EXHIBIT "18"

COST OF STORM WATER TREATMENT FOR THE LOS ANGELES COUNTY NPDES PERMIT AREA

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COST OF STORM WATER TREATMENT FOR THE LOS ANGELES COUNTY NPDES PERMIT AREA

An analysis was performed to determine the cost of treating storm water runoff in the Los Angeles County watershed. Treatment costs were developed based upon different treatment levels required to meet water quality objectives. The costs in this report were prepared as a basis for a further analysis of the economic impact of storm water treatment on the community. The costs in this report are intended to be used in the economic analysis and will be refined as the economic impact analysis progresses and the data needs are refined.

All costs for treatment were calculated in the same manner as the treatment costs in the *Caltrans Storm Water Facilities Retrofit Evaluation* (1). That report described the evaluation of the costs of treating storm water runoff from Caltrans facilities in the Los Angeles area.

DESIGN STORM CHARACTERISTICS

The design storm selected for this study is the one-year storm for a 24-hour period in most of the Los Angeles area. The selected storm allows the storm water treatment facilities to capture most of the runoff for a normal rainfall year. The capacity will be exceeded only when storms greater than the one-year return frequency are experienced. On a long term, several year basis, the design storm will result in treatment of 80 to 90 percent of the runoff. The storm represents a compromise between the cost of attempting to design for a higher intensity storm and desire to maximize pollutant capture. The one year, 24-hour storm is the minimum rainfall with a statistical probability of reoccurring one or more times per year. Rainfall varies depending on the Los Angeles terrain and averages approximately 1.25 inches for the area included in this study.

Treatment systems in this report are designed to contain all of the flow generated by the design storm, and treat and release this volume within a 24-hour period. Therefore, to calculate the average release rate, the volume of water generated by the design storm in 24-hours is calculated and then divided by 24-hours. A treatment period of 24-hours was chosen rather than a longer treatment period such as 72-hours to permit the collection and treatment of two consecutive storms.

The design storm concept is similar to storm water design assumptions made by flood control agencies within Los Angeles County, California. However, flood control designs use longer return frequency storms and greater quantities of runoff. This approach incorporates input from the Caltrans/UCD/CSUS Oversight Committee provided on the previous Retrofit Evaluation.

SIZE OF DRAINAGE AREA WITHIN LOS ANGELES COUNTY

The entire urban Los Angeles County watershed that drains directly to the Pacific Ocean measures approximately 1,702,404 acres. The area has been divided into seven drainage basins and the areas for each obtained from the Southern California Area Governments (SCAG) GIS Land Use Data Base. The size and descriptive name of each basin is listed below:

Table 1. Los Angeles Drainage Basins

Drainage Basin Description	Drainage Area, acres
Dominguez	69,091
Los Angeles River	522,061
Malibu	98,729
San Gabriel	370,468
Santa Ana (Part)	15,680
Santa Clara	491,947
Santa Monica Bay	134,429
Total	**1,702,404**

STORM WATER RUNOFF

The volume of storm water runoff was developed using a modified coefficient of runoff. The runoff coefficient estimates the percentage of the precipitation that will become runoff based on the land use and the imperviousness associated with each land use. This method is similar to the method described in the *California Storm Water Best Management Handbook, Municipal Volume* (5) The modified runoff coefficient predicts 90 percent of the precipitation will runoff from impervious area and 15 percent from the pervious area as described in the Handbook.. Below is the formula used to calculate the modified runoff coefficient.

$$Runoff\ Coefficient = 0.90 \times (impervious\ fraction) + 0.15 \times (1\text{-}impervious\ fraction)$$

In addition, the first 0.06 inches of precipitation was assumed to pond in localized depressions and not be available as runoff. The runoff coefficients and formula above can be found in Appendix D of the *California Storm Water Best Management Handbook, Municipal Volume*. The imperviousness for each type of land use was assumed to be similar to the values reported by the *Santa Monica Bay Restoration Project* (4). Listed below are assumed imperviousness and land uses:

Table 2. Runoff Coefficients by Land Use

Land Use	Impervious	Runoff Coefficient
Single family residential	42 %	0.46
Multi family residential	68 %	0.66
Commercial	92 %	0.84
Public	80 %	0.75
Industrial	91 %	0.83
Other urban	80 %	0.75
Vacant Developable	0 %	0.15
Open	0 %	0.15
Unknown	65 %	0.63

Based on a land use pattern in Los Angeles County, the runoff coefficient for each drainage basin was determined. In turn, this coefficient is used to determine the amount of storm water runoff as related to precipitation.

Table 3. Runoff Coefficient by Basin

Drainage Basin Description	Runoff Coefficient
Dominguez	0.599
Los Angeles River	0.452
Malibu	0.299
San Gabriel	0.403
Santa Ana	0.423
Santa Clara	0.294
Santa Monica Bay	0.504

DESIGN STORM WATER QUALITY

In addition to the storm water quantity, typical storm water quality is an important consideration in determining the types of appropriate treatment. Design storm water quality values were developed by examining the storm water quality data generated from Los Angeles County monitoring and Caltrans statewide sampling which contained a significant amount of Los Angeles area data. Treatment processes were developed from water quality objectives.

The following table shows the typical water quality objectives for Los Angeles and the range of sampling data for various constituents.

Table 4. Water Quality Objectives and Monitoring Results

CONSTITUENT	WATER QUALITY OBJECTIVES (mg/L or MPN/100 mL)					RAINFALL MONITORING DATA (mg/L or MPN/100mL)		
	1-Hour Toxicity (Aquatic Life)			Municipal	Other	Caltrans Statewide[h] 1997	LA Co. DPW[i] 1/3/95 - 4/17/96	
	Inland[b]	Estuarine	Oceanic[c]	Supply[e]	Use	Range	Min	Max
GENERAL QUALITY								
Total Dis. Solids				500	250	<10-20,000	26	1760
Total Sus. Solids			75%**			<4-1,410	4	8728
Turbidity			225			17-1,300	0.9	1800
Hardness	[b]					11.3-96	10	930
Chloride				250	10	<1.0-52.8	1.98	147
Nitrate-NO_3				45		0.39-42.5	1.03	42.2
Sulfate				500	30	<1-94	2.54	758
Oil & Grease			75		No Film	<0.11-48	1	17.8
Ammonia	25		6			0.5-9.2	0.83	4.47
Coliform, fecal	[d]	[d]	[d]		200[d]	27-160,000	80	16,000,000
Coliform, total	[d]	[d]	[d]		70[d]	80-300,000	340	16,000,000
METALS								
Antimony				0.006		<0.015-0.090	0.007	0.049
Arsenic	0.360	0.069	0.032	0.05		<0.004-0.033	0.011	0.028
Barium				1		<0.001-2.01	0.101	0.723
Cadmium	0.009	0.043	0.004	0.005		<0.003-0.015	0.031	0.048
Chromium III	3.064			33		<0.002-0.102	0.01	0.364
Chromium VI	0.016	1.100	0.008	0.05				
Copper	0.034	0.003	0.012	1.3[g]		<0.01-0.48	0.011	0.639
Lead	0.197	0.140	0.008	0.015[g]		<0.001-0.45	0.01	0.188
Mercury	0.002	0.002	0.0002	0.002		<0.0002-0.21	0.001	0.085
Nickel	2.549	0.075	0.020	0.1		<0.002-0.136	0.01	20
Selenium	0.005	0.300	0.060	0.05		<0.001-0.036	0.01	20
Zinc	0.211	0.095	0.080	5[f]		<0.005-3.88	0.051	0.876

(b) Calculated metals values are based on 200 mg/L hardness (SWRCB 1993).
(c) Oceanic limits are daily maximum allowed (SWRCB 1990).
(d) Based on recreational use for whole-body water contact (REC1).
(e) Based on food consumption limitations (SHELL).
(f) Based on secondary drinking water standards (22 CAC 64449.1; Table 64449-A).
(g) Based on primary drinking water standards (22 CAC 64672.3a-b).
(h) From Caltrans, 1997 Summary of Water Quality Data Associated with Run-Off from Caltrans Highways and Freeways.
(i) From LA Co. DPW, 1997 Summary of Database of Sampling Results obtained from M. Ramos, LA Co. DPW.

* Based on Los Angeles Basin Plan, Table 3-5 (RWQCB 1994), unless otherwise noted.
** Infers a required minimum of 75% solids removal from waste stream.

There are several constituents indicated that would potentially violate the water quality objectives. Treatment systems discussed in this report have been developed to treat storm water to meet the objectives.

The monitoring values were then combined to obtain a typical constituent concentration expected in County of Los Angeles runoff. These water quality values were considered in developing levels of treatment which meet the water quality objectives of the receiving water body. The design storm water quality values in the table below are typical urban runoff in Los Angeles County. The values are the average values from a database of county storm water monitoring from 1988 to 1995.

Table 5. Typical Storm Water Runoff Quality

Constituent	Typical Value, mg/L
Total suspended solids	510
Total dissolved solids	285
Biochemical oxidation demand	50
Nitrate	1.9
Phosphate	0.5
Cadmium	0.001
Copper	0.03
Lead	0.04
Zinc	0.19
Oil & grease	2
Fecal coliform, MPN/100 mL	180,000
Total coliform, MPN/100 mL	750,000

The quality data shows that storm water treatment should address suspended solids, which is basically the dirt picked up during runoff, the high levels of bacteria indicated by the coliform tests and the variable levels of metals. The coliform indicates a high potential for contamination by disease carrying bacteria. Metals requirements are especially difficult because of the large variation in sampling results, the stringent requirements that are both existing and proposed and the high cost of removing small concentrations of metals from large quantities of water.

STORM WATER TREATMENT

Storm water treatment was developed to meet the basic requirements of the *Los Angeles Basin Water Quality Control Plan* (6). Three progressive levels of potential treatment are proposed to meet higher levels of water quality objectives required to preserve potential beneficial uses of receiving waters. Beneficial uses of receiving waters are further discussed in the Basin Plan.

RUNOFF QUANTITY AND TREATMENT FACILITY SIZE

Drainage from each basin within Los Angeles County is based a 24-hour, one-year storm equaling 1.25-inch and the modified runoff coefficient described above. The total runoff from each drainage basin is shown on the following table.

Table 7. Storm Water Runoff by Drainage Area

Drainage Basin Description	Drainage Area, acres	Total Runoff, Million Gallons
Dominguez	69,091	1,337
Upper Los Angeles River	522,061	7,572
Malibu	98,729	956
San Gabriel	370,468	4,774
Santa Ana	15,680	214
Santa Clara	491,947	4,641
Santa Monica Bay	134,429	2,190
Total	1,702,404	21,684

Considering the economy of scale that is evident in the construction of treatment facilities, building numerous small treatment facilities is not as cost effective as the construction of a few large regional treatment plants. Although political or land use requirements may require some smaller facilities, the economics favor larger plants. Therefore, treatment selection, design and cost estimates are based upon the assumption that a few large regional treatment plants will be built. The capacity and number of treatment plants is shown on the following table:

Table 8. Storm Water Treatment Plant Capacity

Location and Description	Size and Number Million Gallons (MG)
Dominguez	
Total Runoff to be Treated, MG	1,337
Number of Treatment Plants Required	27
Los Angeles River	
Total Runoff to be Treated, MG	7,572
Number of Treatment Plants Required	173
Malibu	
Total Runoff to be Treated, MG	956
Number of Treatment Plants Required	20
San Gabriel	
Total Runoff to be Treated, MG	4,774
Number of Treatment Plants Required	107
Santa Ana	
Total Runoff to be Treated, MG	214
Number of Treatment Plants Required	5
Santa Clara	
Total Runoff to be Treated, MG	4,641
Number of Treatment Plants Required	104
Santa Monica Bay	
Total Runoff to be Treated, MG	2,190
Number of Treatment Plants Required	44
Entire Los Angeles Area	
Total Runoff, MG	21,684
Number of Treatment Plants	480

The maximum size of any individual treatment plant is assumed to be 500 million gallons.

ESTIMATED COSTS FOR STORM WATER TREATMENT IN LOS ANGELES

The treatment cost estimate for the entire Los Angeles area was done by preparing composite cost curves to represent relative cost savings for construction of a few large treatment plants versus construction of small treatment plants. The cost curves were developed by using the cost determined from the Van Nuys quadrangle study area contained in *the Caltrans District 7 Storm Water Retrofit Plan (1).*

The total flow within the Los Angeles County drainage area is significantly larger than the flow from the Van Nuys quadrangle study area. There are no existing costs available for large storm water treatment facilities which would be required for the larger drainage area, so it was necessary develop new cost curves based upon the cost curves used in the Van Nuys study area. The new treatment cost curves are intended for estimating the cost of treatment for capacities ranging from 10 to 500 million gallons. As a comparison, to test the accuracy of the new cost curves for Los Angeles County, storm water treatment costs were compared with other similar treatment systems. This comparison was done by using the cost estimating curves developed for the City of San Diego *(San Diego Wastewater Programs Managers Technical Advisory Board San Diego Metropolitan Sewerage System Preliminary Cost Estimating Curves, December 8, 1988)* (8). All costs estimate are based upon an ENR Index of 6710 (7).

The costs of the treatment facilities were developed from representative designs and then scaled up for the watershed. Simplifying assumptions were made that part time staff would be available during storm events by drawing municipal labor forces, means for disposal of residual solids would be available through municipal landfills and wastewater plants, and the large land needs for the sites could be accomplished through purchase. These simplifying assumptions may lead to lower costs than would be possible for a large scale treatment project but should not compromise cost estimate for undertaking a storm water treatment program. These are planning level costs and the accuracy is reflective of the preliminary nature of the designs and the general assumptions made. Shown in the table below are capital and operation and maintenance (O & M) costs for each drainage basin within Los Angeles County. Costs were prepared which include and exclude collection costs.

