Appendix 9C: Drainage Strategies

Contents

9C. Drainage Strategies

9C.1 Introduction

9C.1.1 The following information on drainage design and drainage strategies has been provided by the Applicants (VPI Immingham and Phillips 66) and their respective engineering design teams (Worley).

9C.2 Proposed VPI Development Drainage Strategy

Introduction

9C.2.1 The below information regarding the Proposed VPI Development Drainage Strategy is summarised by VPI from the below documents:

- Site Drainage Philosophy, document number: Rev 0: 415000-00201-8310-PH-0001;
- Drainage Philosophy, document number: Rev 0: 415000-00201-8100-PH-0005; and
- Flood Risk Assessment, document number: Rev 1: 415000-00201-8150-RA-0006.

Drainage Philosophy

9C.2.2 The drainage philosophy stipulates that the new VPI Immingham Carbon Capture Unit facility site shall require independent segregated drainage and effluent collection systems. The level of integration of any new drainage and effluent collection systems to the existing facilities systems shall be subject to further review and study as the plot layout develops.

Drain System Design Objectives

9C.2.3 The key objectives of the site drainage and effluent systems are to:

- Ensure compliance to relevant environmental and regulatory standards;
- Provide a drainage system which is inherently safe;
- Identify the different drainage requirements to ensure segregation of solvent drainage with further segregation to enable recovery of solvent where possible;
- Provide high reliability and continuous operation year-round through minimisation of reliance upon rotating equipment by employing gravity drainage where practicable; and
- Make provisions for drainage requirements during normal operation, maintenance activities and emergencies.

9C.2.4 Drainage and surface liquid containment are not supplemental process systems but must be integrated into the overall process design. This is especially true for facilities handling hazardous and/or toxic liquids where spilled liquids can present a danger to the surrounding environment if released. If process drainage systems are handling hazardous materials it is essential the risks are mitigated through the implementation of appropriate design measures. The principal aim is to segregate the hazardous effluents from non-hazardous effluent where possible.

9C.2.5 Process drains include routine draining of equipment and pipework for maintenance operations. As far as practical, drained fluid from amine processing systems will be retained and returned to the appropriate system or sent to off-site disposal if re-use is not practical. Process drains from compression and conditioning systems will be collected in the Drain Drum where it will be tested for amine contamination before being released to the oily water separator

9C.2.6 Surface water run-off contains either rain water, fire water or maintenance water from process areas and the concentrations of process materials will be relatively low. Surface water run-off from non-process areas is unlikely to contain any process materials.

9C.2.7 Spill containment is focused on containing accidental releases of process fluids. Under these circumstances the concentrations of process materials will be relatively high. Loading and storage operation of chemicals is a typical scenario which could result in spills and major leaks. All chemicals should be evaluated for their effects, including flammability, toxicity, corrosion, reactivity and quantity. This is to determine whether collected spills are to be treated (e.g. neutralisation) and/or disposed.

Proposed Drainage and Effluent Systems

9C.2.8 Effluent water originating from the plant shall be collected, segregated and drained to an appropriate drainage system, according to the level of contamination.

9C.2.9 The drain collection systems within the new Carbon Capture Unit facility and associated facilities will have a single level of primary treatment available via an Oily Water Separator and two potential routes for disposal either via a new balancing pond and high efficiency Oily Water Separator to the new site outfall to South Killingholme Drain or via vacuum truck to off-site disposal. Only clean surface run-off and non contaminated process effluent is disposed of to the South Killingholme Drain.

9C.2.10 Any chemicals, solvent and diesel shall be contained within bunded areas and disposed of off-site to third party disposal via vacuum truck.

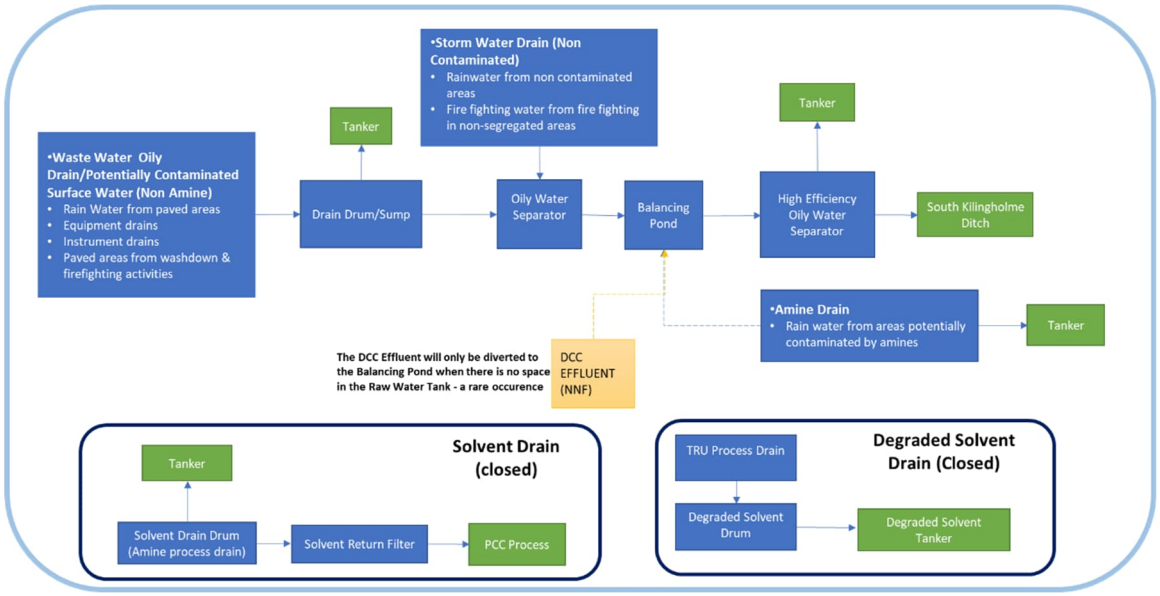

Figure 9C.1: VPI Drainage system block flow diagram

Potentially Contaminated Surface Water Drainage System

9C.2.11 The Potentially Contaminated Surface Water (PCSW) drainage system collects surface water run-off from areas that are at risk of contamination with hydrocarbons (such as compressor lube oils) and chemicals (with the exception of amine contaminated water)

9C.2.12 The PCSW system shall not collect large volumes of drainage from equipment which is contaminated with oil or chemicals.

9C.2.13 The PCSW catchment areas around process equipment handling hydrocarbons, solvent or chemicals which should normally be clean but are not bunded or provided with local collection sumps and which represent a risk of contamination of the PCSW system arising from infrequent maintenance activities, shall be provided with a passive diversion chamber and a local off-line Interceptor Sump. The Interceptor sumps shall be provided with isolation and be arranged to collect credible moderate spill volumes (typically 5 m^3).

