FICHTNER
Consulting Engineers Limited

Indaver Rivenhall Limited

Rivenhall IWMF

Schedule 5 Response

1 Surface water discharge

Provide detail on how it will be ensured that all surface water discharges arising from the facility will be clean and uncontaminated from the point at which it leaves the operational areas of the facility until the point of final discharge to the River Backwater.

It is noted that in the document 'Review of operating techniques' submitted as part of application V003, it is stated that 'it will be necessary to discharge uncontaminated surface water run-off from building roofs and areas of hardstanding, which is collected in the upper lagoon, to the River Backwater'

Indaver can confirm that the drainage designs have been developed to allow for phased construction of the IWMF. The overall drainage design proposals, and also those specific to the CHP plant, are summarised below.

Overall Drainage Design

Indaver can confirm that the following requirements have been incorporated into the overall design of the drainage systems for the IWMF:

1. All drainage has been designed in accordance with the following British Standards:
   - BS EN 752 'Drain and Sewer Systems Outside Buildings'; and
   - BS EN 12056 'Gravity Drainage Systems inside Buildings.'
2. The design of the drainage systems has also been undertaken in accordance with all relevant local Building Regulations. Best practice guidelines have also been considered, where applicable, such as '*The CIRIA SUDs Manual*'.
3. The designed sewerage systems will be constructed in line with the Civil Engineering Specification for the Water Industry - 7th Edition and WRc Sewers for Adoption, where applicable.
4. All drainage to oil/chemical storage or delivery areas have been designed to adhere to the relevant EA Pollution Prevention Guidelines (PPGs). It is understood that the guidelines have been superseded; however, they are still considered to represent best industry practice.
5. The surface water drainage conveyance pipework has been sized to accommodate a 1 in 5 year storm event. The system is also designed to retain water below ground, up to and including the 1 in 30-year storm event; i.e. the system is permitted to surcharge but not flood.

Surface Water Drainage Design

Indaver can confirm that the following requirements have been incorporated into the design of the surface water drainage systems for the IWMF:

1. The surface water system will collect surface run off from roads and hard standings via trapped road gullies and proprietary drainage channels and drainage kerbs as appropriate. Various forms of drainage channels will be adopted depending on the area in question.
2. Channels/drainage kerbs have been selected to be suitable for the load class and environment in which they are located. All channels and gullies are fitted with heavy duty gratings to allow trafficking by HGVs and other heavy vehicles. Suitable access is provided for the maintenance and cleaning of the channels/drainage kerbs.
3. Due to the complex roof form and resulting gutter/valley arrangement, run-off from building roofs is collected in rainwater downpipes (RWPs). In most cases, the RWPs are located internally. Where possible these connections shall discharge directly to external manholes. The proposed roof drainage system across the facility consists of a combination of siphonic and gravity systems (the main building roof shall require a siphonic system, whilst ancillary buildings adopt a gravity solution). The roof drainage system incorporates the green roof system across the extent of the main building.
4. The below ground surface water system comprises a mixture of uPVC and polypropylene pipework, with precast concrete manholes located at changes in both direction and gradient. Pipework sizes and gradients have been selected to ensure that self-cleansing velocities are reached to avoid blockage of the pipes.
5. Surface water from the site will be discharged to the Upper Lagoon. Surface water generated from roadways and vehicle movement areas will be routed directly to the Upper Lagoon via full retention oil separators.
6. There is an area of the CHP plant that is located at 30m AOD, i.e. lower than the rest of the IWMF. The surface water run-off from this area, with the exception of the area of the Flue Gas Treatment (FGT) plant from which surface water is retained within the process water drainage system, is discharged to the Upper Lagoon via a pumping station and pressurised mains. Full retention separators shall be provided upstream of the pumping chamber.

