SUBJECT AREA: **Vegetation and Wetlands, None**

REFERENCE: **Chapter 10, Section 10.3**

QUESTION:

The Forest Resource Inventory (FRI) data were used to map wetlands but these data underrepresent wetland vegetation (e.g. Table 10-7). Additional data sets and wetland classifications were used to supplement the FRI data. The methods of integrating the different wetland data sets and classification systems were unclear (p. 10-15).
Please clarify how the analysis was completed and how the field data were used to verify or correct the results. Is the resultant classification adequate to assess potential impacts on wetlands?

RESPONSE:

The Forest Resource Inventory (FRI) data was used to assess project effects to Vegetation and Wetlands. The FRI data was not altered from the original source (FRI 2000), however, more detailed vegetation and wetland cover class mapping was completed for the Project Development Area (PDA). Available public information and project field survey data was used to refine FRI mapping for the PDA and generate more detailed vegetation and wetland cover class mapping at a scale of 1:3,000. The data sources used to complete the detailed mapping are identified in Chapter 10, section 10.3.1.1 of the EIS. FRI polygons were reviewed against these data and map polygon boundaries and cover classifications were revised as needed. This included review against more recent air photography from multiple years and the addition of swamp wetlands. Vegetation field survey photographs, species data and cover type classification data, along with soils survey data was used to revise map polygon boundaries and classifications for field surveyed locations.

The map classification is adequate to assess potential project effects to wetlands as it identifies all potential wetlands equaling 0.04ha or larger within the PDA. The classification of wetlands within the PDA follows the Canadian Wetland Classification System (National Wetlands Working Group 1997) and Stewart and Kantrud (1971), both of which are commonly used and accepted wetland classification systems.

References:

FRI (Forest Resource Inventory). 2000. Comprehensive Inventory of Forest Resources. FRI, Winnipeg. Available at: http//mli2.gov.mb.ca/forestry/index.html. Accessed November 2014.

National Wetlands Working Group. 1997. The Canadian Wetland Classification System. Second Edition. Warner, B.G. and C.D.A. Rubec eds. University of Waterloo, Waterloo, Ontario.

Stewart, R.E. and H.A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Resource Publication 92. Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center.

SUBJECT AREA: **Vegetation and Wetlands, None**

REFERENCE: **Chapter 10, Section 10.5**

QUESTION:

The claim that “effects on wetlands of transmission lines have been shown to be limited” (p. 10-10) cites Stantec Consulting Ltd. (2014) and is not well supported. The creation of a ROW and use of equipment in a wetland is a potential cause of disrupted hydrology, particularly in fens, which depend on shallow groundwater flow. Winter operations can reduce soil compaction and rutting if the ground is deeply frozen. The Forest Resource Inventory underrepresents wetland vegetation (e.g. p. 10-78) and no fen vegetation was sampled in the field even though this wetland class is highly variable and dependent on shallow ground water flow.
Please elaborate on how sensitive wetland sites will be identified and how rutting and soil compaction will be prevented in wetlands especially if construction takes place when the ground is not deeply frozen.

RESPONSE:

Chapter 10, Section 10.4.3 describes how land cover mapping was refined for the Project Development Area to address wetland underrepresentation that results from relying on the FRI dataset alone. Differences between both FRI and the more detailed imagery analysis are provided in Table 10-6 and 10-7. Wetland class, type and boundaries were reviewed and interpreted at a 1:3,000 scale for the Project Development Area, enabling the identification of sensitive wetland sites for mitigation planning purposes. More details about how the wetland sites were identified can be found in the Vegetation and Wetlands Technical Report Section 2.4 Wetland Cover Classes (Pages 2.29-2.36).

If construction were to take place on non-frozen wetlands, construction matting would be a mitigation method utilized to reduce the effects of soil compaction and rutting.

SUBJECT AREA: **Vegetation and Wetlands, None**

REFERENCE: **Chapter 10, Section 10.4**

QUESTION:

The occurrences of invasive plants are probably underrepresented. No targeted searches for invasive plants were completed and historical data from the LAA is limited. Although invasive plants were noted during rare plant surveys, those surveys targeted undisturbed habitat where the likelihood of finding invasive species is reduced.

The list of invasive species used in the EIS was based on agricultural weeds and did not include some aggressive invasive plants of wetland habitat including Narrow-leaved Cattail (Typha angustifolia), Common Reed (Phragmites australis), and Reed Canary Grass (Phalaris arundinacea) or forest habitat such as Garlic Mustard (Alliaria petiolata).

Will more comprehensive invasive plant surveys be completed before construction to identify areas where mitigation is required?

RESPONSE:

Yes, pre-construction surveys for invasive plants are planned as per Section 4.3.3 of EIS Chapter 22 Appendix 22c.

SUBJECT AREA: Vegetation and Wetlands, None

REFERENCE: Chapter 10, Section 10.4

QUESTION:

Sampling effort was inadequate for rare plants and the distribution of effort was poorly allocated. Only about 0.1% to 0.2% of the PDA was surveyed. Survey locations were determined in the field (apparently based on ease of access) rather than being stratified by habitat and there was apparently no attempt to resurvey historical locations of rare plants. Many of the plant species at risk use prairie habitat but there was little or no sampling effort in pastures or other prairie-like habitats or to check for the presence of tallgrass prairie indicators (an endangered ecosystem).

Will comprehensive rare plant surveys be completed before construction to identify areas where mitigation is required? If not, how will survey locations be determined?

RESPONSE:

Rare plant sampling effort was designed to field survey each vegetation cover class that occurred on each route alternative for the Project. Twenty-five percent of the mapped polygons, that were 20ha or larger, of each vegetation cover class on each route alternative were targeted for field survey. A list of potential rare plants for the intersected ecoregions was reviewed to identify vegetation cover classes of higher rare plant potential. The Manitoba Conservation Data Centre (MBCDC) database was searched for previously documented rare plant locations and three locations were identified in the Project Development Area (PDA) (Biophysical Technical Data Reports, 1.2 Vegetation and Wetlands, Table 2-19).

Prior to the 2014 field season, the Final Preferred Route (FPR) had not been established. The field program was set up to better characterize multiple alternative routes, including a broader area than just the FPR. Field survey data contributed to route selection and was designed to characterize conditions related to multiple alternative routes. Additional data will be collected in gap areas of higher concern (e.g., potential candidate protected areas and rare plant locations) in the PDA prior to construction. Should any sensitive areas be found, mitigation measures will be applied. Sensitive areas found on the ROW will be flagged for avoidance and if previously unidentified species or ecosystems of concern (e.g., tall-grass prairie) are encountered, they will be noted for potential additional mitigation. A pre-construction survey is planned to capture areas along the FPR that may have been missed in earlier surveys.

Due to land access restrictions during field survey timing windows, not all of the targeted polygons were assessed with a field survey. In total, 103 transects were surveyed along alternative routes. Transects were located in wetland, grassland, forest and pasture cover classes. Transects were 100m in length, with one transect completed per quarter section in target areas. Two rounds of rare plant surveys were conducted to account for differences in species growth and flowering times (45 transects in June and 58 in August, 2014). Fifty-six of these transects were within the FPR. The robustness of these baseline surveys, as well as a plan to conduct pre-construction surveys to address any gaps addresses concerns that may arise due to land access restrictions

SUBJECT AREA: Vegetation and Wetlands, Traditional Land and Resource Use

REFERENCE: Chapter 10, Section 10.4

QUESTION:

As described for rare plants, it is unclear how sampling effort was stratified, there was very low search effort within the PDA, and the surveys did not specifically target traditional use plant species. No areas of concentration, habitats supporting traditional use species, or sensitive sites were identified.

Will more comprehensive traditional use plant surveys be completed before construction to identify areas where mitigation is required?

RESPONSE:

Rare plant sampling effort was designed to field survey each vegetation cover class that occurred on each route alternative for the Project. Twenty-five percent of the mapped polygons, that were 20 ha or larger, of each vegetation cover class on each route alternative were targeted for field survey. A list of potential rare plants for the intersected ecoregions was reviewed to identify vegetation cover classes of higher rare plant potential. The Manitoba Conservation Data Centre (MBCDC) database was searched for previously documented rare plant locations. Three such locations were identified in the PDA (Biophysical Technical Data Reports, 1.2 Vegetation and Wetlands, Table 2-19).

Further surveys will be completed prior to construction start. Please refer to Appendix 22C Section 4.3.4 and 7.2.4.

SUBJECT AREA: **Routing, None**

REFERENCE: **EIS Section 5.3.3 Alternative Corridors**

QUESTION:

Map 5-10

Why is there no composite corridor from Riel to Piney West? This seems counter intuitive given that the final preferred route in fact does run from Riel to Piney West.

RESPONSE:

The final preferred route runs from the Dorsey Converter Station to Piney West. The start points for the alternate corridor generation steps were from the western and eastern ends of the RVTC (Section 5.3.3.2, Page 5-22).

As noted on the previous map (Map 5-9) alternate corridors were developed from both potential start points. Corridors were run from the western point to all four border crossings, including Piney West. Corridors were run from the eastern start point to Piney East and Piney West. Composite corridors include all corridors generated to all crossings, and hence include these corridors.

A corridor was created from the western start point to Piney West but is not depicted on Map 5-10. It was, though, included in the development of Alternative Routes.

SUBJECT AREA: Routing, None

REFERENCE: EIS Section 5.3.3.2 Developing Alternative Corridors

QUESTION:

Page: 5-22

Why wasn't a third start point, a mid-point, along the RVTC, also used at this stage in the development of alternative corridors? Later on in the process, the mid-point, or thereabouts, was in fact added as the point of departure for the final preferred route from the RVTC.

RESPONSE:

A third start point or mid-point was not used at this stage because adding it would not change the consideration of potential route segments at this point in the process.

The objective of creating alternate corridors is to narrow the geographic area under consideration for route development (Section 5.3.3, page 5-16), but does not eliminate the potential for routing. A composite corridor represents the top 3% of optimal paths from one start to one end point. Representative start points were chosen at either extreme of the existing RVTC. Two start points and four end points were used to develop alternate corridors.

Each new start point expands the geographic extent of the corridors, minimizing their effectiveness in limiting the area under consideration for subsequent route development.

Please see response CEC-IR-012 for additional context.

SUBJECT AREA: **Routing, None**

REFERENCE: **EIS Section 5.3.4 Gardenton West Border Crossing**

QUESTION:

Page: 5-23

Why was a route to Gardenton West excluded by Manitoba Hydro prior to the results of the comparisons of alternate routes so that the features of this route (including prime farm land, growing rural residential development etc.) could be valued and the factors weighted and the results used to compare the western route to other routes, as was envisioned by the model?

RESPONSE:

Please see the response CEC-IR-015.

SUBJECT AREA: **Wildlife and Wildlife Habitat, None**

REFERENCE: **EIS PEP reports**

QUESTION:

What type of bird diverters will Manitoba Hydro use and why?

RESPONSE:

Many bird diverter devices have been developed by the electrical utility industry to alert birds to the presence of a transmission line including; aerial marker cones, spirals, and suspended devices (swinging, flapping, and fixed). Bird collision risk has been shown to be lowered by 50% and in some cases as much as 80% by installing bird diverter devices (APLIC 2012).

After evaluation by Manitoba Hydro transmission environmental specialists, engineers and collaboration with other Canadian and American utility companies who experience high winds, ice loading, and extreme temperatures, Manitoba Hydro has adopted a line marking protocol that utilizes both spiral diverters (Figure 1) and reflective bird flight diverters (Figure 2). By installing these two devices in an alternating fashion, with the addition of aerial marker cones near aircraft flight paths, Manitoba Hydro is minimizing bird-collision risks, and ensuring no interference with safe and reliable operation of the transmission system. Manitoba Hydro has installed spiral bird diverters on several recent projects including the Wuskwatim, Keeyask, and the Bipole III Transmission Projects.

Figure 1. Power Line Sentry Bird Diverter

Figure 2. Spiral Bird Flight Diverter

References:

APLIC 2012. Reducing Avian Collisions with Power Lines – The State of the Art in 2012. Avian Power Line Interaction Committee. Edison Electric Institute abnd APLIC. Washington, D.C.

Barrientos R., C. Ponce, C. Palacín, C. A. Martín, B. Martín, and J. C. Alonso. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: A BACI designed study. PLoS ONE 7(3):e32569.

SUBJECT AREA: **Cumulative Effects, None**

REFERENCE: **EIS Cumulative effects summaries**

QUESTION:

In the CEA sections of the EIS it is stated that the project's effects may act cumulatively with the effects of the Richer South to Spruce Station transmission line.

Where is Spruce Station and what is the size and path of this line?

RESPONSE:

Richer South to Spruce Station Transmission Line is not yet designed or routed. At this time, Manitoba Hydro has no formal or informal ‘path’ or route planned for the Richer South to Spruce Station Transmission Line. Although it was included in the assessment of cumulative effects, in the spectrum of what projects should be considered ‘reasonably foreseeable’, the Richer South to Spruce Station potential project was considered speculative.

SUBJECT AREA: Routing, None

REFERENCE: Chapter 5 page 5-32

QUESTION:

On Page 5-32 approximately 750,000 routes were generated. Can you provide details on how these were generated? Were these specifically routes determined in the Route Planning Area with start points at Riel Station and end points to the 4 US border crossings using variations of the suitability surface?

RESPONSE:

General Alternate Route Development Approach

The development of alternate routes brings together the consideration of multiple elements that make use of stakeholder and PEP/FNMEP feedback, combined with the expertise of routing professionals and makes use of the tools within the EPRI-GTC methodology, and best available geo-spatial data, all within a framework guided by overall objectives and principles.

The objective in transmission line routing is to develop a preferred route for a proposed transmission line, based on the consideration of multiple factors and interests, with the overarching goal of minimizing the overall impact of the route. There are numerous potential impacts associated with routing new transmission facilities, which are described in various contexts throughout Chapter 5 of the EIS. These potential impacts are not typically mutually exclusive, meaning the avoidance of one potential impact will often result in a trade-off with another. In addition, to utilizing a sound routing methodology, there is the need to ensure it is supported by the application of professional judgment by qualified individuals experienced in how to consider and minimize overall impacts commonly posed by the planning, construction and operation of transmission facilities. In the application of this professional judgment, there are three primary considerations for how potential impacts can be managed:

- *Avoid* – The preference will always be to avoid an impact when possible; however, this is not always feasible, particularly in highly developed areas like urban environments, where multiple impacts could occur and overlap.
- *Mitigate* – Mitigating impacts involves finding ways to minimize the degree of potential impacts posed when a specific impact cannot be avoided.
- *Compensate* – When an impact cannot be avoided or reasonably mitigated, the last option is to compensate for the impact or loss caused by a project. Compensation can come in many forms and is typically developed and balanced through discussion with agencies, other affected stakeholders, landowners and the consideration of project engineering and cost constraints.

Generally, the objective when developing routes is to avoid impacts that are difficult to compensate or mitigate. The more complex the mitigation and compensation required, the greater the pressure will be to simply avoid the potential impact if possible. For MMTP, the types, levels and locations of potential impacts were summarized and categorized to provide general guidance when considering routing options and to enable them to be incorporated within the modified EPRI-GTC siting methodology in an objective and consistent manner.

General Siting Principles were used as high-level guidance for overall alternate route development. These principles are based on professional judgment and experience drawn from a multi-disciplinary team, including additional guidance drawn from previous CEC recommendations, historic feedback from regulatory agencies and feedback from the Public and First Nations and Metis engagement processes received during previous Manitoba Hydro transmission projects across southern Manitoba.

Alternate routing was developed with the following general siting principles in mind:

- Avoid or minimize impacts to residences where practical
- Avoid or minimize environmental impacts where practical
- Utilize existing transmission facilities where practical
- Parallel or follow existing linear developments where practical

- Avoid or minimize impacts to recreational areas where practical
- Avoid or minimize impacts to agricultural operations where practical
- Minimize length and cost of proposed facilities where practical

Alternate Route Development

With siting principles and alternate corridors established through the modified EPRI-GTC siting process described in Chapter 5 of the EIS, the next step for the Manitoba Hydro Routing Team was to develop alternate routes within the alternate corridors, to the extent possible. As discussed in Chapter 5 of the EIS, the general assumption at this initial stage is that any routing proposed within the alternate corridors should theoretically pose lower levels of overall impacts relative to routing outside of them, when considering the use of least cost path in the generation of corridors based on stakeholder feedback (this is discussed in more detail in CEC-IR-073.

The Routing Team worked collaboratively to develop a series of alternate route segments based on a variety of considerations and concerns specific to the different disciplines involved related to potential impacts, and associated layers of geospatial data. As described in Chapter 5 of the EIS (section 5.3.3.1, page 5-19), this began with consideration of the Areas of Least Preference (ALP) within the Route Planning Area (RPA) that were identified with stakeholder input through the Alternate Corridor Model development. These areas of least preference were mapped using a variety of authoritative data sources as well as confirmatory ground and aerial surveys conducted by Manitoba Hydro. It is Manitoba Hydro's intent to use the best information available during the route development process, which recognizes that information may change and may vary in levels of accuracy, coverage and completeness.

Once the initial network of interconnected alternate route segments were identified by the Routing Team within the established corridors, areas of higher potential levels of impact and constraints were re-evaluated to confirm if there may be additional alternate route segment scenarios that may provide further opportunities to consider. This included re-evaluating potential areas that, while outside the established corridors, provided potential alternative locations where alternate route segments could be identified using the same suite of considerations for route segments within the corridors. However, they provided alternate ways to avoid using higher constrained alternate route segments in certain “pinch-points” within the corridors. These alternate route segments provided potential opportunities to mitigate potential impacts, maintain connectivity and also offer alternate routes to each border crossing zone.

A comparative vetting process was then employed by the Routing Team to re-assess the alternate route segments posing higher levels of potential impacts and to further refine the network of alternate route segments to those posing lower levels of potential overall impacts. Confirming the alternate route segments with lower levels of potential residential impacts in comparison to others is one of the more common considerations used at this stage, although other considerations will also be used depending on the specific types and levels of impacts involved at these “pinch points”. For example, in agricultural landscapes, consideration is given to alignments on the half-mile, and whether farm management units appear to be split by potential route segments. In more natural landscapes, route segments developed will seek to avoid constraining features such as intact habitat patches or large wetlands.

The end result is an interconnected network of alternate route segments to be presented during Round 1 of the Public, First Nations and Metis engagement processes and for further analysis by subject matter experts. At this stage, Manitoba Hydro has developed routes with all of the considerations discussed above, with the understanding that they are ready for the next stage of feedback and analysis, which will result in the development of mitigative segments (see Section 5.4.3) that respond to this feedback. This can include additions, modifications or deletions to the network of route segments.

As explained on page 5-32, there were a total of 87 individual alternative route segments developed within the RPA through the initial route planning exercises and the additional mitigative segments identified. When combined, there were approximately 750,000 potential routes generated using the 87 individual segments. The network of routes originated at a single start point (Southern Loop Transmission Corridor) and terminated at one of thirteen potential end points divided into four border crossing zones along the Canada/US border. It is important to note that not all of these routes were logical and this is a total number of all of the potential mathematical combinations that are possible using the network of interconnected segments. For example, the number would also contain potential backtracking options that were eliminated later in the route selection process. Please refer to section 5A.4 of the EIS for details regarding the Alternative Route Evaluation Model (AREM) that was used to compare and progressively reduce routes.

SUBJECT AREA: Routing, None

REFERENCE: Chapter 5 Table 5-3

QUESTION:

Table 5-3 represent the values for Alternative Corridor Evaluation Model listing the factors and features used to generate preference surface or suitability index surface. First, were the stakeholders and public made aware that a limited number of the features in the factor layers had no buffers applied to the features and that the implication was that the route could be directly adjacent to those features such as habitat areas or waterbodies or protected area? Second, Table 5-3 presents the results of ranking and weighting of the factors and features from using the Delphi and AHP. Was a table created to show the weights of individual features for a given grid cell and for each of the modeling scenarios i.e. Simple, Natural, Built and Engineering, to show which factors and features in each scenario had the most significant influence on the routing? If so please provide the table and if not why?
Third could you explain the rationale for arriving at the suitability values derived for the land cover in the Natural model and land use in the Built model where agriculture and forestry are opposite? More precisely in the Built model it is preferred to go through forest and in Natural model agriculture is preferred, is this not inconsistent? What is the impact this would have in a route scenario such as Simple Average where the models are weighted equal?
Fourth, in deriving ranking and weighting values from stakeholder input using Delphi and AHP, was a Consistency Ratio derived to show if the input sample was unbiased and if so could you provide the results and if not why was this not calculated?

RESPONSE:

1) Buffers were discussed at the workshop and were applied to features that the stakeholders thought required buffers. This model is used to evaluate the entire study area and focus areas for alternate route development, as discussed in the response CEC-IR-071. This route development is not generated but is rather guided by the corridors. There are opportunities

in the subsequent, more detailed, phases of the process to further minimize potential impact to these features.

2) Weights are applied to each of the factor layers (provided in dark green in Table 5-3, page 5-17). The weights show which factors have the most influence on the corridors developed (e.g. Special Features, weighted 42.4% has more influence than Land Cover, weighted 10.2%, within the natural perspective sub-model). All features with the factor layers receive the weight of the layer. Therefore, yes, table 5-3 described the weights that individual features receive. Each stakeholder workshop was focused on developing criteria and values for a specific perspective (Engineering, Built or Natural). How stakeholders' input would be used in the context of the entire process was discussed but did not have demonstrated the more complex formula which is used to apply emphasis to each perspective in the suitability analysis process. This is because it is important to focus the workshop participants on the matter at hand and leverage the power of GIS to perform the more complex calculations which consider all of the data in all perspectives.

3) The Natural Environment Perspective is concerned with limiting the effect on the biophysical environment (e.g. wildlife, vegetation, wetlands; Section 5.2, page 5-8). From a "natural" perspective, it is better to route through prime agricultural land, avoiding forests and wetlands. When the model is run from the natural perspective, the resulting corridors will tend towards "built" features as shown on the natural environment suitability surface (Map 5-6).

The Built Environment Perspective is concerned with limiting the effect on the socioeconomic environment (e.g. agriculture, resource use and heritage; Section 5.2, page 5-8). Therefore, from a "built" perspective, it is better to route through forests than prime agricultural land, leading to the built environment suitability surface (Map 5-7).

It is typical to have competing perspectives in a routing process. The EPRI-GTC Methodology acknowledges these differences in perspectives by dividing the Alternate Corridor and the Alternate Route Evaluations Models into subcategories representing these perspectives. This model design supports the development and evaluation of alternatives based on these competing points of view.

Hypothetically, if there were only two features present on the landscape (e.g. forest and agriculture) and they were valued exactly inversely then they would counter balance each other in a “simple average” weighting.

4) During the stakeholder workshop consistency ratios were evaluated, along with several other statistics to determine if the answers were consistent (not unbiased as the question indicates). These ratios were well below the 10% target.

SUBJECT AREA: **Routing, None**

REFERENCE: **Chapter 5**

QUESTION:

Can you provide maps showing Least Cost Path line with the alternative routes and alternative corridor boundaries for Engineering, Natural environment, Built environment, and Simple Average models to each of border crossing including with the map the alternative routes.
If possible please advise if it is possible to place these shapefiles of the routes on Manitoba Hydro's existing online mapping tool for the project?

RESPONSE:

Least cost path was not utilized to generate the alignment of discrete routes or segments. As such there are no maps available showing an individual "least cost path" to any of the border crossings.

The use of the "least cost path" tool is described in Section 5.3.3.2 to develop the composite corridors. Then, the routing team identifies alternate routes using these corridors as a guide (see response CEC-IR-071).

The "least cost path" tool is strictly a mathematical exercise that is not capable of applying the process outlined in CEC-IR-071 and more specifically the professional judgment necessary to develop the network of segments used to form routes.

SUBJECT AREA: Routing, None

REFERENCE: Chapter 5

QUESTION:

Can you please outline in detail the quality control used in conducting the model? Please be specific on the selected data used, data processing, data review, quality checks and how the review was done. In addition, did you review and address processing anomalies and data artifacts in the suitability surface that could affect the least cost path. If so, please provide details on the checks conducted.

RESPONSE:

The following quality control was applied in the application of the model.

Data Acquisition: Available data sets were reviewed to determine:

- Relevancy to the chosen technical solution
- Applicability to the Route Planning Area
- Availability of newer or more accurate information
- Ability to improve information through field reconnaissance.

The applicable data sources were selected using the expert judgement of the routing professionals and applicable subject matter experts.

The process of assessing the available data also determined what additional project specific data was unavailable and would be created or gathered through the review of available aerial imagery and field data collection (windshield surveys). The creation and gathering of data was completed by the applicable subject matter experts or the routing team. The data created through the review of aerial imagery was confirmed when possible with field verification, in some cases the areas in question were located on private lands that could not be initially verified. Additional quality assessment of the data sets was applied through the Public, First

Nations and Metis Engagement processes. Data sources included publically available information, sensitive information (wildlife, historical and traditional), and data acquired for the purpose of this project.

