SOLEXPERTS

Swiss Precision Geomonitoring

Groundwater Multi-Level Monitoring Systems

- Groundwater Monitoring
- Groundwater Sampling
- Hydraulic Testing for Determining Aquifer Parameters

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Overview Groundwater
Multi-Level Monitoring Systems

Specifications	SPMP Stand-Pipe Multi-Packer System	MPS Multi-Packer System	HMPS Hybrid Multi-Packer System
Main application	Monitoring and sampling (1,2,3,4*)	Monitoring in horizontal boreholes (1*)	Monitoring and sampling (1,3,4*)
Tubing/stand-pipe material	Stainless steel	Stainless steel	Stainless steel
Stand-Pipe (SP) / Line (L) - inner diameter	SP - 16.5 mm	L - 4 or 3 mm	SP - 16.5 mm / L - 4 or 3 mm
Number of monitoring levels	4 / 7 / 10	up to 10	4 / 7 / 10
Required minimum borehole diameter	76 / 96 / 130 mm	50 mm	76 / 96 / 130 mm
Maximum installation depth	~ 1000 m	~ 300 m	~ 1500 m
Sampling options	small diameter pump	only free flow at the well head	small diameter pump
Maximum pumping flow rates	~ 0.2 l/ min	variable	~ 0.2 l/min
System retrievable	yes	yes	yes
Accessories (sensors, pumps) retrievable	yes	at the wellhead	yes
Host rock	Hard rock	Hard rock	Hard rock
Separation of monitoring zones	Packer seal	Packer seal	Packer seal

Custom made system modifications upon request

Technical specifications subject to change

* Groundwater Multi-Level Monitoring Systems mainly used for:

1 Site characterization for nuclear waste disposal

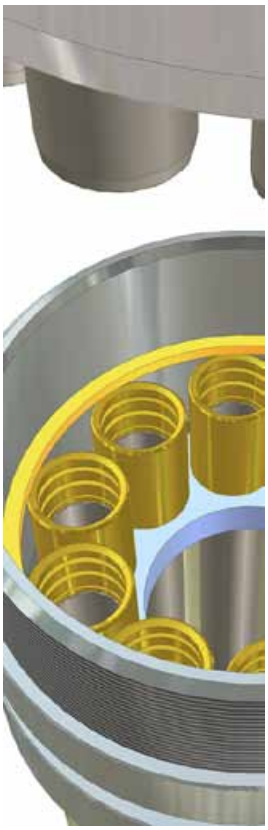
2 Groundwater contamination

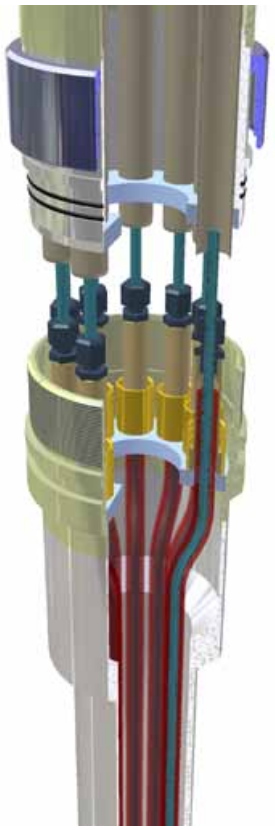
3 Saltwater intrusion

4 Groundwater monitoring related to underground constructions

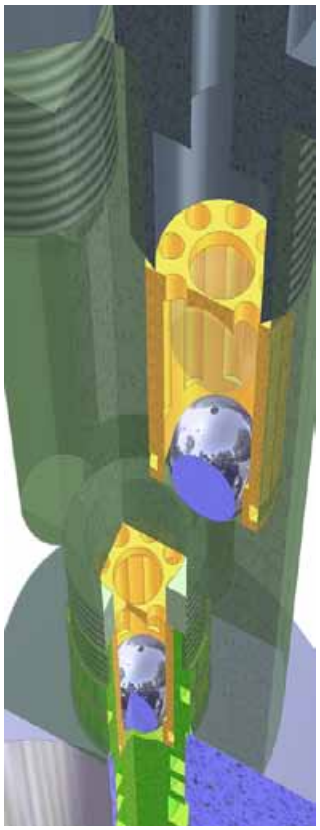
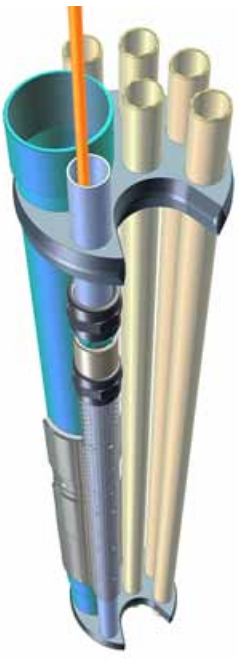
5 Slope instability

6 Buoyancy at dams





Overview Groundwater
Multi-Level Monitoring Systems

PMPS Pump Multi-Packer System	MPSS Multi-Port Sampling System standard	circular	PZP PiezoPress
Sampling and monitoring (2,3,4*)	Sampling and monitoring (2,3,4,5*)		Head monitoring in low-permeable soils (4,5,6*)
Stainless steel / PVC	PVC		PVC
L - 4 mm	SP - 21 mm	SP - 26 mm	SP - 26 mm
up to 5	up to 6		up to 5
76 mm	155 – 200 mm	170 mm	50 mm
~ 1000 m / 300 m	~ 100 m	~ 120 m	~ 100 m
small diameter pump	2” submersible pump	small diameter pump or compressed air-method	optional
~ 0.2 l/min	25 l/min	variable	variable
yes	no		no
no	yes		yes
Hard rock	Hard and unconsolidated rock		Soils; all types of rocks
Packer seal	Grout seal		Grout seal
			

The System

The Stand-Pipe Multi-Packer System combines the accessibility of conventional piezometers with the cost-effective advantages of a multi-packer system.

- Stainless steel construction for durability and sample integrity
- Up to 10 independent observation intervals
- Modular design allows the system configuration to be changed in the field
- Easy to install
- Borehole diameters from 76 mm

The SPMP system consists of tubing and packer modules with integrated stand-pipe guides. Each module can be fitted with up to ten 16.5 mm ID stainless-steel standpipes. All module and stand-pipe connections are fitted with double O-ring seals. The modules are fastened together with convenient swivel-nut couplings.

