



# Husky Energy

## Technical Note

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**Atlantic Region**

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**Argentia Graving Dock - Groundwater Monitoring Plan**

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Kevin Bennett  
Project Coordinator

  
John Shortall  
Construction Engineer

  
David Pinsent Sr.  
Environmental Advisor

  
Gordon Phillips  
Project Manager

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Date

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Checked

Lead Approval

Management  
Approval

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## 1.0 Introduction

Husky Oil Operations Limited (Husky), on behalf of the White Rose Extension Project (WREP) proponents, Husky, Suncor Energy Inc. (Suncor) and Nalcor Energy – Oil and Gas Inc. (Nalcor), is leading the development of the WREP.

The WREP will involve a new Wellhead Platform (WHP) design that consists of a Concrete Gravity Structure (CGS) with topsides that consists of drilling facilities, well heads, requisite life-support services and safety systems. The WHP will be a bottom founded structure that is similar to other WHPs in use elsewhere in the world with the exception of being able to mitigate the risk posed by a combination of harsh weather, icebergs and pack ice.

There will be no storage or processing of fluids onboard the WHP, therefore produced fluids will be transported via subsea flowlines tied back to the Sea Rose Floating Production Storage and Offload vessel (FPSO) for processing and off-loading to dedicated shuttle tankers.

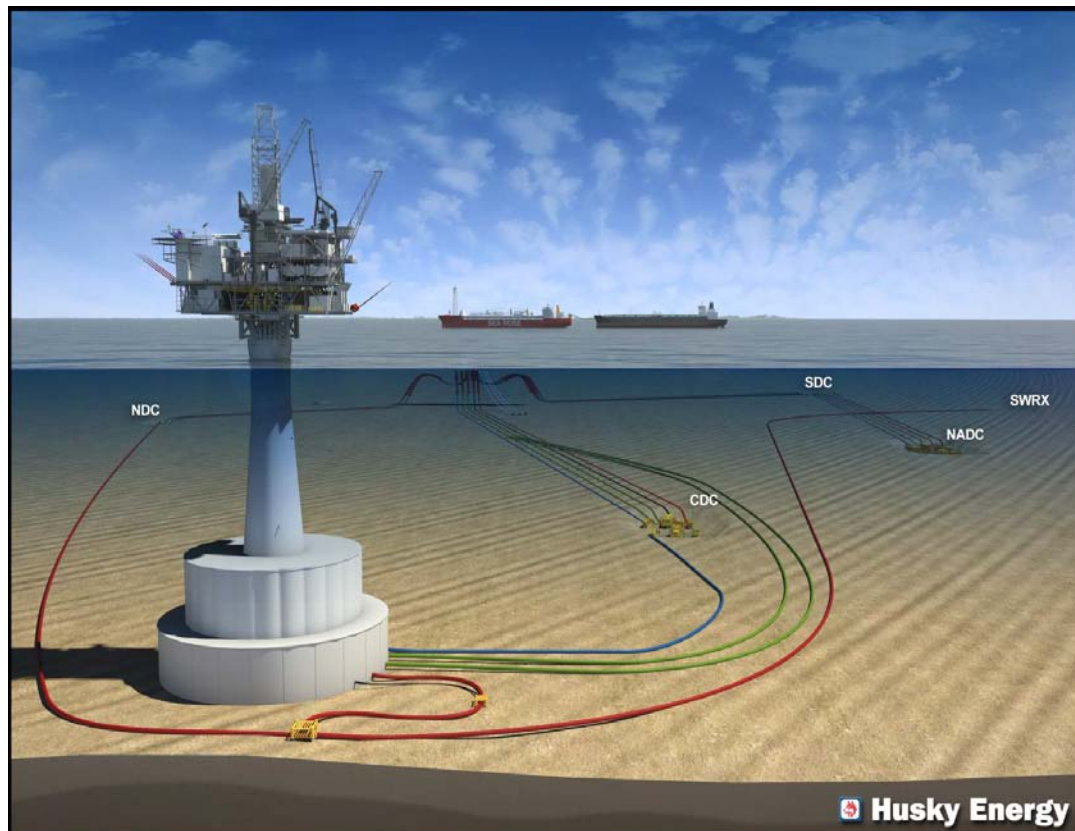


Figure 1 - Wellhead Platform

The CGS portion of the WHP will be built in a Graving Dock in Argentina. The site consists of a 20 hectare lease area, access road, temporary haul road and The Pond. Refer to Figure 2 for an arrangement of the Areas of Interest.



**Figure 2 - Argentia Peninsula - Areas of Interest**

Figure 3 below shows a concept of the CGS in the Graving Dock.



**Figure 3 – CGS in Graving Dock**

## 2.0 Definitions and Acronyms

AMA	Argentia Management Authority
CCME	Canadian Council of Ministers of the Environment
CD	Chart Datum
CGS	Concrete Gravity Substructure
EA	Environment Assessment
EPP	Environmental Protection Plan
FPSO	Floating Production Storage and Offload
HSEQ	Health, Safety, Environment and Quality
Husky	Husky Oil Operations Limited
kh	Horizontal Permeability
kv	Vertical Permeability
l/s	Liters per Second
Nalcor	Nalcor Energy – Oil and Gas Inc.
NL	Newfoundland and Labrador
NLDEC-WRMD	Newfoundland and Labrador Department of Environment and Conservation – Water Resources Management Division
Suncor	Suncor Energy Inc.
USN	United States Naval
WHP	Wellhead Platform
WREP	White Rose Extension Project

### 3.0 Graving Dock Site

#### 3.1 Site Investigation

A geotechnical and hydrogeological investigation was carried out in the lease area during 2011, 2012 and 2013. The site investigation within the graving dock was comprised of nine geotechnical boreholes, seven observation wells and two pump tests. Arup Canada Inc. (Arup) scoped and interpreted the geotechnical investigation. Stantec Consulting Ltd. (Stantec) scoped, supervised and interpreted the pump tests. The fieldwork for the geotechnical boreholes and observation wells was supervised by Golder Associates Ltd. (Golder).

The boreholes were drilled to 40m below ground level and penetrated between 11m to 17m below the -18m CD dock floor. A shallow pump test was located on the inland slope furthest from the sea and a deep pump test was located on the seabund slope. See Appendix A Drawing WH-K-98W-K-LY-00005-001 "Graving Dock Geotechnical Borehole Location Plan" for further information.

The site investigation shows the stratigraphy to be very heterogeneous. No rock was encountered so overburden depths exceed 40m. The overburden is a heterogeneous mixing of glacially derived materials consisting of gravels, sands, silts, clays and various combinations of these constituents. Both high permeable gravel and sand lenses and low permeability silt and clay lenses exist. In-situ testing shows the ground to be generally very dense to hard. However the high particulate nature of the ground had an impact on the in-situ testing leading to a very high number of refusals.

PW1, the shallow pump test, indicated aquifer permeabilities to be of the order of  $1 \times 10^{-4}$  m/s while PW2 indicated aquifer permeabilities to be of the order of  $2 \times 10^{-4}$  m/s. Both wells yielded significantly higher flows than anticipated from the stratigraphy of the surrounding observation wells and boreholes.

In order to assess groundwater inflow volumes into the excavated dock, flow analyses have been undertaken using numerical analysis for assessment of groundwater flow. This is particularly useful for problems with no closed form solution (i.e. anisotropic soils with cut-off walls). The outer/ inner ring of wells taken to -28mCD/ -32mCD will be partly penetrating the full aquifer. The aquifer depth was assumed to be to -50mCD in the analyses where an impermeable stratum has been modeled.

The analyses are based on the following:

- A range of overall permeability between 1 and  $2 \times 10^{-4}$  m/sec based on PW1 and PW2 results, respectively. The  $k_h$  to  $k_v$  relationship is unknown, hence sensitivity analyses were undertaken for  $k_h = k_v$ ;  $k_h = 10k_v$ ;  $k_h = 100k_v$ .
- The base of the unconfined aquifer is unknown (assumed - 50mCD). It is assumed there is no upflow from tight bedrock.

The inflow rate on a given cross-section depends on  $k_h$  and the ratio of  $k_h$  to  $k_v$ , the presence and location of the cut-off wall on the cross-section and the distance to the recharge boundary (i.e. the sea). The total dock inflow was calculated to be in the range of 500l/s to 1000l/s for  $k_h:k_v = 10:1$  and  $k_h:k_v=1:1$ , respectively. This is considered to represent the range of potential inflows. A further allowance of 250l/s vertical upflow has been assumed into the dock floor slope toe drains and drainage blanket. A total dock inflow between 750 and 1250 l/sec has thus been considered in design. A further allowance of 250l/s vertical upflow has been assumed into the dock floor slope toe drains and drainage blanket. A total dock inflow between 850 and 1250 l/sec has thus been considered in design.

During 2011, 2012 and 2013, Husky conducted a soil sampling program within the area of the proposed Graving Dock site located on the former United States Naval Base in Argentia, Newfoundland and Labrador (NL). The scope of work involved the excavation of ten (10) test pits and drilling ten (10) boreholes to assess the environmental conditions at the site to determine any environmental impacts to soil. Note that only seven (7) boreholes provided sufficient amount of soil samples for reliable laboratory testing.

The test results from the soil sampling program demonstrate compliance of the material with Canadian Council of Ministers of the Environment (CCME) guidelines.

