

Technical Note

To : York Potash Ltd
From : Royal HaskoningDHV
Date : 3rd September 2015
Our reference : PB1586/TN012/BC/HR/Rev2

Subject : YPL: Revised dredging arrangement in the vicinity of the sub River Tees pipelines / tunnels

1.0 Introduction

The proposed York Potash Ltd (YPL) Marine Export Facility (port) at Bran Sands on the River Tees will be constructed within the vicinity of a number of pipelines / tunnels which cross the River Tees beneath the river bed.

The construction includes a piled berthing structure, dredging to form a new berth pocket to a level of -16mCD and dredging in the existing River Tees navigation channel to -14.1mCD adjacent to the new berth.

RHDHV Technical Note TN011 (Reference 1) considered the possible impact of dredging over the sub River Tees pipelines / tunnels. However the dredging arrangement has since been amended such that there will be practically no capital dredging of the river bed directly overlying the pipelines. The purpose of this technical note is to review the possible impact of the proposed works on the sub River Tees pipelines / tunnels in light of the revised dredging arrangement.

2.0 Revised dredging arrangement

The revised dredging arrangement is shown on RHDHV Drawing Nos. PB1586-SK105 Rev. 4. The dredging of the navigation channel to -14.1mCD (-16.95mOD) has been re-arranged such that the crest of the dredged slopes approximately coincides with the alignment of the Breagh Onshore Gas Pipelines, which are the pipelines nearest the new port. The total quay frontage provided will be approximately 480m (reduced from the originally proposed 520m).

The dredging will be carried out in two phases. The first phase will involve the dredging of a berthed pocket to -16mCD and dredging of the navigation channel to -14.1 mCD at the downstream end of the development over a length of approximately 280m. The second phase will involve the dredging of a berthed pocket to -16mCD and dredging of the navigation channel to -14.1mCD at the upstream end of the development (nearest the pipelines) over a length of approximately 200m.

An extract from Drawing No. PB1586-SK105 is shown in Figure 1 below:

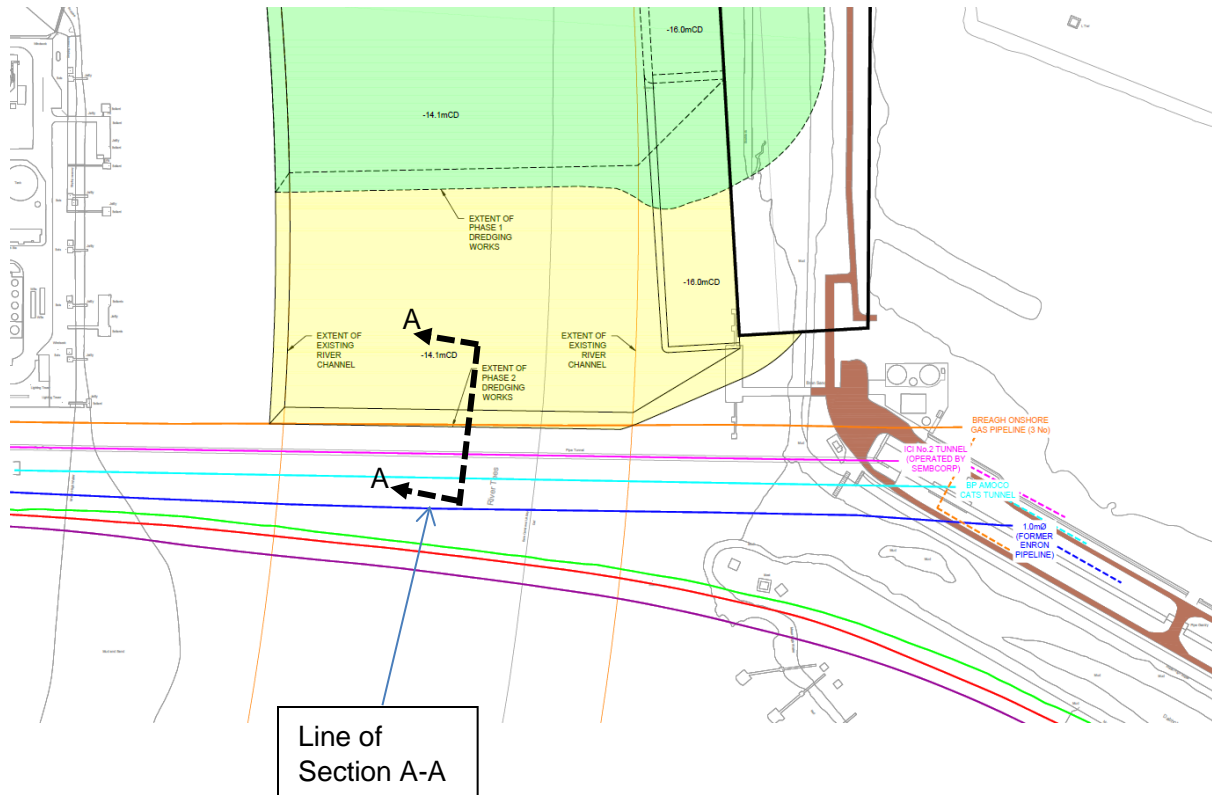


Figure 1: Extract from Drawing No. PB1586-SK105 Rev. 4

3.0 Discussion of the possible effects of dredging / pipelines

A schematic cross section of the revised dredging at mid-channel (Section A-A) is shown in Figure 2 below. The reduction in effective overburden pressure due to the dredging of the river channel to -14.1mCD would be approximately 41 kPa, assuming that the material dredged primarily comprises strata of the Mercia Mudstone formation. The magnitude of the reduction in effective overburden pressure (overburden relief) due to the dredging is likely to reduce with depth and distance away from the dredging according to a Boussinesq (Reference 2) type distribution.

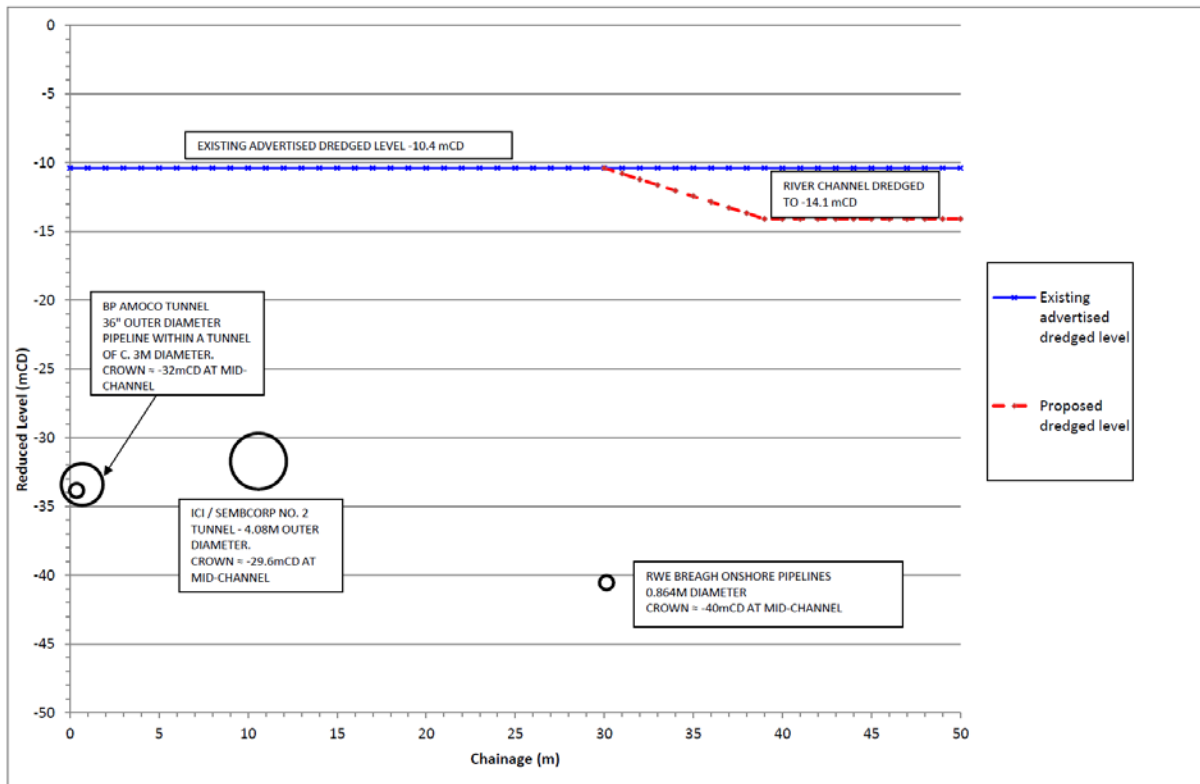


Figure 2: Section A-A - Schematic cross section at mid-channel

Table 1 below provides estimated values for the reduction in effective overburden pressure for each pipeline / tunnel likely to be affected by the revised dredging arrangement. The table also provides comparative values for the original dredging arrangement. The values for reduction in effective overburden pressure, which are expressed as a percentage of the existing effective overburden pressure, were estimated assuming that the reduction in overburden pressure with depth and distance away from the dredging varies according to a Boussinesq type distribution.