Accessories

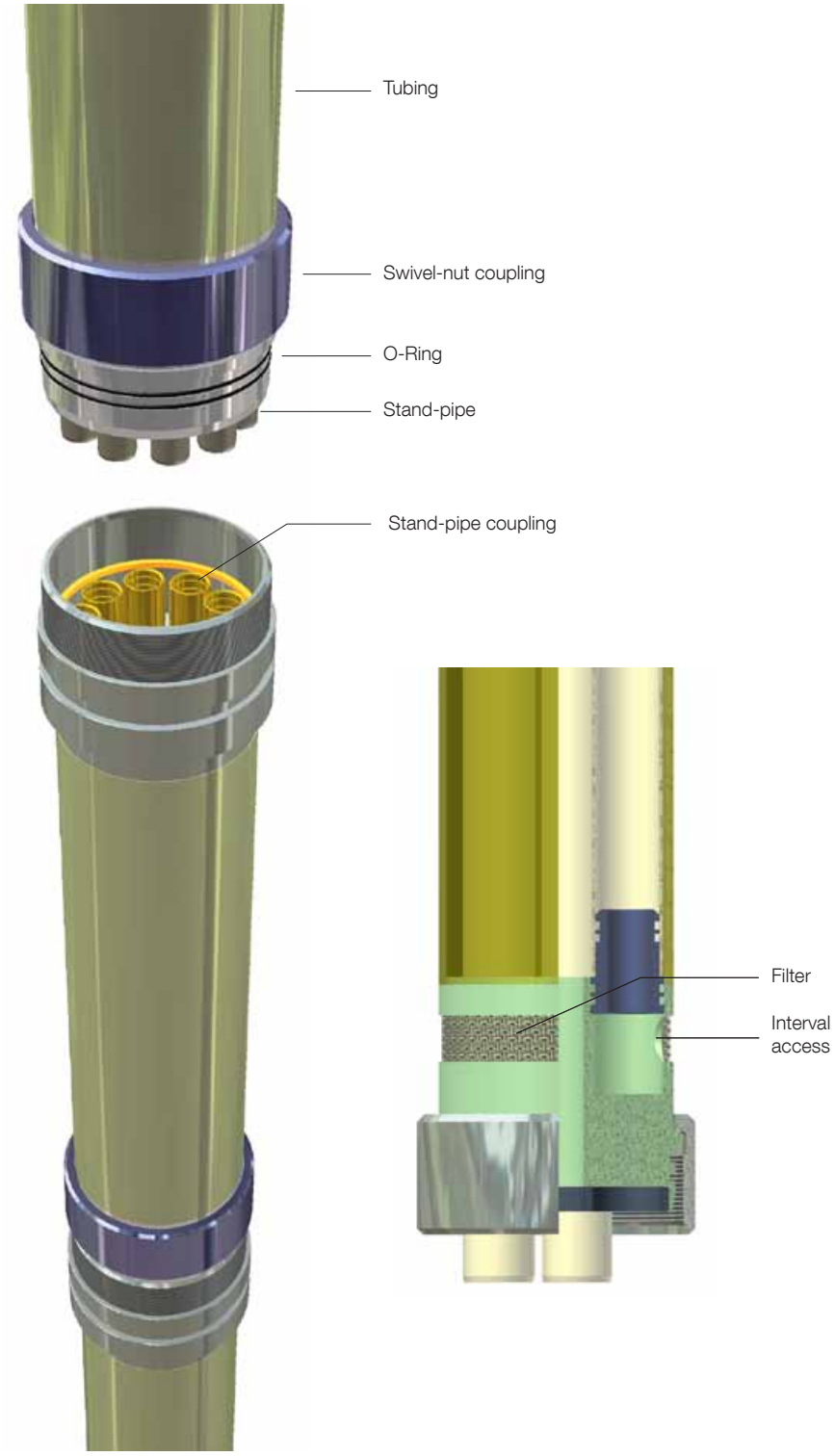
A variety of accessories can be inserted into the stand-pipes once the basic system is installed:

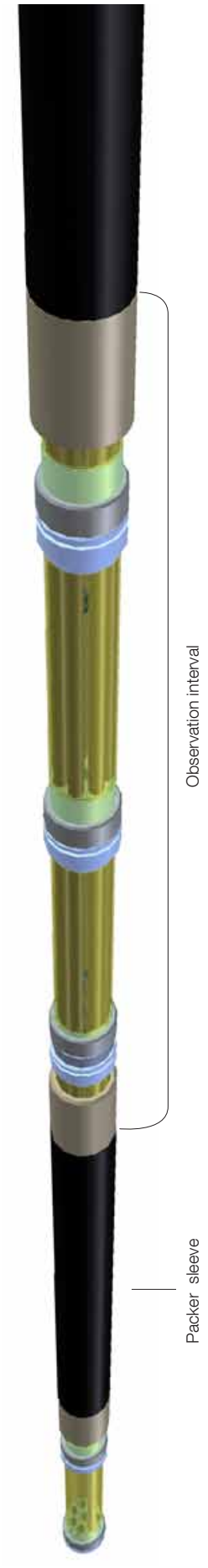
- Pressure transducers
- Sample pump
- Down-hole sampler (for collecting samples at formation depth)
- Bailer

All down-hole accessories can be removed for calibration, maintenance or repair without dismantling of the basic system.

Stand-Pipe Multi-Packer System (SPMP)

- Each observation interval is accessible via an individual stand-pipe
- Modular system design
- Basic system and accessories retrievable





Stand-Pipe Multi-Packer System (SPMP)

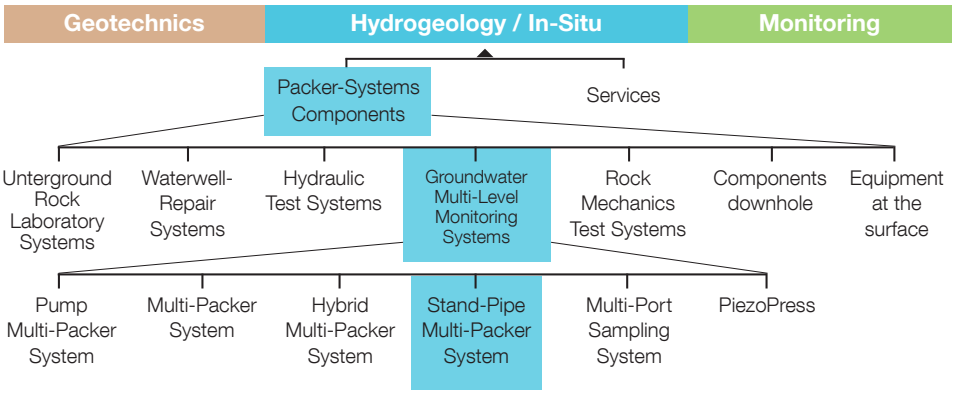
Stand-pipe orientations

Technical Specifications	SPMP-54	SPMP-76	SPMP-106
Tubing diameter [mm]	54	76	106
Max. no. of stand-pipes	4	7	10
Stand-pipe diameter [mm]	16.5		
Tubing lengths [m]	3.0, 1.5, 1.0, 0.5		
Min. packer diameter [mm]	68	89	122
Packer sealing length [m] [1]	1.0, 0.5		
Packer material	natural rubber / nitrile / viton		
Min. interval length [m] [2]	0.5		

1) Custom packer sealing lengths upon request 2) Interval span is increased by adding tubes

Technical specifications subject to change

Accessories	Type / Material	Diameter	Range/Capacity
Pressure sensors	vibrating wire piezoresistive	11 mm 12 mm	1–14 bar 1–20 bar
Sample pump	double valve	15 mm	220 ml/min
Down-hole sampler	stainless steel	15 mm	220 ml
Bailer	stainless steel	15 mm	~ 250 ml



The system

The MultiPacker System is multifunctional and costeffective. The MP System can be installed in very small diameter (from 50 mm) boreholes.

