Ref:01140

HISTORICAL LAND QUALITY INVESTIGATIONS DATA REVIEW AND PRELIMINARY RISK ASSESSMENT

NOVARTIS PHARMACEUTICAL, WIMBLEHURST ROAD, HORSHAM, SUSSEX

March 2016

6 Earls Court
Earls Court Business Park
Roseland Hall
Grangemouth
FK3 8ZE

Tel: 01324 474816
Fax: 01324 492359
E-mail: kdc@kdc.co.uk
Web: www.kdc.co.uk

Ref: 01140

CONTENTS

FIGURES

APPENDICES

Prepared By:	Lara Russo	**Position:** Project Scientist	**Date:**	31/03/2016	**Initials:**	***LR***
Checked By:	Michelle McIntosh	**Position:** Contract Manager	**Date:**	31/03/2016	**Initials:**	***MM***
Approved By:	Christopher Sandground	**Position:** Environmental Director	**Date:**	31/03/2016	**Initials:**	***CS***
Version: V0						
Version No.		**Date**	**Comments**			
V0		31/03/2016	First issue to client.			
V1		29/4/16	Updated Figures and Section 5.4			

1. INTRODUCTION

1.1 Introduction

KDC Contractors Ltd (KDC) was instructed by Novartis Pharmaceutical (Novartis) to undertake a review of publicly available environmental and historic information, as well as the information collected and reported by others from previous site investigations at the Wimblehurst Road site, Horsham.

We understand that Novartis wish to sell the site in a condition where no further remedial works are required to the purchaser. To allow this to be undertaken, a phased approach of investigation and remediation is necessary. This report is undertaken to review existing available information and recommend if further intrusive investigation is required to fill data gaps, prior to the completion of an up to date site Risk Assessment.

The site location plan is included in Figure 1.

1.2 Background

The site is part of a phased demolition programme currently being undertaken by KDC Contractors, which commenced in April 2015. The programme includes the demolition of most of the buildings, with the exception of Building 3, Building 36 and the Lodges. The works also includes the removal of the related slabs and foundations to a depth of 1m.

It is understood that the site within the demolition scope, is to be sold and redeveloped for mixed residential and commercial/light industrial use. Limited information is available regarding the exact areas of the site to be developed for each different land use.

Quantitative risk assessment utilising existing laboratory data collected by others, and the data we recommend is collated in the conclusion of this report, will ultimately be undertaken to determine the remediation required.

Previous intrusive investigations have been undertaken by others, to collect soil and groundwater data and assess the risk to human health and water environment. However, the scope of the previous investigations was constrained by site activities, buildings, infrastructure and the presence of underground services at the time of the investigation. Therefore the locations investigated were mainly situated outside the building footprints and this report aims to identify which areas still require

investigation. Furthermore, the previous risk assessments were predominantly based on further commercial land uses, rather than residential which is now planned for parts of the site.

1.3 Scope of KDC Work

In order to fulfil Novartis Pharmaceutical's requirements, the following scope of works was undertaken:

- Review of publicly available environmental and historical site information.
- Review of previous site investigation reports carried out by others.
- Preparation of a preliminary Conceptual Site Model (CSM) taking into consideration the potential pollutant linkages (source, pathway, receptor) that are relevant to the potential re-development of the site.
- Preparation of a summary report detailing the information review and recommendations for further work necessary to complete a detailed site risk assessment and ultimately allow subsequent remedial recommendations.

1.4 Disclaimer

This report has been prepared for the sole and exclusive use of Novartis and may be relied upon by Novartis only, to whom we owe a duty of care. Our report must not be passed for information, or for any other purpose, to any third party without our prior written consent. Such consent shall not entitle the third party to place any reliance on the report and shall not confer or purport to confer on any third party any benefit or right pursuant to the Contracts (Rights of Third Parties) Act 1999 or otherwise. We do not accept any liability to any third parties unless we have, in the form of a reliance letter, or collateral warranty, expressly accepted that we owe a duty of care to such third parties.

This report has been prepared based on the documentation publicly available and that provided by Novartis on previous site investigations. KDC do not hold any reliance on this data and therefore do not accept any liability on the accuracy of such information. Therefore, should the information be false or inaccurate the observations and conclusions in this report may change.

Moreover, it should be noted that any site investigation provides an assessment of the site conditions in certain locations from which conditions of the site, as a whole, are

interpreted. Therefore, on-site conditions or contamination (including contamination which has migrated or is migrating) may exist which have not been disclosed from the information provided to KDC by third parties. Additionally, the passage of time, natural occurrences and future activities may alter discovered conditions.

2. CONTAMINATED LAND ASSESSMENT

In accordance with existing legislation and available guidance, the initial stage of the contamination land assessment is the development of a Stage 1 Preliminary Risk Assessment.

This risk assessment looks at the potential risks to current and future site users, the water environment and any property and infrastructure which may be built.

It is good practice to adopt the principles of risk assessment. The presence of measurable levels of potential contaminants across the site does not automatically imply that a problem exists, given that the potential for harm to occur requires the following:

- Source of contamination;
- Pathway linking sources to receptors;
- Receptors which may be affected.

Only if potential linkages between all three elements (source – pathway – receptor) are identified, is a potential risk deemed to exist.

In order to assess if a complete pathway linkage exists, KDC have undertaken the following:

- Review of the Envirocheck Report (historical and environmental setting data).
- Review of site information provided by Novartis, referring to previous reports.
- Production of a preliminary Conceptual Site Model in order to identify the geo-environmental sources, pathways and receptors for the site.

This report includes recommendations for further investigation of the identified potential risk(s), where it has not been addressed during previous investigations.

It should be noted that at the time of writing this report, limited data was available with regards to the full development plans following the sale of the site. Therefore the preliminary site conceptual model has been produced assuming both the residential and industrial end use.

3. HISTORICAL MAPS AND ENVIRONMENTAL SETTINGS REVIEW

3.1 Site Location

The site is located to the north east of Horsham town centre.

The site is currently accessed from Wimblehurst Road, with a secondary access located on Parsonage Road, which is currently not in operation. A site location plan is included as Figure 1.

3.2 Site Description

The site is characterised by a pseudo-triangular shape and covers an area of some 7.2 hectares.

The site is bounded by Parsonage Road to the north, beyond which lies the former site car park currently being redeveloped for residential housing. A railway line bounds the site to the east, beyond which an industrial estate comprising of an oil depot is located. The southwestern side of the site is bounded by a railway line, beyond which lies an industrial estate, recreation ground and housing, whilst the north-western side is bounded by Wimblehurst Road beyond which residential properties are located.

The site is currently part of a phased demolition programme which involves the demolition of the existing buildings and the removal related of slabs and foundations to a depth of 1m. The demolition programme of eastern and central part of the site has been completed, with works moving towards north and west.

Outside of the building footprints, the site comprises areas of hardstanding and grass cover. Crushed material resulting from the demolition operations has been spread over the footprint of the buildings demolished to date.

3.3 Site Layout Pre-Demo

Various phases of redevelopment have been undertaken at the Novartis site since it opened in 1939, with a number of original buildings being demolished or refurbished in subsequent years.

Based on the information provided by Novartis to KDC, prior to the demolition works, buildings present at the site were described as per Table 1 below, with the locations shown in the plan shown in Figure 2.

Table 1: Building Use Prior to Demolition

BUILDING USE PRIOR TO CURRENT DEMOLITION					
ID	**Description**	**Area (m^2)**	**ID**	**Description**	**Area (m^2)**
1	Lodge	63	25	Garage	26
2	Lodge	73	26	Gas Governor Station	19
3	Administration	1482	27	Waste Store/ Former Incinerator	125
4	*U/Ground Sewage Pumps**	-	28	Entrance Gatehouse	54
5	*U/Ground Sewage Pumps**	-	29	-	-
6	Coal Hopper	-	30	Solvent Store	57
7	Water Treatment/Substation	123	31	Waste Management/ Foam WAD Store	217
8	Boiler House	399	32	Solvent Drum Store	106
9	*U/Ground Sewage Pumps**	-	33	LPG Cage	7
10	Grounds	112701	34	-	-
11	Former Boiler House	379	35	Archive Building	332
12	*Former production area (Demolished in the 1980s)***	-	36	Administration	997
13	Chiller Building And Pumping Station	182	37	Q.C. & Development	795
14	-	-	38	ADDR Building	1056
15	Production & Stores	12247	39	Despatch	1386
16	*Cycle Rack**	-	40	Sports Pavilion	574
17	Research Solvents Store	79	41	Gardener's Shed	12
18	Restaurant***	822	42	Laboratory/ Research Centre	4553
19	Document Management Centre	270	43	-	
20	-	-	44	*Bicycle Shelter**	-
21	Engineering	854	45	Temporary Offices	390
22	Ancillary Services Building	187	46	Q.C. & Development	686
23	Systems Recovery Building	17	T1	Temporary Offices	118
24	Exit Turnstile	-	T2	*Temporary Offices**	114
HISTORIC AND ANECDOTAL SITE USE					
A	Former Production Area (Building 12)		M	Railway Siding	
B	Diesel Tank (AST)		N	Water Abstraction	
C	Surface Water Tank (infilled)		O	Historical Building	
D	Fire Water Tank		P	Old petrol/filling station	
E	Former Infilled Clay Pit		Q	Electrical Substation/Generator area	
F	Former Underground Solvent Store		S	Generator	
G	Former Extension to Building 18		T	Former Fuel Tank	

BUILDING USE PRIOR TO CURRENT DEMOLITION					
ID	Description	Area (m^2)	ID	Description	Area (m^2)
H	Former Oil UST Tank (Next Building 17)		U	Boiler House (Footprint) Building 11	
I	Diesel Tank (Next to Building 6) - AST		V	Tank Storage Area (Footprint) Building 11	
L	Sump				

* Location not reported on available plans
** Indicated as 'A'
*** Former R&D centre

Based on the information provided, Building 11 was divided in three main areas; i) former boiler house, ii) oil storage tanks (6no) and iii) generator/panel house.

Based on the information provided by Novartis, Building 15 was divided into further process areas, as described in Table 2 below.

