GRAND RENEWABLE ENERGY PARK
PROJECT DESCRIPTION REPORT

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Prepared for:

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Executive Summary

Samsung C&T (Samsung), Korea Electric Power Corporation (KEPCO) and Pattern Energy (Pattern) are proposing to develop, construct, and operate the Grand Renewable Energy Park (the "Project") in response to the Government of Ontario's initiative to promote the development of renewable electricity in the Province. Together, these companies (referred to herein as "SPK") will be involved in the development of the first phase of the energy cluster development.

The Project is proposed within the County of Haldimand and is generally bounded by Townline Road to the north, Haldimand Road 20 to the west, the Grand River to the east and Lake Erie to the south. It consists of a 148.6 MW (nameplate capacity) wind project, a 100 MW (nameplate capacity) solar project located on privately owned and Ontario Realty Corporation (ORC) managed lands and a transmission line to convey electricity to the existing power grid.

The basic components of the Project include 67 wind turbines, approximately 425,000 photovoltaic (PV) solar panels installed on fixed ground-mounted racking structures organized into 100-1 MW solar modules, a collector sub-station, interconnect station and Operations and Maintenance building, temporary storage and staging areas, approximately 20 km of 230 kV transmission lines along Haldimand Road 20, approximately 82 km of new overhead and/or underground 34.5 kV collector lines along public roads, approximately 48 km of new underground collector lines along turbine access roads, approximately 45 km of turbine access roads and 40 km of solar panel maintenance roads.

SPK has retained Stantec Consulting Ltd. (Stantec) to prepare a Renewable Energy Approval (REA) application, as required under Ontario Regulation 359/09 - Renewable Energy Approvals under Part V.0.1 of the Act of the *Environmental Protection Act* (O. Reg. 359/09). According to subsection 6(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. This Project Description Report is one component of the REA application for the Project, and has been prepared in accordance with O. Reg. 359/09, the Ontario Ministry of Natural Resources' (MNR's) *Approval and Permitting Requirements Document for Renewable Energy Projects* (APRD) (September 2009), and MOE's "Technical Guide to Renewable Energy Approvals (July 2011)".

The following table summarizes the documentation requirements as specified under O. Reg. 359/09.

Project Description Report Requirements (as per O. Reg. 359/09 – Table 1)

Requirements	Completed	Section Reference
1. Any energy sources to be used to generate electricity at the renewable energy generation facility.	✓	2.2
2. The facilities, equipment or technology that will be used to convert the renewable energy source or any other energy source to electricity.	✓	2.3
3. If applicable, the class of the renewable energy generation facility.	✓	3.1.2
4. The activities that will be engaged in as part of the renewable energy project.	✓	2.5
5. The name plate capacity of the renewable energy generation facility.	✓	2.1
6. The ownership of the land on which the project location is to be situated	✓	1.2
7. Any negative environmental effects that may result from engaging in the project.	✓	4.0
8. An unbound, well marked, legible and reproducible map that is an appropriate size to fit on a 215 millimetre by 280 millimetre page, showing the project location and the land within 300 metres of the project location.	✓	Attachment A

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1.0 Introduction

1.1 PROJECT OVERVIEW

Samsung C&T (Samsung), Korea Electric Power Corporation (KEPCO) and Pattern Energy (Pattern) are proposing to develop, construct, and operate the Grand Renewable Energy Park (the "Project") in response to the Government of Ontario's initiative to promote the development of renewable electricity in the Province. Together, these companies (referred to herein as "SPK") will be involved in the development of the first phase of the energy cluster development.

The Project is proposed within the County of Haldimand and is generally bounded by Townline Road to the north, Haldimand Road 20 to the west, the Grand River to the east and Lake Erie to the south. It consists of a 148.6 MW (nameplate capacity) wind project, a 100 MW (nameplate capacity) solar project located on privately owned and Ontario Realty Corporation (ORC) managed lands and a transmission line to convey electricity to the existing power grid.

The basic components of the Project include 67 wind turbines, approximately 425,000 photovoltaic (PV) solar panels installed on fixed ground-mounted racking structures organized into 100-1 MW solar modules, a collector sub-station, interconnect station and Operations and Maintenance building, temporary storage and staging areas, approximately 20 km of 230 kV transmission lines along Haldimand Road 20, approximately 82 km of new overhead and/or underground 34.5 kV collector lines along public roads, approximately 48 km of new underground collector lines along turbine access roads, approximately 45 km of turbine access roads and 40 km of solar panel maintenance roads. The Project site plan which depicts the Project Location during construction and operation is provided in **Attachment A**.

The Project Location includes all land and buildings/structures associated with the Project and any air space in which the Project will occupy. This includes structures such as turbines, solar panels, access roads and power lines as well as any temporary construction zones surrounding infrastructure (constructible areas) which will be required during the construction of the Project. This also includes the corridors surrounding infrastructure such as access roads in which the final infrastructure may be located.

For the purposes of the identification of natural heritage features and the assessment of potential effects, a "Zone of Investigation" has been identified based on the requirements of Ontario Regulation 359/09 (O. Reg. 359/09) and the Ministry of Natural Resources' (MNR's) *Approval and Permitting Requirements Document for Renewable Energy Projects* (APRD) (September 2009). The Zone of Investigation encompasses the Project Location and an additional 120 m surrounding the Project Location. This ensures that adverse environmental effects that may result from construction and operational activities have been assessed within this report.

SPK has retained Stantec Consulting Ltd. (Stantec) to prepare a Renewable Energy Approval (REA) application, as required under O. Reg. 359/09. According to subsection 6.(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. This Project Description Report is one component of the REA application for the Project, and has been prepared in accordance with O. Reg. 359/09, the MNR's APRD, and the Ministry of the Environments' (MOE) "Technical Guide to Renewable Energy Approvals (July 2011)".

1.2 PROJECT LOCATION

The Project will be located on located on privately owned and Ontario Realty Corporation (ORC) managed lands within Haldimand County, Ontario, north of the Lake Erie shoreline and west of the Grand River (see **Attachment A**).

The boundary of the Project Location is used for defining setback, records review and site investigation distances and notification areas according to O. Reg. 359/09. The Project Location is generally bounded by Townline Road to the north, Haldimand Road 20 to the west, the Grand River to the east and Lake Erie to the south.

See **Attachment B** for a legal description of parcels of land that will be used by the Project.

1.2.1 Wind Component

The 67 wind turbines will be located at the following coordinates:

Turbine ID Number	Easting	Northing	Turbine ID Number	Easting	Northing
1	607287	4746785	37	602481	4749039
2	605035	4746639	38	602608	4749469
3	606942	4746830	39	603875	4749401
4	604861	4746993	40	604239	4749614
5	602757	4745791	41	590395	4753879
6	606513	4747319	42	600381	4750377
7	608495	4747949	43	588466	4752970
8	607477	4747512	44	599489	4748483
9	600283	4745004	45	590085	4753880
10	593994	4748442	46	590582	4751836
11	603472	4748075	47	604740	4750499
12	601479	4747111	48	594126	4750504
13	594663	4751618	49	608750	4749784
14	603952	4750047	50	609091	4749844
15	608232	4749798	51	601762	4745085
16	594379	4749955	52	599708	4748016

Turbine ID Number	Easting	Northing	Turbine ID Number	Easting	Northing
17	598651	4747922	53	600301	4748359
18	587941	4753452	54	607370	4746400
19	606357	4749366	55	600136	4746677
20	592562	4749469	56	598686	4750284
21	602672	4746244	57	606647	4751294
22	601756	4751401	58	589733	4750362
23	591178	4751634	59	614345	4748206
24	592285	4749800	60	614974	4747470
25	599130	4750267	61	614326	4747732
26	607589	4749481	62	614680	4748176
27	598999	4748313	63	614750	4747811
28	591339	4752273	64	614705	4747338
29	599967	4750467	65	611480	4747403
30	606959	4749603	66	611758	4747387
33	589588	4755581	67	612236	4747633
34	589790	4753921	68	602131	4748909
35	602880	4749652	69	606923	4747368
36	590002	4755767			

1.2.2 Solar Component

The solar power generation component of the Project will include the installation of approximately 425,000 solar photovoltaic (PV) panels on land designated for this purpose bounded by Mt. Olivet Rd on the west, Meadows Rd on the north, Sutor Rd on the east and Haldimand Rd 20 on the south (see **Attachment A**).

The coordinates of the solar component of the Project are as follows:

- Northwest corner – 596145 E, 4750403 N
- Northeast corner – 598018 E, 4750552 N
- Southwest corner – 596760 E, 4747950 N
- Southeast corner – 597571 E, 4748056 N

1.2.3 Electrical Transmission Component

The substation will be located near Haldimand Road 20 and Mt. Olivet Road (see **Attachment A**) within the solar lands of the Project.

The 230 kV transmission line will be located along Haldimand Road 20 within the municipal road right-of-way (see **Attachment A**).

The operations and maintenance building will be constructed on land on the south side of Haldimand Rd 20 opposite the solar farm land area, just east of Mt. Olivet Rd (see **Attachment A**).

1.3 CONTACT INFORMATION

Applicant

The proponent for the Project is Samsung C&T (Samsung), Korea Power Electric Corporation (KEPCO) and Pattern Energy (Pattern). The contact for the Project is:

Name: Adam Rosso
Title: Manager, Business Development
Company: Samsung Renewable Energy Inc.
Address: 55 Standish Court
Mississauga, ON L5R 4B2

Consultant

The lead consultant for preparation of the Renewable Energy Approval (REA) application is Stantec Consulting Ltd. (Stantec). Stantec provides professional consulting services in planning, engineering, architecture, interior design, landscape architecture, surveying, environmental sciences, project management, and project economics for infrastructure and facilities projects. The consultant's office and Project contact is:

Name: Rob Nadolny
Title: Senior Project Manager
Company: Stantec Consulting Ltd.
Address: Suite 1 - 70 Southgate Drive
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Project

Project Email: GrandRenewable@SamsungRenewableEnergy.ca
Project Telephone: (877) 536-6050 or 519-836-6050 (collect)

2.0 Project Information

2.1 NAME PLATE CAPACITY OF THE PROJECT

The Project will consist of 148.6 MW (nameplate capacity) of wind power, 100 MW (nameplate capacity) of solar power, and electrical transmission components. This will be achieved via the utilization of 67 wind turbines, approximately 800 acres occupied by solar panels, and the creation of a 20 km long transmission line which will connect the Project to the provincial grid.

2.2 ENERGY SOURCES

The Grand Renewable Energy Park will utilize wind and sunlight as sources of energy for the Project. A very small amount of electricity will be required to operate the Project's electronic control equipment. No additional supplementary fuel sources would be used to generate electricity for the Project.

2.3 PROJECT COMPONENTS

The basic Project components include wind turbines, access roads, underground and overhead electrical collector lines, solar panels, transformers and a substation, an operation and maintenance building, and a 230 kV transmission line. No equipment in the facility design relate to groundwater and surface water supplies, air discharges and/or water and biomass management.

This section provides a general description of the major equipment and infrastructure associated with operation of the Project.

2.3.1 Wind Component

2.3.1.1 Turbines

The Project will include 67 Siemens SWT-2.3 wind turbines (65 with a nameplate capacity of 2.221 MW and 2 with a nameplate capacity of 2.126 MW) with a total nameplate capacity of 148.6 MW. Details of the turbine are provided below in Table 2.1. The nacelle for the turbine includes the electric generator, as well as blade and turbine control equipment, wind speed and direction sensing equipment, and auxiliary equipment. These components are located at the top of the 100 m supporting tower, and are connected to the blades via a main shaft. Each tower has a concrete foundation which is buried to a depth of up to approximately 2.4 m and is approximately 16.7 m wide depending upon subsurface conditions (land base is approximately 0.02 hectares per turbine foundation). Detailed information about the turbine model is provided in the **Wind Turbine Specifications Report**, which will be completed as part of the REA.

Table 2.1 Turbine Description – Siemens SWT-2.3

Operating Data	Specification
General	
Rated capacity (kW)	2221 and 2126
Cut-in wind speed (m/s)	3-5
Cut-out wind speed (m/s)	25
Rotor	
Number of rotor blades	3 (49 m long each)
Rotor diameter (m)	101
Swept area (m^2)	8000
Rotor speed (rpm)	6-16
Tower	
Hub height (m)	100
Tip height (m)	149

Specifications of the turbines can also be found in **Attachment C**.

2.3.1.2 Turbine Access Roads and Crane Pads

Access roads are required to access each turbine site from existing roads during both the construction and operation phases of the Project. Access roads are approximately 5 m wide (see drawings in **Attachment A**). Access roads will be constructed of native materials or engineered fill and generally consist of approximately 750 mm of granular material. Alternatively, a woven geotextile or cement stabilized soil could also be utilized with a reduced granular material depth. Turbine laydown (prior to turbine erection) will take place adjacent to the access roads and has been incorporated into the Project Location design by designating a 50 m wide "constructible area" for the access roads (see **Attachment A**). A total of approximately 45 km of access roads will be required.

Crane pads will be constructed at the same time as the access roads and will be adjacent to turbine locations (within the constructible area around each turbine as shown in **Attachment A)**. The general crane pad area will be approximately 20 m x 40 m, and will typically consist of the same make up as the access road, whereas the crane platform (where the crane sits) may consist of a heavier granular make up depending on site conditions. Once the turbine erection is complete, the crane pads will be removed, the area restored and farming activities will resume. If necessary the crane pads will be rebuilt if maintenance activities are needed.

2.3.1.3 Step-up Transformers and Collector Circuits (Lines)

A generator step-up transformer (GSU), located immediately adjacent to each turbine, is required to transform the electricity generated in the nacelle of each turbine to a common collection system line voltage (i.e. 690 V to 34.5 kV). From each GSU, 34.5 kV underground and overhead collector circuits carry the electricity to the Project's substation located near Haldimand Road 20 and Wilson Road. The collector lines will be buried underground on private property, where applicable, from the turbines to the municipal road rights-of-way at which time

the lines will be switched to overhead lines or may remain buried. The overhead lines will be constructed on single wooden pole structures, similar to existing distribution lines located throughout the area. In most cases, the underground lines will be built within the proposed access roads to minimize the amount of land disturbed during construction of the Project. Typically the collector lines will be buried at a minimum depth of 1.2 m so that agricultural production can continue on the lands above the collector lines. A total of approximately 130 km of collector lines will be required (48 km underground and 82 km aboveground and/or underground).

2.3.2 Solar Component

2.3.2.1 Solar Panels

The solar power generation part of the Project will include the installation of approximately 425,000 solar photovoltaic (PV) panels on land designated for this purpose bounded by Mt. Olivet Rd on the west, Meadows Rd on the north, Sutor Rd on the east and Haldimand Rd 20 on the south (see **Attachment A**). Some additional solar PV panels will be located south of Haldimand Rd 20 on land facing the solar farm to the north. Each solar PV panel is fabricated using multicrystalline manufacturing techniques and is mounted on structural aluminum or galvanized steel racks in rows. Each rack is fixed position, facing south and angled 28 - 35 degrees to the horizon. The rows of racks are supported by vertical structural steel posts that are founded in the ground to a depth below the frost line, nominally 1.2 m.

The basic building block of the solar farm is a 1 MW rated solar units. There are 100 solar units forming the entire solar farm. A 1 MW solar unit consists of rows of 60 solar PV panels mounted on racks in straight rows. Approximately 72 rows of solar PV panels constitute a solar unit of 1 MW. Physical arrangements may vary slightly from unit to unit to accommodate physical, environmental and archaeological constraints within the designated solar farm area and may also slightly vary based on the manufacturer's panel specifications. Each solar PV panel in a row generates Direct Current (DC) power and the power is collected through a low voltage wiring system along a row and interconnected to the adjacent rows within the typical unit.

A 2.4 m high chain link fence will be installed around the entire perimeter of the solar farm to prevent unauthorized access to the solar panel area. In addition, a 6 m wide berm will be constructed to provide a landscaping barrier for landowners of adjacent residences where close proximity occurs to the solar PV panels.

2.3.2.2 Solar Land Stormwater Management System

The solar land stormwater management system will be a passive system comprised of local vegetated ditches/swales alongside the access roads constructed through the area. Because the solar cells are mounted above the ground, infiltration, filtration through vegetation and other natural hydrologic process will continue similar to existing conditions. Drainage will generally be

directed to existing receiving systems (drainage paths, roadside ditches, etc.) as under current conditions. Therefore, a general area-wide stormwater treatment and/or detention systems are not required. The small increase in runoff from the gravel access roads will be attenuated and filtered through local ditches and no formal basins or other management techniques are required.

2.3.2.3 Solar Farm Access Roads

Solar access roads (laneways) are required to access each row of solar PV panels during the construction and maintenance phase of the Project. The minimum road width between solar panel rows will be 3 m; however these access roads will not be gravelled. Instead, the roads will be seeded with native grassland species following construction and used sparingly during maintenance activities. Solar panel support structures including racks will take place adjacent to the access roads at selected areas within the solar farm land area. Snowmobiles and ATV's will be used to access the laneways during operation.

Around the outside of each 1 MW solar unit, a 4 m wide gravel road will be constructed for construction and operational purposes. Approximately 40 km of graveled access road will be required.

2.3.2.4 Step Up Transformers and Collector Circuits

The power from each solar PV panel row is collected by a wiring system and this wiring system is connected to one of two 500 Kilowatt (kW) DC to Alternating Current (AC) power inverter panels located at each of the 100 solar units. Each power inverter panel is mounted on a precast concrete base foundation at a central point of each solar unit. The AC output from the inverter panels is connected to an adjacent solar step up (SSU) pad-mounted transformer rated at 1 MW. Each SSU is mounted on a precast concrete vault to facilitate cable entry/exit. Each SSU is positioned in close proximity to the solar inverter panels to minimize power loss. The output voltage of the SSU is 34,500 Volts. The power output from each of the 1 MW SSUs (100 MW in total) is connected via 5 underground 34.5 kV power cable circuits to the collector substation located within the solar farm land area.

2.3.3 Electrical Transmission Component

2.3.3.1 Collector Substation

A Collector substation will be built to accumulate the power circuits from the wind and solar generation equipment outlined above. The accumulated power of approximately 253 MW at 34.5 kV will arrive via both underground cable collector circuits and overhead pole line conductor circuits. The power will be transformed from a 34.5 kV collection voltage to a 230 kV transmission voltage. The substation will be located near Haldimand Road 20 and Mt. Olivet Road (see **Attachment A**) within the solar lands of the Project.

The Collector substation will consist of a prepared area of approximately 85 m by 85 m in size. It will be built on a prepared base of engineered fill and crushed stone to a depth of approximately 600 mm. A grounding grid will be built within the crushed stone and extend to 1 m beyond the 2.4 m high perimeter chain link fence for the substation.

Within the substation will be located a prefabricated modular electrical building (EHouse) wherein all the incoming underground 34.5 kV collector circuits will terminate on interior switchgear. The EHouse will be founded on concrete foundations that are constructed below grade to below frost depth. Cable vaults will be installed beneath the EHouse to facilitate cable entry.

Reactive Power Capacitors and control will be located within the Collector Substation. Either one of D-VAR or S-VAR will be installed as approved by local authority(s). The capacitors will be 34.5 kV rated and there will be up to 6 capacitor banks installed in separate concrete containment foundations, founded below grade to below the frost line. The containment will be large enough to hold any insulating fluid that may leak from the capacitors. The dynamic controller will be a Statcom (or similar) controller located adjacent to the capacitors within the substation and on its own concrete foundation founded below grade to below the frost line.

There are two power transformers within the collector substation that will be used to step up the power to 230 kV. The wind power transformer is rated 100/133/166 MVA while the solar power transformer is rated 65/86/108 MVA. Each transformer is mounted on a concrete base foundation within an oil containment facility that would capture all of the oil insulating fluid within each transformer in the event of a leak. A sound attenuation wall will be constructed around the perimeter of the two power transformers to minimize the escape of transformer noise into the surrounding environment. The sound attenuation wall will be constructed with a minimum density of 20 kg/m2 that will break the line of sight with any noise receptors.

Each of the 230 kV outputs of the two transformers are delivered via a 3 phase air bus (aluminum pipe) to a 1200 Amp 230 kV circuit breaker, isolation disconnect switch and Capacitive Voltage Transformers (CVT). The 230 kV outputs from the final isolation disconnect switches are coupled and connected to a 230 kV termination gantry complete with 230 kV lightning arrestors. The 230 kV termination gantry facilitates the connection of the collector substation to the overhead transmission tower adjacent to the substation. Each of the 230 kV devices located within the collector substation are founded on concrete foundations that extend below finished grade to below the frost line.

2.3.3.2 Collector Substation Stormwater Management System

Area drainage from the collector substation will be accomplished through a series of swales adjacent to the proposed access road that will collect and convey runoff from the substation area and associated access road west and south towards Haldimand Rd 20. The total drainage area associated with the substation and access road “hard” surfaces is less than 2 ha and therefore a “wet” water quality control pond (i.e. one containing a permanent pool) is

inappropriate, as per the MOE *SWM Planning and Design Guidelines Manual (2003)*. In addition to the conveyance of runoff, the series of grassed swales will also provide water quality control, which is a suitable stormwater management practice for such an area according to the MOE guidelines. Water quantity control will be provided using a dry detention pond for the storage and slow release of runoff to the existing ditch and drainage system along Haldimand Road 20. Drainage from the solar lands will largely be conveyed around the substation facility, access road, and associated stormwater management measures through the use of diversion swales given that it does not require treatment or detention.

Within the substation footprint itself, the two transformers will be equipped with oil containment storage areas to capture oil in the event of a leak. Additionally, an oil/water separator will be incorporated into the design to treat any effluent before it enters the storm drainage swales.

2.3.3.3 Collector Substation Access Road

An access road for the collector substation and main access to the solar lands will be constructed from Haldimand Rd 20 (see **Attachment A**). The gravel surface of the access road is approximately 8 m wide with grassed swale drainage ditches of variable top width on either side, for stormwater runoff conveyance and treatment. The depth of the roadbed will generally consist of 750 mm of granular material. During construction it will be used to transport all the materials for construction of the substation including the two heavy power transformers and for maintenance purposes during operation.

2.3.3.4 Transmission Line

From the substation, a 20 km long overhead 230 kV transmission line, consisting of single, 3 conductor aluminum circuit will be constructed to connect the power generated by the wind and solar generation equipment to the Ontario electricity grid that is accessible at a location south of Hagersville, Ontario. The transmission line will be located along Haldimand Road 20 within the municipal road right-of-way (see **Attachment A**).

The transmission line will be constructed overhead using bare aluminum conductors. They are vertically isolated from ground via 230 kV insulators and monopole structures measuring 28 m in height. The monopole structures will be erected on concrete foundations located within the existing Haldimand Rd 20 right-of-way. The structures will be spaced approximately 200 m apart except where significant changes in line direction occur along the route. In these cases, the spacing will be closer to reduce the overhead line tension to a practical construction limit. There will also be closer spacing of the structures at the collector substation, the transition stations around Nelles Corners and the interconnect station near the transmission corridor east of Hagersville.

At a location just east of Nelles Corners (intersection of Haldimand Rd 20 and Highway 3), the overhead transmission line will make a transition to underground cable housed within a concrete encased ductbank. The underground cable is required as the overhead transmission line would

violate safety clearances over the built infrastructure of Nelles Corners. The 230 kV ductbank would be constructed a minimum of 1.2 m below grade and be backfilled with thermal fill to dissipate heat of cable power losses throughout the ground.

The ductbank will be nominally 700 m long and will be constructed entirely within the Haldimand Rd 20 right-of-way beneath the village of Nelles Corners. To facilitate the transitioning of the overhead transmission line to underground cable east of Nelles Corners and to overhead line from underground cable west of Nelles Corners, two transitioning stations will be required to be constructed.

The transitioning stations will contain an A-frame galvanized steel lattice type structure complete with 230 kV lightning arrestors. The structure will be anchored to a concrete foundation that is founded to a depth of ground below the frost line. Each transitioning station will consist of a prepared area of 20 m by 20 m in size. It will be built on a prepared base of engineered fill and crushed stone to a depth of approximately 600 mm. A grounding grid will be built within the crushed stone and extend to 1 m beyond the 2.4 m high perimeter chain link fence for each station.

2.3.3.5 Transmission Line Interconnect Station

The 230 kV transmission line will terminate at an interconnect station located on the north side of Haldimand Rd 20, just east of the transmission corridor east of Hagersville. The transmission line overhead conductors will terminate on a termination gantry (structure) contained within the station area. The station will be enclosed by a chain link fence measuring 40 m wide x 40 m long x 2.4 m high. The station will contain two termination gantries complete with 230 kV lightning arrestors. One will be used for the termination of the 230 kV transmission line and the other will be used to facilitate Hydro One's connection of the power collection circuit to the existing transmission circuit originating at the Nanticoke Power Generating Station. Each gantry will be anchored to a concrete foundation that is founded to a depth of ground below the frost line. The station will consist of a prepared area of 40 m by 40 m in size. It will be built on a prepared base of engineered fill and crushed stone to a depth of approximately 600 mm. A grounding grid will be built within the crushed stone and extend to 1 m beyond the 2.4 m high perimeter chain link fence.

In addition, a 230 kV isolation switch and 230 kV-1200 amp circuit breaker will be installed on a concrete foundations between the two termination gantry structures. The foundation will extend below grade to below the frost line. A small EHouse will be installed within the fenced enclosure for the station. The EHouse will be founded on concrete foundations that are constructed below grade to below frost depth. Cable vaults will be installed beneath the EHouse to facilitate control cable entry.

2.3.3.6 Interconnect Station Stormwater Management System

The interconnect station has a small footprint (less than 0.3 ha of disturbed area) and therefore requires minimal stormwater management infrastructure and no water quantity controls. Water quality control will be provided through the use of grassed swales alongside the proposed access roads that convey drainage from the site to the existing ditches alongside Haldimand Road 20.

2.3.3.7 Operations and Maintenance Building

A building will be constructed on land on the south side of Haldimand Rd 20 opposite the solar farm land area, just east of Mt. Olivet Rd (see **Attachment A**). The building will be a prefabricated engineered structure likely measuring 24 m wide by 85 m long by 7 m high. It will be founded on concrete foundations that are extended below grade to below the frost line. The building will be used as an operations and maintenance facility and it will likely contain several offices, employee welfare facilities, control facilities, solar farm and wind farm spare parts storage space, a public greeting centre, common areas, maintenance work area and vehicle storage facilities.

The employee welfare facilities will be supported by an aboveground potable water tank, filled by tanker trucks, as well as septic system for approximately 20 workers.

An access road to the operations and maintenance building will intersect with Haldimand Rd 20 and proceed south to the building parking area located directly south of the woodlot on the north end of the property. The outdoor vehicle and parts storage areas surrounding the operations and maintenance building will be graveled and fenced in by a 2.4 m high chain link fence.

Electrical power for the operations and maintenance facility will be provided from Haldimand County Hydro power circuits located on Haldimand Rd 20. The power will be delivered by overhead wires on overhead poles installed adjacent to the access road from Haldimand Rd 20. The overhead line will terminate on a transformer pole adjacent to the operations and maintenance building. The transformer will step down the power supply to a voltage that can be utilized within the building. The final connection of the power will be made through underground cable from the transformer pole to the building electrical service located within the building.

2.3.3.8 Operations and Maintenance Building Stormwater Management System

The operations and maintenance facility has a total area of about 3.2 ha including building storage and parking areas as well as the access road, plus a septic system and stormwater management facility. Total impervious coverage of the facility and access road footprints is expected to be about 90%. Drainage from this area is generally southerly towards the existing channel at the south property limit. Stormwater management (conveyance, treatment, and detention) will be achieved through a combination of grassed swale drainage ditches and an end-of-pipe constructed wetland stormwater management facility. While the developed

drainage area is slightly less than that recommended by the MOE *Design Manual* for application of a 'wet' end-of-pipe facility, the relatively high degree of impervious coverage and 'tight' nature of on-site soils mean that the drainage area ought to generate sufficient flows to maintain a permanent pool. Drainage from the access road and operations and maintenance building/parking areas will be conveyed to the end-of-pipe facility through grassed swale drainage ditches which themselves provide water quality treatment benefits, in addition to moderate peak flow reduction. Swale runoff to the stormwater management facility will discharge into a small inlet micropool / forebay for energy dissipation and sediment retention prior to passing through the constructed wetland cell, which contains a permanent pool depth of approximately 0.3 m. The basin will provide both water quality treatment (sediment removal) and water quantity control (discharge rate restricted to existing conditions) and will be planted with vegetation species tolerant to a variety of moisture conditions. The basin will discharge in a non-erosive fashion to the existing channel at the southern site boundary.

2.3.4 Water Crossings

Typical culvert requirements for any water crossings are summarized within **Section 4.4** and are described within the **Water Body and Water Assessment Report**. Permits for the water crossings will be obtained from the Grand River Conservation Authority (GRCA) and Long Point Region Conservation Authority (LPRCA) prior to Project construction.

2.4 TEMPORARY COMPONENTS

Lands to be temporarily used during the construction of the Project include the temporary laydown areas paralleling the access roads and turbine locations, the turbine crane pads, the transmission construction staging and laydown area at the interconnect station, the operations and maintenance building construction staging area, and the solar land staging area. The requirements for these temporary areas including upgrades and restoration are described below and within the **Construction Plan Report**. The land use prior to construction at all of these areas is agricultural.

2.4.1 Temporary Turbine Laydown Areas

Turbine laydown (prior to turbine erection) will take place adjacent to the access roads to each turbine location and has been incorporated into the Project Location design by designating a 50 m wide "constructible area" for the access roads (see **Attachment A**). Turbine components will be temporarily placed in these locations prior to erection. No site preparation is required within these laydown areas, however in locations where turbine components are temporarily stored; these areas will be restored following turbine erection to pre-existing conditions.

2.4.2 Operations and Maintenance Building and Solar Panel Construction Staging Areas

A temporary construction staging area for the construction of the Project will be located on the land south of Haldimand Rd 20 at Mt Olivet Rd where the operations and maintenance building will be located. The staging area will be located adjacent to the operations and maintenance building completely within the outer boundary of the proposed solar unit that is to be adjacent to the operations and maintenance building. The staging area will be graveled with compacted surface material suitable for vehicular truck traffic. Prior to installation of the solar unit at this staging area location, the gravel material will be removed and the site will be prepared in the same manner as the other solar unit sites (e.g. gravel road around the solar unit and grassed laneways between each row). The staging area will be approximately five acres in size and it will support the following construction operations:

- Portable construction and Owner's offices and lunch rooms;
- Parking areas for Contractor, Subcontractors and Other Contractors;
- Portable generators;
- Maintenance and tool sheds;
- Water and rinsing facilities (water to be brought in by tanker);
- Equipment storage and maintenance area;
- Approved temporary fuel tanks, in properly contained spill containment structures;
- Disposal facilities for various solid wastes;
- Temporary toilet facilities – self-contained with no on-site disposal;
- Waste disposal containers;
- Laydown areas for small scale solar and wind farm materials, equipment; and,
- Laydown areas for electrical power collection materials.

During the construction of the graveled surface areas forming the construction staging area, surface material will be stripped and stockpiled for reuse (note that only the land to be used by the graveled areas will be stripped). The depth of the graveled areas will vary and will be dependent upon site conditions/requirements at the time of construction. Once the majority of Project construction is complete and the staging area is required for solar unit installation, as described above all facilities will be removed including the graveled areas and the area will be

used for the installation of a solar unit. The stockpiled soil stripped at the beginning of construction operations will be placed back to its original position on the land.

An additional temporary staging area within the solar farm area will be constructed and removed in the same manner as described. This additional staging area will also be located in an area to be ultimately used for the installation of a solar unit.

2.4.2.1 Transmission Construction Staging and Laydown Area

A temporary construction staging area for the construction of the transmission line will be located on land on the north side of Haldimand Rd 20, adjacent to the east side of the transmission corridor, just east of Hagersville. The temporary construction staging and laydown area will be adjacent to the interconnect station. It will be a graveled compacted surface suitable for vehicular truck traffic. The staging laydown area will be approximately 2 acres in size and it will support the following construction operations:

- Portable construction staff lunch rooms;
- Parking areas for Contractor, Subcontractors and Other Contractors;
- Portable generators;
- Maintenance and tool storage;
- Water and rinsing facilities (water to be brought in by tanker);
- Equipment storage and maintenance area;
- Approved temporary fuel tanks, in properly contained spill containment structures;
- Disposal facilities for various solid wastes;
- Temporary toilet facilities – self-contained with no on-site disposal;
- Waste disposal containers;
- Laydown areas electrical power collection materials.

During the construction of the graveled surface areas forming the transmission construction staging area, surface material will be stripped, stockpiled for reuse when the Project is completed (note that only the land to be used by the graveled areas will be stripped). The depth of the graveled areas will vary and will be dependent upon site conditions/requirements at the time of construction. Once construction is complete, all facilities and the storage area will be removed including the graveled areas. The stockpiled soil stripped at the beginning of construction operations will be placed back to its original position on the land.

2.5 PROJECT ACTIVITIES

2.5.1 Description of Regulated Activities

A general overview of the activities during construction, operation, and decommissioning phases of the Project are provided below.

Table 2.1 Key Project Activities

Project Phase	Activities
Construction	**Turbine and Solar Sites**
	Delineation of temporary work areas
	Access road construction
	Completion of necessary site grading
	Installation of tower and panel foundations
	Installation of crane pads
	Tower/turbine erection and panel installation
	Installation of step-up transformer and required wiring
	Installation of collector lines, usually parallel to access roads
	Reclamation of temporary work areas
	Site landscaping (final grading, topsoil replacement, etc.)
	Substation Site
	Preparation of laydown area
	Installation of substation and connection with grid
	Construction of operations and maintenance building
	Reclamation of temporary work areas
	Off-Site Activities
	Installation of collector lines and transmission line in municipal road right of way
Operation	**Turbine and Solar Sites**
	Preventative maintenance
	Unplanned maintenance
	Meter calibrations
	Grounds keeping
	Substation Site
	Preventative maintenance for substation
	Unplanned maintenance for substation
	Remote wind farm condition monitoring
	Operations and maintenance building maintenance
	Off-Site Activities
	Electrical line maintenance
Decommissioning	**Turbine and Solar Sites**
	Removal of turbine and solar panel infrastructure
	Removal of step-up transformer
	Site grading (dependent upon new proposed use)
	Possible removal of access roads dependent upon agreement with property owner
	Possible excavation and removal of collector lines depending upon agreement with property owner

Table 2.1 Key Project Activities

Project Phase	Activities
	Off-Site Activities
	Possible removal of collector system and transmission line in municipal right of way (remove wires and poles)
	Disconnection of substation from provincial grid
	Removal of substation
	Removal of operation and maintenance building, dependent upon agreement with property owner

2.5.2 Facility Phases, Timing & Scheduling

The table below provides an overview of the projected dates associated with the Project.

Table 2.2 Project Schedule Overview

Milestone	Approximate Date
Initiate Public REA Process	June 2010
REA technical studies	June 2010 to February 2011
Public Meeting #1	July 8, 2010
Draft REA Reports to Public	July 2011
Public Meeting #2	September 2011
REA Submission	October 2011
Start of Construction	Fourth quarter 2012
Commercial Operation Date (COD)	March 2014
Repowering/Decommissioning	Approximately 20-25 years after COD

2.5.3 Waste Generation

2.5.3.1 All Project Components

Construction and Decommissioning

During construction and decommissioning, waste material would be generated at, and transported from, the Project Location. Waste material produced by the Project is expected to consist of construction material (e.g. excess fill, soil, brush, scrap lumber and metal, banding, plastic wrap removed from palletized goods, equipment packaging, grease and oil, steel, etc.) and a minor amount of domestic waste (i.e. garbage, recycling and organics). Similar waste material may be generated during decommissioning.

Operation

Lubricating and hydraulic oils associated with Project maintenance and operation would be used for the facility, and waste materials such as oil, grease, batteries, and air filters and a minor amount of domestic waste (i.e. garbage, recycling, and organics), would be generated during standard operation and maintenance activities. Although the exact oil and grease requirements for the wind component of the Project are not known at this time, oil changes will be completed

in accordance with oil analysis recommendations. The amount of oil and grease stored on site would depend on availability, transportation schedules, and the service cycle. Used oil would be stored in a designated area of the operation and maintenance building, and picked up by certified contractor with the appropriate manifests in place.

During operation, the operation and maintenance building will produce waste materials typical of an office setting, including recyclables and domestic waste.

2.5.4 Air Emissions and Dust Generation

2.5.4.1 All Project Components

Construction and Decommissioning

Construction and decommissioning activities would rely on the utilization of a wide range of mobile equipment, such as bulldozers, dump trucks, and cranes. The engine exhaust from these vehicles, especially from those operating on diesel fuel, represents a source of particulate and other emissions.

Additionally, construction and decommissioning related traffic and various construction activities (e.g. excavation, grading, and exposed areas) have the potential to create short-term nuisance dust effects in the immediate vicinity of the Project.

Traffic delays also result in increased emissions from vehicles traveling slowly through construction zones. The delivery of materials to construction sites can also generate significant amounts of emissions, especially for sites that are relatively far from material manufacturers.

The application of recommended mitigation measures during construction and decommissioning (contained within the **Construction Plan Report**) should limit fugitive dust emissions to the work areas and limit combustion emissions.

Operation

During operations, minor localized air emissions would occur from the periodic use of maintenance equipment to repair Project infrastructure over the life of the Project and from personnel vehicles and waste management haulers travelling to and from the operations and maintenance building during regular business hours.

2.5.5 Noise Emissions

2.5.5.1 All Project Components

Construction and Decommissioning

During construction and decommissioning, noise will be generated by the operation of heavy construction equipment at each of the work areas and associated vehicular traffic on-site. The audible noise at receptors beyond the construction areas is expected to be a minor, short-term disruption consistent with noise generated by any construction project.

Operation

Mechanical and aerodynamic sound would be emitted from the wind turbines and their associated transformers. All turbines proposed as part of the Project are located at a distance of at least 550 m from the nearest non-participating noise receptor. In addition, a Noise Assessment Report has been completed for the Project in accordance with the MOE "*Noise Guidelines for Wind Farms*", dated October 2008 and O.Reg 359/09, and is provided as an appendix in the **Design and Operations Report**.

The solar panels themselves do not generate noise; however the two associated inverter panels will generate noise. Additional noise will be generated by the solar step up (SSU) pad-mounted transformer. Additional noise will be generated by the Project's collector substation

During operations of the Project, sound would be generated by the periodic use of maintenance equipment in addition to personnel vehicles and waste management haulers that would travel to and from the operations and maintenance building during regular business hours.

Based upon the Project design, the analysis carried out in the Noise Assessment Report indicates that sound produced by the Project was found to be within the acceptable limits established by the MOE at all noise receptors. The analysis includes the combined impacts of the substation, solar components, wind turbines, and other wind turbines within a three kilometre radius. The Noise Assessment Report has been completed for the Project in accordance with the MOE "*Noise Guidelines for Wind Farms*", dated October 2008 and O.Reg 359/09, and is provided as an appendix in the **Design and Operations Report**.

