2018 Line Assessment

PPL Electric Utilities

Hauto-Siegfried 1 & 4 and Siegfried-East
Palmerton 1 & 2 Lines

25 January 2019

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1. Executive Summary

Osmose was contracted to inspect 26 non-wood transmission structures (H-Frame & single steel poles), 60 steel lattice towers, and 46 wood structures (26 H-Frame & 20 single wood poles) selected at random by Osmose. Due to the inspection procedure, the data for each leg of the wood H-Frame structure was collected and evaluated as its own structure. Therefore, the counts in the following report will show 72 wood structures were inspected.

The inspections were performed over a 10-day span from December 10, 2018, through December 20, 2018. All structures were evaluated by a visual inspection of overhead structural components such as conductors, attachments, ground wires, and cross arm members. Steel structures also received a visual inspection of the existing protective coatings. In addition to the overhead inspections, structures were also evaluated at the ground line. For steel structures, the ground line inspection involved assessing the degree of corrosion on structural members, noting mechanical damage, and assessing the condition of concrete foundations (when present). For wood structures, the ground line inspection involved performing a sound and bore test as well as collecting circumference measurements to identify internal and external decay which may reduce the overall strength of the structure.

The overhead visual inspection returned the following results:

- 12 out of 26 (46%) steel H-Frame and single pole structures inspected had at least one reported item of overhead deterioration or damage.
- 52 out of 60 (87%) steel lattice towers inspected had at least one reported item of overhead deterioration or damage.
- 35 out of 72 (49%) wood H-Frame and single pole structures inspected had at least one reported item of overhead deterioration or damage.

Due to the qualitative nature of the visual overhead inspection, Osmose recommends further inspection be performed to more accurately assess the true condition of the overhead components.

The ground line inspection performed returned the following results:

- 3 out of 26 (12%) steel H-Frame and single pole structures inspected were found to be reject structures.
- 21 out of 60 (35%) steel lattice towers inspected were found to be reject structures.
- Osmose and PPL reject criteria differed for wood structures. Therefore, both results are provided below:
    - Based on Osmose reject criteria, 2 out of 72 (3%) wood H-Frame and single pole structures inspected were found to be reject structures.
    - Based on PPL reject criteria, 56 out of 72 (78%) wood H-Frame and single pole structures inspected were found to be reject structures.

Osmose recommends restoration or replacement of all ground line reject structures be performed within 12 months.

2. Introduction

Osmose was contracted by PPL to perform a ground line and visual overhead inspection of various structure types among four transmission lines within PPL's system. Osmose was contracted to inspect 26 non-wood transmission structures (H-Frame & single steel poles), 60 steel lattice towers, and 46 wood structures (H-Frame & single wood poles) selected at random by Osmose. Critical structures, such as river or highway crossing structures, were weighted more heavily in the random asset selection process.

PPL determined the sample size for these lines by breaking down all structures on the lines by sub type (wood pole, steel pole, 4 leg transmission tower, for example). The counts were provided to PPL's Data Analytics group to determine the amount of each structure sub type that was required to provide a 90% confidence level that the inspections performed could be applied across the entire line, assuming the sample structures were randomly selected.

The inspection process involved three primary types of evaluations:

1) A visual inspection of conductors, ground wires, insulators, structure members, existing coatings, and their connections to determine the overall condition of the component
2) An assessment of the environmental conditions that affect the rate of corrosion of a steel structure
3) A structural assessment at the ground line of each structure to determine existing steel corrosion or wood deterioration and its effect on the integrity of the structure

3. Inspection Results

The results of the 2018 Line Assessment are summarized in the following tables and figures. Further analysis of the data can be found in the Appendix.

Table 1: Overview of Results from Steel Structure Inspection

Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
52304N25364	H-Frame	B	B	N/A	N/A	Very Low	No	Good	N
52412N25084	Steel Pole	A	A	N/A	N/A	Very Low	No	Good	N
52452N24990	H-Frame	A	A	N/A	N/A	Very Low	No	Good	N
51300N25210	Steel Pole	B	B	N/A	N/A	Mild	No	Good	N
51718N25329	4 Leg Suspension Tower	Priority	Priority	N/A	N/A	Very Low	No	Delamination	Y
51996N25462	4 Leg Suspension Tower	Priority	Priority	N/A	N/A	Mild	No	Delamination	Y
52536N24867	4 Leg Suspension Tower	B	B	N/A	N/A	Very Low	Class I	Delamination	Y
52811N24583	4 Leg Suspension Tower	Priority	Priority	C	N/A	Very Low	Class I	Delamination	N

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
53430N23964	4 Leg Suspension Tower	D	D	N/A	N/A	Very Low	Class I	Delamination	Y
53887N23588	4 Leg Suspension Tower	B	B	N/A	N/A	Very Low	Class I	Delamination	Y
54681N23148	4 Leg Suspension Tower	D	D	N/A	N/A	Very Low	Class I	Delamination	Y
55519N22863	4 Leg Suspension Tower	D	D	N/A	N/A	Very Low	Class I	Delamination	Y
56573N22601	4 Leg Suspension Tower	B	B	N/A	N/A	Very Low	No	Delamination	Y
57429S52803	4 Leg Suspension Tower	B	B	N/A	N/A	Very Low	No	Delamination	Y
57906S52603	4 Leg Strain Tower	C	B	C	N/A	Very Low	Class I	Delamination	Y
58002S52553	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	N
58634S52291	4 Leg Strain Tower	B	B	B	N/A	Very Low	No	Delamination	Y
58676S52250	4 Leg Strain Tower	Priority	B	Priority	N/A	Very Low	Class I	Delamination	Y

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
58686S52191	4 Leg Strain Tower	Priority	C	Priority	N/A	Severe	No	Delamination	N
58749S52100	4 Leg Strain Tower	D	D	D	N/A	Very Low	No	Delamination	Y
58884S51960	4 Leg Suspension Tower	Priority	Priority	N/A	N/A	Mild	Class I	Delamination	Y
59067S51890	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
59381S51770	4 Leg Suspension Tower	C	C	B	N/A	Moderate	No	Delamination	Y
59500S51715	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
59794S51558	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	No	Delamination	Y
59966S51515	4 Leg Strain Tower	B	B	N/A	N/A	Very Low	No	Delamination	Y
60007S51512	4 Leg Suspension Tower	Priority	B	Priority	N/A	Very Low	No	Delamination	Y
60105S51463	4 Leg Suspension Tower	C	C	N/A	N/A	Moderate	Class I	Delamination	Y

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
60473S51284	4 Leg Strain Tower	C	B	C	N/A	Mild	Class I	Delamination	Y
60582S51258	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	No	Delamination	Y
60706S51215	4 Leg Strain Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
60903S51145	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
61221S51048	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
61563S51033	4 Leg Suspension Tower	C	C	N/A	N/A	Moderate	Class I	Peeling	N
51300N25197	Steel Pole	B	B	N/A	N/A	Mild	No	Good	N
52308N25283	H-Frame	B	B	N/A	N/A	Very Low	No	Good	N
52309N25283	H-Frame	A	A	N/A	N/A	Very Low	No	Good	N
52370N25138	Steel Pole	B	B	N/A	N/A	Very Low	No	Good	Y
52685N24697	4 Leg Suspension Tower	C	B	C	N/A	Very Low	No	Delamination	N

