Wallace Kuhl & Associates Inc

Slope Stability Evaluation
GRANITE ESPARTO
Yolo County, California
WKA No. 5871.06
August 9, 2007

Prepared For:
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Sacramento, California 95827

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August 9, 2007

Mr. Yasha Saber
Granite Construction Company. Inc.
4001 Bradshaw Road
Sacramento, CA 95827

Slope Stability Evaluation
GRANITE ESPARTO
Southwest of the intersection of West Adams Canal and County Road 87
WKA No. 5871.06

Wallace-Kuhl & Associates, Inc. (WKA) have completed a slope stability analysis for the proposed Granite Esparto aggregate mining facility located near Esparto, in Yolo County California. The purpose of our work has been to evaluate the stability of the slopes of the mining pits adjacent to the West Adams Canal and County Road 87 that would result from the removal of the aggregate resource. Our work has been completed as authorized by Mr. Ben Adamo and Mr. Yasha Saber of Granite Construction Company.

Scope of Work

Our scope of work for this report has included:

- Review of our previous geotechnical engineering investigations and slope stability analyses prepared for the neighboring Granite Capay facility.
- Perform site reconnaissance during drilling and well installation.
- Perform triaxial compression testing of representative samples collected during the drilling and well installation.
- Update the site-specific seismic hazard analysis for the site.
- Develop representative slope stability cross sections adjacent to the West Adams Canal and County Road 87.
- Perform static and seismic slope stability analysis of representative sections.

- Prepare this report summarizing our findings, conclusions, and recommendations regarding slope stability, minimum excavation setbacks, and slope gradients.

Site Description

The site consists of approximately 390 acres of agricultural land that lies within a rural/industrial area of Yolo County. The West Adams Canal bounds the site to the northwest and north. County Road 87 bounds the site to the east. The stream channel for Cache Creek bounds the site to the south (Figure 1). The existing Granite Construction Company Capay facility (aggregate operation) is located to the west and southwest of the site.

Regional Geology

The site is located within the Great Valley geomorphic province of California, a large, elongate, northwest-trending structural trough, generally constrained to the west by the Coast Ranges and to the east by the foothills of the Sierra Nevada (Norris and Webb, 1990). The Great Valley consists of two valleys lying end-to-end, with the Sacramento Valley to the north and the San Joaquin Valley to the south. The Sacramento and San Joaquin Valleys have been filled to their present elevations with thick sequences of sediment derived from both marine and continental sources. The sedimentary deposits range in thickness from relatively thin deposits along the eastern valley edge to more than 25,000 feet in the south central portion of the Great Valley (Norris and Webb, 1990). The sedimentary geologic formations of the Great Valley province vary in age from Jurassic to Quaternary, with the older deposits being primarily marine in origin. Younger sediments are continentally derived and were typically deposited in lacustrine, fluvial, and alluvial environments with their main source being the Sierra Nevada. Review of available geologic maps indicates the site area is underlain by Holocene alluvial deposits and the Modesto Formation (Helley and Harwood, 1985; Wagner et al, 1999). The alluvial deposits consist of unconsolidated clay, silt, sand, and gravel deposited by the existing (active) stream and river systems. The Modesto Formation consists of semi-consolidated alluvial deposits of sand, silt, clay, and gravel.

The alluvium encountered in the excavations typically consisted of brown to yellow-brown and dark brown clayey silt (overburden) overlying varicolored mixtures of sand and gravel. The overburden encountered in the excavations was medium stiff to stiff and varied in thickness from five to 17 feet. The sand and gravel deposits were medium dense to very dense. A yellow to brown clay layer underlies the sand and gravel layer. The clay layer encountered in the excavations was stiff to hard and typically occurred at a depth of 50 to 70 feet below ground surface. Logs of the excavations are presented in WKA's 2007 Groundwater Hydrology Report.

Groundwater

As indicated in our Groundwater Hydrology Report (WKA, 1995, 2001, and 2007), the site lies within the Upper Cache Creek Basin that is separated from the lower Cache Creek Basin by the northwest trending Dunnigan Hills anticline. Specifically, the site overlies the Madison syncline (west of the Dunnigan Hills anticline) where the thickest deposits of alluvium have accumulated (Todd, 1995). Locally, the Dunnigan Hills anticline appears to have pushed the less permeable Tehama Formation upward where it acts as a semi-permeable barrier to the easterly alluvial groundwater flow (Todd, 1995).

Groundwater in the upper Cache Creek basin is relatively shallow. The upper aquifer beneath the site appears largely unconfined and depth to groundwater ranges from approximately 25 to 30 feet below grade near the western and southern site boundaries to approximately 40 to 45 feet below grade near the northern and eastern property boundaries. Based on our experience in the area and the spring 1990, 1993, 1995 and 1996 Groundwater Elevation Contour Maps prepared by Borcalli and Associates for the Yolo County Flood Control and Water Conservation District (YCFCWCD), the regional groundwater flow direction appears to be easterly to northeasterly.

Seismic Coefficient

The seismic coefficient, k_{eq}, utilized in the pseudo-static slope stability analysis was determined using the procedures presented in *Recommended Procedures for Implementation of DMG Special Publication 117 - Guidelines for Analyzing and Mitigating Landslide Hazards in California* (SCEC 2002) and Stewart et al. (2003). In this procedure, the maximum horizontal acceleration at the project location is determined for a soft rock site condition (MHA_r) using probabilistic seismic hazard analysis (PSHA) for a 475-year return period.

A PSHA is a mathematical process based on probability and statistics that is used to estimate the mean number of events per year (Annual Frequency of Exceedance) in which the level of some ground motion parameter exceeds a specified risk level. This can be presented as an average return period (ARP) – the timeframe in which an event is likely to recur. The mathematical computations of probability and statistics are based on work by Cornell (1968). The commercial computer program *EZ-FRISK* ver. 7.22 was used to make the mathematical computations for our analyses.

The seismic source model used for the PSHA computation was the CGS Statewide Database (CGS OFR 96-08, Petersen et al. 1996; Cao et al., 2003). Our PSHA analysis includes background seismic sources based on the latest models published by the California Geological Survey (CGS). A search radius of 100 kilometers was specified for this analysis (*USGS 7.5-Minute Topographic Map of the Esparto Quadrangle*, Latitude 38.7248°N, Longitude 121.0190°W). Our analyses indicate the MHA_r for the site is 0.34g.

The seismic coefficient, k_{eq}, used in the pseudo-static slope stability analysis is calculated using the following formula presented in *Recommended Procedures for Implementation of DMG Special Publication 117 - Guidelines for Analyzing and Mitigating Landslide Hazards in California* (SCEC 2002) and Stewart et al. (2003):

$$k_{eq} = f_{eq} \times (MHA_r/g)$$

where MHA_r is the maximum horizontal acceleration at the site for a soft rock site condition; g = acceleration of gravity (SCEC 2002; Stewart et al., 2003). The term f_{eq} is a factor related to the magnitude, distance, 5-95% normalized Arias Intensity (D_{5-95}) and MHA_r (Bray and Rathje, 1998). Based on our calculations, the seismic coefficient for the pseudo-static slope stability analyses is 0.13.

Slope Stability Analyses

WKA reviewed Granite Construction Company's preliminary mine plan prepared by Cunningham Engineering. Representative cross section profiles along the West Adams Canal and County Road 87 were developed utilizing the following criteria:

- Geologic materials recorded on boring logs for MW-6 through MW-9;
- The ground surface elevation at the well location;
- The "average summer low groundwater" level based on recent data collected in July 2007.
- Criteria presented in the Yolo County Off-Channel Mining Ordinance; and,
- Proposed design slope gradients provided by Granite Construction Company.

The locations of the monitoring wells, MW-5 through MW-9, and the schematic location of the stability cross sections are illustrated in Figure 1.

Based on our discussions, Granite Construction has proposed the following setback and slope gradients for the mine slope:

- Along the canal (west and north side of property) the upper portion of the mine slope will be excavated at a slope ratio of 3:1 (horizontal to vertical). The preceding gradients extend from the top of the mine slope to five feet below the "average summer low groundwater" level. The lower portion of the mine slope from five feet below the "average summer low groundwater" level will be excavated at a slope ratio of 1.5:1 (horizontal to vertical).
- The mine slope will be excavated at a slope ratio of 2:1 (horizontal to vertical) on the east side of the property along County Road 87.
- 50-foot setbacks along the West Adams Canal and County Road.
- The probable depths of excavation were assumed to be the top of the hard clay layer encountered in MW-6 through MW-9.