Process Water Drainage Systems

Indaver can confirm that the following requirements have been incorporated into the design of the process water drainage systems for the IWMF:

1. Process effluents and other potential contaminated effluents within waste handling and processing areas will be collected in a series of drainage channels and gullies have been designed to accommodate such activities - generally they are cast in-situ within the concrete floor slabs.
2. Process drainage pipework is designed to cater for high temperatures (up to 95°C) and chemical composition as per process requirements. This will include, but not be limited to, the following areas:
   - Boiler Hall
   - Turbine Hall
   - FGT Area
   - Ash Storage Areas
   - Residue Silo areas

3. Process water and wash down, collected within the floor channel and gully system, will be discharged to a wastewater pit (circa 30 m^3 volume) and will then discharge onward to a bottom ash water tank (circa 250 m^3 volume). The wastewater pit will collect water directly from the Boiler Hall, FGT, IBA and Turbine Hall areas. Any wash-down or surface water generated within the Tipping Hall will drain directly to the bunker.
4. The wastewater pit includes an overflow to a fire water containment tank (circa 675 m^3 volume).
5. The FGT area is located externally; therefore, rainwater which is collected from this area will be retained via a perimeter drainage channel and conveyed via dedicated process drainage pipework to the wastewater pit.
6. The water balance for the CHP plant utilises water collected in the bottom ash water tank within the process, namely within the ash quench system – as explained within the original EP application.

Drainage from oil and ammonia handling

Indaver can confirm that the following requirements have been incorporated into the design of the drainage systems from the oil and ammonia handling areas for the IWMF:

1. The fuel oil and ammonia storage tanks are sited externally within bunded areas; and the delivery for lime and activated carbon will also be undertaken in a dedicated external area.
2. The surface water run-off from the Carbon/Lime Delivery Area will discharge into the process drainage network, via a dedicated drainage channel.
3. During deliveries of oil and ammonia, the drainage (run-off) from these areas will be able to be isolated by way of a three-way valve. The three-way valve will enable the drainage from the unloading areas to be directed to a below ground storage tank.
4. Therefore, in the event of a spillage during delivery, the contents of the spill will then be collected within the storage tank. The storage tank will be sized to enable it to accommodate the volume of a full tanker compartment. The below ground storage tank can then be pumped out for off-site disposal.

Drainage from External Storage Bunds

Indaver can confirm that the following requirements have been incorporated into the design of the drainage systems from the external storage bunds for the IWMF:

1. Electrical transformers (substation) as well as the oil and ammonia storage tanks will be installed within external reinforced concrete retention bunds. The structures will retain any contamination in the event of a leakage etc. Rainwater falling within the bunds shall also be collected and retained, until it is released via sump pumps, to the adjacent surface water drainage systems.
2. Oil detection sensors will be provided where applicable (transformer and oil storage bunds only) which will prevent the pumps from operating in the event of an oil spill. This system aims to maintain the integrity of the fuel bund and prevents uncontrolled escape of oil. Rainwater released in this manner shall drain to the surface water drainage system and ultimately pass through an oil separator, prior to discharge to Upper Lagoon.
3. Float switch activated alarms will be provided within the bunds to alert that a high-water level is present within the bund.

4. Water collected within the Ammonia tank bund will need to be pumped manually from the bund. Prior to pumping, the run-off will need to be tested/analysed to confirm that it is not contaminated with ammonia

Domestic Effluent Drainage

1. The domestic effluent drainage system will serve the administration building – this is where most welfare facilities will be located. There shall also be welfare facilities provided within the weighbridge office and within the workshop building.
2. Domestic effluents from the welfare facilities will be treated in on-site package treatment plants. Subject to agreement from the EA, it is proposed to discharge the treated effluent into the surface water drainage systems. However, until an Environmental Permit for the package treatment plants has been granted by the EA, Indaver would propose to collect the untreated effluent within the treatment plant and transfer off-site via road tanker to a suitably licenced waste management facility.

Fire Water Containment

The measures for the containment of potentially contaminated waters from fire-fighting are set out in the Fire Prevention Plan submitted to the EA for the discharge of PO10.

