China Harbour Engineering Company PNG Ltd

Kainantu Mine Haul Road River Crossings

K92 Mining Ltd

Lower Baupa River Dredging

Hydrological Report

. Prepared for CHEC by

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Hydrological Report

By

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Contents

1. Executive Summary

Purpose of the Analysis:

China Harbour Engineering Company (PNG) Ltd. (CHEC (PNG)) has a design and build contract with K92 Mining Ltd for upgrading the haul road and river crossings. CHEC (PNG) will design and build a new Lower Baupa Bridge. To support this, CHEC (PNG) developed a river dredging plan aimed at lowering the flood levels and requested J.Buckhill Consultancy Services (JBCS) to conduct a hydrological analysis based on the dredging plan and the hydrological data provided by CHEC (PNG) to determine maximum flood levels. The primary objective is to determine the water flow velocity and the 100-year flood level after the dredging at the bridge site.

Key Findings:

The analysis is based on a bed slope of 3.2% proposed for upstream of the bridge, transitioning to a 5% bed slope over a distance of 20 meters from the centreline of bridge and directly under the bridge. The results provide critical insights for the design and construction of the Lower Baupa Bridge, ensuring it can withstand the anticipated water flow and flood levels.

Table 1: The Estimated Peak Flow Flood Level at the Baupa River

Crossing	Critical Duration(AEP)	10-year AEP	100-year AEP	Remarks
Lower Baupa	10% 6hour 1% 3hour	Design riverbed level +2.5 m	Design riverbed level +3.11 m	Calculation refers to Section 3

Table 2: The Estimated Peak Flow Velocity at inlet and outlet of the bridge based on the Design Riverbed Level

Crossing	Critical Duration (AEP)	10-year AEP	100-year AEP	Remarks
Lower Baupa	10% 6hour 1% 3hour	7.1 m/s	7.9 m/s	3.2% river bed slope
Lower Baupa	10% 6hour 1% 3hour	8.9 m/s	9.9 m/s	5% river bed slope

The levels calculated and shown in Table 1 for each corresponding maximum flood flows fall within the range recommended by CHEC of 2 to 3 meters of dredging down from the existing riverbed level to the proposed river bed level described in Section 5. JBCS have conducted PNG Regional Flood Frequency Method for 100-year AEP resulting in the flowrate of 245 m³/s which is equal to EER flowrates of 246 m³/s based on the same method (PNG RFFM), hence, the decision to use Q_{100} for the peak flood flow of 534 m³/s from the catchment as the basis of design for sizing water structures.

Recommendations:

The worst-case design scenario of Q_{100} is used in the analysis and it is based on the riverbed slope of 3.2% proposed for upstream of the bridge, transitioning to a 5% bed slope over a distance of 20 meters from the centreline and directly under the bridge. A further 2% riverbed slope is proposed to be constructed past the outlet of the bridge and gradually ties into the existing bed slope of the river bed further downstream. A trapezoidal channel matching the bridge width with ripraps install on the river bed and on the batter wall (slope) are to be constructed with an option for flood dykes with sufficient freeboard incorporate into the design be installed on both side of the river channel to contain any variations in maximum flood levels.

2. Introduction

This proposal outlines a comprehensive plan for river dredging aimed at lowering flood levels by 2 to 3 meters along the 1.3 kilometre stretch of the river proposed by China Harbour Engineering Company (CHEC) based on the hydrological data supplied by K92 Mining Ltd. The project aims to enhance the river's capacity to manage high-flow events, thereby reducing flood risks. Key components of the project include detailed site surveys, sediment removal, channel widening, and environmental mitigation measures. The proposal emphasizes a holistic approach, integrating regular maintenance, community engagement, and robust safety measures.

Flow in natural channels, such as rivers and creeks and artificial canals, are free surface flows. The driving forces of water flows in open channels with a free surface (i.e., under atmospheric pressure) are gravitational forces; in other words, the water is set in motion by the slope of the channel. This report proposed a percentage (%) riverbed slope to accommodate an estimated 10% AEP flood flow (Q_{10}) for the Baupa River in a trapezoidal channel of constant dimensions with an option for the construction of flood dykes appropriately sized to contain any variations in the 1% AEP peak flood flow (Q_{100}) as the design flowrate. The Manning-Strickler equation was applied to size the river channels width to match or tie into the existing bridge width of 30 meters. The maximum flood velocity for the respective bed slope was estimated based on the design levels by CHEC. The existing water level of 507.3 meter under the bridge was given with the existing level at peg point K0+680 is 505.621 m supplied by CHEC dredging plan. The report includes a flood frequency analysis and the hydraulic modelling of desilting basin along the length of river between the two peg points to settle suspended sediments based on the proposed levels by CHEC, which will ensure that the construction of the bridge at the existing levels is sound and safe from maximum flood flows (Q_{100}).

2.1 Project Background

The Baupa River is located in the Eastern Highlands Province of PNG, presents a critical waterway that necessitates the construction of a bridge for improved connectivity and transportation for the haul trucks operation between the mine site and the process plant site. The purpose of this analysis is to estimate the maximum flood flow of the Baupa River to incorporate in the design and construction of a robust bridge structure capable of withstanding and avoiding the potential flood events. The analysis incorporates historical hydrological data, flood frequency probabilities, and hydraulic modelling to ensure the safety and durability of the bridge by efficient management of the river and its sediments during and after the flood flows.

Project Location and Purpose:

- Location: Baupa River, Eastern Highlands Province, Papua New Guinea.
- Purpose: To construct a bridge that can safely accommodate the estimated maximum flood flow, ensuring the longevity and stability of the structure.

Hydrological Data Collection:

- Collection of historical rainfall and river flow data for the Baupa River.
- Measurement of river levels to understand flow variations.
- Inclusion of bed slope data upstream (3.2%) and under the bridge (5%) (Hydraulic Manual, 1996).

Flood Frequency Analysis:

- Catchment Area 60.4 km² (Table 5, CHEC)
- Water level under the bridge is 507.3 m (Table 12, CHEC)
- Existing riverbed level at peg point K0+680 is 505.621 m (Dredging Plan 2, CHEC)
- Analysis of historical flood data to determine flood probabilities.
- Estimation of flood magnitudes with a 10% Annual Exceedance Probability (AEP) at 206 cubic meters per second (m³/s) and a 1% AEP out of 100 year return at 534 m³/s (Table 8, CHEC).

Hydraulic Modelling:

- Simulation of flood flows interacting with the proposed bridge structure using hydraulic models based on the hydraulics of the settling basin principle.
- Consideration of the trapezoidal channel lined with ripraps and flood dykes as an option on both sides of the channel to cater for variations in peak flood flow, riverbed slopes proposed to ensure accurate modelling of flood behaviour and sediments transportation.

This thorough approach will aid in designing a bridge that meets safety standards and can withstand potential flood events in the Baupa River area at the existing ground level.

3. Data Collection

Site Information:

The Baupa River area features varied topography, with elevations ranging from low-lying floodplains to moderately steep slopes at the mine site and catchment area. The terrain influences the flow patterns and flood behaviour of the river.

The soil in the region primarily consists of sandy loams and clay loams, which impact the infiltration rates and runoff characteristics. These soil types are considered in the hydrological and hydraulic analyses.

The area surrounding the Baupa River is characterized by tropical rainforest vegetation, which affects the surface runoff and evapotranspiration rates. Dense vegetation upstream of the bridge can help reduce the impact of flooding by slowing down surface water flow.

Hydrological Data:

- Rainfall: Historical rainfall data for the catchment area, indicating average and extreme precipitation events.
- Streamflow: Measurements of river flow rates over time to understand the variability and peak flow conditions.
- Water Table Levels: Data on groundwater levels to assess the contribution of base flow to the river.

Hydraulic Infrastructure

- Bridge Design: Consideration of the proposed bridge dimensions and structural elements by CHEC.
- Channel Dimensions: Proposed Trapezoidal Cross-sectional profiles of the river channel at the bridge site, upstream and downstream is shown as schematic in Fig.3.
- Design Bed Slopes:
  - Upstream of the bridge: 3.2%
  - Under the bridge: 5%
- Channel Roughness: Estimation of Manning's roughness coefficient based on channel conditions and vegetation is 25 taken from hydraulic design manual in Fig.4.
- Flood Dykes as an option is proposed in Fig.3.

4. Methodology

Hydraulic Models: Description of models and software (e.g., HEC-RAS, SWMM) are not used for the analysis. JBCS uses recent experiences in PNG on hydrological study for hydroelectric power generation scheme used in catchment area modelling for peak flood flows and the design of water structure such as weir, desilting chamber and open canal flow is employed. These models provide a comprehensive analysis of the hydraulic behaviour of the Baupa River, ensuring that the bridge design can accommodate the estimated maximum flood flow, for the specific site conditions.

5. Maximum Flood Level Calculations

The term 1% Annual Exceedance Probability (AEP) refers to the likelihood of a specific flow rate or water level being exceeded in any given year. In other words, there is a 1% chance (or 1 in 100 chance) that a flow or level of this magnitude will occur in any single year.

Table 3, show K92 Mine and CHEC supplied hydrological data for the calculation of maximum flood levels.

Table 3: Hydrologic and hydraulic reference design inputs (Table 8, CHEC)

Crossing	Critical Duration (AEP)	Bridge Crossing – Estimated Peak Flow Upstream	
		10-year AEP (m^3/s)	100-year AEP (m^3/s)
Lower Baupa Crossing	10% - 6 hour 1% - 3 hour	206	534

The estimated flood water levels calculated for both scenarios are:

- 10-year AEP (206 m^3/s): Approximately 2.50 meters
- 100-year AEP (534 m^3/s): Approximately 3.11 meters

These levels fall within the range proposed by CHEC of 2 to 3 meters of dredging the river bed to lower the flood levels along the length of the river and under the bridge between the two peg points.

5.1 Design Flood Estimation

Basic Method – Regional Flood Frequency Method

K92 Mining Ltd through CHEC have supplied the hydrological data have been used in the analysis in this section, however the PNG Regional Flood Frequency Method (RFFM) is presented here as an alternative that can be used if the hydrological data were not made available to CHEC. This method (RFFM) is based on the regression analysis of 66 flood records and various catchment and rainfall parameters. The catchments are located throughout Papua New Guinea (although most were on the mainland) and had catchment areas ranging from 5 km^2 to 40 900 km^2. The following parameters are used to estimate flood flows:

Input Requirements

The method uses three parameters for the estimation of floods. These are:

- AREA - catchment area (km^2)
- P_2 - daily rainfall intensity index (mm) -see Fig. 7
- SLOPE - slope index of main channel (m/km) – see Fig.8 and 9

Other factors are used to define the “normality” of the catchments. These are:

- SWAMP - 1.0 + decimal proportion of swamp or flood-prone land along the main river channels as defined on the 1: 100 000 topographic maps – Fig.6
- SHAPE - catchment shape index – see Fig.5
- KARST - percentage of karstic land in the catchment – as defined on the 1:100 000 topographic maps.

Estimation Procedure

We now compute the “best estimate” 10-year return period peak flood estimate, using;

$$Q_{10} = 0.028\, AREA^{0.70} P_2^{1.12} KS$$

and also compute the “best estimate” 100-year return period peak flood estimate, using;

$$Q_{100} = 0.059\, AREA^{0.65} P_2^{1.12} SLOPE^{0.11} KS$$

These equations and other related equations can be used to calculate the maximum flood flow levels at Baupa River. However, Kainantu Mining Ltd Hydrological team have provided the hydrological data of the river in question which has been used in the hydrological analysis and the design of hydraulic settling basin along the full length of river between the two peg points in Section 5.2 below.

5.2 Proposed Percentage (%) Riverbed Slope for the Trapezoidal Channel

On the hydraulic design of the channel, JBCS proposed that for the worst-case scenario, the 100-year AEP (534 m³/s) which equates to approximately 3.11 meters $(3.11m)$ flood level calculated is added to existing water level to obtain maximum flood levels (see Schematic in Fig.3). The proposed 3.2 to 5% bed slope can be employed to lower the maximum flood level based on the proposed level by CHEC of 2 to 3 m of dredging from the existing river level, the existing water level is 507.3 m under the bridge. JBCS proposed for Cut and Fill to obtain the proposed design levels and bed slope to ensure that the new maximum flood levels along the longitudinal section of the river from GHK0 +000 to GHK1+298.087 is within channel, additional flood dykes can be constructed to allow for variations in peak flood flow (both Q_{10} and Q_{100}). Table 4, shows the reference peg points and chainages along longitudinal section of the river showing, existing levels, maximum flood level based on Q_{100} at 534 m³/s, proposed design levels based on percentage river bed slope and mean velocity based on maximum flood flow in the open channel at 3.2% bed slope and 5% bed slope under the bridge.

The Manning-Strickler equation for the free-surface channel flow is employed to obtain the maximum flood velocity based on the 3.2% riverbed slope upstream of the bridge at peg point GHK0+620 to peg point GHK0+000, while the 5% riverbed slope under the bridge is proposed to accelerate sediments from peg points GHK0+620 to K0+720 at the bridge outlet. A further 2% riverbed slope is proposed from peg point GHK0+720 to peg point GHK1+298.087 which is the outlet of the settling basin, this peg point tie into the existing riverbed slope constitute the last length of the desilting basin of length L of the river in question. The length of the river in question is between GHK0+00 and GHK1+ 298.087 which function as a Desilting or Settling Basin for settling suspended stone particles during flood flows at peg point GHK1+298.087. A total horizontal length of approximately 1300 m is measured as length L in Fig.1 is taken from the CHEC dredging plan longitudinal profile shown in Fig.12. The operating principle of the Hydraulic Basin is described in Section 5.3. The velocities at Q_{100} flood flow at the designated 3.2 % upstream to 5% riverbed slope under the bridge in the trapezoidal channel must have a length (L) greater than 206 m to sufficiently settle a 0.2 mm diameter stone size downstream of the bridge to be removed by Front-end loader as part of the routine maintenance work. This ensures that the design riverbed slope is maintained. The flood velocities using hydraulic radius R of trapezoidal channel of 2.35 m and the K_s value of 25 is obtained from Fig.4, the Manning-Strickler equation is given by

$$V_{Q100\, Max.Flood\, Flow} = K_s R^{2/3} \sqrt{J}$$

At 3.2 % river bed slope:

$$V_{Q100\, @3.2\%\, Bed\, Slope} = 25 \left(\frac{73.96}{31.47}\right)^{2/3} \sqrt{0.032} = 7.9\, m/s$$

At 5 % river bed slope under the Bridge:

$$V_{Q100\, @5\%\, Bed\, Slope} = 25 \left(\frac{73.96}{31.47}\right)^{2/3} \sqrt{0.05} = 9.9\, m/s$$

Table 4: Data Containing Flood Levels Shown on Longitudinal Profiles

Reference Point	Existing Levels	Maximum Flood Levels	Proposed Levels	% River Bed Slope	Flood Velocity
GHK0+000	521.681	524.791	521.681	6	10.8 m/s
GHK0+020	520.713	523.771	521.153	6	10.8 m/s
GHK0+040	519.965	523.075	520.445	6	10.8 m/s
GHK0+060	519.547	522.657	519.738	3.2	7.9 m/s
GHK0+080	519.156	522.266	519.030	3.2	7.9 m/s
GHK0+100	518.420	521.530	518.323	3.2	7.9 m/s
GHK0+120	517.884	520.994	517.615	3.2	7.9 m/s
GHK0+140	517.546	520.656	515.907	3.2	7.9 m/s
GHK0+160	517.044	520.154	516.200	3.2	7.9 m/s
GHK0+180	516.346	519.456	515.492	3.2	7.9 m/s
GHK0+200	515.671	518.781	514.785	3.2	7.9 m/s
GHK0+220	515.147	518.258	514.077	3.2	7.9 m/s
GHK0+240	514.810	517.920	513.370	3.2	7.9 m/s
GHK0+260	514.477	517.587	512.662	3.2	7.9 m/s
GHK0+280	513.786	516.896	511.954	3.2	7.9 m/s
GHK0+300	513.627	516.737	511.247	3.2	7.9 m/s
GHK0+320	513.129	516.239	510.539	3.2	7.9 m/s
GHK0+340	512.571	515.681	509.832	3.2	7.9 m/s
GHK0+360	511.798	514.908	509.124	3.2	7.9 m/s
GHK0+380	511.138	514.248	508.416	3.2	7.9 m/s
GHK0+400	510.597	513.707	507.709	3.2	7.9 m/s
GHK0+420	509.683	512.793	507.001	3.2	7.9 m/s
GHK0+440	508.266	511.376	506.294	3.2	7.9 m/s
GHK0+460	505.641	508.751	505.586	3.2	7.9 m/s
GHK0+480	505.360	508.470	504.878	3.2	7.9 m/s
GHK0+500	505.684	508.794	504.171	3.2	7.9 m/s
GHK0+520	505.104	508.214	503.463	3.2	7.9 m/s
GHK0+540	504.853	507.763	502.756	3.2	7.9 m/s
GHK0+560	505.300	508.410	502.048	3.2	7.9 m/s
GHK0+580	505.225	508.335	501.341	3.2	7.9 m/s
GHK0+600	505.190	508.300	500.633	3.2	7.9 m/s
GHK0+620	505.073	508.183	499.925	3.2	7.9 m/s
GHK0+640	502.979	506.089	499.139	5.0	9.9 m/s
GHK0+660	502.647	505.757	498.297	5.0	9.9 m/s
GHK0+680	505.621	508.731	497.455	5.0	9.9 m/s (bridge)
GHK0+700	503.878	506.988	496.613	5.0	9.9 m/s
GHK0+720	501.887	504.997	495.771	5.0	9.9 m/s
GHK0+740	501.511	504.621	495.482	1.5	6.2 m/s
GHK0+760	500.397	503.507	495.197	1.5	6.2 m/s
GHK0+780	499.917	503.027	494.911	1.5	6.2 m/s
GHK0+800	499.381	502.491	494.626	1.5	6.2 m/s
GHK0+820	498.847	502.957	494.341	1.5	6.2 m/s
GHK0+840	498.938	502.048	494.056	1.5	6.2 m/s
GHK0+860	498.604	501.714	493.771	1.5	6.2 m/s
GHK0+880	498.238	501.348	493.485	1.5	6.2 m/s
GHK0+900	497.926	501.036	493.200	1.5	6.2 m/s
GHK0+920	497.227	500.337	492.915	1.5	6.2 m/s
GHK0+940	496.702	499.812	492.630	1.5	6.2 m/s
GHK0+960	496.075	499.185	492.345	1.5	6.2 m/s
GHK0+980	495.758	498.868	492.060	1.5	6.2 m/s
GHK1+000	495.111	498.221	491.775	1.5	6.2 m/s
GHK1+020	494.986	498.096	491.490	1.5	6.2 m/s
GHK1+040	494.137	497.247	491.204	1.5	6.2 m/s
GHK1+060	493.518	496.628	490.919	1.5	6.2 m/s
GHK1+080	493.001	496.111	490.634	1.5	6.2 m/s
GHK1+100	492.523	495.633	490.349	1.5	6.2 m/s
GHK1+120	492.127	495.237	490.064	1.5	6.2 m/s
GHK1+140	491.661	494.771	489.779	1.5	6.2 m/s
GHK1+160	491.114	494.224	489.493	1.5	6.2 m/s
GHK1+180	490.384	493.494	489.208	1.5	6.2 m/s
GHK1+200	489.419	492.529	488.923	1.5	6.2 m/s
GHK1+220	489.146	492.256	488.638	1.5	6.2 m/s
GHK1+240	488.364	491.474	488.353	1.5	6.2 m/s
GHK1+260	488.150	491.260	488.068	1.5	6.2 m/s
GHK1+280	487.701	490.811	487.783	1.5	6.2 m/s
GHK1+298.087	487.525	490.635	487.525	1.5	6.2 m/s

5.3 Hydraulics of the Settling Basin for Sedimentation

Generally, most rivers and creeks in PNG carry a substantial quantity of sand and finer particles in suspension, especially during flood flows. This sediment load cannot be eliminated at the intake peg points upstream of the bridge without a Gabions Weir install across the river. A settling basin / sand trap or desilting basin approach over the entire length of peg points GHK0+000 and GHK1+298.087 to settle the suspended particles further downstream of the bridge to maintain the design (proposed) river bed slope levels, and therefore the maximum flood levels Q_{100}. For trouble-free operation of the bridge in question, there should not be any sediment deposition in the open channel or elsewhere in the water structure that is designed and constructed. This statement is true and has been found in practice that all particles above 0.2 mm are eliminated, provided that the minimum velocity in the channel is maintained according to Manning-Strickler correlation.