2.5.6 Hazardous Materials

2.5.6.1 All Project Components

Construction and Decommissioning

Hazardous materials are limited to fuels and lubricants that will be on-site for use in construction and decommissioning equipment. These materials will be stored in appropriate storage units during construction and decommissioning of the Project. Designated storage unit areas and the

type of storage units will be confirmed by the Contractor prior to construction and decommissioning.

Operation

Hazardous materials to be used during the course of Project operation are limited to fuels, lubricating oils and other fluids associated with overall Project maintenance. No hazardous materials or wastes will be stored on-site during operation and maintenance of the Project. SPK and/or the Operation and Maintenance Contractor would be responsible for implementing environmental procedures during the operation phase of the Project for hazardous waste management.

2.5.7 Sewage

2.5.7.1 All Project Components

Construction and Decommissioning

Sanitary waste generated by the construction and decommissioning crews would be collected via portable toilets and wash stations supplied by a contracted third party. Disposal of these wastes would be the responsibility of the contracted party and would be done in accordance with regulatory requirements.

Operation

No sanitary waste will be generated by the wind and solar components during operations.

The operation and maintenance building will have rest rooms which would be serviced by a septic system. The septic system would have capacity for storage only, with its contents being emptied at regular intervals using tankers.

2.5.8 Stormwater Management

2.5.8.1 Wind Component

Construction and Decommissioning

During construction and decommissioning, proper grading would be conducted and mitigation measures implemented to reduce potential for runoff at the work areas. Runoff will be directed to swales and erosion control berms (where necessary) to ensure that no untreated runoff is discharged from the area.

Operation

Runoff will be directed to swales to ensure that no untreated runoff is discharged from the area.

2.5.8.2 Solar Component

Construction and Decommissioning

The solar farm land area will be graded by earth moving equipment to the elevations determined by the storm water management and grading plans. The stormwater runoff from the solar farm access roads and the solar unit access roads will accumulate in the stormwater management ditches adjacent to the road surfaces and be sloped to the stormwater management ponding facilities which will limit the flow of stormwater into the nearby watercourses.

Operation

Because the solar cells are mounted above the ground, infiltration, filtration through vegetation and other natural hydrologic process will continue similar to existing conditions. Drainage will generally be directed to existing receiving systems (drainage paths, roadside ditches, etc.) as under current conditions. Therefore, a general area-wide stormwater treatment and/or detention systems are not required. The small increase in runoff from the gravel access roads will be attenuated and filtered through local ditches and no formal basins or other management techniques are required.

2.5.8.3 Electrical Transmission Component

Construction and Decommissioning

During construction and decommissioning, proper grading would be conducted and mitigation measures implemented to reduce potential for runoff at the work areas. Runoff will be directed to swales to ensure that no untreated runoff is discharged from the area.

Operation

Area drainage from the collector substation will be accomplished through a series of swales adjacent to the proposed access road that will collect and convey runoff from the substation area and the access road towards Haldimand Rd 20.

The interconnect station has a small footprint (less than 0.3 ha of disturbed area) and therefore requires minimal stormwater management infrastructure.

Stormwater management (conveyance, treatment, and detention) for the operations and maintenance area will be achieved through a combination of grassed swale drainage ditches and an end-of-pipe constructed wetland stormwater management facility.

Drainage from the operations and maintenance access road and operations and maintenance building/parking areas will be conveyed to the end-of-pipe facility through grassed swale drainage ditches. Swale runoff to the stormwater management facility will discharge into a small inlet micropool / forebay for energy dissipation and sediment retention prior to passing through the constructed wetland cell. The basin will discharge in a non-erosive fashion to the existing channel at the southern site boundary.

A Stormwater Management Plan has been completed for the Project, and is provided as an appendix in the **Design and Operations Report**.

2.5.9 Water-taking Activities

2.5.9.1 All Project Components

Construction and Decommissioning

There is potential for groundwater to be encountered during the installation of the turbine foundations, turbine access roads, underground collector lines, solar panel foundations, solar panel access roads, transmission line tower foundations, substation, and operations and maintenance building. As such, it is possible that some dewatering activities may be required when installing these project components. All water pumped during dewatering activities will be directed away from natural features and not directly into wetlands. Due to the dominance of clay soils within the Project Location, seepage is anticipated to be nominal and controllable with standard sump pumps and is anticipated to be below the threshold of 50,000 L/day.

Operation

No water is required for operation and maintenance of the turbines, solar panels, or the electrical transmission component of the Project. Water is not anticipated to be required for solar panel washing as rain water and snow should be sufficient for the cleaning of panels.

Water withdrawal will not be required for the operations and maintenance building staff (approx. 20 workers) as water will be provided via tanker truck from a third party source.

3.0 Regulatory Framework

At the federal, provincial and municipal level multiple permits and approvals may be required to facilitate the development of the Project, in addition to the REA. The ultimate applicability of all permits and approvals will be determined and based on the Project's detailed design.

3.1.1 Government of Canada

It is expected that a Federal Screening report will not be required for the Project, as it is not anticipated that it will cause a 'trigger' under the *Canadian Environmental Assessment Act* (CEAA), such as a Harmful Alteration, Disruption or Destruction of fish habitat under the *Fisheries Act*, or application for project funding under a future program similar to *ecoEnergy for Renewable Power*. However, the agency consultation program for the Project includes all federal departments and agencies typically interested in wind power projects (e.g., Department of National Defense, Environmental Canada, Transport Canada, etc.). All required federal permits and approvals required for the Project will be determined during the REA process, but may include those listed in Table 3.1.

Table 3.1 Key Federal Permits and Authorizations

Permit / Authorization	Administering Agency	Rationale
Aeronautical Obstruction Clearance	Transport Canada – Aviation Division	Turbine lighting and marking
Land Use Clearance	NavCanada	Aeronautical safety mapping and designations
Navigational Clearance	Transport Canada – Marine Division	Crossing a navigable watercourse

3.1.2 Government of Ontario

This document provides a summary of the Project as required by the Ontario Regulation 359/09 – Renewable Energy Approvals under Part V.0.1 of the Act of the Environmental Protection Act ("the Regulation"). According to subsection 6.(3) and 4.(3) of O. Reg. 359/09, the wind component of the Project is classified as a Class 4 Wind Facility and the solar component of the Project is classified as a Class 3 Solar Facility. As agreed upon with the Ministry of the Environment, one REA Application will be submitted for the Project consisting of information related to both the wind and solar projects. In return, two separate Renewable Energy Approvals are being sought, one for the wind project and one for the solar project.

The characteristics of a Class 4 Wind Facility, as described in the Regulation, are as follows:

Class of Wind Facility	Location of Wind Turbines	Name Plate Capacity of the Facility (expressed in kW)	Greatest Sound Power Level (expressed in dBA)
Class 4	At a location where no part of a wind turbine is located in direct contact with surface water other than in a wetland	≥ 50	≥ 102

The characteristics of a Class 3 Solar Facility, as described in the Regulation, are as follows:

Class of Solar Facility	Location of Solar Photovoltaic Collector Panels or Devices	Name Plate Capacity of the Facility (expressed in kW)
Class 3	At a location other than mounted on the roof or wall of a building	>10

At the provincial level there are multiple permits and approvals that may be required to facilitate the development of the Project, in addition to the REA. Their ultimate applicability will be determined during the REA process and based upon the Project's detailed design. The following is a list of key permits and approvals that may be required; however additional permits may also be required.

Table 3.2 Key Provincial Permits and Authorizations

Key Permit / Authorization	Administering Agency	Rationale
Approval of Connection	IESO	Electrical interconnect with IESO regulated network
Connection Assessment	IESO	Integration of project with IESO-controlled transmission system
Customer Impact Assessment	Hydro One Networks Inc. (HONI)	Integration of project with Hydro One and effects to customers
Connection Cost Recovery Agreement (CCRA)	HONI	Recovery of costs to grid operator of changes to allow connection
System Impact Assessment	IESO	Integration of project with IESO-controlled transmission system
Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Permit	Grand River Conservation Authority and Long Point Conservation Authority	Work within floodplains, water crossings, river or stream valleys, hazardous lands and within or adjacent to wetlands. Projects requiring review, *Fisheries Act* authorization and/or assessment under the *Canadian Environmental Assessment Act* are forwarded to the Department of Fisheries and Oceans (DFO)
Certificate of Inspection	Electrical Safety Authority (ESA)	A record that electrical work complies with the requirements of the Ontario Electrical Safety Code.
Generator's License	Ontario Energy Board (OEB)	Generation of electrical power for sale to grid
Leave to Construct	OEB	Authorization to construct power transmission lines
Notice of Project	Ministry of Labour	Notify the Ministry of Labour before construction begins.

Table 3.2 Key Provincial Permits and Authorizations

Key Permit / Authorization	Administering Agency	Rationale
Special vehicle configuration permit	Ministry of Transportation (MTO)	Use of non-standard vehicles to transport large components
Transportation Plan	MTO	Adherence to road safety and suitability
Highway Entrance Permit	MTO	Entrance permit for new or upgraded road entrances onto a provincial highway Interference or obstruction of the highway
Change of Access and Heavy/Oversize Load Transportation Permit	MTO	Compliance with provincial highway traffic and road safety regulations
Wide or excess load permit	MTO	Transportation of large or heavy items on provincial highways

3.1.3 Municipal

Several permits and authorizations may also be required from Haldimand County (Table 3.3).

Table 3.3 Key Municipal Permits and Authorizations

Key Permit / Authorization	Rationale
Municipal Consent, Work with the R.O.W	Required for works in municipal road allowances
Consent/Severance Application	Required if easements over private lands required
Road Cut Permit	May be required for access roads off of county roads or works to county roads
Pre-Condition Survey	Assessment of pre-construction conditions for engineering staff
Building Permit	Compliance with building codes
Entrance Permit	Entrance from county roads
Transportation Plan	Adherence to road safety and suitability
Additional Plans related to general engineering (e.g. siltation control, lot grading, plan of services, etc.), water, wastewater, storm water, transportation, and geotechnical	Required supporting information/plans required by Haldimand County

4.0 Description of Potential Environmental Effects

The effects of constructing, operating, and decommissioning a wind farm, solar project and transmission systems is well understood and can be typically mitigated through well known and accepted techniques and practices. For example, siting turbines away from residential (sound) receptors reduces the potential for adverse environmental effects.

Based upon agency guidance and Stantec's understanding of the potential effects of constructing, operating, and decommissioning a wind farm, solar project and transmission systems, the following Project-specific issues and potential effects have been identified and are further analyzed as part of the Renewable Energy Approval (REA) application process. Please note that below is a summary of the potential effects during the construction, operation, and decommissioning of the Project. Detailed descriptions of all potential effects, mitigation measures, and monitoring plans are provided in the:

- Construction Plan Report;
- Design and Operations Report;
- Decommissioning Report;
- Natural Heritage Assessment/Environmental Impact Study (NHA/EIS);
- Water Body and Water Assessment Report; and,
- Archaeological and Heritage Report.

In addition, a description of the natural features including the results of the findings of the records review and site investigations is provided in the **NHA/EIS**. The Project Site Plan (**Appendix A**) shows the Project Location as well as all natural features within the Project Location. The Zone of Investigation is also shown to identify where natural features are within a 120 m of the Project Location. Where natural features are within the Zone of Investigation, additional analysis is provided within the **NHA/EIS** and **Water Body and Water Assessment Report**.

Monitoring plans have been developed for the various stages of the Project and are identified within the **Construction Plan Report**, **Design and Operations Report,** and **NHA/EIS**. This includes the identification of performance objectives, monitoring requirements, contingency plans, as well as various management systems/programs/plans/procedures. A Complaint Response Protocol has also been developed and will be implemented during all stages of the Project's lifecycle.

4.1 PROJECT RELATED SETBACKS

A key component of the REA process is the establishment of common setbacks for all renewable energy facilities in the Province. The Project was designed to meet the mandatory setbacks within O. Reg. 359/09 in all cases. Within the regulation there are some setbacks for which studies that identify potential adverse environmental effects and mitigation measures can be conducted in lieu of meeting the setback requirements. In some instances in the proposed design, Project components are proposed within the defined setbacks for natural features, water bodies and property lines. In these instances, additional assessments have been conducted as per the requirements of O. Reg. 359/09 and results have established that impacts would be low or not expected. The results of the assessments are provided in the **NHA/EIS**, the **Water Body and Water Assessment Report**, and the Property Line Setback Assessment which is provided as an appendix to the **Design and Operations Report**.

4.2 HERITAGE AND ARCHAEOLOGICAL RESOURCES

A Stage I and II Archaeological Assessment has been completed for the Project and is provided in the **Archaeological and Heritage Report**. In addition, a Built Heritage and Cultural Landscape Inventory Report and a Protected Properties Assessment Report have also been completed for the Project and are provided in the **Archaeological and Heritage Report**.

The results of the Stage 1 Archaeological Assessment indicated that most of the proposed project area demonstrated the potential for the presence of significant and intact archaeological resources. During the completion of the Stage II Archaeological Assessment, a total of 128 archaeological sites were located within or adjacent to the Project Location.

A total of 609 potential built heritage resources and 36 cultural heritage landscapes were identified within or adjacent to the general Project area (not specifically within the Project Location). Ten (10) designated properties were also found in the general Project area.

Archaeological resources located during the course of on-site archaeological assessments will be documented and/or removed (as appropriate) from the Project Location prior to construction in accordance with Ministry of Tourism and Culture guidelines. As such, there are no anticipated significant effects to known archaeological resources during the construction of the Project.

Project related works such as construction activities will avoid the built heritage and cultural resources and protected properties and resources where possible. Additional information is provided within the **Archaeological and Heritage Report.**

4.3 NATURAL HERITAGE RESOURCES

Natural features which were considered in the assessment of potential effects included species at risk, wildlife, habitat, wetlands, sensitive areas, migratory and breeding birds, bats, and fish and fish habitat. The potential effects along with associated mitigation measures are fully described within the **Construction Plan Report**, **Design and Operations Report**, and the **NHA/EIS**. Additional baseline information regarding significant natural features such as significant wildlife habitat and significant woodland based upon records reviews and site investigations are provided within the **NHA/EIS**.

An assessment of how the Project may cause potential effects was conducted and some of the identified potential effects ranged from but were not limited to construction activities such as vegetation clearing; installation of turbines, installation of solar panels, access roads, accidental spills; and turbine operation.

The following provides a summary of the key findings within the **Construction Plan Report**, **Design and Operations Report**, and the **NHA/EIS** related to natural features within the Zone of Investigation.

4.3.1 Wildlife and Wildlife Habitats

4.3.1.1 Construction and Decommissioning

There is some potential for disturbance to wildlife during construction of the wind, solar and electrical transmission components as a result of the limited amount of vegetation removal, increased human activity and increased traffic, noise and dust.

Overall, the total vegetation clearing will represent a very small proportion of the habitat in the general area, and any wildlife that will be displaced will have adequate habitat alternatives. Disturbance effects are expected to be short-term in duration and spatially limited to the work areas and their immediate vicinity

Some limited mortality is possible, however potential long-term effects to wildlife populations from this mortality and from barrier effects is anticipated to be minimal because of the temporary nature of the increased traffic activity.

4.3.1.2 Operation

There is some potential for disturbance to wildlife during construction of the wind, solar and electrical transmission components as a result of the limited amount of vegetation removal, increased human activity, increased traffic, noise, and collisions with turbines.

The installation of the fence around the solar area may disrupt animal movement, however a corridor has been maintained across the site to allow deer to move freely in an east-west direction. Small rodents, amphibians, and mammals will be able to cross the site.

An Environmental Effects Management Plan for Wildlife and Wildlife Habitats (see **Design and Operations Report**) will be implemented which includes post-construction monitoring plan for mortality monitoring and disturbance effects monitoring for birds through point count and transect studies.

MNR, along with the proponent and other relevant agencies, will collectively review the results of the post-construction disturbance effects monitoring to determine if an ecologically significant disturbance/avoidance effect to birds or amphibians is occurring, and whether such effect is attributed to the Project and not external factors. These discussions will determine whether contingency measures, which may include operational controls, will be undertaken.

Most North American studies have shown that direct bird mortality attributable to wind facilities is low, especially when compared to other anthropogenic structures (Arnett et al., 2007; Kingsley and Whittam, 2007; National Academy of Sciences, 2007), and for birds, is not expected to be significant at a population level (Arnett et al., 2007). Mortality of bats is anticipated to be focused in late summer and to primarily affect migratory species.

Potential effects and mitigation measures associated with endangered and threatened species are being addressed as part of a separate process in conjunction with the MNR. Where potential effects indicate that approvals or permits are required for endangered and threatened species, these will be addressed separately through the applicable statute and corresponding permit and approval process.

4.3.2 Wetlands and Woodlands

4.3.2.1 Construction and Decommissioning

All components of the Project (turbines, access roads, substation etc.) are located outside of all wetland boundaries. While the majority of the Project infrastructure has been sited outside of significant woodlands, there is one new access road and turbine within a plantation, one access road along an existing farm laneway through a deciduous forest and three buried collector lines proposed along existing farm laneways through significant woodlands. Additional Project components (e.g. turbines, access roads and corresponding buried collector lines) are found within 120 m of significant woodlands and as a result, potential impacts and mitigation measures are detailed in the **NHA/EIS**. Proposed clearing will result in the removal of approximately 1.72 ha of plantation in areas identified as significant woodland (please see **NHA/EIS**).

Though the effects are anticipated to be minimal, there is some potential for disturbance of natural features during construction of the wind, solar and electrical transmission components as a result of the limited removal of vegetation and increased human activity, traffic, noise and dust. However, these effects are expected to be short-term in duration and spatially limited to the work areas and their immediate vicinity. The relatively small amount of woodland to be removed represents a very small proportion of the available habitat in the general area and is not anticipated to have a significant effect on the ecological functions these features support.

Setbacks from wetlands and mitigation measures for infrastructure within 30 m of wetlands will ensure that there is no disruption of wetland function and no net loss of wetland area.

4.3.2.2 Operation

As stated above, all components of the Project are located outside of all wetland boundaries and the majority of components have been sited outside of significant woodlands. During operation of the Project, some materials such as lubricating oils and other fluids associated with turbine maintenance have the potential for discharge to the on-site environment through accidental spills resulting in a potential impact to the natural features. Improper disposal of wastes (fluids, containers, cleaning materials) could also have an adverse impact on the features. With the implementation of good maintenance practices, it is anticipated any potential effects from an accidental spill would be short term in nature and have little to no effect.

Stormwater management systems will also be incorporated into the Project design to ensure that natural flow patterns and hydrological functions of wetlands and woodlands are not adversely impacted during operation of the Project. Where required, contingency measures will be developed on a site-specific basis, and may include installation of additional culverts or other stormwater management systems to preserve pre-construction flow patterns.

An Environmental Effects Management Plan for Wildlife and Wildlife Habitats (see **Design and Operations Report**) will be implemented which includes post-construction monitoring plan for visual observations of wetland and woodland hydrology to ensure proposed culverts beneath access roads will convey flows and avoid flooding that may impact such features.

Disturbance effects to the wildlife inhabiting the wetlands and woodlands are addressed in Section 4.3.1. The dust and disturbance to vegetation as a result of maintenance vehicle traffic is expected to be negligible due to the infrequency of these activities.

4.4 WATER BODIES AND AQUATIC RESOURCES

Potential effects to surface and ground water features were assessed for all stages of Project development and all project components.

There is potential for groundwater to be encountered during the installation of the turbine foundations, turbine access roads, underground collector lines, solar panel foundations, solar panel access roads, transmission line tower foundations, substation, and operations and maintenance building. As such, it is possible that some dewatering activities may be required when installing these project components. All water pumped during dewatering activities will be directed away from natural features and not directly into wetlands. Due to the dominance of clay soils within the Project Location, seepage is anticipated to be nominal and controllable with standard sump pumps and is anticipated to be below the threshold of 50,000 L/day.

Some materials, such as fuel, lubricating oils and other fluids associated with turbine construction and maintenance have the potential for discharge to the on-site environment through accidental spills. With the implementation of good construction and maintenance practices, it is anticipated any potential effects from an accidental spill would be short term in nature and have little to no effect on surface and/or groundwater quality and adjacent private water wells.

Where culverts are required for watercrossings, culverts will be designed and installed such that there is no restriction of flows through the culvert resulting in upstream pooling, no erosion at the culvert inlets and outlets, and that there is no barrier to fish passage to upstream environments. Mitigation measures will be implemented for construction activities within and near watercourses to protect fish and fish habitat from potential effects including the adherence to timing windows. Culverts will be sized according to hydrologic requirements and will be determined during the permit application stage with the conservation authorities. As described above, stormwater management systems will be incorporated into the Project design to ensure that natural flow patterns and hydrological functions of wetlands and woodlands are not adversely impacted during operation of the Project. Where required, contingency measures will be developed on a site-specific basis, and may include installation of additional culverts or other stormwater management systems to preserve pre-construction flow patterns.

An evaluation of the site's erosion potential yielded a general conclusion of 'low' (as described in the **Design and Operations Report**), owing primarily to the flat character of the areas and the low erodibility of in-situ Haldimand / Lincoln clay soils. In all instances where the potential for erosion is identified a series of control measures will be implemented to protect surface water features from experiencing sediment transport and/or siltation.

4.5 AIR, ODOUR, DUST

4.5.1 Construction and Decommissioning

Construction and decommissioning activities would rely on the utilization of a wide range of mobile equipment, such as bulldozers, dump trucks, and cranes. The engine exhaust from these vehicles, especially from those operating on diesel fuel, represents a source of particulate and other emissions.

Additionally, construction and decommissioning related traffic and various construction activities (e.g. excavation, grading, and exposed areas) have the potential to create short-term nuisance dust effects in the immediate vicinity of the Project.

Traffic delays also result in increased emissions from vehicles traveling slowly through construction zones. The delivery of materials to construction sites can also generate significant amounts of emissions, especially for sites that are relatively far from material manufacturers.

The application of recommended mitigation measures during construction and decommissioning (contained within the **Construction Plan Report**) should limit fugitive dust and odour emissions to the work areas and limit combustion emissions. As a result, any net effects are expected to be short-term in duration and highly localized.

4.5.2 Operation

During operations, minor localized air emissions would occur from the periodic use of maintenance equipment to repair Project infrastructure over the life of the Project and from personnel vehicles and waste management haulers travelling to and from the operations and maintenance building during regular business hours.

The application of recommended mitigation measures during operations (contained within the **Design and Operations Report**) should limit air emissions to the work areas and limit the magnitude of combustion emissions. As a result, any adverse net effects to air quality from air emissions during operation of the Project are anticipated to be short-term in duration and highly localized.

4.6 ENVIRONMENTAL NOISE

4.6.1 Construction and Decommissioning

During construction and decommissioning, noise will be generated by the operation of heavy construction equipment at each of the work areas and associated vehicular traffic on-site. The audible noise at receptors beyond the construction areas is expected to be a minor, short-term disruption consistent with noise generated by any construction project.

The application of recommended mitigation measures during construction and decommissioning (contained within the **Construction Plan Report**) should limit noise emissions to the general vicinity of the work areas. Any net effects are expected to be limited to short-term, intermittent noise increases during daylight hours at the work areas and/or along the haul routes.

4.6.2 Operation

Mechanical and aerodynamic sound would be emitted from the wind turbines and their associated transformers. All turbines proposed as part of the Project are located at a distance of at least 550 m from the nearest non-participating noise receptor. In addition, a Noise Assessment Report has been completed for the Project in accordance with the MOE "*Noise Guidelines for Wind Farms*", dated October 2008 and O.Reg 359/09, and is provided as an appendix in the **Design and Operations Report**.

The solar panels themselves do not generate noise; however the two associated inverter panels will generate noise. Additional noise will be generated by the solar step up (SSU) pad-mounted transformer. Additional noise will be generated by the Project's collector substation.

During operations of the Project, sound would be generated by the periodic use of maintenance equipment in addition to personnel vehicles and waste management haulers that would travel to and from the operations and maintenance building during regular business hours.

Based upon the Project design, the analysis carried out in the Noise Assessment Report indicates that sound produced by the Project was found to be within the acceptable limits established by the MOE at all noise receptors. The analysis includes the combined impacts of the substation, solar components, wind turbines, and other wind turbines within a three kilometre radius. The Noise Assessment Report has been completed for the Project in accordance with the MOE "*Noise Guidelines for Wind Farms*", dated October 2008 and O.Reg 359/09, and is provided as an appendix in the Design and Operations Report.

4.7 LAND USE, RESOURCES AND INFRASTRUCTURE

4.7.1 Construction and Decommissioning

There are no anticipated net effects related to land use, resources and infrastructure as a result of construction of the wind, solar, and electrical transmission components of the Project. The Project's effect on the rural community during construction, including the suspension of recreational uses, traffic, and some disturbance to adjacent land uses, these effects will be temporary and will be minimized through the implementation of good site practices, transport planning, and good communication with the community. Road safety is not expected to be an issue during the construction phase; however, the potential for accidents along the haul routes and on-site cannot be totally avoided.

A positive net effect is anticipated on the local economy during construction of the Project. The Project provides positive income, employment, and fiscal benefits to the local area, including the County and participating landowners. The County would receive ongoing property tax income and participating landowners would receive land lease payments. A nominal increase in municipal services is possible. Existing businesses within local communities could benefit from the demands of the Project workforce during construction.

4.7.2 Operation

Disturbances to agricultural lands and operations are expected to be temporary and spatially limited. With the application of recommended mitigation measures during operation (contained within the **Design and Operations Report**) no adverse net effects on telecommunications and radar networks are anticipated during operation of the facility. No net effects are anticipated to provincial and local infrastructure during operation of the Project. Some disturbance to the viewscape is unavoidable due to the height of the turbines, the solar panels, the size of the operations and maintenance building, and location of the transmission line. Application of mitigation measures such as a berm and buffer area around the solar are will assist in minimizing the potential visual obtrusiveness of the Project. The changed visual landscape would be present during the life of the facility.

A positive net effect is anticipated on the local economy during operations of the facility. The operation of the Project would provide positive income, employment, and fiscal benefits to the local area, including the County and participating landowners. The County would receive ongoing property tax income from the Project and participating landowners would receive land lease payments.

4.8 TRAFFIC AND ROAD USAGE

4.8.1 Construction and Decommissioning

Abnormal wear (e.g. rutting) on municipal roads may be unavoidable. However, the effect of constructing the various Project components is anticipated to have a limited, short term effect on local roads given SPK's commitment to developing maintenance and/or repair plans or agreements with the County. Truck traffic would increase on some roads during Project component deliveries, but would be restricted to predetermined routes and times to the greatest extent possible. Road safety is not expected to be an issue during the construction phase due to the implementation of a Traffic Management Plan (details provided within the **Construction Plan Report**); however, the potential for accidents along the haul routes and on-site cannot be totally avoided.

The effect of constructing the various Project components is anticipated to have a limited, short term effect on traffic during construction and will also be managed through the implementation of the Traffic Management Plan.

4.8.2 Operation

Road safety is not expected to be an issue during operations; however the potential for accidents along the haul routes and on-site cannot be totally disqualified. Truck traffic would increase on some roads during maintenance activities and from personnel vehicles, and waste management haulers, however this traffic would be short-term in duration and intermittent.

The effect of operating the Project is anticipated to have a limited, short term effect on traffic only during non-conventional load movements.

4.9 PUBLIC HEALTH AND SAFETY

4.9.1 Construction and Decommissioning

During construction/decommissioning, potential effects to public health and safety are largely in the form of increased construction related traffic and unauthorized access of the public to the work sites.

The application of recommended mitigation measures (contained within the **Construction Plan Report**) including implementing transportation planning and safety measures during

construction, and controlling land access to the construction sites would minimize the potential for public health and safety concerns. A detailed Traffic Management Plan and a detailed Health and Safety/Emergency Response Plan will be prepared and implemented by the Construction Contractor (details provided within the **Construction Plan Report**).

4.9.2 Operation

4.9.2.1 Wind Component

With the implementation of appropriate operations protocols and routine maintenance there is minimal increased or new risk to public health and safety from the operation of the Project. In addition, under O. Reg. 359/09, minimum setback requirements (in which this Project meets) were introduced specifically to ensure the protection of people and the environment from wind farm projects. An extensive review of potential effects to public health and safety as a result of environmental noise, low frequency noise, infrasound, shadow flicker, electric and magnetic fields, and stray voltage is provided within the **Design and Operations Report**. With the implementation of appropriate operations protocols there is minimal increased or new risk to public health and safety from the operation of the Project.

4.9.2.2 Solar Component

The operation of the solar panels does not pose a threat to human and environmental health and safety as no emissions are produced. For public safety reasons, a 2 m high chain link fence will be installed around the entire perimeter of the solar farm to prevent unauthorized access to the solar panel area.

With the implementation of appropriate operations protocols and fencing around the solar panels, there is minimal increased or new risk to public health and safety from the operation of the Project.

4.9.2.3 Electrical Transmission Component

A review of potential effects to public health and safety as a result of Electromagnetic Fields is provided within the **Design and Operations Report**. With the understanding that the Project will operate well within the range of voluntary standards in North America, and that the potential health effects from Electromagnetic Fields remain inconclusive, no adverse net effects on human health are expected from operation of the Project. A fence will be installed around the substation and interconnect station in order to limit the proximity to which members of the public may approach these facilities.

4.10 WASTE MATERIAL DISPOSAL

4.10.1 Construction and Decommissioning

During construction, the Construction Contractor would implement a site-specific waste collection and disposal management plan. The plan may include practices for the systematic collection and separation of waste materials within on-site storage areas, labelling and proper storage of hazardous and liquid wastes, and disposal of non-hazardous waste at a registered waste disposal site(s).

There will be no on-site disposal of waste generated by the Project. It is assumed that licensed waste disposal sites are compliant with Provincial and County regulations.

With the application of recommended mitigation measures (contained within the **Construction Plan Report**) no adverse net effects are anticipated from waste material.

4.10.2 Operation

During operations, SPK and/or the Operation and Maintenance Contractor would implement a site-specific waste collection and disposal management plan, which may include good site practices such as: the systematic collection and separation of waste materials within on-site storage areas, contractors would be required to remove all waste materials from Project sites during maintenance activities, and implementation of an on-going waste management program consisting of reduction, reuse, and recycling of materials.

With the application of the mitigation measures (contained within the **Design and Operations Report**), no adverse net effects from waste material disposal would occur on-site during operation. However, as with all wastes, it is possible that disposal would have a minor incremental effect on soil, groundwater, and surface water at the waste disposal site(s) depending on municipal on-site containment practices and quality of the landfill protection mechanisms (e.g. use of geotextiles to contain leachate). It is assumed that licensed waste disposal sites are legally compliant.

4.11 ACCIDENTS AND MALFUNCTIONS

Though the possibility of injury from full or partial blade detachment from the turbine or collapse of the entire structure exists, the likelihood of this happening with the built in safety features to the structures and ongoing maintenance of the equipment is very low. In accordance with O. Reg. 359/09, the turbines are located at least the minimum regulated setback distance from any receptor and the event of a failure of the structure would likely not fall beyond the setback distance and not affect public health and safety.

There is the potential for exposure to toxic vapours should a fire consume the solar panel. However, given the melting points of the potentially harmful substances within the photovoltaic

cells (Fthenakis, 2003) and the lack of burnable materials in a solar panel, the risk of fires and the generation of hazardous fumes are extremely limited.

It is anticipated that the probability of transmission tower failure occurring during operation is low, i.e., one occurrence in 150 years. The transmission and collector lines will be designed and constructed in accordance with applicable regulatory guidelines (e.g. International Electrical Commission standards) minimizing the risk of tower failure.

SPK and the Operation and Maintenance Contractor would aim to minimize accidents and malfunctions with proper training and education of staff operating the control system. County emergency response staff would also be trained to appropriately deal with any potential accidents and malfunctions resulting from the operation of the turbines.

With the implementation of an Emergency Response Plan which would include protocols for the proper handling of material spills and associated procedures to be undertaken in the event of a spill no adverse net effects are anticipated from spills during the Project.

4.12 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Though the possibility of injury from ice falling or shed from the turbine tower or blades, the likelihood of this happening with the built in safety features of the structures and ongoing maintenance of the equipment if very low. In addition, in accordance with under O. Reg. 359/09, the turbines are located at least the minimum regulated setback distance from any receptor and the event of falling ice or ice shed would likely not fall beyond the setback distance and not affect public health and safety.

Project components have been designed to withstand the effects from extreme weather events

4.13 AREAS PROTECTED UNDER PROVINCIAL PLANS AND POLICIES

The Project does not fall within any parts of land protected under the following provincial plans: Greenbelt Plan and *Greenbelt Act*, Oak Ridges Moraine Conservation Plan Area, Niagara Escarpment Plan Area, and the Lake Simcoe Watershed Plan Area.

5.0 Closure

This report has been prepared by Stantec for the sole benefit of SPK, and may not be used by any third party without the express written consent of SPK. The data presented in this report are in accordance with Stantec's understanding of the Project as it was presented at the time of reporting.

STANTEC CONSULTING LTD.

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Senior Project Manager

Mark Kozak, B.E.S., Dipl. EA
Project Manager

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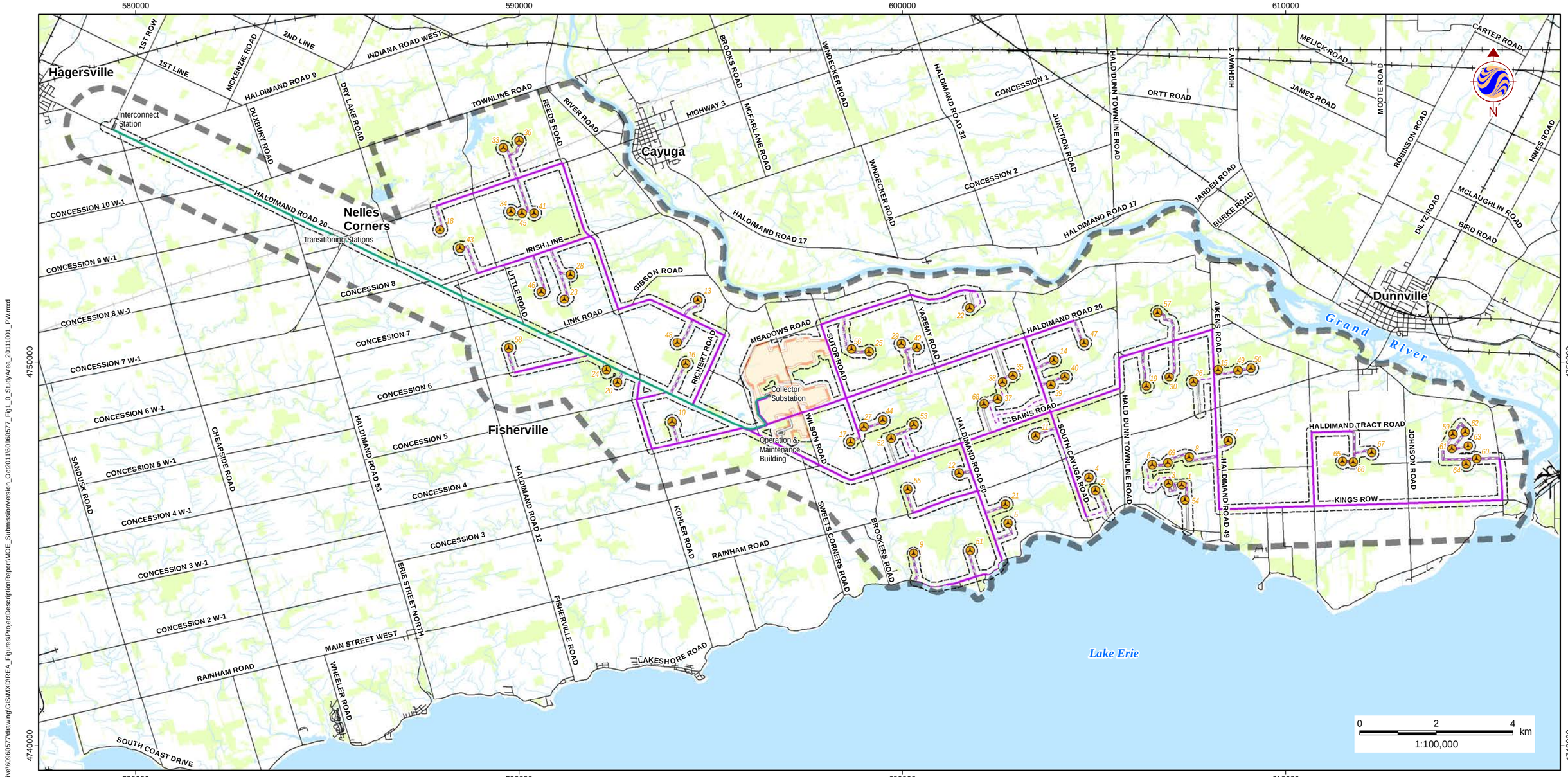
Attachment A

Site Plans



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October 2011
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Stantec

Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

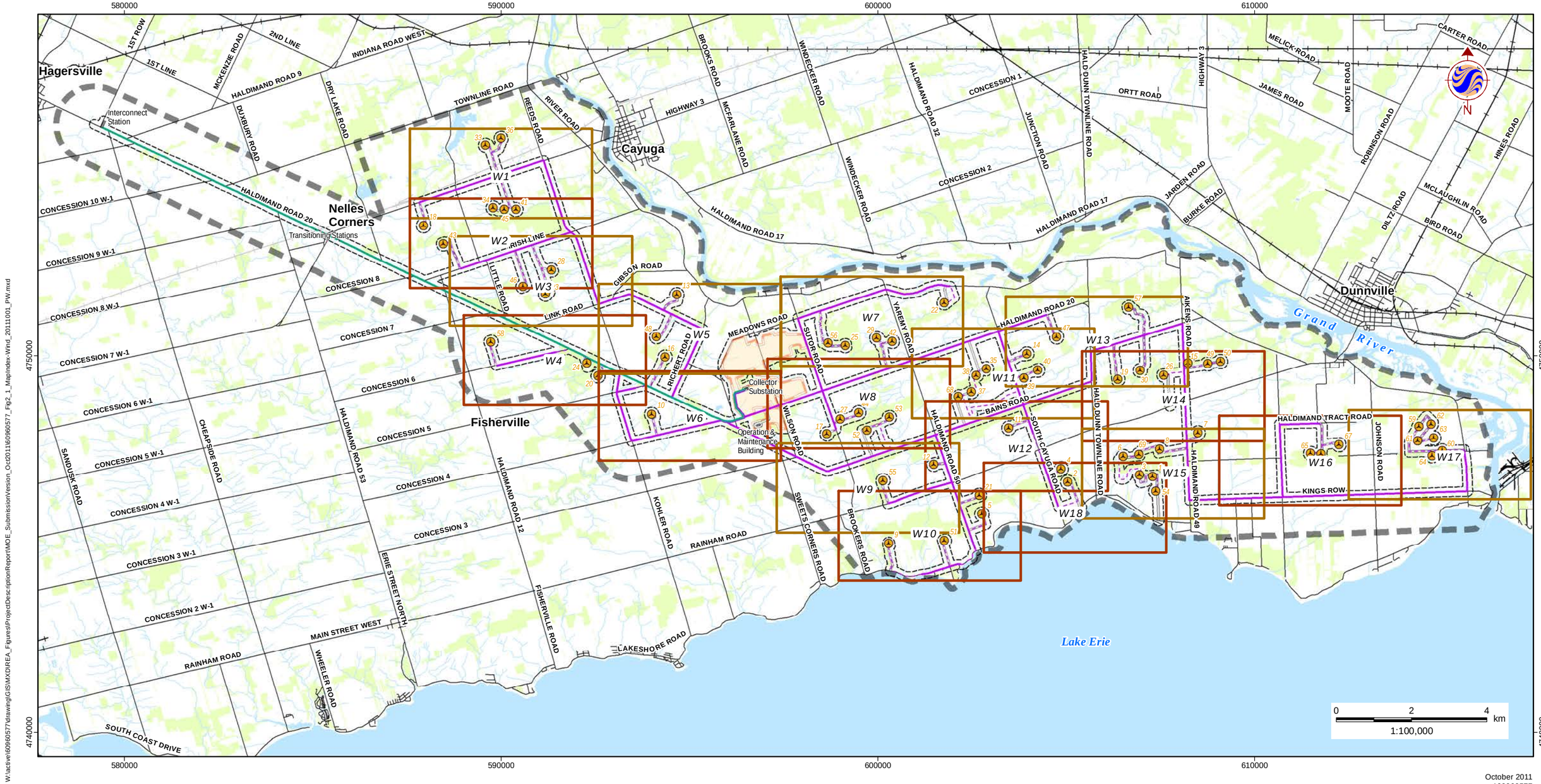
Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queens Printer Ontario, 2011; © Samsung, 2011.

