E6 Ranheim – Værnes

Earthworks and retaining walls - Geotechnical report for day zone 6

E6RV-DJV-GT-RPT-DZ06-0003

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08	Norwegian conclusion and summary	

ABSTRACT

Nye Veier is upgrading the existing E6 between Ranheim and Værnes to a four-lane highway of 110 km/h. The distance is approximately 23 km, and the planned section includes three new tunnels, two larger bridges, five two level interchanges as well as several culverts and overpass bridges. The Design Joint Venture (DJV), a corporation between Rambøll and Acciona Engineering, is engaged by Acciona Construction SA NUF to carry out detailed design of the new highway.

Day zone 6 runs from the east portal of the Hell tunnel to Værnes intersection in Stjørdal municipality. The new road mainly follows the path of the existing highway in this area.

The present report refers to the definition and design (100% detailed design) of the earthworks along the alignment of day zone 6. Geotechnical measures needed in connection with the structures in the day zone will be described in separate reports and are not included in the present report.

Several ground investigations have been carried out in the area in connection with the construction of the existing road and tunnel portal. Relevant information indicates that the soil at Hellstranda consists mainly of layers of granular soils of sand and silt, with increasing silt and clay content with depth. Layers of quick clay has been registered at approximately 15 – 25 meters below ground surface close to the new Hell portal. Rock depth varies between 5 meters to 20 meters along the shoreline close to the new Hell portal, with increasing depth in a north-western direction, towards the fjord.

At Værnes relevant information indicates that the soil consists mainly of layers of coarse and fine sand, with some silt and silty layers. The silt content seems to increase with depth. In some boreholes, layers of silty clay have been registered at depth. Rock depth is unknown, total soundings have been carried out to depths of 45- 50 meters below ground surface without registering the bedrock surface.

Quick clay has been registered at several boreholes in the area. For the zoning plan, Multiconsult has investigated and analysed the areas stability against larger landslides involving quick clay, in accordance with NVE's guide 7/2014 "Sikkerhet mot kvikkleireskred", ref. /17/. Based on the topography and the thickness of soil above the quick- and brittle clay there is considered to be no danger of landslides on Hellstranda, and therefore it is not established any danger zone in this area.

Sammendrag

Nye Veier oppgraderer eksisterende E6 mellom Ranheim og Værnes til en 4-felts motorvei med fartsgrense 110 km/t. Prosjektet omfatter ca. 23 km ny veg, og inkluderer 3 nye tunneler, 2 større bruer, 5 vegkryss over 2 plan og flere kulverter og mindre bruer. Design Joint Venture (DJV), en joint venture mellom Rambøll og Acciona Engineering, er engasjert av Acciona Construction SA NUF for å utføre detaljprosjekteringen av vegprosjektet.

Dagsone 6 går mellom den østre portalen til Hell-tunellen og Værneskrysset i Stjørdal kommune. Den nye vegen følger hovedsakelig eksisterende veg i området.

Foreliggende rapport omhandler geoteknisk detaljprosjektering av dagsone 6. Geotekniske tiltak som er nødvendige i forbindelse med konstruksjoner langs strekningen er beskrevet i separate rapporter, og er ikke inkludert i denne rapporten.

Det er utført grunnundersøkelser i flere omganger på Hellstranda og Værnes. Rambøll har utført supplerende grunnundersøkelser for ny veglinje i 2020. Utførte grunnundersøkelser antyder at grunnforholdene på Hellstranda hovedsakelig består av friksjonsmasser av sand og silt, med økende silt- og leirinnhold med dybden. Det er registrert kvikkleire fra ca. 15-25 m under terreng rett ved nye Hell portal. Dybde til berg varierer fra ca. 5 til 20 meter i området ved den nye tunnelportalen, med økene dybde i nordvestlig retning. Lenger mot nord/nordøst er dybde til berg ikke kjent.

Grunnforholdene på Værnes består hovedsakelig av vekslende lag av grov og fin sand, med enkelte siltige lag. Siltmengden ser ut til å øke med dybden. I enkelte borpunkt er det registrert lag av siltig leire i dybden. Det er boret til dybder på 30-50 meter uten at berg er registrert.

Det er ingen registrerte kvikkleiresoner i området, men det er påtruffet kvikkleire i dybden på Hellstranda. I forbindelse med reguleringsplanen er det derfor utført en utredning av områdestabilitet for Hellstranda iht. NVEs veileder 2/2011 «Sikkerhet mot kvikkleireskred». Resultatene er oppsummert i Multiconsult sin rapport (ref. 1). På bakgrunn av topografi og mektighet av overliggende masser i forhold til kvikke masser, vurderes det å ikke være fare for områdeskred på Hellstranda. Ut fra foreliggende grunnlag og vurderinger er det således ikke grunnlag for å etablere en faresone i området, og videre utredning og faregradsklassifisering er vurdert som ikke nødvendig. Rapporten er kontrollert og godkjent av uavhengig 3. part.

LIST OF CONTENT

1 INTRODUCTION

1.1 General

Nye Veier is upgrading the existing E6 between Ranheim and Værnes to a four-lane highway of 110 km/h. The distance is approximately 23 km, and the planned section includes three new tunnels, two larger bridges, five two level interchanges as well as several culverts and overpass bridges. The Design Joint Venture (DJV), a corporation between Rambøll and Acciona Engineering, is engaged by Acciona Construction SA NUF to carry out detailed design of the new highway.

Day zone 6 runs from the east portal of the Hell tunnel to Værnes intersection in Stjørdal municipality.

The new road mainly follows the path of the existing highway in this area. An overview of the planned road and structures is presented in Figure 1.

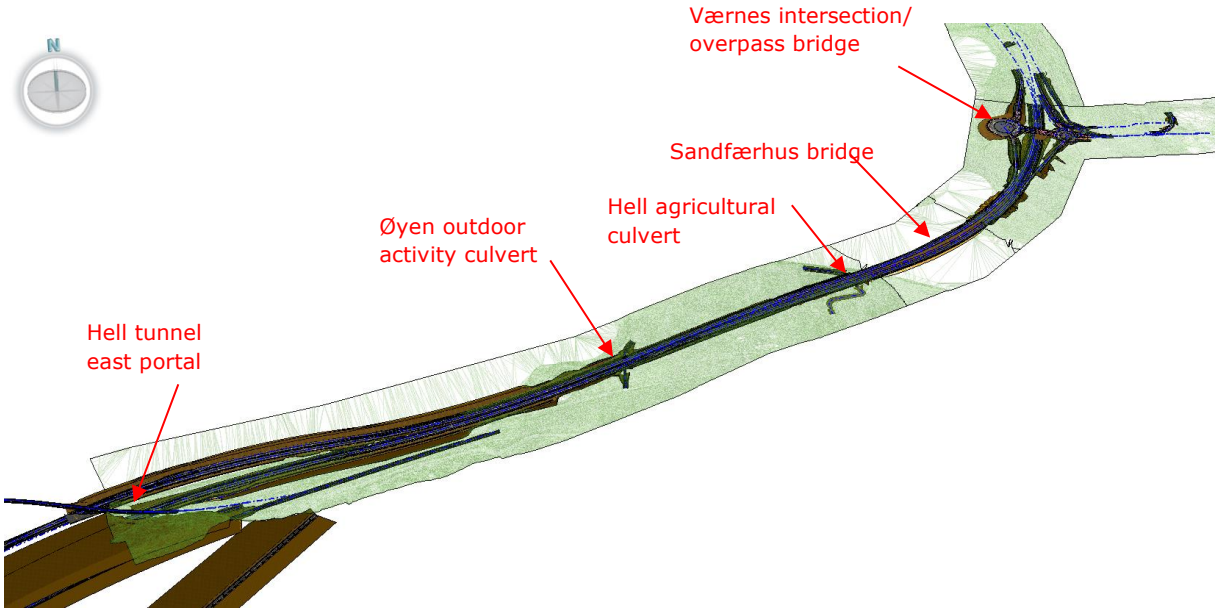


Figure 1: View of proposed scheme looking northwards

The new alignment in day zone 6 includes the following structures:

- A new tunnel between Hommelvik and Hell for the southbound traffic, that will be located north of the existing tunnel.
- Expansion of existing Øyen outdoor activity culvert
- Hell underpass, a new agricultural culvert next to Sandfærhus bridge
- New Sandfærhus bridge
- New crossing bridge at Værnes

The earthworks of day zone 6 also includes:

- Alignment 116100/116200 – E6-roadways until Øyen culvert
- Alignment 116300 – Emergency opening
- Alignment 116400/ 116500- Crossing field
- Alignment 119100/119200 – E6-roadways Øyen culvert – Værnes intersection
- Alignment 119300 – Crossing field
  Alignment 219000 – Bridge over E6
- Alignment 419100 – Northbound exit ramp at Værnes

- Alignment 419200 – Southbound exit ramp at Værnes
- Alignment 419300 – Northbound entry ramp at Værnes
- Alignment 419400 – Southbound entry ramp at Værnes
- Alignment 419500/419600- Roundabouts Værnes intersection
- Alignment 617000/617100 – Local road in connection with Hell underpass
- Alignment 717000 – Path under E6 to Hellstranda in connection with Øyen culvert
- Alignment 717100/717200 – Path Hellstranda
- Alignment 717300 – Turning area Hellstranda south
- Alignment 717400 – Turning area Hellstranda north
- Alignment 719100 – Path west of Værnes bridge
- Alignment 719200 – Path east of Værnes bridge
- Alignment 719300 – Path from Værnes airport to intersection and along E6 northwards.
- Alignment 919300 - Parking lot Hellstranda
- A new fill area to be used as a recreational area at Hellstranda.
- In connection with the new Værnes overpass bridge, the area needs to be preloaded to mitigate the risk of differential settlement of the structure

Temporary roads:

- Alignment 317100 – Temporary road widening of existing E6 (Hellstranda)
- Alignment 317200 – Temporary access road rig area northside (Hellstranda)
- Alignment 317300 – Temporary road widening of existing E6 (Værnes)
- Alignment 317400 – Temporary road widening of existing access E6 (Værnes)
- Alignment 317500 – Temporary access road rig area southside (Hellstranda)
- Alignment 517000 – Temporary diversion roundabout E6 (rig area Hellstranda)
- Alignment 519100 – Temporary diversion roundabout southside (North of Værnes crossing)
- Alignment 519300 – Temporary diversion gravel road (Hellstranda)
- Alignment 519500 – Temporary diversion pathway (Værnes)

1.2 Scope

The present report refers to the definition and design (100% detailed design) of the planned earthworks for day zone 6. Geotechnical measures needed in connection with the structures listen in chapter 1.1 will be described in separate reports and are not included in the present report.

2 BASIS FOR DESIGN

Multiconsult AS has been responsible for the geotechnical assessment of the zoning plan for the area, summarised in the geotechnical report E6RV-MUL-GT-RPT-CA#005-005 «Geoteknisk vurderingsrapport for reguleringsplan – Delstrekning Helltunnelen – Hellstranda», ref. /1/. The detailed design of the planned earthworks and retaining walls is based on the road alignment given in their report.

Rambøll has carried out supplementary ground investigations in the day zone in connection with the detailed design of the road. The results are summarised in report G-rep-E75-01, G-rep-E77-01, G-rep-E79-01, G-rep-E80-01, G-rep-E82-01, G-rep-X7-01 and G-rep-DZ6-01, ref. /2-8/. In addition to this, we have access to several other geotechnical reports from the area. A complete list is provided in section 2.5. Interpretation of available ground investigations and chosen characteristic values of geotechnical parameters is summarized and presented in the interpretative report for day zone 6, ref. /22/.

Novapoint-models presenting the geometry of the planned road, cuts and fills are used as a basis.

NN2000 is used as a height reference in calculations and drawings. Where basis documents have a different height reference, the heights are converted to NN2000 to be used in our drawings and calculations.

2.1 Standards and guidelines used for design

The design will be carried out in accordance with the following guidelines and standards:

- Statens Vegvesen (SVV), Håndbok V220 Geoteknikk i vegbygging, 2014 /10/
- Statens Vegvesen (SVV), Håndbok N200 vegbygging, 2014 /9/
- Statens Vegvesen (SVV), Håndbok V221 Grunnforsterkning, fyllinger og skråninger, rev. 2 juni 2014 /11/
- Norsk standard NS-EN 1990:2002+A1:2005+NA:2016 (Eurocode 0) /12/
- Norsk standard NS-EN 1997-1:2004+A1:2013+NA:2016 (Eurocode 7, del 1) /13/
- Norsk standard NS-EN 1997-2:2007+NA:2008 (Eurocode 7, del 2) /14/
- Norsk standard NS-EN 1998-1:2004+A1:2013+NA:2014 (Eurocode 8) /15/
- Norges vassdrags- og energidirektorat (NVE), NVEs retningslinjer nr. 2/2011 /16/, Flaum og skredfare i arealplanar, og tilhørende NVEs veileder nr. 7/2014 /17/
- Bane NOR, *Teknisk regelverk.* https://trv.banenor.no, 2018 /18/

2.2 Geotechnical assessment in accordance with NVEs guidance 7/2014

Quick clay has been registered at several boreholes in the area. For the zoning plan, Multiconsult has investigated and analysed the areas stability against larger landslides involving quick clay, in accordance with NVE's guide 7/2014 "Sikkerhet mot kvikkleireskred", ref. /17/. Based on the topography and the thickness of soil above the quick- and brittle clay there is considered to be no danger of landslides on Hellstranda, and therefore it is not established any danger zone in this area. The results from the evaluations and stability analysis are summarised in ref. /1/.

2.3 Geotechnical classification

2.3.1 Geotechnical category

Eurocode 7 sets design requirements based on three geotechnical categories. The choice of category is based on section 2.1 of the standard «Requirements for the design». The planned work is considered to fall under the category «conventional types of structures and foundations with no exceptional risk or difficult ground or loading conditions.». Therefore, the requirements for engineering are considered to be in accordance with geotechnical category 2.

2.3.2 Reliability class (CC/RC)

Eurocode 0 Table NA.A1 (901) provides indicative examples for the classification of structures, structures and structural parts. The table is divided into reliability classes (CC/RC) from 1 to 4.

The reliability class is evaluated in accordance with the classification regime according to SVV Håndbok V220, ref. /10/.

New E6 - Hell tunnel to Øyen culvert

Due to the registered ground conditions at Hellstranda with quick clay in depth the new E6 from Hell tunnel to Øyen culvert is considered to fall in the category "large consequences in the form of loss of humans life, or very large economic, social or environmental consequences". The design of the road is therefore placed in reliability class 3.

New E6 - Øyen culvert to Værnes crossing

North of Øyen culvert the new E6 is considered to fall in the category "medium consequences in the form of loss of human life, or considerable economic, social or environmental consequences". The design of the road is therefore placed in reliability class 2.

Hellstranda fill

The fill is considered to fall in the category "medium consequences in the form of loss of human life, or considerable economic, social or environmental consequences". The design of the fill is therefore placed in reliability class 2.

2.3.3 Design and execution control

Eurocode 0 sets requirements for the degree of design and execution control (control class) separately, depending on the reliability class.

New E6 - Hell tunnel to Øyen culvert

For geotechnical works for the new E6 from Hell tunnel to Øyen culvert, using Table NA.A1 (902) and NA.A1 (903) in Eurocode 0, design control and execution control of geotechnical works are set to control class PKK3/UKK3.

For design, control according to the standard applies to the execution of basic self-checking, internal systematic checking and extended 'third-party' control for both design and execution.

New E6 - Øyen culvert to Værnes crossing

For geotechnical works for the new E6 north of Øyen culvert, using Table NA.A1 (902) and NA.A1 (903) in Eurocode 0, design control and execution control of geotechnical works are set to control class PKK2/UKK2.

For design, control according to the standard applies to the execution of basic self-checking, internal systematic checking and extended 'third-party' control for both design and execution. Extended checking in PKK2 and UKK2 is limited to a check that self- and internal checks have been performed.

Hellstranda fill

For the fill at Hellstranda, using Table NA.A1 (902) and NA.A1 (903) in Eurocode 0, design control and execution control of geotechnical works are set to control class PKK2/UKK2.

For design, control according to the standard applies to the execution of basic self-checking, internal systematic checking and extended 'third-party' control for both design and execution. Extended checking in PKK2 and UKK2 is limited to a check that self- and internal checks have been performed.

2.3.4 Ground type and seismic class

In accordance with NS-EN 1998-1:2004 + A1: 2013 + NA: 2014 (Eurocode 8) Table NA.3.1, the soil conditions at Hellstranda are assessed to **soil type D**. Soil type D is a predefined soil type defined as deposits of loose to medium stiff cohesionless soil or mainly soft to stiff cohesive soil.

With the registered ground conditions seismic activity is not considered a relevant issue for the planned earthworks in day zone 6. The structures in the day zone must be considered separately.

2.4 Design approach and required factor of safety

The design and construction of geotechnical structures shall comply with Eurocode 7 part 1 and the corresponding Norwegian National annex, which specifies requirements for the verification of relevant limit states.

Ultimate limit state (ULS) design relates to the overall capacity and stability of geotechnical structures. Generally, the ULS design shall be carried out using design approach 3 in accordance with Eurocode 7 part 1 and the corresponding Norwegian National annex, the only exception being pile design which shall be carried out according to design approach 2. In design approach 3, partial factors are applied to loads and the material's strength parameters.

The required Factor of Safety (FoS) as described in Figure 0.3 in V220, ref. /10/, is dependent on the reliability class and the failure mechanisms of the soil. This is summarised in Table 1. The soil conditions are described in Section 3.

Table 1: Required Factor of Safety

Consequence class	Fracture mechanism		
	Dilatant failure	Neutral failure	Brittle failure
CC1	1.25/1.4*	1.3/1.4*	1.4
CC2	1.3/1.4*	1.4	1.5
CC3	1.4	1.5	1.6

*Where EN 1997-1:2004 + NA: 2008 requires that $\gamma_m \geq 1{,}4$ at overall stress analysis

The new E6 and associated structures are placed in CC3/CC2, while the planned fill at Hellstranda is placed in CC2. Ground conditions consists mainly of granular soils and clayey silt, but in some areas layers of quick clay have been registered in depth. Safety factor requirements will therefore depend on the location and depth of critical slip surface. Table 2 summarises the required factor of safety depending on ground conditions and structures affected by the critical slip surface.

Table 2: Required factor of safety E6 and Hellstranda fill

	Required factor of safety		
Soil type	**Critical slip surface affects road and/ or structure in CC2**	**Critical slip surface affects road and/ or structure in CC3**	**Critical slip surface does not affect road and/ or structure**
Quick/sensitive clay	1.5	1.6	1.5
Non-sensitive soils	1.4	1.5	1.4

2.5 Ground investigations and geotechnical reports

Table 3: Ground investigations and geotechnical reports

Report nr.	Company	Report name	Year
GK. 2287	NSB	Omformerstasjon oljeanlegg v/ Hell stasjon	1956
0.362.2-II	NGI	Grunnundersøkelser ved forlengelse av Værnes flyplass	1957
GK. 2464	NSB	Overgangsbru for riksveg 50 v/ Sandfærhus, Stjørdal	1958
Vd 667A	Statens Vegvesen	Brukskontrollstasjon Gjevingåsen	1981
7790.01	A/S Geoteam	Brukskontrollstasjon på Gjevingåsen	1982
30402.01	A/S Geoteam	Ell Sagbruk og høvleri A/S	1985
30402.01	A/S Geoteam	Ell Sagbruk og høvleri A/S	1985
o.7667-1	Kummeneje	Trondheim Lufthavn – Værnes. Terminalutvidelse – jernbanetunnel	1989
37470-1	Noteby	Trondheim Lufthavn Værnes, område syd	1989
V 295A-1	Statens Vegvesen	E6 Hell – Værnes, datarapport for trykksonderinger	1991
V 295B-1	Statens Vegvesen	E6 Hell – Værnes, Hellstranda pr 21350-22700r	1992

V 295B-2	Statens Vegvesen	E6 Hell – Værnes, Akjøring til Værnes	1992
V 295C-1	Statens Vegvesen	Stjørdalselva bru, grunnundersøkelser	1993
o.10278-1	Kummeneje	Ny Værnes holdeplass	1993
Vd 855A	Statens Vegvesen	E6 Gjevingåsen – Stjørdal SR. Grunnundersøkelser for alt. Traseer.	1994
o.10471-1	Kummeneje	Hovedplan Hommelvik – Hell, tunnelpåhugg / Hell	1994
GK. 4449-1	NSB	Meråkerbanen, Hommelvik – Hell, Gjevingåsen, Stjørdal	1994
12886-1	Scandiaconsult	Trondheim Lufthavn, Værnes, kulvert for ny E6 under taksebane vest	1999
6080603-1	Rambøll	Gevingåsen tunnel	2008
6080603-4	Rambøll	Gevingåsen tunnel	2008
6080603-3	Rambøll	Gevingåsen tunnel	2009
G-rap-001 6120001	Rambøll	Nordlandsbanen, strekningen Hell – Værnes, hastighetsøkning og kapasitet	2012
2220088-G-004	Reinertsen	E6 Ranheim – Værnes, delstrekning 2 og 3	2015
418799-001	Multiconsult	Avløpspumpestasjon Stjørdal	2017
1350038342 G-rep-DZ6-01	Rambøll	Hell tunnel - Værnes	2020
1350038342 G-rep-E75-01	Rambøll	New hell east portal + railway bridge	2020
1350038342 G-rep-E77-01	Rambøll	Øyen underpass	2020
1350038342 G-rep-E79-01	Rambøll	Hell underpass	2020
1350038342 G-rep-E80-01	Rambøll	Sandfærhus Viaduct	2020
1350038342 G-rep-E82-01	Rambøll	Værnes crossing bridge	2020
1350038342 G-rep-X07-01	Rambøll	Værnes wall	2020

3 TOPOGRAPHY AND GROUND CONDITIONS

3.1 Ground investigations

Several ground investigations have been carried out in the area in connection with the construction of the existing road and tunnel portal. A list of relevant reports is given in section 2.5. Supplementary ground investigation was carried out during January - May 2020, to provide sufficient information for the design of the road and structures. The investigation comprised of a number of total soundings, CPTUs, sampling and associated laboratory testing. The main objective was to obtain design parameters for the soil, and close existing gaps in the existing information. The results from the supplementary ground investigations are given in ref. /2-8/.

