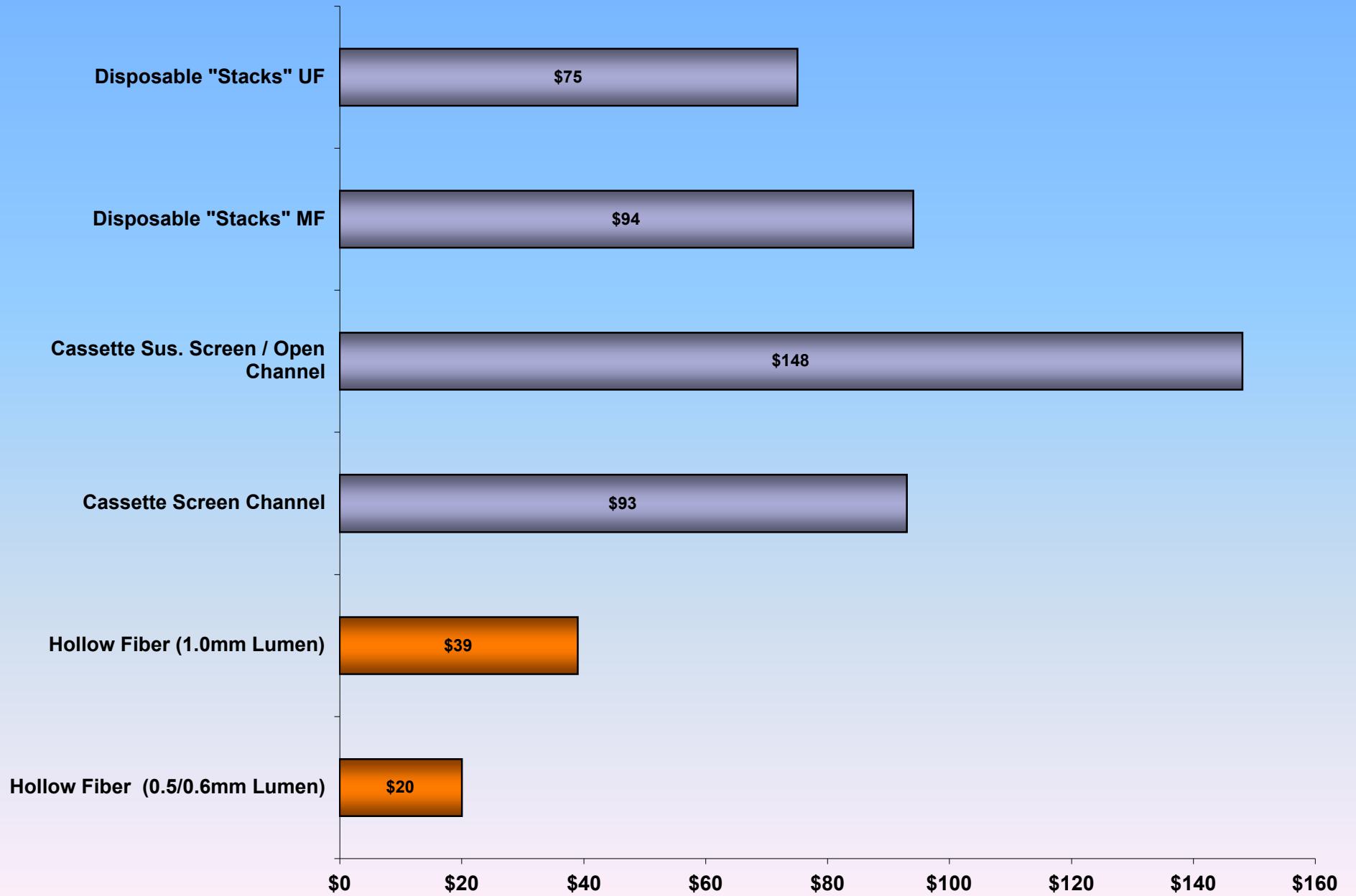


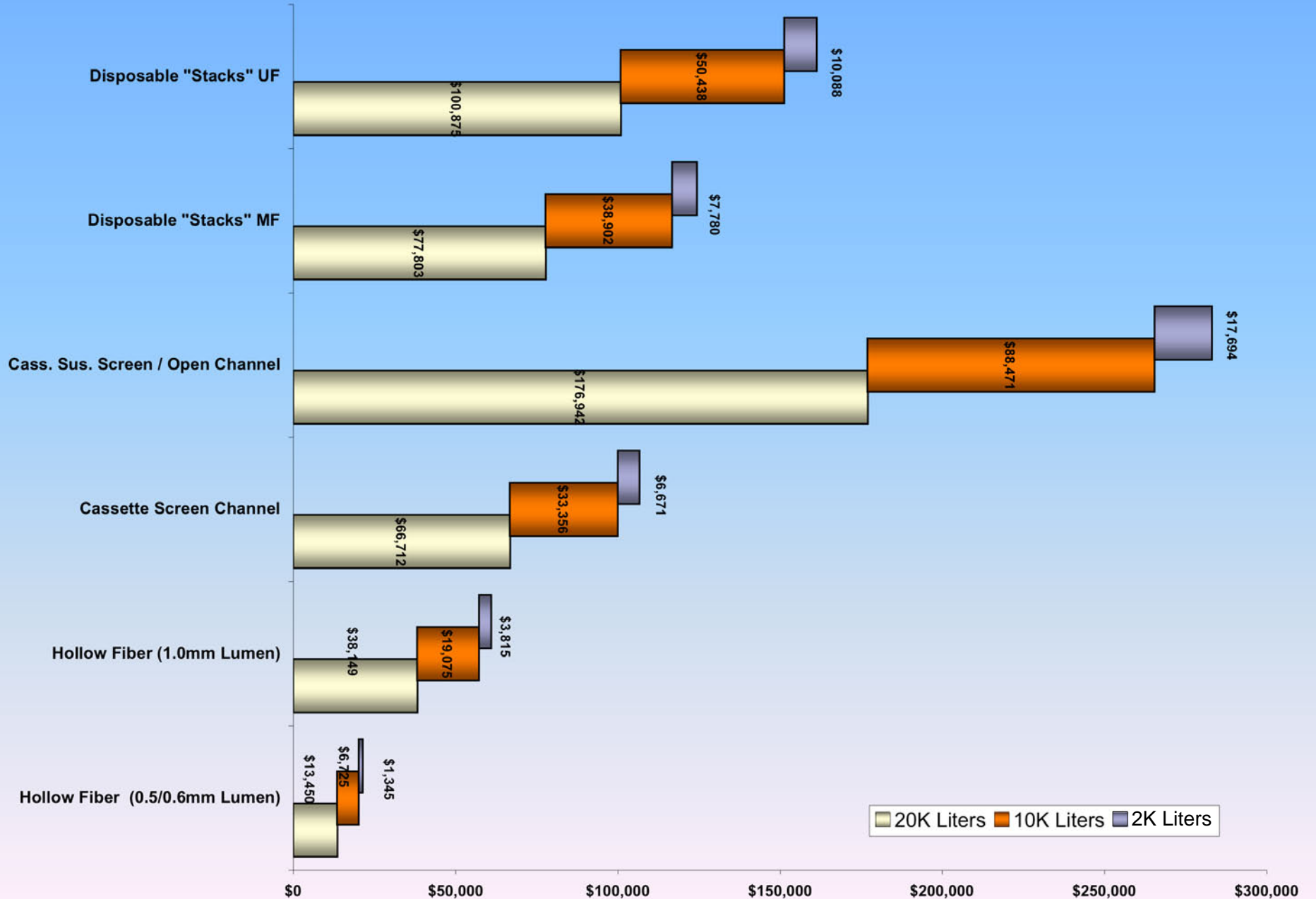
Return on Investment & Cost Analysis: Hollow Fiber vs. Flat-sheet TFF

David Serway,
Director of Business Development
Spectrum Laboratories, Inc.