9C.2.14 The Interceptor Sumps shall be designed to collect the first flows in a storm and shall be provided with a facility to remove storm water after inspection (e.g. portable air-driven pump, permanently installed air-driven jet ejector or access for vacuum tanker).

9C.2.15 Non contaminated surface water run-off shall be routed to the PCSW system. Contaminated surface water may be transferred by tanker or pumped to the on-site treatment facilities provided contaminant levels are permissible for treatment or be removed by road tanker for off-site Third-Party disposal.

9C.2.16 Appropriate design allowance for controlling the quality and flows needs to be made, including the option to purge water when the system is at capacity.

9C.2.17 The following prevention measures can be used to reduce/ avoid contamination of clean surface (storm) water and should be further studied during detailed design:

- Daily patrol for chemicals and oil leakage to be included in operating guidelines;
- Periodical sampling of storm water in each area before purge;
- Installation of drip trays under pumps; and
- Installation of pans and shroud for plate heat exchangers.

Storm Water Drain

9C.2.18 The Storm Water Drain will collect:

- Rainwater from non-contaminated areas, building roofs, parking areas and hardstandings;
- Clean/ Non-contaminated water from bunded and kerbed areas with controlled outlets;
- Treated effluent meeting the requirements for environmental discharge; and
- Fire fighting water from fire fighting in non-segregated areas.

9C.2.19 Non-contaminated surface water run-off from roofs, roads and grade areas shall be collected by a network of surface water ditches.

9C.2.20 Tank bunds and areas of potentially significant contamination (kerbed areas) shall be connected to the surface water ditches through a valved outlet. The valve shall be normally closed. Following periods of rainfall, the collected water shall be tested to verify if it is contaminated. Non-contaminated effluent shall be discharged to the surface water ditches while contaminated effluent shall be removed by vacuum truck for off-site treatment / disposal.

9C.2.21 The surface water channels will be designed for flow rates based on the 1 in 10 year return period. Network simulation is undertaken for 1 in 50 year and 1 in 100 year events. Beyond design basis storms may result in standing water or sheet flow across surfaces. As the outfall will be at the low point of the site these flows are considered to enter the storm drainage system after peak flow.

9C.2.22 The storm water system shall discharge to the off-site ditch via the storm balancing / holding pond.

Firewater Run-Off Collection

9C.2.23 Firewater run-off is collected by the drain system for open areas. Fire fighting run-off within tank bunds will be contained within the bund and fire fighting water may be partially or wholly contained within kerbed areas depending on volume of fire fighting water used. Fire water from bunds will be sampled and then disposed to pond or tankered off site.

9C.2.24 In the event of a fire, the balancing pond should be closed to prevent discharge of fire fighting products to the environment. The method of closure shall be by use of an electrically operated penstock gate and shall be linked in to the fire alarm system to enable automatic closure.

Rainfall

9C.2.25 In respect of Civil engineering requirements, an appropriate storm hydrograph shall be used within the design software package.

9C.2.26 Urban creep allowance factor shall be set at 1.0 as this is considered appropriate for industrial development.

9C.2.27 Climate change allowance factor is set at 1.25. This value is consistent with “Flood Risk Assessment”, 415000-00201-8150-RA-0006.

9C.2.28 Cross check calculations may utilize the Modified Rational Method with r = 0.40 taken from the following map:

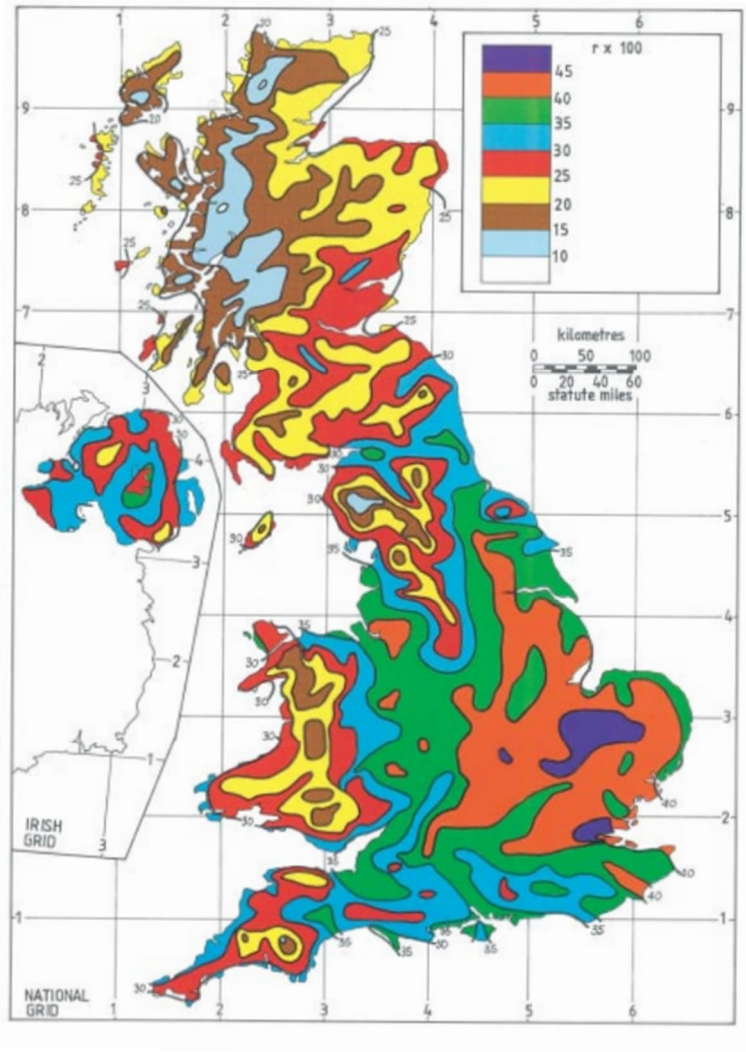

Figure 1 Ratio of 60-minute to 2-day rainfalls of 5-year return period – from *Design and analysis of urban storm damage* (Department of the Environment)

9C.2.29 Ground permeability values are stated in the original O&M manuals as:

- Paved areas 1
- Free draining soils 0.3
- Clayey soils 0.5
- Compacted ground 0.7

9C.2.30 A value of 0.5 shall be taken for areas finished with gravel surfacing.