### **3.2 Excavation**

The overall quantity of material to be excavated from the lease area during the construction of the Graving Dock is currently estimated at 1,366,000 m<sup>3</sup>. Approximately 192,000 m<sup>3</sup> of this material will be used to raise the level of the Lease Area leaving a balance of 1,174,000 m<sup>3</sup> to be removed from the Graving Dock area.

The finished base level of the Graving Dock during CGS construction shall be at -18m CD to allow a minimum 0.5m underkeel clearance at all states of tide so that there are minimal restrictions on the date of the float-out. A working space of at least 13m width shall be provided around the perimeter of the CGS. The current dimensions of the dock floor at -18.5m CD where the CGS will be constructed are approximately 148m x 172m. Refer to the Graving Dock Cross Sections drawing WH-K-98W-K-LY-00004-001 for further information.

### **4.0 Dewatering**

In order to lower and maintain the groundwater levels during excavation and construction of the CGS in the Graving Dock area, a dewatering design has been provided based on anticipated flows in the order of 850 and 1250 l/sec. The dewatering elements are deep wells, cut off walls and a settling pond.

#### **4.1 Deep Wells**

Eighty three (83) deep wells, comprising filter zones, well screens and submersible pumps shall be installed around the Graving Dock on benches at various levels to lower the water table inside the Graving Dock.

An outer ring of deep wells will be installed at 20m centers from the -4m CD bench in the seabund and at +8.5mCD along the land slopes for the 1st stage of groundwater level reduction from +3mCD to -12mCD.

An inner ring of deep pumped wells will be installed from the -11mCD bench at 20m centers (offset 10m from the upper ring) for the 2nd stage groundwater level reduction to -19mCD below the dock floor.

A groundwater monitoring system comprising of 21 standpipe piezometers will be installed to allow monitoring of ground water levels in the Graving Dock during excavation and the construction of the CGS. Monitoring of the dewatering pumps and the permanent works piezometers shall be maintained to ensure controlled dewatering conditions are adequate.

A series of inclinometers in the seabund will be installed to provide information on potential ground movements and developing conditions.

A standard piped trench drain at the toe of the slopes and a drainage blanket under the CGS will be installed to drain surface and ground water. These drains are connected to the pumped dock floor sumps.

The dewatering system, deep wells, piezometers and inclinometers can be seen in Appendix A Drawing WH-K-98W-K-LY-00007-001 "Graving Dock Dewatering Layout" Sheet 1 of 2" and WH-K-98W-K-LY-00007-002 "Graving Dock Dewatering Layout" Sheet 2 of 2".

#### **4.2 Cut-Off Walls**

An impermeable cut-off wall will be constructed to prevent the transmission of seawater to the Graving Dock along the seabund approximately 80m along the side land slopes. The seabund cut-off wall is 800mm thick and extends to -28mCD from an elevation of +5mCD along the seabund side and +3mCD along the landside returns.

A second impermeable cut-off wall will be constructed along the line of the proposed Graving Dock Gates. This will extend to -40mCD with a top elevation of -18mCD along the dock floor and the remainder following the slope of the Graving Dock side slopes before tying into the seabund Cut-Off Wall returns at a minimum elevation of +5mCD. Refer to Appendix A Drawing WH-K-98W-K-LY-00008-001 "Graving Dock - Cut-Off Wall Layout and Monitoring Details" for further information.



### **4.3 Settling Pond**

A settling pond shall be constructed through which all water removed from the Graving Dock and site will pass before discharge to the sea. The settling pond is sized to allow residence time for suspended solids to settle so as to avoid sedimentation plumes in the sea from construction activities.

The settling pond will be located outside of the cut off wall. It will consist of three parts; Area 1 the forebay will cater for initial settlement of the majority of the sediment remaining in the storm water runoff. The water in the forebay will then discharge to Area 2 via a weir structure where further settlement will occur. The third area will cater for dewatering water and the final surface water after settlement has occurred. The pond will be lined with a geotextile liner to prevent infiltration to the ground. The water from the third area will discharge over a weir, through a silt fence then to a soakaway channel before making its way to the sea. Refer to Appendix A Drawing WH-K-98W-K-LY-00012-001 "Graving Dock - Settling Pond - Sections and Details" for further information.

## **5.0 Groundwater Monitoring Plan**

Baseline Hydrogeological Characterization Concrete Gravity Structure Graving Dock Site Argentia, NL was completed by Stantec as part of the Addendum to the WREP EA (submitted to DOEC on April 23, 2013). This study was carried out to gain a better understanding of the hydrogeological conditions at the Graving Dock site, and in particular to provide information on potential impacts to groundwater quality and quantity in the site area related to the construction and operation of the Graving Dock facility. Based on the results of the study, the project report included a general framework for a groundwater flow and quality monitoring plan for the Graving Dock site. This general groundwater monitoring framework was subsequently modified based on discussions with the Newfoundland and Labrador Department of Environment and Conservation – Water Resources Management Division in preparation of this document.

The following sections outline the proposed groundwater monitoring plan for the Graving Dock site. This Plan has been prepared to satisfy the requirements of White Rose Extension Project Scoping Document (C-NLOPB, 2012), and will serve as guidance for monitoring of groundwater flow and quality during the construction and operation of the Graving Dock facility.

### **5.1 Groundwater Quality Monitoring**

Water generated from construction dewatering activities as well as surface water drainage inside the graving dock will be directed into a settling pond prior to discharge into the marine environment. Water samples will be collected at the overflow weir and compared to the NL Environmental Control Water and Sewage Regulations, 2003 Schedule A parameters. The sampling program will include the following requirements:

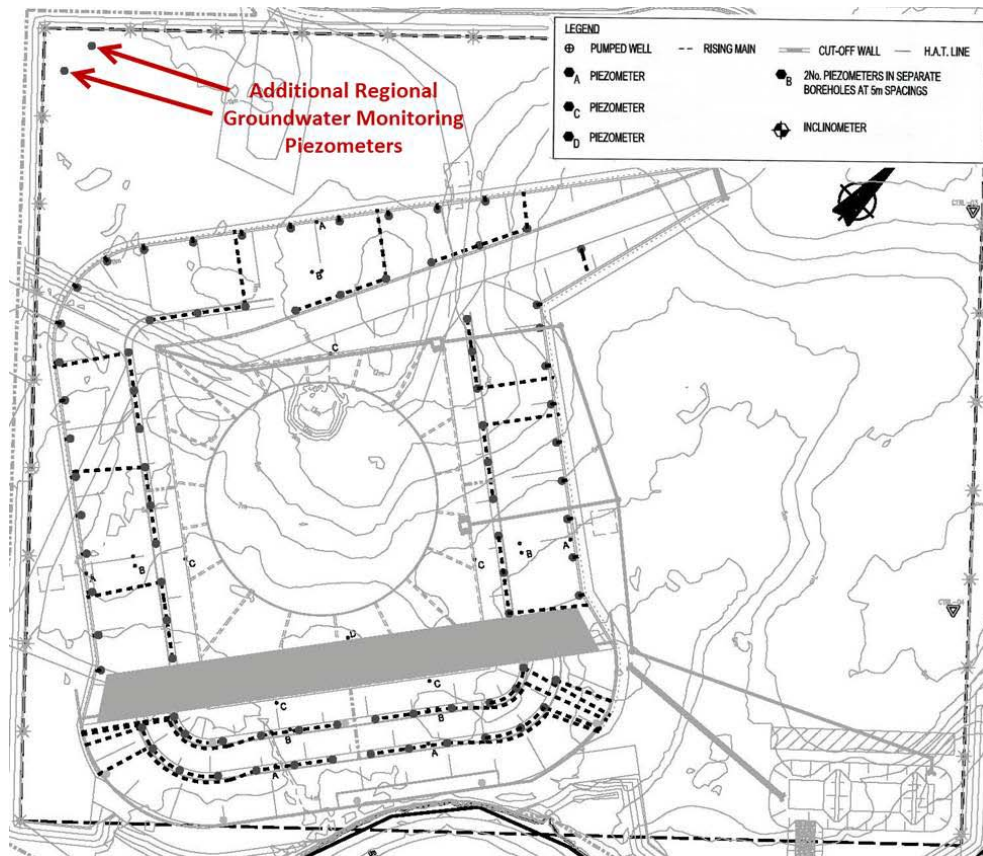
- Once a day for first week of pumping prior to discharge or where additional source of water are added to the treatment system.
- Twice a week (every three or four days) for next three weeks.

- Once a month thereafter.
- If exceedances are detected appropriate mitigation measures will be implemented. Also, the applicable regulatory bodies will be contacted.
- Effluent discharge from the settling pond will be visually inspected on a daily basis. If issues are identified a sample will be collected immediately.

## **5.2 Groundwater Flow Monitoring Plan**

Based on results of the Baseline Hydrogeological Characterization study (Stantec, 2013), the Graving Dock dewatering is anticipated to result in drawdown in the host aquifer that decreases with distance from the excavation. While preliminary estimates of drawdown extent exceed 2,000 m, the actual degree of drawdown will depend on the mitigative effects of the cut-off walls and actual dewatering flows. Monitoring of water levels in the aquifer adjacent to and at distance from the excavation will monitor actual groundwater level drawdown effects and changes to natural hydraulic gradients both within and in outlying areas of the Graving Dock site.

