Stripper Well Consortium
Vortex Flow, LLC Technical Progress Report
Final Report

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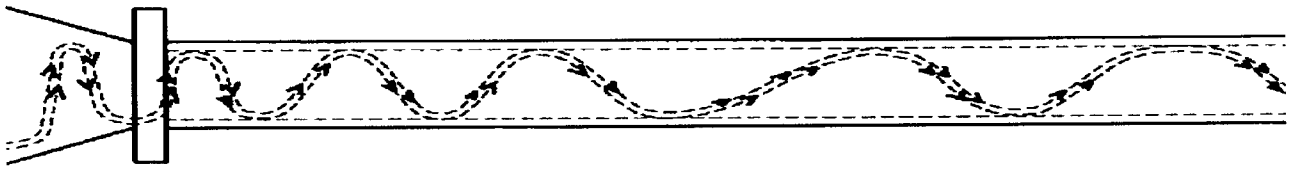
"Gathering Grant"

The scope of our project was to install Vortex SX tools in a gas gathering system working our way away from the delivery point of the gathering system (Amine Plant) back into the producing system. The goal of the installations was to reduce the pressure drop between points within the gathering system and to enable greater throughput when the Amine Plant is capable of greater capacity.

We installed eleven Vortex SX tools at strategic points in a gathering system owned by Cabot Oil and Gas in Wayne County, West Virginia. During the test period, we collected pressure data for all key points in the test gathering system where Vortex Flow SX tools were installed. Test data indicates that the pressure drops across points in the gathering system where Vortex SX tools are present have been very consistent and continue to be in the range of 2% to as much as 80% across a wide range of operating conditions. Data indicates that a combination of pipe size and mass flow have an effect on the magnitude of reduction in pressure drop that can be achieved by use of the tool. This effect would need to be further investigated to get a more definitive model of this effect.

Hypothesis:
The project was based on the theory that the unique flow regime created by the Vortex Flow SX tools would be able to reduce gathering line backpressure felt by all wells connected to the gathering system. It was hypothesized that by either moving accumulated fluids downstream or by improving overall flow organization, the Vortex Flow SX units would reduce backpressure felt by wells connected to the gathering system and allow for increased production. The flow created by the Vortex Flow SX units is depicted in Figure 1.

Figure 1 – Diagram of flow created by Vortex Flow SX unit.



Hypothesis – Continued: If we were successful in reducing gathering system backpressure, as measured by the pressure drop between points in the gathering system, we could effectively lower well bottom hole pressure as indicated by the changing conditions in Figures 2 and 3. Using Vogel's Inflow Performance Relationship Curve (Figure 4), we hypothesized that the reduced bottom hole pressure would result in increased production.

Figure 2 – Typical System Pressure Diagram Before Vortex Flow SX Tool Installation

