



Cork Line Level Crossings – XC201 Ground Investigation

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Client's Representative: JACOBS

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Document Control Sheet

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Project title: Cork Line Level Crossings – XC201
Client: Irish Rail
Client's Representative: JACOBS

Revision	Status	Report prepared by:	Report reviewed by:	Report approved by:	Issue date
001	Draft	Ian Holley	Glen Byrne	Michael O'Connell	1 st October 2020
002	Final Factual	Ian Holley	Glen Byrne	Michael O'Connell	25 th November 2020

The works were conducted in accordance with:

Specification And Related Documents For Ground Investigation In Ireland. (2016) 2nd ed. Engineers Ireland.

BS EN 1997: *Eurocode 7 - Geotechnical Design – Parts 1 & 2* (2007)

UK Specification for Ground Investigation 2nd Edition (2012)

British Standards Institute (2010) BS 5930:1999 + A2: 2010, Code of practice for site investigations. Incorporating Amendment Nos. 1 and 2, as partially replaced by:

- BS EN ISO 22475-1:2006: Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution
- BS EN ISO 14688-1:2002/Amd 1:2013: Geotechnical investigation and testing. Identification and classification of soil. Identification and description
- BS EN ISO 14688-2:2004/Amd 1:2013: Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification
- BS EN ISO 14689-1:2003: Geotechnical investigation and testing. Identification and classification of rock. Identification and description
- BS EN ISO 22476-2:2005/Amd 1:2011: Geotechnical investigation and testing. Field testing. Dynamic probing
- BS EN ISO 22476-3:2005/Amd 1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test



METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in Section 6 of BS 5930: 1999 + A2: 2010, The Code of Practice for Site Investigation. The amendments revised the Standard to remove text superseded by BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and EN ISO 14689-1:2003 and refers to the relevant standard for each affected subclause. However, the following terms are used in the description of fine-grained soils, where applicable:

- Soft to Firm: fine-grained soil with consistency description close to the boundary between soft and firm soil (Table 13 of BS5930).
- Firm to Stiff: fine-grained soil with consistency description close to the boundary between firm and stiff soil (Table 13 of BS5930).

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample
P	Nominal 100mm diameter undisturbed piston sample
B	Bulk disturbed sample
D	Small disturbed sample
W	Water sample
ES / EW	Soil sample for environmental testing / Water sample for environmental testing
SPT	Standard penetration test using a split spoon sampler (small disturbed sample obtained)
SPT (C)	Standard penetration test using 60-degree solid cone
x,x/x,x,x,x	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length. The length achieved is stated (mm) for any test increment less than 75mm
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm)
N=X/Z	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given test length 'Z' (mm)
V VR	Shear vane test (borehole) Hand vane test (trial pit) Shear strength stated in kPa V: undisturbed vane shear strength VR: remoulded vane shear strength
dd/mm/yy: 1.0 dd/mm/yy: dry	Date & water level at the borehole depth at the end of shift and the start of the following shift
Abbreviations relating to rock core – reference Clause 44.4.4 of BS 5930: 1999	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non-Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.



Cork Line Level Crossings – XC201

1 AUTHORITY

On the instructions of JACOBS on behalf of Iarnród Éireann / Irish Rail, a ground investigation was undertaken at multiple locations along the Cork to Dublin railway line, between Limerick Junction and Mallow stations, to provide geotechnical and environmental information for input to the design and construction of proposed overbridges, embankments, culverts, access roads and footpaths to enable the closure of five manned level crossings.

This report details the work carried out both on site at XC201 and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results.

All information given in this report is based upon the ground conditions encountered during the site investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those measured during the investigation.

This report was prepared by OCB Geotechnical Ltd for the use of Iarnród Éireann / Irish Rail and JACOBS in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the JACOBS, included boreholes, trial pits, indirect CBR testing, installation of standpipes, water purging, soil sampling, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, level crossing XC201 is located in the Thomastown townland, 4.9km southeast of Charleville, Co. Cork. An unnamed road crosses the Dublin-Cork railway line approximately 200m east of the N20. The level crossing is currently manned with a house and cabin located adjacent to the east of the railway line. The site is surrounded by agricultural land with a number of residential homes and farms in the area.



The site is relatively flat throughout. The main works areas are within agricultural fields, some may be marshy depending on weather conditions.

The existing site is presented on the site and exploratory hole location plans in Appendix A.

4 SITE OPERATIONS

Site operations, which were conducted between 5th June 2020 and 7th August 2020, included:

- Three (3) Cable Percussion Boreholes
- Three (3) Cable Percussion with Rotary follow-on Boreholes
- A Standpipe Installation in two (2) Boreholes
- Four (4) Trial Pits
- Indirect CBR tests at eight (8) locations
- Water Purging in two (2) locations

The exploratory holes and in situ tests were located as instructed by the Client's Representative, as shown on the exploratory hole location plan in Appendix A.

4.1 Boreholes

A total of six boreholes were put down in a minimum diameter of 150mm through soil strata to their completion depths by a combination of methods, including cable percussion boring by Pilcon rigs, and rotary drilling by a T44 rig.

The borehole logs state the methodology and plant used for each location, as well as the appropriate depth ranges.

A summary of the boreholes, subdivided by category in accordance with the methods employed for their completion, is presented in the following sub-sections.

Appendix B presents the borehole logs.

4.1.1 Cable Percussion Boreholes

Three boreholes (CP01, CP01A & CP02) were put down to completion in minimum 200mm diameter using a Pilcon cable percussion soil boring rig. All boreholes were terminated either at their scheduled



completion depths, on instruction from a Jacobs engineer or else on encountering virtual refusal on obstructions, including large boulders and weathered bedrock.

Hand dug inspection pits were carried out between ground level and 1.2m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

Disturbed (bulk bag and tub) samples were taken within the encountered strata. Environmental samples were taken at standard intervals, as directed by Jacobs.

Standard penetration tests were carried out in accordance with EC7 at standard depth intervals using the split spoon sampler (SPT). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The N-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded.

Where water was added to assist with boring, a note has been added to the log to account for same.

Appendix B presents the borehole logs.

4.1.2 Boreholes by Combined Percussion Boring and Rotary Follow-On Drilling

Three boreholes (CPRC01, CPRC01A & CPRC02) were put down by a combination of cable percussion boring and rotary follow-on open hole drilling techniques. Where the cable percussion borehole had not been advanced onto bedrock, rotary percussive methods were employed to advance the borehole to completion/obstruction.

Hand dug inspection pits were carried out between ground level and 1.2m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

Disturbed (bulk bag and tub) samples were taken within the encountered strata. Environmental samples were taken at standard intervals, as directed by Jacobs.

Standard penetration tests were carried out in accordance with EC7 at standard depth intervals throughout the overburden using the split spoon sampler (SPT). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The N-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded.

Where water was added to assist with boring, a note has been added to the log to account for same.



No rock core recovered.

Appendix B presents the borehole logs.

4.2 Standpipe Installations

A groundwater monitoring standpipe was installed in boreholes CPRC01A and CPRC02.

Details of the installations, including the diameter of the pipe and depth range of the response zone, are provided in Appendix B on the individual borehole logs.

Following the completion of the intrusive investigation work groundwater monitoring was undertaken at the site on four occasions. The results of the monitoring are presented in the report below in Section 6.3.

4.3 Trial Pits

Four trial pits (TP01–TP04) were excavated using a 15t tracked excavator fitted with a 600mm wide bucket, to depths between 2.70m and 3.60m. The trial pits were all terminated upon encountering obstructions or upon the pit walls collapsing.

Environmental samples were taken at depths of 0.05m, 0.50m, 1.0m and 3.0m in each trial pit.

Disturbed (small tub and bulk bag) samples were taken at standard depth intervals and at change of strata.