Table 2: Building 15 Areas

BUILDING 15 Areas	
Floor	Area
Ground	Transformers Area
	Raw Materials and API Storage (On Pallets)
	Mixing and Drying
	Coating Area
	Production Lines
	Laboratory Q/A
	Innovation Production
First	Autoclaves
	Drying Ovens
Second	Plant Room

3.4 Site Topography

The site area is predominantly flat, however, at the southern boundary, the site slopes up steeply to the adjacent railway lines. The area of the former infilled clay pit is also located at an elevated level compared to the remainder of the site.

3.5 Historical Site Development

Following a review of a range of historical maps included in the Envirocheck® report of the site, the historical development of the site, including the immediately surrounding area, was reviewed.

The Envirocheck® historical maps are included as Appendix A. The historical development of the site is summarised in Table 3 below.

Table 3: Historic Site Development

HISTORICAL SITE DEVELOPMENT		
Date	**On Site**	**Off Site**
1875	The site appeared undeveloped and was characterised by open fields, with the exception of a 'clay pit' present in the southern corner of the site.	The site was bound by railway lines on the east and west sides. A brickworks, brick fields, Saw Mill, a station and related station nursery, and several scattered farms were located to the south, within a distance of 1km. Wimblehurst residences were located to the north, within a distance of 500m.
1879 -1880	No significant change.	No significant change.
1897	No significant change.	Horsham Iron Works are noted to the south of the site beyond the railway line.
1898-1899	No significant change.	Residential housing was developed to the north-west, north-east and south of the site. The Grammar School and Cottage Hospital were located to the east/south east (within 1km distance).
1911	No significant change.	The iron works were now identified as 'engineering works'.
1912-1933	No significant change.	No significant change.
1938	A building noted as 'Laboratories' was present in the west/central part of the site.	No significant change.
Since 1939	Site used for pharmaceutical research, development and manufacture*.	No significant change.
1961	An additional building/structure was noted in the central part of the site.	Residential housing developed progressively to the east, south and west of the site.
1963-1964	Structures which appear to be additional roofed buildings are noted within the south/eastern portion of the site. A tennis center is reported in the north/western portion. The 'Clay pit' is reported as infilled.	Several 'works' sites were located along the south-east boundary, beyond the railway line.
1964-1985	Several new buildings appear on site as part of the Pharmaceutical Works. An embankment is noted to the eastern side of the site.	Several warehouses noted to the south on the 1969-1985 map.
1970	The site layout appears simplified.	No significant change.
1972-1985	The map show a site layout very similar to 1964-1985. Some structures were noted north of the clay pit. Building 12 is known to have been demolished in the 1980s (located at the current grass covered courtyard in the centre of the site)*.	A school was noted approx. 400m south east of the site. A tennis court was shown beyond Personage Road. A fuel storage facility was also located south-east of the site in 1985. Further housing developments were noted.

HISTORICAL SITE DEVELOPMENT		
Date	**On Site**	**Off Site**
1993	A simplified site layout is noted, with several buildings demolished.	A playing field is noted to the north beyond Personage Road.
2000	No significant change.	Expansions are noted to the hospital and the college located to the southwest. Nightingale industrial estate noted on the map to the south.
2006	No significant change.	No significant changes
2015	Demolition programme started in April 2015.	-

* Information obtained by anecdotal information gathered from the site.

3.6 Anecdotal Site Development Information

During a recent site walkover involving Michelle McIntosh (KDC) and John Yuill (Novartis representative) the following key pieces of anecdotal information were gathered. The locations discussed below are also shown on Figure 2.

- A multi-storey building was noted on aerial photographs believed to be from circa 1998 to the south west of Building 36. This has since been demolished.
- Prior to Building 42 being constructed, the previous building was used as a canteen.
- The former Building 12 may have undertaken primary and secondary pharmaceutical production.
- An underground rainwater runoff tank was previously located under the carpark to the south west of Building 30. This has since been infilled.
- An old petrol filling station was previously located in the vicinity of Building 17.
- Waste packaging was undertaken in Building 30.
- The area to the south of Building 8, where the site road currently lies, was previously occupied by buildings of an unknown activity. Aerial photos indicate works which may have the potential to cause contamination as these building appeared to be stores or engineering type buildings.
- An old railway siding was present in the vicinity of Building 7. Is is understood that Building 3 previously held a coal fired boiler in its basement. Coal would be delivered to the siding and transported to Building 3 by conveyor.

- Former oil tanks were also noted within the vicinity of Building 7 and 17.
- The solvent store at Building 17 stored solvent in 25-50litre containers.
- A groundwater abstraction borehole was located between Building 7 and 8. This has now been decommissioned.

3.7 Agency and Hydrological

The Envirocheck® report provided information available from different sources. The following section summarises the information collected.

Agency and Hydrological records considered in this section are also shown on the Site Sensitivity Map, reported in Appendix B.

3.7.1 Risk of Flooding from Surface Water

Areas of the site are classed as low (1,000 year return) to medium (100 year return) for flooding as shown on the Risk on Flooding from Surface Water Map is included as Appendix A.

3.7.2 Discharge Consents

There are no discharge consents within the site boundary; however, 10 discharge consents have been recorded within a 500m radius from the site and 15 active consents are located between 500m to 1km.

Details on the consents can be found within Appendix A.

3.7.3 Integrated Pollution Controls

There are no Integrated Pollution Controls within the site boundaries. A single application has been recorded between 500m to 1km. Details can be found within Appendix A.

3.7.4 Local Authority Pollution Prevention and Controls (LAPPC)

There is a single Local Authority Integrated Pollution Controls application within the site boundaries for Ciba - Geigg Pharmaceuticals and was related to PG6/10 Coating manufacturing.

A total of four applications were recorded within 500m radius from the site and five located between 500m to 1km.

Details can be found within Appendix A.

3.7.5 Nearest Surface Water Features

The nearest surface water feature has been recorded to the northeast, at a distance of 326m from the site boundaries.

3.7.6 Pollution Incidents to Controlled Waters

A single pollution incident to controlled waters has been recorded within the site boundaries. The incident occurred 22nd February 1993 and was related to solvents polluting the storm water drains. However, the incident was classed as a 'Minor Incident' (Category 3).

Three pollution incidents to controlled waters, unrelated to the site operations, were recorded within 500m of the site. Details of the recorded incidents are summarised in Appendix A.

3.7.7 Registered Radioactive Substances

A total of 10 authorisations for registered radioactive substances have been recorded within the site boundaries. Details have been summarised in Table 4 below.

Table 4: Registered Radioactive Substances Applications

REGISTERED RADIOACTIVE SUBSTANCES APPLICATIONS		
Permit Reference	**Process Type**	**Description**
CB0323	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7)	Substantial variation to authorisation under RSA
CB0315	Registration under S7 RSA for the keeping and use of Radioactive materials (was RSA60 S1)	Substantial variation to a registration under the Act of an open source which is also the subject of an authorisation
BV7087	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7)	Minor variation to authorisation under RSA
BB9865	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7	Substantial variation to authorisation under RSA
AY4039	Registration under S7 RSA for the keeping and use of Radioactive materials (was RSA60 S1)	Minor variation to a registration under the Act of an open source which is also the subject of an authorisation

REGISTERED RADIOACTIVE SUBSTANCES APPLICATIONS		
Permit Reference	**Process Type**	**Description**
AY4047	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7)	Minor variation to authorisation under RSA
AT5747	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7)	Substantial variation to authorisation under RSA
AR5839	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7)	Minor variation to authorisation under RSA
AA0612	Authorisation under S13 RSA for the disposal of Radioactive waste (was RSA60 S7)	Authorisation under RSA
AC2306	Registration under S7 RSA for the keeping and use of Radioactive materials (was RSA60 S1)	Registration under the Act of an open source which is also the subject of an authorisation

3.7.8 River Quality

The Bolding Brook, located at a distance of 917m form site is classified as River Quality D.

3.7.9 Substantiated Pollution Incidents

A single substantiated pollution incident has been recorded between a radius of 500m to 1km of the site. The pollutant is reported as landfill odour and classed as Category 4 (no impact).

3.7.10 Water Abstractions

Two water abstractions have been recorded within the site boundaries. The abstractions are reported as probably being from a single point and related to chemicals (General Use – Medium Loss).

3.7.11 Groundwater Vulnerability

Soils underneath the site are of High Leaching Potential (U) where soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere. A worst case vulnerability classification (H) assumed within the Envirocheck Report, until proved otherwise

3.7.12 Bedrock Aquifer Designation

The bedrock aquifer underneath the site is designated as Secondary Aquifer (A) and Unproductive Strata.

3.7.13 Detailed River Network Lines

There are no Detailed River Networks Lines recorded within the site boundaries, however there are some located between 251m and 500m distance from the site, as reported in Table 5 below.

Table 5: River Network Lines

RIVER NETWORKS LINES			
Type	**Name**	**Distance from site (m)**	**Direction**
Lake/Reservoir	Kingslea Pond	481	Southeast
Lake/Reservoir	Not Supplied	492	Southeast
Tertiary River	Not Supplied	492	Southeast
Lake/Reservoir	Not Supplied	496	Southeast
Lake/Reservoir	Not Supplied	496	Southeast
Tertiary River	Not Supplied	499	Southeast

3.7.14 Detailed River Network Offline Drainage

No Detailed River Network Offline Drainage designations have been recorded within the site boundaries, however six of them have been recorded between 326m and 407m distance from the site.

It should be noted that previous studies indicated that site surface water drainage discharge was into the Horsham Park Pond, located 800m south-west of the site and that this pond subsequently discharged into the Boldings Brook, a tributary of the River Arun.

3.8 Waste Facilities

Based on the information provided by the Envirocheck® report, there are various waste facilities located on and in the in the vicinity (up to 1km around the perimeter). These are discussed within the sections below.

3.8.1 Licenced waste management facilities

There are no licenced waste management facilities recorded within the site boundaries. However, a metal Recycling Site has been recorded at a distance of 437m from the site.

3.8.2 Local Authority Landfill Coverage

The Envirocheck Data Sheet notes two local authority landfill coverages at the site which relate to landfill data being supplied from Horsham District Council and West Sussex County Council. However, no further information has been supplied.