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
53580N23848	4 Leg Suspension Tower	B	B	N/A	N/A	Very Low	Class I	Delamination	N
57636S52707	4 Leg Strain Tower	D	B	N/A	N/A	Mild	Class II	Delamination	Y
57902S52595	4 Leg Strain Tower	D	B	N/A	N/A	Mild	Class II	Delamination	Y
57961S52564	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
58022S52531	4 Leg Suspension Tower	D	C	N/A	N/A	Mild	Class II	Delamination	Y
58200S52438	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	N
58442S52310	4 Leg Suspension Tower	D	B	D	N/A	Very Low	Class II	Delamination	Y
58629S52283	4 Leg Strain Tower	B	B	N/A	N/A	Very Low	No	Delamination	Y
58667S52246	4 Leg Strain Tower	C	C	N/A	N/A	Moderate	No	Delamination	Y
58674S52192	4 Leg Strain Tower	C	C	N/A	N/A	Mild	No	Fish Mouths	Y

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
59211S51822	4 Leg Strain Tower	Priority	C	Priority	N/A	Very Low	No	Delamination	Y
59271S51802	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
59323S51781	4 Leg Suspension Tower	C	C	N/A	N/A	Very Low	No	Delamination	Y
59491S51709	4 Leg Strain Tower	C	C	N/A	N/A	Moderate	Class I	Delamination	Y
59621S51584	4 Leg Strain Tower	C	C	N/A	N/A	Severe	Class I	Delamination	Y
59745S51558	4 Leg Suspension Tower	D	C	N/A	N/A	Moderate	Class II	Delamination	Y
60003S51503	4 Leg Strain Tower	B	B	N/A	N/A	Very Low	No	Delamination	Y
60303S51354	4 Leg Suspension Tower	C	C	N/A	N/A	Very Low	No	Delamination	Y
60471S51273	4 Leg Strain Tower	B	B	N/A	N/A	Very Low	No	Delamination	Y
60707S51215	4 Leg Strain Tower	C	C	N/A	N/A	Very Low	No	Delamination	Y

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
61043S51093	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	Y
61438S51022	4 Leg Suspension Tower	C	C	N/A	N/A	Mild	Class I	Delamination	N
57905S52642	Steel Pole	B	B	N/A	N/A	Mild	No	No Coating Present	Y
58071S52768	Steel Pole	B	B	N/A	N/A	Very Low	No	No Coating Present	Y
58662S53153	Steel Pole	B	B	N/A	N/A	Mild	No	No Coating Present	N
58970S53260	Steel Pole	B	B	N/A	N/A	Mild	No	Good	N
59900N24085	Steel Pole	B	B	N/A	N/A	Mild	No	Good	N
60069N24160	Steel Pole	D	D	N/A	N/A	Very Low	No	Good	Y
60101N24231	Steel Pole	B	B	N/A	N/A	Mild	No	Good	Y
60105N24257	Steel Pole	B	B	B	A	Very Low	No	Good	N
59286S53592	4 Leg Strain Tower	B	B	B	N/A	Very Low	No	Delamination	Y
59235N23382	4 Leg Strain Tower	C	B	C	N/A	Very Low	No	Delamination	Y

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
59214N23544	4 Leg Strain Tower	D	D	B	N/A	Very Low	No	Delamination	Y
59313N23679	4 Leg Strain Tower	D	B	D	N/A	Mild	No	Delamination	Y
59526N23918	4 Leg Suspension Tower	Priority	B	Priority	N/A	Very Low	No	Delamination	Y
57910S52636	Steel Pole	B	B	N/A	N/A	Very Low	No	No Coating Present	Y
58520S53095	Steel Pole	B	B	N/A	N/A	Mild	No	No Coating Present	N
59154S53311	Steel Pole	B	B	N/A	N/A	Very Low	No	Good	Y
59847N24062	Steel Pole	D	D	N/A	N/A	Mild	No	Good	Y
59894N24077	Steel Pole	B	B	N/A	N/A	Mild	No	Good	Y
61692S51032	4 Leg Strain Tower	C	C	B	N/A	Very Low	Class I	Delamination	Y
58070S52768	Steel Pole	A	A	N/A	N/A	Very Low	No	No Coating Present	Y
60129S51442	4 Leg Suspension Tower	Priority	C	N/A	N/A	Mild	Class III	Delamination	Y
60094N24202	Steel Pole	D	D	N/A	N/A	Mild	No	Good	Y

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Grid	Structure Type	Overall Ground Line Condition	*Steel Condition**	*Foundation Condition**	Anchor Bolt Condition	Environmental Condition	*Mechanical Damage**	*Coating Condition**	Visual Overhead Defect (Y/N)
52453N24990	H-Frame	B	B	N/A	N/A	Very Low	No	Good	N
58905S53237	H-Frame	A	A	N/A	N/A	Very Low	No	Good	N
52305N25364	H-Frame	A	A	N/A	N/A	Very Low	No	Good	Y

**Note: Many structures have multiple foundation conditions, instances of mechanical damage, and coating defects. The worst case of each was represented in Table 1.*

Table 2: Overview of Results from Wood Structure Inspection

Grid	Structure Type	Osmose Reject Status	PPL Reject Status	Ground Line Defect	*Overhead Structural Defect**	Visual Overhead Defect (Y/N)
52103N25514	Wood Pole	Non Reject	Reject	No	Large Woodpecker Holes	Y
52336N25294	Wood H-Frame	Non Reject	Reject	No	Rotten Cross Arm	Y
60869S51165	Wood Pole	Non Reject	Non Reject	No	Decayed Top	Y
52320N25250	Wood H-Frame	Non Reject	Reject	No	Medium Woodpecker Holes	N
57906S52642	Wood Pole	Non Reject	Reject	No	Medium Woodpecker Holes	Y
58105S52817	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	Y
58167S52904	Wood H-Frame	Non Reject	Non Reject	No	Decayed Top	N
58237S53004	Wood H-Frame	Non Reject	Reject	No	Leaning Pole - Major	Y

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Grid	Structure Type	Osmose Reject Status	PPL Reject Status	Ground Line Defect	*Overhead Structural Defect**	Visual Overhead Defect (Y/N)
58261S53014	Wood H-Frame	Non Reject	Reject	No	Shell Rot	Y
58411S53065	Wood H-Frame	Non Reject	Reject	No	Small Woodpecker Holes	N
58541S53111	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
58720S53172	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
58905S53236	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
59092S53301	Wood H-Frame	Non Reject	Non Reject	No	No	Y
59256S53492	Wood H-Frame	Non Reject	Reject	No	Decayed Top	Y
59820N24072	Wood H-Frame	Non Reject	Reject	No	Small Woodpecker Holes	Y
59939N24096	Wood Pole	Non Reject	Reject	No	Decayed Top	Y
60053N24152	Wood Pole	Non Reject	Reject	No	Cross Arm Delamination	Y
60228N24289	Wood Pole	Non Reject	Non Reject	No	Decayed Top	N
60332N24305	Wood Pole	Non Reject	Reject	No	Medium Woodpecker Holes	Y
61259S51032	Wood Pole	Non Reject	Reject	No	Decayed Top	Y
60874S51157	Wood Pole	Non Reject	Non Reject	No	Decayed Top	Y
60731S51221	Wood H-Frame	Non Reject	Reject	Termites	Decayed Top	N
59622S51594	Wood Pole	Non Reject	Reject	No	Large Woodpecker Holes	Y
57898S52608	Wood Pole	Non Reject	Reject	Shell Rot	Large Woodpecker Holes	Y