Waste Water Oily Drain

9C.2.31 The Waste Water Oily Drain will collect:

- Rain water from paved areas subject to regular and continuous contamination;
- Water from floors, paved areas resulting from washdown and fire fighting activities;
- Minor equipment drains;
- Instrumentation drainage; and
- Direct Contact Cooler Blowdown.

9C.2.32 Water that is likely to be polluted by hydrocarbon products shall be collected in this system. Paved areas where contamination is assessed as a regular occurrence shall be segregated by directly connected drain pipes or kerbs falling to catch basins at low points of paving. These

areas shall be connected by submerged outfall gravity sewer to drum 18-D-0001 before discharge to the storm water channel drain system or tanker truck.

Pumps

9C.2.33 These shall be mounted on above grade plinths with the pump base frame designed to hold initial oil leakage. The base frame shall be piped to discharge common underground header pipes from where it will be routed to a common collection sump.

9C.2.34 A typical schematic of pump connection to drain is provided below.

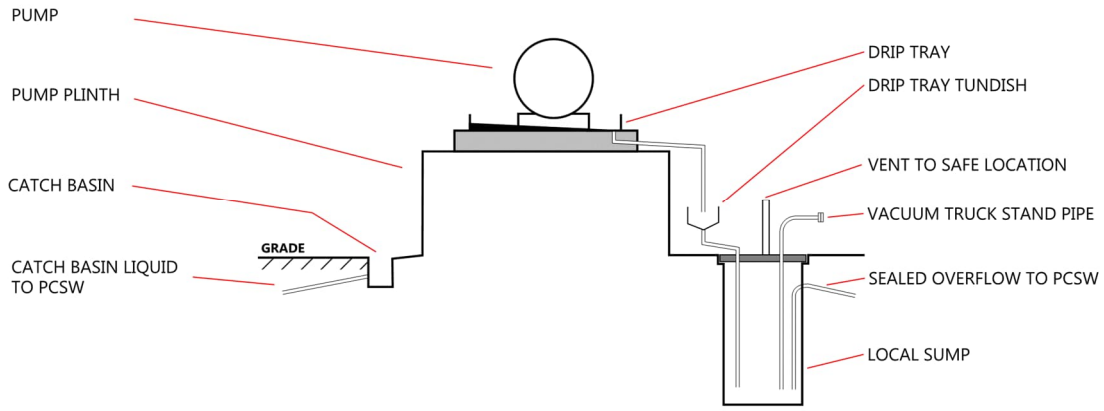

Figure 9C.2.- Diagram of Pump Drip Tray Arrangement

Transformers

9C.2.35 These shall be located above a stone filled sump pit with automatic discharge to storm water channel system. If oil is detected in the sump the flow shall be closed and the oil emptied by tanker."

Carbon Capture Unit Area

9C.2.36 In the Carbon Capture Unit area, fluids with the potential to contaminate are:

- Lube oil;
- Transformer oil;
- Solvent;
- Caustic;
- Antifoam; and
- Refrigerant.

9C.2.37 The capture plant area shall be paved and kerbed/ bunded with controlled discharged to ensure that uncontrolled surface run-off is avoided and spillage and leakages from equipment are contained.

9C.2.38 Outdoor areas containing rotating equipment with lube oil systems (e.g. pumps and turbines) shall be paved and surface run-off shall be routed to the PCSW system.

9C.2.39 Transformers and substations shall be located within kerbed areas.

9C.2.40 Lube-oil and transformer oil change-out shall be drained to portable drums with spillages contained by oil mats and good-practice clean-up. Used oils will be disposed of off-site.

9C.2.41 Drains from process equipment and pipelines within the Carbon Capture Unit area (but not drainage containing solvent) will be routed to the PCSW.

9C.2.42 Areas under pipe racks containing fluids with the potential to contaminate surface water shall be paved and kerbed with the surface run-off from these areas routed to the PCSW.

9C.2.43 Steam traps which discharge to paving will not be allowed. They shall be routed to a local open drain or to a soakaway.

9C.2.44 Chemical spillages in the kerbed/bunded areas will be manually cleaned up and disposed of offsite.

9C.2.45 A connection from the kerbed/bunded area to the PCSW shall be provided with a normally closed valve / sluice gate to enable pooled rainwater not contaminated with chemicals to be drained to the PCSW system. The operator shall test the pooled fluids to confirm chemical and solvent contamination levels before draining to the PCSW system.

Compressor Areas

9C.2.46 In the CO_2 Compression area, fluids with the potential to contaminate are:

- Lube oil.

9C.2.47 The CO_2 Compression plant area shall be paved and kerbed/ bunded with controlled discharged to ensure that uncontrolled surface run-off is avoided and spillage and leakages from equipment are contained.

9C.2.48 These shall be located within weatherproof buildings and connected to normally dry sump pits. Oil collection in the sump pit shall be removed by vacuum truck. Washdown drains from compressor buildings shall be routed to PCSW drain. Any equipment lube oil systems which are located outdoors shall be provided with paving and be kerbed/ bunded with controlled discharge to ensure that uncontrolled surface run-off is avoided and that spillage and leakages from equipment are contained. Lube oil spillages in the kerbed/bunded area will be manually cleaned up and disposed of offsite.

9C.2.49 A connection from the kerbed/ bunded area to the PCSW shall be provided with a normally closed valve/ sluice gate to enable pooled rainwater not contaminated with hydrocarbons to be drained to the PCSW system. The operator shall test the pooled fluids to confirm contamination levels before draining to the PCSW system

Common Utilities Area

9C.2.50 The Common Utility Area includes electrical and instrumentation infrastructure, common cooling equipment, Hydrogen Generation, water and wastewater treatment plants/ PCSW ponds and instrument air compressors. Equipment shall be located indoors as far as practicable to minimise surface run-off.

9C.2.51 In any Common Utilities Area, fluids with the potential to contaminate are:

- Lube oil;
- Transformer oil;
- Water treatment chemicals (for chilled water and effluent. Note that there is no cooling water in the CCU and associated facilities); and
- Solvent.

9C.2.52 Rotating equipment with lube oil systems which are located outdoors shall be provided with paving and be kerbed/bunded with controlled discharge to ensure that uncontrolled surface run-off is avoided and that spillage and leakages from equipment are contained. Lube oil spillages in the kerbed/bunded area will be manually cleaned up and disposed of offsite.

Chemical Storage Area

9C.2.53 The following typical chemicals utilised within injection/ dosing packages and storage tanks (intermediate day tanks) may be distributed within the new facilities:

Table 9C.1: Typical Site Chemicals

Plant Area	Capture Plant
Chemicals	47% Caustic (unloading bay and storage) 20% Caustic (distribution and injection points) Solvent (Type TBC by Licensor) Antifoam Refrigerant (Type TBC by supplier)

9C.2.54 The above chemicals cannot be discharged to the PCSW drainage system or to the site outfall, with the exception of caustic which, if it is neutralized beforehand, may be routing to the PCSW.

