

Tunnel Projects	Period	Tunnelling Technology	System	Geology	Prediction Targets
<u>METRO PARIS - LIGNE 16 LOT 2</u> France	2020 - ongoing	2 EPB-TBMs, each Ø 9.86 m, CREG	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities, and fault zones
<u>METRO NAPOLI LINEA 1</u> Italy	2020 - ongoing	1 EPB-TBM, Ø 6.7 m, HERRENKNECHT	INTEGRAL	ignimbrite	cavities and fault zones
<u>METRO PARIS - LIGNE 16 LOT 1</u> France	2020 - ongoing	3 EPB-TBMs, Ø 9.87 m, Ø 8.92 m, Ø 9.87 m, HERRENKNECHT	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities, and fault zones
<u>METRO PARIS - LIGNE 14 SUD GC02</u> France	2020 - ongoing	1 EPB-TBM, Ø 8.83 m, HERRENKNECHT	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities, and fault zones
<u>AV/AC "TERZO VALICO DEI GIOVI" - LOTTO RADIMERO</u> Italy	2020 - ongoing	1 Mixshield TBM, Ø 9.77 m, HERRENKNECHT	INTEGRAL	metamorphics	water-bearing fault zones
<u>METRO PARIS - LIGNE 14 SUD GC04</u> France	2019 - 2020	1 EPB-TBM, Ø 8.83 m, HERRENKNECHT	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities and fault zones
<u>METRO PARIS - LIGNE 14 SUD GC03</u> France	2019 - ongoing	1 EPB-TBM, Ø 9.92 m, HERRENKNECHT	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities, and fault zones

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<u>MUSAI MEER PUMPING STATION AND OUTFALL PROJECT,</u> Qatar	2019 - ongoing	1 EPB-TBM, Ø 3.7 m, CREG	INTEGRAL	limestones, shales, chalky salty groundwater	karst and water-bearing cavities, fault zones, water salinity, zones of increased porosity
<u>DUBAI DEEP STORMWATER TUNNEL,</u> United Arab Emirates (UAE)	2019 - 2020	2 EPB-TBM, Ø 11.08 m, CREG	INTEGRAL	sandstones, mudstones	air and water-bearing fault and fracture zones, with potentially increased permeability, cavities, clayey softground zones
<u>BRENNER BASE TUNNEL, LOT MULES 2-3</u> Italy	2018 - ongoing	1 DS-TBM, Ø 6.85 m, HERRENKNECHT	INTEGRAL	granite, gneisses, schistes	fault zones, nappe structures, potential water-bearing zones
<u>METRO ROMA GALLERIA TRATTA T3</u> Italy	2018 - 2020	2 EPB-TBM, Ø 6.7 m, HERRENKNECHT	INTEGRAL	silt, clay, sand, gravel	cavities
<u>Galleria Santa Lucia Lotto 2,</u> Italy	2017 - 2020	1 EPB-TBM, Ø 15.87m, HERRENKNECHT	INTEGRAL	carbonate sequences	karst zones, karst cavities, and fault zones
<u>Galerie Des Janots</u> France	2017 - 2019	1 Gripper TBM, Ø 3.50 m, ROBBINS	INTEGRAL	limestones and dolomites	karst cavities
<u>METRO TEHRAN LINE 6</u> Iran	2017	1 EPB-TBM, Ø 9.15 m, HERRENKNECHT	INTEGRAL	sand, gravel, clay	construction objects like shafts and steel structures