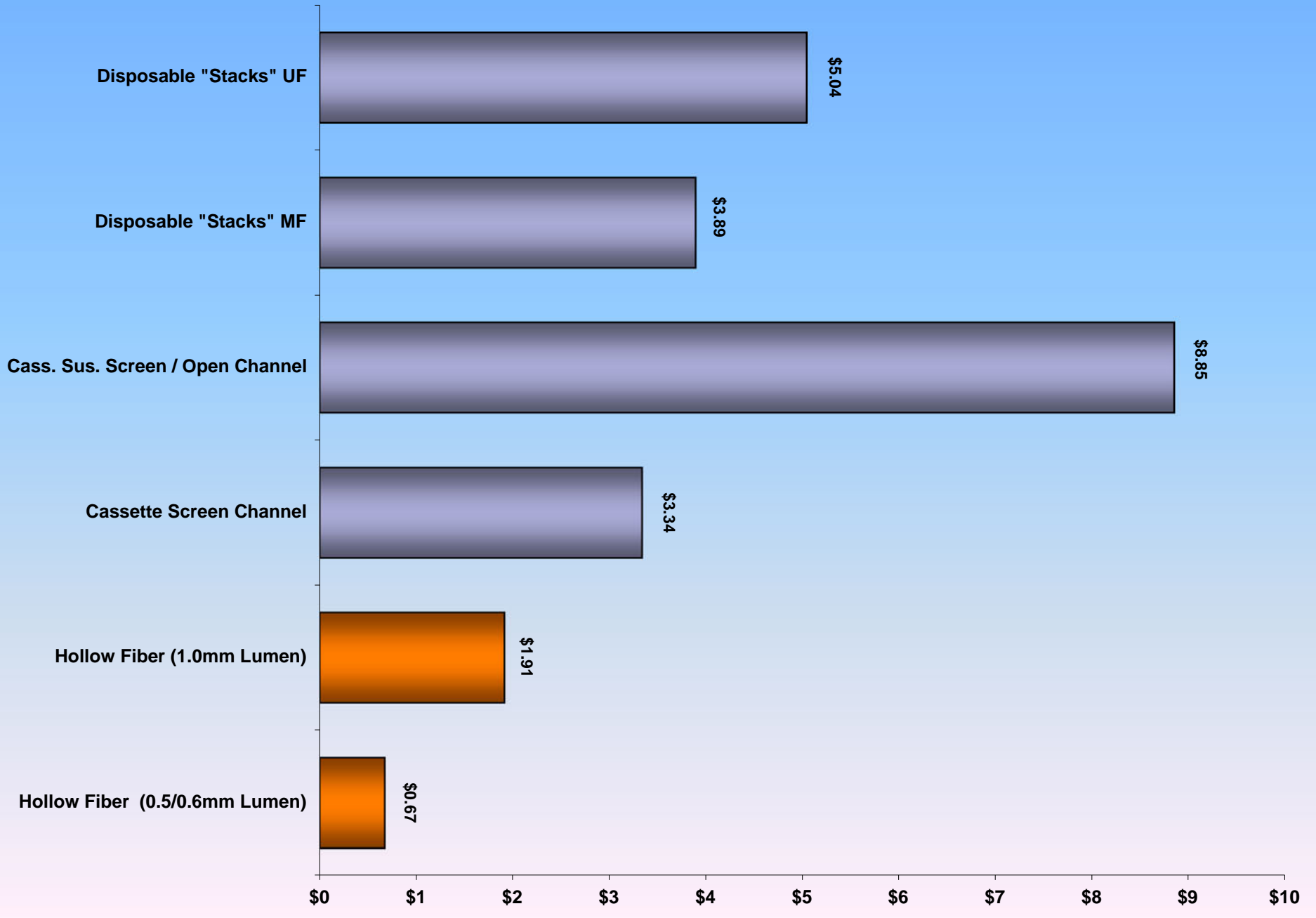
Membrane Cost Per SQ FT Area



Membrane Costs (4 hr Mammalian Process Run)



Process Volume Cost (\$/Liter Process)



Clarification Budgeting—return-on-investment (ROI) analysis

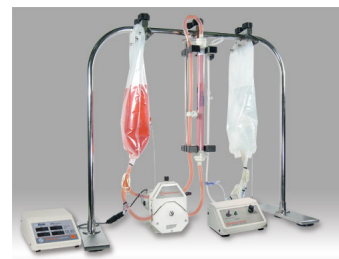
By: David Serway, Director of Bus. Development

Investment overview

Project name: MF TFF Mammalian Cells 2k to 20k Liters

Project sponsor: Spectrum Laboratories

General description of benefits: Understand the potential savings for utilizing disposable hollow fibers system assemblies verses single use cassettes / Stainless Systems for mammalian cell harvesting / clarification (excluding capital costs of systems)



Cash flow and ROI statement

BENEFIT DRIVERS	YEAR			
	0	1	2	3
Greater margin driven by a better production capacity		\$250,000	\$500,000	\$750,000
Improved cycle time benefits:				
Reduced cleaning materials cost due to less running time		375,000	450,000	525,000
Reduced labor cost due to less running time		50,000	75,000	100,000
Fewer contaminations, resulting in less process re-runs		200,000	300,000	400,000
Improved quality benefits:				
Fewer Integrity losses, resulting in less rework		75,000	100,000	125,000
Less Cleaning Validation, resulting in less reprocessing costs		100,000	150,000	200,000
Reduced time spent Installing Membranes		10,000	15,000	20,000
Reduce System Validation / Maintenance		225,000	300,000	375,000
Pre-Irradiated Modules and Disposable Assemblies Utilized				
Less Bioburden Load		20,000	40,000	60,000
Reduced Set Up Time / Fully disposable process path		50,000	75,000	100,000
Total annual benefits		\$1,355,000	\$2,005,000	\$2,655,000
Implementation of Hollow Fiber Disposable Filter		35%	55%	95%
Total benefits realized		\$474,250	\$1,102,750	\$2,522,250