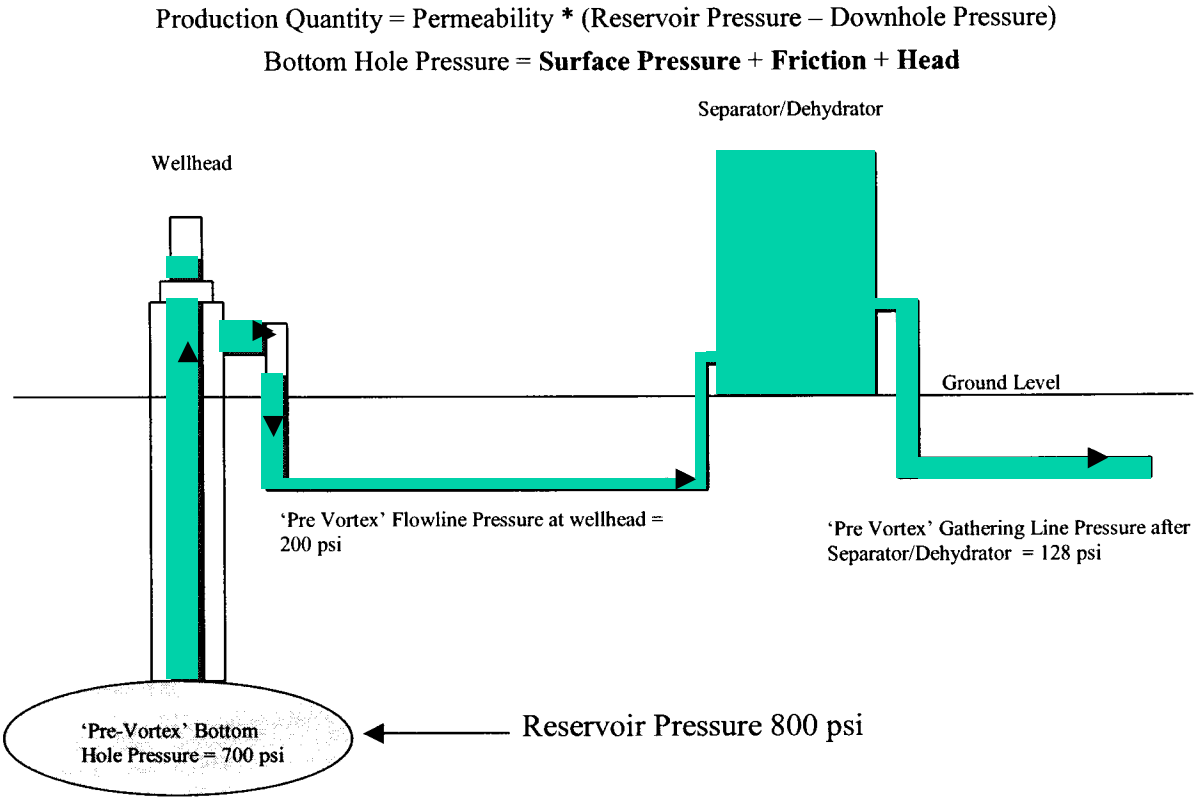


Figure 3 -Typical System Pressure Diagram After Vortex Flow SX Tool Installation

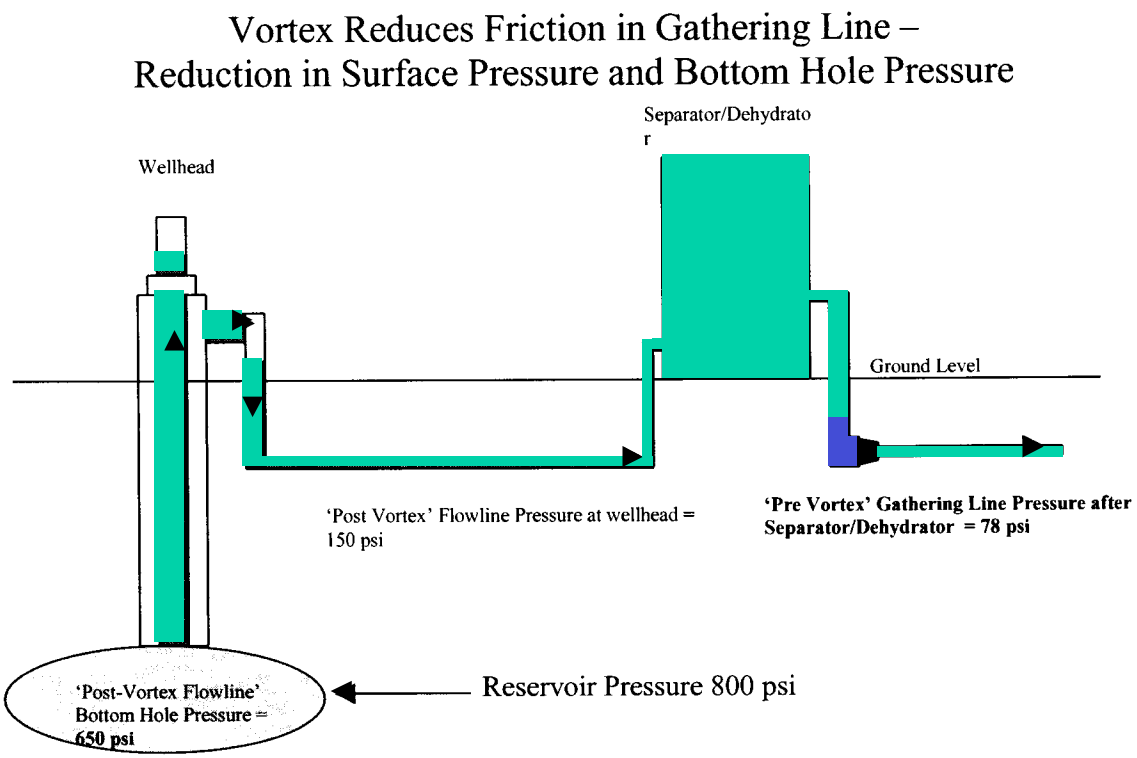
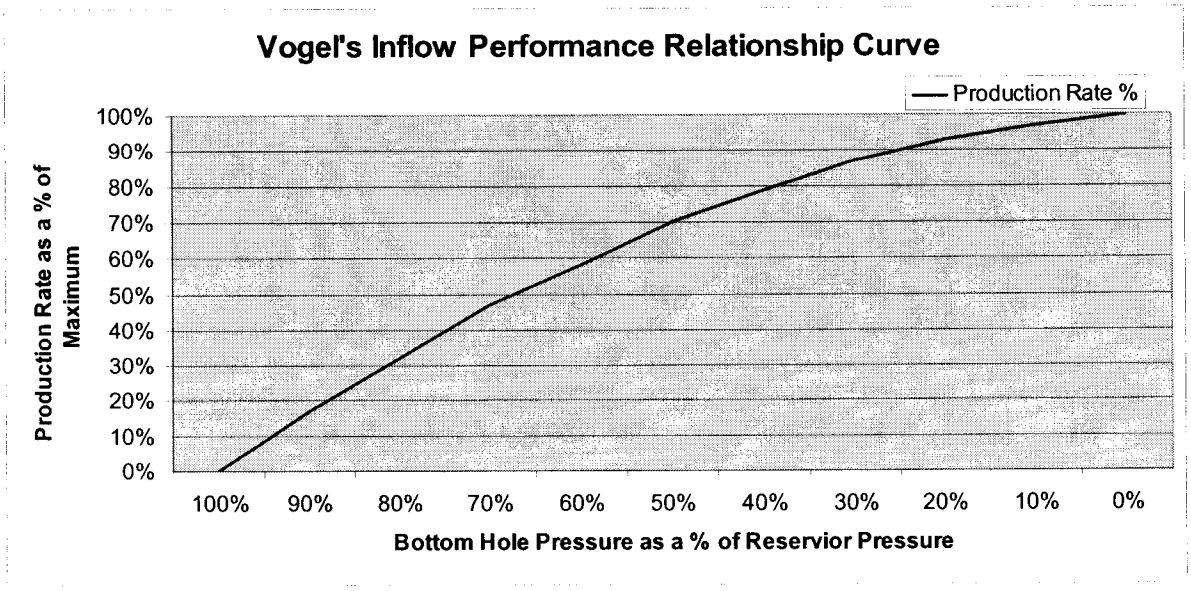


Figure 4 – Vogel's Inflow Performance Relationship Curve



Experimental Apparatus: Standard 2", 4" and 6" Vortex Flow SX units (See technical specifications below) were used in the tests. Units were installed at strategic points in the gathering system with the following general rules for tool placement:

1) Tools were placed at points just AFTER additional feeder lines entered the gathering system
2) Tools were installed at points where the flow regime created by the tool was given log run of straight pipe with no feeder lines entering the line with the tool installed for at least 1,500 feet.
3) All drips downstream of tool installations were removed.
4) Tools were put at low elevation sites in the gathering line when a choice between a low elevation installation site and a higher elevation installation site was available.

A map showing the system and all tool installation points is included with this report. A schedule of tool sizes, installation sites and distances from the collection point (Amine Plant) is included in Table 1. No liquids were observed in the gathering lines during installations. Pressure drop between points in the system and the Amine Plant have been reduced by 2% - 80% since SX tools were installed. The largest reductions in pressure drop were seen in the highest rate sections of the gathering line.