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Grid	Structure Type	Osmose Reject Status	PPL Reject Status	Ground Line Defect	*Overhead Structural Defect**	Visual Overhead Defect (Y/N)
57905S52618	Wood Pole	Non Reject	Non Reject	Mechanical Damage	No	N
57911S52636	Wood Pole	Non Reject	Reject	Shell Rot - No Deduction	Split Top	Y
57953S52668	Wood H-Frame	Non Reject	Reject	Shell Rot - No Deduction	Leaning Pole - Major	Y
58115S52817	Wood H-Frame	Non Reject	Reject	Shell Rot - No Deduction	Medium Woodpecker Holes	Y
58178S52904	Wood H-Frame	Non Reject	Reject	No	Medium Woodpecker Holes	Y
58244S52998	Wood H-Frame	Non Reject	Reject	No	Leaning Pole - Major	Y
58266S53006	Wood H-Frame	Non Reject	Reject	No	Worn Attachment Point Hardware	Y
58920S53234	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
59096S53296	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	Y
59944N24092	Wood Pole	Non Reject	Non Reject	No	Decayed Top	Y
61261S51038	Wood Pole	Non Reject	Reject	No	Medium Woodpecker Holes	Y
59624S51600	Wood Pole	Non Reject	Reject	No	Medium Woodpecker Holes	Y
58017S52728	Wood H-Frame	Non Reject	Reject	No	Decayed Top	Y
58028S52727	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	Y
58970S53259	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
57950S52676	Wood H-Frame	Non Reject	Reject	No	Rusty Cross Arm	Y

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Grid	Structure Type	Osmose Reject Status	PPL Reject Status	Ground Line Defect	*Overhead Structural Defect**	Visual Overhead Defect (Y/N)
58238S53004	Wood H-Frame	Priority Non Restorable Reject	Reject	Compression Wood	Medium Woodpecker Holes	Y
58411S53066	Wood H-Frame	Priority Non Restorable Reject	Reject	Exposed Pocket	Large Woodpecker Holes	N
57954S52668	Wood H-Frame	Non Reject	Reject	No	Small Woodpecker Holes	N
58266S53005	Wood H-Frame	Non Reject	Reject	No	Small Woodpecker Holes	N
58541S53110	Wood H-Frame	Non Reject	Reject	No	Medium Woodpecker Holes	N
58018S52728	Wood H-Frame	Non Reject	Non Reject	Shell Rot - No Deduction	Decayed Top	N
58520S53096	Wood Pole	Non Reject	Non Reject	No	No	Y
57951S52676	Wood H-Frame	Non Reject	Reject	No	Medium Woodpecker Holes	N
58179S52904	Wood H-Frame	Non Reject	Reject	No	Decayed Top	N
58106S52817	Wood H-Frame	Non Reject	Non Reject	No	Decayed Top	N
58168S52904	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
58261S53103	Wood H-Frame	Non Reject	Reject	Shell Rot	Medium Woodpecker Holes	N
58243S52998	Wood H-Frame	Non Reject	Reject	No	Leaning Pole - Major	Y
58029S52727	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
58116S52817	Wood H-Frame	Non Reject	Non Reject	Shell Rot - No Deduction	No	N

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Grid	Structure Type	Osmose Reject Status	PPL Reject Status	Ground Line Defect	*Overhead Structural Defect**	Visual Overhead Defect (Y/N)
58662S53152	Wood Pole	Non Reject	Reject	No	Large Woodpecker Holes	N
52103N25513	Wood Pole	Non Reject	Reject	No	Large Woodpecker Holes	Y
59246S53445	Wood H-Frame	Non Reject	Reject	Shell Rot - No Deduction	Small Woodpecker Holes	Y
59271S53552	Wood H-Frame	Non Reject	Reject	Shell Rot - No Deduction	Medium Woodpecker Holes	Y
58920S53233	Wood Pole	Non Reject	Non Reject	No	No	Y
59096S53295	Wood H-Frame	Non Reject	Reject	No	Medium Woodpecker Holes	Y
59257S53492	Wood H-Frame	Non Reject	Reject	No	Split Top	Y
52321N25250	Wood H-Frame	Non Reject	Reject	No	Large Woodpecker Holes	N
59272S53553	Wood H-Frame	Non Reject	Non Reject	Shell Rot - No Deduction	Mold or Stain	Y
59819N24072	Wood H-Frame	Non Reject	Non Reject	Mechanical Damage	Mold or Stain	Y
52335N25294	Wood H-Frame	Non Reject	Reject	No	Decayed Top	Y
52092S53302	Wood H-Frame	Non Reject	Non Reject	No	No	N
60731S51220	Wood H-Frame	Non Reject	Reject	No	Decayed Top	N
59245S53445	Wood H-Frame	Non Reject	Reject	Shell Rot - No Deduction	Rusted or Deteriorated Guy Wire	Y
59153S53311	Wood H-Frame	Non Reject	Non Reject	No	No	Y

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Grid	Structure Type	Osmose Reject Status	PPL Reject Status	Ground Line Defect	*Overhead Structural Defect**	Visual Overhead Defect (Y/N)
58720S53171	Wood H-Frame	Non Reject	Reject	No	Decayed Top	N

**Note: Many structures have multiple instances of overhead structural defects. The worst defect is represented in Table 2.*

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Table 3: Steel Structure Ground Line Inspection Summary

Fully Inspected Tower Legs:	240
Fully Inspected Poles:	*26**
Structural Reject Legs:	15
Structural Reject Poles:	3
Foundation Reject Legs:	15
Foundation Reject Poles:	0
Anchor Bolt Rejects:	0
Mechanical Damage Reject Legs:	6
Mechanical Damage Reject Poles:	0

**Amount includes 6 steel poles that are leg members of H-Frame structures*

Table 4: Steel Structure Overhead Visual Inspection Reported Items Summary

Structure Damage or Corrosion:	83
Cross Arm Damage or Corrosion:	6
Conductor Damage or Corrosion:	21
Overgrown Trees or Vegetation:	1
Right of Way Infringement:	2
Guy Wire/Anchor Damage or Corrosion:	3
Ground System Damage or Corrosion:	2

Table 5: Wood Structure Ground Line Inspection Summary

Fully Inspected Poles:	*72**
Reject Poles:	0
Priority Non-Restorable Reject Poles:	2
Customer Reject Poles:	56

**Amount includes 26 wood H-Frame structures*

Table 6: Wood Structure Overhead Visual Inspection Reported Items Summary

Pole Damage or Decay:	144
Cross Arm Damage or Decay:	15
Conductor Damage or Corrosion:	27
Overgrown Trees or Vegetation:	0
Right of Way Infringement:	0
Guy Wire/Anchor Damage or Corrosion:	23
Ground System Damage or Corrosion:	16

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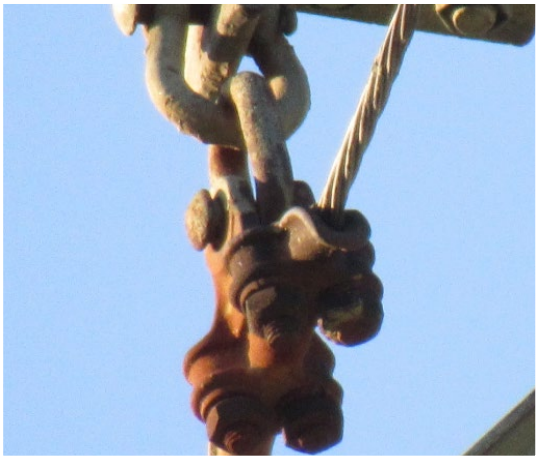
The following images represent the most common findings from the inspection. More inspection images can be found in sections 9.4 – 9.6 of the Appendix:



Worn Attachment Point Hardware

Wood Pecker Holes

Atmospheric Corrosion

Split Top

4. Structural Steel Assessment

A structural steel assessment was accomplished by measuring the section loss of steel due to corrosion. Mechanical damage was also evaluated to determine the effect it had on the structure. The methods for collecting this information varied based on the structure type and construction.