3.8.3 Potentially Infilled Land (Non Water)

An area with potentially infilled land has been recorded within the site boundaries and reported as 'Unknown Filled Ground (pit, quarry, etc)' in the location of the infilled 'Clay Put' in the south of the site.

A total of three potentially infilled lands have been recorded within 250m radius from the site and eight located between 500m to 1km. Details are included within Appendix A.

3.8.4 Potentially Infilled Land (Water)

No potentially infilled land containing water has been recorded within the site boundaries, however a total of eight areas of potentially infilled land (water) have been recorded within 500m radius from the site and 14 located between 500m to 1km. Details are included within Appendix A.

3.8.5 Registered Waste Transfer Sites

A single waste transfer site has been recorded at the east of the site boundaries, at a distance of 677m.

3.8.6 Registered Waste Treatment and Disposal Sites

A single waste treatment site has been recorded within the site boundaries and it is related to an incineration activity with no known restriction on the source of waste. It is noted that this licence has since lapsed/been cancelled/been surrendered.

A scrapyard has been recorded at a distance of 437m to the east of the site boundary.

3.9 Hazardous Substances

Based on the information provided by the Envirocheck® report there are records of hazardous substances within the vicinity of the site as follows:

- A single Control of Major Accident Hazards Sites (COMAH), situated to the south, at a distance of 482m.
- A single Notification of Installations Handling Hazardous Substances (NIHHS), located south, at a distance of 487m.
- Two Planning Hazardous Substance Consents within a 250m radius and a single one between 500m and 1000m.

The information related to hazardous substances is also summarised on the Site Sensitivity Map, reported in Appendix A.

3.10 Industrial Land Use

The Envirocheck® report provided information of various industrial consents on and in the vicinity (up to 1km around the perimeter) of the site.

The following section summarises the information collected from each of the available sources. The location of the contemporary trade entries and petrol filling stations is reported on the Sensitivity Map, included as Appendix A.

3.10.1 Contemporary Trade Entries

There are three contemporary trade directory entries within the site boundary, classified as Pharmaceutical Manufacturers & Distributors, only one of which is reported as active.

A total of 100 entries have been recorded within a 500m radius and a further 118 between 500m and 1km from the site.

3.10.2 Petrol Filling Stations

Two petrol filling stations have been recorded located between 500m and 1000m from the site. However, only one is recorded as ‘open’.

3.10.3 Point of Interests

Four manufacturing and operations points of interest have been recorded within the site boundaries and have been classified as 'Works'. However, 25 manufacturing and operations entries have been recorded within 500m radius and a further 10 are situated between a 500m and 1km distance.

Additional points of interest located in the vicinity of the site are as follows:

- Commercial Services (25 within a radius of 500mm and 19 between 500m and 1km distance.
- Education Health (four between 251m to 500mm and a further two between a 500m and 1km distance).
- Public Infrastructures (five between 251m and 500mm and eight between a 500m and 1km distance).
- Recreational and Environmental (two between 251m to 500mm and further twelve between a 500m and 1km distance).

3.11 Sensitive Land Use

The Envirocheck® report indicates that the site is within a nitrate vulnerable zone and that a number of 'designated areas' lie in the proximity of the site:

- Three Ancient Woodlands located between 865m and 983m from the site boundaries.
- A Local Nature Reserve (Warnham), situated at a distance of 699m from the site.

3.12 Boreholes

A borehole characterised by a depth over 30m has been recorded on site, in the proximity of the south-eastern boundary as indicated by the Agency and Hydrological Map (Boreholes) included within Appendix A. Additional boreholes have been recorded to the north, east and south of the site boundaries (within 1km distance).

3.13 Site Geology

This section summarises the geological information provided by Envirocheck® report and the British Geological Survey (BGS) Maps (reported as Appendix A) along with additional site specific information obtained by previous site investigations.

3.13.1 BGS Maps

Based on BGS maps, the site is not characterised by the presence of artificial ground and is not underlined by superficial deposits.

The solid geology belongs to the Upper Tunbridge Wells Sand Formation and is characterised by the presence of mudstones over the vast majority of the site with sandstone in its north western portion.

3.13.2 Site Specific Geology

Based on the information obtained from previous studies, the site geology comprises:

- Made Ground: Mainly clayey soil containing anthropogenic material including brick and concrete, and rare rusted metal wire, plastic sheeting, charcoal, clinker and glass.
- Natural Ground: Upper Tunbridge Wells Sand comprised light brown and blue-grey slightly clayey silt and light brown and blue grey slightly gravelly silt to grey / light blue grey to orange brown silt.
- Bedrock: Grey Stiff Siltstone.

3.13.3 Estimated Soil Geochemistry

The soil geochemistry recorded within the Envirocheck Report within the site boundary is summarised in the table below. Details of the soil geochemistry in the vicinity of the site can be found within Appendix A.

Table 6: Site Geochemistry

SITE GEOCHEMISTRY		
Sample	**Compound**	**Concentration Range (mg/kg)**
Sediment	Arsenic	<18-25
	Cadmium	<1.8

SITE GEOCHEMISTRY		
Sample	**Compound**	**Concentration Range (mg/kg)**
	Chromium	60-90
	Lead	<100
	Nickel	15-30

3.13.4 Mineral Sites

There is a record of a mineral site within the site boundaries and related to the Horsham Clay Pit (the infilled clay pit in the south of the site), classed as an opencast activity type. The status of the activity is reported as ceased.

There are two mineral sites recorded in a 250m radius and a further eight between 500m and 1km.

3.13.5 Ground Stability Hazard

A number of ground stability hazards have been recorded within the site boundaries, however no exact location was provided. The hazards were all classified as 'low' and are as follows:

- Potential for Collapsible Ground.
- Potential for Landslide.
- Potential For Shrinking and Swelling Clay.

3.13.6 Radon Potential

Based on the Envirocheck®, the site is in a 'lower probability radon area', as less than 1% of homes are above the action level. The Envirocheck Report states that no radon protective measures are necessary in the construction of new dwellings or extensions.

3.14 Foul System

Previous studies (Enviros, March 2008) documented that process water from pharmaceutical manufacture in Building 15 was discharged to foul sewer under a water company consent.

Water containing radionuclides was historically discharged to foul drainage under consent from three buildings on the site, Building 18, Building 38 and Building 42. Discharges from Building 18 and Building 38 ceased in 2000 and radioactive materials from Building 42 were discharged under Environment Agency consent. Previous studies (Enviros, March 2008) indicate that the main contributor to radioactive material disposed to drain since 1985 was tritium (3-H).

4. REVIEW OF PREVIOUS INFORMATION

4.1 Previous Investigation Reports

This section summarises what KDC considers to be the main relevant outcomes of the previous land quality reports provided by Novartis to KDC.

Based on the information receive, Table 7 below lists previously issued, relevant, reports. KDC have also recently undertaken targeted site investigations at the site and that related report is included within the table below.

A summary of the relevant documents are discussed within the following sections. Where contamination has been identified above the Assessment Criteria selected buy the report author, this has been annotated on the site plan available as Figure 3.

Table 7: Review of Previous Documentation

PREVIOUS DOCUMENTATION				
Author	**Title**	**Dated**	**ID**	**Comments**
Enviros Consulting	Phase 1 Site Investigations	May 2006	1	The report has not been received, however, a summary of this report is provided within the Enviros Phase 2 Site Investigation, March 2008.
Enviros Consulting	Phase 2 Site Investigations	March 2008	2	Several Figures and Appendices Missing
Enviros Consulting	Drainage Works Site investigation: Novartis Horsham.	October 2008	3	-
Jacobs	Novartis Horsham Flood Risk Assessment	November 2012	4	Appendices missing
Jacobs	Heritage Statement	December 2012	5	-
Aurora	Independent Radiological Survey & Sampling Of Novartis Buildings B18 & B38 And Associated Drainage Systems, Horsham	December 2013	6	-
SKM Enviros	Phase 2 Land Quality Assessment	July 2013	7	-
Jacobs	Land Quality Investigations (Rev. B)	October 2104	8	-
KDC	Ground Investigation Factual Report	January 2016	9	-

4.2 Phase 1 Land Quality Assessment (Enviros, 2006)

This report was not made available to KDC, however, a summary of the report was available in the Phase 2 Site Investigation Novartis Pharmaceutical (Enviros, March 2008). The details provided below were provided from that summary. It is understood that this report did not include any intrusive investigation.

Table 8: Phase 1 Land Quality Assessment Summary

Phase 1 Land Quality Assessment Summary	
Feature	**Description**
Potential Sources of Contamination *On Site*	• Contaminants associated with historical operations or disposal of wastes in former clay pit on site were identified as potentially being present on site. The contaminants included: toxic metals, hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), chlorinated and non-chlorinated solvents, sulphate, cyanides, phenols, alcohols, acids and alkalis, Benzene Toluene Ethylbenzene Xylene (BTEX), radioactivity, glycol, ammoniacal nitrogen and pharmaceuticals. • Soil gas (methane, carbon dioxide) was identified as a potential issue associated with filling of former clay pit in the south of the site. • Contaminants associated with current operations included: toxic metals, hydrocarbons, PAHs, chlorinated and non-chlorinated solvents, sulphate, cyanides, phenols, alcohols, acids and alkalis, pharmaceuticals.
Potential Sources of Contamination *Off Site*	• An Iron Works, Petroleum Storage Facility, Engineering Works and Industrial Estate were located adjacent to the east end of the site. Contaminants associated with these uses were: toxic metals, hydrocarbons and solvents.
Potential Receptors	• Site users, via direct contact, inhalation or accidental ingestion. • Building structures via migration and ingress of soil gas. • Surface water to Horsham Park Pond via discharge from site drains and lateral movement of perched groundwater. • Groundwater, classed as Minor Aquifer.
Potential Risks	The summary concluded that there was: • A moderate risk to current occupiers and buildings from the production of soil gas from the potential filling of a former clay pit. • A moderate to low risk from the potential presence of radioactivity in soils. The most likely pathway for exposure to be from leaking drains. • A moderate/low risk to groundwater from potential historic contamination. Coverage of the site by hardstanding and the presence of a shallow clay layer in natural stratum was assessed as being likely to reduce surface water ingress. It was considered that any contamination on site would migrate laterally and not vertically

Phase 1 Land Quality Assessment Summary	
Feature	**Description**
	towards the on-site abstraction. It was considered that the potential for horizontal migration would increase the potential for dispersion and dilution of contamination before it reaches the aquifer. • All other potential risks were assessed as low or very low.
Recommendations	• Further limited intrusive investigations were recommended due to the assessed level of risk to groundwater from potential historical contamination and from the potential for landfill gas generation from filling of the former clay pit. • Sampling of near surface soils and any shallow groundwater encountered during the investigation was recommended. • Investigation of the former clay pit to include sampling of shallow soils (and groundwater if encountered) and monitoring for soil gases (methane and carbon dioxide). • It was recommended that should contamination be identified, there would be a need to update the conceptual model and risk assessment and to agree the scope of any remediation works with the local authority. This could include additional stages of site investigation.