Technical Specifications – Vortex Flow SX Tools

Pipe Steel:	ANSI Schedule 40
Back Plate:	A36 Grade Steel
Weld Specification:	ASME B31.3
Tool Hydrotesting:	To 700 p.s.i or greater
Connection:	Threaded, using spools (see Photo 1)
Interior Coating:	None

Table 1 – Schedule of Installation Sites

Well / Tap	Tool Size	Flow Rate MCFD	Distance From Amine Plant (Ft)
CNR #2	**4"**	77	27,000
CNR #18	**2"**	81	27,000
Prichard A-1	**4"**	520	23,000
E. Piles #1	**2"**	125	25,000
Gypsy Wright A-3R	**2"**	39	20,000
Gypsy Wright A-1	**4"**	3	17,500
Gypsy Wright #1	**4"**	45	15,500
Inglehart #1	**2"**	45	17,500
Prichard #8	**2"**	57	14,000
C-619 & C-469 tie	**6"**	3742	13,000
Agee #1	**6"**	34	7,000
Amine Plant	**None**		0

Experimental and Operating Data: Data analysis shows a consistent reduction in pressure drop between measured points in the gathering system and the Amine Plant. Data was collected for 4 weeks before installations and for 8 weeks after installations. All reductions in pressure drops are listed in percentages. Average reduction in pressure drop was on the order of 15% +/- with wide variation as shown below:

Descriptive Statistics for Reduction in Pressure Drop

N	Mean	Median	TrMean	StDev
11	-0.1894	-0.1014	-0.1396	0.2283

Minimum	Maximum	Q1	Q3
-0.8047	-0.0224	-0.2593	-0.0483

Table 2 – Reduced Baseline and Test Data

	Pressure Difference from Installation Points to Amine Plant			
Well / Tap	**Week Pre-Installation Ave.**	**8 Weeks Later**	**% Change in Pressure Drop**	**% Change in Pressure Drop**
CNR #2	**78.00**	76.25	(1.75)	**-2.24%**
CNR #18	**72.00**	68.00	(4.00)	**-5.56%**
Prichard A-1	**69.67**	53.00	(16.67)	**-23.92%**
E. Piles #1	**56.67**	55.25	(1.42)	**-2.50%**
Gypsy Wright A-3R	**37.00**	33.25	(3.75)	**-10.14%**
Gypsy Wright A-1	**36.33**	34.00	(2.33)	**-6.42%**
Gypsy Wright #1	**37.67**	32.25	(5.42)	**-14.38%**
Inglehart #1	**39.67**	37.75	(1.92)	**-4.83%**
Prichard #8	**27.00**	20.00	(7.00)	**-25.93%**
C-619 & C-469 tie	**35.83**	7.00	(28.83)	**-80.47%**
Agee #1	**16.17**	11.00	(5.17)	**-31.96%**
Amine Plant	**-**	-	-	
Ave.	**46.00**	38.89	(7.11)	**-18.94%**