The structural steel assessment results are used to determine the following:

- Current structural condition
- Restoration recommendations
- Mitigation application during inspection

4.1. Structural Steel Condition

The overall evaluation of corrosion severity relative to the structure shall be determined through the visual assessment and direct physical measurement of structural members to determine actual section loss. Structures shall be inspected and categorized per the information below.

CONDITION A – (Good) Steel is in near original condition with only minor surface corrosion evident in a few small areas with 1% or less average section loss evident.

CONDITION B – (Fair) Steel corrosion conditions may range from mild surface rust in several areas to all buried surfaces showing some amount of rust and some minor pitting. To meet the definition of this condition category the average section loss is greater than 1% but shall not exceed 10%.

CONDITION C – (Poor/Restoration Recommended) Steel shows moderate corrosion conditions which may include moderate corrosion in several areas to all buried surfaces showing measurable pitting, thinning and/or edge loss. To meet the definition of this condition category the average section loss must be greater than 10% but not exceed 20%.

Structures in this condition category are generally considered to need restoration and will be reported to the customer for further attention.

CONDITION D – (Severe/Restoration Required) Steel has experienced heavy corrosion activity consisting of significant thinning, pitting and/or edge loss. Corroded areas will typically have a large amount of section loss, with parts completely rusted through due to corrosion. To meet the definition of this condition category the average section loss must exceed 20%.

All structures that have experienced more than 20% average section loss on multiple structural members will receive an engineering review to determine if immediate attention is required.

Structures in this condition category are generally considered to need restoration and will be reported to the customer for further attention.

PRIORITY – Defined as a structure in condition D, with more than a 50% average loss of cross section on any one structural member or has had structural damage due to corrosion, mechanical damage, or Acts of God, which may exceed the Customer's allowable tolerance threshold. Steel poles that have adjacent flats with average section loss exceeding 20% will also be flagged as priorities. These will be communicated directly to the customer project manager for their immediate attention.

4.2. Mechanical Damage Assessment

Mechanical damage can be classified into three separate groups, I, II, and III and is defined as damage that is not corrosion related.

Class I (Minor) – Minor deformations of smaller non-critical members, such as a horizontal redundant. This type of mechanical damage on a member does not, generally, require restoration.

- Minor buckling of the tension member with minimal displacement
- Buckling or deformation of redundant members
- Minor nicks/scratches on steel
- Damage of the members, or portions of the member that does not carry a load (bends on the "free corner" of the member, step bolt damage etc.)
- Bullet holes

Class II (Moderate) – Significant deformation or damage to the members or hardware. Structures are not in immediate danger of significant failure. Structures with Class II (Moderate) mechanical damage will be flagged for restoration.

Significant member deformation over a short distance. Measurements will be made during the inspection that will determine the length of the deformation.

- Missing bolts and nuts
- Damage on hardware
- Tears or cuts in members
- Minor damage to adjacent pole walls
- Insufficient bolt edge distance
- Missing redundant members
- Minor damage to a single face of a post leg

Class III (Severe) – Requires immediate attention and restoration. Customer will be notified of structures that have Class III (Severe) mechanical damage.

- Severe member deformation
- Severe overhead or pole wall buckling
- Large holes (>1") in pole wall
- Missing more than half of the bolts in a connection
- Missing or severely damaged anchor bolts
- Missing load bearing members
- Completely broken off primary & secondary members
- Missing multiple redundant members on one leg
- Any damage to both faces of a critical member such as post leg, stub angle, anchor bolt, or member designed to carry significant load

4.3. Anchor Bolt Condition

Where applicable, and only where access allows, anchor bolts have been evaluated for excessive rust, corrosion, and/or deterioration. Loose rust on the bolts was removed to allow for accurate measurements.

Every effort was made to collect the original bolt diameter (threads included). Condition category is based on the calculated cross-sectional area using the 'net' (threads excluded) diameter. Anchor bolts are categorized in one of the following condition grades based on the worst condition single anchor bolt described below (structures without anchor bolts or anchor bolts that were inaccessible were marked as N/A at the structure level):

CONDITION A – (Good) Condition - Anchor bolt is in near original condition. Only minor surface rust is evident in a few small areas with 1% or less the calculated cross-sectional area loss evident.

CONDITION B – (Fair) Condition - From surface corrosion to pitted rust corrosion – anchor bolt condition may range from surface rust in several areas to all buried surfaces showing rust and some minor pitting. For a condition B rating, the calculated cross-sectional area loss is greater than 1% but shall not exceed more than 10%.

CONDITION C – (Poor) Condition - Corroded and damaged anchor bolts that have lost greater than 10% and less than 25% of the calculated cross-sectional area.

> ***Note**: In addition, when adjacent anchor bolt groups are identified as condition C, Osmose strongly recommends anchor bolts in this condition having higher section loss be evaluated by the Customer for restorations.*

CONDITION D – (Reject) - Heavily corroded anchor bolts exceeding 25% of the calculated cross-sectional area. Significantly corroded areas will typically have large loss of section, with parts completely deteriorated due to corrosion.

PRIORITY STRUCTURES - An anchor bolt in condition D, with more than a 50% loss of cross sectional area or has had structural damage due to corrosion, mechanical damage, and/or Acts of God. These will be communicated directly to the Customer for immediate attention.

> ***Note:** Additionally, when two or more anchor bolt groups exceed 25% loss of cross-sectional area the structure will be flagged as "Priority".*

4.4. Environmental Assessment

For steel structures, key predictive indicators were measured at each structure during the inspection process to evaluate environmental conditions. Measurements include: Soil resistivity, pH, Oxidation Reduction (REDOX), and structure-to-soil potential (half-cell) measurements. Soil type and moisture level are also visually evaluated and noted.

The measurements of the key predictive indicators were evaluated to determine the following:

1) Potential risk of corrosion to the individual structures (the potential risk of corrosion over the entire footprint of the line, in some cases)
2) Corrosion inspection cycle intervals
3) Future mitigation options
4) Additional inspections needed outside of the regular inspection cycle interval

The rate at which steel corrodes below-grade varies significantly based on the physical and chemical properties of the surrounding site conditions. Environmental factors at any given site can be evaluated through measurable indirect field assessment techniques to determine potential corrosion activity. The primary risk indicators are listed below.

4.4.1. Soil Resistivity

Soil resistivity is a significant indicator in determining how corrosive a soil environment is. Soils with low resistivity allow for unrestricted flow of current supporting a higher level of corrosion activity. Soil resistance measurements are taken to sample soil resistivity at various depths and points around the structures using a digital soil resistivity probe.

4.4.2. Soil pH

Corrosion on steel and other similar metals is associated with soils that have a very low pH (highly acidic). Soil pH measurements are taken with a digital soil pH probe from a location near the structure deemed appropriate by the inspector.

4.4.3. Redox Measurement

Redox measures the dissolved oxygen content in the soil and can help indicate the presence of microbial bacteria which can identify areas with the potential for Microbial Induced Corrosion (MIC). Although bacteria itself does not typically attack metals directly, various bacteria can develop corrosive byproducts which are corrosive to steel. Soil Redox measurements are taken from the excavation or at a location deemed appropriate by the inspector.