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
1.0

Title
STUDY AREA



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October 2011
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Stantec

Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

Notes

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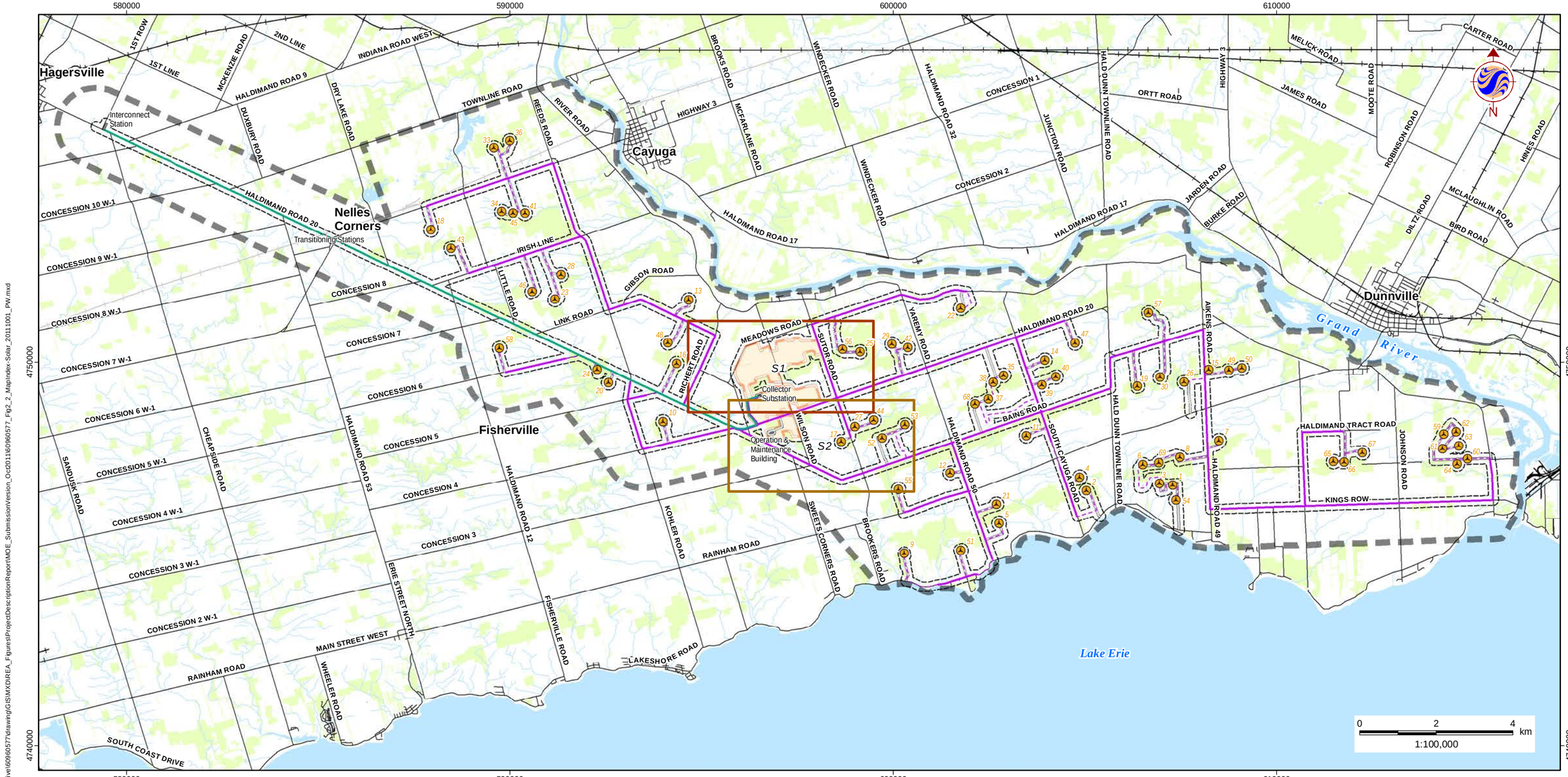
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
2.1

Title
MAPPING INDEX - WIND PROJECT



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October 2011
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Stantec

Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
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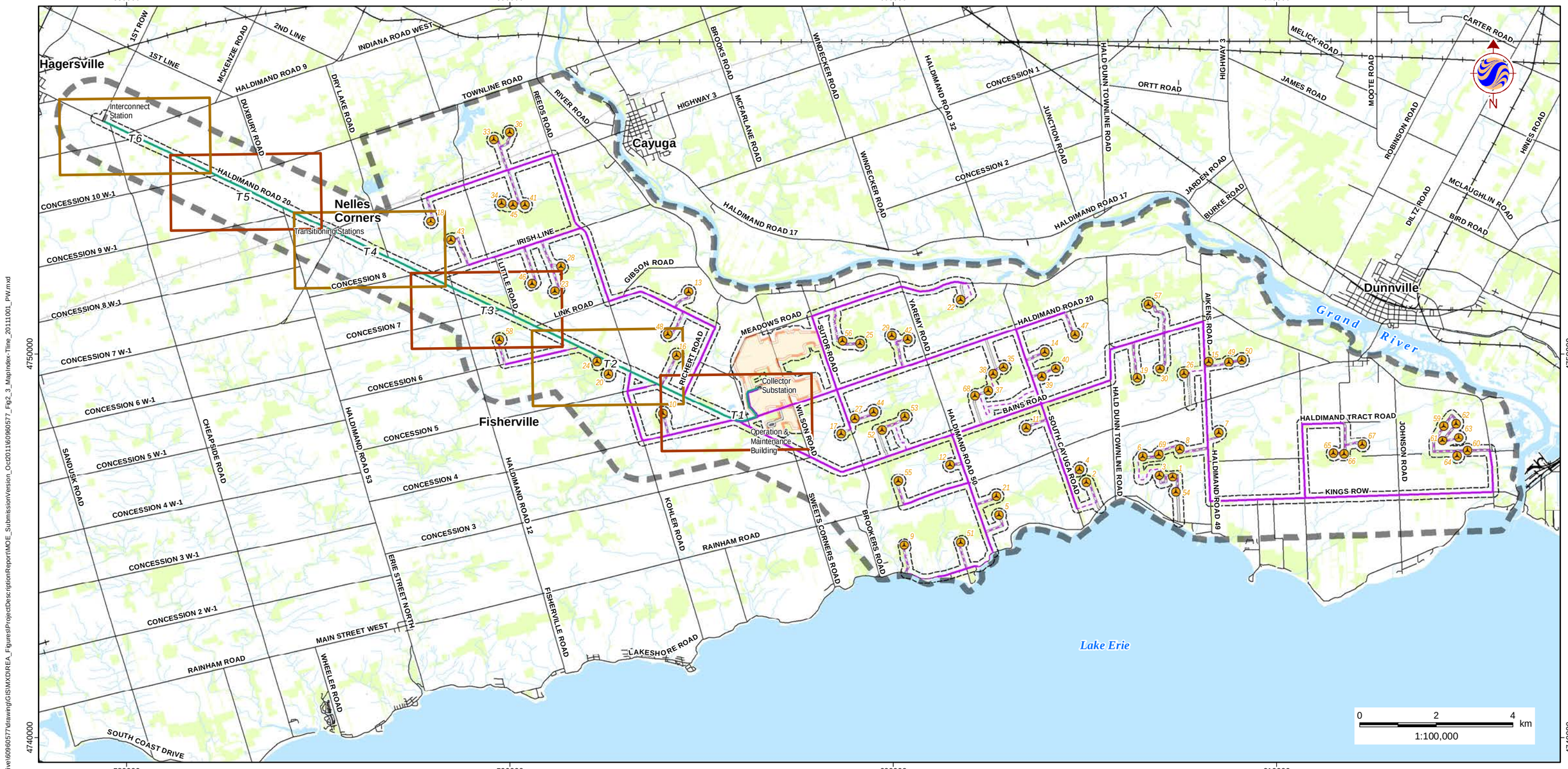
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
2.2

Title
MAPPING INDEX - SOLAR PROJECT



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Stantec

Legend

- Study Area
- Zone of Investigation

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Watercourse (MNR)
- Waterbody (MNR)
- Wooded Area (MNR)

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
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Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
2.3

Title
MAPPING INDEX - TRANSMISSION LINE

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October 2011
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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area

- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

1. Coordinate System: UTM NAD 83 - Zone 17 (N).
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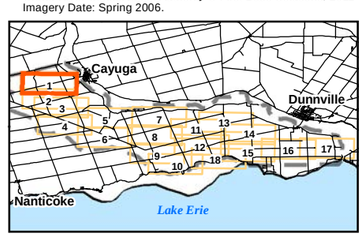

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.1

Title
SIGNIFICANT NATURAL FEATURES - W1

588000 589000 590000 591000 592000

4754000 4753000 4752000

HIGHWAY 3
DECEWSVILLE ROAD
IRISH LINE
LITTLE ROAD
KOHLER ROAD
HALDIMAND ROAD 20
12 ROAD

18 34 45 41 43 28 46 14 16 17 15 5 6 7

N

0 150 300 m
1:12,500

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October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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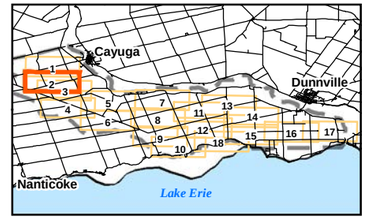

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

3.2

Title

SIGNIFICANT NATURAL FEATURES - W2

589000 590000 591000 592000 593000

4753000 4752000 4751000

DEGEWSVILLE ROAD
IRISH LINE
LITTLE ROAD
KOHLER ROAD
GIBSON ROAD
HALDIMAND ROAD 20
HALDIMAND ROAD 12
CONCESSION 7
LINK ROAD

5 7 7 16 17 15 15-a 15-b 15-c 15-d 15-e 15-f 15-g 15-h 15-i 15-j 15-k 15-l 15-m 15-n 15-o 15-p 15-q 15-r 15-s 15-t 15-u 15-v 15-w 15-x 15-y 15-z 23 23-a 24 24-a 24-b 28 46 14 13 11 10 A

0 150 300 m
1:12,500

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October 2011
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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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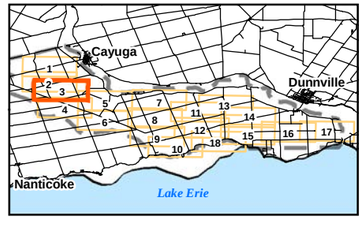

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.3

Title
SIGNIFICANT NATURAL FEATURES - W3

589000 590000 591000 592000 593000

4751000 4750000 4749000

CONCESSION 7
LINK ROAD
KOHLER ROAD
HALDIMAND ROAD 12
CONCESSION 6
HALDIMAND ROAD 20
ERIE AVENUE NORTH
CONCESSION 5

11 10 31 58 19 19-1 19-5 19-6 20 20 24 4 36 19 20 A 22

N

0 150 300 m
1:12,500

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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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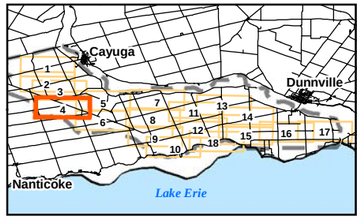

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.4

Title

SIGNIFICANT NATURAL FEATURES - W4

593000 594000 595000 596000 597000

4751000

4750000

Grand River

Grand River Marshes PSW

GIBSON ROAD

LINK ROAD

RIVER ROAD

KOHLER ROAD

HALDIMAND ROAD 20

RICHERT ROAD

MOUNT OLIVET ROAD

MEADOWS ROAD

WILSON ROAD

17 24 24-a 24-b 13 26 27 27-a 27-b 79 A 48 37 33 22 16 B 20 20 19 36 31 30 30-a

N

0 150 300 m

1:12,500

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October 2011
160960577

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location
Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location
Solar Lands

Transmission Line
Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features
Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)
Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features
Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat
Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area

Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts
Wildlife & Flow Culvert
Other Culvert

Notes

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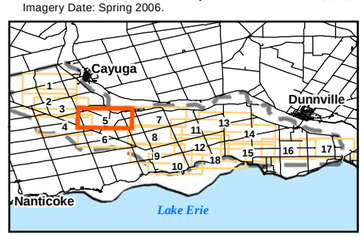

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
3.5

Title
SIGNIFICANT NATURAL FEATURES - W5

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593000 594000 595000 596000 597000

4749000 4748000

HALDIMAND ROAD 20
CONCESSION 5
CONCESSION 4
CONCESSION 3
RICHERT ROAD
KOHLER ROAD
MEADOWS ROAD
MOUNT OLIVET ROAD
WILSON ROAD
BAINS ROAD

0 150 300 m
1:12,500

October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location
- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location
- Solar Lands

Transmission Line
- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features
- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)
- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features
- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat
- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts
- Wildlife & Flow Culvert
- Other Culvert

Notes

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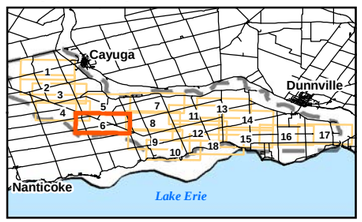
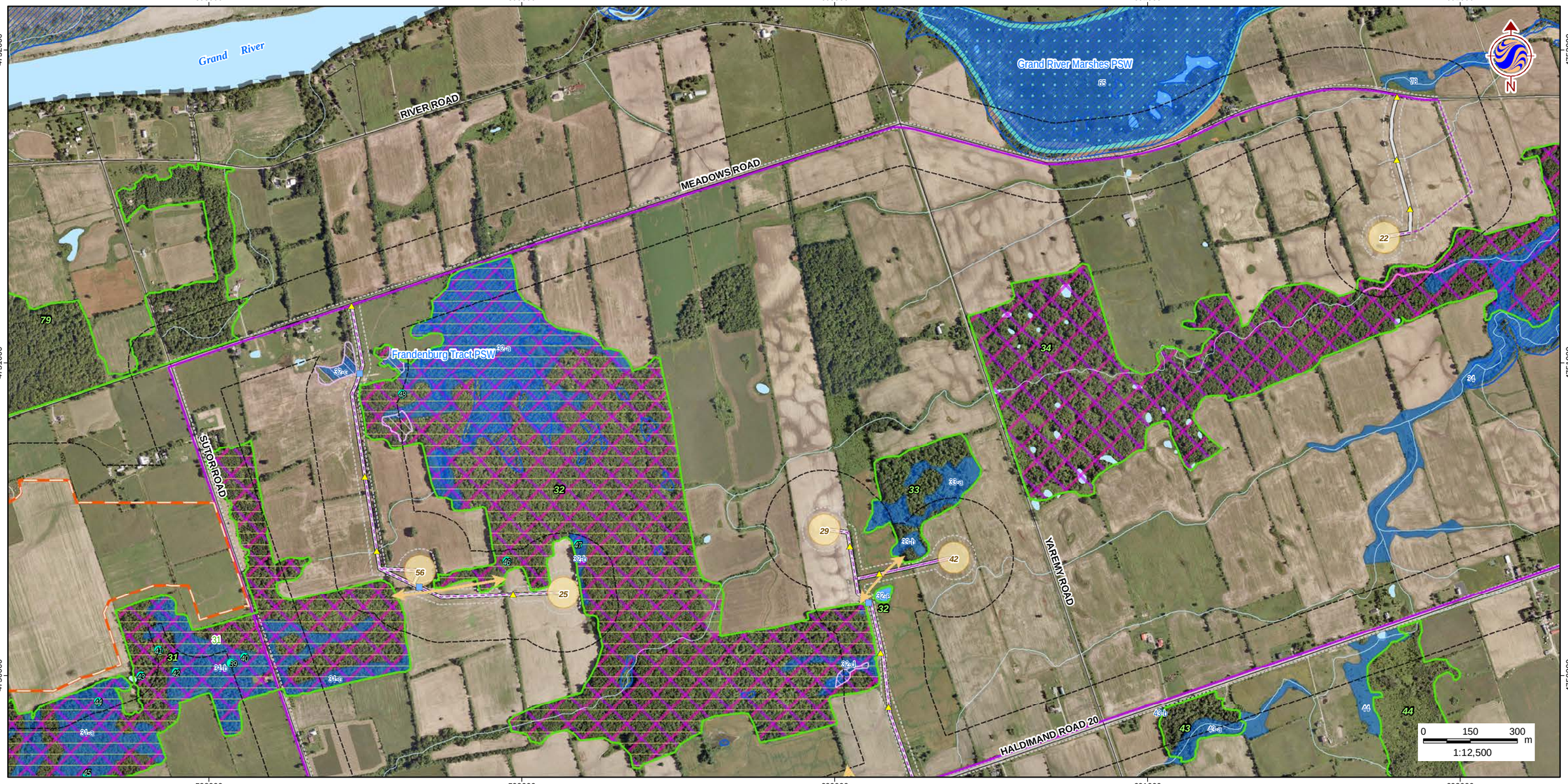


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.6

Title
SIGNIFICANT NATURAL FEATURES - W6



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October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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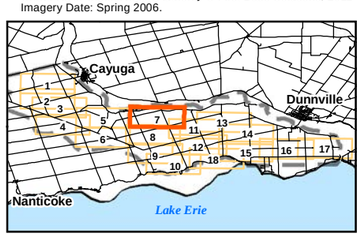

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.7

Title
SIGNIFICANT NATURAL FEATURES - W7

598000 599000 600000 601000

4749000 4748000

Frandenburg Tract PSW

HALDIMAND ROAD 20

HALDIMAND ROAD 50

WILSON ROAD

SUTOR ROAD

BAINS ROAD

0 150 300 m

1:12,500

N

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October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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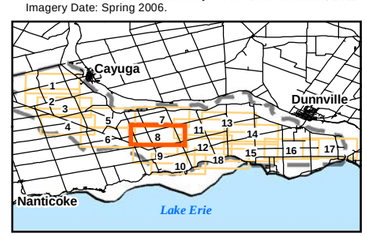

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

3.8

Title

SIGNIFICANT NATURAL FEATURES - W8

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October 2011
160960577

Legend

Study Area
Zone of Investigation
Constructable Area

Wind Project Location

Proposed Turbine Location
Access Road
Overhead Collector Line
Underground Collector Line

Solar Project Location

Solar Lands

Transmission Line

Overhead Transmission Line
Underground Transmission Line
Electrical Transmission Component

Existing Features

Road
Railway
Abandoned Railway
Transmission Line (MNR)
Watercourse (MNR)
Waterbody (MNR)

Wetland (MNR)

Provincially Significant Wetland
Non-Provincially Significant Wetland

Significant Natural Features

Significant Woodland
Significant Wetland
Significant Valleyland

Significant Wildlife Habitat

Deer Wintering Area
Habitat for Declining/Area-Sensitive Grassland Species
Winter Raptor Roosting & Feeding Area
Seep
Vernal Pool
Rare Vegetation Community
Snapping Turtle Habitat
Animal Movement Corridor
Waterfowl Stopover
Migratory Landbird Habitat
Habitat for Declining Woodland Species
Area-Senstitive Species Woodland Habitat
Short-Eared Owl Habitat

Culverts

Wildlife & Flow Culvert
Other Culvert

Notes

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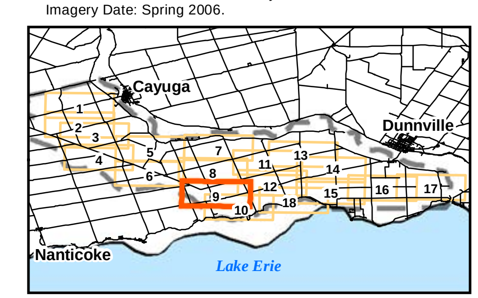
3. Image Source: © Terrapoint, 2011 - Imagery Date: July 2009; Grand River Conservation Authority © First Base Solutions, 2011 - Imagery Date: Spring 2006.



Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.9

Title

SIGNIFICANT NATURAL FEATURES - W9

599000 600000 601000 602000 603000

4746000 4745000 4744000

SUTOR ROAD
RAINHAM ROAD
BROOKERS ROAD
HALDIMAND ROAD 50
LAKESHORE ROAD
WHITE CAP LANE

42b 68a 21 5 66a 51 9 66b 67 66

Evan's Creek LSW
Wardell's Creek Mouth (LET 2) PSW
Evan's Creek LSW
Lake Erie

66-a 66-c 66-d 66-e 66-f 66-g 66-h 66-i 66-j 66-k 66-l 66-n

N

0 150 300 m
1:12,500

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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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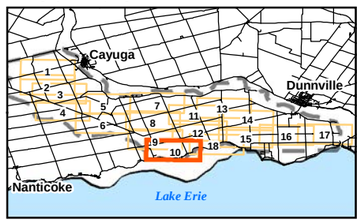


Client/Project

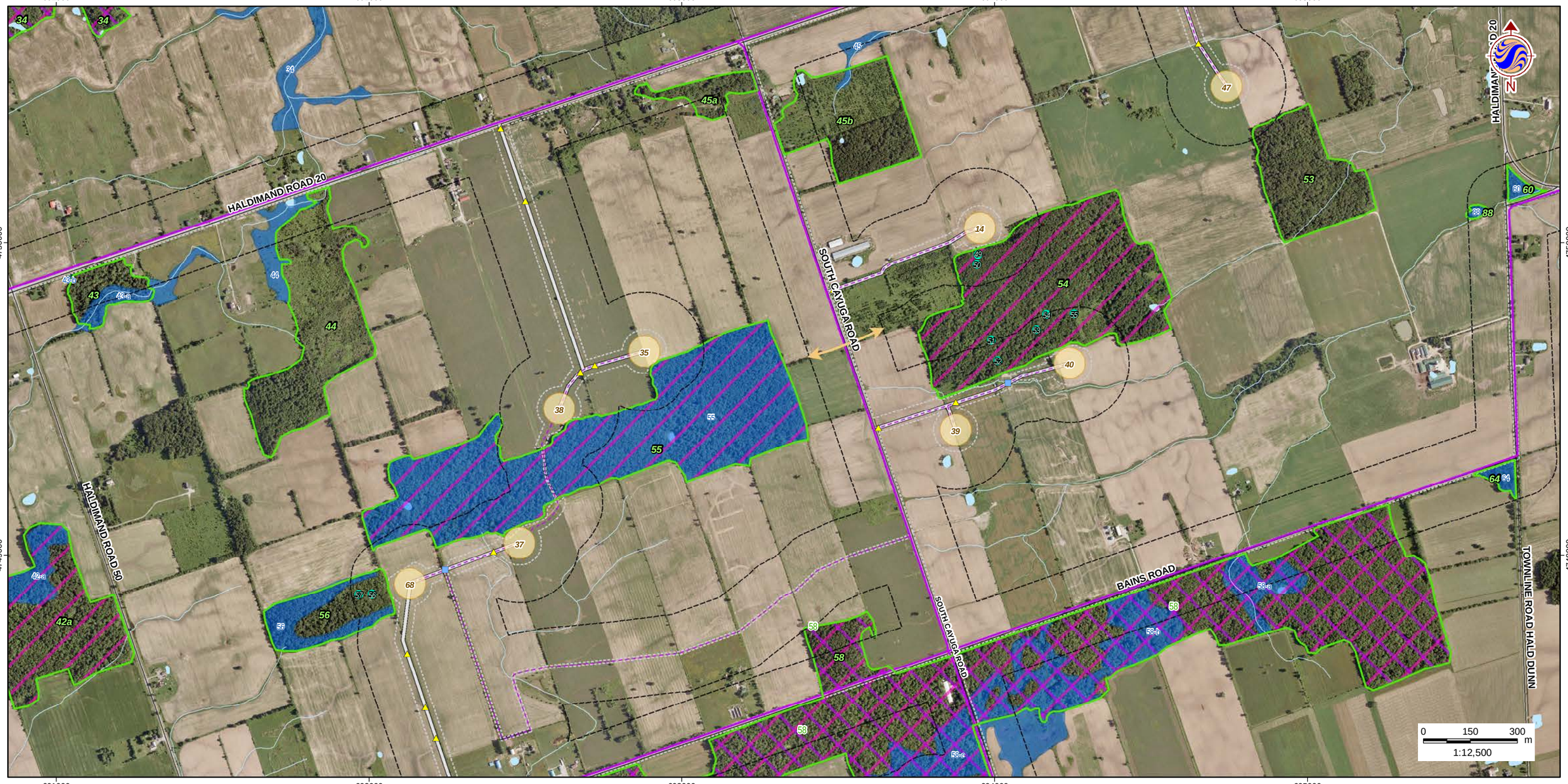
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

3.10

Title

SIGNIFICANT NATURAL FEATURES - W10



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160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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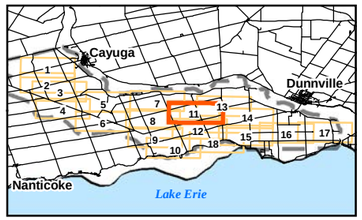
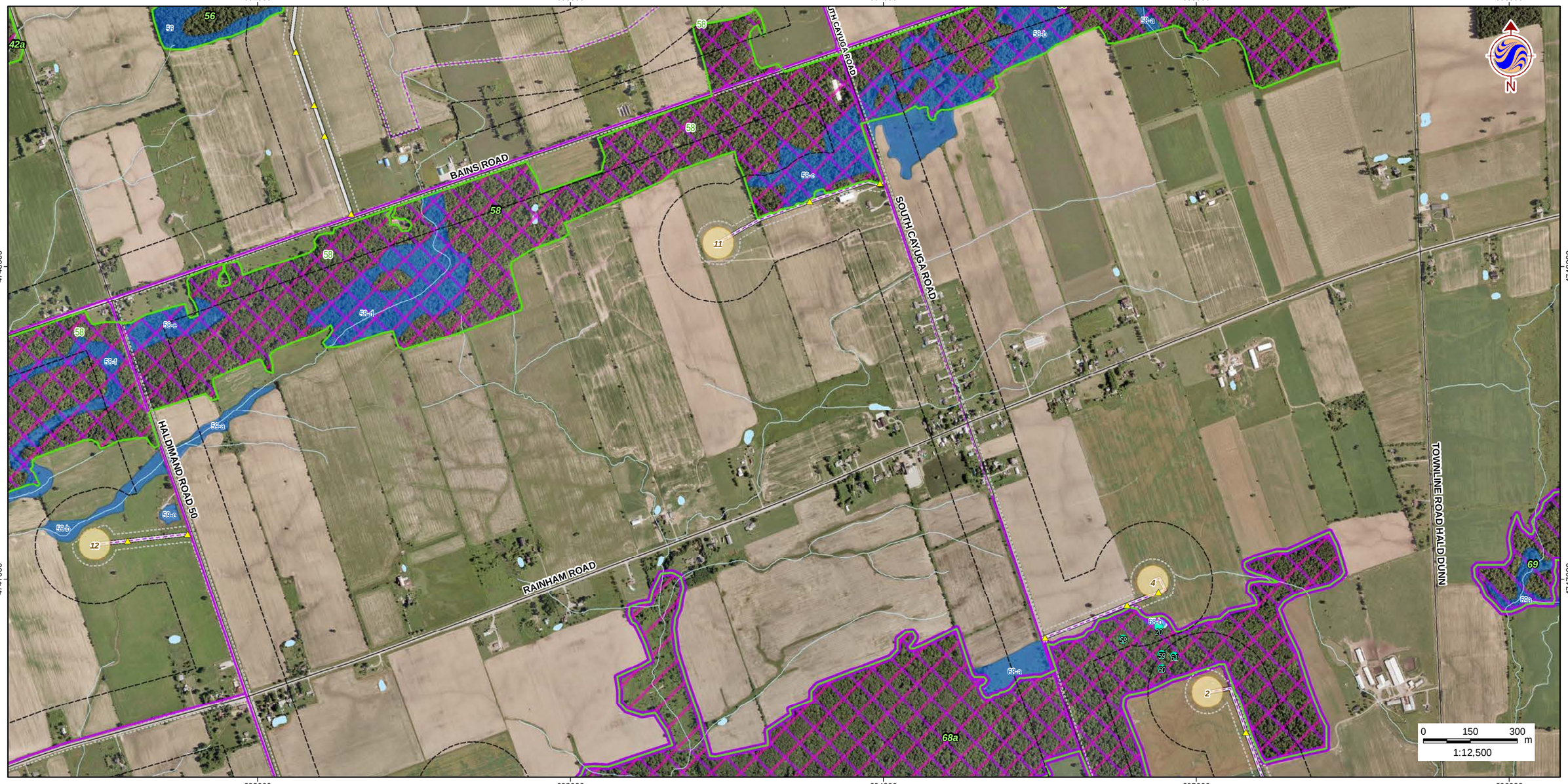


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.11

Title
SIGNIFICANT NATURAL FEATURES - W11



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October 2011
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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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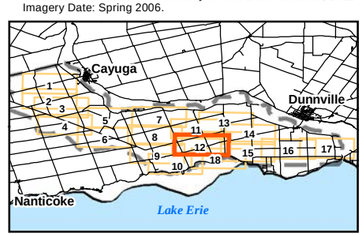


Client/Project

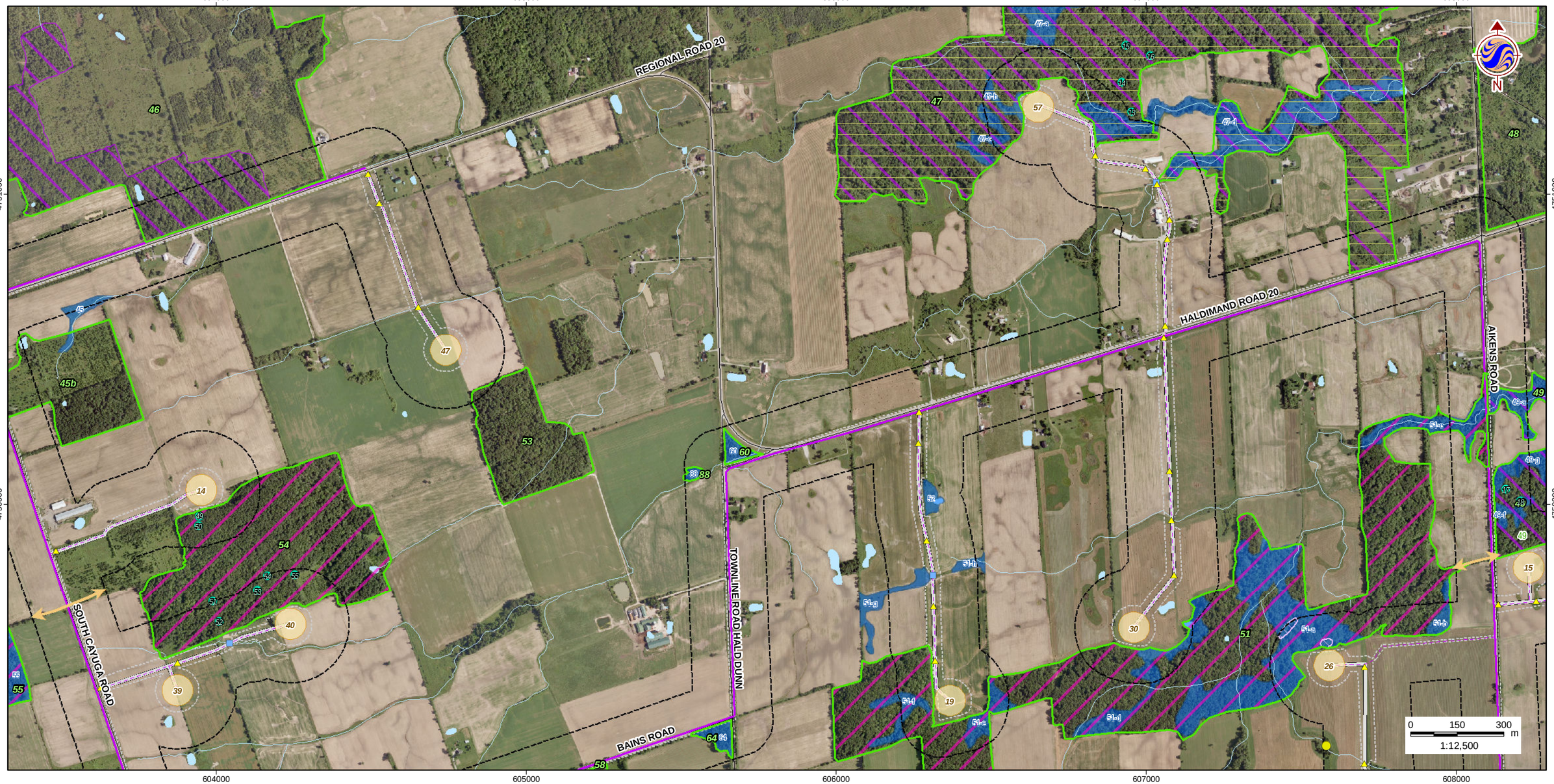
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

3.12

Title

SIGNIFICANT NATURAL FEATURES - W12



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Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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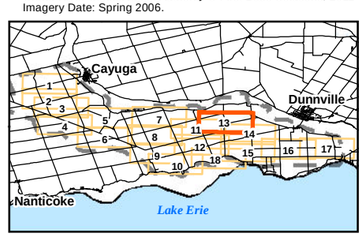

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.13

Title
SIGNIFICANT NATURAL FEATURES - W13

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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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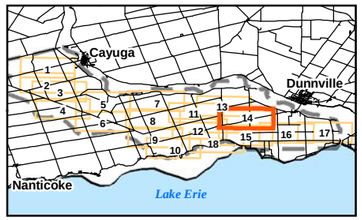


Client/Project

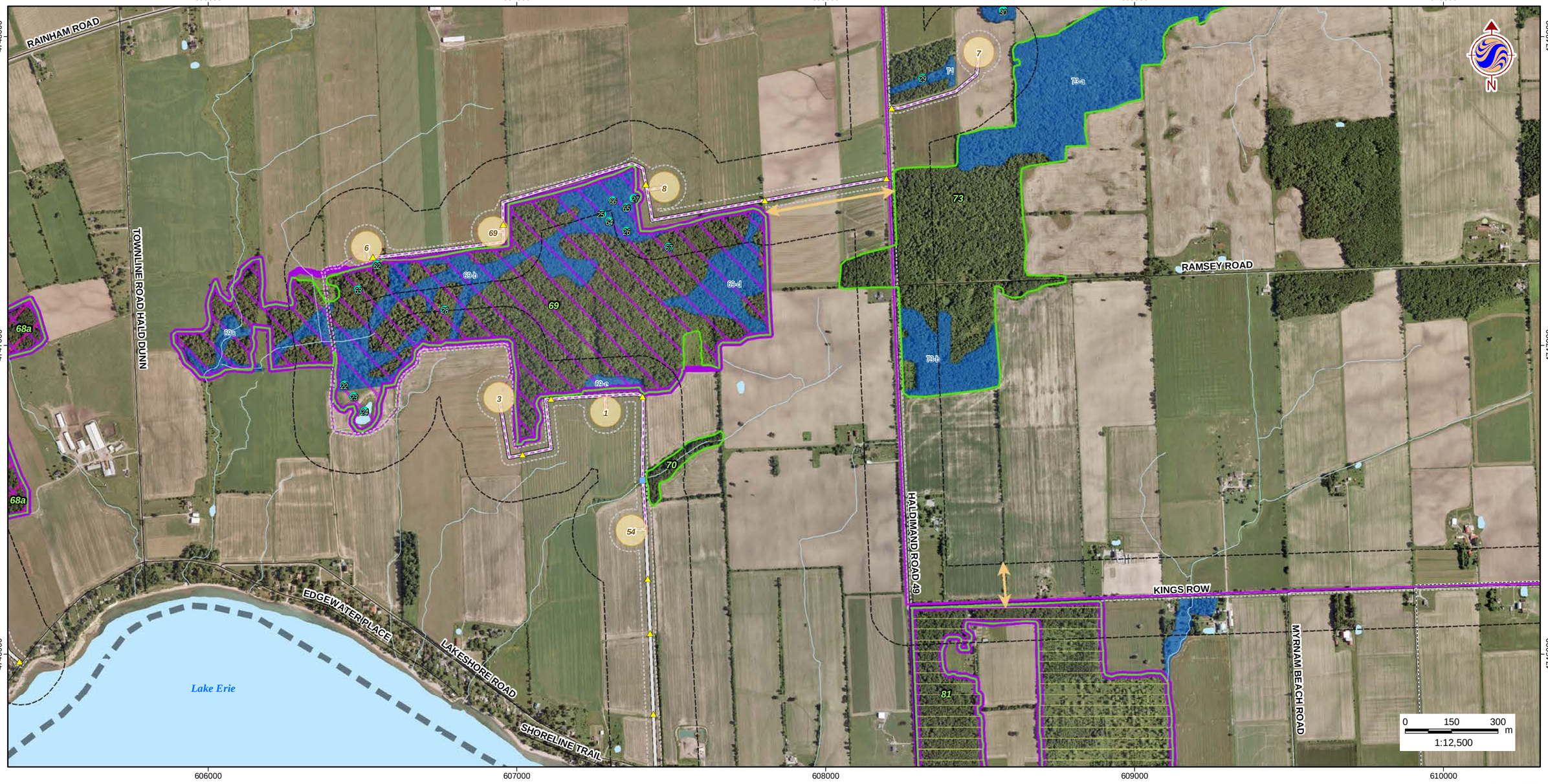
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.14