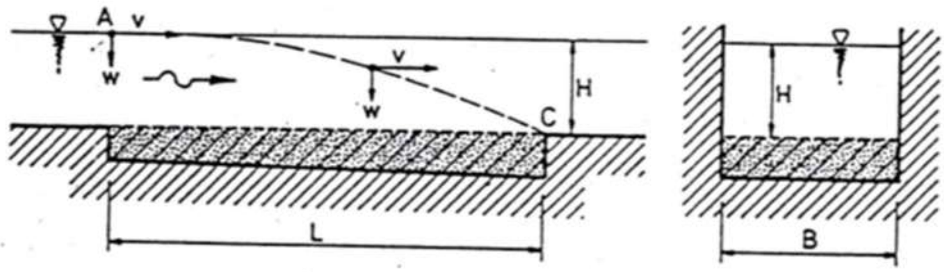


Fig.1: Operating Principle of a Sediment Trap (GTZ Hydraulic Design Manual, PNG, 1996)

The operating principle of a sediment trap is based on the hydraulic design of the settling basin between the two peg points. The water entering the settling basin is slowed down so that the suspended particles settle out at the bottom of the basin. The length of the basin must be such that the design particle of 0.2 mm diameter reaches the bottom at the end of the settling basin as shown in Fig.1.

The travelling time of a particle through the sand trap is;

$$t_x = \frac{L}{v}$$

The settling time of the same particles is;

$$t_y = \frac{H}{w}$$

where w is the fall velocity of the particle obtained from graph in Fig.2

If the particle is to reach the bottom of the basin at point C, the two time t_x and t_y must be equal. Therefore equating both equations, gives;

$$\frac{L}{v} = \frac{H}{w}$$

And with $Q = vHB$ (equation of continuity), the preliminary design formula of a sand trap becomes;

$$L = \frac{Q}{wB}$$

Another condition is that the length of the basin shoulder longer than 8 times width B. If the basin is too wide as compared to its length the water flow tends to meander in the trap, that is;

$$L > 8B$$

Introducing this relationship into the formula above gives;

$$L > \left(\frac{8Q}{w}\right)^{1/2}$$

Therefore, the current trapezoidal channel width, height (maximum flow level), % channel bed slope and the entire length will provide a very efficient sediment removal basin and maximum flood levels is maintained under the bridge.

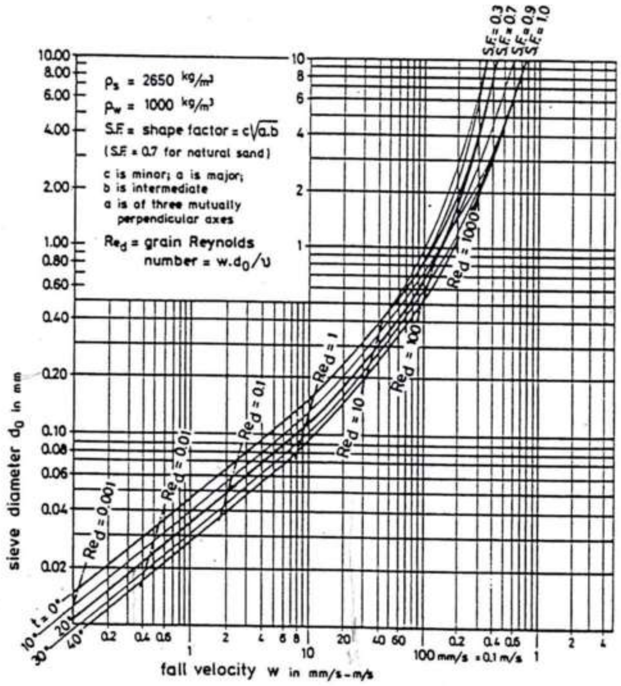


Fig.2: Operating Principle of a Sediment Trap (GTZ Hydraulic Design Manual, PNG, 1996)

5.4 Hydraulics of the Lined Trapezoidal Channel with Ripraps and Flood Dykes

The mean velocity of water flowing in a channel was calculated using the Manning formula. The Manning formula applies to steady uniform flow. For design purposes it is assumed that flow is constant and uniform. Flow in channels can be described as critical, subcritical or supercritical.

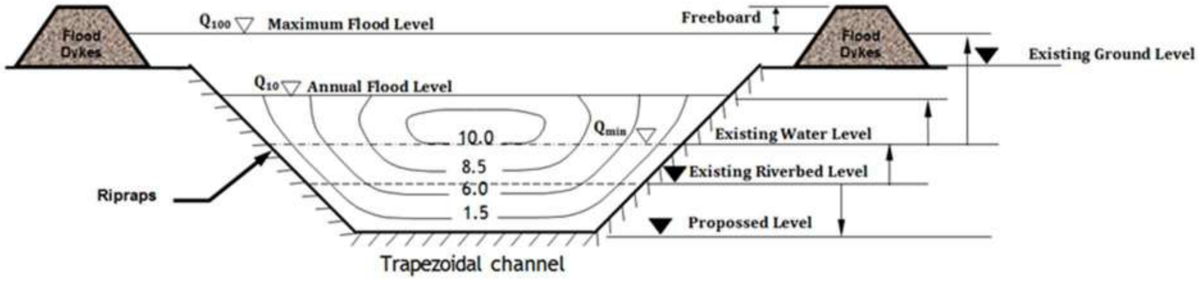


Fig.3: Flood Flow Levels & Variation in flow velocities across a trapezoidal cross section (JBCS, 2024)

Although it is assumed that the mean velocity is constant along the full length a channel, actual velocities will always vary between one cross-section and another. Frictional losses occur where runoff comes in contact with the walls and the base of a channel. As channel roughness increases (or conversely decreases), so does the amount of friction. Friction reduces velocity the most at the edge of the channel and least in the middle as shown in Fig.3.

Dimension of Trapezoidal Channel

Charts have been developed to determine the hydraulic radius of channels of various shapes and sizes. An example for trapezoidal channels is shown in Fig.4 (adapted from Ree 1954). Other charts for a range of shapes are included in the appendices. For channels with differing internal batters, the recommended approach is to firstly determine the average of the two and then use the chart appropriate for that average dimension for the channel as a whole.

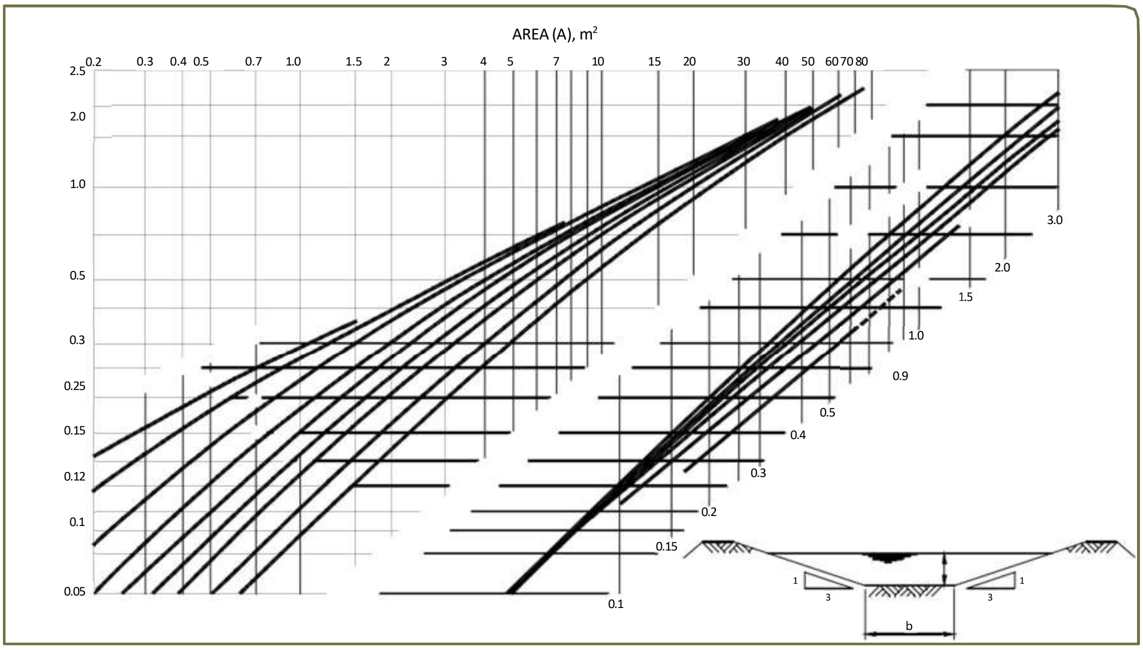


Fig.4: Dimensions of trapezoidal channels with 1:3 (V:H) side channels (adapted from Ree 1954)

6. Analysis and Results

Maximum Flood Flow rates

Flow Rates based on the flood frequency analysis; the following flow rates are considered:

- 10% AEP: 206 m³/s
- 1% AEP: 534 m³/s

Maximum Velocities

- 10% AEP: Flow velocities are estimated based on the channel dimensions and bed slopes.
- 1% AEP: Higher flow velocities are expected due to the increased discharge. The hydraulic model outputs indicate the distribution of velocities along the river channel and around the bridge.

Flood Risk Analysis

Inundation Areas and Flood Levels using the hydraulic models, the potential inundation areas and flood levels for the Baupa River are analysed under different flood scenarios:

- 10% AEP Flood: The inundation area is limited to the immediate floodplain of the river. Flood levels are estimated to rise moderately, affecting low-lying areas near the riverbank.
- 1% AEP Flood: The inundation area significantly expands, covering a larger portion of the floodplain. Flood levels rise considerably, posing a higher risk to nearby infrastructure and settlements. The bridge design must account for these extreme conditions to ensure safety and resilience.

Peak Flow Scenario (1% AEP)

- Flow Rate: 534 m^3/s
- Impact: Significant inundation of the floodplain, high velocities, and increased pressure on the bridge structure. The bridge design should incorporate reinforced foundations and elevated decks to withstand these conditions.

Moderate Flow Scenario (10% AEP)

- Flow Rate: 206 m^3/s
- Impact: Moderate rise in water levels, affecting low-lying areas near the riverbank. The bridge design can accommodate this flow with standard construction practices and minimal additional safety measures.

7. Discussion

Comparison to Design Standards

Assessment against Industry Norms or Regulations. The proposed bridge design and hydraulic infrastructure are assessed against industry standards such as AS (Australian Standards), DMRB (Design Manual for Roads and Bridges), and local regulations. Compliance with these standards ensures the safety, durability, and reliability of the bridge structure.

Critical Findings

- Bottlenecks: Potential bottlenecks include labour shortages, supply chain disruptions, and challenges in obtaining construction materials.
- Risks: Identified risks include structural failures, environmental hazards, and unexpected flood events.
- Inefficiencies: Inefficiencies may arise from poor project management, inadequate planning, and lack of regular inspections.

Implications

- System Operation: Non-compliance with standards and inefficiencies can lead to operational disruptions, increased maintenance costs, and negative environmental impacts.
- Maintenance: Regular inspections and maintenance are crucial to address identified risks and ensure the longevity of the bridge.
- Downstream Effects: Proper design and maintenance can mitigate negative downstream effects, such as flooding and erosion.

8. Conclusion

Maximum Flood Flows and Levels

The hydrological and hydraulic analysis of the Baupa River has provided critical insights for the safe design and construction of a bridge. Key findings include:

- Maximum Flood Flow: The estimated maximum flood flow for the Baupa River is 534 cubic meters per second (m^3/s) with a 1% Annual Exceedance Probability (AEP), and 206 m^3/s with a 10% AEP.
- Bed Slopes: The river features a bed slope of 3.2% upstream of the bridge and 5% under the bridge, which affects the flow velocity and hydraulic behaviour.
- Flood Risk Analysis: The analysis identified significant inundation areas and flood levels for both 10% and 1% AEP scenarios, highlighting the importance of incorporating robust design features to withstand these conditions.
- Environmental and Operational Scenarios: Various scenarios, including peak flow and drought conditions, have been analysed to understand the impact on bridge performance and identify necessary design modifications.

Immediate Actions

1. Finalize Bridge Design: Incorporate the findings from the hydraulic models and flood risk analysis to finalize the bridge design. Ensure that the structure can accommodate the maximum estimated flood flow and account for bed slopes.
2. Regulatory Compliance: Ensure that the bridge design complies with local and international standards, such as the Australian Standard (AS), to guarantee safety and durability.
3. Mitigation Measures: Implement immediate flood defence measures, such as levees and retention basins, to protect the construction site and surrounding areas during the build phase.

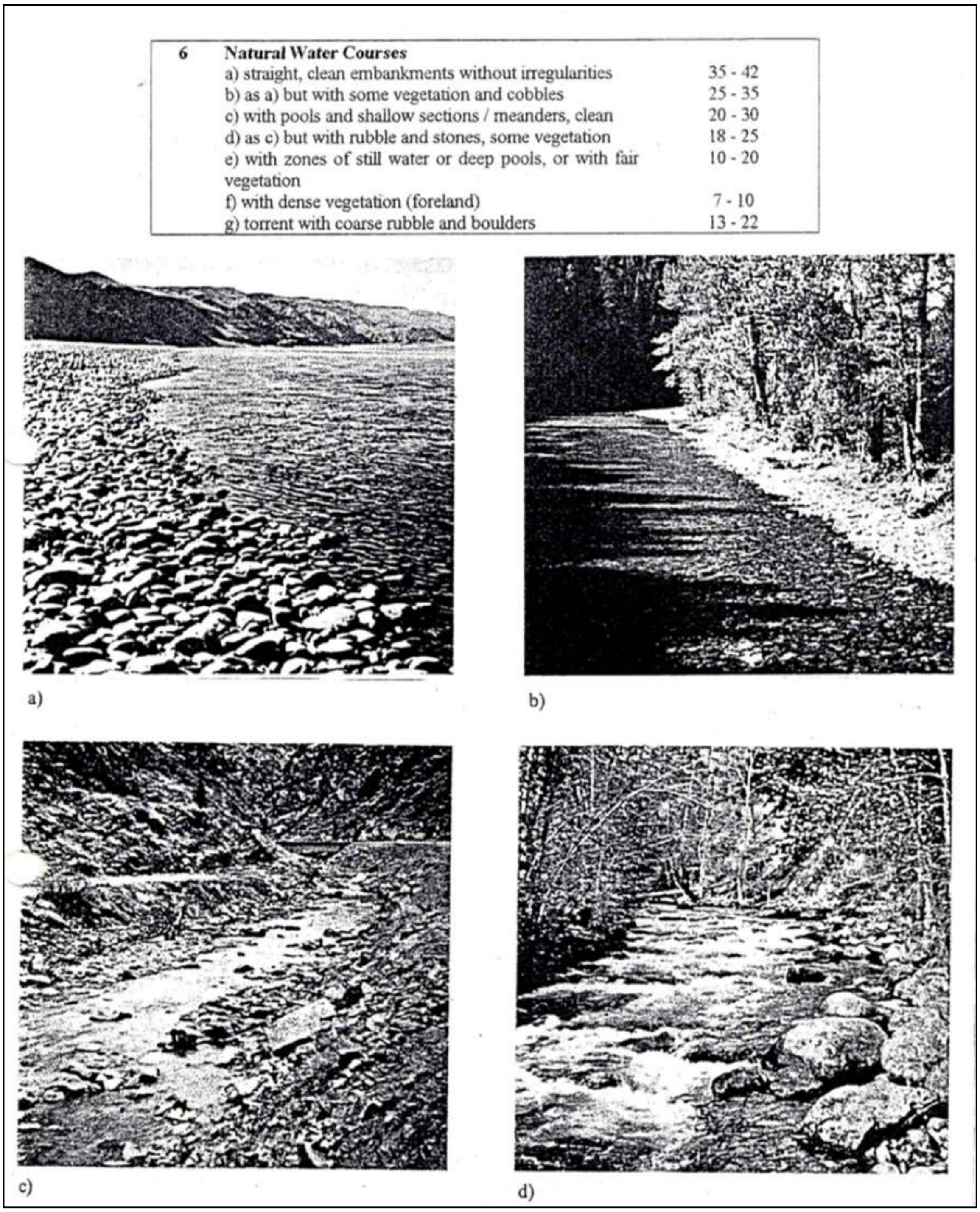
Long-Term Plans

1. Construction Monitoring: Establish a comprehensive monitoring system to track construction progress and detect any potential issues early. Regular inspections should be conducted to ensure adherence to design specifications.
2. Maintenance Schedule: Develop a long-term maintenance plan to inspect and repair the bridge structure regularly. This will help maintain optimal performance and extend the lifespan of the bridge.
3. Environmental Management: Implement strategies to manage the environmental impact of the bridge, ensuring the protection of the river's ecosystem and maintaining ecological health.
4. Community Engagement: Engage with local communities to inform them about the project, address any concerns, and ensure that the bridge meets the needs of the region.

