

GEOTECHNICAL BASELINE REPORTS IN CZECH ENGINEERING PRACTICE

P. Makásek

Mott MacDonald CZ, spol. s r.o. Praha 1, Česká republika

J. Janků

Mott MacDonald CZ, spol. s r.o. Praha 1, Česká republika

With the first applications of the Design & Build approach (FIDIC Yellow and Emerald Book) and PPP procurement models in tunnel construction, the need arises to ensure a *fair* allocation of ground risk between the Employer and the Contractor (or Concessionaire). For this purpose, international practice—particularly in the United States—relies on the Geotechnical Baseline Report (GBR). This paper discusses the preparation of GBRs for the Chotýčany and Hosín railway tunnels on the Nemanice I – Ševětín section and for the Dětřichov and Maletín motorway tunnels on the D35 motorway. It describes the definition of baseline conditions for tunnel excavation and portal construction and the methods used to measure and evaluate these baseline conditions.

1. INTRODUCTION

In recent years, marked by the increasing development of tunnelling projects driven by the trend to “hide everything underground”, the question of how such construction will ultimately be financed is becoming ever more pressing. Consequently, alternative models for project preparation and financing—such as Design and Build (D&B) or Public Private Partnership (PPP)—are being adopted with increasing frequency. At the same time, the use of the Yellow and Emerald Books of the FIDIC international contract suite has become more widespread.

A fundamental issue associated with these developments is how to properly address uncertainties (risks) arising from the heterogeneous nature of the subsurface environment. No matter how detailed, an engineering–geological investigation is inevitably only an interpretation of the occurrence of soils and rocks, and of their most probable properties and behaviour, based on discretely obtained information (boreholes, pits, etc.) that can never describe this heterogeneous environment with complete accuracy. Unexpected ground conditions therefore always arise, and the associated burden cannot be easily allocated wholly to either the Employer or the Contractor.

The Geotechnical Baseline Report is the outcome of a technical dialogue on how to draw lessons from previously completed underground works and allocate construction risks between the contracting parties in a reasonable manner, thereby preventing disputes during construction or unnecessarily high tender prices caused by contractors’ initial contingencies for unforeseen conditions.

The GBR “tool” was used for the first time in the Czech Republic on the Homole Tunnel of the D35 motorway, which is currently under construction. This article presents further GBR interpretation reports prepared as part of the tender documentation for the following two projects:

1.1 MODERNISATION OF THE NEMANICE I – ŠEVĚTÍN RAILWAY SECTION

The project Modernisation of the Nemanice I – Ševětín railway section forms part of the upgrade of the 4th Czech railway transit corridor, which connects the German border near Děčín with Prague, České Budějovice, and continues further towards Linz. The aim of the project is to double-track the Nemanice I – Ševětín section, increase its capacity and raise the line speed to up to 200 km/h. The modernised section is almost 18 km long and, in addition to many other structures, includes two major tunnels: the 4,806 m Chotýčany Tunnel and the 3,120 m Hosín Tunnel.

The documentation for the building permit was prepared in 2021, followed by the detailed design in 2022. In 2023, a study was carried out examining the feasibility of excavating the tunnels using tunnel

boring machines (TBM), with the aim of reducing investment costs, shortening construction time and improving tunnel safety. During the coordination process with the regional Fire Rescue Service (HZS JČK), an agreement on cooperation between the Railway Infrastructure Administration (Správa železnic, Czech Republic, SŽ) and HZS JČK was signed, pursuant to which the tunnels are to be divided by a central wall into two fire-separated tubes. For this reason, the Employer opted for a combined contract model: one part will be procured under the FIDIC Yellow Book, with the Contractor responsible for adjusting the design documentation, while the remaining part will follow the FIDIC Red Book based on the completed detail design.

The tender documentation, including the GBR reports for the Hosín and Chotýčany tunnels, was prepared at the beginning of 2025. The building permit was issued in October 2025. At present, a postponement of the project implementation to 2028 is under discussion.

The GBR was prepared separately for each tunnel, with variants for both NATM and TBM excavation. This paper provides a more detailed description of the preparation of the GBR for the Chotýčany Tunnel based on the NATM excavation methodology.

1.2 TUNNELS ON THE D35 MOTORWAY

The D35 motorway is an integral part of the Czech Republic's national motorway and road system. It serves as the second, north connection between Bohemia and Moravia, running parallel to the D1 motorway, thereby redistributing traffic and relieving the D1; all this by D35 section between Olomouc and Hradec Králové. The D35 is also important for regional connectivity in northern Bohemia and Moravia and, together with the D1 (Lipník nad Bečvou – Ostrava – Polish border) and D11 (Prague – Hradec Králové – Polish border), forms a corridor of international significance.

