perched groundwater levels monitored within the sumps. The rapid response may be attributed to the topography of the site and the predominantly ashy Made Ground and granular Glacial Deposits located within the Railhead Area.

5.8 Particle Size Distribution Testing

In order to refine the Geological Conceptual Site Model (GCSM) five samples of the Glacial Deposits were collected and sent for analysis to assess the physical composition of the material.

The particle size distribution of the material may support the understanding that historical spills and leaks are likely to have migrated freely down slope rather than ponding at the point of discharge. The sampling locations are shown on Drawing-DWG-RAP-864. The results of the five PSDs are summarised in Table 3.7 below.

Table 3.7 - Summary of Particle Size Distribution (PSD) Analysis

Size (%)	PSD 1	PSD 2	PSD 3	PSD 4	PSD 5
Silt and Clay (%)	4	6	10	18	9
Sand (%)	18	18	21	32	19
Gravel (%)	78	76	69	50	72
Cobbles (%)	0	0	0	0	0

Four of the five samples submitted for testing returned results indicating that the Glacial Deposits are predominantly granular.

6. Conclusion

6.1 RAP Features 3 and 4

Based upon a review of the historical logs, the more recent work undertaken in the Western Margin including exploratory holes and monitoring between 2008-2012, it is considered that the installation of the product recovery features along the proposed locations of RAP Features 3 & 4 within the Western Margin is unnecessary.

The monitoring data indicates that there is not a reservoir of free product available for recovery and free product is not present on the shallow groundwater in this area. The geological conceptual site model confirms that there is unlikely to be a direct pathway for contaminants identified within the shallow Made Ground/Glacial Deposits to migrate from sources within the Process Area to the Western Margin.

Since the installation of the monitoring pits, sumps and latterly the interception trench, within the areas relating to RAP Features 3 & 4, no recoverable free phase oil has been encountered and limited evidence for free product has been recorded.

Remediation will be carried out prior to the redevelopment of the Railhead Area to remove potential shallow sources of contamination in accordance with the S106 agreement. It is therefore proposed that no additional RAP works are required at the location of RAP Features 3 & 4. It is proposed that the monitoring of the sumps and boreholes along the Western Margin is continued at intervals to be agreed with the Monitor. Monitoring of the wider area up gradient of the Western Margin will be included as part of the ongoing site wide RAP Monitoring.

In the context of the proposed end use of the site and the surrounding area, it is considered that a suitable restoration standard has been achieved within the confines of RAP Features 3 & 4 which has led to a significant improvement in water, land and aesthetic quality at this location.

External Impacts

The sources external to RAP Features 3 & 4 include occasional ochreous seepages into the Western Margin which can create isolated ochreous sheening. Information on the proposed systems to be installed to intercept ochreous seepages will be provided in a separate technical note. See below. The progression of the redevelopment of the remainder of the former refinery to the east is considered to further lead to an overall reduction in the mobilisation of dissolved hydrocarbon residues towards the Western Margin.

6.2 RAP Features 2 & 5

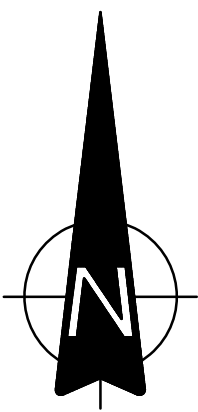
The information collected within the area of RAP Feature 2 indicates that two of the eleven sumps installed contain a small thickness of free product that has recharged when removed. Atkins considers that the works to recover the free oil and monitor the sumps should continue within the area of RAP Feature 2. The interception of the residual free product recorded along RAP Feature 2 will be included as part of the proposal to intercept and collect the ochreous seepages from the Western Margin.

The proposal to intercept and collect the ochreous seepages along RAP Features 2-5 (Western Margin) including the interception of the limited free product recorded within the monitoring installations along RAP Feature 2 is currently being assessed and will be reported in a separate technical note. The proposal is likely to comprise a system of reed filled trenches with a monitored discharge point that may be incorporated into the drainage scheme when the area is redeveloped for residential use.

