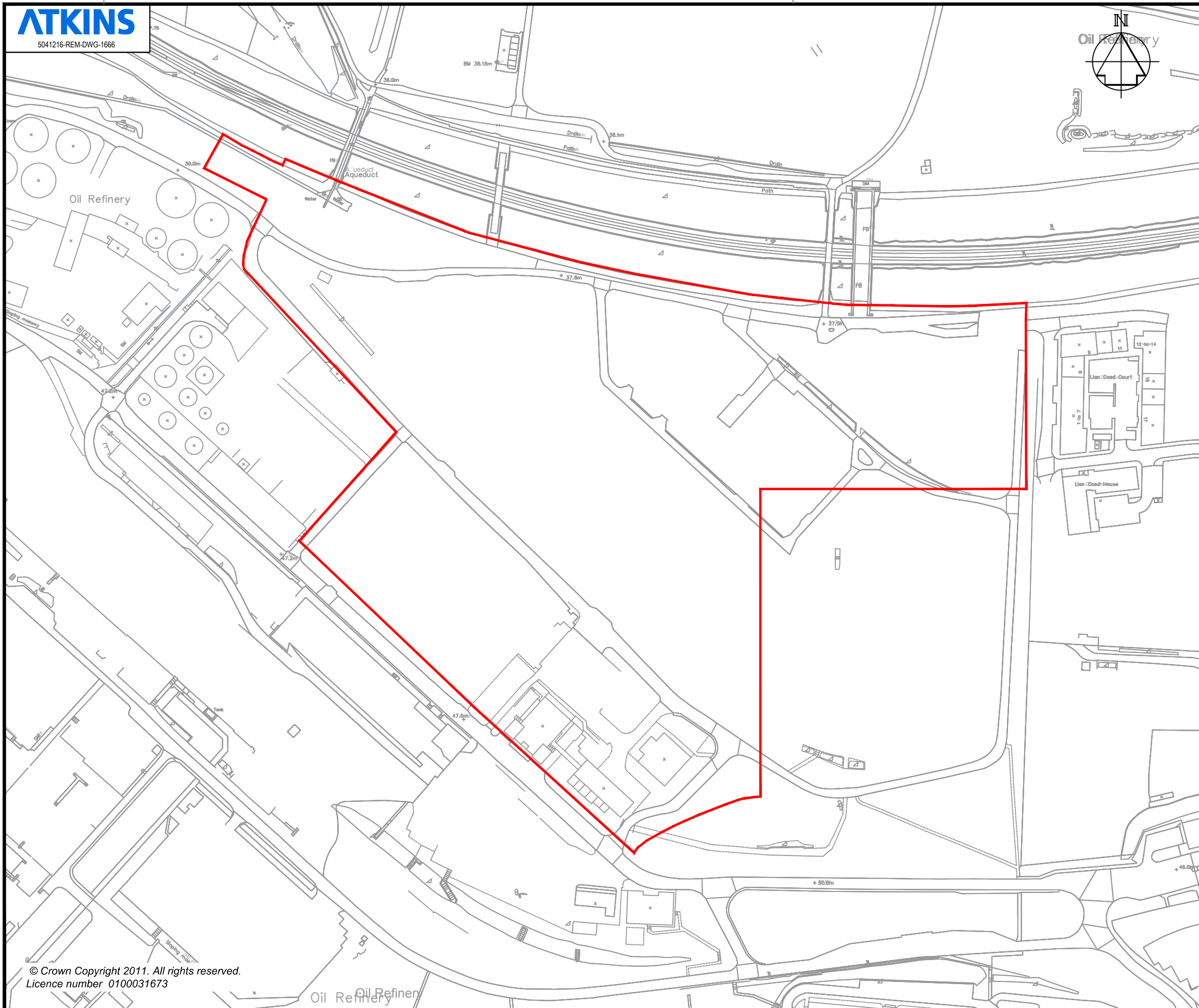


KEY
 Monitor Phase 43 Boundary

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REVISIONS	Drawn By	Checked By	Date
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PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
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THIS DRAWING IS NOT TO BE SCALED

CLIENT



PROJECT

Coed Darcy

DRAWING TITLE

Proposed Phase Boundary
 (Monitor Phase 43)

SCALES	DRAWN	CHECKED	CO-ORD CHECK
1:2000	RS	MT	
	DATE	DATE	DATE
	14/01/14	14/01/14	14.01.14

DRAWING NO	5041216-REM-DWG-1666	REV	-
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***A E I B SC E LE OF T E
SECTION
A REE E T***

SCHEDULE 7

The RAP Works

Purpose, objectives and requirements of the RAP Works

Part 1

1. Purpose and objectives of the RAP Works

- 1.1 The RAP Works (a programme of ongoing voluntary Remedial Action in relation to Pre-Transfer Date Environmental Matters at or in the vicinity of the Property) have been agreed between the Owner and the relevant Environmental Authorities in lieu of the imposition of formal Remedial Action requirements by any such Environmental Authorities.
- 1.2 The current requirements and status of the RAP Works are as set out in Table 1 below.
- 1.3 The parties to this Agreement agree that the purpose and objectives of the RAP Works are the carrying out of the appropriate Remedial Action necessary, and sufficient in the context of both the current use of the Property and the Intended Use or such other use as may be determined from time to time:
 - 1.3.1 to prevent (or where that is not possible, minimise, remedy or mitigate as far as reasonably practicable the effects of) migration from the Property of Pre-Transfer Date Contamination and any Developer Contamination; and
 - 1.3.2 to assess with a frequency agreed as sufficient by the relevant Environmental Authorities and keep under review:
 - (a) the condition of the Environment at and (provided appropriate access is procured (the Developer having used reasonable endeavours to obtain it)) in the vicinity of the Property, including any controlled waters that are or may be affected by such condition, and (provided appropriate access is procured (the Developer having used reasonable endeavours to obtain it)) any land adjoining or adjacent to the Property; and
 - (b) the progress and effectiveness of natural attenuation processesin order in each case to demonstrate whether or not any Pre-Transfer Date Environmental Matters are posing or may pose an unacceptable risk to the Environment beyond the boundaries of the Property in the light of Environmental Law; and
 - 1.3.3 to prevent (or where that is not possible, minimise, remedy or mitigate as far as reasonably practicable the effects of) any harm to the Environment or any pollution of controlled waters or any possibility of such harm or pollution being caused in each case by or as a result of any Pre-Transfer Date Environmental Matter including the containment of free phase Hydrocarbons within the Property boundaries; and
 - 1.3.4 to avoid where reasonably practicable any Environmental Claim by any relevant Environmental Authority in relation to or in connection with any Pre-Transfer Date Environmental Matter, including without limitation to avoid service on any party in relation to or in connection with any Pre-Transfer Date Environmental Matters of:
 - (a) a "remediation notice" under Part IIA of the Environmental Protection Act 1990; or

- (b) a "works notice" under Chapter 1 of Part VII of the Water Resources Act 1991; or
 - (c) a notice under Section 59 of the Environmental Protection Act 1990 requiring removal of waste or the carrying out of steps to eliminate or reduce the consequences of deposited waste; or
 - (d) the imposition of a requirement by any relevant Environmental Authority for any party to carry out any Remedial Action pursuant to EU Directive 2004/35/CE of 21 April 2004 and/or pursuant to any legislation implementing such Directive in England and Wales, or to recover the costs of the taking of such Remedial Action by any such Environmental Authority; and
- 1.3.5 to take all reasonably practicable steps to seek to secure the final and unconditional acceptance by the relevant Environmental Authority of the surrender of the Waste Management Licence as soon as reasonably practicable.

Table 1
Current RAP Works and Status

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Whole Site	Continued demonstration of natural attenuation of dissolved phase hydrocarbons. Consultation with EA and CCW	Six monthly: - Liquid level measurements - Analytical samples from 120 ground and surface water sample locations. Locations specified in the semi-annual reports submitted to the Environment Agency. - Six-monthly reporting of trends. Regular update meetings (minimum bi-annually) with EA and CCW for lifetime of RAP	NA	Routine programme of groundwater level and quality and product thickness monitoring. Annual scope to be agreed with EA on rolling basis.	Ongoing since 2000. Annual reductions in scope have been agreed with EA on basis of data received.

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Western flank of main site / Crymlyn Bog / Boundary with North Reservoir	- Potential for cross boundary free product migration at various locations along boundary - Dissolved-phase hydrocarbon migration	- Monitor 30 'sentinel' wells along northwest and southeast boundaries of North Site for presence of free product. Locations included in 'Whole Site' above. - Install permanent product interception trench system along boundary of North Site, if sentinel well data suggests a risk of downgradient product migration occurring and in any event install a product interception trench to, at a minimum, replace the current sentinel wells prior to redevelopment (300 x 4 metres minimum). Any interception trench must prevent further downgradient migration of free product and allow recovery of intercepted product.	1	Continued six-monthly monitoring of free product thickness, and assess potential for further downgradient migration. All works to be protective of future public health and safety assuming unrestricted recreational access.	Sentinel well installations complete on North Site, and listed in semi-annual monitoring reports.

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Western flank of main site / Crymlyn Bog / Boundary with North Reservoir (cont.)		2. Product interception and recovery, consisting of the following programme elements: 1. Design-level investigations to assess specific requirements 2. Design and Installation of permanent system to intercept and recover free-phase product 3. Diffuse discharge of water arising from interception system to Bog, via purpose-constructed wetland features. 4. System-specific monitoring of surface and groundwater Above programme of works to include the following as a minimum: • Railhead (install 200 x 4 metre trench, and 200 metre linear wetland feature) • Railhead to South reservoir (install 250 x 4 metre trench, interception only, ie, no wetland) • Between North and South reservoirs (install 100 x 2 metre interception and recovery trench only)	2 3 4	Install permanent measures to prevent free product from crossing the site boundary and entering Crymlyn Bog to satisfaction of EA and CCW Diffuse discharge of water arising from interception system to Bog, via purpose-constructed wetland features to reduce dissolved hydrocarbon load and without requirement for a discharge consent. Prevent ochreous precipitate discharges from site to the Crymlyn Bog arising from the interception feature. All works to satisfaction of EA and CCW. All works to be protective of future public health and safety assuming unrestricted recreational access.	Some additional wells installed in 2000 to monitor for free-product.

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Containment Area	Free product migration from filled area into Crymlyn Bog, Crymlyn Bog Lagoon, and South Bay.	Product interception and recovery, consisting of the following programme elements:		Remove free product with a temporary in-situ system to extent practicable until recovery is asymptotic from a system which hydraulically influences the free product contaminated filled area to the satisfaction of EA	System installed in 2005, recovery ongoing.
		1. Complete design-level investigations to assess specific requirements 2. Design and Installation of permanent system to intercept and recover free-phase product 3. System-specific monitoring		Install permanent measures to prevent free product from:	Temporary (plywood bund) system in place; regularly maintained.
		Above programme of Works to include the following as a minimum:	6	• leaving site boundary and entering Crymlyn Bog • entering Crymlyn Bog Lagoon from filled area in Tip	Some survey information collected along Tip perimeter
		• Filled area; expand on existing system; upgrade to 12 pumping wells	7	• entering the licensed area from Tank farm	Some site investigation and monitoring data available to assist in design.
		• Northern Tip perimeter adjacent to Crymlyn Bog (install permanent engineered and covered 500 x 1 metre product interception and recovery feature in place of current plywood bund)	8	in all cases permitting the free flow of groundwater past the interception features and to permit recovery of product, all to satisfaction of EA, NPT and CCW.	
		• Filled area to South Bay/Crymlyn Bog (install 500 x 4 metre, product interception and recovery trench)	9		
		• From north Tank Farm into licensed area (ie, South Bay, and Crymlyn Bog lagoon install 300 x 4 metre product interception and recovery trench)			

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Containment Area	Hydrocarbon-containing peat and sludges.	Excavation and treatment of peats and sludges in (all quantities estimated and unverified): • South Bay (15,000m3) • West Bay (10,000 m3) • Crymlyn Bog Lagoon (20,000m3)	10 11 11	Removal and treatment to achieve restoration quality standards agreed with the Environment Agency of hydrocarbon contaminated surface and near surface soil and sediment to satisfaction of EA.	7,000 m3 peats/sludges removed from lagoon and treated in 2006/7.
	Surrender of Waste Management Licence EAWML34004 (licence status active, but landfill 'closed or closing').	In addition to free-product issues above, the following are also required: • Agree programme of works with EA to permanently restore Tip and secure Waste Management Licence surrender.	6, 12 12	Surrender Waste Management Licence.	Design work commenced to utilise material from Area 1. Ongoing.
	Dissolved-phase hydrocarbon discharge to Crymlyn Bog.	• Ensuring of long term security and immobilisation of wastes in the filled area. • Construct permeable cap and re-profile filled area with cover material (at least 50,000 m2) • Construct engineered wetland in lagoon (15,000 m2) to reduce dissolved hydrocarbon load in surface water exiting Tip. • alterations to drainage regime such that flow to Crymlyn Bog from the site is diffuse, rather than from a point-source, as currently exists.	13 14	Reduce dissolved phase hydrocarbon load in groundwater and surface water leaving the Tip and entering Crymlyn Bog.	
				All works to be protective of future public health and safety assuming unrestricted recreational access.	

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
South Tank Farm	Potential dissolved-phase hydrocarbon discharge to stream discharging to Crymlyn Bog to south	- Constructed wetland (2500 m2), - groundwater monitoring programme	15	Reduction of dissolved phase hydrocarbon load to Crymlyn Bog	Monitoring
North Reservoir and East Bay	- Basal sludges. - Reconfigure reservoir to meet near pre-refinery conditions as part of return of land to the landowner. - Restoration of original drainage patterns.	Design and implement sludge removal and treatment programme for (all quantities estimated and unverified): - North Site Reservoir (40,000 m3), - East Bay (5,000m3) - API Separators (5,000 m3) Isolate reservoir from site drainage system Drain reservoir Remove dam Restore and landscape valley	16 17 18 19 16, 17 20 16, 17	- Sludge removed, treated to satisfaction of EA dependent on fate and disposed of or re-used. - Water removed, treated as required and disposed of. No discharge of NSR water to Crymlyn Bog permitted unless otherwise agreed with appropriate Environmental Authorities. - Valley restored to near pre-refinery conditions so as to be suitable for uncontrolled recreational access. - Dam removed and materials re-used. - Post restoration water management programme implemented consistent with restored valley. All works to be protective of future public health and safety assuming unrestricted recreational access.	Sludge removal from East Bay (part complete); no work on reservoir yet. Not commenced. Not commenced. Not commenced. Not commenced.

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
South Reservoir	Hydrocarbon contaminated sludges to which contaminated groundwater discharges.	1. Design and implement programme of sludge removal and treatment (estimated at 5,000 m3). 2. Prevent / mitigate hydrocarbon seepage from walls and floor of reservoir (150 m) 3. "Soften" walls and landscape to satisfaction of CCW to enhance ecological value	21	Retain significant portion of South Reservoir as "clean" water feature. Reduction of hydrocarbon seepage from walls of reservoir as far as possible to satisfaction of EA. Discharge re-routed. CCW sign off on 'softening' and landscaping to increase ecological value. All works to be protective of future public health and safety assuming unrestricted recreational access.	Not commenced
Southern edge of process area / Llandarcy Bog	Potential free product migration to Llandarcy Bog. Dissolved-phase hydrocarbon discharge to bog/culverted drain.	Intercept free product. Six-monthly water monitoring programme (as specified in 'Whole Site', above) Construct linear wetland (100 m2).	22 23	Install permanent product interception feature. Reduce dissolved phase hydrocarbon load and ochreous precipitate discharges from site as far as possible to satisfaction of EA. All works to be protective of future public health and safety assuming unrestricted recreational access.	Completed in 2005. Not commenced, monitoring ongoing.

Site Area / Potential Receptor	Key Issues	Scope of Currently Envisaged Remedial Action	Figure Reference	Performance Criteria	Works to Date
Eastern process area / Neath valley and river	Potential cross boundary free product migration into railway cutting.	Monitor 30 sentinel wells for free-phase product on six-monthly basis. Install permanent product interception trench system along boundary of North Site, if sentinel well data suggests a risk of downgradient product migration occurring and in any event install such a trench to, at a minimum, replace the current sentinel wells prior to redevelopment (500 x 3 metres minimum). Any interception trench must prevent further downgradient migration of free product and allow recovery of intercepted product.	24	Install permanent interception feature to prevent free product migration downgradient and permit recovery of intercepted product.	Sentinel well installation complete. Groundwater monitoring only.
	Known and or suspected presence of free phase hydrocarbon and chlorinated hydrocarbons. Dissolved hydrocarbon and chlorinated hydrocarbon migration away from areas of product.	Either containment of hydrocarbon and chlorinated hydrocarbon product, vapour and dissolved phase, or; source-reduction solution (of area 30,000m2) to render containment permanently unnecessary, with the following programme elements: 1. Design-level investigations 2. Feasibility tests 3. System implementation and installation 4. Groundwater and air and soil vapour monitoring programme	25	Permanent maintenance of acceptable risk to agreed controlled waters receptors (River Neath and Crymlyn Bog) to the satisfaction of EA and NPT.	Limited work may be required for the RAP subject to results of long term monitoring. Substantial additional (containment) work likely to be required in the event of development.

Figure references are references to the RAP Plan annexed to this Deed

Report References (The following reports contain information which may be of relevance to the development and implementation of the RAP. This list is not exhaustive.):

Report Title	URS Report Ref.	URS Job no.	Issue Date
Environmental Liability Assessment, Llandarcy Refinery Desk Study Findings Vol 1	2048R	37491-001	29-Sep-97
Environmental Liability Assessment Llandarcy Refinery Interpretative Report Vol 2	2049R	37491-002	30-Sep-97
Risk Assessment Methodology Document (see DR810)	2271R	39991-001-401/PI	05-Aug-98
Report - Phase II, Stage 1 Data Report, BP Llandarcy Refinery - Neath, W Glamorgan - for BP Llandarcy Refinery LTD	R642	39991-001	26-Aug-98
Draft Report - Phase II Interim Data Assessment - BP Llandarcy Refinery, Neath, W Glamorgan	DR664	39991-002	06-Nov-98
Preliminary Sludge Treatability Study Report	DR666	39991-001	10-Nov-98
Phase 2 Site Assessment Vol 1, 2 and 3 Phase 2 Final Data Report	DR785	39991-004	28-Jul-99
Risk Assessment Methodology	DR810	39991-005	13-Sep-99
Draft Summary Report Stage 1 Solvent Recovery Pilot Test, DiMe Plant Area	DR829	39991-007	17-Nov-99
Water Balance Report	R835A	39991-009	14-Jan-00
Remedial Action Plan	DR869r3	39991-005	18-Feb-00
Synopsis of Site Assessment and Proposed Remedial Works on behalf of BP Llandarcy Refinery	R896	39991pfound	31-May-00
Phase 2 Site Assessment Crymlyn Bog Historical Spill	DR898	39991-011	12-Jun-00
Routine GW Monitoring Mar - Sept 2000 Vol 1 Draft Report	CD954	39991-013	01-Jan-01
Data & Risk Assessment of the Main Tank Farm	DR946	39991-017	05-Jan-01
Draft Remedial Plan, Vanadium Lagoon	DR962	39991-016	01-May-01
Additional Site Characterisation & Remedial Action Plan	DR963	39991-016	02-May-01
Final Report - Phase II Investigation & Human Health Risk Assessment for BP OIL, Swansea	FR979	39991-019	13-Jul-01
Monitoring Data Summary Report (Sept 2000)	DR980	39991-013	18-Jul-01
Monitoring Data Summary Report (March 2001)	DR980	39991-013	18-Jul-01
Progress Report on the Constructed Wetland Pilot Tests	DR1042	39991-016	01-Feb-02
Final Report - Sept 2001 Monitoring Data Summary Report - BP Llandarcy Refinery, Neath	FR1044	39991-023	08-Feb-02
Water Balance Addendum	DR1031	39991-016	01-Apr-02
South Site Reservoir Sampling Results	6681	39991-025	14-Jun-02
Site Characterisation & Remedial Action Plan Llandarcy Bog	DR1078A	39991-041	31-Jul-02
March 2002 Monitoring Data Summary Report	DR1081	39991-029	02-Aug-02
DiMe Mineralisation Tests	6732/MC	39991-016	16-Aug-02

Report Title	URS Report Ref.	URS Job no.	Issue Date
Informational Supplement for DiMe Plant Area	DR1096	39991-022	01-Sep-02
Results of Sentinel Well Product Mobility	6767	39991-032	12-Sep-02
Site Characterisation Works & Bypass Ditch Outline Design North Site Reservoir	DR1111	39991-016	12-Feb-03
September 2002 Monitoring Data Summary Report	DR1119	39991-036	28-Feb-03
Oil Recovery Tests Containment Area	DR1130	39991-026	25-Apr-03
March 2003 Monitoring Data Summary Report	DR1137	39991-036	01-Jul-03
Draft Factual Report - Site Investigation	DR1140	39991-035-785	10-Jul-03
Draft Factual Report DiMe Area	DR1144	39991-037	11-Jul-03
Rail Cutting Inspection	DR1161	39991-032	06-Aug-03
Specification Report Llandarcy Bog Interception & Recovery System	DR1168	39991-041-785	22-Aug-03
September 2003 Monitoring Data Summary Report	DR1191	39991-036	13-Feb-04
Draft Factual Report Whole Site Investigation	DR1209	39991-044	01-Jun-04
Whole Site Remediation Strategy	DR1224A	39991-035	29-Jun-04
Draft Report Outline Remedial Options Assessment - BP Llandarcy Refinery, Neath, W Glamorgan	DR1158	39991-037	19-Jul-04
March 2004 Monitoring Data Summary Report	DR1220	39991-049	30-Jul-04
September 2004, Monitoring Data Summary Report	R1263	39991-055	14-Dec-04
Solvent Pit RAP Issues: Additional Llandarcy Bog Water Samples	7601	39991-056-785	26-Jan-05
Area 1 - Main Workshop Former Degreasing Pit Investigation	R1278	39991-056	28-Jan-05
Draft Report Containment Area Perimeter Trench Performance Specification	BPRP0005	39991-054	01-May-05
Report on the Constructed Wetland Pilot Tests. Issue no.1	R1236	39991-021	25-May-05
Soil Stockpile Sampling Report. BP Llandarcy Barn Store & Waste Tip - Issue no 1 - DRAFT	R1304	44382527	01-Jun-05
Final Factual Report Site Investigation Phase 1 Area	FR1275	39991-035	22-Jul-05
Groundwater Monitoring and Sampling- BP Oil Llandarcy Refinery	DR1307	44382526-1943	01-Aug-05
Final Factual Report Whole Site Investigation	FR1287	39991-044-785	12-Aug-05
Groundwater Monitoring and Sampling - Factual Report	DR1356	44382526	01-Sep-05
Tip Closure and Completion Strategy Report	R1360	44382538	15-Mar-06
March 2006 Groundwater Report	R1396	44382534	11-Aug-06

Part 2

1. Developer obligations regarding RAP Works

- 1.1 The Developer shall carry out or procure the carrying out of all outstanding Remedial Action identified in Table 1 above in order to achieve the purpose and objectives set out in sub-paragraph 1.3 (including 1.3.1-1.3.5 thereof) of Part 1 of this Schedule and the performance criteria specified in Table 1 (and shall do so to the satisfaction of relevant Environmental Authorities) subject to any variations thereto that may be required in writing by the relevant Environmental Authorities from time to time.
- 1.2 The Developer shall carry out or procure the carrying out of all such further Remedial Action (whether identified in Table 1 above or not) necessary, including any that may be requested or required at any time by any Environmental Authority, acting lawfully, in order to achieve the purpose and objectives set out in sub-paragraph 1.3 (including 1.3.1-1.3.5 thereof) of Part 1 of this Schedule and the performance criteria specified in Table 1 and any such further Remedial Action which a reasonable and prudent owner of the Property bearing full legal responsibility for all Pre-Transfer Date Environmental Matters would otherwise regard as necessary or appropriate from time to time in order to achieve the purpose and objectives set out in sub-paragraph 1.3 (including 1.3.1-1.3.5 thereof) of Part 1 of this Schedule and the performance criteria specified in Table 1 and shall in each case do so to the satisfaction of the relevant Environmental Authorities provided that nothing in this sub-paragraph shall oblige the Developer to perform Remedial Action in relation to Unknown Off-Site Contamination or any Pre-Transfer Date Personal Injury.
- 1.3 The Developer shall take all reasonable steps promptly to create and thereafter maintain an open and constructive dialogue between it and the relevant Environmental Authorities regarding the progress and all other aspects of the RAP Works (including any impact or potential impact on any aspect of the RAP Works of any aspect of the Redevelopment Remediation Works and the inter-relationship between the two) and shall procure that any person acting on its behalf in connection with the RAP Works shall do the same. Without prejudice to the generality of the foregoing, the Developer shall:
 - 1.3.1 Convene a formal meeting with the relevant Environmental Authorities and representatives of the Authority to take place before or as soon as reasonably practicable after the Transfer Date in order to discuss with such Environmental Authorities the current status of the RAP Works, the Developer's plans for redevelopment of the Property as an Urban Village, the future programme of RAP Works in the light of those plans and the Redevelopment Remediation Works and to agree a schedule for future meetings between the Developer, those acting on its behalf and the relevant Environmental Authorities and the Authority such schedule to include as a minimum 6 monthly RAP Works review meetings; and
 - 1.3.2 Promptly comply with all lawful requests for information regarding any aspect of the RAP Works received from any Environmental Authority or the Authority at any time.
- 1.4 The Developer shall, and shall procure that any person acting on its behalf in relation to any aspect of the RAP Works required by this schedule shall, at all times comply with the requirements of Schedule 10 (General Remediation Requirements).

