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GEOLOGIC REPORT FOR THE 1880 HARVEST UNIT

December 15, 2023

Prepared for: Cristian Sanchez, Forest Engineering Specialist
Weyerhaeuser, Pe Ell Forest Area
Pe Ell, Washington

Harvest Unit Name: 1880
HPU Number: 415920
Watersheds: Chehalis Headwaters
Location: Lewis County, Washington
Section 29 T11N R5W, W.M.

OBJECTIVE

The objective of this report is to document the geologic review we conducted on the 1880 Harvest Unit in accordance with Weyerhaeuser policies and State of Washington regulations addressing slope stability, erosion, and forest practices. Our review was specifically conducted in accordance with Section 16 of the Forest Practices Board Manual, Guidelines for Evaluating Potentially Unstable Slopes and Landforms (Division of Forest Practices, 2016). This report has been prepared to support a Class IV Special application due to the need for yarding corridors to pass through UNS buffers.

INTRODUCTION

The 1880 Harvest Unit is planned for clearcut timber harvest. The harvest unit is located eleven miles south of the town of Pe Ell in the Chehalis Headwaters Watershed. I looked at LiDAR-generated topographic data, geologic maps, soil maps, existing landslide inventories, and available photos to conduct a thorough office review. I conducted my geologic field review on September 23, 2021 with Stan Lubinus. We focused on the areas with the most potential for landslide hazard and risk in the eastern half of the unit.

BACKGROUND INFORMATION – OFFICE REVIEW

Stand Description

The harvest unit consists of several stand types dominated by 51 to 55 year old second-growth Douglas fir with western hemlock, and other species in places (Figure 1).

Geomorphology

The harvest unit straddles a low ridge in the headwaters of the West Fork of the Chehalis River. The unit is dominated by gentle (<40%) dormant-indistinct to relict deep-seated landslide terrain. Moderate to steep (>60%) slopes occur along scarps and along streams incised into the otherwise gentle terrain (Figure 2). There is also an area of steep (>60%), moderately dissected slopes in the south-central portion of the unit. Elevation in the unit ranges from 1440 feet to over 1880 feet above mean sea level.

Geology

I reviewed the harvest unit using the WDNR interactive geologic map (Division of Geology and Earth Resources, 2023). Rocks in the eastern portion of the unit are mapped as Em(2ms), the Eocene sandstone member of the McIntosh Formation. Rocks in the western portion of the unit are mapped as Em(2m), Eocene marine sedimentary rocks of the McIntosh Formation. There are numerous northwest and northeast trending faults mapped in the area, including a northwest trending fault just north of the unit. Rocks on the south side of that fault are laying horizontal to dipping up to 15 degrees to the south.

Soils

I reviewed the harvest unit using the NRCS interactive soil map (Soil Survey Staff, 2023). Soils in the harvest unit are mapped as silt loams of the Lytell and Zenker Series, gravelly silt loams of the Squally Series, and cobbly silt loams of the Swem Series. Soils in the Squally Series are classified as GM and soils of the other series are classified as ML to MH soils using the Unified Soil Classification System. The Swem Series consists of moderately well-drained soils and the other series all consist of well-drained soils.

Landslide History

I reviewed the harvest unit using the landslide maps available on the WDNR interactive geologic map (Division of Geology and Earth Resources, 2023). The WDNR inventory identifies four shallow, undifferentiated landslides in the eastern portion of the unit. The Weyerhaeuser inventory from the 2007 storm identifies two additional landslides in the eastern portion of the unit.

OBSERVATIONS – FIELD REVIEW

We made the following observations during our field review (Figure 3):

Point	Observations
1	Slide; 85% slopes; Deep seated; Mixed stand with brush; Old growth stumps; Wet site conditions; Ns channel; Sweep in large conifers; Recommend buffer
2	Swale; 50% slopes; Steeper side slopes and head; Convergent to broadly convergent slopes; Conifer; Old growth stumps; No signs of surface water; No signs of recent slide activity