The dewatering plan includes a series of monitor wells (piezometers) located in the excavation, seabund and land-side slopes to monitor groundwater levels and hydrostatic pressures at the Graving Dock site. In addition, two (2) additional monitoring wells (piezometers) will be installed inland at a distance of approximately 80 m from the west side of the Graving Dock to monitor any changes in regional groundwater flow patterns associated with construction and operation of the facility, and to verify that actual effects on the regional groundwater flow regime are consistent with that predicted as part of the Baseline Hydrogeological Characterization study. The locations of the monitoring wells (piezometers) for the dewatering system and the additional monitoring wells for regional groundwater flow effects are shown in Figure 4 below.



**Figure 4 - Additional Groundwater Monitoring Piezometers**

### 5.2.1 Monitor Well Design & Procedures

The water levels will be measured using an electric water level tape in combination with in-situ, automated water level dataloggers.

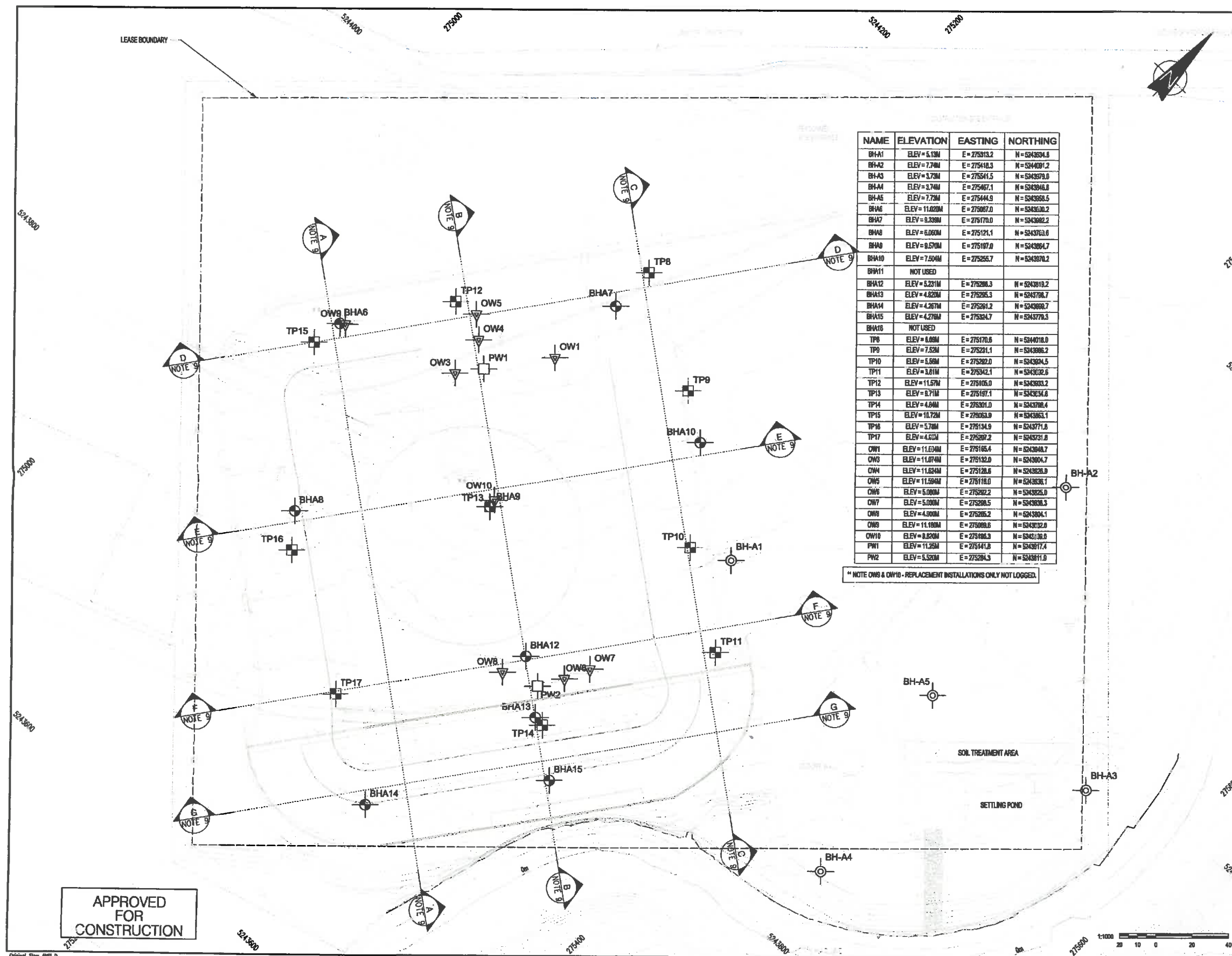
The results of routine groundwater level monitoring will be added to a cumulative database, and ultimately used to generate long-term water level hydrographs for select monitor wells at key locations of the site, including for the two (2) outlying monitoring wells located inland from the Graving Dock. Groundwater level data collected from these two (2) monitor wells will be compared to groundwater levels and drawdowns predicted during construction and operation of the Graving Dock as part of the Baseline Hydrogeological Characterization Study. The water levels in the monitoring wells (piezometers) will be measured daily. Depending on results of groundwater level monitoring, additional evaluation of the groundwater monitoring plan will be undertaken.

### **5.3 Reporting**

In order to maintain a consistent, accurate and useful monitoring program, all aspects of the sampling, analysis, and data management will be maintained and trended in a consistent manner so that groundwater levels and water quality will be comparable over long time periods. Groundwater monitoring reports will be prepared and submitted quarterly to the NL Department of Environment and Conservation during construction of the Graving Dock and CGS.

A database management system will be established for the Graving Dock project. This will be populated with the existing baseline work, and added to with the new monitoring data over the course of the project. The database will include ground water levels and water chemistry.

## 6.0 Appendix A - Graving Dock Reference Drawings



NAME	ELEVATION	EASTING	NORTHING
BHA1	ELEV = 5.13M	E = 275313.2	N = 5243504.6
BHA2	ELEV = 7.74M	E = 275410.3	N = 5244001.2
BHA3	ELEV = 5.73M	E = 275541.5	N = 5243593.0
BHA4	ELEV = 5.74M	E = 275467.1	N = 5243540.8
BHA5	ELEV = 7.73M	E = 275444.0	N = 5243550.5
BHA6	ELEV = 11.02M	E = 275067.0	N = 5243530.2
BHA7	ELEV = 8.33M	E = 275170.0	N = 5243582.2
BHA8	ELEV = 6.06M	E = 275121.1	N = 5243753.6
BHA9	ELEV = 8.57M	E = 275187.0	N = 5243584.7
BHA10	ELEV = 7.50M	E = 275255.7	N = 5243570.2
BHA11	NOT USED		
BHA12	ELEV = 5.23M	E = 275286.3	N = 5243519.2
BHA13	ELEV = 4.62M	E = 275265.3	N = 5243758.7
BHA14	ELEV = 4.26M	E = 275261.2	N = 5243588.7
BHA15	ELEV = 4.27M	E = 275324.7	N = 5243775.3
BHA16	NOT USED		
TP8	ELEV = 4.09M	E = 275170.6	N = 5244018.0
TP9	ELEV = 7.52M	E = 275231.1	N = 5243586.2
TP10	ELEV = 5.59M	E = 275282.0	N = 5243524.5
TP11	ELEV = 3.61M	E = 275342.1	N = 5243532.6
TP12	ELEV = 11.57M	E = 275105.0	N = 5243533.2
TP13	ELEV = 8.71M	E = 275197.1	N = 5243534.6
TP14	ELEV = 4.64M	E = 275301.0	N = 5243788.4
TP15	ELEV = 10.72M	E = 275053.9	N = 5243563.1
TP16	ELEV = 5.78M	E = 275134.9	N = 5243771.8
TP17	ELEV = 4.62M	E = 275287.2	N = 5243731.8
OW1	ELEV = 11.04M	E = 275165.4	N = 5243584.7
OW2	ELEV = 11.07M	E = 275192.0	N = 5243504.7
OW3	ELEV = 11.52M	E = 275128.6	N = 5243528.9
OW4	ELEV = 11.59M	E = 275118.0	N = 5243535.1
OW5	ELEV = 5.00M	E = 275282.2	N = 5243535.0
OW6	ELEV = 5.09M	E = 275280.5	N = 5243538.3
OW7	ELEV = 4.30M	E = 275285.2	N = 5243504.1
OW8	ELEV = 11.18M	E = 275088.6	N = 5243532.0
OW9	ELEV = 8.52M	E = 275188.3	N = 5243530.6
PW1	ELEV = 11.25M	E = 275141.8	N = 5243517.4
PW2	ELEV = 5.52M	E = 275284.3	N = 5243511.9

\* NOTE OW8 & OW10 - REPLACEMENT INSTALLATIONS ONLY NOT LOGGED.