2. Variations to the RAP Works

- 2.1 The Developer shall promptly notify CDL, the Monitor and the Authority if at any time it is notified by a relevant Environmental Authority that such Environmental Authority requires a variation to the RAP Works in which case the following procedure shall apply:
- 2.1.1 As soon as reasonably practicable after serving a notice under paragraph 2.1 above, the Developer shall prepare proposals for the variation to the RAP Works that are consistent with the purpose and objectives of the RAP Works as set out in this Schedule and the standards of prevailing Environmental Law and shall provide a copy of such proposals to CDL the Monitor and the Authority. Any such proposal shall contain a detailed statement of the health risk assessment and general methodology from which the proposed variation to the RAP Works has been derived.
 - 2.1.2 Not earlier than the day of submission of its proposals to CDL the Monitor and the Authority in accordance with sub-paragraph 2.1.1 above, the Developer may submit a written request to the appropriate Environmental Authorities, copied at the same time to CDL, the Monitor and the Authority, for approval of the variation to the RAP Works. The Developer shall provide to the appropriate Environmental Authorities with its request copies of the health risk assessment and general methodology referred to in sub-paragraph 2.1.1 above and a copy of this Agreement clearly drawing attention to the purpose, objectives and requirements of the RAP Works set out therein and the proposed changes thereto.
 - 2.1.3 Each of the Developer, CDL and the Monitor shall be free at any time to make such submissions to the appropriate Environmental Authorities in relation to the Developer's proposals as they see fit, provided such submissions are made in writing and copied to each other and to the Authority at the same time.
 - 2.1.4 The Developer shall ensure that the RAP Works achieve compliance with any variation to the specification for the RAP Works approved in writing by the appropriate Environmental Authorities pursuant to this paragraph 2.1, as if they were also set out in the Table to this Schedule.
 - 2.1.5 No such proposed variation to the RAP Works shall be implemented unless it has been approved in writing by the Environmental Authorities in accordance with this paragraph 2.1 (or if the Developer has only oral approval (or non objection) of the relevant Environmental Authorities no such proposed variation to the RAP Works shall be implemented unless the Developer notifies the relevant Environmental Authorities in writing (copied at the same time to CDL and the Monitor) that it proposes to proceed with the implementation of the proposed variation to the RAP Works 10 Working Days after the date of such notice and no written objection of any relevant Environmental Authority is received within such 10 Working Day period in respect of the same).
 - 2.1.6 Any reference in this Deed to the RAP Works shall be to the RAP Works as varied in accordance with this paragraph 2.1.

A E I C I FOR ATIO SO RCES

***A E I RE ESTS FOR
I FOR ATIO RFI***



Request for Information

Contract Name: Coed D'Arcy **O** ITOR

RFI No:

Contract Number: GNP/NJR/13773-2

Date Raised:

29/04/2010

Subject: DiMe RTC Report Review

To: Hannah White

Atkins

From: Simon Gibbons

URS

Response Required Within:

1 Day

3 Days

5 Days

10 Days

X

Comments

The following comments have been prepared in response to Atkins report ' Remediation Target Criteria for the DiMe Area', dated April 2009, ref.5041216/REM//RPT/000316.

Pages 6 and 8 contain footnotes relating to PCB and dioxins. This element is not discussed in the text in any detail and its inclusion may be potentially misleading. Atkins dismisses PCBs due to there being no substations present. However there is repeated inclusion of 'dioxins' along with PCBs in the text. There could well be other sources of dioxins at the site, for example as the result of power station operations and which is totally separate to substation-related PCB containing oils. It is not clear therefore whether Atkins is mooted that dioxins might be an issue, or whether dioxins are being tagged along with PCBs on the basis that there is no plausible source on the DiMe area. The SGV report referenced in the RTC report deals only with dioxin-like PCBs and is therefore only part of the process required to be followed when assessing potential risks from PCB containing oils from substations. It is recommended that in the introduction to the report the CSM is more fully presented and the potential sources of contamination associated with this part of the site are discussed. By introducing the concept of PCBs/dioxins etc and dismissing it without further explanation may result in queries being raised about the appropriateness of the assessment that has been completed. If there is no identified plausible source then there is no need to make further reference to the HH guidance.

The report dismisses the recreational RBSLs as being irrelevant before establishing whether or not the Atkins conceptual model says otherwise. In order to demonstrate that the potentially lower risk recreational end-uses assessed by URS are not significant it may be appropriate to carry these RBSLs through the process as being the minimum required standard for that generic end-use. Arguments as to why they should not be used should then be raised at the end of the process if any potential issues are identified.

On page 9 of the report Atkins makes a critical assumption in the recreational CSM that children will use other green spaces for ad hoc outdoor activity. This is only relevant if the playing fields don't represent the closest, most convenient open space for a given area of housing. If access to the fields is totally un-fenced, unrestricted, it would be plausible for children living close to the fields to use them for ad hoc activity, rather than walking/biking to a green space further away within the development. This assumption requires further justification and/or explanation about the effect this may have on the RTCs that are generated.

Can Atkins provide a date when the asbestos QRA will be available for review and comment? Is Atkins still proposing to use the residential RBSL for asbestos of 200ppm? Given the demolition activities and former land use it is plausible that asbestos could be present in the shallow made ground soils. The RBSL for asbestos is not depth specific.

It is unclear why metals are not being considered yet Atkins is including other contaminants not expected to be present within the soils. Why include additional contaminants and not metals if there may be a need to screen imported material and which presumably could end up in the top 1m of the soil profile? It should be made clear that the RTCs are only applicable for deep soils and that alternative criteria may need to be developed for shallow soils. Is it practical at this stage to assess recreational quality for imported soils to be used at depths shallower than 1m?

The DiMe area is referenced in a few places and there are several parts of the report which indicate no substations to be present. Can Atkins provide a figure showing which area the assessment relates to? Has a Phase been declared for this area? Given the presence of the power station and large areas of processing plant it seems unlikely that there would be no substations on the DiMe area. The report also refers separately to the site, DiMe and DiMe exclusion area. Can these be defined and the report made clear about which area the RTCs relate to.

The discussion on sources does not seem very specific. It is not clear where the impacts from chlorinated hydrocarbons in particular are located - what the magnitude of observed concentrations is and how this relates to the historic use of this part of the site. This may have been discussed in another site investigation report but as a minimum reference to this information source should be provided.

It is not clear what SOM data is being referenced - site-wide or DiMe specific? Does this vary with geology/depth? How many samples have been collected and used in the selection process? Are the soils a combination of natural and made ground? The selection process described for this parameter seems brief given that this is a stand-alone QRA report and that no data is appended for reference.

The discussion on soil type is brief. A reference to more detailed information would be desirable. A simple clarification that a sand soil is considered conservative might aid in this section since from recollection only the granular made ground would likely be considered a sand and the deeper (perhaps <0.5m below made ground) material is much finer grained. Does vertical stratification of the soils play a role in the modelling and RTC development? Has any consideration been made to the pitch drainage layer and the potential introduction of preferential pathways? Would a gravel sub base create a higher risk since the risk assessment needs to be based on what will be imported not just on what current soil conditions are like.

There is discussion presented on groundwater flow direction, location of school and assertion that concentrations below the school are lower than the RTCs for residential use. This needs greater clarification and discussion. Atkins should indicate that residential RTC are conservative for a school and a drawing with location of the wells used, school position, exclusion zone, etc are required to validate this point. How many wells have been used to confirm this? What does the shallow and bedrock data set actually show? Some discussion on actual concentrations and RTCs would help the reader to understand the assessment that has been completed. What does the time series data show for that particular area of the site? What does the hydrogeological assessment suggest in terms of contaminant depth etc? This element seems to be too simply dismissed with limited back-up with real data.

More explanation on the reason why the longer age-group class used for the female teacher is not significant should be provided rather than simply dismissed.

Is there any national or international guidance on child recreational activity? As noted above what consideration has been given to children using the playing fields more regularly if they live close to them (eg school holidays, other public holidays, evening use, etc)? The assumption of exposure may be appropriate but a clearer breakdown of the thought process used in making the assumptions would be useful.

On page 13 Atkins do not present hazard indices where the RTC is indicated to be > saturation/solubility. Not presenting HI at saturation, therefore leads to uninformed decisions on the degree of risk posed at saturation/solubility limit and the significance for the remedial strategy.

TPH additivity should be discussed so that the risks from all fractions at solubility limit can be considered.

What is the rationale for considering exposure from the school and surrounding grounds to be negligible?

A sensitivity analysis on the exposure frequency for the school child would help provide confidence in the selection of the critical receptor – especially as additional exposure does not appear to have been considered when the child is not on the sports fields?

In the groundwater assessment could you clarify how the exposure frequency is calculated since numerically it appears much lower and inconsistent with the soil model value.

There are inconsistencies between tabulated parameter values and the relevant text in the report.

Signed:  Date: 29/04/2010

Reply

Signed: _____ Date: _____

istribution

To	cc	Name	Company	Fax No
X		Hannah White	Atkins	
	X	Mike Poland	Atkins	

Contract Name:	Coed D'Arcy	O	ITOR	RFI No:	
Contract Number:	GNP/NJR/13773-2			Date Raised:	31/08/2010
Subject:	Review of DiMe Controlled Waters Risk Assessment				
To:	Howel Morris			Atkins	
From:	Simon Gibbons			URS	

Response Required Within:	1 Day		3 Days		5 Days	X	10 Days	
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Comments

The following comments are provided in response to Atkins report 'DiMe Area Controlled Waters Risk Assessment', dated 11th August 2010, ref 5041216-REM-RPT-000372.

geology

Atkins has changed the previous classification system for the geology preferring to split the site into granular and cohesive drift units rather than the previously described Units 'A', 'B' and 'C'. The previous descriptions of the site geology suggest that unit B is a drift deposit which tends to fine downwards and contains what appear to be discontinuous horizons of more permeable material. It is unclear how the Atkins revised assessment deviates significantly from this description. A simplification of the geology – particularly where this will result in a conservative risk assessment may be appropriate but it is not clear if this is why the stratification into more clearly defined granular and cohesive drift deposits has been made.

The report suggests that there is a lack of evidence of groundwater seepage into the railway cutting. This lack of seepage is then used to justify the assumption that the granular units within the sequence are laterally discontinuous (i.e. the main focus for the assessment being vertical migration into the bedrock unit). It is not clear how this conclusion regarding the railway cutting has been formed. From URS' investigation of the railway cutting in 2003 the following observations were made¹;

'The reconnaissance walkover inspection provided a general overview of conditions within the rail cutting. No evidence of severe contamination egress was observed. However, closer inspection and soil boring identified a few locations where contamination was present. The observations are summarised in Table 1. Many water seepages with ochreous precipitates were observed at the base of the cutting, either from soil or bedrock. These seepages were generally observed along the south side of the rail cutting and were often observed to have associated hydrocarbon and/or microbial films.

Soil samples taken from RCSS001 and RCSS002 (approximately 1.5m above the base of the south side of the cutting and 10cm depth) and RCSS008 (approximately 2.0m above the base of the south side of the cutting and 10cm depth) were observed to have black staining and strong hydrocarbon odours. These locations corresponded with ochre rich seepages and hydrocarbon sheens at the base of the cutting. Many soil borings, including samples not contaminated with hydrocarbons, indicated the presence of ashy fill material. It was reported by BP during the inspection, that a lube-oil spill had occurred onto the embankment around location RCSS003, from overhead oil pipes. Vegetative dieback in the immediate area was observed, together with hydrocarbon staining, sheens and odours, further confirming the presence of contamination in this area. However, the extent of soil affected by the spill appeared to be limited to the area beneath and immediately surrounding the overhead pipes on the south side of the cutting.

The Wernandrew separator was observed to collect water from an un-named stream and drainage from the railway cutting. It appeared, although could not be confirmed on site, that separate drainage channels exist for the north side and south side of the cutting. The south side drainage channel is collected into the separator and the north side joins the stream immediately downstream of the separator. Water samples were collected from each of the drainage channels, the upgradient stream and the down gradient stream. No sheens or odours were observed in any of the water samples collected.'

¹ Rail Cutting Inspection, BP Llandarcy Refinery, ref 39991-032-785/DR1161/LT/7205, dated 6th August 2003

A copy of the report is attached for information. On the basis of previous observations of seepages in the railway cutting it is considered that this may indicate a plausible pathway for contamination to migrate off-site. Further consideration of this pathway should therefore be presented in the assessment.

The geological description of the bedrock unit does not appear to present any discussion on the significance of either the dip or bedding control on groundwater movement.

The exclusion of the term boulder clay from the geological succession description is not considered appropriate. The term is a widely used and understood geological term and is considered to be an accurate description of the material encountered beneath the DiMe plant. It is recognised, however that this type of formation may be difficult to model, in which case it may be more appropriate to recognise areas where simplifications have been made (i.e. the distinction between granular and cohesive drift).

hydrogeology

The hydrogeology section reports that groundwater flow is towards the railway cutting but subsequently infers groundwater flow only to the River Neath. Is this considered a reasonable reflection of the data? Is it inferred that groundwater in the bedrock flowing north underpasses the railway cutting and is inferred to ultimately discharge to the River Neath?

It should be noted that the extent of groundwater data used in previous assessments for the site cover a much larger area than the groundwater contouring completed by Atkins. This more comprehensive data set suggests a groundwater catchment divide at or close to the DiMe plant. Its exclusion by Atkins does not appear to be well justified. It may ultimately be appropriate to exclude the Crymlyn Bog catchment on the basis of the position of any divide (eg the bulk of the contamination lies to the east) but it should perhaps not be dismissed so quickly without consideration of the wider groundwater flow regime at the site. Can further justification be provided for consideration of westerly contamination migration only at the DiMe plant?

The brief discussion on recharge to the bedrock should be supported by some form of calculation. Can Atkins demonstrate that recharge alone over the bedrock outcrop at the site is sufficient to supply enough water to maintain the observed gradients across DiMe using the permeability/porosity assumptions used in the model? If not then consideration of vertical recharge through the drift to can be assumed and may help to estimate the relative significance of lateral migration in the drift itself. One of the fundamental parts of the assessment that was discussed at the outset was the provision of a water balance for this area of the site so that the real site data can be used to calibrate the whole assessment. Without this water balance there is likely to be a lack of confidence in the risk assessment results and in particular the likely groundwater residence time and transport velocities to the various receptors.

A large range in water levels is reported in some wells in the DiMe area. Would the large variations in some locations provide supporting evidence for the likely low storage and potentially poor connectivity in the main bedrock unit? This type of evidence needs to be extracted more clearly from the data set and related to the CSM for the site.

With regard to free product, further assessment of its location relative to potential sources, its significance with regard shallow groundwater migration, particularly towards the railway cutting, would be beneficial given the ultimate conclusion presented in the report. A sentinel well monitoring programme is in place specifically to monitor for product migration towards the railway cutting yet this element of the CSM appears to have been dismissed completely in the assessment presented. A plot of product thickness variation with time in key wells would be useful to help assess its potential significance.

The discussion on depressed water levels in the cohesive drift is confusing. Does the initial part of the discussion relate purely to the measured depth to water before consideration of overlying product or is it implying an error in the data set? An entire page dedicated to discussing corrections for the presence of product in wells appears inconsistent with the level of detail presented for the other aspects of the hydrogeology at the site.

For the cohesive drift hydrogeology URS would note that seepages have been observed in the railway cutting and therefore the suggestion that lack of seepage supports the assumption that the water is 'perched' does not appear to be reliable. Notwithstanding this, the conclusion that the majority of groundwater movement in the drift is likely to be vertical appears to be a reasonable assumption. As with the recharge element discussed above, some form of calculation to demonstrate this is considered appropriate (eg what is the groundwater flow laterally given the permeability, gradient, etc versus the calculated vertical flux given the larger area, observed vertical gradients, assumption of homogeneous permeability, etc). Are the various assumptions reasonable? This would likely provide some justification that vertical migration is likely to be the most important element of the CSM (eg the simple calculation may show that 90-95% of the groundwater flow through the drift is vertical (to support the estimated recharge into the bedrock unit) rather than laterally towards the railway cutting). This may also enable certain receptors to be ruled out as being significant although further inspection of seepages and water quality in the railway cutting may ultimately be required to complete this element.

In the made ground/granular drift hydrogeology there does not appear to be any discussion on the effects of the drainage network on groundwater levels? There is no presentation of water level data or assessment of the distribution of free product which has historically been observed in a large number of wells screened in the made ground in the DiMe plant itself. Could the drainage system be a route for discharge of shallow groundwater? It is known that the drainage system has contributed significantly to the transfer of chlorinated hydrocarbon contamination from the DiMe plant into the North Site Reservoir. Therefore a pollutant linkage between shallow ground contamination and drainage must exist. If contaminated shallow groundwater is not considered to be part of the source then further evidence should be presented to rule out this particular pathway (eg are shallow groundwater levels consistently below the invert levels of the drainage system? Can additional data be supplied to support any of the conclusions that are reached? Consideration of removal of the drainage network may help assist future predictive modelling but consideration of the historic influence is still considered appropriate.

The hydraulic conductivity section reports on tests completed across the entire Llandarcy refinery site (as distinct from the DiMe Site?) Whilst a range of values are recorded there is no discussion on the geology type at each of the test locations? How comparable are these results considered to be to the DiMe area? Would it be possible to collect data specifically from DiMe wells and those immediately down hydraulic gradient? It is not apparent that any of this data has been used in the assessment (see below – the report suggests literature values for the cohesive drift have been used).

Whilst the comment on well screens intercepting more productive strata is likely to be correct it is not clear if the comment about the bulk hydraulic conductivity of the cohesive drift is relevant. Whilst the bulk transmissivity of the cohesive drift may be lower than indicated by the slug test data the permeability of the more sandy units in the drift through which contamination is likely to migrate is likely to reasonably well reflected in the test data. Given that migration is likely to occur through the more permeable units it is considered appropriate to consider the use of this permeability value in the assessment itself.

product

It is noted by Atkins that the monitoring well network is likely to be insufficient to assess the potential for LNAPL migration. Atkins do not, however, present their conclusion following this remark? How does it affect the CSM? If product migration was occurring would the assessment be completed differently? The sentinel well monitoring programme has indicated that there is the potential for product migration to occur. Would the sentinel well data assist in assessing the potential for migration of product across DiMe? If free product migration is considered possible what does that suggest about the heterogeneity of the shallow and/or deep drift?

The LNAPL analysis would likely benefit from presentation of pie charts to show the relative proportions of each TPH/BTEX fraction from each sample location. The most recent data clearly shows a significantly different composition to the LNAPL analysed on 21/1/2009? No borehole references are provided however to help the reader understand the location of the various samples? It is not clear if Atkins is implying a change in product composition at the same/similar locations or simply that there are two different types of product in the DiMe plant area. More details on geographic extent would be helpful.

It is not clear what Atkins mean by 'conventional' hydrocarbons. The TPHCWG analysis is based on effective carbon numbers/carbon bonds and therefore could include a wide variety of different aliphatic and aromatic compounds. In order to understand what the 'conventional' hydrocarbon comment means would require a more detailed VOC analysis to rule out certain contaminants and/or would require a more refined assessment of the likely source of the LNAPL. It is not clear if DiMe analysis was included for the product samples?

The potential risk from product to controlled waters does not appear to have been assessed in the risk assessment process.

Contamination Assessment

The discussion on solubility and volume of groundwater appears to be a little abstract. Would it be possible to provide further information on rates of dissolution of the chlorinated hydrocarbons given the site setting? How much water is passing through the aquifer, how much DNAPL might reasonably be expected based on historic concentration data? Taking into account Raoult's Law what solubility might be expected for each determinand in the mixture? Are the observations on site supported by the theory (using calculations to demonstrate Atkins understanding) and/or are there potential data gaps on site that need filling before a conclusion on this aspect can be made.

In the contaminant properties Table 4.6, a selection of half lives are presented for the two key chlorinated contaminants. These rates are likely to be critical in establishing the extent of any contamination plume migrating from the DiMe plant. It is not clear, however, how these rates have been incorporated into the assessment.

There is a brief discussion on anaerobic vs aerobic degradation however no site specific assessment appears to have been completed (it is assumed by Atkins that groundwater will only be anaerobic on site). Use of DO/Redox data etc should help confirm whether conditions are likely to be reducing in the DiMe plant area. It is noted that dissolved methane analysis has been completed recently and this is discussed in more detail later in the report.

The discussion on historical contamination appears relatively brief. Has Atkins reviewed contaminant distribution data for themselves? Has the original risk assessment been reviewed? What sources are considered most likely to have caused the observed distribution of contamination? Is there a distinction between source and plume from the available data set?

It is noted that Atkins has completed more recent monitoring at the site. What is not clear, however, is how the locations of the new wells relate to the likely sources of contamination and whether they have been effective in replacing wells where high concentrations have been recorded historically but which may no longer exist. Can Atkins provide a figure showing which boreholes are included in the statistical analysis for 2009/2010? Have the wells with the highest historical Di and Me concentrations been resampled recently or replaced with appropriate monitoring points? (eg DSB007, DSB009s2, MSMW066d2, DSB008s1, etc).

Whilst the sporadic nature of sampling may lead to an overly pessimistic view of the contaminant distribution at the site it would at least provide a reasonable overview of where contamination has been identified at concentrations which may be considered to represent the main source area.

A specific comment is made on the concentrations in DSB023s2 in the report. It states that the current concentration of 21ug/l is significantly lower than historical data. Based on URS' records this location appears to have been sampled once in February 2002 and a concentration of 17.3ug/l was reported. Can Atkins confirm which data they are using?

For the cohesive drift discussion there is a general inference presented by Atkins that concentrations have decreased. It would be helpful to provide graphical evidence of this, making reference to the more contaminated wells which have not been resampled recently.

Has any assessment of depth of contamination in the cohesive drift been attempted? The potential presence of DNAPL or high dissolved phase concentrations towards the base of the cohesive drift will reduce the vertical distance for attenuation in any vertical migration model.

The conclusions about lack of a DNAPL source in the bedrock appears reasonable based on the bedrock monitoring data.

The significance of potential data gaps requires clarification in each of the contamination distribution sub-sections.

No comments are provided in relation to the distribution/magnitude of shallow groundwater contamination and no discussion is presented on PID data or soil results to help infer where releases to ground may have occurred.

The presence of chloride in the cohesive drift deposits is discussed by Atkins. The report states that chloride is 'preferentially' transported. It would be more accurate to suggest that chloride is relatively little retarded during transport and does not undergo degradation. It is therefore a good tracer to help understand the distribution and longevity of a source of contamination.

The inference that 500mg/l of chloride in the cohesive drift is from dechlorination appears to be reasonable. The correlation data for methane appears to support the earlier supposition that conditions in the groundwater are generally reducing. There does appear to be reasonable evidence to support the conclusion that biodegradation of the DiMe solvents is occurring in the cohesive drift deposits. Is any similar data available for bedrock and/or granular drift wells?

Whilst a detailed discussion on the presence of chloride is presented the significance to the CSM and the risk assessment is not clearly stated. Can this data be used to estimate the potential lateral extent of dissolved phase plumes in each unit?

The calculations for assessing the relative conductivity for Di and Me appear reasonable although further discussion on how/why this calculation is necessary would aid the non-specialist (i.e. the intrinsic permeability is a function of the porous media while the fluid conductivity will be dependent on the dynamic viscosity and density of the fluid). For low viscosity, high density fluids the rate of migration will be higher than the hydraulic conductivity (i.e. the pure phase contaminant will migrate more rapidly than would groundwater alone).

The conclusion presented by Atkins that there is likely to be relatively little residual DNAPL is presumably based on the assumption that the formation is relatively homogeneous vertically and that wells are installed in appropriate locations across the site.

The velocity calculations suggest that a 5m thick cohesive drift unit should be penetrated in 1-10 years allowing for some variation in local permeability. This appears to be a reasonable assumption.

Coal Measures contain a naturally occurring source of chloride. Consideration should be given to the background chloride content in the bedrock across the site (i.e. away from potentially chlorinated solvent contaminated areas) to understand the natural background. A brief review of available site wide chloride data for deep wells suggests a background concentration in the range 25-50mg/l. This suggests that results between 50-300mg/l may be indicative of some dechlorination of chlorinated solvent contamination and as suggested by Atkins may be diluted from the cohesive drift as a result of mixing in the deeper groundwater.

CS Summary

It is not clear why an assessment of all of the TPH fractions has not been undertaken and in particular aromatic C8-C10 which has been reported at up to 18.72% in one sample analysed from 23/01/2009. Based on mass fraction/solubility (i.e. Raoult's Law) even the relatively low proportions of BTEX contaminants could also potentially present a risk but do not appear to have been considered.

For the pathways element it appears as though the DNAPL migration directly to the bedrock is no longer considered by Atkins to be plausible. This is backed-up by evidence from site and calculations presented in the report which indicate declining concentrations and calculated velocities which suggest DNAPL would most likely have reached bedrock and there is no on-going source from site operations which ceased more than 10 years ago. It is not clear, however, if Atkins are satisfied that there is sufficient current monitoring well coverage to be confident in this conclusion. If not what difference would be made by considering the presence of DNAPL in the bedrock as part of the assessment? How would down gradient monitoring data and lateral velocity calculations help support the conclusions regarding potential for on-going sources in the bedrock?

The selection of a compliance point at the eastern site boundary appears reasonable. Consideration should, however, be given to the railway cutting as a potential receptor.

The extent of source areas is not described in the CSM summary. The location of potential sources in the different aquifer units is also not discussed and the relationship between source and pathway is not clearly described.

Understanding of Assessment

The objectives indicate that the controlled waters assessment was to be completed on the basis of the CSM described in Section 4 of Atkins' report. From the information provided in the report it is not clear, however, exactly what S-P-R linkage has been simulated and how the two models relate to one another. The description at the start of Section 5 is confusing. It has been assumed that the following assessments have been completed;

1. Predictive Model – Used to calibrate the risk assessment model to attempt to replicate observed conditions. It is assumed this calibration is completed on a trial and error basis. No details of the calibration method/data are provided. Can you confirm which data points / wells are used for calibration? Can the source/pathway/receptor be described more clearly for this model.
2. Impact Model – Using a revised model following the calibration process to estimate the potential risk at the selected compliance point from the contaminants of concern. Two assessments using a constant and declining source have been completed. It is not clear if this model assumes vertical and then lateral migration using cohesive drift input concentrations or not?