4.3 Phase 2 SI Novartis Pharmaceutical (Enviros, March 2008)

An environmental site investigation was undertaken by Enviros in order to collect environmental data to assess the risks identified in the Phase 1 Land Quality Assessment report issued by Enviros in May 2006. The main findings of the Phase 2 Site Investigation (Enviros, March 2008) are summarised in the table below.

Table 9: Phase 2 Site Investigation (Enviros, March 2008) - Summary

Phase 2 Site Investigation (Enviros, March 2008) - Summary	
Feature	**Description**
Intrusive Site Works Undertaken	• 7no. Window Sample boreholes (WS) were proposed but only 5no. were excavated. • 3no. Hand Pits (HP) were excavated. • 4no. rounds of gas monitoring from all of the boreholes installed. • 1no. round of groundwater sampling from all of the boreholes installed and from the Novartis abstraction well. • Soil and groundwater chemical analysis and radiological monitoring. • Qualitative Risk Assessment.
Targeted Areas (location plan of investigation areas not available)	• Former underground solvent store (WS1). • Former material storage on unpaved areas (WS2). • Former underground petrol tank and spirit store (WS3). • Current and historical solvent store (WS4). • Potential filling of former clay pit (WS5 – Hand Pit Only).

Phase 2 Site Investigation (Enviros, March 2008) - Summary	
Feature	**Description**
	• Monitoring migration from oil storage depot (WS 6 -Not Undertaken). • Monitoring migration from oil storage depot (WS7, HP A, HP B and HP C).
Constrains During Investigations	• Window Sample refusal was noted within all locations between 1.7 – 2.4 mbgl, except WS 2, which was drilled to a depth of 5m). • All hand pits were terminated between 0.3 and 0.7mbgl.
Ground Conditions	• Made ground was encountered within the investigation areas comprising topsoil or hardstanding over dark brown clay with clinker, ash, brick, ceramic and gravels, of some 0.5-1.7m in thickness. • Natural Ground (Upper Tunbridge Wells Sands) was encountered comprising of tan/olive grey, laminated sandstone and clay with shale fragments.
Groundwater	• Perched water was encountered between surface level and 1.58m.
Visual and/or Olfactory Evidence of Contamination	• Black inclusions were recorded in WS1 between 0.2 and 1.7 mbgl. • A hydrocarbon odour and sheen was recorded in: WS2, at 0.15 -0.3mbgl; HP A at 0-0.1mbgl and HP B at 0-0.3mbgl. • Ash was recorded in WS2, at 0.3-0.7mbgl. • Possible coal was noted in WS3, at 0.15 – 1mbgl. • Black gravel with asphalt odour was noted in WS6, at 0.4-0.5 mbgl. • Back stained brick gravel was noted within WS7, at 0.5-1mbgl. • An oily sheen was noted on the surface water ponded at the base of the bank at eastern corner of building 15. An oily sheen was noted on the water within HP-C and WS7.
Chemical Results (Soil) and Interpretation by Enviros	• Organic and inorganic chemical compound detected above the Limit of Detection (LOD) within the soil samples at different locations. • One soil sample (WS2, 0.2mbgl) exceeded commercial/industrial Enviros Soil Values (ESVs) for human health for lead. • One soil sample (WS2, 0.2mbgl) exceeded commercial/industrial ESVs for flora and fauna for zinc and copper.
Asbestos (Soil)	• The asbestos screen did not detect any fibres in the samples tested.
Chemical Results (Water) and Interpretation by Enviros	• Water samples exceeded UK Drinking Water Supply concentrations for iron and manganese in all samples tested. This was assessed by Enviros as being likely due to naturally occurring concentrations of these metals. • Ammonium was found to exceed UK Water Supply Standards in WS7.
Gas monitoring	• Slightly elevated levels of carbon dioxide were recorded, although flows were generally low across the site.
Radiological Results	• Soil was monitored on site for radiation (using an EP 15 probe for beta and gamma radiation) and radiation was not recorded above background levels.
Recommendations	• Recommendations were made in relation to ground gas risk in confined spaces. • Further assessment was recommended for radioactivity around drains. • Further assessment was recommended for potential migration of contamination from off-site sources (e.g. adjacent railway

Phase 2 Site Investigation (Enviros, March 2008) - Summary	
Feature	**Description**
	and oil depot).

4.4 Drainage Works Site Investigation (Enviros, October 2008)

The objectives of this site investigation were specifically to analyse soils in the route of the proposed replacement foul sewerage pipework for radionuclides. The table below summarises the main outcomes of the Drainage Works Site Investigation report (Enviros, October 2008).

Table 9: Drainage Works Site Investigation (Enviros, October 2008)– Summary

Drainage Works Site Investigation (Enviros, October 2008)– Summary	
Feature	**Description**
Intrusive Site Works Undertaken	• Excavation of 6no. Window Sample boreholes (WS). • Installation of 3no. groundwater monitoring wells. • 1no round of groundwater monitoring. • 6 no. soil samples were collected and analysed for chemical testing and for selected radionuclides known to have been discharged from buildings 18, 38 and 42.
Targeted Areas	• Soils adjacent to identified cracked or disjointed drainage pipes. • Investigations were undertaken to between 2.1 and 3mbgl.
Constrains During Investigations	No significant constrains were discussed.
Visual and/or Olfactory Evidence of Contamination	No significant evidence of contamination was discussed.
Ground Conditions	• Made Ground was encountered to 2.5mbgl and typically comprised of a brown clay with brick fragments, ash and gravels. • Natural Ground was encountered beneath topsoil or the made ground and was typically an orange to grey clay, with sandstones. The base of the superficial deposit was proven only within WS3.
Groundwater	No groundwater was encountered during the investigation.
Chemical Results (Soil)	• Volatile Organic Compounds (VOCs) were not detected in any of the analysed samples. • Several metals were detected above the LOD at all the investigated locations. • TPH and SVOCs were scheduled for the sample WS01 (2.1mgl) only and TPH and PAHs were detected above the LOD. • None of the samples exceeded commercial /industrial ESVs for heavy metals, PAHs and TPH.
Asbestos	• Not Scheduled
Chemical Results (Water)	• No groundwater samples were analysed. WS4 and 5 were dry and WS6 was found to have been built over during the groundwater monitoring visit.
Gas monitoring	Not Undertaken
Radiological Results	Radionuclides were not recorded above background concentrations

Drainage Works Site Investigation (Enviros, October 2008)– Summary	
Feature	**Description**
	in any of the samples analysed.
Recommendations	The site investigation indicated that there was no significant additional risk to workers in laying the new pipework in soils 3m from the existing pipework.

4.5 Novartis Horsham Flood Risk Assessment (Jacobs, 2012)

A Flood Risk Assessment was undertaken by Jacobs in 2012 and the main conclusions of the assessment are summarised in the table below.

Table 10: Novartis Horsham Flood Risk Assessment (Jacobs, November 2012) - Summary

Novartis Horsham Flood Risk Assessment (Jacobs, November 2012) -Summary	
Feature	**Description**
Historic Flooding	• There is no record of any flooding event at this location.
Flooding from Rivers	• There is no river in the immediate vicinity of the proposed development, and thus the risk of flooding from rivers was classed as low.
Flooding from the Sea	• N/A
Flooding from Ground Water	• Previous permeability tests indicated that shallow soil permeability is variable and that soils of finely laminated clay and sandstone do not have high permeability. However, no perched water was encountered during the excavation. Based on results of this investigation, the risk of flooding of the proposed development from ground water would be classed as low.
Flooding from Infrastructure Failure	• There is no history of flooding from the surface water sewers, and thus the likelihood of flooding from infrastructure failure is low.
Flooding from Surface Water Drainage	• Surface water drainage systems can lead to flooding when their capacity is exceeded. • The surface water drainage in this area comprises a piped system to public surface water sewers. The ground conditions are not conducive to drainage to soakaways.
Flood Risk to the Surroundings	• The flood risk to the surroundings from the proposed site development is low. The area falls within Flood Zone 1 (low risk).

4.6 Independent radiological survey and sampling (Aurora, 2013)

The main findings of the Independent Radiological Survey & Sampling undertaken by Aurora in 2013 are summarised in the table below.

Table 11: Independent radiological survey and sampling (Aurora, December 2013)

Independent radiological survey and sampling (Aurora, December 2013) – Summary	
Feature	**Description**
Works Undertaken	• Radiological survey of buildings and associated drainage.
Targeted Areas	• Buildings B18 & B38 and associated drainage and ventilation systems.

Independent radiological survey and sampling (Aurora, December 2013) – Summary	
Feature	**Description**
Radiological Results	• The independent radiological surveys and sampling of Buildings B18 & B38 and associated drainage and ventilation systems did not detect any radioactive contamination.
Recommendations	• Future reassurance radiological monitoring should be considered for B18's drainage systems. • The area surrounding the repaired drainage systems should be investigated to ascertain if it is radiologically uncontaminated.

4.7 Gap Analysis and Phase 2 LQA (SKM, 2013)

A gap analysis of existing information followed by a targeted Phase 2 / Intrusive investigation of potentially significant sources of chemical and radiological contamination that was undertaken by SKM in May and June 2013.