Allowing for all of the measures set out above, Indaver considers that the drainage systems have been sufficiently designed to ensure that all surface water discharges from the IWMF will be clean and uncontaminated prior to discharge into Upper Lagoon and subsequent discharge into the River Blackwater.

Provide an updated drainage plan to illustrate the drainage arrangements.

An updated drainage plan is provided in Appendix A. It should be noted that the drainage plan has already been submitted to the EA with the Fire Prevention Plan submitted to the EA for the discharge of PO10.

2 CHP assessment

Describe how the heat created during the incineration and co-incineration process will be recovered as far as possible (for example, through combined heat and power, creating process steam or district heating).

You must consider Article 14 of the EU Energy Efficiency Directive in your description, provide an updated assessment of opportunities and an updated CBA.

Further guidance is included on our website. I also attach draft guidance which will aide your submission.

Whilst the export of heat to the on-site heat users within the IWMF – Pulp Plant and Wastewater Treatment Plant – are still available, Indaver has also developed the CHP plant to enable the export of heat to off-site heat users. The significant heat export opportunities which have been identified to date are detailed in section 2.1.

The options for the recovery of heat from the CHP Plant are provided in section 2.2, and a Cost Benefit Analysis taking into consideration the heat export opportunities and the options for the recovery of heat are provided in section 2.3.

2.1 Heat Export Opportunities

Indaver is in discussions with local developers and has been approached by the developer of the Rivenhall Greenhouse Development (https://www.rivenhallgreenhouse.co.uk/) for the export of heat, power and carbon dioxide from the IWMF.

Indaver has recently submitted an application to amend the planning consent for the IWMF to allow for changes to the design, including the following:

1. Amending the description of development to remove reference to the types of waste which may be processed at the MRF;
2. Reconfiguring the proposed layout of the IWMF to create an area for a carbon capture, usage and storage plant and heat offtake (CCUS-HO plant) and its associated pipework;
3. Amend the types of waste processed by the MRF to allow for the processing of bulky waste and bulky waste containing POPs; and
4. Changes to the design of the Consented Scheme, including the introduction of the proposed phasing to the construction of the IWMF.

The proposed CCUS-HO plant will utilise heat from the CHP plant for the operation of the proposed carbon capture plant, as well as exporting heat, power and carbon dioxide to the proposed Rivenhall Greenhouse Development. The Rivenhall Greenhouse Development is a 40-hectare development consisting of low-carbon greenhouses on land adjacent to the IWMF.

The Rivenhall Greenhouse Development is estimated to have a heat demand of up to 70 MWth. Due to the design constraints of the IWMF, it is only feasible to supply up to 17.239 MWth of the heat demand of the Rivenhall Greenhouse Development.

For the purposes of this submission, Indaver has focused on the export of heat to the adjacent greenhouses. Notwithstanding this, Indaver will continue to investigate additional opportunities for heat export in the local area and pipework has been allowed for within the design of the CCUS-HO plant to the site boundary, via the main access road to the IWMF in the event that additional heat users are identified and commercial agreements for the export of heat can be made.

2.2 Heat Recovery Options

Heat is typically supplied from the energy recovery process in the form of steam and / or hot water, depending on the grade of heat required by the end consumers.

The most commonly considered options for recovering heat are discussed below.

2.2.1 Heat recovery from the condenser

Wet steam emerges from the steam turbine typically at around 40°C. This energy can be recovered in the form of low-grade hot water from the condenser depending on the type of cooling implemented.

An ACC will be installed at the CHP plant. Steam is condensed in a large air-cooled system which rejects the heat in the steam into the air flow, which is rejected to atmosphere. An ACC generates a similar temperature condensate to mechanical draught or hybrid cooling towers. The condensate then returns back to the boiler. Cooling this condensate further by extracting heat for use in a heat network requires additional steam to be extracted from the turbine to heat the condensate prior to being returned to the boiler. This additional steam extraction reduces the power generation from the plant and therefore reduces the plant power efficiency and power revenues.

