Water Supply Project
Eastern and Midlands Region

Water Supply Options Working Paper

Appendix D
Strategic Environmental Assessment (2007-2011) Multi-Criteria Analysis Review

June 2015 Revision A01

Contents

1 Introduction

This paper outlines the Multi Criteria Analysis Review carried out as Phase 1of the option appraisal methodology.

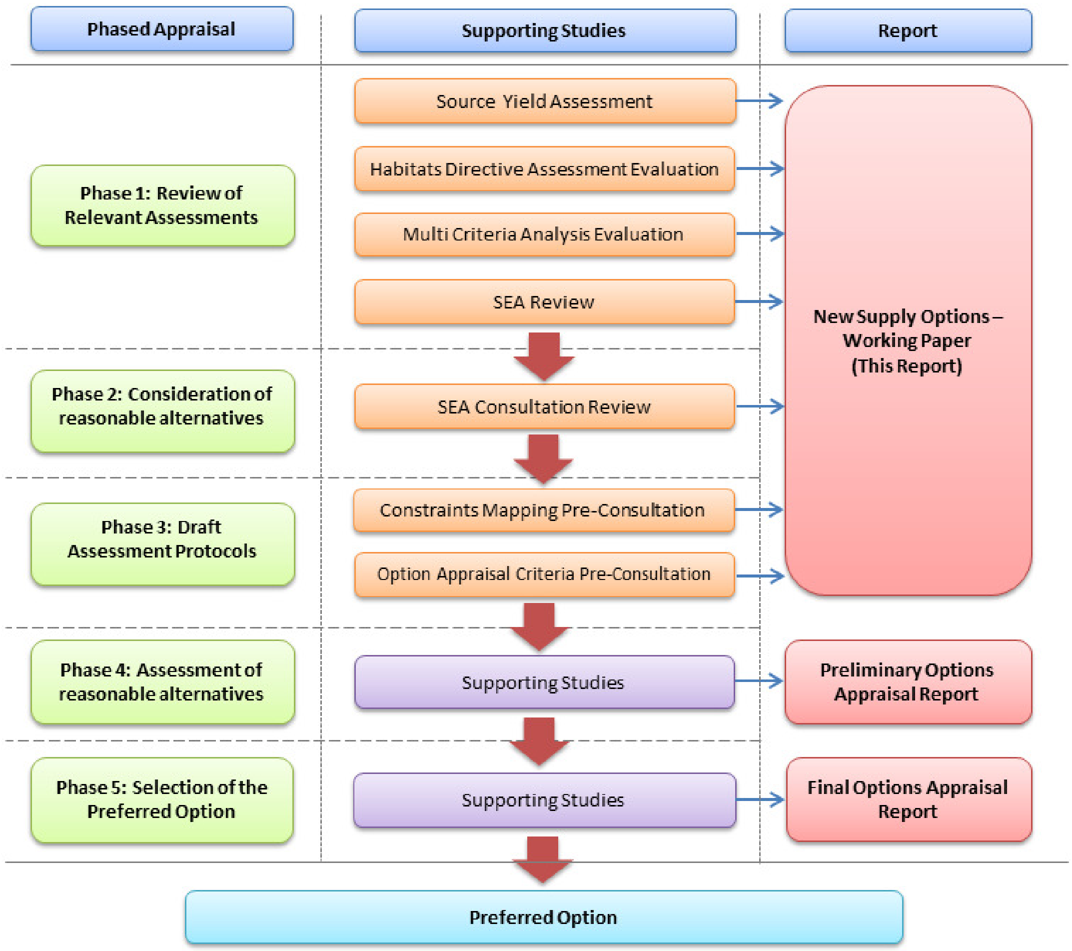

Figure 1-A Options Appraisal Methodology

2 Economic Review

2.1 Background

The Preliminary Report (2010) presented, in tabular format, whole life costings (excluding VAT) of new supply options as a total of developed Capex and Opex costs. The reported figures from that Preliminary Report are as shown in Table 2-A below.

Option	Economic assessment (NPV @ 5% over 25 year operation)
Option B	Capex €490m-€540m ; Opex €110m-€140m ; Whole Life Cost €600m-€680m.
Option C	Capex €590m-€650m ; Opex €130m-€170m ; Whole Life Cost €720m-€820m.
Option F2	Capex €520m-€560m ; Opex €120m-€160m ; Whole Life Cost €640m-€720m.
Option H	Capex €600m-€650m ; Opex €320m-€350m ; Whole Life Cost €920m-€1,000m.

Table 2-A Preliminary Report Economic Assessment (2010)

This whole life costings for options was supported by a more detailed breakdown of cost for the then 'recommended option' F2, as presented within chapter 9 of the Preliminary Report (2010). This splits direct capital costs[1] by key infrastructural elements for the recommended option (in a phased delivery profile). The reported figures are shown in Table 2-B below

Infrastructure	Phase 1 (2020)	Phase 2 (2035)	Total Cost
Pipelines	242.9m	0m	242.9m
Pumping Stations	30.2m	19.9m	50.1m
Water Treatment Plant	54.3m	16.6m	70.9m
Raw Water Reservoirs	40.5m	0m	40.5m
Treated Water Reservoirs	7.0m	3.5m	10.5m
One-off-items	95.5m	8.0m	103.5m
Total	**€470.5m**	**€48.0m**	**€518.5m**

Table 2-B Preliminary Report direct capital costs (2010)

In turn, these direct capital costs were developed from a number of detailed cost assessments, as reported within:

- Pipeline Material and Construction Cost Report (Appendix K to the Preliminary Report (2010)).
- Water Pricing Policy Report (Appendix V to the Preliminary Report (2010)).
- PPP Assessment Report (Appendix W to the Preliminary Report (2010)).

It must be emphasized that these costings are now over five years old, and will be subject to more detailed review.

[1] Costed as 2008/2010 rates, excluding the NPV Capex, Renewal and Opex cost elements included in the whole life costs presented in Table 2-A.

2.2 Review Methodology

In consideration of the information presented within the Preliminary Report (2010), the following methodology was applied for the economic assessment strategic review:

- The significant body of work supporting economic analysis of the F2 preferred option, where information does not currently exist, was applied as a baseline from which direct capital costs were developed for all options under consideration. Costs will be transferred in the following manner:
  - Direct transfer of costs for elements common with option F2.
  - Pro rata of pipeline costs on a “per km” figure developed from F2 analysis.
  - Sourcing of remaining cost components from supporting cost work within the Preliminary Report as deemed prudent.
- Comparison of these compiled costs against the cost ranges provided within the Preliminary Report.

The strategic review is limited to consideration of direct capital costs, with NPV and Opex assessment requiring significant additional consideration beyond the scope of this review, at this stage. The cost of water delivered, as a calculation derived from developed whole life costs, is also not considered at this stage, but will enter the comparison of options taken forward.

