REPORT

Whakatane District Council

Ohope Escarpment Condition Survey
Nos 63 to 71 West End Road, Ohope

Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

REPORT

Whakatane District Council

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Nos 63 to 71 West End Road, Ohope

Report prepared for:

WHAKATANE DISTRICT COUNCIL

Report prepared by:

Tonkin & Taylor Ltd

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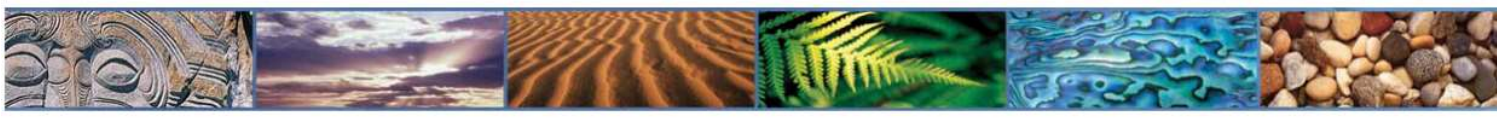

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1 Introduction

1.1 General

A number of heavy rainfall events have affected the Whakatane area in the last year. These rainfall events have caused extensive landsliding and flooding in the region. A number of landslips have occurred on the Ohope Escarpment above West End Road. Following the recent slope failures, Whakatane District Council (WDC) engaged Tonkin & Taylor (T&T) to carry out a condition survey of the Ohope Escarpment above the properties between Nos 63 and 71 West End Road (inclusive). Eight of these properties have been affected by landslips in the last twelve months. This being the case our scope of works has been to:

- Carry out a walkover, visual assessment and preliminary field mapping of the escarpment between Nos 63 and 71 West End Road inclusive
- Assess existing information regarding the area
- Identification of areas that may be prone to landslippage in the future
- Preliminary discussion of the causes of the instability in the field area
- Prepare a report detailing our findings

The field area for this study includes Nos 63 to 71 West End Road only.

1.2 Previous Work

T&T have previously completed a number of geotechnical reports regarding the Ohope Escarpment. The two reports relevant to this current study are:

- **Tonkin & Taylor (2007)** - "West End Beach Cliff Assessment" – Letter report issued September 2007
- **Tonkin & Taylor (2005)** - "West End Escarpment Overview" – Report issued February 2005

2 Ground conditions

2.1 Geomorphology

The geomorphology varies across and along the Escarpment but can generally be divided into the following five elements:

Ohope Beach to base of cliff: This area is generally characterised by flat or gently sloping topography comprising beach sands overlying greywacke rock at variable depth.

Foot of cliff (talus apron): This area is characterised by a steepening of grade between the flat coastal zone and the cliff. The zone slopes at approximately 30° to 35° and comprises historic landslip or erosion deposits (talus) consisting typically of silt and sand overlying coastal sediments.

Cliff face: The escarpment cliffs typically standing at slopes of 45° to 60°. They are formed within the Ohope Beds described in Section 2.2.

Intermediate bench: A discontinuous bench is present at approximately 60 metres above sea level (masl) reflects the presence of Ohope gravel (see Section 2.2) or comparably less competent beds at and above that horizon. This bench was observed behind Nos 65, 67, 68, 70 and 71. It was not observed behind Nos 63, 64, 66 or 69. Soil up to 2.5 m thick was observed on this bench and it has been a major source of debris over the last twelve months.

Cliff top: The cliff top is at a level of around 100 masl. Some arcuate features can be seen in the topography above the cliff that may relate to old landslips. Above the field area, these slopes appear to have stabilised. Any slope failure that does occur from here is likely to be low volume.

2.2 Geology

The Ohope Escarpment is formed of a number of geological sequences, typically including soft to dense sandstone rocks overlain by soils including pumice and ash. It is fully described in Report 2 and is summarised here.