Separate costs estimates were prepared including and excluding collection costs. This was done because of an uncertainty in the locations of large treatment plants proposed.

Costs without collection represent a system where large treatment plants are located at the downstream discharge of major drainage areas. The existing conveyance system is used to bring storm water to the treatment locations. Some of the conveyance systems are actually local channels and waterways that will not receive the benefits of treatment.

Costs with collection represent an effort to parallel important tributary streams and channels with collection systems to protect them from storm water pollution. The parallel collection systems would divert flow to the treatment locations. Obviously, building parallel storm water collection systems is expensive.

Table 9. Treatment Costs by Drainage Area

Dominguez	Cost without Collection, ($1,000,000)	Cost with Collection, ($1,000,000)
Capital Costs		
Collection System		$628
Level 1	$1,234	$1,861
Level 2	$1,950	$2,578
Level 3	$3,643	$4,271
O & M Costs		
Collection System		$0.5
Level 1	$3.5	$4.0
Level 2	$6.4	$7.0
Level 3	$11.4	$11.9
Los Angeles	**Cost without Collection, ($1,000,000)**	**Cost with Collection, ($1,000,000)**
Capital Costs		
Collection System		$4,098
Level 1	$7,386	$11,484
Level 2	$11,679	$15,777
Level 3	$21,810	$25,908
O & M Costs		
Collection System		$3.5
Level 1	$20.3	$23.8
Level 2	$37.9	$41.4
Level 3	$67.6	$71.1
Malibu	**Cost without Collection, ($1,000,000)**	**Cost with Collection, ($1,000,000)**
Capital Costs		
Collection System		$634
Level 1	$894	$1,529
Level 2	$1,414	$2,048
Level 3	$2,641	$3,276
O & M Costs		
Collection System		$0.5
Level 1	$2.5	$3.0
Level 2	$4.7	$5.2
Level 3	$8.3	$8.8

San Gabriel	Cost without Collection, ($1,000,000)	Cost with Collection, ($1,000,000)
Capital Costs		
Collection System		$2,755
Level 1	$4,441	$7,166
Level 2	$6,975	$9,730
Level 3	$13,028	$15,783
O & M Costs		
Collection System		$2.3
Level 1	$12.4	$14.8
Level 2	$23.0	$25.3
Level 3	$40.8	$43.1
Santa Ana	**Cost without Collection, ($1,000,000)**	**Cost with Collection, ($1,000,000)**
Capital Costs		
Collection System		$120
Level 1	$210	$329
Level 2	$331	$ 450
Level 3	$619	$739
O & M Costs		
Collection System		$0.1
Level 1	$0.6	$0.7
Level 2	$1.1	$1.2
Level 3	$1.9	$2.0
Santa Clara	**Cost without Collection, ($1,000,000)**	**Cost with Collection, ($1,000,000)**
Capital Costs		
Collection System		$3,130
Level 1	$4,301	$7,431
Level 2	$6,801	$9,931
Level 3	$12,703	$15,833
O & M Costs		
Collection System		$2.6
Level 1	$12.1	$14.7
Level 2	$22.5	$25.1
Level 3	$39.8	$42.4

Santa Monica Bay	Cost without Collection, ($1,000,000)	Cost with Collection, ($1,000,000)
Capital Costs		
Collection System		$1,121
Level 1	$2,017	$3,138
Level 2	$3,189	$4,310
Level 3	$5,956	$7,077
O & M Costs		
Collection System		$0.9
Level 1	$5.7	$6.6
Level 2	$10.5	$11.5
Level 3	$18.7	$19.6
Entire Los Angeles Area	**Cost without, Collection, ($1,000,000)**	**Cost with Collection, ($1,000,000)**
Capital Costs		
Collection System		$12,500
Level 1	$20,400	$32,900
Level 2	$32,300	$44,800
Level 3	$60,400	$72,900
O & M Costs		
Collection System		$10.4
Level 1	$57.2	$67.6
Level 2	$106.3	$116.7
Level 3	$188.5	$198.9

The construction and land purchase was assumed to take place at the beginning of the project in year one and the annual cost was assumed to stay constant over the life of the project. All costs are based upon the 1998 calendar year. The capital costs for the project levels include 100 acres for each 500 million gallon level 1 treatment facility at an average cost of approximately $900,000 per acre. The level 2, 500 million gallon facility includes an additional 100 acres at the same unit cost. Level 3 is assumed to not require additional land. Land use for smaller treatment plants is assumed to be proportional to capacity.

The background for the cost estimates is included in the attachments. Attachment 1 is the design basis for a typical 500 million gallon facility and includes a schematic layout. Attachment 2 is the design basis for a typical 200 million gallon facility. Attachment 3 includes the standardized cost estimation curves for storm water treatment facilities. Attachment 4 includes the standardized cost estimation curves for wastewater treatment facilities to 10 million gallons.

DISCUSSION

The cost estimates developed in this analysis include several assumptions needed to build the capital cost estimates and develop the operating and maintenance costs. Historical data for the costs is based on municipal utility construction projects which have not been developed specifically for storm water treatment. The assumptions and general municipal background of the estimates result in costs that are potentially low for the storm water treatment project. Potential concerns are:

- Storm facilities will be operated intermittently and seasonally. Treatment levels 2 and 3 require operators skilled in treatment equipment; however, they are only needed for storm events. The availability of these operators is difficult to arrange since they would have to have other more full time positions within the managing municipality or utility. The cost of labor would be higher because of inefficiencies. Level 1 also requires intermittent operation but it may be able to be contracted out to the private construction industry.

- Power costs are relatively more expensive on an intermittent basis and the utility's cost of supplying the seasonal loads imposed by pumps and the equipment in levels 2 and 3 will have to recovered in higher per energy unit costs. Chemical costs will also be higher do to seasonal purchasing needs and the need to not store some chemicals, such as chlorine, during the dry season. There are also risks with chemical storage and delivery in residential and commercial neighborhoods that must be mitigated.

- Land costs have been assumed to represent an average cost in the Los Angeles area. However, a storm water treatment project would need to acquire large tracts of contiguous land to build the facilities. No matter how much community support there is for clean water, residents always want the facilities somewhere away from their property and certainly do not want their land taken. Acquisition of the necessary land would be difficult and expensive. More numerous smaller facilities would increase the number of impacted communities and residents. The treatment units simply cannot be built without land and there is not much available land in metropolitan Los Angeles.

- As indicated in the cost analysis, the protection of the drainage channels and natural waterways that are currently used to convey storm water from storm water pollutants would either require a vast number of small treatment units at every discharge or a parallel collection system for the design storm. The numerous facilities sacrifice the economy of scale found in larger units and the alternative parallel collection system is very expensive. Decisions would have to be made as to where parallel systems were needed based on the streams to be protected.

- The analysis assumes conventional costs for the removal of residual products such as solids and brine. Again they would be seasonal and would require the additional costs of setting up disposal procedures for only seasonal use. In addition there may be the potential requirements for the disposal of hazardous waste.

Although the costs may be conservatively low, they are relatively large. The following table summarizes the Los Angeles area costs with a limited amount of collection facilities.

SUMMARY

Capital Costs

Level 1 - Detention and settling including limited collection	33 billion dollars
Level 2 - Filtration and disinfection in addition to Level 1	45 billion dollars
Level 3 - Advanced treatment for toxics in addition to Level 2	73 billion dollars

Land Required

9,300 to 18,600 acres depending on treatment level

Operating and Maintenance Costs

Level 1 - Detention and settling including limited collection	68 million dollars per year
Level 2 - Filtration and disinfection in addition to Level 1	117 million dollars per year
Level 3 - Advanced treatment for toxics in addition to Level 2	199 million dollars per year

REFERENCES

1. Storm Water Facilities Retrofit Evaluation, Volume 1 & 2, May 13, 1997, Draft Report. Brown and Caldwell.

2. An Economic Valuation of Stormwater Quality Improvements for Ballona Creek, California, May 1997. Final Report. Center for Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, University of California, Davis. Ms. Orit Wilchfort, Prof. Jay R. Lund, Mr. Dan Lew, Prof. Douglas M. Larson.

3. NPDES No. CA0061654. Waste Discharge Requirements Stormwater / Urban Runoff Discharge for Los Angeles County and Co-Permittees. California Regional Water Quality Control Board, Los Angeles Region.

4. Assessment of Storm Drain Sources of Contaminants to Santa Monica Bay, Volume I Annual Pollutants Loading Santa Monica Bay Restoration Project, May 1993.

5. California Storm Water Best Management Handbooks, Municipal. California Stormwater Quality Task Force, March 1993.

6. Water Quality Control Plan – Los Angeles Region – Watersheds of Los Angeles and Ventura Counties, June 13, 1994. California Regional Water Quality Control Board, Los Angeles Region.

7. Engineering News Record – First Quarterly Cost Report. March 30, 1998. McGraw Hill.

8. San Diego Wastewater Programs Managers Technical Advisory Board San Diego Metropolitan Sewerage System Preliminary Cost Estimating Curves, December 8, 1988. City of San Diego, California. James M. Montgomery and Brown and Caldwell.

ATTACHMENT 1

DESIGN BASIS FOR A TYPICAL 500 MILLION GALLON FACILITY

Definitions and Abbreviations Contained in Cost Estimates:

LF – Linear feet
INCH – Inches of rainfall
MGD / mgd – Million gallons per day
LS – Lump sum
SF – Square feet
MG – Million gallons
AC – Acres
gpm – Gallons per minute
CFS / cfs – Cubic feet per second
RO – Reverse osmosis
ft. - Feet
kWh – Kilowatt per hour
MWh – Megawatt per hour
fps – Feet per second
mg/L – Milligram per liter
O & M – Operation and maintenance
sq. – square
mi – miles
Quad – Quadrangle

500 MG Treatment Plant

LOS ANGELES COUNTY SITE SPECIFIC DESIGN PARAMETERS		
ITEM	**VALUE**	**COMMENTS**
Site Details		
Type : Typical 500 MG Plant		
Name : Prototype 500 MG Plant		Exact location of treatment plant is unknown.
Address : Los Angeles County		
Existing Storm Drain Facilities :Use existing Los Angeles County Collection System		
Site Specifications		
Drainage Area		
Acres	38,400	
Square Feet	1,672,704,000	
Approximate Percent Impervious	48%	Estimated - refer to design write-up
Weighted runoff coefficient	0.51	((%Impervious)*0.90)+((1-(%IMP))*0.15) Assumed 90% runoff from impervious surfaces and 15% runoff from pervious surfaces.
Rainfall Details		
Total Rainfall		
One year, 24 hour Storm, inches	1.00	Derived from 50 years of rainfall data. Typical for Greater Los Angeles area.

500 MG Treatment Plant

ITEM	VALUE	COMMENTS
Stormwater Runoff Volume		Assumed 0.06 inches of rain loss due to local ponding
Cubic Feet	66,825,000	
Million Gallons	500	
Peak Rainfall Intensity		
inches/hour	1.41	
Peak Flow		Rational Formula Q = C*I*A (Runoff coeff*Peak rainfall intensity*Drainage area) from Caltrans Hydraulics Design Manual
Cubic feet per second (cfs)	13,000	
Million gallons per day (mgd)	8,400	Assume a 50% reduction in peak flow because of delay in intensity due to size of drainage area.
Treatment Plant Site Details		
Site Characteristics		
Acres	201	Size required to fit treatment units.
Percentage of land used for treatment versus drainage area	0.52%	
Approximate shape of site	rectangular	Shape - triangle, rectangle etc.
Length of site, ft.	2500	
Width of site, ft.	3500	
Approximate Slope of Site Terrain	Level	

500 MG Treatment Plant

ITEM	VALUE	COMMENTS
Existing Land Use	Unkown	
Existing Owner	Unknown	
Distance from Collection Point to Treatment Plant Site, ft.	1,500	Assumes construction next to existing river.
Treatment Process		
Level 1		Bar Screens plus detention basins
Level 2		Gravity filtration with disinfection
Level 3		Advanced treatment, with Reverse Osmosis
Design Criteria		
Collection system inlet pipe, rectangular		
Width, ft.	20.0	
Height, ft.	20.0	
Number of inlet pipes	4	
Capacity, cfs	16,000	Capacity based upon 10 fps max. flow
Velocity, fps	8.1	
Bar Screens	2-inch spacing	Screens located at enterance to detention basin pumping station inlets

R0006153

500 MG Treatment Plant

ITEM	VALUE	COMMENTS
Detention Basin		
Minimum volume in gallons	499,851,000	Assume vertical walls for detention basin
Number of required detention basins	4	Ingnore capacity of sloped basin sides
Length of detention basin (ft)	2,400	Includes 1.5' freeboard.
Width of detention basin (ft)	300	
Depth of detention basin (ft)	25	
Actual capacity of detention basin, gallons	506,314,000	
Capacity, cubic feet per sec	67,680,000	Calculated based on detention basin dimensions
Time to Drain Detention Basin		
Hours (All levels)	24	
Pump Rate		
Gallons per minute (gpm)	347,119	Runoff Volume (gal.)/hr. det./ 60 min.
Million gallons per day (mgd)	500	
Capacity, (cfs)	773	
Number of pumping stations	4	Provide one pumping station per detention basin
Capacity of pump stations, gpm	86,780	
Capacity of pump stations, cfs	193	
Level 2 and 3 Treatment Plant Avg. Capacity, mgd	500	
Max surface loading, @ 7200 gpd/sf (5 gpm/sf)		
Required filter size, square feet	69,424	