Publically available data: The most authoritative, comprehensive, precise and current source data was identified for project analysis. Local experts are leveraged to identify and acquire data that meets these criteria. Each data set is acquired from the authoritative source. Where available, metadata is collected which describes the process of data development and specific quality control procedures employed by the data creators. During the External Stakeholder Workshops these data were presented to resource experts to confirm the applicability of available data set to model the feature or identify a second/alternative data set.

Sensitive Information: Some data applicable to the project area was identified but was only available through specific agencies or organizations by request and are subject to third party data sharing agreements. In these cases, the data stewards within the agency are consulted and the project goals were discussed. Under the data sharing agreements sensitive data was shared with the project team under the condition it would not be used or shared outside of the project team.

In some cases, data applicable to the model did not exist. The project team assessed the viability of creating the data. If the team decided it was viable to create the data, industry best practices were implemented by qualified professionals with experience developing geospatial data. Each created data set underwent a unique quality control process that included review by senior staff before proceeding to the next step.

Once the entire database is consolidated it was reviewed by senior staff before proceeding to the next step.

Data Processing and Analysis: The quality controls applied through the application of the segment identification outlined in CEC-IR-071 and the application of the EPRI-GTC models are described below.

Generally the approach to quality control in the data processing and analysis was the application of expert reviews. Subject matter experts, senior analysts, and project managers evaluated the analysis layers and utilized their experience with similar projects to identify data anomalies or processing errors prior to approving this data to advance to the next step. This is an iterative process repeated as required.

Specific to the development of alternate corridors, the data sets were presented to the project team in the form of hard copy maps and geographic information system (GIS) presentations. The project team as a whole evaluated the data and utilized their collective experience to identify data anomalies or processing errors. This is an iterative process repeated as required.

Additional quality controls were applied by conducting certain aspects of the analysis independently by two separate analysts. The results were compared to determine if there were differences. If so, they were evaluated and the source was identified. The senior analyst decided which method produced the intended result and the process was repeated using the selected method until the independent analysis resulted in identical results.

This process for quality control was applied consistently throughout the project development and specifically included the identification and reviews of processing anomalies and “data artifacts” in the suitability surface. The issues were resolved through the iterative application as described.

SUBJECT AREA: Routing, None

REFERENCE: Chapter 5 Section 5A.1

QUESTION:

In section 5A.1 a statement indicates that the initial routing process and models were established to evaluate a 115Kv – 230Kv line. Can Manitoba Hydro provide details on what sections of the EIS Chapter 5 related to routing a 115Kv-230Kv line and what sections of the report relate to routing the 500Kv line? Please also identify what changes in the model parameters, process or criteria were used in routing a 115Kv – 230kv line versus a 500Kv line? Did this have a substantive effect on the modeling process?

RESPONSE:

All sections of EIS Chapter 5 relate to routing a 500-kV line.

Model adjustments for the context of a 500-kV line are listed in Section 5A.3.1. Changes noted below are primarily to reflect Project size and purpose (500kV, import/export).

Changes to the Alternate Corridor Model:

- Unused ROW (Manitoba Hydro Owned)
  - Slightly less preferred than no linear features as there are more constraints and would need to consider other infrastructure in tower spotting and design.
- Parallel Roads ROW
  - Less desirable than with a 230-kV line due to the number of other constraining factors such as existing distribution lines, and how far in field towers would have to be placed.
- Municipal Road Allowances
  - Removed as 500-kV structures cannot fit in the municipal road allowance.
- Parallel Provincial Highways ROW

- Slightly less preferred for a 500-kV line.
- No Linear Infrastructure
  - Most preferred as there would be less impeding factors like other linear structures to avoid.
- Rebuild Existing Transmission and Sub-Transmission Line
  - Removed as this is not a consideration for this Project.
- Parallel Oil/Gas Transmission Pipeline
  - Slightly less preferred (potential for induction effects).
- Parallel Railway ROW
  - Slightly less preferred (potential for induction effects).

500-kV (MMTP Table 5A-4)

Engineering	
Linear Infrastructure	35.7%
No Linear Infrastructure	1
Unused ROW (Manitoba Hydro owned)	1.2
Parallel Existing Transmission Lines (<300kV)	3.8
Parallel Roads ROW	5
Parallel Provincial Highways ROW	5
Parallel Oil/Gas Transmission Pipeline	7
Parallel Railway ROW	7
Future MIT Plans	7.8
>= 300 kV Transmission Line/Within Buffer	8.5
Within Road, Railroad, or Utility ROW	9

115-230-kV (St Vital Table 8.5.1)[1]

Engineering	
Linear Infrastructure	35.7%
Unutilized ROW (Manitoba Hydro Owned)	1
Parallel Roads ROW	2.6
Municipal Road Allowances	3.1
Parallel Provincial Highways ROW	3.4
Parallel Existing Transmission Lines	3.8
No Linear Infrastructure	4.4
Rebuild Existing Transmission & Sub-Transmission Line	5
Parallel Oil / Gas Transmission Pipeline	5.6
Parallel Railway ROW	5.6
Future MIT Plans	7.8
>= 300 kV Transmission Line & Within Separation Buffer	8.5
Within Road, Railroad, or Utility ROW	9

Alternative Route Evaluation Model adjustments for the context of a 500 kV line are listed in Section 5A.4.1. As listed:

- Engineering Sub-Model:
  - Seasonal Construction and Maintenance restrictions was added
  - The weight of the Accessibility Criteria increased slightly
  - Length in separation buffer was changed to Index of Proximity to Existing 500-kV lines;

[1] St Vital Transmission Complex EA Report May 2014

The % parallel Existing Transmission Lines, % Parallel Roads, and % Rebuild existing transmission lines length in separation buffer were all removed as criteria.

500 kV (MMTP Table 5A-11) 115-230kV (St Vital Table 8.6.1)[2]

Table 5A-11 MMTP Alternative Route Evaluation Model

Criteria	Weight
Built	
Relocated Residences – Within ROW	27.1%
Potential Relocated Residences (75 m) – Edge of ROW	17.1%
Proximity to Residences (75 – 250 m) – Edge of ROW	6.4%
Proposed Developments – Within ROW	15.5%
Current Agricultural Land Use (Value) – ROW	4.4%
Land Capability for Agriculture (Value) – ROW	2.2%
Proximity To Intensive Hog Operations (Acres) – ROW	3.3%
Diagonal Crossings of Agriculture Crop Land (km)	9.9%
Proximity to Buildings and Structures (100m) – EOROW	3.2%
Public Use Areas (250 m) – EOROW	7.4%
Historic/Cultural Resources (250 m) – Edge of ROW	1.8%
Potential Commercial Forest (Acres) – ROW	1.7%
Natural	
Natural Forests (Acres) – ROW	8.0%
Intactness	25.9%
Stream/River Crossings – Centerline	16.4%
Wetland Areas (Acres) – ROW	16.4%
Conservation and Designated Lands (Acres) – ROW	33.3%
Engineering	
Seasonal Construction and Maintenance Restrictions (Value) – ROW	16.5%
Index of Proximity to Existing 500 kV Lines	29.5%
Accessibility	16.5%
Total Project Costs	33.0%
Existing Transmission Line Crossings (#)	4.5%

Table 8.6-1: Alternate Route Evaluation Model

Feature	Weight	
	Original	Adjusted
Built		
Relocated Residences - Within ROW	35.3%	43.4%
Potential Relocated Residences (75m) - Edge of ROW	19.1%	23.5%
Proximity to Residences (75 - 250m) - Edge of ROW	6.4%	7.9%
Proposed Developments - Within ROW	1.1%	0.0%
Agriculture Crop Land (Acres) - ROW	2.6%	3.2%
Irrigated Land (Acres) - ROW	6.5%	0.0%
Shelter Belts (Acres) - ROW	2.5%	3.1%
Diagonal Crossings of Agriculture Crop Land (Km)	6.7%	8.3%
Proximity to Commercial Buildings (100m) - Edge of ROW	1.3%	1.6%
Proximity to Industrial Buildings (100m) - Edge of ROW	1.1%	0.0%
Special Features (Schools, Churches, etc.) (250m) - Edge of ROW	10.1%	0.0%
Historic / Cultural Resources (250m) - Edge of ROW	7.3%	9.0%
TOTAL	*100.0%*	*100.0%*
Natural		
Natural Forests (Acres) - ROW	4.4%	6.1%
Stream/River Crossings - Centerline	1.7%	2.3%
Wetland Areas (Acres) - ROW	11.2%	15.4%
High Quality Wildlife Habitat (Acres) - ROW	15.6%	21.5%
Floodplain/Riparian Areas (Acres) - ROW	8.0%	11.0%
Special Areas (ASI, Proposed Protected Areas, etc.)	27.5%	0.0%
Native Grassland Areas (Acres) - ROW	31.7%	43.7%
TOTAL	*100.1%*	*100.0%*
Engineering		
% Parallel Existing T/L	8.2%	21.4%
% Parallel Roads	8.2%	21.4%
% Rebuild Existing T/L (Reconductor, Double Circuit, etc)	24.6%	0.0%
Length in Separation Buffer (Km)	37.1%	0.0%
Existing Transmission Line Crossings (#)	3.8%	9.9%
Accessibility	15.2%	39.7%
Total Project Costs	2.9%	7.6%
TOTAL	*100.0%*	*100.0%*

These changes did not result in a substantive effect on the modeling process. The same analysis process was used for both projects. It is standard practice by users of the EPRI-GTC Methodology to make slight adjustments to the models to accommodate different types of facilities.

[2] St Vital Transmission Complex EA Report May 2014

SUBJECT AREA: Routing, None

REFERENCE: Chapter 5 page 5A-28

QUESTION:

On page 5A-28 there is referenced to a weather study. Please elaborate on the extent of this weather study, where and what it covered and how it influences any routing consideration?

RESPONSE:

This weather study provided wind, ice, temperature and related climatic information for design of the MMTP Transmission Line planned in southern Manitoba.

Weather data from CAN/CSA-C22.3 No. 60826-10 (Design criteria of overhead transmission lines) for southeastern Manitoba is general and out of date. It was recognized that there were opportunities to provide specific weather data for the MMTP study area. Using specific data in the general study area and providing further refinement to extreme events such as tornados and combined ice and wind events allowed Manitoba Hydro Engineers to optimize the design of the transmission line.

Information developed in this study provided the 50-year return period values of ice accretion and wind speed and corresponding combinations. Related information on wind and temperature combinations was provided. Information on the probability of extreme weather including tornadoes affecting twin parallel lines in the same events at various separation distances, line lengths and directional orientations was also provided.

For operational planning, a rate of ice accretion on conductors was recommended. Finally, information regarding the joint frequency of temperature, wind speed and solar irradiance was developed and provided to assist line rating calculations.

Additional segments were added to the Round 1 route evaluation process as a result of public input to parallel existing infrastructure and the analysis on paralleling transmission lines was conducted in the weather study. See footnote 3 on page 5-29 for more details.

During the preference determination step of route selection, the engineering perspective considered the influence of severe weather (wind events, tornadoes, icing) and the amount of paralleling when determining system reliability values. Probabilities of each proposed route and existing routes both being affected by severe weather were determined and scores were given based on the relative probabilities (Chapter 5 pg 5-88).

For additional information please see responses CEC-IR-019, SSC-IR-061 to SSC-IR-064.

SUBJECT AREA: Heritage Resources, None

REFERENCE: Chapter 12, 12.3.1.3

QUESTION:

In Section 12.3.1.3 there is mention of archaeological methods that: "field methods used are standard field procedures developed by Stantec (Stantec Consulting Ltd. 2014)".
Please provide the document that outlines those field procedures. Stantec Consulting Ltd. 2014. Heritage Resources Investigations in Saskatchewan: Statement of Standard Methods, 2014. Ms on file Stantec Consulting Ltd, Saskatoon, SK and Winnipeg, MB."

RESPONSE:

Please find the requested document (CEC-IR-077_Attachment): Heritage Resources Investigations in Saskatchewan: Statement of Standard Methods, 2014, Prepared by Stantec Consulting Ltd.

Heritage Resource Investigations in Saskatchewan: Statement of Standard Methods, 2014

Stantec

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January 2014

Table of Contents

1 INTRODUCTION

This document describes Stantec Consulting Ltd. (Stantec) Archaeology Group's approach to heritage resource investigations in Saskatchewan. All archaeological investigations, assessments/mitigations, reports and submissions will be conducted under the rules and regulations set out in Section 63 of the *Heritage Properties Act (HPA), 1980* and, when applicable, Chapter R-23.01 of the *Royal Saskatchewan Museum Act, 2007*. The methods described in this document accommodate fieldwork in prairie, parkland, and boreal forest ecological zones, and apply to:

- small developments such as well pads and access roads;
- larger areal developments such as gravel pits, oil batteries, forest harvest blocks, and residential developments;
- short linear developments such as flow lines, seismic surveys, underground electrical and telecommunication lines; and
- longer linear developments such as pipelines, road sections, high kV electrical transmission line corridors

Methods presented herein apply to all heritage resource investigations conducted by Stantec, but deal more explicitly with projects involving the assessment and mitigation of a small number of features or small number of cultural components that are best attended to during the assessment phase of the development. The methodology to be employed on large projects requiring project-specific or site-specific research designs and work plans are not addressed in this document. These supplementary methodologies designed for projects such as reservoirs, mining operations, forest harvesting of operational areas, and large subdivision developments will be formulated in consultation with the Heritage Conservation Branch (HCB) and the proponent.

1.1 Definitions

1.1.1 Archaeological Resource

Material remains of human activity. Examples of archaeological resources associated with the precontact period occupation of the province include stone circles, lithic debitage and tools, and faunal remains. Resources dating to post-contact occupation frequently consist of structures or features that are in a state of complete ruin, and scatters or concentrations of objects relating to household, agricultural or industrial activities.

1.1.2 Historical Resource

The abandoned (but not completely ruined) evidence of human occupation and activity after European contact. Examples are homesteads, cabins, old trails, rail beds and industrial sites.

1.1.3 Cultural Resource

Refers to any place, artefact, feature or person(s) considered important to the group identity of a community or association be it ethnic, geographic, spiritual, or historical. Examples of cultural resources include sweetgrass harvesting areas, spirit rocks, churches, shrines, battlefields, cemeteries (which are historical and archaeological as well), schools, traditional resource extraction areas and landscapes. We leave it to the members of the community or association to define those cultural resources that they identify with.

1.1.4 Palaeontological Resource

The physical remains, fossilized remains or fossilized evidence of now-extinct or extirpated life forms. Such resources are not associated with past human activities.

1.1.5 Heritage Resource

All of the above. Assessment of the resource is subject to scrutiny by the province through the *HPA* permit and reporting process as administered by HCB.

1.1.6 Inventory

Creating a comprehensive list, within the parameters of an agreed upon methodology, of heritage resources within a project area boundary. Methods may include informant interviews, visual reconnaissance, systematic shovel testing and geophysical prospecting. The standard reporting procedure when resources are found is to fill out and submit to HCB a Saskatchewan Archaeological Resource Record (SARR).

1.1.7 Archaeological Reconnaissance

Synonymous with Inventory described above.

1.1.8 Assessment

Use of intensive investigative means to determine the content, character, physical parameters and significance of a heritage resource.

1.1.9 Mitigation

Passive or active measures to lessen an impact on heritage resources in conflict with a development. Examples are avoidance (by moving or canceling a development), collection of a representative sample of materials, systematic shovel testing, photographic documentation, construction monitoring, salvage excavation, post-impact monitoring and compensatory excavation.

1.1.10 Incidental Mitigation

When the assessment process gathers sufficient data to mitigate development impacts to a site. This is a common occurrence in the mapping and testing of stone circle sites. If the tests bear little or no archaeological data, then the act of mapping the features, stone by stone, is adequate to mitigate the impact.

1.1.11 Shovel Test

A 40 cm by 40 cm hole dug with a shovel and described according to soil, sediment and stratigraphic attributes, as well as archaeological content, if any.

1.1.12 Controlled Excavation

Excavations done within a pre-measured 1 m universal grid, tied to a datum of known location so that results are repeatable. Typically the 1 m^2 units are dug by natural stratigraphic layers or arbitrary 10 cm levels.

2 HERITAGE RESOURCE INVESTIGATION METHODOLOGY

2.1 OBJECTIVES

The main objectives of heritage resource investigations conducted by Stantec are to:

- locate, inventory, document, and assess heritage resource sites that may be in conflict with the proposed development;
- to make site-specific recommendations that will assist in development footprint selection and refinement; and
- to make site-specific mitigation recommendations should avoidance of sites(s) prove unfeasible.

Cultural Resource Management (CRM) as practiced in a consultative approach usually involves a contracted agreement with a proponent regarding a well-defined development with project boundaries and impacts, and a predetermined timeline. The primary focus for the majority of CRM studies is the gathering of inductive data to provide further evidence to the ongoing study of precontact and historic settlement patterns, site types, material culture, cultural affiliation and cultural chronology. Small areal and short linear developments provide little opportunity to conduct research or design-driven studies that have a specific problem statement and research goal. Small mitigative projects are generally inductive and take a salvage archaeology approach (i.e. removal of the higher concentrations of resources in areas of greatest impact). Projects that are larger in scope, such as larger areal or long linear developments, may accommodate research design-driven approaches and warrant comprehensive statements of methods. As stated in the Introduction section, this document does not intend to accommodate the theoretical bases or methods needed for large excavation projects or large archaeological inventories. Discussions with HCB will determine which projects warrant specific investigation proposals.

2.2 PREFIELD ASSESSMENT AND RESEARCH METHODS

Typically development projects requiring heritage resource investigations have been submitted by the proponent to HCB for screening prior to proponent consultation with Stantec. As such, the proposed development has been screened by the proponent using the Developer's Online Screening Tool maintained by HCB to determine which lands hold the potential for the presence of heritage resource sites. Should the proponent contact Stantec directly requesting a heritage resource investigation, the development plan will be screened using the Developer's Online Screening Tool, a Heritage Resource Review Referral Form (including detailed project location information, preferably project-specific development plans) will be submitted to HCB and the results will be discussed with personnel at HCB.

A search of the Archaeological Inventory for the Province of Saskatchewan (maintained by HCB) will be conducted to identify the nature, size and contents of sites that are either within the development footprint or within a one kilometer buffer around the development. Recent satellite imagery of the proposed development footprint will be examined to aid in the identification of potentially undisturbed lands requiring archaeological assessment and Soil Survey of Saskatchewan maps will be reviewed to identify lands holding the potential for the presence of deeply buried cultural material. As applicable, a search of the Saskatchewan Homestead Records and the Dominion Land Survey maps, and examination of historic air photographs maintained by Information Service Corporation and the National Air Photo Library will be conducted to aid in the identification of post-European contact period sites associated with the proposed development.

Prior to commencement of the field programme, an Archaeological Resource Investigation Permit will be obtained from HCB. The permit application includes details regarding the project's location, the development type and amount of land to be impacted, the proponent's contact information, and heritage resource sites known to be in conflict with the project. Also included in the application are project-specific schedules and field work timelines that may influence the assessment methodology to be employed. For example, should snow covered conditions be anticipated, the heritage resource investigation may focus on monitoring snow removal and top soil stripping activities instead of a conventional shovel testing programme. Further discussion of alternate seasonal assessment methods is included in Section 2.10.

2.3 FIELD RECONNAISSANCE METHODS

The aim of all field reconnaissance programmes is to identify all heritage resource sites within the development footprint. To this end, reconnaissance strategies may be customized to respond to the terrain and conditions within each development. Field reconnaissance programmes may be composed of one or more of the following:

2.3.1 Visual Inspection

Most heritage resource investigations will involve landscape-based systematic assessments consisting of intensive visual inspection of the ground surface of the development to identify near-surface heritage resources. In open areas, such as meadows and grasslands, we walk or ride all-terrain vehicles in a series of parallel transects approximately 20 m to 50 m apart. In practice, this means five passes across a 100 m^2 well pad and one pass along a 15 m wide right-of-way (pipeline or road). Generally linear developments are examined using some form of zigzagging transect to ensure adequate visual coverage of the development during a single pass of the right-of-way. Single passes of linear developments are a product of "leap-frogging", that is, when two archaeologists use one vehicle to examine a long linear development. One archaeologist begins the pedestrian traverse of the development while the other drives ahead leaving the vehicle at a pre-designated distance and begins the next leg of the reconnaissance. The pattern is repeated until the entire length of the development has been examined. Visual inspection examines the landscape for features, artefacts or areas interpreted as holding the potential for the presence of intact buried cultural materials. Where possible, all fortuitous exposures (e.g. vehicle tracks, erosional cuts, previous development disturbances and rodent burrows) will be examined for the presence of cultural materials.

Environmental conditions that affect surface visibility include vegetation cover, animal disturbances, previous developments, current developments, season (winter being the most limiting) and weather. The surface visibility and conditions are recorded in our field notes. We generally denote visibility as follows:

- excellent visibility >50 % surface exposure;
- good visibility = 25% to 50% surface exposure;
- fair visibility = 10% to 25% surface exposure; and
- poor visibility < 10% surface exposure.

We photograph a representative sample of the types of terrain encountered within the development footprint and the archaeological visibility noted within the footprint. Should heritage resources be encountered during the visual inspection, the site is recorded using the procedures discussed in Section 2.5.

2.3.2 Shovel Testing

Shovel tests will be excavated in judgmentally derived locations at the discretion of the field archaeologist or at a pre-determined distance when a systematic testing strategy has been employed. Shovel tests are usually positioned at locations judged to have the potential for the presence of intact buried cultural materials within the proposed development. Shovel tests may be positioned to sample different types of terrain within the proposed development (e.g. within depressions, on ridges, on terraces, at shorelines). If the proposed development does not provide a variety of terrain to sample, a systematic approach may be considered appropriate. For example, a 100 m^2 well lease with heritage potential may have a test placed at well centre and four additional tests, one at or near each corner of the proposed lease. Alternatively, shovel tests may be positioned at regular intervals across high potential areas of a proposed development. On longer linear developments judgmental testing of high potential portions of the right-of-way will be conducted and may be combined with systematic tests (e.g. a test every 50 m or 100 m between the judgmental test locations). The number of tests may be reduced or increased based on surface visibility factors, soil types, feasibility of avoidance and the need for further assessment of identified subsurface heritage resources. Shovel test locations are captured using handheld GPS units and the judgmental reasoning for their numbers and positioning are detailed in our field notes and explained in our final reports.

Shovel tests approximately 40 cm by 40 cm will be dug to a minimum depth of 20 cm below ground surface. When possible, tests will be excavated to a depth interpreted as being the base of soils potentially containing cultural materials, i.e. "C" horizon soils dating to the terminal Pleistocene. Such shovel testing is aimed at the recovery of cultural materials and testing protocols relating to the identification of palaeontological resources are discussed in Section 2.11. Soils from the shovel tests will be screened either using 6 mm mesh screen or by trowelling through the sediments, depending upon the soil type. A description of the soil profile encountered in each shovel test will be recorded and, should significant soils or cultural features be encountered, the profile will be photographed. All cultural materials will be collected and preferably will be bagged separately according to the soil layer from which the item was recovered, to aid in the identification of multicomponent sites.

2.3.3 Deep Testing

In the case of deep depositional contexts where shovel testing is not possible, mechanical subsurface testing using a backhoe may be recommended. Deep testing is especially pertinent in well-developed valleys and major depositional basins on uplands when the development will involve trenching or quarrying activities that extend to depths beyond the reach of a hand dug shovel test. The fill from each backhoe test will be examined for the presence of cultural materials and the stratigraphy of each deep test will also be examined for heritage resources. Backhoe trench profiles will be recorded or photographed within the bounds of safe work practices. Mechanical testing would occur during the assessment phase of the heritage resource investigation following final development footprint selection. The feasibility of the deep testing programme will be determined in consultation with HCB and the proponent.

2.3.4 Geophysical Prospecting

We use electromagnetic conductivity for geophysical prospecting as we have in-house expertise in the person of David McLeod, Senior Archaeologist in our Winnipeg office. He has written the following description of our approach.

The earth's electrical conductivity at any specific location is determined primarily by its soil type, structure (porosity) and moisture content. Any disturbances significantly affecting these properties may produce a measurable local increase or decrease in the conductivity of electricity, termed an anomaly.

The EM38, approximately the same size and shape as a carpenter's level, contains a transmitter coil at one end and a receiver coil at the other. As the meter slides across the ground, the transmitter coil induces current loops in the earth to a maximum depth of about 1.5 m (Figure 1). Each loop generates a magnetic field that is directly proportional to the electrical conductivity of the ground in the vicinity of that loop. A part of this magnetic field is intercepted by the receiver coil, resulting in an output voltage that is also linearly related to the electrical conductivity of the ground. Units of conductivity are expressed in millisiemens per metre or mS/m.

The general field procedure is to establish a grid over the area to be investigated to maintain horizontal provenience. At cemeteries, where the focus of the survey is to locate unmarked burials, transects are spaced 0.5 m apart and the EM38 is slid slightly above the ground surface recording data continuously at an interval of 10 readings per second in vertical dipole position. Reference points, required for aligning and mapping the data, are marked at regular intervals throughout the grid. These points are known as fiducial markers and are necessary when recording data in continuous mode. The data are collected with an Allegro data acquisition system.