2.3 Summary of Review

The review undertaken is presented in tabular format and is included Appendix D1 to this report.

The review concludes the suitability of the identified options to be taken forward for further consideration in this planning stage.

2.4 Further consideration

In exploring the direct capital costs applied through this review, the Project Engineering Consultant has identified a number of aspects that will need to be considered in greater detail in this planning stage. Additional work will be required to provide a greater degree of accuracy in capital cost estimates applied in all future option appraisal work.

2.4.1 Desalination

Cost figures detailed within the Preliminary Report (2010) for the desalination option appear to address the cost of this network integration within treated water pipeline costs, further consideration will be required on the integration of desalination into the water supply network to allow a comparable assessment of cost for this element of the works. This has the potential to revise upwards the direct capital costs associated with the desalination option.

2.4.2 Garryhinch

The Garryhinch Raw Water Storage has the following global quantities for cost estimation purposes:

Aspect	Quantity
Gross Water Volume	18.12 million m^3
Net Operating Storage	12.10 million m^3
Plan area	3.38 sq. kilometres
Earthworks Fill Materials	2.41 million m^3
Quarry/Borrow Pit Excavation	3.38 million m^3
Peat Strip Volumes	3.87 million m^3
Geosynthetic membranes	0.37 square kilometres
Bentonite/Cement Cut-off wall	16,136 m^3

Table 2-C Garryhinch Global Quantities

Water treatment plant sludge residues would also be stored on site, in sludge lagoons with a plan area of approximately 175,000 sq. metres and a stored volume in six lagoons of 450,000 cu.metres.

The estimated cost in the Preliminary Report of the sludge lagoons was €4.8M, and the storage reservoir has been costed at €40.5M.

This element of the project involves heavy civil engineering, earthworks, and materials management, based on a design which necessarily involved many cost-sensitive assumptions, which must be proven through Subsoil Investigation currently under way.

For example, in terms of embankment construction, test results in 2010 indicated that materials likely to be available from a borrow pit on site will be poor and will require reworking to render them suitable for embankment construction. Permeable zones, estimated at as much as 20% of the floor area of the reservoir, may need to be remediated using Bentonite Enhanced Soils (BES).

Measures to counteract groundwater uplift potentially have considerable design and cost implications. Other uncertainties and risk factors are:

- Greater than expected reworking requirement on silt/clay, or requiring synthetic lining, if the permeability of the clay material does not match assumed values.
- Risk of karst features resulting in seepage or washout and calling for expensive remedial work.
- Greater than expected depth to bedrock.
- Greater than expected peat excavation depths.
- Cost provisions to mitigate environmental impacts from working area runoff.

On review of this element of Option F2, from an economic viewpoint, it is considered that the collective risk factors, and the need to provide against them, would attach considerable uncertainty to the Preliminary Report cost estimate at this time

3 Infrastructure review

3.1 Introduction

The Preliminary Report (2010) presents in tabular format a relative evaluation of infrastructure associated with each new water supply option. This evaluation by infrastructure is based on the relative reliability, resilience, durability, flexibility and technical complexity of the options. It draws heavily on the resilience and flexibility of storage alongside the influence of the water treatment process and pipeline length as distinguishing features between each option.

The relevant points presented in the Preliminary Report (2010) have been extracted and summarised into Table 3-A below.

Option	Technical Assessment – Infrastructure
Option B	Pipeline route from Shannon to Dublin is satisfactory (122km). Route avoids SPAs/SACs/NHAs/archaeology etc. Satisfactory hydraulic profile for pumping requirements. Suitable sites are available for abstraction and water treatment.
Option C	Pipeline route from Shannon to Dublin is long (158km). Abstraction location requires ESB approval re embankments. Satisfactory hydraulic profile for pumping requirements. Suitable sites are available for abstraction and water treatment.
Option F2	Pipeline route from Shannon to Dublin is satisfactory (122km). Relocation of water treatment footprint to bog location satisfactory. Strategic storage – 2 months – satisfactory location. Storage provides resilience and operational flexibility.
Option H	Limited availability of suitable sites for desalination plant (10 – 15 hectares). Complex (expensive) marine works for intake and brine dispersion outfall infrastructure. Treatment plant is highly dependent on consistent water quality. Treatment plant requires regular membrane replacement and is highly energy dependent. Pipeline route is short (25km) but is in semi-urban location.

Table 3-A Preliminary Report Technical Assessment – Infrastructure

This overarching evaluation is supported by a number of comprehensive studies appended to the Preliminary Report (2010) upon which the Project Engineering Consultant (PEC) relied, specifically:

- Desalination Report (Appendix P to the Preliminary Report)
- Shannon Modelling Report (Appendix N to the Preliminary Report)
- Pipeline Route selection (Appendix D to the Preliminary Report)
- Raw Water (Bog) Storage Report (Appendix G to the Preliminary Report)

3.2 Review Methodology

The review is concentrated primarily on the identification of infrastructural elements within the identified options that could compromise their suitability as new supply options to be taken forward for further consideration in this planning stage. It interlinks closely within the review of economic assessment undertaken in consideration of individual elements associated with each option.

3.3 Infrastructure review

The review undertaken is presented in tabular format and is included as Appendix D2 to this report.

The review concluded the suitability of the identified options to be taken forward to further assessment in this planning stage, with no apparent issues identified that would at this stage compromise the reliability, resilience, durability or flexibility of the identified options.

3.4 Further consideration

However, in exploring the infrastructural elements of the identified options, the Project Engineering Consultant has identified an initial number of additional aspects that will need to be explored further in forthcoming detailed options appraisal in this planning stage.

3.4.1 Desalination

The integration study report (Appendix J to the Preliminary Report) details the recommended approach to integration of the recommended new supply option (F2) into the receiving water supply network. The developed solution utilises key pipelines connecting the Saggart and Peamount reservoirs to a new terminal point reservoir in Clonaghlis (option F2). By extension, this solution can be applied to all options sourcing water from the Shannon.

Currently, the desalination option is shown to terminate at Ballycoolin reservoir, representing a differing integration method than that applied to the Shannon options. In this regard the infrastructural elements associated with the desalination option may be subject to revision in conclusion of further assessments.

3.4.2 Pipeline diameters

The Preliminary Report discussed a range of pressure main diameters for the proposed options to supply water to Dublin area from a new main source.

The assessment of the proposed pipeline arrangements indicated that the selected pipeline diameters would, in all likelihood, be non-standard pressure rated pipes, exceeding PN16 bar operating pressure, and pumping water with velocities in a high range of values.