Hand Vane testing was attempted unsuccessfully due to the relatively high granular content of the strata.

Any water strikes encountered during excavation were recorded along with any changes in their levels as the excavation proceeded. The stability of the trial pit walls was noted on completion.

Appendix C presents the trial pit logs with photographs of the pits and arising provided in Appendix D.

4.4 Indirect CBR Tests

An indirect CBR test was conducted at eight locations (CBR-TP01-1 to CBRT04-2) using a Dynamic Cone Penetrometer (DCP). The equipment was developed in conjunction with the UK Transport Research Laboratory, is used widely throughout the world, and is referred to in the UK Highway Agency Interim Advice Note 73/06.

The test results are presented in Appendix E in the form of plots of the variation with depth of the cumulative blow count. Straight lines have been fitted to the plots and the CBR for each depth range estimated using the following relationship, as proposed by DTP Interim Advice Note 73/06 (Design Guidance for Road Pavement Foundations):



$$\text{Log CBR} = 2.48 - 1.057 \text{ Log (mm/blow)}$$

The occasionally elevated CBR values could be a consequence of the coarse-grained content of the penetrated soils and are often not representative of the soil matrix.

4.5 Water Purging

Prior to sampling from each standpipe (in CPRC01A and CPRC02) water purging was carried out.

Appendix F presents the water purging data logs.

4.6 Surveying

A broad survey of the site using a handheld CAT scanner to identify any existing buried services or old foundations/obstructions to excavation was carried out before commencement of excavation works. A GPR survey to PAS 128 specification was carried out at each location prior to excavation. The GPR survey report is presented in an addendum to follow issuance of this report.

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from OCB Geotechnical. Surveying was carried out using a Trimble R6 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish Transverse Mercator, ITM) and ground elevation (mOD Malin) at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

Pre-work site conditions were surveyed and upon completion of all site works at each site a post-work site condition survey was carried out. The pre and post site condition photographs are presented in appendix I.



5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described and their descriptions incorporated into the borehole logs.

5.1 Geotechnical Laboratory Testing of Soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **soil chemistry:** pH, Ammonia content, Chloride content, Nitrate content, Sulphur content and water-soluble and total sulphate content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute (1990) *BS 1377:1990, Methods of test for soils for civil engineering purposes. Parts 1 to 9.*

The test results are presented in Appendix G.

5.2 Environmental Laboratory Testing of Soils

In addition, environmental testing, as specified by Jacobs was conducted on selected environmental samples by Socotec at its laboratory in Burton-on-Trent, United Kingdom. Results of environmental testing are presented in Appendix H.



6 GROUND CONDITIONS

6.1 General Geology of the Area

Teagasc soil mapping indicates that the Thomastown area is underlain by Glacial Till derived chiefly from Devonian sandstones.

The Geological Survey of Ireland (GSI) bedrock mapping database indicates that soils in the site area are underlain at depth by the Lower Carboniferous-age undifferentiated Visean Limestones. The Lower Carboniferous strata were subjected to compressional deformation (tectonic shortening) during the Variscan Orogeny in Late Carboniferous and Early Permian times. Bedrock strata in the site vicinity typically strike west-southwest to east-northeast with variable dips having undergone folding and faulting.

The site is underlain by a locally important aquifer, consisting of bedrock which is moderately productive only in local zones, and has a moderate groundwater vulnerability. Numerous Karst features, such as depressions, swallow holes, caves and springs, occur in the valley underlain by limestones to the north-northwest of the Ballyhoura Mountains.

Note: Bedrock level assumed approximately >30m bgl based on a historic ground investigation in the area.

6.2 Ground Types Encountered During Investigation of the Site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- Topsoil: encountered typically in 200mm thickness, with topsoil and subsoil extending to 400mm depth noted in the Trial Pits.
- Glacial Till: Sandy gravelly silty clay, frequently with cobble and boulder content, typically soft or firm in upper horizons, becoming very stiff with increasing depth.
- Bedrock: Rockhead was not encountered to a maximum depth of 19.70m in CPRC02.

6.3 Groundwater

Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location.



Groundwater monitoring to date in standpipe installations, yielded the following results:

Date	Depth to standing water level (m)	
	CPRC01A	CPRC02
13/08/20	0.63	0.92
17/08/20	0.5	0.86
21/08/20	0.2	0.31
29/09/20	0.795	1.06

Continued monitoring of the two installed standpipes will give an indication of the seasonal variation in groundwater level.

7 DISCUSSION

7.1 Proposed Construction

It is proposed to construct overbridges, embankments, culverts, access roads and footpaths to enable the closure of five manned level crossings.