The data are analyzed using a variety of methods. One method plots an XY profile of conductivity along an individual transect line, with conductivity expressed along the vertical axis and distance along the horizontal (Figure 2). The second method, using data from all of the transect lines, produces contour maps displaying conductivity variations across an entire grid (Figure 3). Surfer ™ automatically blends

FIGURE 1 GEOPHYSICAL SURVEYING USING AN EM38 ELECTROMAGNETIC GROUND CONDUCTIVITY METER AND DATA LOGGER.

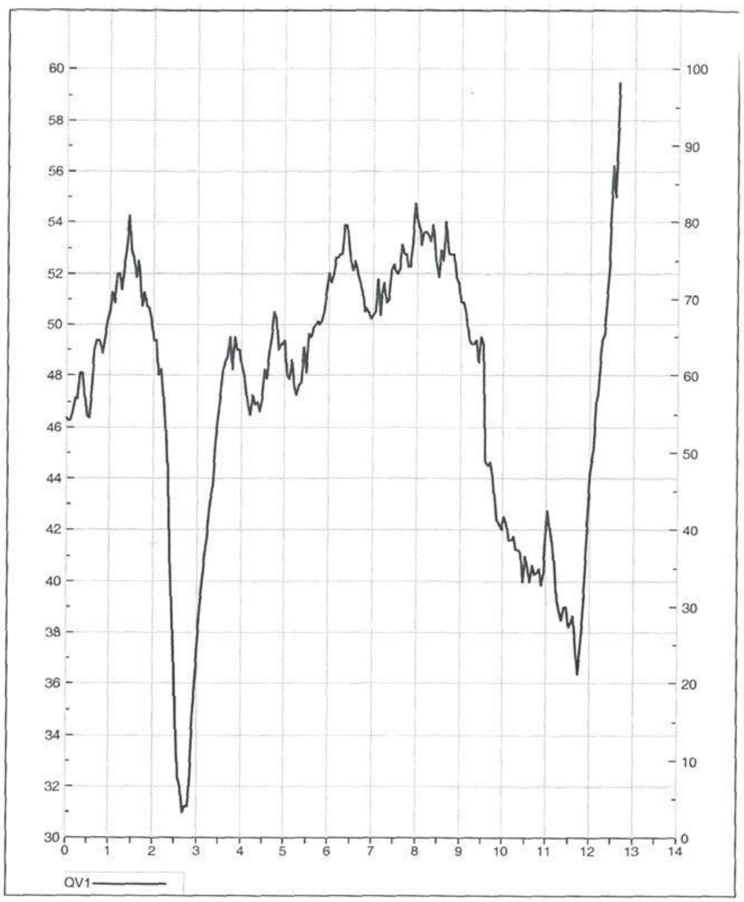

FIGURE 1 EXAMPLE OF TRANSECT DATA ON AN XY PROFILE.

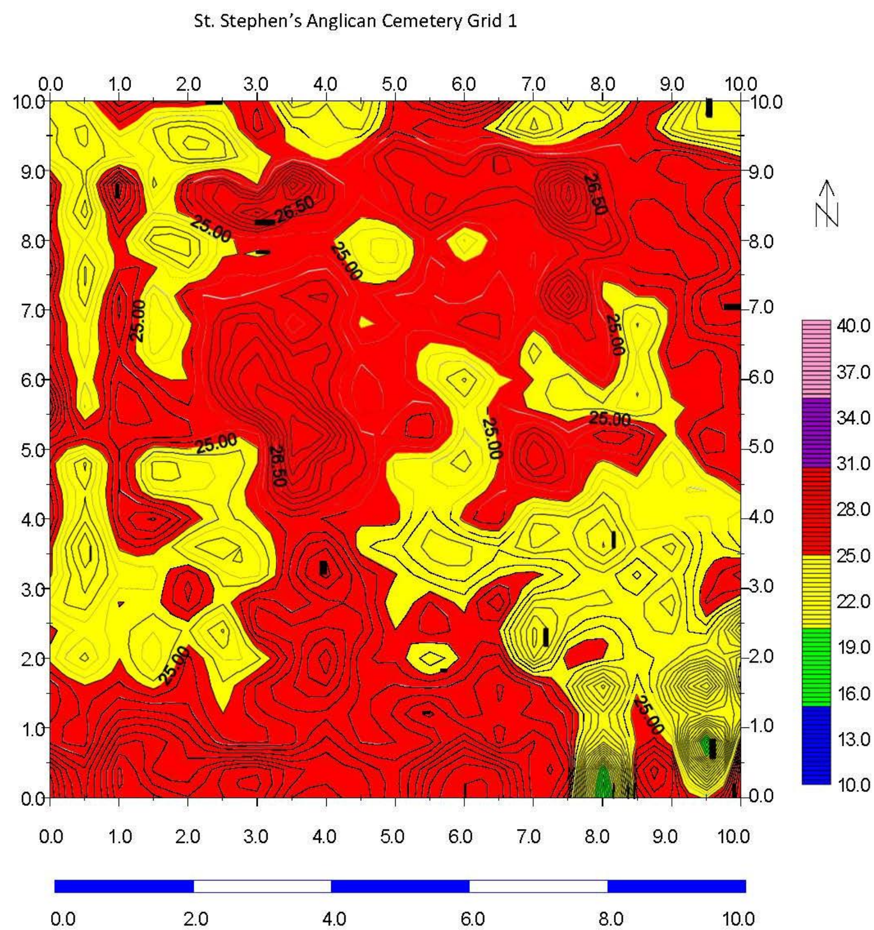

FIGURE 3 EXAMPLE OF DATA CONTOURED AT AN INTERVAL OF 0.3 MS/M.

colours between percentage values to create a smooth colour gradation over the map. Colour anchors can be added at any point between 0 and 100%, with each anchor point being assigned a unique colour and the colours automatically blending between adjacent anchor points.

The third method is to display the data in a 3D surface map (Figure 4). These maps use different colours to represent elevations whereby the colours are associated with percentage values. The percentage values can be displayed either in relation to the minimum and maximum conductivity values recorded in the grid or a selected range of values. The colour associated with 0 percent corresponds to the minimum value selected and the colour associated with 100 percent corresponds to the maximum value. When examining contour maps or 3D plots, the key to data interpretation is not the reading at a single point on a transect line or even at adjacent points along that line, but rather the various patterns of increases and/or decreases throughout the grid. These changes, or anomalies, can indicate the presence of unnatural subsurface features. Burials are usually indicated by gradual increases or decreases in electrical conductivity at the same relative location over a number of transect lines.

By contrast, subsurface metal is usually indicated by major increases or decreases in the EM readings along one specific transect line. Surface and shallowly buried metal often appear in the XY plot as "Ws" whereby both the transmitter and the receiver pass over the object and a significant increase or decrease is registered in the logger on each occasion.

Various soil types also affect the EM data. Ground conductivity surveys at various locations across Manitoba and Saskatchewan have shown that sandy soils, such as the soils at Camp Hughes, Manitoba, produce values ranging from –0.5 to 1.0 mS/m (McLeod 1992). Stony soils or soils where glacial till is close to the surface, such as those encountered at the Siddal Site near Estevan, Saskatchewan, had a range in values of 5 to 30 mS/m (McLeod 2005). Clay soils, such as those present along the Burntwood River at Taskinigup Falls in northern Manitoba, had EM values ranging from 35 to 55 mS/m (Northern Lights Heritage Services Inc. 2002). Therefore, because sandy soils produce low values, they can be said to have a low conductivity and a high resistivity to electrical currents. A prefield task is to review soil reports (Saskatchewan Soil Survey 1986, Mitchell, Moss and Clayton 1977 etc.) to determine the soil type of the study area.

In 2010, a Trimble GeoXH (sub 15 cm horizontal and vertical error with Tornado antenna) handheld computer was added to our tool kit. The EM38 can be directly connected, allowing us to do wider prospection surveys with sub metre accuracy, without the need to first establish a grid. For specific surveys, such as graveyards and homesteads, a grid is still necessary for provenience control.

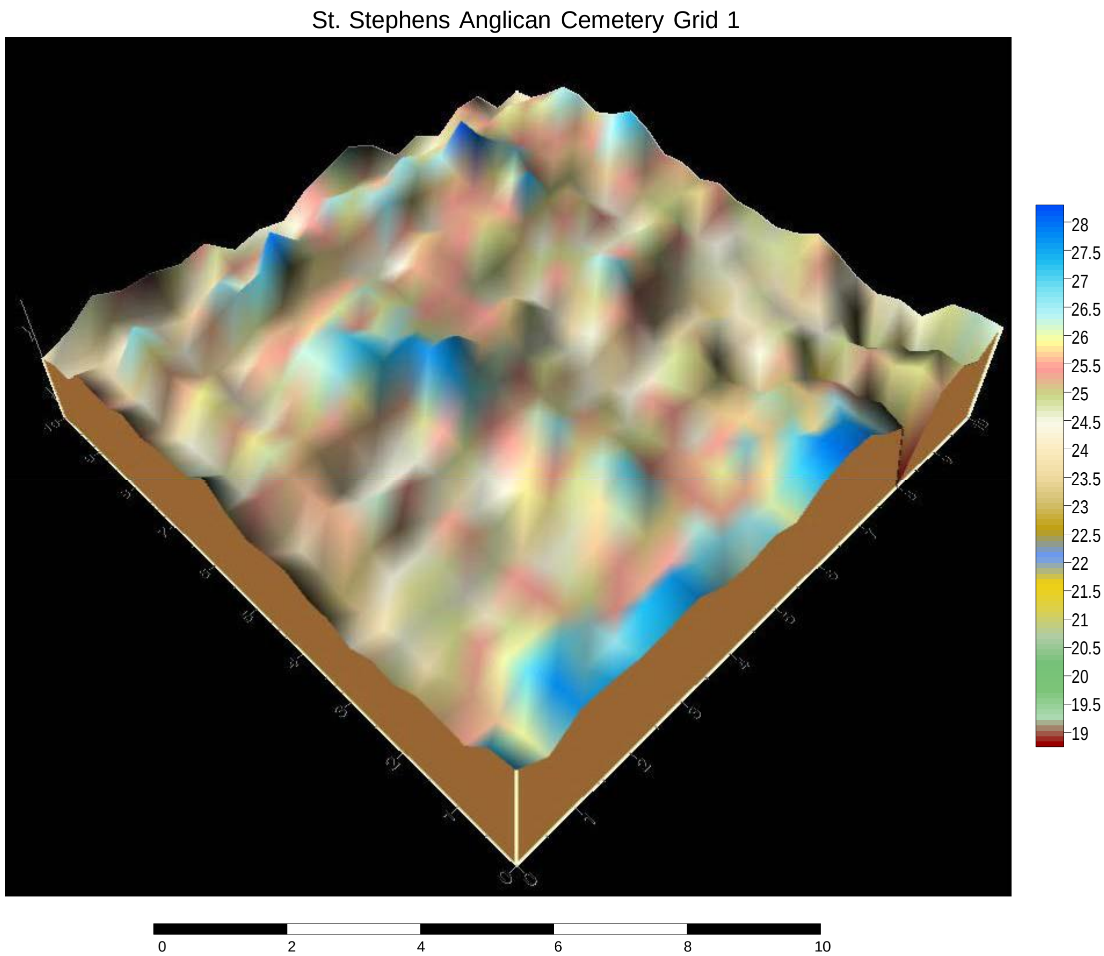

FIGURE 4 A 3D SURFACE MAP DISPLAYING DATA BETWEEN 18 AND 30MS/S.

2.4 SITE DOCUMENTATION

A Saskatchewan Archaeological Resource Record (SARR) will be completed for each newly identified or previously recorded heritage resource site encountered during a heritage resource investigation. Locational information for all features and shovel tests at the site will be recorded using a handheld GPS unit and a written description of all features and shovel tests will be included in the field notes. A sketch map of the site area and all associated features and tests will be completed and be included on the SARR form. As well, photographs of the site and associated features will be taken. Heritage resource sites that are not accepted into the Archaeological Inventory for the Province of Saskatchewan will be documented and photographed in the final report without the use of a SARR form.

2.5 SITE ASSESSMENT

Once we have identified a heritage resource in conflict with the proposed development we proceed with site assessment. The objectives of site assessment are:

- determination of the heritage resource's vertical and horizontal parameters, where appropriate. If a site can be avoided with an adequate buffer zone (decided in consultation with the HCB) it is generally not appropriate to shovel test a heritage site outside the development.
- determination of heritage resource integrity. Are the heritage resources intact, partially disturbed or completely disturbed? Integrity is relevant to the assessment of site significance. If a site or portion of a site is deemed less significant, then more detailed assessment or minor mitigatory investigations can effectively salvage the necessary data to allow development to proceed.
- determination of a heritage sites' stratigraphic nature. Whether a site is single- or multi-component relates to the assessment of site significance. A multi-component site generally increases significance as the site presents an opportunity to examine culture history, culture change and responses to environmental change.
- collection of artefact information that may indicate a sites' cultural affiliation(s) and approximate age(s). Site significance usually increases with the identification of distinct archaeological or ethnological cultures. On the other hand, identification of cultural materials such as plastic-lined or screw-top beer bottle caps indicate cultural occupations more recent than 1971 and the mid-1980s (respectively) and may determine that the occupation is too recent to be historically significant.
- collection of an artefact sample that reflects the diversity and density of archaeological resources. How intensively used was the site? How long did its occupants live there? A high artefact and feature density and diversity presents a better opportunity to learn about the past than does the converse.
- the location and identification of features and activity areas. These generally increase site significance and provide evidence to the character of the site.

The methods employed to fulfill these objectives include such techniques as surface mapping, surface collection, shovel testing, photographic documentation and controlled excavations, and are described below.

2.5.1 Surface Mapping and Collection

In situations where surface finds are encountered, we routinely conduct a more thorough pedestrian search of the area. The identified surface resources are marked with flags or stakes. Subsequently, surface finds and features are mapped in relation to the proposed development. Once marked, locations are recorded with differential GPS. Detailed field notes and photographs help record site setting.

Generally, surface collections are conducted to mitigate small surface scatters with limited items, to preserve diagnostic artefacts or to gather representative samples of artefacts to demonstrate the material culture of a larger, more complex site. Collections may include tools such as projectile points, scrapers, pottery sherds, harpoons, axes, chithos or other distinctive items. Some artefacts may be mapped, but not collected, in situations where materials are located outside the proposed development or if their locations and field identifications can provide mitigative information (e.g. some bone fragments or some lithic shatter).

If a large artefact scatter is present, the situation may warrant a more detailed surface collection. A three point provenience recording device such as an electronic total station will be used to record micro-topography and archaeological data.

2.5.2 Shovel Testing

Shovel testing is required to assess a heritage resource find, scatter or feature. This includes testing of surface finds or scatters to determine whether there are intact heritage resources below the surface. Several tests may be used to evaluate the nature of a subsurface heritage site for size, continuity, depth, density of artefacts, number of components, etc. Shovel tests are also employed to assess historic surface features/areas. Standard shovel testing protocols have been discussed in Section 2.3.2.

Systematic shovel testing usually involves placement of additional tests in the cardinal directions at regular intervals from the discovery test (within the development footprint). Tests continue along the axes until culturally sterile holes are encountered. Each new discovery becomes the origin of another axis and this continues until no new discoveries are made (Figure 5). This approach allows us to follow a buried deposit without digging as many holes, but still adheres to a grid so that site area and densities can be calculated. These tests should provide stratigraphic data as well as an artefact sample to evaluate the cultural context and character of the assemblage.

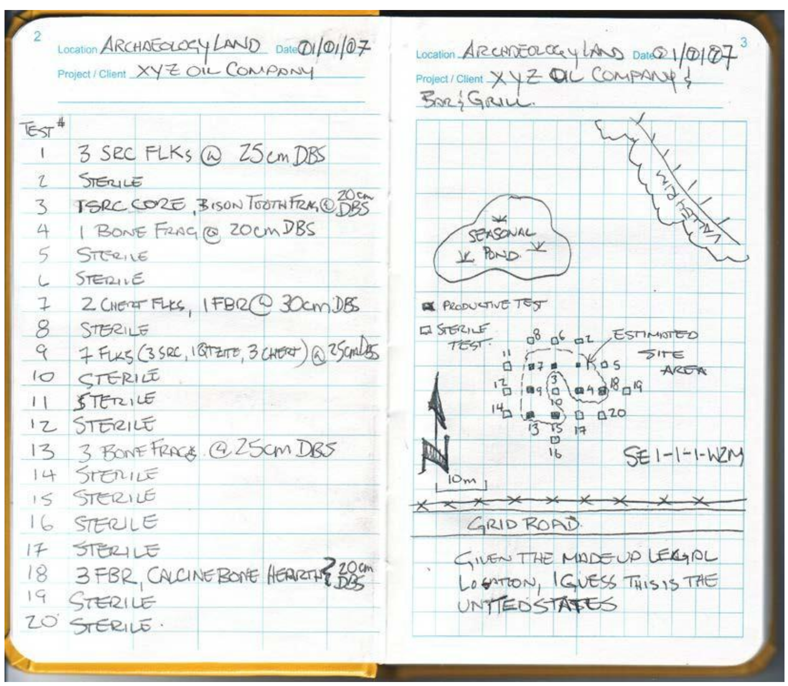

FIGURE 5 FICTITIOUS NOTES DEMONSTRATING OUR APPROACH TO SYSTEMATIC TESTING

2.5.3 Stone Feature Site Assessment

Only stone feature sites that cannot be avoided by development construction activities will be assessed using shovel tests or other invasive assessment techniques. When stone feature sites are encountered during a heritage resource investigation, the locational information for each feature is recorded using a handheld GPS unit and a SARR form will be completed. Details such as stone circle/cairn diameter, number of rocks used in feature construction, how intact the feature appears to be or how deeply buried the feature appears to be are recorded in the field notes. If avoidance is possible, stone cairns are staked with an avoidance buffer of 10 m, stone circles with a 20 m buffer and ceremonial stone features with a 250 m buffer. The location of each feature is compared with the final development footprint and, should avoidance be deemed unfeasible, assessment of the features and site will be undertaken.

Stone circles will be assessed through detailed mapping and photographing of the feature and testing of the circle. Stone circles will be assessed through the excavation of a 1m² unit near circle centre plus four 50 cm² tests judgmentally placed along the perimeter of the circle or outside of the circle's wall. Alternatively, the stone circle may be assessed through the excavation of four judgmentally-placed 50 cm² tests within the boundaries of the circle and four additional 50 cm² tests outside of the boundaries of the feature. Testing near the centre of the stone circle may reveal hearth features containing evidence of archaeological culture, seasonality and calendar age. Tests along the perimeter of the stone circle may reveal cultural materials preserved by rock cover, reduced trampling and increased soil and vegetation accumulation. All test locations will be included on the stone circle map included in the final report or attached to the SARR form for the site.

Stone cairn assessment involves the detailed mapping and photographing of the feature before removing the surface rocks and the beginning of excavation, and continues through removal of subsequent layers of rock and fill. When possible, the cairn is sectioned, where half of the feature is excavated to expose a clear profile of the feature before all rocks are removed and the feature is completely excavated. Typically a 1 m² unit placed over the feature will result in complete excavation of the feature. Stone cairns can be associated with precontact burials, therefore if human remains are encountered during excavation of a cairn, all activities will cease immediately. HCB and the police will be contacted immediately and further actions at the site will be determined through consultation with HCB and all communities (First Nations, Métis, non-aboriginal groups) that may have a concern or connection to the burial. All stone feature sites that are determined to be Sites of a Special Nature (SSN) should be avoided, however, if avoidance is not possible, an appropriate assessment and consultation programme will be developed in consultation with HCB.

In addition to the test units excavated in association with the feature(s), shovel tests will be placed across the site area and between surface features in an attempt to identify activity areas outside of the stone features.

2.5.4 Historic Site Assessment

Photographic documentation and mapping are frequently employed to record heritage resource sites associated with European settlement of the province. The location of any buildings, features or artefact scatters at the site are recorded with differential GPS, a sketch map of the site area is produced and the buildings, features and scatters are photographed in detail. The detailed photographs record information including building techniques, decorative choices that may reflect ethnicity of the residents and types of artefacts associated with the site (e.g. farm equipment that is too large to collect, artefacts that provide limited information regarding use or date of manufacture). Limited surface collection and shovel testing may also be utilized to identify site use and age. Assessment of historic sites will also involve document research into the structures, artefacts, and history of ownership associated with the site. If avoidance of the historic site is not feasible, a detailed assessment/mitigation in consultation with HCB and the proponent will be undertaken if required.

2.5.5 Controlled Assessment Excavation

Systematic shovel testing and the other assessment methods already discussed may not adequately mitigate impact to a heritage resource site within a development. In such cases, further assessment and incidental mitigation can be accomplished by controlled excavation. One m² units may be expanded in 50 cm quadrants to excavate concentrations of material culture until negative quadrants outline an artefact cluster. Units are excavated by natural layers in 50 cm quadrants and may be subdivided into arbitrary 5 cm, 10 cm or 15 cm levels when appropriate. This is the lowest level of horizontal and vertical provenience applied at the assessment stage. If more intensive methods are required to investigate the resource, we will recommend a separate mitigatory phase, with a site-specific statement of methods and likely a new permit application. The feasibility and methodology of a controlled assessment excavation programme will be determined in consultation with HCB.

2.6 EVALUATING SIGNIFICANCE AND FORMULATING RECOMMENDATIONS

We approach archaeological significance with the attitude that all archaeological sites are relevant unless proven otherwise. It is the rare opportunity that we have the number of sites in any given project that a significance-ranking scheme is needed to sort out which ones are deserving of mitigation and which ones can be destroyed without assessment. If we were to consider the entirety of Saskatchewan's cultural and natural heritage when evaluating a solitary stone cairn on a hilltop, it may be considered less than spectacular, so we have to accept the principle that all heritage resources are intrinsically valuable by their own merits. Significance may be determined using one or more of the following:

- historical significance
  - if the site is representative of a person, place, thing or event recognized as important to the corporate identity of people at the local, regional, national or international level
- aesthetic significance
  - if the site is integral to the preservation of a historical, archaeological, cultural or natural landscape, vista or streetscape
- scientific significance
  - if the site contains information with integrity, diversity and density to allow advancement of knowledge about the past through application of the scientific method
- cultural significance
  - is representative or integral to the shared identity of a self-defined community or group

Recommendations for further site management or additional assessment/mitigation will be based on the site type, the contents of the sites, the amount of cultural material recovered at the site, the diagnostic capabilities of the recovered materials and the rarity or uniqueness of the site. Recommendations are made relative to assisting with final development footprint selection.

2.7 MITIGATION

Stantec's preferred method of mitigation for any heritage resource site is avoidance. However, should avoidance not be feasible, active mitigation methods may be recommended. Any active mitigation programme must be agreed upon with HCB and the proponent. Any mitigative activity that exceeds the methods described in Section 2.5 will be done under a new permit with a project specific research design. Standard mitigative methods that may be recommended include:

- controlled excavation/mitigation that involves excavation based on a systematic grid system with a baseline oriented on magnetic north. Hand trowelling or shovel shaving is employed to facilitate full exposure, *in situ* recording, and photographic documentation of features or concentrations of cultural materials. Provenience is typically maintained by 1 m^2 units and natural stratigraphic layers although vertical control may be established using arbitrary 5 cm, 10 cm or 15 cm levels. All soil is screened and all cultural materials are collected.
- controlled mapping and artefact collection which is discussed in Section 2.5.1. This mitigative method can be applied to both precontact and historic sites.
- construction monitoring and post impact excavation/mitigation, most commonly recommended in association with winter programmes (see Section 2.10).

- detailed document research for historic sites. In addition to mapping, photographing, shovel testing, and/or collecting artefacts at a historic site, intensive research involving such resources as land records, township plans, aerial photographs, rural municipality maps and local history books may be conducted to determine the ownership and use of the site.

2.8 CULTURAL MATERIAL ANALYSIS

All cultural materials identified in shovel tests, surface collections and controlled assessment excavations during completion of a heritage resource investigation will be collected. All artefacts will be collected with the detailed provenience of each item recorded. All identified materials will be cleaned appropriate to the artefact type, for example lithic artefacts (excluding tools) will be water-washed and brushed while bone, precontact ceramics, firecracked rock, wood and metal items will be dry-brushed.

Lithic debitage will be classified by artefact type, material type, size, and weight while lithic formed tools and cores will be classified by artefact type, material type, size, weight and dimensions (minimally length, width, thickness). Precontact ceramics will be classified by vessel portion, vessel type, temper material, decorative technique/motif and type, where possible. All faunal items will be classified by taxon, element type, size, weight, pathology and age, and all natural and cultural modifications will be noted. Firecracked rock will be classified by material type, fracture type, size and weight while historic artefacts will be identified, catalogued and researched to determine the date and location of manufacture. All artefacts will be catalogued and submitted to the Royal Saskatchewan Museum for accessioning into the collections.