2.2.2 Heat extraction from the steam turbine

Steam extracted from the steam turbine can be used to generate hot water for district heating schemes. District heating schemes typically operate with a flow temperature of 90 to 120°C and return water temperature of 50 to 80°C. Steam is preferably extracted from the turbine at low pressure to maximise the power generated from the steam. Extraction steam is passed through a condensing heat exchanger(s), with condensate recovered back into the feedwater system. Hot water is pumped to heat consumers for consumption before being returned to the primary heat exchangers where it is reheated.

This source of heat offers the most flexible design for a heat network. The steam bleeds can be sized to provide additional steam above the CHP plant's parasitic steam loads. However, the size of the heat load needs to be clearly defined to allow the steam bleeds and associated pipework to be adequately sized. The capacity of the bleeds cannot be increased once the turbine has been installed.

2.2.3 Heat extraction from the flue gas

The temperature of flue gas exiting the flue gas treatment plant is typically around 140°C and contains water in vapour form. This can be cooled further using a flue gas condenser to recover the latent heat from the moisture. This heat can be used to produce hot water for district heating in the range 90 to 120°C. This method of heat extraction does not significantly impact the power generation from the plant.

Condensing the flue gas can be achieved in a flue gas condenser. However, the recovered temperature is typically no more than 80°C, which restricts the hot water temperature available for the consumer. Additionally, condensing water vapour from the flue gas reduces the flue gas volume and hence increases the concentration of non-condensable pollutants within it. The lower volume of cooler gas containing higher concentration of some pollutants would likely require a different stack height to effect adequate dispersion. The additional cooling of the flue gas results in the frequent production of a visible plume. Given the planning restrictions requiring 'no visible plume' from the stack, this would require additional heat to be utilised to increase the flue gas temperatures to mitigate the visible plumes. This is considered to be very energy inefficient technical solution for the provision of heat export. Furthermore, the water condensed from the flue gas needs to be treated and then discharged under a controlled consent, which the EP does not currently allow for.

2.2.4 Summary of heat recovery options

The best solution to supply heat for the network under consideration is by extracting steam from the turbine. This method for the supply of heat is considered to be favourable for the following reasons.

1. The use of a flue gas condenser would generate a visible plume which would be present for significant periods of the year. This is not allowable within the constraints of the planning consent for the IWMF.

2. Extraction of steam from the turbine offers the most flexibility for varying heat quality and capacity to supply variable demands or new future demands.
3. Extraction of steam from the turbine, heat transfer to a hot water circuit and delivery of heat to consumers can be facilitated by well proven and highly efficient technology.

2.3 Cost Benefit Analysis

A Cost-Benefit Analysis (CBA) has been conducted for the selected heat load in accordance with Section 3 of the draft Article 14 guidance. This analysis utilizes the Environment Agency's Excel template, 'Environment Agency Article 14 CBA Template.xlsx,' with inputs customized to align with the specifics of the heat and power plant (CHP) design case.

The CBA model considers:

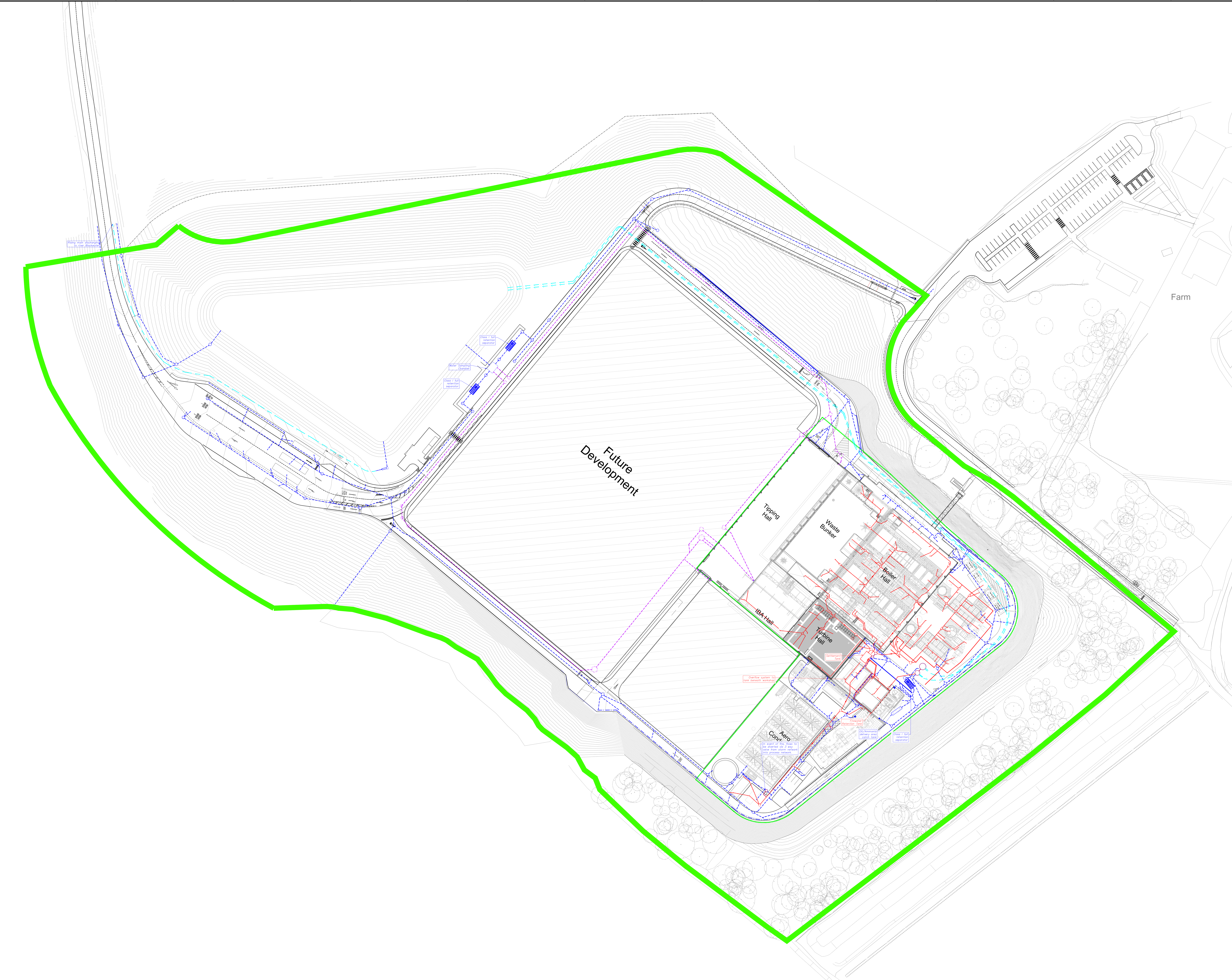
1. Revenue streams from heat sales.
2. Termination points for heat offtake, currently assumed to be at the CHP plant building boundary. This assumption places the capital and maintenance costs of the heat offtake equipment within Indaver's scope.
3. Cost streams associated with the heat supply infrastructure, including both construction and operational expenses.
4. Lost electricity sales revenue over the scheme's lifetime.

The following key assumptions underpin the analysis:

5. The heat station is estimated to cost approximately £2.24 million, with expenditure spread over a construction period of up to two years.
6. The capital cost of the heat export infrastructure required to transport heat from the CHP plant to the termination point at the CHP plant building boundary is estimated at approximately £0.258 million, also distributed over a two-year construction period.
7. Operational costs are estimated based on comparable projects of similar scale.
8. Heat sales revenue is projected at £45/MWh at current prices, with indexation for inflation within the CBA.
9. Electricity sales revenue is projected at £78/MWh at current prices, also index-linked for inflation.

The CBA results indicate that, over a 30-year period, the nominal project internal rate of return (IRR) is 18.7%, and the net present value (NPV) before financing and taxation is £0.23 million. These results confirm that the proposed heat network is economically viable in its current configuration. Further details, including model inputs and key outputs, are presented in Appendix A.

