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Kosta Sainis, Environmental Superintendent
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DENAK EAST PIT: DENAK FAULT STABILITY ASSESSMENT

Dear Mr. Sainis,

Endako is planning to mine out the saddle between the Denak East and Endako Pits, which will require mining through waste rock and the Denak Fault. The Denak Fault is a very wide zone of faulted and poor quality rock, and there is the potential for instability to develop along the north and south walls of the cut through the saddle. This report presents a review of the slope stability impacts that the Denak Fault may have on the proposed north and south walls, and provides recommendations on the slope design configuration through the fault zone.

1.0 MINING AND THE DENAK FAULT

1.1 Proposed Mining of the Saddle between the Denak East and Endako Pits

Mining has previously been carried out in the existing Denak East and Endako Pits. The locations of the existing pits are shown in Figure 1. An in-pit dump has been advanced over the east wall of the Denak East Pit from the saddle, and the wall is covered in waste rock. The floor of the Denak East Pit is located at the 2,926-ft. elevation and the floor of the Endako Pit is located at the 2,530-ft. elevation. A saddle is located between the Denak East Pit and the Endako Pit. The crest of the saddle is located between the 3,179-ft. and the 3,355-ft. elevation. The west wall of the saddle (east wall of the Denak East Pit) is approximately 275 ft. high and the east wall of the saddle (west wall of the Endako Pit) is approximately 700 ft. high.

Future mining in the Endako Pit will be accessed by a ramp that will descend from west to east along the north wall of the pit. The rock cut for the access will be excavated through the saddle between the Denak East and Endako Pits. The Denak East interim pit shell is shown in Figures 2 and 3. The interim pit will partially mine out the nose that existed between the Denak East and the Endako Pit in the previous ultimate pit design. The access rock cut through the new ultimate pits is shown on Figure 4. The crests of the north and south sides of the cut will be located at approximately the 3,322-ft. and the 3,366-ft. elevations, respectively.

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The floor of the cut will be located at the 2,706-ft. elevation and the north and south cut slopes heights will be approximately 616 ft. and 660 ft. high, respectively.

1.2 Denak Fault and West Basalt Fault Complex

The Denak Fault and West Basalt Fault are interpreted to exist in the saddle between the two pits. The Denak Fault is reported to be a wide fault zone that dips toward the northwest at an inclination of approximately 35 degrees. Based on old geologic maps, the West Basalt Fault is located in the footwall of the Denak Fault. The West Basalt Fault reportedly dips toward the northwest at an inclination of 35 degrees, and is approximately 80 ft. wide (Bysouth 1977). Together the faults and adjacent rock comprise a zone of faulted and very poor quality ground that is approximately 435 ft. thick in plan view. The location of the fault with respect to the proposed access road rock cut is shown on Figure 4. The fault will be exposed in the south wall between the saddle that separates the Denak East and the Endako Pit. The fault crosses the floor of the ultimate saddle in a northeast/southwest direction, and will be exposed on the west side of the nose in the north wall of the saddle, and in the cove on the northeast side of the Denak East Pit.

2.0 STABILITY ASSESSMENT

The potential adverse impacts that the fault complex is expected to have on the various portions of the pit walls that it will be exposed in is discussed in the following sections.

2.1 West and South Walls of the Endako Pit

The fault complex will expose a zone of very poor quality and faulted rock along the upper portion of the walls that will be excavated along the southwest and the west sides of the Endako Pit. The southwest and west walls of the Endako Pit will be excavated using a single bench configuration with an inter-ramp angle of 40 degrees to accommodate potential wedge failures that are formed by continuous northwesterly dipping faults. This single bench configuration is expected to provide sufficient catchment for any raveling that develops within the fault complex, and no design modifications are considered necessary for the portions of the Endako Pit walls in which the faults will be exposed.

2.2 South Wall of the Saddle

The south wall of the saddle will also be excavated using a single bench configuration with an inter-ramp angle of 40 degrees. This wall configuration has been designed to accommodate the Denak Fault which was expected to be exposed in the south wall of the saddle. As with the upper southwest walls in the Endako Pit, this bench configuration is expected to provide sufficient catchment for any raveling that develops within the fault complex, and no design modifications are considered necessary for the south wall of the saddle.