3.2 Ground conditions

3.2.1 Ch. 22 250 – ch. 23 120

Relevant information indicates that the soil consists mainly of layers of granular soils of sand and silt, with increasing silt and clay content with depth. Layers of quick clay has been registered at approximately 15 – 25 meters below ground surface close to the new Hell portal. Rock depth varies between 5 meters to 20 meters along the shoreline close to the new Hell portal, with increasing depth in a north-western direction, towards the fjord. Further north/north-east rock depth is unknown, but greater than 20 m.

Piezometer readings from the area shows that the ground water levels generally follow the sea levels in Stjørdalsfjorden and Stjørdal river.

A more detailed description of registered ground conditions, along with chosen characteristic geotechnical parameters area are summarised in ref. /22/.

3.2.2 Ch. 23 120 – ch. 24 660

Relevant information indicates that the soil consists mainly of layers of coarse and fine sand, with some silt and silty layers. The silt content seems to increase with depth. In some boreholes, layers of silty clay have been registered at depth. Rock depth is unknown, total soundings have been carried out to depths of 45- 50 meters below ground surface without registering the bedrock surface.

Oedometer tests and CPTUs indicate that soil generally is normally consolidated.

Piezometer readings from the area shows that the ground water levels generally follow the sea levels in Stjørdalsfjorden and Stjørdal river.

A more detailed description of registered ground conditions, along with chosen characteristic geotechnical parameters area are summarised in ref. /22/.

4 EARTHWORKS DESIGN

4.1 Road alignments

Table 4: Road alignments in day zone 6

Road alignments		
Alignment	Description	Comment
116100/116200	New E6, Hell tunnel to Hellstranda	Section 4.4.
119100/119200	New E6, Hellstranda to Værnes	Section 4.5
116300	Emergency opening	Section 4.6
116400/116500	Crossing field	Section 4.7
219000	Værnes bridge over E6 and road to Værnes airport	Section 4.8. Ref. report E6RV-DJV-GT-RPT-DZ06-0008 E82 Værnes crossing bridge, /26/.
419100/ 419200/ 419300/ 419400/ 419500/ 419600	Entry/exit ramps Værnes bridge	Section 4.9
617000/617100	Local road Hell underpass	Section 4.10. Ref. report E6RV-DJV-GT-RPT-DZ06-0006 Hell underpass, /24/.
717000	Local path Øyen underpass	Section 4.11. Ref. report E6RV-DJV-GT-RPT-DZ06-0005 Øyen underpass, /23/.
717100/717200	Path Hellstranda fill	Section 4.12
717300/717400	Turning area Hellstranda south/north	Section 4.4.
719100/719200	Path roundabouts Værnes bridge	Section 4.9
719300	Path Værnes	Section 4.13
317100	Temporary road, widening of existing E6	Section 4.14.1
317200/317500/517000	Temporary access road rig area Hellstranda (north/southside)	Section 4.14.2. Ref. report E6R-DJV-GT-RPT-NT03-0001_rev01 Hell tunnel rig area, /21/.
317300/317400	Temporary road, widening of existing E6/ access E6 (Værnes)	Section 4.14.2
519100	Temporary road, roundabout (North of Værnes crossing)	Section 4.14.4
519300	Temporary diversion gravel road (Hellstranda)	Section 4.14.5

519500	Temporary diversion pathway (Værnes)	Section 4.14.6

4.2 Methodology

This section of the geotechnical report provides the geotechnical design methodology as well as details of the interpretation of the ground conditions in day zone 6. The geotechnical design of each part of the planned earthwork elements is summarised in section 4.4.

4.2.1 Embankment and fill design

The general approach to embankment and fill design is as follows:

1. Undertake stability (ULS) and settlement (SLS) analyses for the ground models representing existing ground conditions and embankment cross-sections with the standard form and materials to assess whether the embankment is stable and whether ground improvement is required.
2. Undertake stability and settlement analyses to determine changes to the standard embankment form and/or materials, and/or the extent and required performance characteristics for ground improvement.

4.2.2 Cutting design

The general approach to cutting design is as follows:

1. Undertake stability (ULS) analyses for the ground models representing existing ground conditions and cutting cross-sections with the standard form and materials to assess whether the cut is stable and whether ground improvement is required.
2. Undertake stability analyses to determine changes to the standard cutting form and/or materials, and/or the extent and required performance characteristics for ground improvement

4.2.3 Selection of design ground profile

The detailed ground profiles for the planned earthworks has been reviewed. The design ground profiles are considered to be representative for the planned construction and earthworks. The detailed ground profile is presented in section 4.3.

4.2.4 Selection of values of characteristic geotechnical parameters

Location specific characteristic values of geotechnical parameters are evaluated local to the structure or earthworks section being considered, based on the available ground investigation information at the location. If we consider there is insufficient data to justify higher values, more conservative characteristic values based on empiric data from V220, ref. /10/, will be selected for design. Chosen characteristic geotechnical parameters are summarised in Table 5 - Table 6. The basis for the recommended geotechnical design parameters is described in the interpretative report for day zone 6, ref. /22/.

4.2.5 Design groundwater

Piezometer readings from the area shows that the ground water levels generally follow the sea levels in Stjørdalsfjorden. The highest and lowest observed water level at

Muruvikbukta shore is level +2.6 and level -2.0 respectively (NN2000). Recommended water level for design for 200-year floods including an increased water level due to climate change is level +2.8. The registered pore pressure is close to hydrostatic. It is assumed that there will be no build of excess pore pressures for the long-term situation.

4.2.6 Surcharge loads

The following variable surcharges will be incorporated into the calculations:

- Traffic load on the carriageway and hardshoulder for the permanent condition is based on N200, ref. /9/. Where unfavourable, an evenly distributed load of 10 kPa is used on the entire width of the road, including the hardshoulder. In accordance with N200 a partial factor of 1.3 is used for traffic loads. If the load is favourable, a partial factor of 0 is used.
- The Hellstranda fill is designed for an evenly distributed load of 13 kPa at ULS, which takes into account the load from snow plowing vehicles etc. Other high loads from cranes, fills etc. is not considered in this report and must be verified by the geotechnical engineer.

4.2.7 Stability

The stability of the proposed earthworks is assessed for long-term conditions using the calculation program GeoSuite Stability. An undrained analysis is carried out for the proposed land fill slopes to assess short term stability. Long term stability is verified using effective stress parameters, using the highest recorded groundwater level in the fill, and the lowest observed water level in the fjord. Circular slip surfaces are analysed.

Stability analyses have been carried out on the most critical slope locations for mass earthworks. The critical locations are selected following consideration of the following:

- Height of the existing earthwork.
- The proposed change to the existing earthwork.
- The location and thickness of weaker soils.
- The geometry of the ground above the cutting

4.2.8 Settlement of embankment and fill

Embankment and fill settlement will comprise of:

- Immediate settlement.
- Consolidation settlement from cohesive foundation soils.
- Long term secondary compression in organic alluvial deposits and/or peats.
- Self-weight settlement within the fill material.

The settlement of the proposed fill is analysed using hand calculations and/or the calculation program GeoSuite Settlement. The analysis is carried out for the long-term drained case, and the proportions of immediate and consolidation settlement calculated using the settlement coefficients given in section 4.3, appropriate to the soil type.

The predicted period for consolidation will be based on the design soil profile and design cv values based on location specific characteristic values. The direction of drainage will be selected based on the location specific ground profile end proposed embankment fill materials. Where the embankment does not contain a granular starter layer or granular fill the period for consolidation is determined using one-way drainage.

Self-weight settlement will be estimated using the method described in V221, ref. /11/.

4.3 Ground model and geotechnical parameters

The stratigraphy of the ground models adopted for design are presented in drawing 306-310. The characteristic values of geotechnical parameters adopted for design are summarised in Table 5 - Table 6. The basis for the recommended geotechnical design parameters is described in the interpretative report for day zone 6, ref. /22/.

Table 5: Characteristic values of geotehnical parameters adopted for design ch. 22 250 – ch. 23 120

Material	Unit weight [kN/m^3]	Friction angle φ [°]	Attraction [kPa]	Undrained shear strength, c_{uD} [kPa]	Permeability, k [m/year]	Oedometer modulus M [kPa]	Modulus number m [-]
Railway embankment	19	42.0	1.0	-	10^5	-	250
Sand, coarse	19	35.0	0.0	-	10^4	-	200
Sand, fine	19	34.0	0.0	-	10^3	-	150
Silt, clayey	20	31.7	5.0	c_u-profile*	10^{-1}	-	80
Clay	20	26.6	5.0	c_u-profile*	10^{-3}	-	14
Quick clay	20	26.6	5.0	c_u-profile*	10^{-3}	-	18
Moraine	20	38.0	19**	-	10^4	-	250

*Undrained shear strength from CPTU interpretation at locations R6006.
** In stability calculations, a=6.4kPa is used. Due to the depth of the moraine layer (>30 m below ground surface), this does not affect the results.

Table 6: Characteristic values of geotehnical parameters adopted for design ch. 23 120 – ch. 24 660

Material	Unit weight [kN/m^3]	Friction angle φ [°]	Attraction [kPa]	Undrained shear strength, c_{UD} [kPa]	Permeability, k [m/year]	Oedometer modulus M [MPa]	Modulus number m [-]
Fill material	19	33.0	0.0	-	10^4	-	200
Road embankment	19	42.0	1.0	-	10^5	-	250
Sand, coarse	19	36.0	0.0	-	10^4	-	200
Sand, fine	19	35.0	0.0	-	10^3	-	150
Sand, silty/silt, sandy	19	34.0	0.0	-	10^2	-	120
Silt, clayey	20	31.7	5.0	-	10^{-1}	-	80
Clay, silty/silt, clayey	20	26.6	5.0	-	10^{-3}	16	14

4.4 Alignment 116100/116200, ch. 22 250 – ch. 23 120 - New E6, Hell tunnel to Øyen underpass

4.4.1 Location and main features

The new road mainly follows the path of the existing highway in this area. The existing road is established on reclaimed land. The terrain at Hellstranda generally has a gradual slope towards northwest and Stjørdalsfjorden. The southbound lane is mainly planned established on embankments, while the northbound lane switches between shallow cuts and low embankments. For the last part of the stretch both southbound and northbound lane is placed in shallow cuts, before the road crosses Øyen underpass, where alignment 717000 crosses the road. Embankments and cuttings are generally designed with a slope of 1V:2H. The detailed design of Øyen culvert is described in ref. /23/.

Excavated tunnel masses and masses from cuts that cannot be reused in the project will be deposited in nearby fills. Acciona Construction has planned one such fill at Hellstranda, along the shoreline. The reclaimed land will be used as a recreational area. The planned geometry of the fill is shown in Figure 2, including a typical cross section through the existing and new road, flood embankment and fill. See appendix 1 for the complete drawing. The fill is planned as a quality fill with a maximum slope of 1V:3H and erosion control at exposed areas. Part of the fill will be used as a substructure for the southbound lane of the new highway.

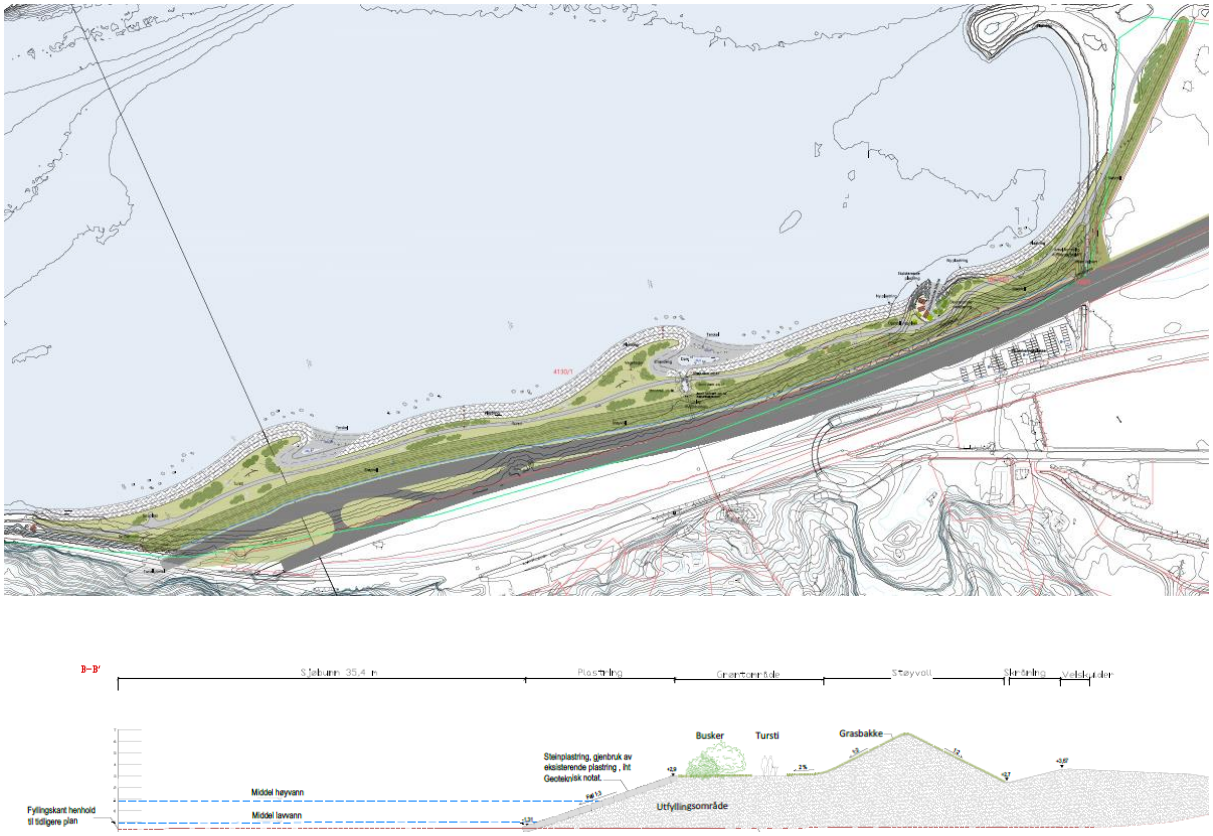


Figure 2: Geometry of planned fill (cutting from landskapsplan og snitt, appendix 1).

Along the north and south side of the road, two noise- and flood embankments will be established, with top embankment at level +6 to +8 approximately. The embankments are designed with a slope of 1V:2H. The embankment north of the new road is designed with a fill height of approximately 3 – 4 m above the top of the new Hellstranda fill, and approximately 7 meters above the existing terrain. The embankment south of the new road is designed with a fill height of approximately 1 – 5 m above existing terrain. As part of the detailed design, the stability and expected settlement of the planned fill and embankments are analysed, to assess whether they are stable and whether ground improvement is required.

Part of the Hellstranda fill will also be used as a rig area during the construction phase for the new Hell tunnel east portal. The rig area will be established some time before the remainder of the fill. We refer to ref. /21/ for geotechnical evaluations and design of the rig area including the temporary access road, alignment 317200 and 517000. To ensure the stability of the Muruvika railway, a counter fill must be established along parts of the foot of the railway embankment, southwest of the rig area. Geotechnical evaluations and design of the counter fill is presented in ref. /27/. The geometry of the planned rig area and counter fill is presented in drawing 301.

From approximately ch. 22 850 to ch. 22 940 the new E6 passes Øyvegen bridge and its approach fill, which crosses the railway south of the existing E6. The widening of the existing E6 means that part of the foot of the fill will be excavated during the construction of the new road. The northern abutment of Øyvegen bridge is founded on piles (ref. /28/), and the planned excavation will not affect the structure. The approach fill of the bridge is however supported by two dry walls on either side of the fill. The

northern wall is 1-4 meters tall. The stability of the wall and approach fill during excavation is analysed.

4.4.2 Stability analysis results

4.4.2.1 Fill and embankment Hellstranda

The fill at Hellstranda is designed at level +4 to level +3, approximately 4 meters above the existing terrain surface. The fill is approximately 30 – 60 m wide and designed with a maximum slope of 1V:3H and erosion protection at exposed areas. The southern part of the fill will be used as a substructure for the new E6. Along the north and south side of the road, two embankments will be established, with top embankment at level +6 to +8 approximately. The embankments are designed with a slope of 1V:2H. Slope stability assessment has been carried out using GeoSuite Stability, as described in section 4.2.7, to assess the stability of the proposed earthworks at Hellstranda.

The stability analysis is carried out in one profile, in ch. 22 700, that is considered to be representative for the planned construction and earthworks at Hellstranda. The location of the profile is presented in drawing 301. The results of the stability analysis carried out are summarised in Table 7. As ground investigation has indicated layers of sand to great depth, only drained analysis is performed.

Table 7: Factor of safety critical slip surface

Chainage	Description	Factor of safety critical slip surface	
		Undrained analysis (short term)	Drained analysis (long term)
Ch. 22 700	Fill stability	Not relevant*	2.8
Ch. 22 700	Noise embankment stability	Not relevant*	2.7

*ref. chapter 4.2.7

The results predicted a critical slip circle with a factor of safety that is equal to or above the minimum acceptable design values stipulated in section 1.4. The calculations are presented in drawing 306.

4.4.2.2 Retaining wall ch. 22 860 to ch. 22 905

From approximately ch. 22 850 to ch. 22 940 the new E6 passes Øyvegen bridge and its approach fill, which crosses the railway south of the existing E6. The widening of the existing E6 means that part of the foot of the fill will be excavated during the construction of the new road. The northern abutment of Øyvegen bridge is founded on piles (ref. /28/), and the planned excavation will not affect the structure. The approach fill of the bridge is however supported by two dry walls on either side of the fill. The northern wall is 1-4 meters tall and can be affected by the planned excavation. The geometry of the embankment and dry wall is presented in Figure 3. The stability of the wall and approach fill during excavation is analysed.

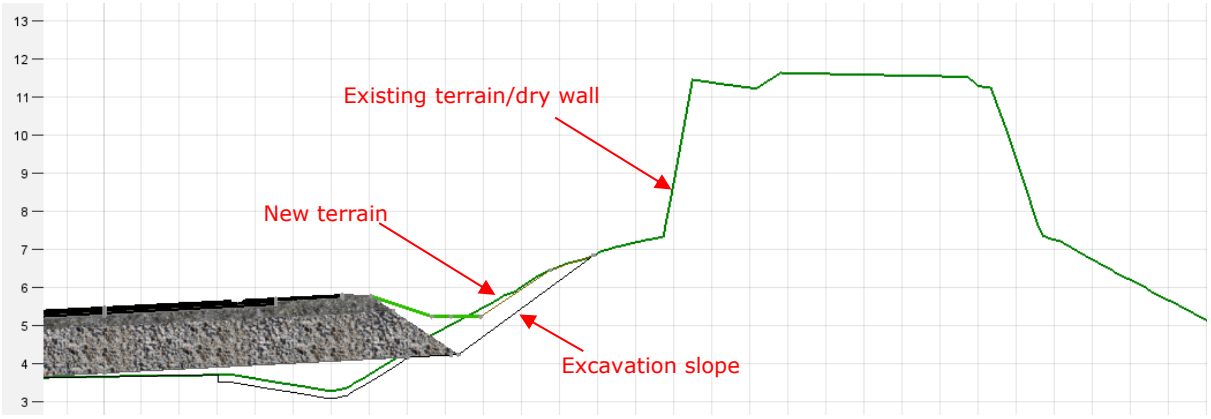


Figure 3: ch. 22 860 (cutting from Novapoint)

According to the design documents for the dry wall, ref. /29/, the wall was designed with the bottom stone level with existing terrain, 2 meters wide at the bottom and 1 meter wide at the top. As ref. /10/ requires a minimum overburden of 0.5 m for dry walls, we consider this to be a conservative assumption. The slope at the foot of the wall is approximately 1V:2H. It is assumed that the embankment is made up of good quality rock from the construction of the Hell tunnel. Øyvegen road is placed in CC2 while the ground conditions mainly consist of blasted rock and coarse sand, which requires a minimum partial factor of 1.3 for the stability analysis.

The stability analysis is carried out in two profiles, ch. 22 860 and ch. 22 870, where the retaining height of the wall is at its highest. The results of the stability analysis carried out are summarised in Table 8. As ground investigation has indicated layers of sand to great depth, only drained analysis is performed.

Table 8: Factor of safety critical slip surface

Chainage	Description	Factor of safety critical slip surface		Required FoS
		Undrained analysis (short term)	Drained analysis (long term)	
Ch. 22 860	Existing situation	Not relevant*	1.56	1.3
Ch. 22 860	Excavation phase	Not relevant*	1.29	1.3
Ch. 22 870	Existing situation	Not relevant*	1.44	1.3
Ch. 22 870	Excavation phase	Not relevant*	1.31	1.3

*ref. chapter 4.2.7

The results predicted a critical slip circle with a factor of safety that is less than the minimum acceptable design values during excavation for the southern part of the fill. The stability quickly improves towards the north, as the fill height is reduced. Given an excavation done section by section, with a maximum section width of 10 meters, the stability analysis gives a FoS=1.42, which is larger than the minimum acceptable design values. The calculations are presented in drawing 307-308.