- NOTES :
- COORDINATE SYSTEM : NAD 83 UTM ZONE 22N.
  - ALL LEVELS ARE TO CHART DATUM = 6.21M ABOVE ELLIPSOID OF NAD 83 UTM ZONE 22N.
  - DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT SPECIFICATIONS AND RELEVANT STANDARD DRAWINGS.
  - FOR DETAILS OF BOREHOLES REFER TO WH-K-98W-K-LY-0001-001.
  - CONTOURS SHOWN REPRESENT EXISTING GROUND LEVELS.
  - SOIL TREATMENT AREA PROVIDED FOR BULK STORAGE OF POTENTIAL CONTAMINATED SOIL WHERE REQUIRED.
  - REFER TO SITE LAYOUT PLAN WH-K-98W-K-LY-0002-001 FOR SURVEY CONTROL POINTS AND LEASE BOUNDARY COORDINATE LOCATIONS.
  - REFER TO WH-DWH-40-02 FOR TOPOGRAPHICAL SURVEY INFORMATION. THIS IS PROVIDED FOR INFORMATION PURPOSES ONLY, ACCURACY SHALL BE CONFIRMED BY THE GRAVING DOCK CONTRACTOR.
  - REFER TO SHEETS WH-K-98W-K-LY-0003-001 TO WH-K-98W-K-LY-0005-004 FOR INDICATED SECTION VIEWS.
  - DO NOT SCALE OFF DIMENSIONS.

- LEGEND :
- NOVEMBER 2012 GEOTECHNICAL BOREHOLE LOCATION
  - SEPTEMBER 2012 TEST PIT LOCATION
  - 2011 INVESTIGATION EXISTING BOREHOLE LOCATION
  - OBSERVATION WELL LOCATIONS
  - PUMPING WELL LOCATION

STAMP:

PROVINCE OF NEWFOUNDLAND AND LABRADOR

**PEG**

PERMIT HOLDER

This Permit Allows

ARUP CANADA INC.

To practice Professional Engineering in Newfoundland and Labrador, Permit No. as issued by PEG NO569 which is valid for the year 2013

STAMP:

**PEG**

JOHN POWERS

Professional Engineer

1971

5	WH-K-98W-K-LY-00015-002	SITE ACCESS ROAD PLAN & PROFILE SHEET 2
4	WH-K-98W-K-LY-00015-003	SITE HAUL ROAD PLAN & PROFILE SHEET 3
3	WH-K-98W-K-LY-00008-001	CUT OFF WALL PLAN AND DETAILS
2	WH-K-98W-K-LY-00003-001	GRAVING DOCK LAYOUT PLAN
1	WH-K-98W-K-LY-00002-001	SITE LAYOUT PLAN
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REFERENCE DRAWINGS		
C1	06/12/13	APPROVED FOR CONSTRUCTION
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		BY CHK ENG APR HUS

**Husky Energy**

SUITE 901, SCOTIA CENTRE, 235 WATER STREET  
ST. JOHN'S, NEWFOUNDLAND & LABRADOR, A1C 1E6

ORIGINATING COMPANY:

**ARUP**

SUITE 2400, 2 BLOOR ST. EAST  
TORONTO, ONTARIO, M4W 1A8

PRIME CONTRACTOR:

**ARUP**

PROJECT:

**WHITE ROSE  
EXTENSION PROJECT**

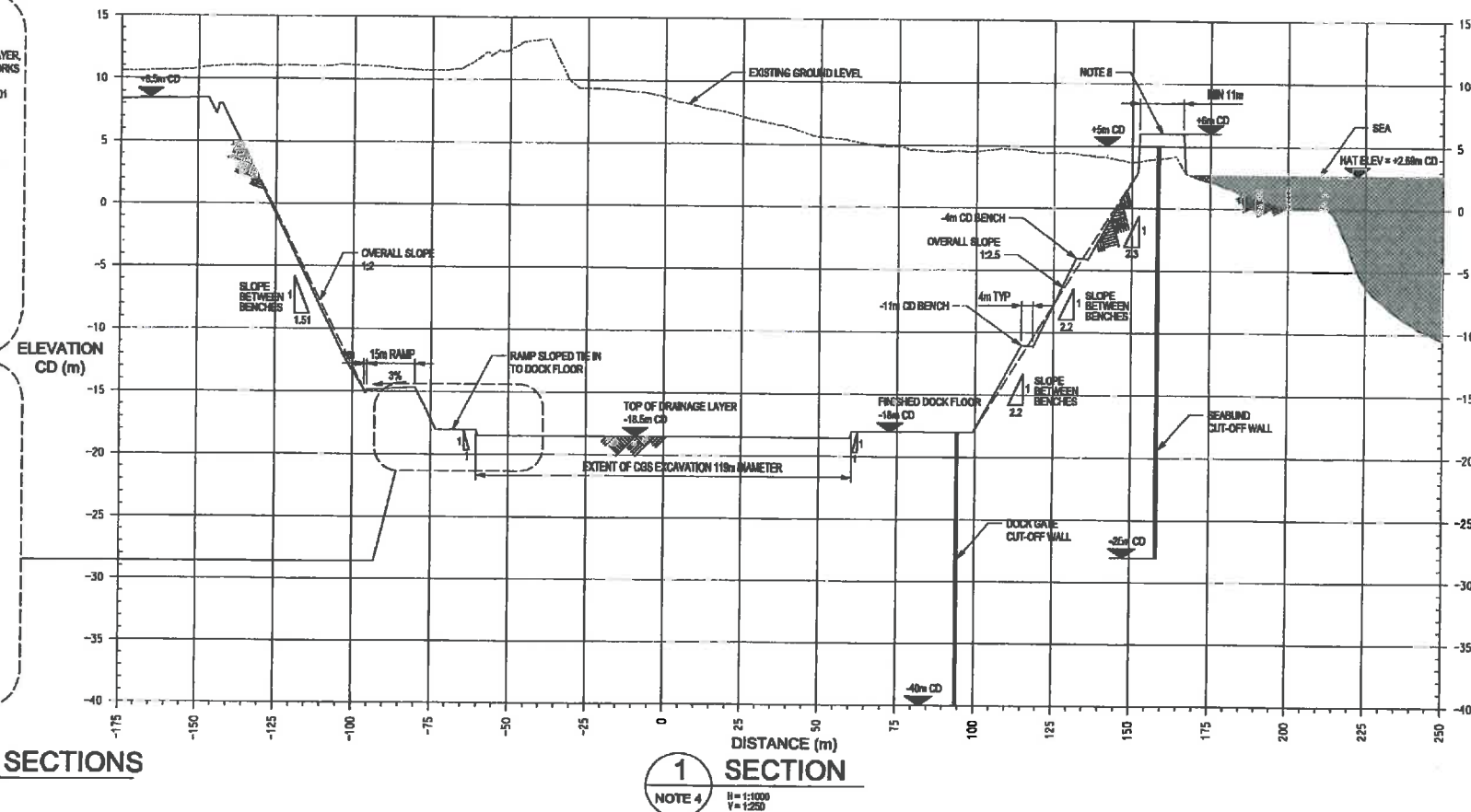
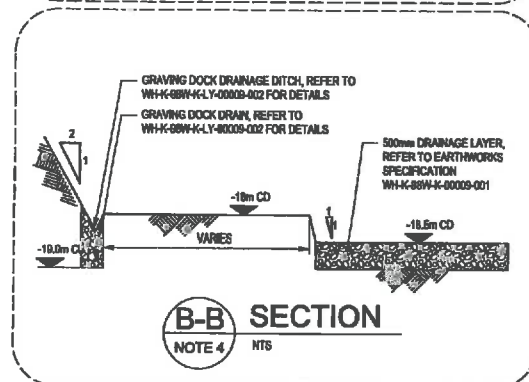
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**GRAVING DOCK  
GEOTECHNICAL  
BOREHOLE LOCATION PLAN**