Shear strength data utilized in our analyses was derived from the results of our laboratory triaxial compression testing (WKA, 1995, 2001, and 2002). The strength parameters are summarized below:

Shear Strength Parameters

Material Type	Unit Weight (pcf)	phi	Cohesion (psf)
Overburden	120	20	350
Sand & Gravel	140	45	70
Hard Clay Layer	120	9	1200

Static and pseudo-static slope stability analyses were performed utilizing the commercial software program *SLIDE 5.0* developed by Rocscience, Inc. Stability analyses were performed utilizing search routines for both circular and non-circular failure surfaces. Spencer's Method was utilized to calculate the factor of safety for both circular and non-circular failure surfaces. Results of the slope stability analyses indicate factors of safety greater than 1.5 and 1.1 for static and pseudo-static conditions, respectively. The results of the slope stability analyses for profiles MW-6, MW-7, MW-8, and MW-9 are presented in Appendix A and summarized in the table below:

Results of Slope Stability Analyses

	Slope Gradient			Factors of Safety	
Profile	Above Water*	Below Water	Search Routine	Static	Seismic
MW-6	3:1	1.5:1	Non-circular	1.8	1.1
MW-6	3:1	1.5:1	Circular	2.0	1.3
MW-7	3:1	1.5:1	Non-circular	1.8	1.1
MW-7	3:1	1.5:1	Circular	2.0	1.3
MW-8	2:1	2:1	Non-circular	1.6	1.2
MW-8	2:1	2:1	Circular	1.7	1.2
MW-9	2:1	2:1	Non-circular	1.9	1.3
MW-9	2:1	2:1	Circular	1.9	1.3

* *and for a distance at least five feet below the low expected water table.*

Recommended Slope Gradients and Setbacks

Based upon our slope stability analysis, the slope gradients proposed by Granite Construction Company meet or exceed the minimum factors of safety set forth in the Yolo County Off-Channel Mining Ordinance.

Observation of Excavations

Excavation slopes exposed above the water level in each pit should be observed by a Geotechnical Engineer or by a Certified Engineering Geologist at every 10 to 15 feet of excavation depth or at least once a year during mining activities. Slopes should be checked for subsurface conditions not encountered during our field exploration that could affect slope stability. Slope stability should be re-evaluated if the average low water elevation within a mining excavation is less than our assumed low water elevation of +135 mean sea level for more than six months. Mining pits should not be drained without consultation with a Geotechnical Engineer or Certified Engineering Geologist.

LIMITATIONS

Our recommendations are based upon the information provided regarding the proposed project, combined with our analysis of site conditions revealed by field exploration and laboratory testing programs. We have used our best engineering judgment based upon the information provided and the data generated from our investigation. If the proposed mining operation is modified or resited; or, if it is found during mining that subsurface conditions differ from those encountered at the boring locations, we should be afforded the opportunity to review the new information or changed conditions to determine if our conclusions and recommendations must be modified.

We emphasize that this report is applicable only to the proposed project and the investigated site. This report should not be utilized for any other site.

Wallace - Kuhl & Associates, Inc.

Patrick J. Jenks, CEG
Senior Engineering Geologist

Mitchell A. Tyler, GE
Senior Engineer

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Legend:
- Approximate location of monitoring well
- Location of Stability Cross Sections

Note:
Image undated provided by Granite Construction

N

0 350 700
SCALE IN FEET

WallaceKuhl & ASSOCIATES INC

SITE PLAN
GRANITE CAPAY FACILITY
Esparto, California

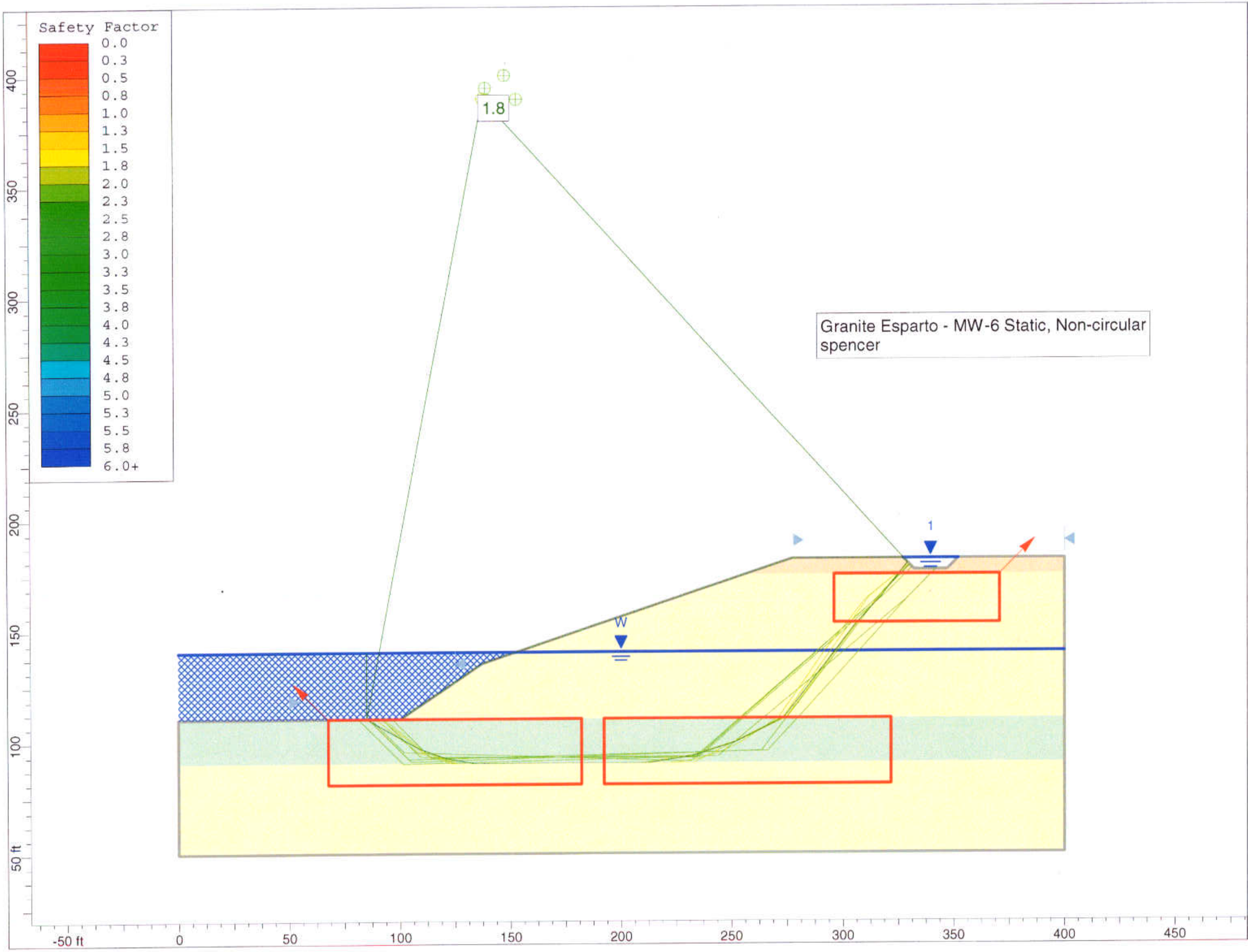
FIGURE	1
DRAWN BY	HCS
CHECKED BY	PJJ
PROJECT MGR	PJJ
DATE	8/07
WKA NO. 5871.06	

APPENDIX A

Results of Slope Stability Analyses

Results of Slope Stability Analyses

Profile MW-6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Granite Esparto - MW-6 Static, Non-circular
spencer
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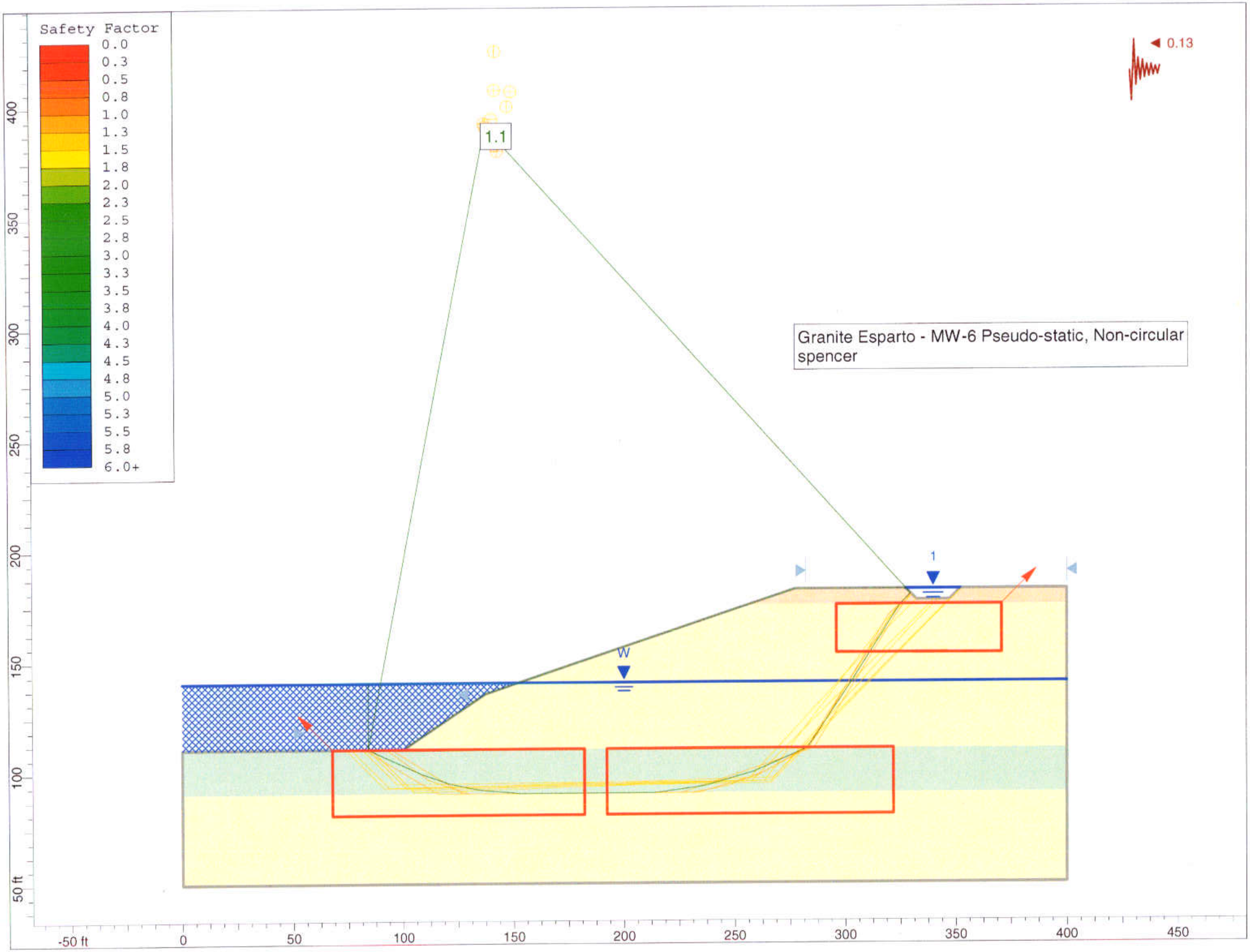