Title

SIGNIFICANT NATURAL FEATURES - W14



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Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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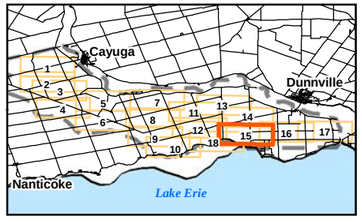

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

3.15

Title

SIGNIFICANT NATURAL FEATURES - W15

609000 610000 611000 612000 613000

4748000 4747000 4746000

HALDIMAND TRACT ROAD
HALDIMAND TRAIL
MARSHALL ROAD
RAMSEY ROAD
RAMSEY ROAD
KINGS ROW
JOHNSON ROAD

73 73-a 89 67 65 66 74-a 74 74-b 75 75 76 76 83 84 84 82

N

0 150 300 m
1:12,500

W:\active\60960577\drawing\GIS\MXD\REA_Figures\ProjectDescriptionReport\MOE_SubmissionVersion_Oct20111609605 77_Fig3_0_SignificantNaturalFeatures-Wind_20111001_PW.mxd

October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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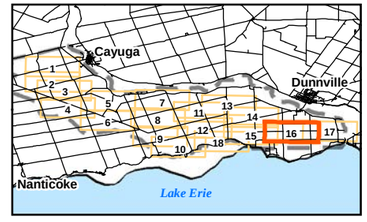

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

3.16

Title

SIGNIFICANT NATURAL FEATURES - W16

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October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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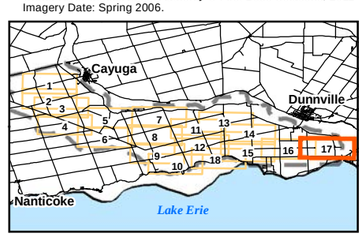


Client/Project

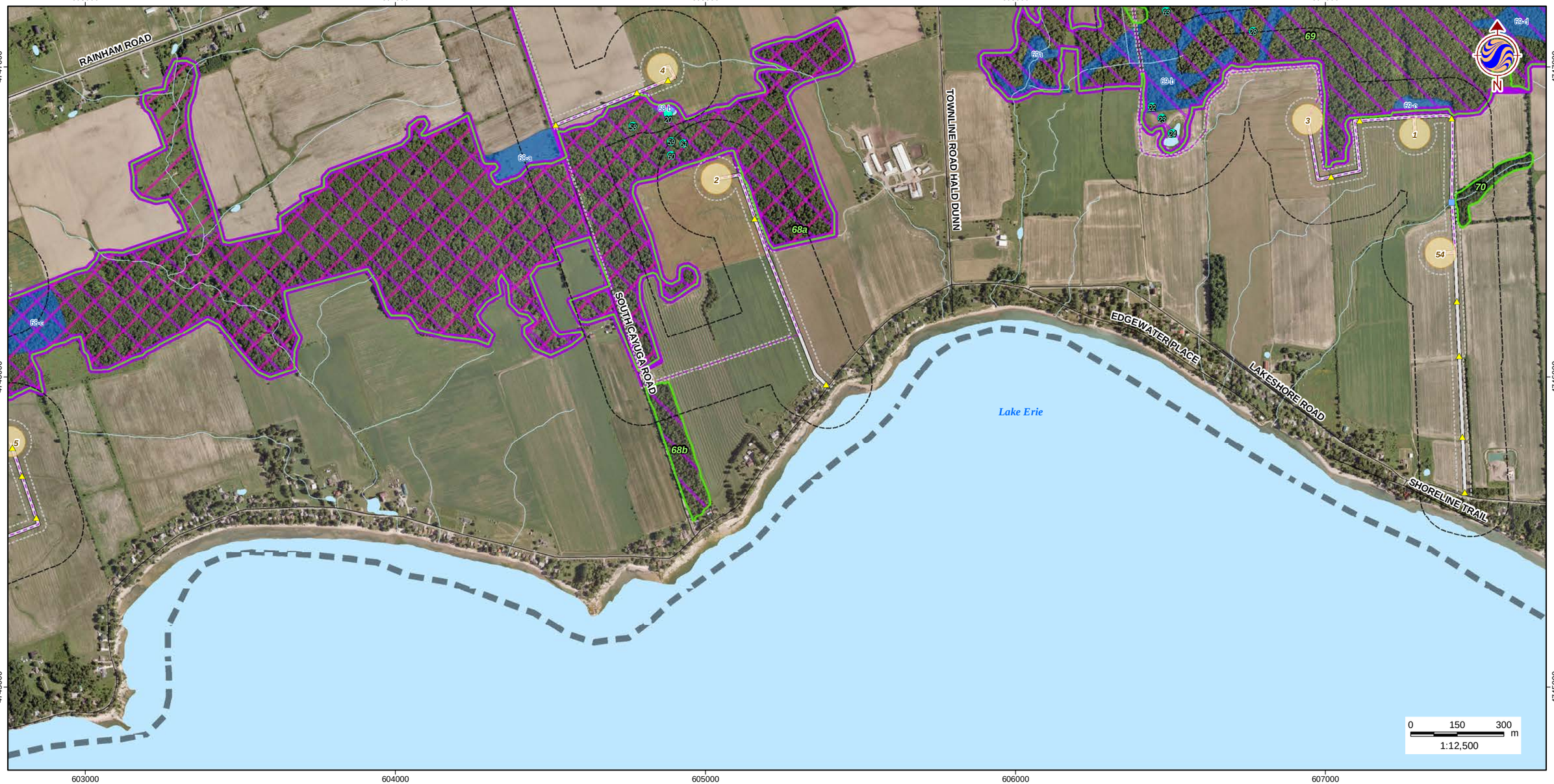
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

3.17

Title

SIGNIFICANT NATURAL FEATURES - W17



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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Winter Raptor Roosting & Feeding Area
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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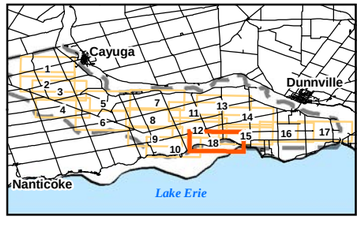

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
3.18

Title
SIGNIFICANT NATURAL FEATURES - W18

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595000 596000 597000 598000 599000

4751000

4750000

4749000

LINK ROAD
RICHERT ROAD
MOUNT OLIVET ROAD
MEADOWS ROAD
WILSON ROAD
SUTOR ROAD
HALDIMAND ROAD 20
Frandenburg Tract PSW 22-e

N

0 150 300 m
1:12,500

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160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location
- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location
- Solar Lands
- Solar Panel Unit
- Solar Berm
- Solar Fence

Transmission Line
- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features
- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)
- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features
- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat
- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Significant Winter Raptor Feeding & Roosting Habitat
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts
- Wildlife & Flow Culvert
- Other Culvert

Notes

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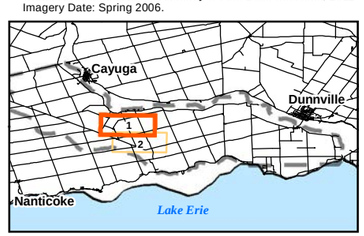

Stantec

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.
4.1

Title
SIGNIFICANT NATURAL FEATURES - S1

596000 597000 598000 599000 600000

4749000 4748000 4747000

HALDIMAND ROAD 20
MOUNT OLIVET ROAD
CONCESSION 4
SUTOR ROAD
WILSON ROAD
CONCESSION 3
SWEETS CORNERS ROAD
BAINS ROAD

29 38 39a 39b 40 36 57 44 27 53 42a 52 17 42 42b 55

N

0 150 300 m
1:12,500

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Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location
- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location
- Solar Lands
- Solar Panel Unit
- Solar Berm
- Solar Fence

Transmission Line
- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features
- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)
- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features
- Significant Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat
- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Significant Winter Raptor Feeding & Roosting Habitat
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts
- Wildlife & Flow Culvert
- Other Culvert

Notes

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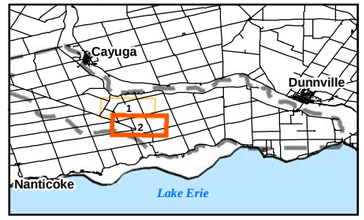
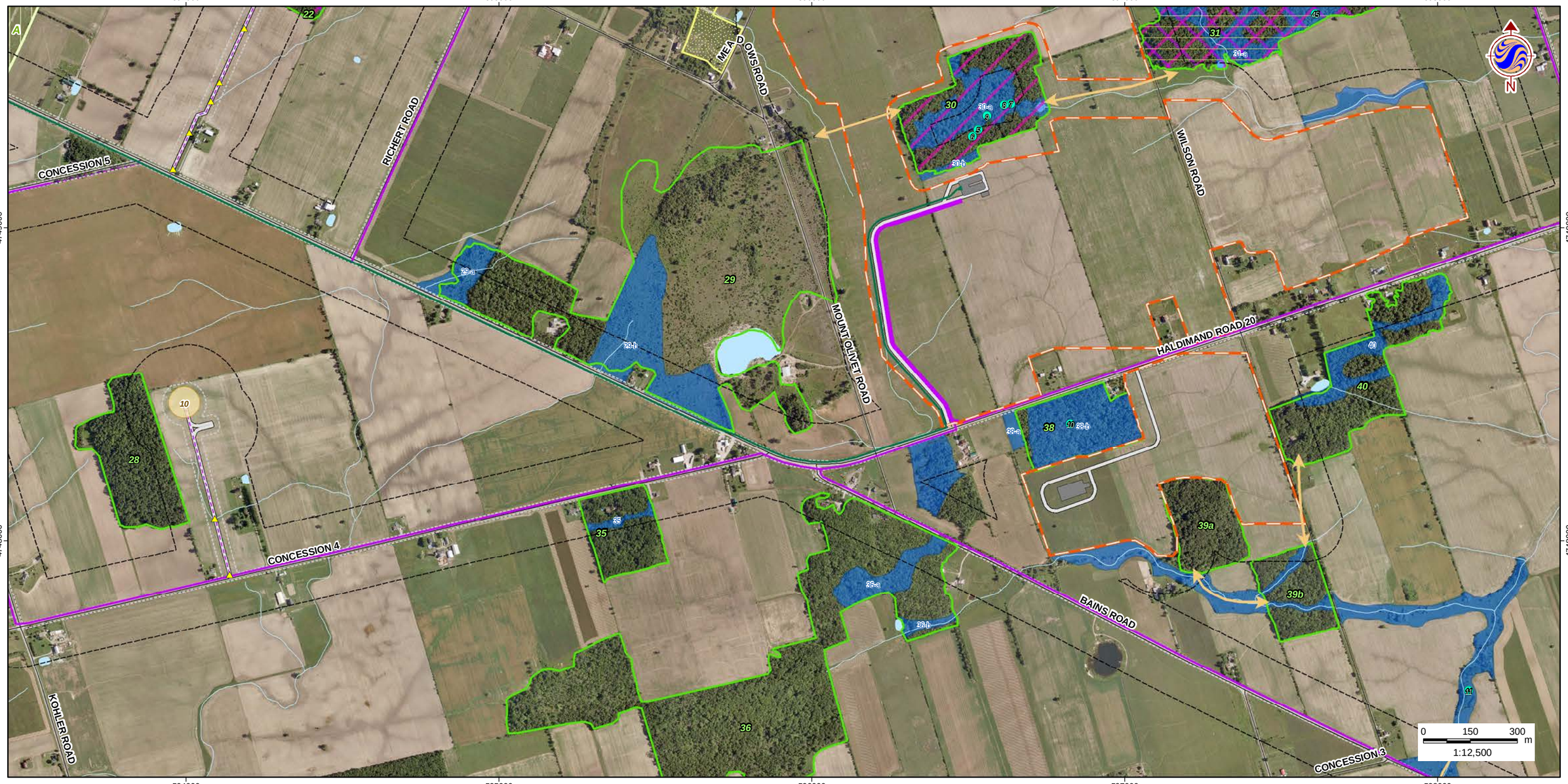


Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
4.2

Title
SIGNIFICANT NATURAL FEATURES - S2



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October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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Client/Project

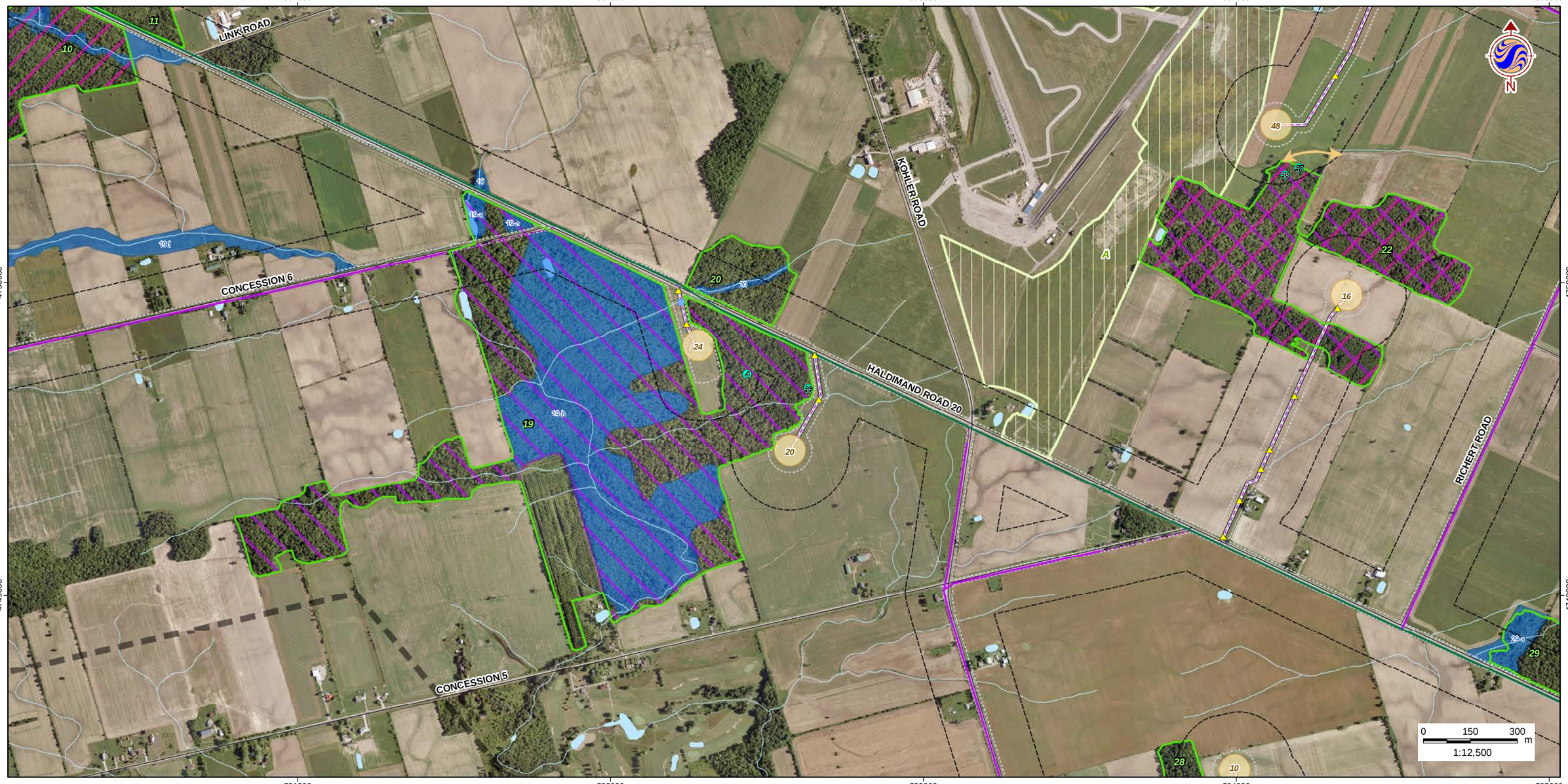
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.

5.1

Title

SIGNIFICANT NATURAL FEATURES - T1



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October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.2

Title

SIGNIFICANT NATURAL FEATURES - T2

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October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

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- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

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SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.3

Title

SIGNIFICANT NATURAL FEATURES - T3

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October 2011
160960577

Stantec

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
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- Vernal Pool
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- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

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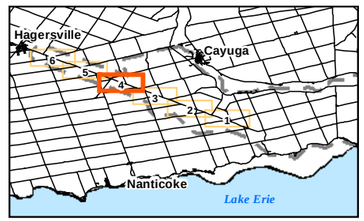

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.4

Title

SIGNIFICANT NATURAL FEATURES - T4

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October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
- Snapping Turtle Habitat
- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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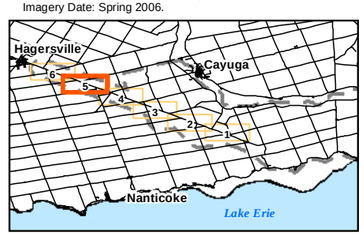

Client/Project
SAMSUNG, PATTERN & KEPCO (SPK) GRAND RENEWABLE ENERGY PARK

Figure No.
5.5

Title
SIGNIFICANT NATURAL FEATURES - T5

578000 579000 580000 581000 582000

4756000

4755000

PARK VIEW ROAD
KING STREET EAST
HEWITT DRIVE
1ST ROW
MCKENZIE ROAD
T LINE
N
HALDIMAND ROAD 9
CONCESSION 11 W-1
CHEAPSIDE ROAD
HALDIMAND ROAD 20
CONCESSION 10
1
2
0 150 300 m
1:12,500

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October 2011
160960577

Legend

- Study Area
- Zone of Investigation
- Constructable Area

Wind Project Location

- Proposed Turbine Location
- Access Road
- Overhead Collector Line
- Underground Collector Line

Solar Project Location

- Solar Lands

Transmission Line

- Overhead Transmission Line
- Underground Transmission Line
- Electrical Transmission Component

Existing Features

- Road
- Railway
- Abandoned Railway
- Transmission Line (MNR)
- Watercourse (MNR)
- Waterbody (MNR)

Wetland (MNR)

- Provincially Significant Wetland
- Non-Provincially Significant Wetland

Significant Natural Features

- Woodland
- Significant Wetland
- Significant Valleyland

Significant Wildlife Habitat

- Deer Wintering Area
- Habitat for Declining/Area-Sensitive Grassland Species
- Seep
- Vernal Pool
- Rare Vegetation Community
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- Animal Movement Corridor
- Waterfowl Stopover
- Migratory Landbird Habitat
- Habitat for Declining Woodland Species
- Area-Senstitive Species Woodland Habitat
- Short-Eared Owl Habitat

Culverts

- Wildlife & Flow Culvert
- Other Culvert

Notes

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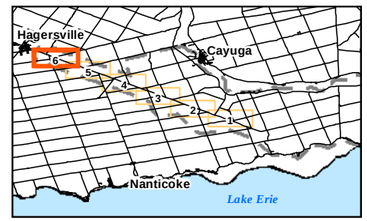

Client/Project

SAMSUNG, PATTERN & KEPCO (SPK)
GRAND RENEWABLE ENERGY PARK

Figure No.

5.6

Title

SIGNIFICANT NATURAL FEATURES - T6

Attachment B

Legal Description of Project Land Parcels

CONC	LOT	DESC2	DESC1
1NTR	39	NCAY CON 1 NTR PT LOT 39 PT LOT 40	HWY #3 00913
1NTR	40	NCAY CON 1 NTR PT LOT 39 PT LOT 40	HWY #3 00913
1NTR	40	NCAY CON 1 NTR PT LOT 39 PT LOT 40	HWY #3 00913
1STR	45	NCAY CON 1 STR PT LOT 45	HWY #3 00552
1STR	44	NCAY CON 1 STR PT LOT 44	IRISH LINE 00133
1STR	41	NCAY CON 1 STR PT LOT 41 PT LOT 42 RP 18R1774 PART 4	HWY #3 00800
1STR	40	NCAY CON 1 STR PT LOT 40	HWY #3 04540
1STR	40	NCAY CON 1 STR PT LOT 39 PT LOT 40	HWY #3 00900
1STR	39	NCAY CON 1 STR PT LOT 39 PT LOT 40	HWY #3 00900
WJONES	27	NCAY TRACT JONES W PT LOT 26 PT LOT 27	REGIONAL ROAD 20 02349
WJONES	19	NCAY TRACT JONES W PT LOT 19	LINK RD 00520
2STR	39	NCAY CON 2 STR PT LOT 40 PT LOT 39 RP 18R4216 PARTS 1,2,3,4 & 5	IRISH LINE
2STR	39	NCAY CON 2 STR PT LOT 39	
2STR	39	NCAY CON 2 STR PT LOT 39 PT LOT 40 RP18R4216 PART 4	IRISH LINE 00404
2STR	40	NCAY CON 2 STR PT LOT 40 PT LOT 39 RP 18R4216 PARTS 1,2,3,4 & 5	IRISH LINE
2STR	41	NCAY CON 2 STR PT LOT 40 PT LOT 41	LINK RD 00015
2STR	41	NCAY CON 2 STR PT LOT 41	IRISH LINE 00320
5	12	RNH CON 5 PT LOT 12	CONCESSION 5 RD 00929
4	14	RNH CON 4 PT LOT 14	CONCESSION 5 RD
4	13	RNH CON 4 PT LOT 13	REGIONAL ROAD 8 00834
4	14	RNH CON 4 PT LOT 14	CONCESSION 4 RD 01081
1	24	RNH CON 1 PT LOTS 24 25	LAKESHORE ROAD 02236
1	22	RNH CON 1 PT LOT 22 RP 18R3471 PART 12	LAKESHORE ROAD 02069
1	22	RNH CON 1 PT LOTS 21 22 RP 18R4242 PARTS 1,2,5,10	LAKESHORE ROAD 02057
6	8	RNH CON 6 PT LOT 8	CONCESSION 6 RD
6	8	RNH CON 6 PT LOT 8	CONCESSION 6 RD
5	11	RNH CON 5 PT LOT 11	CONCESSION 6 RD
5	14	SCAY CON 5 PT LOTS 13 14 RP 18R3238 PARTS 1 & 2 RP 18R1718 PART 2 RP 18R3061 PART 1	REGIONAL ROAD 20
7	18	SCAY CON 7 PT LOTS 16 TO 18 RP 18R2586 PART 1	REGIONAL ROAD 3 01940
5	22	RP 18R3354 PART 1 RP 18R3175 PART 1	SCAY CON 5 PT LOT 21,22
4	23	PT LOT 23	SCAY CON 3 TO 4 PT LOT 22
4	20	RP 18R551 PART 1	SCAY CON 4 PT LOT 19 & 20
4	30	SCAY CON 4 PT LOTS 29,30	
4	29	SCAY CON 4 PT LOTS 29,30	
4	29	SCAY CON 4 PT LOT 28 & 29 RP 18R2943 PART 1	MEADOWS RD 00198
4	28	SCAY CON 4 PT LOT 28 & 29 RP 18R2943 PART 1	MEADOWS RD 00198
4	27	400 WILSON ROAD	SCAY CON 4 PT LOT 27
4	26	RP 18R2851 PARTS 1,2,3	SCAY CON 4 PT LOT 26
4	25	SCAY CON 4 PT LOT 25	SUTOR RD 00697

CONC	LOT	DESC2	DESC1
4	23	SCAY CON 4 PT LOTS 23 24	
4	15	SCAY CON 4 PT LOT 15	
4	14	SCAY CON 4 PT LOT 14 RP 18R2741 PART 9	RIVER RD 00494
5	22	SCAY CON 4 PT LOTS 22 23	REGIONAL ROAD 20
4	20	SCAY CON 4 PT LOT 20	REGIONAL ROAD 20 03237
4	30	SCAY CON 4 PT LOTS 29 30	REGIONAL ROAD 20
4	29	SCAY CON 4 PT LOT 29	
4	28	SCAY CON 4 PT LOT 28	REGIONAL ROAD 20
4	27	SCAY CON 4 PT LOT 27 RP 18R2596 PARTS 1 & 2	WILSON RD 00206
4	26	SCAY CON 4 PT LOT 26 RP 18R3144 PART 1	REGIONAL ROAD 20
4	19	SCAY CON 4 PT LOT 19 RP 18R673 PART 1 RP 18R2631 PART 1	REGIONAL ROAD 20 03299
5	12	SCAY CON 5 PT LOT 12 RP 18R3062 PART 1 S/E PT 1 18R-5612	REGIONAL ROAD 20
5	12	SCAY CON 5 PT LOT 12 RP 18R519 PART	SOUTH CAYUGA RD 00606
5	11	SCAY CON 5 PT LOT 11 RP 18R2610 PART 1	REGIONAL ROAD 20
5	9	RP 18R2610 PART 5	SCAY CON 5 PT LOT 9
5	12	RP 18R2934 PART 1	SCAY CON 5 PT LOT 12
5	11	SCAY CON 5 PT LOTS 10 11 RP 1842939 PART 1	BAINS RD 01195
5	13	SCAY CON 5 PT LOT 13 RP 18R3061 PART 2	SOUTH CAYUGA RD 00709
5	14	SCAY CON 5 PT LOT 14 RP 18R3174 PART OF PART 1	REGIONAL ROAD 20 03552
5	15	SCAY CON 5 PT LOT 15 RP 18R3060 PART 1	REGIONAL ROAD 20
5	17	RP 18R2585 PART 3	SCAY CON 5 LOT 17
5	16	SCAY CON 5 PT LOT 16 RP 18R450 PART 1	BAINS RD 00917
5	16	SCAY CON 5 PT LOT 16 RP 18R2585 PART 4	BAINS RD 00941
5	15	SCAY CON 5 PT LOT 15	
5	14	SCAY CON 5 PT LOT 14	
5	13	SCAY CON 5 PT LOT 13	
5	23	SCAY CON 5 PT LOTS 22 23	
5	21	RP 18R3354 PART 1 RP 18R3175 PART 1	SCAY CON 5 PT LOT 21,22
5	24	SCAY CON 5 PT LOT 24 RP 18R3351 PART 1,2 & 3	REGIONAL ROAD 20 03126
5	23	SCAY CON 5 PT LOT 23	REGIONAL ROAD 20 03080
5	29	SCAY CON 5 PT LOT 29 RP 18R550 PART 1 PT PARTS 2 & 3	BAINS RD 00167
5	28	SCAY CON 5 PT LOT 28	REGIONAL ROAD 20
5	25	RP 18R3262 PART 1	SCAY CON 5 PT LOTS 25 26
6	19	SCAY CON 6 PT LOT 19 RP 18R2623 PART 1	5861 RAINHAM ROAD
		SCAY CON 6 PT LOTS 22 23 RNH CON 2 PT LOT 22 RP 18R428 PART 1	REGIONAL ROAD 3 01667
6	22	SCAY CON 6 PT LOTS 22 23 RNH CON 2 PT LOT 22	REGIONAL ROAD 3
6	14	SCAY CON 6 PT LOT 14 RP 18R3633 PART 1	REGIONAL ROAD 3
6	13	RP 18R2428 PART 1 PT	SCAY CON 6 PT LOT 13
7	18	SCAY CON 7 PT LOT 18	

CONC	LOT	DESC2	DESC1
7	18	SCAY CON 7 PT LOT 18	LAKESHORE ROAD
7	13	SCAY CON 7 PT LOT 13 & 14 RP 18R483 PART 1 RP 18R4018 PART 5,6,7,8,11, PT PARTS 1,9,10	HALD-DUNN TWNLN 00045
7	14	SCAY CON 7 PT LOT 14 RP 18R2572 PART 1 PT	SOUTH CAYUGA RD 00270
7	14	SCAY CON 7 PT LOTS 13 & 14 RP 18R2801 PART 1	REGIONAL ROAD 3
1SDR	3	DUN CON 1 SDR PT LOT 3	REGIONAL RD 3 W 00882
4SDR	3	DUN CON 4 SDR PT LOT 3	3063 LAKESHORE ROAD
2NDR	3	DUN CON 2 NDR PT LOT 3	
1NDR	2	RP 18R3425 PART 2	DUN CON 1 NDR PT LOT 2
1SDR	2	DUN CON 1 SDR PT LOT 2	
4SDR	1	RP 18R3793 PART 1	DUN CON 4 SDR PT LOT 1 & 2
1NDR	4	DUN CON 1 NDR PT LOT 4	
1NDR	8	DUN CON 1 NDR PT LOT 8	REGIONAL RD 3 W 00597
1NDR	7	DUN CON 1 NDR PT LOT 7	REGIONAL RD 3 W 00649
1NDR	6	DUN CON 1 NDR PT LOT 6	
1NDR	5	DUN CON 1 NDR PT LOT 5	
		DUN CON 1 NDR PT LOT 5	REGIONAL RD 3 W 00737
		DUN CON 1 NDR PT LOT 5	
1SDR	5	DUN CON 1 SDR PT LOTS 5 & 6	REGIONAL RD 3 W 00764
1SDR	4	DUN CON 1 SDR PT LOT 4	
4SDR	4	DUN CON 4 SDR PT LOT 4	
HALD	4	DUN TRACT HALDIMAND PT LOT 4 PT LOT 5	HALDIMAND TRAIL 00292
HALD	6	LOT 6, HALDIMAND TRACT	97 HALDIMAND TRACT ROAD
2NDR	4	DUN CON 2 NDR PT LOT 4	REGIONAL RD 20 00628
1SDR	7	DUN CON 1 TO 2 SDR PT LOT 7	REGIONAL RD 3 W 00728
1NDR	9	DUN CON 1 NDR PT LOT 9	REGIONAL RD 3 W 00535
HALD	7	DUN TRACT HALDIMAND RP 14472 LOT 7 PT LOT 8	HALDIMAND TCT RD 00049
		DUN TRACT HALDIMAND PT LOT 6	HALDIMAND TCT RD 00101
HALD	5	DUN TRACT HALDIMAND PT LOT 4 PT LOT 5	HALDIMAND TRAIL 00292
SHEE	3	DUN TCT SHEEHAN PT LOTS 3-7 RP 18R2000 PART OF PART 1	REGIONAL RD 11 00536
SHEE	2	DUN SHEEHAN TCT PT LOT 1 & 2	

Attachment C

Turbine Specifications

WINDTEST

Kaiser-Wilhelm-Koog GmbH

Report of acoustical emissions of a Siemens wind turbine generator system of the type 2.3 MW Mk II near Høvsøre in Denmark

Date(s) of measurements: 2005-08-11 to 13

September 2005

Report WT 4498/05

Laboratory accredited by DAP Deutsches Akkreditierungssystem Prüfwesen according to DIN EN ISO/IEC 17025. This accreditation is valid for the test and measurement procedures given in the certificate.

Deutscher Akkreditierungs Rat

DAP-PL-1556.00

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Report of acoustical emissions of a Siemens wind turbine generator system of the type 2.3 MW Mk II near Høvsøre in Denmark

Report WT 4498/05

Site or measuring place:	Høvsøre, Denmark in the region of Ringkøbing
Customer:	Siemens Wind Power A/S Borupvej 16 7330 Brande, Denmark
Contractor:	WINDTEST Kaiser-Wilhelm-Koog GmbH Sommerdeich 14 b 25709 Kaiser-Wilhelm-Koog, Germany

Date of order:	2005-08-23	Order No.:	4025 05 03069 64

Engineer:	Checked:
Dipl.-Ing. A. Jensen	Dipl.-Ing. J. Neubert Acoustics Group Leader

Kaiser-Wilhelm-Koog, 2005-09-08

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1 Scope

The order from Siemens Wind Power A/S dated 2005-08-23 required WINDTEST Kaiser-Wilhelm-Koog GmbH (WINDTEST) to carry out acoustic noise measurements on the Siemens wind turbine generator system (WTGS or 'turbine') 2.3 MW Mk II of hub height 80 m near Høvsøre, in the region of Ringkøbing in Denmark. From this, the sound power level, relevant for noise propagation calculations, of the noise emitted from the turbine at different wind speeds, and frequency spectra of the same, was also to be determined.

The results given in this report relate only to this WTGS.

2 Method

2.1 Measurement procedures

All measurements and analysis described in this report were done in accordance with the IEC 61400-11: Wind turbine generator systems – Part 11: Acoustic noise measurement techniques, Ed. 2 [IEC 61400-11] using Method 1 as outlined in 7.3.1.1 "Method 1: determination of the wind speed from the electric output and the power curve". In this report the sound power level and the tonality are given in the range of wind speeds from 6 to 10 $^{m}/_{s}$ at a height of 10 m.

Note: A calculated power curve for the turbine was provided by the customer for purposes of converting the measured turbine power output into the standardised wind speed. This power curve is given in the Annex.

2.2 Measurement object

Table 1 shows the characteristics of the measured WTGS. The remaining characteristics can be found in the manufacturer's certificate included in the Annex.

Table 1: Characteristics of the measured WTGS

parameter	Value
manufacturer	Siemens Wind Power A/S
type	2.3 MW Mk II
WTGS No.	2300439
site	Høvsøre, Denmark
hub-height above ground	80 m
rotor diameter	92,4 m
distance middle of tower to middle of blade flange	3,5 m
power control (pitch/stall)	pitch

2.3 Course of the measurements

The total measurement period lasted from 2005-08-12 15:00 h until 2005-08-13 20:00 h. During this time the measured wind speed ranged from 5,5 to 12 m/s at a height of 10 m. The real

electrical power output of the turbine ranged between 300 and 2300 kW. The turbine was running continuously during the operating noise measurements.

The sound pressure level was recorded with a microphone on an acoustically hard board. The real electrical power output and the wind speed at a height of 10 m, taken upwind of the turbine in clear air, were also recorded. Time periods, where there were intermittent background noise of a significant nature, e.g. passing cars, planes flying over, rain etc., were marked accordingly during the measurements, and were omitted in the later evaluation. If there were random and reoccurring disturbances, which could not be marked during the measurement, a later state correction by means of a comparison with the DAT-recording was done.

The wind turbine generator system is sited in farmland. The surface roughness length for this measurement is assumed to be 0.05 m. The microphone position was chosen to minimise the effect of buildings, trees or bushes in the surrounding area of the wind turbine generator system, which might have had an influence on the measurement results. The conditions comply with free field behaviour over a reflecting plane.

During the noise measurements the meteorological conditions given in Table 2 were prevailing.

Table 2: Prevailing meteorological conditions during the measurements

barometric pressure at 2 m height above ground [hPa]	*1001 - 1006*
air temperature at 2 m height above ground [°C]	*14 - 18*
prevailing wind direction	*WNW*
range of wind direction	*280 - 330*
weather conditions	*cloudy and dry*
Turbulence intensity at 10 m height above ground [%]	*14,0*

2.4 Measuring equipment

The measuring equipment used is listed in the Annex. This equipment is tested regularly according to [IEC 61400-11] to ensure a high degree of measurement accuracy as well as security of data. The complete acoustic measurement system was checked before and after the measurements using an acoustic calibrator (B&K 4231).

2.5 Position of microphone

The microphone was placed according to [IEC 61400-11]. The distance from the turbine to the reference measuring point, R_0 = 112 m, was chosen taking local circumstances into account. The height of the microphone with respect to the bottom of the turbine foundation was 0 m.

3 Measurement results

3.1 Determination of directivity

As no significant directivity was ascertained the reference measurement position was chosen to be directly downwind of the turbine. This ensured worst case sound propagation conditions were taken into account.

3.2 Sound pressure level

The microphone converts the sound pressure into a continuous analogue signal which is then fed to a sound level meter. The resulting dB value, L_{Aeq}, together with the status, the wind speed at a height of 10 m, WS, and the real power output of the turbine, P_w, all recorded by the measurement system, is plotted against time in a graph given in the Annex. Here it can be seen at which points in time the turbine is switched on and off and provides an overview of the background noise in relation to the operating noise recorded by the measurement system over the whole period of the measurement. As can be seen, data was captured continuously throughout the whole measurement period. Non-normal background noises occurring in the measurement period, e.g. from aircraft or traffic, were marked during data acquisition to enable their easy omission in the evaluation to follow. The state signal is used to differentiate between periods when the turbine is running and when it is stopped. *State = 3* depicts a running turbine, *state = 0.5* depicts a stopped turbine, and *state = 0* marks the data to be omitted in the evaluation.

The noise produced by the turbine alone $L_{Aeq,c}$ at wind speeds of 6, 7, 8, 9 and 10 m/s is then determined by converting the dB levels of background and in-service noise to intensities, performing a subtraction and converting back again to dB. In order to determine this, regression curves of the measured sound pressure level with the turbine both running and stopped, plotted with respect to the standardised wind speed at a height of 10 m are required. The wind speed measured during the background noise measurement is multiplied by the factor κ, which is defined as the following:

$$\kappa = \frac{V_s}{V_z}$$

where,

V_s is the standardised wind speed

V_z is the measured wind speed.

For this measurement, κ = 0,93.

The results of this regression analysis are given in the Annex. All relevant sound pressure level values are given in the annex.

Remark: The data have been analysed using a fourth order regression because this is the best fitting approximation through all the relevant data points. In accordance with [IEC 61400-11] the data have also been analysed using a second order regression which is given in the annex only for information purposes. The sound levels resulting from the higher order regression have been applied in the third octave analysis.

3.3 Sound power level of the turbine

In accordance with [IEC 61400-11] the sound power level $L_{WA,k}$ of the turbine in dB is derived from the corrected sound pressure level $L_{Aeq,c,k}$, at wind speeds between 6 and 10 m/s at a height of 10 m, using the following formula:

$$L_{WA,k} = L_{Aeq,c,k} - 6 + 10 \cdot \lg\left(\frac{4 \cdot \pi \cdot R_1^2}{S_0}\right)$$

where, 6 dB is the correction due to the doubled sound pressure sensed by the microphone caused by coherent interference at the acoustically hard board.

$10 \cdot \lg\left(\frac{4 \cdot \pi \cdot R_1^2}{S_0}\right)$ = the ratio in dB of the surface area of a sphere having the radius R_1 to the reference surface area of S_0

where,

S_0 = 1 m^2

$R_1 = \sqrt{(R_0 + d)^2 + (H - h_A)^2}$

R_0 = distance between tower centre and microphone position

d = distance between tower centre and rotor flange middle point

H = hub-height above ground level

h_A = height of microphone

The following results are given in the Annex:

- A graph showing regressions through all the measured wind turbine sound data L_{Aeq} and background noise data L_n.
- A plot of the background corrected normalised values of L_{WA} against the standardised wind speed.
- A plot of L_{Aeq} and L_n against measured wind speed.
- A plot of L_{Aeq} against power.
- A plot of rotor speed against power.
- A time plot of the measurement.

For the Siemens 2.3 MW Mk II in the present configuration the real power output and the apparent sound power levels are given in table 4.

3.4 Tonal and frequency analyses

In accordance with the technical guideline [IEC 61400-11] a tonal analysis has to be carried out. The frequency spectrum of the noise, which is measured on the acoustically hard board, is determined on the basis of a narrow band analysis by means of the FFT-analyser B&K 2144. This analysis was performed after the measurements using the audio signal recorded on a DAT-recorder.

The results of the tonal analysis of the Siemens 2.3 MW Mk II according to [IEC 61400-11] are given in table 4.

3.5 3rd octave analysis

The A-weighted sound spectra at all the integer wind speeds are given in the Annex.