By following these steps, the Baupa River bridge project will be well-positioned for success, providing a safe and reliable crossing for the K92 Mining Ltd.

9. Figures and Tables

These figures and tables should provide a comprehensive visual and data-driven representation of the hydrological analysis for the Baupa River.



6	**Natural Water Courses**	
	a) straight, clean embankments without irregularities	35 - 42
	b) as a) but with some vegetation and cobbles	25 - 35
	c) with pools and shallow sections / meanders, clean	20 - 30
	d) as c) but with rubble and stones, some vegetation	18 - 25
	e) with zones of still water or deep pools, or with fair vegetation	10 - 20
	f) with dense vegetation (foreland)	7 - 10
	g) torrent with coarse rubble and boulders	13 - 22

Fig.4 (14): K_s Values for natural;y occuring river (PNG GTZ, Design Manual, 1996)

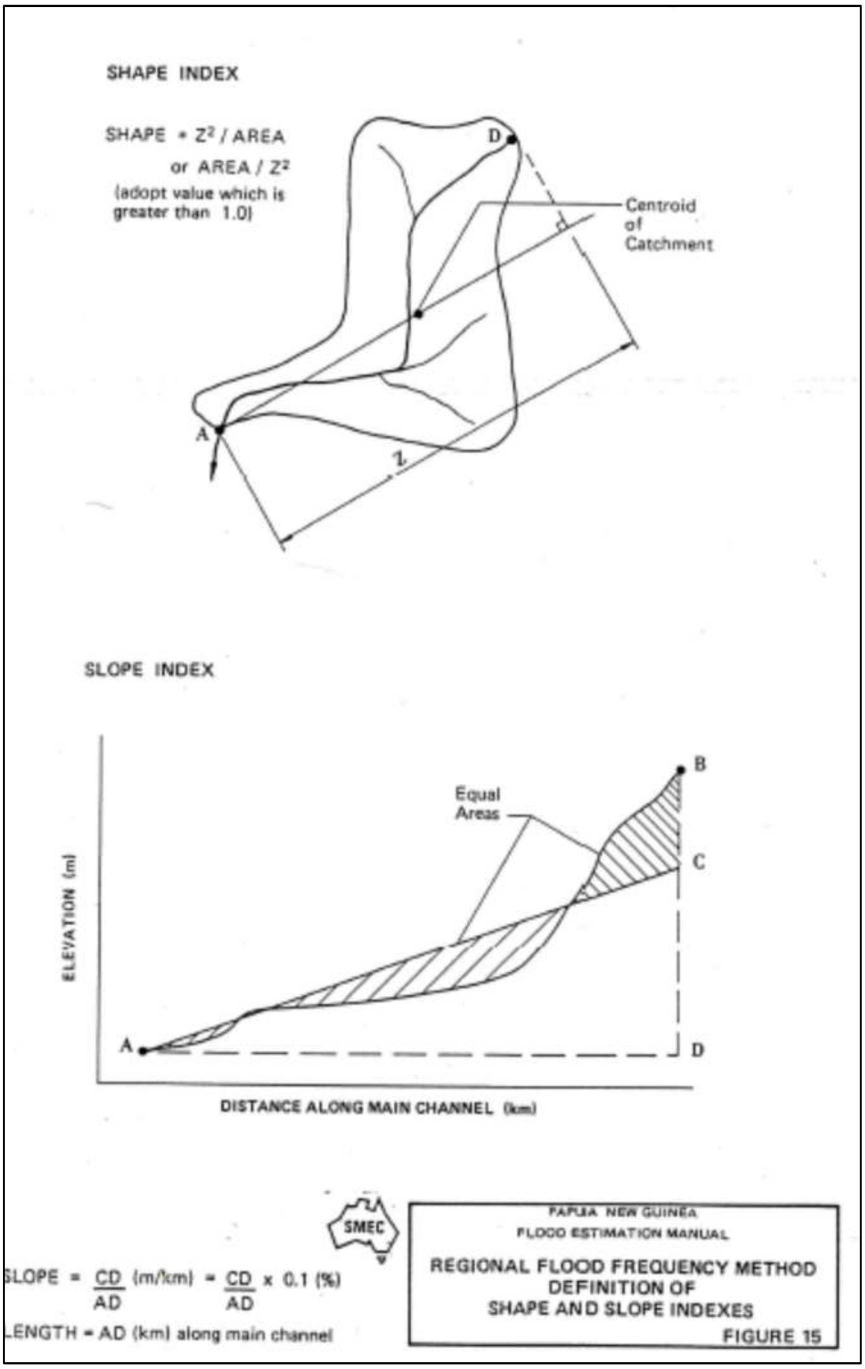


Fig.5: PNG RFFM for Slope Index (PNG GTZ, Design Manual, 1996)

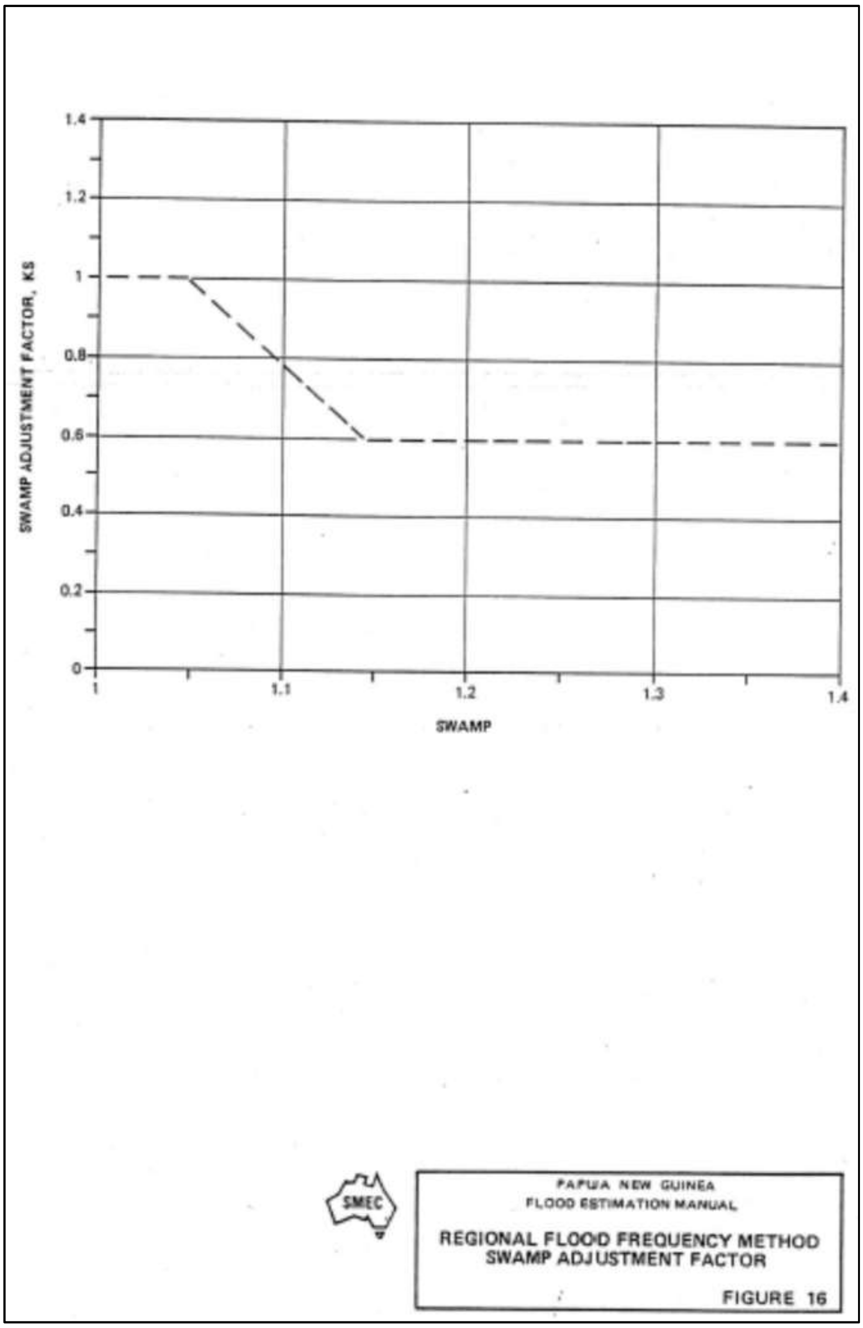


Fig.6: PNG RFFM SWAMP Adjustment Factor (PNG GTZ, Design Manual, 1996)

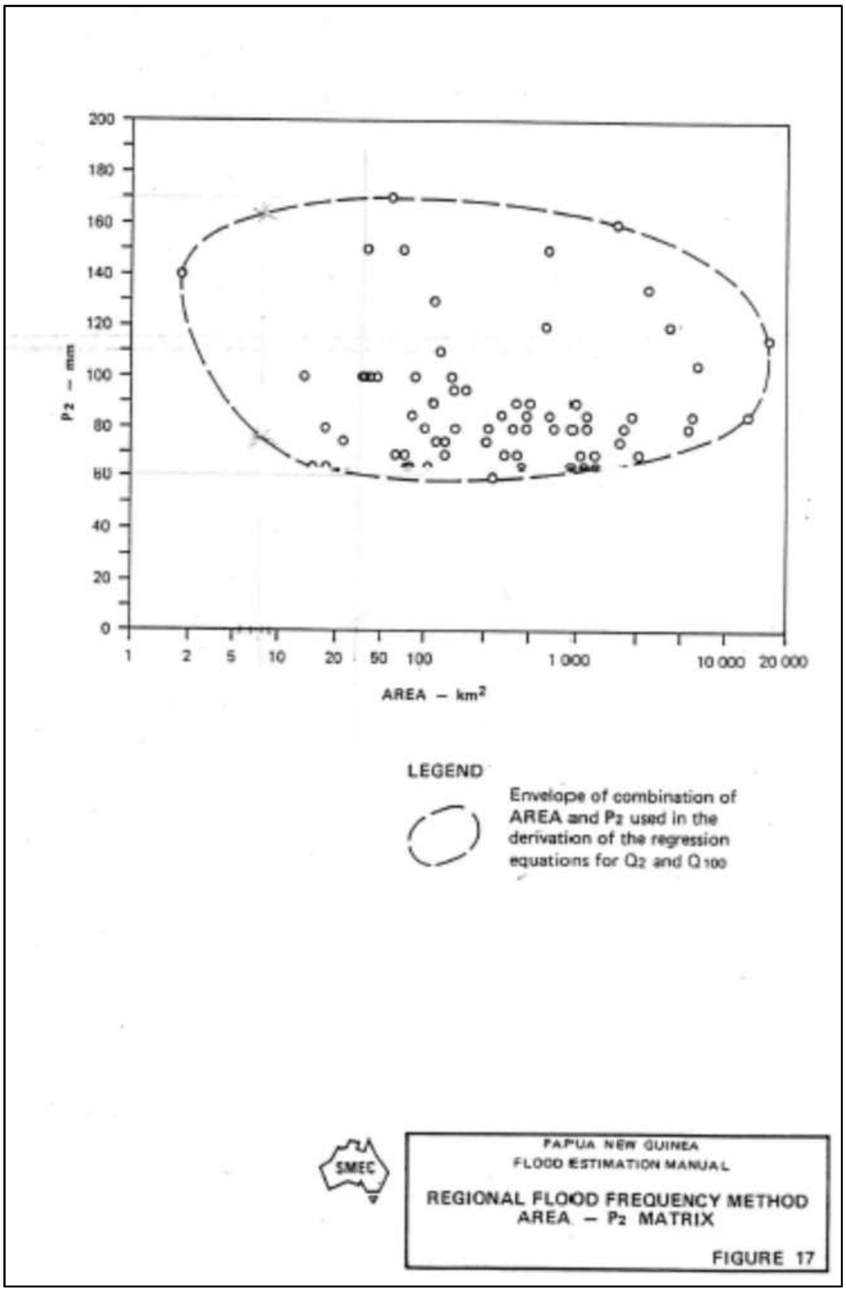


Fig.7: PNG RFFM AREA –P2 Factor (PNG GTZ, Design Manual, 1996)

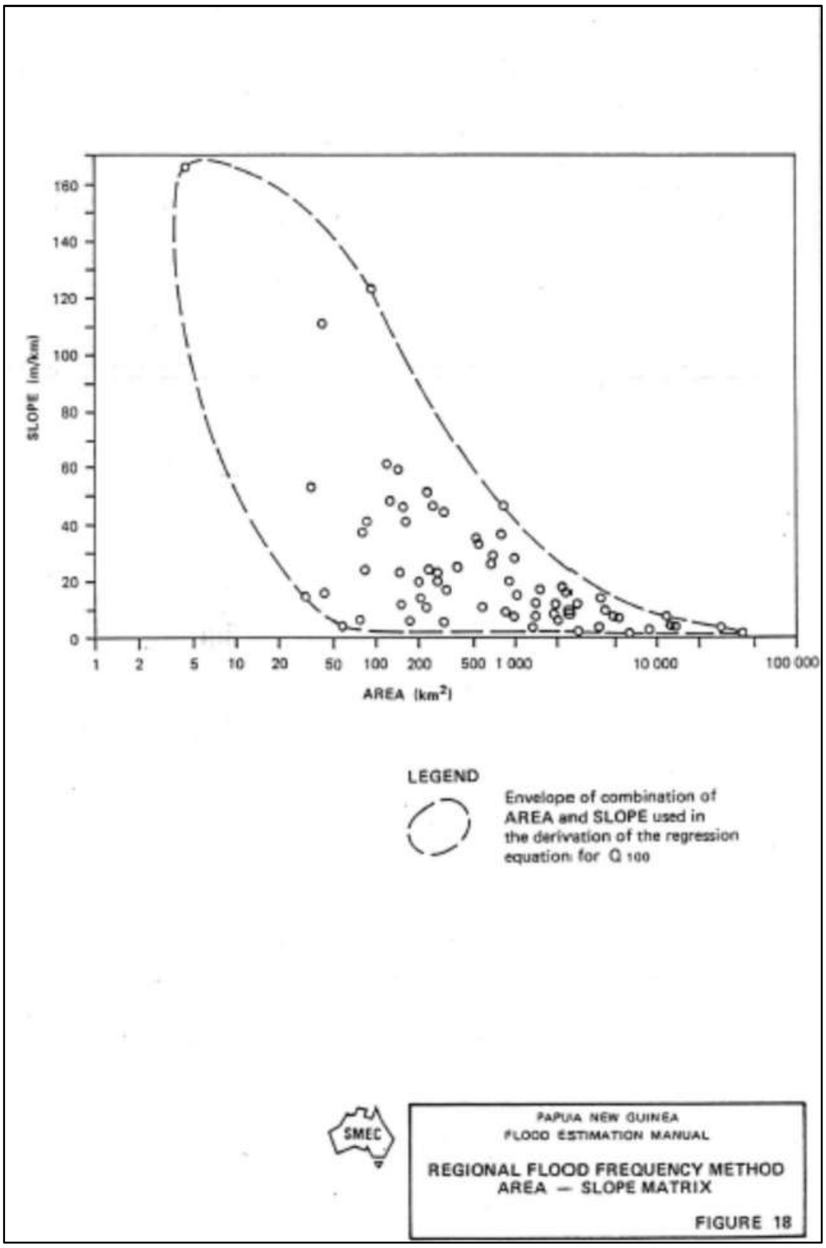


Fig.8: PNG RFFM for AREA –Slope Matrix (PNG GTZ, Design Manual, 1996)

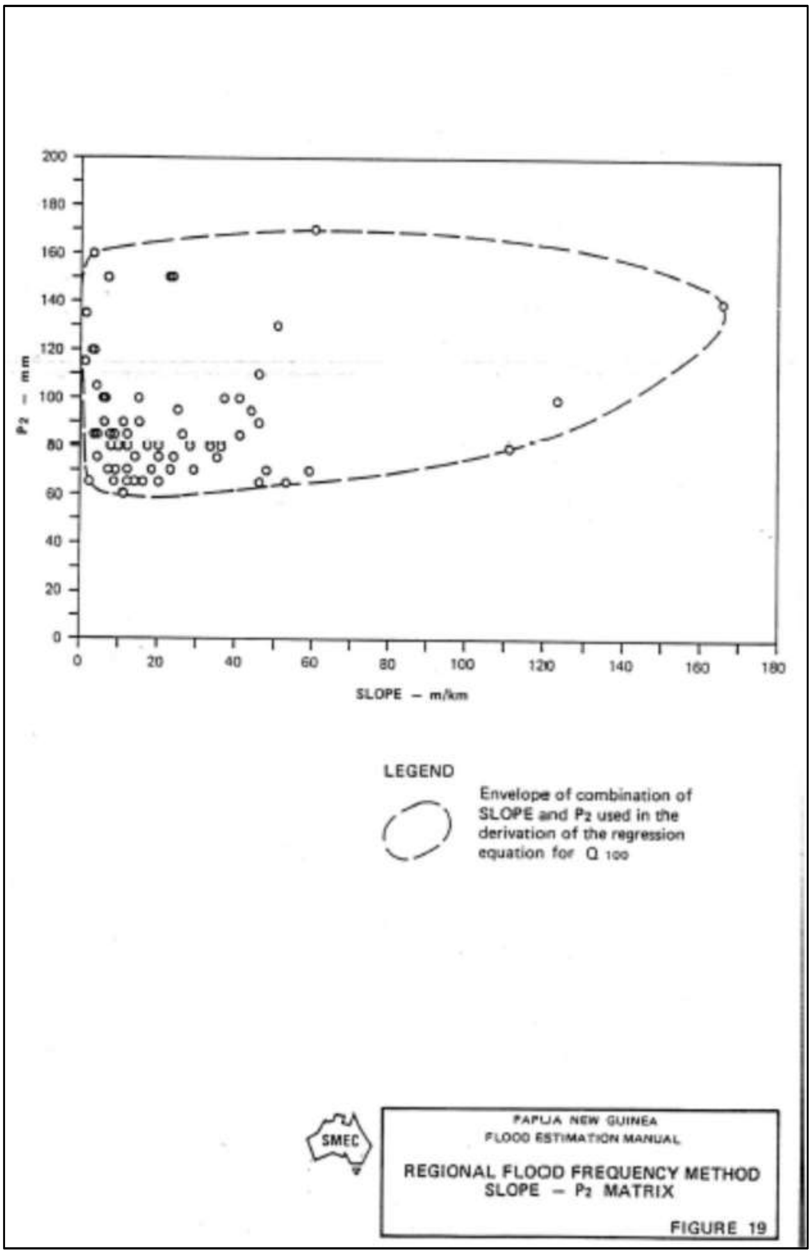
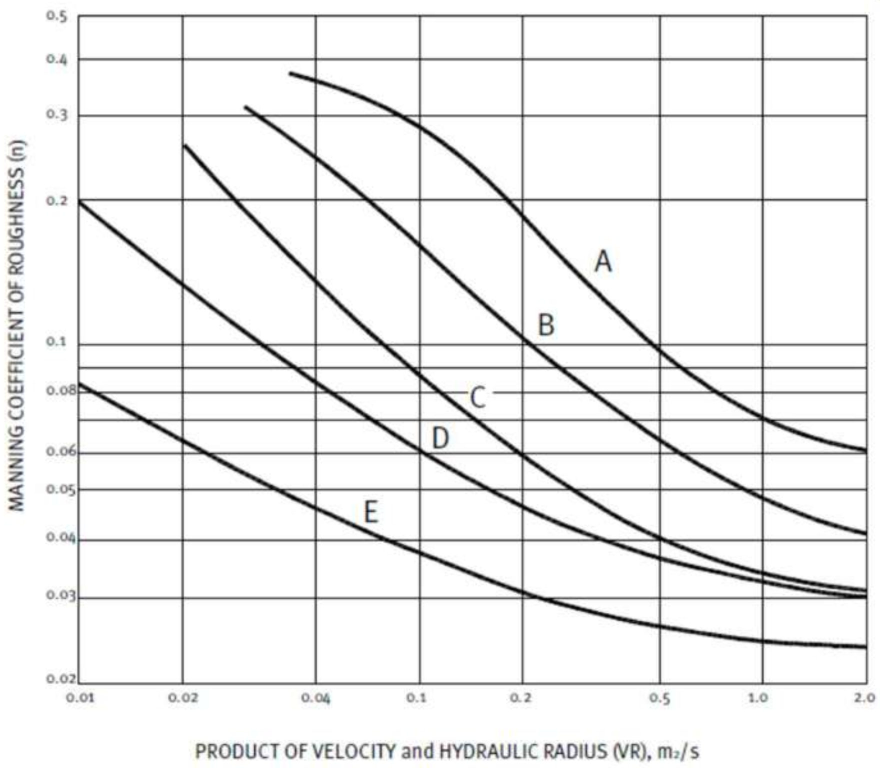