It is understood that this study was undertaken to determine the environmental quality of the land at the site and to assess the potential for health and environmental risks associated with the continuing operation of the main pharmaceutical (commercial/industrial) site, the redevelopment of selected areas of the main site for continued commercial/ industrial end use, and the redevelopment of the car park area for future residential use. The main outcomes of the assessment are summarised in the table below. It is noted that statistical analysis has been undertaken on the chemical analysis results from this investigation.

Table 12: Analysis and Phase 2 LQA (SKM July 2013)

Analysis and Phase 2 LQA (SKM July 2013)	
Feature	**Description**
Intrusive Site Works Undertaken	• Excavation of 54no. exploratory locations comprising 23no hand pits with 31no. follow on window samples cores. • 99no. soil samples were collected and tested for chemical analysis and radiological screening. • 5no. gas and groundwater monitoring wells were installed. • 2no. Rounds of ground gas monitoring in five newly installed boreholes and one existing borehole were undertaken. • 2no. Rounds of groundwater water sampling for chemical analysis from five newly installed boreholes and one existing borehole was undertaken.
Targeted Areas	• Potential made ground deposits, including in the vicinity of previous demolished buildings. • Former and current fuel storage facilities. • Electrical sub-stations. • The infilled former clay pit. • Foul drainage inftrastructure. • The former incinerator. • Potential off-site sources (fuel storage and railways).
Constrains Encountered During Investigations.	• Concrete obstructions were recorded across the base of the inspection pit at 0.7m bgl (WS45), at 0.55 mbgl (WS19A), 0.4mbgl (WS24), 0.55mbgl (WS25) and between 0.6-0.9mbgl

Analysis and Phase 2 LQA (SKM July 2013)	
Feature	**Description**
	(WS29 and WS39 and WS39A). • Window Sample coring was refused at 1.1mgbl (WS6A), 1.5mbgl (WS17 due to siltstone)1.60mbgl (WS19B), 2mbgl (WS30), 2.2mbgl (WS12 due to siltstone), 2.3mbgl (WS38), 2.5mbgl (WS7 due to siltstone), at 2.7mbgl (WS5 due to siltstone), at 2.95mbgl (WS21), at 3mbgl (WS8 and WS10 due to siltstone), at 3.10m (WS9 due to siltstone and WS16), at 3.30 (WS4 due to siltstone and WS15), at 3.6mbgl (WS26), at 3.9mbgl (WS44 due to siltstone). • Coring refused to obstruction to base at WS20, WS22, WS25 and WS32 (between 0.55 and 1mbgl).
Ground Conditions	• The ground surface largely comprised of buildings and hardstanding with limited soft-standing. • Topsoil was recorded at 0.1 – 0.35m in the east and west of site and around Building 18. • Made Ground was encountered at the majority of locations to a maximum depth of 2.5m (WS3). Typically the made ground was identified by the presence of anthropogenic material (such as brick, concrete, clinker and tarmac). • Natural deposits were recorded from 0.1m to at least 4m. The natural deposits was classed as the Upper Tunbridge Wells Sands Formation comprising clayey gravelly silt.
Groundwater	No groundwater strikes were recorded within the report. Seepages of water were recorded at four locations (between 0.8-2.3mbgl), likely to be small amounts of perched water.
Visual Olfactory Evidence of Contamination	Rare tarmac, rare clinker, dark grey-black gravel (including rare clinker and a black, hard, brittle, vitreous material) were noted at several locations. Oil / rubber-like odour was noted within WS5, at 0.3-0.45mbgl). Fuel odour was recorded within WS12 (at 1.6-2mbgl). Rare charcoal / coal was noticed at WS18 (at 0.25 – 0.80mbgl). Black slightly clayey silt with 'ashy' odour at WS26 (at 1.45 -1.60mbgl). Slight oily odour was recorded at WS28 (at 0.35 – 0.45mbgl). Charcoal was recorded at WS39A (at 0.70 – 0.90mbgl).
Chemical Results (Soil) and Assessment of Results by SKM Enviros.	• Metals concentrations were below the GAC for residential with plant uptake use and commercial / industrial use. • Copper and zinc exceeded the phytotoxic threshold in two and one samples, respectively, in the made ground and in one sample in the natural ground. • Some of the PAHs were recorded at concentrations above the Soil Generic Assessment Criteria (GAC) for residential use in a small number of made ground samples (1 -2 samples). With regards to Benzo(a)pyrene, 9 samples exceeded the residential with plant uptake threshold and in a single sample (WS3) also equalled the commercial / industrial GAC. • Benzo(a)pyrene was also recorded at concentrations above the GAC in two samples (WS26 1.5m and WS44 1.2m) of natural soil. • BTEX and phenol were recorded at concentrations below the GAC for residential commercial / industrial use in all made ground samples. A single sample exceeded the phytotoxic threshold for copper. • None of the thirty four samples analysed in the made ground for speciated hydrocarbons exceeded the GAC for a residential with plant uptake use and therefore also the less conservative GAC for commercial / industrial use, however four of the ten samples analysed for the total TPH exceeded the detection limit of 10 mg/kg, with the highest concentrations

Analysis and Phase 2 LQA (SKM July 2013)	
Feature	**Description**
	ranging between 12mg/kg, 220mg/kg and 5,100 mg/kg (in made ground) and 51mg/kg and 210mg/kg (in natural soils). • Polychlorinated Biphenyls (PCBs), SVOCs and VOCs did not exceed the GAC for a residential with plant uptake use in the made ground.
Leachate	• Some exceedances of Water Framework Directive – Environmental Quality Standard (WFD-WQS) range for copper, lead mercury and zinc was exceeded in a number of samples • Lead exceeded the DWS in one sample.
Asbestos	• Asbestos was detected within 3 samples: WS6abd WS24 recorded Amosite at 0.2mbgl and WS43 recorded Chrysotile at 0.4mbgl. • Suspected asbestos containing material (asbestos cement) was also observed in made ground at two locations; WS1 at 0.10-0.55mbgl and WS23 at 0.15 – 0.70mbgl.
Chemical Results (Water)	• PAHs and hydrocarbons were not detected in any of the samples collected. • Some exceedances of WFD-EQS and DWS were recorded for metals.
Gas monitoring	The ground gas data was assessed by SKM enviros in accordance with current CIRIA C665 guidance: • Methane was defined as Amber 1 and CS2 in WS44, due to the elevated methane concentration recorded in one of the monitoring rounds. • Carbon dioxide was defined as Green and CS1 in all boreholes except WS8 (Amber 1 and CS2).
Radiological Results	No readings were recorded significantly in excess of background which varied between 0.5 and 1.0 counts per second (cps). Lab results of four samples confirmed below detection levels of 3H and 14C.
Statistical Analysis	• The statistical analysis of soil data indicates that the Chebyshev 95% Upper Confidence Limits (95% UCL) for Benzo(a)pyrene marginally exceeds the residential with plant uptake use for both made ground and natural ground.
Recommendations	• For the assessment of the chemical results for the continued on-going pharmaceutical site use, all risks were defined as low for with the single exception of ground gas where a low to moderate / low risk was defined. Recommendations were made with respect to ground gas. • Areas proposed for redevelopment were assessed as moderate / low risks with respect to all the identified contamination sources: made ground, fuel storage, the infilled pit and drainage. However, with appropriate health and safety protection measures, the moderate / low risk can be reduced to low for all the sources. • Proposed residential development for the north and north-west areas, which are out of the investigation areas of KDC, were assessed as moderate / low risks with respect to all the identified contamination sources: made ground, fuel storage / electricity sub-stations and drainage. • Elevated PAHs were detected marginally above the residential end use GAC used by SKM and further investigation and assessment with respect to the specific development was recommended.

4.8 Further Land Quality Investigation 1B (Jacobs, 2014)

This report was aimed to undertake further Land Quality Assessment (LQA) at the Novartis site in support of site decommissioning. It is noted that statistical analysis has been undertaken on the chemical analysis results from this investigation.

Table 12: Further Land Quality Investigation (Jacobs, October 2014)

Further Land Quality Investigation (Jacobs, October 2014)	
Feature	**Description**
Intrusive Site Works Undertaken	• 24no intrusive investigations were undertaken including: 7no Window Samples Cores, 1no Rotary follow on (WS51) and 16no. 1.2m deep Hand Pits. • 27no. soil samples were collected for chemical analysis and radiological site monitoring. Selected samples were tested for radiological laboratory tests. • 1no. water sample from the existing monitoring well (BH18) and 2no. samples from BH44, which was installed by Jacobs in 2013 were collected, for chemical and radiological laboratory tests. • A Human Health Risk assessment was undertaken for Residential and Commercial/Industrial end use.
Targeted Areas	The following key areas were targeted: • The former incinerator. • The former clay pit (hand digging only). • The drainage system. • Radiological background levels (away from drainage, incinerator and former clay pit). • Made ground deposits (locations not previously investigated). • Potential radiological contamination in groundwater.
Constrains Encountered During Investigations	• Concrete with rebar across the base of pits was noted at WS60 (at 0.30mbgl) and WS60A (at 0.5mbgl). • A concrete obstruction was recorded across the base of the pit at WS70 (1mbgl). • A metal obstruction was encountered at WS61 at 0.75mbgl.
Ground Conditions	• Made Ground was recorded between surface level and 1.10mbgl. Anthropogenic material in the made ground included brick and concrete, with rare rusted metal wire, plastic sheeting, charcoal, clinker and glass. • Natural ground was encountered between 0.15 and 3.0mbgl and was classed as Upper Tunbridge Wells Sand comprising light brown and blue/grey slightly clayey silt and light brown and blue/grey slightly gravelly silt to grey / light blue grey, orange brown silt. • Bedrock was encountered between 1.0 and 4.0mbgl, and noted to comprise grey stiff siltstone.
Groundwater	No water strikes were recorded during this site investigation.
Visual and/or Olfactory Evidence of Contamination	Black / dark staining but no odour was recorded at 0.3-0.4mbgl in WS55 and at 0.3-0.35mbgl in WS56. Rare black staining at 0.4-0.6mbgl in WS62.
Chemical Results (Soil) and Assessment of Results by Jacobs	• Arsenic was recorded above the Jacobs residential with plant uptake GAC in a single sample (WS68 at 0.30-0.40mbgl). • Lead was recorded in an anomalously elevated concentration of 1,200mg/kg in WS68 at 0.3-0.4mbgl – Car park) which Jacobs considered an outlier. This sample was collected the area used as car park at the time of the investigation. An

