Nuclear Decommissioning

Transfer and Deconstruction Preparations

W048 – Post Fuel Free Active Effluent Discharge Arrangements Preferred Option Selection

Originated by: [redacted]
Project Manager
Date: 12/01/2022

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Programme Manager
Date: As per AMS

Approved by: [redacted]
T&D Preps Group Head
Date: As per AMS

Revision	Amendment	Date
000	First Issue	12/01/2022

Project Title and Ref:	W048 – Active Gaseous Effluent BAT and Making Safe/POCO	**Location / Date:**	HNB T&D CR1 & Skype July - Nov 2022
Meeting Title:	HNB: Post FFV Active Effluent Discharge Line Optioneering		
Attendees:			

[redacted] (DL) - HNB Cat G Programme Manager (Chair)
[redacted] (LM) – HNB Cat G Project Manager
[redacted] (GP) – HNB System Engineer
[redacted] (RG) – HNB Project Engineer
[redacted] (RH) – HNB Project Engineer
[redacted] (AMck) – HNB QA Engineer
[redacted] (RD) – HNB ESGH
[redacted] (MG) – ND Engineering, Lead Engineer
[redacted] (DG) – CTO, Environment Officer
[redacted] – HNB ESG Engineer

TOPIC	DISCUSSION POINTS	ACTION	
		Ref:	Actionee:
Background	This optioneering working group was set up to determine suitable active effluent discharge arrangements at HNB post FFV. A series of meetings were convened between July and November 2022 to review and select a preferred option(s). During the initial meeting, time was taken to agree a clear problem statement regarding the active discharge arrangements as the station moves through defueling, FFV and into C&M. There is a legislative requirement in Scotland to ensure that disposal of radioactive waste are conducted by best practical means. Compliance with this requirement is ensured in EDF by adherence to BEG/SPEC/ENVI/021. The series of meetings that this working group has conducted has concluded that the only practicable method for disposal of abated liquid rad waste following shut down of the CW system is by a direct to sea discharge line and therefore the scope of this BEG Spec is directly relevant to this piece of work. **Problem Statement:** At Fuel Free Verification there are no safety claims on the CW system, however there remains a requirement for aqueous radioactive discharges from HNA/B which, under current permit arrangements, relies on a discharge flow of 7m3/s (equivalent to 1 MCW pump) and suitable tide conditions. In parallel to optioneering, a contract has been placed with Eden Ltd to model Aqueous Discharges to sea. This will provide a baseline on current active discharges and give a facility to model the different options and understand the discharge implications of each.	INFO	
Objectives	The main objective for these meetings is to have a final preferred Active Discharge Line option at HNB. This preferred option will be verified by the plume modelling and inform permit requirements. Agreement of the preferred option will allow design / feasibility of facilities to progress. From the problem statement, it was agreed that the following statements apply: - Development of suitable discharge arrangements (up to at least C&M) is required - Application for relevant permit variation required. - New discharge arrangements are an enabler for deplanting (CW system & turbine hall) **<u>Principal considerations are:</u>** **Environmental safety** – The discharge arrangements must be acceptable under SEPA regulations and be approved under new permit requirements. **Operability/Maintenance** – The arrangements must meet the discharge demands throughout the station lifecycle and function reliably for the duration. **Economics/efficiency** – The CW system costs circa £9M per year in electrical demand to run. There is also a high maintenance requirement on the CW system plus associated plant including drum screens, intakes, hypo dosing systems, RCW etc. This also runs through the turbine hall which could prevent opportunities to deplant. This cost and resource burden supports the decision that the "do nothing" option is not efficient or economical post FFV therefore a new alternative is required.	INFO	

	The optioneering summarised in this document concerns initial high level option selection only. Follow on work will then include more detailed technical review and optioneering of the preferred option at the next level down i.e. specific pipe runs, dimensions, pump specifications.		