With regards to the hydraulics, further analysis will be required to assess the favourable pipe diameters and arrangements to allow for optimised system operation in terms of velocities and associated pipeline friction headloss, pumping requirements in relation to energy consumption, type of pumps utilised and associated surge control arrangements as well as type of fittings and joints, and thrust block sizes.

All the above elements would directly influence the total operational cost of pumping the water and consequently the design life of the pipe material and fittings.

3.4.3 Abstraction

The Preliminary Report and SEA investigated in considerable detail the merits of four abstraction locations, at Slevoir Bay, Mota, Dromineer and Youghal Bay. They were compared across a range of criteria, including landscape/visual, noise, impacts on designated European Sites and habitats, soils and geology, cultural heritage and material assets. The abstraction location has both aquatic and onshore dimensions, needing to be optimised on least impact on the water body, linked to nearby proximity of feasible and least impacting Water Pumping and Water Treatment Plant sites.

Site 1 at Slevoir Bay, an abstraction point in the north eastern corner of Lough Derg, was identified as optimum of the four examined, and Site 4 at Youghal Bay was rejected due to expected ecological impacts at the site.

The precise point of abstraction under either of Option B or F2 would be determined first from modelling of the local effects within the lake around a water supply intake structure, and the model currently being developed , calibrated and verified, will have that capability. The SEA highlighted potential issues related to impact on residence time of water in the lake, and that would need to be modelled and investigated as the primary determinant of abstraction location in the EIA stage. That work is now under way.

An intake structure, at an optimum abstraction point determined by modelling, would need to satisfy constraints related to minimum water depth, minimum clearance from the navigation channel and these and other constraints would be agreed with the navigation and environmental stakeholders. The abstraction location is also linked to nearby proximity of feasible Water Pumping and Treatment Plant sites.
In reviewing the Preliminary Report, appraisal of the landward elements has provided feasible site options to take forward.

3.4.4 Water Treatment

Appendix H of the Preliminary Report provides a detailed design of all of the elements of a Water Treatment Plant, customised to the chemical characteristics of the water. A comprehensive examination of the available technologies for pre-treatment, flocculation, sedimentation (with lamellae plates), filtration and disinfection has been carried out, on the assumption of a Treatment Plant location at Garryhinch, adjacent to the Raw Water Storage. A degree of pilot testing of treatment technologies has been recommended in the PR, to resolve uncertainties on how the raw water from storage will behave in the sedimentation stage of treatment. A full design of waterworks sludge handling and storage lagoons has also been provided.

For optioneering, and to support the abstraction site appraisal (refer to section 3.4.3), it will be necessary to identify feasible Water Treatment Plant sites in the hinterland of L Derg/Parteen Basin, for appraisal of Options B and C.

Raw water sample analyses for treatability are part of the scope of the Water Quality Monitoring Contract. Discussions have been held with the operators of the Clareville WTP, which draws raw water downstream of Parteen, on the water treatment experience there.

3.4.5 Storage

The Preliminary Report sized treated water storage at 2 hours holding capacity in cells on each treatment stream, including a chlorine contact zone. This approach is to some extent Option-specific for F2, in that the amount of treated water storage provided would reflect the adjacency of the Raw Water Storage at Garryhinch, and the distance and pumping head to the Terminal Reservoir.

On review, and particularly in appraising Options B and C, it will be necessary to examine the optimum provision of treated water storage, where that lies immediately upstream of High Lift pumping, perhaps with intermediate Midlands clear water storage/boosting. The choice of clear water storage volume will be influenced by economics of energy and the effectiveness of chlorine residual in transfer pipelines.

3.4.6 Garryhinch

Appendix G of the Preliminary Report (July 2010) examined the civil and soils engineering aspects of the raw water storage reservoir options, and in particular the storage site at Garryhinch. In terms of the global quantities, the Garryhinch Storage Reservoir may be summarised as follows:-

Aspect	Quantity
Gross Water Volume	18.12 million m^3
Net Operating Storage	12.10 million m^3
Plan area	3.38 sq. kilometres
Earthworks Fill Materials	2.41 million m^3
Quarry/Borrow Pit Excavation	3.38 million m^3
Peat Strip Volumes	3.87 million m^3
Geosynthetic membranes	0.37 square kilometres
Bentonite/Cement Cut-off wall	16,136 m^3

Table 3-B Global Quantities for Garryhinch Storage Reservoir

In terms of geology, the reservoir footprint is underlain by Waulsortian Limestone, which in this area is a dark muddy limestone shale. Both Geological Survey of Ireland sources and site geophysical testing indicate dolomitisation and karstification may be present in this bedrock. While the Preliminary Report deemed the risk of karstification to be low, it highlighted the need to address it in detailed design work. The GSI Groundwater Vulnerability Map classifies the area as High Vulnerability, and a small footprint of a Regionally Important Aquifer overlaps the proposed reservoir footprint.

The Preliminary Report envisaged that the reservoir would be constructed in three separate cells, two outer cells enclosing an inner cell. Three options were examined for construction. Options 1 and 2 would both be constructed above the silt/clay layer and above the water table; relying entirely on made embankments to retain the impounded water. A borrow pit excavated on site[2] was proposed to win the embankment material, and to potentially accept unsuitable excavated material subsequently. It would not form part of the reservoir volume because of concerns on karstic bedrock in the excavated quarry area. The positive and negative features of this design were identified, including the large volumes of material needed for embankment formation and the need for BES cut-off walls to prevent ingress of groundwater into the excavation. Option 3 involved excavation through peat and silt into deeper layers of sand and gravel, in a cut-and-fill balance to achieve the required storage capacity. Taking the floor of the reservoir below the groundwater table would require uplift pressure from the external groundwater table to be addressed. In all cases, embankments would have to be lined and protected from scour by wave action and from development of pore water pressures.

[2] measuring 0.68km square, and taken down to approximately 10 m below ground level

The proposal also involved water treatment sludge residue storage on site, in sludge lagoons constructed on the same technology as the raw water reservoir, with a plan area of approximately 175,000 sq. metres and a stored volume in six lagoons of 450,000 cu.metres.

Groundwater uplift at times of low water in the reservoir was addressed in the Preliminary Report with three options:

(a) Self weight design in the reservoir floor.

(b) A peripheral well-pointing system, in the bedrock, with a cone of depression drawing the groundwater table below the floor, but also extending laterally beyond the footprint of the reservoir.

(c) A gravitational, or pumped, underdrainage system with an outfall to an external drainage point.

This is a question with considerable design implications, and the potential to impact on the groundwater regime and surface water regime in the Garryhinch area, will be appraised on review and analysis of the Subsoil Investigation contract results. The precise status of the new water body, under the Water Framework Directive, will also form part of that appraisal.