Further Land Quality Investigation (Jacobs, October 2014)	
Feature	**Description**
	exceedance of lead above the GAC for residential with plant uptake use was also recorded at Ws47 at 0.6-0.7m bgl. • An exceedance of the Jacobs residential with plant uptake GAC was recorded in WS 47 at 0.6-0.7mbgl, were a concentration of 290mg/kg was detected. • Benzo(a)anthracene was recorded above the Jacobs residential with plant uptake GAC at WS70 at 0.70-0.80mbgl and at WS58, at 0.3.-0.4mbgl. • Benzo(a)pyrene was recorded above the residential with plant uptake GAC in 10no. out of the 27no. samples analysed. The maximum value recorded was 6.8mg/kg at WS70, at 0.70-0.80mbgl • Chrysene exceeded the Jacobs GAC at WS70 at 0.70-0.80m and was recorded at a concentration of 6.9mg/kg.
Leachate	• No leachate analysis was undertaken.
Asbestos	• One piece of suspected cement asbestos containing material (ACM) was noted at 0.25-0.7m in WS61. This was identified as amosite. • Asbestos fibres were reported in two out twenty seven samples analysed, with amosite loose fibres reported in WS54 0.3-0.4m and WS61 0.6-0.7m.
Results (Water)	No comments provided in the report in regards to water results.
Gas monitoring	No Gas monitoring was undertaken.
Radiological Results	The 2014 further investigation found no evidence of radiological contamination associated with drain leakage at the site.
Statistical Analysis	The statistical assessment undertaken by Jacobs indicated that: • The Chebyshev 95% Upper Confidence Limits (95% UCL) for arsenic was below the GAC for residential with plant uptake. • The 95% UCL for lead is below the GAC (If the anomaly concentration is removed from the data set). • The 95% UCL for Benzo(a)pyrene is marginally above the GAC for residential with plant uptake but below the new Category 4 Screening Level (C4SL).
Recommendations	• The risk posed by made ground, and associated contamination, to users of a future residential site is increased from moderate / low to moderate due to asbestos (with localised high risk due to lead). • The risk posed by made ground, and associated contamination to construction workers (including demolition and ground workers for proposed demolition and site re-profiling works) is increased from moderate / low to moderate risk. • Verification soil sampling will be required in the case of removal of fuel storage, electricity sub-stations and drainage facilities and any localised contamination identified may require remediation. • Remediation of asbestos and lead, and potentially benzo(a)pyrene, may also be required for residential redevelopment. • Based on the findings of the previous 2013 investigation (Ref. 2), supplementary gas monitoring to confirm the gas regime will be required in any new development.

4.9 KDC Watching Brief (KDC, November 2015)

A watching brief was undertaken by KDC on two occasions during the removal and crushing of the slabs in the area of Building 11. This was the former boiler house location.

Table 13: KDC Watching Brief -Summary

KDC Watching Brief -Summary	
Feature	**Description**
Areas Targeted	• Soils beneath the slab over the footprint of Building 11.
Site Works Undertaken	• 7 no. Soil samples were collected of visually contaminated soils. • 1 no. sample of possible insulation material was collected. • 1 no. water sample was collected from 'Tunnel 1'. • 1 no. Oil sample was collected from the sump.
Ground Conditions and Contamination Observations	• The sub-base underneath the removed slabs was noted to comprise of a layer of brick (approx 0.2m thick), followed by a layer of sandy gravel (approx. 0.3m thick) underlain by clay (assessed as a potentially natural material). • A series of trenches, understood to have previously accommodated pipes carrying oil form the oil tanks to the former boiler, were visible within the boiler house area. The gravel underneath was visually assessed to be contaminated by a black, dense hydrocarbon product displaying a strong hydrocarbon odour at this location. A fibrous material, assessed as a possible pipe insulation textile, was also noted within the gravel layer. • Several water flooded cavities (possible former service rooms) were noted underneath the former slab. The service tunnel (Tunnel 1) located to the east of the Building 11 footprint was also flooded, and displayed a hydrocarbon surface sheen. • A sump containing a black, dense hydrocarbon product with a strong hydrocarbon odour was discovered during operations, immediately to the east of Building 11 footprint. • In the area of the former 'Tank Storage Building' the sub-base was noted to comprise of a layer of geotextile underlain by clay (assessed as a potentially natural material). No evidence of visual or olfactory contamination was noted to the soil underneath these slabs during the watching brief.
Recommendations	• The findings of the watching brief, and subsequent chemical analysis of samples collected during the brief, confirm the presence of hydrocarbon contamination within the footprint of Building 11. This is predominantly located within the gravel layer beneath the slab and above the underlying clay. • Given the elevated chemical results recorded, consideration to further risk assessment and/or remedial action should be undertaken.

4.10 Ground Investigation (KDC, January 2016)

KDC were commissioned to undertaken further ground investigation of six areas of concern highlighted by Novartis. Three of these area have been investigated to date.

The following three will be undertaken on completion of the current demolition programme.

Table 14: KDC Ground Investigation (January 2016)

KDC Ground Investigation (January 2016)	
Feature	**Description**
Areas Targeted	The six areas of investigation are: • Amosite recorded within WS54 • Lead and Arsenic recorded within WS68 • PAHs recorded within WS70 • Amosite recorded within WS61 • The former incinerator area • The infilled Clay Pit area Those investigated so far are: • Amosite recorded within WS61 • The former incinerator area • The infilled Clay Pit area During the same site visit, KDC supervised the removal of soils from around the sump structure.
Site Works Undertaken	A total of 15 soil samples were tested for chemical analysis as a result of the site works; in particular, samples tested were as follows: • One soil sample of the grossly contaminated soil encountered along the sump walls during the sump exposure operations. • Four soil samples from the walls of the excavation which resulted following the sump structure exposure operations. • 10 soil samples from 10 trial pits excavated across the site, including 2 from the trial pits excavated in proximity of the sump and 8 from the three areas of concern. • Two water samples have been collected from the two installed monitoring wells;
Constraints	• Due to access restrictions, the delineation within the southern portion of the site, where the infilled clay pit is known to be located, was undertaken using a mini-excavator which is characterised by a limited excavation depth, of approximately 2.0m.
Ground Conditions and Contamination Observations	• During sump exposure and removal operations, visual and olfactory hot spots of contamination were noticed along three sides of the sump. • Limited evidence of visually grossly contaminated soil was encountered during the intrusive investigation in the wider area around sump. • Visual and olfactory evidence of contamination was noted within the former Clay Pit area where gravelly material containing a black sludge with a ‘strong’ diesel-like odour noted in the vicinity of a brick subbase, thought to be an old oil tank subbase).
Recommendations	• The investigation did not include an assessment of risk caused by the presence of contamination, nor for the identification of soil/water requiring removal, due to such a risk as this was not part of the work scope.

4.11 Potential Limitations from Previous Site Investigations

This section discusses and summarises what KDC consider to be the main limitations associated to the information gathered during the previous site investigations.

Table 15: Previous Studies: Potential Limitations

Previous Studies: Potential Limitations			
Ref.	**Name**	**Limitations Identified Within The Report**	**Additional KDC Comments**
1	Phase 1 Land Quality Assessment Summary	No intrusive investigation is through to have been undertaken.	-
2	Phase 2 Site Investigation (Enviros, March 2008)	• The location of the exploratory locations are unknown as the location plan has not been made available to KDC. • Investigation undertaken most likely outside building footprints. • Not all the potential sources (on site and off site) identified in the Phase 1 report were investigated. • The former clay pit investigated using hand pits only. • The risk aassessment was undertaken for the use of the site at that time (commercial/industrial). Chemical results will need to be reassessed for the proposed new site development. • Limited ground gas monitoring was undertaken.	• Deeper investigations have since been undertaken by SKM within the in the Clay Pit area. • Further investigation should be undertaken under the building footprint following demolition. • Risks to be reassessed considering the final site use of the site, once known. • Additional gas monitoring is likely to be required.
3	Phase 2 Site Investigation (Enviros, October 2008)	• Radiological /chemical investigation undertaken along the cracked or disjointed pipes only. • Investigation undertaken outside building footprints.	• Further radiological investigation has since been undertaken by SKM/ Aurora.
4	Novartis Horsham Flood Risk Assessment (Jacobs, November 2012)	• The site drainage layout has changed due to the demolition works.	• Flood Risk Assessment may need to be reviewed.
5	Aurora Radiological Survey, December 2013	• Further radiological assessment recommended around areas where drains have been repaired.	• Further investigation of these areas is recommended.

Previous Studies: Potential Limitations			
Ref.	**Name**	**Limitations Identified Within The Report**	**Additional KDC Comments**
6	Gap Analysis and Phase 2 LQA (SKM July 2013)	• Investigation locations undertaken outside building footprint. • Investigation depth limited by concrete obstructions. • Limited ground gas monitoring undertaken.	• Further investigation to be undertaken under the building footprint following the buildings demolition. • Additional ground gas monitoring required. • A different investigation technique (e.g. trial pitting with breaker) may be required in the areas were concrete obstructions were encountered.
7	Further Land Quality Investigation (Jacobs, October 2014)	• No ground gas monitoring undertaken. • Investigation undertaken outside building footprint	• Further investigation to be undertaken under the building footprint, following the buildings demolition. • Additional ground gas monitoring required. • A different investigation technique (e.g. trial pitting with breaker) may be required in the areas were a concrete obstructions were encountered.
8	KDC Watching Brief (KDC, November 2015)	• Investigation undertaken within Building 11 footprint (within former boiler house area only), where visual and olfactory evidence of contamination were noticed. • No risk assessment of the results has been undertaken.	• Further investigation to be undertaken within other areas of Building 11 footprint. • Results to be included in future risk assessments.
9	KDC Ground Investigations	• Only 50% of the investigation is complete. • The sump has not been removed; therefore sampling of this base is still required. • No risk assessment of the results has been undertaken.	• Further investigation to be undertaken under the building footprints, following all the building demolition. • Soil sample to be collected from the base of the sump following its removal. • Results to be included in future risk assessments.