2.3 Southeast Side of the Denak East Pit

Figures 2 and 3 indicate that the nose that was originally planned on the portion of the south wall between the Denak East and the Endako Pits will be partially mined out as part of the Denak East interim pit excavation. Figure 4 shows the projection of the Denak Fault on the ultimate south wall. Figure 4 indicates that the fault complex will be exposed in the northwest facing slopes that will be excavated along the southeast side of the Denak East Pit. The benches in these slopes will undercut the shallow northwesterly dipping fault complex. Bench to multi-bench planar instability can be expected to develop along the undercut faults. Consequently, the walls along the southeast and east sides of the pit should be laid back to an angle of approximately 35 degrees to minimize undercutting and planar failure within the fault complex. The two walls segments that should be laid back to 35 degrees are shown on Figure 5.

2.4 West Side of the Nose in the North Wall of the Saddle

On the north side of the rock cut, the fault complex will be exposed in the northwest-facing slopes that will be excavated along the northwest side of the nose that will be excavated above the saddle rock cut. Figure 4 indicates that these northwest-facing slopes will be excavated at a shallow slope inclination with wide benches. The shallow slope inclination will follow the northwesterly-dipping fault complex, and the shallow slope is expected to provide sufficient catchment to accommodate any raveling that may occur within the fault zone. Consequently, slope design modifications are not required on this portion of the slope.

2.5 Northeast Side of the Denak East Pit

Figure 4 indicates that fault will be exposed in the westerly-facing slope that will be excavated along the east side of the cove that will be excavated along the northeast side of the Denak East Pit. The northwesterly-dipping fault complex will be undercut in the westerly-facing benches, and bench to multi-bench scale planar failure can be expected to occur along the undercut faults.

In order to preclude the development of planar failure in this wall, the wall configuration should be modified as follows, and as shown in Figures 6 and 7.

- The west and southwest-facing wall segments could be laid back to an inter-ramp angle of 35 degrees (Figure 6).
- The wall segments could be removed such that the wall on the northeast side of the cove intersects the wall on the southeast side of the cove at a 90 degree angle (Figure 7).

3.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This letter report has presented a review of the impacts that the Denak Fault and West Basalt Fault Complex is expected to have on the stability of the pit walls on the north and south sides of the Endako Pit access road rock cut that will be excavated in the saddle between the Endako Pit and the Denak East Pit.

Based on a review of existing data, the Denak Fault and West Basalt Fault Complex is expected to be zone of faulted and very poor quality ground upwards of 435 ft. thick in plan view. The fault will be exposed in the north and south walls of the access road rock cut.

The results of a stability assessment indicate that modifications of portions of the walls in the Denak East Pit will be required to minimize the potential for possible bench and multi-bench planar failure to develop within these walls. The portions of the pit that will require modifications are shown in Figures 5, 6 and 7.

The geology of the cut slopes on the north and south sides of the saddle should be mapped as the walls are excavated so that changes in geology or the anticipated location of the major faults can be identified in a timely manner so that any required pit wall modifications can be implemented to prevent large scale failures of the pit walls.

4.0 CLOSURE

We trust this letter report satisfies your current requirement. If you have any questions or require further assistance, please do not hesitate to contact us.

GOLDER ASSOCIATES LTD.