Greywacke

The sea cliffs at the northwestern end of Ohope Beach are formed from greywacke. This rock is typically grey, slightly to moderately weathered and moderately strong to strong with irregular, closely to very closely spaced joints. The greywacke may underlie the remainder of the Ohope Escarpment, however it cannot be observed due to the talus cover.

Ohope Beds

The greywacke rock is overlain by horizontally bedded sandstones and siltstones which form part of the Ohope Beds. Due to their horizontal attitude, the Ohope Beds are not particularly susceptible to failure along bedding planes. Joints have been observed in Ohope Beds at the base of the Escarpment that strike approximately parallel to the Escarpment face. These joints do not appear to be laterally continuous and may be relaxation features. They are likely to be exacerbated by weathering. They may lead to the local failure of small slabs from the face of the rock.

The top surface of the sandstone is likely to be undulating (paleotopography) as a result of local erosion prior to the deposition of younger material on top.

Ohope Gravel

Terrestrial brown river gravels have been observed on the Otarawairere track. The gravel beds are impersistent and are not seen as a definite bed along the track on the eastern side of the Otarawairere Track Summit. Their horizon corresponds to "slipping sandstone" described by Fleming (1945)[1] at this level. Its elevation also corresponds approximately with the bench in the eastern part of the Ohope Escarpment.

Gravel deposits do not appear to be present in any of the prominent scarps observed, however there are numerous pebbles sourced from the river gravel in the debris at the base of the escarpment.

It is possible that the bench at the top of the lower cliff is the location of the gravel horizon. It is known to be impersistent which corresponds with the irregularity of the bench feature. Unlike the sandstone below it, the gravel is highly permeable and would likely act as a channel for water, with the bench being a natural site for springs. This material is typically not as stable as the sandstone below it.

[1] Fleming (1955) Fossils fom Ohope. New Zealand Journal of Science and Technology, vol. B6, p511-522

Young Pumice Deposits

Above the Ohope Escarpment and overlying the Ohope Beds are pumice gravel deposits that are probably part of the Rotoiti Breccia that erupted approximately 50,000 years ago. These deposits have buried the topography that would have eroded into the top of the Ohope Beds.

The thickness of the pumice gravel deposits is likely to vary in response to the paleotopography that developed on the underlying Ohope Beds. Elsewhere they have been observed up to 30 m thick. As on the bench, some material would be washed away in heavy rain, but typically not in large quantities. The uppermost Ohope sandstones will have an undulating paleotopography that will result in some overlying soils resting on a rock surface that slopes toward Ohope Beach. Landslippage on the interface between the two strata in areas of unfavourably sloping paleotopography are common.

2.3 Water

Water was observed to be running in areas all along the face between Nos 65 and 71. This water concentrated into streams behind Nos 65 to 68, No. 70 and No. 71/71A.

Water flowing down the escarpment comes from three sources. The first of these are springs that emanate from the Rotoiti Breccia (pumice gravel) that overlies the Ohope Beds. This deposit would have infilled the old erosion surface on the top of the Ohope Beds. Water flowing through the pumice is likely to flow along the old infilled gullies and now emerges approx 15 m vertically below the crest of the escarpment. Two of these sprigs were observed during our walkover and are marked on Figure 1.

The second source of water is direct overland flow of water during high intensity rainfall events affecting the area. Anecdotal evidence suggests that runoff from above the cliff forms significant waterfalls down the cliff face. Approximate overland flow paths are shown on Figure 1.

The third source of water affecting the properties emerges as springs from the river gravel layer that occurs at the approximate level of the bench on the escarpment. These springs were not observed during our walkover, but are described in Report 2.

In addition to the above, a number of significant rainfall events have occurred in the last year. In particular, the months of June to August 2011 were very wet. This has caused the surface soils to remain wet and has increased their susceptibility to landslippage.