Fig.9: PNG RFFM Slope- P2 Matrix (PNG GTZ, Design Manual, 1996)



Curve A $n = 0.440 - 1.674\,VR \quad VR < 0.1542$
$n = 0.046 + 0.0223/VR \quad VR > 0.1542$ } Ref. Green, JEP and Garton, JE (1983)

Curve B $n = 0.032 + 0.01545/(VR)^{7/8}$

Curve C $n = 0.030 + 0.00501/VR$

Curve D $n = 0.027 + 0.00534/(VR)^{3/4}$

Curve E $n = 0.022 + 0.003014/(VR)^{2/3}$

Ref. Findlay, GH and Ellul, GA (1976)

Fig.10: Graphical solution for five degrees of vegetal retardance for the Manning formula (adapted from Ree 1954)

The Manning formula can be solved graphically using the n-VR curves and other charts. The graphical solution of the Manning formula for vegetal retardances ‘C’ is shown in Fig.10 (adapted from Ree 1954).

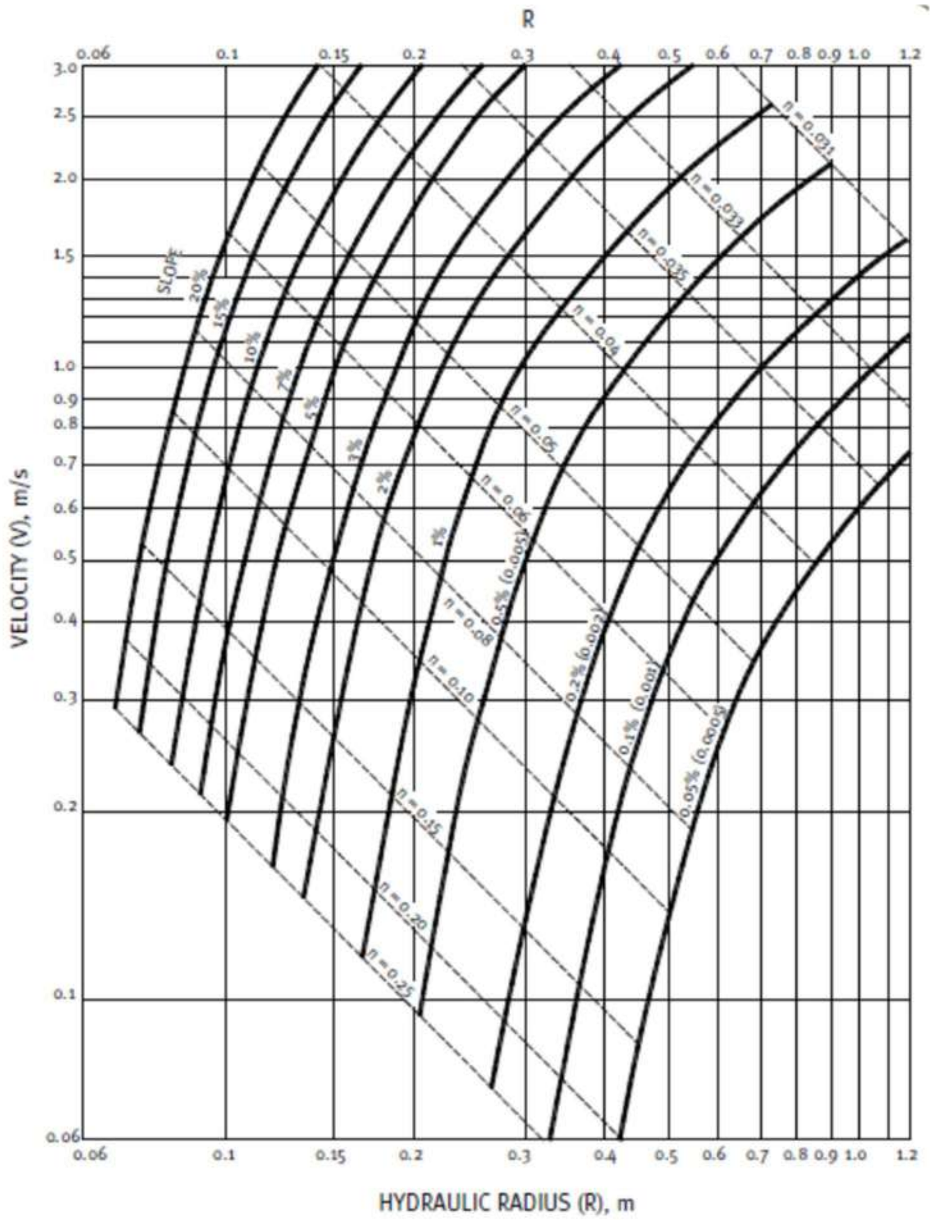


Fig.11: Graphical solution to the Manning formula for retardance C (adapted from Ree 1954)

It should be noted that the A to E retardance charts apply to runoff flows where vegetation is completely submerged or nearly so. For shallow flows through upright vegetation with limited submergence, Manning’s n ceases to be related to VR (Ree 1954).

Fig.12: Dredging Baupa River Plan by CHEC attached separately as pdf file.

A	2.12.24	Client Review
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K92 MINING INC.

CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed	Zhenyu Wang	Date	Dec.2024
Checked	Zeye Tian	Date	Dec.2024
Approved	Zhuode Feng	Date	Dec.2024

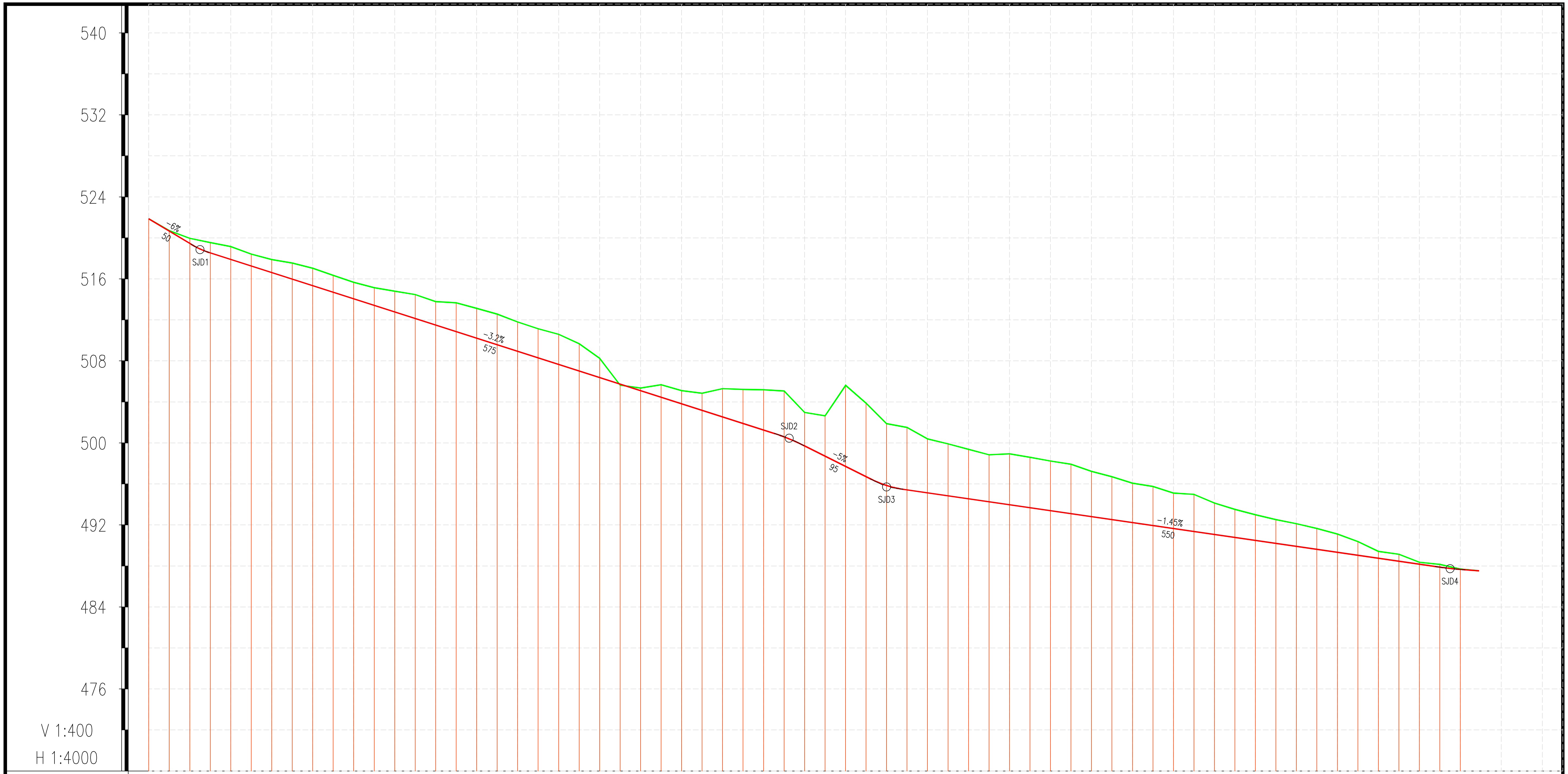
Project: KAINANTU HAUL ROAD AND RIVER CROSSINGS

Title: RIVER PLAN

Project No. S3E

Drawing No. YYYY

Sheet 1 / 1



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+034.902 ZY1	519.766	520.155	-0.389
	519.461	519.965	-0.504
GHK0+060	518.541	519.547	-1.006
GHK0+080	517.901	519.156	-1.255
GHK0+100	517.261	518.42	-1.159
GHK0+120	516.621	517.884	-1.264
GHK0+140	515.981	517.546	-1.565
+157.314 YZ1	515.427	517.112	-1.685
	515.341	517.044	-1.704
GHK0+180	514.701	516.346	-1.645
GHK0+200	514.061	515.671	-1.61
GHK0+220	513.421	515.147	-1.726
+229.419 ZY2	513.119	514.988	-1.869
GHK0+240	512.781	514.81	-2.03
GHK0+260	512.141	514.477	-2.336
GHK0+280	511.501	513.786	-2.286
GHK0+300	510.861	513.672	-2.812
+313.773 YZ2	510.42	513.298	-2.878
	510.221	513.129	-2.908
GHK0+340	509.581	512.571	-2.99
GHK0+360	508.941	511.798	-2.857
GHK0+380	508.301	511.138	-2.837
GHK0+400	507.661	510.597	-2.936
GHK0+420	507.021	509.683	-2.662
GHK0+440	506.381	508.266	-1.886
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GHK0+480	505.101	505.36	-0.26
GHK0+500	504.461	505.684	-1.224
GHK0+520	503.821	505.104	-1.284
+535.99 ZY3	503.309	504.904	-1.595
	503.181	504.853	-1.673
GHK0+560	502.541	505.3	-2.76
GHK0+580	501.901	505.225	-3.325
+591.186 YZ3	501.543	505.206	-3.663
GHK0+600	501.261	505.19	-3.93
GHK0+620	500.593	505.073	-4.48
GHK0+640	499.711	502.979	-3.268
GHK0+660	498.711	502.647	-3.937
GHK0+680	497.711	505.621	-7.91
GHK0+700	496.711	503.878	-7.168
GHK0+720	495.854	501.887	-6.033
+721.9 ZY4	495.795	501.851	-6.057
GHK0+740	495.421	501.511	-6.091
GHK0+760	495.131	500.397	-5.267
+762.371 YZ4	495.096	500.34	-5.244
GHK0+780	494.841	499.917	-5.077
GHK0+800	494.551	499.381	-4.83
GHK0+820	494.261	498.847	-4.586
GHK0+840	493.971	498.938	-4.967
GHK0+860	493.681	498.604	-4.924
GHK0+880	493.391	498.238	-4.848
GHK0+900	493.101	497.926	-4.825
GHK0+920	492.811	497.227	-4.416
GHK0+940	492.521	496.702	-4.181
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GHK0+980	491.941	495.758	-3.817
+981.753 ZY5	491.915	495.701	-3.786
GHK1+000	491.651	495.111	-3.46
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GHK1+040	491.071	494.137	-3.066
GHK1+060	490.781	493.518	-2.738
+060.002 YZ5	490.781	493.518	-2.738
GHK1+080	490.491	493.001	-2.511
GHK1+100	490.201	492.523	-2.322
GHK1+120	489.911	492.127	-2.217
GHK1+140	489.621	491.661	-2.04
GHK1+160	489.331	491.114	-1.783
GHK1+180	489.041	490.384	-1.344
GHK1+200	488.751	489.419	-0.668
GHK1+220	488.461	489.146	-0.686
GHK1+240	488.171	488.364	-0.194
GHK1+260	487.883	488.15	-0.267
+262.636 ZD	487.849	488.091	-0.242
+298.087	487.525	487.525	-0

SLOPE/ SLOPE LENGTH

521.861 +0 | -6% 50 | 518.861 +50 | -3.2% 575 | 500.461 +625 | -5% 95 | 495.711 +720 | -1.45% 550 | 487.736 | 487.525 +298.087

STRAIGHT LINE AND CURVE

R-200 L-122.412 | R-100 L-84.354 | R-100 L-55.196 | R-200 L-40.471 | R-300 L-78.25

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A	2.12.24	Client Review

K92 MINING LTD

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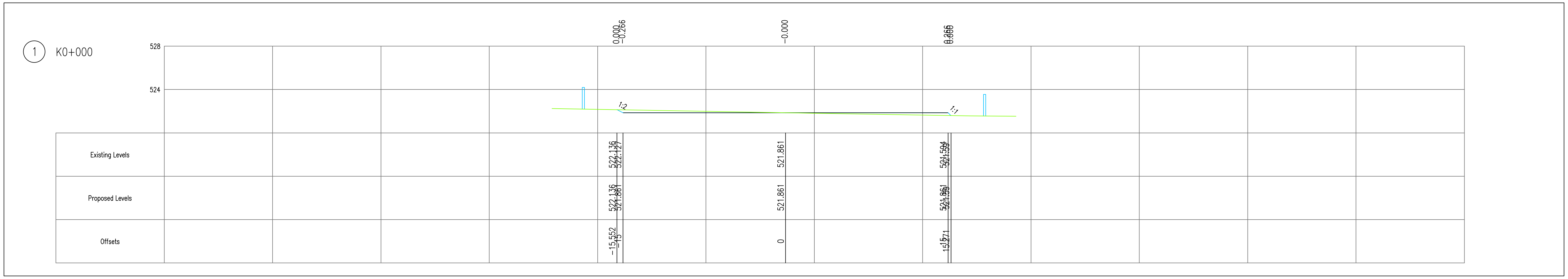
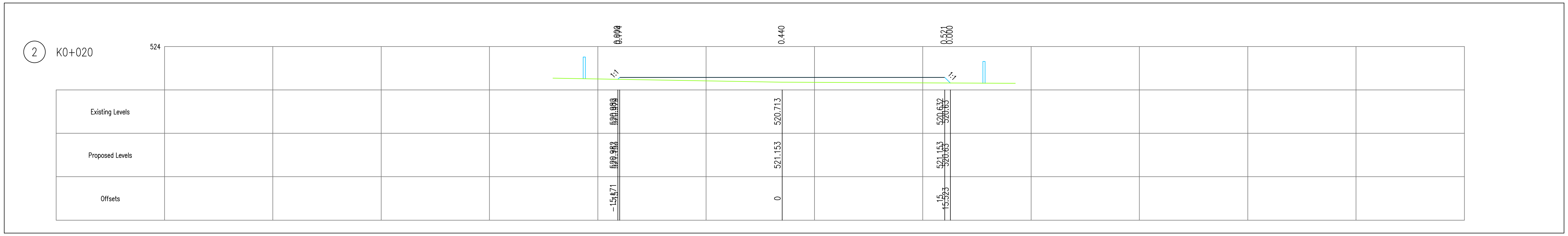
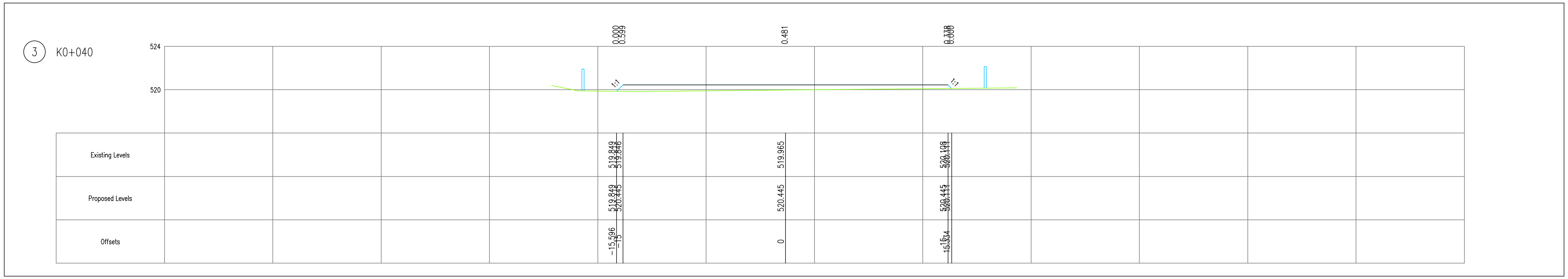
Checked Zeye Tian	Date Dec.2024	Title	RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY
			Sheet 1 / 1