On the Opatovec – Staré Město section, the motorway overcomes a terrain ridge near the village of Dětřichov via a 3,983 m long tunnel. On the Staré Město – Mohelnice section, the motorway enters the 1312.5 m long Maletín Tunnel along the edge of the Petrušov forest.

The building permit documentation for the Opatovec – Staré Město section was prepared in 2021 and the permit was issued in July 2023. For the Staré Město – Mohelnice section, the documentation was completed in 2023 and the permit was issued in August 2024.

In August 2022, both sections were included in the government's PPP programme. In April 2024, the Ministry of Transport appointed a transaction advisor for the selection of the PPP concessionaire, and in August 2024 launched the tender procedure for the concessionaire. The concession agreement is expected to be concluded in the second half of 2026.

The GBR was prepared for the NATM excavation method, separately for each tunnel. This paper provides a more detailed description of the preparation of the GBR for the Dětřichov Tunnel.

2. PURPOSE AND VALIDITY OF THE GBR

The GBR forms an integral part of the contract documentation and serves primarily to:

- Define the contractual baseline of anticipated subsurface conditions expected during tunnel construction;
- Describe the rationale for selected requirements imposed on the Contractor within the contract documents;
- Summarise geotechnical inputs for the design of portal excavations, tunnels, shafts, tunnel accessories and equipment;
- Identify key construction considerations and risks to be addressed both during tender preparation and during construction.

The document establishes the so-called baseline ground conditions which the Contractor may encounter during construction. These represent the contractual standard that the Employer and Contractor agree to use for risk allocation. The behaviour of the ground encountered will depend on the Contractor's methods, procedures and equipment. Therefore, baseline conditions are defined separately for each

tunnelling technology. In some cases, the baseline differs from the results of the geotechnical data analysis; where this occurs, justification is provided.

For the Nemanice I – Ševětín tunnels, the GBR was developed for two permissible construction technologies: the New Austrian Tunnelling Method (NATM) and tunnel boring machines (TBM). For the D35 motorway, the PPP process resulted in GBRs covering only NATM.

The scope of the document was prepared in accordance with the U.S. guidance *Geotechnical Baseline Report: Suggested Guidelines* (ESSEX, 2022). In the PPP variant, the drawing attachments form an integral part of the GBR, whereas in the D&B variant (FIDIC Yellow Book), they are included in a separate section of the tender documentation, the Employer’s Requirements.

3. CHARACTERISATION OF GROUND CONDITIONS AND GEOLOGICAL INTERPRETATION

The definition of baseline conditions was preceded by a comprehensive characterisation of the ground conditions, involving an in-depth interpretation of all available geological and geotechnical data. Interpretation of geotechnical data was one of the contractual deliverables of both GBRs, and the adopted methodology followed a planned sequence of steps. Despite understandable differences between the presented projects, the workflow was approximately as follows:

1. Collection of all available geotechnical data and information
2. Creation of a geotechnical parameter database
3. Development of a platform for visualising statistical analyses
4. Subdivision of the geological environment into characteristic rock types
5. Development of a geotechnical model
6. Final subdivision of the model into geotechnical units
7. Interpretation of statistical analyses and determination of baseline parameter values
8. Definition of baseline conditions for specific segments (portals, excavation, shafts, cross passages, etc.)

The complexity of gathering available data and creating a database of geotechnical parameters depends greatly on the form and format in which the results of the geotechnical investigations were delivered. In addition to digitising and adjusting the informational value of archival data, the core task consisted primarily of unifying the results of the individual stages/phases of the geotechnical investigations, stripped of interpretative elements. To a certain extent, this work overlaps with the preparation of the Geotechnical Data Report (GDR). Although the results were provided in open formats, a substantial amount of effort was still required to process the data into formats suitable for database import.

It is worth noting the positive experience from abroad, where the requirement for digital data formats is standardised through detailed tabular templates covering a wide range of field tests and laboratory analyses. In this respect, we highlight the effort of the Czech Road and Motorway Directorate (ŘSD ČR), as the key client of geotechnical investigations, to promote a unified format for digital data processing and delivery—specifically, the Data Specification C4.