The methodology then states that the deep groundwater concentrations have been ignored? It does not state what data has actually been used. Irrespective of the source of dissolved phase contamination in the bedrock it is not clear why it is considered that the reported deep contamination won't migrate laterally in the dissolved phase towards the receptor. Further clarification of what sources have been considered is required.

The models might be aided by clearly stating the objectives for each assessment;

1. What concentrations do the soil contaminants leach at into the granular drift?
2. What attenuation via dilution is simulated in the shallow groundwater unit?
3. How do these concentrations compare to the observed dissolved phase concentrations in both the granular and cohesive drift groundwater units?
4. What mechanisms are active vertically through the granular/cohesive drift units in order to create the pollutant linkage into the bedrock aquifer?
5. What attenuation factor is calculated for this migration process?
6. What additional dilution may be expected in the bedrock aquifer?
7. How do the vertical model simulated concentrations into the bedrock compare with observed concentrations?
8. What concentrations are simulated laterally to the 360m compliance point assuming current observed deep groundwater concentrations as the source concentration?
9. How does this differ from the results from the vertical model and what adjustments might need to be made to the vertical model to enable a closer match?
10. Given these adjustments how else might the vertical model be used to assess the significance of vertical migration of contamination within the DiMe area?
11. Can the lateral migration be calibrated using down gradient monitoring data?
12. Does the assessment of groundwater velocities and contaminant migration rates mean that down gradient data can be inferred as being in steady state?
13. Would concentrations be expected to increase in the future at down gradient locations?
14. Given the potential for redevelopment of the site can simulated concentrations down gradient of the source be simulated at 50m intervals to aid the HH assessment?

The description of the stochastic nature of the two models is difficult to follow. Can this be stated more simply and clearly? Why is it considered appropriate to use different confidence levels in the two different assessments.

Atkins include the statement that the unsaturated vertical pathway has been incorporated as if it were a saturated pathway using appropriate values. Can these input values be provided and an indication of what processes the vertical 'unsaturated' pathway model in ConSim is trying to replicate. Has consideration of recharge limitation to vertical migration rates been considered (i.e. the rate of vertical migration through a saturated formation may be limited by the rate of recharge to it)? Has degradation been assumed through the vertical migration pathway? Has the DiMe fluid conductivity been incorporated (or adjusted for) when calculating the vertical velocity in the model?

It is not clear from the Parameterisation section whether soil and groundwater sources are being considered in the assessment. The source depth term for groundwater sources should be reflective of conditions described in the CSM so that vertical dispersion during lateral migration is limited or removed. Can the assumed or calculated groundwater source depth be provided.

Why has site specific foc data not been used?

Are the air filled porosity values presented for the unsaturated zone intended to reflect the vertical saturated pathway)?

Is 50% infiltration considered appropriate given the future use of the site? Given the long term presence of hardstanding and drainage systems at DiMe this degree of recharge may be on the high side but for soil leaching would likely be conservative. Does this degree of recharge work with the water balance for the site? How might having the whole DiMe area unsurfaced in the future affect gradients and water levels? Would this affect the output from the risk assessment?

Can a summary of the modelling components used for each of the assessments be provided (eg for soil – leaching, dilution in perched shallow groundwater, vertical migration through shallow saturated zone with biodegradation, dilution in deeper bedrock unit, lateral migration to compliance point, using max observed soil concentrations over whole DiMe source area, etc), together with a rationale for each element?

Why is site specific permeability data not being used for the cohesive drift as a maximum literature value of 0.01m/day seems to be on the low side given the recorded presence of sand and gravel within the drift unit. Whilst the bulk properties of the drift might more closely resemble clay would contamination not migrate preferentially through the more granular units and hence would a higher conductivity be appropriate? IF the sand/gravel lenses are not considered to be interlinked vertically then this should be clearly explained when presenting the rationale for the parameter selection. How would the separation of the cohesive drift into more and less permeable zones affect the incorporation of dispersion in the assessment? IS dispersion considered in the vertical migration model?

Is it assumed that the vertical conductivity is higher or lower than the lateral conductivity? No vertical hydraulic gradient is provided for the vertical pathway in the parameters summary?

The thickness of the bedrock unit appears to be very high and could potentially allow a large degree of vertical dispersion during migration (depending on source depth assumption and source length/width). The comments suggest that only the mixing zone thickness has been used in the assessment, in which case why is a 50m thick aquifer listed in the input parameters? Is the mixing zone thickness used to dilute soil contamination and limit the source thickness term for groundwater? Is the assumed effective porosity intended to reflect the weathered sandstone rather than the unweathered bedrock?

Does the model assume that the compliance point is located directly down hydraulic gradient of the source?

The Model Section does not provide any information on how the ConSim model has been setup and how the different pathways have been simulated.

If reported dissolved phase concentrations (or solubility limits) have been used to represent the source what is the basis for their selection and in which geological unit is the main source considered to reside?

It is indicated that the predictive model is under predicting concentrations compared to the site data and the inference is that degradation is slower than the literature values used in the model. This is one of several reasons why the results might be different. It is indicated that the degradation rate has been increased in order to match the site data to the 50%ile simulated concentration. No data is provided on what this degradation rate is or what the calibration point is taken to be? Without this information the relevance of this model in the whole process can not be evaluated.

Based on URS review of potential degradation rates for the key contaminants, 2 years and 1.5 years for 1,2-DCA and DCM respectively is considered potentially more appropriate.

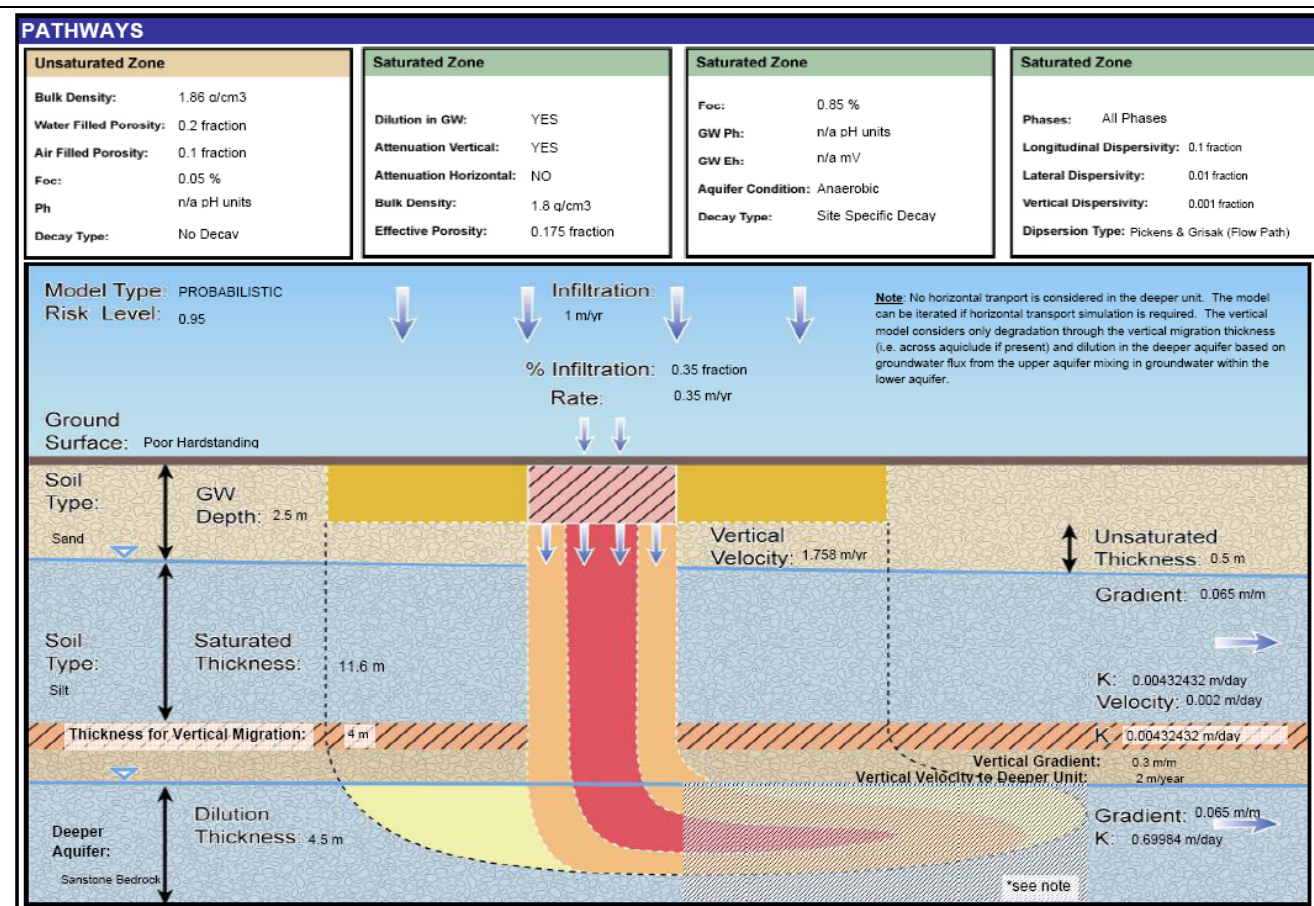
Can the titles in the tables in Section 5 be clarified? What is the target concentration – where does it apply and how does the model that has been set-up calculate the 40 year 50th percentile value.

In order to use degradation rates in the assessment (and to understand their relevance in the calibration process) it is normally necessary to present data which illustrates that the plume is stable or shrinking. In order to establish the potential total attenuation factor for the aquifer it may be more appropriate to follow the USEPA process for calculating First Order Rate Constants since the specific process which is creating the difference between the Predictive Model and observed concentrations is unknown – i.e. the difference could be down to the Koc value, aquifer thickness, permeability, organic carbon content, etc as much as the half life.

In the model the saturated cohesive till thickness may have a significant effect on the degree of attenuation of each of the contaminants – particularly given the low permeability assumed. Should this be adjusted to take account of the depth to the DNAPL (i.e. the saturated aquifer thickness for the vertical model should take account of the source position). Reducing this to 2-4m could make a significant difference to the risk assessment results – particularly at the higher confidence limit.

It is currently unclear exactly how the vertical saturated migration has been simulated. Given the fact that contamination is observed in the bedrock would it not be simpler to use observed bedrock groundwater contaminant concentrations and simulate migration laterally to the compliance point? This would at least provide a conservative baseline assessment from which more complicated vertical models could be developed to understand further attenuation mechanisms and time variant reduction in risk given the potential for source depletion and given the evidence to support a reducing input of contamination into the bedrock.

In Table 5.5 does the current source concentration relate to bedrock or the cohesive drift units? Can a sketch be prepared which shows the details of the parameters used in the assessment overlain on the CSM? An example is provided below;



The constant source impact model identifies exceedances at the down gradient receptor. How does this tally with data from wells down gradient of the source? Has any lateral calibration been completed (i.e. assuming the calibration for the predictive model is only for the vertical part of the assessment)? The declining source impact at the base of the cohesive drift can't be correct since significantly higher concentrations (including inferred DNAPL) have been identified in the bedrock. What evidence is there to support the use of a declining source model and does its method of incorporation in ConSim match the CSM?

How has degradation been applied in the model? Has the applied degradation rate assumed degradation in all phases (which equates to degradation rates for the whole aquifer system from field studies rather than dissolved only rates from lab studies)?

The report does not provide a sufficiently clear description of each of the models, inputs and outputs to understand and assess clearly how the modelling has been completed and whether there are considered to be any significant risks to controlled waters.

The conclusion that product removal from DiMe should be undertaken appears reasonable.

Potential data gaps from the assessment should be identified (eg how comprehensive is the recent groundwater monitoring data set and have historical high concentration wells been sampled or replaced with an appropriate new well?). At present the report simply states more monitoring will be completed in the future but does not critically review the appropriateness of the current monitoring well network.

Signed:  Date: 31/08/2010

Reply

Signed: _____ Date: _____

istribution

To	cc	Name	Company	Fax No
X		Howel Morris	Atkins	
	X	Mike Poland	Atkins	



Request for Information

Contract Name: Coed D'Arcy **O** ITOR

RFI No:

Contract Number: GNP/NJR/13773-2

Date Raised:

07/01/2011

Subject: DiMe RTC Report Review Rev 1

To: Hannah White

Atkins

From: Simon Gibbons

URS

Response Required Within:	1 Day		3 Days		5 Days		10 Days	X
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Comments

The following comments have been prepared in response to Atkins revised report ' Remediation Target Criteria for the DiMe Area', dated 23rd December 2010, ref.5041216/REM//RPT/000316 and associated comments on RFI0056.

1. Pages 6 and 8 contain footnotes relating to PCB and dioxins. This element is not discussed in the text in any detail and its inclusion may be potentially misleading. Atkins dismisses PCBs due to there being no substations present. However there is repeated inclusion of 'dioxins' along with PCBs in the text. There could well be other sources of dioxins at the site, for example as the result of power station operations and which is totally separate to substation-related PCB containing oils. It is not clear therefore whether Atkins is mooted that dioxins might be an issue, or whether dioxins are being tagged along with PCBs on the basis that there is no plausible source on the DiMe area. The SGV report referenced in the RTC report deals only with dioxin-like PCBs and is therefore only part of the process required to be followed when assessing potential risks from PCB containing oils from substations. It is recommended that in the introduction to the report the CSM is more fully presented and the potential sources of contamination associated with this part of the site are discussed. By introducing the concept of PCBs/dioxins etc and dismissing it without further explanation may result in queries being raised about the appropriateness of the assessment that has been completed. If there is no identified plausible source then there is no need to make further reference to the HH guidance.

At ins Response

The human health RTC report will be submitted in conjunction with a geoenvironmental assessment and controlled waters risk assessment and is therefore not a completely stand alone report. A more detailed site history and CSM relating to former sources will be provided within the geo-environmental assessment which will discuss in more detail the potential contaminants of concern for the site and present an approach for establishing other anticipated contaminants (which have not been identified to date) which are considered likely to be present based on the historical uses.

There are identified sources of dioxins, furans or dioxin-like polychlorinated biphenyls (PCBs) upon the DiMe area of the site. Reference to dioxins, furans and dioxin-like PCBs has been included in this report and a site specific assessment is proposed (in line with the Environment Agency 2009 SGV report). Atkins notes that the Environment Agency 2009 SGV report covered available toxicological information for the dioxins, furans and dioxin-like PCBs. There is a paucity of toxicological data for a number of other PCB compounds (non dioxin-like PCB compounds) and a risk assessment may not be realistically feasible given the available data. This lack of data will be confirmed and considered in more detail if appropriate for other source areas.

Conclusion

Noted, although this was not clear in the original version of the report. The text should make specific reference to both the accompanying CWRA report and the geoenvironmental assessment. Given that the Atkins ground investigations have not been completed or reported yet could this make a significant difference to the assessment or have suitably conservative assumptions been made based on historical BP data?

2. The report dismisses the recreational RBSLs as being irrelevant before establishing whether or not the Atkins conceptual model says otherwise. In order to demonstrate that the potentially lower risk recreational end-uses assessed by URS are not significant it may be appropriate to carry these RBSLs through the process as being the minimum required standard for that generic end-use. Arguments as to why they should not be used should then be raised at the end of the process if any potential issues are identified.

At ins Response

This has been re-ordered in the report. The RBSL conceptual model in comparison to the RTC conceptual model is discussed in a section after the RTC conceptual model has been developed. Following the conclusions from this discussion, the RBSLs are not considered to be comparable to the RTCs for the recreational land use. It is understood that this approach has already been discussed and agreed with the Monitor.

Conclusion

No specific agreement has been reached to date with the Monitor for disregarding the existing recreational RBSLs from the process although this now appears in the report. The point previously made by the Monitor was that the RTC conceptual exposure model should be evaluated first and then the resultant criteria reviewed against the RBSLs for the generic land use and only then if significant issues are identified either numerically or following comparison with actual site data should a potential 'issue' be raised that could require amendment of the S106. It should be noted that with the exception of 1,2-Dichloroethane (1,2-DCA) and tetrachloroethene (PCE) the RTCs in this case are generally marginally lower than the recreational RBSLs presented in the S106 Agreement – irrespective of the conceptual model used and how they may have been derived. For 1,2,-DCA and PCE the difference between the RBSL and RTC is unlikely to be significant since the criteria are only marginally different and both are likely to be higher than concentrations reported for on-site soils. It would be preferable for Atkins to make this specific comparison since the RBSLs form an important contractual element of the remediation requirement at the site. Whilst it is noted that the conceptual models are different, the similarity and generally more conservative results when generating the RTC means that the adoption of RTCs only for DiMe will be easier for the relevant regulators to accept. The S106 makes no allowance for disregarding RBSLs in favour of revised conceptual exposure models at the site. In the case where RTCs are more conservative in any case then there should be no significant issues with following the contractual process through. Where the RBSLs represent onerous requirements the need to change the S106 to incorporate alternative criteria will require formal submission to the Planning Authority and may require legal review before acceptance (i.e. the Monitors undocumented comments on likely acceptability will not be sufficient).

3. On page 9 of the report Atkins makes a critical assumption in the recreational CSM that children will use other green spaces for ad hoc outdoor activity. This is only relevant if the playing fields don't represent the closest, most convenient open space for a given area of housing. If access to the fields is totally unfenced, unrestricted, it would be plausible for children living close to the fields to use them for ad hoc activity, rather than walking/biking to a green space further away within the development. This assumption requires further justification and/or explanation about the effect this may have on the RTCs that are generated.

At ins Response

Atkins acknowledges the uncertainty in the actual usage patterns for the playing fields and potential uncertainty relating to the possibility that a child may preferentially use the playing fields as the most accessible or convenient area for adhoc activity. Atkins understands that the playing fields will be secured and that the adjacent school will have sole use. This will mean that the school can use the playing fields when they need for lessons without the general public being present. It is also important for health and safety reasons for the school, as it is possible that the general public (e.g. youths, dog walkers) may leave rubbish on the site (e.g. broken glass, waste) which would render areas of the playing fields unsuitable for the school.

In support of this, the current version of the Masterplan indicates that green space will be available elsewhere on the development for ad hoc playing. It is considered likely that as part of the planning development, designated Neighbourhood Area Equipped for Play (NEAP) and Local Area Equipped for Play (LEAP) areas will be present upon the site which will be specifically designed to encourage activity of children thus reducing the requirement of public use of the playing fields. The playing fields are not considered to represent an area which children will frequent regularly outside of structured sessions.

The potential for additional ad hoc play is not considered by Atkins to be a critical issue as it is considered that there is sufficient conservatism in the conceptual model for an older child and a more frequent usage, as discussed below. The conservatism in the exposure frequency selected for the modelling is discussed in more detail under point number 12. Changes have been made to the report to strengthen the selected receptors using the lines of evidence above.

Conclusion

Based on the stated conservatism in the exposure scenarios modelled this is accepted as a reasonable approach.

4. Can Atkins provide a date when the asbestos QRA will be available for review and comment? Is Atkins still proposing to use the residential RBSL for asbestos of 200ppm? Given the demolition activities and former land use it is plausible that asbestos could be present in the shallow made ground soils. The RBSL for asbestos is not depth specific.

At ins Response

The asbestos report is currently under review and will be submitted at the earliest opportunity.

Conclusion

Noted. Atkins should utilise the asbestos RBSL or RTC as appropriate when reviewing data from the geoenvironmental investigation work and pending agreement from the Monitor and relevant environmental authorities that the RTC is acceptable in this end-use scenario.

5. It is unclear why metals are not being considered yet Atkins is including other contaminants not expected to be present within the soils. Why include additional contaminants and not metals if there may be a need to screen imported material and which presumably could end up in the top 1m of the soil profile? It should be made clear that the RTCs are only applicable for deep soils and that alternative criteria may need to be developed for shallow soils. Is it practical at this stage to assess recreational quality for imported soils to be used at depths shallower than 1m?

At ins Response

The exclusion of metals has been clarified more in the report. The use of RTC for soil at depths greater than 1m has been clarified. Soils at a shallower depth than 1 m will be assessed under separate cover.

Conclusion

Noted. Can Atkins provide an indication of when shallow soil criteria appropriate for the rugby pitch recreational end-use scenario will be developed and/or whether conservative existing criteria may be used (with appropriate justification as to why it is conservative).

6. The DiMe area is referenced in a few places and there are several parts of the report which indicate no sub-stations to be present. Can Atkins provide a figure showing which area the assessment relates to? Has a Phase been declared for this area? Given the presence of the power station and large areas of processing plant it seems unlikely that there would be no substations on the DiMe area. The report also refers separately to the site, DiMe and DiMe exclusion area. Can these be defined and the report made clear about which area the RTCs relate to.

At ins Response

For the purpose of this assessment, the DiMe area has been assumed to occupy the area shown on Drawing 5041216/ENG/DWG/820. It is anticipated that a formal 'Phase' boundary for the DiMe will be submitted in early January 2011.

Conclusion

Noted. The geo-environmental scope should include analysis for PCBs, Dioxins etc as appropriate to the identified potential contaminants of concern from the desk study and previous work undertaken by BP. The results from the geoenvironmental works should be assessed as necessary against appropriate RTCs when reviewing remedial requirements. Can a copy of DWG820 be provided and included in the report for reference.

7. The discussion on sources does not seem very specific. It is not clear where the impacts from chlorinated hydrocarbons in particular are located - what the magnitude of observed concentrations is and how this relates to the historic use of this part of the site. This may have been discussed in another site investigation report but as a minimum reference to this information source should be provided.

At ins Response

A discussion on the nature and extent of contamination present will be provided within the separate geoenvironmental report for this area. This will be combined with the HHRA and CWRA for submission to the regulatory authorities as a single 'package'.

Conclusion

Noted.

8. It is not clear what SOM data is being referenced - site-wide or DiMe specific? Does this vary with geology/depth? How many samples have been collected and used in the selection process? Are the soils a combination of natural and made ground? The selection process described for this parameter seems brief given that this is a stand-alone QRA report and that no data is appended for reference.

At ins Response

Data has now been appended in Appendix B. Please also see comment 1. DiMe specific data has been used to derive the SOM used in the modelling. The selection of a sand soil source is protective of a silt or clay soil type for the vapour inhalation pathway. The modelling assumes a single geological lithology (sand) and does not allow for the contaminant to re-sorb to higher SOM or soil as the vapour travels up towards the surface. As such, the selection of a sand soil type is considered suitably conservative. The potential for preferential pathways will be considered at the pitch design stage, which will take into account the required remediation works.

Conclusion

Noted. The statement about 1.6% SOM being appropriate for any imported top soil should be more fully justified or the text altered since the SOM of the drainage layer, etc is not known and could be lower than that assumed for the natural soils.

9. The discussion on soil type is brief. A reference to more detailed information would be desirable. A simple clarification that a sand soil is considered conservative might aid in this section since from recollection only the granular made ground would likely be considered a sand and the deeper (perhaps <0.5m below made ground) material is much finer grained. Does vertical stratification of the soils play a role in the modelling and RTC development? Has any consideration been made to the pitch drainage layer and the potential introduction of preferential pathways? Would a gravel sub base create a higher risk since the risk assessment needs to be based on what will be imported no just on what current soil conditions are like.

At ins Response

More information regarding the conservatism and impact of the material overlying has been added to the report in section 2.1.2

Conclusion

Noted although the statement that the soils at DiMe are reported as having a high sand content is rather general and probably doesn't reflect the true nature of the granular and cohesive soil mixture underlying the DiMe area. Can Atkins confirm that they consider a sand assumption appropriately conservative for a deeper soil even where granular drainage layers may be placed above the natural soils as part of the pitch development? If consideration of an actual pitch construction could be provided then this may allay concerns over soil type selection.

10. There is discussion presented on groundwater flow direction, location of school and assertion that concentrations below the school are lower than the RTCs for residential use. This needs greater clarification and discussion. Atkins should indicate that residential RTC are conservative for a school and a drawing with location of the wells used, school position, exclusion zone, etc are required to validate this point. How many wells have been used to confirm this? What does the shallow and bedrock data set actually show? Some discussion on actual concentrations and RTCs would help the reader to understand the assessment that has been completed. What does the time series data show for that particular area of the site? What does the hydrogeological assessment suggest in terms of contaminant depth etc? This element seems to be too simply dismissed with limited back-up with real data.

At ins Response

This will be addressed under separate cover, which will include an assessment of the data available at that point in time. An assessment of groundwater flow is provided within Atkins report 5041216-REM-RPT-000372.

Conclusion

Reference to the other two important reports associated with groundwater conditions across DiMe should be made in the text. There is still uncertainty about the full exposure model and potential additivity for recreational use and using the school should there potentially be significant contamination in that area of the site. Can Atkins confirm how the full daily exposure of a school pupil will be considered and why in Atkins opinion the recreational criteria are sufficiently conservative in this circumstance.

11. More explanation on the reason why the longer age-group class used for the female teacher is not significant should be provided rather than simply dismissed.

At ins Response

More information on the critical receptor has been included.

Conclusion

Noted.

12. Is there any national or international guidance on child recreational activity? As noted above what consideration has been given to children using the playing fields more regularly if they live close to them (eg school holidays, other public holidays, evening use, etc)? The assumption of exposure may be appropriate but a clearer breakdown of the thought process used in making the assumptions would be useful.

At ins Response

There is no UK guidance on child recreational activity or conceptual models for recreational land uses. More information on the thought process in developing the input exposure parameters is presented within the input parameters in Appendix B. This has been condensed and summarised in the main report rather than repeating the information. See comment 3.

Conclusion

Noted.

13. On page 13 Atkins do not present hazard indices where the RTC is indicated to be > saturation/solubility. Not presenting HI at saturation, therefore leads to uninformed decisions on the degree of risk posed at saturation/solubility limit and the significance for the remedial strategy.

