Appendix B
Cost Analysis -- Adjusted

FOR DISCUSSION PURPOSES ONLY

A Linear Regression Analysis was done using design flow or the 2002 average yearly flow as the independent variable and the cost as the dependent variable. Actual cost data used for this analysis was obtained from data received from applications for Act 218 grant money to PENNVEST and a survey of systems completed by the Pennsylvania Municipal Authorities Association. Cost data from these two sources was adjusted to 2005 costs using the ENR construction cost indices supplied by the Chesapeake Bay Program.

In addition, cost data for Harrisburg Authority and the Central Williamsport Sanitary Authority were not included in the analysis, due to conditions existing at these two systems that will significantly increase the costs for NRT installation. Finally, the costs for those systems where the NRT technology has already been installed were zeroed out.

Using Design Flow:

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3568605	1202524		2.968	.005
	Design Flow	543554.6	13548.261	.989	40.120	.000

a. Dependent Variable: ENR Adjustment

NRT Cost = 543,554.6 * Design Flow + 3,568,605
Total: **$ 891,474,215**

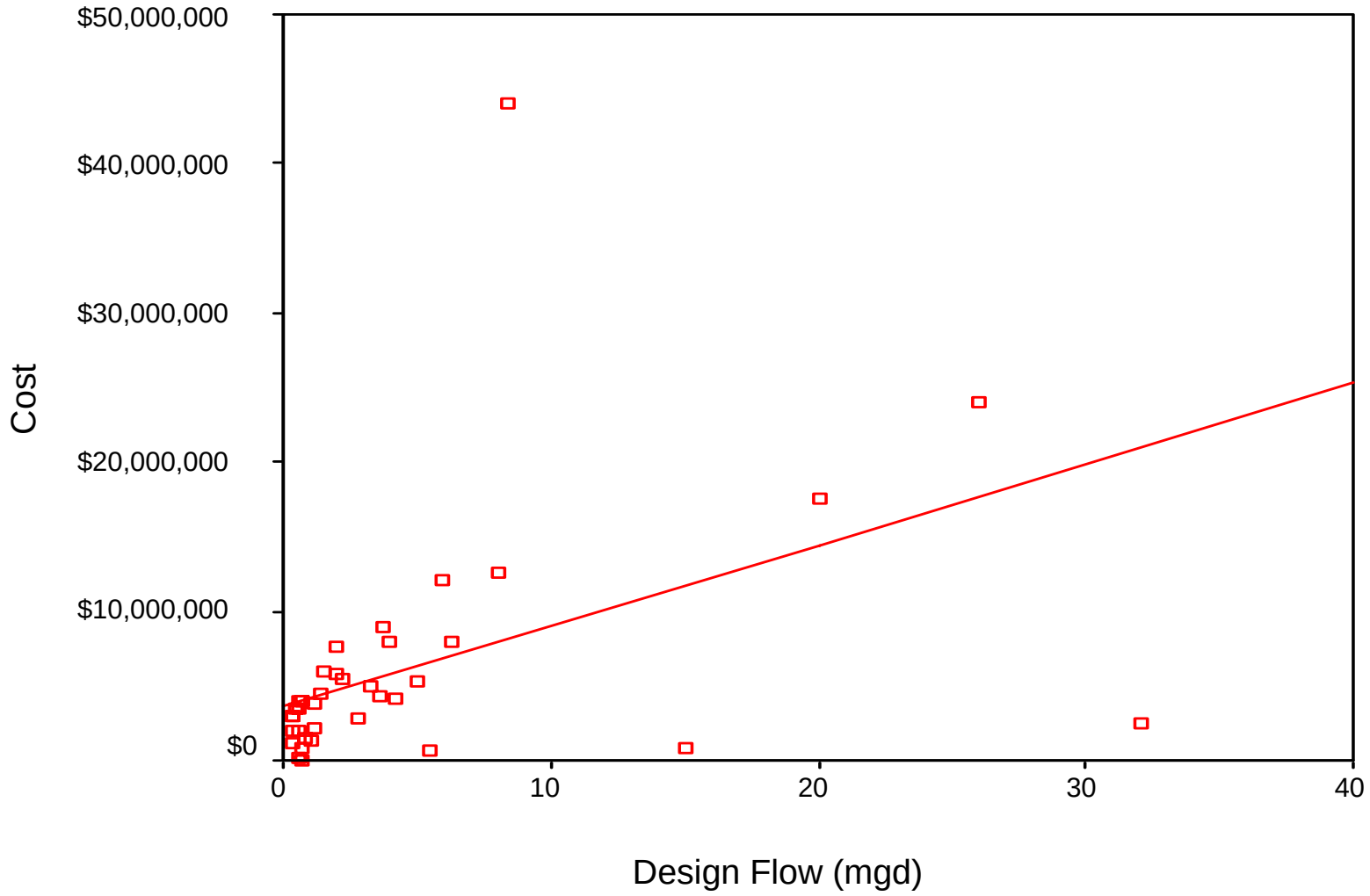
Using 2002 Average Yearly Flow:

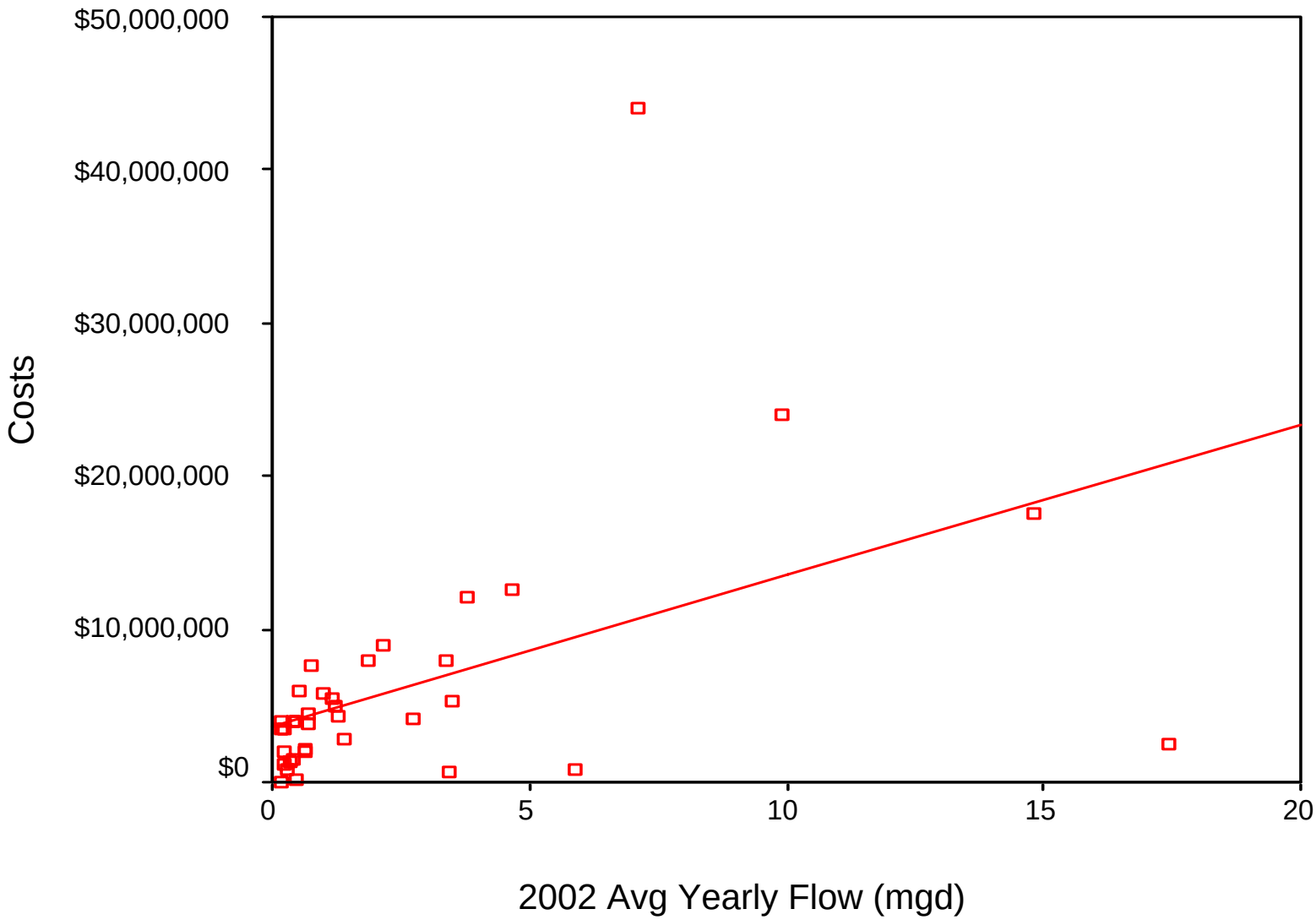
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3638293	1219601		2.983	.005
	2002 Avg Yearly Flow	987070.3	24290.603	.990	40.636	.000