9C.2.55 There is no existing VPI Immingham site wide chemical drainage and therefore all chemical drainage and spills will require local containment for off-site disposal.

9C.2.56 Areas for chemical injection packages and chemical storage tanks (excluding Solvent which is covered separately below) shall be paved and kerbed/ bunded to ensure that spillages and leaks from chemical dosing packages and associated intermediate storage tanks are contained. To minimise rainwater collection where practicable and safe to do so these chemical injection packages and intermediate storage tanks shall be located indoors or be provided with a rain shelter if outdoors. The rain shelters shall have open sides for ventilation.

9C.2.57 Chemical spillages (excluding solvent) in the kerbed/ bunded areas shall be contained by spill mats and good-practice clean-up and disposed of offsite. Caustic spills may be neutralized before being drained to the PCSW. Other chemicals shall be transferred to portable drums to be removed from site.

Loading/ Unloading Bays

9C.2.58 Any road vehicle unloading shall be within kerbed/ bunded areas with controlled discharge which shall be arranged to provide the capacity to contain accidental release of a full tanker. Run-off from any required loading / unloading bay shall drain to the PCSW system or to a sump which shall be provided with a small air-driven pump to allow clean stormwater to be pumped away to the PCSW system.

9C.2.59 Tanker loading bays shall be connected to the stormwater drain system through a valved outlet. The valve shall be normally open, but during tanker loading and unloading operations, the valve shall be closed and potential fluids shall be directed to a holding tank. The accidentally discharged fluid is then contained in the tank and in the surrounding area and may be removed by vacuum truck. The area would require cleaning prior to opening the valve.

9C.2.60 The loading bay is expected to be in common use for several products. Spillages are expected to be cleared before subsequent use for alternative products. Minor spillage is unlikely to drain to the holding tank and should be cleaned using a spill kit at the time of spillage.

Solvent Drain

9C.2.61 Rainwater from areas potentially contaminated by amines.

9C.2.62 Amine shall not enter the storm water system. In areas where amine contamination is possible, the area will drain to a local sump tank where it may be tested before pumped discharge to storm water drain or tanker for off-site treatment / disposal.

9C.2.63 The primary area is that within trains 1 and 2, including below the air coolers.

9C.2.64 Concrete surfacing shall be provided below areas where amine contamination is expected. The slabs will be kerbed to at least 150mm above high point of paving (HPP).

9C.2.65 Below grade trenches leading to water sampling facilities will be provided at the central low point of paving. The trenches are sized to accommodate the average daily rainfall. More

intense storm events will overtop the trenches but still be held within the kerbs. The sampling point will allow the regular testing of water samples without requiring entry into the kerbed area. Contaminated rainwater will be removed by tanker and uncontaminated rainwater will be discharged to the stormwater channel system.

Solvent (Closed) Drain System

9C.2.66 The closed drain systems should collect liquid maintenance drains from equipment and piping, containing hazardous/toxic fluids, and safely dispose and degas the liquid if needed. Also, equipment in non-hazardous service will be connected to the closed drains system when the atmospheric release of the contents could cause an undue risk to the personnel, the environment or the asset.

9C.2.67 The design temperature of the drain headers, drain tank and drain pump should be selected to allow drainage of equipment within reasonable time taking into account that the solvent may be hot. The operating procedures should take these factors into account.

9C.2.68 Solvent utilised in the Carbon Capture Unit shall not be discharged to any open drain systems and must be contained. Where possible clean solvent should be recovered and recycled within the process.

9C.2.69 Solvent drains below grade shall be within covered concrete channels to prevent a loss of containment from the drain system contaminating the soil and ground water. The concrete channels shall slope to the sump within the solvent drain vessel pit to collect any rainwater.

9C.2.70 Surface water run-off from uncovered external paved areas containing equipment which during normal operation is expected to result in chemical drips, leaks and minor spill and which could be contaminated, shall be located within minimised local kerbed areas and be gravity fed to sumps where operators can collect fluid samples for testing and depending on level of contamination discharge to the solvent make-up tank for reintroduction to the process, the PCWS drain, or the degraded solvent tank for offsite disposal.

Carbon Capture Unit Closed Drains

9C.2.71 Equipment drains within the Carbon Capture Unit area which are utilised during maintenance will be routed to a local closed clean solvent drain vessel which will be located below grade.

9C.2.72 Where only parts of the system are to be drained down, as much solvent inventory as possible shall be transferred to other parts of the system or to the storage area prior to draining to the drain drum/ sump. The solvent drain drum should have sufficient volume to contain the liquid below the low level trip from the single largest equipment/segment containing solvent. If drainage to an atmospheric drain tank is considered, it shall be emphasised in operating procedures that equipment must be fully depressurised and degassed before opening of drain isolation valves / spectacle blind. The solvent drain drum shall be designed for easy collection and removal of solid particles.

9C.2.73 The solvent solutions collected within this drum will be transferred to the Absorber or solvent make-up tank (if the Absorber is not online) for re-introduction to the process.

Degraded Solvent Closed Drains

9C.2.74 Degraded solvent waste and unusable drainage from the Carbon Capture Unit will be segregated from the clean solvent streams. Drains to this system will be routed to a local degraded solvent closed drain drum located below grade. Disposal of degraded solvent will be via tanker and off-site disposal.

Foul Sewer (Sanitary Wastewater)

9C.2.75 The PCC development makes no provision for new sanitary systems. Additional staffing are currently expected to utilise the existing facilities. No new sanitary sewerage is anticipated. The existing facility discharges to a biological treatment plant at the north east of the site.

Balancing/ Holding Pond

9C.2.76 All rainwater collected on the site shall discharge via the balancing / holding pond to the diverted South Killingholme drain. Outflow to the drain shall be limited to the greenfield runoff rate calculated in accordance with the procedures described at www.uksuds.com and using the greenfield runoff tool. The outflow is limited to QBAR and this is 21.84 l/s for the proposed site.

9C.2.77 The required retention volume is calculated in the Flood Risk Assessment 415000-00201-8150-RA-0006 and is 3006m^3.

9C.2.78 A class 1 oil separator shall be included in the outfall for the full volume of discharge.

9C.2.79 The pond shall be a two stage design with a first stage designed for commonly occurring storm events and shall discharge to South Killingholme drain via gravity outfall. A second stage shall be accessed via a weir and shall hold the additional water volumes associated with the 1 in 100 year storm event. This shall be discharged by pump to the first stage.