TOPIC	DISCUSSION POINTS	ACTION	
	SUMMARY	Ref:	Actionee:
Conclusion	A credible options report (ND/REP/TAD/0004/HNB/21) was prepared during the early stages of the W048 project involving a wide range of stakeholders and an options screening pack has been prepared more recently by HNB system engineering. The credible options report concluded that strategically the only credible option was for disposal of waste off site or by installing a new 'direct to sea' discharge line to an appropriate location, which would be determined, in part, by ongoing plume modelling work. This report also noted that disposal off site was considered unlikely to represent BPM. Subsequently the work undertaken by HNB engineering captured a list of 13 options for disposal of effluents, broadly aligned with those presented in the aforementioned report and a meeting of this group reduced the options to a short list of 4 options highlighted for further discussion. All 13 scenarios were reviewed with the group on September 28th and further detail on why these 4 options were deemed most credible can be seen in "screening notes", "AETP discharge options and schematics", "AETP Discharge decision flowchart" in APPENDICES A - D. Note that appendix B captures only the 4 credible options however all 13 scenarios and supporting documentation is also stored in the W048 project folder. The 4 credible options from the meeting on Sept 28th were: 1. Run between 1-4 RCW Pumps as designed and update permit. 2. Additional Pump & overland pipework with suction from Townswater Storage Tank and update permit. 3. Install Alternative Active Effluent Discharge Line and Update permit. 4. Install Alternative Active Effluent Discharge Line and Update permit plus install a means of flushing line with townswater post discharge. Following this meeting further calculations were carried out by Engineering which discounted the use of RCW or Townswater meaning options1 and 2 were no longer credible leaving only options 3 and 4 above to consider. Report (ND/REP/TAD/0004/HNB/21) drafted the previous year did not specify whether or not flushing would be required. It was not considered a significant detail to a strategic BPM, but one that could be considered alongside detailed design and operational BPM. Therefore these two strands of work have independently come to the same conclusion. Option 3 "Alternative" discharge lines refers to extending the existing line further to sea to aid dispersion with no additional mixing at the Syphon Seal pit using the existing Final delay tank pumps as the principle flow. This raised the query of whether it is acceptable for active effluent to be left stagnant in the pipeline between discharges, hence option 4 was proposed as a method of purging the line. It has been assumed that plume modelling work, which is underway, should confirm that a discharge location for a direct to sea discharge line with no worse dispersion characteristics to the current plant configuration will be available. Should this assumption not be valid then the above conclusions will need to be revalidated. At Present the work presented here clearly describes the preferred strategic option to take forward for further engineering design and detailed		

	optioneering. This further optioneering work will need to be formally recorded in a BAT / BPM report, in accordance with BEG/SPEC/SHE/ENVI/021 series. It is envisaged that technical feasibility and protection of the environment / public are likely to be key considerations when undertaking this detailed optioneering. A list of risks and assumptions and key actions captured during the meeting are outlined below.		
Assumptions Captured	1. A Method of carrying out Active discharges at HNB will be required at least up until Care and Maintenance. 2. At FFV the CW system no longer has any safety claims and would be running solely to support active discharges. 3. Any changes to discharge flows (currently 7m^3/s) will require updates to the environmental permits. 4. Plume modelling work (underway) should confirm that a discharge location for a direct to sea discharge line with no worse dispersion characteristics to the current plant configuration is available 5. HNA will continue to utilise HNB active effluent discharge arrangements.	INFO	
Risks Captured	1. Discharging with no additional CW flow may result in stagnant radioactivity in the line route. Discharging with no additional CW flow may result in **stagnant radioactivity in the route**. 2. Alternative discharge design and build goes through **Public Contracting Regulations (PCR)** and incurs additional programme delays. 3. **Environmental Permit updates can take up to 2 years to be approved** therefore any delays in specifying the requirements will prevent change over to alternative arrangements.	INFO	
Actions & AOB	1. Continue with plume dispersion modelling to determine relative differences in discharge locations (due Jan 2023). 2. Engage with Magnox to discuss future HNA demand and tie into new discharge arrangements. 3. Progress next level of optioneering to determine pipe runs/pump specifications/dilution options.		

No.	Appendices
A	Screening notes
B	AETP Discharge Options and Schematics
C	AETP Discharge decision flow chart
D	AETP Discharge Calculations to support screening notes

Appendix A

This slidepack summarises W049 New Discharge Arrangement: Options Screening Meeting (28th Sep 2022)

Attendees:

[redacted] *(HNB T&D)*
[redacted] *(HNB Engineering)*
[redacted] *(HNB ESG)*
[redacted] *(ND Engineering)*

PROBLEM STATEMENT

At FFV there are no safety claims on the CW system.
There remains a requirement for aqueous radioactive discharges from HNA/B which under current permit arrangements relies on a discharge flow of 7m3/s (equivalent to 1 MCW pump) and suitable tide conditions.

