RESOURCE WASTE MANAGEMENT PLAN

APPENDIX 2

400kV NORTH SOUTH INTERCONNECTOR

CONSTRUCTABILITY REPORT

400 kV North South Interconnector
Constructability Report

ESB Networks

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1 Introduction

The North South Interconnector (NSIC) permitted development consists of the construction of a new 400 kV overhead line (OHL) linking the existing Woodland 400 kV substation, located approximately 8 km south of Dunshaughlin in Co. Meath, with a permitted 400 kV substation, located approximately 3 km north of the village of Moy in Turleenan, Co. Tyrone. The general alignment of the OHL route from Tyrone in Northern Ireland to Co. Meath in the Republic of Ireland (ROI) is approximately 137.6 km in length.

The methods used by ESB and their contractors to construct OHL transmission towers have remained largely unchanged over the last 30 years. Given the significance of the NSIC, ESB have compiled the following report to summarise alternative and innovative construction methodologies which will be utilised on the NSIC development.

ESB Engineering and Major Projects (EMP) undertook a desktop study (see Section 5 for findings) to assess alternative construction methods for 400 kV transmission towers. The study focused on alternative methods for the below ground works (i.e. the foundations) and the above ground works (i.e. the tower erection). From this desktop study, the proposals were evaluated and taken to an on-site trial stage to prove the findings of the desktop study on a physical site which also replicates the construction of the NSIC.

2 Methodology

To assess alternative construction methods, the following approach was undertaken:

- Parameters for the project were defined – refer to Section 3 for further details.
- Review undertaken of typical tower construction methodology.
- Undertake a desktop exercise to propose alternative tower construction techniques – refer to Section 5 for further details.
- On-site trial stage to prove the benefits of the alternative construction techniques – refer to Section 6 for further details.

Two typical 400 kV towers were assessed as follows:

- Intermediate tower (INT).
- Angle mast (AM).

3 Project Parameters

For this project, it was required that the 400 kV towers be constructed within the following project parameters:

Parameter	Details
Works Area	Ground can only be broken within the works area surrounding the tower. The works area is defined as follows: - 19x19 m for intermediate tower - 24x24 m for angle mast
Working area	Excavated spoil, materials, plant, construction waste and equipment must be stored within the confines of the working area. The working area is defined as follows: - 30x30 m for both intermediate and angle towers
Stone	Imported stone is not allowed on site for access roads.
Access Widths	Access of the proposed plant shall be limited to access widths reflecting the sites identified for the NSIC.

4 Typical Tower Construction

4.1 Below Ground Works – Foundation Installation

4.1.1 General

The foundation type that is installed with the majority of ESB towers is the pad & chimney foundation. For 400 kV towers, an example of the pad & chimney foundation that would be installed with the majority of intermediate towers is shown in Figure 4-1 below.