Under the Preliminary Report heading '*Other Risks to be considered in design'*, the authors listed a number of risks to be addressed in further investigations before the question of feasibility at the Garryhinch site is definitively settled. These include:

- Catastrophic failure risks with flooding.
- Greater than expected reworking requirement on silt/clay, or requiring synthetic lining.
- Risk of karst features resulting in seepage or washout and calling for remedial work.
- Greater than expected depth to bedrock.
- Groundwater is higher than predicted with dewatering and uplift consequences, or seasonal artesian effects.
- Greater than expected peat excavation depths.
- Environmental impacts from working area runoff.

In reviewing the Garryhinch element of the Preliminary Report, and subsequent consultation under the SEA, it was noted that the range of expected water level fluctuation within the cells, on any of the options, and the practicalities of reconciling this with the Eco-Park function of the Raw Water Storage would need to be fully developed with Bord na Móna, and taken into account in design.

4 Recommendation

While identifying a number of infrastructural elements that may require further engineering investigation and engineering design, which are likely to increase construction estimates and the previous economic appraisal, the Project Engineering Consultant is satisfied that these options be carried forward into the planning process for further investigation as part of the options appraisal strategy.

Appendix D1 Economic Review

ECONOMIC REVIEW

JT preliminary position

Cost Element	B - Lough Derg without Storage (122km)	C - Parteen Basin without Storage (157km)	F2 - Lough Derg with Storage (122km)	H - Desalination (25km 10-15ha)	Unit costs
Intake Structure CAPEX	5,000,000	5,000,000	5,000,000.00	43,200,000	
Abstraction Pumping Station CAPEX	23,374,000	23,374,000	23,374,000.00	25,936,000	
RW Pipeline CAPEX	0	0	129,536,000.00	51,796,000	*2,099,449*
Storage Reservoir CAPEX	N/A	N/A	40,502,000.00	8,154,000	
Break Pressure Tank CAPEX	May be required	May be required	N/A	N/A	
WTP CAPEX	70,878,000	70,878,000	70,878,000.00	276,650,000	
Clear Water Pumping Station CAPEX	16,306,000	16,306,000	16,306,000.00	13,888,000	
TW Pipeline CAPEX	207,492,118	267,018,545	92,351,000.00	20,800,000	*1,700,755*
Terminal Point Reservoir CAPEX	51,002,000	51,002,000	10,500,000.00		
Terminal Point Reservoir Pumping Station CAPEX	10,478,000	10,478,000	10,478,000.00		
Integration Pipe CAPEX	16,011,000	16,011,000	16,011,000.00		*1,096,644*
Pipeline Contingency & Transmission crossings				14,235,000	
Design & Supervision	20,027,056	23,003,377	20,747,000.00	22,733,000	*5%*
Land Purchase	7,500,000	7,500,000	7,500,000.00	1,500,000	*15,000*
Wayleaves & Legal	12,200,000	15,700,000	13,060,000.00	2,434,000	*100,000*
Preliminaries & Overheads	60,081,168	69,010,132	62,240,000.00	68,199,000	*15%*
Total CAPEX	**500,349,341**	**575,281,054**	**518,483,000**	**549,525,000**	
Renewals - pipeline (incl. one-off-items)			106,745,000		
Renewals - M&E			71,426,000		
Renewals - Civil Works			32,338,000		
Renewals	210,509,000.00	210,509,000.00	210,509,000.00	369,647,000	
Total CAPEX	**710,858,341**	**785,790,054**	**728,992,000**	**919,172,000**	

Appendix D2 Infrastructure Review

TECHNICAL ASSESSSMENT - INFRASTRUCTURE

The main infrastructure elements of each option are listed below

Option	Infrastructure
B - Lough Derg without Storage	- Intake pipe, - Raw water pumping station, - Raw water pipe, - Water treatment Plant, - Clear water pumping station, - Treated water pipeline (twin 1100mm dia, 122km), - Break pressure tank, - Booster pumping station, - Termination reservoir (205Ml), - Integration pipes (configuration Clonaghlis twin 1000mm dia)
C - Parteen Basin without Storage	- Intake pipe, - raw water pumping station, - raw water pipe, - WTP, - clear water pumping station, - pipeline (twin 1100mm dia, 157km), - break pressure tank, - booster pumping station, - termination reservoir (205Ml), - integration pipes (configuration Clonaghlis twin 1000mm dia)
F2 - Lough Derg with Storage	- Intake pipe, - raw water pumping station, - raw water pipe (twin 1400mm dia, 61.7km), - Garryhinch reservoir (storage & sludge lagoons) (12,000Ml), - Garryhinch WTP, - Garryhinch pumping station, - treated water pipe (twin 1200mm dia, 54.3km), - termination reservoir (90Ml), - integration pipes (configuration Clonaghlis twin 1000mm dia)
H - Desalination	- Intake (twin 1800mm dia, 3km), - sea water pumping station, - reverse osmosis treatment plant, - outlet (twin 1400mm dia, 2km), - potable water pumping station, - treated water pipe (twin 1100mm dia, 24km), - Termination Reservoir

The review of infrastructural requirements has been split by key elements (abstraction, pipeline, storage) and presented in the following tables.

INFRASTRUCTURE REVIEW - Abstraction

JT preliminary position

Criteria	B - Lough Derg without Storage (122km)	C - Parteen Basin without Storage (157km)	F2 - Lough Derg with Storage (122km)	H - Desalination (25km 10-15ha)
Site/ Location	The Preliminary Report and SEA investigated four abstraction locations, at Slevoir Bay, Mota, Dromineer and Youghal Bay. They were compared across criteria including engineering constraints, landscape/visual, noise, emissions to atmosphere, impacts on designated European Sites and habitats, soils and geology, cultural heritage and material assets. The site selection was Option-specific to Option F2, ie a Raw Water Pumping Station site. Site selection for the abstraction location has both aquatic and onshore dimensions, needing to be optimised on least impact on the water body, linked to nearby proximity of feasible and least impacting Raw Water Pumping and Water Treatment Plant sites.	No Abstraction location specifically identified at Parteen Basin, other than that abstraction infrastructure must be sited outside the footprint of ESB Embankments. Suitable sites will need to be identified, agreed with ESB and appraised on engineering and environmental criteria, with due regard to cost.	The Preliminary Report and SEA investigated four abstraction locations, at Slevoir Bay, Mota, Dromineer and Youghal Bay. They were compared across criteria including engineering constraints, landscape/visual, noise, emissions to atmosphere, impacts on designated European Sites and habitats, soils and geology, cultural heritage and material assets. The site selection was Option-specific to Option F2, ie a Raw Water Pumping Station site. Site selection for the abstraction location has both aquatic and onshore dimensions, needing to be optimised on least impact on the water body, linked to nearby proximity of feasible and least impacting Raw Water Pumping and Water Treatment Plant sites.	A Total of eight potential sites were appraised : 1. South Dublin 2. Ringsend 3. Howth Headland 4. Ardgillan 5. Balbriggan 6. Gormanstown 7. Loughshinny South 8. Loughshinny North The "preferred site" in Fingal will need to be assessed in the light of environmental restrictions/designations in the interim period
	Site 1 at Slevoir Bay, an abstraction point in the north eastern corner of Lough Derg, was identified as optimum of the four examined for a Raw Water Pumping facility it needs to be expanded as an appraisal to include a WTP site reasonably close by, and Site 4 at Youghal Bay was rejected due to expected ecological impacts at the site. Ease of access to the required levels of power will need to be investigated.		Site 1 at Slevoir Bay, an abstraction point in the north eastern corner of Lough Derg, was identified as optimum of the four examined for a Raw Water Pumping facility, and Site 4 at Youghal Bay was rejected due to expected ecological impacts at the site. Ease of access to the required levels of power supply will need to be investigated.	The discharge of brine and residues associated with a desalination plant were modelled. The dispersion levels were found to be high, and sedimentation levels were found to be very low, in the vicinity of the proposed discharge site. The dispersion characteristics will need to be reviewed given changes in European Site designations in the interim period

