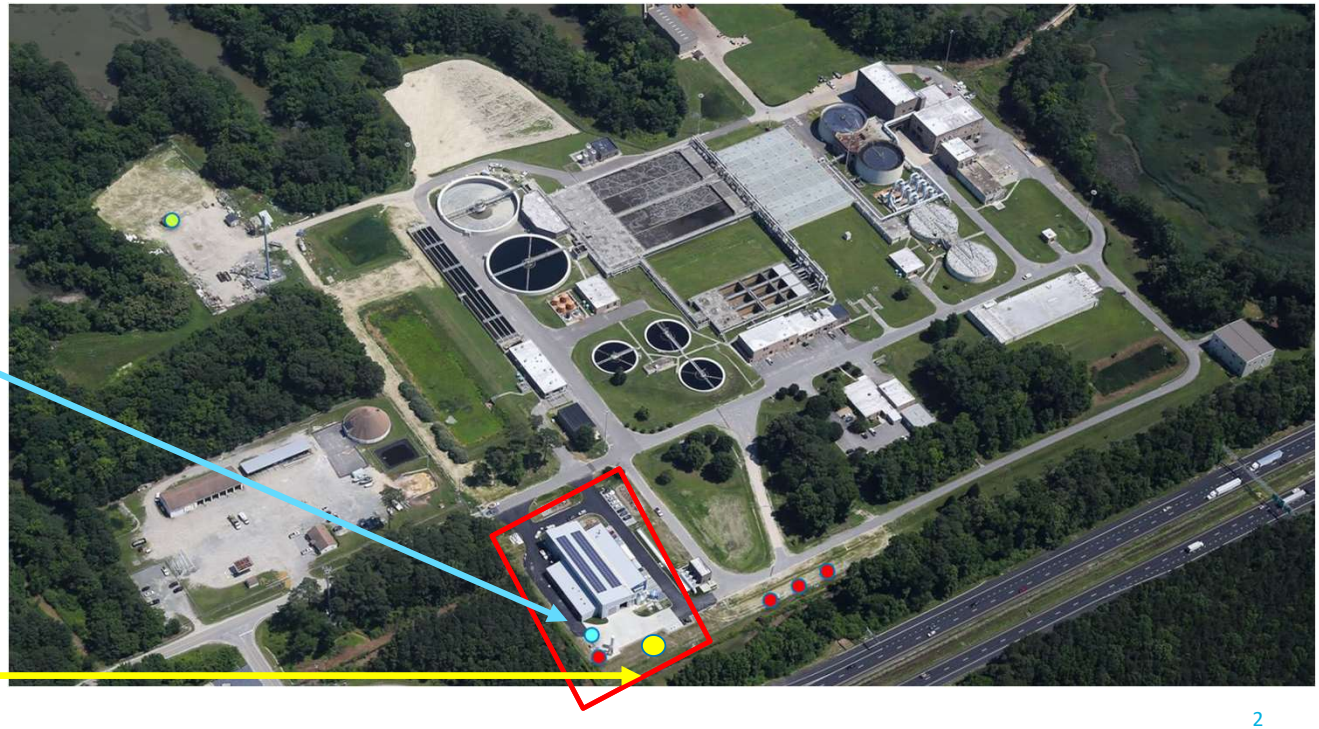
NP_MAR_01 Update

Potomac Aquifer Recharge
Oversight Committee
September 26, 2022

SWIFT Research Center

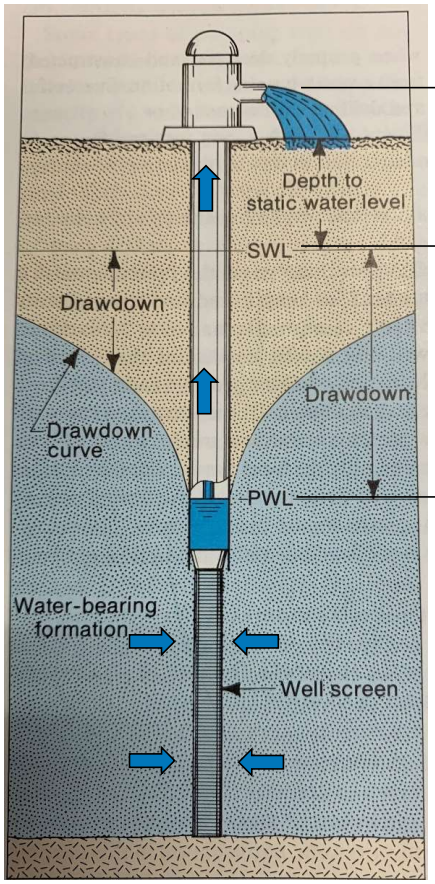
- 1 MGD demonstration facility
- Educational facility
- Research facility
- May 2018 start-up
- Recharge Well TW-1
- Recharge Well NP_MAR_01



Nansemond SWIFT Research Center Wells

Specific Capacity

- Specific capacity (SC) – yield per unit measure of drawdown = gpm/ft of **drawdown** during withdrawal
- Requires a steady pumping rate
- Calculated over a specific duration of pumping
- Typically,
  - longer the duration, the lower the SC
  - higher the pumping rate the lower the SC



Flow: 1200 gpm

Static Water Level: -95’

Pumping Water Level: -145’

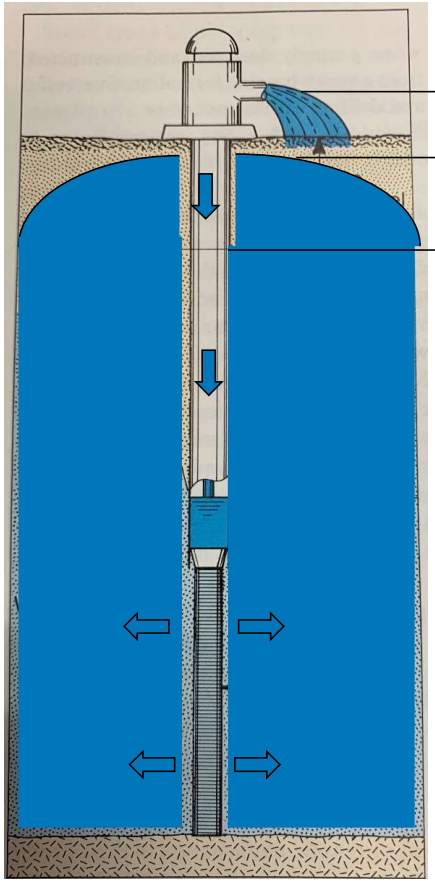
Specific Capacity = 1200 gpm/50ft = 24 gpm/ft

Duration = 24hrs

Modified from Driscoll, 1987

Well Injectivity

- Specific injectivity (SI) – yield per unit measure of draw-up = gpm/ft of **draw-up** on a recharging well
- Requires a steady recharge rate
- Calculated over a specific duration of recharging
- Typically,
  - longer the duration, the lower the SI
  - higher the recharge rate the lower the SI