3.6 Uncertainties

3.6.1 Sound power level

The result of the sound power level measurement is subject to uncertainties which are due to the environment, meteorological conditions and the measurement system. For these measurements all the type B measurement uncertainty components as specified in the technical guideline [IEC 61400-11] are given in Table 3. For all of the type B uncertainties mentioned here, a rectangular distribution of possible values is assumed for simplicity with a range described as "±a". The standard deviation for such a distribution is:

$$U = \frac{a}{\sqrt{3}}$$

Table 3: Type B measurement uncertainty components

Component	**Range [dB]**	**Uncertainty [dB]**
Calibration, U_{B1}	±0,2	0,12
Chain of acoustic measurement instruments, U_{B2}	±0,4	0,23
Acoustically hard board, U_{B3}	±0,5	0,29
Distance measurement, U_{B4}	±0,1	0,06
Acoustic impedance of air, U_{B5}	±0,2	0,12
Meteorological variation (including turbulence), U_{B6}	±0,7	0,40
Wind speed derived from the power curve, U_{B7}	±0,3	0,17
Wind direction, U_{B8}	±0,5	0,29
$\sum_{i=1}^{8} U_{Bi}^{\ 2}$		0,44

The error in the background correction U_{B9} in dB has been calculated for each integer wind speed as follows:

$$U_{B9} = L_{Aeq,c,k} - \left[10 \cdot \log\left(10^{0,1 \cdot L_{Aeq,k}} - 10^{0,1(L_n + U_{HG})}\right)\right]$$

where U_{HG} is the error in the background noise in dB defined as follows:

$$U_{\mathrm{HG}} = \sqrt{\frac{(y_n - y_{n,est})^2}{N_n - 2}}$$

where:

y_n = measured sound pressure level of background noise in dB

$y_{n,est}$ = estimated sound pressure level of background noise from the regression analysis in dB

N_n = number of background noise measurement values in the wind speed bin corresponding to the integer wind speed.

The combined measurement uncertainty U_C relating to the sound power level $L_{WA,k}$ is calculated as follows:

$$U_C = \sqrt{U_A{}^2 + U_{B9}{}^2 + \sum_{i=1}^{8} U_{Bi}{}^2}$$

where:

$$U_A = \sqrt{\frac{\sum (y - y_{est})^2}{N - 2}}$$

where:

y = measured sound pressure level of total noise (operating plus background) in dB

y_{est} = estimated sound pressure level of total noise from the regression analysis in dB

N = number of total noise measurement values in the wind speed bin corresponding to the integer wind speed.

All values for U_A, U_{B9} and U_C are given in the annex.

3.6.2 One-third octave band spectra

The uncertainty in the one-third octave band spectra is given in the Annex for all the third octave bands.

3.6.3 Tonality

The uncertainty in the tonality is given in the Annex for all the given tones.

4 Summary

As ordered by Siemens Wind Power A/S, 7330 Brande, Denmark, WINDTEST Kaiser-Wilhelm-Koog GmbH took measurements of the acoustic noise emissions on the Siemens WTGS 2.3 MW Mk II with a hub height of 80 m.

All measurements and analyses of the sound power level and tonality described in this report were made on the basis of the technical guideline [IEC 61400-11]. The analysis of the sound power level was carried out using the standardised wind speed which was calculated from the power curve provided by the customer (see Annex).

The data on the Siemens WTGS 2.3 MW Mk II have been evaluated by using a fourth order regression because this is the best fitting approximation over all relevant points.

The results of this measurement are given in table 4.

Table 4: Summary of results

wind speed in 10 m height [m/s]	***6***	***7***	***8***	***9***	***10***
electrical power output calculated from the power curve [kW]	*1049*	*1651*	*2106*	*2260*	*2295*
measured pitch angle [degrees]	*-0,8*	*-0,8*	*-0,8*	*0*	*>1*
measured rotor speed [min^{-1}]	*15,1*	*15,3*	*15,4*	*15,8*	*16,0*
sound power level [dB]	*103,4*	*104,9*	*105,1*	*105,0*	*105,0*
combined uncertainty in the sound power level, U_C [dB]	*1,2*	*1,1*	*1,2*	*1,3*	*1,3*
tonality, ΔL_k [dB]	*-5,58*	*-4,68*	*-6,36*	*-5,43*	*-5,91*
tonal audibility, $\Delta L_{a,k}$ [dB]	*-2,58*	*-1,69*	*-3,36*	*-2,43*	*-3,58*
frequency of the most prevalent tone [Hz]	*1200*	*1200*	*1200*	*1200*	*530*

It is assured that this report has been drawn up impartially in accordance with state-of-the-art science and technology and with best knowledge and conscience.

5 List of employed symbols and abbreviations

d	-	distance from rotor centre to tower axis	m
D	-	rotor diameter	m
$\Delta L_{tn,j,k}$	-	tonality of the 'j th' spectrum at 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
ΔL_k	-	energetic average of the 12 $\Delta L_{tn,j,k}$	dB
$\Delta L_{a,k}$	-	tonal audibility	dB
f	-	frequency of the tone	Hz
f_c	-	centre frequency of critical band	Hz
H	-	height of rotor centre (horizontal axis turbine) or height of rotor equatorial plane (vertical axis turbine) above local ground near the wind turbine	m
h_A	-	location point height (in measurement equal to microphone height)	m
κ	-	the ratio between standardised wind speed and measured wind speed	-
L_A or L_C	-	A or C-weighted sound pressure level	dB
$L_{Aeq,k}$	-	equivalent continuous A-weighted sound pressure level, where k = 6, 7, 8, 9, 10	dB
$L_{Aeq,c,k}$	-	equivalent continuous A-weighted sound pressure level corrected for background noise at each integer wind speed and corrected to reference conditions, where k = 6, 7, 8, 9, 10	dB
L_n	-	equivalent continuous sound pressure level level of the background noise	dB
L_p	-	sound pressure level	dB
$L_{pn,j,k}$	-	sound pressure level of masking noise within a critical band in the 'j th' spectrum at the 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
$L_{pn,avg,j,k}$	-	average of analysis bandwidth sound pressure levels of masking noise in the 'j th' spectrum at the 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
$L_{pt,j,k}$	-	sound pressure level of the tone or tones in the 'j th' spectrum at the 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
L_s	-	equivalent continuous sound pressure level of only wind turbine noise	dB
L_{s+n}	-	equivalent continuous sound pressure level of combined wind turbine and background noise	dB
$L_{WA,k}$	-	apparent sound power level, where k = 6, 7, 8, 9, 10	dB
N	-	Number of measured values	-
P_W	-	effective electrical power	kW
R_0	-	reference distance	m
R_i	-	slant distance from rotor centre to actual measurement position	m
S_0	-	reference area, $S_0 = 1\ m^2$	m
U_A , U_B	-	Uncertainty components	dB
U_C	-	Total uncertainty	dB
U_{HG}		Error in the background noise	dB
V_m	-	derived wind speed from power curve	m/s
V_S	-	standardised wind speed	m/s
WTGS	-	wind turbine generator system	-
y	-	measured sound pressure level of operating plus background noise	dB
y_{est}	-	estimated sound pressure level of operating plus background noise from the regression analysis	dB

6 References

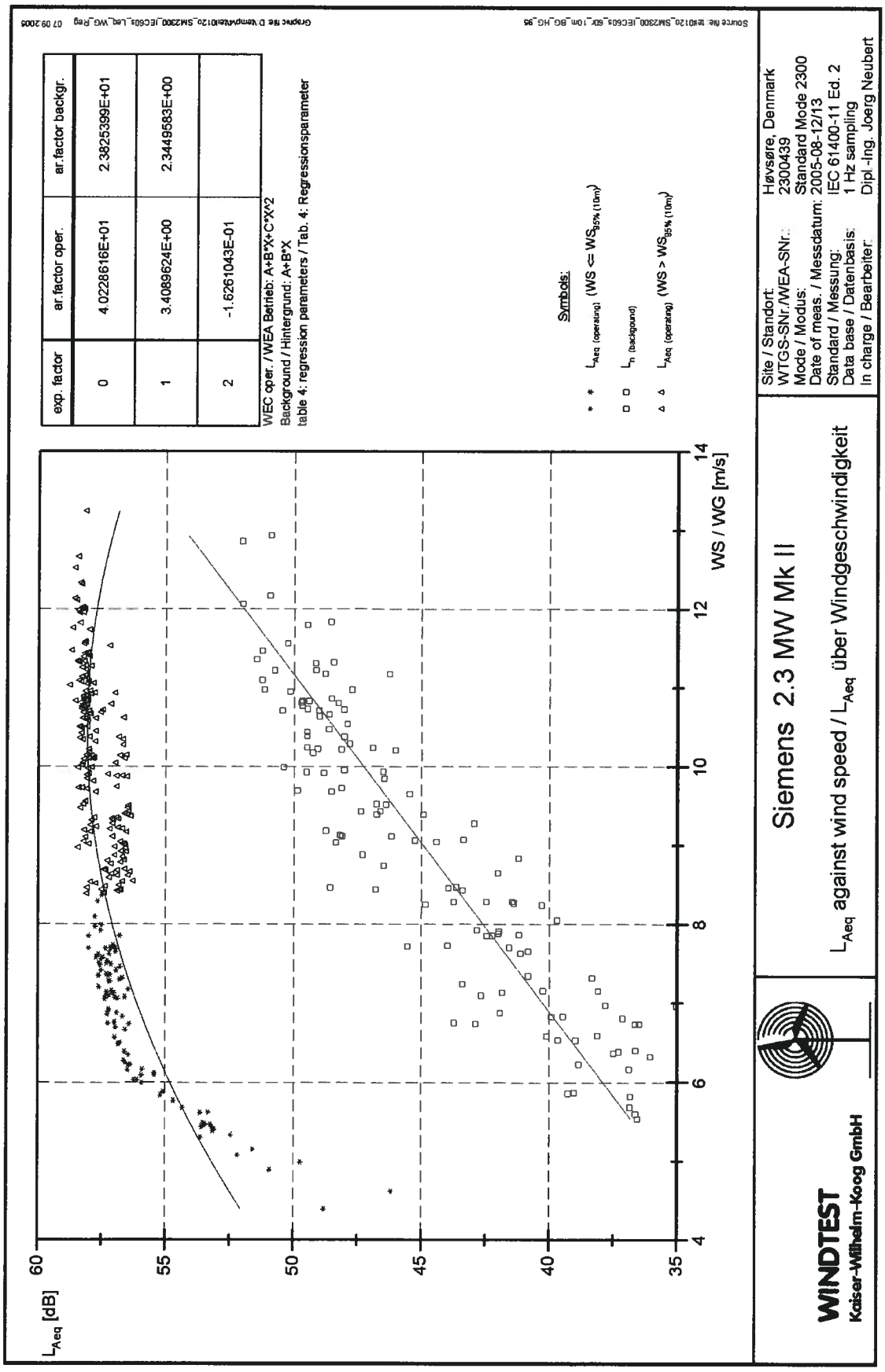
[IEC 61400-11] IEC 61400-11, Wind turbine generator systems - Part 11: Acoustic noise measurement techniques, Ed. 2.

7 Annex

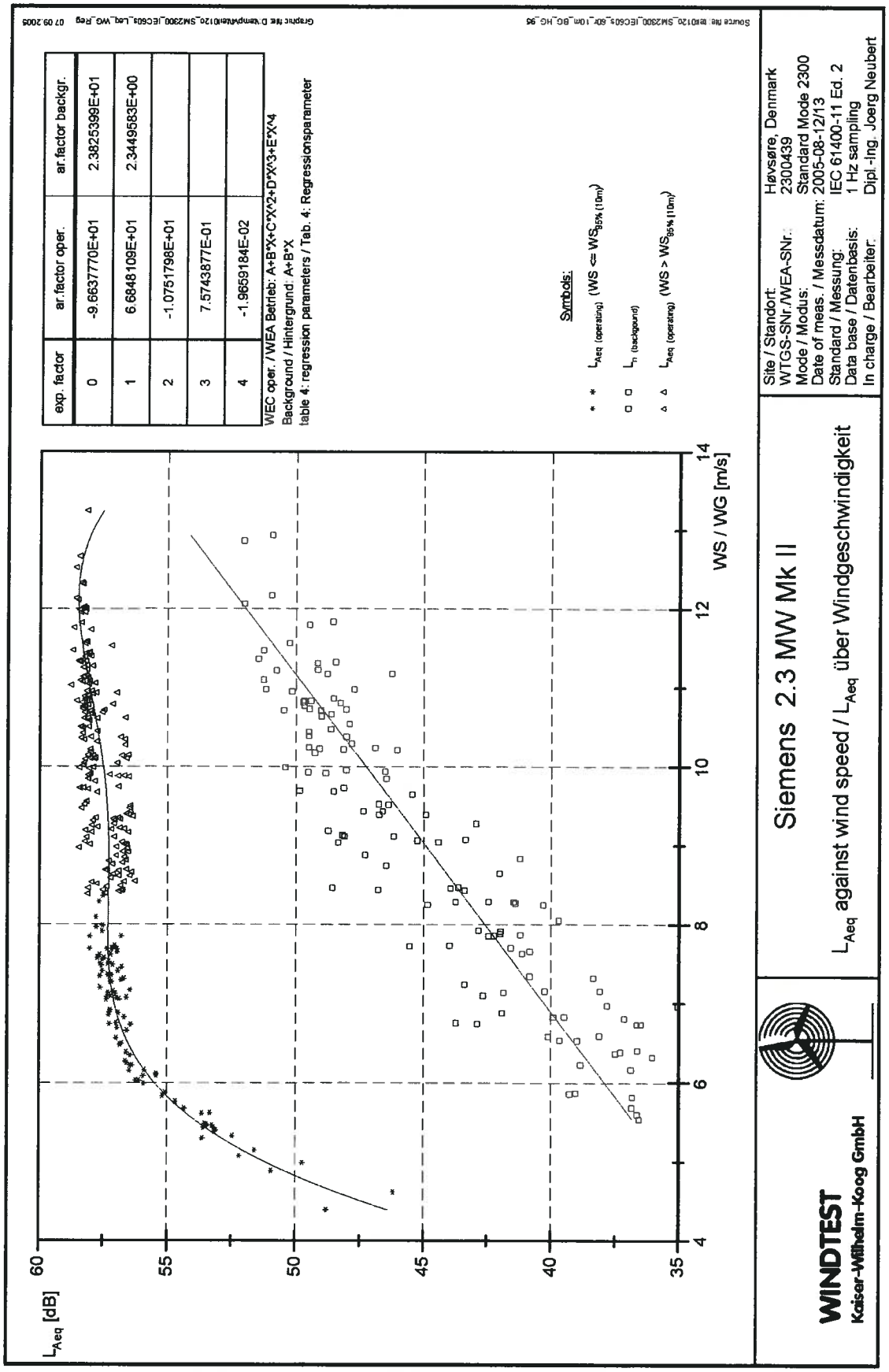
Annex 1: Measuring equipment used

Beschreibung *description*	**Fabrikat** *supplier*	**Typ**/*type*	**WT Nr./Ser.Nr.** *WT stock number/serial number*	**Kal. am** *cal. on*	**Eichung am** *standardisation*	**Einsatz** *used*
Akustischer Kalibrator *acoustic calibrator*	Brüel & Kjær	4231	WT 300083004 (2438819)	-	31.12.2006	x
Mikrofon *microphone*	Brüel & Kjær	4188	zu WT 30002904 (2427565)	-	31.12.2006	x
Vorverstärker *preamp.*	Brüel & Kjær	ZC 0030	zu WT 30002904	-	31.12.2006	x
Mikrofonkabel *microphone cable*	Brüel & Kjær	AO 0560	zu WT 30002904	-	31.12.2006	x
Handschallpegelmesser *decibel meter*	Brüel & Kjær	2238	WT 30002904 (2437622)	-	31.12.2006	x
Primärwindschirm *primary wind shield*	Brüel & Kjær	UA 0237	-	-	-	x
Sekundärwindschirm *secondary wind shield*	Delta Acoustics	SIM	-	-	-	
DAT-Rekorder *DAT-recorder*	Sony	TCD-D100	WT 300083304 (541959)	-	-	x
Anemometer *anemometer*	Thies Clima	4.3519.00.000	WT 010041504 (PN 457 0604)	Jun. 04	-	x
Windrichtungsgeber *wind direction sensor*	Thies Clima	4.3129.00.012	WT 020013504 (0504426	-	-	x
Temperaturgeber *temperature sensors*	Heraeus (Logger)	PT100	WT 300084704	Jul. 05	-	x
Temperaturgeber *temperature sensors*	Heraeus (W+W)	PT100	WT 300084604	Jul. 05	-	x
Luftdruckgeber *pressure sensors*	Wilmers Messtechnik (Logger)	0619	WT 090021803	Jul. 05	-	x
Luftdruckgeber *pressure sensors*	Wilmers Messtechnik (W+W)	0619	WT 090022804	Jul. 05	-	x
Leistungsumformer *power transducer*	Metrawatt (DME 1)	SINEAX DME 442	WT 300070903	Jun. 04	-	
Leistungsumformer *power transducer*	Metrawatt (DME 2)	SINEAX DME 442	WT 300055202	Aug. 03	-	
Leistungsumformer *power transducer*	Metrawatt (DME 3)	SINEAX DME 442	WT 300018898	Feb. 05	-	
Leistungsumformer *power transducer*	Metrawatt (DME 4)	SINEAX DME 442	WT 300079804	Feb. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 1)	D32N	WT 300071603 bis 300071803	Jul. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 2)	D32N	WT 300053501 bis 300053701	Jul. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 3)	AmpFLEX A100	WT 300091804 bis 300092004	Jul. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 4)	AmpFLEX A100	WT 300085804 bis 300086004	Jul. 05	-	
Datenlogger *datalog*	Th. Friedrichs	1020	WT 030013504 (091630)	Jul. 04	-	x
Zweikanal-Echtzeit-Frequenzanalysator *2-channel real time frequency analyser*	Brüel & Kjær	2144	WT 9904897 (1732981)	Sep. 03	-	x
Erfassungs- und Auswertesoftware *data acquisition and analytical software*	GfS Aachen Microsoft DATALOG GmbH	DIAdem 8.1 Excel 2000 Dasy-Lab 7.0	-	-	-	x
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 9005	WT 400023903 (CNF 3371X4F)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	OmniBook XE3	WT 400021502 (TW 21806701)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	OmniBook XE3	WT 400020802 (TW 21121810)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 5000	WT 400026604 (CNU43700RT)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 9005	WT 400024003 (CNF 3371X70)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 9005	WT 400024103 (CNF 3371X4X)	-	-	x
10 m – Teleskopmast *10 m – telescopic mast*	Clark (SMS 3)	QT 12M/HP	WT 050019003	-	-	x
Unterbrechungsfreie Spannungsversorgung *uninterruptable power supply*	APS	Smart UPS 1000	WT 30009002104	-	-	x

Annex 2.1a: 2nd order regression of L_{Aeq} and L_n against standardised wind speed



Annex 2.1b: Higher order regression of L_{Aeq} and L_n against standardised wind speed



Parameters of evaluation / Auswerteparameter :

H	=	80.0	m	d	=	3.50	m	h_A	=	0.0	m
D	=	93.0	m	z_0	=	0.050	m	R_0	=	112.0	m

P_{rated} / P_{Nenn} = 2.30 MW

$WS_{95\%}$ / $WG_{95\%}$ = 11.67 m/s

Results / Ergebnisse :

$WS_{95\%(10m)}$ / $WG_{95\%(10m)}$ = 8.38 m/s

$Power_{95\%}$ / $Leistung_{95\%}$ = 2.185 MW

Range of the wind direction / Windrichtungsbereich = 284.40° - 325.68°

κ = 0.93

average turbulence intensity / mittlere Turbulenzintensität = 14.0 %

WS_{10m} WG_{10m}	U_A [dB]	U_{B9} [dB]	U_C [dB]
6	0.44	0.04	1.2
7	0.31	0.05	1.1
8	0.41	0.08	1.2
9	0.64	0.14	1.3
10	0.68	0.25	1.3

table 1: uncertainty / Tabelle 1: Messunsicherheiten

WS_{10m} WG_{10m}	$L_{Aeq,k}$ [dB]	L_{backgr} [dB]	$L_{Aeq,c,k}$ [dB]	$L_{WA,k}$ [dB]
6	55.5	37.9	55.4	103.4
7	57.1	40.2	57.0	104.9
8	57.3	42.6	57.2	105.1
9	57.3	44.9	57.0	105.0
10	57.5	47.3	57.1	105.0

table 2: results L = f(WS) / Tabelle 2: Ergebnisse L = f(WG)

$WS_{95\%}$ $WG_{95\%}$	$L_{Aeq,k}$ [dB]	L_{backgr} [dB]	$L_{Aeq,c,k}$ [dB]	$L_{WA,k}$ [dB]
8.38	57.3	43.5	57.1	105.1

table 3: results L = f($WS_{95\%}$) / Tabelle 3: Ergebnisse L = f($WG_{95\%}$)

Graphic file: D:\temp\Arbeit\912o_SW2300_IEC60s_result 07.09.2005

Source file: tab912o_SW2300_IEC60s_60r_10m_BG_HG_06

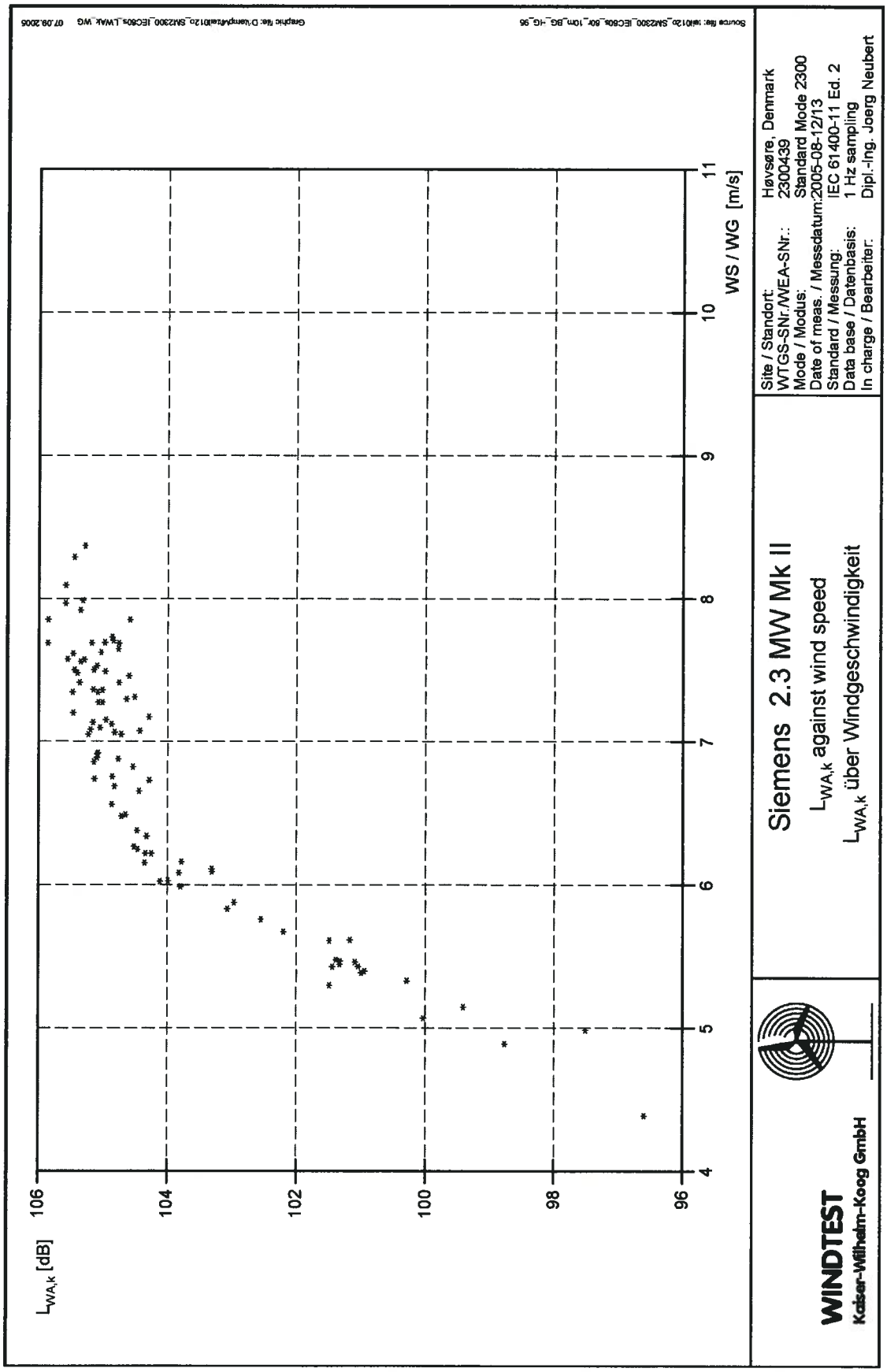
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

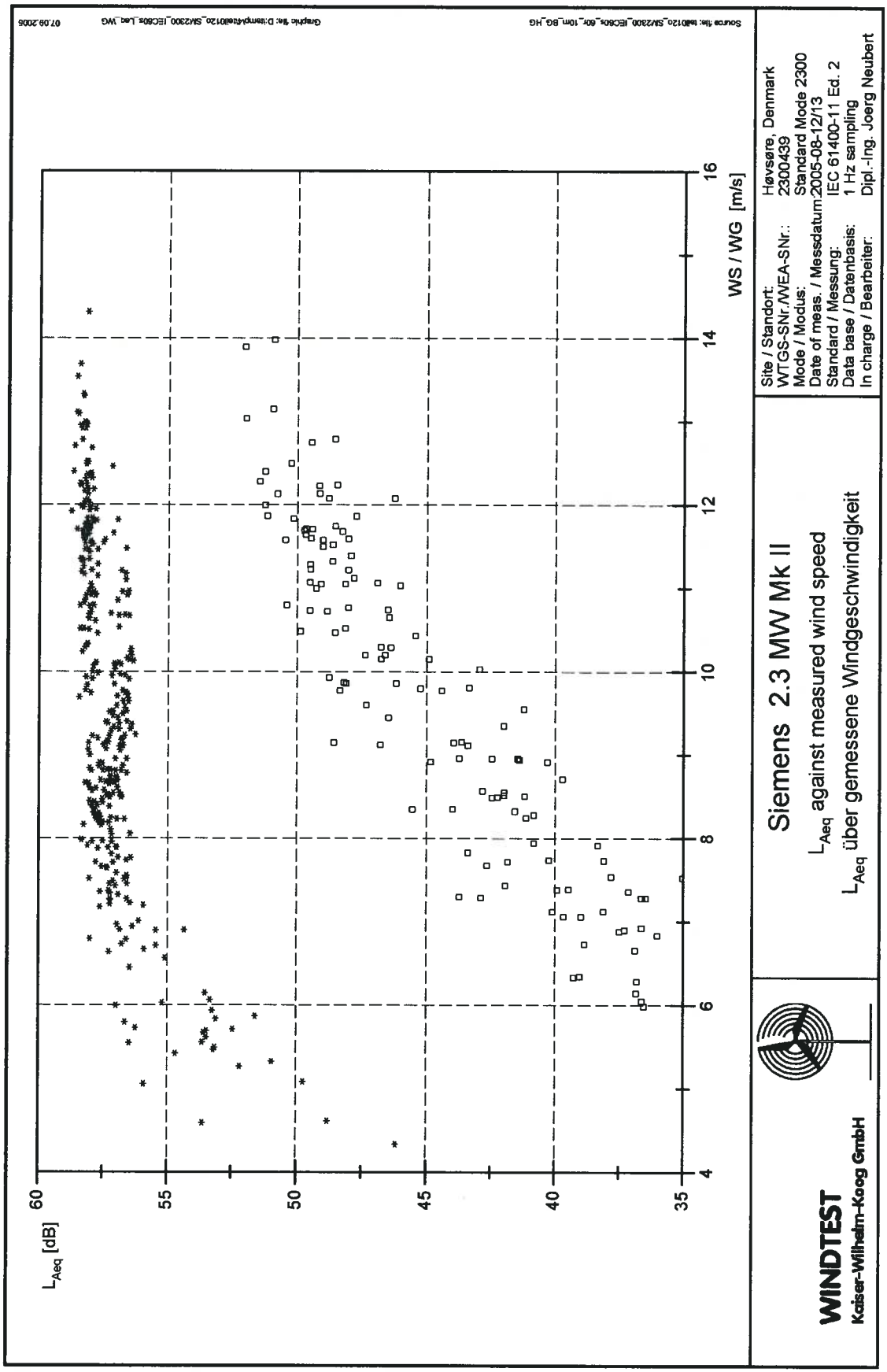
Results / Ergebnisse

Site / Standort:	Høvsøre, Denmark
WTGS-SNr./WEA-SNr.:	2300439
Mode / Modus:	Standard Mode 2300
Date of meas. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11 Ed. 2
Data base / Datenbasis:	1 Hz sampling
In charge / Bearbeiter:	Dipl.-Ing. Joerg Neubert

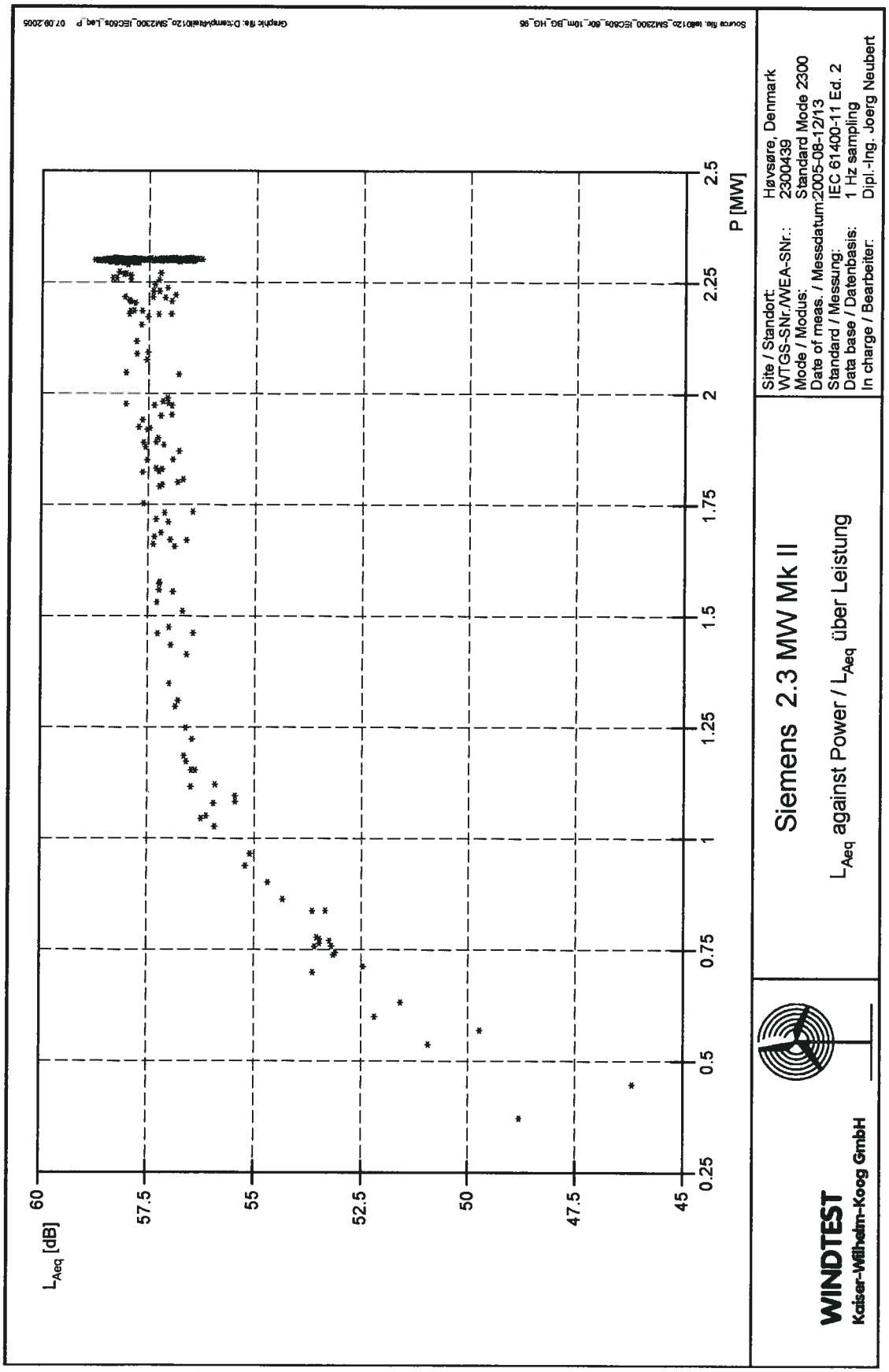
Annex 2.3: Plot of L_{WA} against standardised wind speed



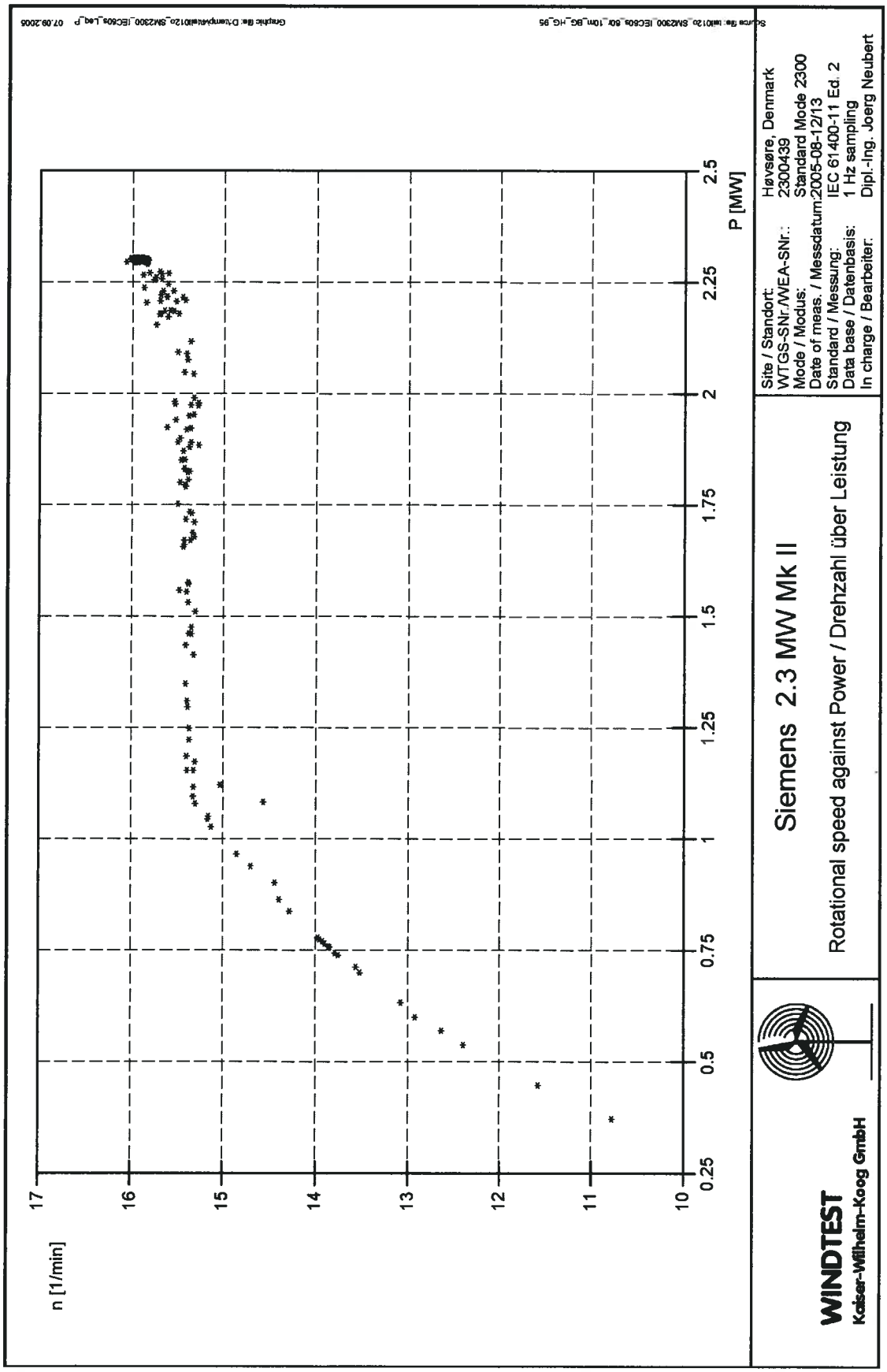
Annex 2.4: Plot of L_{Aeq} and L_n against measured wind speed



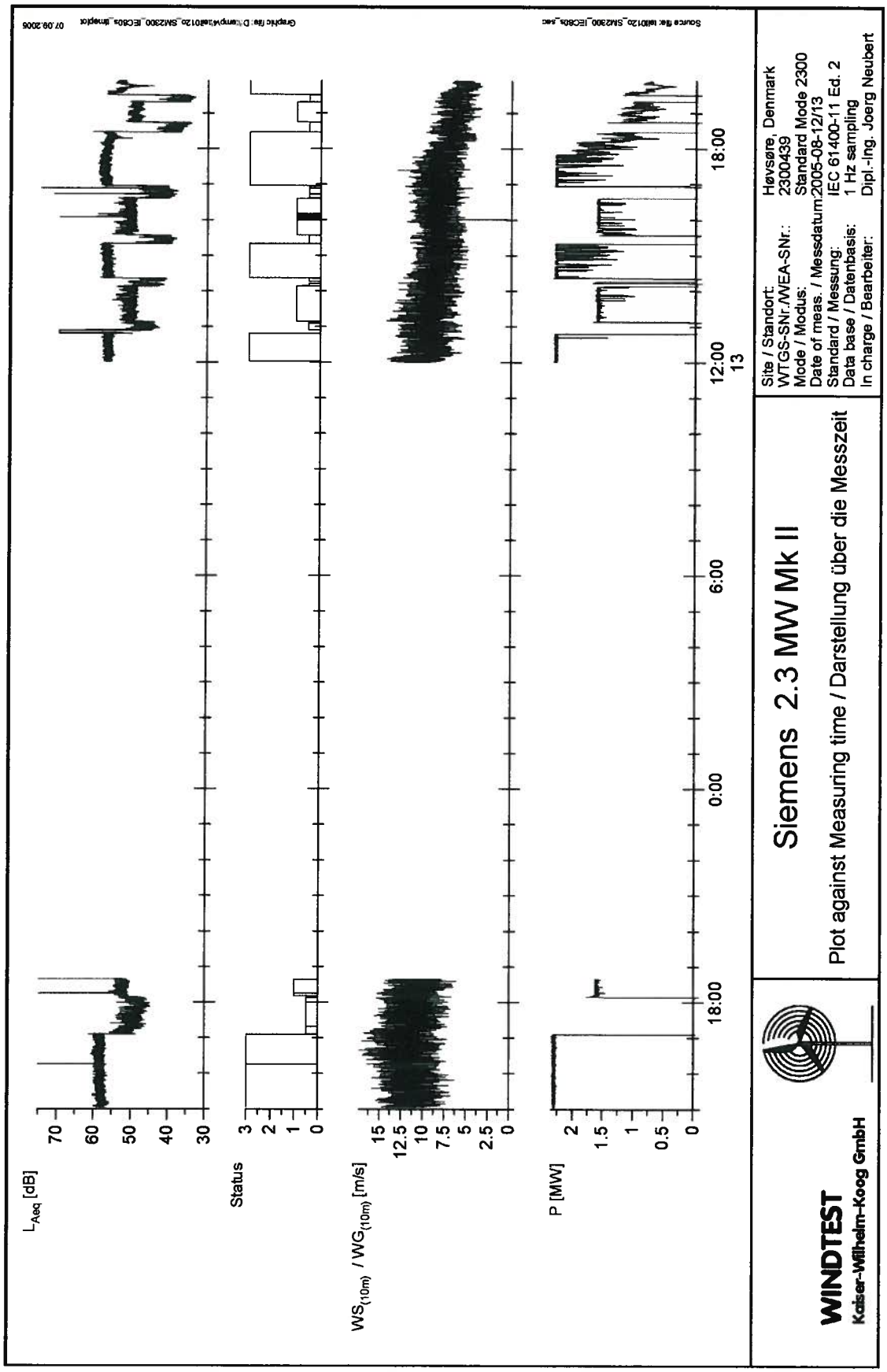
Annex 2.5: Plot of L_{Aeq} against power