- Pressure measurement and water sampling at the wellhead
- Up to 10 independent observation intervals
- Interval lengths from 15 cm
- Simple system design
- Very small tubing diameters

The MPSystem consists of tubing and packer modules which provide access to one or more observation intervals. All module connections are fitted with double Oring seals.
Depending on requirements the modules are fastened together by swivelnut couplings or set screws.

Accessories

Once the MultiPacker System is installed, the packer expansion lines and the interval access lines are connected to a control unit near the wellhead.

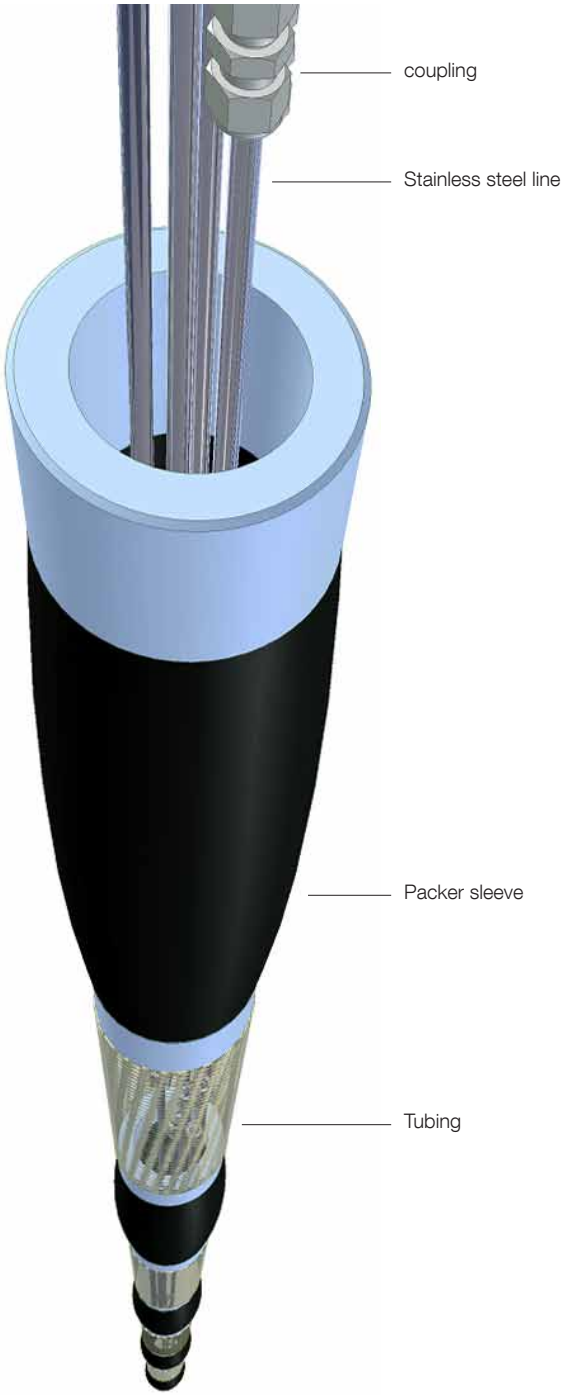
A variety of accessories can be connected to the control unit:

- Pressures transducer
- Injection pump
- Sampling vessel

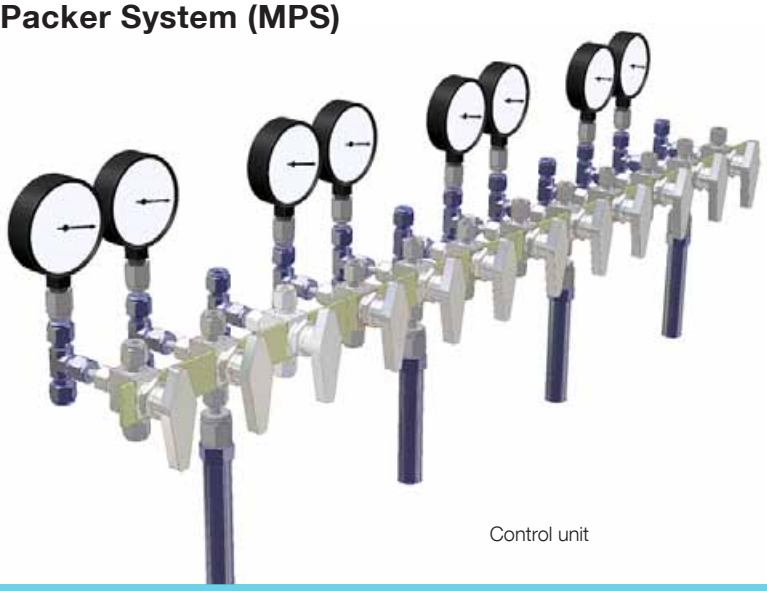
All components at the control unit can be calibrated, repaired or replaced.

Multi-Packer System (MPS)

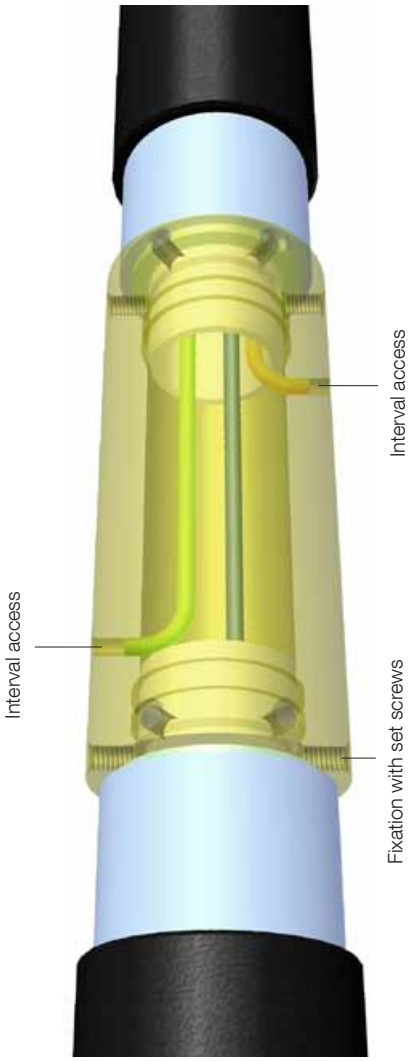
- Each observation interval is accessible via polyamide or stainless steel lines
- Multiple access to each interval possible, e.g. for circulation
- Interval lengths from 15 cm
- Accessories (pressure transducers, pump) at the wellhead
- Cost-effective, for borehole diameters from 50 mm