We may collect hearth or pit feature contents, screen with 16 mesh and float a sample for evidence of the small artefact fraction, palaeobotanical and micro-faunal remains. To calibrate results as cultural versus natural, we collect a comparative sample off site, if possible. During assessment we may find bone, charcoal, ceramic or baked earth appropriate for radiometric dating. Radiocarbon samples are collected in metal containers or in aluminum foil with as little handling as possible. Detailed notes preserve contextual information. Thermoluminescence (TL) samples are collected in metal containers or tinfoil and covered in thick black polyethylene bags or boxes in order to reduce exposure to solar radiation. The appropriate background soil samples are also collected from areas away from the TL samples and stored in like conditions. Lithic tools may be submitted for residue analysis and therefore, every attempt to preserve any remaining residues will be undertaken through limited handling of the artefact.

2.9 REPORTING

All heritage resource investigation reports will be prepared in accordance with the guidelines established by HCB. Reports will include an abstract/executive summary, a biophysical and cultural background, a description of the project, a description of prefield, field and analytical methods, the observed setting of the project area, results, recommendations, literature references, tabulated data and pertinent maps, photographs and illustrations. Locational data regarding Sites of a Special Nature (SSN) will not be included in the report to protect the resource, however, a SARR with all locational data will be completed and submitted to HCB. Artefacts will be described in the text and, where necessary, in tabular form; all formed lithic tools will be described in detail with dimensions. All formed lithic tools and significant artefacts will be photographed and the photographs will be included in the report. Detailed recording contained within the report may include mapping, profiling and photography. Mapping includes site level maps indicating the relationships between site features and any existing or proposed disturbances; and feature maps that include detailed recording of various stone features, associated soil features and soil profiles. All soil profiles and feature maps are recorded at a 1:10 cm scale. Photography includes project and archaeological site area photographs, excavation unit photographs, soil profile photographs and any other images necessary to illustrate important site features. The report will offer recommendations regarding the heritage resources identified during the assessment and will include the proposed management of those resources. As part of the final report, *Heritage Property Act* clearance will be requested. Once the report has been approved by HCB, one paper copy and one digital copy of the report will be submitted to HCB for fulfillment of the HRIA/M permit. A separate paper copy and digital copy of the report will also be sent to the Royal Saskatchewan Museum when artefacts are submitted for accessioning.

2.10 WINTER ARCHAEOLOGY

Since the oil boom of the early 1990s, we have been developing methods to conduct archaeological assessments year-round in order to accommodate the schedules of developers. Snow and ground frost present the biggest challenges to archaeological reconnaissance and assessment, so much so, that we do reserve the right to tell the proponent that they may have to wait for spring.

2.10.1 Visual Reconnaissance in Snow Conditions

If the ground is covered thinly with snow, but is not frozen, a conventional shovel testing programme within the proposed development footprint may be possible. On the prairies, an effective pedestrian transect survey may be conducted through shallow snow cover by narrowing the transects to 5-10 m intervals. Sunshine melts snow off rocks and reveals stone features even better than in many summer conditions due to the stark contrast of white snow and dark rocks. In deeper snow, a blade or power sweeper attachment on an ATV will clear small areas or a series of short transects. Large proposed developments require larger equipment such as bulldozers, graders and power brooms for snow removal.

2.10.2 Construction Monitoring

Deep snow and well-developed ground frost make preconstruction reconnaissance and assessment impossible. When presented with these conditions, we will consult with HCB on whether construction monitoring is appropriate. Monitoring may be recommended during top soil stripping and/or trenching activities.

2.10.3 Post-impact Investigation

In some situations, HCB may approve a development to proceed on the condition that there is a post-construction inspection. Should heritage resources be identified during the post-impact assessment, we will proceed with a mitigation programme agreed upon by HCB and the proponent.

2.11 PALAEONTOLOGICAL RESOURCES

We conduct a thorough examination for fossil remains in outcrops and exposures of bedrock, if available, in the development area at the reconnaissance stage of the study. We rely on natural exposures such as river valley walls or human-caused exposures, such as road cuts, as it is usually not practical to access buried, fossil-bearing strata with hand tools to test palaeontological potential.

When fossils are encountered their locations are measured, mapped and associated with the geological formation in which they occur. A stratigraphic section is compiled and representative sample of fossils may be collected with their sedimentary context. Fossils from separate locations and strata must be collected separately and properly bagged, labeled and catalogued. The fossil collection may then be sent to the Royal Saskatchewan Museum, Geological Survey of Canada, Tyrrell Museum of Palaeontology or other appropriate specialists for identification. Unless the fossils are highly significant (such as rare dinosaur remains), the inventory and assessment of the palaeontological site will suffice for mitigation. Should substantive palaeontological resources be encountered during a heritage resource investigation, a separate palaeontology permit will obtained and mitigations will be undertaken by Stantec palaeontologists based in the Calgary office.

A final report, including geological background, methods, maps, stratigraphic sections, photographs, fossil descriptions and interpretations, is submitted to the appropriate government agencies. The fossil collection will be permanently curated at the provincial museum or other designated museum.

3 PERSONNEL

Leslie (Butch) Amundson, M.A., RPA — **Principal, Geoarchaeologist, Team Lead Archaeology and Traditional Knowledge**

Saskatoon Office

Butch is an archaeologist and geologist with 33 years' experience in all phases of archeological impact assessment and mitigation, palaeontological assessment, oral history, ethnocartography, public consultation, environmental site assessments and environmental geology. He has completed archaeological assessments and mitigation studies on precontact and historic archaeological sites for oil and gas, mining, reservoir, pipeline, electrical transmission line, highway, recreational development, human remains analyses and reburial, historic site management and research projects. Butch's C.V. is attached.

Kim Cloutier, M.A. — **Historical Archaeologist**

Regina Office

Kim has a Master's degree in Archaeology from the University of Saskatchewan with a focus on historical archaeology. With over a decade of archaeological experience, she has had the opportunity to work across Alberta and Saskatchewan in the areas of academic research, public education and engagement, museum studies, archaeological consulting with a focus on forestry and oil and gas projects, and for provincial agencies. Kim has been with Stantec for the past year and has conducted and assisted with a broad range of HRIA's involving oil and gas pipelines, wellsites and flowlines, gravel quarries, telecommunication installations, and mining sites, as well as conducting heritage resource screenings and participating in First Nation engagement and traditional knowledge consultation work. Kim's C.V. is attached.

Lisa Hein, M.A. — **Managing Senior Archaeologist, Physical Archaeologist**

Regina Office

Lisa is a physical archaeologist with ten years of experience, six of those years being employed as an archaeologist with Stantec. Her work and research has focused on human osteology and cemetery studies. During her employment with Stantec, she has gained considerable experience conducting HRIA's for oil and gas well sites and flow lines, transmission lines, and rural subdivisions. Lisa has also been employed as an Inventory Technician for the Saskatchewan Heritage Branch where she acquired first-hand knowledge of archaeological government procedures and policies. She also has significant experience in constructing and maintaining electronic database projects and public presentation. Lisa's C.V. is attached.

Yvonne Mazza, B.A. — **Archaeologist, Traditional Knowledge Facilitator**

Saskatoon Office

Yvonne is an archaeologist, who is completing her Master of Arts in Archaeology at the University of Saskatchewan. Since the beginning of the summer of 2011, she has been working with archaeologists at Stantec Consulting Ltd. This work has given her experience with Heritage Resource Impact Assessments for flowlines, oil and gas well sites, gravel borrow pits, fibre-optic installations, and subdivisions. Project work has been comprised of archaeological desktop studies, Traditional Land Use studies, Traditional Ecological Knowledge studies, Environmental Impact Assessments, excavations, field surveys, monitoring, report writing, project management, as well as mapping and analysis. She also has a diploma in Computer Aided Design and Manufacturing Engineering Technology (CAD/CAM), with over 10 years of experience in the municipal and environmental management sectors. Her experience with municipal projects includes Geographical Information Systems (GIS), Electrical and Instrumentation Controls programming and drafting, and process mechanical and HVAC drafting. Within the environmental management sector her experience includes Environmental Impact Assessment mapping and analysis. She has worked on multiple projects for a variety of clients in the power, water treatment, oil and gas, and mining sectors within the province of Saskatchewan. Yvonne's C.V. is attached.

K. David McLeod, M.A. **Senior Archaeologist, Geophysical Survey Specialist**
Winnipeg Office

David is an archaeologist with 35 years of experience and has spent the last 11 years in the consulting industry. He received a Master's Degree in Anthropology from the University of Manitoba in 1985. David originally specialized in historic archaeology, but, during his 20-year tenure with the Province of Manitoba, acquired skills in site survey, site reporting and legislative requirements for HRIAs, Environmental Impact Assessments (EIAs) as well as conducting preliminary HRIAs for urban land developments. Once in the private sector, he developed his Boreal Forest archaeological experience by conducting a number of multi-year HRIA projects for the proposed Wuskwatim, Keeyask and Conawapa hydro generating stations, several northern hydro transmission lines, post-impact HRIAs of the Limestone and Grand Rapids generating stations, forestry operations and highway rerouting projects. David has also worked closely with a number of First Nation bands through heritage resource surveys and traditional knowledge studies to document land use activities from the precontact to recent historic periods on traditional lands, as well as studies to document and protect cemeteries and the excavation of human remains. He has also developed non-intrusive geophysical survey techniques to locate unmarked burials in abandoned and active cemeteries. David also uses this same technique to map activity areas, building locations and former structure parameters at historic period sites. David's C.V. is attached.

Barb Neal, M.A. **Senior Archaeologist**
Regina Office

Barb has worked in archaeology since 1984. Areas of interest include precontact lithics, and historic sites and artefacts. She has been involved in archaeological projects based in Alberta, Saskatchewan, Manitoba, northern British Columbia, New Mexico, and Ghana. These projects have enabled her to work in a variety of environmental zones including the boreal forest, plains, parkland, montane, and tropical rainforest zones. She has worked in an archaeological capacity in both academic and consulting environments, conducting archaeological survey, excavation, and laboratory analysis. Barb has been involved in major large scale mitigation projects including the Oldman River Dam Campsites Project and the Highway 2/3 Junction Site Project (Alberta), and major survey projects including the Express Pipeline Project and Keystone Pipeline Projects in Alberta and the Keystone XL Pipeline Project in Saskatchewan. Barb's C.V. is attached.

Lauren Stead, M.A. **Archaeologist, Traditional Knowledge Facilitator**
Saskatoon Office

Lauren is an archaeologist and traditional knowledge facilitator with the Stantec team in Saskatoon. Since completing her Master of Arts in the Department of Archaeology and Anthropology at the University of Saskatchewan, she has worked on a variety of projects in both archaeological impact assessment and mitigation and traditional knowledge studies. Her academic research included a geoarchaeological examination of a previously excavated archaeological site located within Wanuskewin Heritage Park. Her experience includes subsurface coring and laboratory analysis, consisting of descriptive core logging, stable carbon isotope analysis and phytolith analysis. Lauren's C.V. is attached.

4 SELECTED REFERENCES AND COMMON RESOURCES

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SUBJECT AREA: **Access, None**

REFERENCE: **General**

QUESTION:

During the operation period of the transmission line will Manitoba Hydro be constructing access controls on the right-of-way to prevent additional public access by all forms of vehicular traffic (i.e. trucks, snowmachines, ATVs)?
What is the program/process for Manitoba Hydro to address this on private land?
What is the program/process for Manitoba Hydro to address this on Crown land?
What are the tools (i.e. signage, gates, fencing) that Manitoba Hydro has to control access?
What involvement/co-operation is required on the part of the various government departments?

RESPONSE:

Manitoba Hydro does not have under the terms of its easements, either on crown or private land, the right to erect permanent access controls during the operation period. Manitoba Hydro's Access Management Plan, Chapter 22 Appendix 22B, outlines in Section 4.8 "Access Rehabilitation" on page 20, the requirements and lists possible techniques that Manitoba Hydro would consider in the development of its access route decommissioning and rehabilitation prescriptions.

SUBJECT AREA: First Nation and Metis Engagement, None

REFERENCE: Chapter 4

QUESTION:

Manitoba Hydro made several commitments to First Nations in Chapter 4, FNMEP. Has engagement continued with these communities since the filing of the EIS? What has transpired since? Please provide specifics on how the concerns of those that had not completed their land use studies at the time of filing will be incorporated into the final plan. Will there be a follow-up or on-going engagement plan and what will it encompass?

RESPONSE:

Since the filing of the EIS, Manitoba Hydro has continued to engage and share information with communities and organizations. Manitoba Hydro has been holding Environmental Protection Program meetings with communities to confirm what we have heard to date, share our proposed plan with leadership, resource users and Elders, determine if concerns brought forward by the community have been addressed, and provide an opportunity for any outstanding concerns to be raised. Manitoba Hydro has invited all FNMEP communities and organizations to participate in Environmental Protection Program meetings. To date, meetings have been held with Buffalo Point First Nation, Dakota Plains Wahpeton First Nation, Dakota Tipi First Nation, Peguis First Nation, Sagkeeng First Nation and Swan Lake First Nation. Manitoba Hydro continues to be open to discussing the Environmental Protection Program with those interested.

Manitoba Hydro also invited participants from FNMEP communities to attend an initial Manitoba-Minnesota Transmission Project Community Monitoring Tour on November 8, 2016. This meeting and tour brought together representatives from Brokenhead Ojibway Nation, Dakota Plains Wahpeton First Nation, Dakota Tipi First Nation, Long Plain First Nation, Manitoba Metis Federation, Swan Lake First Nation, Black River First Nation and Peguis First

Nation . A follow up meeting is planned for March 23, 2017 with all FNMEP communities invited to further discuss how communities may be involved in monitoring through the potential development of a Community Monitoring Working Group. It is Manitoba Hydro's intention to be responsive and adaptive to the needs of the working group with respect to format, discussion topics and reporting.

Manitoba Hydro also continues to work with communities that are completing ATK studies. This includes Dakota Tipi First Nation and the MMF. Information provided in these studies will help inform the Environmental Protection Program for the Project. Some communities completed their studies after the EIS was filed. These communities include Dakota Plains Wahpeton First Nation, Sagkeeng First Nation and Peguis First Nation. The Dakota Plains Wahpeton First Nation and Sagkeeng First Nation reports are being used to inform the Environmental Protection Program for the Project. Manitoba Hydro is working with Peguis First Nation to confirm how the information in their report will be used to inform the project.

SUBJECT AREA: **Heritage Resources, None**

REFERENCE: **CEC MMTP Round 1 IRs - Part 3**

QUESTION:

Chapter 12 Heritage Resources

Technical Data Report – Heritage Resources

1) Was information solicited from the archaeological community about any known sites/archaeological features that have yet to be published or are not yet recorded in Provincial databases?

2) Did the archaeologists or project team contact any individual land owners about archaeological resources on their properties?

3) Predictive modelling - Stantec indicates that proximity to water is important in predictive modelling. They do not clearly specify if their model uses only modern water sources or if they modeled older water courses, sources? Please explain.

4) Small shallow lakes which are prominent in the spring and early summer have been demonstrated to be important for archaeology in southern Manitoba. It is not clear if this has been considered in Stantec's modelling. Please explain.

5) It is unclear how Stantec personnel conducted a windshield survey and how this correlates with Stantec's revisiting of known sites to verify their location. Stantec's shovel testing regime is also unclear as to where test pits were excavated and the frequency of test pits excavated in high/medium/low potential areas. Can this be better explained?

6) It is unclear how Stantec used the variables associated with known sites in their predictive modelling. The existing site database of 61 sites for a project length of 121 km is statistically insignificant and more importantly, it was not assembled through statistically relevant means. Therefore, if Stantec used these variables to predict the location of more sites, then theoretically, the model would only be predicting more of the same. There are statistical methods that can be used to lessen this bias but the overall methodology is unclear. Additionally, the report is not clear on how the model was tested, where it was tested and the frequency of testing. Can more background be provided on the model?

7) How much time was spent doing the 'Fall 2014' survey?

8) How much of the survey was done from the cab of a truck and how much was actually done on the ground? Where were test pits excavated? How many/what percentage were excavated in areas of archaeological potential/not potential verses known site locations?
9) Are there maps indicating areas of archaeological potential? Are those available?
10) When will the CHRPP be completed and made available for comment?

RESPONSE:

1) The Historic Resources Branch was contacted for a list of heritage permits pertaining to any archaeological surveys or excavations within the Project Development Area (PDA) and Local Assessment Area (LAA). The Branch had no record of any such archaeological investigations.

2) Data from Rounds 1 and 2 of the Public Engagement Process were reviewed for information regarding knowledge of heritage resources by openhouse participants prior to the field assessment in the fall of 2014. No detailed data were acquired during either round. Manitoba Hydro staff contacted landowners to obtain permission for Stantec to access private property. None of the landowners contacted relayed information regarding archaeological resources on their land.

3) The alternative, preferred, and Final Preferred routes were evaluated in conjunction with Dominion Land Survey maps dating between *ca*. 1872 and *ca*. 1912 that are available online through the Land Initiative Branch of Manitoba Conservation and Water Stewardship. Therefore, older water courses as well as modern water sources were considered. Furthermore, these data are presented in Sections 12.4.1 to 12.4.5 in the MMTP Environmental Impact Statement (EIS).

4) Small shallow lakes, of which there are minimal in non-agricultural land in the MMTP Project area, were considered during the modelling, under the “Proximity to Water” variable, and as part of the evaluation of the alternative, preferred, and Final Preferred routes. One small lake, Lac Bossé, had a previously recorded archaeological site that was identified as an isolated find. Several shallow lakes are present near the Glenboro Station as summarized in Section 12.4.5. These water bodies are in cultivated fields where no previous heritage resources have been

reported. Discussions with the Historic Resources Branch prior to the field assessment and a presentation of the MMTP heritage assessment methods and results to Brian Smith, former Manager, Archaeological Assessment Services Unit, Historic Resources Branch, determined that cultivated areas had a low potential for intact heritage resources.

5) The windshield survey was the preliminary stage of the assessment as summarized in Section 12.3.1.3. The objective was to examine all alternative routes to record current land use status at previously record archaeological sites, to record current land use at potential heritage resource areas identified during desktop analysis of alternative routes, and to determine which land parcels/sections required land access for field assessment. The database of known archaeological sites was forwarded to Manitoba Hydro during the initial stage of route analysis. These data assisted in formulation of the alternative, preferred, and Final Preferred routes. As a result of the detailed routing analysis, there was only one previously recorded site within the LAA of the New Right-of-Way and four within the LAA of the existing corridor. The LAA, defined in Section 12.2.1, is a 200m-wide corridor for that portion of MMTP that was New Right-of-Way and the existing corridor of the Riel-Vivian Transmission and the Southern Loop Transmission corridors.

The shovel testing regime consisted of shovel pits excavated in areas of heritage resource potential within the LAA corridor. Frequency of test pits at a given location was dependent on the size of the area within the LAA that was considered to have moderate to high potential.

6) The existing database was assembled by obtaining an inventory of known archaeological sites and centennial farms in the MMTP Project area from the Historic Resources Branch, a list of municipally and provincially designated heritage sites from the Historic Resources Branch website, an inventory of historical sites from the Manitoba Historical society website, and reviewing topographic maps for cemetery locations. The existing database of previously recorded archaeological sites and the information contained therein was identified as one of the gaps in the overall assessment as summarized in Section 3.2 of the TDR. Furthermore, there was an absence of previously recorded sites in the southern portion of the MMTP study area where much of the area has remained undeveloped. During the route evaluation phase of the

Project the existing database was reduced as alternatives were discarded as were sites within the LAA of these routes. The modelling used for MMTP was based on previous research within the Project area as summarized in Section 4.2 of the TDR and used to identify those areas within the LAA of the alternative, preferred, and Final Preferred routes that had heritage potential. The six modelling variables and their criterion were then applied equitably to the previously recorded sites to determine if any variable patterning could be deduced. Therefore, the model was developed independent of the existing database but applied to the existing data as a testing exercise and as a means to identify patterning. Locations along the LAA of the alternative, preferred, and Final Preferred routes that intersected with any one of the variable criteria were considered to have heritage resource potential and therefore identified as an area that required further assessment.

7) Nine days were spent completing the survey in 2014.

8) Six days were spent ground truthing areas determined to have a moderate to high heritage resource potential. Several areas in the alternative, preferred, and Final Preferred LAA in the Sandilands Provincial Forest that were initially considered to have a moderate to high potential were observed to have been previously disturbed through past forestry operations such as clearing and/or reforestation. These areas were examined and photographed to document the past land use.

Tests were placed within the LAA at the locations listed in Table 4-3 of the TDR. A summary of the assessments at known sites is presented in Section 6.2.1 of the TDR. Testing was primarily conducted in areas of archaeological potential, with 80% of the tests at those locations, while 20% of the tests were in areas of previously recorded heritage resources. The previously recorded archaeological sites were either in agricultural fields well-removed from active or former streams and therefore had a low potential for deeply buried cultural strata, or had been destroyed by quarrying excavation. Therefore, considerably more testing was conducting within the LAA in areas of heritage potential.

9) Map 12-2 shows an area of heritage potential. Maps 12-100-01 to 23 show locations of previously recorded sites relative to the Final Preferred Route. Maps 1-100-1 to 1-100-23 of the TDR also shows heritage resource locations within the LAA.

10) A draft copy of the CHRPP will be filed prior to the hearing.

SUBJECT AREA: **Environmental Protection, Follow-up and Monitoring, None**

REFERENCE: **Chapter 22**

QUESTION:

In section 22.6.3 Manitoba Hydro indicated that internal and external audits will be undertaken on the Environmental Protection Plans. For the external audits, would these be solely within the responsibility of Manitoba Hydro or would one or more government departments play some role? How many external audits could be expected for the construction period?

RESPONSE:

Environmental Protection Plans as stated in section 22.6.3. will be subject to external audits through the annual assessment of Manitoba Hydro's ISO 14001-registered Environmental Management System. The auditors determine the scope of their audits in consultation with Manitoba Hydro on an annual basis. Manitoba Hydro is subject to continuous inspection by the National Energy Board and Manitoba Sustainable Development to ensure it is fulfilling its commitments as described in the Chapter 22 along with applicable provincial and federal legislation. As the construction period is expected to be only approximately 2.75 years, it is likely that only one audit would be carried out during construction.

SUBJECT AREA: **Accidents, Malfunctions and Unplanned Events, None**

REFERENCE: **Chapter 21**

QUESTION:

With respect to tower collapse on page 21-5 Manitoba Hydro indicated that:” On September 5, 1996, extreme high winds associated with a severe thunderstorm event caused the collapse of 19 steel lattice towers 2 km north of the Dorsey Converter Station”. Did Manitoba Hydro do some root cause analysis as to whether there was a structural deficiency or was this a case of a very extreme event? Did this lead to any changes or considerations with respect to design and planning?

Did this event lead to preference for greater separation between high voltage lines?

RESPONSE:

The Bipole I and II transmission towers that failed during the wind event on September 5, 1996 did not fail due to any structural deficiency. The towers failed due to being loaded beyond their design capacity. At the time the towers were designed and developed, the effects of High Intensity Winds (HIW) and other extreme effects were not well known by Manitoba Hydro or other utilities.

Since the wind event on September 5, 1996, Manitoba Hydro conducted extensive studies the impact of high intensity winds (HIW) on transmission lines. Research funded by Manitoba Hydro, completed at the University of Western Ontario, developed state of the art loading criteria to deal with HIW on transmission lines. The research has been internationally accepted and provides criteria to develop transmission line structural loading criteria to mitigate the effects of HIW.

Based on the results of this research as well as our experiences with other transmission lines, Manitoba Hydro helped develop the CAN/CSA-22.3 No. 60826 standard for Design Criteria of Overhead Lines. This design standard introduced security requirements whose objective was to minimize the probability of uncontrolled propagation of failures (cascades) which may extend beyond, as was the case on September 5, 1996, the failed tower or section. These security requirements are currently being used by Manitoba Hydro and will be used on the Manitoba-Minnesota Transmission Project.

This weather event contributed to the development of a better understanding of separation of high voltage lines related to extreme weather events.

SUBJECT AREA: Routing, None

REFERENCE: Chapter 20

QUESTION:

Can Manitoba Hydro explain how it sites transmission towers to ensure they are outside of the floodplain of any watercourse. Is there a margin of error built into this siting as a result of climate change considerations (i.e., increased precipitation)? Is this type of concern addressed through the CAN/CSA-C22.3 No. 60826-10 “Design Criteria of Overhead Transmission Lines” standard?

Is avoidance of a floodplain an absolute requirement or a strong preference? Does avoidance of floodplains mean that a large part of the Red River valley is not an option for future high voltage ROWS?

RESPONSE:

Transmission towers are sited using LIDAR technology that provides ground elevation data which when combined with high resolution imagery allows the transmission line designer to site towers with an informed knowledge of the potential floodplain extent. The large number of rivers and streams combined with relatively flat topography of Manitoba, it is not feasible for Manitoba Hydro to site its transmission towers outside the floodplain of every watercourse. The CAN/CSA-C22.3 No. 60826-10 “Design Criteria of Overhead Transmission Lines” standard does not address this concern. Please see SSC-IR-236 for additional mitigation measures Manitoba Hydro considers when siting in flood prone areas.