Bearing capacity analysis for the wall gives a factor of safety F≥1.3 for the existing situation where the retaining height of the wall is at its maximum. The planned excavation will reduce the bearing capacity of the wall. The average slope between the foot of the wall and the excavation is approximately 1:1.4 - 1:1.7 where the retaining height of the wall is at its highest, and the distance between excavation and wall is at its smallest. Bearing capacity analysis for the wall with a slope of 1:1.4 gives a factor of safety of approximately 1.3, which is above the required level of safety for the structure.

The retaining height of the wall is quickly reduced in the northern direction, from approximately 4 meters at ch. 22 860 to approximately 2.4 meters at ch. 22 880. The distance between the excavation and the foot of the wall also increases towards the north. North of ch. 22 880 the distance between the foot of the wall and the excavation is equal or larger than 2.4 meters, and the excavation is considered to have a limited effect on the bearing capacity of the wall. As a result of this, we consider the first 20 meters of the excavation along the wall to be critical.

The excavation must be done section by section, with a slope of 1V:1H and with a maximum section width of 3 meters for the critical stretch between ch. 22 860 to ch. 22 880. From ch. 22 880 and northward to the end of the dry wall, the sections can have a maximum width of 10 meters. We also recommend that the northern lane of the entry ramp for the Øyvegen bridge is closed for traffic during the excavation of the critical stretch.

4.4.3 **Settlement analysis results**

The settlement of the fill, embankment and new E6 has been determined following the procedures set down in section 4.2.8. Settlement analysis is carried out using the design profile at ch. 22 700. The proposed height of the fill and expected settlement at these critical locations is summarized in Table 9.

Table 9: Predicted settlement

Profile	Fill height above existing terrain	Predicted settlement in soil below fill	Self- weight settlement
New E6	1 – 4 m	5 – 15 cm	1 – 2 cm
Noise embankment	7 m	15 – 20 cm	7 cm
Fill	4 m	10 – 15 cm	4 cm

The calculations give a best estimate of expected settlement in the order of 10-20 cm for both fill and embankment, not including the self-weight settlement of the fill. The design ground profile consists mainly of granular soils of blasted rock, gravel and sand, and the bulk of the settlement is expected to comprise of immediate settlement that will occur during loading of the embankment.

Self-weight settlement within the fill material must also be expected. A filling laid out from a tip and compressed as described in V221, ref. /11/, will have self-weight settlement in the order of 1% of the total fill height. The main part of the settlement is expected to take about 6 months but can be accelerated by heavy rainfall or heavy watering/flushing during filling.

Part of the fill will be part of the new highway embankment, and it is therefore sensitive to settlement. As the fill will be established some time before the construction of the new road and the ground mainly consists of granular soils, overfilling or other special ground improvements are not considered necessary prior to the construction of the road. The rig area will be established before the rest of the fill, and ground movement during and after filling will be monitored, as describe in ref. /21/. Results from this monitoring can be used to confirm or reassess expected settlement for the remainder of the fill, especially for the part that will be used as a substructure for the new E6.

Settlement of new road

Between ch. 22 300 to ch. 23 000 parts or the entire cross section of the new road will be established on top of an embankment with a fill height varying between 1 to 4 meters above the existing terrain. The road embankment will be established as part of the Hellstranda fill. As the thickness of the embankment varies from 0 to 4 meters, differential settlement across the road must be expected, with little or no settlement on the parts of the road that is established at or below the existing terrain level, and settlement in the order of 10 – 15 cm for the areas with a fill height of 3 – 4 meters, not including self-weight settlement of the embankment. The 7-meter-high noise embankment that runs parallel to the road will also affect the settlement of the road. We recommend that the fill and road embankment is established at least 3 months before the construction of the road, to make sure that most of the settlement in the embankment has occurred before the road is completed.

The road embankment must be built up and compacted in accordance with figure 2-0-14 in V221, ref. /11/, presented in Figure 4. If the fill is built up in layers with a thickness of up to 2 meters and compacted for each layer, the expected self-weight settlement is in the order of 0.5 % of the fill height. The main part of the settlement is expected to be completed by 6 months after the fill is established. The settlement can be further reduced by reducing the thickness of each layer and increase the compaction work.

Underbygnings-materiale	Konsistens	Komprimeringsutstyr	Statisk linjelast [kN/m]	Masse [tonn]	Lagtykkelse etter komprimering [mm]	Antall passeringer
Sprengt stein	-	Vibrerende vals	> 45 > 30		Utlagt på endetipp 500–2000	10 5
Grus, sand, selvdrenerende	Bløt	Vibrerende vals	> 30		200–600	4–6
	Tørr	Vibrerende vals	> 30		200–300	6–8
Finsand, silt	Bløt	Beltemaskin		10–20	200	2–4
	Tørr	Vibrerende vals Dumper/-hjullaster	> 30	 25–70	 200	4–6 2–4
Leire, siltig leire	Bløt	Beltemaskin (lavt marktrykk)		10–20	200	2–4
	Tørr	Dumper/-hjullaster		40	200	2–4

Figure 4: Compaction of road embankment (Cutting from V221, ref. /11/)

Settlement of existing road

The new road alignment is designed parallel to, but at varying distance to the existing road at Hellstranda, with approximately 5 – 30 meters between the two (min. with of the median is 2 meters). The planned fill at Hellstranda will most likely cause some settlement on parts of the existing road that are located close to the new fill. Settlement calculations indicate an expected settlement in the order of 3 - 4 cm on the outer northern part of the existing road. The settlement is expected to occur simultaneously with the construction of the fill. According to chapter 205.2 in N200, ref. /9/, differential settlement of any cross section of the road cannot exceed 1%. The existing road is planned to be in operation during the construction process, and we recommend regular inspection of the road to monitor any ground movement caused by the filling, and assess the need for any correcting measures if differential settlement exceeds the requirements given in in ref. /9/ .

4.4.4 Erosion protection

When establishing a fill in the ocean, wave erosion can cause soil slips in the fill. It is therefore important to establish an erosion protection in exposed areas. When designing the erosion protection emphasis should be placed on local experiences regarding necessary measures. Significant wave height H_s is used as a basis for dimensioning. For significant wave heights above 1.5 m it is recommended to use stones of equal size D_{n50} for the rock cover, ref. V221 /11/.

At Hellstranda H_s is calculated to 1.9 m, following the procedure set down in ref. /11/. Necessary stone size for the rock cover is D_{n50}=0.8 m. The rock cover must be raised to the level of the top fill and must have a maximum slope of 1V:2H. It is recommended to establish protection against flushing at the top of the fill where the rock cover ends. The principle of the design of the rock cover is presented in Figure 5.

A filtering layer should be established between the rock cover and the fill. This may consist of graded fine blasted rock. The principle of the filter layer is that the average opening between stones in the filter layer should be so small that stones and other smaller fragments from the underlying masses cannot pass through the openings.

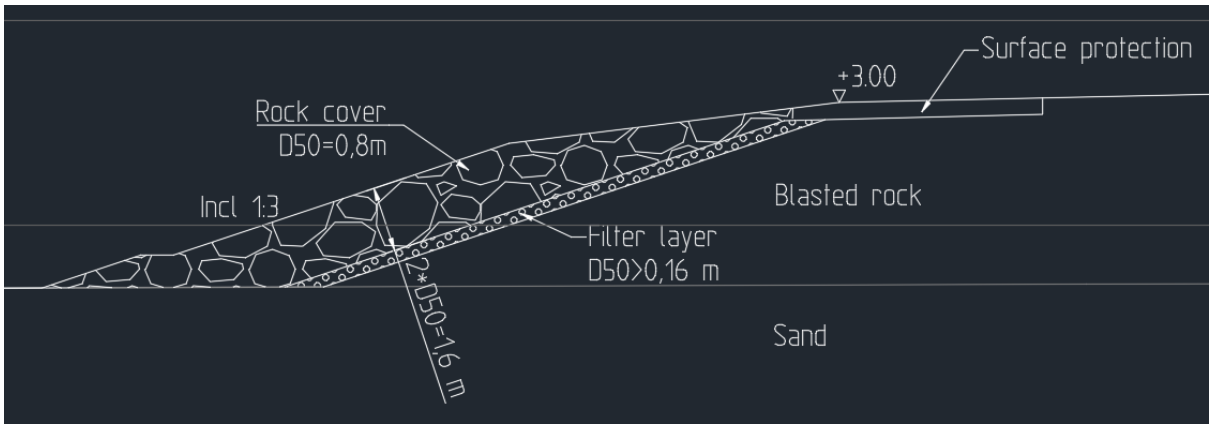


Figure 5: Principle design of rock cover at Hellstranda

4.5 Alignment 119100/119200, ch. 23 120 – ch. 24 660 - New E6, Øyen underpass to Værnes

4.5.1 Location and main features

The new road mainly follows the path of the existing highway in this area. The existing road is established on reclaimed land. The terrain at Hellstranda generally has a gradual slope towards the north/northwest and Stjørdalsfjorden. At the north side of Stjørdalselva river the terrain is generally flat. Approximately between ch. 23 120 to ch. 23 420 the northbound roadway (heading for the existing Sandfærhus bridge) will be established at the same elevation as existing road. The new southbound roadway will climb slightly higher to gain sufficient elevation to establish the new Sandfærhus bridge at required heights. Further on, the southbound lane is planned established on an embankment of approximately 1 – 3 meters height up to Sandfærhus Viaduct at ch. 23 600. From approx. ch. 23 120 to ch. 23 220 a new noise embankment will be established 30 to 180 meters northwest of the new road, with top embankment at level +7, approx. 3-4 meters above the existing terrain. The embankment is designed with a slope of 1V:2H. The stability of the planned embankment is analysed.

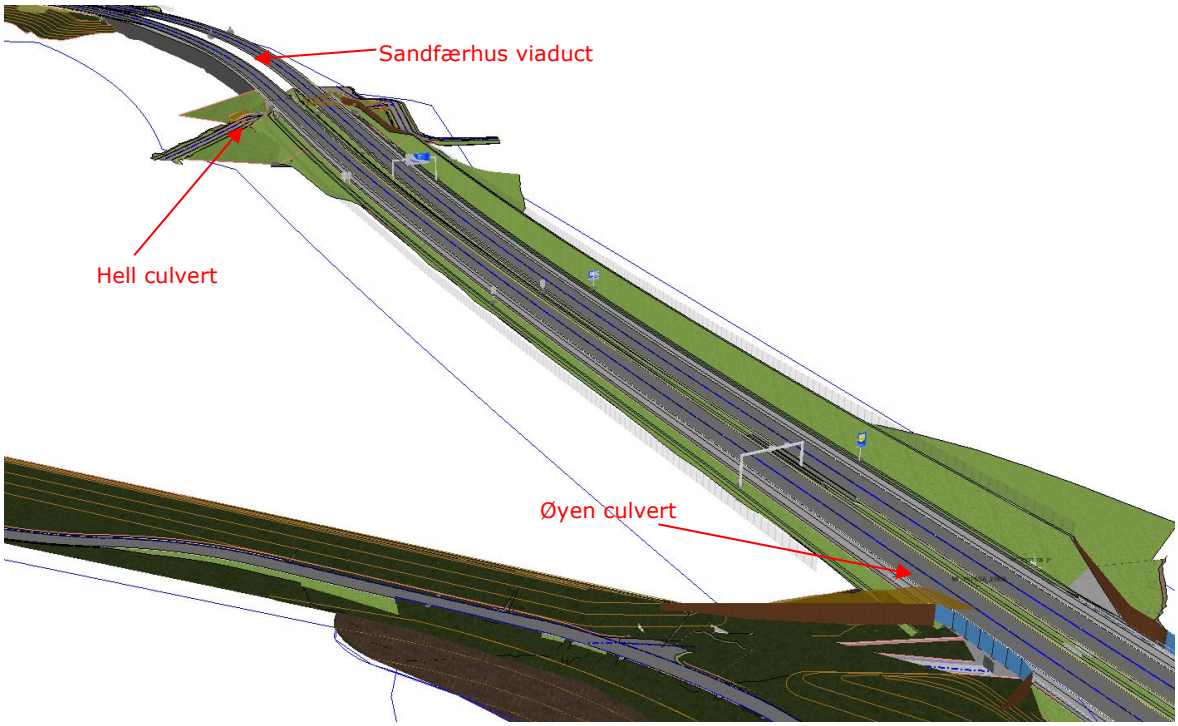


Figure 6: Øyen culvert to Sandfærhus Viaduct (Approx. ch. 23 100 – ch. 23 900)

From ch. 23 600 to 23 900 the road is placed on a viaduct across Stjørdalselva river. The detailed design of Sandfærhus Viaduct, including geotechnical measures needed for establishing the foundations, abutments and approach fills, are described in ref. /25/.

North of Sandfærhus Viaduct, from approximately ch. 23 900, the northbound lane is generally established on the same level as the existing terrain. The southbound lane is mainly planned established on embankments of approximately 1 – 4 meters height up to approximately ch. 23 940. Between ch. 24 100 to ch. 24 400 the alignment crosses below the Værnes Crossing bridge, with associated on- and off ramps and roundabouts. Both north- and southbound lane are here designed in cuts with heights of up to 7 meters. Further north the road is designed at approximately the same level as existing terrain.

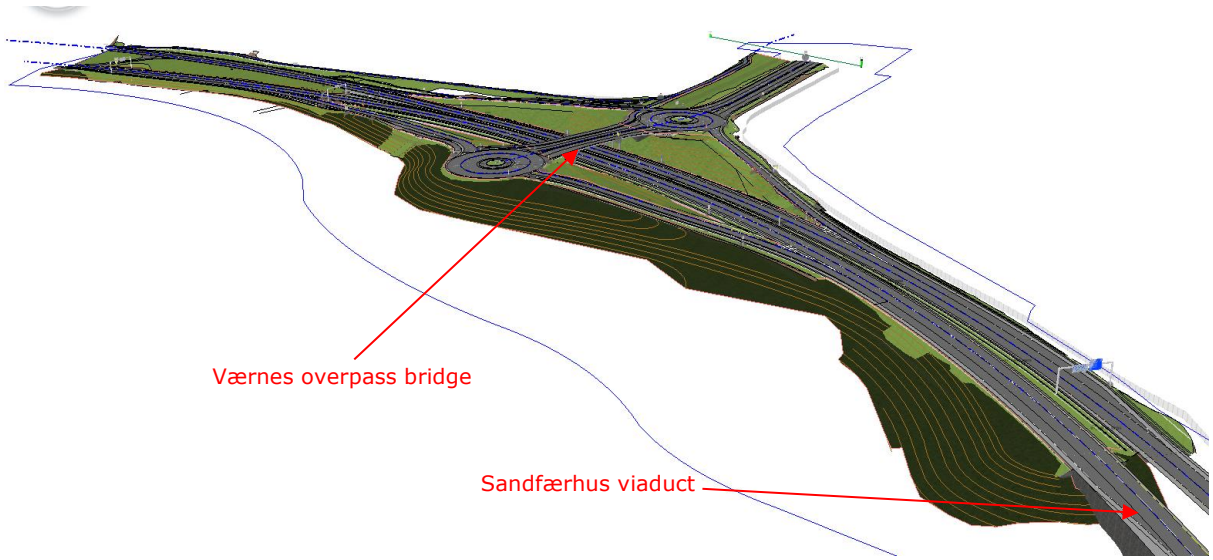


Figure 7: Sandfærhus viaduct to Værnes (Approx. ch. 23 860 – ch. 24 660)

North of the Værnes bridge, from approximately ch. 24 400 to ch. 24 620 a flood protection embankment will be established parallel with the new road. The embankment will have a height of approximately 2-4 m above existing terrain, with top embankment designed at level +3.5 to level +4.5, and a slope of 1V:2H. The flood embankment will also work as a guardrail along the exit-lane.

Embankments and cuttings are generally designed with a slope of 1V:2H.

As part of the detailed design, the stability of the planned embankments is analysed, to assess whether they are stable and whether ground improvement is required.

4.5.2 Stability analysis results

The placement of the new road means that the existing road embankment at Værnes must be expanded. The new fill is designed at level +6 to +5, approximately 1 - 4 meters above existing terrain. The fill is designed with a maximum slope of 1V:2H. At Hellstranda, from approx. ch. 23 150 to ch. 23 220, a new noise embankment will be established 30 to 180 meters northwest of the new road. The embankment is designed at approx. 3-4 meters above the existing terrain. Slope stability assessment has been carried out using GeoSuite Stability, as described in section 4.2.7, to assess the stability of the proposed earthworks.

The stability analysis is carried out in one profile, ch. 23 960, that is considered to be representative for the planned construction and earthworks along the main alignment at Værnes. In addition to this, the stability of the noise embankment at Hellstranda is analysed. The location of the profiles are presented in drawings 302 and 304. The results of the stability analysis carried out are summarised in Table 10. As ground investigation has indicated layers of sand to great depth, only drained analysis is performed.

Table 10: Factor of safety critical slip surface

Chainage	Description	Factor of safety critical slip surface	
		Undrained analysis (short term)	Drained analysis (long term)
Ch. 23 960	Embankment stability	Not relevant*	1.50
Noise embankment	Embankment stability	Not relevant*	2.83

*ref. chapter 4.2.7

The results predicted a critical slip circle with a factor of safety that is equal to or above the minimum acceptable design values stipulated in section 1.4. The calculations are presented in drawing 309 and 311.

4.5.3 Settlement

The expected settlement of the road embankment has been determined following the procedures set down in section 4.2.8. Settlement analysis is carried out using the design profile at ch. 23 960. The proposed height of the fill and expected settlement along the new road is summarized in Table 11.

Table 11: Predicted settlement

Profile	Fill height above existing terrain	Predicted settlement in soil below fill	Self- weight settlement
Road embankment	1 – 4 m	5 – 10 cm	1-4 cm

The calculations give a best estimate of expected settlement in the order of 5-10 cm for the road embankment. This is not including the self-weight settlement of the fill. The design ground profile consists mainly of granular soils of blasted rock, gravel and sand, and the bulk of the settlement is expected to comprise of immediate settlement that will occur during loading of the embankment.

Self-weight settlement within the fill material must also be expected. A filling laid out from a tip and compressed as described in ref. /11/ will have self-weight settlement in the order of 1% of the total fill height. The main part of the settlement is expected to take about 6 months but can be accelerated by heavy rainfall or heavy watering/flushing during filling.

Where the road is to be established on embankments of more than 4 meters height, we recommend that the embankment is established at least 3 months before the completion of the road, to make sure the primary settlement due to the fill is complete.

4.5.4 Flood protection embankment

North of the Værnes bridge, from approximately ch. 24 400 to ch. 24 620 a flood protection embankment will be established parallel with the new road, to avoid flooding of the road during periods with high tide. The embankment will have a height of approximately 2-4 m above existing terrain, with top embankment designed at level +3.5 to level +4.5, and a slope of 1V:2H.

We recommend reusing material from the existing flood protection embankment on the stretch when establishing the new embankment. We also recommend establishing the new flood protection embankment before the excavation for the new road begins, to minimize problems with water in the pit.

This part of the road is not exposed to waves from the fjord, and erosion protection is therefore not considered necessary.

4.6 Alignment 116300 – Emergency opening

Alignment 116300 is an emergency opening between the southbound and northbound lane. The road is placed partly level with existing terrain, and partly on embankments of up to 3 meters height. The embankment is part of the Hellstranda fill, and the design of the embankment, including stability and settlement analysis, is described in chapter 4.4.

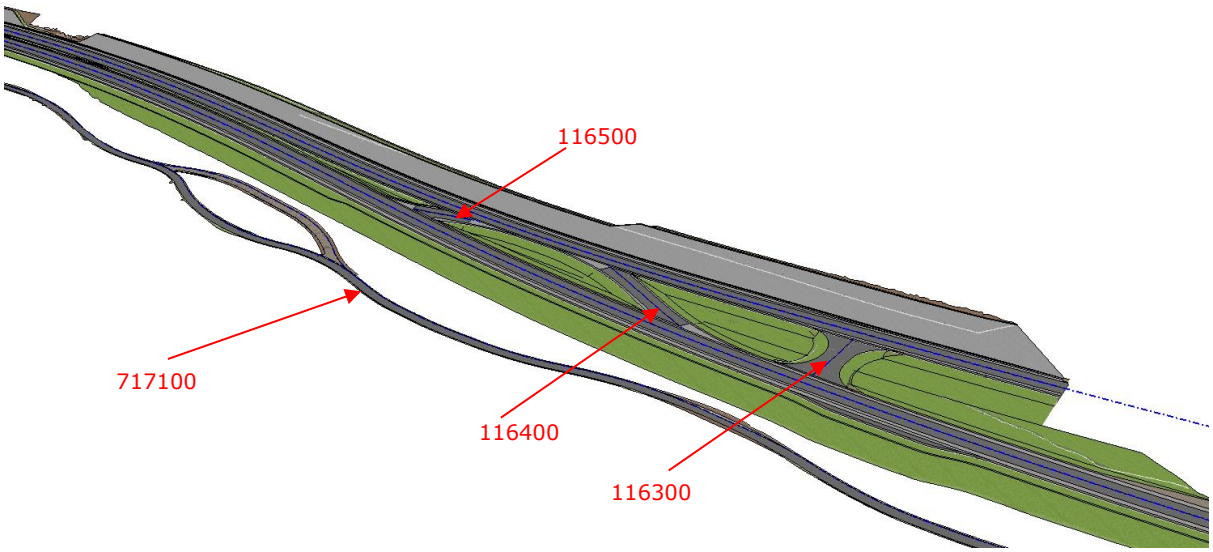


Figure 8: Hellstranda (Approx. ch. 22 300 - ch. 22 900)

4.6.1 Stability

The road embankment is part of the Hellstranda fill, and the stability of the embankment is analysed in chapter 4.4.2.

4.6.2 Settlement

The road embankment is part of the Hellstranda fill, and the expected settlement is analysed in chapter 4.4.3.