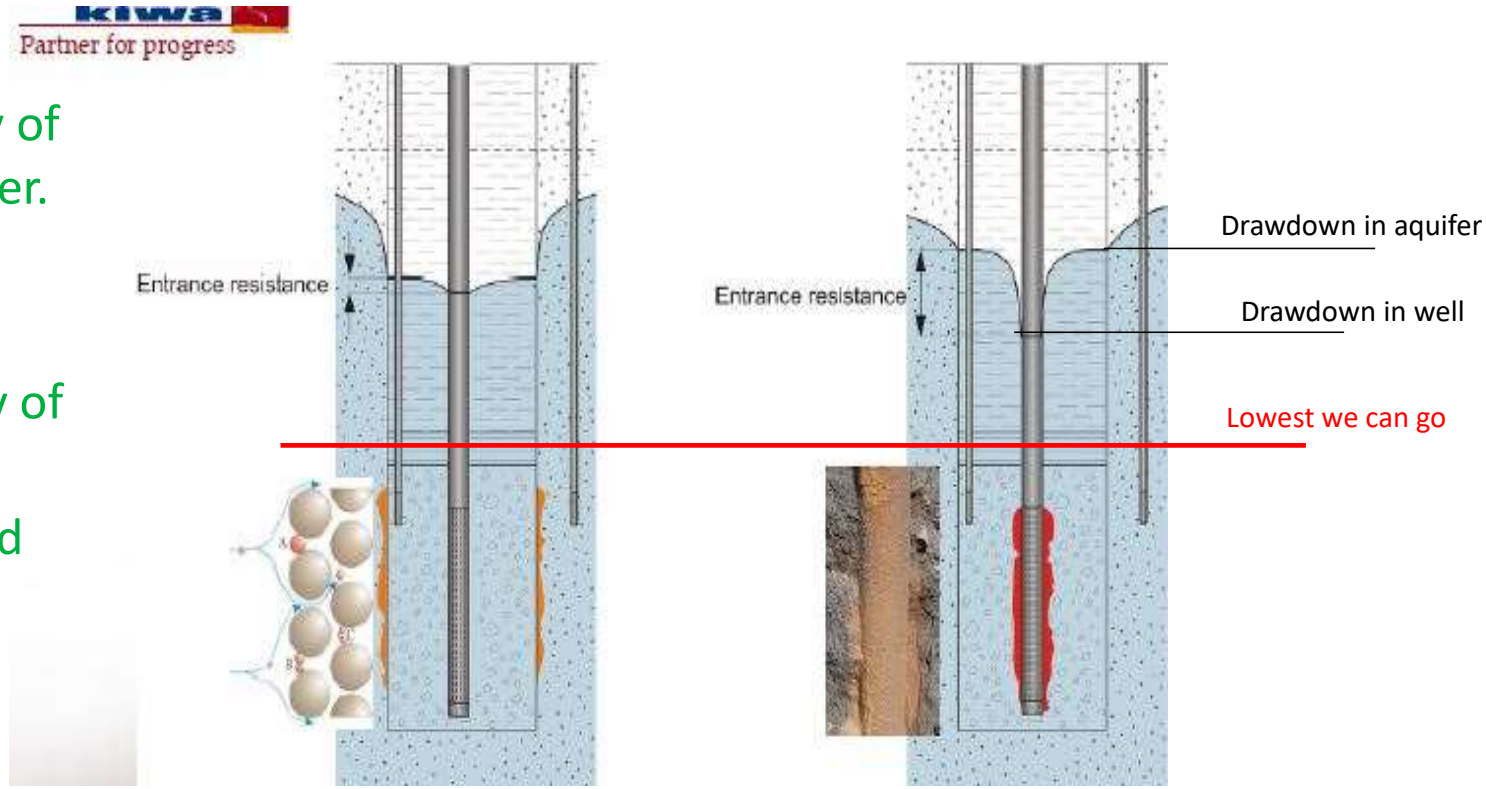
Specific Injectivity = 700 gpm/50ft = 14 gpm/ft

Duration = 24hrs

Modified from Driscoll, 1987

Well Capacity

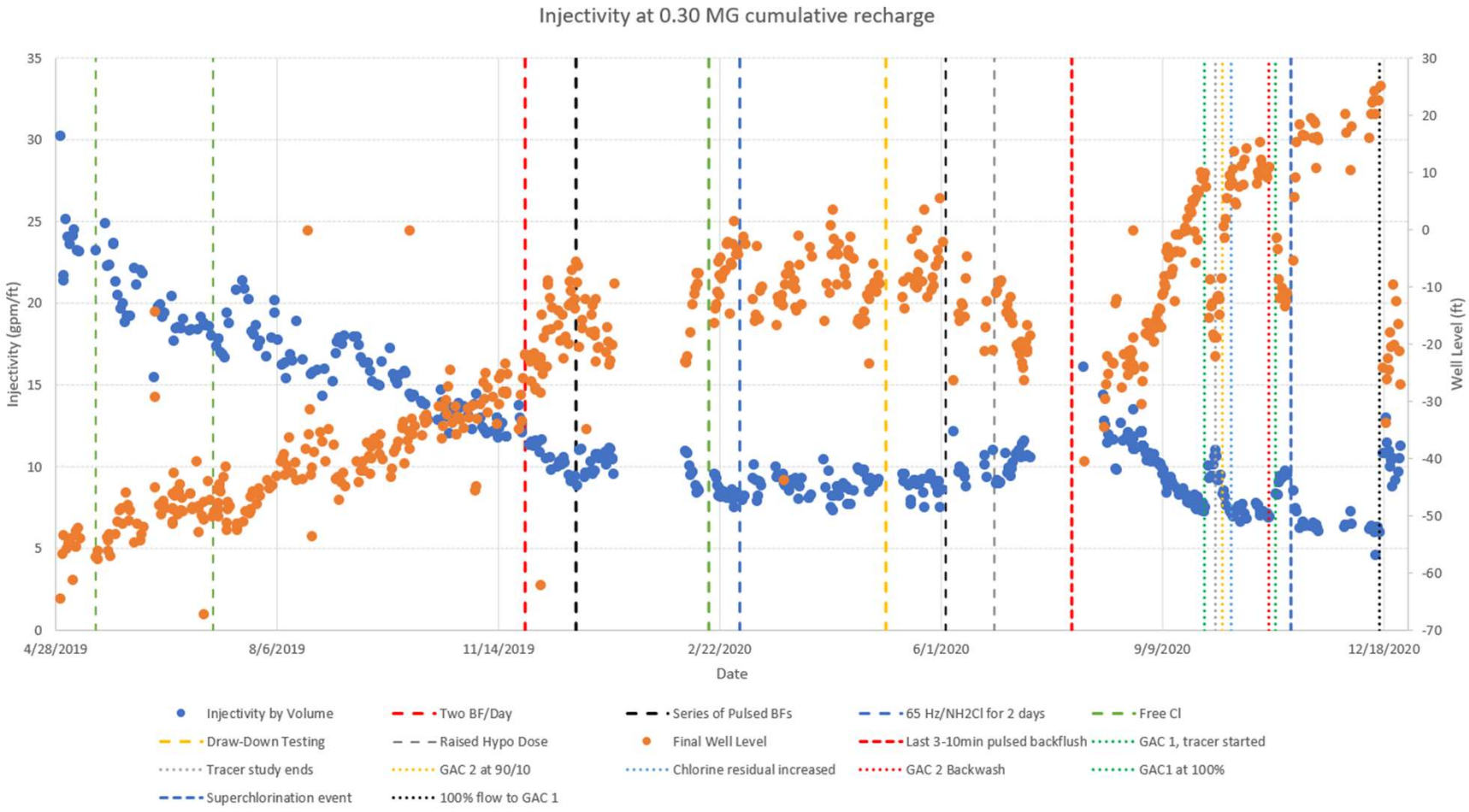
- SC and SI provide capacity of the well not just the aquifer.
  - Losses in the aquifer
  - Losses in the well (gravel pack/screens)
- Good for tracking capacity of a well over time
- Production production and recharge flow capacities