Multi-Packer System (MPS)



Control unit



Interval access module

Technical Specifications	MPS-48	up to 106	>106
Tubing diameter [mm] 1)	48	106	variable
Max. no. of lines	15	20	variable
Outer/inner diameter lines [mm]	4 / 3	6 / 4; 6 / 3; 4 / 3	
Tubing lengths [m]	6.0; 3.0; 1.5; 1.0; 0.5; 0.1		
Min. packer diameter [mm]	48	122	variable
Packer sealing length [m] 1)	3.0; 1.0; 0.5 down to 0.1		
Packer material	natural rubber / nitrile / viton		
Min. interval length [m] 2)	0.15		

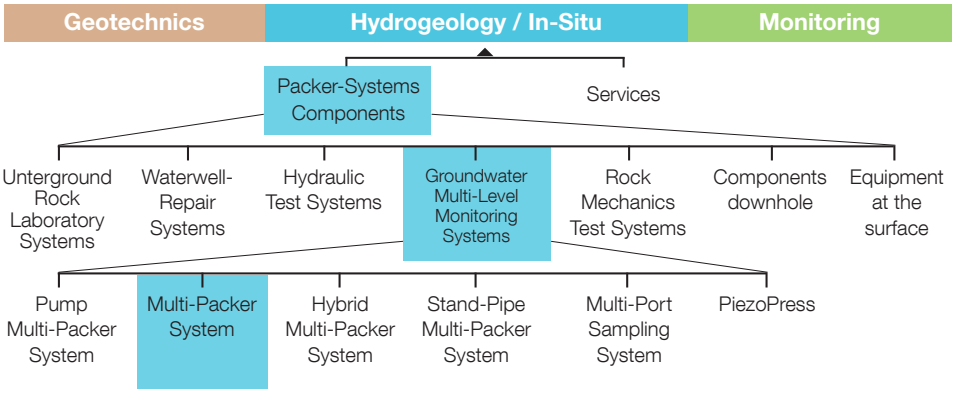
1) Custom diameters and lengths upon request
2) Interval span is increased by adding tubing lengths

Technical specifications subject to change

Accessories	Type/Material	Diameter	Range/Capacity
Pressure sensors	vibrating wire piezoresistive	variable variable	variable variable
Injection/vaccum pump	variable	variable	variable
Pressure vessel/scale	stainless steel	variable	from ~ 1 ml/min

Technical specifications subject to change

Other Solexperts activities, products and services:



The System

The Hybrid Multi-Packer System combines the benefits of the Stand-Pipe Multi-Packer System (SPMP) and the Multi-Packer System (MPS).

- With stand-pipes in the upper section and lines in the lower section of the system
- Each observation interval is accessible via an individual stand-pipe
- Up to 10 independent observation intervals
- Small, cost-effective tubing diameter in the lower section of the system
- The depth of the transition between the line and the stand-pipe section can be customized
- The design allows the system configuration to be modified in the field
- Borehole diameters from 76 mm

The Hybrid Multi-Packer System consists of tubing and packer modules. Up to 10 interval access lines in the lower section of the system are connected to 16.5 mm ID stainless-steel standpipes of the upper section. All module and stand-pipe connections are fitted with double O-ring seals. The modules are fastened together with convenient swivel-nut couplings.

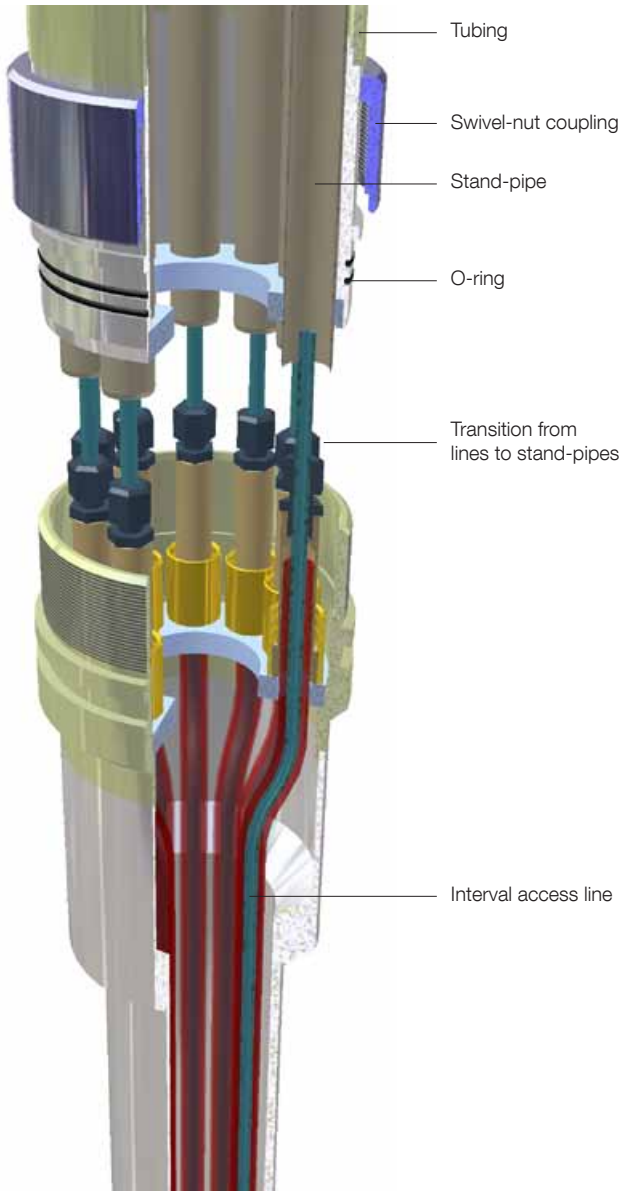
Accessories

A variety of accessories can be inserted into the stand-pipes once the basic system is installed:

- Pressure transducers
- Sample pump
- Down-hole sampler (for collecting samples at formation depth)
- Bailer