R0006154

500 MG Treatment Plant

ITEM	VALUE	COMMENTS
Rectangular filters		
Filter size, ft./ ft.	63	
Number of filters, including two back-up filter	20	
Width of filter, ft.	55	
Length of filter, ft.	72	
Filter surface area per filter, square feet	3960	
Total filter surface area, square feet	71,280	
Wash Water Volume		
Backwash time, minutes/cycle	20	Use two tanks for redundancy
Backwash rate, gpm/sf	25	
Minimum volume, gallons	1,980,000	
Tank diameter, ft.	110	
Tank, height. ft.	32	
Actual tank capacity, gallons	2,274,647	
Number of tanks	2	
Total backwash water capacity, gallons	4,549,294	
Disinfection		
Hypochlorite criteria		
Hypochlorite concentration, percent	6%	Alternatively, chlorine gas might be used
Hypochlorite available Cl2, pounds/gal	0.5	
Chlorine dosage rate, mg/L	30	
Feed rate, gallons per day (gpd)	250,125	
Feed rate, gallons per minute (gpm)	174	

500 MG Treatment Plant

ITEM	VALUE	COMMENTS
Hypochlorite tank capacity		
Number of design storms	3	
Hypochlorite tank capacity, gallons	750,376	
Actual tank capacity, gallons	800,000	
Volume of Contact Tank		
Contact detention time, minutes	60	
Volume of contact tank, gallons	27,125	
Length of tank, feet.	720	
Width of tank	360	
Depth of tank, feet	12	
Actual volume of tank, gallons	23,268,902	
Dechlorination		
Sodium Bisulfite criteria		
Sodium Bisulfite available SO, pounds/gal	2.5	
Sodium Bisulfite rate, mg/L	15	
Feed rate, gallons per day (gpd)	25,013	
Sodium Bisulfite tank capacity		
Storage capacity, number of design storms	3	
Hypochlorite tank capacity	75,038	
Actual tank capacity, gallons	80,000	
Reverse Osmosis		Provide building.
Req. capacity of RO units, gpm	260,339	50% bypass around filters
Number of RO units	135	Provide 5 additional RO units for backwash
Capacity of individual RO units, gpm	2,000	

500 MG Treatment Plant

ITEM	VALUE	COMMENTS
Capacity of RO treatment system, gpm	260,000	
Power requirements for RO units, kWh	93,722	6 kWh per 1000 gal. (Water Treatment Design, Robert L. Sanks)
Plant's total power requirements, MWh	103	Assume 10% higher than RO unit
Brine Storage Basin		
Minimum Volume, gallons	10,152,000	Storage for 3 storm events at 5% per storm
Minimum Volume, cubic feet	1,357,038	
Storage Basin , length, ft.	1,000.0	
Storage Basin , length, ft.	400.0	
Tank depth, feet	3.5	Annual evaporation rate, 42-inches per year. Remaining water will be discharged to sewer
Actual Tank Capacity, cubic feet	1,400,000	
Length of final effluent discharge pipe, feet	1,000	Effluent discharge to River
Dimensions of outlet pipe, rectangular	12.0	
Number of outlet pipes	1	
Width of outlet pipe, ft.	10	
Height of outlet pipe, ft.	10	
Velocity in outlet pipe, fps	8	Maximum velocity, 10 fps

CALTRANS FACILITY COST SPREAD SHEET

ITEM	QUANTITY	UNIT	UNIT PRICE $	TOTAL COST $	ANNUAL OPERATION AND MAINTENANCE COST				
					LABOR $	POWER $	CHEMICALS $	MATERIALS $	TOTAL $
Level I Treatment									
Existing River bypass structure (inflatable dam)	1	LS		$100,000	$1,000				$1,000
Gravity to detention basin 4 (20' x 20')	1500	LF	3,000	4,500,000	$45,000				$45,000
Treatment plant discharge piping									
Discharge piping	1000	LF	1,000	1,000,000					
Level I Detention Basin / Pump Station									
Detention Basin and Pump Station	500	MG	360,000	179,968,511	1,799,685	2,841	17,049		$1,819,575
Pump Operation	500	mgd			461,735	29,979		115,434	$607,148
Level I Site Work									
Paving	15,000	SF	$1.50	$22,500					
Maintenance and storage building	2,500	SF	$100	$250,000	50,000	12,500	$5,000		$67,500
Land / easements	100	AC	$914,760	91,476,000					
Outside piping			5%	8,998,426					
Subtotal				286,315,437					
Level I Miscellaneous									
Construction Contingency			30%	85,894,631					
Subtotal				372,210,068					
Engineering/Legal/Administrative			20%	74,442,014					
Level I Total				446,652,081					$2,540,224

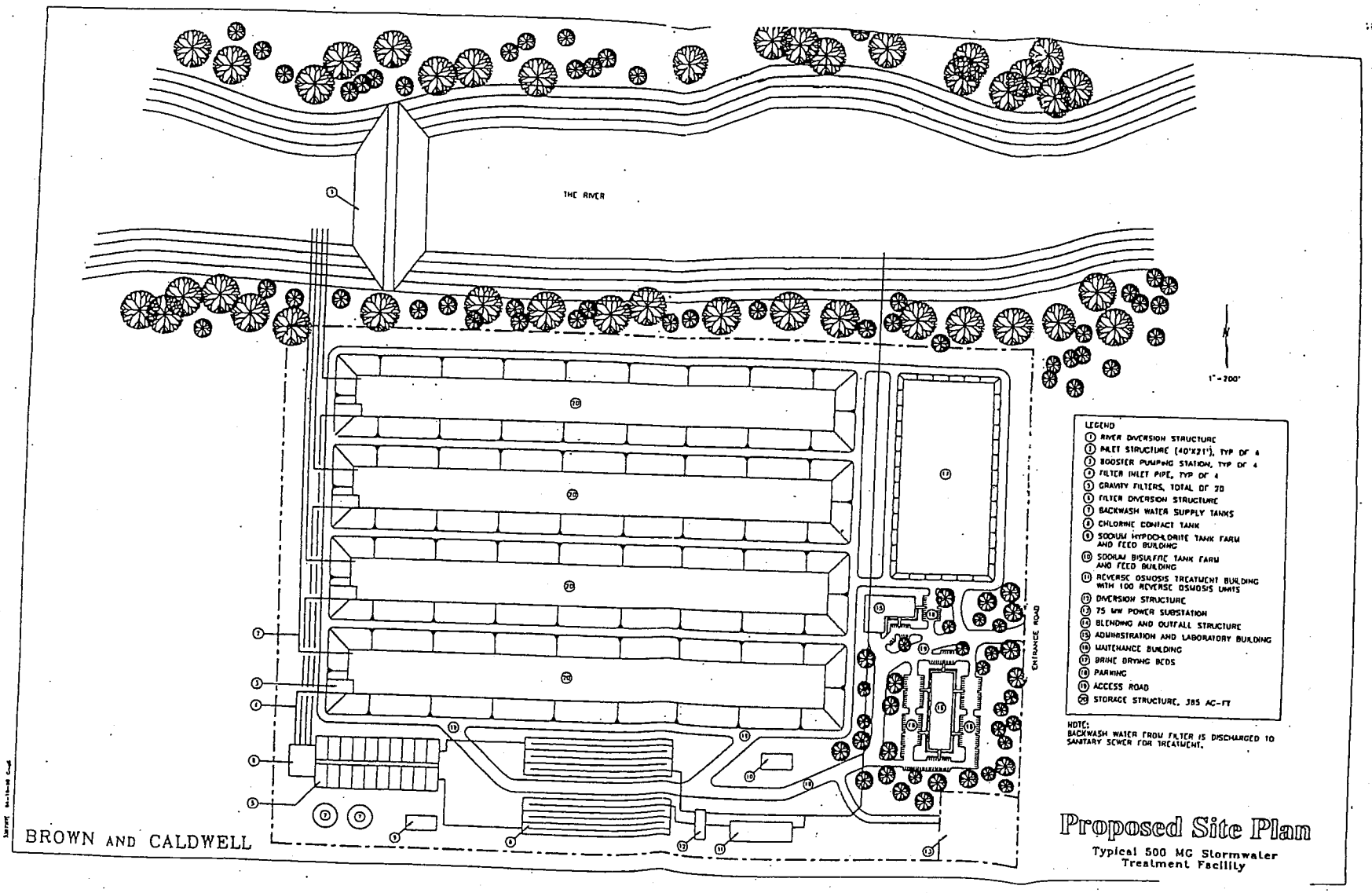
CALTRANS FACILITY COST SPREAD SHEET

ITEM	QUANTITY	UNIT	UNIT PRICE $	TOTAL COST $	ANNUAL OPERATION AND MAINTENANCE COST				
					LABOR $	POWER $	CHEMICALS $	MATERIALS $	TOTAL $
Level 3 - Pressure Filtration									
Filter	500	MG	13,000	$165,474,461	$1,654,745	$74,987		$827,372	$2,557,104
Level 3 - Disinfection and Dechlorination									
Disinfection and dechlorination	500	MG	3,500	$1,819,188			$172,608		$172,608
Level 3 - [illegible]									
Paving	25,000	SF	$1.50	$37,500					
Building	6,000	SF	$100	$600,000					
Outside piping			5%	$8,364,682					
Subtotal				176,295,831					
Level 3 - miscellaneous									
Construction Contingency			30%	$52,888,749					
Subtotal				$229,184,581					
Engineering / legal / administrative			20%	$45,836,916					
Subtotal				$275,021,497					
Land / easements	100	AC	$914,760	$91,476,000					
Level 2 Total				$366,497,497					$2,729,712

CALTRANS FACILITY COST SPREAD SHEET

ITEM	QUANTITY	UNIT	UNIT PRICE $	TOTAL COST $	ANNUAL OPERATION AND MAINTENANCE COST				
					LABOR $	POWER $	CHEMICALS $	MATERIALS $	TOTAL $
Level 3 – Advanced Treatment, Reverse Osmosis									
Reverse osmosis (power costs assumes 15 storm a year)	375	MG	$1,500,000	$562,500,000	$2,812,500	$2,969,480	$21,825	$1,406,250	$7,210,055
Level 3 – site work									
Paving	25,000	SF	$1.50	$37,500					
Building	200,000	SF	$100	$20,000,000					
Outside piping			5%	$29,126,875					
Subtotal				$611,664,375					
Level 3 – [illegible]									
Construction Contingency			30%	$183,499,313					
Subtotal				$795,163,688					
Engineering / legal / administrative			20%	$159,032,738					
Subtotal				$954,196,425					
Land / easements				none					
Level 3 – Total				$954,196,425					$7,210,055

R0006160


THE RIVER
ENTRANCE ROAD
1" = 200'
LEGEND
1 RIVER DIVERSION STRUCTURE
2 INLET STRUCTURE (40'X21'), TYP OF 4
3 BOOSTER PUMPING STATION, TYP OF 4
4 FILTER INLET PIPE, TYP OF 4
5 GRAVITY FILTERS, TOTAL OF 20
6 FILTER DIVERSION STRUCTURE
7 BACKWASH WATER SUPPLY TANKS
8 CHLORINE CONTACT TANK
9 SODIUM HYPOCHLORITE TANK FARM AND FEED BUILDING
10 SODIUM BISULFITE TANK FARM AND FEED BUILDING
11 REVERSE OSMOSIS TREATMENT BUILDING WITH 100 REVERSE OSMOSIS UNITS
12 DIVERSION STRUCTURE
13 75 MW POWER SUBSTATION
14 BLENDING AND OUTFALL STRUCTURE
15 ADMINISTRATION AND LABORATORY BUILDING
16 MAINTENANCE BUILDING
17 BRINE DRYING BEDS
18 PARKING
19 ACCESS ROAD
20 STORAGE STRUCTURE, 385 AC-FT
NOTE:
BACKWASH WATER FROM FILTER IS DISCHARGED TO SANITARY SEWER FOR TREATMENT.
BROWN AND CALDWELL
Proposed Site Plan
Typical 500 MG Stormwater Treatment Facility

R0006161

ATTACHMENT 2

DESIGN BASIS FOR A TYPICAL 200 MILLION GALLON FACILITY

LOS ANGELES COUNTY SITE SPECIFIC DESIGN PARAMETERS		
ITEM	**VALUE**	**COMMENTS**
Site Details		
Type : Typical 200 MG Plant		
Name : Prototype 200 MG Plant		Exact location of treatment plant is unknown.
Address : Los Angeles County		
Existing Storm Drain Facilities :Use existing Los Angeles County Collection System		
Site Specifications		
Drainage Area		
Acres	15,400	
Square Feet	670,824,000	
Approximate Percent Impervious	48%	Estimated - refer to design write-up
Weighted runoff coefficient	0.51	((%Impervious)*0.90)+((1-(%IMP))*0.15) Assumed 90% runoff from impervious surfaces and 15% runoff from pervious surfaces.
Rainfall Details		
Total Rainfall		
One year, 24 hour Storm, inches	1.00	Derived from 50 years of rainfall data. Typical for Greater Los Angeles area.