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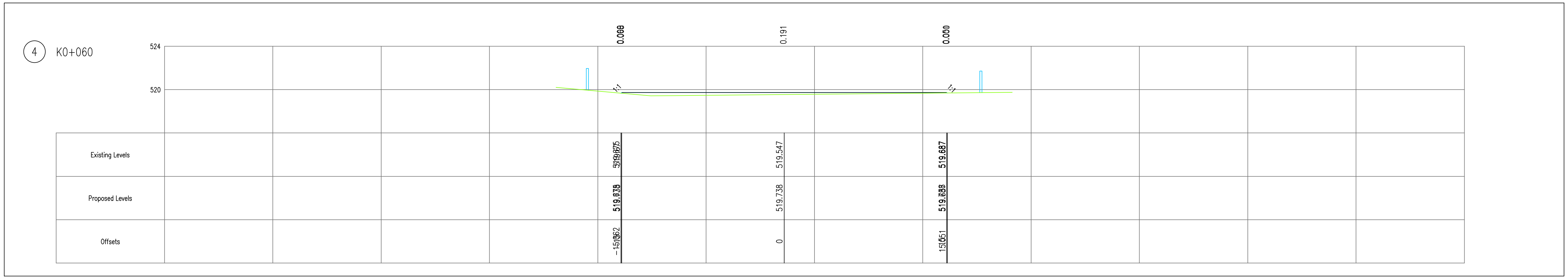
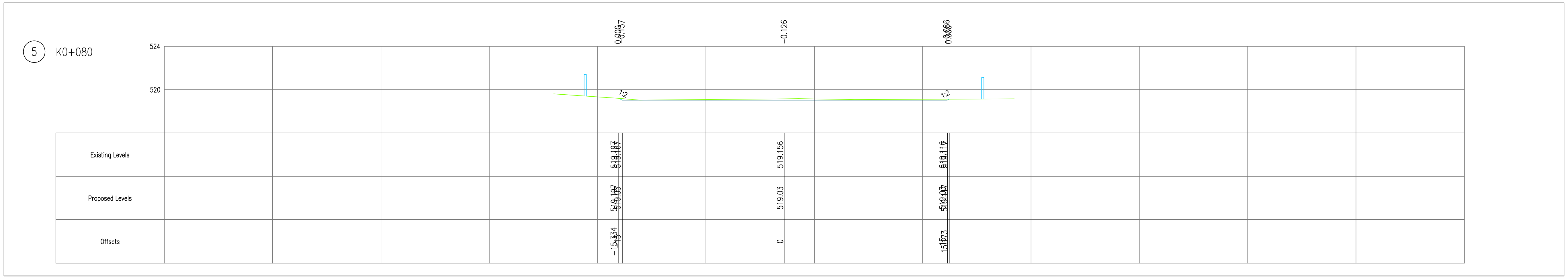
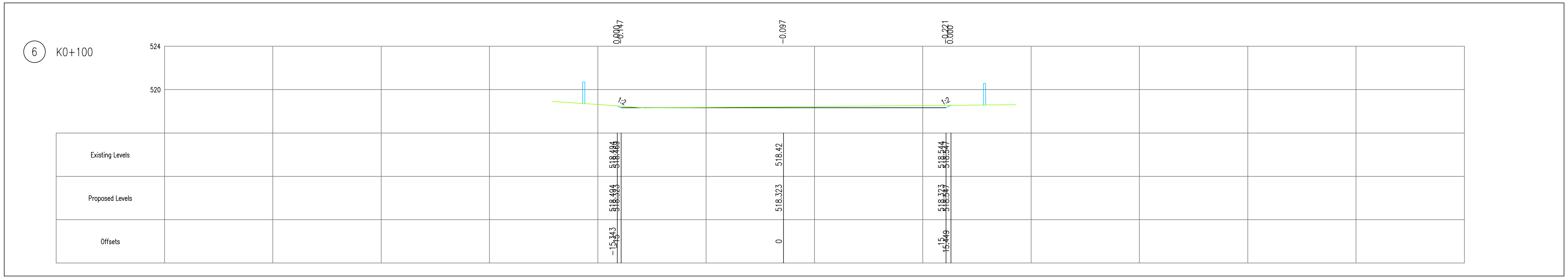
Sheet
1 / 28







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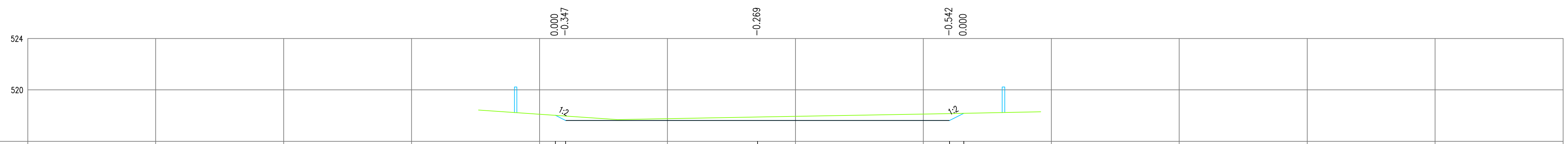
Sheet
2 / 28

⑦ K0+120



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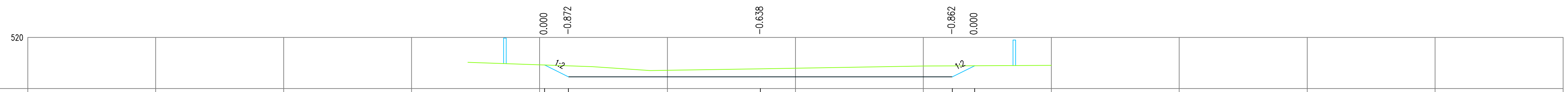
⑧ K0+140



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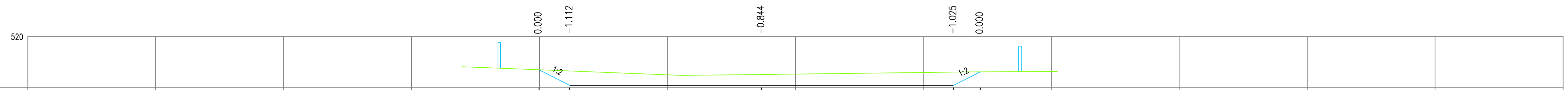
⑨ K0+160



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Project
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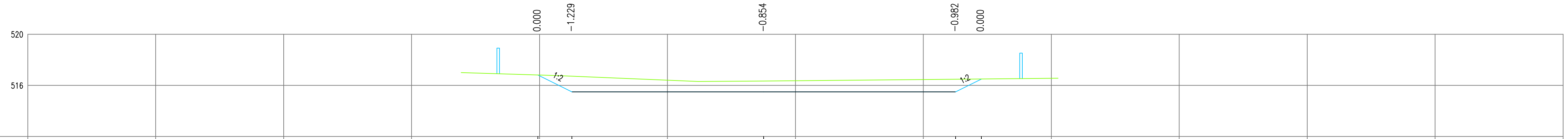
Title
RIVER PLAN

Project No. S3E
Drawing No. YYYY
Sheet 3 / 28

⑩ K0+180



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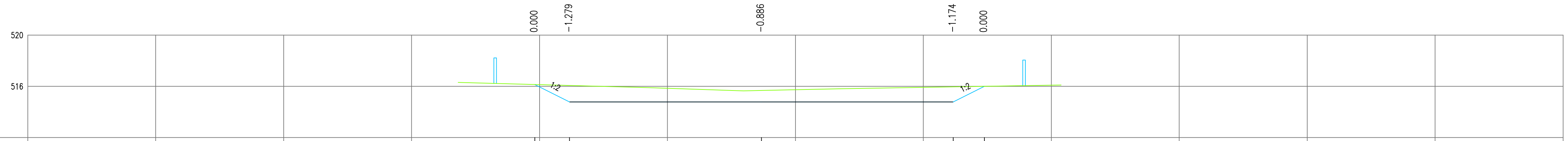
⑪ K0+200



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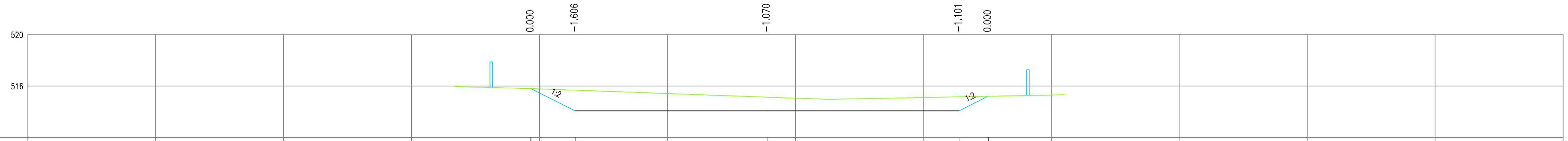
⑫ K0+220



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Project
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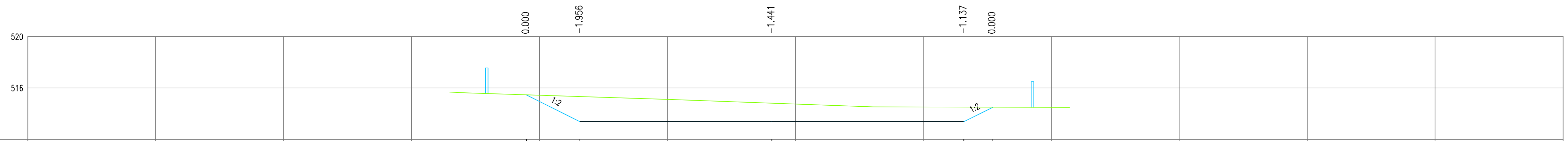
Title
RIVER PLAN

Project No.
S3E

Drawing No.
YYYY

Sheet
4 / 28

13 K0+240



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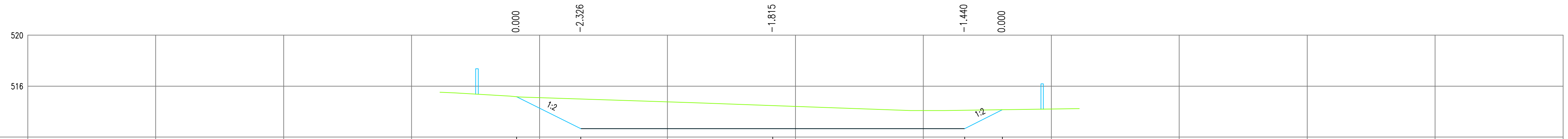
14 K0+260



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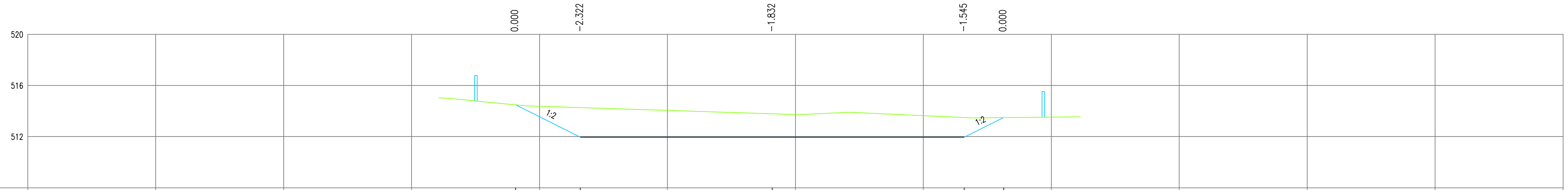
15 K0+280



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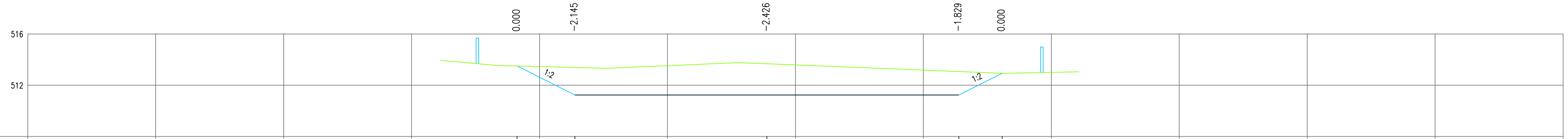
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY Sheet 5 / 28

⑯ K0+300



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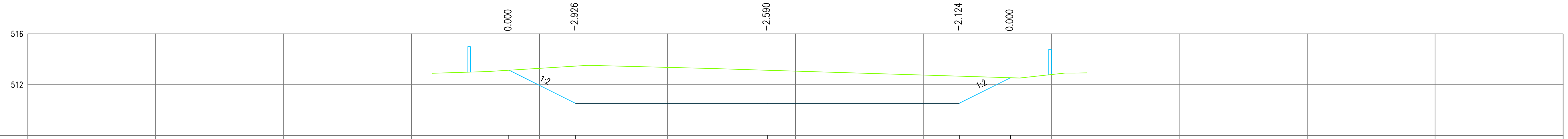
⑰ K0+320



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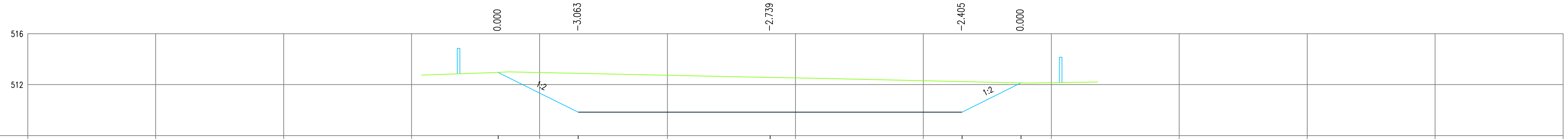
⑱ K0+340



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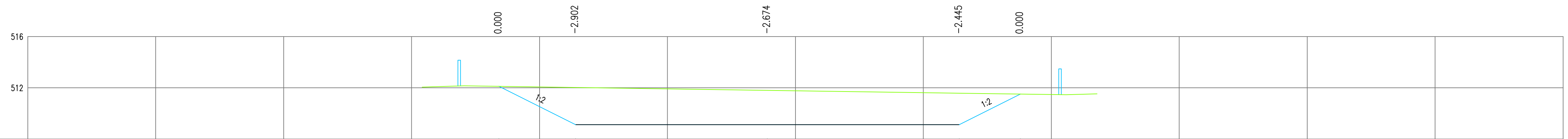
Sheet 6 / 28

19 K0+360

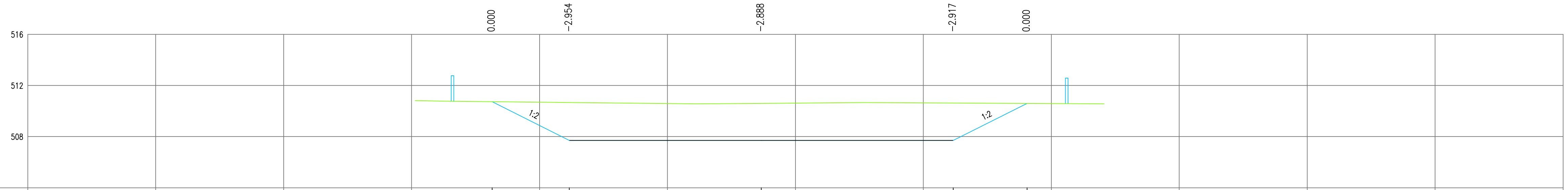


Existing Levels	512.117	512.026	511.798	511.569	511.508
Proposed Levels	512.117	509.124	509.124	509.124	511.508
Offsets	−20.987	−15	0	15	19.768

20 K0+380

Existing Levels	511.359	511.297	511.138	510.979	510.926
Proposed Levels	511.359	508.416	508.416	508.416	510.926
Offsets	−20.886	−15	0	15	20.019

21 K0+400



Existing Levels	510.727	510.663	510.597	510.626	510.6
Proposed Levels	510.727	507.709	507.709	507.709	510.6
Offsets	−21.037	−15	0	15	20.782

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

K92 MINING INC.

HEC

CHINA HARBOUR ENGINEERING COMPANY LTD.

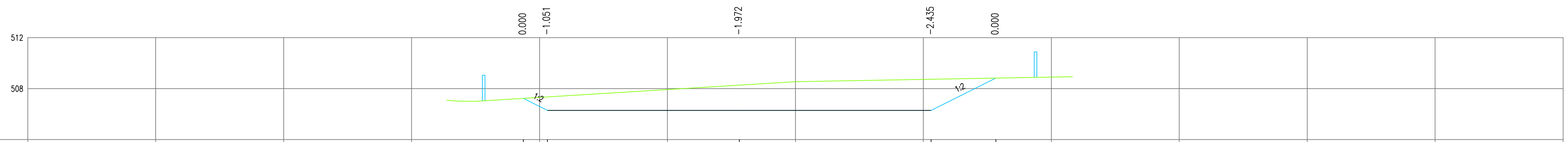
Designed Zhenyu Wang Date Dec.2024
Checked Zeye Tian Date Dec.2024
Approved Zhuode Feng Date Dec.2024

Project KAINANTU HAUL ROAD AND RIVER CROSSINGS
Title RIVER PLAN
Project No. S3E
Drawing No. YYYY
Sheet 7 / 28

22 K0+420

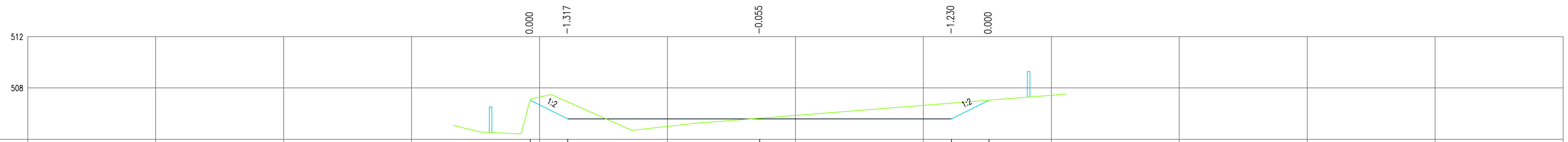
Existing Levels	509.661	509.667	509.683	509.699	509.704
Proposed Levels	509.661	507.001	507.001	507.001	509.704
Offsets	-20.32	-15	0	15	20.407

23 K0+440



Existing Levels	507.23	507.345	508.266	508.729	508.821
Proposed Levels	507.23	506.294	506.294	506.294	508.821
Offsets	-16.873	-15	0	15	20.054

24 K0+460



Existing Levels	507.048	506.904	505.641	506.816	507.045
Proposed Levels	507.048	505.586	505.586	505.586	507.045
Offsets	-17.925	-15	0	15	17.918

A	2.12.24	Client Review
Revision	Date	Revision Description

K92 MINING LTD

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INC.

