Project # GTZ-2006-02

Development of Gotzborg National Railway Route #1

Lonenberg to Bellelay

Project Overview

On 31 January 2006, Montin Engineering Consultants (Gotz) Limited was chosen by the General Manager of the Gotzborg National Railway, Thomas Maher, as the preferred Engineering and Design Contractor for the development of railway routes and facilities.

At the time of contracting, the Gotzborg National Railway consisted of zero routes and only one facility in the city of Lonenberg. Montin Engineering Consultants (Gotz) Limited was directed to begin work on developing the national railway system in early February 2006. On 21 February, the General Manager and Montin Engineering Consultants (Gotz) Limited agreed that the first route to be developed on the national network would best be a short route in order to gauge the scope of larger projects in the future. It was agreed that the first route to be developed would run from the national capital of Lonenberg to the municipality of Bellelay in Kerinberg.

The scope of the contract for the development of the Lonenberg to Bellelay route (Route #1) encompasses the development of the rail network only. Existing facility in Lonenberg will be maintained as originating point for the route, with a separate, future contract to be let for the development of a train station in Bellelay.

Due to various delays associated with inadequate national maps, commencement of conceptual and design planning stage for the project did not occur until 12 April 2006. The availability of proper topographical and national maps did not occur until 14 August 2006 with the launch of the Geographical Standards Organization world mapping project. Previously, Gotzborg was a participant in the Micronational Cartography Society world mapping project, however the maps available from this entity in 2006 were rejected by Montin Engineering Consultants (Gotz) Limited and the Gotzborg National Railway on the basis that the maps did not show the full extent of Gotzborg territory (cities on the Micronational Cartography Society map did not coincide with those found on the official national map of Gotzborg).

Further delays were encountered throughout the process due to hiccups with respect to infrastructure and information not being in place to adequately allow for an efficient project development process. With exemplary work on the part of both the Gotzborg National Railway and His Royal Majesty's Office, Montin Engineering Consultants (Gotz) Limited was able to obtain access and revisions to required data in a timely fashion.

The deadline for submission of final engineering report by Montin Engineering Consultants (Gotz) Limited has been set at 20 December 2006. A full report and appropriate drawings and data will be submitted to the General Manager on that date, along with all necessary invoices for payment.

Route Survey

A route survey was conducted by Montin Engineering Consultants (Gotz) Limited to determine the most advantageous route between Lonenberg and Bellelay. It was decided that the route, at a suitable point along its length, should "bulge" out in an Easterly manner towards the municipality of Juin in the Duchy of Markham. While not a considerable "bulge", the somewhat-circular nature of the Lonenberg to Bellelay route survey allows for a reduction in the amount of track required for the future route connecting Eastern Gotzborg with Lonenberg. Figure 1 shows the track of the Lonenberg to Bellelay route as finalized by Montin Engineering Consultants (Gotz) Limited.

Figure 1: Lonenberg to Bellelay Route Survey (Route indicated by solid white line)

The length of the Lonenberg to Bellelay route is 113.4 kilometres, based on available scales from the Geographical Standards Organization's GEISS world map project. The route runs through primarily riverside lowlands, which may present a concern of flooding during the spring-thaw. The likelihood of such a potentially catastrophic event occurring is focused near the destination ports as most of the track is located further inland and at a higher elevation than the river system and its floodplains. Figure 2 illustrates the general topographic profile of the route. As can be seen, the route increases relatively gently from Lonenberg to Bellelay, until approximately kilometre 75 when the elevation decreases substantially on the final leg of the journey.