At ins Response

The contribution of the saturation limit to the hazard index has been included in Appendix E for TPH and PAHs and is discussed in section 2.4.

Conclusion

Some other contaminant groups indicate the RTC to be >saturation. It appears these are provided in Appendix E too (i.e. not just TPH/PAHs).

14. TPH additivity should be discussed so that the risks from all fractions at solubility limit can be considered.

At ins Response

A discussion of additivity has been included in the report.

Conclusion

Noted.

15. What is the rationale for considering exposure from the school and surrounding grounds to be negligible?

At ins Response

The source for the contaminants of concern within the DiMe area is centred around the exclusion zone, some distance down hydraulic gradient from the school. School buildings are proposed to be constructed with vapour membranes. This will negate the inhalation of vapours indoors, such that exposure within the school area is likely to be negligible. The quantitative nature of this statement will be further evaluated upon development of the school building and area, when more data is available which will establish the conceptual model for the proposed school site. The school will be assessed under separate cover.

Conclusion

Note the pitches are up hydraulic gradient of the school not down gradient based on the master plan provided to the Monitor. It is not acceptable to use engineering measures in the generation of RTCs. Any future consideration of RTCs for the school must incorporate the risks from use of the sports pitches.

16. A sensitivity analysis on the exposure frequency for the school child would help provide confidence in the selection of the critical receptor – especially as additional exposure does not appear to have been considered when the child is not on the sports fields?

At ins Response

See comment 11.

One key parameter in the modelling is the air dispersion factor. It is noted in SR3 that “ a receptor height of 0.8 m is representative of young children (aged zero to six years) and a height of 1.6 m is representative of older children and adults.” The software uses the child air dispersion factor for age classes 1-16 (i.e. the adult factor is only applied to receptors over the age of 16). However, Table 4.6 of SR3 shows that the average child reaches a height of 0.8 m by the time that they are three years old and grows to a height of 1.6 m by the age of 13 years. As such, it would be more appropriate to apply the adult air dispersion factor (which would increase an assessment criterion by the order of 60% to those calculated) to children over 10 years of age given that the children will be on their feet for the majority of their time spent on the playing field. However, this was not implemented, and the modelling used the air dispersion factor at a height of 0.8 m for both the child aged 0-6 years and the child aged 11-16 years).

As they stand, assessment criteria currently developed for children over the age of six are considered to be over conservative based on the air dispersion factor.

The modelling allowed for approximately 112 days/year (2 days/week) exposure for a 0-6 year old child and 290 days/year (5.5 days/week) for a secondary school child, each for 2 hours/day.

It is considered most likely that a young child under the age of 6 will not frequent the playing field for ad-hoc playing. At this young age, they are considered likely to play in their rear gardens, and undertake activities in the LEAP and NEAP areas of the site which are designed for young children (based on Atkins' observations of similar areas). An exposure frequency of 2 days/week is therefore considered suitably conservative.

When evaluating the percentage of 60% regarding the air dispersion factor differences against the exposure frequency, the following can be established:

- An older child / adolescent could spend 60% extra on the field than they currently are assumed to. The revised exposure frequency would equate to $290 \times 1.6 = 464$ days per year on the playing field.

If a child aged 6-11 years were also to use the site outside of school hours, it is likely that the assessment criteria for a 0-6 year old would be protective of this age group for the following reasons:

- The assessment criteria derived for an 11-16 year old were higher than those for a 0-6 year old child, even though an 11-16 year old spends longer on site and is more active;
- Inhalation rates for a 4-11 year old would not be significantly greater than those for a 11-16 year old based on data within SR3;
- Time spent on site for a 4-11 year old would not be significantly greater than those for a 11-16 year old (given that the 4-11 year old would not attend the school with 11-16 year olds);
- The air dispersion factor for a height of 1.6 m would apply to some age classes (thereby increasing assessment criteria up to 60%); and
- They have a higher bodyweight leading to a lower dose per unit bodyweight than a 0-6 year old receptor.

It is therefore considered that no further sensitivity analysis regarding the critical receptor is required. A summary evaluation of this information has been included in the report in Section 3.2.

Conclusion

Noted.

17. In the groundwater assessment could you clarify how the exposure frequency is calculated since numerically it appears much lower and inconsistent with the soil model value.

At ins Response

A calculation control sheet has been included in Appendix B.

Conclusion

Noted.

18. There are inconsistencies between tabulated parameter values and the relevant text in the report.

At ins Response

Atkins has contacted URS to obtain further information relating to the inconsistencies noted by URS. It is Atkins' understanding that the inconsistencies are not significant to the RTC derived. Atkins has therefore re-checked sections of the report for consistency.

Conclusion

Noted.

Further Comments

The upcoming ground investigation work and interpretation of the data will be important and specifically needs to consider hazard indices to place the data in context. Gross contamination issues need to be considered in detail in the remedial strategy along with how visual/olfactory evidence of contamination may be addressed along with free phase product. The RTCs must be applied appropriately given the inference that high concentrations could be left in-situ since potential placement of granular backfill, drainage pipes, etc could create vapour issues and exposure risks beyond those considered in the RTC derivation. It is anticipated these particular issues will be addressed in the GI report and subsequent remedial strategy for the site once updated soil and groundwater data is made available.

Signed:



Date: 07/01/2011

Reply

Signed:

Date:

istribution

To	cc	Name	Company	Fax No
X		Hannah White	Atkins	
	X	Mike Poland	Atkins	



Request for Information

Contract Name: Coed D'Arcy **O** ITOR RFI No:
Contract Number: GNP/NJR/13773-2 Date Raised: 07/01/2011
Subject: Review of DiMe Controlled Waters Risk Assessment Rev 1
To: Howel Morris / Edward Lewis Atkins
From: Simon Gibbons URS

Response Required Within:	1 Day		3 Days		5 Days		10 Days	X
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Comments

The following comments are provided in response to Atkins report 'DiMe Area Controlled Waters Risk Assessment', dated 21st December 2010, ref 5041216-REM-RPT-000372 and associated Atkins response to URS' RFI0065.

geology

Atkins has changed the previous classification system for the geology preferring to split the site into granular and cohesive drift units rather than the previously described Units 'A', 'B' and 'C'. The previous descriptions of the site geology suggest that unit B is a drift deposit which tends to fine downwards and contains what appear to be discontinuous horizons of more permeable material. It is unclear how the Atkins revised assessment deviates significantly from this description. A simplification of the geology – particularly where this will result in a conservative risk assessment may be appropriate but it is not clear if this is why the stratification into more clearly defined granular and cohesive drift deposits has been made.

The exclusion of the term boulder clay from the geological succession description is not considered appropriate. The term is a widely used and understood geological term and is considered to be an accurate description of the material encountered beneath the DiMe plant. It is recognised, however that this type of formation may be difficult to model, in which case it may be more appropriate to recognise areas where simplifications have been made (i.e. the distinction between granular and cohesive drift).

Atkins Response

The simplification of the classification of the superficial strata at the DiMe site was derived from a pragmatic view of the existing borehole logs and field observations during the drilling and installation of additional boreholes in 2009. Section 4.1.2 of the report now includes some extra lines in justification for this interpretation of the superficial geology and the lack of reference to boulder clay in the report.

Conclusion

Section 4.1.2 still refers to 'lack of groundwater seepage into the railway cutting'. Based on data collected historically by BP and from surveys of the railway cutting itself there is evidence to suggest that groundwater seepage into the cutting does occur. The remainder of the geological summary and the reasons for its simplification for the risk assessment appear reasonable.

The report suggests that there is a lack of evidence of groundwater seepage into the railway cutting. This lack of seepage is then used to justify the assumption that the granular units within the sequence are laterally discontinuous (i.e. the main focus for the assessment being vertical migration into the bedrock unit). It is not clear how this conclusion regarding the railway cutting has been formed. From URS' investigation of the railway cutting in 2003 the following observations were made¹;

'The reconnaissance walkover inspection provided a general overview of conditions within the rail cutting. No evidence of severe contamination egress was observed. However, closer inspection and soil boring identified a few locations where contamination was present. The observations are summarised in Table 1. Many water seepages with ochreous precipitates were observed at the base of the cutting, either from soil or bedrock. These seepages were generally observed along the south side of the rail cutting and were often observed to have associated hydrocarbon and/or microbial films.'

¹ Rail Cutting Inspection, BP Llandarcy Refinery, ref 39991-032-785/DR1161/LT/7205, dated 6th August 2003

Soil samples taken from RCSS001 and RCSS002 (approximately 1.5m above the base of the south side of the cutting and 10cm depth) and RCSS008 (approximately 2.0m above the base of the south side of the cutting and 10cm depth) were observed to have black staining and strong hydrocarbon odours. These locations corresponded with ochre rich seepages and hydrocarbon sheens at the base of the cutting. Many soil borings, including samples not contaminated with hydrocarbons, indicated the presence of ashy fill material. It was reported by BP during the inspection, that a lube-oil spill had occurred onto the embankment around location RCSS003, from overhead oil pipes. Vegetative dieback in the immediate area was observed, together with hydrocarbon staining, sheens and odours, further confirming the presence of contamination in this area. However, the extent of soil affected by the spill appeared to be limited to the area beneath and immediately surrounding the overhead pipes on the south side of the cutting.

The Wernandrew separator was observed to collect water from an un-named stream and drainage from the railway cutting. It appeared, although could not be confirmed on site, that separate drainage channels exist for the north side and south side of the cutting. The south side drainage channel is collected into the separator and the north side joins the stream immediately downstream of the separator. Water samples were collected from each of the drainage channels, the upgradient stream and the down gradient stream. No sheens or odours were observed in any of the water samples collected.'

A copy of the report is attached for information. On the basis of previous observations of seepages in the railway cutting it is considered that this may indicate a plausible pathway for contamination to migrate off-site. Further consideration of this pathway should therefore be presented in the assessment.

Atkins Response

A new section has been inserted into the report as Section 4.3.2 to address the potential pathway via the railway cutting using the additional information on the previous surveys. Additional text in considering the pathways and receptors has been carried forward through the report concerning the railway cutting. The potential for the railway cutting to be a pathway for contamination will need to be addressed through monitoring, via groundwater sentinel wells immediately up-gradient of the cutting. The sentinel wells are installed to a depth of 5m and are monitored monthly for free product (Atkins report 5041216/RAP/RPT/000421).

Conclusion

The first sentence of section 4.3.2 should indicate that it is Atkins interpretation that there are no seepages of contamination of water into the railway cutting since subsequent information taken from BP investigations contradicts this. The rationale for concluding seepages are from bedrock should be stated (i.e. due to the high natural iron content in the bedrock and its mobilisation through degradation processes – although it is not clear why this is unlikely to be associated with shallower deposits). The discussion on the railway cutting should provide reference to screening criteria in order to satisfactorily dismiss the chlorinated hydrocarbons in surface water sampled at RCGS017 since it clearly indicates there is a pollutant linkage along this pathway. Section 4.3.2 should clearly conclude how the railway cutting is to be addressed going forward (i.e. not assessed as a receptor per se but to be monitored using sentinel wells - which need to include groundwater quality monitoring for key contaminants of concern). Furthermore Atkins should indicate if a repeat inspection of the cutting is proposed to at least enable a re-assessment if appropriate in the future. This was indicated to be likely during 2010 but to date has not taken place. Can any data from the sentinel wells be provided to indicate if there is significant dissolved (or free phase) contamination in this area down gradient of the DiMe area under review?

The geological description of the bedrock unit does not appear to present any discussion on the significance of either the dip or bedding control on groundwater movement.

Atkins Response

There is discussion of the potential for geological structures within the Upper Pennant Measure sandstones in section 4.1.2.1 of the report. This has been amended to include discussion of the weathered zone considered likely to be the most transmissive zone for groundwater flow beneath the cohesive drift deposits.

Conclusion

Acknowledged.

Hydrogeology

The hydrogeology section reports that groundwater flow is towards the railway cutting but subsequently infers groundwater flow only to the River Neath. Is this considered a reasonable reflection of the data? Is it inferred that groundwater in the bedrock flowing north underpasses the railway cutting and is inferred to ultimately discharge to the River Neath?

It should be noted that the extent of groundwater data used in previous assessments for the site cover a much larger area than the groundwater contouring completed by Atkins. This more comprehensive data set suggests a groundwater catchment divide at or close to the DiMe plant. Its exclusion by Atkins does not appear to be well justified. It may ultimately be appropriate to exclude the Crymlyn Bog catchment on the basis of the position of any divide (eg the bulk of the contamination lies to the east) but it should perhaps not be dismissed so quickly without consideration of the wider groundwater flow regime at the site. Can further justification be provided for consideration of westerly contamination migration only at the DiMe plant?

Atkins Response

The potential for groundwater to divide at the site has been addressed in Section 4.2.1.1 of the revised report.

Conclusion

Acknowledged, however the text still indicates flow east across the DiMe area to the Neath. Based on the remainder of the text this is inaccurate as flow towards the north is inferred from Atkins' data. Whilst the River Neath is acknowledged as being the most likely ultimate receptor for groundwater in the bedrock a flow path beneath the railway cutting, which it is assumed is then diverted to be eastwards to the River based on the high ground on North Site creating a divide, should be noted. Whilst it is also acknowledged that the Atkins data suggests no hydraulic divide on the DiMe plant this is potentially due to a significantly reduced and constrained aerial data set. Catchment wide monitoring completed by BP clearly identifies a divide consistently throughout 10 years of monitoring. It is agreed that the implication on the DQRA is likely to be insignificant but it should not be dismissed as being a phantom effect from the old data when it is in fact the data used in this assessment which appears limited in nature.

The brief discussion on recharge to the bedrock should be supported by some form of calculation. Can Atkins demonstrate that recharge alone over the bedrock outcrop at the site is sufficient to supply enough water to maintain the observed gradients across DiMe using the permeability/porosity assumptions used in the model? If not then consideration of vertical recharge through the drift to can be assumed and may help to estimate the relative significance of lateral migration in the drift itself. One of the fundamental parts of the assessment that was discussed at the outset was the provision of a water balance for this area of the site so that the real site data can be used to calibrate the whole assessment. Without this water balance there is likely to be a lack of confidence in the risk assessment results and in particular the likely groundwater residence time and transport velocities to the various receptors.

For the cohesive drift hydrogeology URS would note that seepages have been observed in the railway cutting and therefore the suggestion that lack of seepage supports the assumption that the water is 'perched' does not appear to be reliable. Notwithstanding this, the conclusion that the majority of groundwater movement in the drift is likely to be vertical appears to be a reasonable assumption. As with the recharge element discussed above, some form of calculation to demonstrate this is considered appropriate (eg what is the groundwater flow laterally given the permeability, gradient, etc versus the calculated vertical flux given the larger area, observed vertical gradients, assumption of homogeneous permeability, etc). Are the various assumptions reasonable? This would likely provide some justification that vertical migration is likely to be the most important element of the CSM (eg the simple calculation may show that 90-95% of the groundwater flow through the drift is vertical (to support the estimated recharge into the bedrock unit) rather than laterally towards the railway cutting). This may also enable certain receptors to be ruled out as being significant although further inspection of seepages and water quality in the railway cutting may ultimately be required to complete this element.

Atkins Response

A simple water balance analysis is provided in Section 4.2.2 and Appendix E. The results of the water balance are referenced where relevant through the report. The results of the water balance appear to justify the assumptions made regarding the aquifer properties and the recharge rates. This addresses a number of comments later in the monitors review.

Conclusion

Acknowledged.

A large range in water levels is reported in some wells in the DiMe area. Would the large variations in some locations provide supporting evidence for the likely low storage and potentially poor connectivity in the main bedrock unit? This type of evidence needs to be extracted more clearly from the data set and related to the CSM for the site.

Atkins Response

No further analysis of variations in groundwater levels has been added to the report. The available data does not support a clear interpretation of the causes, or effects for the historical variations in level in some of the deeper boreholes. The main gradients of groundwater flow and directions appear to have been stable in recent years and are not anticipated to vary significantly in future.

Conclusion

Whilst the overall gradient of the groundwater is likely to be constant and the variation in levels is unlikely to affect the numerical assessment of risk it is an important element in the overall CSM for the site. The data should be reviewed either in this report or the forthcoming SI report so that the overall conceptual understanding of the whole system can be demonstrated. If groundwater levels increase by many meters in the winter this suggests likely low storage and/or poor connectivity. It does not need to be proven but is an important inference from the data. Just as important is demonstration of an understanding of the water levels relative to the screened intervals versus potential for free product as this appears to have had limited detailed interpretation to date.

With regard to free product, further assessment of its location relative to potential sources, its significance with regard shallow groundwater migration, particularly towards the railway cutting, would be beneficial given the ultimate conclusion presented in the report. A sentinel well monitoring programme is in place specifically to monitor for product migration towards the railway cutting yet this element of the CSM appears to have been dismissed completely in the assessment presented. A plot of product thickness variation with time in key wells would be useful to help assess its potential significance.

The discussion on depressed water levels in the cohesive drift is confusing. Does the initial part of the discussion relate purely to the measured depth to water before consideration of overlying product or is it implying an error in the data set? An entire page dedicated to discussing corrections for the presence of product in wells appears inconsistent with the level of detail presented for the other aspects of the hydrogeology at the site.

Atkins Response

The confusing text regarding LNAPL in the drift (Section 4.2.2.2) has been clarified. The question of free product migration is addressed in new text in Section 4.2.2.3. Migration of LNAPL free product is not considered likely to be occurring based on an overview of the long term monitoring data, however plots through time are considered likely to be misleading due to differing patterns of wells monitored over time.

Conclusion

Acknowledged and it is noted that there is an implicit assumption that LNAPL will be removed which should be carried forward to the remedial strategy.

In the made ground/granular drift hydrogeology there does not appear to be any discussion on the effects of the drainage network on groundwater levels? There is no presentation of water level data or assessment of the distribution of free product which has historically been observed in a large number of wells screened in the made ground in the DiMe plant itself. Could the drainage system be a route for discharge of shallow groundwater? It is known that the drainage system has contributed significantly to the transfer of chlorinated hydrocarbon contamination from the DiMe plant into the North Site Reservoir. Therefore a pollutant linkage between shallow ground contamination and drainage must exist. If contaminated shallow groundwater is not considered to be part of the source then further evidence should be presented to rule out this particular pathway (eg are shallow groundwater levels consistently below the invert levels of the drainage system? Can additional data be supplied to support any of the conclusions that are reached? Consideration of removal of the drainage network may help assist future predictive modelling but consideration of the historic influence is still considered appropriate.

Atkins Response

A new Section (4.3.1) of the report describes the potential for the surface water drainage systems to have carried contamination off site to the reservoir. The potential pathway for contaminants to migrate off site via the surface water drainage systems will be addressed in the engineering design part of the remediation.

Conclusion

Acknowledged, however Section 4.3.1 appears to dismiss the drainage as no source is considered to be present in the made ground. It is not clear that this is the case and will need to be assessed following the forthcoming SI works. This should be indicated in the report along with stating the likelihood that engineering controls/measures will likely be adopted to address this pathway. This pollutant linkage is not therefore considered further in the assessment process?

The hydraulic conductivity section reports on tests completed across the entire Llandarcy refinery site (as distinct from the DiMe Site?) Whilst a range of values are recorded there is no discussion on the geology type at each of the test locations? How comparable are these results considered to be to the DiMe area? Would it be possible to collect data specifically from DiMe wells and those immediately down hydraulic gradient? It is not apparent that any of this data has been used in the assessment (see below – the report suggests literature values for the cohesive drift have been used).

Whilst the comment on well screens intercepting more productive strata is likely to be correct it is not clear if the comment about the bulk hydraulic conductivity of the cohesive drift is relevant. Whilst the bulk transmissivity of the cohesive drift may be lower than indicated by the slug test data the permeability of the more sandy units in the drift through which contamination is likely to migrate is likely to reasonably well reflected in the test data. Given that migration is likely to occur through the more permeable units it is considered appropriate to consider the use of this permeability value in the assessment itself.

Atkins Response

The hydraulic conductivity data presented in the report is not specific to the DiMe area, however the nature of the cohesive drift and bedrock is not thought to vary considerably across the wider Coed Darcy site. The use of stochastic predictive modelling is considered to justify that; the ranges of values considered for the hydraulic conductivity of the cohesive drift, and the bedrock were reasonable; and that the ranges used accounted for the potential for inconsistencies between the values applied and the site specific properties of each unit at DiMe.

The hydraulic conductivity, hydraulic gradients and pathways through the cohesive drift are assessed in section 4.2.2.2 in the report. The potential for sandier lenses increasing the bulk permeability of the cohesive drift was considered. For flow to occur through such a lens there would need to be hydraulic gradient across it. As the flux into and out of any higher permeability lens would be controlled by the surrounding low permeability strata there should not be an enhanced driving hydraulic gradient through a lens, therefore no preferential flow. Provided the lenses are not linked, and there is no evidence they are, there should be little influence from them on the bulk transmissivity of the wider cohesive unit. The parameterisation of the cohesive made ground as a reasonably low permeability unit is considered reasonable given the evidence from the site. The lack of migration of TPH type contaminants through the cohesive drift is probably the strongest evidence that the permeability of this unit is low. In terms of recharge and a reality check on the hydrogeology of the site and surrounding area, Sections 4.2.2 and 5.2.4 of the report justify the water balance and predicted groundwater flow which pertain to the recharge rates. The assumptions regarding vertical flow being the dominant direction of water flow and contaminant transmission through the cohesive drift appear to be supported by the available site specific evidence and are supported by the predicted groundwater flux under the site in the ConSim models.

Conclusion

Acknowledged.

Product

It is noted by Atkins that the monitoring well network is likely to be insufficient to assess the potential for LNAPL migration. Atkins do not, however, present their conclusion following this remark? How does it affect the CSM? If product migration was occurring would the assessment be completed differently? The sentinel well monitoring programme has indicated that there is the potential for product migration to occur. Would the sentinel well data assist in assessing the potential for migration of product across DiMe? If free product migration is considered possible what does that suggest about the heterogeneity of the shallow and/or deep drift?

Atkins Response

The monitoring network may be insufficient currently to map LNAPL migration (See Section 4.2.2.3) however this is not considered an issue. The location of the LNAPL across much of the DiMe site is not considered in doubt and it has not migrated towards the sentinel wells in a concerning manner in recent years. It is proposed to remove the LNAPL contaminant source to remediate the DiMe area, therefore plotting its past migration (if at all) is not considered directly relevant to the risk assessment. The risk assessment assumes the LNAPL source will be removed otherwise simulating a declining soil source of TPH would not be justifiable.

Conclusion

Acknowledged.

The LNAPL analysis would likely benefit from presentation of pie charts to show the relative proportions of each TPH/BTEX fraction from each sample location. The most recent data clearly shows a significantly different composition to the LNAPL analysed on 21/1/2009? No borehole references are provided however to help the reader understand the location of the various samples? It is not clear if Atkins is implying a change in product composition at the same/similar locations or simply that there are two different types of product in the DiMe plant area. More details on geographic extent would be helpful.

It is not clear what Atkins mean by 'conventional' hydrocarbons. The TPHCWG analysis is based on effective carbon numbers/carbon bonds and therefore could include a wide variety of different aliphatic and aromatic compounds. In order to understand what the 'conventional' hydrocarbon comment means would require a more detailed VOC analysis to rule out certain contaminants and/or would require a more refined assessment of the likely source of the LNAPL. It is not clear if DiMe analysis was included for the product samples?

The potential risk from product to controlled waters does not appear to have been assessed in the risk assessment process.

Atkins Response

The full analyses of the make up the various LNAPL samples taken in 2009 are presented with the report (Appendix D) and summarised in the text. This is considered to show clearly the compositions of LNAPL encountered. Pie charts of relative proportions are not considered likely to enhance the understanding of the LNAPL chemistry. The analysis of the LNAPL did include SVOC and VOC analyses which showed that none of the samples contained either DiMe solvent above the limit of detection. The term "conventional hydrocarbons" has been removed from the report as it was misleading.

The LNAPL chemistry is likely to vary across the DiMe site, however few boreholes currently have sufficient LNAPL thickness to allow sampling therefore spatial analysis of the chemistry of 5 samples is not considered a useful exercise. The entire LNAPL source should be removed from the site as far as practicable, irrespective of its chemical constituents.

Conclusion

Acknowledged although the locations of the samples has not been confirmed. A brief explanation in this section about assuming LNAPL will be removed but that partitioning of the product into dissolved phase forms part of the basis for selecting risk driving fractions for use in the main assessment.

Contamination Assessment

The discussion on solubility and volume of groundwater appears to be a little abstract. Would it be possible to provide further information on rates of dissolution of the chlorinated hydrocarbons given the site setting? How much water is passing through the aquifer, how much DNAPL might reasonably be expected based on historic concentration data? Taking into account Raoult's Law what solubility might be expected for each determinant in the mixture? Are the observations on site supported by the theory (using calculations to demonstrate Atkins understanding) and/or are there potential data gaps on site that need filling before a conclusion on this aspect can be made.

Atkins Response

Some clarification of the discussion on solubility has been provided. Some of the concepts discussed in this section are a little abstract and theoretical however are considered necessary to explain the possible reasons for the groundwater quality monitored. Assessing the potential solubility of DiMe DNAPL using Raoult's Law is potentially problematic. The solubility of a mixture of organic solvents coming into contact with groundwater is unlikely to be predicted with accuracy. A qualitative argument only has been provided in Section 4.4.5.3 based on the high solubility of the individual DiMe chemicals and the likely volumes of groundwater flow available for dilution (Water balance, and ConSim modelling).

Conclusion

Noted. Is it possible though to confirm through estimates what volume of DNAPL might have been able to be dissolved by the inferred flux of groundwater in areas where DNAPL has historically been implied – i.e. is it reasonable to consider that DNAPL is unlikely to still exist 10 years after source removal? For example if solubility is 1000mg/l you would theoretically need 1000 litres to dissolve the product entirely. If the DNAPL is estimated to comprise a volume of 5,000 litres then a volume of 5,000,000 litres of water would be required. If the DNAPL is present over an area of 100m² and the recharge rate of 0.5m/year applied then this would require 50m³/year or 10 years worth of recharge to affect complete dissolution... These are abstract numbers but would help with a sense check on plausibility of DNAPL having been washed out of the system.