A Updated Drainage Plan



ALL INFORMATION ON THIS DRAWING IS INDICATIVE ONLY, AND MAY BE SUBJECT TO FURTHER DESIGN DEVELOPMENT.

DO NOT SCALE

NOTES:

KEY:-

- IWMF SITE BOUNDARY
- ENVELOPE OF CHP
- RISING MAIN
- SURFACE WATER DRAINAGE
- SURFACE WATER DRAINAGE CHANNEL
- SURFACE WATER SOIL NAIL WALL TOE DRAIN
- PROCESS DRAINAGE
- PROCESS DRAINAGE CHANNEL
- ROOF WATER DRAINAGE

REV.	DETAILS OF REVISION	DRAWN	CHKD	APR	DATE
R1.0	PRELIMINARY	DTW	AO1	DMH	25.03.25

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CLIENT: INDAVER RIVENHALL LTD.

SITE: RIVENHALL IWMF

PROJECT: RIVENHALL OE

TITLE: CHP PLANT - DRAINAGE SUMMARY

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B Cost Benefit Analysis

INPUTS

Version Jan 2015

Scenario Choice (dropdown box) | **1** | Power generator (Heat Source) same fuel amount

Technical solution features

Heat carrying medium (hot water, steam or other) (dropdown box)	Hot water
Total length of supply pipework (kms)	3.76
Peak heat demand from Heat User(s) (MWth)	17.238
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) (MWh)	*Lines 49 & 79*

DCF Model Parameters

Discount rate (pre-tax pre-financing) (%) - 17% suggested rate	17%
Project lifespan (yrs)	30
Exceptional shorter lifespan (yrs)	0

Key

2	Participant to define
2	Regulatory prescribed
2	Calculated
2	Prescribed - but possibility to change if make a case

Cost and revenue streams

Construction costs and build up of operating costs and revenues during construction phase

% operating costs and revenues during construction phase	Heat Supply Infrastructure - used in Scenarios 1, 2, 3 and 5	Heat Station - used in Scenarios 1, 2 and 3	Standby boilers (only if needed for Scenarios 1, 2 and 3)	Industrial CHP - used in Scenario 4 *

		% (ONLY IF APPLICABLE)	£m	£m	£m	£m
Project asset lifespan (yrs)			30	30	30	20
Exceptional reason for shorter lifespan of Heat Supply Infrastructure, Standby Boiler and/ or Heat Station (yrs)						
Construction length before system operational and at steady state (yrs)	2					
Number of years to build			2	2	0	0
Year 1 costs (£m) and build up of operating costs and revenues (%)		0%	0.1290096	1.1199906		
Year 2 costs (£m) and build up of operating costs and revenues (%)		0%	0.1290096	1.1199906		
Year 3 costs (£m) and build up of operating costs and revenues (%)						
Year 4 costs (£m) and build up of operating costs and revenues (%)						
Year 5 costs (£m) and build up of operating costs and revenues (%)						

Non-power related operations

OPEX for full steady state Heat Supply Infrastructure on price basis of first year of operations (partial or steady state) (£m)	0.0
OPEX for full steady state Heat Station on price basis of first year of operations (partial or steady state) (£m)	0.1
OPEX for full steady state Standby Boilers on price basis of first year of operations (partial or steady state) (£m)	
OPEX for full steady state Industrial CHP on price basis of first year of operations (partial or steady state) (£m) *	

Additional equivalent OPEX to pay for a major Industrial CHP overall spread over the life of the asset (£m) on price basis of first year of operations (partial or steady state) (£m) *	
Other 1 - Participant to define (£m)	
Other 2 - Participant to define (£m)	
Total non-power related operations	**0.1**
Annual inflation for all non-power related OPEX from first year of operations (full or partial) (%)	2.0%

Unit Energy Prices, Energy Balance, Fuel Related Operational costs and Revenue Stream