Pipeline / Tunnel	Maximum reduction in effective overburden pressure (expressed as % of existing effective overburden pressure)	
	Original dredging arrangement (ref. PB1586/SK105 Rev. 1)	Revised dredging arrangement (ref. PB1586/SK105 Rev. 4)
ICI No. 2 Tunnel	c. 20%	c. 2%
RWE Breagh Onshore Gas Pipelines	c. 30%	c. 6%
BP AMOCO CATS Tunnel, former Enron pipelines, BOC pipelines and Excelerate Energy pipeline	c. 20%	c. 1%

Table 1: Estimated reduction in overburden pressure

It is considered that the magnitude of heave would depend upon the reduction in overburden pressure caused by the dredging and the heave potential of the strata around the pipelines. The information in Table 1 indicates that the revised dredging arrangement would significantly reduce magnitude of overburden relief and thus significantly reduce the likely magnitude of heave in comparison with the originally proposed dredging. However there is insufficient information of the ground conditions to accurately quantify the risk of heave or to carry out the design of mitigation measures.

Therefore it is considered that it will be necessary to carry out an overwater ground investigation in the vicinity of the pipelines to provide information on the heave potential and permeability of the Mercia Mudstone strata. The additional ground investigation could be included within the scope of the proposed ground investigation for the York Potash Marine Export Facility.

4.0 Conclusions and recommendations

This technical note discusses the possible effects on the sub River Tees pipelines which might result from the revised dredging associated with the development of the York Potash Marine Export Facility. Preliminary estimations indicate that the revised dredging arrangement significantly reduces the risk of the heave associated with dredging affecting the ICI No. 2 Tunnel, RWE Breagh Onshore Gas Pipelines and the other pipelines / tunnels which are located further upstream.

The magnitude of the heave may be estimated by geotechnical analysis. However it is considered that additional ground investigation is required in order to carry out a detailed assessment of heave. Such heave assessments should take into account any stipulated constraints on construction near the pipelines.

It is recommended that the following further studies are undertaken to allow the residual risks to be assessed:

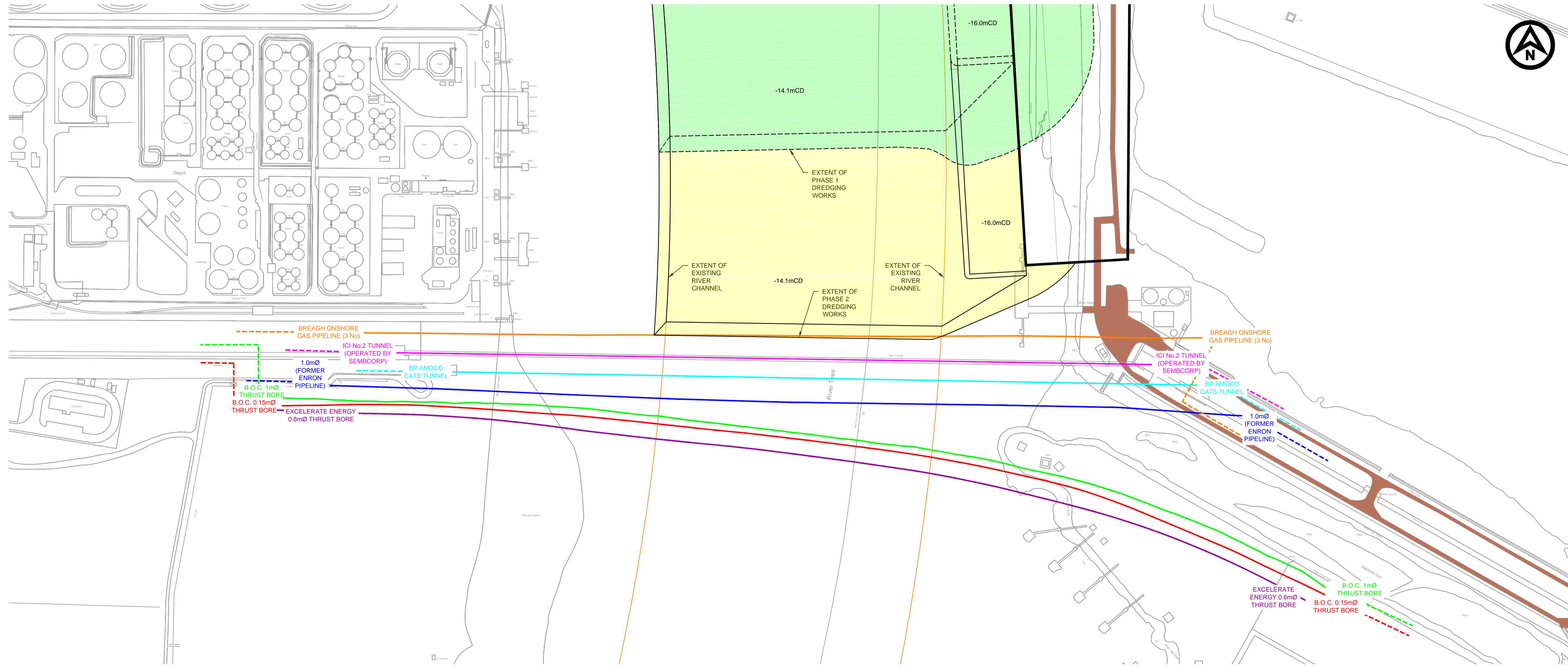
- i) Determine whether there are any restrictions on works over, near or within a certain distance of the sub-River Tees pipelines.
- ii) Carry out an overwater ground investigation in the vicinity of the ICI No. 2 Tunnel and RWE Breagh Onshore Gas Pipelines to provide information on the heave potential and permeability of the Mercia Mudstone strata. The additional ground investigation could be included within the scope of the proposed ground investigation for the York Potash Marine Export Facility.
- iii) Carry out more detailed geotechnical assessments of heave and modified seepage characteristics of the ground following the proposed development.