4.4.4. Half Cell Potential Measurement (VDC or Structure to Soil Potential)

Half-cell measurements indicate the potential for steel to corrode within a specific site environment. Using a digital potential meter, measurements are taken from approximately (2) two feet from each structure.

4.4.5. Environmental Corrosion Assessment

Environmental factors at any given site can be evaluated through measurable indirect field assessment techniques (listed previously) to determine the potential for very low to severe corrosion activity. The evaluation of this data is used to categorize the structures into manageable groups for follow up maintenance and possible mitigation. Because environmental site conditions are not static, the structure should be re-inspected in regular intervals or anytime site conditions change due to construction or agricultural activity as these changes can increase corrosion activity.

The categories are defined as follows:

Very Low - A structure with low or neutral environmental indicators and low potential for corrosion activity. Typically, these structures are low risk and do not need further attention at the time of inspection.

Mild - A structure with environmental indicators that reflects a slightly elevated potential for corrosion. These structures are at a threshold that may require mitigation to offset potential deterioration.

Moderate - A structure with moderate environmental indicators and a more serious potential for corrosion activity. These structures should have mitigation applied, likely in the form of coatings, to assist in preventing further deterioration.

Severe - A structure with environmental indicators that reflect a severe potential for corrosion. Structures in this category should have mitigation applied in the form of coatings, at a minimum, and be evaluated for cathodic protection.

Please note that if no mitigative efforts are utilized on structures in this condition, the inspection interval should be significantly shortened.

4.5. Concrete Foundations

4.5.1. Concrete Inspections

Where applicable, concrete foundations were evaluated by means of visual assessment, physical evaluation, and collection of measurements. The following are descriptions of the field assessment process.

4.5.1.1. Visual Inspection

A visual inspection of each foundation was conducted to identify signs of damage and/or deterioration. These conditions may include cracking, spalling, delamination, disintegration, exposed or corroded rebar, and exposed coarse aggregate and/or steel reinforcement.

4.5.2. Concrete Foundation Condition

The data collected during the foundation assessment was evaluated to estimate the condition and determine any necessary rehabilitation. Foundations have been categorized by a qualified individual in one of the following categories (structures without concrete foundations will be marked as N/A):

CONDITION A – (Good) No signs of damage and/or deterioration. Like new.

CONDITION B – (Fair) No signs of spalling or exposed reinforcement. Minor cracking (not exceeding .016" wide) or deterioration which can be easily restored, and/or light scaling (less than 0.25" of surface mortar loss).

CONDITION C – (Poor/Restorations Recommended) Larger cracks (between 0.016" and 0.187" wide) and/or presence of minor spalls (up to ~25% of total exposed surface or edge, up to a 1" maximum depth) with no exposed reinforcement. Foundations in this condition may also exhibit medium scaling (surface mortar loss between 0.25" and 0.50", with some exposed aggregate).

CONDITION D – (Reject) Cracks wider than 0.187" but less than 0.25", large spalls (> ~25% of total exposed area) with possible exposed reinforcing, and/or disintegration. Severe scaling (mortar loss between 0.50" and 0.75" deep with exposed aggregate) and/or medium spalls (between 25% and 50% of total exposed surface or edge, between 1" and 3" deep) may be present.

PRIORITY STRUCTURES – Cracks 0.25" or wider, very severe scaling (mortar loss depth greater than 0.75"), large spalling (large sections of concrete missing, greater than ~50% of total exposed surface or edge, greater than 3" deep), or exposed corroded rebar. Complete failure of concrete foundation requiring extensive foundation reconstruction.

4.6. Visual Coating Inspection

Existing steel structure coatings were visually assessed by the following:

- Comparing to the SSPC VIS-1, VIS-2, or inspection standard selected by the Osmose corrosion engineer
- Checking for visible fish mouths at the tops of the coatings
- Checking for visible coating delamination
- Recording if no coatings were present
- Noting other types of coating failures

5. Wood Pole Assessment

5.1. Wood Pole Inspection

Wood poles were evaluated by means of sound and bore inspection and collection of circumference measurements. The following are descriptions of the field assessment process.

5.1.1. Sound Inspection

Sound inspection involves striking a pole repeatedly with a hammer from as high as the inspector can reach to the exposed ground line area in order to locate interior pockets of decay. Hammer marks should be visible to indicate that the area was sounded.

5.1.2. Bore Inspection

Poles were bored with a 3/8" bit. Bore holes are located at the ground line and drilled at a 45° angle to a depth of the center line of the pole. A shell thickness indicator was used to detect the existence and estimated extent of any interior decay. If enclosed decay pockets were discovered in a pole, a minimum of four (4) borings were taken to determine the size and extent of decay.

Shell borings were made at an angle of approximately 60°. The holes were bored in a manner so the boring stayed within the outer 2-3" of shell. Therefore, the hole was intentionally bored off-center from the pole. Shell borings were made at the discretion of the inspector based on field/pole conditions and pole species.

Once completed, bored holes were plugged with tight fitting treated wood dowels or plastic plugs.

5.1.3. Circumference Measurements

The effective ground line circumference was collected and recorded for each pole during inspection. It was then compared to the original ground line circumference to determine remaining strength of the pole at the ground line.

5.2. Wood Pole Condition

5.2.1. Osmose Wood Pole Condition Criteria

The data collected during the wood pole assessment were evaluated to estimate the condition and determine any necessary rehabilitation. The structures have been categorized by a qualified individual in one of the following categories:

NON-REJECT – A non-reject pole is any sound and bored pole with a remaining strength greater than 67% of original design strength.

REJECT – A reject pole is any sound and bored pole with a remaining strength of less than 67% of original design strength.

PRIORITY NON-RESTORABLE REJECT – A priority pole is a pole with an effective circumference of less than 50% of its original circumference and/or 13% or less remaining original strength and shall be reported to owner's representative.

5.2.2. PPL Wood Pole Condition Criteria

In addition to Osmose wood pole condition criteria, the wood poles were also rated based on customer condition criteria. Per customer specification, instances of the following would be used in determining which structures were candidates for replacement:

- Excessive pole top rot
- Woodpecker holes
- Leaning or bending poles
- Previously restored poles
- Cracked, split, or checked poles
- Deficiencies found at hardware attachment points (e.g., guy wire attachment points)

5.3. Determining Reinforceable Rejects

When the initial inspection revealed reject poles, the pole was marked for replacement or reinforcement. The following inspections were performed to determine if the pole is reinforceable:

5.3.1. Ground Line Pole Condition

Poles exhibiting shell rot at or below ground line shall have a minimum remaining sound wood circumference of 33% or greater than the original ground line circumference and/or 4% remaining strength.

5.3.2. Lower Band Pole Condition

A single truss application requires two inches (2”) or greater of average sound shell at fifteen inches (15”) from ground line. A double truss application may have less than two inches (2”) but requires greater than or equal to one inch (1”) of average sound shell at fifteen inches (15”) from ground line.

5.3.3. Top of Truss Pole Condition

A standard truss requires an average sound shell of four inches (4”) or greater at the installed height of the standard truss required, typically five feet (5’). A tall truss requires four inches (4”) or greater of average sound shell anywhere from six to eight feet (6-8’) above ground line.