200 MG Treatment Plant

ITEM	VALUE	COMMENTS
Stormwater Runoff Volume		
Cubic Feet	26,799,000	Assumed 0.06 inches of rain loss due to local ponding
Million Gallons	200	
Peak Rainfall Intensity		
inches/hour	1.40	Refer to Appendix-C of 6/17/96 Summary of Task 2
Peak Flow		
Cubic feet per second (cfs)	5,200	Rational Formula Q = C*I*A (Runoff coeff*Peak rainfall intensity*Drainage area) from Caltrans Hydraulics Design Manual
Million gallons per day (mgd)	3,400	Assume a 50% reduction in peak flow because of delay in intensity due to size of drainage area.
Treatment Plant Site Details		
Site Characteristics		
Acres	72	Size required to fit treatment units.
Percentage of land used for treatment versus drainage area	0.47%	
Approximate shape of site	rectangular	Shape - triangle, rectangle etc.
Length of site, ft.	1500	
Width of site, ft.	2100	
Approximate Slope of Site Terrain	Level	

200 MG Treatment Plant

ITEM	VALUE	COMMENTS
Existing Land Use	Unknown	
Existing Owner	Unknown	
Distance from Collection Point to Treatment Plant Site, ft.	1,500	Assumes construction next to existing river.
Treatment Processes		
Level 1		Bar Screens plus detention basins
Level 2		Gravity filtration with disinfection
Level 3		Advanced treatment, with Reverse Osmosis
Design Criteria		
Collection system inlet pipe, rectangular		
Width, ft.	15.0	
Height, ft.	10.0	
Number of inlet pipes	4	
Capacity, cfs	6,000	Capacity based upon 10 fps max. flow
Velocity, fps	8.7	
Bar Screens	2-inch spacing	Screens located at enterance to detention basin pumping station inlets

200 MG Treatment Plant

ITEM	VALUE	COMMENTS
Detention Basin		
Minimum volume in gallons	200,457,000	Assume vertical walls for detention basin
Number of required detention basins	4	Ingnore capacity of sloped basin sides
Length of detention basin (ft)	1,200	Includes 1.5' freeboard.
Width of detention basin (ft)	240	
Depth of detention basin (ft)	25	
Actual capacity of detention basin, gallons	202,526,000	
Capacity, cubic feet per sec	27,072,000	Calculated based on detention basin dimensions
Time to Drain Detention Basin		
Hours (All levels)	24	
Pump Rate		
Gallons per minute (gpm)	139,206	Runoff Volume (gal.)/hr. det./ 60 min.
Million gallons per day (mgd)	200	
Capacity, (cfs)	310	
Number of pumping stations	4	Provide one pumping station per detention basin
Capacity of each pump stations, gpm	34,802	
Capacity of pump stations, cfs	77.5	
Level 2 and 3 Treatment Plant Avg. Capacity, mgd	200	
Max surface loading, @ 7200 gpd/sf (5 gpm/sf)		
Required filter size, square feet	27,800	

200 MG Treatment Plant

ITEM	VALUE	COMMENTS
Rectangular filters		
Number of filters, including two back-up filter	20	
Width of filter, ft.	40	
Length of filter, ft.	40	
Filter surface area per filter, square feet	1,600	
Total filter surface area, square feet	28,800	
Wash Water Volume		
Backwash time, minutes/cycle	20	Use two tanks for redundancy
Backwash rate, gpm/sf	25	
Minimum volume, gallons	800,000	
Tank diameter, ft.	92	
Tank, height. ft.	24	
Actual tank capacity, gallons	1,193,300	
Number of tanks	2	
Total backwash water capacity, gallons	2,386,600	
Disinfection		
Hypochlorite criteria		
Hypochlorite concentration, percent	6%	Alternatively, chlorine gas might be used
Hypochlorite available Cl2, pounds/gal	0.5	
Chlorine dosage rate, mg/L	30	
Feed rate, gallons per day (gpd)	100,309	
Feed rate, gallons per minute (gpm)	70	

200 MG Treatment Plant

ITEM	VALUE	COMMENTS
Hypochlorite tank capacity		
Number of design storms	3	
Hypochlorite tank capacity, gallons	300,926	
Actual tank capacity, gallons	325,000	Mulitple tanks will be used
Volume of Contact Tank		
Contact detention time, minutes	60	
Volume of contact tank, gallons	8,352,375	
Length of tank, feet.	460	
Width of tank	205	
Depth of tank, feet	12.0	
Actual volume of tank, gallons	8,465,500	
Dechlorination		
Sodium Bisulfite criteria		
Sodium Bisulfite available SO, pounds/gal	2.5	
Sodium Bisulfite rate, mg/L	15	
Feed rate, gallons per day (gpd)	10,031	
Sodium Bisulfite tank capacity		
Storage capacity, number of design storms	3	
Hypochlorite tank capacity	30,093	
Actual tank capacity, gallons	35,000	Multiple tanks used
Reverse Osmosis		Provide building.
Req. capacity of RO units, gpd	150,342,750	25% bypass around filters
Capacity of RO units (racks), gpd	1,000,000	Unit capacity 1,000,000 gpd

200 MG Treatment Plant

ITEM	VALUE	COMMENTS
Capacity of RO treatment system, gpd	150,000,000	Unit are 40' in length, 1.5' in dia. Each
Number of RO units	170	Allow 20 for backwashing
Building size for RO units, sq. ft.	85,000	Each unit with access area 500 sq. ft.
Power requirements for RO units, kWh	37,586	6 kWh per 1000 gal. (Water Treatment Design, Robert L. Sanks)
Plant's total power requirements, MWh	41.3	Assume 10% higher than RO unit
Brine Storage Basin (Water not Recovered by RO)		
Minimum Volume, gallons	5,414,400	Storage for 1 storm event at 20% per storm
Minimum Volume, cubic feet	723,754*	
Storage Basin , length, ft.	500.0	
Storage Basin , length, ft.	420.0	
Tank depth, feet	3.5	Annual evaporation rate, 42-inches per year. Remaining water will be discharged to sewer
Actual Tank Capacity, cubic feet	735,000	
Length of final effluent discharge pipe, feet	1,000	Effluent discharge to River
Number of outlet pipes	1	
Diameter of pipe, ft.	8.0	Use circular pipe

PROTOTYPE 200 MGD TREATMENT PLANT

ITEM	QUANTITY	UNIT	UNIT PRICE $	TOTAL COST $	ANNUAL OPERATION AND MAINTENANCE COST				
					LABOR $	POWER $	CHEMICALS $	MATERIALS $	TOTAL $
Level 1 Treatment									
Existing River bypass structure (inflatable dam)	1	LS		$100,000	$1,000				$1,000
Gravity to detention basin 4 (15' x 10')	1500	LF	1,500	$2,250,000	$22,500				$22,500
Annual Maintenance Cost			1.00%						
[illegible]									
Discharge piping	1000	LF	300	$300,000					
[illegible]									
Detention Basin and Pumping Station	200	MG	360,000	$72,165,475	*********	$2,686	$16,115	$180,414	$920,870
Pump Operation	200	MGD			$258,522	$11,924		$64,630	$335,076
[illegible]									
Paving	10,000	SF	$1.50	$15,000					
Maintenance and storage building	1,000	SF	$100	$100,000	$20,000	$5,000	$2,000		$27,000
Land / easements	40	AC	$914,760	$36,590,400					
Outside piping			5%	$3,608,274					
Subtotal				$115,129,149					$1,306,446
Level 1 [illegible]									
Construction Contingency			30%	$34,538,745					
Subtotal				$149,667,893					
Engineering/Legal/Administrative			20%	$29,933,579					
Level 1 Total				$179,601,472					$1,306,446

R0006170

PROTOTYPE 200 MGD TREATMENT PLANT

ITEM	QUANTITY	UNIT	UNIT PRICE $	TOTAL COST $	ANNUAL OPERATION AND MAINTENANCE COST				
					LABOR $	POWER $	CHEMICALS $	MATERIALS $	TOTAL $
Level 2 - Filtration									
Filter	200	MG	33,000	$42,714,092	$427,141	$30,069		$213,570	$670,780
Level 2 - Disinfection and Dechlorination									
Disinfection and dechlorination	200	MG	3,500	$1,266,830			$69,213		$69,213
Level 2 - [illegible]									
Paving	10,000	SF	$1.50	$15,000					
Building	2,500	SF	$100	$250,000					
Outside piping			5%	$2,199,046					
Subtotal				$46,444,968					
Level 2 - [illegible]									
Construction Contingency			30%	$13,933,490					
Subtotal				$60,378,458					
Engineering / legal / administrative			20%	$12,075,692					
Subtotal				$72,454,150					
Land / easements	40	AC	$914,760	$36,590,400					
Level 2 Total				$109,044,550					$739,993

R0006171

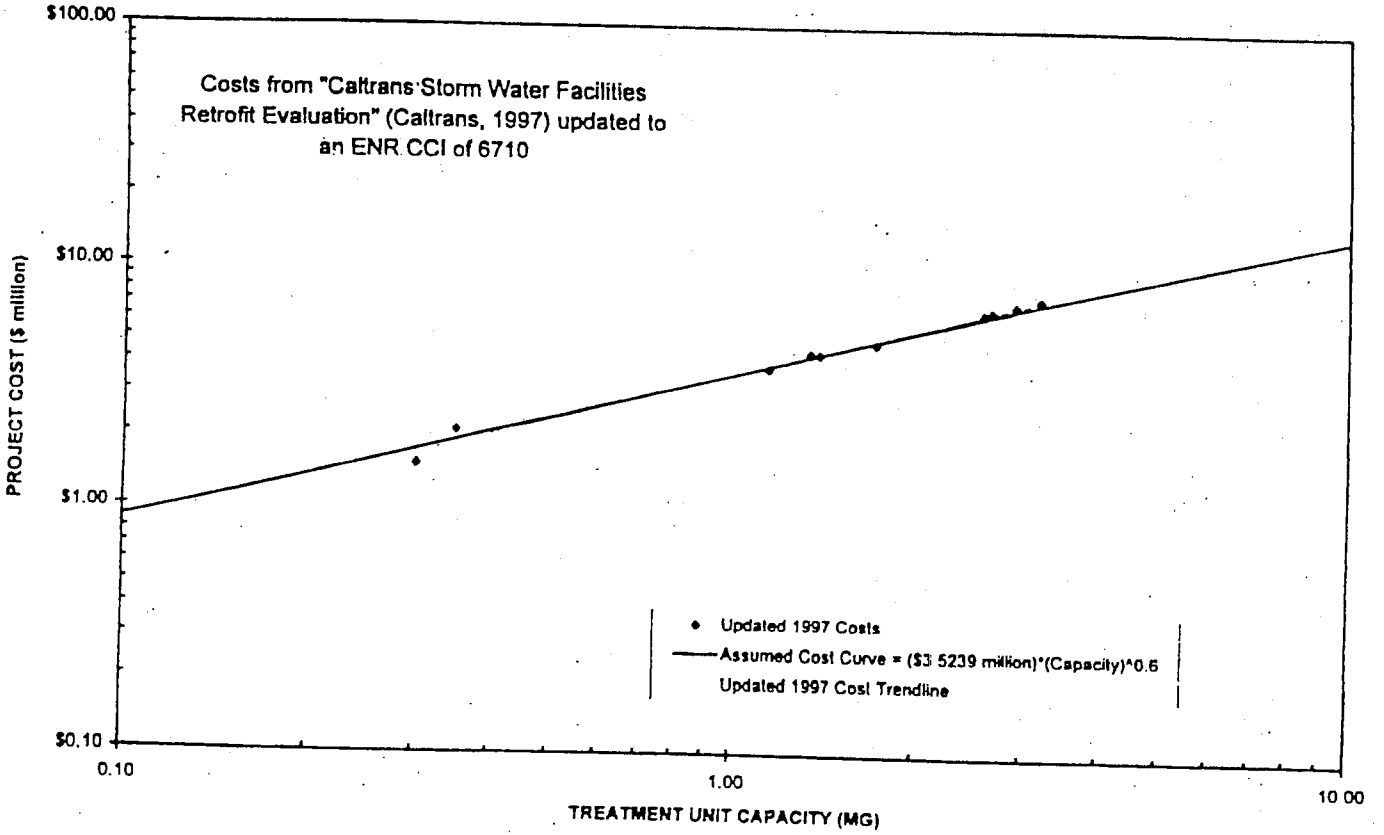
PROTOTYPE 200 MGD TREATMENT PLANT

ITEM	QUANTITY	UNIT	UNIT PRICE $	TOTAL COST $	ANNUAL OPERATION AND MAINTENANCE COST				
					LABOR $	POWER $	CHEMICALS $	MATERIALS $	TOTAL $
Level 3 -- Advanced Treatment									
Reverse osmosis (power costs assumes 15 storm a	150	MG	$1,500,000	$225,000,000	$1,125,000	$1,190,730	$8,730	$562,500	$2,886,960
Level 3 -- site work									
Paving	10,000	SF	$1.50	$15,000					
Building	85,000	SF	$100	$8,500,000					
Outside piping			5%	$11,675,750					
Subtotal				$245,190,750					
Level 3 -- Indirect Costs									
Construction Contingency			30%	$73,557,225					
Subtotal				$318,747,975					
Engineering / legal / administrative			20%	$63,749,595					
Subtotal				$382,497,570					
Land / easements				none					
Level 3 --Total				$382,497,570					$2,886,960