In the contaminant properties Table 4.6, a selection of half lives are presented for the two key chlorinated contaminants. These rates are likely to be critical in establishing the extent of any contamination plume migrating from the DiMe plant. It is not clear, however, how these rates have been incorporated into the assessment.

Atkins Response

The half lives in Table 4.6 (now 4.7), of the report are for reference purposes only. The half lives were used as the starting point for the calibration of the transport properties of the DiMe solvents in the predictive modelling of these substances.

Conclusion

Noted.

There is a brief discussion on anaerobic vs aerobic degradation however no site specific assessment appears to have been completed (it is assumed by Atkins that groundwater will only be anaerobic on site). Use of DO/Redox data etc should help confirm whether conditions are likely to be reducing in the DiMe plant area. It is noted that dissolved methane analysis has been completed recently and this is discussed in more detail later in the report.

Atkins Response

Some additional justification for the conditions (aerobic or anaerobic) likely to be prevalent in groundwater at DiMe is provided in Section 4.4.1 of the report.

Conclusion

Noted. More detailed MNA data and use of field DO/Redox potential would help strengthen the conclusions.

The discussion on historical contamination appears relatively brief. Has Atkins reviewed contaminant distribution data for themselves? Has the original risk assessment been reviewed? What sources are considered most likely to have caused the observed distribution of contamination? Is there a distinction between source and plume from the available data set?

Whilst the sporadic nature of sampling may lead to an overly pessimistic view of the contaminant distribution at the site it would at least provide a reasonable overview of where contamination has been identified at concentrations which may be considered to represent the main source area.

Atkins Response

The summary of the historical contamination data is brief in the report, some additional text is provided in Section 4.4.3 to explain this. It was not considered necessary to recapitulate the content of previous reports, however the historical monitoring data made available has been utilised in the report, and is presented in the report appendices.

Conclusion

Noted.

A specific comment is made on the concentrations in DSB023s2 in the report. It states that the current concentration of 21ug/l is significantly lower than historical data. Based on URS' records this location appears to have been sampled once in February 2002 and a concentration of 17.3ug/l was reported. Can Atkins confirm which data they are using?

Atkins Response

The specific reference to concentrations in borehole DSB023s2 (Section 4.4.5.1) has been removed, this reference was not appropriate under the circumstances and an alternative, more appropriate borehole, has been selected as an example of reducing concentrations of DiMe solvents in the Made Ground/ Granular Drift.

Conclusion

Noted.

It is noted that Atkins has completed more recent monitoring at the site. What is not clear, however, is how the locations of the new wells relate to the likely sources of contamination and whether they have been effective in replacing wells where high concentrations have been recorded historically but which may no longer exist. Can Atkins provide a figure showing which boreholes are included in the statistical analysis for 2009/2010? Have the wells with the highest historical Di and Me concentrations been resampled recently or replaced with appropriate monitoring points? (eg DSB007, DSB009s2, MSMW066d2, DSB008s1, etc).

Atkins Response

The new monitoring wells did not attempt to replace specific lost wells, but aimed at extending the coverage of the groundwater monitoring over the southern area of the DiMe site which had lost the vast majority of its monitoring boreholes. Sufficient wells were considered available to assess the current groundwater quality at DiMe, including several of the older boreholes which recorded high concentrations of contaminants historically.

Conclusion

Noted.

For the cohesive drift discussion there is a general inference presented by Atkins that concentrations have decreased. It would be helpful to provide graphical evidence of this, making reference to the more contaminated wells which have not been resampled recently.

Atkins Response

The concentrations of DiMe solvents in solution in the cohesive drift tended to remain high until 2005, and then following a gap in monitoring were lower or non-detects in 2008/09. There do remain some boreholes however which record high concentrations of both DiMe solvents up to 2009. Graphs of these data are however less compelling than inspection of the data provided in the report appendices. The high residual concentrations of DiMe solvents in pockets within the cohesive drift is consistent with the arguments provided in the report and these are taken into account in the source concentrations considered in the risk assessment modelling.

Conclusion

Noted although if review of data suggests clear decreases why would graphical representation of this not help support Atkins conclusions?

Has any assessment of depth of contamination in the cohesive drift been attempted? The potential presence of DNAPL or high dissolved phase concentrations towards the base of the cohesive drift will reduce the vertical distance for attenuation in any vertical migration model.

The conclusions about lack of a DNAPL source in the bedrock appears reasonable based on the bedrock monitoring data.

The significance of potential data gaps requires clarification in each of the contamination distribution sub-sections.

Atkins Response

The consistency of the monitoring is discussed in Section 4.4.6 of the report. The consistency and adequacy of the monitoring was queried at a number of points in the monitors comments.

Conclusion

Noted, however it is not clear what specific location of DNAPL/source is assumed in the assessments.

No comments are provided in relation to the distribution/magnitude of shallow groundwater contamination and no discussion is presented on PID data or soil results to help infer where releases to ground may have occurred.

Atkins Response

Soil data and PID data has not been considered in the report. The groundwater quality at source and along the pathway is considered to provide the most revealing evidence for contaminant concentrations migrating from the DiMe site and impacting controlled waters. The groundwater quality is assumed to be reflective of leachate which should be reflective of the worst case concentrations. Soil analyses may indicate high concentrations which may not be leachable and therefore misleading in a risk assessment.

Conclusion

Noted although the intention of the comment was to use the soil data to help define potential source areas. The upcoming ground investigation data may help with that element and should be reviewed following collection to confirm that the assessment is still appropriate. The model indicates a soil source assessment was completed?

The presence of chloride in the cohesive drift deposits is discussed by Atkins. The report states that chloride is 'preferentially' transported. It would be more accurate to suggest that chloride is relatively little retarded during transport and does not undergo degradation. It is therefore a good tracer to help understand the distribution and longevity of a source of contamination.

The inference that 500mg/l of chloride in the cohesive drift is from dechlorination appears to be reasonable. The correlation data for methane appears to support the earlier supposition that conditions in the groundwater are generally reducing. There does appear to be reasonable evidence to support the conclusion that biodegradation of the DiMe solvents is occurring in the cohesive drift deposits. Is any similar data available for bedrock and/or granular drift wells?

Whilst a detailed discussion on the presence of chloride is presented the significance to the CSM and the risk assessment is not clearly stated. Can this data be used to estimate the potential lateral extent of dissolved phase plumes in each unit?

Coal Measures contain a naturally occurring source of chloride. Consideration should be given to the background chloride content in the bedrock across the site (i.e. away from potentially chlorinated solvent contaminated areas) to understand the natural background. A brief review of available site wide chloride data for deep wells suggests a background concentration in the range 25-50mg/l. This suggests that results between 50-300mg/l may be indicative of some dechlorination of chlorinated solvent contamination and as suggested by Atkins may be diluted from the cohesive drift as a result of mixing in the deeper groundwater.

Atkins Response

The discussions regarding chloride concentrations and their distribution contained in Section 4.4.5 and its sub-sections were purely to show that the likely source of the elevated concentrations monitored in the cohesive drift and bedrock were likely to be generated from biodegradation of the chlorinated DiMe solvents. There being low concentrations of chloride present in the made ground and granular drift, it is considered that other sources of chloride are therefore unlikely. This is clarified in the report.

There is no wider significance for the CSM to this point other than that it suggests that conditions suitable for biodegradation are present along the pathway and that degradation, at least in the dissolved phase, is occurring beneath DiMe. This justifies the applicability of considering biodegradation in the dissolved phase in the risk assessment models.

Conclusion

Noted.

The calculations for assessing the relative conductivity for Di and Me appear reasonable although further discussion on how/why this calculation is necessary would aid the non-specialist (i.e. the intrinsic permeability is a function of the porous media while the fluid conductivity will be dependent on the dynamic viscosity and density of the fluid). For low viscosity, high density fluids the rate of migration will be higher than the hydraulic conductivity (i.e. the pure phase contaminant will migrate more rapidly than would groundwater alone).

The conclusion presented by Atkins that there is likely to be relatively little residual DNAPL is presumably based on the assumption that the formation is relatively homogeneous vertically and that wells are installed in appropriate locations across the site.

The velocity calculations suggest that a 5m thick cohesive drift unit should be penetrated in 1-10 years allowing for some variation in local permeability. This appears to be a reasonable assumption.

Atkins Response

Additional text (in Section 4.4.5.3) explains intrinsic permeability and why a DNAPL of DiMe solvent might be expected to have a substantially more rapid travel time through the cohesive drift than the same contaminants dissolved in water.

Conclusion

Noted.

CS Summary

It is not clear why an assessment of all of the TPH fractions has not been undertaken and in particular aromatic C8-C10 which has been reported at up to 18.72% in one sample analysed from 23/01/2009. Based on mass fraction/solubility (i.e. Raoult's Law) even the relatively low proportions of BTEX contaminants could also potentially present a risk but do not appear to have been considered.

Atkins Response

In order to justify the priority contaminants (TPH) taken forward for risk assessment, a risk screening has been provided. The risk screening is presented in Section 4.5.2 of the report. The risk screening took account of the source concentrations (solubility for TPH fractions), contaminant transport properties of the various fractions, and showed that the aromatic fractions represent the highest risk to controlled waters. The screening assessment also showed that of these aromatic fractions, once the mass loading (volume) was taken into account the TPH C10-C16 range were indicated to be the highest risk. The DiMe solvents were also included in the risk screening and shown to be high risk, mainly by virtue of the large contrast between their source concentrations and their individual water quality standard.

Conclusion

Noted, however the point about the proportion of C8-C10 aromatic reported in the LNAPL seems to have been missed. At this concentration the risk screening would be expected to identify that fraction as a risk driver?

For the pathways element it appears as though the DNAPL migration directly to the bedrock is no longer considered by Atkins to be plausible. This is backed-up by evidence from site and calculations presented in the report which indicate declining concentrations and calculated velocities which suggest DNAPL would most likely have reached bedrock and there is no on-going source from site operations which ceased more than 10 years ago. It is not clear, however, if Atkins are satisfied that there is sufficient current monitoring well coverage to be confident in this conclusion. If not what difference would be made by considering the presence of DNAPL in the bedrock as part of the assessment? How would down gradient monitoring data and lateral velocity calculations help support the conclusions regarding potential for on-going sources in the bedrock?

Atkins Response

An additional borehole (DIME5) was installed down gradient of the DiMe source (north east), and other boreholes previously existed at the site in this area which can be used for this purpose. These wells are considered suitable to demonstrate that there is unlikely to be a DNAPL source in the bedrock impacting groundwater in the bedrock currently.

Conclusion

Noted. Can Atkins confirm that reasonable worst case concentration data has been input to the model when assessing lateral migration from DiMe to the receptor in the bedrock unit?

The selection of a compliance point at the eastern site boundary appears reasonable. Consideration should, however, be given to the railway cutting as a potential receptor.

Atkins Response

Consideration of the railway cutting as a receptor has now been included in Section 4.5.4 of the revised report.

Conclusion

Noted. A programme of monitoring should be proposed to confirm dissolved phase concentrations in appropriate sentinel wells along with proposal to confirm Atkins' inference that there is no significant seepage into the railway cutting from the shallow or deep groundwater units.

The extent of source areas is not described in the CSM summary. The location of potential sources in the different aquifer units is also not discussed and the relationship between source and pathway is not clearly described.

[Atkins Response](#)

The source area was not discussed in the previous version of the report. The entire DiMe area was considered as the source. New text in Section 4.5.2 explains the reasons for this. Assuming a site wide source rather than a more limited area does not significantly affect the predicted impacts in the model, provided the source area considered is wide enough for the plume core to be relatively unaffected by dispersion effects and dilution. As the source areas would be large enough for these factors to be nullified it became a natural assumption of the modelling that the entire site area should be considered as the source. This assumption has been inserted in Section 5.1.2 of the report.

[Conclusion](#)

Noted.

Understanding of Assessment

The objectives indicate that the controlled waters assessment was to be completed on the basis of the CSM described in Section 4 of Atkins' report. From the information provided in the report it is not clear, however, exactly what S-P-R linkage has been simulated and how the two models relate to one another. The description at the start of Section 5 is confusing. It has been assumed that the following assessments have been completed;

1. Predictive Model – Used to calibrate the risk assessment model to attempt to replicate observed conditions. It is assumed this calibration is completed on a trial and error basis. No details of the calibration method/data are provided. Can you confirm which data points / wells are used for calibration? Can the source/pathway/receptor be described more clearly for this model.
2. Impact Model – Using a revised model following the calibration process to estimate the potential risk at the selected compliance point from the contaminants of concern. Two assessments using a constant and declining source have been completed. It is not clear if this model assumes vertical and then lateral migration using cohesive drift input concentrations or not?

The methodology then states that the deep groundwater concentrations have been ignored? It does not state what data has actually been used. Irrespective of the source of dissolved phase contamination in the bedrock it is not clear why it is considered that the reported deep contamination won't migrate laterally in the dissolved phase towards the receptor. Further clarification of what sources have been considered is required.

Atkins Response

The risk assessment modelling has been revised to address the concerns raised in the review and during the meeting on 16th September 2010. The revised modelling has been explained in a revised Section 5.2 which explains the objectives, methodology and results of each simulation. The parameterisation table has been removed from the report text and individual parameterisation tables are inserted into Appendix F for each of the three ConSim models.

Conclusion

Noted, however the three models do not clearly state the assumed source-pathway and receptors. It is still not clear what the predictive model uses as input concentrations and position of the source, what vertical pathway is assumed and where the compliance point is. It is not clear from the report text how calibration has been achieved. Some input values seem to be under conservative such as vertical pathway length, air filled porosity (for a saturated pathway), thickness of underlying aquifer, etc based on Appendix E information). My comments on these parameters do not seem to have been incorporated.

It would be useful to see results based on literature degradation rates etc first and then explain how these have been adjusted to get a good match. It is also not explained what is being calibrated here. Is it the most recent maximum dissolved phase concentration reported in the bedrock wells at the site? The same applies to the impact modelling. This describes a soil source which Atkins dismissed above indicating only groundwater has been considered (presumably soil source is used to enable declining source in the model?) It is not clear what the input concentrations relate to and where the groundwater is migrating through...is this from made ground vertically to bedrock and then laterally to the compliance point? It is assumed that the groundwater source impact model uses maximum observed bedrock contaminant data to assess risks at the compliance point.

The models might be aided by clearly stating the objectives for each assessment;

1. What concentrations do the soil contaminants leach at into the granular drift?
2. What attenuation via dilution is simulated in the shallow groundwater unit?
3. How do these concentrations compare to the observed dissolved phase concentrations in both the granular and cohesive drift groundwater units?
4. What mechanisms are active vertically through the granular/cohesive drift units in order to create the pollutant linkage into the bedrock aquifer?
5. What attenuation factor is calculated for this migration process?
6. What additional dilution may be expected in the bedrock aquifer?
7. How do the vertical model simulated concentrations into the bedrock compare with observed concentrations?
8. What concentrations are simulated laterally to the 360m compliance point assuming current observed deep groundwater concentrations as the source concentration?
9. How does this differ from the results from the vertical model and what adjustments might need to be made to the vertical model to enable a closer match?
10. Given these adjustments how else might the vertical model be used to assess the significance of vertical migration of contamination within the DiMe area?
11. Can the lateral migration be calibrated using down gradient monitoring data?
12. Does the assessment of groundwater velocities and contaminant migration rates mean that down gradient data can be inferred as being in steady state?
13. Would concentrations be expected to increase in the future at down gradient locations?
14. Given the potential for redevelopment of the site can simulated concentrations down gradient of the source be simulated at 50m intervals to aid the HH assessment?

Atkins Response

The 14 points made are not addressed in detail as they largely pertain to the calculations and assumptions contained in the ConSim modelling package. They can be verified from the electronic versions of the ConSim model provided and the ConSim manual if required. The application of ConSim to the pathway considered at the site is considered sound and reflective of a reasonable worst case assessment of the risks pertaining to controlled waters.

Conclusion

Noted, however it is not agreed that the response to these specific questions simply pertain to the calculations and assumptions in the ConSim modelling package. Most of the points raised relate to how the ConSim model is set-up and used which is subject to the modellers understanding of the CSM. Without providing a response to these elements for each model it is not possible to confirm the model has been used correctly and it is not for the Monitor to have to run the models to try and assess this. A response on these specific elements of the modelling is still considered appropriate. The response to these questions should provide a good sense check on what the dominant mechanisms for contaminant concentration reductions are in the models. Some of the specific questions might be answered by more clearly stating the inputs and pathways considered in each assessment. It is not clear in the list of parameters where the vertical gradient/permeability is input to the model.

The description of the stochastic nature of the two models is difficult to follow. Can this be stated more simply and clearly? Why is it considered appropriate to use different confidence levels in the two different assessments.

Atkins Response

The 50thile confidence level in the predictive model is considered appropriate as this model is seeking to approximate reality. The 50thile is the model prediction of the most likely outcome given the variables input, therefore is the most relevant percentile for calibration purposes given the uncertainties input into the stochastic model. Assessing the calibration at any other percentile would be inappropriate. The 50thile reporting concentration does not reflect a lack of confidence in this prediction.

The impact modelling however assesses the potential impact at the receptor where it is considered appropriate to require a high confidence level, reflective of a reasonable worst case. The 95thile is considered appropriate for this situation. Text to this effect has been inserted in the relevant sub sections of Section 5.2.

Conclusion

Noted.

Atkins include the statement that the unsaturated vertical pathway has been incorporated as if it were a saturated pathway using appropriate values. Can these input values be provided and an indication of what processes the vertical 'unsaturated' pathway model in ConSim is trying to replicate. Has consideration of recharge limitation to vertical migration rates been considered (i.e. the rate of vertical migration through a saturated formation may be limited by the rate of recharge to it)? Has degradation been assumed through the vertical migration pathway?

The source depth term for groundwater sources should be reflective of conditions described in the CSM so that vertical dispersion during lateral migration is limited or removed. The source depth for the vertical models should reflect the proximity of residual DNAPL to the bedrock unit.

Why has site specific foc data not been used?

Are the air filled porosity values presented for the unsaturated zone intended to reflect the vertical saturated pathway)?

Is 50% infiltration considered appropriate given the future use of the site? Given the long term presence of hard standing and drainage systems at DiMe this degree of recharge may be on the high side but for soil leaching would likely be conservative. Does this degree of recharge work with the water balance for the site? How might having the whole DiMe area unsurfaced in the future affect gradients and water levels? Would this affect the output from the risk assessment?

Can a summary of the modelling components used for each of the assessments be provided (eg for soil – leaching, dilution in perched shallow groundwater, vertical migration through shallow saturated zone with biodegradation, dilution in deeper bedrock unit, lateral migration to compliance point, using max observed soil concentrations over whole DiMe source area, etc), together with a rationale for each element?

Why is site specific permeability data not being used for the cohesive drift as a maximum literature value of 0.01m/day seems to be on the low side given the recorded presence of sand and gravel within the drift unit. Whilst the bulk properties of the drift might more closely resemble clay would contamination not migrate preferentially through the more granular units and hence would a higher conductivity be appropriate? If the sand/gravel lenses are not considered to be interlinked vertically then this should be clearly explained when presenting the rationale for the parameter selection. How would the separation of the cohesive drift into more and less permeable zones affect the incorporation of dispersion in the assessment? Is dispersion considered in the vertical migration model?

Is it assumed that the vertical conductivity is higher or lower than the lateral conductivity? No vertical hydraulic gradient is provided for the vertical pathway in the parameters summary?

The thickness of the bedrock unit appears to be very high and could potentially allow a large degree of vertical dispersion during migration (depending on source depth assumption and source length/width). The comments suggest that only the mixing zone thickness has been used in the assessment, in which case why is a 50m thick aquifer listed in the input parameters? Is the mixing zone thickness used to dilute soil contamination and limit the source thickness term for groundwater? Is the assumed effective porosity intended to reflect the weathered sandstone rather than the unweathered bedrock?

Does the model assume that the compliance point is located directly down hydraulic gradient of the source?

It is indicated that the predictive model is under predicting concentrations compared to the site data and the inference is that degradation is slower than the literature values used in the model. This is one of several reasons why the results might be different. It is indicated that the degradation rate has been increased in order to match the site data to the 50%ile simulated concentration. No data is provided on what this degradation rate is or what the calibration point is taken to be? Without this information the relevance of this model in the whole process can not be evaluated.

Based on URS review of potential degradation rates for the key contaminants, 2 years and 1.5 years for 1,2-DCA and DCM respectively is considered potentially more appropriate.

No response appears to have been received in relation to the above queries?

Can the titles in the tables in Section 5 be clarified? What is the target concentration – where does it apply and how does the model that has been set-up calculate the 40 year 50th percentile value.

Atkins Response

The titles of the tables in Section 5 have been clarified, and hopefully the added text introducing each model and the discussion provided of the results should further clarify the content of the tables.

Conclusion

Noted.

In order to use degradation rates in the assessment (and to understand their relevance in the calibration process) it is normally necessary to present data which illustrates that the plume is stable or shrinking. In order to establish the potential total attenuation factor for the aquifer it may be more appropriate to follow the USEPA process for calculating First Order Rate Constants since the specific process which is creating the difference between the Predictive Model and observed concentrations is unknown – i.e. the difference could be down to the Koc value, aquifer thickness, permeability, organic carbon content, etc as much as the half life.

The use of the degradation rates from literature is supported by the presence of chloride along the pathway. A plume may not be stable or shrinking and still be undergoing biodegradation. It will only be stable or shrinking if it has reached a balance of the advective flow and degradation rates to prevent its further migration. It is not considered necessary at this site at this juncture to demonstrate a stable or shrinking plume as there two pathways to consider in assessing the current concentration in groundwater. The former transport of DiMe solvents as DNAPL for which there is likely to be some residual signature of dissolved phase contamination in the bedrock, and the current migration of residual contamination dissolved in groundwater from the sources in the Made Ground/Drift.

Degradation as a process can occur in and around a plume whether it is expanding, stable or shrinking. The loss of the source of DiMe solvent contamination at the site and their high mobility in groundwater make analysis of the concentrations through time problematic. First order rate constants could be calculated for 1,2-dichloroethane using the USEPA document *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies, 2002* (Ref. 1) for the concentration v time in specific boreholes in the cohesive Made Ground and bedrock sandstones which show concentrations dropping at consistent rates. The conversion to half lives shows the degradation rates are slower than the calibrated biodegradation rates at the site. Significant biodegradation over much of the period being considered is probably precluded by the high concentrations (in the range 1000 – 10,000µg/l) and therefore the rates of reduction over time in these boreholes are considered most likely to be related to the loss of source mass over time. This justifies the assumption of a declining plume source as applicable and therefore probably a stable or shrinking plume, although that cannot be confirmed from the current data set.

Borehole	nit	Concentration vs Time Rate Constants point in days	Rates converted to half lives in years
MSM220s	Cohesive Made Ground	0.0009	2.11
MSM220S2	Cohesive Made Ground	0.003	0.63
MSM220D	Bedrock	0.003	0.63
MSM222d2	Bedrock	0.002	0.95

The Bulk Attenuation Rate Constant (k) for 1,2-dichloroethane in the bedrock aquifer could be calculated using the methodology from USEPA document on First-Order Rate Constants (Ref. 1). To calculate k the concentrations from boreholes across the DiMe area (boreholes MSM222d2, DME04, DME05 and MSM224D) were used along with the unretarded travel time (50th %ile as most likely prediction) from the ConSim model for the transport rate; and the site specific K_d value (K_{oc} * foc) for 1,2-dichloroethane as the degradation factor. The bulk degradation rate calculated was 0.0058 per day which equates to a half life of 0.327 years which is similar to the range calibrated for the site and then parameterised in the risk assessment (0.35 to 0.49 years).

The analysis of first order rate constants has not been incorporated into the report, however the analysis does support the assumptions made regarding the conceptual model, parameterisation (i.e. biodegradation) and the conclusions, especially regarding the predicted impact of 1,2-dichloroethane in the new groundwater source model.

The choice of the half lives of the DiMe solvents and the K_{oc} of 1,2-dichloroethane to affect the model calibration is considered reasonable as the half lives are the least certain parameters, i.e. most likely to vary between this site and others. Provided the model is predicting values at concentrations similar to those monitored in the aquifer in the correct time frame the balance of parameters is considered justifiable. The half life of a species is considered likely to be the one which varies most with site specific circumstances, therefore has been varied first. The K_{oc} has been varied for 1,2-dichloroethane in preference to f_{oc} (which is site specific) as changing the f_{oc} would also influence the transport of the other substances in the simulation. Parameters were varied to be more conservative, therefore have been changed from justifiable literature ranges towards more conservative site specific ranges, which should provide confidence in the predicted modelling rather than conjecture over the exact mechanism controlling travel times and impact concentrations.

Conclusion

Noted. An expanding plume is not acceptable to the EA since the distance to compliance point will continue to shrink although it is acknowledged that attenuation will be on-going in this instance the assessment of potential risk can not be quantified in an expanding plume. The half-lives quoted above are closer to the URS literature values although it should be noted that the calculated rates are total attenuation rates and not just biodegradation and therefore shouldn't be directly compared to the Atkins calibrated rates. Graphs of the trend data used in the calculations would be useful. Overall this assessment appears to support the overall attenuation rates modelled in the Atkins assessment.

In the model the saturated cohesive till thickness may have a significant effect on the degree of attenuation of each of the contaminants – particularly given the low permeability assumed. Should this be adjusted to take account of the depth to the DNAPL (i.e. the saturated aquifer thickness for the vertical model should take account of the source position). Reducing this to 2-4m could make a significant difference to the risk assessment results – particularly at the higher confidence limit.

