APPENDIX A- CONTROLLED WATERS RISK ASSESSMENT, RHODIA SUB Z

1. INTRODUCTION

At the southwestern end of the Rhodia Whitehaven site, a substation (known as "Sub Z") was recently dismantled and removed by a contractor acting on behalf of United Utilities. URS understands that during the removal of this substation, hydrocarbons were accidentally released onto the ground surface and that these subsequently infiltrated into shallow soils surrounding the site of the former substation. At the request of the Environment Agency remedial works were undertaken in order to remove contaminated soil by excavation of visual contamination to a maximum depth of 0.5 m bgl. URS understands arisings from the excavation were removed off site to suitably licensed landfill facilities and the excavation subsequently backfilled with gravel.

URS was commissioned to obtain validation samples from the sidewalls and base of this trench. Soil samples were analysed, and returned elevated concentrations of a number of hydrocarbon fractions and a single Polychlorinated Byphenol (PCB Aroclor-1254). A number of these samples were from below the base of the remedial trench.

In order to understand the potential risk to controlled waters posed by the residual contamination in the vicinity of Sub Z, a quantitative risk assessment was required. The closest identified controlled waters receptor was a surface water stream at the southern end of the site, called Sandwith Beck.

2. METHODOLOGY

The Controlled Waters Quantitative Risk Assessment (CW QRA) is based upon the UK Department of the Environment, Food and Rural Affairs (DEFRA) and Environment Agency (EA) "best practice" in regard to the assessment of contaminated land. More specifically, this approach follows the "*Source - Pathway - Receptor*" methodology as defined in Part IIa of the Environmental Protection Act (1990) [as inserted by Section 57 of the Environment Act (1995)] and detailed in the following UK Environment Agency's published guidance:

- Environment Agency R&D Publication 20 (1999) *Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources* (referred to as R&D P-20);
- Environment Agency R&D Publication CLR11 (2004) *Model Procedures for the Management of Land Contamination* (referred to as CLR11).

The approach involves the identification of sources, pathways and receptors as derived from the conceptual understanding of the site and the surrounding environment's geology, hydrogeology, observed contamination (and its distribution), and potential receptors. From this conceptual understanding, potential pollutant linkages (*source-pathway-receptor* relationships) are identified whose significance is evaluation using a tiered risk-based approach, in accordance with the Environment Agency's "Integrated Methodology".

Several models have previously been generated for the site to assess the potential risks to controlled waters posed by analytes found within the shallow strata. One such model was applicable for this assessment, and was adopted accordingly. The model used was the CONSIM assessment from the Plot C investigation; Sub Z is situated immediately to the west of Plot C, it is underlain by a similar geological profile, and has the same controlled waters receptor (Sandwith Beck). The methodology for the CONSIM assessment is presented in the Plot C Report[1].

3. CONCEPTUAL MODEL

3.1. Sources

For the purposes of this risk assessment, given that only a targeted number of analytes were scheduled for analysis (7 analytes in total), the most elevated concentrations of each of the analytes was entered into the model. The following table presents the analytes, and associated concentrations.

Compound	Maximum recorded soil concentration (mg/kg)
PCB Aroclor-1254	18
TPH (>EC12-16) aromatic	5.5
TPH (>EC16-21) aromatic	110
TPH (>EC21-35) aromatic	400
TPH (>EC12-16) aliphatic	53
TPH (>EC16-21) aliphatic	590
TPH (>EC21-35) aliphatic	460

3.2. Potential Pathways

The geological and hydrogeological conditions encountered during this site investigation, and the Plot C investigation (along with an understanding of the geological profile across the entire Whitehaven site), have been utilised to formulate the conceptual site model. These findings have been summarised below.

Made Ground:

- Remnant concrete plinths are visible at the ground surface within the Sub Z area.
- Surrounding the concrete plinths is grey purple medium gravel, thought to be the material backfilled into the trench following the removal of the contaminated soils. The thickness of the gravel backfill varies from 0.1m to 0.5m. Concrete was also found to be underlying some of the gravel backfill in the central area of Sub Z.

[1] Remediation Statement Appendix E Plot C Site Investigation. Former Albright and Wilson Facility, Whitehaven, Cumbria.20 November 2007Final Issue. Issue No 244319943/MARP0002

- Underlying the gravel backfill is black brown sandy reworked silt, brick and concrete fragments.
- Water ingress was noted in four of the seven trial pits, at approximately 0.35-0.45m depth.