- Development of suitable discharge arrangements (up to at least C&M) is required
- Application for relevant permit required
- Enabler for deplanting (CW system & turbine hall)

This should be read in conjunction with the following attachments:

- *AETP Discharge Illustrations 050922.pdf*
- *Options table for AETP discharge – 060922 GP.docx*

Option	Credible ?	Justification
[1] Existing Arrangement (at least 1 MCW pump in service during discharges)	N	Option prevents deplanting MCW Pumphouse and Turbine Hall Option requires cost of running and maintaining at least 1 MCW pump (not cost effective)
[2] Option 2 – 1 RCW pump as designed (and change Permit) *Note: Options covers 1, 2 or 3 RCW pumps operating also.*	Y	More appropriate / cost effective option to dilute discharges with sea water relative to Option 1. Enables deplanting of CW pump house but will prevent deplanting of CW inlet and areas of turbine hall. Note: Considered to be a relatively weak option based on above logic but agreed to bring through optioneering.
[3] Option 3 – 4 RCW pumps as designed (and change Permit)	N	No redundancy in operation relative to Option 2 (i.e. weaker than option 2). Enables deplanting of CW pump house but will prevent deplanting of CW inlet and areas of turbine hall.
[4] Option 4 – Additional pump and overland pipework (suction at CW forebay) (and change Permit) to syphon seal pit	N	Weaker than option 2 (more complex and cost relative to option 2). Option prevents deplanting of CW inlet. Also unlikely if you could demolish the CW pumphouse with the forebay full.
[5] Option 5 – Additional pump and overland pipework (suction from Townswater Storage Tank (and change Permit)	Y	This option will prevent deplanting of the townswater supply storage tank and there are concerns the tank cannot provide a sufficent flow over a discharge window (Volume of CW outlet ~6500m^3, volume of tank 1000m^3). However it was agreed this option was still viable and worth bringing to optioneering.

Option	Credible ?	Justification
[6] Option 6 – Install Alternative Active Effluent Discharge Line (and change Permit) (i.e. line out to sea)	Y	Proven method at many decommissioning sites and is a viable option. Note this method contains no dilution (See option 13 for dilution/flushing option.
[7] Option 7 – Install Alternative Active Effluent Discharge Line (and change Permit) and tee in pumped water supply (1x RCW)	N	Enables deplanting of CW pump house but will prevent deplanting of CW inlet and areas of turbine hall. Weaker option compared to Option 2 as more complex and higher cost. Therefore Option 7 discounted.
[8] Option 8 – Install Alternative Active Effluent Discharge Line (and change Permit) and tee in pumped sea water supply	N	Option prevents deplanting of CW inlet. Also unlikely if you could demolish the CW pumphouse with the forebay full. Weaker than option 4 (more complex and cost relative to option 4). Therefore Option 8 discounted.
[9] Option 9 - Install Alternative Active Effluent Discharge Line (and change Permit) and tee in pumped townswater supply	N	This option has been superseded by Option 13.

Option	Credible ?	Justification
[10] Option 10 – Process discharges offsite (i.e. no new line). Bowser and process offsite.	N	This is not considered to be BPM to process (> 10 years) of discharges offsite due to transportation/environmental impacts. Could risk an avoidable event (i.e. spillage during transport).
[11] Option 11 – Dilute in final delay tank with townswater	N	Difficult to control discharges and likely lead to stagnant water in CW outlet. Option deemed not fit for purpose.
[12] Option 12 – Extend Existing Discharge (move discharge at CW outfall)	NA	Sub Option under several other options – i.e. extend line out to sea.
[13] Option 13 – Install Alternative Active Effluent Discharge Line (and change Permit) (i.e. line out to sea) and install means of flushing line with townswater post discharge	Y	Arguably the most feasible option as it contains the flexibility and benefit over Option 6 of dilution/flushing. Note additional considerations / detail to include access points for Laundry/LLW facility and HNA.