Avoidance of a floodplain is a strong preference based on decades of previous experience Manitoba Hydro has had with transmission lines within floodplains. The Red River valley spans a large portion of south central Manitoba, due to its location and high density of customers, removal of it as an option for routing of future high voltage ROWs is not feasible.

SUBJECT AREA: Vegetation Management, None

REFERENCE: Chapter 22, Appendix 22A, 5.2 – General Mitigation Tables

QUESTION:

Mitigation measure PC – 9.02 mentions Manitoba Hydro Vegetation Clearance requirements. Can Manitoba Hydro please provide the Commission with the Manitoba Hydro Vegetation Clearance Requirements? Please provide all guidance documents with respect to vegetation clearance and management.

RESPONSE:

For MMTP the Manitoba Hydro Vegetation Clearance Requirements are based on allowable vegetation height which is dependent on several factors, including:

- the type and height of structures and their below-grade foundations,
- span lengths between structures,
- conductor properties,
- design weather conditions and the conductor behavior (sag and swing) when exposed to these weather conditions,
- safety considerations to allow regular operation and maintenance activities such as helicopter inspection and emergency restoration,
- regulatory requirements, such as:
    1. conductor-to-ground clearances defined in CSA Standard C22.3 No.1-15 ‘Overhead Systems’ , and
    2. Minimum Vegetation Clearance Distance (MVCD) as identified in NERC FAC-003, Transmission Vegetation Management standard (attached),

- environmental factors (such as rare species of flora and fauna).

As the above factors may vary within the project corridor, the exact clearances varies along the line length, however the approximate maximum vegetation height (subject to final design) is 4m.

Manitoba Hydro’s approach to vegetation management is documented in Manitoba Hydro’s ‘Transmission Line and Transmission Station Vegetation Management Practices’ document (CEC-IR-084_Attachment1 and CEC-IR-084_Attachment2).

Transmission Line & Transmission Station

VEGETATION MANAGEMENT PRACTICES

Manitoba Hydro

In operating and maintaining its major transmission line system Manitoba Hydro must manage the vegetation that grows under the transmission lines and in the transmission stations. This publication has been prepared to provide background information and a general understanding of Manitoba Hydro's transmission line system vegetation management practices.

Does Manitoba Hydro Have A Vegetation Control Policy?

Vegetation control practices fall within Manitoba Hydro's responsibilities to build, operate and maintain transmission line facilities that provide a reliable supply of electricity while being safe to the public and respectful of the environment. Manitoba Hydro must take steps to prevent trees from growing to a height where they could interfere with the reliable operation of a transmission line; impede access to crews to do maintenance and repairs; create a fire hazard; or create an unsafe condition to people or the environment. Keeping transformer station yards in a weed free condition is also part of this ongoing responsibility.

Manitoba Hydro's Environmental Management Policy states....

Manitoba Hydro is committed to protecting the environment. In full recognition of the fact that Corporate facilities and activities affect the environment, Manitoba Hydro integrates environmentally responsible practices into its business, thereby:

- Preventing or minimizing any adverse impacts, including pollution, on the environment, and enhancing positive impacts;
- Meeting or surpassing regulatory requirements and other commitments;
- Considering the interests and utilizing the knowledge of customers, employees, communities, and stakeholders who may be affected by Manitoba Hydro's actions;
- Reviewing our environmental objectives and targets annually to ensure improvement in environmental performance;
- Continually improving the Environmental Management System;
- Documenting and reporting activities and environmental performance.

All measures to control tree growth on transmission lines and weed growth in transmission stations are implemented with full respect for these environmental policies.

Before a transmission line (115 000 volts and higher) is constructed and operated Manitoba Hydro conducts a detailed site selection and environmental assessment (SSEA) study. The SSEA process includes a comprehensive public involvement program to ensure input from communities, landowners, and other stakeholders with an interest in the project. The SSEA process is designed to study and document the environment within which the line is to be located. It also assesses and documents potential impacts associated with constructing and operating the transmission line. Through the identification of these potential impacts measures can be prescribed to avoid, reduce, eliminate or compensate for impacts incurred when the line is constructed and operated. The SSEA will also consider impacts associated with line clearing and right-of-way maintenance including the need for future tree control programs. The SSEA results are documented in an Environmental Impact Statement which is used to support an application to Regulatory authorities for environmental approval(s) to build and operate the transmission line or transmission station.

Why Does Manitoba Hydro Need Vegetation Management Practices?

Transmission Lines

Before a transmission line can be built and operated Manitoba Hydro must first clear the tree growth from the right-of-way. The voltage of the transmission line and the type of structure used determine the width of the right-of-way and the width of clearing required. Transmission line rights-of-way are typically cleared to a width of 40 - 60 meters using tracked dozer type equipment. ***Manitoba Hydro does not use herbicides to clear new rights-of-way before building the lines.***

The root system of the cleared deciduous trees (those that lose their leaves in the fall) will send up suckers or re-growth in the first spring following clearing operations. Physical disturbance of the surface layers during right-of-way clearing and line construction also causes seeds from the cones of cleared spruce, pine and tamarack trees to become embedded in soil where they may germinate new seedlings. If not controlled, tree suckers and seedlings will grow to a size and density where they would be a physical barrier affecting the ability to access the right-of-way to do line inspection, maintenance and repairs and could eventually grow to a height where they become a very serious threat to the safe, reliable operation of the transmission line. This situation poses hazards to people, property, forests, customers and the transmission line itself. Manitoba Hydro cannot allow trees to grow to a size and density where they become a threat to line operation, line reliability or public safety. Vegetation control is practiced periodically throughout the life of a transmission line to prevent this from happening.

Transmission Stations

Manitoba Hydro designs its transmission station facilities as level, well drained, stone-surfaced and fenced industrial sites. Specific design criteria for buildings and grounds maintenance procedures must be met when operating and maintaining transmission stations. These ensure Manitoba Hydro meets or exceeds safety, station grounding and operational requirements. Weed control is important as weeds may contribute to:

- poor drainage conditions
- altered electrical grounding of the station
- fire hazard situations in the spring and fall
- hazardous conditions for workers who require well drained and dry surface material to maximize electrical safety when working around live wires and energized equipment
- reducing the ability for trucks and heavy equipment to move around the station yard
- the general unsightliness of the facility
- non-compliance with provincial Noxious Weed Act

Most other utilities around the world have concluded, after many years of implementing programs to control weed growth in and around transformer station yards, proper herbicide applications offer the only effective method to control weeds which grow in all transmission station yards. Other methods including hand weeding, hand cultivation, weed blankets, hot steam and biological control methods, have proven to be non-practical and/or ineffective.

What Is A Vegetation Control Cycle?

Transmission Lines

A "vegetation control cycle" is the period of time between implementing consecutive vegetation / tree control programs on a transmission line right-of-way. Most electrical utilities have an objective of making this time period as long as possible to reduce costs and impact on the environment. Any transmission line right-of-way will see many vegetation control cycles during its period of operation (50+ years). The length of a control cycle will depend on the tree species being controlled and the methods being used to control the species. Some methods have a short cycle time but are more effective and desirable for controlling very young tree suckers while others can have a longer cycle if trees can be allowed to grow taller before they are controlled. Experience shows that throughout the life of any transmission line it will be necessary to use a number of tree control methods on a right-of-way. Combinations of methods in successive years can also be effective in lengthening the control cycle.

Several methods are available to Manitoba Hydro for controlling tree growth (suckers & saplings) on power line rights-of-way. These range from mechanical removal – to hand cutting – to broadcast and selective spraying of tree re-growth with herbicides – to selective herbicide treatments to individual stems and stumps – to doing nothing where desirable vegetation has occupied the right-of-way.

As described and illustrated in Drawing # 1 (inside back cover) the vegetation control cycle for a particular transmission line really starts in the first spring following the initial right-of-way clearing for line construction. It is in this first spring that the roots of the cleared deciduous trees and shrubs start to send up suckers or re-growth. Profuse and dense suckering will always occur after cutting down deciduous species like birch, poplar, elm, aspen, ash, willow, maple, oak, willow, maple, cranberry, saskatoon, chokecherry, alder, willow and dogwood. Many of the ground cover plants including herbs, sedges and grasses will also begin to re-occupy the right-of-way at this time.

During clearing and construction activities, which typically occur under frozen ground conditions, the heavy equipment working on the right-of-way will physically crush seed cones releasing spruce, pine and tamarack seeds which may also germinate in this first summer following clearing of the right-of-way.

By the end of the first summer, particularly in areas where deciduous trees were initially cleared, there will be sucker growth that reaches 1-2 meters in height. The sucker growth tends to be very thick and can be mixed with pioneer plant species like Fireweed. It is typically after the second summer, for a new line, that Manitoba Hydro will conduct its first line patrol to document where there is prolific re-growth of deciduous trees. After a few summers following line construction the coniferous species are only very small seedlings hidden in the overgrowth of suckering trees and pioneer plants species such as Fireweed and grasses/sedges. This is the time when right-of-way managers plan for the future vegetation control needs of the line.

The vegetation re-growth information will be used to plan for the first vegetation / tree control program for the transmission line right-of-way. This is the start of the vegetation control cycle. The first vegetation control cycle is complete only when a tree control program is implemented, results monitored and a second tree control program planned. Vegetation management must be continuous for the life of the transmission line.

Transmission Stations

Undertaking vegetation control programs in all transmission station yards is also critical. The control cycle begins with conducting an annual weed control survey in each transformer station yard to document the weed problems present. This information is then used to plan actions to remove the weed problem. The specific control actions may be implemented almost immediately or may be planned for implementation in the following year. In many stations it is necessary to undertake some weed control annually using herbicide products approved for controlling weeds in these types of facilities.

Who is responsible for the tree control programs on transmission line rights-of-way?

Manitoba Hydro does vegetation control on both the distribution system (lower voltage lines supplying customers) and transmission system. This document primarily addresses the transmission system.

The responsibility of maintaining the transmission system lies with the Transmission Line Construction & Line Maintenance Division of Manitoba Hydro's Transmission & Distribution Business Unit. Within the Division the responsibility for vegetation control on transmission lines falls within the responsibilities of the Transmission Line Maintenance Managers – North & South. These two groups are responsible for the day to day maintenance of all the transmission lines within their assigned geographical area. This organizational group is most knowledgeable of the lines themselves and the terrain crossed and is properly equipped to access all portions of the lines at any time of year.

Manitoba Hydro's Forestry Section staff is available to the Division to provide supporting expertise and advice related to a variety of tree control methodologies including non-herbicide and herbicide methods. This group maintains good knowledge and expertise related to tree control methods and equipment and the herbicide products used on Manitoba Hydro property. The Forestry Section obtains the necessary provincial authorizations (Pesticide Use Permits) required in accordance with the Pesticide Use Permit Regulation of the Manitoba Pesticide & Fertilizer Control Act. This group must also submit to Manitoba Conservation "Post Seasonal Reports" in accordance with this same regulation. The Forestry Section also ensures all those in direct supervision of staff applying herbicides on Manitoba Hydro's transmission lines and transmission stations are properly licensed in Manitoba to conduct this type of work.

What methods are used to control tree growth on rights-of-way?

Mechanical Clearing Methods

a.) Winter Shearing

Currently the most extensively used tree control method on northern transmission line rights-of-way is the Winter Shearing method (Figure 1). There has not been any large scale northern transmission line herbicide use since 1990. The Winter Shearing method is used only in the winter months and involves wide-track crawler tractors equipped with a front mounted V-Blade traversing back and forth along right-of-way sections to shear off the woody growth at the frozen ground surface. Some northern rights-of-way have seen 2 & 3 control cycles using this method. The advantages of this method include:

- the work is done during frozen conditions on rights-of-way which could not be easily accessed during non-frozen ground conditions

- the method is more economical on a cost per hectare basis (Figure 2) than other methods which could only be practiced during summer months (e.g., herbicide control, mowing)
- with good productivity rates (e.g., hectares per hour) the method allows for a large number of hectares of tree re-growth to be controlled in a single season using a small labor force
- the method allows for a longer period of time between treatments (5-12 years depending on location and site conditions)
- results are immediate
- work is done in winter months when there is less wildlife use of the rights-of-way

The sheared material is generally pushed into windrows as the crawler tractors move back & forth along the right-of-way. The material left on the right-of-way will settle down onto the soil surface after snow melt and will decompose to return organic material to the soil. The method however does not reduce the number of hectares of deciduous tree re-growth requiring re-treatment over time because the sheared trees will sucker back. In areas of spruce or pine re-growth only, this method does result in a long control cycle by removing trees until such time that seeds from these species again germinate on the right-of-way.

Figure 1: Northern Transmission Line Tree Control History 1990 - 2002

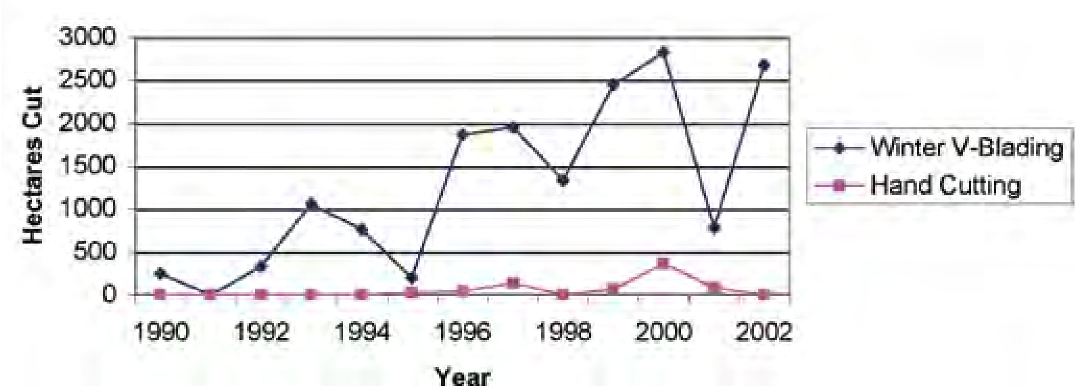
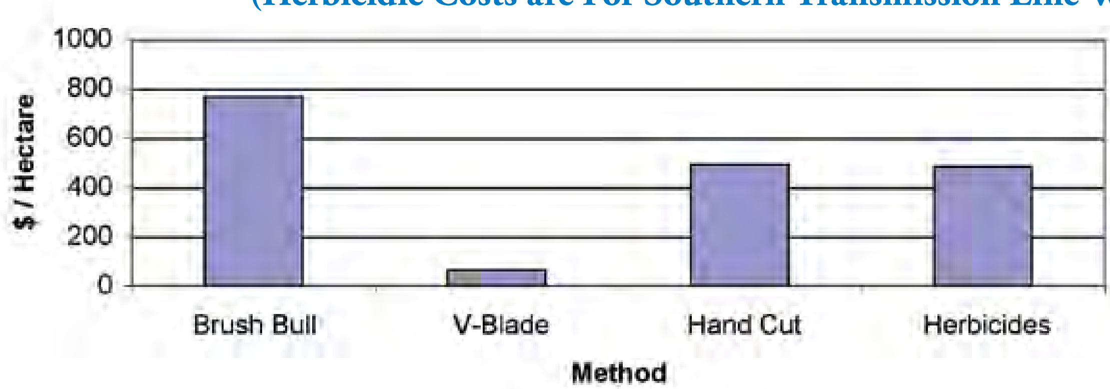


Figure 2: Cost Comparison Of Northern Transmission Line Tree Control Methods
(Herbicidle Costs are For Southern Transmission Line Work)



b.) Mowing (Brush Bulls / Mulchers)

Tree re-growth on rights-of-way can be mowed using rubber tired or tracked tractor units equipped with a special mower head or flail type cutting head. Typically these units can mow a 6 -8 foot (2.5 – 3m) swath as they move along the right-of-way. This type of equipment is used where larger re-growth is present. The equipment is designed to chip or grind the woody material into smaller pieces which are dispersed behind the cutting unit as it works. The woody material will settle on the ground surface and eventually decompose adding organics to the soil. These units are typically only used where summer access is possible and do not work well under snow cover conditions.

As with the winter shearing these units do not eliminate the deciduous tree re-growth. The deciduous tree roots will continue to sucker back onto the right-of-way and repeat cycles are required every 5-7 years.

c.) Hand Cutting

Hand cutting involves the use of brush saws and/or chainsaws to cut down tree re-growth and to remove tall danger trees along right-of-way edges. This method is labor intensive and it's use by the remoteness of many transmission lines. To work in remote areas with this method on a large scale would require aerial support and temporary or mobile work camps and support systems. Hand cutting on transmission lines is typically done in small and sensitive areas like river bank buffers and park areas. It is also done periodically to control individual tall trees that are close to interfering with transmission line operation and safety. This method is used frequently on small areas during line patrols. Hand cutting tends to be a very costly method to remove large areas of tree re-growth occurring on transmission line rights-of-way.

Herbicide Treatments

Throughout North America there are many well accepted herbicide control products and methods for transmission line rights-of-way. Herbicides are a very effective tool which a right-of-way manager can integrate with several other tree control methods over a long period of time. Herbicides provide a tool to effectively strive for development of stable plant communities on the rights-of-way. Stable plant communities have very long periods of "do nothing" between control cycles. There are several herbicide methods currently available to Manitoba Hydro as follows:

a.) Broadcast Ground Spraying

In using this method, specially designed rubber-tired or tracked herbicide spray units traverse back and forth along the right-of-way to deposit large droplets of a solution of water and herbicide product over the leaves of the tree re-growth. The herbicide solution is delivered through a specially designed spray nozzle that produces large droplets that do not easily drift off target. Broadcast spraying is typically done in areas of dense young (1-2m tall) tree growth covering the entire right-of-way width and then only when trees are actively growing and when the weather conditions allow safe application of the herbicide solution.

b.) Selective Handgun Spraying

In selective handgun spraying a solution of water and herbicide is delivered to target trees through a hand operated spray gun . This method is very effective in that the operator can direct the herbicide solution at the undesirable species while avoiding, where possible, desirable low shrubs and other plant species. This promotes growth of desirable species on the right-of-way as the unsprayed plants will continue to grow and thrive. These plants will then compete against trees for nutrients and growing space and thusly help to reduce the return of undesirable tree species onto the right-of-way. This method is widely used with other tree control methods to move toward establishing stable plant communities on rights-of-way.

c.) Basal Bark Sprays

In this method a spray solution is carefully directed to the lower portion of the stem of target tree species. The method can be used when the tree is actively growing or when it is dormant for the winter. The method is highly selective and works well to remove small pockets of low density deciduous tree re-growth. In this method a solution of oil and herbicide is typically used.

d.) Stem Injections

This is a very selective herbicide application method where herbicide is injected into the bark of an individual tree. This method works well in areas such as river crossing buffers which are typically very sensitive to broadcast herbicide application. The herbicide stays within the individual tree stem and is not released to the surrounding environment. Because of the highly selective application method its use is more common in small areas with a few stems to be treated or where one may not want to use hand cutting or mechanical cutting methods.

e.) Stump Treatments

This method involves the application of a herbicide solution to a recently cut deciduous tree stump. It will prevent the tree roots from sending up "suckers" and thusly provides long term control. This method works well in conjunction with hand cutting of small areas. It also works well where it has been necessary to return many times to small areas to re-cut trees growing back in the area. It also works well in small areas which are difficult and costly to access repeatedly. As the method is used on individual stumps it is highly selective in what is controlled.

Biological Control

Manitoba Hydro has funded some research into biological control but does not yet have proven methods that are known to work on our rights-of-way. It is very apparent a carefully prescribed tree control program, will over time, encourage the growth of desirable species on rights-of-way which will then act as a form of biological control. This makes it hard for a tree species that have been removed to seed back onto a right-of-way. Natural competition from other plants is a form of biological control.

Danger Tree Removal

Manitoba Hydro must monitor all transmission line rights-of-way edges for trees that may fall onto the lines. These trees are called "danger trees". They are typically removed during line patrols using chainsaws. Occasionally where transmission lines are located on rights-of-way where the initial clearing widths were minimized it is necessary after several years to conduct a widening of the right-of-way using hand cutting methods.

g.) Tree Trimming

Tree trimming is required on transmission line rights-of-way where taller trees are allowed to remain under or adjacent to the lines for aesthetic or environmental reasons. These situations typically occur in cities, towns and in specific locations within provincial or federal parks. Tree trimming on energized transmission lines is done exclusively by Manitoba Hydro staff who are fully qualified to work in and around energized transmission lines. Special electrical knowledge and training is required to work around energized circuits. Tree trimming also requires special equipment, tree trimming skills and knowledge to work on tall trees. Tree trimming contractors who have certified utility arborists on the crews are however often used on lower voltage distribution lines.

How does Manitoba Hydro choose which method to use?

When prescribing tree control practices for transmission lines several factors must be carefully considered. Consideration of the volume of work or length of line to be treated; vehicle access limitations; environmental sensitivities; the species, growth stage and size of the tree problem (age/height/density); workload planning; timing; contract versus in-house options; and finally costs involved are all important factors. Several of the methods described in the previous section may be used during the life of a transmission line to control tree growth.

A "one method only" approach to any line will not work well over the long term due to the wide variety of terrain and environmental conditions that exist on and adjacent to transmission lines. For example, if a winter shearing program is prescribed to control tree re-growth on a section of high voltage transmission line right-of-way it will also be necessary to prescribe other methods and approaches to control tree growth in smaller sensitive areas or segments within the overall line section. In such cases there could be several stream and river crossing with sensitive riparian areas where winter shearing would not be used. In these situations chainsaw hand clearing followed by a herbicides applied to the freshly cut stumps may be prescribed. The two prescriptions may not happen at the same time depending on the situation, location, timing and workload priorities.

There are many situations and circumstances where herbicides are not an option for controlling tree growth on portions of transmission lines. In some cases the Manitoba Environment Act License issued for the line prohibits their use and in others Manitoba Hydro will decide that given the location and situation at hand herbicides cannot be used (e.g., trees are too tall, herbicides are not suitable in the local environment or the species present, herbicide use will present a risk to adjacent land use, timing is wrong, costs are too high, and right-of-way access in summer time is not available).

In making a decision on what method to use, all of the tree control methods described earlier, which are well accepted in the industry, are available as options to be considered for the problem at hand. The objective is to prescribe a method or combination of methods that provide acceptable tree control at a reasonable cost while trying to achieve a long tree control cycle and ultimately a stable plant community on the right-of-way.

Why are chemicals called herbicides used?

Herbicide application, when properly prescribed and applied, is recognized as an accepted and effective method to control tree growth. There are Federally approved & registered products specifically designed for right-of-way tree control situations. The Province of Manitoba also decides which herbicide products can be used in Manitoba and under what conditions they may be used. The Province also sets guidelines for the rates at which products may be used; how they may be applied; when they may be applied; and where they may not be used. Direct supervisors of herbicide applicators working for Manitoba Hydro on Manitoba Hydro rights-of-way must be trained and licensed by the Province before applying herbicides to rights-of-way. In point of fact most applicators themselves are also licensed by Manitoba.

Manitoba Hydro must also apply each year to Manitoba Conservation for "Pesticide Use Permits" issued under the Manitoba Environment Act before any herbicide program is implemented. Manitoba Hydro must also provide a "Post Seasonal Report" to Manitoba Conservation by year end. This report provides specific information on the work that was done including the herbicide products used, the quantities used of each product, the locations where each product's was applied, the name of the applicator(s) and other information as required by the Province. These Regulatory requirements of Canada and Manitoba are in place to ensure only approved herbicides are used safely and properly.

How does Manitoba Hydro notify the public of its proposed vegetation control programs?

Herbicide Programs

Manitoba Hydro's Forestry Section inititiates public notifications related to proposed herbicide applications to rights-of-way and transmission stations in accordance with requirements of the Provincial Pesticide Use Permit Regulation and in accordance with Manitoba Hydro's internal public notification policies.

The Provincial Pesticide Use Permit process requires Manitoba Hydro apply for a pesticide use permit issued by Manitoba Conservation. In making this application Manitoba Hydro must identify which pesticide (i.e.; herbicide) products are intended to be used; where they are intended to be used; the equipment/methodology to be used; and which Provincially Licensed Applicators will be applying the pesticide. The Regulation also requires the public be notified when an application for a Pesticide Use Permit has been made. To achieve this Manitoba Hydro will typically place advertisements in the Winnipeg Free Press and/or local newspaper in the vicinity of where the work is to be completed. Manitoba Hydro will also contact landowners with property adjacent to the right of way that is to be treated with a herbicide to inform them of the proposed work and to address concerns related to carrying out the program adjacent to their land. This would also include contacting First Nations should herbicide use be proposed on Reserve Lands.

Non-herbicide Programs

When non-herbicide tree control work is to occur on private property it is Manitoba Hydro's policy to contact the landowner prior to entering the property to do the work. For work that is to occur on First Nations Reserve lands Manitoba Hydro would, in advance of the program, contact the Chief & Council of the affected First Nation. Where work is to be done on rights-of-way crossing Crown lands Manitoba Hydro must obtain a Work Permit from Manitoba Conservation prior to work beginning.