Recharge well TW-1

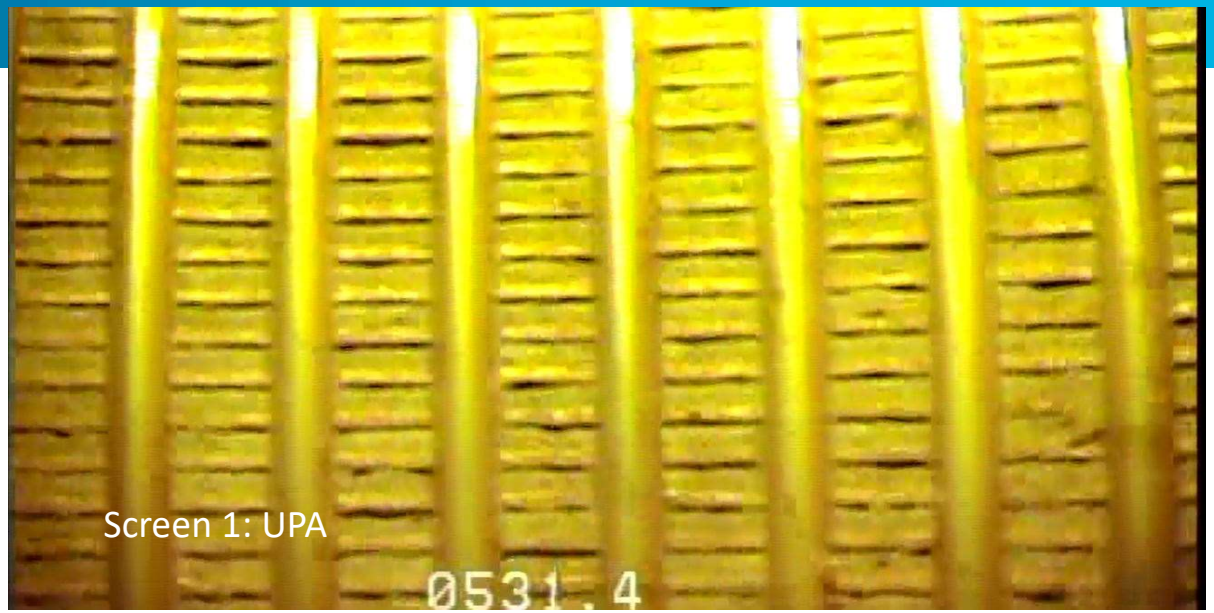
- TW-1 installed in Aug 2016
- Test well and recharge well
- 12” diameter, carbon steel
- Initial specific capacity (withdrawal) of 37 gpm/ft at 1,200 gpm
- Initial recharge specific injectivity (recharge) of 23 gpm/ft

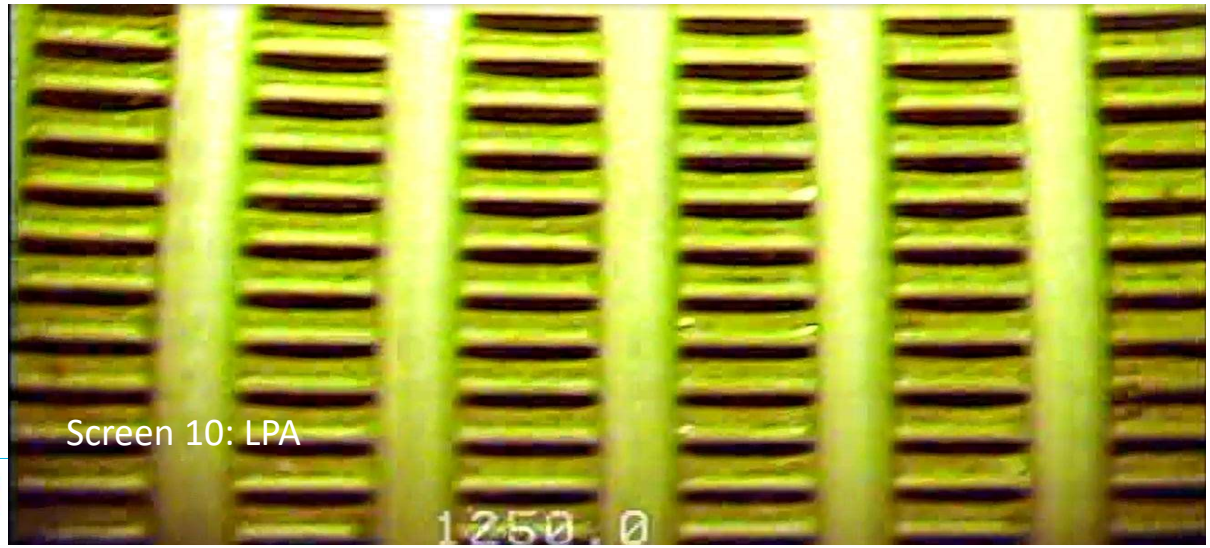
TW-1 specific capacity history



Pre-Rehab Video Log at TW-1

- Screen(s) exhibit clogging by siltation with fine- grained material filling screen slots.
- No visual evidence of biofilm or mineral incrustation appears on screen faces.
- Bottom of TW-1, contained 28 feet of sand accumulation compared to 83 feet in December 2018





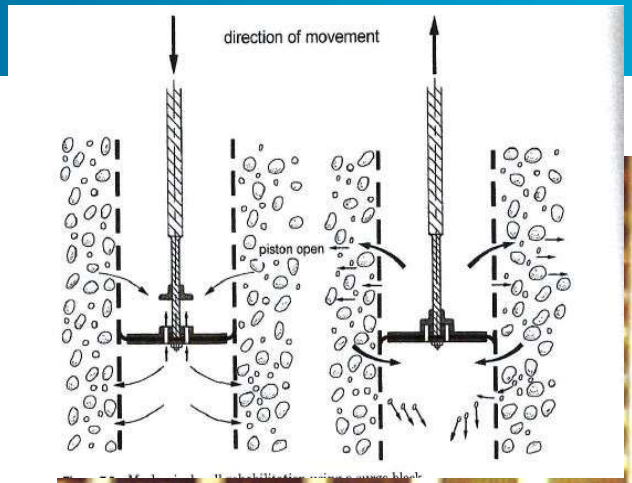
Percent of Screen Slots Clogged

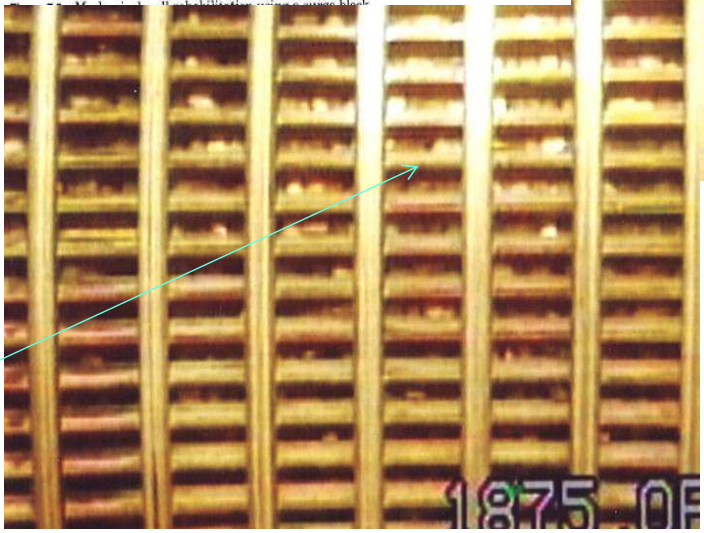
- Screens are between 15 and 83 percent clogged.
- Screens in UPA significantly more clogged than the MPA and LPA.
- **Injectivity @ 8 gpm/ft now 1/3 of original value**.
- From the perspective of transmissivity, clogging the screens set against the UPA drops the transmissivity by 2/3.