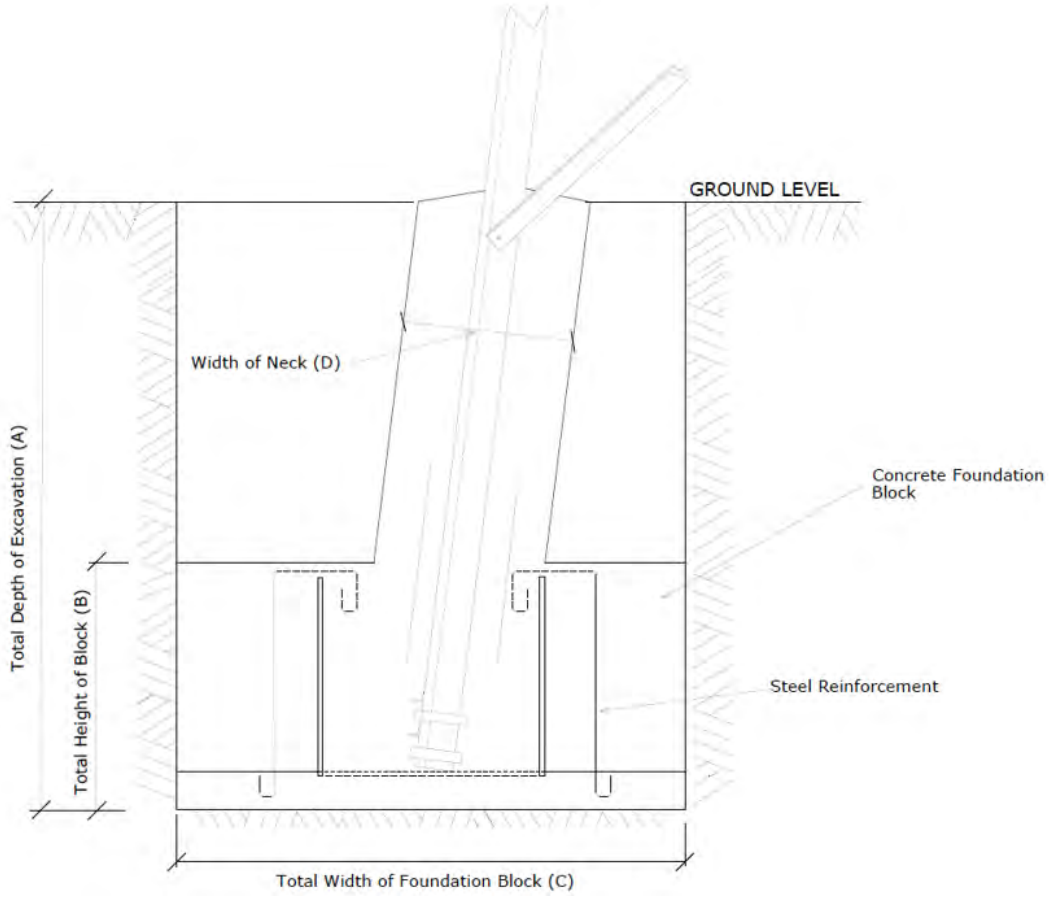

Figure 4-1 – Typical pad & chimney foundation for an intermediate tower

4.1.2 Construction Methodology

The typical methodology used for constructing the pad & chimney foundation is as follows:

- All four foundations are excavated simultaneously, typically using a 13-tonne tracked excavator and the excavated spoil is stored on site, within the 30 x 30 m working area. To ensure stability in the excavation, the sides of the excavation are usually either stepped back or supported using sheet piles.
- The four tower stubs are set using ESB's traditional setting template (where setting using the tower base is not an option). An example of such a template is shown in Figure 4-2.

- The concrete is typically delivered to site by a 6 m^3 / 8 m^3 concrete truck, and the foundation pad is poured, followed later by the foundation chimney (or neck).



Figure 4-2 – Traditional ESB stub setting template

- Foundations are backfilled using the excavated spoil and any sheet piles present are removed.
- The remaining surplus spoil is then removed from site to a waste facility unless a suitable location on site can be used to retain it.

4.2 Above Ground Works – Tower Erection

4.2.1 General

A mobile crane is typically used to erect towers where access allows. For 400 kV towers, an example of a typical crane that would be required to erect the towers is shown in Figure 4-3.



Figure 4-3 – Typical mobile crane for 400 kV tower erection

4.2.2 Construction Methodology

The typical methodology used for erecting steel transmission towers is as follows:

- The tower steelwork is assembled at ground level into a number of individual tower sections.
- The mobile crane is driven into site and is set up adjacent to where the tower is to be erected.
- Once crane set up is complete, each tower section is then lifted into place.

5 Proposed Alternative Construction Methodologies

5.1 Below Ground Works – Foundation Installation

Following a desktop assessment, a number of alternative construction techniques were proposed:

5.1.1 Single Leg Stub Setting Template

An alternative to ESB's traditional stub setting template is the single leg stub setting template. The single leg stub setting template is a device which allows each stub to be set independently of the others. The stub is set into its correct position using the single leg template (refer to Figure 5-1) and a total station.

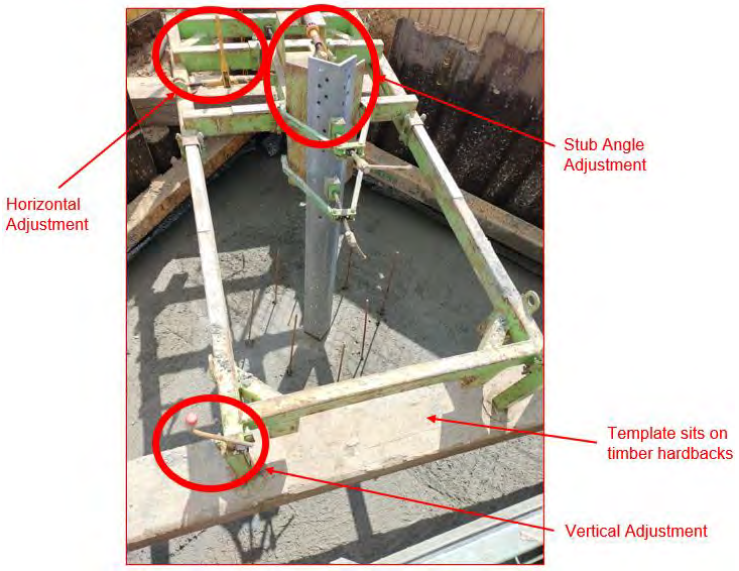

Figure 5-1 – Single leg stub setting template

The single leg template therefore offers the following advantages over the traditional ESB four-leg stub setting template:

- **Reduced spoil volumes:** Since a minimum of one leg can be set at a time, the amount of excavated spoil on site is much reduced and can be more easily retained on a constrained site throughout the foundation works.
- **Limited assembly works:** The traditional stub setting template is made up of steel members, plates and bolts which require assembly on site and a telescopic handler / crane to lift it into place. The single leg template is a single unit which can be brought into site in a 4x4 and trailer, lifted into place using a small excavator and set up quickly, safely and accurately.

5.1.2 Mini Piled Foundations

An alternative to ESB's traditional pad & chimney type foundation is the mini piled foundation. Mini piled foundations generally have a smaller footprint than the pad & chimney foundation due to the greater load capacities provided by the deeper piles. Piled foundations will typically require the drilling or auguring of a number of holes at each leg of the tower. The holes are then reinforced with steel and then filled with concrete or grout. The piles form a stable base upon which a concrete pile cap is

then installed. Typical mini pile foundation arrangements are shown in Figure 5-2 and Figure 5-3 for an intermediate tower and an angle mast respectively. The final arrangement of the pile cap size and number of mini piles at any specific tower would be dependent on site investigation results and would be within the dimensional minima and maxima as shown on planning drawing reference MT-007-002.