3	Old slide scar; Slope break; 45% slopes above break; 75% slopes below break; Conifer; Old growth stumps; Back rotated trees; Recommend expanding RMZ to protect feature
4	Old slide scar; Slope break; 45% slopes above break; 75% slopes below break; Brush in scar; Conifer adjacent; Old growth stumps adjacent; Recommend expanding RMZ to protect feature
5	Deep seated slide; 2007 storm; Scarp; Lower portion mobilized; 45% open slopes; Young mixed stand and brush in scar; Conifer adjacent; Old growth stumps; No signs of surface water
6	Old slide scar; Slope break; 45% slopes above break; 95% slopes below break; Conifer; Old growth stumps; Back rotated trees; Recommend expanding RMZ to protect feature
7	Active deep-seated slide; 2007 storm; Slope break 15% slopes above; 85% slopes below; Back rotated trees below break; Recommend buffer
8	Active deep-seated slide; Activity extending downslope towards stream
9	Active deep-seated slide; Apparent right margin of activity
10	Active deep-seated slide; Smaller secondary failures on headscarp deposited on bench
11	Active deep-seated slide; Headscarp; Exposed soil; Near vertical slopes; Back sweep in large conifer on slide bench below; Buffer flagged along slope break up around scarp
12	Steep slopes below knob; 90% slopes; Open slopes; Conifer; Old growth stumps adjacent; No signs of surface water; No signs of recent slide activity
13	Deep seated slide; Dormant distinct; 25-55% slopes; Conifer; Old growth stumps; No signs of surface water; No signs of recent slide activity
14	Inner gorge buffered per engineer's notes

INTERPRETATION and RECOMMENDATIONS

Timber Harvest

The harvest unit has been laid out to avoid harvesting the areas with the highest landslide hazard and risk of sediment delivery to streams (Figure 4). Slope stability protection measures are summarized below:

- The slide at Point #1 will be protected in a UNS buffer.
- The old slide scars at Points #3 and #4 will be protected within the RMZ.
- The recently active deep-seated landslide at Point #5 will be protected with a combination of UNS and RMZ buffers.
- The active deep-seated slide that includes Points #7, #8, #9, #10, and #11 and the adjacent area of historic landslide activity at Point #6 will all be protected with a combination of UNS and RMZ buffers.
- The inner gorge at Point #14 will be protected in a combination of UNS and RMZ buffers.
- Sections of inner gorge elsewhere in the unit will be protected within RMZ buffers.

Yarding Corridors

Due to the rugged terrain and relative inaccessibility of the unit, we discussed the possible necessity of yarding corridors that would cross unstable slopes buffers (Figure 5). We have considered other options and will pursue temporary road access through the bottom of the unit, but that may not work due to timing constraints associated with a fish stream crossing. In case

the temporary road does not work out, the forest practices application will be filed as a Class IV Special to address the option of yarding corridors across unstable slopes buffers. Your analysis of the yarding skyline profiles indicates that yarded logs will have full suspension, but trees may need to be cut in some of the corridors to safely operate. I have included the yarding profiles you provided for the corridors (Figures 6 and 7).

We discussed utilizing the following options to mitigate and/or minimize any impacts to the slopes and leave trees in the buffers:

- Avoid crossing buffers as much as feasible.
- Utilize natural openings in the canopy to avoid impacts to leave trees.
- Maximize lift in the yarding system as safe to do so.
- Buck logs on the slope to minimize the yarded log length (only as necessary and safe to do so).
- Operate the carriage slowly as it passes through the canopy in the buffers.
- Maintain full suspension during yarding to avoid ground disturbance.

Given that the yarding corridors will not impact unstable slopes, will avoid ground disturbance, and will minimize impacts to the leave trees, I do not have any serious concerns with the proposed yarding corridors.

CONCLUSIONS

We conducted a thorough office review of existing information and followed up with a field review covering those areas with the highest risk of sediment delivery to streams. I recommended adjustments to the unit layout where we identified areas of concern with the potential for sediment delivery. Leave tree areas were added or existing buffers were expanded accordingly.

We discussed possible yarding corridors across a couple unstable slopes buffers in the unit. We identified key mitigation strategies to avoid impacts to the slopes and leave trees in the buffers if this logging option becomes necessary.

I have attached an evaluation of the proposed harvest unit directly addressing Washington Department of Natural Resources requirements outlined in WAC 222-10-030 (1). This evaluation can be found in Appendix B.

Contact me if you have any questions or concerns.

LIMITATIONS

We have conducted our geologic review to the standard of care for such reviews of forest practices in Washington, consistent with work conducted by other qualified experts, and in accordance with the requirements of the Washington Department of Natural Resources and the Geologist Licensing Board. Our review was specifically conducted in accordance with Section 16 of the Forest Practices Board Manual, Guidelines for Evaluating Potentially Unstable Slopes and Landforms (Division of Forest Practices, 2016).