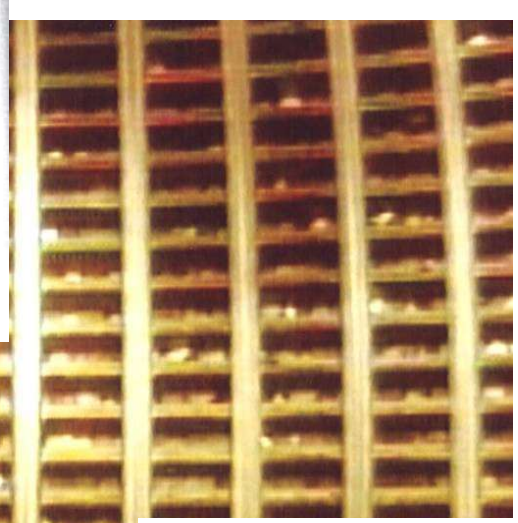
Depth (fbg)	Screen	Aquifer Zone	Visual average clogged for screen (%)
508 to 531	1	UPA	51
555 to 595	2		27
677 to 685	3		83
725 to 756	4		36
822 to 835	5	MPA	17
861 to 885	6		15
906 to 920	7		18
965 to 989	8		18
1050 to 1090	9		23
1230 to 1335	10	LPA	23
1375 to 1395	11		31

Rehab at TW-1

- Brush casing and screen
- Swabbing Pass #1
- Swabbing Pass #2 with chemical addition (acid/dispersant)
- Post swabbing video survey
- Over-pumping
- Re-swab & airlift Screen 4
- Airlift material 1,395 to 1,415 fbg
- Install new pump and shafting
- Backflush to raise pH
- Resume MAR operations
- Post rehab video of well screening Lower Zone of Potomac Aquifer







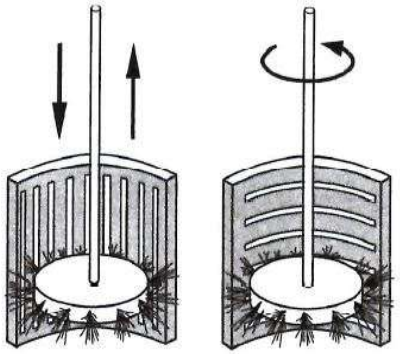
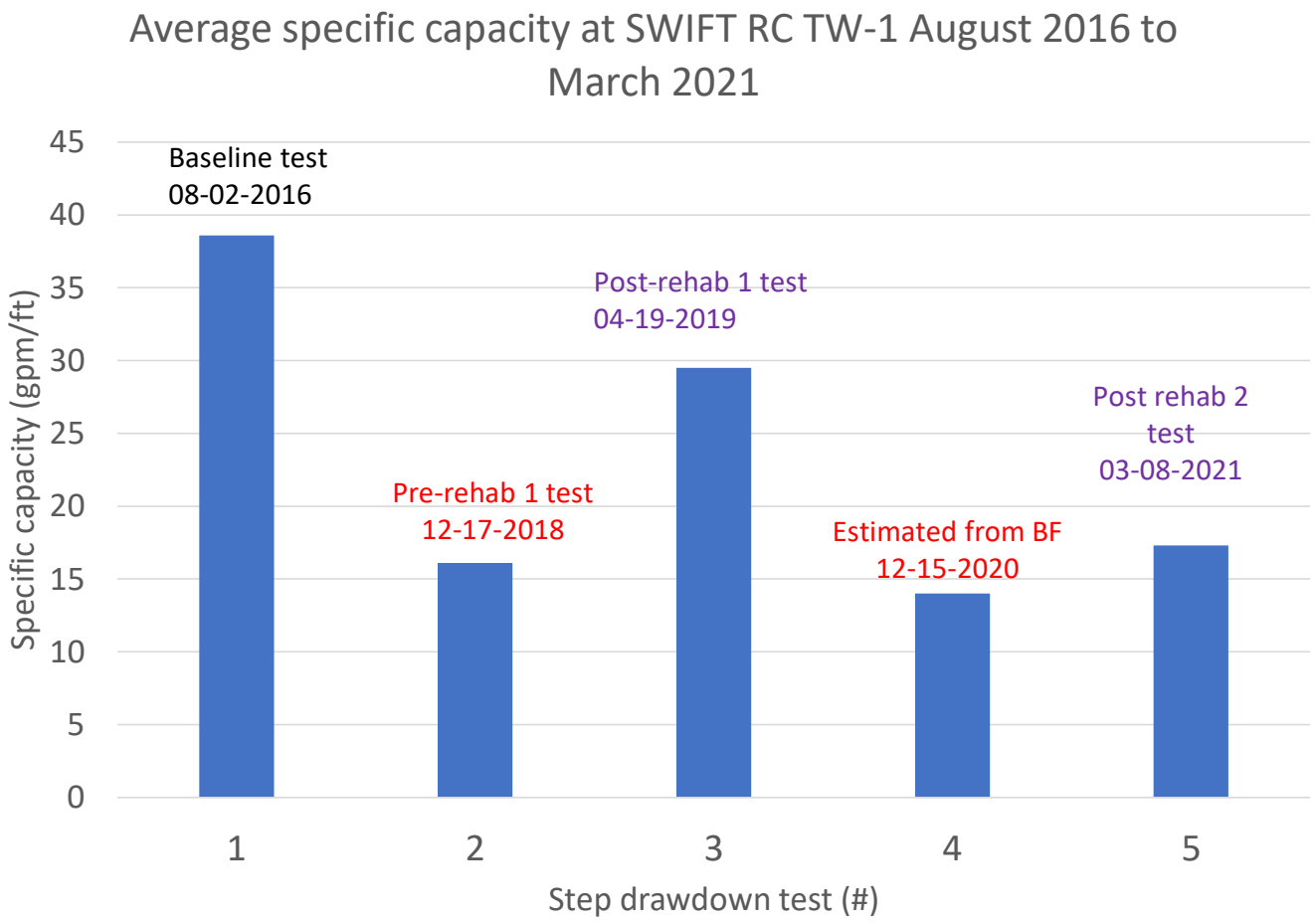


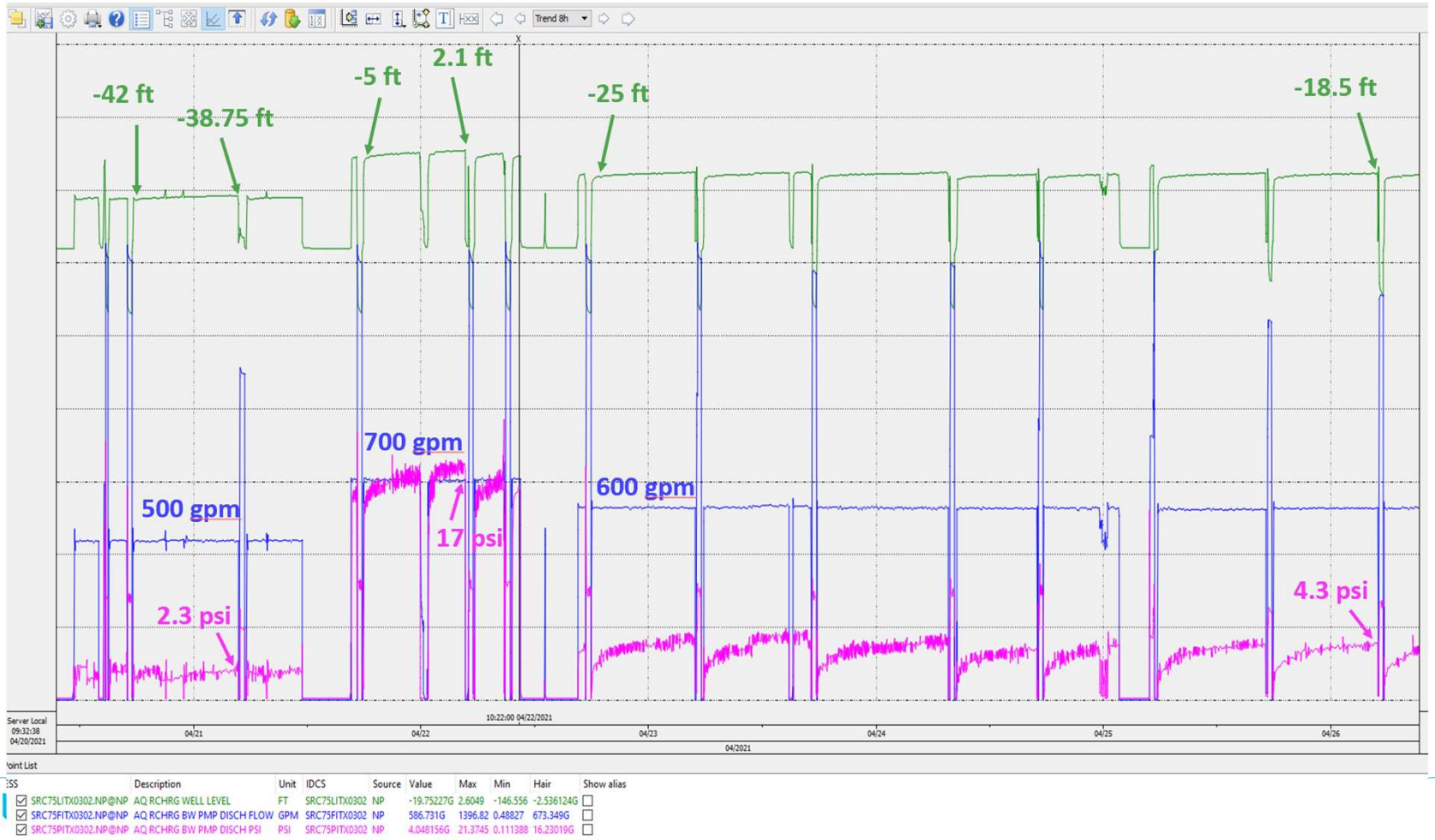
Figure 7.2 Brushing of wells with different screen slot arrangements. *Drawing: Schröder.*