INFRASTRUCTURE REVIEW - PIPELINE

JT preliminary position

Criteria	B - Lough Derg without Storage (122km)	C - Parteen Basin without Storage (157km)	F2 - Lough Derg with Storage (122km)	H - Desalination (25km 10-15ha)
Infrastructure	Intake pipe, raw water pumping station, raw water pipe, WTP, clear water pumping station, pipeline (twin 1100mm dia, 122km), break pressure tank, booster pumping station, termination reservoir (157Ml), integration pipes (configuration Clonaghlis twin 1000mm dia)	Intake pipe, raw water pumping station, raw water pipe, WTP, clear water pumping station, pipeline (twin 1100mm dia, 157km), break pressure tank, booster pumping station, termination reservoir (157Ml), integration pipes (configuration Clonaghlis twin 1000mm dia)	Intake pipe, raw water pumping station, raw water pipe (twin 1400mm dia, 61.7km), Garryhinch reservoir (storage & sludge lagoons) (12,000Ml), Garryhinch WTP, Garryhinch pumping station, treated water pipe (twin 1200mm dia, 54.3km), termination reservoir (42Ml), integration pipes (configuration Clonaghlis twin 1000mm dia)	Intake (twin 1800mm dia, 3km), sea water pumping station, reverse osmosis treatment plant, outlet (twin 1400mm dia, 2km), potable water pumping station, treated water pipe (twin 1100mm dia, 24km), termination at Ballycoolen reservoir
Pipe Diameter(s)	Small diameter pipelines, while cheaper, give rise to higher level of headloss which results in higher operating pressures. Large diameter pipelines, whilst more expensive, involve lower headlosses and lower operating pressures. An economic optimum must be found bearing in mind the strategic nature of this proposed infrastructure and the need for future-proofing. The final diameter should give rise to manageable total linear headloss requirements (less than 200m of pressure after the pumps). RPS indicate from their operational experience that the optimum economical diameter gives rise to max water velocities ranging between 1.0m/s and 1.5m/s. However, a higher velocity at max capacity was considered in the case of this project because the design capacity of the pipelines will be very rarely reached (410Mld max refilling flow should be required only from year 2045 onwards, and only for approx. 4 months of the year). The max flow greatly exceeds the average flow over the first 25 years (2020-2045). Therefore, a max velocity of approx. 1.7m/s may be acceptable for optimising pipe diameters for this project. Pipe diameters that would reach velocities higher than 1.7m/s before 2045 are not recommended mainly because of the water hammer effects which increase with velocity. The twin 1200mm pipelines give rise to a pressure head of approx. 300m. Although, the whole life cost calculations would indicate a preference for this approach, this solution would involve additional CAPEX (water hammer protection, valves and fittings, etc.) and would likely give rise to future maintenance difficulties as well as higher susceptibility to leakage from increased water pressures. Also, this solution would become significantly more expensive than the other options beyond 2040 due to much greater energy OPEX. Therefore twin 1200mm pipes are not recommended. Both the 1800mm option and the twin 1400mm option are suitable from a hydraulic point of view. Although the twin 1400mm pipes are more expensive in terms of CAPEX, this is recommended. 1400mm dia is 'standard' ductile iron pipe, not 'special'. 1400mm dia pipe can be constructed in shallower trenches than 1800mm dia which reduces construction constraints and groundwater constraints.			
Pipeline Resilience/ Reliability/ Flexibility/ Durability	There would be security of supply at the storage reservoir; a single raw water pipeline could be built since during maintenance periods or in unforeseen circumstances at source or along the pipeline route water from the storage reservoir could be used for supply purposes. Twin pipes could give security of supply without a storage reservoir during maintenance or in unforeseen circumstances along the pipeline route. Even if cost was not a significant factor, it is not recommended to phase pipeline construction because there could be no guarantees of maintenance of the integrity of the existing pipeline in such circumstances. It is almost impossible to ensure the stability of the existing pipe bedding, bends and thrust blocks. Also, after the lapse of a number of years, returning to install the second pipeline, where crops are sown and hedges/ undergrowth have matured, will require extensive trial holing to locate precisely where the buried structures are - an operation in itself which could be self-defeating. In such circumstances, satisfactory insurance cover could also be an issue.			
Pipeline Capacity	Twin 1100mm pressure mains before booster Pumping Station has design capacity of 350Mld. Twin 1100mm pressure mains after booster Pumping Station has design capacity of 300Mld.	Twin 1100mm pressure mains before booster Pumping Station has design capacity of 350Mld. Twin 1100mm pressure mains after booster Pumping Station has design capacity of 300Mld.	Twin 1400mm pressure mains before Garryhinch has design capacity of 410Mld. Twin 1200mm pressure mains Garryhinch has design capacity of 306Mld. Twin 1000mm integration pipes have design capacity of ~200Mld.	Twin 1800mm pressure mains has design capacity of 715Mld. Twin 1400mm pressure mains has design capacity of 415Mld.
Pumping Requirements	Satisfactory hydraulic profile for pumping requirements. 350Ml/d is 100% available in dry or climate change periods. 350Mld capacity of raw water Pumping Station in Phase 2. 350Mld capacity of treated water Pumping Station before booster Pumping Station in Phase 2. 300Mld capacity of booster Pumping Station in Phase 2.	Satisfactory technical profile for pumping requirements. 350Ml/d is 100% available in dry or climate change periods. 350Mld capacity of raw water Pumping Station in Phase 2. 350Mld capacity of treated water Pumping Station before booster Pumping Station in Phase 2. 300Mld capacity of booster Pumping Station in Phase 2.	Satisfactory hydraulic profile for pumping requirements. 350Ml/d is 100% available in dry or climate change periods. 410Mld capacity of raw water Pumping Station in Phase 2. 306Mld capacity of treated water Pumping Station in Phase 2.	Satisfactory hydraulic profile for pumping requirements. 715 Mld max capacity of sea water Pumping Station in Phase 2. 300Mld capacity of potable water Pumping Station in Phase 2.
Pipeline Route	Pipeline route from Shannon to Dublin is satisfactory (122km). 122km pipeline has flexible route re SPAs, SPCs etc.	Pipeline route from Shannon to Dublin is long (158km on schematic).	Pipeline routes from Shannon to Dublin are satisfactory (F2 - 122km) Why is TWB recommended over TWA in Section 4 (TWA avoids bog)?	Pipeline route is short (25km) but is in semi-urban location. [Suitable sites for location of Desalination Treatment Works including an area of 10-15ha required at a coastal location with adequate access to the site.] Is location of Desalination Plant assessed by another section?