R0006172

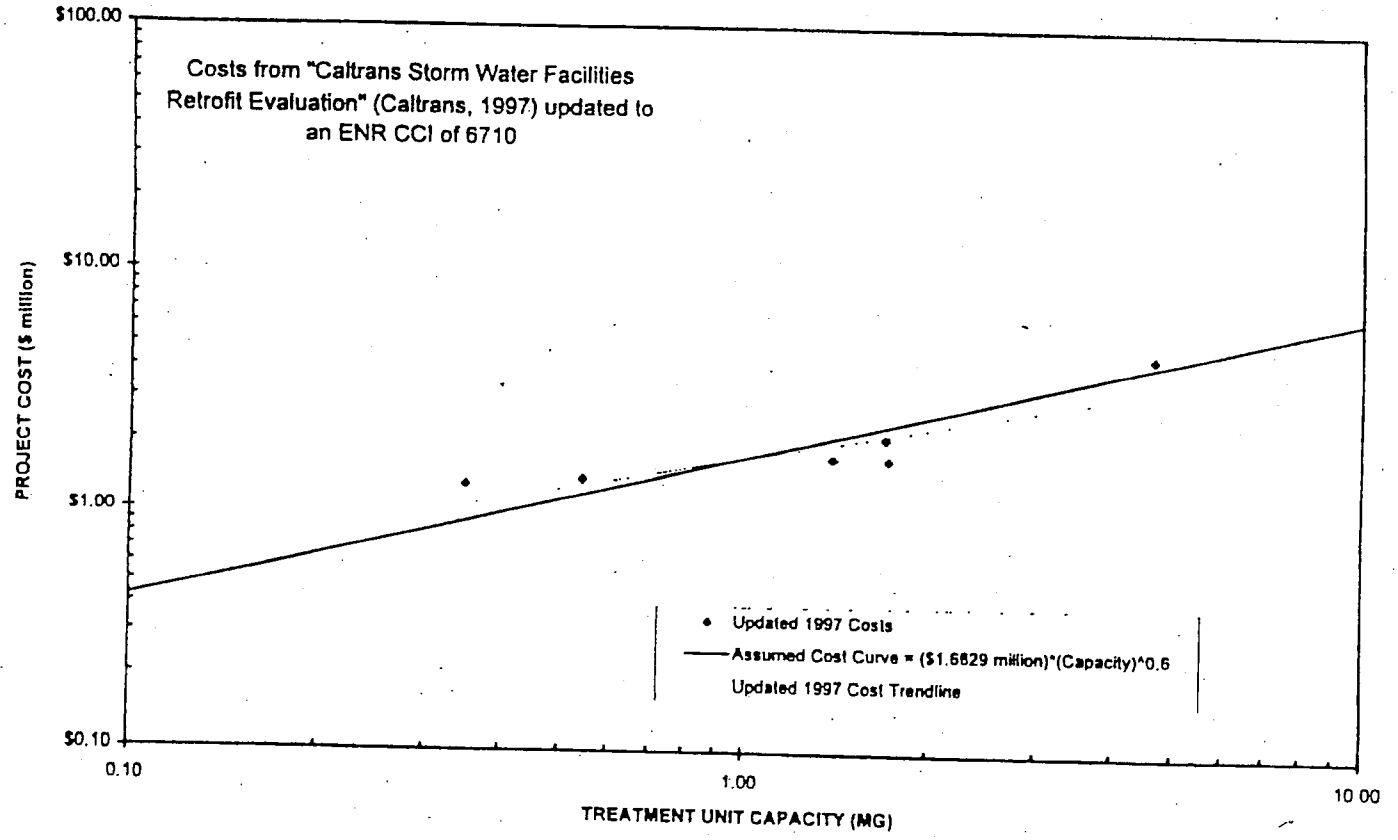
ATTACHMENT 3

STANDARDIZED COST ESTIMATION CURVES FOR TREATMENT PLANTS

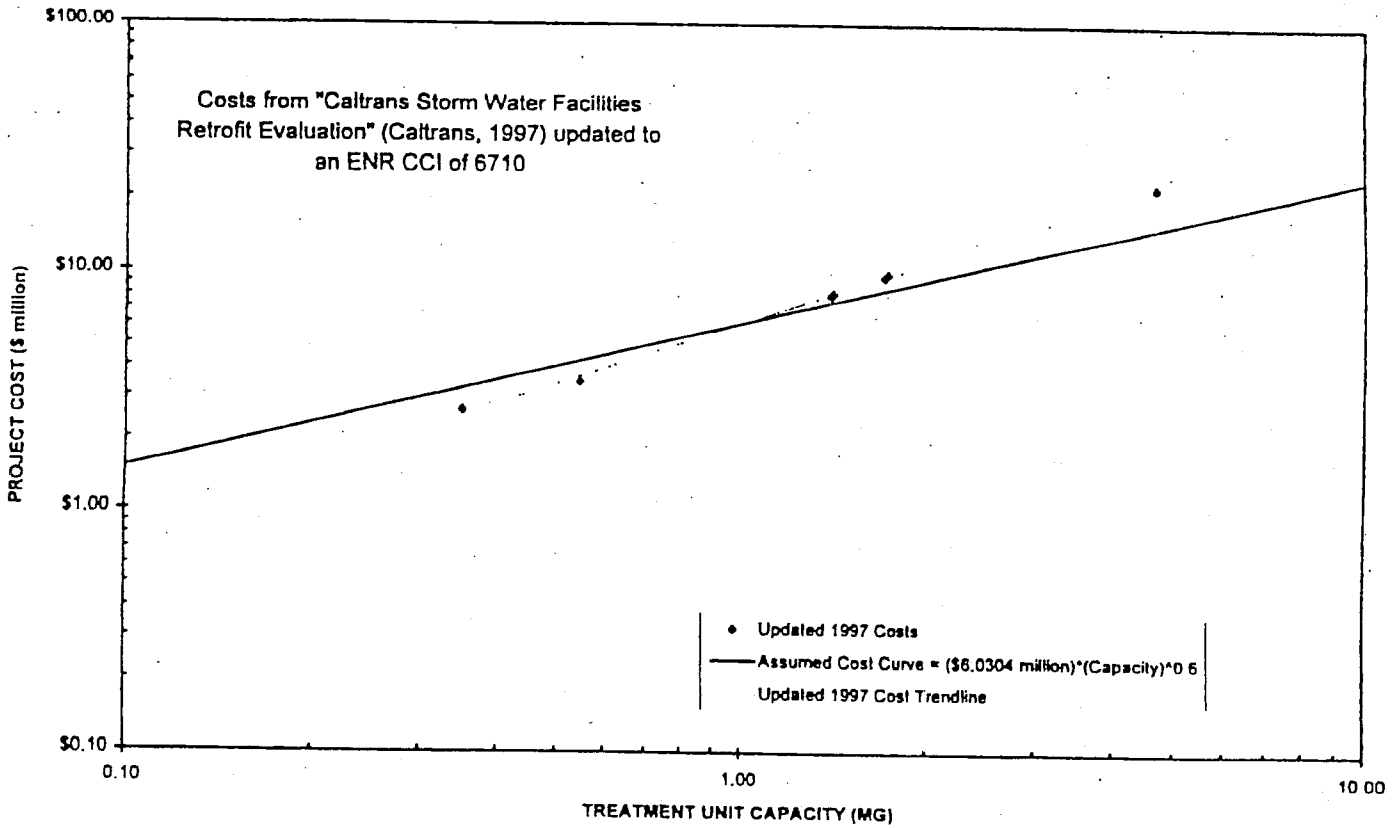


R0006174

Level 1 Treatment Project Costs



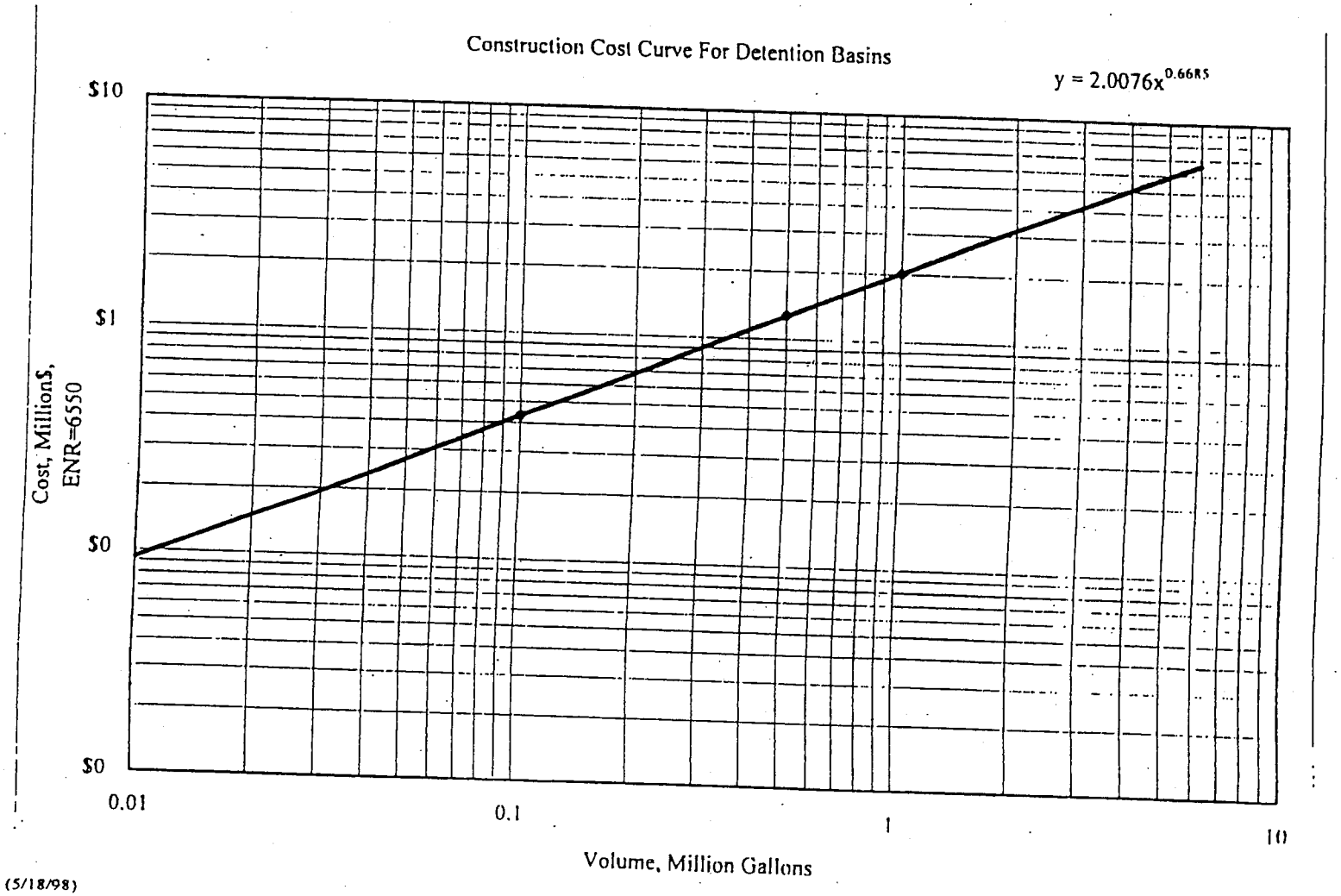
Level 2 Treatment Incremental Project Costs



Level 3 Treatment Incremental Project Costs

ATTACHMENT 4

STANDARDIZED COST ESTIMATION CURVES FOR TREATMENT PLANT SIZES TO 10 MILLION GALLONS



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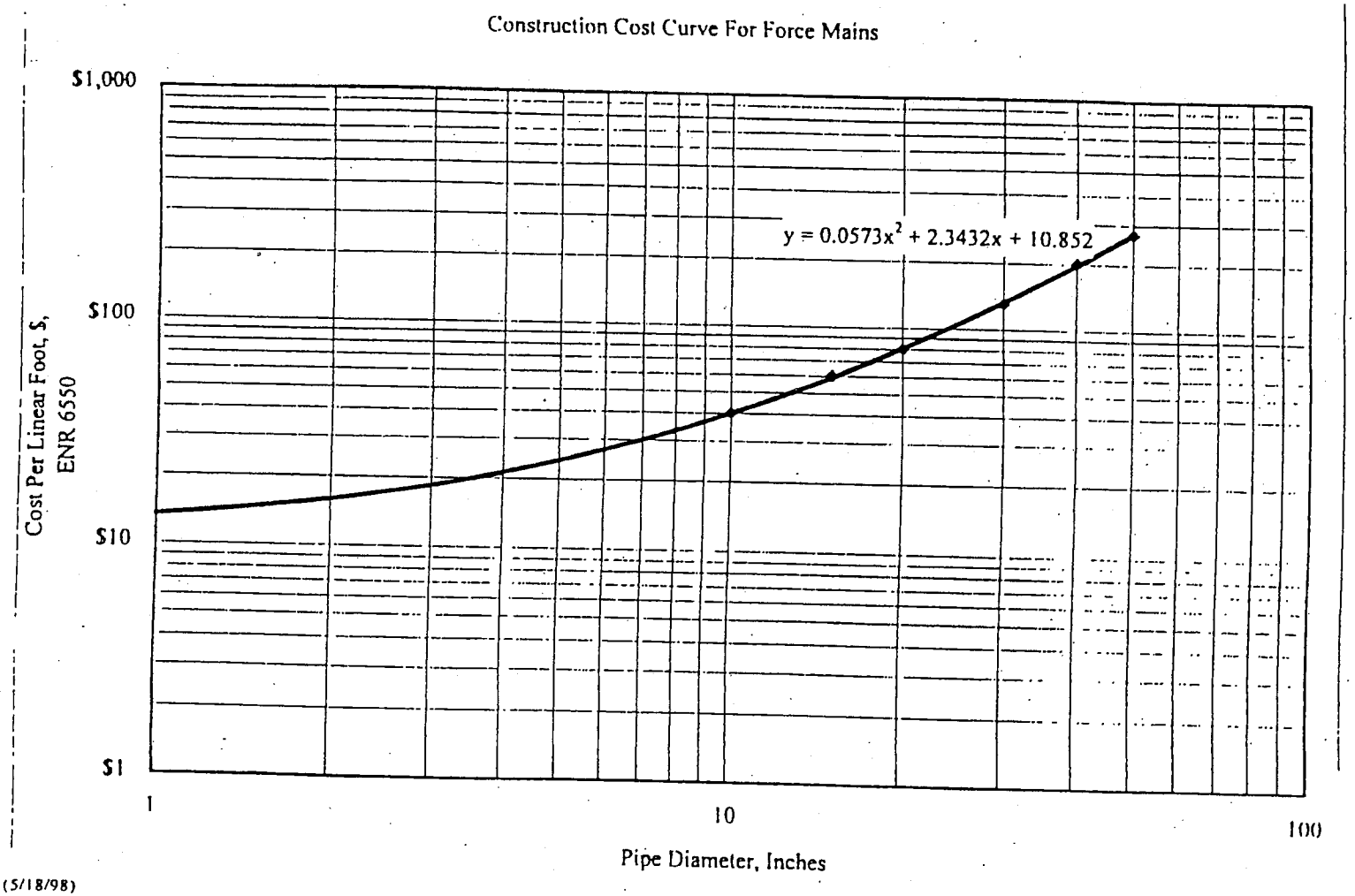