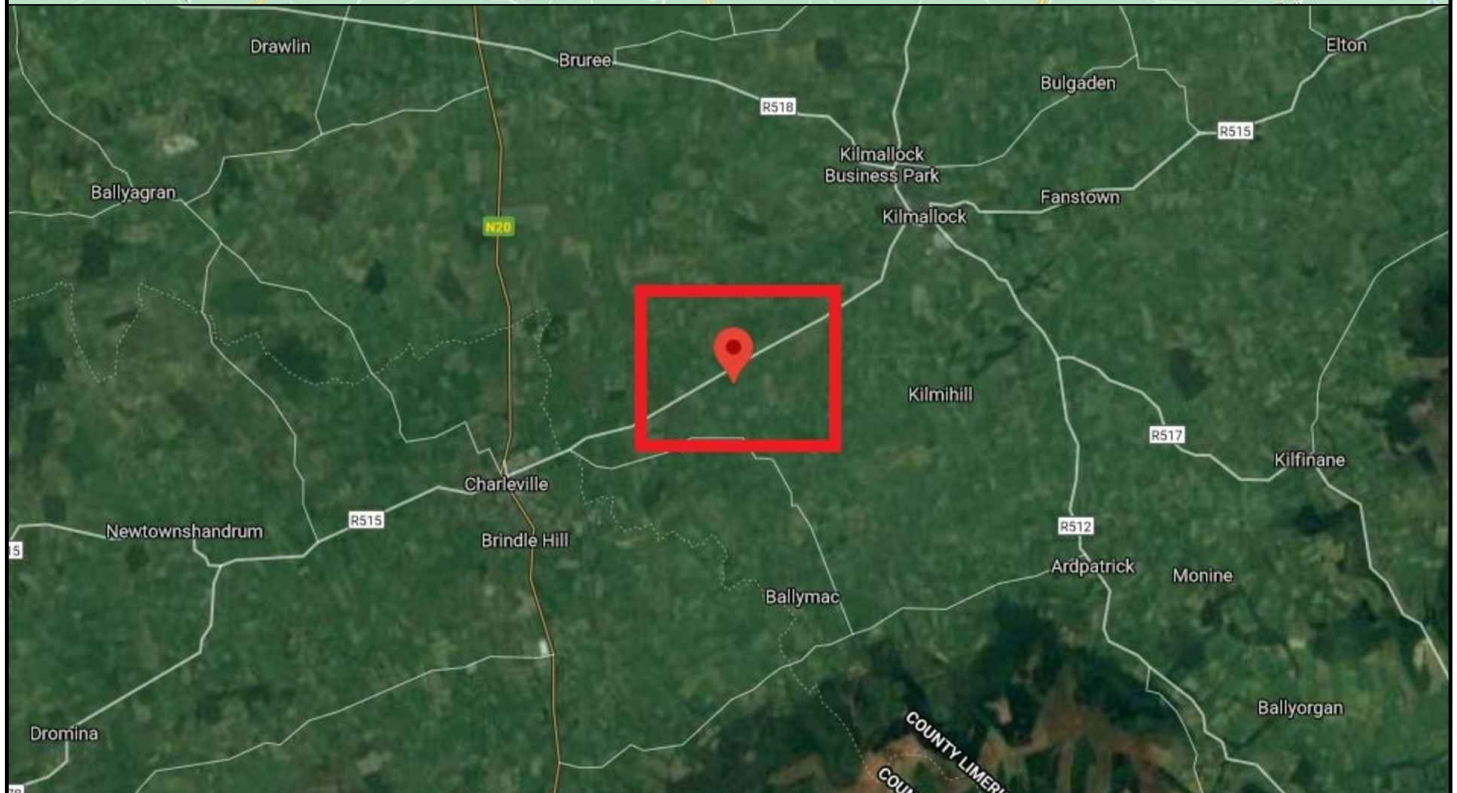
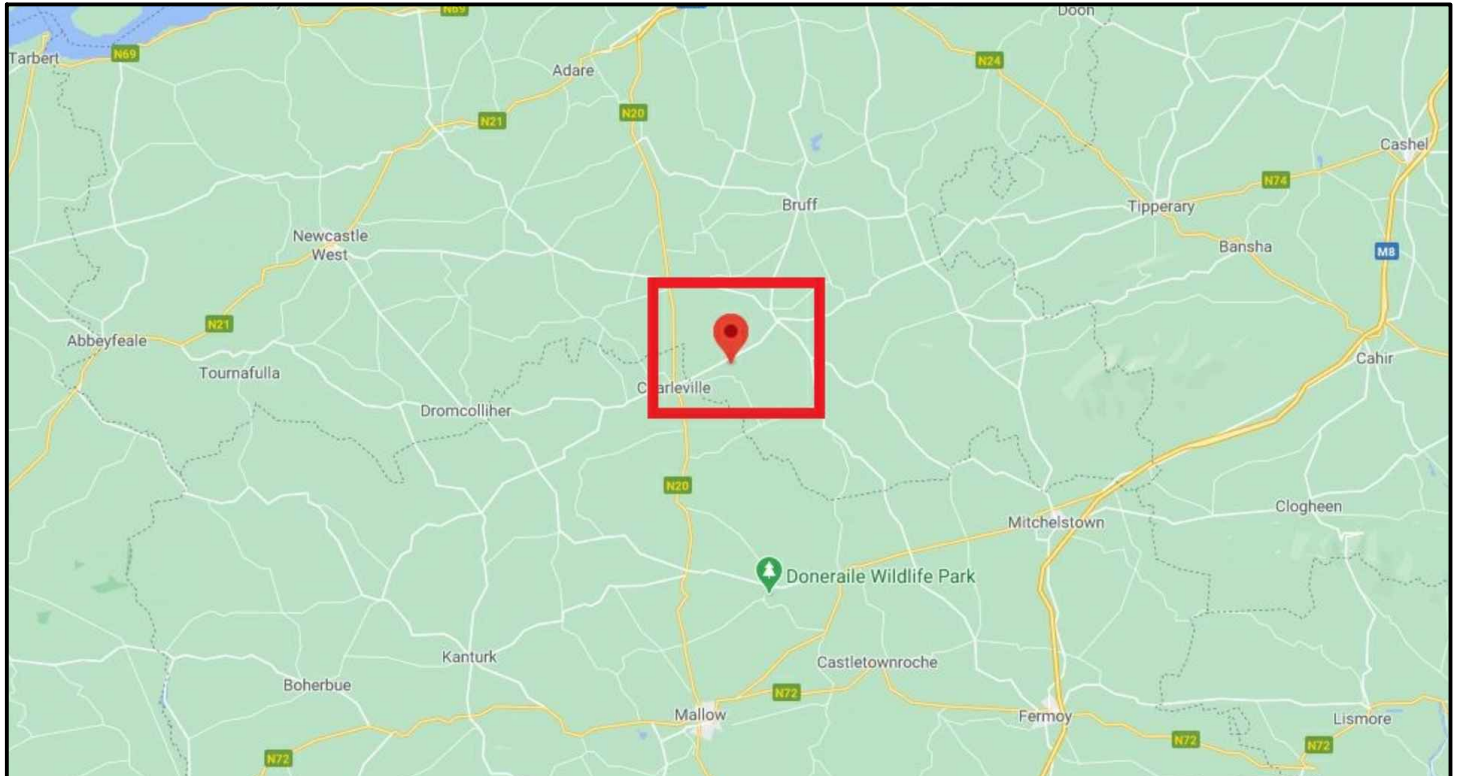
No further details were available to OCB Geotechnical at the time of preparing this report.



8 REFERENCES

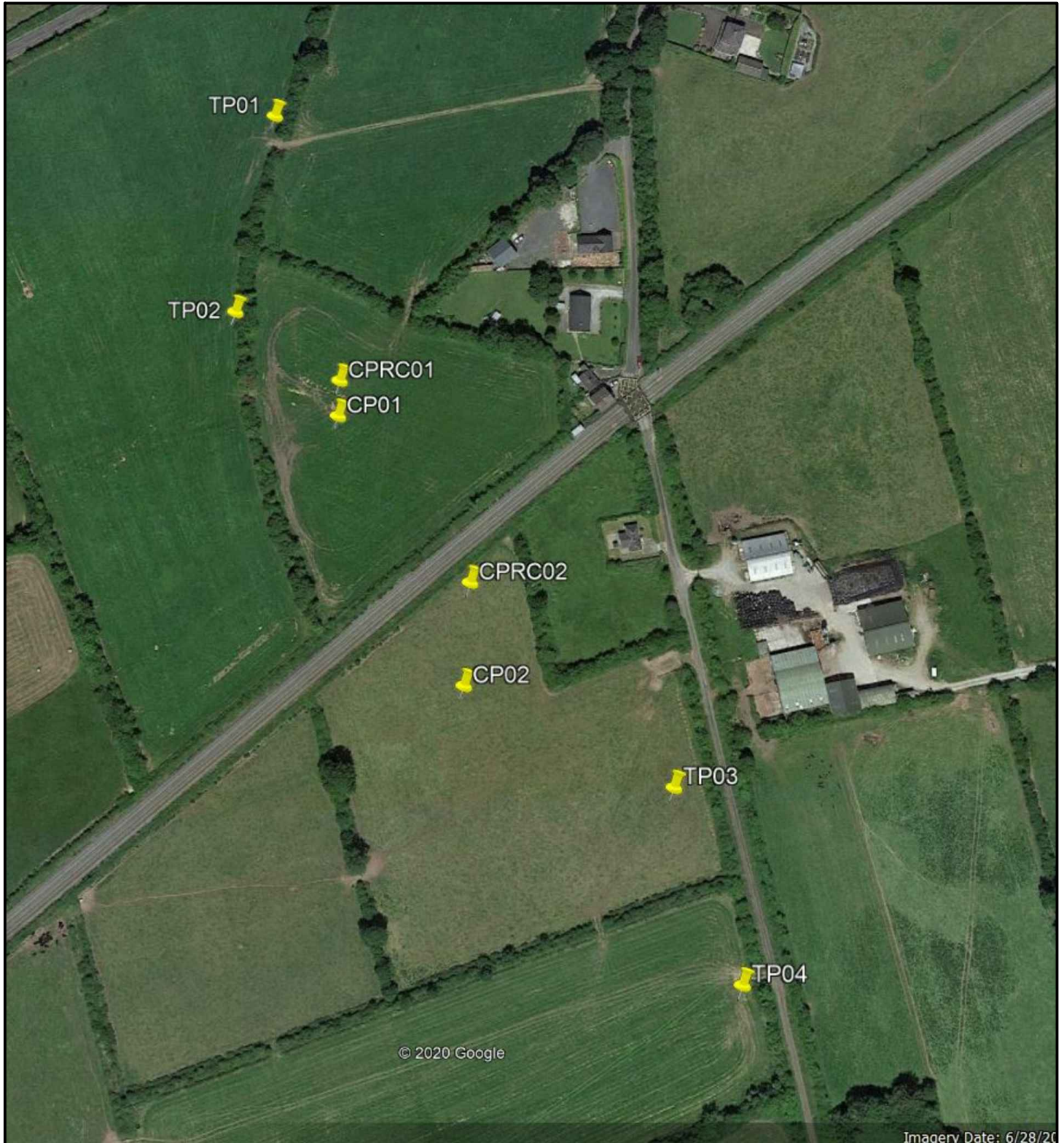
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<https://rwsenvironment.eu/subjects/soil/legislation-and/soil-remediation/>