Route - Topography	High elevation between Slieve Bloom Mountains & Tullamore. Elevated land in vicinity of Kildare town and the Curragh racecourse. High elevation cannot be avoided near Saggart reservoir (TWL 145mOD).		High elevation between Slieve Bloom Mountains & Tullamore. Elevated land in vicinity of Kildare town and the Curragh racecourse. High elevation cannot be avoided near Saggart reservoir (TWL 145mOD).	
Route - Water Features	River Shannon, Lough Derg, Shannon harbour, Grand Canal (meets R. Shannon), River Barrow/ Nore (close to Portarlington).		River Shannon, Lough Derg, Shannon harbour, Grand Canal (meets R. Shannon), River Barrow/ Nore (close to Portarlington).	
Route - Designated Areas	A number of SACs close to Lough Derg (incl. Kilcarren-Firville Bog, Liskeenan Fen, Ballyduff/ Clonfinane Bog), Clonaslee Eskers, Derry Bog SAC, River Barrow/ Nore SAC, Pollardstown Fen, Mounds Bog SAC.		A number of SACs close to Lough Derg (incl. Kilcarren-Firville Bog, Liskeenan Fen, Ballyduff/ Clonfinane Bog), Clonaslee Eskers, Derry Bog SAC, River Barrow/ Nore SAC, Pollardstown Fen, Mounds Bog SAC.	
Route - Infrastructure	Dublin- Portlaoise railway line, N7 road.		Dublin- Portlaoise railway line, N7 road.	
Route - Land Use	Number of urban settlements (Banagher, Birr, Portarlington, Rathangan, Sallins, Prosperous, Clane, Rathcoole), (Kinnity, Clonaslee, Mountmellick, Monastrevin, Kildare, Newbridge, Naas, Kill, Tullamore, Edenderry, Celbridge. Significant portions of bogland owed by BNM.		Number of urban settlements (Banagher, Birr, Portarlington, Rathangan, Sallins, Prosperous, Clane, Rathcoole), (Kinnity, Clonaslee, Mountmellick, Monastrevin, Kildare, Newbridge, Naas, Kill, Tullamore, Edenderry, Celbridge. Significant portions of bogland owed by BNM.	
Renewable Energy Use			Raw water storage facilitates optimum use of renewable power (wind) to pump raw water, accommodating the intermittent nature of this energy source.	The proposed optimum site location for a desalination plant for the Dublin Region is not an optimum site for co-location of a wind farm. Use of substantial renewable energy to power the desalination plant would lower the carbon footprint of this option but would give rise to even higher operating and overall costs. Ultimately, the national objective of increasing and optimising renewable energy is not served by promoting high energy use technologies where lower energy use options exist.
Midland Supply	Has capability of supplying 50Mld treated water to Midlands Local Authorities along the pipeline route.	Has capability of supplying 50Mld treated water to Midlands Local Authorities along the pipeline route.	Has capability of supplying 50Mld treated water to Midlands Local Authorities from Portarlington.	Does not have capability of supplying Midlands Local Authorities. Potential to supply Meath.

INFRASTRUCTURE REVIEW - STORAGE

JT preliminary position

Criteria	F2 - Lough Derg with Storage (122km)
Bedrock	The Preliminary Report deemed the risk of karstification to be low, it highlighted the need to address it in detailed design work.
Groundwater	Groundwater uplift at times of low water in the reservoir was addressed in the Preliminary Report with three options:-(a) Self weight design in the reservoir floor, (b) A peripheral well-pointing system, in the bedrock, with a cone of depression drawing the groundwater table below the floor, and (c) A gravitational, or pumped, underdrainage system with an outfall to an external drainage point.
Water Framework Directive	The status of the new water body, under the Water Framework Directive, will need to be established in appraisal. It may be required to achieve 'Good' Status, which might be incompatible with its intended purpose
Design Risks	Under the Preliminary Report heading *Other Risks to be considered in design* , the authors listed a number of risks to be addressed in further investigations before the question of feasibility at the Garryhinch site is definitively settled. These include:- • Catastrophic failure risks with flooding. • Greater than expected reworking requirement on silt/clay, or requiring synthetic lining. • Risk of karst features resulting in seepage or washout and calling for remedial work. • Greater than expected depth to bedrock. • Groundwater is higher than predicted with dewatering and uplift consequences, or seasonal artesian effects. • Greater than expected peat excavation depths. • Environmental impacts from working area runoff.
Eco-Park	The range of expected water level fluctuation within the cells, on any of the options, and the practicalities of reconciling this with the Eco-Park function of the Raw Water Storage will need to be fully developed