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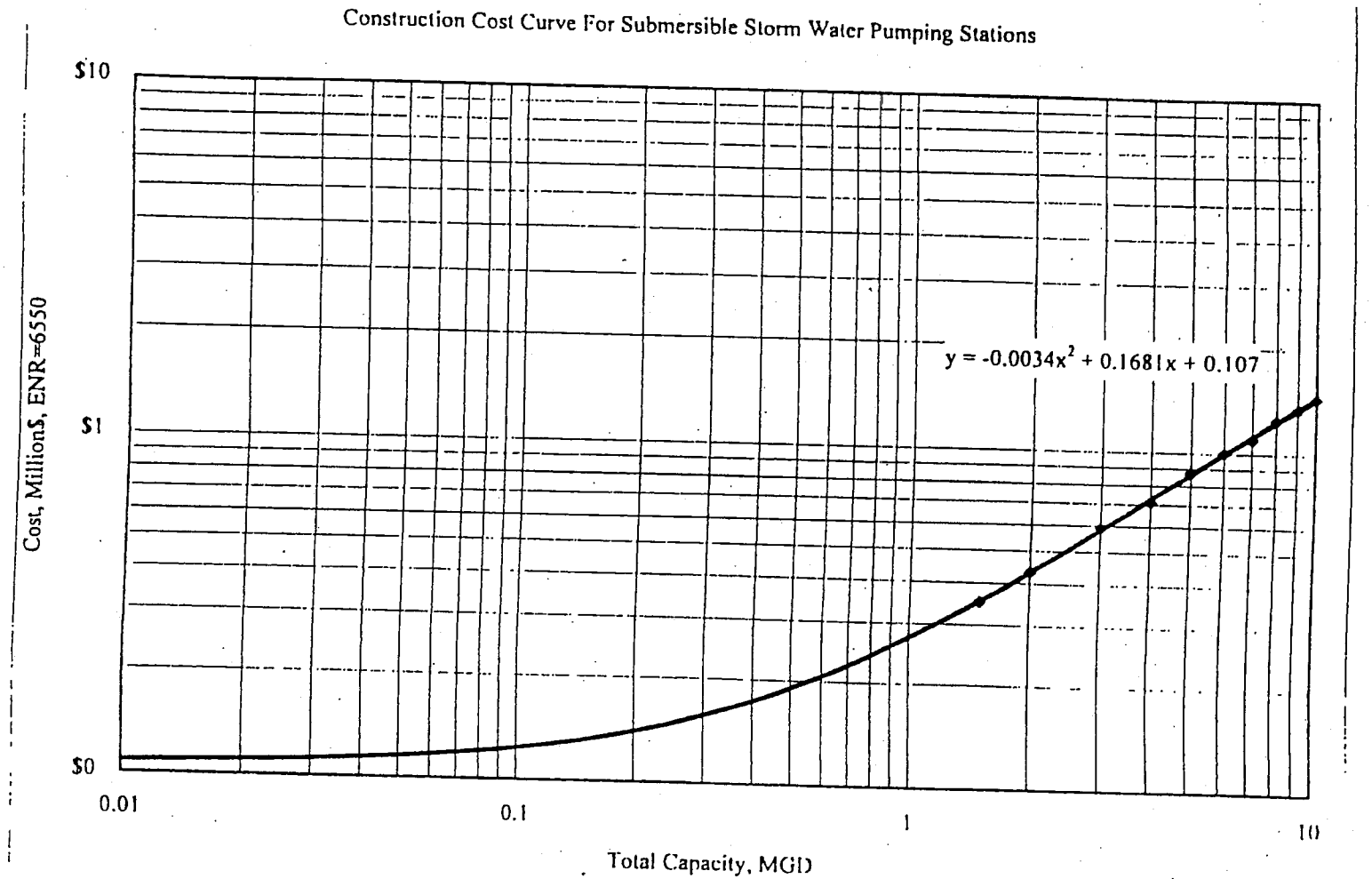

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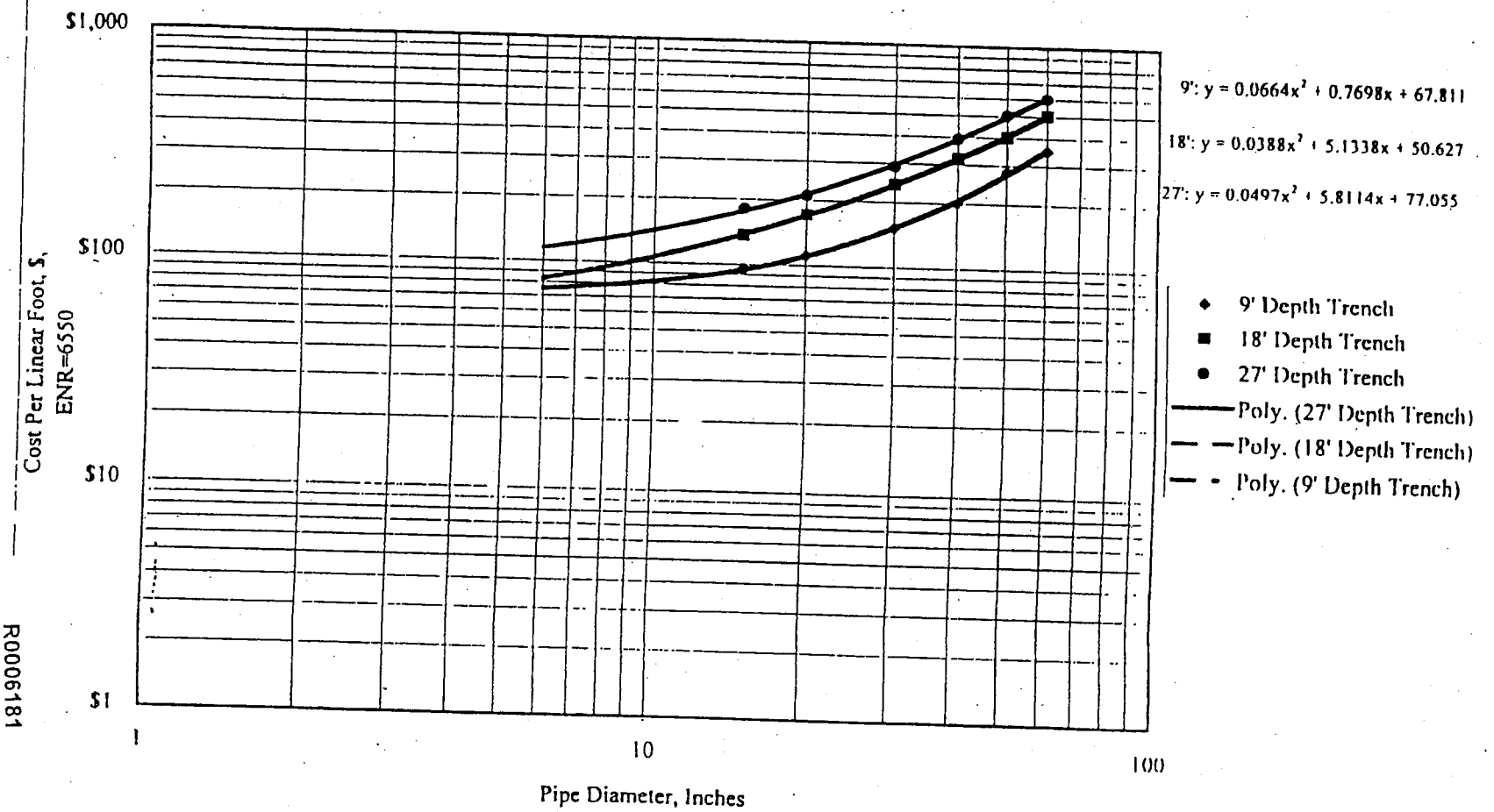
Construction Cost Curve For Gravity Sewers



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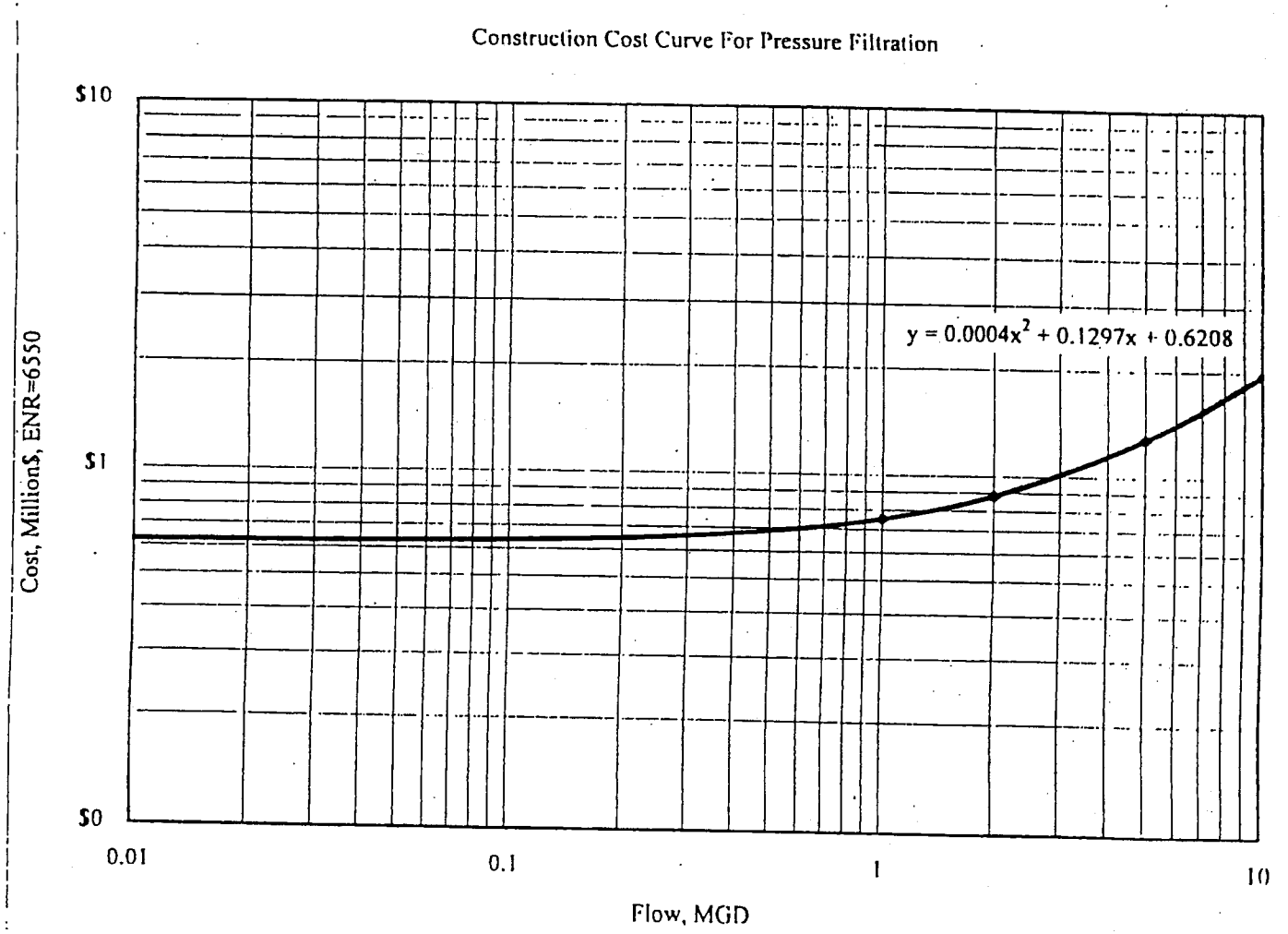