Appendix A Site and Exploratory Hole Location Plans



Iarnród Éireann
 Cork Line Level Crossings
 XC201 (19-135-1)

SITE LOCATION MAPS	
Client:	Iarnród Éireann
Engineer:	Jacob's
Date:	June/July 2020



Iarnród Éireann
 Cork Line Level Crossings
 XC201 (19-135-1)

Exploratory Hole Locations	
Client:	Iarnród Éireann
Engineer:	Jacob's
Date:	June/July 2020

Appendix B Borehole Logs



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CP01
Coordinates: 557500.72 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Cable Percussion	Client's Representative: JACOBS	Scale: 1:50
Plant: Pilcon	Ground Level: 80.60 mOD	Dates: 05/06/2020 - 05/06/2020
		Driller: AA
		Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.05	ES1					(0.20)		TOPSOIL		
0.20 - 1.20	B2				80.40	0.20		Firm light greyish brown with some yellow mottling slightly sandy slightly gravelly silty CLAY with frequent rootlets. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded.		
0.20 - 1.20	D3					(1.00)				
0.50	ES4									
1.20 - 2.00	B5			N=9 (2,1/2,2,3,2)	79.40	1.20		Firm light brown modeled grey slightly sandy gravelly SILT with low to medium cobble content and low boulder content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles and boulders are subrounded.		
1.20 - 2.00	D6					(0.80)				
1.20 - 1.65	SPT (C) N=9									
1.50	ES7									
2.00 - 2.45	SPT (C) N=7			N=7 (3,2/1,2,2,2)	78.60	2.00		End of borehole at 2.000m		

Remarks Instructed by clients engineer to relocate borehole at 2.00m.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
	Casing Details		Chiselling Details			
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
2.00	200					



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CP01A
Coordinates: E N	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
	Client's Representative: JACOBS	Scale: 1:50
Method: Cable Percussion	Ground Level: mOD	Driller: AA
Plant: Pilcon	Dates: 08/06/2020 - 08/06/2020	Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.20 - 1.20	B1					(0.20)	TOPSOIL			
0.20 - 1.20	D2					0.20		Brown slightly silty slightly sandy slightly gravelly CLAY with frequent rootlets and low cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subrounded.		
0.50	ES3					(1.00)				
1.20 - 2.00	B4			N=7 (1,1/2,1,2,2)		1.20		Soft brown slightly silty slightly sandy slightly gravelly CLAY with frequent rootlets and medium cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded.		
1.20 - 2.00	D5					(0.80)				
1.20 - 1.65	SPT (C) N=7					2.00		Soft to Firm greyish brown slightly sandy slightly gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subrounded.		
1.50	ES6					(1.00)				
2.00 - 3.00	B7			N=7 (2,2/1,2,2,2)		3.00		Very Stiff greyish brown slightly sandy silty gravelly CLAY with high cobble and medium boulder content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles and boulders are subangular to subrounded, grey Limestone.		
2.00 - 3.00	D8					(0.40)				
2.00 - 2.45	SPT (C) N=7					3.40		End of borehole at 3.400m		
3.00	ES9									
3.00 - 3.40	B10			N=48 (1,1/48 for 255mm)						
3.00 - 3.40	D11									
3.00 - 3.40	SPT (C)			50 (25 for 0mm/50 for 0mm)						
3.40 - 3.40	SPT (C)									

Remarks Cable Percussion terminated at 3.40m due to probable boulder obstruction.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
Casing Details		Chiselling Details				
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
3.40	200	3.40	3.40	01:00		



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CP02
Coordinates: 557552.80 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Cable Percussion	Client's Representative: JACOBS	Scale: 1:50
Plant: Pilcon	Ground Level: 82.31 mOD	Dates: 10/06/2020 - 10/06/2020
		Driller: AA
		Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.05	ES1					(0.20)		TOPSOIL		
0.20 - 1.20	B2				82.11	0.20		Light brown slightly sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded.		
0.20 - 1.20	D3					(1.00)				
0.50	ES4									
1.20 - 2.00	B5			N=26 (1,1/4,11,7,4)	81.11	1.20		Stiff brown slightly sandy slightly gravelly silty CLAY with low cobble content and occasional rootlets. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded. Cobbles are subangular.		
1.20 - 2.00	D6									
1.20 - 1.65	SPT (C)					(0.80)				
1.50	ES7									
2.00 - 2.20	B8			50 (50 for 2mm/50 for 0mm)	80.31	2.00		Brown slightly sandy gravelly sandy CLAY with high cobble and medium boulder content. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded. Cobbles and boulders are subangular, predominantly limestone.		
2.00 - 2.20	D9				80.11	(0.20)				
2.00 - 2.00	SPT (C)			50 (25 for 0mm/50 for 0mm)		2.20				
2.20 - 2.20	SPT (C)							End of borehole at 2.200m		

Remarks Cable Percussion terminated at 2.20m due to possible boulder obstruction.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
Casing Details		Chiselling Details				
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
2.20	200	2.20	2.20	01:00		



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CPRC01
Coordinates: 557501.38 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Cable Percussion+Rotary Open	Client's Representative: JACOBS	Scale: 1:50
Plant: Pilcon+T44	Ground Level: 80.47 mOD	Dates: 04/06/2020 - 19/06/2020
		Driller: AA +NOB
		Logger: MN

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.05	ES1					(0.20)	TOPSOIL			
0.20 - 0.50	B2				80.26	0.20		Light yellowish brown mottled light greyish brown slightly sandy slightly gravelly silty CLAY with low cobble content and occasional rootlets, moist. Sand is fine to coarse. Gravel is fine to coarse, subangular. Cobbles are subangular, predominantly limestone.		
0.20 - 0.50	D3					(0.30)				
0.50	ES4				79.96	0.50		Yellowish brown mottled light grey and orange brown slightly sandy gravelly silty CLAY with low cobble content, moist. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded, predominantly limestone.		
0.50 - 1.20	B5					(0.70)				
0.50 - 1.20	D6									
1.20 - 2.00	B7			N=6 (0,1/1,2,2,1)		1.20				
1.20 - 2.00	D8									
1.20 - 1.65	SPT (C)					(0.80)		Soft yellowish brown with occasional light greyish brown mottling slightly sandy gravelly silty CLAY with low cobble content, moist. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded, predominantly limestone.		
1.50	N=6									
1.50	ES9									
2.00 - 3.00	B10				78.46	2.00		Stiff yellowish brown slightly sandy gravelly silty CLAY with low cobble content, moist. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded, predominantly limestone.		
2.00 - 3.00	D11			N=17 (1,1/2,4,6,5)						
2.00 - 2.45	SPT (C)					(1.20)				
2.00 - 2.45	N=17									
3.00	ES14									
3.00 - 3.20	B12				77.26	3.20		Yellowish brown sandy gravelly clayey SILT. Sand is fine to coarse. Gravel is fine to coarse, angular to subangular.		
3.00 - 3.20	D13			75 (4,5/75 for 50mm)		(0.50)				
3.00 - 3.20	SPT (C)									
3.20 - 3.70	B15				76.76	3.70		Open Hole Boring, Driller Described: BOULDERS		
3.20 - 3.70	D16			50 (25 for 0mm/50 for 0mm)						
3.20 - 3.70	SPT (C)					(1.40)				
5.10 - 5.18	SPT (C)			50 (50 for 75mm/50 for 0mm)	75.36	5.10		End of borehole at 5.10m		