Unconsolidated Drift Deposits (based on Plot C Investigation Results):

- Boulder clay/till – red-brown generally firm to stiff (occasionally soft) clay with varying amounts of inter-bedded silt and occasional fine to medium sand horizons. The silt or fine sand lenses that were present were typically less than 0.3m thick. The boulder clay was present to up to approximately 8.0m in Plot C. A discontinuous groundwater table was encountered in the locations investigated as part of the Plot C investigation. Groundwater, where present, was associated with silt and sand lenses within the boulder clay. Measured groundwater elevations and interpreted discontinuous groundwater contours are presented as Figure 2 of the Plot C report. In areas within Plot C where some form of groundwater body was encountered, a generally convergent groundwater flow towards Sandwith Beck was inferred.
- A single deep borehole was drilled by URS in 2003 (REF: Further Soil and Groundwater Investigation, 44557-033, dated 8th August 2003) that is approximately 30m to the north east of Sub Z. This was logged as drift deposits (very silty clay) to at least 21m, which was typically dry throughout with no continuous groundwater encountered until 49mbgl.

Consolidated Deposits:

- URS did not encounter bedrock was not encountered during either the Sub Z or Plot C investigations. However, the borehole log for BH201 determined St.Bees Shale at 34mbgl (with weathered shale horizons between 21mbgl and 34mbgl). BH201 is screened within this shale unit, and measured rest-water levels are approximately 49mbgl (35mAOD).

3.3. Controlled Waters Receptors

The likely receptor requiring further assessment is Sandwith Beck. This is a small stream that runs from the southern edge of the site south through Sandwith village, reaching the sea a few kilometres to the south. The conceptual model is presented in Figure 1 below.

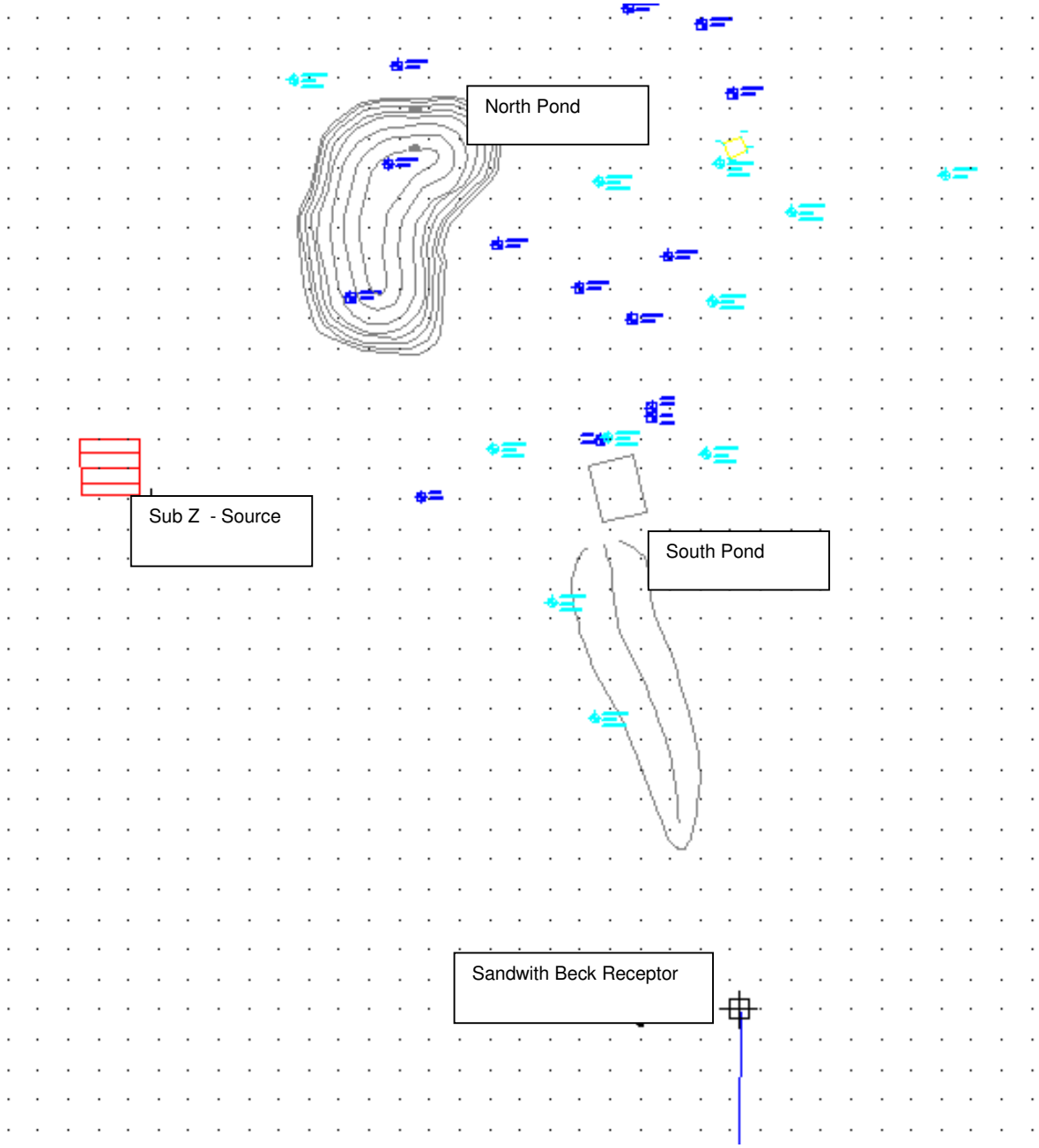

Figure 1- Conceptual Model created in CONSIM

4. MODEL INPUTS SUMMARY

The model parameters (including contaminant physio-chemical parameters such as the partition coefficients) are presented in Tables 5, 6, and 7 at the end of this report. Justification for a number of the model inputs relating to the conceptual model is presented below.