6. Visual Overhead Inspection

Using gyroscopic stabilized binoculars and gyroscopic stabilized cameras, Osmose inspection crews examined and recorded instances of the following:

- Broken strands, gunshots, and lightning damage on conductors
- Broken strands, severe corrosion, lightning damage, missing dampers, damaged marker balls, and worn attachment point hardware on overhead ground wires
- Cross arm type (steel, pole, laminated, square, etc.) and identified splits, cracks, missing hardware, vegetation, and bird holes
- Mechanical damage
- Insulator type (glass, porcelain, polymer, or NCI) and identified broken, flashed, contaminated, rusted, and worn attachment point hardware
- Missing or visibly loose connection hardware
- Broken, disconnected, or missing ground wires
- Broken or slack guy wires
- Atmospheric corrosion
- Right of way infringement
- Surrounding vegetation
- Evidence of soil migration such as buried concrete foundations

7. General Recommendations

7.1. Ground Line Inspections on Steel Structures

The steel structure inspection, conducted by Osmose Utilities Services, produced multiple recommendations. The following list describes the restoration and/or mitigation strategy recommended for each condition type.

Priority

1. Structural and Foundation Priority structures require restoration within 6 months and should be placed on a 10-year inspection cycle.

Condition D

1. Structural and Foundation Condition D structures require restoration within 12 months and should be placed on a 10-year inspection cycle.

Condition C

1. Structural and Foundation Condition C structures should receive remediation to prevent further deterioration. If not remediated, these structures should be placed on a 5-year inspection cycle.

Condition A & B

1. Structural and Foundation Condition A & B structures should be placed on a 10-year inspection cycle.

Mechanical Damage

1. Structures sustaining Class III damage should be restored within 6 months and be placed on a 10-year inspection cycle.
2. Structures sustaining Class II damage should be restored within 12 months and be placed on a 10-year inspection cycle.
3. Structures sustaining Class I damage should be placed on a 10-year inspection cycle.

7.2. Ground Line Inspections on Wood Structures

The wood structure inspection, conducted by Osmose Utilities Services, produced multiple recommendations. The following list describes the restoration and/or mitigation strategy recommended for each condition type.

Customer Reject

1. Customer reject structures have been noted in this report and should be restored or replaced based on customer specifications.

Priority Non-Restorable Reject

1. Priority non-restorable reject structures should be replaced within 6 months and be placed on a 10-year inspection cycle.

Reject

1. Reject structures require restoration within 12 months and should be placed on a 10-year inspection cycle.

Non-Reject

1. Non-Reject structures should be placed on a 10-year inspection cycle.

7.3. Visual Overhead Inspections

The visual overhead inspection, conducted by Osmose Utilities Services, produced multiple recommendations. The following list describes the restoration and/or mitigation strategy recommended for each condition type.

Restoration Recommended

1. Structures in this category should receive restoration within 6 months and should be placed on a 10-year inspection cycle.

Further Investigation Needed

1. Structures in this category should be inspected further within 12 months to determine if restoration is required and should be placed on a 10-year inspection cycle.

No Issues Found

1. Structures with no reported items recorded should be placed on a 10-year inspection cycle.

8. Osmose Contact Information

Please contact Osmose with any questions or to discuss this matter in more detail.

For sales inquiries, contact:

Mark Lapos, Senior Director-Business Development
mlapos@osmose.com
484-695-7550

For technical inquiries, contact:

Mark Pitre, E.I.T., Engineer II
mpitre@osmose.com
423-762-5145

9. Appendix

9.1. Summary of Mechanical, Structural, Environmental, and Foundation Data

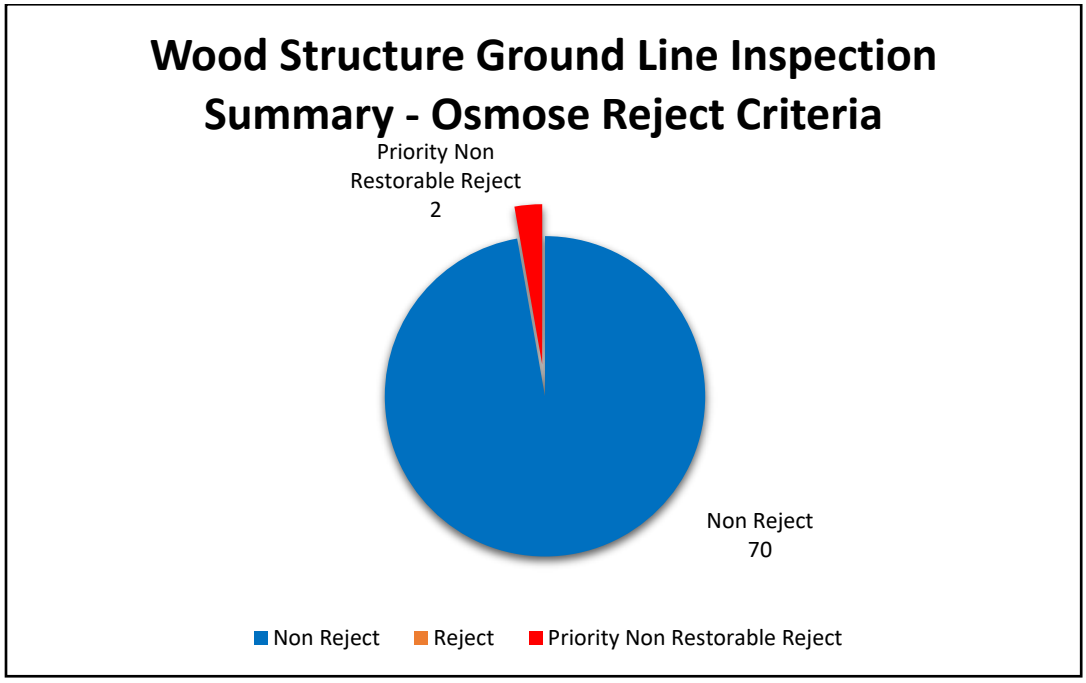


Figure 1: Summary of Wood Structure Ground Line Inspection Using Osmose Reject Criteria

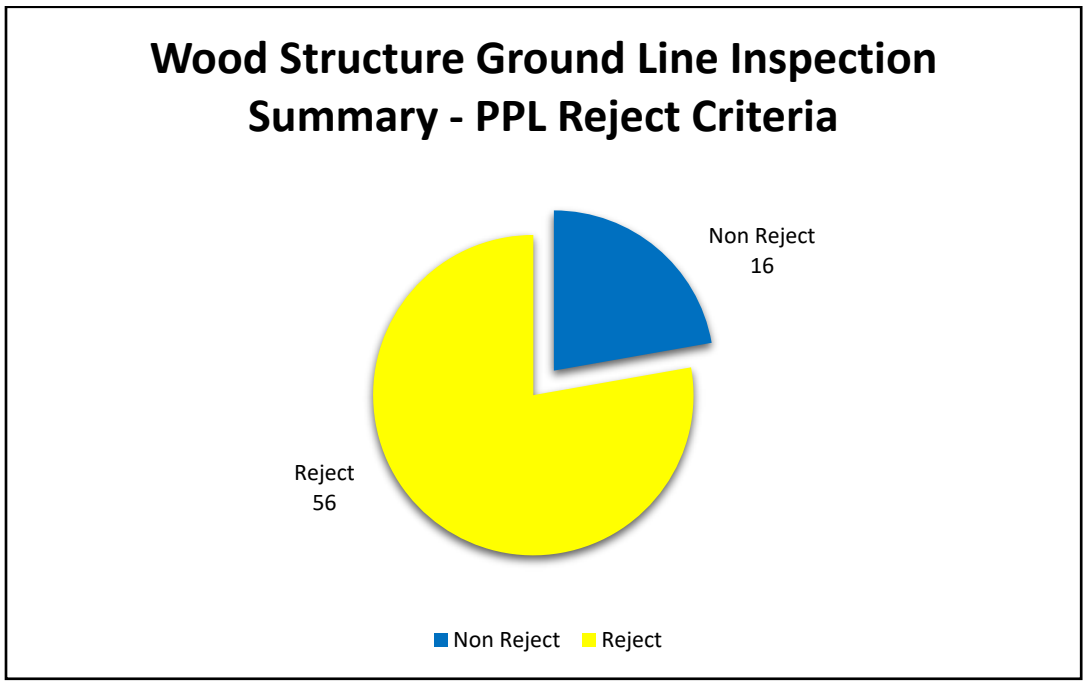


Figure 2: Summary of Wood Structure Ground Line Inspection Using PPL Reject Criteria