For data management, the software tool OpenGround Cloud was used, selected due to its compatibility with Leapfrog for 3D geological modelling and its ability to link tabulated database outputs with Power BI. In Power BI, a platform was developed for visualising the results of statistical analyses of the geotechnical data. The platform consisted of a set of graphs—most commonly histograms—displaying key statistical parameters for any selected dataset. The choice of distribution function depended on the nature of the dataset and determined which statistical indicators were shown, typically: number of records, appropriate type of mean value, standard deviation, and confidence interval limits.

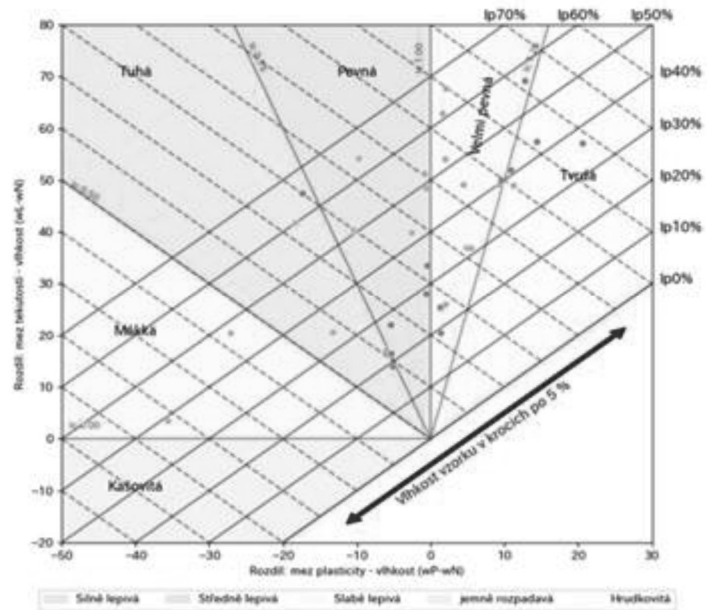
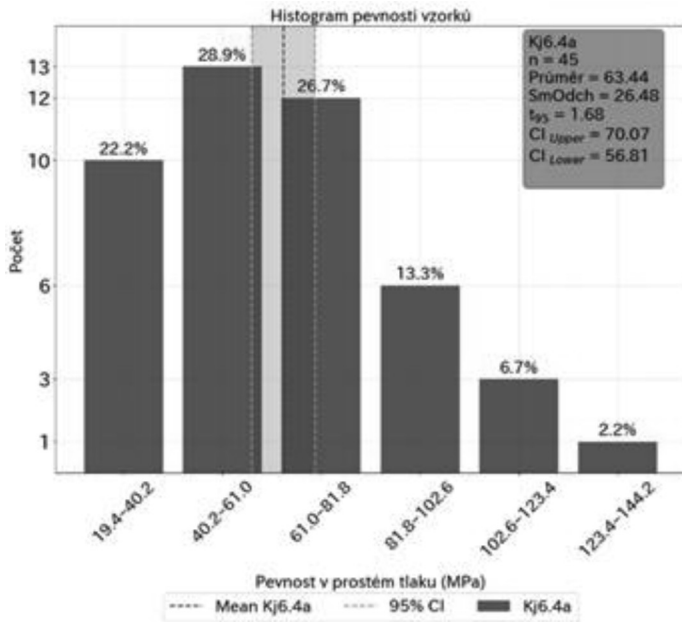


Figure 1: Examples of visualising statistical assessments of geotechnical data.

This platform provided invaluable insight into large datasets on a macro scale, while also enabling detailed evaluation at micro scale for individual borehole depths. It also allowed efficient display of variability across parameters, supporting the selection of indicators used to define contractual baseline subsurface conditions.

Steps 4–6 (see above) formed an iterative process. Initial subdivision of the geological environment, based on geological units defined by the investigation authors, was used to build a preliminary geotechnical model with two interconnected levels:

- A. Assignment of rock geotypes to specific borehole depths, linked to core logs, discontinuity records, field tests and laboratory results.
- B. Construction of a 3D geotechnical model.

Iteration involved evaluating parameters for each rock type, followed by merging or subdividing units if a revised classification improved interpretation for design and construction (excavation, shafts, special geological zones, etc.). This iterative process produced the final geotype system used for updating the 3D model and interpreting statistical results.

Baseline conditions were then defined by interpreting selected geotype parameters. Typically, the baseline was represented by an appropriate type of average-value or confidence interval boundary. Setting the baseline near the mid-range of plausible values promotes fair risk sharing, acknowledging the possibility that actual in-situ conditions may differ from those inferred from investigation data. Where limited data prevented reliable statistical assessment, the baseline value was set based on a synthesis of:

- Evaluated or recommended values from the geotechnical investigation;
- Locally typical values for the given material, preferably supported by experience from comparable projects;
- The engineer's professional judgement.