Juliana Martin (EIT/GIT)
Intermediate Geological Engineer

Al Chance, P.Eng.
Principal, Mining Division

JMM/AVC/kp

Attachment: Figures 1 - 7

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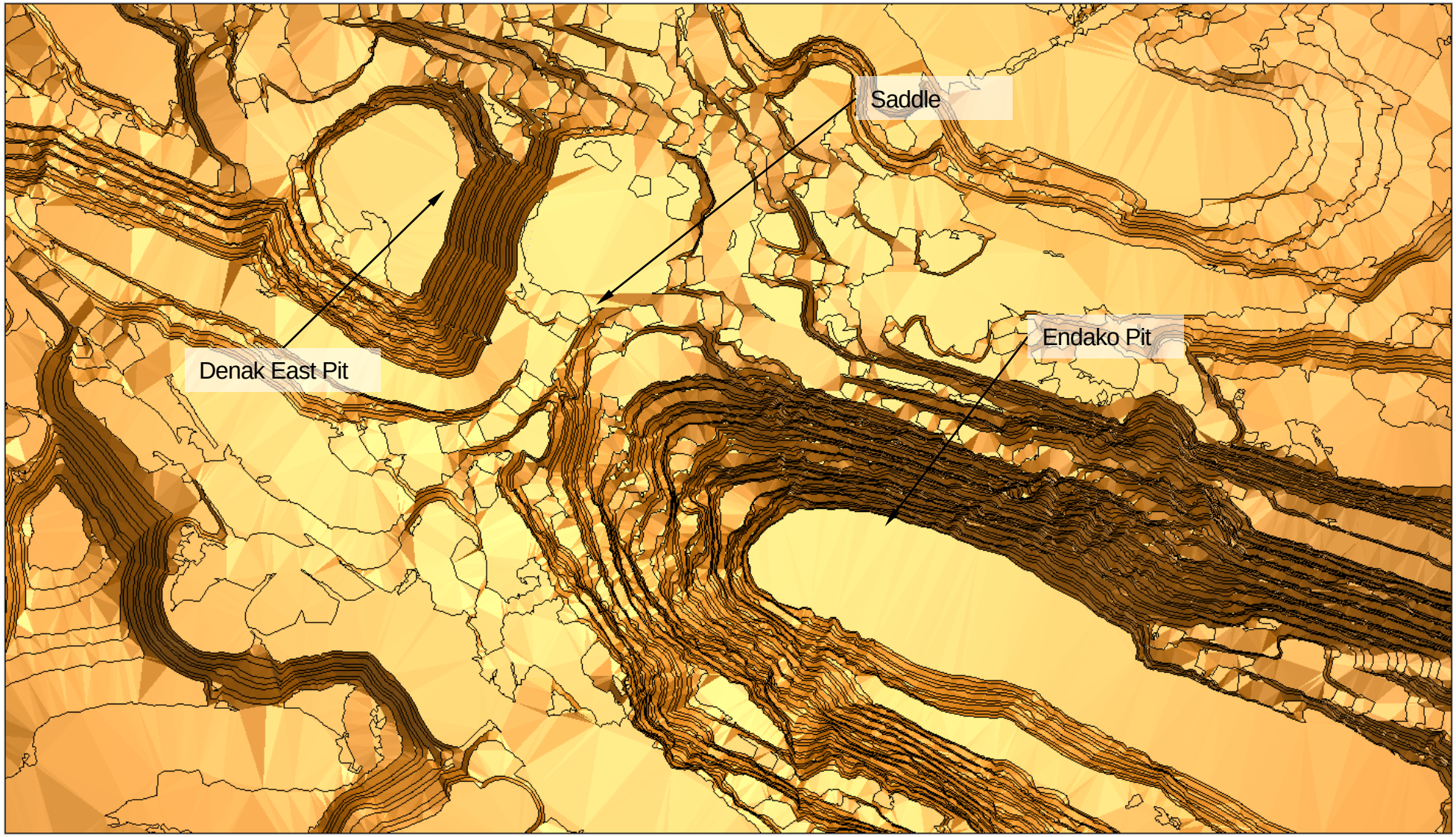
REFERENCE

Bysouth 1977, “The Systems Concept Applied to the Endako Ore Deposit”, January 1977.



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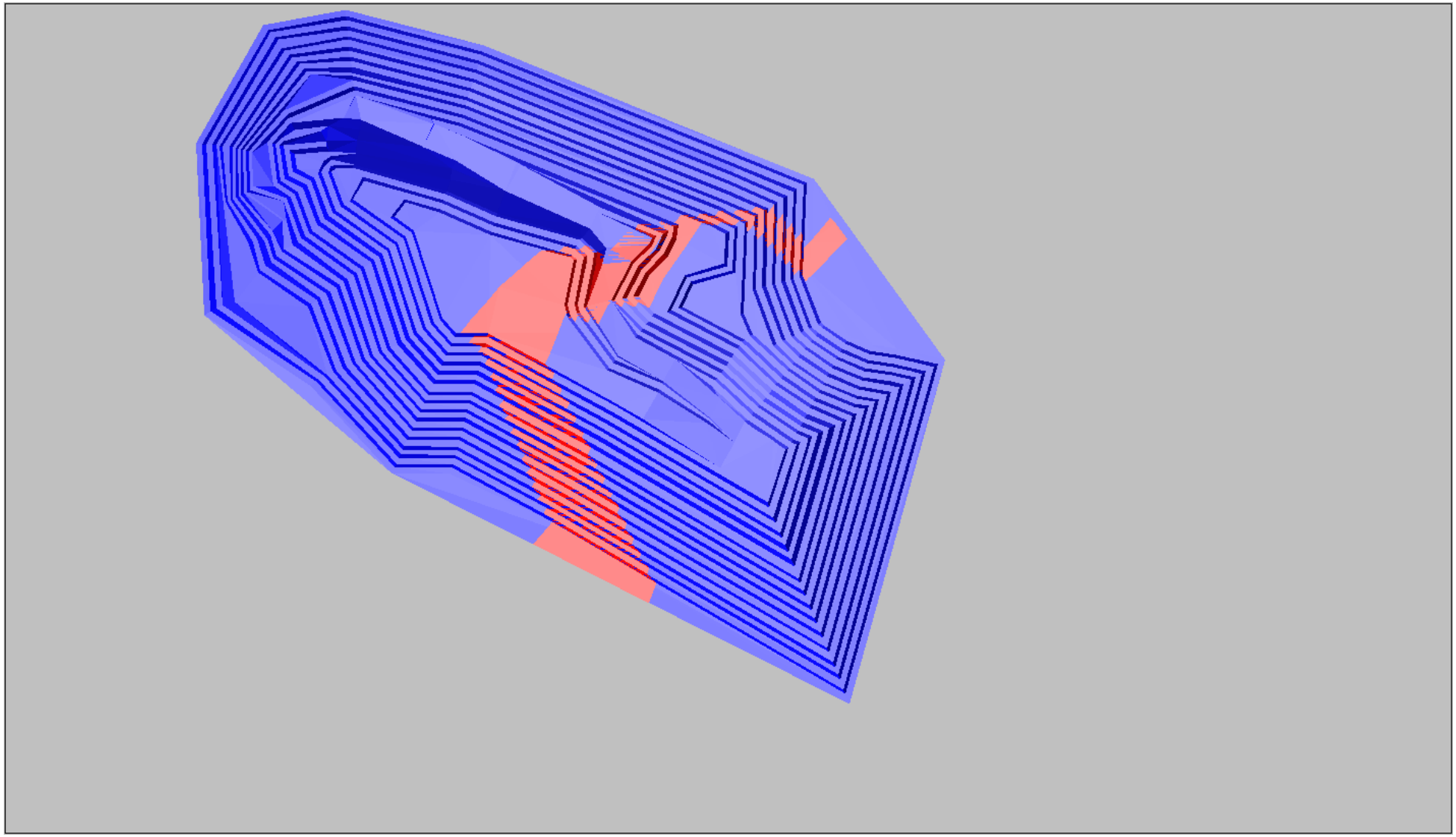
DESIGN	JMM
REVIEW	AVC
APPROVED	AVC