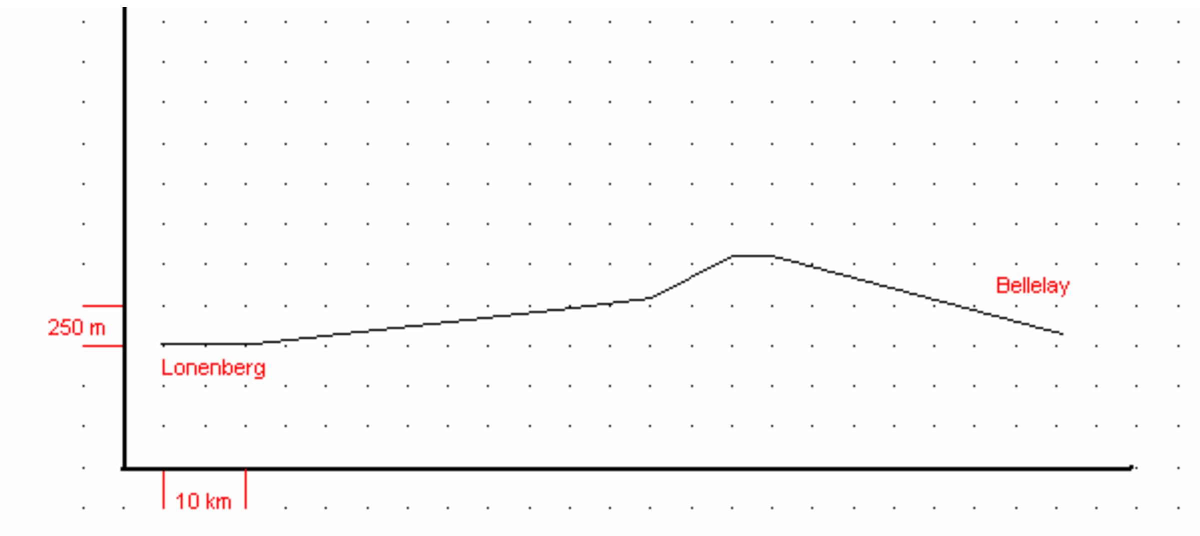


Figure 2: Lonenberg to Bellelay Route General Topographic Profile

Environmental Impacts

As with any civil project, there is the possibility of the development having an adverse affect on wildlife in its vicinity. Impact on the local wildlife due to the Lonenberg to Bellelay route development is highest during the actual construction of the line due to the increased frequency with which the track will be laid as well as the excavation and related work required in preparing the subgrade for the track. The presence of work camps and human civilization will impact the surrounding environment during construction. As such, the contractor should be required by the Gotzborg National Railway to take steps to ensure that any damage to the surrounding environment by construction is remediated and that all waste be removed and disposed of in a responsible manner. This will help ensure the continuance of a healthy environment that will nurture both plant life and wildlife, thereby making the potential for a more enjoyable journey by the passenger possible.

The regular scheduled trips on the route – estimated at five per day by GNR Director of Administration Hugh O'Neill – will have minimal impact on surrounding wildlife as the trip is estimated at 2 hours and 40 minutes one-way. There remains the potential for other environmental damage to occur from any derailments or illegal (or unintentional) dumping of fuels or other chemicals.

It is advisable that the Gotzborg National Railway take proper measures to ensure that dumping of sewage and other chemicals from washroom facilities aboard its trains does not occur. While it is common amongst railways of this era to dump sewage straight onto the tracks during travel, the installation of sewage retention systems that can be emptied at proper facilities would be a significant advantage for the Gotzborg National Railway in terms of making it an environmental leader in the railway industry.

Gotzborg National Railway Specifications

Montin Engineering Consultants utilized specification data provided by the Gotzborg National Railway in the design of the Lonenberg to Bellelay route. The provided specifications detail the type of crosstie and rail track required to permit the Gotzborg National Railway to use locally manufactured trains. A representation of a standard crosstie used along the route is provided at appendix 1. The specifications provided by the Gotzborg National Railway are summarized as follows. Montin Engineering Consultants has included additional specification data where necessary and has elaborated on each of the railway components.

<u>Standard Crosstie – Lonenberg to Bellelay Route (GNR)</u>

Wood type (GNR):	Pine softwood
Wood density (GNR):	455 kg/m^3
Standard dimensions (GNR):	178 mm x 229 mm x 2591 mm
Wood engineering properties (MEC):	Static bearing capacity: 0.61; dynamic bearing capacity: 0.80
Standard crosstie spacing (MEC, GNR):	508 mm C/C (centre to centre)
Crossties per kilometre (MEC, GNR):	1969
Tonnes of crosstie per kilometre (MEC):	98.45

Crossties have three purposes in a railway: (1) to secure the two lines of rails transversely and hold them to the correct gage, (2) the axle loads are borne and transmitted with diminished unit pressure to the ballast, and (3) the crosstie embedded in the ballast anchors the track against lateral, longitudinal, and vertical movement.

In terms of maintenance, the choice of the Gotzborg National Railway to utilize softwood as material has both advantages and disadvantages. The primary advantage is that softwoods more readily absorb treatment chemicals meant to prevent rapid decay. Consequently, however, the softwood will become worn much quicker than a hardwood due to the load and forces induced on the crosstie by traffic on the route. On the other hand, a hardwood, while more resistant to wear, absorbs treatment chemicals more inefficiently.