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<u>IDRIS MTS-01, Sewerage Tunnel</u> Qatar	2017 - 2018	2 EPB-TBMs, Ø 3.85 m, HERRENKNECHT	INTEGRAL	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	karst and water-bearing cavities, fault zones, water salinity, zones of increased porosity
<u>5th Water Supply System to Jerusalem</u> Israel	2016 - 2017	1 Hard Rock TBM, Ø 3.90 m, ZUEBLIN	INTEGRAL	limestones	karst zones, Karst cavities, and fault zones
<u>METRO ATHENS LINE 3 EXTENSION</u> Greece	2016 - 2017	EPB TBM, Ø 9.5m, LOVAT	INTEGRAL	siltstones, serpentinites, limestones	karst zones including large cavities
<u>Uma Oya Multipurpose Development Project,</u> Sri Lanka	2016	1 Double Shield TBM, Ø 4.3m, HERRENKNECHT	INTEGRAL	gneisses	fault zones, potential water-inflow and gas-inflow zones, characterization of relative fracturing
<u>SS1 Nuova Aurelia Highway Tunnel,</u> Italy	2015 - 2018	Single Shield TBM, Ø 13.72m, HERRENKNECHT	INTEGRAL	gneisses, amphibolites	fault zones, fracture zones, water-bearing zones
<u>METRO PARIS LINE 14 LOT T01,</u> France	2015 - 2018	2 EPB-TBMs, Ø 8.9 m, HERRENKNECHT	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities, and fault zones
<u>METRO PARIS LINE 14 LOT T02,</u> France	2015 - 2018	1 EPB-TBMs, Ø 8.96 m, NFM TECHNOLOGIES	INTEGRAL	marlstones, limestones, gypsum, sand, gravel	karst zones, karst cavities, and fault zones

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<u>METRO RIYADH LINE 5,</u> Saudi Arabia	2015-2016	2 EPB-TBMs, Ø 9.73 m, HERRENKNECHT	SCAN	limestone formation of different karstification grades partly brecciated	karst zones, air-filled/water-bearing cavities, fault zones, zones of increased porosity
<u>METRO RIYADH LINE 3,</u> Saudi Arabia	2015 - 2017	1 EPB-TBM, Ø 10.16 m, NFM TECHNOLOGIES	INTEGRAL	limestone formation of different karstification grades partly brecciated	karst zones, air-filled/water-bearing cavities, fault zones, zones of increased porosity
<u>AZAD WATER CONVEYANCE TUNNEL,</u> Iran	2015 - 2018	1 EPB-TBM, Ø 3.71 m, HERRENKNECHT	INTEGRAL	conglomerates, sandstones and mudstones, limestones, shales	fault and fracture zones
<u>METRO DOHA Gold Line,</u> Qatar	2014-2016	6 EPB-TBMs, Ø 7.05 m, HERRENKNECHT	SCAN	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	karst and water-bearing cavities, fault zones, zones of increased porosity
<u>METRO DOHA Red Line North,</u> Qatar	2014-2016	4 EPB-TBMs, Ø 7.05 m, HERRENKNECHT	INTEGRAL/ SCAN	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	karst and water-bearing cavities, fault zones, zones of increased porosity
<u>METRO DOHA Green Line,</u> Qatar	2014-2016	6 EPB-TBMs, Ø 7.05 m, HERRENKNECHT	SCAN	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	karst and water-bearing cavities, fault zones, zones of increased porosity
<u>HEADRACE TUNNEL PROJECTS PANDO,</u> Panama	2014-2015	EPB-TBMs, Ø 3.78 m, LOVAT	INTEGRAL	lahars formation, pyroclastics	differentiation between clay and debris, fault zones and water-bearing zones