2.4 Landslip evolution of the escarpment

The weathering and landslipping processes of the Ohope escarpment are described in Report 2. It is summarised here. Figure 2 shows the natural weathering and erosion cycle of the escarpment. Following the landslip, a fresh face of bare rock is exposed. Gradually small plants colonise the face as the rock weathers and soil begins to accumulate. The soil gradually thickens and larger plants and trees begin to grow. At the same time, the underlying rock weathers as it is affected by carbonic and humic acids. Larger plants also affect the rock mass as roots grow into joints and cause them to open. Eventually the slope becomes overloaded and prone to landslips.

The process illustrated on Figure 2 will be cyclical. There are likely to be extended periods of soil and vegetation build up on the slopes. Once the soil thickness and vegetation density reaches a critical level then landslipping will become more frequent. Landslipping will eventually remove much of the soil and the process will start again.

3 Recent Landslip Activity and Current Condition

3.1 Nos 63 and 64

3.1.1 Recent landslip activity

No landslip activity has affected these properties in the last year.

3.1.2 Possible unstable features on the slope

Some steep faces are present on the slope above these properties, but there does not appear to be major vegetation or large trees overhanging the slope. The dwelling at No. 63 is approximately 50 m from the base of the steep slope and the rear of the property has been benched. The risk to the dwellings from landslip debris is likely to be low.

Some small to moderate-sized trees were observed on the escarpment slope behind No. 64, but the soil appeared to be thin. The talus slope below the escarpment is also heavily vegetated and this would provide some protection from landslip debris.

The bench on the escarpment described in Section 2.1 is thin above these properties, however it may contain a reasonable thickness of soil and weathered rock that may be prone to instability.

3.1.3 Water

No water was observed on the slopes behind these two properties.

3.2 No. 65

3.2.1 Recent landslip activity

This property has been affected by three landslips within the last year. The first of these originated from a bench on the northern side of the property and involved a large volume of debris which impacted the rear of the apartment block and caused minor damage. The second of these landslips originated from the bench on the escarpment on the southern side of the property and also impacted the rear of the apartments. The last landslip was a failure of the soil material that was present on the steep part of the escarpment below the bench and between the first two landslips. Debris from the third landslip did not reach the apartments.

3.2.2 Possible unstable features on the slope

A portion of soil and a moderate-sized Pohutukawa tree remain on the bench and have been undermined by the second landslip. A Pohutukawa tree was also observed overhanging the slope at the crest of the escarpment above the bench.

Soil and vegetation are still present on the escarpment bench. This may also be prone to future landslippage.

3.2.3 Water

Water flows in two streams along the northern and southern property boundaries. Water on the northern boundary is collected by drains on No. 66. Water on the southern boundary currently flows around the southern end of the apartment buildings, down the driveway to the road.

3.3 No. 66

3.3.1 Recent landslip activity

This property was inundated by landslips from two neighbouring properties. The debris inundated flat earthworked benches at the rear of the property and silt washed down to the buildings at the front. No buildings were impacted by landslip debris.

3.3.2 Possible unstable features on the slope

The escarpment here forms a steep face and does not appear to contain any benches. There is some overhanging vegetation, but the soils appear to be thin. Any new landslip material is likely to collect on the benches.

3.3.3 Water

Water from the escarpment above No. 65 and No. 66 flows to the rear bench of this property and is then collected and piped to the property's front.

3.4 Nos. 67 and 68

3.4.1 Recent landslip activity

These two properties have been affected by three landslips. The first two occurred during a heavy rainfall event on 24/25 May 2010. The dwelling at No. 67 was badly damaged and the property owner injured by debris. The dwelling at No. 68 was totally destroyed. These two landslips involved the mobilisation of material that had collected on a bench part way up the escarpment.

The third landslip occurred later during the winter of 2010. Debris from this landslip was mainly composed of material from the bench, but also included material from a source higher up the escarpment which could not be observed.

3.4.2 Possible unstable features on the slope

A large Pohutukawa sits on a thick block of soil on the rock bench. The soil and Pohutukawa are gradually being undermined and are at risk of failure. Material that was involved in the third landslip was sourced from further up the escarpment in an area that could not be accessed. This suggests that there is material that is prone to failure at higher levels which may periodically fail and flow down the slope.