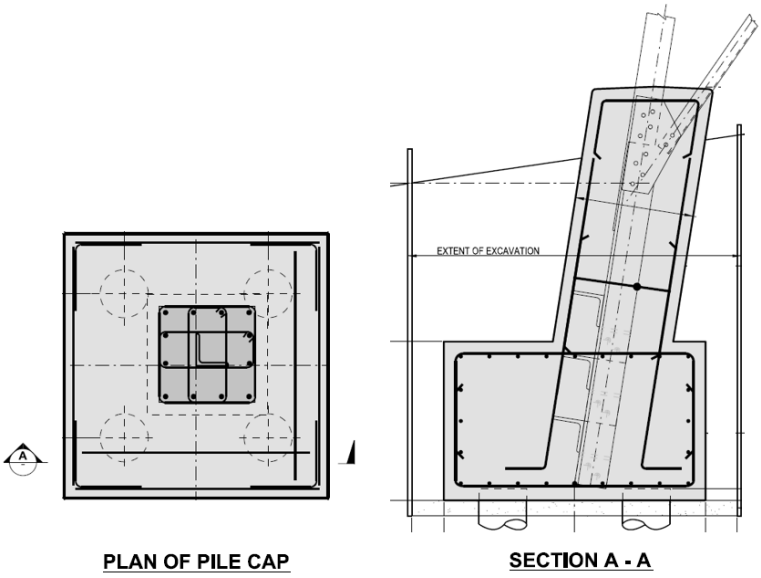

Figure 5-2 – Typical mini pile foundation for an intermediate tower

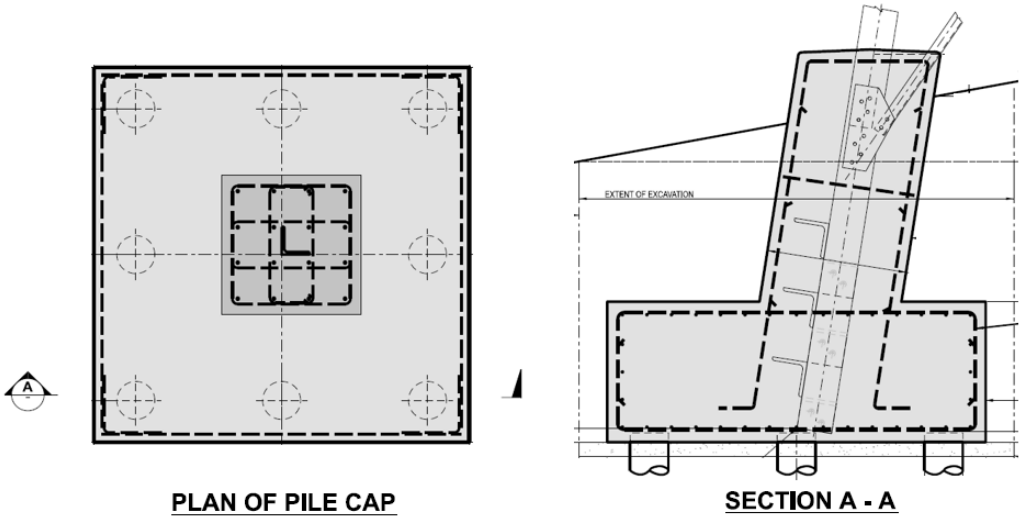

Figure 5-3 – Typical mini pile foundation for an angle tower

The mini pile foundation offers the following advantages over the traditional ESB pad & chimney foundation:

- **Vehicle size reduction:** The mini pile foundation can be constructed using smaller plant than that required for the pad & chimney foundation. The typical plant required is a small piling ring and a 6-tonne / 8-tonne excavator. Smaller and lighter plant may also result in a reduced requirement for the construction of tracked access roads into sites.
- **Reduced spoil volumes:** The typical mini pile foundation requires less concrete and generates less excess spoil than the pad & chimney foundation.



Figure 5-4 – Typical mini pile rig

5.2 Above Ground Works – Tower Erection

5.2.1 General

A desktop assessment was undertaken to investigate alternative methods for erecting steel transmission towers where the project parameters noted in section 3 are present.

Following review, it was determined that the best fit for the parameters was the development of a gin pole system. A gin pole is a temporary vertical or inclined lifting mast, typically fabricated from steel or aluminium, rigged to a partially erected tower and used in conjunction with winches, pulleys, and guy lines to lift and position tower members during erection. This is explained further in the following section.

5.2.2 Gin Pole Solution

EMP contracted a third-party designer who specialises in non-standard OHL construction methodologies to develop the alternative gin pole solution.

An outline drawing of the solution is shown in Figure 5-5. The main body of the gin pole is made up of a number of aluminium sections which can be assembled on site. The gin pole is then supported by stay wires at a number of levels and the anchor points for the stay wires are all contained within the tower footprint, where they attach onto clamps on the tower legs just above ground level. The gin pole has a lifting arm which can then be used to lift the individual tower sections into place and erect the complete tower.