Costs	Year 0	Year 1	Year 2	Year 3
Total	\$158,500	\$5,000	\$2,500	\$2,500

Benefits	Year 0	Year 1	Year 2	Year 3
Annual benefit flow	(\$158,500)	\$469,250	\$1,100,250	\$2,519,750
Cumulative benefit flow	(\$158,500)	310,750	1,411,000	3,930,750

Discounted Hollow Fiber benefit flow	Year 0	Year 1	Year 2	Year 3
Discounted costs	\$158,500	\$4,762	\$2,268	\$2,160
Discounted benefits	0	451,667	1,000,227	2,178,814
Total discounted benefit flow	(\$158,500)	446,905	997,959	2,176,655
Total cumulative discounted benefit flow	(\$158,500)	288,405	1,286,364	3,463,019

Initial investment	Year 0	Year 1	Year 2	Year 3
Initial Process Equip Investment 24 Sqmeter Components	\$120,000	\$0	\$0	\$0
Implementation / Validation Costs	25,000	0	0	0
2 Totes for Reservoirs / Holds 200 L Material	6,000	0	0	0
Training costs	5,000	5,000	2,500	2,500
Other miscel. costs	2,500	0	0	0
Total costs	\$158,500	\$5,000	\$2,500	\$2,500

ROI measures

Cost of capital for Hollow Fiber Utilization	5%			
Net present value	\$3,463,019			
Return on investment		277%	877%	2165%
Payback (in years)	0.34			

Mammalian Cell MF TFF Process**2,000****Liter Process Scale**

<u>Membrane Type</u>	<u>Cost / Sq. Ft</u>	<u>Ave. Process Flux</u> LMH	<u>Process Time</u> Hr	<u>Area Required</u> sq. ft.	<u>Membrane Cost</u> Total	<u>Process Cost</u> Per Liter
Hollow Fiber						
Spectrum (0.5/0.6mm Lumen)	\$20	80	4	67	\$1,345	\$0.67
Spectrum (1.0mm Lumen)	\$39	55	4	98	\$3,815	\$1.91
Cassette						
Screen Channel	\$93	75	4	72	\$6,671	\$3.34
Suspended Screen / Open Channel	\$148	45	4	120	\$17,694	\$8.85
Disposable Flat Sheet						
"Stacks" MF	\$94	65	4	83	\$7,780	\$3.89
"Stacks" UF	\$75	40	4	135	\$10,088	\$5.04

Mammalian Cell MF TFF Process**10,000****Liter Process Scale**

<u>Membrane Type</u>	<u>Cost / Sq. Ft</u>	<u>Ave. Process Flux</u> LMH	<u>Process Time</u> Hr	<u>Area Required</u> sq. ft.	<u>Membrane Cost</u> Total	<u>Process Cost</u> Per Liter
Hollow Fiber						
Spectrum (0.5/0.6mm Lumen)	\$20	80	4	336	\$6,725	\$0.67
Spectrum (1.0mm Lumen)	\$39	55	4	489	\$19,075	\$1.91
Cassette						
Screen Channel	\$93	75	4	359	\$33,356	\$3.34
Suspended Screen / Open Channel	\$148	45	4	598	\$88,471	\$8.85
Disposable Flat Sheet						
"Stacks" MF	\$94	65	4	414	\$38,902	\$3.89
"Stacks" UF	\$75	40	4	673	\$50,438	\$5.04

Mammalian Cell MF TFF Process**20,000****Liter Process Scale**

<u>Membrane Type</u>	<u>Cost / Sq. Ft</u>	<u>Ave. Process Flux</u> LMH	<u>Process Time</u> Hr	<u>Area Required</u> sq. ft.	<u>Membrane Cost</u> Total	<u>Process Cost</u> Per Liter
Hollow Fiber						
Spectrum (0.5/0.6mm Lumen)	\$20	80	4	673	\$13,450	\$0.67
Spectrum (1.0mm Lumen)	\$39	55	4	978	\$38,149	\$1.91
Cassette						
Screen Channel	\$93	75	4	717	\$66,712	\$3.34
Suspended Screen / Open Channel	\$148	45	4	1196	\$176,942	\$8.85
Disposable Flat Sheet						
"Stacks" MF	\$94	65	4	828	\$77,803	\$3.89
"Stacks" UF	\$75	40	4	1345	\$100,875	\$5.04