Current Drainage Layout

9C.2.80 The South Killingholme Drain runs through the area of the new VPI plant development. This drain receives runoff from the northern part of the drain bordering the plant boundary. In addition to this flow, it receives water from other nearby areas.

9C.2.81 During the site visit it was possible to inspect the part of the drain that runs through the site and the continuation of the drain along the Rosper Road. In terms of drainage elements, there are four culverts along the South Killingholme Drain, within the project limits. These vary in dimensions and materials. As the culverts were inaccessible during the site visit, it was not possible to obtain accurate dimension data. However, from viewing the culverts at a distance they appear to vary in diameter between 0.5 m in the upstream part of the drain and 1.5 m in the downstream section.

9C.2.82 Observations that have been made on the drain describe the bottom material as 50 mm to 75 mm of black sludge of organic material. Beneath this layer is soft sticky brown clay with some sand. This becomes firm between 25 mm and 50 mm and is assumed to be puddle clay. The base of the initial section of the drain within the project limits is described as hard and may be concrete lined.

9C.2.83 Regarding the presence of vegetation, river weed appeared to be totally absent from the channel, but it was observed that floating material, including vegetation, was occasionally trapped in the submerged parts of the bank side vegetation. Bank vegetation, consisting of grasses, nettles and brambles, was present down to the waterline on the south side. The north side was similar, but there was also larger scrub vegetation, brushes and small trees. Vegetation extended to the waterline with occasional vegetation within the channel.

9C.2.84 Figure 9C.3 shows the total route undertaken by the South Killingholme Drain. It can be seen that the beginning of the drain is located west of P66 Humber Oil Refinery. It then circles to the south and east of it until it reaches the proposed development area, where it crosses from west to east. It then runs parallel to Rosper and Humber Road and finally flows into the estuary.

9C.2.85 From this route, the limit discharge flows from P66 Humber Oil Refinery and VPI Immingham CHP Plant are known, but any other inflows are unknown.

9C.2.86 No other drainage features were observed on site.

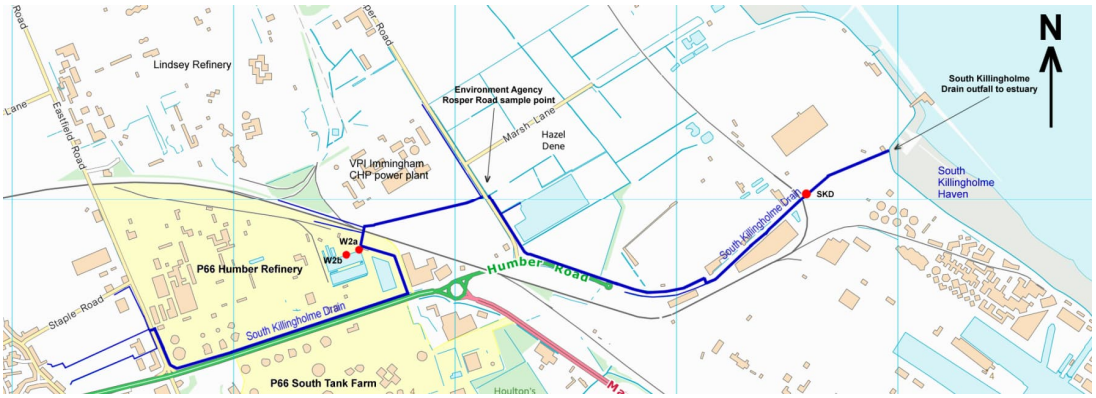

Figure 9C.3: Sketch plan showing P66 Humber Oil Refinery water discharge points and South Killingholme Drain. Source: Humber Refinery - Environment permit improvement conditions IC28 and IC29, Wood, October 2021"

Surface Water Management

Allowable Drainage Discharge Rates

9C.2.87 It is assumed that the allowable discharge rate from the site during operation should not exceed the Greenfield Mean Annual Runoff Rate (QBar).

9C.2.88 The Greenfield runoff rate for the site has been calculated using the Greenfield Runoff Tool on the UK Sustainable Drainage System (SuDS) website (HR Wallingford, 2022) following the Institute of Hydrology 124 methodology. The area (orange line) for which this has been calculated are shown in Figure 9C.4 and the sum of the area amounts to 8.78 ha.

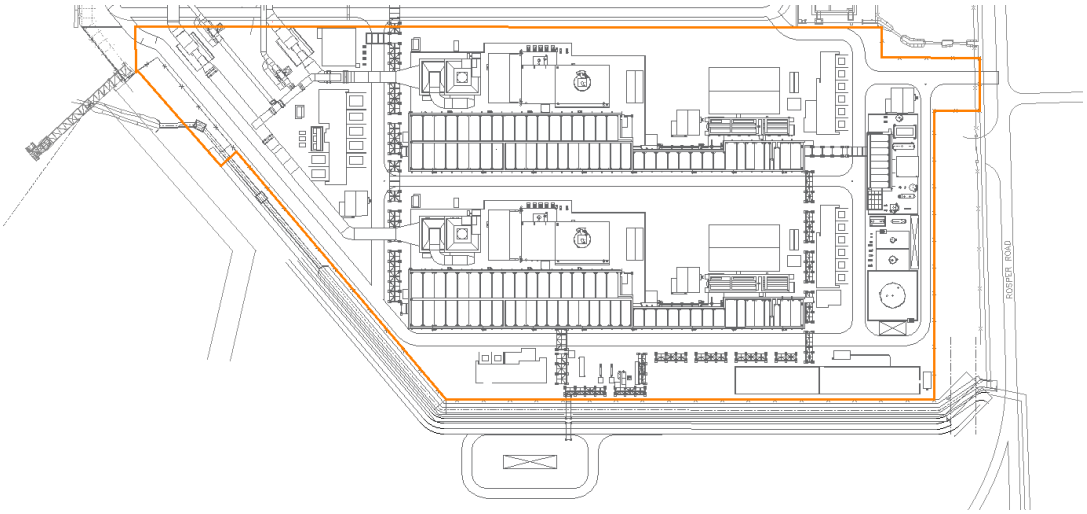

Figure 9C.4: Area (orange line) considered in the greenfield runoff rate calculation

9C.2.89 The area south of the new drain alignment has not been considered in the calculation as the natural conditions of the area will not be modified and the Transport and Storage compound is outside Worley's scope. The operational area of the VPI Immingham CHP Plant has also not been considered as it is equipped with a stormwater drainage system that will not change as an outcome of the proposed development. The drainage system collects the runoff produced on it and finally discharges it into the South Killingholme Drain at the downstream end.