PROJECT
DENAK EAST PIT
DENAK FAULT STABILITY ASSESSMENT

TITLE
Plan View of Denak East and Endako Pits
August 2013 Asbuilt

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**1**



LEGEND

- Denak Fault and West Pit Fault Complex

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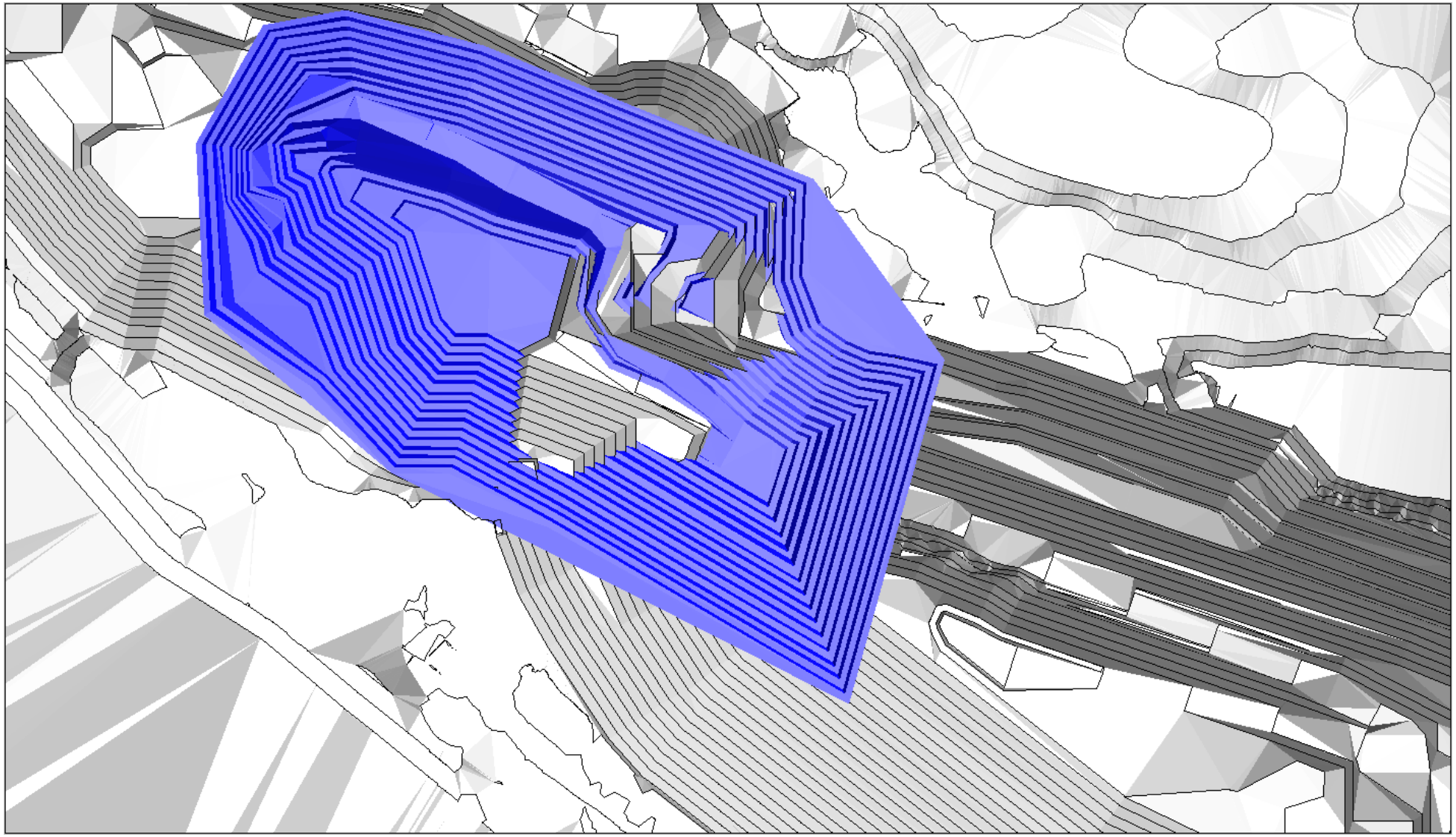
PROJECT
DENAK EAST PIT
DENAK FAULT STABILITY ASSESSMENT