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Granite Esparto - MW-6 Pseudo-static, Non-circular spencer
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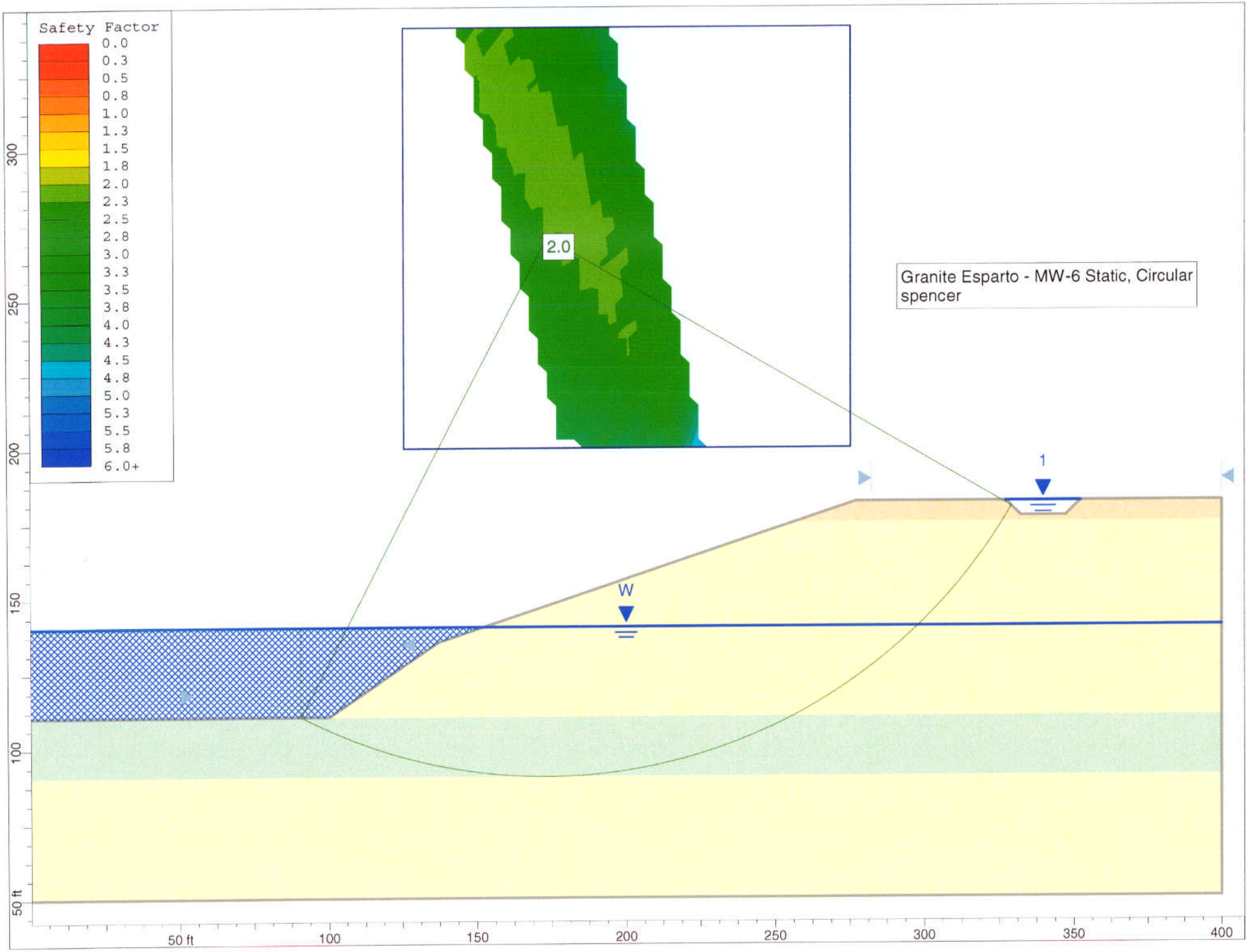
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Granite Esparto - MW-6 Static, Circular
spencer
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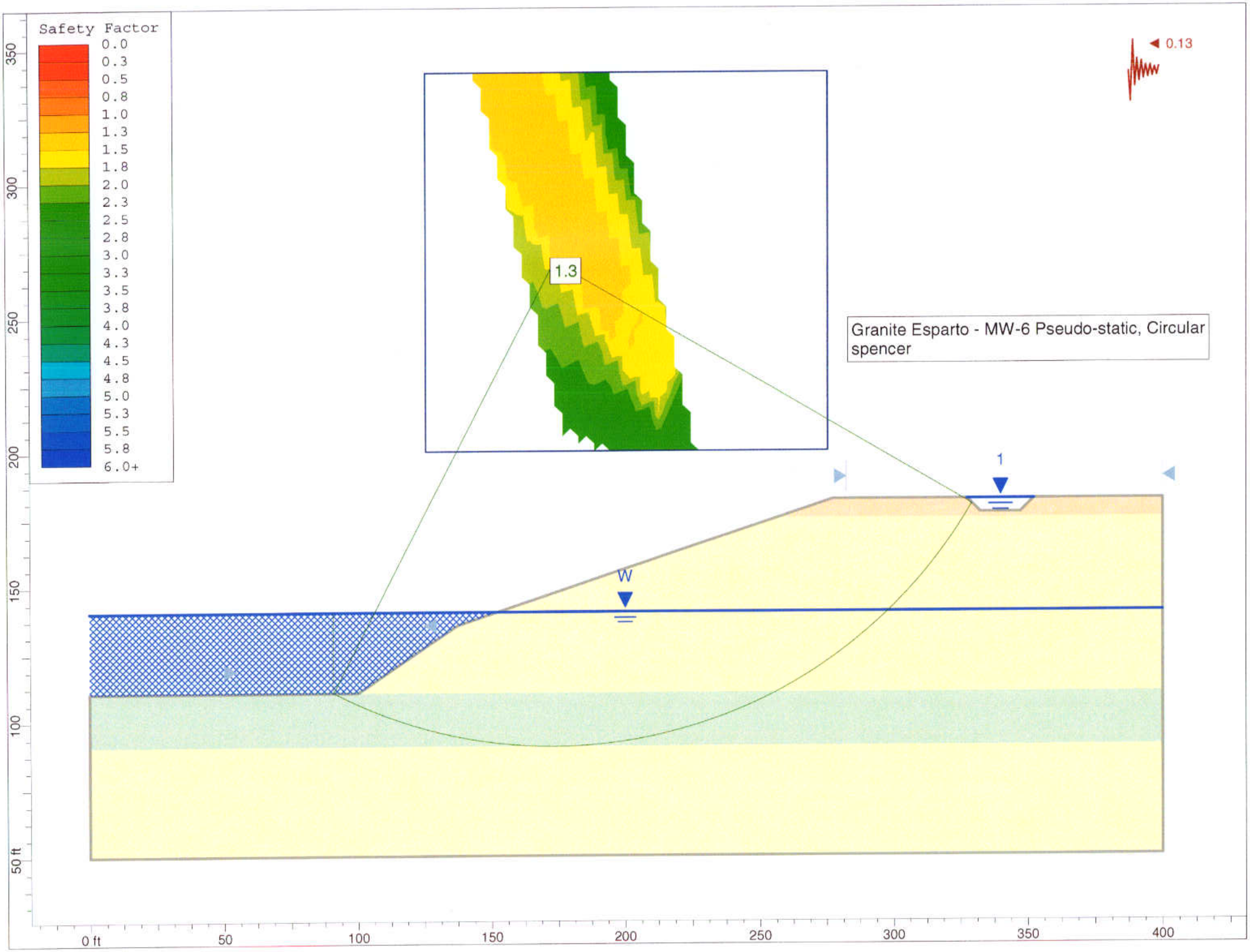