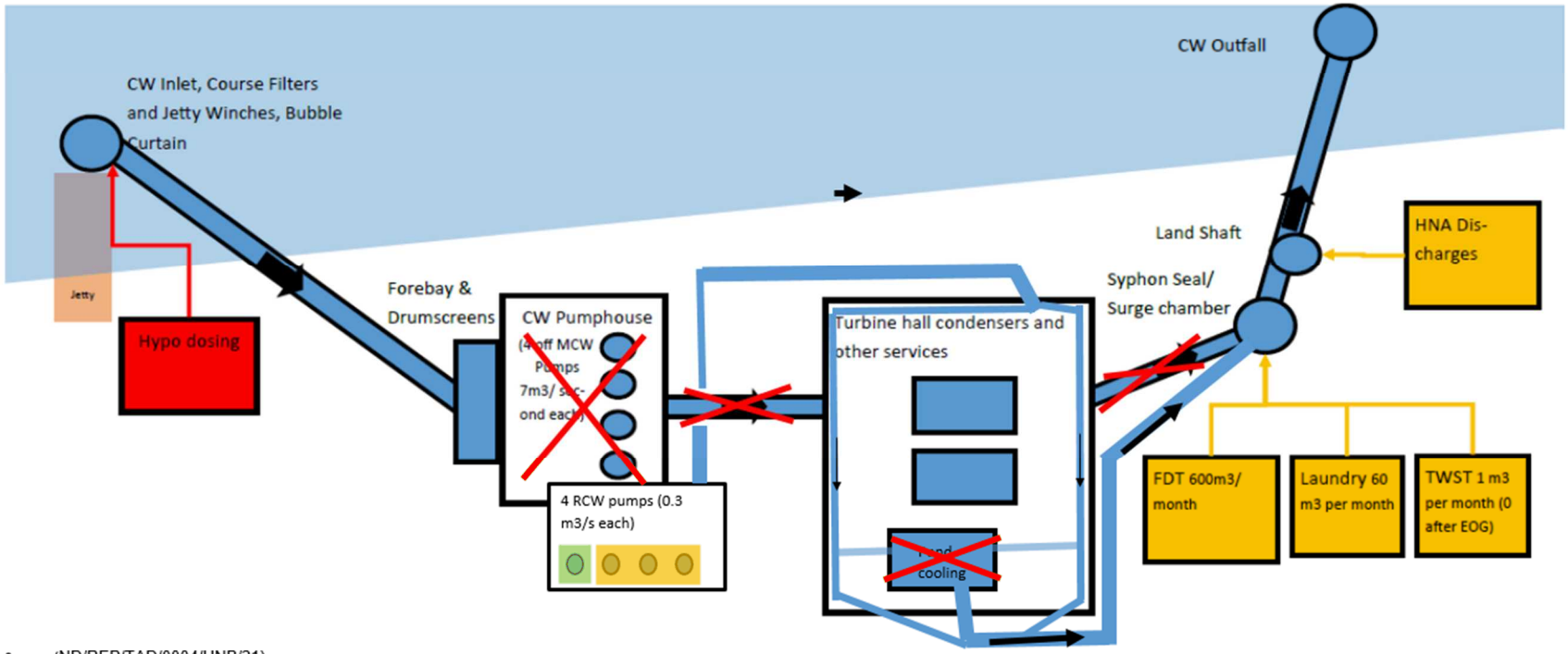
Appendix B

Option	Flow rate (dilution medium)	Mixing location	Discharge location	Flow to carry LAE to discharge?	Cost	Benefits	Risks/ Disbenefits	Comments/ Assumptions
[1] – RCW pump(s) as designed (and change Permit)	~ 0.33 m^3/s per pump (at full pump rating)	Syphon seal pit – HNB Land shaft (HNA)	CW outlet Structure	Y – RCW	Low - Ongoing	No physical modification HNA effluent still diluted without modification	Permit may not be achievable. Potential drop out and concentration of active effluent in outlet tunnel Possible limitation on HNA/ HNB discharges concurrently. Low flow through inlet culvert (marine fouling risk) Hypo Dosing requirement variation (control range/ mixing?) Potential complexity to timing of discharges **Delay in CW pumphouse de-planting** Potentially limited or no redundancy in RCW pumps	
[2] – Dilution/ transport flow provided by townswater flow into Syphon Seal (and change Permit) Sub options: (a) Pumped townswater sourced at storage tank (b) Un-pumped supply tee'd off from site townswater supply pipe (1 of 2 8" lines)	**TBC – Reliant on plume modelling output**	Syphon seal pit – HNB Land shaft (HNA)	CW outlet Structure	Y – pre-treated townswater	M – Ongoing Hire/ purchase Fuel/ Electricity costs	Not impacted by marine fouling Reliant on townswater supply (increased claim on system reliability) Removed reliance on CW intake structure and dosing etc.	Change of medium (impact on mixing and dispersion) Reliant on Fuel Free Safety case to permit shutdown of all RCW pumps Environmental impact and cost of treated water to sea Maintenance requirement for additional pumpset	Minimum flow requirement may rule out feasibility for both sub-options