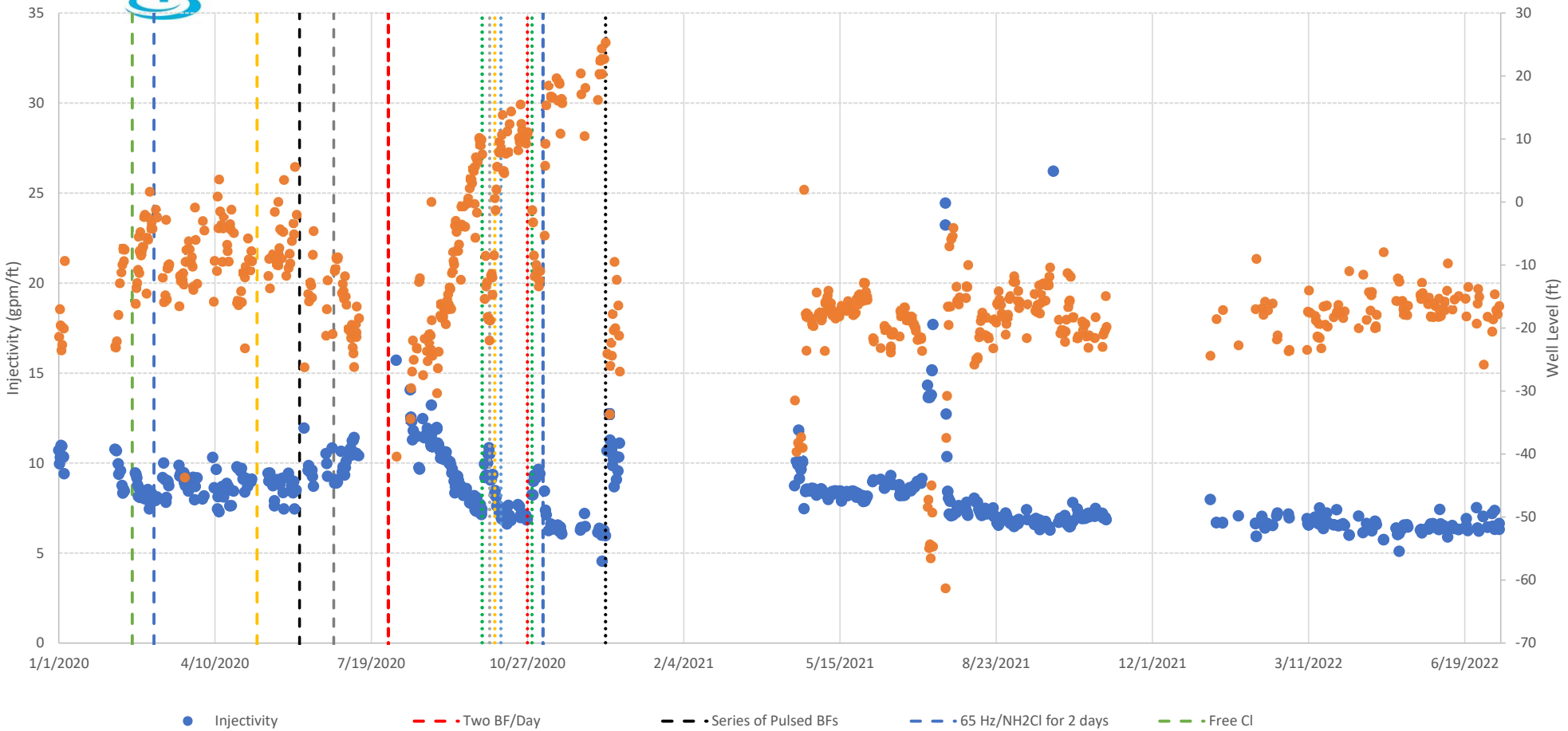
Comparing Average SC's from step tests at TW-1



- Goal is to preserve capacity, NP_MAR_01 online end of 2021
- Operate at lower recharge rate @ TW-1~ 500 - 600 gpm.
- Backflush twice/day