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Geologic Report for the 1880 Harvest Unit

We utilized available information for our office review and conducted a reconnaissance-level field review. Our investigation was limited to observations of surface conditions and we did not conduct a sub-surface investigation.

Landslides are a natural hazard inherent to the slopes of the Pacific Northwest and are part of the geologic process. Forest practices may exacerbate that hazard. We have conducted our review with the intent of reducing potential adverse impacts that the planned forest practices may have on slope stability.

CLOSING

Thank you for the opportunity to review this harvest unit and roads project. Please let me know if you have any questions or concerns.

Sincerely,



Jason Hinkle, LEG, QE



APPENDIX A

REFERENCES

Division of Forest Practices, Washington State Department of Natural Resources, Forest Practices Board Manual Section 16 Guidelines for Evaluating Potentially Unstable Slopes and Landforms. Available online at http://www.dnr.wa.gov/Publications/fp_board_manual_section16.pdf . 2016.

Division of Geology and Earth Resources, Washington State Department of Natural Resources, Washington Interactive Geologic Map. Available online at <https://fortress.wa.gov/dnr/geology/?Site=wigm> . Accessed 2023.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Lewis County, Washington. Available online at <http://soildatamart.nrcs.usda.gov> . Accessed 2023.

APPENDIX B

WASHINGTON DEPARTMENT OF NATURAL RESOURCES
WAC 222 10-030 REQUIREMENTS

The following are responses addressing WAC 222-10-030 (1) (a, b, c).

(1) In order to determine whether such forest practices are likely to have a probable significant adverse impact, and therefore require an environmental impact statement, the applicant must submit the following additional information, prepared by a qualified expert. The expert must describe the potentially unstable landforms in and around the application site and analyze:

(a) The likelihood that the proposed forest practices will cause movement of the potentially unstable slopes or landforms, or contribute to further movement of a potentially unstable slope or landforms;

The likelihood that timber harvest will cause movement of potentially unstable slopes is low to moderate because areas of concern have been identified and flagged as leave tree areas or posted out of the harvest unit.

(b) The likelihood of delivery of sediment or debris to any public resources or in a manner that would threaten public safety; and

The likelihood of sediment delivery to streams resulting from the proposed timber harvest is low. The areas of concern, where the likelihood would have been high, have been flagged as leave tree areas or posted out of the harvest unit. The risk to public safety is low because there are no high traffic volume roads, homes, or other structures in the runout zone if a landslide were to initiate within the harvest unit.

(c) Any possible mitigation for the identified hazards and risks.

The areas of concern have been flagged as leave tree areas or posted out of the harvest unit. I recommended adjustments to the harvest layout and those adjustments were made accordingly.

We discussed the yarding corridors that may need to cross a couple unstable slopes buffers (Figure 5). Analysis of yarding skyline profiles indicates that yarded logs will clear the ground surface with full suspension, but some trees may need to be cut in some corridors to safely operate (Figures 6 and 7). We discussed utilizing the following options to mitigate and/or minimize any impacts to the slopes and leave trees in the buffers:

- *Avoid crossing buffers as much as feasible.*
- *Utilize natural openings in the canopy to avoid impacts to leave trees.*
- *Maximize lift in the yarding system as safe to do so.*
- *Buck logs on the slope to minimize the yarded log length (only as necessary and safe to do so).*
- *Operate the carriage slowly as it passes through the canopy in the buffers.*
- *Maintain full suspension during yarding to avoid ground disturbance.*