A crosstie must possess hardness and toughness, resistance to the abrasion of the rails, tie plates, and ballast, resistance to decay and freedom from splits, shakes, and knots. It is important that any structurally defective wood be discarded as its inclusion in the production of crossties would pose a safety and environmental risk, as well as financial liability for Gotzborg National Railway. The disqualifying conditions for a length of wood intended for use as a crosstie are as follows. Note that a crosstie must be perfectly straight from end to end.

Decay: No decay which extends further than 6.3 mm into the wood.
Holes: No hole more than 12.5 mm in diameter and 76 mm deep or covering more than one-fourth the width of the surface on which it appears and 76 mm deep outside, the sections of ties 508 mm and 1016 mm from the middle. Numerous small holes may be equivalent to one large hole.
Knots: Large knots with diameter exceeding one-fourth the wide of the surface are not permitted, but may be allowed if outside the areas 508 mm to 1016 mm from the middle. Numerous small knots are considered to be equivalent to a large knot.
Shakes: One not over one-third the tie width is permitted.
Splits: One not more than 127 mm long is allowed if antisplitting devices are used.

The crosstie will be affected by several factors which ultimately contribute to its service life. These limiting factors are: natural causes, the drying process, service wear, and abuse. Pine softwood will shatter, split or develop dry rot when subjected to wear. The source of service wear includes the trains that travel along the track, as well as ballast particles which come into an abrasive contact with the crosstie due to vibrations, etc. As with any construction material, the method by which it is installed is critical to the service life: trackmen should take care in installing each crosstie, and not subject the crosstie to impacts, such as beating it with a spiking hammer to set it square with the rails or to poke it in place with a lining bar.

Some crossties are expected to fail within the first 5 to 10 years of service, while others may last for up to 50 years depending on the local climatic and service conditions affecting the crosstie. For the crosstie used on this route, Montin Engineering Consultants predict a safe tie life of 30 years. This means that by the 30 year mark, 50% of the crossties are expected to require replacement, and by the thirty-fifth (35) year, 85% of the original crossties will need to be replaced.

Industry custom dictates that all crossties be inspected twice annually to ensure that they are in acceptable condition for operations.

Standard Rail – Lonenberg to Bellelay Route (GNR)

Rail material (GNR):	Steel
Rail style (GNR):	Flat bottom 'jointed'
Gauge (GNR):	1435 mm
Gauge on bends > 6° (GNR):	1441 mm
Rail weight (GNR):	49.61 kg/m (mainline)
Rail lengths (GNR):	11.89 m per length

The Gotzborg National Railway also provides a specification for rail weight of branch line; however, the Lonenberg to Bellelay route, and future routes connecting the major municipalities, will all be designed with mainline rail steel. The heavier weight of the mainline rail increases the moment of inertia (i.e. the stiffness) of the line. This greater stiffness reduces rail deflection and the heavier weight of the rail contributes to stability and provides redundancy in areas where the track support may be weaker due to wear, etc.

The mainline rail weight is designed to support a concentrated wheel load of 13,608 kg, with normal crosstie spacing. It is strongly recommended that the Gotzborg National Railway not exceed this load rating with its trains. Other engineering properties of the steel to be used in the mainline rail for this route are, by steel industry standard, provided by the steel manufacturer for review by the engineer prior to order.

Rail life is generally measures in millions of gross tonnes (mgt) carried along the line. Total million gross tonnes divided by annual traffic density provides a measure of life in years. The service life of a rail varies with traffic, the amount of curvature, gradient, subgrade, and ballast support, and the standard of maintenance. Rail life may be determined by wear and fatigue observed through inspections. Montin Engineering Consultants recommend, for this rail, replacement when the cumulative gross tonnage travelled reaches 500 mgt.

Rail Spike

While not included in the specifications by the Gotzborg National Railway, rail spikes are a critical component of the railway system. It is therefore required that a specification be issued for this component. Montin Engineering Consultants recommends that all rail spikes conform to the 'cut spike' hold-down device. Each cut spike shall be 178 mm long, with spike head width of 31.8 mm and weight of 0.38 kg.

Ballast

In the selection of ballast material for a railway, two behavioural characteristics are important: the short-term elastic response, and the long-term plastic (permanent) deformation and degradation. The characteristics affecting ballast are strength, toughness, durability, stability, drainability, cleanability, workability, availability, resistance to deformation, minimum purchase price, and overall economy. Good ballast will emulate the positive end of each of these individual characteristics, though some compromise may be required as not every characteristic listed can be well-achieved in unison.