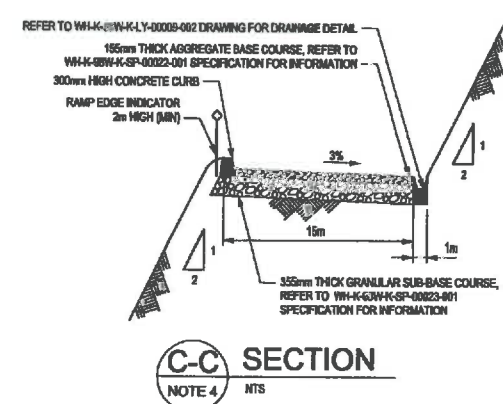
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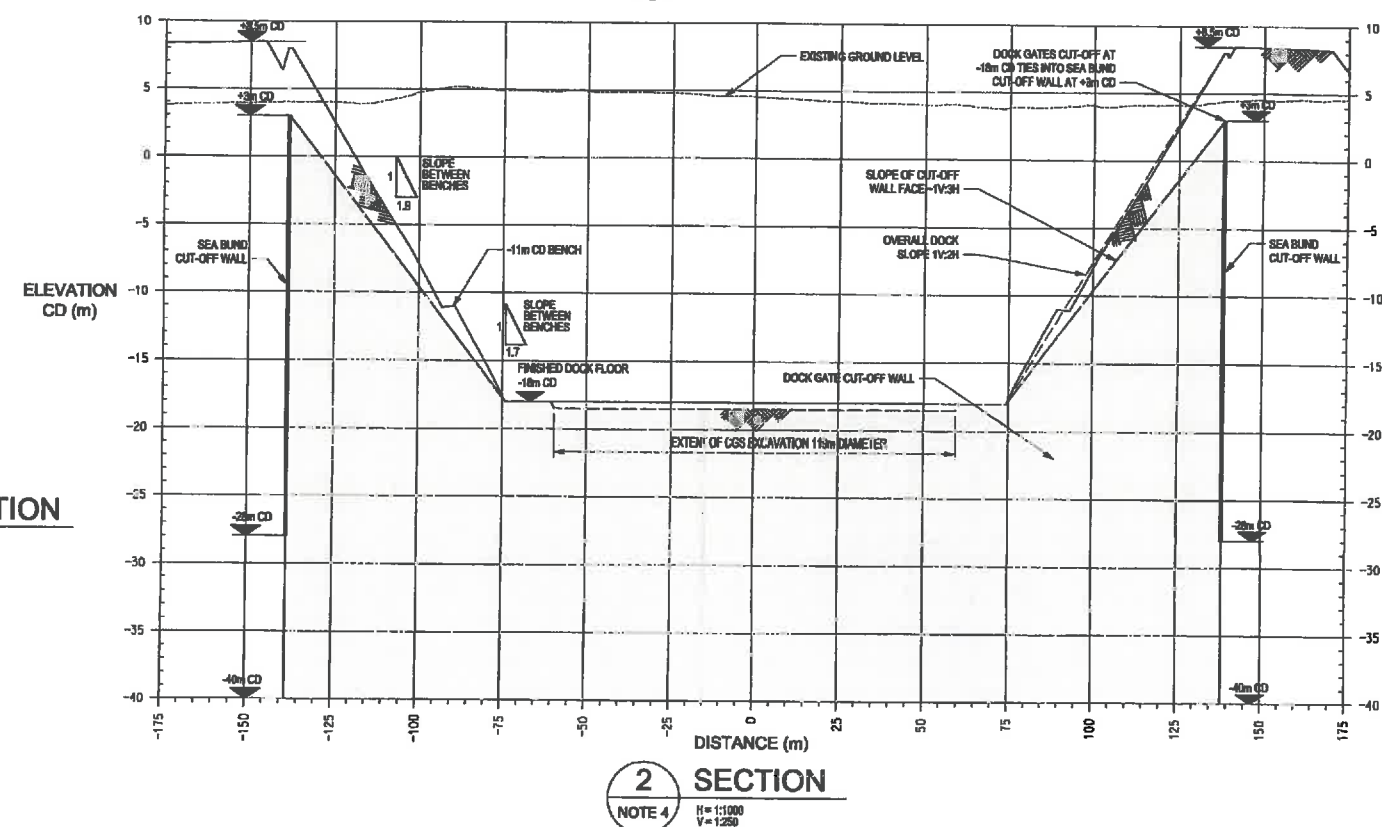
APPROVED FOR CONSTRUCTION



## TYPICAL GRAVING DOCK FLOOR CROSS SECTIONS



### TYPICAL RAMP CONSTRUCTION CROSS SECTION



APPROVED  
FOR  
CONSTRUCTION

Original Size: ANSI D

NOTES :

1. COORDINATE SYSTEM HAD 83 UTM ZONE 22N.
2. ALL LEVELS ARE TO CHART DATUM = 6.2M ABOVE ELLIPSOID OF HAD 83 UTM ZONE 22N.
3. DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT SPECIFICATIONS AND RELEVANT STANDARD DRAWINGS.
4. REFER TO SHEET WH-K-60W-KLY-0000-001 FOR INDICATED PLAN VIEW.
5. RAMP EDGE INDICATOR FLAGS TO BE PLACED AT 3m CENTRES ON HORIZONTAL STRAIGHTS AND AT 0.5m CENTRES ON HORIZONTAL CURVES.
6. CONCRETE CURBS TO BE PLACED ALONG FULL LENGTH OF RAMP.
7. DO NOT SCALE OFF DIMENSIONS
8. REFER TO THE DEWATERING AND GROUNDWATER MONITORING SPECIFICATION WH-K-60W-KSP-0000-001 FOR REQUIREMENTS FOR EARLY WARNING SYSTEMS FOR THE DOCK.

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To practice Professional Engineering in Newfoundland and Labrador, Permit No. as issued by PEG 10569 which is valid for the year <b>2013</b>			
3	WH-K-9BW-K-LY-00009-002	GRAVING DOCK DRAINAGE DETAILS	
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1	WH-K-9BW-K-LY-00003-001	GRAVING DOCK LAYOUT PLAN	
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REFERENCE DRAWINGS			
C1	08/12/13	APPROVED FOR CONSTRUCTION	JS EOD JP JP BY CHK ENG APR HUS
REV	DATE	DESCRIPTION	

## Husky Energy

SUITE 901, SCOTIA CENTRE, 235 WATER STREET  
ST. JOHN'S, NEWFOUNDLAND & LABRADOR, A1C 1B6

ORIGINATING COMPANY:
PRIME CONTRACTOR:

# ARUP

SUITE 2400, 2 BLOOR ST. EAST  
TORONTO, ONTARIO, M4W 1A8

# ARUP

PROJECT:  

## WHITE ROSE EXTENSION PROJECT

## GRAVING DOCK CROSS SECTIONS

DRAWING TITLE:


## GRAVING DOCK CROSS SECTIONS

COMPANY DRAWING NUMBER	HUSKY DRAWING NUMBER	REVISION
224194-DR1-CS-301	WH-K-9BW-K-LY-00004-001	C1

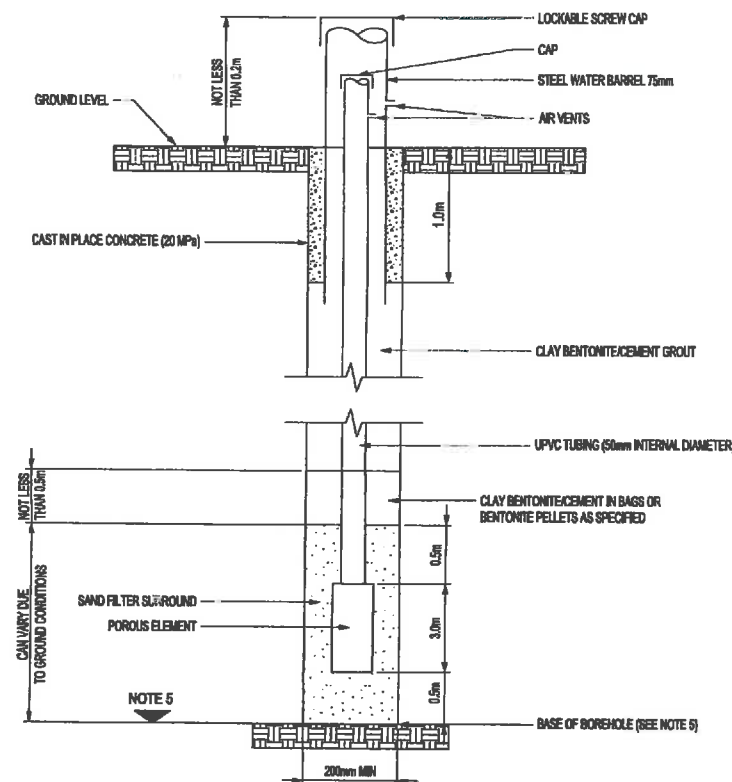
DCN NO:	PROJECT NO: 224194-06	SCALE: AS SHOWN
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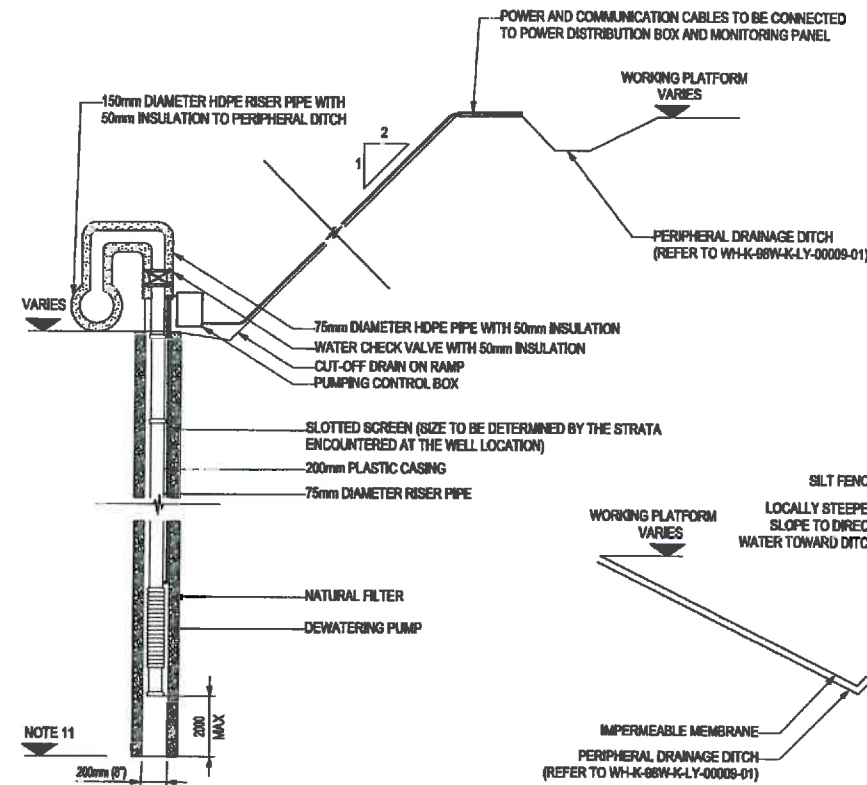
- |                                                                                                             |  |                                                        |  |
|-------------------------------------------------------------------------------------------------------------|--|--------------------------------------------------------|--|
|  <h1>Husky Energy</h1> |  |                                                        |  |
| SUITE 901, SCOTIA CENTRE, 235 WATER STREET<br>ST. JOHN'S, NEWFOUNDLAND & LABRADOR, A1C 1B6                  |  |                                                        |  |
| ORIGINATING COMPANY:<br><h2>ARUP</h2>                                                                       |  | PRIME CONTRACTOR:<br><h2>ARUP</h2>                     |  |
| SUITE 2400, 2 BLOOR ST. EAST<br>TORONTO, ONTARIO, M4W 1A8                                                   |  |                                                        |  |
| PROJECT: <b>WHITE ROSE<br/>EXTENSION PROJECT</b>                                                            |  |                                                        |  |
| DRAWING TITLE: <b>GRAVING DOCK<br/>DEWATERING LAYOUT</b>                                                    |  |                                                        |  |
| COMPANY DRAWING NUMBER<br><b>224194-DR1-CS-401</b>                                                          |  | HUSKY DRAWING NUMBER<br><b>WH-K-98W-K-LY-00007-001</b> |  |
|                                                                                                             |  | REVISION<br><b>C1</b>                                  |  |
| DCN NO:                                                                                                     |  | PROJECT NO: 224194-00                                  |  |
|                                                                                                             |  | SCALE: 1:1000                                          |  |