9C.2.90 The current layout is considering a single 7 metre easement to the south of the new drain alignment. The areas to the south of the current South Killingholme Drain alignment does not drain towards it, so this surface has not been considered in the calculation.

9C.2.91 The results are provided in Table 9C.2.

Table 9C.2: Estimated Greenfield Runoff Rates for the VPI Site

Event	Flow (l/s)
Qbar (mean annual)	21.84
100% AEP	19.00
3.3% AEP	53.50
1% AEP	77.80

Surface Water Storage Volume

9C.2.92 The surface water storage volume estimation tool (HR Wallingford, 2022) provides estimates of the required volumes of storage needed on a site along with recommendations on the limits of discharge that should be applied.

9C.2.93 There are four storage volumes to determine. These are:

- Interception storage may not require explicit provision of storage but is the volume of runoff which must be prevented from leaving the site up to the first 5 mm of a rainfall event.
- Attenuation storage aims to limit the rate of runoff into the receiving water to similar rates of discharge to that which took place before the site was developed (greenfield runoff rate). This can be provided at one or several different locations using a variety of SuDS or other storage techniques.
- Long Term storage is similar to attenuation storage but aims to specifically address the additional volume of runoff caused by the development. This is either infiltrated into the ground or, if this is not possible due to soil conditions, attenuated and discharged at very low rates of flow to the receiving watercourse so as to minimise the risk of exacerbating river flooding.
- Treatment storage aims to ensure the water quality of the stormwater is sufficiently improved to minimise its impact on the flora and fauna in the receiving water. This is normally provided as the dry period volume of one or more ponds. This value has not been considered in the calculation.

9C.2.94 The area naturally discharging into the South Killingholme Drain is the northern area. However, by realigning the drain, the area contributing to the drain is around 25% greater. When comparing the increase in discharge flow between pre and post development, from 17.24 l/s to 21.84 l/s, with the estimated total flow through the drain, 10.84 m3/s the increase is negligible, around a 0.04% increase, and is not expected to pose a risk downstream.

Design Criteria

9C.2.95 The design criteria considered in the calculation were:

- The lifetime of the project is 25 years (2050s epoch), however, in terms of climate change an additional peak rainfall intensity allowance has been added to take a conservative approach. On this basis, the climate change allowance factor considered has been 25%. This value corresponds to the central allowance of the 2070s epoch.
- The urban creep allowance factor reflects the future predicted increase of paved surfaces over the future life of the development. Due to the nature of the proposed development, controlled access industrial site, it is not considered that paved areas will be extended in the future, therefore this factor has not been taken into account in the calculation.
- The contribution of permeable areas has been considered as 37% based on the runoff coefficients for the rational method based on the Rossmiller Equation for translating NRCS curve number into Rational Method “C” values. It is stated that for gravel land use, hydrologic group D, considering that the soil is clayey, and slope of the terrain between 0 and 2%, the runoff coefficient is 0.37 (American Legal Publishing, 2021).
- Hardstanding areas and roads have been considered as impervious areas. Since the impervious area of the proposed development is less than 50% of the total area, around

48%, and the tool only calculates with impervious values in the range of 50% to 100%, the impervious area has been approximated to 50% of the total development area.

- The areas considered in the calculation of surface water storage volume have been determined on the basis of the plant boundary and planning application boundary.

Results

9C.2.96 Based on the design criteria, Table 9C.3 lists the main inputs introduced in the tool and the storage volumes.

Table 9C.3: Surface Water Storage Requirements

Parameter	Proposed Development Area
Total Site Area (ha)	8.78
Impermeable Area (ha)	4.39
Attenuation Storage 1/100 years (m^3)	2861
Long Term Storage 1/100 years (m^3)	145
Total Storage 1/100 years (m^3)	3006

9C.2.97 On this basis, the proposed storage method which is currently a stormwater pond shall be sized for 3006 m^3.

Existing Site Drainage Systems

9C.2.98 Figure 9C.5 below provides an overview of the existing VPI Immingham facility drainage collection systems within the facility with oily water treatment prior to disposal via the existing site outfall (South Killingholme Drain, adjacent to Rosper Road):

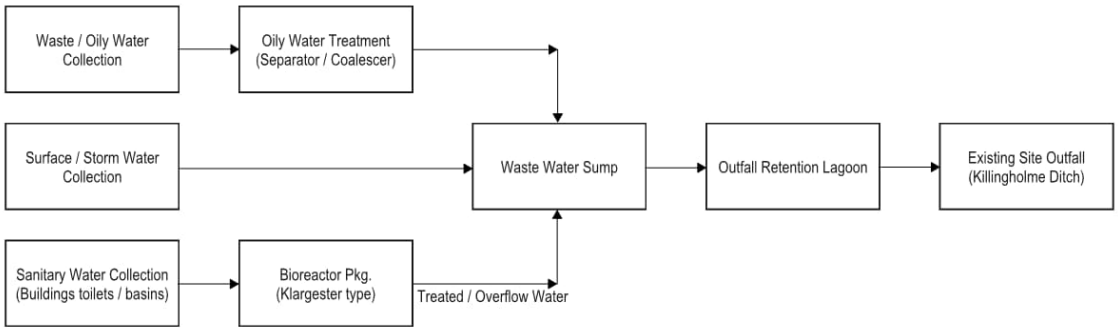

Figure 9C.5: Overview of Existing VPI Immingham Drainage Collection System

9C.2.99 The existing VPI Immingham CHP facility includes the following segregated drainage collection systems:

- Waste/ Oily Water;
- Surface/ Storm Water, including flows from the:
  - Cooling tower blowdown (purge), and/ or
  - Wastewater drainage from the existing water treatment plan; and
- Sanitary Wastewater

9C.2.100 The segregated oily surface water collection system is routed for primary treatment within an Oil Separator/ Coalescer prior to transfer to the facility wastewater sump, discharge water lagoon and site outfall (South Killingholme Drain).

9C.2.101 Surface and storm water runoff including flows from the cooling tower blowdown and wastewater drainage from the water treatment plant are routed directly to the wastewater sump prior to transfer to the discharge water lagoon and site outfall.

9C.2.102 Sanitary Wastewater from buildings and gatehouses is routed to a Klargester type technology bioreactor unit for treatment prior to discharge.

9C.2.103 The VPI site does not have any existing requirement for a closed drain collection system.

9C.3 Proposed Phillips 66 Development Drainage Strategy

Overview

9C.3.1 All equipment and areas installed as part of the development shall be provided with facilities to enable them to be drained via the appropriate system.