A Pohutukawa tree was also noted in Report 1 to be overhanging the slope near the crest of the escarpment. This tree is still in place and is at risk of detaching from the face.

3.4.3 Water

Some water now flows down the exposed rock behind No. 67. This water has formed a small stream on the talus apron below the cliff face. During our recent visit the water in the stream is absorbed into the ground before it reaches the base of the talus slope. It flows over the talus slope and across the lawn during periods of high rainfall. A smaller stream flows down the escarpment upslope from No. 68. This stream was not present during our visit and may only flow during winter or during periods of heavy rainfall.

3.5 No. 69

3.5.1 Recent landslip activity

A garage/sleepout was recently destroyed by a landslip which occurred on the escarpment above No. 70. No recent activity has occurred on the escarpment immediately behind No. 69. In addition a large number of trees are growing on the talus apron behind the property which would partly protect the property from landslipping.

3.5.2 Possible unstable features on the slope

There is a thin layer of soil present on the escarpment behind No. 69. This soil contains flaxes, grasses and some moderate-sized Pohutukawa trees that are overhanging the slope. This soil may be prone to slippage, however the presence of the trees on the talus slope partly mitigate the risk to the land and dwellings on No. 69.

3.5.3 Water

Some water seepage was noted on the slopes behind No. 69, however this did not collect to form streams and appeared to soak into the talus material below the escarpment.

3.6 No. 70

3.6.1 Recent landslip activity

A large landslip happened at this property following storms that occurred during late January 2011. The landslip inundated land and narrowly missed the dwelling. The source area of the landslip is now bare rock.

3.6.2 Possible unstable features on the slope

A small ledge has formed on the slip face on which there are two boulders that may be at risk of toppling. There is also a minor amount of overhanging material around the head of the recent landslip. A number of moderate to large Pohutukawa trees overhang the slope above the slip that may be prone to landslippage.

Immediately upslope of the dwelling, thin soil and light vegetation is present on lower levels of the escarpment, although larger trees are present further up. A stand of Pohutukawa trees is present on the talus apron between the dwelling and the escarpment which may partly shield the house from debris impact.

3.6.3 Water

A stream flows from a bench part way up the escarpment at the southern end of the recent landslip. The water from this stream currently collects behind a bund and is adjacent to the boundary by No. 69.

3.7 Nos 71 and 71A

3.7.1 Recent landslip activity

This cross-leased property has been affected by three landslips during 2011. The first of these occurred to the north of the dwelling on No. 71. It was a long shallow landslip of soil from the escarpment face that caused inundation at the foot of the escarpment and blocked a drain leading to siltation of the lawn. No structural damage to buildings occurred.

The second was a large landslip that occurred from a bench approximately half way up the escarpment on 26 April. The soil below the bench also failed. Debris from the landslip overtopped a bund at the base of the escarpment blocking a drain and impacting the dwelling at 71A causing severe damage.

The third landslip occurred adjacent to a water course from the bench approximately halfway up the escarpment to the southwest of the dwelling at 71A. Debris flowed down the stream channel before merging with the debris from the second landslip. It is likely that the stream undercut the soil on the bench and caused it to fail at this location.

Prior to the landslips above, these two properties were affected by a landslip that occurred during a storm event in 2004.

3.7.2 Possible unstable features on the slope

The escarpment slopes between the landslips described above are still covered by a reasonably thick layer of topsoil and also contain many large Pohutukawa trees. In addition to this, there is still a thick layer of soil (approximately 2.5 m thick) on the bench half way up the escarpment. The remaining soil on the bench and on the escarpment below is likely to be prone to landslippage.