APPENDIX C

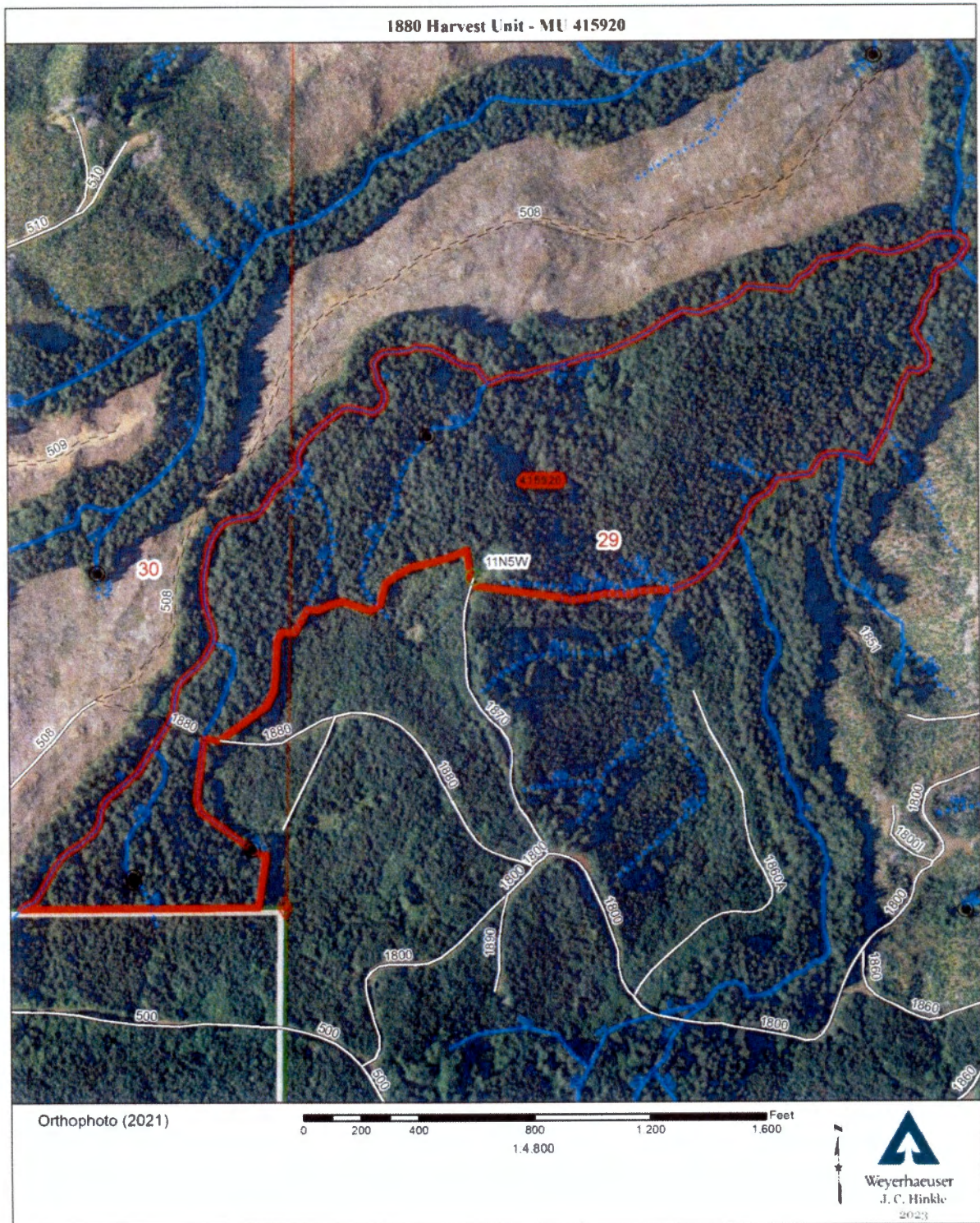


Figure 1: 2021 Orthophoto.