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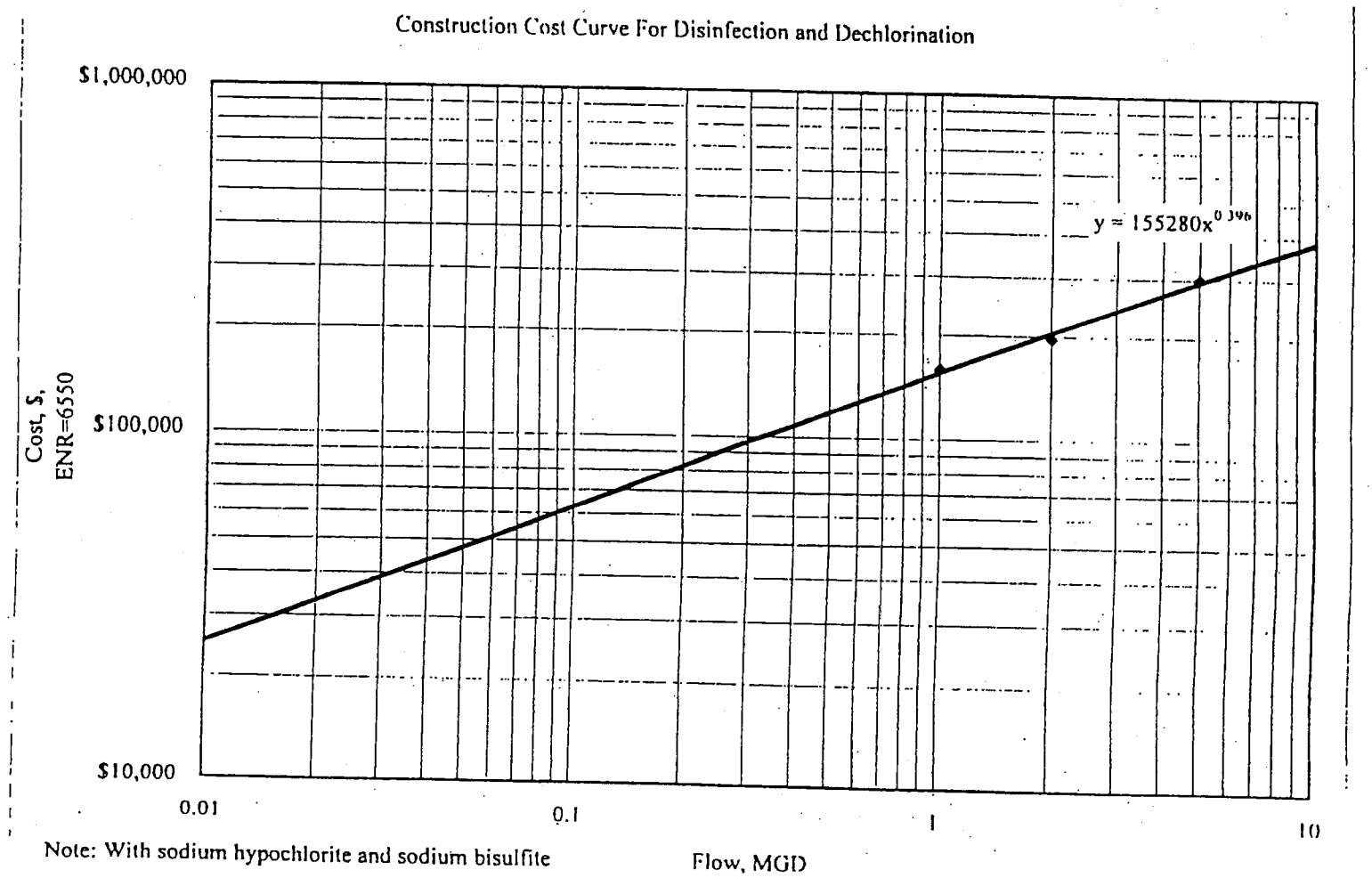

Note: With sodium hypochlorite and sodium bisulfite

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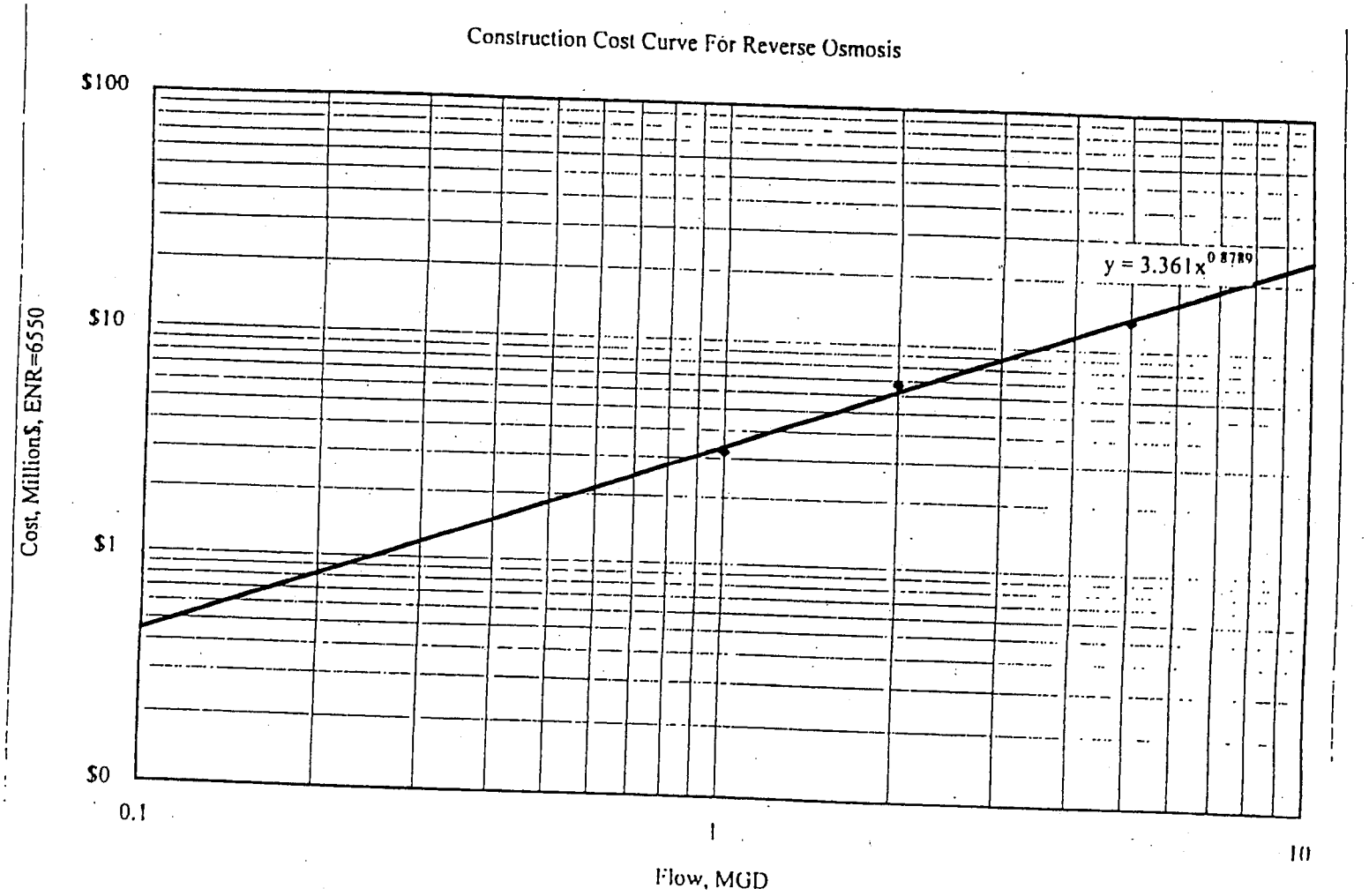

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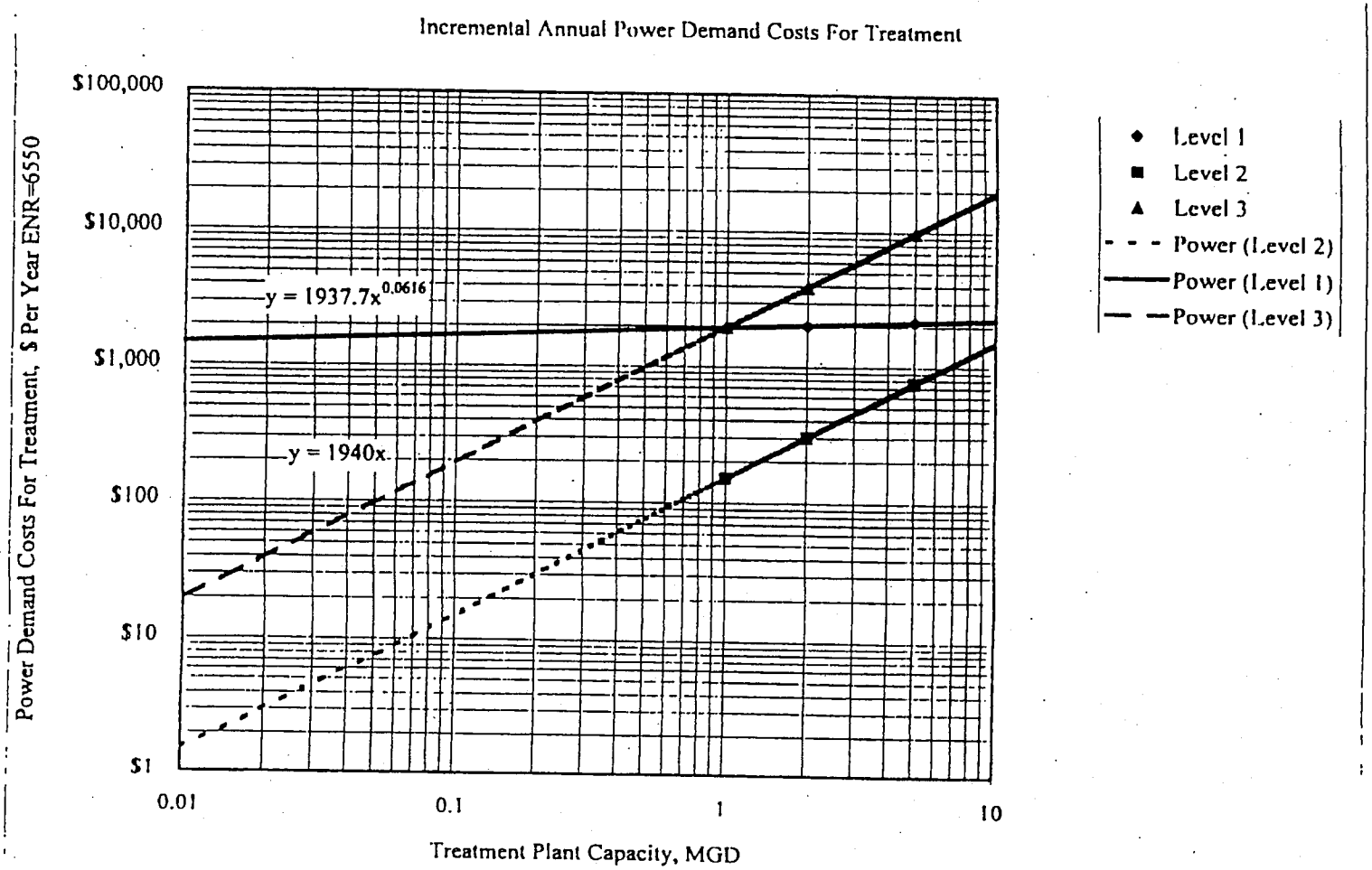

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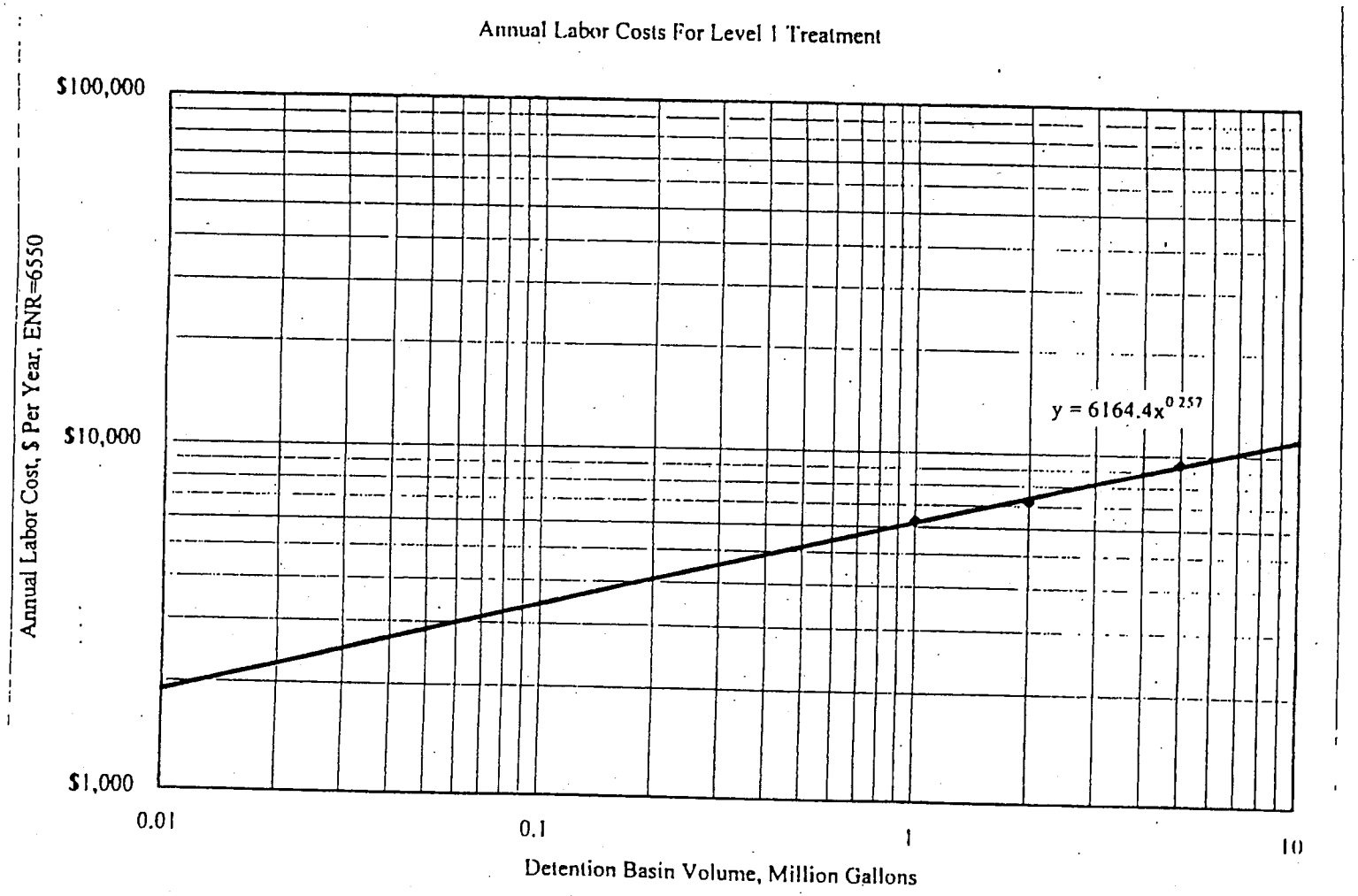