	Scenario used	1 Power generator (Heat Source) same fuel amount	2 Power generator (Heat Source) same electrical output	3 Industrial installation (Heat Source) - use waste heat	4 Industrial installation (Heat Source) - CHP set to thermal input	5 District heating (Heat User)
Heat sale price (£/ MWh) at first year of operations (partial or full)	45.00	45.00	50.00	50.00		
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	13,968	13,968	1,000,000	250,000		
Equivalent heat sales if first year of operations is steady state (£ m)	0.6					

Heat sale price inflation from first year of operations (full or partial) (% per year)	2.0%	2.0%	3.0%	3.0%		
Percentage of heat supplied by Standby Boiler (if relevant)	0%	0%	20%	20%		
'Lost' electricity sale price (£/ MWh) at first year of operations	78.03	78.03				
Z-ratio (commonly in the range 3.5 - 8.5)	10.47	10.47				
Power generation lost at steady state (MWh)	1,334	1,334				
Equivalent 'lost' revenue from power generation if first year of operations is steady state (£ m)	0.10					
Electricity sale price inflation from first year of operations (full or partial) (% per year)	2.0%	2.0%				
Industrial CHP electricity sale price (£/ MWh) at first year of operations (full or partial)	0.00				110.00	
Industrial CHP electrical generation in steady state (MWh)	0				* 285,714	
Equivalent revenue from power generation if first year of operations is steady state (£ m)	0.00					
Industrial CHP electricity price inflation from first year of operations (full or partial) (% per year)	0.0%				2.0%	
Fuel price for larger power generator/ CHP at first year of operations (full or partial) (£ / MWh)	0.00		40.00		40.00	
Z-ratio (commonly in the range 3.5 - 8.5)	0		3.50			
Power efficiency in cogeneration mode (%)	0		30%			
Additional fuel required per year for larger power generator / CHP in steady state (MWh)	0		761,905		* 300,000	
Equivalent additional fuel costs if first year of operations is steady state (£ m)	0.00					

Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%		3.0%		5.0%	
Fuel price for Standby Boiler at first year of operations (£ / MWh)	0.00	0.00	40.00	40.00		
Boiler efficiency of Standby Boiler (%)	80%	80%	80%	80%		
Additional fuel required per year for Standby Boiler in steady state (MWh)	-	-	250,000	62,500		
Equivalent additional fuel costs if first year of operations is steady state (£m)	-					
Fuel price inflation for Standby Boiler from first year of operations (full or partial) (% per year)	2.00%	2.0%	3.0%	3.0%		
Heat purchase price (£/ MWh) at first year of operations (partial or full)	0.00					35.00
Annual quantity of heat supplied from the Heat Source(s) to Heat User(s) at steady state (MWh)	0					200,000
Equivalent cost of heat purchased if first year of operations is steady state (£ m)	0.0					
Heat purchase price inflation from first year of operations (full or partial) (% per year)	0.0%					3.0%
Fuel price (£ / MWh) at first year of operations (partial or full)	0.00					40.00
Boiler efficiency of district heating plant	0%					80%
Fuel avoided per year in steady state (MWh)	0					250,000
Equivalent fuel savings if first year of operations is steady state (£m)	0.0					
Fuel price inflation from first year of operations (full or partial) (% per year)	0.0%					4.0%

Fiscal benefits (£m) in first year of operations assuming it is at steady state **	0.00	0.00	2.50		2.50	
Fiscal benefits inflation rate from first year of opeations (full or partial) (%) **	0.0%		1.0%		1.0%	

* In the case of Industrial CHP a separate model template is available for typical indicative CAPEX, non-power related OPEX, additional equivalent OPEX to pay for a major overall, MWh of electricity generated in the steady state and the additional fuel required.

*

* Operator only needs to enter a value for fiscal benefits (£m) and the annual fiscal benefit inflation rate (%) if the NPV without fiscal benefits is negative at the specified discount rate

OUTPUTS

Nominal Project IRR (before financing and tax) over 32 years	18.7%
Nominal NPV (before financing and tax) (£m) over 32 years	0.23