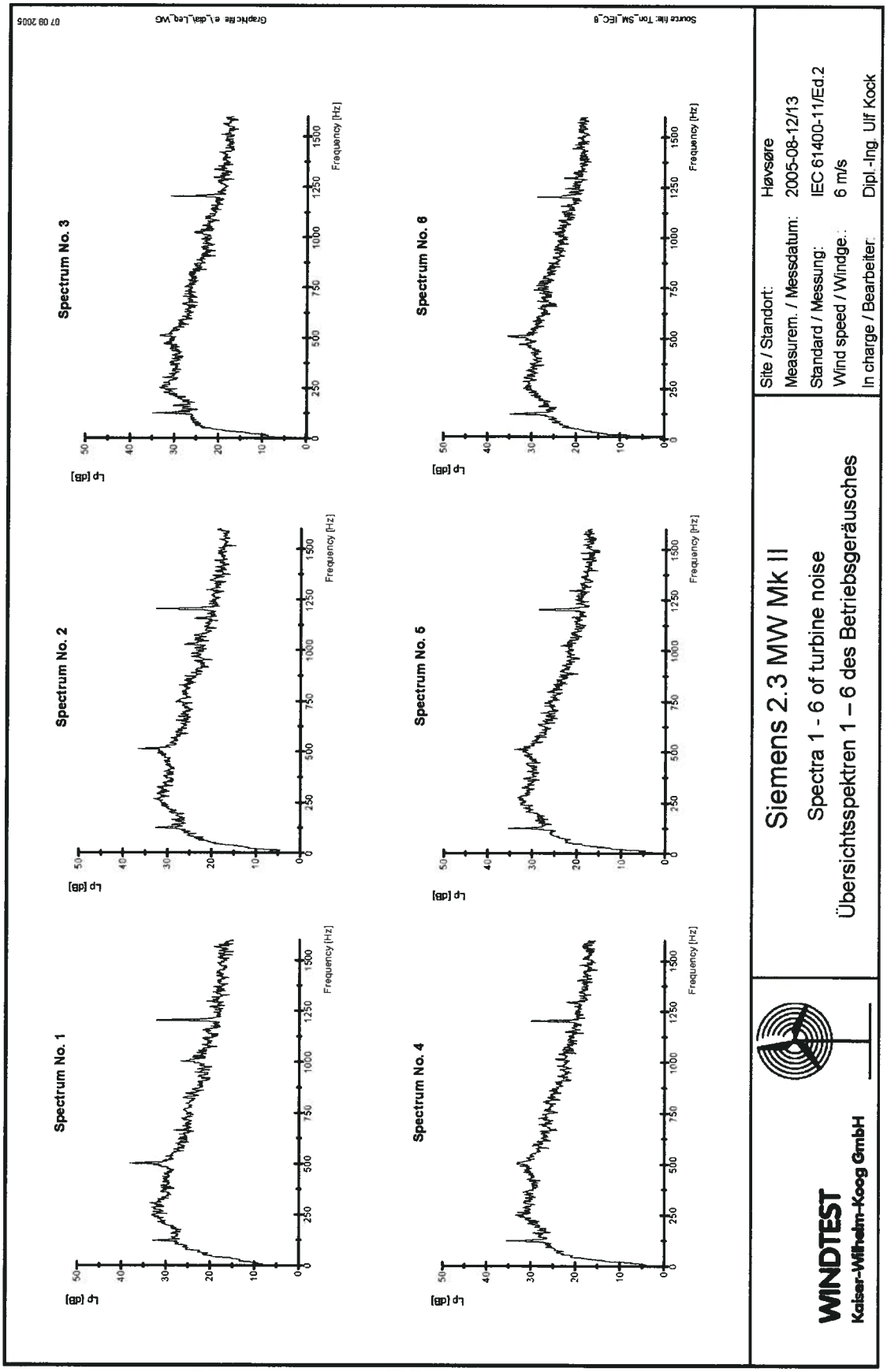
Annex 2.6: Plot of rotor speed against power



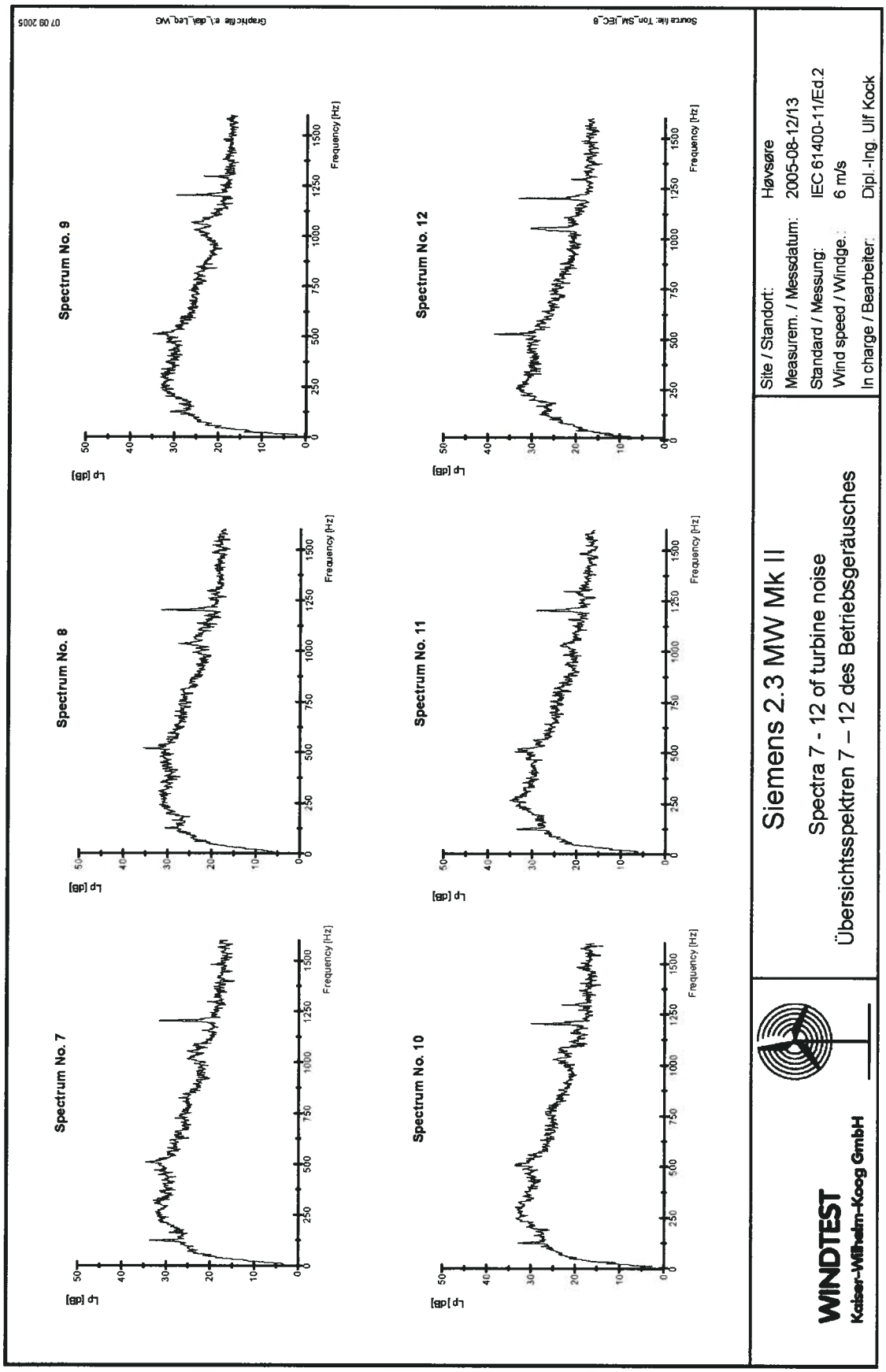
Annex 2.7: Time plot of measurement



Annex 3.1a: Overview spectra 1-6 of turbine noise at a wind speed of 6 m/s



Annex 3.1b: Overview spectra 7-12 of turbine noise at a wind speed of 6 m/s



m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1204	2.00	19.36	33.06	37.29	-4.23	-3.00	-1.24
2	1204	2.00	20.40	33.91	38.33	-4.42	-3.00	-1.43
3	1204	2.00	20.14	31.73	38.07	-6.34	-3.00	-3.35
4	1204	2.00	20.19	30.86	38.12	-7.26	-3.00	-4.26
5	1204	2.00	19.57	29.77	37.49	-7.73	-3.00	-4.73
6	1204	2.00	20.97	30.07	38.90	-8.83	-3.00	-5.83
7	1204	2.00	19.65	32.98	37.57	-4.59	-3.00	-1.60
8	1202	2.00	20.35	32.08	38.27	-6.19	-2.99	-3.20
9	1202	2.00	19.20	31.01	37.12	-6.11	-2.99	-3.12
10	1204	2.00	18.92	31.62	36.85	-5.22	-3.00	-2.23
11	1202	2.00	19.38	30.27	37.31	-7.04	-2.99	-4.04
12	1202	2.00	18.82	34.02	36.74	-2.73	-2.99	0.27

Energetic average of delta Lt (delta Lk) = -5.58 [dB]

Frequency dependant audibility criterion (La) [dB] = -3.00 [dB]

Audibility, delta Lk - La (delta La,k) = -2.58 [dB]

Uncertainty of delta La,k (Ua) = 2.41 [dB]

Audibility greater than or equal to -3.0 dB ?: Yes

07.09.2005

Graphic file: a_tab_Ton_SWG

Source file: Ton_SM_IEC_8

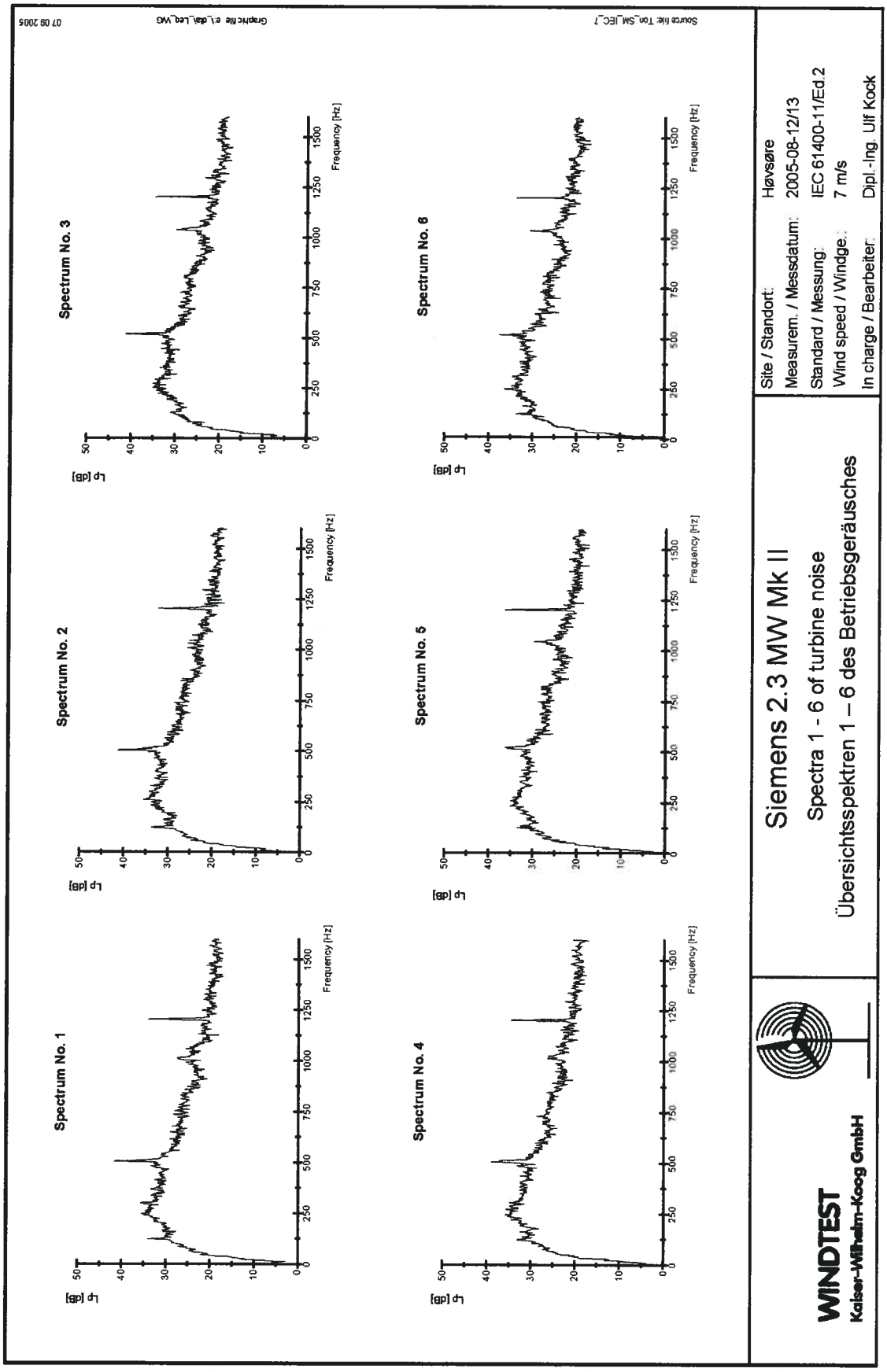
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

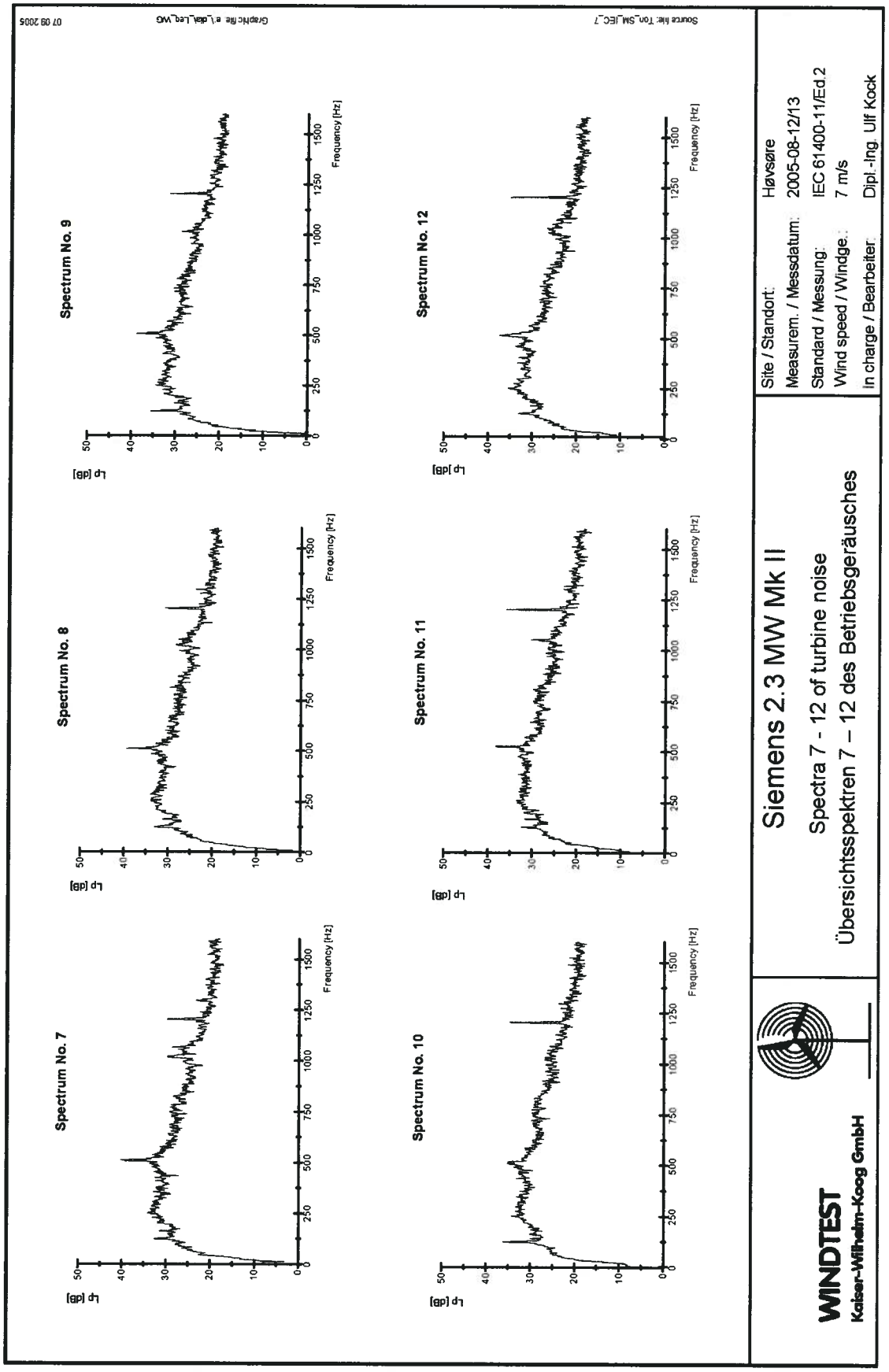
Analysis of tonality of turbine noise
Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	6 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 3.2a: Overview spectra 1-6 of turbine noise at a wind speed of 7 m/s



Annex 3.2b: Overview spectra 7-12 of turbine noise at a wind speed of 7 m/s



m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1204	2.00	20.72	34.72	38.65	-3.93	-3.00	-0.94
2	1204	2.00	21.03	33.39	38.95	-5.57	-3.00	-2.57
3	1202	2.00	21.44	35.77	39.36	-3.59	-2.99	-0.60
4	1204	2.00	21.13	35.80	39.06	-3.26	-3.00	-0.26
5	1202	2.00	21.86	36.97	39.78	-2.82	-2.99	0.18
6	1202	2.00	21.88	34.03	39.80	-5.78	-2.99	-2.78
7	1204	2.00	21.62	30.69	39.55	-8.87	-3.00	-5.87
8	1204	2.00	22.07	31.40	40.00	-8.60	-3.00	-5.60
9	1204	2.00	22.34	31.52	40.27	-8.75	-3.00	-5.75
10	1204	2.00	22.48	35.58	40.41	-4.83	-3.00	-1.83
11	1202	2.00	22.37	36.62	40.29	-3.68	-2.99	-0.68
12	1202	2.00	20.90	36.18	38.82	-2.64	-2.99	0.36

Energetic average of delta Lt (delta Lk) = -4.68 [dB]

Frequency dependant audibility criterion (La) [dB] = -3.00 [dB]

Audibility, delta Lk - La (delta La,k) = -1.69 [dB]

Uncertainty of delta La,k (Ua) = 2.43 [dB]

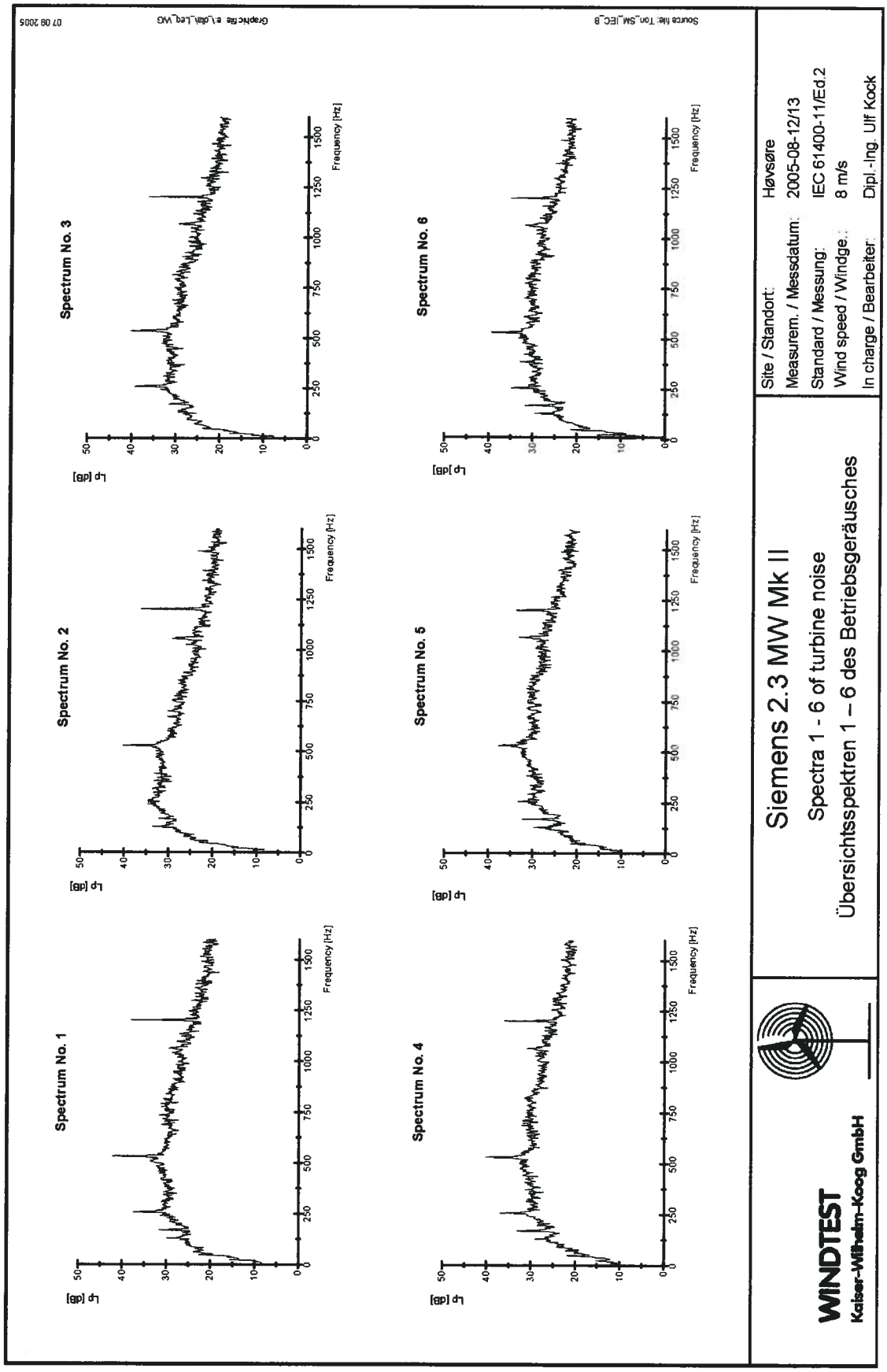
Audibility greater than or equal to -3.0 dB ?: Yes

07.09.2005

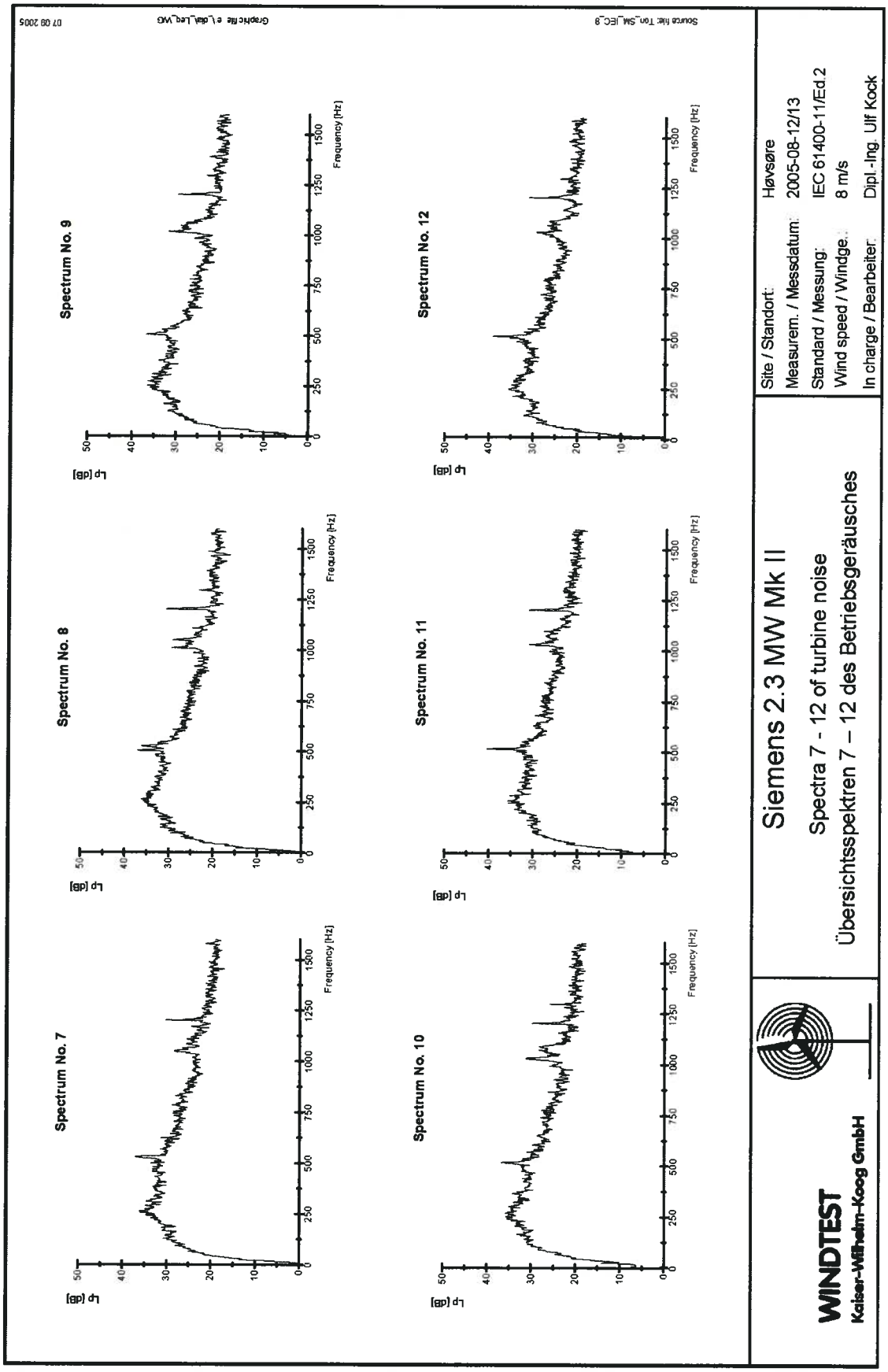
Source file: Ton_SM_IEC_7

WINDTEST Kaiser-Wilhelm-Koog GmbH	Siemens 2.3 MW Mk II Analysis of tonality of turbine noise Tonhaltigkeitsbewertung des Betriebsgeräusches	Site / Standort: Høvsøre Measurem. / Messdatum: 2005-08-12/13 Standard / Messung: IEC 61400-11/Ed.2 Wind speed / Windge.: 7 m/s In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 3.3a: Overview spectra 1-6 of turbine noise at a wind speed of 8 m/s



Annex 3.3b: Overview spectra 7-12 of turbine noise at a wind speed of 8 m/s



m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1202	2.00	24.17	38.84	42.09	-3.24	-2.99	-0.25
2	1202	2.00	21.96	36.91	39.88	-2.97	-2.99	0.03
3	1202	2.00	23.10	36.78	41.02	-4.24	-2.99	-1.25
4	1202	2.00	25.03	36.71	42.95	-6.25	-2.99	-3.25
5	1202	2.00	25.78	34.91	43.70	-8.78	-2.99	-5.79
6	1202	2.00	25.29	35.47	43.21	-7.74	-2.99	-4.75
7	1202	2.00	22.13	28.51	40.05	-11.54	-2.99	-8.55
8	1202	2.00	20.56	32.53	38.48	-5.95	-2.99	-2.96
9	1204	2.00	21.44	30.29	39.37	-9.08	-3.00	-6.08
10	1202	2.00	21.77	31.03	39.70	-8.67	-2.99	-5.67
11	1202	2.00	22.44	31.96	40.36	-8.41	-2.99	-5.41
12	1204	2.00	21.66	31.46	39.59	-8.13	-3.00	-5.13

Energetic average of delta Lt (delta Lk) = -6.36 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.99 [dB]

Audibility, delta Lk - La (delta La,k) = -3.36 [dB]

Uncertainty of delta La,k (Ua) = 2.56 [dB]

Audibility greater than or equal to -3.0 dB ?: No

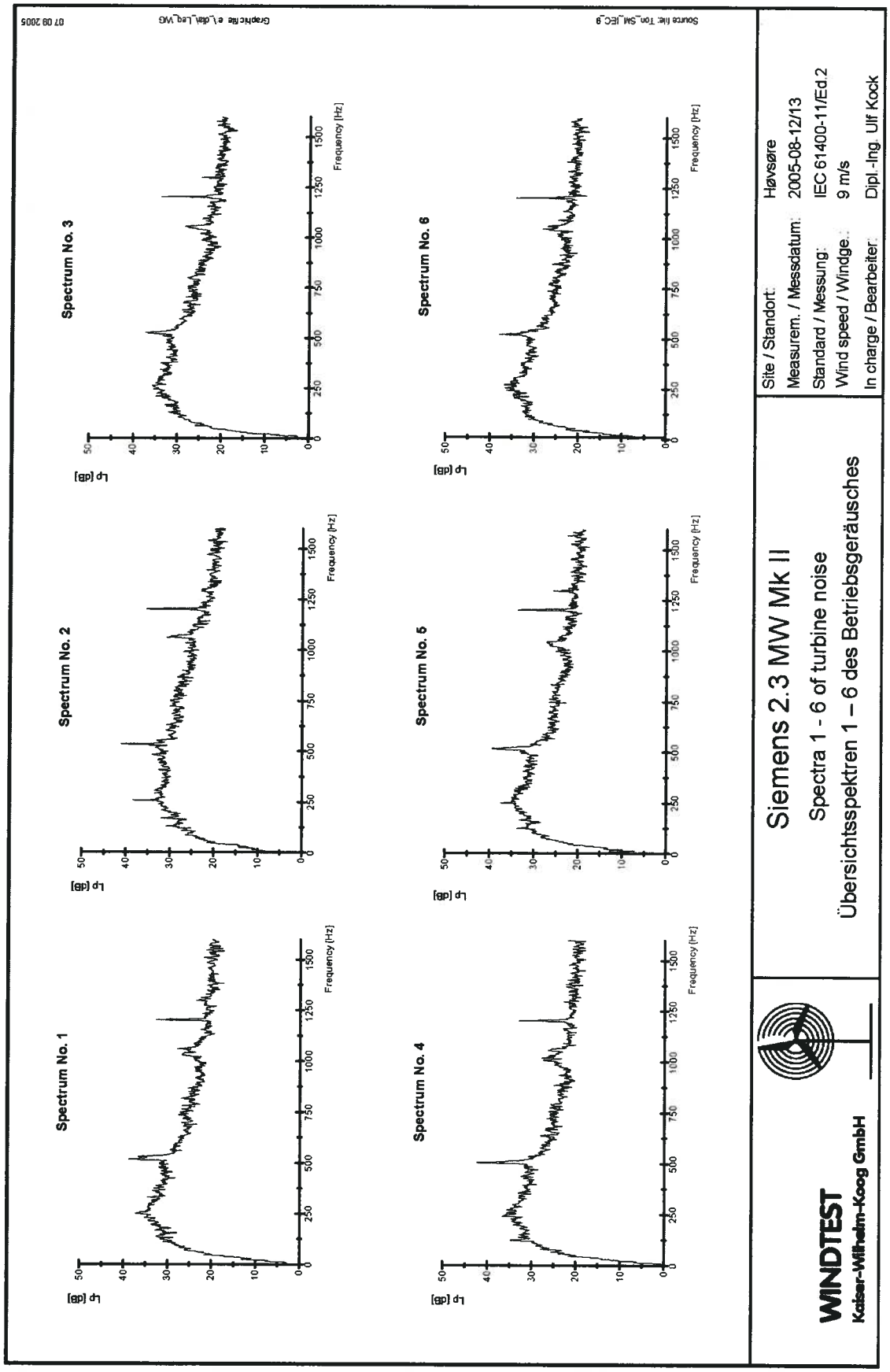
07 09 2005

Graphic file: La_tab_Ton_SM

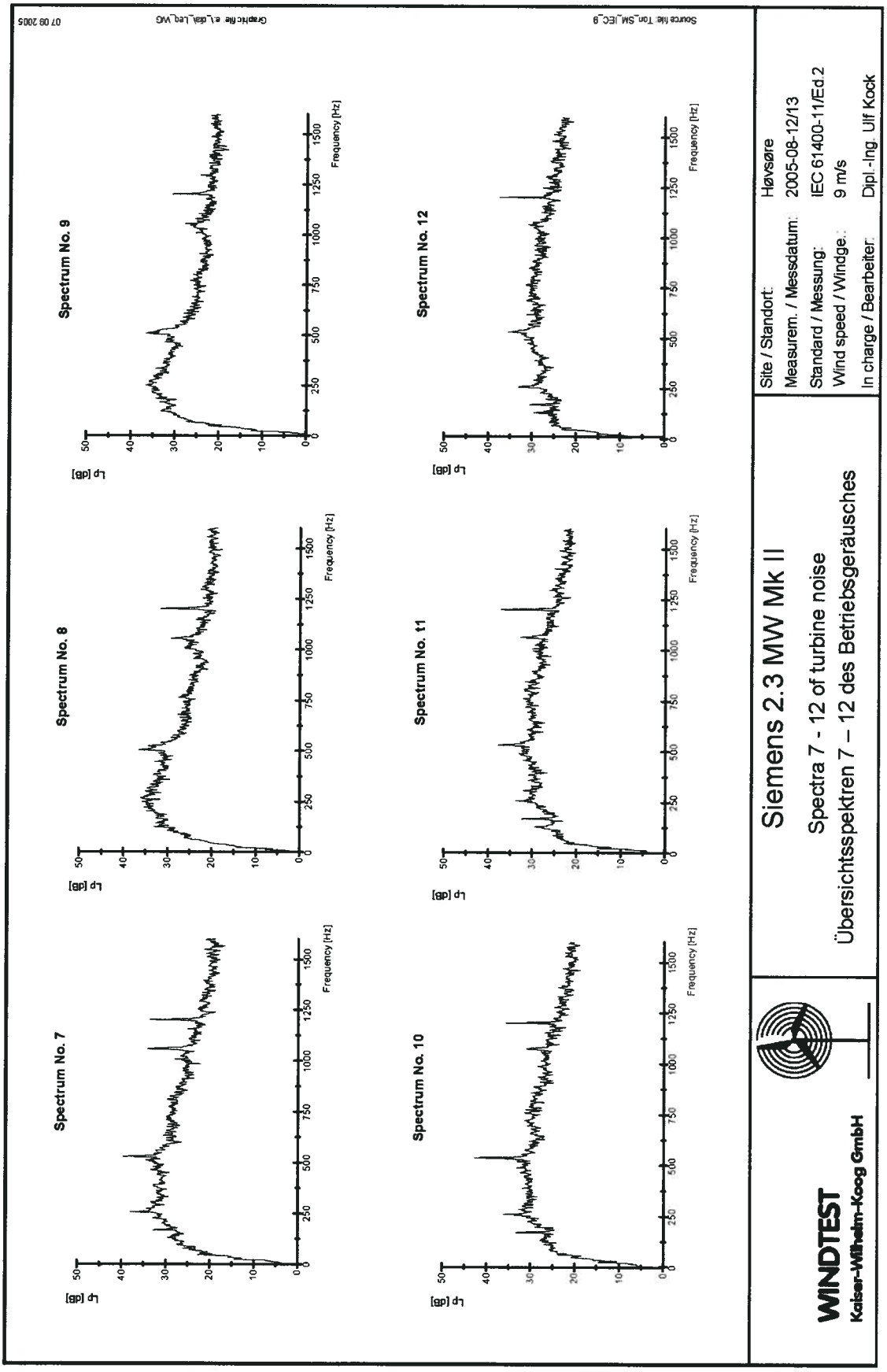
Source file: Ton_SM_IEC_8

WINDTEST Kaiser-Wilhelm-Koog GmbH	Siemens 2.3 MW Mk II Analysis of tonality of turbine noise Tonhaltigkeitsbewertung des Betriebsgeräusches	Site / Standort: Høvsøre Measurem. / Messdatum: 2005-08-12/13 Standard / Messung: IEC 61400-11/Ed.2 Wind speed / Windge.: 8 m/s In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 3.4a: Overview spectra 1-6 of turbine noise at a wind speed of 9 m/s



Annex 3.4b: Overview spectra 7-12 of turbine noise at a wind speed of 9 m/s



m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1202	2.00	21.21	34.04	39.13	-5.09	-2.99	-2.09
2	1202	2.00	22.59	36.23	40.51	-4.28	-2.99	-1.29
3	1202	2.00	21.36	34.35	39.28	-4.93	-2.99	-1.94
4	1204	2.00	21.53	33.98	39.46	-5.48	-3.00	-2.48
5	1202	2.00	21.56	34.35	39.48	-5.13	-2.99	-2.14
6	1202	2.00	21.44	35.08	39.36	-4.28	-2.99	-1.28
7	1202	2.00	22.59	34.75	40.52	-5.76	-2.99	-2.77
8	1202	2.00	21.53	32.08	39.45	-7.37	-2.99	-4.37
9	1202	2.00	22.20	31.49	40.12	-8.63	-2.99	-5.64
10	1202	2.00	24.50	36.83	42.42	-5.59	-2.99	-2.60
11	1202	2.00	25.28	38.67	43.20	-4.54	-2.99	-1.54
12	1202	2.00	26.09	38.16	44.01	-5.85	-2.99	-2.86

