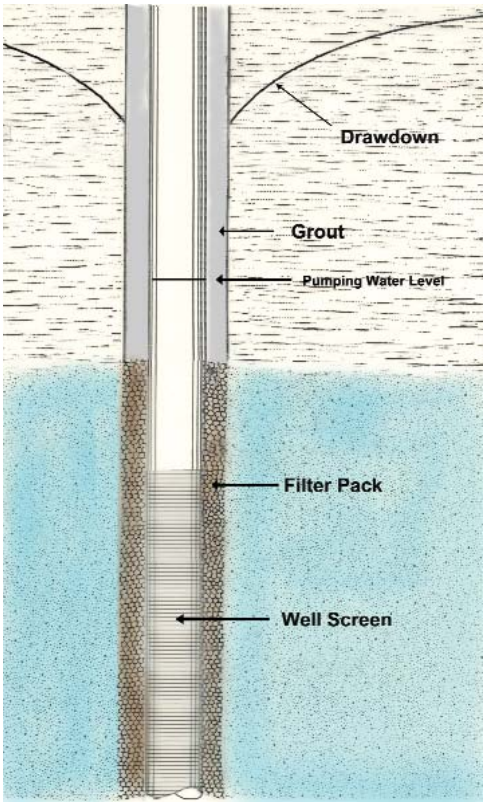
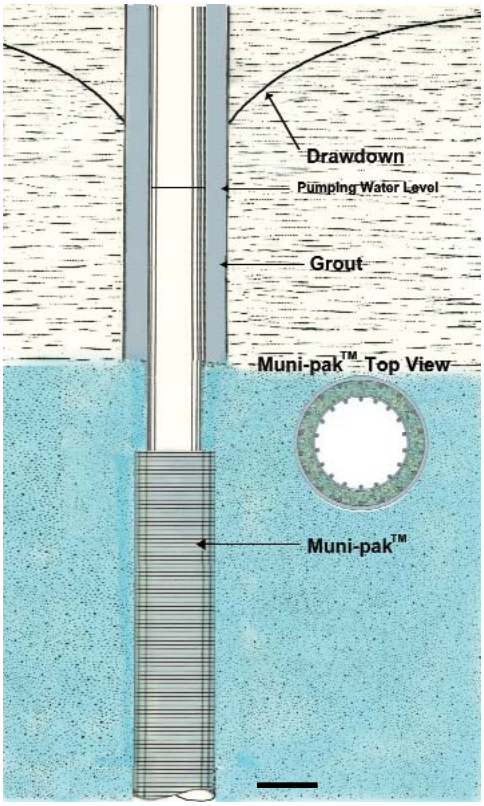
Johnson screens™

A Weatherford Company

MUNI-PAK™

A GIANT STEP FORWARD IN WELL DESIGN TECHNOLOGY





MUNI-PAK™ - A BETTER WAY TO GRAVEL PACK

Artificial filter pack is one of the most common well designs practiced today for high-capacity municipal, industrial and agricultural wells. Prior to the installation of a filter pack, the contractor and well owner must take into account some significant issues.

1) The borehole must be sufficiently oversized to allow for adequate placement. In practice, an annular thickness of 3-5 inches is considered minimum - often more is considered. This oversized borehole is costly to the contractor and keeps his crew on site for additional time.

2) Placement of the filter pack requires careful selection, placement and development to avoid bridging and sand pumping.

3) For the well owner there are concerns with long-term performance. Biofowling and encrustation are issues that will eventually become problems.

Johnson's Solution to improve the gravel pack is the Muni-Pak ™. It simplifies the contractor's work, improves the odds for successful development and offers long-term benefits for the owner.

The Muni-Pak™ is the state-of-the-art technology for pre-packed screens.

For the contractor, the pre-packed screen eliminates the need for a larger borehole. It shortens the amount of time required to drill a well, and speeds development time.

Muni-Pak™, uses carbolite beads as the filter media. This unique concept provides a filter pack that is less likely to get fouled with biofilm and encrustation. Muni-Pak™ lowers overall maintenance costs for the owner.