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Granite Esparto - MW-6 Pseudo-static, Circular spencer
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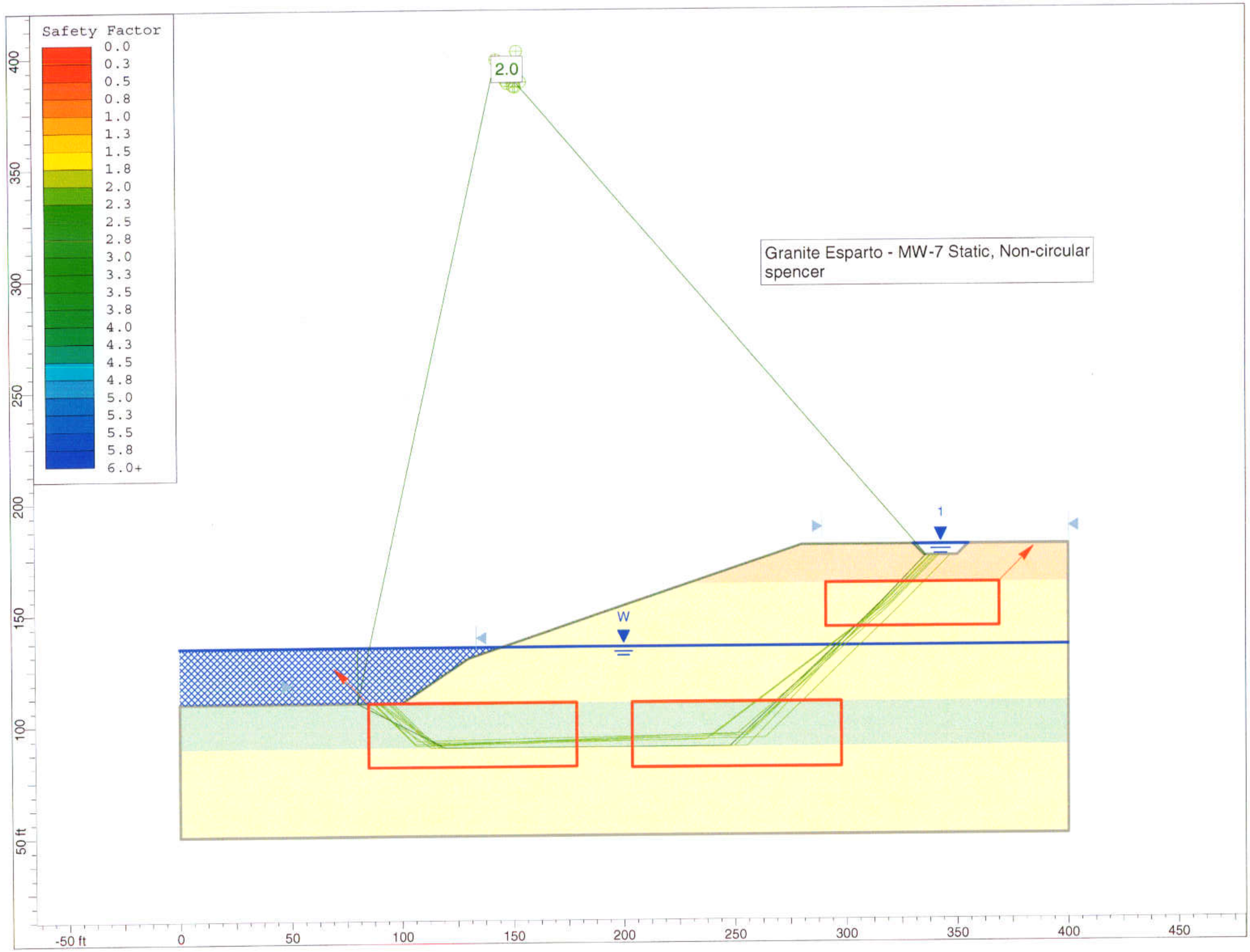
Results of Slope Stability Analyses

Profile MW-7



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Granite Esparto - MW-7 Static, Non-circular
spencer
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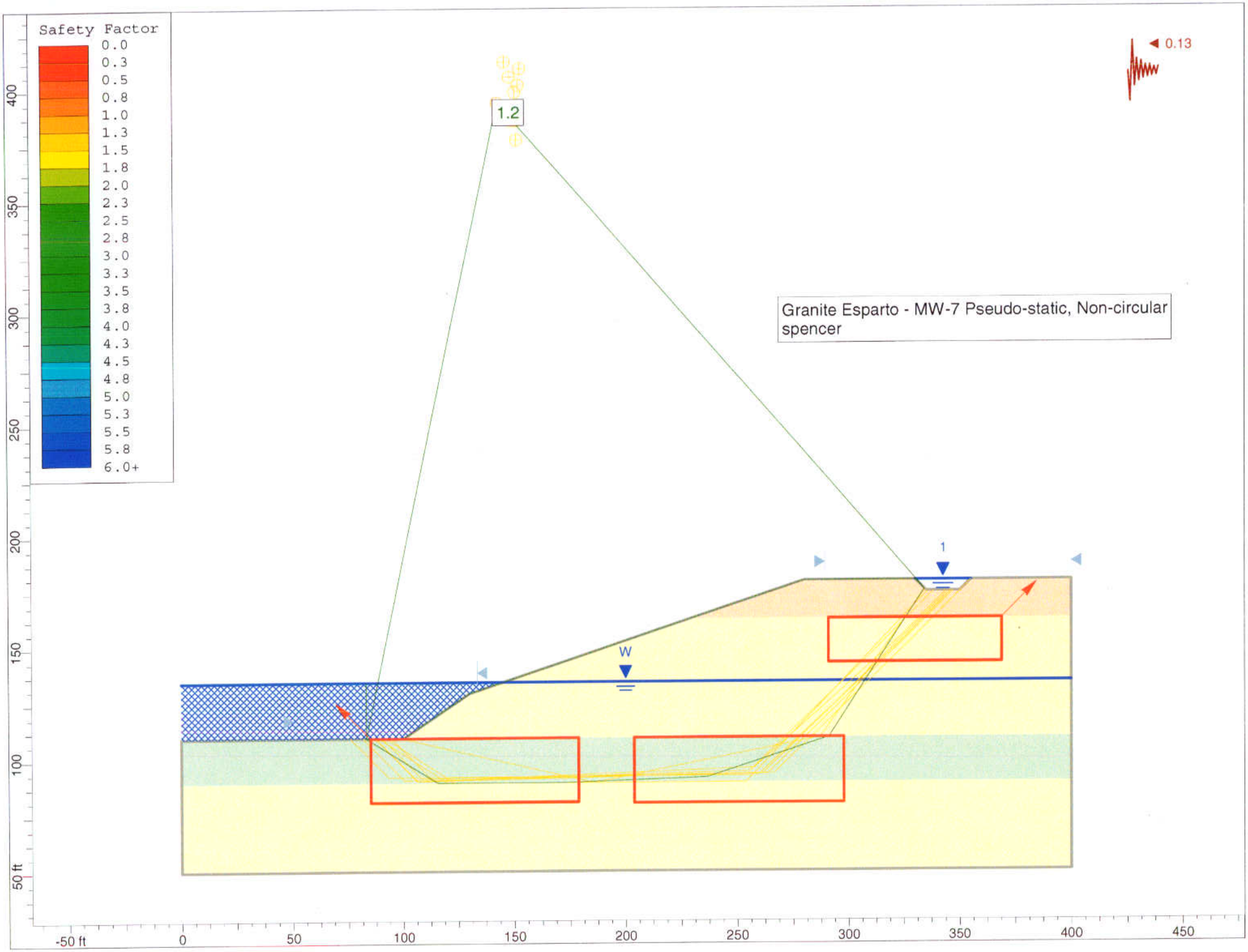