CHINA HARBOUR
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LTD.

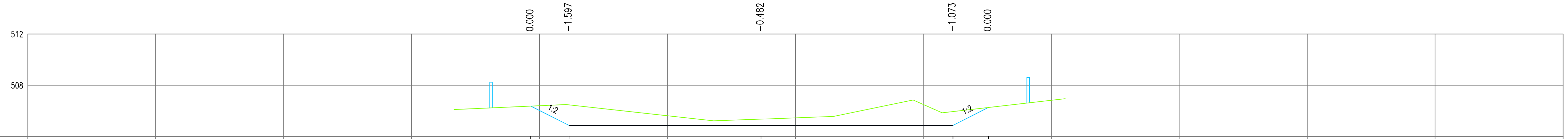
Designed Zhenyu Wang
Date Dec.2024
Checked Zeye Tian
Date Dec.2024
Approved Zhuode Feng
Date Dec.2024

Project
KAINANTU HAUL ROAD AND RIVER CROSSINGS

Title
RIVER PLAN

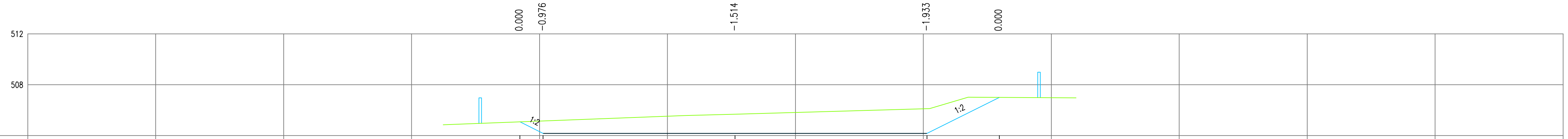
Project No. S3E
Drawing No. YYYY
Sheet 8 / 28

㉕ K0+480



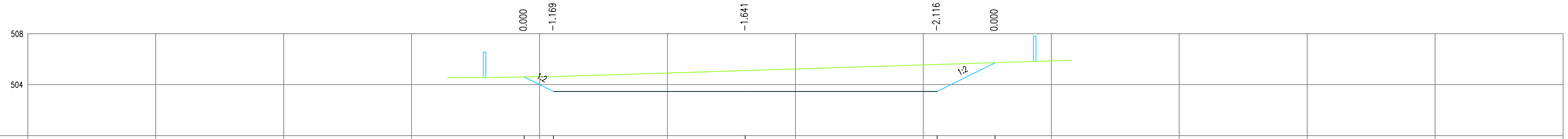
Existing Levels	506.378	506.476	505.36	505.952	506.268
Proposed Levels	506.378	504.878	504.878	504.878	506.268
Offsets	−18	−15	0	15	17.779

㉖ K0+500



Existing Levels	505.077	505.147	505.684	506.104	506.996
Proposed Levels	505.077	504.171	504.171	504.171	506.996
Offsets	−16.812	−15	0	15	20.65

㉗ K0+520



Existing Levels	504.603	504.632	505.104	505.579	505.722
Proposed Levels	504.603	503.463	503.463	503.463	505.722
Offsets	−17.279	−15	0	15	19.517

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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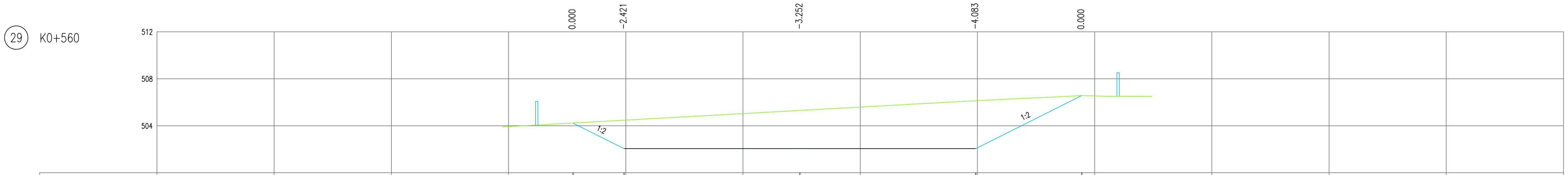
CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang	Date Dec.2024	Project	KAINANTU HAUL ROAD AND RIVER CROSSINGS
Checked Zeye Tian	Date Dec.2024	Title	RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY

Sheet
9 / 28

Existing Levels	504.612	504.66	504.853	505.047	505.355
Proposed Levels	504.612	502.756	502.756	502.756	505.355
Offsets	−18.713	−15	0	15	20.198



Existing Levels	504.228	504.469	505.3	506.131	506.571
Proposed Levels	504.228	502.048	502.048	502.048	506.571
Offsets	−19.36	−15	0	15	24.046

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang — Date Dec.2024
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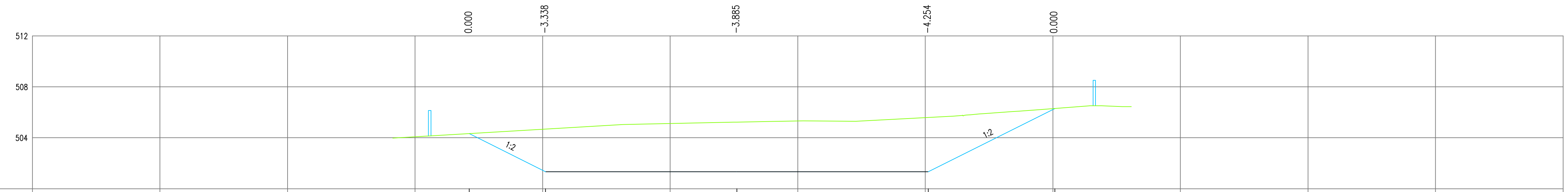
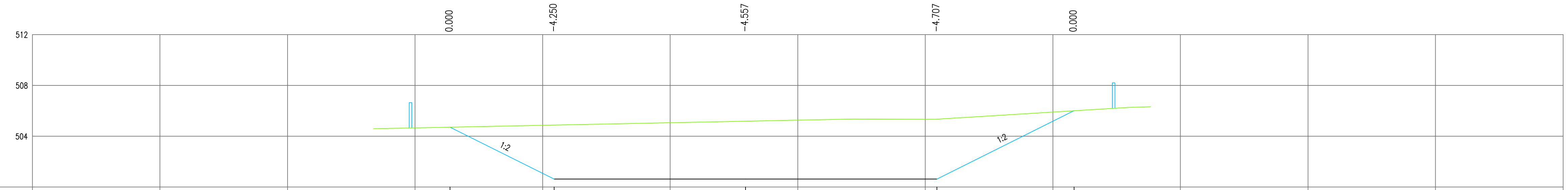
Project: KAINANTU HAUL ROAD AND RIVER CROSSINGS
Title: RIVER PLAN
Project No. S3E
Drawing No. YYYY
Sheet 10 / 28

30 K0+580



Existing Levels	504.325	504.679	505.225	505.595	506.302
Proposed Levels	504.325	501.341	501.341	501.341	506.302
Offsets	-20.969	-15	0	15	24.923

31 K0+600



Existing Levels	504.715	504.883	505.19	505.34	506.013
Proposed Levels	504.715	500.633	500.633	500.633	506.013
Offsets	-23.165	-15	0	15	25.759

Revision	Date	Revision Description
A	2.12.24	Client Review

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CHINA HARBOUR ENGINEERING COMPANY LTD.

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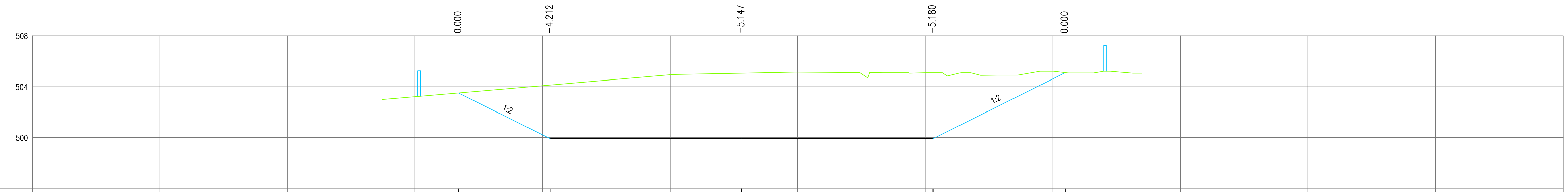
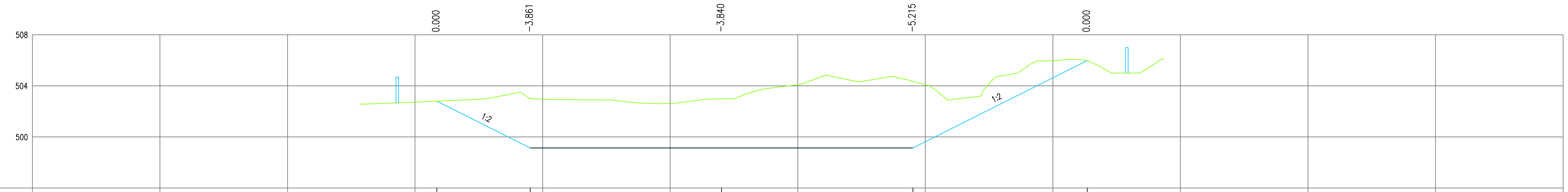
Checked Zeye Tian	Date Dec.2024	Title	RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY	Sheet 11 / 28

32 K0+620



Existing Levels	503.516	504.138	505.073	505.106	505.117
Proposed Levels	503.516	499.925	499.925	499.925	505.117
Offsets	-22.182	-15	0	15	25.383

33 K0+640



Existing Levels	502.802	503	502.979	504.354	505.974
Proposed Levels	502.802	499.139	499.139	499.139	505.974
Offsets	-22.326	-15	0	15	28.67

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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CHINA HARBOUR ENGINEERING COMPANY LTD.

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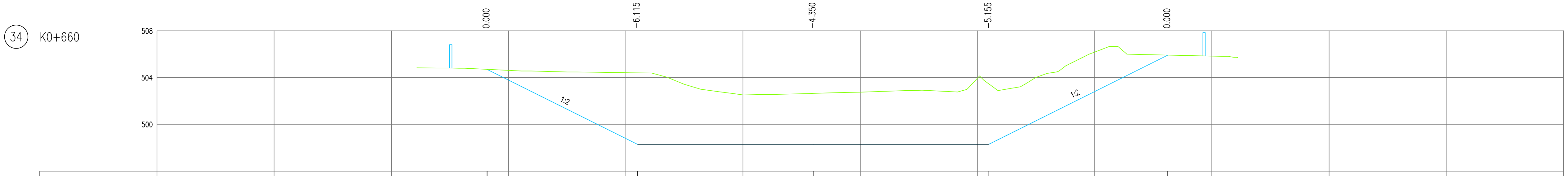
Checked Zeye Tian	Date Dec.2024	Title	RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY

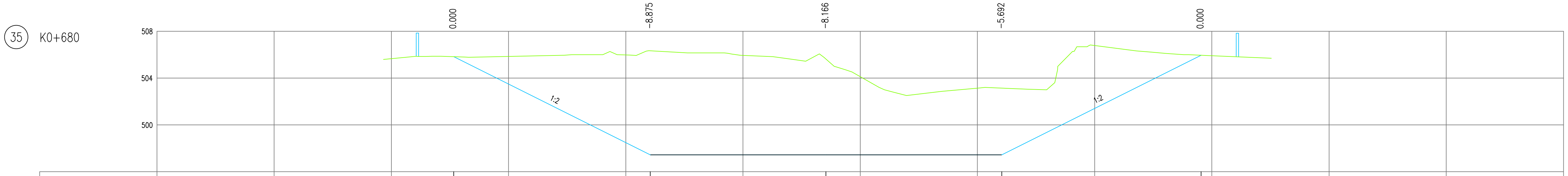
Sheet
12 / 28

㉞ K0+660



Existing Levels	504.706	504.412	502.647	503.452	505.923
Proposed Levels	504.706	498.297	498.297	498.297	505.923
Offsets	-27.818	-15	0	15	30.252

㉟ K0+680



Existing Levels	505.834	506.33	505.621	503.147	505.955
Proposed Levels	505.834	497.455	497.455	497.455	505.955
Offsets	-31.759	-15	0	15	32

A	2.12.24	Client Review
Revision	Date	Revision Description

K92 MINING LTD

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CHINA HARBOUR
ENGINEERING COMPANY
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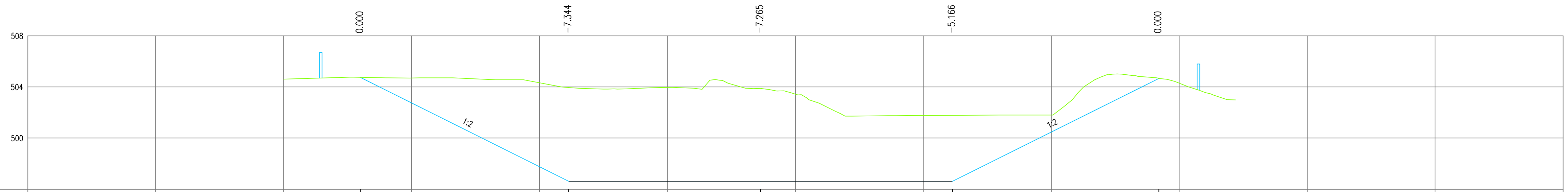
Designed Zhenyu Wang	Date Dec.2024	Project	KAINANTU HAUL ROAD AND RIVER CROSSINGS
Checked Zeye Tian	Date Dec.2024	Title	RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY

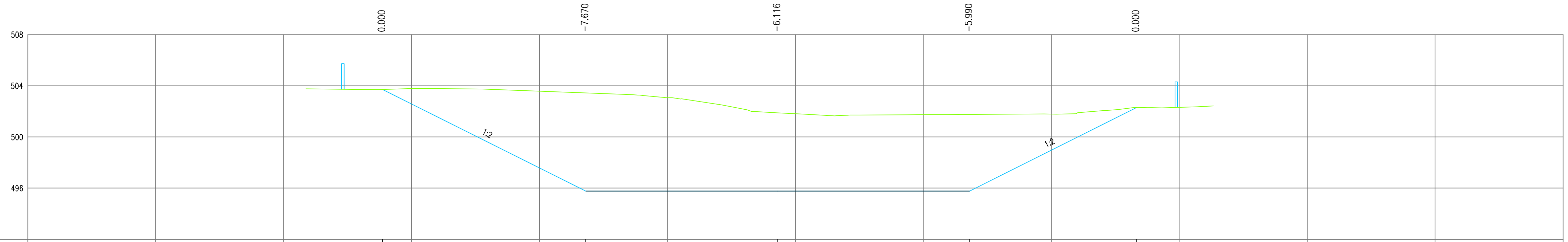
Sheet 13 / 28

36 K0+700



Existing Levels	504.749	503.957	503.878	501.779	504.671
Proposed Levels	504.749	496.613	496.613	496.613	504.671
Offsets	-31.272	-15	0	15	31.115

37 K0+720



Existing Levels	503.71	503.441	501.887	501.761	502.298
Proposed Levels	503.71	495.771	495.771	495.771	502.298
Offsets	-30.878	-15	0	15	28.053

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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CHINA HARBOUR ENGINEERING COMPANY LTD.