The 3D geotechnical model was developed in Leapfrog. Input data included borehole logs, geological interfaces defined in the investigations, and surfaces representing faults and fractured zones. The software allows generation of groundwater surfaces in separate aquifers, which proved highly beneficial when modelling piezometric levels in hydrogeologically isolated units identified in detailed assessments.

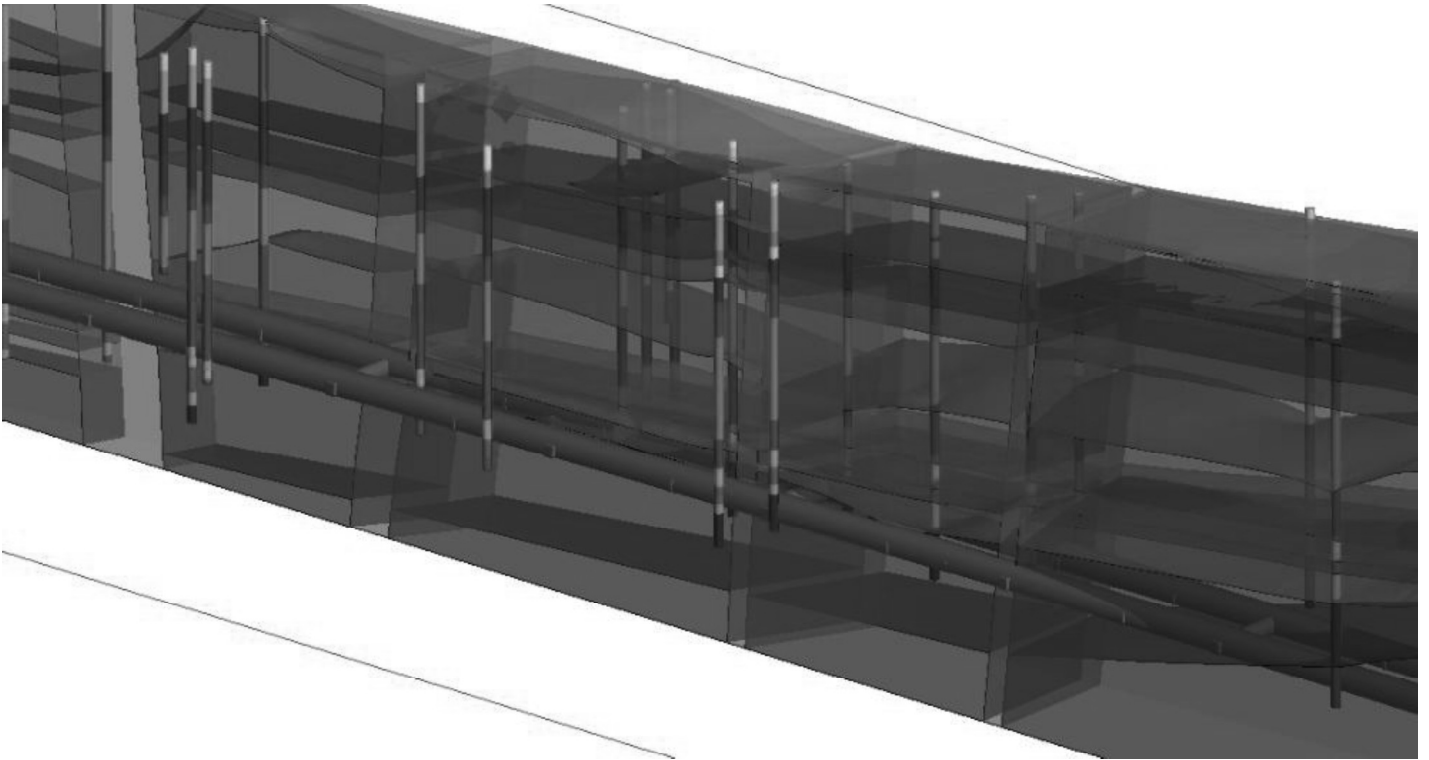


Figure 2: Examples of visualising 3D geotechnical model in Leapfrog software.

4. ESTABLISHED BASELINE CONDITIONS

Based on the characterisation of the ground conditions and the interpretation of geotechnical data for the individual geotypes, it was possible to complement the contractual framework of baseline subsurface conditions with baseline conditions defined for the specific components of the project (portal excavation pits, tunnels, shafts and cross passages).