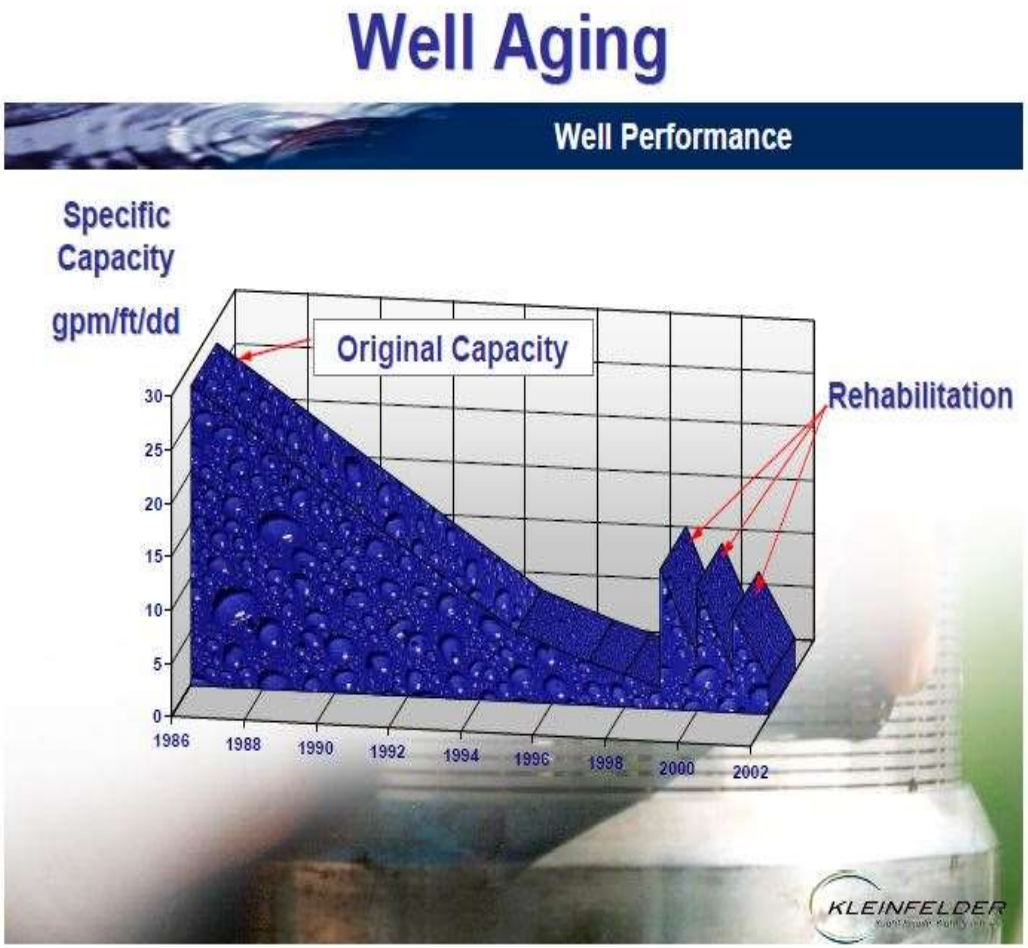
Post Rehabilitation Operations at TW-1




Injectivity (gpm/ft)
Well Level (ft)
35
30
25
20
15
10
5
0
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1/1/2020
4/10/2020
7/19/2020
10/27/2020
2/4/2021
5/15/2021
8/23/2021
12/1/2021
3/11/2022
6/19/2022
Injectivity
Two BF/Day
Series of Pulsed BFs
65 Hz/NH2Cl for 2 days
Free Cl
Draw-Down Testing
Raised Hypo Dose
Last 3-10min pulsed backflush
GAC 1, tracer started
Tracer study ends
GAC 2 at 90/10
Chlorine residual increased
GAC 2 Backwash
GAC1 at 100%
Superchlorination event
100% flow to GAC 1
Water level

Why New Full Scale Well at Nansemond – NP_MAR_01?

- Recharge well TW-1
  - Initial rehab after 6 months
  - Second rehab after ~3 yrs
  - Limited success
- **Shows signs of an aged well**
- Compromised from clogging, difficult to resuscitate
- TW-1 pumping sand
- Provides HRSD run time with a full scale well and unique features
- Incorporated into Nansemond SWIFT



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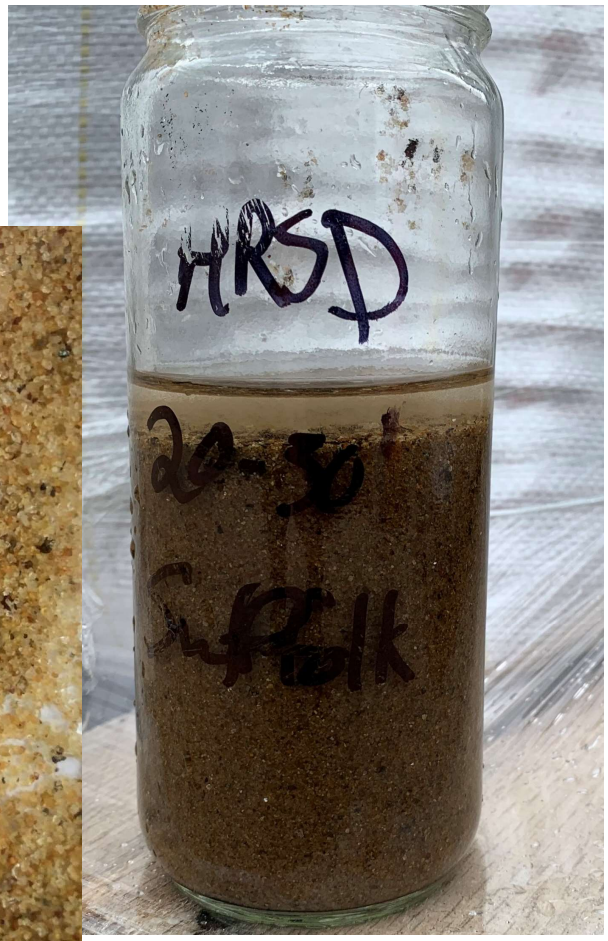
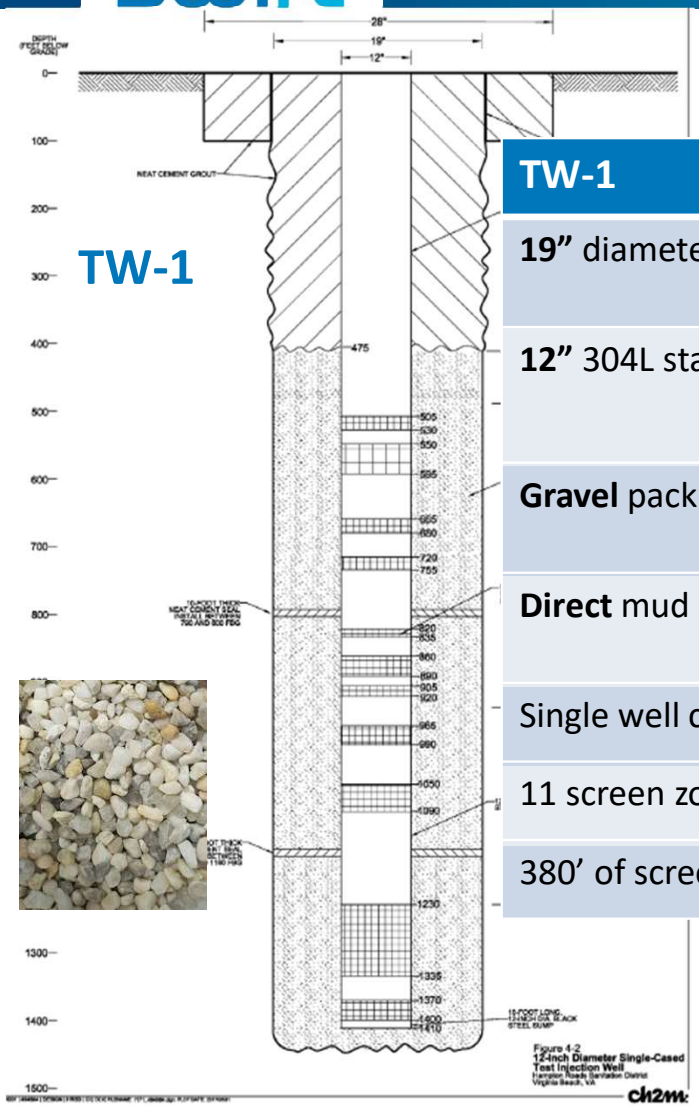
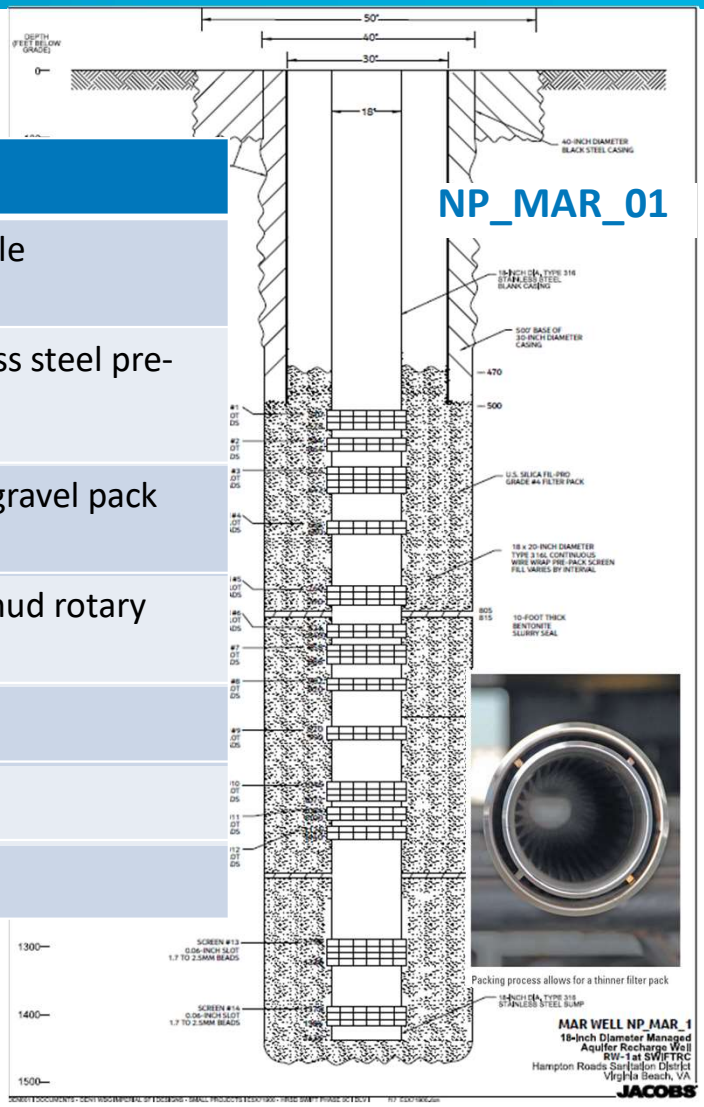