3.7.3 Water

A stream is present to the southwest of the house on No. 71A and flows to the corner of the property before being diverted by a bund and channel to the north, around the dwelling at No. 71 before discharging to Ohope Beach. Water was also observed flowing off the other landslips around the property including the one that occurred in 2004.

4 Discussion

A number of potentially unstable features have been identified that may be prone to failure. These include:

- Overhanging trees
- Large blocks of soil undermined by previous landslips
- Loose boulders
- Areas of thick soil on the escarpment that have not yet been affected by slope failure

A full assessment of each of these features is beyond the scope of this report. Further assessment of the features should be made and remedial works implemented as required. Some general comments are made below.

The most likely triggers that may cause landslips from the escarpment are heavy rainfall and seismic activity. All of the landslips that have occurred in the last year have been triggered by rain storm events. Most of the landslips occurred during intense periods of rainfall (up to 45 mm per hour). Anecdotal evidence suggests that the streams flowing down the escarpment flow at hugely increased rates during these events and generate waterfalls in places down the escarpment. The increase in the volume of water in these streams is due to overland flow of stormwater from direct rainfall onto the escarpment and from rainfall onto the limited catchment below Otarawairere Road. It also likely that the landslips have been triggered mainly by the overland flow of stormwater rather than by increased spring activity.

A number of the landslips observed were the result of soil failure from a bench part way up the escarpment (No. 65, 67, 68 and 71). Thick deposits of soil are able to accumulate on the bench

part way up the escarpment. Soil up to 2.5 m thick was observed on the bench on No. 71. It is possible that river gravel outcrops at this level and that springs also emerge here. The springs would keep this soil perpetually wet. Rainfall then results in excess pore pressures in this area triggering a landslip. The landslip debris then travels down slope overloading or scouring soils on lower levels of the escarpment leaving a rock face.

There is also evidence that slope failures are occurring from levels above the bench, particularly around stream channels.

The Ohope Beds are highly competent in their unweathered condition and have little overall stability threat in that state. The bedding within them is horizontal, and therefore that bedding plane induced landslippage is unlikely. The Ohope Beds do have some discontinuous joints that run parallel to the face of the escarpment which may result in the detachment of localised slabs. These were not encountered in the field area, but have been observed in the large landslip above the Otarawairere Track at the north western end of Ohope Beach.

The area below any unweathered face that has been exposed after a landslip (which would also have removed the trees) is the safest part of the Escarpment provided there is no oversteepened material above the cliff. The risk of instability in other areas, where the face is weathered, would broadly be inversely related to the time when the last landslip occurred at that location.

Report 2 indicates that the recurrence interval of a landslip from a particular location is likely to be in excess of 200 years. The process of soil and vegetation accumulation followed by slope failure will be cyclical. It is possible that the Ohope Escarpment is currently undergoing a period of more frequent landslipping. This may eventually remove much of the unstable material leaving mostly bare rock faces that are not prone to instability.

5 Applicability

This report has been prepared for the benefit of Whakatane District Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

This opinion is not intended to be advice that is covered by the Financial Advisers Act 2010.

Tonkin & Taylor LTD

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
David Milner	for Kevin Hind
Senior Engineering Geologist	Project Director

dmmm

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Appendix A: Figures

SCALE 1: 2000

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SCALES (AT A3 SIZE)	1: 2000
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WHAKATANE DISTRICT COUNCIL
63-71 WEST END ROAD
WHAKATANE
Landslip Location Plan