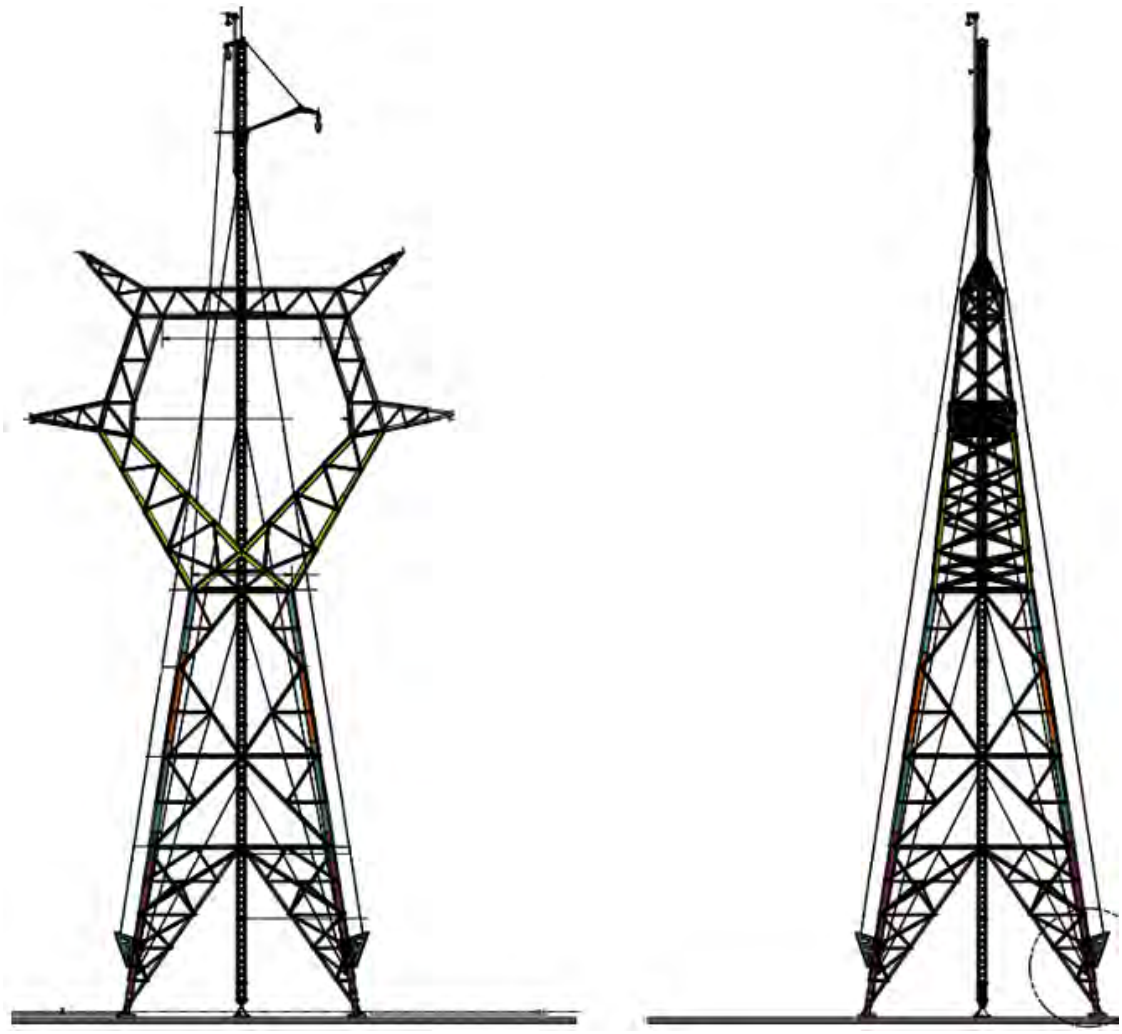

Figure 5-5 –Gin pole, shown with a 400 kV angle mast

6 Trial Stage

6.1 Methodologies Trialled

The trial works of the proposed alternative construction methodologies commenced in July 2023. For the trial, it was decided that both a 400 kV intermediate tower and a 400 kV angle mast would be constructed on site. The methodologies trialled during the construction of each tower are set out in Table 1.

Trial	Tower Type	Foundations	Tower Erection
Trial No. 1	400 kV Intermediate Tower	Pad & Chimney with single leg template	Gin Pole
Trial No. 2	400 kV Angle Mast	Mini Pile with single leg template	Gin Pole

Table 1: Methodologies trialled

6.2 Purpose of Trial

The main purposes for each stage of the trial are set out in Table 2.

Table 2: Purpose of trial

Trial	Stage	Purpose
Trial No. 1	Install pad & chimney foundations	• Assess storage of spoil within 30x30 m area • Assess single leg template
	Erection of intermediate tower	• Assess intermediate tower erection using gin pole solution
Trial No. 2	Install mini pile foundations	• Assess construction utilising smaller plant • Assess storage of spoil within 30x30 m area • Assess piling off mats
	Erection of angle mast	• Assess angle mast erection using gin pole solution

6.3 Trial No.1

6.3.1 Site Setup

The following works took place on site during the site set up stage:

1. A temporary access road of aluminium mats was constructed from site access entrance to the 30x30 m working area.
2. The 30x30 m working area was marked out and fenced off using Heras fencing.

3. Foundation dimensions were pegged out on site.
4. Plastic matting was installed around the perimeter of the tower base.