4.7 Alignment 116400/116500 - Crossing field

4.7.1 Location and main features

Alignment 116400/116500 are two crossing fields between the northbound and southbound E6. The road is placed partly level with existing terrain, and partly on embankments of up to 3 meters height. The embankment is part of the Hellstranda fill, and the design of the embankment, including stability and settlement analysis, is described in chapter 4.4.

4.8 Alignment 219000 - Værnes overpass bridge

4.8.1 Location and main features

Alignment 219000 is the new Værnes bridge over E6, located at approximately ch. 23 050 (main alignment). The detailed design of the bridge and connected roads, including geotechnical measures needed for establishing the foundations, are described in ref. /26/.

4.9 Alignment 419100 to 419600, 719100 and 719200 – On/off ramps at Værnes crossing

4.9.1 Location and main features

At approximately ch. 24 235 on the main alignment the new Værnes overpass bridge is located. Alignment 419100 – 419400 are the entry-and exit ramps of the bridge.

Alignment 419500 and 419600 are the roundabouts on the east- and west side of the overpass. Alignment 719100 and 719200 are the path lanes on the roundabouts.

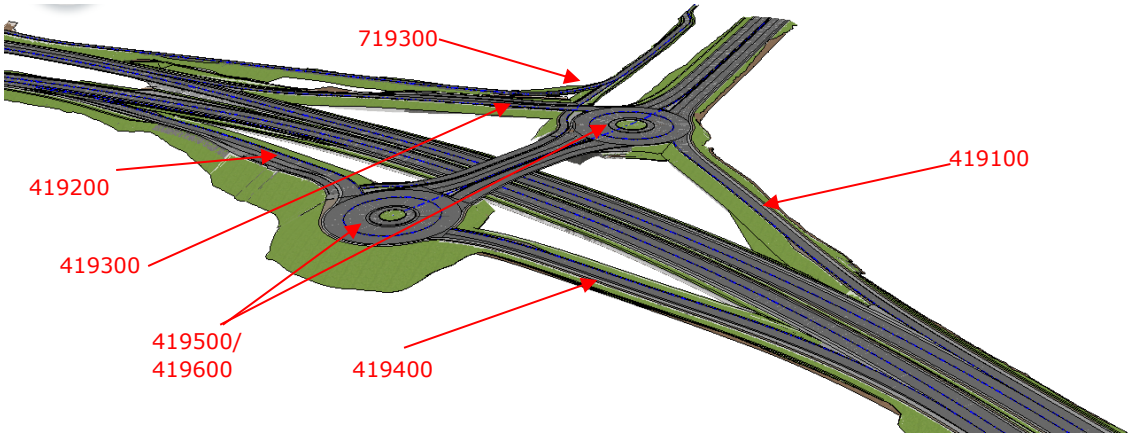


Figure 9: Værnes overpass bridge with on/off ramps

The entry-/exit ramps and roundabouts for the overpass will be established on embankments that will have a height of up to 9 meters above the existing terrain. The embankments will cause settlement on the surrounding soil, and preloading of the area is necessary to avoid large settlement on the structure. The embankments are designed with a slope of 1V:2H. The detailed design of the bridge is described in ref. /26/.

4.9.2 Stability analysis results

As part of the detailed design, the stability of the planned embankments is analysed, to assess whether they are stable and whether ground improvement is required.

Slope stability assessment has been carried out using GeoSuite Stability, as described in section 4.2.7. The stability analysis is carried out in one profile, ch. 24 235, where the embankment is at its highest. The location of the profile is presented in drawing 310. The results of the stability analysis carried out are summarised in Table 12. As ground investigation has indicated layers of sand to great depth, only drained analysis is performed.

Table 12: Factor of safety critical slip surface

Chainage	Description	Factor of safety critical slip surface	
		Undrained analysis (short term)	Drained analysis (long term)
Ch. 24 235	Slope of 1V:2H	Not relevant*	1,60

*ref. chapter 4.2.7

The results predicted a critical slip circle with a factor of safety that is equal to or above the minimum acceptable design values stipulated in section 1.4. The calculations are presented in drawing 310.

4.9.3 Settlement analysis

The expected settlement of the road embankment has been determined following the procedures set down in section 4.2.8. Settlement analysis is carried out using the design profile at ch. 24 235. The proposed height of the fill and expected settlement at these critical locations is summarized in Table 13.

Table 13: Predicted settlement

Profile	Fill height above existing terrain	Predicted settlement in soil below fill	Self- weight settlement
Road embankment	1 – 9 m	20 – 25 cm	1 – 9 cm

The calculations give a best estimate of expected settlement in the order of 20-25 cm for the road embankment at its highest point. This is not including the self-weight settlement of the fill. The design ground profile consists mainly of granular soils of blasted rock, gravel and sand, and the bulk of the settlement is expected to comprise of immediate settlement that will occur during loading of the embankment. For fill heights larger than 4 meters we recommend that the fill is established early in the construction process, as the primary settlement is expected to take approximately 2-4 months for larger loads. The roundabout on the west side of the new highway is designed on a fill of 8-9 meters height, and the depth effect of the weight of the fill is therefore greater and will cause larger settlement over a longer time period compared to smaller fills. We therefore recommend establishing the embankment at least 6 months prior to the construction of the road. This is to avoid any delays in the construction process due to expected settlement taking longer than estimated.

The settlement must be monitored. We recommend settlement plates in 2 locations, beneath both roundabouts. Suggested monitoring is described in section 6.

Self-weight settlement within the fill material must also be expected. A filling laid out from a tip and compressed as described in ref. /11/ will have self-weight settlement in the order of 1% of the total fill height. The main part of the settlement is expected to take about 6 months but can be accelerated by heavy rainfall or heavy watering/flushing during filling.

4.9.4 **Preloading**

The new Værnes crossing bridge will be founded directly on the existing ground and road embankment, and therefore affected by the expected settlement due to the approach fills and embankments. To avoid differential settlement of the bridge foundations, we recommend preloading of the area.

During the construction of the existing Værnes bridge, the area was preloaded and the settlement was monitored in 4 points. After about 14 months, the observed settlement was approximately 8 – 14 cm. The primary settlement took roughly 2 months. The new Værnes crossing bridges is located approximately 30 meters north of the existing bridge, and ground conditions are similar. As the building of the new bridge will include two large embankments for the new roundabouts, the depth effect of the weight of the fill is therefore greater and will cause larger settlement over a longer time period compared to the existing bridge.

At present, the detailed design of the bridge has not started. The slope of the roundabout embankment will be adjusted to fit the location of the bridge foundations when they are known. The preloading fill must be designed to match the actual loads on the bridge foundations. Design of the preloading can be done when the 30% design of the structure is approved. The temporary traffic diversion must be adapted to the preloading.

4.10 Alignment 617100

4.10.1 Location and main features

At approximately ch. 23 580 the new Hell underpass will be established. The culvert will also be part of the abutment of the new Sandfærhus viaduct, which is located between ch. 23 600 to approximately ch. 23 900, parallel with the existing bridge. Road alignment 617100 passes through the culvert. On both side of the culvert the road will be established in soil cuts with a maximum slope of 1V:2H and maximum height of approximately 3-4 meters. The detailed design of the culvert is described in ref. /24/. The detailed design of the viaduct is described in ref. /25/.

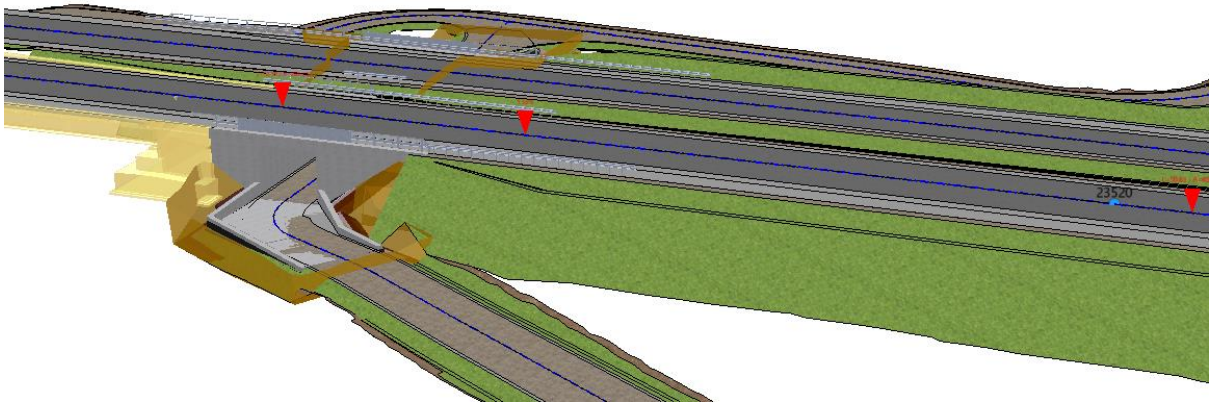


Figure 10: Hell underpass

4.10.2 Stability

No stability calculations have been performed

4.10.3 Settlement

The alignment is located at or below existing terrain level in the area, and the expected settlement is therefore negligible.

4.11 Alignment 717000

4.11.1 Location and main features

At approximately ch. 23 115, Øyen culvert is located. The existing culvert will be extended to pass beneath the southbound lane of the new E6. Road alignment 717000 passes through the culvert. On both side of the culvert the path will be established in soil cuts with a maximum slope of 1V:1,5H and maximum height of 5 meters. The detailed design of the culvert is described in ref. /23/.

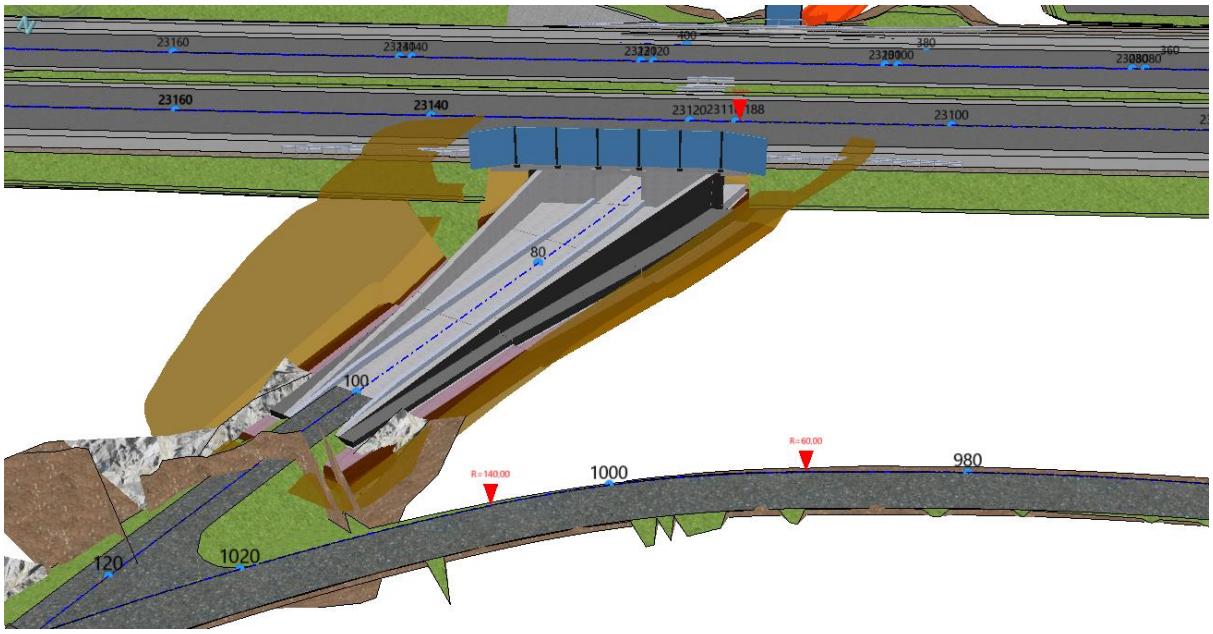


Figure 11: Øyen culvert

4.11.2 **Stability**

No stability calculations have been performed

4.11.3 **Settlement**

The main part of the alignment is placed level with or below existing terrain, and the expected settlement is negligible.

From approximately ch. 105 the road will be established on an embankment of approximately 1 – 3 meters height. The ground consists mainly of layers of sand and sandy silt in this area and settlement due to the embankment is expected to occur simultaneously with the loading.

The expected settlement of the embankment has been determined following the procedures set down in section 4.2.8. Settlement analysis is carried out using the design profile at ch. 23 115. The proposed height of the fill and expected settlement is summarized in Table 14.

Table 14: Predicted settlement

Profile	Fill height above existing terrain	Predicted settlement in soil below fill	Self- weight settlement
Embankment	1 – 3 m	5 – 10 cm	1 – 2 cm

The calculations give a best estimate of expected settlement in the order of 5 - 10 cm for the embankment, not including the self-weight settlement of the fill. The design ground profile consists mainly of granular soils of sand and silt, and the bulk of the settlement is expected to comprise of immediate settlement that will occur during loading of the embankment.

Self-weight settlement within the fill material must also be expected. A filling laid out from a tip and compressed as described in ref. /11/ will have self-weight settlement in

the order of 1% of the total fill height. The main part of the settlement is expected to take about 6 months but can be accelerated by heavy rainfall or heavy watering/flushing during filling.

4.12 Alignment 717100/717200

Alignment 717100 and 717200 is a path at Hellstranda fill. The path is placed level with the fill, which is approximately 4 meters above existing terrain. The design of the fill, including stability and settlement analysis, is described in chapter 4.4.

4.12.1 **Stability**

The path is part of the Hellstranda fill, and the stability of the embankment is analysed in chapter 4.4.2.

4.12.2 **Settlement**

The path is part of the Hellstranda fill, and the expected settlement is analysed in chapter 4.4.3.

4.13 Alignment 719300

4.13.1 **Location and main features**

Alignment 719300 is a new path connecting Værnes with an existing path north of Værnes. From approximately ch. 160 to ch. 540 the path runs parallel to the new E6. The path is generally designed with shallow cuts and minor embankments of 1-2 meters height that does not need geotechnical design. Cuts and embankments are generally designed with a slope of 1V:2H.

From approximately ch. 430 to ch. 480 the road will be established at the foot of an existing dry wall. We do not have any information of the design of the dry wall, but according to ref. /10/ a minimum foundation depth of 0,5 m is required for dry walls. Assuming the dry wall is built after these principles, the excavation for the path will not lead to undermining of the wall. We recommend minimizing the excavations close to the wall for this stretch.

4.13.2 **Stability**

No stability calculations have been performed.

4.13.3 **Settlement**

No settlement calculations have been performed. As the road is mainly placed in cuts or on smaller embankments, expected settlement is close to negligible. The design ground profile consists mainly of granular soils of sand and silt, and the bulk of the settlement is expected to comprise of immediate settlement that will occur during loading of the embankment.

4.14 Temporary roads

4.14.1 Alignment 317100 – Temporary widening of existing E6

Alignment 317100 is a temporary widening of the existing E6 at Hellstranda. The road is designed on approximately the same level as existing terrain in the area, with minor embankments and cuttings that does not require geotechnical design.

4.14.2 Alignment 317200/317500/517000 – Temporary access road rig area Hellstranda

The geotechnical design of the temporary access road to the rig area at Hellstranda is described in ref. /21/.

4.14.3 Alignment 317300/317400 – Temporary widening of existing E6/existing access to E6

Alignment 317300 and 317400 is a temporary widening of the existing E6 and existing access road to E6 north of the Værnes intersection. The road is designed on approximately the same level as existing terrain in the area, with minor cuttings that does not require geotechnical design.

4.14.4 Alignment 519100 – Temporary diversion roundabout southside (North of Værnes crossing)

Alignment 519100 is a temporary roundabout for traffic diversion north of the Værnes intersection. The road is designed on approximately the same level as existing terrain in the area, with minor embankments and cuttings that does not require geotechnical design.

4.14.5 Alignment 519300 – Temporary diversion gravel road (Hellstranda)

Alignment 519300 is a temporary traffic diversion of the gravel road connecting the path along Hellstranda with the Øyen culvert. The road is mainly designed on approximately the same level as existing terrain in the area, with shallow cuts and minor embankments of 1-2 meters height that does not need geotechnical design. Cuts and embankments are generally designed with a slope of 1V:2H.

4.14.6 Alignment 519500 – Temporary diversion pathway (Værnes)

Alignment 519500 is a temporary traffic diversion of the path going north from Værnes. The road is mainly designed on approximately the same level as existing terrain in the area, with shallow cuts and minor embankments of 1-2 meters height that does not need geotechnical design. Cuts and embankments are generally designed with a slope of 1V:2H.

4.15 Geotechnical measures

In connection with the establishment of the rig area at the Hell portal, a piezometer and settlement plate will be installed on the fill, to monitor pore pressure and settlement of the rig area during construction and the surcharge/hold periods. See ref. /21/ for full description of monitoring program. Values from these measurements can be used to reassess the expected settlement of the road and the remainder of the fill in more detail.

If the measured settlement is larger or takes longer than expected, settlement reducing measures for the new E6, such as preloading, should be considered. In addition to this, we recommend the installation of another 3 piezometers, to monitor pore pressure during filling at Hellstranda. Suggested monitoring program is described in section 6. Suggested placement of piezometers is presented in drawing 301.

Experience indicates that excess pore pressure build-up can occur in soils of loosely stored sand and silt below ground water level during loading. It is therefore required that any built-up pore pressure resulting from the filling of the area is allowed to dissipate before construction rigs and storing of masses on the fill commences.

We recommend establishing the road embankments during the summer months. Establishing embankments during winter season with below-zero-temperatures will lead to less effective compaction and can cause increased self-weight settlement in the fill. The settlement will also extend over a longer time period compare to when established in mild weather.

Material used in the fill or embankment should not be frozen. Any frozen material from previously established layers in the fill must be removed before further filling continuous. This applies to all levels in the fill.

When establishing a fill in the sea it is important to be aware that the actual quantity of fill material used in the fill usually is a great deal larger than the theoretical amount calculated in ground profiles, sometimes as much as 20 % more. This is due to inaccurate filling and strong currents in the sea, as well as self-weight settlement of the fill and the displacement of loose material below the fill.

We recommend that the existing erosion protection on Muruvika Shore in the area of the fill is removed before the filling begins. The erosion protection consists of high-quality material/rocks that can be reused.

We also recommend reusing the material from the existing flood protection embankment north of the Værnes crossing bridge in the new flood protection embankment that is to be established along the same stretch for the new road.

The roundabout on the west side of the new Værnes bridge is designed on a fill of 8-9 meters height, and the depth effect of the weight of the fill is therefore greater and will cause larger settlement over a longer time period compared to smaller fills. We therefore recommend establishing the embankment at least 6 months prior to the construction of the road. This is to avoid any delays in the construction process due to expected settlement taking longer than estimated. The settlement must be monitored. We recommend settlement plates in 2 locations.

4.16 Earthworks materials

The earthwork shall consist of quality masses of blasted rock or similar material with a minimum internal friction angle of 42° and a minimum density of 19 kN/m3. Embankments of stones (blasted rock) should be built sectional in layers of 1 – 2 meters, with compaction for each layer. The largest stone size in the fill material shall not exceed 2/3 of the thickness of the layer.

For the part of the fill that will be used a substructure for the new E6, construction procedure and all material used should be in accordance with requirements given in chapter 25 in N200, ref. /9/.

For the erosion protection along the exposed end of the fill at Hellstranda a rock cover with minimum stone size of 0.8 m is recommended.

For the flood protection embankment north of the Værnes crossing bridge, we recommend reusing material from the existing flood embankment along this part of the road.

5 EXECUTION

5.1 Fills and embankments

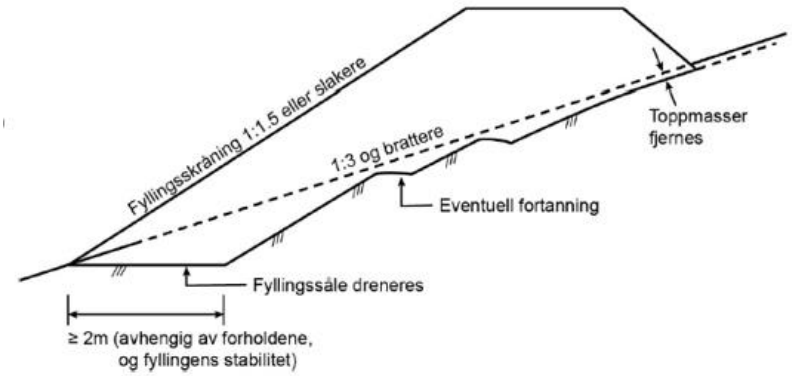
Fillings and embankments must be carried out in accordance with V221, ref. /11/.

The filling must be established in layers, start filling in the lower part, and then fill upwards. The embankment must be laid out and compacted in a way that prevents unacceptable self-weight settlements from occurring after the construction period, and so that the greatest possible homogeneity is achieved to a horizontal extent.

Embankments of stones (blasted rock) should be built sectional in layers of 1 – 2 meters, with compaction for each layer. The largest stone size in the fill material shall not exceed 2/3 of the thickness of the layer. The material must be compacted in accordance with figure 2-0-14 in ref. /11/, presented in figure 4.

All peat, where encountered at ground surface/below topsoil, must be excavated before the construction begins. A nonwoven fabric must be used to separate the natural appearing soil and blasted rock.

If existing terrain is steeper than 1:3, the road embankment needs to have minimum 2 meters width at the filling toe. The principal is illustrated in Figure 12.



Figur 254.1 Fyllingssåle ved terrengskråning 1:3 og brattere

Figure 12: Illustration of the principal for filling toe when terrain slope is steeper than 1:3, ref. figure 2-0-2 in V221 ref. /11/.