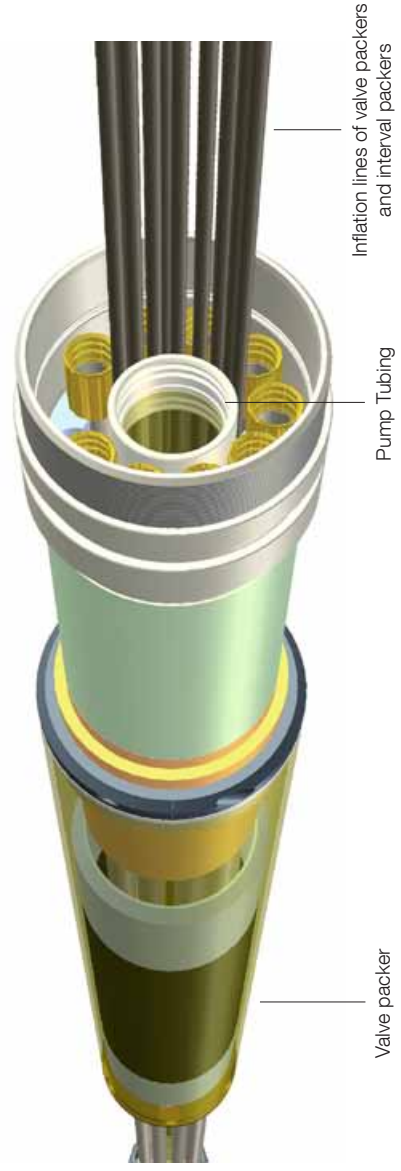
All downhole accessories can be removed for calibration, maintenance or repair without dismantling of the basic system.

- Combines the Stand-Pipe Multi-Packer System and the Multi Packer System
- Each observation interval is accessible via an individual stand-pipe
- Modular system design
- More cost-effective than the Stand-Pipe Multi-Packer System
- Effective in deep boreholes with different diameters
- Basic system and accessories retrievable



transition Part

The Hybrid Multi-Packer System can be modified. Additional pump interval accesses, operated by valve packers, can be integrated into the lower MP-System-part and/or into the upper SPMP-part. By opening a pump interval access, formation water flows into the (pump)tubing. Optionally a separate pump casing, which is connected to the pump tubing, can be installed with the Hybrid MPS in the upper borehole section. The pump tubing and especially the pump casing allow the installation of pumps with high flow rates (up to 100 l/min in the pump casing).



Hybrid MPS with optional pump interval accesses (valve packers) and pump tubing

Hybrid Multi-Packer System (HMPS)

Technical Specifications SPMP	54	76	106
Tubing diameter [mm]	54	76	106
Max. no. of stand-pipes	4	7	10
Stand-pipe diameter [mm]	16.5		
Tubing lengths [m]	3.0, 1.5, 1.0, 0.5		
Min. packer diameter [mm]	68	89	122
Packer sealing length [m] [1]	1.0, 0.5		
Packer material	natural rubber / nitrile / viton		
Min. interval length [m] [2]	0.5		

Technical Specifications MPS	48	up to 106	>106
Tubing diameter [mm] [1]	48	106	variable
Max. no. of lines	15	20	variable
Outer/inner diameter lines [mm]	4/3	6/4; 6/3; 4/3	
Tubing lengths [m]	6.0; 3.0; 1.5; 1.0; 0.5; 0.1		
Min. packer diameter [mm]	48	122	variable
Packer sealing length [m] [1]	3.0; 1.0; 0.5 bis 0.1		
Packer material	natural rubber / nitrile / viton		
Min. interval length [m] [2]	0.15		

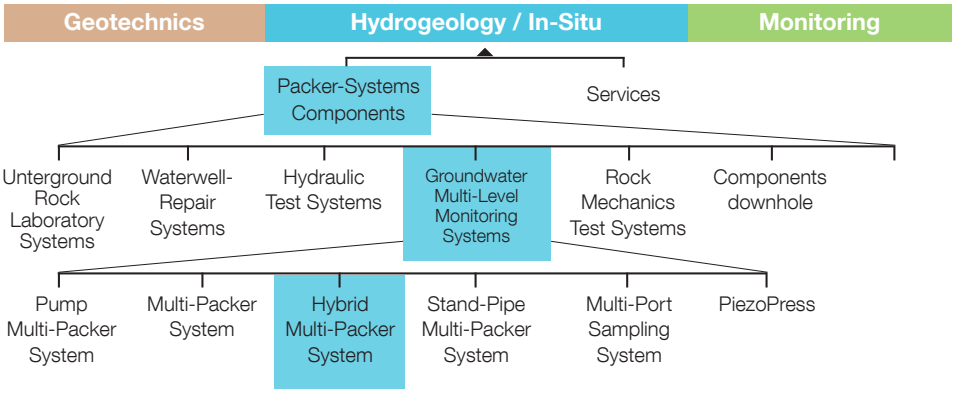
1) Custom lengths upon request 2) Interval span is increased by adding tubing lengths
System modifications upon request

Technical specifications subject to change

Accessories	Type/Material	Diameter	Range/Capacity
Pressure sensors	vibrating wire piezoresistive	11 mm 12 mm	1–14 bar 1–20 bar
Sample pump	double valve	15 mm	220 ml/min
Down-hole sampler	stainless steel	15 mm	220 ml
Bailer	stainless steel	15 mm	~ 250 ml

Technical specifications subject to change

Other Solexperts activities, products and services:



The System

The Pump Multi-Packer System is a conventional Multi-Packer System with double-valve pump and pressure transducer installed at each test interval.

- Withdrawal of water samples and observation of water pressures at test interval depth
- Up to 5 independent sampling and observation intervals for borehole diameters of 76 mm
- Modular structure allows the system configuration to be changed in the field
- Small tubing diameters