BENEFITS OF USING A MUNI-PAK™

Johnson Screens' Muni-Pak™ provides unique features and benefits for both the contractor and the well owner. These are listed below in tabular form to show how important this new

FEATURES	BENEFITS
Pre-Packed construction	**Smaller borehole** ◆ Lower bit and cement costs ◆ Reduced drilling time ◆ Fewer cuttings ◆ Reduced circulating volume ◆ Increased uphole velocity
Media included as part of screen package	**No gravel placement** ◆ No bridging of filter packs ◆ No packing time ◆ Less equipment needed
Extra strong construction	**Increased strength** ◆ 3-4 times stronger than standard rod-base screen ◆ More aggressive development ◆ More forgiving to unexpected hole problems.
Smaller annulus	**Thinner filter pack** ◆ Less resistance to development means better formation penetration ◆ Easier to maintain and rehab the "near-well" area over time

BENEFITS OF USING A MUNI-PAK™

FEATURES	BENEFITS
Wide range of diameters and connections ◆ 2 Inch to 20 Inch ◆ Weld rings, threaded fittings	Can meet most application needs with a variety of standard or custom end fittings
Continuous slot construction	Maximum open area optimizes development and re-development techniques
Custom lengths up to 40-Ft with no mid-weld	Minimizes field assembly time
Custom applications	Multiple wire-size and filter-media options are available for customized applications
Carbolite Ceramic Media	**Excellent roundness & sphericity** ◆ Increased hydraulic conductivity and efficiency ◆ Better flow characteristics compared to silica sands ◆ Hinders the build-up of biofilm and encrustation ◆ Smooth beads are more easily cleaned than irregular shaped silica sand grains
It can be used as a liner in existing well construction	Eliminates the need to construct a new well

INSTALLATION COST COMPARISON BETWEEN GRAVEL PACK AND MUNI-PAK™

Item	Description	Single String Completion	
		Gravel Pack	Muni-Pak™
1	Mobilization	$13,000	$13,000
2	Demobilization	$7,500	$7,500
3	Drilling	$94,509	$74,184
4	Casing	$35,827	$35,827
5	Screen	$27,633	$76,700
6	Gravel Pack	$14,959	$0
7	Grout	$40,881	$28,350
8	Development	$24,844	$16,148
9	Testing	$7,800	$7,800
10	Disinfection	$275	$275
11	Video	$700	$700
12	Site Cleanup	$12,000	$12,000
	TOTAL	**$279,928**	**$272,484**

In deep wells (greater than 1000 feet), the cost of a Muni-Pak™ installation is less than the cost of a conventional gravel gack well. Savings in under-ream completions can be greater than single string.

MUNI-PAK™ SCREENS SPECIFICATIONS

Size* in	Approx Screen ID in	Approx Screen OD in	Media Annular Thickness in	Inner Screen Open Area (in²/ft) Screen Slot Size in thousandths of an inch					Outer Screen Open Area (in²/ft) Screen Slot Size in thousandths of an inch					Approx Screen Weight lbs/ft
				12	20	30	40	50	12	20	30	40	50	
2 x 4	2.2	4.5	0.85	13	23	31	38	43	22	39	53	64	74	17
3 x 5	3.0	5.7	0.97	18	31	42	51	59	27	47	64	77	88	23
4 x 6	4.0	6.7	0.94	22	39	53	64	74	25	45	62	77	89	25
5 x 7	5.0	7.7	0.87	27	47	64	77	86	28	51	71	87	101	27
6 x 8	6.0	8.7	0.84	25	45	62	77	89	33	59	81	100	116	35
8 x 10	8.0	10.8	0.84	33	59	81	100	116	41	74	101	125	145	55
10 x 12	10.0	12.8	0.84	41	74	101	125	145	42	77	107	133	155	70
12 x 15	12.0	15.0	0.84	42	77	107	133	155	39	73	102	129	153	85
14 x 16	13.2	16.0	0.69	46	84	117	146	170	42	78	110	138	163	100
16 x 18	15.2	18.0	0.69	42	78	110	138	163	47	88	123	155	183	115
18 x 20	17.0	20.0	0.78	47	88	123	155	183	52	97	137	172	204	128

*Other sizes available on request. Deep well construction specifications available on request.