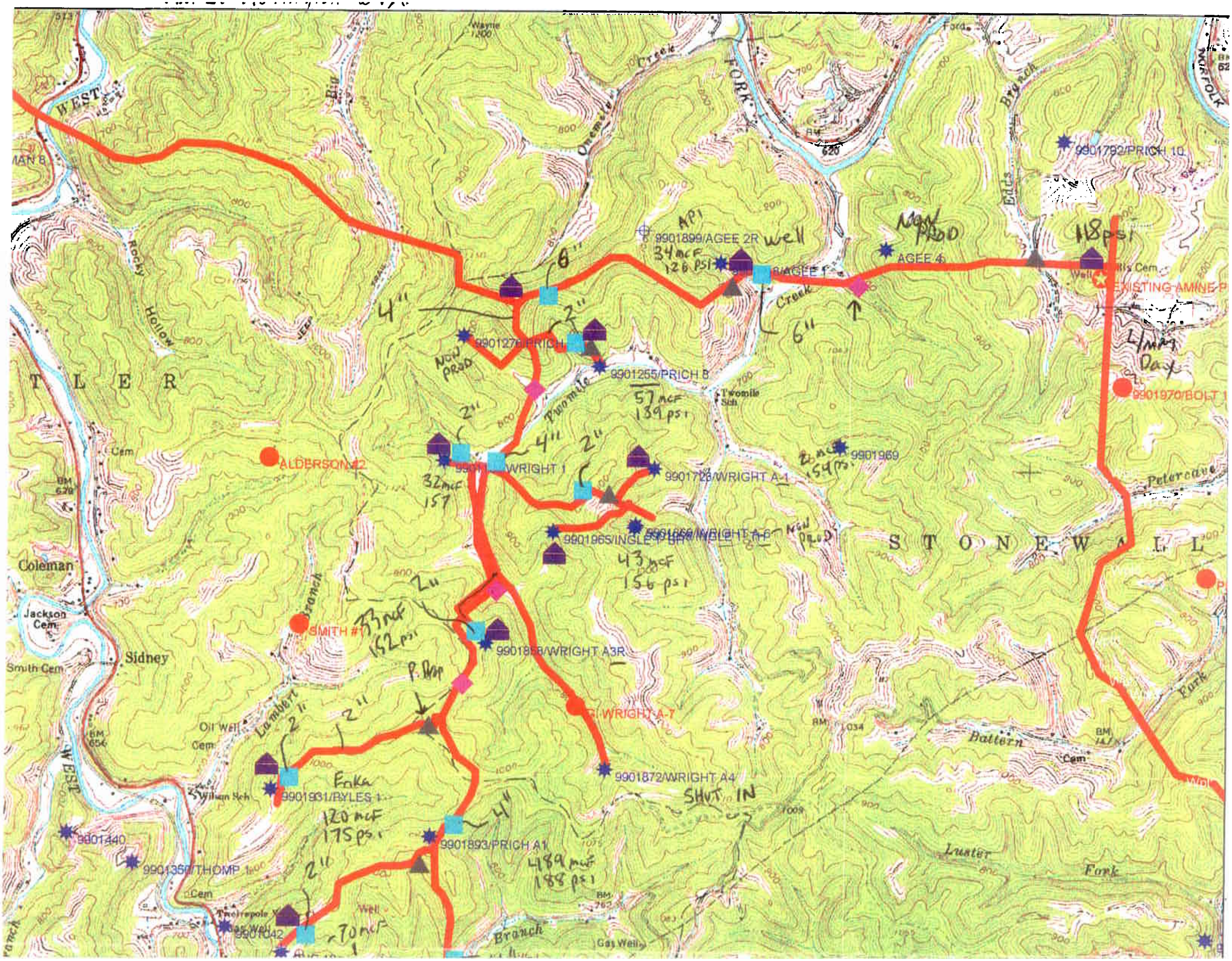
Hypothesis and Conclusions: Our initial conclusion is that the Vortex SX units have the ability to help gathering systems reduce pressure drop across all points in the system by both organizing the flow within the gathering line and by ensuring that accumulated fluids are swept downstream to points in the system where they can be properly collected. Use of the tools will lower total system pressure and will allow wells attached to the gathering system with good pressure response to realize additional production as the efficiency of the gathering system is improved.

In our tests, we did see a reduction in pressure drop (alternatively – improved system efficiency) but did NOT see increased production as the producing formation was very tight and did not have characteristics that would allow for a good production response to lower pressures.