Once the residual risks have been assessed, the requirement for further mitigation measures can be assessed (if required). Possible additional mitigation measures may include the following:

- a) Undertake structural assessment and monitoring of the ICI No. 2 Tunnel and RWE Breagh Onshore Pipelines.
- b) Strengthening of the ground overlying the pipelines / tunnel (for example by jet grouting).
- c) Strengthening of the pipelines / tunnel.

References:

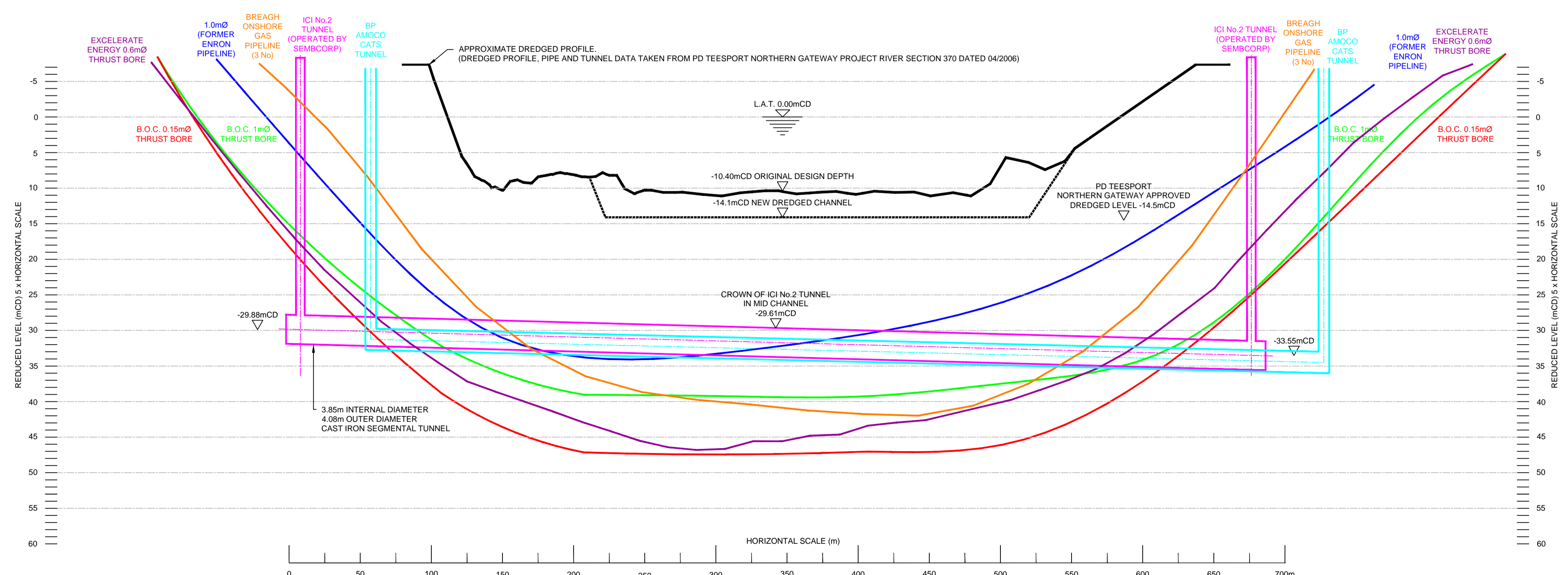
1. Royal HaskoningDHV (2014). Technical Note 11. YPL: Dredging and piling in the vicinity of the sub River Tees pipelines / tunnels Rev. 4. December 2014.
2. Bowles, J.E. (1997). Foundation Analysis and Design. Fifth Edition. McGraw-Hill. Singapore 1997.