9C.3.2 Unmade ground (gravel, grass, etc) shall not be provided with engineered drainage. It is assumed that rainwater will eventually soak away into the ground. Where access pathways cross such areas of ground it shall be assumed that the unmade ground can drain any runoff without additional engineered drainage.

9C.3.3 The following sources requiring drainage are applicable to the project:

- Foul wastewater
- Rainwater runoff from non-process areas
- Rainwater runoff from process areas
- Intentional drainage from equipment either during normal operation, maintenance and shutdown
- Unintentional drainage from equipment during a process upset (e.g. unintentional overflow, leaks)
- Firewater runoff

9C.3.4 The project scope involves the installation of new infrastructure associated with the following systems:

- Foul Water Drainage
- Oily Water Sewer (OWS)
- Surface Water Sewer (SWS)
- Solvent Drain System

9C.3.5 With the exception of the new Solvent Drain System, all systems will tie into existing site drainage systems.

9C.3.6 The Surface Water system will be designed to attenuate rainwater runoff at a rate equivalent to 1% AEP (Annual Exceedance Probability) plus 30% enhancement for climate change.

Existing Site

Existing Foul Water Drainage

9C.3.7 The site has a segregated foul water collection network. The site's main foul water collection network discharges foul water to the public sewer. All new routes into existing foul water infrastructure are subject to confirmation that there is adequate capacity.

Existing Oily Water Sewer (OWS)

9C.3.8 The OWS is routed through the refinery Effluent Treatment Plant (ETP), which includes primary, secondary and biological treatment before being routed to No.1 Holding Pond. The No.1 Holding Pond provides water attenuation prior to water being discharged to the South Killingholme Drain. The outlet of No.1 Holding Pond is then combined with the outlet from No.2 holding pond, with the combined stream passing through Induced Air Floatation (IAF) before being discharged at the refinery outfall. See Figure 9C.A.

9C.3.9 Discharges to OWS include process discharges and discharges from areas of higher risk of contamination. This approach minimises the impact on the OWS. The OWS has multiple overflow connections to the SWS as a safeguard to prevent the OWS from being overwhelmed. The SWS can be routed through the ETP in this case as needed.

9C.3.10 All new routes into the OWS are subject to confirmation that the existing OWS system is able to accommodate the additional flow.

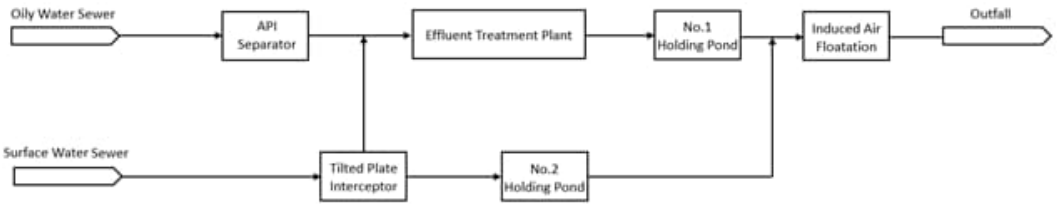

Figure 9C.A. SWS/OWS Block Flow Diagram

9C.3.11 Neither the OWS or the ETP are intended to receive large quantities or concentrations of contaminants. The refinery Environmental Management System has defined authorised process drainage activities which can be carried out for drainage of process effluent to OWS. These activities can be carried out on a regular or as needed basis. Any unauthorised draining requires further internal review and approval prior to discharge to the OWS, which could include testing of the discharge stream as needed.

Existing Surface Water Sewer (SWS)

9C.3.12 The Surface Water Sewer (SWS) Drains gather rainwater runoff from the entire refinery site (north of the A160/not including the South Tank Farm) including various operational areas, roadways, building roofs, car parks etc. The SWS is routed to a Tilted Plate Interceptor (TPI) after which the stream can be routed either through the refinery ETP, or to the No.2 Holding Pond and to offsite discharge, or a combination of both. The default operation is to route the SWS stream through the ETP. However, during periods of high flow due to heavy rainfall, or due to reduced performance of the ETP, the surface water can be routed to No.2 Holding Pond to reduce the load going through the ETP. The No.2 Holding Pond provides attenuation before water is discharged to the South Killingholme Drain. See Figure 9C.A. The No.2 Holding Pond effluent must meet the refinery effluent discharge limit specifications prior to discharge.

9C.3.13 All new routes into the SWS are subject to confirmation that the existing SWS system is able to accommodate the additional flow.

New Drainage Systems

New Foul Water Drainage Infrastructure

9C.3.14 Foul water drainage arising from new occupied buildings (toilets, sinks, showers etc.) shall be discharged through one of the following ways:

- to the public sewer via the existing foul water drainage network. The preference is to tie into the existing main site foul water collection network. As with other buildings on site, a foul water tank may be required to collect foul water from new occupied buildings.
- A new septic tank or Klargester for treatment of the effluent prior to discharge either into site SWS, or other route to be defined.

9C.3.15 Grease traps shall be fitted to sink outlets from kitchens / mess rooms to reduce blockage risk in the drains.

9C.3.16 The design flow and discharge criteria for foul water shall be confirmed based on anticipated occupancy levels, shift patterns and an estimated water usage per person.

9C.3.17 The requirement for a new laboratory for the testing of samples taken from new equipment is to be confirmed. Should a new laboratory be required it is anticipated that it will operate a type-specific sample waste collection system using drums / containers for disposal of contaminated waste. It is expected that sinks shall drain to the foul sewer with administrative procedures in place to prevent discharge of hazardous substances down the sinks.

New Surface Water Drainage Infrastructure

Rain Shelters

9C.3.18 Rain shelters shall be considered over process equipment where required or where there this would reduce demand on the OWS. Clean water from the roofs of such shelters shall be routed to the surface water drains.

Process Areas Without Containment

9C.3.19 The following criteria must be considered for surface water in process areas (including those containing toxic, flammable or harmful liquids) to be routed directly to the SWS.

a. Process area does not contain equipment requiring frequent or routine maintenance;

b. Process area does not contain equipment which is prone to leakage;

c. Process area does not contain equipment where containment of the liquid is difficult during maintenance (regular or irregular).

9C.3.20 For process areas meeting the above requirements the ground shall be paved with an engineered fall to a drain (or multiple drains if required) which connect to the surface water drains. No sumps for the purpose of attenuation are required for such areas.

9C.3.21 Maintenance procedures will guide operators on how to avoid draining liquid to grade in these areas. Where discharge of material to grade during maintenance is unavoidable operators shall utilize temporary bunding, spill kits or similar to collect material for discharging to the OWS and therefore minimise the volume of material discharged to the surface water drains.