Remarks Cable Percussion terminated at 3.70m due to possible boulder obstruction. Rotary Open Hole techniques employed to 5.10m upon encountering a boulder obstruction. Instructed by client to move off and relocate to XC201-CPRC01A.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
	3.20	3.60				
Casing Details		Chiselling Details				
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
3.70	200	3.20	3.40	00:40		
5.10	151	3.60	3.70	00:30		



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CPRC01A
Coordinates: E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 2
Method: Cable Percussion+Rotary Open	Client's Representative: JACOBS	Scale: 1:50
Plant: Pilcon+T44	Ground Level: mOD	Driller: AA +NOB
	Dates: 08/06/2020 - 22/06/2020	Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.20 - 0.50	B1					(0.20)	TOPSOIL			
0.20 - 0.50	D2					0.20		Brown slightly silty slightly sandy CLAY with medium cobble content. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded. Cobbles are angular to subrounded, predominantly grey limestone.		
0.50	ES3									
0.50 - 1.20	B4					(1.00)				
0.50 - 1.20	D5									
1.20 - 2.00	B6					1.20				
1.20 - 2.00	D7			N=6 (1,1/1,2,1,2)				Soft brown mottled grey slightly sandy gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is fine to coarse, angular to subrounded. Cobbles are angular to subrounded, predominantly grey limestone.		
1.20 - 1.65	SPT (C)					(0.80)				
1.50	N=6									
1.50	ES8									
2.00 - 2.20	B9					2.00				
2.00 - 2.20	D10			N=11 (1,3/2,3,3,3)		(0.20)		Firm brown slightly sandy slightly gravelly silty CLAY with medium cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded.		
2.00 - 2.45	SPT (C)					(0.20)				
2.00 - 2.45	N=11					2.40				
2.20 - 2.40	B11							Light brown slightly sandy slightly silty gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular.		
2.20 - 2.40	D12					(1.00)				
2.40 - 3.40	B13							Very Stiff - Hard grey / brown slightly sandy gravelly CLAY with medium to high cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subrounded.		
2.40 - 3.40	D14									
3.00	ES15									
3.00 - 3.46	SPT (C)			N=68 (3,5/68 for 305mm)		3.40		Dark grey slightly clayey sandy very gravelly subangular Limestone		
3.40 - 3.60	N=68					(0.20)		COBBLES with low boulder content.		
3.40 - 3.60	B16					3.60		Open Hole Boring, Driller Described: BOULDERS with sand and gravel.		
3.40 - 3.60	D17									
3.40 - 3.40	SPT (C)			50 (25 for 0mm/50 for 0mm)						
5.10 - 5.18	SPT (C)			50 (25 for 75mm/50 for 0mm)		(4.50)				
6.60 - 6.90	SPT (C)			88 (16,18/88 for 150mm)						
8.10 - 8.25	SPT (C)			50 (14,20/50 for 0mm)		8.10		Open Hole Boring, Driller Described: BOULDERS		
9.60 - 9.68	SPT (C)			50 (25 for 75mm/50 for 0mm)						

Continued on Next Page

Remarks Cable Percussion terminated at 3.60m due to possible boulder obstruction. Rotary Open Hole techniques employed to 19.60m.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
	2.20	3.40	2.20	20	20	2.20
			5.60	20	20	4.90
		8.60	20	20	7.60	
		9.60	20	20	8.50	
Casing Details		Chiselling Details				
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
3.60	200	3.40	3.60	01:00		
19.60	151					



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CPRC01A
Coordinates: E N	Client: Iarnród Éireann / Irish Rail	Sheet 2 of 2
	Client's Representative: JACOBS	Scale: 1:50
Method: Cable Percussion+Rotary Open	Ground Level: mOD	Dates: 08/06/2020 - 22/06/2020
Plant: Pilcon+T44		Driller: AA Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
10.60 - 10.90	SPT (C)			85 (14,16/85 for 150mm)		(6.00)				
13.60 - 13.90	SPT (C)			89 (14,16/89 for 150mm)		14.10		Open Hole Boring, Driller Described: Sandy gravelly CLAY		
						(1.50)				
						15.60		Open Hole Boring, Driller Described: Sandy CLAY with boulders.		
						(1.50)				
16.60 - 17.05	SPT (C) N=81			N=81 (11,11/16,20,20,25)		17.10		Open Hole Boring, Driller Described: BOULDERS		
						(2.50)				
19.60 - 19.82	SPT (C)			70 (17,19/70 for 75mm)		19.60		End of borehole at 19.600m		

Remarks Cable Percussion terminated at 3.60m due to possible boulder obstruction. Rotary Open Hole techniques employed to 19.60m.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
	2.20	3.40	2.20	20	20	2.20
			5.60	5.60	20	4.90
			8.60	7.60	20	7.60
		9.60	8.50	20	8.50	
	Casing Details		Chiselling Details			
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
3.60	200	3.40	3.60	01:00		
19.60	151					



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CPRC02
Coordinates: 557555.87 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 2
Method: Cable Percussion+Rotary Open	Client's Representative: JACOBS	Scale: 1:50
Plant: Pilcon+T44	Ground Level: 81.98 mOD	Dates: 09/06/2020 - 17/06/2020
		Driller: AA +NOB
		Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
0.05	ES1					(0.20)		TOPSOIL		
0.20 - 1.20	B2				81.78	0.20		Orange brown slightly sandy gravelly CLAY with low cobble content and frequent rootlets. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded.		
0.20 - 1.20	D3					(1.00)				
0.50	ES4									
1.20 - 2.00	B5			N=13 (2,4/3,3,3,4)		1.20		Firm light brown slightly sandy slightly gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded.		
1.20 - 2.00	D6					(0.80)				
1.20 - 1.65	SPT (C) N=13									
1.50	ES7									
2.00 - 2.50	B8			N=27 (1,1/4,5,8,10)		2.00		Stiff light brown slightly gravelly sandy silty CLAY with low cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded.		
2.00 - 2.50	D9					(0.50)				
2.00 - 2.45	SPT (C) N=27									
2.50 - 2.80	B10					2.50		Light brown slightly gravelly sandy CLAY with low to medium cobble content. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded. Cobbles are subangular to subrounded.		
2.50 - 2.80	D11					(0.80)				
2.80 - 3.30	D12									
2.80 - 3.30	D13									
3.00	ES14									
3.00 - 3.00	SPT (C)			50 (25 for 0mm/50 for 0mm)	78.68	3.30		Open Hole Boring, Driller Described: Boulder CLAY.		
3.30 - 3.30	SPT (C)			50 (25 for 0mm/50 for 0mm)						
4.70 - 5.01	SPT (C)			N=107 (9,11/107 for 160mm)		(2.40)				
6.20 - 6.51	SPT (C)			N=103 (10,12/103 for 160mm)	76.28	5.70		Open Hole Boring, Driller Described: Sandy gravelly boulder CLAY.		
						(3.00)				
9.20 - 9.60	SPT (C)			N=67 (9,9/67 for 255mm)	73.28	8.70		Open Hole Boring, Driller Described: Sandy CLAY		
						(2.00)				

Continued on Next Page

Remarks Cable Percussion terminated at 3.30m due to probable boulder obstruction. Rotary Open Hole techniques employed to 19.70m.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
	Casing Details		Chiselling Details			
	To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)	
3.30	200	2.50	2.50	00:15		
19.70	151	3.00	3.00	00:20		
		3.30	3.30	00:15		