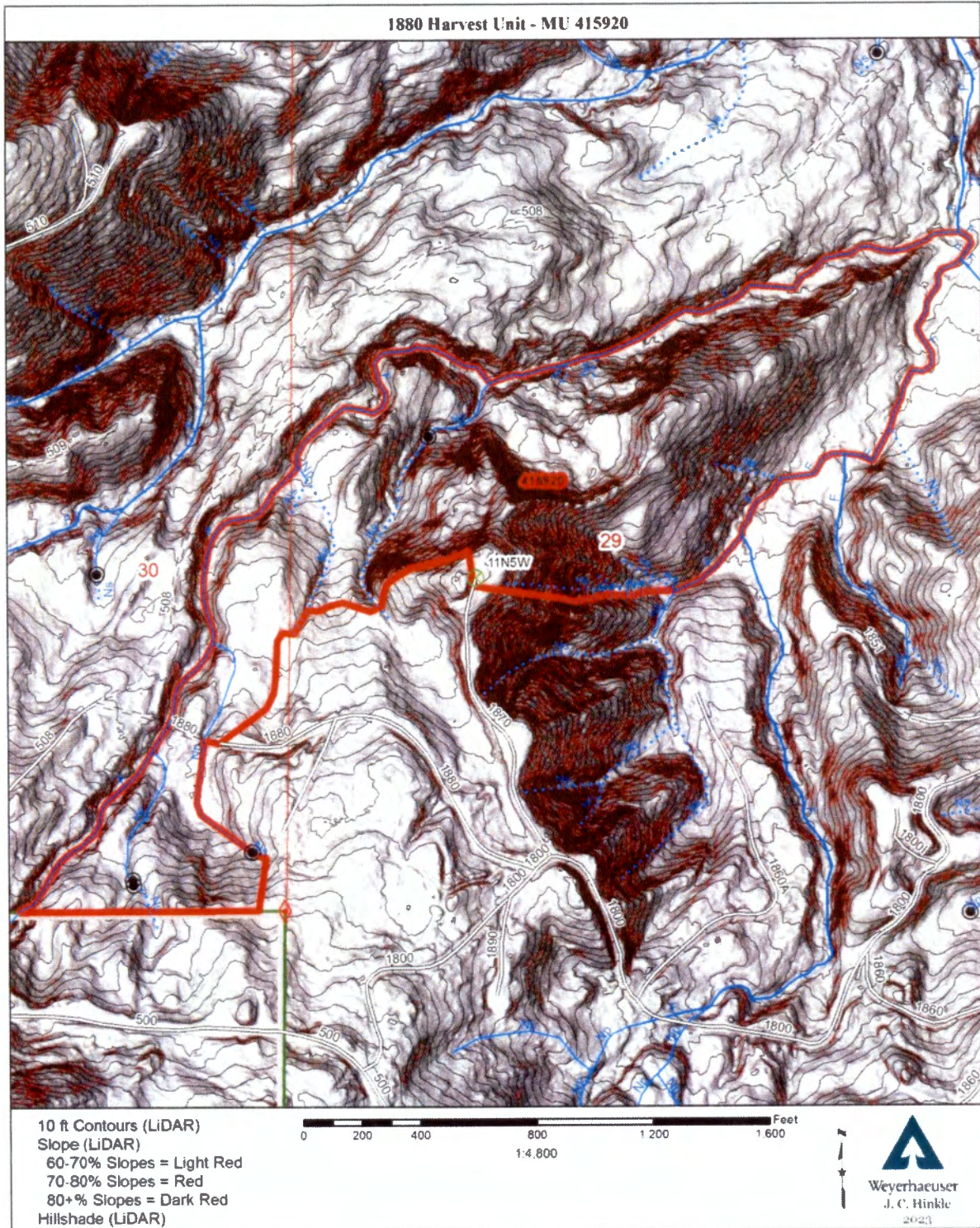


Figure 2: LiDAR 10 ft contours, slopes, and hillshade.