TITLE
Plan View of Denak East Pit
Proposed Revised Interim Pit with Fault Intersection

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**2**



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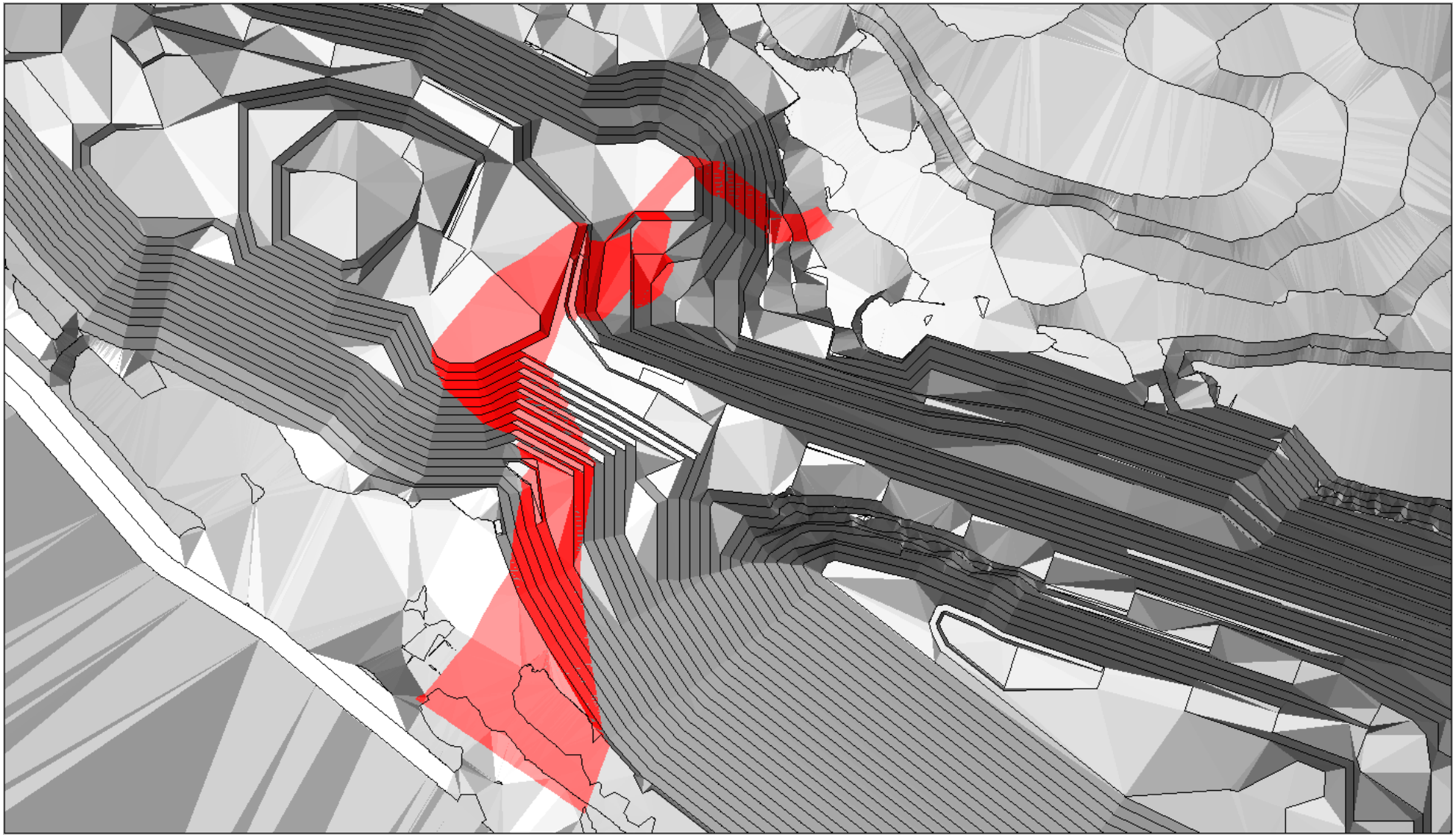
TITLE
Plan View of Denak East Pit and Endako Pits
Previous 2029 Ultimate Pit with Proposed Revised Interim Pit