INFRASTRUCTURE REVIEW - TERMINAL POINT RESEVOIR

JT preliminary position

Criteria	B - Lough Derg without Storage (122km)	C - Parteen Basin without Storage (157km)	F2 - Lough Derg with Storage (122km)	H - Desalination (25km 10-15ha)
Site/ Location	Baldonnel. There is no further information in the Preliminary Report regarding the Terminal Point Reservoir for this option. However it is assumed that the Terminal Point Reservoir will be the same for all Shannon options. Following selection of preferred option F2- Clonaghlis was selected as an optimised location for the Terminal Point Reservoir. This location may need to be changed depending on the size of the Terminal Point Reservoir. As this is a direct option, the Terminal Point Reservoir will be bigger than the one designed on the Clonaghlis Site (Size: 157Ml).	Baldonnel. There is no further information in the Preliminary Report regarding the Terminal Point Reservoir for this option. However it is assumed that the Terminal Point Reservoir will be the same for all Shannon options. Following selection of preferred option F2- Clonaghlis was selected as an optimised location for the Terminal Point Reservoir. This location may need to be changed depending on the size of the Terminal Point Reservoir. As this is a direct option, the Terminal Point Reservoir will be bigger than the one designed on the Clonaghlis Site (Size: 157Ml).	In the Preliminary Report initial outline of options, all Shannon options have the same terminal reservoir location - at Baldonnel. This was taken from recommendation in the Feasibility Study Report 2005. It was outlined in the Feasibility Report that the reason for this location was: > the proximity to existing infrastructure - Leixlip WTP and Saggart Reservoirs. > It had an optimum elevation for : - pipelines hydraulic profile between Shannon and Dublin - Gravity supply potential to Peamount Reservoir > Protection from competing land use pressures due to Airport. Other than this location, there was no further details of termination reservoirs in the Preliminary Report. As the report moves on, and following selection of F2 as the preferred option, the terminal reservoir location is studied further. The location of the Terminal Reservoir is expanded on in the Integration Report - appendix J. This report outlines 5 possible locations for the Terminal Reservoir for option F2. These are Baldonnel, Athgoe, Lyons, Clonaghlis and Peamount. The report recommends an optimised terminal storage location at Clonaghlis. This site appears suitable for the required 47Ml Terminal Point Reservoir.	Initial description of this option in the Preliminary Report indicates Ballycoolin as the location of the Termination Reservoir. There is no details in the Preliminary Report or the Desalination Report Appendix as to why this location was chosen. They refer to the Feasibility Study. This study selects Ballycoolin as the location after a short explanation. This will have to be examined further, especially with regard to integration (see integration). There is no further details on the Terminal Point Reservoir in the Preliminary Report or the Desalination Report.
Supply Links	It is recommended in the Integration Study - appendix J and the Storage Study by McCarthy Hyder, that the Terminal Point Reservoir will supply water by gravity to Peamount (TWL: 87.5mOD) and by rising main to Saggart (TWL:145mOD).	It is recommended in the Integration Study - appendix J and the Storage Study by McCarthy Hyder, that the Terminal Point Reservoir will supply water by gravity to Peamount (TWL: 87.5mOD) and by rising main to Saggart (TWL:145mOD).	It is recommended in the Integration Study - appendix J and the Storage Study by McCarthy Hyder, that the Terminal Point Reservoir will supply water by gravity to Peamount (TWL: 87.5mOD) and by rising main to Saggart (TWL:145mOD).	There is limited detail regarding the Terminal Point Reservoir for the Desalination Option. The desalination plant at North Loughshinny will link to a reservoir at Ballycoolin. A GIS based desktop study was carried out to delineate the proposed transmission route from the desalination plant location at North Loughshinny to the termination point at Ballycoolin reservoir. In-house GIS datasets were used for constraint identification and all route options were mapped at 1:50,000 scale using the Ordnance Survey Ireland Discovery Series raster map. The suggested location will need to be analysed further, as it may not be able to provide the links to the whole DRWSA.

Elevation/ Topography	There is no specific information on elevation for the Terminal Point Reservoir for this option. It is assumed that the elevation requirement will be the same for this option (between 100-110mOD).	There is no specific information on elevation for the Terminal Point Reservoir for this option. It is assumed that the elevation requirement will be the same for this option (between 100-110mOD).	The Terminal Point Reservoir must be placed at an elevation higher than the highest point along the treated water pipeline route from the storage area/WTP at Garryhinch to the Terminal Point Reservoir. This point is located close to Allen/Kilmeague, with an existing ground elevation of approx. 98mOD. The Terminal Point Reservoir will supply Peamount (TWL: 87.5mOD) and Saggart (TWL:145mOD). The elevation must be sufficient to supply Peamount Reservoir by gravity and minimise pumping requirements to supply water to Saggart. The elevation must also minimise the pumping needs at the pumping station located at the Water Treatment Plant. Therefore the recommended bottom water level of the Terminal Point Reservoir must be at a minimum of 100mOD (2m buffer for no-flow conditions). The most suitable location for the Terminal Point Reservoir is between 100-110mOD. Further studies into securing the maximum flow to Peamount (234Mld average flow and 183Mld contingencies in 2035) indicate that the minimum water level, with the recommended 1000mm dia. pipes, is 104m at Clonaghlis. The second outlet to Saggart presents no major constraint on the minimum water level. The pumping station will balance the difference in elevation. However, it is recommended that to optimise the overall pumping cost, the reservoir minimum water level should stay as low as possible . A usable depth of 5m is recommended for storage, which will give a maximum water level of 109mOD.	N/A
Integration Options Layout	This may need to be examined further as the Site, as Clonaghlis may not be suitable for the larger Terminal Point Reservoir that is required for this option.	This may need to be examined further as the Site, as Clonaghlis may not be suitable for the larger Terminal Point Reservoir that is required for this option.	Total distances for Integration Pipeline for 5 potential sites: Peamount-66.8km Athgoe-67.5km Clonaghlis-68.9km Baldonnel-69.1km Lyons-69.7km The Peamount option was taken out due to elevation issues. This leaves Athgoe and Clonaghlis as the preferred options in terms of pipeline length. During the economic assessments, Clonaghlis was the preferred site. When the routes were examined, Clonaghlis had the shorter distance between the WTP and the Terminal Point Reservoir. As this pipe was a larger diameter, it incurred more costs. Therefore Clonaghlis, with the shorter 1200 pipe was the preferred option in terms of cost.	N/A
Vertical Profiles	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	The vertical profiles for each possible Terminal Point Reservoir location are presented in chapter 2 of the Integration Report. All the options satisfy the elevation criteria, except the Peamount location.	N/A
Cost	The cost of the Terminal Point Reservoir for this option has not been looked into in the Preliminary Review. A cost for a 157Ml reservoir was provided in the Storage Study by McCarthy Hyder of 38.3m euro. This will need to be examined in detail. The Terminal Point Reservoir cost for this option will be different from the cost for option F1 and F2, as this option will require a larger Terminal Point Reservoir. However, it may not be necessary to construct a 157Ml reservoir (v large)? If a reservoir could be provided at the mid point, then the required capacity of the Terminal Point Reservoir could be reduced.	The cost of the Terminal Point Reservoir for this option has not been looked into in the Preliminary Report. A cost for a 157Ml reservoir was provided in the Storage Study by McCarthy Hyder of 38.3m euro. This will need to be examined in detail. The Terminal Point Reservoir cost for this option will be different from the cost for option F1 and F2, as this option will require a larger Terminal Point Reservoir. However, it may not be necessary to construct a 157Ml reservoir (v large)? If a reservoir could be provided at the mid point, then the required capacity of the Terminal Point Reservoir could be reduced.	In Economic terms, the recommended site at Clonaghlis was the most competitive of the 5 possible sites. The 5 sites were compared in terms of CAPEX, OPEX and Whole Life Costs. The economic assessment only considered the costs associated with the variable elements of the 5 possible Terminal Point Reservoir sites (i.e. the integration pipeline routes). The cost of the Terminal Point Reservoir itself was not evaluated, as this was considered to be the same for all possible Terminal Point Reservoir location options. There are discrepancies in the cost of the Terminal Point Reservoir for this option. The Preliminary Report summary states 10.5 million euro. In Appendix B of Appendix V of the Preliminary Report, a spreadsheet gives a cost of 12.075 million euro. This cost is for a 42Ml reservoir.	The cost associated with the Terminal Point Reservoir for this option has not been considered (see economic assessment of Option H). The Terminal Point Reservoir will need to provide storage for the projected demand/water produced.
Environmental Receptors	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	When selecting the 5 possible Terminal Point Reservoir sites and integration pipeline routes, environmental constraints such as National monuments, NHA's, proposed NHS's, SAC's & Archaeology were mapped and the recommended sites/routes did not impact these areas. See figures in chapter 2 of the Integration Report.	N/A
Constructability	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	It states in the Integration Report that construction feasibility was assessed on site for each of the suggested Terminal Point Reservoir location options.	N/A