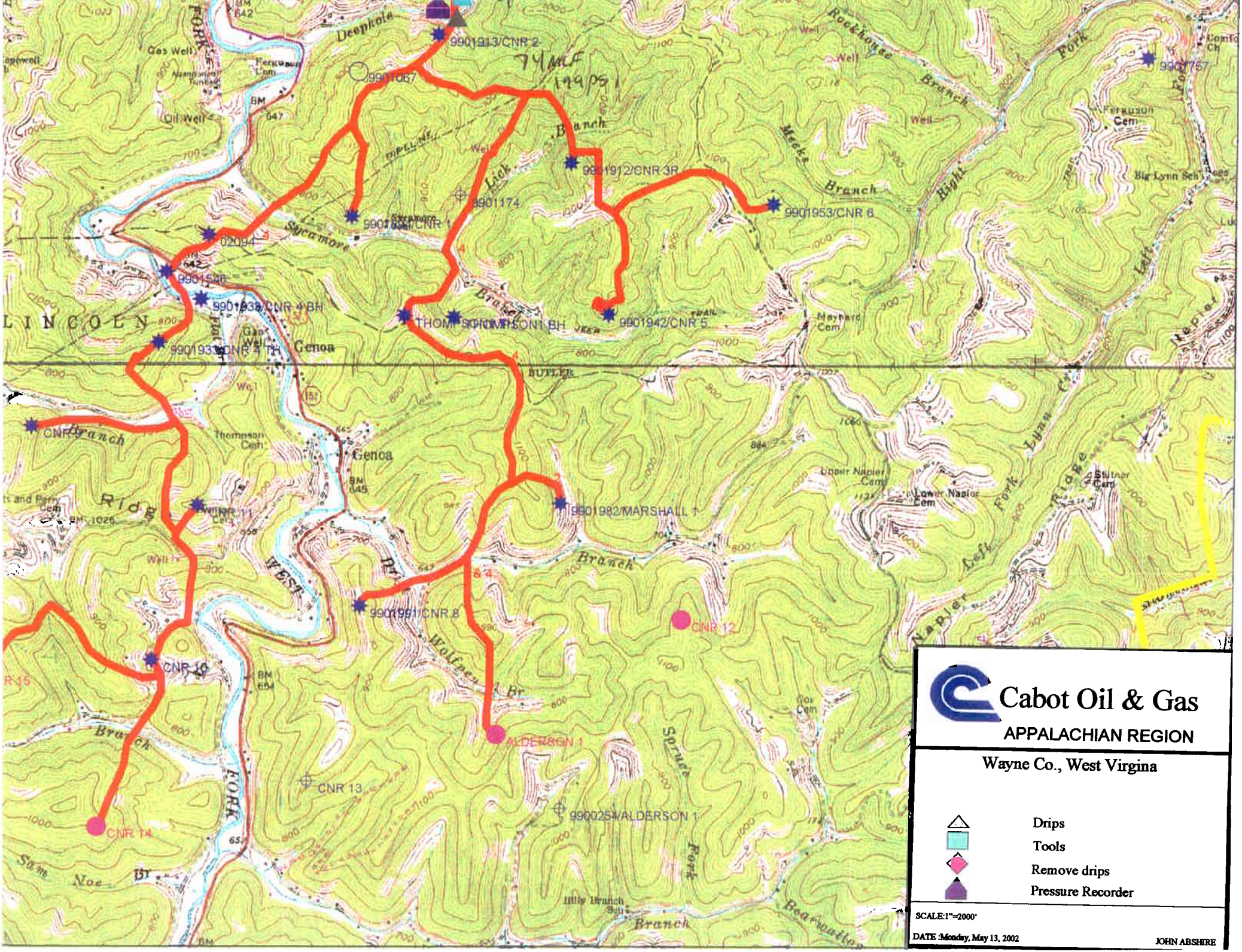
From these tests, we have confirmed the need for good field pressure response if a key objective of tool use is to improve production. The tools are effective in lowering line pressures and moving fluids if the objective of tool use is to increase throughput or move fluids through the system.

It also appears that there is a relationship between mass flow rates and the associated reduction in pressure drop found at various points in the test system. This effects would have to be further investigated to better define and understand if this effect is repeatable and statistically significant and predictable.

Photo 1. 4" Tool installation with spool



9901792/PRICH 10
9901899/AGEE 2R
API
Well
34 mcf
126 psi
AGEE 1
NON PROD
AGEE 4
118 psi
EXISTING AMINE P
6"
4"
2"
6"
9901276/PRICH
NON PROD
9901255/PRICH 8
57 mcf
139 psi
Twomile Sch
9901970/BOLT 1
ALDERSON #2
2"
4"
2"
WRIGHT 1
32 mcf
157
9901728/WRIGHT A-1
9901969
154 psi
9901965/INGLE
9901868/WRIGHT A-6
NEW PROD
43 mcf
156 psi
STONEWALL
Coleman
Jackson Cem
Sidney
Smith Cem
SMITH #1
73 mcf
152 psi
2"
9901858/WRIGHT A3R
P. Prop
C. WRIGHT A-7
2"
2"
9901872/WRIGHT A4
SHUT IN
9901931/BYLES 1
120 mcf
175 psi
4"
9901893/PRICH A1
9901440
9901350/THOMP 1
2"
489 mcf
188 psi
9901042
70 mcf
Twelvepole
Bartern
Luster
Fork
Petercave
Twomile
Creek
Big
Rocky
Hollow
Lambert
Branch
WEST
FORK
Wayne
Edds
Branch
Oil Well
Gas Well


9901913/CNR 2
9901067
9901912/CNR 3R
9901953/CNR 6
9901174
9901942/CNR 5
9901982/MARSHALL 1
9901991/CNR 8
CNR 12
CNR 13
CNR 14
CNR 15
ALDERSON 1
9900254/ALDERSON 1
Genoa
LINCOLN
BUTLER
Cabot Oil & Gas
APPALACHIAN REGION
Wayne Co., West Virgina
Drips
Tools
Remove drips
Pressure Recorder
SCALE:1"=2000'
DATE :Monday, May 13, 2002
JOHN ABSHIRE