New Oily Water Sewer (OWS) Infrastructure

9C.3.22 Sources of potentially contaminated water in process areas include:

- Bunded Areas;
- Kerbed Areas;
- Road Tanker Loading/ Unloading; and
- Intentional drainage from equipment either during normal operation, maintenance and shutdown.

Bunded Areas

9C.3.23 The project philosophy is to provide bunding for process areas which are primarily designed for bulk chemical storage. Such areas will contain equipment intended for bulk storage of liquids (in storage tanks, IBCs etc.) which are considered toxic, flammable or harmful.

9C.3.24 Where a process area is identified as requiring bunding, the bund shall be sized based on the largest of the following criteria:

- Where the bund contains a single vessel - 110% of the maximum liquid inventory of the largest single vessel contained within the bund (excluding any sump volume).
- Where the bund contains multiple vessels – 25% of the total system volume (excluding any sump volume).
- One day of rainfall at the site maximum rainfall rate excluding the sump volume.

9C.3.25 The bund floor shall slope towards a blind sump. The sump itself shall be sized for one week's worth of average rainfall falling on the entire bund area up to a maximum of $1m^3$.

9C.3.26 Bunds / sumps and any associated drainage channels / pipework shall be constructed from materials which are compatible with the full range of materials which they could credibly encounter.

9C.3.27 Each sump shall be provided with a plug type drain connected to the Oily Water Sewer. Operators will identify high level in bund sumps visually as part of routine walkarounds. The procedures for emptying a sump are outlined in the following bullet points.

- If no maintenance has been performed recently in the area and the operator has no reason to suspect the contents may be contaminated (e.g. no leaks in the process area, no visual signs of contamination) they will open the plug valve and drain the contents of the sump to the OWS.
- If maintenance has been performed in the area recently or the operator suspects the contents may be contaminated (e.g. they have spotted a leak in the process area or there are visual signs of contamination) they will take a sample of the sump liquid. The operator will then take action according to the sample analysis results:
  - If contamination levels of each chemical species tested are found to be below the acceptable levels for the Humber Refinery's ETP the operator will open the plug drain and discharge the sump contents to the OWS.
  - If bulk contamination levels in the sump are found to be above the limits for the Humber Refinery's ETP the operator will open the drain to OWS and drain the contents slowly to the site ETP (thus achieving dilution with other streams entering the ETP). The drain rate will depend on the type and levels of contaminants present. Alternatively, it may be necessary for the contents of the sump to be pumped out and taken offsite for specialist disposal.

9C.3.28 Spill kits shall be provided within a reasonable distance from a bund to allow containment of any hazardous material and minimise the volume of such material entering the sump.

Kerbed Areas

9C.3.29 The following criteria must be considered for the provision of kerbing around process areas with equipment containing toxic, flammable or harmful liquids:

a. The equipment in the area is likely to require regular maintenance (e.g. pump sets);
b. The equipment in the area is prone to leakage (e.g. equipment containing seals);
c. The nature of the equipment makes the liquid particularly hard to contain during irregular maintenance activities (e.g. plate & frame exchangers)

9C.3.30 For equipment meeting the above requirements, kerbing will be provided as needed.

9C.3.31 Kerbed areas / sumps and any associated drainage channels / pipework shall be constructed from materials which are compatible with the full range of materials which they could credibly encounter.

Road Tanker Loading/Unloading

9C.3.32 Road tanker loading / unloading areas shall be provided with kerbing as needed.

Intentional Drainage From Equipment

9C.3.33 Water needs to be removed from several items of equipment during normal operation. Wherever possible this water will be recycled back into the process. Water that cannot be recycled will be routed to the OWS if the ETP limits are satisfied. Water that does not meet acceptable levels for drainage to the ETP will be taken offsite for treatment.

9C.3.34 The Wet Gas Scrubber unit generates an effluent stream that has a high concentration of sulphates due to the removal of SOx from the flue gas into the liquid effluent. The feasibility of sulphate treatment is being considered, however, cost effective options are limited.

9C.3.35 In the absence of sulphate removal from the effluent stream the following options are being considered:

- Routing the effluent stream to OWS for treatment through the ETP. Expert advice has been received to suggest that the sulphate levels in the effluent would inhibit the activity of the bugs in the biological stage of the ETP. Further investigation is required to review this option.
- Routing the effluent stream to by-pass the site ETP. In order to bypass the ETP in all operating modes the effluent stream from the Wet Gas Scrubber will need to be routed through dedicated piping to a discharge point that is either into or downstream of the

No.1 and No.2 Holding Ponds into the final outfall. The discharge point will also need to be at a suitable location upstream of the analysers on the refinery outfall to the South Killingholme Drain. The environmental impact and any relevant Environmental Quality Standards need to be assessed for this option.

New Solvent Drain System

9C.3.36 The new Solvent Drain System is primarily required to minimise solvent losses during maintenance. Prior to maintenance the inventory of solvent in an item of equipment will be reduced as far as practicable (e.g. pumping the solvent inventory down to solvent storage, water washing). Any residual solvent will be drained down into the new Solvent Drain System.

9C.3.37 The new Solvent Drain System can also be used to remove solvent contaminated water from various items of equipment.

9C.3.38 Subject to testing, liquid stored by the new Solvent Drain System can be re-used to replenish the Carbon Capture Plant's solvent inventory. Alternatively, the liquid stored in the system can be sent for offsite treatment.

Fire Water Runoff and Unintentional Releases

9C.3.39 Unintentional releases outside of bunding will be managed in accordance with site spill and emergency response procedures. Where possible, the spill will be prevented from entering the site drainage. If this is not possible then the release will enter the surface water drain, where it can be held up in the onsite sewer system and ETP. The ETP has various isolation, routing and holding capacity options, that will divert the contaminant away from the bioreactors and prevent the spill from leaving the site. The spill can then be gulped into storage for consideration of best route of treatment or disposal.

9C.3.40 The new development will be equipped with hydrants for firefighting as needed. The existing site fire water network can be extended to include new hydrants. The existing fire water tanks and pumps are assessed to have adequate capacity for additional hydrants. In the event of a fire, firewater will be directed into the Surface Water Sewer and held up in the onsite drainage system, and holding ponds, in accordance with current procedures.

9C.3.41 The Humber Refinery is an Upper Tier COMAH site and receives regular inspection by the COMAH Competent Authority, including review of emergency response plans and capabilities. A detailed study has been carried out to assess the tertiary containment for the site, which culminates in the completion of a holistic Environmental Risk Assessment. The pillars of this assessment focus on flood, spill and additional firewater impact on tertiary containment and Environmental receptors.