What has been the history of northern herbicide use since 1990?

There are over 4200 kilometers of transmission lines in northern Manitoba to be monitored annually for tree re-growth problems. The last transmission line spraying of significance on a northern transmission line occurred in 1990 on a 230 kV transmission line running between Flin Flon and The Pas. Instead of using herbicides, right-of-way vegetation managers treat approximately 2000 hectares of right-of-way each winter using hand cutting, mechanical mowing and winter shearing methods to control tree re-growth.

Since 1985 the use of herbicides on northern transmission lines has diminished to where only very small sections of transmission rights-of-way have recently been treated with herbicide. These involved application of herbicide to woody growth in and around tower bases to allow annual monitoring of tower footing movement and to highly selective individual stem treatments on small sections of rights-of-way.

Since 1985 Manitoba Hydro has, in its overall use of herbicides, significantly reduced the amount of active ingredient (ai) used per treated hectare of right-of-way or station yard (Figure 3 & 4). A review of Post Seasonal Control Reports since 1985 confirms that since 1991 tree control programs using herbicide products have been, for the most part, on the distribution lines (66 kilovolt & lower lines) and not on transmission lines (115 kilovolt & higher lines). Although Figure 5 shows a slightly increasing trend in the amount of area treated annually with herbicides to control tree re-growth this trend is exclusively due to increased use of herbicides on the distribution system. The trend of increasing hectares of weed control each year is largely due to recent acquisition of Centra Gas and Winnipeg Hydro. Manitoba Hydro has also, since 1985, significantly reduced the use of soil residual herbicide products. This trend is confirmed in Figure 6. Herbicide products used by Manitoba Hydro today are much more selective in the species they control and have minimal soil residue lingering into the next growing season.

Although aircraft are still commonly used elsewhere in North America to apply herbicides, Manitoba Hydro does not use aircraft to apply herbicides to rights-of-way and has no plans to re-introduce the method in the foreseeable future. Manitoba Hydro does however remain current with respect to various application methodologies and equipment available in the industry and will assess its suitability for Manitoba Hydro's right-of-way situations.

With the exception of the North Central Project (because of specific conditions of its Environment Act Licence prohibiting herbicide use on the project) herbicides are used in all transmission stations in northern Manitoba. Manitoba Hydro makes use of herbicide products to control weeds in transmission stations which are effective but do not have long term soil residual properties (i.e.: where herbicide effects on plants can be seen into the second growing season). Additionally Manitoba Hydro has, since 1985, significantly reduced the active herbicide ingredient applied per hectare annually in station weed control programs.

Figure 3: Tree Control Herbicide Programs
(Transmission & Distribution Lines Combined)
Active Ingredient Use 1985 - 2002

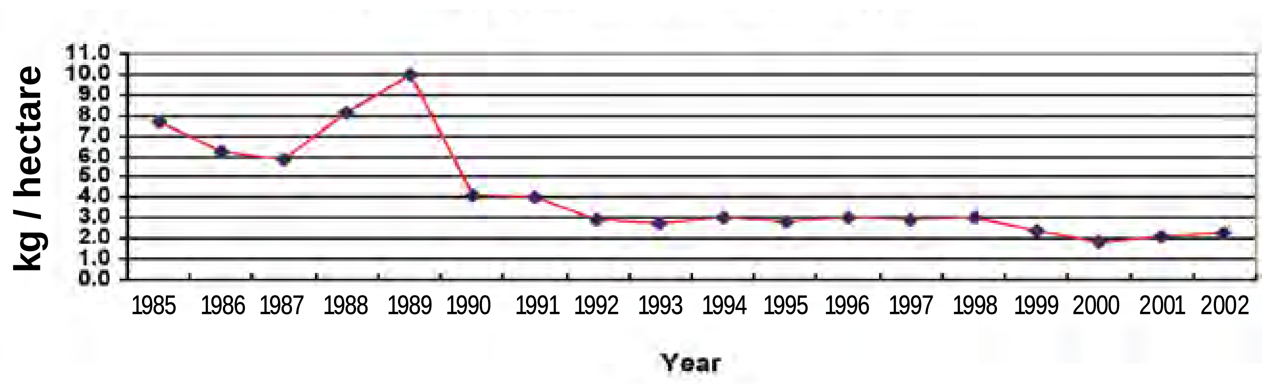


Figure 4: Station Weed Control Herbicide Programs
(Transmission & Distribution Combined)
Active Ingredient Use 1985 - 2002

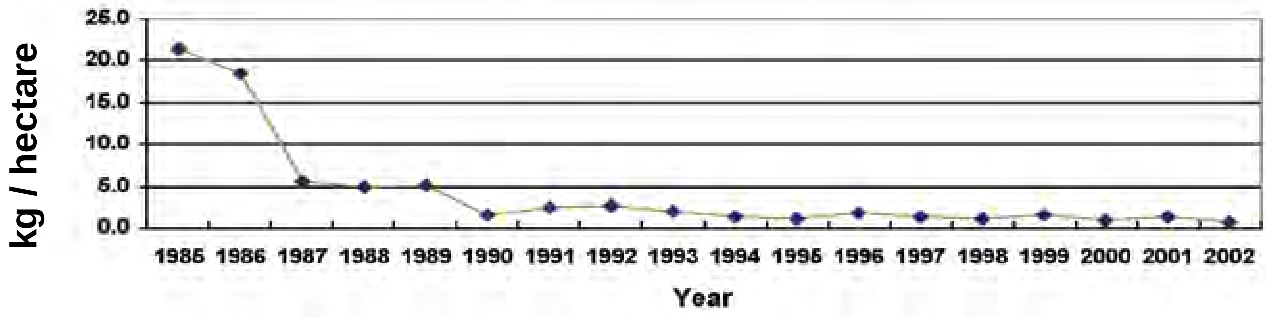
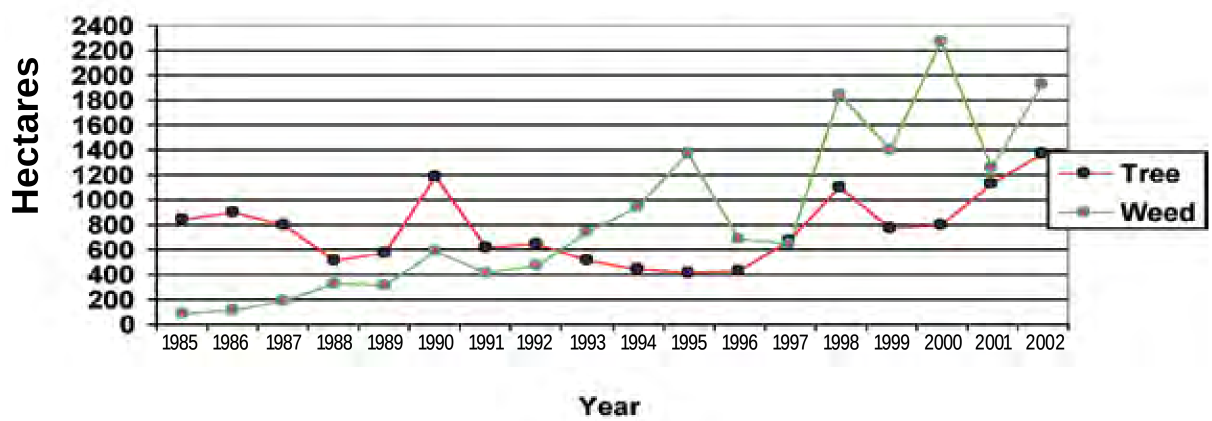


Figure 5: Tree & Weed Control Herbicide Programs
(Transmission & Distribution Combined)
Area Treated 1985 - 2002



Drawing #1 — Vegetation Control Cycle

Step 1 “RIGHT-OF-WAY CLEARING”

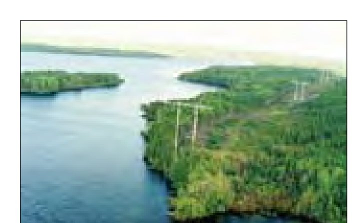
Trees on the Transmission line right-of-way are cleared to allow line construction and operation


Step 2 “RIGHT-OF-WAY RECOVERY FROM TREE CLEARING”

In the spring of the first summer following right-of-way clearing the roots of the deciduous trees and shrubs start to send up suckers. The pioneer plants species (herbs/forbs/grasses/sedges) start to grow back within the Right-of-way. Seeds released from crushed pine and spruce seed cones may germinate and grow under the suckers and other plants now growing on the right-of-way


Step 3 “DOCUMENT TREE RE-GROWTH”

After two growing seasons following the clearing of the right-of-way the first transmission line patrol is completed to monitor & document tree re-growth occurring on the new right-of-way. This survey will document those locations (recorded by span #’s) along the right-of-way with deciduous tree suckering now present

Step 4 “A VEGETATION MANAGEMENT PLAN”

The line patrol information is analyzed and compiled to develop a long term plan and approach, including budget estimates, scheduling information and a prescription for method(s) that could be used for controlling the tree re-growth


Step 5 “PLAN FOR IMPLEMENTATION”

The Vegetation Management Plan is further refined where more detailed plans are developed including:

- assignment of dollars to the tree control program
- confirming the method(s) to be used to control the tree re-growth
- finalizing work schedules
- obtaining all necessary regulatory approvals prior to work being started
- preparing contract specifications where required
- selection & awarding of Contract(s)/ organizing of MH work crews

Step 6 “IMPLEMENT TREE CONTROL PROGRAM(S)”

Conduct of the tree control program(s) on the right-of-way



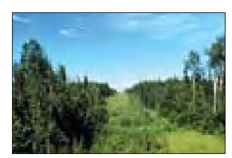
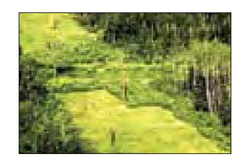






Step 7 “ASSESS RESULTS”

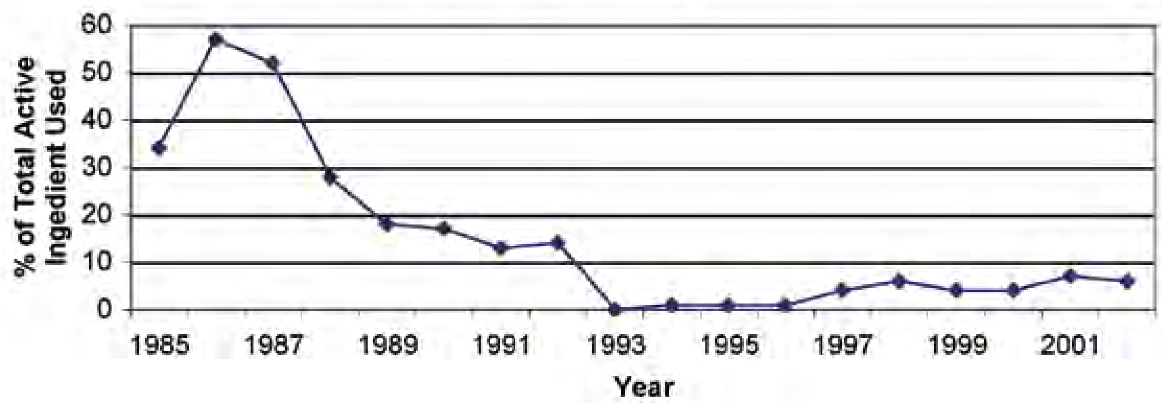
Patrol the work areas to assess effectiveness of control methods and to develop plans to correct deficiencies


Step 8 “DOCUMENT TREE RE-GROWTH”

Two years after the previous tree control work conduct another line patrol to document and map the locations and extent of tree growth problems on the right-of-way

Figure 6: Residual Herbicide Use Expressed As A Percent Of Total Active Ingredient Use



In Closing…

Tree and weed control responsibilities required to operate and maintain transmission lines and transformer stations are taken very seriously at Manitoba Hydro. This work must be carried out periodically on all transmission lines and transmission stations. However Manitoba Hydro also takes its environmental stewardship policies very seriously when prescribing methods and conducting any work to control tree and weed growth on transmission facilities. In this way the environment can be protected as the work is being done.

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A. Introduction

1. **Title:** **Transmission Vegetation Management**
2. **Number:** **FAC-003-4**
3. **Purpose:** **To maintain a reliable electric transmission system by using a defense-in-depth strategy to manage vegetation located on transmission rights of way (ROW) and minimize encroachments from vegetation located adjacent to the ROW, thus preventing the risk of those vegetation-related outages that could lead to Cascading.**
4. **Applicability:**

4.1. Functional Entities:

4.1.1. Applicable Transmission Owners

4.1.1.1. Transmission Owners that own Transmission Facilities defined in 4.2.

4.1.2. Applicable Generator Owners

4.1.2.1. Generator Owners that own generation Facilities defined in 4.3.

4.2. Transmission Facilities: Defined below (referred to as "applicable lines"), including but not limited to those that cross lands owned by federal[1], state, provincial, public, private, or tribal entities:

4.2.1. Each overhead transmission line operated at 200kV or higher.

4.2.2. Each overhead transmission line operated below 200kV identified as an element of an IROL under NERC Standard FAC-014 by the Planning Coordinator.

4.2.3. Each overhead transmission line operated below 200 kV identified as an element of a Major WECC Transfer Path in the Bulk Electric System by WECC.

4.2.4. Each overhead transmission line identified above (4.2.1. through 4.2.3.) located outside the fenced area of the switchyard, station or substation and any portion of the span of the transmission line that is crossing the substation fence.

4.3. Generation Facilities: Defined below (referred to as "applicable lines"), including but not limited to those that cross lands owned by federal[2], state, provincial, public, private, or tribal entities:

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[1] EPAct 2005 section 1211c: *"Access approvals by Federal agencies."*

[2] *Id.*

4.3.1. Overhead transmission lines that (1) extend greater than one mile or 1.609 kilometers beyond the fenced area of the generating station switchyard to the point of interconnection with a Transmission Owner's Facility or (2) do not have a clear line of sight[3] from the generating station switchyard fence to the point of interconnection with a Transmission Owner's Facility and are:

4.3.1.1. Operated at 200kV or higher; or

4.3.1.2. Operated below 200kV identified as an element of an IROL under NERC Standard FAC-014 by the Planning Coordinator; or

4.3.1.3. Operated below 200 kV identified as an element of a Major WECC Transfer Path in the Bulk Electric System by WECC.

5. Effective Date: See Implementation Plan

6. Background: This standard uses three types of requirements to provide layers of protection to prevent vegetation related outages that could lead to Cascading:

a) Performance-based defines a particular reliability objective or outcome to be achieved. In its simplest form, a results-based requirement has four components: *who, under what conditions (if any), shall perform what action, to achieve what particular bulk power system* <u>*performance result or outcome*</u>*?*

b) Risk-based preventive requirements to reduce the risks of failure to acceptable tolerance levels. A risk-based reliability requirement should be framed as: *who, under what conditions (if any), shall perform what action, to achieve what particular result or outcome that* <u>*reduces a stated risk*</u> *to the reliability of the bulk power system?*

c) Competency-based defines a minimum set of capabilities an entity needs to have to demonstrate it is able to perform its designated reliability functions. A competency-based reliability requirement should be framed as: *who, under what conditions (if any), shall have* <u>*what capability*</u>*, to achieve what particular result or outcome to perform an action to achieve a result or outcome or to reduce a risk to the reliability of the bulk power system?*

The defense-in-depth strategy for reliability standards development recognizes that each requirement in a NERC reliability standard has a role in preventing system failures, and that these roles are complementary and reinforcing. Reliability standards should not be viewed as a body of unrelated requirements, but rather should be viewed as part of a portfolio of requirements designed to achieve an overall defense-in-depth strategy and comport with the quality objectives of a reliability standard.

[3] "Clear line of sight" means the distance that can be seen by the average person without special instrumentation (e.g., binoculars, telescope, spyglasses, etc.) on a clear day.

This standard uses a defense-in-depth approach to improve the reliability of the electric Transmission system by:

- Requiring that vegetation be managed to prevent vegetation encroachment inside the flash-over clearance (R1 and R2);
- Requiring documentation of the maintenance strategies, procedures, processes and specifications used to manage vegetation to prevent potential flash-over conditions including consideration of 1) conductor dynamics and 2) the interrelationships between vegetation growth rates, control methods and the inspection frequency (R3);
- Requiring timely notification to the appropriate control center of vegetation conditions that could cause a flash-over at any moment (R4);
- Requiring corrective actions to ensure that flash-over distances will not be violated due to work constrains such as legal injunctions (R5);
- Requiring inspections of vegetation conditions to be performed annually (R6); and
- Requiring that the annual work needed to prevent flash-over is completed (R7).

For this standard, the requirements have been developed as follows:

- Performance-based: Requirements 1 and 2
- Competency-based: Requirement 3
- Risk-based: Requirements 4, 5, 6 and 7

R3 serves as the first line of defense by ensuring that entities understand the problem they are trying to manage and have fully developed strategies and plans to manage the problem. R1, R2, and R7 serve as the second line of defense by requiring that entities carry out their plans and manage vegetation. R6, which requires inspections, may be either a part of the first line of defense (as input into the strategies and plans) or as a third line of defense (as a check of the first and second lines of defense). R4 serves as the final line of defense, as it addresses cases in which all the other lines of defense have failed.

Major outages and operational problems have resulted from interference between overgrown vegetation and transmission lines located on many types of lands and ownership situations. Adherence to the standard requirements for applicable lines on any kind of land or easement, whether they are Federal Lands, state or provincial lands, public or private lands, franchises, easements or lands owned in fee, will reduce and manage this risk. For the purpose of the standard the term “public lands” includes municipal lands, village lands, city lands, and a host of other governmental entities.

This standard addresses vegetation management along applicable overhead lines and does not apply to underground lines, submarine lines or to line sections inside an electric station boundary.

This standard focuses on transmission lines to prevent those vegetation related outages that could lead to Cascading. It is not intended to prevent customer outages due to tree contact with lower voltage distribution system lines. For example, localized customer service might be disrupted if vegetation were to make contact with a 69kV transmission line supplying power to a 12kV distribution station. However, this standard is not written to address such isolated situations which have little impact on the overall electric transmission system.

Since vegetation growth is constant and always present, unmanaged vegetation poses an increased outage risk, especially when numerous transmission lines are operating at or near their Rating. This can present a significant risk of consecutive line failures when lines are experiencing large sags thereby leading to Cascading. Once the first line fails the shift of the current to the other lines and/or the increasing system loads will lead to the second and subsequent line failures as contact to the vegetation under those lines occurs. Conversely, most other outage causes (such as trees falling into lines, lightning, animals, motor vehicles, etc.) are not an interrelated function of the shift of currents or the increasing system loading. These events are not any more likely to occur during heavy system loads than any other time. There is no cause-effect relationship which creates the probability of simultaneous occurrence of other such events. Therefore these types of events are highly unlikely to cause large-scale grid failures. Thus, this standard places the highest priority on the management of vegetation to prevent vegetation grow-ins.

B. Requirements and Measures

R1. Each applicable Transmission Owner and applicable Generator Owner shall manage vegetation to prevent encroachments into the Minimum Vegetation Clearance Distance (MVCD) of its applicable line(s) which are either an element of an IROL, or an element of a Major WECC Transfer Path; operating within their Rating and all Rated Electrical Operating Conditions of the types shown below[4] *[Violation Risk Factor: High] [Time Horizon: Real-time]*:

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[4] This requirement does not apply to circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner subject to this reliability standard, including natural disasters such as earthquakes, fires, tornados, hurricanes, landslides, wind shear, fresh gale, major storms as defined either by the applicable Transmission Owner or applicable Generator Owner or an applicable regulatory body, ice storms, and floods; human or animal activity such as logging, animal severing tree, vehicle contact with tree, or installation, removal, or digging of vegetation. Nothing in this footnote should be construed to limit the Transmission Owner's or applicable Generator Owner's right to exercise its full legal rights on the ROW.

1.1. An encroachment into the MVCD as shown in FAC-003-Table 2, observed in Real-time, absent a Sustained Outage,[5]

1.2. An encroachment due to a fall-in from inside the ROW that caused a vegetation-related Sustained Outage,[6]

1.3. An encroachment due to the blowing together of applicable lines and vegetation located inside the ROW that caused a vegetation-related Sustained Outage[7],

1.4. An encroachment due to vegetation growth into the MVCD that caused a vegetation-related Sustained Outage.[8]

M1. Each applicable Transmission Owner and applicable Generator Owner has evidence that it managed vegetation to prevent encroachment into the MVCD as described in R1. Examples of acceptable forms of evidence may include dated attestations, dated reports containing no Sustained Outages associated with encroachment types 2 through 4 above, or records confirming no Real-time observations of any MVCD encroachments. (R1)

R2. Each applicable Transmission Owner and applicable Generator Owner shall manage vegetation to prevent encroachments into the MVCD of its applicable line(s) which are not either an element of an IROL, or an element of a Major WECC Transfer Path; operating within its Rating and all Rated Electrical Operating Conditions of the types shown below[9] *[Violation Risk Factor: High] [Time Horizon: Real-time]*:

2.1. An encroachment into the MVCD, observed in Real-time, absent a Sustained Outage,[10]

2.2. An encroachment due to a fall-in from inside the ROW that caused a vegetation-related Sustained Outage,[11]

2.3. An encroachment due to the blowing together of applicable lines and vegetation located inside the ROW that caused a vegetation-related Sustained Outage,[12]

2.4. An encroachment due to vegetation growth into the line MVCD that caused a vegetation-related Sustained Outage.[13]

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[5] If a later confirmation of a Fault by the applicable Transmission Owner or applicable Generator Owner shows that a vegetation encroachment within the MVCD has occurred from vegetation within the ROW, this shall be considered the equivalent of a Real-time observation.

[6] Multiple Sustained Outages on an individual line, if caused by the same vegetation, will be reported as one outage regardless of the actual number of outages within a 24-hour period.

[7] *Id.*

[8] *Id.*

[9] See footnote 4.

[10] See footnote 5.

[11] See footnote 6.

[12] *Id.*

[13] *Id.*

M2. Each applicable Transmission Owner and applicable Generator Owner has evidence that it managed vegetation to prevent encroachment into the MVCD as described in R2. Examples of acceptable forms of evidence may include dated attestations, dated reports containing no Sustained Outages associated with encroachment types 2 through 4 above, or records confirming no Real-time observations of any MVCD encroachments. (R2)

R3. Each applicable Transmission Owner and applicable Generator Owner shall have documented maintenance strategies or procedures or processes or specifications it uses to prevent the encroachment of vegetation into the MVCD of its applicable lines that accounts for the following: *[Violation Risk Factor: Lower] [Time Horizon: Long Term Planning]:*

3.1. Movement of applicable line conductors under their Rating and all Rated Electrical Operating Conditions;

3.2. Inter-relationships between vegetation growth rates, vegetation control methods, and inspection frequency.

M3. The maintenance strategies or procedures or processes or specifications provided demonstrate that the applicable Transmission Owner and applicable Generator Owner can prevent encroachment into the MVCD considering the factors identified in the requirement. (R3)

R4. Each applicable Transmission Owner and applicable Generator Owner, without any intentional time delay, shall notify the control center holding switching authority for the associated applicable line when the applicable Transmission Owner and applicable Generator Owner has confirmed the existence of a vegetation condition that is likely to cause a Fault at any moment *[Violation Risk Factor: Medium] [Time Horizon: Real-time].*

M4. Each applicable Transmission Owner and applicable Generator Owner that has a confirmed vegetation condition likely to cause a Fault at any moment will have evidence that it notified the control center holding switching authority for the associated transmission line without any intentional time delay. Examples of evidence may include control center logs, voice recordings, switching orders, clearance orders and subsequent work orders. (R4)

R5. When an applicable Transmission Owner and an applicable Generator Owner are constrained from performing vegetation work on an applicable line operating within its Rating and all Rated Electrical Operating Conditions, and the constraint may lead to a vegetation encroachment into the MVCD prior to the implementation of the next annual work plan, then the applicable Transmission Owner or applicable Generator Owner shall take corrective action to ensure continued vegetation management to prevent encroachments [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*].

M5. Each applicable Transmission Owner and applicable Generator Owner has evidence of the corrective action taken for each constraint where an applicable transmission line was put at potential risk. Examples of acceptable forms of evidence may include initially-planned work orders, documentation of constraints from landowners, court orders, inspection records of increased monitoring, documentation of the de-rating of lines, revised work orders, invoices, or evidence that the line was de-energized. (R5)

R6. Each applicable Transmission Owner and applicable Generator Owner shall perform a Vegetation Inspection of 100% of its applicable transmission lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.) at least once per calendar year and with no more than 18 calendar months between inspections on the same ROW[14] [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*].