5.2 Construction procedure Hellstranda

The construction of the fill at Hellstranda must be done in the following order:

1. The rig area is established, as described in ref. /21/. Piezometer and settlement plate are monitored during and after filling.
2. In addition to the piezometer for the rig area, 3 extra piezometers are to be installed at Hellstranda. These must be monitored regularly to keep track of pore pressure build-up due to the construction of the fill. If a significant increase in the pore pressure is detected, the filling must be stopped until the excess pore pressure has dissipated.
3. The establishment of the remainder of the fill will start once the rig area is finished. The first layer of the fill must be established up to level +0, before it is compacted. Thereafter the fill must be laid out in layers and compressed in

accordance with figure 2-0-14 in ref. /11/. It is required that the material used has a rock size less or equal to 2/3 of the thickness of the layers. For the part of the fill that will be used a substructure for the new E6, construction procedure and all material used should be in accordance with requirements given in N200 chapter 25, ref. /9/.

Once the filling is established at the designed level, pore pressure must be controlled to make sure excess pore pressure is allowed to dissipate before the fill can be used as a recreational area.

5.3 Execution control plan

An execution control plan for the construction works must be prepared by the contractor prior to the construction works. The control plan shall as a minimum include check points for

- Excavations
- Slope of cuttings and fillings
- Plan to comply with the restrictions of loads in the different areas
- No frozen material in or below fill.
- Compaction
- Requirements for sequences

The execution shall be documented by check lists and photos.

6 SUPERVISION, INSTRUMENTATION AND MONITORING

6.1 Objective

The primary objective of the scheme geotechnical instrumentation is to:

- Monitor the response of groundwater during the filling to make sure any build of excess pore pressure is allowed to dissipate before construction/filling continuous.
- Monitor ground movement to confirm the total and differential settlement of the Værnes overpass bridge is as expected in the design.

6.2 Instrument types

Instrumentation is proposed during the construction phase to monitor the pore pressure during filling, and to monitor the settlement of the Værnes bridge embankment. The instruments proposed includes 3 piezometers and 3 settlement plates, as summarised in Table 15.

Table 15: Instrument types for monitoring

Instrument type	Purpose	Frequency of readings
Piezometers	To monitor build of pore pressure in the granular soils. To be installed before embankment filling operations.	To take into account the effect of the tide on the ground water level, the piezometer data needs to be automatically and continuously logged before and during filling. It is important to start the logging some time prior to filling to obtain background readings.
Settlement plates	To monitor settlement of the embankments at the Værnes crossing bridge.	Prior to filling then twice weekly during filling at no less than one reading per metre of fill placed; weekly during surcharge/hold periods. It is important to measure the position of the plates before the filling of the area begins, to obtain a good basis to evaluate measured settlement during and after filling.

Suggested placement of the piezometers is shown in drawing 301, in borehole R6042-R6044. The piezometers should be installed at a depth approximately 8 meters below existing terrain (seabed). The piezometers must be installed before the main part of the filling begins. To gain access to the piezometer locations with a drilling rig, the same procedure that was used for the rig area piezometer can be used. A small fill/ construction road can be established at approximately level +0/sufficiently high to keep the rig above sea level. Time for installation should be adapted to fit the low tide in the area, so the fill does not have to be established at a higher level than necessary. It is important to start the logging some time prior to filling to obtain background readings.

Settlement plates should be installed at 2 locations: in the center of both roundabouts on either side of the new Værnes crossing bridge (alignment 419500 and 419600), where the fill height is at its tallest. Settlement plates must be established level with original terrain in the area, prior to filling.

6.3 Results

The results of the construction and surcharge monitoring will be collated and interpreted by the responsible geotechnical advisor. Changes made to the surcharge height duration will be agreed with the Designer depending on the actual measured performance.

Stability analysis gives a critical increase in pore pressure of 25 kPa, which equals a critical pore pressure level of 105 kPa at the monitoring location at level -8. The analysis is performed for a situation with ground water at level +0, and the pore pressure at the monitoring level will increase and decrease with the tide. If a pore pressure level above the critical level of 105 kPa is registered during filling, the measured values must be compared to ground water level at the time of registering, before any measures are initiated. If the registered increase in pore pressure is less than 25 kPa compared to expected values with the given ground water level, filling can continue. Pore pressure should be monitored closely during such events and should never reach values above 120 kPa.

The settlement must be monitored at least until the primary settlement of the fill is finished. Primary settlement of the fill is expected to take 3-4 months.

7 SUMMARY

- The fill at Hellstranda is designed at level +4 to level +3, approximately 4 meters above the existing terrain surface. The fill is approximately 30 – 60 m wide and designed with a maximum slope of 1V:3H and erosion protection at exposed areas. The southern part of the fill will be used as a substructure for the new E6.
- Along the north and south side of the road, two embankments will be established, with top embankment at level +6 to +8 approximately. The embankments are designed with a slope of 1V:2H.
- From approximately ch. 22 850 to ch. 22 940 the new E6 passes Øyvegen bridge and its approach fill. The widening of the existing E6 means that part of the foot of the fill will be excavated during the construction of the new road. The northern abutment of Øyvegen bridge is founded on piles, and the planned excavation will not affect the structure. The approach fill of the bridge is supported by two dry walls on either side of the fill. The northern wall is 1-4 meters tall, and the stability and bearing capacity of the wall will be reduced by the planned excavation. The excavation must be done section by section, with a slope of 1V:1H and with a maximum section width of 3 meters for the critical stretch between ch. 22 860 to h. 22 880. From ch. 22 880 and northward to the end of the dry wall, the sections can have a maximum width of 10 meters. We also recommend that the northern lane of the entry ramp for the Øyvegen bridge is closed for traffic during the excavation of the critical stretch.
- As the thickness of the road embankment varies from 0 to 4 meters, differential settlement across the new road must be expected, with little or no settlement on the parts of the road that is established at or below the existing terrain level, and settlement in the order of 10 – 15 cm for the areas with a fill height of 3 – 4 meters.
- The planned fill at Hellstranda will most likely cause some settlement on parts of the existing road that are located close to the new fill. Settlement calculations indicate an expected settlement in the order of 3 -4 cm on the outer northern part of the existing road. The settlement is expected to occur simultaneously with the construction of the fill. We recommend regular inspection of the road to monitor any ground movement caused by the filling.
- As the ground profile consists mainly of granular soils of blasted rock, gravel and sand, and the bulk of the settlement is expected to comprise of immediate settlement that will occur during loading of the embankment. Where the road is to be established on embankments of more than 4 meters height, we recommend that the embankment is established at least 3 months before the completion of the road, to make sure the primary settlement due to the fill is complete.
- The roundabout on the west side of the new Værnes bridge is designed on a fill of 8-9 meters height, and the depth effect of the weight of the fill is therefore greater and will cause larger settlement over a longer time period compared to smaller fills. We therefore recommend establishing the embankment at least 6 months prior to the construction of the road. This is to avoid any delays in the construction process due to expected settlement taking longer than estimated. The settlement must be monitored. We recommend settlement plates in 2 locations.
- The new Værnes crossing bridge will be founded directly on the existing ground, and therefore affected by the expected settlement due to the approach fills. To avoid differential settlement of the bridge foundations, we

recommend preloading of the area. Based on settlement monitoring from the existing Værnes bridge, primary settlement of the fill is expected to take 3-4 months. The detailed design of the preloading can be done when the 30% design of the Værnes bridge (E82) is approved.

- The temporary traffic diversion must be adapted to the preloading.
- North of the Værnes bridge, from approximately ch. 24 400 to ch. 24 620 a flood protection embankment will be established parallel with the new road, to avoid flooding of the road during periods with high tide. We recommend reusing material from the existing flood protection embankment on the stretch when establishing the new embankment. We also recommend establishing the new flood protection embankment before the excavation for the new road begins, to minimize problems with water in the pit.
- Self-weight settlement within the fill material must also be expected. A filling laid out from a tip and compressed as described in ref. /11/ will have self-weight settlement in the order of 1% of the total fill height. The main part of the settlement is expected to take about 6 months but can be accelerated by heavy rainfall or heavy watering/flushing during filling.
- We recommend that the expected settlement of the road and the remainder of the fill is reassessed after the settlement of the rig area has been monitored.
- We also recommend monitoring the build of pore pressure during filling.
- The earthwork shall consist of quality masses of blasted rock or similar material with a minimum internal friction angle of 42° and a minimum density of 19 kN/m3. Embankments of stones (blasted rock) should be built sectional in layers of 1 – 2 meters, with compaction for each layer. The largest stone size in the fill material shall not exceed 2/3 of the thickness of the layer. The material must be compacted in accordance with figure 2-0-14 in /11/.
- All peat, where encountered at ground surface/below topsoil, must be excavated before the construction begins. A nonwoven fabric must be used to separate the natural appearing soil and blasted rock.
- For the erosion protection along the exposed end of the Hellstranda fill a rock cover with minimum stone size of 0,8 m is required.

8 OPPSUMMERING

- Fyllingen på Hellstranda er planlagt på kote +3 til kote +4, ca. 4 meter over eksisterende terreng i området. Fyllingen er omtrentlig 30 – 60 meter bred, og prosjektert med en maksimal helning på 1:3. Det er planlagt erosjonssikring på utsatte områder. Den sørlige delen av fyllingen vil brukes som underbygning for ny E6.
- Det skal etableres to jordvoller på begge sider av ny E6, med topp fylling på ca. kote +6 til kote +8. Fyllingene er prosjektert med helning 1:2.
- Mellom ca. profil 22.850 til profil 22.940 vil ny E6 passere Øyvegen bru og den tilhørende tilløpsfyllingen. Utvidelsen av eksisterende E6 medfører at deler av fyllingsfoten skal midlertidig graves vekk under utførelse. Det nordlige landkaret til Øyvegen bru er fundamentert på peler, og den planlagte utgravningen vil derfor ikke påvirke konstruksjonen. En høyeste delen av tilløpsfyllingen er støttet opp at 2 tørrmurer på begge sider av fyllingen. Den nordligste muren har en oppstøttingshøyde på 1-4 meter, og murens stabilitet og bæreevne vil reduseres av den planlagte utgravningen. Utgravningen må utføres seksjonsvis, med helning graveskråning lik 1:1 og maksimal seksjonsbredde lik 3 meter for den kritiske strekningen mellom profil 22.860 og 22.880. Fra profil22.880 og videre nordover til enden av tørrmuren kan seksjonsbredden økes til maksimalt 10 meter. Vi anbefaler også at det nordlige kjørefeltet for påkjøringsrampen til Øyvegen bru stenges for trafikk under utgravningen langs den kritiske seksjonen.
- Da mektighet av ny vegfylling varierer fra 0 til 4 meter må det påregnes differansesetninger langs ny veg, med lite til neglisjerbare setninger for deler av vegen som etableres på eller under nivå for eksisterende terreng, og setninger i størrelsesorden 10 – 15 cm for områder med fyllingshøyde opp til 3 - 4 meter.
- Den planlagte utfyllingen på Hellstranda vil antagelig medføre setninger på deler av eksisterende veg som ligger nærmest utfyllingen. Setningsberegninger indikerer en forventet setning i størrelsesorden 3-4 cm for den nordlige delen av eksisterende veg. Setningen forventes å påløpe fortløpende med utfyllingen. Vi anbefaler jevnlig inspeksjon av eksisterende veg for å overvåke eventuelle bevegelser i vegen som følge av fyllingen.
- Da løsmassene i området hovedsakelig består av friksjonsmasser av sprengstein, grus og sand er det forventet at hoveddelen av setningene vil påløpe umiddelbart under utlegging av fyllingen. I områder der veg skal etableres på fylling med over 4 meter mektighet anbefaler vi at fyllinger leges ut minimum 3 måneder før veg skal ferdigstilles, for å sikre at primærsetningene som følge av oppfyllingen er fullført.
- Rundkjøringen på vestsiden av Værneskrysset er prosjektert med en fyllingshøyde på 8-9 meter over dagens terreng. Dybdeeffekten av denne fyllingen vil derfor være betydelig større, og medføre større setninger over en lengre periode sammenlignet med mindre fyllinger. Vi anbefaler derfor at denne etableres minimum 6 måneder før veg er planlagt ferdigstilt, for å unngå forsinkelser i anleggsarbeidet som følge av at setningene tar lenger tid enn antatt. Vi anbefaler også at fyllingen etableres med overhøyde, for å redusere ventetiden. Det må utføres setningsmålinger på begge sider av brua. Detaljprosjekteringen av forbelastning for Værneskrysset og bru er utført i egen rapport.
- Den nye Værnes-brua skal direktefundamenteres på stedlige masser, og vil derfor påvirkes av setninger som følge av fyllingene på begge sider av brua.

For å unngå skadelige differansesetninger på brua skal området forbelastes. Detaljprosjektering av forbelastningen er utført i egen rapport.

- Midlertidig traffikavvikling må tilpasses forbelastningen.
- Nord for Værneskrysset, fra ca. profil 24 400 til profil 24 620, skal det etableres en flomvoll parallelt med ny E6, for å unngå oversvømmelse av vegbanen i perioder med høy vannstand. Vi anbefaler å gjenbruke masser fra eksisterende flomvoll i området i den nye vollen. Vi anbefaler også å etablere ny flomvoll før en starter med utgravning for ny E6, for å redusere problemer med vann i byggegropa.
- Det må forventes egensetninger i fyllingene som skal etableres. En fylling lagt ut fra tipp og komprimert som beskrevet i ref. /11/ vil ha en egensetning i størrelsesorden 1% av total fyllingsmektighet. Hoveddelen av setningene er forventet å påløpe innen 6 måneder, men setningshastighet kan økes ved spyling under utfylling.
- Vi anbefaler forventet setning av vegfylling revurderes etter at resultatene fra setningsmålingene fra utfylling for riggområdet er klare.
- Vi anbefaler også å overvåke poretrykket i grunnen under oppfylling.
- Vegfylling skal bestå av kvalitetsmasser av sprengt stein eller lignende med minimum friksjonsvinkel lik 42° og minimum tyngdetetthet lik 19 kN/m^3. Fylling av sprengstein bør bygges opp i lag på 1-2 meters mektighet, med komprimering for hvert lag. Største steinstørrelse i underbygningen skal ikke være større enn 2/3 av tykkelsen til laget. Materialet på komprimeres i henhold til figur 2-0-14 i /11/.
- All torv eller humusholdig jord må fjernes før oppfylling starter. Det skal benyttes en fiberduk mellom original grunn og sprengsteinsfylling.
- Fylling langs Hellstranda skal erosjonssikres med minimum steinstørrelse D_{n50}=0,8 m.

9 DRAWINGS

301. DZ06-0003-301, SITUATION PLAN CH. 22 250 – CH.22 840, 1:1000
302. DZ06-0003-302, SITUATION PLAN CH. 22 830 – CH.23 500, 1:1000
303. DZ06-0003-303, SITUATION PLAN CH. 23 470 – CH.24 000, 1:1000
304. DZ06-0003-304, SITUATION PLAN CH. 23 750 – CH.24 370, 1:1000
305. DZ06-0003-305, SITUATION PLAN CH. 24 280 – CH.24 750, 1:1000
306. DZ06-0003-306, STABILITY ANALYSIS CH. 22 700, 1:500
307. DZ06-0003-307, STABILITY ANALYSIS CH. 22 860, 1:300
308. DZ06-0003-308, STABILITY ANALYSIS CH. 22 870, 1:300
309. DZ06-0003-309, STABILITY ANALYSIS CH. 22 860, 1:400
310. DZ06-0003-310, STABILITY ANALYSIS CH. 23 960, 1:400
311. DZ06-0003-311, STABILITY ANALYSIS Noise embankment, 1:400

10 APPENDIX

1. Landskapsplan og snitt, Hellstranda. 100% delivery

11 REFERENCES

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Ch. 22 700

New land fill at Hellstranda
Top land fill at level +4,0 - level +3
Slope: 1V:3H

Noise embankment

Rig area
Top land fill at level +3,4 - level +2,9
Slope: 1V:2H

Counter fill railway
Top fill at level +3,0
Slope (not shown): 1V:2H

N1606900
N1606800
N1606700
N1606600
N1606500

MÅLESTOKK: 1:650

REFERENCES BOREHOLES

Reference DZ-6	Report nr.
G6-X	30402.01
G8-X	7790.01
K12-X	o.10471-1
K14-X	o.10278-1
K18-X	o.7667-1
M5-X	418799-001
N4-X	o.362.2-II
NOT3-X	37470-1
NS1-X	GK. 2287
NS2-X	GK. 4440-1
NS3-X	GK. 2464
R3-X	6080603-1
R4-X	6080603-4
R10-X	G-rap-001 6120001
R11-X	6080603-3
11300-22000	22200888-G-004
SC2-X	12886-1
S15-X	V 295A-1
S16-X	V 295B-1
S17-X	V295B-2
S41-X	V 295C-1
S42-X	Vd 855A
S43-X	Vd 667A
R60XX	G-rep-DZ6-01
R60XX	G-rep-E75-01
R60XX	G-rep-E77-01
R60XX	G-rep-E79-01
R60XX	G-rep-E80-01_rev01
R60XX	G-rep-E82-01
R60XX	G-rep-X6-01
R60XX	G-rep-X7-01

EXPLANATION - DRILLING

Sounding type (symbol)
Drilling point
4 Terrain elevation / Bedrock level — Drilling depth in soil + drilling in rock (m)

- Total sounding
- Rotary-pressure sounding
- CPTU
- Soil sampling
- Piezometer
- Vane boring
- Pressure sounding
- Pit
- Bedrock control drilling
- Percussion sounding
- Simple sounding
- Rock at terrain

Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
04	Updated chainage and new landscape plans	SIJO	HBO	OED	02.05.2022
03	IFR (100% design)	SIJO	EOH	OED	24.02.2021
02	IFR (60% design)	SIJO	EOH	OED	19.11.2020
01	IFR (60% design priority works)	SIJO	EOH	OED	02.09.2020

Saksnr.

NyeVeier
Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

SITUATION PLAN CH. 22 250 - CH. 22 840

Day zone 6

E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 1000
Halv målestokk A3	1 : 2000
Tegningsnummer / revisjon	DZ06-0003-301 Rev. 04

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJO	EOH	ODE	1350037838

N1607100

N1607000

N1606900

N1606800

N1606700

Noise embankment

Noise embankment

Noise embankment

New land fill at Hellstranda
Top land fill at level +4,0 - level +3
Slope: 1V:3H

Ch. 22 860

S42-P18

S42-P17

S42-P16

S16-130

S16-127

S16-125

S16-122

S16-120

S16-118

NS2-N8

NS2-N9

NS2-N7

NS2-N5

NS2-N6

NS2-N3

NS2-N4

NS2-N2P

NS2-N1P

R4-G76

R4-G77

R4-G78

R4-G68

R4-G65

R4-G63

R4-G72

R4-G71

R4-G82

R4-G81

R4-G84

R4-G74

R4-G73

R4-G79

R4-G88

R4-G75

R4-G87

R4-G89

R11-9582

M5-4

G6-1

G6-3

R6014

R6013

R6012

R6011

R6010

R6009

R6008

22000V33

22000V22

0119300

0119400

0119500

0119600

0119700

0119800

REFERENCES BOREHOLES

Reference	Report nr.
DZ-6	
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G8-X	7790.01
K12-X	o.10471-1
K14-X	o.10278-1
K18-X	o.7667-1
M5-X	418799-001
N4-X	o.362.2-II
NOT3-X	37470-1
NS1-X	GK. 2287
NS2-X	GK. 4440-1
NS3-X	GK. 2464
R3-X	6080603-1
R4-X	6080603-4
R10-X	G-rap-001 6120001
R11-X	6080603-3
11300-22000	22200888-G-004
SC2-X	12886-1
S15-X	V 295A-1
S16-X	V 295B-1
S17-X	V295B-2
S41-X	V 295C-1
S42-X	Vd 855A
S43-X	Vd 667A
R60XX	G-rep-DZ6-01
R60XX	G-rep-E75-01
R60XX	G-rep-E77-01
R60XX	G-rep-E79-01
R60XX	G-rep-E80-01_rev01
R60XX	G-rep-E82-01
R60XX	G-rep-X6-01
R60XX	G-rep-X7-01

EXPLANATION - DRILLING

Sounding type (symbol)
Drilling point
4 Terrain elevation / Bedrock level — Drilling depth in soil + drilling in rock (m)

- Total sounding
- Rotary-pressure sounding
- CPTU
- Soil sampling
- Piezometer
- Vane boring
- Pressure sounding
- Pit
- Bedrock control drilling
- Percussion sounding
- Simple sounding
- Rock at terrain

Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
04	Updated chainage and new landscape plans	SIJO	HBO	OED	02.05.2022
03	IFR (100% design)	SIJO	EOH	OED	14.06.2021
02	IFR (60% design)	SIJO	EOH	OED	19.11.2020
01	IFR (60% design priority works)	SIJO	EOH	OED	02.09.2020
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