Source Area

The source area was conservatively assumed to be the size of investigation area, which was approximately 20 meters long by 20 meters wide. This is larger than the footprint of Sub Z and reflects the potential for some migration of contamination within shallow soils.

Underlying the backfilled gravel horizons (which extend to up to 0.5mbgl), it has been conservatively assumed that residual contamination extends for 1m (0.5-1.5mbgl), justification for this is provided in Table 5C.

It has been assumed that a saturated silt horizon directly underlies the source area (again conservative, but considered necessary in the absence of deep trial pit or borehole log), and consequently, that no unsaturated zone is present between the source and the groundwater within the silt horizon.

Pathways

The viable pathway applicable to this source involves the leaching of soil contamination downwards into the shallow water table, followed by mixing in shallow groundwater and subsequent *horizontal* migration of shallow groundwater within the silt horizon, which has been conservatively assumed to extend to the receptor.

Receptor

The single receptor modelled in the assessment is the closest surface water to the site, Sandwith Beck, located 250m to the south east of Sub Z. Vertical migration is considered unlikely given the substantial thickness of likely to be in this area of the site.

5. MODEL RESULTS- RISKS FROM SOIL CONTAMINATION TO SANDWITH BECK

The model results are presented in Table 8. Based on the data obtained from the Sub Z site investigation, no risks to Sandwith Beck were simulated for TPH fractions or PCB (aroclor 1254) at the 50^{th} or 95^{th} percentile confidence limit.

6. LIMITATIONS OF CONTROLLED WATERS QUANTITATIVE RISK ASSESSMENT

The risk assessment conclusions are based on the risks to Controlled Waters, under the requirements of Part 2A (ENVIRONMENTAL PROTECTION ACT 1990, SECTION 78H(7)).

The additional assessment, that evaluated risks to human health, assumed a future "right to roam" end use without any continued industrial operations and no significant changes to the site layout, or off-site changes. As such, if such changes occur it will be necessary to reassess the risk assessment results and conclusions; a change of use of the site will be regulated by Planning Legislation.

It is acknowledged that there are uncertainties inherent in all risk assessment methodologies, particularly in relation to the assignment of assumed values for difficult to measure site specific variables, such as infiltration rate. However, a reasonable body of research exists such that these variables can be estimated with reasonable accuracy, and in a manner that is known to be conservative. It is therefore likely that risks are, if anything, overestimated, as a result of these assumptions (constant source terms, use of 95th percentile concentrations), and so the results of the Controlled Waters risk assessment should be viewed in this context.

The assessment can only be undertaken on the data set available from site investigations, thus it is possible that higher concentrations of ground contaminants than observed during the recent site assessment works may exist.

Assessment of Uncertainty

A degree of uncertainty is associated with the adopted parameters characterising the various geological strata encountered at the site that make up the source and pathways. As such, a probabilistic 'Monte Carlo' assessment has been adopted encompassing distributions in the likely range in parameters that could be considered appropriate for the strata encountered at the site. In addition, the undertaking of probabilistic modelling and simulating concentrations at the 50th & 95th percentile level of confidence presents an assessment of the effects of the variability in parameters, be they poorly or well understood. Simulated 50th and 95th percentile concentrations can be interpreted as follows:

- Simulated concentrations at the 50th percentile confidence limit represent 'on the balance of probabilities' the most likely simulated concentrations given the range of parameters applied.
- Simulated concentrations at the 95th percentile confidence limit represent a worse case or extreme condition, resulting from a worse case combination of parameters (e.g. high permeability, high source concentrations, low degradation rate etc).

The simulation of 95th percentile concentrations already takes into account a worse case scenario resulting from the combination of worse case parameters such as high permeability etc. In addition, calibration exercises typically result in the predicted concentrations at the 50th percentile confidence level matching observed data (*Pers. Comm*. Hugh Potter of Environment Agency, Groundwater Modelling Seminar, Birmingham, 8 May 2006).

7. REFERENCES

CLR-7 (2002) Assessment of Risks to Human Health from Land Contamination: An overview of the Development of Soil Guideline Values and Related Research. Department for the Environment, Food and Rural Affairs (DEFRA) and Environment Agency (EA), Appendix A.

CLR-11 (2004) Model Procedures for the Management of Land Contamination" (Environment Agency, 2004).

Environment Agency (1999) Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources. Authors Marsland, P.A. and Carey, M.A. Environment Agency R&D Publication 20, 89pp.

Tables