Standard Rod Base vs Muni-Pak					
Nominal Size		Collapse Strength		Tensile Strength	
Rod Base	Muni-Pak	Rod Base	Muni-Pak	Rod Base	Muni-Pak
2	2x4	3,830	16,500	4,000	18,800
3	3x5	1,350	5,650	4,800	21,400
4	4x6	660	2,830	5,800	25,700
5	5x7	420	1,550	6,600	28,300
6	6x8	180	990	17,600	33,200
8	8x10	320	1,160	24,200	67,500
10	10x12	170	630	30,800	81,600
12	12x15	150	880	35,200	127,900
14	14x16	220	1,110	34,000	127,900
16	16x18	150	760	38,400	135,400
18	18x20	110	540	39,600	143,000
*Typical Construction for 500 to 1500 ft					

*Other sizes available on request.

RECOMMENDED PROCEDURES FOR MUNI-PAK™ SLOT SELECTION

1) Measure and record the 70% retained grain size distribution for each interval sequence.
2) Choose 70% retained size of the finest interval sequence in the area to be screened.
3) Determine the Muni-Pak™ filter media size based upon a ratio of native sand to filter media(1:5).
4) Determine Muni-Pak™ slot configuration at 100 percent retention.

Slot Size (inches)	Carbolite Size	Filter Pack
0.008	n/a	40/60
0.012	20/40	20/40
0.020	16/20	16/30
0.025	n/a	10/20
0.030	12/18	n/a
0.040	8/14	8/12
0.050	6/12	n/a

FORMAT FOR SPECIFYING A MUNI-PAK™ SCREEN

SCREEN SUBMITTALS: Upon request, the screen manufacturer shall provide a submittal and schematic drawing of the proposed screen design. The documents shall include the OD, ID, construction materials, slot size, approximate weight/ft; wrap wire width, wrap wire height, collapse strength, percent open area, inlet open area / ft, transmitting capacity / ft, number of support rods, diameter of support rods; total cross sectional rod area, material yield strength, tensile strength, and recommended hanging weight.

GENERAL: Muni-Pak™ screens shall be of the continuous slot designed to provide maximum open area to reduce entrance velocity, increase hydraulic efficiency and promote more effective development. Both the inner and outer screens shall be constructed of vee-shaped wire continuously wrapped around an array of equally spaced support rods of the same material. The wire shape shall cause the slot opening to widen inwardly to minimize clogging. Each junction of wire/rod contact shall be resistance welded. The screens and end fittings shall be made of _____ (material). The well screens shall be manufactured by Johnson Screens, a Weatherford Company or approved equal.

DIAMETER: The Muni-Pak™ shall be _____ inch Pipe Size inner screen, _____ inch Pipe Size outer screen.

OPEN AREA: The slot size and filter pack are to be selected on the basis of a sieve analysis of the water bearing formation. The slot size shall be _____. The inner screen shall provide _____ sq.in. of inlet area per foot of screen at the design slot size. The outer screen shall be of the same slot as the inner screen.

FILTER PACK: The annulus between screens shall be filled with ceramic beads of uniform size and excellent sphericity. The pack size shall be _____ filter size. The pack material shall be installed and compacted by vibrating the unit in a vertical position, while being filled. The top and bottom filter seal plates shall be secured by welding.

COLLAPSE: The screen shall be manufactured with a wrap wire designed to yield a minimum collapse pressure of _____ PSI.

TENSILE STRENGTH: The minimum screen tensile strength must exceed 2 times the total Hang Weight of screen and blank casing below the top screen joint. The tensile strength shall be a minimum of _____ pounds. (Tensile strength is total rod area times material yield strength).