[3] – Install Alternative Active Effluent Discharge Line (and change Permit) (i.e. line out to sea)	None	HNB- At discharge point HNA – tbc – connection point will be needed	New discharge point (location tbc based on plume model)	Moved by final delay pumps (uprate may be required to overcome pipe losses?)	M – One off Design/ Install	Removes linkage to previously nuclear safety claimed plant operation (RCW)	Pump ratings may not be sufficient (risk not quantified)	RCW may still have requirements for fire fighting – outside scope of this review HNA discharge line impacted also
[4] - Install Alternative Active Effluent Discharge Line (and change Permit) (i.e. line out to sea) and add facility to flush line with townswater post discharge	Driven by final delay pumps	HNB- At discharge point HNA – tbc – connection point will be needed	Tbc (insisting outlet structure or beyond)	Moved by final delay pumps (uprate may be required to overcome pipe losses?) AND Townswater	M Majority one off but LOW ongoing for flushing	No reliance on CW plant reliability	Increased reliance on townswater	HNA discharge line impacted also (solution to be incorporated in design)

SCHEMATICS

[1] RCW pump(s) as designed (and change Permit)

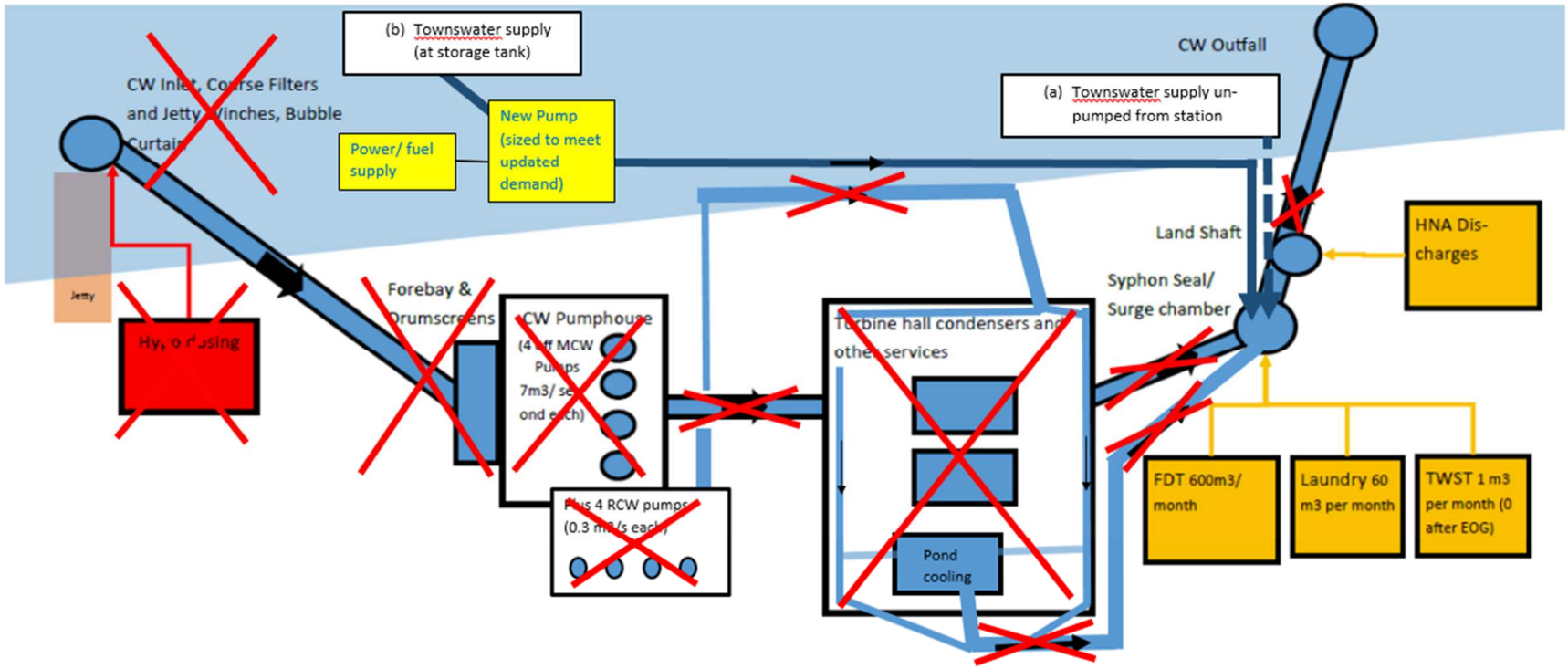


Source (ND/REP/TAD/0004/HNB/21)