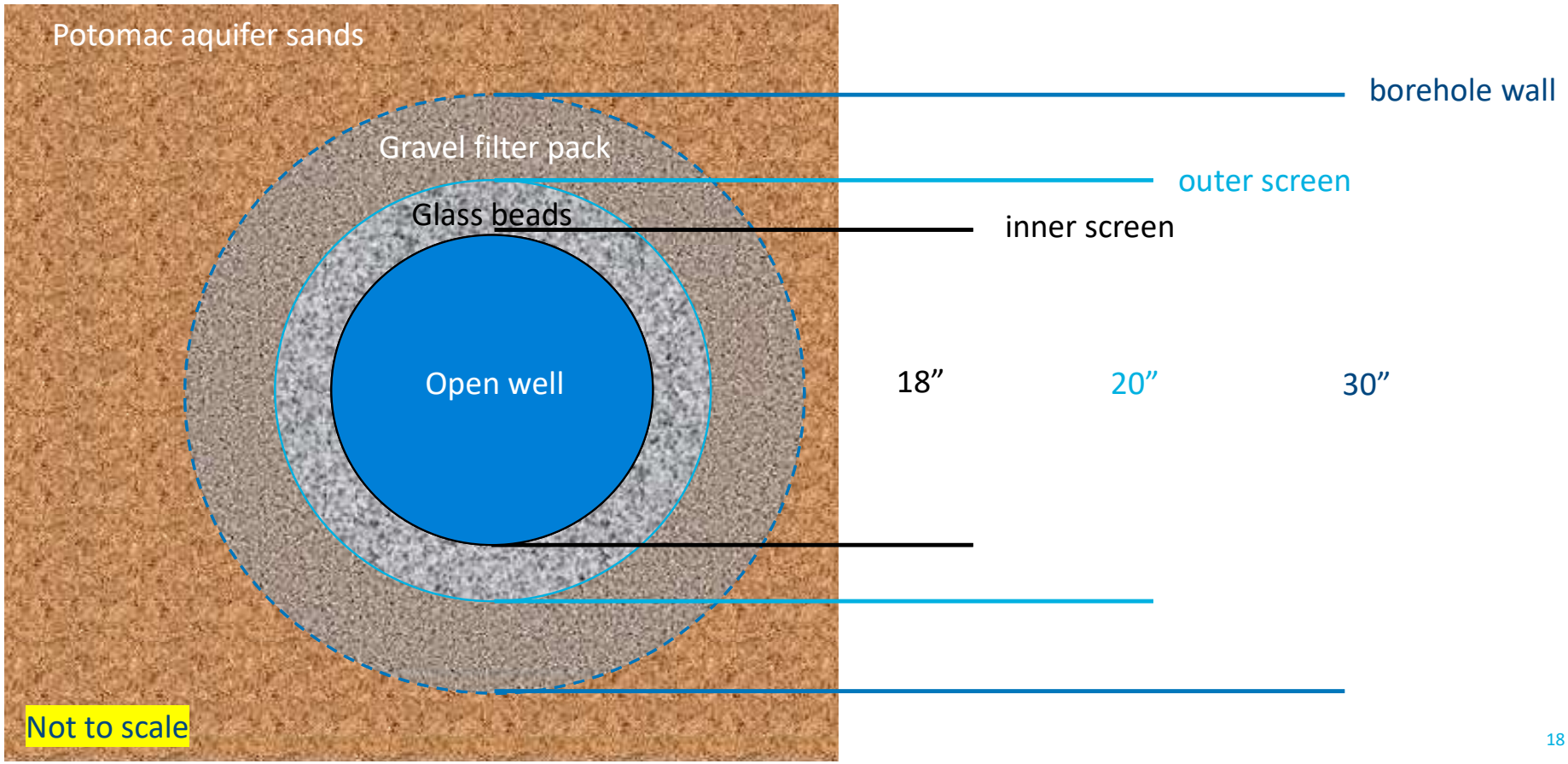
TW-1 vs NP_MAR_01



TW-1	NP_MAR_01
19” diameter borehole	**30”** diameter borehole
12” 304L stainless steel screen	**18”x20”** 316L stainless steel pre-packed screen
Gravel pack only	Si **spherical beads** + gravel pack
Direct mud rotary drilling	**Reverse** circulation mud rotary drilling
Single well casing/screen	Overlap construction
11 screen zones	14 screen zones
380’ of screen	342’ of screen

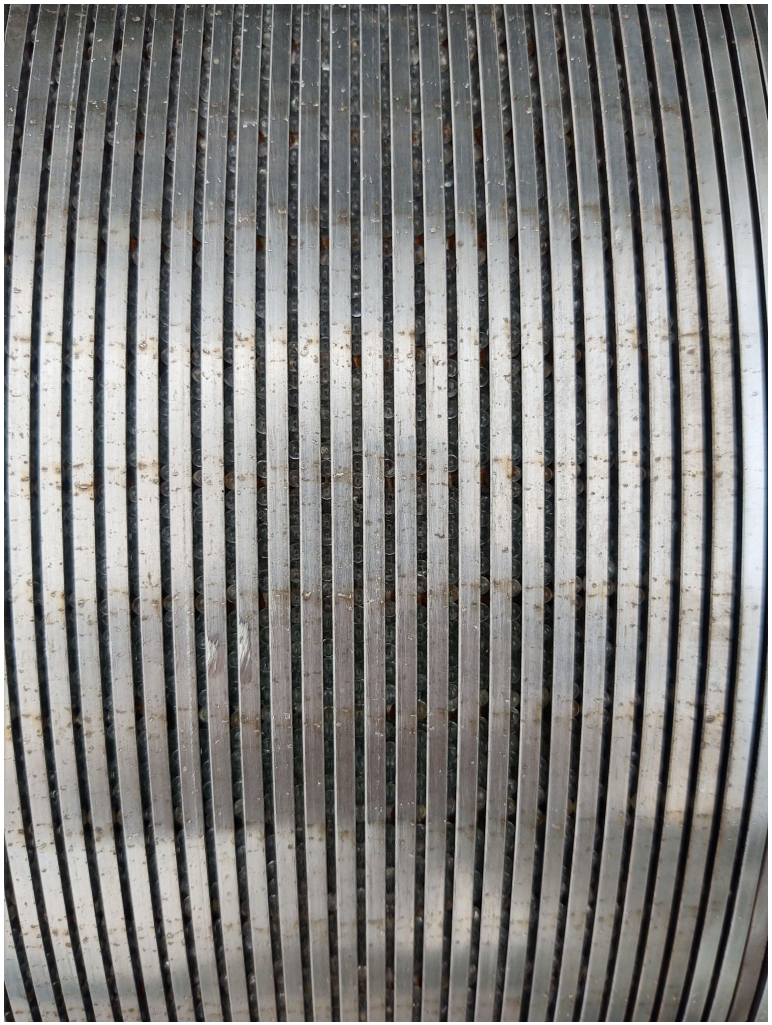


Pre-packed well screen, gravel pack borehole cross-section



316 Stainless Steel Pre-packed well screen

- Almost perfect spheres
- Uniform and consistent bead size
- Can custom size per sand lens
- Stronger crush strength
- No bridging of filter pack
- Less loss of capacity from bio-fouling and mineral scaling
- Easy to clean and chemical resistance