M6. Each applicable Transmission Owner and applicable Generator Owner has evidence that it conducted Vegetation Inspections of the transmission line ROW for all applicable lines at least once per calendar year but with no more than 18 calendar months between inspections on the same ROW. Examples of acceptable forms of evidence may include completed and dated work orders, dated invoices, or dated inspection records. (R6)

R7. Each applicable Transmission Owner and applicable Generator Owner shall complete 100% of its annual vegetation work plan of applicable lines to ensure no vegetation encroachments occur within the MVCD. Modifications to the work plan in response to changing conditions or to findings from vegetation inspections may be made (provided they do not allow encroachment of vegetation into the MVCD) and must be documented. The percent completed calculation is based on the number of units actually completed divided by the number of units in the final amended plan (measured in units of choice - circuit, pole line, line miles or kilometers, etc.). Examples of reasons for modification to annual plan may include [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]:

7.1. Change in expected growth rate/environmental factors

7.2. Circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner[15]

7.3. Rescheduling work between growing seasons

7.4. Crew or contractor availability/Mutual assistance agreements

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[14] When the applicable Transmission Owner or applicable Generator Owner is prevented from performing a Vegetation Inspection within the timeframe in R6 due to a natural disaster, the TO or GO is granted a time extension that is equivalent to the duration of the time the TO or GO was prevented from performing the Vegetation Inspection.

[15] Circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner include but are not limited to natural disasters such as earthquakes, fires, tornados, hurricanes, landslides, ice storms, floods, or major storms as defined either by the TO or GO or an applicable regulatory body.

7.5. Identified unanticipated high priority work

7.6. Weather conditions/Accessibility

7.7. Permitting delays

7.8. Land ownership changes/Change in land use by the landowner

7.9. Emerging technologies

M7. Each applicable Transmission Owner and applicable Generator Owner has evidence that it completed its annual vegetation work plan for its applicable lines. Examples of acceptable forms of evidence may include a copy of the completed annual work plan (as finally modified), dated work orders, dated invoices, or dated inspection records. (R7)

C. Compliance

1. Compliance Monitoring Process

1.1. Compliance Enforcement Authority:
"Compliance Enforcement Authority" means NERC or the Regional Entity, or any entity as otherwise designated by an Applicable Governmental Authority, in their respective roles of monitoring and/or enforcing compliance with mandatory and enforceable Reliability Standards in their respective jurisdictions.

1.2. Evidence Retention:
The following evidence retention period(s) identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full-time period since the last audit.

The applicable entity shall keep data or evidence to show compliance as identified below unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

- The applicable Transmission Owner and applicable Generator Owner retains data or evidence to show compliance with Requirements R1, R2, R3, R5, R6 and R7, for three calendar years.
- The applicable Transmission Owner and applicable Generator Owner retains data or evidence to show compliance with Requirement R4, Measure M4 for most recent 12 months of operator logs or most recent 3 months of voice recordings or transcripts of voice recordings, unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

- If an applicable Transmission Owner or applicable Generator Owner is found non-compliant, it shall keep information related to the non-compliance until found compliant or for the time period specified above, whichever is longer.

1.3. Compliance Monitoring and Enforcement Program
As defined in the NERC Rules of Procedure, "Compliance Monitoring and Enforcement Program" refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with the associated Reliability Standard.

1.4. Additional Compliance Information

Periodic Data Submittal: The applicable Transmission Owner and applicable Generator Owner will submit a quarterly report to its Regional Entity, or the Regional Entity's designee, identifying all Sustained Outages of applicable lines operated within their Rating and all Rated Electrical Operating Conditions as determined by the applicable Transmission Owner or applicable Generator Owner to have been caused by vegetation, except as excluded in footnote 2, and including as a minimum the following:

- The name of the circuit(s), the date, time and duration of the outage; the voltage of the circuit; a description of the cause of the outage; the category associated with the Sustained Outage; other pertinent comments; and any countermeasures taken by the applicable Transmission Owner or applicable Generator Owner.

  A Sustained Outage is to be categorized as one of the following:

- Category 1A — Grow-ins: Sustained Outages caused by vegetation growing into applicable lines, that are identified as an element of an IROL or Major WECC Transfer Path, by vegetation inside and/or outside of the ROW;
- Category 1B — Grow-ins: Sustained Outages caused by vegetation growing into applicable lines, but are not identified as an element of an IROL or Major WECC Transfer Path, by vegetation inside and/or outside of the ROW;
- Category 2A — Fall-ins: Sustained Outages caused by vegetation falling into applicable lines that are identified as an element of an IROL or Major WECC Transfer Path, from within the ROW;
- Category 2B — Fall-ins: Sustained Outages caused by vegetation falling into applicable lines, but are not identified as an element of an IROL or Major WECC Transfer Path, from within the ROW;
- Category 3 — Fall-ins: Sustained Outages caused by vegetation falling into applicable lines from outside the ROW;
- Category 4A — Blowing together: Sustained Outages caused by vegetation and applicable lines that are identified as an element of an IROL or Major WECC Transfer Path, blowing together from within the ROW;

- Category 4B — Blowing together: Sustained Outages caused by vegetation and applicable lines, but are not identified as an element of an IROL or Major WECC Transfer Path, blowing together from within the ROW.

  The Regional Entity will report the outage information provided by applicable Transmission Owners and applicable Generator Owners, as per the above, quarterly to NERC, as well as any actions taken by the Regional Entity as a result of any of the reported Sustained Outages.

Violation Severity Levels (Table 1)

R #	Table 1: Violation Severity Levels (VSL)			
	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1.			The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line identified as an element of an IROL or Major WECC transfer path and encroachment into the MVCD as identified in FAC-003-4-Table 2 was observed in real time absent a Sustained Outage.	The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line identified as an element of an IROL or Major WECC transfer path and a vegetation-related Sustained Outage was caused by one of the following: • *A fall-in from inside the active transmission line ROW* • *Blowing together of applicable lines and vegetation located inside the active transmission line ROW* • *A grow-in*
R2.			The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line not identified as an element of	The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line not identified as an element of

			an IROL or Major WECC transfer path and encroachment into the MVCD as identified in FAC-003-4-Table 2 was observed in real time absent a Sustained Outage.	an IROL or Major WECC transfer path and a vegetation-related Sustained Outage was caused by one of the following: • *A fall-in from inside the active transmission line ROW* • *Blowing together of applicable lines and vegetation located inside the active transmission line ROW* • *A grow-in*
R3.		The responsible entity has maintenance strategies or documented procedures or processes or specifications but has not accounted for the inter-relationships between vegetation growth rates, vegetation control methods, and inspection frequency, for the responsible entity's applicable lines. (Requirement R3, Part 3.2.)	The responsible entity has maintenance strategies or documented procedures or processes or specifications but has not accounted for the movement of transmission line conductors under their Rating and all Rated Electrical Operating Conditions, for the responsible entity's applicable lines. (Requirement R3, Part 3.1.)	The responsible entity does not have any maintenance strategies or documented procedures or processes or specifications used to prevent the encroachment of vegetation into the MVCD, for the responsible entity's applicable lines.
R4.			The responsible entity experienced a confirmed	The responsible entity experienced a confirmed

			vegetation threat and notified the control center holding switching authority for that applicable line, but there was intentional delay in that notification.	vegetation threat and did not notify the control center holding switching authority for that applicable line.
R5.				The responsible entity did not take corrective action when it was constrained from performing planned vegetation work where an applicable line was put at potential risk.
R6.	The responsible entity failed to inspect 5% or less of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.)	The responsible entity failed to inspect more than 5% up to and including 10% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.).	The responsible entity failed to inspect more than 10% up to and including 15% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.).	The responsible entity failed to inspect more than 15% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.).
R7.	The responsible entity failed to complete 5% or less of its annual vegetation work plan for its applicable lines (as finally modified).	The responsible entity failed to complete more than 5% and up to and including 10% of its annual vegetation work plan for its applicable lines (as finally modified).	The responsible entity failed to complete more than 10% and up to and including 15% of its annual vegetation work plan for its applicable lines (as finally modified).	The responsible entity failed to complete more than 15% of its annual vegetation work plan for its applicable lines (as finally modified).

D. Regional Variances

None.

E. Associated Documents

- FAC-003-4 Implementation Plan

Version History

Version	Date	Action	Change Tracking
1	January 20, 2006	1. Added "Standard Development Roadmap." 2. Changed "60" to "Sixty" in section A, 5.2. 3. Added "Proposed Effective Date: April 7, 2006" to footer. 4. Added "Draft 3: November 17, 2005" to footer.	New
1	April 4, 2007	Regulatory Approval - Effective Date	New
2	November 3, 2011	Adopted by the NERC Board of Trustees	New
2	March 21, 2013	FERC Order issued approving FAC-003-2 (Order No. 777) FERC Order No. 777 was issued on March 21, 2013 directing NERC to "conduct or contract testing to obtain empirical data and submit a report to the Commission providing the results of the testing."[16]	Revisions

[16] *Revisions to Reliability Standard for Transmission Vegetation Management, Order No. 777,* 142 FERC ¶ 61,208 (2013)

2	May 9, 2013	Board of Trustees adopted the modification of the VRF for Requirement R2 of FAC-003-2 by raising the VRF from “Medium” to “High.”	Revisions
3	May 9, 2013	FAC-003-3 adopted by Board of Trustees	Revisions
3	September 19, 2013	A FERC order was issued on September 19, 2013, approving FAC-003-3. This standard became enforceable on July 1, 2014 for Transmission Owners. For Generator Owners, R3 became enforceable on January 1, 2015 and all other requirements (R1, R2, R4, R5, R6, and R7) became enforceable on January 1, 2016.	Revisions
3	November 22, 2013	Updated the VRF for R2 from “Medium” to “High” per a Final Rule issued by FERC	Revisions
3	July 30, 2014	Transferred the effective dates section from FAC-003-2 (for Transmission Owners) into FAC-003-3, per the FAC-003-3 implementation plan	Revisions
4	February 11, 2016	Adopted by Board of Trustees. Adjusted MVCD values in Table 2 for alternating current systems, consistent with findings reported in report filed on August 12, 2015 in Docket No. RM12-4-002 consistent with FERC’s directive in Order No. 777, and based on empirical testing results for flashover distances between conductors and vegetation.	Revisions
4	March 9, 2016	Corrected subpart 7.10 to M7, corrected value of .07 to .7	Errata
4	April 26, 2016	FERC Letter Order approving FAC-003-4. Docket No. RD16-4-000.	

FAC-003 — TABLE 2 — Minimum Vegetation Clearance Distances (MVCD)[17]

For **Alternating Current** Voltages (feet)

(AC) Nominal System Voltage (KV)+	(AC) Maximum System Voltage (kV)[18]	MVCD (feet) Over sea level up to 500 ft	MVCD feet Over 500 ft up to 1000 ft	MVCD feet Over 1000 ft up to 2000 ft	MVCD feet Over 2000 ft up to 3000 ft	MVCD feet Over 3000 ft up to 4000 ft	MVCD feet Over 4000 ft up to 5000 ft	MVCD feet Over 5000 ft up to 6000 ft	MVCD feet Over 6000 ft up to 7000 ft	MVCD feet Over 7000 ft up to 8000 ft	MVCD feet Over 8000 ft up to 9000 ft	MVCD feet Over 9000 ft up to 10000 ft	MVCD feet Over 10000 ft up to 11000 ft	MVCD feet Over 11000 ft up to 12000 ft	MVCD feet Over 12000 ft up to 13000 ft	MVCD feet Over 13000 ft up to 14000 ft	MVCD feet Over 14000 ft up to 15000 ft
765	800	11.6ft	11.7ft	11.9ft	12.1ft	12.2ft	12.4ft	12.6ft	12.8ft	13.0ft	13.1ft	13.3ft	13.5ft	13.7ft	13.9ft	14.1ft	14.3ft
500	550	7.0ft	7.1ft	7.2ft	7.4ft	7.5ft	7.6ft	7.8ft	7.9ft	8.1ft	8.2ft	8.3ft	8.5ft	8.6ft	8.8ft	8.9ft	9.1ft
345	362[19]	4.3ft	4.3ft	4.4ft	4.5ft	4.6ft	4.7ft	4.8ft	4.9ft	5.0ft	5.1ft	5.2ft	5.3ft	5.4ft	5.5ft	5.6ft	5.7ft
287	302	5.2ft	5.3ft	5.4ft	5.5ft	5.6ft	5.7ft	5.8ft	5.9ft	6.1ft	6.2ft	6.3ft	6.4ft	6.5ft	6.6ft	6.8ft	6.9ft
230	242	4.0ft	4.1ft	4.2ft	4.3ft	4.3ft	4.4ft	4.5ft	4.6ft	4.7ft	4.8ft	4.9ft	5.0ft	5.1ft	5.2ft	5.3ft	5.4ft
161*	169	2.7ft	2.7ft	2.8ft	2.9ft	2.9ft	3.0ft	3.0ft	3.1ft	3.2ft	3.3ft	3.3ft	3.4ft	3.5ft	3.6ft	3.7ft	3.8ft
138*	145	2.3ft	2.3ft	2.4ft	2.4ft	2.5ft	2.5ft	2.6ft	2.7ft	2.7ft	2.8ft	2.8ft	2.9ft	3.0ft	3.0ft	3.1ft	3.2ft
115*	121	1.9ft	1.9ft	1.9ft	2.0ft	2.0ft	2.1ft	2.1ft	2.2ft	2.2ft	2.3ft	2.3ft	2.4ft	2.5ft	2.5ft	2.6ft	2.7ft
88*	100	1.5ft	1.5ft	1.6ft	1.6ft	1.7ft	1.7ft	1.8ft	1.8ft	1.8ft	1.9ft	1.9ft	2.0ft	2.0ft	2.1ft	2.2ft	2.2ft
69*	72	1.1ft	1.1ft	1.1ft	1.2ft	1.2ft	1.2ft	1.2ft	1.3ft	1.3ft	1.3ft	1.4ft	1.4ft	1.4ft	1.5ft	1.6ft	1.6ft

* Such lines are applicable to this standard only if PC has determined such per FAC-014 (refer to the Applicability Section above)

+ *Table 2 – Table of MVCD values at a 1.0 gap factor (in U.S. customary units), which is located in the EPRI report filed with FERC on August 12, 2015. (The 14000-15000 foot values were subsequently provided by EPRI in an updated Table 2 on December 1, 2015, filed with the FAC-003-4 Petition at FERC)*

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[17] The distances in this Table are the minimums required to prevent Flash-over; however prudent vegetation maintenance practices dictate that substantially greater distances will be achieved at time of vegetation maintenance.

[18] Where applicable lines are operated at nominal voltages other than those listed, the applicable Transmission Owner or applicable Generator Owner should use the maximum system voltage to determine the appropriate clearance for that line.

[19] The change in transient overvoltage factors in the calculations are the driver in the decrease in MVCDs for voltages of 345 kV and above. Refer to pp.29-31 in the Supplemental Materials for additional information.

TABLE 2 (CONT) — Minimum Vegetation Clearance Distances (MVCD)[20]

For **Alternating Current** Voltages (meters)

(AC) Nominal System Voltage (KV)⁺	(AC) Maximum System Voltage (kV)[21]	MVCD meters Over sea level up to 153 m	MVCD meters Over 153m up to 305m	MVCD meters Over 305m up to 610m	MVCD meters Over 610m up to 915m	MVCD meters Over 915m up to 1220m	MVCD meters Over 1220m up to 1524m	MVCD meters Over 1524m up to 1829m	MVCD meters Over 1829m up to 2134m	MVCD meters Over 2134m up to 2439m	MVCD meters Over 2439m up to 2744m	MVCD meters Over 2744m up to 3048m	MVCD meters Over 3048m up to 3353m	MVCD meters Over 3353m up to 3657m	MVCD meters Over 3657m up to 3962m	MVCD meters Over 3962 m up to 4268 m	MVCD meters Over 4268m up to 4572m
765	800	3.6m	3.6m	3.6m	3.7m	3.7m	3.8m	3.8m	3.9m	4.0m	4.0m	4.1m	4.1m	4.2m	4.2m	4.3m	4.4m
500	550	2.1m	2.2m	2.2m	2.3m	2.3m	2.3m	2.4m	2.4m	2.5m	2..5m	2.5m	2.6m	2.6m	2.7m	2.7m	2.7m
345	362[22]	1.3m	1.3m	1.3m	1.4m	1.4m	1.4m	1.5m	1.5m	1.5m	1.6m	1.6m	1.6m	1.6m	1.7m	1.7m	1.8m
287	302	1.6m	1.6m	1.7m	1.7m	1.7m	1.7m	1.8m	1.8m	1.9m	1.9m	1.9m	2.0m	2.0m	2.0m	2.1m	2.1m
230	242	1.2m	1.3m	1.3m	1.3m	1.3m	1.3m	1.4m	1.4m	1.4m	1.5m	1.5m	1.5m	1.6m	1.6m	1.6m	1.6m
161*	169	0.8m	0.8m	0.9m	0.9m	0.9m	0.9m	0.9m	1.0m	1.0m	1.0m	1.0m	1.0m	1.1m	1.1m	1.1m	1.1m
138*	145	0.7m	0.7m	0.7m	0.7m	0.7m	0.7m	0.8m	0.8m	0.8m	0.9m	0.9m	0.9m	0.9m	0.9m	1.0m	1.0m
115*	121	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.7m	0.7m	0.7m	0.7m	0.7m	0.8m	0.8m	0.8m	0.8m
88*	100	0.4m	0.4m	0.5m	0.5m	0.5m	0.5m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.7m	0.7m
69*	72	0.3m	0.3m	0.3m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.5m	0.5m	0.5m

∗ Such lines are applicable to this standard only if PC has determined such per FAC-014 (refer to the Applicability Section above)

⁺ *Table 2 – Table of MVCD values at a 1.0 gap factor (in U.S. customary units), which is located in the EPRI report filed with FERC on August 12, 2015. (The 14000-15000 foot values were subsequently provided by EPRI in an updated Table 2 on December 1, 2015, filed with the FAC-003-4 Petition at FERC)*

[20] The distances in this Table are the minimums required to prevent Flash-over; however prudent vegetation maintenance practices dictate that substantially greater distances will be achieved at time of vegetation maintenance.

[21] Where applicable lines are operated at nominal voltages other than those listed, the applicable Transmission Owner or applicable Generator Owner should use the maximum system voltage to determine the appropriate clearance for that line.

[22] The change in transient overvoltage factors in the calculations are the driver in the decrease in MVCDs for voltages of 345 kV and above. Refer to pp.29-31 in the supplemental materials for additional information.

TABLE 2 (CONT) — Minimum Vegetation Clearance Distances (MVCD)[23]

For **Direct Current** Voltages feet (meters)

(DC) Nominal Pole to Ground Voltage (kV)	MVCD meters Over sea level up to 500 ft (Over sea level up to 152.4 m)	MVCD meters Over 500 ft up to 1000 ft (Over 152.4 m up to 304.8 m	MVCD meters Over 1000 ft up to 2000 ft (Over 304.8 m up to 609.6m)	MVCD meters Over 2000 ft up to 3000 ft (Over 609.6m up to 914.4m	MVCD meters Over 3000 ft up to 4000 ft (Over 914.4m up to 1219.2m	MVCD meters Over 4000 ft up to 5000 ft (Over 1219.2m up to 1524m	MVCD meters Over 5000 ft up to 6000 ft (Over 1524 m up to 1828.8 m)	MVCD meters Over 6000 ft up to 7000 ft (Over 1828.8m up to 2133.6m)	MVCD meters Over 7000 ft up to 8000 ft (Over 2133.6m up to 2438.4m)	MVCD meters Over 8000 ft up to 9000 ft (Over 2438.4m up to 2743.2m)	MVCD meters Over 9000 ft up to 10000 ft (Over 2743.2m up to 3048m)	MVCD meters Over 10000 ft up to 11000 ft (Over 3048m up to 3352.8m)
±750	14.12ft (4.30m)	14.31ft (4.36m)	14.70ft (4.48m)	15.07ft (4.59m)	15.45ft (4.71m)	15.82ft (4.82m)	16.2ft (4.94m)	16.55ft (5.04m)	16.91ft (5.15m)	17.27ft (5.26m)	17.62ft (5.37m)	17.97ft (5.48m)
±600	10.23ft (3.12m)	10.39ft (3.17m)	10.74ft (3.26m)	11.04ft (3.36m)	11.35ft (3.46m)	11.66ft (3.55m)	11.98ft (3.65m)	12.3ft (3.75m)	12.62ft (3.85m)	12.92ft (3.94m)	13.24ft (4.04m)	13.54ft (4.13m)
±500	8.03ft (2.45m)	8.16ft (2.49m)	8.44ft (2.57m)	8.71ft (2.65m)	8.99ft (2.74m)	9.25ft (2.82m)	9.55ft (2.91m)	9.82ft (2.99m)	10.1ft (3.08m)	10.38ft (3.16m)	10.65ft (3.25m)	10.92ft (3.33m)
±400	6.07ft (1.85m)	6.18ft (1.88m)	6.41ft (1.95m)	6.63ft (2.02m)	6.86ft (2.09m)	7.09ft (2.16m)	7.33ft (2.23m)	7.56ft (2.30m)	7.80ft (2.38m)	8.03ft (2.45m)	8.27ft (2.52m)	8.51ft (2.59m)
±250	3.50ft (1.07m)	3.57ft (1.09m)	3.72ft (1.13m)	3.87ft (1.18m)	4.02ft (1.23m)	4.18ft (1.27m)	4.34ft (1.32m)	4.5ft (1.37m)	4.66ft (1.42m)	4.83ft (1.47m)	5.00ft (1.52m)	5.17ft (1.58m)

[23] The distances in this Table are the minimums required to prevent Flash-over; however prudent vegetation maintenance practices dictate that substantially greater distances will be achieved at time of vegetation maintenance.

Guideline and Technical Basis

Effective dates:

The Compliance section is standard language used in most NERC standards to cover the general effective date and covers the vast majority of situations. A special case covers effective dates for (1) lines initially becoming subject to the Standard, (2) lines changing in applicability within the standard.

The special case is needed because the Planning Coordinators may designate lines below 200 kV to become elements of an IROL or Major WECC Transfer Path in a future Planning Year (PY). For example, studies by the Planning Coordinator in 2015 may identify a line to have that designation beginning in PY 2025, ten years after the planning study is performed. It is not intended for the Standard to be immediately applicable to, or in effect for, that line until that future PY begins. The effective date provision for such lines ensures that the line will become subject to the standard on January 1 of the PY specified with an allowance of at least 12 months for the applicable Transmission Owner or applicable Generator Owner to make the necessary preparations to achieve compliance on that line. A line operating below 200kV designated as an element of an IROL or Major WECC Transfer Path may be removed from that designation due to system improvements, changes in generation, changes in loads or changes in studies and analysis of the network.

Date that Planning Study is completed	PY the line will become an IROL element	Date 1	Date 2	Effective Date The later of Date 1 or Date 2
05/15/2011	2012	05/15/2012	01/01/2012	05/15/2012
05/15/2011	2013	05/15/2012	01/01/2013	01/01/2013
05/15/2011	2014	05/15/2012	01/01/2014	01/01/2014
05/15/2011	2021	05/15/2012	01/01/2021	01/01/2021

Defined Terms:

Explanation for revising the definition of ROW:

The current NERC glossary definition of Right of Way has been modified to include Generator Owners and to address the matter set forth in Paragraph 734 of FERC Order 693. The Order pointed out that Transmission Owners may in some cases own more property or rights than are needed to reliably operate transmission lines. This definition represents a slight but significant departure from the strict legal definition of "right of way" in that this definition is based on engineering and construction considerations that establish the width of a corridor from a technical basis. The pre-2007 maintenance records are included in the current definition to allow the use of such vegetation widths if there were no engineering or construction standards that referenced the width of right of way to be maintained for vegetation on a particular line but the evidence exists in maintenance records for a width that was in fact maintained prior to this standard becoming mandatory. Such widths may be the only information available for lines that had limited or no vegetation easement rights and were typically maintained primarily to ensure public safety. This standard does not require additional easement rights to be purchased to satisfy a minimum right of way width that did not exist prior to this standard becoming mandatory.

Explanation for revising the definition of Vegetation Inspection:
The current glossary definition of this NERC term was modified to include Generator Owners and to allow both maintenance inspections and vegetation inspections to be performed concurrently. This allows potential efficiencies, especially for those lines with minimal vegetation and/or slow vegetation growth rates.

Explanation of the derivation of the MVCD:
The MVCD is a calculated minimum distance that is derived from the Gallet equation. This is a method of calculating a flash over distance that has been used in the design of high voltage transmission lines. Keeping vegetation away from high voltage conductors by this distance will prevent voltage flash-over to the vegetation. See the explanatory text below for Requirement R3 and associated Figure 1. Table 2 of the Standard provides MVCD values for various voltages and altitudes. The table is based on empirical testing data from EPRI as requested by FERC in Order No. 777.