a. Dependent Variable: ENR Adjustment

NRT Cost = 987070.3*2002 Average Yearly Flow + 3,638,293
Total: **$ 905,381,016**


$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
Cost
0
10
20
30
40
Design Flow (mgd)


$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
Costs
0
5
10
15
20
2002 Avg Yearly Flow (mgd)

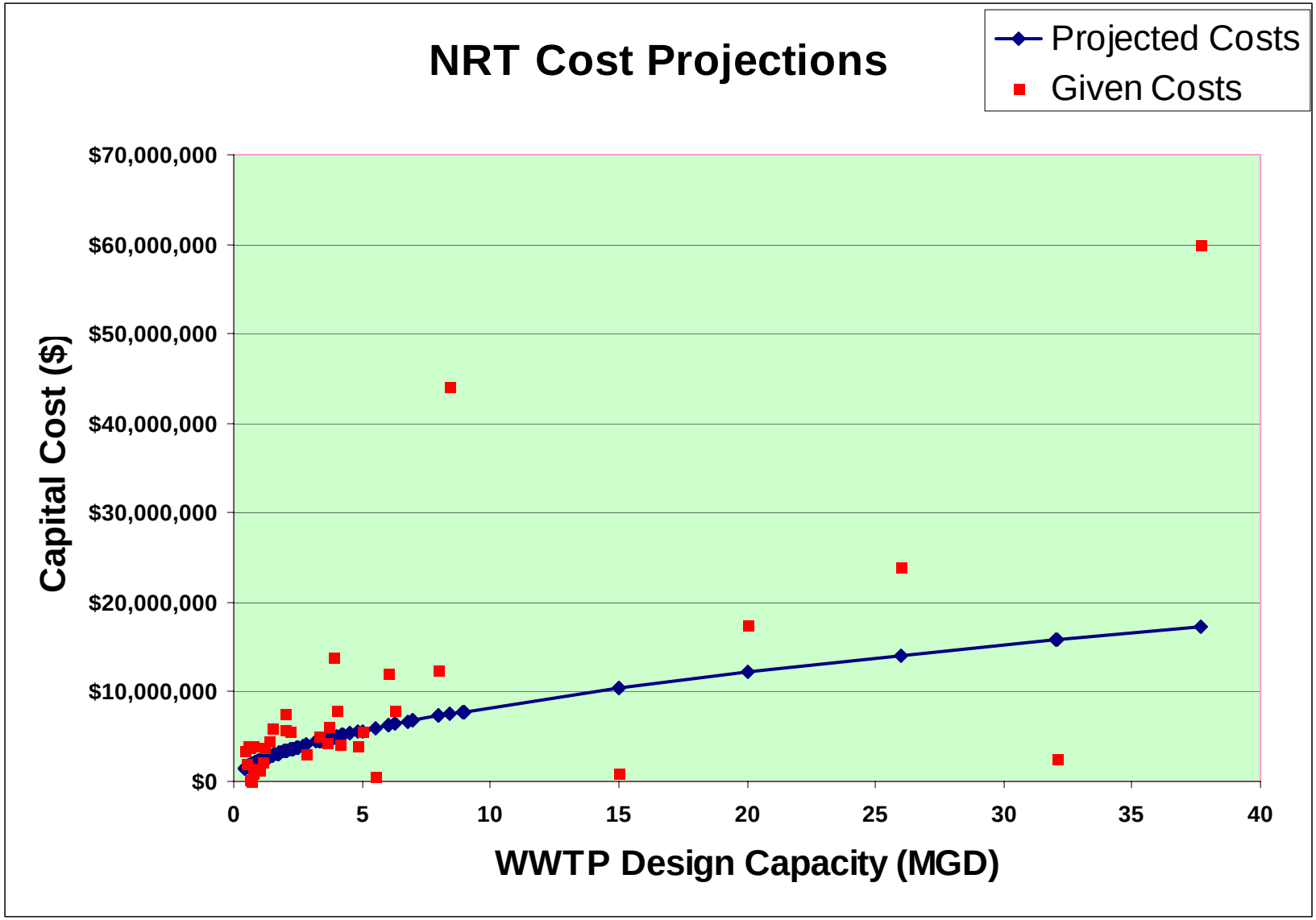
After reviewing the above analysis, it became apparent that this should not be a straight line. When design flow equals zero, the costs must equal zero. In other words, if there is no project, there is no cost, and thus the function must pass through the origin. In addition, the economy of scale would dictate that the slope of the line is steeper for the smaller plants than it would be for the larger plants. That dictates that this line is actually a curve. Another analysis was performed to see what the best-fit curve might be.