NP_MAR_01 Performance

- Pumped topped out at 2,813 gpm (4 MGD!)
- Specific Capacity @ 2,700 gpm = **69 gpm/ft**
- TW-1 SC @ 1,100 gpm = 37 gpm/ft
- NP_MAR_01 @ 1,220 gpm = 83 gpm/ft

Post ACH treatment Specific Capacity

TW-1 SC @ 1,100 gpm = 37 gpm/ft
NP_MAR_O1 SC @ 1220 gpm = 68.7 gpm/ft

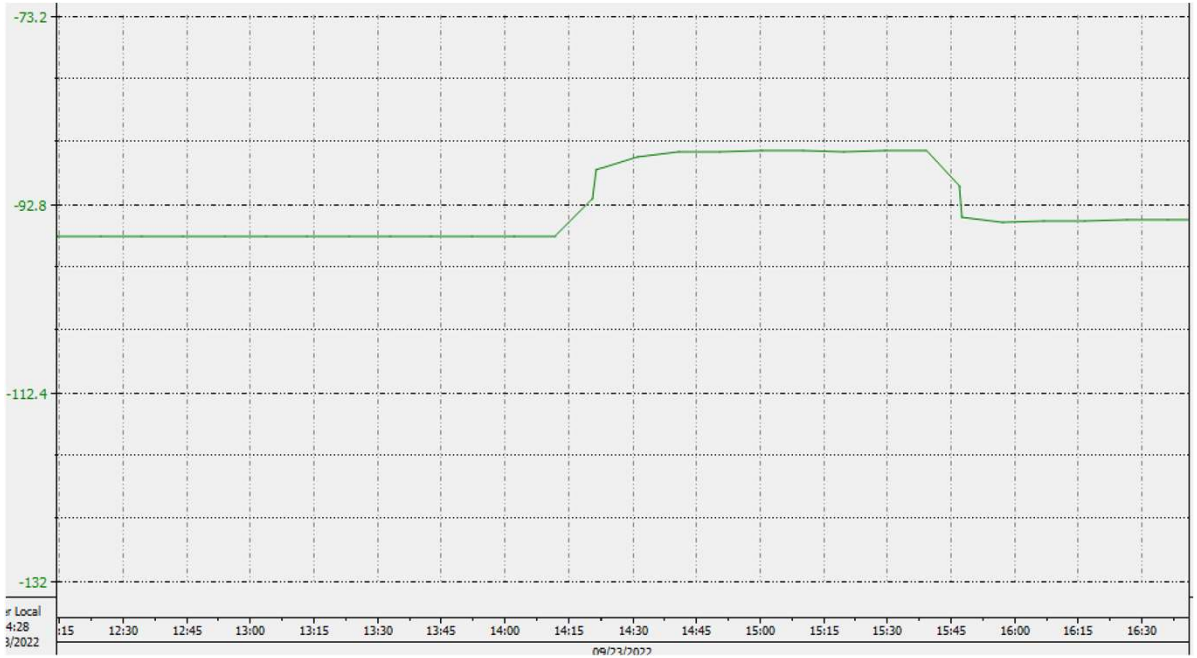
Static Water Level 100.5 feet below grade

Step No.	Pumping Rate (gpm)	Pumping Level (feet)	Drawdown (feet)	Specific Capacity (gpm/ft)	Specific Discharge (ft/gpm)	Skin Coefficient BQ (feet)	Well Loss CQ^2 (feet)	Caused by Laminar Flow (%)	Post Conditioning Diff (gpm/ft)	(%)
1	1220	118.3	17.8	68.7	0.0145	15.74	2.98	88.66	14.8	17.7
2	1494	123.7	23.2	64.4	0.0155	19.27	4.46	83.11	12.3	16.0
3	1795	130.2	29.7	60.4	0.0165	23.16	6.44	77.96	9.8	14.0
4	2112	136.0	35.5	59.6	0.0168	27.24	8.92	76.85	9.8	14.1
5	2414	142.6	42.1	57.3	0.0174	31.14	11.65	73.97	11.6	16.8
6	2704	146.7	46.2	58.6	0.0171	34.88	14.62	75.57	9.6	14.1
C	2.00E-06					Diff		Avergage	11.3	15.5
B	0.0129		average	61.51 gpm/ft		10.40 gpm/ft		14.46	(%)	

NP_MAR_01 Recharge testing complete

- Recharge cycle
  - ~ 450 gpm
  - ~ 2 hrs
- Static -96 ft below ground
- Recharge -87 ft below ground
- Recharge rate = 490 gpm
- Resulting specific injectivity (SI) = 54 gpm/ft

- Recharge at 700 gpm?

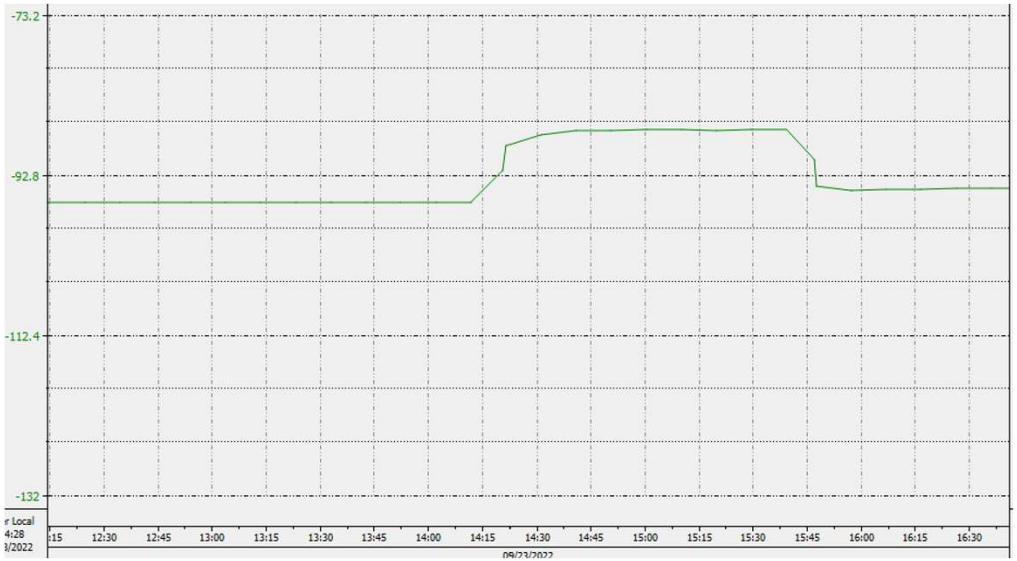


NP_MAR_01 performance compared to TW-1

- TW-1 Initial
  - Withdrawal @ 1,300 gpm **SC 37 gpm/ft**
  - Recharge @ 700 gpm SI **23 gpm/ft**

- TW-1 current
  - Recharge @ 450 gpm **SI 8 gpm/ft**

- NP_MAR_01 (post ACH treatment)
  - Withdrawal @ 1,300 gpm **SC 69 gpm/ft**
  - Recharge @ 490 gpm SI **54 gpm/ft**



Questions?