SITUATION PLAN CH. 22 830 - CH. 23 500

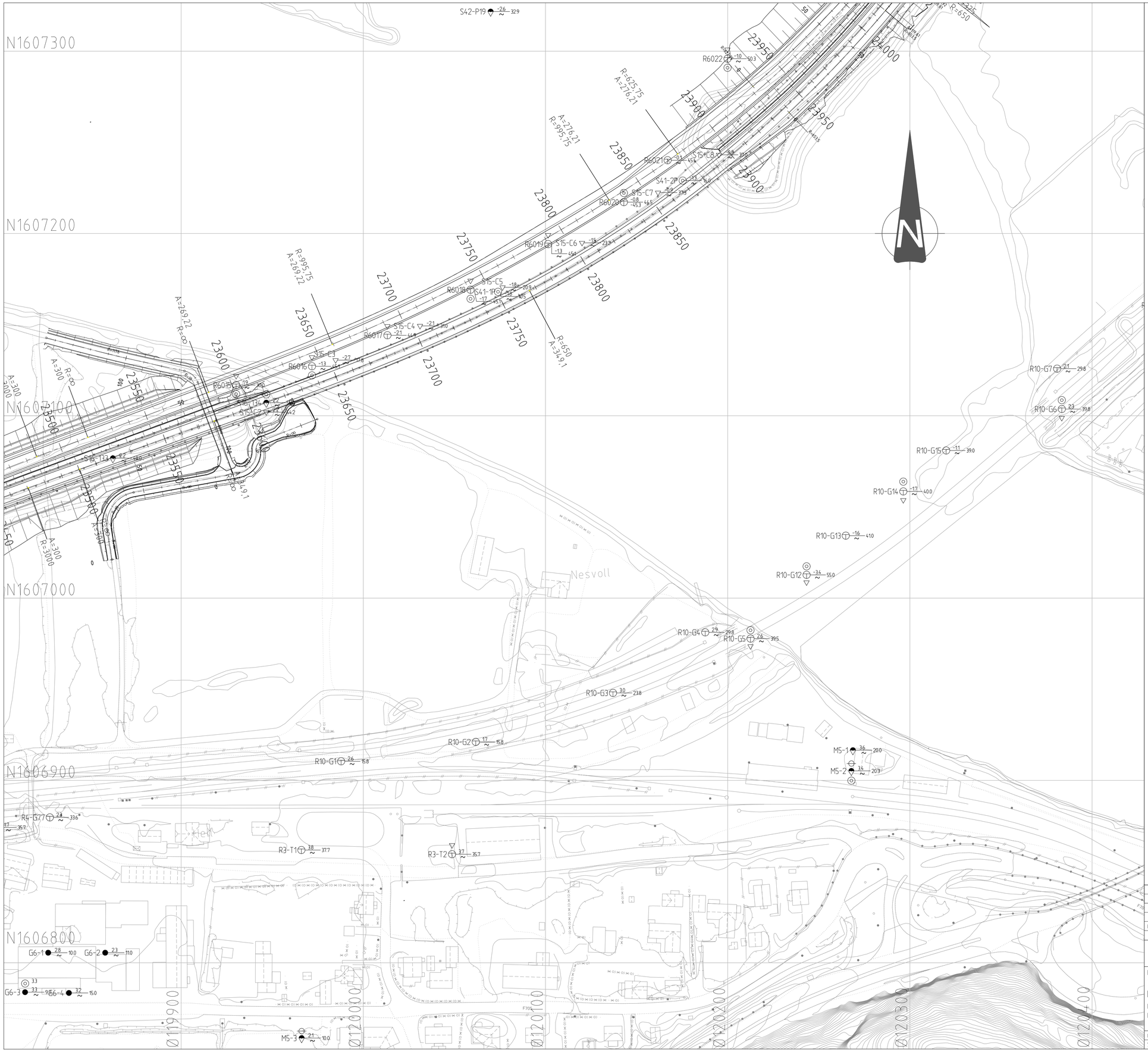
Day zone 6

E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJO	EOH	ODE	1350037838

Tegningsdato	
Bestiller	Nye Veier
Produsent for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 1000
Halv målestokk A3	1 : 2000
Tegningsnummer / revisjon	DZ06-0003-302 Rev. 04



REFERENCES BOREHOLES

Reference	Report nr.
DZ-6	
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G8-X	7790.01
K12-X	o.10471-1
K14-X	o.10278-1
K18-X	o.7667-1
M5-X	418799-001
N4-X	o.362.2-II
NOT3-X	37470-1
NS1-X	GK. 2287
NS2-X	GK. 4440-1
NS3-X	GK. 2464
R3-X	6080603-1
R4-X	6080603-4
R10-X	G-rap-001 6120001
R11-X	6080603-3
11300-22000	22200888-G-004
SC2-X	12886-1
S15-X	V 295A-1
S16-X	V 295B-1
S17-X	V295B-2
S41-X	V 295C-1
S42-X	Vd 855A
S43-X	Vd 667A
R60XX	G-rep-DZ6-01
R60XX	G-rep-E75-01
R60XX	G-rep-E77-01
R60XX	G-rep-E79-01
R60XX	G-rep-E80-01_rev01
R60XX	G-rep-E82-01
R60XX	G-rep-X6-01
R60XX	G-rep-X7-01

EXPLANATION - DRILLING

Sounding type (symbol)
Drilling point
4 Terrain elevation / Bedrock level
Drilling depth in soil + drilling in rock (m)

- Total sounding
- Rotary-pressure sounding
- CPTU
- Soil sampling
- Piezometer
- Vane boring
- Pressure sounding
- Pit
- Bedrock control drilling
- Percussion sounding
- Simple sounding
- Rock at terrain

Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
03	Updated chainage and new landscape plans	SIJO	HBO	OED	02.05.2022
02	IFR (60% design)	SIJO	EOH	OED	19.11.2020
01	IFR (60% design priority works)	SIJO	EOH	OED	02.09.2020

Saksnr.

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

SITUATION PLAN CH. 23 470 - CH. 24 000

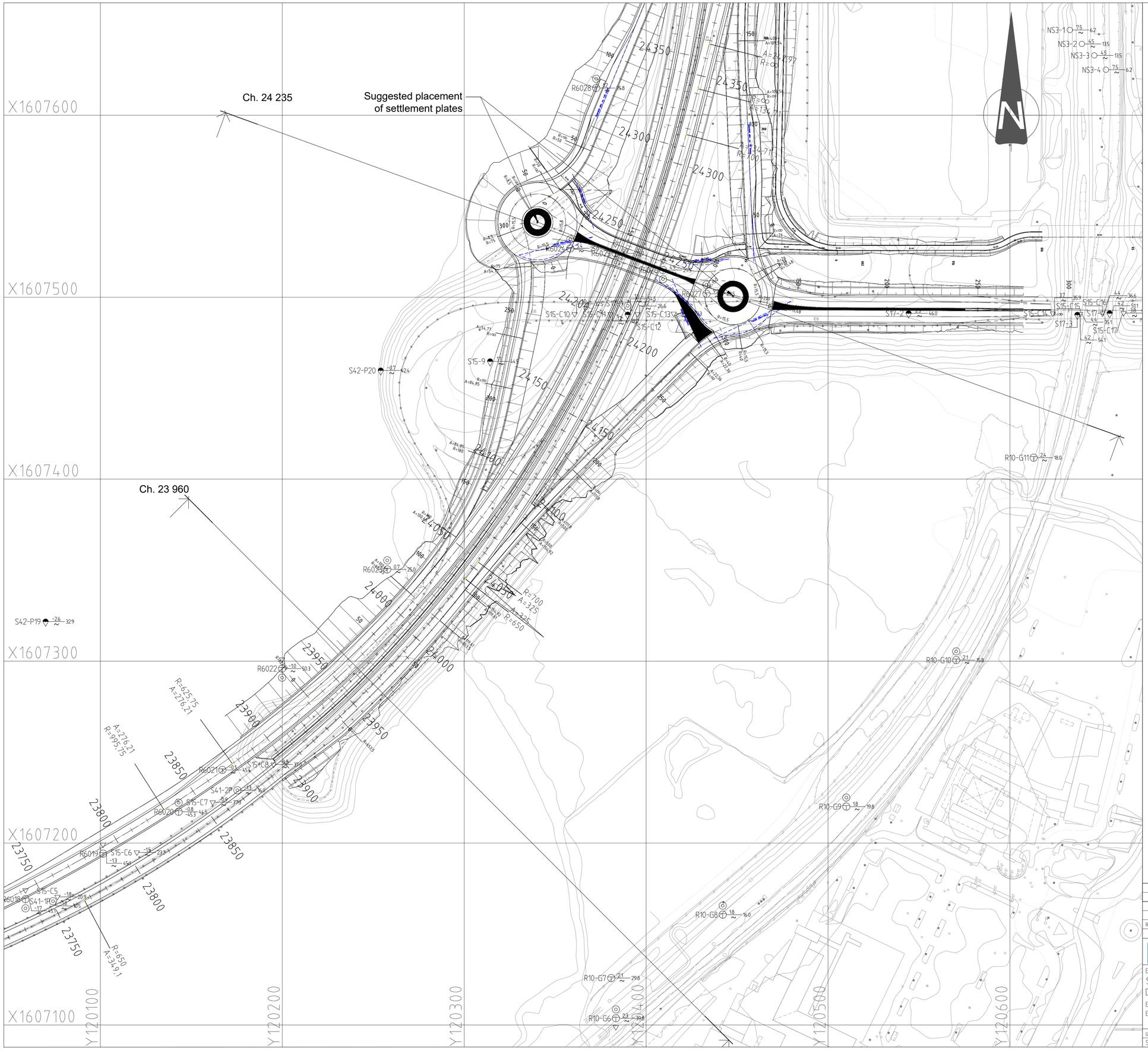
Day zone 6

E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 1000
Halv målestokk A3	1 : 2000
Tegningsnummer / revisjon	DZ06-0003-303 Rev. 03

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJO	EOH	ODE	1350037838



REFERENCES BOREHOLES

Reference	Report nr.
DZ-6	
G6-X	30402.01
G8-X	7790.01
K12-X	o.10471-1
K14-X	o.10278-1
K18-X	o.7867-1
M5-X	418799-001
N4-X	o.362.2-II
NOT3-X	37470-1
NS1-X	GK. 2287
NS2-X	GK. 4440-1
NS3-X	GK. 2464
R3-X	6080603-1
R4-X	6080603-4
R10-X	G-rap-001 6120001
R11-X	6080603-3
11300-22000	22200888-G-004
SC2-X	12886-1
S15-X	V 295A-1
S16-X	V 295B-1
S17-X	V295B-2
S41-X	V 295C-1
S42-X	Vd 855A
S43-X	Vd 667A
R60XX	G-rep-DZ6-01
R60XX	G-rep-E75-01
R60XX	G-rep-E77-01
R60XX	G-rep-E79-01
R60XX	G-rep-E80-01_rev01
R60XX	G-rep-E82-01
R60XX	G-rep-X6-01
R60XX	G-rep-X7-01

EXPLANATION - DRILLING

Sounding type (symbol)
Drilling point
4 Terrain elevation
Bedrock level
Drilling depth in soil + drilling in rock (m)

- Total sounding
- Piezometer
- Bedrock control drilling
- Rotary-pressure sounding
- Vane boring
- Percussion sounding
- CPTU
- Pressure sounding
- Simple sounding
- Soil sampling
- Pit
- Rock at terrain

Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
03	Updated chainage and new landscape plans	SIJO	HBO	OED	02.05.2022
02	IFR (100% design)	SIJO	EOH	OED	24.02.2021
01	IFR (60% design)	SIJO	EOH	OED	19.11.2020

Saksnr.

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

SITUATION PLAN CH. 23 750 - CH. 24 370

Day zone 6

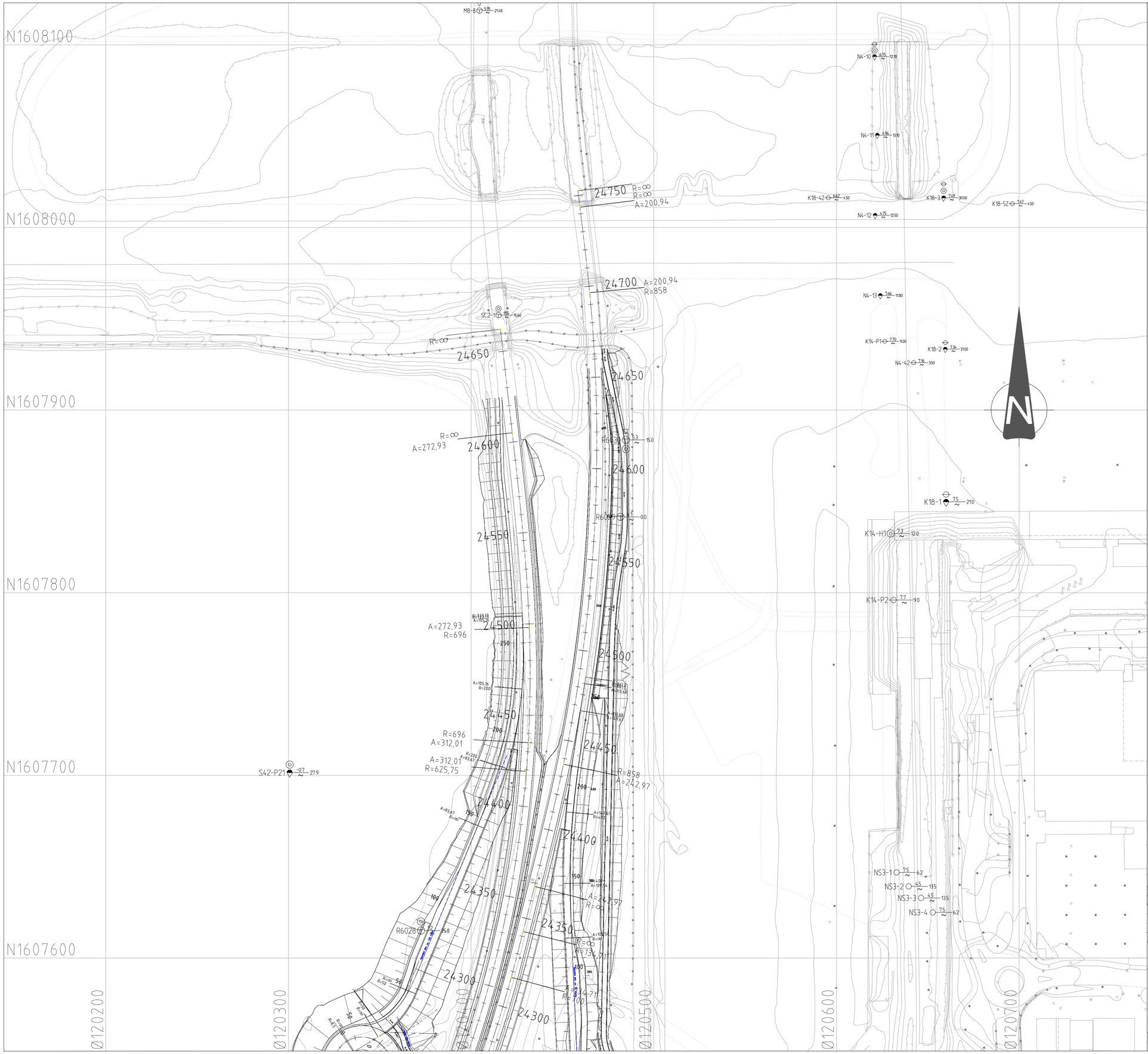
E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 1000
Halv målestokk A3	1 : 2000

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJO	EOH	ODE	1350037838

Tegningsnummer / revisjon: DZ06-0003-304 Rev. 03



REFERENCES BOREHOLES

Reference	Report nr.
DZ-6	
G6-X	30402.01
G8-X	7790.01
K12-X	o.10471-1
K14-X	o.10278-1
K18-X	o.7667-1
M5-X	418799-001
N4-X	o.362.2-II
NOT3-X	37470-1
NS1-X	GK. 2287
NS2-X	GK. 4440-1
NS3-X	GK. 2464
R3-X	6080603-1
R4-X	6080603-4
R10-X	G-rap-001 6120001
R11-X	6080603-3
11300-22000	22200888-G-004
SC2-X	12886-1
S15-X	V 295A-1
S16-X	V 295B-1
S17-X	V295B-2
S41-X	V 295C-1
S42-X	Vd 855A
S43-X	Vd 667A
R60XX	G-rep-DZ6-01
R60XX	G-rep-E75-01
R60XX	G-rep-E77-01
R60XX	G-rep-E79-01
R60XX	G-rep-E80-01_rev01
R60XX	G-rep-E82-01
R60XX	G-rep-X6-01
R60XX	G-rep-X7-01

EXPLANATION - DRILLING

Sounding type (symbol) — Drilling point

4 — Terrain elevation / Bedrock level — Drilling depth in soil + drilling in rock (m)

- Total sounding
- Rotary-pressure sounding
- CPTU
- Soil sampling
- Piezometer
- Vane boring
- Pressure sounding
- Pit
- Bedrock control drilling
- Percussion sounding
- Simple sounding
- Rock at terrain

Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
02	Updated chainage and new landscape plans	SIJO	HBO	OED	02.05.2022
01	IFR (60% design)	SIJO	EOH	OED	19.112020

Saksnr.

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

SITUATION PLAN CH. 24 280 - CH. 24 750

Day zone 6

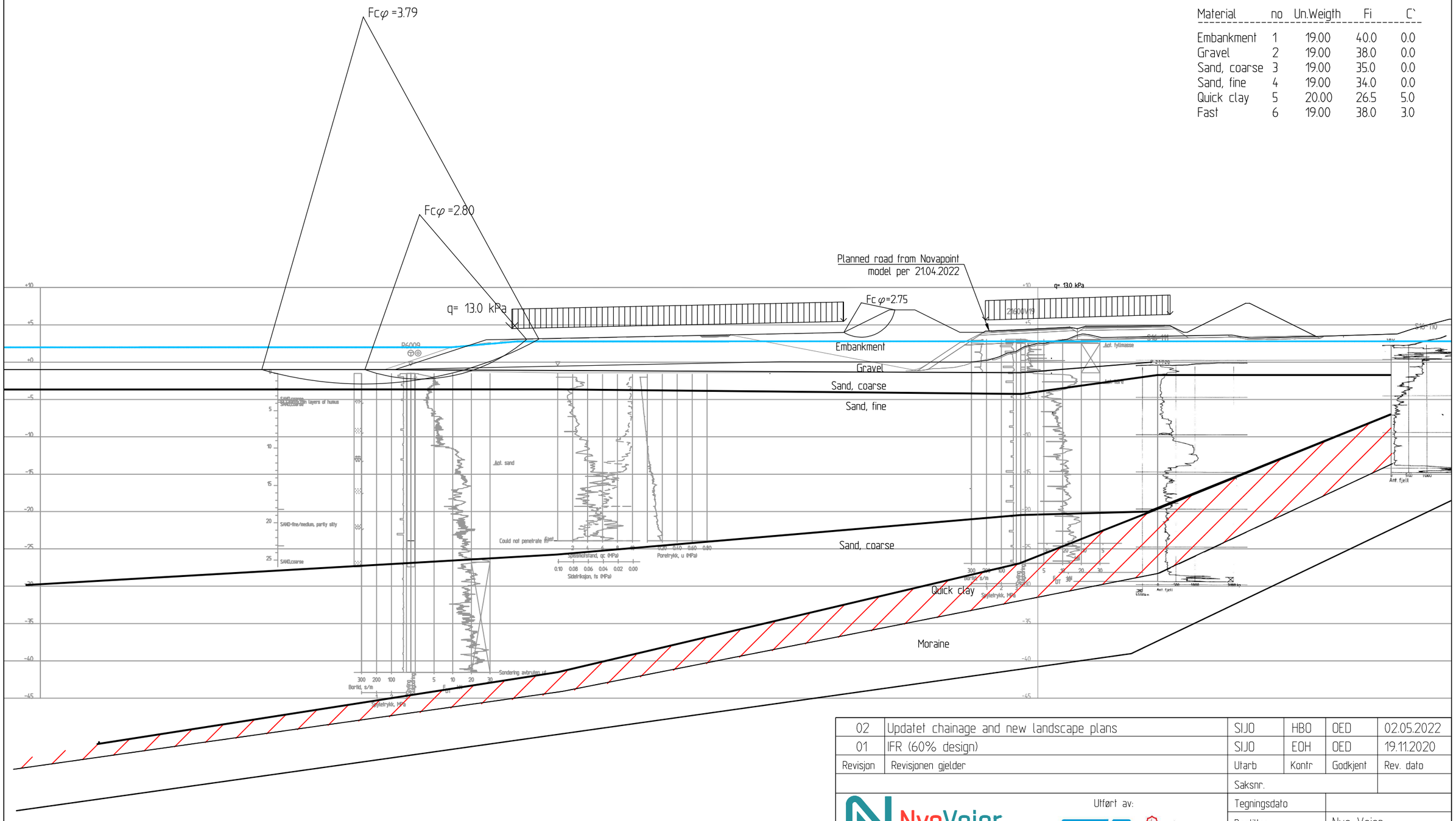
E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 1000
Halv målestokk A3	1 : 2000
Tegningsnummer / revisjon	DZ06-0003-305 Rev. 02

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJO	EOH	ODE	1350037838

Material	no	Un.Weigth	Fi	C`
Embankment	1	19.00	40.0	0.0
Gravel	2	19.00	38.0	0.0
Sand, coarse	3	19.00	35.0	0.0
Sand, fine	4	19.00	34.0	0.0
Quick clay	5	20.00	26.5	5.0
Fast	6	19.00	38.0	3.0



02	Updatet chainage and new landscape plans	SIJO	HBO	OED	02.05.2022
01	IFR (60% design)	SIJO	EOH	OED	19.11.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Stability analysis ch. 22 700

