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APPENDIX C

Construction Methodology

Construction Methodology for the Southland Wind Farm

The construction of the Southland wind farm is broken down into two main areas;

1. On the land on which wind turbines are located and subject to long-term wind farm rental agreements,
2. On land outside the wind farm area to enable the wind farm to be constructed and used for long term operations.

The majority of the construction works is undertaken on the wind farm land and includes activities such as on-site access road construction, foundation construction, construction of the electrical cable network between the turbines, sub-station construction and the installation of the wind turbines. The works on the land outside the wind farm include upgrades to the public road network to allow the transport of the over-weight and over dimensional loads to site and the construction of a transmission line and switching station (aka Grid Injection Point) to connect the wind farm sub-station to the existing Transpower network.

The high-level construction activities are discussed in more detail in the sections below.

1. Wind Farm Construction Activities

At a high level the order of wind farm construction activities is outlined in the sequence listed in section 1.1 to 1.9. While not exhaustive, it gives an overview of the construction requirements and sequencing.

1.1 Completion of site enabling works

Site enabling works includes the preliminary works to allow the construction facilities to be set up on site. This work includes the setup of porta-cabins as site offices, electricity, communication, potable water and wastewater. The works may include a site compound area to allow for on-site parking and deliveries to site. Where necessary road intersection upgrades may be required to allow site traffic and local traffic to continue to be able to use the roads safely and for the duration of the construction period. Traffic management and traffic controls may be required for safe movement of loads and local traffic. Existing weather monitoring on site may be complemented with a weather monitoring station for onsite construction monitoring.

1.2 Construction of access tracks within the wind farm

This activity comprises of the bulk of the site earthworks forming the new on-site tracks. These tracks are designed to be able to accommodate the transport of the turbine loads to each of the turbine locations. After excavating the new tracks to grade, imported material will be used to create a bearing surface for the heavy loads. The majority of the tracks will be metal surfaced, however there may be a few which have asphalt or chip seal surface where steep gradients exist and additional traction is required to deliver the heavy loads. The construction of the tracks will also include the formation of temporary silt ponds, in place for the duration of the construction period, and form the site drainage for the completed wind farm. Where excess cut material is obtained, this will be disposed of in identified fill sites and will incorporate necessary drainage and re-seeded or planted once complete.

1.3 Construction of each of the wind turbine foundations

Once access to a number of turbines has been completed, foundation excavation and construction can commence. The size of foundation will be dependent on the wind turbine model procured for

the wind farm but will involve excavating a large hole, likely between 20-25m wide and approximately 2m deep. The bottom of the hole will have a thin layer of concrete laid over it so that the foundation works can be completed on a hard surface and control the drainage during construction. Foundation construction continues with the placement of the reinforcing steel, the turbine anchor bolts and the electrical conduits. Shuttering is placed around the edges of the foundation to ensure that the concrete is held in place once poured. With the steelwork completed, the concrete is trucked and pumped into the foundation, sourced from a concrete batching plant that is located at a central area on site for the duration of the project. Raw materials for the concrete are trucked onto site and stored adjacent to the concrete batching facility. The fully laden concrete trucks operate on the tracks between the turbines only. On-site holding ponds may be required to retain water for the concrete production and dust suppression activities on site. Sources of water will be identified during the consenting phase for these activities.

1.4 Installation of the underground electrical cable and communications networks interconnecting each of the wind turbines to the wind farm sub-station.

All the turbines are electrically connected back to the wind farm sub-station to allow for the electricity generated to be exported into the Transpower grid. The electrical cables within the wind farm typically operate at 33 kV – although 66kV is a possibility being explored for this wind farm. The turbines are also connected to each other and to the sub-station via a fibre optic communications network, to allow the control of the wind farm and facilitate the transfer of operational data.

The electrical cabling and fibre optic cable between the turbines is generally buried underground within the wind farm roads to an appropriate depth to ensure electrical safety requirements. The cable routes are marked to identify their routes. In some instances, there may be a need for there to be short sections of above ground cabling to accommodate particular geographical or environmental features (such as stream crossings).

The ends of each cable enter each turbine via the conduit installed in the foundation. Typically, these cables connect to switchgear, protection and a transformer located within the turbine – although in some instances, the turbine transformer is located outside of the wind turbine tower - this is dependent on the particular turbine design.

1.5 Construction of the wind farm sub-station and service building

The wind farm sub-station is generally located somewhere central to the wind turbines and has cables that propagate outwards from the substation to the wind turbines. Connected to each of those cables, or circuits there may be five to seven turbines, depending on the cable size, cable length and turbine power. The substation houses the main wind farm transformers which will transform the voltage for 33 kV, within the wind farm, to 220kV from the transformers. The substation also houses the wind farm metering and switch gear equipment. This allows the generation from the wind farm to be measured and for the wind farm to be connected to the transmission line. The construction of the sub-station can commence as soon as access to the sub-station site has been completed. Initial work will involve creating a flat area of appropriate size and placing base course and aggregate to ensure that the transformers can be transported to their final locations. Foundations will be poured for the transformers, overhead support structure and any control and facilities building required.