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**3**



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Denak Fault and West Pit Fault Complex

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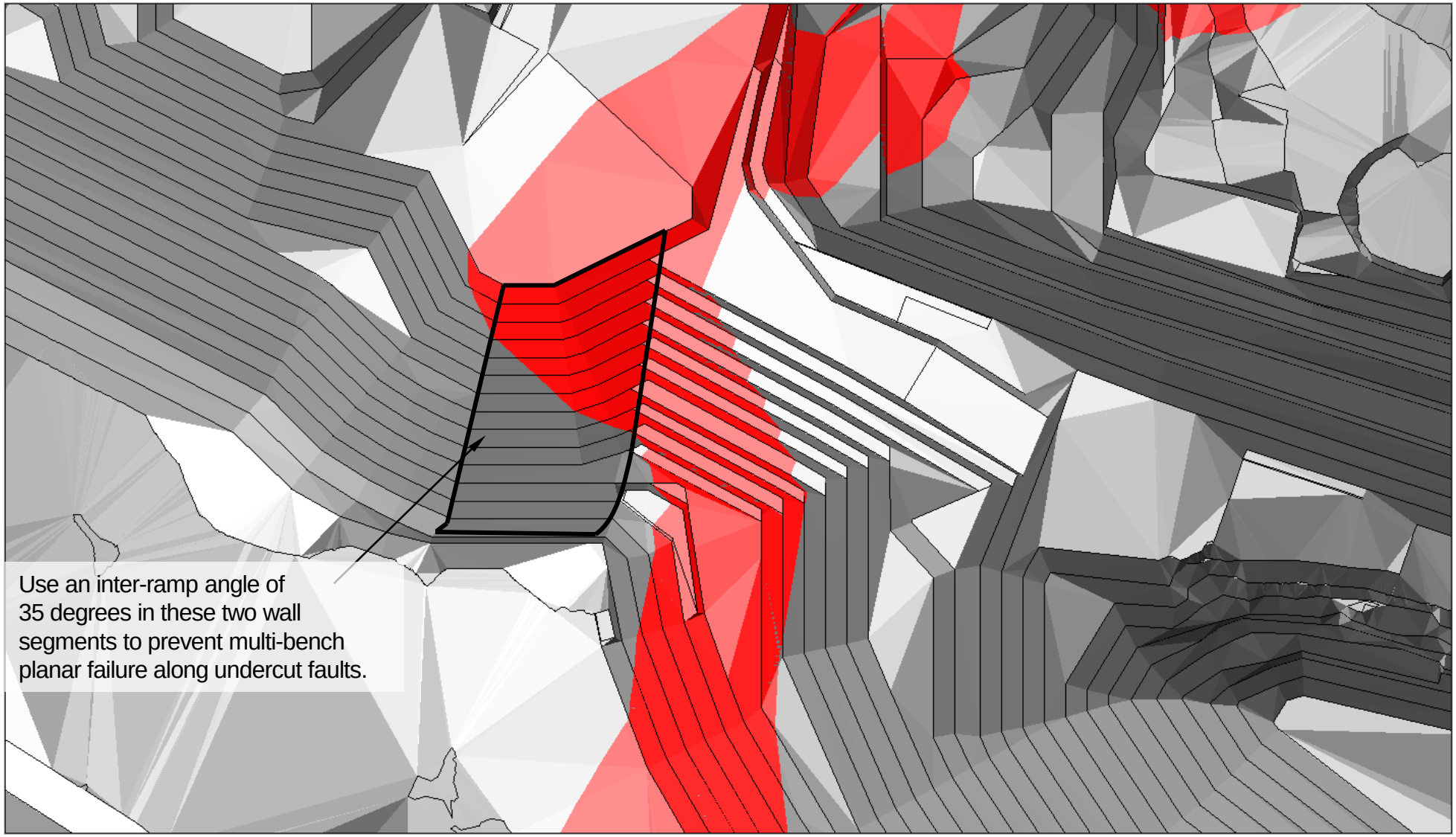
DENAK FAULT STABILITY ASSESSMENT