6.3.2 Foundation Stage

The foundations were constructed with the following works taking place on site during the foundation stage:

1. All required plant and equipment delivered to site and stored within the 30x30 m working area.
2. Sheet piles installed by 13-tonne excavator at legs 1 and 3. Prior to driving the sheet piles, the excavator removed large stones using a riddle bucket to facilitate the driving of the sheet piles.
3. Excavations were dug at legs 1 and 3 and spoil stored on site (top soil and sub soil kept separate).
4. A blinding layer of concrete (0.15 m deep) was poured at legs 1 and 3. The blinding was delivered directly to site by 8 m^3 concrete truck. Two delivery mechanisms were trialled with both confirmed to provide adequate concrete quality:
    - Concrete truck delivered directly to foundation excavation site.
    - Concrete transferred from truck to dumper at site entrance with dumper delivery of concrete to foundation excavation site.
5. Stubs at legs 1 and 3 were set into the correct position using the single leg setting template and a total station which was set up in the centre of the proposed tower footprint.
6. A 1.2 m deep foundation pad was poured at legs 1 and 3. The concrete was delivered directly to site by 8 m^3 concrete trucks.
7. The first pour for foundation chimneys was carried out at legs 1 and 3 (chimneys poured to ~0.5 m below ground level).
8. The foundations at legs 1 and 3 were then backfilled with the excavated spoil and temporary works removed. Surplus spoil (i.e. the soil displaced by concrete) was retained on site.
9. Steps 2-8 were repeated for legs 2 and 4.
10. The tower earthing grid was installed.
11. Surplus spoil from the foundations was then backfilled and reinstated across the extent of the 19x19 m works area.

Figure 6-1 demonstrates the working 30x30 m area working on single leg setting templates for legs 2 and 4. Figure 6-2 shows all four tower foundations in place with stubs protruding from the ground and spoil reinstated within the working area.



Figure 6-1 – Pad & chimney foundation stage: Works at legs 2 and 4



Figure 6-2 – Tower stubbed and surplus spoil graded within the works area

6.3.3 Tower Assembly and Erection Stage

The intermediate tower was constructed in accordance with the manufacturer's assembly drawings. The following works took place on site during the tower erection stage:

1. All tower steelwork and gin pole components were delivered to site.
2. The tower was assembled on the ground into a number of individual sections, refer to Figure 6-3.

3. The tower base was erected using a telehandler and attached to the stubs.
4. The second concrete pour was then carried out at all four legs to complete the chimneys, refer to Figure 6-3 .
5. The gin pole base plate was positioned in the centre of tower, and the gin pole was then assembled and erected to its full height according to the supplier's instructions. During erection of the gin pole, stays were attached at four separate levels to anchor the gin pole to clamps which had been installed on the tower, refer to Figure 6-4.
6. The lifting cable was installed on the gin pole and attached to a mechanical winch on the ground.
7. Each tower section was then lifted into place using the gin pole, refer to Figure 6-5 and Figure 6-6.
8. Once the tower was fully erected, the gin pole was disassembled and removed from the tower.



Figure 6-3 – Preassembled tower sections with tower base and second concrete pour complete



Figure 6-4 – Gin pole erected



Figure 6-5 – Preparation of tower section for lifting



Figure 6-6 – Completed tower prior to gin pole removal

6.3.4 Works Completion

After completion of the tower erection stage, this trial was completed and all temporary works were removed from site. The following works took place on site during the site restoration stage:

1. Removal of temporary access road from site entrance.
2. Removal of Heras fencing.
3. Removal of plastic matting from 30x30 working area.

6.4 Trial No.2

6.4.1 Site Setup

The site setup works required for Trial No.2 involved the same activities as Trial No.1. Refer to Section 6.3.1 for further details.

6.4.2 Foundation Stage

The following works took place on site during the construction of the mini piled foundations:

1. All plant and equipment required for piling was delivered to site and stored within the 30x30 m working area.
2. The piling rig was positioned on timber mats, and the piles were drilled from ground level (mats and piling rig were repositioned around site as required after completion of each pile). Dust on site was controlled using water spray and netting installed around the outside of the Heras fencing. Water bowsers can be drawn to site on a trailer by a 4x4 vehicle, including where access is restricted.
3. When piles were drilled to the required depth, the steel rebar was placed into position, and the piles were filled with concrete.
4. During the piling works the reinforcement steel required for pile caps was delivered to site and the reinforcement cages were preassembled.
5. Following completion of piling, pile testing took place in situ. Figure 6-9 shows the pile testing equipment in place at the mini piled foundation site.
6. Following completion of the pile tests, pile caps works then commenced. The mini pile rig, compressor and pile testing equipment were removed off site and the additional plant and equipment required for pile cap works were delivered to site.
7. Sheet piles were installed using an 8-tonne excavator at legs 1 and 3. Prior to driving the sheet piles, the excavator removed large stones using a riddle bucket to facilitate the driving of sheet piles.
8. Excavation works for the pile caps were undertaken at legs 1 and 3 and spoil was stored on site.
9. The piles at legs 1 and 3 were cut down to the pile cut off level. Steel plates were then fixed to the top of each bar to anchor it into the pile cap.
10. A concrete blinding layer of 0.15 m for pile caps was poured at legs 1 and 3.
11. Reinforcement cages were lifted into position by the excavator at legs 1 and 3 and shuttering for the pile cap was installed.
12. Stubs at legs 1 and 3 were set into the correct position using the single leg setting template and a total station which was set up in the centre of the proposed tower footprint. Figure 6-7 shows the single leg setting template in place above the reinforcement cage and mini piles, all contained within the sheet piled excavation.
13. A 1.0 m thick pile cap was poured at legs 1 and 3.
14. The first pour for foundation chimneys was then carried out at legs 1 and 3 (chimneys poured to ~0.5 m below ground level).
15. Foundations at legs 1 and 3 were then backfilled with the excavated spoil and temporary works were removed. Surplus spoil (i.e. the soil displaced by concrete) was retained on site.
16. Steps 7-15 were repeated for legs 2 and 4.
17. Surplus spoil from the foundations was then backfilled and reinstated across the extent of the 24x24 m works area.