It is currently unclear exactly how the vertical saturated migration has been simulated. Given the fact that contamination is observed in the bedrock would it not be simpler to use observed bedrock groundwater contaminant concentrations and simulate migration laterally to the compliance point? This would at least provide a conservative baseline assessment from which more complicated vertical models could be developed to understand further attenuation mechanisms and time variant reduction in risk given the potential for source depletion and given the evidence to support a reducing input of contamination into the bedrock.

Atkins Response

Vertical migration in ConSim is through plug flow assuming all the infiltration is transmitted through the unsaturated zone. The vertical pathway in ConSim is assumed to be unsaturated however has been simulated as if saturated at the DiMe site through the use of a very small value for the air filled porosity of the vertical pathway. The current distribution of contamination within the cohesive drift means the full thickness of the Cohesive drift is not available as a vertical pathway. This has been taken into account in the predictive modelling through the reduction of the range of thickness of the vertical pathway in the ConSim modelling.

A separate groundwater source model (Section 5.2.4) has been produced for comparison with the soil source model. This shows the potential impacts off site for the currently monitored groundwater concentrations.

Conclusion

Noted but please be clear when discussing groundwater whether it is in bedrock, cohesive or granular drift. When discussing the groundwater source model it is assumed the source is in the bedrock and lateral migration only is simulated?

In Table 5.5 does the current source concentration relate to bedrock or the cohesive drift units? Can a sketch be prepared which shows the details of the parameters used in the assessment overlain on the CSM?

Atkins Response

Individual tables of input parameters for each simulation have been produced and clearly identify the inputs utilised in ConSim for each part of the pathway relevant to that simulation. This is considered to show clearly the parameters and pathways without a requirement for sketch drawings. The overall CSM remains unchanged, however different parts of the pathway apply depending on the source and receptor being considered in each case.

Conclusion

Noted, however the comments noted above about being clear where the source is, in which unit and what pathways are being modelled needs clarification in the report text. Whilst Atkins may not consider it necessary a schematic section illustrating the parameters for the aquifers being modelled would be helpful. The sources, pathways and receptors for each assessment could then be clearly indicated and their relationship to each other better understood.

The constant source impact model identifies exceedances at the down gradient receptor. How does this tally with data from wells down gradient of the source? Has any lateral calibration been completed (i.e. assuming the calibration for the predictive model is only for the vertical part of the assessment)? The declining source impact at the base of the cohesive drift can't be correct since significantly higher concentrations (including inferred DNAPL) have been identified in the bedrock. What evidence is there to support the use of a declining source model and does its method of incorporation in ConSim match the CSM?

Atkins Response

The draft report included a constant soil source, as well as a declining soil source ConSim model. Following the meeting with the monitor the constant source soil model, which was unrealistic with regard to the CSM (due to the remedial proposals to remove all LNAPLs), was considered redundant in the risk assessment and has therefore been removed.

Conclusion

Noted.

How has degradation been applied in the model? Has the applied degradation rate assumed degradation in all phases (which equates to degradation rates for the whole aquifer system from field studies rather than dissolved only rates from lab studies)?

Atkins Response

Degradation within ConSim has only been applied in the dissolved phase. No degradation in the sorbed phase has been considered applicable in any part of the pathway in accordance with EA guidance.

Conclusion

Noted.

The report does not provide a sufficiently clear description of each of the models, inputs and outputs to understand and assess clearly how the modelling has been completed and whether there are considered to be any significant risks to controlled waters.

The conclusion that product removal from DiMe should be undertaken appears reasonable.

Potential data gaps from the assessment should be identified (eg how comprehensive is the recent groundwater monitoring data set and have historical high concentration wells been sampled or replaced with an appropriate new well?). At present the report simply states more monitoring will be completed in the future but does not critically review the appropriateness of the current monitoring well network.

Atkins Response

There are considered to be sufficient monitoring boreholes (at least 7 locations) within the bedrock for monitoring the aquifer quality. The boreholes provide good coverage of the site area including beneath the former production areas (central area, towards northern site boundary) and down gradient of this production area (east and northeast), including some depth sensitivity in two places (MSMW069 and MSMW224). Some of the existing bedrock wells have been monitored periodically as part of the RAP monitoring, however the DiMe substances have not been regularly detected in these boreholes since 2008. No spatial patterns of contamination can therefore be presented on the basis of the recent monitoring data.

Conclusion

Noted. Can a proposed sampling plan be generated from which a final review of the suitability of the assessment and its conclusions can be made?

Signed:  Date: 07/01/2011

Reply

Signed: Date:

istribution

To	cc	Name	Company	Fax No
X		Howel Morris	Atkins	
X		Edward Lewis	Atkins	
	X	Mike Poland	Atkins	



Request for Information

Contract Name: Coed D'Arcy **O** ITOR

RFI No:

Contract Number: GNP/NJR/13773-2

Date Raised:

5/01/2011

Subject: Review of DiMe SI Scope

To: Michelle Lee

Atkins

From: Simon Gibbons

URS

Response Required Within:

1 Day

3 Days

5 Days

X

10 Days

Comments

The following general comments are provided in response to Atkins 'Detailed Ground Investigation' scoping document, dated 20th December 2010, ref 5041216-REM-TN-000467.

It would be useful if investigation of former service routes could be undertaken as part of the SI works unless it is considered these are sufficiently shallow that all soils (and contamination) associated with these will be removed as part of the default remedial scope?

The version of drawing 820 received did not appear to have the black crosses showing indicative SI locations and the key was missing text?

The HH QRA for the DiMe plant has indicated potential presence of dioxins. Can you confirm if these form part of the analytical suite for the SI works and if so what areas/source is being considered?

The HH QRA also makes reference to drawing 820 as indicating the relevant area for the HH assessment. Drawing 820 seems to show a much larger area than will be occupied by just the sports pitches. If the intention is to have one large Phase to cover the whole of the school area then additional RTCs may be required to go with those developed for the sports pitches (eg schools are not covered by any of the existing exposure scenarios and are not included in the current DiMe HHQRA). Can confirmation of proposed Phase(s) be provided to ensure sufficient screening data is available to compare against the SI data?

Is any information available on final levels for the DiMe area?

Can Atkins provide an updated drawing of the current active drainage and confirm which elements have been either physically removed or simply disconnected? Given the potential for drainage to be a source and pathway for contamination it would be preferable if sampling could be undertaken along these routes in accordance with the requirements of the S106 Agreement.

Can you confirm how the trial pits will be positioned on the ground to ensure Atkins get as close as possible to potential source areas? Following the general demolition works and stockpiling across the area it is not currently possible to precisely identify former features such as the solvent storage tanks on the ground.

Of particular interest in these works will be development of a CSM which helps to assess where the free product is (i.e. beneath the former slab, permeable made ground or within specific granular zones in the drift)? The observation of significant product in wells yet lack of free phase in the shallowest groundwater unit suggest that the pathway for product loss into and through the ground may not yet be fully understood and this could have implications during future earthworks (if not captured during remediation).

Signed:

Date: 05/01/2011

Reply

Signed:

Date:

istribution

To	cc	Name	Company	Fax No
X		Michelle Lee	Atkins	
	X	Mike Poland	Atkins	

Request for Information

Contract Name:	Coed D'Arcy	O	ITOR	RFI No:	
Contract Number:	GNP/NJR/13773-2	Date Raised:	7 th April 2011		
Subject:	Re-Use of Existing Stockpiled Material on DiMe				
To:	Michelle Lee	Atkins			
From:	Simon Gibbons	URS			

Response Required Within:	1 Day		3 Days		5 Days	X	10 Days	
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Comments

The following general comments are provided in response to Atkins Technical Note 552, 'Proposed re-use of Existing Stockpiled Materials', dated 1st April 2011.

In general terms the re-use of these materials as suggested in the Note is supported. A few clarifications are, however, required before these works can ultimately be certificated as part of the Monitors Phase completion declaration;

The validation frequency for the stockpiles currently on DiMe is quoted as approximately 1 in 500m³. This is closer to 1 in 660m³ and is required to be 1 in 400m³ prior to re-use although for some analytes given the insignificant risk even at saturation the full suite may not be necessary.

The validation frequency for BTEX/VOC in the railhead stockpile is significantly less than this at 1 per 3,333m³ and this validation frequency will need to be increased prior to re-using any of this material unless a rationale against further testing can be presented and agreed.

The technical note does not present the visual/olfactory quality of the soils in these stockpiles and no target for this is presented in the technical note for soils >1mbgl under a recreational scenario. The approach should be clarified and if not relevant for the given end-use this should be stated.

It would be useful to have confirmation of the sources of contamination which relate to each stockpile so that I can be sure the appropriate analytical testing suite has been completed (i.e. some of these stockpiles were presumably from the power station and no PCB data appears to be presented)? In addition no asbestos analysis appears to have been completed which is essential in stockpiles of made ground. URS will also need to see the asbestos QRA before any sign-off/certification can be produced for re-use of made ground materials.

Can Atkins confirm what the implication is in terms of reuse of stockpile material to increase levels ahead of finalising the remedial strategy for DiMe. Is there a chance for material to require re-excavation to remove contaminated deeper soils – eg where they are known to be saturated with free product? Will the DiMe remediation be completed before re-use or will the use of stockpiled materials be completed at risk?

Can Atkins confirm how the depth of fill will ultimately be validated (i.e. what approach will be used to confirm all of this re-used material will be >1mbgl following redevelopment as sports pitches)? Will any demarcation occur on the ground to ensure that the filled material only gets used below the pitch areas? If this is a non-issue due to material passing shallow RTC/RBSLs then this should be stated to provide further re-assurance.

The tables of results only appear to refer to non-RBSL contaminants. Please could data be presented with comparison against S106 RBSLs and RTC as well as presenting screening for additional contaminants which only have an RTC. The presentation of the results is otherwise slightly misleading. Can all analytical data be provided to enable a cross check?

Signed:		Date:	07/04/2011
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Reply

Signed:	Date:

istribution

To	cc	Name	Company	Fax No
X		Michelle Lee	Atkins	
	X	Mike Poland	Atkins	

Contract Name:	Coed D'Arcy	☒ ITOR	RFI No:	
Contract Number:	GNP/NJR/13773-2		Date Raised:	8 th April 2011
Subject:	DiMe Controlled Waters QRA, DiMe Area			
To:	Howel Morris / Edward Lewis		Atkins	
From:	Simon Gibbons		URS	

Response Required Within:	1 Day		3 Days		5 Days	X	10 Days	
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Comments

The following general comments are provided in response to Atkins Report 'DiMe Area Controlled Waters Risk Assessment' and Atkins response to the Monitor RFI 0078, both received April 2011.

General points

In a couple of responses Atkins has referred the Monitor to the ConSim manual for answers to queries that have been raised. I am fully aware of what the Consim model can do and where to find the answers but it is for Atkins to demonstrate that the data has been applied correctly in the model. I raised queries at a number of points in the reporting process in order to get clear confirmation about the processes being simulated as I did not feel they had been clearly defined in the text of the report and in order to obtain reassurance that the processes being simulated in the different models were appropriate to the CSM. The queries were raised as ConSim can be a black box and given the complexity of the assessment and the different calibration steps I considered it appropriate to challenge what some of the intermediate outputs were in the process. Notwithstanding this I am happy that the approach taken in the risk assessment is reasonable and that Atkins should be able to take this report forward with the human health and site specific data to discuss and agree with the Regulators.

Specific comments

Groundwater divide - I agree with the latest Atkins response in general terms based on identified contamination and the eastward flow being the main flow path for the DiMe area. My issue all along has been that Atkins should consider use of the older data to confirm the catchment boundary rather than relying on a much smaller data set which is too focussed on DiMe and which may not be appropriate to provide the catchment definition required. This was not meant as an argumentative statement nor was it trying to push Atkins towards a more or less conservative assessment (or to ignore more recent data) but wanted the correct available data to be used to support the assessment. It is perfectly valid to make reasonable worst case assumptions but please make reference to the most useful available data.

Groundwater level variation. It would still be useful to present the data on groundwater levels and in the main SI report present a summary of the ranges and implied changes in vertical gradient (if any) in order to complete the hydrogeological assessment.

Dissolution assessment. It is unlikely that the DNAPL will be exposed to the full volume of water calculated in the water balance when considering the dissolution of DNAPL. The DNAPL will occupy a very small volume of the aquifer and therefore dissolution will likely be much slower than indicated in the calculation presented. I suggest this calculation be re-assessed to demonstrate reasonable time frames (or back calculated volumes as presented by Atkins) that may be calculated using more appropriate volumes of groundwater for dissolution. Section 4.4.5.3 will need to be amended accordingly.

The conclusions on DNAPL appear reasonable though and the reference to minor residual DNAPL being more slowly leached from the formation is likely to be true. The significant reduction in dissolved phase concentrations since DiMe was decommissioned also support the Atkins conclusion that DNAPL is now likely to be limited in extent.

Trend charts - If Atkins can not show this graphically or make reasonable assumptions with surrogate wells etc then it cannot be claimed that clear decreases are observed. If Atkins can not support trends with clear presentation of data then simply stating it with words is not appropriate. A more general comment on decreases may be more appropriate.

Note that with regard to the DNAPL source area I simply requested confirmation of its extent and location using site features and there was no implication that the source needed to be more conservative in terms of physical dimensions.

The TPH screening approach appears reasonable but C10-C12 aromatic is not a 'suitable surrogate' for C8-C10 aromatic. If Atkins consider C8-C10 to be present at sufficiently low concentrations given the product composition reported by the laboratory then I am satisfied with the screening approach. This is an irrelevant point going forward given the likely risk.

The detailed response to the set of 14 questions is welcomed and I have no further queries on these aspects. I would note, however, that adjustment of ConSim or use of other models may be appropriate for the assessment. The soil/leachate assessment could in theory consider dilution both in shallow groundwater (although Atkins state that is in effect what the leachate represents) and in the deeper unit.

Note that monitoring requirements will need to be agreed with the Monitor as well as the Regulators.

I look forward to closing out the assessment so that the significance of the latest data can be considered.

Signed: 

Date: 08/04/2011

Reply

Signed:

Date:

istribution

To	cc	Name	Company	Fax No
X		Howel Morris	Atkins	
X		Edward Lewis	Atkins	
	X	Mike Poland	Atkins	

Contract Name: Coed Darcy Monitor RFI No:
Contract Number: GNP/NJR/13773-2 Date Raised: 30 September 2015
Subject: Review of Atkins' Validation Report for Monitor Phase 43 (Former DiMe Plant and Proposed Sports Pitches)
To: Michelle Lee Atkins
Cc: Mike Poland Atkins
From: Rhys Mander AECOM

Comments

The following queries are raised in relation to Atkins' Validation Report for Phase 43 the former DiMe plant (report ref. 5041216-PLOTS-RPT-1405):

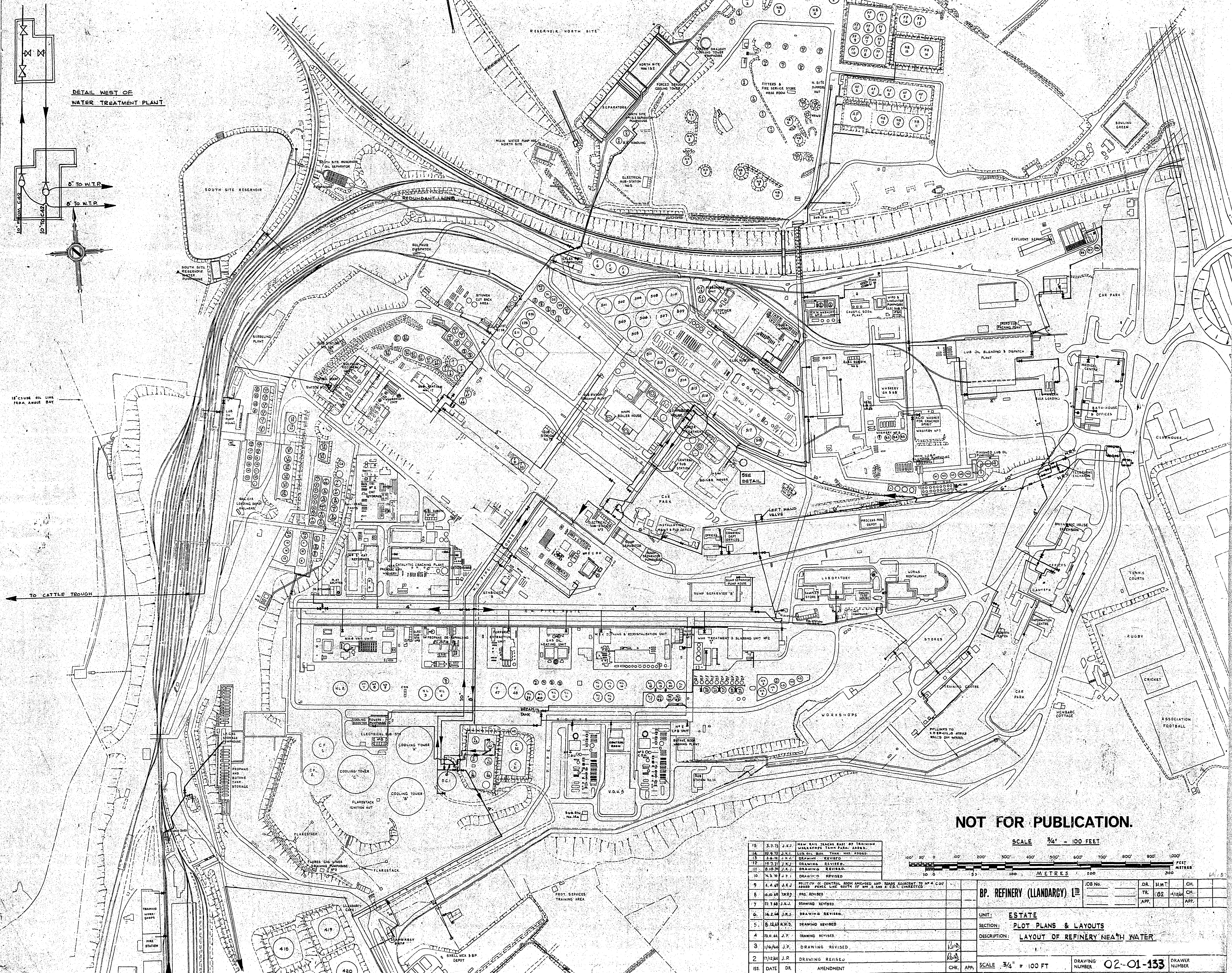
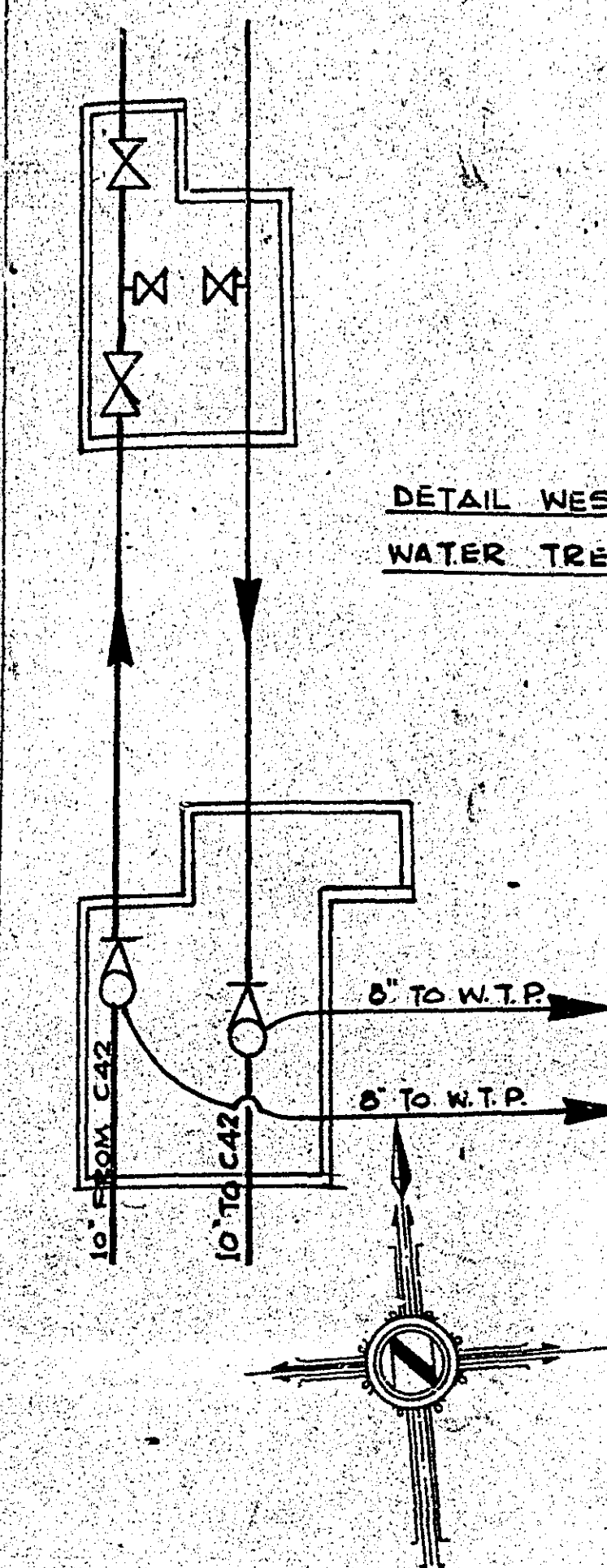
- Section 1.1 / 1.2 – It is noted that the phase has been declared partly as public open space and partly for a commercial end use. For future reference, and to avoid potential confusion, it would be useful if the phase boundary drawing could clearly indicate the intended use for each part of the phase.
- Section 1.1 / 1.2 – It is noted on Drawing no. 906 that a club house is proposed. Is it appropriate for this area to be declared as a public open space or would the commercial requirements be more appropriate where the club house is to be constructed?
- Section 1.2 – With regards the RAP works, please could you clarify whether or not you are seeking a RAP Works Completion Statement – i.e. do you consider the RAP works to have been completed? With reference to the Section 106 Agreement, the RAP works require either the containment of hydrocarbon and chlorinated hydrocarbon product, vapour and dissolved phase, or source-reduction to render containment permanently unnecessary. It is recognised in the Section 106 Agreement that limited work may be required for the RAP, subject to the results of long term monitoring, but that substantial additional works (containment) is likely to be required in the event of development. Can you demonstrate either that the source reduction has been successful, or otherwise, is containment necessary? In particular, how does this affect the commercial plot?
- Section 4.2.1 – The report refers to drawing no. 5041216-OSW-DWG610M but a copy of the drawing has not been provided. Drawing no. 5041216-OSW-DWG610L is included but this does not show the two lagoons referenced in the text.
- Section 4.2.1 – With reference to these lagoons, please could you provide details of the chemical quality of the water collected in the lagoons and where it is discharged to.
- Section 4.2.1 – The report discusses the low permeability clay which did not appear to be impacted. Were any trial pits extended beyond this layer? The groundwater regime is such that if these are lenses of clay, then underlying soils could become impacted by the movement of groundwater carrying up-gradient sources. Could there be impacted soils beneath this clay layer, or is the bedrock situated directly beneath the clay? What do the boreholes show in this respect?
- Section 4.3.1 – The report refers to a volume of 340,000m³. Presumably this should read 34,000m³?
- Section 4.3.1 – The report refers to drawing no. 1961 as showing pre-remediation ground levels and drawing no. 1844 as showing formation level – is this correct? For example, drawing no. 1844 is titled pre-remediation ground levels (although the notes state that the survey was taken in March 2015) and drawing no. 1961 is titled pre-works levels. It is not clear what the difference is between pre-remediation and pre-works? Please also could all drawings be labelled with the date of the survey to make it clear what is being shown.
- Drawing no. 1844 – The contours are not labelled so it is not possible to interpret the levels.
- Drawing no. 1845 – The pdf has not printed correctly and the right hand edge has been cut off. For example the date of the survey cannot be read.
- Section 5.3 – With reference to the above, the report states that drawing no. 1844 shows the finished levels on completion of the works. However the drawing is titled pre-remediation ground levels. Please clarify.
- Section 5.5 – The report again states that final levels are shown on drawing no. 1844, however this is titled pre-remediation ground levels. Please clarify.
- Section 4.2.2 – The report discusses free product thicknesses observed in the boreholes. Data is presented up to July 2012. Please could more recent data be provided?