The final form of the established baseline conditions for the projects described was influenced by the differing approaches to compensation mechanisms in the event that actual conditions differ from those defined. For the D35 motorway PPP project, it is required to assess the correctness of the risk-sharing allocation between the public and private sectors, including any compensation mechanisms and their calculation, in accordance with Eurostat rules. In other words, compensation mechanisms must be predefined on the basis of agreed unit prices for measurable construction outputs, the so-called pre-priced outcomes.

In contrast, the D&B project addresses compensation for differing site conditions on the basis of demonstrated additional costs incurred relative to the defined baseline conditions.

4.1 EXCAVATION PITS

In both presented projects, the cut-and-cover portal excavation pits were assessed separately from the main tunnel works. Taking into account the locally specific geotechnical conditions at each portal location, key baseline indicators were defined as baseline conditions, with the expectation that they would provide a clear metric for resolving disputes in the event that actual conditions deviate from those assumed. Based on the established baseline values of key soil and rock parameters assigned to the defined geotypes, the final baseline conditions for the construction of the portal excavation pits were defined as follows:

1. The percentage distribution of geotypes, each assigned excavation and drillability classes according to standardised scales;
2. The elevation of the interfaces between geotypes, expressed through contact lines defined in longitudinal and cross-sections;
3. Total groundwater inflows into the excavation pit;

4. The number of obstructions or oversized boulders.

The percentage distribution of geotypes—and the corresponding excavation and drillability classes—was determined using the 3D geological model. The elevations of the geotype interfaces shown in the GBR drawings were likewise generated from the 3D model. Acknowledging the natural variability of the geotechnical profile, and with the intention of describing it as realistically as possible, a tolerance of ± 3 m from the defined interface location was incorporated into this baseline condition. Layers of soil or rock with a thickness not exceeding 1.0 m were generally not included in the interpreted profiles. Where the occurrence of a thin layer of geotechnically distinct material was possible, this was noted together with an assigned probability of occurrence.

Groundwater inflows are an important factor influencing construction and are often the subject of additional works; therefore, the GBR devoted substantial attention to them. To establish the baseline condition for groundwater inflows into the excavation pit, the inflows were defined using two parameters:

- Inflow rate in L/s until depletion of the static groundwater storage, including an estimate of the time required for depletion;
- Reduced inflow rate in L/s after this period.

Baseline inflow values were established on the basis of hydraulic calculations for the given hydrogeological setting.

The occurrence of obstructions that delay excavation or impede earthworks is another factor that can only be captured by investigation with difficulty or by chance. For baseline purposes, *obstructions* were defined as boulders, concrete, asphalt, metal, brick, timber, plastic, or any object or fragment encountered at depths shallower than the upper boundary of bedrock that would cause a delay exceeding 2 hours. In one case, the occurrence of very hard residual material within the weathered rock mantle was considered possible; this too was included in the baseline by defining the expected volume of such an individual body. The baseline condition specified the expected number of obstructions within the given excavation volume, derived as the mean probability of occurrence.

During the ongoing PPP tender process, the excavation pits of the Dětrichov Tunnel were reclassified as early works, meaning they are to be executed immediately after financial close at a fixed price under the existing building permit. For this reason, the baseline conditions and associated compensation mechanism were reduced to only two items: the defined contact lines of geotypes and the expected number of obstructions within the excavation area.

Table 1: Baseline conditions for excavation pits

Baseline Condition	Chotýčany Tunnel	Dětrichov Tunnel
Percentage representation of geotypes	x	
Contact lines between geotypes	x	x
Total groundwater inflows into the excavation pit	x	
Obstruction or oversized boulder > 3 m ³	x	x

4.2 TUNNELS

For the behaviour of the rock mass during NATM excavation, the key indicators are:

- rock mass characteristics,
- groundwater conditions,
- density and character of discontinuities,
- tectonic and fault zones.

These indicators therefore require a defined set of baseline conditions describing the rock mass behaviour that the Contractor must assume in its tender and against which any additional costs arising from the encounter of differing site conditions may be compensated. In particular, these conditions must be reliably determined and measurable during construction. For this reason, it is difficult to take into

account, for example, the height of overburden or other quantities that cannot be measured directly within the tunnel.