Montin Engineering Consultants recommends that rail deflection, including ballast and subgrade, should not exceed 6.3 mm. Ballast should be of a No. 5 (4.00 mm) well-graded nature to resist plastic deformation.

The rail bed for this route will be constructed to hold two lines; however, at this time, only one of the lines will be laid until traffic warrants the laying of the second line.

Cross Section of Track

A sketch of a typical representative track cross-section for the route is provided as appendix 2.

Required Materials

For the 113.4 kilometre length of track connecting Lonenberg to Bellelay, the amount of gross materials required has been estimated by Montin Engineering Consultants as follows:

Aggregates:	335,672	m^3 required
Steel:	5,622,103	kg required
Lumber:	11,223,300	kg required

The amounts indicated above are the absolute minimums for the project. The Gotzborg National Railway may be required to order additional materials should any unforeseen circumstances arise during construction. Please note that these amounts are based on the installation of a uni-directional track (one track along the route).

Engineering & Estimated Construction Costs

The following is a summary of the engineering-related costs due to Montin Engineering Consultants for this project, as well as Montin Engineering Consultants' cost estimates for the aforementioned required materials.

Engineering Consultant Fees

All amounts in Gotzborg Thaler

Base fee (7% of construction costs):	46,991.50
Engineer Hourly Fee (155/hr – 18 total):	2790.00
Drafting Costs (75/hr – 13 total):	975.00
Disbursements:	
Payment to Karnali RecWar Society for maps:	2,600.00
Total Engineering Consultant Fees Due:	**53356.50**

Estimated Construction Materials Cost

All amounts in Gotzborg Thaler

Aggregates:	137,625.50
Steel:	309,215.70
Lumber:	224,466.00
5% Contingency:	33,565.36
Total Estimated Construction Materials Cost:	**704,908.20**
TOTAL PROJECT COSTS:	**758264.70**

The Engineering Consultant Fees portion is due upon submission of the final report.

Certification

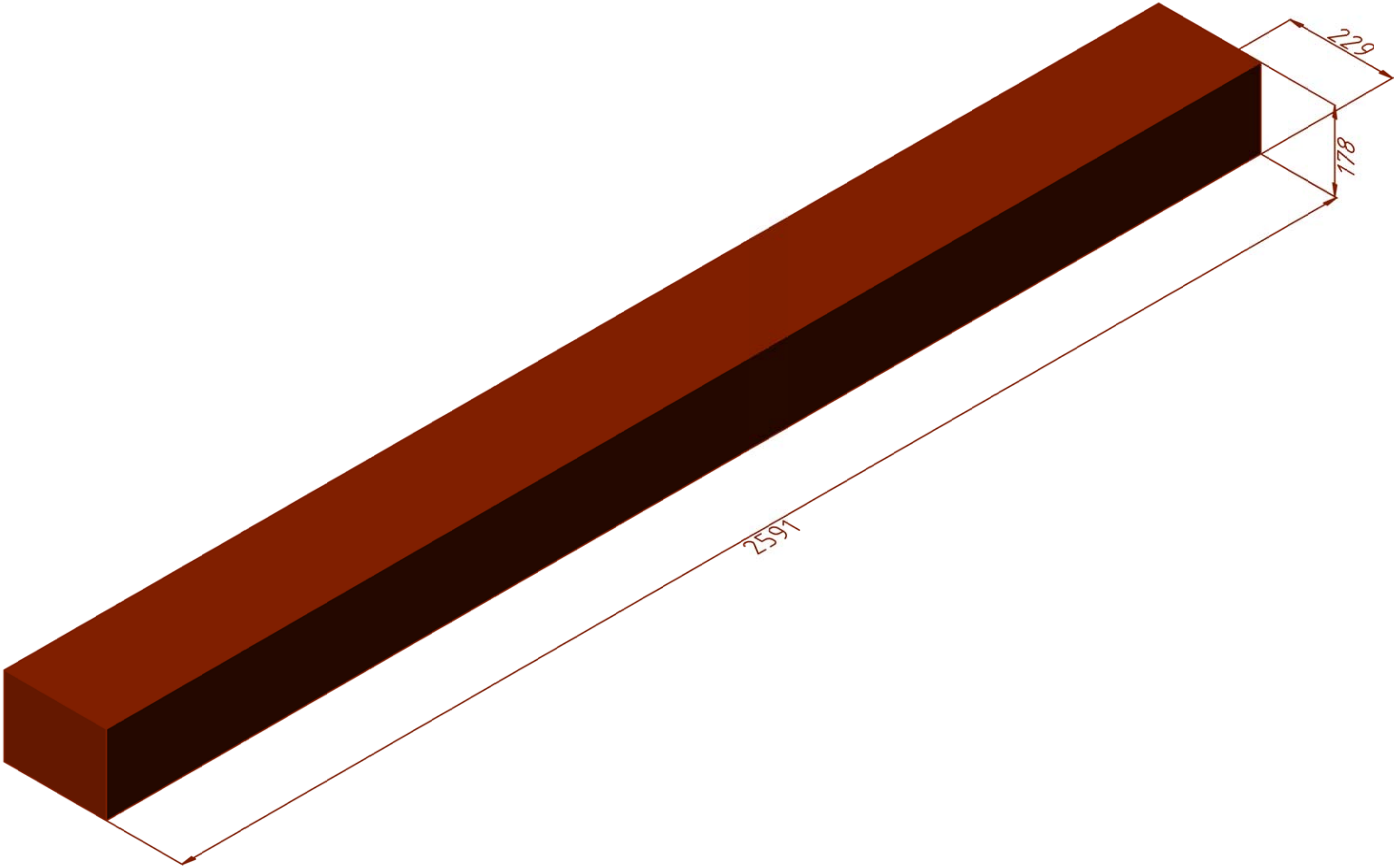
This document has been certified for use as a work specification for the development of Gotzborg National Railway Route #1 (Lonenberg to Bellelay) by a certified engineer registered with the Royal Kingdom of Gotzborg. Additionally, all work done by the contractor firm shall be supervised and certified by a registered certified engineer, else the work shall be considered void and the contractor required, at own expense, to perform any corrective measures.