- Section 4.3.3 – During the works an area of grey thixotropic material was identified. This does not appear to have been discussed in the report?
- Section 5.2 – The report states that validation samples of the exposed glacial till were taken across all three phases at a minimum frequency of 1 per 200m² and that this testing frequency was agreed with the Monitor. From recollection a specific testing frequency was not agreed, but it was suggested that something between the residential and commercial frequencies may be appropriate for the areas designated for a public open space. With reference to the Section 106 Agreement, it is up to the developer to propose an “appropriate scheme of validation testing”. Please discuss why a testing frequency of 1 per 200m² is considered appropriate.
- Section 5.2 – With reference to the above, it should be noted that testing frequencies for the commercial area – i.e. Phase 3, must meet the testing frequencies for commercial phases as specified in the Section 106 Agreement.
- Section 5.2 – Despite the reference to a proposed testing frequency of 1 per 200m², it is noted that this testing frequency was not achieved for Phases 1 or 2.
- Section 5.3 – Please confirm the surface area of each of the three phases to allow the testing frequencies to be verified.
- Section 5.3 – The report states that the final development platform for each phase is 0.5m below FFL but also states that a minimum of 1m of clean fill will be placed. Please clarify the depth below FFL of each phase.
- Section 5.3.1 – The report states that 30,000m³ of site won material was used, however previous sections of the report had stated 34,000m³.
- Section 5.3 – It is noted that the validation trial pits appear to be of relatively shallow depth. Please discuss whether or not the validation samples have been taken at a sufficient depth. Using the figures quoted in the report (i.e. by taking the surface area of the whole phase and using the volumes of material excavated and the volumes of material backfilled) it would appear that the average depth of excavation was approximately 0.83m and that the average depth of acceptable soils placed thereon to form the finished plateau was approximately 0.73m. Given that there will be a further 1m of soils placed the base of excavation is therefore, on average, approximately 1.73m below FFL. The question is – is that deep enough? Residential standards require remediation down to groundwater level plus 0.5m and commercial standards relate to the top 2m. Please provide some justification that the depth of excavation is appropriate, particularly given that the solvent impacted groundwater will be at depth.
- Section 5.3 – With reference to the trial pit logs, it would be useful to have ground levels marked in mAOD on the trial pit logs to give an understanding of the ground profile and the relative depths at which the samples have been collected.
- Section 5.3 – Please clarify if soil samples were collected in situ or from stockpiles prior to placement.
- Section 5.3 – With reference to drawing no. 1781 there appear to be quite a few gaps where samples have not been collected. In particular along the northern boundary adjacent to the railway cutting but also along a corridor through the centre of the phase (presumably the line of the haul road) and also the southern boundary. The northern boundary is of most concern given that with reference to drawing no. 1845 it does not appear to have been turned over. We recognise the various constraints, including buried services, but the groundwater flow is such that these areas could be impacted. Have the historic boreholes been re-sampled? Could hand dug trial pits be excavated?
- Section 5.3.3 – Reference is made to an IOM report. Please could a copy of the report be provided.
- Section 5.3.3 – It is noted that 67 samples indicated a positive ID for asbestos but only 34 samples were quantified. Please explain the rationale how it was decided which samples to quantify.
- Section 5.4.1 – Reference is made to the results from groundwater sampling which indicated a reduction in solvent levels. With reference to the graphs presented in Appendix E it is noted that the vertical scales are not particularly useful. Some of the scales start at 800,000µg/l and others start at 4.5µg/l so it is difficult to compare the significance of the various graphs. Furthermore, it is not possible to see the detail on the graphs with larger scales. Could they be plotted on a log scale for example so that the results can be more easily interpreted?
- Section 5.4.1 – The report discusses various ‘spikes’ on the graphs. Please discuss what impact, short and long term, these spikes may have had. Are they significant and what was done to protect the receptors?
- Section 5.4.1 – The report discusses water samples taken from the validation trial pits. Were these samples collected immediately, or could they have been diluted by rainwater for example?

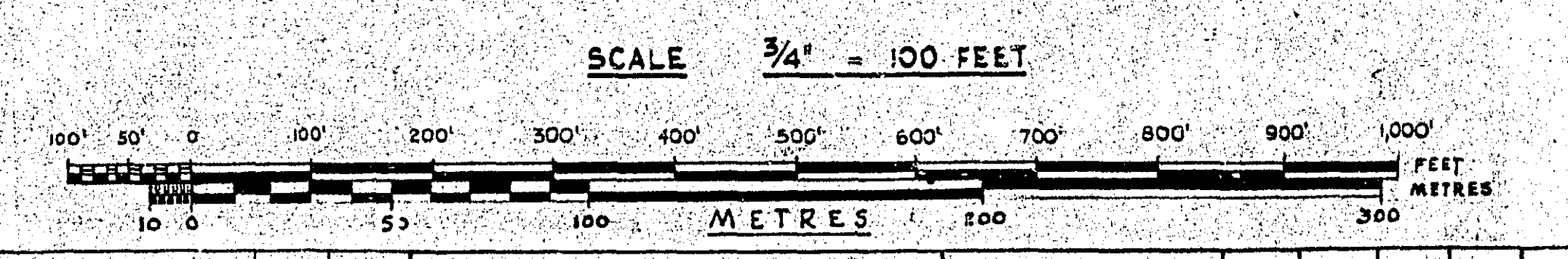
- Section 5.4.1 – The report discussed water samples collected from North Site Reservoir. These are likely to be diluted and may not be particularly representative. We really need to see results from the contaminant areas.
- Section 5.4.1 – The report does not appear to discuss deep groundwater. Have any samples been collected from the existing boreholes?
- Section 5.4.1 – With regards deep groundwater, please provide further analysis particularly focussing on Dichloroethane (Di) and Methylene Chloride (Me). From the screening tables presented in Appendix D, there were a number of exceedances for Di pre-works. Are these still present in the deep groundwater?
- Section 5.4.1 – The report does not appear to draw any conclusions with regards groundwater quality. Is the deep groundwater still a concern? Does the contamination profile change with depth? Are there any concerns for human health? What implications do the results have for the Controlled Waters Risk Assessment and the RAP requirements?

Date: 30 September 2015

A E I E HISTORICAL LA S

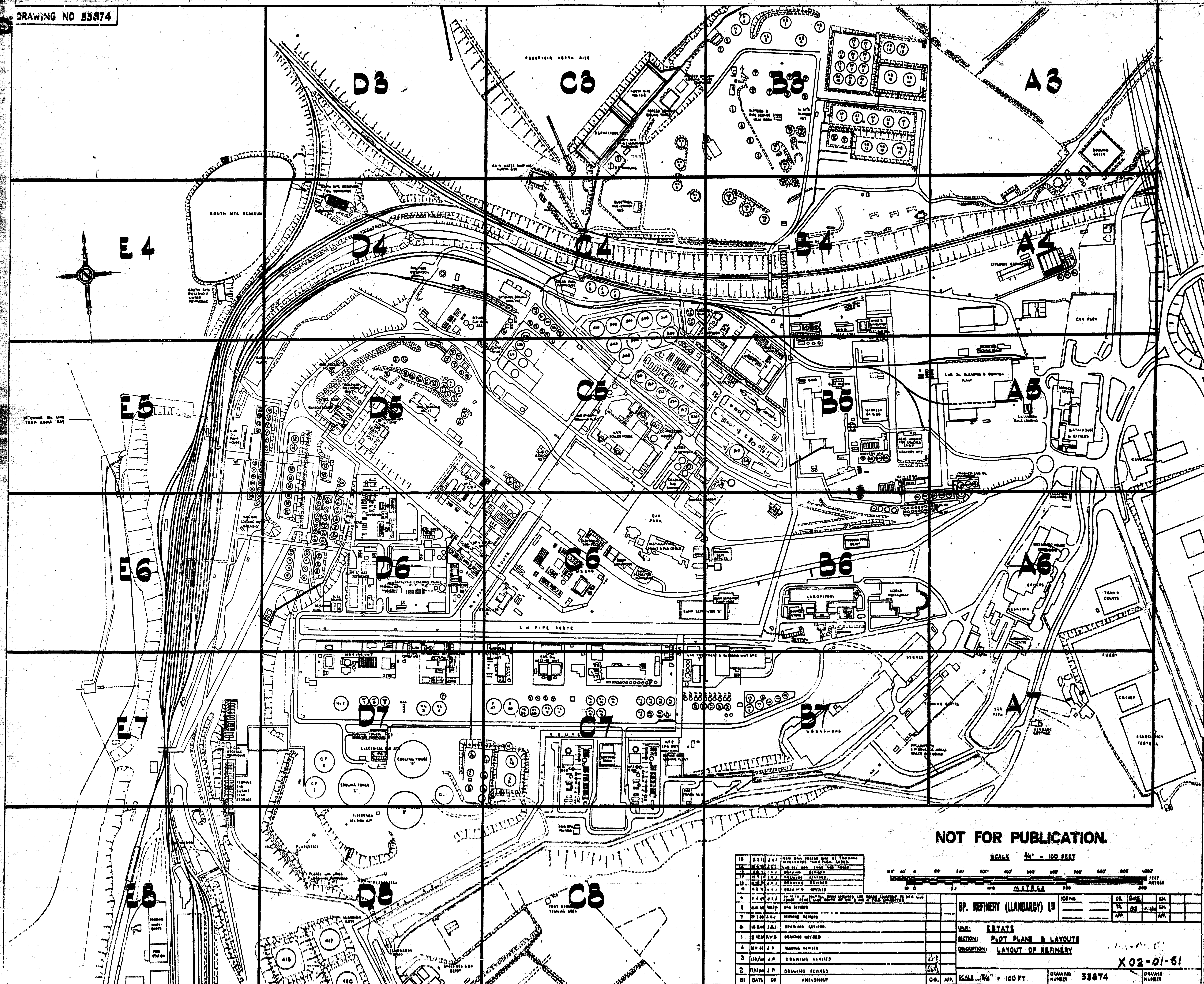


NOT FOR PUBLICATION.



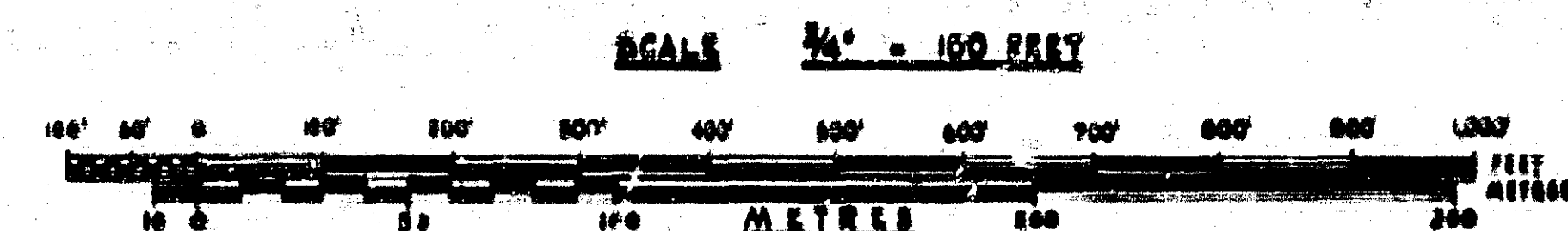
15	3.7.71	J.K.J.	NEW RAIL TRACKS EAST OF TRAINING WORKSHOPS TANK PARK ADDED.
14	22.9.70	J.K.J.	LUB OIL BLENDING TANKS ADDED.
13	3.6.70	J.K.J.	DRAWING REVISED.
12	12.7.71	J.K.J.	DRAWING REVISED.
11	8.10.70	J.K.J.	DRAWING REVISED.
10	24.3.70	J.K.J.	DRAWING REVISED.
9	4.4.69	J.K.J.	REVISION TO CENTRAL ROAD ADDED AND ROAD ADJACENT TO NO. 4 C.O.V. ADDED FENCE LINE SOUTH OF NO. 3 AND A.C.B. CORRECTED.
8	10.10.68	J.K.J.	DRG. REVISED.
7	21.7.68	J.K.J.	DRAWING REVISED.
6	14.2.68	J.K.J.	DRAWING REVISED.
5	8.12.67	R.W.D.	DRAWING REVISED.
4	23.11.66	J.P.	DRAWING REVISED.
3	1/6/64	J.P.	DRAWING REVISED.
2	7/12/64	J.P.	DRAWING REVISED.
1	DATE	DR.	AMENDMENT

BP. REFINERY (LLANDARCY) LTD		JOB NO.	DR.	H.M.T.	CH.
UNIT: ESTATE		TR.	OS	4/7/64	CH.
SECTION: PLOT PLANS & LAYOUTS		APP.			APP.
DESCRIPTION: LAYOUT OF REFINERY NEATH WATER					
SCALE 3/4" = 100 FT		DRAWING NUMBER	02-01-133		
		DRAWER NUMBER			

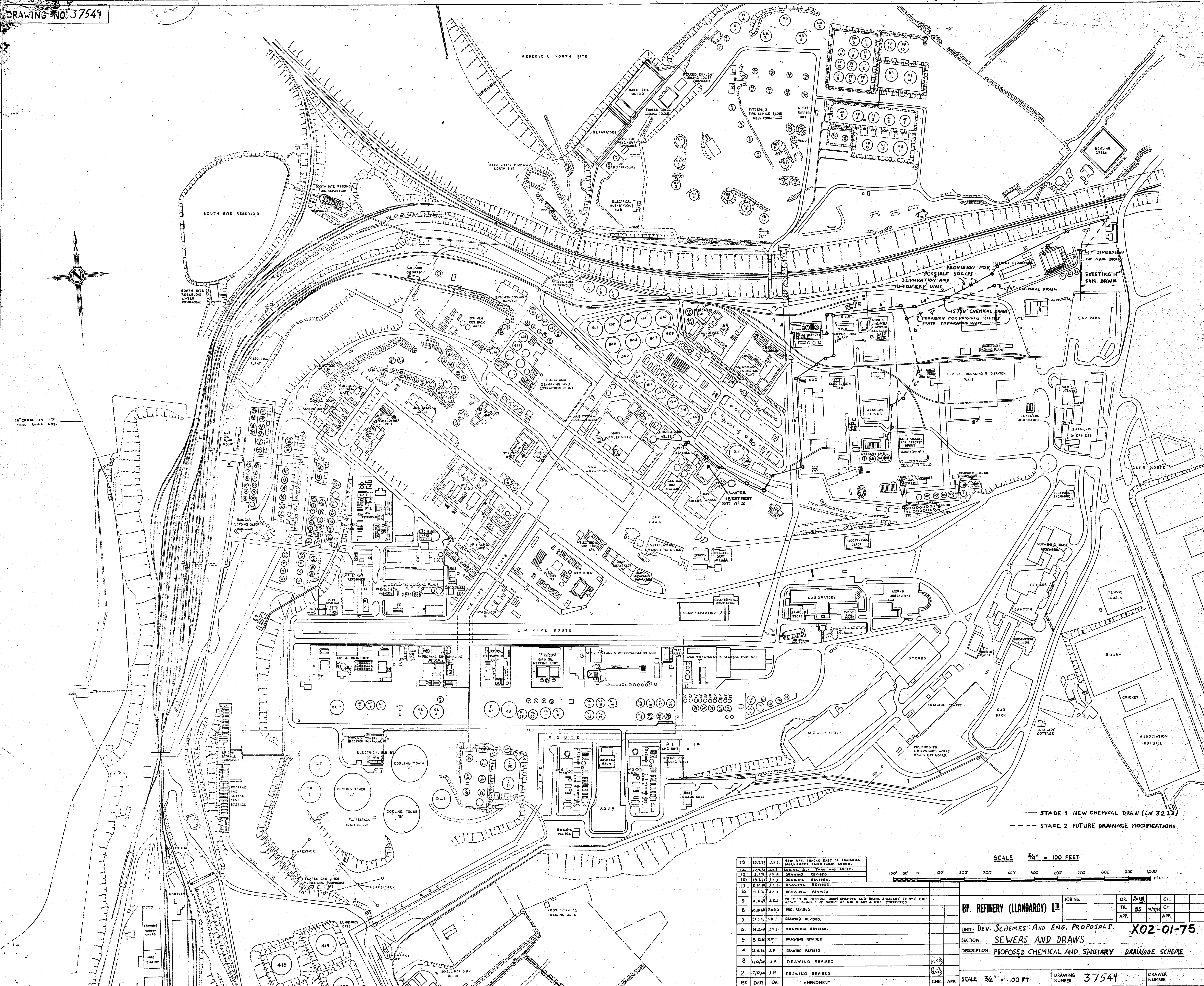


NOT FOR PUBLICATION.

NO	DATE	BY	DESCRIPTION
1	5/11/51	J.P.	NEW GAS TANKS EAST OF TANKING WORKSHOPS FROM TANK AREA
2	5/11/51	J.P.	DRAWING REVISED
3	5/11/51	J.P.	DRAWING REVISED
4	5/11/51	J.P.	DRAWING REVISED
5	5/11/51	J.P.	DRAWING REVISED
6	5/11/51	J.P.	DRAWING REVISED
7	5/11/51	J.P.	DRAWING REVISED
8	5/11/51	J.P.	DRAWING REVISED
9	5/11/51	J.P.	DRAWING REVISED
10	5/11/51	J.P.	DRAWING REVISED
11	5/11/51	J.P.	DRAWING REVISED
12	5/11/51	J.P.	DRAWING REVISED
13	5/11/51	J.P.	DRAWING REVISED
14	5/11/51	J.P.	DRAWING REVISED
15	5/11/51	J.P.	DRAWING REVISED
16	5/11/51	J.P.	DRAWING REVISED
17	5/11/51	J.P.	DRAWING REVISED
18	5/11/51	J.P.	DRAWING REVISED
19	5/11/51	J.P.	DRAWING REVISED
20	5/11/51	J.P.	DRAWING REVISED
21	5/11/51	J.P.	DRAWING REVISED
22	5/11/51	J.P.	DRAWING REVISED
23	5/11/51	J.P.	DRAWING REVISED
24	5/11/51	J.P.	DRAWING REVISED
25	5/11/51	J.P.	DRAWING REVISED
26	5/11/51	J.P.	DRAWING REVISED
27	5/11/51	J.P.	DRAWING REVISED
28	5/11/51	J.P.	DRAWING REVISED
29	5/11/51	J.P.	DRAWING REVISED
30	5/11/51	J.P.	DRAWING REVISED
31	5/11/51	J.P.	DRAWING REVISED
32	5/11/51	J.P.	DRAWING REVISED
33	5/11/51	J.P.	DRAWING REVISED
34	5/11/51	J.P.	DRAWING REVISED
35	5/11/51	J.P.	DRAWING REVISED
36	5/11/51	J.P.	DRAWING REVISED
37	5/11/51	J.P.	DRAWING REVISED
38	5/11/51	J.P.	DRAWING REVISED
39	5/11/51	J.P.	DRAWING REVISED
40	5/11/51	J.P.	DRAWING REVISED
41	5/11/51	J.P.	DRAWING REVISED
42	5/11/51	J.P.	DRAWING REVISED
43	5/11/51	J.P.	DRAWING REVISED
44	5/11/51	J.P.	DRAWING REVISED
45	5/11/51	J.P.	DRAWING REVISED
46	5/11/51	J.P.	DRAWING REVISED
47	5/11/51	J.P.	DRAWING REVISED
48	5/11/51	J.P.	DRAWING REVISED
49	5/11/51	J.P.	DRAWING REVISED
50	5/11/51	J.P.	DRAWING REVISED
51	5/11/51	J.P.	DRAWING REVISED
52	5/11/51	J.P.	DRAWING REVISED
53	5/11/51	J.P.	DRAWING REVISED
54	5/11/51	J.P.	DRAWING REVISED
55	5/11/51	J.P.	DRAWING REVISED
56	5/11/51	J.P.	DRAWING REVISED
57	5/11/51	J.P.	DRAWING REVISED
58	5/11/51	J.P.	DRAWING REVISED
59	5/11/51	J.P.	DRAWING REVISED
60	5/11/51	J.P.	DRAWING REVISED
61	5/11/51	J.P.	DRAWING REVISED
62	5/11/51	J.P.	DRAWING REVISED
63	5/11/51	J.P.	DRAWING REVISED
64	5/11/51	J.P.	DRAWING REVISED
65	5/11/51	J.P.	DRAWING REVISED
66	5/11/51	J.P.	DRAWING REVISED
67	5/11/51	J.P.	DRAWING REVISED
68	5/11/51	J.P.	DRAWING REVISED
69	5/11/51	J.P.	DRAWING REVISED
70	5/11/51	J.P.	DRAWING REVISED
71	5/11/51	J.P.	DRAWING REVISED
72	5/11/51	J.P.	DRAWING REVISED
73	5/11/51	J.P.	DRAWING REVISED
74	5/11/51	J.P.	DRAWING REVISED
75	5/11/51	J.P.	DRAWING REVISED
76	5/11/51	J.P.	DRAWING REVISED
77	5/11/51	J.P.	DRAWING REVISED
78	5/11/51	J.P.	DRAWING REVISED
79	5/11/51	J.P.	DRAWING REVISED
80	5/11/51	J.P.	DRAWING REVISED
81	5/11/51	J.P.	DRAWING REVISED
82	5/11/51	J.P.	DRAWING REVISED
83	5/11/51	J.P.	DRAWING REVISED
84	5/11/51	J.P.	DRAWING REVISED
85	5/11/51	J.P.	DRAWING REVISED
86	5/11/51	J.P.	DRAWING REVISED
87	5/11/51	J.P.	DRAWING REVISED
88	5/11/51	J.P.	DRAWING REVISED
89	5/11/51	J.P.	DRAWING REVISED
90	5/11/51	J.P.	DRAWING REVISED
91	5/11/51	J.P.	DRAWING REVISED
92	5/11/51	J.P.	DRAWING REVISED
93	5/11/51	J.P.	DRAWING REVISED
94	5/11/51	J.P.	DRAWING REVISED
95	5/11/51	J.P.	DRAWING REVISED
96	5/11/51	J.P.	DRAWING REVISED
97	5/11/51	J.P.	DRAWING REVISED
98	5/11/51	J.P.	DRAWING REVISED
99	5/11/51	J.P.	DRAWING REVISED
100	5/11/51	J.P.	DRAWING REVISED



BP. REFINERY (LANBARGY) 12	JOB NO.	DR.	CHK.
UNIT: ESTATE			
SECTION: PLOT PLANS & LAYOUTS			
DESCRIPTION: LAYOUT OF REFINERY			
X 02-01-51			
SCALE: 1/4" = 100 FT	DRAWING NUMBER: 33874	DRAWER NUMBER:	



— STAGE 1 NEW CHEMICAL DRAIN (LN 3223)
 --- STAGE 2 FUTURE DRAINAGE MODIFICATIONS

SCALE 3/4" = 100 FEET

100' 50' 0 100' 200' 300' 400' 500' 600' 700' 800' 900' 1000' FEET

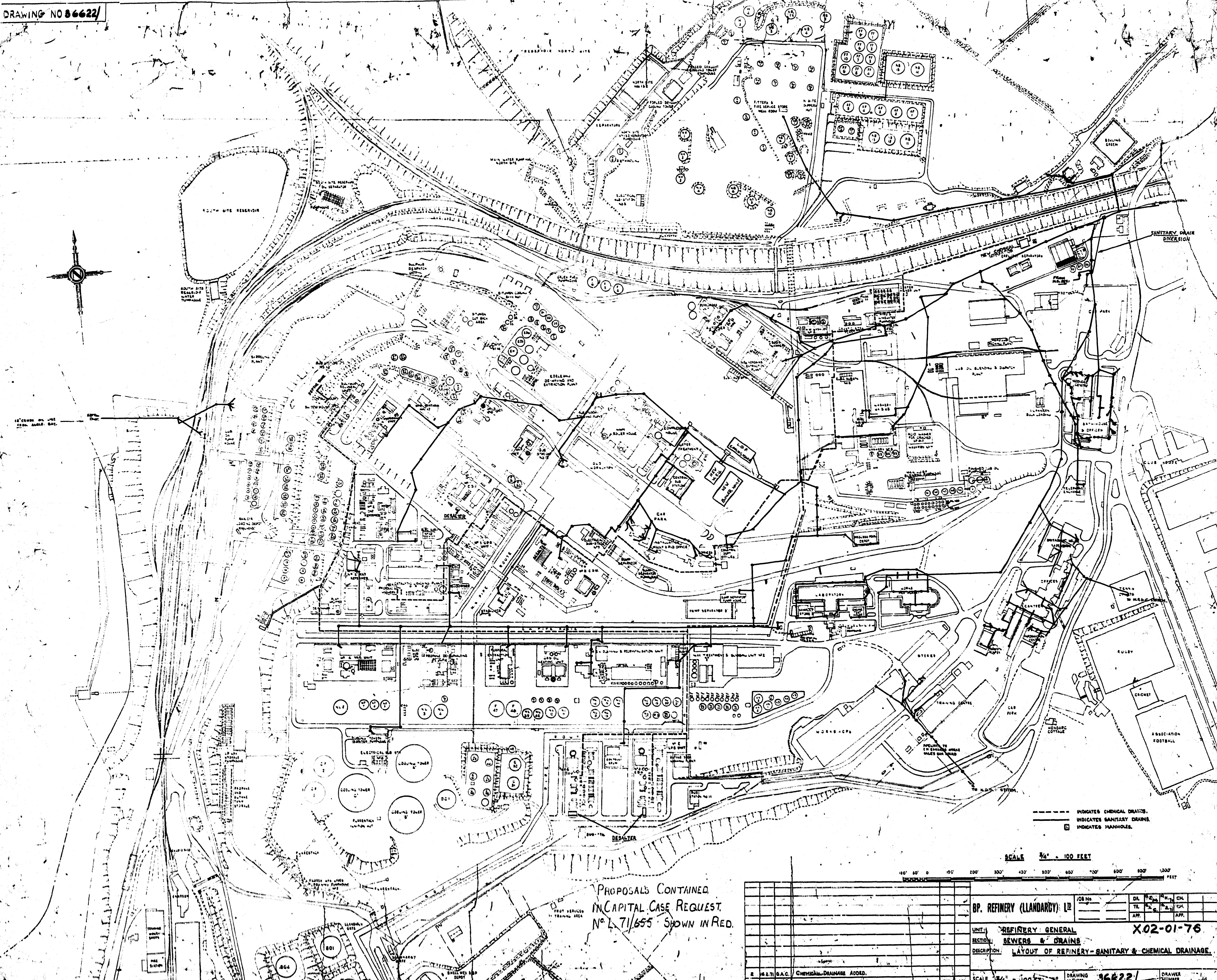
15	12.7.73	J.K.J.	NEW RAIL TRACKS EAST OF TRAINING WORKSHOPS, TANK FARM, ADDED.
14	22.9.72	J.K.J.	LUB OIL BKG. TANK HAS ADDED.
13	3.1.72	J.K.J.	DRAWING REVISED.
12	10.7.71	J.K.J.	DRAWING REVISED.
11	8.10.70	J.K.J.	DRAWING REVISED.
10	4.3.70	J.K.J.	DRAWING REVISED.
9	4.4.69	J.K.J.	POSITION OF CONTROL ROOM AMPLIFIED AND ROADS ADJACENT TO NO 4 CDU ADDED. FENCE L. OF ROAD OF NO 3 AND 4 CDUs CHANGED.
8	6.10.68	R.M.D.	DWG. REVISED.
7	27.1.68	J.K.J.	DRAWING REVISED.
6	16.2.66	J.K.J.	DRAWING REVISED.
5	5.12.65	R.M.D.	DRAWING REVISED.
4	23.8.64	J.P.	DRAWING REVISED.
3	1/6/64	J.P.	DRAWING REVISED.
2	7/12/64	J.P.	DRAWING REVISED.
155	DATE	DR.	AMENDMENT

BP. REFINERY (LLANDARCY) LTD. JOB No. DR. *Law* CH. TR. OS. *14/1/68* CH. APP. APP.
 UNIT: DEV. SCHEMES AND ENG. PROPOSALS. X02-01-75
 SECTION: SEWERS AND DRAINS
 DESCRIPTION: PROPOSED CHEMICAL AND SANITARY DRAINAGE SCHEME

SCALE 3/4" = 100 FT

DRAWING NUMBER 37549

DRAWER NUMBER



PROPOSALS CONTAINED
IN CAPITAL CASE REQUEST,
NO. L 71/655 SHOWN IN RED.