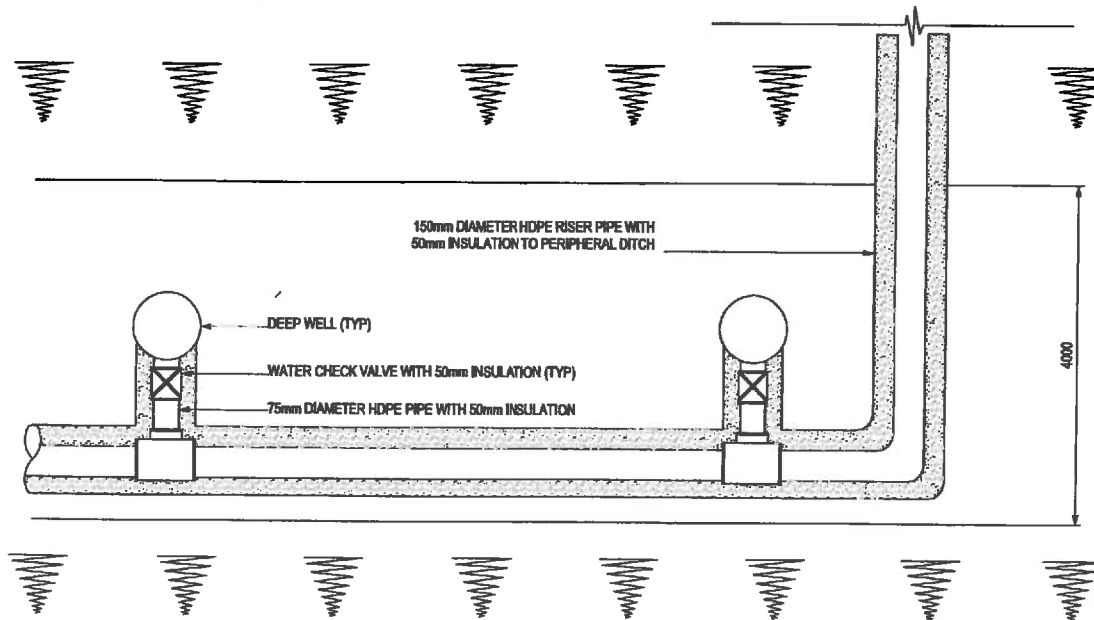
TYPICAL PIEZOMETER DETAIL

NTS



TYPICAL GRAVING DOCK DEEP WELL DETAIL

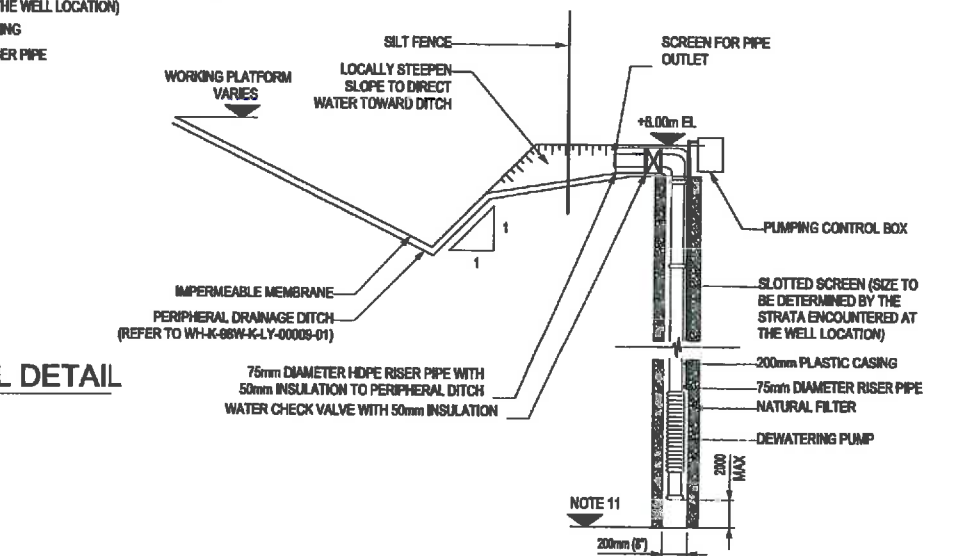
NTS



APPROVED  
FOR  
CONSTRUCTION

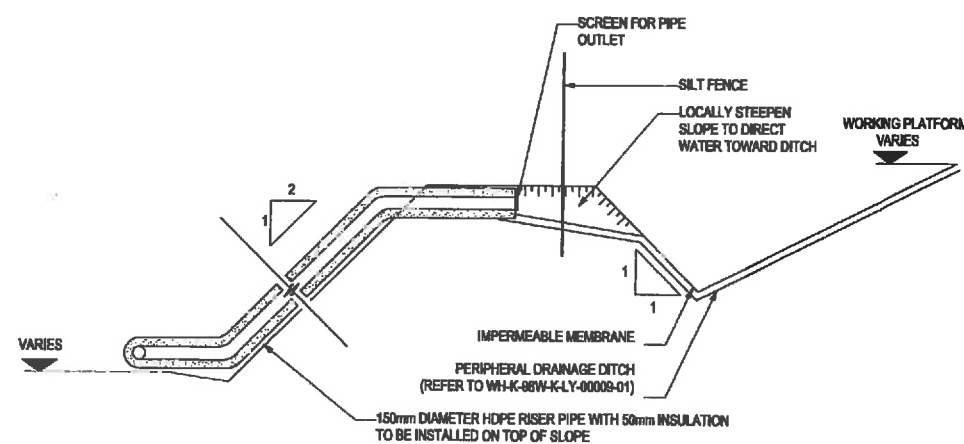
TYPICAL DETAIL FOR DEWATERING RISER

NTS



TYPICAL PERIPHERAL DEEP WELL DETAIL

NTS

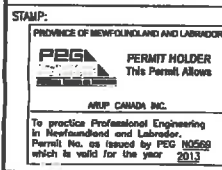


TYPICAL CROSS-SECTION FOR DEWATERING RISER

NTS

# NOTES :

1. LENGTH OF PLAIN CASING AND SLOTTED SCREENS (0.5m, 1.0m) TO BE DECIDED ON SITE TO SUIT SITE CONDITIONS BY HUSKY'S REPRESENTATIVE.
2. ELECTRIC SUBMERSIBLE PUMPS DUTY: 10 L/SEC AT HEAD OF 42m.
3. DUTY AND STANDBY GENERATORS REQUIRED.
4. REFER TO THE DEWATERING SPECIFICATION WH-K-98W-K-SF-00008-001 FOR REQUIREMENTS FOR STAGGERING LABELLING OF PIEZOMETERS. PIEZOMETERS 42m TO BE INSTALLED IN SEPARATE BOREHOLES AT THE FOLLOWING LOCATIONS AND LEVELS:  
A: -12m CD; -18m CD; -28m CD (A3, A2, A1)  
B: -18m CD; -28m CD (B2, B1)  
C: -28m CD (C1)
5. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE DEWATERING SPECIFICATION WH-K-98W-K-SF-00008-001.
6. DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT SPECIFICATIONS AND RELEVANT STANDARD DRAWINGS.
7. INDIVIDUAL PUMPING WELLS AND MONITORING PIEZOMETERS TO BE CLEARLY TAGGED/LABELLED ON SITE IN ACCORDANCE WITH THE TAGGING TABLE PROVIDED IN THE DEWATERING SPECIFICATION WH-K-98W-K-SF-00008-001. POWER LINES TO BE CLEARLY TAGGED WITH WELL ID AT CONTROL PANEL. TAGGING/LABELLING DETAILS TO BE FINALISED AND AGREED WITH HUSKY ON SITE.
8. NO WELLS TO BE CONSTRUCTED WITHIN 30m OF THE CUT-OFF WALL BEFORE THE CUT-OFF WALL IS CONSTRUCTED AND MORE THAN 7 DAYS OLD. HOWEVER, SUCH WELLS MAY BE DRILLED AND CAGED, NO WELLS SHALL BE DRILLED AND CAGED LESS THAN 10m FROM THE CUT-OFF WALL LESS THAN 7 DAYS OLD.
9. SLOTTED SCREEN SHALL BE 200mm (8") OD PLASTIC SLOTTED WELL SCREEN IN A 250mm (10") OD DRILLHOLE.
10. DO NOT SCALE OFF DIMENSIONS.
11. ALL WELLS SHALL EXTEND TO -28mCD EXCEPT FOR WELLS LOCATED ON THE -11mCD BENCH WHICH SHALL EXTEND TO -32mCD.