Project No.: 19-135	Project Name: Cork Line Level Crossings	Borehole No.: XC201-CPRC02
Coordinates: 557555.87 E	Client: Iarnród Éireann / Irish Rail	Sheet 2 of 2
Method: Cable Percussion+Rotary Open	Client's Representative: JACOBS	Scale: 1:50
Plant: Pilcon+T44	Ground Level: 81.98 mOD	Dates: 09/06/2020 - 17/06/2020
		Driller: AA Logger: IH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
10.70 - 11.10	SPT (C)			N=70 (14,14/70 for 255mm)	71.28	10.70 (2.00)		Open Hole Boring, Driller Described: Gravelly SAND with boulders.		
13.70 - 13.78	SPT (C)			50 (25 for 75mm/50 for 0mm)	69.28	12.70 (2.00)		Open Hole Boring, Driller Described: SAND with boulders.		
16.70 - 17.00	SPT (C)			78 (10,16/78 for 150mm)	67.28	14.70 (1.00)		Open Hole Boring, Driller Described: Boulder CLAY.		
19.70 - 20.00	SPT (C)			78 (11,17/78 for 150mm)	66.28	15.70 (3.00)		Open Hole Boring, Driller Described: Gravelly SAND with boulders.		
					63.28	18.70 (1.00)		Open Hole Boring, Driller Described: Very sandy CLAY with boulders.		
					62.28	19.70		End of borehole at 19.700m		

Remarks Cable Percussion terminated at 3.30m due to probable boulder obstruction. Rotary Open Hole techniques employed to 19.70m.	Water Added		Water Strike - General			
	From (m)	To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
	Casing Details		Chiselling Details			
To (m)	Diam (mm)	From (m)	To (m)	Time (hh:mm)		
3.30	200	2.50	2.50	00:15		
19.70	151	3.00	3.00	00:20		
		3.30	3.30	00:15		

Appendix C

Trial Pit Logs



Project No.: 19-135	Project Name: Cork Line Level Crossings	Trial Pit No.: XC201-TP01
Co-ordinates: 557473.29 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Excavation	Client's Representative: JACOBS	Scale: 1:20
Plant: Kobelco SK140SRLC	Ground Level: 79.59 mOD	Driver: AL
	Date: 03/07/2020	Logger: MN

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
0.05	ES1			(0.20)		TOPSOIL: Soft dark brown slightly sandy silty CLAY with occasional gravel and frequent rootlets, moist	
			79.39	0.20			
				(0.20)		SUBSOIL: Firm orange brown slightly sandy slightly gravelly silty CLAY with occasional rootlets, moist. Sand fine to coarse. Gravel fine to coarse predominantly limestone.	
			79.19	0.40			
0.50 0.50 - 1.00 0.50 - 1.00	ES2 B3 D4					Stiff yellowish brown and light grey sandy gravelly silty CLAY with medium cobble and small boulder content, moist. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone.	0.5
1.00	ES5			(1.30)			1.0
1.70 - 2.20 1.70 - 2.20	B6 D7		77.89	1.70		Firm yellowish brown slightly sandy slightly gravelly CLAY with medium cobble and boulder content, very moist becoming wet. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone. Boulders up to 1.0m x 0.6m x 0.5m.	2.0
				(0.80)			
2.20 - 2.50 2.20 - 2.50	B8 D9		77.09	2.50		Very stiff yellowish to greyish brown slightly sandy gravelly CLAY with medium cobble and boulder content, moist. Sand fine to coarse. Gravel fine to coarse, angular to subrounded. Cobbles and boulders subangular to subrounded light and dark grey limestone.	2.5
2.70 - 3.20 2.70 - 3.20	B10 D11			(0.70)			
3.00	ES12		76.39	3.20		End of trial pit at 3.200m	3.0
							3.5

Remarks Hand Vane Tests attempted unsuccessfully due to relatively high granular content. Trial Pit terminated at 3.20m on either a large limestone boulder or possible bedrock.	Water Strikes:		Stability: Sides collapsing
	Struck at (m):	Remarks:	
	2.50		Width: 2.00 Length: 4.50



Project No.: 19-135	Project Name: Cork Line Level Crossings	Trial Pit No.: XC201-TP02
Co-ordinates: 557456.95 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Excavation	Client's Representative: JACOBS	Scale: 1:20
Plant: Kobelco SK140SRLC	Ground Level: 80.24 mOD	Date: 03/07/2020
		Driver: AL
		Logger: MN

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
0.05	ES1			(0.20)		TOPSOIL: Soft dark brown slightly sandy silty CLAY with occasional gravel, frequent rootlets and occasional roots, moist	
			80.04	0.20			
				(0.20)		SUBSOIL: Firm light brown mottled orange slightly sandy slightly gravelly silty CLAY with occasional roots and rootlets, moist. Sand fine to coarse. Gravel fine to coarse predominantly limestone.	
			79.84	0.40			
0.50 0.50 - 1.00 0.50 - 1.00	ES2 B3 D4			(0.70)		Stiff becoming very stiff yellowish brown and light grey sandy gravelly silty CLAY with medium cobble and low small boulder content, moist. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone.	0.5
1.00	ES5		79.14	1.10			1.0
1.50 - 2.00 1.50 - 2.00	B6 D7			(1.30)		Firm, locally soft, yellowish brown sandy gravelly silty CLAY with medium cobble and boulder content, very moist. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone with occasional purple conglomerate.	1.5
2.60 - 3.10 2.60 - 3.10	B8 D9		77.84	2.40		Very stiff yellowish to greyish brown sandy gravelly silty CLAY with medium cobble and boulder content, moist with occasional wet pockets. Sand fine to coarse. Gravel fine to coarse, angular to subrounded. Cobbles and boulders subangular to subrounded light and dark grey limestone. Largest boulder is 0.7m x 0.45m x 0.4m.	2.5
				(0.90)			
3.00	ES10		76.94	3.30		End of trial pit at 3.300m	3.0
							3.5

Remarks Hand Vane Tests attempted unsuccessfully due to relatively high granular content. Trial Pit terminated at 3.30m due to a large boulder in the south-west corner obstructing further excavation.	Water Strikes:		Stability: Sides spalling
	Struck at (m):	Remarks:	
	2.40		Width: 1.40
		Length: 5.60	



Project No.: 19-135	Project Name: Cork Line Level Crossings	Trial Pit No.: XC201-TP03
Co-ordinates: 557638.45 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Excavation	Client's Representative: JACOBS	Scale: 1:20
Plant: Kobelco SK140SRLC	Ground Level: 82.90 mOD	Date: 03/07/2020
		Driver: AL
		Logger: MN

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
0.05	ES1			(0.20)		TOPSOIL: Soft dark brown slightly sandy silty CLAY with occasional gravel and frequent rootlets, moist	
				82.70 0.20			
				(0.20)			
				82.50 0.40			
0.50	ES2					Firm to stiff becoming firm yellowish brown and light grey sandy gravelly silty CLAY with medium to high cobble and medium small boulder content, moist. Occasional large boulders. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone with occasional purple conglomerate.	0.5
0.50 - 1.00	B3						
0.50 - 1.00	D4						
1.00	ES5			(1.50)			1.0
1.40 - 1.90	B6						
1.40 - 1.90	D7						
2.20 - 2.70	B8					Firm, locally soft, yellowish brown slightly sandy gravelly CLAY with medium to high cobble and boulder content, wet. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone.	2.0
2.20 - 2.70	D9						
3.00	ES10					Very stiff yellowish to greyish brown sandy gravelly silty CLAY with medium cobble and boulder content, moist. Sand fine to coarse. Gravel fine to coarse, angular to subrounded. Cobbles and boulders subangular to subrounded predominantly light and dark grey limestone.	3.0
3.00 - 3.50	B11						
3.00 - 3.50	D12			(0.60)			
				79.30 3.60			
						End of trial pit at 3.600m	