Energetic average of delta Lt (delta Lk) = -5.43 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.99 [dB]

Audibility, delta Lk - La (delta La,k) = -2.43 [dB]

Uncertainty of delta La,k (Ua) = 2.32 [dB]

Audibility greater than or equal to -3.0 dB ?: Yes

07 09 2005

Source file: Ton_SM_IEC_B

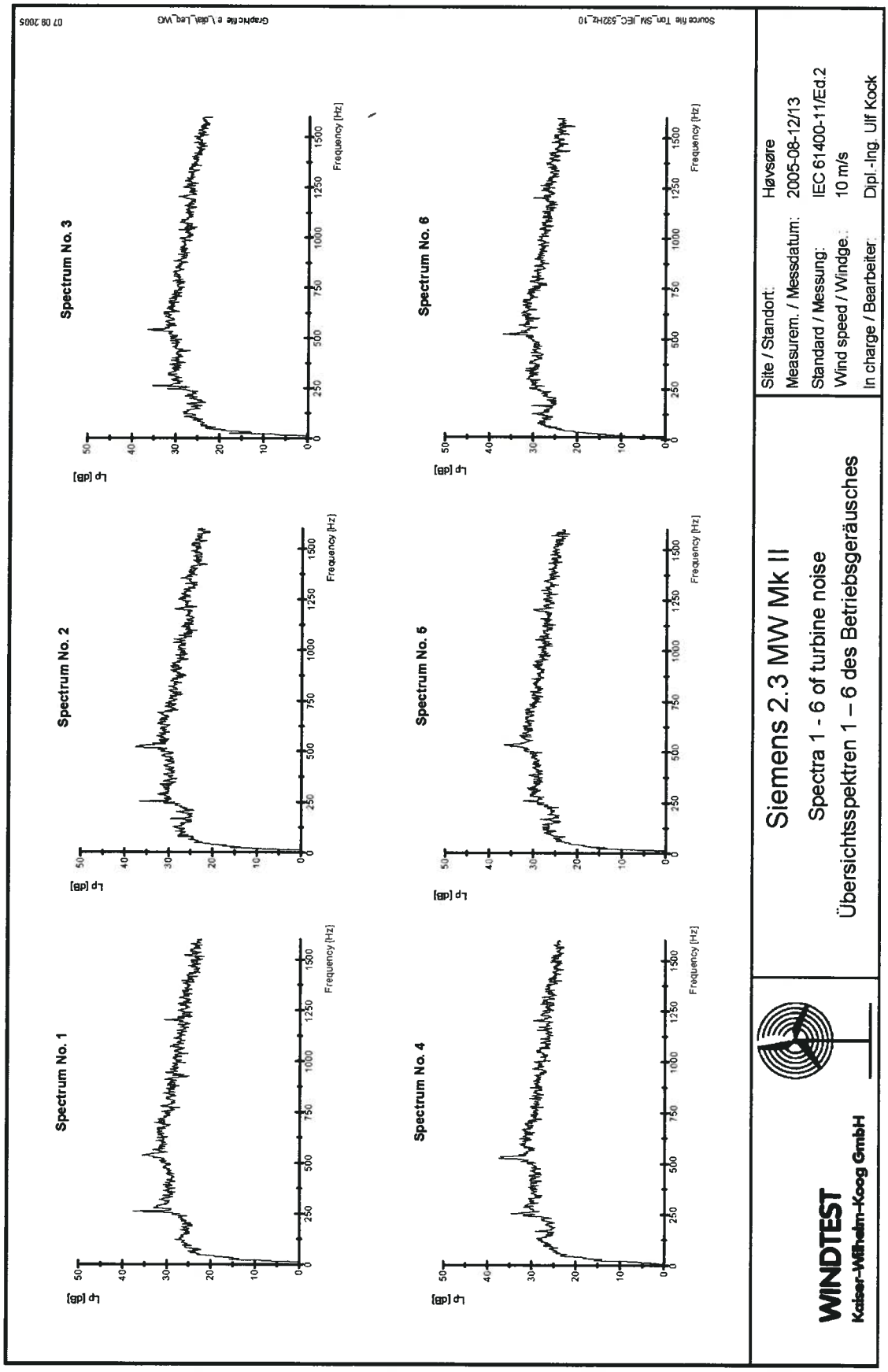
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

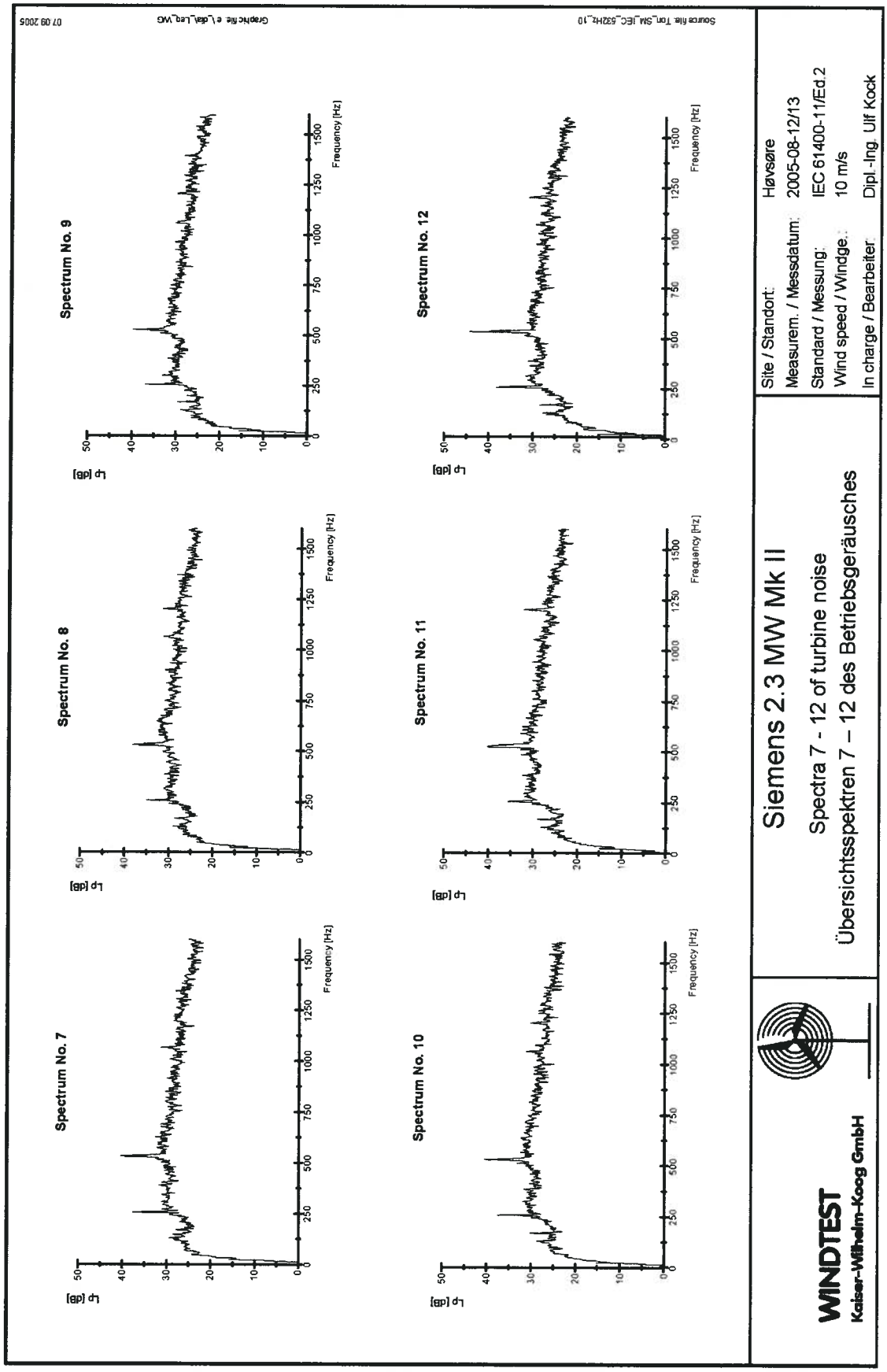
Analysis of tonality of turbine noise
Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	9 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 3.5a: Overview spectra 1-6 of turbine noise at a wind speed of 10 m/s



Annex 3.5b: Overview spectra 7-12 of turbine noise at a wind speed of 10 m/s



m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	536	2.00	31.80		47.81	-16.01	-2.34	-13.67
2	520	2.00	31.72		47.69	-15.97	-2.32	-13.65
3	540	2.00	31.75		47.77	-16.02	-2.34	-13.68
4	526	2.00	30.81	41.35	46.79	-5.44	-2.33	-3.12
5	534	2.00	31.98		47.99	-16.00	-2.34	-13.67
6	524	2.00	31.25		47.23	-15.98	-2.32	-13.65
7	534	2.00	31.08	43.89	47.08	-3.19	-2.34	-0.85
8	530	2.00	31.00	39.38	47.00	-7.62	-2.33	-5.29
9	528	2.00	31.53	40.32	47.52	-7.20	-2.33	-4.87
10	530	2.00	31.04	42.17	47.03	-4.87	-2.33	-2.53
11	526	2.00	31.04	44.67	47.03	-2.36	-2.33	-0.03
12	534	2.00	30.39	46.01	46.39	-0.39	-2.34	1.95

Energetic average of delta Lt (delta Lk) = -5.91 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.33 [dB]

Audibility, delta Lk - La (delta La,k) = -3.58 [dB]

Uncertainty of delta La,k (Ua) = 3.13 [dB]

Audibility greater than or equal to -3.0 dB ?: No

07.08.2005

Graphic file: a_ton_a_SMG

Source file: Ton_SM_IEC_532Hz_10

WINDTEST Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

Analysis of tonality of turbine noise

Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	10 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	536	2.00	31.80		47.81	-16.01	-2.34	-13.67
2	520	2.00	31.72		47.69	-15.97	-2.32	-13.65
3	540	2.00	31.75		47.77	-16.02	-2.34	-13.68
4	526	2.00	30.81	41.35	46.79	-5.44	-2.33	-3.12
5	534	2.00	31.98		47.99	-16.00	-2.34	-13.67
6	524	2.00	31.25		47.23	-15.98	-2.32	-13.65
7	534	2.00	31.08	43.89	47.08	-3.19	-2.34	-0.85
8	530	2.00	31.00	39.38	47.00	-7.62	-2.33	-5.29
9	528	2.00	31.53	40.32	47.52	-7.20	-2.33	-4.87
10	530	2.00	31.04	42.17	47.03	-4.87	-2.33	-2.53
11	526	2.00	31.04	44.67	47.03	-2.36	-2.33	-0.03
12	534	2.00	30.39	46.01	46.39	-0.39	-2.34	1.95

Energetic average of delta Lt (delta Lk) = -5.91 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.33 [dB]

Audibility, delta Lk - La (delta La,k) = -3.58 [dB]

Uncertainty of delta La,k (Ua) = 3.13 [dB]

Audibility greater than or equal to -3.0 dB ?: No

07.09.2005
Graphic file: a_Ton_ba_GWG
Source file: Ton_SM_IEC_532Hz_10

WINDTEST Kaiser-Wilhelm-Koog GmbH	Siemens 2.3 MW Mk II Analysis of tonality of turbine noise Tonhaltigkeitsbewertung des Betriebsgeräusches	Site / Standort: Høvsøre Measurem. / Messdatum: 2005-08-12/13 Standard / Messung: IEC 61400-11/Ed.2 Wind speed / Windge.: 10 m/s In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 4.1: A-weighted sound pressure 1/3-octave spectrum at 6 m/s

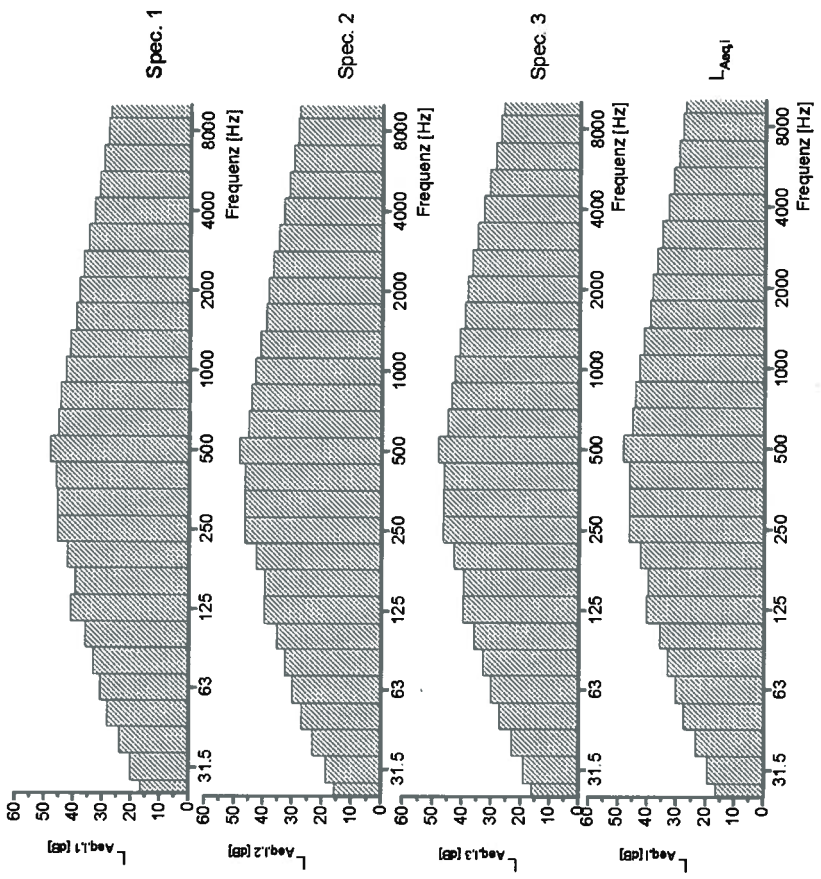
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 55.4 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 37.9 dB

reference sound power
Referenz - Schallleistung L_{WA} = 103.4 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 6 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	16.6	15.8	16.1	16.2	64.1	0.4	2.0
31.5	20.1	18.5	19.0	19.2	67.1	0.8	2.1
40	24.0	23.0	23.0	23.4	71.3	0.5	2.1
50	28.1	26.8	27.1	27.4	75.3	0.7	2.1
63	30.7	30.1	30.0	30.3	78.2	0.4	2.0
80	33.2	32.6	32.8	32.9	80.8	0.3	2.0
100	35.8	35.2	35.8	35.6	83.5	0.4	2.0
125	40.9	39.5	39.9	40.2	88.1	0.7	2.1
160	39.5	39.4	39.5	39.5	87.4	0.1	2.0
200	42.2	42.4	42.6	42.4	90.3	0.2	2.0
250	45.8	46.2	46.4	46.2	94.1	0.3	2.0
315	45.8	46.2	46.4	46.1	94.0	0.3	2.0
400	46.0	46.3	46.2	46.2	94.1	0.1	2.0
500	48.2	48.2	48.1	48.2	96.1	0.1	2.0
630	45.3	45.1	45.1	45.2	93.1	0.1	2.0
800	44.7	44.0	43.8	44.2	92.1	0.5	2.0
1000	42.9	42.8	42.7	42.8	90.7	0.1	2.0
1250	41.5	41.2	41.1	41.3	89.2	0.2	2.0
1600	39.4	39.2	39.1	39.3	87.2	0.2	2.0
2000	38.5	38.4	38.4	38.4	86.3	0.1	2.0
2500	36.9	36.8	36.8	36.8	84.7	0.1	2.0
3150	35.1	35.0	35.0	35.1	83.0	0.1	2.0
4000	33.2	33.1	32.8	33.0	80.9	0.2	2.0
5000	31.3	31.4	30.8	31.2	79.1	0.3	2.0
6300	29.9	30.0	29.0	29.6	77.5	0.6	2.1
8000	28.3	28.5	27.2	28.0	75.9	0.7	2.1
10000	27.6	27.9	26.2	27.3	75.2	0.9	2.2



Source file / Quelldatei: Terz_SM_IEC_8_eng
Graphic file / Grafikdatei: D:_dat\Terz_SM_IEC_8 07.09.2005

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort: Høvsøre
Measurem. / Messdatum: 2005-08-12/13
Standard / Messung: FGW / IEC
In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 4.1: A-weighted sound pressure 1/3-octave spectrum at 6 m/s

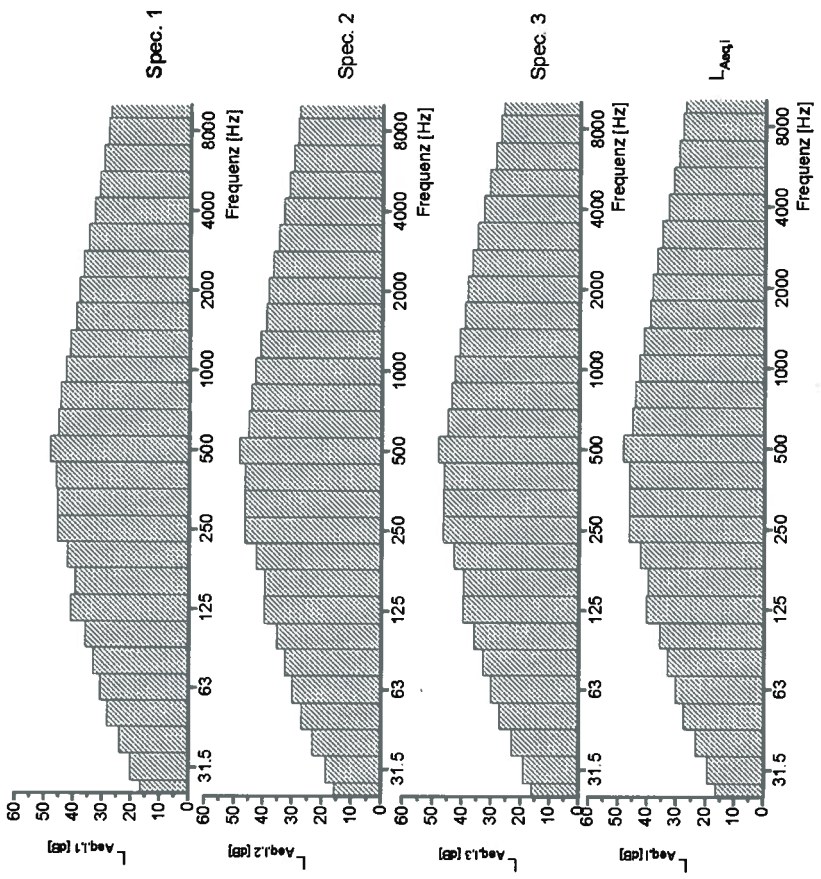
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 55.4 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 37.9 dB

reference sound power
Referenz - Schallleistung L_{WA} = 103.4 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 6 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	16.6	15.8	16.1	16.2	64.1	0.4	2.0
31.5	20.1	18.5	19.0	19.2	67.1	0.8	2.1
40	24.0	23.0	23.0	23.4	71.3	0.5	2.1
50	28.1	26.8	27.1	27.4	75.3	0.7	2.1
63	30.7	30.1	30.0	30.3	78.2	0.4	2.0
80	33.2	32.6	32.8	32.9	80.8	0.3	2.0
100	35.8	35.2	35.8	35.6	83.5	0.4	2.0
125	40.9	39.5	39.9	40.2	88.1	0.7	2.1
160	39.5	39.4	39.5	39.5	87.4	0.1	2.0
200	42.2	42.4	42.6	42.4	90.3	0.2	2.0
250	45.8	46.2	46.4	46.2	94.1	0.3	2.0
315	45.8	46.2	46.4	46.1	94.0	0.3	2.0
400	46.0	46.3	46.2	46.2	94.1	0.1	2.0
500	48.2	48.2	48.1	48.2	96.1	0.1	2.0
630	45.3	45.1	45.1	45.2	93.1	0.1	2.0
800	44.7	44.0	43.8	44.2	92.1	0.5	2.0
1000	42.9	42.8	42.7	42.8	90.7	0.1	2.0
1250	41.5	41.2	41.1	41.3	89.2	0.2	2.0
1600	39.4	39.2	39.1	39.3	87.2	0.2	2.0
2000	38.5	38.4	38.4	38.4	86.3	0.1	2.0
2500	36.9	36.8	36.8	36.8	84.7	0.1	2.0
3150	35.1	35.0	35.0	35.1	83.0	0.1	2.0
4000	33.2	33.1	32.8	33.0	80.9	0.2	2.0
5000	31.3	31.4	30.8	31.2	79.1	0.3	2.0
6300	29.9	30.0	29.0	29.6	77.5	0.6	2.1
8000	28.3	28.5	27.2	28.0	75.9	0.7	2.1
10000	27.6	27.9	26.2	27.3	75.2	0.9	2.2



Source file / Quelldatei: Terz_SM_IEC_8_eng
Graphic file / Grafikdatei: D:_dat\Terz_SM_IEC_8 07.09.2005

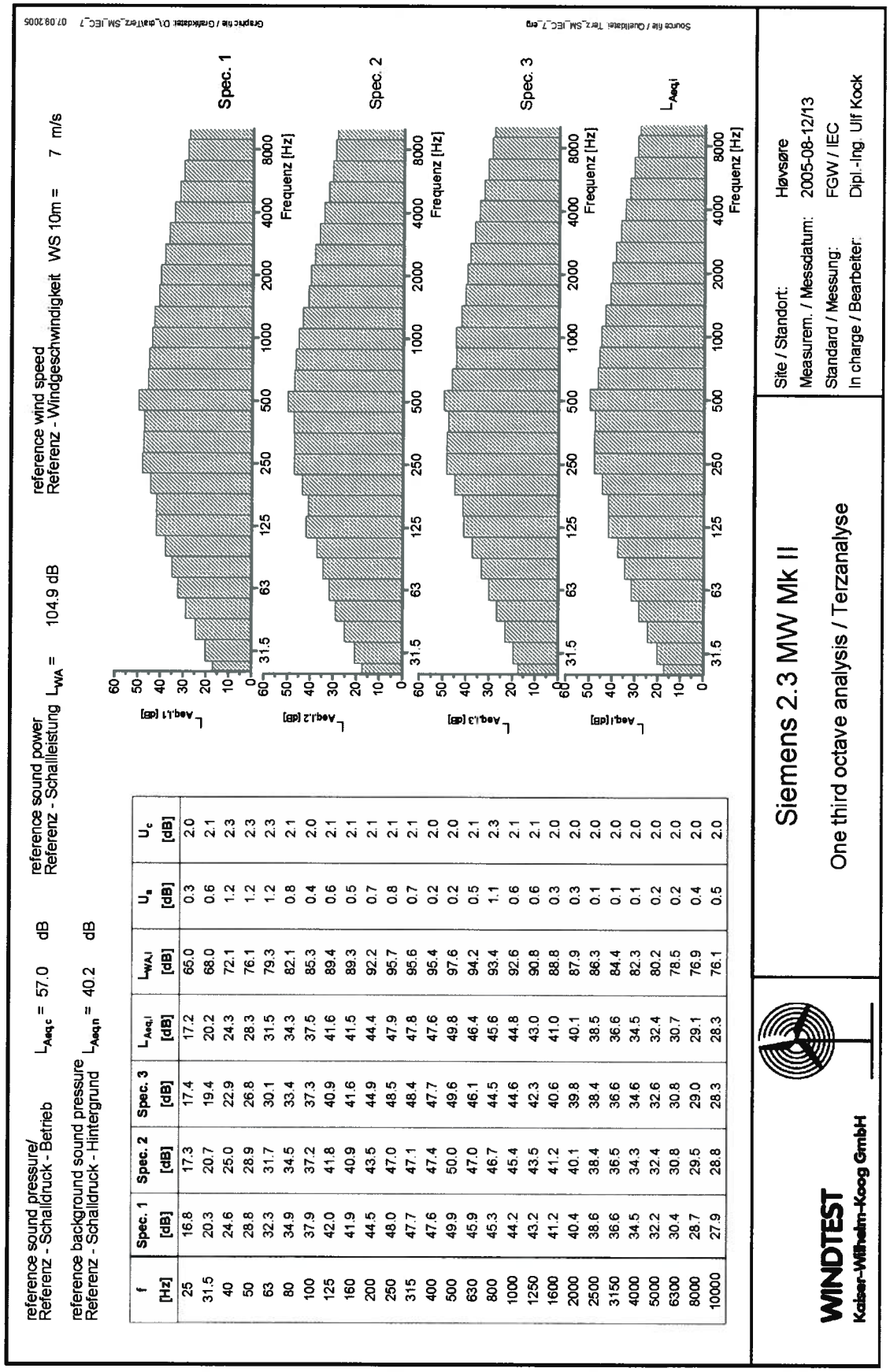
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort: Høvsøre
Measurem. / Messdatum: 2005-08-12/13
Standard / Messung: FGW / IEC
In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 4.2: A-weighted sound pressure 1/3-octave spectrum at 7 m/s



f	Spec. 1	Spec. 2	Spec. 3	$L_{Aeq,i}$	$L_{WA,i}$	U_e	U_c
[Hz]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
25	16.8	17.3	17.4	17.2	65.0	0.3	2.0
31.5	20.3	20.7	19.4	20.2	68.0	0.6	2.1
40	24.6	25.0	22.9	24.3	72.1	1.2	2.3
50	28.8	28.9	26.8	28.3	76.1	1.2	2.3
63	32.3	31.7	30.1	31.5	79.3	1.2	2.3
80	34.9	34.5	33.4	34.3	82.1	0.8	2.1
100	37.9	37.2	37.3	37.5	85.3	0.4	2.0
125	42.0	41.8	40.9	41.6	89.4	0.6	2.1
160	41.9	40.9	41.6	41.5	89.3	0.5	2.1
200	44.5	43.5	44.9	44.4	92.2	0.7	2.1
250	48.0	47.0	48.5	47.9	95.7	0.8	2.1
315	47.7	47.1	48.4	47.8	95.6	0.7	2.1
400	47.6	47.4	47.7	47.6	95.4	0.2	2.0
500	49.9	50.0	49.6	49.8	97.6	0.2	2.0
630	45.9	47.0	46.1	46.4	94.2	0.5	2.1
800	45.3	46.7	44.5	45.6	93.4	1.1	2.3
1000	44.2	45.4	44.6	44.8	92.6	0.6	2.1
1250	43.2	43.5	42.3	43.0	90.8	0.6	2.1
1600	41.2	41.2	40.6	41.0	88.8	0.3	2.0
2000	40.4	40.1	39.8	40.1	87.9	0.3	2.0
2500	38.6	38.4	38.4	38.5	86.3	0.1	2.0
3150	36.6	36.5	36.6	36.6	84.4	0.1	2.0
4000	34.5	34.3	34.6	34.5	82.3	0.1	2.0
5000	32.2	32.4	32.6	32.4	80.2	0.2	2.0
6300	30.4	30.8	30.8	30.7	78.5	0.2	2.0
8000	28.7	29.5	29.0	29.1	76.9	0.4	2.0
10000	27.9	28.8	28.3	28.3	76.1	0.5	2.0

Annex 4.3: A-weighted sound pressure 1/3-octave spectrum at 8 m/s

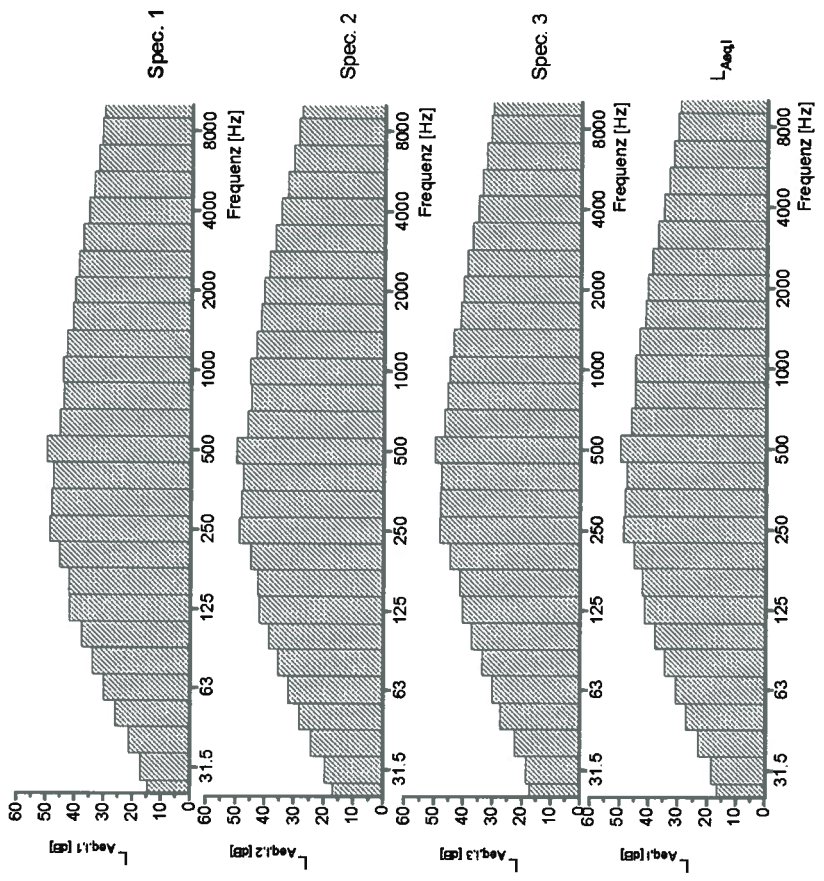
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 57.2 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 42.6 dB

reference sound power
Referenz - Schallleistung L_{WA} = 105.1 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 8 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	14.7	17.0	17.3	16.5	64.3	1.4	2.4
31.5	17.2	19.6	18.5	18.5	66.3	1.2	2.3
40	21.2	24.4	22.6	22.9	70.7	1.6	2.5
50	25.9	28.4	27.3	27.3	75.1	1.3	2.4
63	29.9	32.0	30.0	30.8	78.6	1.2	2.3
80	33.8	35.4	33.7	34.4	82.2	1.0	2.2
100	37.6	38.6	37.3	37.9	85.7	0.6	2.1
125	42.0	41.8	40.3	41.4	89.2	0.9	2.2
160	42.3	42.3	41.3	42.0	89.8	0.6	2.1
200	45.4	44.8	44.8	45.0	92.8	0.3	2.0
250	48.8	48.6	48.3	48.6	96.4	0.2	2.0
315	48.3	48.0	48.0	48.1	95.9	0.2	2.0
400	47.7	47.6	47.7	47.6	95.4	0.0	2.0
500	49.9	49.7	49.8	49.8	97.6	0.1	2.0
630	45.4	46.1	46.7	46.1	93.9	0.6	2.1
800	44.1	45.0	45.6	44.9	92.7	0.7	2.1
1000	44.5	45.2	45.0	44.9	92.7	0.4	2.0
1250	43.3	43.1	43.8	43.4	91.2	0.4	2.0
1600	41.2	41.6	41.3	41.4	89.2	0.2	2.0
2000	40.6	40.7	40.4	40.5	88.3	0.2	2.0
2500	39.2	39.0	39.0	39.1	86.9	0.1	2.0
3150	37.5	37.0	37.2	37.3	85.1	0.3	2.0
4000	35.5	34.9	35.4	35.3	83.1	0.4	2.0
5000	33.7	32.7	34.0	33.5	81.3	0.7	2.1
6300	32.5	30.7	32.6	32.0	79.8	1.1	2.2
8000	31.2	28.9	31.1	30.5	78.3	1.3	2.4
10000	30.4	28.0	30.4	29.7	77.5	1.4	2.4



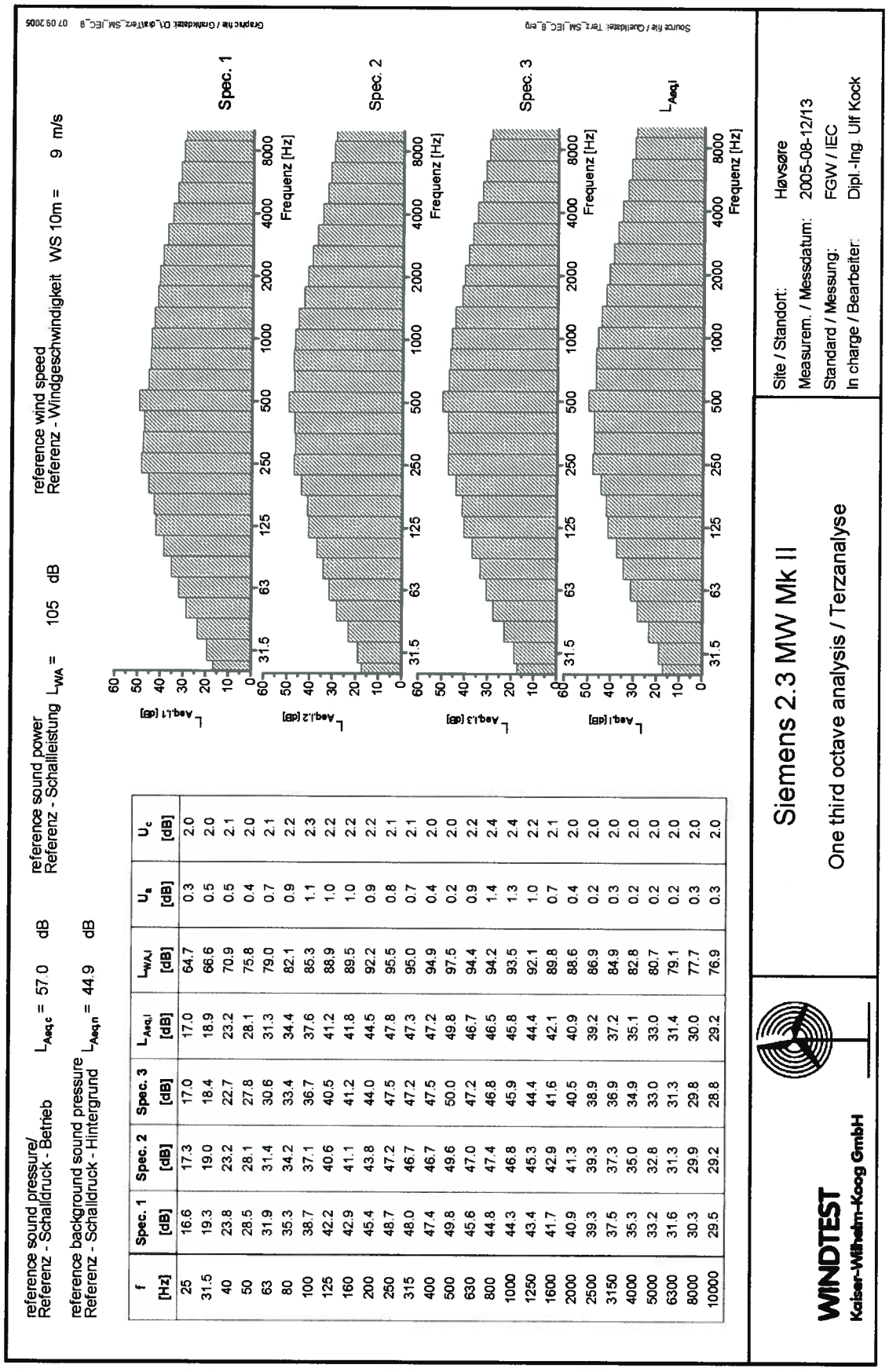
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort: Høvsøre
Measurem. / Messdatum: 2005-08-12/13
Standard / Messung: FGW / IEC
In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 4.4: A-weighted sound pressure 1/3-octave spectrum at 9 m/s



f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	16.6	17.3	17.0	17.0	64.7	0.3	2.0
31.5	19.3	19.0	18.4	18.9	66.6	0.5	2.0
40	23.8	23.2	22.7	23.2	70.9	0.5	2.1
50	28.5	28.1	27.8	28.1	75.8	0.4	2.0
63	31.9	31.4	30.6	31.3	79.0	0.7	2.1
80	35.3	34.2	33.4	34.4	82.1	0.9	2.2
100	38.7	37.1	36.7	37.6	85.3	1.1	2.3
125	42.2	40.6	40.5	41.2	88.9	1.0	2.2
160	42.9	41.1	41.2	41.8	89.5	1.0	2.2
200	45.4	43.8	44.0	44.5	92.2	0.9	2.2
250	48.7	47.2	47.5	47.8	95.5	0.8	2.1
315	48.0	46.7	47.2	47.3	95.0	0.7	2.1
400	47.4	46.7	47.5	47.2	94.9	0.4	2.0
500	49.8	49.6	50.0	49.8	97.5	0.2	2.0
630	45.6	47.0	47.2	46.7	94.4	0.9	2.2
800	44.8	47.4	46.8	46.5	94.2	1.4	2.4
1000	44.3	46.8	45.9	45.8	93.5	1.3	2.4
1250	43.4	45.3	44.4	44.4	92.1	1.0	2.2
1600	41.7	42.9	41.6	42.1	89.8	0.7	2.1
2000	40.9	41.3	40.5	40.9	88.6	0.4	2.0
2500	39.3	39.3	38.9	39.2	86.9	0.2	2.0
3150	37.5	37.3	36.9	37.2	84.9	0.3	2.0
4000	35.3	35.0	34.9	35.1	82.8	0.2	2.0
5000	33.2	32.8	33.0	33.0	80.7	0.2	2.0
6300	31.6	31.3	31.3	31.4	79.1	0.2	2.0
8000	30.3	29.9	29.8	30.0	77.7	0.3	2.0
10000	29.5	29.2	28.8	29.2	76.9	0.3	2.0