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Granite Esparto - MW-7 Pseudo-static, Non-circular spencer
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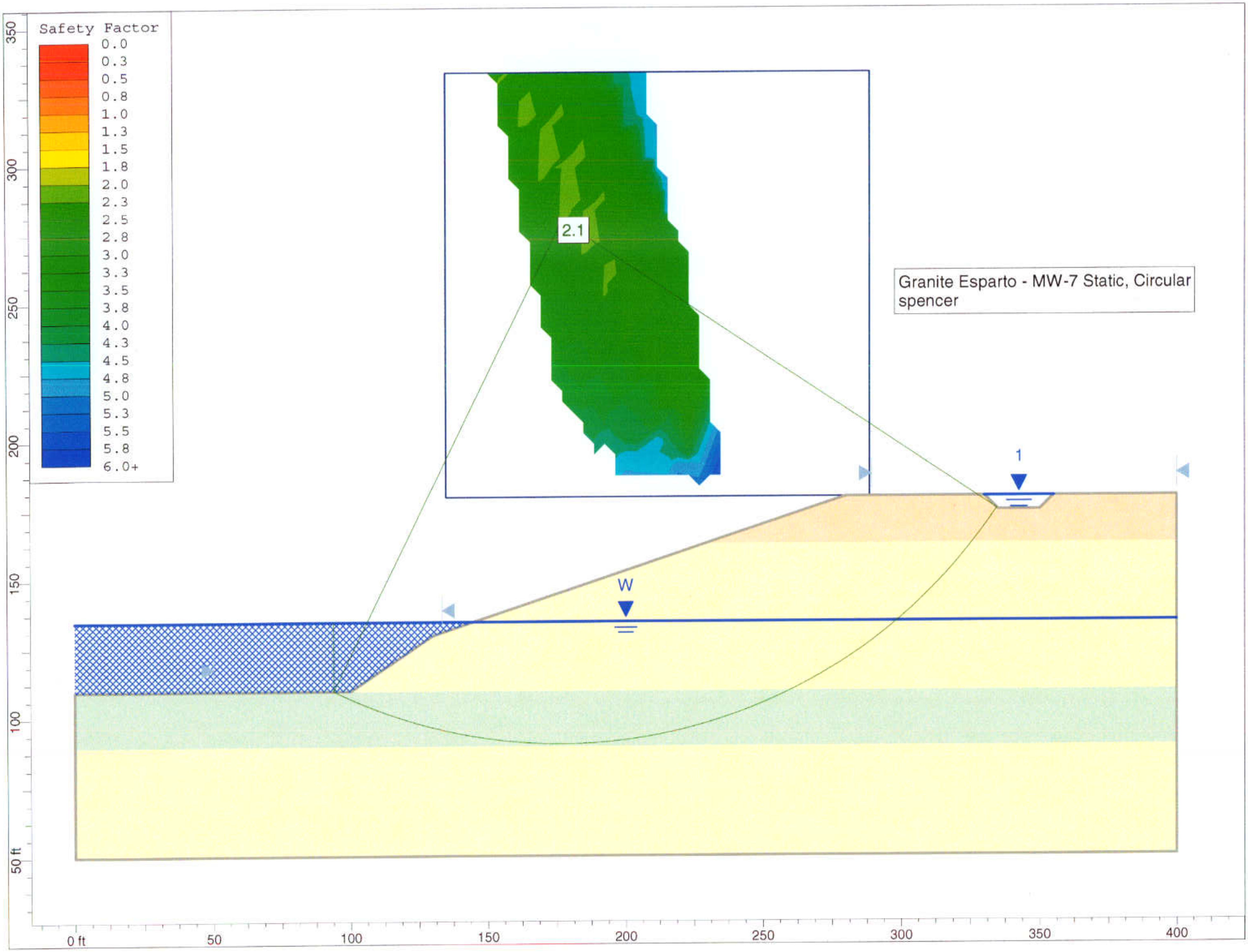
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Granite Esparto - MW-7 Static, Circular
spencer
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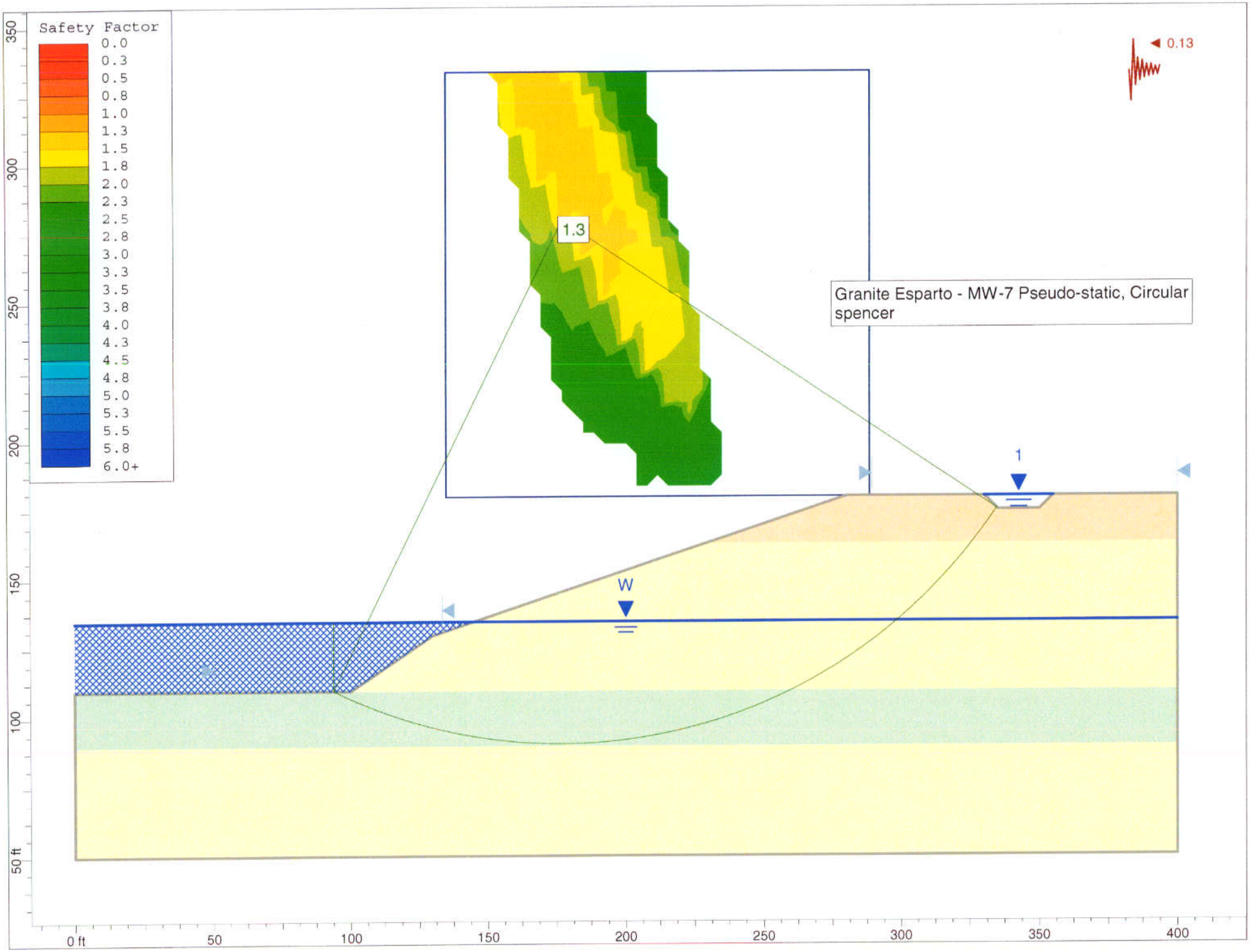
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Granite Esparto - MW-7 Pseudo-static, Circular
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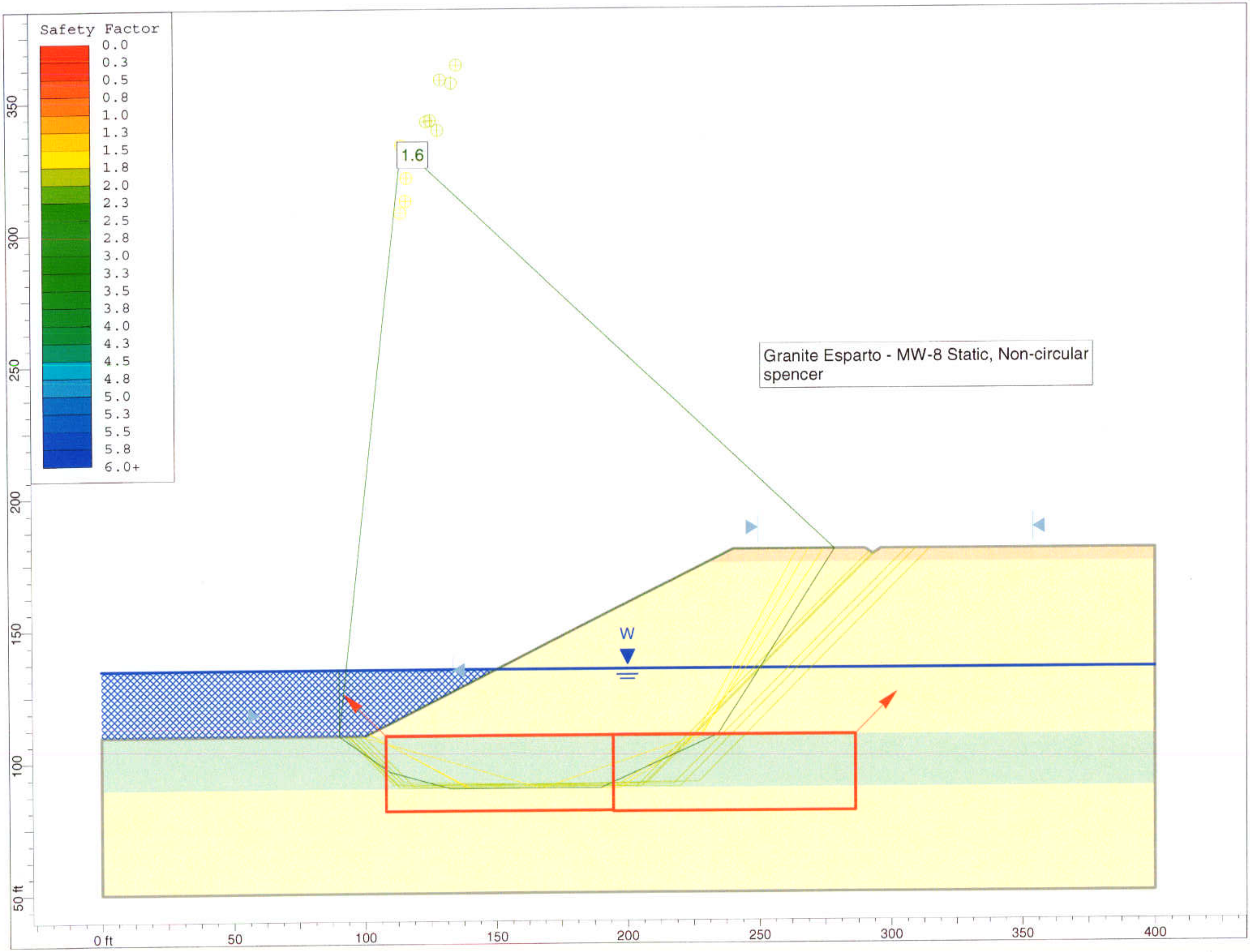
Results of Slope Stability Analyses