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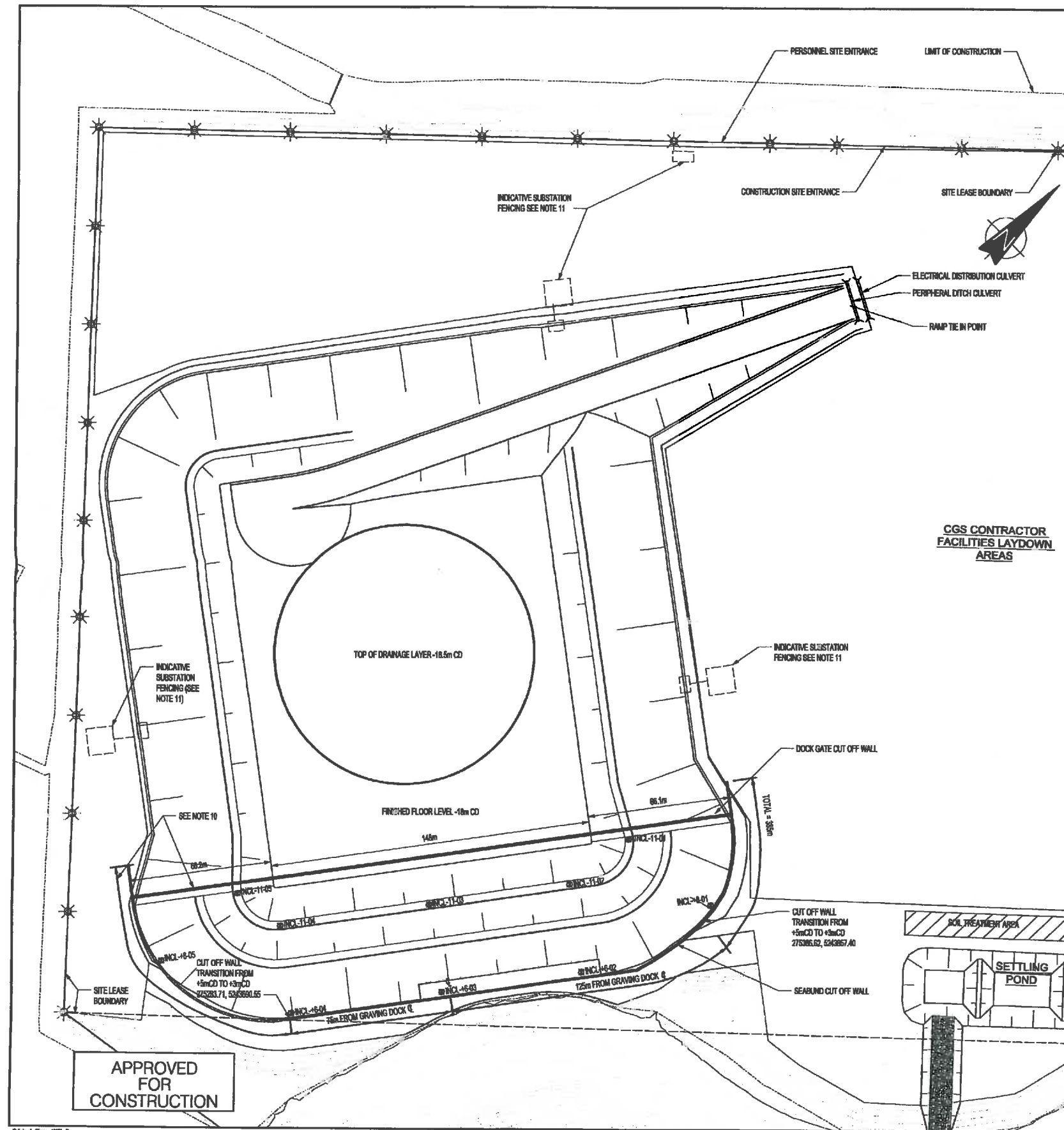
**Husky Energy**  
SUITE 901, SCOTIA CENTRE, 235 WATER STREET  
ST. JOHN'S, NEWFOUNDLAND & LABRADOR, A1C 1B6

ORIGINATING COMPANY: **ARUP**  
SUITE 2400, 2 FLOOR ST. EAST  
TORONTO, ONTARIO, M4W 1A8

PROJECT: **WHITE ROSE  
EXTENSION PROJECT**

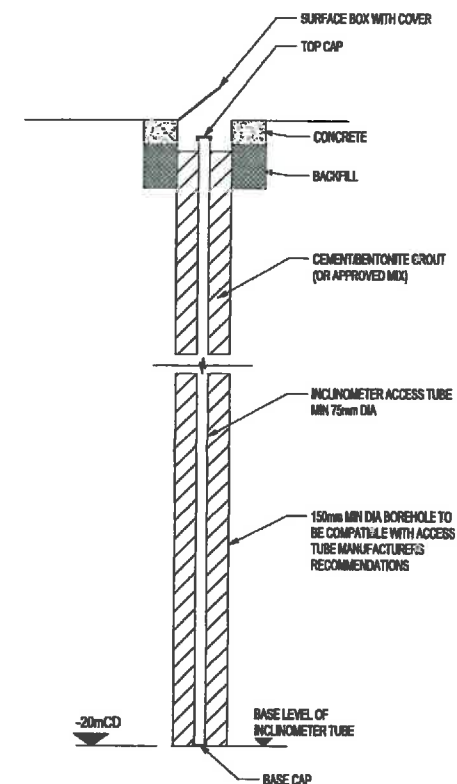
DRAWING TITLE: **GRAVING DOCK  
DEWATERING DETAILS**

COMPANY DRAWING NUMBER	HUSKY DRAWING NUMBER	REVISION
224194-DR1-CS-407	WH-K-98W-K-LY-00007-002	C1
DCN NO:	PROJECT NO: 224194-00	SCALE: 1:1000



# LEGEND :

- SEABUND CUT OFF WALL +5m CD TO -20m CD, LENGTH OF 200m
- SEABUND CUT OFF WALL +3m CD TO -20m CD, LENGTH OF 185m
- DOCK GATE CUT OFF WALL -10m CD TO -40m CD, LENGTH OF 148m
- DOCK GATE CUT OFF WALL DEPTH TO -40m CD, LENGTH OF 132m, TOP OF WALL TO FOLLOW DOCK SIDE SLOPE FACE, SEE WH-K-98W-K-LY-0004-001 FOR DETAILS
- INCL-JXX-XXX INCLINOMETER WITH TAGGING ID NUMBER (NOTE 6)



TYPICAL INCLINOMETER DETAIL

WTS

## NOTES :

- COORDINATE SYSTEM: NAD83 UTM ZONE 22N.
- ALL LEVELS ARE TO CHART DATUM = 6.21M ABOVE ELLIPSOID OF NAD 83 UTM ZONE 22N.
- SITE LEVELS RAISED/LOWERED TO GENERAL PLATFORM LEVEL OF +0M(+/-) CD. REFER TO THE GRADING LAYOUT PLAN DRAWING WH-K-98W-K-LY-0004-001 FOR DETAILS.
- SOIL TREATMENT AREA PROVIDED FOR BULK STORAGE OF CONTAMINATED SOIL WHERE REQUIRED.
- REFER TO SITE LAYOUT PLAN WH-K-98W-K-LY-0002-001 FOR SURVEY CONTROL POINTS, LEASE BOUNDARY COORDINATE LOCATIONS, AND GRADING DOCK LOCATION.
- REFER TO THE INCLINOMETER SPECIFICATION WH-K-98W-K-SF-0003-001 FOR FURTHER DETAILS AND FOR INCLINOMETER TAGGING INFORMATION.
- DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT SPECIFICATIONS AND RELEVANT STANDARD DRAWINGS.
- DO NOT SCALE OFF DIMENSIONS.
- STRUCTURAL STRENGTH OF 100kPa REQUIRED. REFER TO CUT-OFF WALL SPECIFICATION WH-K-98W-K-SF-0007-001 FOR FURTHER INFORMATION.
- CUT-OFF WALL, SEABUND WALL TO -20m CD AND DOCK GATE CUT-OFF WALL TO -40m CD. PERMEABILITY = 1x10<sup>-10</sup> m/s.
- REFER TO ELECTRICAL DETAILS DRAWING WH-K-98W-K-SF-0001-002 FOR DETAILS OF UNIT AND MINI SUBSTATION FENCING AND SIGNAGE DETAILS.
- THE CONTRACTOR'S ATTENTION IS DRAWN TO THE COMPACT/LOOSE GROUND FOUND IN BOREHOLES BH43 AND BH44 IN THE 2011 SITE INVESTIGATION. THE LAYER OCCURRED FROM -1.4m CD TO -14.8m CD IN BH43 AND FROM -8.9m CD TO -15m CD IN BH44. IT IS RECOMMENDED THAT THE CONTRACTOR PRE-PROBE THE GROUND TO A MINIMUM DEPTH OF 20m TO CONFIRM THAT SUCH A COMPACT/LOOSE GROUND IS NOT PRESENT ALONG THE LINE OF THE SEABUND SLURRY CUT-OFF WALL. THE FINDINGS OF THE PROBING EXERCISE SHALL BE ADVISED TO HUSKY'S REPRESENTATIVE WITHIN 48 HOURS OF THE COMPLETION OF EACH PROBE. REFER TO WH-DWH-RP-0010 FINAL GEOTECHNICAL REPORT ARGENTIA HARBOUR ARGENTIA, NL FOR FURTHER INFORMATION.