5. PRELIMINARY CONCEPTUAL SITE MODEL

5.1 General

This section summarises the principal findings of the desk top study and highlights the potential sources, pathways and receptors at the proposed development of the site.

5.2 Preliminary Conceptual Site Model (CSM)

The Conceptual Site Model identifies potential **sources** of contamination and the **pathways** by which they could reach the **receptor**. Where all three of these elements are in place, a *pollutant linkage* is said to exist and there is a risk of harm to the receptor. If any element of the pollutant linkage is missing then it is concluded that there is no risk of harm to the receptor.

The following table summarises the potential pollutant linkages for the site based on the previous information presented in the previous chapters.

5.2.1 Potential Sources of Contamination

Based on a review on the information provided by previous studies, the main potential sources of contamination are summarised in the table below. It should be noted that the term 'former' refers to buildings which were demolished in the past and prior to the recent demolition programme.

Table 16: Potential Source of Contamination

POTENTIAL SOURCES OF CONTAMINATION		
Source	**Details**	**Comments**
On Site Sources		
Manufacturing Buildings		
Former Manufacturing Building (demolished in the 1980s)	Former Building 12 (located at the courtyard in the centre of the site.	Potential for contaminants associated with demolition material present in the ground (e.g. asbestos). Possible leakages to the ground may have occurred due to historical activities undertaken in the buildings. This may result in radioactive, organic and inorganic contamination.
	Annex to the current Building 18 (location of the annex unclear)	

POTENTIAL SOURCES OF CONTAMINATION		
Source	**Details**	**Comments**
On Site Sources		
Manufacturing Building	Building 15	Possible leakages of contaminants (radioactive, organic and inorganic compounds) to ground may have occurred due to historical activities undertaken within the buildings.
Solvent Storage Areas		
Former Underground Solvent Store	Considered to be located between Buildings 24 and 36 in the eastern end of the site.	Possible leakage of solvents to the ground.
Solvent Store	Located in Buildings 17, 30 and 32.	
Fuel Storage/Usage Areas		
Former USTs	Considered to be located north-west of Building 7 and 17.	Possible leakage of hydrocarbons to ground.
Former Boiler House	South western part of Building 11.	Visual and Olfactory evidence of oil presence within the gravel stratum underneath the former oil fired boiler house.
Above Ground Fuel Tanks (no.6)	Eastern portion of Building 11	Possible leakage of hydrocarbons to ground.
Sump Containing Oil	Located to south-east of building 11 and south-west of building 37	Visual and Olfactory evidence of hydrocarbons within the gravel stratum around the sump.
Possible Old Fuel Tank	Located north of the former clay pit, at the foot of the soil bank.	Visual and olfactory evidence of hydrocarbons contamination found during KDC investigations. Migration of oil / fuel from leaks and spills to site.
Oil Fired Boiler House (included three modern ASTs)	Building 8.	Possible leakage of hydrocarbons to ground.
Former Petrol Filling Station	East of Building 17.	Possible leakage of hydrocarbons to ground.

POTENTIAL SOURCES OF CONTAMINATION		
Source	**Details**	**Comments**
On Site Sources		
Diesel tanks at generators	ASTs for generators adjacent to Building 22 in the south of the site.	Possible leakage of hydrocarbons to ground.
	Diesel within standby generator considered to be located close to Building 38 and adjacent to Building 23.	
	Diesel tank considered to be located near Buildings 6.	
Former Railway Siding	Located in the vicinity of Building 7 and 8.	Possible hydrocarbon leakages and presence of coal within the soils.
Electricity Sub-Stations/ Electrical Panels Control Areas		
Electricity Sub-Stations	Northern portion of Building 11.	Possible leakage of hydrocarbons and PCBs to ground.
	Inside the eastern side of building 15.	
	Near Building 7, 17 and 38.	
Waste Management Areas		
Former incinerator	Building 27.	The Incinerator using to burn waste pharmaceutical product and packaging from the site. Leakage or deposition of a variety of organic and inorganic contaminants (including Polychlorinated dibenzodioxins and Polychlorinated dibenzofurans).
Infilled Former Clay Pit	Infilled pit located the south side of the site.	Asbestos fibres identified in a single sample during previous investigations. Disposal of a wide range of hazardous and hon hazardous waste.
Water and Wastewater		
Drainage system	Discharge to foul sewer of water from Pharmaceutical manufacture manufacturing building (Building 15).	Wide range of organic and inorganic compounds and radiological contamination.
	Discharge to foul sewer of water from research laboratories of Building 42	
	Discharge to foul sewer of water from historical laboratories from buildings 12, 18 and 38.	

POTENTIAL SOURCES OF CONTAMINATION		
Source	**Details**	**Comments**
On Site Sources		
Made Ground Related Sources		
Made ground	Made ground is known to be present across the site.	Wide range of organic and inorganic compounds have been recorded such as: PAHs, TPH, metals and asbestos.
Ground Gases	Localised elevated methane and carbon dioxide but low flow.	CO2 and Methane / VOCs.
Off Site Sources		
Oil storage depot and railway use	N/A	Possible migration of oil / fuel from leaks and spills to site. Also, contaminants associated with infilled ground such as ash and clag containing heavy metals and PAHs.

5.2.2 Potential Pathways

The potential environmental fate pathways are as follows:

- Migration, ingress and accumulation through soils and subsequent inhalation of ground gas& vapours.
- Migration through, or associated with, leakage from drainage pipework.
- Leaching of contamination from soils via rainwater infiltration.
- Vertical migration of infiltrating rainwater to groundwater.
- Migration via site drainage to Horsham Park Pond in connectivity with River Arun.
- Lateral migration via groundwater to Horsham Park Pond in connectivity with River Arun.

The potential environmental exposure pathways are as follows:

- Ingestion, inhalation and dermal contact.

- Plant uptake.

5.2.3 Receptors

With respect to the potential residential and commercial/industrial use of the site following redevelopment, the potential receptors are;

- Future users (residence and/or construction and maintenance workers)
- Plants and vegetables.
- Future Buildings/and associated subservices
- Groundwater (Secondary A Aquifer).
- Surface water (Horsham Park Pond).

5.3 Conceptual Site Model (CSM)

The Conceptual Site Model (CSM) is summarised in the table below.