Remarks Hand Vane Tests attempted unsuccessfully due to relatively high granular content.	Water Strikes:		Stability: Sides collapsing
	Struck at (m):	Remarks:	
	1.90		Width: 2.30
Trial Pit terminated at 3.60m due to pit walls collapsing.			Length: 4.80



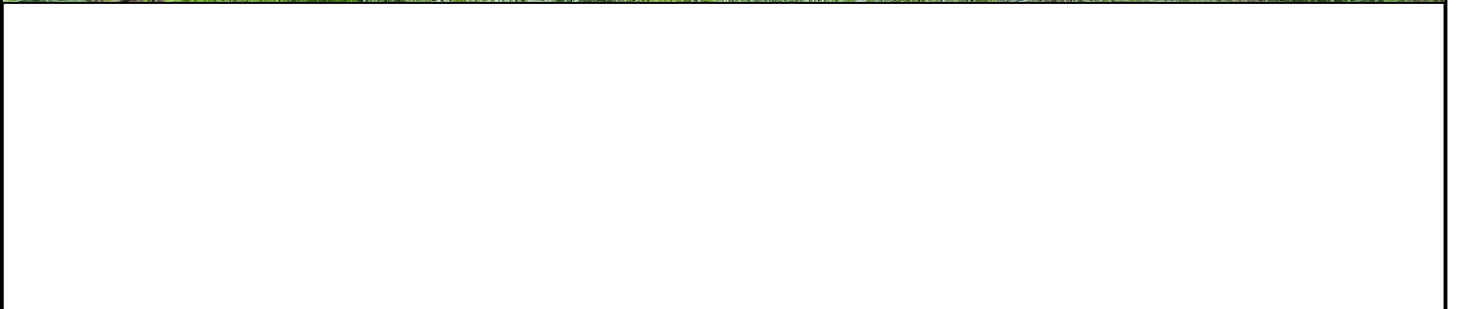
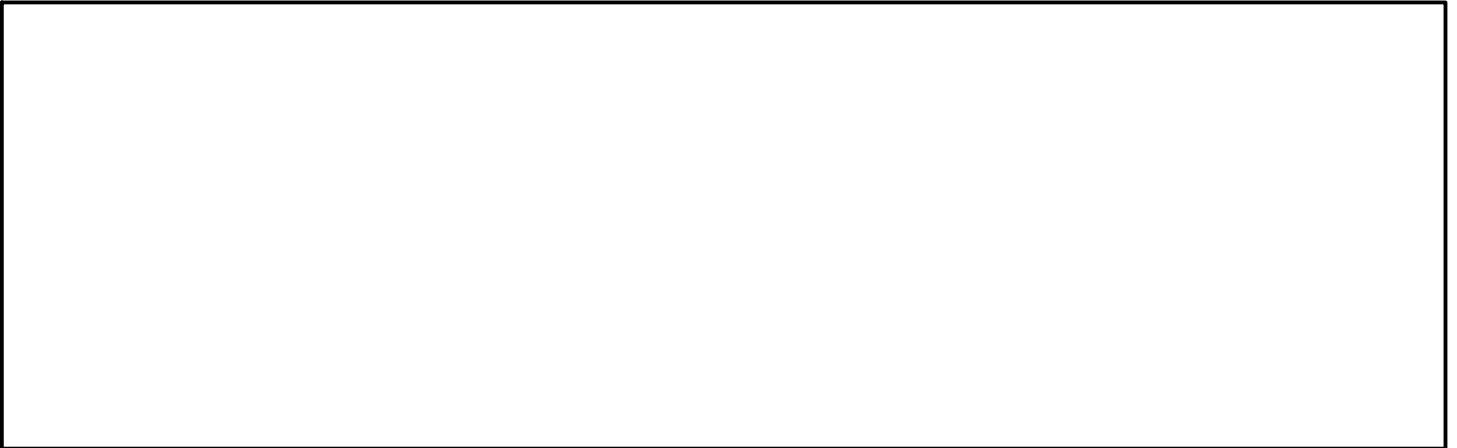
Project No.: 19-135	Project Name: Cork Line Level Crossings	Trial Pit No.: XC201-TP04
Co-ordinates: 557663.87 E	Client: Iarnród Éireann / Irish Rail	Sheet 1 of 1
Method: Excavation	Client's Representative: JACOBS	Scale: 1:20
Plant: Kobelco SK140SRLC	Ground Level: 84.20 mOD	Driver: AL
	Date: 03/07/2020	Logger: MN

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water
0.05	ES1			(0.20)		TOPSOIL: Soft dark brown slightly sandy silty CLAY with occasional gravel and frequent rootlets, moist	
				84.00			
				(0.20)		SUBSOIL: Firm light brown, light greyish brown and orange brown slightly sandy slightly gravelly silty CLAY with occasional rootlets, moist. Sand fine to coarse. Gravel fine to coarse predominantly limestone.	
0.50	ES2			83.80			
0.60 - 1.10	B3			(0.90)		Firm/stiff yellowish brown and light grey sandy gravelly silty CLAY with medium to high cobble and small boulder content, moist. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone.	0.5
0.60 - 1.10	D4						
1.00	ES5						1.0
1.30 - 1.80	B6			82.90		Firm yellowish brown slightly sandy gravelly CLAY with medium to high cobble and boulder content, wet. Sand fine to coarse. Gravel fine to coarse. Gravel, cobbles and boulders subangular to subrounded predominantly light and dark grey limestone. Boulders up to 0.7m. Pocket of medium to dark grey gravelly sand from 1.6m to 1.8m at southeast corner.	1.5
1.30 - 1.80	D7			(0.60)			
2.00 - 2.50	B8			82.30		Very stiff yellowish to greyish brown sandy gravelly silty CLAY with medium cobble and boulder content, moist. Sand fine to coarse. Gravel fine to coarse, angular to subrounded. Cobbles and boulders subangular to subrounded light and dark grey	2.0
2.00 - 2.50	D9			(0.80)			2.5
				81.50		End of trial pit at 2.700m	3.0
				2.70			3.5

Remarks Hand Vane Tests attempted unsuccessfully due to relatively high granular content. Trial Pit terminated at 2.70m due to large boulder obstructions.	Water Strikes:		Stability: Sides collapsing
	Struck at (m):	Remarks:	
	1.20		Width: 2.70 Length: 4.60