FIG. No. Figure 1 REV. 0

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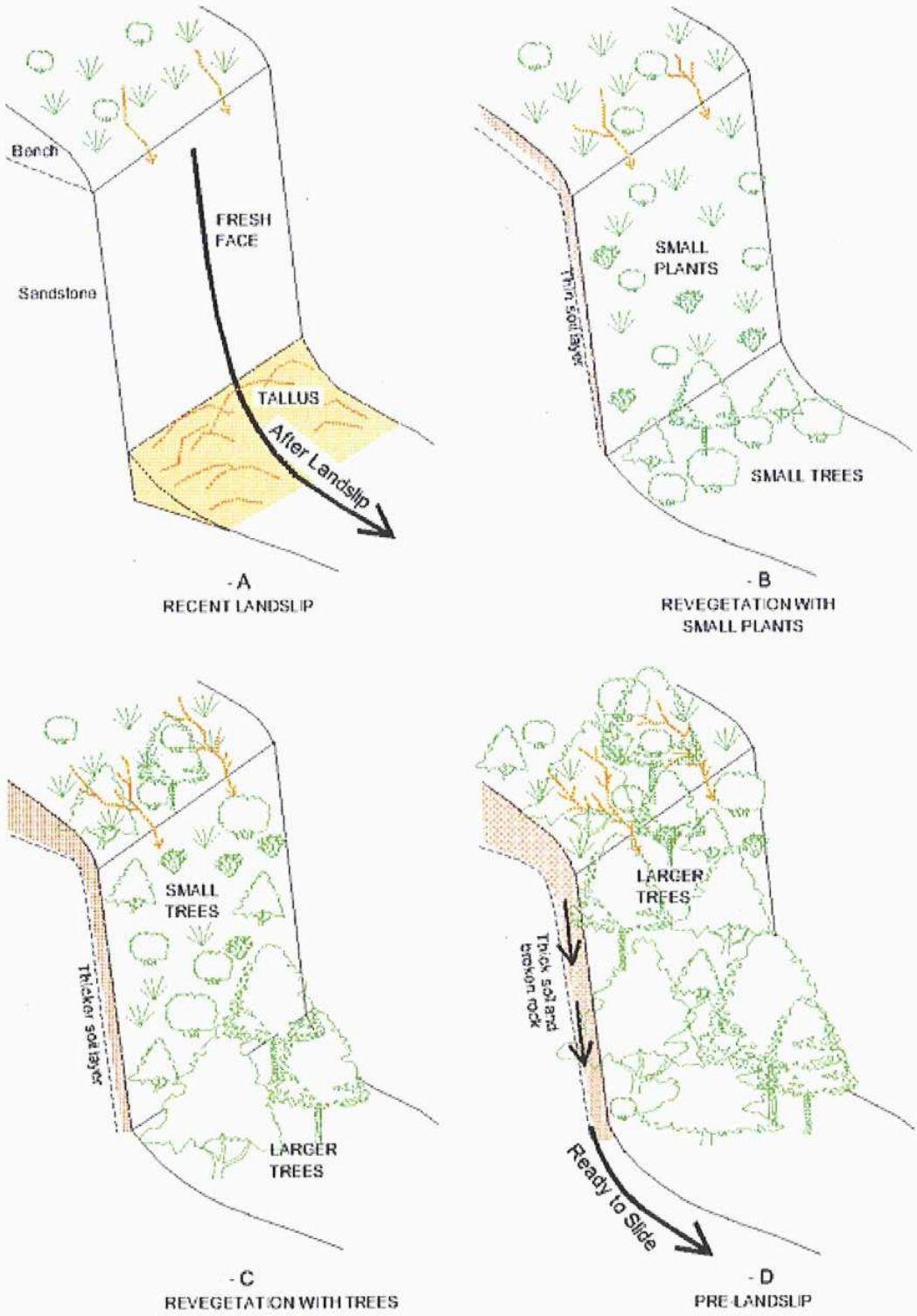

P:\851478\Working\Material\CAD\851478 Fig 2.dwg Layout: 16/06/2011 3:18:58 p.m.

Tonkin & Taylor Environmental and Engineering Consultants Level 1, 36 Grey Street, Tauranga www.tonkin.co.nz	DRAWN	amc	Jun.11
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WHAKATANE DISTRICT COUNCIL
OHOPE ESCARPMENT CONDITION SURVEY
63–71 WEST END ROAD
Schematic sketch showing escarpment development cycle

FIG. No. Figure 2 | REV. 0

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