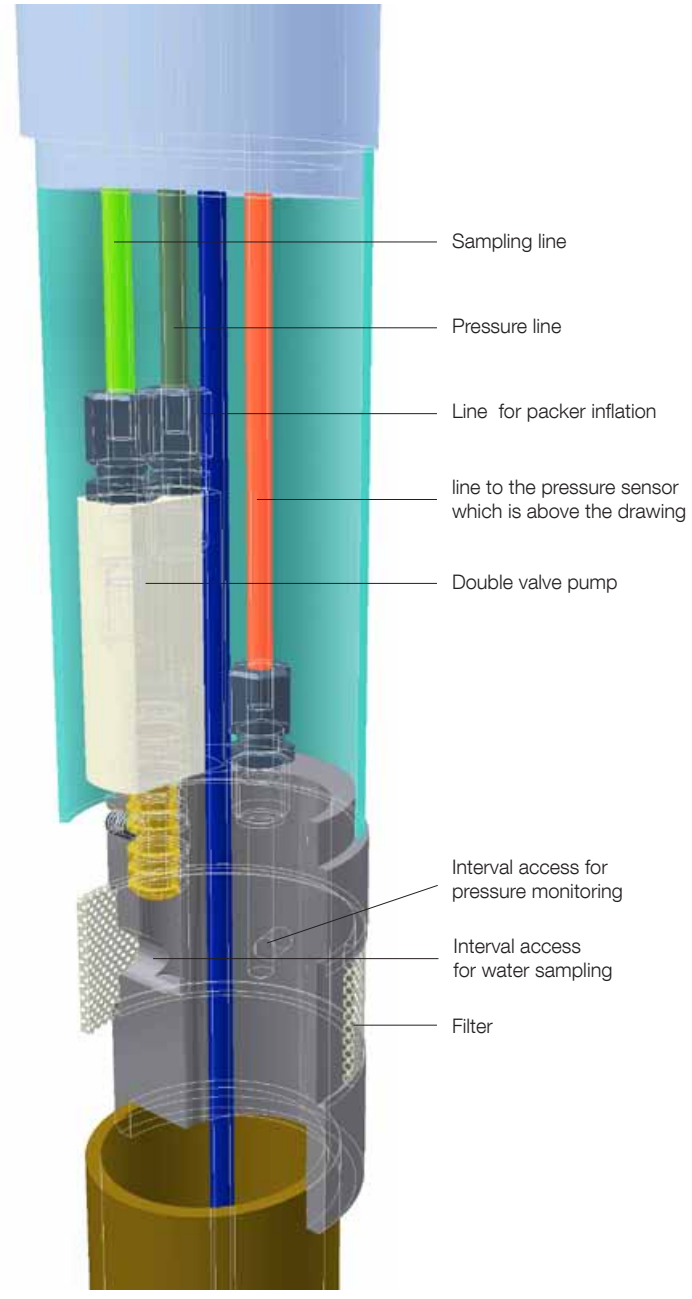
The Pump Multi-Packer System consists of packer, tubing and interval access modules. Each interval access module is equipped with a pressure transducer and a double valve pump that are connected to individual interval access ports. The double valve pump is controlled via a pressure and a sampling line. All module connections are fitted with double O-ring seals. The modules are fastened together with convenient swivel-nut couplings.

Accessories

Once the Pump Multi-Packer System is installed, the pressure and the sampling lines as well as those for the packer extension are connected to a control unit. The pump control unit is used to take water samples. During the pumping cycle nitrogen is injected into the pressure line (the pressure must be high enough to move the water column from the pressure line into the sampling line). During the following production cycle the nitrogen over-pressure is discharged through a valve in the pump control unit and water flows from the test interval into the pressure line. The pump control unit is operated manually or electronically.

Pump Multi-Packer System (PMPS)

- A double-valve pump and a pressure transducer are installed at each test interval
- Water sampling possible without installation of an additional pump
- Up to 5 isolated intervals in boreholes of 76 mm diameter
- Stainless steel or PVC tubing
- Cost-effective sampling and monitoring system.

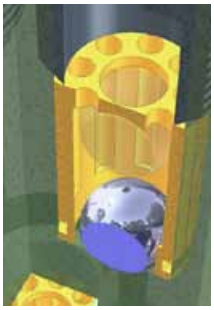


Interval access module

Pump Multi-Packer System (PMPS)

Double valve pump

Sketch during
a pumping cycle



Technical Specifications	PMPS-60	PMPS-76	PMPS-89	PMPS-106
Tubing diameter [mm]	60	76	89	106
Max. no. of intervals	5	> 5	> 5	> 5
Outer/inner diameter lines [mm]	6 / 4; 6 / 3; 4 / 3			
Tubing lengths [m]	6.0, 3.0, 1.5, 1.0, 0.5			
Min. packer diameter [mm]	72	89	100	122
Packer sealing length [m] 1)	1.0, 0.5			
Packer material	natural rubber / nitrile / viton			
Min. interval length [m] 2)	0.5			
	Type		**Range/Capacity**	
Pressure sensors	vibrating wire piezoresistive		variable variable	variable variable
Sample pump	double valve		200 ml/min	

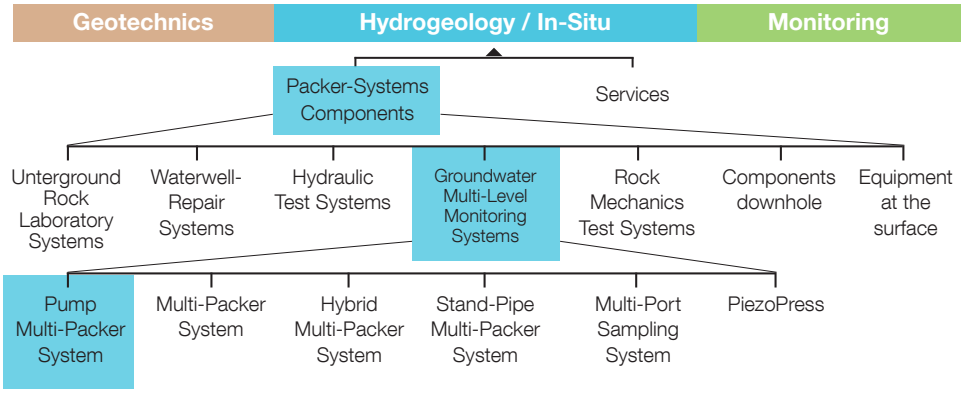
1) Custom lengths upon request 2) Interval span is increased by adding tubing lengths

Technical specifications subject to change

Accessories	Type	Range
Pump control unit	manual electronical	max. 50 bar max. 50 bar

Technical specifications subject to change

Other Solexperts activities, products and services:



The System

The MPS System was designed for monitoring and testing the vertical distribution of hydraulic parameters in hard rock and unconsolidated rock.

- Up to 6 independent observation intervals
- Modular design allows the system configuration to be changed in the field
- Easy to install
- Borehole diameters from 155 mm
- The use of a submersible pump in the pump tube allows for pumping rates up to 25 l/min
- Easy pumping port activation
- Water levels can be continuously monitored, also during testing and pumping

The MPS system comprises a pump tube running the length of the borehole with pumping ports, surrounded by up to six access ports, each terminating in a different response zone. The stand-pipes are equipped with filter tips, and each sand filled response zone is separated by impermeable backfill such as clay-based cement-bentonite-grout.
The pump tube and the stand-pipes are held together by circular brackets. The disc-shaped plastic elements ensure sufficient clearance between the stand-pipes. The pump tube sections are threaded together and sealed, while the stand-pipes are joined using short collars with double O-ring seals that slide into place over the pipes.