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<u>ABU HAMOUR DRAINAGE TUNNEL,</u> Qatar	2014-2015	2 EPB-TBMs, Ø 4.52 m, HERRENKNECHT	INTEGRAL	limestones, shales, chalky limestones, Evaporites, Karst, silty clayey material	karst and water-bearing cavities, fault zones, zones of increased permeability
<u>STEP DEEP TUNNEL SEWER - T03,</u> United Arab Emirates (UAE)	2012	2 EPB-TBMs, Ø 6.34 m, HERRENKNECHT	INTEGRAL	dolomitic claystones and siltstones, gypsum, clay, silt	water-bearing cavities, zones of increased permeability
<u>GALLERIA MACUGNAGA,</u> Highway Pilottunnel, Alps, Italy	2012	Hard Rock GripperTBM, Ø 3.60 m	INTEGRAL	mica schists	fault zones, weathered mica schists
<u>GALLERIA SPARVO,</u> Highway Bologna-Florence, Italy	2011-2012	EPB-TBM, Ø 15.55 m, HERRENKNECHT	SCAN	unconsolidated weathered complex ophiolitic geology	fault zones, differentiation between arenitic and argillic/pelitic lithology
<u>STEP DEEP TUNNEL SEWER - T02,</u> United Arab Emirates (UAE)	2011-2012	3 EPB-TBMs, Ø 6.34 m, HERRENKNECHT	SCAN	dolomitic claystones and siltstones, gypsum, clay, silt	water-bearing cavities, zones of increased permeability
<u>METRO ROMA LINEA C, T4</u> Italy	2010-2011	2 EPB-TBMs, Ø 6.7 m, HERRENKNECHT	SCAN	gravel, clay, silt, silty clay, pyroclastics	cavities and archeological remains ahead and around of face
<u>GASTAU Gaspipe Project,</u> Brazil	2009-2011	DS-GRIPPER TBM, Ø 6.3 m, WIRTH	INTEGRAL	gneisses, granites, diabas dykes	subhorizontal and subvertical water- bearing fault and fracture zones

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<u>TARRASA UTE Railway Project,</u> Spain	2009	EPB-TBM, Ø 6.4 m, LOVAT	INTEGRAL	clay/silt, silty gravel sand/gravel, clayey carbonates, karst structures	(reinforced) concrete structures of old foundations and water wells linings, structures of Karst and old piles
<u>METRO ROMA LINEA C. T5,</u> Italy	2009-2010	2 EPB-TBMs, Ø 6.7 m, HERRENKNECHT	SCAN	gravel, clay, silt, silty clay, pyroclastics	cavities and archeological remains ahead and around of face
<u>Brenner Base Tunnel,</u> Austria - Italy	2008-2010	DS-TBM, Ø 6.3 m, WIRTH	INTEGRAL	granites, gneisses	fault zones
<u>METRO ROMA LINEA C. T6A,</u> Italy	2008-2009	2 EPB-TBMs, Ø 6.7 m, HERRENKNECHT	SCAN	gravel, clay, silt, silty clay, pyroclastics	cavities and archeological remains ahead and around of face
<u>Blessberg Tunnel, Germany</u> (Erfurt - Nuremberg)	2008	Perimeter exploration in an existing tunnel	PERIMETER	limestones	karst cavities, open air-filled and filled with sand, gravel
<u>METRO NAPOLI LINEA 1,</u> Italy	2008	S-TBM, Ø 6.7 m, HERRENKNECHT	INTEGRAL	tuff	old-mine cavities
<u>TÚNEL DE LA CABRERA, Spain</u> (Valencia-Madrid)	2007-2008	DS-TBM, Ø 9.5 m, HERRENKNECHT	SCAN, INTEGRAL	limestones and dolomites	water-bearing fault/ karst zones and cavities

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<u>METRO NAPOLI LINEA 1,</u> Italy	2007	S-TBM, Ø 6.7 m, HERRENKNECHT	INTEGRAL	tuff	old-mine cavities
<u>VAL PASSIRIA Project,</u> Italy	2007-2008	DS-TBM, Ø 3.7 m, WIRTH	INTEGRAL	gneisses	water-bearing fault zones
<u>Proyecto del Emisario Submarino de Berria,</u> Spain	2006-2007	Micro-TBM AVN2000D, Ø 2.0 m, HERRENKNECHT	INTEGRAL	limestones	karst cavities
<u>BELES Multipurpose Project,</u> Ethiopia	2006-2008	DSU-EPB-TBM, Ø 8.1 m, SELI	INTEGRAL	volcanic rock, pyroclastics, various kind of basalt, lacustrine sediments	water-bearing fault zones, disintegrated weathering zones, silty areas
<u>CANADA LINE, Canada</u> (Vancouver - Int. Airport Vancouver)	2006-2007	EPB-TBM, Ø 6.1 m, LOVAT	INTEGRAL	sandstone, till, clayey sandy silt, coarse sand, siltstone	transition zones between sandstone and till, water-bearing formations
<u>Water Supply Tunnel TBM 1 + 3,</u> China	2006	Gripper TBM, Ø 8.3 m, ROBBINS	INTEGRAL	volcanics, metamorphics, marbles	karst cavities and fault zones with potential water-inrush zones
<u>PAJARES Tunnels Lot 1, Spain</u> (León-Asturias)	2006	2 DS-TBM, Ø 9.9 m, HERRENKNECHT and NFM	INTEGRAL	folded and faulted schistes, grey waxes and karstic limestones	water-bearing fault/ karst zones and cavities