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Project: KAINANTU HAUL ROAD AND RIVER CROSSINGS

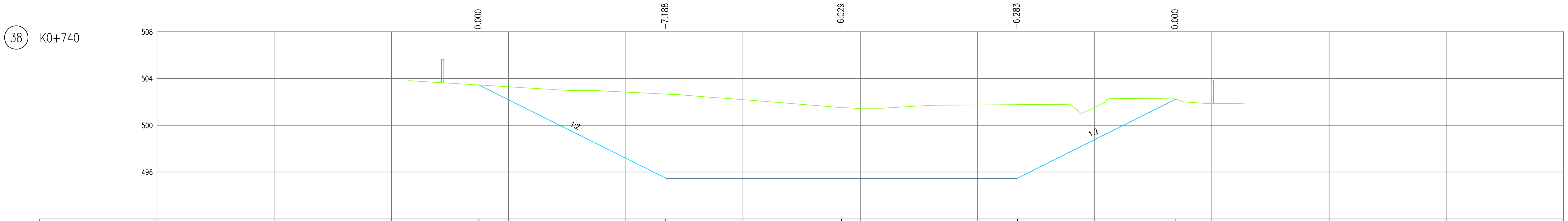
Title: RIVER PLAN

Project No. S3E

Drawing No. YYYY

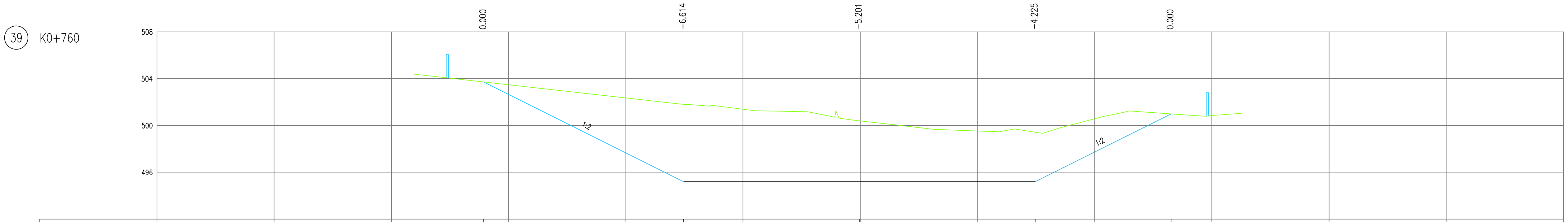
Sheet 14 / 28

38 K0+740



Existing Levels	503.449	502.67	501.511	501.765	502.235
Proposed Levels	503.449	495.482	495.482	495.482	502.235
Offsets	-30.935	-15	0	15	28.506

39 K0+760



Existing Levels	503.718	501.811	500.397	499.421	500.991
Proposed Levels	503.718	495.197	495.197	495.197	500.991
Offsets	-32.043	-15	0	15	26.59

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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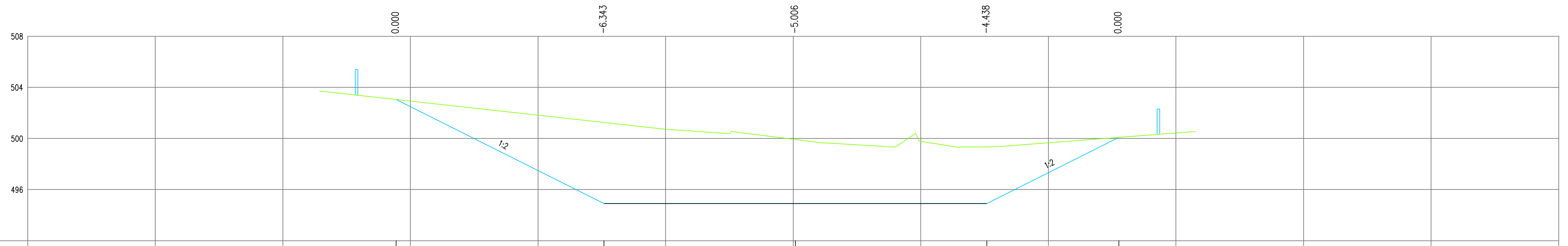
CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang	Date Dec.2024	Project KAINANTU HAUL ROAD AND RIVER CROSSINGS
Checked Zeye Tian	Date Dec.2024	Title RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E

Drawing No. YYYY

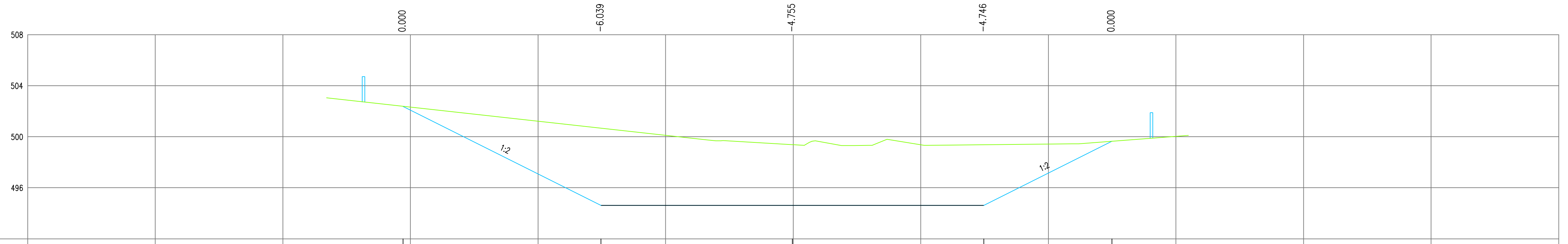
Sheet 15 / 28

40 K0+780



Existing Levels	503.056	501.254	499.917	499.35	500.084
Proposed Levels	503.056	494.911	494.911	494.911	500.084
Offsets	-31.289	-15	0	15	25.345

41 K0+800



Existing Levels	502.38	500.665	499.381	499.372	499.649
Proposed Levels	502.38	494.626	494.626	494.626	499.649
Offsets	-30.508	-15	0	15	25.045

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang Date Dec.2024
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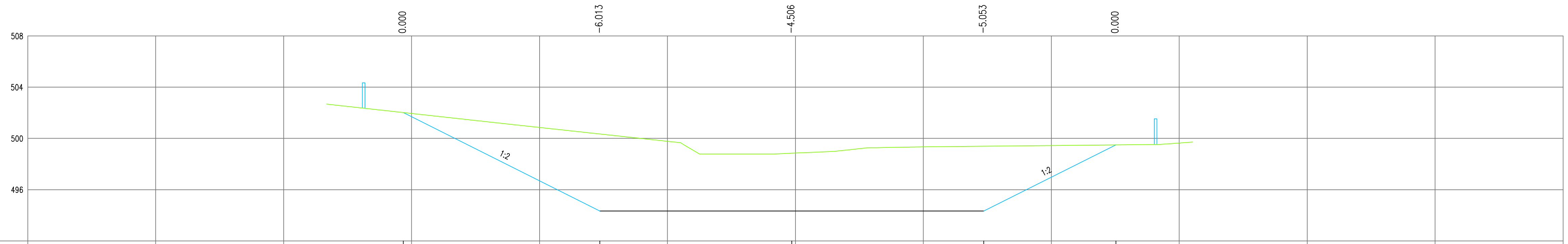
Project KAINANTU HAUL ROAD AND RIVER CROSSINGS

Title RIVER PLAN

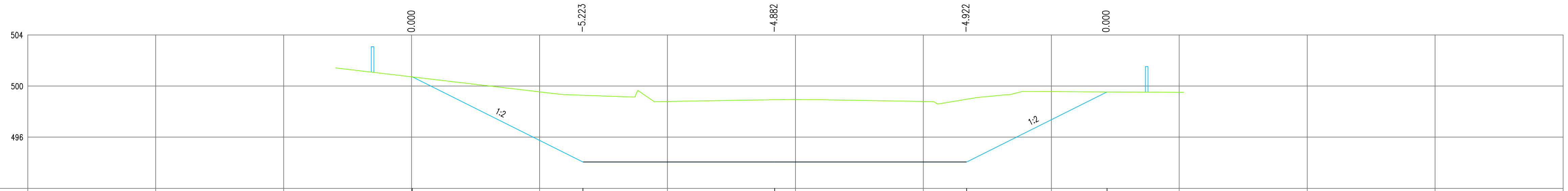
Project No. S3E
Drawing No. YYYY
Sheet 16 / 28

42 K0+820



Existing Levels	502.022	500.354	498.847	499.395	499.504
Proposed Levels	502.022	494.341	494.341	494.341	499.504
Offsets	-30.362	-15	0	15	25.325

43 K0+840



Existing Levels	500.722	499.279	498.938	498.978	499.537
Proposed Levels	500.722	494.056	494.056	494.056	499.537
Offsets	-28.333	-15	0	15	25.962

A	2.12.24	Client Review
Revision	Date	Revision Description

K92 MINING LTD

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Designed Zhenyu Wang Date Dec.2024
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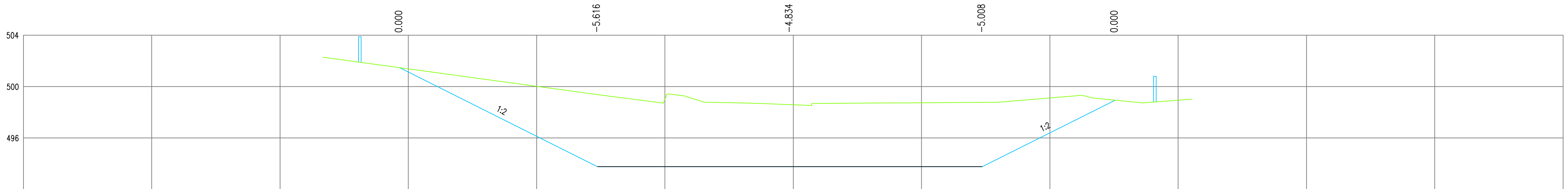
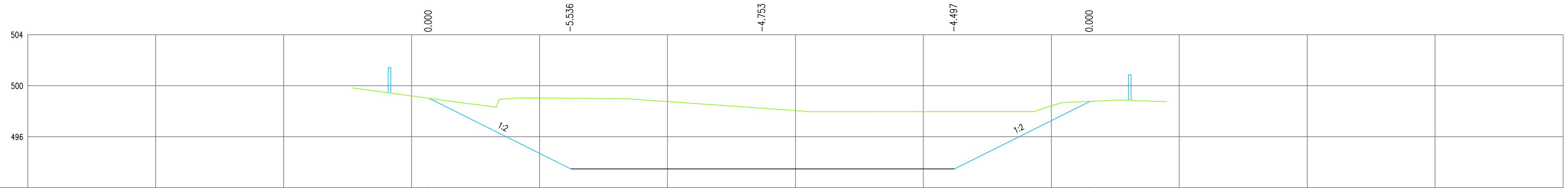
Project KAINANTU HAUL ROAD AND RIVER CROSSINGS
Title RIVER PLAN
Project No. S3E
Drawing No. YYYY
Sheet 17 / 28

㊹ K0+860



Existing Levels	501.475	499.387	498.604	498.779	498.944
Proposed Levels	501.475	493.771	493.771	493.771	498.944
Offsets	-30.409	-15	0	15	25.346

㊺ K0+880



Existing Levels	499.019	499.022	498.238	497.983	498.782
Proposed Levels	499.019	493.486	493.486	493.486	498.782
Offsets	-26.067	-15	0	15	25.592

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD

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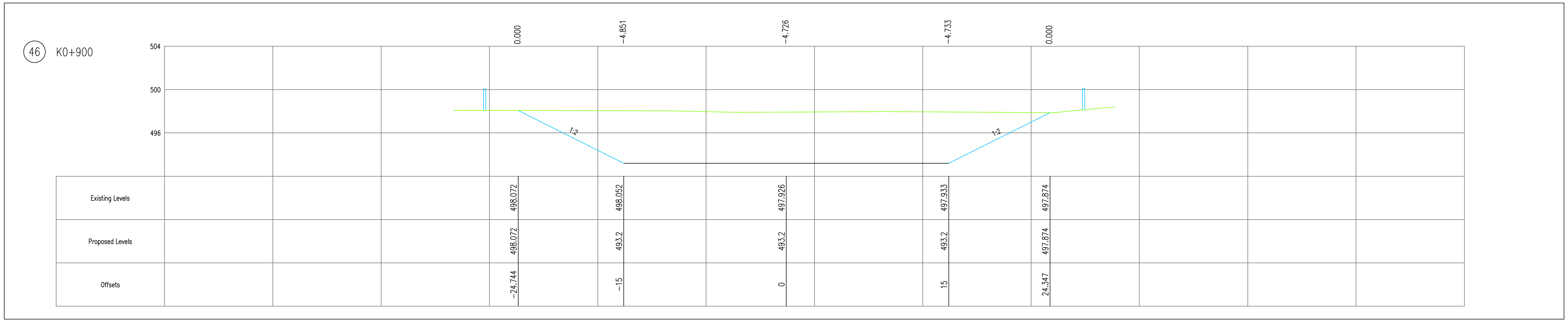
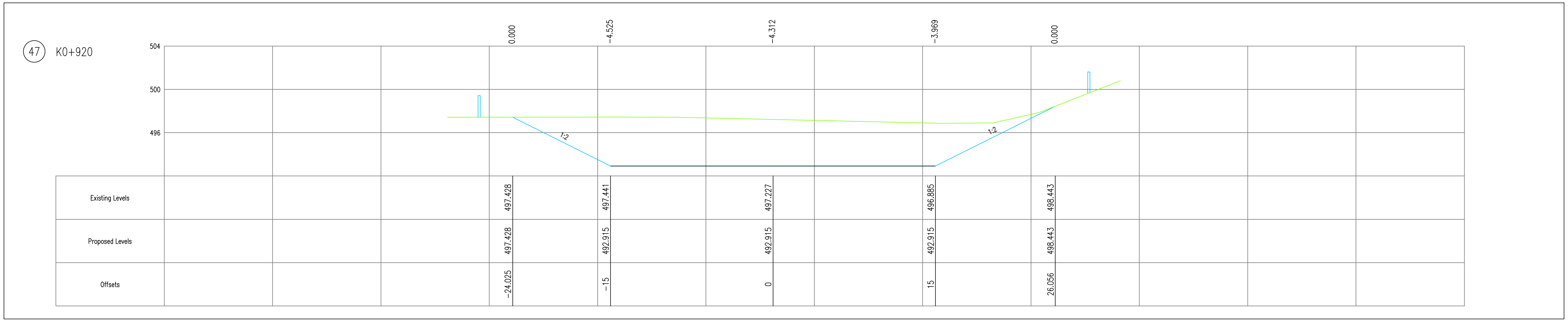
CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang	Date Dec.2024	Project	KAINANTU HAUL ROAD AND RIVER CROSSINGS
Checked Zeye Tian	Date Dec.2024	Title	RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY

Sheet 18 / 28



Existing Levels	498.072	498.052	497.926	497.933	497.874
Proposed Levels	498.072	493.2	493.2	493.2	497.874
Offsets	-24.744	-15	0	15	24.347



Existing Levels	497.428	497.441	497.227	496.885	498.443
Proposed Levels	497.428	492.915	492.915	492.915	498.443
Offsets	-24.025	-15	0	15	26.056

Revision	Date	Revision Description
A	2.12.24	Client Review

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Date Dec.2024
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Date Dec.2024
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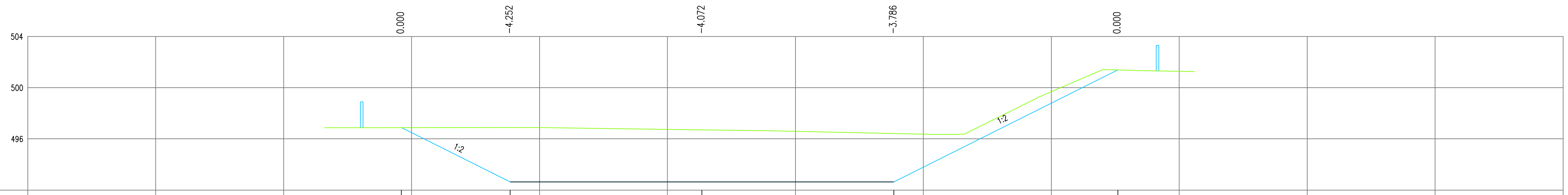
Date Dec.2024

Project
KAINANTU HAUL ROAD AND RIVER CROSSINGS

Title
RIVER PLAN

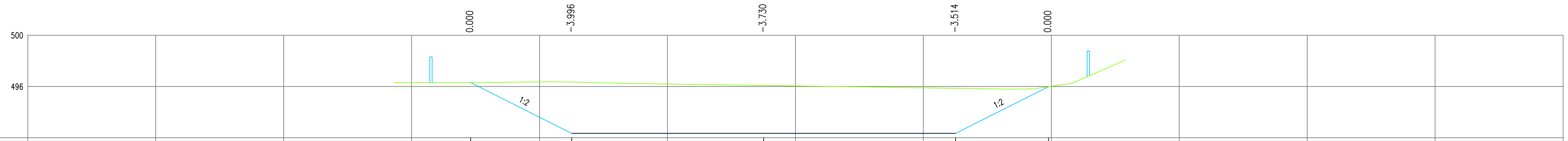
Project No. S3E
Drawing No. YYYY
Sheet 19 / 28

㊽ K0+940



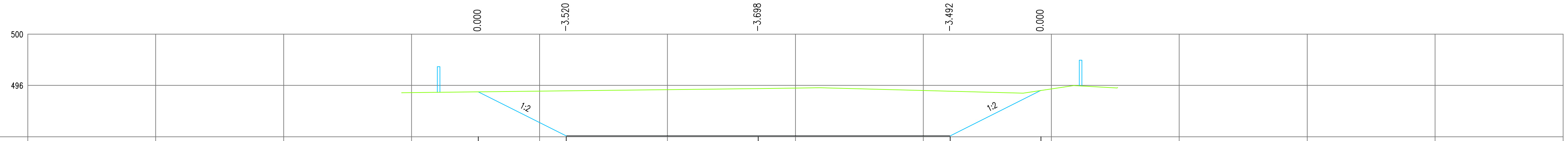
Existing Levels	496.878	496.882	496.702	496.416	501.382
Proposed Levels	496.878	492.63	492.63	492.63	501.382
Offsets	-23.495	-15	0	15	32.503

㊾ K0+960



Existing Levels	496.297	496.341	496.075	495.859	495.981
Proposed Levels	496.297	492.345	492.345	492.345	495.981
Offsets	-22.903	-15	0	15	22.272

㊿ K0+980



Existing Levels	495.498	495.58	495.758	495.552	495.61
Proposed Levels	495.498	492.06	492.06	492.06	495.61
Offsets	-21.876	-15	0	15	22.101

Revision	Date	Revision Description
A	2.12.24	Client Review

K92 MINING LTD
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CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed: Zhenyu Wang
Date: Dec.2024
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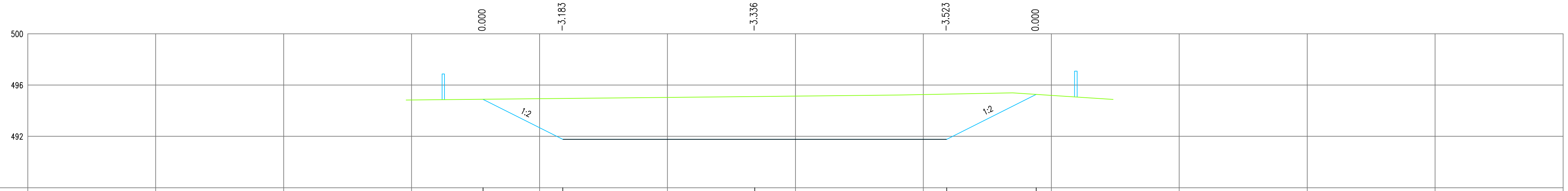
Date: Dec.2024
Approved: Zhuode Feng
Date: Dec.2024

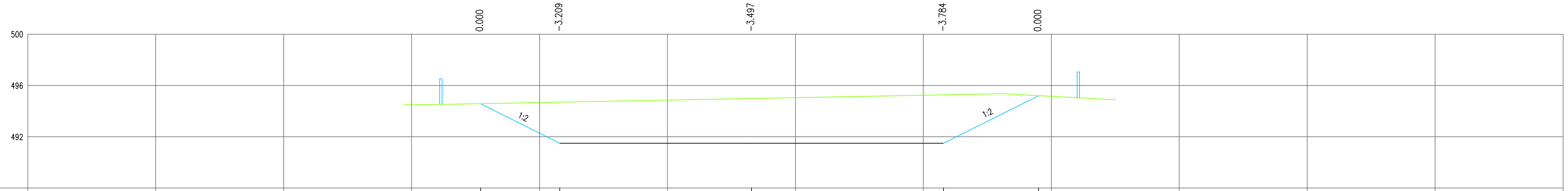
Project: KAINANTU HAUL ROAD AND RIVER CROSSINGS
Title: RIVER PLAN
Project No.: S3E
Drawing No.: YYYY
Sheet: 20 / 28

(51) K1+000



Existing Levels	494.894	494.958	495.111	495.297	495.277
Proposed Levels	494.894	491.775	491.775	491.775	495.277
Offsets	-21.239	-15	0	15	22.004