Profile MW-8



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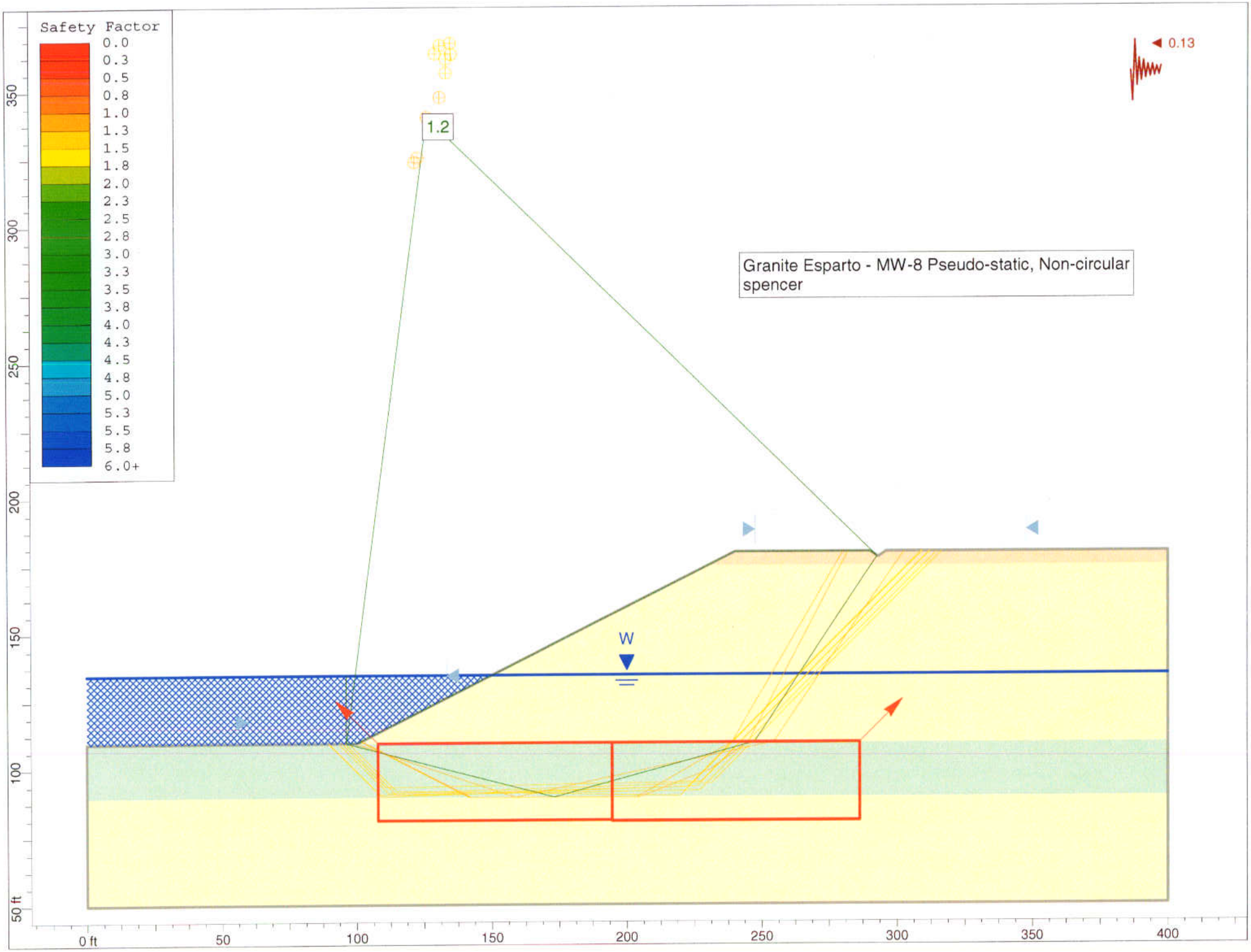