TITLE
Denak Fault and West Pit Fault Complex
Intersection with Proposed Revised 2029 Ultimate Pit

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**4**



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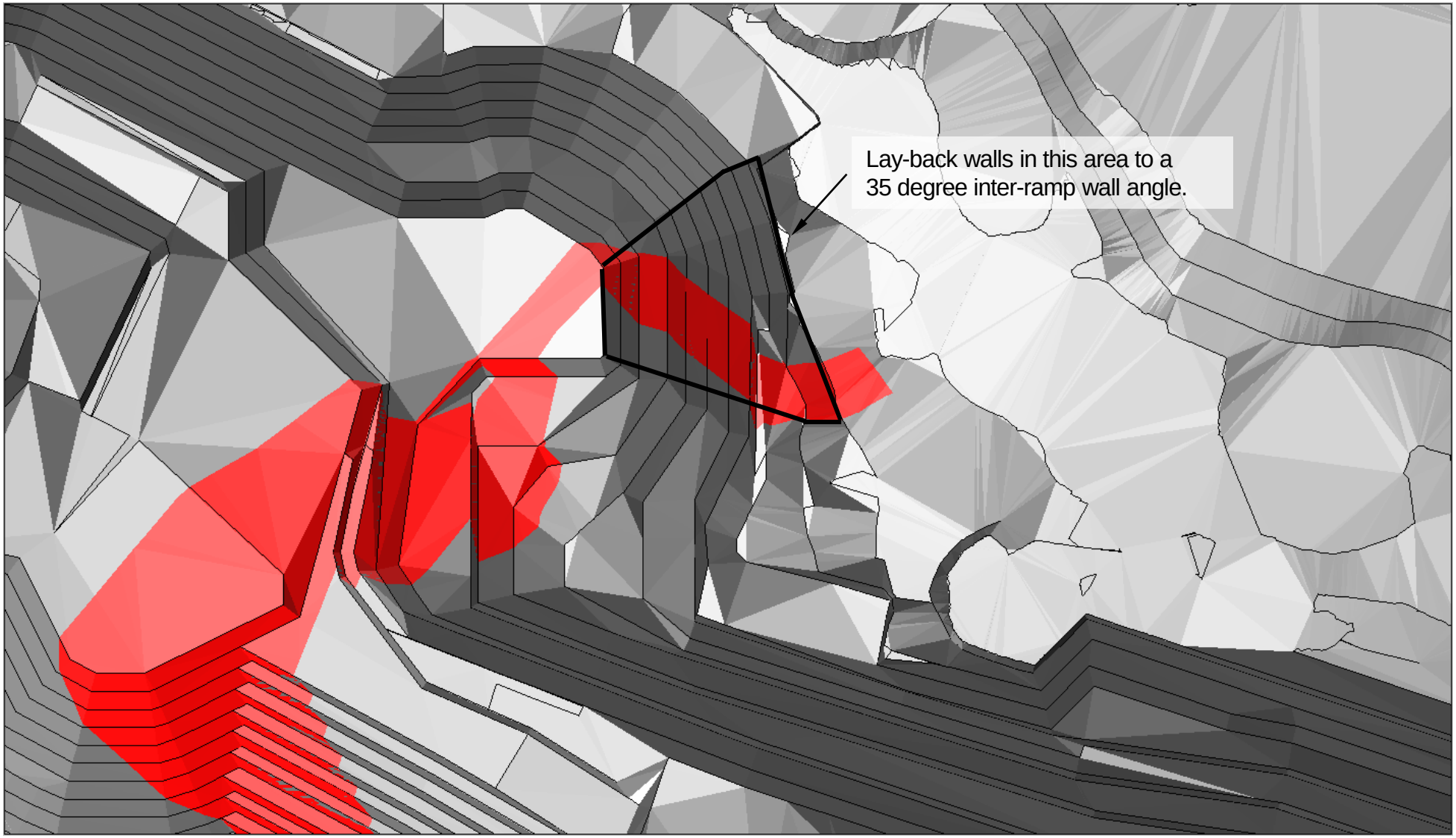
PROJECT
DENAK EAST PIT
DENAK FAULT STABILITY ASSESSMENT