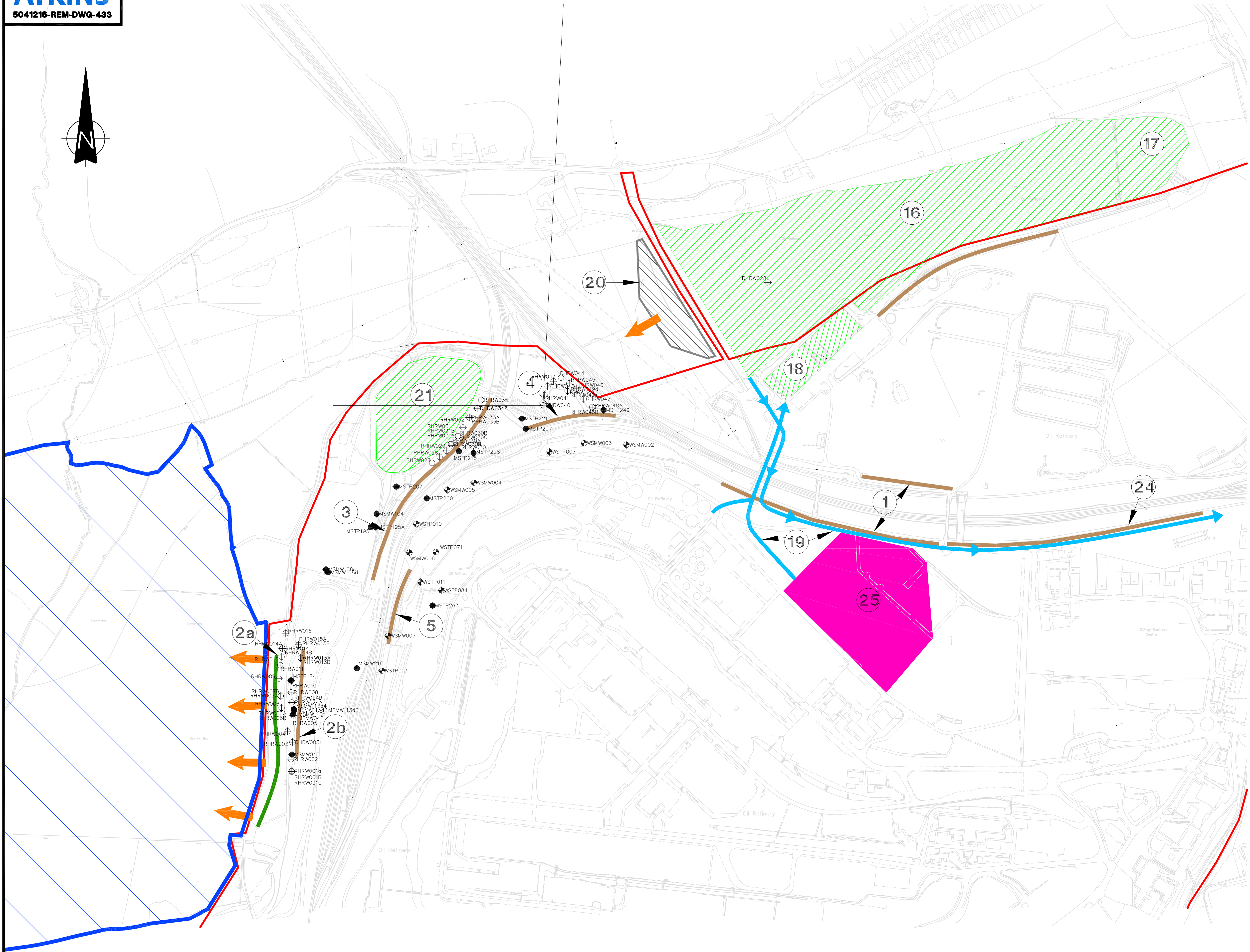
The final design and verification of the efficacy of the system installed will be provided in a separate report.

Based on the observations and activities summarised in preceding sections it is considered that the works undertaken by Atkins has achieved the requirements of the RA in relation to the interception and removal of free phase hydrocarbons. RA feature as set out in the Section 4 Agreement for the Coedarcy development. Water quality migrating from site is only likely to improve with the redevelopment of the site.

Drawings



- KEY
- DEVELOPMENT BOUNDARY
 - Diffuse Discharge
 - Free product monitoring/interception
 - Oily sludge removal & treatment
 - Constructed Wetland
 - Earthwork/capping/landscaping
 - Remove/reconfigure drainage
 - Source reduction/containment
 - CRYMLYN BOG SSSI/CRYMLYN BOG SAC
CRYMLYN BOG RAMSAR
(BOUNDARY DETAILS SUPPLIED BY CCW)
 - WSMW002
MSTP249
RHRW013A
 - GI Locations



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PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

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THIS DRAWING IS NOT TO BE SCALED

CLIENT

ST.MODWEN

PROJECT

COED DARCY URBAN VILLAGE

DRAWING TITLE

WESTERN MARGIN RAP FEATURES

Scales	DRAWN	CHECKED	CO-ORD CHECK
1:2500	PY	HM	MP
DATE	DATE	DATE	DATE
05/05/09	05/05/09	05/05/09	07/12/09
DRAWING NO	SHEET	PLOT DATE	REV
5041216-REM-DWG-433	A1	07/12/09	A