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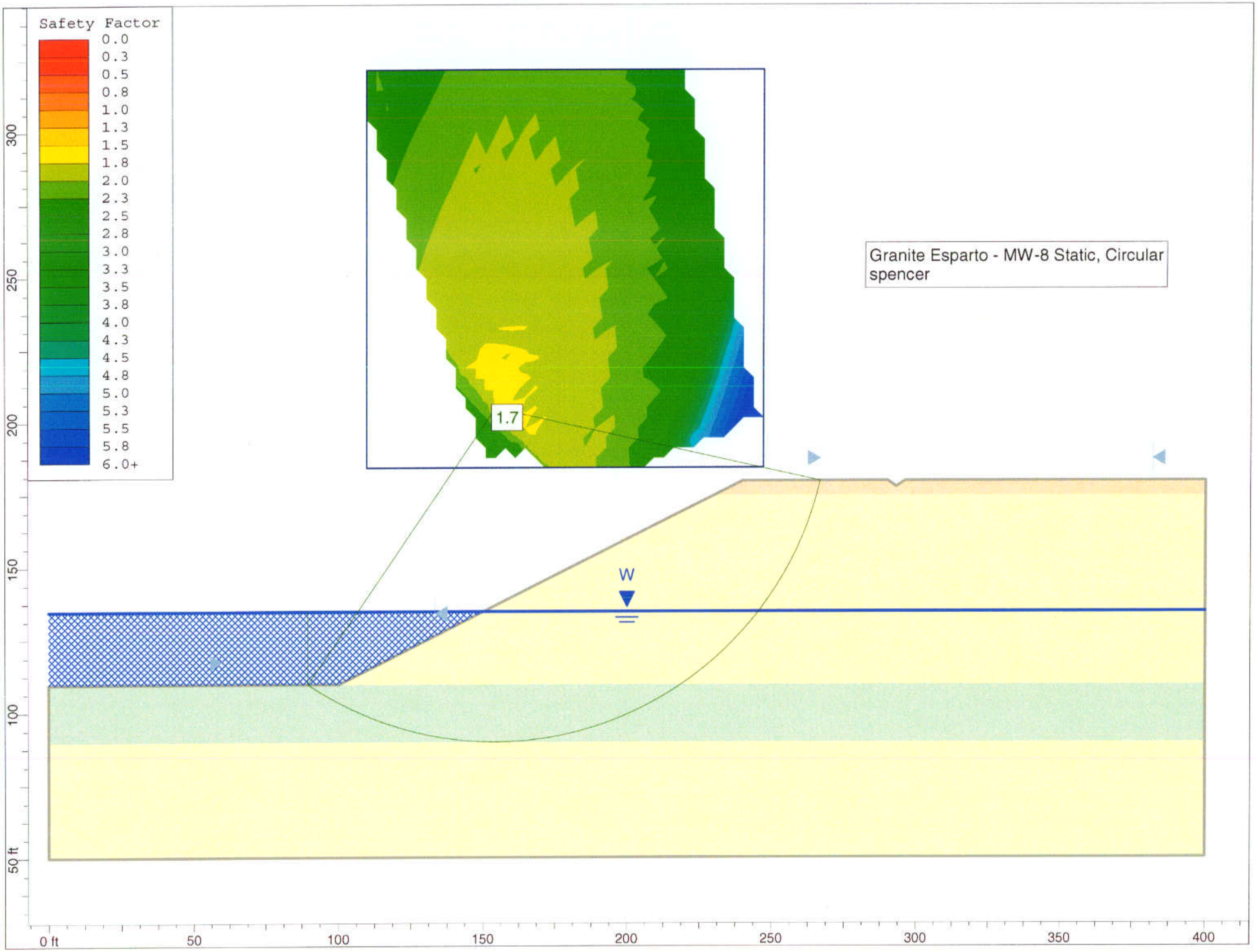
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Granite Esparto - MW-8 Static, Circular
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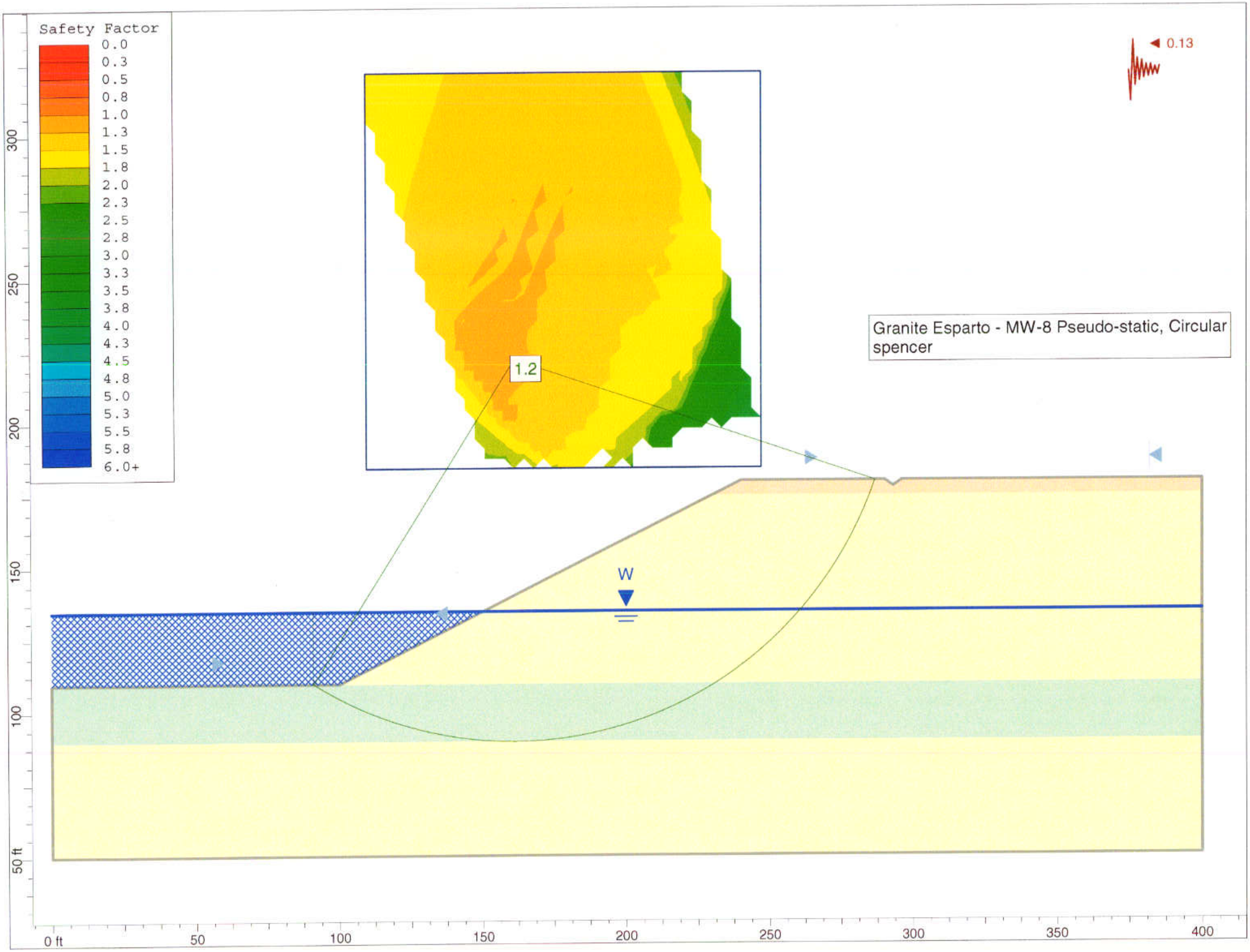
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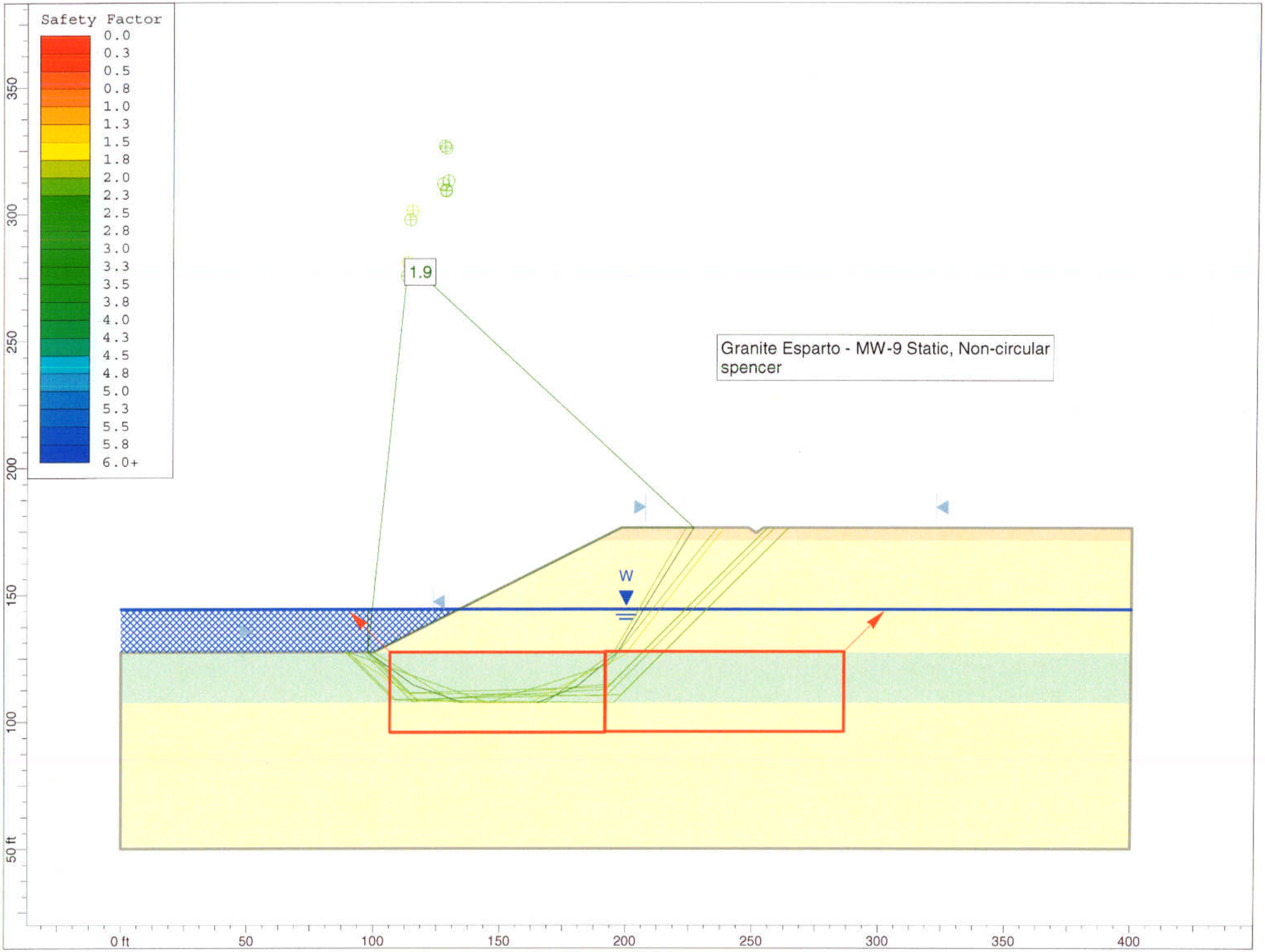
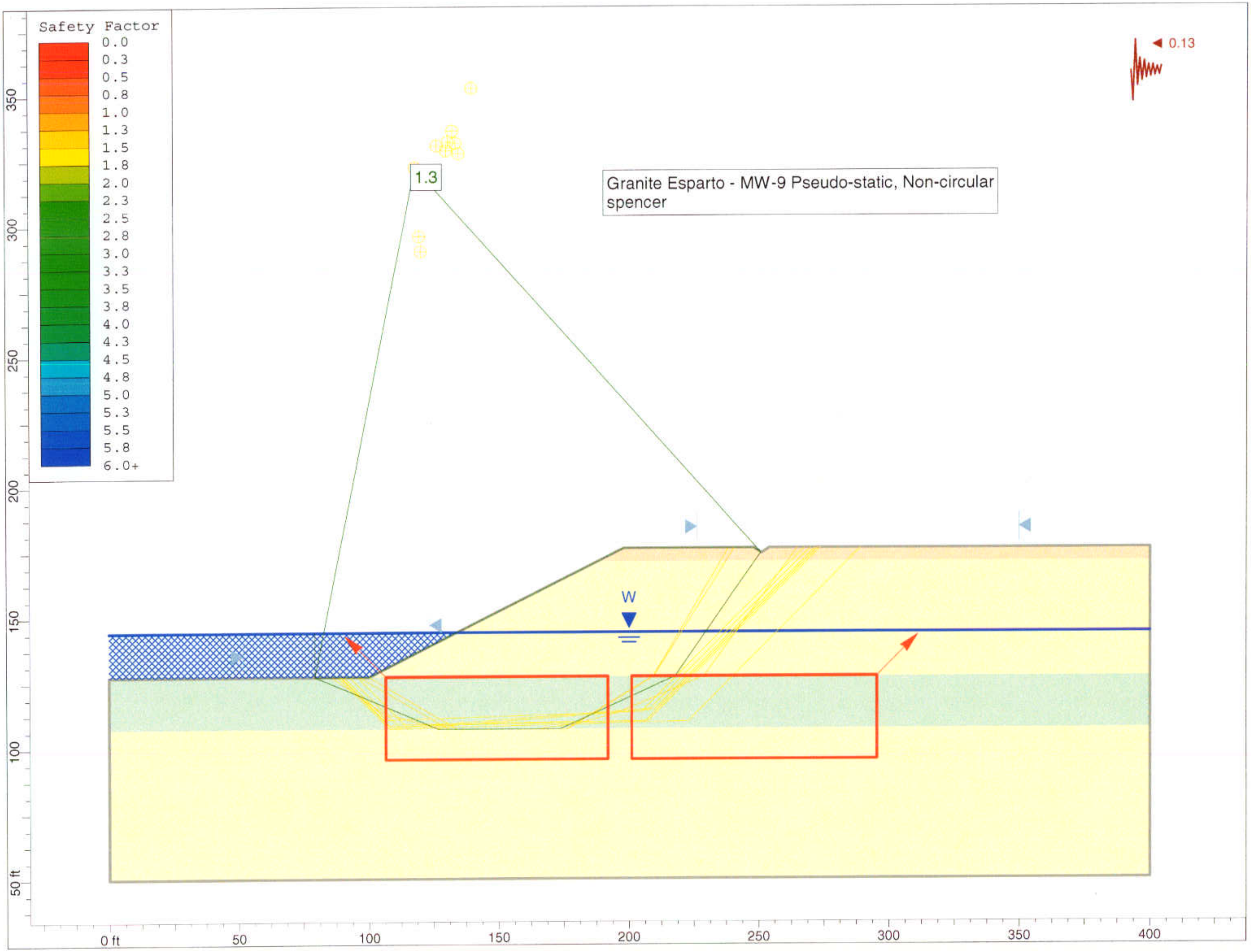
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
0.13
1.2
Granite Esparto - MW-8 Pseudo-static, Circular
spencer
W
0 ft
50
100
150
200
250
300
350
400
50 ft