Day zone 6

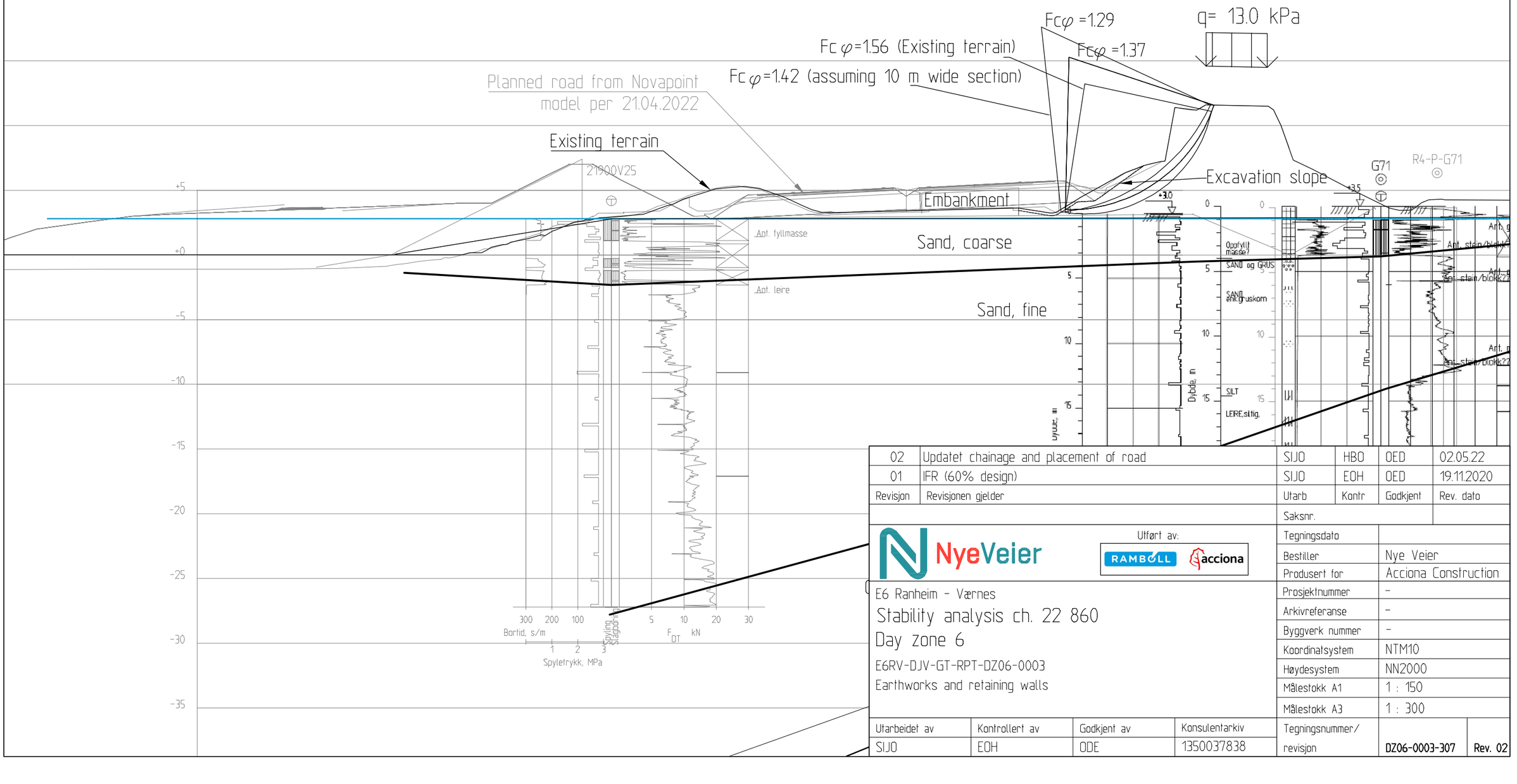
E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 250
Målestokk A3	1 : 500

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon		
SIJO	EOH	ODE	1350037838		DZ06-0003-306	Rev. 02

Material	no	Un.Weigth	Fi	C`
Embankment	1	19.00	42.0	1.0
Sand, coarse	2	19.00	36.0	0.0
Sand,fine	3	19.00	35.0	0.0
Clay/silt	4	20.00	26.5	2.5
Moraine	5	19.00	38.0	2.0
Bedrock				



02	Updatet chainage and placement of road	SIJO	HBO	OED	02.05.22
01	IFR (60% design)	SIJO	EOH	OED	19.11.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Stability analysis ch. 22 860

Day zone 6

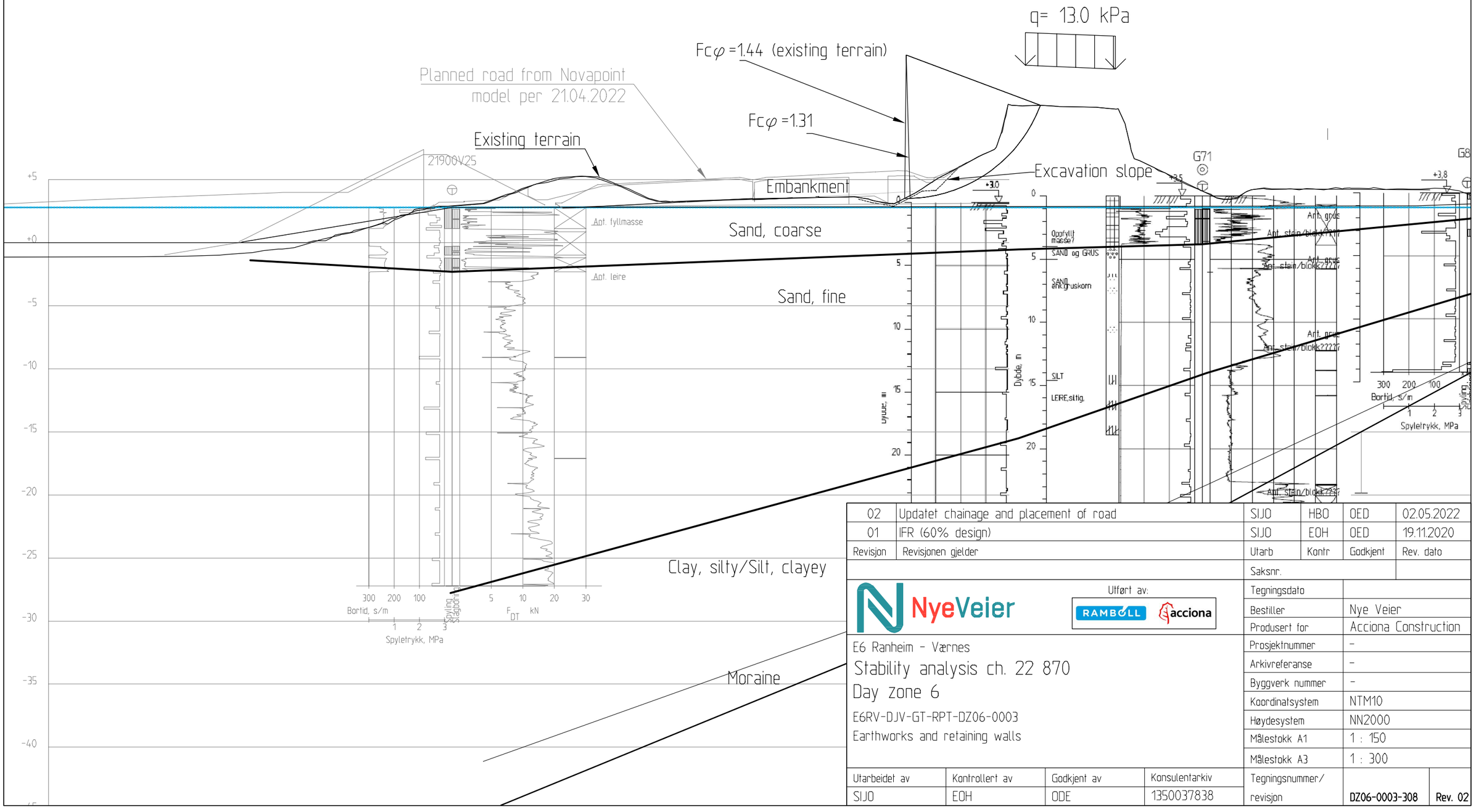
E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 150
Målestokk A3	1 : 300

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon		
SIJO	EOH	ODE	1350037838		DZ06-0003-307	Rev. 02

Material	no	Un.Weigth	Fi	C`
Embankment	1	19.00	42.0	1.0
Sand, coarse	2	19.00	36.0	0.0
Sand, fine	3	19.00	35.0	0.0
Clay/silt	4	20.00	26.5	2.5
Moraine	5	19.00	38.0	2.0
Bedrock				



02	Updatet chainage and placement of road	SIJO	HBO	OED	02.05.2022
01	IFR (60% design)	SIJO	EOH	OED	19.11.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Stability analysis ch. 22 870

Day zone 6

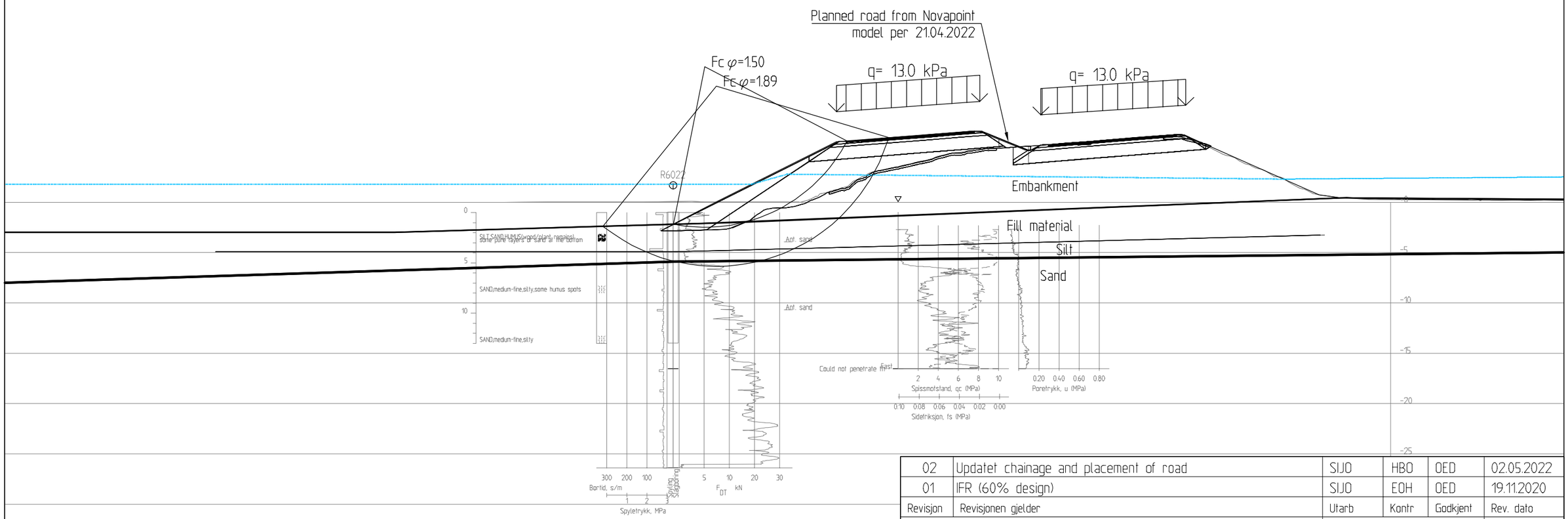
E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 150
Målestokk A3	1 : 300

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon		
SIJO	EOH	ODE	1350037838		DZ06-0003-308	Rev. 02

Material	no	Un.Weigth	Fi	C`
Embankkment	1	19.00	42.0	1.0
Fill	2	19.00	33.0	0.0
Silt	3	20.00	31.7	3.0
Sand	4	19.00	35.0	0.0



02	Updatet chainage and placement of road	SIJO	HBO	OED	02.05.2022
01	IFR (60% design)	SIJO	EOH	OED	19.11.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Stability analysis ch. 23 960

Day zone 6

E6RV-DJV-GT-RPT-DZ06-0003

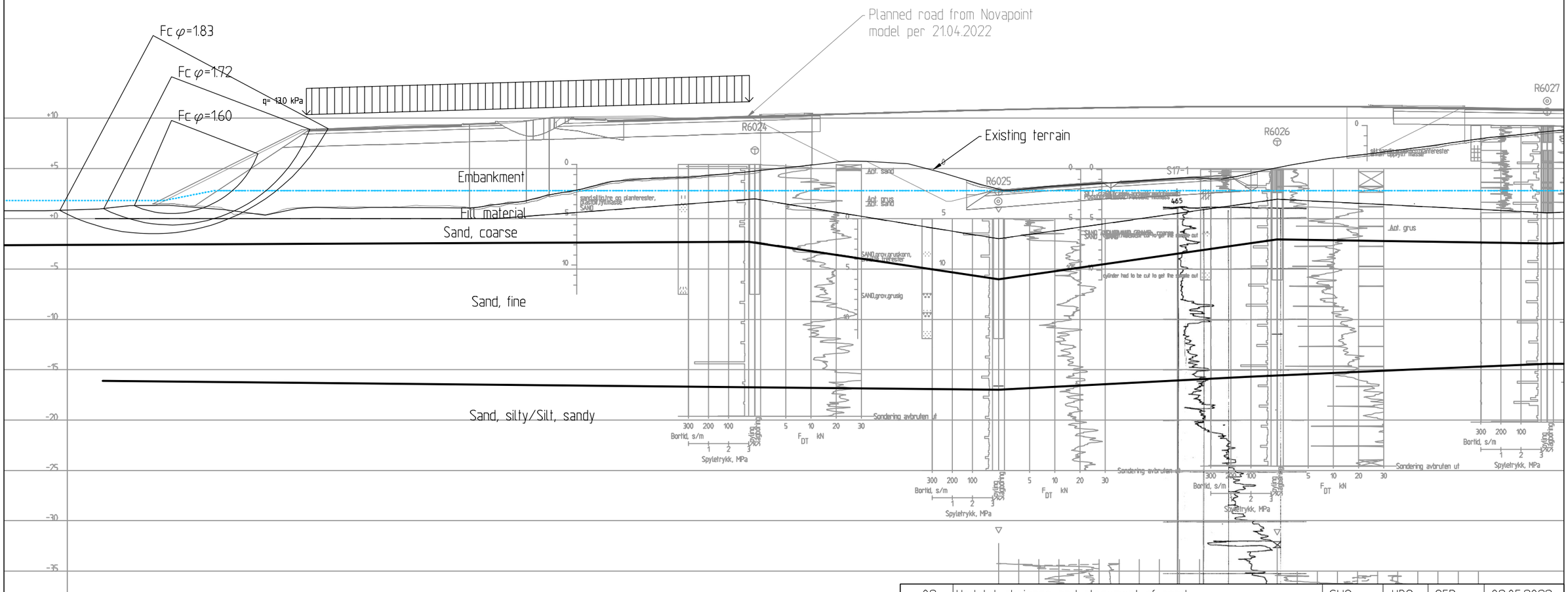
Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 200
Målestokk A3	1 : 400

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJO	EOH	ODE	1350037838

Tegningsnummer/ revisjon		
	DZ06-0003-309	Rev. 02

Material	no	Un.Weigth	Fi	C`
Embankment	1	19.00	42.0	1.0
Fill	2	19.00	33.0	0.0
Sand, coarse	3	19.00	36.0	0.0
Sand, fine	4	19.00	35.0	0.0
Sand/Silt	5	20.00	32.0	3.0



02	Updatet chainage and placement of road	SIJO	HBO	OED	02.05.2022
01	IFR (60% design)	SIJO	EOH	OED	19.11.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Stability analysis ch. 24 235 Day zone 6

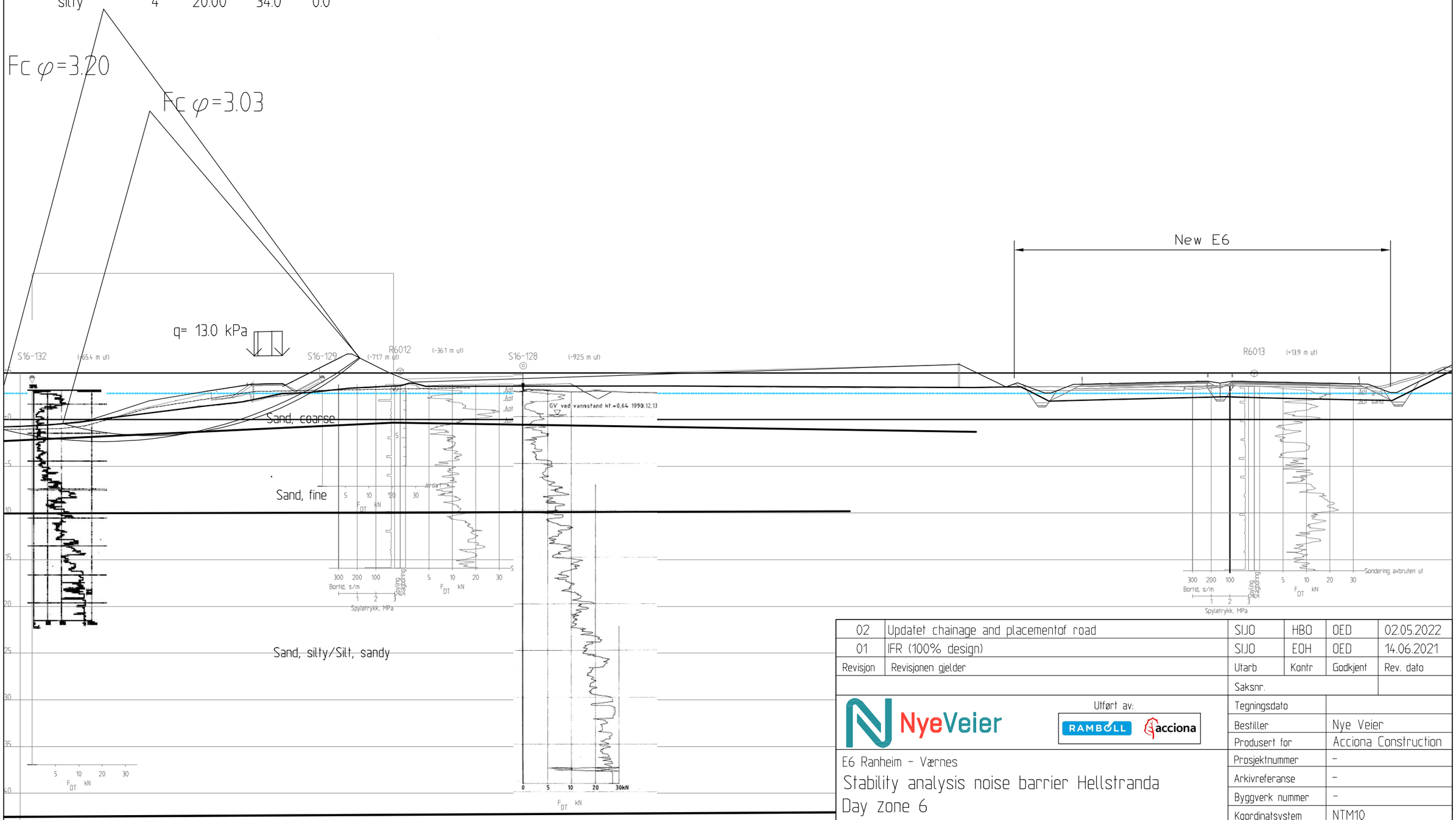
E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 200
Målestokk A3	1 : 400

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon		
SIJO	EOH	ODE	1350037838		DZ06-0003-310	Rev. 02

Material	no	Un.Weigth	Fi	C`
Blasted	1	19.00	42.0	1.0
Sand, coarse	2	20.00	36.0	0.0
Sand, fine	3	20.00	35.0	0.0
silty	4	20.00	34.0	0.0



02	Updatet chainage and placementof road	SIJO	HBO	OED	02.05.2022
01	IFR (100% design)	SIJO	EOH	OED	14.06.2021
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
		Saksnr.			