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<u>Headrace Tunnel, China</u>	2006	Boring jumbo Drill + Blast	D+B- SCAN	volcanics, metamorphics, marbles	karst cavities and fault zones with potential water-inrush zones
<u>Jin Ping II Hydropower Project, China</u>	2006	Boring jumbo Drill + Blast	D+B- SCAN	marbles, schistes	water- and air-/gas-filled caverns
<u>ABDALAJIS Tunnel West, Spain (Malaga-Cordoba)</u>	2004-2005	Double-shield TBM, Ø 10.2 m, MITSUBISHI/ ROBBINS	INTEGRAL	clay-/siltstones, limestones, marls, dolomites	weak claystones, karst structures, water- and gas-filled cavities and fault zones
<u>Metro Barcelona Linea 9, Spain</u>	2004-2005	Dual Rock-Soil TBM, Ø 11.95 m, WIRTH/ NFM	INTEGRAL	granite, discomposed granite (sand, gravel and boulders)	fault and fracture zones, (thermal) water-bearing zones
<u>PRISNIG Tunnel, Italy</u>	2004-2005	Open type TBM, Ø 5.80 m, JARVA	INTEGRAL	calcareous and anhydrite/ gypsum formations	fault/ karst zones and caverns
<u>Guadarrama North-Tunnel, Spain (Madrid-Segovia)</u>	2004	Double-shield TBM, Ø 9.51 m, HERRENKNECHT	INTEGRAL	gneisses and intrusive rocks of granitoid type	finegrained (mylonitic) shear zones
<u>GOTTHARD Base Tunnel, South Portal, Switzerland</u>	2003-2004	2 Gripper TBMs, Ø 9.51 m, HERRENKNECHT	INTEGRAL	gneisses	subhorizontal and subvertical water- bearing fault and fracture zones

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<u>GOTTHARD Base Tunnel,</u> Section Sedrun, Switzerland	2003	Drill & Blast	D+B-SCAN	schists and gneisses	water-bearing fault zones
<u>Stammham Tunnel, Germany</u> (Nuremberg – Ingolstadt)	2002-2003	Perimeter exploration in existing tunnel	PERIMETER	limestones and dolomite	karst cavities, open air-filled and filled with sand, gravel
<u>Geisberg Tunnel, Germany</u> (Nuremberg – Ingolstadt)	2002-2003	Perimeter exploration in existing tunnel	PERIMETER	limestones and dolomite	karst cavities, open air-filled and filled with sand, gravel
<u>GINORI Tunnel, Italy</u> (Florence-Bologna)	2000-2003	Telescopic-shield TBM, Ø 6.3 m, WIRTH	SCAN	limestones	high water-bearing and high permeability subvertical karst and fault zones
<u>Irlahuell Tunnel, Germany</u> (Nuremberg – Ingolstadt)	2000-2003	Perimeter exploration in existing tunnel	PERIMETER	limestones and dolomite	karst cavities, open air-filled and filled with sand, gravel
<u>Loetschberg Base Tunnel,</u> Switzerland	2000	Drill & Blast Boring jumbo	D+B-SCAN	schists, marls and limestone	karst-structures and clayey schist shear zones