Signed -- X

Liam Sinclair

Liam Sinclair, C. Eng.
Senior Engineer & Project Manager
Montin Engineering Consultants (Gotz) Ltd.

19 December 2006
Final Report



	Appendix 1: Standard Crosstie	
Drawn by	Date 19 Dec 06	Approved by Liam Sinclair
Notes	1. All dimensions in (mm)	
Revisions	0	Issued for final report - 19 Dec 2006

ROYAL KINGDOM OF GOTZBORG
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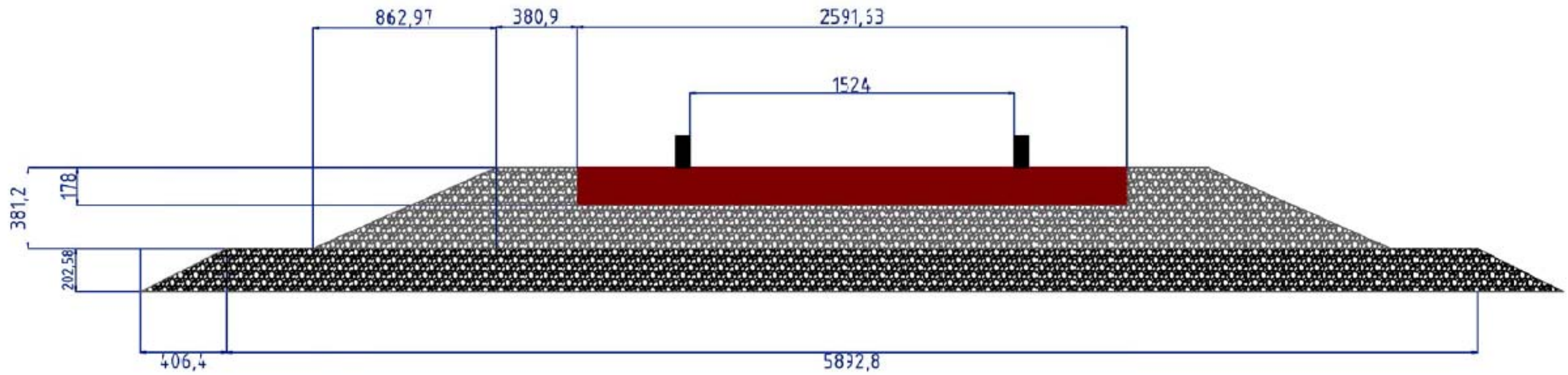
MEC

GOTZBORG NATIONAL RAILWAY



Appendix 2: Railbed Cross-Section		
Drawn by	Date 19 Dec 06	Approved by Liam Sinclair
Notes	1. All dimensions in (mm)	
Revisions		
	0	Issued for final report - 19 Dec 2006

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