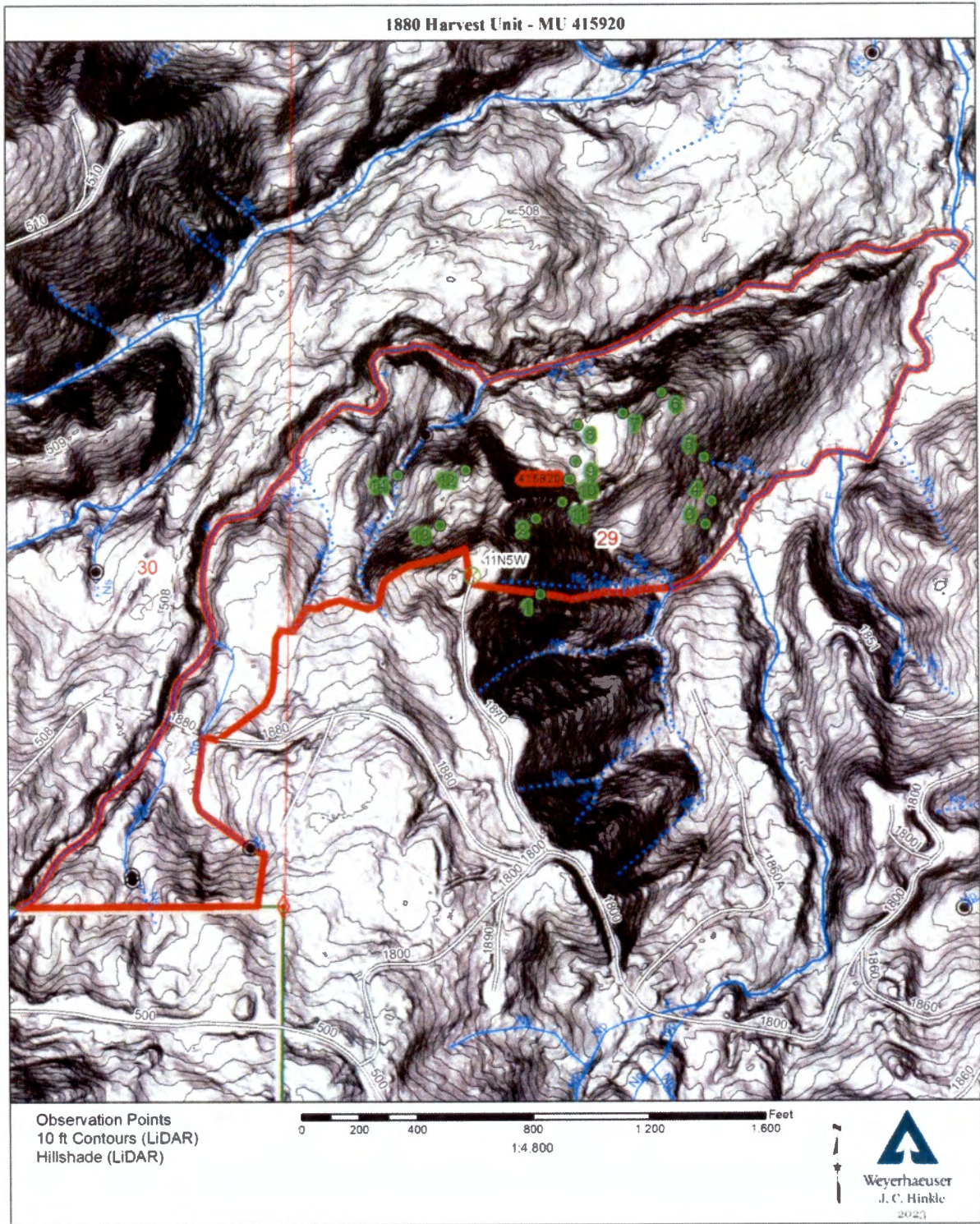


Figure 3: Observation points.