Annex 4.5: A-weighted sound pressure 1/3-octave spectrum at 10 m/s

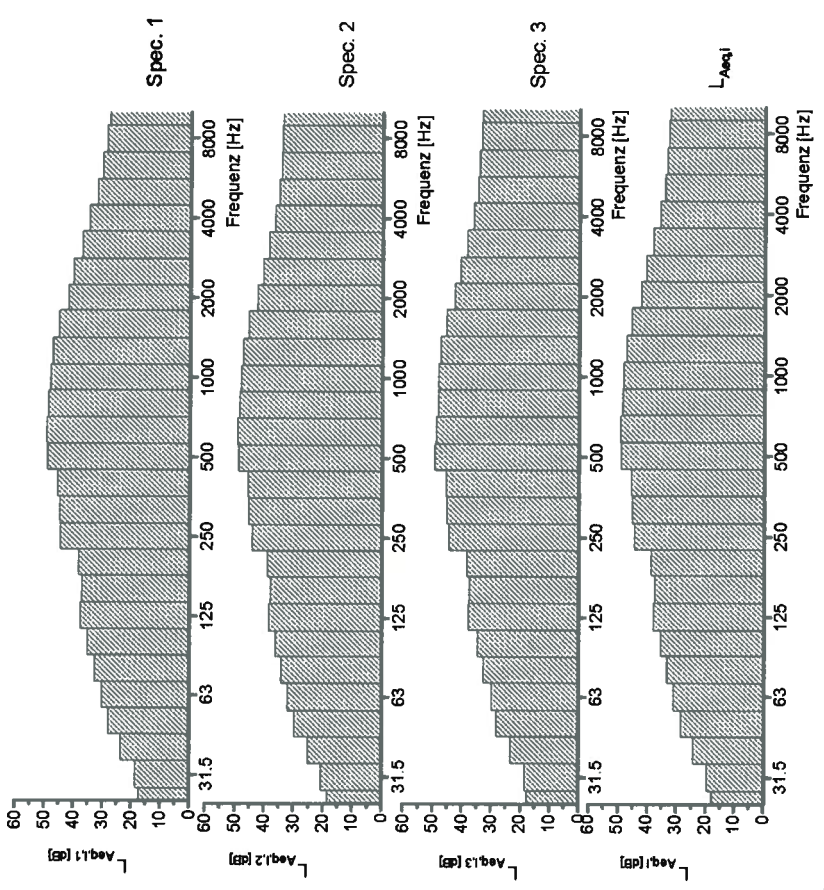
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 57.1 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 47.3 dB

reference sound power
Referenz - Schallleistung L_{WA} = 105 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 10 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	17.5	18.5	17.7	17.9	65.4	0.5	2.1
31.5	18.6	20.8	18.4	19.4	66.9	1.3	2.4
40	23.6	25.2	23.5	24.1	71.6	0.9	2.2
50	27.9	29.7	28.1	28.6	76.1	1.0	2.2
63	30.1	32.1	29.9	30.8	78.3	1.2	2.3
80	32.7	34.3	32.5	33.2	80.7	0.9	2.2
100	35.1	36.3	34.8	35.4	82.9	0.8	2.1
125	37.7	38.4	37.7	37.9	85.4	0.4	2.0
160	37.2	37.9	37.4	37.5	85.0	0.4	2.0
200	38.2	39.1	38.3	38.5	86.0	0.5	2.0
250	44.8	44.0	44.4	44.4	91.9	0.4	2.0
315	45.1	45.2	45.2	45.1	92.6	0.1	2.0
400	45.5	45.5	45.5	45.5	93.0	0.0	2.0
500	49.1	48.7	49.4	49.1	96.6	0.3	2.0
630	49.4	49.3	48.9	49.2	96.7	0.3	2.0
800	48.8	48.5	48.1	48.5	96.0	0.4	2.0
1000	48.3	48.0	48.2	48.2	95.7	0.1	2.0
1250	47.3	47.3	47.6	47.4	94.9	0.1	2.0
1600	45.3	45.5	45.5	45.4	92.9	0.1	2.0
2000	42.2	42.6	42.6	42.5	90.0	0.2	2.0
2500	40.3	40.8	40.8	40.6	88.1	0.3	2.0
3150	37.5	38.8	38.4	38.2	85.7	0.7	2.1
4000	34.8	36.6	36.4	36.0	83.5	1.0	2.2
5000	32.2	35.1	34.9	34.2	81.7	1.6	2.6
6300	30.3	34.5	34.3	33.4	80.9	2.4	3.1
8000	29.0	34.2	33.7	32.8	80.3	2.9	3.5
10000	27.9	34.0	33.4	32.4	79.9	3.4	3.9



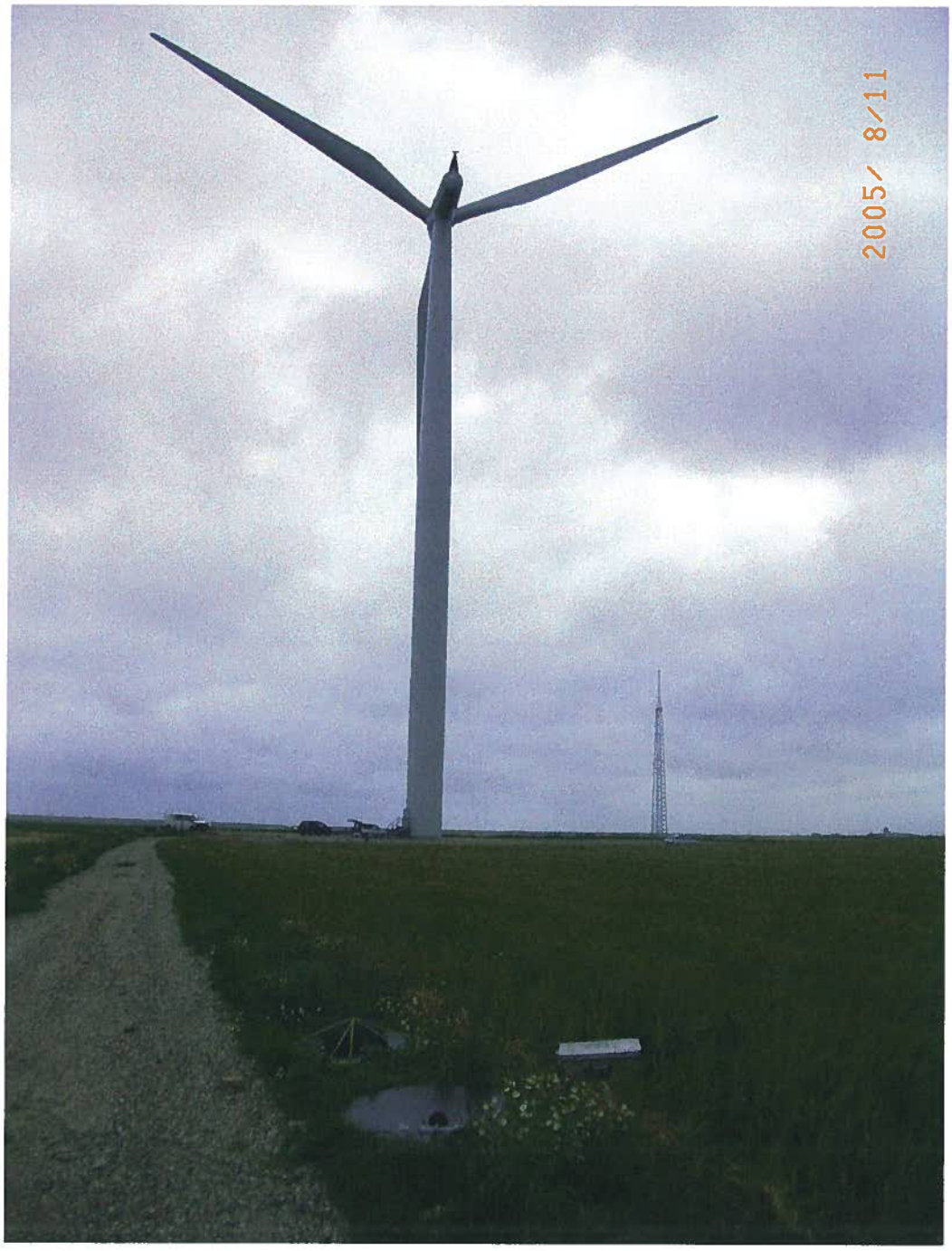
Source file / Quelldatei: Terz_SM_IEC_10_eng
Graphic file / Grafikdatei: D:\...dat\Terz_SM_IEC_10 07.09.2005

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort: Høvsøre
Measurem. / Messdatum: 2005-08-12/13
Standard / Messung: FGW / IEC
In charge / Bearbeiter: Dipl.-Ing. Ulf Kock



Picture from the board in direction of the WTGS

Picture of microphone and board

Bonus 2.3 MW Mk II, 1.225 kg/m3 Sales Power Curve, Preliminary

The calculated power curve data are valid for the above air density conditions, clean rotor blades, and horizontal, undisturbed air flow with 10% turbulence intensity.

Wind [m/s]	Power [kW]
0	0
1	0
2	0
3	0
4	65
5	180
6	352
7	590
8	906
9	1308
10	1767
11	2085
12	2234
13	2283
14	2296
15	2299
16	2300
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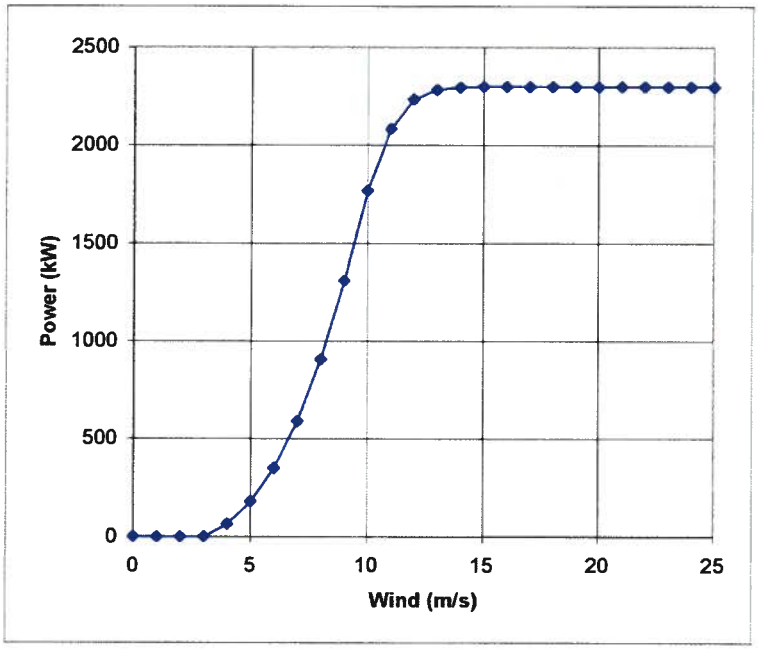
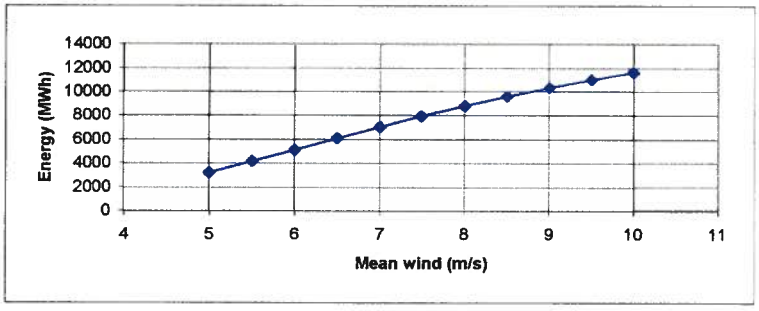
21	2300
22	2300
23	2300
24	2300
25	2300



The annual energy production data for different annual mean wind speeds in hub height are calculated from the above power curve assuming a Rayleigh wind speed distribution, 100 percent availability, and no reductions due to array losses, grid losses, or other external factors affecting the production.

Wind [m/s]	Energy [MWh]
5.0	3238
5.5	4179
6.0	5134
6.5	6089
7.0	7037
7.5	7926
8.0	8792
8.5	9580
9.0	10324
9.5	11002
10.0	11616



Herstellerbescheinigung zu spezifischen Daten der Anlage vom Typ
Manufacturer's certificate on specific data of the type of installation

Datum / date: 22/08/2005

1. Allgemeines		General
Hersteller	Siemens Wind Power A/S	manufacturer
Anlagenbezeichnung	2.3 MW mkII	type name
Art (horizontale/vertikale Achse)	Horizontal	type (horizontal / vertical axis)
Nennleistung	2300 kW	rated power
Nabenhöhe über Grund	80 m	hub height above ground
Nabenhöhe über Fundamentflansch	80 m	hub height above top of foundation flange
Nennwindgeschwindigkeit	12 m/s	rated wind speed
Ein- und Ausschaltwindgeschwindigkeit	3/25 m/s	cut-in and cut-out wind speed
Beitrag zum Kurzschlussstrom	appr. 2.5 kA	contribution to short circuit current
2. Rotor		**Rotor**
Durchmesser	92.4 m	diameter
Bestrichene Fläche	6706 m²	swept area
Anzahl der Blätter	3	number of blades
Nabenart (pendelnd/starr)	Rigid	kind of hub (teetered/rigid)
Anordnung zum Turm (luv/lee)	Luv	relative position to tower (luv/lee)
Nenndrehzahl / -bereich	6,1-18,4 U/min / rpm	rated speed / speed range
Auslegungsschnellaufzahl	___	design tip speed ratio
Rotorblatteinstellwinkel	-2 to 82° Pitch controlled	rotor blade pitch setting
Konuswinkel	2°	cone angle
Achsneigung	6°	tilt angle
Abstand Rotorflanschmittelpunkt - Turmmittellinie	3.5 m	distance between rotor flange centre and tower centre line
3. Blatt		**Blade**
Hersteller	Siemens Wind Power A/S	manufacturer
Typenbezeichnung	B45	type
Profile innen/außen	FFAW3/ NACA63-6xx	blade section inner/outer
Material	GRE	material
Länge	45 m	length
Profiltiefe max./min.	3.35 m/ 0.7 m	chord length (max./min.)
Zusatzkomponenten (z.B. stall strips, Vortex-Generatoren, Turbulatoren)	Vortex generator	additional components (e.g. stall strips, vortex generators, trip strips)
Extenderlänge	N/A	extender length
4. Getriebe		**Gear**
Hersteller	Flender	manufacturer
Typenbezeichnung	PEAB 4456	type
Ausführung	Planetary/helical	design
Übersetzungsverhältnis	1 : 90.84	speed ratio
5. Generator		**Generator**
Hersteller	ABB	manufacturer
Typenbezeichnung	AMA500L4A	type
Anzahl	1	numbers
Art	Asynchronous	design
Nennleistung(en)	2400 kW	rated power (s)
Nennscheinleistung	2690 kVA	rated apparent power
Nenndrehzahlen oder Drehzahlbereich	600-1800 1/min rpm	rated speed (s)/ speed range
Spannung	750 V @1550rpm	voltage
Frequenz	20-60 Hz	frequency
Nennschlupf	___ %	rated slip
6. Turm		**Tower**
Hersteller		manufacturer
Typenbezeichnung	DSSM04	type
Ausführung (Gitter/Rohr, zyl./kon.)	Tapered turbular	design (lattice/tubular, cylindrical/ conical)
Material	S355	material
Länge	78 m	length

Annex 7b: Manufacturer's certificate, page 2

7. Windrichtungsnachführung		**Yaw control**
Ausführung (aktiv/Passiv)	Active	design (active/passive)
Antriebsart (el./mech./hydr.)	Electrical	drive (electr./mech./hydr.)
Dämpfungssystem während des Betriebes	Friction	damping system during operation
8. Betriebsführung/ Regelung		**Other electric installations**
Art der Leistungsregelung	Pitch control	kind of power control
Antrieb der Leistungsregelung	Blade pitch	actuation of power control
Hersteller der Betriebsführung/ Regelung	KK-electronic	manufacturer of control system
- Typenbezeichnung	WTC 3	- type
- Verwendete Steuerungskurve		- applied used control characteristics
9. Sonstige elektrische Komponenten		**Other electric installations**
Anzahl der Kompensationsstufen	Controlled by use of 4 quadrant frequency converter	number of compensation stages
Blindleistung Stufe 1	___ kvar	reactive power stage 1
Art der Netzkopplung	Connected by use of frequency conv.	kind of interconnection
- Hersteller	Alstom	- manufacturer
- Typenbezeichnung	4 quadrant frequency conv.	- type
Netzschutzhersteller	KK	mains protective manufacturer
- Typenbezeichnung	_____	- type
- Einstellbereiche:		- adjustment ranges:
Spannungssteigerungsschutz	759 V line-line	overvoltage protection
Spannungsrückgangsschutz	621 V line-line for more than 3 sec.	undervoltage protection
Frequenzsteigerungsschutz	51,5 Hz	overfrequency protection
Frequenzrückgangsschutz	47,5 Hz	underfrequency protection
Typenbezeichnung der Abschalteinheit	Short circuit breaker	type of contact break device
Oberschwingungsfilter (Ja/Nein)	Yes	harmonic filter (yes/no)
(Oberschwingungsfilter müssen auf den Netzverknüfpungspunkt ausgelegt sein.)		(harmonic filter have to be designed for the point of common coupling)
10. Bremssystem		**Brake system**
Bremssystem (primär/sekundär)	Blade / Mech. brake	brake system (primary/secondary)
- Aktivierung	Hydraulic	- activation
- Anordnung	Hydraulic	- location
- Bremsenart	Pitch blade/ brake disc	- type
- Betätigung	Active / Passive	- actuation
11. Typenprüfung		**Type test**
Prüfbehörde	DNV	testing authority
Aktenzeichen	_____	reference
12. Informativer Teil		**Informative**
Standort der vermessenen WEA	Høvsøre DK	location of measured WTGS
Koordinaten des Standorts	_____	coordinate of location
Seriennummer der WEA	2300439	Serial number of WTGS
der Blätter	1001/ 1002/ 1003	blades
des Getriebes	4803384-020-1	gearbox
des Generators	457691	generator

Anschrift des Herstellers

Address of manufacturer

SIEMENS

Siemens Wind Power A/S
Postbox 171 - Borupvej 16
DK-7330 Brande - Denmark
tel.: +45 9942 2222

22.8.05

Stempel, Unterschrift
stamp, signature

Der Hersteller der Windenergieanlage bestätigt, daß die WEA, deren Schallemission, Leistungskurve und elektrischen Eigenschaften in den Prüfberichten abgebildet ist, hinsichtlich ihrer technischen Daten mit den o.g. Positionen identisch ist.

The manfacturer of the wind turbine generator system confirms that the WTGS whose noise level, power curve and grid compatability is measured and depicted in the test report xxxxxxx is identical with the above entries with regard to its technical data.

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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

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Borupvej 16
7330 Brande, Denmark
www.siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

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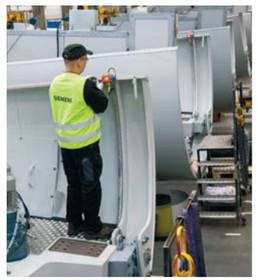
Siemens has been a major driver of innovation in the wind power industry since the early 1980s when wind turbine technology was still in its infancy.

Technology has changed with the times, but Siemens' commitment to providing its customers with proven wind turbine solutions remains the same.

The combination of robust and reliable turbines, highly efficient solutions for power transmission and distribution and a deep understanding of the entire energy market ensures that Siemens will continue to be a leading supplier.

Siemens' record, when it comes to on-time delivery, is impeccable. Long-lasting customer relationships, based on the successful installation of wind turbines, provide for a sound, sustainable and profitable investment.

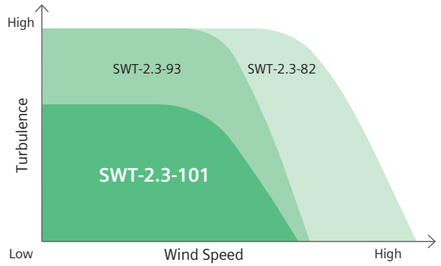
Drawing on 140 years of experience in the energy sector, a strong focus on renewables and a global network of highly skilled and trained employees, Siemens has proven itself to be a trustworthy and reliable business partner. And will continue to be in the future.



Harvest more energy from sites with moderate wind conditions

The Siemens SWT-2.3-101 turbine is designed to deliver unparalleled performance and reliability, making it especially suited to areas with moderate wind conditions.

Siemens has the right turbines for all wind conditions



The SWT-2.3-101 turbine offers low energy production costs, and joins Siemens' 2.3-MW product family, which has proven availabilitity that is among the highest in the industry. The 101-meter rotor is specifically designed to optimize the energy output in areas with moderate wind conditions. The turbine is also ideal for all types of grid connections in most major markets.

The SWT-2.3-101 is designed to last. The robust and reliable design offers a high yield with low maintenance costs. The turbine is backed by advanced condition monitoring and diagnostics, which constantly examine the turbine. Any change in a turbine's performance is promptly addressed by an experienced after-sales service team either remotely or in the field.

If you desire a better return on investment and superior availability, take a closer look at the SWT-2.3-101 turbine.

Superior performance gives higher yields

Optimum energy at moderate wind conditions

Harvesting more energy
The SWT-2.3-101 wind turbine is designed to increase the energy returns from sites with moderate wind conditions. Advanced blade technology also allows for quieter operation. The B49 blade with a rotor diameter of 101 meters and pitch regulation optimizes power output and increases control over the energy output.

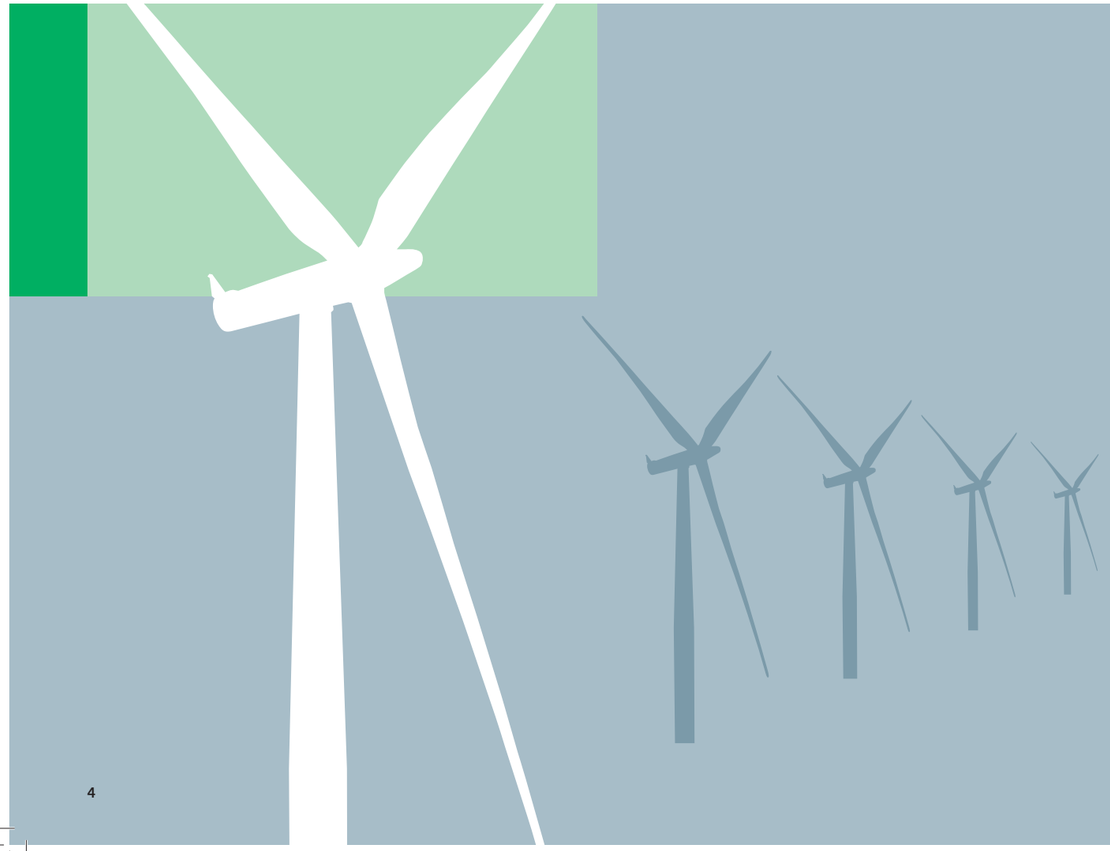
High availability
Currently, the Siemens fleet of 2.3-MW wind turbines sets the industry standard for availability. The SWT-2.3-101 will build on the reputation for reliability that the market has come to expect from a Siemens Wind turbine.

High yield with minimal maintenance
Siemens optimizes the return on investment in its wind turbines through intelligent maintenance that ensures the turbine to deliver high yield with low operational costs.

The rugged structural design, combined with an automatic lubrication system, internal climate control and a generator system without slip rings contributes to exceptional reliability. The innovative design of the SWT-2.3-101 allows for longer service intervals.

Superior grid compliance
The Siemens NetConverter® system is designed for maximum flexibility in the turbine's response to voltage and frequency variations, fault ride-through capability and output adjustment. The advanced wind farm control system provides state-of-the-art fleet management.

Proven track record
Siemens has a proven track record of providing reliable turbines that last. The world's first offshore wind farm in Vindeby, Denmark, was installed in 1991 and is still fully operational. In California, Siemens installed over 1,100 turbines between 1983 and 1990, with 97% still in operation today. Siemens takes its commitment to reliability seriously and prides itself on the long lifespan that its turbines have demonstrated.



No compromise on reliability

SWT-2.3-101: Newest member of the extremely reliable product family

Designed for life
Siemens turbines are designed to last. The robust design of the SWT-2.3-101 allows for trouble-free output throughout the complete lifecycle of the turbine.

The blades are made of fiberglass-reinforced epoxy in Siemens' proprietary IntegralBlade® manufacturing process. The blades are cast in one piece in a closed process, which eliminates the traditional weaknesses found at glue joints in other manufacturers' blades. Like the turbine itself, the blades are designed to last.

Climate control within the turbine protects vital equipment from the outside environment. The turbine also offers controlled-wear strategies for critical components, which results in a further reduction of maintenance costs.

Safety first
Safety is at the heart of all Siemens operations. From production to installation, operation and service, Siemens strives to set the standard in safety.

The fail-to-safe capabilities within a turbine, combined with Siemens' superior lightning protection system, are designed to enhance security for the turbine.

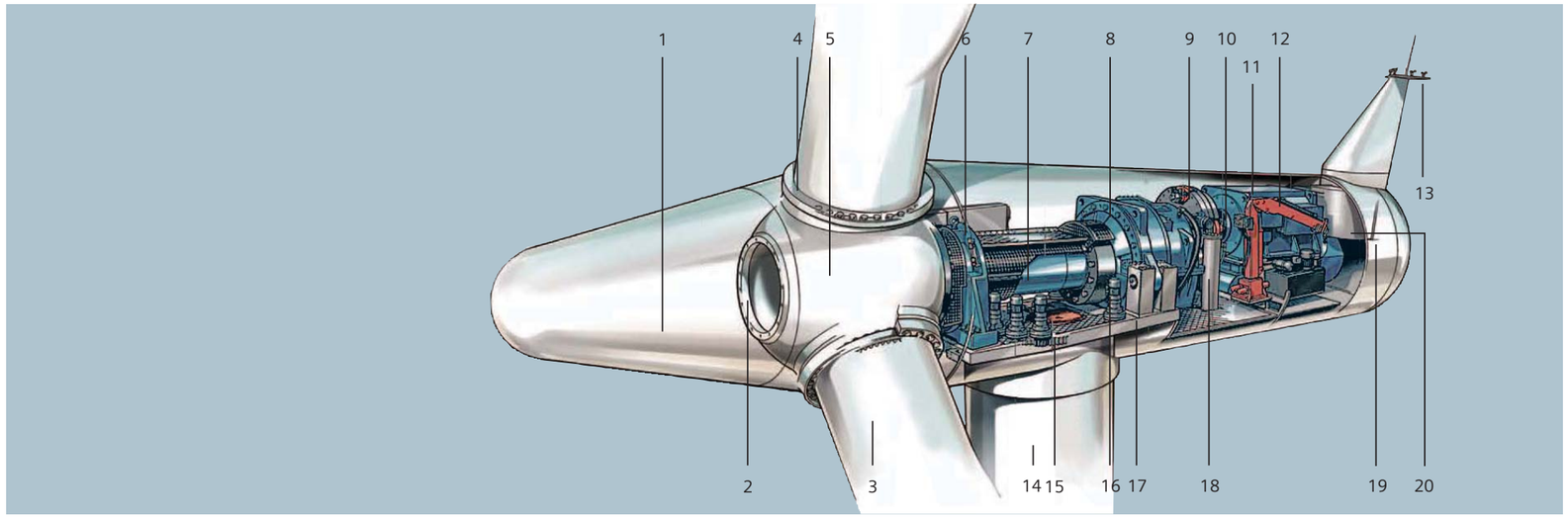
Advanced operations support
Given the logistical challenges associated with servicing wind farms, Siemens has equipped its turbines with a Turbine Condition Monitoring (TCM) system that reduces the need for on-site servicing.

Continuous monitoring of turbines allows for the discovery of small faults before they become major problems.

The TCM system continuously checks the external and internal condition of the wind turbine. Twenty-four hours a day, seven days a week precise measurements are taken of vibrations in the gearbox, the generator and the main shaft bearings. The system instantly detects deviations from normal operating conditions.

Using the knowledge gained from monitoring thousands of turbines over the years, Siemens' experts are exceptionally skilled at analyzing and predicting faults within a turbine. This allows Siemens to proactively plan the service and maintenance of the turbines as each fault can be categorized and prioritized based on the severity of the fault. Siemens can then determine the most appropriate course of action to keep the turbine running at its best.

Technical specifications



Rotor	
Diameter	101 m
Swept area	8,000 m²
Rotor speed	6-16 rpm
Power regulation	Pitch regulation with variable speed

Blades	
Type	B49
Length	49 m

Aerodynamic brake	
Type	Full-span pitching
Activation	Active, hydraulic

Transmission system	
Gearbox type	3-stage planetary/helical
Gearbox ratio	1:91
Gearbox oil filtering	Inline and offline
Gearbox cooling	Separate oil cooler
Oil volume	Approximately 400 l

Mechanical brake	
Type	Hydraulic disc brake

Generator	
Type	Asynchronous
Nominal power	2,300 kW
Voltage	690 V
Cooling system	Integrated heat exchanger

Yaw system	
Type	Active

Monitoring system	
SCADA system	WebWPS
Remote control	Full turbine control

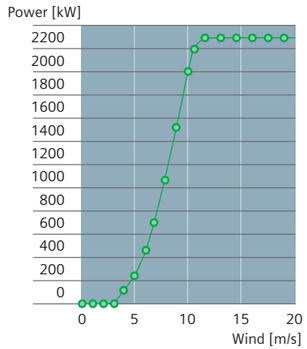
Tower	
Type	Cylindrical and/or tapered tubular
Hub height	80 m or site-specific

Operational data	
Cut-in wind speed	3-4 m/s
Rated power at	12-13 m/s
Cut-out wind speed	25 m/s
Maximum 3 s gust	55 m/s (standard version)
	60 m/s (IEC version)

Weights	
Rotor	62 tons
Nacelle	82 tons
Tower for 80-m hub height	162 tons

Sales power curve

The calculated power curve data are valid for standard conditions of 15 degrees Celsius air temperature, 1013 hPa air pressure and 1.225 kg/m³ air density, clean rotor blades and horizontal, undisturbed air flow. The calculated curve data are preliminary.



Nacelle arrangement

1. Spinner
2. Spinner bracket
3. Blade
4. Pitch bearing
5. Rotor hub
6. Main bearing
7. Main shaft
8. Gearbox
9. Brake disc
10. Coupling
11. Generator
12. Service crane
13. Meteorological sensors
14. Tower
15. Yaw ring
16. Yaw gear
17. Nacelle bedplate
18. Oil filter
19. Canopy
20. Generator fan

SWT-2.221-101 Low Noise, Hub Height 99.5 m Acoustic Emission

Sound Power Levels

The warranted sound power levels are presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 1.661 m as described in the IEC code. The sound power levels (Lwa) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Up to cut-out**
Sound Power Level	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table 1: Noise emission, Lwa [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound Power Level	82.6	93.8	97.0	99.5	99.6	97.1	89.3	84.9

Table 2: Typical octave band for 6 m/s

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound Power Level	82.4	93.0	96.0	99.8	100.1	96.5	89.6	85.7

Table 3: Typical octave band for 8 m/s

SWT-2.126-101 Low Noise, Hub Height 99.5 m Acoustic Emission

Sound Power Levels

The warranted sound power levels are presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 1.800 m as described in the IEC code. The sound power levels (Lwa) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Up to cut-out**
Sound Power Level	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0

Table 1: Noise emission, Lwa [dB(A) re 1 pW]

Typical Octave Band

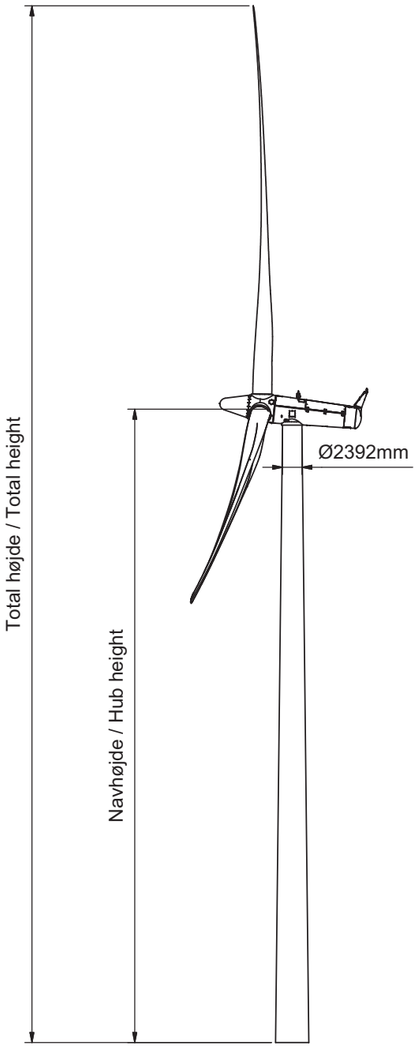
Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

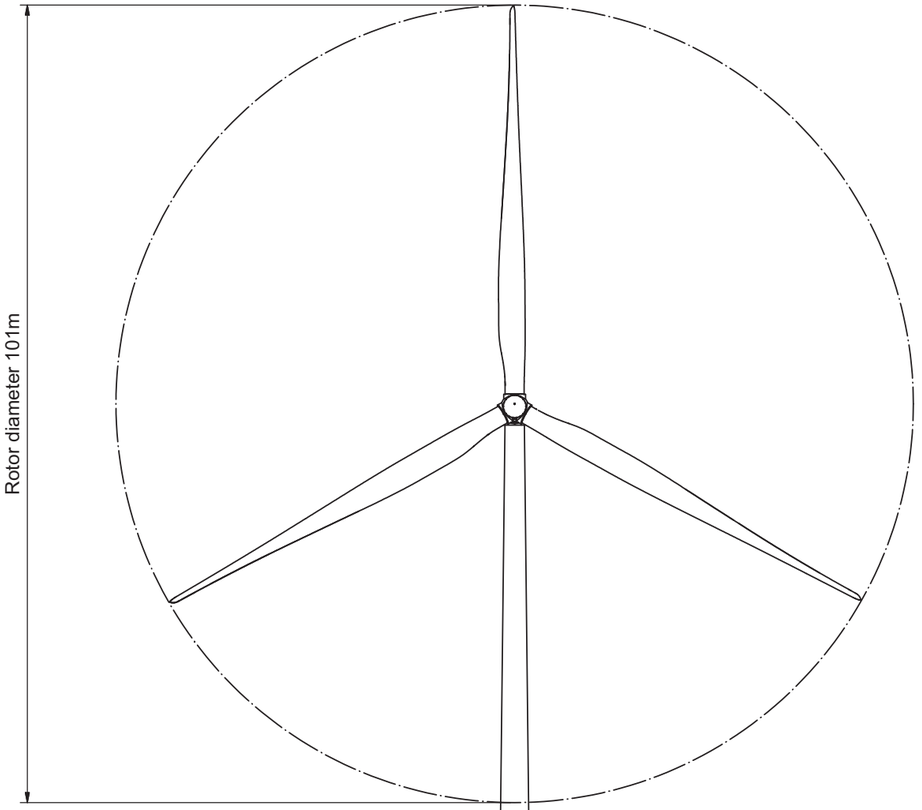
Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound Power Level	83.1	94.1	96.6	97.8	97.9	96.5	88.4	84.0

Table 2: Typical octave band for 6 m/s

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound Power Level	82.2	92.5	94.8	98.5	99.1	95.5	89.0	85.1

Table 3: Typical octave band for 8 m/s





SWT-2.3-101			
Total height	130.500m	140.500m	150.000m
Hub height	80.000m	90.000m	99.500m
Tower height	78.540m	88.540m	98.040m
Tower top diameter	2392mm	2392mm	2392mm
Tower bottom diameter	4200mm	4200mm	3960mm

030209	30373	AWO/HAS
Dato: Date:	ECN nr.: ECN no.:	Init: Init:

Vægt ca.: Weight app.:

Matr.: Matr.:

Emne: Part:

Opstalt SWT-2.3-101
Elevation SWT-2.3-101

Tegn. format: Draw. format: A2

ISO

SIEMENS

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Tegn. skala/Draw. scale: 1:500

Tegn. nr./Draw. no.: 1005651

Turbine ID	UTM_X	UTM_Y	DATUM
1	607287	4746785	NAD83, UTM Zone 17
2	605035	4746639	NAD83, UTM Zone 17
3	606942	4746830	NAD83, UTM Zone 17
4	604861	4746993	NAD83, UTM Zone 17
5	602757	4745791	NAD83, UTM Zone 17
6	606513	4747319	NAD83, UTM Zone 17
7	608495	4747949	NAD83, UTM Zone 17
8	607477	4747512	NAD83, UTM Zone 17
9	600290	4745005	NAD83, UTM Zone 17
10	593994	4748442	NAD83, UTM Zone 17
11	603472	4748075	NAD83, UTM Zone 17
12	601479	4747111	NAD83, UTM Zone 17
13	594663	4751618	NAD83, UTM Zone 17
14	603952	4750047	NAD83, UTM Zone 17
15	608232	4749798	NAD83, UTM Zone 17
16	594352	4749960	NAD83, UTM Zone 17
17	598648	4747922	NAD83, UTM Zone 17
18	587941	4753452	NAD83, UTM Zone 17
19	606366	4749368	NAD83, UTM Zone 17
20	592573	4749463	NAD83, UTM Zone 17
21	602692	4746290	NAD83, UTM Zone 17
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24	592280	4749799	NAD83, UTM Zone 17
25	599133	4750265	NAD83, UTM Zone 17
26	607589	4749481	NAD83, UTM Zone 17
27	598999	4748313	NAD83, UTM Zone 17
28	591339	4752273	NAD83, UTM Zone 17
29	599967	4750467	NAD83, UTM Zone 17
30	606959	4749603	NAD83, UTM Zone 17
33	589588	4755581	NAD83, UTM Zone 17
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35	602880	4749652	NAD83, UTM Zone 17
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37	602481	4749039	NAD83, UTM Zone 17
38	602608	4749469	NAD83, UTM Zone 17
39	603875	4749401	NAD83, UTM Zone 17
40	604239	4749614	NAD83, UTM Zone 17
41	590395	4753879	NAD83, UTM Zone 17
42	600381	4750377	NAD83, UTM Zone 17
43	588466	4752970	NAD83, UTM Zone 17
44	599489	4748483	NAD83, UTM Zone 17
45	590085	4753880	NAD83, UTM Zone 17
46	590582	4751836	NAD83, UTM Zone 17
47	604740	4750499	NAD83, UTM Zone 17
48	594126	4750504	NAD83, UTM Zone 17

49	608750	4749784	NAD83, UTM Zone 17
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51	601762	4745085	NAD83, UTM Zone 17
52	599708	4748016	NAD83, UTM Zone 17
53	600301	4748359	NAD83, UTM Zone 17
54	607370	4746400	NAD83, UTM Zone 17
55	600136	4746677	NAD83, UTM Zone 17
56	598675	4750335	NAD83, UTM Zone 17
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62	614680	4748176	NAD83, UTM Zone 17
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