Accessories

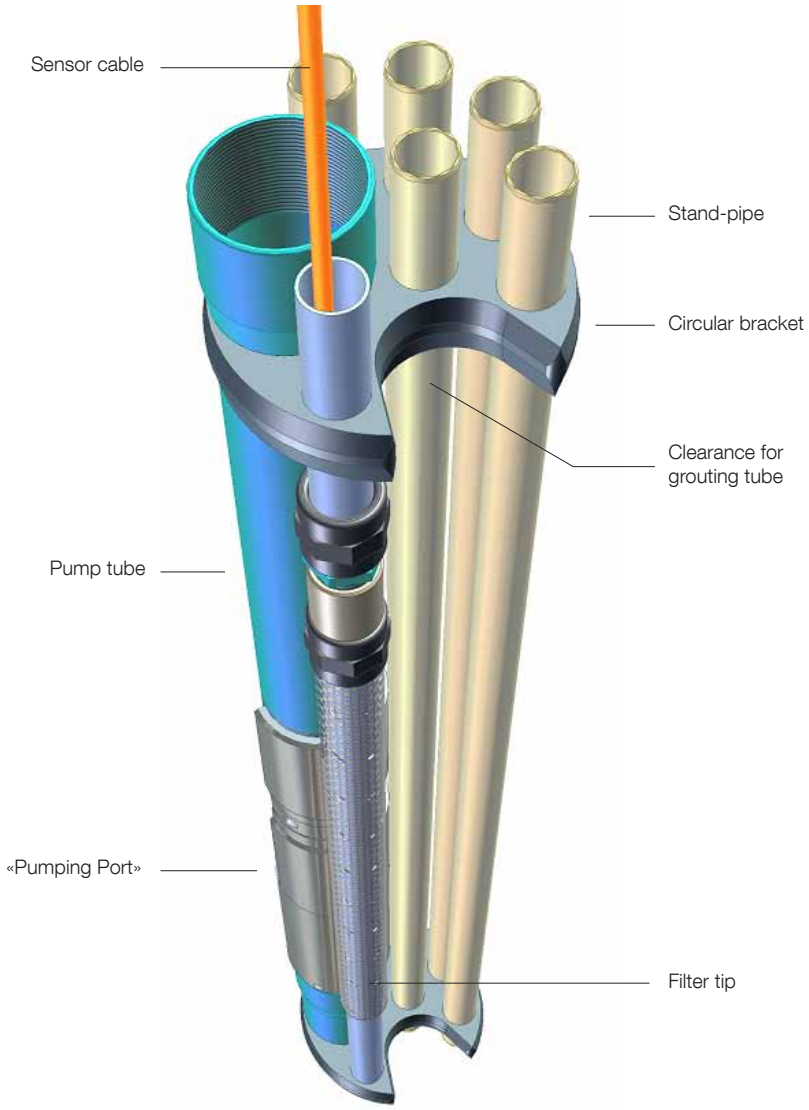
A variety of accessories can be inserted into the stand-pipes once the basic system is installed:

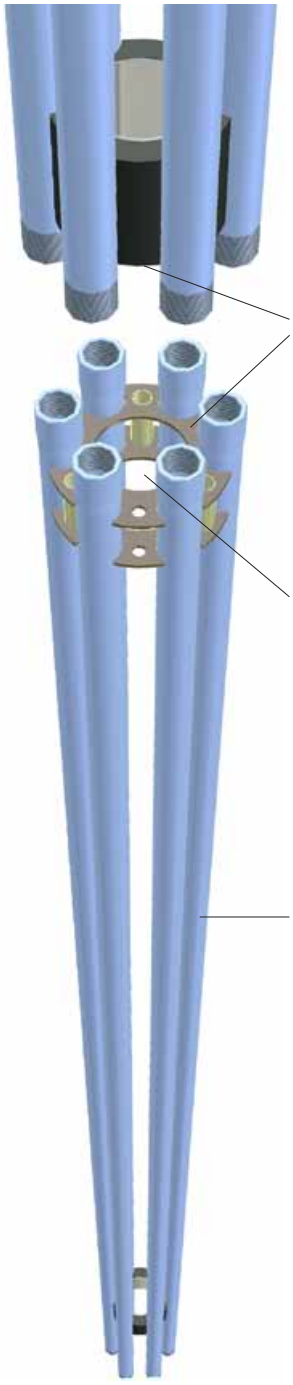
- Pressure and temperature transducers
- Submersible conductivity probe
- Packer which is expanded at valve position to open and close the pumping port
- Pumps for pumping tests / sampling
- Down-hole sampler (for collecting samples at formation depth)
- Bailer

All down-hole accessories can be removed for calibration, maintenance or repair.

Multi-Port Sampling System (MPSS)

- Each observation interval is accessible via an individual stand-pipe (piezometer)
- The optional pumping port of the pump tube provides additional access to the observation / test interval.
- Sealing of the observation intervals by a mixture of clay-based bentonitecement grout.
- High volume pumping rates up to 25 l/min
- Cost-effective MPS System for hard rock and unconsolidated rock
- Accessories retrievable

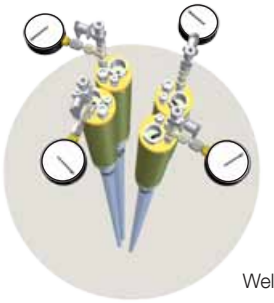




MPSS circular

Multi-Port Sampling System circular (MPSSc)

The «circular» MPS-System does not have a pump tube like the standard MPSS. The spacer element holds the stand-pipes in position allowing the grouting tube to be installed during the backfill and ensures sufficient clearance between the stand-pipes. Various filter tip options, sampling options and sensor types are available.



Wellhead MPSSc

Technical Specifications	MPSS	MPSS circular
System diameter [mm]	140	155
Max. no. of stand-pipes	6	
Stand-pipe inner diameter [mm]	21	26
Pump tube inner diameter [mm]	51 / 48	-
Stand-pipe material	PVC	
Pump tube material	PVC / stainless steel [1]	-
Stand-pipe filter screen material	UHMW/LD - PE [2]	PVC / geotextile
Circular brackets material	PVC	stainless steel/EPDM [3]
Min. interval length [m]	0.5	

1) Pumping ports (pump tube-valves) made of stainless steel 2) UHMW / LD-PE: Ultra High Molecular Weight / Low Density Polyethylene 3) EPDM: Ethylene Propylene Diene Monomer (rubber)