STAMP:



STAMP:



4	WH-K-98W-K-LY-00012-001	SETTLING POND PLAN AND SECTIONS
3	WH-K-98W-K-LY-00008-001	CUT-OFF WALL PLAN
2	WH-K-98W-K-LY-00014-001	GRADING PLAN
1	WH-K-98W-K-LY-00003-001	DRAWING DOCK LAYOUT PLAN
REF	DRAWING NUMBER	DRAWING TITLE
REFERENCE DRAWINGS		

**Husky Energy**

SUITE 901, SCOTIA CENTRE, 235 WATER STREET  
ST. JOHN'S, NEWFOUNDLAND & LABRADOR, A1C 1B6

ORIGINATING COMPANY:

**ARUP**

SUITE 2400, 2 BLOOR ST. EAST  
TORONTO, ONTARIO, M4W 1A8

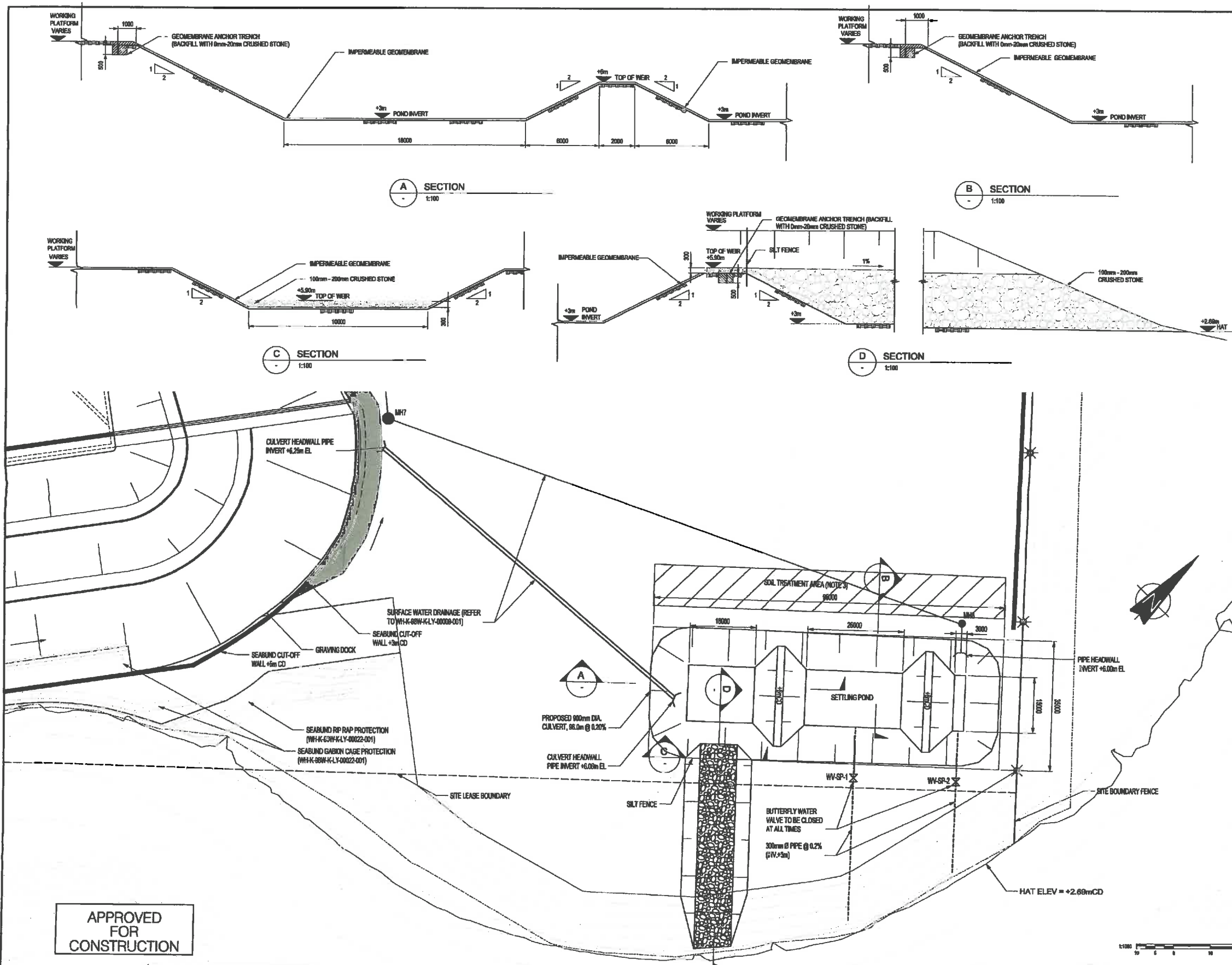
PRIME CONTRACTOR:

**ARUP**

PROJECT: **WHITE ROSE  
EXTENSION PROJECT**

DRAWING TITLE: **GRAVING DOCK  
CUT-OFF WALL LAYOUT  
AND MONITORING DETAILS**

COMPANY DRAWING NUMBER	HUSKY DRAWING NUMBER	REVISION
224194-DR1-CS-901	WH-K-98W-K-LY-00008-001	C1
DCN NO:	PROJECT NO: 224194-00	SCALE: 1:1000



- NOTES :**
- COORDINATE SYSTEM: NAD83 UTM ZONE 22N.
  - ALL LEVELS ARE TO CHART DATUM = 6.21M ABOVE ELLIPSOID OF NAD 83 UTM ZONE 22N.
  - SOIL TREATMENT AREA PROVIDED FOR BULK STORAGE OF POTENTIAL CONTAMINATED SOIL WHERE REQUIRED BY EPP.
  - FOR MATERIAL INFORMATION REFER TO WH-K-98W-K-SP-00014-001 AGGREGATE MATERIALS SPECIFICATION.
  - REFER TO WH-K-98W-K-SP-00014-001 FOR TOPOGRAPHICAL SURVEY INFORMATION. THIS IS PROVIDED FOR INFORMATION PURPOSES ONLY. ACCURACY SHALL BE CONFIRMED BY THE GRAVING DOCK CONTRACTOR.
  - DRAWINGS TO BE READ IN CONJUNCTION WITH RELEVANT SPECIFICATIONS AND RELEVANT STANDARD DRAWINGS.
  - REFER TO DOCUMENT WH-K-98W-K-SP-00014-001 FOR STANDARD DRAWING DETAILS.
  - ALL WORKS SHALL COMPLY WITH THE EPP WH-K-98W-K-SP-00014-001.
  - DO NOT SCALE OFF DIMENSIONS.
  - REFER TO WH-K-98W-K-SP-00014-001 FOR GRADING PLAN LAYOUT DETAILS.
  - THE SETTLING POND IS DESIGNED TO OPERATE DURING THE CGS CONSTRUCTION. ANY USE OF THE SETTLING POND BY THE GRAVING DOCK CONTRACTOR DURING THEIR CONSTRUCTION WORKS SHALL BE AT THEIR OWN RISK. ON HANDOVER, THE POND SHALL BE CLEARED OUT OF ANY SEDIMENTS THAT HAS BUILT UP DURING THE CONSTRUCTION PERIOD AND ANY EROSION DAMAGE SHALL BE REPAIRED.
  - ALL WATER DISCHARGING FROM THE LEASE BOUNDARY DURING THE GRAVING DOCK AND ASSOCIATED SITE INFRASTRUCTURE CONSTRUCTION SHALL BE THE RESPONSIBILITY OF THE GRAVING DOCK CONTRACTOR. ALL REQUIREMENTS AS PER THE EPP SHALL BE ADHERED TO.

STAMP: PROVINCE OF NEWFOUNDLAND AND LABRADOR <b>PBS</b> PERMIT HOLDER This Permit Allows ARUP CANADA INC. To practice Professional Engineering in Newfoundland and Labrador Permit No. as issued by PEO NO. 1013 which is valid for the year 2013	STAMP: 
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SUITE 901, SCOTIA CENTRE, 235 WATER STREET ST. JOHN'S, NEWFOUNDLAND & LABRADOR, A1C 1B6	
ORIGINATING COMPANY: <b>ARUP</b> SUITE 2400, 2 BLOOR ST. EAST TORONTO, ONTARIO, M4W 1A8	PRIME CONTRACTOR: <b>ARUP</b>
PROJECT: <b>WHITE ROSE EXTENSION PROJECT</b>	
DRAWING TITLE: <b>GRAVING DOCK SETTLING POND SECTIONS AND DETAILS</b>	
COMPANY DRAWING NUMBER 224194-DR1-CS-404	HUSKY DRAWING NUMBER WH-K-98W-K-LY-00012-001
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SCALE: AS SHOWN	

APPROVED FOR CONSTRUCTION

Original Size: A3

PLOT BY: SUBNAME PLOT TIME: 2013-12-13 14:15:00