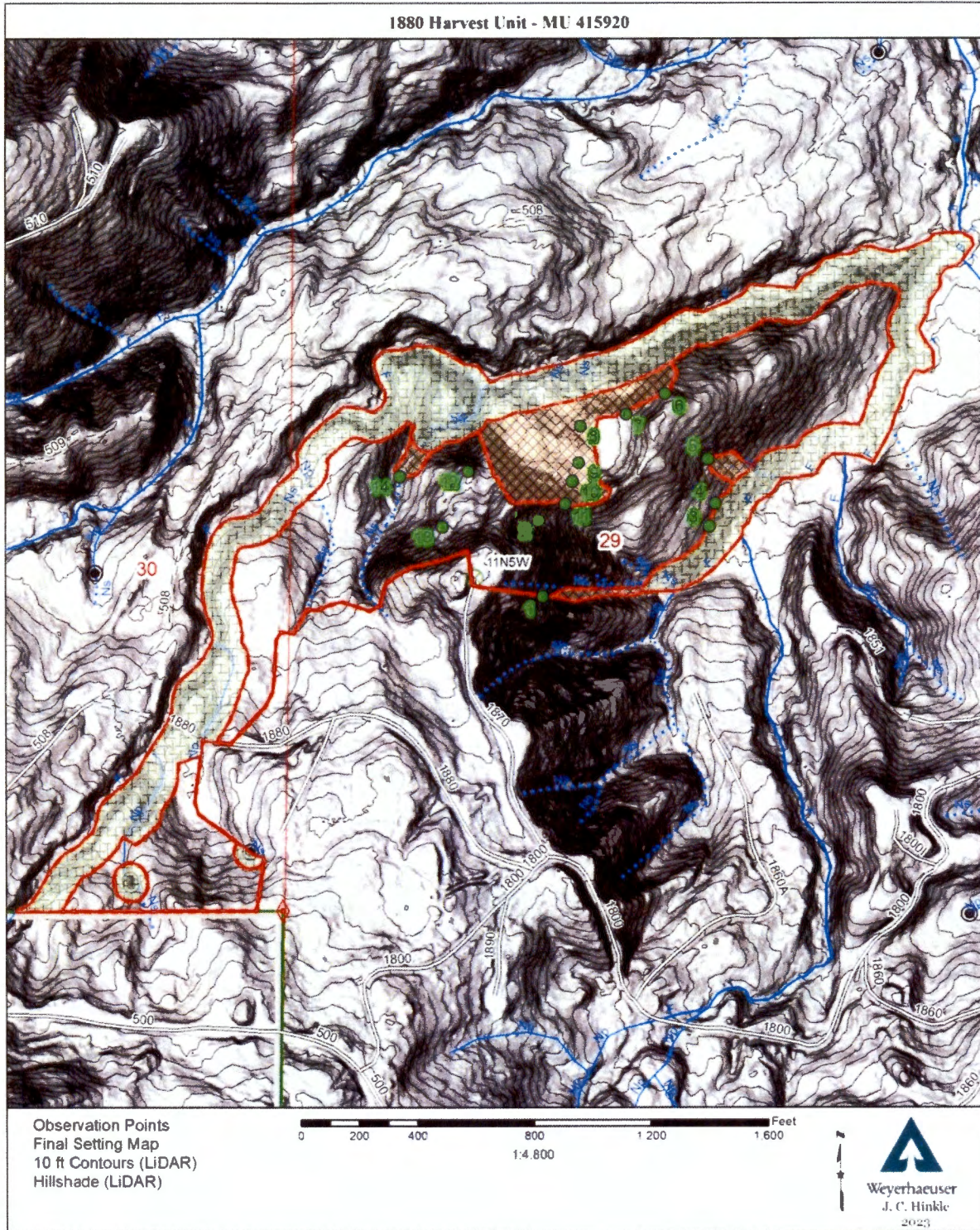


Figure 4: Final unit layout.

SkylineXL 15.0 Skyline Analysis - Analysis Input Phase 2

For Standing and Multi-span Systems Only

Analysis type

Standing

Units English

Analysis name

Phase 1 un-stretched skyline length (ft) = 3,288.80

Phase 1 minimum payload (lbs) = 9,877

Phase 2 Analysis: adjust payload and/or un-stretched skyline length (yellow-shaded cells)...

Desired payload for load path (lbs) =

9,877	4,940	14,810
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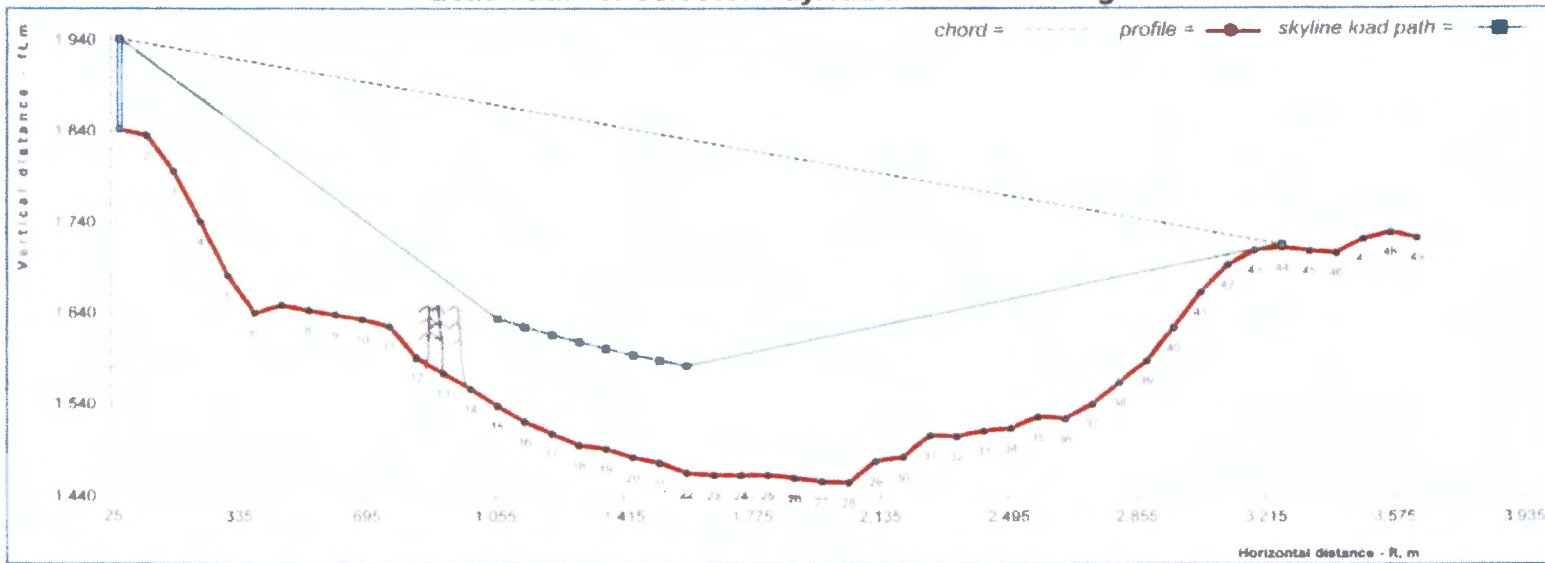
Max skyline tension
72,100