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Stability analysis noise barrier Hellstranda Day zone 6

E6RV-DJV-GT-RPT-DZ06-0003

Earthworks and retaining walls

Tegningsdato	
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	-
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1 : 200
Målestokk A3	1 : 400

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon		
SIJO	EOH	ODE	1350037838		DZ06-0003-311	Rev. 02

APPENDIX 1: LANDSKAPSPLAN OG SNITT, HELLSTRANDA. 100 % DELIVERY

Tegnforklaring

- Eksisterende kote
- Ny kote
- Eiendomsgrense
- Ny kystkontur/strandlinje
- Voll/skråning
- Eksisterende terreng og vegetasjon bevares
- Vann
- Sti
- Regulert kjøreveg
- Plastring
- Eksisterende plastring
- Strandeng
- Gress/blomstereng
- Beplantning
- Trær
- Elvereodert stein
- Trestamme

Merknader

03	Diverse endringer	SIJY	JOL	OLSA	16.02.2022
02	Reduced filling	SIJY	JOL	OLSA	08.12.2021
01	Endret plassering av oppstillingsplass for bil	JOL	RASY	RHO	09.09.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato

Godkjent arbeidstegning

Saksnr. Saksnr

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Dayzone 6

Tegn-type-profil

Tegn-info-1

Landskapsplan Hellstranda

100 % delivery

Tegningsdato	04.09.2020
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	1350037838
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1:1500
Halv målestokk A3	1:3000

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon	
SIJY	JOL	RHOTRH	E6RV-DJV-LS-DRO-DZ06-0001	0621	03

Tegnforklaring

- Eksisterende kote
- Ny kote
- Eiendomsgrense
- Ny kystkontur/strandlinje
- Voll/skråning
- Eksisterende terreng og vegetasjon bevares
- Vann
- Sti
- Regulert kjøreveg
- Plastring
- Eksisterende plastring
- Strandeng
- Gress/blomstereng
- Beplantning
- Trær
- Elvereodert stein
- Trestamme

Merknader

03	Diverse endringer	SIJY	JOL	OLSA	16.02.2022
02	Reduced filling	SIJY	JOL	OLSA	08.12.2021
01	Issued for review	SIJY	JOL	RHOTRH	04.09.2021
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
Godkjent arbeidstegning		Saksnr.	Saksnr		

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Dayzone 6

Tegn-type-profil

Tegn-info-1

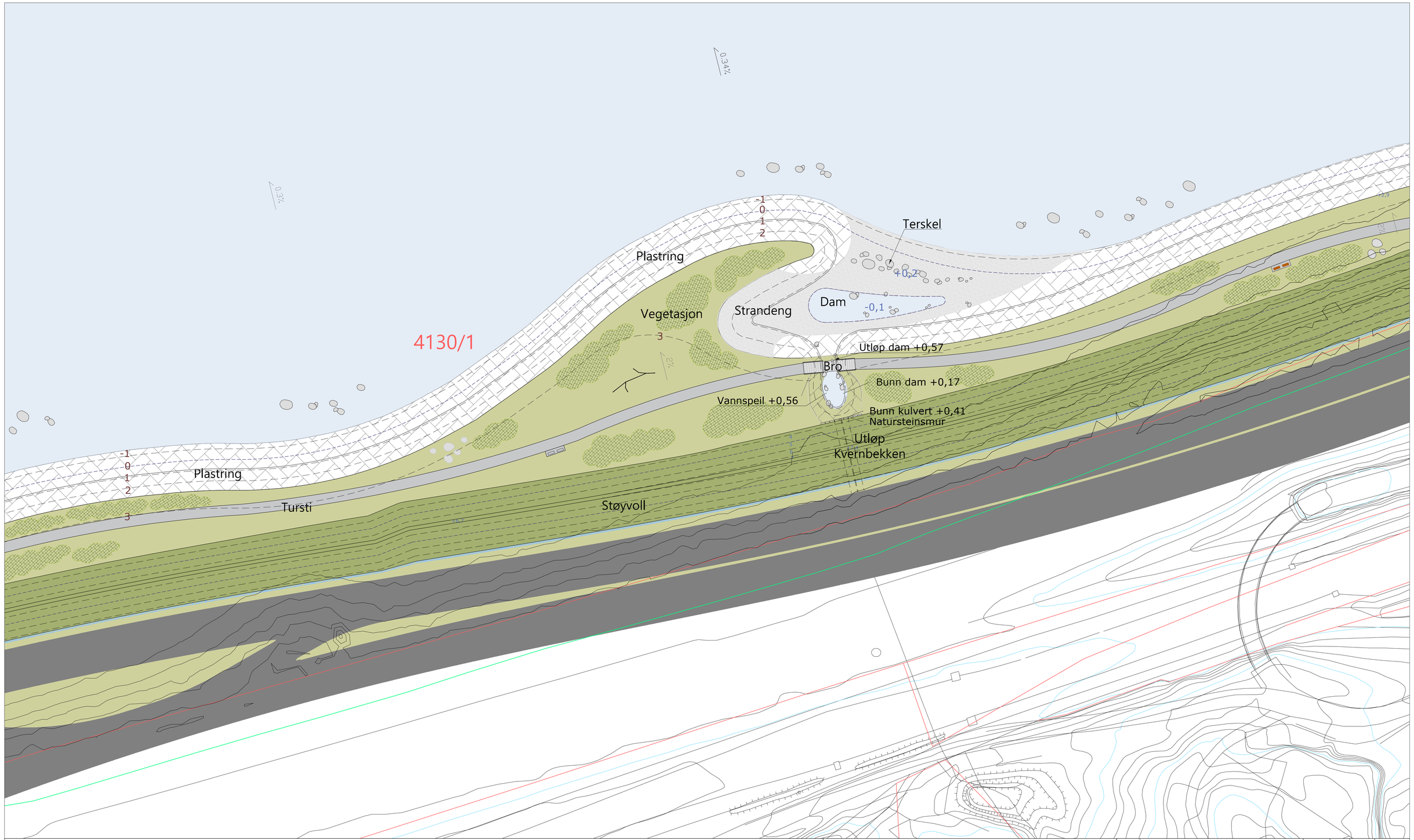
Landskapsplan for Hellstranda

100 % delivery

Tegningsdato	04.09.2020		
Bestiller	Nye Veier		
Produsert for	Acciona Construction		
Prosjektnummer	1350037838		
Arkivreferanse	-		
Byggverk nummer	-		
Koordinatsystem	NTM10		
Høydesystem	NN2000		
Målestokk A1	1:500		
Halv målestokk A3	1:1000		

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJY	JOL	RHOTRH	E6RV-DJV-LS-DRO-DZ06-0002

Tegningsnummer/revisjon: 0622 03



Tegnforklaring

- Eksisterende kote
- Ny kote
- Eiendomsgrense
- Ny kystkontur/strandlinje
- Voll/skråning
- Eksisterende terreng og vegetasjon bevares
- Vann
- Sti
- Regulert kjøreveg
- Plastring
- Eksisterende plastring
- Strandeng
- Gress/blomstereng
- Beplantning
- Trær
- Elvereodert stein
- Trestamme

Merknader

Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato
03	Diverse endringer	SIJY	JOL	OLSA	16.02.2022
02	Reduced filling	SIJY	JOL	OLSA	08.12.2021
01	Issued for review	SIJY	JOL	RHOTRH	04.09.2020

Godkjent arbeidstegning

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Dayzone 6

Tegn-type-profil

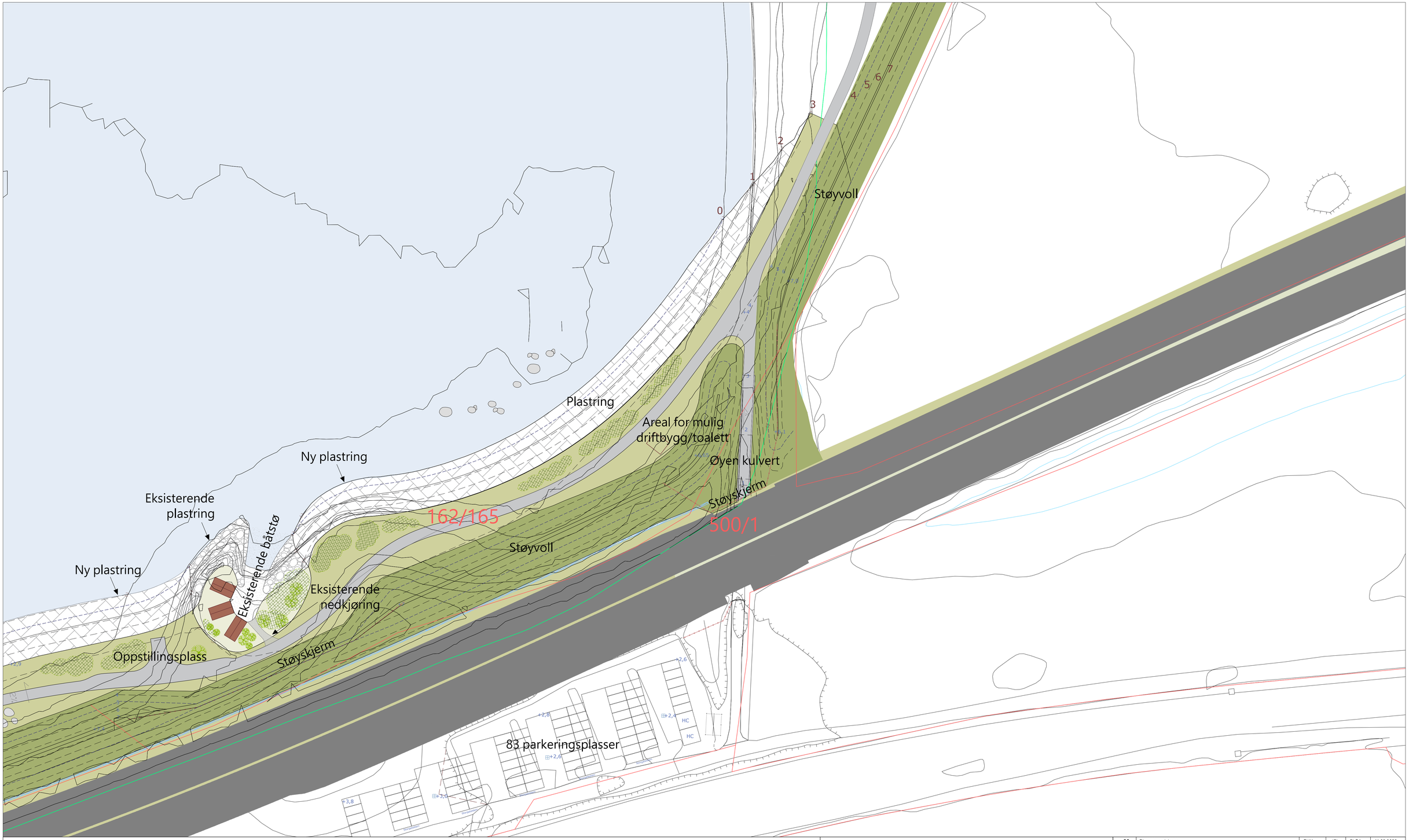
Tegn-info-1

Landskapsplan for Hellstranda

100 % delivery

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJY	JOL	RHOTRH	E6RV-DJV-LS-DRO-D206-0003

Saksnr.	Saksnr
Tegningsdato	04.09.2020
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	1350037838
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1:500
Halv målestokk A3	1:1000
Tegningsnummer/ revisjon	0623 03



Tegnforklaring

- Eksisterende kote
- Ny kote
- Eiendomsgrense
- Ny kystkontur/strandlinje
- Voll/skråning
- Eksisterende terreng og vegetasjon bevares
- Vann
- Sti
- Regulert kjøreveg
- Plastring
- Eksisterende plastring
- Strandeng
- Gress/blomstereng
- Beplantning
- Trær
- Elvereodert stein
- Trestamme

Merknader

03	Diverse endringer	SIJY	JOL	OLSA	16.02.2022
02	Reduced filling	SIJY	JOL	OLSA	08.12.2021
01	Endret plassering av oppstillingsplass for bil	JOL	RASY	RHO	09.09.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato

Godkjent arbeidstegning — Saksnr.: Saksnr

NyeVeier — Utført av: RAMBØLL, acciona

E6 Ranheim - Værnes

Dayzone 6

Tegn-type-profil

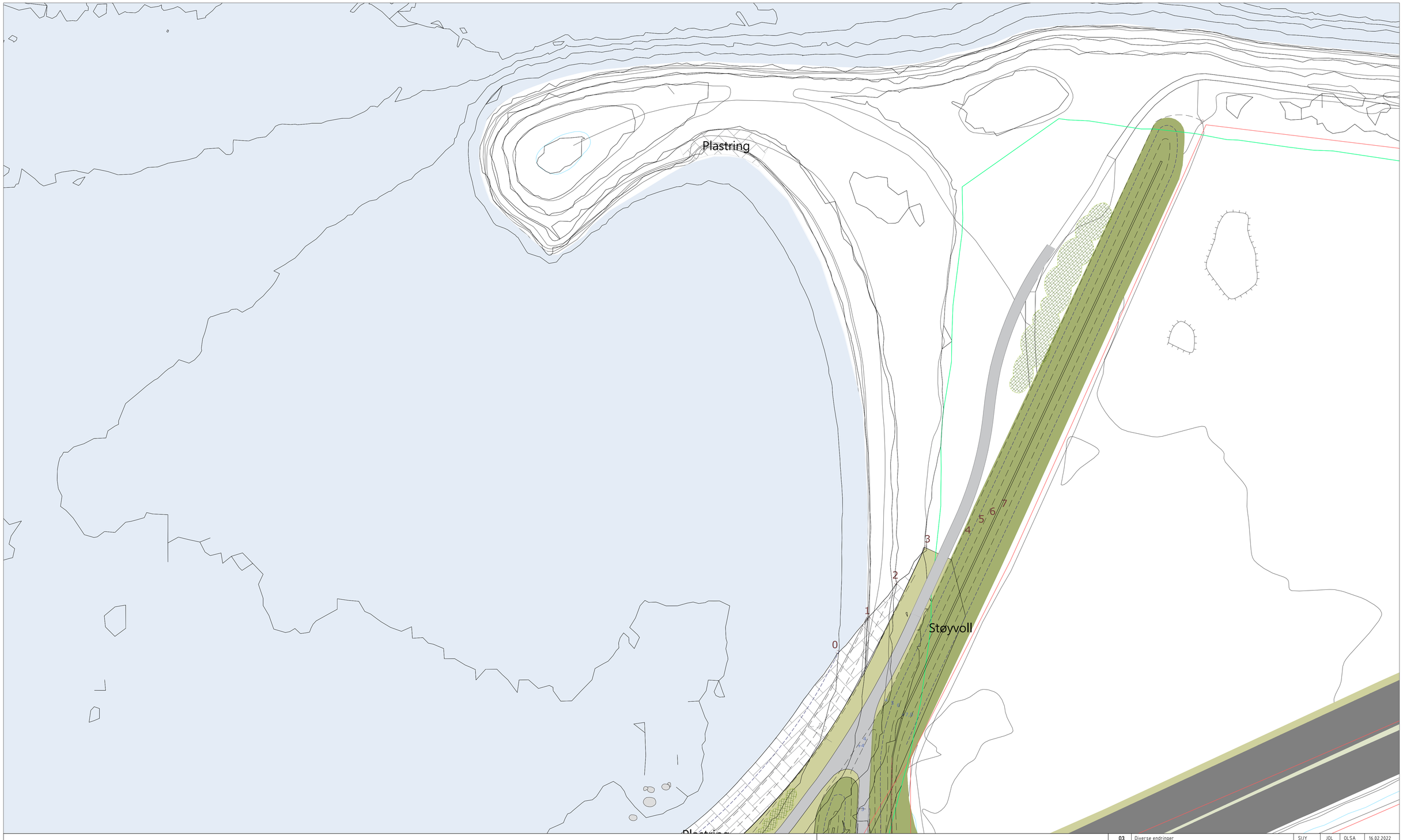
Tegn-info-1

Landskapsplan for Hellstranda

100 % delivery

Tegningsdato	04.09.2020
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	1350037838
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1:500
Halv målestokk A3	1:1000

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon		
SIJY	JOL	RHOTRH	E6RV-DJV-LS-DRO-DZ06-0004	0624	03	



Tegnforklaring

- Eksisterende kote
- Ny kote
- Eiendomsgrense
- Ny kystkontur/strandlinje
- Voll/skråning
- Eksisterende terreng og vegetasjon bevares
- Vann
- Sti
- Regulert kjøreveg
- Plastring
- Eksisterende plastring
- Strandeng
- Gress/blomstereng
- Beplantning
- Trær
- Elvereodert stein
- Trestamme

Merknader

03	Diverse endringer	SIJY	JOL	OLSA	16.02.2022
02	Reduced filling	SIJY	JOL	OLSA	08.12.2021
01	Issued for review	SIJY	JOL	RHOTRH	04.09.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato

Godkjent arbeidstegning

Saksnr. Saksnr

NyeVeier

Utført av: RAMBØLL acciona

E6 Ranheim - Værnes

Dayzone 6

Tegn-type-profil

Tegn-info-1

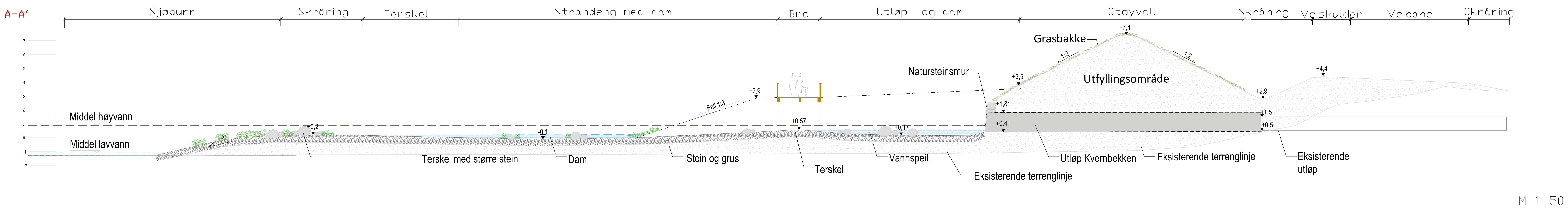
Landskapsplan for Hellstranda

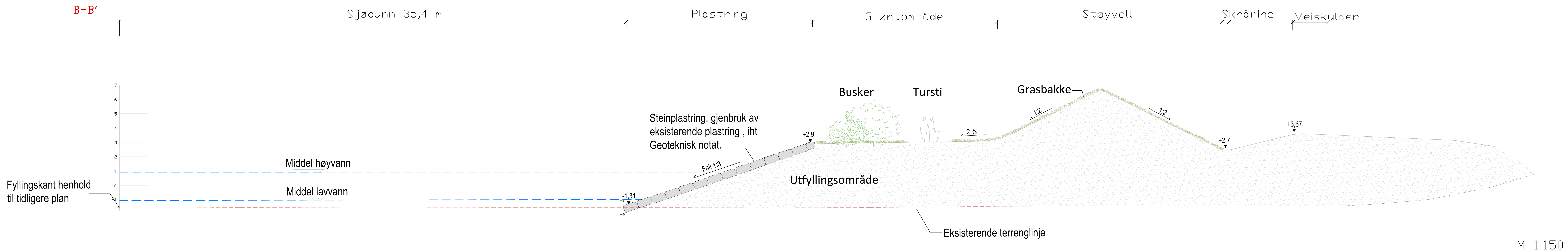
100 % delivery

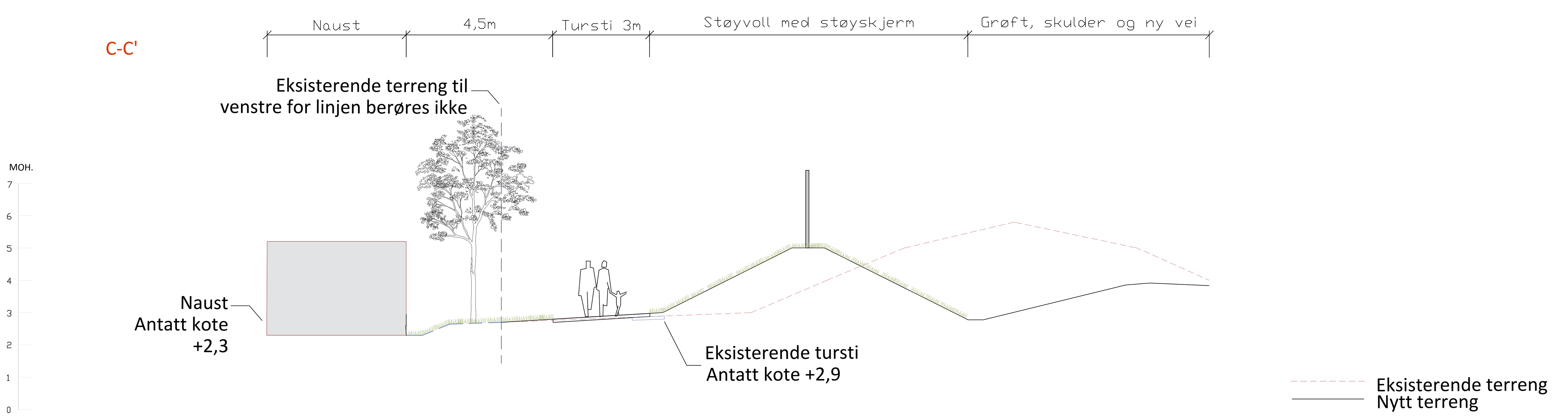
Tegningsdato	04.09.2020
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	1350037838
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1:500
Halv målestokk A3	1:1000

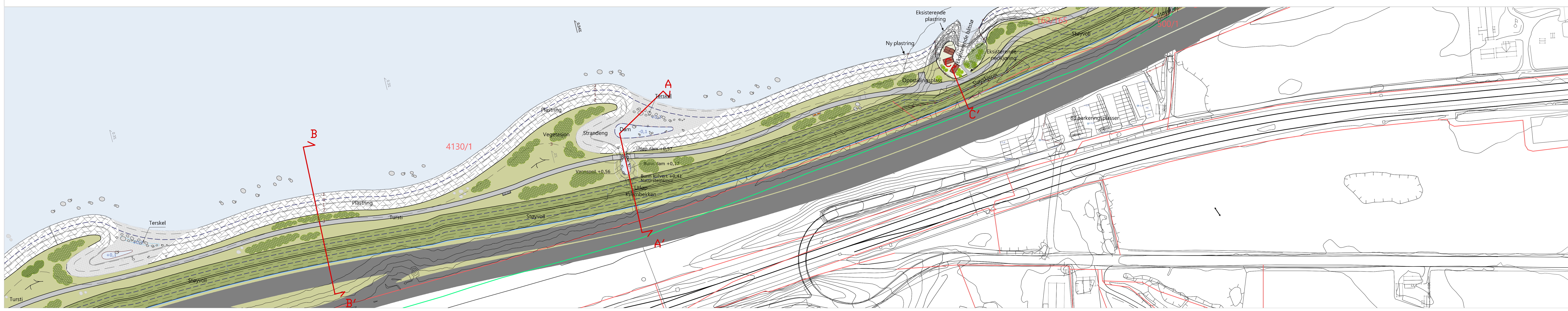
Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv
SIJY	JOL	RHOTRH	E6RV-DJV-LS-DRO-D206-0005

Tegningsnummer/revisjon: 0625 03









03	Diverse endringer	SIJY	JOL	OLSA	16.02.2022
02	Reduced filling	SIJY	JOL	OLSA	08.12.2021
01	Issued for review	SIJY	JOL	RHOTRH	04.09.2020
Revisjon	Revisjonen gjelder	Utarb	Kontr	Godkjent	Rev. dato

Godkjent arbeidstegning — Saksnr. Saksnr

NyeVeier — Utført av: RAMBOLL acciona

E6 Ranheim – Værnes

Dayzone 6

Tegn-type-profil

Tegn-info-1

Hellstranda Snitt A-A', B-B' og C-C'

100% delivery

Tegningsdato	04.09.2020
Bestiller	Nye Veier
Produsert for	Acciona Construction
Prosjektnummer	1350037838
Arkivreferanse	-
Byggverk nummer	-
Koordinatsystem	NTM10
Høydesystem	NN2000
Målestokk A1	1:150 og 1:100
Halv målestokk A3	1:300 og 1:200

Utarbeidet av	Kontrollert av	Godkjent av	Konsulentarkiv	Tegningsnummer/ revisjon	
SJ	JOL	RHOTRH	E6RV-DJV-LS-DRO-DZ06-0100	0640	03