Table 7: Decay Summary of Wood Structures

Pole	*Location**	Type of Decay
57898S52608	Unset 0.12	External Shell Rot
57905S52618	-90°, 0.5, 4.5	External Mechanical Damage
58411S53066	+135°, 5, 16.5	External Exposed Pocket
58411S53066	Unset 1.91	External Shell Rot
58261S53103	Unset 0.24	External Shell Rot
59819N24072	+LOL, 0.5, 2	External Mechanical Damage

**Location provided as follows: degrees clockwise from line of lead, depth, and elevation relative to ground line. "Unset" denotes multiple locations.*

***Note: 11 instances of shell rot with no deduction in overall pole strength were recorded.*

Table 8: Mechanical Damage Summary of Steel Structures

Tower	Leg	Component	Class
57636S52707	1	Diagonal Left	II
57902S52595	4	Diagonal Right	II
58022S52531	1	Diagonal Left	II
58442S52310	3	Post Leg	II
59745S51558	3	Left and Right Horizontal Redundant	II
60129S51442	1	Post Leg	III

**Note: 88 instances of Class I mechanical damage were recorded.*

Table 9: Structural Condition Summary of Steel Structures

Condition Rating	Number of Affected Legs/Poles
A	14
B	152
C	82
D	13
Priority	5
Total Legs/Poles	266

Table 10: Environmental Condition Summary of Steel Structures

Condition Rating	Number of Affected Legs/Poles
Very Low	192
Mild	63
Moderate	9
Severe	2
Total Legs/Poles	266

Table 11: Foundation Condition Summary of Steel Structures

Condition Rating	Number of Affected Legs/Poles
A	0
B	40
C	8
D	6
Priority	9
N/A*	203
Total Legs/Poles	266