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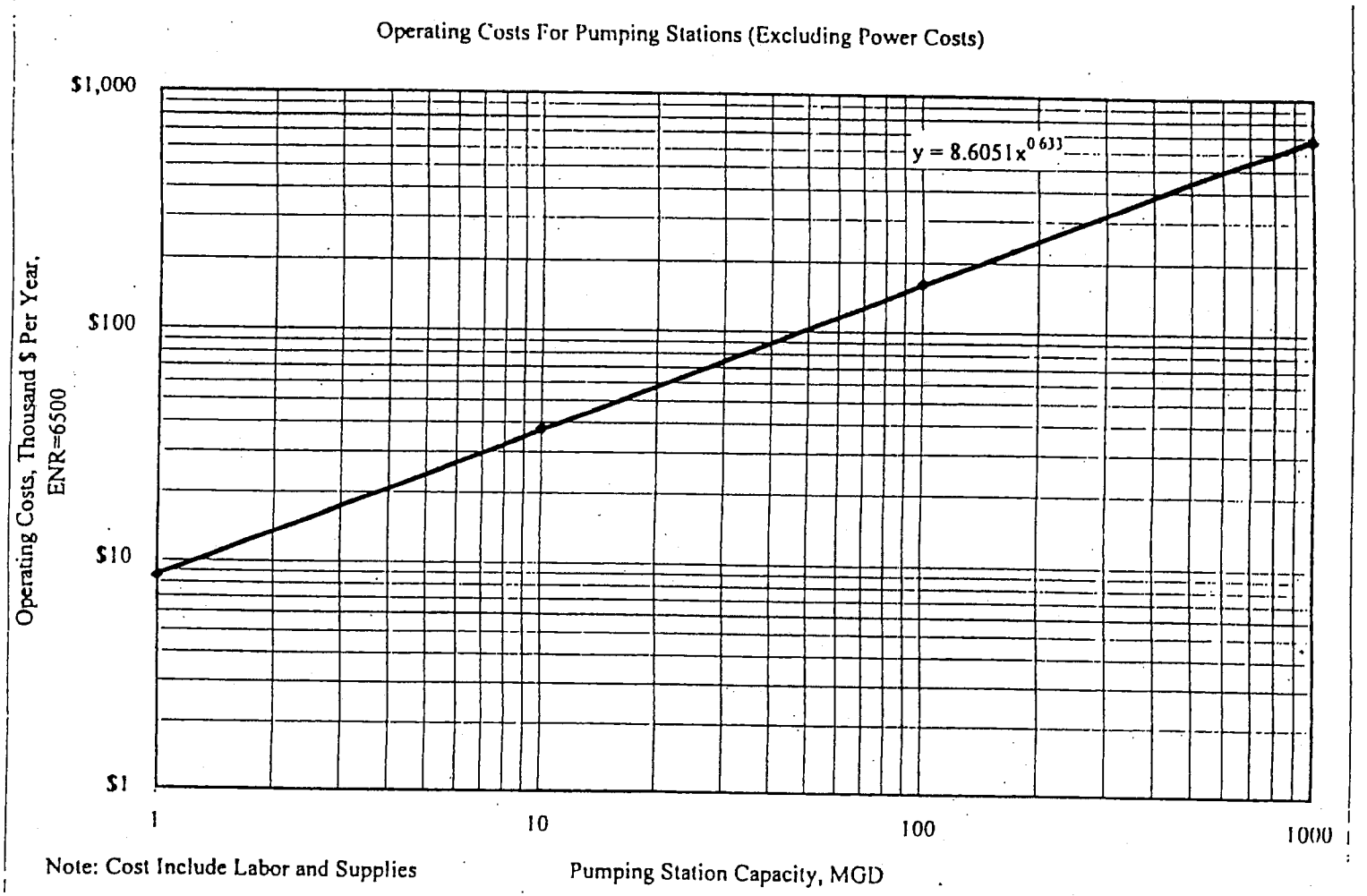

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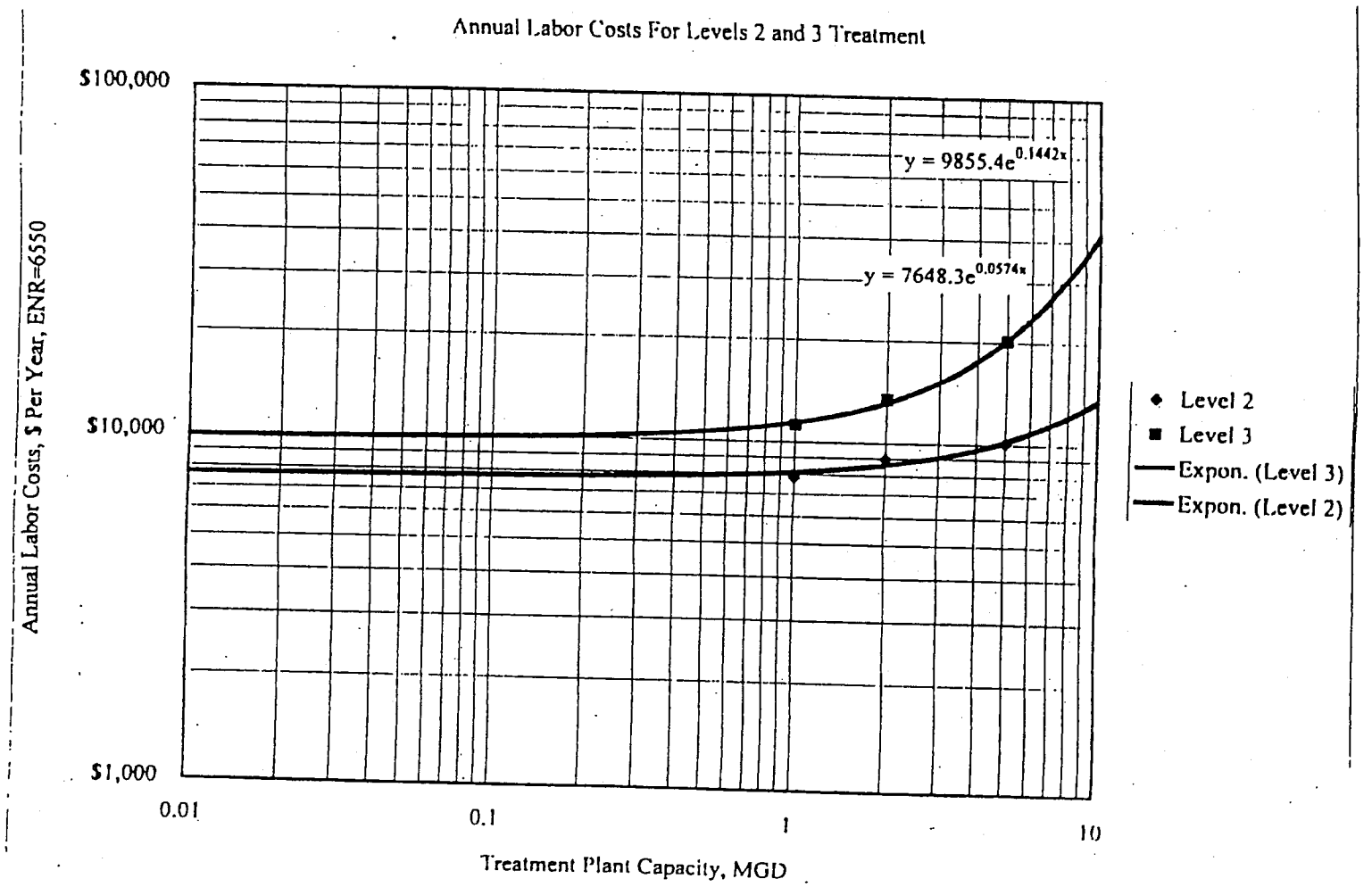

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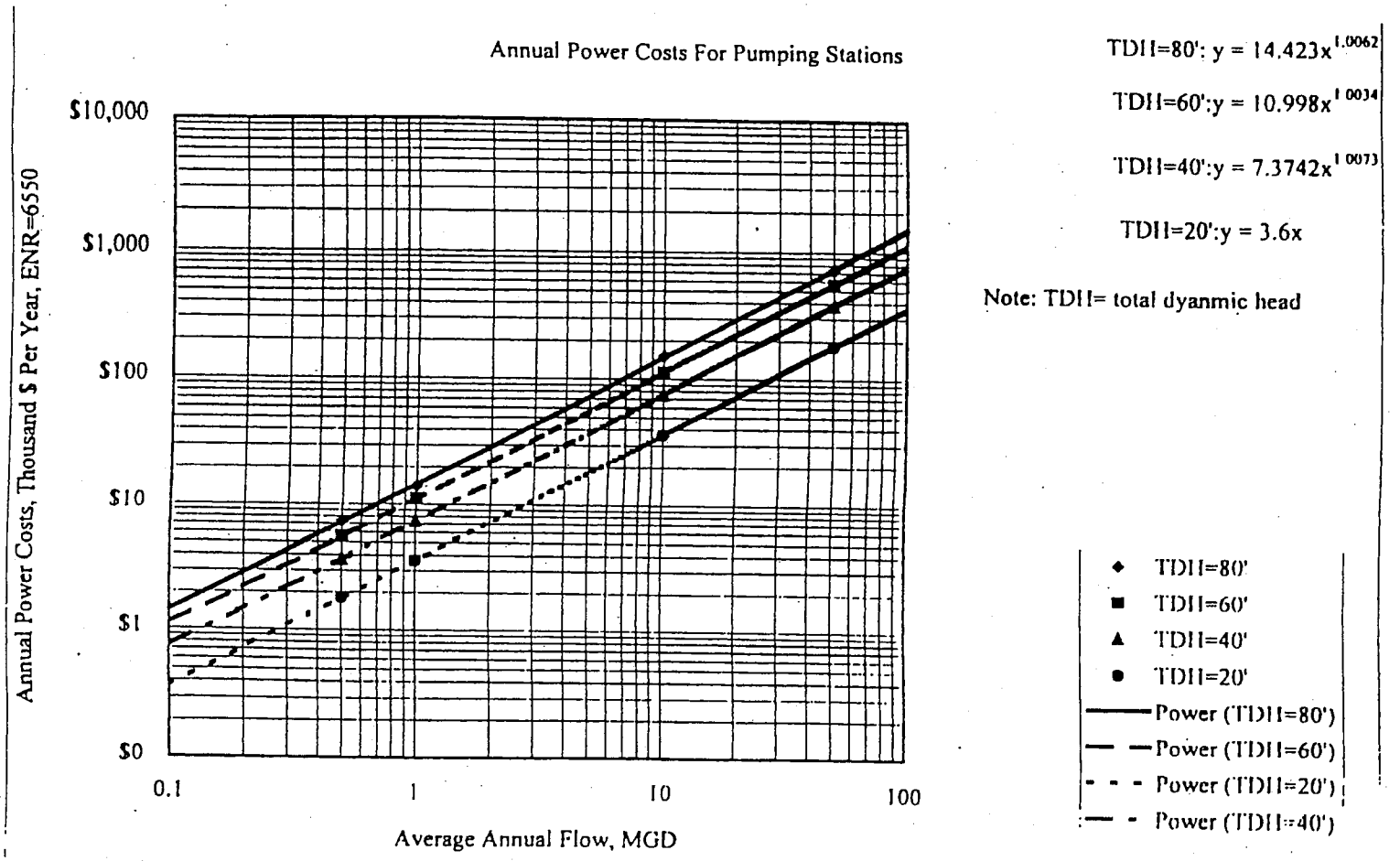

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(Pump-pwr Chart 2)