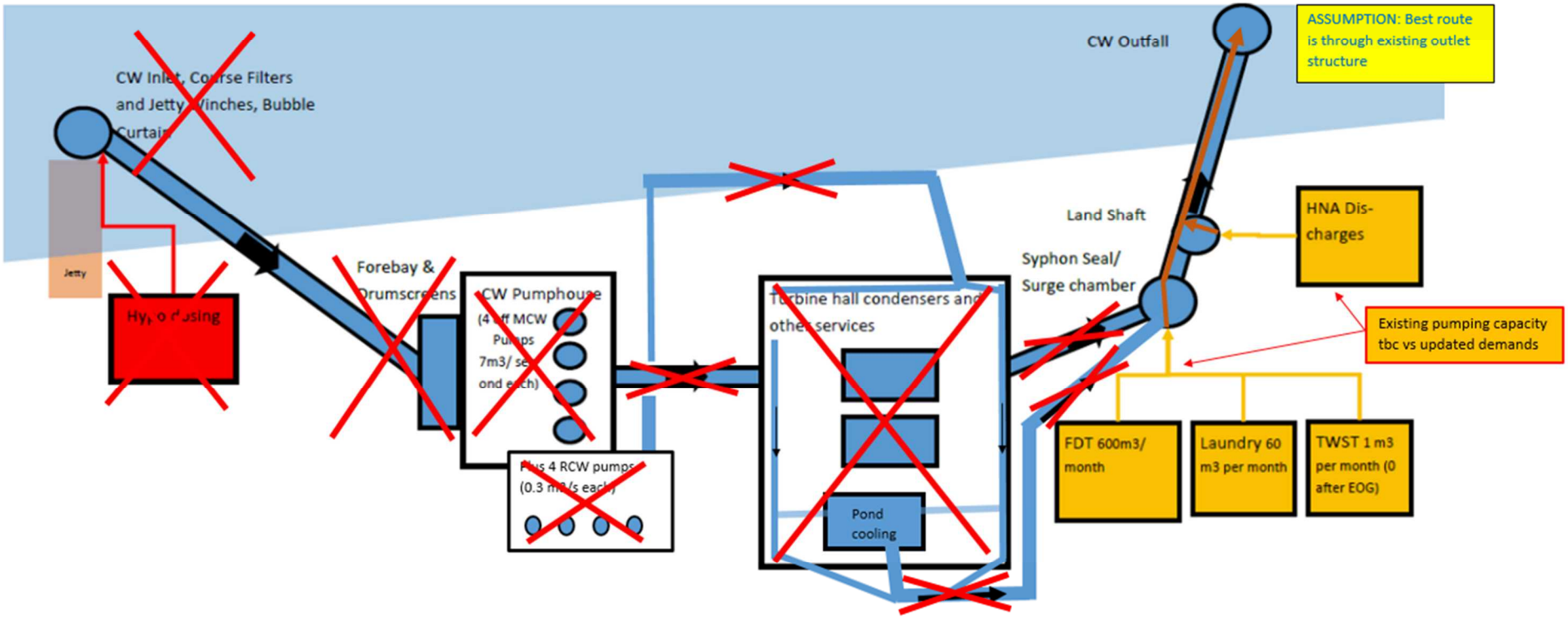
[2] – Dilution/ transport flow provided by townswater flow into Syphon Seal (and change Permit)

Sub options to be developed if feasible (based on flow requirements:

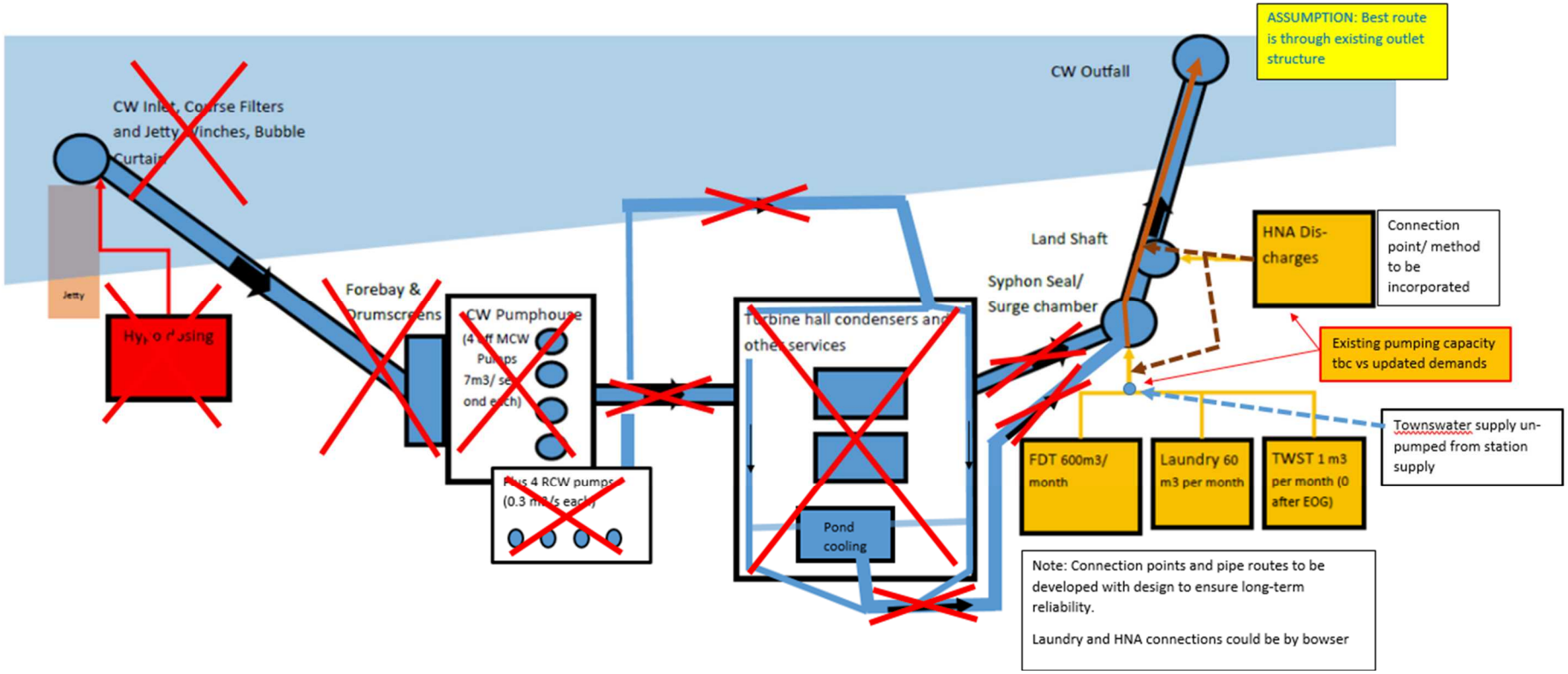
(c) Pumped townswater sourced at storage tank
(d) Un-pumped supply tee'd off from site townswater supply pipe (1 of 2 8" lines)



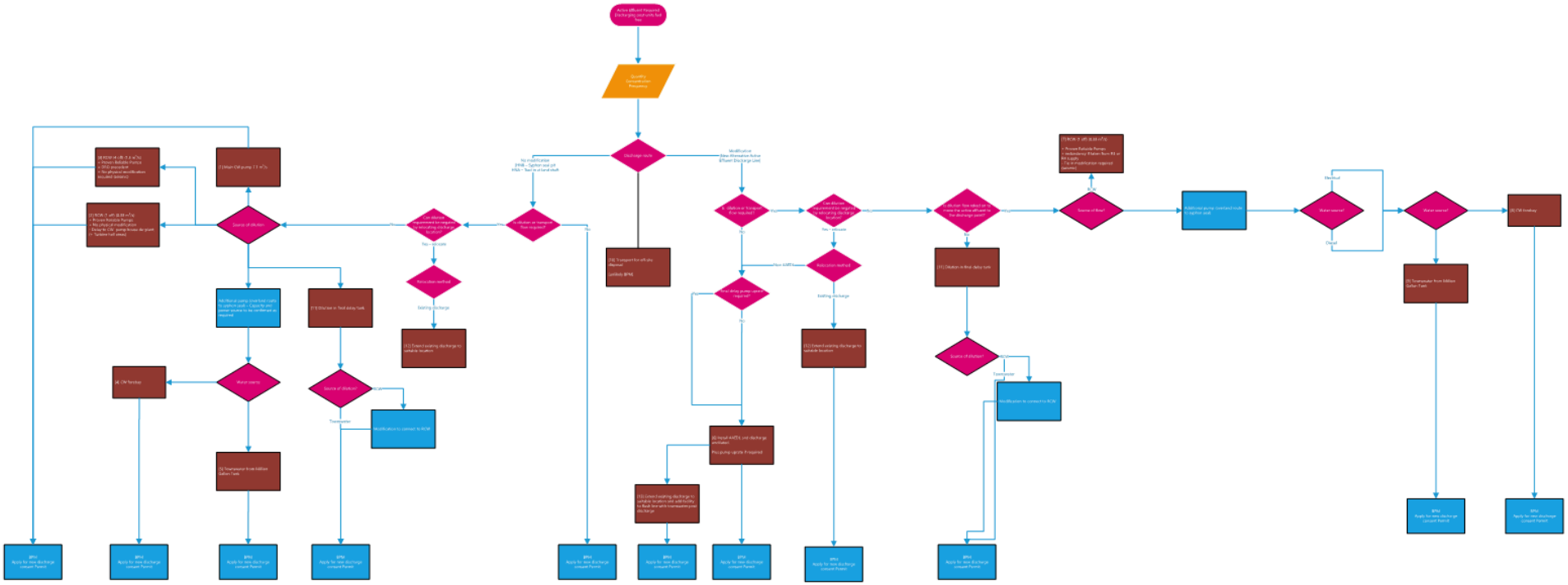
[3] – Install Alternative Active Effluent Discharge Line (and change Permit) (i.e. line out to sea)