The site operations and maintenance building is constructed as part of the wind farm facilities on site. This typically includes a building to provide storage for spares and equipment, office facilities

and restrooms for maintenance staff. Parking for service vehicles and delivery vehicles is normally included.

1.6 Formation of the wind turbine hard-stands.

The turbine hard stands allow for the assembly and placement of the main installation crane when constructing each of the turbines. The hard stand needs to have sufficient bearing strength to ensure that the crane remains stable while installing the turbine. The hard stand area includes space for the temporary storage of wind turbine components. Construction of each of the wind turbine hard stands can be completed once the electrical cables have been installed. Some of the excavation work for the hard stand area may be completed as part of the track formation works. The hard stand areas need to be completed prior to the assembly of the wind turbine. The hard stand areas are retained as gravelled platforms for the life of the wind farm to enable ongoing maintenance on the turbines when required.

1.7 Formation of temporary storage areas on site

The wind turbines are procured from international turbine manufacturers and they usually ship the individual turbine main components to New Zealand in batches on dedicated vessels. This results in a number of components arriving in the port on one shipment and needing to be transported out of the port to the wind farm site. Temporary storage areas are constructed within the wind farm site to store these components prior to their delivery to the individual turbine locations. This can also allow for different on-site traction vehicles to be used to move turbine components within the wind farm site, to those used on the public roads. These general storage areas will be similar to the individual turbine hard stand areas and will be placed at strategic locations within the wind farm area. These need to be completed prior to the arrival of the turbine components on site.

1.8 Assembly of each of the wind turbines.

Once sufficient turbine components have been delivered to site to allow continuous assembly of the wind turbines, the wind turbine assembly will commence. A suitable main crane will be delivered to site which is capable of lifting the top tower, nacelle and blades to the hub height of the turbine. The assembly of the turbine commences with the lower or base tower section, followed by the intermediate sections, before the top tower section is lifted into place. The nacelle and drive train are then lifted into place before fitting the hub. Once the turbine hub is in place, each of the three blades is installed individually which requires the turbine hub to be rotated 120° between each blade lift. Once the turbine is erected, it is usually followed by a mechanical and electrical completion where internal fit-outs are completed. The large assembly crane then moves on to the next turbine site and repeats the process.

1.9 Commissioning of the wind turbines and electrical infrastructure to enable electricity to be exported.

Once all electrical and mechanical fit-outs are completed there will be a requirement to complete a number of pre-livening electrical tests. After they are complete, the turbine will be energised to allow electrical power to flow into the turbine. The energisation of the turbine will then allow the full commissioning and testing of further sub-systems prior to the wind turbine being tested in a generation mode. Once generating the turbine will go through some acceptance tests however from this point, it will be free to generate and export energy when the wind blows. The sub-station, transmission line and switching station all need to be completed prior to the first wind turbine being commissioned. If required wind monitoring stations may be installed in the site to provide information on the wind resource and used to measure the performance of the wind farm. Final

commissioning and testing of the entire wind farm is undertaken once all the turbines are operational.

1.10 Site disestablishment.

At the end of the construction phase the site construction facilities are disestablished and the temporary buildings and structures are removed from the wind farm. The main crane and other heavy equipment is transported off the site. The wind farm is handed over to the site operations team who will continue to maintain the facilities with ongoing operations from the main operations and maintenance building.

2 Construction outside of the wind farm area

The three primary construction activities that will occur outside of the wind farm area are as follows:

2.1 Upgrade to the public roads on the route between South Port and the site entrance.

The longest components that need to be transported to site are the wind turbine blades, and a number of the other turbine components are in the order of 80 tonnes each. The main wind farm transformers are the heaviest loads at about 150 tonnes. To allow these loads to be transported to site a route has been identified, however there will be a requirement to upgrade some sections of the public road network to allows these components to be transported. These upgrades will be undertaken in accordance with standard roading maintenance and upgrade procedures and agreed with the road owner, Waka Kotahi NZ Transport Agency or the relevant local council. This upgrade work will need to be completed prior to the first turbine deliveries arriving at South Port.

2.2 Construction of an overhead 220 kV transmission line.

The wind farm needs to be connected to the Transpower network to allow the power generated at the wind farm to be delivered to customers. The wind farm sub-station transforms the generation voltage to 220 kV and an overhead line will be constructed between the wind farm sub-station and the existing Transpower 220 kV network to the north-east of the wind farm. The construction of that line will follow standard transmission line construction methodology. Foundations will be constructed initially, followed by the erection of the support towers. Once the towers are in place, the electrical lines will be rolled out over the length of the route and fixed to the towers. The transmission line will be built while the wind farm is being built and needs to be completed prior to the commissioning of the wind farm sub-station.

2.3 Construction of a switching station adjacent to the Transpower transmission network.

Where the wind farm transmission line joins the existing Transpower line, there will be a requirement to construct a switching station to allow the wind farm line to connect to the Transpower network in a safe and efficient manner. This facility will include necessary protection and switches to allow the safe operation of the Transpower network and the interconnection of the wind farm. The construction of this facility will take place in conjunction with the transmission line construction and will meet Transpower's design requirements.