4.2.1 Engineering Classes

To define the physico-mechanical behaviour of the rock mass along the tunnel alignment, so-called *Engineering Classes* were established. These classes are determined based on the percentage representation of each geotype at the tunnel face and on the RMR classification. They therefore do not define the excavation support or excavation procedure, as is customary in design documentation, since under both contract models this lies within the future Contractor's responsibility. An Engineering Class simply delineates zones with similar rock mass behaviour (physico-mechanical characteristics).

The classification into Engineering Classes must be clearly distinguished from classification into *technological excavation classes* under mining legislation, which is the responsibility of the Contractor's authorised mining supervisor. Engineering Classes serve solely for the purpose of quantifying excavation costs. Because it is not possible to predict how a future Contractor will subdivide the excavation face, final classification can only be performed once the entire tunnel profile has been excavated. Between successive faces or advance lengths, the evaluation parameters must be interpolated.

The classification of each face into an Engineering Class thus defines the measurable extent of each class, whose expected ranges are defined in the GBR longitudinal profile.

The Chotýčany Tunnel will be excavated through gneisses and granodiorites, ranging from soil-like, highly weathered material to fresh rock. Its excavation will therefore be strongly influenced by the proportion of each geotype present at the face. Approximately halfway along the alignment, the tunnel intersects the Drahotěšice Fault Zone, a regionally significant tectonic structure where strongly tectonised rock and abrupt lithological changes can be expected. Fresh gneisses transition into crushed, cemented rock of tectonic breccia character, bound by calcite and quartz. These breccias are strongly to completely weathered to depths of up to 17 m. Strongly tectonised granodiorites have the character of medium-grained, mica-rich, cemented kaolinitic sand with irregularly distributed firmer remnants of the parent rock. At the tectonic contact, completely weathered material may also occur. Due to the anticipated complexity of excavation through this lithological boundary below the groundwater table, a special Engineering Class L was defined.

The tunnel is therefore subdivided into the following Engineering Classes:

- **Class A** — face excavated in soils (or decomposed rock of strength class R6)
- **Class B** — face excavated in mixed soil-rock conditions, further subdivided into B-1 and B-2 depending on the proportion of soil at the face
- **Class C** — face excavated in rock (strength class R5 or stronger), further subdivided into C-1 and C-2 according to the degree of weathering
- **Class L** — special class defined for the lithological boundary (Drahotěšice Fault Zone) between the gneiss and granodiorite formations

Tabulka 9.3. Stanovené výchozí podmínky pro inženýrskou třídu B-1

Inženýrská třída	B-1		Rozsah v délce tunelu: 245 m TM 105 - 135, 265 - 370, 4100 - 4155, 4335 - 4370, 4410-4430				RMR	21 - 34			
	Geotyp	[-]	KT1p	KT1c	KT2p	KT2c	KT3p	KT3c	KT4p	KT4c	QTZ
Zastoupení v ploše výrubu	[%]	< 80%		-		0-30%				< 3%	
Pevnost v prostém tlaku ¹	[MPa]	<1.5	<1.5	2.9 (+/-2.0)	4.6* (+/-9.1)	7.6 (+/-6.1)	41.1 (+/-29.7)	58.0 (+/-33.2)	98.2 (+/-45.6)	88.3 (+/-1.7)	
Těžitelnost (dle ČSN 736133)		I.	I.	I.	I.	II.	II.	III.	III.	III.	
Přítoky podzemní vody na 10 m tunelu	[l/s]	0.6									
Způsob rozpojování	[-]	mechanicky									

¹ pevnost intaktní horniny, průměrná hodnota (*- směrodatná odchylka), * minimální hodnota je 0.5 MPa

Figure 3 Example of Engineering class B-1 for Chotýčany tunnel

In contrast, the Dětrichov Tunnel passes through Cretaceous strata with a pronounced influence of groundwater within a multi-level aquifer system, as well as through Permian formations. To describe the rock mass behaviour, the mass was subdivided into the following Engineering Classes:

- Class A-1 — excavation in Cretaceous rocks of the Jizera Formation
- Class A-2 — excavation in Cretaceous rocks of the Bělohorské Formation
- Class B — excavation in the transition from Cretaceous rocks of the Peruc–Korycany Formation to Permian units
- Class C-1 — excavation in Permian rocks affected by chemical weathering
- Class C-2 — excavation in unweathered Permian rocks

Due to the PPP procurement approach, the description of Engineering Classes as baseline conditions was simplified and limited solely to the percentage representation of geotypes and the expected range of RMR classification scores, see figure below:

Inženýrská třída					
Geotyp	A-1	A-2	B	C-1	C-2
Kj5.4s	< 5%				
Kj5.5s					
Kj5.5p	> 50%				
Kj6j		< 50%			
Kb5.4/5s	< 50%	> 50%	< 100%		
Kb5.4/5p					
Kp7.3/4p					
Kp5p/6j			0 - 100%	< 5%	
Ps7.0					
Ps7.3/4			0 - 50%	> 50%	< 50%
Pc7.3/4				< 50%	> 50%
Pc7.1					
Ps/c7.2					< 30%
Klasifikace RMR					
klasifikační body	49 – 69	57 – 64	33 – 49	40 – 48	52 – 59
Třída kvality horniny	II - Dobrá / III - Uspokojivá	II - Dobrá / III - Uspokojivá	III - Uspokojivá / IV - Špatná	III - Uspokojivá	III - Uspokojivá

Figure 4 Example of Engineering classes for Dětrichov Tunnel

4.2.2 Fault Zones

In both projects, the rock mass along the tunnel alignment is affected by tectonic disturbances. Their locations are interpreted based on the executed boreholes and geophysical surveys and are shown in the longitudinal geological profiles.

As the excavation approaches these structures, the rock mass becomes progressively weakened. These are primarily normal and thrust fault structures with repeated movements, locally with minor horizontal displacements. The rock is highly crushed, its geomechanical parameters significantly altered, and the more pronounced fault zones are water-bearing.

The baseline condition for the fault zones in the Chotýčany Tunnel is defined as the number of fault zones occurring within Engineering Class C, i.e., where the tunnel passes through rock mass conditions requiring additional stabilisation measures beyond those assigned to the engineering class itself. A total of 12 significant fault zones are anticipated, each with a thickness of up to 20 m (length of tunnel face passage through the zone).

For the established geotypes in the Dětrichov Tunnel, tectonic influence is expected to lead to a substantial increase in the frequency of discontinuities, a reduction in RQD, and a marked increase in groundwater inflow. Consequently, the RMR value for the same geotype will decrease when such conditions occur. It is therefore defined that whenever the RMR value falls below the threshold assigned to a given geotype, excavation is considered to be taking place within a fault zone, which is contractually valued as a separate Engineering Class within a fault.

Areas of low overburden—where reduced RMR values are also expected—are included within the defined extent of these fault-related excavation zones.

4.2.3 Groundwater

The amount of groundwater is a key factor during tunnel excavation and has a substantial impact on construction costs. Equally sensitive is the issue of potential impacts on the surrounding groundwater regime and the protection of any water sources.

For the Chotýčany Tunnel, groundwater inflows are defined for each Engineering Class. If the total inflows within an Engineering Class exceed the specified values, the Contractor is entitled to compensation for the additional costs, provided that such costs are duly substantiated.

An additional baseline condition addresses the possibility of a significant instantaneous inflow that may hinder excavation progress (dewatering, shotcrete application, mucking). If concentrated inflows exceed 15 L/s and do not diminish over a period of 3 days (i.e., the inflow does not represent the discharge of static storage), groundwater inflow mitigation by means of rock grouting will be required. Along the tunnel alignment, 12 significant fault zones of approximately 20 m thickness have been identified where increased groundwater flow is expected.

As a baseline condition, it was therefore assumed that in two cases, excessive inflows within a fault zone will require mitigation by grouting.

This approach could not be applied for the Dětrichov Tunnel due to the specific constraints of the PPP model, under which general compensation for increased costs is not permissible. Predicting inflow rates to the tunnel face for each Engineering Class is highly problematic in advance. The geotechnical investigation defines hydrogeological segments with anticipated flows; however, these segments do not correspond to the established Engineering Classes. Determining inflows would therefore require complex interpolation across segments, face divisions, and advance lengths. Furthermore, defining a reliable measurement location for individual inflows is inherently difficult.

For this reason, inflow ranges are presented for each Engineering Class as expected values, referenced to a 10 m section of tunnel, but do not constitute baseline conditions.

A particularly sensitive issue for the Dětrichov Tunnel is the potential impact on the groundwater regime within the regional Cretaceous hydrogeological unit, which is a source of drinking water of regional importance. Although the engineering–geological investigation estimated groundwater inflows for individual hydrogeological segments, it did not assess potential impacts on regional drinking-water sources (only on local ones).

A detailed assessment of the tunnel's impact on the entire Svitava River hydrogeological region (Mott MacDonald CZ, spol. s r.o., 2025) was therefore carried out as part of the GBR, in order to evaluate the risks associated with the tunnel's drainage effect and to establish relevant baseline conditions for mitigation measures and the overall required watertightness of the tunnel structure.