Table 17: Conceptual Site Model

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Manufacturing Buildings – On Site					
Former Manufacturing Building (demolished in the 1980s) and recent Manufacturing Building	Former Building 12 (located at the courtyard in centre of the site. Annex to Building 18. Building 15.	Direct dermal contact, inhalation and ingestion (soil and groundwater) Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Asbestos fibres and ACMs were identified at shallow depth and as such the potential for exposure to site users is considered to be moderate to high in these areas. Possible leakage to the ground due to activities in the buildings (radioactive, organic and inorganic compounds). The risk is considered to be moderate to high in these areas. There is the potential for contaminants migration underneath the site obstructions. The risk is considered to be moderate in these areas. Soil is classed as a soil with high leaching potential (U). The risk to the underlying groundwater is considered to be high.	Further investigation and assessment is considered to be required in the former Building 12 areas, using a more suitable investigation technique that can allow breaking those obstructions (trial pitting with a breaker). Investigation to include soil and groundwater sampling and testing along with soil leachate analysis. Investigation also recommended for the Building 15 and 18 footprint following demolition. Gas monitoring to be undertaken. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Solvent Storage Areas - On Site					
Former Above and Underground Solvent Stores	Above ground stores located in Building 17, 30 and 32. Underground store located between Buildings 24 and 36 in the east of the site	Direct dermal contact, inhalation and ingestion (soil and groundwater) Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Possible leakage of solvent to the ground may have occurred due to activities in the buildings. The risk is considered from moderate to high. There is the potential for contaminants migration underneath the site obstructions. The risk is considered to be moderate in these areas. Soil is classed as a soil with high leaching potential (U). The risk to the underlying groundwater is considered to be high.	Further investigation and assessment is considered within each of these areas following demolition of the buildings. A more suitable investigation technique that can allow breaking those obstructions (trial pitting with a breaker). Investigations to include soil and groundwater sampling and testing along with soil leachate analysis. Gas monitoring to be undertaken. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas					
Former USTs	Northwest of Buildings 7 and 17	Direct dermal contact, inhalation and ingestion (soil and groundwater) Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Moderate risk of inhalation, direct contact and vapours from soil and groundwater for both future site users and workers and off site receptors. Soil is classed as a soil with high leaching potential (U). The risk to the underlying groundwater is considered to be high.	Further investigation and assessment is considered to be required in the area of Buildings 7 and 17 following the demolition. Investigations to include soils and groundwater sampling and testing along with soil leachate analysis. Gas monitoring to be undertaken and depending on chemical analysis results, may also require VOC monitoring. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Former Boiler House	Eastern portion of Building 11	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Evidence of visual and olfactory contamination identified during the watching brief. Risks to future construction workers and future site users considered to be high Risks to groundwater and off site receptors to be from moderate to high.	No further intrusive investigation required. Quantitative Risk Assessment to be undertaken using data collected by KDC during the watching brief, in order to assess if remediation is required in this area. Gas monitoring to be undertaken and depending on the outcome of the risk assessment, may also require VOC monitoring. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Former Above Ground Fuel Tanks (6No.)	Eastern portion of Building 11	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Limited evidence of visual and olfactory contamination identified during the watching brief. Risks to future construction workers and future site users considered to be moderate.	No further intrusive investigation required. Quantitative Risk Assessment to be undertaken using data collected by KDC during the watching brief, in order to assess if further investigation is required in this area.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Sump Containing Oil	Located to south-east of building 11 and south-west of building 37	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Visual and olfactory contamination identified but localised along the wall of the sump. Oil has been removed from the sump and surrounding visibly contaminated soil has been stockpiled. Risks to future construction workers and future site users considered to be moderate to high until further assessment is undertaken. Risks to groundwater and off site receptors to be high.	Base sample to be collected following the sump removal. Quantitative Risk Assessment is recommended to be undertaken using chemical analysis results collected to assess if the stockpiled soil is to be removed and if further soil removal is required. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Possible Old Fuel Tank	Located north of former clay pit, at the foot of the soil bank (in the area of former incinerator)	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Visual and olfactory evidence of contamination has been noted during the recent trial pitting exercise undertaken by KDC in January 2016. Risks to future construction workers and future site users considered to be moderate to high in this area. Risks to groundwater and off site receptors considered to be moderate to high.	No further intrusive investigation required. Quantitative Risk Assessment is recommended to be undertaken using chemical analysis results collected to assess if the stockpiled soil is to be removed and if further soil removal is required. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Oil Fired Boiler House	Building 8 including modern three ASTs.	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Moderate risks to future users and construction workers due to presence of potential oil/fuel contamination below the building footprint. Risks to groundwater and off site receptors considered to be low to moderate.	Further investigation and assessment is considered to be required in the area of Building 8 following the demolition. Investigations to include soils and groundwater sampling and testing along with soil leachate analysis. Gas monitoring to be undertaken and depending on the outcome of the risk assessment, may also require VOC monitoring. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Diesel tanks at generators	ASTs generators adjacent to Building 22. Diesel within standby generator close to Building 38 and adjacent to Building 23. Diesel tank near buildings 6.	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Moderate risks to future users and construction workers due to presence of potential oil/fuel contamination below the diesel tanks. Risks to groundwater and off site receptors considered to be low to moderate.	Further investigation and assessment is considered to be required in the area of these diesel tanks following the demolition. Investigations to include soils and groundwater sampling and testing along with soil leachate analysis. Gas monitoring to be undertaken and depending on the outcome of the risk assessment, may also require VOC monitoring. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Fuel Storage/Usage Areas – Continued					
Former Railway Siding	Located in the vicinity of Building 7 and 8.	Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Moderate risks to future users and construction workers due to presence of potential oil/fuel contamination at the railway siding. Presence of coal in the vicinity is also a potential. Risks to groundwater and off site receptors considered to be moderate to high.	Further investigation and assessment is considered to be required in this area following the demolition. Investigations to include soils and groundwater sampling and testing along with soil leachate analysis. Gas monitoring to be undertaken and depending on the outcome of the risk assessment, may also require VOC monitoring. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Electricity Sub-Stations/ Electrical Panels Control Areas -On site					
Electricity Sub-Stations	Northern portion side of Building 11. Inside the eastern side of building 15. Near Building 7, 17 and 38	Direct dermal contact and ingestion of PCB and petroleum hydrocarbons. Inhalation of volatile organic compounds. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Low/Moderate risks to future users and construction workers due to presence of potential contaminants leaking from the substations location to ground. Risks to groundwater and off site receptors considered to be low to moderate.	Further investigation required outside and within the building footprint following the demolition. Gas monitoring required. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Waste Management Areas - On Site					
Former incinerator	Building 27.	Direct dermal contact, ingestion, inhalation of a variety of organic /inorganic contaminants, including asbestos fibres. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	BTEX and TPHs detected in this area during KDC investigations undertaken in January 2016. Moderate risk to future users and construction workers due to presence of organic and inorganic contaminants detected in this area. Risks to groundwater and off site receptors considered to be low to moderate.	Installation of boreholes required for the collection of water samples. Quantitative Risk Assessment is recommended to be undertaken using chemical analysis results collected to assess if the stockpiled soil is to be removed and if further soil removal is required. Gas monitoring required and to include VOCs monitoring. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Waste Management Areas - On Site – Continued.					
Infilled Former Clay Pit	Infilled pit located the south side of the site.	Direct dermal contact, ingestion, inhalation of a variety of organic /inorganic contaminants, including asbestos fibres. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Asbestos fibres identified in a single sample during previous investigations. Moderate risks are considered to be present to site users and water environment.	Further intrusive investigation using a mechanical excavator with a breaker may acquire more robust data for this area top allow a Quantitative Risk Assessment to be completed. Gas monitoring required. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Water and Wastewater - On Site					
Drainage system	Discharge to foul sewer of water from pharmaceutical manufacture of building Discharge to foul sewer of water from research laboratories of building 42 Discharge to foul sewer of water from historical laboratories from buildings 12, 18 and 38.	. Direct dermal contact, ingestion, inhalation of a variety of organic /inorganic contaminants, including asbestos fibres and radiological contamination. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Based on the previous investigations results, the risk associated to the presence of radiological contamination along the drains and at the discharge points is relatively low. No significant chemical or radiological contamination identified in the vicinity of the drainage system from previous reports by others.	Previous investigation focused the drainage outwith the building footprint. Further investigation and risk assessment to be undertaken following demolition. Gas monitoring required. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Made Ground Related Sources - On Site					
Made ground	Made ground is known to be present on site with several contaminants detected at different locations.	Direct dermal contact, ingestion, inhalation of a variety of organic /inorganic contaminants, including asbestos fibres and radiological contamination. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users. Construction Workers. Off site residential and commercial premises and their occupants. Future site services and foundations . Underlying groundwater. Downgradient groundwater. Rivers/Ponds (Horsham Park Pond in connectivity with the River Arun).	Wide range of organic and inorganic compounds have been identified in the made ground, including: • Anomalous elevated lead concentration (in subbase • beneath existing car park) • Widespread marginally elevated benzo(a)pyrene • Localised areas with asbestos. • Rare exceedances of copper and zinc above phytotoxic guideline value.	Further investigation required outside and within the buildings footprint following demolition works to allow a robust site investigation to be completed to gather the necessary data to complete a Quantitative Risk Assessment. Gas monitoring required. Should any construction or maintenance be required in the meantime, suitable PPE to be worn for construction workers to avoid contact with the potential contaminants.
Ground Gases	Localised elevated methane and carbon dioxide but low flow.	Inhalation and migration of ground gases	On Site Users and Off Site receptors. Construction Workers	Gound gas exceedances were identified in previous investigations.	Further ground gas monitoring should be undertaken on site and the data used to re-assess the risks.

Conceptual Site Model					
Source	**Details**	**Pathways**	**Potential Receptors**	**Qualitative Risk Assessment of Potential Pollutant Linkages Action**	**Actions**
Off-Site Sources					
Oil storage depot and railway use		Direct dermal contact, inhalation and ingestion of petroleum hydrocarbons residues in soils and groundwater. Leaching of soil contamination via infiltration. Lateral migration of impacted groundwater towards off site receptors. Migration towards surface water bodies. Migration of soil vapours Volatilisation of vapours form groundwater.	Site Users Construction Workers Future site services and foundations. Underlying Groundwater. Downgradient groundwater. Rivers/Ponds	No evidence of on-site migration of hydrocarbon contamination from off-site sources including the railway and fuel storage depot were found in previous reports.	No further investigation is considered required. The site investigation proposed within this table is considered sufficient to address these risks also.

5.4 Conceptual Site Model Output

The actions which have been identified within the conceptual site model are:

- Further intrusive investigation to be undertaken under the main building footprints, and other areas of concern where no previous investigation has been undertaken, following the building demolition.
- A different investigation technique (e.g. trial pitting with breaker) may be required in the areas were concrete obstructions were encountered during previous intrusive investigations.
- Ground gas monitoring is required on a site wide basis. Current guidance recommends six rounds are undertaken as a minimum. Discussions should be held with the necessary stakeholders to determine if the site purchasers will accept a reduced scope of gas monitoring given the short timescales available.
- Human Health Risk should be reassessed based on the anticipated land use. If this is unknown, KDC can agree with Novartis the end use to be adopted. It is understood that a least part of the site is to be for residential redevelopment.
- Further assessment of risk to the Water Environment and property is required.
- Further assessment of radiological risk is also required as per the recommendations of the Aurora report.

KDC recommend 40No. trial pits and 5No. boreholes form the intrusive site investigation, in the locations shown on Figure 4. We recommend 90 soil samples are collected from these investigation locations for analysis, along with collection and analysis of at least one round of groundwater monitoring from the 5 new boreholes. It is considered that the data collected from this site investigation will be sufficient to address the data gaps identified and provide sufficient information to allow a subsequent Quantitative Risk Assessment to be undertaken.

KDC propose that the following suite of chemical analysis is undertaken during the site investigation:

Soils:

- Asbestos Screen (with quantification if a positive result is recorded)
- TPH CWG
- PAH
- VOC
- SVOC
- pH
- TOC/SOM
- Metals
- PCBs

Leachate

- TPH CQG
- PAH
- VOC
- SVOC
- Metals

Groundwater

- TPH CQG
- PAH
- VOC
- SVOC
- Metals

6. CONCLUSIONS AND RECOMENDATIONS

Further to the review of the available land quality data at the site and the development of preliminary conceptual site model, the following conclusions can be made:

- Several potential contamination sources may be still present on site and the extent of this potential contamination needs to be further investigated.

- Investigation should be undertaken within the building footprint of the main buildings of concern to identify any leakage underneath the building due to the previous site activities. In particular, soil sampling should be undertaken following the removal of plant and equipment (e.g. fuel storage tanks, electricity sub-stations and drainage facilities, etc).

- Further investigations should be undertaken in those areas were previous investigation depth was limited by anthropogenic obstructions (e.g. concrete etc). To this aim, a most suitable investigation technique (e.g. trial pitting with a breaker) should be used to allow to investigate the ground condition underneath the obstruction.

- A proposed further investigation location plan is include in Figure 4, which is considered to address the data gaps and provide sufficient information to allow a subsequent Quantitative Risk Assessment to be undertaken. Investigations to include soil and groundwater sampling and testing along with soil leachate analysis.

- A further six rounds of ground gas and groundwater monitoring should be undertaken on site, in accordance with current guidance.

Figure 1
Site Location Plan

Figure 2
Areas of Potential Concern

Figure 3
Summary of External Reports Exceedances

Figure 4
Proposed Further Investigation Locations

Appendix A
Envirocheck Report