Desired un-stretched skyline length (ft) =

3,298.80	3,127.00	3,450.00
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Ground lead point(s)

Load Path For Selected Payload and/or Line Length



Print date 1/4/2024

Skyline analysis - Phase 2

Profile_A.xdm

Figure 6. Yarding profile for corridor A.

SkylineXL 15.0 Skyline Analysis - Analysis Input Phase 2

For Standing and Multi-span Systems Only

Analysis type

Units English

Analysis name

Standing

Phase 1 un-stretched skyline length (ft) = 3,732.87

Phase 1 minimum payload (lbs) = 583

Phase 2 Analysis: adjust payload and/or un-stretched skyline length (yellow-shaded cells)...

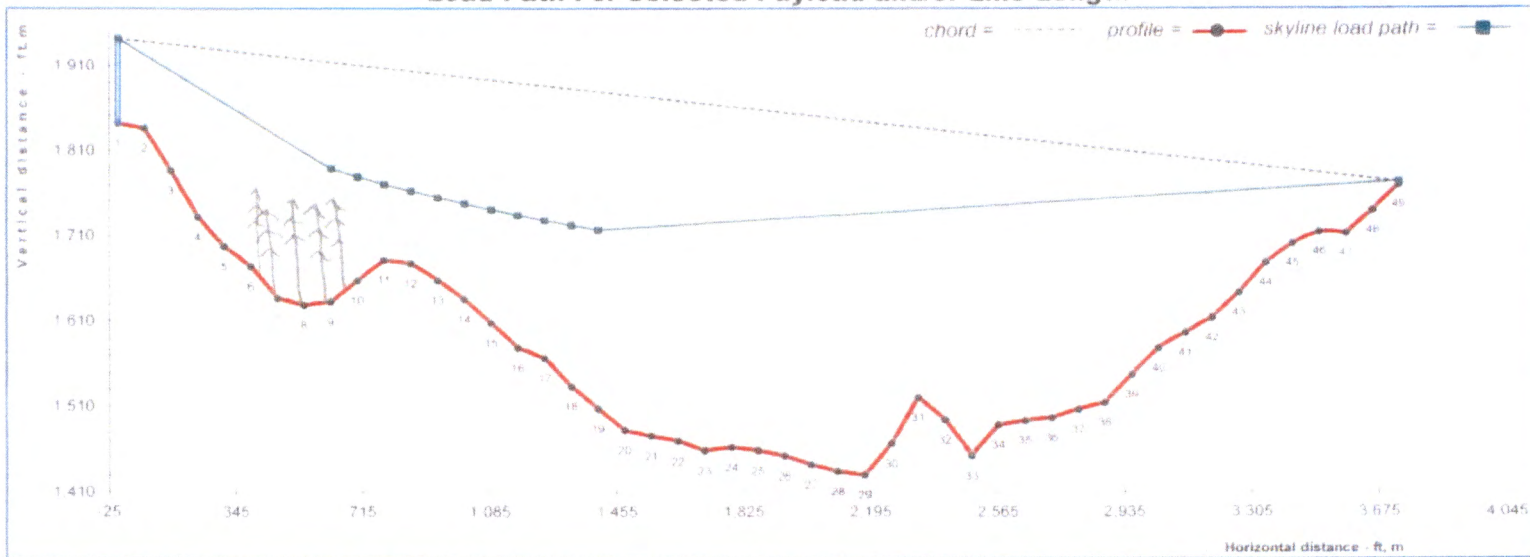
Desired payload for load path (lbs) = 583 (min) 290 (max) 870

Max skyline tension
72,100

Desired un-stretched skyline length (ft) = 3,732.87 (min) 3,550.00 (max) 3,916.00

Ground lead point(s)

Load Path For Selected Payload and/or Line Length



Print date 1/4/2024

Skyline analysis Phase 2

Profile_B.xism

Figure 7. Yarding profile for corridor B.