(52) K1+020



Existing Levels	494.581	494.699	494.986	495.274	495.208
Proposed Levels	494.581	491.49	491.49	491.49	495.208
Offsets	-21.182	-15	0	15	22.437

A	2.12.24	Client Review
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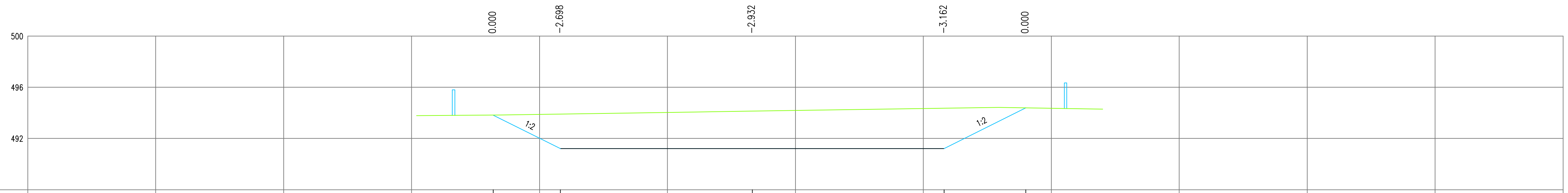
Project
KAINANTU HAUL ROAD AND RIVER CROSSINGS

Title
RIVER PLAN

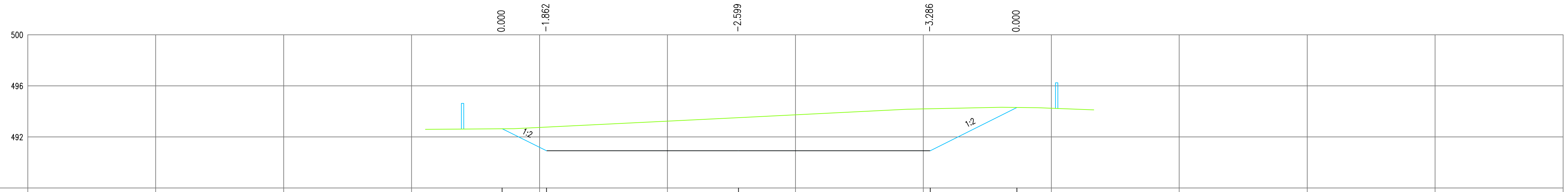
Project No. S3E
Drawing No. YYYY
Sheet 21 / 28

㊸ K1+040



Existing Levels	493.824	493.902	494.137	494.366	494.396
Proposed Levels	493.824	491.204	491.204	491.204	494.396
Offsets	−20.239	−15	0	15	21.384

(54) K1+060



Existing Levels	492.649	492.781	493.518	494.205	494.307
Proposed Levels	492.649	490.919	490.919	490.919	494.307
Offsets	−18.459	−15	0	15	21.775

Revision	Date	Revision Description
A	2.12.24	Client Review

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CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed	Zhenyu Wang	Date	Dec.2024
Checked	Zeye Tian	Date	Dec.2024
Approved	Zhuode Feng	Date	Dec.2024

Project: KAINANTU HAUL ROAD AND RIVER CROSSINGS

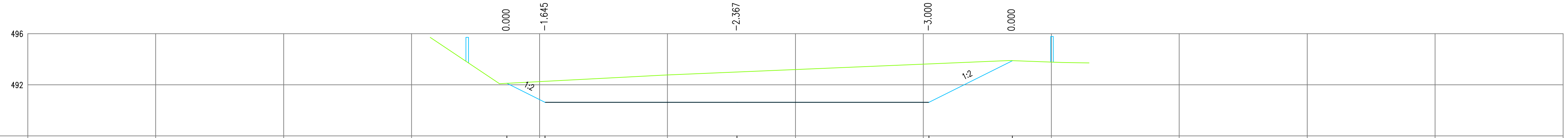
Title: RIVER PLAN

Project No. S3E

Drawing No. YYYY

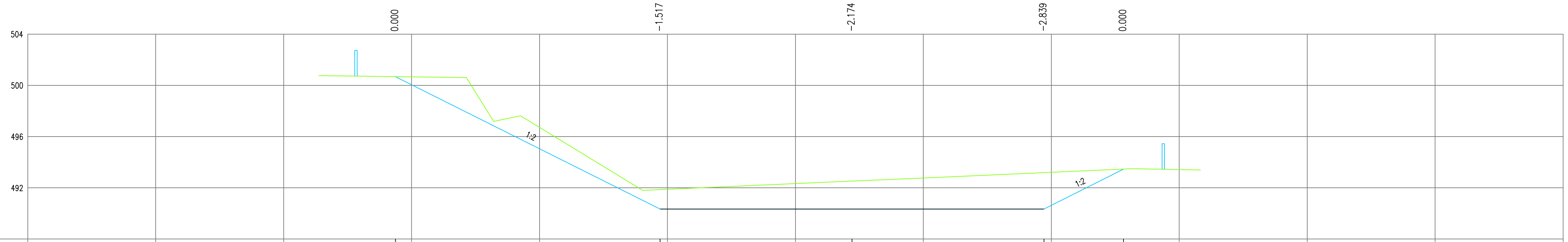
Sheet 22 / 28

55 K1+080



Existing Levels	492.125	492.279	493.001	493.634	493.891
Proposed Levels	492.125	490.634	490.634	490.634	493.891
Offsets	-17.982	-15	0	15	21.514

56 K1+100



Existing Levels	500.682	491.866	492.523	493.188	493.464
Proposed Levels	500.682	490.349	490.349	490.349	493.464
Offsets	-35.666	-15	0	15	21.231

Revision	Date	Revision Description
A	2.12.24	Client Review

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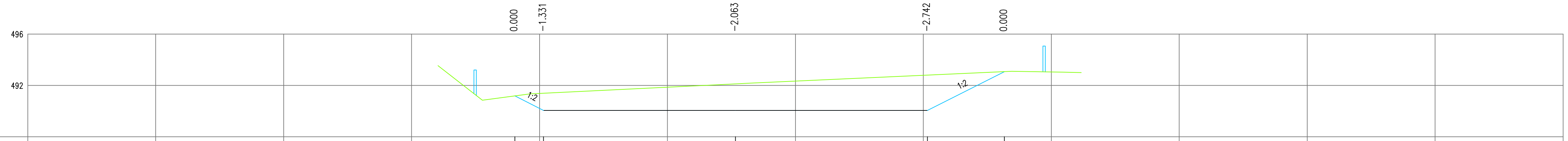
CHINA HARBOUR ENGINEERING COMPANY LTD.

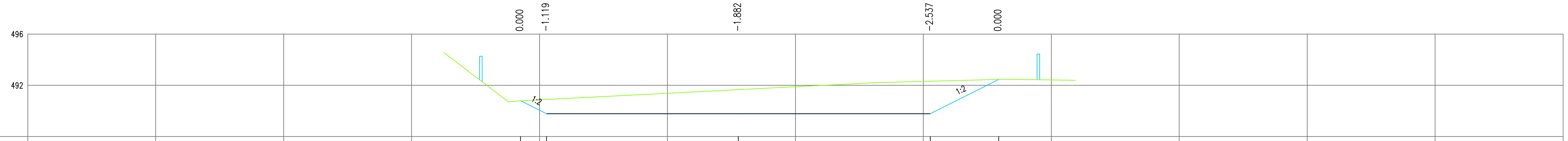
Designed Zhenyu Wang	Date Dec.2024	Project KAINANTU HAUL ROAD AND RIVER CROSSINGS	
Checked Zeye Tian	Date Dec.2024	Title RIVER PLAN	
Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY
			Sheet 23 / 28

57 K1+120



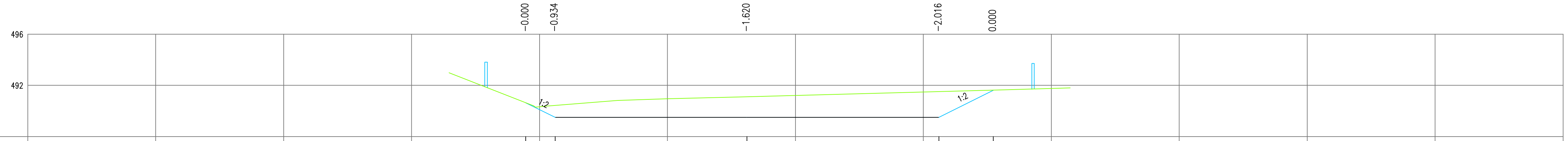
Existing Levels	491.185	491.395	492.127	492.805	493.076
Proposed Levels	491.185	490.064	490.064	490.064	493.076
Offsets	−17.243	−15	0	15	21.025

58 K1+140



Existing Levels	490.79	490.898	491.661	492.315	492.453
Proposed Levels	490.79	489.779	489.779	489.779	492.453
Offsets	−17.024	−15	0	15	20.348

59 K1+160



Existing Levels	490.637	490.427	491.114	491.509	491.622
Proposed Levels	490.637	489.493	489.493	489.493	491.622
Offsets	−17.287	−15	0	15	19.256

Revision	Date	Revision Description
A	2.12.24	Client Review

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CHINA HARBOUR ENGINEERING COMPANY LTD.

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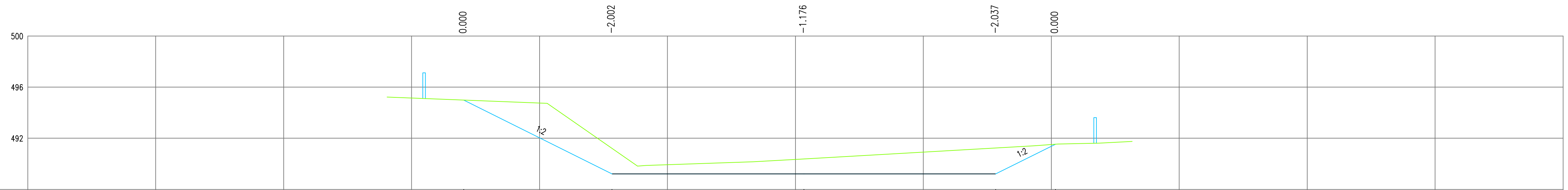
Checked Zeye Tian	Date Dec.2024	Title RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E

Drawing No. YYYY

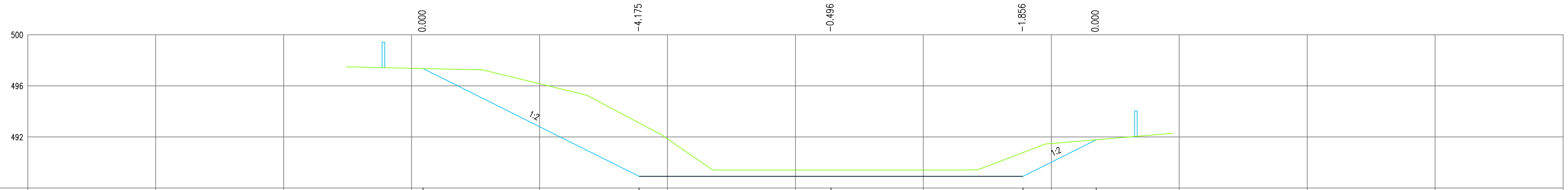
Sheet 24 / 28

⑥⓪ K1+180



Existing Levels	494.995	491.21	490.384	491.245	491.539
Proposed Levels	494.995	489.208	489.208	489.208	491.539
Offsets	−26.574	−15	0	15	19.66

(61) K1+200



Existing Levels	497.362	493.098	489.419	490.78	491.783
Proposed Levels	497.362	488.923	488.923	488.923	491.783
Offsets	−31.878	−15	0	15	20.721

A	2.12.24	Client Review
Revision	Date	Revision Description

K92 MINING INC.

CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang Date Dec.2024
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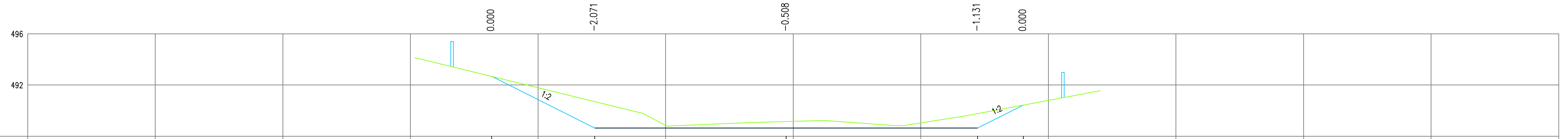
Project
KAINANTU HAUL ROAD AND RIVER CROSSINGS

Title
RIVER PLAN

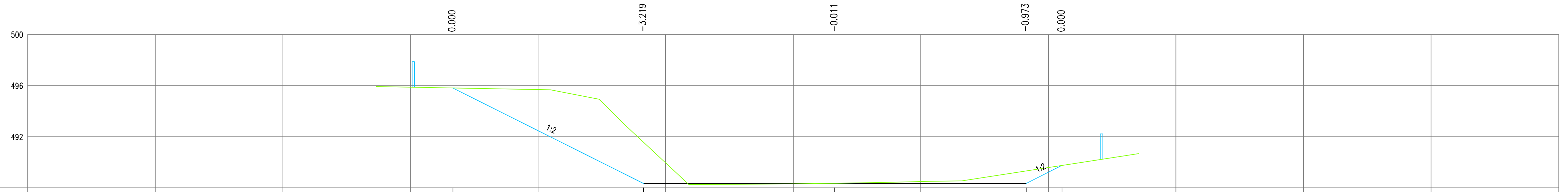
Project No. S3E
Drawing No. YYYY
Sheet 25 / 28

62 K1+220



Existing Levels	492.679	490.709	489.146	489.769	490.439
Proposed Levels	492.679	488.638	488.638	488.638	490.439
Offsets	-23.083	-15	0	15	18.602

63 K1+240



Existing Levels	495.821	491.572	488.364	489.326	489.759
Proposed Levels	495.821	488.353	488.353	488.353	489.759
Offsets	-29.936	-15	0	15	17.812

Revision	Date	Revision Description
A	2.12.24	Client Review

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CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang Date Dec.2024
Checked Zeye Tian Date Dec.2024
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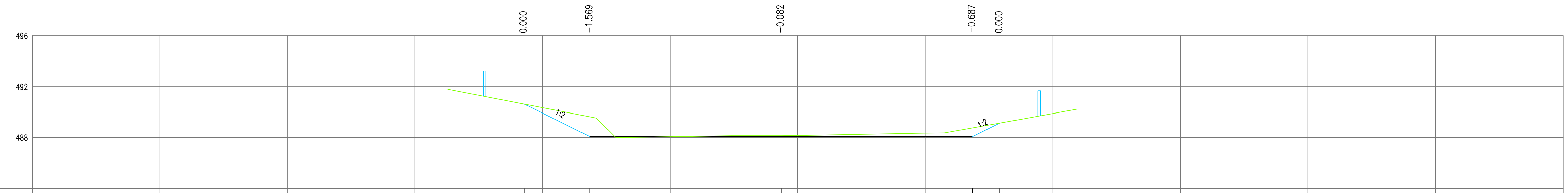
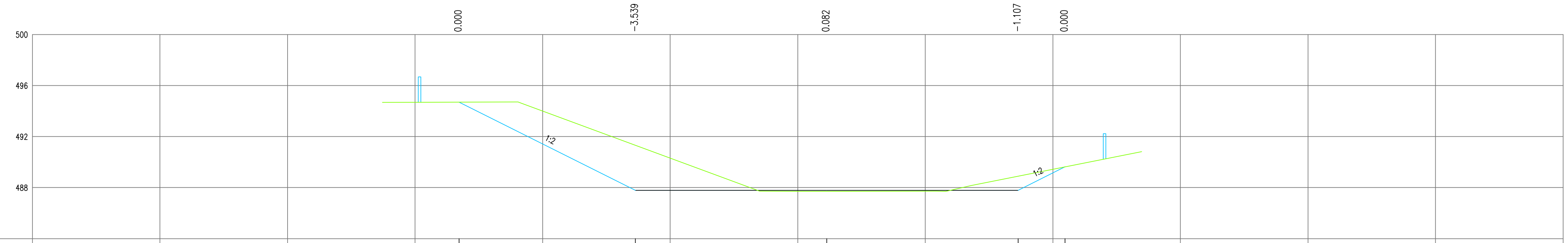
Project KAINANTU HAUL ROAD AND RIVER CROSSINGS
Title RIVER PLAN
Project No. S3E
Drawing No. YYYY
Sheet 26 / 28

64 K1+260



Existing Levels	490.638	489.637	488.15	488.754	489.138
Proposed Levels	490.638	488.068	488.068	488.068	489.138
Offsets	−20.141	−15	0	15	17.141

65 K1+280



Existing Levels	494.694	491.322	487.701	488.889	489.626
Proposed Levels	494.694	487.783	487.783	487.783	489.626
Offsets	−28.822	−15	0	15	18.687

Revision	Date	Revision Description
A	2.12.24	Client Review

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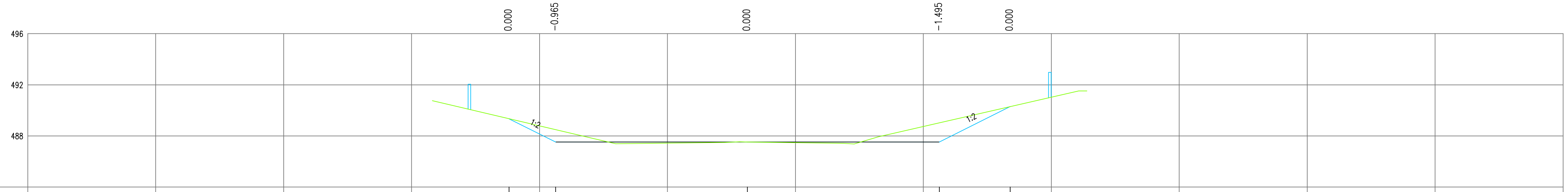
CHINA HARBOUR ENGINEERING COMPANY LTD.

Designed Zhenyu Wang	Date Dec.2024	Project KAINANTU HAUL ROAD AND RIVER CROSSINGS
Checked Zeye Tian	Date Dec.2024	Title RIVER PLAN
Approved Zhuode Feng	Date Dec.2024	Project No. S3E / Drawing No. YYYY / Sheet 27 / 28

66 K1+298.087



Existing Levels	489.343	488.49	487.525	489.02	490.292
Proposed Levels	489.343	487.525	487.525	487.525	490.292
Offsets	-18.636	-15	0	15	20.535

A	2.12.24	Client Review
Revision	Date	Revision Description

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Approved Zhuode Feng	Date Dec.2024	Project No. S3E	Drawing No. YYYY

Sheet
28 / 28