**Note: N/A denotes structures with direct bury foundations*

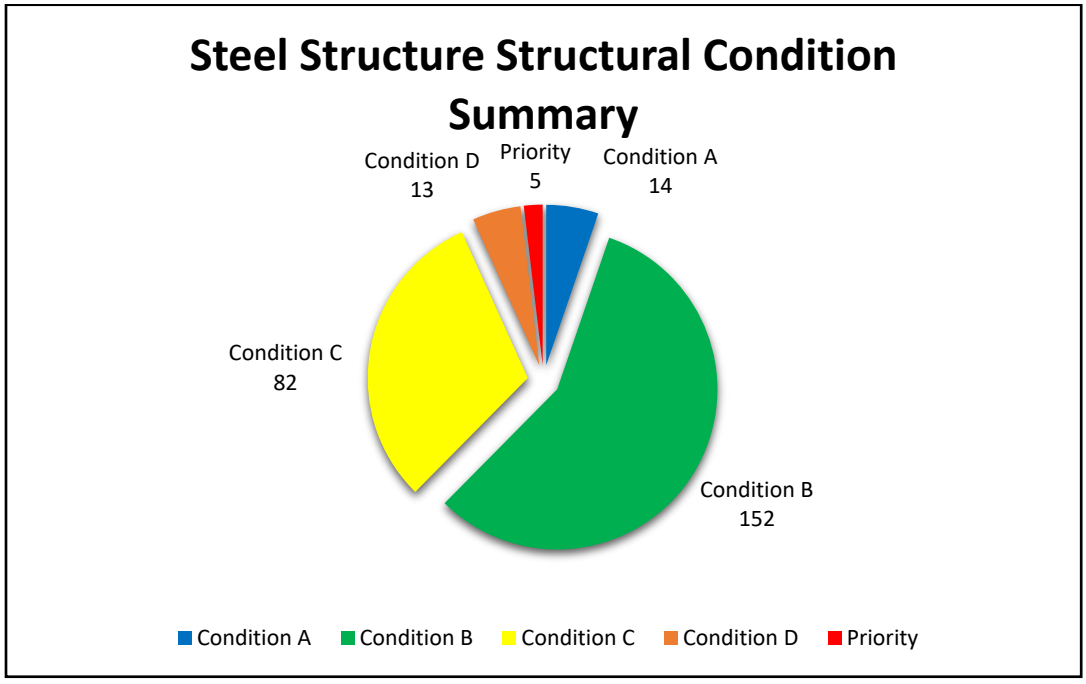


Figure 3: Structural Condition Summary of Steel Structures at the Ground Line

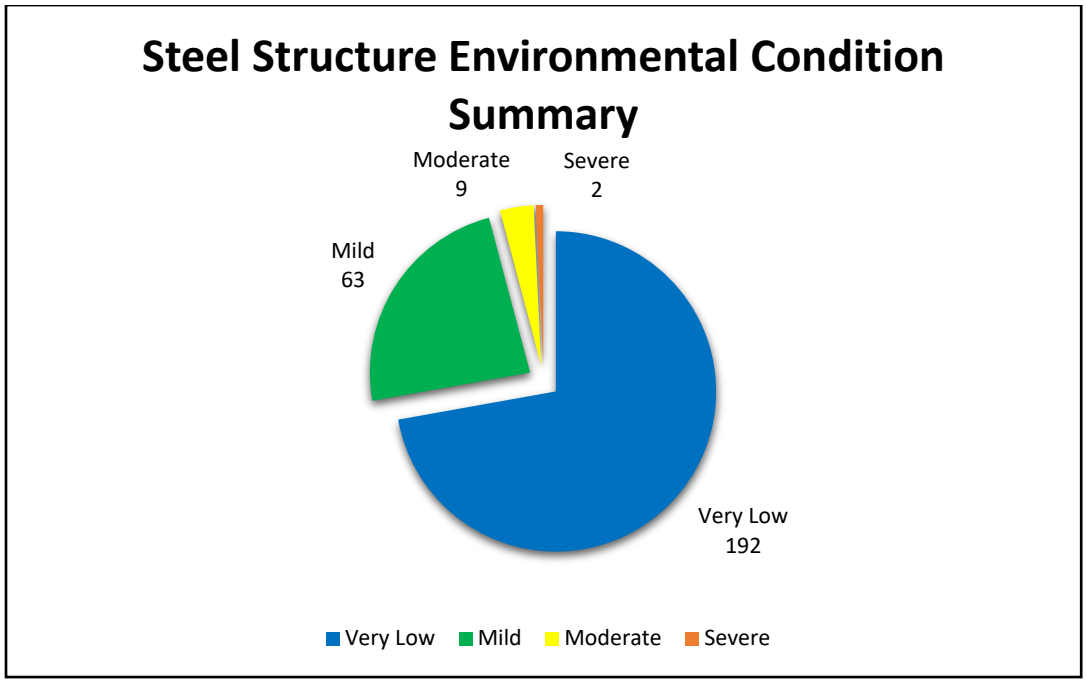


Figure 4: Environmental Condition Summary of Steel Structures

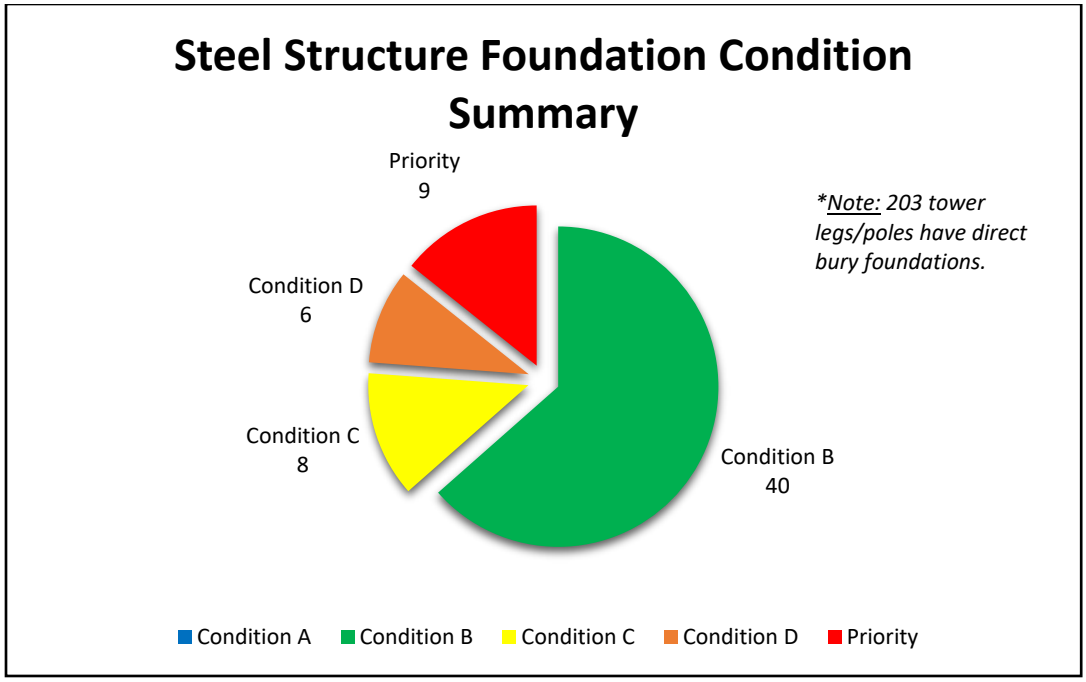


Figure 5: Foundation Condition Summary of Steel Structures

9.2. Summary of Visual Overhead Inspection Reported Items

Table 12: Summary of Structural Reported Items on Steel Structures

Description	Number of Instances
Atmospheric Corrosion	32
Buried Concrete Foundation	6
Overhead Mechanical Damage	3
Missing Structure Identification	28
Missing Warning Sign	3
Worn Attachment Point Hardware	11
Corrosion on Cross Arm Attachments	1
Broken or Damaged Cross Arm	3
Visible Rust on Cross Arm	2
Total Instances	89

Table 13: Summary of Structural Reported Items on Wood Structures

Description	Number of Instances
Leaning Pole (Minor or Major)	4
Missing Identification	5
Compression Wood	1
Decayed Top	32
Excessive Spur Cuts	4
Mold or Stain	18
Overhead Shell Rot	1
Split Top	18
Termites	1
Woodpecker Holes (Small, Medium, or Large)	61
Cracked/Split/Decayed Cross Arm	11
Rust on Cross Arm	3
Total Instances	159

Table 14: Summary of Conductor and Ground System Reported Items on All Structures

Description	Number of Instances
Frays or Damage	9
Broken or Damaged Insulator	2
Red Rust on Attachments	40
Corrosion	1
Severe Corrosion	1
Worn Attachment Point Hardware	11
Total Instances	64

Table 15: Summary of Trees and Vegetation Reported Items on All Structures

Description	Number of Instances
Vines Present on Structure	1
Total Instances	1

**Note: There were no reports of tree or vegetation growth on any of the wood structures that were inspected.*

Table 16: Summary of Right of Way Reported Items on All Structures

Description	Number of Instances
Right of Way Infringement	2
Total Instances	2

**Note: There were no reports of right of way infringement on any of the wood structures that were inspected.*

Table 17: Summary of Guy Wire/Anchor Reported Items on All Structures

Description	Number of Instances
Deteriorated Anchor	1
Missing Guy Marker	10
Slack or Broken Guy Wire	5
Guy Wire Needing Attention	1
Pulled Anchor	2
Rusted or Deteriorated Guy Wire	7
Total Instances	26

9.3. Visual Coatings Inspection

Table 18: Summary of Visual Coatings Inspection on Steel Structures

Description	Number of Affected Legs/Poles
Delamination	234
Fish Mouths	1
Peeling	4
No Coating Present	7
No Coating Issues	20
Total Affected Towers/Poles	266

9.4. Ground Line Inspection Images

Structure 58686S52191 Leg 3
Concrete Foundation
Priority

Structure 60007S51512 Leg 1
Concrete Foundation
Priority

Structure 51718N25329 Leg 3
Right Horizontal Wrap
Structural Priority

Structure 58884S51960 Leg 1
Right Horizontal Wrap
Structural Priority

ATTACHMENT TUS A-1D

Structure 58442S52310 Leg 3
Post Leg
Class II Mechanical Damage

Structure 59745S51558 Leg 3
Right Horizontal Redundant
Class II Mechanical Damage

Structure 60129S51442 Leg 1
Post Leg
Class III Mechanical Damage

Structure 58676S52250 Leg 2
Concrete Foundation
Priority

9.5. Wood Pole Inspection Images

Structure 58238S53004
Compression Wood
Priority Non Restorable Reject

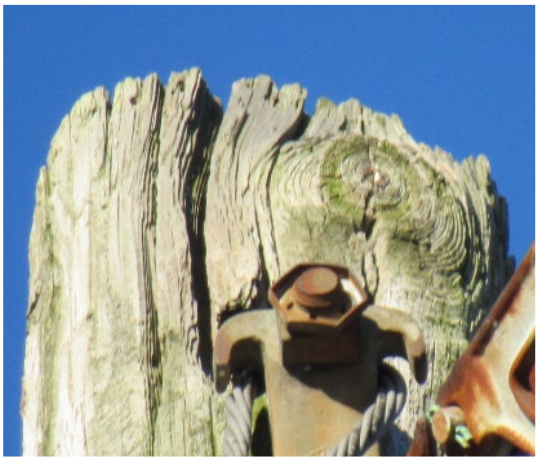
Structure 58411S53066
Exposed Pocket
Priority Non Restorable Reject

Structure 59819N24072
Mechanical Damage
Osmose Non Reject

Structure 58970S53259
Large Woodpecker Holes
Reported Item

ATTACHMENT TUS A-1D

Structure 59096S53295
Excessive Spur Cuts
Reported Item



Structure 61261S51038
Split Top
Reported Item

Structure 58261S53014
Shell Rot Above
Reported Item

Structure 58106S52817
Mold or Stain
Reported Item

9.5.1. Visual Overhead Inspection Images

Structure 58634S52291
Broken or Damaged Insulator
Reported Item

Structure 58884S51960
Broken or Damaged Insulator
Reported Item

Structure 59313N23679
Red Rust on Conductor Attachments
Reported Item

Structure 60707S51215
Atmospheric Corrosion
Reported Item

ATTACHMENT TUS A-1D

Structure 60582S51258
Worn Attachment Point Hardware
Reported Item

Structure 59271S53552
Anchor Deteriorated
Reported Item

Structure 58238S53004
Guy Wire Needs Attention
Reported Item

Structure 52103N25514
Slack Guy Wire
Reported Item