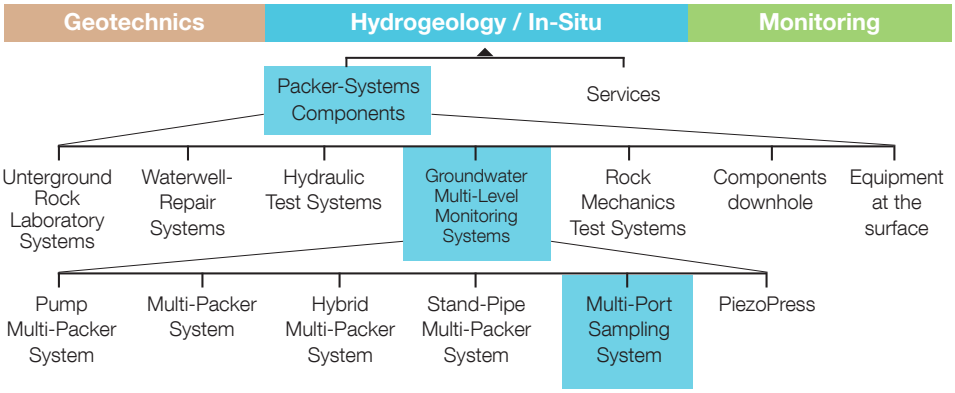
Technical specifications subject to change

Accessories	Type/Material	Diameter	Range/Capacity
Pressure sensors	vibrating wire piezoresistive	19 mm 19 mm	variable variable
Probe for electr. conductivity	-	24 mm	0 – 50 mS/cm
Sample pump / MPSS Sample pump / MPSSc	subm. pump double valve or [1]	15 mm -	25 l/min variable
Bailer	stainless steel	variable	~ 250 ml
Valve packer [1]	stainless steel / [2]	42 mm	-
Sensor seat	stainless steel / brass	variable	-

1) compressed air-method 2) natural rubber/nitrile/viton

Technical specifications subject to change

Other Solexperts activities, products and services:



The System

The PiezoPress System consists of individual piezometers with retrievable pressure sensors.

- Up to 5 independent observation intervals
- Sensor seat at the filter tip of each piezometer
- For borehole diameters from 50 mm

The piezometers have a filter tip at the end. Each piezometer is inserted to the depth of an individual observation interval. The observation intervals are filled with quartz sand and are isolated by cement-bentonite-grout.

Accessories

After the screened observation interval is saturated, the retrievable pressure sensor is seated in the piezometer filter tip, using glass-reinforced plastic rods. Thus the interval will be hydraulically isolated.

The access to the observation interval enables also performance of hydraulic testing or water sampling.

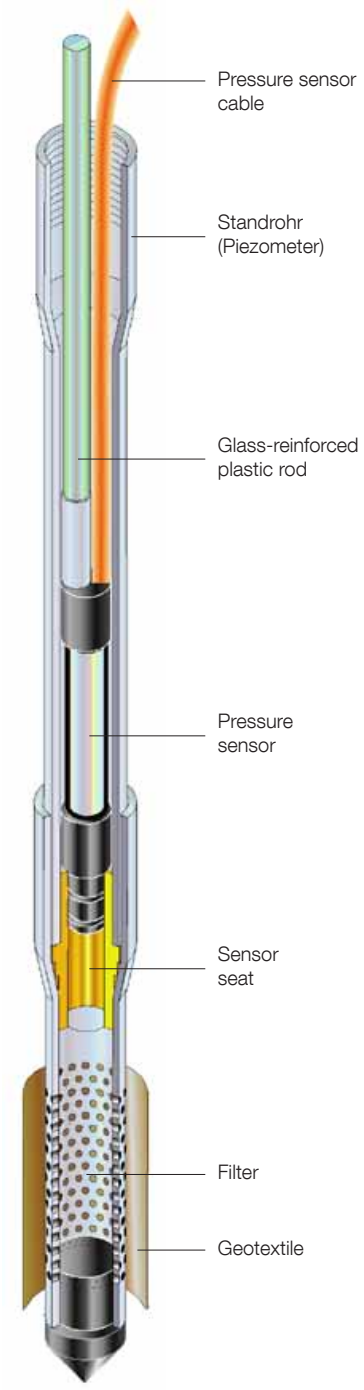
A variety of accessories can be inserted into the standpipes (piezometers):

- Pressure and temperature transducers
- Pump for pumping tests / sampling
- Down-hole sampler (for collecting samples at formation depth)
- Bailer

All down-hole accessories can be removed for calibration, maintenance or repair.

PiezoPress (PZP)

- Each observation interval is accessible via an individual stand-pipe (piezometer)
- The pressure transducer is seated at the test interval depth sealing the filter tip from the piezometer
- Head monitoring in low permeable rock and soils
- A mixture of cement-bentonite grout is used to isolate the observation intervals
- Cost-effective multi-level monitoring system
- Accessories retrievable



PiezoPress (PZP)

Technical Specifications	PZP
System diameter [mm]	≥ 34 [1]
Max. no. of stand-pipes	5
Stand-pipe inner diameter [mm]	26
Stand-pipe material	PVC
Stand-pipe filter tip material	perforated/[2]
Sensor seat	ss [3]/brass/PVC
Sealing tube	stainless steel
Min. interval length [m]	0.5

1) 34 mm with one piezometer
2) made of PVC or stainless steel, encased in geotextile
3) ss=stainless steel

PZP-System with spacers: see Multi-Port Sampling System circular

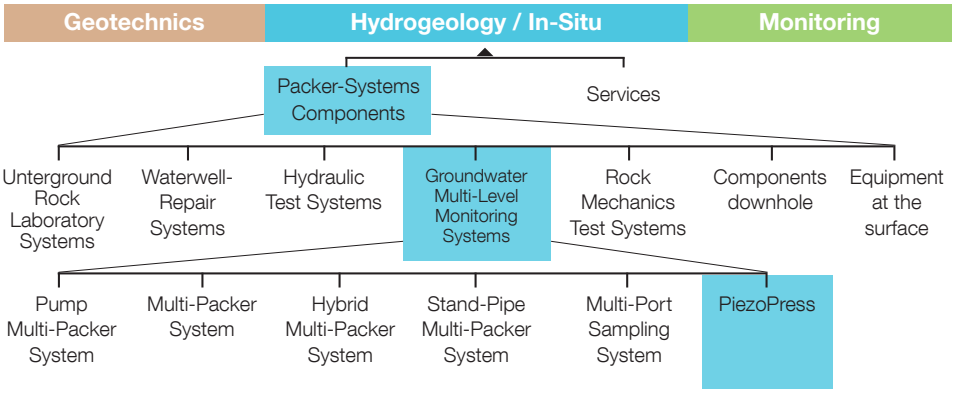
Technical specifications subject to change

Accessories	Typ/Material	Durchmesser	Rache/Capacity
Pressure sensors	vibrating wire piezoresistive	19 mm 19 mm	variable variable
sensor installation tool	glass-reinforced plastic rods	~ 8 mm	-

Optional: sample pump, bailer, temperature sensor, probe for electr. conductivity

Technical specifications subject to change

Other Solexperts activities, products and services:



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Swiss Precision Geomonitoring

For further information, please see our Solexperts Info «Groundwater Multi-Level Monitoring Systems» or contact us.

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