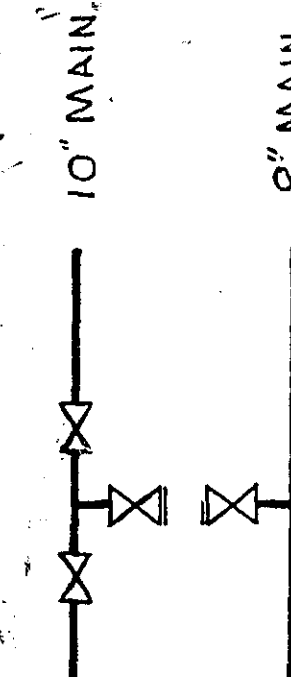
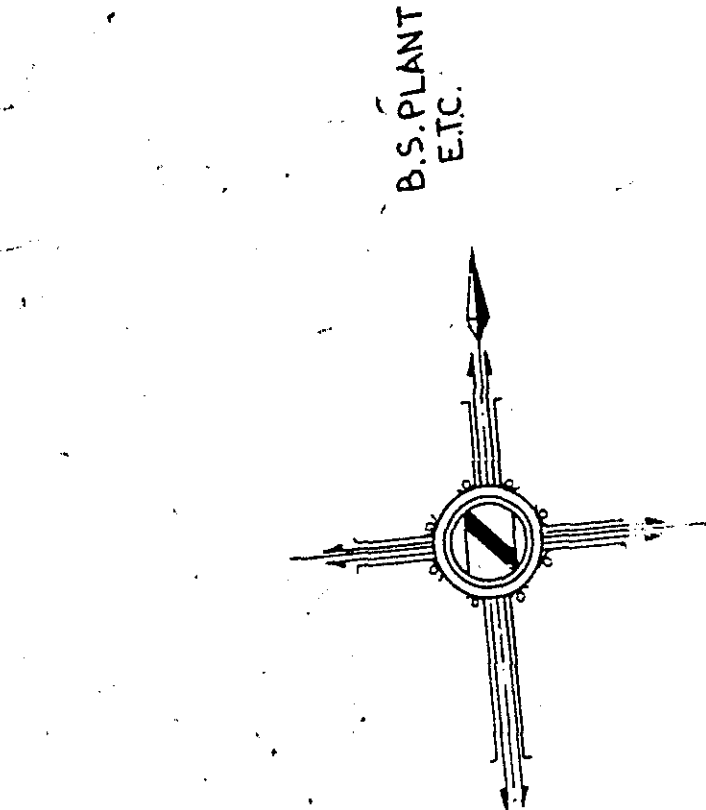
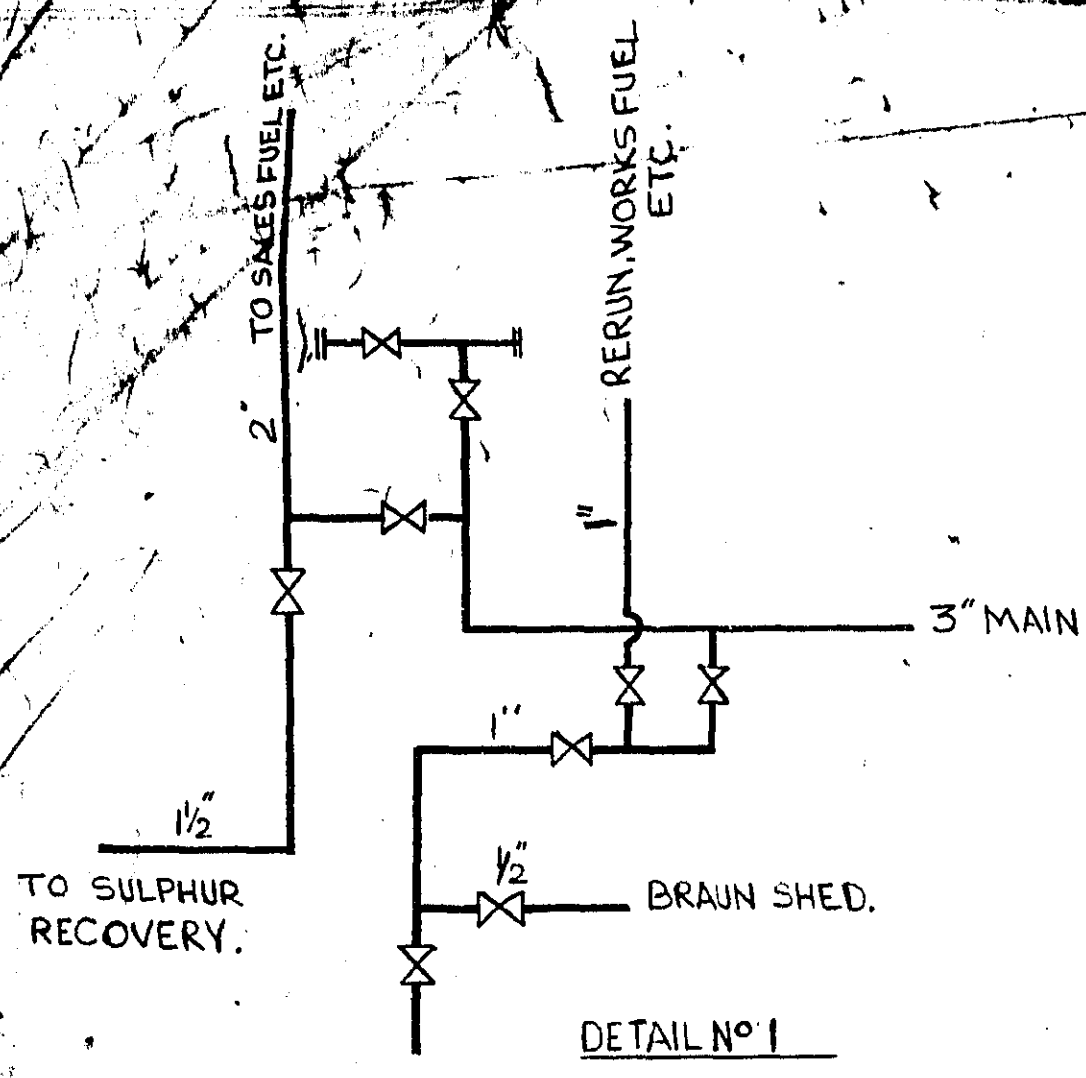
INDICATES CHEMICAL DRAINS.
INDICATES SANITARY DRAINS.
INDICATES MANHOLES.

SCALE 1/4" = 100 FEET

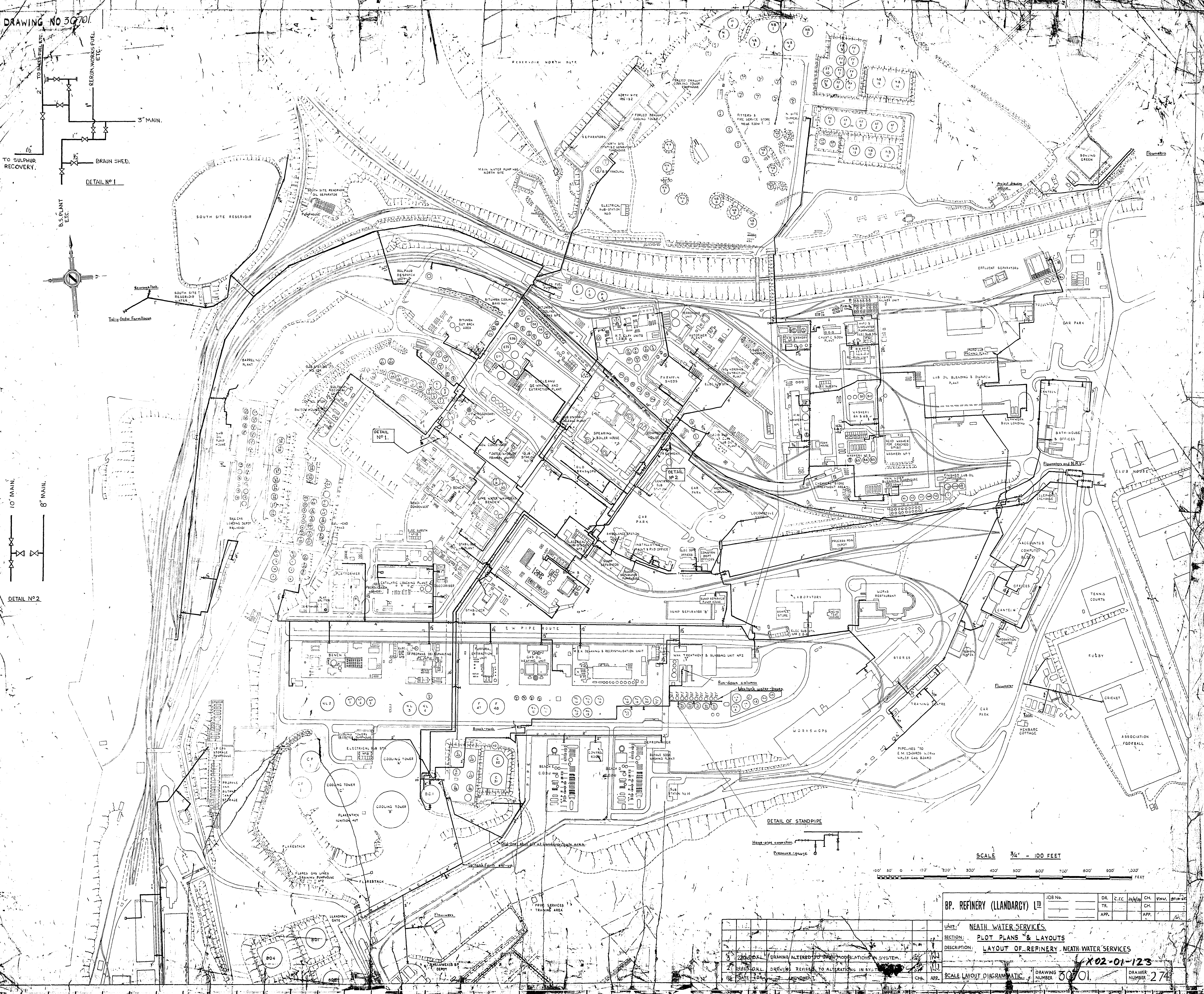
100' 80' 60' 40' 20' 0' 20' 40' 60' 80' 100' 120' 140' 160' 180' 200' FEET

BP. REFINERY (LLANDARCY) LTD		JOB No.		DR.	TR.	APP.	CH.	CH.
UNIT: REFINERY GENERAL		SECTION: SEWERS & DRAINS		DESCRIPTION: LAYOUT OF REFINERY - SANITARY & CHEMICAL DRAINAGE.		X.02-01-76		
2 16.7.71 G.A.C. CHEMICAL DRAINAGE ADDED.		AMENDMENT		SCALE 1/4" = 100 FT.		DRAWING NUMBER 36622/		DRAWER NUMBER
DATE		CHK.		APP.				

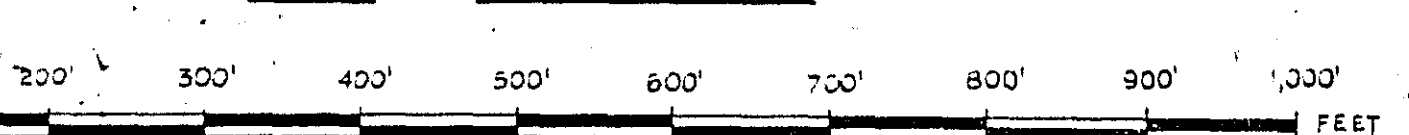
DRAWING NO 30701



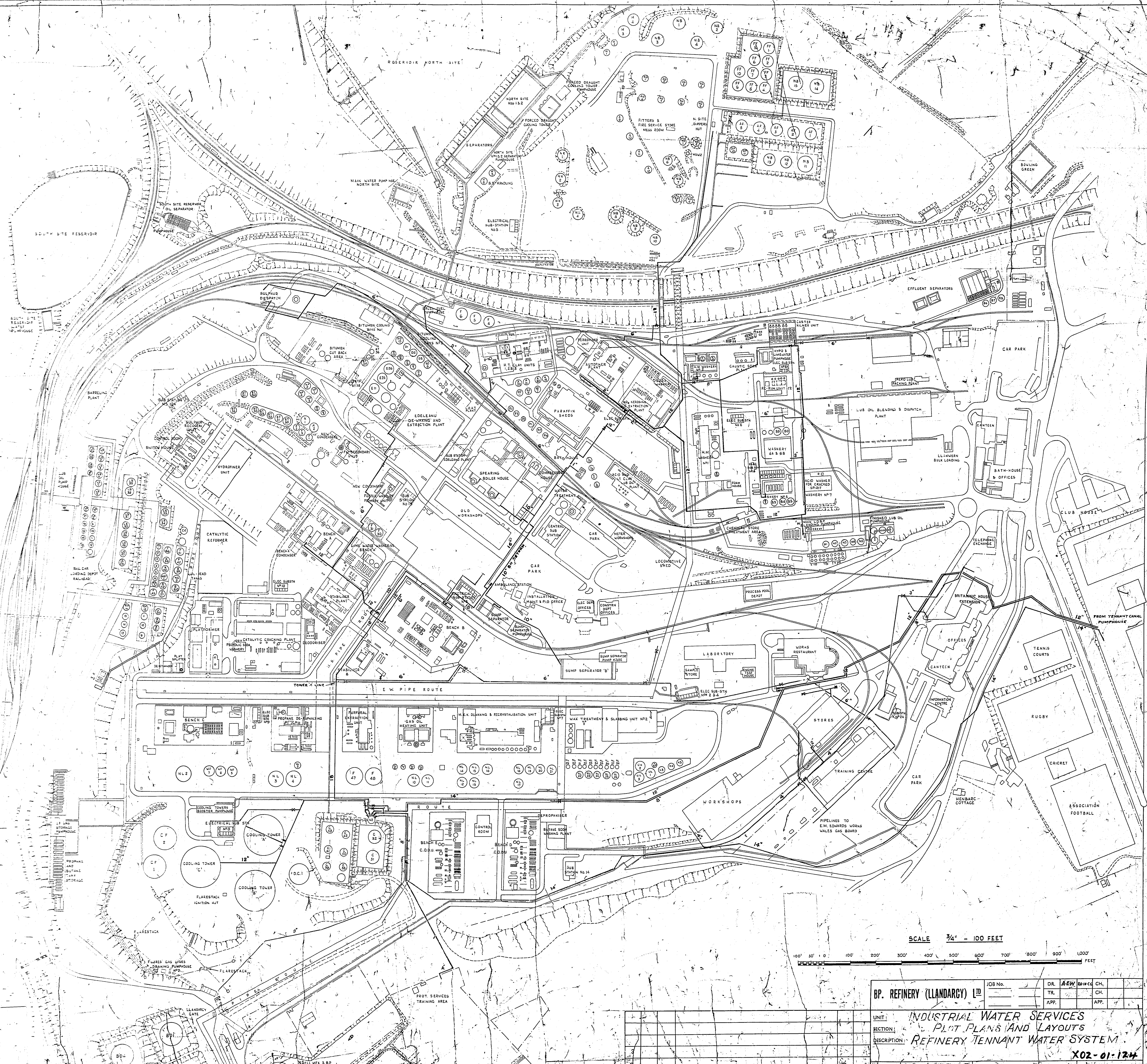
DETAIL No 2



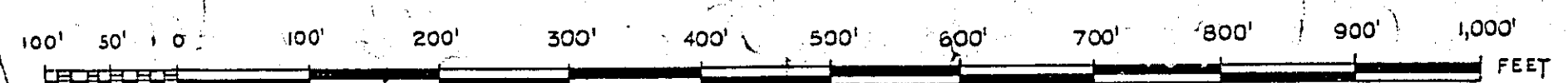
SCALE 1/4" = 100 FEET



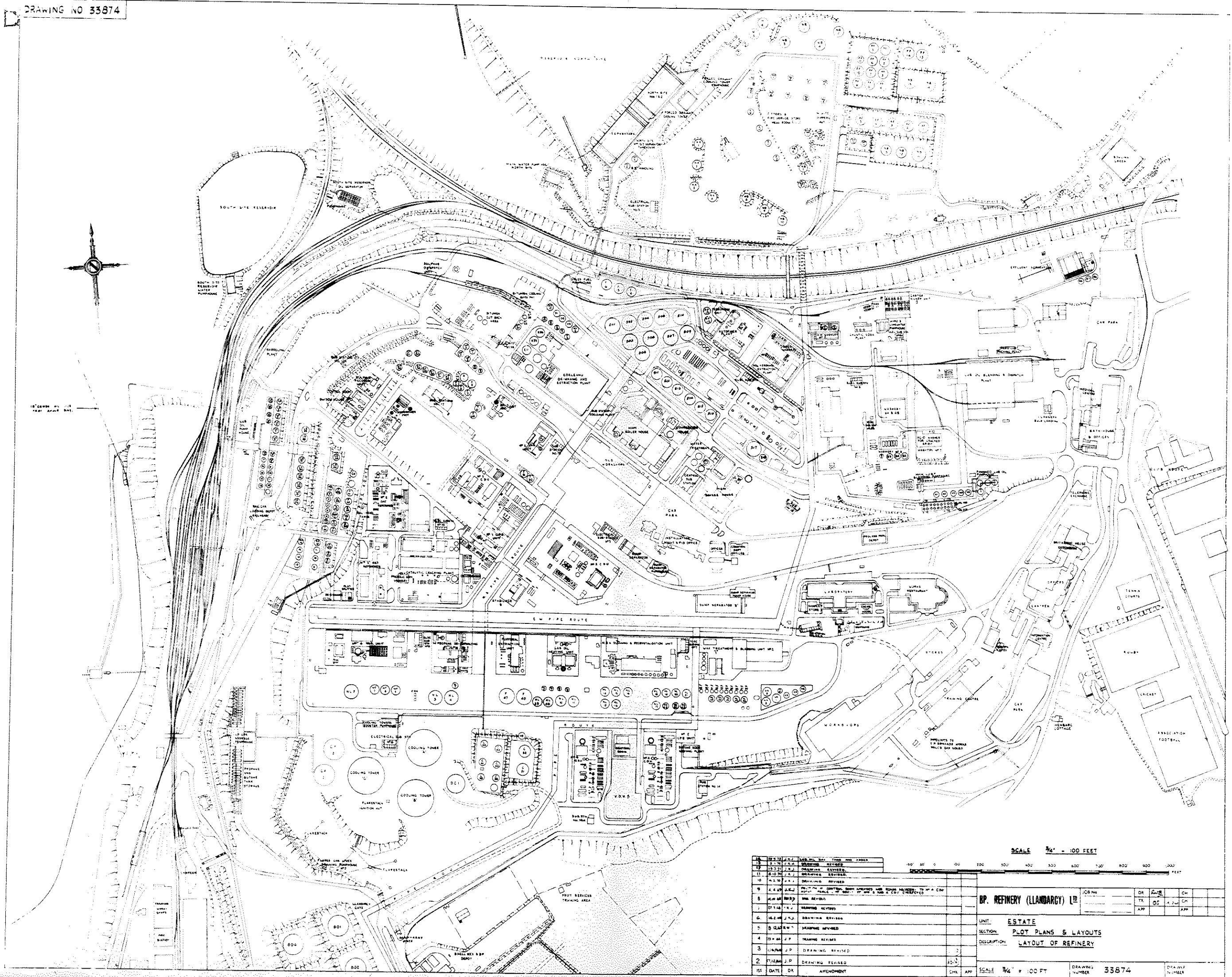
BP. REFINERY (LLANDARCY) LTD		JOB No.	DR.	C.F.C.	26/6/58	CH.	27/7/58
SECTION: NEATH WATER SERVICES		TR.					
DESCRIPTION: LAYOUT OF REFINERY NEATH WATER SERVICES		APP.					
DRAWING NUMBER 30701		DRAWING NUMBER 30701		DRAWER NUMBER 274		X02-01-123	

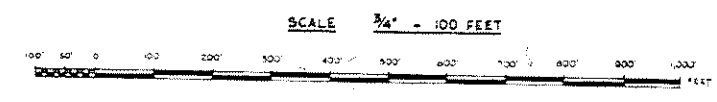
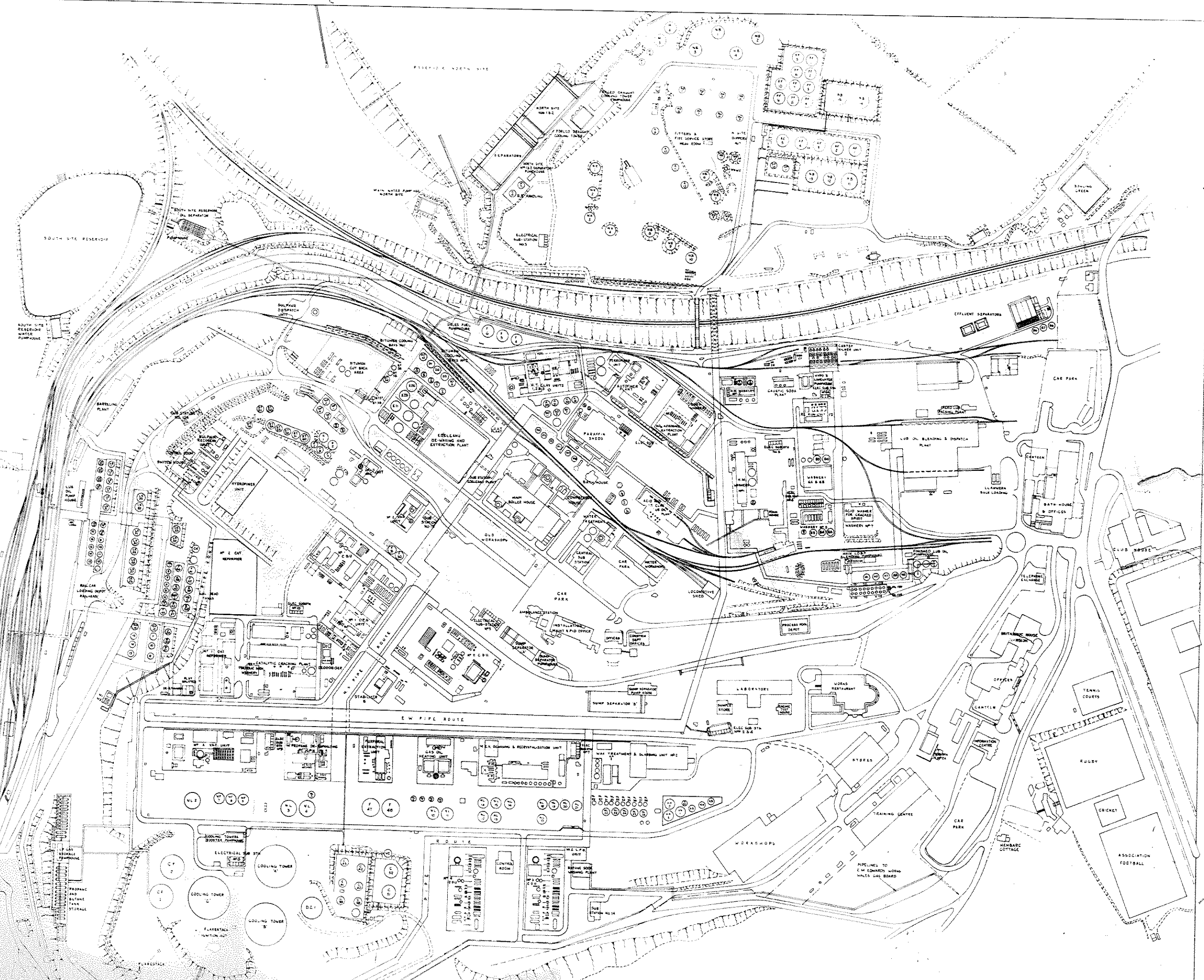
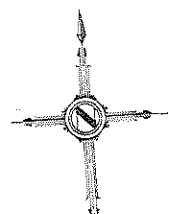


SCALE 3/4" = 100 FEET



BP. REFINERY (LLANDRUGY) LTD		JOB No.	DR. AEW	CH.
		TR.		
		APP.		
UNIT: INDUSTRIAL WATER SERVICES				
SECTION: PLANT PLANS AND LAYOUTS				
DESCRIPTION: REFINERY TENNANT WATER SYSTEM				
		X02-01-124		
IS.	DATE	DR.	APP.	SCALE 3/4" = 100 FT
				DRAWING NUMBER 35027
				DRAWER NUMBER





BP. REFINERY (LLANDARCY) LTD			
UNIT	ESTATE	JOB No.	DA 100
SECTION	PLOT PLANS & LAYOUTS	TR	DS
DESCRIPTION	LAYOUT OF REFINERY	CH	1

4	DA 100	J.P.	DRAWING REVISED
3	DA 100	J.P.	DRAWING REVISED
2	DA 100	J.P.	DRAWING REVISED
1	DA 100	J.P.	DRAWING REVISED

UNIT: ESTATE
SECTION: PLOT PLANS & LAYOUTS
DESCRIPTION: LAYOUT OF REFINERY