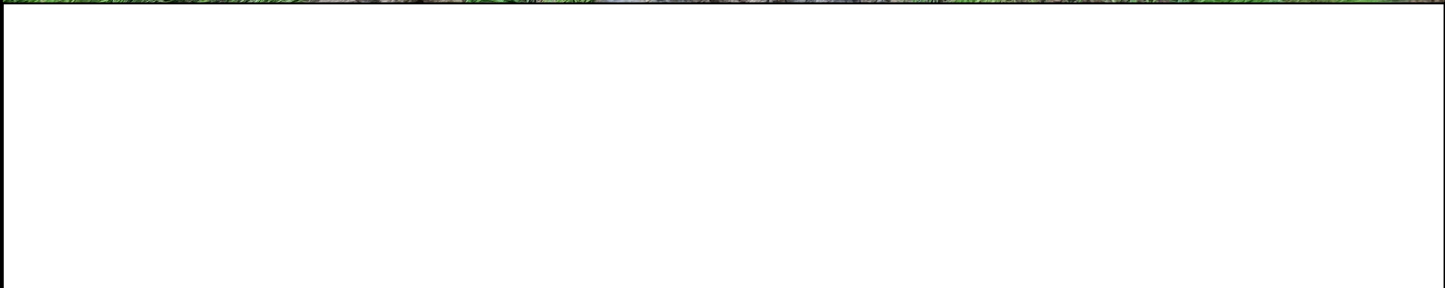
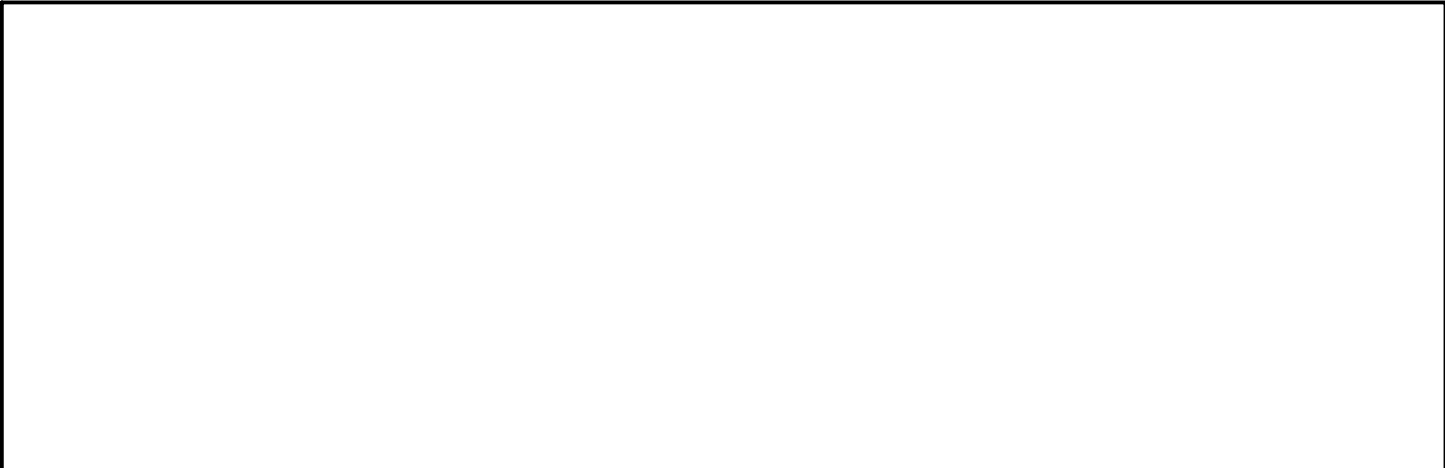
Appendix D

Trial Pit Photographs



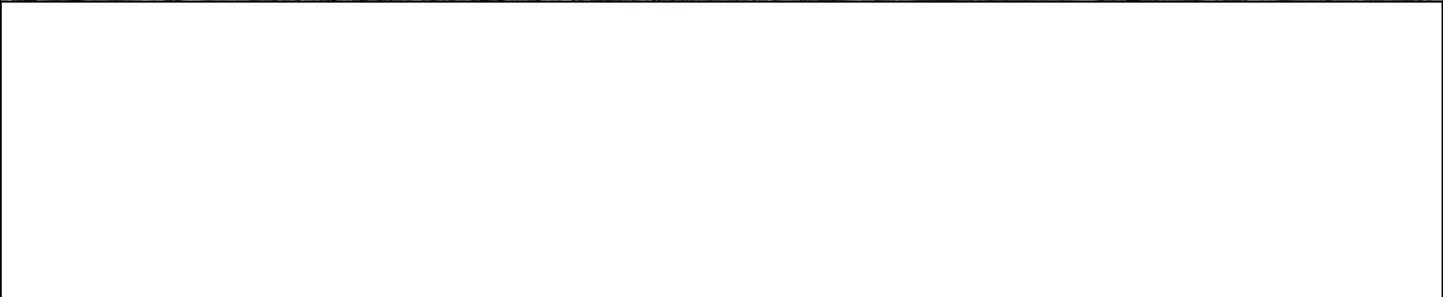
Iarnród Éireann
Cork Line Level Crossings
XC201 (19-135-1)

	T.PIT1
	Trial Pit Photographs
Client:	Iarnród Éireann
Engineer:	Jacob's
Date:	July 2020



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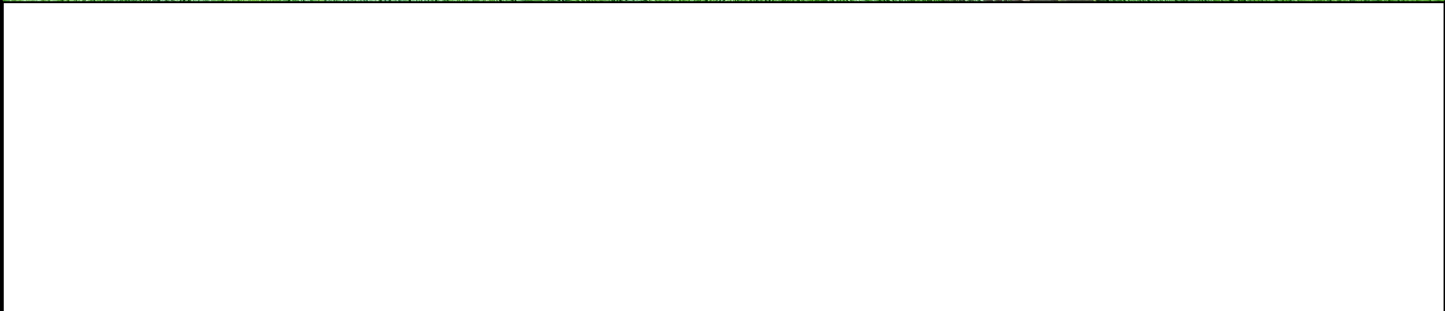
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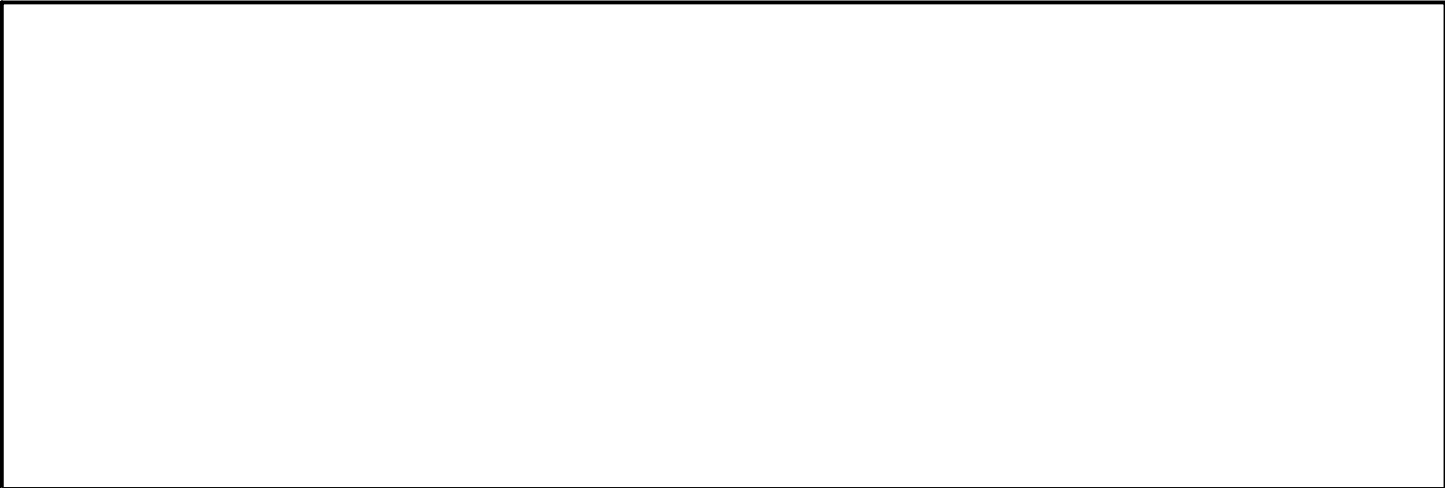
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	Trial Pit Photographs
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