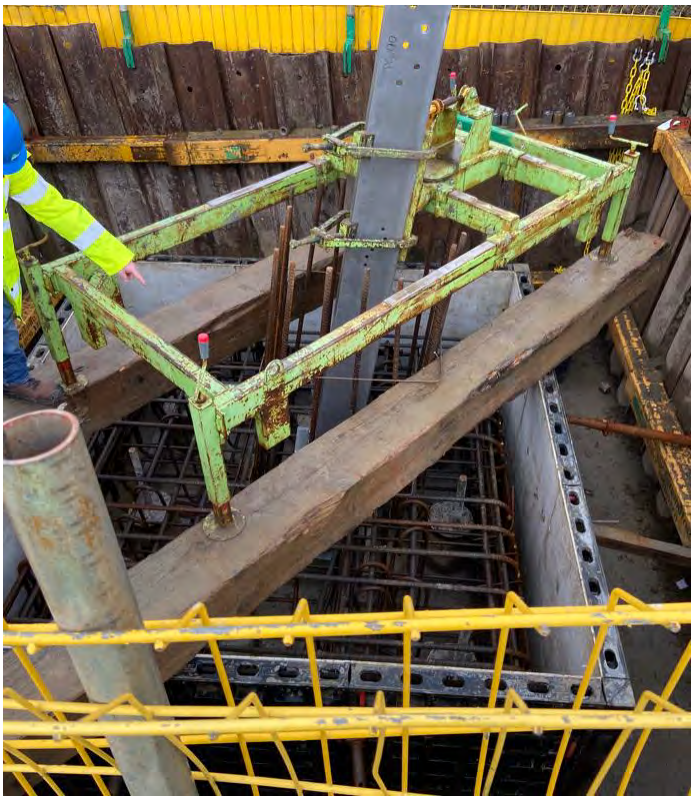

Figure 6-7 – Single leg setting template above the pile cap reinforcement



Figure 6-8 – Mini pile foundation stage: Works at legs 2 and 4

Figure 6-8 provides an aerial overview of the Trial 2 works within the 30x30 m working area. Legs 1 and 3 are complete to ground level before the second chimney concrete pour while legs 2 and 4 have sheet piling installed and mini pile works underway.



Figure 6-9 – Pile testing

6.4.3 Tower Assembly and Erection Stage

The angle mast was constructed in accordance with the manufacturer's assembly drawings. The works which took place on site during this stage was a repeat of steps 1-8 undertaken for the intermediate tower in Trial No.1 – refer to Section 6.3.3 for details.

6.4.4 Works Completion

The site restoration works required for Trial No.2 involved the same activities as Trial No.1. Refer to Section 6.3.4 for further details.

7 Waste Management

Following completion of the trial works, it was determined that the 30x30 m working area would be sufficient to adequately manage waste during the construction works.

Segregated storage bins are to be provided to cater for the following waste types:

- **Mixed Municipal Waste** [EPA Waste Classification Code 20 03 01]
- **Biodegradable Kitchen and Canteen Waste** [EPA Waste Classification Code 20 01 08]
- **Concrete** [EPA Waste Classification Code 17 01 01]
- **Metal** [EPA Waste Classification Code 17 04 07]
- **Plastic** Packaging [EPA Waste Classification Code 15 01 02]
- **Cardboard / Paper** [EPA Waste Classification Code 20 01 01]
- **Timber** [EPA Waste Classification Code 17 02 02]
- **Soil and Stone** [EPA Waste Classification Code 17 05 04]

The removal of segregated storage bins will be via trailer which can be drawn to and from site by a 4x4 vehicle or a van.

Depending on the final foundation type and site details, it may be necessary for certain waste to be transported from the tower construction site to the site entrance via dumper before being removed from site by a licensed haulier and transported to a suitable licensed waste disposal facility or waste transfer station.

These approaches can be utilised where access is restricted.

Further details on waste management can be found in the Resource & Waste Management Plan (PE687-F0422-PS422-007).

8 Transport of Plant and Material to NSIC Tower Sites

The intention for the NSIC is for plant and materials to be transported to tower sites from the storage yard using the required vehicle to access the relevant tower site. In this way, transferring of materials or plant from one transport type to another will be removed.

If it transpires that at any specific tower sites this approach is not viable, locations for stepping down of vehicle size will be proposed and discussed with the relevant County Council Roads Department prior to finalisation.