Project 2010-07.1 Adjusted MVCDs per EPRI Testing:
In Order No. 777, FERC directed NERC to undertake testing to gather empirical data validating the appropriate gap factor used in the Gallet equation to calculate MVCDs, specifically the gap factor for the flash-over distances between conductors and vegetation. See, Order No. 777, at P 60. NERC engaged industry through a collaborative research project and contracted EPRI to complete the scope of work. In January 2014, NERC formed an advisory group to assist with developing the scope of work for the project. This team provided subject matter expertise for developing the test plan, monitoring testing, and vetting the analysis and conclusions to be submitted in a final report. The advisory team was comprised of NERC staff, arborists, and industry members with wide-ranging expertise in transmission engineering, insulation coordination, and vegetation management. The testing project commenced in April 2014 and continued through October 2014 with the final set of testing completed in May 2015. Based on these testing results conducted by EPRI, and consistent with the report filed in FERC Docket No. RM12-4-000, the gap factor used in the Gallet equation required adjustment from 1.3 to 1.0. This resulted in increased MVCD values for all alternating current system voltages identified. The adjusted MVCD values, reflecting the 1.0 gap factor, are included in Table 2 of version 4 of FAC-003.

The air gap testing completed by EPRI per FERC Order No. 777 established that trees with large spreading canopies growing directly below energized high voltage conductors create the greatest likelihood of an air gap flash over incident and was a key driver in changing the gap factor to a more conservative value of 1.0 in version 4 of this standard.

Requirements R1 and R2:
R1 and R2 are performance-based requirements. The reliability objective or outcome to be achieved is the management of vegetation such that there are no vegetation encroachments within a minimum distance of transmission lines. Content-wise, R1 and R2 are the same requirements; however, they apply to different Facilities. Both R1 and R2 require each applicable Transmission Owner or applicable Generator Owner to manage vegetation to prevent encroachment within the MVCD of transmission lines. R1 is applicable to lines that are identified as an element of an IROL or Major WECC Transfer Path. R2 is applicable to all other lines that are not elements of IROLs, and not elements of Major WECC Transfer Paths.

The separation of applicability (between R1 and R2) recognizes that inadequate vegetation management for an applicable line that is an element of an IROL or a Major WECC Transfer Path is a greater risk to the interconnected electric transmission system than applicable lines that are not elements of IROLs or Major WECC Transfer Paths. Applicable lines that are not elements of IROLs or Major WECC Transfer Paths do require effective vegetation management, but these lines are comparatively less operationally significant.

Requirements R1 and R2 state that if inadequate vegetation management allows vegetation to encroach within the MVCD distance as shown in Table 2, it is a violation of the standard. Table 2 distances are the minimum clearances that will prevent spark-over based on the Gallet equations. These requirements assume that transmission lines and their conductors are operating within their Rating. If a line conductor is intentionally or inadvertently operated beyond its Rating and Rated Electrical Operating Condition (potentially in violation of other standards), the occurrence of a clearance encroachment may occur solely due to that condition. For example, emergency actions taken by an applicable Transmission Owner or applicable Generator Owner or Reliability Coordinator to protect an Interconnection may cause excessive sagging and an outage. Another example would be ice loading beyond the line's Rating and Rated Electrical Operating Condition. Such vegetation-related encroachments and outages are not violations of this standard.

Evidence of failures to adequately manage vegetation include real-time observation of a vegetation encroachment into the MVCD (absent a Sustained Outage), or a vegetation-related encroachment resulting in a Sustained Outage due to a fall-in from inside the ROW, or a vegetation-related encroachment resulting in a Sustained Outage due to the blowing together of the lines and vegetation located inside the ROW, or a vegetation-related encroachment resulting in a Sustained Outage due to a grow-in. Faults which do not cause a Sustained outage and which are confirmed to have been caused by vegetation encroachment within the MVCD are considered the equivalent of a Real-time observation for violation severity levels.

With this approach, the VSLs for R1 and R2 are structured such that they directly correlate to the severity of a failure of an applicable Transmission Owner or applicable Generator Owner to manage vegetation and to the corresponding performance level of the Transmission Owner's vegetation program's ability to meet the objective of "preventing the risk of those vegetation related outages that could lead to Cascading." Thus violation severity increases with an applicable Transmission Owner's or applicable Generator Owner's inability to meet this goal and its potential of leading to a Cascading event. The additional benefits of such a combination are that it simplifies the standard and clearly defines performance for compliance. A performance-based requirement of this nature will promote high quality, cost effective vegetation management programs that will deliver the overall end result of improved reliability to the system.

Multiple Sustained Outages on an individual line can be caused by the same vegetation. For example initial investigations and corrective actions may not identify and remove the actual outage cause then another outage occurs after the line is re-energized and previous high conductor temperatures return. Such events are considered to be a single vegetation-related Sustained Outage under the standard where the Sustained Outages occur within a 24 hour period.

If the applicable Transmission Owner or applicable Generator Owner has applicable lines operated at nominal voltage levels not listed in Table 2, then the applicable TO or applicable GO should use the next largest clearance distance based on the next highest nominal voltage in the table to determine an acceptable distance.

Requirement R3:
R3 is a competency based requirement concerned with the maintenance strategies, procedures, processes, or specifications, an applicable Transmission Owner or applicable Generator Owner uses for vegetation management.

An adequate transmission vegetation management program formally establishes the approach the applicable Transmission Owner or applicable Generator Owner uses to plan and perform vegetation work to prevent transmission Sustained Outages and minimize risk to the transmission system. The approach provides the basis for evaluating the intent, allocation of appropriate resources, and the competency of the applicable Transmission Owner or applicable Generator Owner in managing vegetation. There are many acceptable approaches to manage vegetation and avoid Sustained Outages. However, the applicable Transmission Owner or applicable Generator Owner must be able to show the documentation of its approach and how it conducts work to maintain clearances.

An example of one approach commonly used by industry is ANSI Standard A300, part 7. However, regardless of the approach a utility uses to manage vegetation, any approach an applicable Transmission Owner or applicable Generator Owner chooses to use will generally contain the following elements:

1. *the maintenance strategy used (such as minimum vegetation-to-conductor distance or maximum vegetation height) to ensure that MVCD clearances are never violated*

2. *the work methods that the applicable Transmission Owner or applicable Generator Owner uses to control vegetation*
3. *a stated Vegetation Inspection frequency*
4. *an annual work plan*

The conductor's position in space at any point in time is continuously changing in reaction to a number of different loading variables. Changes in vertical and horizontal conductor positioning are the result of thermal and physical loads applied to the line. Thermal loading is a function of line current and the combination of numerous variables influencing ambient heat dissipation including wind velocity/direction, ambient air temperature and precipitation. Physical loading applied to the conductor affects sag and sway by combining physical factors such as ice and wind loading. The movement of the transmission line conductor and the MVCD is illustrated in Figure 1 below.

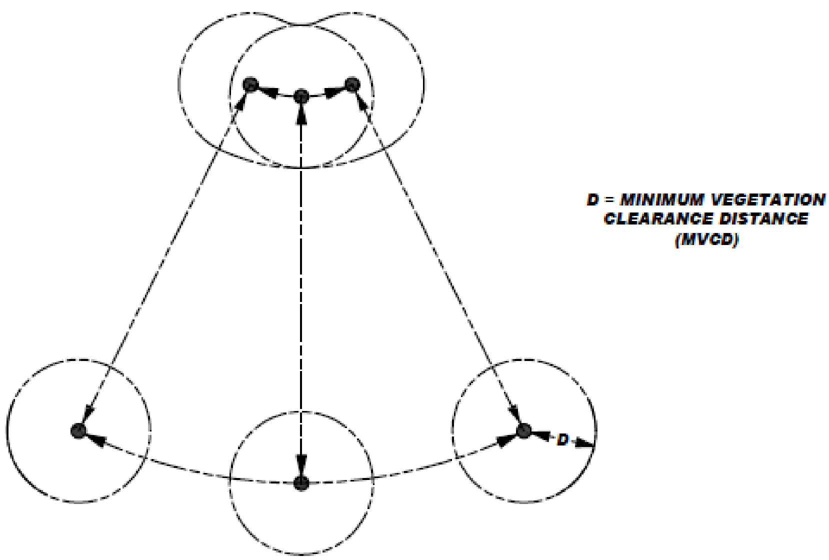

Figure 1

A cross-section view of a single conductor at a given point along the span is shown with six possible conductor positions due to movement resulting from thermal and mechanical loading.

Requirement R4:
R4 is a risk-based requirement. It focuses on preventative actions to be taken by the applicable Transmission Owner or applicable Generator Owner for the mitigation of Fault risk when a vegetation threat is confirmed. R4 involves the notification of potentially threatening vegetation conditions, without any intentional delay, to the control center holding switching authority for that specific transmission line. Examples of acceptable unintentional delays may

include communication system problems (for example, cellular service or two-way radio disabled), crews located in remote field locations with no communication access, delays due to severe weather, etc.

Confirmation is key that a threat actually exists due to vegetation. This confirmation could be in the form of an applicable Transmission Owner or applicable Generator Owner employee who personally identifies such a threat in the field. Confirmation could also be made by sending out an employee to evaluate a situation reported by a landowner.

Vegetation-related conditions that warrant a response include vegetation that is near or encroaching into the MVCD (a grow-in issue) or vegetation that could fall into the transmission conductor (a fall-in issue). A knowledgeable verification of the risk would include an assessment of the possible sag or movement of the conductor while operating between no-load conditions and its rating.

The applicable Transmission Owner or applicable Generator Owner has the responsibility to ensure the proper communication between field personnel and the control center to allow the control center to take the appropriate action until or as the vegetation threat is relieved. Appropriate actions may include a temporary reduction in the line loading, switching the line out of service, or other preparatory actions in recognition of the increased risk of outage on that circuit. The notification of the threat should be communicated in terms of minutes or hours as opposed to a longer time frame for corrective action plans (see R5).

All potential grow-in or fall-in vegetation-related conditions will not necessarily cause a Fault at any moment. For example, some applicable Transmission Owners or applicable Generator Owners may have a danger tree identification program that identifies trees for removal with the potential to fall near the line. These trees would not require notification to the control center unless they pose an immediate fall-in threat.

Requirement R5:
R5 is a risk-based requirement. It focuses upon preventative actions to be taken by the applicable Transmission Owner or applicable Generator Owner for the mitigation of Sustained Outage risk when temporarily constrained from performing vegetation maintenance. The intent of this requirement is to deal with situations that prevent the applicable Transmission Owner or applicable Generator Owner from performing planned vegetation management work and, as a result, have the potential to put the transmission line at risk. Constraints to performing vegetation maintenance work as planned could result from legal injunctions filed by property owners, the discovery of easement stipulations which limit the applicable Transmission Owner's or applicable Generator Owner's rights, or other circumstances.

This requirement is not intended to address situations where the transmission line is not at potential risk and the work event can be rescheduled or re-planned using an alternate work methodology. For example, a land owner may prevent the planned use of herbicides to control incompatible vegetation outside of the MVCD, but agree to the use of mechanical clearing. In this case the applicable Transmission Owner or applicable Generator Owner is not under any immediate time constraint for achieving the management objective, can easily reschedule work using an alternate approach, and therefore does not need to take interim corrective action.

However, in situations where transmission line reliability is potentially at risk due to a constraint, the applicable Transmission Owner or applicable Generator Owner is required to take an interim corrective action to mitigate the potential risk to the transmission line. A wide range of actions can be taken to address various situations. General considerations include:

- Identifying locations where the applicable Transmission Owner or applicable Generator Owner is constrained from performing planned vegetation maintenance work which potentially leaves the transmission line at risk.
- Developing the specific action to mitigate any potential risk associated with not performing the vegetation maintenance work as planned.
- Documenting and tracking the specific action taken for the location.
- In developing the specific action to mitigate the potential risk to the transmission line the applicable Transmission Owner or applicable Generator Owner could consider location specific measures such as modifying the inspection and/or maintenance intervals. Where a legal constraint would not allow any vegetation work, the interim corrective action could include limiting the loading on the transmission line.
- The applicable Transmission Owner or applicable Generator Owner should document and track the specific corrective action taken at each location. This location may be indicated as one span, one tree or a combination of spans on one property where the constraint is considered to be temporary.

Requirement R6:
R6 is a risk-based requirement. This requirement sets a minimum time period for completing Vegetation Inspections. The provision that Vegetation Inspections can be performed in conjunction with general line inspections facilitates a Transmission Owner's ability to meet this requirement. However, the applicable Transmission Owner or applicable Generator Owner may determine that more frequent vegetation specific inspections are needed to maintain reliability levels, based on factors such as anticipated growth rates of the local vegetation, length of the local growing season, limited ROW width, and local rainfall. Therefore it is expected that some transmission lines may be designated with a higher frequency of inspections.

The VSLs for Requirement R6 have levels ranked by the failure to inspect a percentage of the applicable lines to be inspected. To calculate the appropriate VSL the applicable Transmission Owner or applicable Generator Owner may choose units such as: circuit, pole line, line miles or kilometers, etc.

For example, when an applicable Transmission Owner or applicable Generator Owner operates 2,000 miles of applicable transmission lines this applicable Transmission Owner or applicable

Generator Owner will be responsible for inspecting all the 2,000 miles of lines at least once during the calendar year. If one of the included lines was 100 miles long, and if it was not inspected during the year, then the amount failed to inspect would be 100/2000 = 0.05 or 5%. The "Low VSL" for R6 would apply in this example.

Requirement R7:
R7 is a risk-based requirement. The applicable Transmission Owner or applicable Generator Owner is required to complete its annual work plan for vegetation management to accomplish the purpose of this standard. Modifications to the work plan in response to changing conditions or to findings from vegetation inspections may be made and documented provided they do not put the transmission system at risk. The annual work plan requirement is not intended to necessarily require a "span-by-span", or even a "line-by-line" detailed description of all work to be performed. It is only intended to require that the applicable Transmission Owner or applicable Generator Owner provide evidence of annual planning and execution of a vegetation management maintenance approach which successfully prevents encroachment of vegetation into the MVCD.

When an applicable Transmission Owner or applicable Generator Owner identifies 1,000 miles of applicable transmission lines to be completed in the applicable Transmission Owner's or applicable Generator Owner's annual plan, the applicable Transmission Owner or applicable Generator Owner will be responsible completing those identified miles. If an applicable Transmission Owner or applicable Generator Owner makes a modification to the annual plan that does not put the transmission system at risk of an encroachment the annual plan may be modified. If 100 miles of the annual plan is deferred until next year the calculation to determine what percentage was completed for the current year would be: 1000 – 100 (deferred miles) = 900 modified annual plan, or 900 / 900 = 100% completed annual miles. If an applicable Transmission Owner or applicable Generator Owner only completed 875 of the total 1000 miles with no acceptable documentation for modification of the annual plan the calculation for failure to complete the annual plan would be: 1000 – 875 = 125 miles failed to complete then, 125 miles (not completed) / 1000 total annual plan miles = 12.5% failed to complete.

The ability to modify the work plan allows the applicable Transmission Owner or applicable Generator Owner to change priorities or treatment methodologies during the year as conditions or situations dictate. For example recent line inspections may identify unanticipated high priority work, weather conditions (drought) could make herbicide application ineffective during the plan year, or a major storm could require redirecting local resources away from planned maintenance. This situation may also include complying with mutual assistance agreements by moving resources off the applicable Transmission Owner's or applicable Generator Owner's system to work on another system. Any of these examples could result in acceptable deferrals or additions to the annual work plan provided that they do not put the transmission system at risk of a vegetation encroachment.
In general, the vegetation management maintenance approach should use the full extent of the applicable Transmission Owner's or applicable Generator Owner's easement, fee simple and

other legal rights allowed. A comprehensive approach that exercises the full extent of legal rights on the ROW is superior to incremental management because in the long term it reduces the overall potential for encroachments, and it ensures that future planned work and future planned inspection cycles are sufficient.

When developing the annual work plan the applicable Transmission Owner or applicable Generator Owner should allow time for procedural requirements to obtain permits to work on federal, state, provincial, public, tribal lands. In some cases the lead time for obtaining permits may necessitate preparing work plans more than a year prior to work start dates. Applicable Transmission Owners or applicable Generator Owners may also need to consider those special landowner requirements as documented in easement instruments.

This requirement sets the expectation that the work identified in the annual work plan will be completed as planned. Therefore, deferrals or relevant changes to the annual plan shall be documented. Depending on the planning and documentation format used by the applicable Transmission Owner or applicable Generator Owner, evidence of successful annual work plan execution could consist of signed-off work orders, signed contracts, printouts from work management systems, spreadsheets of planned versus completed work, timesheets, work inspection reports, or paid invoices. Other evidence may include photographs, and walk-through reports.

Notes:

The SDT determined that the use of IEEE 516-2003 in version 1 of FAC-003 was a misapplication. The SDT consulted specialists who advised that the Gallet equation would be a technically justified method. The explanation of why the Gallet approach is more appropriate is explained in the paragraphs below.

The drafting team sought a method of establishing minimum clearance distances that uses realistic weather conditions and realistic maximum transient over-voltages factors for in-service transmission lines.

The SDT considered several factors when looking at changes to the minimum vegetation to conductor distances in FAC-003-1:

- avoid the problem associated with referring to tables in another standard (IEEE-516-2003)
- transmission lines operate in non-laboratory environments (wet conditions)
- transient over-voltage factors are lower for in-service transmission lines than for inadvertently re-energized transmission lines with trapped charges.

FAC-003-1 used the minimum air insulation distance (MAID) without tools formula provided in IEEE 516-2003 to determine the minimum distance between a transmission line conductor and vegetation. The equations and methods provided in IEEE 516 were developed by an IEEE Task Force in 1968 from test data provided by thirteen independent laboratories. The distances provided in IEEE 516 Tables 5 and 7 are based on the withstand voltage of a dry rod-rod air gap, or in other words, dry laboratory conditions. Consequently, the validity of using these distances in an outside environment application has been questioned.

FAC-003-1 allowed Transmission Owners to use either Table 5 or Table 7 to establish the minimum clearance distances. Table 7 could be used if the Transmission Owner knew the maximum transient over-voltage factor for its system. Otherwise, Table 5 would have to be used. Table 5 represented minimum air insulation distances under the worst possible case for transient over-voltage factors. These worst case transient over-voltage factors were as follows: 3.5 for voltages up to 362 kV phase to phase; 3.0 for 500 - 550 kV phase to phase; and 2.5 for 765 to 800 kV phase to phase. These worst case over-voltage factors were also a cause for concern in this particular application of the distances.

In general, the worst case transient over-voltages occur on a transmission line that is inadvertently re-energized immediately after the line is de-energized and a trapped charge is still present. The intent of FAC-003 is to keep a transmission line that is in service from becoming de-energized (i.e. tripped out) due to spark-over from the line conductor to nearby vegetation. Thus, the worst case transient overvoltage assumptions are not appropriate for this application. Rather, the appropriate over voltage values are those that occur only while the line is energized.

Typical values of transient over-voltages of in-service lines are not readily available in the literature because they are negligible compared with the maximums. A conservative value for the maximum transient over-voltage that can occur anywhere along the length of an in-service ac line was approximately 2.0 per unit. This value was a conservative estimate of the transient over-voltage that is created at the point of application (e.g. a substation) by switching a capacitor bank without pre-insertion devices (e.g. closing resistors). At voltage levels where capacitor banks are not very common (e.g. Maximum System Voltage of 362 kV), the maximum transient over-voltage of an in-service ac line are created by fault initiation on adjacent ac lines and shunt reactor bank switching. These transient voltages are usually 1.5 per unit or less.

Even though these transient over-voltages will not be experienced at locations remote from the bus at which they are created, in order to be conservative, it is assumed that all nearby ac lines are subjected to this same level of over-voltage. Thus, a maximum transient over-voltage factor of 2.0 per unit for transmission lines operated at 302 kV and below was considered to be a realistic maximum in this application. Likewise, for ac transmission lines operated at Maximum System Voltages of 362 kV and above a transient over-voltage factor of 1.4 per unit was considered a realistic maximum.

The Gallet equations are an accepted method for insulation coordination in tower design. These equations are used for computing the required strike distances for proper transmission line insulation coordination. They were developed for both wet and dry applications and can be used with any value of transient over-voltage factor. The Gallet equation also can take into account various air gap geometries. This approach was used to design the first 500 kV and 765 kV lines in North America.

If one compares the MAID using the IEEE 516-2003 Table 7 (table D.5 for English values) with the critical spark-over distances computed using the Gallet wet equations, for each of the nominal voltage classes and identical transient over-voltage factors, the Gallet equations yield a more conservative (larger) minimum distance value.

Distances calculated from either the IEEE 516 (dry) formulas or the Gallet “wet” formulas are not vastly different when the same transient overvoltage factors are used; the “wet” equations will consistently produce slightly larger distances than the IEEE 516 equations when the same transient overvoltage is used. While the IEEE 516 equations were only developed for dry conditions the Gallet equations have provisions to calculate spark-over distances for both wet and dry conditions.

Since no empirical data for spark over distances to live vegetation existed at the time version 3 was developed, the SDT chose a proven method that has been used in other EHV applications. The Gallet equations relevance to wet conditions and the selection of a Transient Overvoltage Factor that is consistent with the absence of trapped charges on an in-service transmission line make this methodology a better choice.

The following table is an example of the comparison of distances derived from IEEE 516 and the Gallet equations.

Comparison of spark-over distances computed using Gallet wet equations vs.

IEEE 516-2003 MAID distances

(AC) **Nom System** **Voltage (kV)**	**(AC)** **Max System** **Voltage (kV)**	**Transient** **Over-voltage** **Factor (T)**	**Clearance (ft.)** **Gallet (wet)** **@ Alt. 3000 feet**	Table 7 (Table D.5 for feet) **IEEE 516-2003** **MAID (ft)** **@ Alt. 3000 feet**
765	800	2.0	14.36	13.95
500	550	2.4	11.0	10.07
345	362	3.0	8.55	7.47
230	242	3.0	5.28	4.2
115	121	3.0	2.46	2.1

Rationale:

During development of this standard, text boxes were embedded within the standard to explain the rationale for various parts of the standard. Upon BOT approval, the text from the rationale text boxes was moved to this section.

Rationale for Applicability (section 4.2.4):

The areas excluded in 4.2.4 were excluded based on comments from industry for reasons summarized as follows:

1) There is a very low risk from vegetation in this area. Based on an informal survey, no TOs reported such an event.
2) Substations, switchyards, and stations have many inspection and maintenance activities that are necessary for reliability. Those existing process manage the threat. As such, the formal steps in this standard are not well suited for this environment.
3) Specifically addressing the areas where the standard does and does not apply makes the standard clearer.

Rationale for Applicability (section 4.3):

Within the text of NERC Reliability Standard FAC-003-3, “transmission line(s)” and “applicable line(s)” can also refer to the generation Facilities as referenced in 4.3 and its subsections.

Rationale for R1 and R2:

Lines with the highest significance to reliability are covered in R1; all other lines are covered in R2.

Rationale for the types of failure to manage vegetation which are listed in order of increasing degrees of severity in non-compliant performance as it relates to a failure of an applicable Transmission Owner's or applicable Generator Owner’s vegetation maintenance program:

1. This management failure is found by routine inspection or Fault event investigation, and is normally symptomatic of unusual conditions in an otherwise sound program.
2. This management failure occurs when the height and location of a side tree within the ROW is not adequately addressed by the program.
3. This management failure occurs when side growth is not adequately addressed and may be indicative of an unsound program.
4. This management failure is usually indicative of a program that is not addressing the most fundamental dynamic of vegetation management, (i.e. a grow-in under the line). If this type of failure is pervasive on multiple lines, it provides a mechanism for a Cascade.

Rationale for R3:

The documentation provides a basis for evaluating the competency of the applicable Transmission Owner’s or applicable Generator Owner’s vegetation program. There may be many acceptable approaches to maintain clearances. Any approach must demonstrate that the applicable Transmission Owner or applicable Generator Owner avoids vegetation-to-wire conflicts under all Ratings and all Rated Electrical Operating Conditions.

Rationale for R4:

This is to ensure expeditious communication between the applicable Transmission Owner or applicable Generator Owner and the control center when a critical situation is confirmed.

Rationale for R5:

Legal actions and other events may occur which result in constraints that prevent the applicable Transmission Owner or applicable Generator Owner from performing planned vegetation maintenance work.

In cases where the transmission line is put at potential risk due to constraints, the intent is for the applicable Transmission Owner and applicable Generator Owner to put interim measures in place, rather than do nothing.

The corrective action process is not intended to address situations where a planned work methodology cannot be performed but an alternate work methodology can be used.

Rationale for R6:

Inspections are used by applicable Transmission Owners and applicable Generator Owners to assess the condition of the entire ROW. The information from the assessment can be used to determine risk, determine future work and evaluate recently-completed work. This requirement sets a minimum Vegetation Inspection frequency of once per calendar year but with no more than 18 months between inspections on the same ROW. Based upon average growth rates across North America and on common utility practice, this minimum frequency is reasonable. Transmission Owners should consider local and environmental factors that could warrant more frequent inspections.

Rationale for R7:

This requirement sets the expectation that the work identified in the annual work plan will be completed as planned. It allows modifications to the planned work for changing conditions, taking into consideration anticipated growth of vegetation and all other environmental factors, provided that those modifications do not put the transmission system at risk of a vegetation encroachment.