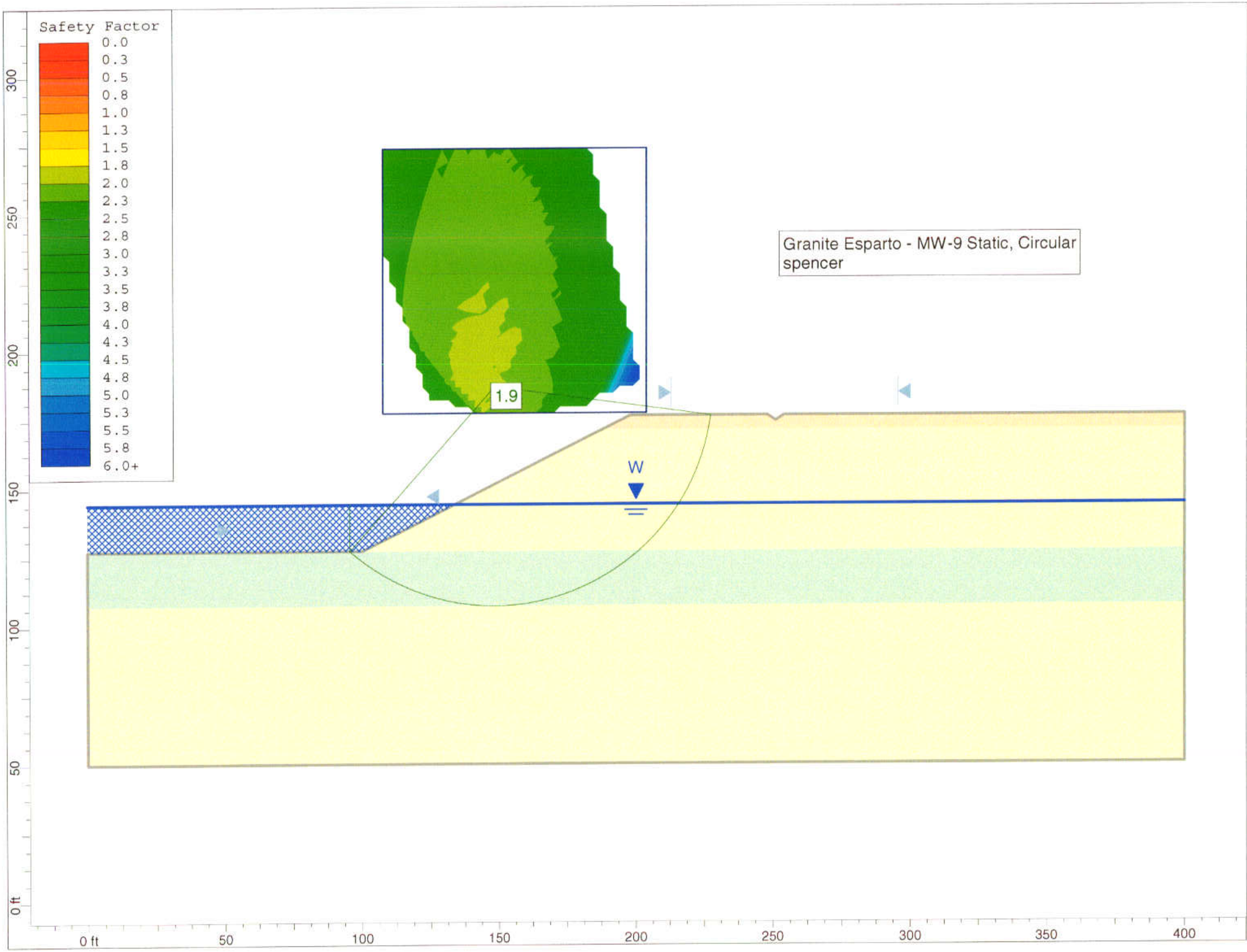
Results of Slope Stability Analyses

Profile MW-9

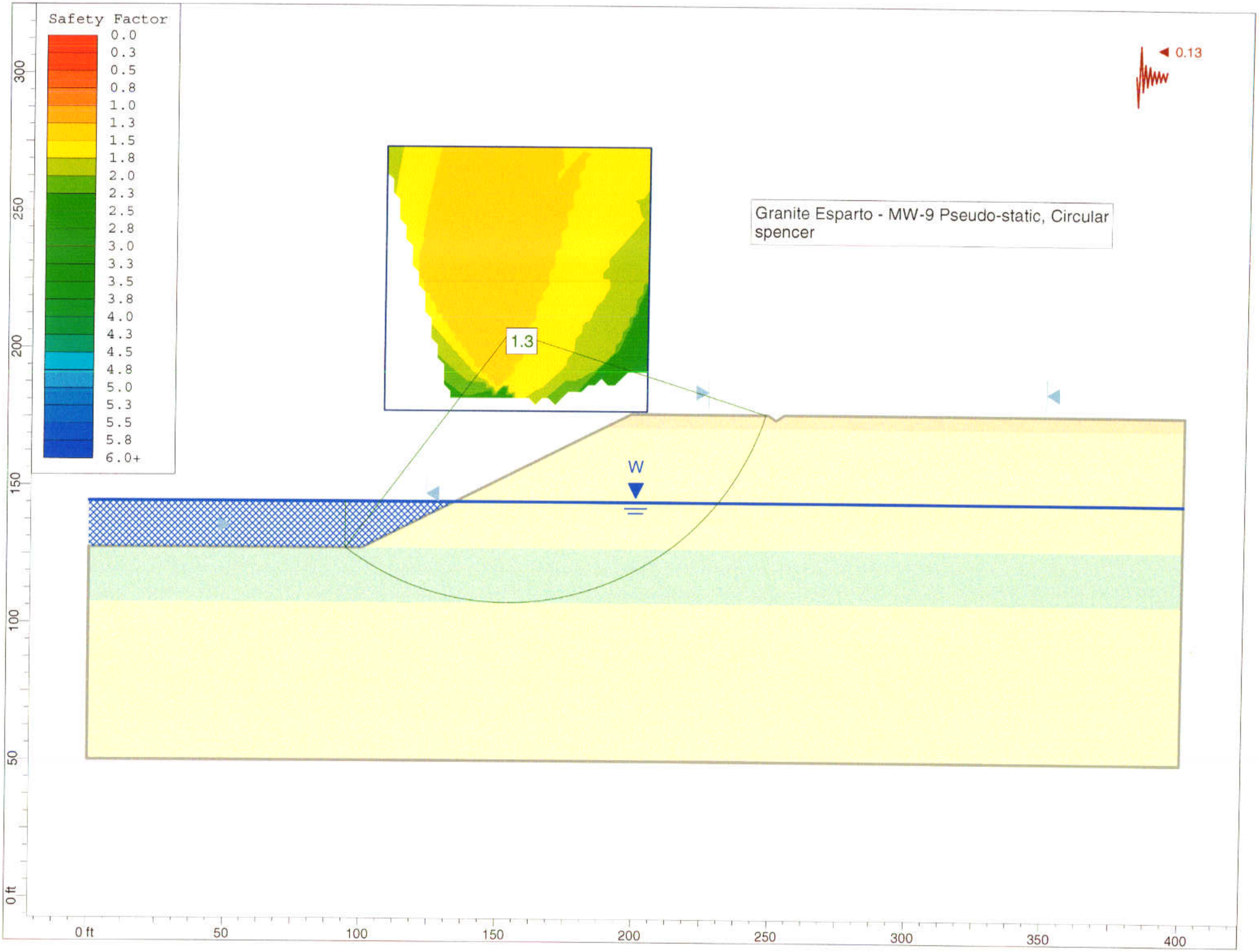


Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.9
Granite Esparto - MW-9 Static, Non-circular spencer
W
350
300
250
200
150
100
50 ft
0 ft
50
100
150
200
250
300
350
400


Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
0.13
1.3
Granite Esparto - MW-9 Pseudo-static, Non-circular
spencer
W
350
300
250
200
150
100
50 ft
0 ft
50
100
150
200
250
300
350
400



Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.9
W
Granite Esparto - MW-9 Static, Circular
spencer
300
250
200
150
100
50
0 ft
0 ft
50
100
150
200
250
300
350
400



Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
0.13
Granite Esparto - MW-9 Pseudo-static, Circular
spencer
1.3
W
0 ft
50
100
150
200
250
300
350
400
0 ft
50
100
150
200
250
300