Integration/ Contingency Water	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	It is assumed that this will be the same as option F2. This will need to be examined again if the location changes.	The pipeline configuration suggested has been examined by RPS and will allow for contingency supplies to be made available from the new source. Terminal Point Reservoir to Peamount: twin 1000mm dia. pipes - allow 234Mld gravity feed Terminal Point Reservoir to Saggart: twin 1000mm dia. pipes- 249Mld rising mains The benefits of this configuration will be significant in terms of security/safety of supply and operational flexibility for the entire DRWSA. Crucial maintenance/ refurbishment works on key elements of the existing network would be made possible, particularly at the beginning of each phase.	There are significant issues with regard to integration because of the suggested location of the Terminal Point Reservoir at Ballycoolin. Currently, treated water from Ballycoolin reservoir does not have the potential to supply the southern areas of the DRWSA. This means that the treated desalinated water will not have the potential to supply these areas. This will need to be examined in detail. The possibility of relocating the Terminal Point Reservoir to Clonaghlis or a similar area could be a possible solution. Although this will require another 25km of transmission pipeline (double what has been considered). Another option may be to bring the treated water to Leixlip, which has the potential to supply Saggart.
Flexibility	The Terminal Point Reservoir location and connections will create a link between Leixlip and Saggart which will provide operational flexibility for the whole DRWSA.	The Terminal Point Reservoir location and connections will create a link between Leixlip and Saggart which will provide operational flexibility for the whole DRWSA.	The Terminal Point Reservoir location and connections will create a link between Leixlip and Saggart which will provide operational flexibility for the whole DRWSA.	N/A
Capacity of Terminal Point Reservoir	The required capacity of the Terminal Point Reservoir for this option was not considered in the Preliminary Report. The Storage Study recommended that the required reservoir storage capacity should be 157Ml. This comprises of 21Ml balancing volume, 21Ml of response storage time and 115Ml of contingency storage for mobilisation and repair time. RPS suggest a capacity of 42Ml for option F2. This will not apply to the direct options as there is no bog storage provided. However, there may be issues with regard to finding an appropriate site for the 157Ml Terminal Point Reservoir suggested in the Storage Study. This will have to be examined in detail. There is a possibility that it may not be necessary to construct a 157Ml reservoir (v large)? If a reservoir could be provided at the mid point, then the required capacity of the Terminal Point Reservoir could be reduced.	The required capacity of the Terminal Point Reservoir for this option was not considered in the Preliminary Report. The Storage Study recommended that the required reservoir storage capacity should be 157Ml. This comprises of 21Ml balancing volume, 21Ml of response storage time and 115Ml of contingency storage for mobilisation and repair time. RPS suggest a capacity of 42Ml for option F2. This will not apply to the direct options as there is no bog storage provided. However, there may be issues with regard to finding an appropriate site for the 157Ml Terminal Point Reservoir suggested in the Storage Study. This will have to be examined in detail. There is a possibility that it may not be necessary to construct a 157Ml reservoir (v large)? If a reservoir could be provided at the mid point, then the required capacity of the Terminal Point Reservoir could be reduced.	The Storage Study recommended that the required reservoir storage capacity should be 157Ml. This comprises of 21Ml balancing volume, 21Ml of response storage time and 115Ml of contingency storage for mobilisation and repair time. When the storage study was carried out, it did not envisage bog storage. As the F2 option allows for 12 million cubic meters of storage at Garryhinch, the proposed effective storage for the Terminal Point Reservoir for this option is 42Ml (21Ml balancing volume and 21Ml of response time storage). This means that the size of the Terminal Point Reservoir will be significantly smaller than direct options.	There is no specific detail provided for the capacity of the Terminal Point Reservoir. The reservoir will need to provide storage for 300Mld.
Size of Terminal Point Reservoir	The size of the Terminal Point Reservoir has not been detailed in the Preliminary Report. It may be possible to double the suggested size of the option F2 Terminal Point Reservoir. This would result in storage volume of 84Ml, which would provide 6-7hours storage. The remaining storage would need to be provided by a reservoir where the proposed break pressure point along the pipeline is located. However, it will need to be assessed whether the recommended Terminal Point Reservoir site at Clonaghlis would be suitable for a larger Terminal Point Reservoir.	The size of the Terminal Point Reservoir has not been detailed in the Preliminary Report. It may be possible to double the suggested size of the option F2 Terminal Point Reservoir. This would result in storage volume of 84Ml, which would provide 6-7hours storage. The remaining storage would need to be provided by a reservoir where the proposed break pressure point along the pipeline is located. However, it will need to be assessed whether the recommended Terminal Point Reservoir site at Clonaghlis would be suitable for a larger Terminal Point Reservoir.	The Integration Reports recommend 3 reservoirs to be constructed in 2 phases (each with dimensions - 5m Deep/ 50mWide/ 60m Length).	N/A
Storage at Terminal Point Reservoir	The 157Ml (157,000m^3) reservoir (recommended in the Storage Study) would provide approximately 11-12 hours of storage. It may not be necessary to have a Terminal Point Reservoir this large.	The 157Ml (157,000m^3) reservoir (recommended in the Storage Study) would provide approximately 11-12 hours of storage. It may not be necessary to have a Terminal Point Reservoir this large.	The 42Ml (42,000m^3) reservoir would provide approximately 3-4 hours of storage.	N/A
Configuration of Integration Pipelines	No specific detail for this option. Assumed that this will be the same as option F2.	No specific detail for this option. Assumed that this will be the same as option F2.	As outlined in RPS Preliminary Report	As outlined in RPS Preliminary Report