The assessment confirmed that the most affected area would be the municipality of Dětrichov and the springs of the Dětrichov Stream, where groundwater levels are expected to decrease by several metres. The headwaters of the stream may shift downstream, emerging only beyond the village. Due to the tunnel's drainage effect, the overall loss of groundwater within the hydrogeological region is estimated at 14–21 L/s, corresponding to 0.9–1.4% of the region's total groundwater resources.

Based on this hydrogeological assessment, and with the aim of limiting inflows and protecting in particular the Dětrichov Stream catchment, the segments with the highest expected groundwater inflows were identified as the most suitable for implementing mitigation measures. In these segments, the Concessionaire is required to consider the implementation of verification boreholes, and, if groundwater inflows in at least one of two boreholes exceed 10 L/s and do not drop below this value after 3 hours, to undertake pre-excavation sealing injections. The contract price includes the execution of sealing injections along 200 m of tunnel lining.

If, during excavation itself, additional locations are encountered where concentrated inflows exceed 10 L/s and do not diminish below this value after 3 hours, making safe excavation or application of primary support impossible, supplementary sealing injections must be carried out. These injections are

to be applied locally and directly into zones of concentrated seepage or water ingress. The baseline condition defines a total of 10 individual cases requiring sealing injections, each up to an area of 10 m² of tunnel lining from which water discharges in excess of the permissible limit. Any additional cases beyond this number are compensated according to a unit-rate mechanism.

The baseline condition for the required overall watertightness of the completed tunnel was set as a long-term stabilised inflow into the entire Dětřichov Tunnel system (both tubes combined) not exceeding 35 L/s.

4.2.4 Geologically Induced Overbreak

Geologically induced overbreak was a major topic of discussion during the PPP concession dialogues. Although overbreak caused by unforeseen geological conditions should in principle be compensated, its magnitude and frequency can be strongly influenced by the Contractor's excavation methods and workmanship.

Ultimately, this baseline condition was included, with the requirement that the determination of whether the overbreak is attributable or non-attributable must be confirmed by the Employer's Independent Engineer based on an assessment of the geotechnical monitoring data. Geologically induced overbreak is defined relative to the technologically induced overbreak line, which is specified by the Contractor in its construction design. This line must be set to a minimum thickness corresponding to the selected excavation technology and must comply with Good Industry Practice.

For the purpose of compensation, the actual volume of geologically induced overbreak above the technologically induced overbreak line is measured (provided that any individual continuous occurrence exceeds 1.0 m³).

The baseline condition is defined as 1 occurrence of geologically induced overbreak of 1 m³ per 1 m of excavated tunnel, i.e., 3,737.5 m³ per tunnel tube. This amount must be included in the unit prices of the respective Engineering Classes, and only geologically induced (non-attributable) overbreak beyond this baseline quantity is subject to compensation.

For the Chotýčany Tunnel, no such baseline condition is defined, and all overbreak is deemed to be included in the Contractor's tendered price.

4.2.5 Summary of Established Baseline Conditions

The table below summarises the established baseline conditions for the monitored tunnels.

Table 2: Baseline Conditions for the Tunnels

Baseline Condition	Chotýčany Tunnel	Dětřichov Tunnel
Range of Engineering Classes	x	x
Percentage representation of geotypes	x	x
RMR classification	x	x
Groundwater inflow into the tunnel	x	
Excessive groundwater inflows	x	
Groundwater inflow reduction	x	
Pre-excavation sealing injections		x
Supplementary sealing injections		x
Overall watertightness of the tunnel		x
Fault zones	x	x
Geologically induced overbreak		x

5. OTHER TUNNEL STRUCTURES

The excavation of tunnel cross passages, as well as technological chambers and galleries, will be carried out within the same Engineering Classes as those defined for the main tunnels, and the same baseline

conditions apply. Likewise, for the escape shafts of the Chotýčany Tunnel, the excavation conditions correspond to those established for the portal excavation pits.

6. CONCLUSION

Only the actual construction of both projects will show how well the baseline conditions were selected and whether they can be effectively applied for risk sharing during construction. It remains to be hoped that their implementation will proceed as soon as possible.

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Ing. Petr Makásek, Ph.D.

Mott MacDonald CZ, spol. s r.o. – Tunnel Department

E-mail: petr.makasek@mottmac.com

Ing. Jiří Janků

Mott MacDonald CZ, spol. s r.o. – Department of Geotechnics and Underground structures

E-mail: jiri.janku@mottmac.com