SCREEN CONFIGURATION: Screens shall be manufactured in various lengths with a maximum of 40 ft. length overall. Screens shall be complete with _____ (material) end fittings attached to each end. Standard weld rings are 6 inches. Weld rings of longer lengths, or threaded fittings may be requested. Screen barrels shall be provided in standard _____ (overall or full) lengths which _____ (include or exclude) the weld ring lengths. Lengths and end fitting configuration to be requested, by the Contractor, and approved by the Engineer.

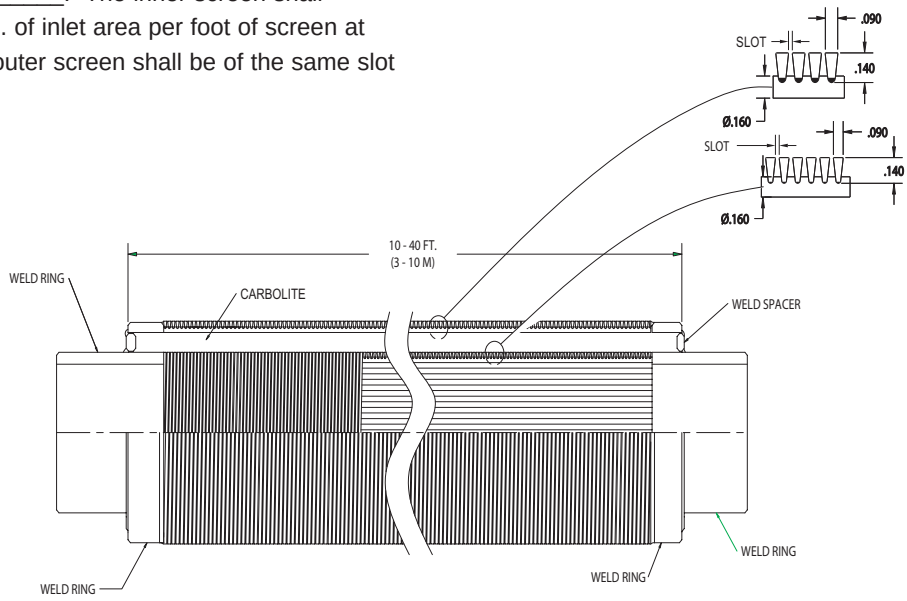


Photo by Tom Fitzwilliams, MSA Professional Services

Photo by Marty Eby

MUNI-PAK™ INSTALLATIONS

New Life To An Old Collector Well.

Collector Wells are a major investment and not easily replaced. The City of Nekoosa, Wisconsin constructed two in the 1960s. One became so severely biofouled and encrusted that pumping just 200 GPM practically dewatered the laterals.

The problem was that the design of the original laterals did not facilitate effective rehabilitation. The original laterals were slotted 8" PVC. Johnson Screens personnel introduced the contractor to Muni-Pak™.

- The prepack design simplified installation.
- High open area with a compact, highly conductive Carbolite™ pack facilitated development (and future maintenance).
- The properties of the Carbolite™ ceramic beads are a deterrent to biological growth.

Three Muni-Pak™ replacement laterals were successfully installed without removing the existing PVC laterals. After development and testing, the refurbished collector well had over a seven-fold increase in specific capacity and testing determined that 78% of the production was coming from the Muni-Pak™ laterals.

New Prepack Screen Installed In Indiana Well.

The City of Laporte, Indiana was to construct a new well in their Warneke well field in 2000. Existing wells in this field were under-ream gravel pack completions drilled by reverse circulation, and had been plagued with decreased specific capacity.

Johnson Screens worked with the City's contractor on presenting the Muni-Pak™ product to the City Engineers. There was initial concern about proper packing and adequate production from a prepack design.

- The pre-pack design negated concerns over proper pack placement.
- The slim pack afforded greater development potential vs under-ream.
- The Carbolite™ pack was considered superior to conventional silica sand.

After successful placement of Muni-Pak™ the new well was developed without problem and a 24-hour pumping test was conducted. The well produced 805 GPM with a specific capacity of 24.6 gallons/minute-ft drawdown which compares favorably to the existing wells in the Warneke field that had much larger under-ream holes. Muni-Pak™ passed the test.

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