TITLE
Denak East Pit
Southeast Wall Modifications

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**5**



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Denak Fault and West Pit Fault Complex

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PROJECT
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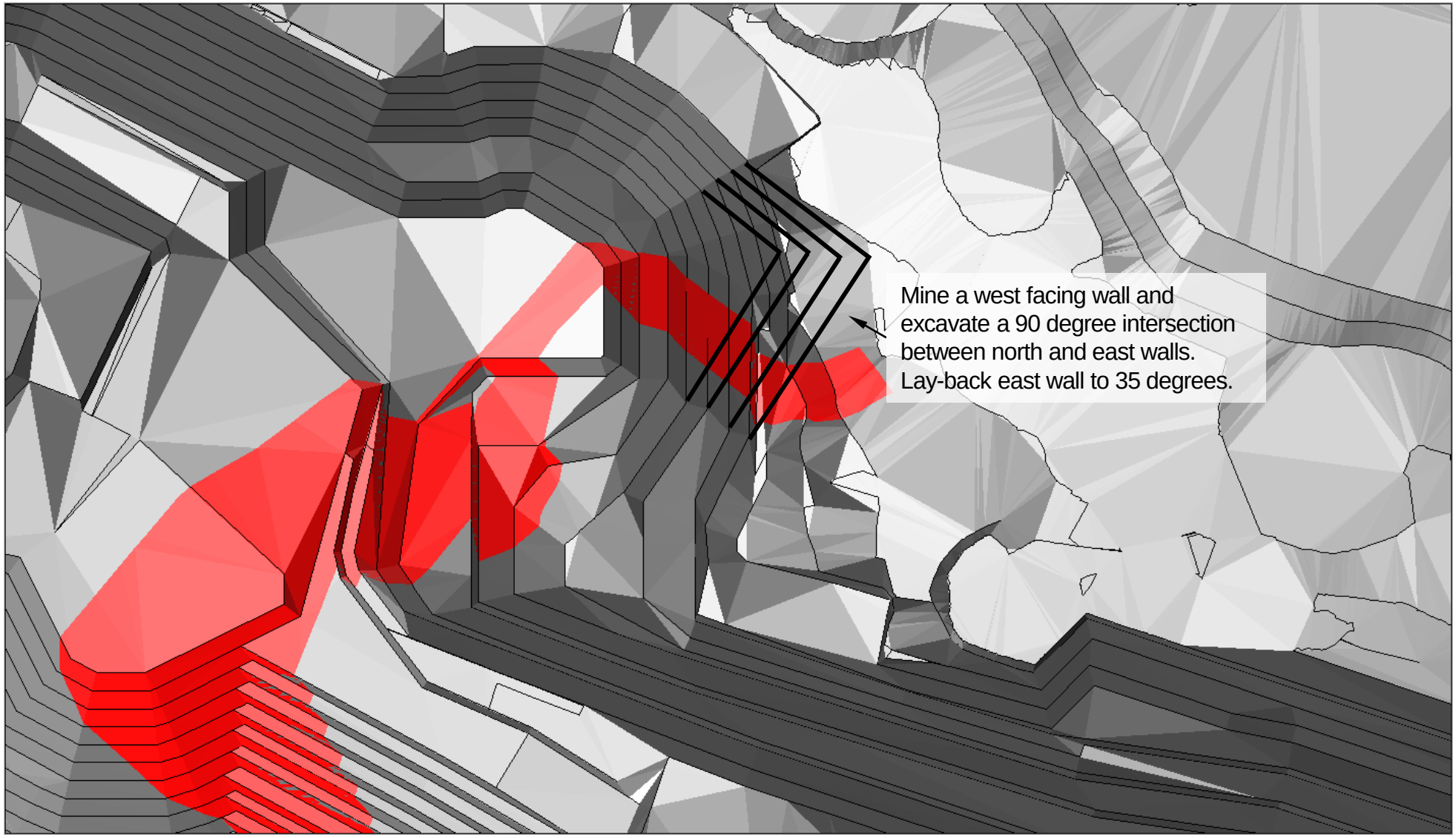
DENAK FAULT STABILITY ASSESSMENT

TITLE
Denak East Pit
Northeast Wall Modification Option 1

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**6**



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PROJECT
DENAK EAST PIT
DENAK FAULT STABILITY ASSESSMENT

TITLE
Denak East Pit
Northeast Wall Modification Option 2

PROJECT No.	Phase	Rev.	Figure
05-1413-495	**2114**	**0**	**7**