Table 3 notes the vehicle size and concrete delivery mechanism for the foundations and tower erection methods discussed in this report.

Category	Foundation Construction	Tower Erection	Largest Transport Vehicle	Concrete Delivery Mechanism
Widest	Standard Pad & Chimney	Crane	Crane	Concrete truck to excavation
	Standard Pad & Chimney	Telehandler	Telehandler / Concrete truck	Concrete truck to excavation
	Standard Pad & Chimney/Mini Piles	Gin Pole	13-tonne Excavator	Dumper to excavation from site entrance
Narrowest	Mini Piles	Gin Pole	Tractor & Trailer	Dumper to excavation from site entrance

Table 3: Vehicle and concrete delivery categories

9 Results and Conclusions

The trials undertaken in accordance with the parameters of the 400 kV OHL set out in Section 3 demonstrate that foundation construction and tower erection can be completed within a working area of 30x30 m. Where site entrances and access roads provide sufficient space, the equipment listed in Table 3 (for example, cranes) can be utilised. Where entrances and access roads are more constrained, alternative equipment and construction methodologies can be employed, as demonstrated in this report. Section 9.1 and Section 9.2 provide conclusions for Trial 1 on Intermediate Tower construction and Trial 2 on Angle Mast construction.

9.1 Trial No.1 – Intermediate Tower

Objective	Conclusion
Assess storage of spoil within 30x30 m area	30x30 m area is an adequate space to temporarily store spoil and for construction personnel / plant to operate.
Assess single leg template	• Can set stubs to required ESB tolerances • Advantages over standard setting template as follows: o No preassembly of template required on site o Reduces amount of spoil temporarily stored on site during the works
Assess intermediate tower erection using gin pole	• The gin pole is a suitable solution for erecting intermediate towers.

9.2 Trial No.2 – Angle Mast

Objective	Conclusion
Assess storage of spoil within 30x30m area	30x30 m area is an adequate space to temporarily store spoil and for construction personnel / plant to operate.
Assess piling off timber mats	The piles were successfully installed to the required tolerances with the piling rig operating off timber mats.
Assess angle tower erection using gin pole	The gin pole is suitable for erecting angle masts.

Assess construction using smaller plant	The trial proved that the tower could be successfully constructed using plant with a reduced size when compared to traditional ESB construction.

Appendix A

The following table notes the estimated tower erection methods and foundation types for towers location in County Monaghan.

Tower No.	County	Tower Type	Tower Height (m)	Estimated Tower Erection Method*	Estimated Foundation Type**
103	Monaghan	Intermediate Tower	31	Crane/Telehandler	Pad & Chimney
104	Monaghan	Intermediate Tower	42	Crane/Telehandler	Pad & Chimney
105	Monaghan	Angle Mast	34.2	Crane/Telehandler	Mini Pile
106	Monaghan	Intermediate Tower	37	Crane/Telehandler	Pad & Chimney
107	Monaghan	Intermediate Tower	38	Gin Pole	Pad & Chimney
108	Monaghan	Intermediate Tower	36	Gin Pole	Pad & Chimney
109	Monaghan	Angle Mast	28.2	Gin Pole	Mini Pile
110	Monaghan	Intermediate Tower	36	Gin Pole	Pad & Chimney
111	Monaghan	Intermediate Tower	32	Gin Pole	Pad & Chimney
112	Monaghan	Angle Mast	26.2	Gin Pole	Mini Pile
113	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
114	Monaghan	Intermediate Tower	39	Gin Pole	Pad & Chimney
115	Monaghan	Intermediate Tower	39	Gin Pole	Pad & Chimney
116	Monaghan	Angle Mast	29.2	Crane/Telehandler	Mini Pile
117	Monaghan	Intermediate Tower	28	Crane/Telehandler	Pad & Chimney
118	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
119	Monaghan	Transposition Tower	45.98	Crane/Telehandler	Pad & Chimney
120	Monaghan	Transposition Tower	50.98	Gin Pole	Pad & Chimney
121	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
122	Monaghan	Intermediate Tower	39	Crane/Telehandler	Pad & Chimney
123	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
124	Monaghan	Intermediate Tower	42	Gin Pole	Pad & Chimney
125	Monaghan	Intermediate Tower	32	Gin Pole	Pad & Chimney
126	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
127	Monaghan	Intermediate Tower	31	Gin Pole	Pad & Chimney
128	Monaghan	Intermediate Tower	38	Gin Pole	Pad & Chimney
129	Monaghan	Intermediate Tower	40	Gin Pole	Pad & Chimney
130	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
131	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
132	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
133	Monaghan	Intermediate Tower	42	Gin Pole	Pad & Chimney
134	Monaghan	Intermediate Tower	34	Gin Pole	Pad & Chimney
135	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
136	Monaghan	Angle Mast	35.2	Crane/Telehandler	Mini Pile
137	Monaghan	Intermediate Tower	33	Crane/Telehandler	Pad & Chimney
138	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
139	Monaghan	Intermediate Tower	27	Gin Pole	Pad & Chimney
140	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile

Tower No.	County	Tower Type	Tower Height (m)	Estimated Tower Erection Method*	Estimated Foundation Type**
141	Monaghan	Intermediate Tower	36	Gin Pole	Pad & Chimney
142	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
143	Monaghan	Intermediate Tower	36	Gin Pole	Pad & Chimney
144	Monaghan	Intermediate Tower	40	Gin Pole	Pad & Chimney
145	Monaghan	Intermediate Tower	42	Gin Pole	Mini Pile
146	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
147	Monaghan	Intermediate Tower	38	Crane/Telehandler	Pad & Chimney
148	Monaghan	Intermediate Tower	38	Gin Pole	Pad & Chimney
149	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
150	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
151	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
152	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
153	Monaghan	Intermediate Tower	43	Crane/Telehandler	Pad & Chimney
154	Monaghan	Angle Mast	33.2	Crane/Telehandler	Mini Pile
155	Monaghan	Intermediate Tower	40	Gin Pole	Pad & Chimney
156	Monaghan	Intermediate Tower	31	Gin Pole	Pad & Chimney
157	Monaghan	Angle Mast	36.2	Crane/Telehandler	Mini Pile
158	Monaghan	Intermediate Tower	33	Gin Pole	Mini Pile
159	Monaghan	Intermediate Tower	38	Crane/Telehandler	Pad & Chimney
160	Monaghan	Intermediate Tower	33	Gin Pole	Pad & Chimney
161	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
162	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
163	Monaghan	Intermediate Tower	42	Crane/Telehandler	Pad & Chimney
164	Monaghan	Intermediate Tower	29	Gin Pole	Pad & Chimney
165	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
166	Monaghan	Angle Mast	28.2	Gin Pole	Mini Pile
167	Monaghan	Intermediate Tower	32	Gin Pole	Pad & Chimney
168	Monaghan	Intermediate Tower	42	Gin Pole	Pad & Chimney
169	Monaghan	Angle Mast	29.2	Gin Pole	Mini Pile
170	Monaghan	Intermediate Tower	37	Gin Pole	Pad & Chimney
171	Monaghan	Intermediate Tower	29	Gin Pole	Pad & Chimney
172	Monaghan	Intermediate Tower	43	Crane/Telehandler	Pad & Chimney
173	Monaghan	Intermediate Tower	31	Gin Pole	Pad & Chimney
174	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
175	Monaghan	Intermediate Tower	34	Crane/Telehandler	Pad & Chimney
176	Monaghan	Angle Mast	35.2	Gin Pole	Mini Pile
177	Monaghan	Intermediate Tower	32	Gin Pole	Pad & Chimney
178	Monaghan	Intermediate Tower	38	Gin Pole	Pad & Chimney
179	Monaghan	Intermediate Tower	35	Gin Pole	Pad & Chimney
180	Monaghan	Intermediate Tower	42	Crane/Telehandler	Pad & Chimney
181	Monaghan	Angle Mast	31.2	Gin Pole	Mini Pile
182	Monaghan	Intermediate Tower	39	Gin Pole	Pad & Chimney
183	Monaghan	Intermediate Tower	36	Gin Pole	Pad & Chimney

Tower No.	County	Tower Type	Tower Height (m)	Estimated Tower Erection Method*	Estimated Foundation Type**
184	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
185	Monaghan	Intermediate Tower	41	Gin Pole	Pad & Chimney
186	Monaghan	Angle Mast	36.2	Gin Pole	Mini Pile
187	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
188	Monaghan	Angle Mast	28.2	Gin Pole	Mini Pile
189	Monaghan	Intermediate Tower	38	Gin Pole	Pad & Chimney
190	Monaghan	Intermediate Tower	37	Crane/Telehandler	Pad & Chimney
191	Monaghan	Intermediate Tower	32	Crane/Telehandler	Pad & Chimney
192	Monaghan	Intermediate Tower	39	Gin Pole	Pad & Chimney
193	Monaghan	Intermediate Tower	32	Gin Pole	Pad & Chimney
194	Monaghan	Intermediate Tower	42	Gin Pole	Pad & Chimney
195	Monaghan	Intermediate Tower	42	Gin Pole	Pad & Chimney
196	Monaghan	Intermediate Tower	36	Gin Pole	Pad & Chimney
197	Monaghan	Angle Mast	29.2	Gin Pole	Mini Pile
198	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
199	Monaghan	Intermediate Tower	40	Gin Pole	Pad & Chimney
200	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
201	Monaghan	Intermediate Tower	40	Gin Pole	Pad & Chimney
202	Monaghan	Intermediate Tower	34	Gin Pole	Mini Pile
203	Monaghan	Angle Mast	26.2	Gin Pole	Mini Pile
204	Monaghan	Intermediate Tower	30	Crane/Telehandler	Pad & Chimney
205	Monaghan	Intermediate Tower	40	Crane/Telehandler	Pad & Chimney
206	Monaghan	Intermediate Tower	43	Gin Pole	Pad & Chimney
207	Monaghan	Angle Mast	33.2	Gin Pole	Mini Pile
208	Monaghan	Intermediate Tower	27	Gin Pole	Pad & Chimney
209	Monaghan	Intermediate Tower	39	Gin Pole	Pad & Chimney
210	Monaghan	Intermediate Tower	38	Gin Pole	Pad & Chimney
211	Monaghan	Intermediate Tower	43	Gin Pole	Mini Pile

*Estimated tower erection method to be confirmed prior to mobilisation.

**Estimated foundation types may change based on site investigation.