- NOTES**
1. DREDGED PROFILE, PIPE AND TUNNEL DATA TAKEN FROM PD TEESPORT NORTHERN GATEWAY PROJECT RIVER SECTION 370 DATED 04/2006 (SOURCE: PD TEESPORT).
 2. DETAILS OF ICI No.2 TUNNEL TAKEN FROM MOTT, MAY & ANDERSON DRAWING No. 505 / N / 201 REV A DATED 06/1974 (SOURCE: PD TEESPORT).
 3. ALL LEVELS STATED RELATIVE TO CHART DATUM.
 4. DETAILS OF BREACH ONSHORE GAS PIPELINES TAKEN FROM MURPHY DRAWING No. DPL0055/DWG/SM003 AND LMR DRILLING DRAWING No. 1385/02/E.
 5. BREACH ONSHORE GAS PIPELINES COMPRISE 864mm DIA. DRILLED HOLE TO TAKE 1 No. 514mm O.D. x 22.2mm W.T. GRADE L450M PIPE AND 2 No. 89mm O.D. x 7.6mm W.T. GRADE L245 PIPES.
 6. BP AMOCO CATS TUNNEL IS C. 3m DIA AND INCLUDES A 36" DIA PIPELINE.
 7. ALL ASSET POSITIONS SHOULD BE CONFIRMED WITH ASSET OWNERS/OPERATORS PRIOR TO ANY CONSTRUCTION OR INVESTIGATION WORKS.

KEY

- PHASE 1 DREDGING
- PHASE 2 DREDGING



REV	DATE	DESCRIPTION	BY	CHK	APP
4	2025/10	BP AMOCO TUNNEL DETAILS ADDED	GIC	BC	RWP
3	19/03/15	ISSUED FOR INFORMATION	SA	DGB	DGB
2	12/12/14	PLANNING ISSUE	GIC	RWP	RWP
1	09/12/14	PLANNING ISSUE	TF	RWP	RWP
D3	04/12/14	LEGEND AND EXCELERATE PIPE ADDED	TF	BC	RWP
D2	03/12/14	ADDITION OF BREACH ONSHORE GAS PIPELINE	TF	BC	RWP
D1	03/10/14	DRAFT FOR COMMENT	IT	BC	RWP
REV	DATE	DESCRIPTION	BY	CHK	APP

REVISIONS

YORKPOTASH
A Sirius Minerals Project

PROJECT
YORK POTASH
CONCEPT OPTIONS DEVELOPMENT REPORT

TITLE
PROPOSED DREDGING
IN VICINITY OF SUB
RIVER TEES PIPELINES

Royal HaskoningDHV
Enhancing Society Together

HASKONINGDHV UK LTD
MARITIME & WATERWAYS
Marborough House
Marborough Crescent
Newcastle upon Tyne NE1 4EE
+44 (0) 191 211 1300 Telephone
+44 (0) 191 211 1313 Fax
info@newcastle.royalhaskoning.com Email
www.royalhaskoningdhv.com Internet

DRAWN	GIC	CHECKED	PASSED
DATE	SEP 14	CLIENT'S REF.	
SCALE	AT A1	AUTOCAD REF.	PB1586-SK105

DRAWING No. **PB1586-SK105** REVISION **4**