The concept of the EPA cost curves was that there is a recognized economy of scale, and this can be documented in a plot of cost versus capacity for various types of processes. The methodology is to plot the logarithm of the cost versus the logarithm of the capacity. The result is a plot of data points that can be analyzed to fit a straight line. If the straight line has a slope less than 1.0, then the “economy of scale” is demonstrated. Based on this analysis, the log-log plot is a straight line, but when it is plotted on a normal scale it does appear as a curve (demonstrating the economy of scale).

The R-squared is not as good as would be preferred, but this is due to several factors:

- Small sample set
- Variety of technologies; some are "BNR ready" like Hanover and LASA; some have trickling filters what are a process liability in removing too much carbon; one has high purity oxygen with short sludge age tanks (Harrisburg), etc. Cost curves will be a tighter fit when comparing similar technology upgrades.- Variety of site space available: a tighter site like Williamsport Central WWTP will have major costs to upgrade.
- Some are going to ENR, although that is a small number

This newer and more complete data set is based on engineering studies or completed designs. It is an improvement over the earlier "desk top" estimates. The estimates will become better over time, but with the data we have now, there is a reasonable total cost figure that we can agree as the "best available estimate" - $620 million. It is also consistent with the experience in Connecticut and Maryland.


NRT Cost Projections
Projected Costs
Given Costs
Capital Cost ($)
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$0
0
5
10
15
20
25
30
35
40
WWTP Design Capacity (MGD)

Other attempts to generate costs curves using statistical analysis packages resulted in a range of values as shown in the table below:

System	Est. Cost (Design)	Estimate 1	Estimate 2	Estimate 3	Estimate 4	Estimate 5
Overall Total cost Estimates	**$ 1,148,689,937**	**$ 882,668,605**	**$ 1,077,917,442**	**$ 691,726,648**	**$ 1,069,265,198**	**$ 854,356,904**
Cost of Phase 4	$257,215,722	$0	$102,423,901	$ 36,083,107	$ 160,906,938	$ 143,671,260
Cost without Phase 4	**$ 891,474,215**	**$ 882,668,605**	**$ 975,493,541**	**$ 655,643,541**	**$ 908,358,260**	**$ 710,685,644**

PMAA, 4/28/06

POTW Cost Estimates for Nutrient Removal

DEP Strategy (8N and 1P at 2010 flow)

Original estimate: 124 plants, total cost: $376M
Updated 2005 estimate: 160 plants, total cost: $190M
Current 2006 estimate: 184 plants, total cost: $190M
(numbers are for municipal plants, does not include industrial dischargers)

PMAA estimates:

PMAA Survey results: 30 responses, total estimated cost: $266M
Average cost per plant: $8.9M, not incl. Harrisburg* at $60M: $7.1M
Average cost per plant: not incl. Hbg $60M, Wmsprt(1) $44M: $5.8M**

CET/Gannett Fleming Engineers Survey result: 10 responses, total estimated cost: $96M
Average cost per plant: $9.6M, not incl. Harrisburg* at $60M: $4M

(PMAA, CET/GF numbers are based on only nutrient reduction upgrades)

Estimated total cost: using average cost of $5M/plant x184 plants: $920M

Pennvest estimates:

Current grant round requests: 24 nutrient reduction projects, total cost: $80M
Average cost per plant: $3.3M ($3.3M x 184 plants: $607M)
Actual projects funded on 3/22/06: 12 for $33.47M
Average cost per plant: $2.7M ($2.7M x 184 plants: $496M)

Maryland (66 plants)

Cost for Phase I (BNR= 8N, 1P): $530M (per plant: $8M)
Cost for Phase II (ENR= 3N, .1P): $800M (per plant: $12M) Total MD cost: $1.3B

Virginia (100 plants)

Cost for nutrient reduction (4N to 6N, depending on location): $1.5Billion (per plant: $15M)

Connecticut (84 plants)

Cost for nutrient reduction in Long Island Sound (4N to 8N, depending on location):
$637M (with possible trading reduction of $200M, cost: $437M)
Cost per plant: at $637M, $7.5M, at $437M, $5.2M

[N-nitrogen, P-phosphorus, M-million, B-billion, BNR-biological nutrient reduction, ENR-enhanced nutrient reduction]
*Harrisburg is largest and most expensive plant to upgrade. Costs not included to portray realistic average for other plants.
**Hbg, and Williamsport Central plant ($104M combined) excluded to portray realistic average for other plants.

PMAA Rev 4-12-06 Preliminary Cost Estimates for 30 WWTPs

Facility	Design Flow (MGD)	Estimated N&P Reduction Cost	DEP Cost In Million Dollars Low	Estimate High	
WWTP A	0.60	$ 3.4 Million	0.25	1	Derry Twp SW
WWTP B	5.00	$ 5.5 Million	0	0	Derry Twp CW
WWTP C	3.30	$ 4 Million			Shippensburg
WWTP D	6.25	$ 8 Million	1	5	Lower Allen Twp
WWTP E	38.00	$ 60 Million	5	35	Harrisburg
WWTP F	5.90	$ 8 Million	1	5	Huntingdon
WWTP G	2.00	$ 2.7 Million	0	0	Eastern Snyder Cty
WWTP H	5.90	$ 0.45 Million			Exeter Twp
WWTP I	0.95	$ 1.43 Million	0	0	Greencastle
WWTP J	4.50	$ 0.58 Million	0.5	1	Hanover
WWTP K	0.75	$ 3 to $ 5 Million	0.5	1	Annville Twp
WWTP L	0.90	$ 0.005 Million	0.25	0.5	Chestnut Ridge
WWTP LL	2.00	$ 7.6 Million	1	1	Columbia Boro
WWTP M	0.75	$ 3.5 to 4.5 Million	1	1	Curwensville
WWTP N	2.30	$ 6 Million	0.5	1	Dillsburg
	3.70	$ 7 to 12 Million	1	1	E. Pennsboro Twp
WWTP O	32.00	$ 2.5 Million	0	0	Lancaster
WWTP OO	8.00	$ 10 - 15 Million	1	5	Lebanon
WWTP P	6.00	$12.1 Million	1	5	Lower Lack Vly SA
	2.20	$ 5.5 Million	1	1	Middletown Boro
WWTP Q	1.40	$ 4.5 Million	0	0	Mifflinburg
	1.00	$ 1.3 Million			Millersburg Auth
WWTP R	4.20	$ 5.2 Million	0	0	Mt Top Area
WWTP S	0.50	$ 3 to 4 Million	0	0	Northern Lanc Cty
		$ 3 Million	1	1	Northeastern York Cty SA
WWTP S 1	20.00	$ 15 - 20 Million	1	5	Scranton
WWTP S 2	0.63	$ 0.83 Million	0.5	1	Stewartstown
	8.40	$ 44.4 Million	1	5	Williamsport Central
	3.90	$ 13.9 Million	0.5	1	Williamsport West
WWTP T	26.00	$ 24 Million	0.5	0.5	York City
Total	212.50	$266 Million	Avge 266/212 = $1.25/gal		

185 "significants" having 530 MGD total design flow x $1.25 = $663 Million total cost projection
OR
$266 Million/30 plants = $8.9 Million per plant x 185 plants = $1.64 Billion
W/o Harrisburg $206 Million/29 plants = $7.1 Million/plant x 185 plants = $ 1.3 Billion
W/o Hbg, Wmpt Central $162 Million/28 plants = $5.8 Million/plant x 185 plants = $ 1.07 Billion