[4]– Install Alternative Active Effluent Discharge Line (and change Permit) (i.e. line out to sea) and install means of flushing line with townswater post discharge



Appendix C – Decision Chart



Appendix D – Supporting Calculations

AETP Discharge - Calculations to support screening

CW Outlet Culvert dimensions			
Internal Diameter		3.35	m
Length		745	m
Cross sectional area		8.81	m^2
Volume		6567	m^3

Transit time in outlet tunnel:

Motive source of water to seal pit		**Flow (m^3/s)**	**Linear velocity* (m/s)**	**Duration in outlet culvert (minutes)**	**Duration in outlet culvert (hours)**	
Main CW Pump (existing permit)	**MCW**	**7**	**0.79**	**16**	0.26	Baseline (accepted as BPM)
1 RCW Pump	RCW	0.3	**0.03**	**365**	6.08	Too slow to meet intent of permit
2 RCW Pumps	RCW	0.6	**0.07**	**182**	3.04	Discharge would have to be very early in window

						and very short duration.
3 RCW Pumps	RCW	0.9	**0.10**	**122**	2.03	Discharge duration of up to around 1 hour to the syphon seal pit would be manageable
4 RCW Pumps	RCW	1.2	**0.14**	**91**	1.52	Not sustainable (over reliance on Equipment reliability)
8" Townswater pipe	Townswater	0.121226667	**0.01**	**903**	15.05	(based on 8" NB Schd40 and max flow of 1600 gpm* (0.121 m^3/s)) - NOT FEASIBLE WITH EXISTING

						DIMENSIONS

Permit requirements EAS/P1173596

Tide Window: 1h after high tide to 1h before low tide

Discharge location: National Grid reference NS 1773 5176

Nominal Flow of Cooling Water not less than 7 m^3/s

Note: this allows a nominal discharge window duration of approximately 3 hours -> **Assumption. All Active Effluent 'released' must have left the discharge location within this window**

Unit conversion	
gpm	1600
l/m	7273.6
l/s	121.2266667
m3/s	0.121226667

assumed uk gallons

Useful links/ sources supporting assumptions

https://www.tideschart.com/United-Kingdom/Scotland/North-Ayrshire/West-Kilbride/Weekly/

https://resources.hy-techroof.com/blog/how-much-water-can-flow-through-a-pipe

https://magic.defra.gov.uk/MagicMap.aspx

AAETP design consideration (for flushing medium)

Length (m) 745 (assumed existing length)

Pipe nominal bore	AAETP Diameter (m)	Volume of route (m^3) from syphon seal to sea	Flow rate to eject in 15 minutes (aligning with current BPM) (m^3/s)	Flow rate to transit discharge route in 15 minutes (aligning with current BPM) (gpm)
1 inch nb	0.025	0.36570	0.00041	111
2 inch nb	0.05	1.46280	0.00163	443
3 inch nb	0.075	3.29131	0.00366	996
4 inch nb	0.1	5.85121	0.00650	1771